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A User's Guide to ALMA Scheduling Blocks (Cycle 3)

ALMA

NAOJ National Astronomical Observatory of Japan

NRAO

www.almascience.org

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User Support:

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

Revision History:

Version	Date	Editors
1	**16 Sept 2015**	**G. Schieven**

Contributors

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OT Version

The following is a guide for interpreting ALMA Scheduling Blocks (SBs), using the ALMA Observing Tool (OT). You will need to download and install the latest version of the OT from the ALMA Science Portal at www.almascience.org. To check that you're using a version of the OT set up for working with SBs, click the "Help" menu, then click "About" and select the "Version" tab. You should see *PhaseII* in the User version (see Figure 1). If not, then download a more recent version from the Science Portal.

This particular document has been updated for use with the ALMA OT user version Cycle3PhaseII(u1).

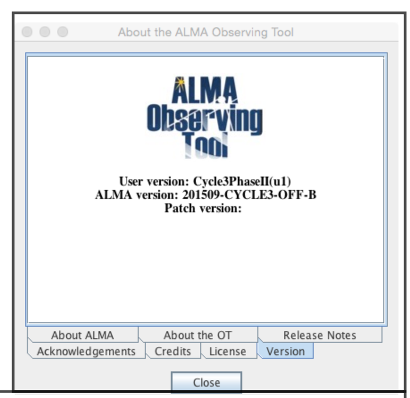

Figure 1: To determine which version of the OT you're using, under the "Help" menu select "About…" and click the "Version" tab. This document has been updated for use with "User version: Cycle3PhaseII(u1)".

A Users' Guide to ALMA Scheduling Blocks (SBs)

Introduction

When preparing your ALMA proposal (a process often referred to as *Phase 1*) with the ALMA *Observing Tool* (OT), you created one or more *Science Goals* (SGs; *Figure 2*) in which you specified the science targets and properties, observing frequencies and correlator settings, required sensitivities, and other observing constraints. These can be viewed by clicking the "Proposal" tab (*Figure 2*). After your project was approved, your proposal entered *Phase 2* (visible under the "Program" tab (*Figure 3*)), in which your SGs were used to generate *Scheduling Blocks* (SBs). SBs contain all the instructions needed by the telescope control software to carry out your science and calibration observations. Before your SBs can be made available for observing, however, you need to verify that the SBs will, indeed, be carrying out the observations as you required. This document provides a quick guide for checking your SBs. Remember, however, that you can always contact your Contact Scientist (CS) through the Helpdesk if you have any questions or concerns.

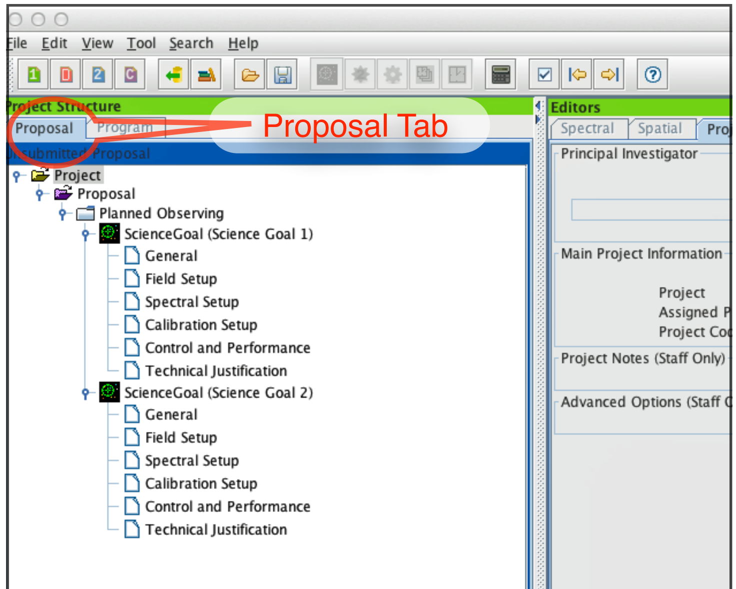

Figure 2: The "Proposal" tab shows the Science Goals (SGs) exactly as they were generated by you when you prepared your proposal.

