HERSCHEL *SPACE OBSERVATORY*

Announcement of Opportunity for Key Programmes

Herschel-Spot (HSpot) Users' Guide: Herschel Observation Planning Tool

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Preface: The Herschel Observation Planning Software (HSpot)

1. Purpose of this Document

HSpot is the means by which users and potential users of the Herschel Space Observatory can provide new and updated observing requests for the observatory. It also incorporates a proposal submission tool. It is based on Spot (originally SPOT - Spitzer Observing Planning Tool) developed for NASA's Spitzer Space Telescope, but includes many upgrades and is designed for the formulation of observing requests for the three science instruments on board Herschel -- HIFI, SPIRE and PACS. Detailed information on the instruments, and some further, instrument specific, HSpot illustrations are provided in the three instrument manuals also available from the Herschel Space Observatory website at:

http://herschel.esac.esa.int/

For help that is not provided in either the instrument or HSpot manuals, the Herschel Helpdesk can be contacted at:

http://herschel.esac.esa.int/esupport/

Helpdesk will only have a web interface. Users will not be able to send questions by email. To submit a question a user must register with Helpdesk (http://herschel.esac.esa.int/registration.shtml) as, only by registering will the user be able to supply all the contact details that we need to respond to queries.

The prime purpose of this manual is therefore to describe the setup and use of the user interface to HSpot.

2. What this Document Does Not Provide

This manual provides information on the user interface for HSpot only, and does not attempt to describe more fully the transformation to uplinked spacecraft/instrument commands which are written in the Common Uplink System (CUS) language. Only a general description of this process, for each of the instruments, is given in chapters 9-12.

Information on the data products, pipeline processing and data processing (included in the Herschel Common Science System, HCSS) is also not covered in this manual. Processing and products information is available from the Herschel web site at

http://herschel.esac.esa.int/

Brief descriptions of data products and pipelines for each of the instruments are also contained in the instrument manuals available at the same site.

3. How to use this manual

Despite the size of this manual, users will find that HSpot is a user friendly and in no way intimidating tool. The basic functions of HSpot are simple and largely self-explanatory. Many users will find that, once HSpot is installed, they can start to use it with little or no difficulty without recourse to documentation. Such users will find that this manual is a useful aid to consult where they have doubts about a particular function of HSpot and how it works. For those users who feel less confident, there is no need to read this manual from cover to cover: concentrate on the chapters relevant to your own proposal with the aid of the chapter guide. Use this manual more as a reference source to check detailed points about HSpot use, rather than as a must-read document.

Once you are familiar with the basic functions of HSpot this manual will help you to discover the

many other functionalities of the program, some of which you may well even find valuable for activities beyond preparation of proposals for Herschel.

4. Differences between HSpot versions on different platforms

The screenshots presented here are mainly from the Windows version of HSpot. Users will find that the appearance of the different screens will be subtly different with, for example, pop-ups appearing with slightly different style or colours on the different operating systems that run HSpot. Occasionally, in some user dialogues, the MAC version of HSpot may have the same buttons, but in a different order to the Windows and Linux versions; we have also noticed that the handling of tabbing in pop-up windows is slightly different. Although the flavour of HSpot is slightly different on each operating system, the functionality is the same.

Warning
There are a few platform-dependent bugs due to problems with Java or window managers. These bugs are reported to the relevant company, but we cannot always guarantee that they will be fixed as they are out of our control. The level of user-support offered by external software suppliers is highly variable.

5. A disclaimer

HSpot is an evolving system. Every effort has been made to ensure that the screenshots and description in this document are completely up to date, however there may be some cases where new functionality has been added that has not been completely documented, or could be better documented. If you find an example of incomplete or out-of-date documentation of a function, please contact Helpdesk http://herschel.esac.esa.int/esupport/, with a description of the problem, or a suggestion about how the documentation can be improved.

6. Acknowledgements

This version of the HSpot Users' Guide has been prepared by Mark Kidger at the Herschel Science Centre. The instrument chapters have been prepared by the Instrument Calibration Scientists for PACS (Roland Vavrek and Bruno Altieri), SPIRE (Sarak Leeks and Ivan Valtchanov) and HIFI (Tony Marston and David Teyssier), at the Herschel Science Centre.

HSpot has been a development that has been largely based on the Spot tool created by the Spitzer Science Center for observation planning and proposals for NASA's Spitzer Space Telescope. We are extremely grateful to the original SPOT developers.

The HSpot Users' Guide has been based on the excellent Spot User's Guide produced by the Spitzer Science Center Observer Support Team (especially Nancy Silbermann) and adapted initially for HSpot by Tony Marston at the Herschel Science Centre.

The work of adapting Spot for Herschel's needs has been largely the development work of one person, Andrew Bonfield, at ESTEC. Andrew's contribution to HSpot has been vital.

Since June 2007 the work of maintaining HSpot has been taken over by Kevin Phipps.

Many people have been involved in the development of the Herschel Astronomical Observing Templates and associated time estimators at various institutions. This has been a joint effort between ESA and the three instrument building teams.

Chapter 1. Chapter Guide

A brief guide to the contents of this manual. The following gives a simple, one line description of the contents of each chapter to orientate users.

1.1. Chapter 2: Introduction to HSpot

A brief introduction to HSpot with some general advice for users. Section 2.1

1.2. Chapter 3: Hardware and software required to use HSpot

Details of platforms (Section 3.3) and operating systems (Section 3.4)supported and minimum system requirements to run HSpot Section 3.3. Summary of supported systems ((Section 3.5)).

1.3. Chapter 4: Installing and starting HSpot

How to install and start-up HSpot on Windows (Section 4.1), Solaris/Linux (Section 4.2)and MAC (Section 4.3).

1.4. Chapter 5: General information

Some essential information on using HSpot and the information that it provides. Client-server interactions (Section 5.1), help and tool tips (Section 5.2), time estimates (Section 5.3), maximum times for observations (Section 5.4), the dangers of putting restrictions on your requests (Section 5.6) and HSpot troubleshooting (Section 5.7).

1.5. Chapter 6: HSpot menus

An extensive overview of the different options provided by the general drop-down menus in HSpot. Input and output options (Section 6.1), saving work in progress (Section 6.1.2), targets (Section 6.3) and images (Section 6.6) menus, etc.

1.6. Chapter 7: HSpot main screen

Features of the main screen of HSpot: the icons (Section 7.1) and observations table (Section 7.2).

1.7. Chapter 8: Entering an Astronomical Observation Request (AOR)

Basic information on menus for defining an observation with Herschel. Target information (Section 8.2), templates (Section 8.3) and observation estimates (Section 8.6).

1.8. Chapter 9: The target entry dialogue

How to enter an object for observation in HSpot and use HSpot to obtain essential information about that target and its observability with Herschel. Target types (Section 9.2), coordinate systems (Section 9.3) and name resolution (Section 9.4).

1.9. Chapter 10: Astronomical Observation

Templates

How to define an observation of a selected target with any of the three Herschel instruments. Common aspects to the three instruments. (Chapter 10)

1.10. Chapter 11: Astronomical Observation Templates for PACS

How to define an observation of a selected target with PACS. Line spectroscopy (Section 11.1), range spectroscopy (Section 11.2) and photometry (Section 11.3).

1.11. Chapter 12: Astronomical Observation Templates for SPIRE

How to define an observation of a selected target with SPIRE. Photometry (Section 12.2) and spectroscopy (Section 12.3).

1.12. Chapter 13: Astronomical Observation Templates for HIFI

How to define an observation of a selected target with HIFI. Point source observations (Section 13.2), mapping (Section 13.3) and spectral scans (Section 13.4).

1.13. Chapter 14: PACS-SPIRE parallel mode

How to define an observation of a selected target with the PACS-SPIRE Parallel Mode (Section 14.2).

1.14. Chapter 15: Tools for replicating AORs

How to apply a standard observation request to a list of targets (Section 15.1), or to apply a list of observations to each a list of targets (Section 15.2).

1.15. Chapter 16: Timing constraints editing

Defining timing constraints on observations: a fixed time for an observation (Section 16.2), a fixed sequence for a series of observations, follow-up observations (e.g. monitoring at regular intervals), concatanation, etc. (Section 16.1)

1.16. Chapter 17: Proposal submission tool

Preparing and submitting your Herschel observing proposal with HSpot. Overview of how to fill in the proposal (Section 17.12.3), registration with Herschel Science Centre (Section 17.3), submission and correction of a submitted proposal (Section 17.12)

1.17. Chapter 18: Spectral lines for planning purposes

Defining spectral line(s) to observe with Herschel (Chapter 18).

1.18. Chapter 19: Visualising your target and observations

How to display your target overlaying coordinate grids (Section 19.2.7), different catalogues of data (Section 6.8.1.1). Making rgb plots of your target field (Section 19.2.5).

1.19. Chapter 20: Moving target and more advanced visualisation

How to display a moving target - comet or asteroid (Chapter 20) - using advanced display options (Section 20.6). Visualisation of the planned observations of a moving or fixed target on an image(Section 19.2.8.4). Deciding whether or not to apply a chopper constraint to observations (Section 20.6.10).

1.20. Chapter 21: Sample HSpot target file

What your target file may look like. Use this file as a template if you need to generate a personal target file (Chapter 21).

Chapter 2. Introduction to HSpot

2.1. Overview

Welcome to HSpot, the tool for planning Herschel observations and submitting proposals. The HSpot software is available to download from the Key Project Announcement of Opportunity page at the Herschel Science Centre (HSC) web site (http://herschel.esac.esa.int/). The process of planning a Herschel observation with HSpot consists of entering targets which are individually linked to a desired Herschel observing mode via an Astronomical Observation Template (AOT). The instrument parameters that completely specify the observation are entered via the AOT. The complete target and instrument information results in an Astronomical Observation Request (AOR), which is the primary unit of Herschel observing. HSpot allows you to prepare all your observations and to determine how much time will be required to execute the observation by obtaining an estimate from CUS server software at the HSC. This is the amount of time you must request for this AOR in your observing proposal that HSpot allows you to prepare and submit.

> **Warning**
> The on-line Help in HSpot only presents a very much reduced version of this manual. To see the full manual, either print out the PDF file on the webpage http://herschel.esac.esa.int/ or, if you are opening Help from HSpot, open "Overview" and press the "Home" button at the bottom of the page.

HSpot and this manual may look intimidating to the new user, but HSpot is actually a remarkably simple and user-friendly piece of software. Most users will find that they can start to use it with little or no instruction.

This User's Guide provides information about how the HSpot software works. The Release Notes that are packaged with the software provide additional information about computer platforms supported for this version, performance issues, and a list of known bugs, although bugs are generally fixed rapidly when reported. To make using HSpot and planning your Herschel observations easier, we recommend that you:

- Read the relevant sections of the Herschel Instrument and Observatory Manuals (available on the HSC website at http://herschel.esac.esa.int/) to decide how best to implement your observations.

- Read the Release Notes that are packaged with the software (or download them from the web page). Some, but not all, of that information is repeated here.

- Check the Announcement of Opportunity (AO) web page for additional information in helping you plan your observations. Check the known bugs/issues list on the web page as well. Note that if you have automatic updates enabled HSpot will download a new version as the known or newly discovered bugs are fixed.

  HSpot is a mixture of what is termed "core Spot", which is hardwired into HSpot and maintained by the Spitzer staff at IPAC and Herschel-specific functionality maintained by Herschel staff.

  A list of core Spot bugs can be found at the Spot public bug list page.

  A list of HSpot bugs can be found on the Herschel AO page Herschel web page.

- If possible, use one of the officially acceptance tested versions of HSpot. Although every effort is made to support a wide range of platforms and operating systems, HSpot is a highly complex piece of software and no guarantees can be offered that all the new functionality that has been added for Herschel's instruments will work with all the older versions of the operating systems offered.

- Save your AORs often. HSpot does not save your work to disk automatically. Given the variety of operating systems we support, we cannot guarantee that it will never crash on your particular

computer and operating system. Saving your work often will make these events much less painful should they happen.

• HSpot offers a wide range of visualisation options for your observations. Many problems and complications can be avoided by using these.

Please contact us at the Herschel Help Desk (http://herschel.esac.esa.int/esupport/) with any questions (for technical reasons we will only have a Web interface to Helpdesk).

Chapter 3. Hardware and Software Required to Use HSpot

HSpot is written in the JAVA language and therefore requires a lot of memory and a fast processor in your computer. If you run HSpot on a system with less memory or processor power than our minimum recommended configuration, the software may work, but it is likely to be slow, and you will probably see window redraw/refresh problems, or system hang-ups. While we suggest minimum hardware configurations, we recommend that users have more RAM (512 MB or above) and a fast processor if you plan on intensive use of the visualization features within HSpot. The minimum recommended hardware configurations are provided in the following section.

3.1. What screen resolution do I need to display HSpot?

Some problems have been found when displaying HSpot on old, low resolution screens. In particular, some text boxes may show truncated or distorted and some windows may go off the edge of the screen.

We recommend strongly that a screen resolution of at least 1026x768 be used. Higher resolutions are preferable.

3.2. What platforms has HSpot been intensively Acceptance Tested on?

Intensive Acceptance Testing has been carried out on the following systems, which act as our baseline:

- Microsoft Windows XP Professional (2002 version) with Service Pack 2 on a Dell Precision M65. 1.83GHz Intel processor. 1Gbt RAM at 1.83GHz.

- MAC OS X v10.4.8 Tiger on a MacBook Pro 1,1. Intel processor at 2.16GHz. 1GBt DDR2 SDRAM at 667MHz.

- Red Hat Enterprise Linux 4 with the GNOME windowing environment. Dell laptop. 1.86GHz Intel processor. 1GBt RAM at 798MHz with 2GBt Swap memory.

Other platforms and operating systems that have been tested are detailed below.

3.3. Hardware Configurations Supporting HSpot

3.3.1. Sun Workstations: Sun Ultra 5 with 256 MB RAM

If you are not using the visualization features in HSpot, then it may run acceptably on an Ultra 1 with 256 MB of RAM. HSpot will not run acceptably on Sparc 1, 2, 5, 10, or 20 workstations.

3.3.2. Windows PC (2000, NT): Pentium 3 processor with 256 MB RAM

Earlier versions of HSpot have had more limited testing on Windows2000. Users are recommended to use WindowsXP, if possible. HSpot is performance sensitive on a PC and that when using its capabilities to the full an older and slower machine may take a long time to perform some operations.

> **Note**
> Windows Vista is expected to be made available at about the time that the initial Herschel Announcement of Opportunity (AO) is made. The release version of HSpot that will be made available at AO will not have been tested on Vista. We do not anticipate problems with Vista use, but it is extremely unlikely that extensive testing on Vista will be possible until some time after AO.

3.3.3. Windows PC (XP): Pentium M processor at 1.73GHz with 504 MB and 1 Gbt RAM

HSpot has been extensively tested with Windows XP with 512 and 1 Gbt of RAM. All testing was carried out with Service Pack 2 installed. Note that for some image and overlay applications HSpot is memory intensive and that a minimum of 512Mbt of memory is strongly recommended, with 1Gbt preferable.

3.3.4. Linux PC: Pentium 2 processor, with 256 MB RAM

We have done limited testing on Linux systems running with a Pentium 2 processor at 266 MHz and 256 MB of RAM, as well as with a Pentium 3 processor and 256 MB of RAM.

3.3.5. Mac PC: G4 processor, with 256 MB RAM

We have tested HSpot on a G4 processor with 256 MB RAM, and it runs acceptably.

3.4. Operating System Configurations Supported

Please read the Release Notes (packaged with the software or available on the web page) for more details on operating system issues, particularly with respect to window managers. The majority of the testing for this version of HSpot has been done under Solaris 2.8 and WindowsXP. We do not anticipate major problems with other versions of Windows. Additional testing has been done under Linux and Mac OS 10.3.6 and higher. Except for Mac, the versions of HSpot in this release come with JAVA 1.5.

3.4.1. UNIX: Solaris 2.8

The software has been tested on Solaris 2.8. Links to required patches for Solaris to support JAVA better are listed on the Herschel web site where you download the HSpot software (http://herschel.esac.esa.int/). If you have problems with the way HSpot looks, it is highly likely that the problem is missing patches.

3.4.2. Windows: NT, ME, 2000, XP

The functionality of older versions of the software has been tested using Windows 2000. The most extensive testing has been completed using WindowsXP, but older versions of Windows should give acceptable results. With some versions of Windows, e.g., XP, you may need system administration privileges for software installation.

There are no plans at present to adapt HSpot to the upcoming release of Windows Vista, but this may change if there is sufficient demand from the community.

3.4.3. Linux: RedHat 7.X, 8.0, 9.0; Fedora Core

HSpot on Linux runs acceptably on RedHat 8.0, 9.0. We tested each distribution "straight out of the box". We have run the GNOME windowing environment. We know that HSpot does *NOT* run properly with the fvwm2 window manager (all JAVA Swing programs appear to hang) or KDE. HSpot does appear to run OK with the older fvwm window manager, but testing has so far been cursory. HSpot also appears to run well under Fedora Core, although we have not yet fully tested Fedora Core 4.

Note: This version of HSpot, will not run under RedHat 7.

Warning

Running KDE on Linux - Not recommended for HIFI users

A serious bug has been found when working with HIFI in HSpot with Linux SUSE 9.1 and the KDE window manager. This bug, which is in KDE, causes system crashes when windows are opened to define HIFI AORs.

Users are strongly recommended to use Gnome rather than KDE until the bug is fixed by KDE. At the time of the current version of the HSpot Manual this bug is still awaiting solution.

3.4.4. Mac: OS X

HSpot requires JAVA 1.5, so Mac OS 10.4 at a minimum is required. JAVA 1.5 is not packaged with HSpot for Macs, so check that you have the most recent JAVA 1.5 release already installed before running HSpot. HSpot appears to work with auto-updates of JAVA. However, we caution that the Mac version of HSpot is the most likely to have significant problems for users due to incompatibilities of the operating system with some aspects of JAVA.

You can download JAVA 1.5 for Mac here:

http://www.apple.com/support/downloads/

with associated documentation at

http://www.apple.com/java/ .

3.5. Summary of platforms and operating systems supported by HSpot

HSpot is supported on the following operating systems and platforms only:

Solaris 5.8 and 5.9 - Gnome and CDE window managers.

Windows NT, ME, 2000, XP

Linux RedHat 8.0, 9.0 - Gnome window manager

Linux Suse 9.0 - KDE window manager

MAC OS 10.4

The operating systems and platforms have been chosen to support the largest possible number of potential users. Resources do not permit the supporting and testing additional versions of HSpot.

We do not recommend trying to run HSpot using emulators, as full functionality cannot be guaranteed.

Note
There is a known Java bug that affects the display of Help texts. When Help is opened in HSpot some of the links will include unusual control characters and will look untidy. This bug has been reported to Sun and is pending a fix; it appears to be platform independent.

Chapter 4. Installing and Starting HSpot

With this, and future, releases we provide HSpot via a downloadable installer script. HSpot should be installed on the computer where you want to run it. The start-up script is not configured to allow it to run on an X-terminal. You can run them across a Sparc network if it is installed on a disk that is nfs mounted across the network. The first step is to download the software from the HSC web page onto your hard disk (http://herschel.esac.esa.int/). If you have earlier versions of HSpot, you should be able to upgrade gracefully by installing the software in the same directory as your previous installation.

4.1. Windows Installation

After downloading the software WindowsXP should run the installation manager directly if you have elected the "execute" option rather than saving the file to disk. If not, double-click on the HerschelSpot***.exe file to install HSpot. Click on the HSpot icon to start the program.

4.2. Linux or Solaris Installation

To install HSpot on Linux systems do the following:

1. Go to the software download page and select the Linux/Solaris version. Right click on it and save the link in your home directory.

2. Go to the directory where you saved the install file. You must have write permission in this directory and should have at least 200 MB of free disk space.

3. Open a terminal and type, in Linux:

    sh PHS_name_of_version_Linux_Installer.bin

    In Solaris, type:

    sh PHS_name_of_version_Solaris_Installer.bin

4. Return and the installer will guide you through the process, including installing in a default directory in the disk (/home/username/HerschelSpot).

    > **Warning**
    > If the installer asks you if you wish to create a link in the directory where you have installed HSpot, respond "no". Creating a link in the same directory will potentially cause an infinite regression loop and crash the installation process.

    If for any reason you wish to install in a different directory to the default then, when the script asks you for the directory name where you want to install HSpot, be sure to type the full directory path, e.g., /scr/user/my_hspot. Make sure the directories exist before you try to install it there. If you are in the directory /scr/user/ and just type "my_hspot", it will tell you that the directory name must start with a slash.

5. When the installation is complete, click on "Done" in the installer window to close the installer.

6. Type "./runHerschelSpot" in the command window from the installation to launch the program.

4.3. Mac Installation

Download the software package. Double-click on it to uncompress it. The directory name is "hspot". Within it are the Release Notes, User's Guide (as a PDF file), and executables. If desired, you can drag the executables to the applications folder. Click on the HSpot executable to start HSpot.

4.4. HSpot Automatic Update

The automatic update feature from the Options menu will allow the client side of HSpot to update itself if, when starting up, it detects that a newer version is available at the HSC; new versions are released at regular intervals as bugs are reported and fixed and additional functionality is added to HSpot. In general these new releases will be planned well in advance and will coincide with project milestones, but additional releases may be made if important bugs that would affect many users are found and fixed.

HSpot will access the updated files at the HSC via the Internet and will automatically install them on your computer. Auto-update is the default setting when you first install HSpot. If you turn this feature off, or decline an auto-update at any time, HSpot will remember that you have turned it off. We encourage users strongly to leave auto-update turned on and to accept auto-updates when they occur.

Chapter 5. General Information

5.1. Client-Server Software Interactions

The HSpot software that you download onto your computer acts as the 'client' and requests information over the network from the 'server' software located at the Herschel Science Centre (HSC). The main means of providing observing time estimates for HSpot is via the CUS (Common Uplink System) server.

Entry of targets and Astronomical Observation Template (AOT) parameters are self-contained within HSpot. An Internet connection to contact the servers is required to resolve names of targets, to calculate observing time estimates, to obtain visibility windows, to obtain background estimates, to download astronomical images and catalogues, for proposal submission, etc. - in other words for a large part of all HSpot functionality. HSpot works efficiently over a standard broadband connection and, of course, a LAN. If images are to be downloaded, or visibility windows calculated for a significant number of targets a standard dial-up connection will probably be unacceptably slow. When the servers are accessible by HSpot, the net-up symbol (see Figure 5.1) will appear at the bottom of the main HSpot window.

HSpot caches information (images and calculations) so, if the Internet connection goes down during an HSpot session any images previously downloaded or calculations previously made will still be accessible for display however, they will obviously not be updatable until the connection returns.

Figure 5.1. The net-up symbol that appears at bottom right of the HSpot window. The net-up symbol means HSpot can access the HSC servers. The net must be up to calculate observing time estimates, obtain visibility windows, obtain background estimates, or download images or catalogues.

If your computer is not connected to the Internet, or if our servers are temporarily down, the net-down symbol (Figure 5.2) will appear at the bottom of the main HSpot window.

Figure 5.2. The net-down symbol means HSpot cannot access the HSC servers. You may still enter target and AOT information when the net is down but you cannot calculate observing time estimates, obtain visibility windows, obtain background estimates, and may not be able to download images or catalogues.

Check the Release Notes if you are using a Windows PC and never see the net-up symbol. This has been noted in two instances, and the fix is described in the Release Notes. If you see the net-down symbol and believe that HSpot should be connected to the servers, please send email to the Helpdesk at http://herschel.esac.esa.int/esupport/. We expect to provide 24-hour support for the HSC servers, but not for the Helpdesk.

5.2. On-line Help and Tool Tips

In addition to the Release Notes, this User's Guide, and the Herschel Instrument Manuals, on-line help for HSpot is available from the help menu on the main HSpot screen. There are also help buttons throughout the program that connect directly to applicable help files. On-line help is also available in the form of 'tool tips', one-sentence messages that appear whenever the cursor is placed over a field or button for longer than 3 seconds. Tool tips are used to define acronyms, expand abbrevi-

ations, and provide data entry instructions. For example, placing the cursor over the new target ("bulls-eye") button in the icon bar displays the tool tip that says, "Create a new target of any type" (Figure 5.3).
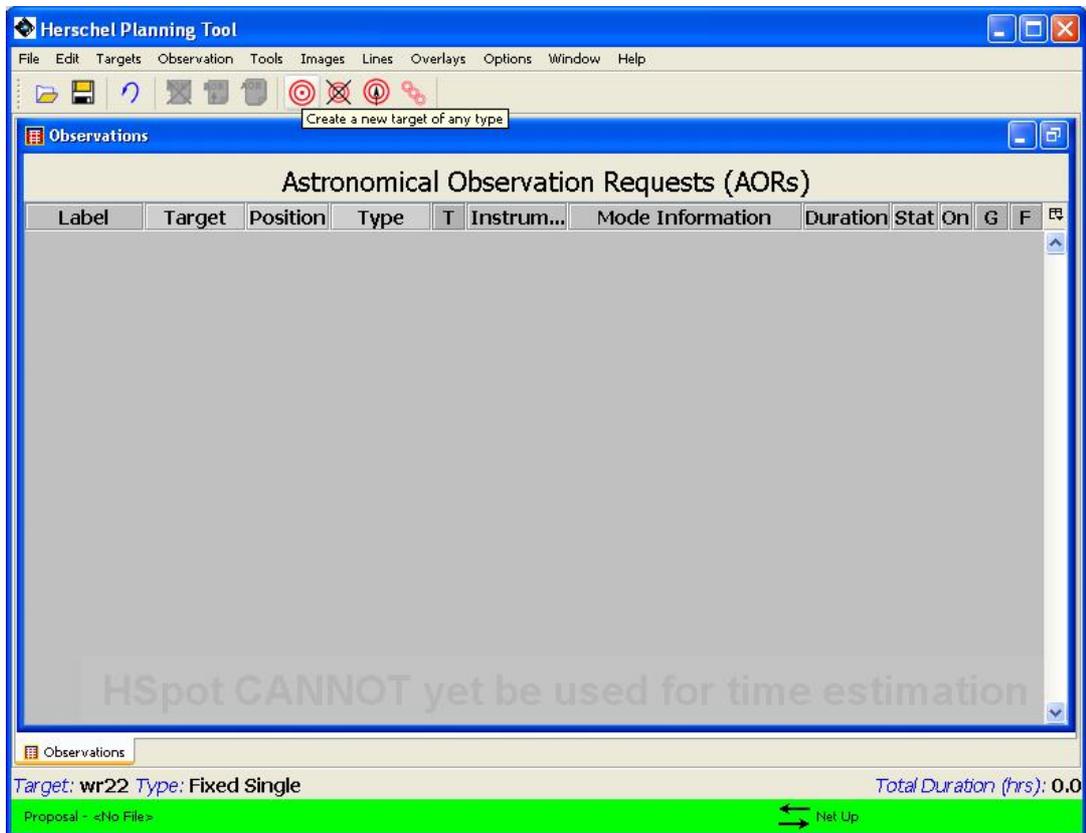
Figure 5.3. A 'tool tip' is displayed by placing the cursor over the "bulls-eye" icon. This icon brings up the dialog for creating a new target.

5.3. Time Estimates

In calculating the time estimates, we have used all the information available to date about the instruments and flight software performance. We expect that, barring unforeseen circumstances, these estimates are good to around 10% of the total 'AOR duration', or 'wall-clock time'. This information will be updated as knowledge of the characterisation of the instruments and telescope improves. Obviously, this means that the time estimates may change during proposal preparation if new information becomes available. Out of date time estimates are shown in red in the observations table and should be recalculated before proposal submission.

HSpot reports the following when you request an observing time estimate:

1. *AOR Duration:* This is the 'wall-clock' time or total time required to execute the observation, including time on source, internal calibrations, slewing, settling, command execution, and the fixed slew overhead applied to each AOR. This is the time you must request in your proposal for this observation.

2. *Slew Time: The time spent on slews internal to the AOR.*

3. *Observatory Overhead:* A 180 second overhead applied to all AORs to account for the initial slew to source and other observatory overheads. For constrained observations the overhead applied is 600s to compensate for the increased difficulty in scheduling and thus hidden overhead implied by constrained observations.

4. *Integration Time(s):* Estimated on-source integration time(s) in seconds. HSpot returns observing time estimates from the CUS server for all of the AOTs.

Time estimates are liable to change after launch as the observatory and the instruments are properly characterised in flight. No guarantee can be made that some time estimates will not increase with better knowledge of instrument sensitivity and observatory performance (while other AORs will give better than expected s/n in the time calculated). The amounts of time given to each proposal by HOTAC will not change *a posteriori* based on in-flight performance. It is expected that after launch some modification of AORs may be needed to optimise them; this process will be carried out in co-operation with the Herschel Science Centre.

5.4. Maximum Duration of AORs

The duration limits for all AORs are currently 18 hours for any Herschel observation as observatory maintenance and the need for a daily uplink means that longer AORs are not practical. If the estimated duration (not including the slew overhead) of your AOR is longer than this time, the software will return a message telling you to make the observation shorter. In general, AORs longer than about 9 hours (half an operational day) may be more difficult to schedule.

If requesting an AOR with a duration close to the maximum permitted, you should be aware of the danger that when the in-flight performance of Herschel is known, AORs that are "just possible" based on the best time estimate pre-launch, may become impossible after launch if the overheads or integration times for a particular instrument or configuration have to be increased.

5.5. Solar System objects and their visualisation

5.5.1. Solar System objects in HSpot

At present there are more than 360 000 solar system objects (SSOs) that have been catalogued. HSpot does not have the capability to include this complete database, nor are the majority of these objects observable by Herschel for reasons of sensitivity and, in the case of many satellites, also spatial resolution. A total of approximately 400 SSOs are included in the database. These are listed in Appendix C. HSpot at present uses a static ephemeris from the JPL Horizons system; that is, it does not update, even if the orbit file in Horizons is improved. This will potentially be a serious problem with some comets and many NEAs. A dynamic ephemeris service will be installed in HSpot during Spring 2007; this service will update the ephemeris file as the Horizons database improves, however it will not be available at AO.

Note
If you need to observe a SSO that is not included in the HSpot database, please contact Helpdesk (http://herschel.esac.esa.int/esupport/) at the Herschel Science Centre.

5.5.2. Moving target visualisation limitations

Warning

At AO it will be impossible to visualise moving targets (i.e. SSOs) for HIFI AORs. Visualisation and animation of AORs works for PACS and SPIRE. HIFI moving target AOR visualisation capability is being added, but will not be available at AO.

5.6. General advice on AORs

The more restrictions that you put on an AOR, the harder it will be to schedule. HSpot allows you to define many restrictions on observations such as chopper avoidance angle(s), detector orientation,

sequencing observations, requesting very long AORs that are close to the maximum permitted time, concatenation, etc. These should be used warily in the knowledge that putting limitations on an observation may make it difficult, or even impossible to schedule.

In general, splitting a long AOR into several shorter ones will generally give the scheduler more flexibility to programme them.

Any chopper angle constraint, or detector orientation requirement, translates into a physical constraint on the (already limited) dates when the observation can be made. A strong constraint on chopper avoidance angle may mean that a particular observation can never be scheduled. Similarly, requesting a specific detector orientation obliges the scheduler to programme the observation for a particular day, something that may or may not be possible given the limitations on scheduling instruments.

So, the best advice is to be as flexible as possible with your requests. Check carefully to see if a constraint is really necessary before requesting it (even if you see a bright star close to your source in a 2MASS image, that star is unlikely to have significant emission at Herschel wavelengths). Avoid, where possible, both very short (i.e. inefficient because the overheads are longer than the integration time) and very long observations (that may overrun the maximum permissible time).

5.7. Troubleshooting

The current list of known bugs and issues is updated regularly and kept on the Proposal Kit web page from which HSpot can be downloaded. If you think you have found a bug, before reporting it please check the bugs list to discover if it is a 'feature' we already know about. Also check the appropriate section of this Guide and the Herschel Observer's Manual to understand what the software is doing.
If you find a real bug, then please do let us know about it.

1. Email a description of the problem to the Helpdesk at http://herschel.esac.esa.int/esupport/

2. Include the hardware configuration you are using (e.g., SunBlade 100, 512 MB).

3. Please attach the HSpot log file, created in the default directory when you install the software. Each time that you run HSpot, it creates a file called 'hspot_DATE_TIME.log.' The default directories are:

```
Solaris/Linux/Mac:
/home/{username}/.spotherschel

Windows ME:
c:\spot

Windows NT/2000/XP:
C:\Documents and Settings\{username}\Application Data\spotherschel
```

The text showing in any error windows that pop up in HSpot should show up in the logfile as well. Logfiles are stored for the last five sessions of HSpot.

Chapter 6. HSpot Menus

HSpot has 11 menus that provide the tools needed to create your AORs. Section 6.12 gives a single page summary of all the HSpot menu items. The menus provide the following functions.

6.1. File Menu

File I/O is handled from this menu.

6.1.1. Read AORs and Targets

This function opens a dialogue to select a file of targets or AORs that has *previously been written out with HSpot* . AOR and target files are XML files created by HSpot with the formatting required by the software. HSpot expects AOR files to have the suffix ".aor" and HSpot target files to have the suffix '.tgt'. A sample file illustrating the format used for targets and AORs are provided in Appendix A.

The "Read AORs and Targets" dialogue is shown in Figure 6.1. You can browse directories and select a target or AOR file from the list or type in the name. At the right side of the dialogue, you can select the method HSpot should use for handling duplicate AORs, i.e., if an AOR file you are reading in contains an AOR with the same "Unique AOR Label" as one already loaded in HSpot. The default is for HSpot to read in the duplicates and append "copy" to the labels, so that they remain unique. The name of the last AOR file read into HSpot will appear in the lower left corner of the main HSpot window. You can also select to discard duplicate AORs, as well as overwrite AORs already in HSpot with AORs read in from local disk.
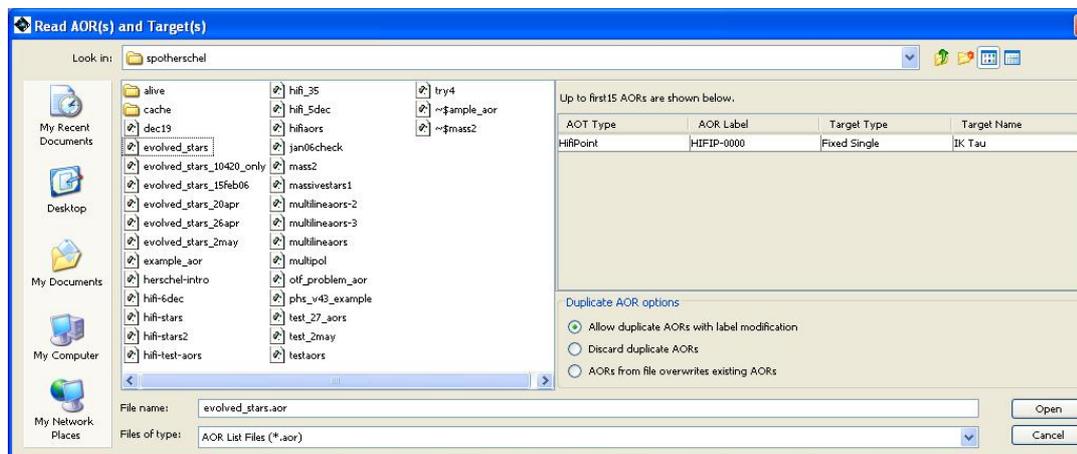
Figure 6.1. The "Read AORs and Targets" dialogue

If you are a Linux user, and are trying to read your saved AORs in the default directory of /home/{username}/.spot you may need to enter the full pathname in the filename field.

6.1.2. Save AORs and Targets

This function opens a dialogue to allow you to write out either your targets (in HSpot format) or your AORs to XML files. HSpot writes out AOR files with the suffix ".aor" and HSpot target files have the suffix ".tgt". These are plain XML files created by HSpot with the required formatting. A sample file illustrating the format is shown in Appendix A.

When writing out AOR files, you can either write out all of your AORs, or a subset of files for which you have set the 'ON' flag. It is important that you save your AORs before exiting HSpot, otherwise your work will be lost. HSpot does not save AORs or targets to disk automatically.

On leaving HSpot you will be asked if you wish to save your AORs - the default is yes.

If you have targets that have been entered, but not saved as AORs, HSpot *does not* prompt on leaving the program to ask if you wish to save them. Any unsaved targets will be lost.

If you do not select a directory in which to save your files, the default directory is:

1. Solaris/Linux/Mac: /home/{username}/.spot

2. Windows 95, 98, ME: C:\spot

3. Windows   NT/2000/XP: C: \Documents   and   Settings\{username}\Application Data\spotherschel

When you select "Save AORs and Targets", the dialogue shown in Figure 6.2 opens. The default function for this dialogue is to save AORs to a file. In this example HSpot would create a file called "newfile.aor". If you include the ".aor" suffix in the File name, HSpot will also create "newfile.aor". If you read in a file of AORs and save them to a new file name, the file name in the lower left corner of the HSpot window will not change. It continues to show the last AOR file that was read into HSpot.
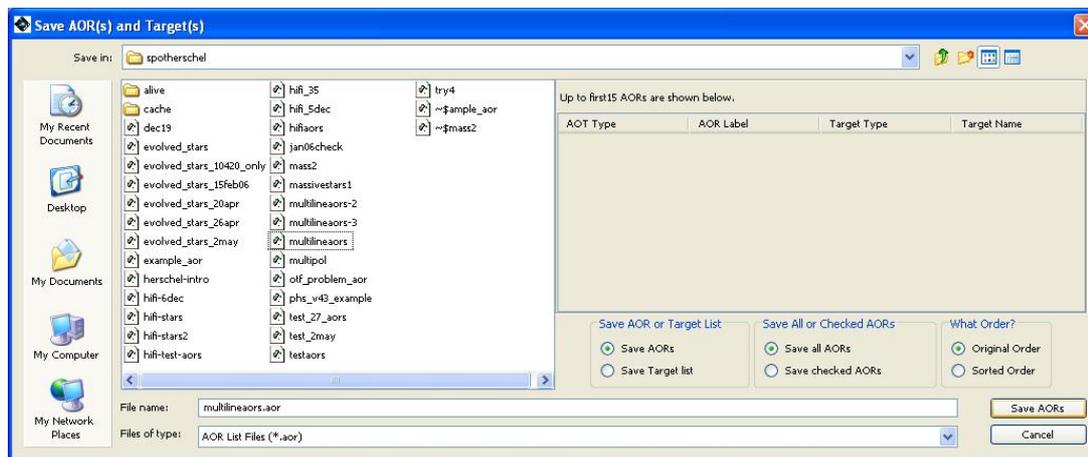
Figure 6.2. The "Save AORs and Targets" dialogue. Note that AORs and targets can be saved in separate files which have expected extensions of ".aor" and ".tgt" respectively.

If instead of saving a file of AORs you want to save just targets to a file, select the "Save Target list" button near the bottom of the window. The dialogue then changes to the form shown in Figure 6.3. HSpot is now ready to save a file of the currently entered targets called "newfile.tgt".
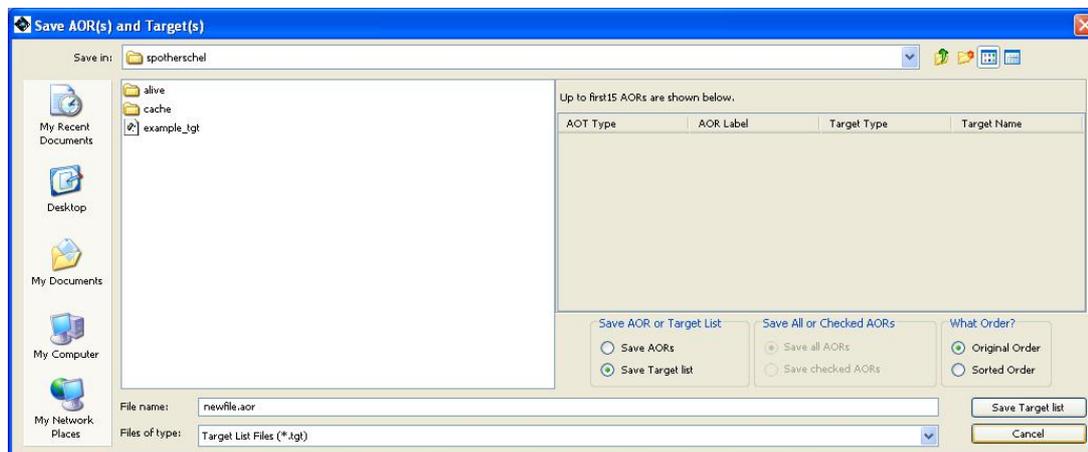
Figure 6.3. The "Save AORs and Targets" dialogue shown after selecting the "Save Target list" radio button. HSpot will save the targets you have entered to a file using the format shown in Appendix A. The filename should be changed to have a ".tgt" extension.

6.1.3. Import Fixed Single Target List

HSpot can read in single target/line lists for inertial targets in ASCII format. A sample file is shown in Figure 6.4, and the required format of the file is described. HSpot will resolve the name from the target list. The keyword, "NAME-RESOLVER", can be input at the top of the list, with values of either "ned" or "simbad." If the target list with this keyword included contains a line consisting only of a target name, the name resolver is contacted via the Internet to retrieve the positional information. HSpot must be connected to the Internet and the name resolver available for this feature to function - at the time of writing HSpot is occasionally suffering from problems with NED access due NED downtime. Previously NED went out on a port that may be blocked by some firewalls, but this problem has now have been solved by the opening of a new port.

```
COORD_SYSTEM: Equatorial # Equatorial, Galactic, or Ecliptic
EQUINOX: J2000 # B1950, J2000, or blank for Galactic
NAME-RESOLVER: simbad # Name resolution by either NED or SIMBAD
# Name RA/LON DEC/LAT PM-RA PM-DEC EPOCH
"NGC 001" 12h34m23.45s 34d23m56.2s 2.3 3.4 1950.3
NGC2222 23.56d 34.456d 2.3 3.4 1950.3
NGC4444 "12 34 12.23" "34 23 45.45" 2.3 3.4 1950.3
NGC4321
```

Figure 6.4. Format for ASCII target lists. Importing this ASCII file will allow the targets to be available for AOR creation.

In Figure 6.4:

1. The first two keywords give the coordinate system and equinox for all the positions in this list; these keywords are optional.

2. The list columns are separated by spaces. If there are spaces in the values for a column, quotation marks are needed surrounding the value. This is particularly true for name resolving.

3. Any lines starting with the pound sign (#) will be treated as comments.

4. Proper motion for RA and DEC, in arcseconds, are not required, may only be entered for Equatorial coordinates, and must always be supplied in RA and Dec pairs.

5. If the value for the fourth column is larger than 1900.0, it is interpreted as the epoch. If it is smaller than 1900.0 it is assumed to be a proper motion, as discussed above. The epoch field need only be entered for equinox B1950 coordinates.

6. *Notwithstanding the previous comment, for operational reasons, HSpot will only support J2000 coordinate entry. Users should precess their coordinates to J2000 if using other systems. The epoch for the coordinate must also been given for 2000.0.*

7. If only a name is listed in the first field, and a name resolver is specified (in the example above, "ned"), the resolver will be contacted for positional information. In general NED has a more forgiving name resolver.

    The following examples work, or do not work in NED and SIMBAD:

3C66A - Works in NED and SIMBAD

3C66a - Works only in NED

3C 66A - Works in NED and SIMBAD

3C 66a - Works only in NED

3c66A - Works in NED and SIMBAD

3c 66A - Works in NED and SIMBAD

3c 66a - Works only in NED

Abell3511 - Works in NED and SIMBAD

Abell 3511 - Works in NED and SIMBAD

A3511 - Works in NED and SIMBAD

A 3511 - Works in NED and SIMBAD

NGC4321 - Works in NED and SIMBAD

NGC 4321 - Works in NED and SIMBAD

N4321 - Works only in NED

N 4321 - Works only in NED

You can create targets in the format required by HSpot with a text editor and then read in these files.

6.1.4. Import Moving Single Target List

HSpot can read in lists of single moving targets. The format for the input file must follow these rules:

1. Comments must start with # or !.

2. Each line should have at most 2 elements. The first element is the NAIF Name and the second is the NAIF ID if both elements are present.

3. If only one element is provided, it is assumed to be the NAIF ID if it is all numbers (put it in quotation marks, if it is a name). If the one element has characters other than numbers, it is assumed to be the name.

4. If there are spaces in the name, put the entire name inside quotation marks.

    Note

    What works and does not work in a moving single target list:

    Saturn - Offers a choice between Saturn Barycentre and Saturn (physical centre). For the spatial resolution of Herschel both are exactly equivalent.

    Pluto - Offers a choice between Pluto barycentre, Pluto (physical centre) and the (primary) Minor Planet designation. For the spatial resolution of Herschel all three are exactly equivalent.

    Orcus - Accepted and correctly resolved.

    15789 - Offers a choice of 14 different asteroids that have a provision designation "Year SC". Select 1993 SC.

"1993 SC" - Accepted and correctly resolved without ambiguity.

"1992 QB1" - Accepted and correctly resolved.

1992 QB1 - Gives error in NAIF ID.

1992QB1 - Ignored, but no error message given.

Note that it is better to use "1993 SC" in quotation marks than to use the equivalent permanent number designation 15789, which gives an ambiguous resolution to NAIF ID.

5. The NAIF ID must not be in quotation marks.

If only one element is on the input line, HSpot will attempt to resolve the missing Name or ID. HSpot will issue a warning message if a given name does not resolve a NAIF ID (and no entry for the object will appear in the target list). If both Name and ID are provided, both will be used as they appear on the input line.

Remember that names may not be unique, although NAIF IDs are. Type in the name "Io" and resolve it with NAIF and you will receive a choice between Jupiter's satellite Io (NAIF ID 501) and the asteroid (85) Io (NAIF ID 2000085). You must select the object that corresponds to the one that you wish to observe to proceed. Not all objects with a NAIF ID will have their ephemeris loaded into HSpot; the list of science target solar system objects is given in Appendix C, while a number of additional asteroids of interest for Herschel calibration are also included.

An example moving single target list looks is shown in Figure 6.5.

Figure 6.5. Target list input for moving single targets

6.1.5. Save Target Visibility Windows

The menu item is only active if you have calculated visibility windows for targets in your target list. If you select it you can save the visibility windows that are currently stored in memory to a text file. HSpot cannot read this file back in.

6.1.6. Save Current Plotted Image as FITS file

If you are currently displaying an image in HSpot selected from the "Images" menu, this will save the image as a FITS file. It does not save any overlays, just the image.

6.1.7. Save Current Plotted Image and Overlays to JPEG, GIF, BMP, or PNG

If you are currently displaying an image in HSpot selected from the "Images" menu, this will save

the image, along with any overlays, as a GIF, JPEG, BMP (bitmap), or PNG format file.

6.1.8. View Accepted Proposal

This feature allows you to view the abstract for and download into HSpot direct from our database, all the AORs in an approved Herschel observing proposal. You can then save these AORs on your local disk and/or modify the most up-to-date set of AORs for a program. You must be connected to the Internet and see the "Net Up" icon in HSpot (bottom right) to download an approved proposal from the Herschel Science Centre (HSC). Proposal identification is by name, or by proposal identification number, entered in the dialogue shown in Figure 6.6.

Figure 6.6. Dialogue to enter a program ID number or name to View Program.

Note that you should have deleted first any AORs that you have in HSpot before reading in the proposal and its associated AORs, otherwise you will receive the error message shown in Figure 6.7.

Figure 6.7. The warning that you already have AORs in HSpot that must be deleted before you can read in an accepted proposal and its associated AORs.

6.1.9. Quit

HSpot will prompt you to save any unsaved AORs when you attempt to quit the program.

6.2. Edit Menu

6.2.1. Undo [ctrl-Z]

This reverses the last action.

6.2.2. Delete Current AOR [delete]

Delete the AOR in the main AOR table that is currently selected.

6.2.3. Modify Current AOR [ctrl-M]

Open the AOT template for the AOR that is currently selected.

6.2.4. Copy Current AOR [ctrl-C]

This makes a duplicate entry of the selected AOR. The unique AOR label is automatically edited with the addition of 'copy' to remain unique.

6.2.5. Delete All AORs

This will clear all of the AORs in the AOR table from HSpot. This action is *not* reversible, so be sure you have saved any work you need to keep before you clear HSpot.

6.2.6. Delete All Targets

This will clear all of the targets in the AOR table from HSpot. This action is *not* reversible, so be sure you have saved any work you need to keep before you clear HSpot.

This does nothing to the target information in the AORs in the AOR table. It only clears the target list in HSpot's memory.

6.2.7. Enable All AORs

This function turns the flag ON for all AORs currently in HSpot. This function is most likely to be used if you are planning to write out a subset of your AORs to a file, or are recalculating resource estimates for a subset of AORs.

6.2.8. Disable All AORs without G/F Constraints

This turns the flag OFF for all AORs that are not part of a Grouping or Follow-on constraint (see Chapter 20).

6.2.9. Toggle ON Flag (AORs without G/F Constraints)

For all AORs that are not part of a Grouping or Follow-on constraint (see Section 16.1), this turns the flag from OFF to ON, or ON to OFF. Once you have added Group/Follow-on constraints, HSpot won't let you turn these AORs OFF. This prevents you from saving a set of AORs and their associated constraints with 'missing' AORs because you unintentionally turned one or more of the AORs OFF. All the AORs within each constraint must be in the AOR file; otherwise, the constraint is not valid.

6.3. Targets Menu

The functions in the Targets menu are:

1. New Target - Enter a new target from the target entry window.

2. Delete Target - Delete the currently selected target. The name of the current target is displayed at the bottom of the main screen.

3. Modify Target - Bring up a target entry dialogue with the current target entered to change or add information.

4. Target List - Opens a dialogue showing a summary list of the targets currently loaded. Clicking on an entry makes this target the 'current' target. The name will appear at the bottom of the main HSpot window. In addition, from this dialogue window you can show the background es-

timates and visibility windows for the list of targets. You can save them to disk by selecting the appropriate option under the "File" menu. As you enter targets into HSpot, the target list appears at the bottom of the "Targets" pull-down menu.

5. Calculate Visibility Windows for All Targets

> **Warning**
> The targets in the Target List and the AORs are not linked. If you change the coordinates in a target that you have already entered into an AOR, they are *NOT* updated in that AOR, unless you modify the target from within the AOT dialogue. To change the coordinates for a target already included in an AOR, load the AOR file into HSpot, double-click on the AOR to open it up, and then select the "Modify Target" button to correct/modify the coordinates.

At the bottom of the targets menu is a list of currently available targets. Click a target on the list to use this as the default target for the next AOR you create.

6.3.1. Deleting multiple targets

If you work with long target lists you may wish to delete many sources because you find that they are not observable, or have found them not to be of interest after checking them out.

To delete multiple sources you should highlight them using Shift + Down/up arrow. Selecting "Delete selected targets" from the "Targets" menu will then delete them.

> **Warning**
> HSpot does not request confirmation of this action and it is not reversible. Use it with care.

6.4. Observation Menu

The selection of the desired AOT parameters is made from the "Observation" menu. The Herschel and Instrument Observer's Manuals are your primary reference for information about using the Herschel instruments and selecting the appropriate AOT parameters. Additional comments about the AOTs are provided in Chapter 8, Chapter 10, Chapter 11, Chapter 12 and Chapter 13 of this Guide. There are nine Herschel AOTs fully implemented in HSpot. Each AOT has several options as to the mode of operation (e.g., reference source, array choice or spectrometer resolution).

6.5. Tools Menu

6.5.1. AOR Replication Tool

The AOR Replication Tool allows HSpot to automatically create a number of AORs by merging a "template" AOR and a list of targets. For every target in your selected group, an AOR with the template parameters will be created. The Replication Tool is discussed in Section 6.5.1.

6.5.2. Target Replication Tool

The "Target Replication Tool" allows HSpot to automatically create a number of AORs by merging a particular target with a set of AORs. If you want to perform the same set of AORs on several different targets, you can create the first set individually and then use the "Target Replication Tool" to create the AORs for the other targets.

6.5.3. Group/Follow-on Constraints

This tool allows you to apply grouping and follow-on constraints to your AORs. See Section 16.3 for a discussion of constraints editing.

6.5.4. Timing Constraints

This tool allows you to apply timing constraints to AORs. See Section 16.2 for details.

6.5.5. Proposal Submission Tool

You will use this tool if you wish to submit a Herschel observing proposal during an open Call for Proposals. See Chapter 17 for details.

6.5.6. Show Current Resource Estimates

This brings up the resource estimates dialogue that shows the time estimates previously calculated for this AOR. The same function is implemented with the "clock" icon on the main HSpot screen.

6.5.7. Recompute All Estimates

This function recomputes the observing time estimates for the current AOR, the AORs with the ON flag set, or all the AORs loaded into HSpot. The user selects the appropriate set to use from a button on the dialogue shown in Figure 6.8. As HSpot recomputes the estimates, they are updated in the main AOR table. The "Recompute All" function runs in the background. You can continue to work with other HSpot functions while it is running.
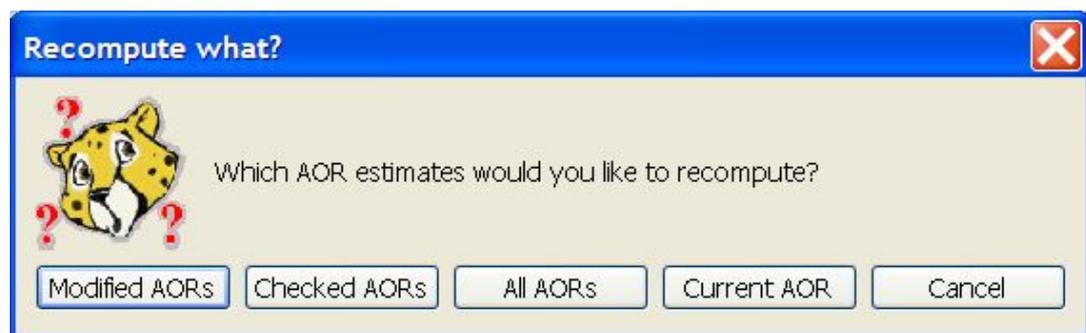
Figure 6.8. The dialogue that appears if "Recompute All Estimates" is selected from the Tools menu. The user selects the set of AORs to use by clicking the appropriate button.

6.5.8. Compute Backgrounds from File

The Compute Backgrounds from File tool allows the user to read in a list of targets and calculate the background levels of the targets at a given wavelength on a specified date. The file format for this list is discussed in detail in Section 9.7.5.

6.5.9. Memory Monitor

This dialogue shows how much memory (bytes) JAVA has allocated (total memory) and how much of that allocation is currently available (free memory). We have been using this mainly as a debugging tool to determine when JAVA is having trouble with the memory allocation, mainly on Sun Workstations.

6.6. Images Menu

Images from a variety of different wavelengths of your target region can be downloaded and displayed within HSpot. Catalogue, coordinate grid, Herschel focal plane, target position, and AOR area coverage overlays are available from the "Overlays" menu. The visualisation functionality is discussed in Chapter 19. HSpot reads and writes FITS format files. The images available in this HSpot release are:

6.6.1. ISSA: The IRAS Sky Survey Atlas

The ISSA images are IRAS Sky Survey Atlas maps at 12, 25, 60, and 100 microns that will help you characterise the sky at mid-infrared wavelengths (these images have had zodiacal light contributions removed). These are the same images that have been previously available via the IRSky tool. Input the desired image size (in degrees), and select the desired initial zoom level (no zoom, 2X, 3X, etc.). The images are served directly from IRSA, the InfraRed Science Archive (http://irsa.ipac.caltech.edu/).

As a guide, a 5 degree diameter IRAS image with no zoom will give an image 6-cm across on the screen of a standard laptop. A 1 degree diameter IRAS image with 8X zoom will give an image 10-cm across on the screen (albeit a highly pixelated one). Adjust the zoom according to the field size that you request. The range of field size permitted is from 1-12.5 degrees.

The dialogue for ISSA image selection is shown in Figure 6.9. The target buttons allow you to select or change the desired target region. Three choices for how the images are displayed are given in the "Where?" box. The default is to put each image into its own frame. All the plots may be put into the same frame. Alternatively they can be stacked on top of each other; this saves space on a small screen and each individual image can be selected for display by selecting the tabs at the bottom of the screen. A new HSpot feature compared to older versions of SPOT is that three-colour (rgb) composite image displays can now be created too. This feature is useful to identify sources with unusual colours in a particular field.

To make a 3-colour plot, select the image size and tick the "Make this a 3 Colour Plot" box. When this box is ticked, the "Colour Band" window will activate allowing you to select the band to define (red, green or blue) and the plot type (the image to identify with that band), for example, if you want a three-colour IRAS image, you could pick: red, 100 microns; green, 60 microns; blue, 25 microns.

HSpot allows you to combine images from different surveys in a three-colour plot (for example, a POSS plate for blue, 2MASS K for green and IRAS 60 microns for red) but, in practice the image scales and permitted sizes are so divergent that, in most cases combining different surveys is not practical.

The three colour image that you prepare can be saved, along with any overlays such as the target identification. In the "File" dropdown menu you can select to save the current plotted image as FITS, or as a jpeg, gif, bmp, or a png file.
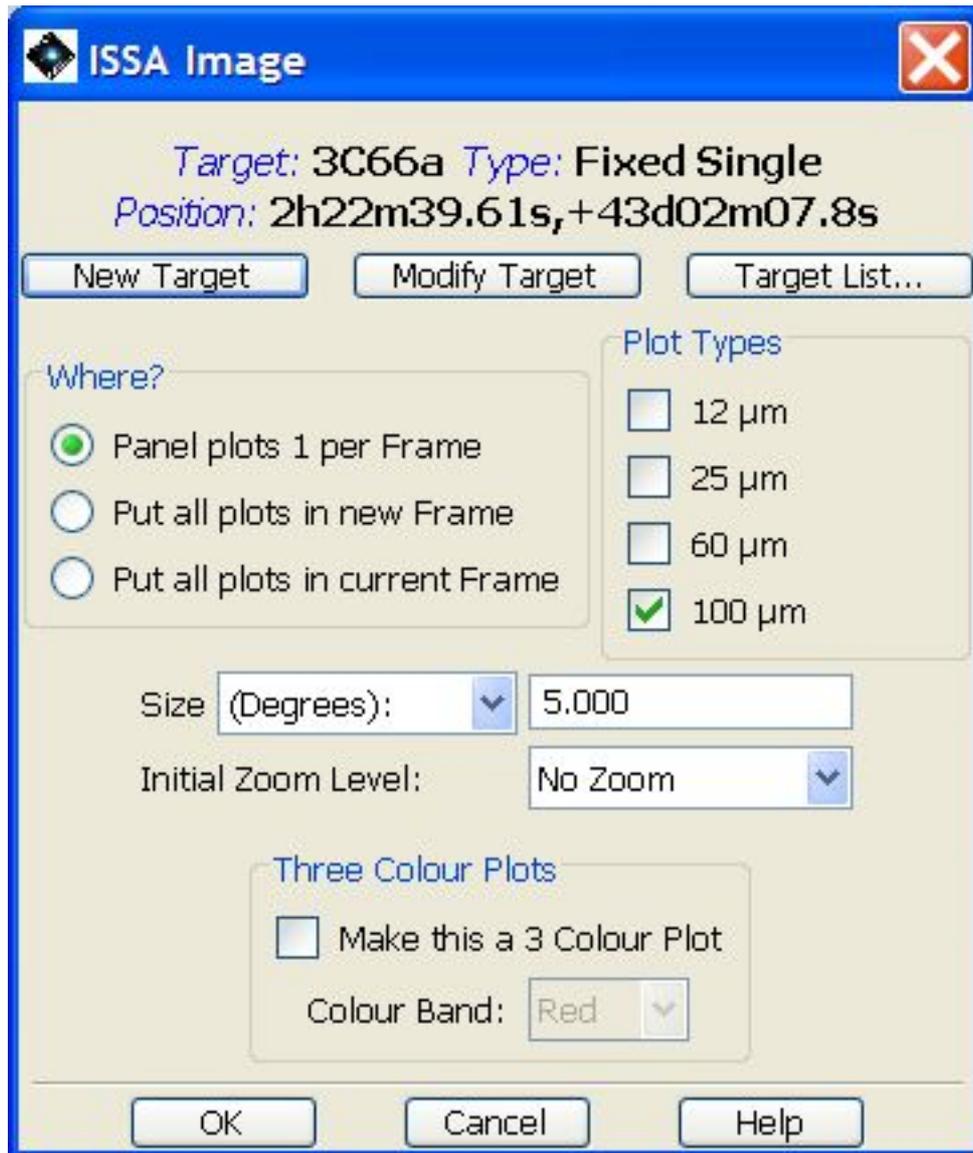
Figure 6.9. The ISSA dialogue that allows selection of IRAS images for display in HSpot. You may select 12, 25, 60, and/or 100 micron images. Three choices for how the images are displayed are available from the "Where?" box. You enter the size (1-12.5 degrees on a side) and the initial zoom level.

The displayed ISSA image may not be the full size requested. The images are stored and returned as 'plates' with a limited overlap. The ISSA server picks the best plate by maximising the distance from the target to the nearest edge of the plate. This edge may still be close enough to the target that the displayed image will appear to have one side "shaved off", or the target may not be centred in the image, but off to one side. If you already have existing images displayed, you may also select to have the new ones stacked into that frame. If you utilise this feature, you must again remember that the plate scales for the images from the different servers are very different. For instance, ISSA images are 1-12.5 degrees on a side, while 2MASS images are 50 - 500 arcseconds on a side. You can also create three-colour (RGB) image composites. For this, you enter the size (50-500 arcseconds, 0.83-8.33 arcminutes, or 0.014-0.139 degrees on a side) and the initial zoom level.

6.6.2. 2MASS: Two Micron All Sky Survey

The 2MASS images are also served from ISSA. You can select J, H, and/or Ks band. At this time, large area mosaics of the images are not available; only single atlas images will be retrieved in the region specified. Even though these are full-fidelity images, they should not be used directly for

photometry; use the 2MASS catalogues for detailed source information. The image selection dialogue is shown in Figure 6.10. Choices of target, image size, image location, zoom, and three-colour composites, are available, analogous to those for the IRAS images.

Note that the image may not have the full size that you requested if your target is close to the edge of a 2MASS plate.
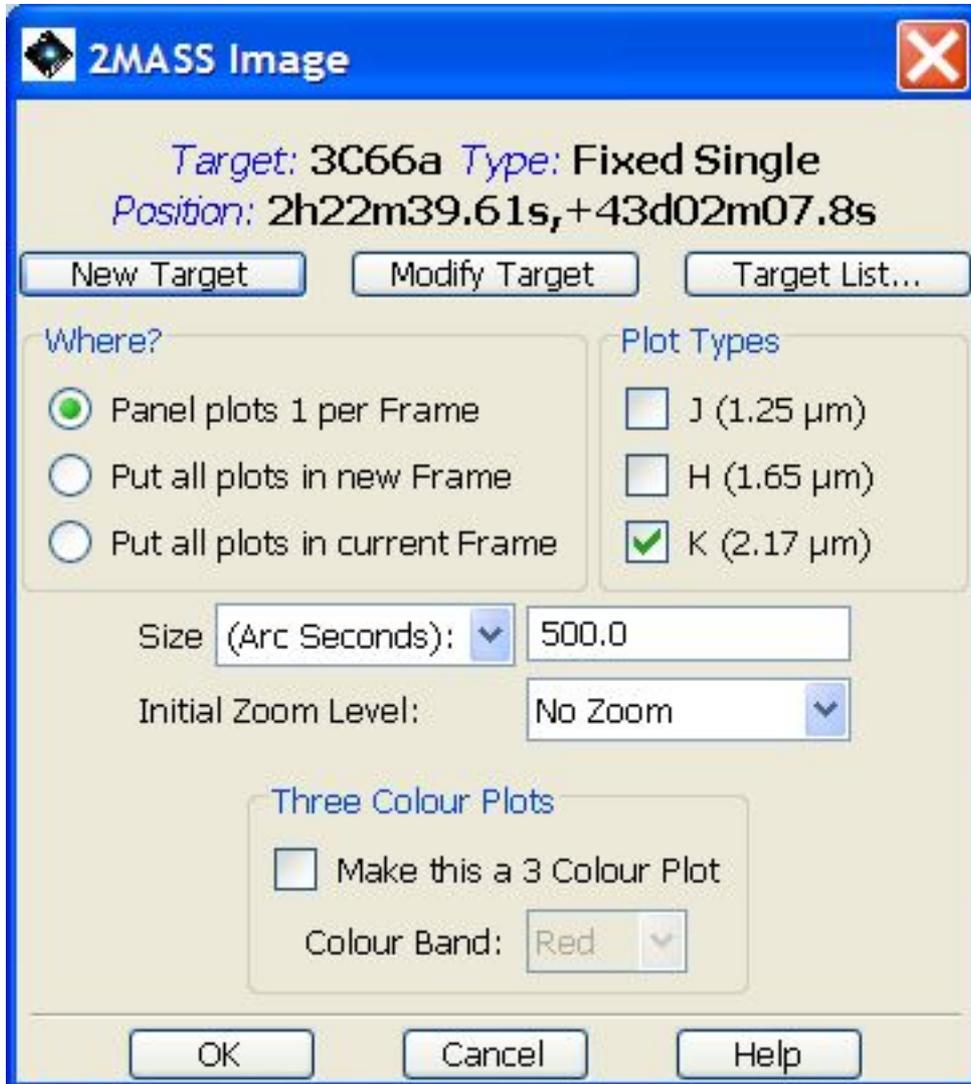
Figure 6.10. The dialogue that allows selection of 2MASS J, H, or Ks-band images for display in HSpot.

6.6.3. MSX: Midcourse Space Experiment

The MSX A, C, D, and E mid-infrared images are provided here. The image selection dialogue is shown in Figure 6.11. For more information on the MSX mission, see ht-tp://www.ipac.caltech.edu/ipac/msx/msx.html. Choices for target, image size, image location, and zoom, are available, analogous to those for the ISSA images. At this time, all MSX FITS headers define Galactic North to be "up." As such, MSX images may appear to be rotated with respect to other images that define Equatorial North to be "up." HSpot does not rotate images, but AOR overlays will appear the way they will be observed, regardless of coordinate system.
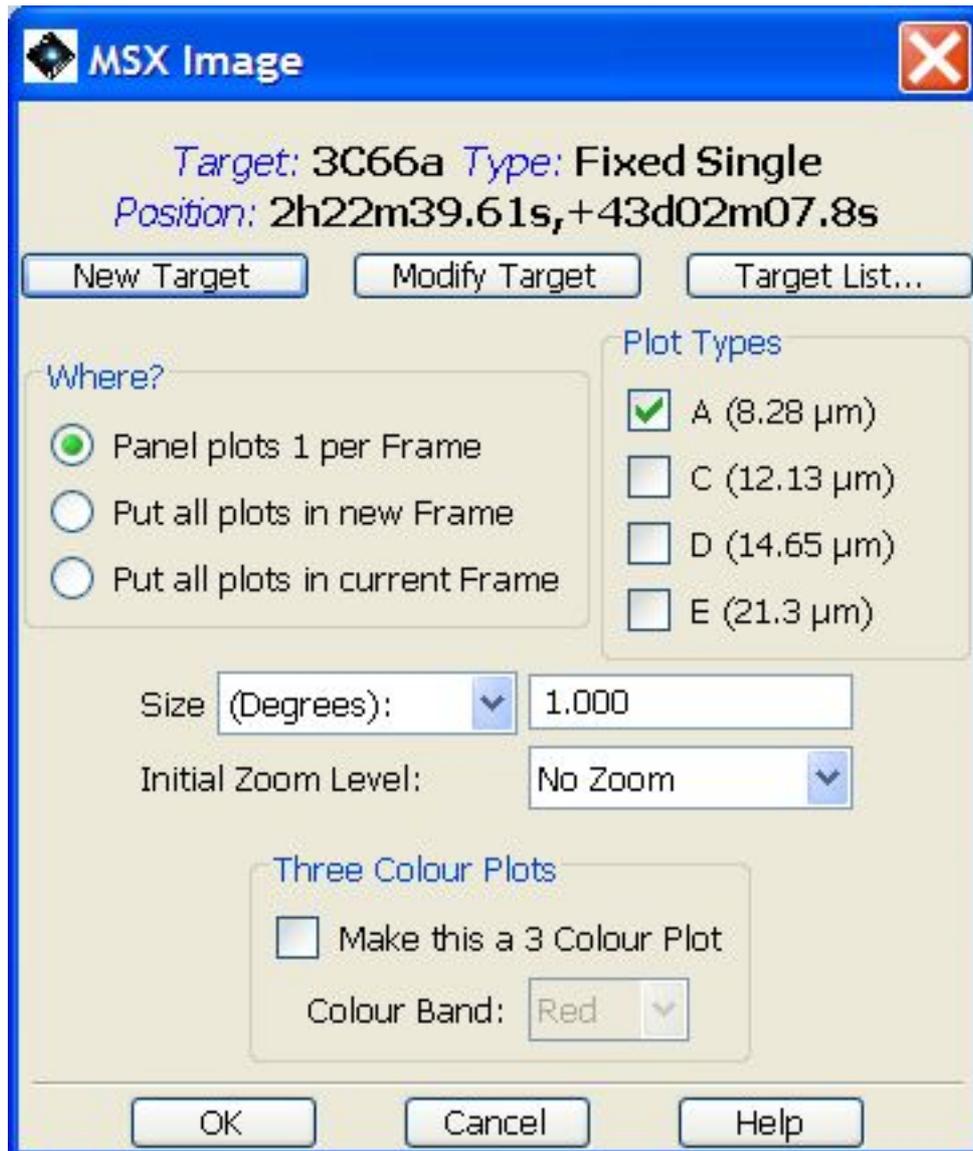
Figure 6.11. The dialogue that allows selection of MSX A, C, D, and E-band images for display in HSpot. You enter the size (360-5400 arcseconds, 6-90 arcminutes, or 0.1-1.5 degrees on a side) and the initial zoom level. There is a feature that allows the creation of three-colour (RGB) image composites.

6.6.4. DSS: Digitized Sky Survey

The optical Palomar Sky Survey images are provided here. They are served from the Space Telescope Science Institute (http://stdatu.stsci.edu/dss/dss_form.html). The image selection dialogue is shown in Figure 6.12. Choices of target, image size, image location, zoom, and three-colour composites, are available, analogous to those for the ISSA images. If you require an image larger than 15 arc minutes on a side, please get it directly from the DSS web page and then load it as a local FITS file Section 6.6.10 or from the "Skyview" image option (Section 6.6.7). Note that the default image size of 0.25 degrees will usually be about double the window height when displayed on screen and will require large quantities of memory.
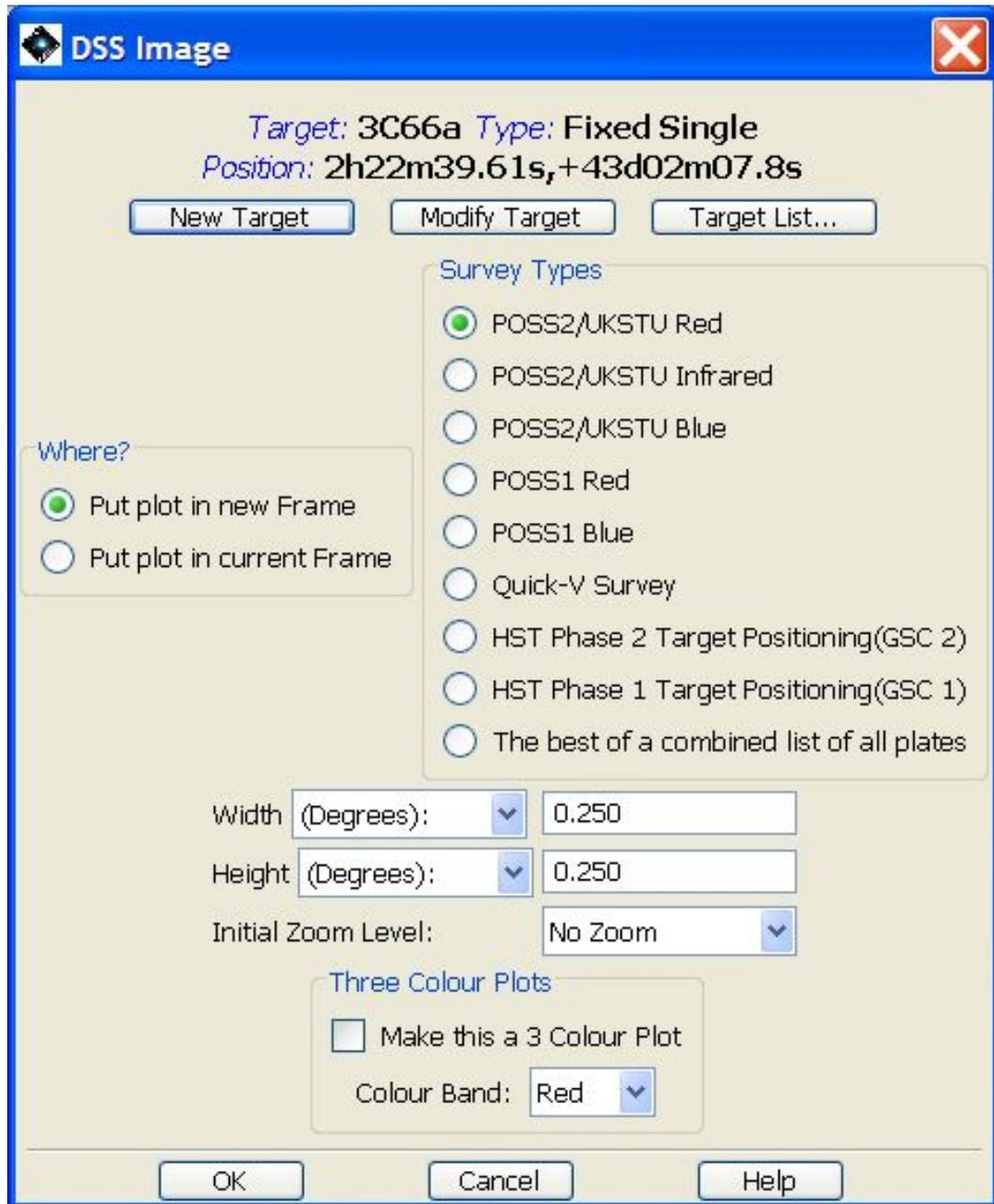
Figure 6.12. The dialogue that allows selection of DSS images for display in HSpot. You enter the size (0.016-0.25 degrees on a side) and the initial zoom level. There is a feature that allows the creation of three-colour (RGB) image composites.

6.6.5. Memory and cleanup

It is easy to display large numbers of images in different layers, sometimes without even realising that you have done it. However, displaying several images, especially DSS images, or images with large numbers of overlaid source detections, uses considerable quantities of memory and can cause your computer to go very slowly. It is strongly recommended that users delete images that are not required to liberate memory; this is done by going to the image control box on the right of the screen. Here you will find a box for the image and for each overlay. For a three-colour rgb plot you will find controls for each layer of the image, each in the appropriate colour and, above them, in black, the overall control for the rgb image. You may delete an individual layer (for example, the

green layer), by pressing the cross of the appropriate colour; when you do this the panel will prompt you to redefine this layer. If you press the black cross above the red buttons, you will delete the entire rgb image.

If you have defined overlays, a control box will appear for each overlay. By pressing the black cross you erase that overlay. Large images in the Milky Way may have huge numbers of detections and may use extremely large quantities of memory. If you have generated such an overlay unwittingly it is advisable to remove it to recover memory.

6.6.6. Summary of HSpot permitted image sizes

- ISSA (IRAS): Minimum, 1 degree; Maximum, 12.5 degrees; Default, 5 degrees.

- 2MASS: Minimum, 50 arcseconds; Maximum, 500 arcseconds; Default, 500 arcseconds.

- MSX: Minimum, 0.1 degrees; Maximum, 1.5 degrees; Default, 1 degree.

- DSS: Minimum, 0.016 degrees; Maximum, 0.5 degrees; Default, 0.25 degrees.

6.6.7. SkyView: SkyView image data

The multiwavelength SkyView ground- and space-based image data are provided here. They are served from NASA's High Energy Astrophysics Science Archive Research Centre (HEASARC; http://heasarc.gsfc.nasa.gov). The image selection dialogue is shown in Figure 6.13. Choices of target, image size, image location, zoom, and three-colour composites, are available, analogous to those for the ISSA images. Variable image size limits apply. For some image data, if you require an image larger than HSpot's maximum limit for those data, please get the image directly from the HEASARC web site and then load it as a local FITS file Section 6.6.10.
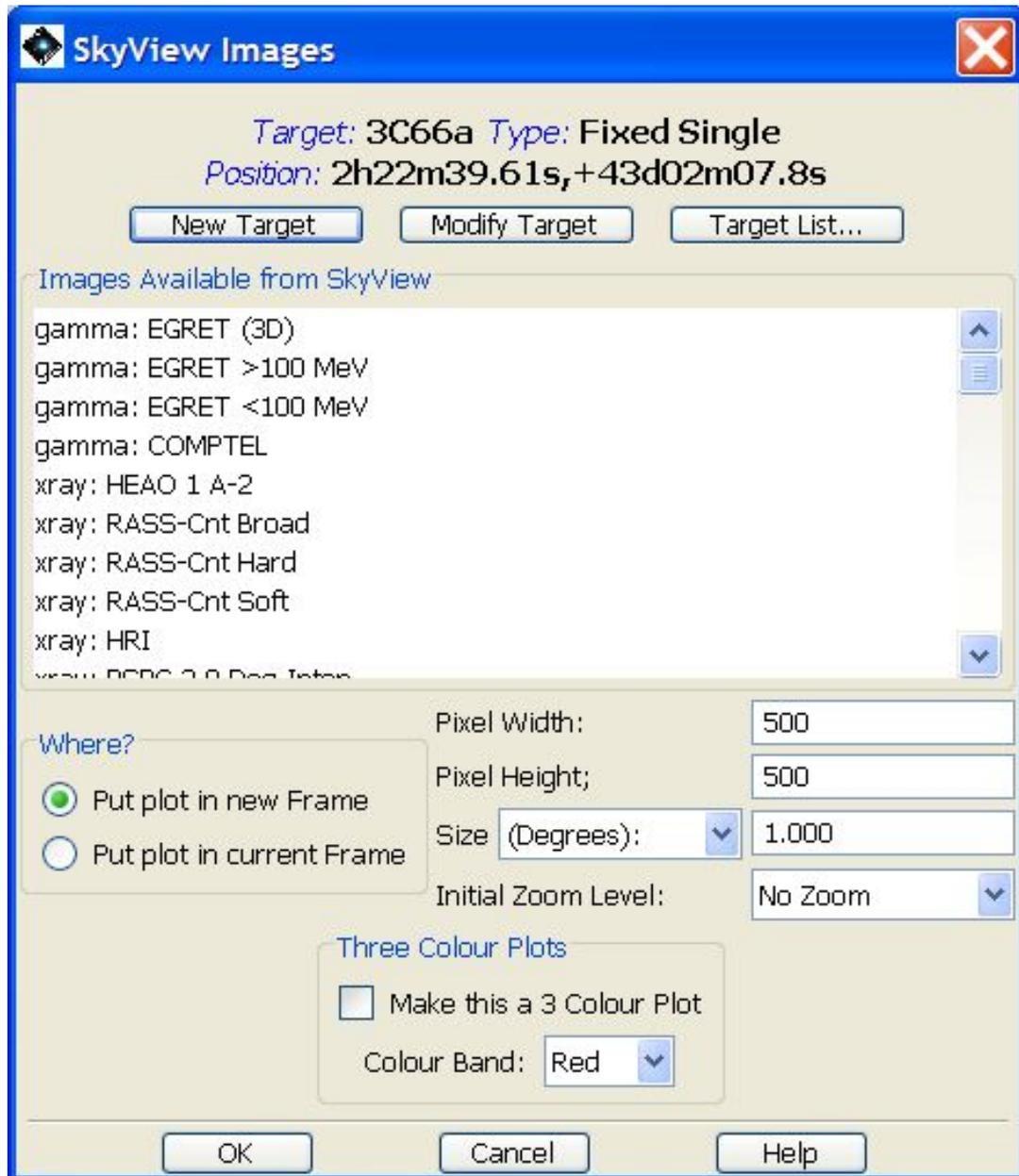
Figure 6.13. The dialogue that allows selection from NASA GSFC's Skyview catalogue of sky images.

SkyView offers many frequency ranges from gamma rays through to radio. Several of the options (IRAS, 2MASS and DSS images) are duplicated from the "Image" pull-down menu, but have slightly different funcionality in SkyView.

The default image size is 500x500 pixels. You may select the size of the image to be displayed up to 2000x2000 pixels if greater screen resolution is required. A 1000x1000 pixel image typically occupies 3.9MBt so, unless you have a fast connection, you may prefer to select a smaller size. SkyView also cuts and pastes across plate borders and allows much larger diameter images to be displayed than, for example, the 2MASS option of the "Images" pull-down, although at the cost of losing resolution in the image.

Warning
The SkyView image headers do not supply sufficient information for HSpot to display the size of the image to be downloaded in the download progress pop-up. The pop-up only tells you how much data has been downloaded so far, not how much is to be downloaded or the instantaneous percentage that has been downloaded. This bug has been notified by HSC and IPAC, but we have

no information on when it may be fixed.

Options of making three-colour images and adding overlays generally work well however, users are recommended to use the dedicated "Image" pull-down menus for 2MASS, DSS and IRAS images unless there is a particular reason not to.

Note
Not all SkyView "images" are actually image data. The x-ray data includes exposure maps and sky coverage frames. To select ROSAT imaging data you should use the frames entitled "****-count".

Warning

SkyView is offered "as is" and is NOT SUPPORTED by HSpot. In Acceptance Testing it was found that there are many issues, particularly of IO errors and incorrect downloading of frames when used in conjuntion with HSpot. The MAC operating system seems particularly prone to IO errors, with the Windows platform apparently the most robust.

These issues have been reported by HSC staff, but there is no guarantee that they will be resolved (or resolvable) and the time scale for resolution (if possible) is not known, as they are not under direct Herschel control.

The error "Could not read FITS file. IO error: java.io.IOException: Not FITS format at 0:..." can often be overcome by re-requesting the download or, if that does not work, by reducing the image size.

The SkyView server has a limited capacity. Attempting two or more downloads simultaneously will usually give a "too many processes" error.

In some cases HSpot will download several MBt of data from SkyView and then give an error that there was no image data (Figure 6.14). This happens when the SkyView frame that has been downloaded is, for some reason, blank and thus all the pixels have zero value.
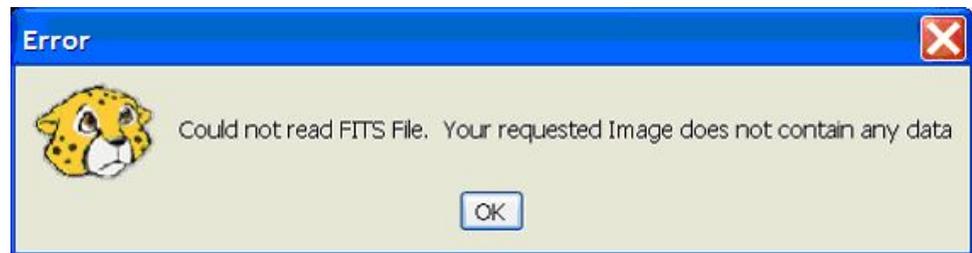
Figure 6.14. The error message that warns that even though an image has been downloaded it is full of pixels with zero value and thus contains no information.

6.6.8. NED: NASA/IPAC Extragalactic Database

HSpot will display a list of images that are available for the target from NED (http://nedwww.ipac.caltech.edu). The search uses the target name, not the target coordinates to locate an image in the database. An example for M31 is shown in Figure 6.15. If HSpot cannot find the image by target name, you will have to retrieve it directly from NED and load it as a FITS file (see Section 6.6.10).
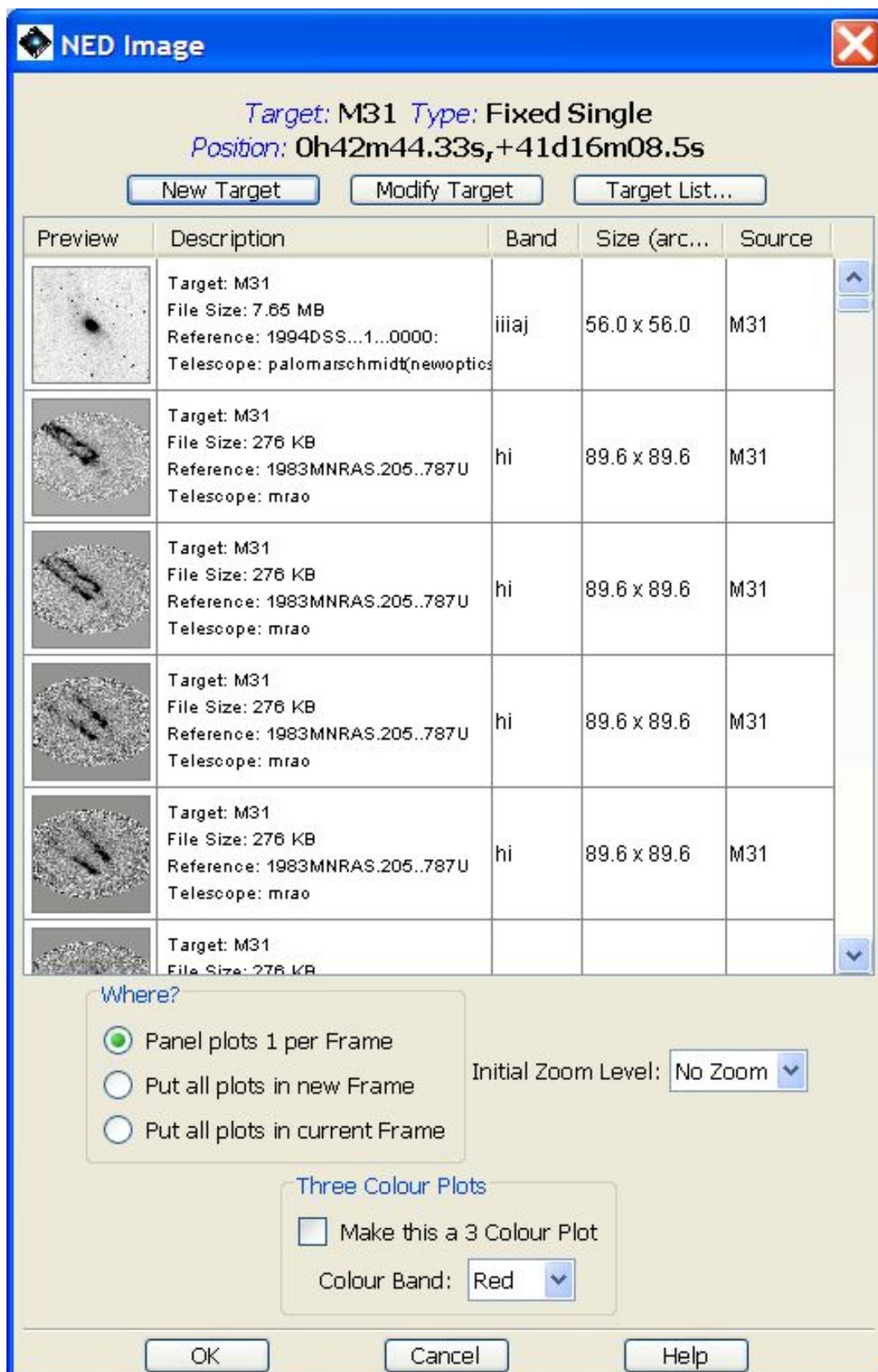
Figure 6.15. The listing of the images available from NED for the sample target (M31). You enter the initial zoom level.

6.6.9. ISO Archive Database

HSpot will display a list of images that are available for the target from the ISO archives (http://www.iso.vilspa.esa.es/ida/). The search uses the current target name and coordinates. An example for M31 is shown in Figure 6.16.
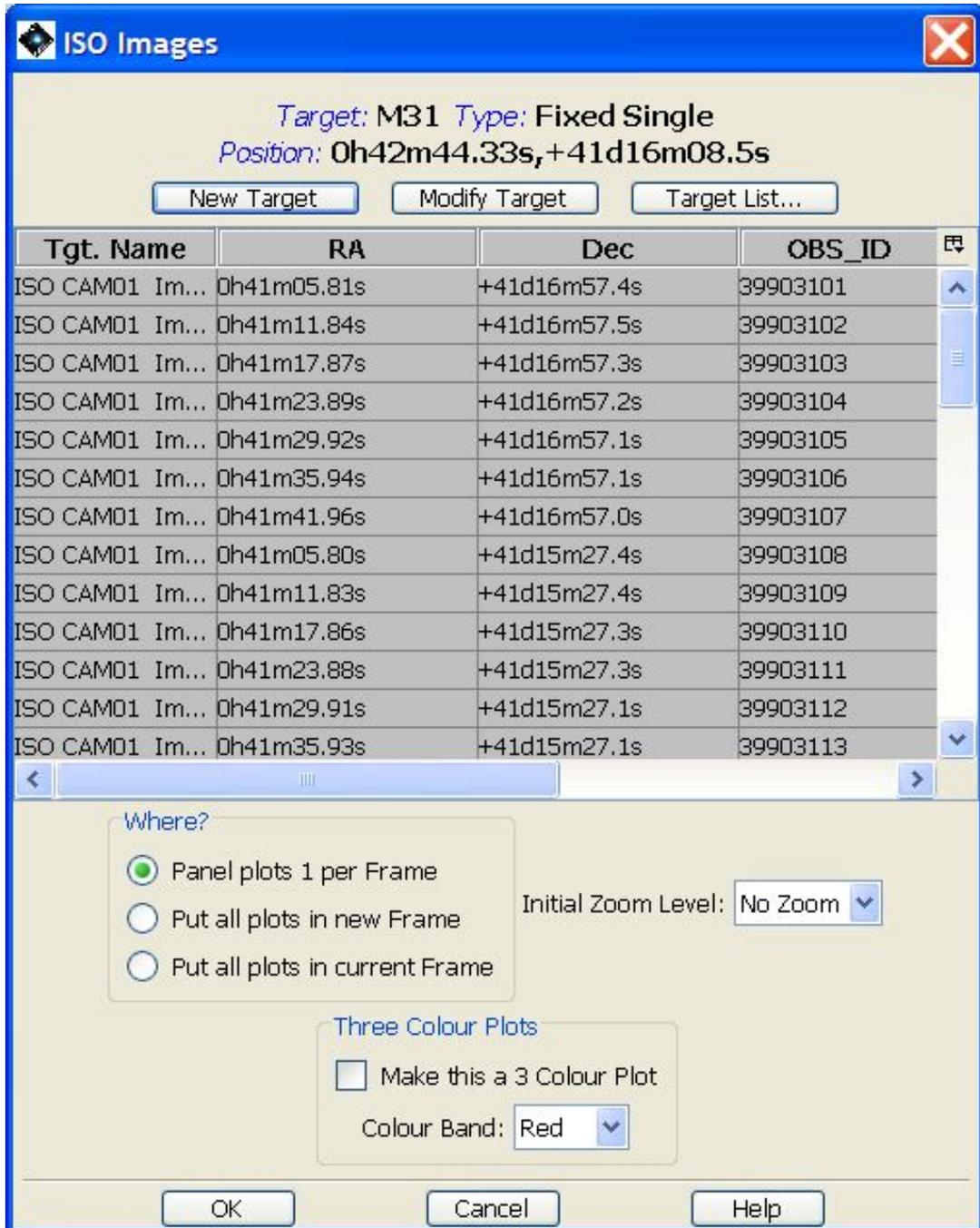
Figure 6.16. The listing of the images available from the ISO archive for the sample target (M31).

6.6.10. FITS File

HSpot can also display any images that have been obtained from another image server, or that you have taken yourself. HSpot also reads gzipped FITS files and, new to this version of HSpot, FITS files with extensions. There must be world coordinate system keywords in the header for the posi-

tional information to be read accurately. Data from most modern telescopes that conform to FITS standard should be handled well. The available computer system memory limits the size of a FITS image that may be loaded into HSpot. Loading large FITS images may compromise the memory left available for other HSpot functions. The images selection dialogue is shown in Figure 6.17.
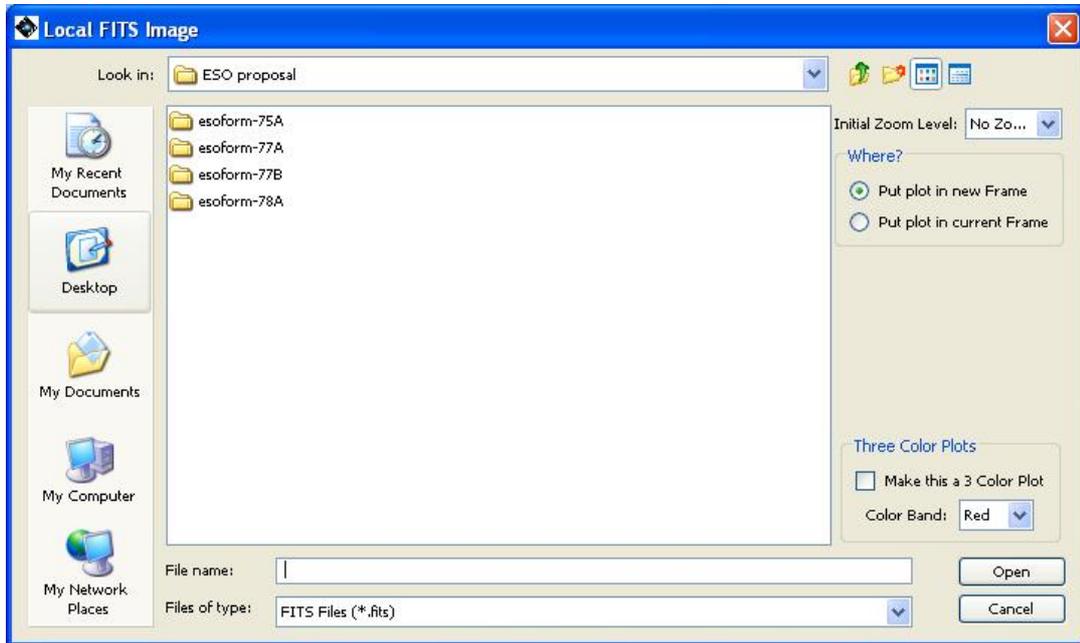
Figure 6.17. The image selection dialogue for reading in a local FITS file. This utility will also read in gzipped FITS files and FITS files with extensions. You can enter the initial zoom level.

6.6.11. All Sky Images

Select from DIRBE 4.9, 60 and 140 micron images and ISSA All Sky Images. These are particularly useful for visualising moving targets with high apparent rates. The selection dialogue is shown in Figure 6.18. The ISSA All Sky Image is a low-resolution IRAS composite which has been smoothed to half degree by half degree resolution. Unlike the individual ISSA plates, it contains the zodiacal background component, but it should not be used for background estimates if small-scale structure is important. The DIRBE 60 micron image does provide reliable background estimates for the Galactic and extragalactic background components, and is accurate for the zodiacal light background expected if you observe your target at 90 degrees solar elongation. However, if accurate background estimates are crucial for your observation, we recommend *strongly* that you use the values obtained from "Background" button in the "Target" window.
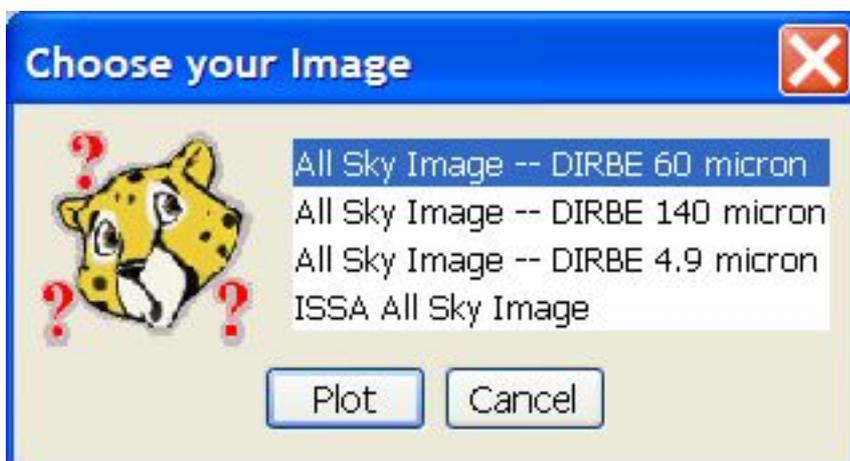
Figure 6.18. The selection dialogue for All Sky Images

6.7. Lines Menu

Managing and incorporating lines into HSpot for observation planning purposes is discussed in Chapter 18 of this manual.

6.8. Overlays Menu

The overlays menu presents a series of options for overlaying information on an image. This may be sources from a catalogue, or graphical information such as identifying the source in a particular image frame.

6.8.1. Catalogue Overlay

It is frequently of interest to see what catalogued sources lie within a particular image frame. HSpot can find and identify sources from various catalogues, displaying the identifications and presenting the catalogue information. The following are the available catalogues.

6.8.1.1. Catalogues from IPAC

HSpot currently serves seven catalogues from IPAC servers whose sources can be overlaid onto the image display. From the dialogue (Figure 6.19) you select the catalogue and appropriate search radius for sources. These catalogues are served from IRSA, like the ISSA and 2MASS images, and NED. The text catalogues are cached, like the images, to your designated cache directory (see Section 6.9.5).

Once the catalogue(s) is/are selected a search is performed and the catalogue object positions overlaid on the current image of the target. An example is shown in Figure 6.20 where the 2MASS and MSX catalogues are overlaid on an ISSA 25 micron image of M31. Remember that your image will usually be square while the overlay will be calculated for a particular radius, so the search radius must be at least as large as the semidiagonal distance across the image.

The list of catalogues, highlighting of targets and changing of symbols can be done for each catalogue by clicking on the appropriate listing button ( ) under the catalogue's name on the right hand side of Figure 6.20. This can be done for any overlaid catalogue and produces a listing similar to Figure 6.21, which in this example is the MSX search results for the M31 area.
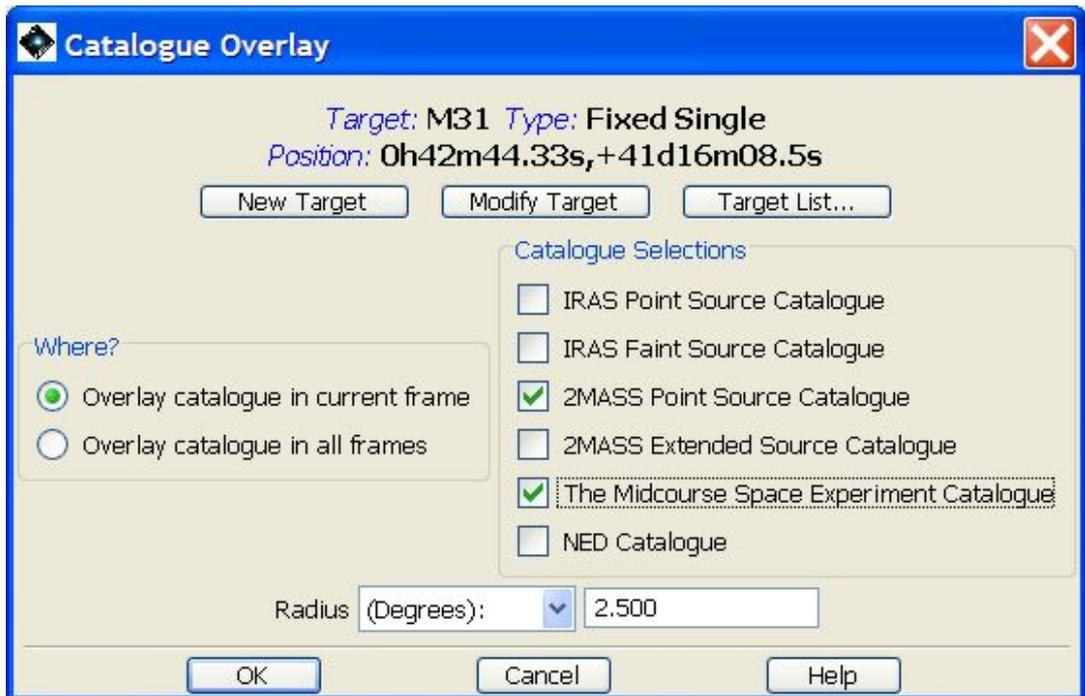
Figure 6.19. HSpot currently serves seven IPAC catalogues that can be overlaid onto the image display
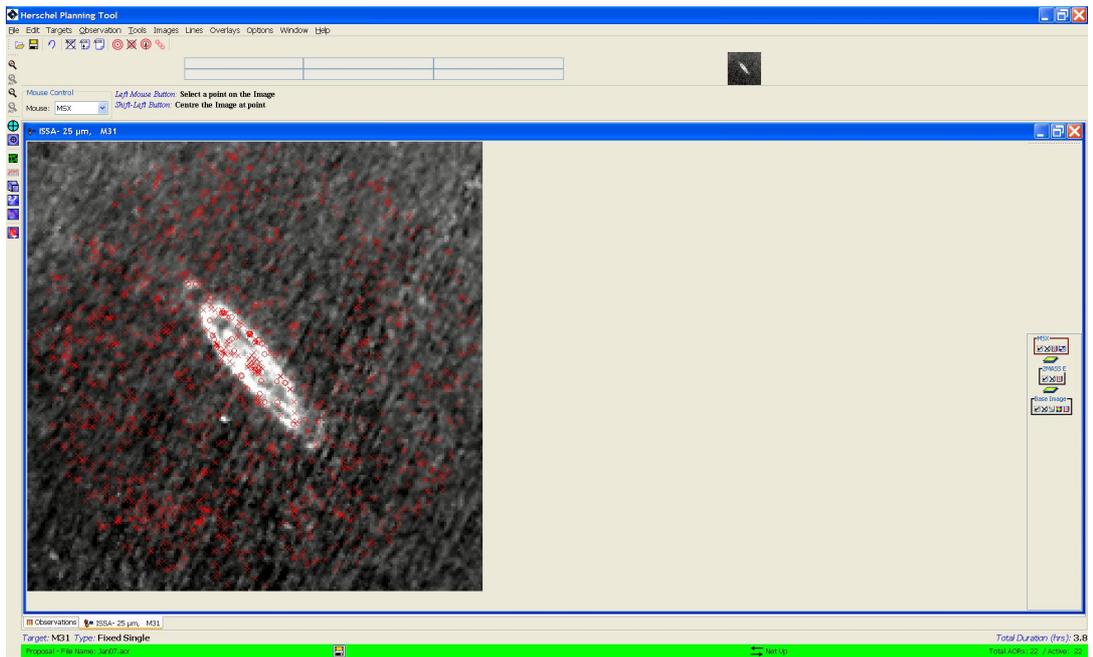
Figure 6.20. The 2MASS extended source (crosses) and MSX (circles) catalogues overlaid on the IRAS - ISSA 25 micron image of M31. Bear in mind that the density of sources in some catalogues is very high and that they may thus be unsuitable for overlaying on a wide-field image.

Figure 6.21. Catalogue listing for the MSX points found in a search around M31

Each overlaid catalogue generates its own control panel to the right of the screen. Four buttons are generated:

You can switch the target overlay box in the control box to the right of the screen on and off by pressing the tick symbol. If you press the cross symbol you erase the overlay.

• Tick mark: switches the overlay on and off. Useful for uncluttering without erasing the detections if you are overlaying from several catalogues on a single frame.

• Cross: Erases the overlay completely. If you erase it you must redefine the overlay to regenerate it.

• Page of text icon: Opens the catalogue file. This gives you the catalogue information for each detected source (name, position, flux(es), flags, etc.) and allows the presentation of the overlay to be modified. The control buttons allow the name of each source to be displayed on the overlay by selecting the "show all names" button (this action can be reversed by pressing this button again) and the shape and colour of the symbol to be changed; if you display several catalogues on the same image each is shown by default with the same symbol and colour, it is advisable to customise the symbols so that each catalogue's overlay can be identified.

It is also possible to change the display for one or a few sources identified in a single catalogue: to change the symbol used for the display, click on the drop-down menu in the "Shape" column for the source or sources that you wish to identify with a different symbol; selecting the "N" column for a source switches its name on and off in the image; selecting the "On" column hides

and displays the source; while the "Hi." column changes the colour of the symbol to its inverse (e.g. red to blue).

• Blue pennants icon: allows the overlay to be constrained. The data field can be selected and the constraint; a slide bar can be moved to show a range of fluxes, for example, only to display sources brighter or fainter than a certain flux.

