ALMA Observing Tool Quickstart Guide

www.almascience.org

ALMA, an international astronomy facility, is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), NSC and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ.

User Support:

For further information or to comment on this document, please contact your regional Helpdesk through the ALMA User Portal at **www.almascience.org**. Helpdesk tickets will be directed to the appropriate ALMA Regional Center at ESO, NAOJ or NRAO.

Revision History:

Version	Date	Editors
0 (IT3)	15.03.2011	S. Randall, D. Espada
1 (OT release Cycle 0)	30.03.2011	S. Randall, D. Espada, E. Humphreys
2 (OT release Cycle 1)	31.05.2012	E. Hatziminaoglou, S. Randall
3 (OT release Cycle 2)	07.10.2013	S. Randall
4 (OT release Cycle 3)	12.03.2015	S. Randall

Contributors

The ALMA OT Team, and the many Testers.

In publications, please refer to this document as:
S. Randall: ALMA Observing Tool Phase 1 Quickstart Guide: Creating a Proposal in 10 Easy Steps, Version Cycle 3, ALMA

Contents

This page was intentionally left almost blank

Chapter 1

Scope

This document is intended as a Quickstart guide to Phase 1 proposal preparation in Cycle 3 for the novice ALMA Observing Tool (OT) user. It takes the reader through all the basic steps to create an ALMA Observing Proposal, and contains some useful tips for the novice user in particular.

A more comprehensive description of the OT and the different aspects of proposal preparation can be found in the ALMA OT User Manual. The ALMA OT Reference Manual provides a more concise explanation for all the fields and menu items in the OT, and can be accessed interactively from within the OT by clicking on the **?** icons. **All the documentation (including this Quickstart Guide) can also be accessed and interactively searched via the Help menu in the OT**. For a visual demonstration of different aspects of the OT you are invited to consult the suite of ALMA OT video tutorials.

Chapter 2

Getting started

In order to access the ALMA Archive and submit an observing proposal, you must have previously **registered** with the ALMA Science Portal. You can then **download** the OT from the OT page in the ALMA Science Portal. Please follow the detailed installation instructions there; in case of any problems you can consult the Troubleshooting page. You **start the OT** either by clicking on the ALMA OT icon (Web Start) or from the command line by typing `./ALMA-OT.sh` in the installation directory (tarball). A splash screen with different options will appear. To follow the step-by-step guide for creating a new Cycle 3 proposal submission, please select the first option 'Create a new proposal' [1].

> If you would like to re-submit a proposal from Cycle 0, 1, or 2 as a new Cycle 3 proposal you can simply open the old version **saved on disk** in the OT, edit it as needed, and submit it. This project will then be assigned a new (Cycle 3) project code. You will however not be able to edit proposals from previous cycles retrieved from the ALMA Science Archive. If you did not save a local copy of the .aot file you would like to re-submit, you can retrieve the old proposal from the archive and open it as a template. This will allow you to at least copy individual Science Goals into a new Cycle 3 project; the proposal information must however be filled from scratch.

Alternatively, once the OT has opened you can select the green *New Proposal (Phase 1)* button from the toolbar in the OT. You will be presented with the window shown in Fig. 2.1, which illustrates the main Graphical User Interface (GUI) components:

Menu: Allows access to all functions available in the OT via pop-up submenus.

Toolbar: A selection of icons for some of the most frequently used functions in the Menu.

Project Structure Pane: Visualisation and navigation of the **Project tree**. You can expand and collapse parts of the tree by clicking the node icon to the left of each component

Editor Pane: The technical specifications of the project are filled and edited in this pane. The content of the editor pane changes depending on the branch of the Project tree selected. For the spatial and spectral setup the editor panes are composed of several tabs.

Feedback Pane: Provides feedback on the validation process and allows you to identify problems with your proposal.

Overview Pane: Informative summary of the proposal creation process and contextual help.

[1] Choosing 'Create a new DDT proposal' will present you with the Cycle 2 version of the OT until the end of Cycle 2. This option must **not** be used to submit Cycle 3 proposals.

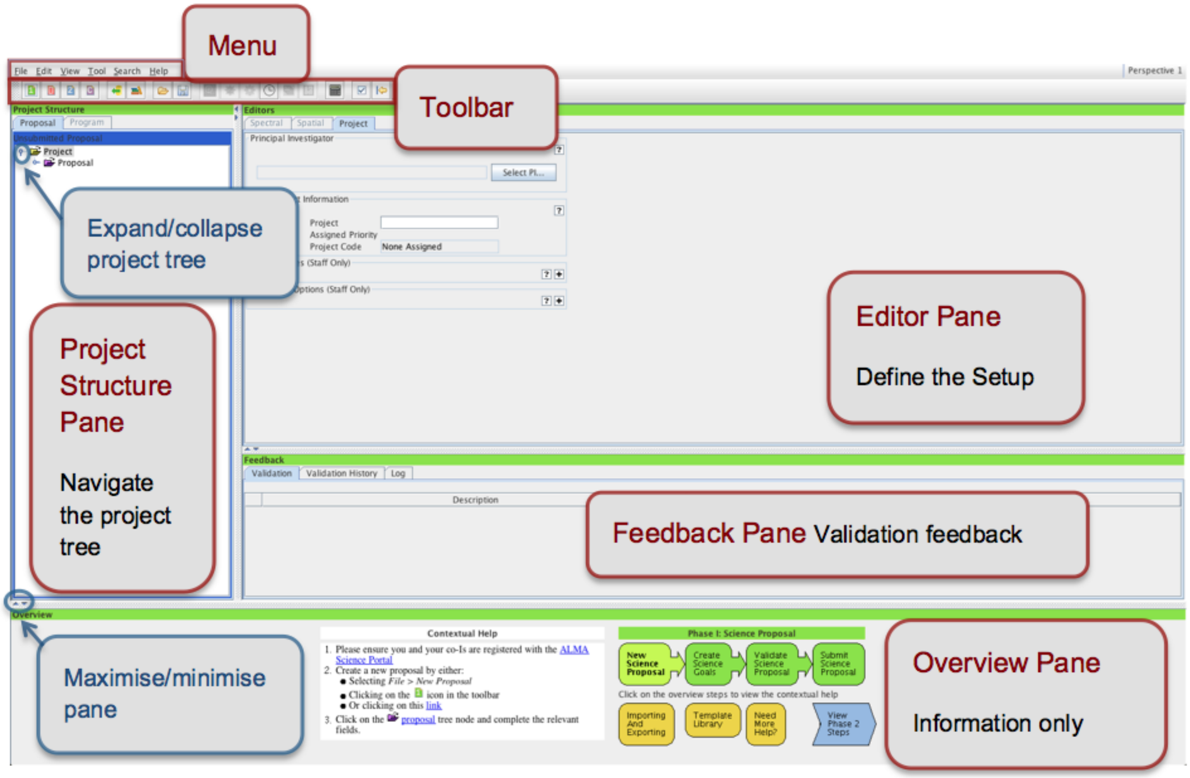

Figure 2.1: OT Graphical User Interface.

You can customize the GUI according to your needs. The size of the different panes can be modified by clicking and dragging their borders, or maximised/minimised by clicking on the triangular arrow symbols. You can toggle the *Overview* and *Feedback* panes by clicking on *View >Feedback/Overview* in the Menu, e.g. in order to maximise the Editor pane. The *Feedback* pane will normally not be visible upon starting the OT, but it will pop up when the project is validated (see Step 3.10). You can customise the OT further by selecting *File > Preferences*. In particular, you may want to change the font size or colour scheme, or preferentially show certain editors.

Chapter 3

Proposal creation and submission in 10 easy steps

1. Enter the basic information for your proposal
2. Attach supporting material
3. Create a Science Goal
4. Add the source information
5. Configure the spectral setup
6. Finalise the spatial setup
7. Select the calibration strategy
8. Enter the control and performance parameters
9. Enter the technical justification
10. Validate and submit your proposal

3.1 Enter the basic information for your proposal

Start by **filling the fields in the Proposal editor pane** labelled *Proposal Title* and *Abstract*, select the *Proposal Type* and *Scientific Category* using the radio buttons and choose up to two *Keywords* from a list (to select multiple keywords hold the Ctrl button, or the Cmd button on Macs). To facilitate filling in the abstract you can launch an editor, which allows you to load and edit a previously prepared text file. You can optionally provide additional information on previous proposals or recent publications related to the project.

> You can copy and paste text in the usual way using Ctrl-c and Ctrl-v. On Macs, the usual Cmd-c and Cmd-v does not work, you need to use the Ctrl button instead.

In order for you to be able to submit the proposal, you will have to **select yourself as PI** by scrolling down, pressing the *Select PI* button and searching by name, e-mail or ALMA ID in the pop-up window (see Fig. 3.1). The ALMA ID is your Science Portal login.