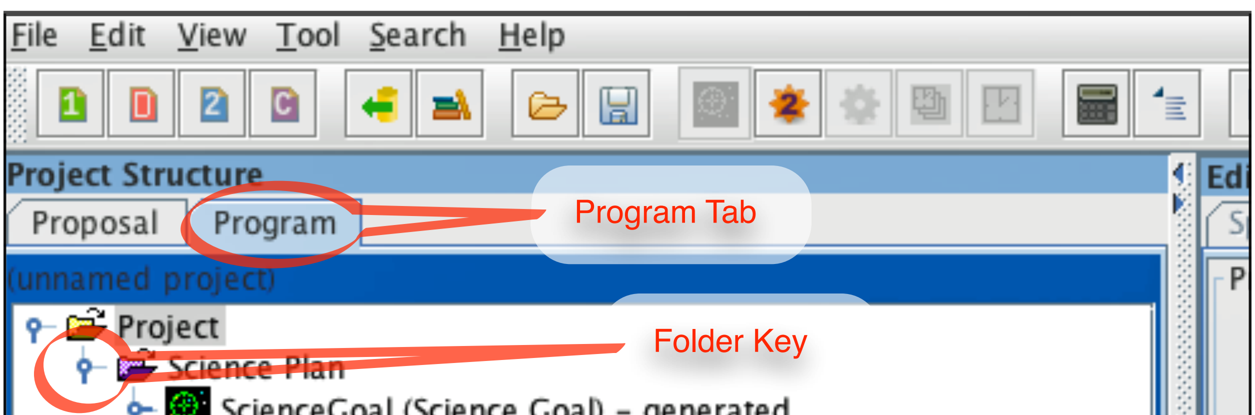

Figure 3: The "Program" tab (circled) contains the files generated at Phase 2, including the SBs. Clicking the folder key symbol exposes or hides the contents of the file. Right-clicking the key symbol and selecting "Expand all" allows you to see all the files under that key.

Finding Your SBs

In order to check your SBs, you will need to launch the OT (see **Version** above), and download your project from the archive (*File → Open Project → From ALMA Archive*). Click on the Program Tab (*Figure 3*). Here you'll see a set of nested folders, similar to when you created your SGs. To expand the folders, just click on the key symbols (circle with a line segment; *Figure 3*) or expand them all using *right-click → expand all* (*Figure 3*). The top level folder is the *Project*, the second level is the *Science Plan*, and the third level of this hierarchy contains the *Science Goals*. So far this is the same structure as you saw when generating your proposal. At Phase 2, a hierarchy of files called Observing Unit Sets (OUSs; see *Figure 4*) is created from each SG, inside of which you'll find your SBs. (For a full description of the OUS hierarchy, see the *Technical Handbook*, Chapter 8.)

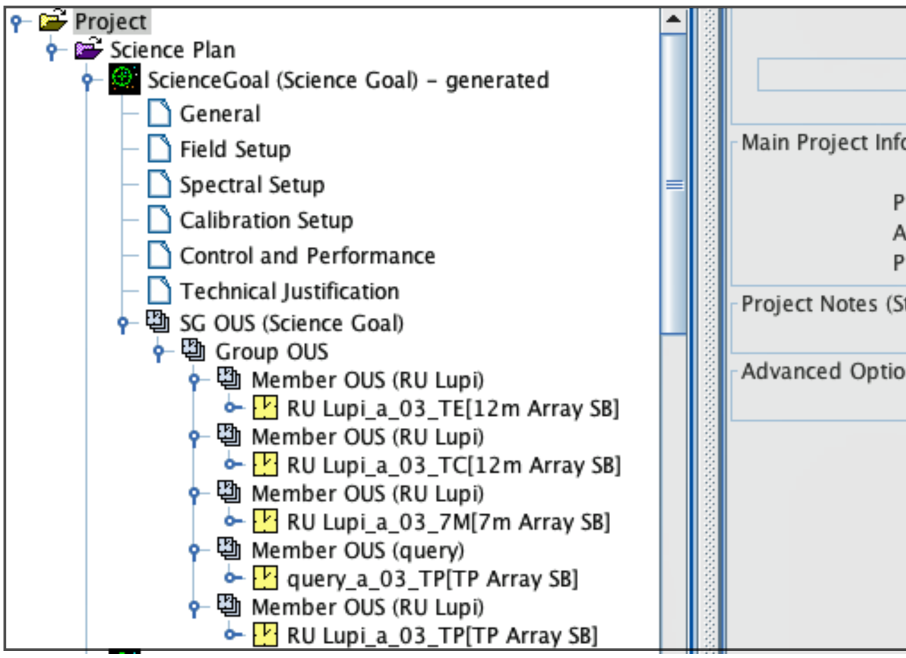

Figure 4: Each SG contains a hierarchy of files called an Observing Unit Set (OUS), which include the SBs. Each SG contains one or more SBs, depending on whether multiple arrays and/or multiple tunings are required for the science goal.

Structure of SBs

Depending on the angular resolution, largest angular structure (LAS), and number of tunings specified in the SG, at Phase 2 one or more SBs will be generated for each SG, each in its own Member OUS (Figure 4).

The SB can be identified with a yellow clock icon (*Figure 4*). Each SB in your project has a unique name, with the structure SRCName_a_XX_AR, where 'SRCName' is the first (up to) 8 characters of the representative science target, 'XX' is the receiver band used (e.g. 03 for Band 3), 'AR' distinguishes the array ('TE' or 'TC' for the 12m-Array, '7M' for the 7m-Array, and 'TP' for the TP-Array), and 'a' has the value 'a', 'b', 'c', etc., to give the SB a unique name.

