An Introduction to the Cycle 4 ALMA Observing Tool

How to turn that great idea into ALMA data..

Sabrina Stierwalt

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Atacama Large Millimeter/submillimeter Array

Expanded Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array

ALMA Cycle 4 Planning

- ALMA Cycle 4 will provide 3000 hours of 12-m array science observations. The remaining time on ALMA will be reserved for engineering, computing and scientific testing to extend and optimize ALMA capabilities.

- Dates to remember:
  - 22 March 2016 Call for Proposals
  - **21 April 2016 Proposal deadline**
  - August 2016 Review results sent to PIs
  - October 2016 Start of ALMA Cycle 4 observations
  - September 2017 End of Cycle 4 observations

Cycle 4 Capabilities

- At least forty (40) antennas in the 12-m Array, ten (10) 7-m antennas (for short baselines) and three (3) 12-m antennas (for zero-spacing)
- Receiver bands 3, 4, 6, 7, 8, 9, & 10 (wavelengths of about 3.1, 2.1, 1.3, 0.87, 0.74, 0.44, and 0.35 mm, respectively)
- Nine 12-m array configurations with maximum baselines from 155 m to 12.6 km
- Maximum baselines of 2.7 km for Bands 8, 9 and 10, 5.3 km for Band 7, 12.6 km for Bands 3, 4, & 6
- Spectral line, continuum, and mosaic observations
- Single pointing, on axis, full (linear) polarization capabilities for continuum and full spectral resolution observations in Band 3, 6 and 7 on the 12-m array

Cycle 4 Capabilities

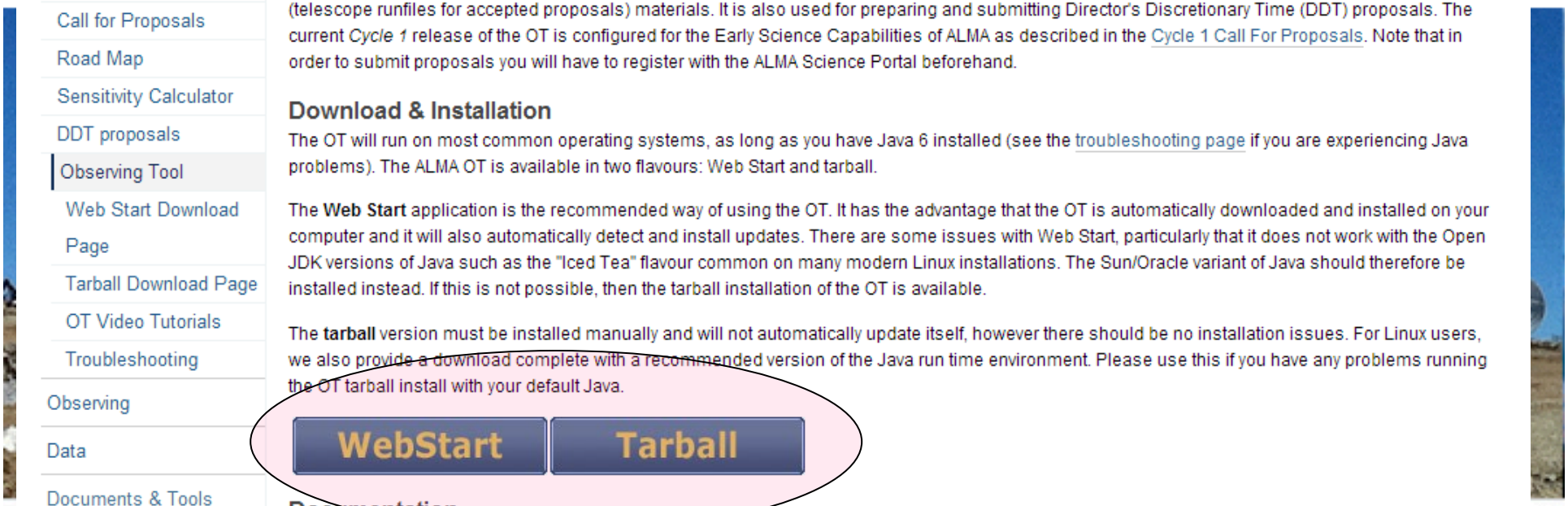
- Cycle 4 observing modes will be classified as standard or non-standard, and up to 20% of the observing time will be allocated to proposals requesting **non-standard modes**, which include:
- Bands 8, 9 & 10 observations
- Band 7 observations with maximum baselines > 2.7 km
- All polarization observations
- Spectral Scans
- Bandwidth switching projects (less than 1GHz aggregate bandwidth over all spectral windows)
- Solar Observations
- VLBI observations
- User-specified calibrations

New Capabilities to Note:

In Cycle 4, the following opportunities will be available to Proposers for the first time.

- ACA stand-alone mode
  - Proposals will be accepted to use the ACA in a stand-alone capacity for spectral line (7m Array plus Total Power Array) or continuum (7m Array) observations.
- Large Programs
  - defined as more than 50 hours of observations with either the 12-m Array or the ACA in stand-alone mode.
- Millimeter-wavelength VLBI
  - Proposals will be accepted for Very Long Baseline Interferometry (VLBI) observations with ALMA in Bands 3 and 6 continuum, in concert with an existing VLBI network: the Global mm-VLBI Array (GMVA) at 3 mm and a new NRAO/Event Horizon Telescope Consortium (EHTC) network at 1.3 mm. In addition to submitting an ALMA proposal, VLBI programs must also submit a proposal to the appropriate VLBI network according to their deadlines. Additional information about proposing with ALMA using these networks will be made available in mid-January 2016.
- Solar observations – Bands 3 and 6.

Once you have done this…



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  - DDT proposals
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    - Tarball Download Page
    - OT Video Tutorials
    - Troubleshooting
- Observing
- Data
- Documents & Tools
- Knowledgebase/FAQ

User Services at ARCs

- Helpdesk
- EU ARC

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Observing Tool

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

Download & Installation

The OT will run on most common operating systems, as long as you have Java 6 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 Sun/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 run time environment. Please use this if you have any problems running the OT tarball install with your default Java.

WebStart Tarball

Documentation

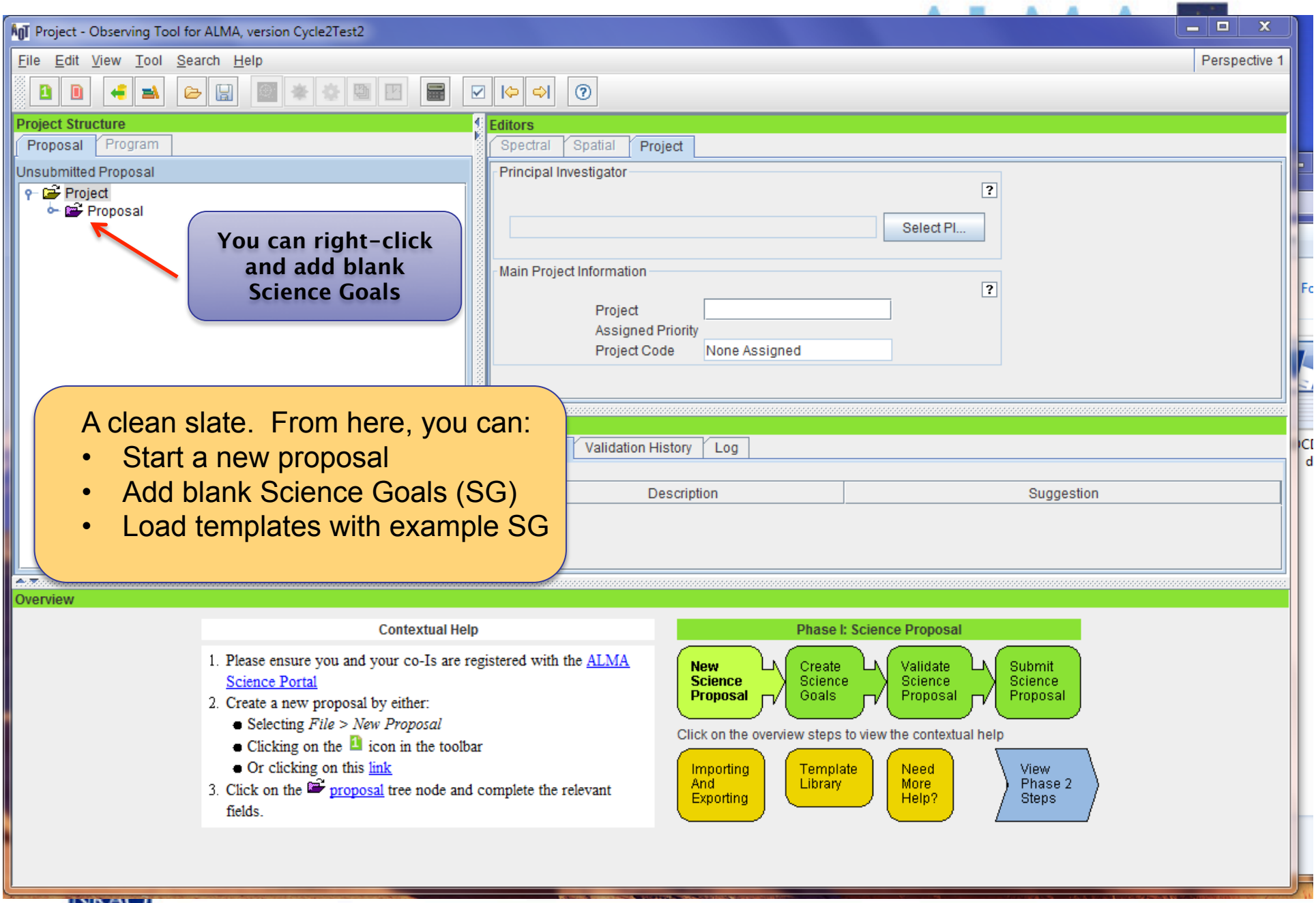
Extensive documentation is available to help you work with the OT and optimally prepare your proposal:

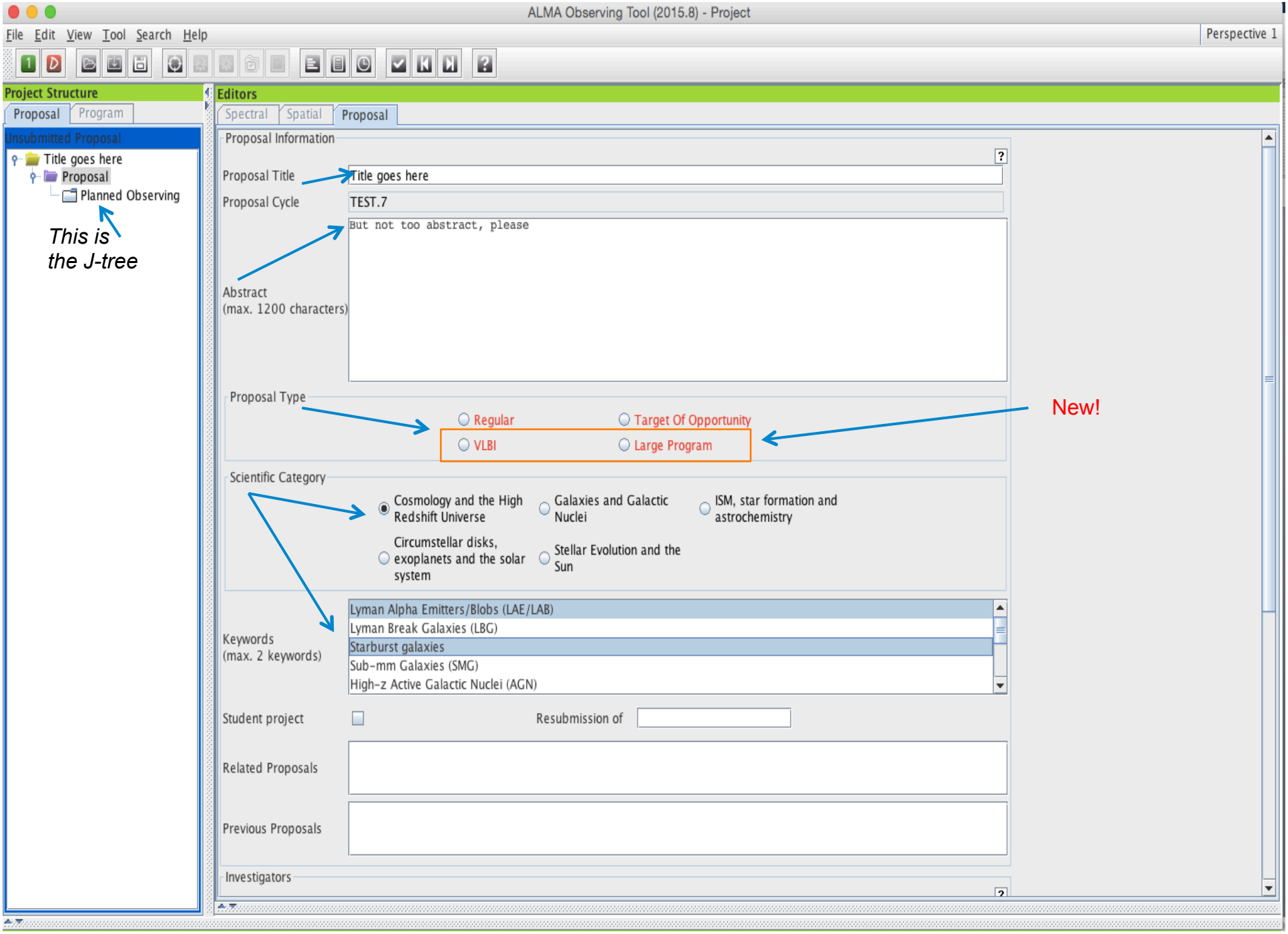
- If you are a novice OT user you should start with the OT Quickstart Guide, which takes you through the basic steps of ALMA proposal preparation.
- Audio-visual illustrations of different aspects of the OT can be found in the OT video tutorials. These are recommended for novices and advanced users alike.
- 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.

Associated Universities Inc.

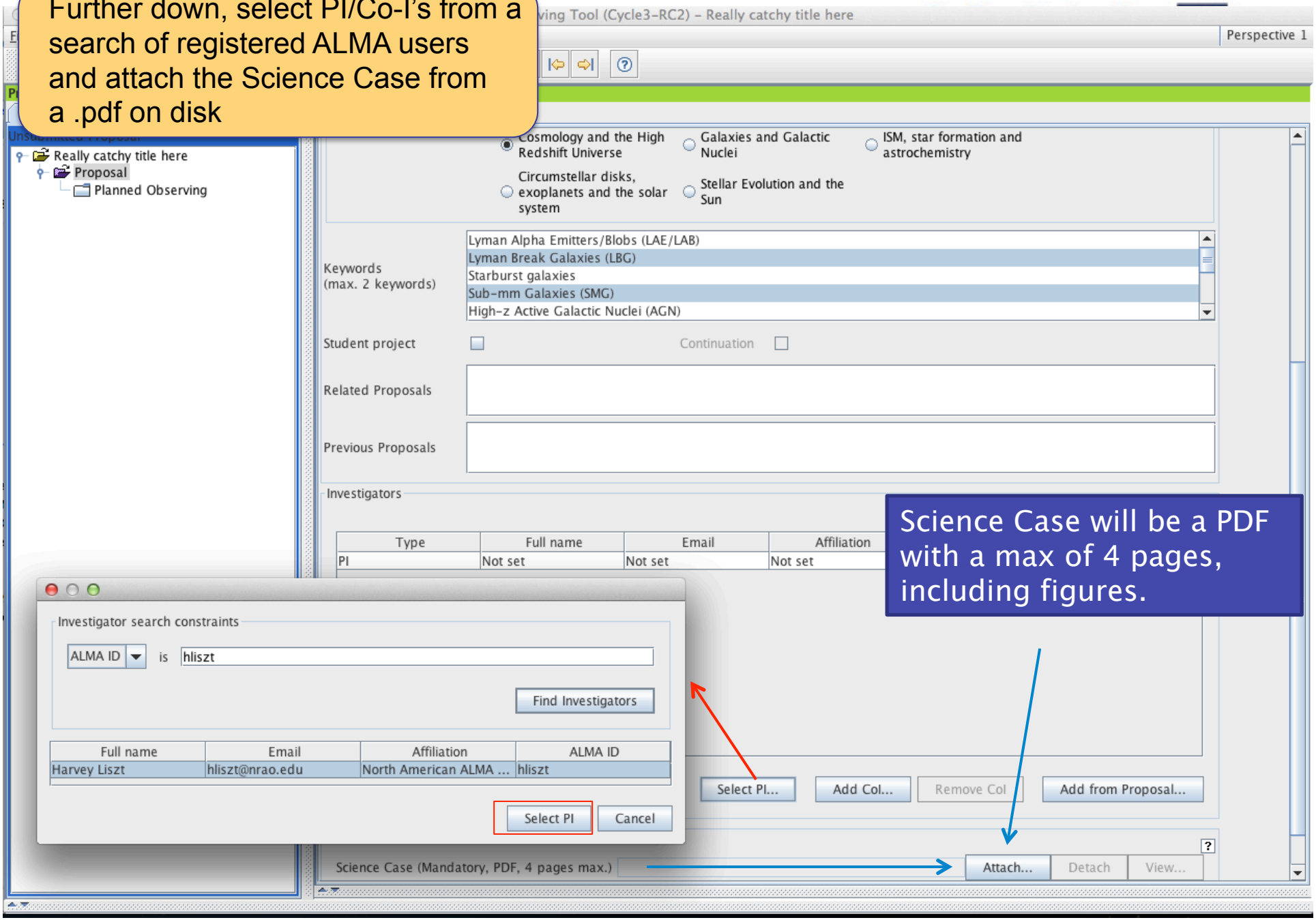
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

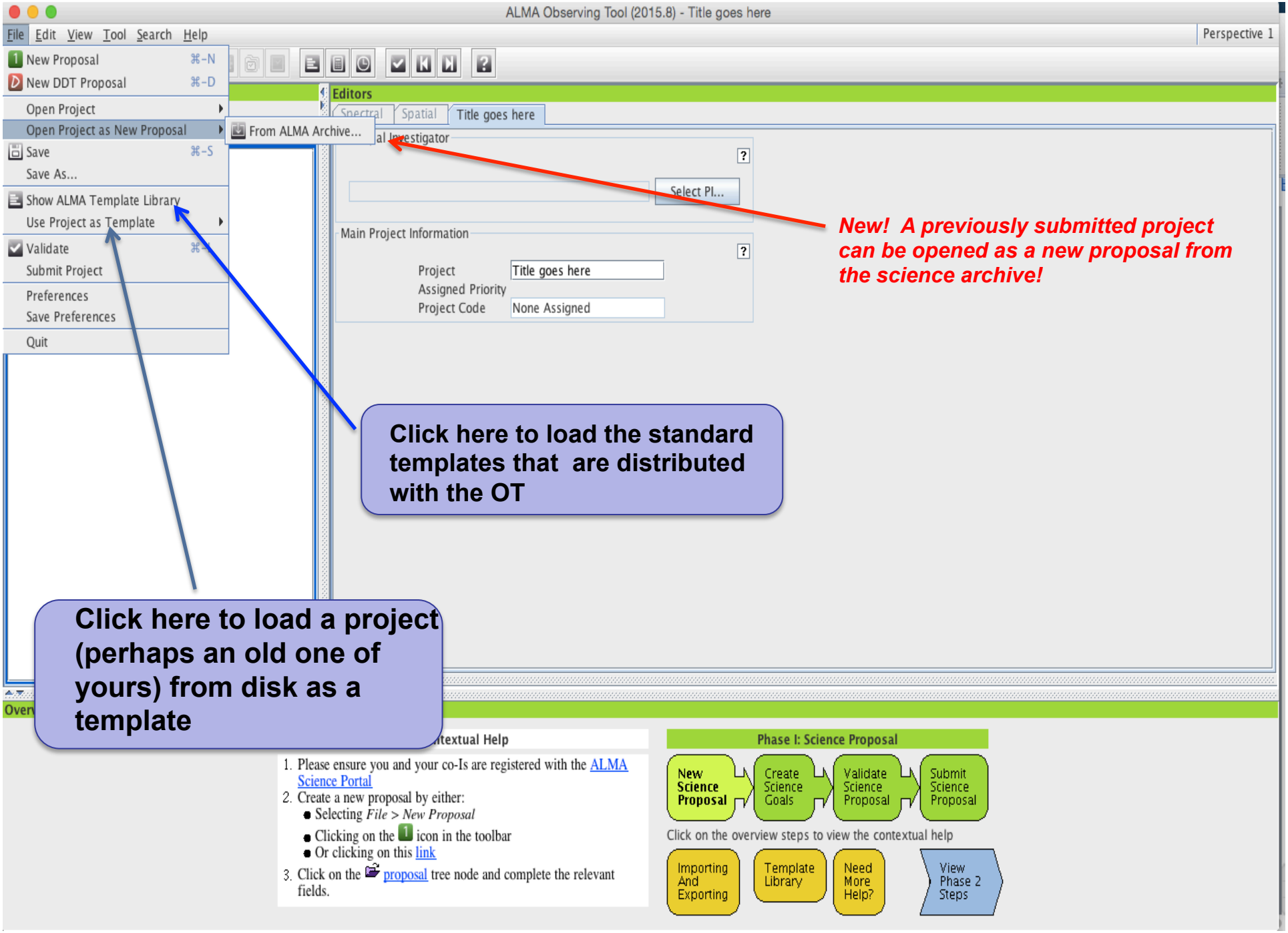
NRAO

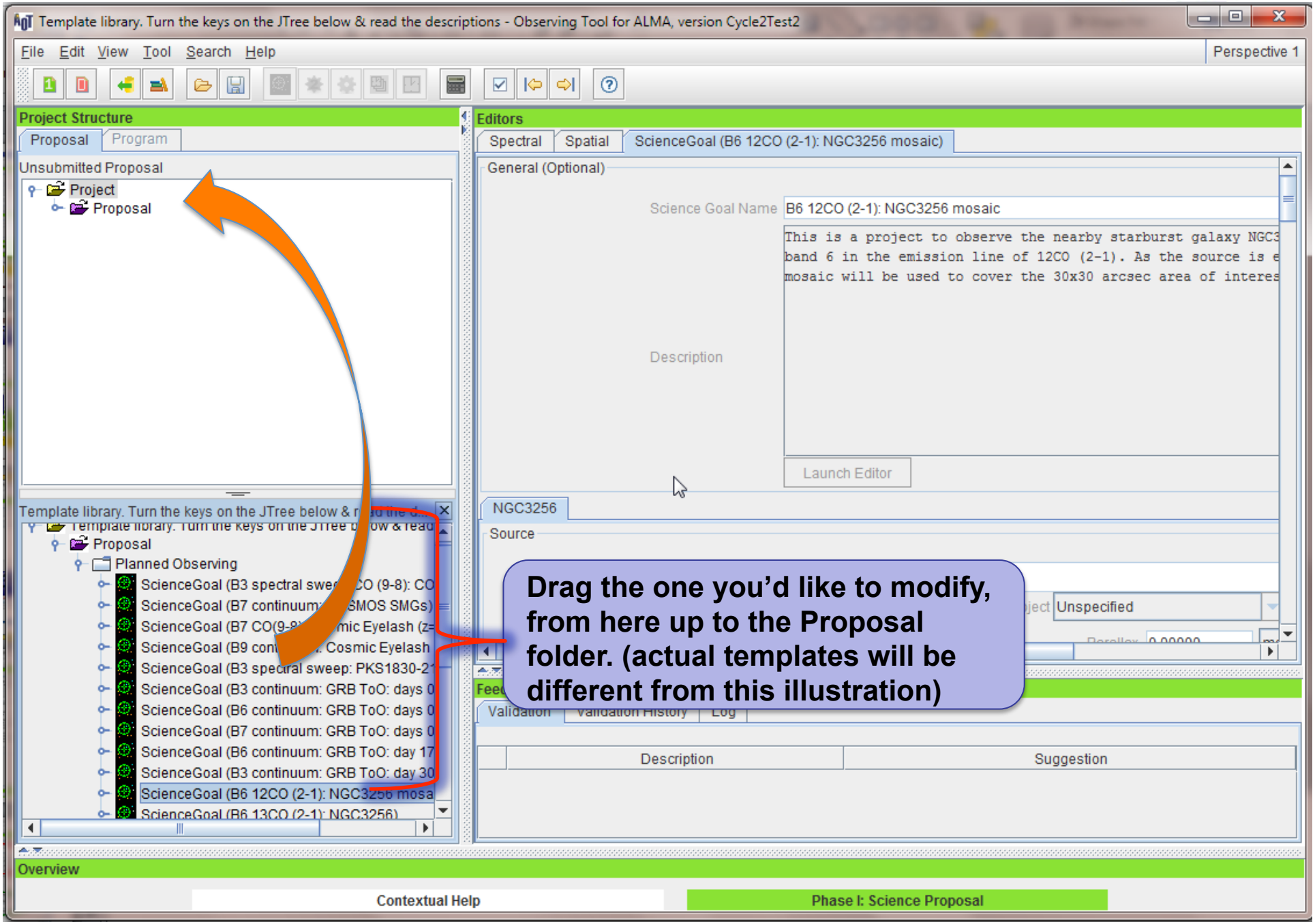

Project - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
You can right-click and add blank Science Goals
Editors
Spectral Spatial Project
Principal Investigator
Select PI...
Main Project Information
Project
Assigned Priority
Project Code
None Assigned
A clean slate. From here, you can:
• Start a new proposal
• Add blank Science Goals (SG)
• Load templates with example SG
Validation History Log
Description 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

