Doc. 13.6, Ver. 1.0 | February 2026

ALMA Observing Tool Reference Manual

Katharina Immer, Anna Miotello, Andy Biggs, Rein H. Warmels

www.almascience.org

ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), NSTC 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 Centre at ESO, NAOJ or NRAO.

Revision History:

Version	Date	Editors
0.6, Ver. 1.0	March 2011	Rein Warmels
0.6, Ver. 1.1	August 2011	Rein Warmels
1.6, Ver. 1.0	May 2012	Rein Warmels
1.6, Ver. 1.2	November 2012	Andy Biggs
1.6, Ver. 1.3	February 2013	Andy Biggs
2.6, Ver. 1.0	October 2013	Andy Biggs
3.6, Ver. 1.0	March 2015	Andy Biggs
4.6, Ver. 1.0	March 2016	Andy Biggs
4.6, Ver. 2.0	May 2016	Andy Biggs
5.6, Ver. 1.0	March 2017	Andy Biggs
5.6, Ver. 2.0	June 2017	Andy Biggs
6.6, Ver. 1.0	March 2018	Andy Biggs
6.6, Ver. 2.0	July 2018	Andy Biggs
7.6, Ver. 1.0	February 2019	Andy Biggs
7.6, Ver. 2.0	June 2019	Andy Biggs
7.6, Ver. 2.1	July 2019	Andy Biggs
8.6, Ver. 1.0	January 2020	Andy Biggs
8.6, Ver. 1.1	March 2020	Andy Biggs
8.6, Ver. 1.2	March 2021	Andy Biggs
9.6, Ver. 1.0	March 2022	Andy Biggs
10.6, Ver. 1.0	March 2023	Anna Miotello
10.7, Ver. 1.0	September 2023	Anna Miotello
11.6, Ver. 1.0	March 2024	Katharina Immer
12.6, Ver. 1.0	February 2025	Anna Miotello
13.6, Ver. 1.0	March 2026	Katharina Immer

Contributors

The ALMA OT Team and the many testers.

In publications, please refer to this document as:
ALMA Observing Tool Reference Manual, ALMA Doc. 13.6, Version 1.0

Contents

Chapter 1

Introduction

The ALMA Observing Tool Reference Manual provides a concise description of the inputs to the ALMA Observing Tool (OT) that is used to prepare observing proposals (Phase 1) for the Atacama Large Millimeter/submillimeter Array (ALMA). The OT is a web-based application consisting of a set of user interfaces that are needed to prepare an ALMA observing project.

1.1 How to Use this Manual

For most users preparing to submit a proposal to ALMA, the User Manual gives the fullest description of how the OT actually works. However, this does not go into detail of what every button in the OT does and what the meaning of every parameter is. When this kind of information is required, the OT contextual help or the reference manual can be consulted.

Chapter 2 describes the staging area. Chapter 3 provides descriptions of the main OT menu and header bar at the top of the OT. Chapter 4 provides details about the general project information that needs to be provided. In Chapter 5, information is provided for the parameters required for completing Science Goals. Chapter 6 describes the buttons of the Tools and Simulators, i.e. the ALMA Sensitivity Calculator (ASC) and the calibration selection tools. Descriptions for the Spatial and Spectral Visualizers are provided in Chapter 7.

1.2 Release Information

This version of the manual is intended for the OT that will be used to submit all proposal types except DDT[1] proposals for Cycle 13. The OT can be accessed via `https://cycle-13.sps.alma.cl`. The OT is supported on latest version of the web-browsers Chrome, Firefox and Safari.

1.3 Credits and Acknowledgements

The ALMA OT is a software product of the ALMA Observation Preparation Software Team and is developed on the basis of the ALMA Science Software Requirements (SSR) and the ALMA High Level Analysis (HLA) documents, produced by the respective groups. The OT software group acknowledges the valuable inputs of these groups during the development phases of the OT. Also, the OT software groups thank the OT external community testing group for their testing efforts of the various versions of the OT.

[1]Cycle 12 DDT proposals will still need to be submitted with the Java-based desktop OT for Cycle 12.

This page was intentionally left almost blank

Chapter 2

The start-up screen and the staging area

When the ALMA OT is first opened, a start-up screen with the following options appears (Fig. 2.1):

- **Create a new proposal**: Create a new proposal for the Main Call submission deadline and scientific and technical review process. This will require proposal details and Science Goals to be added.

- **Create a new DDT proposal**: Create a new Director's Discretionary Time proposal. This will require proposal details and Science Goals to be added. This option will only be available from the start of Cycle 13. Cycle 12 DDT proposals need to be submitted with the Java-based desktop OT.

- **Retrieve a project from the server**: Open an existing project from the staging area or the ALMA archive.

- **Open project as new proposal**: Open an existing project as a new proposal, either from the staging area or the archive.

- **Log out**: Log out of the application.

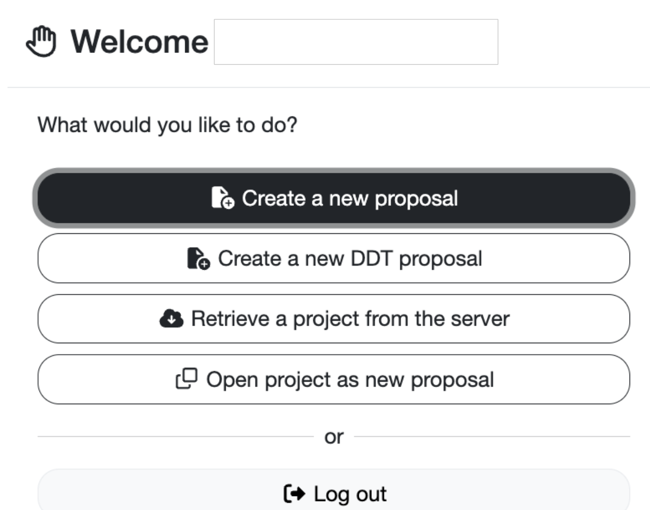

Figure 2.1: Start-up screen seen after opening the OT.

2.1 The staging area

The staging area (Fig. 2.2) gives access to all proposals for which the user is PI, Co-PI or Co-I. This staging area can either be accessed via the buttons "Retrieve a project from the server" or "Open project as new proposal". The projects can be filtered by PI, Co-I or Co-PI ALMA ID, Project Name, Project Code or Cycle as well as by project status "Draft", "Submitted" and "Unsubmitted changes".

When a proposal is first created, it gets the status "Draft" which it keeps until first submission. After submission, the status changes to "Submitted". If further changes are then conducted on the proposal, the status changes to "Unsubmitted changes". Only once the user hits the "Submit" button again, these changes are transmitted to the archive and visible to the observatory. Then, the status changes back to "Submitted".

Draft proposals can be deleted from the staging area with the "Delete" button next to each proposal and a pop-up will ask for confirmation of this action. Once a proposal is submitted and receives a project code, it can only be reverted to the submitted version. If the user wants to retract a submitted proposal, they have to submit a helpdesk ticket.

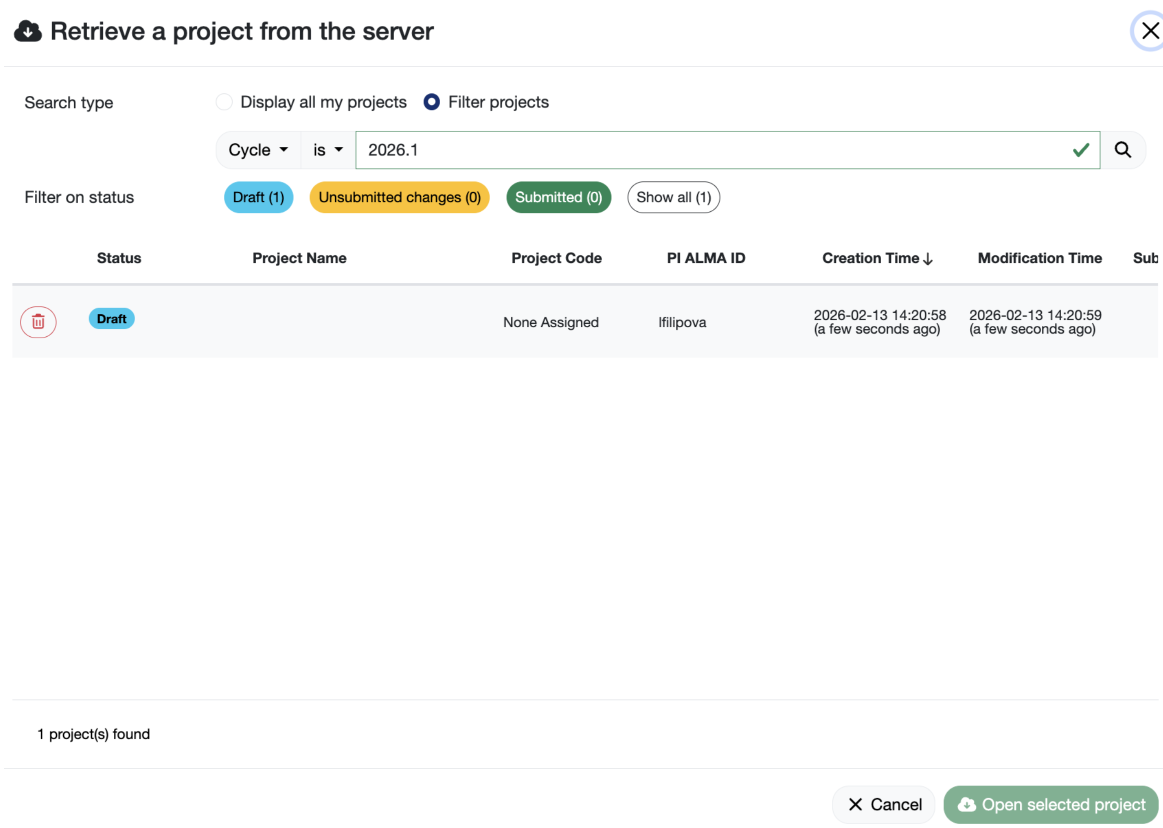

Figure 2.2: Staging area. Here, all draft proposals, submitted proposals and submitted proposals with unsubmitted changes are listed. Different filter options allow the user to see only a subset of their proposals.

2.2 The autosave function

Edits in the Project Name, Abstract, and Duplicate Observation fields are saved when the user stops typing for 500 ms. In all other fields, the input is saved once the user leaves the field. Any changes to the proposal thus overwrite the previous version. Users are recommended to submit their proposals early or work on copies of the proposal (via "Open project as new proposal") to try out different versions. It is not advised to open the same proposal in multiple browser windows. If the OT detects a newer version existing in the staging area, it forces a reload of the proposal. PIs, Co-PIs, and Co-Is have equal access to the proposal. If multiple users wish to work on the proposal, it is recommended to coordinate the work so that only one user at a time makes significant changes to the proposal. Quasi simultaneous access might otherwise lead to frequent requests of the OT to reload the proposal to ensure that the users are working on the latest version.