An example of an SB name might be 'RU_Lupi_b_03_TE', where 'RU_Lupi' comes from the first (up to) 8 letters of the representative science source in the SB, 'b' means that there is another SB in the project with a similar name (i.e. RU Lupi_a_03_TE), '03' means the SB uses the Band 3 receivers, and '_TE' means that this is a 12m Array observation. (If you had chosen an angular resolution and LAS combination that required two 12m Array configurations, the SB for the second, more compact configuration would have been labeled '_TC'; see *Figure 4*.)

Each SB is made up of three sections: *Groups*, *Targets*, and *Resources* (*Figure 5*).

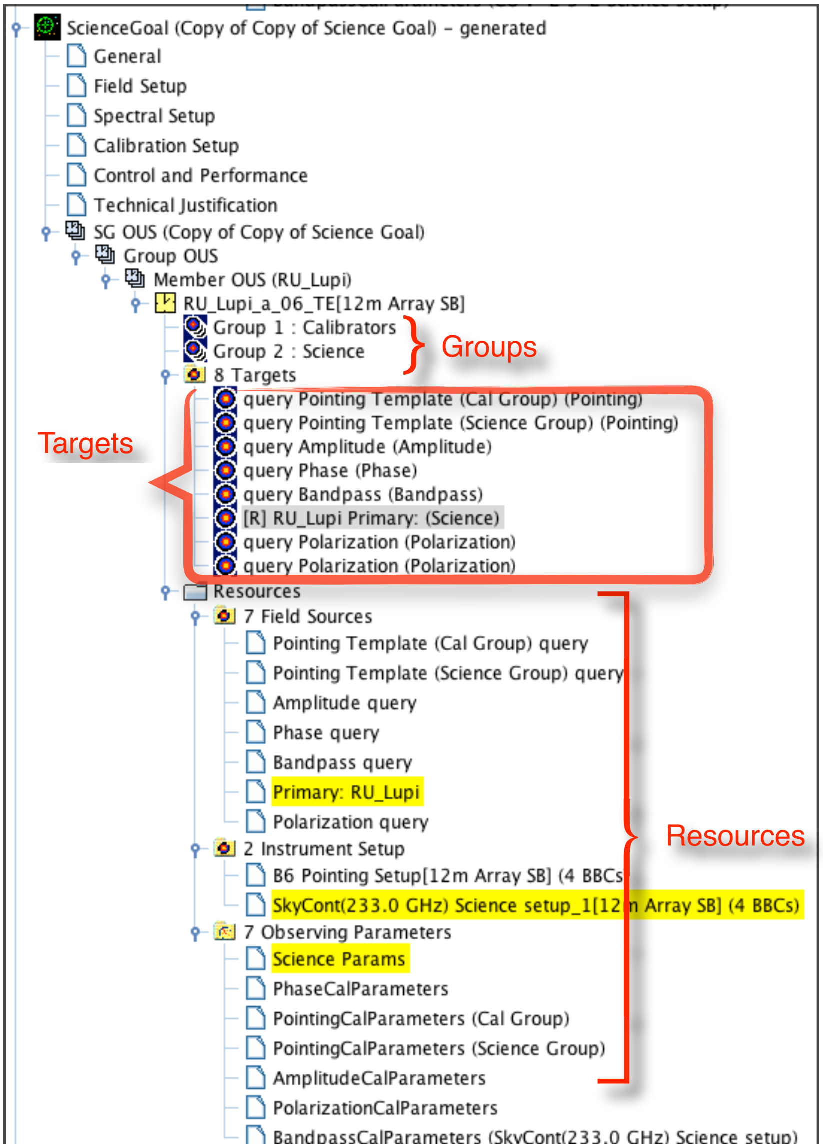

Figure 5: The basic structure of an SB consists of three elements: Groups; Targets; and Resources.

Groups

All observing targets that are to be executed are included in a *Group* within the SB. Each SB can include multiple *Groups*. The first, *Group 1*, generally contains the initial calibration observations (*e.g.* amplitude, bandpass, sideband ratio, *etc.*), and the targets within this Group are intended to be done once per execution of the SB. (Note, however, that for spectral scans, *Group 1* is empty.) The second (or subsequent) Group contains the science targets plus relevant calibrators (e.g. phase, atmosphere, pointing, etc.) which are repeated until the science integration time is completed. If you click on a group, then the targets associated with that group are highlighted in yellow.

Targets

Targets define all the information needed for an observation, using *Resources* (see below). There is one *target* for each science source or calibrator. Clicking on a target causes all of the resources associated with that target to be highlighted in yellow (*Figure 5*). All of the resource parameters for the target are also shown at the same time in the *Editor* window (*Figure 6*).

