An Introduction to the ALMA Observing Tool

How to turn that great idea into an ALMA proposal...

Sixteenth Synthesis Imaging Workshop

16-23 May 2018

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How to turn that great idea into an ALMA proposal...

Rachel Friesen

With thanks to Arielle Moullet & Harvey Liszt

What is ALMA?

- A global partnership to deliver a revolutionary millimeter/submillimeter telescope array by North America, Europe, East Asia, in collaboration with Chile
- 66 reconfigurable, high precision antennas
- λ ~ 0.32 – 8.5mm
- Array configurations between 150 meters and >16 kilometers:
  - Main Array: 50 x 12m antennas
  - Total Power Array: 4 x 12m antennas
  - Atacama Compact Array (ACA): 12 x 7m antennas
  - TP + ACA (Morita Array)
- Array Operations Site is located at 5000m elevation in the Chilean Andes
- Provides unprecedented imaging* & spectroscopic capabilities at mm/submm λ

ALMA in a Nutshell...

- Angular resolution down to 0.015” (at 300 GHz)
- Sensitive, precision imaging 84 to 950 GHz (3 mm to 320 μm)
- State-of-the-art low-noise, wide-band receivers* (8 GHz bandwidth)
- Flexible correlator with high spectral resolution at wide bandwidth
- Full polarization capabilities including circular.
- Estimated 1 TB/day data rate
- All science data archived
- Pipeline processing

ALMA Current Status

- Construction Project ended in September 2014
- Science observing has been out to > **16 km baselines (C43-10)** thanks to the highly successful Long Baseline Campaigns in 2014 and 2015
- **All 66 antennas accepted**
  - Currently all 66 antennas are at the high site (AOS), of which ~47 on average (up to max ~54) are being used for Cycle 5 observations
  - Some construction and verification items remain to be finished (e.g., wide-field polarization; various observing modes)
- The ACA (Atacama Compact Array) or Morita Array – up to 12x7m antennas and 4x12m antennas for TP observations
  - currently being used for Cycle 5 observations

ALMA Capabilities

The Cycle 6 capabilities are fully described in Appendix A of the ALMA Proposers Guide available at:

https://almascience.nrao.edu/documents-and-tools

In summary:

- **Number of antennas**
  - At least forty-three (43) antennas in the 12-m Array
  - At least ten (10) 7-m antennas (for short baselines) and three (3) 12-m antennas (for making single-dish maps) in the ACA
- **Receiver bands**
  - Receiver Bands 3, 4, 5, 6, 7, 8, 9, and 10 (wavelengths of about 3.1, 2.1, 1.6, 1.3, 0.87, 0.74, 0.44, and 0.35 mm, respectively)
- **12-m Array Configurations**
  - Maximum baselines for the antenna configurations between 0.15 km and 16 km
  - Maximum baselines of 3.6 km for Bands 8, 9 and 10
  - Maximum baselines of 8.5 km for Band 7
  - Maximum baselines of 16 km for Bands 3, 4, 5 and 6

ALMA Capabilities

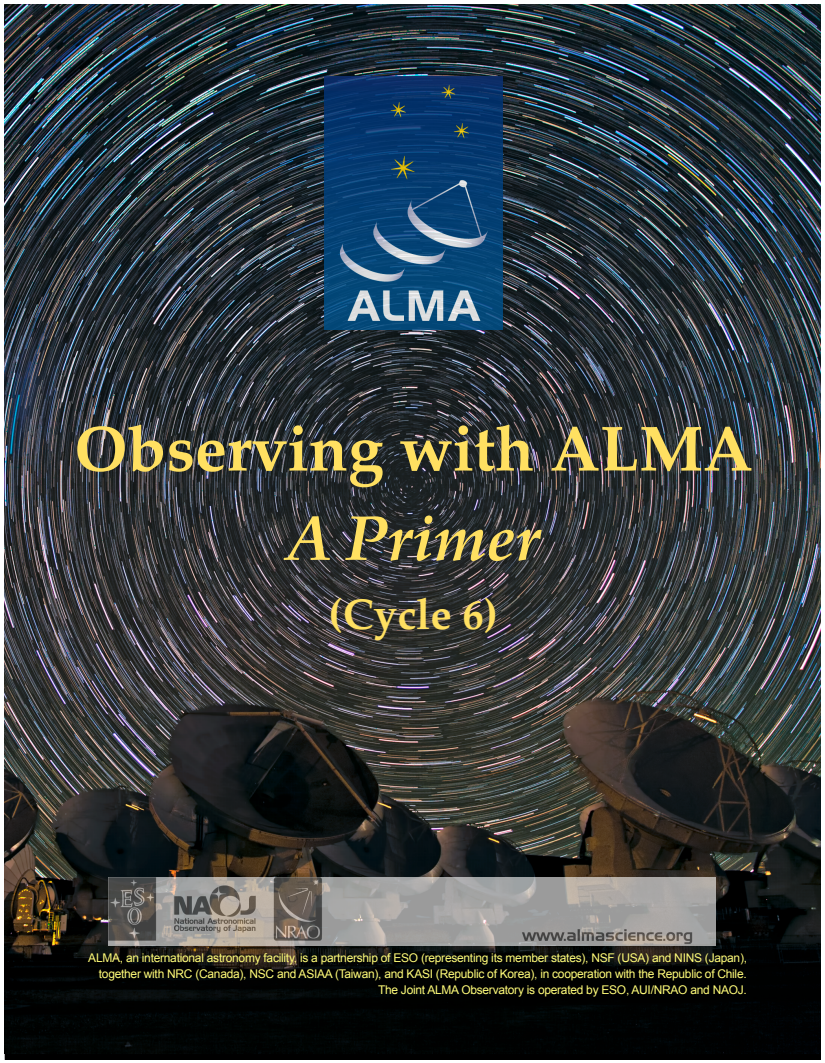
- **Spectral line, continuum, and mosaic observations**
  - Spectral line and continuum observations with the 12-m Array and the 7-m Array in all bands
  - Single field interferometry (all bands) and mosaics (Bands 3 to 9) with the 12-m Array and the 7-m Array
  - Single-dish spectral line observations in Bands 3 to 8
- **Polarization**
  - Single pointing, on axis, full (including circular) polarization for both continuum and full-spectral-resolution observations in Band 3, 4, 5, 6, and 7 are offered on the 12-m Array. (min polarization percentage of 1.8% of the peak flux for circular polarization; only for sources that are on-axis with an angular size less than 10% of the FWHM primary beam).
- **Observing Time:**
  - 4000 hours for successful proposals of PI programs expected on the 12m Array (includes DDT, Cycle 4 Carryover and resubmissions)
  - 3000 hours available on the ACA
  - 3000 hours available on the Total Power Array

Proposal Checklist

- Read relevant documentation (CfP Guide, Primer, etc.)
- Create an ALMA account by registering at the Science Portal (almascience.org)
- Download the Observing Tool (OT) & related guides
- Prepare the Science Case
  - Note the new capabilities for the current cycle!
- Prepare Science Goals (sources, frequency & correlator setup, integration times) within the OT
- Make use of the Helpdesk & the Knowledgebase

Cycle 6 Documentation & Timeline

- Call for Proposals
- Proposer's Guide
- ALMA Primer
- OT Guide
- ALMA Tech Handbook
- Timeline for Cycle 6
  - ~~Mar. 20 – Call for Proposals~~
  - ~~Apr. 19 – Proposal Deadline~~
  - End July – Results to PIs
  - Aug. 2018 – PIs submit SBs
  - Oct. 2018 – Start of Cycle 6
  - Sept. 2019 – End of Cycle 6



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- Source(s):
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- Spectral configuration:
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  - frequency: which band?
- Are you doing polarization?
  - what is the expected polarization fraction?
- Sensitivity:
  - what rms do you need to achieve your science goals?
  - over what bandwidth? i.e., 3 km/s, or 1.875 GHz, etc.

ALMA configuration schedule

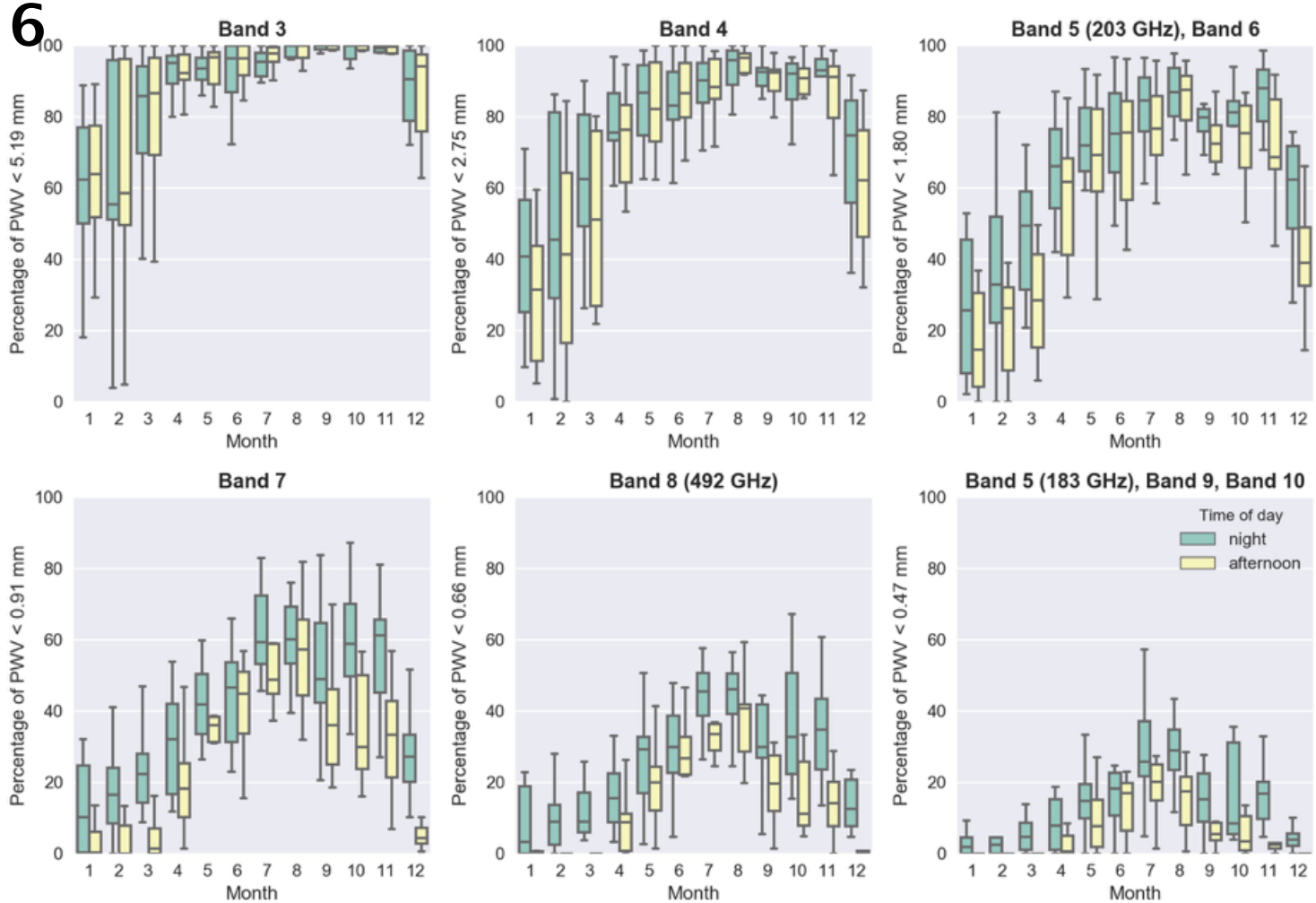
- The configuration schedule may determine when an object will be observed
- In Cycle 6, for example:
  - C43-1,2 January, March
  - C43-3,4 December, April
  - C43-5 October only
  - C43-8..10 June, July
- Some combinations of object + configuration may not be available for night-time observing