This page was intentionally left almost blank

Chapter 3

The Header bar

The OT pages contain two major components: the Header bar at the top (in blue), followed immediately below by the Navigation bar, where the user can choose between the Proposal panel and the Science Plan panel. The remaining part of the page displays the content of either panel, and it is described in detail in Chapters 4 and 5.

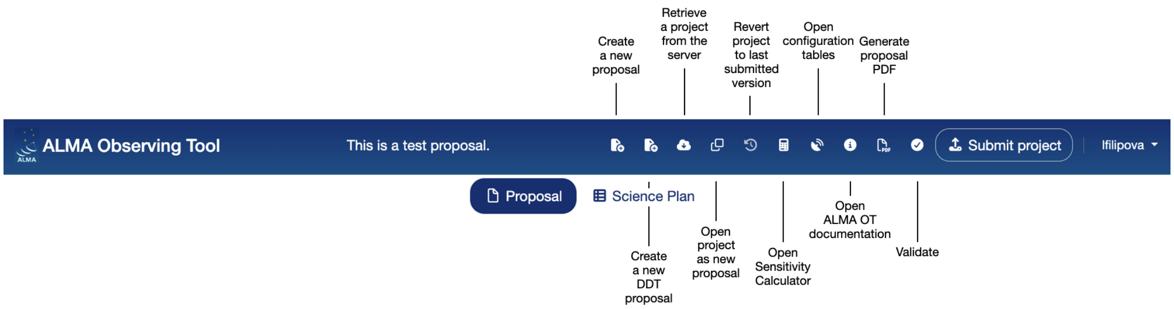

Figure 3.1: Header bar and Navigation bar at the top of the OT pages.

The header bar gives access to a variety of OT functions and tools through a number of buttons that are now described in the order they appear, from left to right.

- **Create a new proposal**: Create a new proposal for the Main Call submission deadline and scientific and technical review process. This will require proposal details and Science Goals to be added in order to be submitted.
- **Create a new DDT proposal**: Create a new DDT proposal after the Main Call's submission deadline. This option will only be available from the start of Cycle 13 (October 2026).
- **Retrieve a project from the server**: Open a project from the staging area or the ALMA archive.
- **Open project as new proposal**: Open a project as a new proposal, either from the staging area or the archive.
- **Revert project to last submitted version**: Re-open the last submitted version from the archive. Any unsubmitted changes will be overwritten.
- **Open Sensitivity Calculator**: Open a new webpage with the ALMA Sensitivity Calculator. The inputs are independent of those entered into the OT main page. See Sect. 6.2 for more information.
- **Open configuration tables**: Open a new collapsible panel, showing tables of the angular resolution ranges and maximum recoverable scales for declination ranges from -80 deg to 43 deg for each of the 12-m configurations as well as the Atacama Compact Array.

- **Open ALMA OT Documentation**: Open a new webpage containing the OT documentation. There, the OT reference manual (this document), the OT user manual and several video tutorials are available.
- **Generate proposal PDF**: Produce a PDF that contains the cover sheet, Science Goal summary sheets (including technical justification information) and the scientific justification. Users are advised to make sure that the text in this document meets the anonymity guidelines.
- **Validate**: Validate the project currently loaded in the OT. When this is clicked, the interface opens a table of the error and warning messages. By clicking on the target symbol at the beginning of the warning/error line, the systems jumps directly to the erroneous item in the interface. This is the main feedback window.
- **Submit project**: Submit the project to the ALMA Archive for validation and proposal review if appropriate.

At the right end of the header bar, the user menu can be found. In particular, one can directly access the user's profile in the ALMA main webpage using the "My profile" button. Under "Preferences", the user can disable several popups available in the interface. Furthermore, "Helpdesk" links to the creation of a new Helpdesk ticket.

Chapter 4

The Proposal tab

When the Proposal tab is selected in the navigation bar, several collapsible panels appear below it. These are used to specify a number of administrative details that are necessary to submit a proposal to ALMA. They are described in this Chapter, whilst the preparation of Science Goals is discussed in Chapter 5.

4.1 Main Project Information

In this panel, the user can specify the project title typing in the **Project Name** input text. The title is limited to 120 characters. When input, the title is also shown in the Header bar.
The **Assigned Project Code** is also shown in this panel. This is a unique code for the project, assigned automatically upon its first submission. The format consists of four separate fields:

- Year of submission (4 digits)
- Period of submission (single digit or, for DDT proposals, a single character)
- Order of submission (5 digits)
- Letter Code (a single character for PI projects - observatory projects can use more characters), specifying the Proposal Type.

4.2 Proposal Information

This panel contains two text boxes:

- **Proposal cycle**: This is formed from the proposal year and the submission period. If a non-submitted proposal created during a previous cycle is read into the OT the old proposal cycle will be shown, but this will be updated to the current cycle if the project is then submitted. This field cannot be edited by the user.
- **Abstract**: The abstract can be entered as plain text and is limited to 1200 characters.

Finally, at the bottom of the panel the user can find a button to generate the PDF of the whole proposal, similarly to that found in the Header bar.

4.3 Proposal Type

This panel allows the user to select the **Proposal Type**[1] among five possibilities:

- Regular (Letter Code = `S`): This type of project describes observations that can be fully specified by the proposal submission deadline and whose estimated execution time does not exceed 50 hours on the 12-m Array or 150 hours on the 7-m Array in stand-alone mode. Regular proposals may involve time-critical, multiple-epoch observations, and the monitoring of a target over a fixed time interval.
- Target of Opportunity (Letter Code = `T`): These projects will need to be triggered during the observing period. It is not necessary to enter the source coordinates as these may not be known at proposal submission time.
- VLBI (Letter Code = `V`): Selecting this will significantly change the information that must be entered into the Science Goal. A proposal must also be submitted to the other telescopes that will form the VLBI array.
- Large Program (Letter Code = `L`): If >=50 hours of 12-m Array or >150 hours of 7-m Stand-alone ACA time is requested, this Proposal Type must be selected. Projects must receive an A grade in order to receive time and are allowed a longer Scientific Justification. This proposal type is not available for ACA Supplemental Call proposals.
- Phased Array Mode (Letter Code = `P`): This is very similar to the VLBI mode and requests use of the phased-up array that is used for VLBI observations. However, in this mode the ALMA antennas operate as a single instrument and are not combined with data from other telescopes.

Once a proposal type has been selected and the proposal submitted, the proposal type cannot be changed anymore. If the proposing team wishes to submit the proposal with a different proposal type, they need to retract the current proposal via a helpdesk ticket and re-open their project as a new proposal where they then can change the proposal type.

4.4 Scientific Category

There are five Scientific Categories:

- Cosmology and the High Redshift Universe
- Galaxies and Galactic Nuclei
- ISM, star formation and astrochemistry
- Circumstellar disks, exoplanets and the solar system
- Stellar Evolution and the Sun.

Once the category is chosen, a new subpanel appears right underneath, containing a list of keywords related to that category. Assign at least one and preferably two keywords to the project. The second keyword is added by holding down the Shift key for adjacent keywords or the Ctrl/Command key for separate keywords.

4.5 Joint Proposals

This panel allows the PI to select if this is a Joint Proposal with other facilities. If Joint Proposal is selected then the PI should declare if ALMA is the Main Observatory or a Partner Observatory.

[1] Please refer to the Proposer's Guide for more information about the Proposal Types.

- **Main**: ALMA is the Main Observatory, meaning it is the observatory where the largest amount of time is requested, either on the 12-m Array, or on the 7-m Array for Standalone ACA projects.
- **Partner**: ALMA is one of the Partner Observatories, or the only Partner Observatory, as long as the time requested on ALMA is smaller than the time requested on the Main Observatory.

A button at the bottom of the panel allows a partner observatory ore several partner observatories (when hit multiple times) to be added. Each observatory can be selected among JWST, VLA, and VLT. The project code can be input if applicable. The user must specify the amount of requested time. A technical justification of the requested time on each partner observatory is also required (more details can be found in the Proposer's Guide).

4.6 Investigators

The Investigators panel contains information about the proposal investigators, displayed in the table at the bottom of the panel. All investigators must already be registered with ALMA via the Science Portal. The PI is required and one or more Co-PIs (Large Programs only) and Co-Investigators (Co-Is) may also be added.

At the top of the panel, a number of buttons are available to select and enter investigators:

- **Select PI**: Select a PI by accessing the ALMA user database. By default, the user creating the proposal is designated as PI. If the PI is changed to someone else than the user, the user is automatically added as a co-investigator.
- **Add CoPI**: Select Co-PIs in the same way. This is only available for Large Programs.
- **Add CoI**: Select Co-Is in the same way.
- **Add from Project**: Add the investigators from a project in the staging area or the archive as Co-Is.
- **Select all collaborator(s)**: select all the investigators listed in the table. Alternatively, one can select individual investigator by clicking on the respective row in the table. The selected ones are highlighted in blue.
- **Deselect all collaborator(s)**: action opposite to the previous button.
- **Remove collaborator(s)**: Delete a highlighted investigator from the table. Note that the PI can only be changed, not deleted.

For each investigator, the table displays the following details:

- **Reviewer**: This is the only editable column and is used to designate the investigator who will be responsible for reviewing proposals. This column is not present in Large Programs.
- **Type**: Is this a PI, a Co-PI or a Co-I? Co-PIs are only allowed for Large Programs and have equal access rights to the data. The time for the proposal is charged to the different executives in accordance with the number of Co-PIs from each executive.
- **Full Name**: Full name of the investigator as stored in the ALMA user database.
- **Affiliation**: The affiliation/institute of the investigator.
- **ALMA ID**: This is the username used to access the Science Portal.
- **Executive**: This determines how a project's time will be "charged". Taiwanese users can choose between EA, NA or half-half. For everyone else, this is fixed to the value entered in the Science Portal.

4.7 Reviewer Information

A reviewer must be nominated to participate in the Distributed Peer Review (DPR) process. The OT will require that reviewer's information is added for all proposal types except Large Programs. More information can be found in the Proposer's Guide. Once a reviewer has been selected, it is necessary to enter some additional information about that investigator. First, the user must indicate if the reviewer has a PhD or not. In the latter case, a further text box appears to indicate the name of the mentor that will supervise the student's review. The button "Select mentor" allows to search in the ALMA database. A further option to indicate whether the mentor has a PhD or not will then appear. In the latter case, an error is thrown.

4.8 Science Case (and Management Plan)

In this panel, the mandatory science case can be added to the proposal. Note that the document's format must be PDF and its length at most four pages. For Large Programs, the length is increased to seven pages and shall also include a description of the Management Plan. The minimum font size is 12 point and an error will be issued if >15 per cent of the text is smaller than this. Note that cropping a figure from a document can lead to text outside the cropped area still being present in the extracted figure.

The PDF should not contain the technical case as this is instead entered as part of each Science Goal. Figures that might be referred to as part of the technical justification however should be included in the PDF.

The available buttons are:

- **Attach**: Launch a file browser dialogue to allow the user to choose the PDF file.
- **View**: Open a new browser window to display the attached document.
- **Remove**: Remove a previously attached file from the proposal.