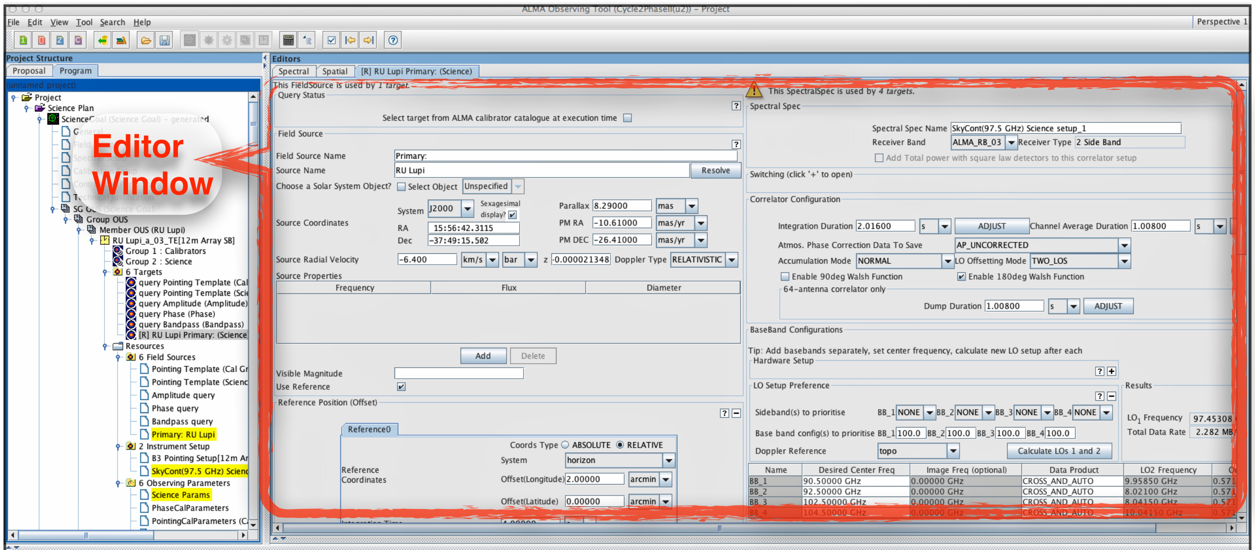

Figure 6: All observing parameters for the SB are viewable in the Editor Window.

One of the science *targets* is labeled with an '[R]'. This target is used as a representative target for the SB when the Scheduler is looking for available SBs to observe.

Resources

Resources define the parameters used for a particular type of observation. A *resource* may be used by several *targets*. Clicking on the *resource* will highlight the *targets* making use of it in yellow. It also shows the parameters for that *resource* in the Editor window.

There are three types of resources (*Figure 5*):

Field Sources

Field Sources define the position, offsets and radial velocity of each source, including calibration sources. If multiple science sources were defined in the SG, each will have its own *field source*. Calibration *field sources* are usually left as a *query*, to be defined at the time of the observation. Calibration sources, because they tend to be variable, are monitored periodically by the observatory. If there are no suitable calibrators in the catalogue, a "cone search" may be carried out prior to observing your SBs.

Instument Setup

The *instrument setup* defines how the receiver is tuned and the correlator is set up. Usually there are two setups: one for pointing, and one for the science observations, but in certain circumstances (e.g. multiple tunings for a spectral scan, multiple sources with different redshifts, very narrow total bandwidth) there may be several science setups.

Observing Parameters

Observing parameters define the sub-scan duration (basic integration time) and the total integration time per execution of the SB for each *target*, as well as other parameters.

Verifying Your SBs

The most common items that need to be verified are the science source positions and radial velocities, the instrument setups, and the integration time. We look at each item in turn.

Science Source Positions and Radial Velocity

Each science source has its own *Field Source* resource (*Figure 7*), where the source position and radial velocity are defined. Clicking on the *Field Source* (e.g. in *Figure* 7*,* the *Field Source* for RU Lupi) shows the parameters in the Editor window to the right. Where a mosaic or offsets have been specified, you may need to scroll down the Editor window to see them (*Figure 8*). Total Power (_TP) science observations require a reference position, which your Contact Scientist may have requested you to provide. That can be checked by scrolling down the Editor window.

On the top left corner of the Editor window (*Figure 9*), if you click on the Spatial tab you can get a graphical view of the source position, offsets and mosaic positions. This view works the same way as when you generated your SGs in Phase 1.

Instrument Setup

Because of the power and flexibility of the ALMA correlator, the *Instrument Setup* resources are much more complex than the other resources, and checking them can be daunting. However, in most cases only a few numbers are relevant and can be checked quickly.