Table 1: Cycle 6 configuration schedule

Start date	Configuration	Longest baseline	LST for best observing conditions
2018 October 1	C43-6	2.5 km	~ 22h – 10h
2018 October 15	C43-5	1.4 km	~ 0h – 12h
2018 November 25	C43-4	0.78 km	~ 2h – 14h
2018 December 15	C43-3	0.50 km	~ 4h – 15h
2019 January 5	C43-2	0.31 km	~ 5h – 16h
2019 January 20	C43-1	0.16 km	~ 6h – 17h
2019 February 1-28	*No observations due to February shutdown*		
2019 March 1	C43-1	0.16 km	~ 8h – 21h
2019 March 15	C43-2	0.31 km	~ 8h – 22h
2019 April 1	C43-3	0.50 km	~ 9h – 23h
2019 April 15	C43-4	0.78 km	~ 10h – 0h
2019 May 1	*No observations due to major antenna relocation*		
2019 June 1	C43-10	16.2 km	~ 13h – 3h
2019 June 20	C43-9	13.9 km	~ 14h – 5h
2019 July 10	C43-8	8.5 km	~ 16h – 6h
2019 August 1	C43-7	3.6 km	~ 18h – 8h
2019 September 5	C43-6	2.5 km	~ 20h – 9h

ALMA Observing Strategies

Cycle 6



- Box and whisker plots of the percentage of time that the precipitable water vapor (PWV) is less than the thresholds adopted for the various ALMA bands versus the month of the year. Results are shown for both night time (green) and mid-afternoon (yellow), and assume a source elevation of 60 degrees. The horizontal line within a box indicates the median, the boundaries of a box indicate the 25th- and 75th -percentile of the distribution, and the whiskers indicate the highest and lowest values of the distribution. The PWV measurements were obtained by the APEX weather stations between 2007 and 2017.

Before you start the OT...

From your science case:

- Source(s):
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  - what angular resolution do you need?

On to the Observing Tool!

- Spectral configuration:
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Downloading the ALMA OT

https://almascience.nrao.edu

Atacama Large Millimeter/submillimeter Array
In search of our Cosmic Origins

Log in

About | Science | Proposing | Observing | Data | Processing | Tools | Documentation | Help

Search Site

Observing Tool

The ALMA Observing Tool (OT) is a Java application used for the preparation and submission of ALMA Phase 1 (observing proposal) and Phase 2 (telescope runfiles for accepted proposals) materials. It is also used for preparing and submitting Director's Discretionary Time (DDT) proposals. The current *Cycle 6* release of the OT is configured for the present capabilities of ALMA as described in the Cycle 6 Call For Proposals. Note that in order to submit proposals you will have to register with the ALMA Science Portal beforehand.

Note that preparation of Cycle 5 DDT proposals needs to be done using the Cycle 5 version of the Observing Tool. This version of the OT can be found in the DDT page, or the Phase 2 menu.

Download & Installation

The OT will run on most common operating systems, as long as a **64-bit version of Java 8** is installed (see the troubleshooting page if you are experiencing Java problems). The ALMA OT is available in two flavours: Web Start and tarball.

The **Web Start** application is the recommended way of using the OT. It has the advantage that the OT is automatically downloaded and installed on your computer and it will also automatically detect and install updates. There are some issues with Web Start, particularly that it does not work with the Open JDK versions of Java such as the "Iced Tea" flavour common on many modern Linux installations. The Oracle variant of Java should therefore be installed instead. If this is not possible, then the tarball installation of the OT is available.

The **tarball** version must be installed manually and will not automatically update itself, however there should be no installation issues. For Linux users, we also provide a download complete with a recommended version of the Java Runtime Environment. Please use this if you have any problems running the OT tarball with your default Java.

Webstart | Tarball

Using webstart is easier and has the advantage that it checks for and will download a newer version at startup

Documentation

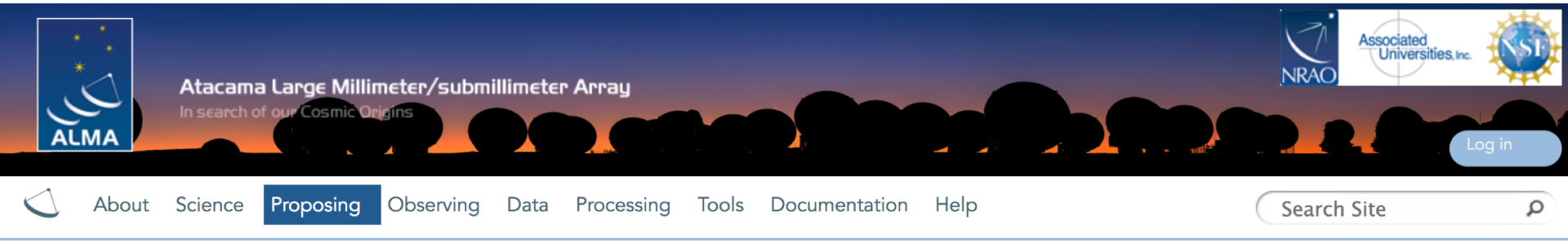
Extensive documentation is available to help you

- If you are a novice OT user you should start w
- Audio-visual illustrations of different aspects of the OT can be found in the **OT video tutorials**. These are recommended for novices and advanced users alike.
- More in-depth information on the OT can be found in the **User Manual**, while concise explanations of all fields and menu items in the OT are given in the **Reference Manual**. These two documents are also available within the OT under the Help menu.

Troubleshooting

If you have problems with the installation and/or startup of the OT, please see the troubleshooting page. A list of currently known bugs, their status and possible workarounds can be found on the regularly updated **known OT Issues** page. A further source of information is the OT section of the ALMA Helpdesk Knowledgebase - this contains a number of articles that deal with frequently-asked questions. After exploring these resources, if confusion over some aspect of the OT remains, or if a previously unidentified bug has been uncovered, please file a Helpdesk ticket.

OT Video Tutorials



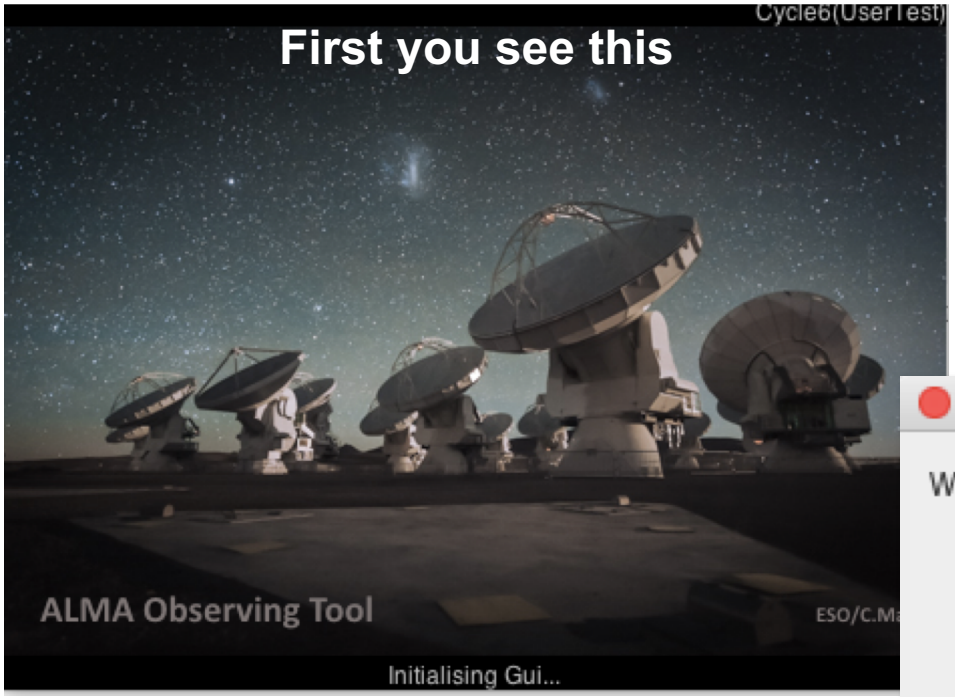
OT Video Tutorials

The OT video tutorials provide an audio-visual demonstration of different aspects of proposal preparation in the OT. Novice users should start with the first video and work their way down, while more experienced users may want to jump straight to one of the specialised videos.

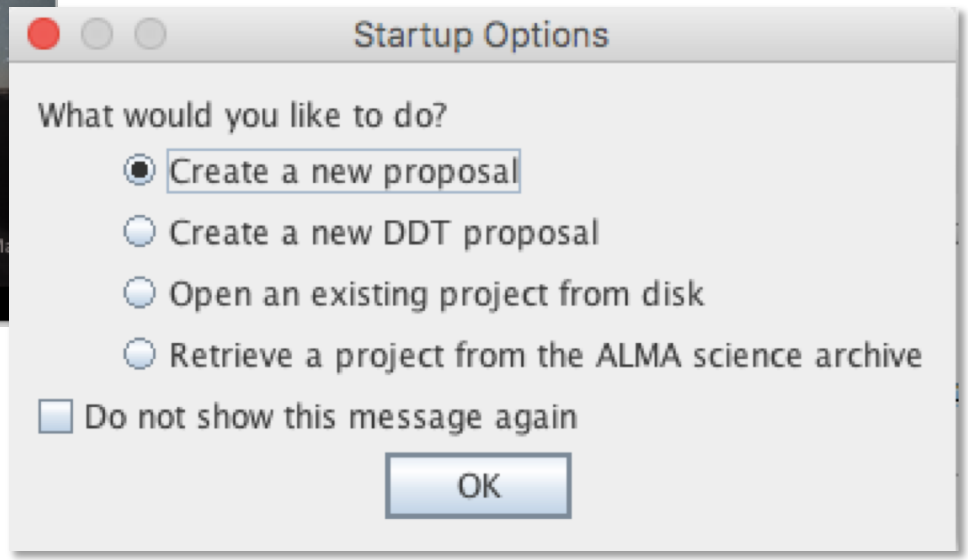
OT Video Tutorial 1: Useful to Know

This video will help you get started with the OT and introduce you to some handy tips and tricks. Topics covered include navigating the OT, using the help function, the template library, time estimation, validation, opening & submitting projects including re-submissions, and the concept of non-standard modes. **Note**: this video is from Cycle 4, some things have changed slightly in Cycle 5. In particular, time constraints can now also include simultaneous 12-m and 7-m observations, and re-submissions are no longer defined by the user. Also, the time estimate interface has changed a bit.