6.8.1.2. Catalogues from SkyView

HSpot currently serves a large number and range of catalogues from HEASARC whose sources can be overlaid onto the image display. From the dialogue (Figure 6.22) you select the catalogue and appropriate search radius for sources. The text catalogues are cached, like the images, to your designated cache directory (see Section 6.9.5).
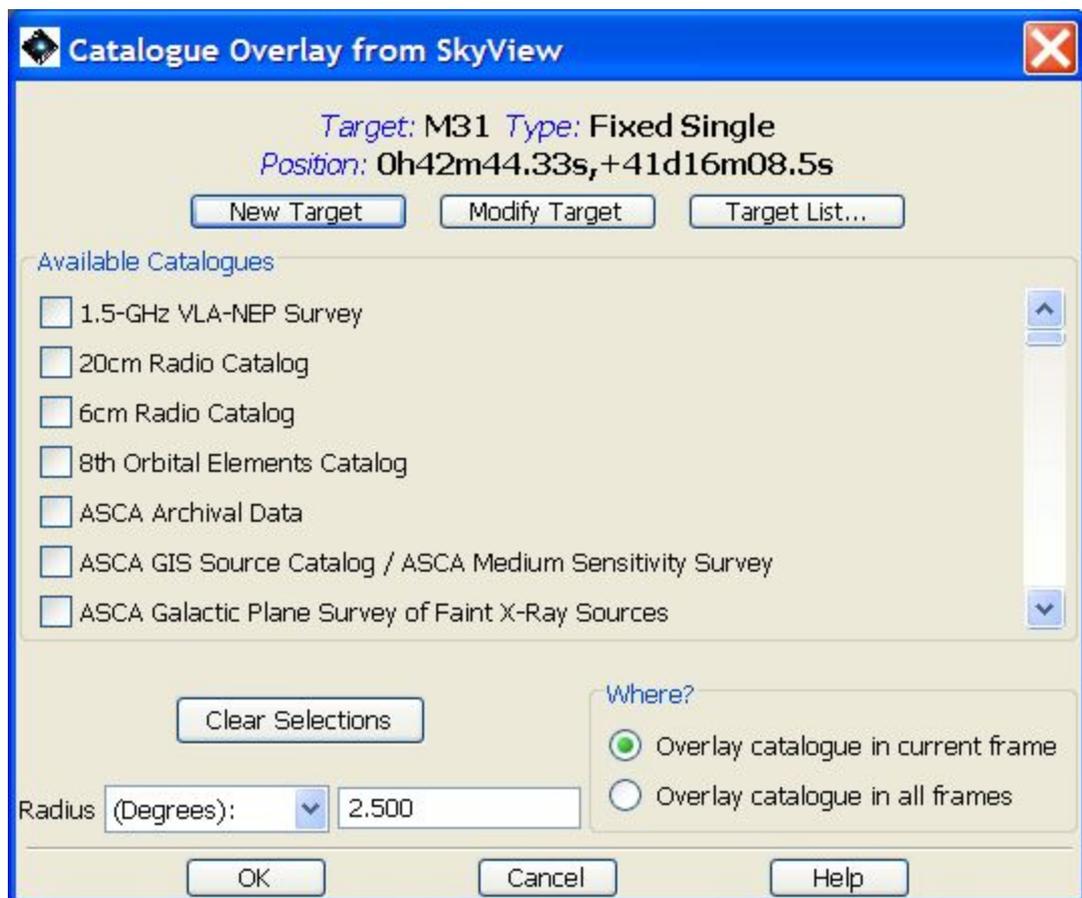
Figure 6.22. HSpot currently serves catalogues from SkyView that can be overlaid onto the image display

6.8.1.3. Catalogue File

HSpot can also overlay a catalogue file from local disk if it is in the modified IPAC table format. The selection dialogue is shown in Figure 6.23. A description of the modified IPAC table format is provided below. The file should have the 'tbl' extension so that HSpot knows it is an IPAC table. The format is comprised of three parts: keywords, column headers, and data in columns.
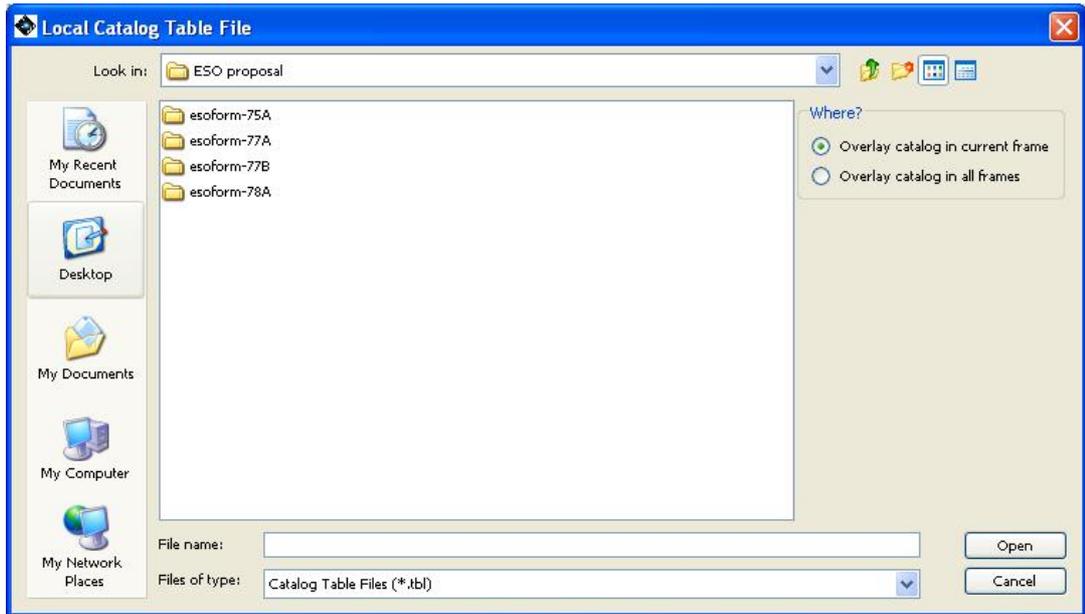
Figure 6.23. This dialogue will allow you to select a local catalogue file, in the modified IPAC table format, to overlay onto your images.

Keywords

Keywords start with a back-slash (\). There should be no space between the back-slash and the keyword. For example:

\ORIGIN = 'IPAC Infrared Science Archive (IRSA), Caltech/JPL'

\fixlen = F

\RowsRetrieved = 215

The required keyword is \RowsRetrieved which tells how many lines of data are in the file. The keywords are placed first in the file and they must be followed by column header lines.

Column Headers

The column headers describe the name, data type, and units of the tabular data.

```
| name1 | name2 |
 data type | double |
 unit | degrees|
| null1 | null2 |
```

The three required columns are:

```
| name| ra| dec|
 char| double| double|
 | degrees| degrees|
| null| null| null|
```

All four column header lines are required. Every column owns the rightmost bar, except for the first that owns two bars.

Sample IPAC Table File

Note that spacing is extremely important. All columns must fit within the space delimited by the vertical bars, as in the following example.

```
\RowsRetrieved = 10
  fscname   | ra      | dec     | fnu_12| fnu_25| fnu_60| fnu_100|
  char      | double  | double  | double| double| double| double  |
            | degrees | degrees | Jy    | Jy    | Jy    | Jy      |
  null      | null    | null    | null  | null  | null  | null    |
F23545+2632 359.2639  26.8250   0.221   0.112   0.126   1.100
F23548+2633 359.3554  26.8394   0.173   0.103   0.554   1.219
F23567+2659 359.8219  27.2697   1.298   0.315   0.152   0.838
F23568+2554 359.8425  26.1917   0.070   0.111   0.303   0.848
F23574+2800 359.9940  28.2814   0.112   0.054   0.228   0.951
F23561+2901 359.6731  29.3036   0.091   0.118   0.249   0.616
F23570+2846 359.8954  29.0547   0.224   0.130   0.146   0.465
F23554+2822 359.5090  28.6531   0.202   0.149   0.310   2.078
F23555+2735 359.5287  27.8722   0.098   0.170   0.234   0.840
```

6.8.2. Cropping an image

HSpot will allow you to crop an image to any required size. Press the left button of the mouse on the top left hand corner of the area that you wish to display and draw the box across. When you release the mouse button the image is automatically cropped to just the part in the box (Figure 6.24). The cropped image will display as a new image layer. If the image is larger than the screen size, by pressing SHIFT + left button at any point in the image the image will be centred there.
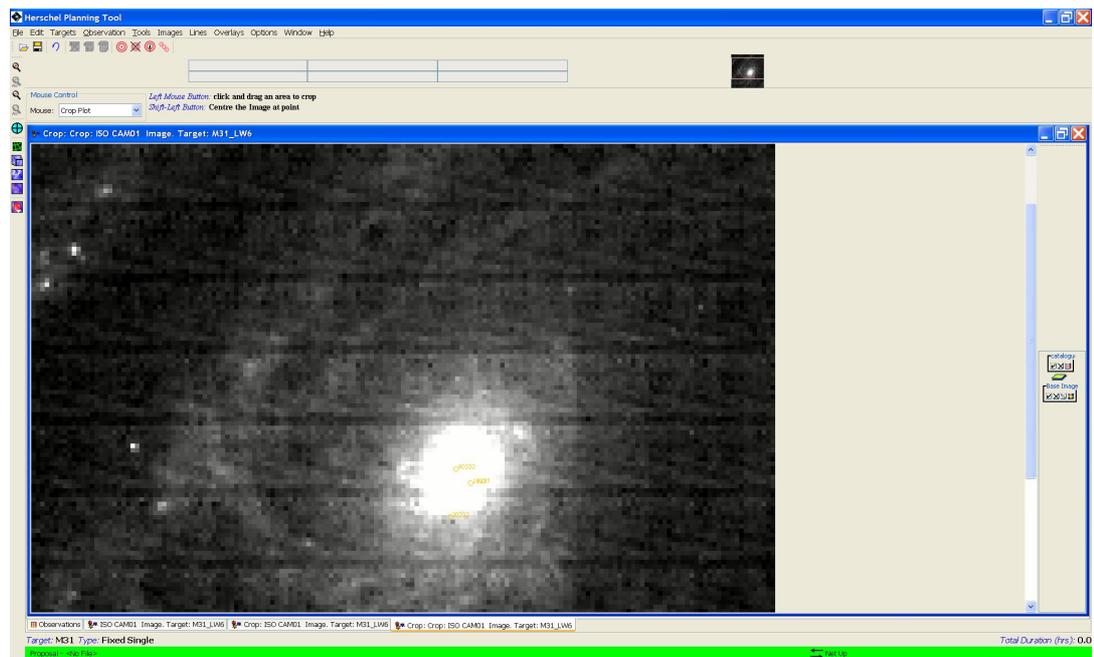
Figure 6.24. The crop image display. Instructions appear at the top of the screen, above the image.

6.8.2.1. Grid, a.k.a Coordinate Grid Overlay

HSpot will overlay a variety of coordinate grids onto the image display. From the dialogue (Figure 6.25), you select the type of grid and where to display it. You can now also force HSpot to overlay a coordinate grid on every image displayed, as well as control the spacing of the grid lines.

Figure 6.25. The coordinate grid overlay dialogue allows selection of the desired type of grid

6.8.3. Current Fixed Target Overlay

HSpot places a red box onto the current fixed target position in the displayed images. It also marks each offset position (in celestial coordinates) with a red plus sign if you have a cluster target type.

In the control box to the right of the screen you can switch the target overlay box on and off by pressing the tick symbol. If you press the cross symbol you erase the overlay.

6.8.4. Add Moving Target

This option allows you to visualise the track of moving targets. See Chapter 20 for a detailed description of how to use this feature.

6.8.5. Add Marks to Plot/User Created Catalogue

This tool allows to you selectively mark and label points of interest on your image plot. An example is shown in Section 20.6.2. You can save the marks to a catalogue file (in IPAC table format) to local disk. This user-created catalogue later can be read back into HSpot to overlay (see Section 19.2.8.4).

6.8.6. Distance Tool

Once this item is selected, the left mouse button can be used to click and drag a line across a region on your image. The length of the dragged line in selected units is then displayed both on the plot and in tabular form. An example is shown in Figure 6.26).

To see the results, click on the table icon to the right of the image. It will open and give you the start and finish positions of the line and the distance between them. The default units are arcseconds, but the units can be changed to degrees or arcminutes using a drag-down menu. Clicking on a row in the table and pressing "delete highlighted" allows you to erase any line to reduce clutter in the image.
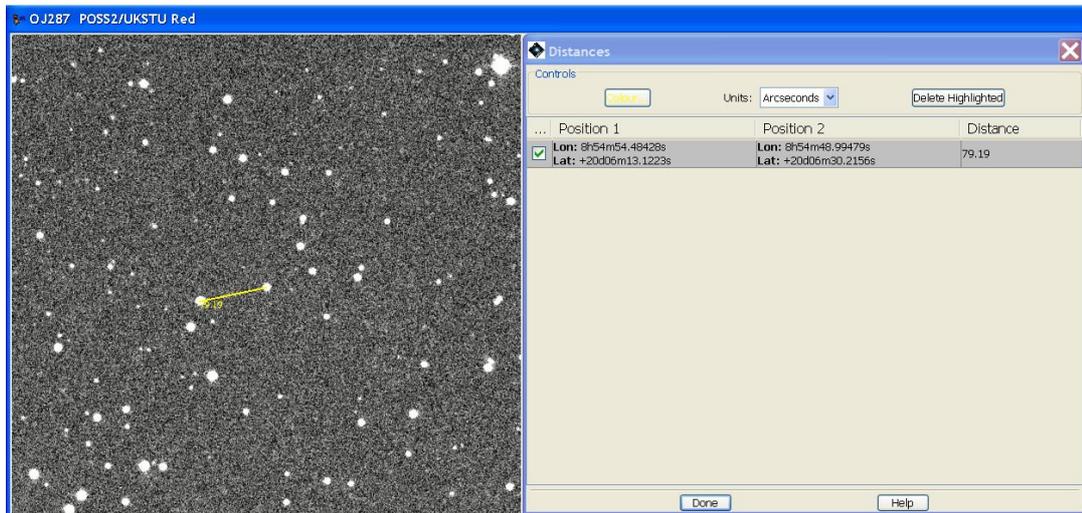
Figure 6.26. An example of a distance calculation and the distance tool control display showing the results.

6.8.7. Image Overlays

You can overlay an ISSA, 2MASS, MSX, DSS, SkyView, NED, ISO or a FITS file from disk onto your current image. Wavelength or generation (DSS) options are the same as for normal image display (Section 19.2).

6.8.8. Generic Focal Plane Overlay

This tool allows you to overlay a user specified square or circular aperture onto your image. The dialogue is shown in Figure 6.27. However, to be able to edit the aperture using the control box - under the word "circle" in the red box in the right hand sidebar (Figure 6.28) - you must have first set a date of observation in the "Visibility Windows" dialogue. The aperture diameter should be entered in arcseconds and may take any value from 0 to 54 000 arcseconds.
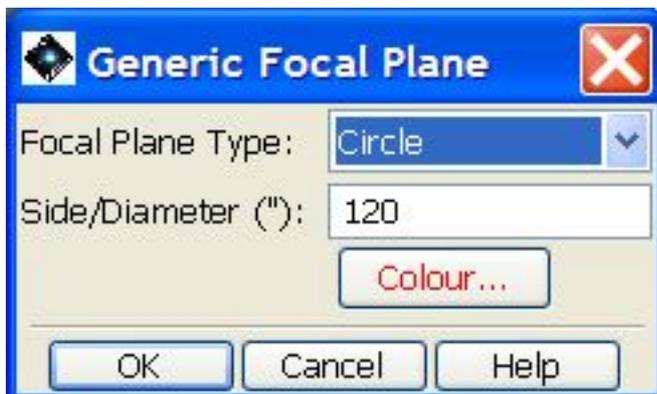
Figure 6.27. The generic focal plane selection dialogue allows the user draw a square or circle, of user selected size and orientation, onto an image.
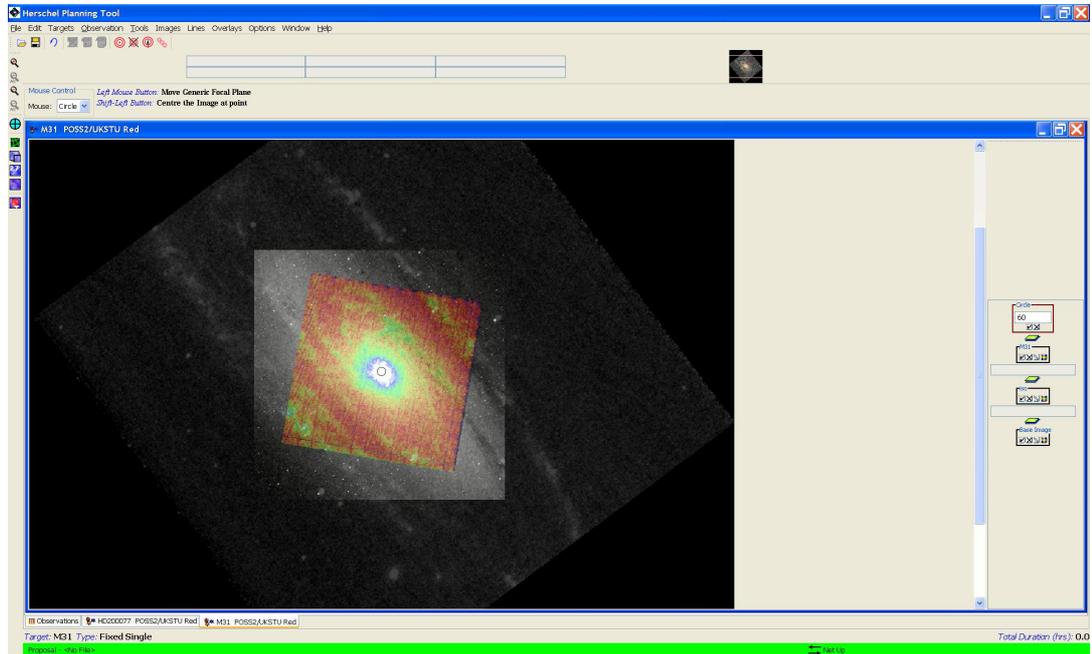
Figure 6.28. An image of M31 showing a circular 60 arcsecond generic aperture or focal plane with the control box in the right hand sidebar. Once a date of observation is set the user may change the size of the aperture to any value between 0 and 54 000 arcsecs.

6.8.9. Herschel Focal Plane Overlay

This item allows you to overlay the Herschel Focal Plane at any position and specified angle onto the current image (Section 20.6.6). When selected, the focal plane is drawn over the current image, centred on the current target position, and a box of controls is added to the side bar of the current image. This is the layer control, discussed in more detail in Section 20.6.6. The position angle (degrees east of north of the projected Herschel-to-sun vector) of the focal plane can be rotated by entering the value in degrees in the small entry field in the layer and hitting "Return". To move the focal plane overlay to somewhere else in the image, click the mouse at the desired point in the current image. To change the colours of the instrument fields-of-view (FOV), where the focal plane is centred, and which instrument fields-of-view are shown, click the focal plane configuration icon in the "Herschel Layer" box on the sidebar (⊞). This brings up the dialogue shown in Figure 6.30.

You can turn off/on any instrument fields-of-view or change their display colours here. To select which FOV in the focal plane is centred where you click the mouse, use the pull-down menu at the bottom of this dialogue. A display of the FOVs is given in Section 20.6.6.
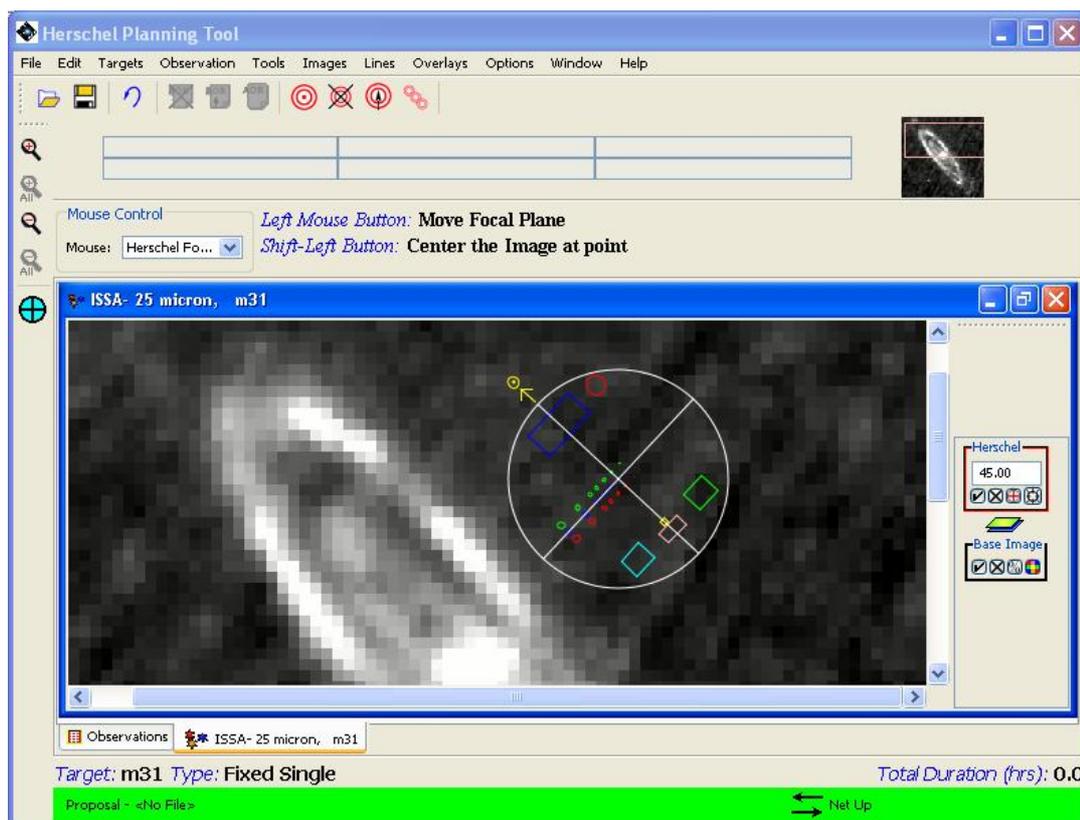
Figure 6.29. An overlay of the Herschel Focal Plane is shown on an ISSA 25 micron image. The desired position angle (e.g., 45), in degrees east of north, is entered into the field in the Focal Plane box.
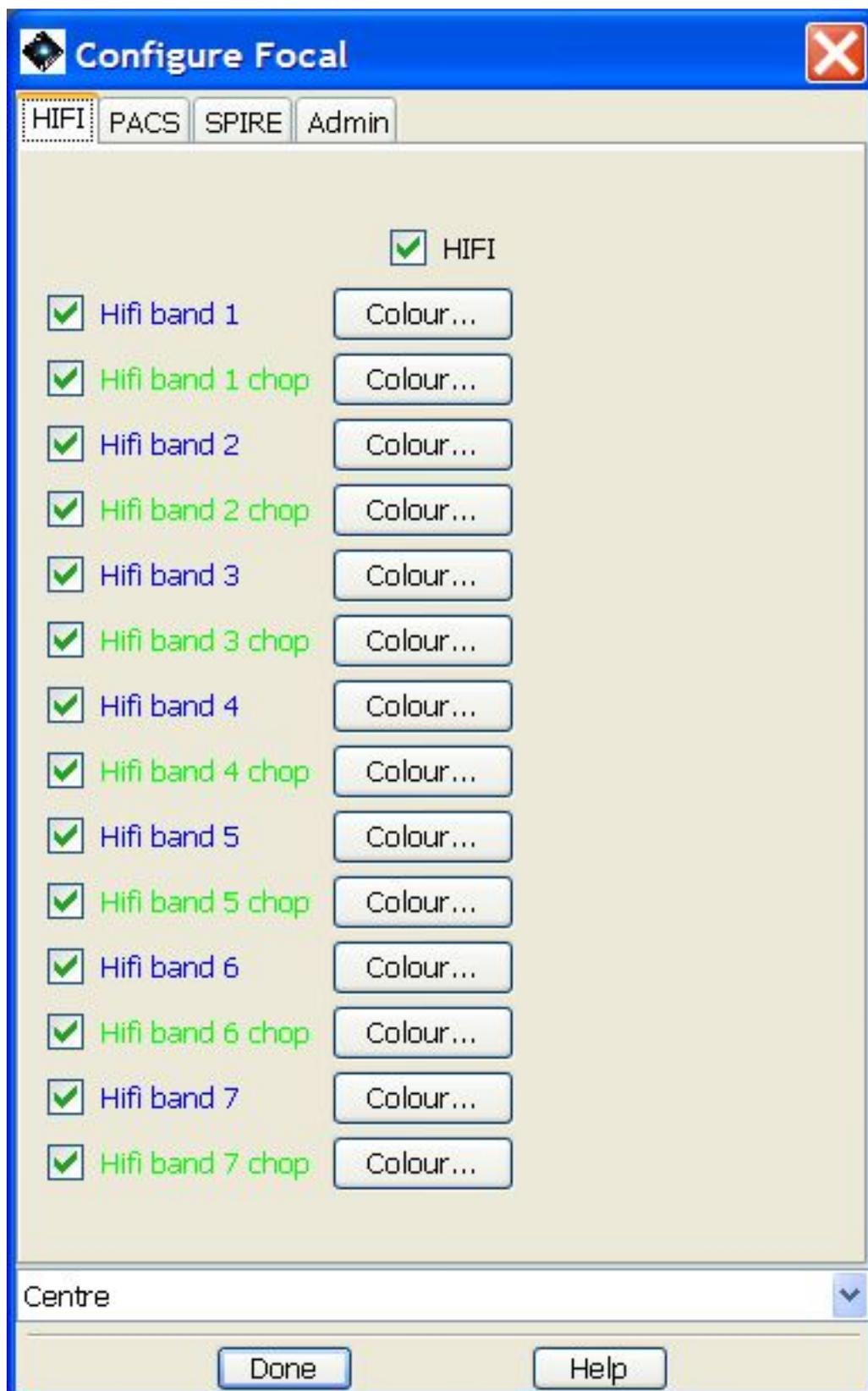
Figure 6.30. The configuration of the focal plane overlay is controlled from this dialogue. You can select the colours of the instrument fields-of-view overlays and also select which FOVs are shown. The pull-down menu at the bottom allows you to select which instrument FOV will be centred on the image where you click the mouse.

6.8.10. AOR Overlays

This function allows you to overlay the area coverage for one or more AORs onto the displayed images (see Section 19.2.8.3). When an AOR overlay is selected, the dialogue shown in Figure 6.31 asks you which AORs to overlay: the current one, only selected AORs, only AORs checked in the "Observations" window, or all AORs currently loaded in HSpot.

Next, the dialogue window for target visibility, shown in Figure 6.32, displays the visibility windows for the target, as well as a date in the middle of the next available visibility window, which is the default selection. If you want to plot the AOR for a specific observation date within any visibility window, enter that date here. You can click on any visibility window in the dialogue to automatically select the mid-date in that window. Or, just select the default. Click "OK" for the overlay. See the example in Section 19.2.8.4 for a description of how it works. HSpot must be connected to the Internet to do the overlay, as it contacts the HSC servers to get the correct orientation and sky positions for the overlay.

The set of pointings displayed can be viewed and saved. Click on the pointing list icon (⊞) to the right side of the image. You can animate through the different pointings made by the telescope during the observations, with or without leaving a trail, and you can save the pointings in a ".pts" file which can later be overlaid on other images.
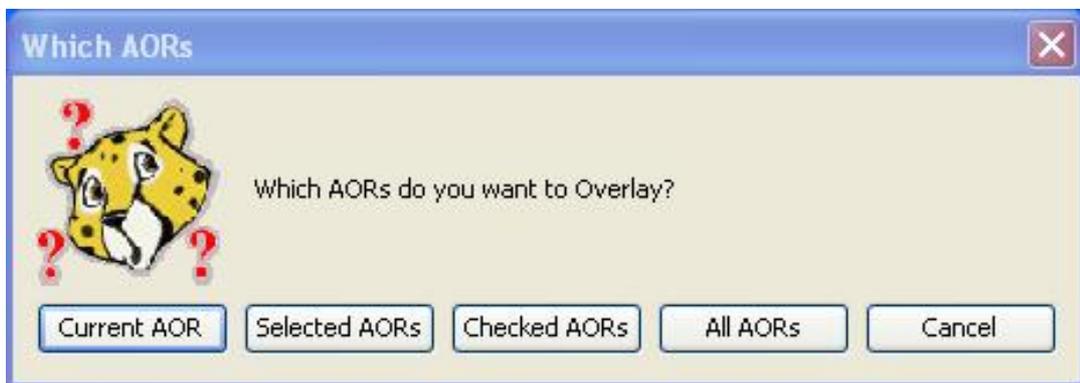
Figure 6.31. The dialogue for selecting which AORs to overlay on an image. You can overlay multiple AORs at once on a single image.
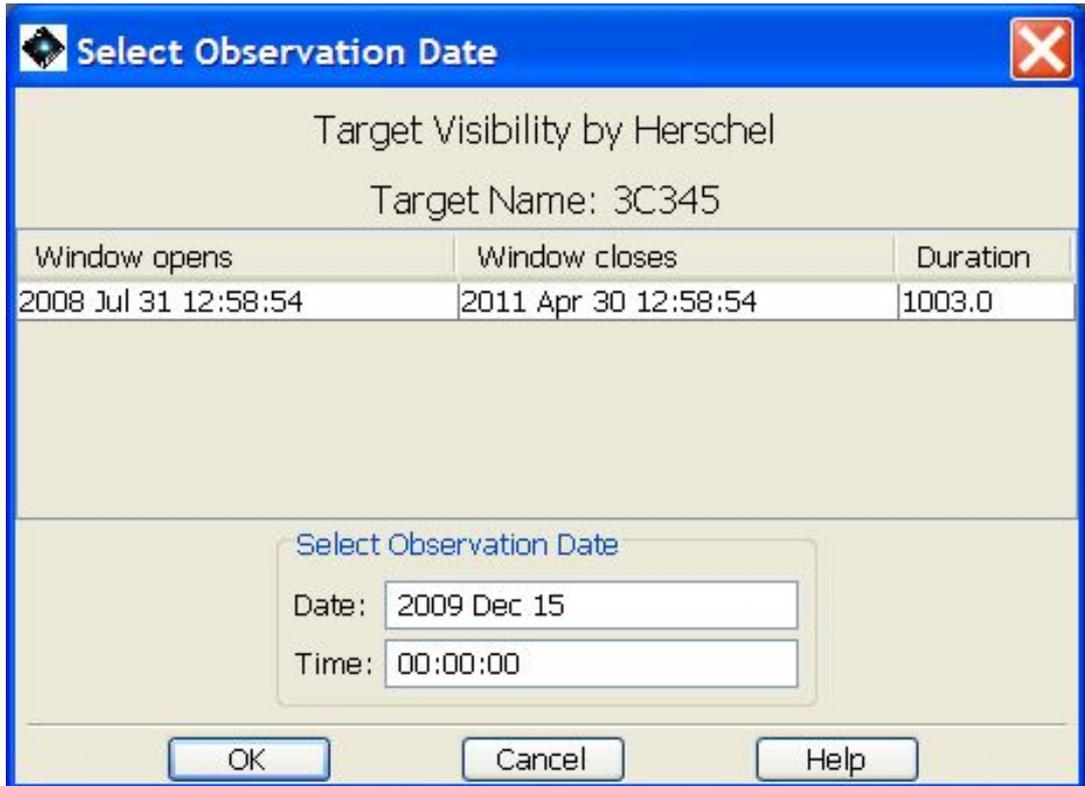
Figure 6.32. The dialogue for showing target visibility. Note that this is an object with permanent sky visibility; in such cases the visibility window opens at the moment of launch.

6.8.11. Read AOR Overlay Mapping File

You can save the pointings table for an AOR overlay to local disk (see Section 6.8.1). This file can be read back into HSpot at a later time for overlaying on images. The dialogue for reading the file into HSpot is shown in Figure 6.33. Currently, only the overlay for one AOR at a time can be read in. This feature, however, is intended to make AOR overlays more convenient and to be a time-saver when planning your observations.
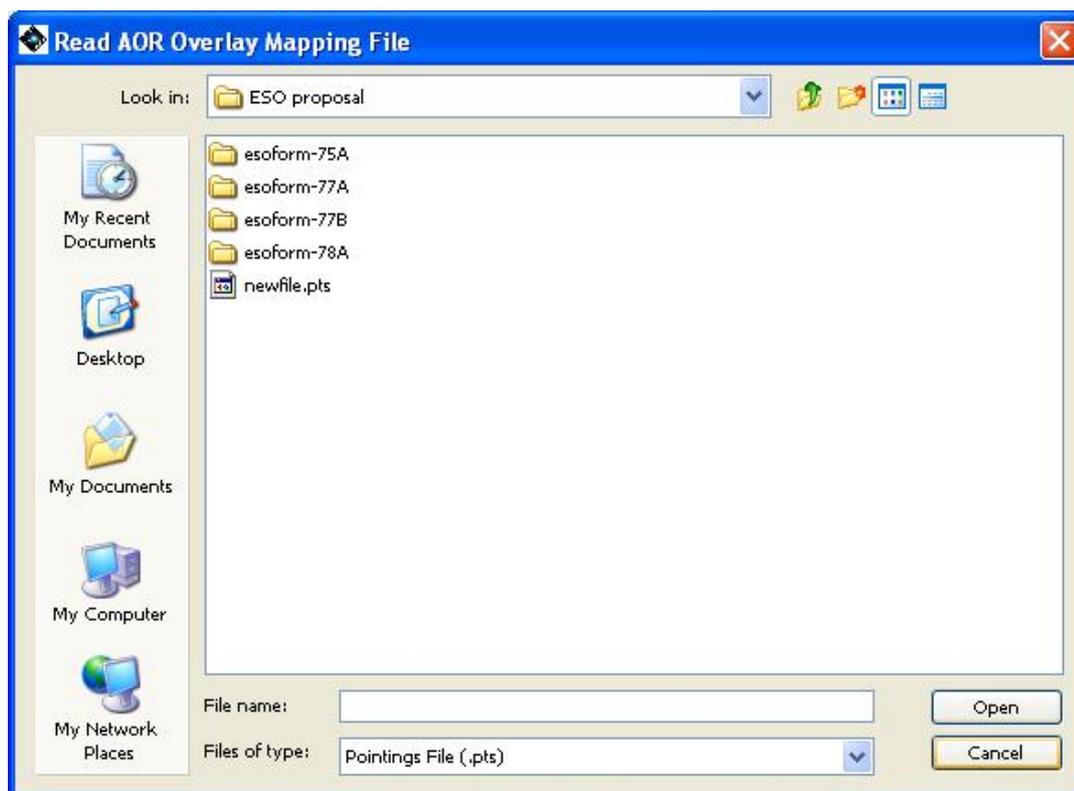
Figure 6.33. The dialogue for obtaining a previously saved set of pointings for overlaying on the current image.

6.9. Options Menu

6.9.1. User Automatic HSpot Version Update

The default for this is 'Yes'. When enabled, if an update for HSpot is available, you will be asked if you would like to update your software (approximately 2 minutes after you start HSpot with an Internet connection). If selected, HSpot will download the update and install it on your computer. The update will 'take effect' the next time you start up HSpot. Select the option to exit HSpot and start it again if you wish to access the update immediately. You may though download the update, finish your session and then choose to close HSpot to make the update effective. It is *strongly* recommended that you allow auto-updates.

6.9.2. Sum Only Checked AORs

When selected, only the AORs with the ON flag checked will be summed in the "Total Duration" shown at the bottom right of the main AOR table. This function is useful for getting the total time for a subset of AORs.

6.9.3. Visualisation: Coordinate System Preferences

This option allows you to select a default coordinate system displayed in the tables in HSpot. Options include equatorial (B1950, J2000), ecliptic (B1950, J2000), Galactic or super-galactic coordinate displays.

6.9.4. Visualisation: Readout Prefs

HSpot returns three different pairs of values for the cursor position (Figure 6.34) just below the main icon bar when displaying an image. To the left, HSpot shows the flux or DN value for the pixel and the pixel scale. For the ISSA images, these values are correct. For the 2MASS images, you should not rely on the DN readout for photometry. Use the 2MASS catalogues (click on the table icon to the right of the image to see the tabulated data for all the sources that were found in the search) for accurate scientific data values. In the centre and right boxes, HSpot displays two user-selected values for the present cursor position. The "Readout Prefs" dialogue is how you select those values. For example, you can display the equatorial and ecliptic coordinates, or any coordinate system versus image pixel. The read-out works for both the main image display and the thumbnail display shown to the right of the read-out boxes.

The format of the two coordinate columns shown in Figure 6.34 is selected from the "Readout Prefs" item in the Options menu Figure 6.35.

| Flux: 2.619 MJY/SR | Eq-J2000 RA: 0h42m32.80s | X: 101.312 |
| 1 Pixel: 90.000" | Eq-J2000 Dec: +41d49m36.8s | Y: 122.750 |

Figure 6.34. HSpot displays the three different pairs of values for the cursor position on the image currently being displayed. On the far left, HSpot shows the flux or DN value and the pixel scale. In the centre and right, HSpot displays two different user selected coordinates.
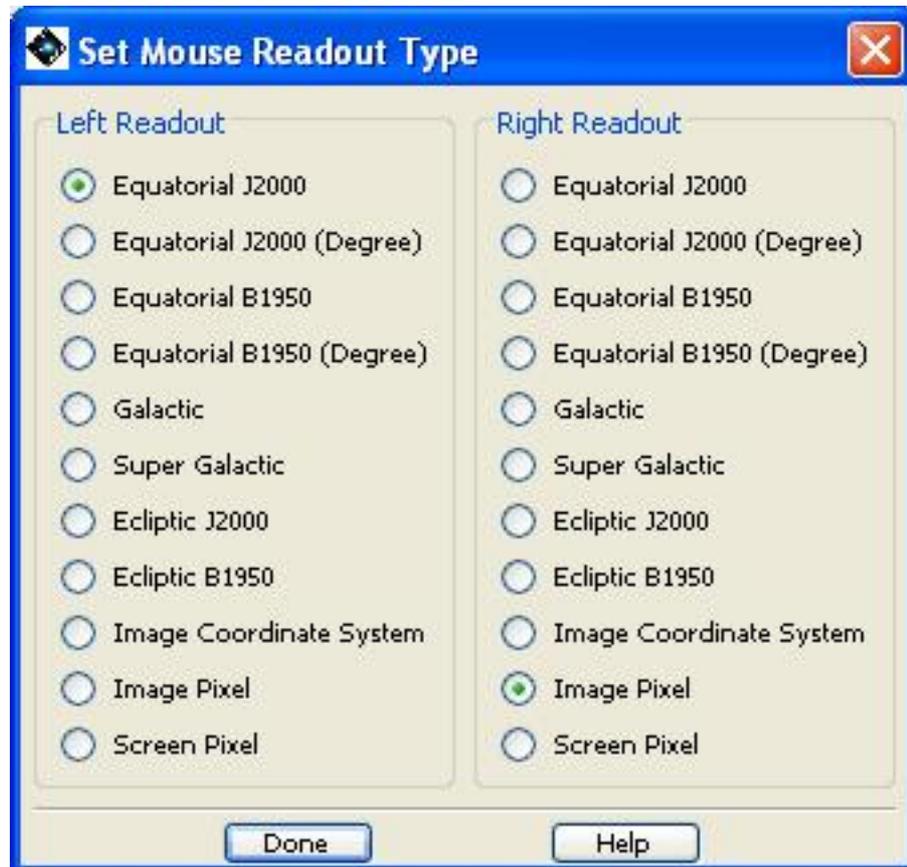
Figure 6.35. dialogue for selection of displayed coordinates for images

6.9.5. Cache Prefs

HSpot caches the images that it retrieves from remote servers to the local disk so that the images are available locally the next time you ask HSpot to display them. This saves time and network traffic. The first time you retrieve an image, HSpot will ask you to designate a cache directory. You can

change the location or size of the disk cache directory from this dialogue (Figure 6.36).
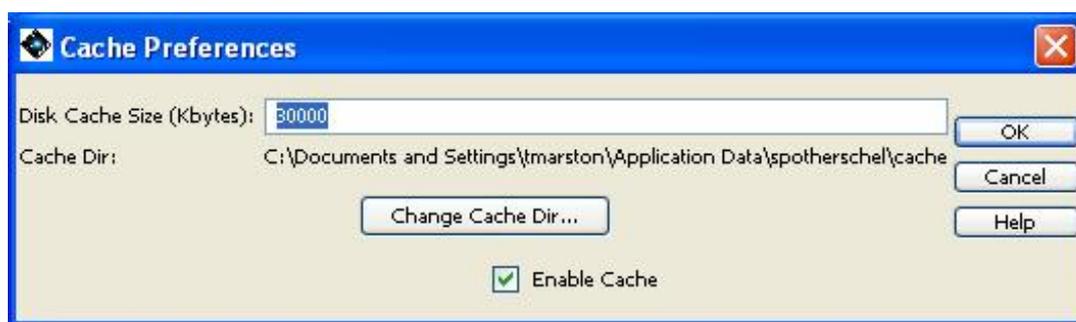
Figure 6.36. The size and location of the disk cache directory, where HSpot stores images retrieved from remote servers, is controlled from this dialogue.

6.9.6. Network Proxy Setup

If you select this option, you will see two options – "Direct Connect to Internet" and "Manual Proxy Configuration". If your institution has a firewall or proxy server in place, you will want to select the "Manual Proxy Configuration" option and fill in the appropriate values for HTTP and HTTPS proxy ports and hosts, as well as proxy user name and password. It is recommended that you check with your systems administrator for the proper values, though, these can often be found by checking in your internet browser, "Preferences"/"Options," then "Advanced," and then "Proxies."

6.9.7. Visualisation: Show Mouse Help

If you check this box, HSpot will display messages in the region above the Images and AOR frames that provide help for using the mouse. For example, if you put your cursor over the image thumbnail (Figure 6.29, far right), it tells you that you can move the image by using the left mouse button.

6.9.8. Visualisation: Show Side Bar on Current Frame

This allows you to manage your screen menus and controls for the currently displayed image. If you are working on a very small screen, you may wish to turn off the sidebars on the right hand side of the image that allow you to manipulate overlays. This option allows you to show or hide them.

6.9.9. Visualisation: Show Side Bar on All Frames

This works as in the previous option except that the action is applied to all images that are displayed, not just the current frame.

6.10. Window Menu

This menu shows "Observations" (the AORs that have been defined) and the names of any images currently displayed in HSpot. It brings the window you choose to the front. Selecting "Observations" brings forward the main AOR table; this is useful for managing HSpot, if you are displaying several images and going back and forth between them and the AOR table.

6.11. Help Menu

Returns the Help options

6.11.1. Overview...

This is the access point to the HSpot on-line help. The Help is linked to this HSpot manual and is presented as a tree ordered by topic and sub-topic. Please also see the Herschel Observer's Manual and the HSpot Release Notes, as well as the additional information available on the HSC web pages.

6.11.2. Tip Of The Day

This controls the viewing of HSpot Tips. You can turn on/off the display of the Tip Of The Day at HSpot start-up. You can also browse through the Tips. More than 20 practical tips are offered. Take a look.

6.11.3. AOR File Format Changes

AORs created with older versions of HSpot may be changed when read into the current version. These changes mainly handle keyword changes between the versions. The changes that have been made for each version of HSpot are listed here, with the most recent changes shown first.

6.11.4. AOT Field Descriptions

This shows a table that lists all the fields that can be entered in the AOTs. The allowed and default values are shown here.

6.11.5. About...

This function reports the version of HSpot running on your computer and the version of the AOR Estimator Server at the HSC that you are accessing to calculate resource estimates. In the next section we provide a summary list of the functions available from all of the HSpot menus.

6.12. HSpot Menu Command Summary

- FILE MENU

- [ctrl-Q]

- Read AOR(s) and Target(s) [ctrl-R]

- Save AOR(s) and Target(s) [ctrl-S]

- Import Fixed Single target list

- Import Moving Single target list

- Save Target Background Estimates

- Save Target Visibility Windows

- Save Current Plotted Image as FITS file

- Save Current Plotted Image & Overlays to JPEG, GIF, BMP, or PNG

- View Program

- Search Programs

- Check In Program

- Quit

- EDIT MENU

- Undo [ctrl-Z]

- Delete current AOR [delete]

- Modify current AOR [ctrl-M]

- Copy current AOR [ctrl-C]

- Delete All AORS

- Delete All Targets

- Enable All AORs [ctrl-E]

- Disable all AORs without G/F Constraints [ctrl-D]

- Toggle On Flag (AORs without G/F constraints)

- TARGET MENU

- New Target [ctrl-T]

- Delete Target

- Modify Target

- Target List

- Calculate Visibility Windows for All Targets

- Calculate Background for All Targets

- OBSERVATION MENU

- HIFI Single Point....

- HIFI Mapping....

- HIFI Spectral Scan....

- PACS Photometer....

- PACS Line Spectroscopy....

-
- PACS Range Spectroscopy....

- SPIRE Photometer....

- SPIRE Spectrometer....

- TOOLS MENU

- AOR Replication Tool

- Target Replication Tool

- Group/Follow-on Constraints

- Timing Constraints

- Proposal Submission Tool

- Show Current Resource Estimates [ctrl-A]

- Recompute All Estimates

- Compute Backgrounds from File

- Memory Monitor

- IMAGES MENU

- ISSA Image

- 2MASS Image

- MSX Image

- DSS Image

- SkyView Image

- NED Image

- FITS File Image

- All Sky Images

- LINES MENU

- JPL Line...

- CDMS Line...

- Manage Lines...

- OVERLAYS MENU

- Catalogues from IPAC

- Catalogues from SkyView

- Catalogue File

- Grid

- Current Fixed Target

- Add Moving Target

- Add Marks to Plot/User-created catalogue

- Distance Tool

- Image Overlays

- Herschel Focal Plane

- Generic Focal Plane

- AORs on current image

- Read AOR Overlay Mapping File

- OPTIONS MENU

- Use Automatic HSpot Version Update

- Sum Only Checked AORs

- Visualisation: Coordinate System Prefs

- Visualisation: Readout Prefs

- Cache Prefs

- Network Proxy Setup

- Visualisation: Show Mouse Help

- Visualisation: Show Side Bar on Current Frame

- Visualisation: Show Side Bar on All Frames

- WINDOW

- Observations

- Open image windows...

- HELP

- Overview...

- Tip Of The Day...

- AOT Field Descriptions

- About...

Chapter 7. HSpot Main Screen

7.1. Icons

HSpot uses several icons as shorthand for commonly used functions that are also available under the menus. They are shown in Figure 7.1. The first three icons are associated with handling AORs. From left to right the icons are: read in AORs/targets from a file; save AORs/targets to a file; undo last action. A button is displayed in colour if active and grey when inactive (e.g. you cannot save AORs unless you have defined some AORs to save).

Figure 7.1. Shortcut icons used on the main screen of HSpot

The next three AOR icons become active once you have defined AORs.

- delete the current AOR

- modify the current AOR

- make a copy of the current AOR

The four bulls-eye icons are for manipulating targets.

- new target

- delete target

- modify target

- show the current target list

The image manipulation icons will appear on the left-hand side of the HSpot window zooms in the current image, and this one whenever you display images (Figure 7.2). The magnifying glass icons are all for zooming your images in or out. There is a stack of twelve image control icons. The top two zoom in, either for just the current image or for all images (if you have only one image displayed the "all" icon will not be active). The next two zoom out, again either the current image or all images. The crosshair icon is used to centre the image on the current target if the image is larger than the size of the window. The next icon identifies the current target on the image. The section of geodesic globe plots a grid on the image. The graph icon plots a graph of the flux between two points. The interlocked squares icon crops the current image. The "number" icon opens the distance tool to compute the distance between two points. The final two icons plot a mark on the imae at a point determined by the user overlay another image, respectively.

Figure 7.2. The zoom and centring icons will appear on the left of the HSpot window whenever images are displayed.

7.2. Observations Table

The list of AORs currently loaded in HSpot is shown on the main screen (Figure 7.3) in the "Observations" table. For each AOR, it lists:

- Unique AOR Label

- Target Name

- Abbreviated Target Position

- Target Type

- T = timing constraint flag

- G = grouping constraint flag

- F = follow-on constraint flag

- Instrument = AOT selected

- Duration = total wall-clock time in seconds for this AOR

- Stat = status of this AOR. This is always 'new' for any AORs that you have just created. If you are modifying AORs that have been checked out of our database, this field will represent the ap-

propriate status for them.

- ON flag

Figure 7.3. The main screen shows the Observations table, displaying the AORs currently loaded into HSpot.

Tables formatted in the JAVA language have several features that can be exploited while using HSpot. The columns can be rearranged by clicking on and dragging the column headers. Simply clicking on a column header enables sorting of the table by the column contents. When the header is clicked upon once or twice, red or blue arrows appear next to the column header. The red arrow signifies sorting in increasing order; the blue arrow indicates sorting in decreasing order. A third click, or no arrow, means that the list is returned to its original order. You may edit an AOR by double clicking on it, or delete an AOR by selecting it and clicking on the "Delete Current AOR" button. By clicking and dragging on the edge of the header cell, you can change the width of the column.

The small icon in the upper right hand corner will iconify the Observations table and leave the HSpot screen clear. The slightly larger icon in the upper right hand corner will minimize and maximize the area of the HSpot screen covered by the Observations table.

7.3. Bottom Bar

At the bottom of the main screen, HSpot provides information about the currently selected target, as well as information about the status of the network and the total amount of time to execute all, or a selection, of the AORs loaded in HSpot (Figure 7.4). The information provided is:
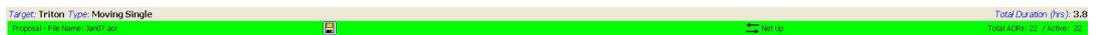
Figure 7.4. The bottom of the main screen shows current target, network and total current AOR timing estimate. If a question mark is showing it indicates that some or all the AORs in the Observations window have not got current time estimates.

- Target: The name and type of the currently selected target are shown at the bottom left of the main screen.

- Total Duration: The total amount of time, in decimal hours, for the AORs that have time estimates and are currently loaded (or selected as ON; see Section 6.9.2), is shown in this field in the lower right corner. If you click on this field, the format toggles between decimal hours and hours:minutes:seconds.

- Proposal: This will show the proposal/program number of your approved observing programme or the name of the AOR file you have read into HSpot from disk.

- Disk Icon: If you have entered AORs into HSpot that have not yet been saved to a file, the diskette icon will appear in the bottom bar of the main window. You may save your AORs by clicking this icon, clicking the disk icon in the upper icon bar, or by selecting "Save AORs and

Targets" from the file menu.

- Net Icon: The "Net Up" or "Net Down" messages and symbols give you the current status of your connection to the servers at the Herschel Science Centre, if you are connected via the Internet. If the network is down, or you are working offline, you can still enter target and AOT information into HSpot, and display images or catalogues you have cached or have locally on disk. You cannot obtain time estimates, background estimates, visibility windows, orientation information, or load new images or catalogues from the server if the network is down.

- Total AORs/Active: If you have AORs loaded, on the far right of the bottom bar HSpot reports how many AORs are currently loaded, and how many are active, i.e., the ON flag is checked.

Chapter 8. Entering An Astronomical Observation Request (AOR)

Creating an AOR for Herschel consists of entering targets that are individually linked to a desired Herschel observing mode or Astronomical Observation Template (AOT), and then obtaining a time estimate. The basic steps in completing an AOR are:

8.1. Start the HSpot software

Launch HSpot by either clicking on the Herschel icon (Windows or Mac PC), or by running the program by typing "./HerschelSpot" from the directory where you have installed HSpot for UNIX or Linux installations.

8.2. Enter Target Information

Enter a target by selecting "new target" from the target menu or clicking on the bulls-eye icon. You may also read in a list of targets via the file menu using "Read Fixed Single Target List" or "Read AORs and Targets." How to enter a target is described in Chapter 9.

8.3. Fill Out an Astronomical Observation Template

Select an AOT from the Observation menu. The instrument configuration and integration time parameters are entered in the AOT form. The Herschel Observer's Manual and Instrument Observer's Manuals are the primary reference for information to use in planning your science observations. Some additional comments are provided in this User's Guide in Chapter 8, Chapter 10, Chapter 11, Chapter 12 and Chapter 13.

8.4. Unique AOR Label

The first field at the top of each AOT is the 'Unique AOR Label'. The contents of this field must be different for each AOR you enter. HSpot provides a default name (e.g., 'HPoint-0000' for the HIFI point source photometry templates). Normally you should find the default naming system perfectly adequate. If you prefer to personalise the names, you can use a naming system of your choice. You might include a project name or abbreviation with a number, or you can use something simple like numbers or letters. Do not use full stops (.) or colons (:) in the AOR Label field. You may use alphanumeric characters (including spaces), the dash (-), and the underscore (_).

8.5. Target Buttons

From each AOT, there are buttons that allow you to create a new target, modify the currently selected target, or view the current list of targets. These work in the same fashion as the target menu items and target icons. If you have previously created an AOR and want to modify the target parameters, you must modify the target using the "Modify Target" button within the AOT form.

8.6. Observation Estimates

Determine how long your observation as specified will take to execute by clicking on the "Observation Est... " button at the bottom of the AOR pop-up. If you are connected to our servers via the Internet, HSpot will return resource estimates in the a dialogue box. The most important number returned here is the AOR Duration. This is the wall-clock time that Herschel will require to execute the observation. You need to request this amount of time for the observation in your observing pro-

posal.

On occasion the "Observation Est... " button may give a network error. This problem is usually transitory.

The information returned in the time estimate dialogue will depend on exactly which instrument/ mode is being used but will include:

- AOR Duration: This is the total wall-clock time required to execute the observation.

- Estimator Version: This is the version of the software server that is calculating the resource estimates.

- Integration Times: These are estimated on-source integration times in seconds for each array/ module selected in the AOR.

8.7. Other AOT Buttons

8.7.1. Comments

This is a text field where you may enter any additional information that you wish to save with your AOR. The maximum length of a comment is 500 lines (see also the note below). *In general, the Community Support staff at the HSC will only read the comment field if there is a problem with your AORs.* All the information necessary to execute the AOR should be included in the AOR and constraint parameters.

Note

If you try to paste in a comment of ~3000 lines or more, which is well in excess of the maximum permitted length of comment and you are using a Windows-based PC system, HSpot may crash. This is a Java problem on Windows.

Please use this feature sensibly and make any comments succinct and to the point. The longer the comment, the more danger there is that critical information in it may be missed.

8.7.2. Visibility

Calculating the visibility windows for your AOR, i.e., the time periods during which Herschel can observe the object, is discussed in Section 9.7. If you click this button, HSpot will calculate the visibility windows including the AOT parameters (the extreme edges of maps are taken into account, for example) you have entered, instead of just using the target position.

8.7.3. Save AORs

Save the AORs you have created from the "File" menu function or by clicking on the diskette icon in the icon bar or at the bottom of the main screen. AOR files are saved with the suffix '.aor'. If you do not select a specific directory, HSpot saves these files in the default directories listed below.

- Solaris/Linux/Mac ~/.hspot

- Windows 95,98,ME c:\hspot

- Windows NT/2000/XP c: \Documents and Settings\{username}\Application Data\hspot

It is important that you save your AORs before exiting HSpot, otherwise, your work will be lost. HSpot does not save AORs or targets to disk automatically. Although saving them is the default option on exiting HSpot, a computer (or HSpot) crash will cause all unsaved work to be lost.

Chapter 9. The Target Entry Dialogue

9.1. Target entry dialogue window

Several HSpot features are available from the target entry dialogue. Selecting "New Target" from the "Targets" menu or clicking the bulls-eye icon on the main screen opens a new target entry dialogue. The target entry dialogue is shown in Figure 9.1.
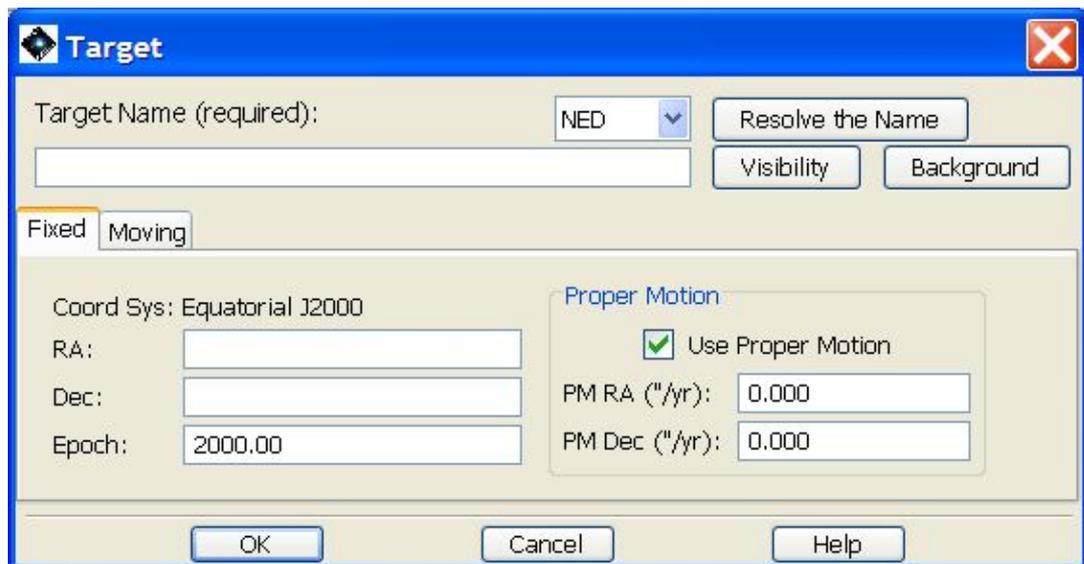
Figure 9.1. The target entry dialogue is shown. The two types of targets (fixed or moving) are selected from the tabs. This example shows the information you can enter for a Fixed Single target type.

The target types, target coordinate systems, and target entry formats supported by HSpot are discussed below. The other features accessed from the target entry dialogue are:

- SIMBAD/NED/NAIF Target Name Resolution.

- Sky Background Estimates for inertial targets.

- Visibility Windows for inertial and moving targets.

- Position Angle of the Herschel focal plane.

9.2. Target Types

You must define your target using one of the following target types. These are selected from tabs in the target entry dialogue.

9.2.1. Fixed

A fixed-single target is one object or map centre outside of the solar system. This default entry dialogue is shown in Figure 9.1.

9.2.2. Moving

A moving target is a solar system object that has a different tracking to the normal sidereal rate.

Entry of moving targets is discussed in more detail in Figure 9.2. The entry dialogue is shown in Figure 9.2.
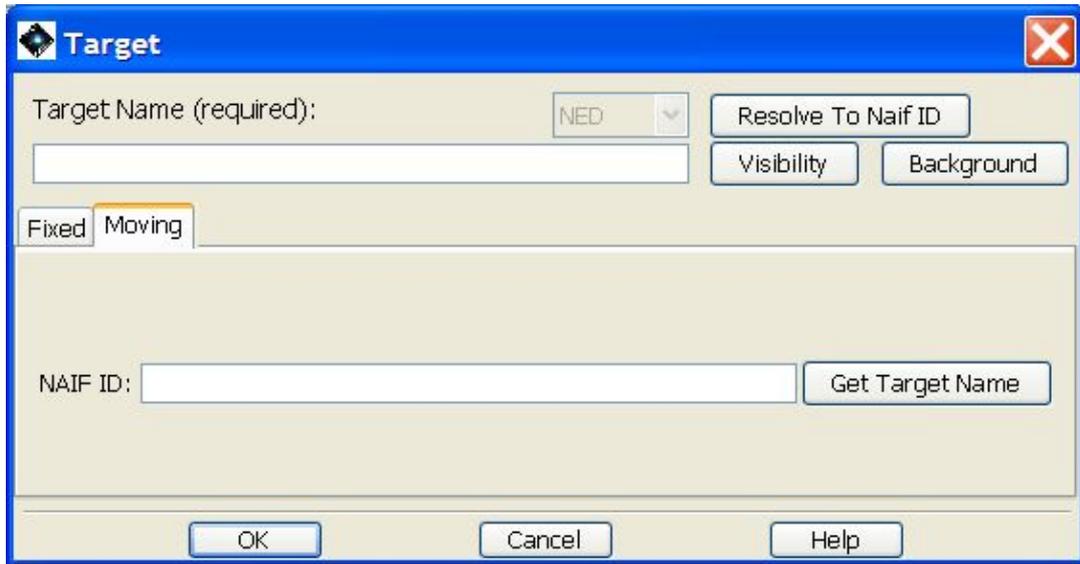
Figure 9.2. The moving target entry dialogue is shown with the name Dione entered. It will list the NAIF IDs of objects with this name for you to choose from, in this case, Dione the satellite versus Dione the asteroid (see Figure 9.3).

For a comet, entering "2P" is correctly resolved as "Encke" and gives NAIF ID "1000025". Entering "Encke" is also resolved as the correct NAIF ID. Rather perversely though, if you give the full, official IAU designation "2P/Encke" the name gives a name resolution error.

9.3. Inertial Target Coordinate Systems

9.3.1. Coordinate Entry Formats

To simplify mission planning and target handling, HSpot only allows the entry of coordinates for inertial targets in the fixed-single and fixed cluster-position target types in equinox J2000. All proper motions must have the same epoch as the target coordinates. A fixed position dialogue is displayed in Figure 9.1.

You may enter inertial coordinates in a variety of formats:

- Equatorial RA

    12:5:10

    12:05:10

    12 5 10

    12h5m10s

    12.5 (= 12.5 hours of RA = 12h30m00s)

    12.5d (= 12.5 degrees)

- Equatorial Dec

    12:5:10

12:05:10

12 5 10

12d5m10s

12.5 (= 12.5 degrees = 12d30'00")

You may not enter the declination as 12d5'10". This is to prevent confusion between quotation marks and arcminutes or arcseconds when coordinates are read in from a list. Declinations are also displayed with 'm' standing for arcminutes and 's' standing for arcseconds.

- Galactic/Ecliptic: Enter longitude and latitude in decimal degrees: 12.5 or 12.5d

9.3.2. Coordinate Conversion

You must enter coordinates in the Equatorial J2000 system, but if you would like to know what the ecliptic coordinates are at that position, simply select Ecliptic J2000 from the coordinate system tab. HSpot will convert the coordinates to the new system for you. HSpot will convert and display the entered coordinates to or from any of the allowed formats.

9.3.3. Entering Targets at the Celestial Pole

If you enter a target directly at either the north or south celestial pole, the right ascension you enter is important. When Herschel is calculating mapping positions and offsets it creates a new local co-ordinate system, with the equator running through the specified target position, and north and east determined from this initial position. Therefore, if you enter a position of J2000 RA = 1 hr, DEC = 90 deg, if you have mapping offsets from your primary positions, they will be in different locations if you specify J2000 RA = 5 hr, DEC = 90 deg. The central position for the map is though, of course, the same in both of these instances. Use the visualisation tools to see how your observations will look when executed.

9.3.4. Moving Target Entry

For moving targets, you must enter a standard ephemeris specified by the NAIF ID number.

9.3.5. Standard Ephemeris

For targets in the NAIF database, enter either the NAIF ID or the target name (se the Herschel Observers' Manual for more information about NAIF IDs), and HSpot will return the appropriate target name or NAIF ID number when you click on "Get target Name", or "Resolve the Name" buttons. A list of NAIF IDs and names recognisable to HSpot can be found on the Herschel AO web page and in Appendix C (Appendix C). It is also possible to use the JPL DASTCOM database (http://ssd.jpl.nasa.gov/dastcom.html#browse) to interactively search for NAIF IDs (called "SPK-IDs" on the DASTCOM database) and names. If the name you enter is used by more than one object in the NAIF database, for example Dione the satellite and Dione the asteroid, HSpot will provide you with a list of NAIF IDs to select from after entering the name and clicking on the "Resolve to Naif ID button" (Figure 9.3). It is important to select the correct NAIF ID for your object, as the NAIF ID is the single identifier Herschel uses to provide ephemeris information for planning and scheduling.
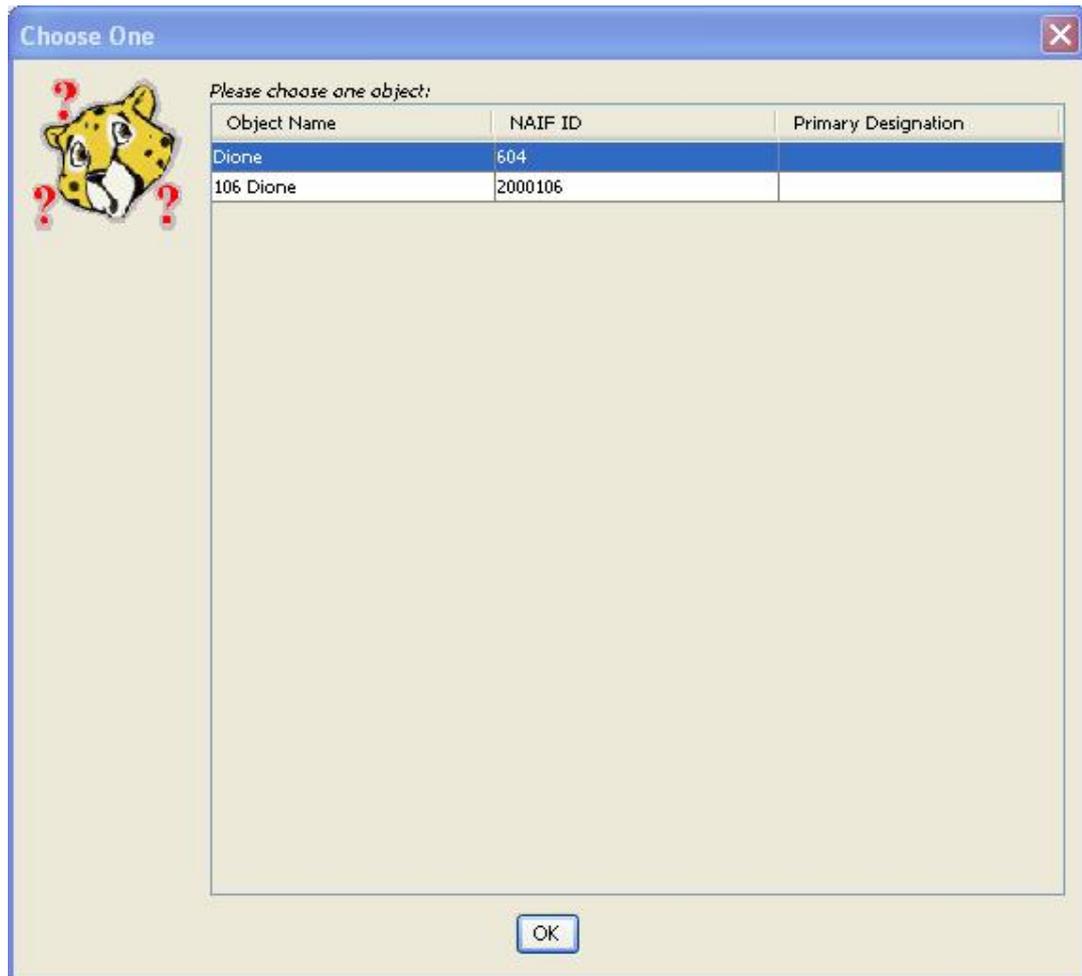
Figure 9.3. Dialogue indicating the possible moving target name confusion. Dione is the name for both an asteroid and a planetary satellite. The choices of NAIF ID numbers for Dione are shown. It is important to select the correct NAIF ID for your object, as the NAIF ID is the single identifier Herschel uses to provide ephemeris information for planning and scheduling.

As a guide to distinguishing between NAIF IDs, NAIF numbering has the following conventions:

- 7-digit numbers starting with "1": comets

- 7-digit numbers starting with "2": numbered asteroids

- 7-digit numbers starting with "3": relatively newly discovered objects (e.g., some asteroids and KBOs)

- 3-digit numbers: planets and planetary satellites. The first digit identifies the planet involved (100=Mercury, 200=Venus, …, 500=Jupiter, etc. For natural planetary satellites the system is the first digit is the planet identifier and the next two the satellite number: Io, or Jupiter I, is 501; Amalthea, or Jupiter V, is 505; Titan, or Saturn VI, is 606).

- 1-digit numbers: planetary system barycentres. Again, 1=Mercury, 2=Venus, 3=The Earth, etc. Where a planet has no large satellite the barycentre and the planetary centre will coincide.

Note
For the purposes of Herschel the planetary centre and barycentre will effectively coincide in all cases. Any difference in position will be well below the resolution of Herschel. NAIF also uses negative integers for spacecraft identification, but these have no relevance to Herschel users.

In the case of Saturn's satellite Dione, shown in (Figure 9.3), the NAIF ID = 604: "6" because it is a satellite of planet 6 (Saturn) and "04" because Dione was the 4th satellite of this planet to be discovered (Saturn IV in the classical designation).

Following the decision on Pluto's status at the 2006 IAU General Assembly at Prague, Pluto now has three NAIF IDs. The primary designation is (134340) Pluto, with a NAIF ID = 2134340. However, the old "planetary" IDs of 9 (for the barycentre of the Pluto system) and 999 (for the centre of the body) are still used in NAIF.

9.4. Target Name Resolution

Name resolution of fixed targets in the SIMBAD Astronomical Database and the NASA/IPAC Extragalactic Database (NED) is available. After entering the target name, click on the Resolve the Name button on the target entry dialogue. If the target is found in the selected database, HSpot will enter the coordinates (fixed target) or NAIF Identification number (moving target) automatically into the dialogue.

9.5. Bright Moving Object Avoidance

Bright inertial objects are automatically avoided when planning observations using the Herschel Bright Objects for AOR overlay described in Section 6.8.4. HSpot automatically reduces the visibility window if a bright object (Earth, Moon, Mars, Jupiter, Saturn, Uranus, Neptune, and the asteroids 4 Vesta, 6 Hebe, 1 Ceres, 7 Iris, and 15 Eunomia) passes close to your source.

The visibility window will be adjusted to preclude times when your target coordinates are within 7 degrees of the Earth and Moon, or within 30 arcminutes of other objects. The Earth and Moon can only interfere at extreme positions of the Herschel orbit. They will usually remove a small amount of time at the start or end of a visibility window. Bright planets and asteroids may cause a visibility window to be broken into two. If this happens the "Target Visibility" window will display a message in red stating that the visibility windows have been reduced to avoid bright moving objects.

Solar system observers planning to observe an object, or satellite of an object, on the bright moving object list (e.g., Neptune or Triton) can still observe without difficulties. HSpot is smart enough to know that you do not want to avoid your selected target.

For a fixed target near the ecliptic the visibility window will typically be about 60-65 days twice each year. Summer visibility windows will be longer than their winter equivalents because the Earth is at aphelion and thus moving more slowly in early July and at perihelion in early January and thus moving more quickly. The difference in length of visibility window is 3-4 days. At higher declinations the visibility window will increase until it reaches permanent visibility for objects within 30 degrees of the ecliptic pole.

9.6. Target List

Pressing the "Current Target List" button will bring up a dialogue with the list of targets, an example of which is shown in Figure 9.4. From this dialogue you can highlight a target in the list by clicking on the rows in the list and then delete targets from the list or modify a target entry. The "Calculate Visibility Windows for All Targets" pull-down from the "Targets" menu allows you to calculate visibility windows for your entire list of targets all at once. For a long list of targets - say 1000 - this may take 15-20 minutes to do on a slow computer. The "Show Visibility" button from the "List of Targets" function reports the windows when the selected target, or the list of targets, will be visible to Herschel. The "Show Background" button from the "List of Targets" function reports these backgrounds for individual objects in the list of targets if they have been been calculated previously at target entry. If no background has been calculated previously the background display pop-up will be blank, as shown in Figure 9.5. The display that appears if results have been calculated is shown in Figure 9.6 - the panel presents the last results to have been calculated. Note that the background value is not stored until the target dialogue has been accepted and dismissed.
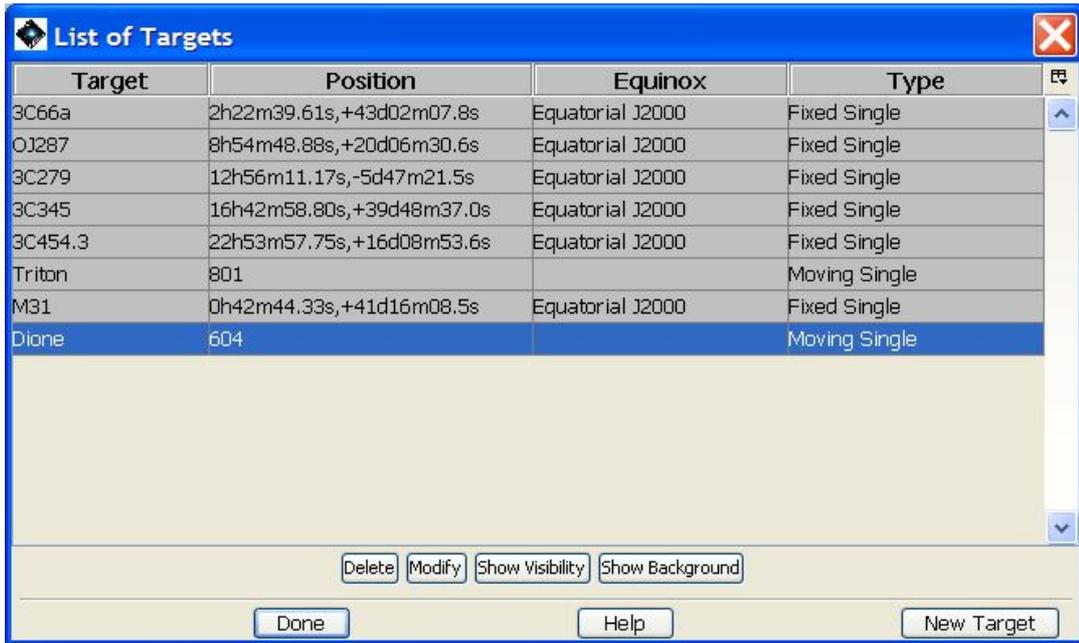
Figure 9.4. A small target list that shows the buttons for "Show Visibility" and "Show Background" (see Section 9.6).
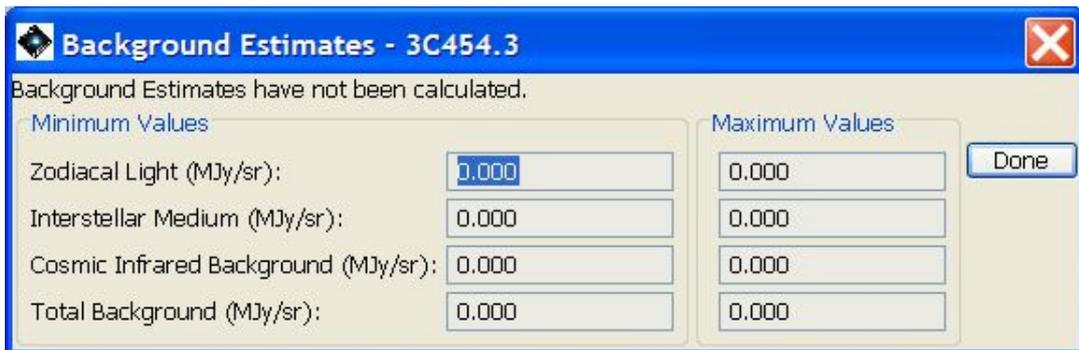
Figure 9.5. The background display for an object in a target list for which no values have previously been calculated. Null results and a warning are shown.
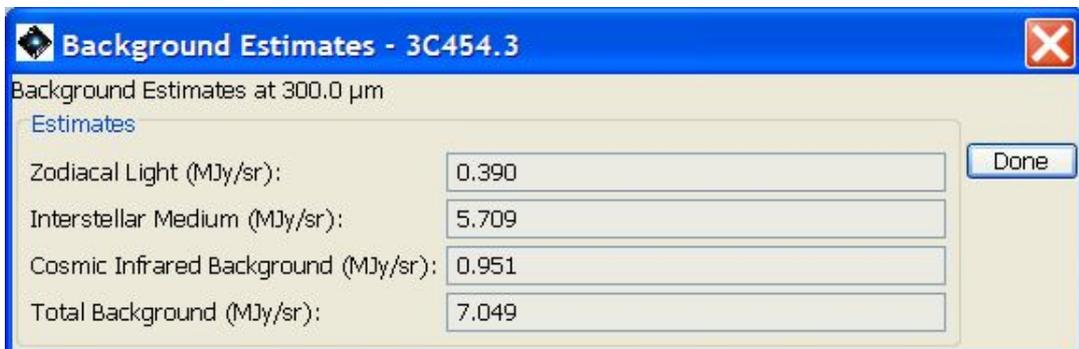
Figure 9.6. The background display for an object for which values have previously been calculated. The last result to be calculated is shown.

Warning

If you have not calculated the background individually for each source in your target list you will see a dialogue like the one in Figure 9.7. HSpot will display the last value that was calculated (i.e. for the previous target for which the background was calculated), together with a warning that the background estimate has not been calculated for this target.
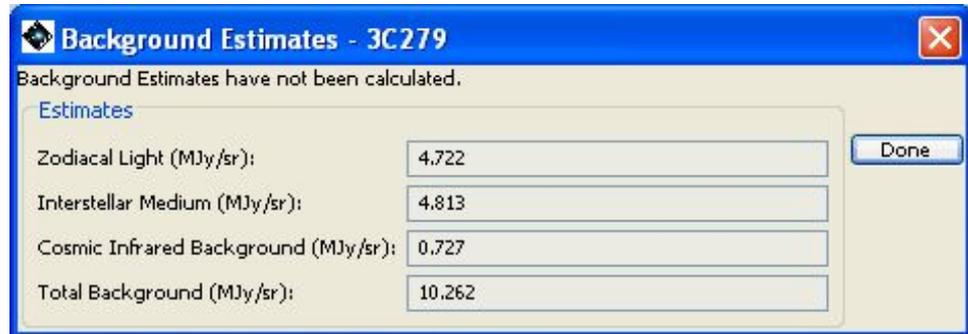
Figure 9.7. The dialogue showing the "Show background" estimate that appears when requesting a display of the background for a target that does NOT have previously calculated background estimate, although other objects in the Target List do. The last calculated value is displayed, together with a warning that the background has not been calculated for the selected target.

9.7. Visibility Windows

9.7.1. Visibility Windows for Inertial Targets

The visibility windows function in HSpot is reached from the "Visibility/Orientation" button in the upper right-hand quadrant of the target entry window or from the AOT input dialogues. The visibility/orientation dialogue is shown in Figure 9.8. Any periods when a bright moving target will be in the field are deleted from the visibility window. The "Calculate Visibility Windows for All..." pull-down from the "Targets" menu allows you to calculate visibility windows for your entire list of targets all at once. For both inertial and moving targets, you can also save the list of visibility windows to a text file using the "Save Target Visibility Windows" item in the "File" menu.
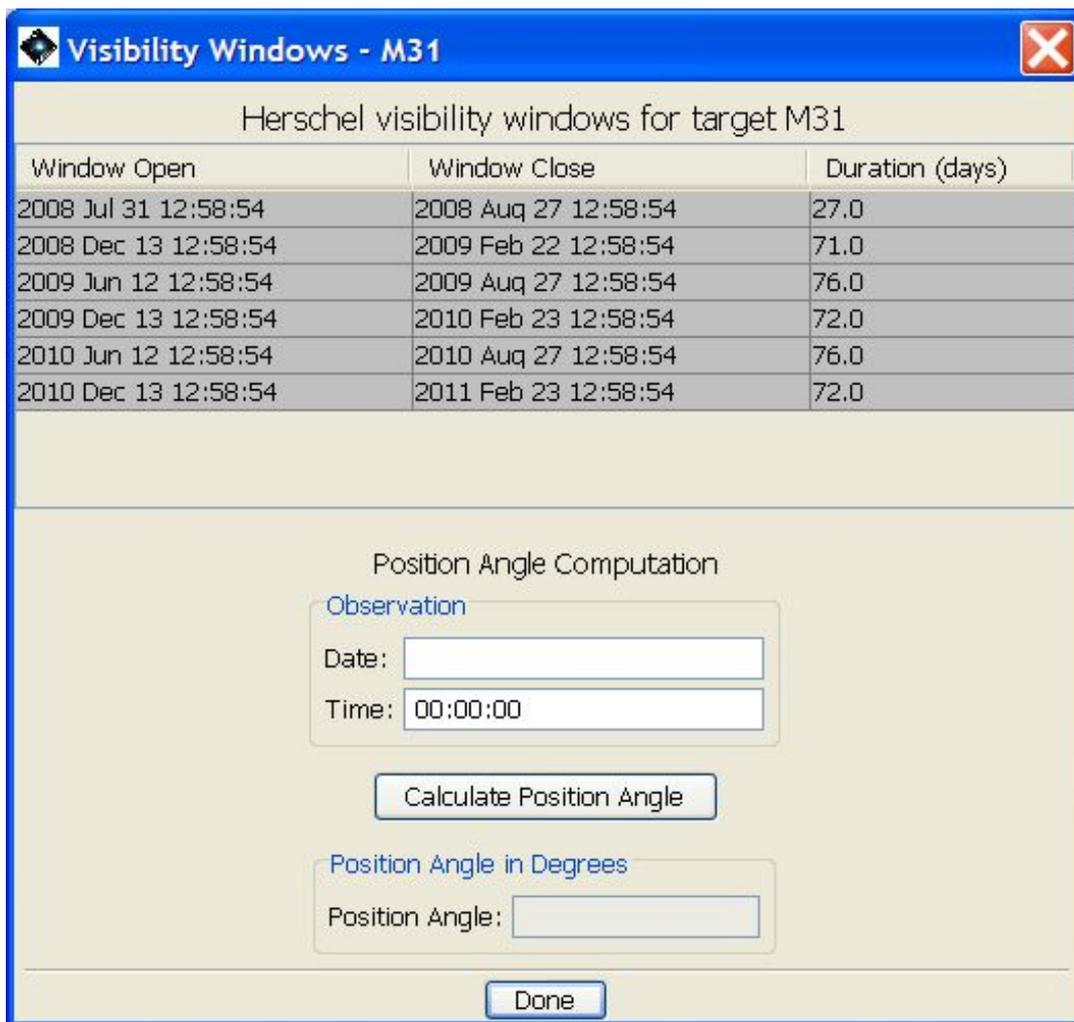
Figure 9.8. The "Visibility/Orientation" dialogue that shows the windows when your inertial target is visible. It is also possible to indicate the position angle of the Herschel focal plane on a date when the target is visible.

The visibility windows dialogue for a selected target or target cluster also appear when overlaying AORs on an image (see Section 19.2.8.4).

9.7.2. Moving Object Visibility Information

After entering your NAIF ID or target name into the target entry window, click on the "Visibility/ Orientation" button in the upper right-hand quadrant of the target entry window. If HSpot has access to the ephemeris corresponding to the NAIF ID of your object, it will now calculate the periods during which your object is visible to Herschel. If bright object avoidance is selected, HSpot will modify the visibility windows to avoid times when a bright object is near your target object. The visibility/orientation dialogue is shown in Figure 9.9. A list of moving objects is provided on the Herschel web page to help you determine which ephemeredes are already in the HSC database. The list includes the date on which the ephemeris files were generated. If HSpot does not have access to the ephemeris corresponding to the NAIF ID of your object, a message will be returned requesting that you contact the HSC Helpdesk at http://herschel.esac.esa.int/esupport/ with the NAIF ID of the object you want to observe. We will add this ephemeris to our database and contact you when it is ready to use.
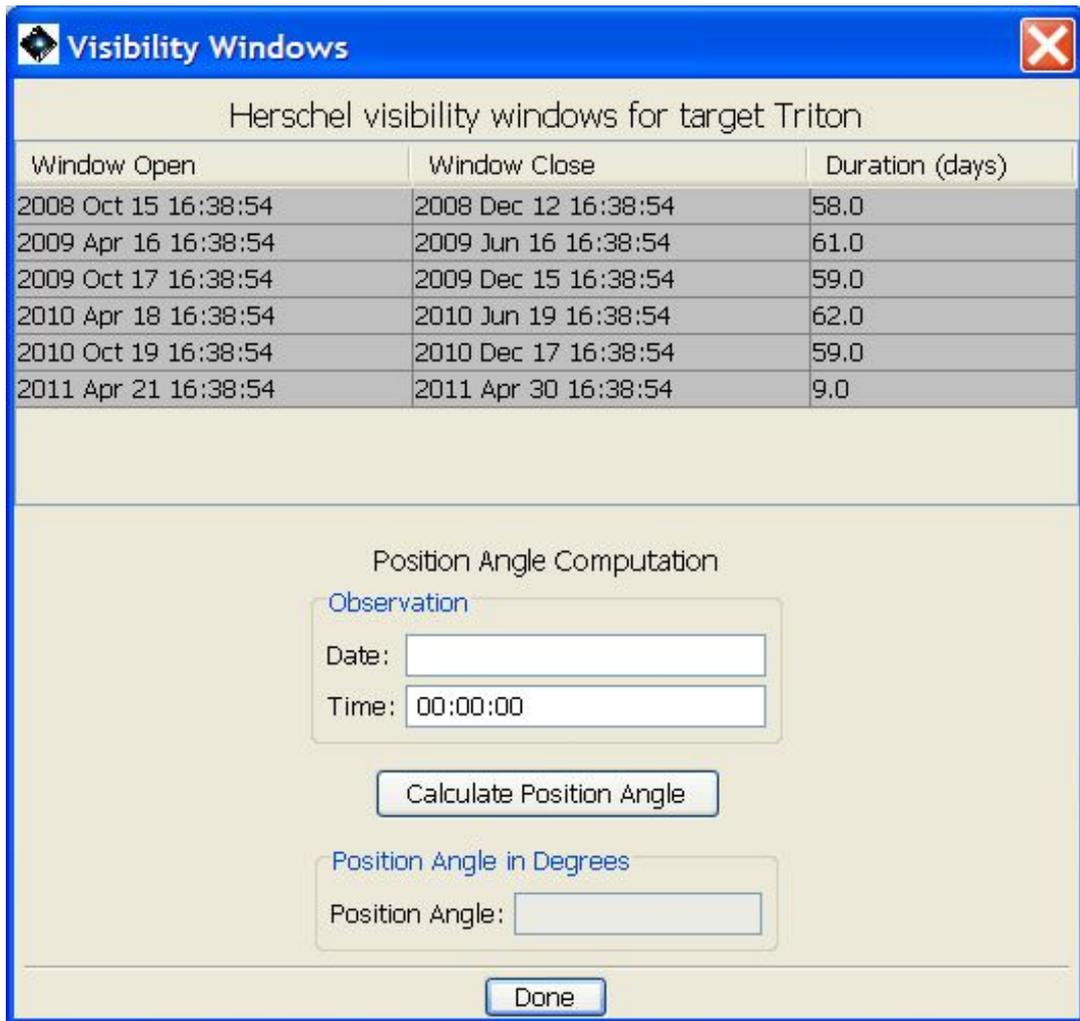
Figure 9.9. The "Visibility/Orientation" dialogue that shows the windows when your moving target is visible.

9.7.3. Herschel Planning with Horizons

For planning moving target observations HSpot will return visibility windows for your target and provide time estimates for execution of your AORs. However, it does not have the capability to provide more specific geometric information required for planning some Solar System observations. To further assist planning your Herschel observations with HSpot, the JPL Solar System Dynamics group has kindly incorporated the Herschel orbit file into the publicly available JPL Horizons software (http://ssd.jpl.nasa.gov/horizons.html). To generate an ephemeris for a solar system object in Horizons please use the site code *500@-486* to define the Herschel Space Observatory as your observing station (the Horizons web interface does not locate "Herschel" as a search term, so you must enter the exact site code).

Herschel can be requested as an observatory within Horizons using the telnet and e-mail and web interfaces. Horizons will return Herschel-centred target positions and geometric information, such as maximum elongation of satellites from their parent planets. An illustrative step-by-step example showing how to use Horizons to generate Herschel-centric information can be found on the Proposal Kit web page. Please consult the JPL Horizons User's Manual (http://ssd.jpl.nasa.gov/horizons_doc.html) for more detailed information on Horizons' capabilities and instructions for use.

9.7.4. Position Angle: Focal Plane

Computing the position angle of the Herschel focal plane can be done from the "Visibility/Orientation" dialogue (shown in Figure 9.4). This defines the angle at which chopping will occur on any given date. The position angle for a user-selected date is reported as the degrees east of celestial north of the Herschel-to-Sun vector projected onto the sky. The defaulVisibilityt is with respect to equatorial north, but the user can also have the position angle reported with respect to ecliptic and galactic north by clicking on the pull-down menu. The nominal field-of-view locations and the direction of the Herschel-to-Sun vector, projected onto the sky, are shown in Figure 9.10.

To determine a position angle, enter an acceptable date from the visibility window range into the "Observation Date" entry field and click on the "Compute Position Angle" button. HSpot will now return the projected position angle on the sky (degrees E of N) at your target on the specified date for the Herschel focal plane. You may enter the position angle that HSpot returns into the focal plane overlay (Section 20.6.6) and display the Herschel focal plane properly rotated on a sky image. If north is up and the PA HSpot returned is zero, then Figure 9.10 would rotate 90 degrees anticlockwise.

Figure 9.10. The Herschel field-of-view locations projected onto the sky. The Herschel-to-Sun vector points to the right in this figure. The position angle that HSpot returns is the degrees east of north of this axis, projected onto the sky. If north is up in this figure, the position angle returned is 270 degrees.

9.7.5. Estimating the Sky Background

One of the important ingredients required to plan your Herschel observing program is the absolute brightness of the sky at the time of your observation. To judge the feasibility of detection of astronomical sources in the presence of strong foreground signals from the zodiacal light and interstellar

cirrus, the observer requires knowledge of the background sky level relative to the astronomical source of interest. The HSC provides tools for estimating the sky background levels for your target. It should be taken into consideration that HSpot does not "remember" the sky background levels when creating AORs, thus it is the responsibility of the observer to take these into consideration when preparing observations.

9.7.6. IRAS Sky Maps

If you are interested in the structure of the sky brightness on the scale of a few arcminutes, the best source is the IRAS sky maps (ISSA). You can examine these by displaying your target region from the Images menu (Section 6.6). These are the same maps that you can obtain from IRSKY (www.ipac.caltech.edu/ipac/services/irsky/irsky.html). These maps have had zodiacal light contributions removed, and may not provide an accurate estimate of sky brightness for IRAC observations, especially on or near the ecliptic plane.

9.7.7. HSpot Background Estimate

If you are interested in the background on larger angular scales, HSpot provides a background estimate. This is accessed via the "Background" button on the HSpot target entry dialogue, which pops up a dialogue shown in Figure 9.11. The observer enters the desired wavelength. A date and time is requested (date and time is required for a moving target background estimate). HSpot returns an estimate for the specified date. The units for the estimates are MJy/sr. The 'beam size' of the interstellar medium component of HSpot's background model is 5 arcminutes. The output will look like the one shown in Figure 9.12.
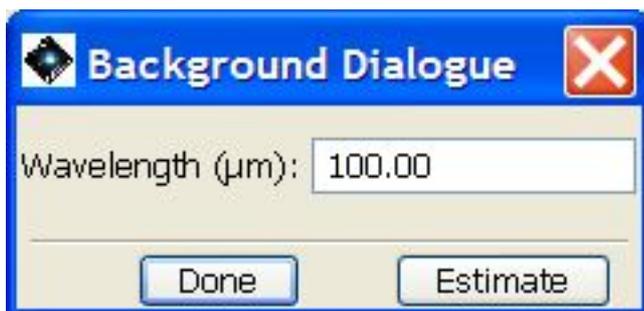
Figure 9.11. The HSpot "Background Estimate" dialogue. The user enters the desired wavelength and then a date for the observation and HSpot calculates the estimate for the given date and time at the specifed wavelength.
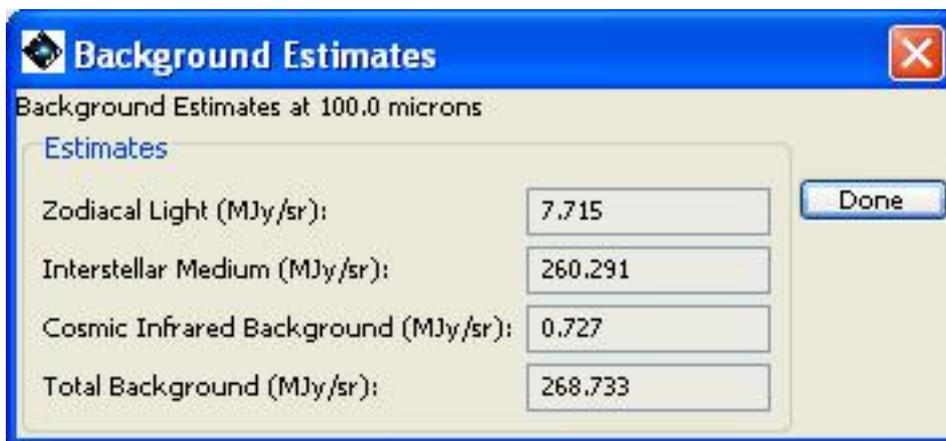
Figure 9.12. Background Estimate breakdown obtained for a given date when a target is visible.

If you have previously calculated a background for a target you can display it by selecting the "Show Background" button on the Target List dialogue Figure 9.13
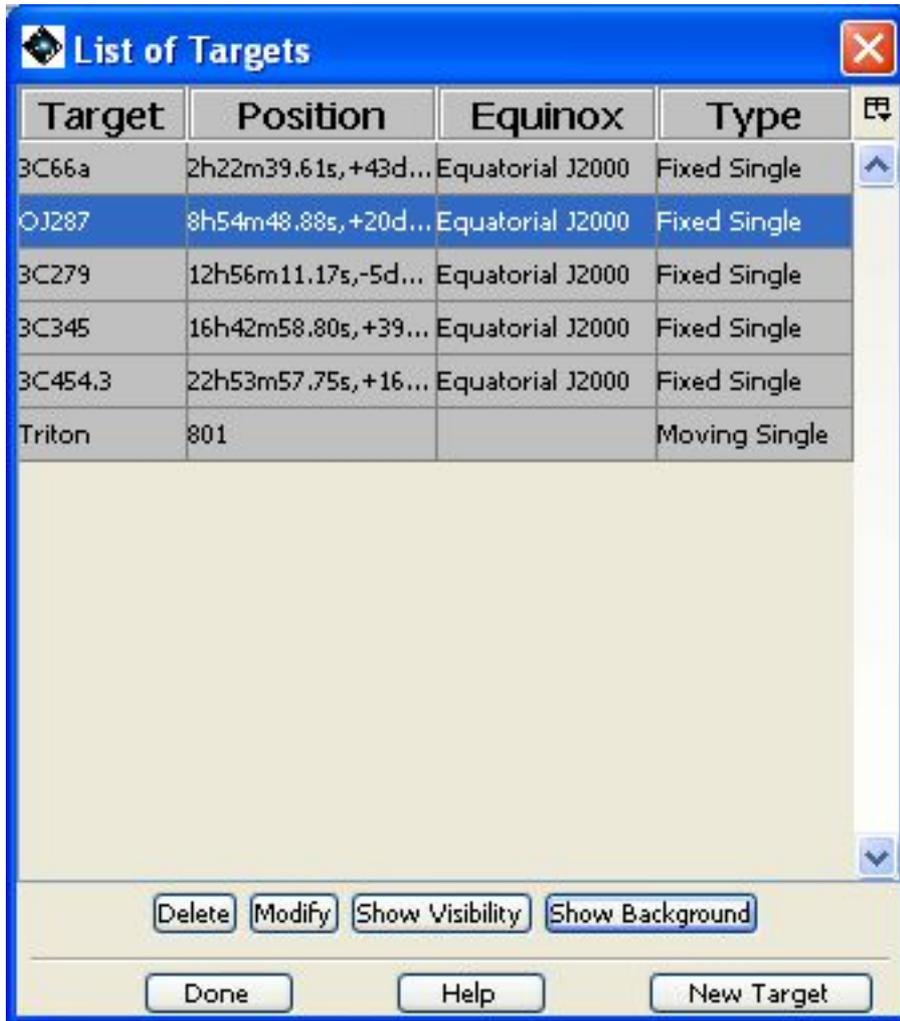
Figure 9.13. Target list dialogue showing the "Show background" button for displaying a previously calculated background estimate.

> ⚠ **Warning**
>
> If you have not calculated the background individually for each source in your target list you will see a dialogue like the one in Figure 9.14. HSpot will display the last value that was calculated (i.e. for the previous target for which the background was calculated), together with a warning that the background estimate has not been calculated for this target.
>
>
>
> **Figure 9.14. The dialogue showing the "Show background" estimate that appears when re-**
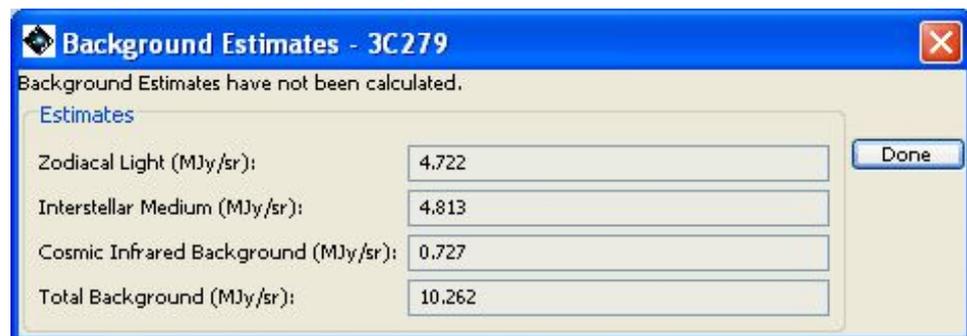
questing a display of the background for a target that does NOT have previously calculated background estimate. The last calculated value is displayed, together with a warning that the background has not been calculated for the target.

Chapter 10. Astronomical Observation Templates (AOTs)

10.1. Introduction

The appropriate Herschel Instrument Manual is your primary reference for information about using the Herschel instruments and selecting appropriate AOT parameters. We provide some additional information for the individual AOTs in the following chapters.

Note that target entry and naming conventions have communality, whatever instrument you choose to use. These are described briefly here.

10.2. Unique AOR labels

Each AOR submitted by a user must have a unique ID. HSpot chooses this for you automatically. However the AOR label field can be edited and the astronomer can provide any name he/she wishes. As long as it is a unique name within the current set of requests being formulated.

- For the HIFI Single Point AOT the unique label always starts with "HPoint", for mapping it is "HMap" and for spectral scan "HScan". A rising four digit integer is then added to the end of this string to create each unique label.

- For the SPIRE Photometer AOT the unique label always starts with "SPhoto" and for the SPIRE Spectrometer AOT starts with "SSpec". A rising four digit integer is then added to the end of this string to create each unique label.

- For the PACS photometry AOT the unique label always starts with "Pphoto", for line spectroscopy mode, "PSpecL" and for range spectroscopy "PSpecR". A rising four digit integer is then added to the end of this string to create each unique label.

- For the SPIRE PACS parallel mode AOT the unique label always starts with "SPParallel".

> **Warning**
> SPIRE PACS Parallel Mode can only be used for single fixed targets.

10.3. Startracker information

When you define an AOR you will receive Startracker information as shown in Figure 10.1. The star tracker looks in the opposite direction to the telescope in the sky and is used for acquisition and guiding. The number of stars available to the startracker for the target is displayed under the target information at the top of the AOR screen (here it has been circled with a red ellipse). Pointing may be slightly worse in the cases where this number drops below 9. If the number is smaller still there may be some difficulty with carrying out the requested observation (limit TBC).
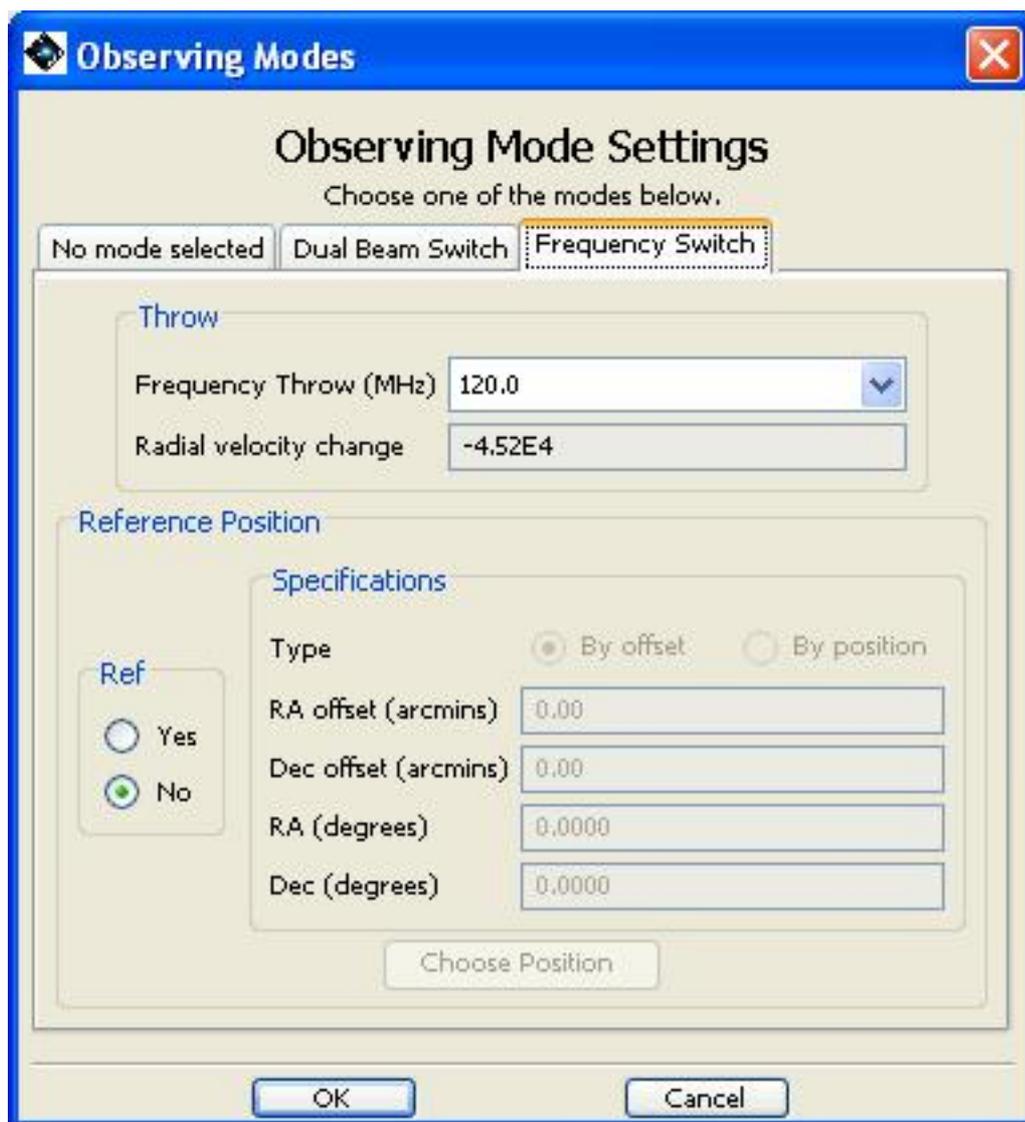
Figure 10.1. A sample AOR showing the startracker information for the target (outlined with a red ellipse).

More information on the Startracker and the information that it provides can be found in the Observatory manual.

10.4. Target

The current target (see Section 6.3) is displayed in the window. Hitting the "Modify target" button allows the target to be changed. Alternatively, a target can be chosen from the list of targets already created within the astronomer's session by bringing up the target list.

Finally, if the next target is a new one, the user can enter a "New target" which allows target information to be input in the same way as described in Section 6.3.

10.5. Position angle and chopper avoidance

Many of the observing modes offered allow the observer to select certain parameters such as a chopper avoidance angle (see, for example, the section called "Observing mode parameters - Chopping/nodding") that requests that the observation be carried out in such a way that we do not chop over a

certain angle on the sky.

Over the year the apparent rotation of the sky makes the position angle of the chopper on the sky change (this is the roll angle of the spacecraft, measured from north through east, using the spacecraft z-axis as reference - the z-axis is perpendicular to the orientation of the long axis of the PACS and SPIRE arrays). In other words, by selecting a chopper angle constraint we are effectively placing a timing constraint on our observations, stating that it may not be made at certain times of year. However, the Position Angle calculated in Figure 10.2 has a strong latitude dependence. For sources in the ecliptic the Position Angle will barely vary with time during a visibility window. For the two observing windows available each year two values differing by exactly 180 degrees will be found (Figure 10.3). In these cases defining a chopper avoidance angle is, at best, irrelevant (as the PA will only vary in a range of a few degrees anyway) and, at worst, catastrophic because it is may make all observations totally impossible, with no part of the visibility window permitted.

	Note
	Understanding chopper avoidance angles
	The PA that HSpot reports the spacecraft roll angle for any particular date of observation. The chop angle will be perpendicular to this angle. If, when you visualise an AOR, you find a bright source in your reference position, you must ADD 90 degrees to the PA in HSpot to avoid a position in the chopper off position. If you have a source in the nod off position you must SUBTRACT 90 degrees to the PA reported in HSpot.

At high ecliptic latitude we have a zone of permanent sky visibility and the PA of the chopper rotates rapidly with time. Here, even a quite wide chopper avoidance angle range may equate to only a relatively small effective restriction on dates. Figure 10.3 shows how the PA changes for a source almost at the ecliptic pole, which is within the permanent sky visibility zone.

At high ecliptic latitude we have a zone of permanent sky visibility and the PA of the chopper rotates rapidly with time. Here, even a quite wide chopper avoidance angle range may equate to only a relatively small effective restriction on dates. Figure 10.3 shows how the PA changes for a source almost at the ecliptic pole, which is within the permanent sky visibility zone.

At intermediate ecliptic latitudes there will be a break in the visibility windows, although this may be small. When the instrument +Z-axis crosses celestial north there will be a discontinuity in the PA value. Observers should take care of this when defining chopper avoidance angles for sources that are close to +60 degrees ecliptic latitude. A practical example of this is shown for PACS in Figure 10.4 for an object at an ecliptic latitude of 59.5 degrees, close to the point at which there is continuous visibility, but where there is are still two annual visibility windows with a short gap between them. PA=000 degrees is shown (the horizontal position), along with the plotted positions of the PACS imaging detectors for 2008 March 31st (start of visibility window) PA=127.4 degrees, 2008 June 15th (mid-window) PA=054.6 degrees, 2008 September 10th (end of visibility window) PA=333.7 degrees.

	Warning
	Close to the ecliptic even a small range of chopper avoidance angle may equate to a huge scheduling restriction, potentially making observations impossible to schedule.
	At high ecliptic latitude it is easier for telescope scheduling to take a chopper avoidance into account.
	However, at high ecliptic latitude the chopper PA will often rotate through 360 degrees giving a dephase that must be taken into account when defining a chopper avoidance angle.
	However, in all cases an observer should consider very carefully if defining a chopper avoidance angle is really, genuinely necessary.
	All constraints on observations imply an increased observing overhead and thus decreased observing efficiency.

Figure 10.2. The position angle calculated by HSpot for the ecliptic source Ganymede, the Jovian satellite.