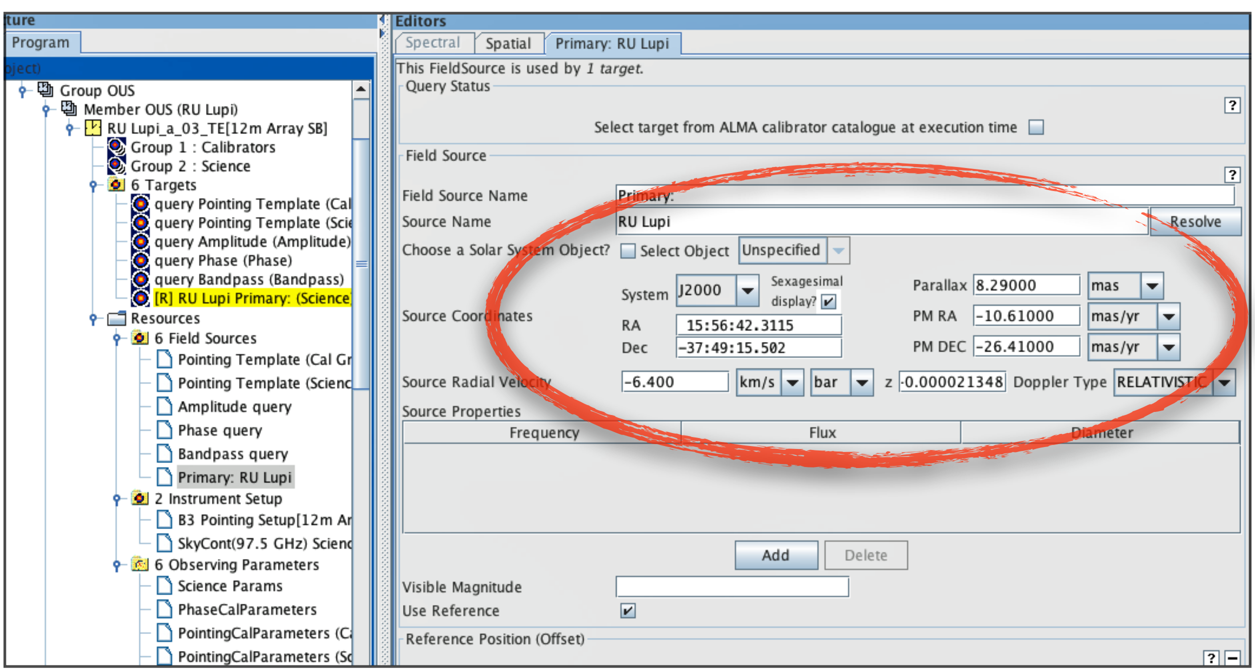

Figure 7: The Field Source resource, showing the position, radial velocity and velocity frame, proper motion, and other properties.

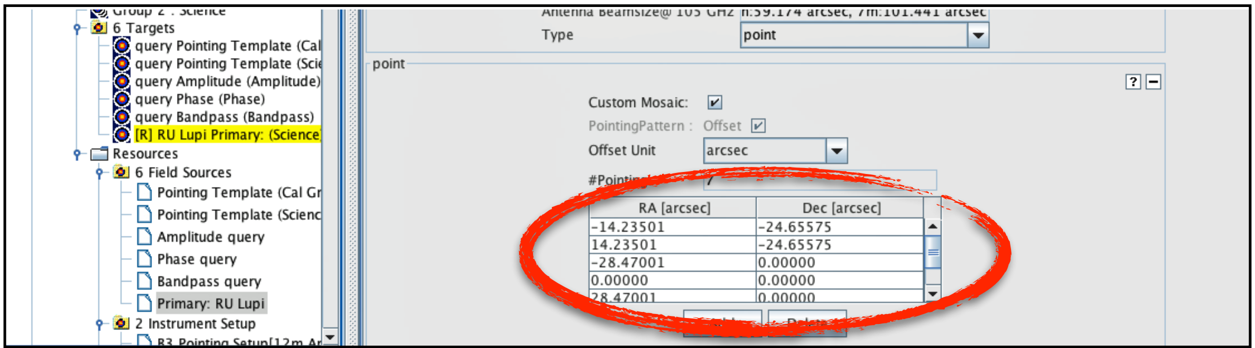

Figure 8: Offset positions (e.g. for a mosaic) are found by scrolling to the bottom of the Editor window in the Field Source resource.