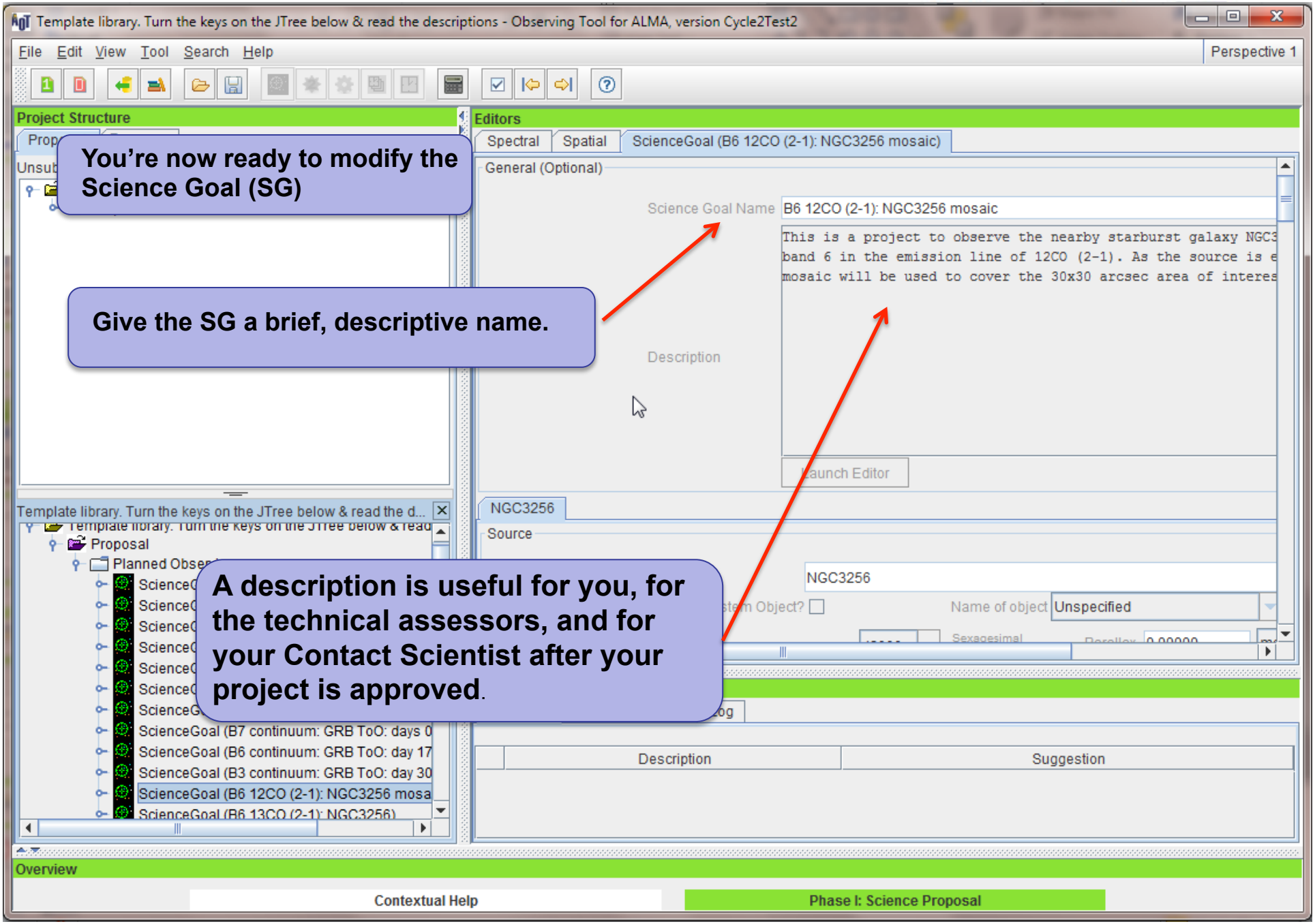

ALMA Observing Tool (2015.8) - Project
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Title goes here
Proposal
Planned Observing
This is the J-tree
Editors
Spectral Spatial Proposal
Proposal Information
Proposal Title
Title goes here
Proposal Cycle
TEST.7
But not too abstract, please
Abstract (max. 1200 characters)
Proposal Type
Regular
Target Of Opportunity
VLBI
Large Program
New!
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
Resubmission of
Related Proposals
Previous Proposals
Investigators

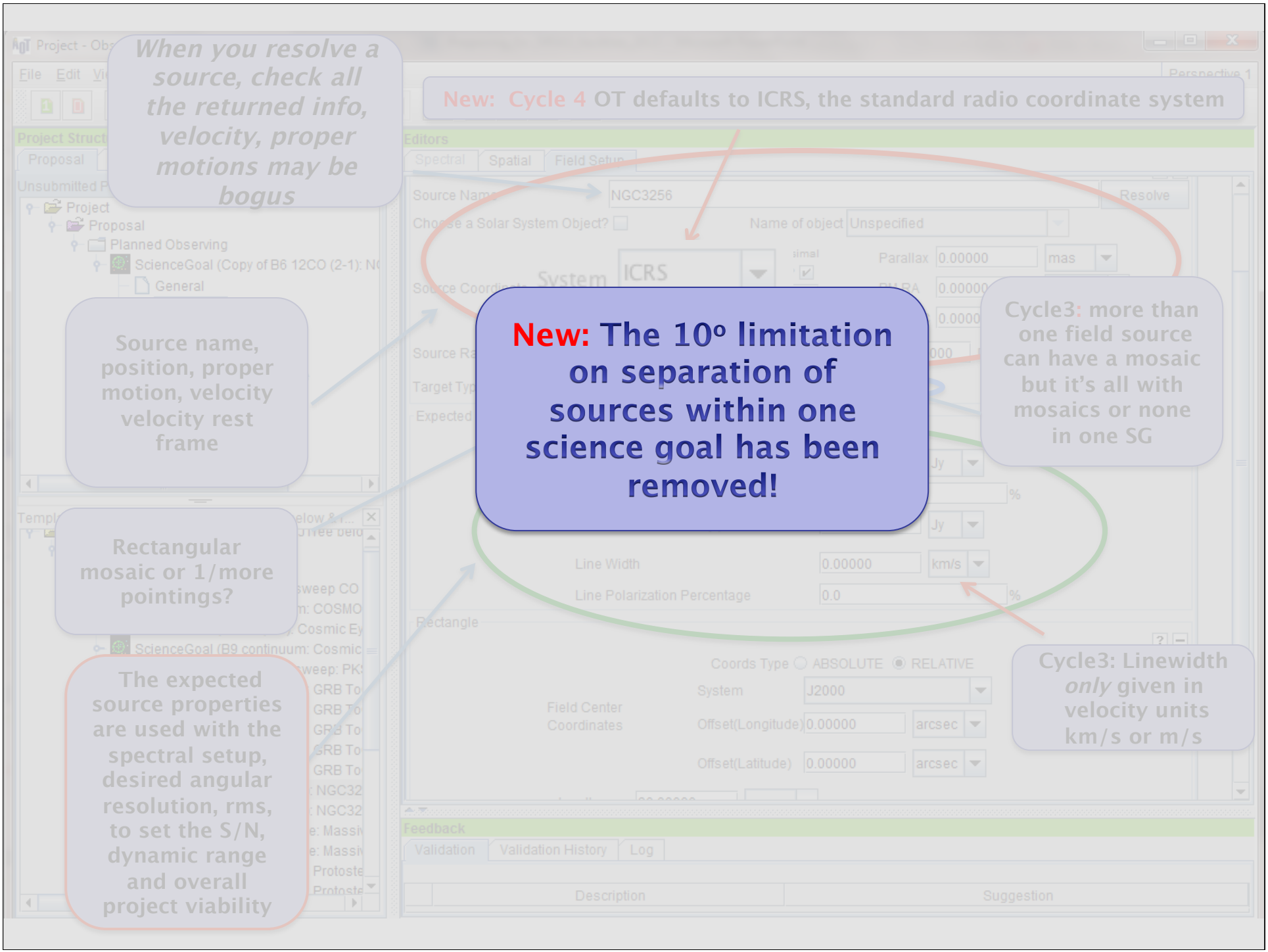
Further down, select PI/Co-I's from a search of registered ALMA users and attach the Science Case from a .pdf on disk




ALMA Observing Tool (2015.8) - Title goes here
File Edit View Tool Search Help
Perspective 1
New Proposal ⌘-N
New DDT Proposal ⌘-D
Open Project
Open Project as New Proposal
From ALMA Archive...
Save ⌘-S
Save As...
Show ALMA Template Library
Use Project as Template
Validate
Submit Project
Preferences
Save Preferences
Quit
Editors
Spectral
Spatial
Title goes here
Select PI...
Main Project Information
Project
Title goes here
Assigned Priority
Project Code
None Assigned
New! A previously submitted project can be opened as a new proposal from the science archive!
Click here to load the standard templates that are distributed with the OT
Click here to load a project (perhaps an old one of yours) from disk as a template
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
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.


Template library. Turn the keys on the JTree below & read the descriptions - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
Editors
Spectral Spatial ScienceGoal (B6 12CO (2-1): NGC3256 mosaic)
General (Optional)
Science Goal Name B6 12CO (2-1): NGC3256 mosaic
This is a project to observe the nearby starburst galaxy NGC3
band 6 in the emission line of 12CO (2-1). As the source is e
mosaic will be used to cover the 30x30 arcsec area of interes
Description
Launch Editor
NGC3256
Source
Unspecified
Template library. Turn the keys on the JTree below & r
Proposal
Planned Observing
ScienceGoal (B3 spectral swe CO (9-8): CO
ScienceGoal (B7 continuum SMOS SMGs)
ScienceGoal (B7 CO(9-8 mic Eyelash (z=
ScienceGoal (B9 con Cosmic Eyelash
ScienceGoal (B3 spectral sweep: PKS1830-21
ScienceGoal (B3 continuum: GRB ToO: days 0
ScienceGoal (B6 continuum: GRB ToO: days 0
ScienceGoal (B7 continuum: GRB ToO: days 0
ScienceGoal (B6 continuum: GRB ToO: day 17
ScienceGoal (B3 continuum: GRB ToO: day 30
ScienceGoal (B6 12CO (2-1): NGC3256 mosa
ScienceGoal (B6 13CO (2-1): NGC3256)
Drag the one you'd like to modify, from here up to the Proposal folder. (actual templates will be different from this illustration)
Validation Validation History Log
Description
Suggestion
Overview
Contextual Help
Phase I: Science Proposal


You're now ready to modify the Science Goal (SG)
Give the SG a brief, descriptive name.
A description is useful for you, for the technical assessors, and for your Contact Scientist after your project is approved.
Template library. Turn the keys on the JTree below & read the descriptions - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Editors
Spectral
Spatial
ScienceGoal (B6 12CO (2-1): NGC3256 mosaic)
General (Optional)
Science Goal Name
B6 12CO (2-1): NGC3256 mosaic
This is a project to observe the nearby starburst galaxy NGC3
band 6 in the emission line of 12CO (2-1). As the source is e
mosaic will be used to cover the 30x30 arcsec area of interes
Description
Launch Editor
NGC3256
Source
NGC3256
Name of object
Unspecified
Proposal
ScienceGoal (B7 continuum: GRB ToO: days 0
ScienceGoal (B6 continuum: GRB ToO: day 17
ScienceGoal (B3 continuum: GRB ToO: day 30
ScienceGoal (B6 12CO (2-1): NGC3256 mosa
Description
Suggestion
Overview
Contextual Help
Phase I: Science Proposal


When you resolve a source, check all the returned info, velocity, proper motions may be bogus
New: Cycle 4 OT defaults to ICRS, the standard radio coordinate system
Source name, position, proper motion, velocity velocity rest frame
New: The 10º limitation on separation of sources within one science goal has been removed!
Cycle3: more than one field source can have a mosaic but it's all with mosaics or none in one SG
Rectangular mosaic or 1/more 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
Cycle3: Linewidth only given in velocity units km/s or m/s
Project - Obs
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Perspective 1
Project Struct
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Unsubmitted P
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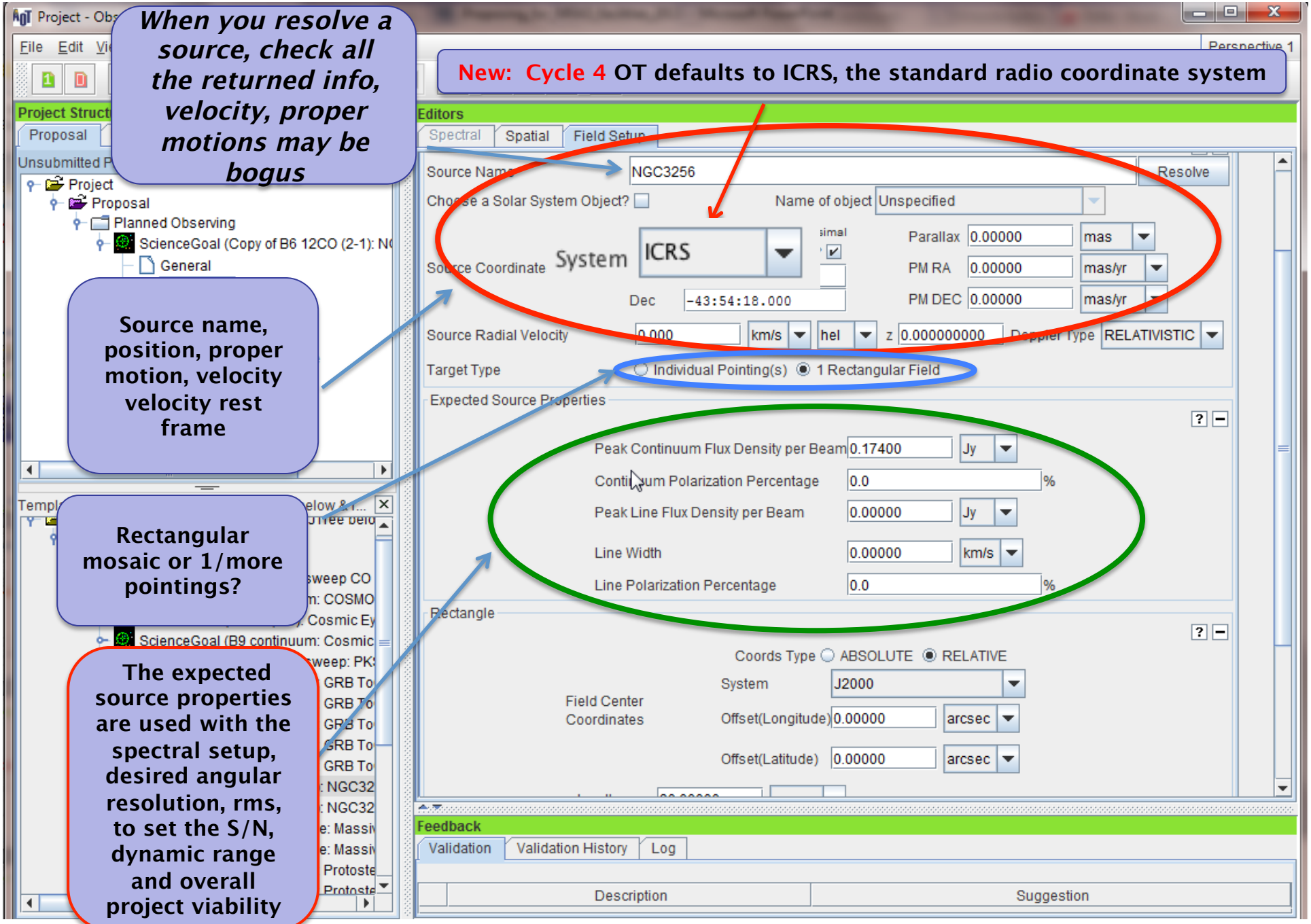
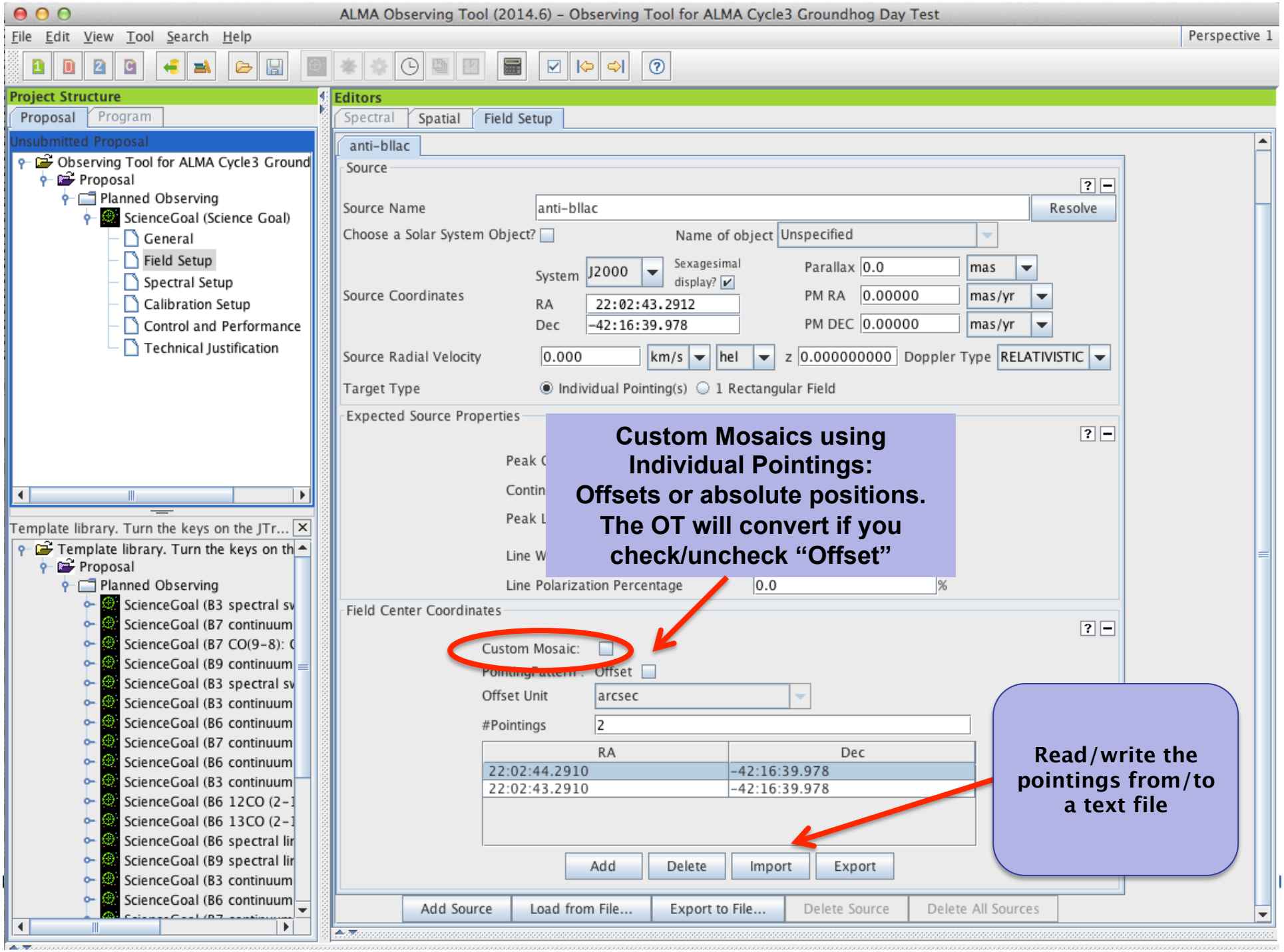
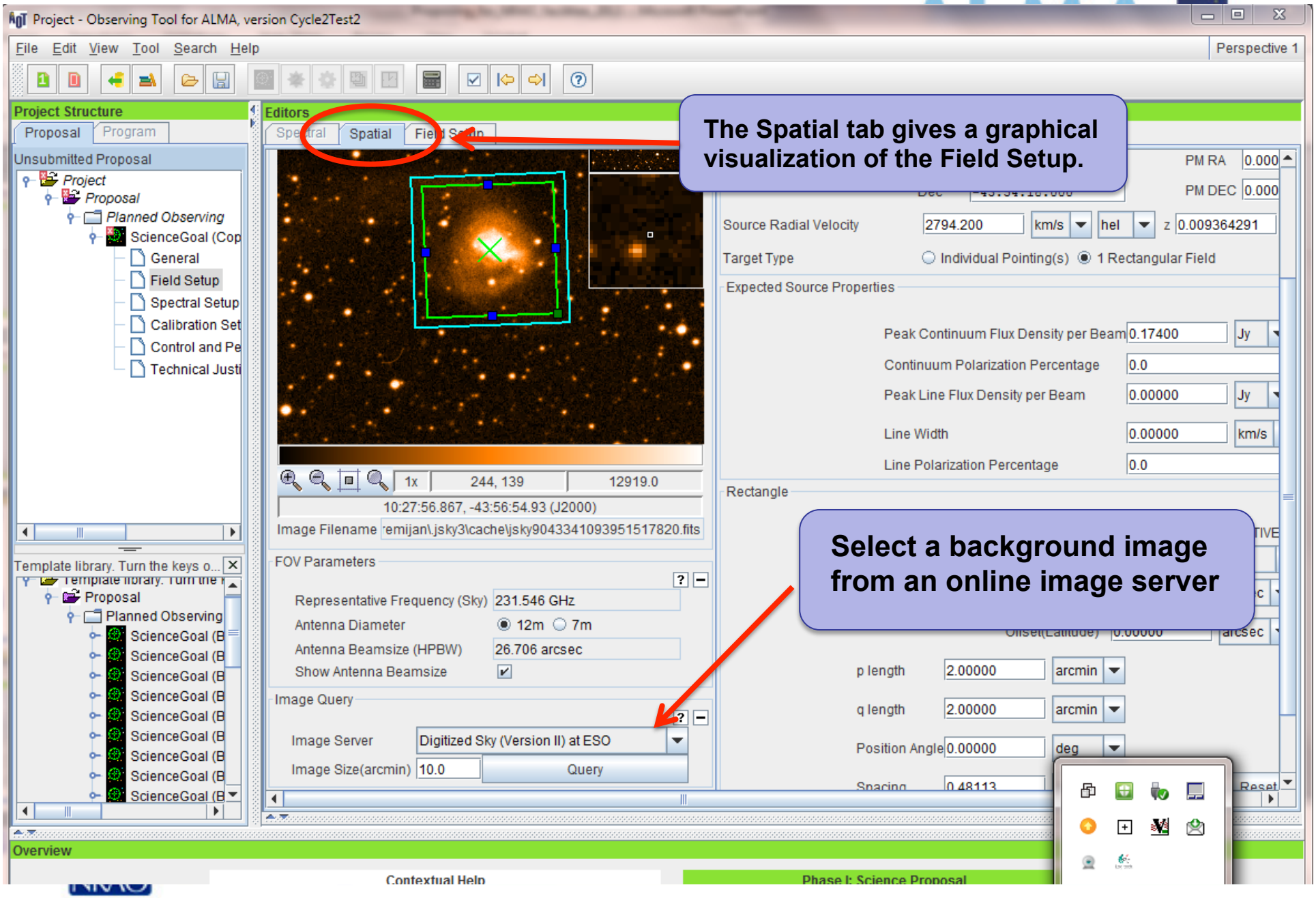
Proposal
Planned Observing
ScienceGoal (Copy of B6 12CO (2-1): N
General
Editors
Spectral
Spatial
Field Setup
Source Name
NGC3256
Resolve
Choose a Solar System Object?
Name of object
Unspecified
System
ICRS
Parallax
0.00000
mas
Source Coordi
Source Ra
Target Typ
Expected
Jy
%
Line Width
0.00000
km/s
Line Polarization Percentage
0.0
Rectangle
Coords Type
ABSOLUTE
RELATIVE
System
J2000
Field Center Coordinates
Offset(Longitude)
0.00000
arcsec
Offset(Latitude)
0.00000
arcsec
Templ
ScienceGoal (B9 continuum: Cosmic
GRB To
NGC32
Massi
Protoste
Feedback
Validation
Validation History
Log
Description
Suggestion