Figure 10.3. Position angle variation for sources on the ecliptic and at the ecliptic pole, in the zone of permanent sky visibility. For sources at intermediate ecliptic latitude the annual range of variation of PA will be between these two extremes. This plot has been generated for a launch in early 2008; it remains valid for any launch date.
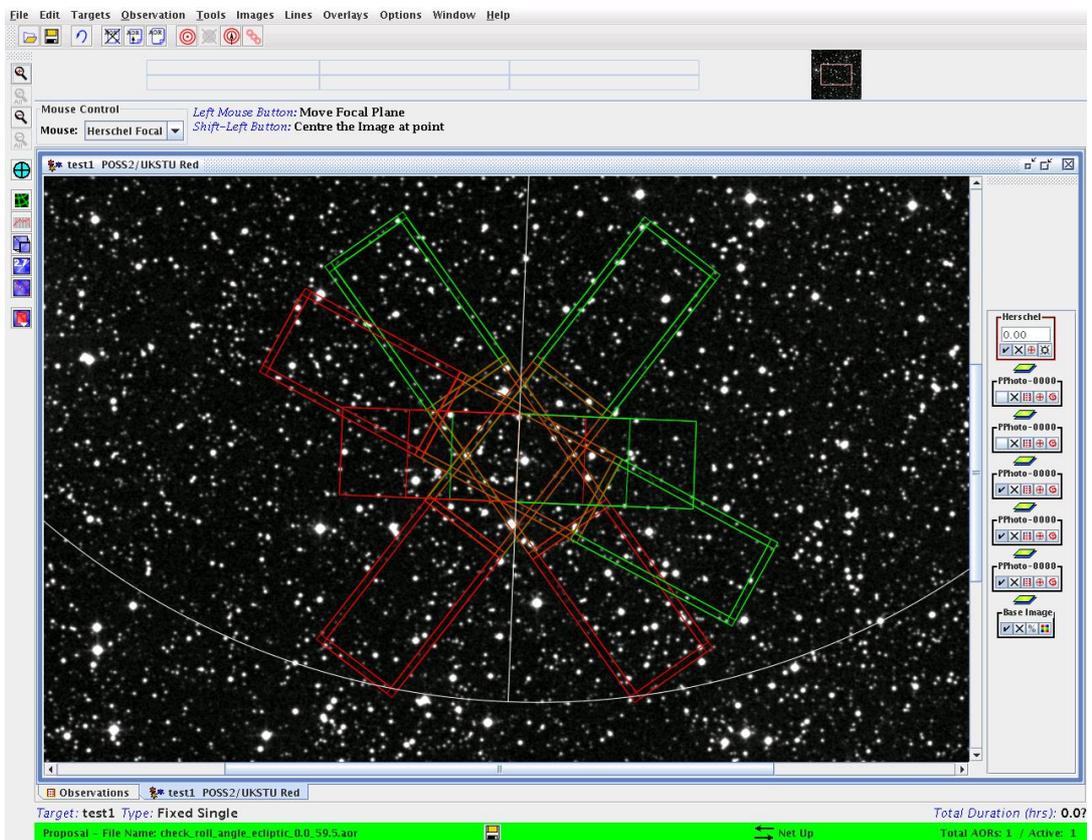
Figure 10.4. The position angle variation for PACS for an object at an ecliptic latitude of 59.5 degrees, close to the point of permanent visibility. The horizontal position is PA=000 degrees. The plotted positions of the PACS imaging detectors are for 2008 March 31st (start of visibility window) PA=127.4 degrees, 2008 June 15th (mid-window) PA=054.6 degrees, 2008 September 10th (end of visibility window) PA=333.7 degrees.

10.6. Time required for time estimation

When you make a time estimate HSpot connects with the server at the HSC to pass the information on the AOR and make the calculation of the time required to carry it out. You will need to calculate a duration for all your AORs before proposal submission and every time that the AORs are revised. For PACS and SPIRE the calculation is particularly rapid, especially in photometry mode. On a fast Internet connection time estimation for 500 PACS or SPIRE photometry AORs can be calculated in approximately 100 seconds. Time estimation for the same number of SPIRE PACS Parallel Mode, or PACS or SPIRE spectroscopy AORs will take from 150-200 seconds. Because of the large number of parameters in some HIFI AORs, the calculation is somewhat slower for HIFI: time estimation for 500 HPoint or HMmap AORs will take some 600-800s even if there is no other load on the system; while 500 HScan AORs will take in excess of 1000s. Even when several users are carrying out time estimation simultaneously and the system is under heavy load, the time required should not increase by more than a factor of two.

In Figure 10.5 a graphical relationship is shown between number of AORs to to have their duration calculated and the time required to run the estimation. For PACS the time required to run a certain number of time estimates is generally slightly shorter than for similar SPIRE AORs: generally HSpot should carry out from 3 to 6 time estimates per second. HIFI runs somewhat slower due to the large number of parameters to be optimised, but will usually be in the range from 1 to 3 seconds per time estimate.
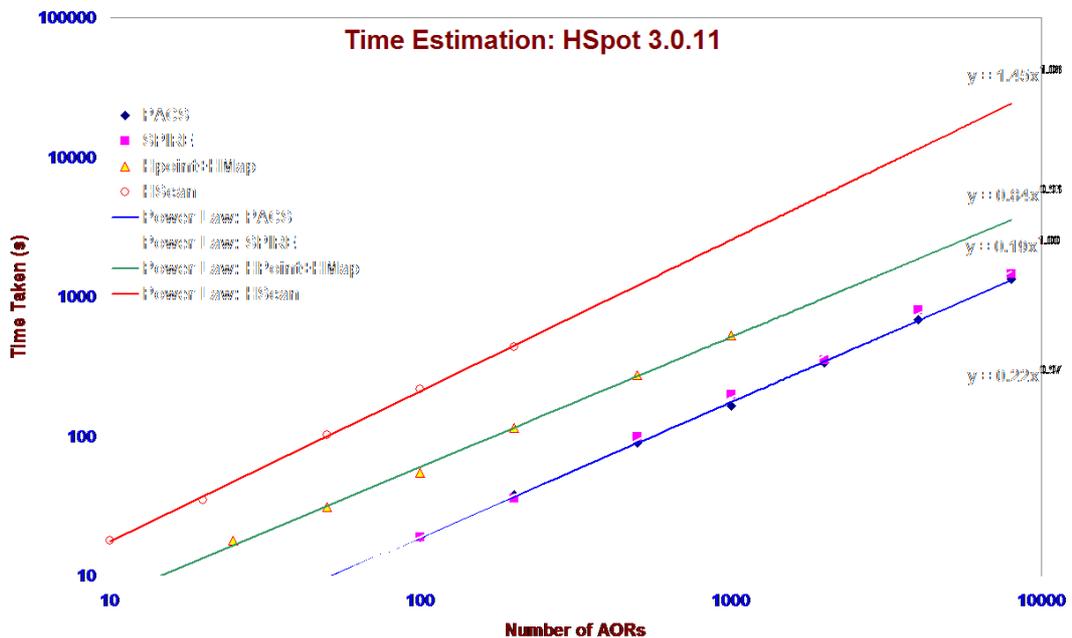
Figure 10.5. A graphical relationship between number of AORs to have their duration estimated and time required assuming a rapid Internet connection and no other load on the system.

Chapter 11. PACS AOTs

11.1. PACS Line Spectrometry AOT

In this AOT the PACS spectrometer is operating for observations of individual spectral lines. Depending on the requested grating order, the short-wavelength array observes in the 55-73 micron, or 73-98 micron band, while the long wavelength red array observes in the 103-210 micron band. For improved flat-fielding, the grating will be scanned by a number of discrete steps around the spectral line central wavelength, such that drifts in detector responsivity between individual pixels are eliminated. These grating scans provide a short spectrum covering ~1500 km/h with a resolving power of ~1700 in its highest resolution for each line and for each of the five by five spatial pixels. Background subtraction can be achieved either through standard chopping/nodding (for faint/compact sources), or through 'wavelength-switching' techniques of the grating mechanism (especially for line measurements of bright extended sources). The observer can select either chopping/nodding, or wavelength switching, in combination with one of the three observing modes: "pointed", "pointed with dither" and "mapping".

Figure 11.1. The Line Spectroscopy AOT main window

11.1.1. Wavelength Settings

The "Wavelength Settings" part of the PACS Line Spectroscopy start-up screen provides the observer with the opportunity to specify a set of spectral lines to observe within a single AOR. The main component of this functionality is the "PACS Line Editor" table which is where spectral line information is held. Before the observer provides table entries, the applicable wavelength ranges have to be specified.

11.1.1.1. Selection of wavelength ranges

The user selects the applicable wavelength ranges (defined by the grating diffraction orders) via the

first pull-down menu. There are two possibilities:

- Option 1 - "[73-98] and [103-210] microns (2nd + 1st orders) " - default option

- Option 2 - "[55-73] and [103-210] microns (3rd + 1st orders)"

As a result of the selection, the (redshifted) wavelengths of line centres have to be specified in the "PACS Line Editor" table, either within the 73-98 and 103-210 microns band, or within the 55-72 and 105-210 microns band.

Note
The PACS spectral coverage is not continuous over the entire 55-210 microns range, it has a gap from 98 to 103 microns. Spectral lines cannot be requested in this unsensitive range.

Note
As it is indicated in the options above, irrespective the blue order selection spectral lines can be always requested in the 103-210 microns band (1st diffraction order) of the red spectrometer array.

Tip
The observer has a choice of creating an observation of spectral lines located along the entire PACS wavelength range by grouping AORs. In this case at least two AORs have to be filled with flipped grating order options. See Section 6.5.3 and Section 16.2 (grouping and timing constraints) for further information.

11.1.1.2. The PACS Line Editor

When setting up the list of spectral lines to be observed the PACS Line Editor is used. The AOT allows a maximum of ten lines to be entered into the table, although the use of "Repetition factor" parameter could result a further restriction on the number of observable lines (see below).

Tip
If your observation requires more than the allowed number of lines consider to set up a group of AORs. See Section 6.5.3 and Section 16.2 (grouping and timing constraints) for further information.

11.1.1.3. Setting Values in the PACS Line Editor

The table gives a summary of spectral line dependent attributes of your AOR. You cannot enter, modify or remove values in the table directly. The three buttons at the bottom of the table allow the following:

Figure 11.2. Window to add- and modify spectral line entries

- Add line manually - pressing this button allows the addition of a new spectral line in the chosen wavelength range. A "Create a new line" window is opened and the user can enter values in the enabled fields. The "Line ID" and "Wavelength" fields cannot be edited if the line is taken from a database. Once the "OK" button is pressed the spectral line settings are stored in the PACS Line Editor.

- Add line from database - The selection of a given line/transition can be made via the HSpot spectral line managing system. Clicking on this button will make the "Add Lines to the Observation Request" dialogue window pop-up (see below). This dialogue allows the addition of a spectral line that is within the PACS [55-210] microns wavelength range. Once the line/transition is selected and the "OK" button is clicked the line settings are stored and a synopsis is displayed in the PACS Line Editor. Line attributes will show default settings in the table, you have to click on "Modify Line" to reset parameters.

- Modify line - This button allows spectral line settings to be modified after they have been created with the "Add line manually" or "Add line from database" functionalities noted above. The window popping-up is identical to the "Create a new line" dialogue in all functionalities (see below).

- Delete line - Allows the deletion of a spectral line. Click on the table entry holding the spectral line to highlight it then hit the "Delete" button to remove it. Deleting a line has no effect on other

lines in the table. Default line IDs will not change for already configured lines.

11.1.1.4. Add Lines to the Observation Request dialogue

The "Add Lines to the Observation Request" dialogue is a shopping basket which filters PACS detectable transitions from the HSpot "Manage Lines" facility (see Section 18.1).

Origin	Name	Transition	Wavelength...	Line Width	Selected
DEFAULT	CII	C+0000	157.741	1	
DEFAULT	NII	N+0000	205.178	1	
DEFAULT	HD	1-0	112.07	1	
DEFAULT	O I	3P0-3P1	145.52	1	✔
DEFAULT	O I	3P1-3P2	63.18	1	
DEFAULT	O III	3P1-3P0	88.36	1	
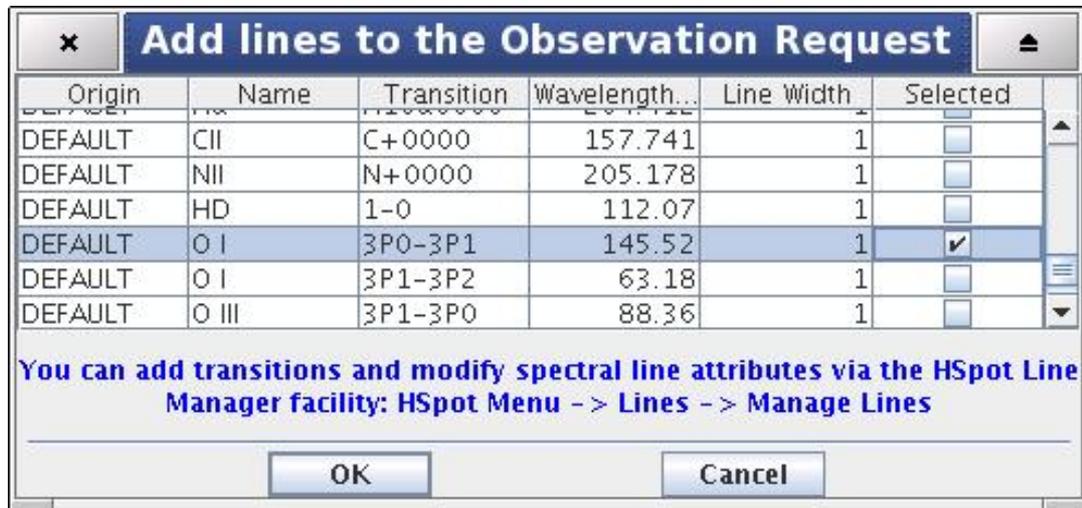
Figure 11.3. "Add Lines to the Observation Request" dialogue

The "Add Lines to the Observation Request" dialogue has some rules applied to it:

• Only one line may be selected in a single dialogue. To retrieve additional spectral lines, click on again the "From Database" check box and repeat the procedure for the next line in the table.

• If your "Manage Lines" window does not contain any user defined lines that fall in the specified PACS wavelength range the "Add Lines to the Observation Request" dialogue will open containing the default lines only. You should click on "Cancel" and fill your line database with appropriate transitions through the "Manage Lines" dialogue (see Section 18.1).

Note
Default lines included in the "Add Lines to the Observation Request" dialogue provides a handful set of most often requested strong lines. Some of these transitions (mostly atomic lines) are not included in the online available catalogues linked to HSpot.

Tip
An extended list of lines can be added to the "Add Lines to the Observation Request" window from online catalogues and/or individual line information provided by the user (see Section 18.1 and the functionalities of the "Manage Lines" dialogue).

11.1.1.5. Create a new line / Update a line dialogues

Pressing the "Add line manually" or "Modify line" button will pop-up either the "Create a new line" or the "Update a line" window. The content of these two windows are identical and allow the user to enter/modify values in the PACS Line Editor.

Note
The Create a new line / Update a line dialogues include optional parameters for signal-to-noise calculation in case the observer can supply source estimates. Optional parameters are highlighted in green text in the HSpot windows.

Line ID

Mandatory parameter. A unique line identification label. It has to be at least one character different for the subsequent lines, default values are "Line 1, Line 2, ... Line 10". User defined Line Ids could contain any character string including spaces up to 40 characters. If the user removes a line from the table (see below) the Line Id will not change for the remaining set of lines.

Note
If a spectral line is taken from the "Manage Lines" database (see Section 6.5.3 and Section 16.2) then the Line Id will be copied from the database. This string can be overwritten as can default line Ids. If a line is taken from a database the user is not allowed to reset its Line Id and wavelength in the Line Editor Table. Attributes of database transitions can be changed using the "Manage Lines" functionality (see Section 18.1).

Wavelength (microns)

Mandatory parameter. The rest wavelength of the line centre. If no redshift is specified, the PACS grating will perform an up- and down scan, centred around the line's central wavelength. For about two thirds of the on-source time PACS measures the (unresolved) spectral line and about one third of the time is spend on measuring the baseline. See the PACS Observers' Manual (ht-tp://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html) for more information.

Note

• Lines/transitions taken from a database always refer to the rest wavelength.

• The wavelength order of spectral lines as entered in the Line Editor Table has no effect on the duration of the observation. The AOT backend logic sorts the observing sequence of spectral lines to minimise instrument (grating) overheads.

Redshifted wavelength (microns)

Parameter calculated by HSpot, it appears only in the PACS Line Editor and indicates the redshifted wavelength of the line centre. The bottom pull-down menu allows the reference frame for the redshift to be input.

Note

• The redshifted wavelength has to fit within the selected grating order combination.

• Each redshifted wavelength in the PACS Line Editor have to be at least 0.001 microns apart.

Line flux unit

This menu gives the flexibility to switch between physical input units supported by the PACS AOT logic. The pull-down menu allows the unit of line flux to be defined:

• Option 1 - "Flux (10^-18 Watt/m^2)", default option

• Option 2 - "Flux (10^-15 erg/s/cm^2)"

The "Line Flux" parameter of the Line Editor Table is interpreted in the selected units.

Note
In cgs units the flux is measured in erg s^-1 which can be converted to watts, 1 watt = 1 x 10^7 erg s^-1.

Line flux

Optional parameter. User supplied line flux estimate in units specified by the "Line Flux Units" option. Line flux input is used for signal-to-noise estimation only. None of the instrument or observing mode settings can be influenced by this parameter (in later versions of HSpot this information will be used for dynamic range adjustment as well). Leaving the parameter as the default 0.0 value means the PACS Time Estimator will not perform signal-to-noise estimation (sensitivity estimates are still provided).

Continuum flux density (mJy)

Optional parameter. Continuum flux density estimate at the line (redshifted) wavelength. The value of this parameter is interpreted by the PACS Time Estimator as flux density for a spectrometer resolution element. Leaving the parameter as the default 0.0 value means the PACS Time Estimator will not perform signal-to-noise estimation (sensitivity estimates are still provided).

> **Tip**
> The PACS spectrometer spectral resolution as a function of wavelength and gration order can be found in the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html).

Line width unit

This menu gives the flexibility to switch between physical input units supported by the PACS AOT logic. The pull-down menu allows the unit of line width to be defined:

- Option 1 - "1 km/s", default option

- Option 2 - "1 micron"

The "Line Width" parameter in the PACS Line Editor is interpreted in the selected unit.

Line width (FWHM)

Optional parameter. The spectral line full width at half maximum value in units specified by the "Line Width Units" pull-down menu. Line width input is used only for checking purposes. It helps the observer to ensure the specified line width fits within the predefined wavelength range hard coded in the PACS Line Spectroscopy AOT logic (see the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html) for further details). None of the instrument or observing mode settings can be influenced by this parameter. The PACS Time Estimator will perform signal-to-noise estimation for the specified line width.

> **Warning**
> The PACS Line Spectroscopy AOT is designed to measure unresolved or narrow spectral lines. HSpot raise a warning message if the specified line is too broad for a complete profile detection in PACS Line Spectroscopy AOT. In such a case the observer should consider to measure this spectral line in PACS Range Spectroscopy AOT high sampling density range scan mode.

Line Repetition

Mandatory parameter. The relative line strength (fraction of on-source time per line) is taken into account by specifying the grating scan repetition factor for each line. A maximum of 10 repetitions in total can be specified in the table. For instance, in the case that 10 lines are selected, the "Line repetition" factor has to be 1 for each line; if 3 lines are selected then the total of the 3 repetition factors has to be less or equal to 10 (e.g. 4+5+1 or 2+3+3 ...). If the sum of repetitions exceeds 10 then you must either remove spectral line(s), or reduce the scan repetition factor(s).

The following considerations have to be made when specifying the repetition factor:

- Each grating scan has equal duration irrespective of the observation wavelength.

- The grating scan pattern is repeated for every on-source and nod position (except in wavelength switching mode).

- Higher sensitivity can be achieved either by scanning one line more often within a nod position, or by repeating the nod pattern of grating repetitions more often (see "Observing mode settings"). The latter would then affect all lines in the PACS Line Editor. If you are observing only one or two lines you should consider increasing the "Line repetition" factor in the table. This is more efficient as it minimises the nod slewing overhead.

- In wavelength switching mode the "Line repetition" factor has precisely the same effect as the "Nodding or wavelength switching cycles". For instance, 3 repetition of a line with 2 cycles gives exactly the same on-source time and same measurement sequence if 2 line repetition would be combined with 3 cycles.

Tip
You can specify an observation with more than ten grating scans per pointing position by grouping AORs.

11.1.1.6. Redshift Selection

The redshift selection menu allows the observer to make adjustments to the observing wavelength. The input can be specified either in known radial velocities or redshifts. Once any area in the PACS Line Editor is clicked on the "Redshifted Wavelength" field turns to show the wavelength to be observed.

Note
If the line rest wavelength is shorter than 55 microns then HSpot will reject the line even if the redshifted wavelength fits to the valid PACS range. For such a line you need to enter directly the redshifted wavelength into the PACS Line Editor and set the redshift to default zero.

11.1.2. Observing Mode Settings

The "Observing Mode Settings" screen provides the observer with the opportunity to specify the combination of instrument modes with spacecraft pointing modes. To start the procedure just click on the "Set the Observing Modes" action button in the main AOT window. This returns a screen with the choice of observing modes, simple click on a tab to select the mode required. The default observing mode is "None selected". You must then choose another tab to validate the selected observation.

Observing Modes

Observing Mode Settings
Choose one of the modes below.

| None selected | Pointed | Pointed with dither | Mapping |

You must select an Observing Mode

OK   Cancel

Figure 11.4. The Observing Mode Settings window in its start-up status

The main driver of observing modes is the pointing mode in which you wish to observe. The tab labels refer to "Pointed", "Pointed with Dither" and "Mapping" observing modes, each of them can be combined either with chopping/nodding or with wavelength switching.

11.1.2.1. Nodding or wavelength switching cycles

On the left hand side of the observing mode settings area a text box labelled "Nodding or wavelength switching cycles" can be found. The absolute sensitivity of the observation can be controlled by entering an integer number between 1 and 100. The on-source time is increased by repeating the nodding pattern the number of times that is entered. For each of the nod positions the sequence of line scans is repeated with the relative depth specified in the PACS Line Editor (see Sec-

tion 11.1.1.2). In case wavelength switching is used the on-source time is increased by switching with the grating the number of times that is entered. No nodding is applied in this latter case.

11.1.2.2. Pointed mode

This mode is offered for taking data for a point-like object. The integral-field concept allows simultaneous spectral and spatial multiplexing, for the most efficient detection of weak individual spectral lines, with sufficient baseline coverage and high tolerance to pointing errors, without compromising spatial resolution. The PACS spectrometer arrays have 5 by 5 spatial pixels covering a square field of view of 49 by 49 arcseconds. Both channels view identical positions on the sky. The line flux from a point source object will always be collected with the filled detector array. Therefore, for a simple detection of a line source, one pointing is sufficient.

Figure 11.5. Options for the Pointed observing mode

Background subtraction can be achieved either through a standard chopping/nodding, or through 'wavelength-switching technique.' These modes are mutually exclusive.

Chopping/nodding

This mode allows a classic three-position nodding observation to eliminate inhomogeneities in to the telescope and sky background. The PACS focal plane chopper is moved between the on-target and the off-positions during a grating scan and the whole sequence of spectral line scans is repeated in the nod position. One half of the total integration time is spent on-source. This mode can be selected by clicking on "Chopping/nodding" in the "Observing mode selection" field.

Observing mode parameters - Chopping/nodding

The chopper throw and chopper avoidance angle can be selected. The choice of "Small", "Medium" and "Large" refer to 1.5, 3.0 and 6.0 arcminutes chopper throws respectively on the sky. The chop direction is determined by the date of observation; the observer has no direct influence on this parameter. If an emission source would fall in within the chopper throw radius around the target the observer may consider setting up a chopper avoidance angle constraint. The angle is specified in Equatorial coordinates anticlockwise with respect the celestial North (East of North). The avoidance angle range can be specified up to 345 degrees.

> **Warning**
> Specifying the chopper avoidance angle place restrictions on when the observation can be scheduled. This constraint might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper angles. You should use chopper avoidance angle only for observations where it is absolutely necessary (see Section 10.5). You may check your observation's footprint orientations by clicking in the HSpot "Overlays" menu (see Chapter 19 and Chapter 20).

Chopping/nodding (bright lines)

This option is similar to the normal chopping/nodding option described above but optimized for spectral line measurements relaxed in sensitivity. By the grating up- and down scan only 16 positions are visited with larger step size to cover the same spectral range. This mode is almost six times faster than normal chopping/nodding.

Wavelength Switching

If by chopping a maximum of six arcminutes the field-of-view would not be placed in an emission-free area, the observer should consider wavelength switching as an alternative of the chopping mode. There may be be other reasons in a number of science cases to use this option. For very bright objects (typically solar system targets) chopping to off-source could introduce a high contrast, resulting in memory effects in the spectrometer's Ge:Ga detectors. Such an effect would lead to data that can only be poorly calibrated.

In wavelength switching mode three spectra are taken with sufficient overlap in between. The grating is frequently switched between the on-line and the two symmetrically placed off-line positions. There is no observing parameter the user can access for this mode. You can select wavelength switching by clicking on the "Wavelength switching" option button in the "Observing mode selection" field.

> **Note**
> The continuum information is eliminated when using wavelength switching technique. This mode is very inefficient if significant continuum gradients are expected over the covered wavelength range. More information about this mode can be obtained in the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html).

11.1.2.3. Pointed with Dither mode

This mode is offered to take data for a point-like object in a very similar way to "Pointed" observing mode (see Section 11.1.2.2). The underlying pointing mode is slightly different; dithering will be done by small spacecraft movements perpendicular to the chopper direction. In such a configuration this observing mode can compensate for image slicer effects, especially important for faint targets (see further explanation in the PACS Observers' Manual (ht-tp://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html)). User parameters are identical to the "Pointed" mode.
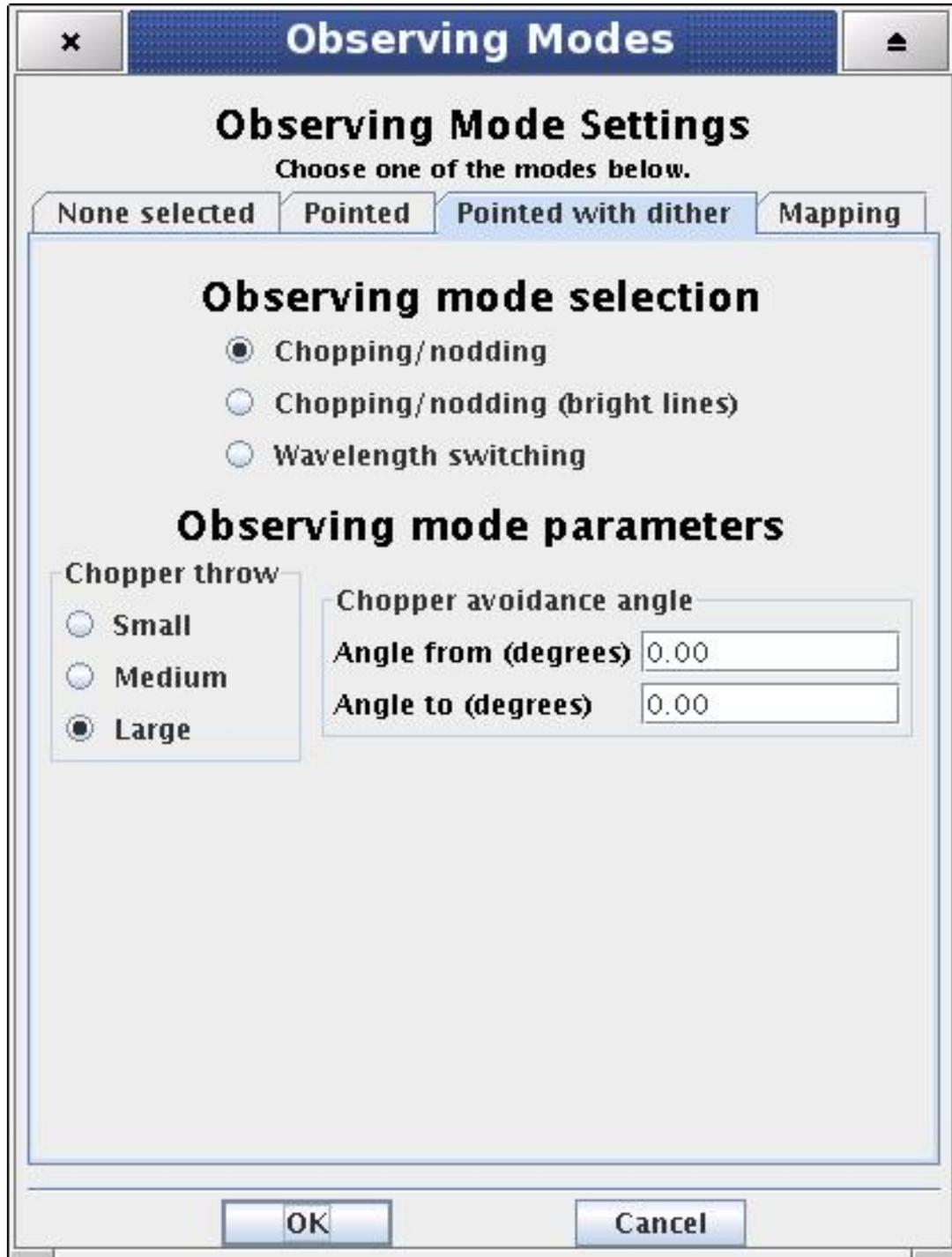
Figure 11.6. Options for the Pointed with Dither observing mode

11.1.2.4. Mapping mode

Setting up the instrument mode parameters on the "Mapping" screen is identical to that for the "Pointed" or "Pointed with dither" modes. The one difference can be seen at the bottom of the tab within the "Raster map" frame.
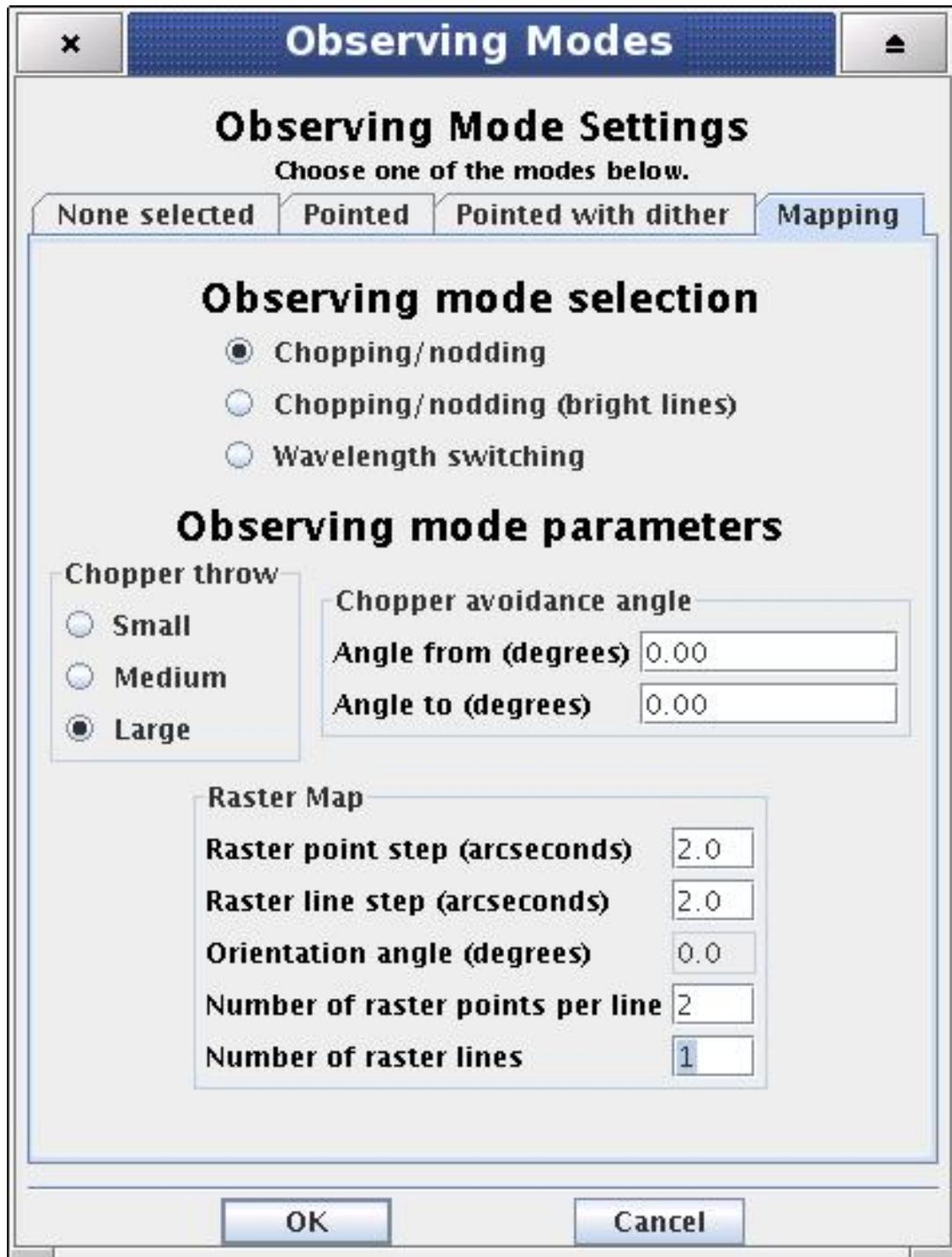
Figure 11.7. Options for the Mapping observing mode

This mode allows the observer to set up a raster map observation in combination with chopping/nodding or wavelength switching techniques. Chopping/nodding and wavelength switching options are described above.

The figure above (Figure 11.7) shows the user options for raster mapping, however, parameter val-

idation and ranges are slightly different depending on whether chopping/nodding, or wavelength switching is selected.

Setting the map size

The centre of the map is at the coordinates given by the target position. The map size along a raster line can be expressed as the number of raster points per line times the raster point step. In perpendicular direction, the map size is given by the number of raster lines times the raster line step. Mapping parameter ranges are defined as:

- Raster point step in [2, 480] arcseconds

- Raster line step in [2, 480] arcseconds

- Number of raster points per line in [2, 100]

- Number of raster lines in [1, 100]

Note

- The maximum map size is restricted to 6 arcminutes in chop/nod mode to allow for clean off-positions with the chopper for each raster position. Only the large chopper throw is allowed; sparsely sampled maps are possible.

- The maximum map size is 2 degrees in wavelength switching mode; sparsely sampled maps are possible.

Setting the map orientation angle

Selecting the chop/nod mode the map (raster line) orientation is defined by the chopping direction, the observer has no direct access to the map orientation parameter (disabled field). However, the observer has two choices to influence the map orientation:

- by setting a timing constraint or

- by setting a chopper avoidance angle (see the restrictions in Section 10.5)

In wavelength switching mode the map orientation can be set via the "Orientation angle" parameter. The telescope moves along raster lines in a direction with a position angle between 0 and 360 degrees from North to East in equatorial coordinate system.

11.1.3. PACS Time Estimator messages

To get a time estimate for the observing mode configuration chosen and its associated noise level, click the "Observation Estimation" button on the bottom of the AOT main screen. This runs the PACS Time Estimator and once the calculation is done brings up a window "PACS Time Estimation".
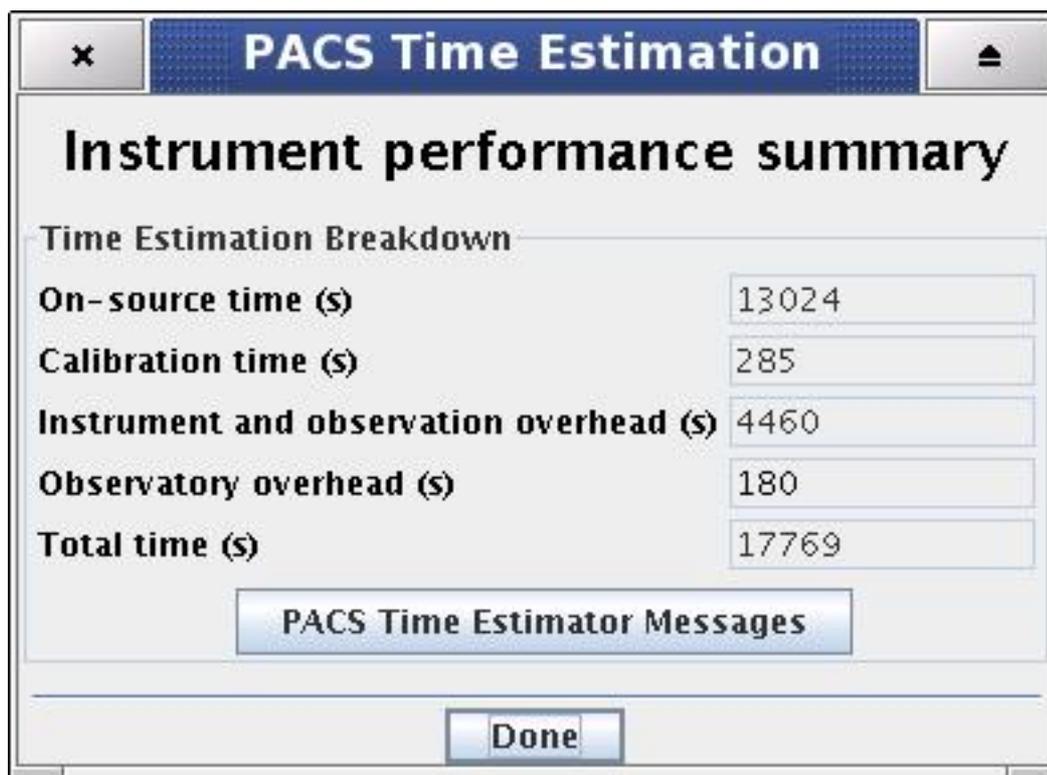
Figure 11.8. PACS Time Estimator main window

Running the estimator invokes a sequence of optimisation processes through possible combinations stored in instrument configuration tables. This process selects the most efficient way of observing on-target, reference and calibration measurements and also minimises the instrument overheads.

The exact time for the observing sequence and the associated expected noise are presented to the observer. A set of messages and information regarding the sequence chosen are also given.

11.1.3.1. PACS Instrument Performance Summary

The breakdown of the observation is provided in the "PACS Time Estimation" screen (Figure 11.8). It indicates the on-source time, calibration time, instrument and observatory overheads and the total observing time. Further details on calculation of the timing components can be obtained in the PACS Time Estimator messages window (see below).

> **Note**
> The 180 seconds observatory overhead is always charged to the observer as a compensation for the initial slewing time. In case the AOR is constrained (see Section 10.5 and Chapter 16) a total of 10 minutes observatory overhead is charged.

11.1.3.2. PACS Time Estimator messages window

More detailed information can be obtained by clicking the "Messages" button on the "PACS Time Estimation" screen.
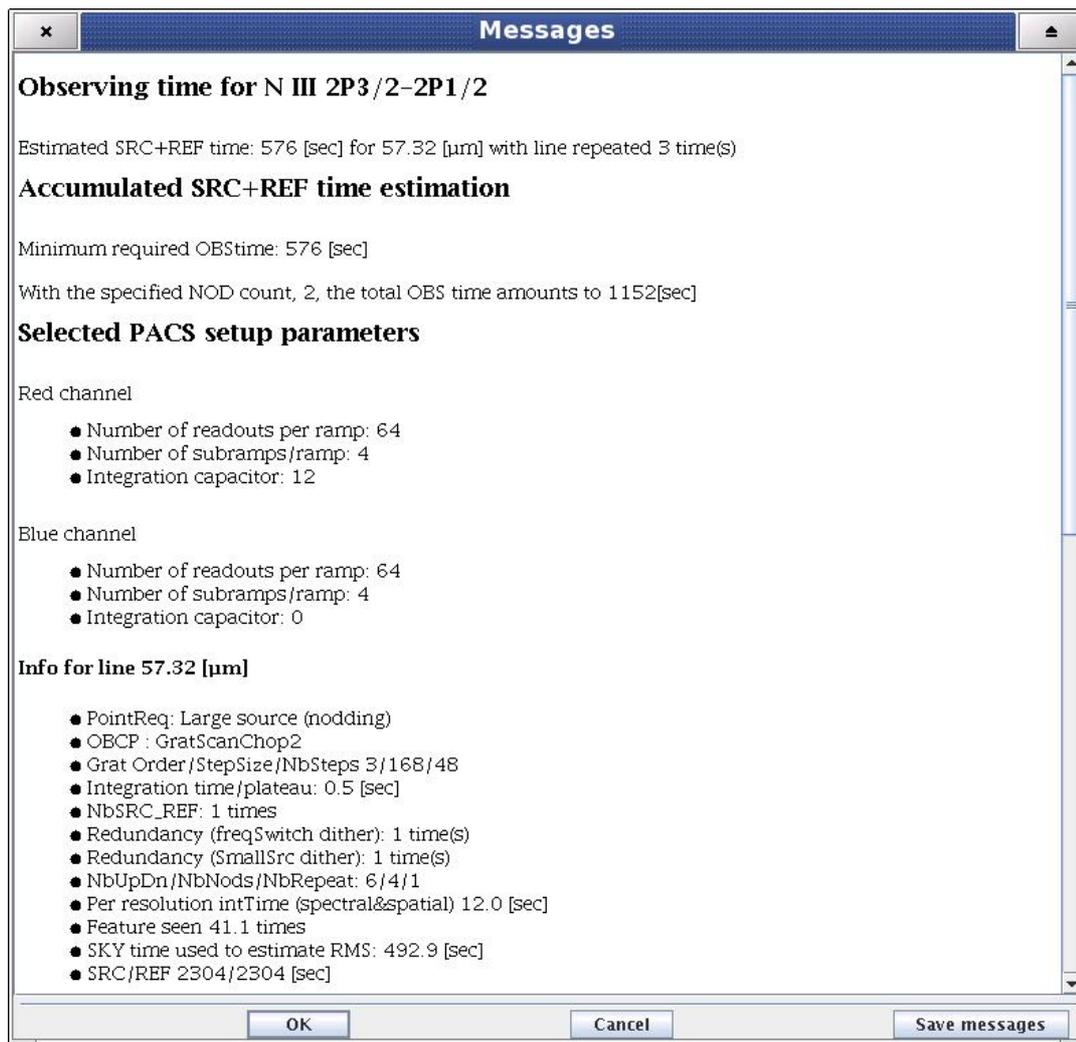
Figure 11.9. PACS Time Estimator messages window

The message window presents information of two kinds: (1) a summary of the data entered in HSpot (line wavelengths and observing mode parameters); and (2) several relevant pieces of timing information, as well as the RMS noise and signal-to-noise for the resulting times:

- HSpot decoding logic; number of repetitions per spectral line and observing time per line per pointing position

- Observing time required; minimum observing time and actual requested time

- AOT, pointing mode and nodding / wavelength switching info

- Global AOT durations

- Setup and calibration summary

- Spectral line summary; observing wavelengths, continuum sensitivity for a point source, spectral line sensitivity for a point source, observing time spent per line, on-source time plus observing time on reference position (chop-off field)

11.2. PACS Range Spectrometry AOT

In this AOT the PACS spectrometer takes observations of specified spectral ranges. As in the PACS Line Spectroscopy AOT, it also performs an observation of one or several spectral features within the band specified by the combination of chosen grating orders. Unlike the PACS Line Spectroscopy AOT, the observer can specify freely the wavelength range to be explored, or can choose the Spectral Energy Distribution (SED) mode offering a predefined range that will cover the entire bandwidth of the selected orders. In this AOT the observer also has control over the grating sampling density. The AOT may be used in staring or in raster mapping modes; in both cases background subtraction can be achieved with the standard chopping/nodding technique. In mapping mode for crowded-field spectroscopy an additional option is offered where background subtraction can be done by visiting an off-position.

Figure 11.10. The Range Spectroscopy AOT main window

11.2.1. Wavelength Settings

The 'Wavelength Settings' part of the PACS Range Spectroscopy start-up screen provides the observer with the opportunity to specify a set of spectral ranges to observe in the observing request. The main component of this functionality is the Range Editor table, which stores the spectral range information. Before the observer starts to provide table entries, a fundamental attribute of the observation have to be specified.

11.2.1.1. Range spectroscopy mode selection

This pull-down menu in the "Range scan or SED mode" frame gives the choice to select between two scan modes the flexible "Range scan" and the fast "SED" (Spectral Energy Distribution) mode. Depending on the applicable wavelength ranges (defined by the grating diffraction orders) these options are further divided all together into five categories:

- Option 1 - "Range scan in [71-98] and [102-210] microns (2nd + 1st orders) " - default option

- Option 2 - "Range scan in [55-73] and [102-210] microns (3rd + 1st orders)"

- Option 3 - "SED Red [71-210] microns (2nd + 1st orders)"

- Option 4 - "SED Blue [55-73] microns (3rd order)"

- Option 5 - "SED Blue high sensitivity [60-73] microns (extended 2nd order)"

As a result of the selection, the spectral ranges to observe have to be specified in the PACS Range Editor as being within either the 71-98 and 102-210 micron band, or within the 55-72 and 105-210 micron bands. However, PACS always observes in two parallel bands, beside the 'nominal' range, data are obtained in the 'parallel' channel as well.

> **Note**
> As is indicated in the options above, irrespective of the blue order selection, PACS always observes a part of the [102-210] microns range (1st order) in the red spectrometer array. Details about the covered ranges and grating step sizes in 'nominal' and 'parallel' channels can be found in the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html).

> **Note**
> The PACS spectrometer has a sensitivity gap from 98 to 102 microns.

> **Tip**
> The observer has a choice of creating an observation comprising of spectral ranges spread along the entire PACS wavelength range (55-210 micron) by grouping AORs. In this case, at least two AORs have to be requested, one with each of the grating order options. See Section 6.5.3 and Section 16.2 (grouping and timing constraints) for further information.

The use of range scan options in combination with high sampling density (see "Instrument settings") is recommended to observe broad spectral lines of FWHM typically larger than few hundred km/s. The poorer sampled SED modes or the range scan options in combination with Nyquist sampling are more suitable for continuum studies.

> **Tip**
> Very long integrations over the full spectrum in range scan mode with high sampling density is possible with the PACS spectrometer but not recommended. Indeed, this is a very time efficient way to explore the continuum and detect spectral lines at the highest possible resolution but data could be barely calibratable. Two alternatives should be considered: (i) split up the full wavelength range into parts defining several AORs if the detection of faint lines is the goal, or (ii) increase the repetition factor in SED mode (or in range scan options in combination with Nyquist sampling) in order to increase the continuum sensitivity.

In SED mode parameters stored in the PACS Range Editor are ignored by the AOT backend except the reference wavelength and continuum flux density parameters if given. The observation will cover the blue or the red SED domain as defined by the selected grating order combination. In this mode, the observer has no control over the grating sampling density; the "Instrument settings" field is disabled for this purpose.

> **Note**
> In case one of the "Range scan" mode is selected in full wavelength range combined with "Nyquist sampling" then the observation is identical to the corresponding SED mode option.

> **Tip**
> The observer has a choice of creating an observation comprising of SED scans spread along the entire PACS wavelength range (55-210 micron) by grouping AORs. In this case two AORs have to be requested, one with "SED Red" and a second observation with "SED Blue" option. See Section 6.5.3 and Section 16.2 (grouping and timing constraints) for further information.

11.2.1.2. The PACS Range Editor

The PACS Range Editor is used to set up the list of spectral ranges to be observed. The AOT allows a maximum of ten ranges to be entered into the table, although the use of the "Repetition factor" parameter could result in a further restriction of the number of observed ranges (see below).

> **Tip**
> If your observation requires more than the allowed number of ranges consider setting up a group of AORs. See Section 6.5.3 and Section 16.2 (grouping and timing constraints) for further information.

11.2.1.3. Setting Values in the PACS Range Editor

The table gives a summary of spectral range dependent attributes of your AOR. You cannot enter, modify, or remove values directly in the table. The three buttons at the bottom of the table allow the following:

Figure 11.11. Window to add- and modify spectral range entries

- Add - hitting this button allows the addition of a new spectral range in the chosen wavelength range. A "Create a new range" window is opened and the user can enter values in the enabled fields. Once the "OK" button is hit the spectral line settings are stored in the PACS Range Editor.

- Modify - This button allows spectral range settings to be modified after they have been created with the "Add" functionality noted above.

- Delete - Allows the deletion of a spectral range. Click on the table entry holding the spectral range to highlight it, then hit the "Delete" button to remove it. Note, deleting a line has no effect

on other lines in the table, default line IDs will not change for already configured ranges.

11.2.1.4. Create a new line / Update a line dialogues

Pressing the "Add" or "Modify" button will pop-up either the "Create a new range" or the "Update a range" window. The content of these two windows are identical and serve the user to enter/modify values in the Pacs Range Editor.

> **Note**
> The "Create a new range" / "Update a line" dialogues include optional parameters for signal-to-noise calculation in case the observer can supply source estimates. Optional parameters are highlighted in green text in the HSpot windows.

Range ID

Mandatory parameter. A unique range identification label. It has to be at least one character different for each subsequent line. Default values are "Range 1, Range 2, ... Range 10". User defined Range Ids can contain any character string, including spaces, up to 40 characters. If the user removes a range from the table (see below) the Range Id will not change for the remaining set of ranges.

Blue Edge (microns)

Mandatory parameter. The starting wavelength of the range to be observed. The PACS grating will perform an up and down scan starting at this wavelength.

> **Note**
>
> • The "Blue Edge" must have a shorter wavelength than the "Red Edge", the minimum permitted separation is 1 micron.
>
> • The wavelength order of the spectral ranges entered in the PACS Range Editor has no effect on the duration of the observation. The AOT backend logic sorts the observing sequence for the spectral ranges to minimise grating overheads.

Red Edge (microns)

Mandatory parameter. The longest red wavelength of the range to be observed. The PACS grating will perform an up and down scan terminating at this wavelength.

Reference wavelength for S/N calculations (microns)

Optional parameter. The PACS sensitivity could have a significant variation over the selected wavelength range or SED domain. In order to support a custom way to calculate signal-to-noise, the HSpot dialogue allows to set up a fiducial reference wavelength where the line flux, continuum flux density and line width parameters are interpreted. The PACS Time Estimator provides the minimum and maximum sensitivities for each of the ranges (or SED domains) and signal-to-noise for the reference wavelength. Be careful to specify the reference wavelength within the boundaries of the spectral range you fill.

> **Tip**
> Figures on spectrometer sensitivity variations as a function of wavelength can be found in the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html).

Line flux unit

This menu gives the flexibility to switch between physical input units supported by the PACS AOT logic. The pull-down menu allows the unit of line flux to be defined:

- Option 1 - "Flux (10^-18 Watt/m^2)", default option

- Option 2 - "Flux (10^-15 erg/s/cm^2)"

The "Line Flux" parameter of the PACS Range Editor is interpreted in the selected units.

> **Note**
> In cgs units the flux is measured in erg s^-1 which can be converted to watts, 1 watt = 1 x 10^7 erg s^-1.

Line flux

Optional parameter. User supplied line flux estimate in units specified by the "Line Flux Units" option. Line flux input is used only for signal-to-noise estimation at the given reference wavelength. None of the instrument or observing mode settings can be influenced by this parameter. Leaving the parameter as the default 0.0 value means the PACS Time Estimator will not perform signal-to-noise estimation (sensitivity estimates are still provided).

Continuum flux density (mJy)

Optional parameter. Continuum flux density estimate at the reference wavelength. The value of this parameter is interpreted by the PACS Time Estimator as flux density for a spectrometer resolution element. Leaving the parameter as the default 0.0 value means the PACS Time Estimator will not perform signal-to-noise estimation (sensitivity estimates are still provided).

> **Tip**
> The PACS spectrometer spectral resolution as a function of wavelength and gration order can be found in the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html).

Line width unit

This menu gives the flexibility to switch between physical input units supported by the PACS AOT logic. The pull-down menu allows the unit of line width to be defined:

- Option 1 - "1 km/s", default option

- Option 2 - "1 micron"

The "Line Width" parameter in the PACS Range Editor is interpreted in the selected unit.

Line width (FWHM)

Optional parameter. The spectral line full width at half maximum value in units specified by the "Line Width Units" pull-down menu. Line width input is used only for signal-to-noise estimation at the reference wavelength. None of the instrument or observing mode settings can be influenced by this parameter. Leaving the parameter as the default 0.0 value means the PACS Time Estimator will not perform signal-to-noise estimation for an unresolved line.

Range Repetition

The relative range strength (fraction of on-source time per range) is taken into account by specifying the grating scan repetition factor for each range. In total, a maximum of 10 repetitions can be specified in the table. For instance, if 10 ranges are selected then the "Range repetition" factor has to be 1 for each range; if 3 ranges are selected the total of the 3 repetition factors has to be less than or equal to 10 (e.g. 4+5+1 or 2+3+3, ...). If the sum of repetitions exceeds 10 you must either remove spectral range(s) or reduce the scan repetition factor(s).

The following considerations have to be made when specifying the repetition factor:

- Each grating scan has equal duration irrespective of the observation wavelength.

- The grating scan pattern is repeated for every on-source and nod position (except in mapping with off-position mode).

- Higher sensitivity can be achieved either by scanning one line more often within a nod position, or by repeating the nod pattern of grating repetitions more often (see "Observing mode settings"). The latter would then affect all lines in the PACS Range Editor. If you are observing only one or two lines you should consider increasing the "Range repetition" factor in the table. This is more efficient as it minimises the nod slewing overhead.

> **Tip**
> You can specify an observation with more than ten grating scans per pointing position by grouping AORs.

11.2.2. Instrument Settings

In Range mode the grating sampling density can be chosen by the observer. A pull-down menu offers two options: "Nyquist sampling" or "High sampling density".

- Nyquist sampling density - here, the grating stabilisation times are significantly longer and it is assumed that the observer is not aiming for the highest possible sensitivity.

- High sampling density - this mode can be used to take advantage of the best spectrometer sensitivity. In this configuration the grating operates in exactly the same way as in the Line Spectroscopy AOT.

> **Note**
> In principle, the selected grating sampling density does not effect the spectral resolution of the PACS spectrometer. Nonetheless, the line profile full sampling can be achieved only in high sampling density mode.

11.2.3. Observing Mode Settings

The "Observing Mode Settings" screen provides the observer with the opportunity to specify the combination of instrument modes with spacecraft pointing modes. To start the procedure just click on the "Set the Observing Modes" action button on the main AOT window. This action returns a screen with the choice of observing modes (see figure below). Click on a tab to select the mode required. The default observing mode is "None selected". You must choose another tab for a valid observation.

Figure 11.12. The Observing Mode Settings window in its start-up status

The main driver of observing modes is the pointing mode in which you wish to observe. The tab labels refer to "Pointed", "Pointed with Dither" and "Mapping" observing modes, each of them is combined with chopping/nodding.

11.2.3.1. Nodding or map repetition cycles

On the right hand side of the observing mode settings area there is a button labelled "Nodding or map repetition cycles". The absolute sensitivity of the observation can be controlled by entering an integer between 1 and 100. This parameter has the effect of increasing the on-source time by repeating the nodding pattern the number of times that you specify. For each of the nod positions the sequence of range scans is repeated with the relative depth specified in the PACS Range Editor (see "Range Repetition" above). In SED mode this parameter has a very similar effect, the entire spectral range is repeated the number of times that is specified. In case crowded-field observation with mapping with off-position is used the on-source time is increased by repeating the map the number of times that is entered. No nodding is applyied in this latter configuration.

11.2.3.2. Pointed mode

This mode is for observing point sources, i.e. sources that are not extended at the wavelength of observation. The integral-field concept allows simultaneous spectral and spatial multiplexing for the most efficient detection of weak individual spectral lines, with sufficient baseline coverage and high tolerance to pointing errors, without compromising spatial resolution. The PACS spectrometer arrays have 5 by 5 spatial pixels covering a 49 x 49 arcsecond field of view. Both channels view identical positions on the sky. The line flux from a point source object will always be collected with the filled detector array. Therefore, for a simple detection of a line source, one pointing is sufficient.
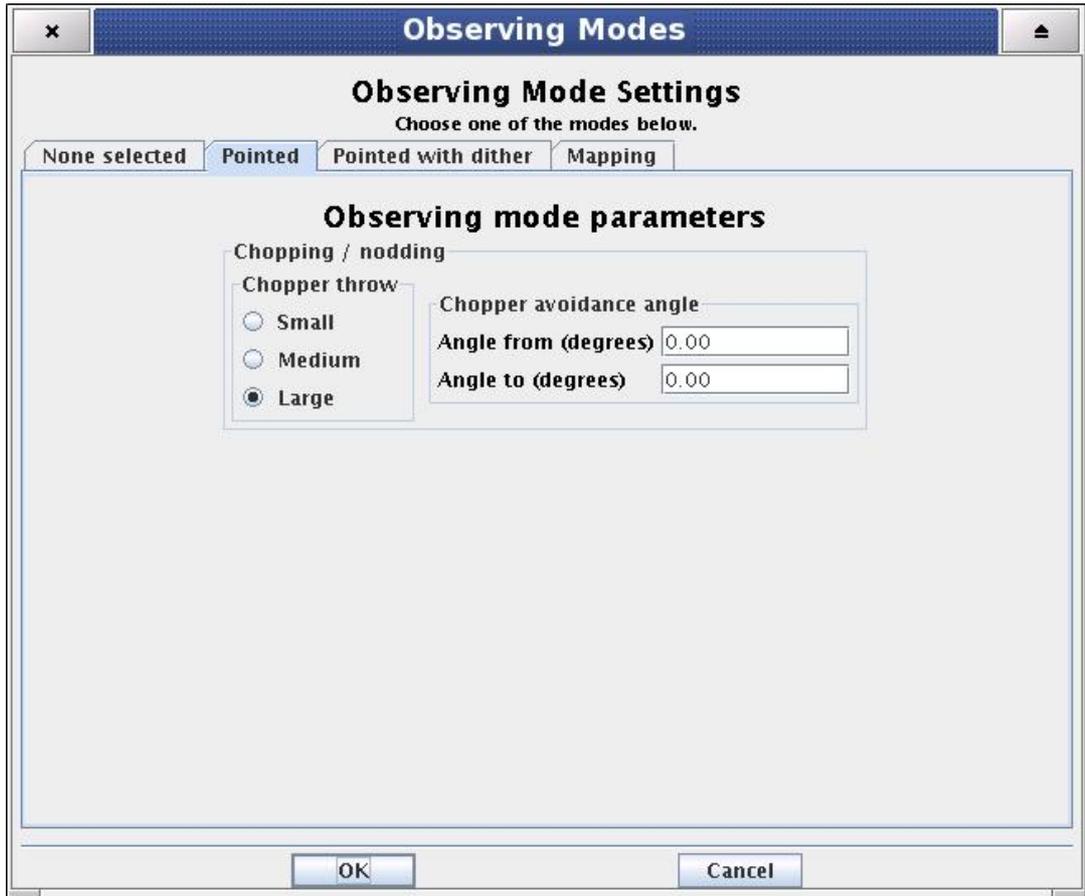
Figure 11.13. Options for the Pointed observing mode

Background subtraction can be achieved through standard chopping/nodding technique.

Chopping/Nodding

This mode allows a classical three position nodding observation to eliminate inhomogeneities between the telescope and sky background. The PACS focal plane chopper is moved between the on-target and the off-positions during a grating scan. The whole sequence of spectral line scans is then repeated in the nod position. In total, one half of the integration time is spent on-source. This mode is always enabled.

Observing mode parameters - Chopping/Nodding

The chopper throw and chopper avoidance angle can be selected. The choice of throws "Small", "Medium" and "Large" refer to 1.0, 3.0 and 6.0 arcminute chopper throws on the sky respectively. The chopping direction is determined by the date of observation, the observer cannot directly influence this parameter. If a source of emission falls within the chopper throw radius around the target, the observer should consider setting up a chopper avoidance angle constraint. The angle can be specified in Equatorial coordinates, anticlockwise with respect the celestial North (East of North). The avoidance angle range can be specified up to 345 degrees.

> **Warning**
> Setting up a chopper avoidance angle requires an additional constraint on mission planning, therefore this parameter should have to be used only for observations where it is absolutely necessary. Specifying the chopper avoidance angle place restrictions on when the observation can be scheduled. This constraint might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper angles. You should use chopper avoidance angle only if a constraint is essential for your observation (see Section 10.5). You may check your observation's footprint orientations by clicking in the HSpot's "Overlays"

menu (see Chapter 19 and Chapter 20).

11.2.3.3. "Pointed with Dither" mode

This mode is offered for taking data on a point-like object in a similar way to the "Pointed" observing mode (see above). The underlying pointing mode is slightly different, as dithering will be carried out by small spacecraft movements perpendicular to the chopper direction. In this configuration the observing mode can compensate for image slicer effects, especially important for faint targets (see further explanation in the PACS Observer's Manual). The user parameters are identical to the "Pointed" mode.
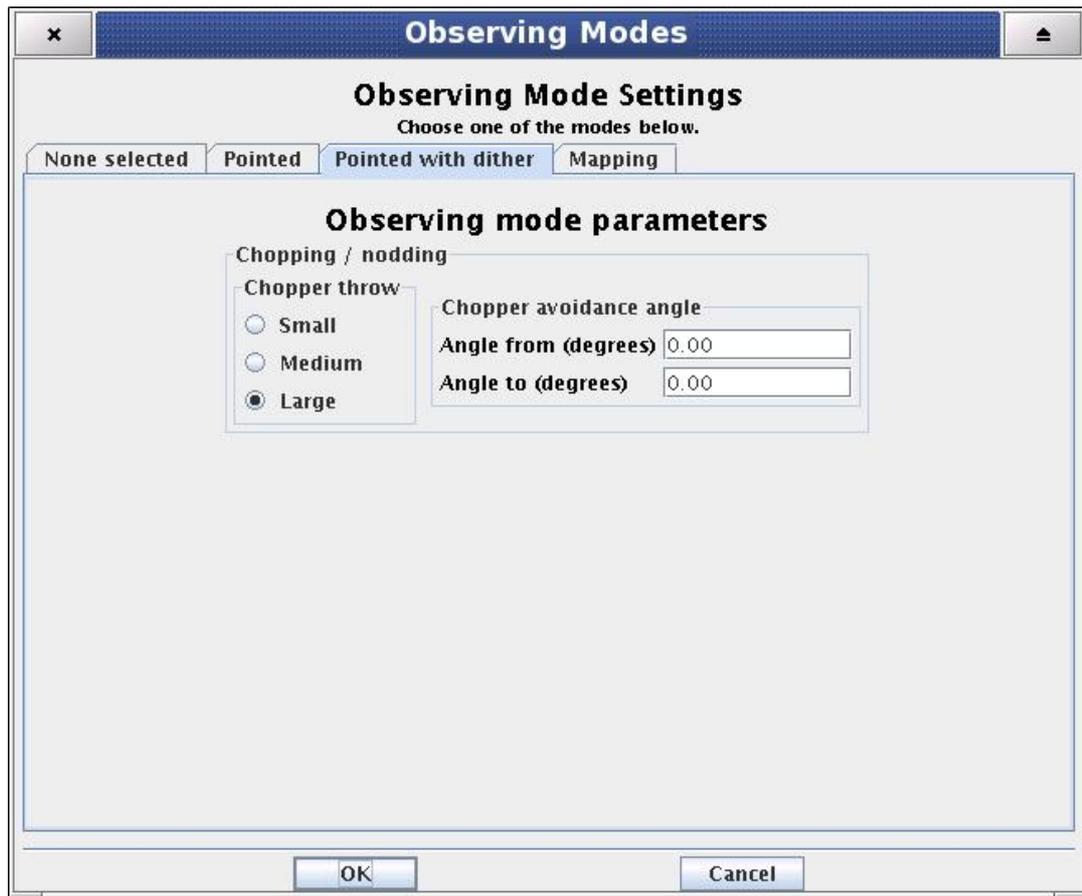
Figure 11.14. Options for the Pointed with Dither observing mode

11.2.3.4. Mapping mode

Setting up the instrument mode parameters on the Mapping screen is identical to that for the "Pointed" or "Pointed with dither" modes. The difference can be seen at the bottom of the tab under "Raster map parameters" and the "Off-position" settings.
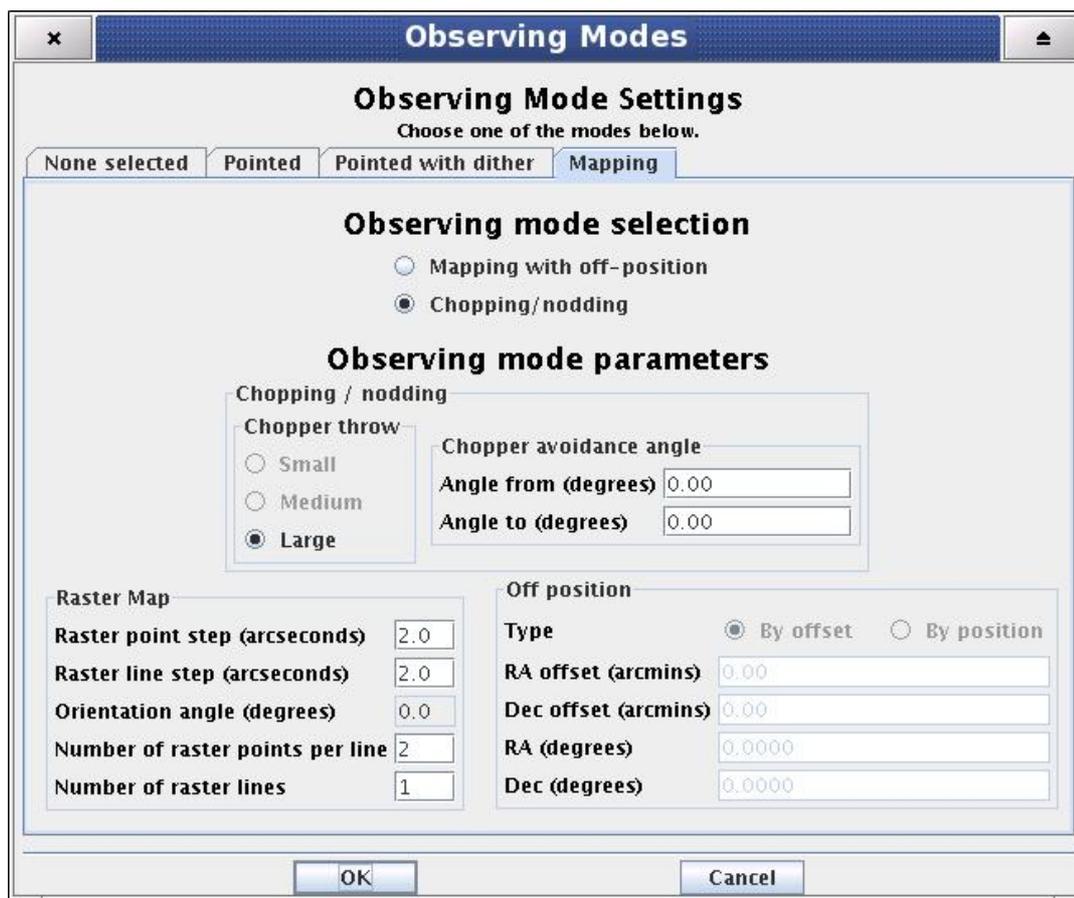
Figure 11.15. Options for the Mapping observing mode

This mode allows the observer to set up a raster map observation in combination with chopping/nodding or off-position. If the field of view would not be placed in an emission-free area by chopping 6 arcminutes away, a selected off-position on the sky can be given as a reference position. Note that the reference position must be within 2 degrees of the target. The frequency of calibration blocks at the off-position is optimised by the AOT backend; the user has no control over it.

The figure above shows the options for raster mapping, however, parameter validation and ranges are slightly different depending on whether chopping/nodding, or an off-position is selected.

Setting the map size

The centre of the map is at the coordinates given by the target position. The map size along a raster line can be expressed as the number of raster points per line times the raster point step. In perpendicular direction, the map size is given by the number of raster lines times the raster line step. Mapping parameter ranges are defined as:

- Raster point step in [2, 480] arcseconds

- Raster line step in [2, 480] arcseconds

- Number of raster points per line in [2, 100]

- Number of raster lines in [1, 100]

Note

- The maximum map size is restricted to 6 arcminutes in chop/nod mode to allow for clean off-positions with the chopper for each raster position. Only the large chopper throw is allowed; sparsely sampled maps are possible.

- The maximum map size is 2 degrees in off-position mode; sparsely sampled maps are possible.

Setting the map orientation angle

Selecting the chop/nod mode the map (raster line) orientation is defined by the chopping direction, the observer has no direct access to the map orientation parameter (disabled field). However, the observer has two choices to influence the map orientation:

- by setting a timing constraint or

- by setting a chopper avoidance angle (see restrictions in Section 10.5)

In off-position mode the map orientation can be set via the "Orientation angle" parameter. The telescope moves along raster lines in a direction with a position angle between 0 and 360 degrees from North to East in equatorial coordinate system.

Off-position parameters

The off-position can be specified either in absolute coordinates, or in relative coordinates with respect the target position. The off-position has to fall within a 2 degrees circle with respect the target position (map centre).

11.2.4. PACS Time Estimator messages

To get a time estimate for the observing mode configuration chosen and its associated noise level, click the "Observation Estimation" button on the bottom of the AOT main screen. This runs the PACS Time Estimator and once the calculation is done, brings up a "PACS Time Estimation" window.

Figure 11.16. PACS Time Estimator main window

Running the estimator invokes a sequence of optimisation processes through possible combinations stored in instrument configuration tables. This process decides the most efficient way of observing on-target, reference and calibration measurements and also minimises the instrument overheads.

The estimated time required for the observing sequence and the associated expected noise is returned to the observer. A series of messages and information regarding the chosen sequence are also presented.

11.2.4.1. PACS Instrument Performance Summary

The breakdown of the observation is provided in the "PACS Time Estimation" screen (Figure 11.16). It indicates the on-source time, calibration time, instrument and observatory overheads and the total observing time. Further details on calculation of the timing components can be obtained in the PACS Time Estimator messages window (see below).

Note
The 180 seconds observatory overhead is always charged to the observer as a compensation for the initial slewing time. In case the AOR is constrained (see Section 10.5 and Chapter 16) a total of 10 minutes observatory overhead is charged.

11.2.4.2. PACS range spectroscopy sensitivity plots

The spectrometer sensitivities over the requested ranges can be obtained by clicking on the "Range Sensitivity Plots" button of the time estimator main window. The pop-up window has two tabs, one for RMS sensitivities of a point source in 10^-18 W/m^2 units, the other is for point source continuum sensitivities in mJy units.

The individual curves represent system level sensitivities as a function of wavelength for each range specified in the PACS Range Editor plus sensitivities in the corresponding parallel ranges. The sensitivity estimation takes into account the relative line repetition factors, the number of observation cycles and relevant properties of the selected observing mode.
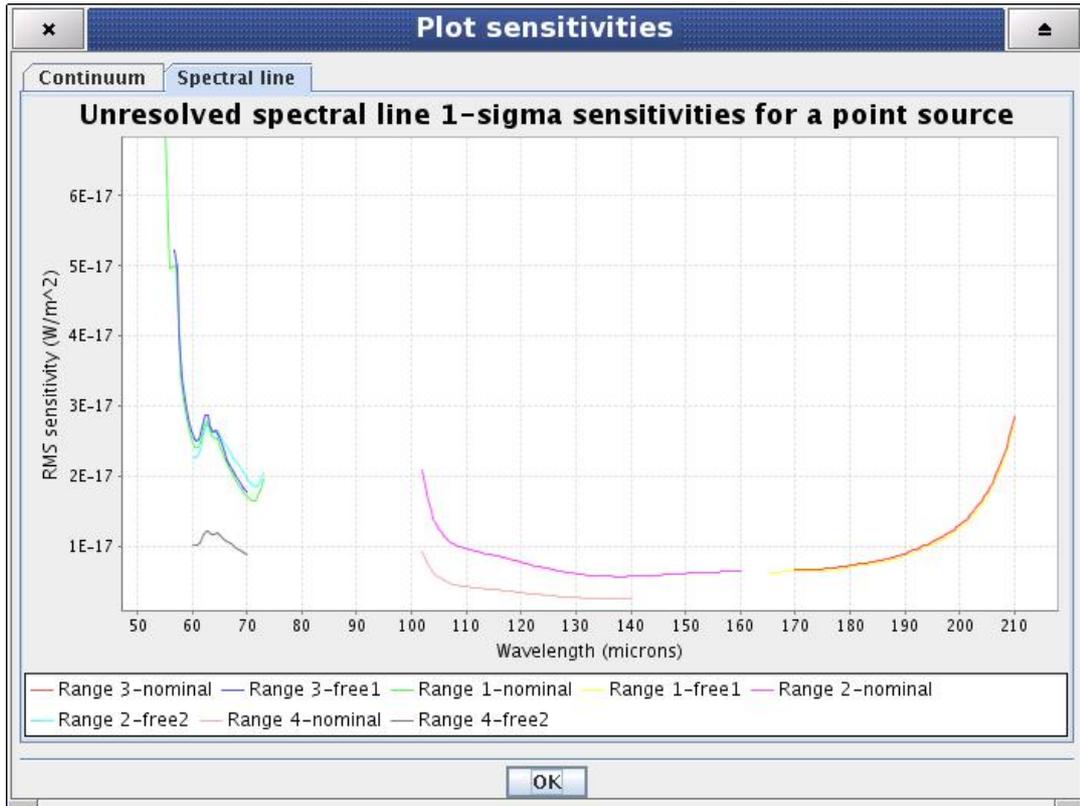
Figure 11.17. Range sensitivity plots for spectral lines
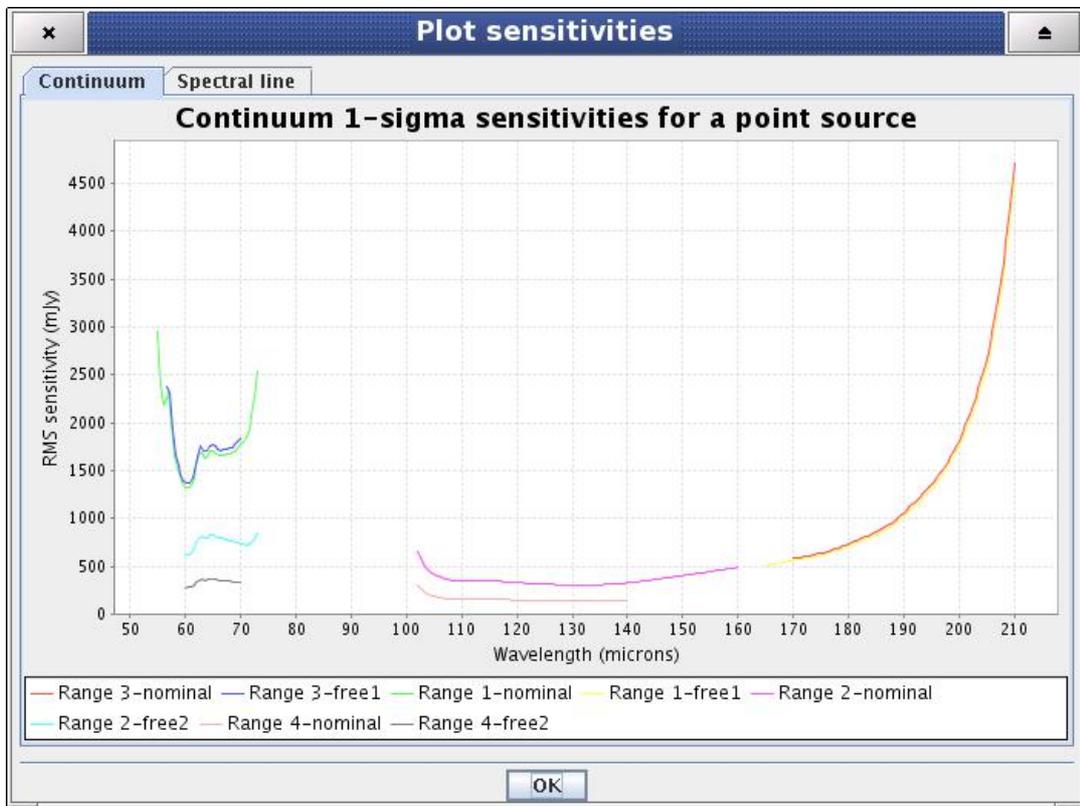
Figure 11.18. Range sensitivity plots for continuum

Note
Depending on the grating order/wavelength range combination a user selected range could have 0, 1 or 2 parallel ranges. These are shown as "free" ranges on the legend of the plot.

Tip
The observer should always check the range sensitivity plots before completing an AOR. This would help to avoid unnecessary duplications of data.

Tip
Using the left mouse button you can zoom in/out in the image. Hitting the right mouse button some further options can be obtained (Properties, Save as, Print..., Auto Range).

11.2.4.3. PACS Time Estimator messages window

More detailed information can be obtained by clicking the "Messages" button on the "PACS Time Estimation" screen.
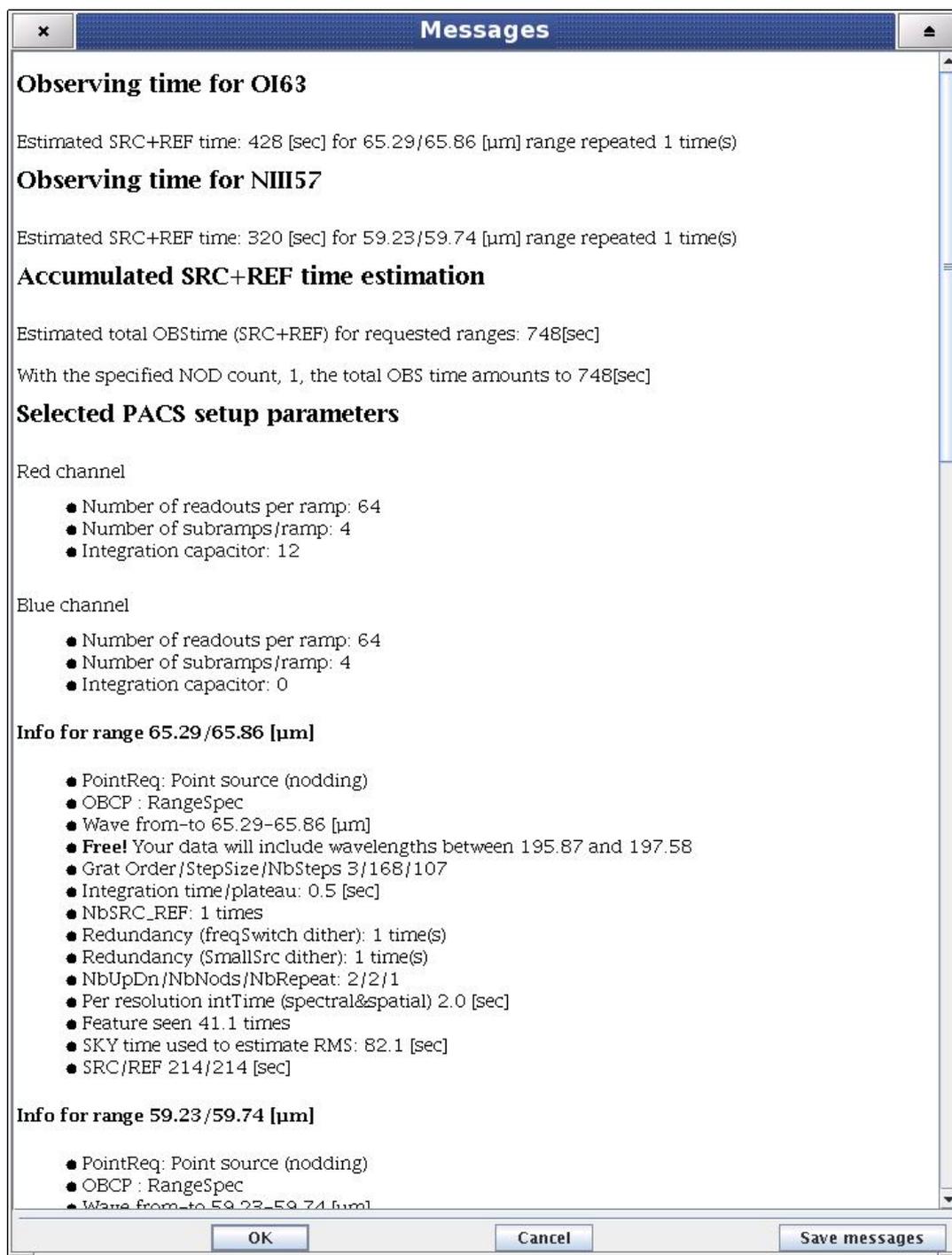
Figure 11.19. PACS Time Estimator messages window

The message window presents information of two kinds: (1) a summary of the data entered in HSpot (line wavelengths and observing mode parameters); and (2) several relevant pieces of timing information, as well as the RMS noise and signal-to-noise for the resulting times:

- HSpot decoding logic; number of repetitions per spectral range and observing time per line per pointing position

- Observing time required; minimum observing time and actual requested time

- AOT, pointing mode and nodding info

- Global AOT durations

- Setup and calibration summary

- Spectral range summary; observing wavelength ranges, continuum sensitivity for a point source (best and worst estimates), spectral line sensitivity for a point source (best and worst estimates), observing time spent per line, on-source time plus observing time on reference position (chop-off field), information on parallel (free) ranges

11.3. PACS Photometry AOT

In this AOT the PACS photometer is operating in dual band mode. PACS observes in the blue channel, either in the 60-85, or in the 85-130 micron band, depending on the requested filter combination, while in the red channel the 130-210 micron band is observed simultaneously. The telescope point spread function is fully sampled in both bands by the 3.5 by 1.75 arcminute filled bolometer arrays. Observing modes offer a choice of mapping modes, combined with specific background subtraction techniques.
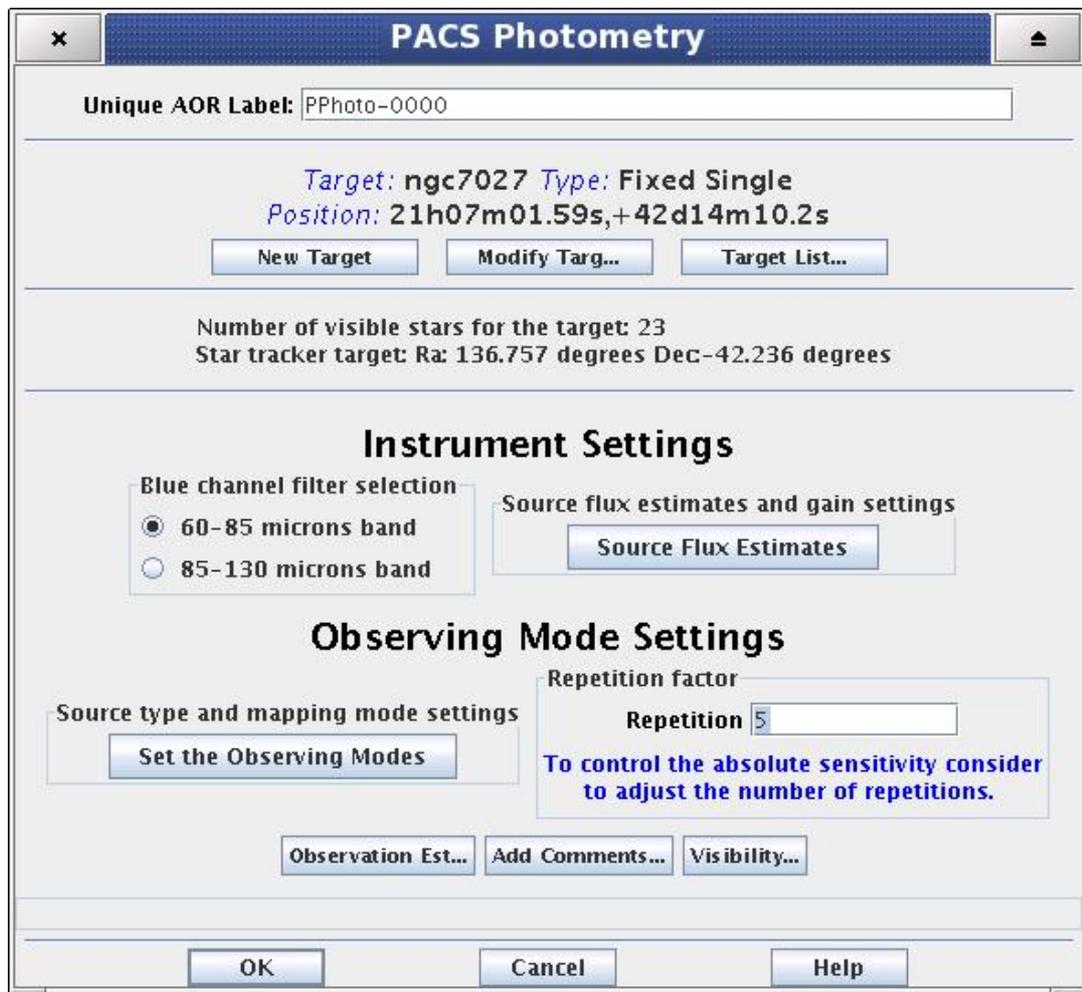
Figure 11.20. The Photometry AOT main window

11.3.1. Instrument Settings

11.3.1.1. Blue channel filter selection

The first step to create a PACS Photometry AOR is the filter selection in the blue channel. The two mutually exclusive options are [60-85] or [85-130] microns bands. Irrespective the blue filter selection, parallel data are always obtained in the red channel.

11.3.1.2. Source flux estimates and gain settings

Clicking on the "Source Flux Estimates" action button a pop-up window will offer four entry fields:

- Point source flux density blue channel (mJy)

- Point source flux density red channel (mJy)

- Extended source surface brightness blue channel (MJy/sr)

- Extended source surface brightness red channel (MJy/sr)

Figure 11.21. The Photometry AOT main window

These are optional AOR parameters, source estimated data used only for S/N calculation except if very a bright source is specified. In case "Point source photometry" observing mode is selected the extended source entry fields get disabled.

Warning
Specifying a very bright source will induce a change in gain settings. Check the applicable flux limits in the HSpot Observers Manual.

11.3.2. Observing Mode Settings

The "Observing Mode Settings" screen provides the observer with the opportunity to specify the combination of instrument modes with spacecraft pointing modes. To start the procedure just click on the "Set the Observing Modes" action button in the main AOT window. This returns a screen with the choice of observing modes, simple click on a tab to select the mode required. The default observing mode is "None selected". You must then choose another tab to validate the selected observation.
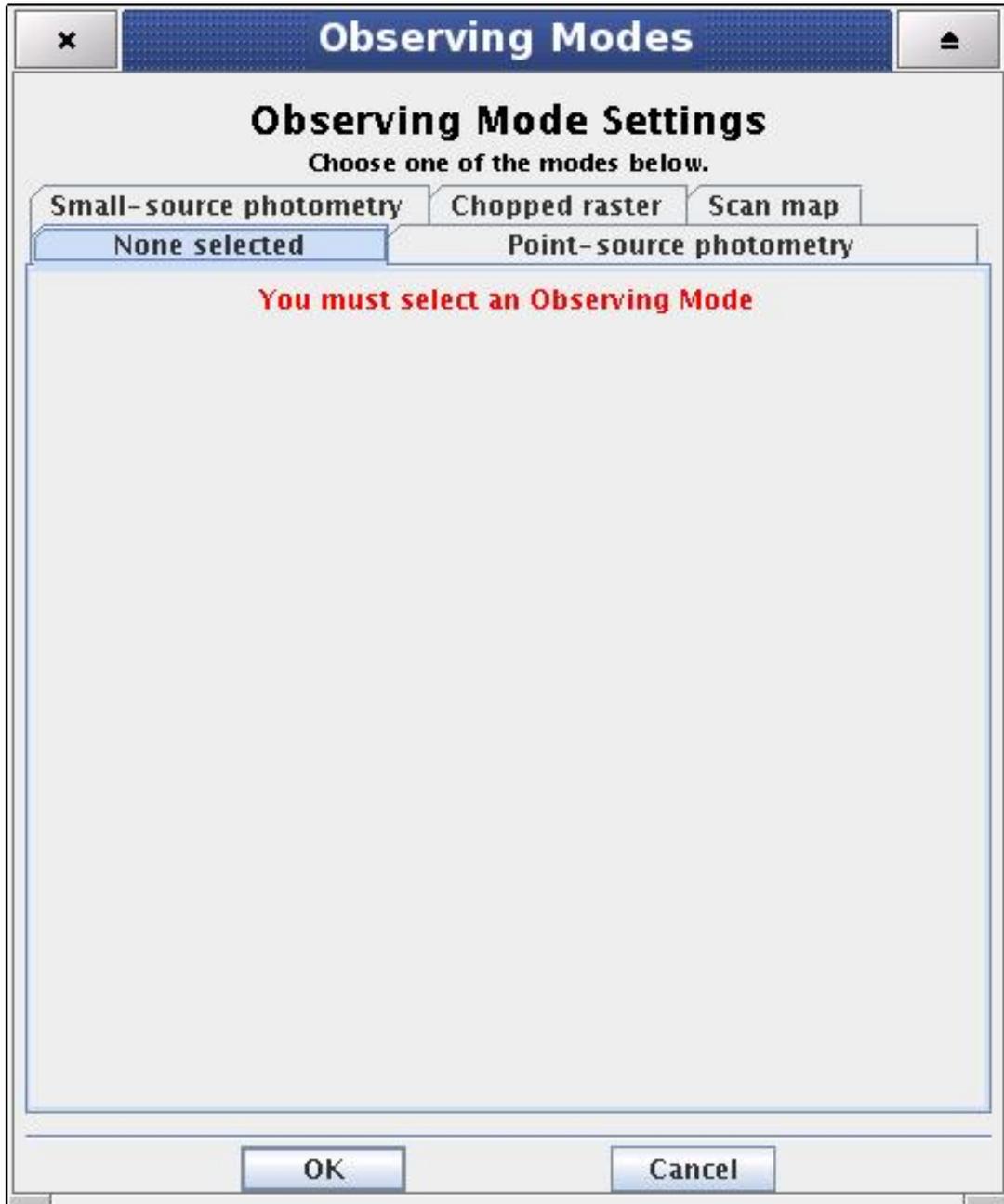
Figure 11.22. The Observing Mode Settings window in its start-up status

The main driver of observing modes is the pointing mode in which you wish to observe. The tab labels refer to "Point Source Photometry", "Small Source Photometry", "Chopped Raster" and "Scan Map" options.

11.3.2.1. Repetition factor

On the right hand side of the observing mode settings area a text box labelled "Repetition factor" can be found. The absolute sensitivity of the observation can be controlled by entering an integer number between 1 and 120. However, there are further rules to apply depending on the observing mode selection. The repetition factor has to fit within the range:

- [1, 120] for point source photometry

- [1, 32] for small source photometry

- [1, 100] for chopped raster

- [1, 100] for scan map

The on-source time is increased by repeating the nodding pattern the number of times that is entered in case "Point Source Photometry" or "Small Source Photometry" modes are used. For each of the nod positions the minimum 64 seconds chopped exposure sequence is repeated. In case "Chopped Raster" or "Scan Map" large area mapping options are used the number of map coverages increased the number of times that is entered.

11.3.2.2. "Point Source" Photometry
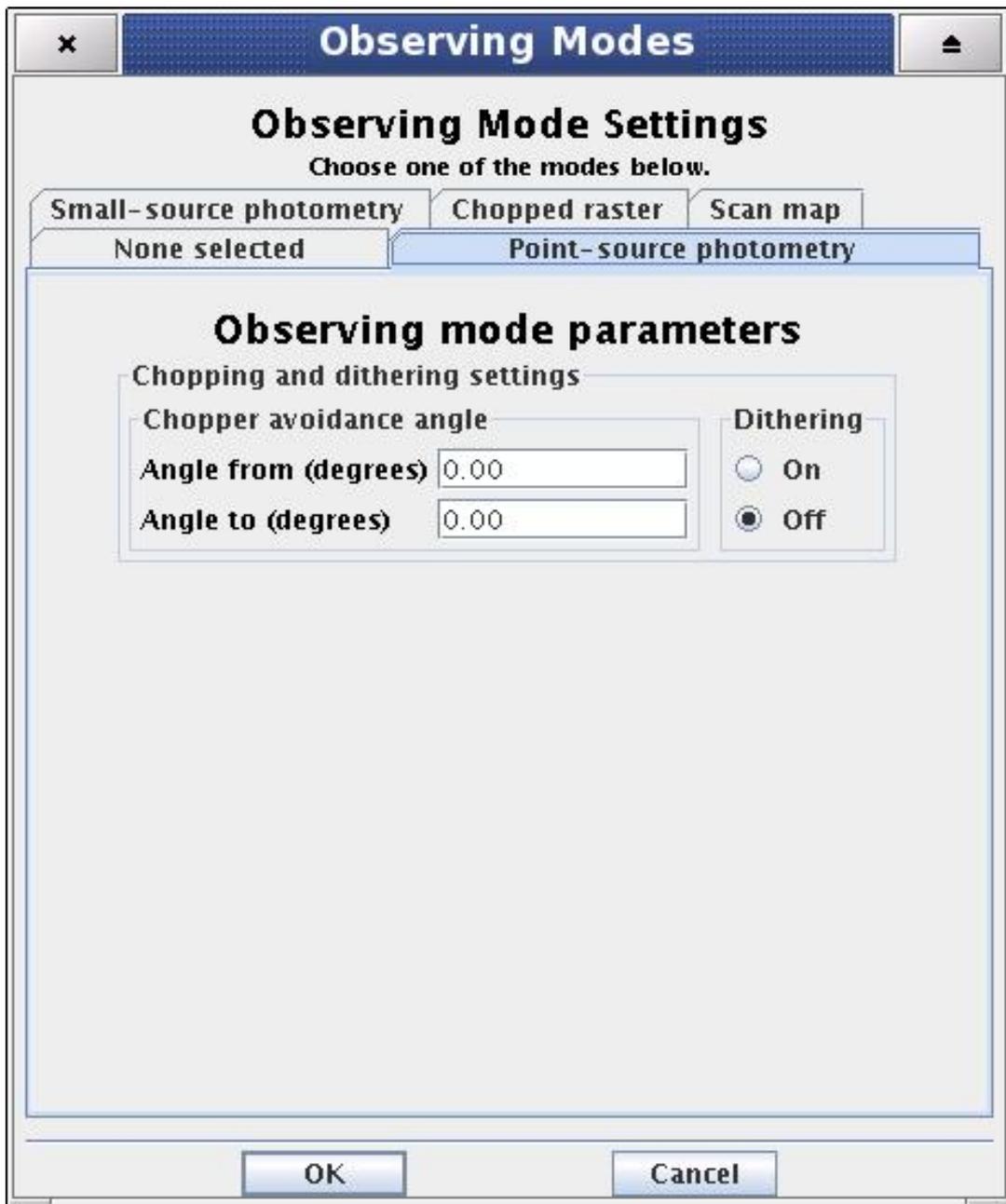
Figure 11.23. Point Source Photometry tab

This mode is reserved for observers who want to target a source that is completely isolated and point-like, or smaller than one blue matrix (approx. 85 arcseconds). It uses chopping and nodding, both with amplitude of 1 blue matrix, and dithering with an amplitude of a single pixel.

The point-source photometry mode is using a classic 4-position chopping, with dithering along the chopper axis, combined with nodding in the perpendicular direction. This setup compensates for the different optical paths in the most efficient way since the source is always kept on-array.

The observer specifies a repetition factor that is used to adjust the number of nod cycles to reach the requested integration time. The minimum time per nod position is 64 seconds. This is to block very short observations that have a poor observing efficiency, but is done at the expense of a stepwise behaviour in the AOR total time.

Depending on the user specified source flux level, the photometer gain is adjusted by the backend logic to provide a comprehensible dynamic range.

Chopper avoidance angle

The chop direction is determined by the date of observation; the observer has no direct influence on this parameter. If an emission source would fall in within the chopper throw radius around the target the observer may consider setting up a chopper avoidance angle constraint. The angle is specified in Equatorial coordinates anticlockwise with respect the celestial North (East of North). The avoidance angle range can be specified up to 345 degrees.

Warning
Specifying the chopper avoidance angle place restrictions on when the observation can be scheduled. This constraint might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper angles. You should use chopper avoidance angle only for observations where it is absolutely necessary. (You may check your observation's footprint orientations by clicking in the HSpot menu: Overlays -> AORs on current image...)

Dithering

A predefined set of dithering positions can be observed by clicking on this parameter. In the current AOT logic three dithering positions are used (see the PACS Observers' Manual (http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html) for further details).

Note
In the Photometry AOT dithering is performed only along the spacecraft Y-axis using the PACS focal plane chopper for beam modulation. More complicated two-axis dithering patterns are not allowed in the current design.

11.3.2.3. Small Source Photometry
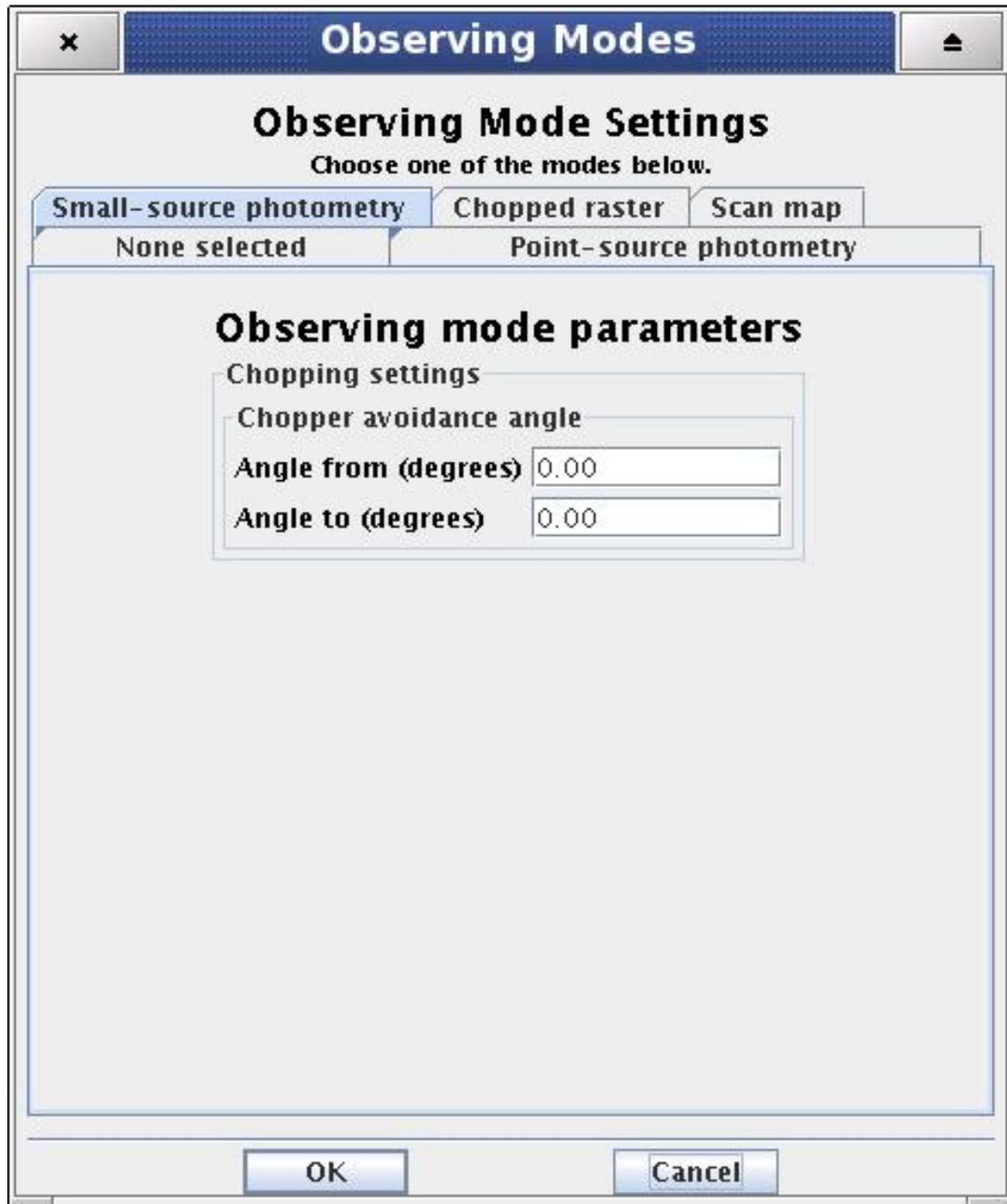
Figure 11.24. Small Source Photometry tab

Here the term "small source" refers to sources that are smaller than the array size, yet larger than a single matrix. To be orientation invariant, sources must fit within approximately 2 by 2 arcminutes. Classic three-position nodding is performed in a 2 by 2 raster minimap (with fixed map parameters), in this configuration the source cannot be kept on the array at all times. The chopper is moving along the long size of the field of view with largest possible 4 arcminute throw. Again, as in the point-source photometry mode, the unit is one nod cycle, and the total duration is computed as multiples of this cycle. The only option of this observing mode is the "Chopper avoidance angle". For detailed description of this parameter see "Point Source Photometry" above.

11.3.2.4. Chopped Raster Map

If the source is significantly larger than the array, or the objective is to cover a large contiguous area of the sky, there are two possible observing modes: chopped raster and unchopped scan mapping.
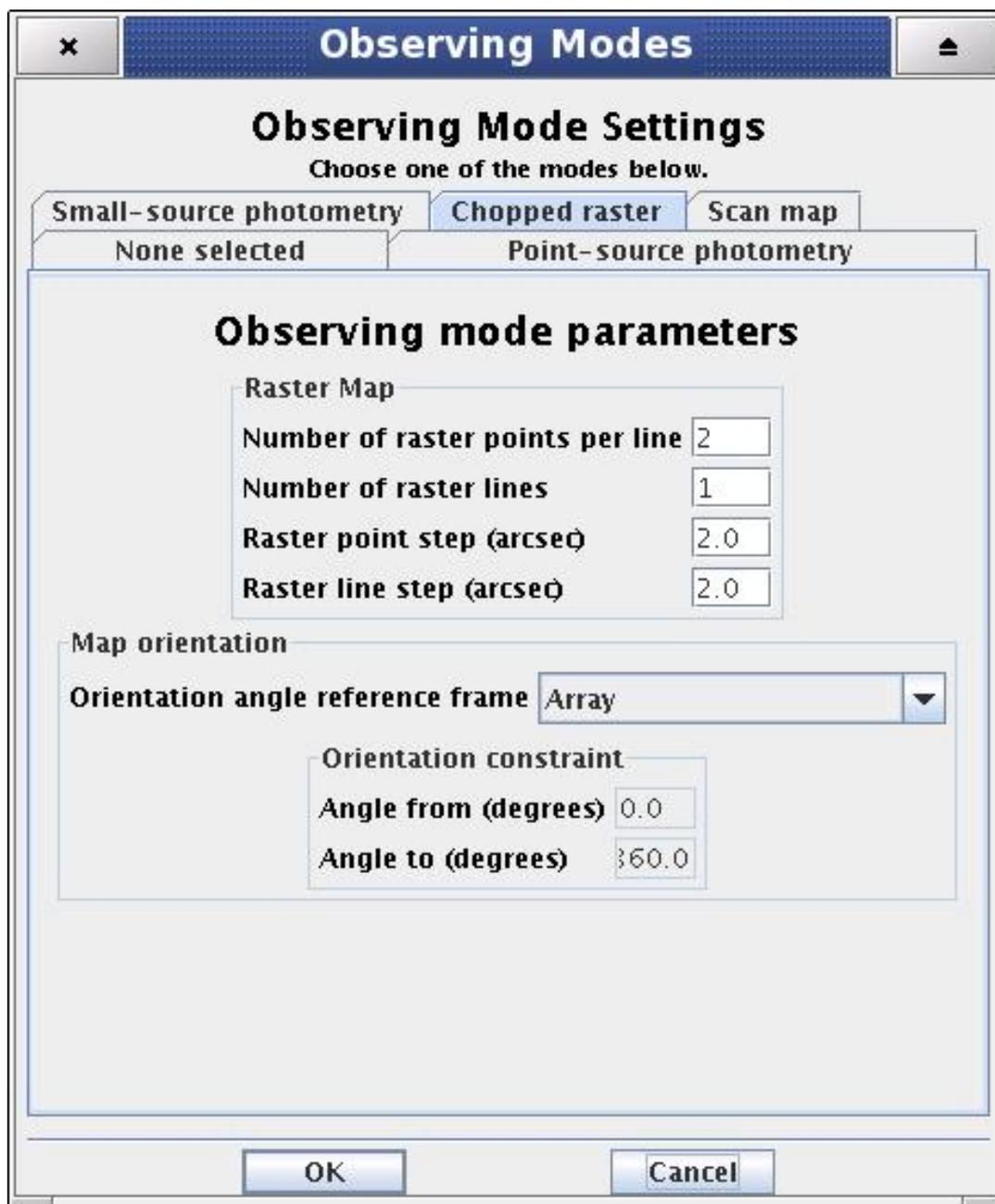
Figure 11.25. Chopped Raster tab

The raster map option, combined with on-array chopping, preserves the PACS highest spatial resolution without degrading the point spread function. Maps can be specified in instrument coordinates, the chopper axis is perpendicular to the raster lines. The observing unit is the chopper cycle; the total duration is computed by multiples of this cycle.

Setting the map size

The centre of the map is at the coordinates given by the target position. The map size along a raster line can be expressed as the number of raster points per line times the raster point step. In perpendicular direction, the map size is given by the number of raster lines times the raster line step. These four parameters have to be given in the following ranges to define a raster map:

- Number of raster points per line in range [2-100]

- Number of raster lines in range [1-100]

- Raster point step (arcseconds) in range [2-210]

- Raster line step (arcseconds) in range [2-105]

> **Note**
>
> - The maximum step sizes are limited by the angular size of the PACS photometer footprint. As a consequence, sparsely sampled maps are not possible in this mode.
>
> - The maximum raster map size is limited to 350 times 175 arcminutes in this mode.

> **Warning**
> Raster maps are time efficient only for areas smaller than 10 by 10 arcminutes respectively. The observatory overheads make this mode inefficient for large fields (see the PACS Observer's Manual for further information).

Setting the map orientation parameters

In raster mapping mode mode the map (raster line) orientation is defined by the chopping direction, the observer has no direct access to the map orientation parameter. However, there are two choices to influence the map orientation.