4.9 Team Expertise

If the proposal is a Large Program, a document describing team expertise must be attached. This is a PDF file with a maximum of one page and a maximum size of 1 MB. The same font-size restrictions as used for the Science Case PDF apply. The same buttons described in Section 4.8 are available.

4.10 Scheduling Feasibility

If the proposal is a Large Program, then the proposer group is required to assess the scheduling feasibility of the proposal following the configuration/LST scheduling constraints for Large Programs as described in the Proposer's Guide, and indicate through this check box that they have done this work and that the program complies with the scheduling requirements.

4.11 Duplicate observations

Before a proposal is submitted, the ALMA Science Archive should be checked to see that duplicate observations do not already exist. If they do, it should be explained here why the observations need to be repeated. A single panel is provided for free-format text as well as a clickable link to the ALMA duplication policy.

Chapter 5

The Science Plan tab

When the Science Plan tab is selected, two main new elements appear underneath the navigation bar. On the left side, a side bar leading to several collapsible panels allows users to input and describe the Science Goal(s) of the proposal. This side bar is described in depth in Sect. 5.4. On the right side, a new navigation bar containing three panels is displayed: Project Overview, Time Summary, and Data Volumes & Data Rates.

5.1 Project Overview

In the Project Overview, the user can see a summary of all Science Goals present in the proposal. In the table, for each SG the system reports in order: the Science Goal name, the number of sources, the ALMA band, the spectral type and the number of spws specified in the spectral setup, the kind of polarisation chosen, the type of calibration (system/user defined), the representative frequency, the requested angular resolution, the largest angular scale, and the requested sensitivity. By clicking on one of the entries, the OT brings the user directly to the corresponding panel in the selected SG.

5.2 Time Summary

This shows a table that contains the time required for each Science Goal. This is broken down into the different arrays (main array, ACA-7m, and ACA-TP). The times needed for calibration are also indicated. Specific or all Science Goals can be expanded/collapsed with the arrows next to the Science Goals or the arrows on top of the table.

5.3 Data Volumes & Data Rates

This shows a table that contains the data volumes and the average data rates required for each Science Goal, separated by distinct arrays. Individual or all Science Goals can be expanded/collapsed with the arrows next to the Science Goals or the arrows on top of the table.

5.4 The Science Goals

The left side bar allows the user to navigate among the Science Goals of the proposal. By default, one Science Goal is created by the interface. In order to add new ones, one can use the "+" button at the top-right corner of the side bar. This creates a new collapsible panel and increments by one the counter in parenthesis. The buttons "expand all" and "collapse all" allow to manipulate all the Science Goal collapsible panels at once. An individual

Science Goal can be expanded/collapsed with the arrow on the right of the Science Goal title. The button at the left of the title of each SG allows users to copy that particular SG in a new one, or to delete it. Note that no confirmation is asked before the SG is deleted. At the top of the side bar, a search bar is visible. This allows users to search by SG name and by source name. When "enter" is hit, the system brings the user to the item. If nothing is found, an error is thrown. Note that abbreviations are allowed, when unique (for instance, one can search for "IRAS15", instead of the complete name "IRAS15398-3359", when that is the only source name starting with that string).

The following subsections describe the content of each Science Goal panel, where all the technical information about the proposal must be entered. When clicking on one of the items of a SG, the corresponding content opens on the right side of the interface.

5.4.1 General

This is used to provide the name and description of the Science Goal. Whilst the latter is optional, it is necessary that all SGs in a proposal have unique names. Once the name is entered, it also appears in the title of the corresponding panel in the left side bar.

5.4.2 Field Setup

In the Field Setup panel, the user is asked for target parameters such as the name, coordinates, velocity and proper motion. Either individual (one or more) pointings or a single rectangle (that will be automatically mosaiced) can be defined. The OT includes a clustering algorithm that will attempt to split the sources into multiple clusters such that all the sources lie within band-dependent distances of each other (1 degree for long-baseline projects). There is a maximum of 150 pointings per Science Goal.

The side bar contains the following buttons associated with the Field Setup:

- **Add Source**: Add a science source, the details of which can either be "resolved" from SIMBAD or NED, or added manually. Source names composed of only numbers are not allowed; in such cases a letter should be added to the source name. A new source line is created in the left side bar.
- **Load from File**: Add one or more sources, including their properties, using a local ASCII file. The user has the option to append the new sources to the current source list, or to replace it entirely. In the file, source coordinates can be entered either in sexagesimal (ICRS) or decimal degrees (Galactic). The format of the file (case-insensitive) is as follows:

```
Name, RA|Galactic Long (Degs), Dec|Galactic Lat (Degs), PMRA(mas/yr), PMDec(mas/yr),
vel(km/s), Ref frame, Doppler type, peak cont flux(mJy), peak line flux(mJy), cont pol(%),
line pol(%), line width(km/s), cont circular pol (%), line circular pol (%)
--   This signals end of the header
ngc253, 00:47:33.134, -25:17:19.68, 0.0, 0.0, 258.6, lsrk, RADIO, 200, 1000, 2, 0, 1500, 0, 0
ngc1068, 02:42:40.771, -00:00:47.84, 0.0, 0.0, 1142.0, topo, OPTICAL, 1100.0, 30, 0, 0, 20, 0, 0
```

- **Export to File**: Write the source information to an ASCII file. The user can choose between saving the full source information or only the positions. In the latter case, several options are available for the coordinate format.
- **Delete All Sources**: This button deletes all sources from the source list. A confirmation is asked before performing the action.

Each source line underneath the Field Setup also presents two buttons:

- **Copy Source**: Create a copy of the currently selected source.
- **Delete Source**: Delete the source.

When one source is selected, three collapsible panels appear on the right. These are now described in detail.

5.4.2.1 Source

The Source collapsible panel contains several elements to describe the source properties in terms of coordinates on the left and the Spatial Visualizer on the right. The Spatial Visualizer is described in detail in Sec. 7.1. The properties that the user is requested to input are:

- **Source Name**: Source names should only contain the following characters: a-z, A-Z, 0-9, -,+, _ or a . (full stop). Characters other than these will be removed or replaced when the project is validated. Spaces are replaced by underscores after submission. The source name will appear in the corresponding list item in the left side bar.
- **Resolve source**: Fill in source details by searching for the entered source name in SIMBAD or NED. SIMBAD is checked first and then NED if no match was found. Check the returned information (coordinates, parallax, proper motion, velocity/redshift) carefully. Note that the so-called IAU format e.g. B0218+357, is no longer allowed – an additional identifier (usually of a survey) must be placed before the coordinates e.g. JVAS B0218+357.
- **Choose a Solar System Object**: Check this box if the target is a Solar System object. A number of solar system objects are recognised by the telescope control system and can be selected here. It is also possible to enter an ephemeris for any non-sidereal source. The source coordinates and velocity definitions are not displayed if a solar system object is selected as the system that controls the observations has detailed ephemeris information for each object.
  - **Name of Object**: Recognised objects are:
    - Stars: The Sun. This is a special target as it requires that an ephemeris be entered. This can be generated using the Solar Ephemeris Tool that is located within the Science Portal.
    - Planets: Mercury, Venus, Mars, Jupiter, Saturn, Uranus and Neptune.
    - Satellites: The Moon, Ganymede, Callisto, Io and Titan.
    - Dwarf planets: Pluto and Ceres.
    - Asteroids: Pallas, Juno and Vesta.
    - Ephemeris: Load a JPL HORIZONS format ephemeris[1]. The source name will be extracted from the ephemeris and inserted into the appropriate field.
- **Source Coordinates**: Note that these fields do not appear for solar-system objects.
  - **System**: The available options are ICRS, galactic, and horizon. Only ICRS or galactic should be chosen. ICRS is effectively the only system that is supported by the telescope control system and all calibrator positions are measured within this frame. If Galactic coordinates are entered, these will be properly converted to ICRS during the generation of the Scheduling Blocks (SBs).
  - **Sexagesimal display?**: ICRS coordinates will be displayed in sexagesimal format if this is ticked (default). Unclicking this will allow input in degrees for these systems.
  - **RA/Lon**: Source Right Ascension or Galactic Longitude. Default input formats are sexagesimal for ICRS and degrees for everything else.
  - **Dec/Lat**: Source Declination or Galactic Latitude. Ditto.
  - **Parallax**: Source parallax. Note that negative values are possible when resolving the source using an external server. This is due to the parallax being small compared to the measurement error.
  - **PM RA**: Proper motion in the R.A. (cross-declination) direction. Units should be milliarcsec/yr. Proper motions are used to calculate the current source position assuming that the ICRS position refers to Epoch J2000.
  - **PM DEC**: Proper motion in the declination direction. Units should be milliarcsec/yr.
- **Source Radial Velocity**: Note that this field does not appear for solar-system objects. The radial velocity of the source is used to convert source rest-frame frequencies to their observable (sky) equivalents. The user can specify units (m/s or km/s) and the **Doppler frame**. For the latter, a number of options are

[1] http://ssd.jpl.nasa.gov/horizons.cgi

available, but the most useful ones are barycentric and lsrk. Heliocentric can also be chosen, but is not currently supported by the telescope control system and during SB generation will be replaced by the nearly identical barycentric (these only differ by a maximum of approximately 12 m/s). If the frame is changed, no conversion is performed of an already-entered velocity/redshift. If lsrk is selected, the user-entered spectral window frequencies are converted to the barycentric frame when calculating tuning solutions. Topocentric is also available, but is not particularly useful given that no astronomical sources have a constant velocity in the frame of the telescope. Inserting a velocity value will automatically update the redshift field.

- **z**: Redshift. This is set automatically if a velocity is entered, but the redshift can also be entered and will set the velocity accordingly. For Single Continuum setups, automatic SB generation will set the redshift to zero (in the SB only). The user is asked to specify the **Doppler Type**: This sets the velocity definition (radio, optical or relativistic). Changing this will make the velocity agree with the entered redshift.
- **Target Type**: The supported observing patterns: “Individual pointing(s)” and “1 Rectangular Field”. All sources in a Science Goal must use the same Target Type. This field can only be modified if there is only one source in the Science Goal. Otherwise, it is greyed out.

5.4.2.2 Expected Source Properties

All relevant items in this panel should be filled in or the project will not validate. One of the reasons for providing this information is to aid in technical assessment. This means that a continuum flux must be entered for a continuum project and a line flux and width must be filled in for a spectral line project. If full polarization is selected, at least one of the line or continuum polarization percentages must also be given.