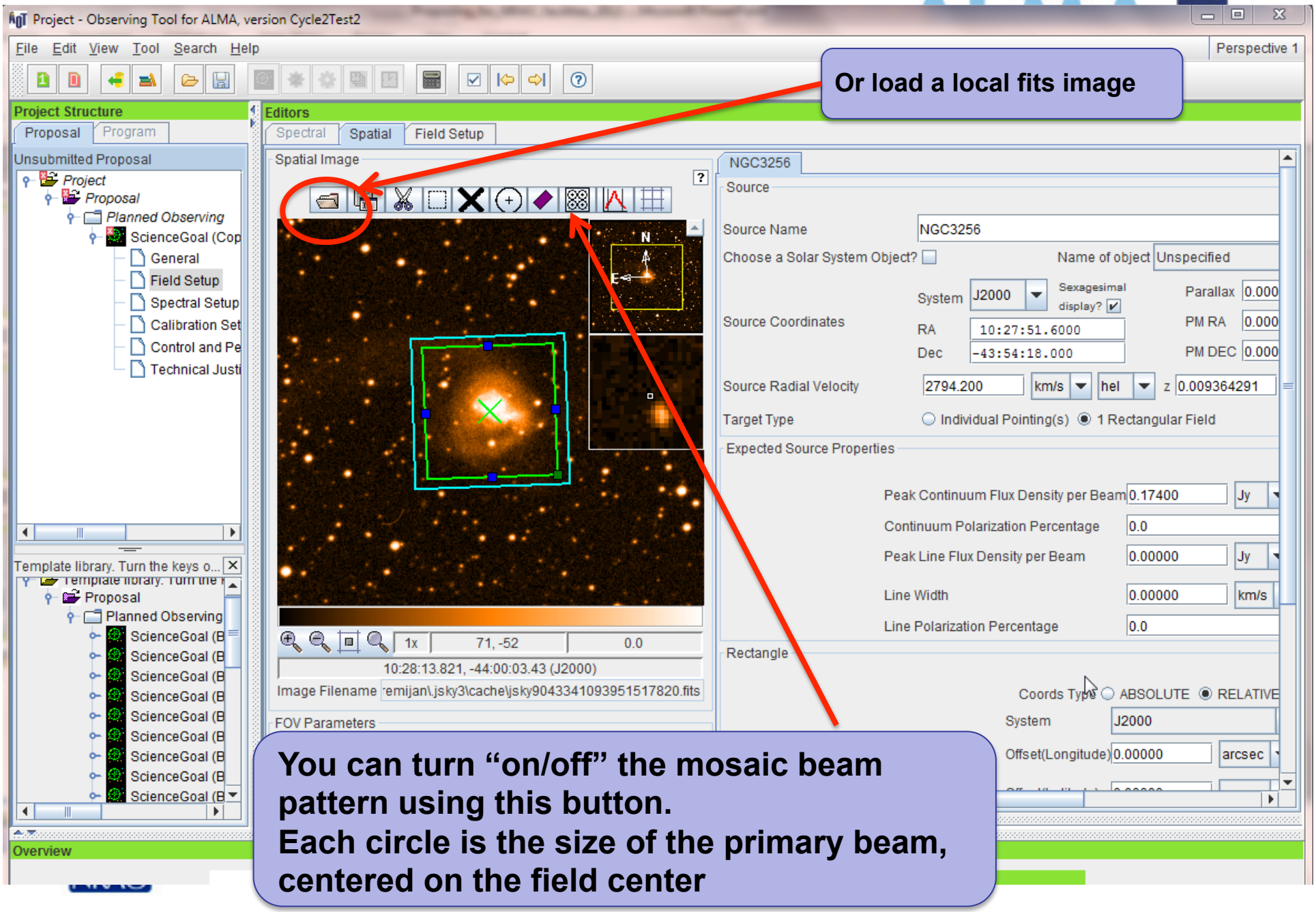

When you resolve a source, check all the returned info, velocity, proper motions may be bogus
New: Cycle 4 OT defaults to ICRS, the standard radio coordinate system
Source name, position, proper motion, velocity velocity rest frame
Rectangular mosaic or 1/more pointings?
The expected source properties are used with the spectral setup, desired angular resolution, rms, to set the S/N, dynamic range and overall project viability
Editors
Spectral
Spatial
Field Setup
Source Name
NGC3256
Resolve
Choose a Solar System Object?
Name of object
Unspecified
Source Coordinate System
ICRS
Parallax
0.00000
mas
PM RA
0.00000
mas/yr
Dec
-43:54:18.000
PM DEC
0.00000
mas/yr
Source Radial Velocity
0.000
km/s
hel
z
0.000000000
Doppler Type
RELATIVISTIC
Target Type
Individual Pointing(s)
1 Rectangular Field
Expected Source Properties
Peak Continuum Flux Density per Beam
0.17400
Jy
Continuum Polarization Percentage
0.0
%
Peak Line Flux Density per Beam
0.00000
Jy
Line Width
0.00000
km/s
Line Polarization Percentage
0.0
%
Rectangle
Coords Type
ABSOLUTE
RELATIVE
System
J2000
Field Center Coordinates
Offset(Longitude)
0.00000
arcsec
Offset(Latitude)
0.00000
arcsec
Feedback
Validation
Validation History
Log
Description
Suggestion
Project Struct
Proposal
Unsubmitted P
Project
Proposal
Planned Observing
ScienceGoal (Copy of B6 12CO (2-1): N
General
ScienceGoal (B9 continuum: Cosmic


ALMA Observing Tool (2014.6) – Observing Tool for ALMA Cycle3 Groundhog Day Test
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Observing Tool for ALMA Cycle3 Ground
Proposal
Planned Observing
ScienceGoal (Science Goal)
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Template library. Turn the keys on the JTr...
Template library. Turn the keys on th
Proposal
Planned Observing
ScienceGoal (B3 spectral sv
ScienceGoal (B7 continuum
ScienceGoal (B7 CO(9-8): (
ScienceGoal (B9 continuum
ScienceGoal (B3 spectral sv
ScienceGoal (B3 continuum
ScienceGoal (B6 continuum
ScienceGoal (B7 continuum
ScienceGoal (B6 continuum
ScienceGoal (B3 continuum
ScienceGoal (B6 12CO (2-1
ScienceGoal (B6 13CO (2-1
ScienceGoal (B6 spectral lir
ScienceGoal (B9 spectral lir
ScienceGoal (B3 continuum
ScienceGoal (B6 continuum
Editors
Spectral Spatial Field Setup
anti-bllac
Source
Source Name anti-bllac Resolve
Choose a Solar System Object?
Name of object Unspecified
Source Coordinates
System J2000
Sexagesimal display?
RA 22:02:43.2912
Dec -42:16:39.978
Parallax 0.0 mas
PM RA 0.00000 mas/yr
PM DEC 0.00000 mas/yr
Source Radial Velocity 0.000 km/s hel
z 0.000000000
Doppler Type RELATIVISTIC
Target Type
Individual Pointing(s)
1 Rectangular Field
Expected Source Properties
Peak
Contin
Peak L
Line W
Line Polarization Percentage 0.0 %
Custom Mosaic:
Offset
Offset Unit arcsec
#Pointings 2
RA
Dec
22:02:44.2910 -42:16:39.978
22:02:43.2910 -42:16:39.978
Add
Delete
Import
Export
Add Source
Load from File...
Export to File...
Delete Source
Delete All Sources
Custom Mosaics using Individual Pointings: Offsets or absolute positions. The OT will convert if you check/uncheck “Offset”
Read/write the pointings from/to a text file