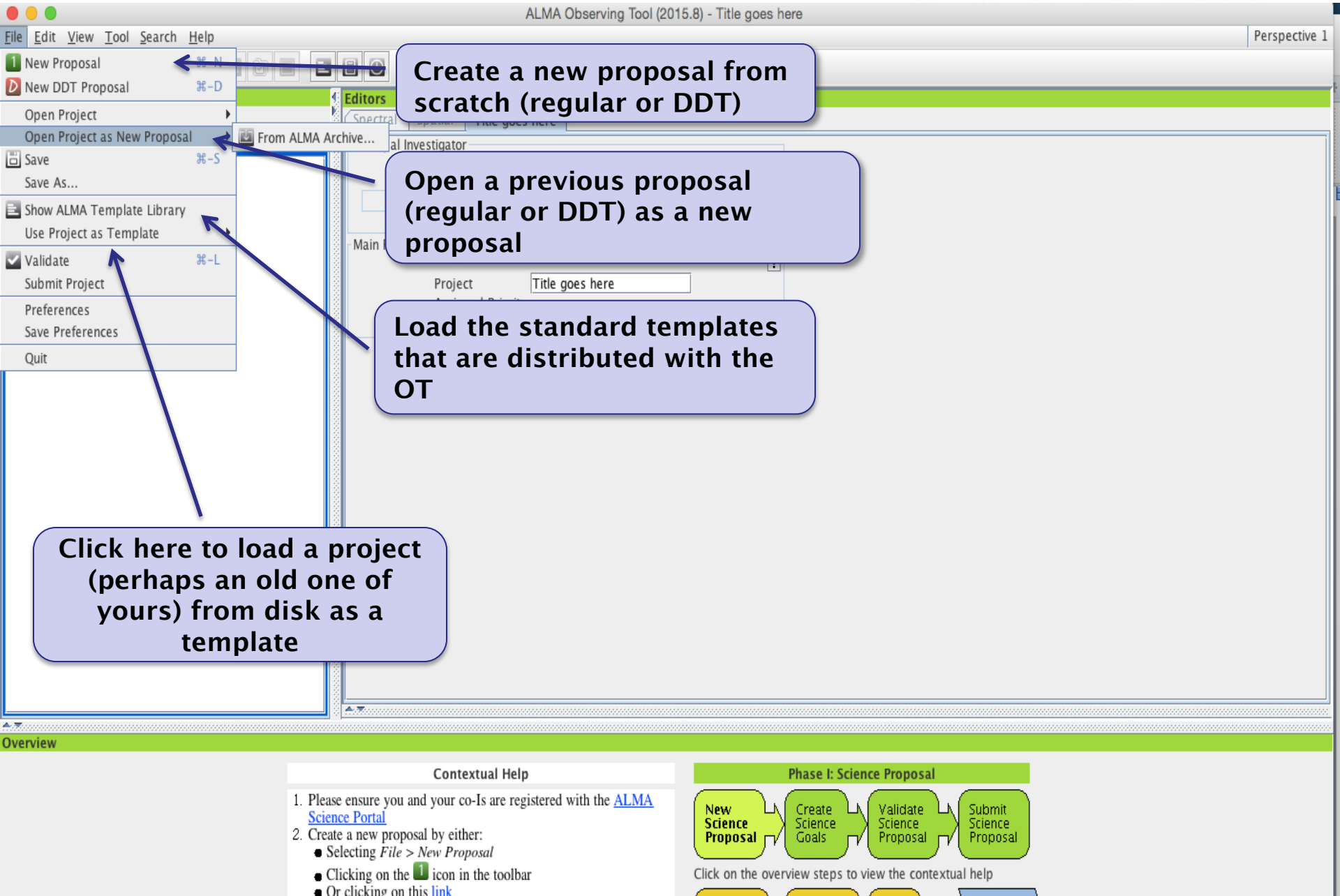
When the ALMA OT starts



Then you see this



Creating a new proposal



Proposal front page

ALMA Observing Tool (Cycle5(Phase2)u2) - Your snazzy title

File Edit View Tool Search Help

Perspective 1

Project Structure

Proposal | Program

Unsubmitted Proposal

- Your snazzy title
  - Proposal

Editors

Spectral | Spatial | Proposal

Proposal Information

Proposal Title: Your snazzy title

Proposal Cycle: 2017.1

Abstract (max. 1200 characters): Not too abstract, please!

Proposal Type

- (•) Regular
- ( ) Target Of Opportunity
- ( ) VLBI
- ( ) Large Program

Scientific Category

- (•) 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

Keywords (max. 2 keywords)

- Lyman Alpha Emitters/Blobs (LAE/LAB)
- Lyman Break Galaxies (LBG)
- Starburst galaxies
- Sub-mm Galaxies (SMG)
- High-z Active Galactic Nuclei (AGN)

Student project: [ ]

Related Proposals:

Previous Proposals:

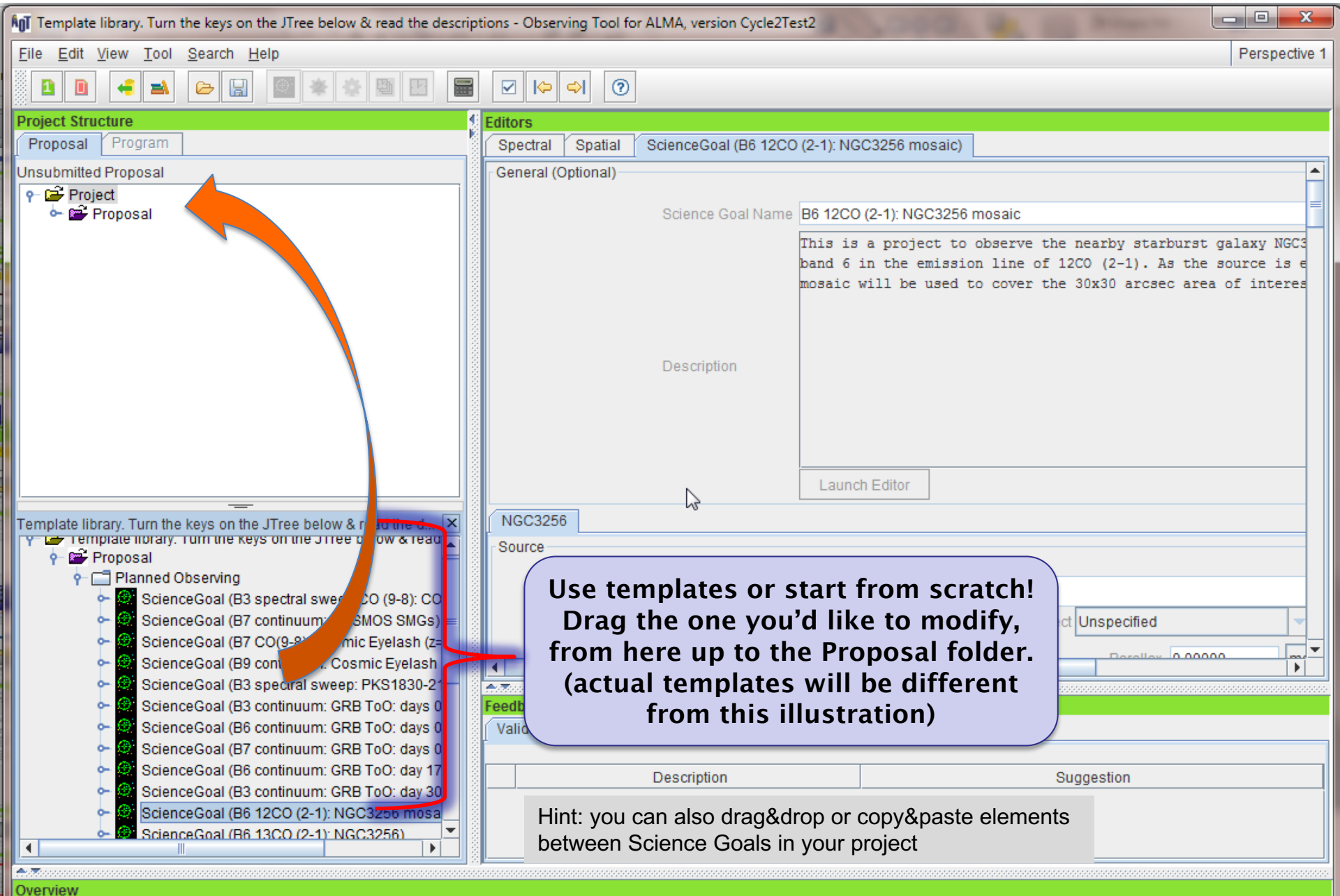
Investigators

Feedback

Validation | Validation History | Log

Description	Suggestion

Next: Add science goals



Use templates or start from scratch! Drag the one you'd like to modify, from here up to the Proposal folder. (actual templates will be different from this illustration)

Hint: you can also drag&drop or copy&paste elements between Science Goals in your project