The observer can select the map orientation reference coordinate system and map orientation angle constraint through the following parameters:

- Position angle reference frame, options: "Array" or "Array with sky constraint". If "Array with sky constraint" is selected then the map orientation can be limited within a given range of angles.

- Constraint angle from (degrees). Angle calculated East of North (counterclockwise in equatorial coordinate system).

- Constraint angle to (degrees). Angle calculated East of North (counterclockwise in equatorial coordinate system).

The other way to influence the map orientation is setting up a timing constraint on the AOR.

> **Warning**
> Specifying a map orientation constraint place restrictions on when the observation can be scheduled. These constraints might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper or map angles. You should use constraint angle only if it is essential for your observation. (You may check your observation's footprint orientations by clicking in the HSpot menu: Overlays -> AORs on current image...)'

11.3.2.5. Scan Map (unchopped)

Line scan maps are the suggested default to map large areas of the sky, for Galactic as well as extragalactic surveys. In this mode the signal modulation is provided by the spacecraft motion. The extended emission is filtered out by fitting the temporal signal, but point sources can be detected without losing sensitivity. Line scan maps can be performed in spacecraft coordinates, or in sky coordinates, although there is no direct control of the homogeneity of the map coverage when performed in sky coordinates. The observer has the choice of selecting the scan speed (low, medium and high), which determines the on-source time and the depth of the observation.
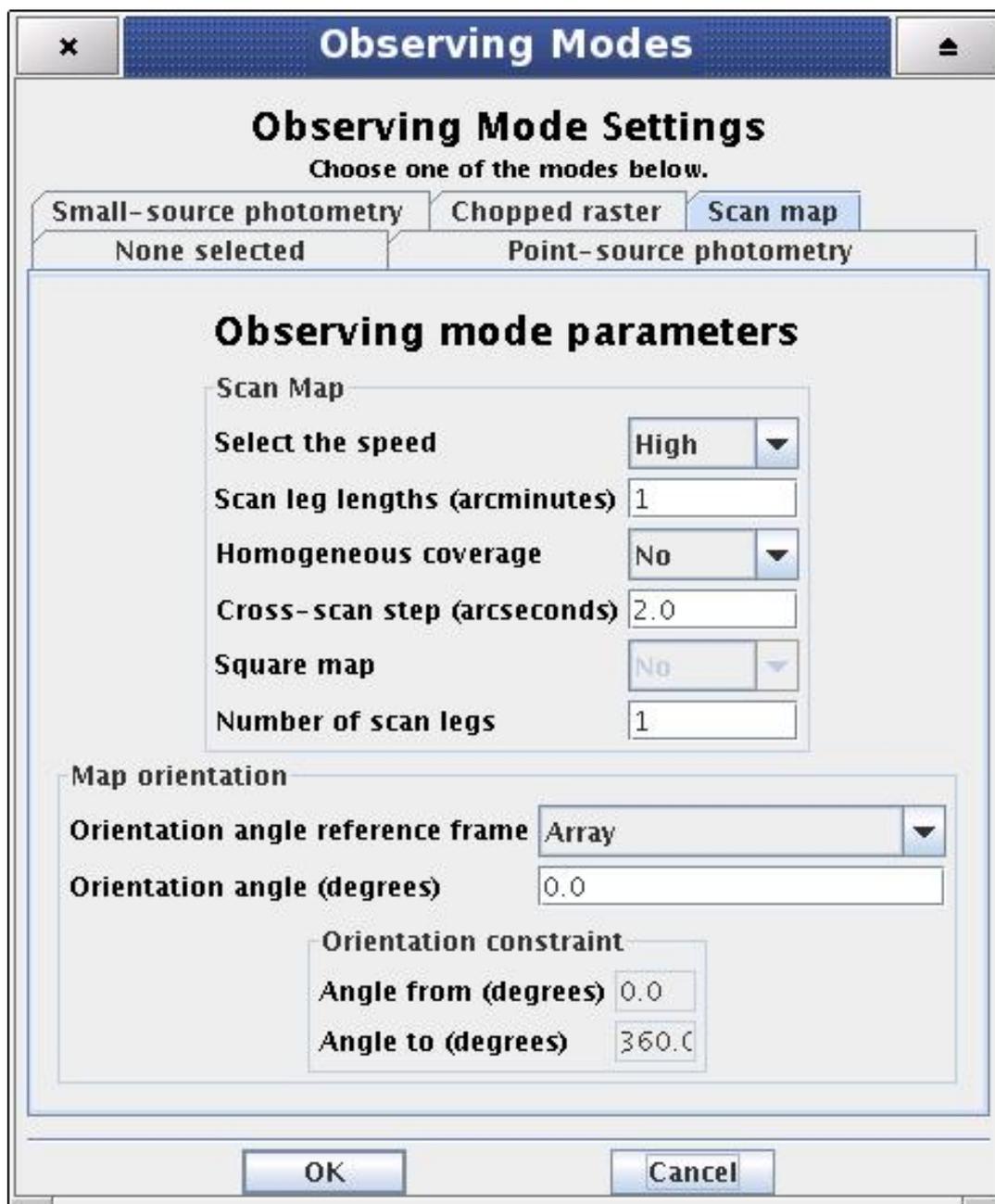
Figure 11.26. Scan map tab

Setting the scan speed

The three values of the map scan speed parameter refer to 10"/second, 30"/second and the high speed is 60"/second. Details about beam smearing effects and degradation of spatial resolution can be found in the PACS Observer's Manual.

Setting the map size

The centre of the map is at the coordinates given by the target position. The map size along a scan line is given by the "Scan leg length" parameter. In perpendicular direction, the map size is given by the number of scan lines times the cross-scan step. These parameters have to be given in the following ranges to define a scan map:

- Scan leg lengths (arcminutes) in range [1-1200]

- Number of scan legs in range [1-1500]

- Cross-scan step (arcseconds) in range [2-210]

The map parameter panel allows to set up two further parameters what might help to optimize the reconstructed map quality and the observing time. These parameters are:

- Homogeneous coverage. Setting the pull-down menu to "Yes" the AOT logic will calculate automatically the cross-scan step size for a given map angle. This functionality is enabled only if the position angle reference frame is either "Array" or "Array with sky constraint". The calculated step size ensures that all positions in the map are seen the same amount of time, therefore the signal-to-noise ratio can be kept almost constant ovet the mapped area.

- Square map. If "Homogeneous coverage" option is selected then the number of scan legs can be calculated automatically by the AOT logic to form a nearly squared shape map on the sky.

Note

- The maximum cross-scan step size is limited by the size of the PACS photometer footprint. As a consequence, sparsely sampled maps are not possible in this mode.

- The maximum scan map size is limited to 20 times 4 degrees in this mode.

Warning
Scan maps are time efficient only for areas larger than 10 by 10 arcminutes respectively. The observatory overheads make this mode inefficient for small fields (see the PACS Observer's Manual for further information).

Map orientation parameters

The observer can select the map orientation reference coordinate system and map orientation angle through the following parameters:

- Position angle reference frame, options: "Sky", "Array", Sky with array constraint" and "Array with sky constraint"

- Position angle (degrees). If Position angle reference frame is given in "Sky" coordinates then this angle is defined East of North (counterclockwise in equatorial coordinate system) to the scan direction. If Position angle reference frame is given in "Array" coordinates then this angle is defined between the instrument +Z-axis and the first scan leg to the scan direction.

- Constraint angle from (degrees). Angle calculated in the selected reference system.

- Constraint angle to (degrees). Angle calculated in the reference system.

Warning
Specifying a map orientation constraint place restrictions on when the observation can be scheduled. These constraints might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper or map angles. You should use constraint angle only if it is essential for your observation. (You may check your observation's footprint orientations by clicking in the HSpot menu: Overlays -> AORs on current image...)'

11.3.3. PACS Time Estimator messages

To get a time estimate for the observing mode configuration chosen and its associated noise level, click the "Observation Estimation" button on the bottom of the AOT main screen. This runs the PACS Time Estimator and once the calculation is done brings up a window "PACS Time Estimation".

Figure 11.27. PACS Time Estimator main window

Running the estimator invokes a sequence of optimisation processes through possible combinations stored in instrument configuration tables. This process selects the most efficient way of observing on-target, reference and calibration measurements and also minimises the instrument overheads.

The exact time for the observing sequence and the associated expected noise are presented to the observer. A set of messages and information regarding the sequence chosen are also given.

11.3.3.1. PACS Time Estimator summary

The breakdown of the observation is provided in the "PACS Time Estimation" screen. It indicates the on-source time, calibration time, overheads and the total observing time.

11.3.3.2. PACS Time Estimator messages window

More detailed information can be obtained by clicking the "Messages" button on the "PACS Time Estimation" screen.

PACS Photometer AOT

ObsMode: *Large source, line scan mode (no chopping)*

ScanLeg: 2400.0 [arcsec]; number of legs: 12; leg separation: 210.0 [arcsec], scan speed: 60.00 [arcsec/sec]

Map area: 6,048,000 [arcsec2]

Nod pattern (as applicable)

No nodding, S/C is in line scan mode

Dithering information

Dithering information is not applicable.

Duration information

AOT duration (w/overheads): 8124 [sec]

(AOT duration comprises 'on-sky' plus setup and CAL during slew)

Breakdown of AOT duration:

- On-sky time (w/overheads): 8080 [sec]
- (actual on-sky time: 2400 [sec])
- Setup and CAL during slew (w/overheads): 44 [sec]
- (actual calibration time: 32 [sec])

Cost of the AOT is calculated as **on-sky time + 180** [sec]: 8080+180=8260 [sec]

Sensitivity information

Effective on-sky time (one spatial resolution element) : 8.8 [sec]

RMS (red): 9.5 [mJy]

RMS (blu): 9.4 [mJy]

RMS (red): 6.49 [MJy/sr]

RMS (blu): 9.91 [MJy/sr]

| OK | Cancel | Save messages |

Figure 11.28. PACS Time Estimator messages window

The message window presents information of two kinds: (1) a summary of the data entered in HSpot (instrument settings and observing mode parameters); and (2) several relevant pieces of timing information, as well as the RMS noise and signal-to-noise for the resulting times.

11.3.3.3. PACS Confusion Noise Estimation Summary

The breakdown of calculated confusion noise in the "PACS Time Estimation" screen. It indicates the confusion noise specific for the AOR configuration (see the "Herschel Confusion Noise Estimator Science Implementation Document for details). On startup this table is kept empty, in order to receive a confusion noise estimation the "Update confusion noise estimates" button has to be pushed.

Note
In case the estimated confusion noise is higher than the instrument sensitivity then HSpot provides a warning message. You may consider to reduce the number of repetition factors unless there is a well established reason to observe deeper than the local confusion noise limit.

Chapter 12. SPIRE AOTs

12.1. SPIRE AOTs

The SPIRE AOTs are described in Chapter 4 of the SPIRE Observers' Manual and a cookbook guide with specific examples of observations and how to enter them into HSpot is given in Chapter 6 of that manual.

12.2. SPIRE Photometer AOT

Selecting "SPIRE Photometer" from the "Observation" menu gives the AOT for photometry with SPIRE (SPIRE Observers' Manual). This AOT is used to make photometric images in 3 bands 'centred' at 250, 350 and 500 μm with a resolution of ~3. The first step is to define a target, see Section 6.3. Under "instrument setting" on the screen you see "Source Type", "On-source Integration Time", "Source Flux Estimates" and "Observation Estimates" parts which are briefly described in the following sections and then in more detail for the specific "Source Type" selections.
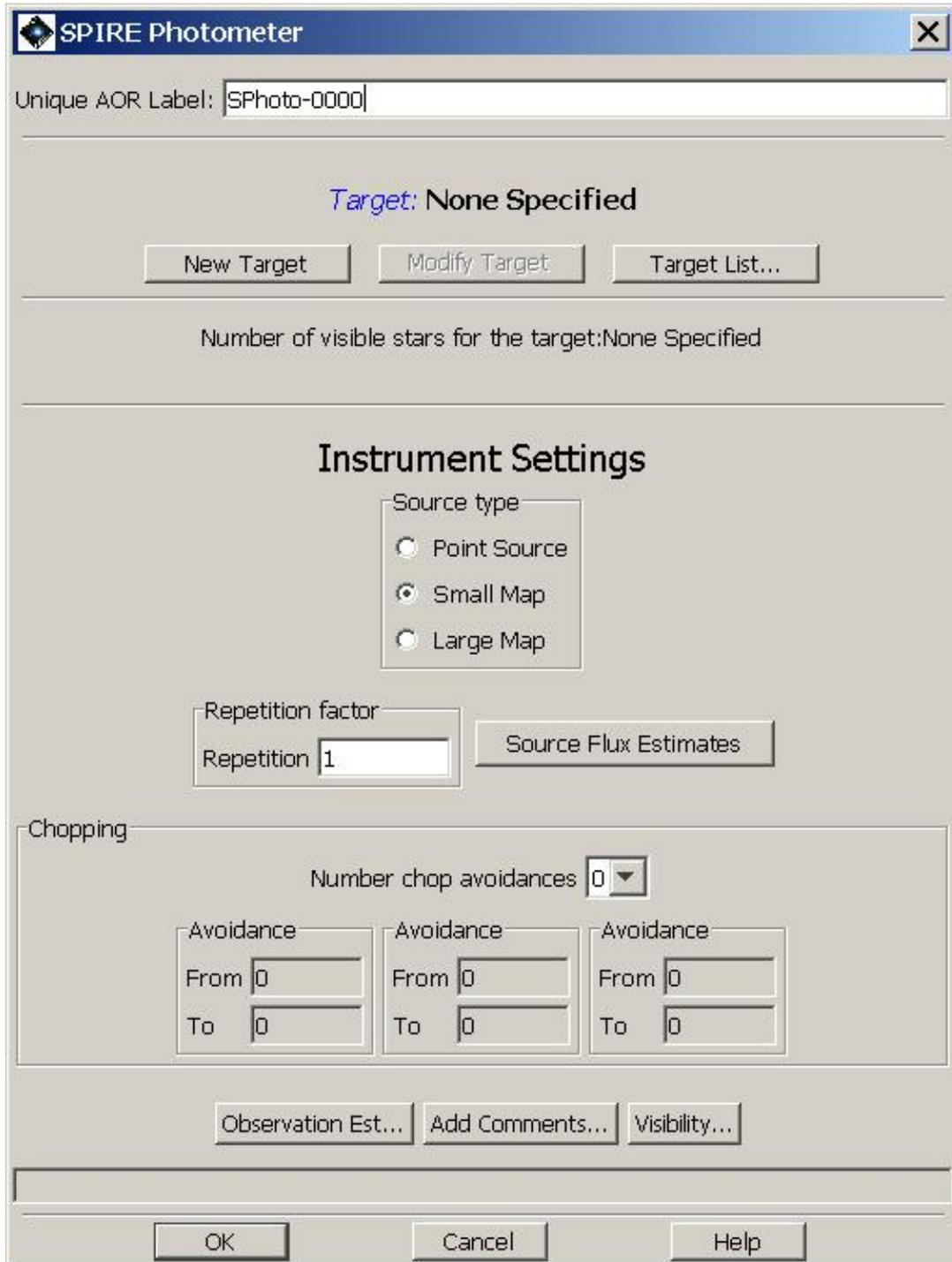
Figure 12.1. The SPIRE Photometer AOT, as it appears on first opening.

Source Type

Three modes are permitted:

- Point sources

  Point source observations require good knowledge of the position of the target.

- Small maps

  This is for regions <4 arcminutes diameter

- Large maps

  Anything larger than 4 arcminutes diameter, requiring the telescope to be scanned to produce a larger field of view.

See the SPIRE Observers' Manual for details of the AOTs. You should select the option appropriate to the required source type. Depending on the selection additional menus may appear. For point sources and small maps you can define chopper avoidance constraints (see warning in Section 12.2.1.1). For large maps a panel appears that allows you to enter the parameters that define the map (size, speed, map orientation constraints etc.). The AOT screen also presents a box for entering the "Repetition factor" and a button to bring up a panel for entering source flux estimates. The "Repetition factor" controls the on-source integration time, as the SPIRE AORs consist of basic units which can be repeated to increase the time spent observing with them. The "Repetition factor" and source type selection are used to make a time estimate for the duration of the observation. If estimates for the source fluxes are also entered then signal to noise estimates will be reported back in the time estimation results.

Repetition factor

Here you should enter the number of repetitions of the basic observation that you would like to use. This will be used by the observation estimator to give you the estimated time required to carry out the observation. You can change the factor entered and repeat the estimate; this is particularly useful when one wants to obtain a required signal to noise ratio.

Source Flux Estimates

This button pops-up a panel in which you can enter source flux estimates, if you wish. These numbers are not necessary for the time estimation, however if values are filled in the expected S/N of the observation is shown. Further details of the "Source Flux Estimates" panel are given in the sections below.

12.2.1. Point Source

A Point Source observation is made by a 7-point jiggle pattern around a co-aligned pixel, giving data simultaneously in all three bands. Chopping and nodding are also performed (see the SPIRE Observers' Manual for details). To select this source type the radio button should be selected as shown in Figure 12.2. For this selection the Chop Avoidance panel is displayed.
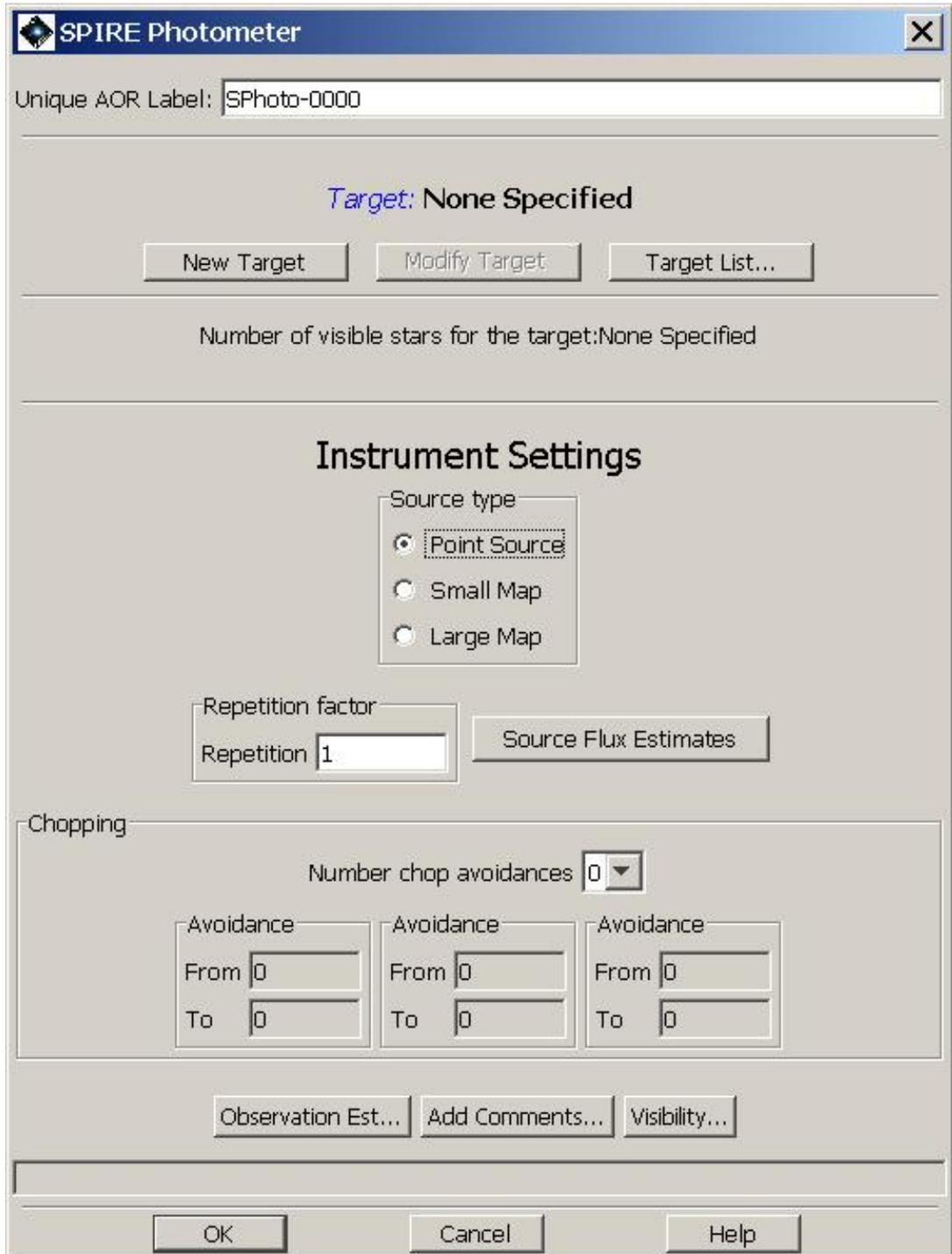
Figure 12.2. The SPIRE Photometer AOT with point source selected. Note the "Chop Avoidance" panel.

12.2.1.1. Chop Avoidance

When Point Source is selected the Chop Avoidance can be used. You can use this to avoid chopping and nodding onto nearby bright sources. Initially the boxes cannot be edited. The number of chop avoidances to be defined should be selected from the pull down menu which gives you the option to select up to 3.

> **Warning**
> Chopper avoidances should only be defined if really necessary, as each one reduces the visibility window for your source. Electing too strong a chopper constraint may make it impossible to schedule the observation, or even make the source unobservable for Herschel. A chopping constraint is incompatible with a fixed time observation.

On selection of 1, 2 or 3 the following warning is presented in Figure 12.3:
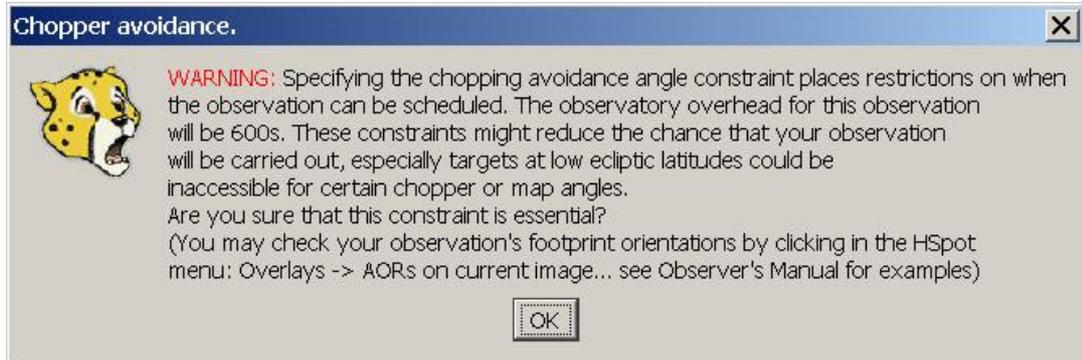
Figure 12.3. The Chopper Avoidance warning

Once the warning has been understood and dismissed by pressing "OK", the number of "Avoidance From and To" boxes corresponding to the number selected are ungreyed. These can be edited, so that the angles for avoidance can be entered. The angles are in degrees from north, through east and can be entered with a precision of one degree. To avoid a source located to the north one should remember to enter a number lower than 360 in the "From" box and one greater than 0 in the "To" box. As chopping and nodding occur to either side of the source then the range of angles ± 180 are also avoided. See the SPIRE Observers' Manual for examples of how to work out the chop avoidance angles using HSpot visualisation.

12.2.1.2. Repetition factor

The required number of repetitions of the basic observation should be put here. The Repetitions are defined in the SPIRE Observers' Manual.

12.2.1.3. Source Flux Estimates

The table allows estimated source fluxes to be introduced to give the expected S/N (see Figure 12.4). The sensitivity results assume that a point source has zero background. The source details that can be entered are the estimated point source flux density in mJy for zero to three of the SPIRE bands. If no value is given for a band the corresponding S/N is not reported back. The time estimation will return the corresponding S/N, as well as the original values entered, if applicable.

Figure 12.4. Source flux estimates panel for point sources.

12.2.1.4. Observation Time Estimation

On pressing the "Observation Estimation" button the duration of the observation is estimated and a panel pops up with the results (Figure 12.5).

Figure 12.5. Time estimation panel for Point Source observation.

At the top of the panel there is a table with one entry per wavelength band with columns for:

- Flux density (mJy): the number entered in the source flux estimates table is displayed.

- S/N: a result is displayed if estimated source flux densities were given. Note that maximum achievable S/N is 200.

- 1-# noise (mJy): always calculated and displayed.

After this, the break down into observing time and overheads is displayed:

- On-source time per repetition (s): the time of the basic observation unit.

- Number of repetitions: the repetition factor as entered by the user.

- Total on-source integration time (s): (On-source time per repetition)*(Number of repetitions)

- Instrument and observation overheads (s): the calibration time and dead time associated with the observation.

- Observatory overheads (s): the slew overhead implicit in every observation (3 minutes normally, 10 if the observation is constrained).

- Total time (s): The total time of the observation, equaling the sum of the following contributions: Total on-source integration time, the Instrument and observation overheads and the Observatory overheads.

This is followed by a note to explain how to increase the observation time.

Time Estimation Details Button

Message level 1 indicates how the observation is built up. Message level 3 gives parameters of the observation such as the number of nod cycles and the nod/chop throw.

12.2.1.5. Confusion Noise Estimation Summary

The breakdown of calculated confusion noise is given in a table at the bottom of the "SPIRE Time Estimation Summary" screen. It indicates the confusion noise specific for the AOR configuration (see the Herschel Confusion Noise Estimator Science Implementation Document for details). When the window pops up this table is empty, in order to get a confusion noise estimation the "Update confusion noise estimates" button has to be pushed.

12.2.2. Small Map

A Small Map observation is made using a 64-point jiggle pattern to give a fully filled map with simultaneous data in all three bands. Chopping with the beam steering mirror and nodding with the telescope are also performed (see the SPIRE Observers' Manual. The Small Map option is the default that is selected when one opens a new SPIRE Photometer AOT as is shown in Figure 12.1.

12.2.2.1. Repetition factor

The required number of repetitions of the basic observation should be put here. The Repetitions are defined in the SPIRE Observers' Manual.

12.2.2.2. Source Flux Estimates

Pressing the Source Flux Estimates buttons brings up a table that allows estimated source fluxes to be introduced to give the expected S/N (see Figure 12.6). The point source flux density and the extended source surface brightness are treated independently by the sensitivity calculations; the sensitivity results assume that a point source has zero background and that an extended source is not associated with any point sources. The source details that can be entered are the estimated point source flux density in mJy and/or the extended source surface brightness in MJy/sr. If no value is given for a band the corresponding S/N is not reported back. The time estimation will return the corresponding S/N, as well as the original values entered, if applicable.
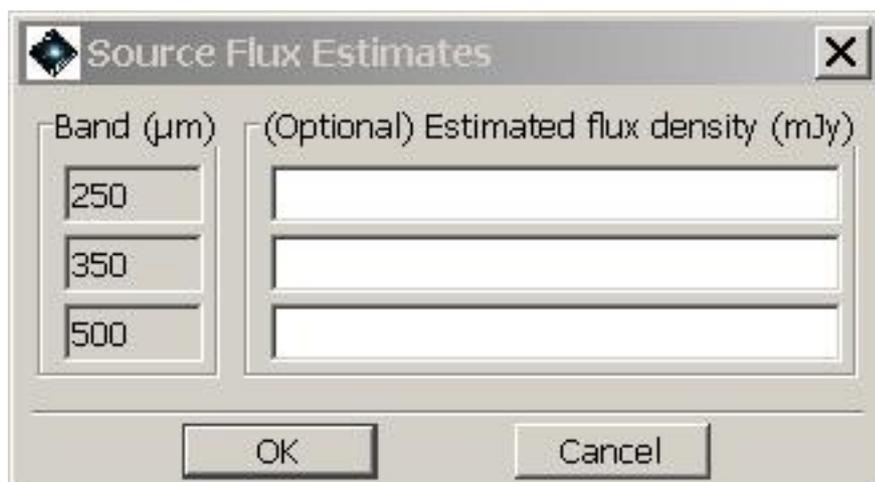
Figure 12.6. Source flux estimates panel for Small Map Source types.

12.2.2.3. Observation Time Estimation

On pressing the "Observation Est..." button the estimated duration of the observation is displayed and a pop-up gives the results (see Figure 12.7 for the appearance without source flux estimates and Figure 12.8 with the estimates as given in Figure 12.6). At the top of the panel there is a table with one entry per wavelength band with columns for:

- Point source flux density (mJy): a number is displayed which mirrors the corresponding estimated point source flux density field (if filled in).

- Point source S/N: a number is displayed if the corresponding estimated point source flux density field was filled in. Note that maximum achievable S/N is 200.

- Point source 1-# noise (mJy): always displayed.

- Extended source surface brightness (MJy/sr): a number is displayed if the corresponding estimated extended source surface brightness field was filled in.

- Extended source S/N: a number is displayed if the corresponding estimated extended source surface brightness field was filled in. Note that maximum achievable S/N is 200.

- Extended source 1-# noise (MJy/sr): always displayed.

After this, the break down into observing time and overheads is displayed:

- On-source time per repetition (s): the time of the basic observation unit.

- Number of repetitions: the repetition factor as entered by the user.

- Total on-source integration time (s): (On-source time per repetition)*(Number of repetitions)

- Instrument and observation overheads (s): the calibration time and dead time associated with the observation.

- Observatory overheads (s): the slew overhead implicit in every observation (3 minutes normally, 10 if the observation is constrained).

- Total time (s): The total time of the observation, equaling the sum of the following contributions: Total on-source integration time, the Instrument and observation overheads and the Observatory overheads.

This is followed by a note to explain how to increase the observation time.

SPIRE Time Estimation Summary

Band (μm)	Point Sour... Flux Density (mJy)	Point Sour... S/N	Point Source 1-σ noise (mJy)	Extended ... Surface Brightness (MJy/sr)	Extended ... S/N	Extended ... 1-σ noise (MJy/sr)
250			4.7			1.05
350			6.3			0.74
500			5.3			0.30

On-source time per repetition (s)	256
Number of repetitions	1
Total on-source integration time (s)	256 (=1*256)
Instrument and observation overheads (s)	251
Observatory overhead (s)	180
Total time (s)	687 (=256+251+180)

Note: to change the observation time, change the repetition factor on the AOR main screen. It multiplies the on-source integration time per repetition to give the total on-source time.

Confusion noise estimation summary

Band (um)	Est. 1-σ Confusion Noise Level for Point Sources (mJy)	Est. 1-σ Confusion Noise Level for Extended Sources (MJy/sr)	Est. 1-σ Confusion Noise Level per Pixel (mJy)
250			
350			
500			

Update Confusion Noise Estimation   Confusion Noise Estimator Messages

OK   Details

Figure 12.7. Small Map time estimation results.

Figure 12.8. Small Map time estimation results with some source flux estimates previously entered.

12.2.2.4. Time Estimation Details Button

Message level 1 indicates how the observation is built up. Message level 3 gives parameters of the observation such as the number of nod cycles and the nod/chop throw.

12.2.2.5. Confusion Noise Estimation Summary

The breakdown of calculated confusion noise is given in a table at the bottom of the "SPIRE Time Estimation Summary" screen. It indicates the confusion noise specific for the AOR configuration (see the Herschel Confusion Noise Estimator Science Implementation Document for details). When

the window pops up this table is empty, in order to get a confusion noise estimation the "Update confusion noise estimates" button has to be pushed.

12.2.3. Large Map

A Large Map is made by scanning the telescope to move the arrays over the required field of view. The telescope is scanned along lines at one of two speeds hence, to increase integration time for a certain speed the scan is repeated (see the SPIRE Observers' Manual for more details). The panel with the Large Map selected as the source type is shown in Figure 12.9.

SPIRE Photometer

Unique AOR Label: SPhoto-0001

Target: m31 **Type:** Fixed Single
Position: 0h42m44.33s,+41d16m08.5s

| New Target | Modify Targ... | Target List... |

Number of visible stars for the target: 14
Star tracker target: Ra: 190.685 degrees Dec:-41.269 degrees

Instrument Settings

Source type
○ Point Source
○ Small Map
◉ Large Map

Repetition factor
Repetition 1

Source Flux Estimates

Large Map Parameters

Length (arcmin)	200.0
Height (arcmin)	100.0
Select the speed	Nominal
Scan Direction	Scan Angles A and B
Map centre offset Y (arcmin)	0.0
Map centre offset Z (arcmin)	0.0

Orientation

Map Orientation	Array
Angle from (degrees)	0
Angle to (degrees)	360

| Observation Est... | Add Comments... | Visibility... |

| OK | Cancel | Help |

Figure 12.9. The SPIRE Photometer AOT with Large Map selected and map sizes filled in.

12.2.3.1. Large Map Parameters

When a "Large Map" is selected the "Large Map Parameters" panel appears. The required map size should be entered, in arcminutes, in Length (the distance, along the first scan direction, of the area to be mapped) and Height (the distance to be covered in the direction perpendicular to the first scan). The speed at which the telescope scans can be selected as either Nominal (the default, currently 30"/s) or Fast (currently 60"/s). When the Scan Direction is set to either Scan Angle A or Scan Angle B, Length can be in the range of 4.0 - 1186.0 arcminutes and the Height between 0.0 and 240.0 arcminutes, when the Scan Direction is set to Scan Angles A and B then Length can be between 4.0 and 226.0 arcmin and the Height between 0.0 and 226.0 arcmin. The map centre Y and Z offsets can be used to define a map centre that is offset compared with the coordinates of the target of the observation. See the SPIRE Observers' Manual for uses of this and example observations.

Orientation

Maps are made at a specific angles (A=42.4 degrees, B=-42.4 degrees) to the SPIRE arrays' short axis (Z). As the arrays rotate with time against to the sky one can choose to restrict the amount of rotation on the sky by specifying a range of angles. This equates to a period within which the observation can be scheduled hence the following warning is given with the option Array with Sky Constraint is selected:

> **Warning**
> "Specifying the map orientation constraint places restrictions on when the observation can be scheduled. The observatory overhead for this observation will be 600s. These constraints might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper or map angles. Are you sure that this constraint is essential? (You may check your observation's footprint orientations by clicking in the HSpot menu: Overlays -> AORs on current image... see the SPIRE Observers' Manual for examples) "

Once the warning has been understood and dismissed by pressing OK, the "Angle From" and "Angle To" values, between which the Scan leg length dimension of the map should lay, can be given in degrees East of North can be entered. See the SPIRE Observers' Manual for a worked example.

12.2.3.2. Repetition factor

The required number of repetitions of the basic observation should be put here. The Repetitions are defined in the SPIRE Observers' Manual.

12.2.3.3. Source Flux Estimates

Pressing the Source Flux Estimates buttons brings up a table that allows estimated source fluxes to be introduced to give the expected S/N (see Figure 12.6). The Point source flux density and the extended source surface brightness are treated independently by the sensitivity calculations; the sensitivity results assume that a point source has zero background and that an extended source is not associated with any point sources. The source details that can be entered are the estimated point source flux density in mJy and/or the extended source surface brightness in MJy/sr. If no value is given for a band the corresponding S/N is not reported back. The time estimation will return the corresponding S/N, as well as the original values entered, if applicable.

12.2.3.4. Observation Time Estimation

On pressing the "Observation Est..." button the duration of the observation is estimated (calculated) and a pop-up displays the results (see Figure 12.10 for the screen when no flux estimates have been given, and Figure 12.11 using estimates given in Figure 12.6).

Figure 12.10. Large Map (200x100 arcmin) time estimation where no source flux estimates have been provided
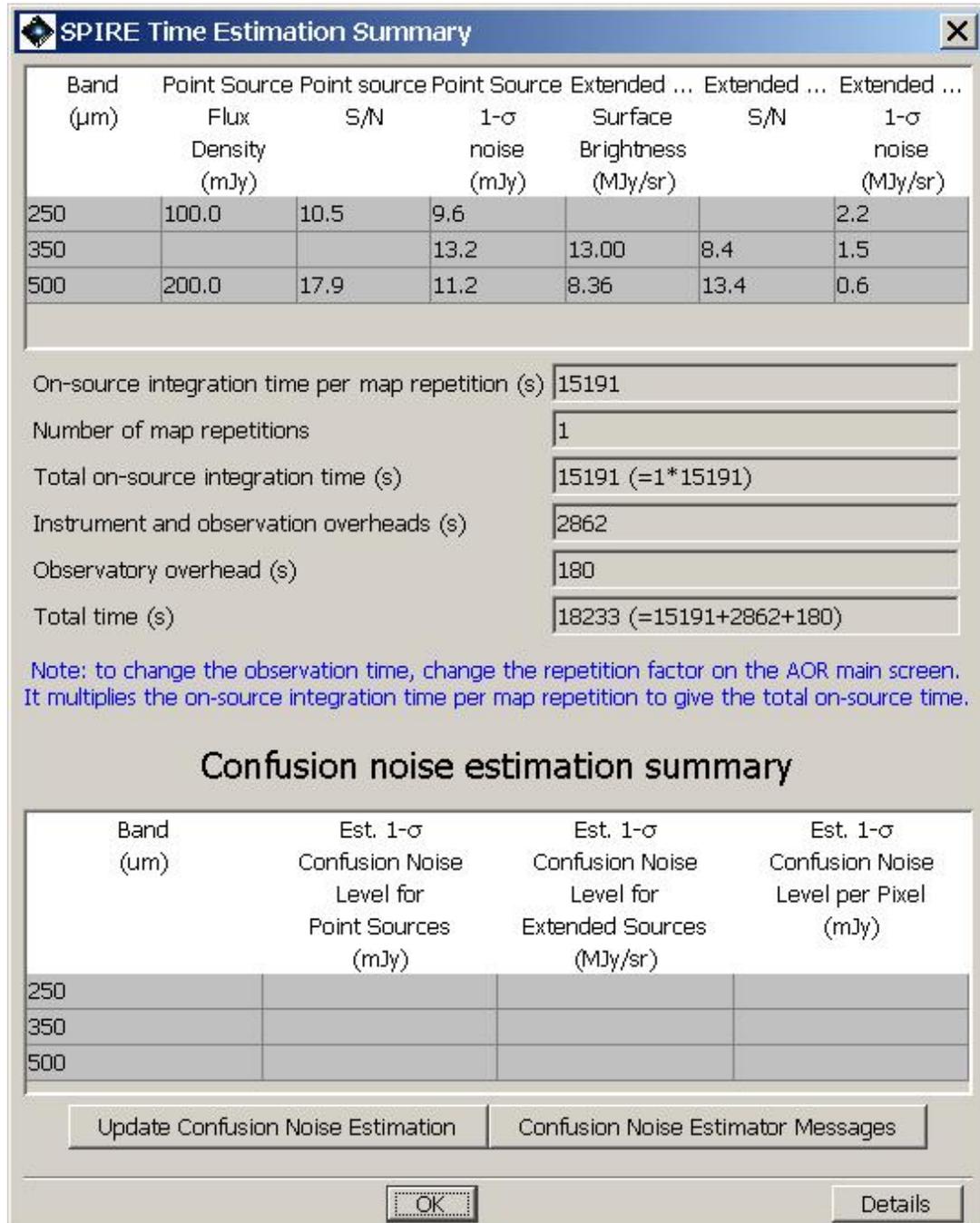
Figure 12.11. Large Map (200x100 arcmin) time estimation where source flux estimates have been provided

An example of a table. There is one entry per wavelength band. The columns are:

- Point source flux density (mJy): a number is displayed that mirrors the corresponding estimated point source flux density field (if filled in).

- Point source S/N: a number is displayed if the corresponding estimated point source flux density field was filled in. Note that maximum achievable S/N is 200.

- Point source 1-# noise (mJy): always displayed.

- Extended source surface brightness (MJy/sr): a number is displayed if the corresponding estimated extended source surface brightness field was filled in.

- Extended source S/N: a number is displayed if the corresponding estimated extended source surface brightness field was filled in. Note that maximum achievable S/N is 200.

- Extended source 1-# noise (MJy/sr): always displayed.

Next, the break down into observing time and overheads is displayed:

- On-source integration time per map repetition (s): the time it takes to make one coverage of the map.

- Number of map repetitions: the repetition factor as entered by the user.

- Total on-source integration time (s): (On-source integration time per map repetition)*(Number of map repetitions)

- Instrument and observation overheads (s): the calibration time and dead time associated with the observation.

- Observatory overheads (s): the slew overhead implicit in every observation (3 minutes normally, 10 if the observation is constrained).

- Total time (s): The total time of the observation, equaling the sum of the following contributions: Total on-source integration time, the Instrument and observation overheads and the Observatory overheads.

This is followed by a note to explain how to increase the observation time.

Time Estimation Details Button

Message level 1 indicates how the observation is built up. Message level 3 gives parameters of the observation such as the angle at which the array is scanned , the total scan length (increased from your input to get as even coverage as possible over requested area), and the number of scans needed to cover the area.

Confusion Noise Estimation Summary

The breakdown of calculated confusion noise is given in a table at the bottom of the "SPIRE Time Estimation Summary" screen. It indicates the confusion noise specific for the AOR configuration (see the Herschel Confusion Noise Estimator Science Implementation Document for details). When the window pops up this table is empty, in order to get a confusion noise estimation the "Update confusion noise estimates" button has to be pushed.

12.3. SPIRE Spectrometer AOT

This AOT is used to make spectroscopic images from 194-672 μm. The AOT entry form is as shown in Figure 12.12. The AOT is described in detail in the SPIRE Observers' Manual. Before continuing, first select your target, see Section 6.3 if your current target is not the one that you wish to observe.
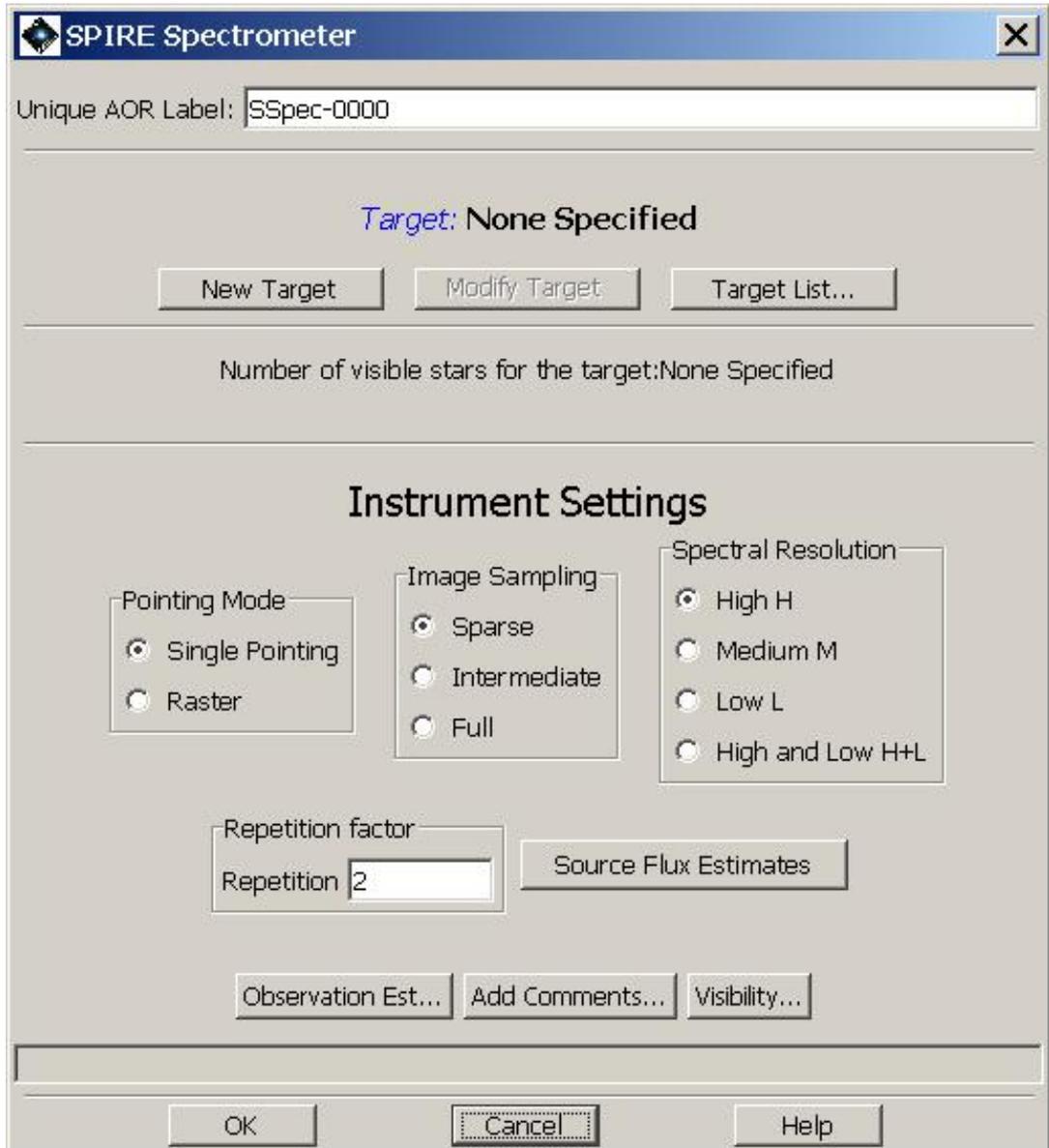
Figure 12.12. The SPIRE Spectrometer AOT, as it appears when opened.

12.3.1. Pointing Mode

The pointing mode is selected using this box, the choice is between a "Single Pointing" of the telescope and "Raster" - multiple pointings to make a map. If "Raster" is selected, the "Raster Map Parameters" panel appears (see Section 12.3.4).

12.3.2. Image Sampling

Three choices are offered:

• Sparse sampling - samples the unfilled array on the sky once per pointing.

• Intermediate sampling - provides greater coverage of the area as 4 pointings of the Beam Steering Mirror (BSM) are used to partially fill in the unfilled array.

- Full sampling obtained via 16 pointings of the BSM, which provides complete coverage of the area.

12.3.3. Spectral Resolution

Here there are four choices of spectral resolution: "High", "Medium", "Low" and "High and Low". This determines the spectral resolution of the observation. In the case of "High and Low", scans at both resolutions are carried out to provide not only high resolution data, but also low resolution - continuum- data with a higher S/N than can be gained for the continuum with high resolution scans. With the selection of the "High and Low" resolution the Repetition Factor panel changes to allow the user to give a value for each resolution to control the number of repetitions (number of spectral forward and back scan pairs) independently (see Section 12.3.5).

12.3.4. Raster Map Parameters

Note this option appears with the selection of the "Raster Pointing Mode".

When "Raster" is selected the "Raster Map Parameters" panel appears. The required map size should be entered, in arcminutes, in Length and Height. Length can be in the range of 0 - 30 arcminutes and Height can be between 0 and 30 arcminutes. The Map centre offset Y and Z can be used to define a map centre that is offset compared to the coordinates of the target of the observation. This is useful when one wants to split observations up into schedulable-sized segments. See the SPIRE Observers' Manual for worked example.

12.3.4.1. Orientation

Maps are made at a specific angle to the SPIRE arrays. As the arrays rotate with time against the sky one can choose to restrict the amount of rotation on the sky by specifying a range of angles. This equates to a period within which the observation can be scheduled hence the following warning is given when the option "Array with Sky Constraint" is selected:

> **Warning**
> "Specifying the map orientation constraint places restrictions on when the observation can be scheduled. The observatory overhead for this observation will be 600s. These constraints might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper or map angles. Are you sure that this constraint is essential? (You may check your observation's footprint orientations by clicking in the HSpot menu: Overlays -> AORs on current image... see the SPIRE Observers' Manual for examples)"

Once the warning has been understood and dismissed by pressing "OK" the "Angle From" and "Angle To" values, between which the Length dimension of the map should lay, given in degrees from North through East, can be entered. See the SPIRE Observers' Manual for examples.

12.3.5. Repetition factor

The required number of repetitions of the basic observation should be put here. One Repetition corresponds to one pair of spectral scans. The minimum number of repetitions is 2. The maximum value that can be entered depends on the other values selected, in the case that a message is displayed indicating that the time esimation is unable to complete you should consider to reduce your repetition factor. Here are some typical maximum values: Sparse with High = 364, Full with High = 22, Full with Low= 205. When the "High and Low" spectral resolution is selected, two repetition factors must be entered, one for each resolution. One can come back to this box to change the value and hence the amount of time for the observation; this is particularly useful when one wants to try to vary the time to obtain a required signal to noise ratio.

12.3.6. Source Flux Estimates

This button pops-up a panel in which you can enter source data for up to 8 wavelengths (see Fig-

ure 12.14). These numbers are not necessary for the time estimation, however if values are filled in not only the time and the 1-# noise of the observation, but also the expected S/N of the observation is returned. For "High", "Medium" and "High and Low" resolution selections you can enter wavelength, estimated line flux, the flux per beam, in 10^{-17} W m^{-2} and estimated continuum, flux density per beam, in selectable units of either Jy or W m^{-2} μm^{-1} (see Figure 12.13). A corresponding wavelength is mandatory once a continuum or line flux estimate is entered. For the low resolution only the continuum, units selectable, and its wavelength can be entered, as one is not measuring lines with this mode (see Figure 12.14).

Figure 12.13. Panel to enter source flux estimates for High, Medium and "High and Low" resolution.

Figure 12.14. Panel to enter source flux estimates for Low resolution.

12.3.7. Observation Time Estimation

On pressing the "Observation Estimation" button the duration of the observation is estimated and a pop-up displays the results. At the top of the panel there is a table with entries for 8 predefined wavelengths, with columns for:

- Wavelength (μm): The predefined wavelengths are 194, 200, 250, 300, 320, 400, 550 and 672 μm.

- 1-# line flux sensitivity (10^{-17} W m^{-2}): This is given for the High, Medium and the High part of "High and Low" resolution settings. It is not available for the "Low" resolution.

- 1-# continuum sensitivity: The units that the user selected as input are given in the column heading and the numbers reported back are in those units. This is given for all resolutions.

- Unapodised resolving power: This is reported back for all the resolutions.

Figure 12.15 is a screen shot of the time estimation for the High and the Medium resolution observations (without any input source estimates). When the resolution is set to "High and Low" the continuum sensitivity and the unapodised resolving power are given for both the "High" resolution part as well as the "Low" resolution part as shown in Figure 12.16.

SPIRE Time Estimation Summary

Wavelength (µm)	1-σ line flux sensitivity (10^-17 W/m^2)	1-σ continuum sensitivity (Jy)	Unapodised resolving power (λ/Δλ)
194	2.9	2.4	1,288.7
200	2.5	2.1	1,250.0
250	2.1	1.8	1,000.0
300	2.0	1.6	833.3
320	2.3	1.9	781.2
400	1.5	1.3	625.0
550	2.9	2.4	454.5
672	2.6	2.2	372.0

Number of raster points	1
Number of jiggle positions per raster point	1
On-source time per FTS scan (s)	66.6
Number of FTS scans per jiggle position	4 (=2* repetition factor)
Total on-source integration time (s)	266 (= 1*1*66.6*4)
Instrument and observation overheads (s)	116
Observatory overhead (s)	180
Total time (s)	562 (= 266+116+180)

Note: to change the observation time, change the repetition factor on the AOR main screen. This factor increases the number of scan pairs made per jiggle position, hence changes the total on-source integration time accordingly.

OK   Details

Figure 12.15. Time estimation panel for the High and the Medium Resolution (note the actual numbers are different for Medium resolution, but the table format is the same).
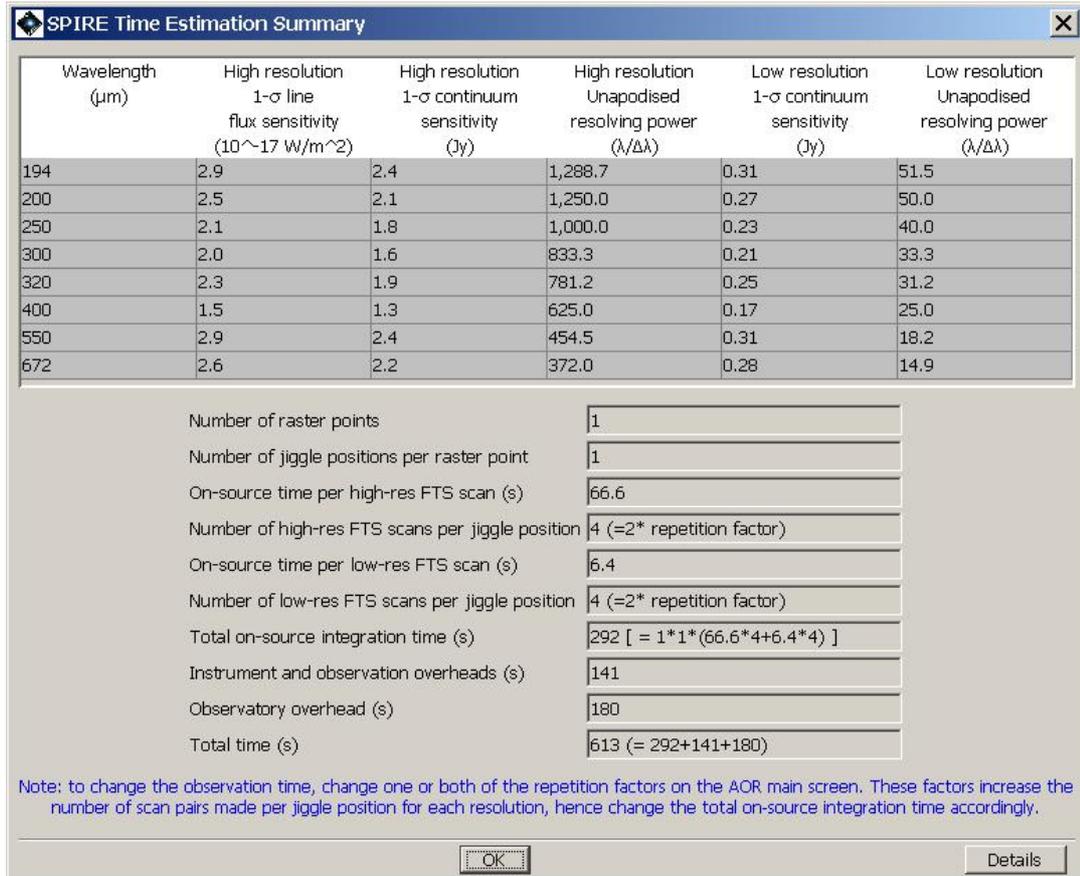
Figure 12.16. Time estimation panel for the "High and Low" resolution, without any source flux estimates entered.

When the resolution is set to "Low" the output is as given in Figure 12.17.

Figure 12.17. Time estimation panel for the "Low" resolution, without any source flux estimates entered.

Another table appears below the first, if you entered source flux estimates, with the results for those wavelengths defined (example given in Figure 12.18 for low resolution case).
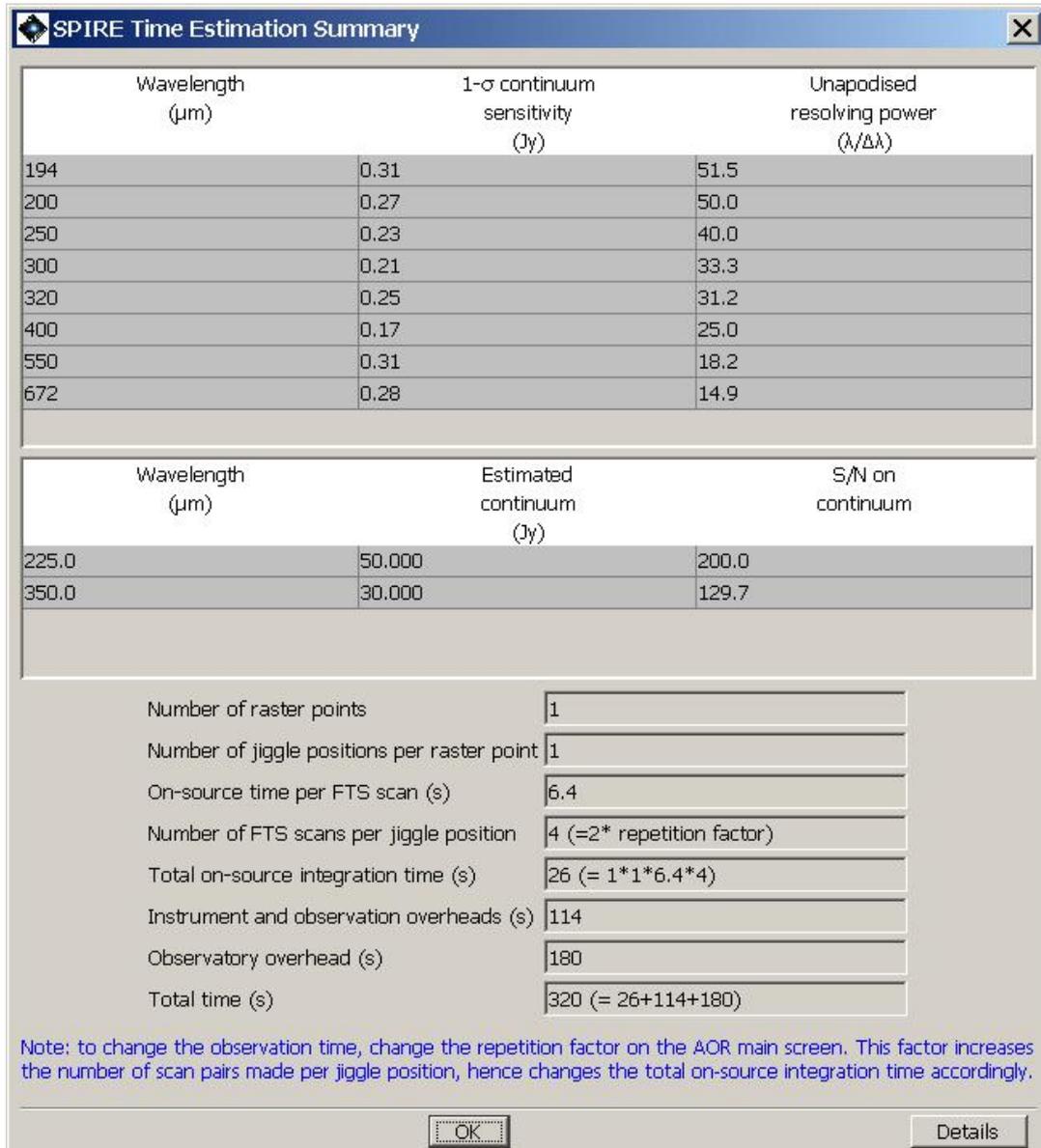
Figure 12.18. An example of the time estimation panel with source flux estimates results for the "Low" resolution.

The table has columns for:

- Wavelength (μm): The wavelength entered in the source flux estimates table.

- Estimated line flux ($10^{-17}Wm^{-2}$): The estimated line flux if entered in the source flux estimates table.

- S/N on line: The signal-to-noise on the lines is displayed if you entered an estimated line flux for this wavelength. Note that maximum achievable S/N is 200.

- Estimated continuum (mJy): the number that you entered is displayed here. If no number was entered box is empty.

- S/N on continuum: This signal-to-noise is displayed if you entered a corresponding continuum value for this wavelength in the source flux estimates table. Note that maximum achievable S/N is 200.

Below this is information on how the observing time is split up between on-source integration time and overheads through the following entries:

- Number of raster points: The number of raster points, determined by the map size. For a single pointing observation the value is 1.

- Number of jiggle positions per raster point: This is determined by the image sampling. For sparse the value is 1. For intermediate it is 4, and for full it is 16.

- On-source time per FTS scan (s): The time it takes to make one spectral scan. This depends on the resolution. Observations are built up as multiples of this time. For the "High and Low" resolution option there are two entries for this, one for high-resolution scans and one for the low-resolution scans.

- Number of FTS scans per jiggle position: The number of scans made at each jiggle position. This is always an even number and is equal to the repetition factor multiplied by 2. Note for the "High and Low" resolution option there are two entries for this, one for high-resolution scans and one for the low-resolution scans.

- Total on-source integration time (s): (Number of raster points)*(Number of jiggle positions per raster point)*(On-source time per FTS scan)*(Number of FTS scans per jiggle position).

  For the "High and Low" resolution option the total on-source integration time is the total time for all the high-resolution scans at all positions and points and all the low-res scans at these places, i.e.:

  (Number of raster points)*(Number of jiggle positions per raster point)*((On-source time per high-resolution FTS scan)*(Number of FTS high-resolution scans per jiggle position)+(On-source time per high-resolution FTS scan)*(Number of FTS high-resolution scans per jiggle position)).

- Instrument and observation overheads (s): Overheads associated with the observation (i.e., everything except slewing).

- Observatory overheads (s): The slewing overhead associated with every observation (3 minutes normally, 10 if a observation is constrained).

- Total time (s): The total time of the observation, equaling the sum of the following contributions: Total on-source integration time, the Instrument and observation overheads and the Observatory overheads.

This is followed by a note to explain how to increase the integration time via changing the Repetition Factor.

12.3.7.1. Details Button of Time Estimation

Message level 1 indicates how the observation is built up. Message level 3 gives parameters of the observation such as the number of spectral scans.

Chapter 13. HIFI AOTs

13.1. Description of HIFI AOTs

The HIFI Observers' Manual (http://herschel.esac.esa.int/Docs/HIFI/html/hifi.html provides basic information on the instrument, how the instrument works and its use. Several examples for setting up science observations with HIFI are also provided.

HIFI has three basic AOT forms for pointed, mapping and spectral scan observations. Several reference schemes are available for each type including dual beam switch (DBS) and frequency switch -- amongst others. The following sections describe the AOTs and the modes available within each AOT.

13.2. HIFI Single Point AOT

The HIFI Single Point AOT (Figure 13.1) includes several modes of data taking for a point-like object. HIFI is a single-beamed instrument, but with two polarisations measured separately although viewing almost identical positions in space. It provides for very high resolution spectroscopy (< 0.1 km/s in its highest resolution) over a wide range of sub-millimetre frequencies (480 to 1913 GHz; or 615 to 157 microns). At the highest available frequencies (1.9THz) the beam size is approx. 12" (full width at half maximum), making pointed observations appropriate for objects up to a few arc-seconds in extent.

In order to make well-calibrated observations, regular periodic observations of calibration and reference sources are made during an observing request. The use of regular references means that the effect of instrumental drifts, creating extra noise and a reduction in sensitivity, in the instrument can effectively be reduced.

There are several reference schemes available to the astronomer. The best reference scheme to use for any particular situation often depends on the type of source being observed.
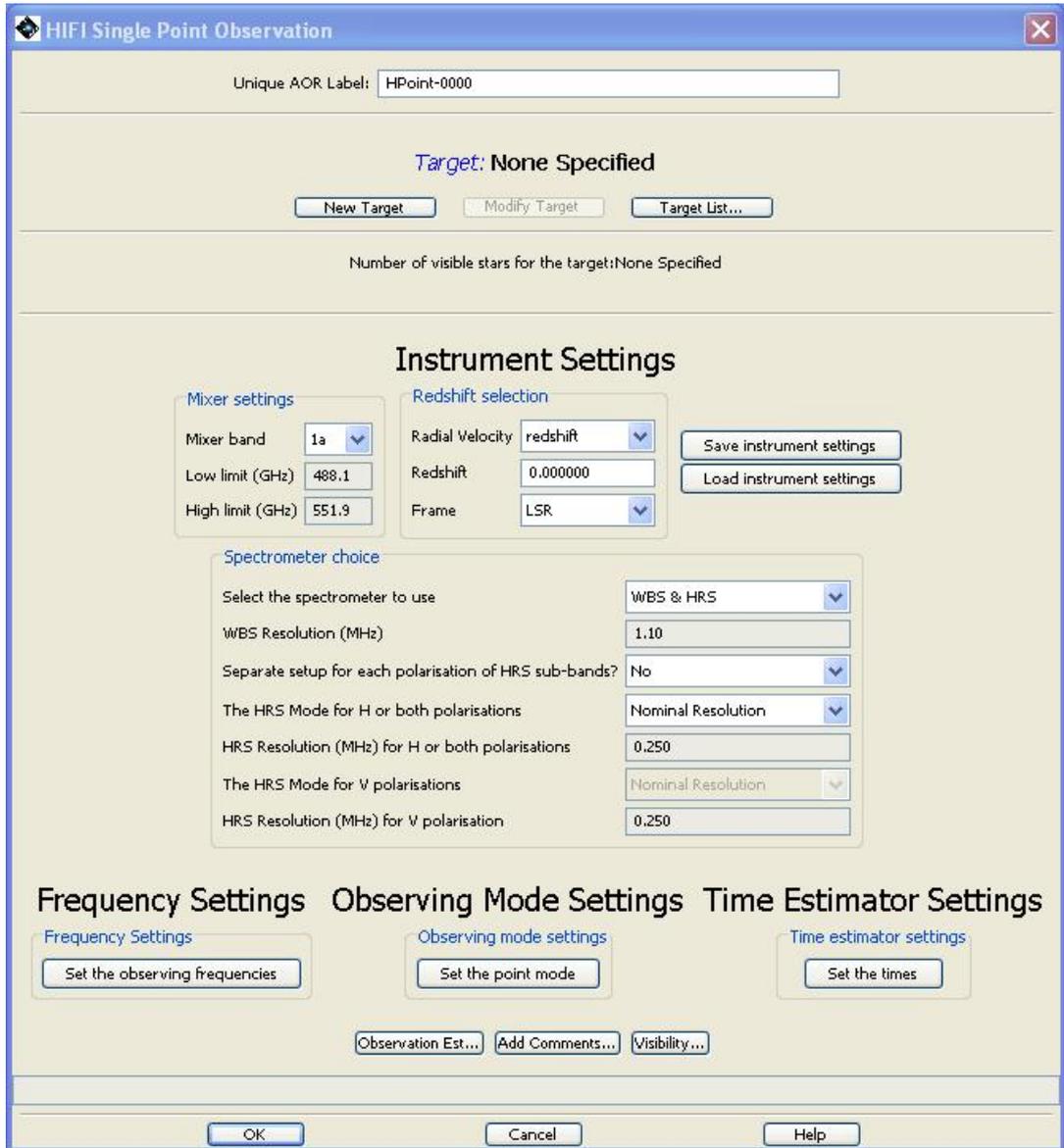
Figure 13.1. The Single Point AOT, showing the instrument setup dialogue.

13.2.1. Instrument Settings

The initial HIFI single point start-up screen provides the astronomer with the opportunity to select the spectrometers that are to be used. There are four spectrometers in HIFI, two for each polarisation. These can all be used simultaneously providing spectrometers with different resolutions. At the fastest readout speeds it is not possible to read out the data from all the spectrometers simultaneously.

Note

Astronomers who want to read out their data quickly must therefore reduce the number of spectrometers used.

13.2.2. Mixer Settings

The astronomer chooses the mixer band to be used for an observation. Current options are 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7b. The frequency range (in GHz) associated with the band

selection is displayed in the two boxes below the pulldown menu.

This selection determines which instrument antenna is to be used together with its associated amplifier chain(s). The antennas use heterodyne mixers which react to the beat frequency formulated between the incoming signal and a locally produced oscillation of known frequency (*Local Oscillator -- LO*).

It is currently believed likely that only a limited number of mixer bands will be available for use in a given observing day, **so linking of observations using more than one mixer band is currently not permitted in HSpot.**

13.2.3. Redshift selection

At the highest resolution of HIFI even Galactic objects can produce a large enough frequency shift in the observed lines that adjustments need to be made to the observed frequency to avoid the possibility of the spectrometers missing the expected spectral lines altogether because they are redshifted out of the observed frequency range. The redshift selection area allows the astronomer to input known radial velocities or redshifts for objects.

The top pull-down menu allows the type of radial velocity/redshift to be defined ("redshift", "optical (km/s)", "radio (km/s)").

An input box for the redshift value is where the known radial velocity/redshift is supplied by the astronomer.

Warning
After entering the value the user MUST hit RETURN or click in a separate box in the HIFI single point window.

The bottom pull-down menu allows the reference frame for the redshift to be input.

13.2.3.1. Changing redshift/radial velocity value

If the redshift value is changed during a setup or in further editing of the AOR then the user is asked if the local oscillator (LO) frequency should be updated -- if previously set. On answering "yes" to accepting the LO frequency change, the local oscillator frequency is changed to compensate for the change in redshift/radial velocity entered.

13.2.3.2. Note on Observatory Motion Compensation

The orbital motion of the Herschel Observatory itself is accounted for during mission planning once the date and time is known for observing the given target. The observed frequency will therefore frequently be slightly different from that requested.

13.2.4. Spectrometer Choice

HIFI has four spectrometers. Two Wide Band Spectrometers (WBS -- resolution set at 1.1MHz) and two High Resolution Spectrometers (HRS -- resolutions from 0.125MHz to 1.0MHz). The HRS spectrometers can only cover half the bandwidth of the WBS spectrometers in each of the two polarisations. However, the HRS has from 1 to 4 sub-bands per polarisation that can be moved to different parts of the amplified spectrum available from the mixers and their amplification chains (the so-called intermediate frequency, IF, bandwidth).

A total bandwidth of 4GHz is available to all bands except the band 6 and 7 mixers where only 2.4GHz of bandwidth is available (providing a velocity bandwidth of 360km/s at the highest frequencies).

The user selects the spectrometers to use via the first pull-down menu. Remember -- A reduction in the number of spectrometers being read out leads to the possibility of a faster readout, which may be very useful for observations of bright objects. Current spectrometer combinations are "WBS &

HRS", "WBS only", "HRS only", "Half HRS only (fast mode)".

The resolution of the WBS (if used) is shown in the following line.

The user is then asked if the HRS is to have different resolutions for each of its polarisations. "Yes" and "No" are available from the pull-down menu.

The user can then choose the resolution for the HRS. There are four standard resolutions ("high", "nominal", "low" and "wide"). If the user has chosen to have different resolutions for the two HRS spectrometers attached to each polarisation then the choice needs to be made for the vertical (V) polarisation also. For each polarisation, the spectrometer resolution is reported by HSpot.

> **Note**
> For the "Half HRS" mode a similar choice is available, but a reduced number (half) of sub-bands are read out.

A similar instrument settings panel is used for both pointed and mapping observations.

13.2.5. Save and Load of Instrument and Frequency Settings

The instrument and frequency settings (see Section 13.2.6 can be saved to the user's local hard disk using the "Save instrument settings" button. These can be loaded again for any AOR using the "Load instrument settings" button.

13.2.6. Frequency Settings

Hitting the "Set the observing frequencies" button brings up a window labelled "Frequencies" (see Figure 13.2). This window lists the selected frequency settings for the given observation. The four buttons at the top of the screen "Add", "Modify", "Delete" and "Copy" allow the following:
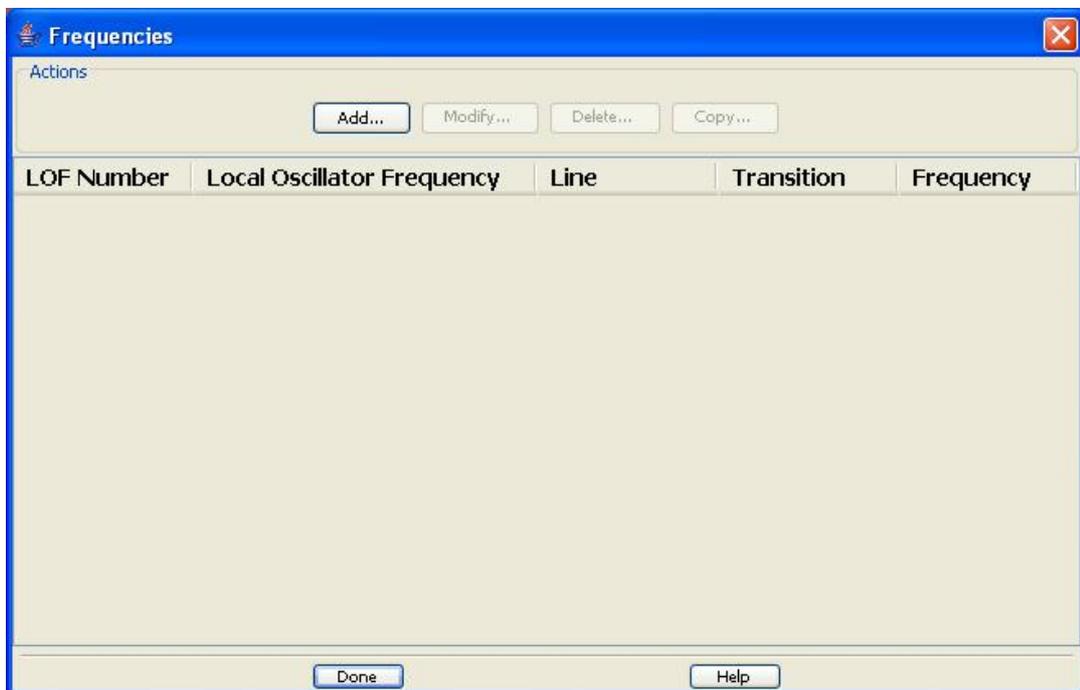
Figure 13.2. The Frequencies window where HIFI frequency settings are displayed. In this case the frequency setting for a CS 10-9 molecular emission line observation is displayed. Modification of this setting can be obtained by clicking on the line and hitting the "Modify" button in the window.

- Add -- selecting this button allows the addition of a frequency setting to the observation that is within the selected frequency band chosen in the instrument settings. A "Frequency Editor" window (see Section 13.2.6.1) is opened and the user can set up the positions of the WBS and HRS spectrometers within the allowed frequency range. Once the "OK" button is clicked the frequency settings are stored and a synopsis is displayed in the "Frequencies" window.

    Note
    At present only ONE frequency setting is allowed per observing request.

- Modify -- This allows frequency settings to be modified after they have been created with the "Add" capability noted above. To modify a selected frequency setting, select -- by clicking on the line in the "Frequencies" window -- the frequency setting to be modified. Clicking on the line in the "Frequencies" window highlights it. Now click the "Modify" button. The "Frequency Editor" window is opened with the current settings and modifications can then be made and stored by clicking the "OK" button in the editor window.

- Delete -- Allows deletion of selected frequency setting. Click on the line holding the frequency setting to highlight it, then hit the "Delete" button to remove it.

- Copy -- This is currently disabled, but making a copy of a selected frequency setting with this button will be possible in the future.

13.2.6.1. Frequency Editor Window

When setting up the range of frequencies for each of the spectrometers in use the "Frequency Editor" window is used. There is a lot of information about HIFI and how it works that is illustrated within this window (see Figure 13.3). At the top of the window -- at left and right -- bars are shown that show the available bandwidths of the WBS and HRS spectrometers given the resolutions selected in the instrument setup window.

Figure 13.3. The Frequency Editor for setting up the local oscillator and HRS sub-band offset setting for HIFI. In this case the spectrometers chosen were the WBS and HRS in parallel with both polarizations of

the HRS to be made with "nominal resolution."

In Figure 13.3 three spectrometer lines are shown, one for the WBS spectrometer and two for the two subbands available using the HRS spectrometer in "nominal resolution."

Dual sideband display

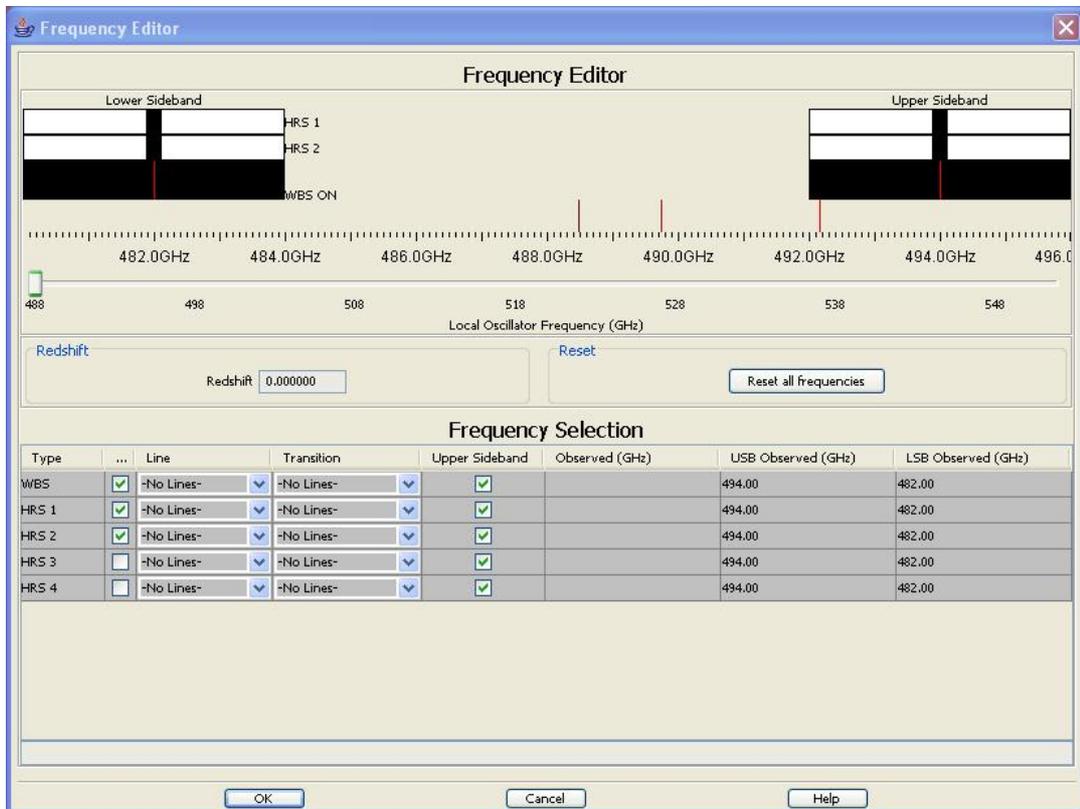The reason why bandwidths are displayed at both the left and the right is that HIFI is a dual sideband (DSB) instrument (see the HIFI Observers' Manual ([ht-tp://herschel.esac.esa.int/Docs/HIFI/html/hifi.html](http://herschel.esac.esa.int/Docs/HIFI/html/hifi.html) for details). The heterodyne technique used means that two parts of the spectrum are viewed simultaneously (in a single spectrum -- one sideband on top of another) either side of the local oscillator (LO) frequency.

A frequency scale is shown below both sideband displays indicating which sky frequencies are being viewed by the current setup.

Emission/absorption lines displayed

The positions of known emission/absorption lines are indicated by lines appearing above the upper frequency scale with different colours (each species has its own colour) being used to indicate different species. HSpot contains a default line list containing most of the stronger lines available in the HIFI frequency range.

Note
The displayed/available lines are the redshifted lines available within the band.

The list of lines can be added to from on-line catalogues and/or individual line information provided by the user (see Chapter 18). It is also possible to change the width and height displayed of chosen lines in the "Lines" menu in HSpot. However, this is NOT a simulation of the expected spectrum from any given source, but merely an indication of where lines appear and to provide a rough indication of possible "contaminating" lines that might be superimposed from the second sideband that will not contain the main signal of interest.

A left mouse-click near one of the lines appearing in the display will display its identification and stored frequency (see Figure 13.3).

13.2.6.2. Changing the HRS sub-band positions

The HRS sub-band sliders can be moved via a mouse-click-and-drag to positions available to them (within surrounding rectangular box) or via the pull-down menus in the table at the bottom of the frequency editor screen (see Section 13.2.6.1). The frequencies being sampled by the WBS and HRS can be seen in the scale below the bandwidth bars.

13.2.6.3. Changing the Local Oscillator (LO) frequency via the slider

The LO frequency can be changed via the slider on the second scale shown. The slider has a range over all the available frequencies for the band chosen. As the LO frequency is changed (click-and-drag) the sampled spectrometer frequencies are also changed.

13.2.6.4. Choosing a spectral line using the pull-down menus

An alternate means of changing the LO frequency, which also has the advantage of automatically placing the line at the best position within the WBS spectrometer, is via the pull-down line and transition menus. The available spectrometer bands have check marks beside them. For these spectrometers, we can optimally place a selected line in either the upper or lower sideband. To select a line and have the spectrometer set up adjusted for you.
Line Selection via the Pull-down Menus: An Example

We can set up an observation to use the WBS and HRS spectrometers simultaneously to observe more than one emission line at a time spaced close to each other in frequency space. For example the CS 10-9 and CI 1-0 emission lines in band 1a of HIFI.

After selecting the mixer band to be band 1a in the HIFI point or mapping mode AOT window and selecting to "Add" a frequency within the "Frequencies" window we can set up the example by doing the following.

- Use the pull-down menus next to first select an atom/ion/molecule (e.g., CS).

- Use the pull-down menu under "Transitions" to see which lines are available in the band.

- Indicate via the checkbox whether the line should appear in the lower sideband (left) or upper sideband (right).

The example is illustrated in Figure 13.4 where the line CS 10-9 was chosen in band 1a. It was chosen to appear in the lower sideband (checkbox is blank). We can identify it via a left button mouse-click on the dark red line appearing above the frequency scale. This appears in the figure as a blue box with the line id and frequency in GHz. The id information is placed immediately to the right of the line clicked on.

Note that the line chosen is NOT placed at the centre of the lower sideband IF bandpass, but is placed in a "best IF frequency" position. Lines appearing in other parts of the IF band are likely to have higher noise levels. More information on the variation of sensitivity across the bandpass from the different HIFI mixers is given in the HIFI Observers' Manual (http://herschel.esac.esa.int/Docs/HIFI/html/hifi.html).
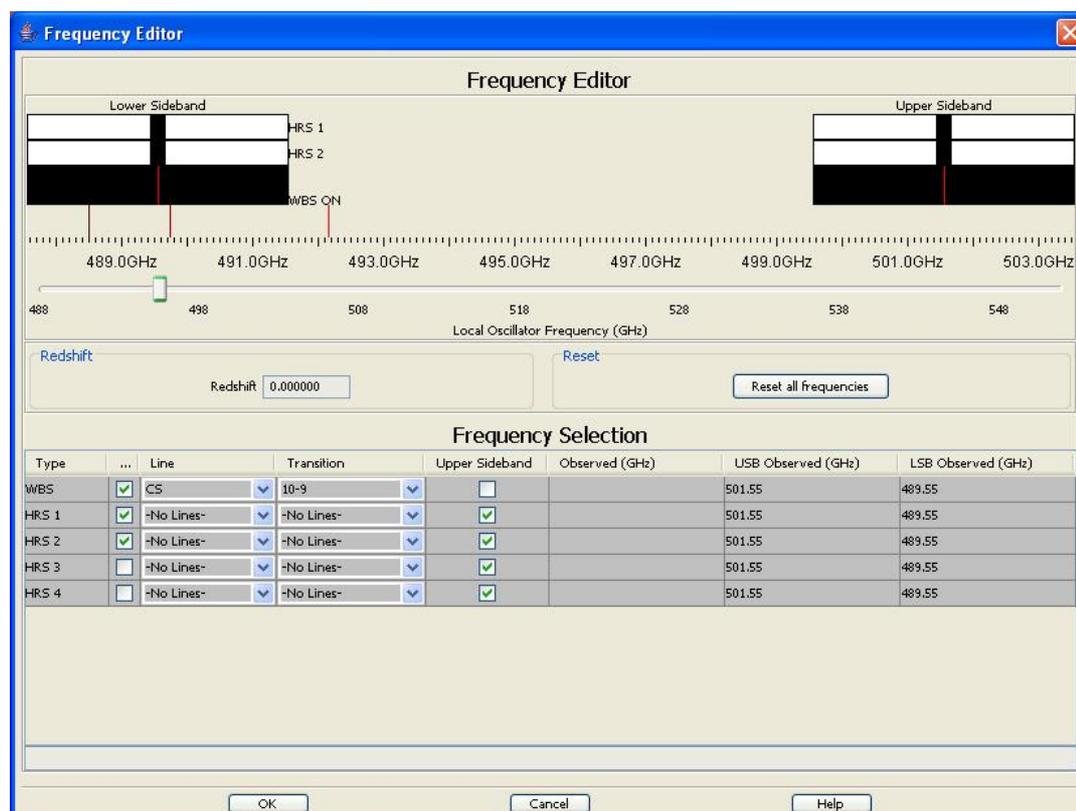

Figure 13.4. An example of a setup around the CS 10-9 line in Band 1a of HIFI.

Note that a warning sign will normally come up to tell you that you are moving the LO by more than 2GHz. Due to the limits of placement of the HRS sub-bands, moving the LO by more than this

amount means that all settings (bar the one just changed with the pull-down menus) will be reset to their default "No line" status, otherwise they would be out of the available frequency range of the instrument for the LO setting.

Note too that, when choosing a line from the pull down menus, the position of the line is not in the centre of the IF band (centre of spectrometer range). There are two reasons -- the centre marks a boundary between two of the four CCDs that form the detector of the WBS and the area chosen has the best noise levels within the IF band.

> **Note**
> The sensitivities across the IF band do not vary much for bands 1, 2 and 5 but degrade towards the edges of the 4GHz bandpass for bands 3 and 4. Bands 6 and 7 have a steadily decreasing sensitivity towards the upper edges of their bandpass (towards the far left and right on the HSpot screen). Please see the HIFI Observers' Manual (http://herschel.esac.esa.int/Docs/HIFI/html/hifi.html for more details.

The selection of a given line/transition via the pull-down menus can be done for both the WBS and HRS. But -- the HRS sub-bands can not move outside of the 4GHz (or 2.4GHz for the case of bands 6 and 7) sideband ranges. If you try to pick a line that would require a different LO setting a warning will come up and you will be asked if you really wish to proceed (see Figure 13.5). In the case shown, a warning is given when trying to centre on the CI 1-0 line after having previously setup the spectrometers to look at the CS 10-9 line in band 1a. It is possible to look at these lines simultaneously. An example is presented below.
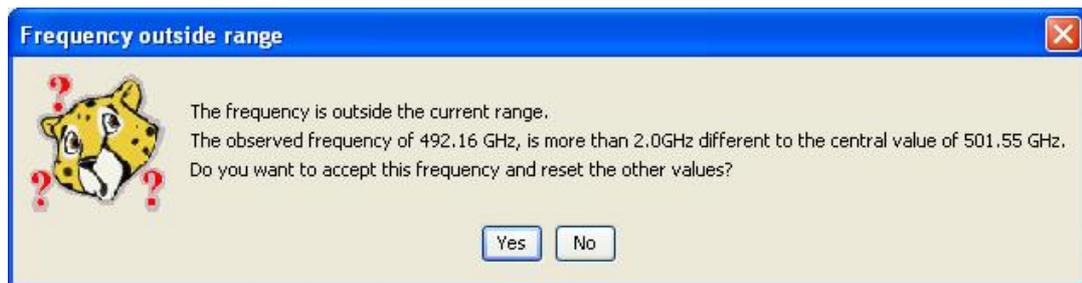

Figure 13.5. Warning pop-up that comes up if there is a large LO frequency move requested.

An example setup is shown in Figure 13.6 for a combined WBS & HRS observation of CS 10-9 and CI 1-0 lines, with the HRS in nominal resolution. In this case, there are two HRS sub-bands available to us. To obtain what is illustrated here the following was done.
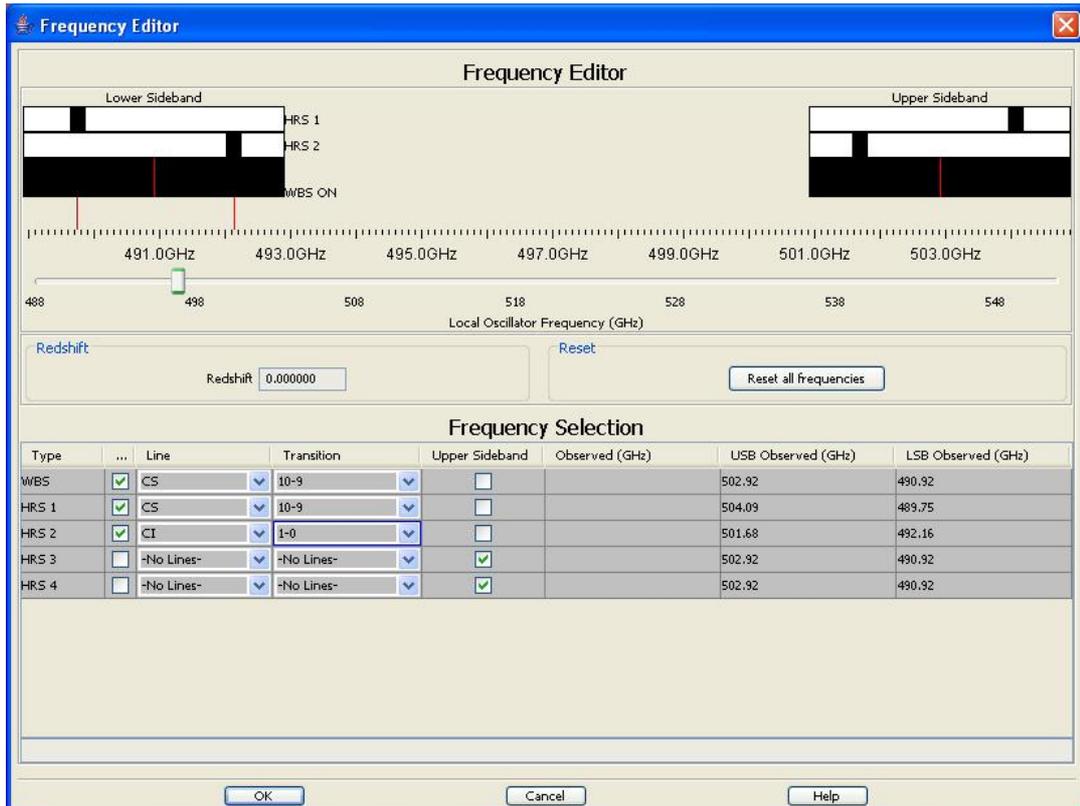
Figure 13.6. Example setup for using the Wide-band (WBS) and High resolution (HRS) spectrometers of HIFI simultaneously.

- The lower sideband was chosen for the measurements and the "upper sideband" checkboxes for the WBS and 2 HRS sub-bands were un-checked.

- The pull-down menu for the WBS was used to find the "line", in this case CS, and then the transition, in this case 10-9.

- A warning that the LO will be moved more than 2GHz is given. Answer "OK" to this.

- The CI 1-0 line then appeared just outside the lower sideband window (to the right). In order to get to observe this line simultaneously, the LO slider was adjusted so that both the CS 10-9 and CI 1-0 line appear under the lower sideband window at the top left of the screen.

- In order to look at the CS 10-9 and CI 1-0 lines with the HRS at higher resolution, the pull-down menu of the first HRS sub-band was used to give "line" = CS and "transition" = 10-9. Note how the HRS band goes directly to the *current* position of the CS 10-9 line.

- We can use the pull-down menus for the second HRS sub-band to centre it on the CI 1-0 line in a similar way to the previous step.

-
  > **Note**
  > When doing the above, you will also notice the HRS sub-band slider moving in the upper sideband. This illustrates the sky frequency being sampled simultaneously by the first sub-band of the HRS spectrometer. The central frequencies of the HRS sub-bands and the WBS, for the upper (USB) and lower sidebands (LSB), are automatically listed in the table to the bottom right of the frequency editor screen.

13.2.6.5. Choosing a frequency by typed input.

It is also possible to type in a frequency for the frequency positions of both the WBS and the HRS sub-bands. Note that the frequency chosen is automatically placed in the "best" position within the available WBS band, as for the pull down menu line selection.

An illustration of this is given in Figure 13.7, which again uses band 1a. In order to provide this setup we performed the following.
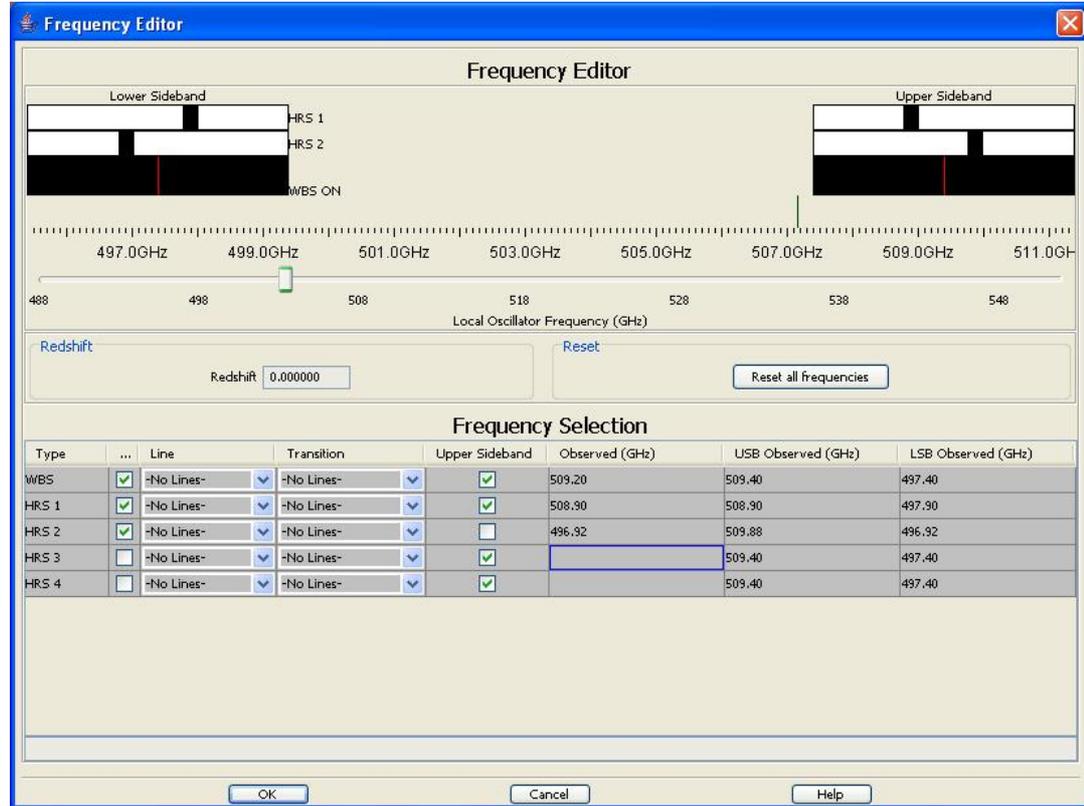
Figure 13.7. Illustration of typed-in frequency setting for HIFI spectrometers

- Make sure that all pull-down menus show "-No Lines-".

- Click in the WBS cell under the heading "Observed (GHz)". The cell should turn white and become editable. Enter the frequency required: in this case "520.0". Then click in the cell below (it is necessary to click in another table box for the input to be confirmed). After indicating "OK" to the pop-up warning, the frequency chosen should be placed in the upper sideband (note that the "upper sideband" box is checked for the WBS).

- We can do a similar thing in the box below for the first of our HRS sub-bands. Note that we cannot request a frequency for the HRS sub-band that is outside of the 4GHz range indicated by the black rectangular box showing the full bandwidth instantaneously available to the WBS. In this case "507.17" is well within the range of the lower sideband and theer is a hydrogen emission line there. Uncheck the sideband in the first line for the HRS so that the line to be centred is in the lower sideband. After input of the frequency, we again click on the cell below.

- We can do a similar process for placing the second subband of the HRS.

13.2.6.6. Completing the Frequency Selection

After hitting the "OK" button on the frequency editor window the user is returned to the "Frequencies" window. A descriptive line of the frequencies chosen is given in the window (see Figure 13.8). Settings can be modified by clicking on the line in the table to be modified and clicking the "Modify" button.
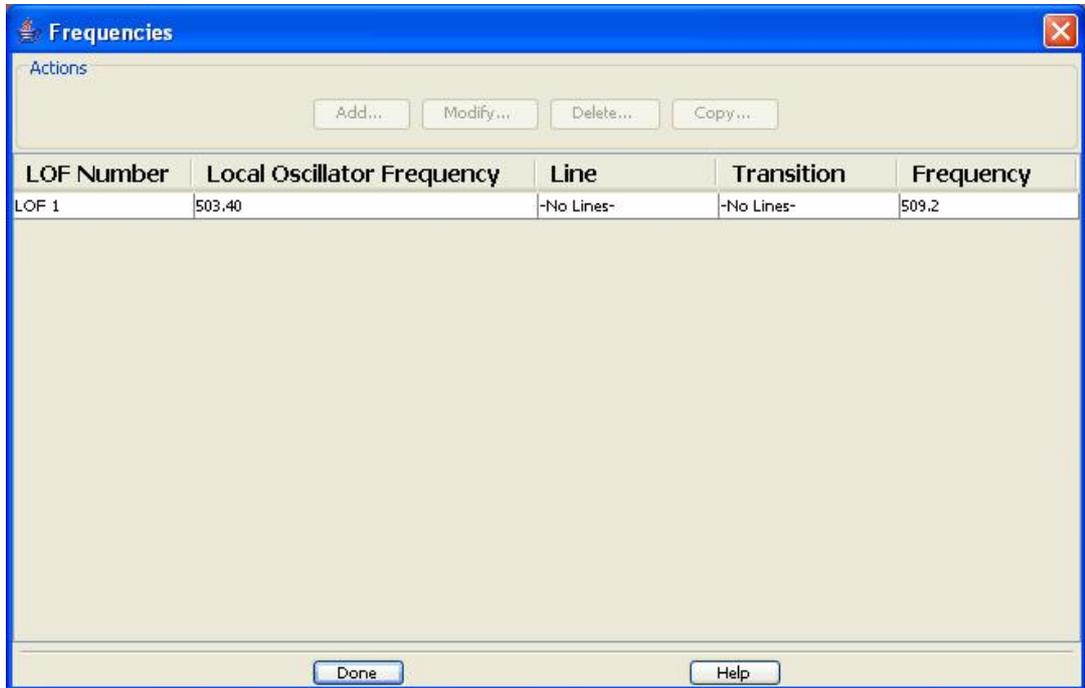
Figure 13.8. "Frequencies" window indicating the frequency settings stored for the current observation.

If you are happy with the frequency settings, then clicking "OK" in the "Frequencies" window completes the selection and returns you to the "AOT" window.

13.2.7. Pointing Mode Selection

To select a pointing mode from the HIFI "Single Point AOT window" just click on the button marked "select the point mode" under the "Observing Mode Setting" title. This returns a screen with the choice of observing modes (see Figure 13.9). The default observing mode is "None". In other words, the user is forced to choose an observing mode.
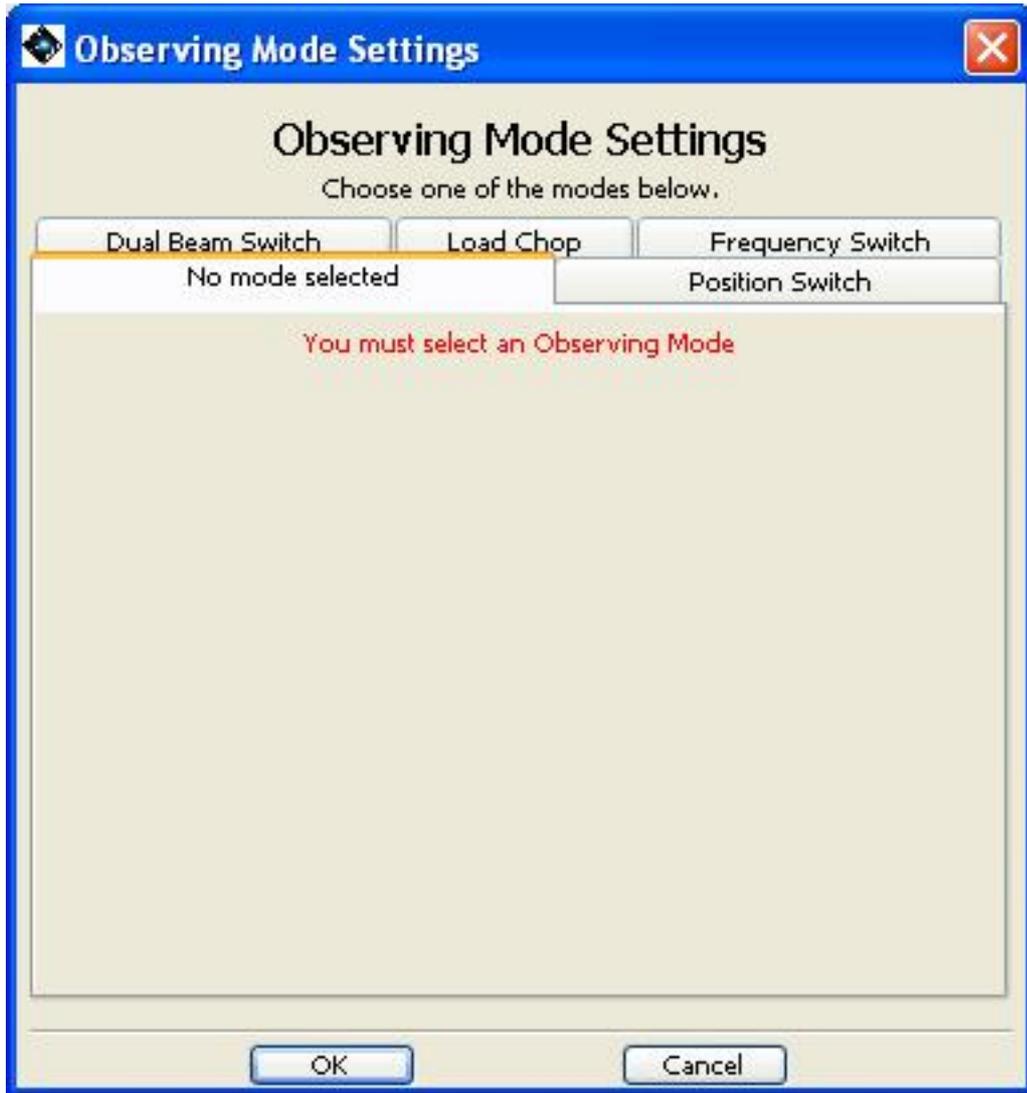
Figure 13.9. HIFI pointed observation mode selection. Simply click a tab to select the mode required.

To select a mode, simply click on the appropriate tab. Doing this automatically selects the mode with a given set of defaults.

13.2.7.1. Dual Beam Switch (DBS) mode

In dual beam switch (DBS), the HIFI chopper is used to switch the beam from looking at the target object and looking at a position 3 arcminutes from this (along the X axis of the spacecraft -- see the Herschel Observatory Manual). The second half of the cycle has the telescope move 3 arcminutes to place the chopped beam on the target position. Chopping now continues between the target and a position 3 arcminutes on the other side of the target. Calibration measurements are made at regular intervals dependant on the stability of the HIFI band being used (see the HIFI Observers' Manual (http://herschel.esac.esa.int/Docs/HIFI/html/hifi.html).

The standard (slow) chopping rate provides a 16-second cycle with an ABBA chopping cycle, where A is the off target position and B the on target position. So 4 seconds are used per readout, which allows readout of all spectrometers.

The user has two choices to make in this mode (see Figure 13.10).

```
1. Fast chop uses a ABABAB structure with 1 second spent at each on/off position. This is particula
```

```
for measurements of bright
objects, but slightly less efficient than the standard slow chop, which is the default. Or...
2. Continuum measurement. For accurate continuum level measurements, timing/frequency
of calibration measurements is adapted to reduce drift noise effects on the continuum level measure
```


Figure 13.10. Options for the HIFI Dual Beam Switch mode.

13.2.7.2. Position Switch mode

If, by chopping 3 arcminutes, the off position would not be placed in an emission-free area a position on the sky can be selected for the off reference position in the position switch mode (see Figure 13.11). However, the reference position *must be within 2 degrees of the target*.

The frequency of calibrations and switching is determined by the backend logic of HSpot when the time estimation is calculated for this mode, and is based on the distance between the reference and target positions. Reference positions at greater distances from the target have correspondingly lower observing efficiencies and will take longer to achieve a given noise level.
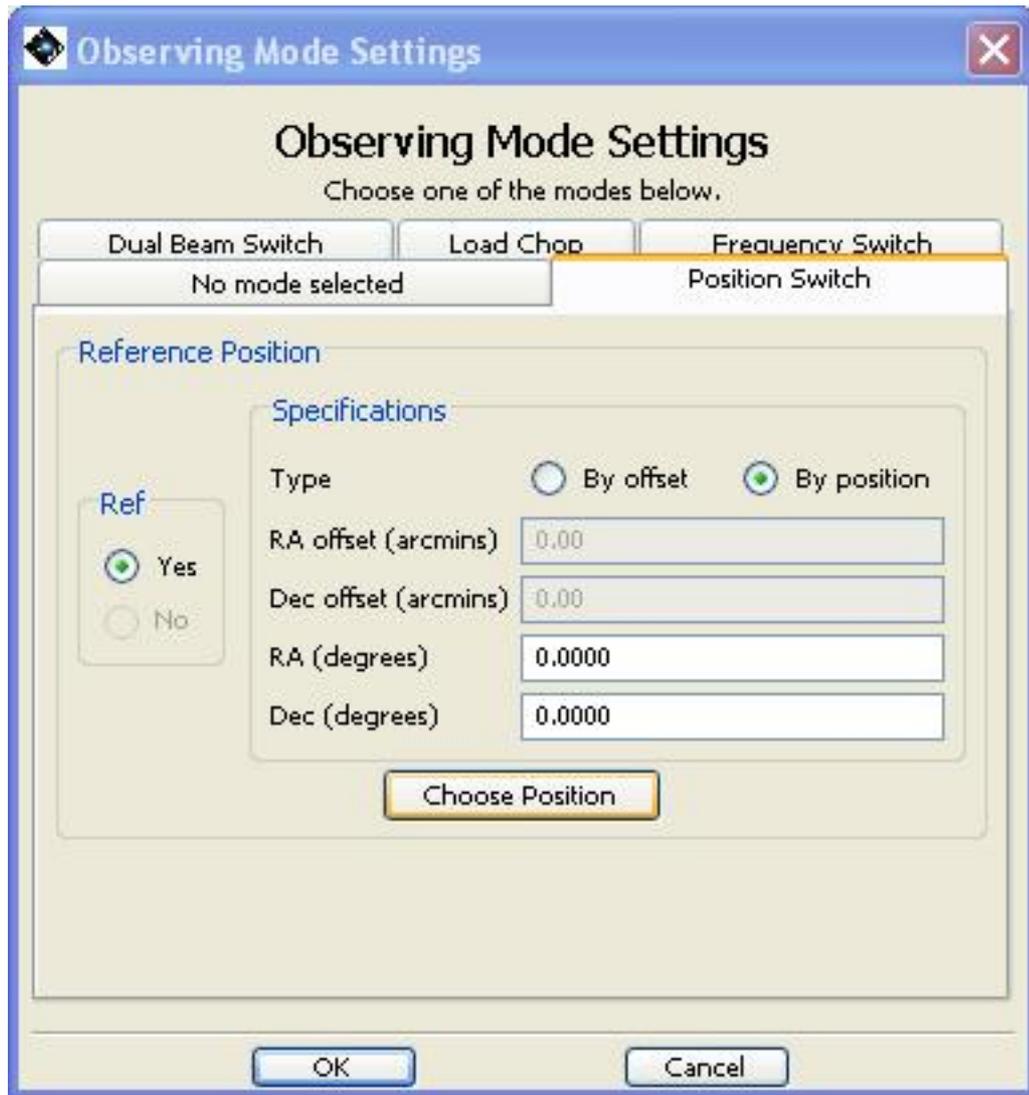
Figure 13.11. Options for the HIFI Position Switch mode.