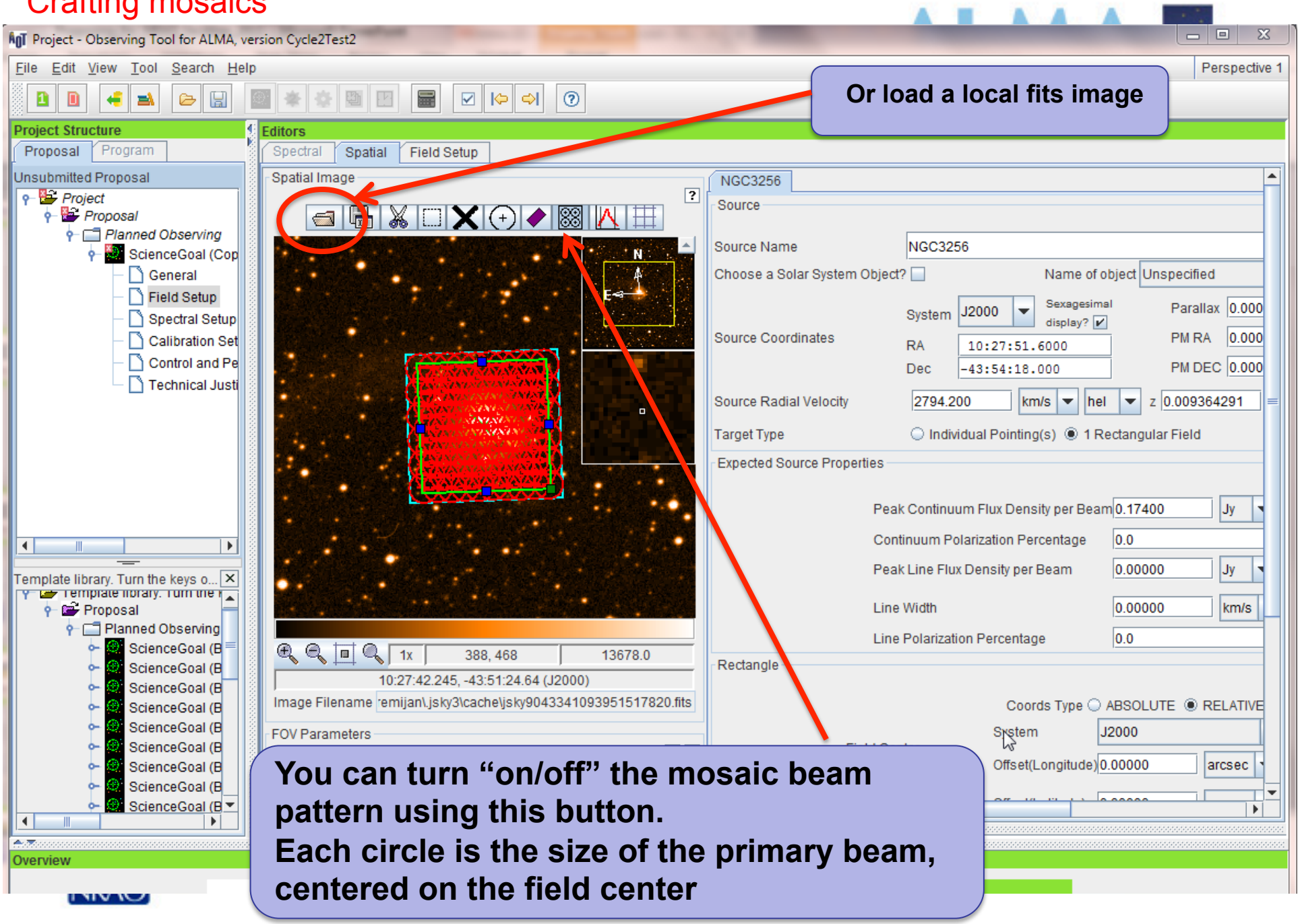
Crafting mosaics



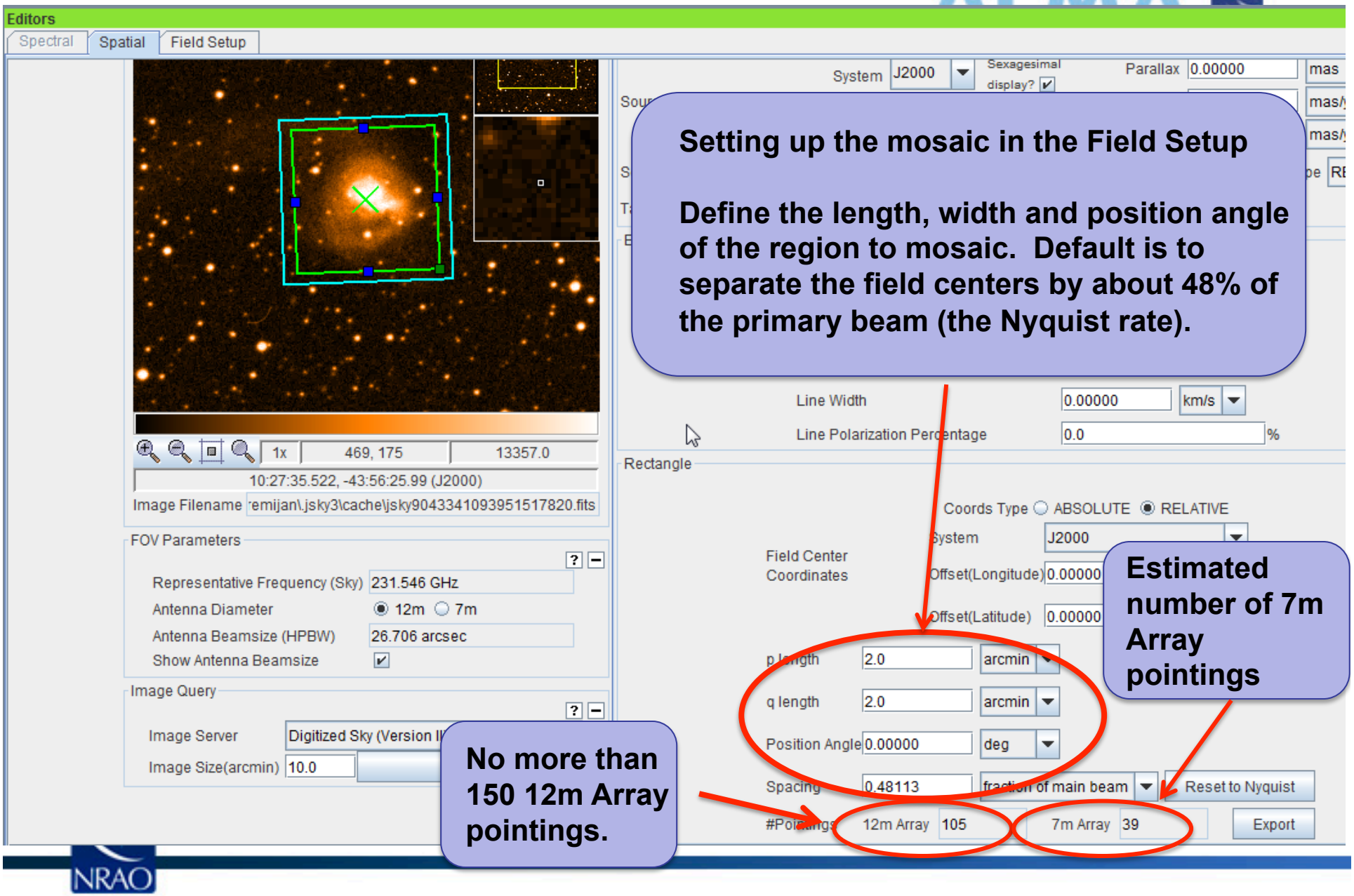
Crafting mosaics

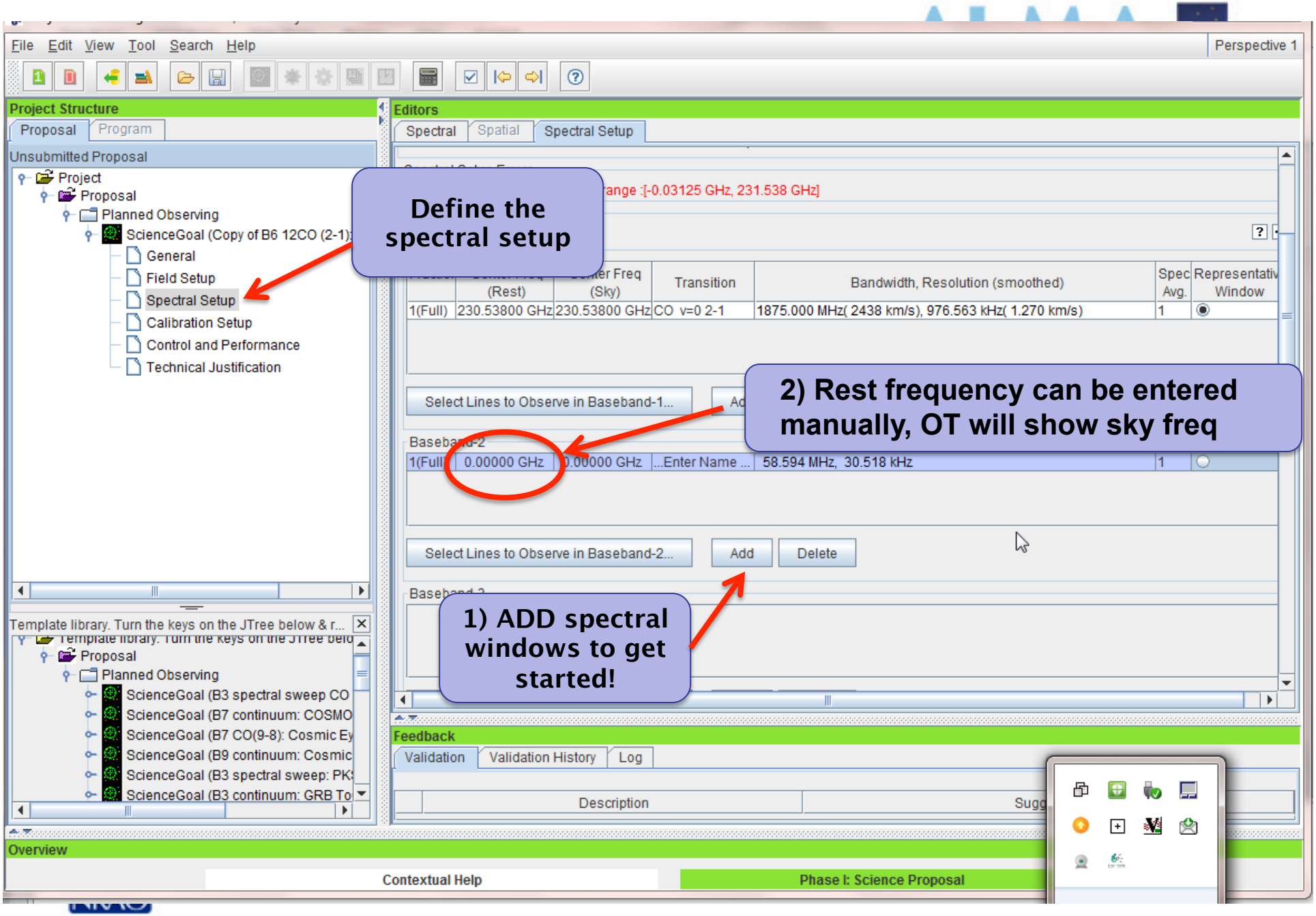


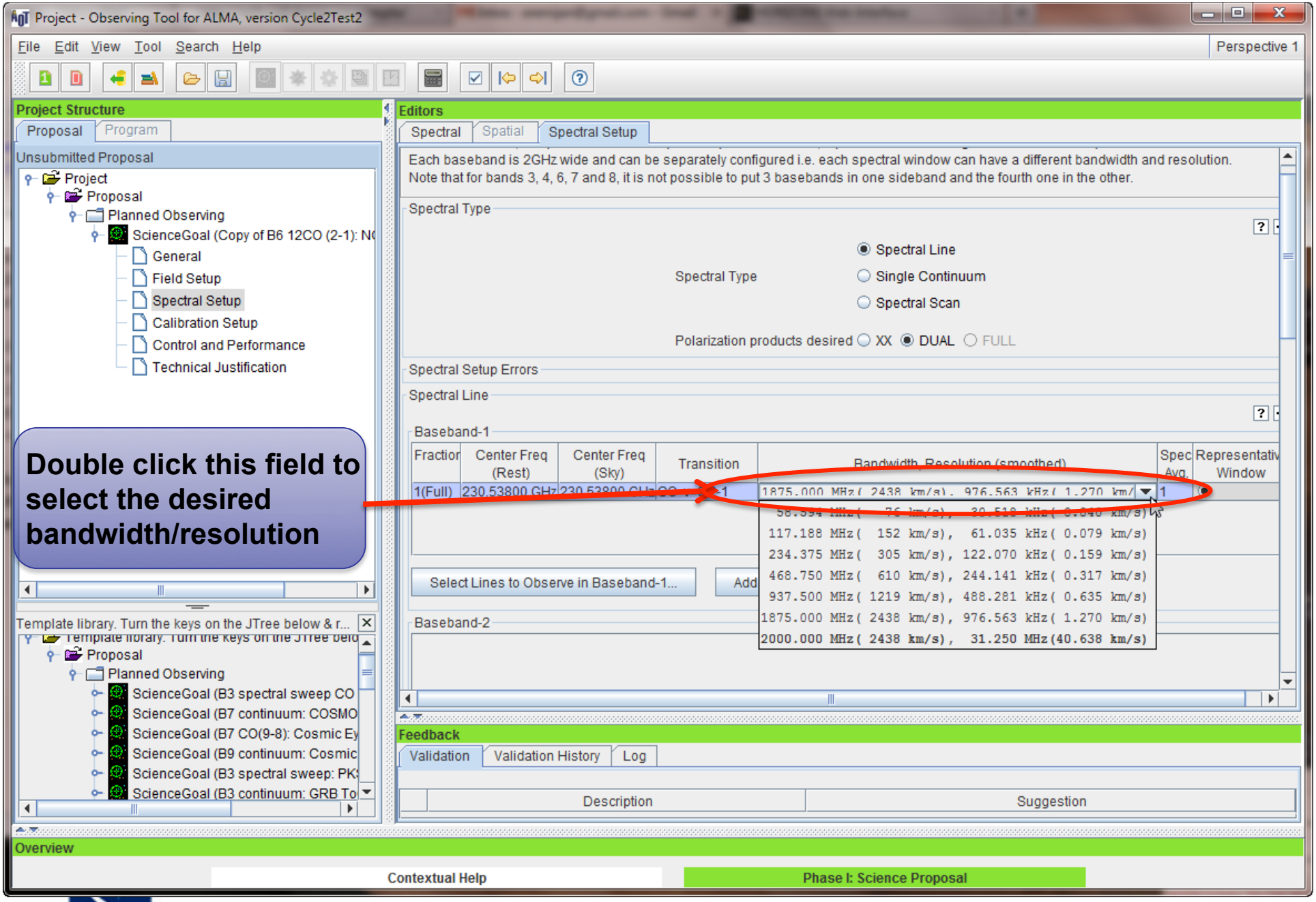
Crafting mosaics

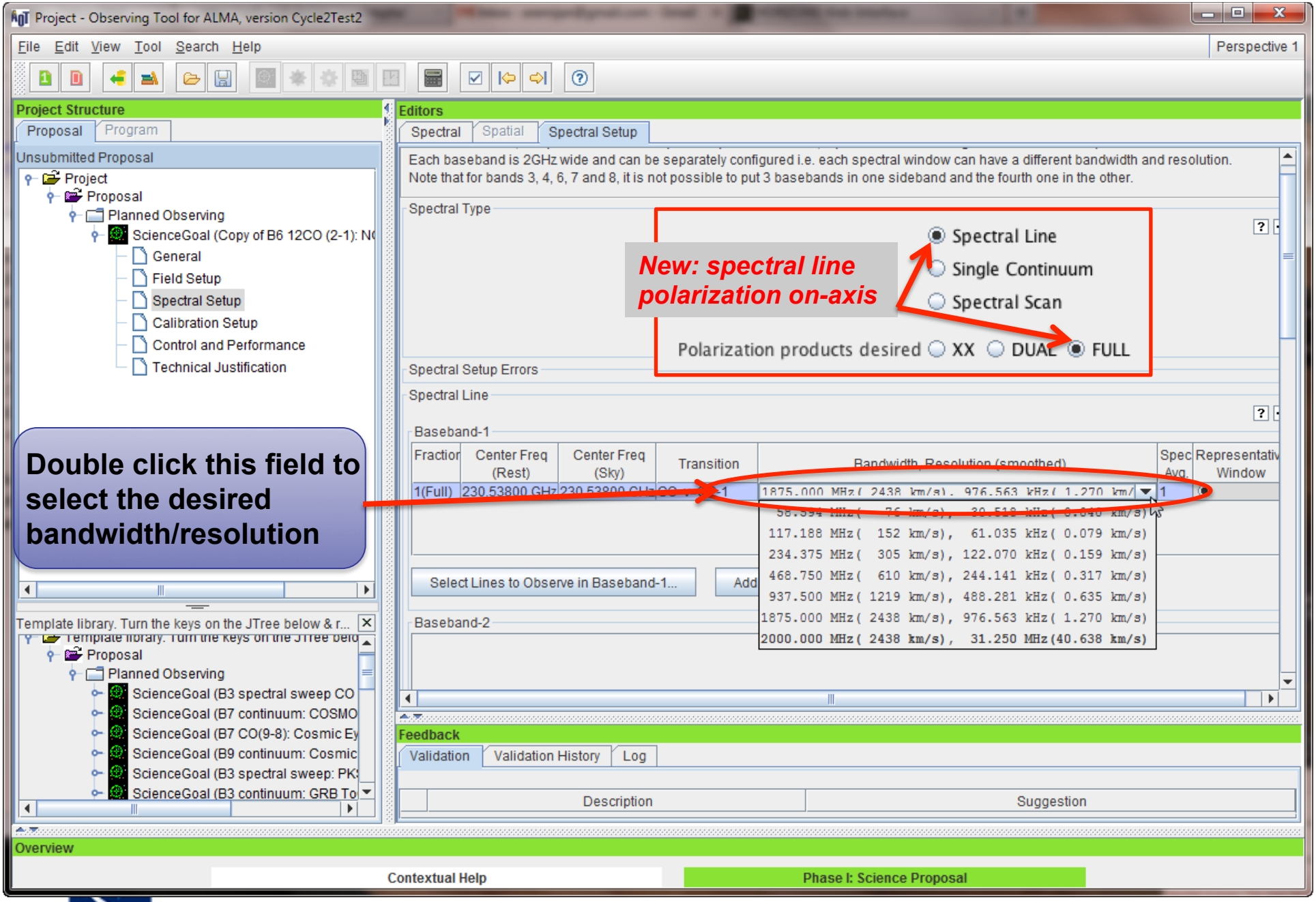


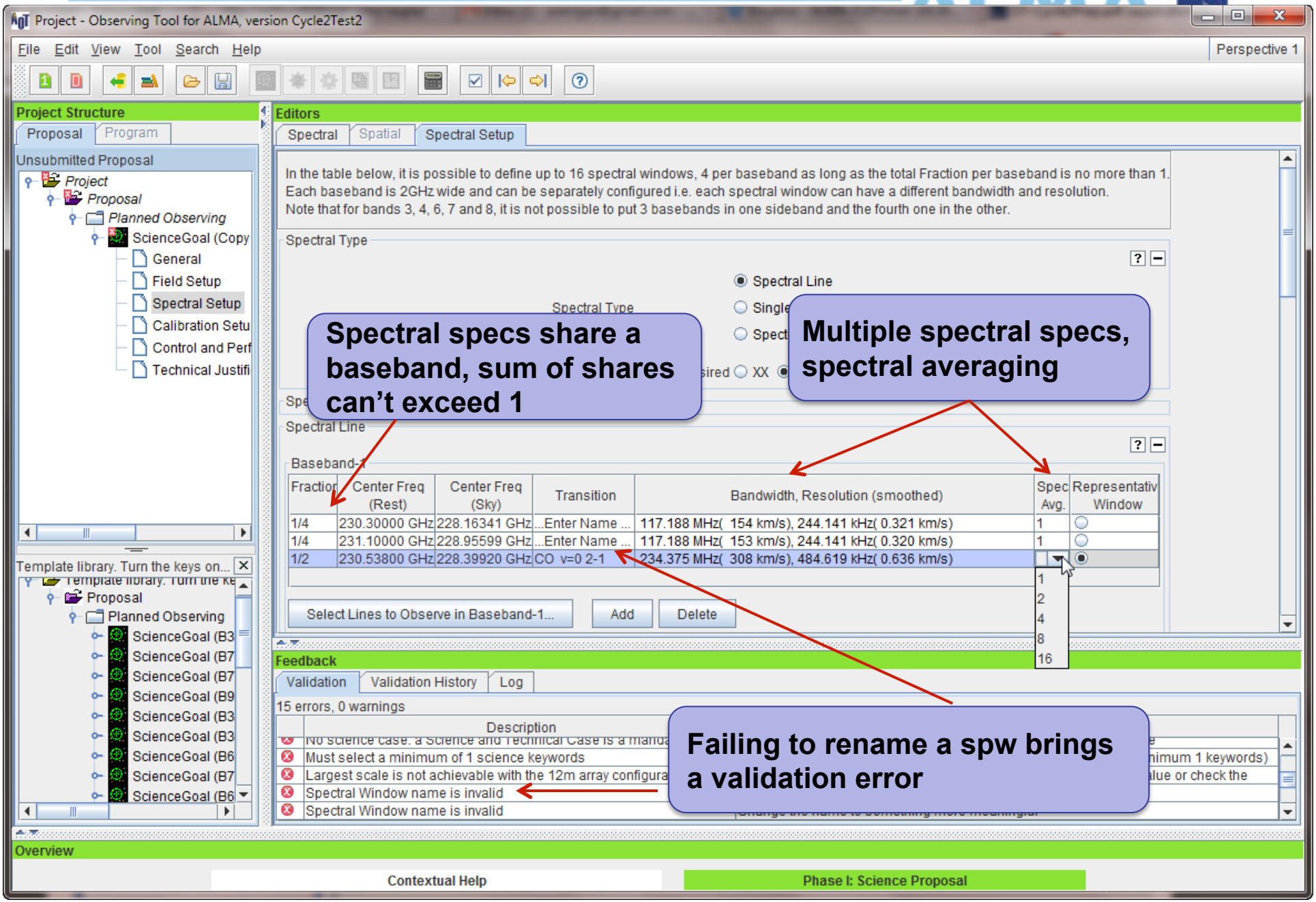
Crafting mosaics

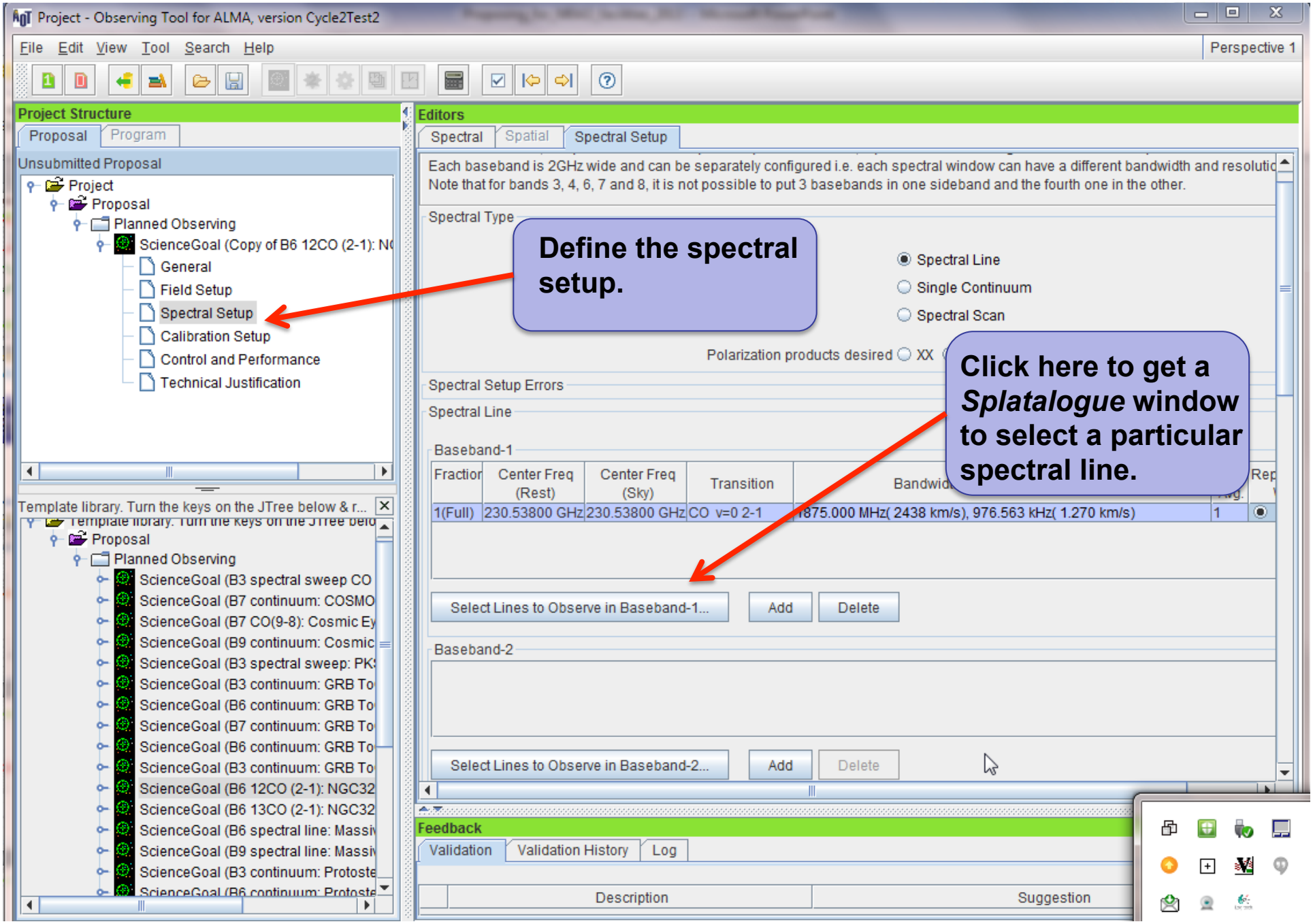


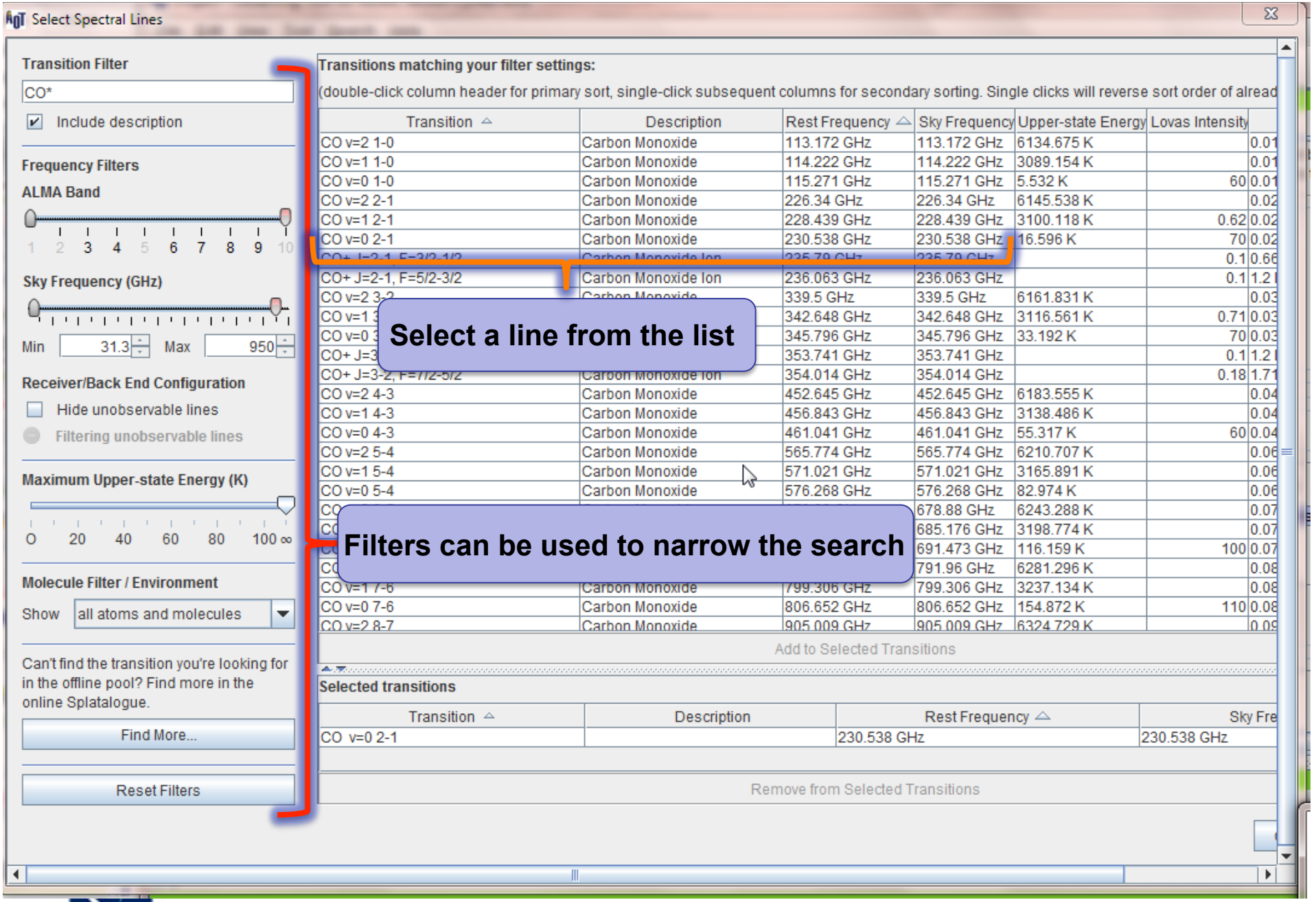

File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
Planned Observing
ScienceGoal (Copy of B6 12CO (2-1)
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Define the spectral setup
Editors
Spectral Spatial Spectral Setup
Transition
Bandwidth, Resolution (smoothed)
Spec Avg.
Representativ Window
1(Full) 230.53800 GHz 230.53800 GHz CO v=0 2-1 1875.000 MHz(2438 km/s), 976.563 kHz(1.270 km/s) 1
Select Lines to Observe in Baseband-1...
2) Rest frequency can be entered manually, OT will show sky freq
0.00000 GHz
...Enter Name ...
58.594 MHz, 30.518 kHz
Select Lines to Observe in Baseband-2...
Add
Delete
1) ADD spectral windows to get started!
Template library. Turn the keys on the JTree below & r...
Proposal
Planned Observing
ScienceGoal (B3 spectral sweep CO
ScienceGoal (B7 continuum: COSMO
ScienceGoal (B7 CO(9-8): Cosmic Ey
ScienceGoal (B9 continuum: Cosmic
ScienceGoal (B3 spectral sweep: PK
ScienceGoal (B3 continuum: GRB To
Feedback
Validation Validation History Log
Description
Overview
Contextual Help
Phase I: Science Proposal

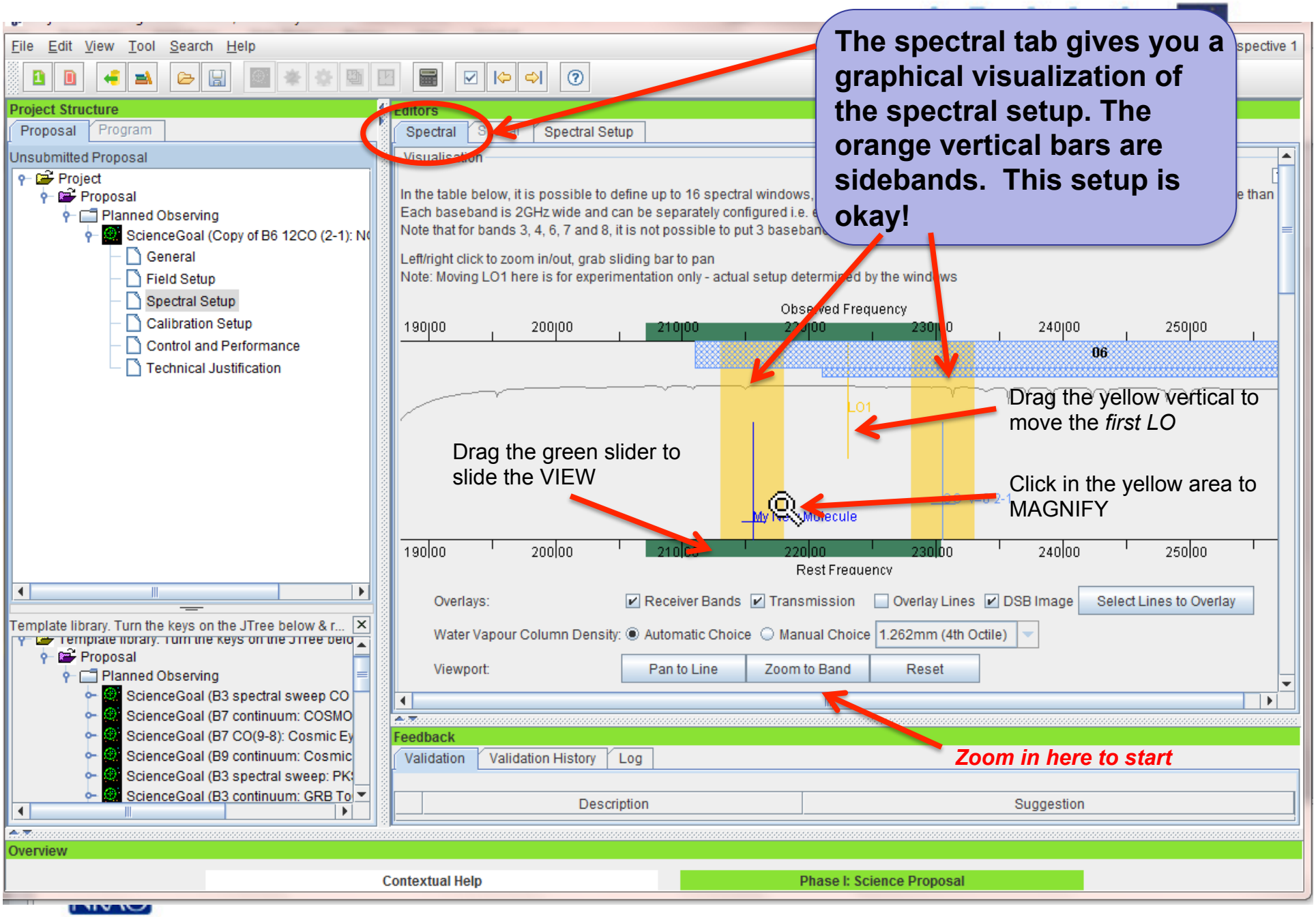

Project - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
Planned Observing
ScienceGoal (Copy of B6 12CO (2-1): N
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Double click this field to select the desired bandwidth/resolution
Template library. Turn the keys on the JTree below & r...
Proposal
Planned Observing
ScienceGoal (B3 spectral sweep CO
ScienceGoal (B7 continuum: COSMO
ScienceGoal (B7 CO(9-8): Cosmic Ey
ScienceGoal (B9 continuum: Cosmic
ScienceGoal (B3 spectral sweep: PK
ScienceGoal (B3 continuum: GRB To
Editors
Spectral Spatial Spectral Setup
Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution.
Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.
Spectral Type
Spectral Type
Spectral Line
Single Continuum
Spectral Scan
Polarization products desired XX DUAL FULL
Spectral Setup Errors
Spectral Line
Baseband-1
Fraction
Center Freq (Rest)
Center Freq (Sky)
Transition
Bandwidth, Resolution (smoothed)
Spec Avg.
Representativ Window
1(Full)
230.53800 GHz
1
1875.000 MHz(2438 km/s), 976.563 kHz(1.270 km/
1
117.188 MHz(152 km/s), 61.035 kHz(0.079 km/s)
234.375 MHz(305 km/s), 122.070 kHz(0.159 km/s)
468.750 MHz(610 km/s), 244.141 kHz(0.317 km/s)
937.500 MHz(1219 km/s), 488.281 kHz(0.635 km/s)
1875.000 MHz(2438 km/s), 976.563 kHz(1.270 km/s)
2000.000 MHz(2438 km/s), 31.250 MHz(40.638 km/s)
Select Lines to Observe in Baseband-1...
Baseband-2
Feedback
Validation Validation History Log
Description
Suggestion
Overview
Contextual Help
Phase I: Science Proposal


Project - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
Planned Observing
ScienceGoal (Copy of B6 12CO (2-1): N
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Editors
Spectral Spatial Spectral Setup
Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution.
Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.
Spectral Type
Spectral Line
Single Continuum
Spectral Scan
New: spectral line polarization on-axis
Polarization products desired XX DUAL FULL
Spectral Setup Errors
Spectral Line
Baseband-1
Fraction
Center Freq (Rest)
Center Freq (Sky)
Transition
Bandwidth, Resolution (smoothed)
Spec Avg.
Representativ Window
1(Full)
230.53800 GHz
1
1875.000 MHz(2438 km/s), 976.563 kHz(1.270 km/
1
117.188 MHz(152 km/s), 61.035 kHz(0.079 km/s)
234.375 MHz(305 km/s), 122.070 kHz(0.159 km/s)
468.750 MHz(610 km/s), 244.141 kHz(0.317 km/s)
937.500 MHz(1219 km/s), 488.281 kHz(0.635 km/s)
1875.000 MHz(2438 km/s), 976.563 kHz(1.270 km/s)
2000.000 MHz(2438 km/s), 31.250 MHz(40.638 km/s)
Select Lines to Observe in Baseband-1...
Baseband-2
Double click this field to select the desired bandwidth/resolution
Template library. Turn the keys on the JTree below & r...
Proposal
Planned Observing
ScienceGoal (B3 spectral sweep CO
ScienceGoal (B7 continuum: COSMO
ScienceGoal (B7 CO(9-8): Cosmic Ey
ScienceGoal (B9 continuum: Cosmic
ScienceGoal (B3 spectral sweep: PK
ScienceGoal (B3 continuum: GRB To
Feedback
Validation Validation History Log
Description
Suggestion
Overview
Contextual Help
Phase I: Science Proposal