- **Passive phasing is required**: This is only shown for VLBI and Phased Array projects and is used to signify that the total flux of the source being observed is not sufficient to allow phasing of the array using that source and thus that an additional calibrator must be used. The continuum flux limits are 0.35 Jy for Band 1, 0.5 Jy for Band 3 and Band 6, and 0.7 Jy for Band 7. For spectral line observing the flux thresholds are calculated using the formula reported in the Proposer’s Guide. If this is selected, a specific ("fixed") phase calibrator must be defined in the Calibrator Setup.
- **Peak Continuum Flux Density per Synthesized Beam**: The expected flux density per synthesized beam of the source continuum. Please refer to the corresponding Helpdesk knowledgebase article for more information on how to fill this field.
- **Continuum Linear Polarization**: The expected degree of **linear** polarization for the source, expressed as a percentage of the peak continuum flux. The polarization of the weakest component should be entered. Note that if the polarization percentage is <0.1 per cent, then the OT will issue a validation error as it will not be possible to detect it reliably.
- **Continuum Circular Polarization**: As above except for circular polarization. A different limit of 1.8 per cent is applied.
- **Peak Line Flux Density per Synthesized Beam**: The expected peak flux density per synthesized beam of the line emission. Please refer to the corresponding Helpdesk knowledgebase article for more information on how to fill this field. If the line is seen in absorption against a continuum, enter the depth of the line as a positive quantity.
- **Line Width**: The expected line width for the lines in this Science Goal (FWHM). The line width must be in velocity units. This parameter is also shown for VLBI spectral line observing where it is used to ensure that the line falls within the VLBI spectral window.
- **Line Linear Polarization**: The expected degree of **linear** polarization for the source, expressed as a percentage of the peak line flux. The same polarization limit (0.1 per cent) applies as for continuum.
- **Line Circular Polarization**: The same as continuum circular polarization, but for spectral lines.

If observing the sun, this panel is titled “Solar Activity Level” and there will only be two choices:

- **Quiet Sun**
- **Active Sun**

To compensate for the sun's prodigious flux density, solar observations will often make use of a special observing mode known as mixer debiasing. Which mode will be used will depend on the level of solar activity and the frequency band.

5.4.2.3 Field Center Coordinates

This collapsible panel is visible if Individual Pointing(s) has been selected in the Source panel.

- **Coordinates Type**: Field centre in relative or absolute coordinates. Relative positions are offset from the source coordinate and are recommended. Absolute coordinates can be entered for non-solar-system objects, but will be converted to offsets from the source coordinate during SB generation as absolute coordinates cannot be used with the telescope control system.
- **Array Type**: If both the 12- and 7-m Arrays are required, this allows the user to choose which array's pointings to display.
- **Offset Unit**: If relative coordinates have been selected, set the unit of the offset (usually arcsec).
- **Number of Pointings**: A count of how many pointings have been defined. The number of pointings that can be defined is nominally 150 per Science Goal, distributed between multiple sources. In practice, more pointings can be created if the source list can be split into multiple clusters. It is possible to define multiple pointings per source, but each one must overlap such that they form a single mosaic. If multiple mosaics are required, they must be placed in separate Field Sources.
- **RA** and **Dec**: The position of each pointing should be entered in this table, usually relative to the source coordinate. Absolute coordinates are also possible, but are not recommended. No pointing can be more than 5 degrees away from the source coordinate.

In the subpanel "Pointings" the coordinates (RA and Dec) of the requested pointings are shown. This subpanel contains a number of buttons:

- **Add**, to add new pointings manually,
- **Reset**, to delete all pointings,
- **Import**, to load pointings from an ASCII file,
- **Export**, to save them to a file.

The output file format is very flexible and allows a user to write out the pointing positions in either offset or absolute coordinates and will automatically do the conversion between the two i.e. one can export in a different system to what is displayed. An example of the format for absolute coordinates in sexagesimal is shown here:

```
RA , Dec, Coordinate Type, Coordinate Units
--   This signals end of the header
 04:31:38.4369, 18:13:57.651,Absolute,Sexagesimal
 04:31:40.5426, 18:13:57.650,Absolute,Sexagesimal
 04:31:36.3312, 18:13:57.650,Absolute,Sexagesimal
```

The "Absolute" coordinate type can be combined with the units "Sexagesimal", "Degrees" or "Radians", whilst "Offset" pointings can be defined in "Arcsecs", "Arcmin" or "Degrees". Both the unit and coordinate type are case-insensitive. Galactic coordinates are not supported.

5.4.2.4 Rectangle

This panel is only visible when "1 Rectangular Field" is selected as Target Type in the Source panel. It is possible to define multiple sources, each of which uses a rectangular field pattern. To do this, one must start with only a single source in the Science Goal. This can be set up as a rectangular mosaic and any further sources that are defined will be forced to use rectangular field patterns.

For each rectangle, the OT will calculate a mosaic pattern for the 12- and 7-m Arrays based on the spacing parameter. A larger version of the user-drawn rectangle will be used for raster scanning with the TP Array. A total of 150 12-m Array pointings is allowed, summed over all rectangles. Rectangle sizes can also be small enough that only one pointing is required.

- **Coordinate Type**: Field centre in absolute or relative coordinates. Relative positions are offset from the source coordinate and are recommended. Absolute coordinates can be entered, but will be converted to offsets from the source coordinate during SB generation as absolute coordinates cannot be used with the telescope control system. If absolute coordinates is the chosen option, a further tick box to show them in sexagesimal or degree display appear.
- **Field Centre Coordinates** This field changes if relative or absolute coordinates type is chosen. In the first case, the two inputs are:
  - **Offset(Longitude)**: Longitudinal offset of the centre of the rectangle from the source coordinate.
  - **Offset(latitude)**: Latitudinal offset of the centre of the rectangle from the source coordinate.

  In the second case, the panel shows:
  - **RA**: The R.A. coordinate of the centre of the rectangle.
  - **DEC**: The Declination coordinate of the centre of the rectangle.
- **p length**: Length of one side of the rectangle. For a rectangle with zero rotation, this refers to the horizontal axis.
- **q length**: Length of the other side of the rectangle.
- **Position Angle**: Position angle of the "p" side of the rectangle from the horizontal direction.
- **Spacing**: Distance between mosaic pointings. This can be specified in arcsec or in fraction of the antenna beamsize, the latter being the default. Nyquist spacing ($\lambda/\sqrt{3}D$ where D is the antenna diameter) is assumed and should usually be selected, unless the sources being observed are relatively small. The spacing is usually shown as a fraction of the antenna beamsize ($1.13\,\lambda/D$) and thus in these units is approximately equal to 0.51. If Nyquist sampling is not used, the reasons for this should be given in the Technical Justification panel, but values between 0.7 and 0.8 are fairly typical for observing wide-fields of relatively small sources. A button is provided to reset to the Nyquist value.
- **Number of pointings**: The number of pointings calculated by the OT is displayed, for the 12- and (if required based on the Control & Performance parameters) 7-m Arrays. The number of 12-m pointings is zero for SACA setups.

A button is provided to export the pointings (12-m and 7-m Array) to an ASCII file on disk. If desired, this can be used as the basis of a set of individual pointings that can be read into the Field Source.

5.4.3 TP Regional Mapping

It was previously the case that solar observing with the TP Array would only produce maps of the full solar disc. It is now, however, possible to *additionally* obtain TP imaging of the area of interest on the Sun's surface i.e. that imaged by the interferometric array. The TP regional mapping area will be centred on the interferometric mapping position.

- **TP Mapping**: Here you select whether you want the previous default (map of just the full solar disc) or whether you also require a TP map of the interferometric mapping area.
- **Pattern Type**: The TP mapping area can be observed in different ways and currently double-circle or rectangular Lissajous patterns are foreseen. Only double circle is currently available.
- **Diameter**: For the double-circle pattern, the only parameter required is the diameter of the area to be mapped and this should be somewhat larger than the area covered by the interferometric observations.

5.4.4 Spectral Setup

This panel contains fields to specify the frequency setup of the observations i.e. the frequencies and bandwidths of the spectral windows. The different collapsible panels that appear on the right-hand side of the web interface are described in the following sections.

5.4.4.1 Visualisation

This panel contains the Spectral Visualizer. See Sect. 7.2 for more information.

5.4.4.2 Spectral Type

- **Spectral Type**: The kind of spectral type observations. Choices are: "Spectral Line", "Single Continuum", or "Spectral Scan". The panel displayed below the Spectral Type Panel depends on which option is selected.
- **Produce image sidebands**: Bands 9 and 10 are DSB receivers for which special processing (90-degree Walsh switching – not available for TP observations) is required to produce both sidebands. This is particularly useful for wide-bandwidth modes such as Single Continuum and Spectral Scan as it doubles the bandwidth and is therefore always enabled. It is also enabled by default for Spectral Line, but can be disabled by the user. It is common to refer to the spw that is defined in the table as the "signal" and the other as the "image". In order to select this mode, a spw in either Band 9 or 10 must first be created and all spws must have the maximum bandwidth of 1875 MHz.
- **Polarization**: Options are XX, DUAL (XX and YY) or FULL (XX, YY, XY and YX), where X and Y are the linear orthogonal polarizations detected by the ALMA receivers. Full polarization should be chosen if a measurement of the source polarization (magnitude and position angle) is desired, but it is not yet available for Bands 8, 9 or 10. Full polarization is available for the Stand-alone ACA but only with single pointings.

5.4.4.3 Spectral Setup Errors

The spectral setup panels will display errors and warnings for the spectral specifications, if any. Note that it is often the case that not all sources have errors (due to different velocities and therefore tuning solutions) and the error will not be shown unless the source is selected in the source table at the bottom of the Spectral Setup page.

5.4.4.4 Spectral Line

Four subpanels, one for each baseband, will be visible and up to four spectral windows (spw) can be added to each baseband. Adding a spectral window is done either by selecting spectral lines from the spectral line catalogue or by adding them manually. One of the spectral windows should be selected as the Representative Window. In this window's frequency range, the Representative Frequency can be specified. It defaults to the centre of the spectral window, but can be changed at the bottom of the page. This sets the size of the antenna beamsize drawn in the Spatial Editor and is also used to work out the time estimate for the Science Goal.

For each baseband, the following buttons are available:

- **Add spectral window centred on a spectral line**: This opens the Spectral Line Picker which allows a huge list of transitions to be searched from the Splatalogue catalogue. For each line selected, a spectral window will be added to the table centred on the line and the transition information filled in.
- **Add spectral window manually**: This adds a blank row to the table that can then be completed manually.
- **Delete all**: Delete all spws in the baseband.

For observations in Band 9 and 10, an additional tick box **Show image spectral windows** appears. If 90-degree Walsh switching has been selected, the details of the image spws can be displayed by ticking it.

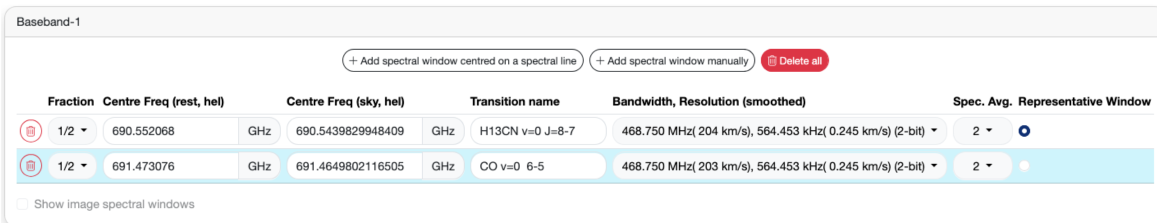

Figure 5.1: The spectral window table for a single baseband. Two spectral windows have been defined, each of which take up half of the available correlator capacity. Note that each spw has the same spectral resolution (this must be the case) and that the bandwidths are proportional to the assigned fraction. Further note that if there were different spectral averaging factors per spectral window, the spectral resolutions would not appear to be the same, although the bandwidths would still indicate the chosen fraction.