You can select an unlimited number of Co-Is in a similar way, **provided that they have previously registered with the ALMA Science Portal**. Please make sure they do so at least 24 hours prior to the

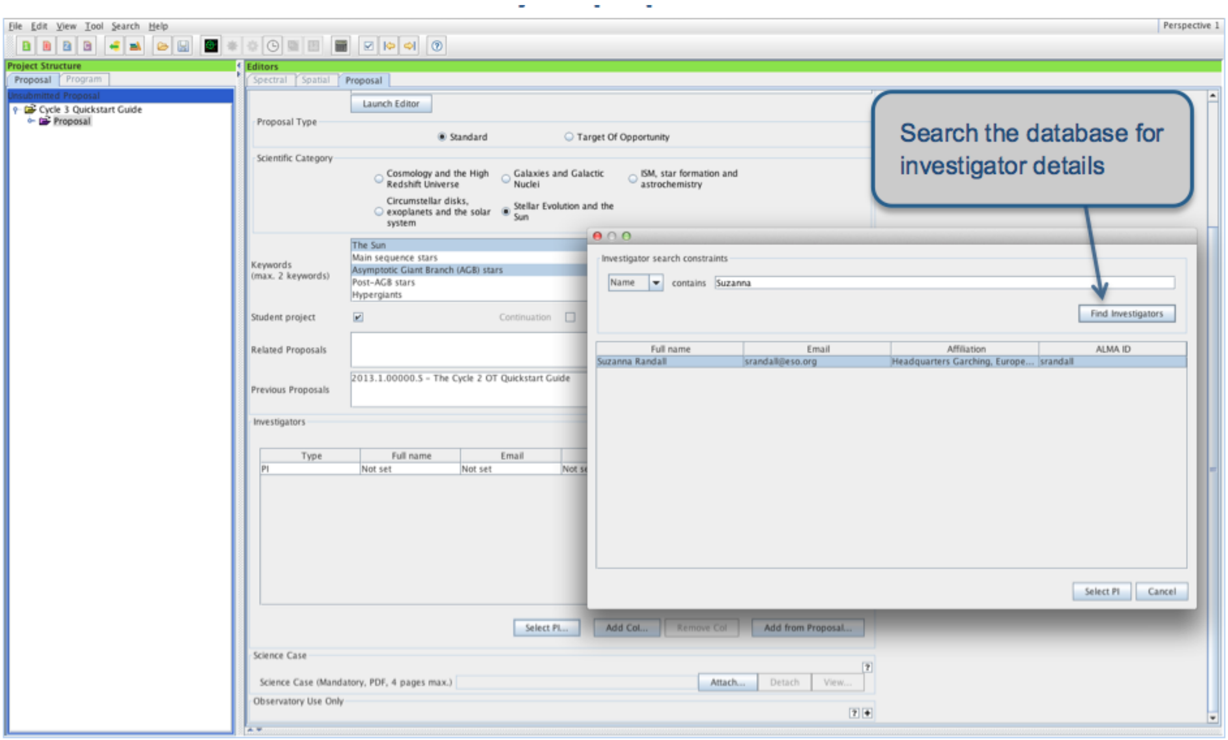

Figure 3.1: Select the PI and Co-Is in the Proposal editor pane.

submission deadline. If you have a long list of Co-Is you may prefer to add them from a proposal previously saved on disk using the *Add from proposal* button.

3.2 Attach supporting material

In the second step you **attach supporting material** used for the scientific assessment of your proposal. You are required to present your science case in a single .pdf file not exceeding 4 pages in total, including any figures and tables. The science case should put the proposed observations in a broad scientific context, highlight their impact on the field of research and present the immediate goal you expect to achieve. While the text of the technical justification is entered directly into the OT (see Step 3.9), any associated figures must still be included in this .pdf file. For more details please see the *General Guidelines for writing a proposal* section of the Proposers Guide.

3.3 Create a Science Goal

All the technical specifications for your project are contained in one or more Science Goals. Each Science Goal may contain up to a total of 150 pointings attributed to one or more sources of the same target type (offset pointings or rectangular mosaic) located within 10° of each other on sky, and is limited to one correlator setup with up to five frequency tunings, one calibration strategy, and one set of Control and Performance parameters (see Step 3.8). You **create a new Science Goal** by clicking on the *New Phase 1 Science Goal* icon in the toolbar or selecting *Edit > New Phase 1 Science Goal* from the Menu. The Science Goal can be **renamed** by

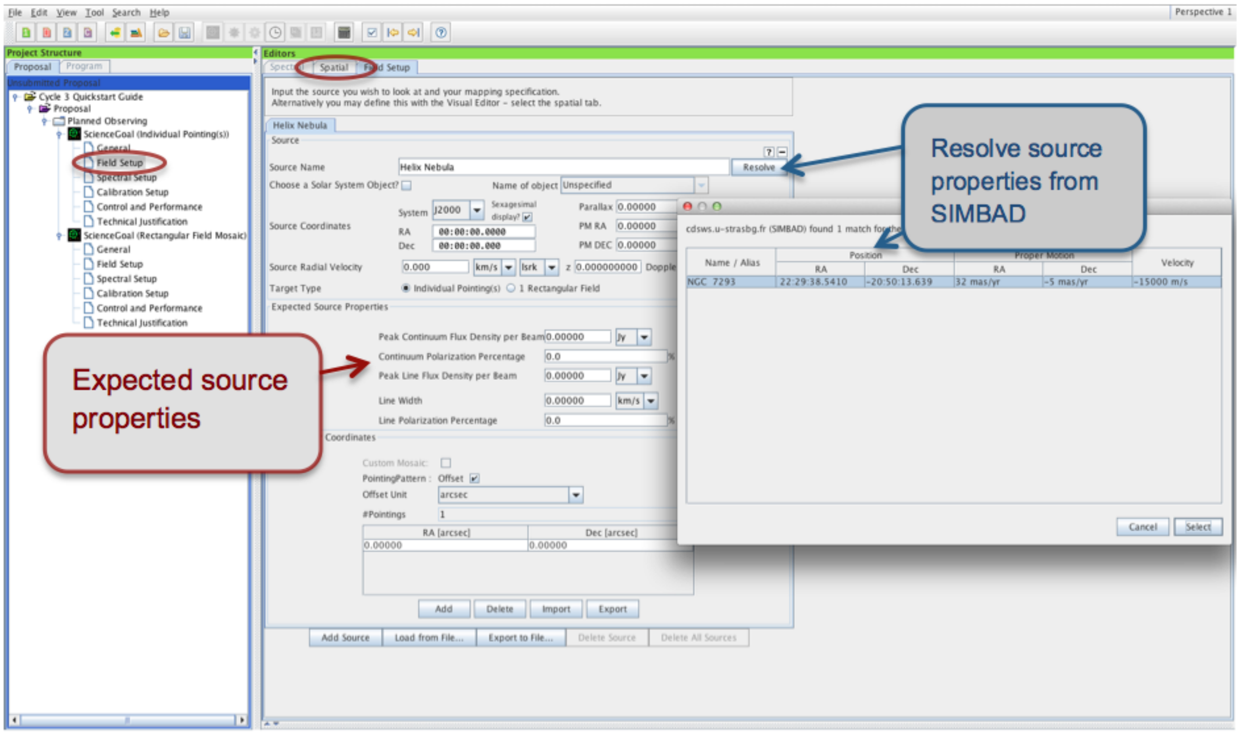

Figure 3.2: Adding the source information in the Field Setup pane.

right-clicking on the *Science Goal* node and selecting *Rename*, or by visiting the *General* editor pane, where a short description of the Science Goal may also be optionally entered in the corresponding field. A **template library** containing a range of pre-defined science goals can be brought up with *View > Show ALMA Template Library*.

> You can easily **copy and paste Science Goals**, or parts of a Science Goal such as the spectral setup. In the Project tree, right-click on the component you want to copy and select 'Copy' (the Science Goal copied will turn pink). Then right-click on the next higher branch of the Project tree where you want to paste and select 'Paste'. Alternatively, you can select a node and drag & drop it to where you want it copied. Note that Science Goals can only be pasted/dropped at the *Proposal* or *Planned Observing* node level, and parts of a Science Goal can only be pasted/dropped at the *Science Goal* node level. You cannot e.g. paste a Science Goal into another Science Goal.

3.4 Add the source information

A source can contain either one or more individual pointings (offset pointings or custom mosaic) or 1 rectangular mosaic. All pointings defined in a given source share the velocity information and Expected Source Properties. Setting up the actual pointings within a source is covered in Step 3.6. For the moment, it is sufficient to enter the source information, especially the velocity, as this will be used for the spectral setup.

By default, the *Field Setup* editor pane (see Fig. 3.2) contains one source tab. **The first thing to select is the Target Type:** ***Individual Pointings*** **or** ***1 Rectangular field.*** The target type must be the same for all sources in a Science Goal, and it is not possible to switch to *1 Rectangular field* once additional sources have been added. You can then use the *Add source* button to open additional source tabs. **You will need to specify the source information for each source individually.** If your source has an entry in SIMBAD or NED, you can simply type in its name in the *Source Name* field and hit *Resolve* to import the field centre coordinate and velocity information from there (see Fig. 3.2). Otherwise, this information must be entered by hand. Solar System targets can be selected from a pull-down list if the *Choose a Solar System Object* box is checked.

It is your responsibility to **ensure that the source information is correct**. The source coordinates and the velocity are used by the OT to calculate the pointing(s) and the sky frequencies respectively. The expected source properties are used for the technical feasibility assessment of your proposal, and incorrect or incomplete information may lead to the rejection of your proposal on technical grounds. For more information on how to convert existing flux measurements for your source to the peak flux density per synthesised beam required by the OT please see Knowledgebase articles How can I estimate the Peak Flux Density per synthesised beam using flux measurements in Jy or K from other observatories? and How do I convert flux measurements given in Jy km/s or K km/s into the peak flux density required by the OT?.