Identifying a reference position

The reference position can either be given as an offset in RA and Dec from the target (in arcminutes) or its position given explicitly.

> **Note**
> **The reference position MUST be within 2 degrees of the target.**

Click the appropriate button to identify whether an offset or a specific position is to be used.

If a specific position is to be input, the user has the choice of either typing in a decimal RA and Dec (J2000) in degrees, or by clicking on the "Choose Position" button. This brings up the window shown in Figure 13.12, which provides a wider range of possible inputs for the reference (OFF) position of the position switch mode.
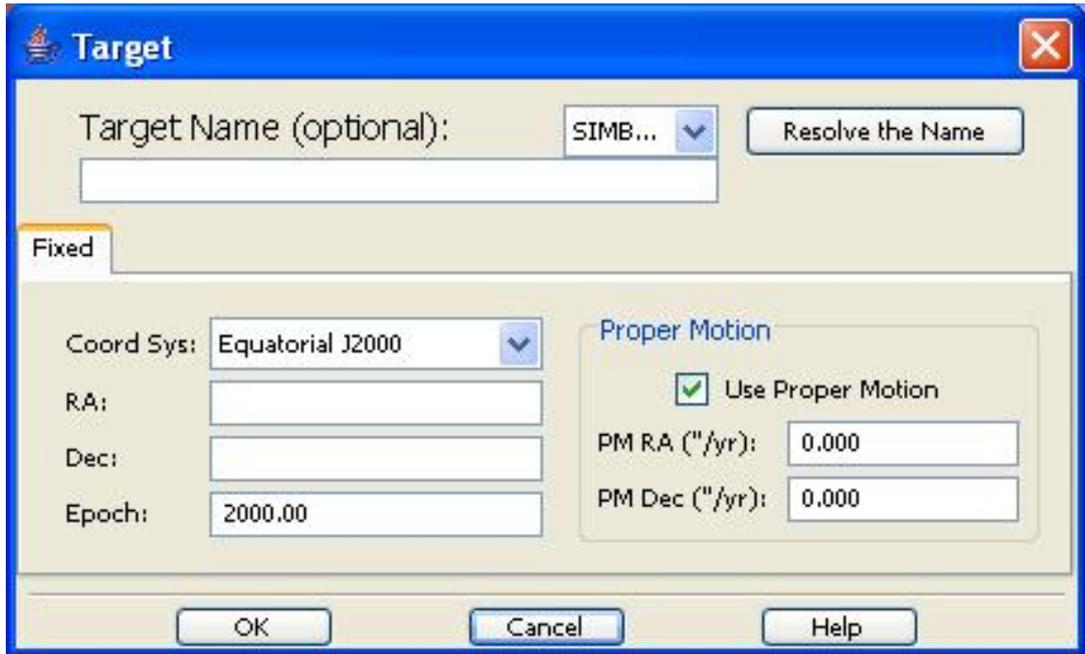
Figure 13.12. Dialogue window for identifying the OFF position for the HIFI modes. Note that this uses a similar dialogue to the standard Target input window.

13.2.7.3. Frequency Switch mode

Sometimes we can use the reference of a second spectrum taken with a slightly different LO setting. Doing this has the added advantage that the two spectra taken substantially overlap. Data can therefore be taken very efficiently in this mode (nearly 100%), but gain ripples are likely to remain. It is therefore recommended that an OFF position be used. It is expected that gain ripples will be removed or, at least, reduced by using a reference OFF position in the sky and repeating the same set of measurements.

This mode provides a choice of the frequency switch "throw" (the difference between the two LO frequencies to be used) and the choice of an OFF position (see Figure 13.13). For the frequency throw the user uses a pull-down menu of available frequency throws. Currently there are 4 values allowed, -240, -120, 120 and 240 MHz.

> **Note**
> The velocity (in m/s) associated with the chosen frequency throw is displayed under the frequency throw pull-down menu.

The position of any OFF position is done in the same way as for "Position Switch" mode (see the section called "Identifying a reference position"). Note that for frequency switch observations the choice of an OFF position is optional. Use of an OFF position makes the observation more robust against residual baseline ripples after data processing.

Figure 13.13. Options for HIFI Frequency Switch pointed mode.

13.2.7.4. Load Chop mode

This mode allows a reference measurement to be taken against the internal loads of HIFI. This can be particularly useful when a sky reference position is not within 2 degrees of the target or when a large slew would lead to high drift noise (which can be the case for bands 6 and 7 observations).

The HIFI chopper is moved between the on target position and the position of the hot/cold internal calibrator loads of HIFI in order to remove gain variations. Due to the likelihood of residual ripples, this should also be done on a reference OFF position.

The input from the user only requires information about any required OFF position to be defined (see Figure 13.14). The OFF position is included in the same way as for the "Position Switch" mode (see the section called "Identifying a reference position") and, likely the Frequency Switch case, is an optional input.

Figure 13.14. Options for HIFI Load Chop pointed mode.

13.2.8. Time Estimator Settings

To get a time estimate for the chosen mode and its associated expected noise level, click the "Set the times" button at the bottom right of the AOT screen. This brings up a window similar to Figure 13.15. The time estimator provides two ways to get a time estimate.
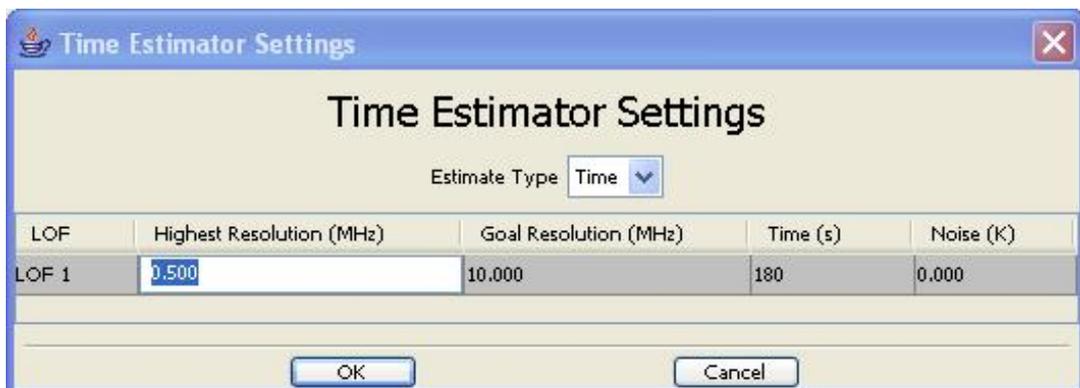
Figure 13.15. HIFI time estimator settings window.

- The user can provide a goal time

  The most efficient way to utilise an input goal time from the user is calculated, a more exact time for the mode (including observatory overhead) is calculated and the expected *noise temperature associated with the main beam temperature for a single sideband (SSB) and single polarisation noise* is returned.

  Typically, time estimates returned are within 10-30% of the goal time introduced by the user or 10-30% of the goal noise request from the user, unless the goal time is very short or goal noise very large, in which case a minimum time for the observation is calculated.

  Note that there is a time limit of 18 hours for a single observing request.

- The user can provide a goal noise

  The fastest way to obtain a given noise goal is calculated, and a more exact time for the mode (including observatory overhead) and the expected *noise temperature associated with the main beam temperature for a single sideband (SSB) and single polarisation noise* is returned.

  If a high noise level is requested the shortest useful time for making is calculated. Low noise levels may not be possible in single observations due to the 18 hour time limit.

The user can also input the range of resolutions that are useful for their particular science and for which they would like a noise estimate (the "goal resolution max" is used as the resolution goal, the resolution at which the data is expected to be used/smoothed to). Given the very high resolution available to HIFI, there will be many times when the observer does not require the full resolution available to either the WBS or the HRS. *It should be noted that these time estimates ARE affected by the values of these user-requested resolutions. This is becauses stability times (and therefore how often calibrations are required) are longer if the resolution required is higher ("Goal Resolution Minimum" is a smaller number).*

Once the resolutions and time or noise goal have been set, click on "OK". Time estimates can be made from the main AOT window (see Chapter 13). Time estimates can also be made from the main "Observations" window of HSpot using the "Recompute All Estimates" selection on the "Tools" pull-down menu.

13.2.8.1. Choosing Time or Noise Goal

This is done via the pull-down menu at the top of the time estimator window (see Figure 13.15). The default is "Time" where the user indicates how much time he/she wishes to spend on the observation.

13.2.8.2. Setting the Resolutions

To change the goal resolution minimum and maximum values, simply click on the box in the table below each of the headings and input the required value.

13.2.8.3. Setting the Time Goal

To input a time goal (how much time to be spent on the observation), the user clicks on the table cell in the "Time (s)" column. The goal for the observation should be entered, in seconds.

13.2.8.4. Setting the Noise Goal

If "Noise" is chosen from the pull-down menu in the time estimator settings screen, a noise goal (in degrees Kelvin antenna temperature for a single sideband and single polarisation) can be input. Click on the table cell below "Noise (K)" and input a value.

13.2.9. Getting the Observing Time Estimate

Once the settings have been made for the AOR, the observing time estimate is obtained by clicking the "Observation Est." button at the bottom left of the AOT window (see Figure 13.1).

Running the estimator invokes a sequence of checks of possible combinations of on target, reference and calibration measurements/timings to find the most efficient mode for obtaining the lowest overall noise within the allocated time or the shortest time to obtain a given noise goal. The calculation takes into account the radiometric and drift noise, plus the known temporal stability of the HIFI instrument (as measured in ground testing) in the chosen frequency band.

> **Warning**
> The HIFI time estimator can currently take some time to make a time estimate (occasionally more than one minute). This is particularly for the more complex modes.

The exact time for the observing sequence and the associated expected noise is returned to the user. A set of messages and information regarding the sequence chosen are also available via the "Show Messages" button on the returned estimate screen.

Figure 13.16 shows the information that is returned for a position switch measurement. In our example case the noise expected at the user selected resolutions in the upper and lower sidebands is returned (when we have more information on instrument sideband ratios this will typically differ from each other in the future), and the time taken for the observing sequence chosen.

13.2.9.1. Show Messages

The HIFI AOT logic uses a code to compute optimal observing sequences based on user input parameters. Information on the sequence chosen is displayed with the "Show Messages" button. Doing so provides a message window to show sequence/observation information (see Figure 13.17, messages returned for our position switch observation).
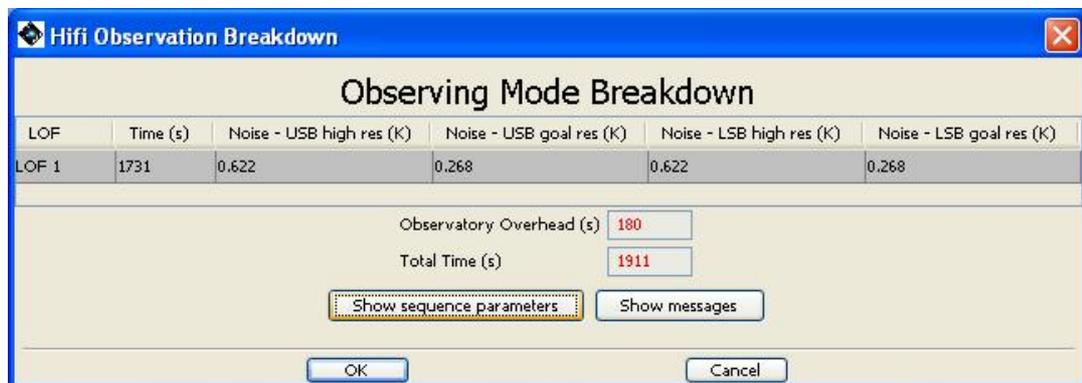

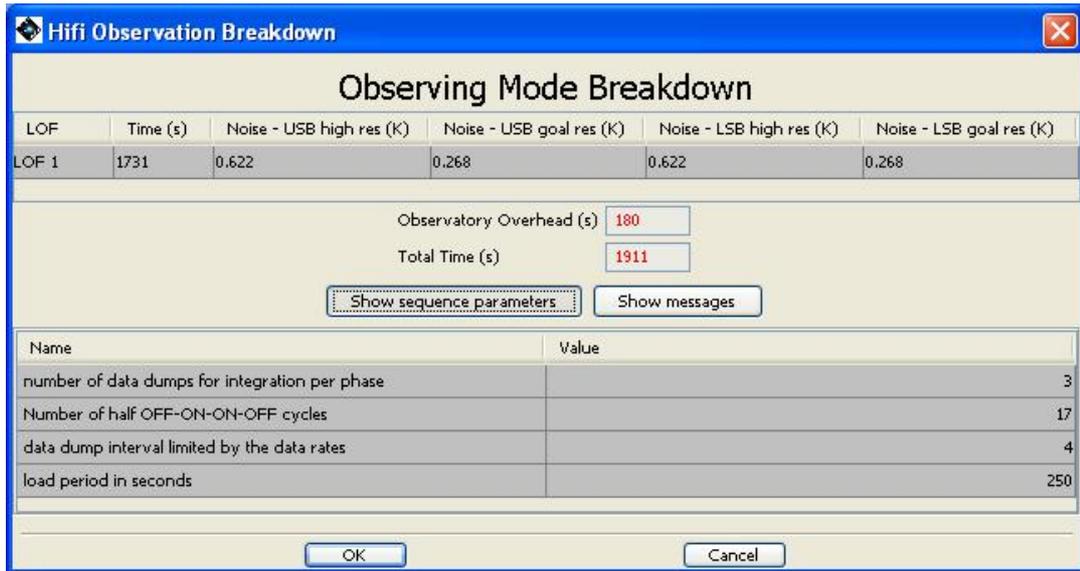**Figure 13.16. Time return information from the HIFI time estimator**

Figure 13.17. Time return information extended to show HIFI messages. This indicates the sequence of measurements taken by HIFI -- chop/switch cycles in each position and nod positions for the example case -- during the course of the observation request and time taken both ON and OFF the target. The efficiency of the mode indicates the time/noise compared to an ideal instrument looking at the target throughout the observing time.

- Load period -- the period between calibration load measurements is 1800 seconds.

- Data dump interval -- there is 11 seconds between each readout of the spectrometers.

- Number of switch cycles on source -- there are 6 BAAB chop cycles to be used, starting on the OFF position.

- The number of position cycles -- there are 13 position nods during the observation.

Such parameters in the message information differ slightly for each observing mode, but provide fundamentally similar sets of information.

Always provided for each mode are the following:

- Total observing time without initial slew.

- On and Off (reference) source integration times.

- Total time in overheads (including telescope motion during nod cycles.

- Total time (on source and on reference as compared to total time) efficiency and noise efficiency as compared to an ideal instrument (e.g. using the radiometry equation).

- Drift noise contribution. Nois contribution due to instability in the given mixer band.

- Beam size assumed/expected and assumed main beam efficiency

Message information can be saved to disk using the "Save" button at the bottom of the messages window. Messages are also automatically saved in the AOR file of observations after a time estimate has been made, including when batch estimates are made using the "Recompute All Estimates..." selection under the "Tools" menu within the main window of HSpot.

13.3. HIFI Mapping AOT

The AOT screen for the "HIFI Mapping" AOT is very similar to that for the pointed observation mode (see Figure 13.18). Essentially, setting up the instrument is identical for each of the pointed and mapping modes, including the setting up of the time estimator. The one difference can be seen at the bottom of the AOT screen under "Observing Mode Settings". Clicking the button marked "Set the mapping mode" allows the choice between "On-the-Fly" and "DBS raster" mapping (see Figure 13.19).

Figure 13.18. HIFI Mapping AOT window

Figure 13.19. HIFI mapping mode choice window

To choose the mapping mode that you want, just click on the appropriate tab.

"On-the-Fly" mapping involves continuous readout while scanning and is potentially a very efficient mode. This mode can also be used with a frequency switch option. Dual Beam Switch (DBS) raster and cross maps involve using the DBS pointed mode -- with 3 arcminute chop throws -- at each map point (see Figure 13.19).

13.3.1. On-the-Fly (OTF) Mapping setup

In Figure 13.20 the options for OTF mapping are displayed. The X direction = in-scan direction while the Y direction = cross-scan direction. The in-scan and cross-scan sampling has the same spatial size, typically Nyquist sampling.
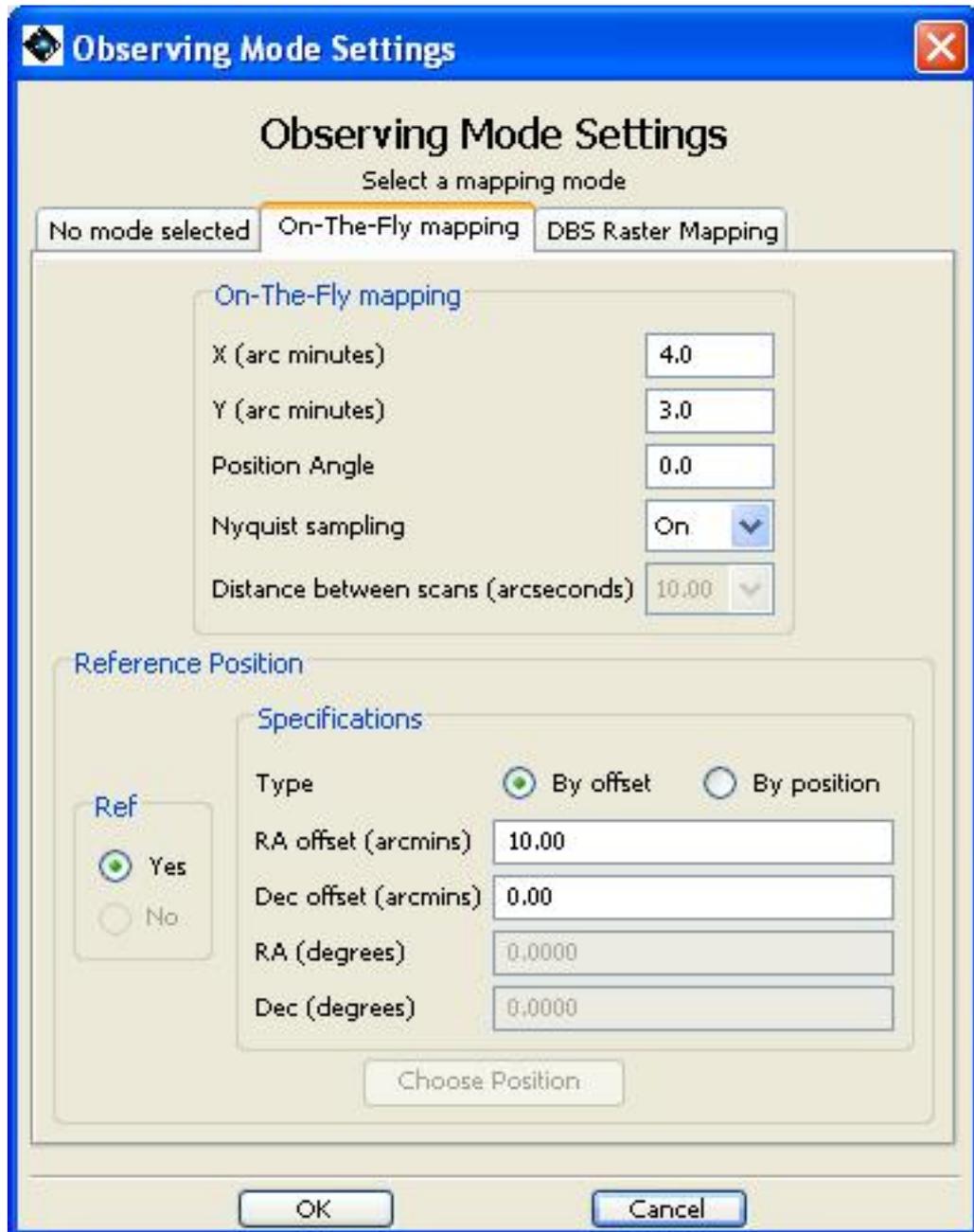
Figure 13.20. HIFI On-The-Fly map setup window.

13.3.1.1. Setting the Map Size

The centre of the map is at the coordinates given by the target position. The total in-scan and cross-scan lengths (in arcminutes) then indicate the size of the map around this centre. The total in-scan length is restricted to 90 arcminutes or less. However, for higher frequency measurements, where calibrations are more frequently required, the scan length is restricted to much less than this.

> **Warning**
>
> The length of a scan in the X direction is limited by the maximum length of time that can be taken between load calibrations. Since the high frequency bands have shorter stability times, this effectively restricts map sizes to only a few arcminutes in bands 6 and 7 (approx. 3-4 arcminutes for Nyquist sampling in bands 6 and 7, with all spectrometers in use). An increased map size in a single AOR can be obtained by

- Reducing the number of spectrometers being read out (e.g., use WBS only).

- Increasing the cross-step size, at the expense of likely undersampling of the map.

Restrictions on the cross-scan size (Y direction) come only from the total time allowed for a single observation.

13.3.1.2. Setting the Position Angle

In order to do an OTF map, the telescope is scanned in a direction with a position angle between 0 and 360 degrees from north to east.

13.3.1.3. Setting the Cross-scan Step

The user can either have Nyquist sampling (the default), or can choose to have a cross-step. Choosing Nyquist sampling or not is given by a "Yes/No" pull-down menu (see Figure 13.20). If "No" is chosen the user has a selection of available cross-step values (in arcseconds) that can be used.

13.3.1.4. Choosing a Reference Position

The OTF mapping mode requires a reference OFF position to be used. This can be incorporated in the same way as the pointed mode reference positions (e.g., see the section called "Identifying a reference position").

Note
The reference position MUST be within 2 degrees of the target.

13.3.2. On-the-Fly Scanning Map with Frequency Switch

This mapping mode has the same elements as the OTF scanning (see Section 13.3.1) but allows the user to additionally use a frequency switch while scanning. There is therefore the additional user input parameter of the frequency throw for the switch. The mode does not require the user to use a reference OFF position. Referencing only occurs between the frequency-switched positions. However, accurate bandpass measurements allowing for best continuum baseline removal should use a frequency switch measurement of an OFF position too.

On-the-fly with frequency switch is particularly useful for situations where the stability times are short (such as in the cases of bands 6 and 7) where standard OTF maps use a reference at the ends of line scans which may take long periods of time leading to large drifts.

This mode requires the same input parameters as the standard OTF mapping mode (see Section 13.3.1) except for the fact that an OFF position is optional (see the section called "Identifying a reference position" for information) and that a frequency throw needs to be selected by the user (see Figure 13.21).
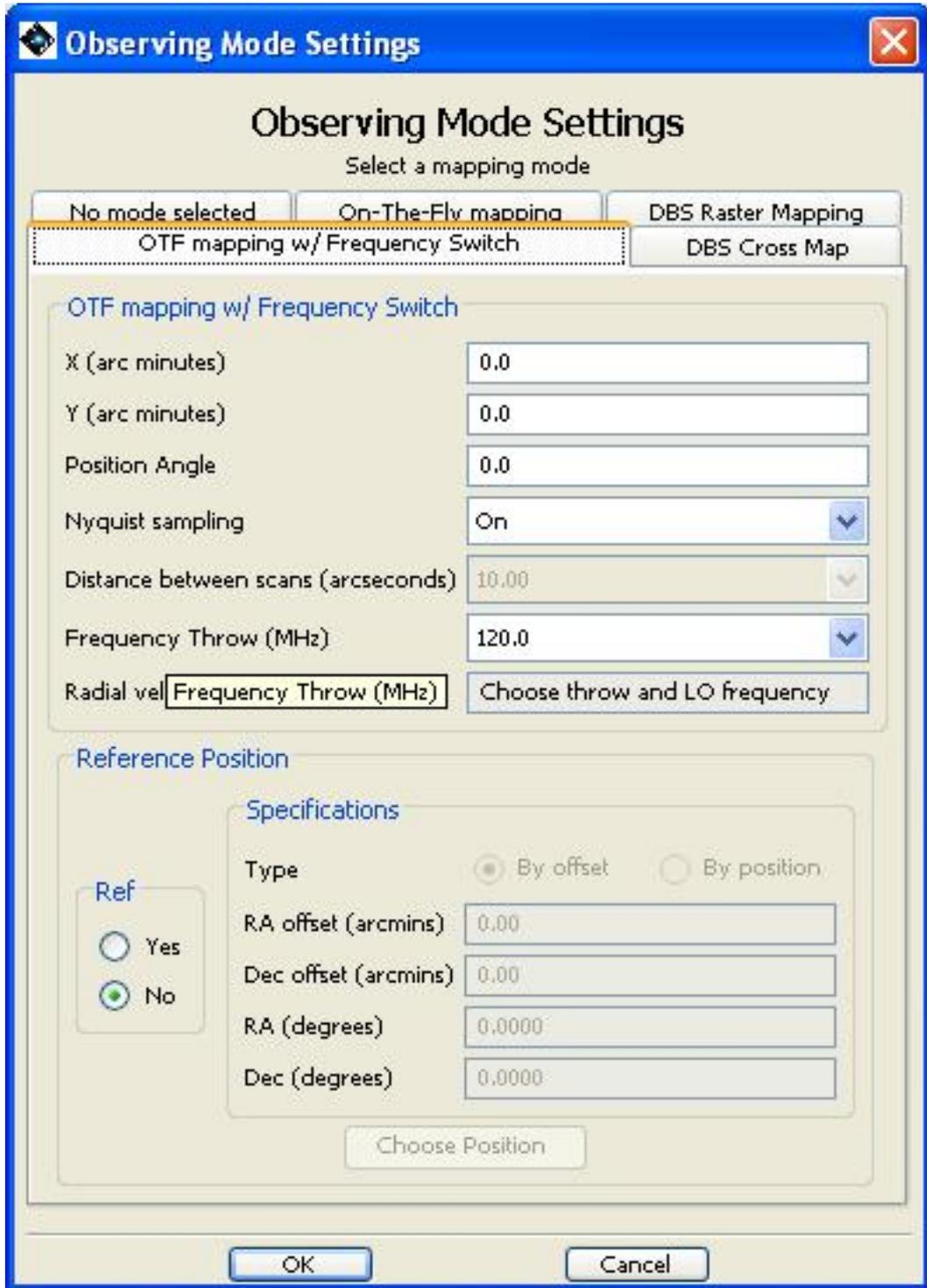
Figure 13.21. HIFI On-The-Fly map with frequency switch setup window.

This mode provides a choice of the frequency switch "throw" (the difference between the two LO frequencies to be used) and the choice of an OFF position (see Figure 13.13). For the frequency throw the user uses a pull-down menu of available frequency throws. Currently there are 4 values allowed, -240, -120, 120 and 240 MHz.

Note
The velocity (in m/s) associated with the chosen frequency throw is displayed under the frequency throw pull-down menu.

13.3.3. DBS Raster Mapping mode

An alternate method of mapping is to use the Dual Beam Switch (DBS) method at each point in a map. Since each position effectively uses a reference, no OFF position needs to be defined for this mode (see Figure 13.22). *However, the chopper throw is only 3 arcminutes and for maps larger than this in extent, the user should be aware of possible OFF position contamination issues.*

Figure 13.22. HIFI raster map setup window

13.3.3.1. Setting the Map Size and Map Size Limit

The limitation on map size is due to the stability of the band used and the associated calibration cycle. *The DBS raster map size is limited to being 32x32 points.* This means that maps are effectively restricted to a few arcminutes on a side in the high frequency bands of HIFI if Nyquist sampling is being used. HSpot provides a warning if the user attempts to input map sizes that are too

large to fit this criterion.

13.3.3.2. Setting the Position Angle

This is done in the same way as for OTF maps -- see previous section.

13.3.3.3. Fast Chop and Continuum Timing

These choices are identical in nature to the ones for the pointed DBS mode (see Section 13.2.7.1).

13.3.4. DBS Cross Map

For point-like objects where the position is less well known or where flux accuracy is needed a standard DBS cross map is used that provides a five-point cross map with small offsets (choice of "Pointing jitter" -- based on approximate pointing error of Herschel; "Nyquist" -- Nyquist sampling of beam size at the user-selected observing frequency; "10", "20", "40" -- for step size in arc seconds).

The mode is very similar to the point DBS mode (see Section 13.2.7.1) with fast chop or continuum timing user choices for the mode along with the cross step size (see Figure 13.23).

Figure 13.23. HIFI cross map setup window.

13.3.5. Time Estimates for HIFI Mapping Modes

The time estimator interface for HIFI mapping modes is the same as for point source modes. An optimum observing sequence that fits the input user setup is found and the time it takes is estimated.

OFF measurements and calibrations are taken after one or more line-scans in the OTF maps. *For long scans the time taken for a scan can be long with respect to the stability time of the observing*

band. This can lead to a large drift noise component to the total noise of the observation.

For mapping observations, an integer number of map repetitions can lead to large steps in the amount of time a map takes to be observed. A match between input user request time or noise may therefore not be very close. This is particularly true if a minimal amount of time is requested for a mapping observation. In this case a fast backend readout is chosen to cover the area requested in as short a period of time as is reasonable.

> **Warning**
> The HIFI time estimator can currently take some time to make a time estimate (occasionally more than one minute). This is particularly for the more complex modes such as mapping.

13.4. Spectral Scan AOT

The spectral scan AOT allows the user to setup HIFI so that multiple LO settings are observed over a wide frequency range (see Figure 13.24). In principle this allows complete coverage of a HIFI mixer band to be set up in a single observation, although a part of a band may also be chosen. The mode uses Dual Beam Switch (DBS) or Frequency Switch at a single position (single point DBS and frequency switch are discussed in Section 13.2.7.1 and Section 13.2.7.3 respectively).

Only the WBS is used in this mode to provide the wide spectral bandpass.

Figure 13.24. HIFI spectral scan setup window
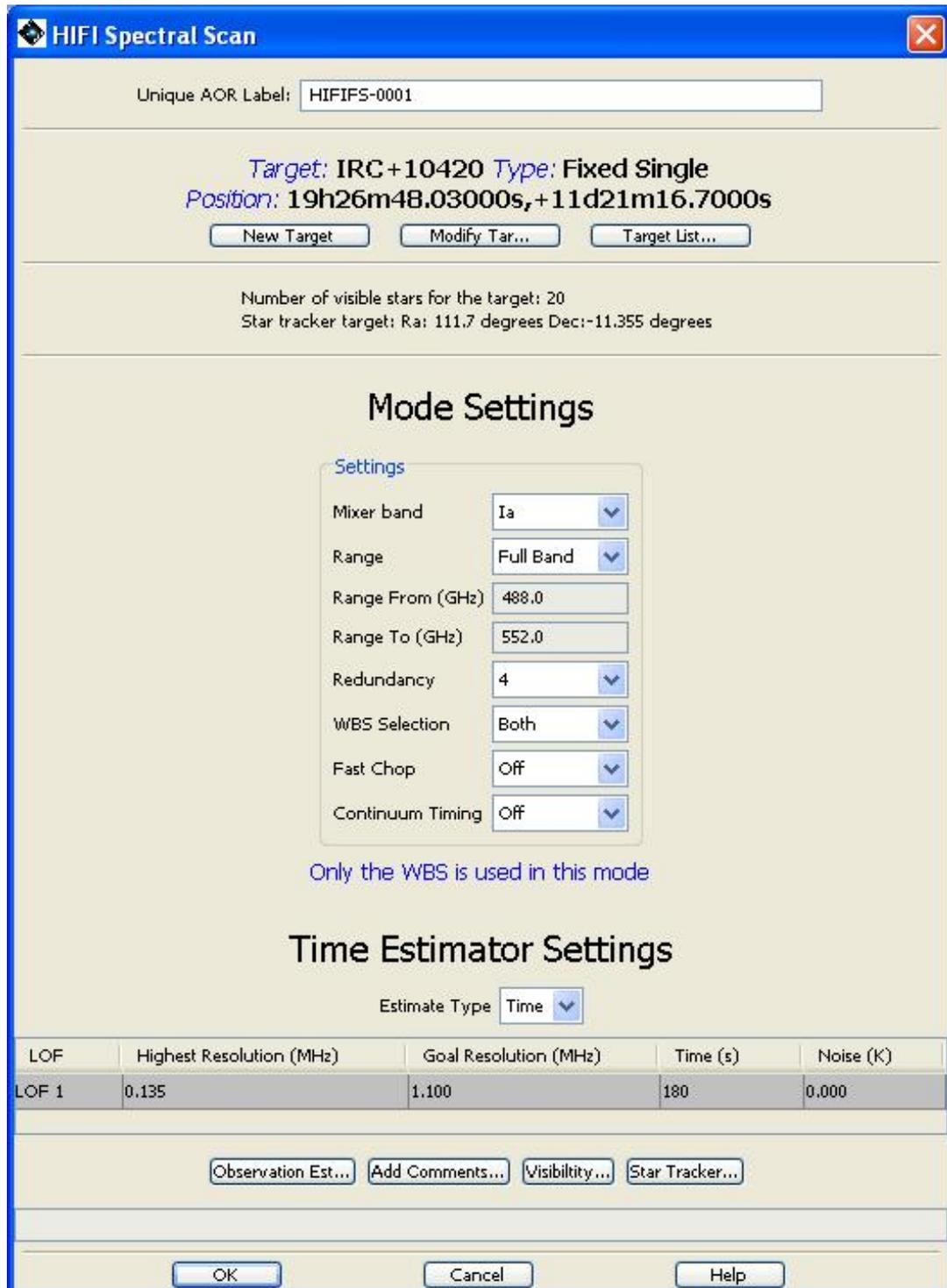
13.4.1. Setting up the Frequency Range

For either mode, the user has the choice of either creating a spectral scan of the whole set of frequencies available in a given mixer band, or just over part of a band. The first pull-down menu allows selection of a particular mixer. The frequency range it covers is shown in the "Range from (GHz)" and "Range to (GHz)" windows.

The frequency range can be reduced by selecting "Partial" rather than "Full" from "Range" pull-down menu (the second one down). Selecting "Partial" allows editing of the "Range from (GHz)" and "Range to (GHz)" boxes so that the appropriate frequency range is covered.

Experiments suggest that scans of less than 20GHz in frequency range are NOT RECOMMENDED. It is recommended that the range of frequencies to be surveyed is larger than this.

13.4.2. Selecting the Redundancy

Since HIFI is a dual sideband instrument, we need to separate out the contributions from two separate spectral ranges in our data. The tools for this are currently being developed (see the HIFI Observers' Manual (http://herschel.esac.esa.int/Docs/HIFI/html/hifi.html for more information). These tools involve a deconvolution of the spectral scan dataset to form a single sideband spectrum where the overlaying parts of the spectrum have been disentangled. In order for such a deconvolution to be accomplished then the 4GHz IF frequency range of HIFI needs to be sampled many times. A redundancy parameter is used to indicate the degree of oversampling of the frequency range. The default value is 4, meaning that 4 spectra are taken for every 4GHz (or 2.4GHz in bands 6 and 7), or approximately one spectrum for every 1GHz of spectrum to be surveyed.

A minimum redundancy of 4 is recommended. A redundancy of 2 is really only useful for cases where the spectrum is known to sparse in terms of the density of lines.

13.4.3. WBS Selection

It is possible to use HSpot to select whether the "best" or both polarizations of the WBS are to be used in the observation.

13.4.4. DBS spectral scan: Fast Chop and Continuum Timing

Since the DBS spectral scan mode uses (as its basis) the Dual Beam Switch capability of HIFI, it is also possible to choose a fast chop mode or a calibration timing suitable for continuum measurements (see Section 13.3.3.3 for details of these options).

To select these hit the "Select the observing mode" button in the Figure 13.24 window and click on the "Dual Beam Switch" tab in the following window. This provides Figure 13.25 window.
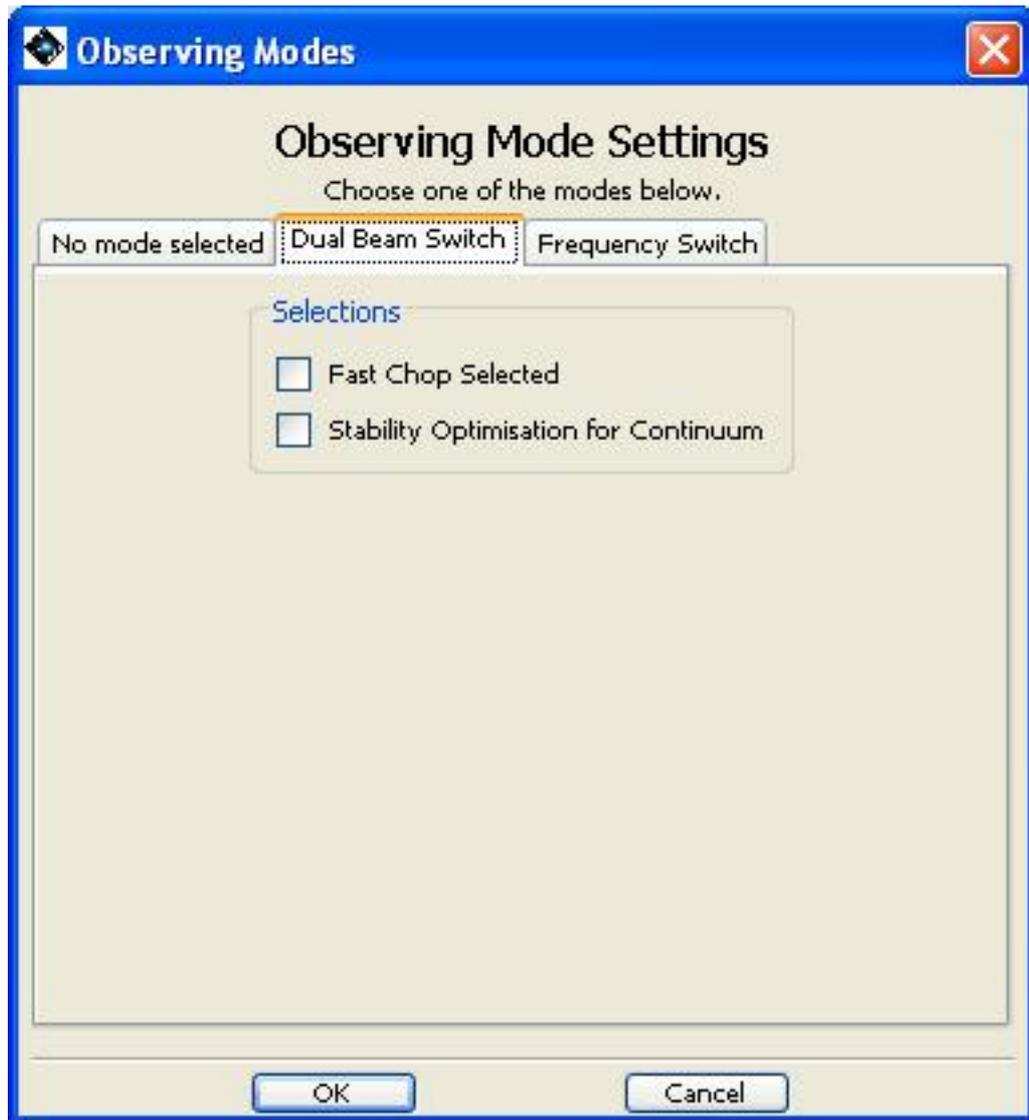
Figure 13.25. HIFI spectral scan with dual beam switch setup window

13.4.5. Frequency switch spectral scan: Frequency throw

As for other frequency switch modes of HIFI, the user has the choice of -240, -120, 120 or 240 MHz frequency throws.

To select the frequency throw, click the "Select the observing mode" button in the Figure 13.24 window and click on the "Frequency Switch" tab in the following window. This provides the Figure 13.26 window.

Figure 13.26. HIFI spectral scan with frequency switch window

An OFF position is also selectable in this window. A choice of offset or absolute positions can be made (see the section called "Identifying a reference position".

13.4.6. Time Estimator Settings For HIFI Spectral Scans

The time estimator for spectral scans works the same way as for the other HIFI modes (see Section 13.2.8). The only difference being that, since the WBS is being used for this mode, the "Goal Resolution Minimum" should be at least 1.1MHz.

Note that during observations it will take time to setup and accumulate data at multiple LO frequencies, so low input user times to the time estimator will lead to the time estimator returning a useable "minimum" time for the scan. For full scans covering a whole band the user can expect at least one hour (at a minimum redundancy of 2) for a minimum time estimate.

It should also be noted that unrealistically low noise goals will inevitably lead to time estimates that are much larger than the 18 hours allowed by the observatory.

Warning

The HIFI time estimator can currently take some time to make a time estimate (occasionally more than one minute). This is particularly for the more complex modes such as spectral scans.

Chapter 14. SPIRE PACS Parallel Mode AOT

14.1. Description

This is a special observing mode that is intended for large area photometric mapping using both PACS and SPIRE simultaneously covering 5 bands, the 3 SPIRE and plus the PACS Red and a choice of PACS blue channel making a total of 5 simultaneous bands that cover the full wavelength range of Herschel. This AOT, along with a cookbook guide with an example observation, is described in the [SPIRE PACS Parallel Mode Observers' Manual](#).

14.2. Details

Selecting "SPIRE PACS Parallel Mode" from the "Observation" menu gives the AOT for photometry with SPIRE and PACS simultaneously. The first step is to define a target, see Section 6.3. On the AOT screen (shown in Figure 14.1) you see "PACS Blue channel filter selection", "Scan Speed" and "Large Map Parameters" boxes along with the button "Observation Estimaties" these are described in the following sections.
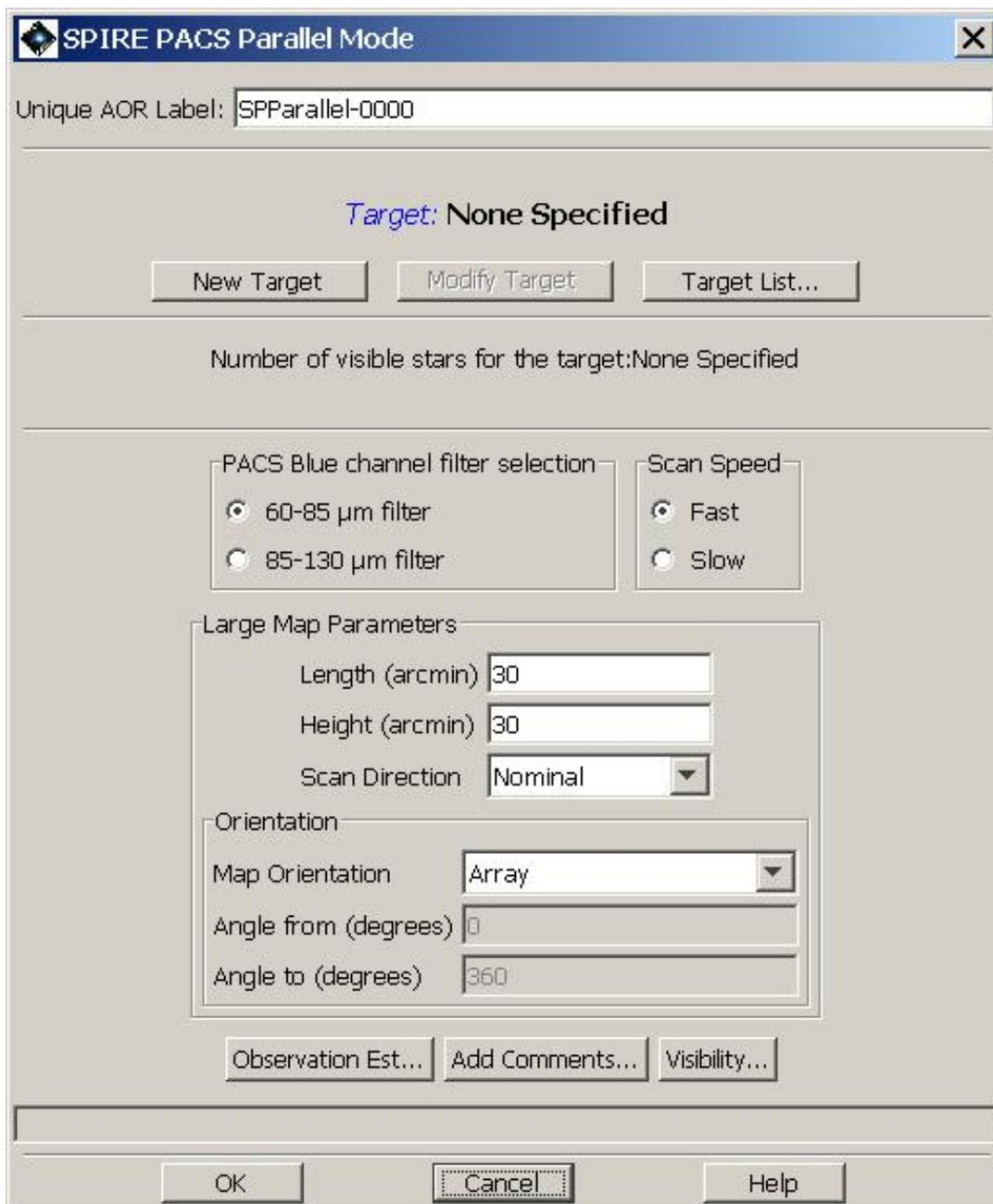
Figure 14.1. The SPIRE PACS Parallel Mode AOT, as it appears on first opening.

14.2.1. PACS Blue channel filter selection

This option allows to select the PACS Blue channel, the choice is from the 60-85 μm or 85-130 μm filter. This AOT automatically produces data from the 3 SPIRE bands and the PACS red channel as well.

14.2.2. Scan Speed

The speed at which the telescope is scanned can be chosen, between fast (60"/s) and slow (20"/s) speeds.

14.2.3. Large Map Parameters

The map is made by scanning the telescope to move the fields of views of SPIRE and PACS over the requested area of sky. Due to the large offset of the fields of views of SPIRE and PACS (21 arcminutes) this mode is extremely inefficient for small maps, as excess area has to be mapped by each instrument so that both instruments will cover the user requested area fully (see the SPIRE PACS Parallel Mode Observers' Manual for details). The size of the area to be mapped, centred on the target coordinates, is entered in the "Length" and "Height" boxes in arcminutes. The "Length" corresponds to the dimension of the map in the scan direction. Note that the actual scan legs made by the telescope will be longer than this to ensure that both SPIRE and PACS cover this area properly. The "Height" option corresponds to the dimension of the map in the cross-scan direction, again this dimension will be increased to ensure proper coverage with both instruments. A choice of scan directions, "Nominal" or "Orthogonal", is available from the "Scan Direction" pulldown menu. For details about this option see the SPIRE PACS Parallel Mode Observers' Manual.

14.2.3.1. Orientation

Like the SPIRE and PACS mapping, the SPIRE PACS Parallel Mode also has the option to constrain the direction of the scan legs. Maps are made at a specific angle (depending on the selection of nominal or orthogonal) to the instrument arrays. The area mapped depends on the day that the observation is scheduled for high ecliptic latitudes, this "Orientation" option can be used to restrict the possibilities by selecting "Array with Sky Constraint" and specifying a range of angles. This equates to a period within which the observation can be scheduled hence the following warning is given with the option Array with Sky Constraint is selected:

> **Warning**
> "Specifying the map orientation constraint places restrictions on when the observation can be scheduled. The observatory overhead for this observation will be 600s. These constraints might reduce the chance that your observation will be carried out, especially targets at low ecliptic latitudes could be inaccessible for certain chopper or map angles. Are you sure that this constraint is essential? (You may check your observation's footprint orientations by clicking in the HSpot menu: Overlays -> AORs on current image... see the Observers' Manual for examples)."

Once the warning has been understood and dismissed by pressing OK, the "Angle From" and "Angle To" values, between which the "Length" dimension of the map should lay, can be given in degrees east of north can be entered to a precision of one degree. To have the "Length" dimension lie in approximately the north-south direction one should remember to enter a number lower than 360 in the "From" box and one greater than 0 in the "To" box. See the SPIRE PACS Parallel Mode Observers' Manual for a worked example.

14.2.4. Observation Time Estimation

On pressing the "Observation Est..." button the duration of the observation is estimated (calculated) and a pop-up displays the results (see Figure 14.2 for the resulting screen for a Fast Scan Speed map of 120 by 120 arcminute.
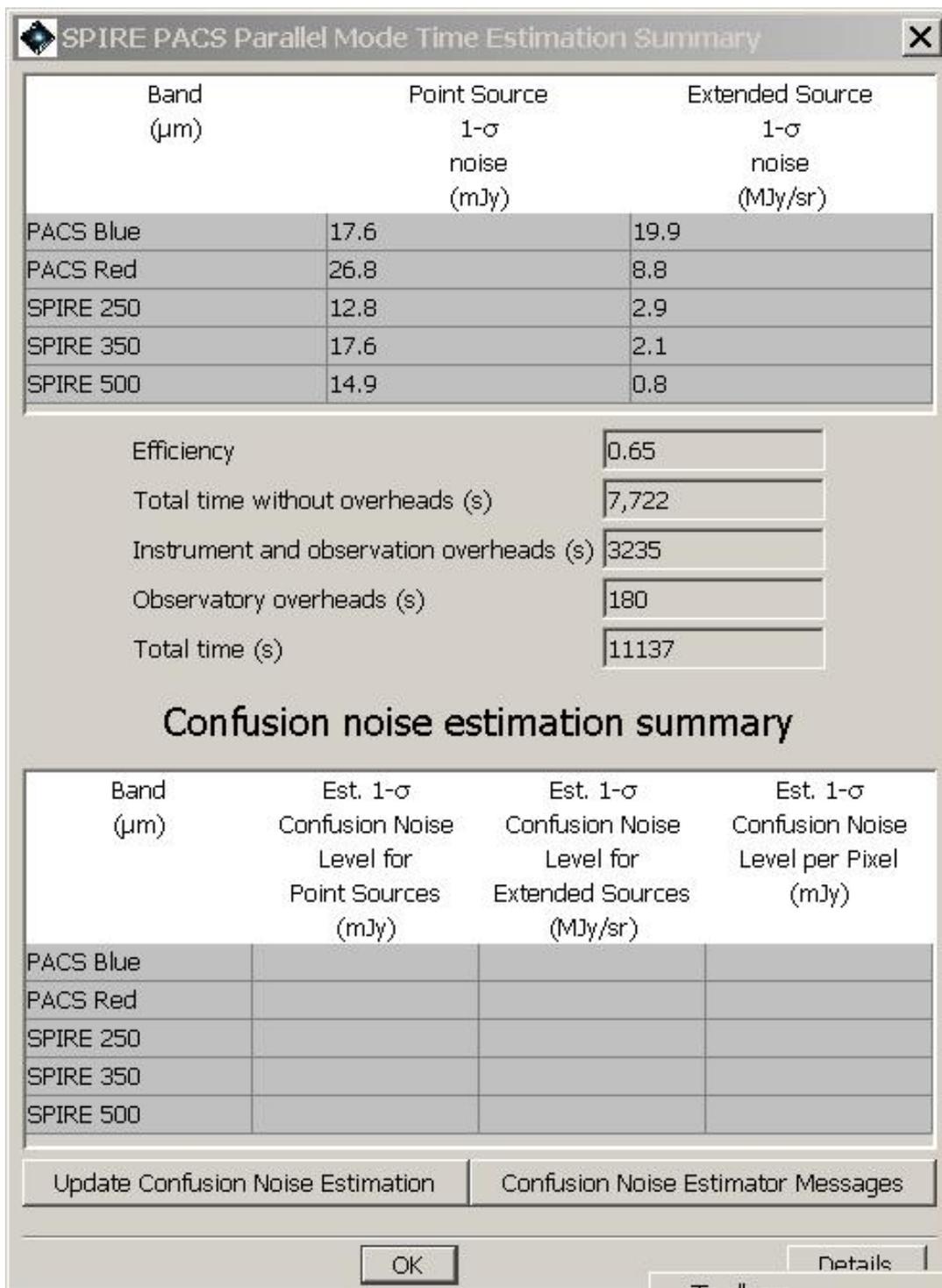
Figure 14.2. Large Map time estimation for a 120 by 120 arcminute map with Fast Scan Speed selected

The Observation Time Estimation returns the point source 1-sigma noise (mJy) and the extended source 1-sigma noise (MJy/sr) of the observation for each wavelength band.

Next, the break down into observing time and overheads is displayed:

- Efficiency: this is the ratio of the user requested area to the total area map by SPIRE, it is an indication of the how much extra area is needed to map the user area with both instrument.

- Total time without overheads (s): This is the time taken to map the total area covered by the observation. It does not include instrument and observations overheads which are accounted for in the next entry.

- Instrument and observation overheads (s): the calibration time and dead time associated with the observation (such as instrument set up time and telescope turn around time).

- Observatory overheads (s): the slew overhead implicit in every observation.

- Total time (s): the sum of the above time contributions.

14.2.4.1. Time Estimation Details Button

The "Details" button at the button of the window pops up a window with details messages about the AOR. To display one or more message levels select the relevant box(es). Message level 1 gives indicates how the observation is built up. Message level 3 gives parameters of the observation such as the angle at which the array is scanned (patt), the distance between scan leg centres (d2, in arcseconds), the "required scan length" in arcseconds (increased from your input to get as even coverage as possible over requested area), and the "required number of scan lines in map" needed to cover the area.

14.2.4.2. Confusion Noise Estimation Summary

The breakdown of calculated confusion noise is given in a table at the bottom of the "SPIRE PACS Parallel Mode Time Estimation Summary" screen (see Figure 14.2). It indicates the confusion noise specific for the AOR configuration (see the Herschel Confusion Noise Estimator Science Implementation Document for details). When the window pops up this table is empty, in order to get a confusion noise estimation the "Update confusion noise estimates" button has to be pushed.

Chapter 15. Tools for Replicating AORs

In order to use the same observing setup for each target individually, the user is supplied with replication capabilities that allow the same AOR to be applied to a number of targets.

15.1. AOR Replication Tool

The AOR Replication Tool allows HSpot to create a number of AORs automatically by merging a 'template' AOR and a list of targets. For every target in your selected group, an AOR will be created with the template parameters.

To use the AOR Replication Tool:

1. First create the template AOR. Click on this AOR in the AOR table to make it the current one. It will be highlighted with a blue colour to show that it is selected. All the AORs created with the AOR Replication Tool will have the AOT parameters specified in this AOR.

2. Select the "AOR Replication Tool" from the Tools menu.

3. Select the targets you wish to have merged with this template.

    You may do this in one of three ways:

    •   Open the current Target List from the "Targets" menu, the "Target List" icon, or the "Target List" button in the "AOR Replication Tool" dialogue. You may then drag-and-drop targets from the target list into the "AOR Replication Tool" window as shown in Figure 15.1.
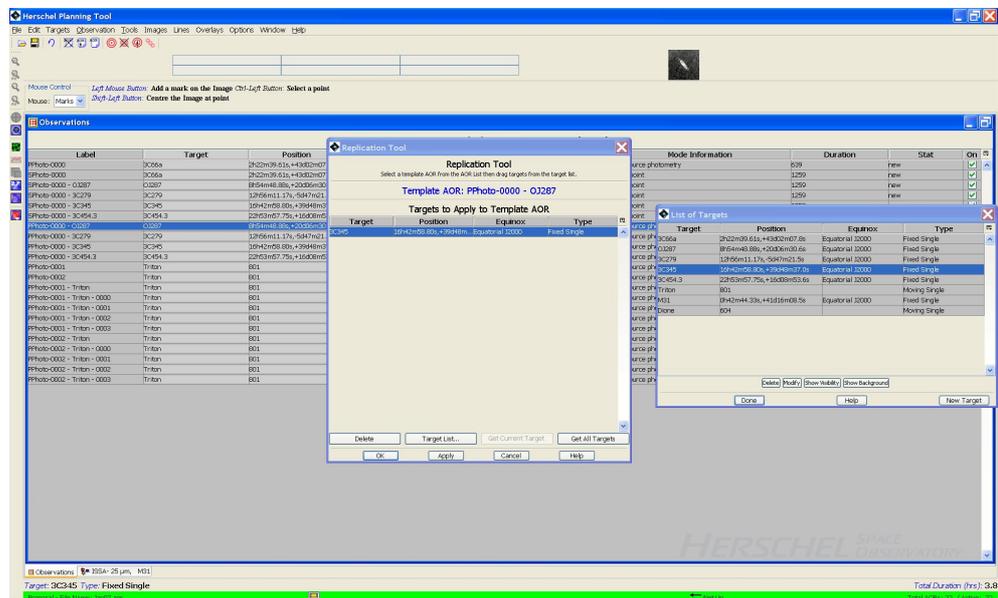
Figure 15.1. An example of replicating an AOR. A PACS photometry AOR has been selected, highlighting it in blue in the observations table. Target 3C345 is then selected from the Target List and dragged and dropped into the Replication Tool window.

    •   You can select all of the targets in the Target List with the "Get All Targets" button from the "AOR Replication Tool" window. Note that this replicates the AOR for ALL targets, including your template AOR so that this target will be duplicated in the final list of AORs

and should be deleted to avoid a duplicate pointing.

- You can select the current target in the Target List with the "Get Current" button from the "AOR Replication Tool" window.

4. If you click "Apply" or "OK", the new AORs will be created. "Apply" leaves the dialogue window open so that you can continue editing and do more replications. "OK" creates the AORs and closes the dialogue.

> **Note**
>
> If you click "Apply" and create your AORs and then click "OK", HSpot will be asking if you want to create the duplicates AGAIN. To create just one set of duplicated AORs, use "OK" when you are ready to duplicate them, or click "Apply" followed by "Cancel" when you are finished.

15.2. Target Replication Tool

The Target Replication Tool allows HSpot to create a number of AORs automatically by merging a set of AORs with a list of targets. It creates an AOR, with the selected target, for each AOR in the set. In other words, if you want to apply a set of 5 AORs to each source a target list of 20 objects, you do it with this tool.

To use the Target Replication Tool:

1. Enter your targets into HSpot and open the target list.

2. Create the set of AORs that you want for one of the targets.

3. Select a new target from the target list.

4. Select the "Target Replication Tool" from the "Tools" menu as shown in Figure 15.2.
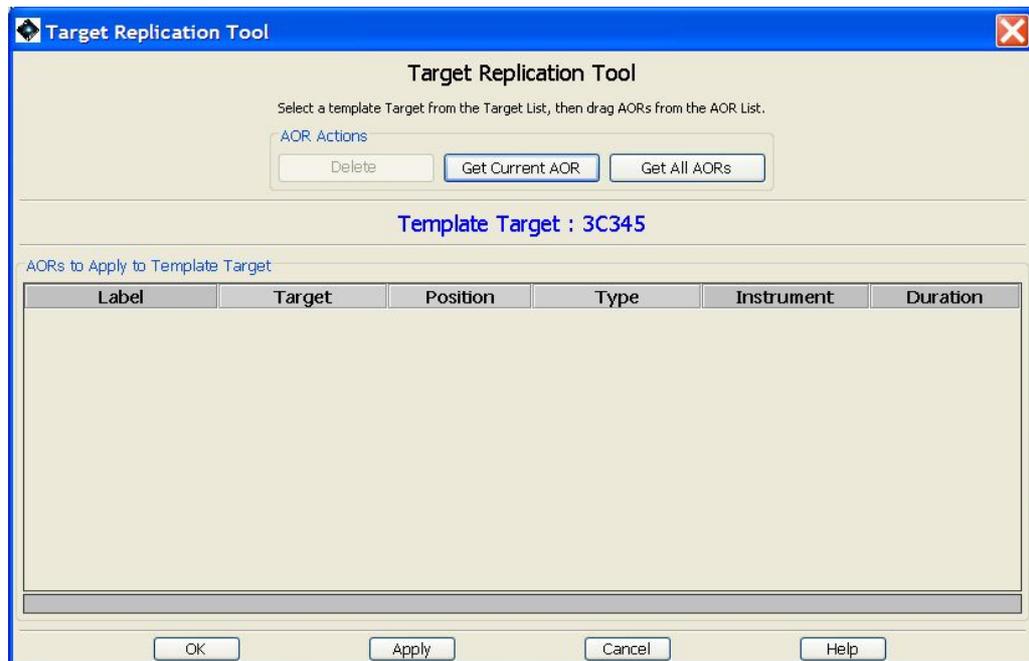

Figure 15.2. An example of replicating a target. Target 3C345 is selected from the Target List and the AORs that we wish to apply to this target are then dragged and dropped into the Replication Tool window.

5. Drag the AORs that you want replicated into the window. By clicking and dragging on the AOR(s) you may change the current target to be what it is in the template AOR. This is easy to work around.

    After you have dragged all the desired AORs into the replication window, open the target list (under "Targets" or click the "Target" button) and select the target you want.

    It should appear in the "Template Target" field in the replication window (in blue) as shown in Figure 15.3.
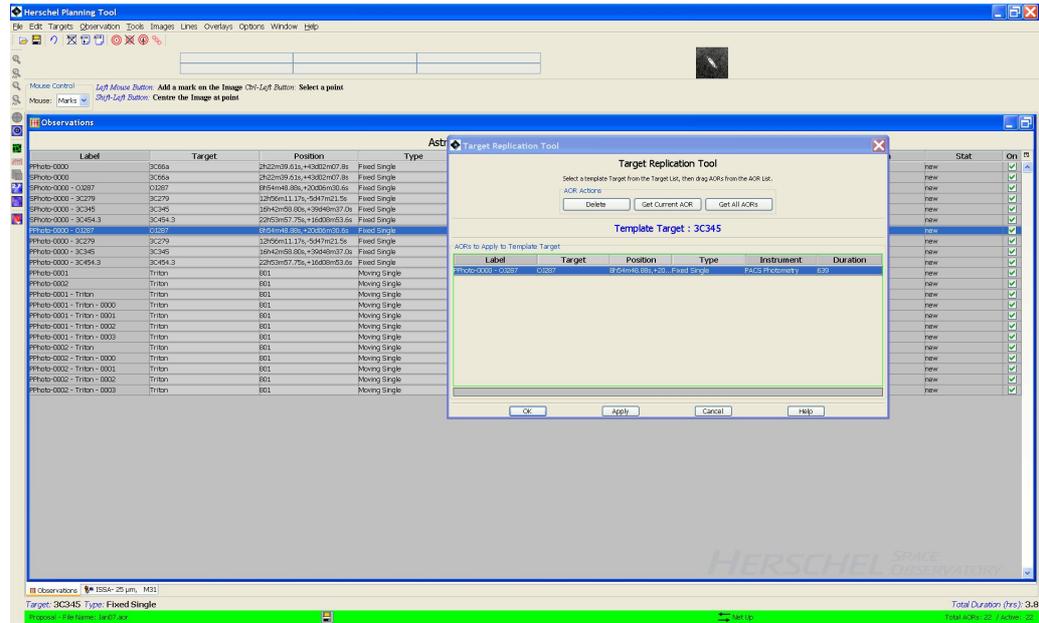

Figure 15.3. An example of replicating a target. Target 3C345 is selected from the Target List and the AORs that we wish to apply to this target are then dragged and dropped into the Replication Tool window.

    Click Apply.

6. Continue this process until you have created all of the AORs that want with this tool.

Chapter 16. Timing Constraints Editing

16.1. Description

HSpot allows you to create TIMING and GROUPING constraints by selecting "Timing Constraints" or "Group/Follow-on Constraints" from the "Tools" menu. When you save your AORs, each timing constraint will be saved with the appropriate AOR and the grouping constraints will be written out at the end of the AOR file. All constraints must be scientifically justified in your proposal for telescope time. It is recommended that you complete all of your AORs before adding Grouping or Follow-on constraints that link them. This will lower the probability of your constraints becoming invalid due to changes made to the AORs included in the constraints.

> **Warning**
> Constraints add a hidden overhead to the observatory planning system by making observations planning less efficient. All constrained observations will thus be penalised with a 600s "slew" overhead rather than the standard 180s.

16.2. Timing Constraints

To enter a timing constraint, select an AOR from the AOR table and then select "Timing Constraints" from the "Tools" menu. The dialogue shown in Figure 16.1 will appear. HSpot will connect to the HSC servers and obtain the visibility information for the observation prior to you being able to set any Timing Constraints. If you are not connected to the Internet, HSpot will warn you about this, but will still allow you to add timing constraints to your AORs. Check the visibility windows for your observations and then enter the start and end dates/times that define the window(s) when your observation should be made. HSpot will not let you set timing constraints that are completely outside a visibility window (if connected to Internet). If you set timing constraints "offline" be sure to check that the timing constraints fit within a visibility window before you submit such AORs to the HSC. All times should be entered as Universal Time (UT). The AOR will start within the given timing window.
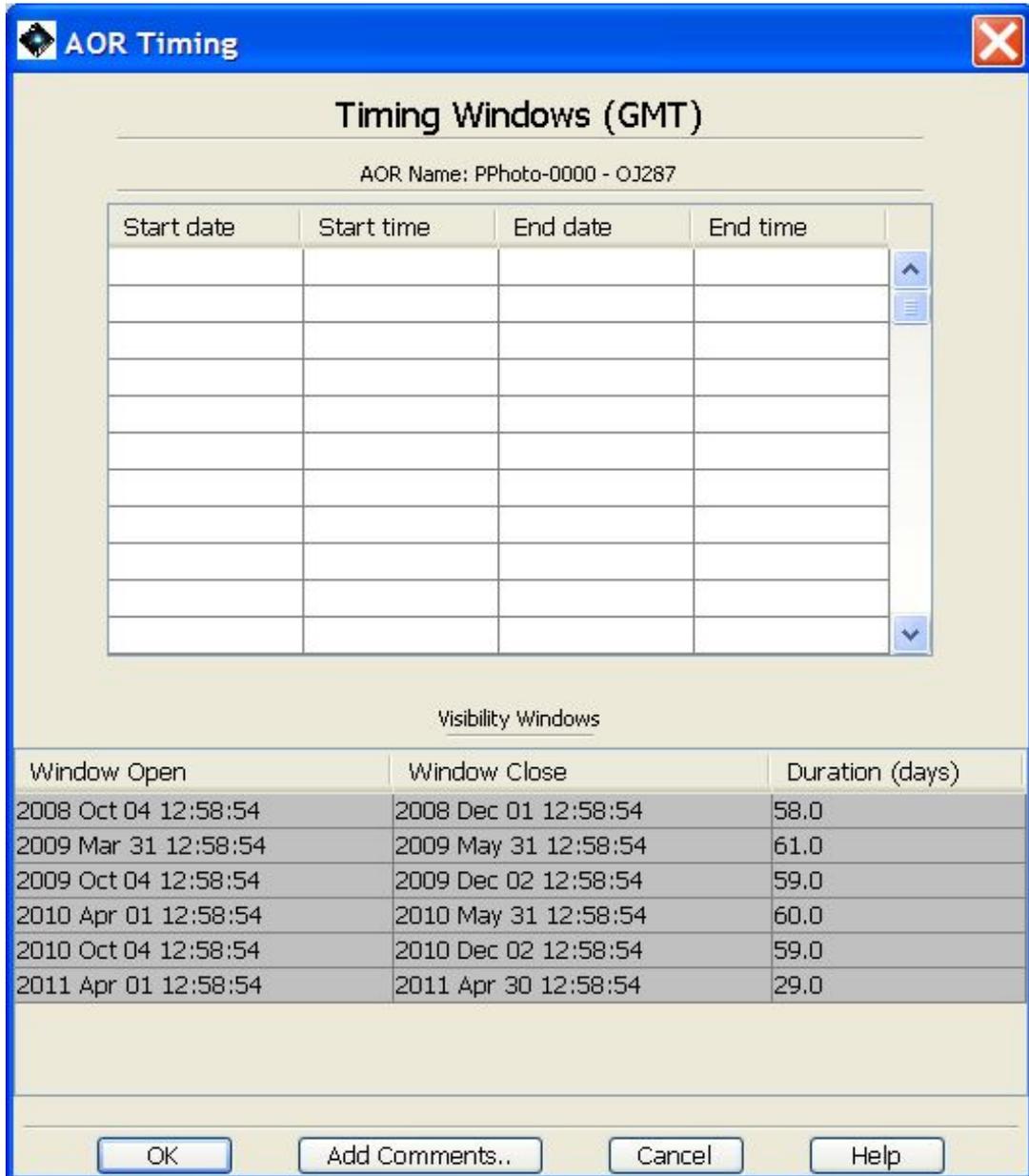
Figure 16.1. The Timing Windows dialogue allows entry of multiple timing constraints for an AOR. HSpot checks the visibility of the observation before you can set any timing constraints.

You can also use this dialogue to create ABSOLUTE TIME, BEFORE or AFTER constraints. For absolute time observations, enter the same date and time for both the start and end fields.

For a BEFORE constraint, enter the nominal Herschel launch date for the start date/time and the date/time before which the observations should be done as the end time.

For an AFTER constraint, enter the first date/time the observation should be done as the start time, and some distant date in the future for the end time. Some examples are shown in Table 16.1.

Table 16.1. Examples of timing constraints that can be specified in the timing window.

Start_Date: 2009 Dec 6	Absolute Time: 14:12:35
Before Dec 1, 2009: 2009 Aug 23 00:00:00	After June 3, 2009: 2009 Jun 3

When specifying an ABSOLUTE TIME constraint for fixed targets, the AOR will start executing within a few seconds of the specified time. This does not mean that the first exposure will start at this time but the main AOR commanding will begin executing. For moving targets, the tracking will start within 3 seconds of the specified time. When you have finished entering constraints, if you click "OK" or "Apply", the "T" flag will be turned on in the main AOR table for this AOR. This is shown in Figure 16.2. Clicking "OK" closes the Timing Window while clicking "Apply" leaves it open.

Figure 16.2. When a timing constraint has been added to an AOR, the "T" flag will be turned on in the main AOR table.

You may also access the "Timing Window" from the "Group/Follow-on Constraints" dialogue by clicking the "Add Timing" button. Grouping and Follow-on constraints are discussed in the next section.

16.3. Grouping/Follow-on Constraints

16.3.1. Description

You may create 3 types of grouping constraints: "Sequence", "Chain", and "Group Within" using the "Group/Follow-on Constraints" tool available under the "Tools" menu of HSpot (Figure 16.3).

- **Chain:** An ordered, non-interruptible group. The AORs will be executed in the order specified with NO interruptions in the chain. If you chain together AORs, you must ensure that the chain does not exceed the maximum allowable duration for a single AOR (18 hours). HSpot will warn you if your chain is too long. It will show you the total time in the chain in the "Constraints" window.

- **Group Within:** A group of AORs executed within a specific length of time, but with no particular starting date/time constraint. Once the first AOR has been executed, the rest of the AORs in the group will begin within the specified time interval. They may be executed in any order within the time interval.

- **Sequence:** An ordered, interruptible group. The AORs will be executed in the order specified and a duration in which they should be completed is specified. The sequence constraint should only be used when the science requires sequential ordering of the AORs.

You may also create a constraint that requires an AOR to be executed at a specified time, or specified interval after another AOR, but a specific timing window is not required. This is called a "Follow-on constraint".

- **Follow-on:** Execute the "follow-on" AOR within a specified time range after a particular AOR has been executed. An example of a follow-on constraint is discussed in Section 16.3.3.

- **Shadow:** Execute the shadow AORs within a specified time range before/after the primary AOR has been executed. This is special case of a follow-on constraint for moving targets.

> **Warning**
> This option has not been implemented yet as of the Announcement of Opportunity in February 2007. If you require information about this option, send a message to the Helpdesk ([ht-

tp://herschel.esac.esa.int/esupport/).

16.3.2. Caveats for Grouping Constraints

We have built several checks into HSpot to prevent the creation of grouping constraints that are impossible to schedule. If you have questions about constraints, please see the **Herschel Observatory Manual** and **Herschel Policy and Proceedures** documents for more information. If you are still in doubt, send a message to the Helpdesk (http://herschel.esac.esa.int/esupport/). Three guidelines for groups that are not allowed are:

1. Herschel operates only one instrument at a time and it takes a finite amount of time to switch from one instrument to another. HSpot will prevent you from chaining AORs from different instruments.

   -- PACS spectrometer and PACS photometer are counted as different instruments and will never be scheduled on the same day.

   -- Idem for SPIRE spectrometer and SPIRE photometer.

   -- PACS line spectroscopy and range spectroscopy CAN be grouped in a single chain.

   -- Only one HIFI band will be scheduled on any observing day. Observations with different HIFI bands cannot be concatenated.

   -- Fixed and moving targets cannot be mixed in a single chain.

2. The maximum allowable duration for a non-interruptible group (chain) of AORs is 18 hours. HSpot will show you the total duration in your chained AORs. Be sure you have calculated a time estimate for all the AORs in the chain.

3. If you create a "Group Within" constraint, check that the sum of the AOR durations in the constraint does not exceed the time period specified in the constraint. HSpot will warn you if it does.

16.3.3. Creating New Grouping and Follow-on Constraints

To create a new constraint, select "Group/Follow-on Constraints" from the "Tools" menu. This opens the "Constraint Editor Tool" dialogue shown in Figure 16.3. To add a new grouping constraint, you click on the "Add Sequencing", "Add Chaining", "Add Group-Within", or "Add Follow On".

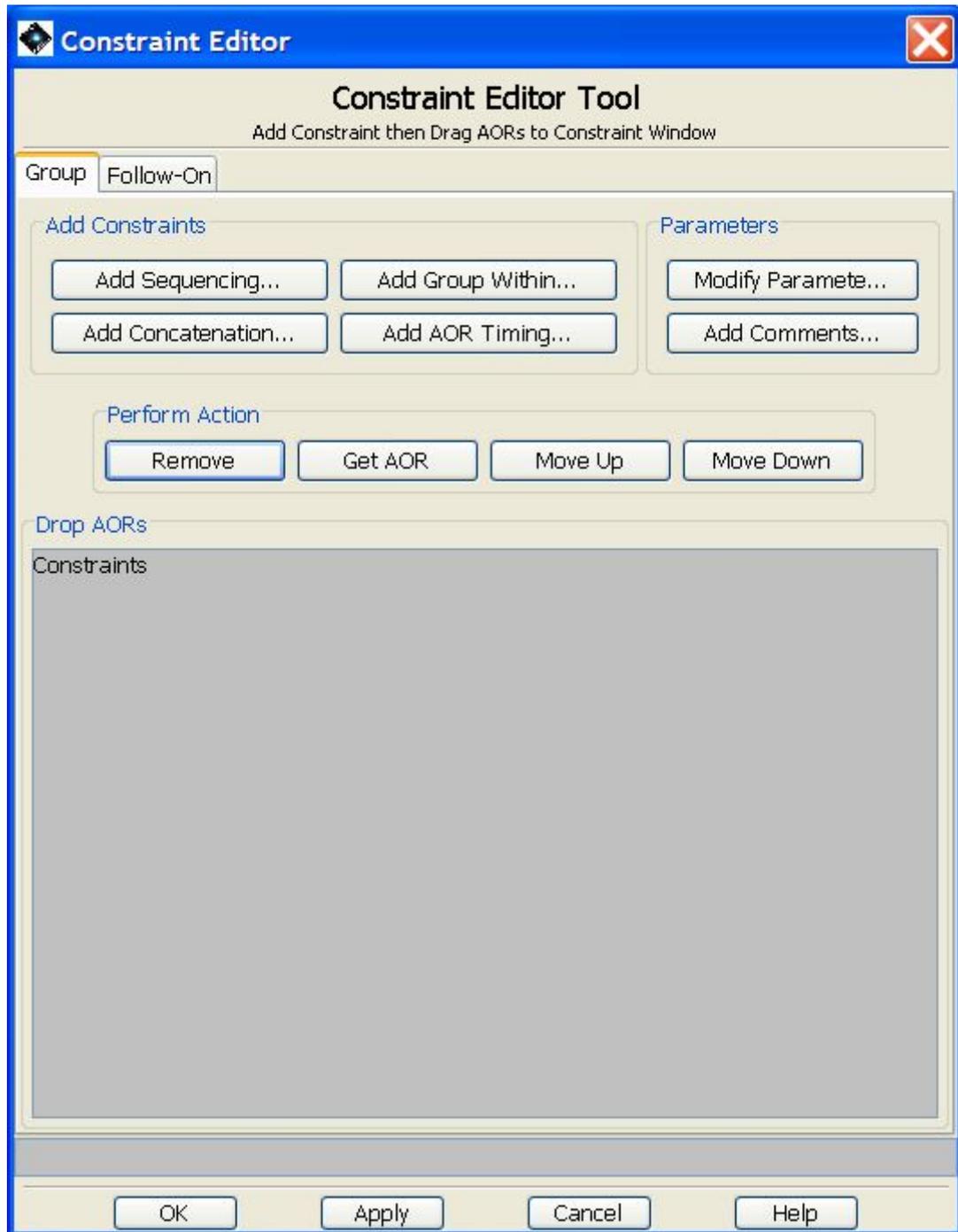**Figure 16.3. The Constraint Editor dialogue is the tool used to add grouping and follow-on constraints.**

16.3.3.1. Grouping and chaining

If you choose to add a new Sequence constraint, HSpot opens the dialogue shown in Figure 16.4 with the default name "Sequence-0000". Enter the time period in which the AORs in the sequence must be completed. You may also change the constraint name in this dialogue.
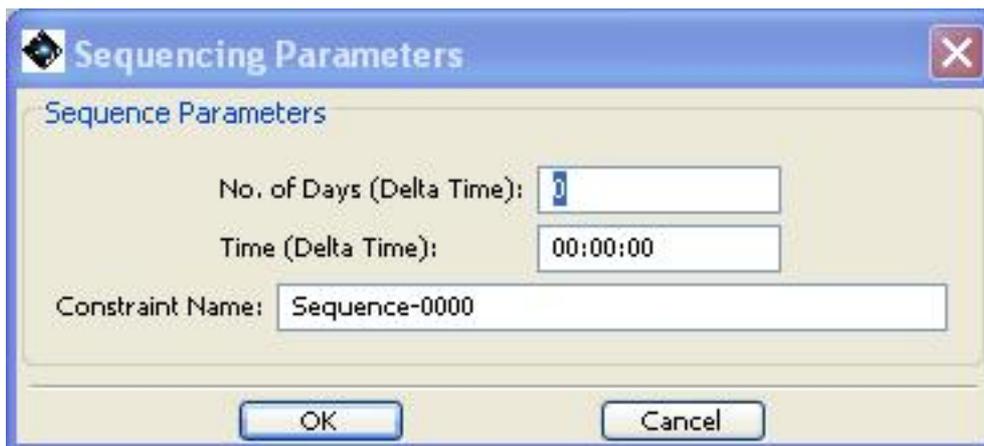
Figure 16.4. The dialogue for creating a Sequence constraint, an ordered interruptible group. This is opened from the Add Sequencing button in the constraint editor dialogue.

HSpot uses the name for each constraint to identify it and lists the constraints by name when you write out your AOR file. If you selected "Chain" (concatenation) or "Group-Within" constraints instead of "Sequence", HSpot will open the dialogues shown in Figure 16.5 and Figure 16.6, respectively. When you click "OK", HSpot adds the newly created constraint to the "Constraint Editor Tool" dialogue, shown in Figure 16.7. If you close the Constraint Editor Tool without linking any AORs to the constraints, HSpot will not save the constraints in memory.

Note

Permitted chainings:

HSpot will only allow AORs that are of the same object, using the same instrument and same AOT to be chained. So, you may chain PACS observations using the 60-85 and the 85-130 micron filters. You may also chain PACS line spectroscopy and range spectroscopy, or a SPIRE photometry map with SPIRE point-source photometry. You may not chain PACS photometry with SPIRE photometry, or SPIRE spectroscopy with HIFI spectroscopy.

To this end, HIFI observations in different bands are counted as different AOTs and are not permitted in chains.
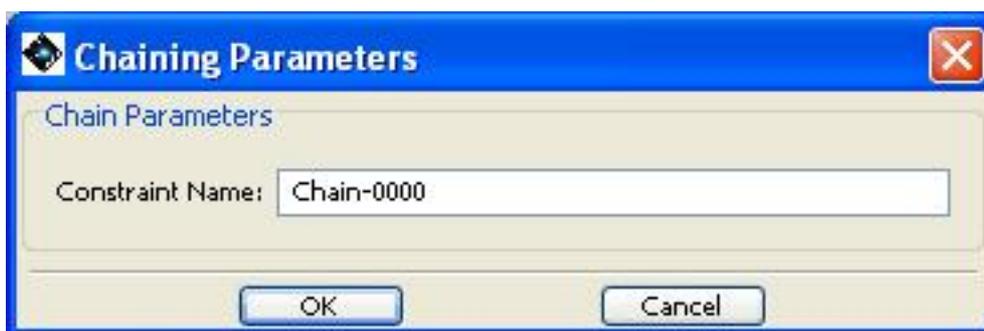

Figure 16.5. The dialogue for creating a "Chain" constraint (concatenation of observations), an ordered non-interruptible group.

Figure 16.6. The dialogue for creating a "Group Within" constraint is opened from the constraint editor dialogue by clicking the Add Group Within button.

16.3.3.2. Linking AORs to a Grouping Constraint

After creating the Sequence, Chain, or Group Within constraint, you are ready to specify which AORs are included in this constraint. There are two methods for doing this:

1. Drag-and-drop: Click on the desired AOR in the main AOR table and keep the mouse button pressed, drag your cursor to the appropriate constraint name in the constraints dialogue, and release the cursor to add the AOR to the constraint. Repeat this process to add additional AORs.

2. Get AOR button: First click on the constraint to which you want to add AORs. Next, in the AOR table, click on the AOR you want to link to the constraint. Then click the "Get AOR" button in the "Perform Actions" section of the constraints dialogue (see Figure 16.8) to add the AOR to the constraint. Repeat the process to link additional AORs to the constraint.
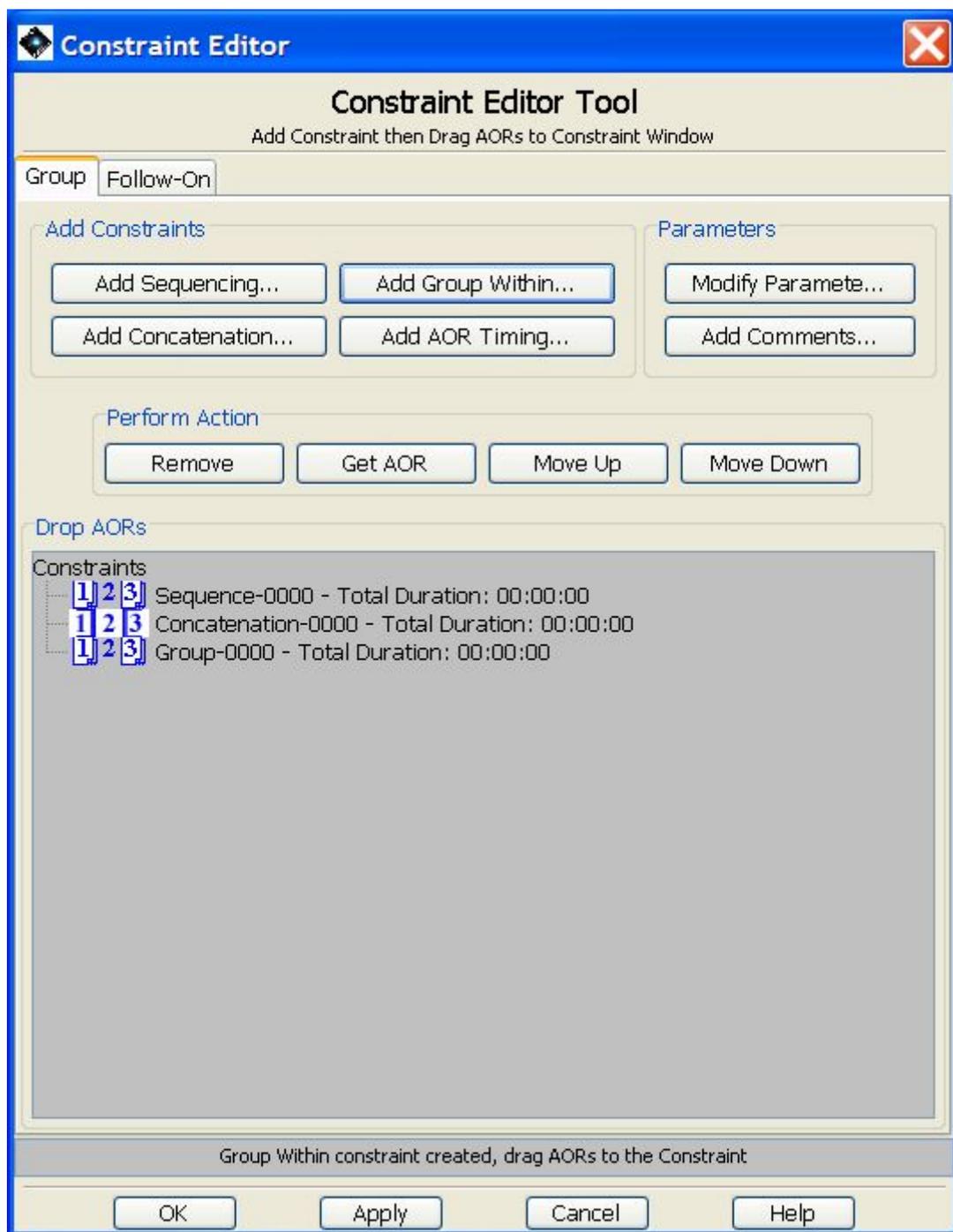
Figure 16.7. The constraint editor dialogue with 3 new constraints added. No AORs have been linked to these constraints yet.
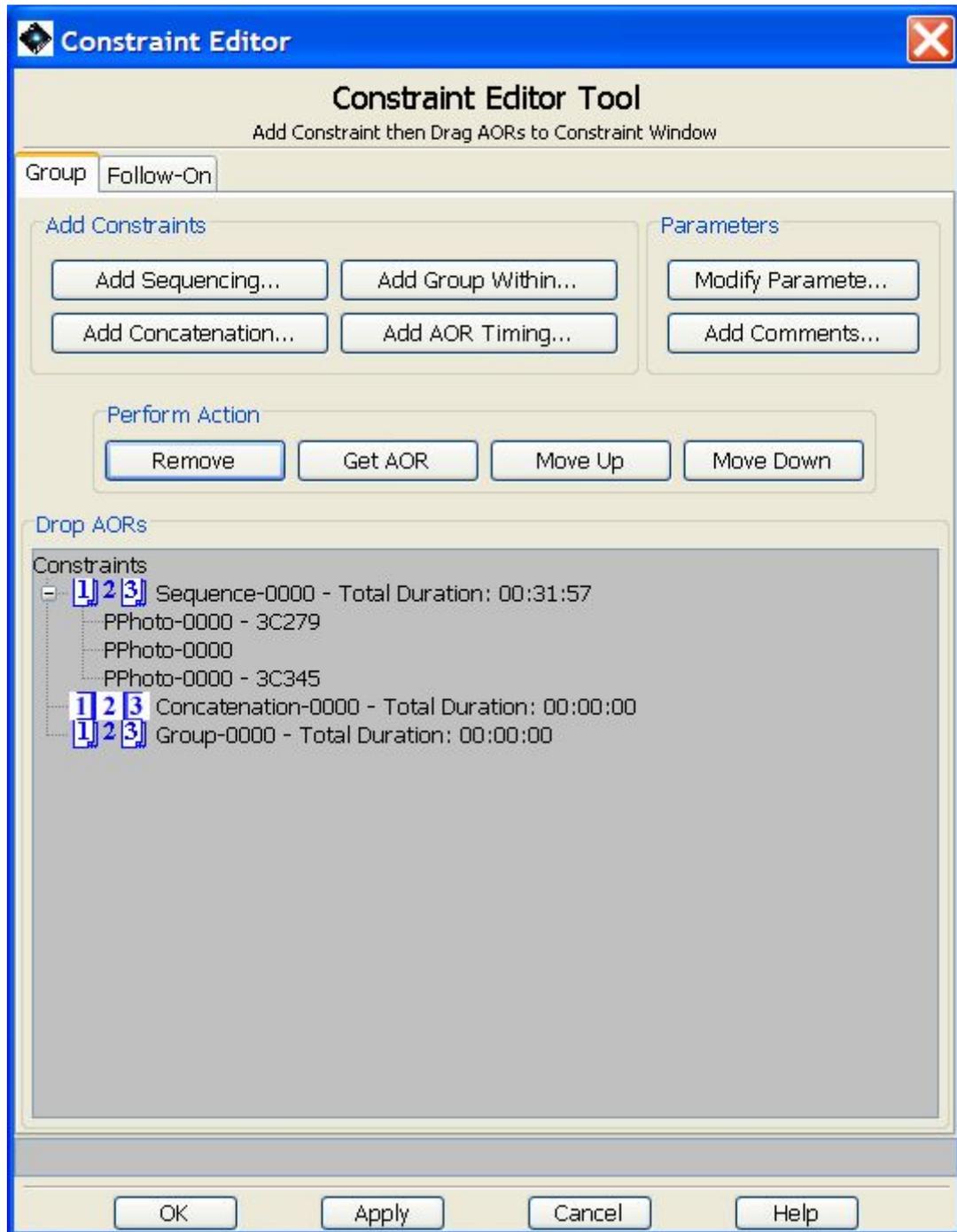
Figure 16.8. After linking four AORs to the Sequence-0000 constraint, the constraint editor will look like this. You can manipulate the order of the AORs by selecting one and using the "Perform Action" buttons to remove the AOR, or to move it up or down in the order.

After linking four AORs to the Sequence-0000 constraint the constraint dialogue will look like Figure 16.8.

After clicking "OK", the constraint appears in the observations listing on the right side of the screen. A checked box appears next on the AOR line under the column headed "G" (for a Group constraint -- see Figure 16.9).

Figure 16.9. AOR listing in the observations table showing the ticked grouping checkbox in the "G" column for AORs in our group constraint.

16.3.3.3. Follow-On observations

Follow-On observations allow a target to be monitored over a period of time, for example, once a week during an observing window, or once each observing window throughout the mission. The interval between observations can be fixed (a severe constraint on telescope scheduling), or flexible (strongly recommended). The example below shows you how to define a series of AORs that are both chained and spaced as Follow-On.

In this example, a series of PACS photometry AORs of Neptune's satellite Triton have been defined. As PACS has three bands, only two of which can be observed simultaneously, two AORs are defined to allow all three bands to be observed (PPhoto-0001 and PPhoto-0002) which are each then replicated five times to give a series of 6 observations of each AOR (Figure 16.10). On each occasion we wish to chain the observations in the two bands to defined 6 individual observations and then make these 6 observations over the course of a single observing window.

Figure 16.10. Two PACS photometry AORs to observe the 60-85 and 85-130 micron windows are defined (PPhoto-0001 and PPhoto-0002). These are then replicated to give a total of six observations of each AOR which we wish to spread out over a visibility window.

These observations are first chained and then the Follow-On defined. Note that the "T", "G" and "F"

columns are initially blank as no constraint has yet been added.

Go to the "Group/Follow-on Constraints..." option of the "Tools" menu. Select the "Group" tab and then "Add Concatanation..." as shown in Figure 16.11.
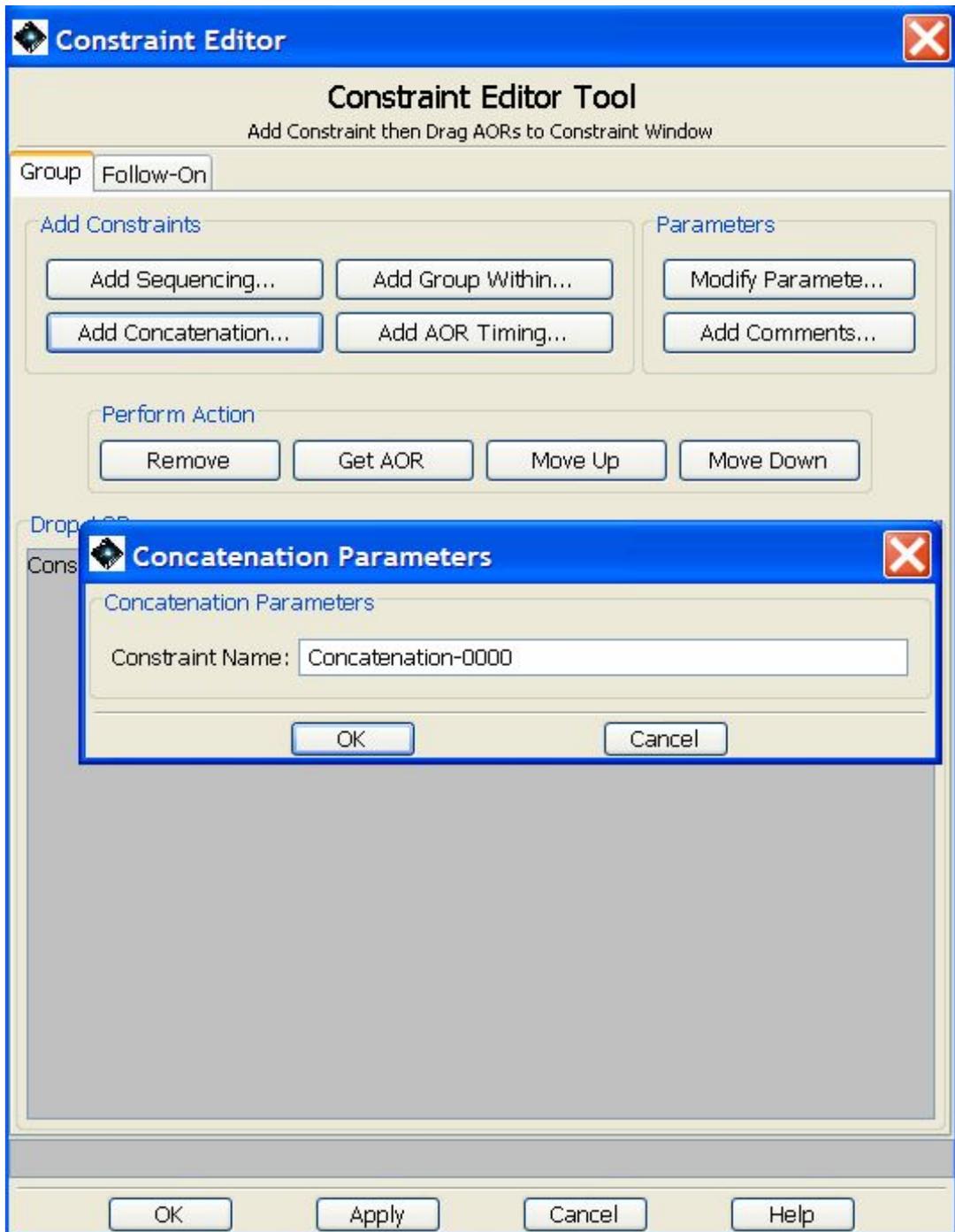
Figure 16.11. The Constraint Editor Tool is then opened and "add Concatanation..." is selected.

HSpot will open the concatenation with a default name as shown in Figure 16.12. Unless you have a particular reason to change the name, accept the default. You should now select the AORs that you wish to chain and drag them across, one by one.
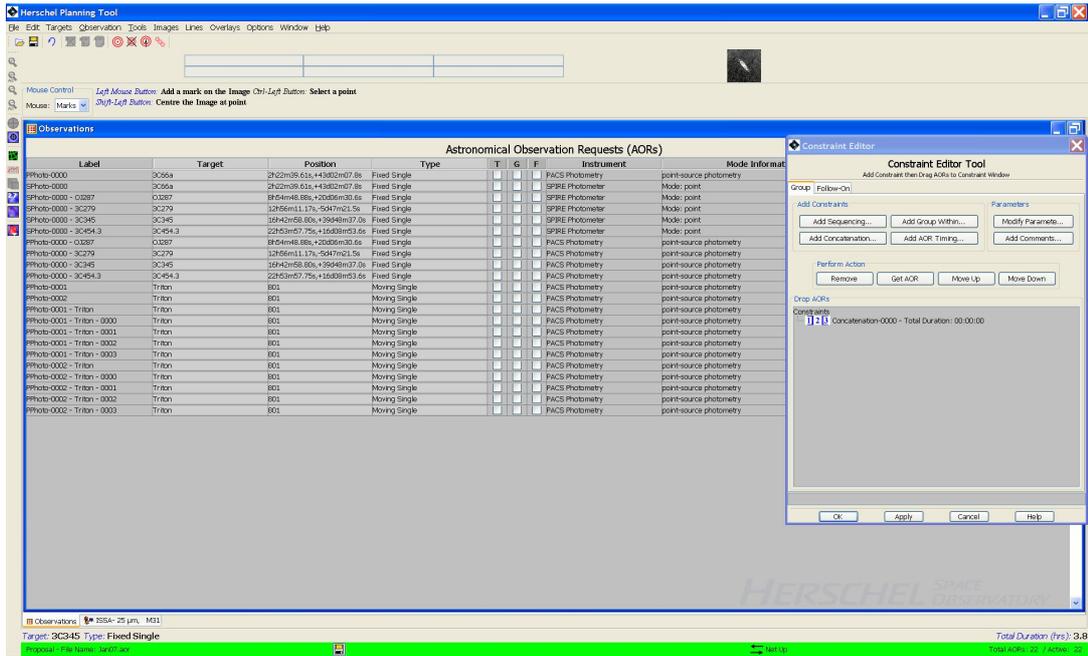
Figure 16.12. The Constraint Editor Tool open to receive AORs that are dragged across to define a concatenation.

When both AORs have been dragged across and added, close the chain and start a new one by selecting "Add Concatenation..." again. HSpot will increase the concatenation number sequentially. Accept the new name and drag across the next two AORs to define the second chain, as shown in Figure 16.13.
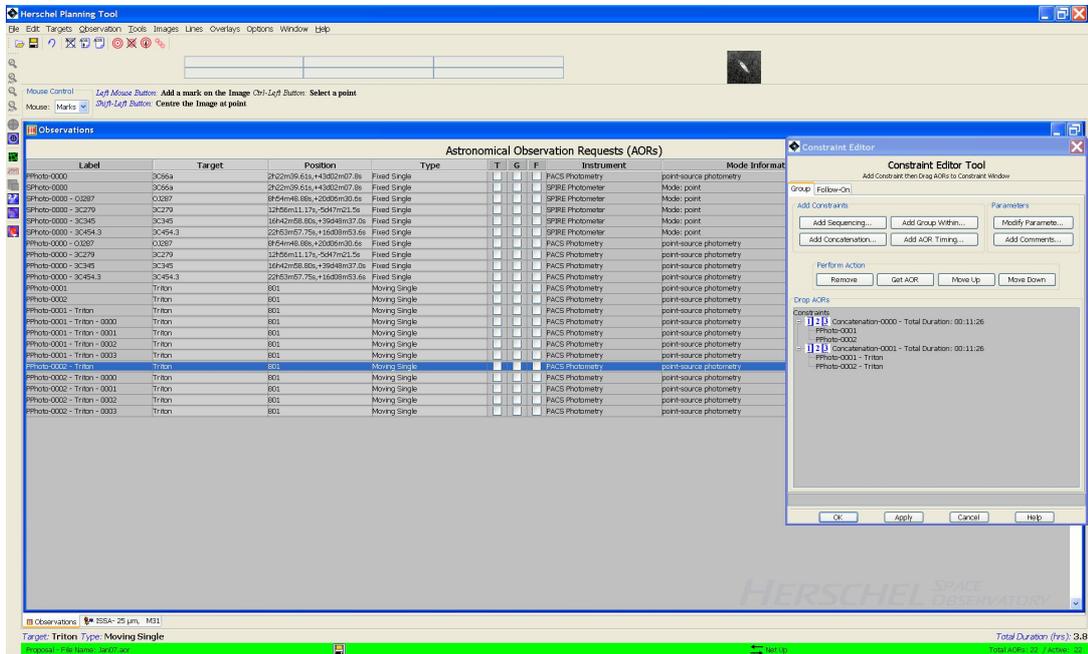
Figure 16.13. The Constraint Editor Tool open to receive AORs that are dragged across to define a concatenation.

Continue creating concatenations and dragging the AORs across until all the chains have been defined, as shown in Figure 16.14. Now press "Apply" for HSpot to add these concatenations to the

AORs that you have defined. If you make a mistake, you can highlight an AOR or chain in the Constraint Editor Tool window and press "Remove" to erase it. Other buttons allow you to change the sequence of observations, if required. Press "OK" to close the Constraint Editor Tool window.
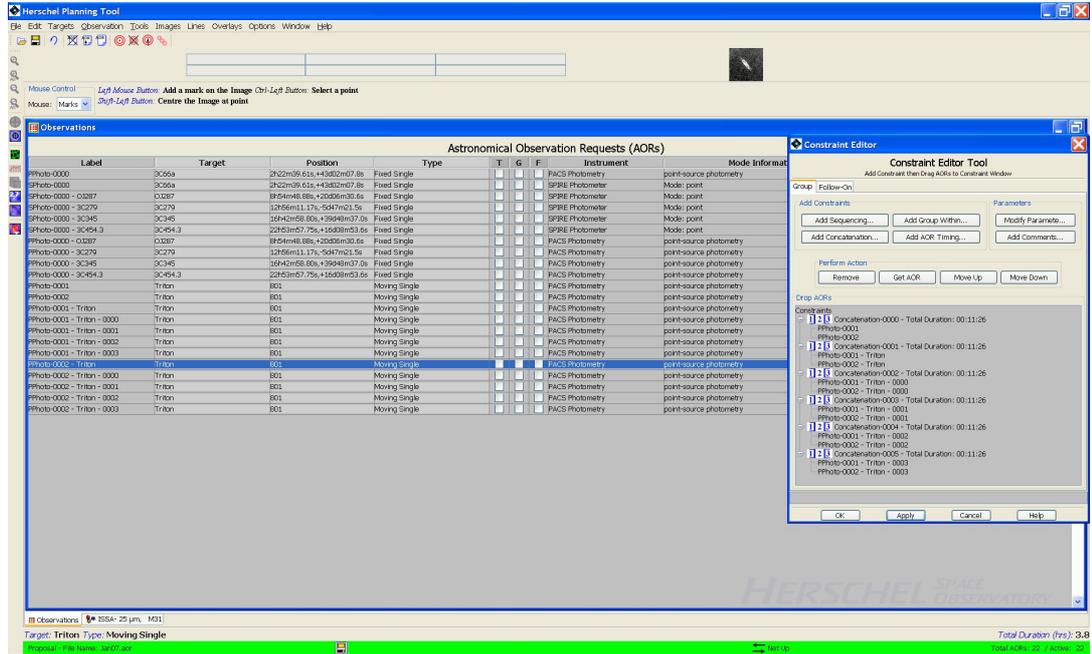
Figure 16.14. The Constraint Editor Tool when all six concatenations have been defined. Press "Apply" for these to be accepted by HSpot.

On pressing "Apply" all the chained AORs will be flagged in the "G" (Group) column to show that the constraint has been applied, as shown in Figure 16.15.
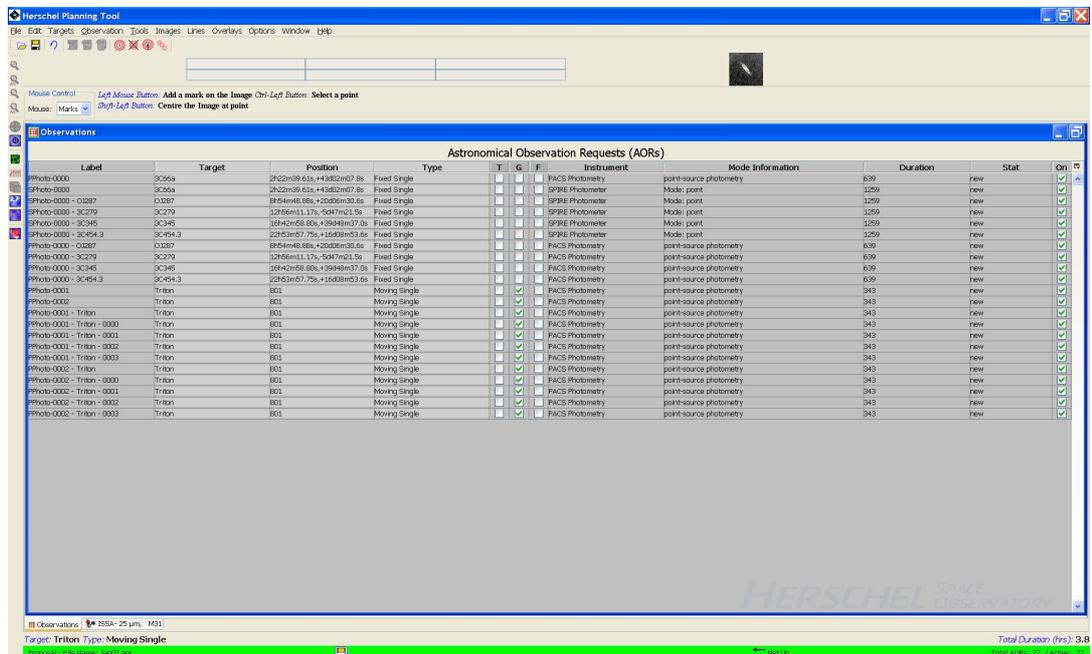
Figure 16.15. The AOR main window when all six concatenations have been defined. All the AORs are flagged in the "G" (Group) column to show that a grouping constraint has been applied.