For each spw (see Fig. 5.1), the following parameters are to be entered:

- **Fraction**: Each baseband can currently only support a single correlator mode i.e. a bandwidth and number of channels, where the latter is 8192 for high-resolution modes (FDM) and 256 for low-resolution mode (TDM). These channels can be spread over the chosen number of polarization products and be split into multiple spectral windows. This splitting is indicated using the Fraction parameter where e.g. a factor of 1/2 indicates that the spectral window should contain half of the maximum number of available channels. For dual-polarization and FDM, a factor of 1/2 indicates that the channel should contain 8192/2/2=2048 channels. As each mode has a different total bandwidth, spectral windows with different bandwidths can therefore be created. Up to four spectral windows are allowed per baseband and thus only the values 1, 1/2 and 1/4 are appropriate. Depending on what fraction is selected, the available bandwidths and spectral resolutions in the drop-down list change. As each spectral window stems from the same correlator mode, each must have the same spectral resolution (before spectral averaging).
- **Centre Freq (Rest)**: The centre rest frequency of the window. This can be set for each spectral window separately by double-clicking on the table cell, but the total extent of each spectral window must lie fully within the total extent of the baseband (2 GHz).
- **Centre Freq (Sky)**: The centre sky frequency of the currently selected field source i.e. the rest frequency corrected for the source velocity. If lsrk was given as the Doppler frame, the sky frequency will have been converted to the barycentric frame. Otherwise, no frame conversion is made. Sources are selected using the Targets table (located at the bottom of the Spectral Setup editor page and described in Section 5.4.4.9).
- **Transition name**: A standard name to identify the purpose of the spectral window. Some kind of label identifying the main goal of this spectral window must be entered. The Spectral Line Picker will automatically enter the name of the chosen transition.
- **Bandwidth, Resolution (smoothed)**: The bandwidth and spectral resolution of the spectral window. Only allowed modes may be chosen from a drop-down list and, within a baseband, each must have the same spectral resolution (before spectral averaging). The resolution is calculated assuming Hanning smoothing. This is applied by default to the reported spectral resolution, as is the value of the spectral averaging factor. TDM correlator modes are shown in bold font and are usually used to observe continua or broad

spectral lines. For dual polarisation, not only 2bit but also 4bit correlator modes can be selected. If a 4bit spectral window is selected, no other spectral windows can be added to the baseband.

- **Spec. Avg.**: Spectral averaging factor. This can be any power of two up to a maximum value of 16 and can be useful for reducing the correlator output data rate – if the average data rate exceeds a maximum value (a different value for the 64-input and ACA Correlators) the project will not validate. The default value is 2 as this halves the data rate whilst only degrading the spectral resolution by ∼15 per cent (the non-linearity is due to Hanning smoothing also being applied in the correlator). Spectral averaging can be turned off, but this can lead to very high data rates if many FDM spws are defined, and particularly if 90-degree Walsh switching is also used. The Spec. Avg. value chosen will modify the spectral resolution shown in "Resolution (smoothed)". TDM spectral windows cannot be spectrally averaged.

- **Store Image**: If 90-degree Walsh switching has been selected, not all image spws must be written out by the correlator. If the image is not required for a particular spw, it can be de-selected here. This will reduce the data rate output of the correlator.

- **Representative Window**: Select one of the spectral windows to set the Representative Frequency. This is the parameter that together with the sensitivity requirement sets the required time and is therefore very important. If the spectral setup lies in areas of variable atmospheric opacity, which spectral window is set as the representative one can greatly influence the time estimate.

Each spw line begins with a **delete** button (trash can symbol) to delete it.

Spectral line observing with VLBI is significantly different. At the moment, it is only possible to carry out line observing in Band 1, 3, 6 and 7. For Band 1 and Band 3, baseband 1 needs to be in VLBI mode, i.e., its bandwidth must be 1875 MHz, and only one spectral window is allowed there. For Band 6 and Band 7 at least one of the basebands must be in VLBI mode (but not necessarily baseband 1) and only one spw is allowed there. Spectral windows can be added to the other basebands and their properties can be freely edited – VLBI data will only result from the VLBI spw though. It is also necessary to enter a date for the observation in the time-constraint interface (Control & Performance) in order for the OT to check that the line will be observable.

5.4.4.5 Single Continuum

This allows a maximum-bandwidth setup to be defined using only a single receiver band or frequency. Upon choosing a band, the OT will automatically set the spectral window frequencies to recommended defaults, such that the sensitivity is maximised. In Band 6, this involves avoiding the inner portions of the sidebands as these are somewhat (∼20 per cent) noisier. See the Technical Handbook for more details. In receiver Bands 2 to 8 two spws are placed in each sideband and the total bandwidth is 7.5 GHz. For Bands 9 and 10, 90-degree Walsh switching is enabled allowing four spws per sideband and a total bandwidth of 15 GHz. If this is selected, the image frequencies of each spw can be seen by clicking the "Show image spectral windows" button underneath each baseband.

It is possible to change the absolute positions of the spectral windows by changing a single parameter, the average frequency of the setup, but the relative separations remain the same. A low-resolution correlator mode (TDM) is chosen by default for each spectral window.

- **Receiver Band**: Selecting a band will set up default spectral window frequencies.

- **Sky Frequency**: This is the average frequency of the defined spectral windows and more-or-less corresponds to the value of the first local oscillator (LO1). There is a default for each band, but this can be changed here by entering a frequency in the observed (sky) frame. It is possible to reset to the band default frequencies using the button provided. Changing the default value requires a technical justification text box to be filled.

- **Rest Frequency**: The rest frequency corresponding to the sky frequency is displayed for reference only. It corresponds to whichever source has been selected in the Sources panel (see 5.4.4.9).

- **Correlator Mode**: Although the default is to use a low-spectral-resolution correlator mode (TDM), higher spectral resolution can also be selected. This will use FDM mode, still with a bandwidth per spw of 1875 MHz but with many more channels (4096 when using dual polarization). This can be useful for e.g. removing spectral lines during continuum data analysis but results in a much larger dataset and should only be used when really necessary.

Single Continuum is currently enforced for polarization mosaics and all solar observations. In these cases there is also no possibility to change the spw frequencies from their defaults.

5.4.4.6 Spectral Scan

It is possible to define a complicated setup involving multiple tunings that are meant to cover a contiguous range in frequency using the spectral scan interface. Given a start and stop frequency, and a correlator mode, the OT will devise a set of tunings that achieve the requested frequency range. The tunings are overlapped to ensure that bad edge channels can be flagged without leading to gaps in the combined spectrum. The overlaps are greatest for the 1875 MHz-wide spectral windows (∼170 MHz) and smaller (∼31 MHz) for the remainder.

- **Requested start frequency (sky)**: Frequencies can only be entered in the sky (observed) frame. The OT will start placing its spectral windows at this frequency.
- **Requested stop frequency (sky)**: The OT will attempt to achieve this frequency by creating up to five tunings. The OT will rarely achieve this exact frequency as there are fixed gaps between each tuning and each tuning implies a fixed amount of extra frequency coverage.
- **Requested range (rest)**: The requested range is also shown in the rest frame of the first target defined in the Field Source editor. The OT will warn if the requested range was not achieved.
- **Achieved scan range (sky)**: In general, the OT will not achieve the exact frequency range requested, and what is achieved is displayed here.
- **Bandwidth, Resolution (Hanning smoothed)**: One of three correlator modes (in 2-bit or 4-bit mode) should be chosen from the drop-down menu. The displayed values of spectral resolution include Hanning smoothing and spectral averaging.
- **Spectral averaging**: A single spectral averaging factor to be applied to all spectral windows.
- **Representative frequency (sky)**: The default value (centre of requested range) can be changed.

Once enough information has been added, the OT will calculate a tuning setup and display the derived spectral windows. Spectral scans are only allowed for sources observed with a single pointing and cannot observe in full polarization.

5.4.4.7 Representative Frequency

The value of the Representative Frequency is displayed in this panel. The panel is only present when Single Continuum or Spectral Line spectral types have been selected. Its value will default to the centre of the chosen spectral window, but can be changed to another frequency within that spectral window if the transition of greatest interest is not at the centre. *For spectral line setups this is defined in the rest frame of the source.* This is so that sources with different velocities end up with the appropriate Representative Frequency in the observed frame.

5.4.4.8 Rest Frequencies

During data reduction, it is desirable to know the rest frequencies of those transitions that are contained within each spectral window so that the velocity scale can be set. Another reason is that this information can be used to enhance the search interface of the ALMA Science Archive and the user is strongly encouraged to enter the rest frequencies of all targeted transitions.

The button opens a version of the Spectral Line Picker (Rest Frequency SLP or RFSLP) that allows the user to enter the rest frequencies of spectral lines that will be targeted by the defined spectral setup. The panel is only present when Single Continuum or Spectral Line spectral types have been selected.

When this tool is first opened, it will automatically include any rest frequencies that were used to define a spectral window. It will also ask the user if they would like to add the frequencies of any overlaid lines that fall into spws. Therefore, we recommend that this tool be used once the spectral setup has been fully defined. This default list of rest frequencies can then be edited i.e. rest frequencies added or deleted. Adding or deleting spws and re-opening the tool will update the list of rest frequencies accordingly.

If a spectral window is moved such that a defined rest frequency no longer falls within an spw, this will cause a validation error and the offending line will be highlighted in red in the table. It should then be deleted. This includes spws that were created using the SLP and these must be deleted and re-entered if the line used to define the spw no longer falls within it. Users will find that Science Goals which have been extensively edited and used as the basis for new projects, perhaps in different bands, now give such validation errors.

If it is desired to start again with a revised spectral setup and/or additional overlaid lines, all rest frequencies should be deleted and the rest-frequency tool re-opened.

5.4.4.9 Sources

This panel contains a table of the sources that were defined in the Field Setup panel. Clicking on one will update various aspects of the Spectral Setup page, including the sidebands and spectral windows displayed in the Spectral Visualizer, as well as the velocities displayed in the spectral window table.

5.4.5 Calibration Setup

The Calibration Setup panel allows users to specify the calibration strategy.

5.4.5.1 Goal Calibrators

This panel presents three options:

- **System-defined calibration (recommended)**: The default calibration strategy whereby a single observation of a bright quasar is used to calibrate both the flux scale and the bandpass. A phase calibrator will also be scheduled, as well as a polarization calibrator if full polarization was requested. For the vast majority of projects, standard observatory calibration observing strategies will be perfectly adequate and this option should be selected.

- **System-defined calibration (force separate amplitude calibration)**: This is similar to the first option, but differs in that the amplitude (flux) calibration will be done using a separate observation of a solar-system object if one is available at the time of SB execution. If this is not the case, a grid source will be observed instead. Only select this if particularly high amplitude accuracy is required.