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- Sensitivity:
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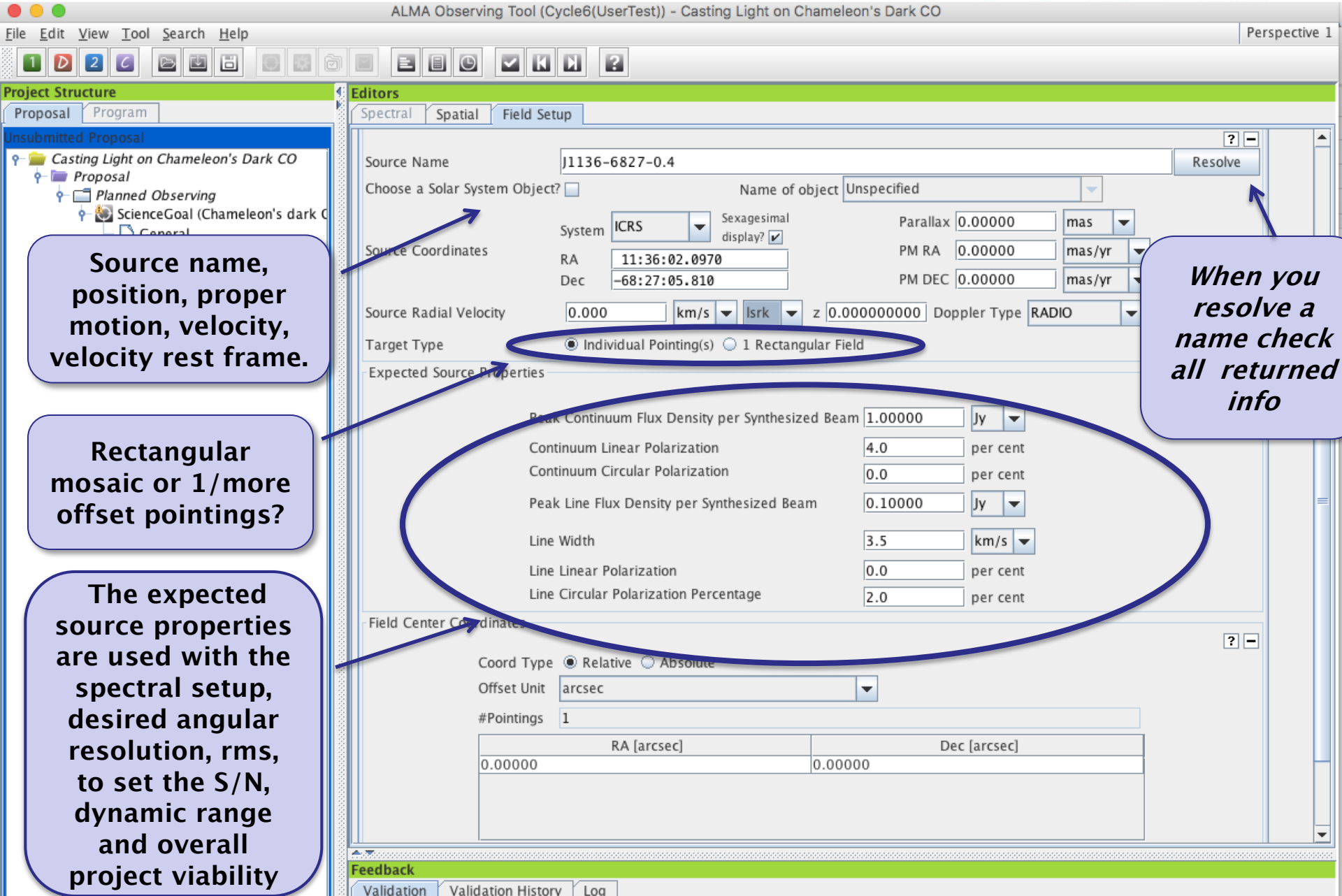
Set your targets: Field Setup



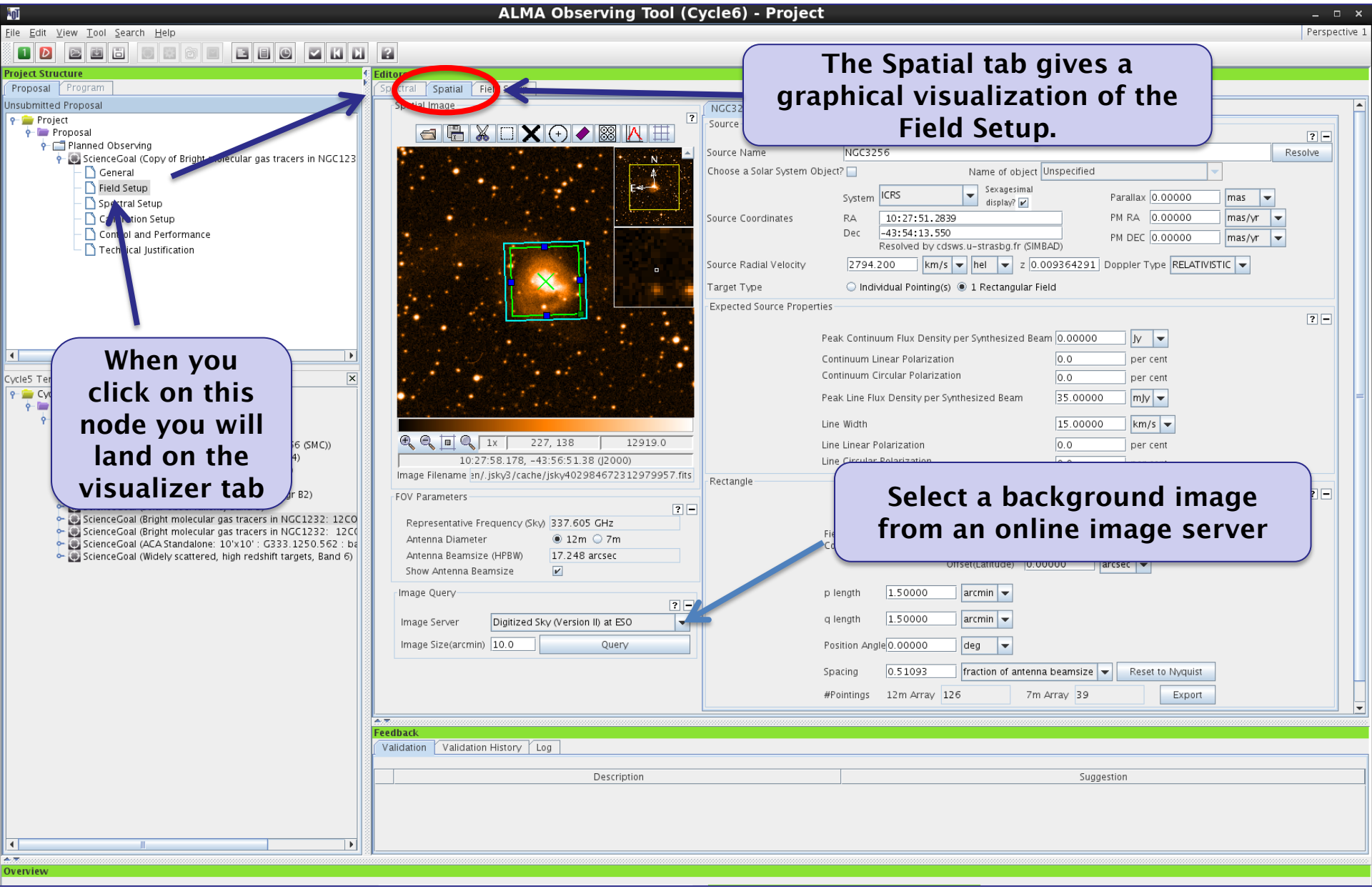
Source name, position, proper motion, velocity, velocity rest frame.

Rectangular mosaic or 1/more offset pointings?

The expected source properties are used with the spectral setup, desired angular resolution, rms, to set the S/N, dynamic range and overall project viability

When you resolve a name check all returned info

Set your targets: Mosaics



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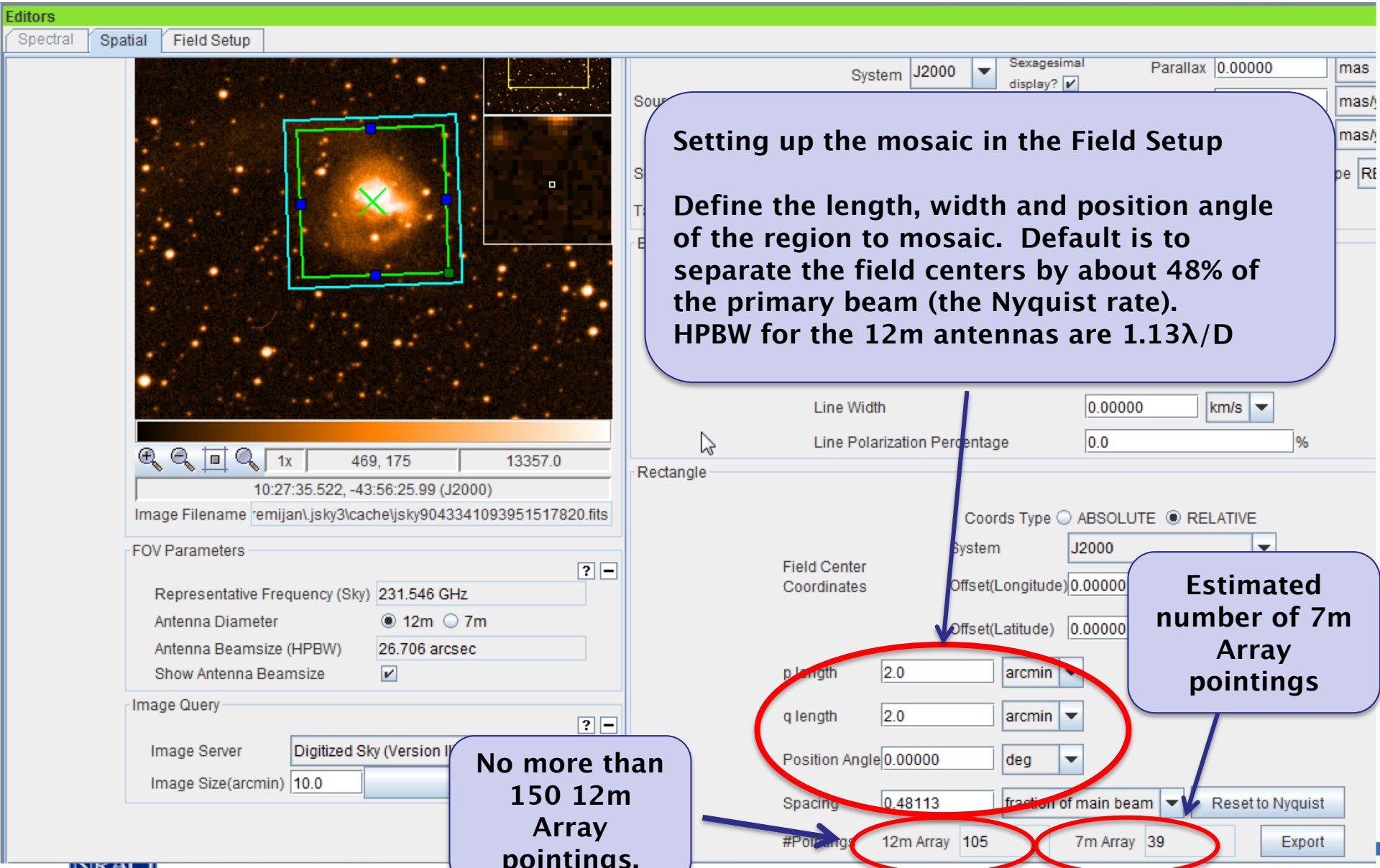

Setting up the mosaic in the Field Setup

Define the length, width and position angle of the region to mosaic. Default is to separate the field centers by about 48% of the primary beam (the Nyquist rate). HPBW for the 12m antennas are 1.13λ/D

Estimated number of 7m Array pointings

No more than 150 12m Array pointings.