Now we wish to define the Follow-On so that the chains will be observed sequentially at regular in-

tervals. Again, go to the "Group/Follow-on Constraints..." option of the "Tools" menu. Select the "Follow-On" tab and then "Add Follow On...". A pop-up will appear as shown in Figure 16.16 asking us to define the parameters for the Follow-On.
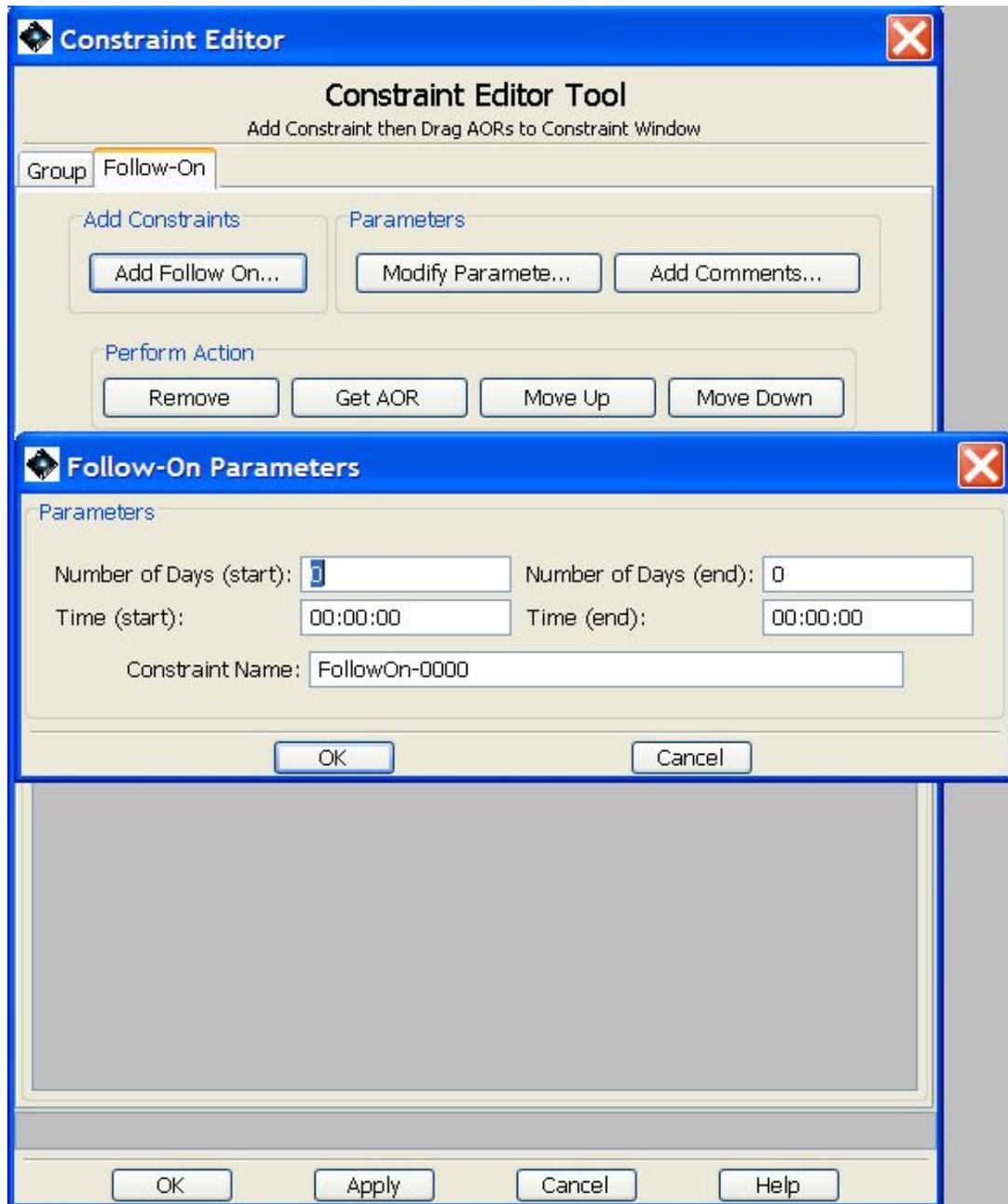
Figure 16.16. The window to define the Follow-On parameters for Follow-On observations.

The most strictly we constrain the observations, the more difficult it will be for the observations planning software to accomodate them. In this case we request that the observations be carried out at intervals between 8 and 12 days as shown in Figure 16.17. Click on "OK" to accept the parameters. A Follow-On will be added to the Constraint Editor Tool window, as shown in Figure 16.18.
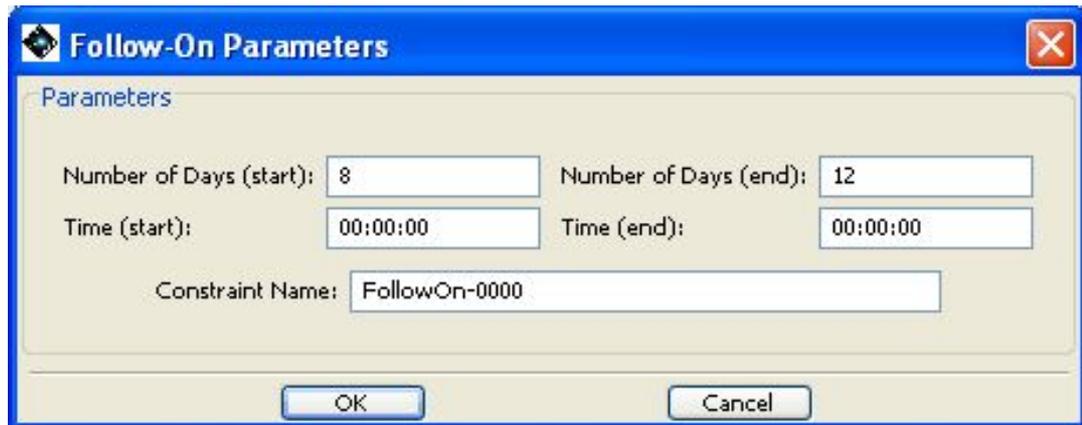
Figure 16.17. The window to define the Follow-On parameters for Follow-On observations.
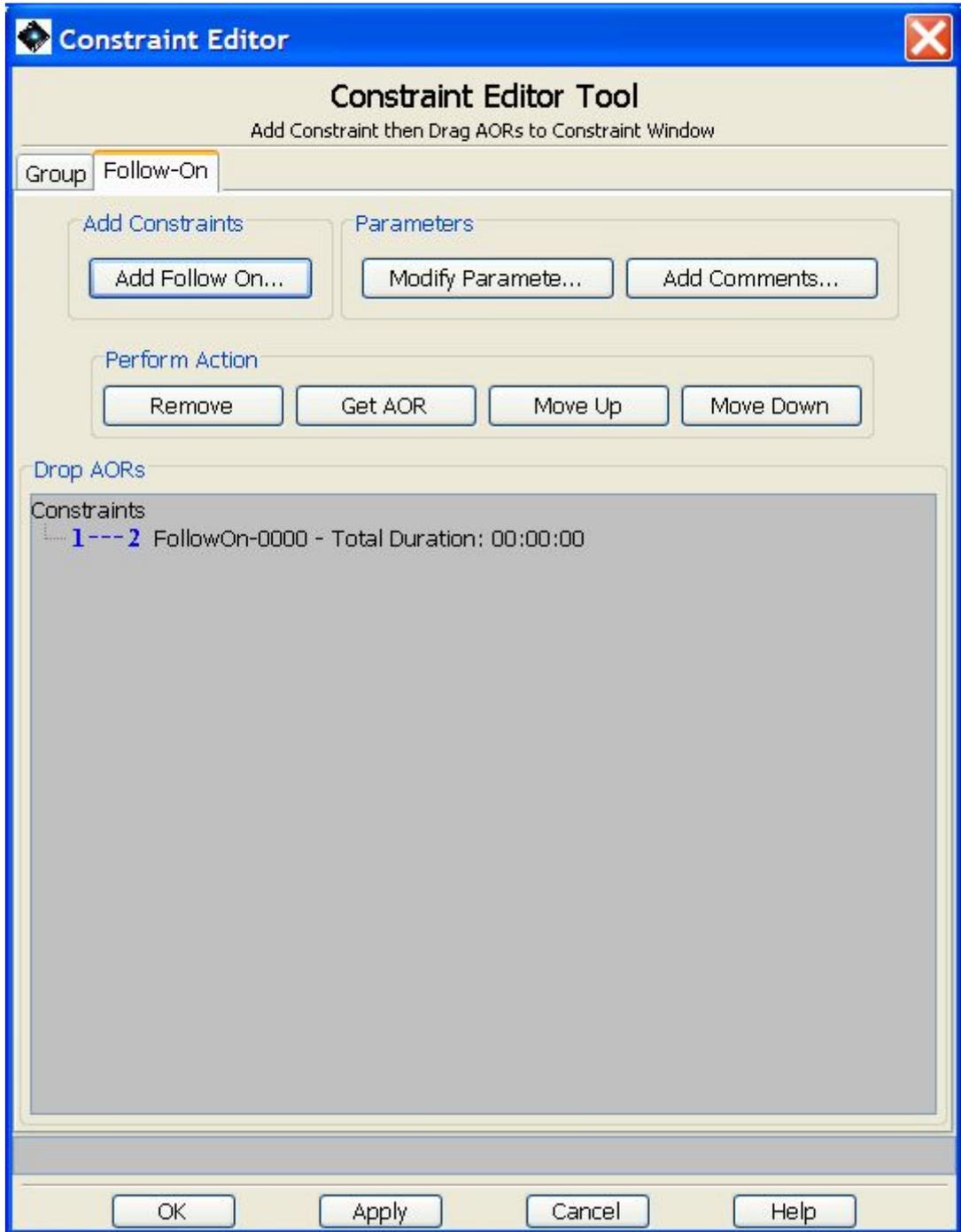
Figure 16.18. The Constraint Editor Tool window when the Follow-On parameters have been defined.

We must now drag and add the AORs across to the Follow-On. However, as we have already con-
catenated the pairs of observations, we must only add the first AOR of each chain, as shown in Fig-
ure 16.19. If we try to link both AORs of a chain, HSpot will give an error and refuse to accept the
second AOR as valid.
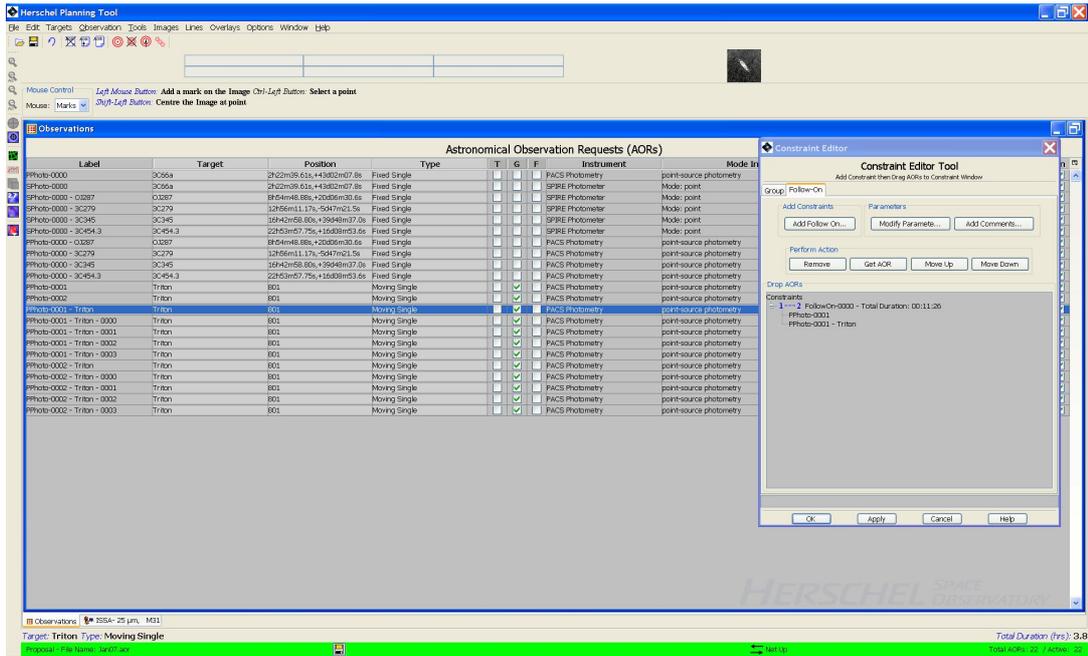
Figure 16.19. Definition of the first Follow-On. As we are Following-Up with concatenated observations, only the first AOR in each chain should be added. Attempting to add both AORs in a chain will give an error.

We now create the second Follow-On. This can have the same interval or a different one as required by circumstances. Here, we link the second AOR of the first Follow-On with the next AOR that we wish to observe in the sequence, as shown in Figure 16.20.
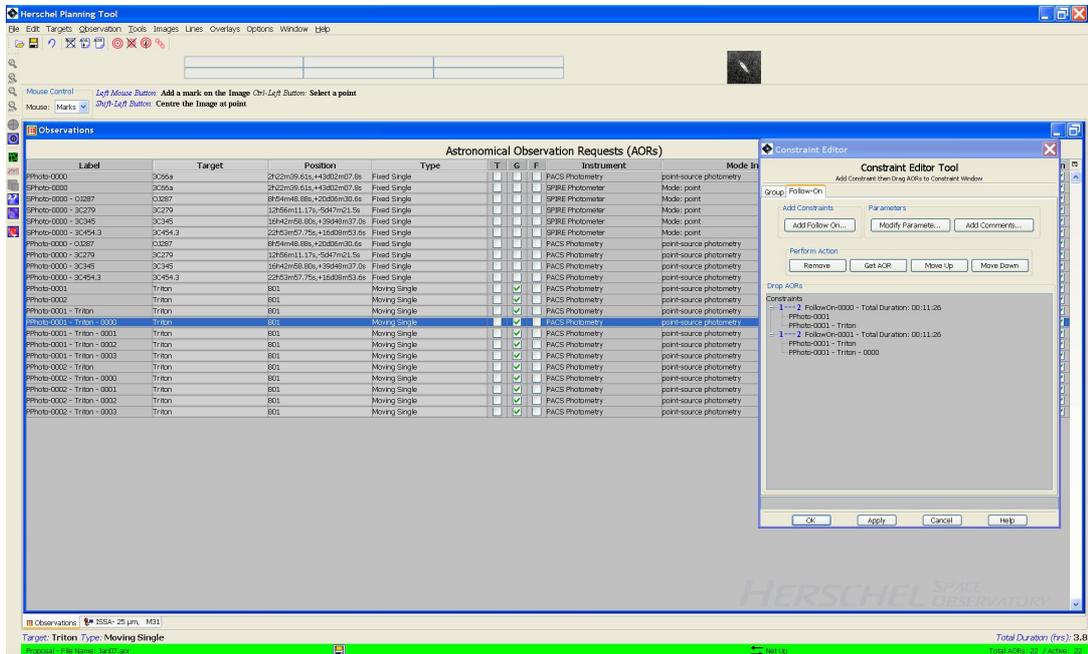
Figure 16.20. Definition of the second Follow-On. We now link the second AOR in the previous Follow-On to the next AOR in the table.

We continue creating Follow-Ons, linking the second AOR of the previous Follow-On and the next AOR in the sequence to be observed, as shown in Figure 16.21.
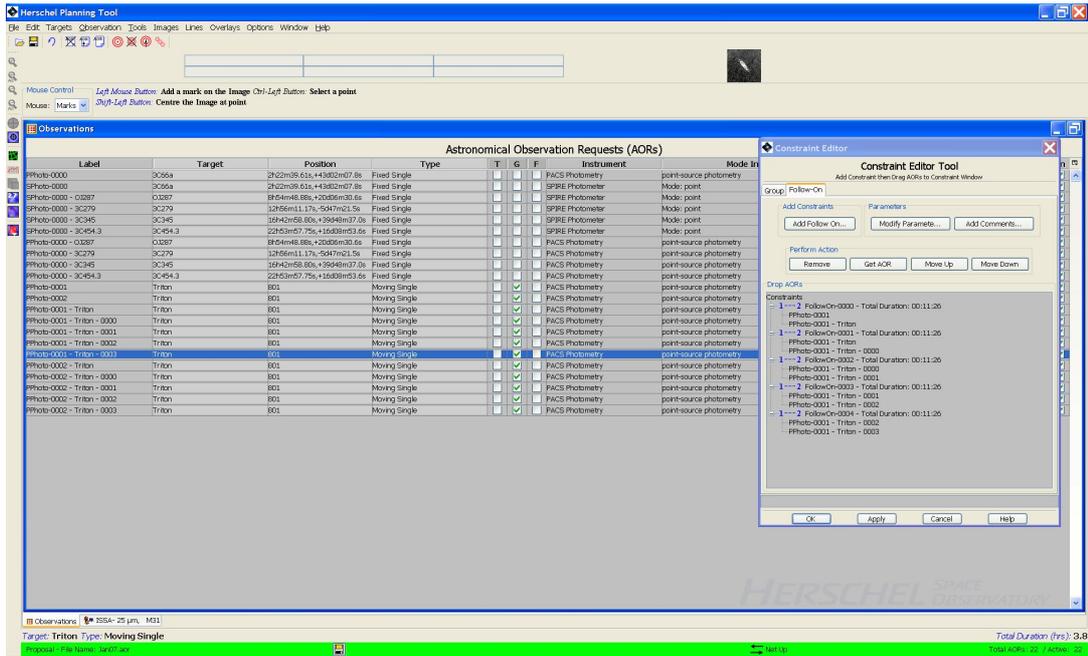
Figure 16.21. The complete sequence of Follow-On observations to observe the 6 chains over the course of a single visibility window.

Click on "Apply" to accept the constraints, when correctly defined and the "OK" to close the window. Now, six AORs are marked in the "F" (Follow-On) column on the main Observations window, as shown in Figure 16.22.
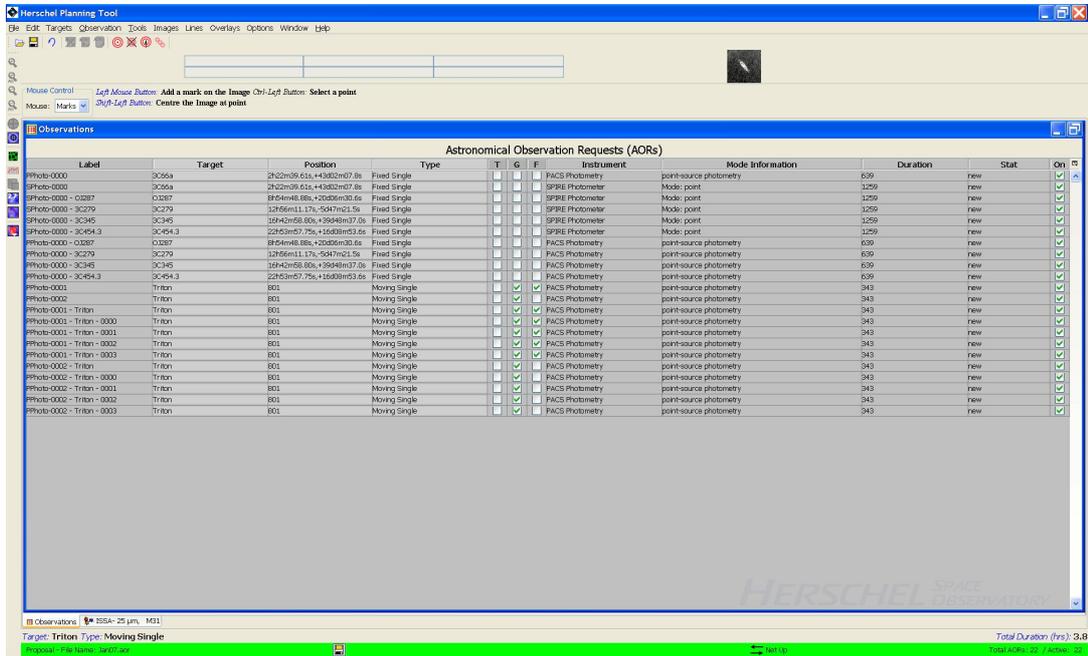
Figure 16.22. The main Observations window showing the grouping of all the AORs and the definition of 6 Follow-Ons.

Chapter 17.   Proposal Submission Tool

17.1. What it does

The Proposal Submission Tool will allow you to submit all the necessary information to the HSC needed to process your science observing proposals. You do not need to be connected to the Internet to fill out the requested information. It can be entered, saved to local disk, and later modified if needed, as a "coversheet" (.cs) file. When you are ready to submit your proposal to the HSC you only need to ensure you are connected to the Internet, load a set of AORs into the AOR window, open the Proposal Submission Tool and open you coversheet file and click on Submit in the Proposal Submission Tool toolbar. Refer to the current Herschel Call for Proposals and website at [ht-tp://herschel.esac.esa.int/](http://herschel.esac.esa.int/) for more information about creating and submitting your Herschel observing proposal.

17.2. Proposal Submission Tool Main Window

Clicking on "Proposal Submission Tool" under the Tools Menu on the HSpot toolbar will bring up the Proposal Submission Tool Main window shown in Figure 17.1. In this main window, you can:
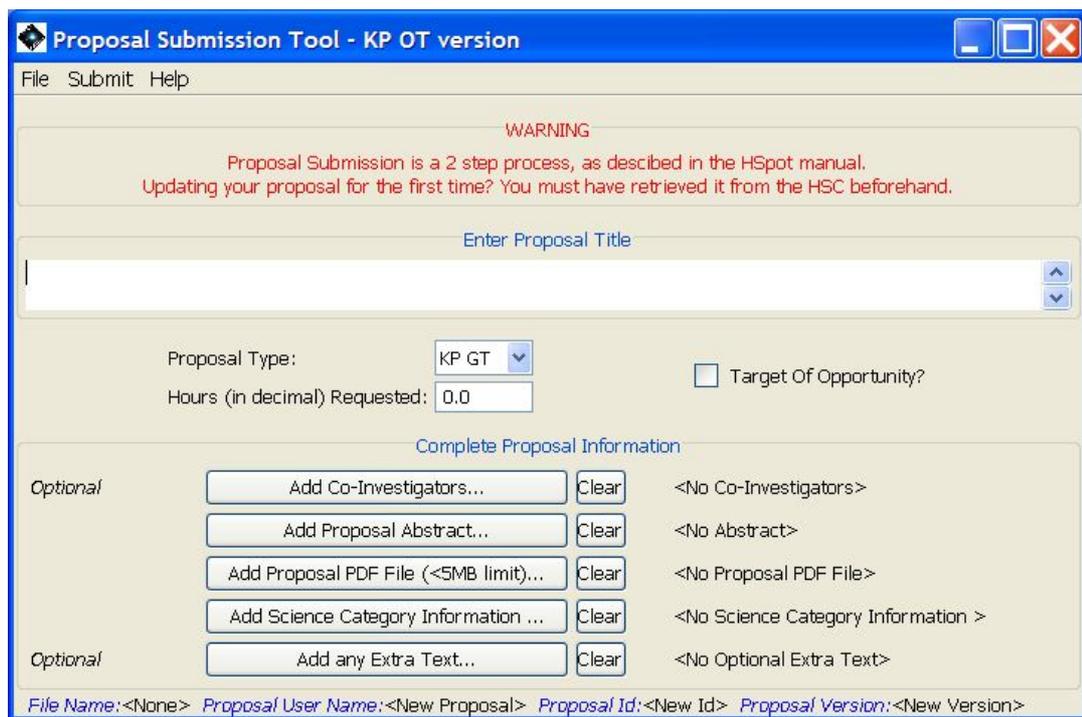
Figure 17.1. Proposal Submission Tool window.

1.   Enter the full proposal title;

2.   Select the proposal type (see Figure 17.2);

3.   Select the hours of observatory time requested;

4. Indicate if the proposal contains targets of opportunity;

Figure 17.2. The proposal type can be chosen from the pull-down menu. For the initial call for proposals in February 2007 only the "KPGT" (Key Project Guaranteed Time) and "KPOT" (Key Project Open Time) options will be activated. At a later stage these will be replaced with the relevant options for the call that is active at the time (Open Time, Guaranteed Time and Target of Opportunity). Below this top area in the main window are buttons you can click to add information about the Principal Investigator (Section 17.3), Technical Contact, Co-Investigators, etc.

Note
To be considered a Key Programme a proposal must request a minimum of 100 hours. HSpot does not apply a time check. It is the proposer's responsability to ensure that the proposal meets this requirement to be considered. There is no upper limit to the time that may be requested. Similarly, HSpot does not apply a consistency check that the same amount total of time is entered in the Proposal Submission Tool as has been submitted in the form of AORs, so it is the responsability of PIs to ensure that the correct amount of time is requested.

17.2.1. File Menu

File I/O is handled by this menu. These menus are similar to other I/O menus in HSpot.

17.2.2. Open Proposal

This function opens a dialogue to select a proposal file to load into the Proposal Submission Tool. HSpot will look for files with a suffix ".cs" ("coversheet" information).

17.2.3. Save Proposal

This function opens a dialogue window to allow you to write out to disk your proposal information. HSpot will write out the file with the suffix ".cs".

17.2.4. Save Proposal As...

This function opens a dialogue that allows you to save the proposal information to a new file name.

17.2.5. Print Cover Sheet

This function brings up a dialogue window to select various options for printing the proposal cover-sheet information (general printer information, page setup, and preferences).

17.2.6. Print Cover Sheet to File

This function allows you to quickly save the proposal coversheet to disk. You can save it in HTML, Postscript, or PDF format.

17.2.7. Prepend Cover Sheet onto Sci Just File

This function allows you to prepend the proposal coversheet to the PDF Scientific Justification (i.e., proposal) file. A dialogue opens, allowing you to save the resulting merged PDF format to local disk. Note: This function often causes the Mac OSX version of HSpot to terminate abruptly; for this reason, this function has been currently rendered inactive for Macs.

17.2.8. Clear

This function will clear the proposal information entered in the Tool. HSpot will ask you if you are sure you want to clear the Tool.

17.2.9. Close proposal window

This function will close the Proposal Tool window. When you have finished using the Proposal Submission Tool, select this option to close the Tool.

17.3. Registration

In order to submit a proposal as a PI, you **MUST** first register with the HSC. To do this use a web browser and go to the web page

http://herschel.esac.esa.int/registration.shtml

(see Figure 17.3). Follow the simple instructions on the page.
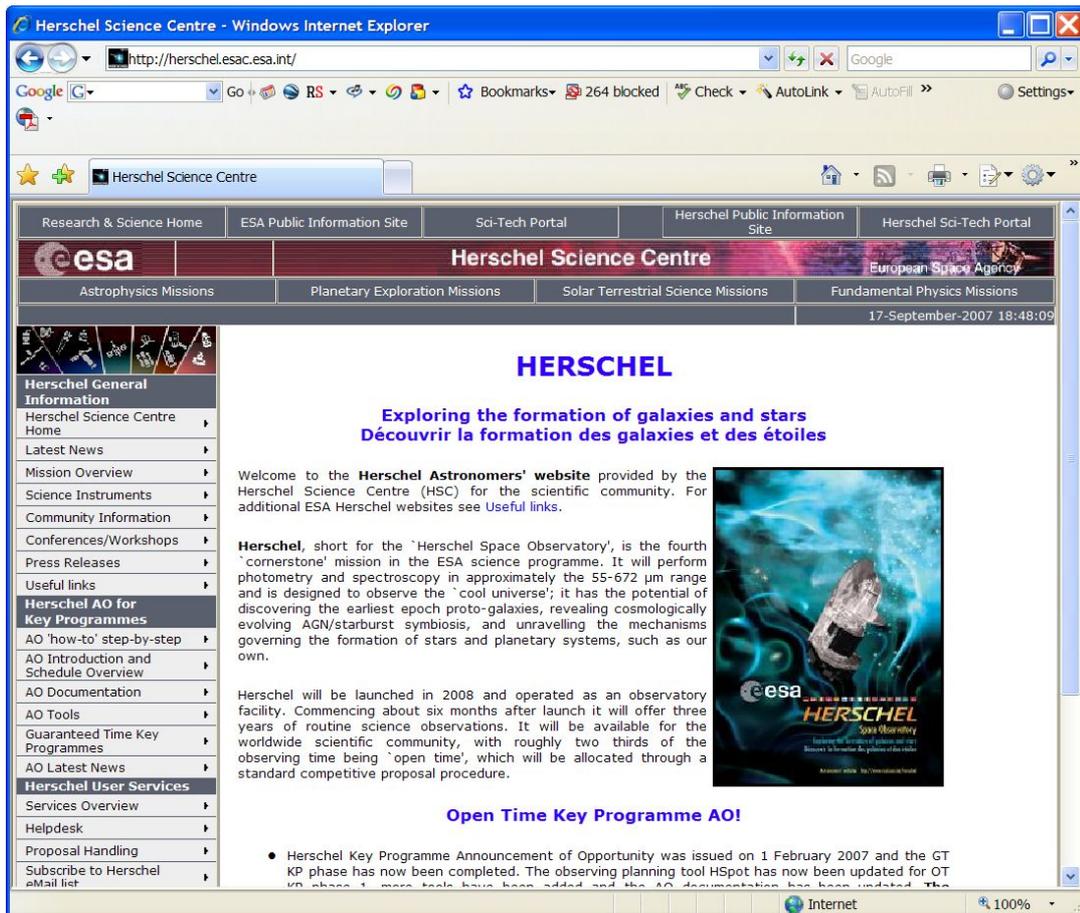
Figure 17.3. Project Home Page. Follow the links to register.

17.4. Submit Menu

17.4.1. Submit proposal to Herschel Science Centre (HSC)

This function will allow you to submit a new observing proposal to the HSC. You should have loaded your coversheet information into the Tool, the AORs to execute, and included the correct disk file system path to the scientific justification file before using this function. If there is no Call for Proposals open, HSpot will return a warning message saying it was unable to submit your proposal successfully as the call was closed; you will also get this message if you try to submit after a deadline has passed.

17.4.2. Update proposal at HSC

This function will allow you to update a proposal you have already submitted to the HSC. You should ensure you have the proper coversheet information loaded into the Proposal Submission Tool and the AORs, or the scientific justification file if they need to be updated. If there is no Call for Proposals open, HSpot will not let you submit the update.

"Update proposal" should only used after using "Retrieve Proposal" (Section 17.4.3). If no Proposal ID is shown at the bottom of the Proposal Submission Tool window you will get a server error. The Proposal ID is shown in Figure 17.4, circled in red at the bottom of the window; if this is set to "New ID", as in this example, resubmission will fail because the Proposal Handling software will not recognise the proposal as one existing in the database, which has been previously retrieved be-

fore updating.
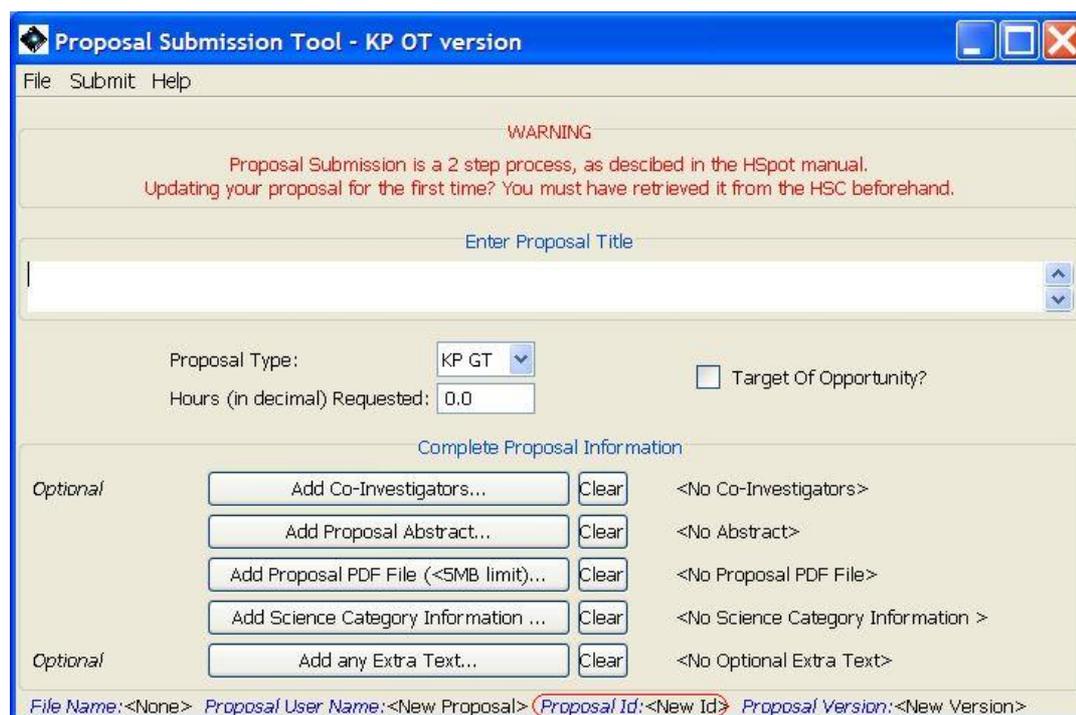
Figure 17.4. The Proposal Submission Tool window with the Proposal ID identified by being circled in red. When resubmitting a proposal, the Proposal ID must have been set correctly first by retrieving the proposal from the database and only then modifying the elements that need to be updated. If the Proposal ID is set to "New ID", as here, resubmission will fail with a server error.

17.4.3. Retrieve Latest Proposal from HSC

This allows you to download the latest version of one of your proposals submitted to the HSC, including the associated AOR files (which appear in the Observations window). To do this you must give your username and password and, on them being verified, will see a list of all proposals that you have submitted, allowing to download any of them. Note that the cover sheet information searches for the route of the scientific justification file on your computer and loads it from your local disk: if you retrieve a proposal from a different computer it may give an error and require you to re-link the justification file.

The AORs and cover sheet information will be loaded into your current HSpot session. Because of this HSpot requires you to have deleted any AORs that you may have in your session before downloading the proposal. If you omit this step the proposal retrieval will give an error and request that you do delete the AORs before attempting to download again.

17.5. Help

An online overview of the Proposal Submission Tool is available from the Help function.

17.6. Add Co-Investigators

Click on the "Add Co-Investigators..." button to bring up the co-investigator window as shown in Figure 17.5.
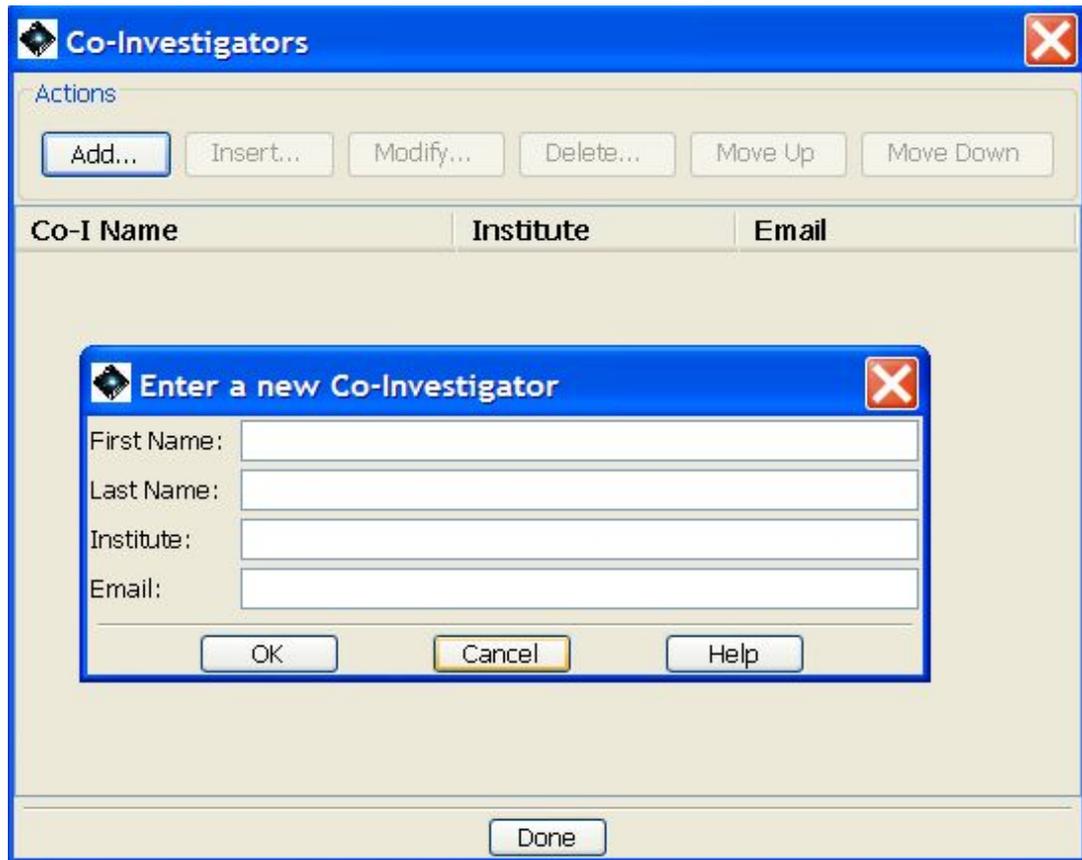
Figure 17.5. Proposal Submission Tool Co-Investigator window. Clicking on Add brings up the inset window for input of Co-I information.

Click on "Add..." and a small window appears where you can enter the appropriate information for a co-investigator (Figure 17.5).

Click the "OK" button once you have entered the information. The information is added to the list (Figure 17.6). Click the "Add..." button to continue to add co-investigators. Clicking on a name in the list will activate the other action buttons. You can then insert co-investigator names between two others, modify a co-investigator's information (Figure 17.8), delete it, or move it up or down in the list.
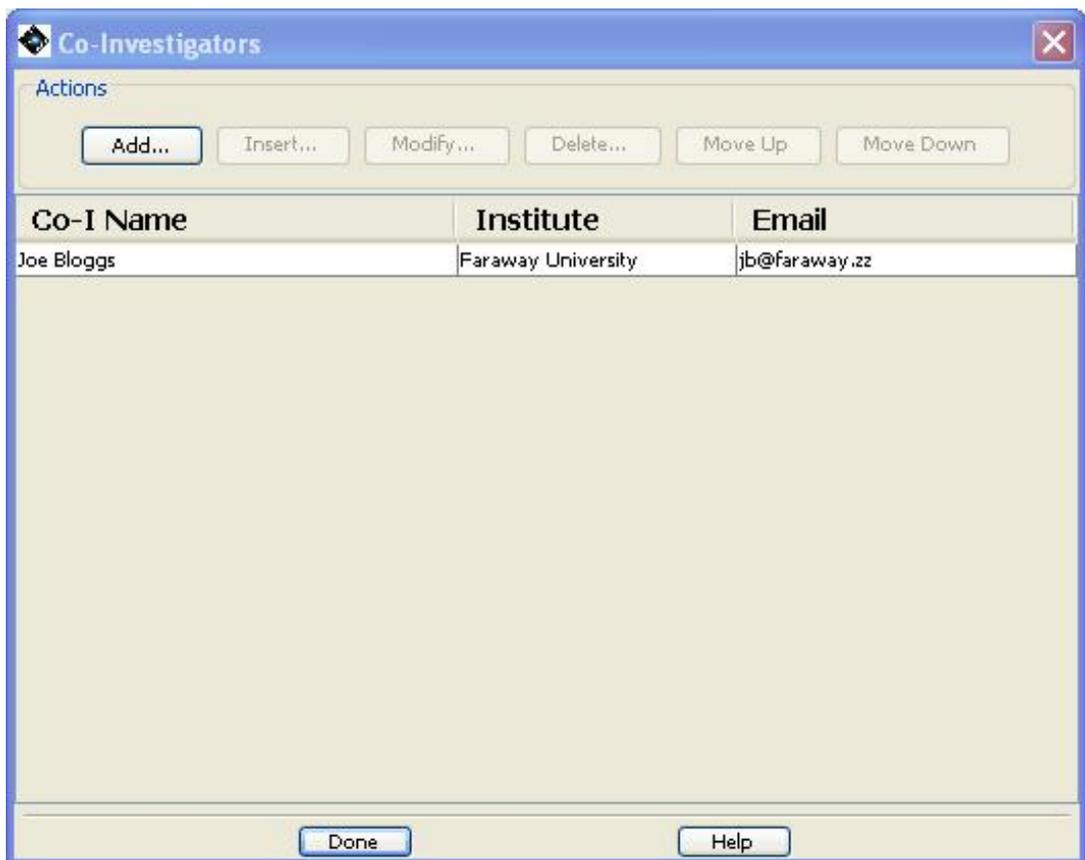
Figure 17.6. Proposal Submission Tool Co-Investigator window. Click on a name and the other action buttons become active.

Click "Done" in the Co-Investigators window when you have finished entering your list of co-investigators. In the "Proposal Submission Tool" main window, the names of the first few co-investigators will appear to the right of the Co-Investigators button and the word "Done" will appear to the left if all the information for each Co-I was filled in as shown in Figure 17.7.
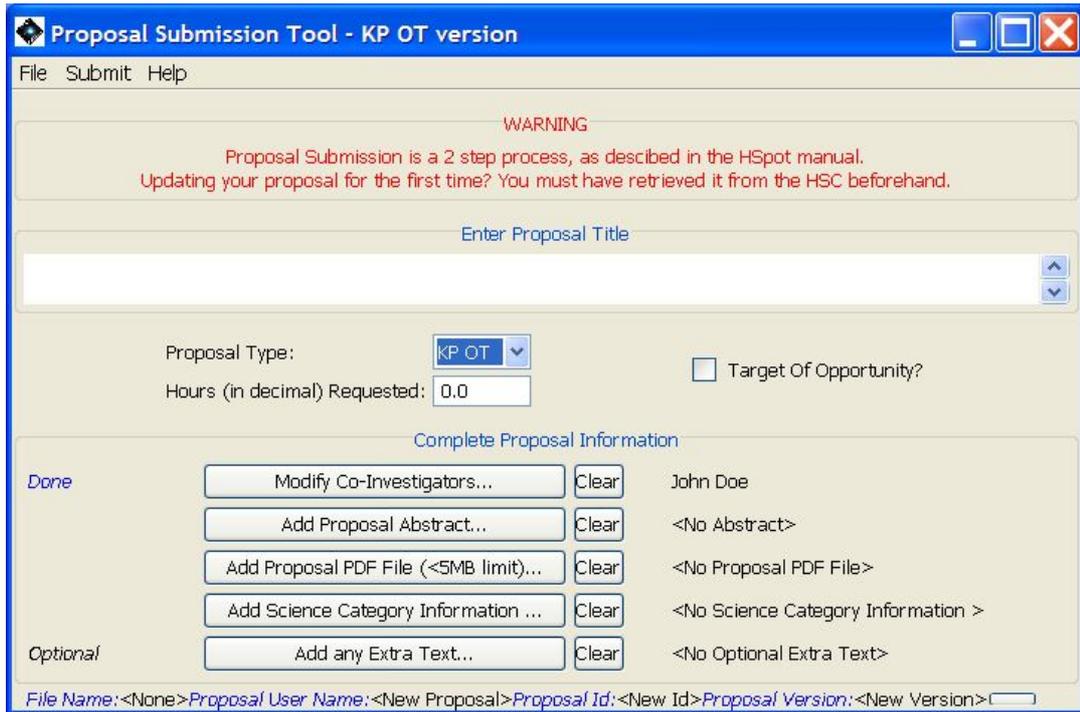
Figure 17.7. The Proposal Submission Tool Main Window after entering co-investigator information. The names of the first few co-investigators will appear to the right.

17.7. Modify Co-Investigators

Click on the "Add Co-Investigators" and then the "Modify Co-Investigators..." button in the pop-up that appears to bring up the co-investigator window as shown in Figure 17.5. A small window appears where you can modify the information that you have submitted for a co-investigator (Figure 17.8).

Figure 17.8. Proposal Submission Tool Co-Investigator window. You can modify the details that need updating. Click on "OK" to update.

Click the "OK" button once you have changed the information. The Co-I's details will then be updated in the list (Figure 17.6).

17.8. Add Proposal Abstract

Click on "Add Proposal Abstract..." to add the abstract. An abstract window will appear (Figure 17.9). You can type in the abstract, or read it as text in from a separate text file (cut and paste from a Word file does not work). Note that no more than 2040 characters -- including blank spaces -- may be included in the Abstract.

If you enter more than 2040 characters an error pop-up will appear that displays the character count and requests you to restrict the amount of text that is entered. This you can do "live" in the abstract window, or in the file that is read in. If you read in a revised file it will overwrite the text already in the "Proposal Abstract" window.

Use plain ASCII text characters and avoid mark-up languages, such as LaTeX. Enter the abstract as you would like it to appear in print.

Warning

Please remember that if you use special characters such as accents and letters that are not used in English, these may not reproduce correctly when the proposal is processed and may be interpreted as "junk" characters; try to avoid their use where possible.
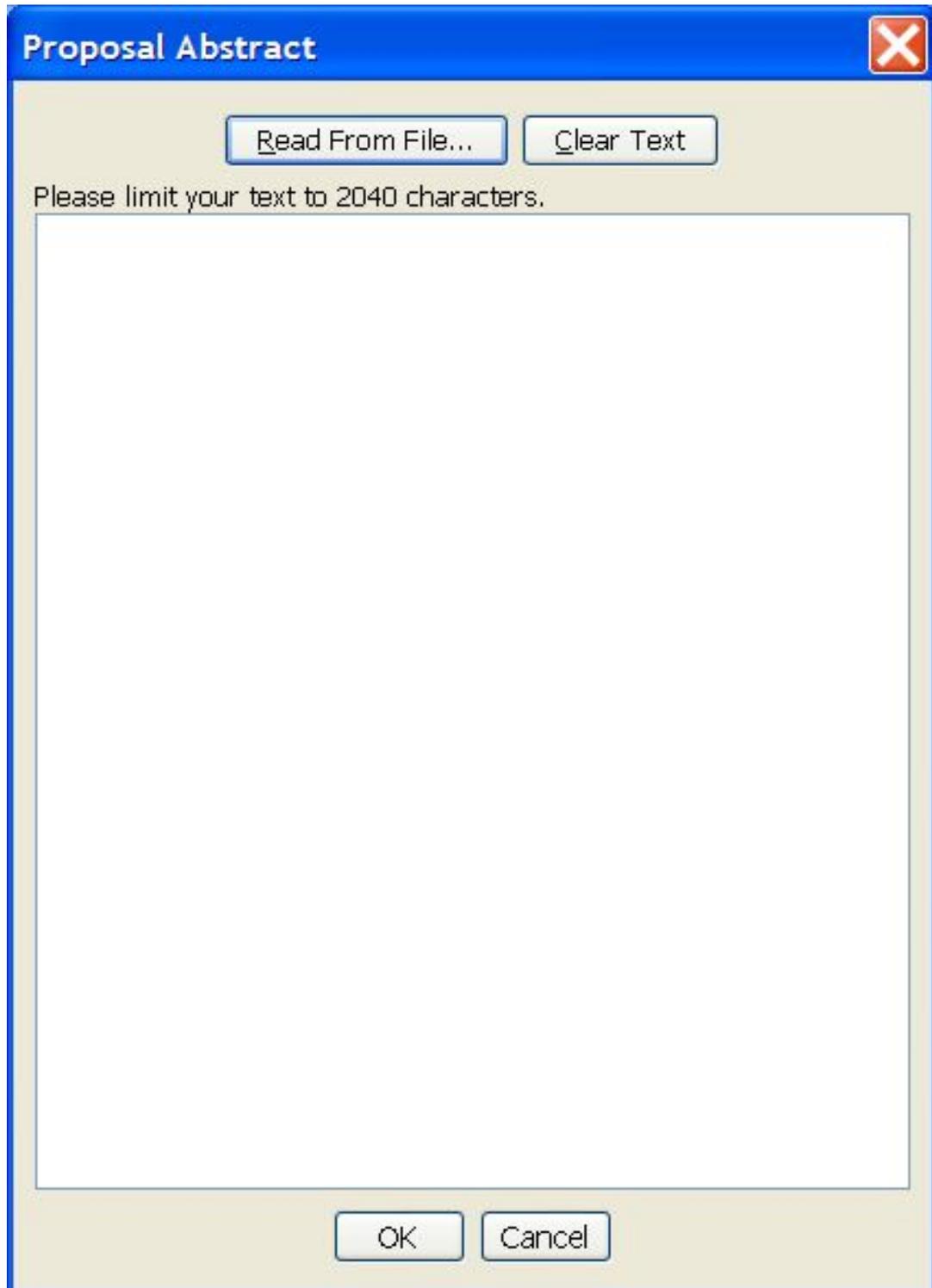
Figure 17.9. The Proposal Submission Tool Abstract window. Type in the abstract, or read it in from a file. When finished, click the "Done" button at the bottom of the window.

17.9. Add Scientific Justification File (Proposal PDF file)

Clicking on this button will bring up an open dialogue box. You can enter the path and filename or

browse for the correct directory and file as shown in Figure 17.10. Enter, or choose the correct path and filename and click "Open". The "Proposal Submission Tool" will add the path and filename to the Main Window (Figure 17.11). When you submit the proposal, HSpot will look for this path and filename for the file and transfer the file to the HSC. The file must be in PDF format and is limited to 5Mbt.

Note
The scientific justification should be prepared using the latest version of the Herschelform PD-FLatex package (available as a tarball at http://herschel.esac.esa.int/ao_kp_tools.shtml and follow the style set out in the Herschel Policies and Procedures document that is found in the AO call documentation at:

http://herschel.esac.esa.int/Docs/Herschel/html/policy.html
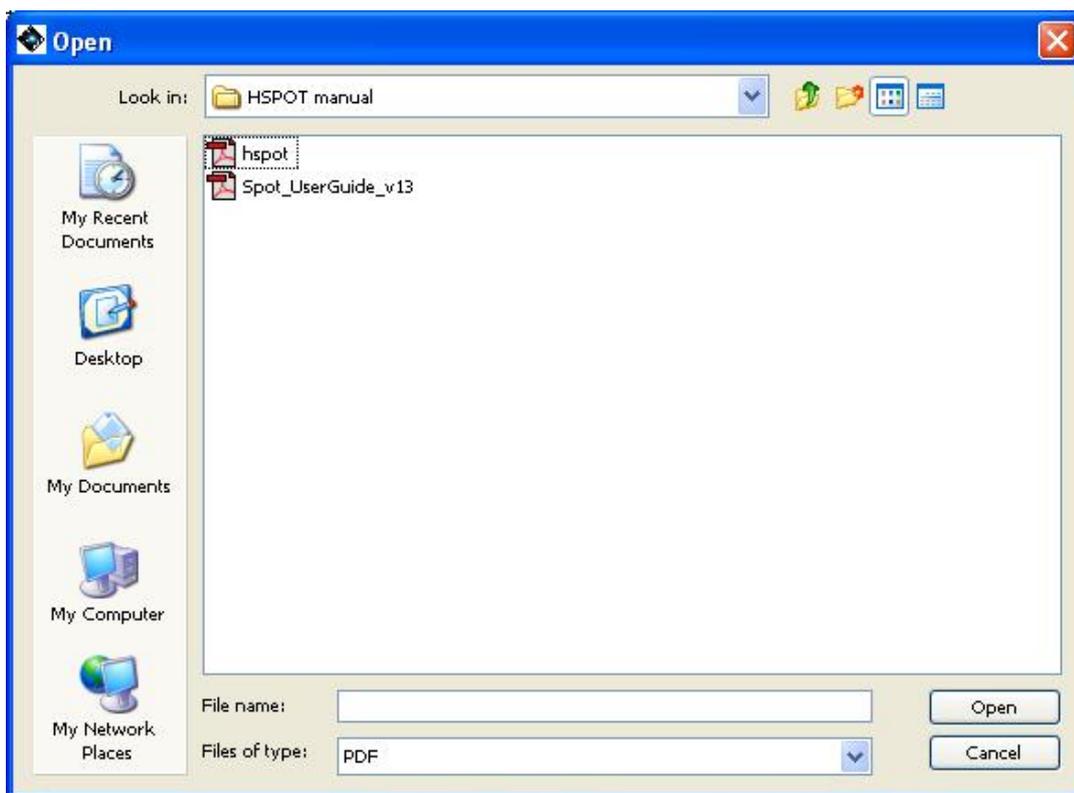
Figure 17.10. Proposal Submission Tool "Add Scientific Justification File" Open dialogue box. You can enter the filename or browse the directories and files to locate the correct file.
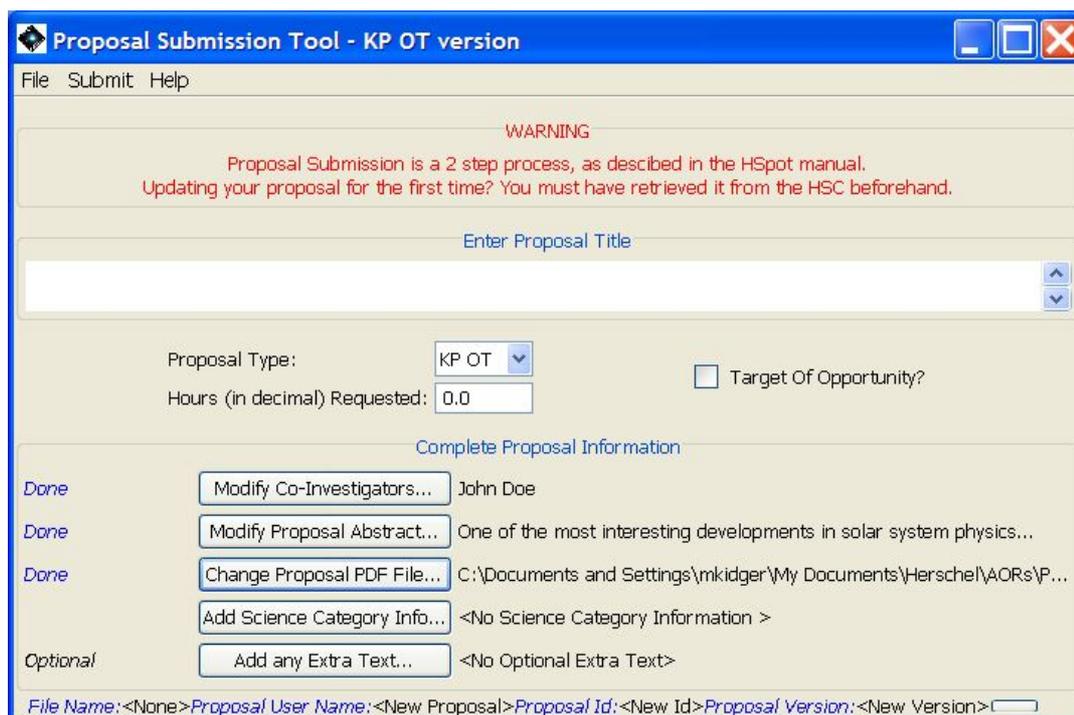
Figure 17.11. Part of the Proposal Submission Tool Main Window after adding the Scientific Justification file information to the proposal.

17.10. Add Science Category Information

This button allows you to choose a broad science category or categories into which you feel your proposal fits from the broad Extragalactic, Galactic, or Solar System headings (Figure 17.12). Note that these are not "keywords". You must select just one sub-category from the options offered. You should attempt to select the one that best describes your proposal as this category will determine how the proposal is handled and refereed in HOTAC.
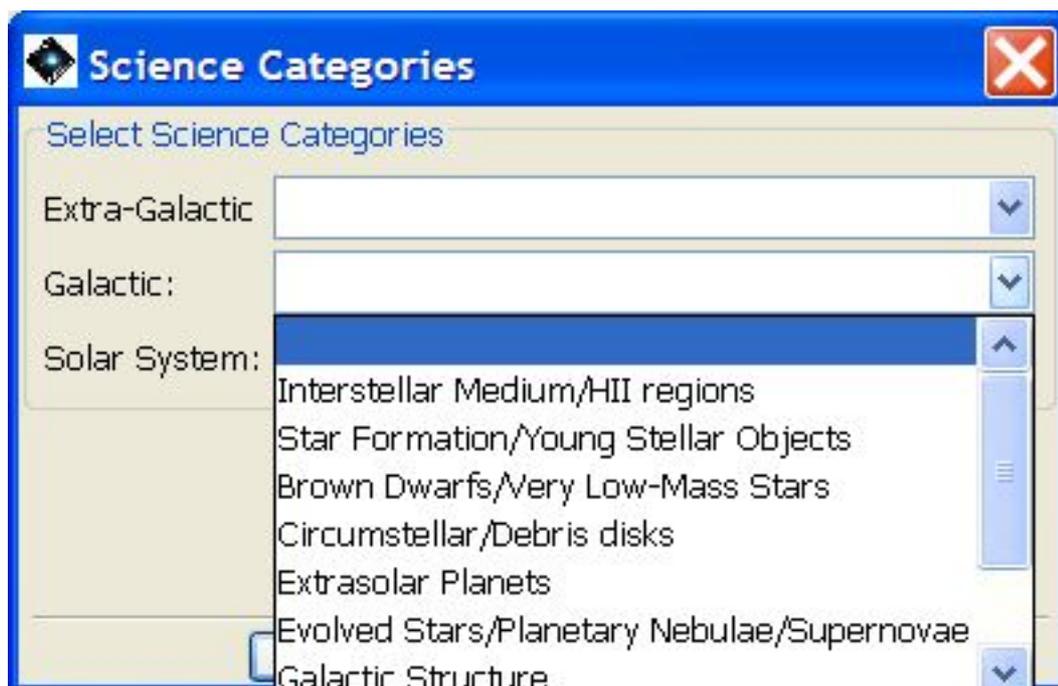
Figure 17.12. Proposal Submission Tool Science Categories shown inset. Select one of the types - Extragalactic, Galactic, Solar System - and then the sub-category that best describes your proposal. Shown is the pull-down menu for Extragalactic. Once chosen, the category appears to the right of the "Modify Science Category Inf..." button.

When you have finished choosing the appropriate Science Category, click the "OK" button. Your choices will be shown on the Proposal Submission Tool Main Window as shown in Figure 17.13.
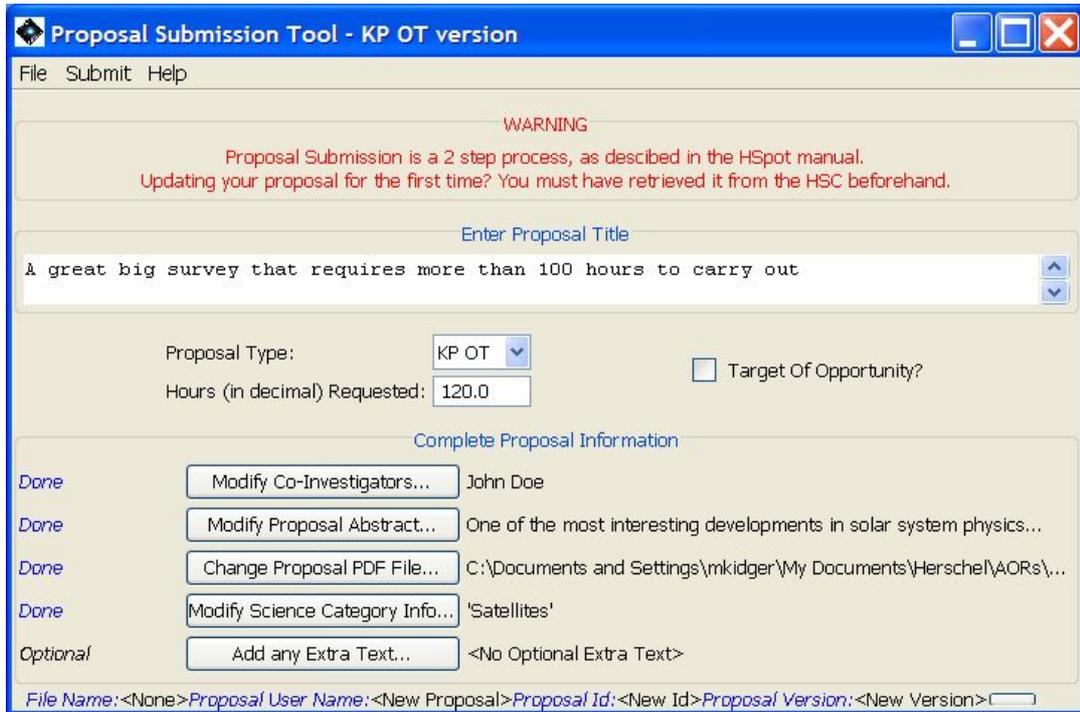
Figure 17.13. Proposal Submission Tool window after completion of all elements for submission.

17.11. Add any Extra Text

This field is useful for communicating any additional information to the HSC, as needed. See the relevant Call for Proposals to determine if you need to enter any information in this field. Otherwise leave the Extra Text field blank.

In the initial call for proposals the limit to extra text has been set to 200 lines. However, as lines do not wrap around, the limit is effectively 200 paragraphs.

Warning
This field will not usually be read unless some problem is found with the proposal. Astronomers should thus be wary of adding large amounts of extra information on the automatic assumption that it will go to HOTAC.

17.12. The Final Stretch: Submitting the Proposal

17.12.1. The Prologue

To submit an observing proposal successfully, you need to have a "coversheet" file (which is created

from the submitted information), a scientific justification file (PDF format only, limited to 5Mbt), and a finished set of AORs. In addition to the above files, you need the username and password that you have obtained by registering with the HSC (see Section 17.3).

To submit, use the "Submit" pull-down menu and go to "Submit proposal to HSC". You will be queried as to whether the AORs currently showing in HSpot are the ones you want to submit. If you answer "Yes" then you will be queried for your registered username and password (see Figure 17.14).
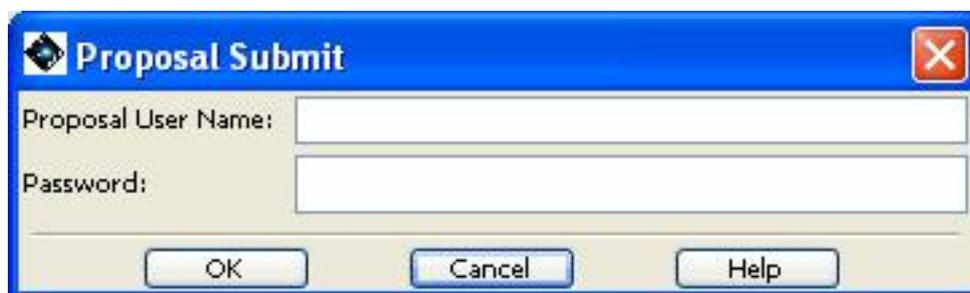
Figure 17.14. Username and password request for proposal submission.

You will be asked to save your information in a coversheet (".cs") file (Figure 17.15). This you MUST do to proceed with the submission of the proposal.
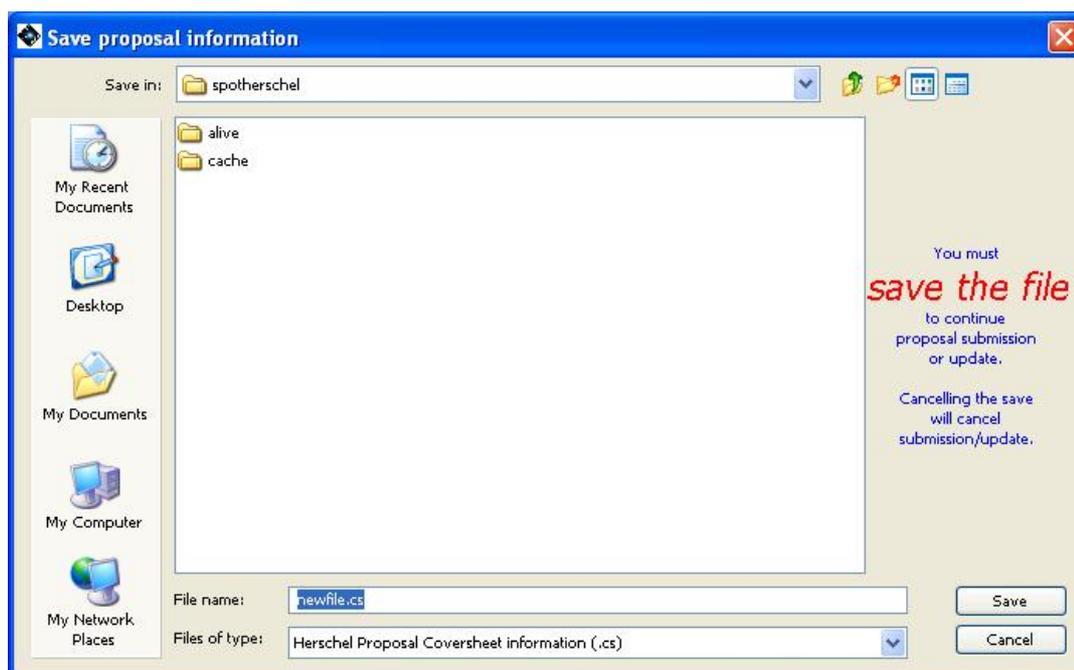
Figure 17.15. Dialogue for saving coversheet/proposal information

If you are resubmitting a proposal you may wish to store the coversheet with the same name as previous versions. In this case the Proposal Submission Tool will query you as to whether or not it is okay to overwrite the coversheet file (Figure 17.16).

Figure 17.16. Dialogue for overwriting coversheet/proposal information

This the final step for submission. On confirmation of the coversheet file name proposal submission will start. Note that the network needs to be up for this to happen.

If no problems during the transfer to the HSC are detected, HSpot will inform you that the submission was successful (Figure 17.17). A "receipt of submission" will be sent from the HSC to the submitter's email address.

Figure 17.17. Correct submission pop-up message.

Warning

The appearance of the pop-up and confirmation message in Figure 17.17 should appear almost immediately. It confirms that communication has been established with the server at the HSC and that the transfer of the proposal to the Proposal Handling System has been successful.

If, after a reasonable period of time, 1-2 minutes, the pop-up for successful proposal transfer has not been received, you should abort submission and re-submit.

After you have completed the submission, the proposal information appears on the bottom of the Proposal Submission tool window (Figure 17.18). The username for the proposal is filled in, but the Proposal ID remains blank until the proposal has been successfully retrieved from the database.
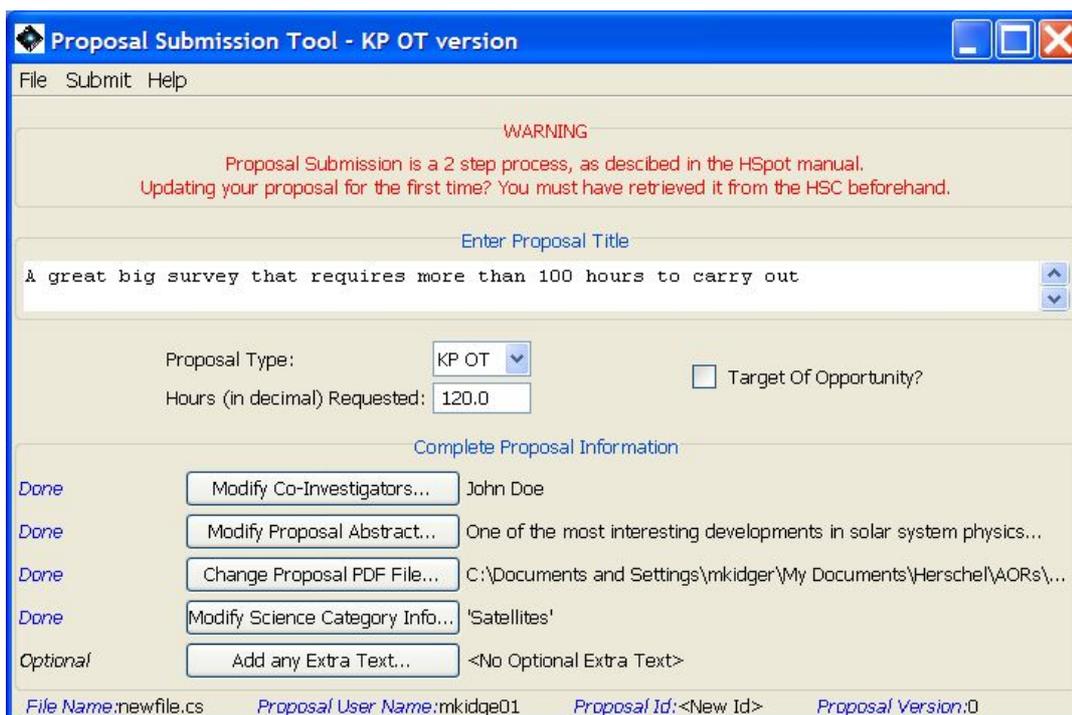
Figure 17.18. Successful proposal initial submission. The proposal username is identified on the bottom line of the window, but the proposal ID remains blank.

17.12.2. Updating an Existing Proposal

If you have submitted an observing proposal, but have noticed that there was an error in something, an AOR, the name of a Co-I, a rotated figure in the scientific justification file, or just something that needs to be revised or updated (such as the spelling mistake in the title of Figure Figure 17.11), it is possible to change a submitted proposal. Provided that the deadline for the Call for Proposals has not yet passed, you can re-submit your proposal, replacing the part that has the error. There is no need to submit a "new" proposal to correct errors in a submitted proposal.

When you "Update" an existing proposal, HSpot will overwrite and replace the old information with the new in the HSC database. For AORs, this means that even if you detected an error in just one of your AORs, you must submit the entire set of AORs again with the error corrected. Do not just submit only the corrected AOR as, if you do, you will end up with a proposal with just one AOR associated with it.

You can resubmit as many times as you wish. Each time that you do the "Proposal Version" number will increment in the bottom right hand corner of the Proposal Submission Tool.

To make changes to your original submission.

1. Go to the Proposal Submission Tool.

2. Under the "File" menu go to "Open proposal". This will then allow you to import the coversheet (".cs" file) information stored with the original proposal.

3. Make the appropriate changes, or include new version of the scientific justification, etc., in the same way as for a new proposal.

4. Ensure that the Proposal ID is set correctly. The Proposal ID shown in Figure 17.4, circled in red at the bottom of the window; if this is set to "New ID", as in this example, resubmission will fail with a server error because the Proposal Handling software will not recognise the proposal as one existing in the database. You cannot resubmit until you have retrieved the propos-

al and its corresponding ID from the database at least once.

5. Go to the "Submit" menu and pull down to "Update proposal at HSC".

6. After input of your username and password, you will be requested to save your updated coversheet information on your local hard disk before the update is allowed.

The coversheet information (title, abstract, PI information, etc.) is always updated at the HSC when you submit a proposal update. Each time you submit a proposal, or an update to a proposal, check that the coversheet information is correct. When the new version is submitted, the "version number" of the proposal shown at the foot of the "Proposal Submission Tool" pop-up window will update. In principal you can update your proposal as many times as you wish; the number of updates is though recorded in this version number.

After you have completed the resubmission, the proposal information (username and id) appears on the bottom of the Proposal Submission tool window (Figure 17.19)
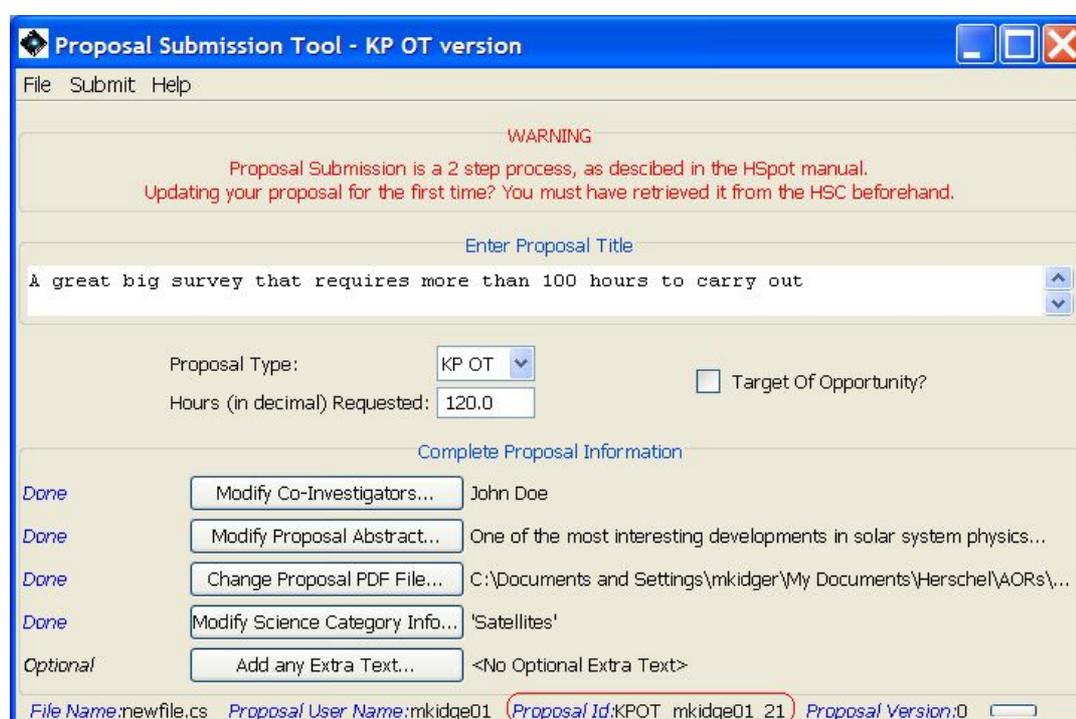
Figure 17.19. Successful proposal resubmission. The proposal is identified on the bottom line of the window.

Tip

Submitting a draft version of a proposal before the final version is ready is a good way of:

(a) Having a back-up of the latest version of your proposal at a secure site

and

(b) Making incremental versions of the proposal available to your co-Is.

Your can revise and update the proposal as many times as you wish before the deadline and can give selected co-Is access to the proposal version in the HSC database so that they can download it and revise it too.

17.12.3. Submitting a Herschel Observing Proposal:

Review

These are the steps you need to take to submit a Herschel observing proposal:

1. Think of some great science you can do with Herschel.

2. Remember: You will have to specify all the details of your observations when you submit your proposal via HSpot. proposals will need a "coversheet" file (created using the Proposal Submission Tool in HSpot), a set of AORs (created using HSpot), and scientific justification.

3. Obtain all the relevant documentation about Herschel and its science instruments on the Herschel Science Centre website at http://herschel.esac.esa.int/. These include the Herschel Science Observing Rules, Instrument Observer's Manual, Call for Proposals and HSpot User's Guide, among others.

4. Download and install HSpot. Do this early! Get to know your HSpot and the Herschel science instruments well ahead of the proposal submission deadline. Herschel Observation Planning Workshops are often held before submission deadlines: check the Web page and sign up for them if you want to learn about Herschel and HSpot from the experts.

5. If you have any problems installing or using HSpot or any questions regarding Herschel or its instruments, contact us at the Herschel Helpdesk: http://herschel.esac.esa.int/esupport/.

6. Check that your favourite target(s) is/are not too bright or faint for Herschel. Remember that the sky background is significant at Herschel's wavelengths.

7. Use HSpot to fill out AOTs and create AORs. Check the visibility of your observations especially if you need to time-constrain your observations. Use HSpot to visualise just how your observations will be executed on the sky. Is it what you expected?

8. Start writing that scientific justification. The final file must be in PDF format. See the Call for Proposals for details on what you need to include in your justification. Check the Policies and Procedures document for the required scientic justification style and download the latest version of the Herschelform PDFLatex package (available as a tarball at http://herschel.esac.esa.int/ao_kp_tools.shtml - if you are not familiar with tarballs, the "readme" file gives instructions how to decompress it).

9. Early in your planning, open the Proposal Submission Tool in HSpot and see what kind of administrative information we need from you. Create a "coversheet" file as you work on your proposal. Save a final, clean version to disk when you are about ready to submit your proposal. Be sure that the hours requested and scientific justification file are correct. The coversheet information will be ingested into our database when you submit your proposal. It will be used by the HSC during the technical and science review of your proposal. If your proposal is approved, a subset of this information (PI name, title, abstract, etc.) will be made publicly available via the HSC WWW and HSpot.

10. Save all the AORs you will submit to a file that contains no other test, or what-if-I-try-this-option AORs. This will be the AOR file you load into HSpot when actually submitting your observing proposal to the HSC. It should contain only those AORs you want to be executed as part of your observing program.

11. Register at the HSC user registration website (http://herschel.esac.esa.int/registration.shtml).

12. When you are ready to submit your observing proposal, the steps to follow are as follows:

- Start up HSpot.

- Load in the appropriate set of AORs.

- Open the Proposal Submission Tool.

- Load the coversheet file and double-check that all the information is correct, especially Total Hours requested and the scientific justification file.

- Click on the Submit Menu in the Proposal Submission Tool and select "Submit proposal to HSC" for a new proposal.

- Enter your proposal user name and password when prompted.

- When finished, HSpot will inform you that the proposal has been successfully submitted to the HSC. You will also receive a confirmation email.

Prior to the deadline for the Call for Proposals, you can update any submitted proposal. This is a handy feature if you noticed a significant error in the AORs you submitted, in the scientific justification file, or in any other aspect of your proposal, or have simply decided to make some improvements. To update your submitted observing proposal:

- Open the "Proposal Submission Tool" in the "Tools" menu.

- If this is your first update, or you wish to update a proposal for which you do not have the latest version on your local disk:

1. Erase any AORs that you have in your current HSpot session.

2. Go to the "Submit" menu and select "Retrieve latest proposal from HSC".

3. Supply your username and password.

4. Select the proposal that you wish to modify. On accepting, the coversheet information and the AORs will be loaded into your current session. Bear in mind that the coversheet will link to the scientific justification file on your local disk (it is NOT downloaded) and needs it to be in the same directory as when you originally submitted the proposal.

- Otherwise

1. Go to the "File" menu and select "Open Proposal" to load a proposal cover sheet from disk.

2. Select the required cover sheet and accept it. Note that, in this case, no AORs will be loaded!

3. Load the AORs for your proposal from disk if you have not done so already.

- Make all necessary modifications to the proposal.

- Choose the "Update proposal at HSC" option in the "Submit" menu and follow the instructions on the screen.

- HSpot will confirm that the update was successfully submitted to the HSC. You will receive an email confirmation when it has been received and processed.

> **Warning**
>
> Close to the deadline for closure of a Call for Proposals there may be a heavy load on the server that receives and processes the proposals. All proposals are queued and processed sequentially: this means that a new proposal may, in extreme cases, take a some tens of minutes, or even hours to be processed. Even when there is no other load on the system, proposals with large numbers of HIFI AORs may take a few minutes to be processed.

Even though it may take a while for a proposal to be processed and hence for the confirmation message to arrive, provided that the proposal is submitted before the deadline it will be accepted. If a proposal misses the deadline (i.e. is submitted after formal closure) a email message confirmation of failure due to deadline closure will be received.

Chapter 18.   Spectral Lines for Planning Purposes

In order to aid in spectrometer observation planning, a system of default lines available within the Herschel frequency/wavelength range are available for use within HSpot, for observation planning purposes. In particular, for the HIFI instrument there are expected to be a plethora of (mostly molecular) spectral lines of interest. HSpot contains a default list of lines with accurate frequency measurements, has the ability to obtain spectral line information from on-line databases and allows the user the ability to import his or her own line lists. It can also allow different colour, height and width displays of lines within the HIFI frequency editor.

18.1. Managing Lines

Since there are so many spectral lines within the frequency/wavelength range of Herschel, the user is only supplied with a default set of lines to avoid line confusion (see Appendix B). However, lines that the user is interested in that are outside this base set can be imported and then stored for later use. An example might be a complete set of water lines.

In order to manage lines, go to the main screen of HSpot and go to the "Lines" menu (see Figure 18.1). The last item on the menu allows line managing. Selecting this brings up the scrollable window shown in Figure 18.2. This shows the list of lines currently available in your planning session. At the bottom of the screen are buttons that allow you to "Add", "Modify" or "Delete" individual lines or save, "Import" or "Include" line lists.
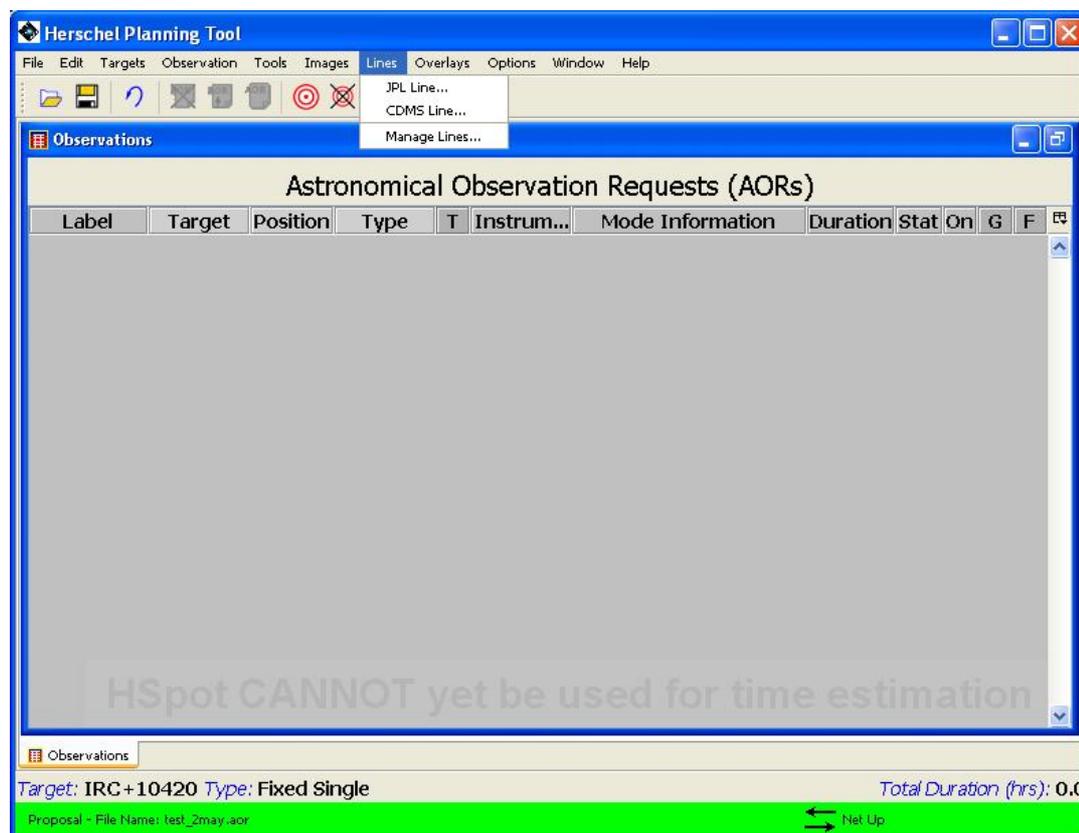
Figure 18.1. The HSpot "Lines" pulldown menu

Figure 18.2. The HSpot line management capability

18.2. Adding, Modifying or Deleting an Individual Line

Clicking on "Add" allows the window in Figure 18.3 to appear. This allows the user to include individual specific lines of interest to his/her personal line list for use in planning. The name and transition allows the line to be used in, e.g., the HIFI frequency editor (see Section 13.2.6.1). The height and width refer to how the high and wide the line appears in any pictorial display. The maximum height is 1.0.

Figure 18.3. The HSpot spectroscopic line addition screen

To modify information about a given line, clicking on the table line then on the "Modify" button allows a similar display to appear (see Figure 18.4). The name and transition cannot be edited, but

new or preferred frequency/wavelength values can be input by the user together with a default height/width.

To delete a line, click on the appropriate table line then hit the "Delete" button at the the bottom of the window shown in Figure 18.2.
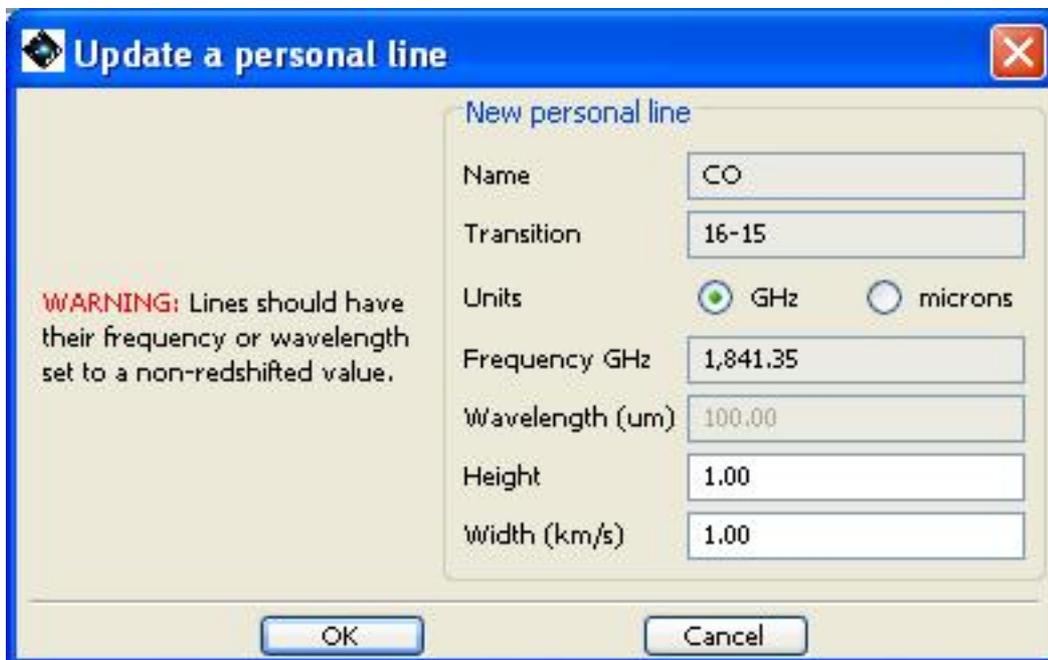
Figure 18.4. The HSpot line information modification window.

18.3. Import or Include Line Lists

Line lists of the appropriate format stored on your local hard disk can be included into a session. The "Import" button at the bottom of the window shown in Figure 18.2 allows the current line list to be replaced by a separate line list stored on disk (see Figure 18.5). Such lists are often saved from the HSpot line list management tool. But other lists can be imported as long as they have the same XML style as shown in Figure 18.6.
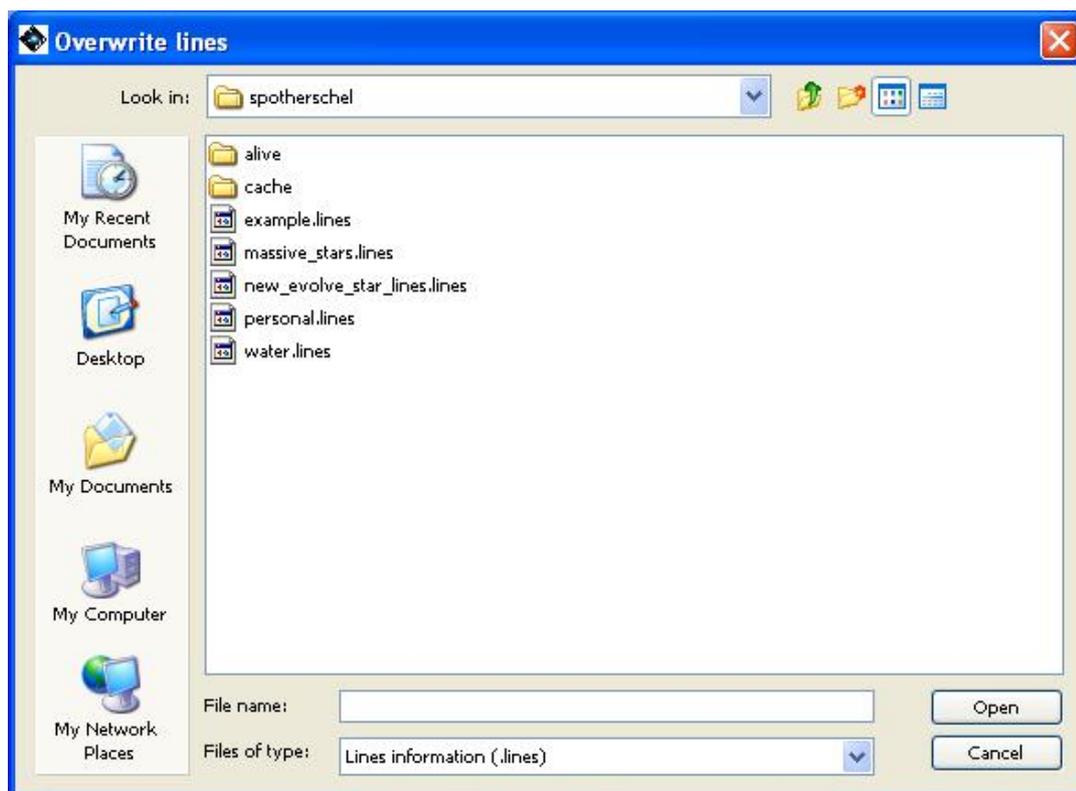
Figure 18.5. The HSpot line information storage window

```
<?xml version="1.0" encoding="UTF-8"?>
<her:LinesHolder xmlns:her="http://www.esa.int/herschel">
  <Line>
    <Origin>PERSONAL</Origin>
    <name>18003  H2O</name>
    <transition>8630-7700</transition>
    <height>0.5</height>
    <width>20.0</width>
    <Value>
      <Frequency>503.57</Frequency>
    </Value>
  </Line>
  <Line>
    <Origin>JPL</Origin>
    <name>18003  H2O</name>
    <transition>8620-7710</transition>
    <height>0.0</height>
    <width>0.0</width>
    <Value>
      <Frequency>504.482692</Frequency>
    </Value>
  </Line>
  <Line>
    <Origin>JPL</Origin>
    <name>18003  H2O</name>
    <transition>195140-188110</transition>
    <height>0.0</height>
    <width>0.0</width>
    <Value>
      <Frequency>525.8428933</Frequency>
    </Value>
  </Line>
</her:LinesHolder>
```

Figure 18.6. The HSpot line storage is done in a ".lines" file which has a XML format of a similar type to this example.

The "Include" enables several ".lines" files to be made available in the observation planning session by including them one at a time.

The complete set of lines in an observing session can be saved to disk and the default line list separately using the "Save Lines" and "Save Default Lines" buttons respectively at the bottom of the window shown in Figure 18.2.

18.4. Adding Lines from On-line Catalogues

On-line catalogues of (mainly) molecular lines are available at JPL and Cologne (CDMS). Lines from these lists can be incorporated in much the same way.

It should be noted that, at this time, these catalogues provide the best set of information on line frequencies for many molecules, but work is ongoing to improve the model line frequencies for many molecules. Further information regarding the sources of the line positions in these catalogues can be obtained from the JPL and CDMS websites at

```
http://spec.jpl.nasa.gov/          --- JPL site
http://www.cdms.de                  --- CDMS site
```

To add a line or set of lines from either site, from the main menu use the "Lines" menu and pull down to either "JPL Line..." or "CDMS Line...". A similar menu comes up for either (see Figure 18.7). Scroll down to the molecule you wish and click on the appropriate name/line. Then choose the wavelength/frequency range for which you would like to search for lines of this molecule/atom. Finally, a minimum transition strength can be used to modify the selection (units are log 10 of the integrated intensity at 300K -- in nm^2MHz).
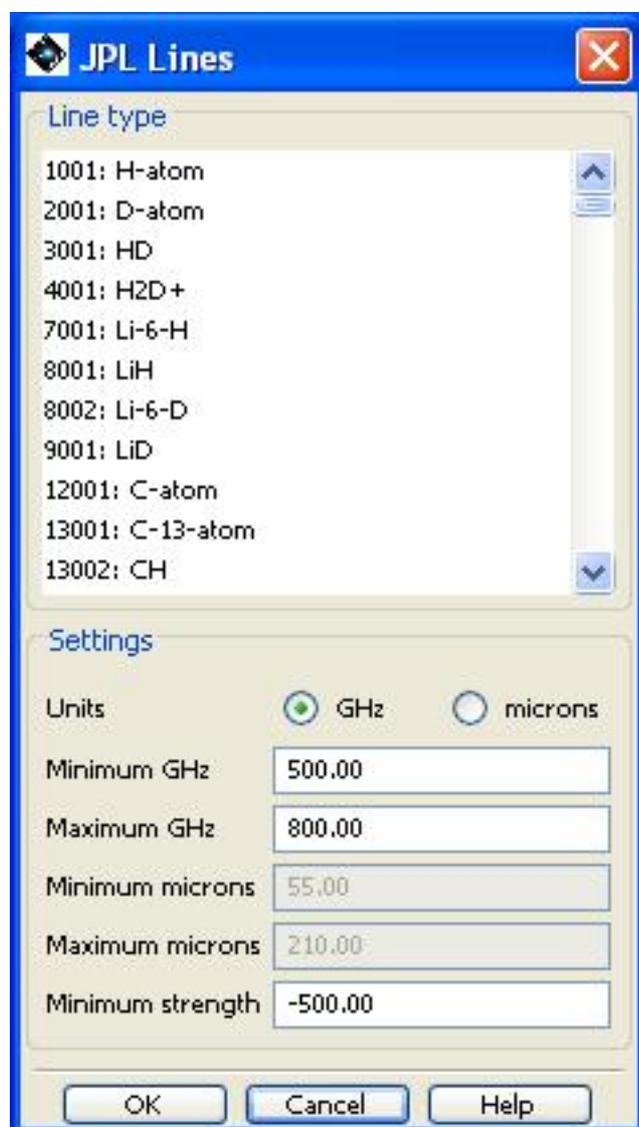
Figure 18.7. **The window for interacting with the JPL molecular line database. A similar interface to the Cologne molecular line database (CDMS) is also available.**

After hitting "OK" a search is done of the catalogue and a list of lines found is returned. You are asked to select/deselect from the list. The lines that were found can be added into your current set of personal lines being used in your observation planning session (see Figure 18.8 where a set of OH lines have been selected from the JPL database).

Figure 18.8. The returned set of known OH lines within the requested wavelength range. These can be selected for inclusion within the current observation preparation session by the user.

Once added into a session, the set of lines can be stored on your local disk, together with other personal lines in your session, using the line managing tools noted in the previous section.

Chapter 19. Fixed Target and AOR Visualisation

19.1. Visualisation Overview

In this section, we describe the HSpot capabilities for visualising the sky at inertial target positions (Section 6.6). Moving target visualisation is discussed in Chapter 20. Overlaying the area coverage of an AOR is discussed in Section 19.2.8.4. Descriptions of the "Images and Overlays" menu functions are discussed in Section 6.6 and Section 6.8. In this section, we walk through examples using HSpot's visualisation capabilities in planning your AOR.

19.2. Displaying and Manipulating Images

To visualise the sky at a target position, you can go directly to the "Images" menu and select the appropriate sky image(s). If you display multiple images within a frame, the tabs along the bottom of the frame allow you to toggle between the images in the frame. In Section 6.6.1 and Section 6.6.2, we showed how to download IRAS Sky Survey Atlas (ISSA) and Two Micron All Sky Survey (2MASS) images. In Figure 19.3, we show what the HSpot screen would look like after downloading an ISSA 25 micron image and a 2MASS K-band image. The frame with the ISSA image is the currently active frame.

19.2.1. Image information

The right hand sidebar contains a control panel for the image (Figure 19.1). For a monochrome image there are five icons that control, from left to right: image display (toggle the tick to display and hide the image); image erasure (click on the cross to erase the image completely); image opacity (see Section 19.2.8.3); the image display parameters and (for a three colour plot) the control of the histogram for each layer (see Figure 19.9) and the image headers (Figure 19.2).

Figure 19.1. The image control panel in the right hand sidebar for a black and white image.

Selecting the image header icon a panel is displayed (Figure 19.2) that gives the full FITS header information for the current image.

Figure 19.2. The image headers displayed for the current image.

19.2.2. Image Control

To zoom the image in or out, use the magnifying glass icons on the left of the HSpot window (Figure 19.3). The "in" and "out" icons apply the zoom to all the images in the selected. The icon centres the current image in the frame. To move the image around in the frame you can use the scroll bars on the frame, or move the positioning box on the thumbnail image.
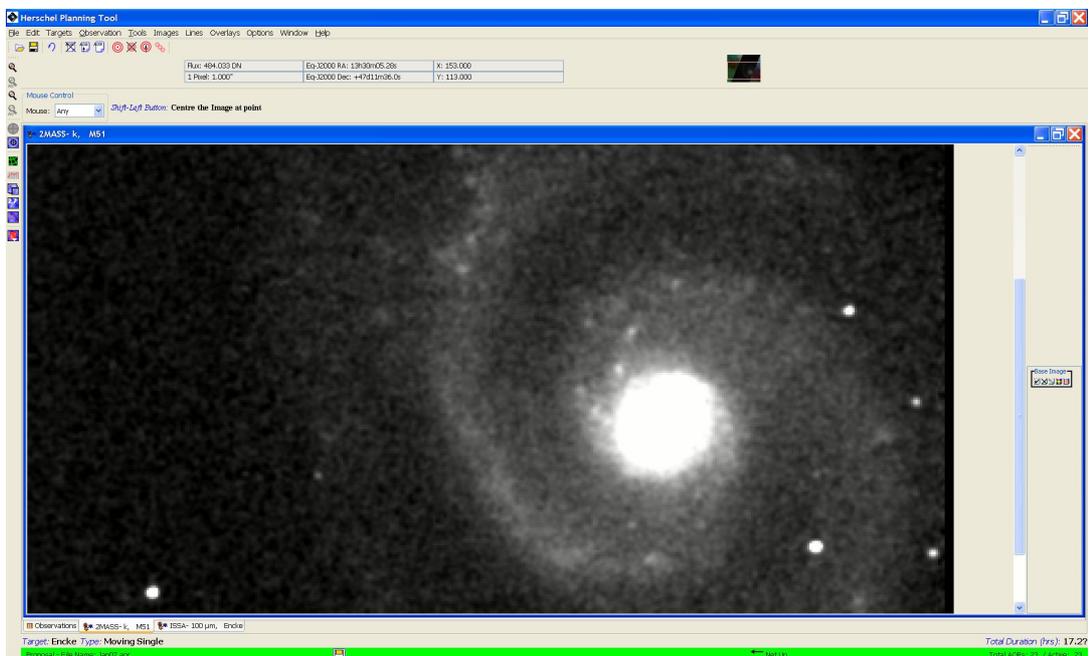
Figure 19.3. The HSpot screen after downloading a 2MASS K-band image of M51.

19.2.3. Cursor Readout

When you move your cursor over an image the flux, pixel scale, and two sets of coordinate values are displayed below the HSpot icon bar. See Section 6.8.6 to select which coordinate values HSpot returns in these displays. For the ISSA images, HSpot returns flux values in MJy/Sr in the left-most readout below the icon bar. For the 2MASS images, you should not rely on DN readout for photometry. Use the 2MASS catalogues for accurate photometric measurements; use the "text" icon of the 2MASS catalogue overlay to see the catalogue data.

19.2.4. Layer control and blinking images

The side bar to the right of the image frames (Figure 19.3) shows a box that says "Base Image" with show/hide layer, delete layer, opacity control, and colour table control icons in it (hold the mouse over each icon for a short time to see the tooltip indicating its function).

If you click the show/hide layer icon, HSpot hides or shows the image. If you click the delete layer icon, the image layer in the frames will be deleted. The opacity control icon brings up an image opacity control dialogue. This allows you to control how opaque will be the image layer. This is very useful if you have a second image as an overlay in a frame (not 'loaded' in the same frame, overlaid as in Overlay and then Image Overlays from the HSpot menus). The colour table control icon brings up a dialogue allowing you to adjust the colour table for the image.

The side bar contains the controls of image and overlay layers. You can create several layers and then hide or show them with the show/hide layer icons without having to recreate them each time. Each overlay introduces a new layer control box on the side bar. The Base Image layer does not need to be the bottom layer. You can move it between other overlays in the frame by clicking on any part of the layer control box and dragging it between layers to where you want it.

HSpot allows you several display options, as shown in Figure 19.4. The default option is "Panel plots 1 per frame". This places each image side-by-side in the top layer and each image may be controlled seperately by a tab in the bottom bar. This option is useful for displaying images of the same object at different wavelengths to compare them.

However, HSpot also allows you to place the three images on top of each other in a single layer. Just one tab will appear in the bottom bar -- that of the last image to be displayed, in this case the 2MASS K image -- and the other two bands will be hidden. An icon will appear in the top right hand corner of the screen (see Figure 19.5 - the icon is highlighted here with a red oval) that allows you to pass between images every time you hit the left or right arrow. This feature can be used to blink frames to compare images.
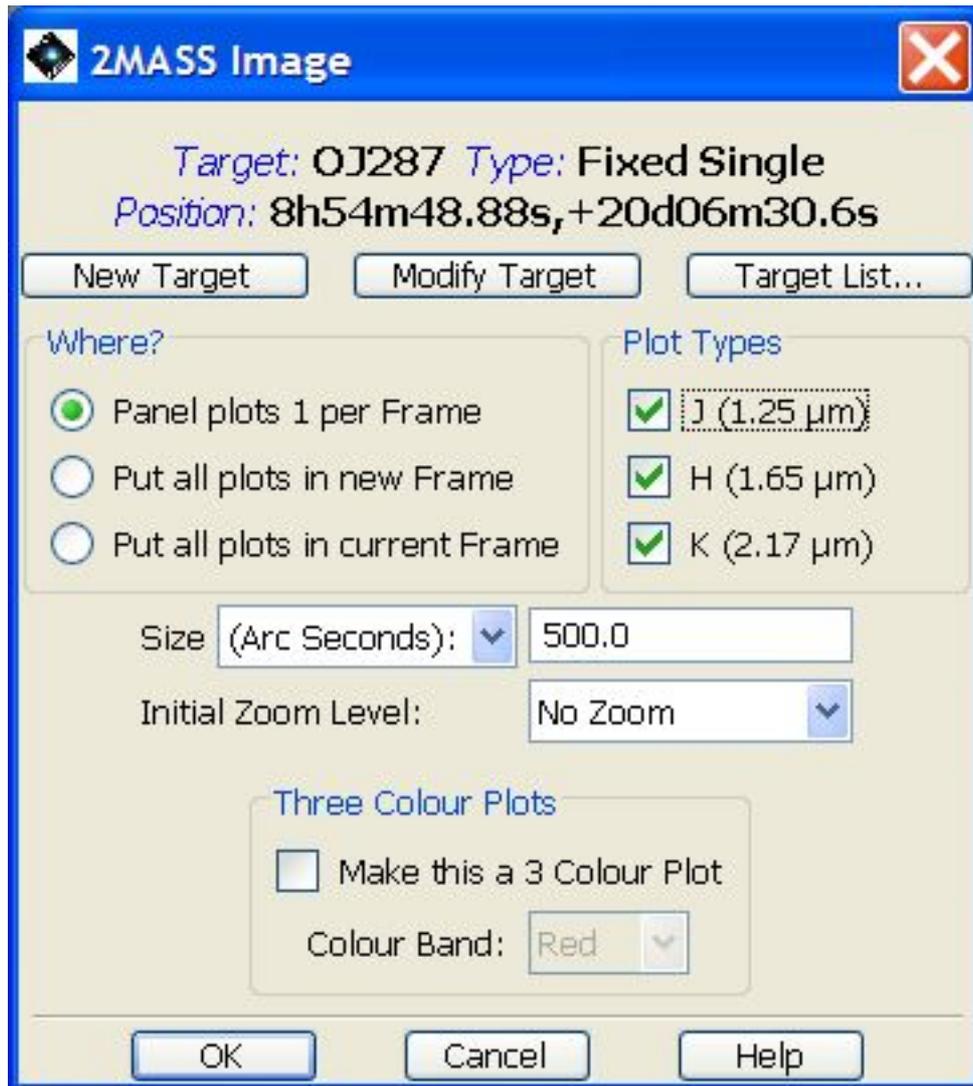
Figure 19.4. The image display dialogue set to show three images in the same frame.
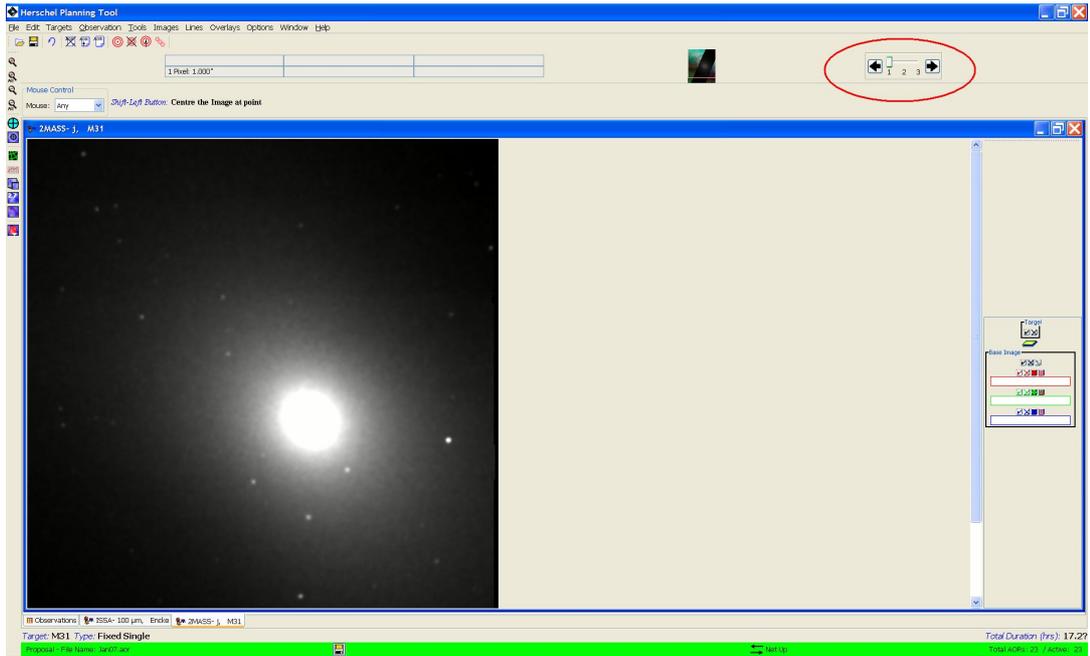
Figure 19.5. The image display icon (circled in red) that allows you to blink between several images in the same frame.