For each source, you are required to provide an estimate of the expected source properties. The peak flux density entered should be an estimate of the **weakest component** driving the sensitivity requirement of your Science Goal. For continuum observations only the *Peak Continuum Flux Density per Beam* is required, while for spectral line and spectral scan observations the *Peak Line Flux Density per Beam* and the (FWHM) *Line Width* must be specified. In the latter case it may also be appropriate to enter the *Peak Continuum Flux Density per Beam* if you want to observe both lines and continuum. The *Line/Continuum Polarisation Percentage* is required only if full polarization observations are requested. The expected source parameters entered are used to calculate a number of quantities in the Technical Justification editor (see Step 3.9) and the proposal/science goal summary sheets. They should be used for guidance when choosing the correlator setup and sensitivity requirements for your Science Goal.

You can also read in the complete source information from an ASCII file using the *Load from File...* button at the bottom of the Field Setup editor. This is particularly useful if you have a large number of sources. As with adding sources manually you should make sure that the correct Target Type is set **before** you load the source list. For the required file format, please see the *Field Setup* section of the ALMA OT Reference Manual.

3.5 Configure the spectral setup

The spectral viewer
The spectral viewer is available under the *Spectral* tab of the *Spectral Setup* editor. It shows the ALMA bands offered for Cycle 3 (bands 3, 4, 6, 7, 8, 9, 10), as well as the atmospheric transmission curve of the Chajnantor site. The OT automatically chooses the water vapour column density appropriate for the observing frequency, and bases the sensitivity calculation on this *Automatic Choice*. **The** *Manual Choice* **is for visualisation purposes only.** Once you specify at least one spectral window, the Local Oscillator (LO1) frequency is calculated, and (yellow) sidebands appear in the spectral viewer. The sidebands straddle the LO1 frequency and show the frequency ranges where basebands may be placed. They do **not** indicate the frequency range that will be sampled by the observations. ALMA uses 4 basebands (not displayed in the spectral viewer) with a bandwidth of 2 GHz, within each of which one or more spectral windows may be placed. Spectral windows are defined directly by the user from within the spectral line table and are represented in the spectral viewer by dark blue lines. The vertical dark blue line corresponds to the central frequency of a given spectral window, while the horizontal line represents the frequency range covered. The LO1 frequency, sidebands and basebands are automatically calculated by the OT based on the spectral windows defined and cannot be controlled by the user directly. If the OT cannot compute a valid spectral setup for your spectral windows, the sidebands will turn grey and a red error message will appear. In that case, you will have to modify your spectral setup, if necessary by placing "offending" spectral windows into separate Science Goals.

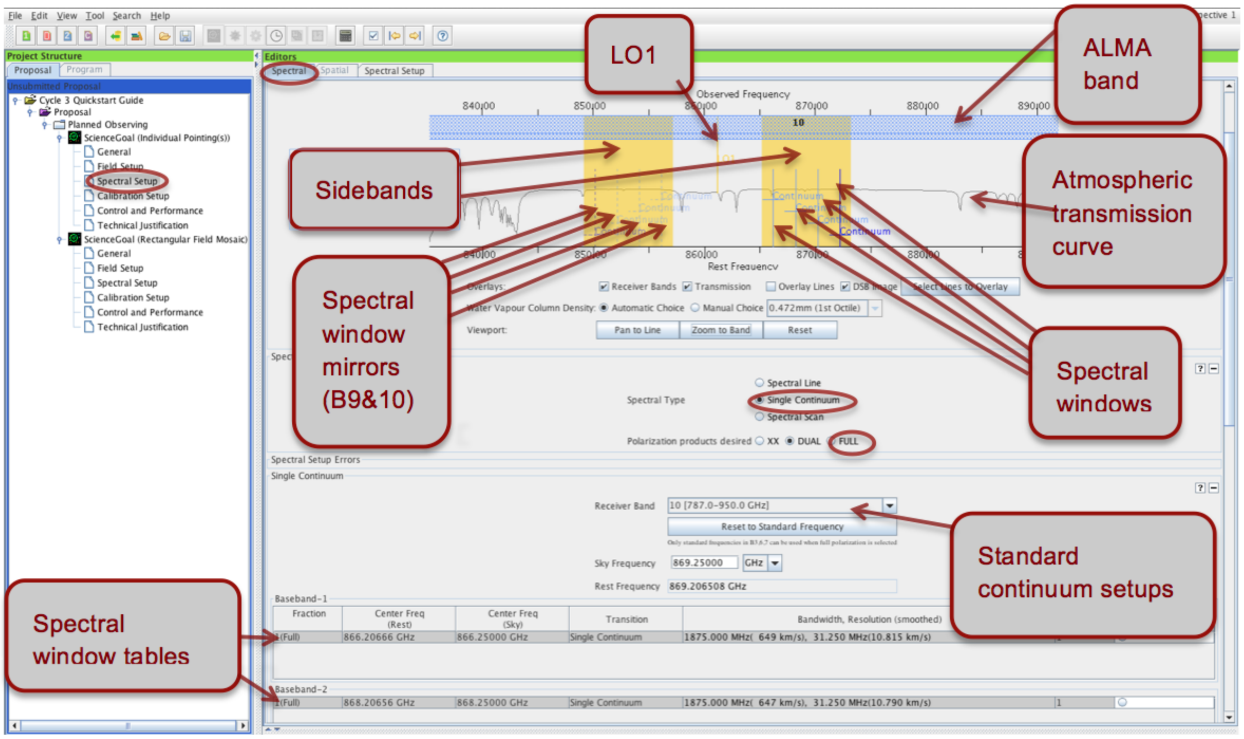

Figure 3.3: The spectral editor pane. Here, continuum observations have been defined.

> You can zoom in/out of the spectral viewer by left/right-clicking on the magnifying glass symbol cursor, or by using the *Zoom to Band* and *Reset* buttons. You can move along the frequency axis by moving the cursor near the axis and dragging the green sliding bars, or using *Pan to Line*. For a practical demonstration of the spectral editor please watch OT video tutorial 2: The Spectral Setup.

In the *Spectral Setup* editor, start by selecting the *Spectral Type* and the *Polarisation Products Desired*, as these will influence the choices you have for defining your spectral setup. In particular, selecting *Full* polarisation will limit you to continuum measurements in Bands 3, 6 and 7, and single pointings of well-centred targets filling no more than 1/3 of the 12-m Array primary beam. If you are not interested in polarisation information, you should generally leave the radio button set to the default *Dual*. *XX* polarisation is appropriate only if you need extremely fine spectral resolution ($<$ 30 kHz).

3.5.1 Spectral Line

Selecting *Spectral Line* will present you with a spectral window table for each of four available basebands. Unless your Science Goal requires more than 4 spectral windows (see "Multi-region mode" boxed text below), **you will normally define one spectral window per baseband**. It is good practice to fill any basebands not needed for spectral line observations with continuum spectral windows, as this facilitates calibration, especially in the case of narrow spectral windows.

> For ALMA bands 3, 4, 6, 7 and 8 it is not possible to place three basebands in one sideband, and one in the other for technical reasons. This restriction does not apply to bands 9 and 10.

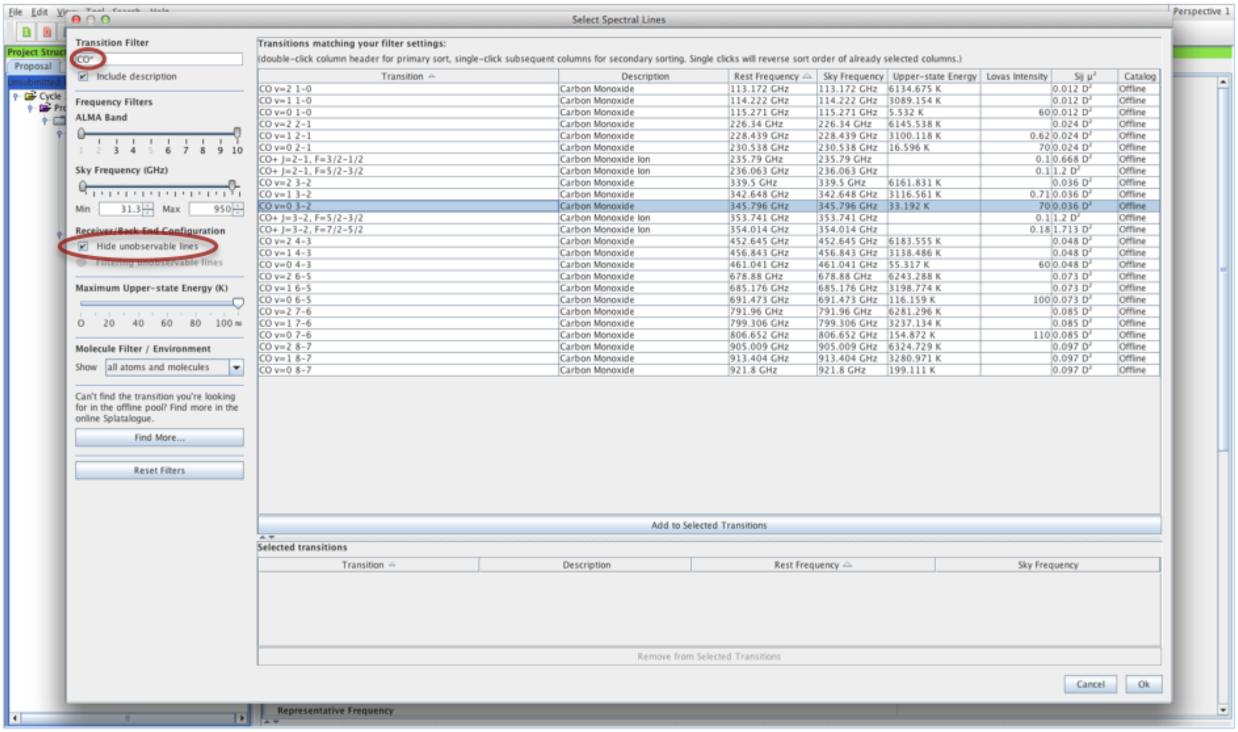

Figure 3.4: The spectral line selector tool.