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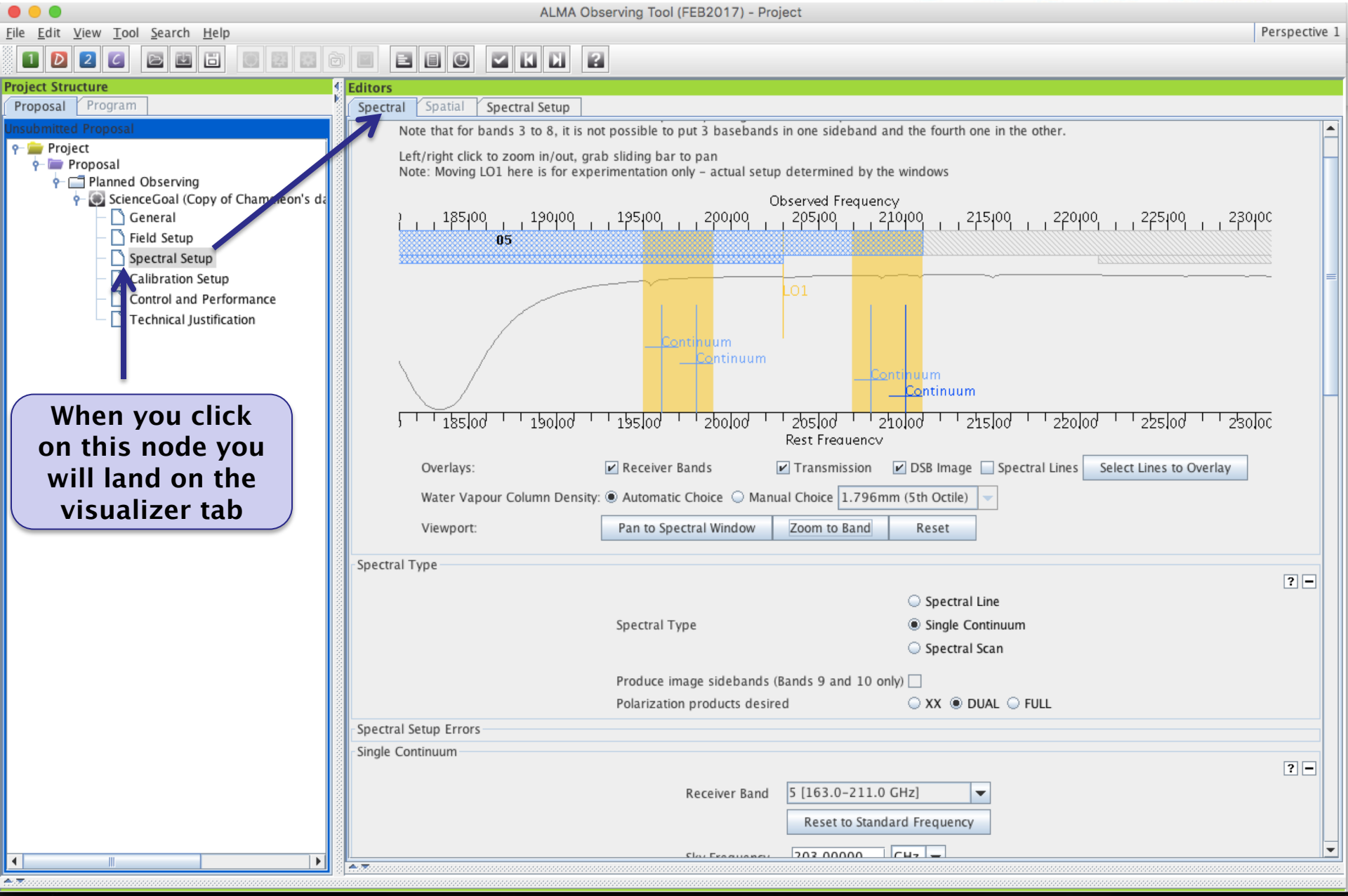
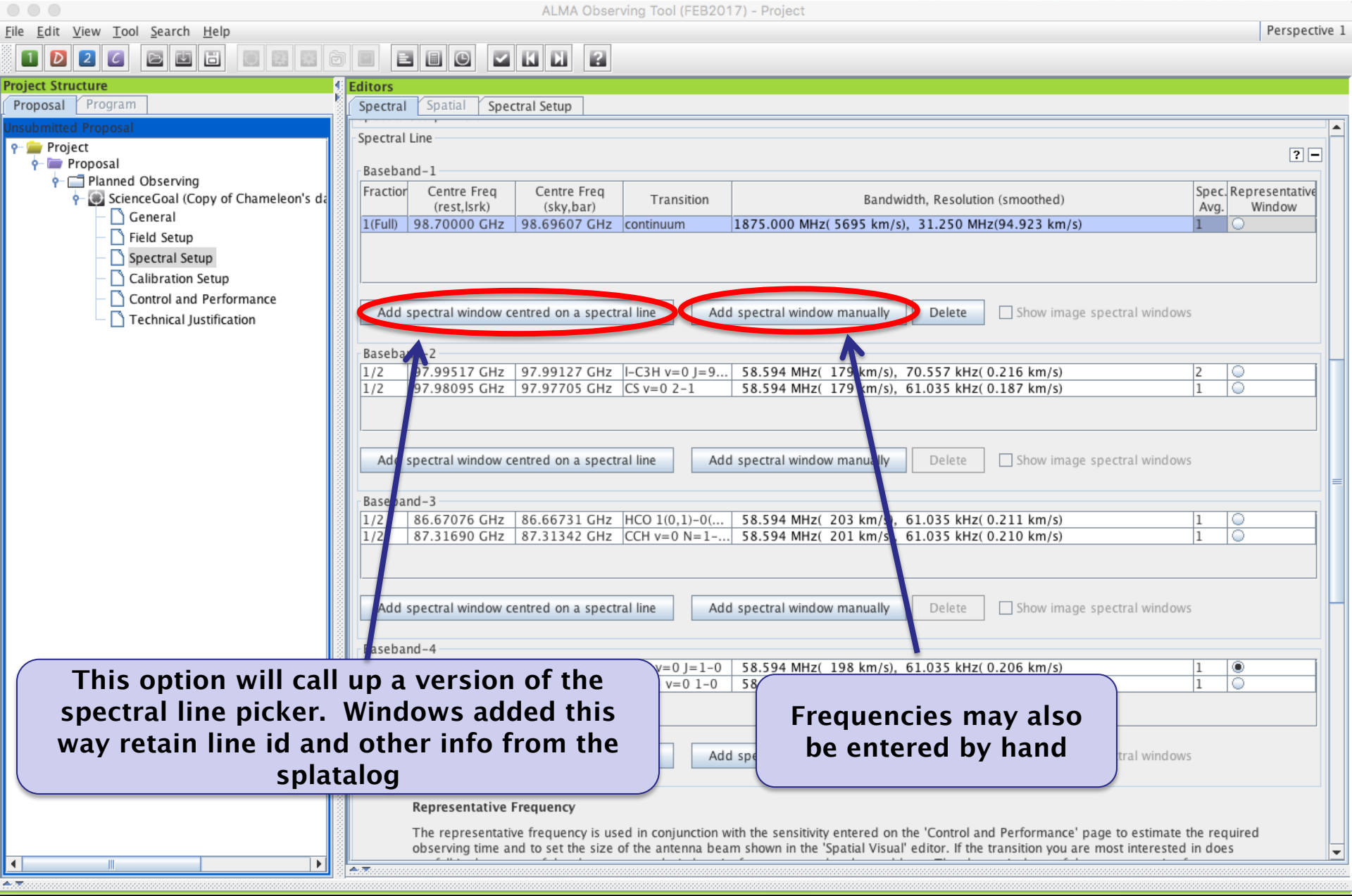
Spectral setup



When you click on this node you will land on the visualizer tab

Adding spectral windows



This option will call up a version of the spectral line picker. Windows added this way retain line id and other info from the splatalog

Frequencies may also be entered by hand

Using the spectral line catalog

Select Spectral Lines

Transition Filter

CO*

☑ Include description

Frequency Filters

ALMA Band

1 2 3 4 5 6 7 8 9 10

Sky Frequency (GHz)

Min 31.3 Max 950

Receiver/Back End Configuration

☐ Hide unobservable lines

Filtering unobservable lines

Maximum Upper-state Energy (K)

0 20 40 60 80 100 ∞

Molecule Filter / Environment

Show all atoms and molecules

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Find More...

Reset Filters

Transitions matching your filter settings:

(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of alread

Transition	Description	Rest Frequency	Sky Frequency	Upper-state Energy	Lovas Intensity	
CO v=2 1-0	Carbon Monoxide	113.172 GHz	113.172 GHz	6134.675 K		0.01
CO v=1 1-0	Carbon Monoxide	114.222 GHz	114.222 GHz	3089.154 K		0.01
CO v=0 1-0	Carbon Monoxide	115.271 GHz	115.271 GHz	5.532 K	60	0.01
CO v=2 2-1	Carbon Monoxide	226.34 GHz	226.34 GHz	6145.538 K		0.02
CO v=1 2-1	Carbon Monoxide	228.439 GHz	228.439 GHz	3100.118 K	0.62	0.02
CO v=0 2-1	Carbon Monoxide	230.538 GHz	230.538 GHz	16.596 K	70	0.02
CO+ J=2-1, F=3/2-1/2	Carbon Monoxide Ion	235.79 GHz	235.79 GHz		0.1	0.66
CO+ J=2-1, F=5/2-3/2	Carbon Monoxide Ion	236.063 GHz	236.063 GHz		0.1	1.21
CO v=2 3-2	Carbon Monoxide	339.5 GHz	339.5 GHz	6161.831 K		0.03
CO v=1 3-2		Hz	342.648 GHz	3116.561 K	0.71	0.03
CO v=0 3-2		Hz	345.796 GHz	33.192 K	70	0.03
CO+ J=3-2, F=5/2-3/2		Hz	353.741 GHz		0.1	1.21
CO+ J=3-2, F=7/2-5/2	Carbon Monoxide Ion	354.014 GHz	354.014 GHz		0.18	1.71
CO v=2 4-3	Carbon Monoxide	452.645 GHz	452.645 GHz	6183.555 K		0.04
CO v=1 4-3	Carbon Monoxide	456.843 GHz	456.843 GHz	3138.486 K		0.04
CO v=0 4-3	Carbon Monoxide	461.041 GHz	461.041 GHz	55.317 K	60	0.04
CO v=2 5-4	Carbon Monoxide	565.774 GHz	565.774 GHz	6210.707 K		0.06
CO v=1 5-4	Carbon Monoxide	571.021 GHz	571.021 GHz	3165.891 K		0.06
CO v=0 5-4	Carbon Monoxide	576.268 GHz	576.268 GHz	82.974 K		0.06
CO v			78.88 GHz	6243.288 K		0.07
CO v			85.176 GHz	3198.774 K		0.07
CO v			91.473 GHz	116.159 K	100	0.07
CO v			91.96 GHz	6281.296 K		0.08
CO v=1 7-6	Carbon Monoxide	799.306 GHz	799.306 GHz	3237.134 K		0.08
CO v=0 7-6	Carbon Monoxide	806.652 GHz	806.652 GHz	154.872 K	110	0.08
CO v=2 8-7	Carbon Monoxide	905.009 GHz	905.009 GHz	6324.729 K		0.09