- **User-defined calibration**: If this option is selected, the user can define their own calibration sources. This is not recommended and should only be selected if the user is highly experienced in interferometric observations and has a strong justification for making this selections. If passive phasing for VLBI or phased array observations have been selected, then this option is selected by default in which case a fixed phase calibrator must be defined. All user-defined calibrations must be fully explained in the Technical Justification. A table of calibrators appears in the panel, together with the following buttons:
  - **Add Query**: In this case, the source is chosen at SB execution time based on some criteria (usually a search radius around a position and perhaps a minimum flux constraint) entered by the user.

- **Add Fixed Calibrator**: Using this interface a specific calibrator source can be chosen when creating the proposal.
- **Delete All**: This button is most useful for restarting a calibration setup.

The Table contains by default three rows, respectively for Amplitude, Bandpass, and Phase calibrators. Additionally, Polarization and CheckSource rows can be added. At the beginning of each line, two buttons are available: the first on the left to edit the query details, and the second to delete the selected row.

Fixed Calibrator Selection A pop-up allows the user to select a fixed calibrator for Amplitude, Bandpass, Phase or Polarization calibration or a CheckSource. In the calibrator source editor, the user can choose between a Solar System Target or a Sidereal Target as Calibrator Type.
If Solar System Target is selected, different planets, moons and asteroids can be chosen from a drop-down list. Additionally, the user can add Flux Density Measurements that are displayed in a list at the bottom of the page.
If Sidereal Target is selected, the user can either enter the source information themselves (Source name, Source coodinates, Source Radial Velocity, Redshift as well as Flux Density Measurements) or select a source from the Source Catalogue.
The Calibrator Query Editor contains the following fields:

- **RA**: The centre R.A. coordinate of the cone search.
- **Dec**: The centre Declination coordinate of the cone search.
- **Radius**: The search radius in degrees around the cone centre coordinates - 180 will use the whole sky.
- **Flux Min**: Minimum flux for the search.
- **Flux Max**: Maximum flux for the search.
- **Frequency Min**: Minimum frequency for the search.
- **Frequency Max**: Maximum frequency for the search.
- **Max Results**: Maximum number of source to return [1-1000].
- **Submit Query**: Query the ALMA Calibrator Database for possible calibrator given the constraints. The result of the query is shown in a table below the input fields.
- **Select Calibrator**: Once a calibrator in the list is clicked, it can be selected as calibrator.
- **Cancel**: Cancel the query. No fixed calibrator will be added to the calibrator list.

5.4.5.2 Astrometry

If better positional accuracy is required than provided by ALMA by default (due to use of a standard calibration scheme or default observing conditions), this can be indicated using the controls in this panel.

Currently, an astrometry mode has not been formally commissioned but it would still be useful if PIs could indicate if enhanced positional accuracy is required by clicking the appropriate button. If this is done, a Technical Justification box must be filled out with any relevant details including why the enhanced accuracy is required. Users should consult the Proposer's Guide and Technical Handbook for more details.

It is not possible to select enhanced accuracy for solar observations, Large Programs, the Stand-alone ACA or for VLBI.

5.4.5.3 DGC Override

If the OT determines that Differential Gain Calibration (DGC) is required, privileged users (i.e. observatory staff) will be able to override this and turn DGC off using the checkbox displayed here. It is not possible to force DGC execution if the DGC criteria (lack of a suitable calibrator) are not met.

5.4.6 Control and Performance

When this panel is selected, a new navigation bar appappears with tabs for Desired Performance, Planning and Time Estimate, and Configuration Information. The contents of these three tabs are described in the following subsections.

5.4.6.1 Desired Performance

The user should enter desired performance parameters in this panel. These will determine which configurations and how much time are required (including ACA and TP) and can constrain when the observations take place. The following fields are included:

- **Desired Angular Resolution**: A number of options are available to request the desired angular resolution i.e. the finest detail that will be visible in the map of the source. These are:
  - **Range**: To increase the chances of a project being observed, users are advised to provide a range of angular resolution values. This gives the observatory more flexibility when scheduling. However, a user may request a single value of angular resolution by entering the value twice in the fields of the Range option. If the range of values is smaller than ± 20 per cent around the central value, the range will be increased to ± 20 per cent around the central value internally for all calculations. Note that if the possible configurations include a mixture of long-baseline and smaller configurations, the long-baseline possibilities will be disregarded as the observing overheads are much higher.
  - **Any**: By selecting this the user indicates that the SBs could be observed in any of the available configurations. As with a specific range of values, long-baseline configurations (C-7 or more extended) will not be considered by the OT or by the Scheduler.
  - **Stand-alone ACA**: Instead of entering an angular resolution, the Stand-alone ACA is selected using this option. No 12-m configuration will be selected, but the TP Array might be added depending on the requested LAS.

  Any value that is entered must lie in the range provided by the available configurations i.e. given in the Configuration Information tab. Unless the Stand-alone ACA was requested, the OT will select one or more 12-m configurations according to the various restrictions mentioned above. If any of these require additional (smaller) array configurations (including the 7-m and TP Array) to achieve the source LAS, only those combinations that require the smallest number of configurations will be considered. An angular resolution is never entered for VLBI or Phased Array proposals.

- **Largest Angular Structure in source**: The angular extent of the largest components in the source that need to be imaged. If this parameter (also sometimes referred to as the Largest Angular Scale – LAS) is smaller than the maximum recoverable scale of the selected 12-m configuration, smaller configurations must be added, if possible. For example, multiple 12-m configurations, the ACA 7-m and Total Power Arrays might be necessary to reliably image the indicated size of the source structure. Various restrictions exist including that the most extended 12-m configuration (C-10) cannot be combined with anything else. If the source size is very small, a value of zero can be used. The OT will also issue a validation error if the LAS is larger than the field of view as defined by the arrangement of pointings or the dimensions of a rectangle in the Field Setup. This parameter is not shown for VLBI or Phased Array observations.

- **Desired sensitivity**: The sensitivity goal for each source. If a rectangle has been defined, this value should be what is desired in the final mosaic i.e. including beam overlaps. For "Individual Pointing(s)", it is the value per pointing, even if a custom mosaic has been defined. If the angular-resolution choice was "Any", the sensitivity must be entered in flux units. This is not shown for VLBI or solar observations. If the requested sensitivity were in flux units then the OT will also display the **Equivalent sensitivity** equivalent in temperature units, and vice versa. Things are more complicated if a range is entered. A desired sensitivity in flux units will be converted to the equivalent temperature for the angular resolutions of the smallest and largest nominal configurations within the range. If the user-requested value is in kelvins, however, the flux-equivalent is first shown for the largest possible nominal configuration. As this flux sensitivity is what the observatory will deliver regardless of what configuration is actually scheduled (the time estimates are always based on the flux sensitivity) it is then converted into a temperature-equivalent using the coarsest requested angular resolution.

- **Bandwidth used for Sensitivity**: Specify which bandwidth should be used to calculate the required time. This is used in conjunction with the desired sensitivity and the Representative Frequency. A number of shortcuts are possible or a user-defined value can be entered. The effective channel width of the representative window ("RepWindowEffectiveChannelWidth") is the default for spectral line setups and will use the narrowest effective channel width (including Hanning smoothing and spectral averaging) of the spectral window chosen as the sensitivity driver for the observations. Please refer to the Spectral Setup section of the Technical Handbook for a definition of the effective channel width. If additional smoothing is envisaged post-observation, then a user-defined value can be entered - velocity units are preferred. For continuum observations where the spectral line interface has been used, the entered value should be the total non-overlapping bandwidth that is free from significant line emission. The "AggregateBandWidth" option will calculate the total non-overlapping bandwidth automatically and is the only option for Single Continuum setups. "FinestEffectiveChannelWidth" refers to the smallest effective channel width of any of the defined spectral windows and is the default for spectral scan observations. This is not shown for VLBI or Phased Array observations.

- **Override OT's sensitivity-based time estimate?**: If complicated and bright sources are being observed, the sensitivity target might not be reached due to limited *uv*-coverage. Alternatively, a user might not be interested in sensitivity, but rather in observing a source for a fixed amount of time in order to follow source variability. In either case, the sensitivity-based time estimate can be overridden here, but this must be rigorously justified. The time entered must be equal to the total time required for all the arrays, including calibration and overheads. This option is probably only useful for experts and it is not expected that it will be used very much. This is not shown for VLBI, Phased Array or solar observations.

- **Simultaneous 12-m and ACA observations**: If the observations require a single 12-m configuration and the 7-m Array only, it is possible to request that these be observed simultaneously. This is thought to be most useful for the planetary community and will result in the 7-m time being set to the same as that of the 12-m Array. Please note that configurations C-7, C-8, C-9, and C-10 are however excluded from simultaneous observing, as they cannot be paired with ACA.

- **Are the observations time-constrained?**: Clicking this reveals an interface for setting various scheduling constraints for the observations. If time-constrained observing is selected, it must be justified in the Technical Justification node. Currently, there are two types of time constraints:

  - **Single visit**: Multiple time windows can be entered, during **any of which** the Scheduling Block execution shall be started. It is possible to import these windows from an external ASCII file. Each visit should go on a separate row and each row should contain two comma-separated values of format YYYY-MM-DDThh:mm:ss e.g.

    ```
    2015-03-19T01:30:00, 2015-03-19T01:30:00
    2015-03-21T01:30:00, 2015-03-21T01:30:00
    2015-03-23T01:30:00, 2015-03-23T01:30:00
    2015-03-25T01:30:00, 2015-03-25T01:30:00
    ```

  - **Multiple visits**: Multiple time windows (either absolute or relative to one of the epochs) during **each of which** the Scheduling Block execution shall be started.

- **VLBI SG total time** For VLBI and Phased Array observations, the user must enter their own time estimate, including calibration, for the whole science goal. If the user-set time is less than 3h, the total time is automatically increased to 3h.

- **Total on-source time estimate** For solar observations, the on-source time should be entered.

5.4.6.2 Planning and Time Estimate

This panel shows the time requested to achieve the scientific objectives of the Science Goal. At the top, the interface summarizes a few of the key input parameters used in the calculation, and it states the total time necessary for the science goal. Right below, the calculation is split into clusters of sources. For each one, a more detailed break-down of the request is shown, including the possible array configurations needed to perform the observations and the different time estimates (on source, calibration, overheads, etc.) for each array.