If you cannot find the transition you want in the Spectral Line Selector tool, try the *Find More...* button: you will then be able to search online from a more extensive database. By default, the Spectral Line Selector shows only transitions that are simultaneously observable with any other transitions already defined in the spectral setup; un-tick the *Hide unobservable lines* option to display all transitions corresponding to the search criteria.

You define spectral windows individually for each baseband using either the *Select Lines to Observe* or the *Add* buttons. The first option brings up the **Spectral Line Selector tool** (see Fig. 3.4), which allows you to search an extensive database[1] for popular transitions based on species, ALMA band, Sky frequency, maximum upper-state energy or molecules detected in a variety of astronomical sources. Simply select the transition you want, press *Add to Selected Transitions*, and a spectral window with a central frequency corresponding to the transition will be created. The second option *Add* allows you to manually enter a spectral window central frequency. Conversion between rest and sky frequencies is automatically performed based on the source velocities defined in Step 3.4.

Spectral windows must be associated with a correlator mode, which can be selected independently for each baseband. Double-click on the red text in the *Bandwidth, Resolution* column to bring up the list of available options. The bottom entry in bold text corresponds to the lowest spectral resolution (continuum) mode. Please make sure that the bandwidth and resolution selected for each spectral window are appropriate for the expected spectral properties of your source(s) as entered in Step 3.4.

[1] The Splatalogue, for detailed information see http://www.splatalogue.net

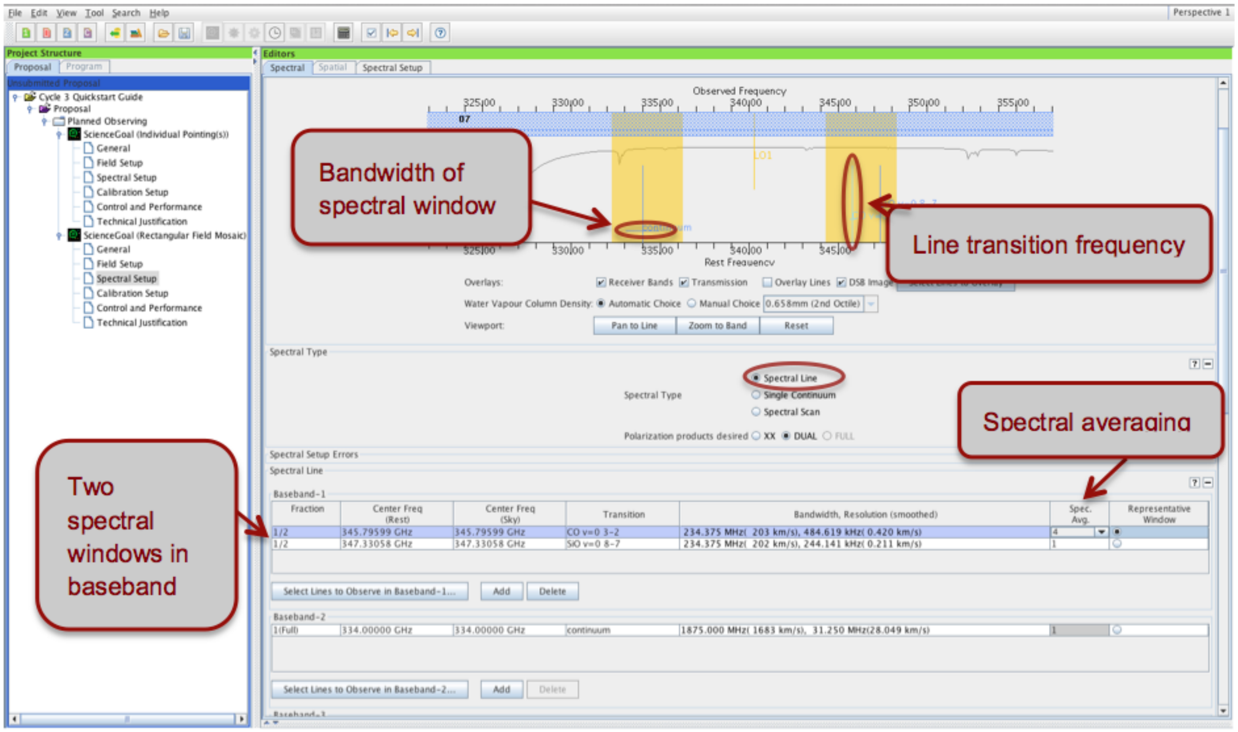

Figure 3.5: Visualisation of spectral line observations in the spectral editor pane.

ALMA bands 9 and 10 are different from the other receivers in that the information coming from the two sidebands cannot be separated. Therefore, the quality of the data in a spectral window defined (solid blue lines in the spectral viewer) in one sideband is influenced by whatever signal is present in the "mirror" spectral window (dashed blue lines, see Fig. 3.3) in the other sideband. It is therefore advisable to ensure that the "mirror" spectral window does not fall into a region of bad atmospheric transition, or contain e.g. a strong line. The OT will take into account the atmospheric transmission in the "mirror" spectral window when calculating a time estimate.

The **data rate** estimated for a Science Goal (see Step 3.10) is directly related to the spectral setup. You should aim to lower the data rate by using **spectral averaging** wherever possible. Double-click on the default '1' entry in the *Spec Avg.* column of the spectral window table to bring up a list of possible spectral averaging factors. Selecting one of the values will immediately change the spectral resolution in the table. Note that an averaging factor of 2 degrades the spectral resolution only marginally, but halves the data rate for that spectral window. Another way to lower the data rate is to select the lowest resolution (continuum) correlator mode whenever possible.

Based on the spectral windows defined, the OT will try to configure a spectral setup and display it in the spectral viewer (see boxed text above). In order for your proposal to pass validation, **all spectral windows for all source velocities must fit within a valid sideband configuration and the same ALMA band**. If several sources with different velocities were specified in Step 3.4, the OT will generate up to 5 separate frequency tunings based on the velocities, the width of the spectral windows, and spectral line width entered in the Expected Source Properties. The number of tunings may affect the time estimate for a Science Goal and can be checked in the *Time Estimate* dialogue (see Step 3.8).

Multi-region mode
Multi-region mode allows more than one spectral window to be set up per baseband. In Cycle 3, you can specify up to 4 spectral windows per baseband, yielding a maximum total of 16 spectral windows in a single spectral setup containing 4 basebands. Simply *Select Lines to Observe* or *Add* extra spectral windows in the baseband tables. Because only a fixed number of channels are available for each baseband they must be divided between the spectral windows defined, implying that at a given resolution the bandwidth available for each of two spectral windows will be half that available for a single spectral window. Therefore, the fraction of the baseband assigned to each spectral window must be changed in such a way that the sum of all fractions does not exceed 1. The available choices for the correlator modes in the *Bandwidth, Resolution* field will then be automatically updated to reflect the lower number of channels available. Note that **within a baseband** all spectral windows must have the same spectral resolution.

3.5.2 Single Continuum

Selecting the *Single continuum* option is basically a shortcut to defining 4 continuum spectral windows maximising the available bandwidth (see Fig. 3.3). You are presented with a drop-down list of **standard continuum frequency setups** for each of the available ALMA bands, chosen so as to optimise atmospheric transparency. The sky frequency of the setup can be changed to anything that still yields a valid spectral setup, but any deviation from the standard frequencies must be fully justified in Step 3.9.

Single Continuum and *Spectral Scan* observations are specified in the sky reference frame. Unlike for *Spectral Line* mode, the velocity information entered in Step 3.4 is ignored, and all sources are observed with the same frequency tuning.

The spectral windows set up by the OT based on the input continuum frequency for each baseband are listed in the spectral window tables and visualised in the spectral viewer. Note that the sky frequency specified corresponds to the LO frequency and is not itself observed for Bands 3, 4, 6, 7 and 8. For Bands 9 and 10, the sky frequency corresponds to the frequency at the centre of the 8 GHz wide upper sideband.

3.5.3 Spectral scans

The *Spectral Scan* interface is a convenient way of setting up several correlator tunings to cover a wide, uninterrupted frequency range within a single ALMA band. You need to specify the start and end frequency as well as the desired *Bandwidth, Resolution* of each spectral window making up the scan. A maximum of 5 tunings can be observed within one Science Goal, which means there is a trade-off between achieving a high spectral resolution and covering a wide frequency range (if you want to cover a wider frequency range than possible with 5 tunings you will have to split the spectral scan across multiple Science Goals). Spectral averaging is possible in the same way as it is for *Spectral Line* observations.

The spectral scan interface may in certain cases yield a very inefficient observing strategy, causing the time estimate to skyrocket. This will happen mostly for observations with relatively long on-source times and many frequency tunings. It may be more efficient to set up such spectral scans using separate Science Goals for each frequency tuning.

If the requested spectral scan can be set up successfully, the frequency tunings calculated by the OT are displayed in the spectral visualiser (see Fig. 3.6) and also listed in the spectral scan table. If not, a red error message will appear, indicating the origin of the problem. In Cycle 3, spectral scan observations are offered only for *Individual Pointing(s)* field setups with one pointing per source and a maximum limit of 150 pointings over all tunings (i.e. for 5 tunings the maximum number of pointings is 30).