Add to Selected Transitions

Selected transitions

Transition	Description	Rest Frequency	Sky Fre
CO v=0 2-1		230.538 GHz	230.538 GHz

Remove from Selected Transitions

Select a line from the list

Filters can be used to narrow the search

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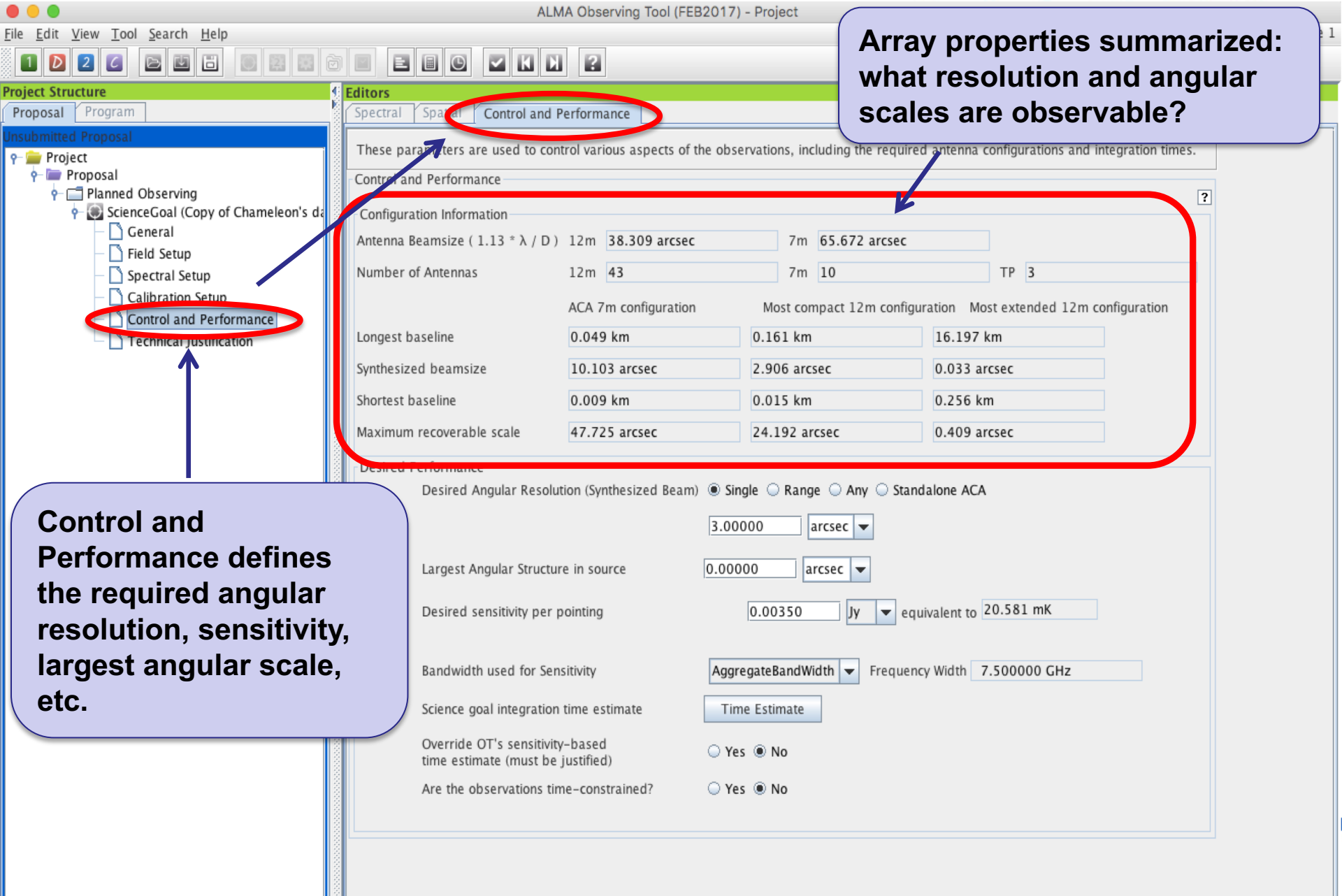
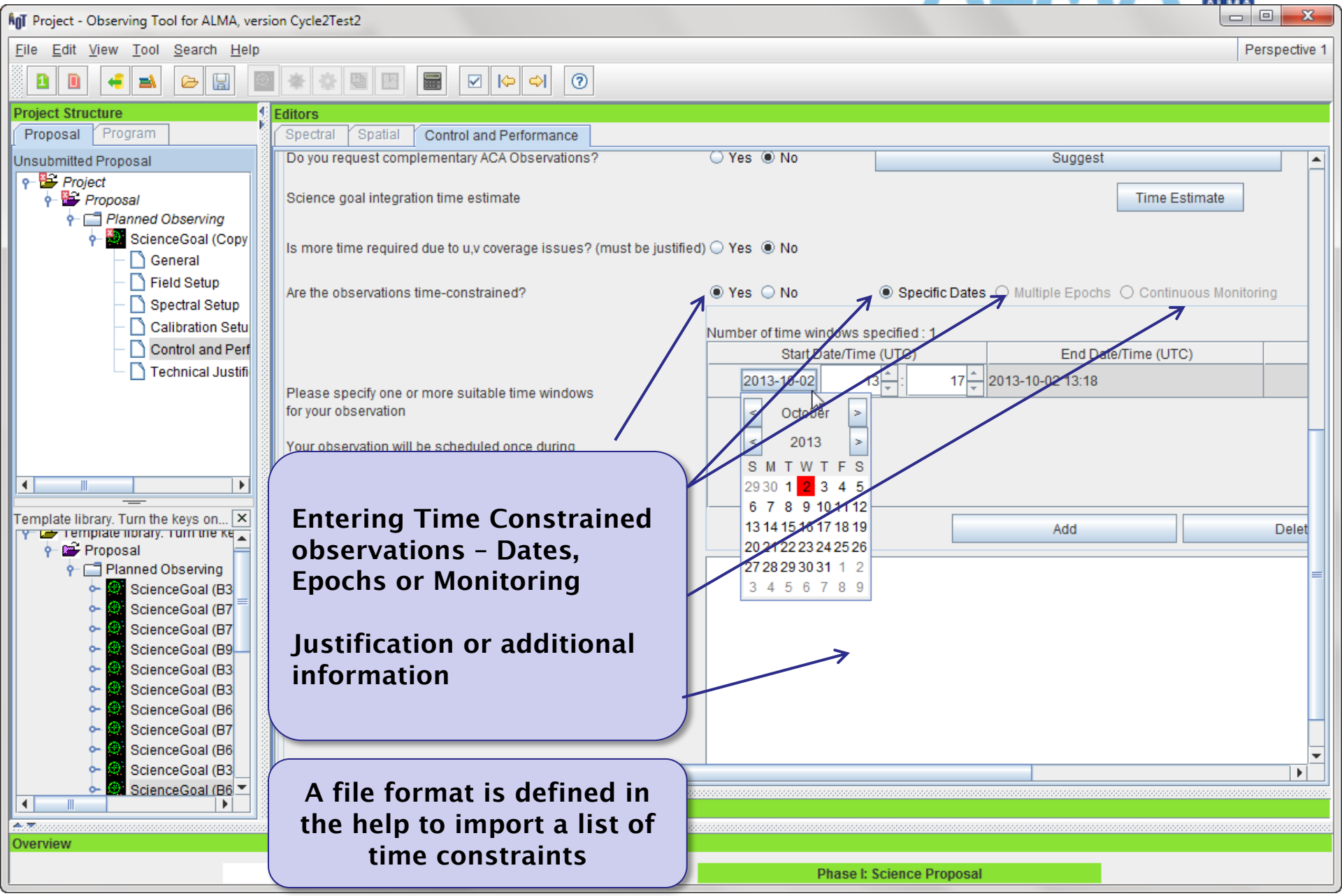
Control & Performance



Array properties summarized: what resolution and angular scales are observable?

Control and Performance defines the required angular resolution, sensitivity, largest angular scale, etc.