Project - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
Planned Observing
ScienceGoal (Copy
General
Field Setup
Spectral Setup
Calibration Setu
Control and Perf
Technical Justifi
Editors
Spectral Spatial Spectral Setup
In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1.
Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution.
Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.
Spectral Type
Spectral Line
Spectral Line
Baseband-1
Fraction
Center Freq (Rest)
Center Freq (Sky)
Transition
Bandwidth, Resolution (smoothed)
Spec Avg.
Representativ Window
1/4 230.30000 GHz 228.16341 GHz ...Enter Name ... 117.188 MHz(154 km/s), 244.141 kHz(0.321 km/s) 1
1/4 231.10000 GHz 228.95599 GHz ...Enter Name ... 117.188 MHz(153 km/s), 244.141 kHz(0.320 km/s) 1
1/2 230.53800 GHz 228.39920 GHz CO v=0 2-1 234.375 MHz(308 km/s), 484.619 kHz(0.636 km/s)
1
2
4
8
16
Select Lines to Observe in Baseband-1...
Add
Delete
Spectral specs share a baseband, sum of shares can't exceed 1
Multiple spectral specs, spectral averaging
Feedback
Validation Validation History Log
15 errors, 0 warnings
Description
Must select a minimum of 1 science keywords
Largest scale is not achievable with the 12m array configura
Spectral Window name is invalid
Spectral Window name is invalid
Failing to rename a spw brings a validation error
Template library. Turn the keys on...
Proposal
Planned Observing
ScienceGoal (B3
ScienceGoal (B7
ScienceGoal (B7
ScienceGoal (B9
ScienceGoal (B3
ScienceGoal (B3
ScienceGoal (B6
ScienceGoal (B7
ScienceGoal (B6
Overview
Contextual Help
Phase I: Science Proposal


Project - Observing Tool for ALMA, version Cycle2Test2
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Project
Proposal
Planned Observing
ScienceGoal (Copy of B6 12CO (2-1): N
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Define the spectral setup.
Template library. Turn the keys on the JTree below & r...
Proposal
Planned Observing
ScienceGoal (B3 spectral sweep CO
ScienceGoal (B7 continuum: COSMO
ScienceGoal (B7 CO(9-8): Cosmic Ey
ScienceGoal (B9 continuum: Cosmic
ScienceGoal (B3 spectral sweep: PK
ScienceGoal (B3 continuum: GRB To
ScienceGoal (B6 continuum: GRB To
ScienceGoal (B7 continuum: GRB To
ScienceGoal (B6 continuum: GRB To
ScienceGoal (B3 continuum: GRB To
ScienceGoal (B6 12CO (2-1): NGC32
ScienceGoal (B6 13CO (2-1): NGC32
ScienceGoal (B6 spectral line: Massi
ScienceGoal (B9 spectral line: Massi
ScienceGoal (B3 continuum: Protoste
Editors
Spectral Spatial Spectral Setup
Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolutio
Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.
Spectral Type
Spectral Line
Single Continuum
Spectral Scan
Polarization products desired XX
Spectral Setup Errors
Spectral Line
Click here to get a Splatalogue window to select a particular spectral line.
Baseband-1
Fraction
Center Freq (Rest)
Center Freq (Sky)
Transition
Bandwid
1(Full)
230.53800 GHz
230.53800 GHz
CO v=0 2-1
875.000 MHz(2438 km/s), 976.563 kHz(1.270 km/s)
1
Select Lines to Observe in Baseband-1...
Add
Delete
Baseband-2
Select Lines to Observe in Baseband-2...
Add
Delete
Feedback
Validation Validation History Log
Description
Suggestion


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
0.1 | 0.66
CO+ J=2-1, F=5/2-3/2 | Carbon Monoxide Ion | 236.063 GHz | 236.063 GHz | 0.1 | 1.2
CO v=2 3-2 | Carbon Monoxide | 339.5 GHz | 339.5 GHz | 6161.831 K | 0.03
CO v=1 3
342.648 GHz | 342.648 GHz | 3116.561 K | 0.71 | 0.03
CO v=0 3
345.796 GHz | 345.796 GHz | 33.192 K | 70 | 0.03
CO+ J=3
353.741 GHz | 353.741 GHz | 0.1 | 1.2
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
678.88 GHz | 6243.288 K | 0.07
685.176 GHz | 3198.774 K | 0.07
691.473 GHz | 116.159 K | 100 | 0.07
791.96 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


The spectral tab gives you a graphical visualization of the spectral setup. The orange vertical bars are sidebands. This setup is okay!
Drag the yellow vertical to move the first LO
Drag the green slider to slide the VIEW
Click in the yellow area to MAGNIFY
Zoom in here to start
File Edit View Tool Search Help
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Visualisation
Left/right click to zoom in/out, grab sliding bar to pan
Observed Frequency
Rest Frequency
LO1
Overlays:
Receiver Bands
Transmission
Overlay Lines
DSB Image
Select Lines to Overlay
Water Vapour Column Density:
Automatic Choice
Manual Choice
1.262mm (4th Octile)
Viewport:
Pan to Line
Zoom to Band
Reset
Feedback
Validation
Validation History
Log
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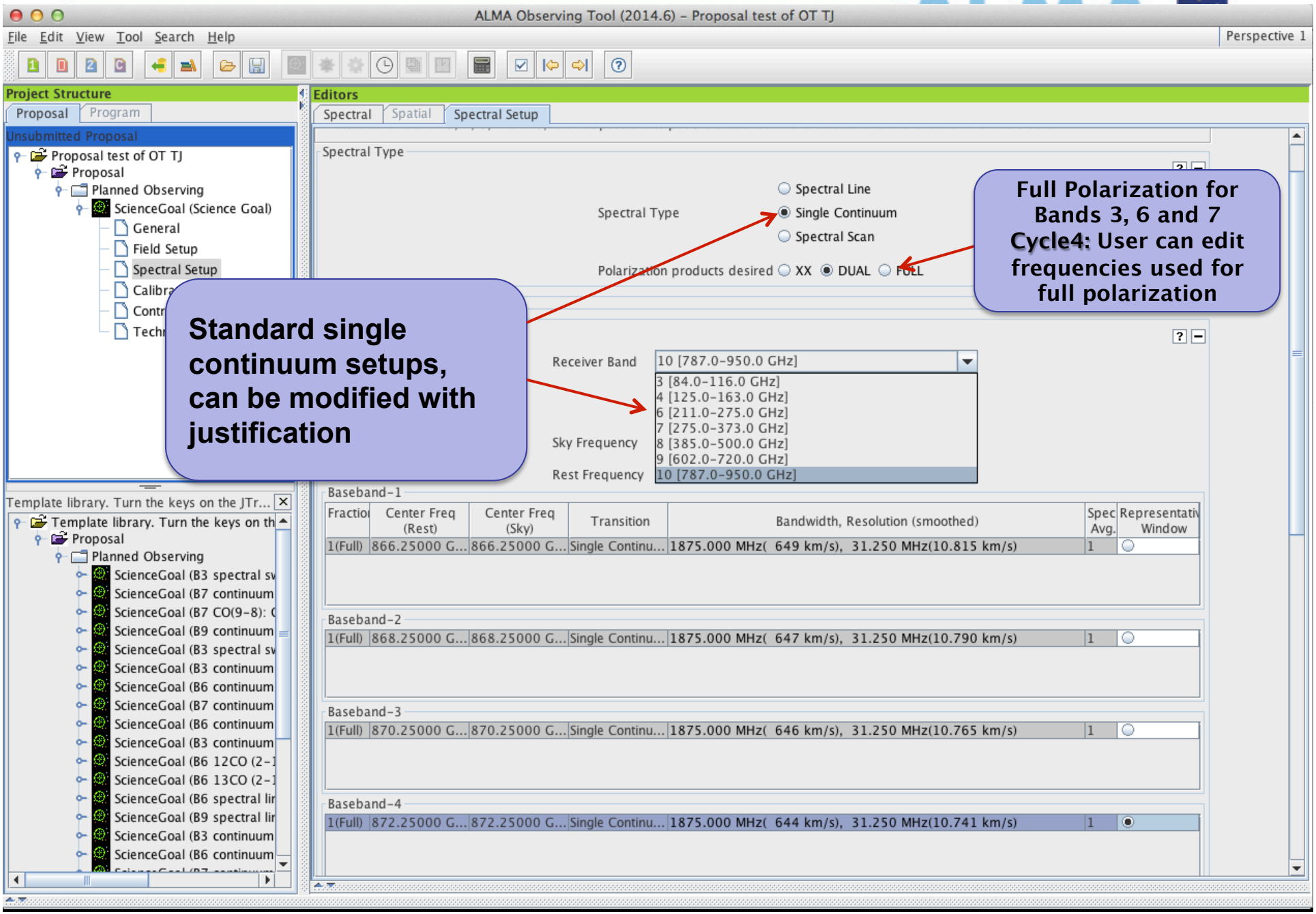
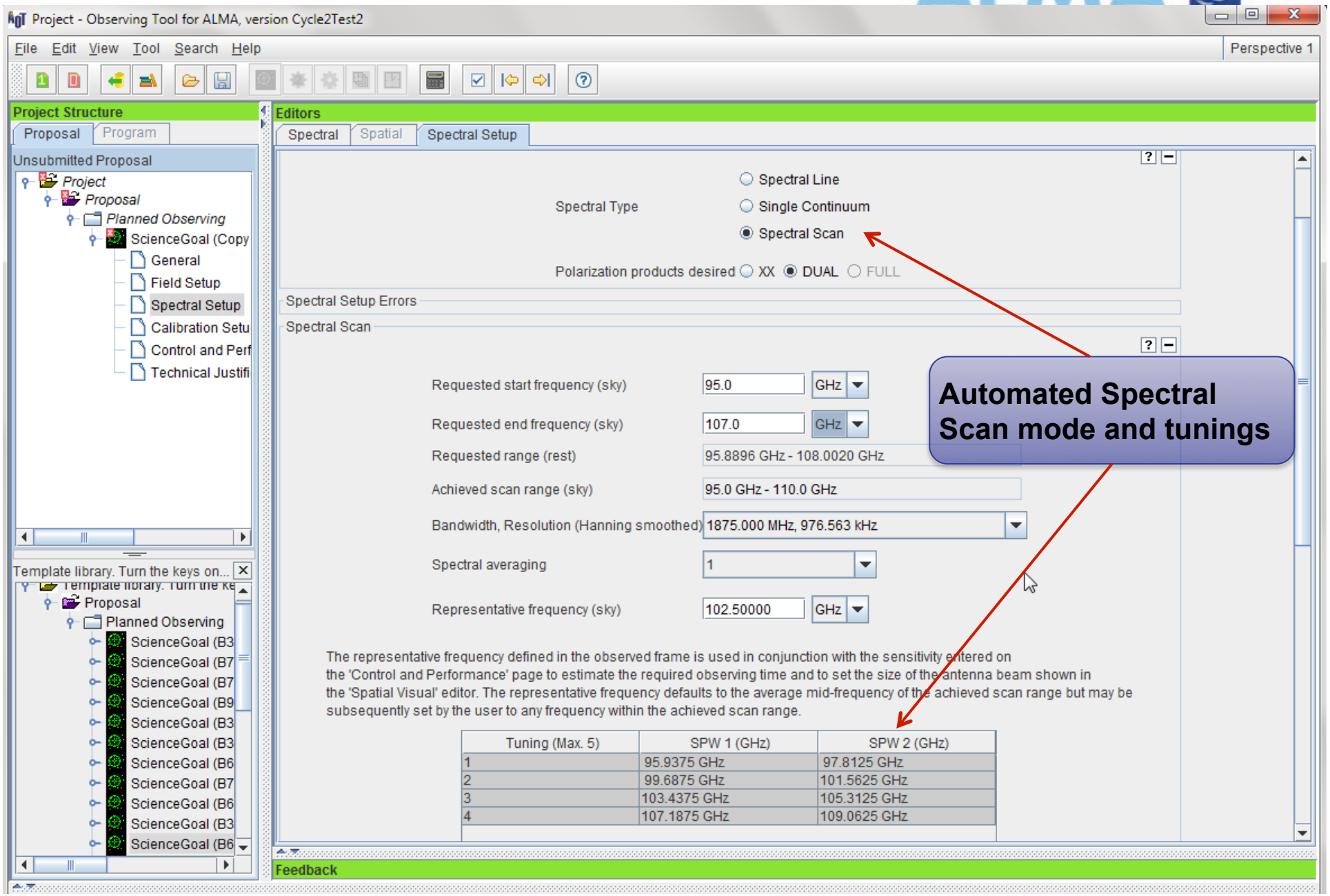
Phase I: Science Proposal

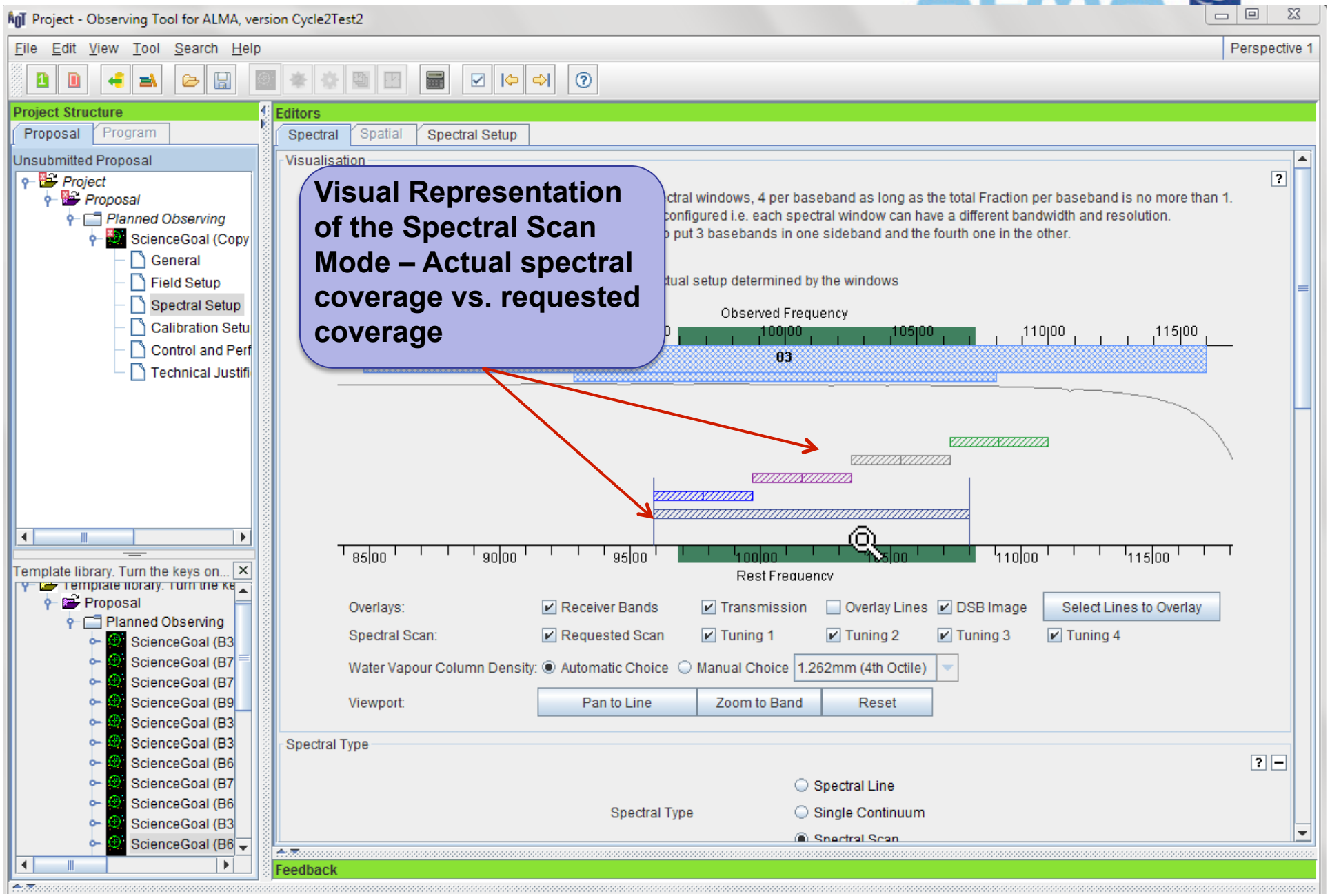
Full Continuum & Polarization

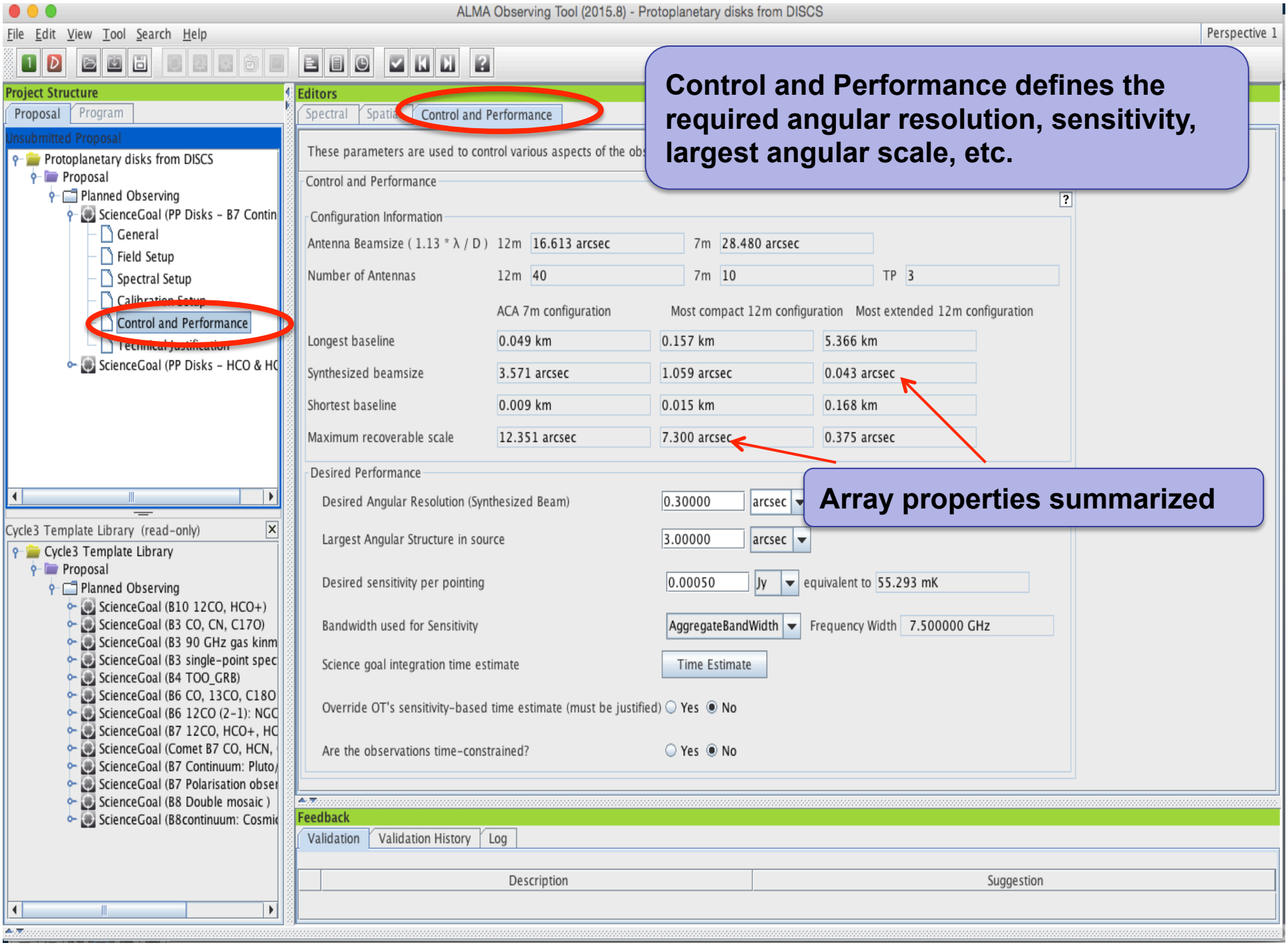


Automated spectral scan - I



Automated spectral scan - II




ALMA Observing Tool (2015.8) - Protoplanetary disks from DISCS
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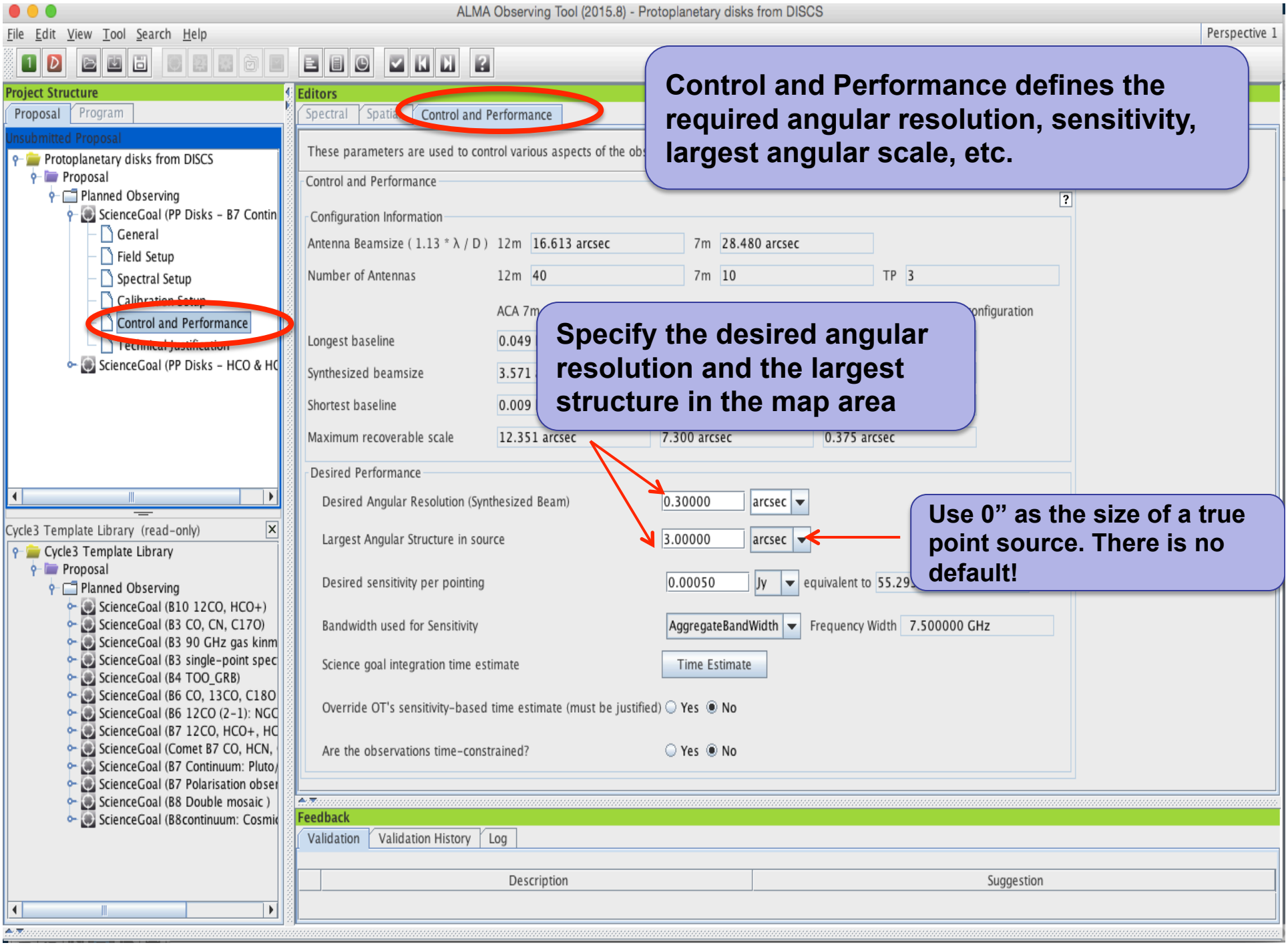
Proposal Program
Unsubmitted Proposal
Protoplanetary disks from DISCS
Proposal
Planned Observing
ScienceGoal (PP Disks – B7 Contin
General
Field Setup
Spectral Setup
Control and Performance
ScienceGoal (PP Disks – HCO & HC
Cycle3 Template Library (read-only)
Cycle3 Template Library
Proposal
Planned Observing
ScienceGoal (B10 12CO, HCO+)
ScienceGoal (B3 CO, CN, C17O)
ScienceGoal (B3 90 GHz gas kinm
ScienceGoal (B3 single-point spec
ScienceGoal (B4 TOO_GRB)
ScienceGoal (B6 CO, 13CO, C18O
ScienceGoal (B6 12CO (2-1): NGC
ScienceGoal (B7 12CO, HCO+, HC
ScienceGoal (Comet B7 CO, HCN,
ScienceGoal (B7 Continuum: Pluto/
ScienceGoal (B7 Polarisation obser
ScienceGoal (B8 Double mosaic)
ScienceGoal (B8continuum: Cosmic
Editors
Spectral
Control and Performance
These parameters are used to control various aspects of the obs
Control and Performance
Configuration Information
Antenna Beamsize (1.13 * λ / D) 12m 16.613 arcsec 7m 28.480 arcsec
Number of Antennas 12m 40 7m 10 TP 3
ACA 7m configuration
Most compact 12m configuration
Most extended 12m configuration
Longest baseline 0.049 km 0.157 km 5.366 km
Synthesized beamsize 3.571 arcsec 1.059 arcsec 0.043 arcsec
Shortest baseline 0.009 km 0.015 km 0.168 km
Maximum recoverable scale 12.351 arcsec 7.300 arcsec 0.375 arcsec
Desired Performance
Desired Angular Resolution (Synthesized Beam) 0.30000 arcsec
Largest Angular Structure in source 3.00000 arcsec
Desired sensitivity per pointing 0.00050 Jy equivalent to 55.293 mK
Bandwidth used for Sensitivity AggregateBandWidth Frequency Width 7.500000 GHz
Science goal integration time estimate Time Estimate
Override OT's sensitivity-based time estimate (must be justified) Yes No
Are the observations time-constrained? Yes No
Feedback
Validation Validation History Log
Description
Suggestion
Control and Performance defines the required angular resolution, sensitivity, largest angular scale, etc.
Array properties summarized