19.2.5. Three-Colour Image Display

HSpot provides you with the ability to produce three-colour composite image display. The three images are read individually into the 'red,' 'green,' and 'blue' (RGB) colour planes to produce the composite. To produce a composite, first select an image from the "Images" menu. Then, select "Make This a 3 Colour Plot" in the "Three Colour Plots" box in the "Image" window. Select a colour and the image to read in as that colour. To read in another image and map it into another colour plane, for instance for the green layer, select the "Add Colour: green" item in the layer control box shown in Figure 19.6 for the base image. This results in a menu from which you can select the next image in the composite. For example, to produce an rgb plot from 2MASS data, you should select 2.17 microns for the red image, 1.65 microns for the green image and 1.25 microns for the blue image.

The dialogue to create a three-colour plot for the blazar OJ287 from IRAS data (identified with a small box produced using the "show current fixed target" overlay) is shown in Figure 19.6. The 100 micron band is defined as red, 60 microns as green and 25 microns as blue, giving the result shown in Figure 19.7.
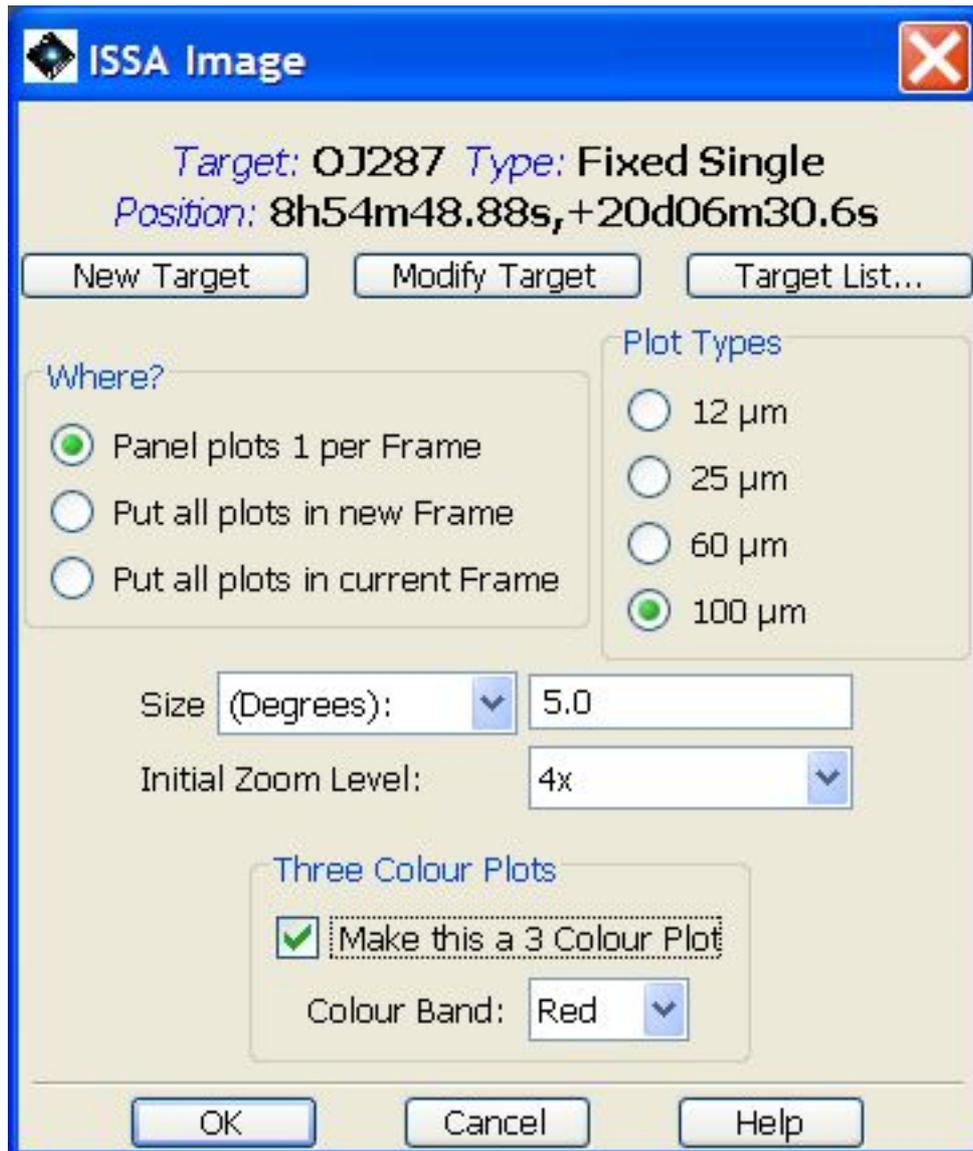
Figure 19.6. The dialogue box to produce a three colour image of the blazar OJ287. To produce an image of suitable size on screen a 5 degree field and 4x zoom have been defined. The "make this a 3 colour plot" box has been ticked and the 100 micron band image defined for the red frame. The "current fixed target" overlay has been used to identify the source with a small box.
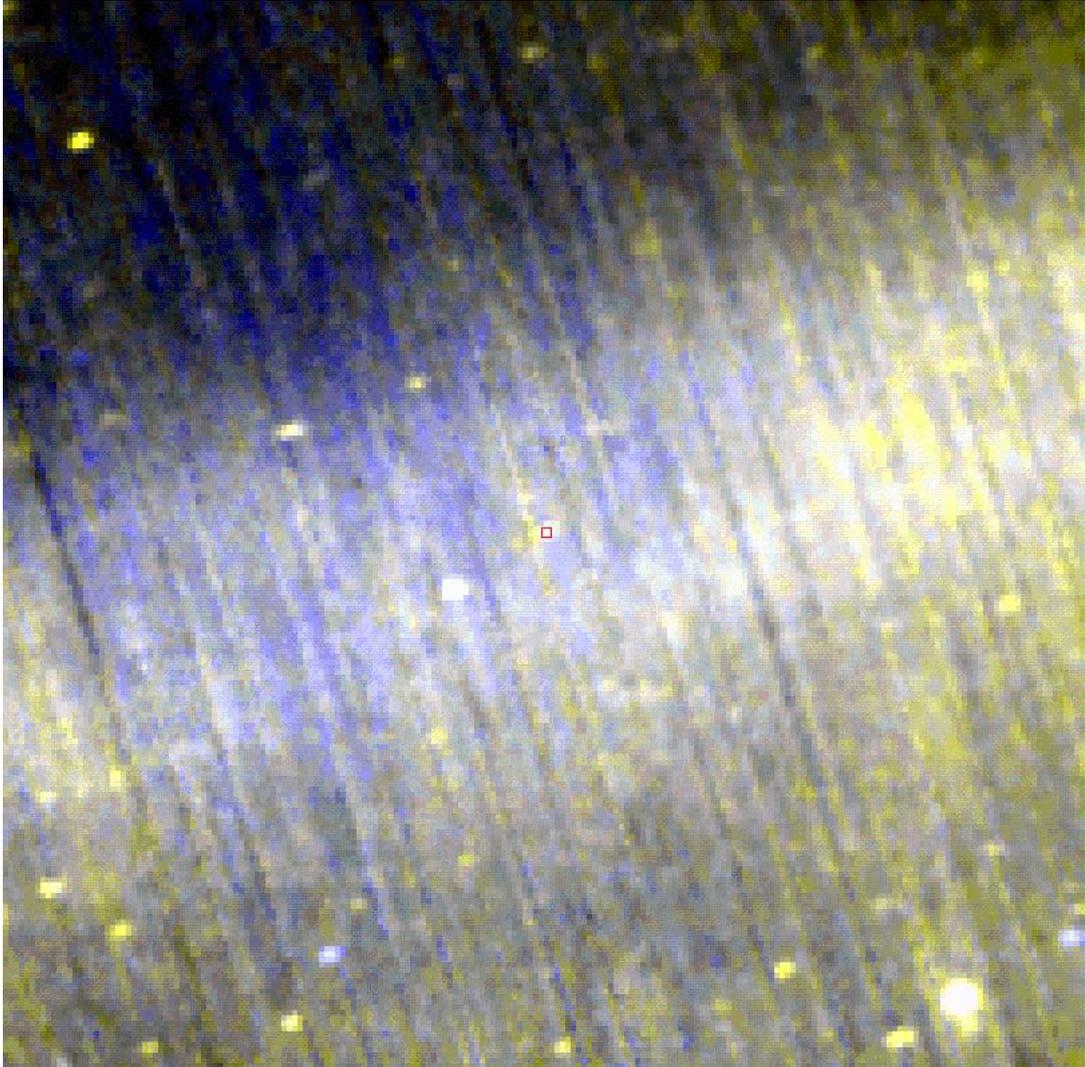
Figure 19.7. A three-colour composite image display for the blazar OJ287 from IRAS data after applying the dialogue in Figure 19.6 - the 100 micron image is mapped into red, the 60 micron image is mapped into green, and the 25 micron image into the blue layer.

The three images do not necessarily need to be from the same image source. For instance, the composite shown in Figure 19.8 is assembled from the DSS image of M51 mapped into the green band, the 2MASS Ks image mapped into red, and the a ROSAT PSPC (from SkyView) mapped into blue. Note that HSpot will automatically perform any transformations for the images, so that they are registered to a common reference frame, using the WCS information in each of the image headers. You can use the layer controls for each image to show/hide the layer, delete the layer, or adjust the colour table for the layer.

HSpot will take the parameters for the first image plane to be defined (e.g. the red image) and will apply those defaults to the other images. Make sure that your choice of field diameter and zoom factor are appropriate for all three images, particularly if you are using different image sources.
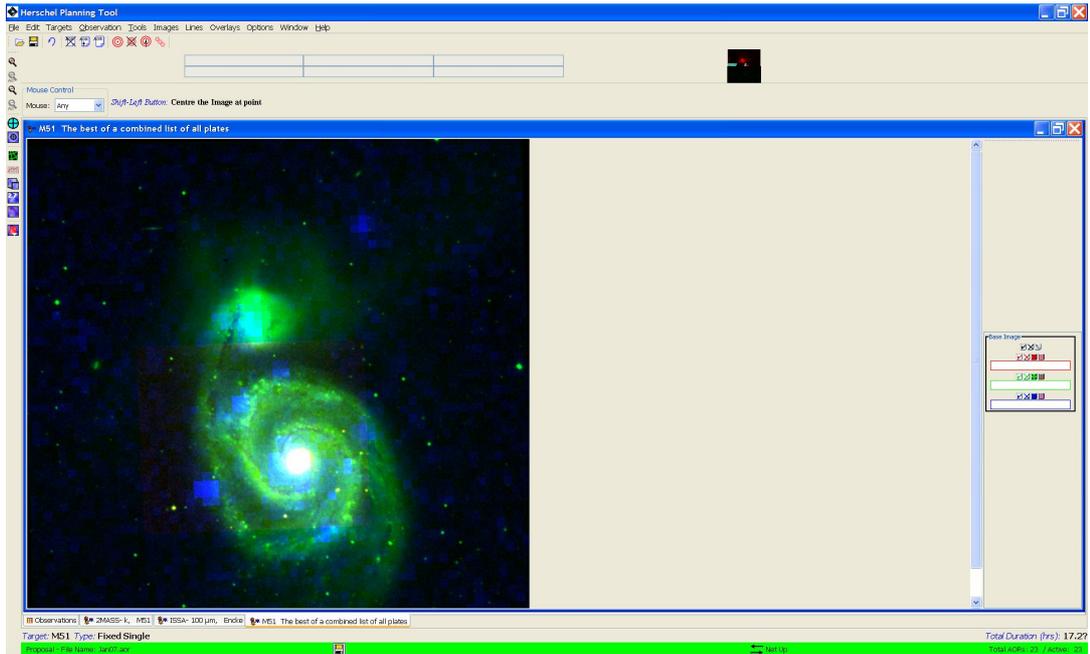
Figure 19.8. A three-colour composite image display for M51 - the DSS image is mapped into green, the 2MASS Ks image is mapped into red, and the ROSAT PSPC into the blue layer. Note that there is only partial overlap between the fields of view of the three images.

19.2.5.1. Image layer control parameter dialogue

When you display a three-colour plot a layer control will appear in the side bar for each layer of the image - this is displayed in the same colour as the layer that it controls - and a further overall control is displayed on top of the three layer controls. The right hand icon of each layer control is "Change Colour Table or Stretch" control. When selected, the dialogue shown in Figure 19.9 is shown.

The user may change the colour table, the data histogram and the image display parameters. By pressing "Apply" you apply the changes and see the effects of them. The "Cancel" option is the panic button: it discards all changes that you have not yet applied. If you press "OK" you accept the changes and leave the dialogue.

To define the stretch, use the pull-down menus to define how you wwish to define the maximum and minimum values for the plot, then set them in the right hand window. You control the type of stretch applied from the "Stretch type" pull-down; options are "Linear", "Log", "Log-Log" and "Histogram equalisation".

At the bottom of the window there are various selection options. You may define the options that you have chosen as defaults for all further plots; be sure to check that the options give acceptable results before doing this. You can also choose to apply the colour table and/or stretch to all the images that you have displayed. This option is useful because you can change the image scaling in a single colour plane - for example from "Linear" to "Log" scaling - and then apply those changes to the other colour planes without having to change each image in turn.
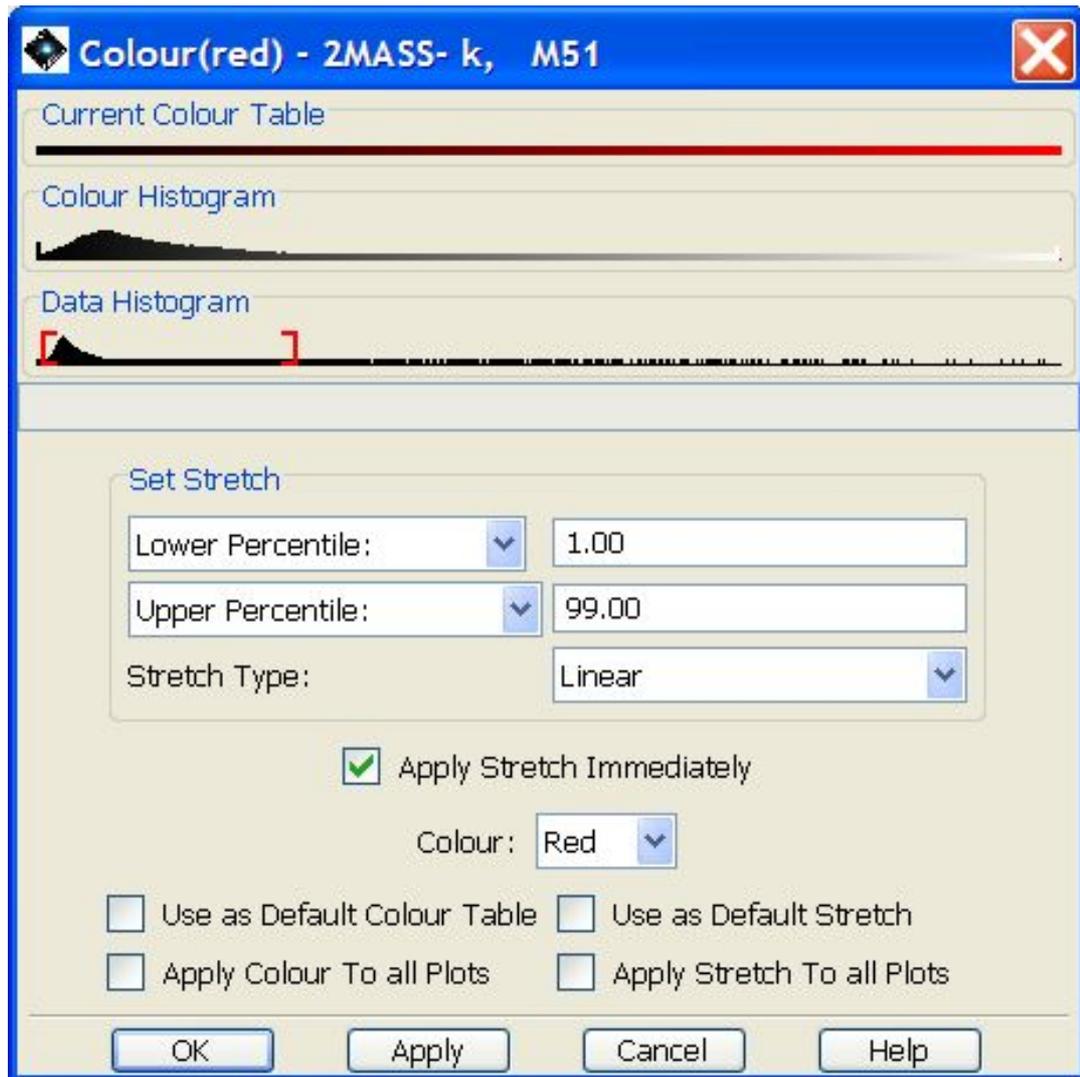
Figure 19.9. The dialogue that opens for each colour layer control in the side bar. The user can change the Look Up Table for the image display, the range of the image histogram to be displayed and the image scaling. The default options are shown.

The dialogue allows you to use the data histogram: that is, the stored fluxes for each pixel to defined the stretch. The range displayed is defined by the red brackets on the "Data Histogram" bar. To change them, click on one of the brackets and drag it, as shown in Figure 19.10
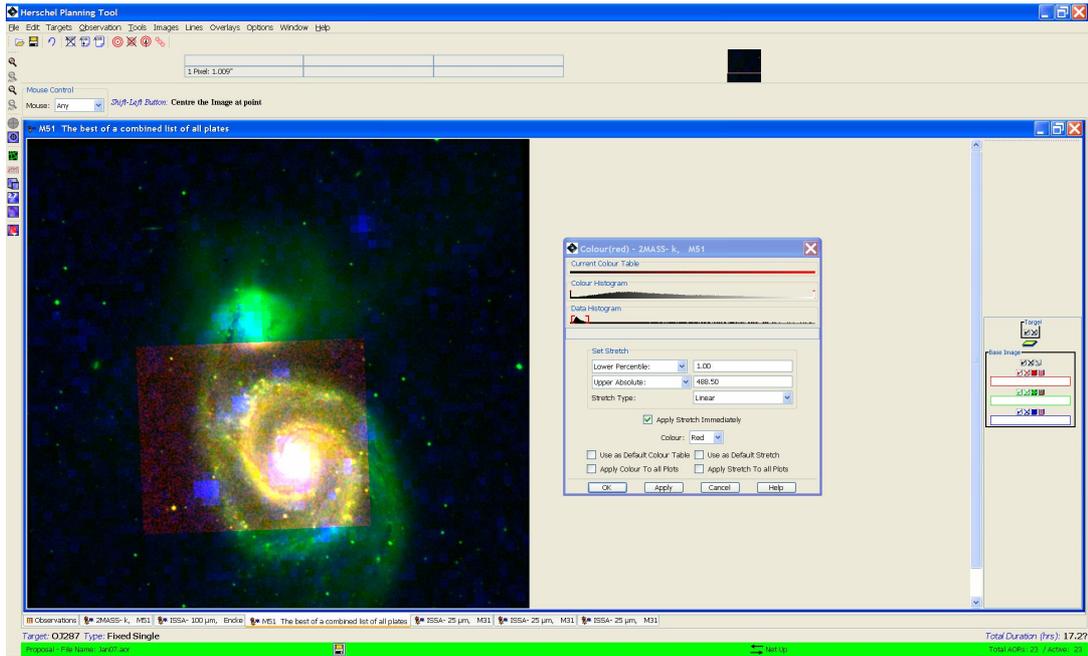
Figure 19.10. An example of changing the data stretch by selecting and dragging one of the red brackets on the data histogram scale. The image display is changed to the values that you have selected and the "Set stretch" changed to "Lower Absolute" or "Upper Absolute" as appropriate.

19.2.6. Current Fixed Target Overlay

To see the position of your target on the current image, select "Current Fixed Target" from the "Overlays" menu (Section 6.8.3). HSpot will display a red box at the coordinate position of the target you currently have selected from the target list. The name of the current target is always listed in the HSpot bottom bar. In Figure 19.11 we show the current target for M31 marked on the ISSA 25 micron image. Another layer control has now been added to the side bars. You can show or hide the Target box with the show/hide layer icon and delete this overlay with the delete layer icon.
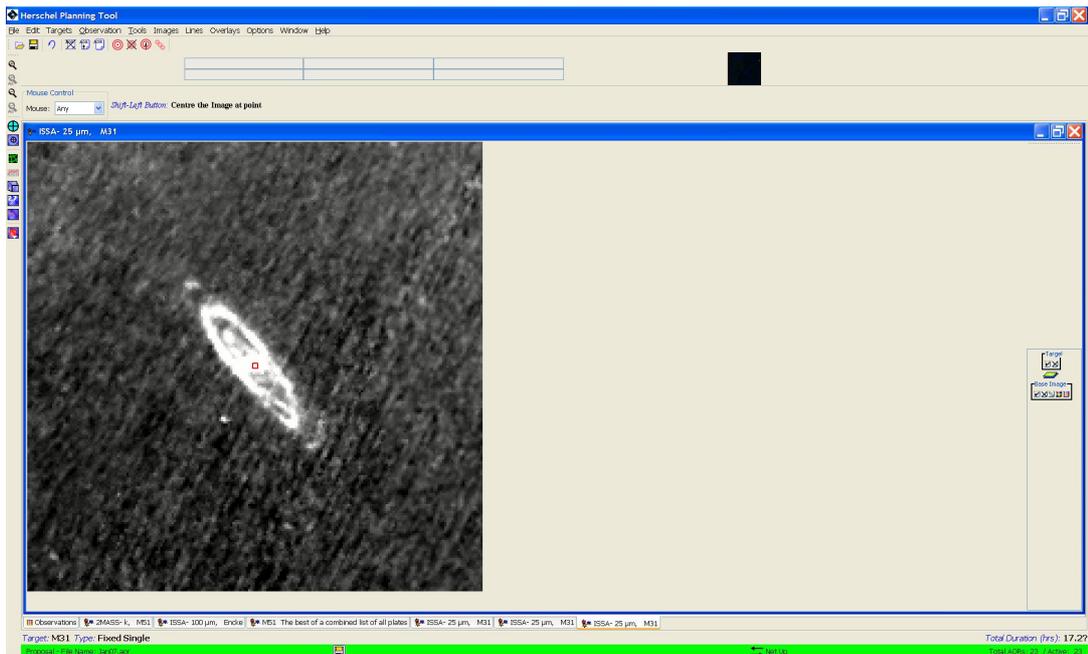
Figure 19.11. The current target position is marked on the ISSA 25-micron image by the red box. To

display a 5-degree ISSA image such as this effectively you should use a zoom factor of about 4, otherwise it will be very small on the screen.

19.2.7. Overlaying a Coordinate Grid

If you select "Grid" from the "Overlays" menu (Section 6.8), or the geodesic icon in the left hand sidebar, HSpot allows you to overlay a coordinate grid on an image. The functionality is identical for both methods of generating a grid. In both cases the dialogue shown in Figure 19.12 will appear. HSpot permits multiple options for the grid coordinates including equatorial and ecliptic coordinates in B1950 and J2000 and Galactic coordinates. HSpot will select the grid spacing automatically unless you deselect the "Use automatic line spacing" box.

If you deselect automatic line spacing the boxes at the bottom of the window will activate. HSpot will expect you to specify a maximum and minimum permitted line spacing for the plot. HSpot will elect a spacing in this range according to the size and scale of the plot; in most cases the minimum will be used unless a very small minimum spacing is defined, in which case the routine will generally choose the maximum requested spacing. This manual option is sometimes required for images that will be zoomed as the automatic grid does not adjust to an increasing zoom factor. When an image is zoomed in the grid spacing will reduce towards the minimum requested separation. Users are recommended to use the automatic spacing as this will be adequate in most cases.

Note

When manual spacing is used, the grid separation plotted by HSpot in R.A. and Dec. may be different.

Examples of manual input and output

IRAS 5 degree field:

- Minimum 1 degree, maximum 2 degrees. HSpot gives 1 degree

- Minimum 0.5 degrees, maximum 1 degree. HSpot gives 0.5 degrees

- Minimum 0.25 degrees, maximum 2 degrees. HSpot gives 0.5 degrees

- Minimum 0.25 degrees, maximum 1 degree. HSpot gives 0.5 degrees

- Minimum 0.25 degrees, maximum 0.5 degrees. HSpot gives 0.5 degrees

- Minimum 0.1 degrees, maximum 0.25 degrees. HSpot gives 0.25 degrees

2MASS 500 arcsecond field:

For a 500 arcsecond 2MASS field, the minimum must be in the range 36-180 arcseconds and the maximum in the range 180-180 000 arcseconds.

- Minimum 60 arcseconds, maximum 500 arcseconds. HSpot gives 120 arcseconds

- Minimum 60 arcseconds, maximum 5 degrees, HSpot gives 120 arcseconds

- Minimum 40 arcseconds, maximum 180 arcseconds. HSpot gives 120 arcseconds.

The result of choosing an equatorial J2000 coordinate grid with automatic spacing for the ISSA 25 micron image is shown on the left in Figure 19.13. The additional layer control labeled "Grid" has also appeared in the right hand side bar. In addition to the show/hide layer and delete layer icons, there is now a coordinate grid control icon. Clicking on this brings up a dialogue where you can change the type of coordinate grid shown in the overlay.

At any point you can remove the overlay by clicking on the X icon in the layer control to the right of the screen. Alternatively, you can plot a new grid, in which case the previous overlay is erased and replaced by the new one.
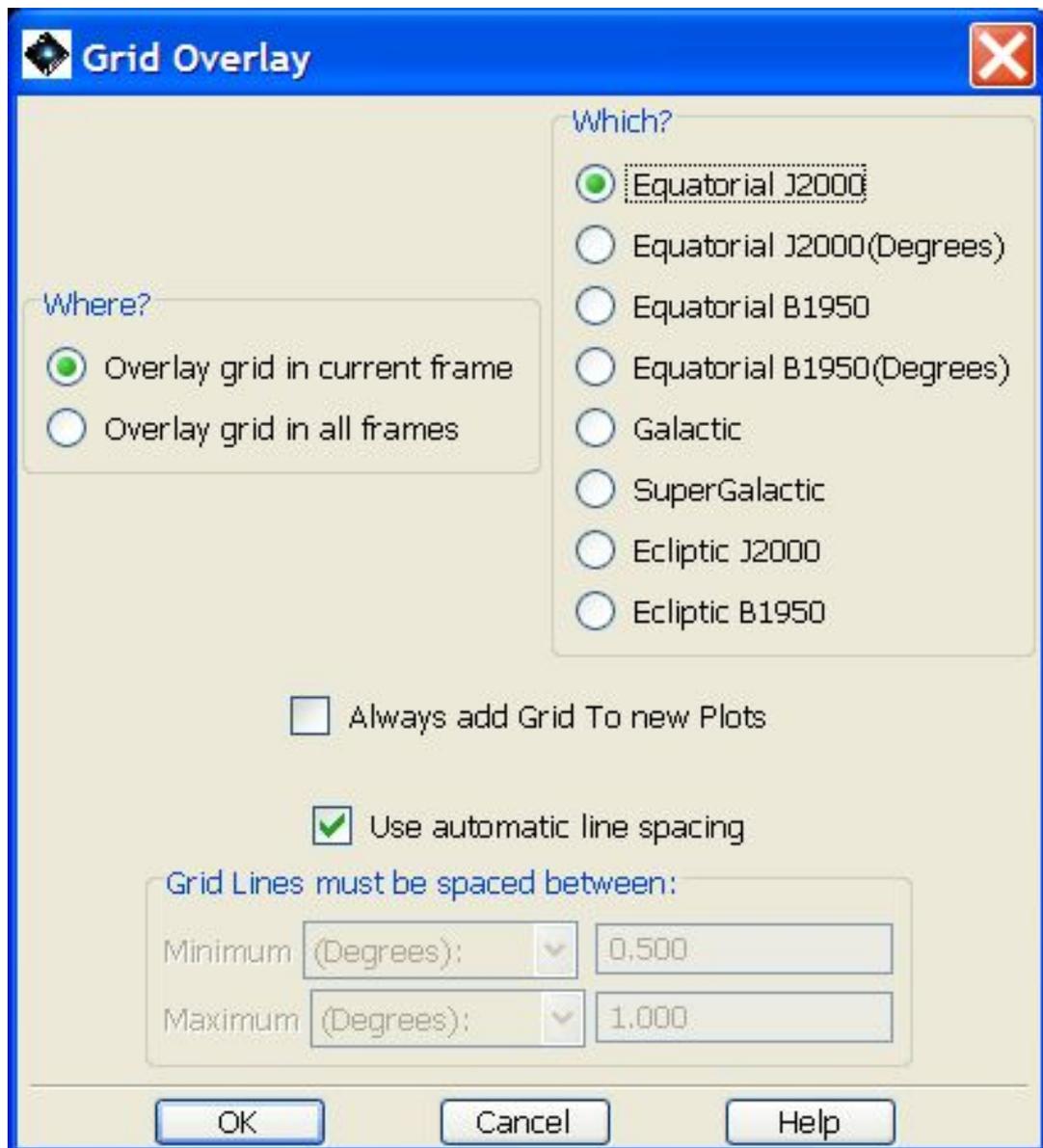
Figure 19.12. The grid overlay dialogue window. The default is to give automatic line spacing. If you untick this box you can define a spacing for the grid lines manually. The manual option is required for images that will be zoomed as the automatic grid does not adjust to an increasing zoom factor.
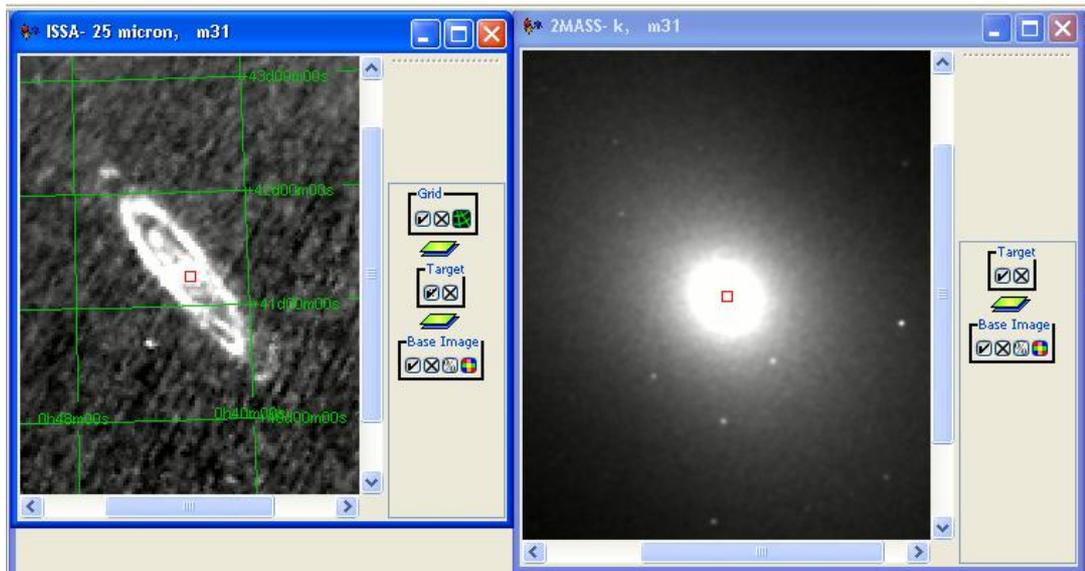
Figure 19.13. An equatorial J2000 (degrees) coordinate grid overlaid on the ISSA 25 micron image of M31.

By clicking on the grid icon a pop-up appears that allows you to change the colour of the grid lines and the overlaid text, as shown in Figure 19.15. Depending on the background colour and intensity it may be necessary to do this to make the overlay clearer and more legible.
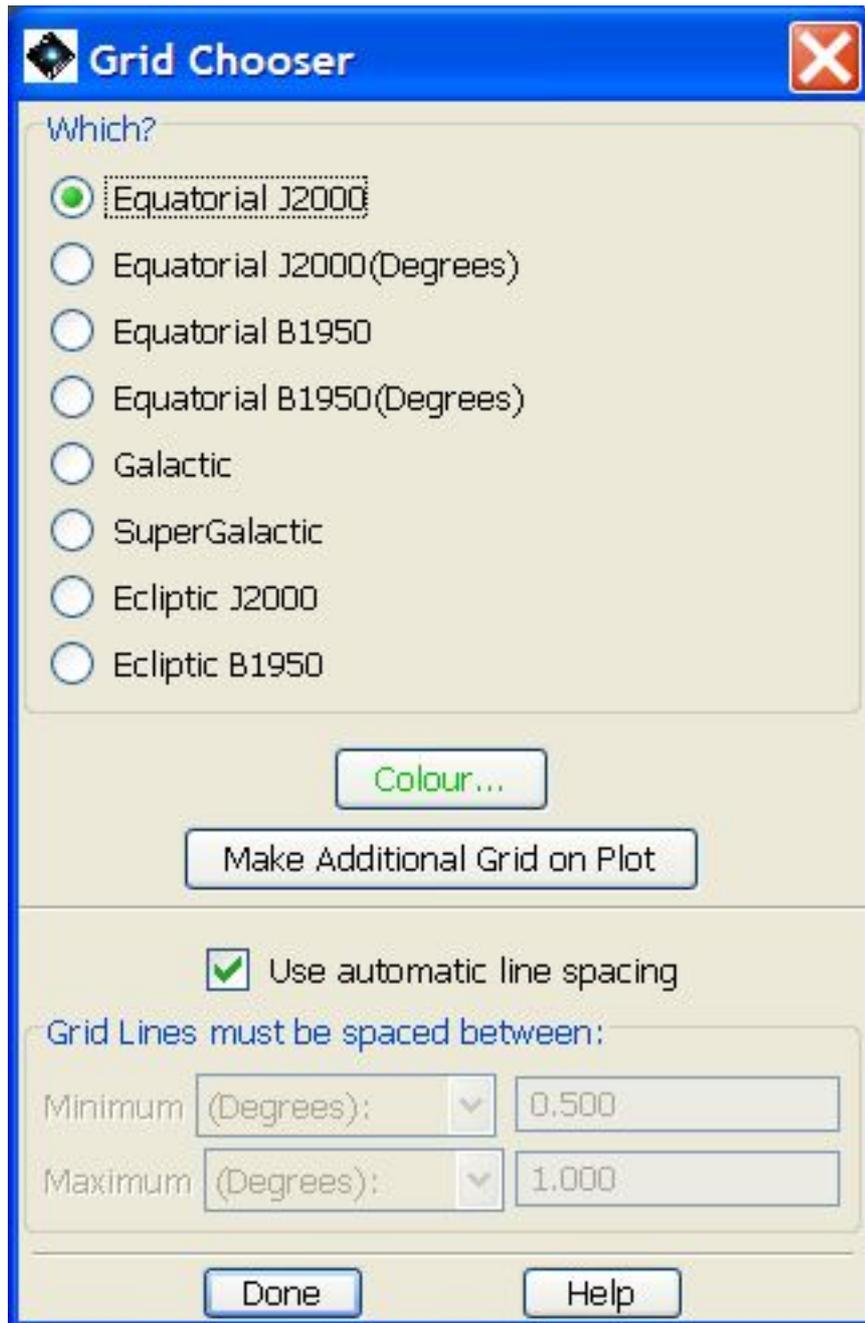
Figure 19.14. The dialogue that permits the style of the grid overlay to be changed by the user. It is often useful to change the display colour to make the overlay more clearly visible, as shown in Figure 19.15.
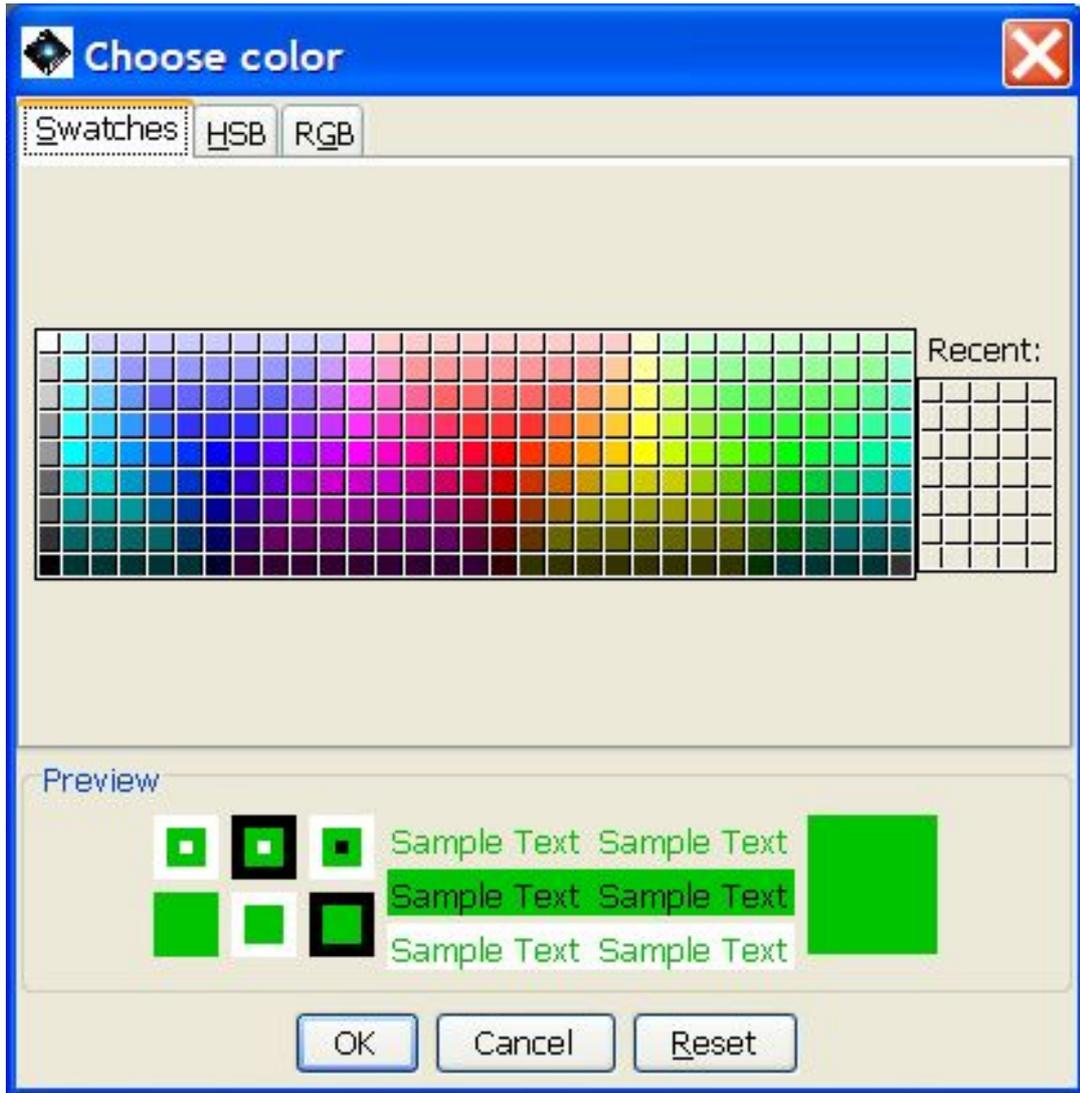
Figure 19.15. The dialogue that permits the colour of the grid overlay and superimposed text to be changed by the user. It is often useful to do this to make the overlay more clearly visible.

19.2.8. Overlaying a Catalogue

In Figure 19.16, we show the dialogue that allows selection of an IPAC catalogue for overlay -- the first item on the "Overlays" menu. The results of the selection in the figure (2MASS Point Source catalogue with a 1.0 degree search radius) are shown in the right image (2MASS K, M31) displayed in Figure 19.17. The layer control for the catalogue has the name of the catalogue, 2MASS PSC. There are four boxes in the layer control that allow you to do various things: The usual hide/show and delete layer icons are now joined by a catalogue table icon.

Click on the catalogue table icon, and a list, such as that seen in Figure 19.18, will appear. Each object in the catalogue found within your specified search radius is listed. As with other target lists you can sort the columns by clicking on the column headers (once for sorting up, twice for down, and a third click will return you to the original order of the catalogue). The colour and shape scheme for the catalogue overlay allow a few kinds of selecting and highlighting so some explanation is needed. When a catalogue is overlaid all the objects' marks in the catalogue are "On" (checked in the 'On' box) and shown with the default red colour. Clicking on a line in the catalogue will activate that object's mark as 'selected'. The colour of that object's mark will change to yellow -- the *selected* colour. Clicking on another line in the catalogue will turn the colour of that object's mark to yellow and the first object's mark will chang e colour back to what it was previously.

You can show all the names for the catalogue sources on the screen, or for a selected few (mark the checkbox in column headed by 'N').

You can highlight certain objects in the catalogue by clicking on the "Hi" box for the object. At first the object's mark will turn yellow (the *selected* colour since you clicked on it). When you click on another object in the catalogue, the first object's mark will turn blue, the highlight colour. Both the selected and highlighted colours of object's marks appear when the object is On ("On" box is checked). If you "Hide All" or otherwise turn off various objects in your catalogue, selecting or highlighting them will not turn the marks back on with the appropriate colour. They must be "On" for selecting or highlighting to work.

By clicking on an object line in the catalogue you make it eligible to be selected as a target and be added to your target list. After selecting the line then hit the "Make Target ..." button at the top of the screen.

The "Colour" box at the top of the "Catalogue Window" controls the colour of the object's marks when they are "On" ("On" box is checked). It does not change the colour of selected or highlighted marks. This will be the colour of object's marks when the objects are "On", but not otherwise highlighted or selected.

Finally, you can save the selected catalogue objects on your local disk using the "Save Table" button at top right of the screen.
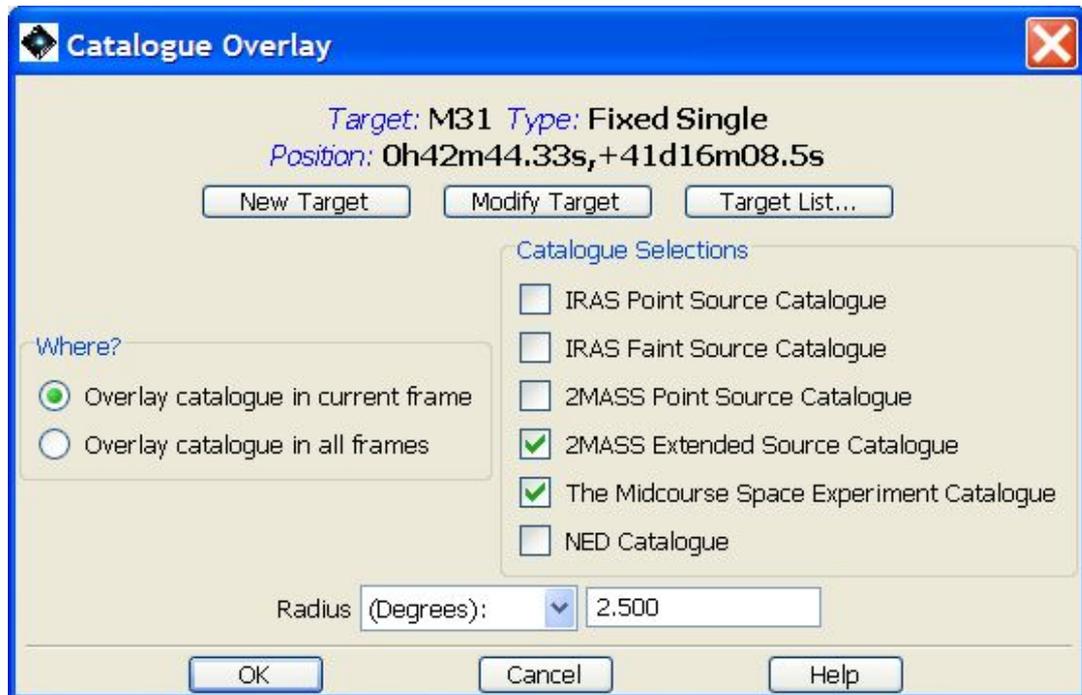
Figure 19.16. The dialogue for IPAC catalogue selection. Catalogue sources can be loaded into all image frames, or just the current image frame.
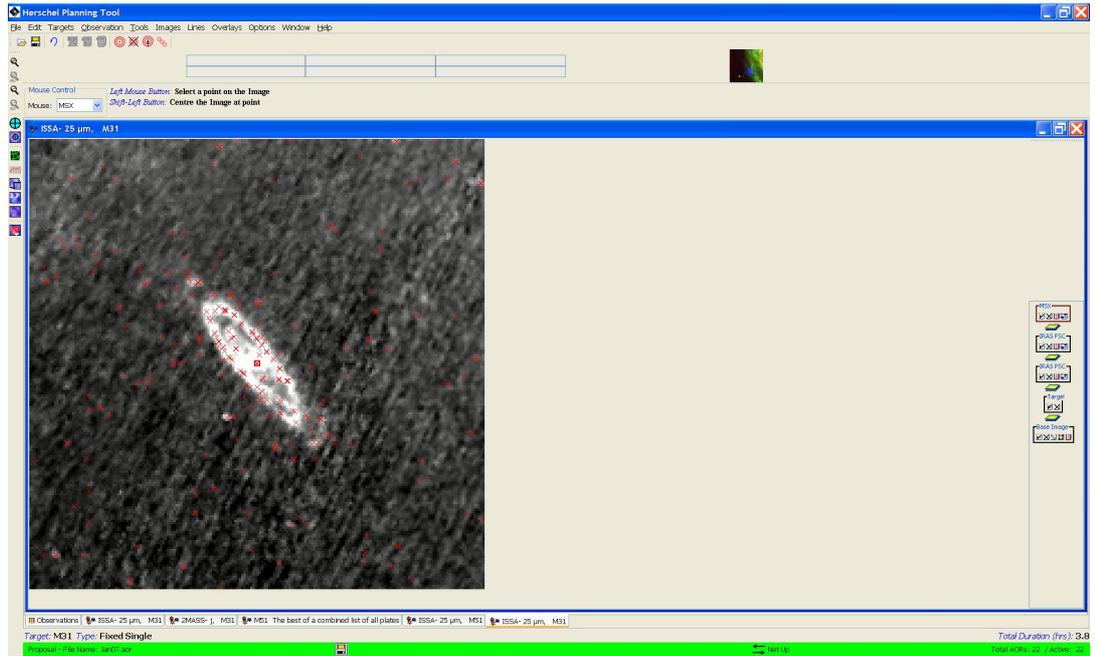
Figure 19.17. Overlay of IRAS Point Source and Faint Source Catalogues and MSX catalogues of objects overlayed on the image of M31.

Figure 19.18. Clicking on the catalogue table icon allows the display of catalogue details (e.g., MSX magnitudes for our point sources in the overlay).

> **Note**
>
> This is one of the cases where the different platforms on which HSpot runs have different flavours. Users will notice that the overlay symbol used in Windows is significantly smaller than the symbol in MAC or Linux. Unfortunately the user has no control over the symbol size, which is set by the platform itself.

19.2.8.1. SkyView catalogue overlay

The display works in a similar fashion for the SkyView catalogues as in the case of IRAS, 2MASS, MSX and NED catalogues offered by ISSA.

SkyView offers 271 catalogue options, which cover all wavelengths from radio to high energies and include numerous well-known catalogues such as the Bright Star, SAO, USNO A2.0 and Tycho star catalogues and the Veron-Cetty and Veron AGN catalogue. Catalogues are listed alphabetically. The menu is shown in Figure 19.19. These range from all-sky catalogues to specific source or region-oriented ones (e.g. catalogues of Pleiades or Hyades cluster stars), to telescope observing logs (e.g. ROSAT and Einstein). The user may select as many catalogues as he/she requires for display; pressing the "Clear Selections" button clears all the selected catalogues.
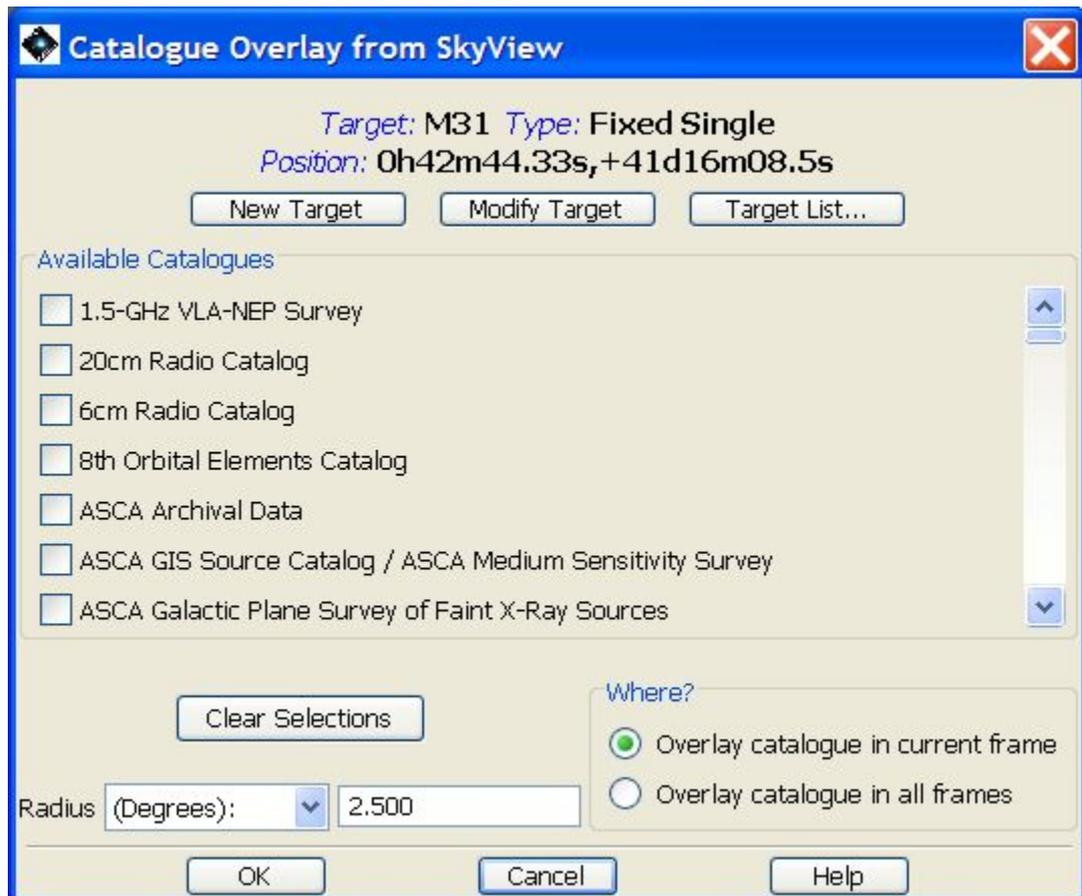
Figure 19.19. Clicking on the SkyView catalogue overlay option allows 271 catalogues to be overlaid on the displayed image.

> **Warning**

As of December 2006, all but four of the 271 SkyView catalogues overlay correctly on HSpot images. The four that do not are the HST Guide Star catalogue, the Old Chandra Master Catalogue, the USNO A2.0 catalogue and the ROSAT All-Sky Public Archival data catalogue, which all give format errors. These errors are under investigation and will hopefully be corrected in an upcoming release of HSpot.

19.2.8.2. Changing the overlay scale

If you click on the right hand icon of the overlay dialogue (two half arrows) a dialogue opens as shown in Figure 19.20. You may use the drop-down menus to select the band to be constrained and the constraint to be applied to the overlay (either to display a limited range of magnitudes/fluxes, or to display only magnitudes/fluxes outside the range that is displayed -- i.e. sources brighter and/or fainter than a certain limit). For example, you can decide to use 2MASS J in the overlay and only to display sources brighter than J=9. The range of magnitudes to be displayed is controlled by the two sliders.
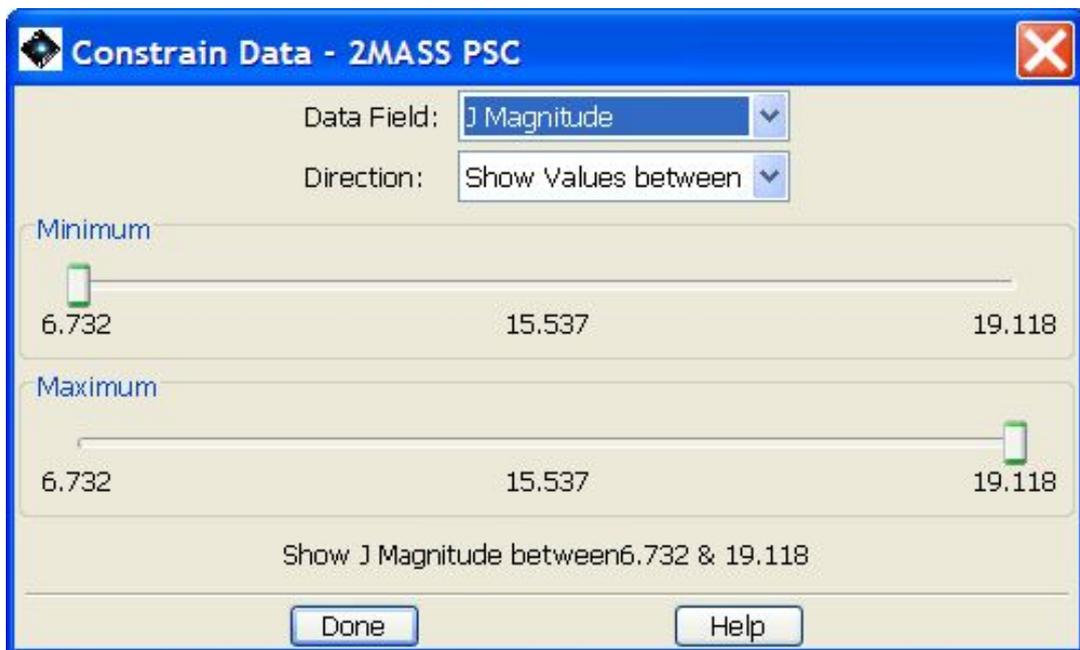
Figure 19.20. Clicking on the "constrain data" icon to the right of the cluster of overlay control icons in the sidebar brings up this dialogue. The dialogue permits the user to change the band and the limiting magnitude/flux of the sources overlaid.

Note that there is a slight difference in behaviour on different platforms. With Linux and MAC the display will update as you hold and move the slider. In Windows the display does not update until the slider is released after moving it.

19.2.8.3. Overlaying an Image

It is possible to overlay one of more image onto another by selecting "Image Overlays" in the "Overlays" pull-down menu. Once you have selected your base image from the "Images" pull-down menu, the "Image Overlays" menu allows you to select another image (either ISSA, 2MASS, MSX, DSS, SkyView, NED, or a user-selected FITS image from local disk) to overlay on the base image. The opacity of each image can be controlled using the opacity control dialogue that pops up when you press the icon in the layer control box for each image. In Figure 19.21 we show an example of a MSX 8 micron image overlaid on a DSS image of NGC 2024. In this example the opacity for each image has been adjusted to 50%. You can vary an image's opacity by adjusting the slider on the control. You can continue to overlay additional images, if desired. Also, you can perform these image overlays in colour (red, green, or blue), by selecting "Make This a 3-Colour Plot" when overlaying an ima ge. The three-colour image visualisation described in Section 19.2.5 is analogous to this util-

ity.
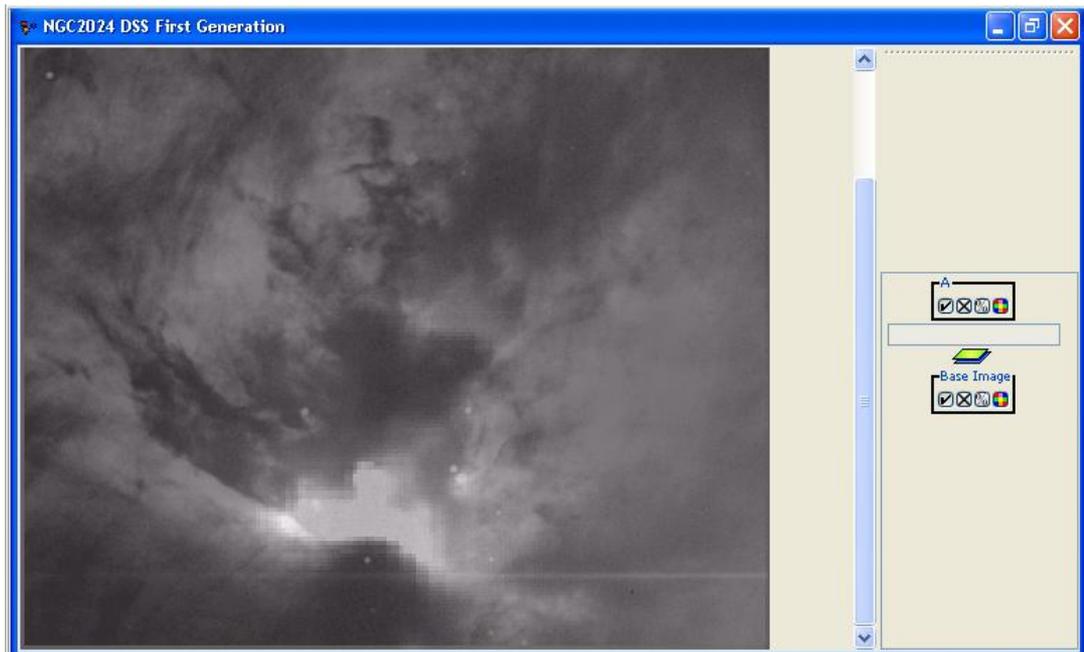
Figure 19.21. An example of Image Overlays. Here we have overlaid a MSX 8.28 micron image on a DSS image of NGC 2024. The opacity of each image can be adjusted using the opacity control. In this example, each image's opacity has been adjusted to 50%.

An even more spectacular example showing several functionalities is shown in Figure 19.22 where a 0.5 degree diameter DSS Red image of M31 is displayed with an ISO-CAM image overlaid, with the histogram changed to a colour scale (by clicking on the rainbow icon in the righthand sidebar) and then a 1 degree 8.28 micron MSX image overlaid on that.
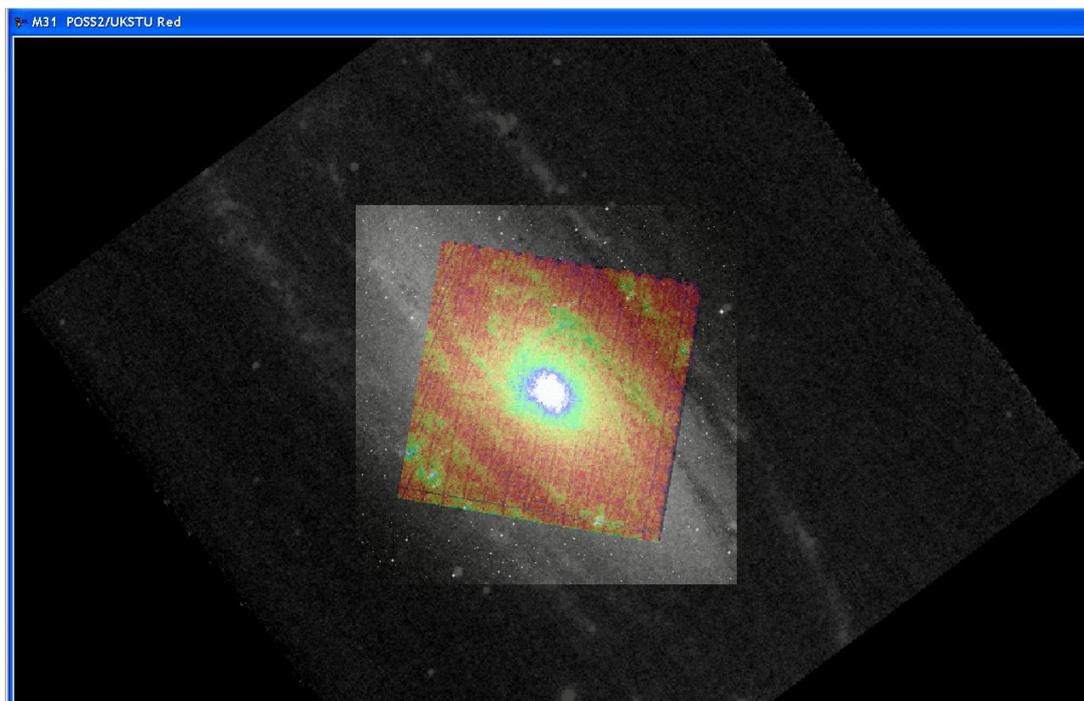
Figure 19.22. An more complex example of Image Overlays. An ISO-CAM image with a colourscale display and an MSX 8.28 micron image are overlaid on a 0.5 degree DSS Red image.

19.2.8.4. Overlaying AORs

> **Warning**
>
> When you display an AOR any constraints that you have added (chopper avoidance angle, map orientation, etc.) will not be taken into account in the display. Please ensure that the date selected is compatible with any constraints that you may have put on the observation.

Descriptions of how to overlay the Herschel focal plane and AORs was given in Section 20.6.6 and Section 19.2.8.4. We now provide some examples that explain in more detail how to use the AOR visualisation features. Overlaying the area footprint of your AOR will be particularly useful if you are concerned about covering or avoiding particular features on the sky and need to determine how the AOR will be oriented on the sky during its visibility periods. This is also a valuable tool in assessing whether or not the science you hope to accomplish with the AOR will be successful. It is always a good practice to visualise your AORs as you develop your observations for proposal submission or programme revision.

SPIRE Photometry AOR

In this example we illustrates the visualisation of SPIRE Point Source Photometry AOR.

1. From the drop-down menu "Observations" choose SPIRE Photometer...

2. In SPIRE Photometer window, add new target by clicking on "New Target" button.

3. For this example we are going to use NGC 7027. So enter the name, resolve it with Simbad or NED, check the visibility and then exit from the target window by clicking on the "OK" button.

4. Next, you may want to re-label the AOR to some more relevent name: as we are using NGC 7027 in this example then our choice is Sphoto-ngc7027-point.

5. In the "Instrument settings" section select source type "Point Source".

6. And then we click on "OK" as our AOR is ready.

7. From the drop-down menu "Images" select the image archive you want to use. We use DSS image, POSS2/UKSTU Red and image of size 0.25 by 0.25 degrees.

8. Once the image is downloaded it opens in a new tab of HSpot

9. You can overlay the created AOR using the drop-down menu "Overlays" and choosing "Current AORs". This brings up a new window where you should select the observational date. We suggest to use the first day in any of the observing windows. For this example we use 2009 Mar 31.

10. This will overlay the AOR on the image. If there are more than one AOR in the main HSpot panel then you have the choice to overlay the current AOR (the one that is selected, marked by a blue line).

    This overlay shows the four nod positions for this SPIRE observing mode, but two of them are the same so that is why there are only two green rectangles of 4x8 arcmin.

    The overlay also shows the chopping pixels (as blue circles) for the nod positions.

11. It is also important to check the position angle of the AOR at the last day of the visibility window so that one has an idea of the changes in the chopping directions. This is important when there are bright sources which is better to avoid to chop onto. To display the AOR at different date without loosing the previous AOR you can follow 9.

12. The final picture with the same AOR at the two extreme dates of the visibility window: 2009 Mar 31 and 2009 Aug 01 is shown in Figure 19.23
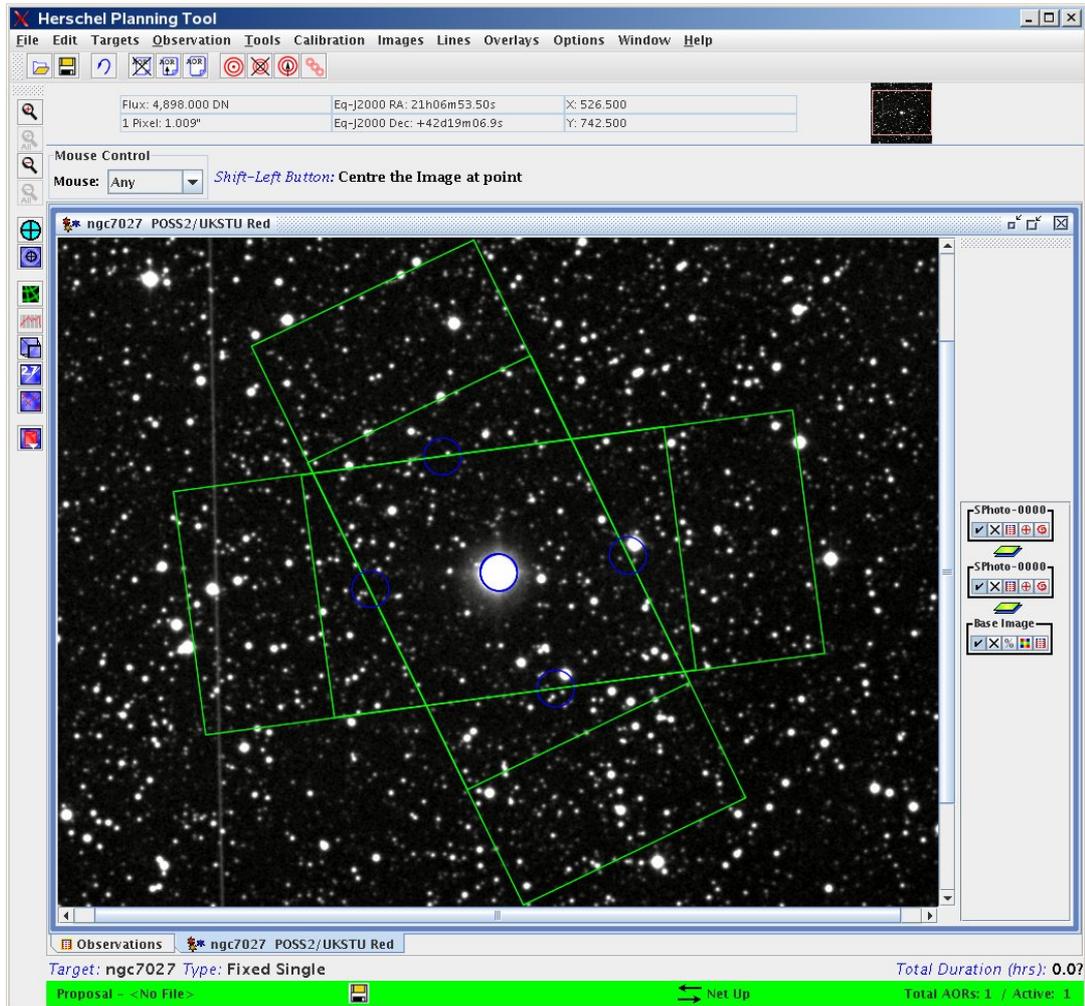
Figure 19.23. SPIRE Point Source Photometry: an example of an AOR overlay.

PACS Photometry AOR

This example illustrates the visualisation of a PACS Photometry AOR parametrised in "Small-source photometry" observing mode. As a first step, create a sample AOR with default parameters and change only the following settings:

- Target: NGC7027

- Observing mode: Small-source photometry

Go to the "Images" pull-down menu and and select the archive from which you wish to display the background image (in the sample figure a DSS image of size 0.5 by 0.5 degrees was retrieved).

In the "Overlays" pull-down menu select option "AORs on current image...". The current AOR is the one highlighted with blue in the main HSpot window, this will be visualised by default.

Now, you have to select an observing day from the list of visibility windows. Let's set a time close to the beginning of one of the available windows. In the sample image date 04 October 2008 was choosen at observing time 0.0hr.

The combination of telescope positions and chopper positions are shown by overlayed frames with size of the PACS Photometer array's footprint. On-source positions are plotted with green and chop-

per off-positions are given in red colour. Using the animation facility of the pointing table the sequential chopping/nodding scheme can be reproduced (see possibilities for manipulation of the overlay and background images in Section 20.6.9).

In order to visualise the allowed range of position angles of the footprint image, you should add the overlay of the AOR for a time close to the end of the visibility window. In the example an image date of 30 January 2009 was choosen with an observing time of 0.0hr.
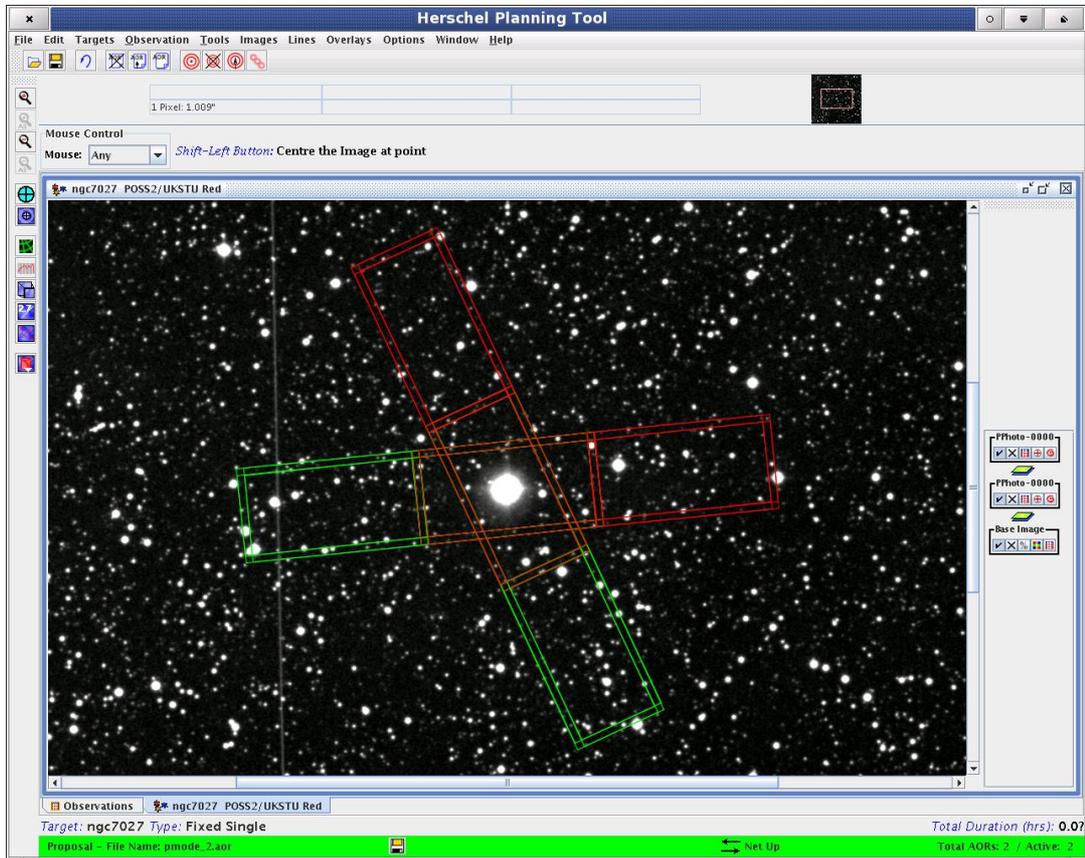
Figure 19.24. PACS "Small-source photometry" observation shown overlayed on a DSS background image of NGC7027. The choper off-positions are shown in red, the two footprints correspond the borders of the object visibility window respectively.

HIFI Pointed and Spectral Scan AORs

Once a HIFI pointed or spectral scan AOR has been constructed (see Chapter 13), a visualisation of the telescope pointings can be made.

First select the AOR of interest from the main "Observations" window by a single click.

Go to the "Images" window and pull-down to the image type you want displayed (e.g., an ISSA image, to show an image of IRAS data for the region). Choose the band and window size for the image type chosen. HSpot will now fetch the image from where it is stored on the net and display it as a separate window.

Go to the overlays window and pull-down to "AORs on current image...". One or more chosen AORs from the "Observation" window can now be overlayed on your image. The current AOR is the one clicked earlier. Selected AORs have the "On" checkbox ticked in the "Observations" window.

The telescope positions are shown by overlayed circles with widths the same size as the beamwidth for the band chosen in the AORs selected. Chopped positions are shown by green circles.

An example is shown in Figure 19.25
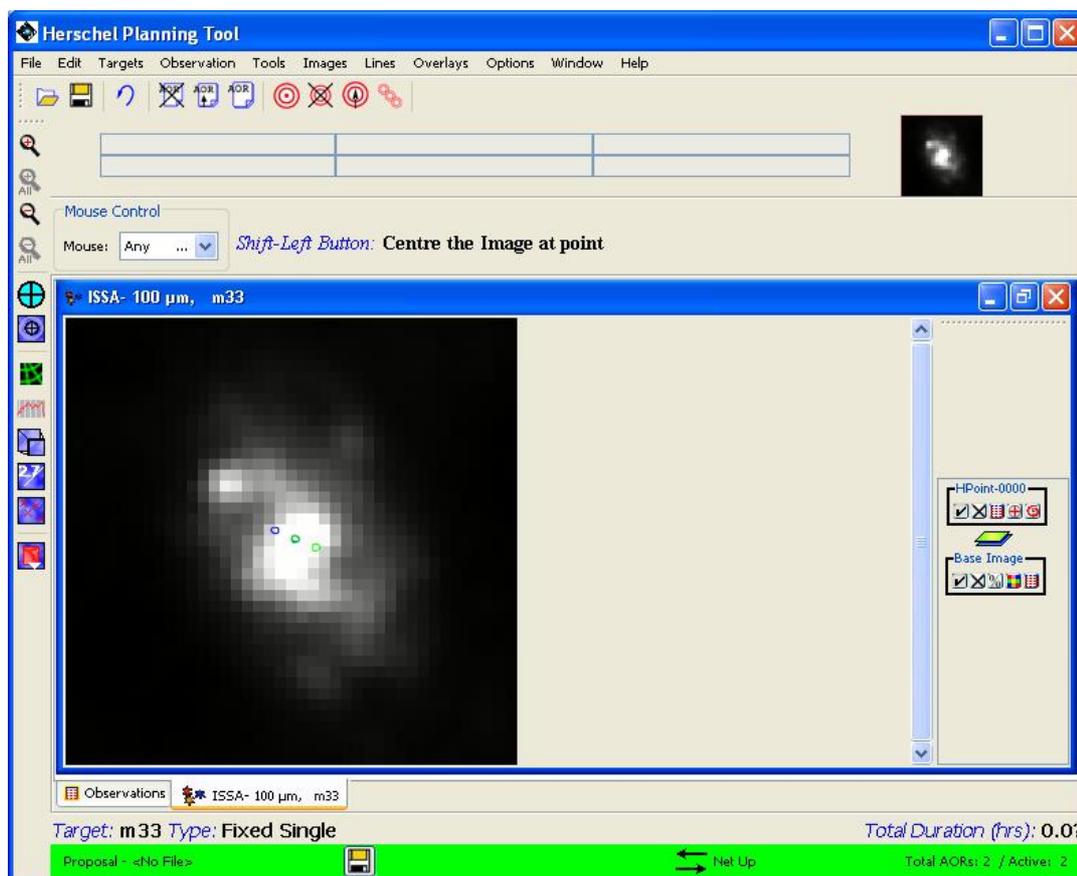
Figure 19.25. HIFI dual beam switch observation shown overlayed on an one degree ISSA 100 micron image of M33. Note that the chopped positions are shown in green. Three arc minutes exist between each beam position.

SPIRE Mapping AOR

In this example we illustrates the visualisation of SPIRE Large Map AOR.

1. From the drop-down menu "Observations" choose SPIRE Photometer...

2. In SPIRE Photometer window, add new target by clicking on "New Target" button.

3. For this example we are going to use M31. So enter the name, resolve it with Simbad or NED, check the visibility and then exit from the target window by clicking on the "OK" button.

4. Next, you may want to re-label the AOR to some more relevent name: as we are using M31 in this example then our choice is Sphoto-m31-lmap.

5. In the "Instrument settings" section select source type "Large Map".

6. In the Large Map Parameters section enter the scan leg and the cross-scan length. We use 20x120 arcmin in this example.

7. And then we click on "OK" as our AOR is ready.

8. From the drop-down menu "Images" select the image archive you want to use. We use an ISSA image at 100 μm with the default size of 5 degrees.

9. Once the image is downloaded it opens in a new tab of HSpot

10. You can overlay the created AOR using the drop-down menu "Overlays" and choosing "Current AORs". This brings up a new window where you should select the observational date.In this example we use 2010 Feb 22.

11. This will overlay the AOR on the image.

    The overlay is shown in Figure 19.26. Note that the position angle of the scan depends on the observation date so you should check the overlay at a different date.
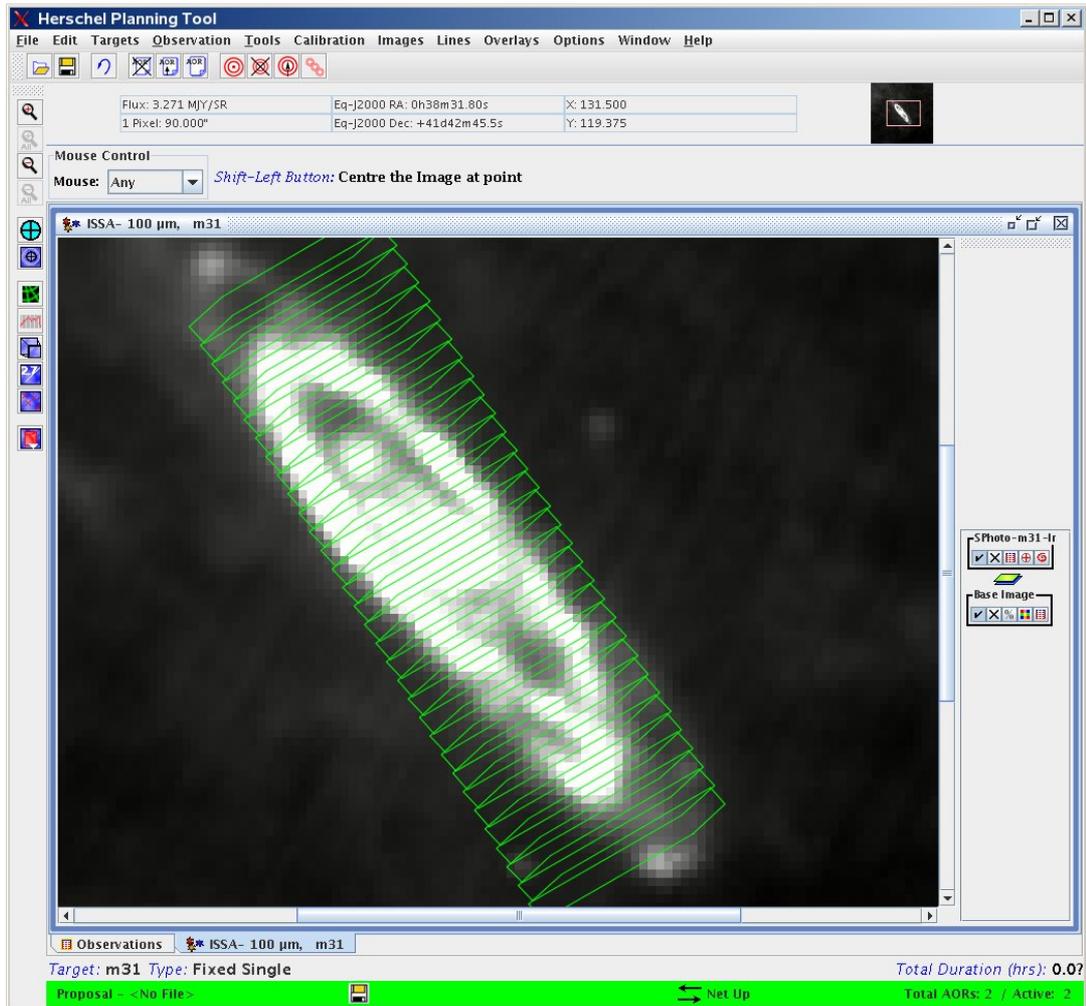
Figure 19.26. SPIRE Large Map example of an AOR overlay.

PACS Mapping AOR

This example illustrates the visualisation of a PACS Line Spectroscopy AOR parametrised in "Mapping" observing mode. As a first step, create a sample AOR with default parameters and change only the following settings:

*   Target: NGC7027

*   Observing mode: Mapping

*   Chopper throw: Medium

- Map parameters: set raster point step and raster line step to 25 arcseconds for a 2 by 2 two mini-imap

Go to the "Images" pull-down menu and and select the archive from which you wish to display the background image (in the sample figure a DSS image of size 0.5 by 0.5 degrees was retrieved).

In the "Overlays" pull-down menu select option "AORs on current image...". The current AOR is the one highlighted in blue in the main HSpot window; this will be visualised by default.

Now, you have to select an observing day from the list of visibility windows. We set a time close to the beginning of one of the available windows. In the sample image date 04 October 2008 was choosen, with an observation time of 0.0hr.

The combination of telescope positions and chopper positions are shown by overlayed frames with size of the PACS Spectrometer array's footprint. On-source positions are plotted with green and chopper off-positions are given in red colour. Using the animation facility of the pointing table the sequential chopping/nodding scheme can be reproduced (see possibilities for manipulation of the overlay and background images in Section 20.6.9).

In order to visualise the allowed range of position angles of the footprint image, you should add the overlay of the AOR for a time close to the end of the visibility window. In the sample image date 30 January 2009 was choosen at an observation time of 0.0hr.
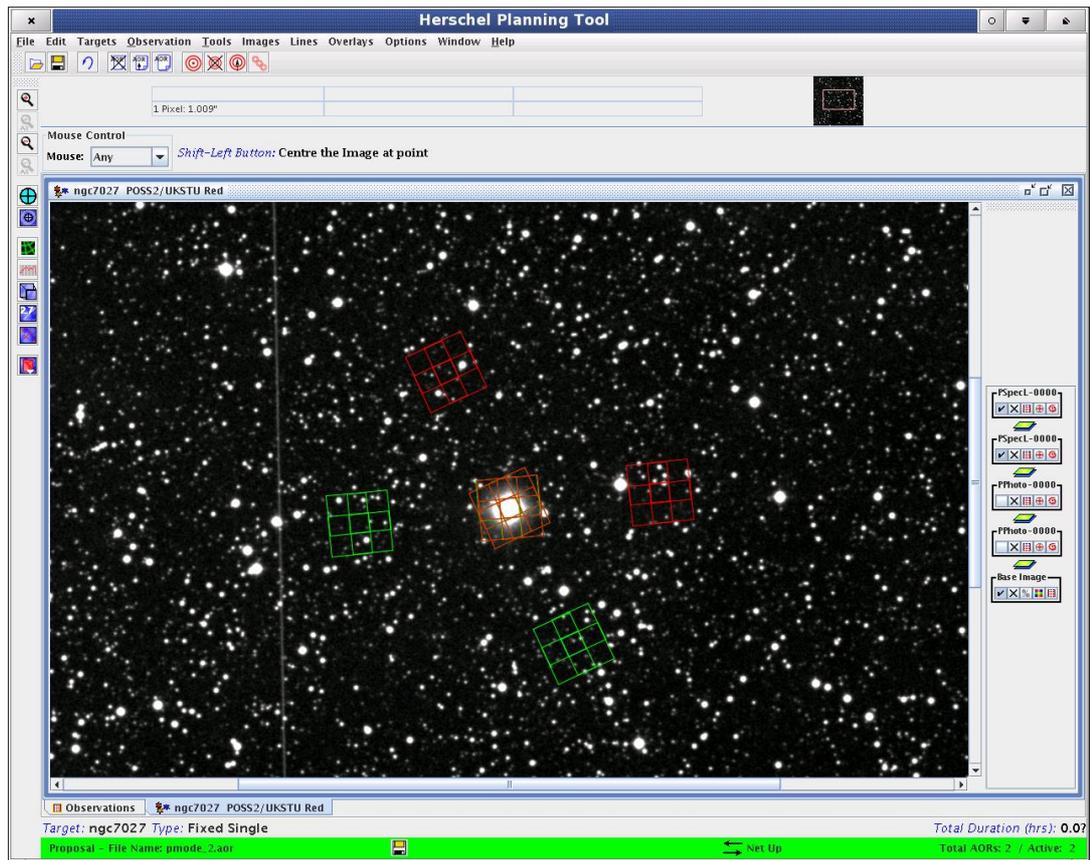
Figure 19.27. PACS Line Spectroscopy "Mapping" observation is shown overlaid on a DSS background image of NGC7027. The chopper off-positions are shown in red. The two footprints correspond to the beginning and end of the object visibility window.

HIFI Mapping AOR

Once a HIFI mapping AOR has been constructed (see Chapter 13), a visualisation of the telescope

pointings and/or scans can be made.

First select the mapping AOR of interest from the main "Observations" window by a single click.

Go to the "Images" window and pull-down to the image type you want displayed (e.g., an ISSA image, to show an image of IRAS data for the region). Choose the band and window size for the image type chosen. HSpot will now fetch the image from where it is stored on the net and display it as a separate window.

Go to the overlays window and pull-down to "AORs on current image...". One or more chosen AORs from the "Observation" window can now be overlaid on your image. The current AOR is the one clicked earlier. Selected AORs have the "On" checkbox ticked in the "Observations" window.

An example is shown in Figure 19.28
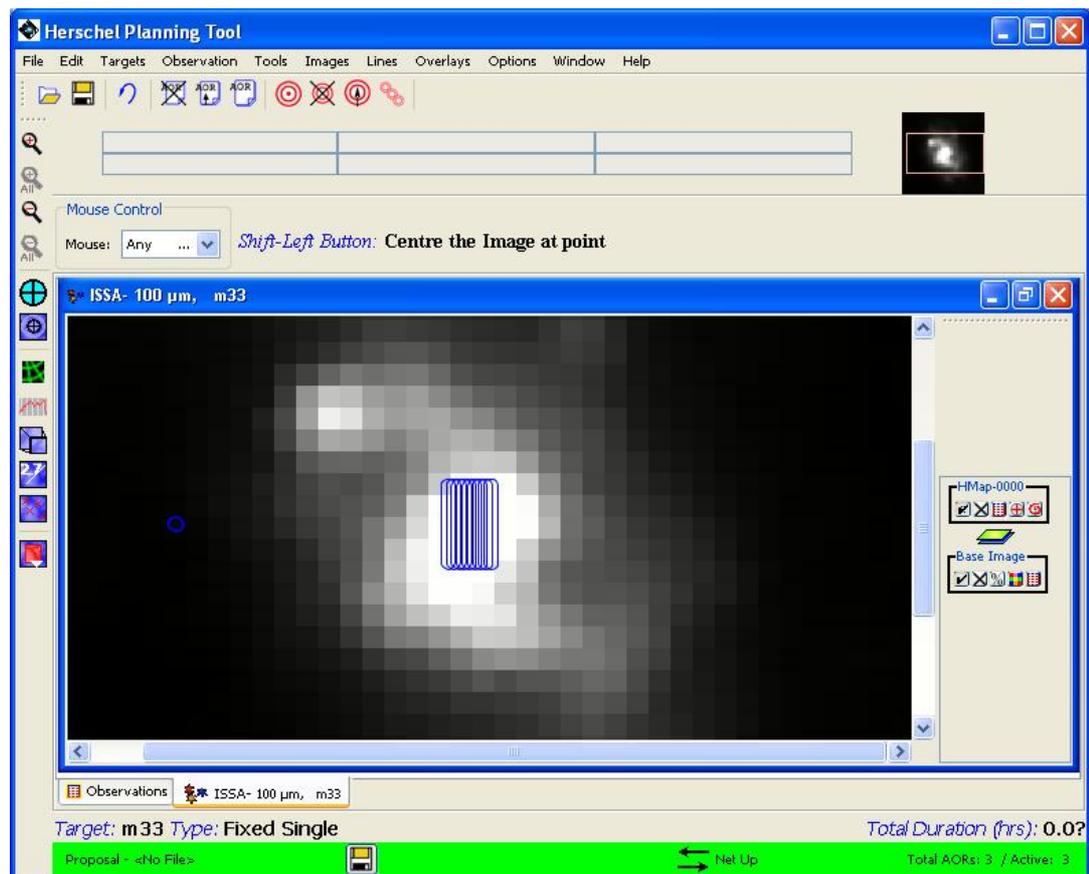
Figure 19.28. A 5' x 3' HIFI On-the-Fly scan map observation shown overlayed on an one degree ISSA 100 micron image of M33 (enlarged). An OFF position was chosen 20 arc minutes away in RA, at the position of the single circle.

AOR overlay control

When you overlay an AOR various icons are generated that enable you to control the AOR layer (see Figure 19.29). If we select the fourth button from the left (see Figure 19.30) we open a dialogue that controls which parts of the AOR overlay are displayed; each observing mode produces its own individual display according to the available options -- some of the PACS and SPIRE options are shown in Figure 19.31.

For each AOR that is overlaid you may select which elements are displayed. This can be used to un-clutter the screen if the display become overly crowded, or to identify individual elements, such as which is the on and which the off position. The display can be toggled to display and hide individual elements as many times as is required.
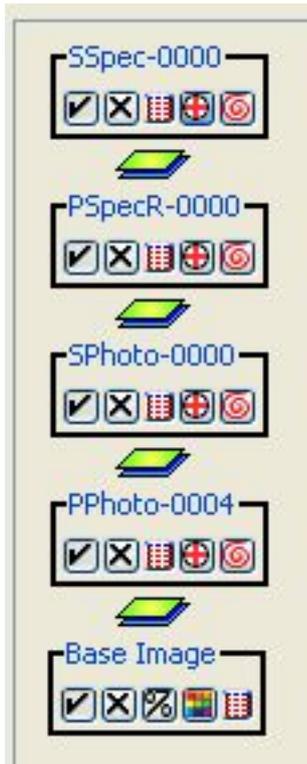
Figure 19.29. The overlay control icons that appear to the right of the screen when an AOR is overlaid on an image.

Figure 19.30. The icon the controls which elements of the AOR overlay are displayed.
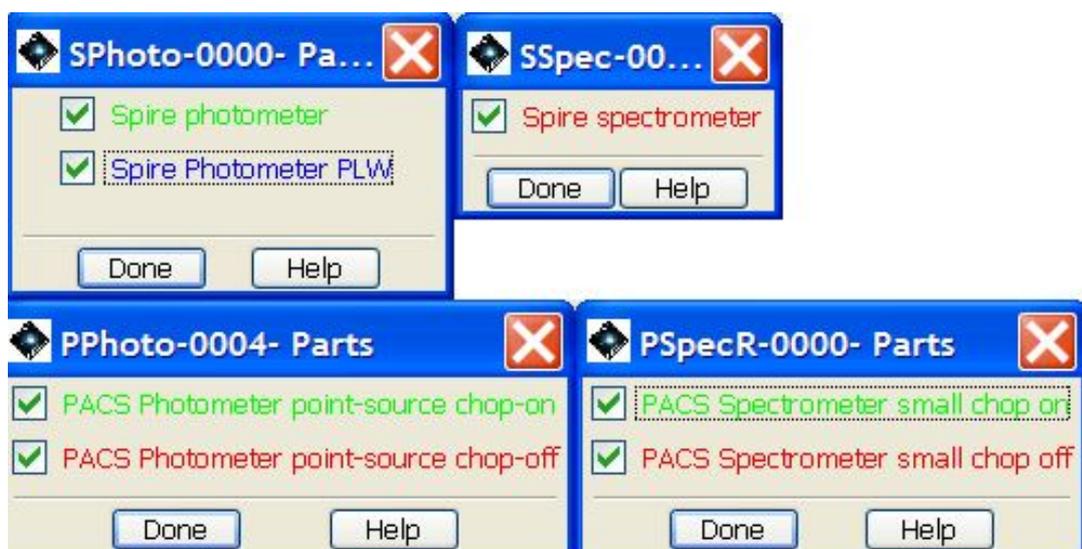
Figure 19.31. A selection of PACS and SPIRE AOR overlay control options. The user can select or deselect options to be displayed on screen to identify different elements of the AOR (e.g. the on or off position) and/or unclutter the screen.

19.2.9. PACS Depth of Coverage Map Tool

Scrolling down in the "Overlays" menu the "Show Depth of Coverage Map on Current Image..." option can be found at the end of the list. This option is made available only for PACS Photometer observations. If the current AOR is any other type of observation then this option appears in disabled mode. The depth of coverage map behaves similar to the AOR overlay images but in addition to the detector matrix contour it shows the relative exposure time spent on a certain position of the covered region. This information is useful to check inhomogeneities in the exposure due to map geometry effects, gaps and bad pixels in the detectors.

The HSpot depth of coverage map will not accurately display the map at or near the poles (+/- 90 degrees). This issue is common to both spot and HSpot and may be improved with improved display capabilities in the future.

The depth of coverage map are not very sophisticated and rebin the depth of coverage FITS file to the native resolution of the underlying sky image. This means that for coarsely sampled images, such as ISSA plates, the depth of coverage maps are highly pixelated.

The FITS file produced by the depth of coverage map algorithm is saved in your cache directory (usually .spotherschel in your home area) and is called 'mycoverage.fits'.
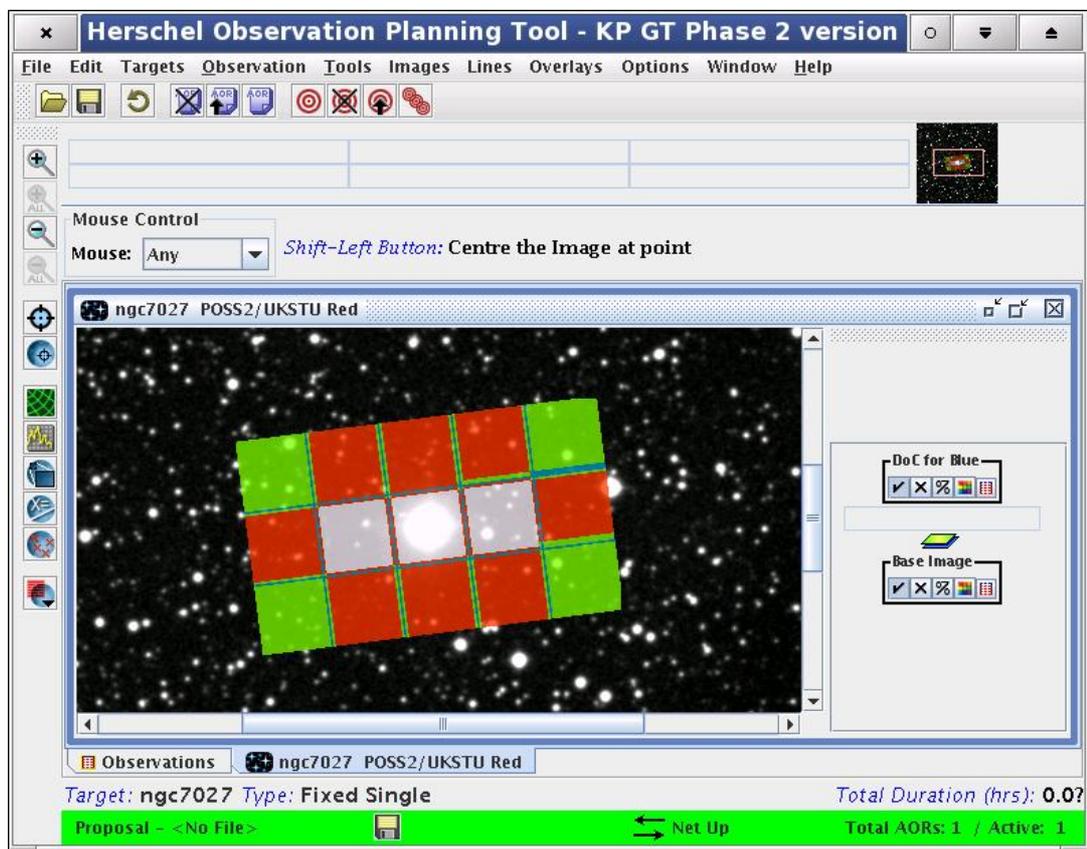
Figure 19.32. Depth of coverage overlay example in PACS point-source photometry mode

Chapter 20. Moving Target Visualisation

20.1. Overview

As an aid to planning your Herschel solar system observations, HSpot provides the capability to display the position of moving targets on the infrared sky as a function of date and time. In addition, the user can also visualise the position of a moving object with respect to the Herschel focal plane, instrument apertures, diffraction spikes, and other nearby moving objects. Visualisation of a planned Herschel AOR for a moving target is also supported, and shows the positions on the sky of individual data frames within an AOR, taking into account both the spacecraft and moving object's motion. Visualisation of an AOR in the object's rest frame is currently not explicitly supported for moving targets, but can be mimicked by selecting a position and its corresponding date from the objects orbital path, and entering this as a fixed target position.

These capabilities are provided to allow the user to optimise moving target observations with Herschel, by selecting the best available backgrounds/times for observation, and by being able to visualise the AOR pattern across the sky and the effect of nearby bright objects on the planned observation.

> **Warning**
> HIFI moving target AOR visualisation will not be implemented in HSpot in time for AO. Contact Helpdesk at the Herschel Science Centre (http://herschel.esac.esa.int/esupport/) for information on its availablity.

20.2. Getting Started

Before you can use the HSpot visualisation capabilities to display your moving target, you need to enter a moving target using the target entry window or have a HSpot target list available from which to choose. If you would like to display a moving target AOR, you need to enter the target and create the AOR first (see Section 9.2.2).

20.3. Selecting a Background Sky Image

Once you have your moving target and/or moving target AOR, select "Images" from the menu bar and select the type of image you would like to have used to show the background of the target. The visualisation section for fixed targets (Chapter 19) describes the types of images that can be used, including a user-provided FITS image, with some important caveats on their suitability for quantitative background estimates. If you are observing a rapidly moving object, such as a comet, or near-Earth asteroid on close pass to Earth, it may be more instructive to select the All Sky Images option (Section 9.2.2), at least until you can determine the extent of the object's path across the sky. For general purpose use, though, requesting the ISSA plates with the default parameters is generally a good starting point for visualisation (Figure 20.1).

20.4. Selecting an Observation Date

Once the type of background image that you need has been selected, you will be asked to enter an observation date to allow HSpot to select the correct background image on which to display your object (Figure 20.2). In the "Select Observation Date" window that appears, HSpot will display the visibility windows for your object. That is, those date ranges in which your object can be acquired by the Herschel spacecraft. Select a date within the visibility window periods, choose the number of points on the orbital track that you would like HSpot to label, and click on OK.
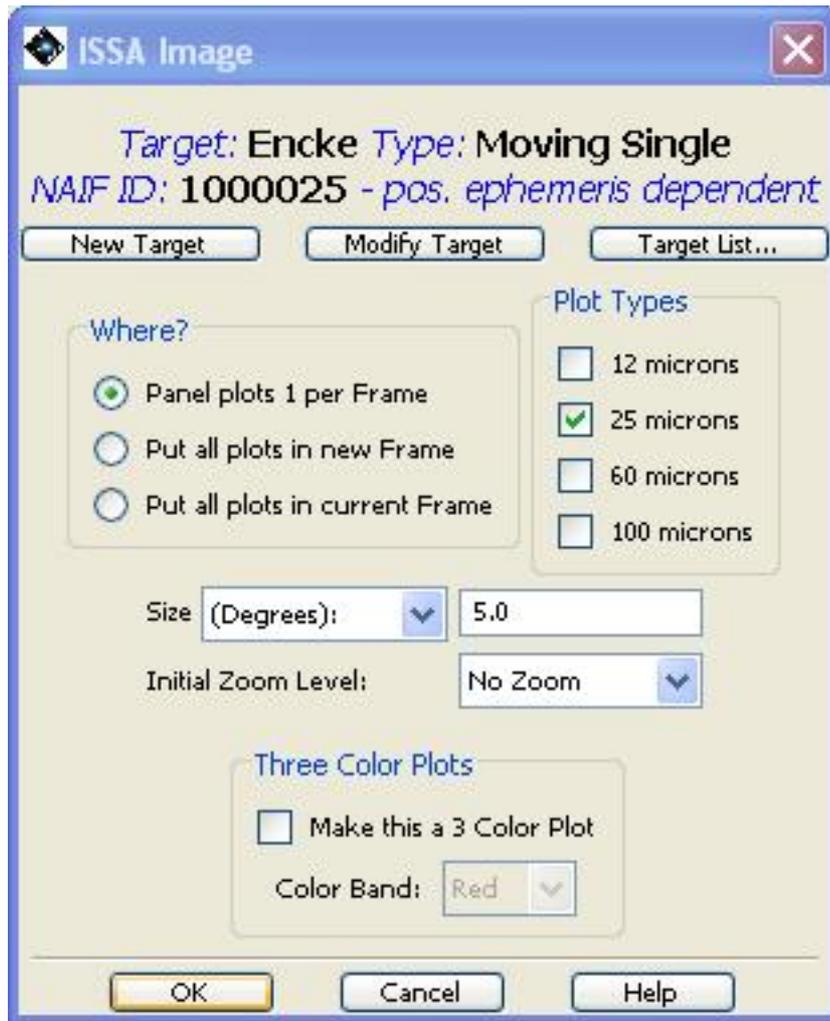
Figure 20.1. The dialogue box for requesting an ISSA image of the sky background for Comet 2P/Encke.
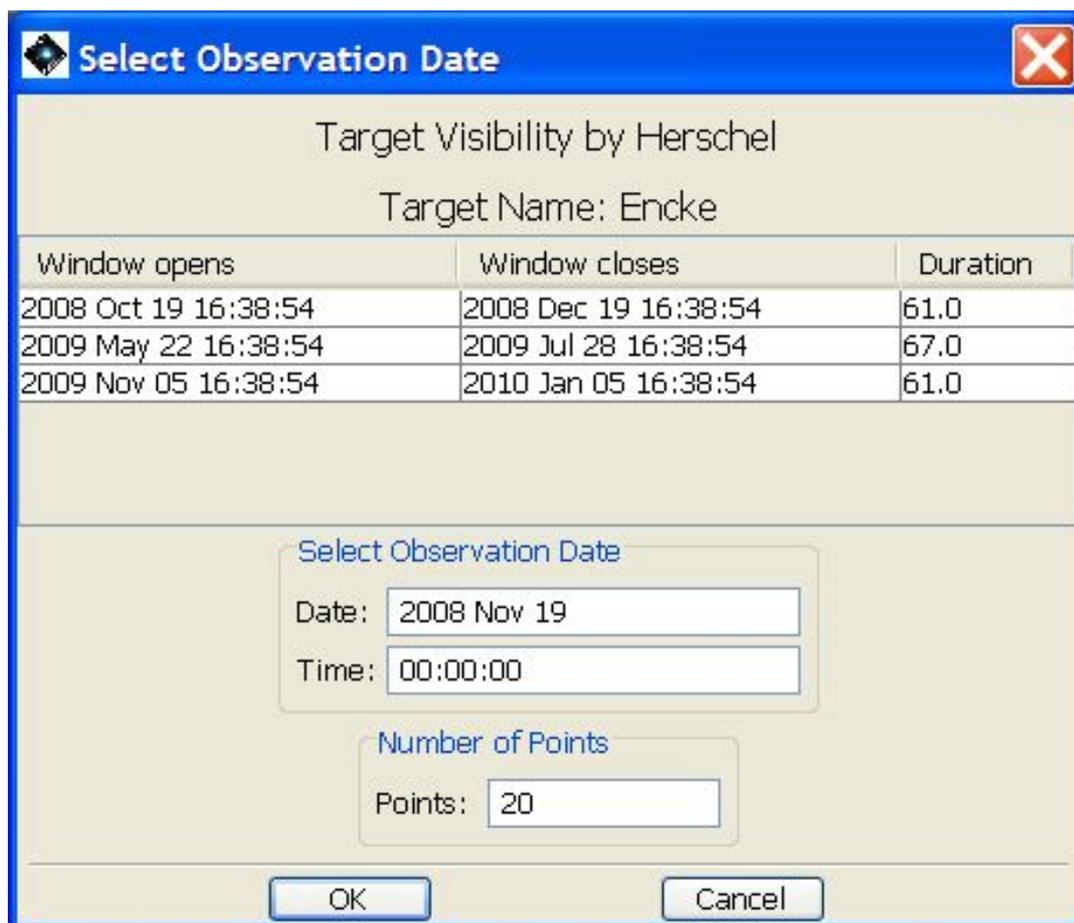
Figure 20.2. Target Visibility dialogue for Comet 2P/Encke. The "Number of Points" option allows you to choose the number of date points HSpot will display for your moving target. You can then animate through the track of the moving target on the displayed image.

If you are displaying on an ISSA, 2MASS, DSS or NED image, the track of your object across that image should now be visible in the HSpot window for the date specified (Figure 20.3). If you are displaying on an All Sky Image, you will need to go to the "Overlays" menu and select "Add Moving Target" before the track will be displayed.
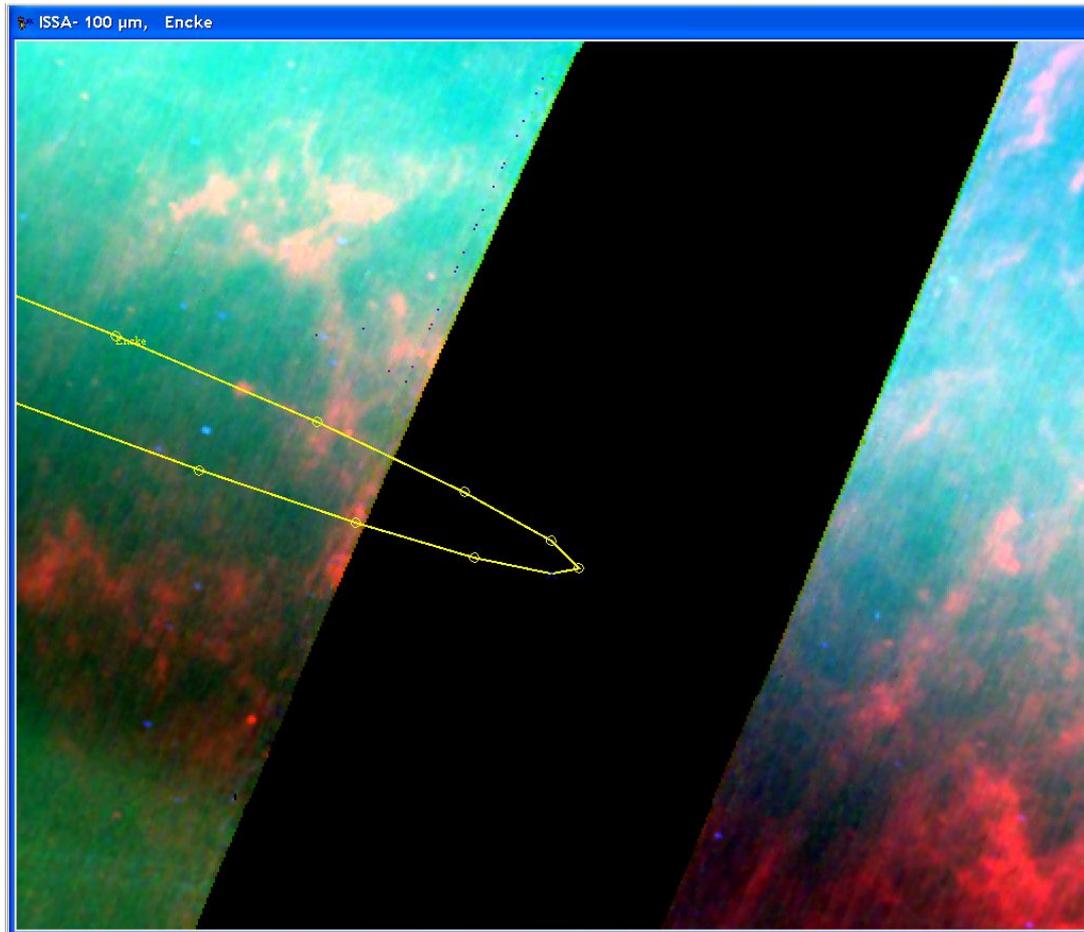
Figure 20.3. The displayed track of Comet 2P/Encke on an ISSA plate background. The number of points selected was 20. As in this case, you may find that the selected background has an inconvenient gap in data coverage.