Time-constrained observing

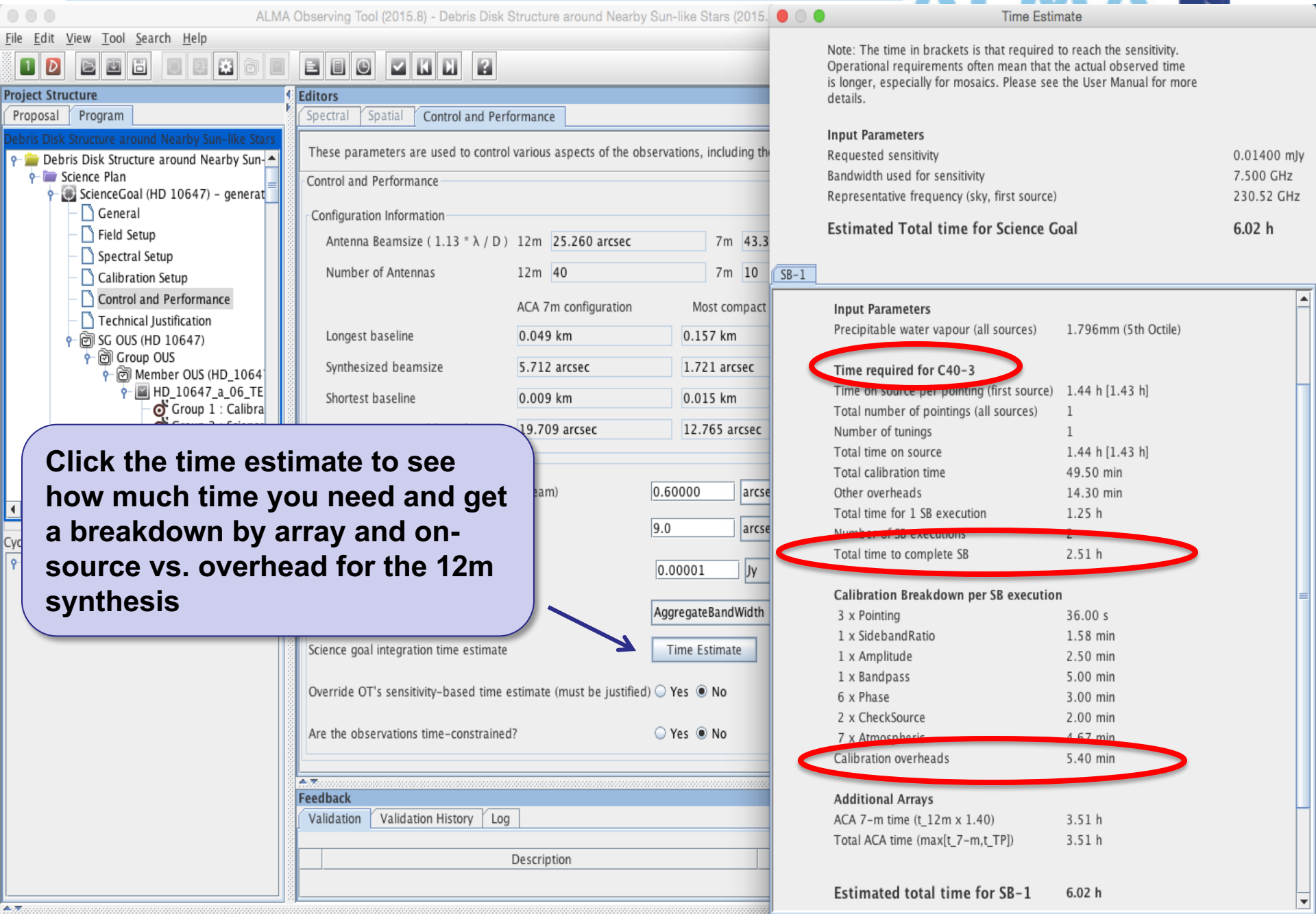


Entering Time Constrained observations – Dates, Epochs or Monitoring

Justification or additional information

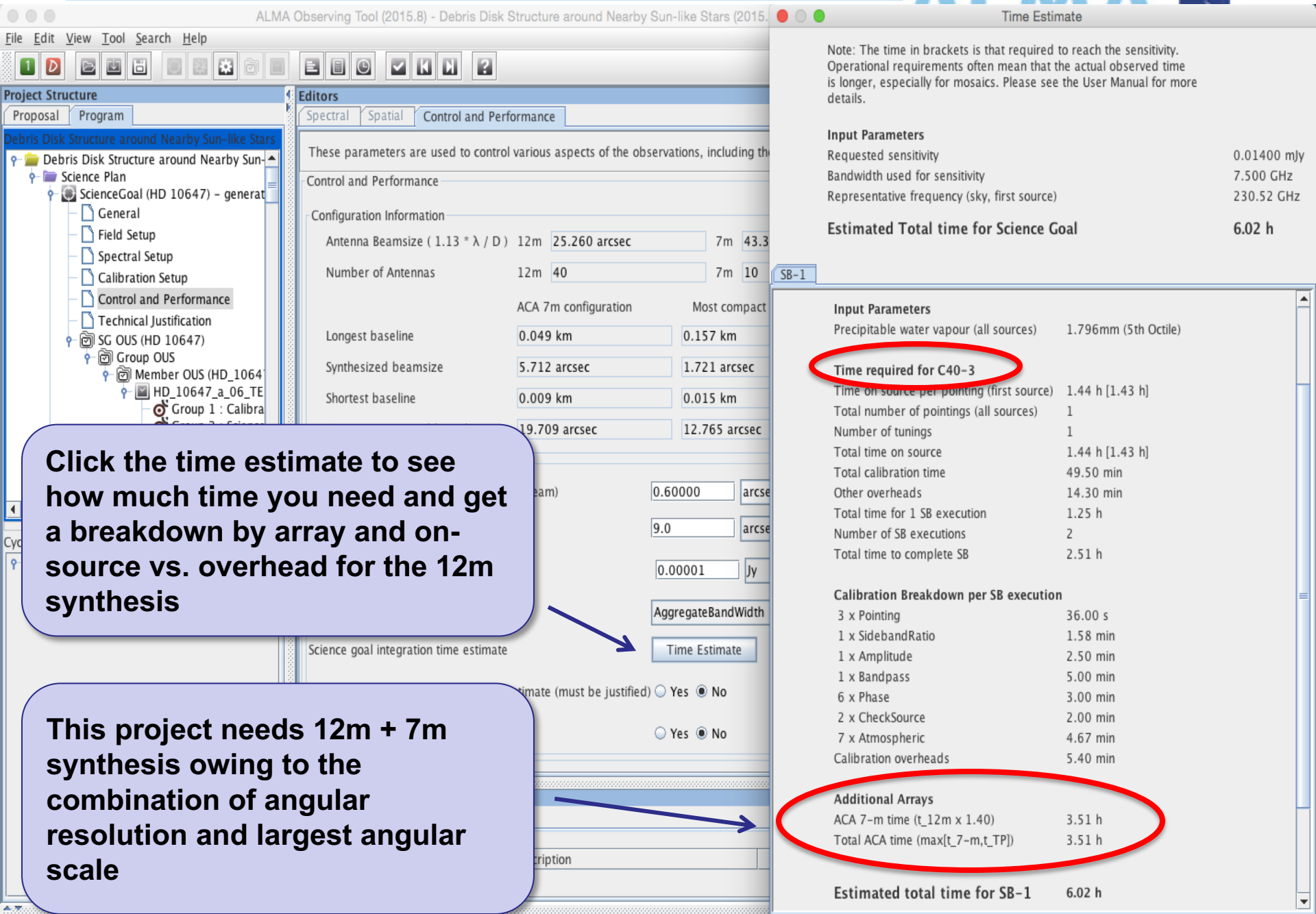
A file format is defined in the help to import a list of time constraints

Science Goal time estimates



Click the time estimate to see how much time you need and get a breakdown by array and on-source vs. overhead for the 12m synthesis

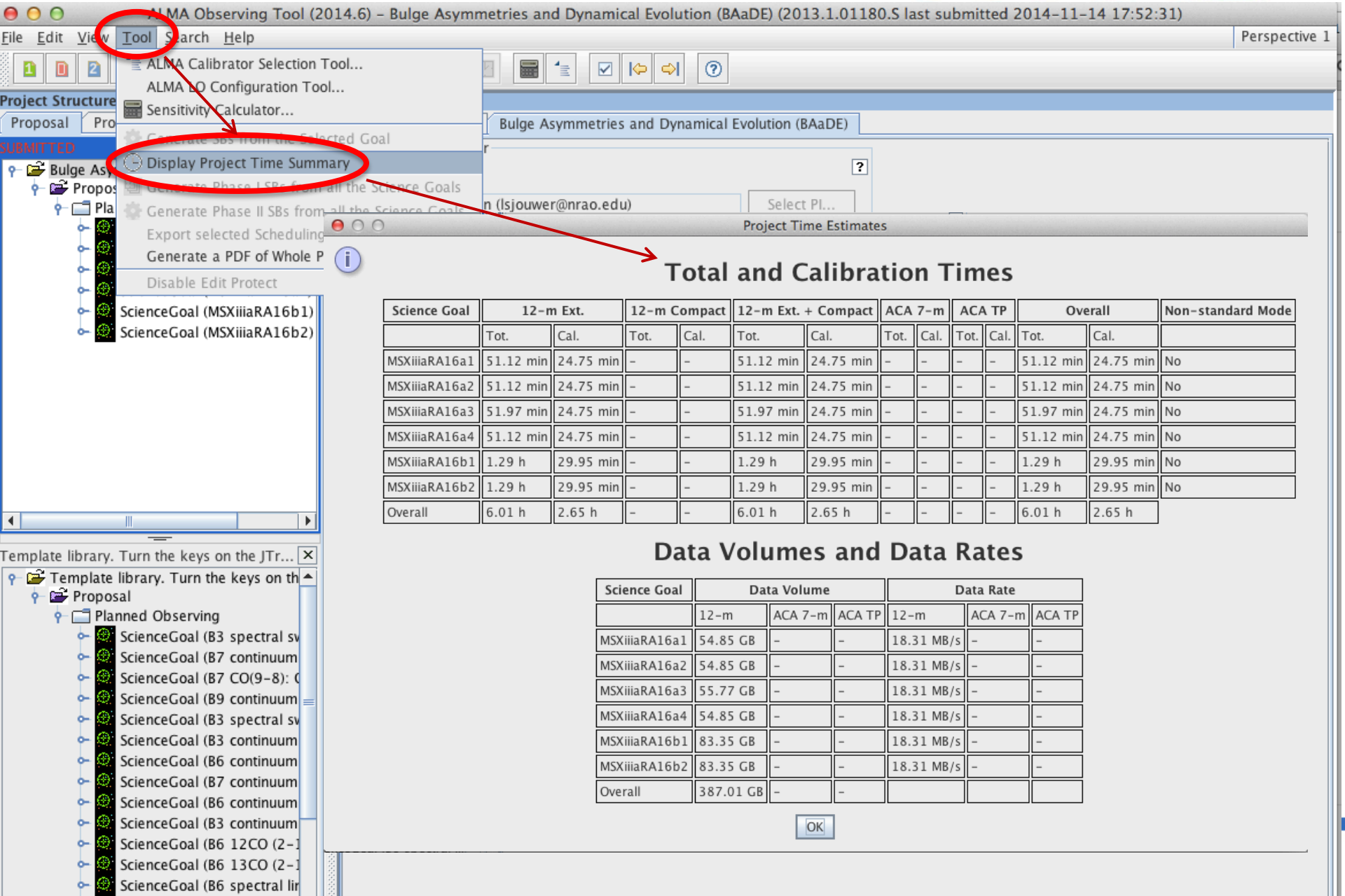
Science Goal time estimates



Click the time estimate to see how much time you need and get a breakdown by array and on-source vs. overhead for the 12m synthesis

This project needs 12m + 7m synthesis owing to the combination of angular resolution and largest angular scale