ALMA Observing Tool (2015.8) - Protoplanetary disks from DISCS
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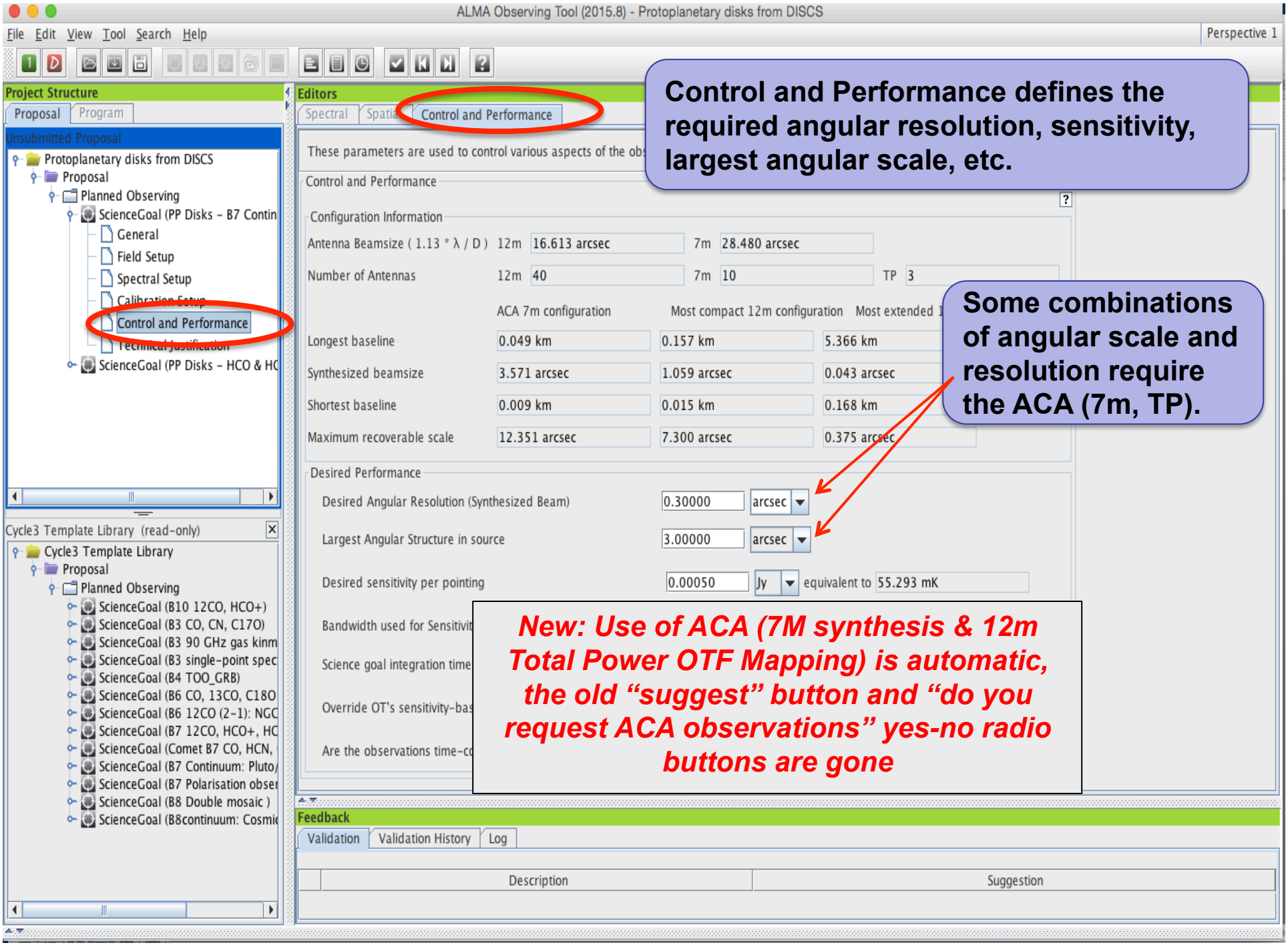
ScienceGoal (PP Disks - B7 Contin
General
Field Setup
Spectral Setup
Control and Performance
ScienceGoal (PP Disks - HCO & HC
Cycle3 Template Library (read-only)
Cycle3 Template Library
Proposal
Planned Observing
ScienceGoal (B10 12CO, HCO+)
ScienceGoal (B3 CO, CN, C17O)
ScienceGoal (B3 90 GHz gas kinm
ScienceGoal (B3 single-point spec
ScienceGoal (B4 TOO_GRB)
ScienceGoal (B6 CO, 13CO, C18O
ScienceGoal (B6 12CO (2-1): NGC
ScienceGoal (B7 12CO, HCO+, HC
ScienceGoal (Comet B7 CO, HCN,
ScienceGoal (B7 Continuum: Pluto/
ScienceGoal (B7 Polarisation obser
ScienceGoal (B8 Double mosaic)
ScienceGoal (B8continuum: Cosmic
Editors
Spectral
Spatial
Control and Performance
These parameters are used to control various aspects of the ob
Control and Performance
Configuration Information
Antenna Beamsize (1.13 * λ / D) 12m 16.613 arcsec 7m 28.480 arcsec
Number of Antennas 12m 40 7m 10 TP 3
ACA 7m
onfiguration
Longest baseline 0.049
Synthesized beamsize 3.571
Shortest baseline 0.009
Maximum recoverable scale 12.351 arcsec 7.300 arcsec 0.375 arcsec
Desired Performance
Desired Angular Resolution (Synthesized Beam) 0.30000 arcsec
Largest Angular Structure in source 3.00000 arcsec
Desired sensitivity per pointing 0.00050 Jy equivalent to 55.29
Bandwidth used for Sensitivity AggregateBandWidth Frequency Width 7.500000 GHz
Science goal integration time estimate Time Estimate
Override OT's sensitivity-based time estimate (must be justified) Yes No
Are the observations time-constrained? Yes No
Feedback
Validation
Validation History
Log
Description
Suggestion
Control and Performance defines the required angular resolution, sensitivity, largest angular scale, etc.
Specify the desired angular resolution and the largest structure in the map area
Use 0” as the size of a true point source. There is no default!


ALMA Observing Tool (2015.8) - Protoplanetary disks from DISCS
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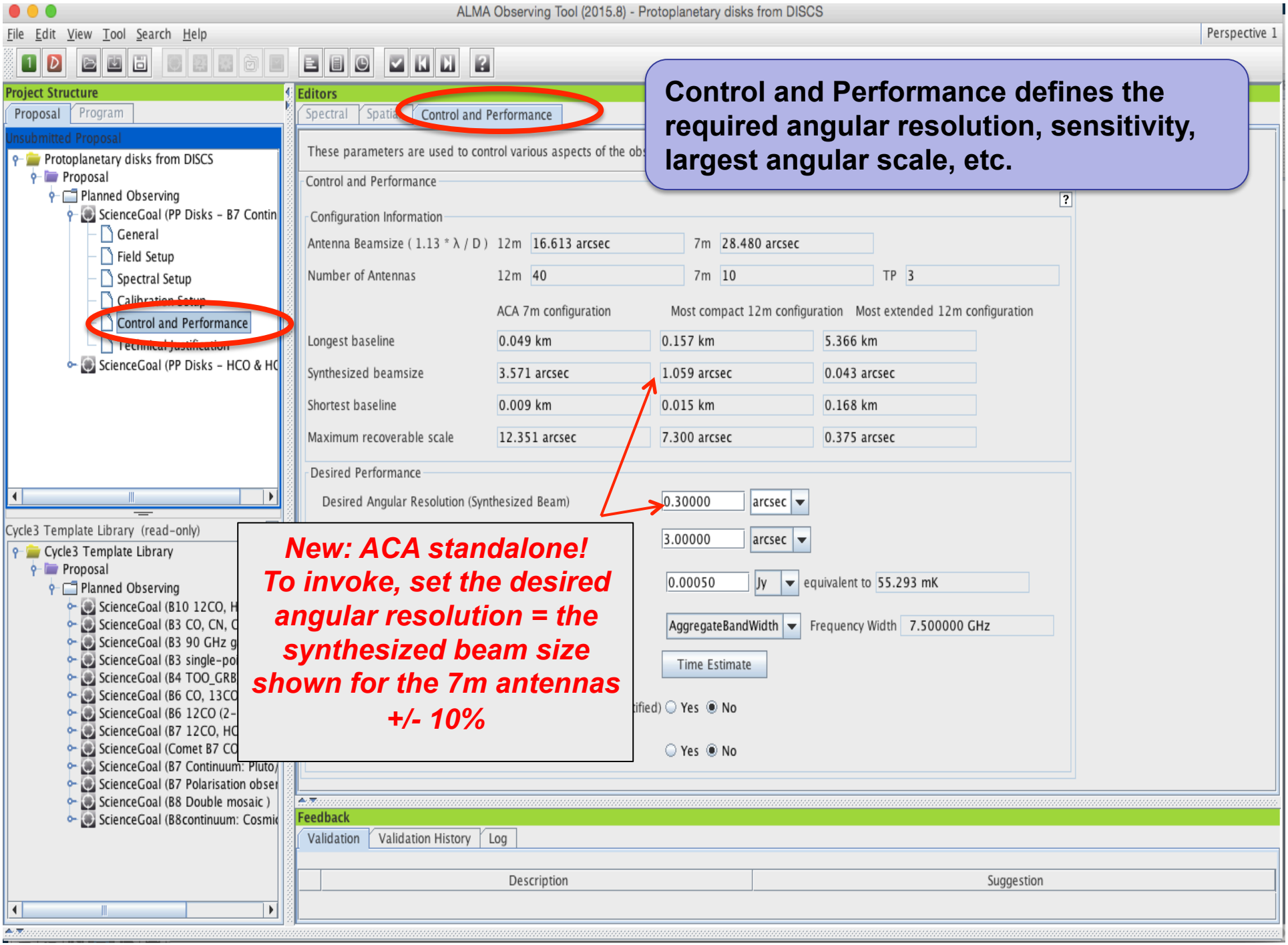
Cycle3 Template Library (read-only)
Cycle3 Template Library
Proposal
Planned Observing
ScienceGoal (B10 12CO, HCO+)
ScienceGoal (B3 CO, CN, C17O)
ScienceGoal (B3 90 GHz gas kinm
ScienceGoal (B3 single-point spec
ScienceGoal (B4 TOO_GRB)
ScienceGoal (B6 CO, 13CO, C18O
ScienceGoal (B6 12CO (2-1): NGC
ScienceGoal (B7 12CO, HCO+, HC
ScienceGoal (Comet B7 CO, HCN,
ScienceGoal (B7 Continuum: Pluto/
ScienceGoal (B7 Polarisation obser
ScienceGoal (B8 Double mosaic)
ScienceGoal (B8continuum: Cosmic
Editors
Spectral
Control and Performance
These parameters are used to control various aspects of the ob
Control and Performance
Configuration Information
Antenna Beamsize (1.13 * λ / D) 12m 16.613 arcsec 7m 28.480 arcsec
Number of Antennas 12m 40 7m 10 TP 3
ACA 7m configuration
Most compact 12m configuration
Most extended
Longest baseline 0.049 km 0.157 km 5.366 km
Synthesized beamsize 3.571 arcsec 1.059 arcsec 0.043 arcsec
Shortest baseline 0.009 km 0.015 km 0.168 km
Maximum recoverable scale 12.351 arcsec 7.300 arcsec 0.375 arcsec
Desired Performance
Desired Angular Resolution (Synthesized Beam) 0.30000 arcsec
Largest Angular Structure in source 3.00000 arcsec
Desired sensitivity per pointing 0.00050 Jy equivalent to 55.293 mK
Bandwidth used for Sensitivit
Science goal integration time
Override OT's sensitivity-bas
Are the observations time-c
Feedback
Validation
Validation History
Log
Description
Suggestion
Control and Performance defines the required angular resolution, sensitivity, largest angular scale, etc.
Some combinations of angular scale and resolution require the ACA (7m, TP).
New: Use of ACA (7M synthesis & 12m Total Power OTF Mapping) is automatic, the old “suggest” button and “do you request ACA observations” yes-no radio buttons are gone


ALMA Observing Tool (2015.8) - Protoplanetary disks from DISCS
File Edit View Tool Search Help
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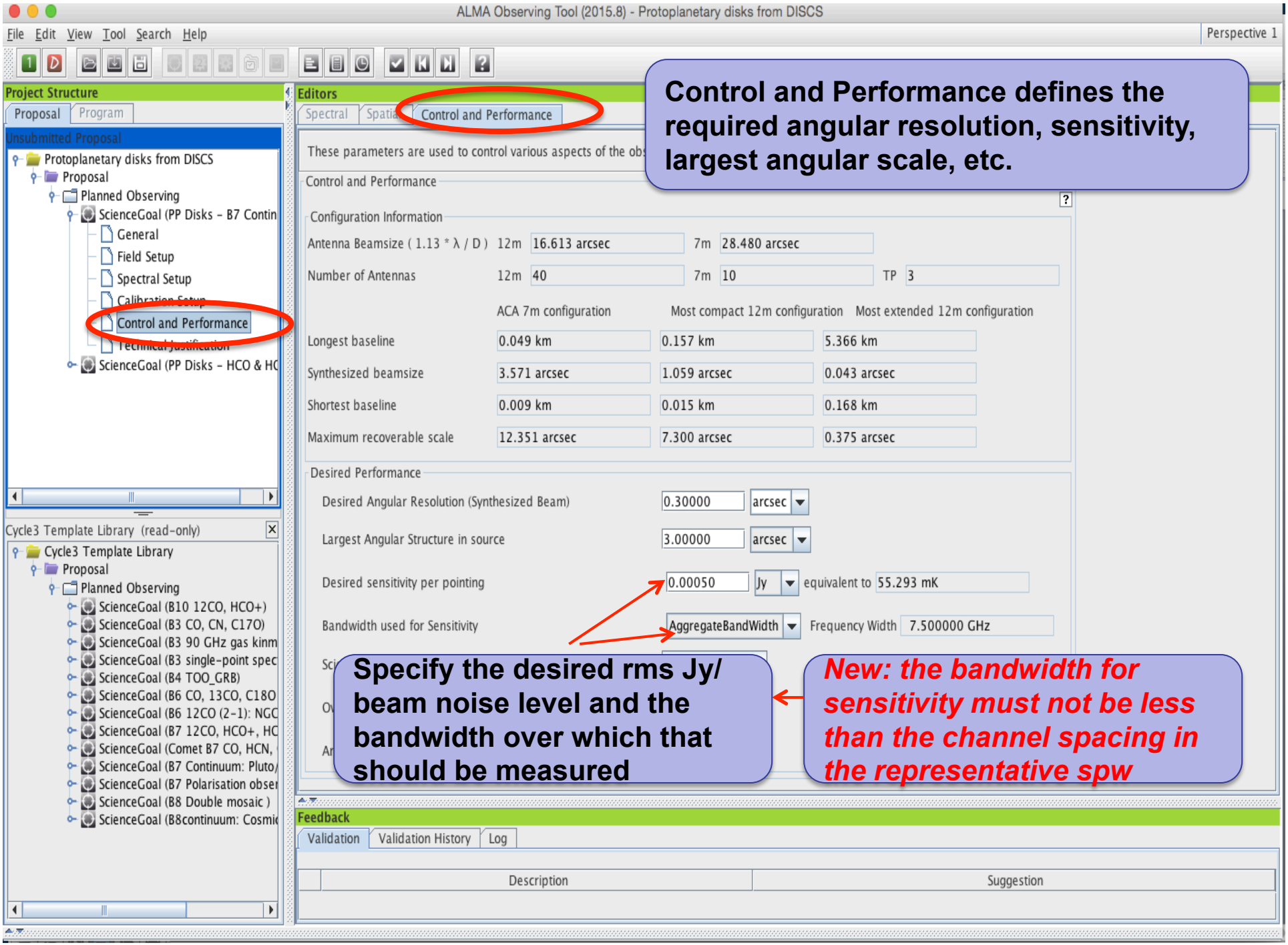
Protoplanetary disks from DISCS
Proposal
Planned Observing
ScienceGoal (PP Disks – B7 Contin
General
Field Setup
Spectral Setup
Control and Performance
ScienceGoal (PP Disks – HCO & HC
Editors
Spectral
Control and Performance
Control and Performance defines the required angular resolution, sensitivity, largest angular scale, etc.
These parameters are used to control various aspects of the ob
Control and Performance
Configuration Information
Antenna Beamsize (1.13 * λ / D) 12m 16.613 arcsec 7m 28.480 arcsec
Number of Antennas 12m 40 7m 10 TP 3
ACA 7m configuration
Most compact 12m configuration
Most extended 12m configuration
Longest baseline 0.049 km 0.157 km 5.366 km
Synthesized beamsize 3.571 arcsec 1.059 arcsec 0.043 arcsec
Shortest baseline 0.009 km 0.015 km 0.168 km
Maximum recoverable scale 12.351 arcsec 7.300 arcsec 0.375 arcsec
Desired Performance
Desired Angular Resolution (Synthesized Beam) 0.30000 arcsec
3.00000 arcsec
0.00050 Jy equivalent to 55.293 mK
AggregateBandWidth Frequency Width 7.500000 GHz
Time Estimate
Yes No
Yes No
New: ACA standalone!
To invoke, set the desired angular resolution = the synthesized beam size shown for the 7m antennas
+/- 10%
Cycle3 Template Library (read-only)
Cycle3 Template Library
Proposal
Planned Observing
ScienceGoal (B10 12CO, H
ScienceGoal (B3 CO, CN, C
ScienceGoal (B3 90 GHz g
ScienceGoal (B3 single-po
ScienceGoal (B4 TOO_GRB
ScienceGoal (B6 CO, 13CO
ScienceGoal (B6 12CO (2-
ScienceGoal (B7 12CO, HC
ScienceGoal (Comet B7 CO
ScienceGoal (B7 Continuum: Pluto
ScienceGoal (B7 Polarisation obser
ScienceGoal (B8 Double mosaic)
ScienceGoal (B8continuum: Cosmic
Feedback
Validation Validation History Log
Description
Suggestion