5.4.6.3 Configuration Information

This panel shows array and telescope configuration information. They are all calculated assuming the sky-frame equivalent of the Representative Frequency for the first source in the Science Goal. At the top, the Antenna Beam sizes (FWHM) of both the 12-m and 7-m dishes is presented. This roughly sets the field of view of a single telescope pointing. Sources larger than this, or multiple sources spread over a larger area, must be mosaiced together using multiple pointings. Right below, the OT shows the number of antennas assumed for each of the arrays. These numbers are also set by default in the ALMA Sensitivity Calculator. Finally, a table summarises the following information for the ACA 7-m array and the most compact and most extended 12-m configurations:

- **Longest baseline**: The maximum baseline available as measured between antennas. All baseline lengths are *unprojected* i.e. they are not a function of source declination. Projection effects are taken into account though when calculating the synthesized beamsize.
- **Synthesized beamsize**: The synthesized beam sizes for the corresponding maximum baselines. This number is dependent on the source declination, or the average declination if there is more than one source. The best angular resolution is possible when observing a source at the same declination as the latitude of the observatory (−23 degrees). As the magnitude of the declination difference increases, the angular resolution deteriorates for a given configuration. If the sources have been split into multiple clusters, the value reported for the most compact configuration corresponds to the cluster which produces the largest beamsize. Likewise, the most extended configuration will correspond to the smallest beamsize possible out of all the clusters.
- **Shortest Baseline**: The minimum baselines available. All baseline lengths are *unprojected* i.e. they are not a function of source declination. Projection effects are taken into account though when calculating the maximum recoverable scale.
- **Maximum recoverable scale**: The largest structure that is possible to image with the different configurations. Like the angular resolution, this is also declination dependent.

5.4.7 Technical Justification

The Technical Justification (TJ) for the various parameters entered by the user into the OT is dealt with in a dedicated panel. For most projects, this is split into three main sections (Sensitivity, Imaging and Correlator Configuration), each displayed in a collapsible panel on the right. Some user settings will also need to be justified and additional text boxes will then be present under the collapsible panel "Choices to be justified". For solar, VLBI and Phased Array observations, the TJ does not use the sensitivity, imaging and correlator-configuration boxes and instead additional text boxes are shown in "Choices to be justified" that should cover most aspects of these observations.

5.4.7.1 Sensitivity

In this panel, the OT first presents a number of sensitivity-related parameters based on user input entered elsewhere in the Science Goal. These are designed to help users with the textual discussion of the sensitivity goals to be filled out in the free-format text box below. Note, if multiple sources have been included in the Field Setup, the most restrictive values of the Expected Source Properties are used i.e. the flux of the weakest source and the narrowest line width is assumed. If the OT detects potentially problematic issues, a message will appear in blue text and special attention should be paid to addressing these in the justification text.

The parameters reported by the OT vary depending on the contents of the Science Goal. The full list is:

- The signal to noise ratio (SNR) over the user-requested bandwidth for sensitivity: This calculation divides either the continuum or line flux by the requested rms. The continuum flux is used for single continuum setups (or where the bandwidth for sensitivity is more than twice the line width) and the line flux in the remaining situations. The user is notified if this or any of the other SNR values in the TJ node are less than three.

- The SNR over the aggregate, non-overlapping bandwidth: For spectral line (not single continuum) setups, this calculates the rms that would be achieved over the full, non-overlapping bandwidth (continuum rms) and subsequently the continuum SNR (continuum flux / continuum rms). This assumes that the entire bandwidth is free of spectral lines.

- The SNR over one third of the line width: For any Science Goal that includes line parameters in Expected Source Properties, the OT will calculate the rms over one third of the line width and calculate the corresponding line rms. In order to properly sample a spectral line profile, it is common to have approximately three spectral bins over the spectral line width.

- The ratio of the line width to the bandwidth for sensitivity: If line parameters have been entered in Expected Source Properties, this calculation will be presented. Three spectral points are often placed across each line, although higher values are often used if the shape of the line profile is to be measured. The user is notified if this value is less than three.

- Spectral dynamic range: If both spectral line properties and a continuum flux have been entered, the ratio of the continuum flux and the line rms are reported as the "spectral dynamic range". The line rms is taken as the requested sensitivity, unless the bandwidth for sensitivity is greater than twice the line width, in which case the rms is that which would be achieved over one third of the line width. The spectral dynamic range is relevant as detecting weak lines against a strong continuum is difficult and requires good bandpass calibration. The OT will issue a warning message if the band-dependent limit is exceeded.

When calculating many of these parameters, the OT will use the time that will actually be observed, rather than the time implied by the sensitivity alone. For example, a minimum time per source is enforced and when calculating the rms over one third of the line width, the OT would use this time if the sensitivity request meant that the limit had not been reached.

5.4.7.2 Imaging

Discuss the imaging goals of the project in the text box, particularly with regard to the desired angular resolution and source LAS which are printed at the top of the panel.

5.4.7.3 Correlator configuration

Here the OT reports some basic parameters of the correlator configuration, specifically the number of spectral resolution elements (including Hanning smoothing and spectral averaging) per line width and the bandwidth of the Representative Window. In the free-form text box the user should discuss the correlator configuration, particularly with regards to how many resolution elements there will be across each spectral line.

5.4.7.4 Choices to be justified

If selected by the user, the following user settings will also need to be justified. A new collapsible panel will appear, containing a free-format box for each relevant one.

- Non-Nyquist mosaic sampling: Non-Nyquist values are usually used when the scientific goal is to cover a large survey area and large-scale structures are not being observed. Polarization mosaicing may benefit from sampling at higher than the Nyquist frequency.

- Single polarization: Observations are usually done recording dual polarization, and single polarization is only used when the highest spectral resolution is required.

- Non-default continuum frequencies: The continuum setups are chosen so as to optimise atmospheric transparency. Choosing a different continuum setup thus requires a justification.
- Low max elevation: Sources with low declinations will suffer large atmospheric attenuation and be difficult to schedule because of limited time above the horizon.
- User-defined calibration: As the observatory guarantees appropriate calibration without user input, selecting user-defined calibration must be rigorously justified. For VLBI and Phased Array projects, the choice of phasor should be explained here.
- Override of OT's sensitivity-based time estimate: This may be necessary if you want to monitor a source over a certain time span or if your source has a complicated structure but the sensitivity-based time estimate does not allow for sufficient *uv*-coverage. You must give a detailed justification for the time override, and explain how the new time estimate was calculated. The time override must include calibrations and overheads.
- Time-constrained observing: These imply significant constraints on the scheduling of all ALMA projects and must therefore be fully justified.
- Astrometry: If enhanced positional accuracy was selected, please explain why this is necessary i.e. state the positional requirements with reference to what ALMA provides by default (consult the Proposer's Guide and Technical Handbook for more information).
- Solar Technical Justification: All technical details of solar observations should be discussed in this text box. See the Proposer's Guide for more information.
- VLBI Technical Justification: All technical details of VLBI observations should be discussed in this text box. If passive phasing has been selected then the choice of calibrator must be discussed in the box reserved for that purpose. See the Proposer's Guide for more information.
- Phased Array Technical Justification: All technical details of phased-array observations should be discussed in this text box and there should also be discussion of the post-processing steps. See the Proposer's Guide for more information.
- Passive Phasing Technical Justification: Describe here the source selected to be used for passive phasing i.e. why it is suitable to be used for this purpose. Its brightness and proximity should be discussed.
- High Imaging and/or Spectral Dynamic Range Technical Justification: Describe here why high dynamic range is required and how this can be achieved.

This page was intentionally left almost blank

Chapter 6

Tools and Simulators

6.1 Spectral Line Picker

The spectral line catalogue used by the OT is Splatalogue[1] and the millions of spectral line transitions contained within this catalogue can be searched for and selected using the Spectral Line Picker. This appears at various points in the OT where it fulfills different functions: creating spectral windows, overlaying lines in the Spectral Visualizer and defining rest frequencies.

- **Transition Filter**: Text string for selecting the transitions from the Transition field. Note that quantum numbers are ignored. The Description fields can be searched at the same time and this is enabled by default.
- **ALMA Band**: To search in the selected ALMA bands. Selections here will automatically adjust the min/max Sky Frequencies.
- **Sky Frequency**: Search in a certain sky frequency range, using the `Min` and `Max` fields. Selections here will automatically adjust the min/max ALMA Bands.
- **Upper-state Energy**: This filter sets the minimum and maximum energy levels of the upper state of the transitions.
- **Molecular Filter/Environment**: Narrow the candidate molecular transitions by selecting the category of lines to be shown.
- **Receiver/Back End Configuration**:
  - **All lines**: Perform no filtering i.e. show all lines.
  - **Potentially selectable lines**: Show lines that might possibly give a valid tuning solution if added to the current setup.
  - **Lines in defined spws**: Only show those lines which fall into the currently defined spectral windows. This is the only option when defining rest frequencies.
- **Reset Filters**: Reset the filters to the original values.
- **Add selected lines to spectral window(s)** By double-clicking an entry in the query list or by highlighting it and clicking the "Add selected lines to spectral window(s)" button, the transition is added to the "Spectral windows in this baseband" list at the bottom of the page. Selected transitions can be deleted by clicking the delete button in the table.
- **Add to selected transitions** Similarly to the previous button. Transitions are added to the table "Selected transitions" at the bottom of the page. This button is available when opening the spectral line picker from the “Select Spectral Lines to Overlay” button or from the “Define Rest Frequencies” button.

[1] https://splatalogue.online

6.2 ALMA Sensitivity Calculator

The ALMA Sensitivity Calculator webpage, hosted at `asa.alma.cl/SensitivityCalculator/`, can be opened with the button available in the header bar.

6.2.1 Common Parameters

- **Dec**: Declination of the target. This will be used to calculate the source's maximum elevation.
- **Polarization**: Dual or Single polarization.
- **Observing Frequency**: Only frequencies falling within the 10 envisaged ALMA bands are allowed.
- **Observing Band**: This is mainly there for information purposes i.e. to make clear which band is being used. However, where frequency bands overlap (Bands 4 and 5) or join together (e.g. Bands 6 and 7) it is possible to choose which Band should be used in the calculation. In the frequency overlap between Band 2 and 3, Band 3 is chosen by default and cannot be changed.
- **Bandwidth per polarization**: Bandwidth (frequency resolution) per polarization. Valid range is between 0 and 16 GHz. This value multiplied by the number of polarizations gives the effective bandwidth.
- **Water Vapour Column Density**: Precipitable water vapour column density in mm and corresponding octile (1–7). A number of standard values can be selected, but the tool defaults to automatically determining these based on the observing frequency.
- **Trx, tau, Tsky**: Display of the receiver temperature, zenith opacity and sky temperature (at the target's maximum elevation) given the previous selection.
- **Tsys**: Display of the derived system temperature.

6.2.2 Individual Parameters

These parameters are separated into the three available arrays.

- **Number of Antennas**: The number of antennas per array. These default to the expected numbers in the cycle corresponding to the version of the OT.
- **Resolution**: Desired angular resolution. This cannot be entered for the TP Array as this is a fixed number (antenna beamsize).
- **Sensitivity (rms)**: Requested/derived sensitivity. May be specified in Jy or K. Also displayed are the equivalent values of sensitivity, in K or Jy.
- **Integration Time**: Requested/derived integration time. This only includes the time on source – no overheads e.g. for calibration, are included.

6.2.3 Buttons

- **Calculate Integration Time**: Calculate observing time based on the system setup and the desired sensitivity.
- **Calculate Sensitivity**: Calculate sensitivity based on the system setup and the desired integration time.

Concerning the measurement units of both the integration time and the sensitivity calculation, the user can choose between "automatic" and keeping the unit displayed in the Individual Parameters tab.