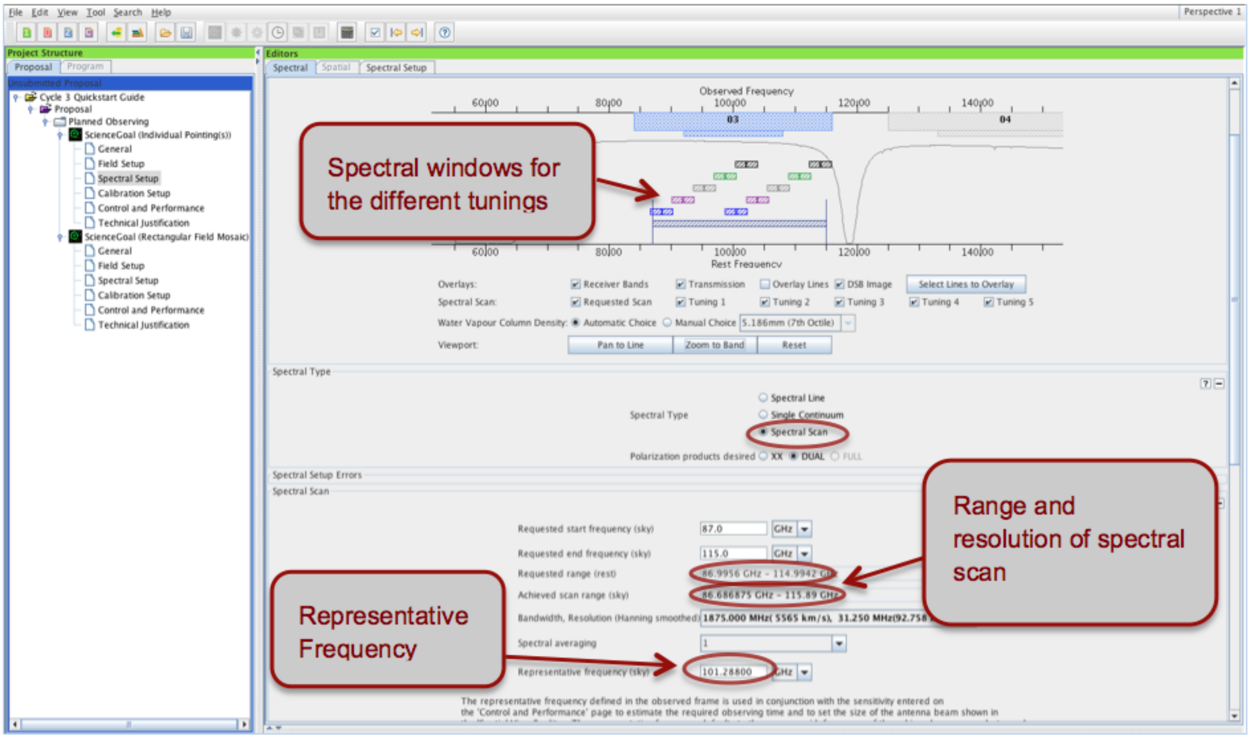

Figure 3.6: Visualisation of spectral scan observations in the spectral editor pane.

3.5.4 The representative frequency

Every spectral setup is characterised by a representative frequency, which is used to compute the spatial parameters of the Science Goal (primary beam, synthesised beamsize, maximum recoverable scale) and controls the atmospheric transmission used in the time estimate (see Step 3.8). It defaults to the centre of the last spectral window defined, but can be changed by the user to lie anywhere within the spectral windows of the setup using the representative window radio button and/or typing in the relevant field below the baseband tables. Note that the representative frequency is a rest frequency that will be transformed to a sky frequency using the velocity information for each source. **Please check it carefully for each source, and modify it if necessary.** For spectral line observations, the representative frequency should normally correspond to your transition of greatest interest, or if you are interested in several lines the one that has the poorest atmospheric transmission.

The exact choice of representative frequency can severely impact the time estimate, especially in the higher frequency bands 7, 8, 9 and 10. If it falls in a region of poor atmospheric transmission the time estimate will skyrocket compared to a setup with a representative frequency in an area of good atmospheric transmission. It is important that the representative frequency is set to the line of interest that falls into the region of the poorest atmospheric transmission, otherwise the requested sensitivity will not be reached for this line.

3.6 Finalise the spatial setup

Having specified the spectral setup and in particular the representative frequency, you are now ready to finalise the spatial setup based on the sources you defined in Step 3.4. The maximum total number of 12-m pointings is 150, regardless of whether these are treated as mosaics, offset pointings, or separate sources. 7-m ACA pointings are counted separately.

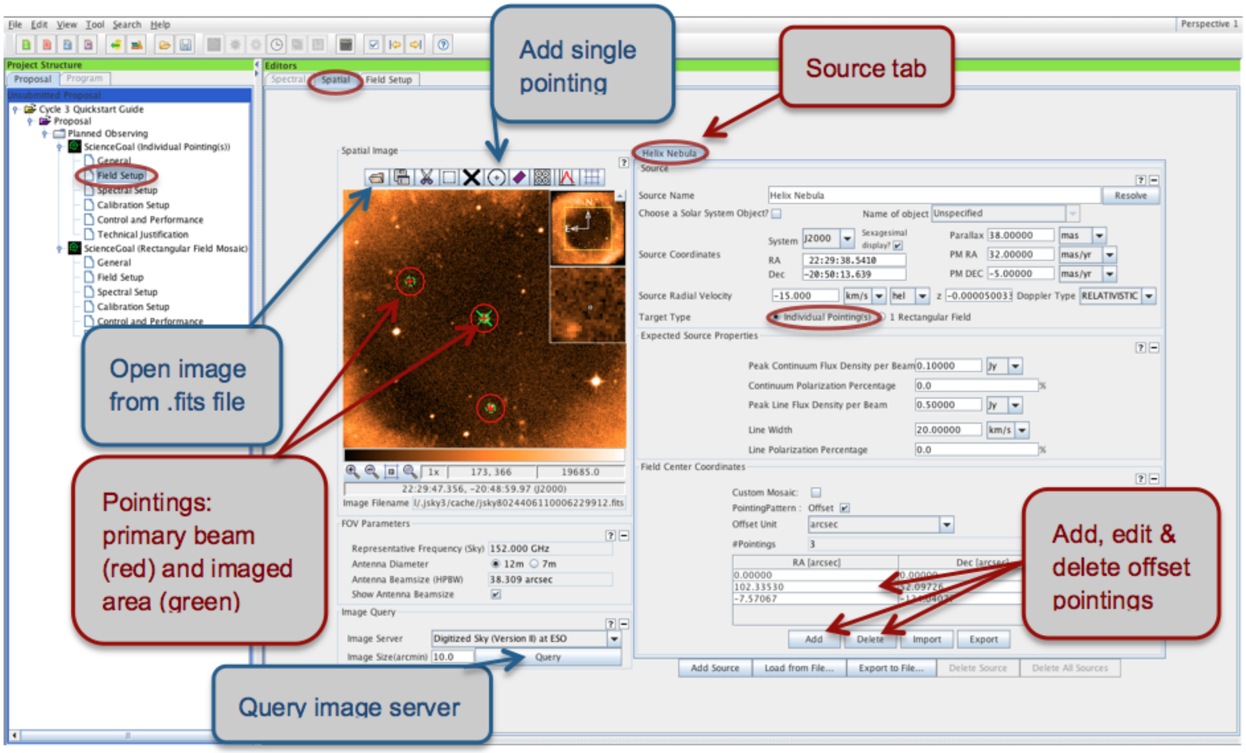

Figure 3.7: Visualisation of individual pointings in the spatial tab of the Field Setup pane.

The spatial editor

The spatial editor (see Fig. 3.7) is found under the *Spatial* tab of the *Field Setup* editor. It can be used to view and edit pointings **on a per source basis** and will work properly only if you load an image. Either *Query* one of the image servers selected from the drop-down menu to display a catalogue image of the area surrounding your source, or load and display your own FITS image by clicking the folder icon in the spatial editor toolbar (only J2000 equatorial coordinates are supported). The primary beams of the pointings defined are represented by red circles, and can be moved, added and deleted interactively. They can be displayed for either the 12-m or the 7-m antennas if ACA observations have been requested. If Total Power observations are requested, the area scanned is shown by a turquoise box. For individual pointings, this box dynamically adapts to cover the pointings defined. You can use the buttons in the toolbar above and below the spatial viewer to perform simple visualisation operations such as adjusting the cut levels, zooming, and saving the image. Please see *OT video tutorial 3: The Spatial Field Setup* for a practical demonstration of all functionalities.

The response of the receivers is not uniform across the antenna primary beam, but falls off towards the beam edges. The primary beam (represented by the red circles) is defined as the FWHM of the PSF. For rectangular mosaics, the falloff in sensitivity towards the beam edges is automatically taken into account by the fact that the individual pointings are set up so as to overlap. For single pointings, the source should fit within the central 1/3 of the primary beam for a more or less uniform sensitivity coverage; else a small mosaic should be set up. The inner third of the primary beam is shown by the smaller green circle in the spatial editor.