ALMA Observing Tool (2015.8) - Protoplanetary disks from DISCS
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Protoplanetary disks from DISCS
Proposal
Planned Observing
ScienceGoal (PP Disks – B7 Contin
General
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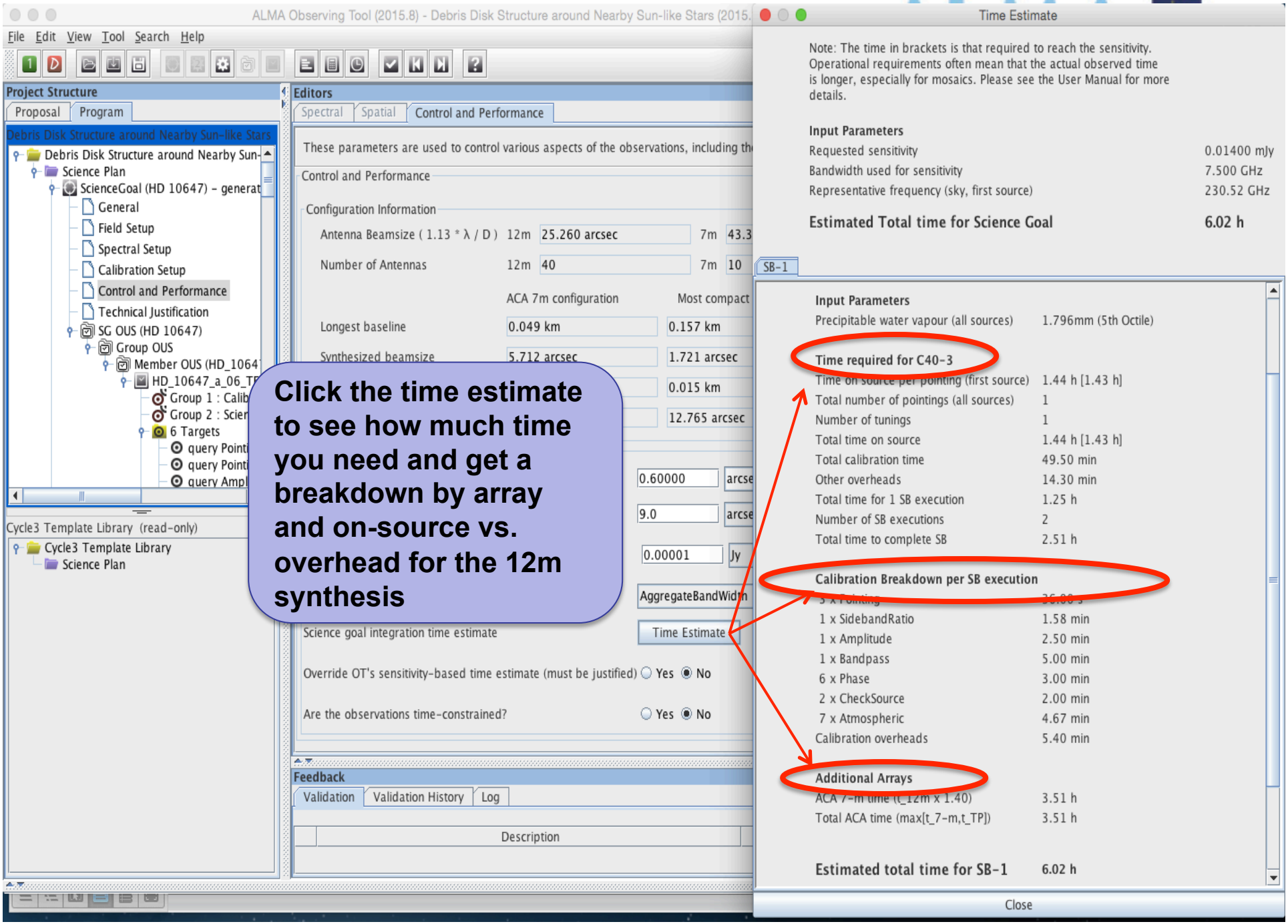
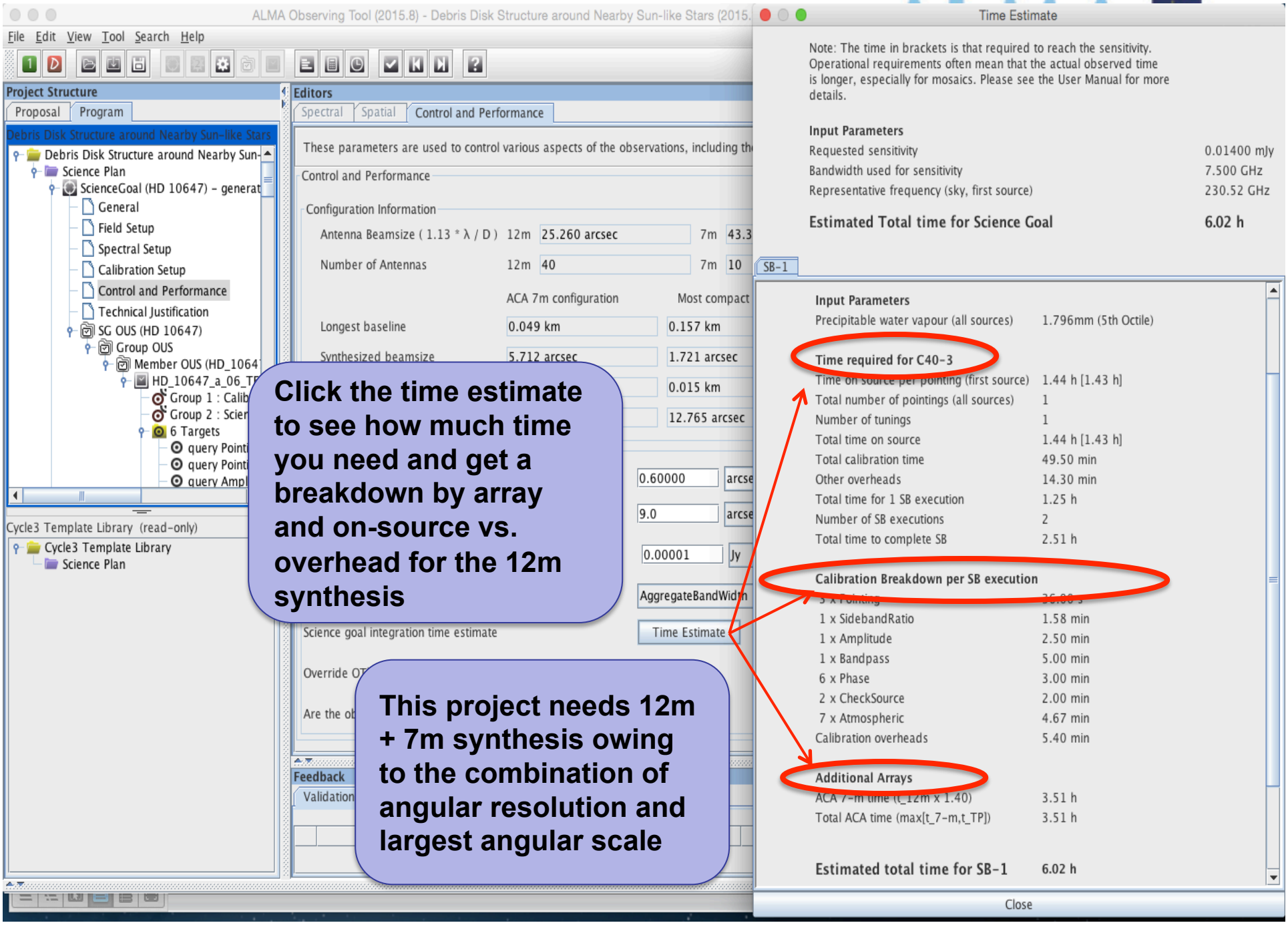
Control and Performance
ScienceGoal (PP Disks – HCO & HC
Cycle3 Template Library (read-only)
Cycle3 Template Library
Proposal
Planned Observing
ScienceGoal (B10 12CO, HCO+)
ScienceGoal (B3 CO, CN, C17O)
ScienceGoal (B3 90 GHz gas kinm
ScienceGoal (B3 single-point spec
ScienceGoal (B4 TOO_GRB)
ScienceGoal (B6 CO, 13CO, C18O
ScienceGoal (B6 12CO (2-1): NGC
ScienceGoal (B7 12CO, HCO+, HC
ScienceGoal (Comet B7 CO, HCN,
ScienceGoal (B7 Continuum: Pluto/
ScienceGoal (B7 Polarisation obser
ScienceGoal (B8 Double mosaic)
ScienceGoal (B8continuum: Cosmic
Editors
Spectral
Control and Performance
These parameters are used to control various aspects of the ob
Control and Performance
Configuration Information
Antenna Beamsize (1.13 * λ / D) 12m 16.613 arcsec 7m 28.480 arcsec
Number of Antennas 12m 40 7m 10 TP 3
ACA 7m configuration
Most compact 12m configuration
Most extended 12m configuration
Longest baseline 0.049 km 0.157 km 5.366 km
Synthesized beamsize 3.571 arcsec 1.059 arcsec 0.043 arcsec
Shortest baseline 0.009 km 0.015 km 0.168 km
Maximum recoverable scale 12.351 arcsec 7.300 arcsec 0.375 arcsec
Desired Performance
Desired Angular Resolution (Synthesized Beam) 0.30000 arcsec
Largest Angular Structure in source 3.00000 arcsec
Desired sensitivity per pointing 0.00050 Jy equivalent to 55.293 mK
Bandwidth used for Sensitivity AggregateBandWidth Frequency Width 7.500000 GHz
Feedback
Validation
Validation History
Log
Description
Suggestion
Control and Performance defines the required angular resolution, sensitivity, largest angular scale, etc.
Specify the desired rms Jy/beam noise level and the bandwidth over which that should be measured
New: the bandwidth for sensitivity must not be less than the channel spacing in the representative spw

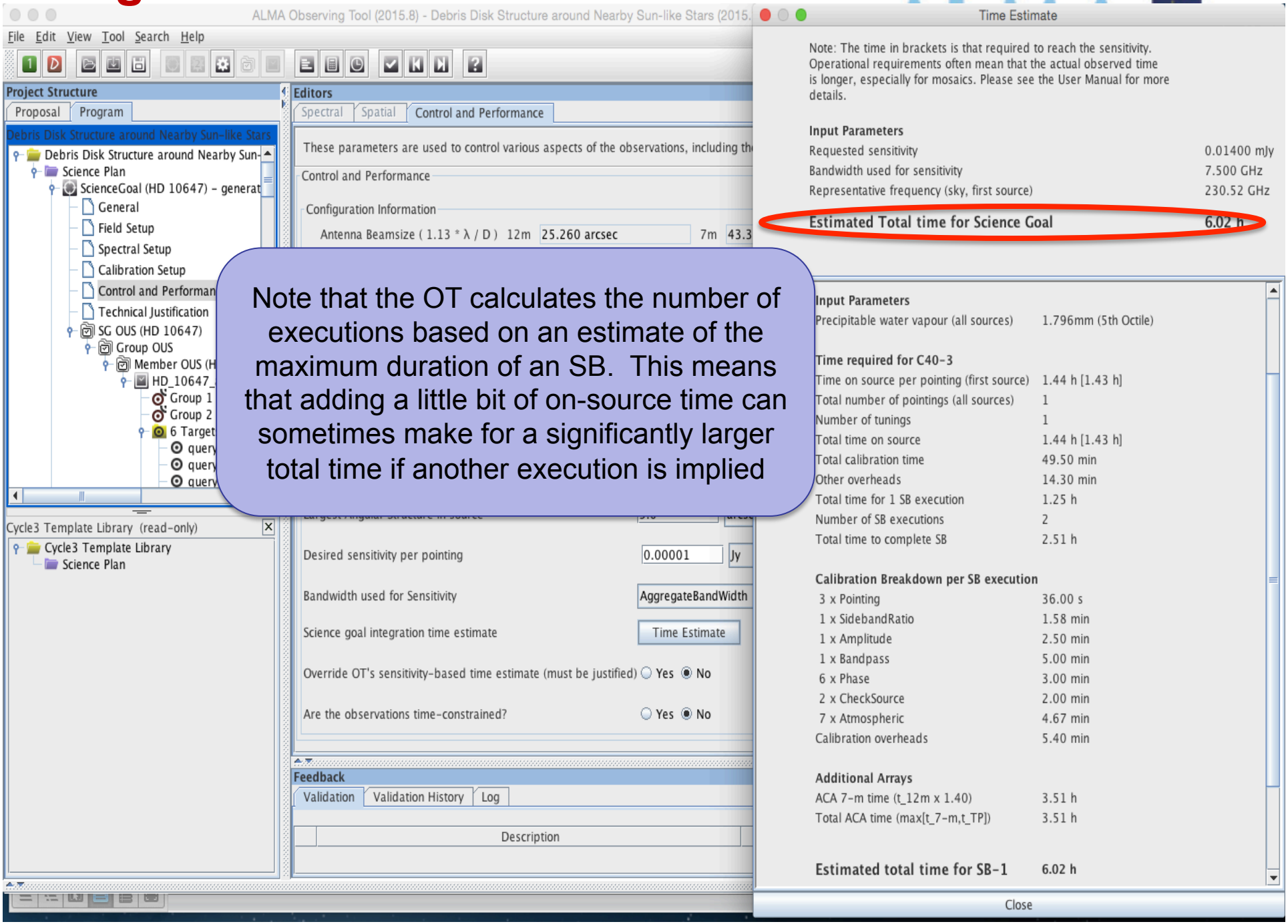
SG Time Estimates



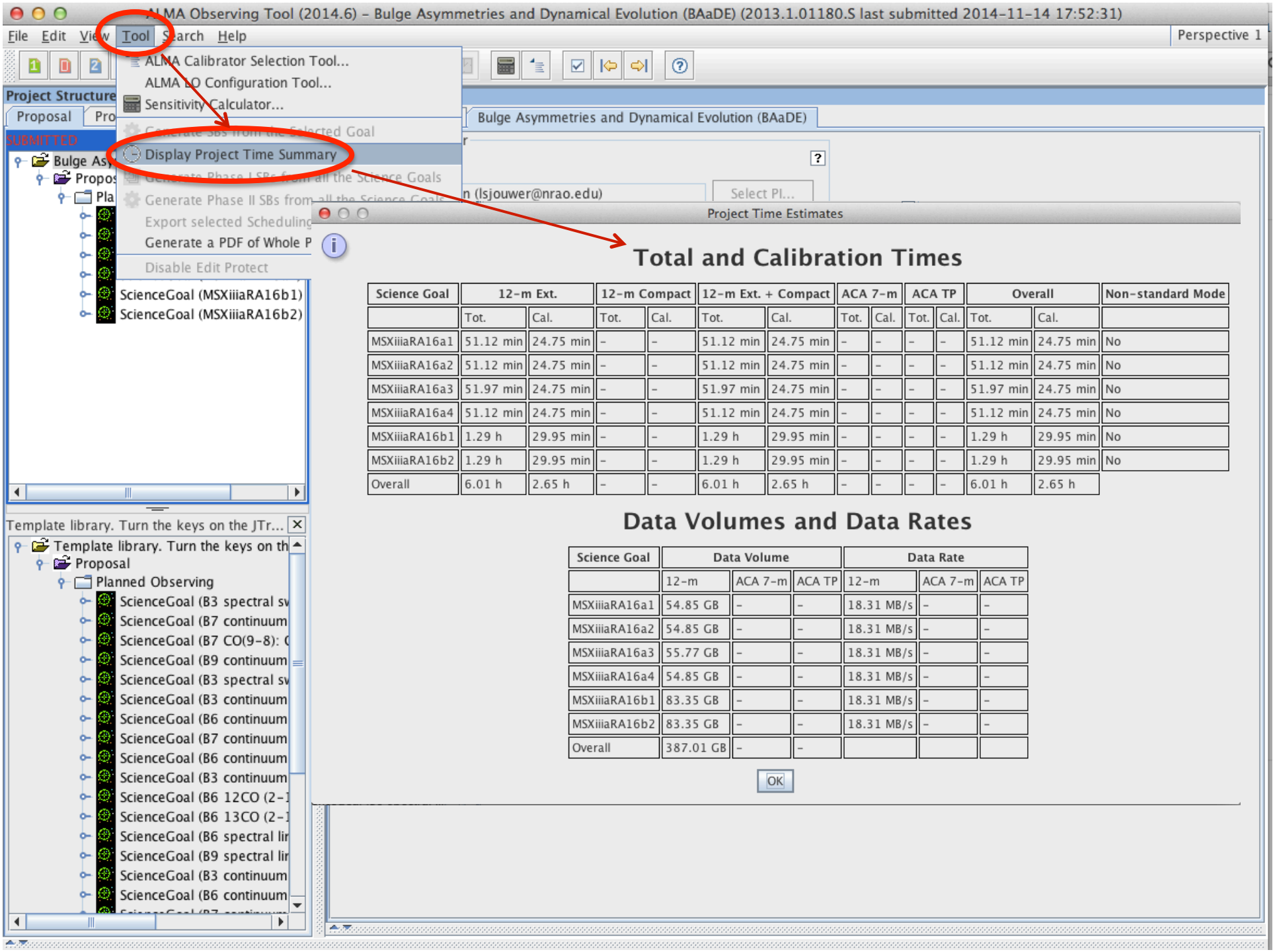
SG Time Estimates



Single source time estimates



Note that the OT calculates the number of executions based on an estimate of the maximum duration of an SB. This means that adding a little bit of on-source time can sometimes make for a significantly larger total time if another execution is implied



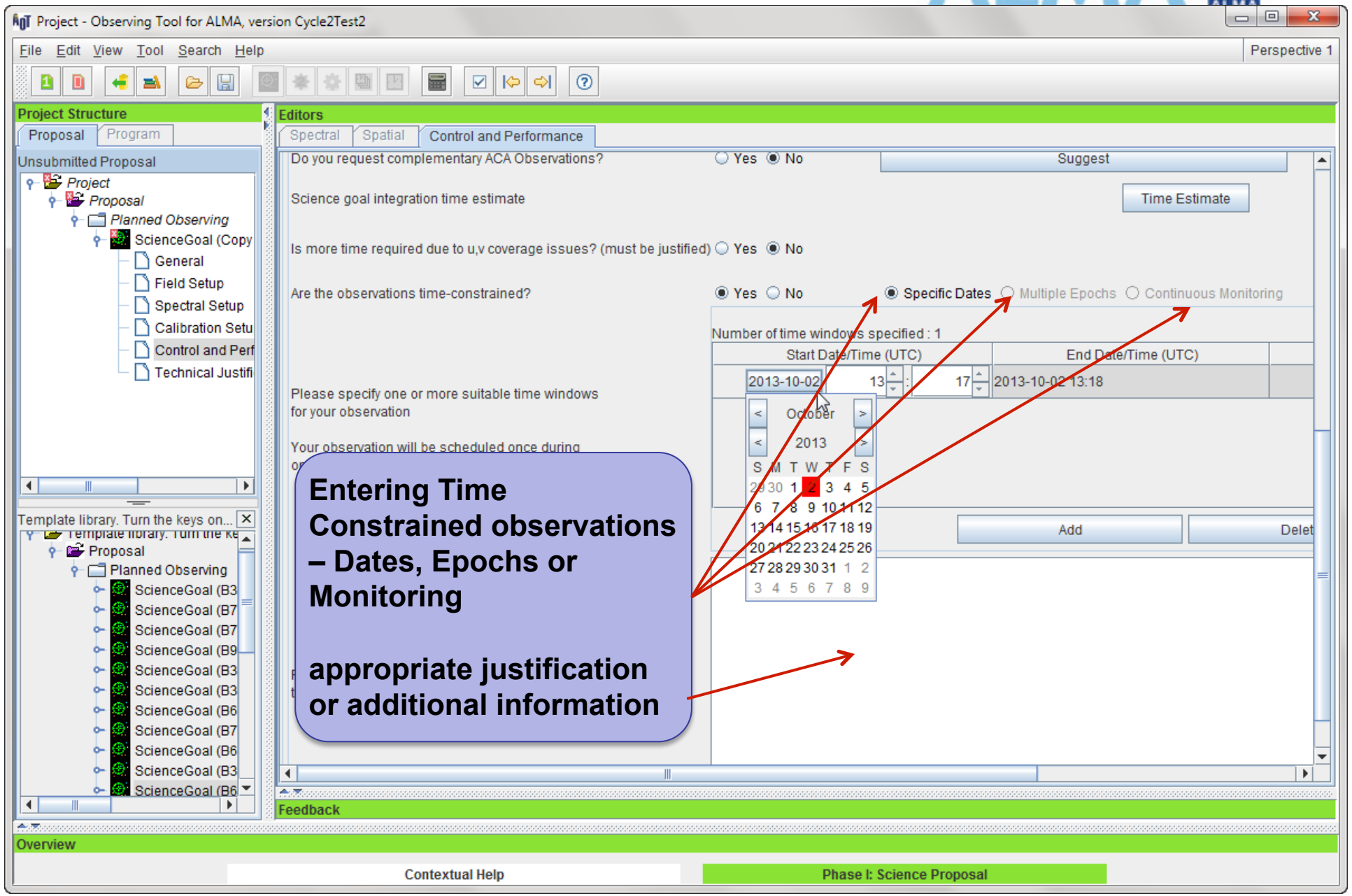
Total and Calibration Times

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	

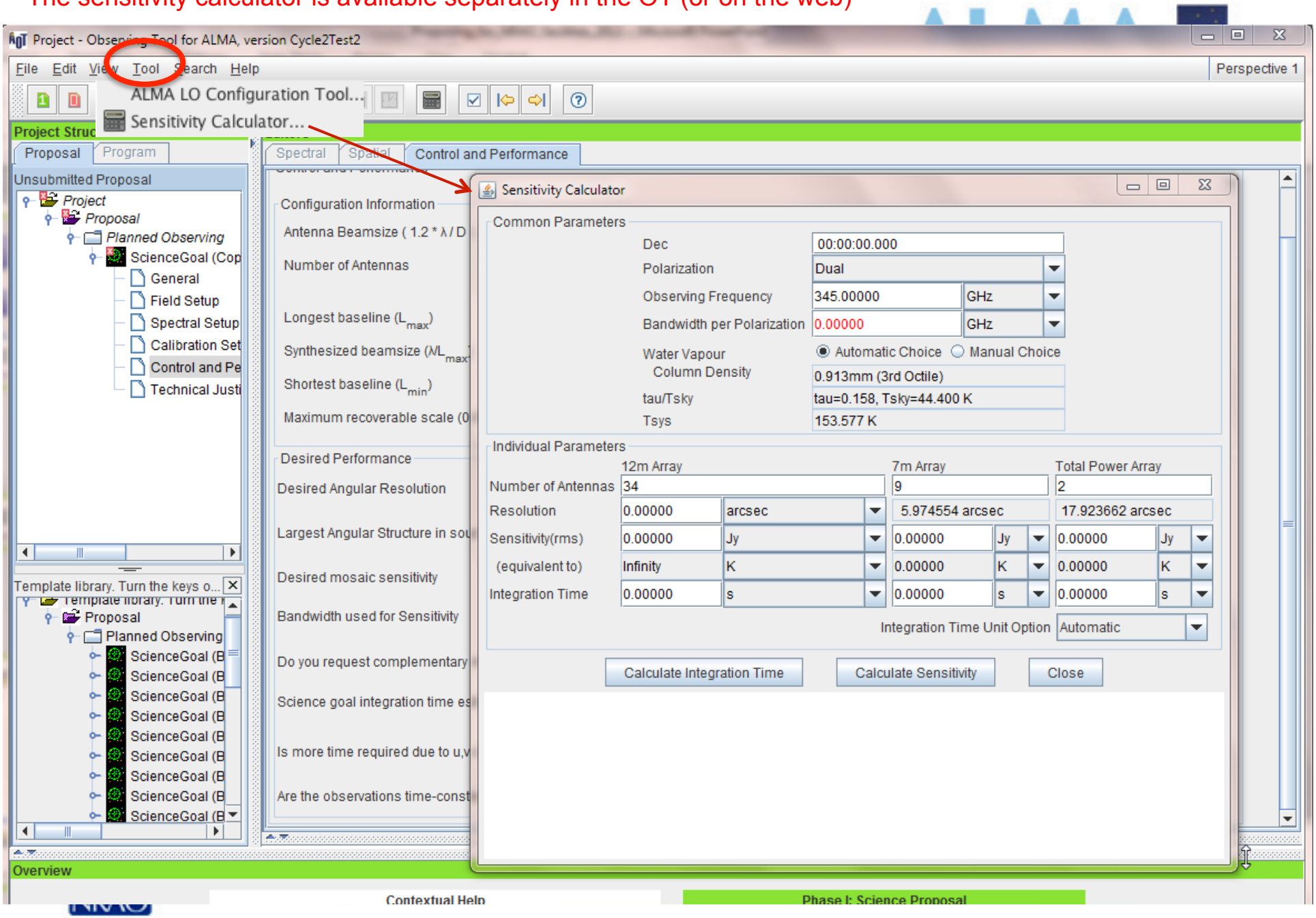
Data Volumes and Data Rates

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	-	-			

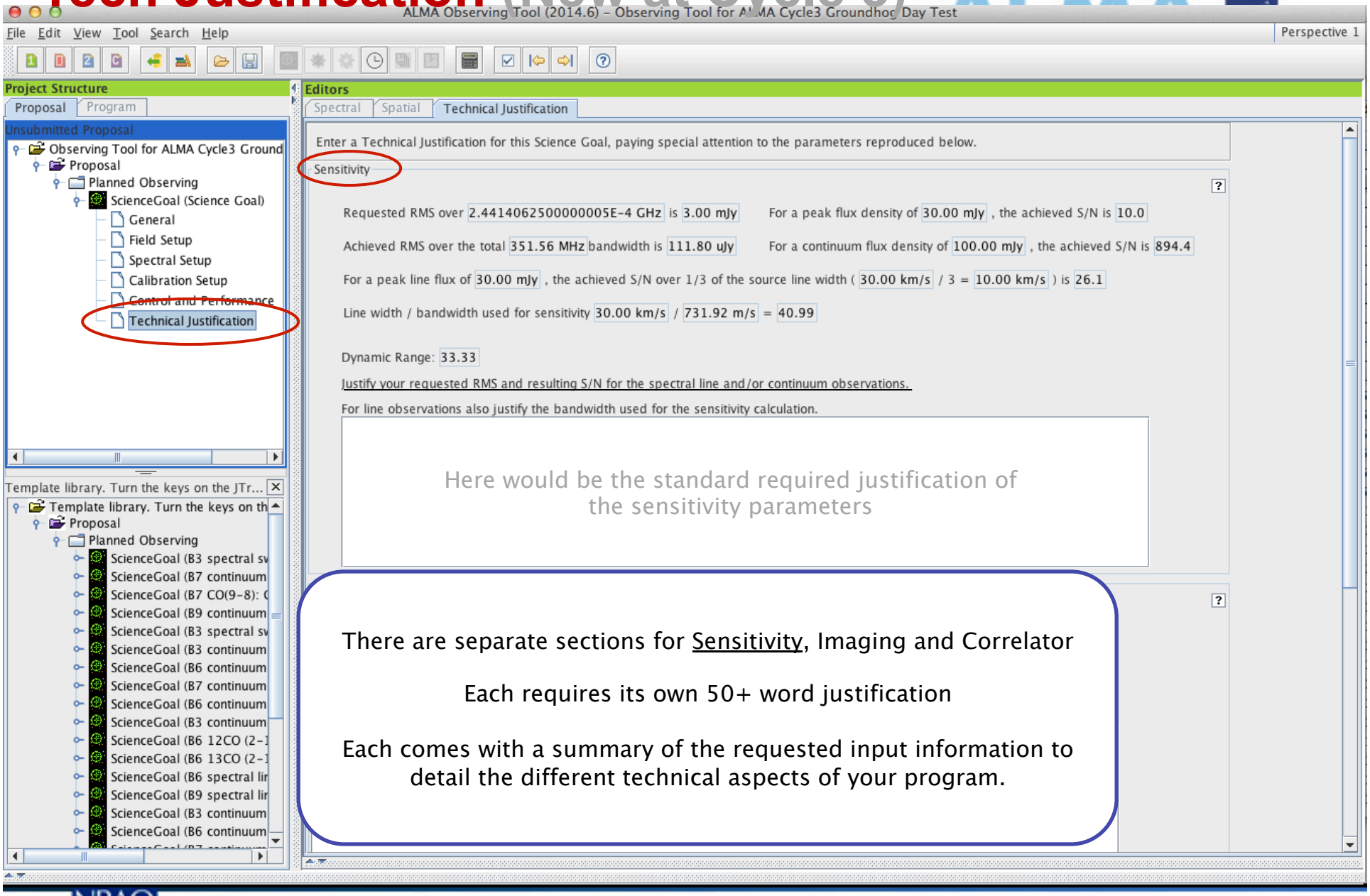
Time constrained observing



The sensitivity calculator is available separately in the OT (or on the web)