20.5. Resizing and Zooming Your Image

When using the visualisation tools, we suggest that you maximise your HSpot window to fill your computer screen. The displayed image space can then be maximised by clicking on the maximise icon in the upper right hand corner of the image frame. The iconify icon will iconify the image and place the icon at the bottom of the HSpot window. To zoom the image within the window, use the magnifying glass icons in the upper left corner of the HSpot window. See Figure 20.3.

20.6. Getting Fancy

Now you have an infrared image of the sky, with the path of your object across it, centred on the observation date you entered. On the lower right side of the HSpot window, there are two groups of small icons (Figure 20.4), one labelled "Base Image" and the other labelled with your target name. The icon is a toggle that turns each display component on and off. The icon will delete the component with which it is associated (use with caution!). If you do inadvertently delete something you had merely wanted to switch off for a moment, you must display it again from scratch.
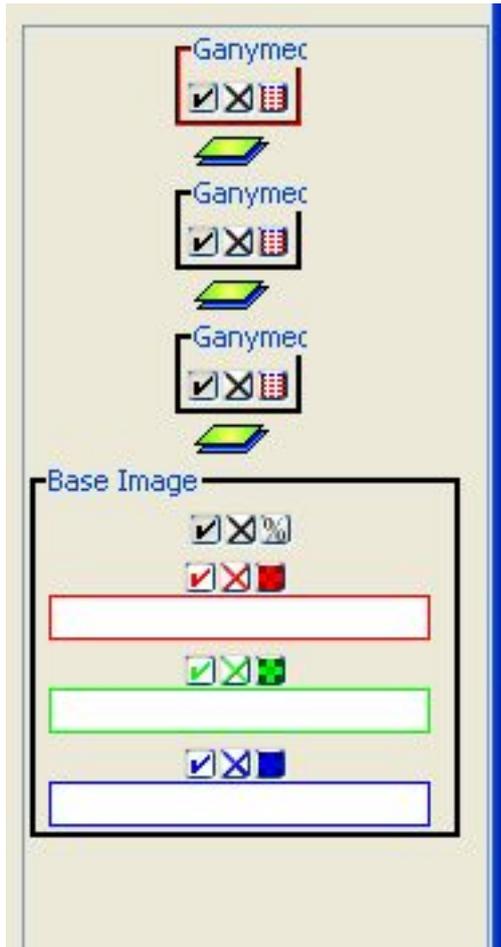
Figure 20.4. Icons associated with each layer drawn in the visualisation frame. In this case there is an ISSA Image and the track of Comet 2P/Encke is overlaid. Clicking the check mark will 'hide' the layer. Clicking the "X" will delete it. Clicking "%" will allow you to modify the opacity of the displayed image. Clicking the colour grid will allow you to modify the colour table options for the displayed image.

20.6.1. Highlighting Points and Displaying Date Markings on a Moving Target Trajectory

In the cluster of mini-icons associated with your object name in the side bar is the list icon (this is the rightmost mini-icon in the "Encke" box shown in Figure 20.4). Clicking on this icon will display a list of dates and positions for your moving target (Figure 20.5).

In this display, "Hide All Points" will remove the point markings from the trajectory (once "Hide All Points" has been clicked, it will be replaced with "Show All Points," so this button acts as a toggle).

The first column of the table allows you to select which points to display by toggling the check mark on or off. The "Hide Path" toggle button will remove the trajectory, but leave the points, if desired.

The second column, marked "Hi", allows you to selectively highlight points (and dates, see below). The current selected point is highlighted in one colour, and previously highlighted points are given a different colour.

The third column allows you to change the shape of the plotted points. The "Show All Dates/Hide All Dates" toggle button will label each of the points on your trajectory with the date. A subset of the dates can be displayed by toggling the check mark under the "Show Date" column.

The RA/Dec. positions for the selected dates are shown in the table. However, RA, Dec., and underlying flux at any point on the image (and the trajectory) can be determined by moving the cursor over the image and reading the position from the table just under the menu icons in the main HSpot window.
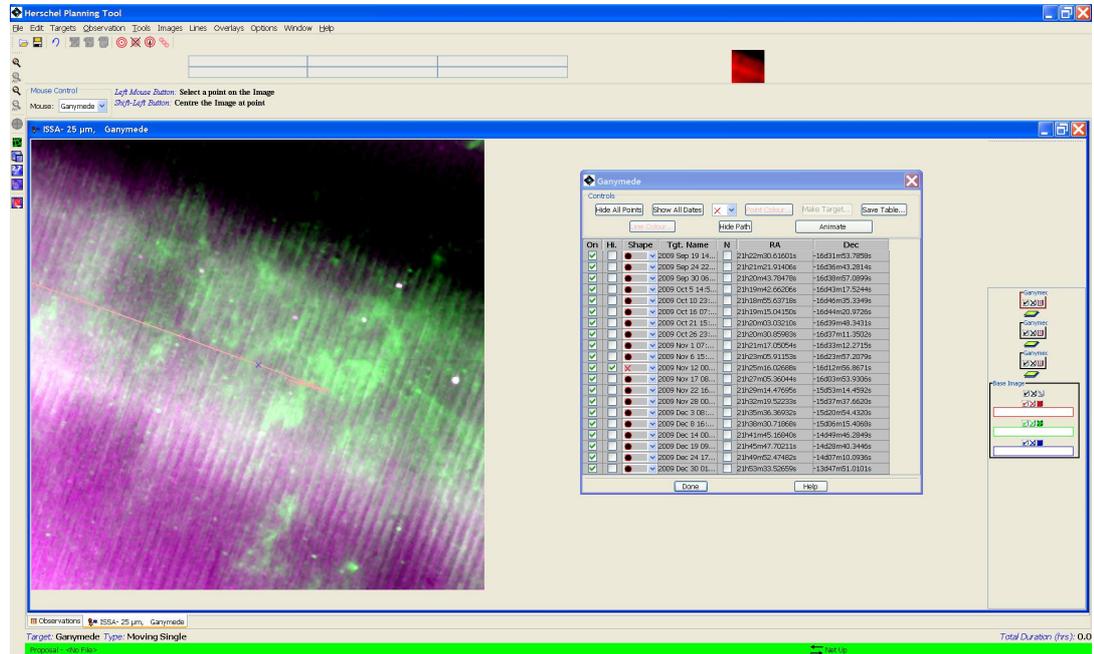
Figure 20.5. List of dates and positions for Comet 2P/Encke. This dialogue box will appear if you click on the icon with the red lines under 'Encke' in Figure 20.4.

Clicking on the Line Colour or Point Colour buttons allows interactive selection from colour tables for line and point colour. The Save Table button allows the user to save the table text (i.e., the date, RA and Dec.) as a plain text file.

20.6.2. Adding Your Own Marks/Labels to a Trajectory or Image

If you want to add your own marks to a trajectory or image, select "Add Marks to Plot/User created catalogue" from the Overlays menu on the HSpot main menu bar. Then, use the left mouse button to add marks to the image or trajectory. HSpot will record the RA and Dec of the positions marked, which can be accessed under the list icon in the "Marks" box now on the right of your image display (Figure 20.6). Labels for the points marked can also be entered (in the User Marks "Name" field) and will be added to the image display when the user clicks the "Done" button on the Marks catalogue window. The list of marks can be saved to a table on local disk, by clicking the "Save Table" button and specifying a table name and local disk directory in the resulting dialogue.
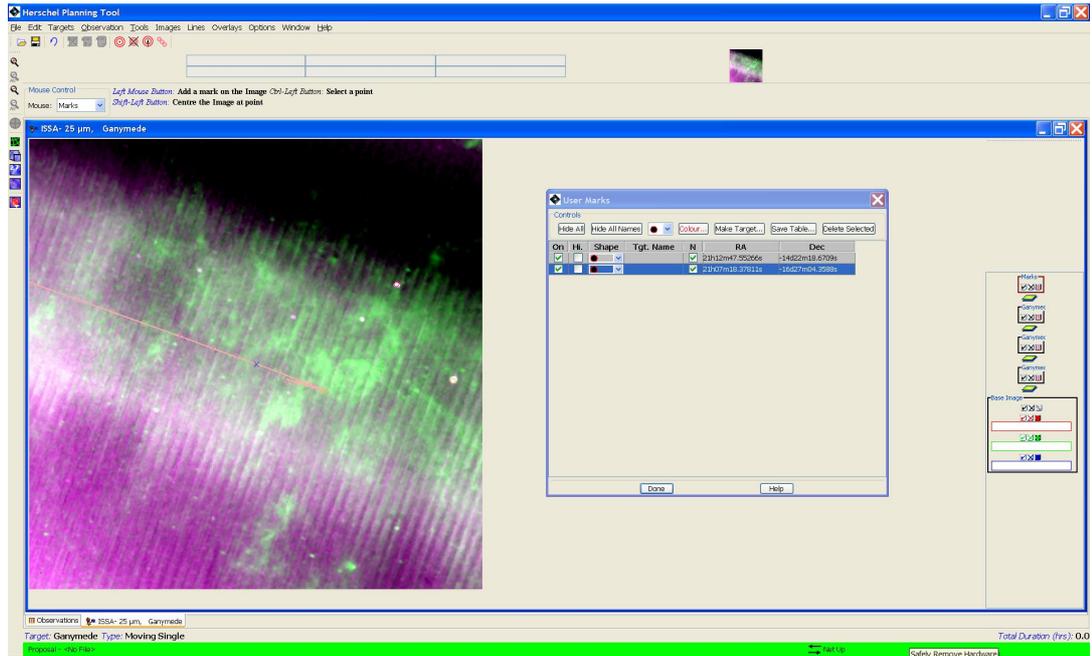
Figure 20.6. Adding marks to an image. Another layer called "Marks" is added to the frame. Clicking on the small red line icon under "Marks" will bring up the dialogue box of "User Marks".

20.6.3. Adding a Grid

Using the "Overlays" menu on the HSpot main menu bar, you can select "Grid..." and choose to overlay a coordinate grid on your image. In addition to the standard equatorial coordinate systems, you can overlay a grid in, e.g., Ecliptic coordinates.

20.6.4. Displaying Multiple Moving Targets

Planetary satellite and other observers may wish to display not only their science target, but also the relative position of a nearby moving target (e.g., the parent planet for a satellite). You should enter the second target into HSpot via the target entry window (see Chapter 9), so that it appears in your HSpot target list.

After displaying your primary science target, go to the "Overlays" menu on the HSpot top menu bar and select "Add Moving Target" (see Section 6.8.4). HSpot will then display the target list for you from which to choose your second target. Once selected, it will be plotted on the same image as your first target, over the date range initially specified for the first target, and with the same date points used for the first target.

If your second target does NOT cross the image in the date range specified for the first target, HSpot will display a window to that effect, and ask you whether you would like to see the position of the second target relative to the first on an all sky image. The sky patch labelled "Sky Image" will show the image area that contains your first target, and your second target will be labelled by name, elsewhere on the all sky image.

20.6.5. The Distance Tool

This tool can be used at any time during moving target visualisation, but is particularly useful when you want to determine the approximate angular separation of a moving target and a nearby fixed target, or two moving targets on a given date. To activate it, go to the "Overlays" menu on the HSpot main menu bar and select "Distance Tool." Now use the left mouse button to select a point and drag to another point. A coloured line should appear, denoting the distance that you dragged the cursor, and the distance in arcseconds will be displayed above the line (Figure 20.7).
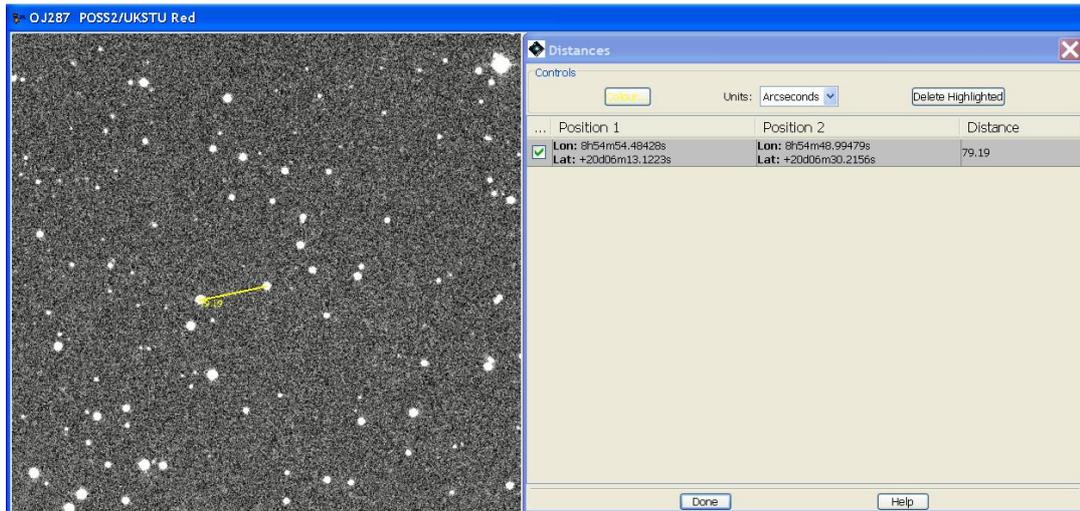
Figure 20.7. The Distance Tool in action. The yellow line indicates the distance between the two selected points. The distance, in arcseconds, is displayed on the image. Detailed information can be brought up in the "Distance" dialogue box.

Note that estimating the distance between two moving targets using this tool is only valid between points on the two trajectories that correspond to the same date. We have exact date point matching for two moving bodies in HSpot. With this hand drawn tool, it is possible to estimate separation distances to an accuracy of a fraction of an arcsecond, when compared with the calculated ephemeris positions. However, if your observation crucially depends on separation estimates to higher accuracy, we strongly recommend that you calculate these separations using JPL's Horizons software. For instructions on how to use Horizons to assist with Herschel observation planning, please see the Herschel website at http://herschel.esac.esa.int/.

20.6.6. Displaying the Herschel Focal Plane

To display the Herschel Focal Plane to scale, go to the Overlays menu in the main HSpot menu bar and select "Herschel Focal Plane." The focal plane to scale will appear on your image. Clicking the left mouse button at a position on the image will re-centre the focal plane at the click point. Note the cluster of mini icons labelled "Herschel" that have appeared on the right of the image window (Figure 20.8). The box with the number in it shows the position angle of the focal plane. The focal plane is generated at a default position angle of 0.0 degrees. To visualise the focal plane on a particular date, use the Visibility/Orientation capability in the HSpot target entry window (the bulls-eye symbol on the HSpot main menu bar). Enter your moving target and determine the position angle for the Herschel focal plane on the date you want to observe your target. You can then enter that position angle into the box in the "Herschel" layer control to re-orient the focal plane display. In the example in the figure, a position angle of 035 degrees has been entered.

To change the angle displayed (i.e. to investigate the focal plane orientation on other dates, change the value in the control box and pres RETURN. For ecliptic sources the orientation is almost constant with date (see Figure 10.3). The orientation changes with date more rapidly and with a wider range as the ecliptic latitude increases. A fuller discussion of this effect is given in Section 10.5.
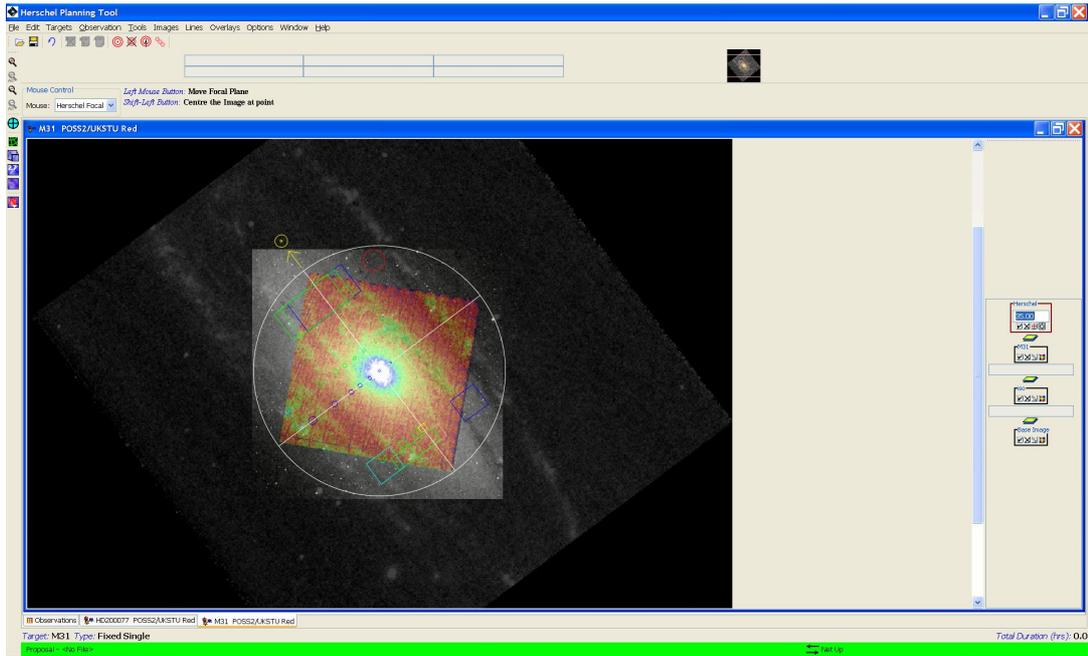
Figure 20.8. Displaying the Herschel Focal Plane. A position angle of 35 degrees is shown.

The focal plane configuration icon in the "Herschel" layer allows you to toggle apertures on and off and change the colour of the displayed apertures. See the Herschel Observer's Manual for a full description of the apertures on the focal plane. The arrow pointing to the Sun symbol in the focal plane display denotes the Herschel-Sun direction, as projected on the sky.

20.6.7. Configuring the Herschel Focal Plane Display

A control panel for the Herschel Focal Plane overlay is found in the right hand sidebar (Figure 20.9). There are four buttons: toggling the tick mark switches the overlay display on and off; the cross erases the display; while the rightmost button switches on and off the Herschel diffraction spikes in the overlay. Clicking on the circled cross in the Herschel panel - the third button from the left - (Figure 20.9) brings up a dialogue that allows the colours of the overlay to be configured. The default display on opening is shown in Figure 20.10. The user can change the colours and display for each instrument by selecting the appropriate tab and modifying the appropriate item. When you select the "colour" button for a channel the dialogue in Figure 20.11 appears allowing the user to choose a colour for the display for that channel.

The configuration dialogue boxes for PACS (Figure 20.12), SPIRE (Figure 20.13) and general configuation (Figure 20.14) are similar to the HIFI tab.

Figure 20.9. The control panel for the Herschel Focal Plane overlay in the righthand sidebar.

Figure 20.10. The Focal Plane Overlay configuration dialogue as it opens. The user can change the colours and display for each instrument by selecting the appropriate tab.

Figure 20.11. The dialogue panel to change the display colour of the selected HIFI channel.
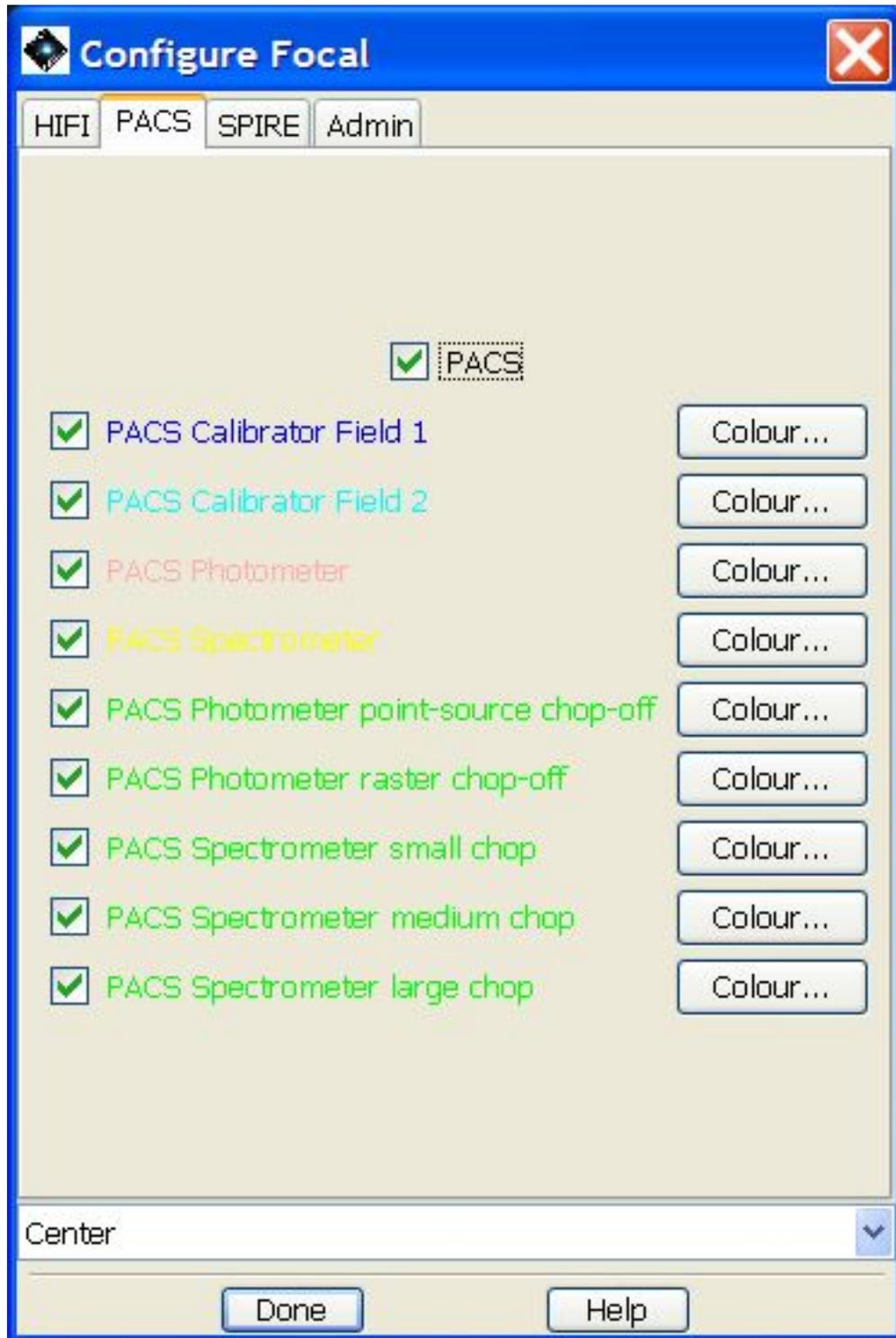
Figure 20.12. The Focal Plane Overlay configuration dialogue for PACS.
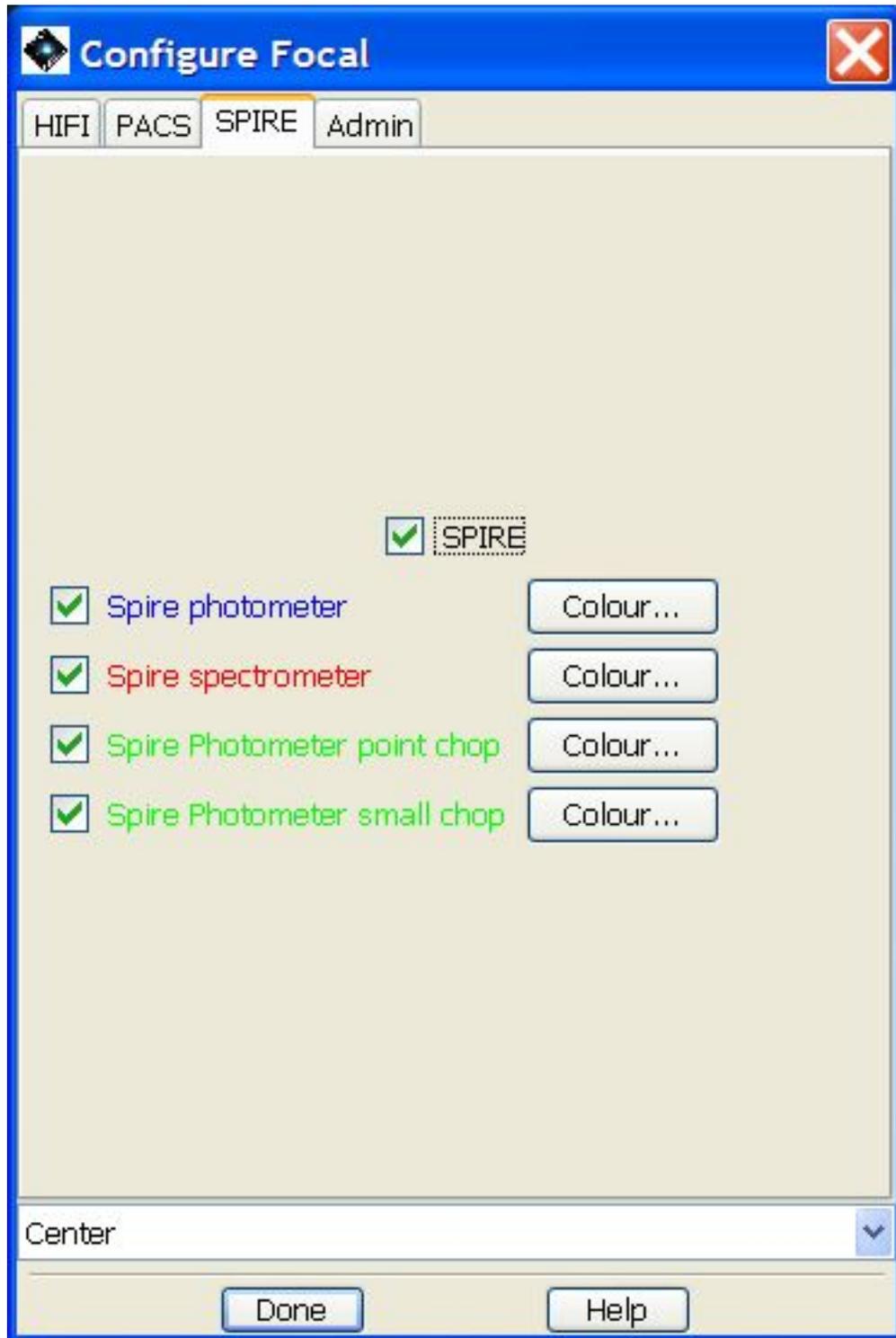
Figure 20.13. The Focal Plane Overlay configuration dialogue for SPIRE.
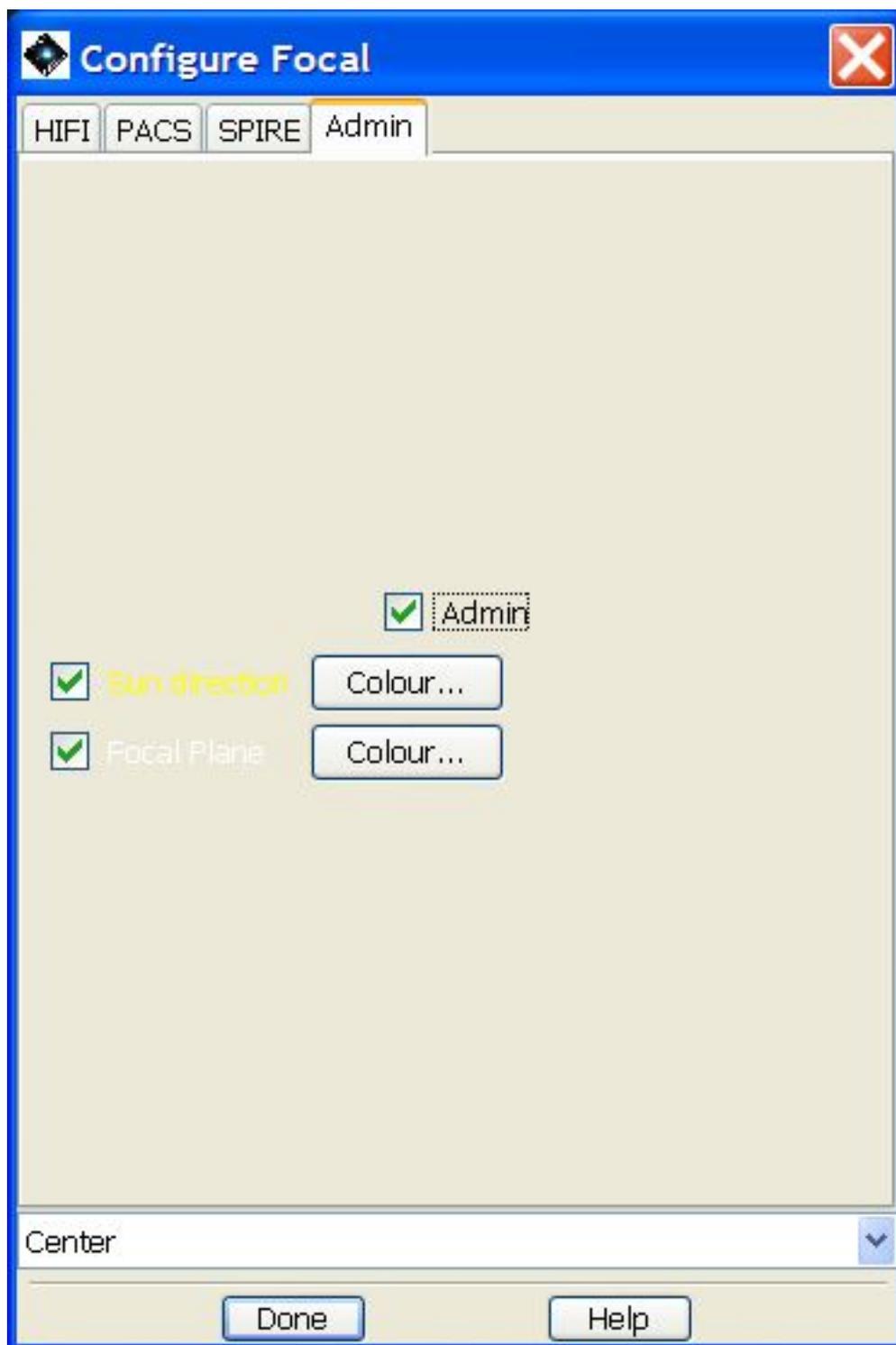
Figure 20.14. The Focal Plane Overlay configuration dialogue for administration.

A further option is to change the position of the Herschel Focal Plane overlay. The default position is that the centre of the Herschel field is overlaid in the position of your target. However, by selecting the appropriate tab and chosing the pull-down menu at the bottom of the page, as illustrated for PACS and SPIRE in Figure 20.15.

From the pull-down menu at the bottomo of the page you can select the exact observing mode that you are going to to use - for example, a PACS point-source photometry AOR with chopping on -

and visualise more precisely the AOR that you have generated. The overlay will shift so that the appropriate instrument and observing mode are overlaid on the position of your target.
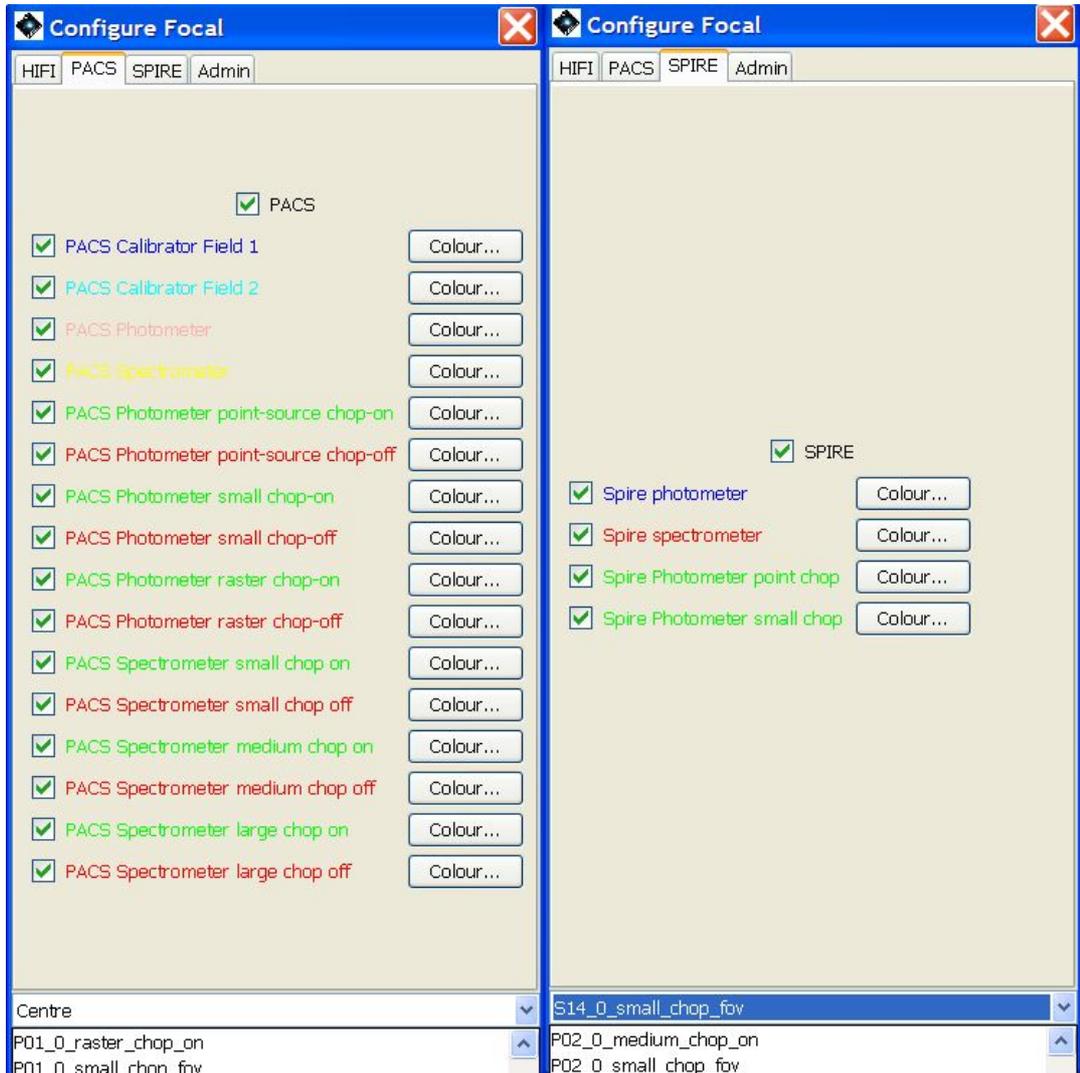
Figure 20.15. The pull-down menu to change the positioning of Focal Plane Overlay on the target. The default option is the field centre, but the user can specify with exactitude the observing mode to be displayed (for example, PACS with large chop) and centre the appropriate part of the Focal Plane overlay on the target to visualise the observation more exactly. Two examples, for PACS and SPIRE, are shown, side by side.

20.6.8. Displaying Moving Target AORs

Once you have entered a moving target AOR, you can display this AOR on your image for a given date. The AOR display is derived from the same command sequence logic that will be sent to the spacecraft. Consequently, for moving targets, the AOR display shows not only the spacecraft pointing and mapping motions, but also the combined effect of the moving target's track on those pointings. What this means is that for a rapidly moving object, you may be able to see the actual elongation of a mapping pattern in the direction of the object's motion. HSpot does not yet explicitly support visualisation of a moving target AOR in the object's rest frame. However, this can be mimicked to a limited extent by entering a dummy fixed target that corresponds to the object's position at the observing time desired. However, for a rapidly moving object (typically comets near perihelion or near-Earth asteroids) this fixed target approximation will provide a clearer visualisation of the map extent around the target object, but unlike the moving target visualisation described above, it will not accurately display the background in each AOR frame.

20.6.9. How to display an AOR

> **Warning**
> When you display an AOR any constraints that you have added (chopper avoidance angle, map orientation, etc.) will not be taken into account in the display. Please ensure that the date selected is compatible with any constraints that you may have put on the observation.

In general, displaying a moving and a fixed target is very similar. For the moving target some additional options -- described below -- must be defined, but otherwise you can do things in essentially the same way for both types of target.

To display an AOR, select an AOR (preferably one that corresponds to the target you are currently displaying) listed in the "Observations" window. Then, select AORs on "Current Image" from the "Overlays" menu on the HSpot main menu bar. If your target is not a fixed one, you will be asked if you want to plot the same visibility date for the moving target that you currently have plotted (Figure 20.16). If you don't want to do that, select "No", and you will be asked to supply a different date. Your requested AOR will appear on the image, and a set of icons associated with that display will appear on the right-hand side of the image window (layer controls). As for the layer controls, the icon will toggle the display of the AOR, the icon will delete the AOR display, and the icon opens a table that lists all the AOR pointings. Individual pointings can then be selectively toggled on/off in the table. This window also gives the position angle for the AOR on the date specified. Furthermore, this window allows animation of the AOR - displaying the instrument aperture pointings in the sequence that they will be executed on-board the spacecraft. The "Animation" button shows the pointings, one after the other, and the "Animation w/Trail" button shows the successive pointings, but leaves a trail showing the apertures for all previous pointings in the sequence.

Figure 20.16. When attempting to overlay AORs on an image for a moving target, this dialogue appears indicating that the track for the target is already plotted on the image and asking whether or not to use the current moving target date.

Multiple AORs for the same moving target can be displayed (e.g., a SPIRE and a PACS AOT). You may wish to check-off the previous AOR using the icon (but not remove, which is done by clicking on the icon) when doing this, to clearly see the new AOR overlaid.

Note that if you have several images of the same target displayed, for example, you have a DSS, an MSX and a 2MASS image plotted, the AOR(s) will be plotted on all of them, not just on the image on top.

20.6.10. How to use an overlay to decide whether or not to constrain your observations

Unless you are observing in a crowded region or one with strong background variations, constraints are usually unnecessary. However bright a nearby star is, it is unlikely to be detectable by Herschel. When then is a constraint justifiable, given that constraining observations is generally not advised

because it makes their scheduling more difficult?

A typical case is shown in Figure 20.17. A SPIRE chopped photometry AOR is shown. In the image the on-source position and the two off-source chop and nod positions are shown with blue circles. Two stars appear in the lower off position; these can be ignored because they will be many orders of magnitude too faint to be detected by Herschel and will not affect the quality of the photometry in any way.
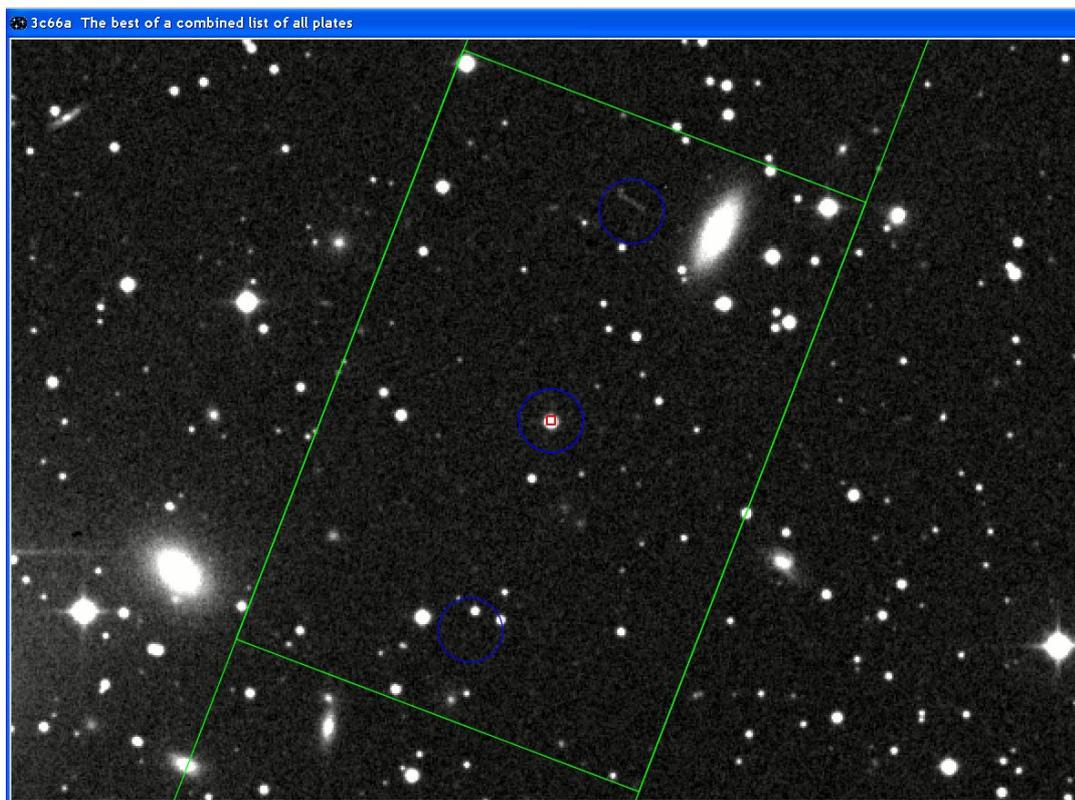
Figure 20.17. A SPIRE point source photometry AOR for the blazar 3C66a on a DSS image. The source is identified with a small, red square. blue circles show the on-source and off-source chop and nod positions.

However, the spiral galaxy to the upper right is at exactly the distance of the off position and, for a different date, would fall in the off aperture. As we see in the 60 micron IRAS image (Figure 20.18), this galaxy is far brighter than our target, as is the galaxy to the lower left.

These galaxies would interfere seriously with the photometry at this wavelength if they were to fall in the off position, which they would for a narrow range of Position Angle. You can check this by changing the date for the observations and seeing how the off position rotates (you may find that the source will only be in your off position at a time when Herschel cannot observe your target anyway, in which case the chopper constraint is irrelevant). In the case that the off position would be contaminated for a certain range of dates a constraint would not only be justified, but necessary. However, if we look at the same field at 100 microns we see that the same galaxies are still visible, but are now much less prominent as we are well off the peak of the black body curve. By the wavelength range covered by SPIRE they will be quite faint and probably much fainter than our target. In this case the constraint is of very marginal utility and justification.
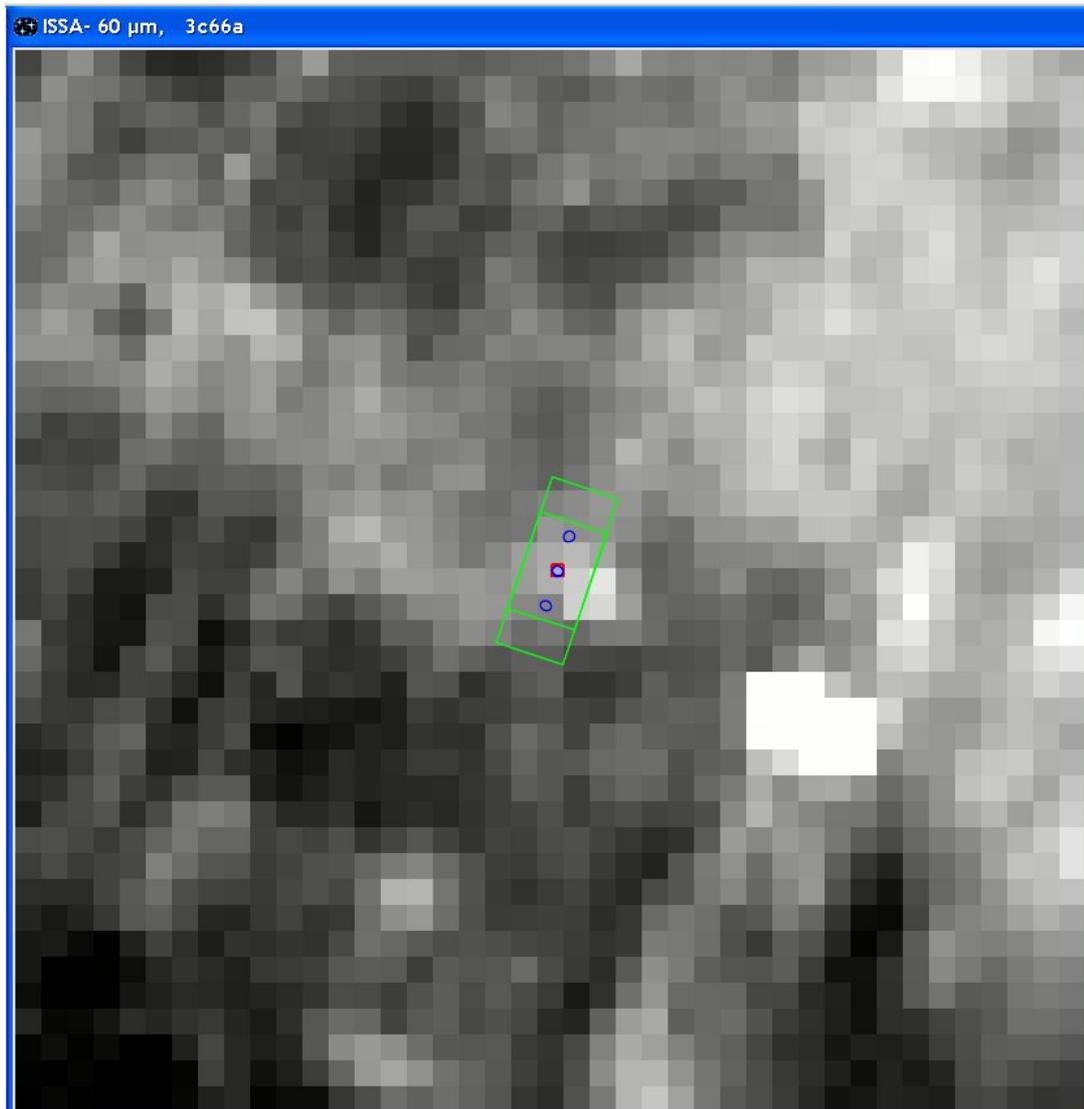
Figure 20.18. The same SPIRE point source photometry AOR for the blazar 3C66a superimposed on a IRAS 60 micron image. In this case we see that the two galaxies in the field are much brighter than our target and must be avoided in the off position.
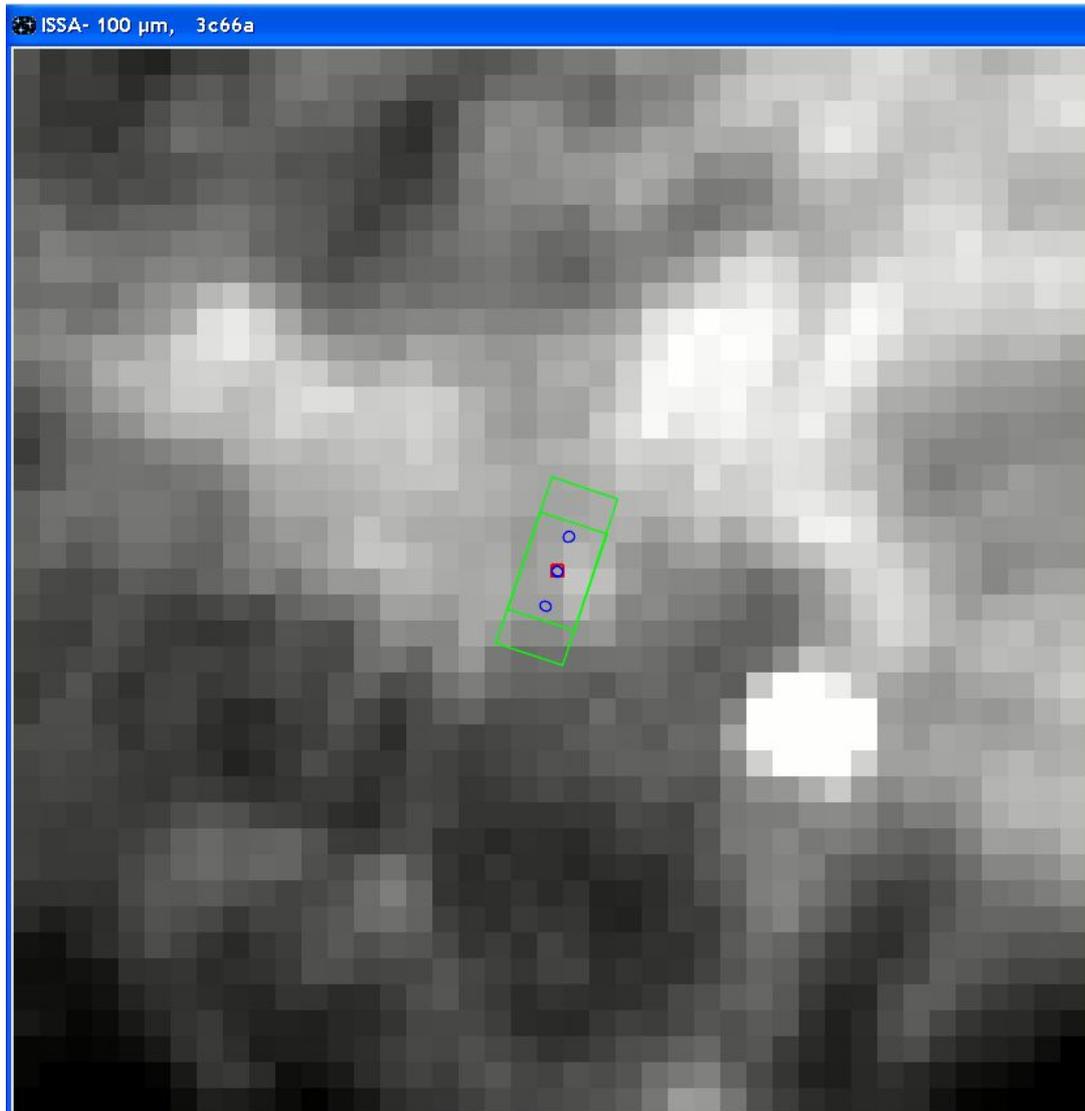
Figure 20.19. The same SPIRE point source photometry AOR for the blazar 3C66a superimposed on a IRAS 100 micron image. Although the two galaxies in the field are still brighter than our target and must be avoided in the off position, they are very much less prominent than at 60 microns: at longer wavelengths, particularly those for SPIRE AORs, it is unlikely that they would be a serious problem for photometry.

If you are uncertain about adding a chopper constraint you should ask the following question: is it worth sacrificing 7 minutes of my Herschel time (the additional overhead applied to constrained observations) to add this constraint? Is the likely gain in data quality worthwhile? If you have just one observation you may answer in the affirmative. If you have 20 AORs, you are sacrificing more than 2 hours of precious Herschel time for a more than doubtful gain.

20.6.11. Displaying a background cross-section

When you are planning your AOR you may be interested in knowing the background variations across an area of sky, or across the path of a particular moving target. When you display the moving target a new icon will appear in the left-hand sidebar showing a small graph and a small control box labelled "Slice" will appear in the right-hand sidebar (Figure 20.20).

Click on the graph icon in the left-hand sidebar and the cursor will activate. Click on a position in the image and drag the cursor across. A line will appear on the image (Figure 20.21).

When you release the cursor HSpot will calculate the flux along this slice of the image and will present the information as a graph (Figure 20.22). The graph can be dismissed by pressing "Done" on the graphic and recovered by pressing the "listing" icon on the right-hand sidebar.
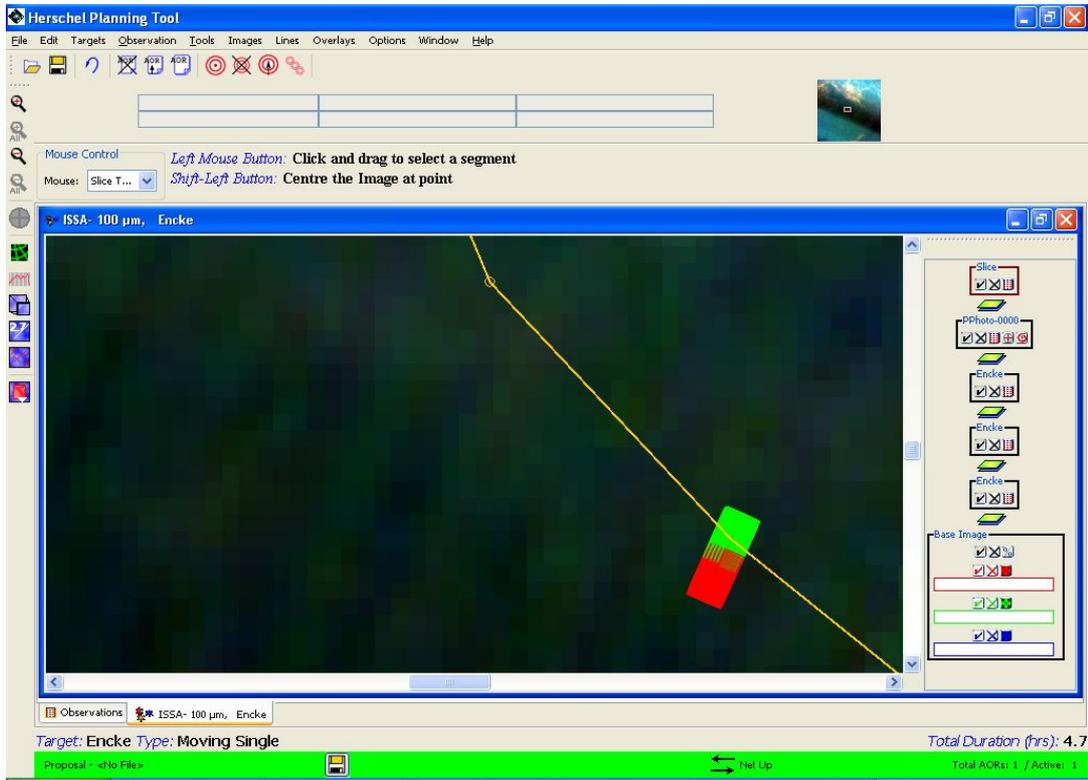
Figure 20.20. When you overlay AORs on an image for a moving target, additional icons appear that allow you to calculate the background across a slice of the image.
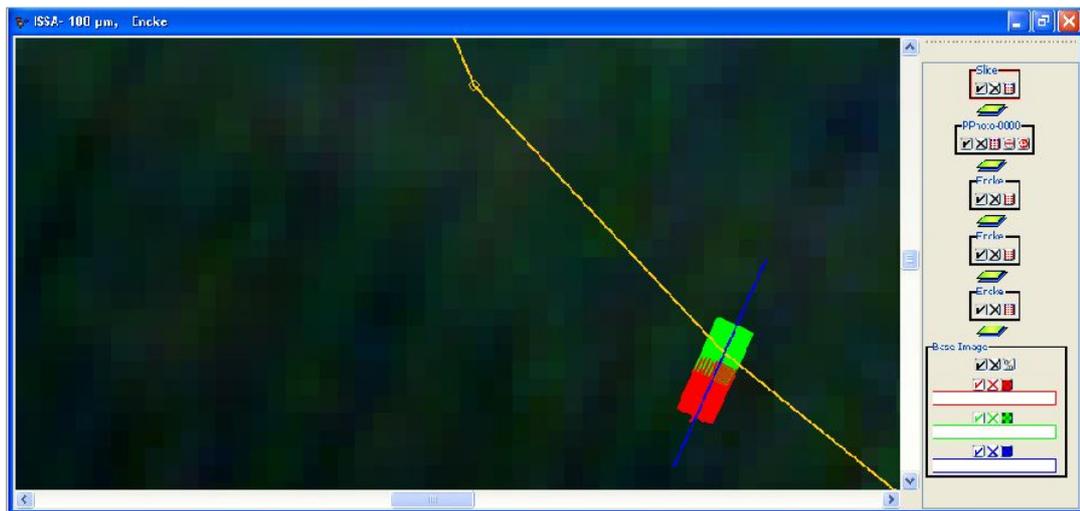
Figure 20.21. The appearance of the image when the slice is defined, before the cursor is released.

Figure 20.22. The graphic of the background across a slice of the image. In this case a three-colour image has been used, so three colours and lines are plotted.

By moving the cursor along the slice that you have defined you can select a particular pixel along the slice and see its position and value on the flux-along-a-slice graphic, as in Figure 20.23. Move the cursor along the slice without pressing or holding any of the mouse buttons to move the display in the "Flux vs. Position" graph. Alternatively, you can pick a position on the "Flux vs. Position" graph and see where it falls on the image slice: by moving along the graphic the cursor position will change correspondingly on the slice.
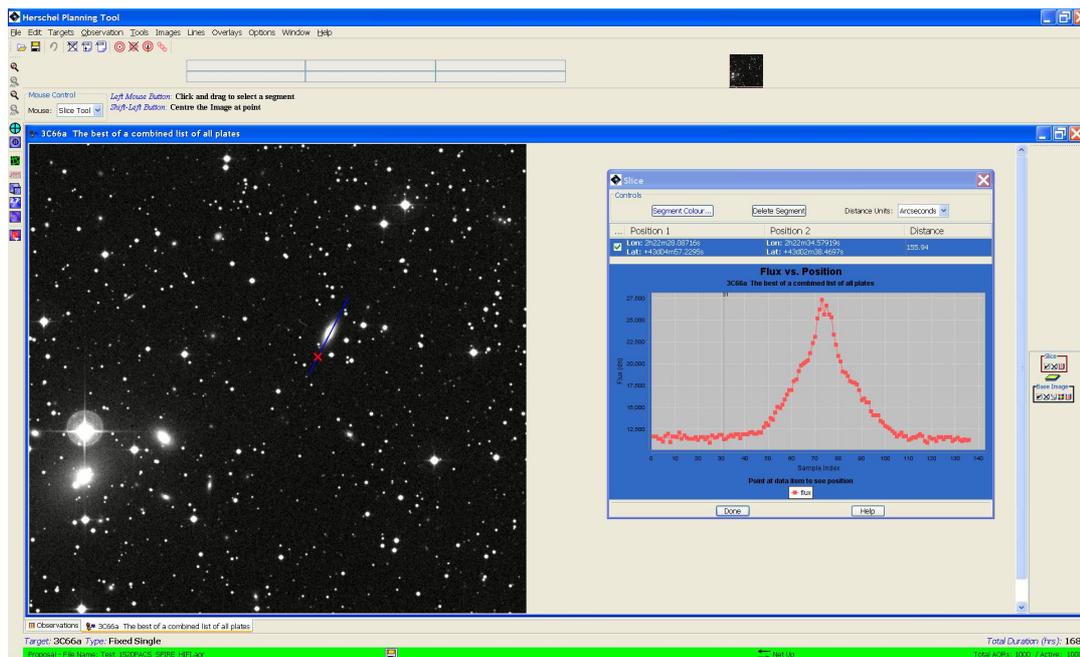
Figure 20.23. Using the cursor to select and display the background at a specific point along the slice.

20.6.12. An Illustrative Example

Visualising a small map of Comet 2P/Encke (see Figure 20.24):

1. Enter "Encke" (NAIF ID = 1000025) as a moving single target using the HSpot Target entry window (the bull's-eye icon).

2. From the Images menu, select "ISSA image". Make sure that Encke is the target in the ISSA image dialogue window. Accept the defaults (e.g., 5-degree image size) and press OK. Enter 2008 June 05 00:00:00 as your selected date; this is not the default, but the midpoint of the first visibility window of the planned mission. You can select this by clicking on the date range for that window.

3. Resize the HSpot window to fill the screen and use the magnifying glass with the red "plus sign" (upper left) to zoom the image.

4. Go to the Encke icons on the right and bring up the ephemeris window by clicking on the list icon . Click "Show All Dates". The time taken by Comet 2P/Encke to cross the image depends on how close it is to perihelion and its apparent velocity in the sky.

5. Select the Distance Tool from the Overlays menu. Using the left mouse button, click at one date on the trajectory, e.g., 2008 April 01, and drag approximately to the next shown date to the left, 2008 April 10. Click on the Encke check mark to toggle off the trajectory and dates, so that you can read the distance off the display. The distance value can also be read by clicking on the Distance overlay table icon.

6. Click the Encke trajectory back on and the distances line off. Go into the Encke list icon and "Hide all dates," or select just a few for display.

7. To display your AOR, first select a date in the "visibility windows" pop-up.Then, in the "Observation" pull-down, select and instrument and observing mode. In this case "PACS Photometer" has been selected. Select the observing mode in the pop-up window and define any parameters that you wish to define (source flux estimates, repetition factor, etc.). In this case a raster map with 10 points, 10 lines and a separation of 10 arcseconds has been selected, with a repetition

factor of 2 (i.e. the raster pattern will be carried out twice). Click on "Observation Est..." and check that the observation takes an acceptable amount of time. If satisfied and the time estimator accepts the observation, click OK at the bottom of the AOR window.

8. In the "Overlays" menu, select "AORs on Current Image". Answer "Yes" to having plotted the moving target provided that your target is on the displayed frame for the selected date. HSpot will now display the aperture positions on the sky for this observation (see Figure 20.24).

20.6.13. AOR Overlay Control

Clicking on the AOR display layer control pointings icon in the right hand sidebar (Figure 20.24) will bring up the control panel shown in Figure 20.25. This lists the R.A. and Dec. for each of the pointings that compose the raster map, plus useful ancilliary information such as the date of observation and the spacecraft roll angle (position angle) for the map. The table of pointings can be saved and read back in later using the "Read AOR Overlay Mapping File" option in the "Overlays" menu.

To animate the AOR that you have defined, select "Animation" or "Animation w/Trail". Clicking on "Animation" shows how the PACS field moves during the map. If you click on "Animation w/Trail" each successive position is displayed on the previous ones. Note that the mapping path that SPIRE/PACS may generally take is a zigzag shape on the sky, as compared to the shape that would be expected for a fixed target. This is because the spacecraft tracking of the rapidly moving Encke is being superimposed on the mapping motions of the AOR map. The Herschel pipeline has the capability to take these frames and recreate the map of the target in the target's rest frame. This will be a rectilinear map with the tracked extended target reassembled as a continuous image, but with the disjointed pieces of sky background that you may see.
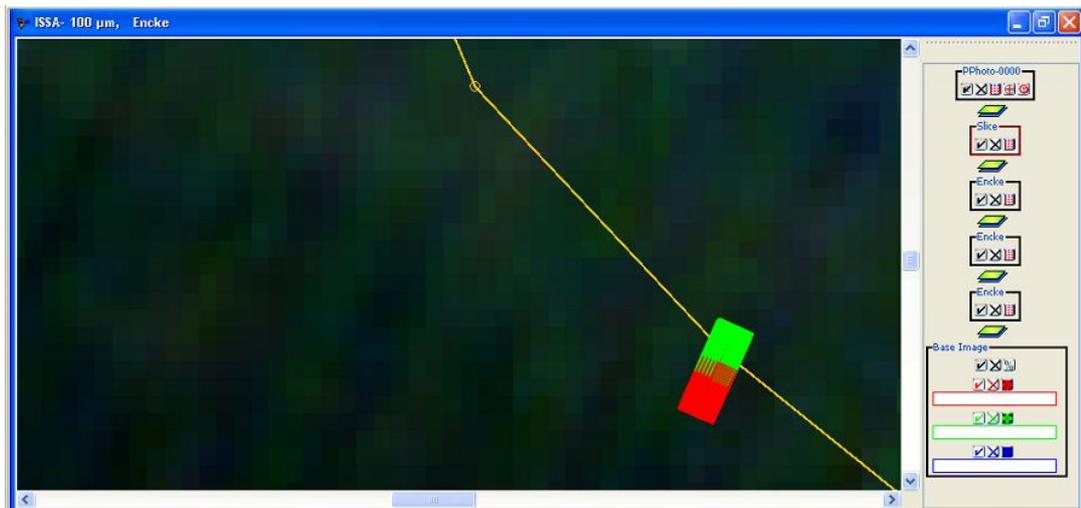
Figure 20.24. The PACS raster map discussed above is shown. Note that the map may show a slight zigzag shape, due to movement of the target during the observation.
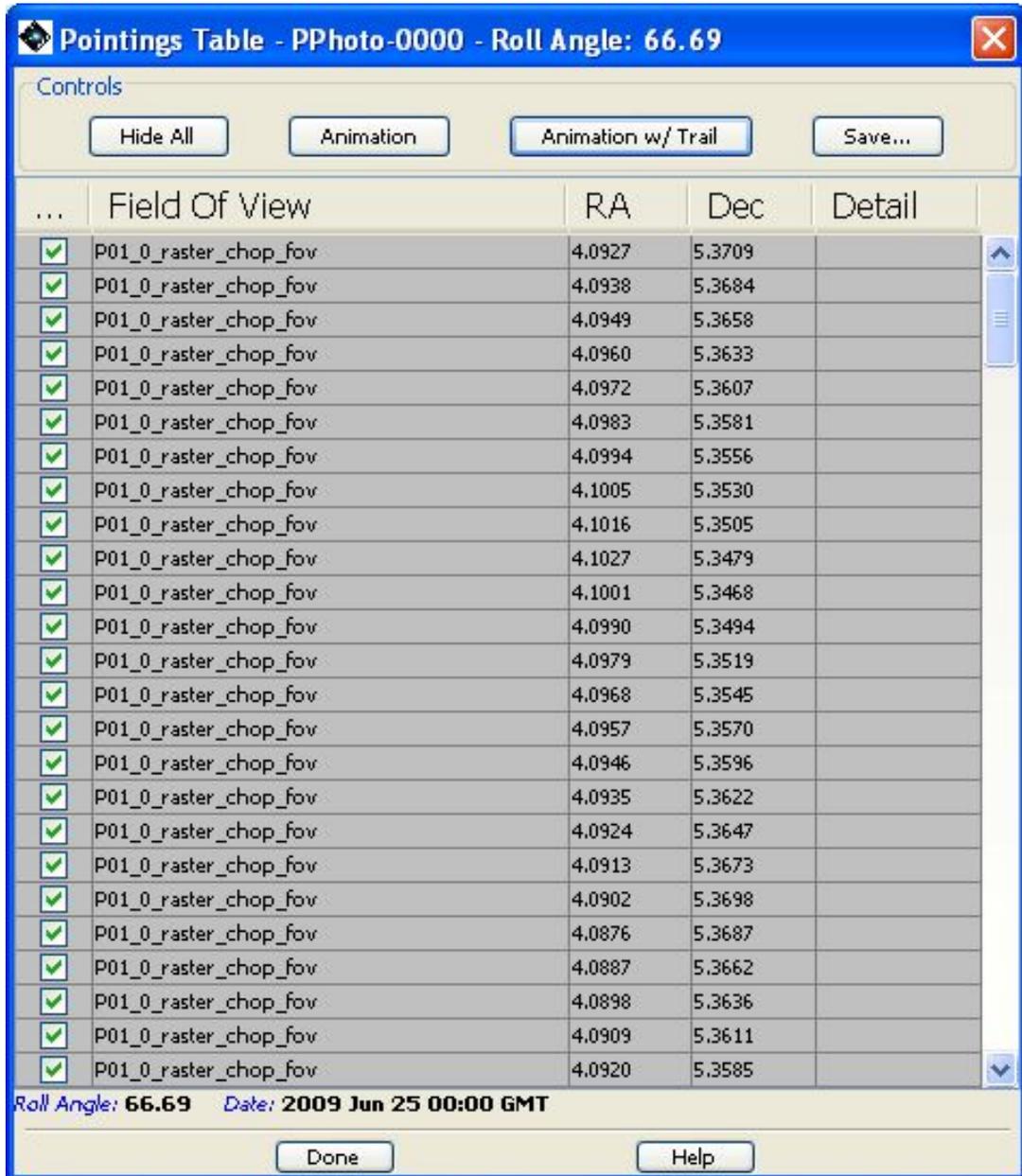
Figure 20.25. The control panel for the PACS raster map AOR that has been defined. The position of each integration is shown, along with date and roll angle information. Clicking on "Animation" shows how the PACS field moves during the map. If you click on "Animation w/Trail" each successive position is displayed on the previous ones.

20.6.14. Seeing it all together

Spectrometer mapping AORs have been defined for PACS, SPIRE and HIFI as shown in Figure 20.26. The Instrument and Mode Information columns give a description of the AOR. These AORs are then plotted in the image Figure 20.27, which shows the multiple elements that make up the display of a series of AORs for a single target.

Figure 20.26. A series of spectrometer AORs for comet 67P/Churyumov-Gerasimenko. These use PACS, SPIRE and HIFI, as described in the Instrument and Mode Information columns.

1. The comet's track

   The comet's track is shown in red, superimposed on a ISSA three-colour (r=100microns, g=25microns, b=12microns) image. In this case a considerable zoom has been made, so only a small part of the comet's track is shown. Note that, at this scale the individual pixels of the IRAS background image are rather large.

2. The Sun vector

   A yellow arrow and yellow circle outside the circle of the Herschel view, shows the Sun direction vector. For this date the Sun is at a Right Ascension of 104.5 degrees.

3. The Herschel focal plane

   A schematic of the Herschel Focal Plane is shown. The large, white circle shows the unvignetted field of view of Herschel (radius 0.249 degrees). The focal plane has been rotated to the appropriate position angle for the date of observation (292.8 degrees). This is the spacecraft roll angle referred to the z axis (perpendicular to the orientation of the instruments); this is measured from north through east.

4. The PACS AORs

   The positions of each of the PACS integrations are shown. Small green squares give the "on" position, red the "off". There are three groups of integrations: at the centre of the field we have the "On" position for the first nod position and the "Off" position for the second nod position (the negative beam). On either side we have the respective nod positions for each position in the raster map.

5. The SPIRE AORs

   The positions of each of the SPIRE integrations are shown with large red circles. SPIRE measures a 3x3 raster with 4 jiggle positions in each raster position.
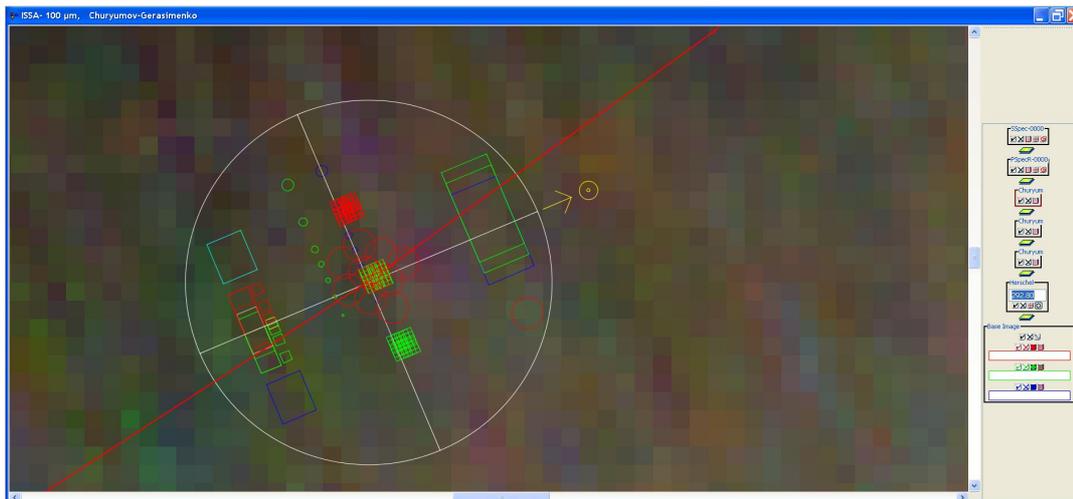
Figure 20.27. A combined PACS and SPIRE spectroscopic raster map, showing the Focal Plane overlay and the track of comet 67P/Churyumov-Gerasimenko. The display combines all the elements that an observer needs. The focal plane is rotated to the angle at the date of observation (2010 July 6). A yellow circle and the yellow arrow give the solar orientation for the observation. The red curve is the track of the comet at this time, with the focal plane superimposed. Red circles represent the positions of SPIRE during the raster observation. PACS integrations are shown by green squares for the "on" and red squares for the "off" position.

> **Warning**
> At present it is not possible to visual HIFI moving target AORs. If you try to do so you will receive a warning that the AOR is not in the image.

Chapter 21. Sample HSpot Target File

In this section we provide a sample target file that includes an example of every coordinate type/ target type combination that can be imported into HSpot. These are not real astronomical targets. They are random positions used to illustrate the correct format for HSpot targets, if you are using a text editor to create a target file. The target list window from HSpot for these targets is shown below.

```
# Please edit this file with care to maintain the
# correct format so that HSpot can still read it.
# Generated by HSpot on: 10/20/2005 12:29:26
HEADER: FILE_VERSION=11.0, STATUS = PROPOSAL
MOVING_TARGET: NO
TARGET_TYPE: FIXED SINGLE
TARGET_NAME: A_Target_Galactic
COORD_SYSTEM: Galactic
POSITION: RA_LON=40.50000000d, DEC_LAT=+31.32000000d
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: NO
TARGET_TYPE: FIXED SINGLE
TARGET_NAME: Test_Target
COORD_SYSTEM: Equatorial J2000
POSITION: RA_LON=1h02m03.00000s, DEC_LAT=+4d05m06.0000s,
PM_RA=0.0", PM_DEC=0.0", EPOCH=2000.0
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: NO
TARGET_TYPE: FIXED CLUSTER - POSITIONS
TARGET_NAME: Cluster_Pos_2000
COORD_SYSTEM: Equatorial J2000
POSITION1: RA_LON=2h03m04.00s, DEC_LAT=-5d06m07.0s, PM_RA=3.0",
PM_DEC=4.0", EPOCH=2000.0
POSITION2: RA_LON=2h03m16.00s, DEC_LAT=-5d04m03.0s, PM_RA=5.0",
PM_DEC=6.0", EPOCH=2000.0
POSITION3: RA_LON=2h03m30.00s, DEC_LAT=-4d50m00.0s, PM_RA=7.0",
PM_DEC=8.0", EPOCH=2000.0
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: NO
TARGET_TYPE: FIXED SINGLE
TARGET_NAME: A_Target_2000
COORD_SYSTEM: Equatorial J2000
POSITION: RA_LON=12h07m00.00000s, DEC_LAT=-5d05m00.0000s,
PM_RA=3.5", PM_DEC=4.21", EPOCH=2000.0
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: YES
TARGET_TYPE: MOVING SINGLE
TARGET_NAME: Encke
EPHEMERIS: NAIF_ID=1000025, NAIF_NAME=Encke
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: YES
TARGET_TYPE: MOVING SINGLE
TARGET_NAME: New TNO
EPHEMERIS: EPOCH=2451325.5, T=2450131.5,
LITTLE_OMEGA=281.130004882812, BIG_OMEGA=78.839996337891,
ECCENTRICITY=0.316406709909, PERIHELION-DISTANCE=8.169799575806,
INCLINATION-OF-ORBIT=5.960000038147
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = NO
MOVING_TARGET: YES
TARGET_TYPE: MOVING SINGLE
TARGET_NAME: M_Vesta
EPHEMERIS: NAIF_ID=2000004, NAIF_NAME=M_Vesta
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: NO
TARGET_TYPE: FIXED SINGLE
TARGET_NAME: A_Target_Ecliptic_1950
COORD_SYSTEM: Ecliptic B1950
POSITION: RA_LON=17.20000000d, DEC_LAT=+35.60000000d,
EPOCH=1950.0
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
MOVING_TARGET: NO
TARGET_TYPE: FIXED SINGLE
TARGET_NAME: A_Target_Ecliptic_2000
COORD_SYSTEM: Ecliptic J2000
POSITION: RA_LON=5.00000000d, DEC_LAT=+5.00000000d
OBJECT_AVOIDANCE: EARTH = YES, OTHERS = YES
```

Appendix A. Example AOR and Target files

The two figures in this appendix illustrate the format of the AOR and target files that are saved on local disk by the user. Files are held in XML format.

An example AOR file (extension '.aor') containing a single HIFI AOR is shown in Figure A.1.

An example of the target associated with the single AOR stored as a HSpot '.tgt' file is provided in Figure A.2.

> **Note**
> Note that there is overflow on some lines. These have had to be broken to keep the text within the page area of this manual. The overflow is right justified in the following line.

```
<?xml version="1.0" encoding="UTF-8"?>
<v04:RequestHolder xmlns:v04="http://www.esa.int/herschel/aors/v04">
   <v04:AorIoVersion>0.4</v04:AorIoVersion>
   <v04:Request>
      <v04:Title>HIFIP-0000</v04:Title>
      <v04:Status>new</v04:Status>
      <v04:Comment xsi:nil="true" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instan
                                                                               ce"/>
      <v04:ModeType>
         <v04:HifiPoint>
            <v04:HifiInstrument>
               <v04:band>Ia</v04:band>
               <v04:spectrometer>both</v04:spectrometer>
               <v04:redshift>0.0</v04:redshift>
               <v04:redshiftType>redshift</v04:redshiftType>
               <v04:hrsModeH>Nominal</v04:hrsModeH>
               <v04:hrsModeV>Nominal</v04:hrsModeV>
               <v04:seperatePol>false</v04:seperatePol>
               <v04:frame>LSR</v04:frame>
               <v04:Frequency>
                  <v04:lof>513.043</v04:lof>
                  <v04:hrs1h>9.999999999998899E-4</v04:hrs1h>
                  <v04:hrs2h>9.999999999998899E-4</v04:hrs2h>
                  <v04:hrs3h>9.999999999998899E-4</v04:hrs3h>
                  <v04:hrs4h>9.999999999998899E-4</v04:hrs4h>
                  <v04:hrs1v>0.0</v04:hrs1v>
                  <v04:hrs2v>0.0</v04:hrs2v>
                  <v04:hrs3v>0.0</v04:hrs3v>
                  <v04:hrs4v>0.0</v04:hrs4v>
                  <v04:wbs_line>-No Lines-</v04:wbs_line>
                  <v04:wbs_transition>-No Lines-</v04:wbs_transition>
                  <v04:wbs_rest_frequency>NaN</v04:wbs_rest_frequency>
                  <v04:wbs_usb>true</v04:wbs_usb>
                  <v04:hrs1_h_line>-No Lines-</v04:hrs1_h_line>
                  <v04:hrs1_h_transition>-No Lines-</v04:hrs1_h_transition>
                  <v04:hrs1_h_rest_frequency>NaN</v04:hrs1_h_rest_frequency>
                  <v04:hrs1_h_usb>true</v04:hrs1_h_usb>
                  <v04:hrs2_h_line>-No Lines-</v04:hrs2_h_line>
                  <v04:hrs2_h_transition>-No Lines-</v04:hrs2_h_transition>
                  <v04:hrs2_h_rest_frequency>NaN</v04:hrs2_h_rest_frequency>
                  <v04:hrs2_h_usb>true</v04:hrs2_h_usb>
                  <v04:hrs3_h_line>-No Lines-</v04:hrs3_h_line>
                  <v04:hrs3_h_transition>-No Lines-</v04:hrs3_h_transition>
                  <v04:hrs3_h_rest_frequency>NaN</v04:hrs3_h_rest_frequency>
                  <v04:hrs3_h_usb>true</v04:hrs3_h_usb>
                  <v04:hrs4_h_line>-No Lines-</v04:hrs4_h_line>
                  <v04:hrs4_h_transition>-No Lines-</v04:hrs4_h_transition>
                  <v04:hrs4_h_rest_frequency>NaN</v04:hrs4_h_rest_frequency>
                  <v04:hrs4_h_usb>true</v04:hrs4_h_usb>
                  <v04:hrs1_v_line>-No Lines-</v04:hrs1_v_line>
                  <v04:hrs1_v_transition>-No Lines-</v04:hrs1_v_transition>
                  <v04:hrs1_v_rest_frequency>NaN</v04:hrs1_v_rest_frequency>
                  <v04:hrs1_v_usb>true</v04:hrs1_v_usb>
                  <v04:hrs2_v_line>-No Lines-</v04:hrs2_v_line>
                  <v04:hrs2_v_transition>-No Lines-</v04:hrs2_v_transition>
                  <v04:hrs2_v_rest_frequency>NaN</v04:hrs2_v_rest_frequency>
                  <v04:hrs2_v_usb>true</v04:hrs2_v_usb>
                  <v04:hrs3_v_line>-No Lines-</v04:hrs3_v_line>
                  <v04:hrs3_v_transition>-No Lines-</v04:hrs3_v_transition>
```

```
                    <v04:hrs3_v_rest_frequency>NaN</v04:hrs3_v_rest_frequency>
                    <v04:hrs3_v_usb>true</v04:hrs3_v_usb>
                    <v04:hrs4_v_line>-No Lines-</v04:hrs4_v_line>
                    <v04:hrs4_v_transition>-No Lines-</v04:hrs4_v_transition>
                    <v04:hrs4_v_rest_frequency>NaN</v04:hrs4_v_rest_frequency>
                    <v04:hrs4_v_usb>true</v04:hrs4_v_usb>
                </v04:Frequency>
            </v04:HifiInstrument>
            <v04:HifiTeInputs>
                <v04:timeSelected>true</v04:timeSelected>
                <v04:highestRes>0.135</v04:highestRes>
                <v04:goalRes>1.1</v04:goalRes>
                <v04:noise>0.1</v04:noise>
                <v04:time>2000</v04:time>
            </v04:HifiTeInputs>
            <v04:modeName>dbs</v04:modeName>
            <v04:Dbs>
                <v04:Fast>false</v04:Fast>
                <v04:Continuum>false</v04:Continuum>
            </v04:Dbs>
        </v04:HifiPoint>
    </v04:ModeType>
    <v04:TargetType>
        <v04:FixedSingle>
            <v01:Name xmlns:v01="http://www.esa.int/herschel/targets/v01">M31</v01:
                                                                          Name>
            <v01:AvoidEarth xmlns:v01="http://www.esa.int/herschel/targets/v01">true
                                                                  </v01:AvoidEarth>
            <v01:AvoidOthers xmlns:v01="http://www.esa.int/herschel/targets/v01">true
                                                                 </v01:AvoidOthers>
            <v01:CoordSystem xmlns:v01="http://www.esa.int/herschel/targets/v01">Equ
                                                          atorial</v01:CoordSystem>
            <v01:Equinox xmlns:v01="http://www.esa.int/herschel/targets/v01">J2000<
                                                                  /v01:Equinox>
            <v01:RaLon xmlns:v01="http://www.esa.int/herschel/targets/v01">0h42m44.31
                                                              000s</v01:RaLon>
            <v01:DecLat xmlns:v01="http://www.esa.int/herschel/targets/v01">+41d16m09
                                                            .4000s</v01:DecLat>
            <v01:PropMo xmlns:v01="http://www.esa.int/herschel/targets/v01">
                <v01:Lon>0.0</v01:Lon>
                <v01:Lat>0.0</v01:Lat>
            </v01:PropMo>
            <v01:Epoch xmlns:v01="http://www.esa.int/herschel/targets/v01">2000.0</
                                                                  v01:Epoch>
        </v04:FixedSingle>
    </v04:TargetType>
    <v04:ObsEstType>
        <v04:HifiTimeEst>
            <v04:version>V0.17</v04:version>
            <v04:totalTime>1022</v04:totalTime>
            <v04:overheadTime>180</v04:overheadTime>
        </v04:HifiTimeEst>
    </v04:ObsEstType>
    </v04:Request>
</v04:RequestHolder>
```

Figure A.1. Example '.aor' file in XML format.

```
<?xml version="1.0" encoding="UTF-8"?>
<v01:TargetHolder xmlns:v01="http://www.esa.int/herschel/targets/v01">
    <v01:AorIoVersion>0.4</v01:AorIoVersion>
    <v01:Target>
        <v01:FixedSingle>
            <v01:Name>M31</v01:Name>
            <v01:AvoidEarth>true</v01:AvoidEarth>
            <v01:AvoidOthers>true</v01:AvoidOthers>
            <v01:CoordSystem>Equatorial</v01:CoordSystem>
            <v01:Equinox>J2000</v01:Equinox>
            <v01:RaLon>0h42m44.31000s</v01:RaLon>
            <v01:DecLat>+41d16m09.4000s</v01:DecLat>
            <v01:PropMo>
                <v01:Lon>0.0</v01:Lon>
                <v01:Lat>0.0</v01:Lat>
            </v01:PropMo>
            <v01:Epoch>2000.0</v01:Epoch>
        </v01:FixedSingle>
    </v01:Target>
</v01:TargetHolder>
```

Figure A.2. Example '.tgt' file in XML format.

Appendix B. Default Line List Used in HSpot

The following set of lines must be made available for selection within the default frequency editor window [more lines may be added to this list based on the recommendations of the HIFI ICC and the CCB]. Further lines can be added by the user by utilizing a "personal" line list.

```
Molecule/Atom/Ion        Transition           Frequency (GHz)
CO                         5-4                  576.2679305
CO                         6-5                  691.4730763
CO                         7-6                  806.6518060
CO                         8-7                  921.7997000
CO                         9-8                 1036.9123930
CO                        10-9                 1151.9854520
CO                        13-12                1496.9229090
CO                        14-13                1611.7935180
CO                        15-14                1726.6025066
CO                        16-15                1841.3455060
CS                        10-9                  489.751040
CS                        11-10                 538.688830
CS                        12-11                 587.616240
CS                        13-12                 636.531841
CS                        14-13                 685.434764
CS                        15-14                 734.323997
CS                        16-15                 783.198519
CS                        17-16                 832.057299
CS                        18-17                 880.899299
CS                        19-18                 929.723470
CS                        20-19                 978.528750
CS                        21-20                1027.314070
CS                        22-21                1076.078345
CS                        23-22                1124.820480
CS                        24-23                1173.539367
CS                        25-24                1222.233882
CS                        29-28                1416.745273
CS                        30-29                1465.300578
CS                        31-30                1513.824457
CS                        32-31                1562.315677
CS                        33-32                1610.772984
CS                        34-33                1659.195107
CS                        35-34                1707.580753
CS                        36-35                1755.928612
CS                        37-36                1804.237351
CS                        38-37                1852.505615
CS                        39-38                1900.732030
H20                       624-717               488.4911330
H20                       101-101               556.9360020
H20                       532-441               620.7008070
H20                       211-202               752.0332270
H20                       422-331               916.1715820
H20                       524-431               970.3150220
H20                       202-111               987.9267640
H20                       312-303              1097.3647910
H20                       111-000              1113.3429640
H20                       312-221              1153.1268220
H20                       634-541              1158.3237430
H20                       321-312              1162.9115930
H20                       744-651              1172.5258350
H20                       422-413              1207.6387140
H20                       220-211              1228.7887720
H20                       523-514              1410.6180740
H20                       726-633              1440.7815440
H20                       633-542              1541.9667850
H20                       643-716              1574.2320730
H20                       413-404              1602.2191820
H20                       221-212              1661.0076370
H20                       212-101              1669.9047750
H20                       432-505              1713.8829730
H20                       303-212              1716.7696330
H20                       533-606              1716.9566161
H20                       633-624              1762.0427910
H20                       735-642              1766.1987480
H20                       624-615              1794.7889530
H20                       734-725              1797.1587620
H20                       532-523              1867.7485940
H20                       634-707              1880.7523612
H20                       331-404              1893.6865446
HCN                        6-5                  531.71635
HCN                        7-6                  620.3040952
```

HCN	8-7	708.8772081
HCN	9-8	797.4336638
HCN	10-9	885.9714087
HCN	11-10	974.4884000
HCN	12-11	1062.9826043
HCN	13-12	1151.4520030
HCN	14-13	1239.8945896
HCN	17-16	1505.0416397
HCN	18-17	1593.3572244
HCN	19-18	1681.6362074
HCN	20-21	1769.8766871
HCN	21-20	1858.0767832
CH+	J=1-0	835.0709678
HCl	J=1-0	625.9187560
HDO	JKaKc=111-000	893.6386660
HF	J=1-0	1232.4762700
NH	3S-N=1-0	974.4504380
NH3	JK=10-00	572.4980678
o-H3O+	JK=11+-11-	1655.8135511
OD	2P1/2J=3/2-1/2	941.6312586
OD	2 P3/2J=5/2-3/2	1390.6247266
OH	2 P1/2J=3/2-1/2	1837.8370200
p-H3O+	JK=10-00	984.6967430
H#	H15#	1769.610820
H#	H16#	1466.610151
H#	H17#	1229.033572
H#	H18#	1040.131063
H#	H19#	888.047035
H#	H20#	764.229558
H#	H21#	662.404172
H#	H22#	577.896461
H#	H23#	507.175490
CI	1-0	492.1607
CI	2-1	809.3435
CII	C+	1900.5372
NII	N+	1461.1321

Appendix C. Solar System Objects that have ephemeris information in HSpot

Ephemeris information is given in HSpot for a limited sample of the most likely Herschel targets among Solar System Objects. For objects that are not included in these lists, the observer should contact Helpdesk.

> **Warning**
>
> These list are not exhaustive, but rather an approximation to the most likely Solar System targets for observers. Inclusion in the list does not guarantee that Herschel will have the sensitivity or capability to observe the choosen target.
>
> If your intended target is not in the list, please contact the Helpdesk (http://herschel.esac.esa.int/esupport/) at the Herschel Science Centre to get the target included. Please note though that this is not an instant process and is unlikely to be possible in the days before a deadline. Any such requests should be made well in advance of AO closure.

Asteroids: The following are likely calibration targets for Herschel and are included in the HSpot ephemeris database as such.

```
1 Ceres
2 Pallas
3 Juno
4 Vesta
5 Astraea
6 Hebe
7 Iris
9 Metis
10 Hygiea
12 Victoria
17 Thetis
18 Melpomene
19 Fortuna
20 Massalia
21 Lutetia
23 Thalia
24 Themis
28 Bellona
29 Amphitrite
31 Euphrosyne
37 Fides
40 Harmonia
41 Daphne
42 Isis
47 Aglaja
48 Doris
51 Nemausa
52 Europa
54 Alexandra
56 Melete
65 Cybele
69 Hesperia
85 Io
88 Thisbe
93 Minerva
94 Aurora
196 Philomela
241 Germania
313 Chaldaea
354 Eleonora
360 Carlova
423 Diotima
451 Patientia
471 Papagena
505 Cava
511 Davida
532 Herculina
704 Interamnia
776 Berbericia
```

Near Earth Asteroids: the following are all numbered objects with a predicted close-approach to the Earth during the likely Herschel mission duration. Three objects have more than one close approach during the expected Herschel mission duration.

```
No.     Name            NAIF ID

  433   Eros              2000433
 3103 Eger               2003103
 3361 Orpheus            2003361
 3838 Epona              2003838
 3988 1986 LA            2003988
 4179 Toutatis           2004179
 4183 Cuno               2004183
 4486 Mithra             2004486
 4581 Asclepius          2004581
 4769 Castalia           2004769
 6239 Minos              2006239
 7341 1991 VK            2007341
 8566 1996 EN            2008566
 8567 1996 HW1           2008567
 9162 1987 OA            2009162
10145 1994 CK1           2010145
11885 1990 SS            2011885
14402 1991 DB            2014402
17274 2000 LC16          2017274
22099 2000 EX106         2022099
23187 2000 PN9           2023187
24761 Ahau               2024761
33342 1998 WT24          2033342
35107 1991 VH            2035107
37655 Illapa             2037655
52768 1998 OR2           2052768
54509 2000 PH5           2054509
54660 2000 UJ1           2054660
65679 1989 UQ            2065679
65690 1991 DG            2065690
65909 1998 FH12          2065909
66146 1998 TU3           2066146
68216 2001 CV26          2068216
85236 1993 KH            2085236
85640 1998 OX4           2085640
85640 1998 OX4           2085640
85770 1998 UP1           2085770
85774 1998 UT18          2085774
85938 1999 DJ4           2085938
85953 1999 FK21          2085953
85989 1999 JD6           2085989
88213 2001 AF2           2088213
88254 2001 FM129         2088254
90367 2003 LC5           2090367
90403 2003 YE45          2090403
99907 1989 VA            2099907
99942 Apophis            2099942
```

Comets: The following list includes all the brightest periodic comets that are expected to be visible up to the end of 2011 three potentially bright unnumbered (i.e. first return) objects are included - the ephemeris information for these will logically be less precise until they are recovered and may well be insufficiently accurate to permit observations until these objects have been recovered and the orbit refined. The list includes five objects with an Earth approach to within 0.2AU during the likely Herschel mission duration. One non-periodic comet of interest is also included.

Warning

In most cases it will be necessary for the comet to have been recovered and the ephemeris corrected for observations to be possible with Herschel.

```
Name                    NAIF ID
2P/Encke                1000025
6P/d'Arrest             1000017
9P/Tempel 1             1000093
10P/Tempel 2            1000094
15P/Finlay              1000027
```

```
19P/Borrelly                     1000005
21P/Giacobini-Zinner             1000032
22P/Kopff                        1000054
27P/Crommelin                    1000016
29P/Schwassmann-Wachmann 1       1000079
43P/Wolf-Harrington              1000111
45P/Honda-Mrkos-Pajdusakova      1000045
64P/Swift-Gehrels                1000090
65P/Gunn                         1000035
67P/Churyumov-Gerasimenko        1000012
73P-B/Schwassmann-Wachmann 3     1000320
73P-C/Schwassmann-Wachmann 3     1000081
78P/Gehrels 2                    1000030
81P/Wild 2                       1000107
85P/Boethin                      1000004
88P/Howell                       1000046
103P/Hartley                     1000041
116P/Wild 4                      1000122
118P/Shoemaker-Levy 4            1000150
144P/Kushida                     1000148
169P/NEAT                        1001656
C/1995 O1                        1000132
P/2001 MD7 (LINEAR)              1000345
P/2002 O5 (NEAT)                 1000400
P/2004 X1 (LINEAR)               1000530
```

TNOs and dwarf planets: The largest known TNOs to date are included. Note that there are multiple NAIF IDs for Pluto.

```
No.     Name/designation         NAIF
20000   Varuna                   2020000
28978   Ixion                    2028978
50000   Quoaor                   2050000
55565   2002 AW_197              2055565
90377   Sedna                    2090377
90482   Orcus                    2090482
134340  Pluto                    9, 999, 2134340
136108  2003 EL_61               2136108
136199  Eris = 2003 UB_313       2136199
136472  2005 FY_9                2136472
```

Planetary bodies: Only planets observable by Herschel are included. Note that planetary centres are NAIF IDs ending with "99", barycentres are single-digit NAIF IDs. For the purposes of Herschel planning the two positions can be regarded as equivalent.

```
Mars            4, 499
Jupiter         5, 599
Saturn          6, 699
Uranus          7, 799
Neptune         8, 899
```

Major planetary satellites: the list excludes objects that have a maximum elongation from their parent body too small to make them feasible targets for Herschel. Stray light may be an important issue in some cases.

```
Jupiter:
Io              501
Europa          502
Ganymede        503
Callisto        504

Saturn:
Mimas           601
Enceladus       602
Tethys          603
Dione           604
Rhea            605
Titan           606
Hyperion        607
Iapetus         608
Phoebe          609
```

```
Uranus:
Titania          703
Oberon           704

Neptune:
Triton           801
```

Additional TNOs and Centaurs included in an expanded list of Solar System bodies in HSpot v3.0.7.

Numbered TNOs and Centaurs:

```
  2060 Chiron
  5145 Pholus
  8405 Asbolus
 10199 Chariklo
 10370 Hylonome
 12929 1999 TZ1
 15788 1993 SB
 15820 1994 TB
 15874 1996 TL66
 15875 1996 TP66
 19308 1996 TO66
 19521 Chaos
 24835 1995 SM55
 26181 1996 GQ21
 26308 1998 SM165
 26375 1999 DE9
 29981 1999 TD10
 31824 Elatus
 32532 Thereus
 32929 1995 QY9
 33128 1998 BU48
 33340 1998 VG44
 35671 1998 SN165
 38628 Huya
 40314 1999 KR16
 42301 2001 UR163
 42355 Typhon
 44594 1999 OX3
 47171 1999 TC36
 47932 2000 GN171
 48639 1995 TL8
 52872 Okyrhoe
 54598 Bienor
 55576 Amycus
 55636 2002 TX300
 55637 2002 UX25
 55638 2002 VE95
 60454 2000 CH105
 60558 Echeclus
 60608 2000 EE173
 65489 Ceto
 66652 1999 RZ253
 73480 2002 PN34
 78799 2002 XW93
 79360 1997 CS29
 79978 1999 CC158
 79983 1999 DF9
 80806 2000 CM105
 82075 2000 YW134
 82155 2001 FZ173
 82158 2001 FP185
 83982 Crantor
 84522 2002 TC302
 84719 2002 VR128
 84922 2003 VS2
 86177 1999 RY215
 87555 2000 QB243
 88268 2001 KK76
 88611 Teharonhiawa
 90568 2004 GV9
 91133 1998 HK151
 95625 2002 GX32
 95626 2002 GZ32
113804 2002 TA207
119068 2001 KC77
119069 2001 KN77
119070 2001 KP77
119315 2001 SQ73
119473 2001 UO18
119878 2002 CY224
119951 2002 KX14
```

```
119956 2002 PA149
119979 2002 WC19
120061 2003 CO1
120132 2003 FY128
120178 2003 OP32
120181 2003 UR292
120216 2004 EW95
120347 2004 SB60
120348 2004 TY364
126154 2001 YH140
126155 2001 YJ140
127546 2002 XU93
127871 2003 FC128
133067 2003 FB128
134860 2000 OJ67
135182 2001 QT322
135571 2002 GG32
136204 2003 WL7
138537 2000 OK67
139775 2001 QG298
143685 2003 SS317
143707 2003 UY117
143991 2003 YO179
144897 2004 UX10
145451 2005 RM43
145452 2005 RN43
145453 2005 RR43
145474 2005 SA278
145480 2005 TB190
145486 2005 UJ438
148780 2001 UQ18
149560 2003 QZ91
150642 2001 CZ31
```

Currently unnumbered TNOs and Centaurs with only a provisional designation.

Warning

Not all of these objects will have an ephemeris of sufficient quality to be observable by Herschel. In some cases, particularly single opposition orbits, it will be necessary to obtain astrometry to update the ephemeris before observations can be considered with Herschel. However, even some objects with two or more oppositions for which the second opposition was several years ago may also have significant errors in the ephemeris.

The following warning flags are shown:

* Objects with possibly unsatisfactory multiopposition orbits (3 # position error >6-20" from the current ephemeris in mid-2007).

** Objects with unsatisfactory multiopposition orbits (3 # position error >20" extrapolated from the current ephemeris in mid-2007), or an orbit for which Horizons cannot presently extrapolate an error.

*** Single opposition, short-arc objects with very poor ephemerides.

Please check the Herschel Observers' Manual for information on the constraints imposed by each instrument on the target position accuracy.

```
1995 SN55   ***
1996 TC68   ***
1996 TS66
1998 XY95   **
1999 CD158
1999 XY143 **
2000 CL104
2000 CN105
2000 GP183
2000 KK4
2000 ON67   **
2000 OU69   *
2000 PE30   **
2000 QL251 *
2000 YH2    **
2001 DC106 ***
2001 HY65
```

```
2001 KB77
2001 KD77
2001 KN76
2001 KO77   **
2001 KQ77   *
2001 KU76
2001 KY76   **
2001 PK47   **
2001 QA298  **
2001 QB298  *
2001 QC298
2001 QD298  **
2001 QF298  **
2001 QJ298  **
2001 QO297  **
2001 QQ199
2001 QQ322  **
2001 QR297  **
2001 QR322
2001 QS297  ***
2001 QS322  **
2001 QU297  ***
2001 QW297
2001 QX297  **
2001 QX322
2001 QY297  *
2001 QZ297  **
2001 RU143  **
2001 RX143  **
2001 RZ143  *
2001 XD255  ***
2001 XR254  **
2002 CB249  ***
2002 CP154  ***
2002 CY248  **
2002 GF32   **
2002 GH166  ***
2002 GH32   **
2002 GJ32   **
2002 GN32   ***
2002 GP32   **
2002 GR32   ***
2002 GU32   ***
2002 GV31   **
2002 GV32   **
2002 GY32   **
2002 GZ31   **
2002 JR146  ***
2002 KW14   *
2002 KY14   ***
2002 MS4
2002 PJ149  ***
2002 PQ145  **
2002 PQ149  ***
2002 PQ152  ***
2002 QX47   **
2002 VD130  **
2002 VT130  *
2002 VU130
2002 XH91   **
2002 XV93   **
2003 AZ84
2003 FE128  **
2003 FF128  **
2003 FM129  ***
2003 GH55   **
2003 HC57   **
2003 LE7    ***
2003 MW12   **
2003 QA91   **
2003 QA92   **
2003 QM91   ***
2003 QP91   ***
2003 QR91   **
2003 QW90   *
2003 QX111  **
2003 SQ317  **
2003 UE292  ***
2003 UJ292  ***
2003 UP292  ***
2003 UT292  **
2003 UW292  ***
2003 UZ117  **
2003 WU172  **
2003 WU188  **
2004 EO95   ***
2004 FU148  **
```

```
2004 OL12   ***
2004 PA108  **
2004 PR107  ***
2004 PT107  **
2004 PW107  **
2004 PY107  **
2004 TF282  **
2004 TV357  **
2004 VT75   **
2004 VZ75   **
2004 XR190  **
2005 EB299  **
2005 EC318  **
2005 EF298  **
2005 ER318  **
2005 EX318  ***
2005 EZ296  **
2005 GB187  **
2005 GE187  **
2005 JA175  **
2005 JP179  **
2005 JR179  **
2005 PM21   ***
2005 PR21   **
2005 PU21   **
2005 RO43   **
2005 RP43   **
2005 RS43   **
2005 VA123  ***
2005 VJ119  **
2005 XN113  ***
2005 XU100  **
2006 HF123  ***
2006 HH123  ***
2006 HJ123  **
2006 HQ122  **
2006 QJ181  ***
2006 RC103  ***
2006 SQ372  **
2006 SX368  **
2006 UX184  ***
2006 UZ184  ***
```

Chapter 22. Change record

- 2007/02/13: change Section 17.11 to reflect SCR-2885 and planned update for HSpot v2.2.

- 2007/02/14: change Section 16.3.3.1 to clarify rules on permitted chainings.

- 2007/04/04: change Section 20.6.11 to include a new graphic of functionality of image slice identifying the flux at a user-selected point on the slice.

- 2007/04/09:

  Change Section 20.6.9 to make the description applicable to both fixed and moving targets. Change section name to reflect this change. Add a note on overlaying AORs when there are multiple images.

  Change title of Chapter 16 to reflect its content better (timing constraints, not chopper or map orientation constraints).

  Add a subsection (Section 20.6.10 to Chapter 20 to explain when adding a chopper constraint may be justified and when not.

- 2007/04/30:

  Change Section 3.4.3 to update the information on the KDE bug.

  Change Section 5.4 to update and correct information on maximum duration of AORs.

  Change Section 5.7 to update and correct information on the Bug List.

  Change Figure 6.32 to update the figure caption.

  Change Section 6.9.1 to update the information of automatic activation of HSpot updates.

  Change Section 9.3.5 to link to the Herschel Observers' Manual where more information on NAIF ID's is given.

  Change Section 17.12.3 to link to the Herschel Policies and Procedures document.

  Change Section 17.12.3 to update the information on proposal submission to include a reference to the system of queuing proposals and possible delays in receiving email confirmation if the JBOSS server is under heavy load or if a proposal has many HIFI AORs.

  Change Section 17.12.3 to add a tip recommending users to submit draft versions of their proposals as a security measure.

- 2007/05/29:

  Add the section called "AOR overlay control" to document an undocumented Help button.

  Change Section 17.12 to document the changes in the proposal handling dialogue compared to HSpot v2.0.

- Add Section 19.2.9 to describe the new PACS depth of coverage option.

- 2007/06/01 -- PACS changes:

  Updated description in Section 11.1.1.1 including new grating order wavelength ranges.

  Updated description in the section called "Chopping/nodding (bright lines)" regarding new choice of observing mode.

  Update figure Figure 11.5 including "Chopping/nodding (bright lines) option.

Update figure Figure 11.6 including "Chopping/nodding (bright lines) option.

Update figure Figure 11.7 including "Chopping/nodding (bright lines) option.

Updated description in Section 11.2.1.1 including new grating order wavelength ranges and new range scan option (SED blue high sensitivity).

New section added Section 11.2.4.2 regarding the description of PACS range sensitivity plots.

- 2007/05/08 -- HIFI changes:

Change Section 13.2 to update figure of front end of HIFI point AOT.

Change Section 13.2.5, a short new section discussing the save and load of instrument and frequency settings.

Updated figure Figure 13.23 for the new cross map front end.

Updated description in Section 13.3.4 including new options for the user.

Updated section Section 13.2.9.1 regarding the saving of time estimator messages.

Added short new section, Section 13.2.3.1 for updates to redshift values.

Updated figure reference in Section 13.4.4 to point to correct JPG file name.

- 2007/08/01 -- Changes in HSpot v3.0.7:

Change Appendix C to include an updated list of TNOs and Centaurs linked to ephemerides.

- 2007/09/18 -- Changes in HSpot v3.1:

Change Chapter 17 to reflect the new proposal submission process and the requirement to use the PDFLatex template for the scientific justification.

- 2007/09/28:

Update Section 6.1.4 to give more detailed information on importing a moving single target list.

- 2007/10/16:

Update Section 17.2 to give more detailed information on time checks in proposal submission.

Update Section 17.4.2 to give details of the server error in proposal resubmission if the proposal has not been correctly retrieved first.

Update Section 17.12.2 to give a warning of the server error received on proposal resubmission if the proposal has not been correctly retrieved first.