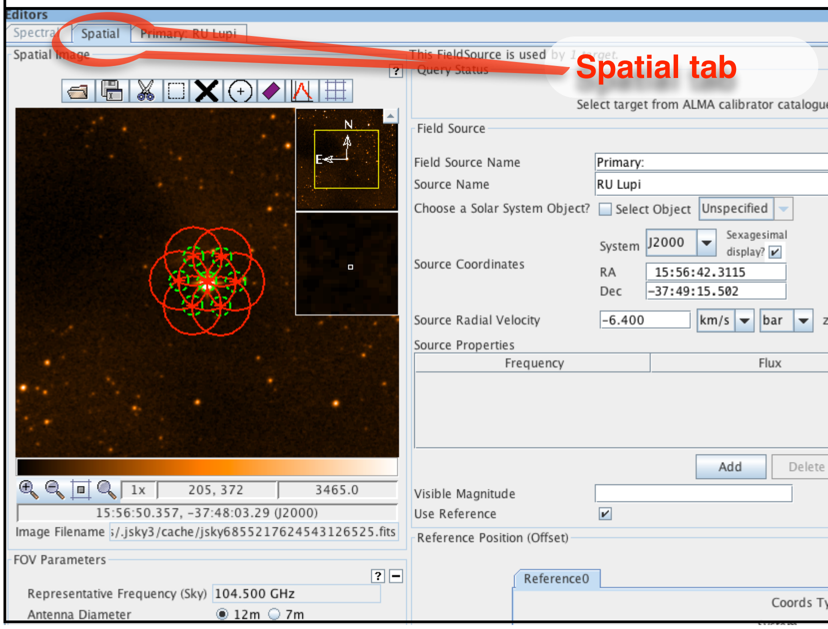

Figure 9: The Spatial tab shows a graphical presentation of source positions and offsets. A background image must be loaded from an online server or using a local fits file.

Click on the *Science Instrument Setup resource* (see *Figure 5*). The targets using this setup are highlighted in yellow. Scrolling down the *Editor* window, near the bottom you'll see (up to) four tabs, one for each baseband (BB_1, BB_2, etc.; *Figure 10*). Click on each baseband tab in turn. At the bottom of each baseband window is another set of 1-4 tabs, one for each spectral window (SW-1, SW-2, etc.; *Figure 10*). Click on each of these tabs in turn to check the center frequency of the spectral window (rest and sky), the bandwidth, averaging factor, and spectral resolution (after smoothing and averaging).

If you have multiple SBs within an SG (*Figure 3*) due to multiple array configurations, then all of the 12-m and 7-m Array SBs (_TE, _TC, _7m) and the science TP-Array SB (e.g. RULupi_a_03_TP), should all have identical science instrument setups. The TP-Array calibration SB (CalSourceName_xxx_TP) may have a different instrument setup from the others.

(Note that the *Desired Center Freq* listed near the top of the BB window (*Figure 10*) may be different from the center frequency of the spectral window. This is because the former is the centre frequency of the 2 GHz wide baseband, whereas the spectral window can be anywhere in the baseband. See *Figure 11*.)

On the top left corner of the Editor window, if you click on the Spectral tab you can get a graphical view of the correlator setup (*Figure 11*). This view is similar to the Spectral