Tech Justification (New at Cycle 3)



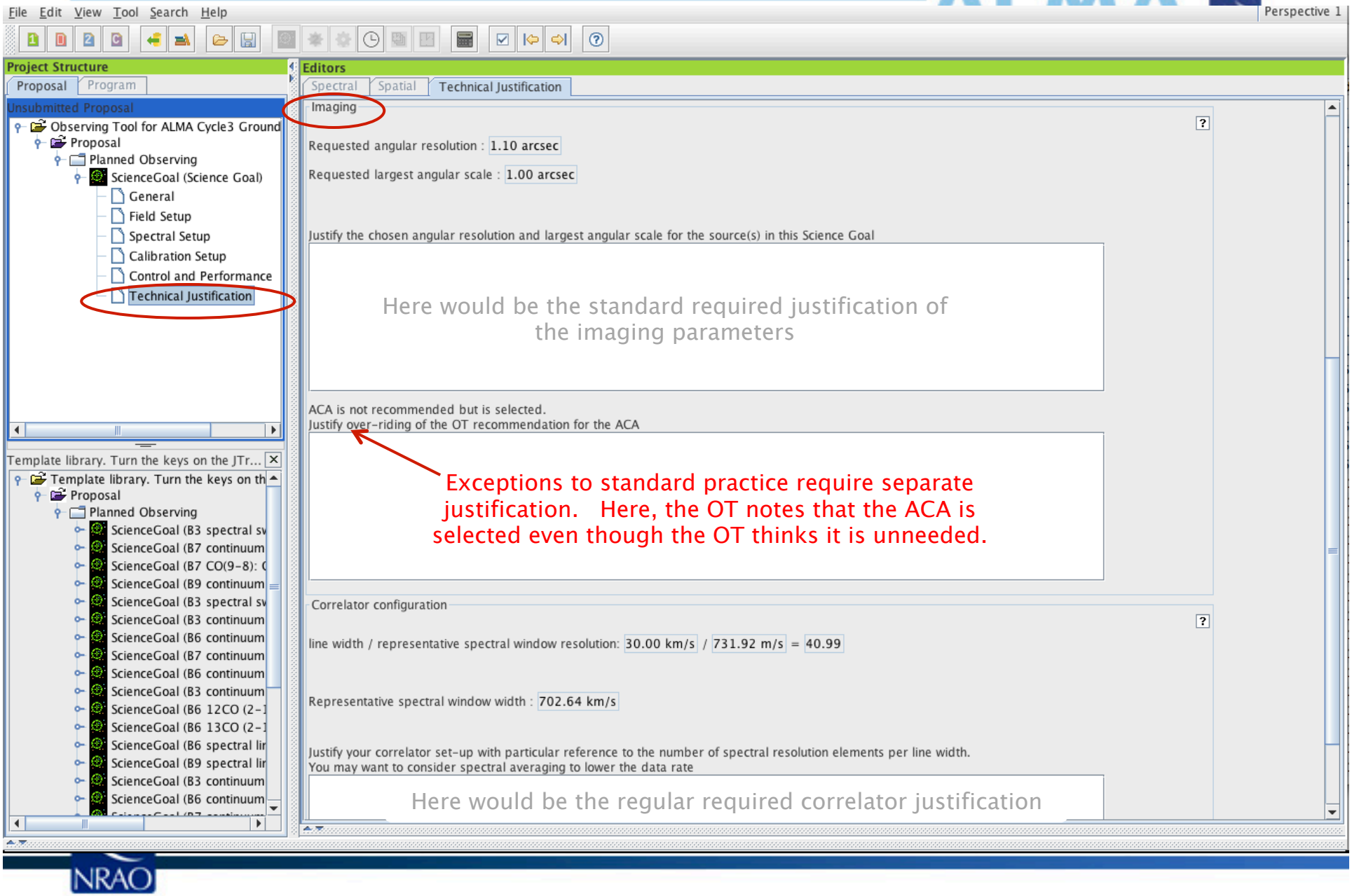
There are separate sections for Sensitivity, Imaging and Correlator

Each requires its own 50+ word justification

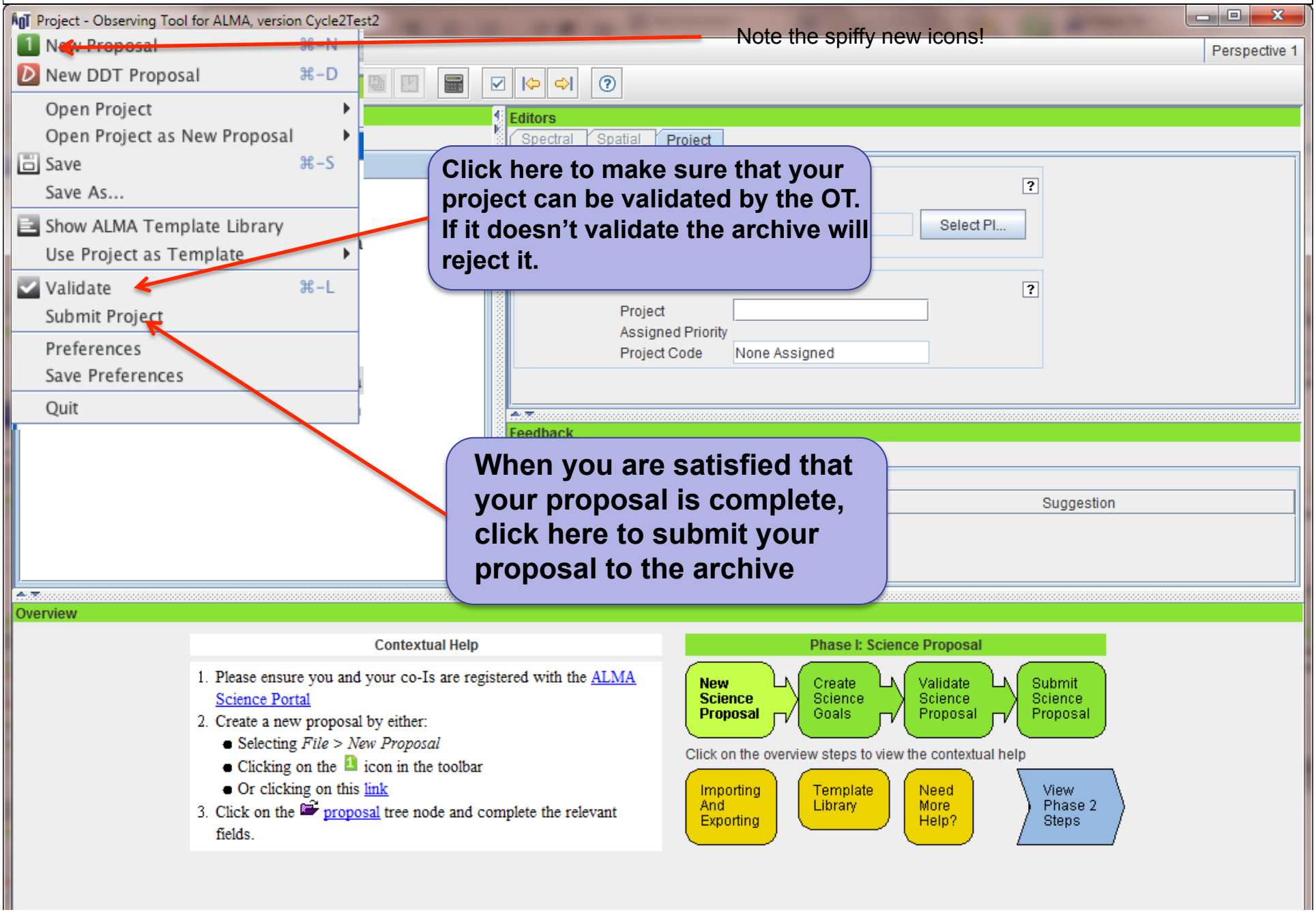
Each comes with a summary of the requested input information to detail the different technical aspects of your program.

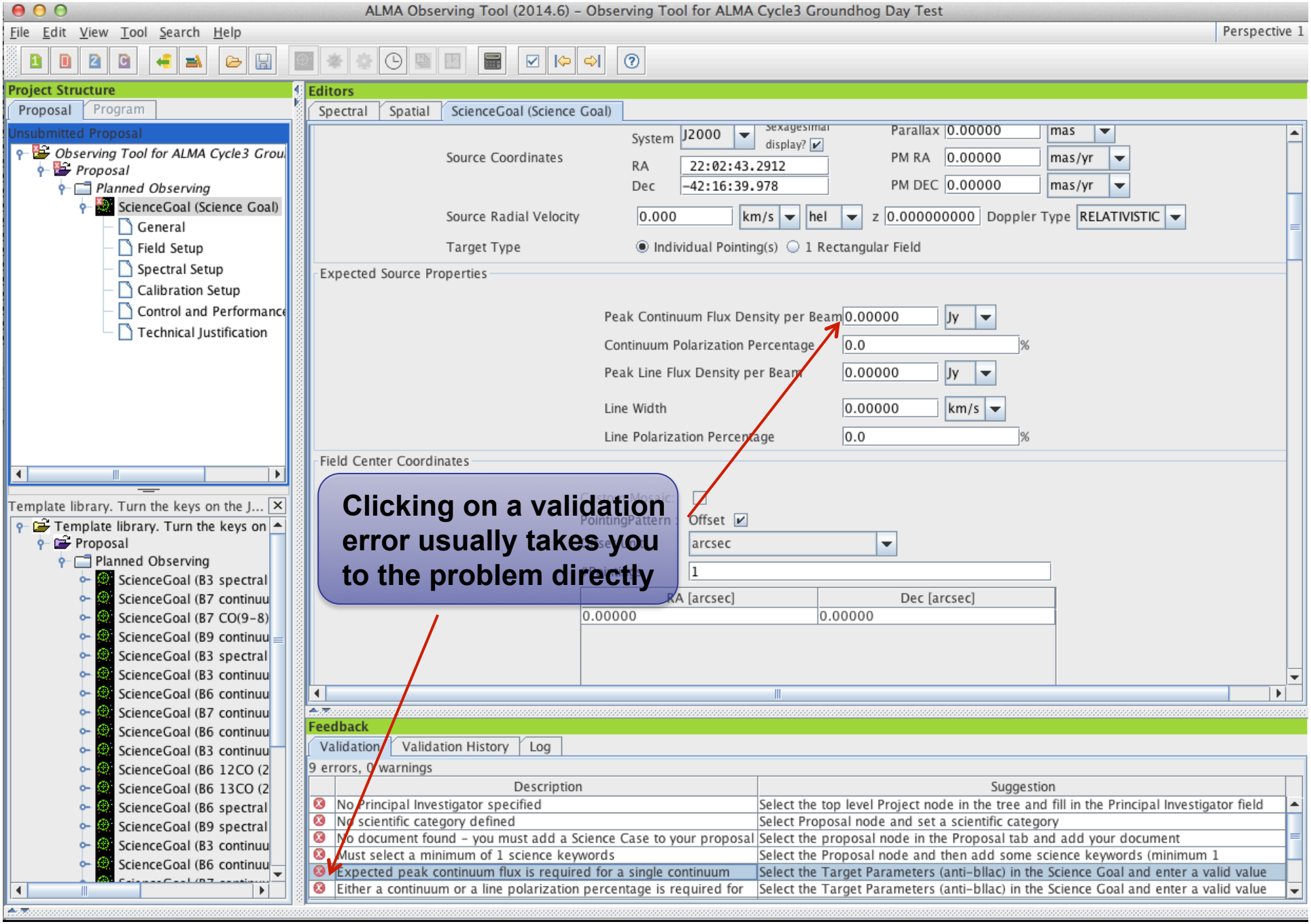
NRAO

Tech Justification



When the time is ripe … validate & submit




ALMA Observing Tool (2014.6) – Observing Tool for ALMA Cycle3 Groundhog Day Test
File Edit View Tool Search Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
Observing Tool for ALMA Cycle3 Grou
Proposal
Planned Observing
ScienceGoal (Science Goal)
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Template library. Turn the keys on the J...
Template library. Turn the keys on
Proposal
Planned Observing
ScienceGoal (B3 spectral
ScienceGoal (B7 continuu
ScienceGoal (B7 CO(9-8)
ScienceGoal (B9 continuu
ScienceGoal (B3 spectral
ScienceGoal (B3 continuu
ScienceGoal (B6 continuu
ScienceGoal (B7 continuu
ScienceGoal (B6 continuu
ScienceGoal (B3 continuu
ScienceGoal (B6 12CO (2
ScienceGoal (B6 13CO (2
ScienceGoal (B6 spectral
ScienceGoal (B9 spectral
ScienceGoal (B3 continuu
ScienceGoal (B6 continuu
Editors
Spectral Spatial ScienceGoal (Science Goal)
Source Coordinates
System J2000
Sexagesimal display?
RA 22:02:43.2912
Dec -42:16:39.978
Parallax 0.00000 mas
PM RA 0.00000 mas/yr
PM DEC 0.00000 mas/yr
Source Radial Velocity 0.000 km/s hel z 0.000000000 Doppler Type RELATIVISTIC
Target Type Individual Pointing(s) 1 Rectangular Field
Expected Source Properties
Peak Continuum Flux Density per Beam 0.00000 Jy
Continuum Polarization Percentage 0.0 %
Peak Line Flux Density per Beam 0.00000 Jy
Line Width 0.00000 km/s
Line Polarization Percentage 0.0 %
Field Center Coordinates
PointingPattern
Offset
arcsec
1
RA [arcsec]
Dec [arcsec]
0.00000
0.00000
Clicking on a validation error usually takes you to the problem directly
Feedback
Validation Validation History Log
9 errors, 0 warnings
Description
Suggestion
No Principal Investigator specified
Select the top level Project node in the tree and fill in the Principal Investigator field
No scientific category defined
Select Proposal node and set a scientific category
No document found – you must add a Science Case to your proposal
Select the proposal node in the Proposal tab and add your document
Must select a minimum of 1 science keywords
Select the Proposal node and then add some science keywords (minimum 1
Expected peak continuum flux is required for a single continuum
Select the Target Parameters (anti-bllac) in the Science Goal and enter a valid value
Either a continuum or a line polarization percentage is required for
Select the Target Parameters (anti-bllac) in the Science Goal and enter a valid value

Summary: New for Cycle 4 OT

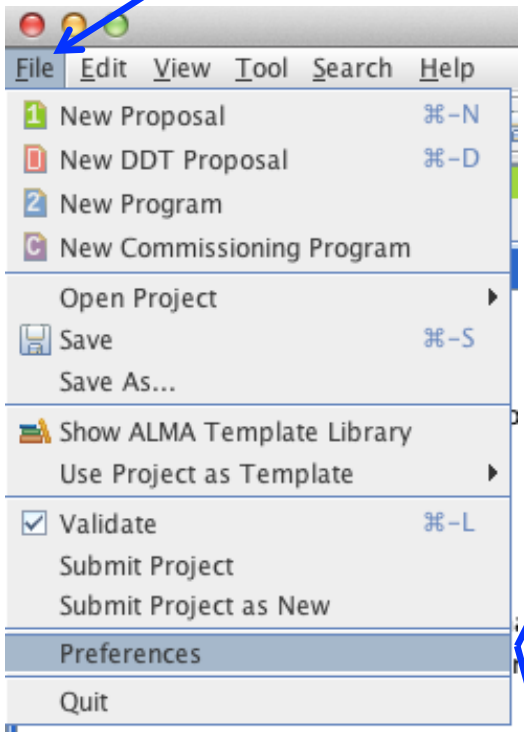
For Cycle 4, some notable new "ALMA" features:

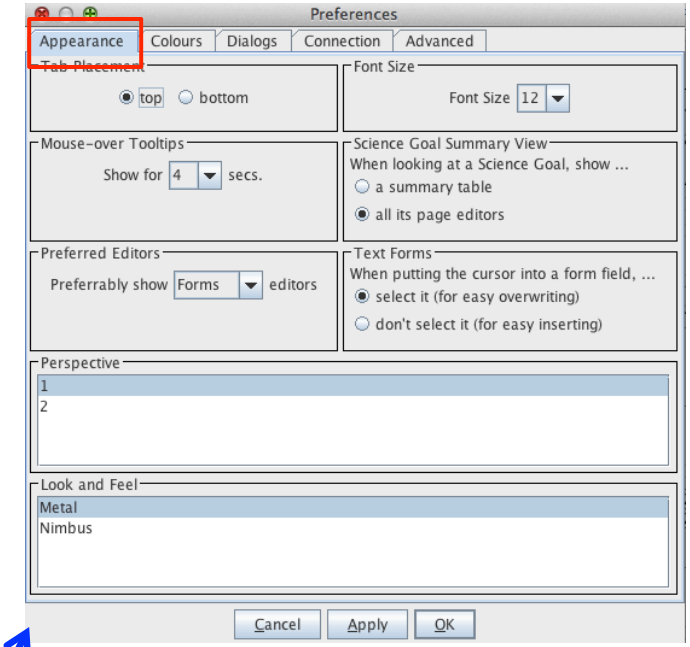
+ Large, VLBI and ACA-standalone projects
  to invoke ACA-standalone set desired angular resolution = 7m synthesized hpbw
+ On-axis spectral line polarization
+ 40 12-m array, 10 7-m array, 3 TP antennas

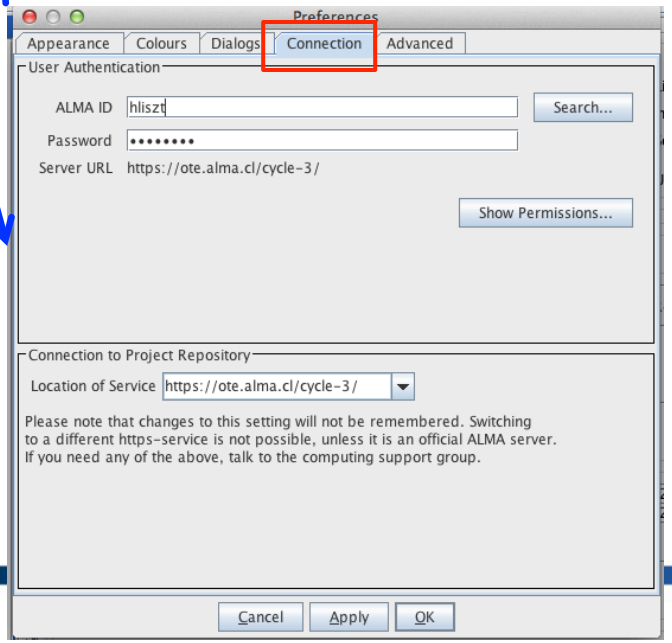
There are also new "OT" features:

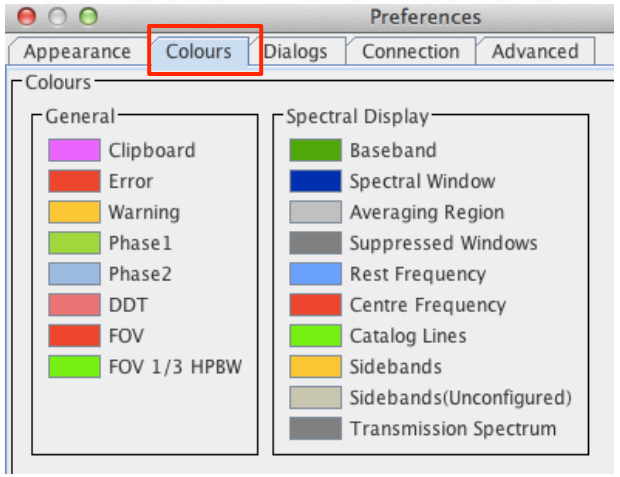
+ The 10^{o} size limitation on SG is gone, the OT will cluster your targets for you
+ Inclusion of the ACA is automatic, no more “suggest” and “do you request”
+ The bandwidth for sensitivity can’t be smaller than representative spw’s channel spacing
+ ICRS generally replaces “FK5 J2000”
+ Cut/paste commands are the same inside the OT and outside in your OS

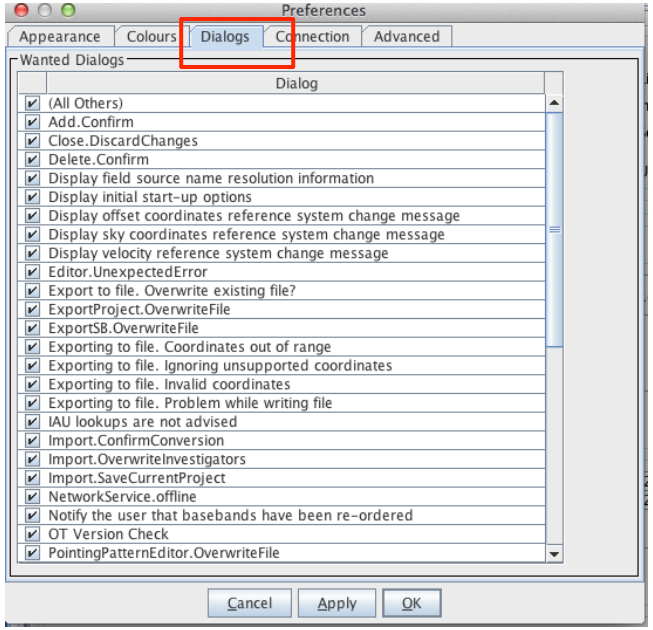
Use preferences to customize











A Few OT Tips…

- New: The same cut and paste commands you use outside the OT for text also now work inside it
- Ctrl-Z global shortcut will expand out succeeding items in the J-tree (try it, you'll see what we mean)
- Holding down ALT when making choices in dropdown lists will convert to the unit or type of the new choice
  - Otherwise, only the description changes, not value
- OT does galactic-celestial conversion automatically
  - Cannot convert in other ways, eg not FK5 J2000 to ICRS. FK5 J2000 now deprecated

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