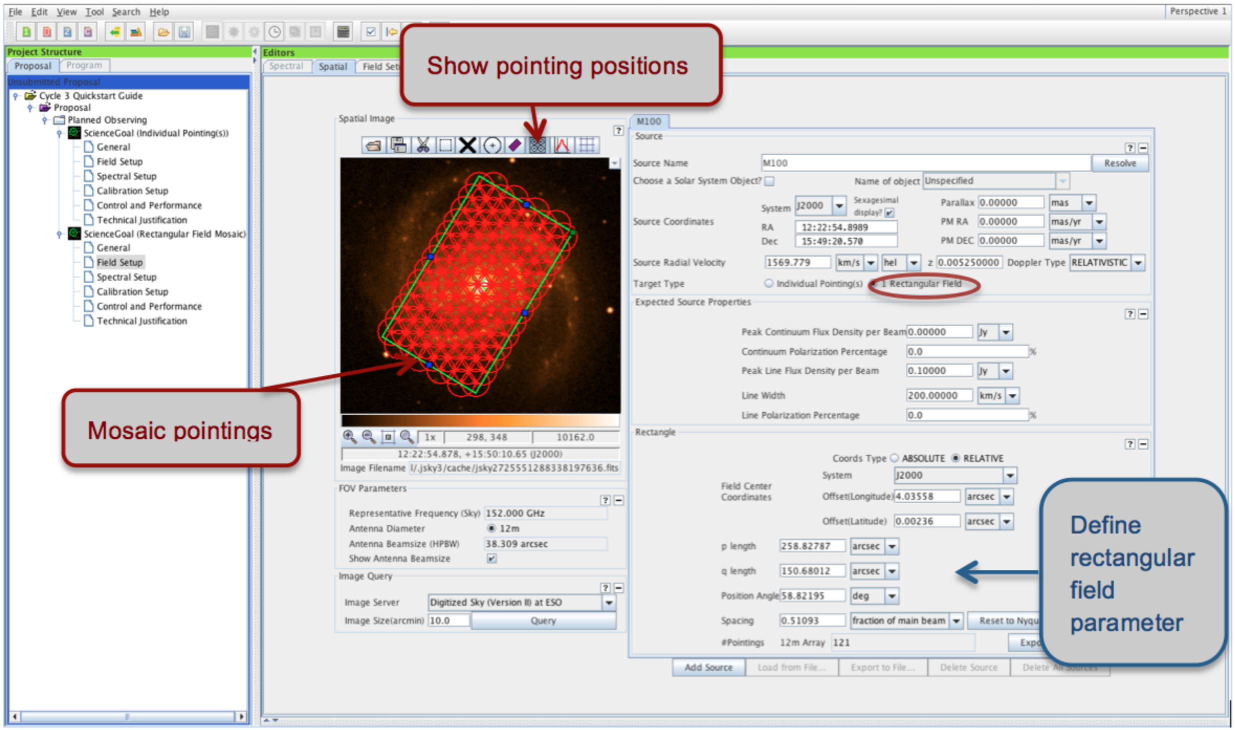

Figure 3.8: Visualisation of a rectangular mosaic.

3.6.1 Individual Pointing(s)

You can visualise and configure the spatial setup for each source individually by selecting the relevant source tab. By default, there will be just one pointing at the source coordinates specified earlier. Offset pointings can be added, edited and deleted directly in the 'Field Center Coordinates' pane, or interactively in the spatial editor (see boxed text). The *Import* button will read offset pointings for a given source from an ASCII file in simple RA, DEC format. You can also *Export* pointings, e.g. to be used for simulations, in different coordinate formats.

You can choose to process the pointings as a single image by ticking the *Custom Mosaic* box. In this case, the pointings must overlap. If the box is not ticked, each pointing will be processed separately. If ACA observations are requested (Step 3.8) these will have the same pointing centres as the 12-m pointings; any custom-defined mosaic will not be adjusted for the larger primary beam size of the 7-m antennas. Also, the sensitivity specified in Step 3.8 is assumed to be per pointing and the estimate entered should take into account any overlap.

3.6.2 1 Rectangular field (mosaic)

DID YOU KNOW?

By default, the spatial editor shows only the rectangular area defined for the mosaic. To see the individual pointings set up by the OT, you need to press the *Show pointing positions* button in the toolbar above the spatial editor.

The *Rectangular Field* option is a convenient way to easily set up evenly sampled rectangular mosaics on a per-source basis. You simply specify the size of the field as *p length* times *q length*, the *Position Angle* and the *Spacing* of individual pointings. By default, the spacing is set to Nyquist sampling (*Spacing* = 0.48113 times *fraction of main beam*). If you change this, you must carefully justify your choice in the *Technical Justification* (Step 3.9). For rectangular fields, the 7-m Array pointings are automatically set up to optimally sample the area specified, therefore the number of pointings will be smaller than for the 12-m Array. You may wish to export the

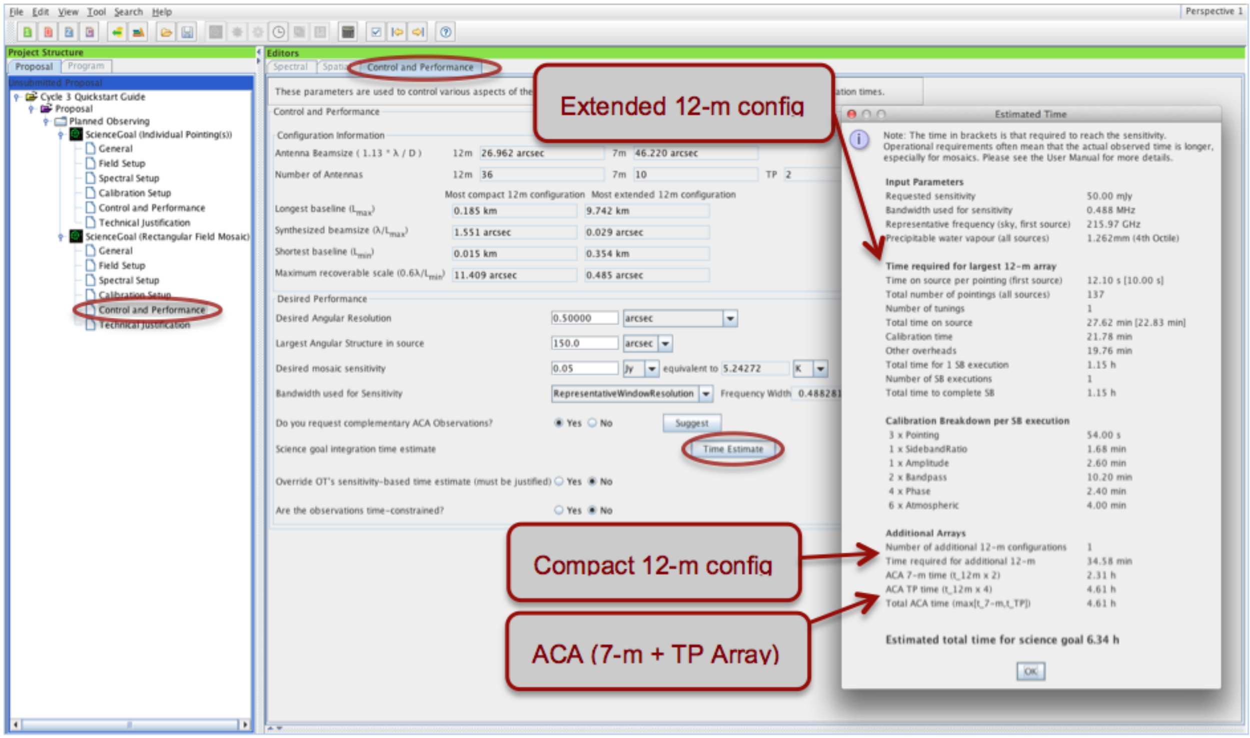

Figure 3.9: Control and Performance editor pane and the Time Estimate box.

coordinates of the individual pointings; this is easily done using the *Export* button next to the displayed number of pointings.

3.7 Select the calibration strategy

You should normally use the default *System-defined calibration* option in the *Calibration Setup* editor. The system-defined calibration is designed to fully calibrate your science observations using the most appropriate sources available at execution time, and will at least include pointing, bandpass, gain and flux calibration. Science Goals requiring full polarisation will receive an appropriate calibration strategy. Only experts whose projects have special calibration requirements should specify *User-defined calibration*.

3.8 Enter the control and performance parameters

The final technical specifications of your Science Goal are entered in the *Control and Performance* panel (see Fig. 3.9). The *Configuration Information* section at the top of the panel displays information on the array configurations planned for Cycle 3, and uses the representative frequency defined in the spectral setup to calculate the *Synthesized beamsize* and the *Maximum recoverable scale* of the observations.

The Desired Angular Resolution (AR) and the Largest Angular Structure (LAS) are used together to determine the array configuration(s) the observations can be executed in. **PIs cannot explicitly request certain configurations**, but should instead make sure that the AR and LAS entered are correct. The array configuration selected for your observations will have baselines long enough to achieve an AR **better than** that requested, and be compact enough to resolve the LAS. Often this will mean that a number of configurations are acceptable for a given Science Goal. If it is not possible to achieve both the AR and LAS desired with just one 12-m array configuration, the OT will automatically add a second 12-m configuration if possible, and/or suggest use of the ACA. This is not possible for long baselines. For details on which configurations can be used together, please consult the Technical Handbook.

If you enter 0.0 for the LAS, your Science Goal will be scheduled in any configuration that meets the AR requirement. For example, if you ask for an AR of 1.2", you will get this or better (i.e. you may get an AR of 0.5" and your data will be smoothed in the data reduction process.)

You can define and check technical details of the observations using the following fields (fields displayed in red must be filled):

Desired Angular Resolution: your choice is guided by the *synthesized beamsizes* corresponding to the most compact and most extended configurations available in Cycle 3 as displayed in the *Configuration Information*. The value entered cannot be smaller than the synthesized beam size of the most extended configuration, and cannot be larger than twice the synthesized beam size of the most compact configuration. You can input the angular resolution in arc-seconds or a fraction of the main beam size.