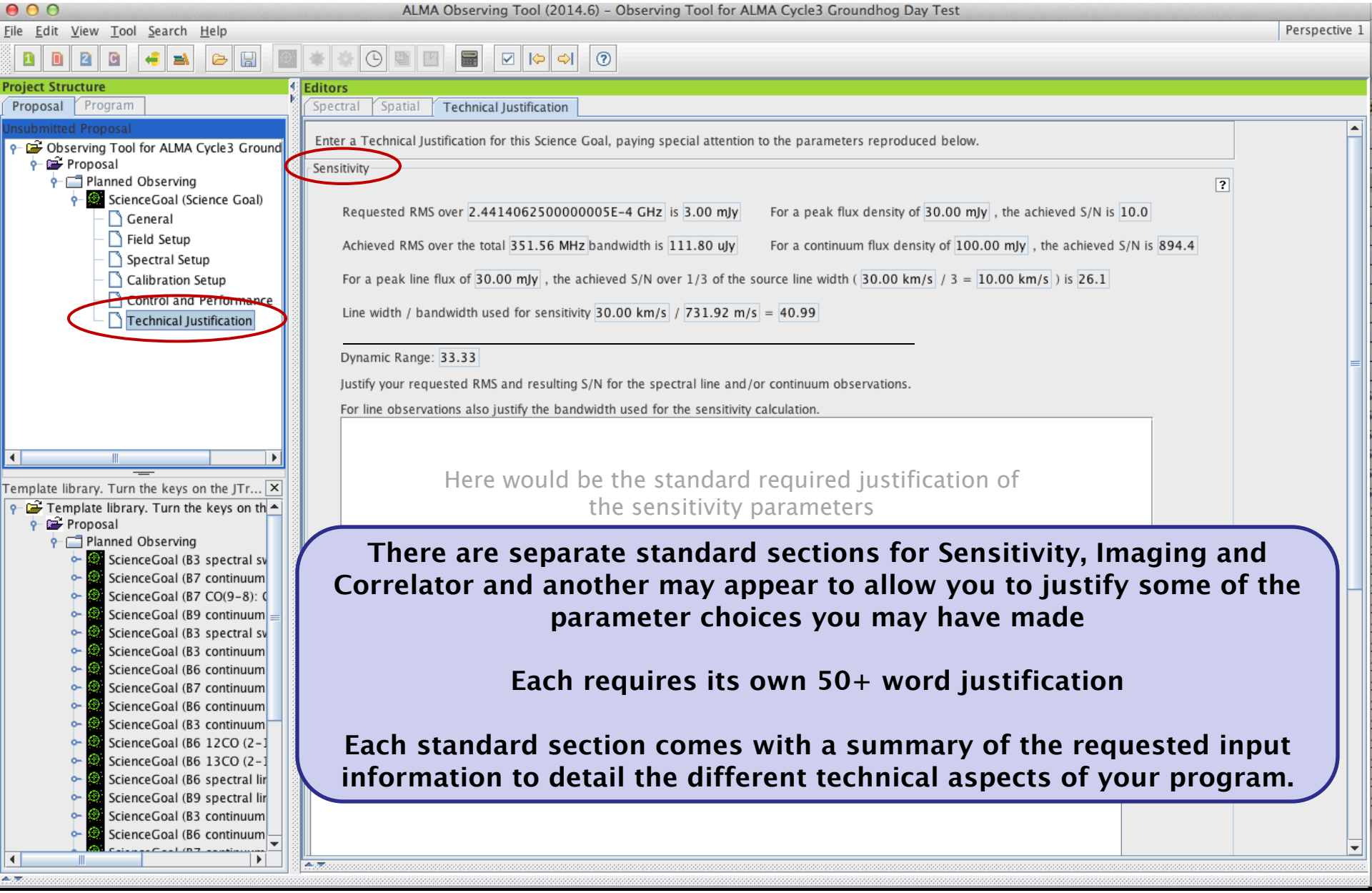
View the project time summary



Science Goal	12-m Ext.		12-m Compact		12-m Ext. + Compact		ACA 7-m		ACA TP		Overall		Non-standard Mode
	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	
MSXiiiaRA16a1	51.12 min	24.75 min	-	-	51.12 min	24.75 min	-	-	-	-	51.12 min	24.75 min	No
MSXiiiaRA16a2	51.12 min	24.75 min	-	-	51.12 min	24.75 min	-	-	-	-	51.12 min	24.75 min	No
MSXiiiaRA16a3	51.97 min	24.75 min	-	-	51.97 min	24.75 min	-	-	-	-	51.97 min	24.75 min	No
MSXiiiaRA16a4	51.12 min	24.75 min	-	-	51.12 min	24.75 min	-	-	-	-	51.12 min	24.75 min	No
MSXiiiaRA16b1	1.29 h	29.95 min	-	-	1.29 h	29.95 min	-	-	-	-	1.29 h	29.95 min	No
MSXiiiaRA16b2	1.29 h	29.95 min	-	-	1.29 h	29.95 min	-	-	-	-	1.29 h	29.95 min	No
Overall	6.01 h	2.65 h	-	-	6.01 h	2.65 h	-	-	-	-	6.01 h	2.65 h	

Science Goal	Data Volume			Data Rate		
	12-m	ACA 7-m	ACA TP	12-m	ACA 7-m	ACA TP
MSXiiiaRA16a1	54.85 GB	-	-	18.31 MB/s	-	-
MSXiiiaRA16a2	54.85 GB	-	-	18.31 MB/s	-	-
MSXiiiaRA16a3	55.77 GB	-	-	18.31 MB/s	-	-
MSXiiiaRA16a4	54.85 GB	-	-	18.31 MB/s	-	-
MSXiiiaRA16b1	83.35 GB	-	-	18.31 MB/s	-	-
MSXiiiaRA16b2	83.35 GB	-	-	18.31 MB/s	-	-
Overall	387.01 GB	-	-			

Technical justification



There are separate standard sections for Sensitivity, Imaging and Correlator and another may appear to allow you to justify some of the parameter choices you may have made

Each requires its own 50+ word justification

Each standard section comes with a summary of the requested input information to detail the different technical aspects of your program.

Ready? Validate & submit!

Note the spiffy new icons!

Click here to make sure that your project can be validated by the OT. If it doesn't validate the archive will reject it.

When you are satisfied that your proposal is complete, click here to submit your proposal to the archive.

Project - Observing Tool for ALMA, version Cycle2Test2

- New Proposal ⌘-N
- New DDT Proposal ⌘-D
- Open Project
- Open Project as New Proposal
- Save ⌘-S
- Save As...
- Show ALMA Template Library
- Use Project as Template
- Validate ⌘-L
- Submit Project
- Preferences
- Save Preferences
- Quit

Perspective 1

Editors: Spectral | Spatial | Project

Select PI...

Project
Assigned Priority
Project Code: None Assigned

Feedback

Suggestion

Overview

Contextual Help

1. Please ensure you and your co-Is are registered with the ALMA Science Portal
2. Create a new proposal by either:
   - Selecting *File > New Proposal*
   - Clicking on the icon in the toolbar
   - Or clicking on this link
3. Click on the proposal tree node and complete the relevant fields.

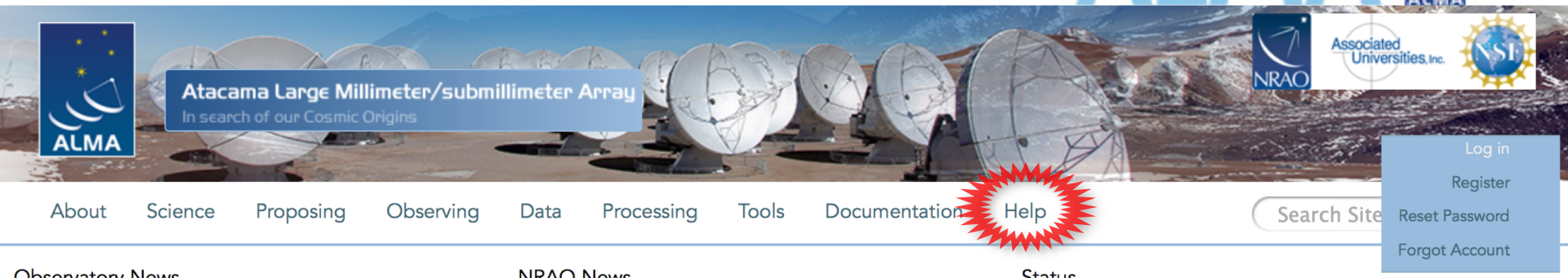
Phase I: Science Proposal

New Science Proposal → Create Science Goals → Validate Science Proposal → Submit Science Proposal

Click on the overview steps to view the contextual help

Importing And Exporting | Template Library | Need More Help? | View Phase 2 Steps

User support



Observatory News

Additional Information for Cycle 5 Proposals
Feb 01, 2017

Release of a New Installment of Science Verification Data
Jan 18, 2017

RadioNet: Calls for financial support - OPEN
Jan 16, 2017

More news...

NRAO News

American Astronomical Society Meeting
Jun 04, 2017

2017 Astrobiology Graduate Conference
Jun 05, 2017

Women in Astronomy IV: The Many Faces of Women Astronomers
Jun 09, 2017

More...

Status

ALMA Cycle 5 Pre-Announcement

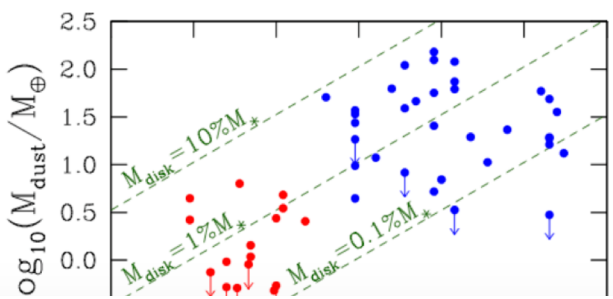
Refereed publications:

Last observed source:

Current configuration: C40-2

More...

Science Highlights - Possible Disk Truncation in Ophiuchus Brown Dwarfs



The sensitivity, resolution and the wavelength coverage of ALMA makes it an ideal tool for studying the properties of the cold outer disks of young stars and low mass objects. Such observations can aid us in understanding the formation of their central objects and their likelihood of ultimately hosting planets. In a recent Astronomy & Astrophysics paper, Dr. Testi and his collaborators made use of ALMA Band 7 to observe an unbiased sample of spectroscopically confirmed Ophiuchus brown dwarfs with infrared excesses.

www.almascience.org

ALMA Science Portal @ NRAO

I could use a hand…

ALMA

Have no fear, the ALMA Helpdesk is here…

<< Science Portal | Home | Knowledgebase | News | English (U.S.)

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» Knowledgebase

- General ALMA Queries (13)
- Early Science - Cycle 1 (31)
- Resources & Observer Support (12)
- Project Planning (14)
- ALMA Observing Tool (OT) (29)
- Proposal Handling (5)
- Archive & Data Retrieval (4)
- Offline Data Reduction and/or CASA (14)
- Development Program (1)

Live Chat Software by Kayako

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Knowledgebase

General ALMA Queries (13)

- Can I submit a ticket in Japanese?
- How close can ALMA observe to the Sun?

Early Science - Cycle 1 (31)

- Can I use "breakpoints" in ALMA cycle 1?
- The Cycle 1 Technical Handbook has some gaps in its discussion of ALMA receivers (SSB, 2SB, DSB). What else can you tell me about them?

Resources & Observer Support (12)

- How do I arrange a visit to one of the ARCs?
- Where can I find ALMA documentation and manuals?

Project Planning (14)

- What should I include for the content of the Technical Justification and in what format should I submit it?
- Where can I find the online ALMA observing simulator developed by the University of Manchester?

ALMA Observing Tool (OT) (29)

- What do I do if I can't get the OT to work?
- How do I deal with targets with unspecified coordinates in the OT?

Proposal Handling (5)

- May I submit an identical proposal to more than one category, e.g. submitting a proposal on distant galaxies both to cosmology and to galaxy categories?
- Which category should I submit a proposal on distant galaxies: "cosmology/high-z" or "Galaxies/Nuclei"?

NRAO

ALMA

For more info:

https://almascience.nrao.edu/

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of Europe, North America and East Asia in cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere (ESO), in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC), and in East Asia by the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Academia Sinica (AS) in Taiwan. ALMA construction and operations are led on behalf of Europe by ESO, on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI), and on behalf of East Asia by the National Astronomical Observatory of Japan (NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction and operation of ALMA.

NRAO