Chapter 7

The Graphic Visualizers

7.1 The Spatial Visualizer

The Spatial Visualizer is a graphical tool to aid in choosing input parameters for the Field Setup of a Science Goal. An example of the image display can be seen in Figure 7.1.

One feature of the Spatial Visualizer is that it will convert between ICRS and Galactic coordinates in the event that the displayed image and the coordinates defined in the Forms editor use different systems. Therefore, individual pointings defined in ICRS will be shown at the correct position on a Galactic image and, if the pointings are defined or shifted on the image, the ICRS coordinates in the Forms editor will be appropriately updated. In a similar way, a rectangle will be rotated to take into account the angle between the two coordinate systems at the source position.

7.1.1 The graphic window

Above the graphic window, several buttons are available:

- **Set coordinates**: When this is selected, one can set the Source coordinates (see Sect. 5.4.2.1) directly by clicking on a position in the maps shown by the visualizer.
- **Add pointings**: This is available only when Individual Pointing(s) is selected in the Source panel (see Sect. 5.4.2.1). When selected, a new pointing can be added by clicking on the desired position on the map. The new pointing will appear in the Field Centre Coordinates table (see Sect. 5.4.2.3).
- **Reset FOV**: This button re-centers the displayed image in the source's coordinates.
- **Show pointing positions**: This is available only when 1 Rectangular field is selected in the Source panel (see Sect. 5.4.2.1). It shows/hides the pointing positions (beam sizes) of the rectangular field.

The graphic window displays the browser version of the Aladin interactive Sky Atlas (Aladin lite; see https://aladin.cds.unistra.fr/). It retains most of its functionalities in the toolbar available on the left side of the interface. In particular, from the top button to the bottom one:

- **Open the overlays menu**: This opens a panel with several items that can be shown or hidden in the displayed image; furthermore, by clicking on the "+" button next to "Surveys", the user can open a local FITS file to be shown as background image.
- **Settings**: Some general settings, including for instance grid properties.
- **Simbad pointer tool**: Allows to search the Simbad database by coordinates, chosen clicking in the graphic window.

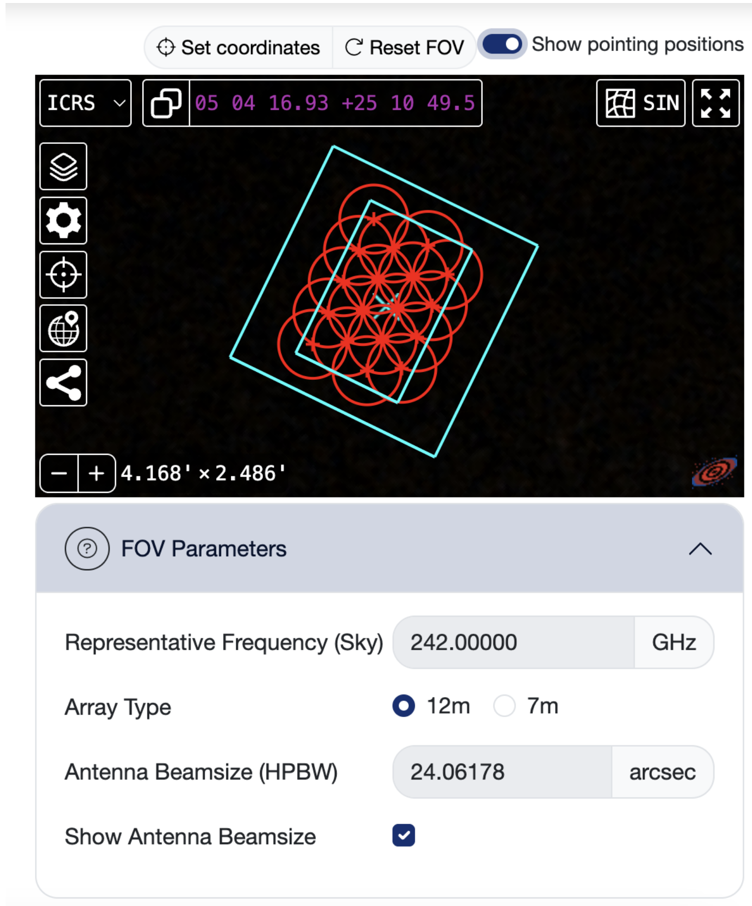

Figure 7.1: An example of the image display area of the Spatial Editor. This is for a rectangular field, and it shows the individual pointings (in red) and the total field-of-view of the mosaic (in cyan). The size of the TP rectangle is shown as the bigger rectangle.

- **Display the coordinate grid**
- **Share**: Share the displayed view, as a link (to Aladin), as a FITS cutout, or as a snapshot of the panel.

There are other buttons available to manipulate the graphic window. In particular, in the top-left corner the user can select between ICRS and galactic coordinates. In the top-right corner, the full-screen mode can be activated. The user can zoom in and out in the window, using their mouse pad. A right-click in the window gives a short cut to some of the functionalities described above.

7.1.2 FOV Parameters

Below the graphical window is one collapsible panel that controls various display options.

- **Representative Frequency (Sky)**: The sky equivalent of the Representative Frequency is used to determine the antenna beamsize.
- **Array Type**: If both the 12- and 7-m configurations are required, this button will determine which array's pointings are displayed.
- **Antenna Beamsize (FWHM)**: Indicates the size of the primary beam at the Representative Frequency.
- **Show Antenna Beamsize (circle)**: Tick to display the chosen antenna beamsize.

7.2 The Spectral Visualizer

In the Spectral Visualizer window, the defined spectral windows are shown along with the tuning solution derived from them. This consists of the receiver sidebands (the spectral windows must all fit inside these) and the first local oscillator frequency (LO1). If a tuning solution has been found, the sidebands will be coloured yellow. If a tuning solution cannot be found, the sidebands turn grey. A project cannot be submitted unless a tuning solution has been found by the OT. A table at the bottom contains all sources that are specified in the Field Setup (see also Sec. 5.4.2.1). Selecting these will move the spectral windows in the graphical interface, but note that the sidebands and LO1 frequency will not shift – these remain at the position appropriate for the first source.

7.2.1 Spectral Editor for Science Goals

We now describe the content of the Visualisation collapsible panel. Above the graphic window, on the right side, five buttons are available:

- **Pan To Spectral Window**: This will centre the visualizer on the currently selected spectral window.
- **Zoom To Band**: Zoom to the current receiver band.
- **Zoom in**: Zoom into the current view in finite steps.
- **Zoom out**: Zoom out of the current view in finite steps.
- **Reset**: Reset the display settings.

  The user can also zoom in by keeping the left mouse button clicked and then marking an area of the spectral visualizer.

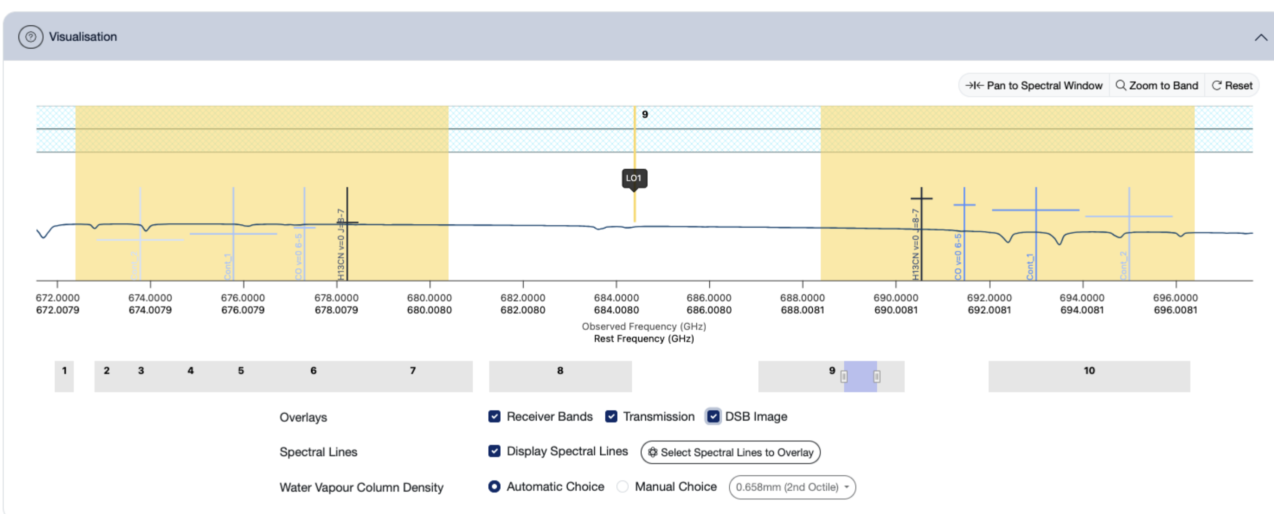

Figure 7.2: The graphical representation of the frequency information for a given Science Goal. The yellow sidebands indicate that a valid tuning solution has been found – these would otherwise appear grey.

Below the graphic visualisation of the spectral setup, several other options are available:

- **Overlays**
  - **Receiver Bands**: Displays the available receiver bands as a hatched bar along the top of the display.
  - **Transmission**: Display the atmospheric transmission curve. This will change depending on what is selected for the Water Vapour Column Density (see below).

  - **DSB Image**: For DSB receivers (Bands 9 and 10) this displays the “image” counterpart of each spectral window. The image spectral window lies in the other sideband (equidistant from the LO1 frequency) and will show sources of contamination or excess noise e.g. other lines and atmospheric absorption, that will also affect the requested spectral window.

- **Spectral Lines**
  - **Display Spectral Lines**: Display lines selected with the Spectral Line Picker.
  - **Select Lines to Overlay**: Choose lines to overlay using the Spectral Line Picker.

- **Spectral Scan** (this is only available if Spectral Scan is selected)
  - **Requested scan**: Show the range over which the spectral scan was supposed to cover. This will rarely exactly correspond to what was achieveable in practice.
  - **Tuning 1, 2, etc.**: Display the spectral windows corresponding to a specific tuning. Each tuning is coloured differently and is offset vertically.

- **Water Vapour Column Density**
  - **Automatic Choice**: Allow the OT to automatically select the appropriate value of PWV according to the Representative Frequency and draw the corresponding transmission plot. This is recommended.
  - **Manual Choice**: Override the OT’s choice. This is for experimentation only – the OT will ignore this when calculating the time required for a Science Goal.

Chapter 8

Acronym List

ACA: Atacama Compact Array
ALMA: Atacama Large Millimeter/submillimeter Array
ARC: ALMA Regional Centre
ASC: ALMA Sensitivity Calculator
DGC: Differential Gain Calibration
DDT: Director's Discretionary Time
DSB: Double Sideband (receiver)
FOV: Field Of View
LAS: Largest Angular Scale
LO: Local Oscillator
OT: Observing Tool
PI: Principal Investigator
PWV: Precipitable Water Vapour
SACA: Stand-alone ACA
SB: Scheduling Block
SG: Science Goal
SLP: Spectral Line Picker
SPW: Spectral Window
TJ: Technical Justification
TP: Total Power

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of the European Organisation 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 and Technology Council (NSTC) in Taiwan 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.