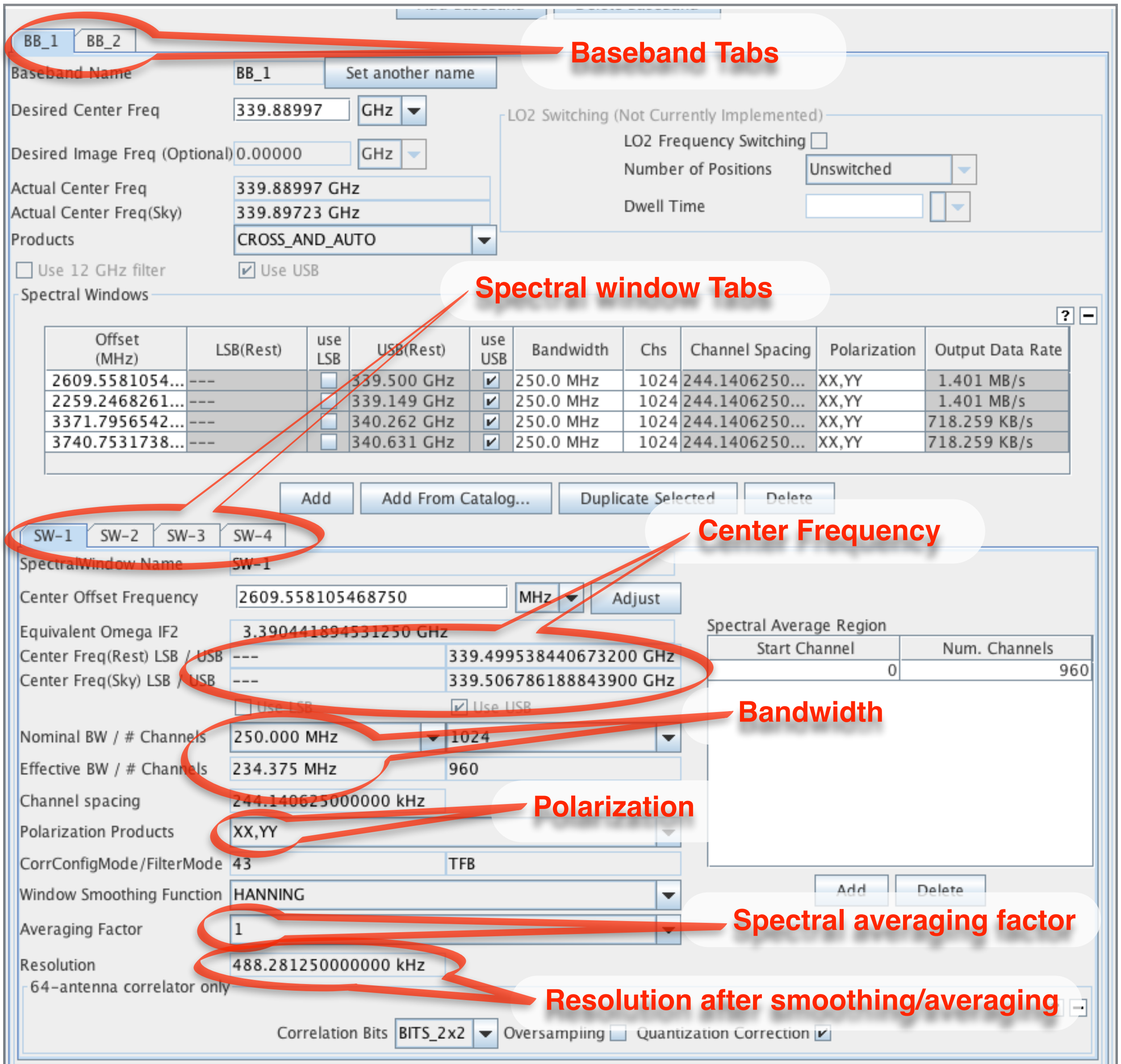

Figure 10: Click on the Science Instrument Setup and scroll to the bottom of the Editor window in order to check your correlator setup. Each baseband (BB) has its own tab, and each spectral window (SW), if more than one within the baseband, has its own tab. Click on each in turn to check the setup for each spectral window in each baseband.

view when you generated your SGs in Phase 1, except that now both the baseband location and width as well as all spectral window widths are shown graphically.

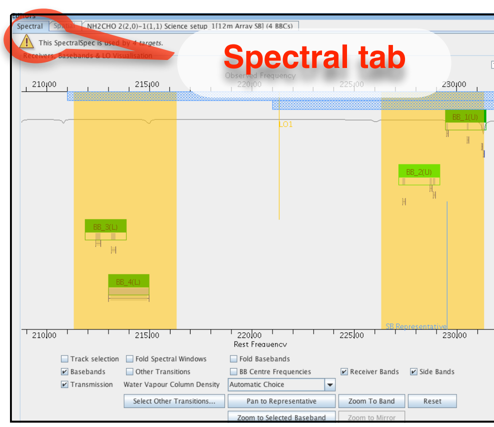

Figure 11: A graphical view of the correlator setup using the Spectral tab, showing the ranges for each baseband as well as the bandwidth and range of each spectral window.

Integration Time

Click on the *Science Observing Parameter* resource (*Figure 5*). The target(s) using this setup will be highlighted in yellow. In the Editor window (*Figure 12)* you can check the *Integration Time on Source*, which is the total integration time (per execution of the SB) for each target using this resource (*Figure 12*). (For targets with multiple offsets, e.g. mosaics, the integration time per point will be the *integration time on source* divided by the number of offsets.) The *integration time on source* is limited so that the SB will be completed in approximately 2 hours or less including all calibration observations, so it will often be shorter than the total integration time required. In this case, the SB may need to be executed multiple times. Click on the SB icon (yellow clock) and scroll down to *Execution Count* (*Figure 13*). The overall total integration time on source is then the *execution count* multiplied by the *integration time on source*.

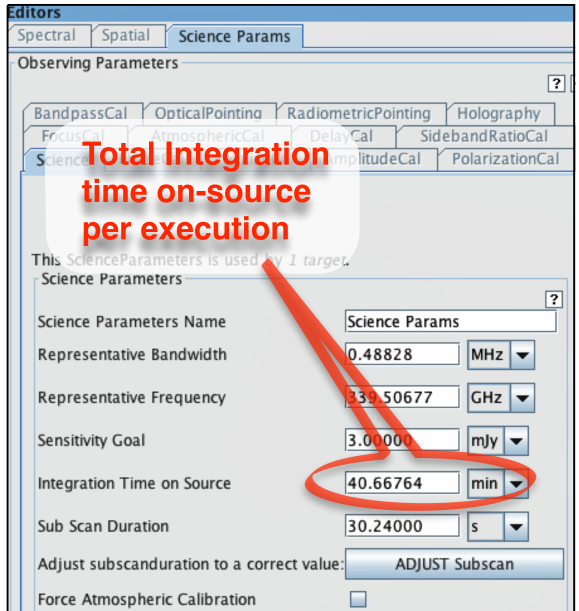

Figure 12: The Science Observing Parameter resource shows, among other things, the total integration time on source per execution of the SB.