Observations requesting very small angular resolutions (i.e. those making use of long baselines) are very inefficient because they need to be heavily calibrated to correct for atmospheric phase fluctuations. Since the array configuration is determined based on the AR defined in the OT, it is possible to inadvertently trigger long baseline observations by entering an AR just slightly smaller than that actually required (e.g. standard B3 continuum observations requiring a 0.34″ AR will trigger long baselines, while 0.35″ AR observations will not). You can see if the observations defined make use of long baselines in the time estimate pop-up (the number of phase calibrator observations per SB execution will be unusually large, above 25 or so), or by running a validation check (see Section 3.10). Obviously, long baselines should be avoided if they are not necessary to achieve a Science Goal.

Largest Angular Structure in source: here you should enter the largest angular structure that you **wish to resolve** in your source(s), which may be different from the actual size of the source. The value entered determines whether you need multiple 12-m configurations and/or the ACA, and therefore has a direct influence on the time estimate (see the *Maximum recoverable scale* for the 12-m configurations in the *Configuration Information* table for guidance.). The input units are the same as for the angular resolution.

Desired sensitivity per pointing: you should enter the sensitivity required for the **most restrictive** line/continuum observation to achieve the scientific aims of the Science Goal, and if relevant mention the S/N achieved for the remaining lines/continuum in the Technical Justification. In the case of a rectangular field mosaic you should specify the sensitivity required over the mosaic, not that for individual overlapping pointings. We recommend that the sensitivity requested is good enough to give a 3 σ detection at the very least, ideally 5 σ.

Bandwidth used for Sensitivity: for continuum observations, this field is automatically set to *AggregateBandwidth*. For spectral line or spectral scan observations you can pick one of six choices given in the dropdown menu:

- *RepresentativeWindowBandWidth*: the bandwidth of the spectral window chosen as the representative spectral window (and containing the *Representative Frequency*) in Step 3.5
- *RepresentativeWindowResolution (default)*: the (Hanning-smoothed) spectral resolution of the representative spectral window, taking into account spectral averaging
- *AggregrateBandwidth*: the summed bandwidth of all your selected spectral windows
- *LargestWindowBandwidth*: the bandwidth of your widest spectral window defined
- *FinestResolution*: the finest (Hanning-smoothed) resolution of any spectral window, taking into account spectral averaging
- *User*: a bandwidth of your choice (useful if you are intending to smooth your data after observation to achieve a certain S/N)

Please pay close attention that the *Bandwidth used for sensitivity* is appropriate for your scientific aims. For spectral line observations we recommend that it is at most 1/3 of the expected spectral line width. Selecting too wide a bandwidth will lower the time estimate, but yield too low a sensitivity.

Do you request complementary ACA observations: press the *Suggest* button to see whether the OT recommends/allows ACA observations based on the requested AR and LAS. The ACA comprises the 7-m Array as well as the Total Power (TP) Array. Note that the TP array is not offered for continuum observations and in Bands 9 and 10. You can choose to override the recommendation of the OT, but must carefully justify this in the technical justification. Note that the ACA cannot be used with the most extended 12-m configurations as this would result in a gap in the baseline coverage.

In Cycle 3, the OT will differentiate between the need for the 7-m array and the Total Power (TP) array based on the LAS entered, i.e. the TP array will be invoked only if the LAS cannot be recovered by the 7-m array. This is in contrast to previous cycles, where the TP array was automatically included with the 7-m array whenever possible.

Science goal integration time estimate: The *Time Estimate* button will estimate the total time required to achieve the desired sensitivity goal on the 12-m antennas, including calibrations, multiple pointings, and overheads (see Fig. 3.9). In the event that two 12-m configurations are needed to provide sufficient baseline coverage, the time breakdown will be calculated for the more extended of the two, while the time required for the more compact configuration will be calculated from the former using a fixed multiplicative factor. Similarly, the 7-m Array and TP Array observations are estimated to require a factor of 2 and 4 times the most extended 12-m Array observations respectively. Unless specified otherwise (see below), it is the total time reported here that will be used by the observatory as an estimate of how long your project will take to complete. Note that, for Cycle 3, proposals requiring more than 100 hours cannot be submitted.

Override OT's sensitivity-based time estimate If your Science Goal is not sensitivity driven, but instead requires a certain time (e.g. for a monitoring experiment) you can choose to override the OT's time estimate. The time entered should be the total time (including calibrations and overheads) for the more extended 12-m configuration needed; time estimates for the ACA are the automatically calculated by the OT.

Are the observations time-constrained? The OT now has the ability to capture the following time constraints:

- *Single Visit*: specify fixed time intervals during which your observations should be executed. The observations will be carried out **only once in total**, within any of the time windows specified. You can manually *Add* time windows individually, or *Import* a list of time slots from an ASCII file. See the Control & Performance section of the ALMA OT Reference Manual for the format required.

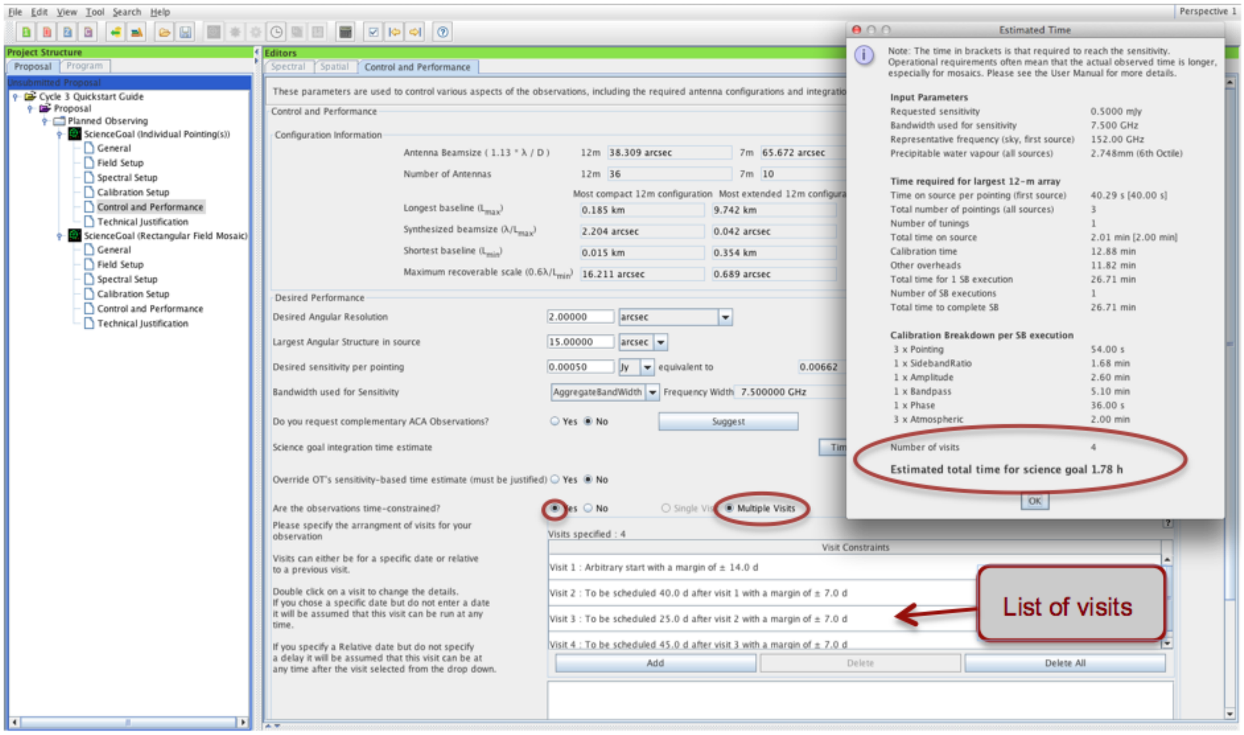

Figure 3.10: The time constraints interface and Time Estimate box for the example of *Multiple Visits*.

- *Multiple Visits*: define multiple visits for your Science Goal. The timing constraints of the individual visits are specified in terms of arbitrary, fixed or relative time intervals (see Fig. 3.10). Here, the observations will be carried out **once for each visit specified**. The time estimate computed by the OT will be multiplied by the number of visits.

> Selecting *Tool* in the OT menu gives you access to a number of useful tools to help you better plan your observations. You can use the **Sensitivity Calculator** to bring up a pop-up window that allows you to experiment with project execution times and sensitivities, the **Project time summary** to give a time and data rate summary, and generate **printable and pdf summaries** of individual Science Goals as well as the project.

3.9 Enter the Technical Justification

The technical justification editor has been completely re-designed for Cycle 3 with the aim of making it easier for PIs to fill a complete Technical Justification. Note that any supporting figures (e.g. simulations) should be included in the supporting material attached in Step 3.2).

The technical justification is now entered in three sections: Sensitivity, Imaging, and Correlator configuration. Relevant parameters as taken or computed from the Science Goal setup and the Expected Source Properties are displayed for each. If the OT detects values it thinks should be double-checked, an informative message is displayed in blue. You should pay special attention to these issues in your justification text.

You must enter a short justification text in the free-format text boxes of each section. In addition, text boxes will appear for any choices that need to be justified. These include using single polarisation, non-standard continuum frequencies, non-Nyquist spatial sampling, a user-defined calibration strategy, overriding of the OT's

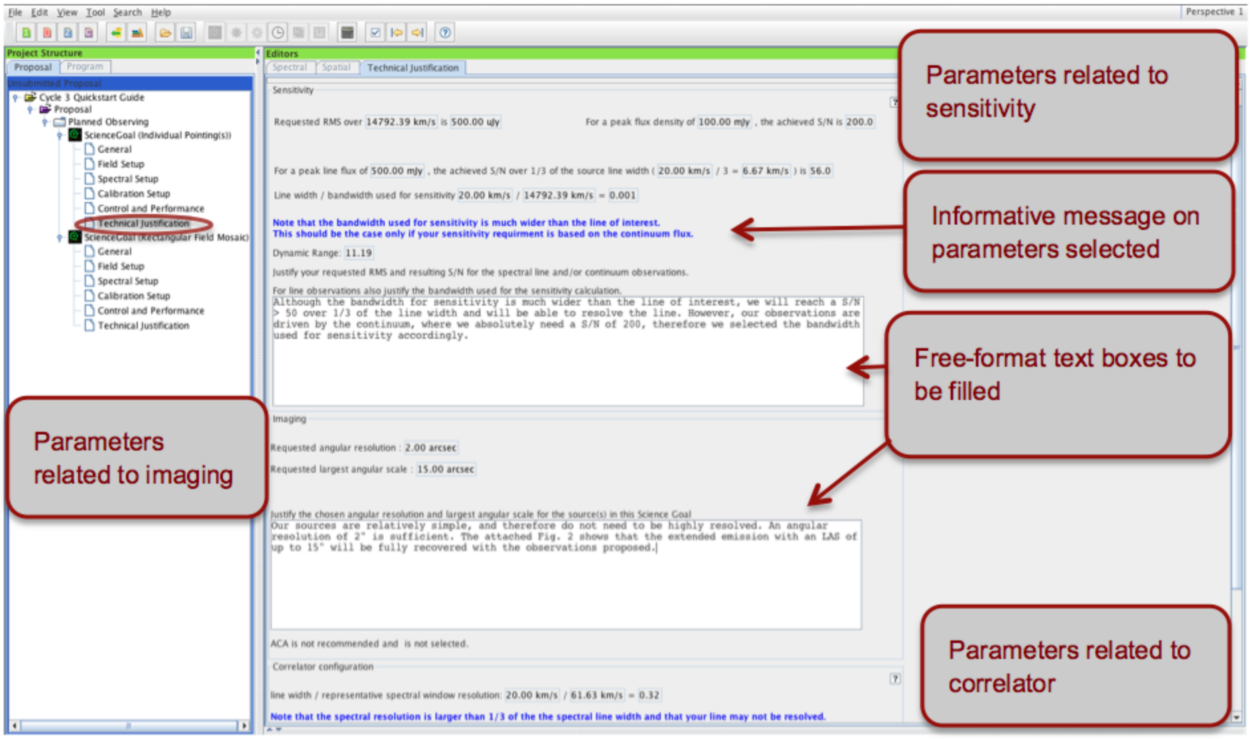

Figure 3.11: The technical justification editor.

suggestion of the ACA or time estimate, low maximum elevation of a source, time-constrained observations and high data rates. For detailed guidelines on filling the Technical Justification please see Appendix C of the Proposers Guide and *OT video tutorial 4: The Technical Justification*.

3.10 Validate and submit your project

By clicking on *Menu* > *Validate* or the corresponding tick icon in the toolbar you can check whether the project contains any setup errors (see Fig. 3.12). Successful validation is required before submitting a project. Warnings are for your attention and should be double-checked, but they do not prevent you from submitting a technically sound proposal. Double-clicking on an error/warning message will take you to the relevant Science Goal, so that you can easily identify and correct the problem. If all is well, the Feedback pane will report "No problems found" (Fig. 3.13). Your project is now ready to be submitted!

Before submitting your project, you should check whether any of your Science Goals make use of non-standard modes. Non-standard modes require manual intervention during data reduction and will be allocated up to a maximum of 25% of the available observing time. You can see which, if any, of your Science Goals use non-standard modes on the Proposal summary sheet. Non-standard modes will also trigger a validation warning, and include long baselines, full polarisation observations and bands 8, 9, and 10, among other things (see Appendix A of the Proposers Guide for a complete list). Since it is expected that observing time for these modes will be more competitive than for standard observations you should ensure that you did not inadvertently trigger a non-standard mode.

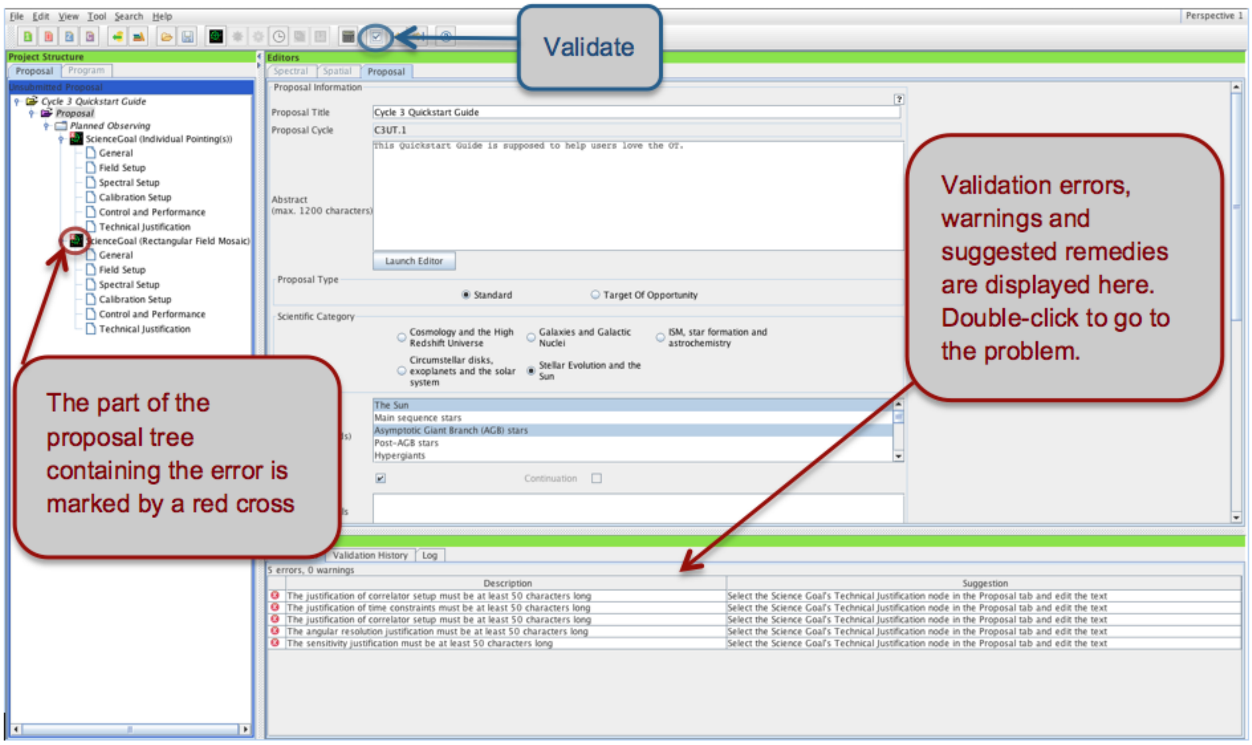

Figure 3.12: An example of failed validation.

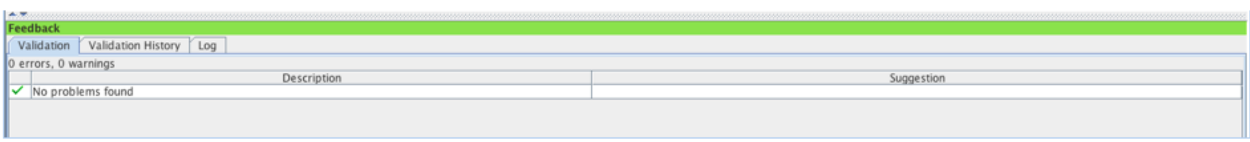

Figure 3.13: Successful validation!

To submit your project to the ALMA archive, select *File > Submit Project* in the menu bar. You and all of your Co-Is should receive a confirmation e-mail after each proposal submission. Once you have submitted, the *Unsubmitted Proposal* label in the blue proposal status bar will be replaced by a red Submitted label. This indicates that the proposal has been stored in the ALMA archive and assigned the *Project Code* listed in the top-level overview panel of your proposal. You are encouraged to save your project to disk after submission in order to ensure that any updates are made on the submitted version.

You can make changes and re-submit your *Submitted* proposal until the deadline; any re-submission will overwrite the previous version of the proposal stored in the archive. If you want to edit the proposal and then submit it as a new project you need to work with an unsubmitted version of the proposal that has not yet been assigned a project code.

For more detailed information on the ALMA OT and the technical capabilities in Cycle 3 you are invited to consult the documentation available on the Science Portal. If you have any questions or comments please feel free to submit a ticket to the ALMA Helpdesk, also accessible from the Science Portal.

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of the European Organization for Astronomical Research in the Southern Hemisphere (ESO), the U.S. National Science Foundation (NSF) and the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Republic of Chile. ALMA is funded by ESO on behalf of its Member States, by NSF in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC) and by NINS in cooperation with the Academia Sinica (AS) in Taiwan and the Korea Astronomy and Space Science Institute (KASI).

ALMA construction and operations are led by ESO on behalf of its Member States; by the National Radio Astronomy Observatory (NRAO), managed by Associated Universities, Inc. (AUI), on behalf of North America; and by the National Astronomical Observatory of Japan (NAOJ) on behalf of East Asia. The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.