Note that if more than one array configuration is required for your SG (e.g. a second, more compact 12m-Array configuration, and/or the ACA, etc.), then the integration time for the more compact configuration(s) will be governed by the required integration time for the most extended configuration (i.e. the SB with the '_TE' at the end of its name). For Cycle 3, the integration time for the compact 12m-Array configurations ('_TC') will have half the total integration time on source as the extended configuration SB ('_TE'); the 7m-Array and TP-Array SBs have a more complicated formula for determining the total integration time.

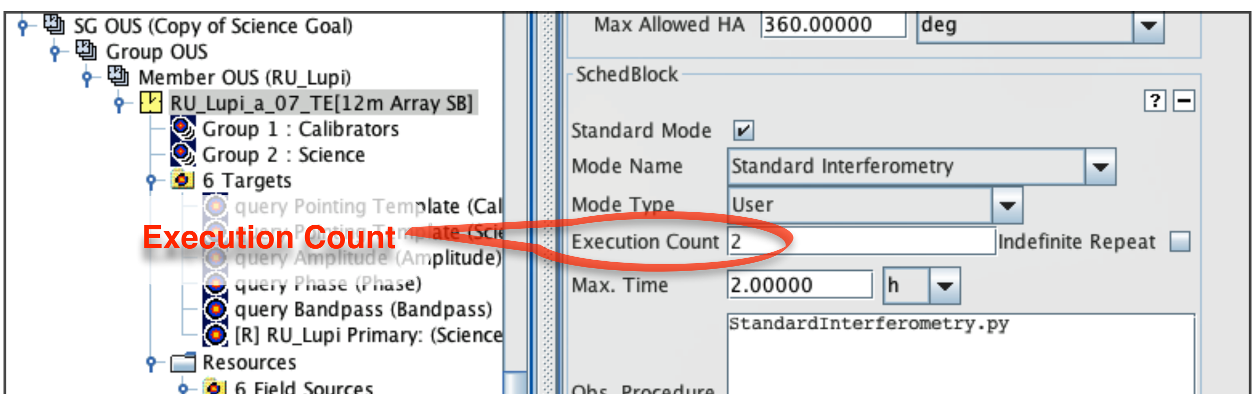

Figure 13: Click on the SB name (yellow clock icon) and scroll down the Editor window to find the Execution Count. The total time on source will be the Integration Time on Source (Figure 12) multiplied by the Execution Count.

Array Configuration

Currently the ALMA observing software uses the values of angular resolution and LAS stored in the *Control and Performance* section of the SG to determine which array configurations are suitable for observing your SBs. To confirm which array configurations are likely to be used for your SBs, consult with your Contact Scientist through the ALMA Helpdesk.

Other Considerations

For other observing constraints, such as time constraints, observing cadences, 7m-Array and TP-array setups, etc., consult with your Contact Scientist through the ALMA Helpdesk.

What Next

Once you've checked your SBs you will need to communicate with your Contact Scientist whether:

a) everything is fine and you approve the SBs as-is; or

b) you've encountered a problem, e.g. source position error, wrong bandwidth in a spectral window, etc.

Everything is Fine

You've checked everything in your SBs and there are no errors or inconsistencies. You will still need to communicate with your Contact Scientist using the ALMA Helpdesk that you approve your SBs. The CS will then have the SBs marked as *Ready to Observe* in the Project Tracker (PT). You can check the status of your SBs using the PT, which you'll find on the ALMA Science Portal (almascience.org) under the Observing menu. You can also enable the PT to send you notices automatically whenever the status of your SBs changes (e.g. when observations are taken).

Problem in the SBs

If you've found any errors in the source positions, velocity, correlator settings, etc., or if you have better information on these parameters than you had when you first submitted the proposal, then you should communicate these to your Contact Scientist through the Helpdesk. Small corrections or updates to source positions or velocities may be considered as "minor" changes, and if agreed by the CS, may be applied to the SBs. Once the changes have been made, you should again check your SBs and let your CS know whether or not you approve them

Significant changes to source positions, velocities or correlator settings, or changes which would result in an increase in observing time, may be classed as "major" changes, and your CS will let you know if this is the case. Major change requests must be submitted through the Helpdesk and are reviewed by a committee at the JAO with a final decision by the ALMA Director. While the request is being processed, all observations for your project are suspended until a decision is made. Major changes are approved only in very exceptional cases. See the *ALMA Proposer's Guide*, Appendix D.2 for an explanation of the policy on changes to submitted projects.

Appendix A - Acronyms used

ACA - Compact array, including 7m Array and TP Array
ALMA - Atacama Large Millimeter/Submillimeter Array
BB - baseband
CS - Contact Scientist
FDM - correlator spectral mode
JAO - Joint ALMA Observatory
LAS - Largest Angular Structure
OT - ALMA Observing Tool
PT - Project Tracker
SG - Science Goal
SB - Scheduling Block
spw - spectral window
TDM - correlator continuum mode
TP Array - total power array, part of ACA

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

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