The ALMA Observing Tool

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The ALMA Observing Tool (OT)

- The ALMA OT performs two roles:
  - Preparation and submission of ALMA proposals
    - Including Director's Discretionary Time and Supplemental Call
  - Production of Phase-2 products (Scheduling Blocks)
    - SBs are generated automatically – PIs do not do this!
    - Observatory staff can edit if required
- The OT has been in use since Cycle 0 (2011)
  - More than 10^4 proposals have been submitted with it so far
- The tool remains under continuous development
  - New features are added in every cycle
  - Already discussed the ALMA capabilities in the previous talk

Installation

- Downloaded from ALMA Science Portal
  - *https://almascience.eso.org/proposing/observing-tool*

Installation

- The OT is a Java Desktop Application (not a web app)
- There are two installation choices
  - Java Web Start
  - Traditional tar archive (“tarball”)
- Web Start is **generally** recommended
  - “Single-click” install
  - Automatically gets updates
- Tarball most useful if user can’t install Java
  - Manual installation and updates necessary
  - The OT will warn the user if an update is available

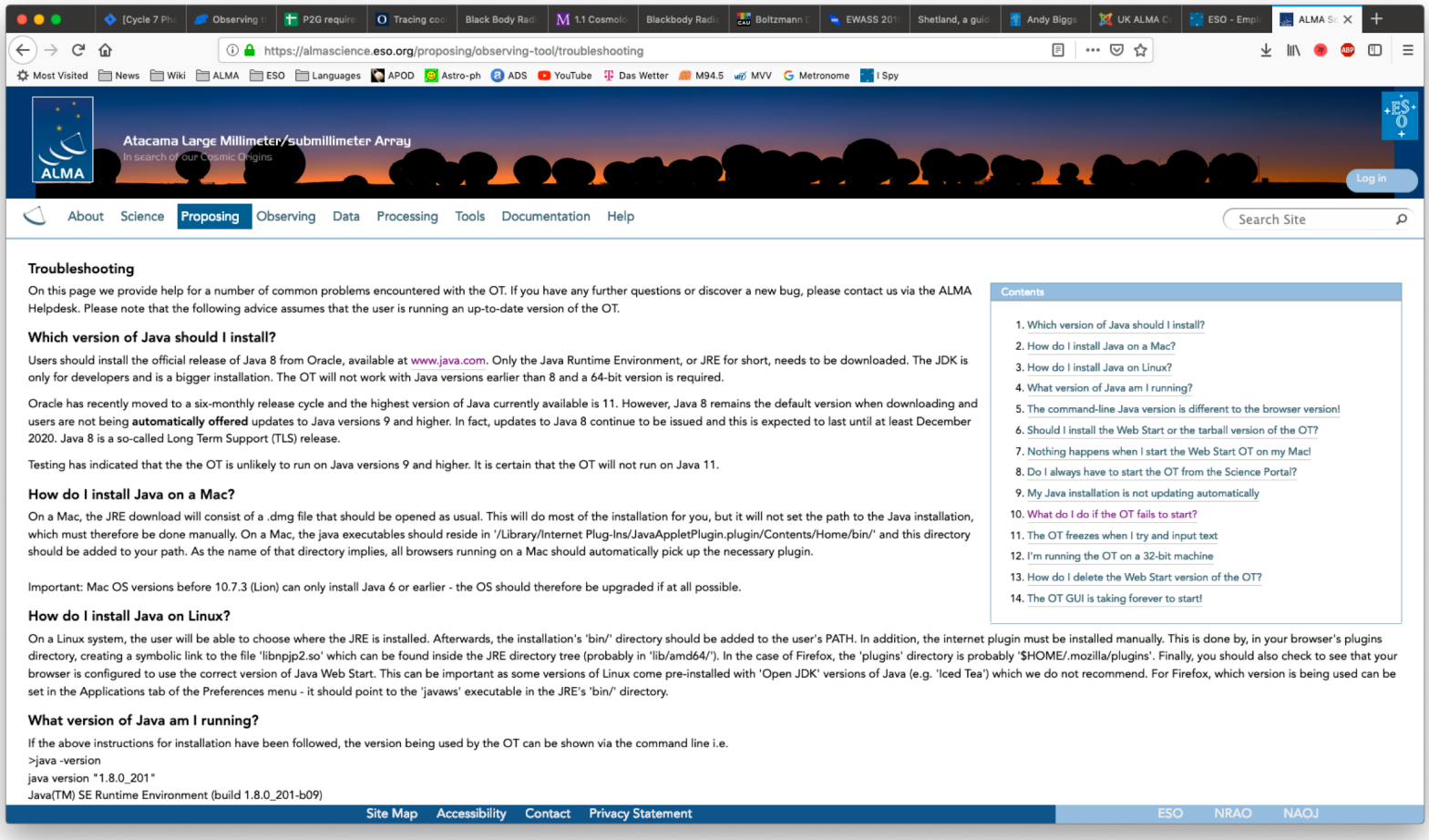
Java

- The OT is written in Java and requires this to run
- **Java 8 is required!!!**
  - Downloadable from *https://www.java.com*
- The official Oracle version should be used
  - OpenJDK variants cannot be guaranteed to work
- Beware: Oracle has moved to six-monthly releases
  - Java 11 is the current release, but …
  - Java 8 remains the default download
  - Java 8 continues to be updated
  - Automatic updates **will not** install a higher version (9, 10 or 11)

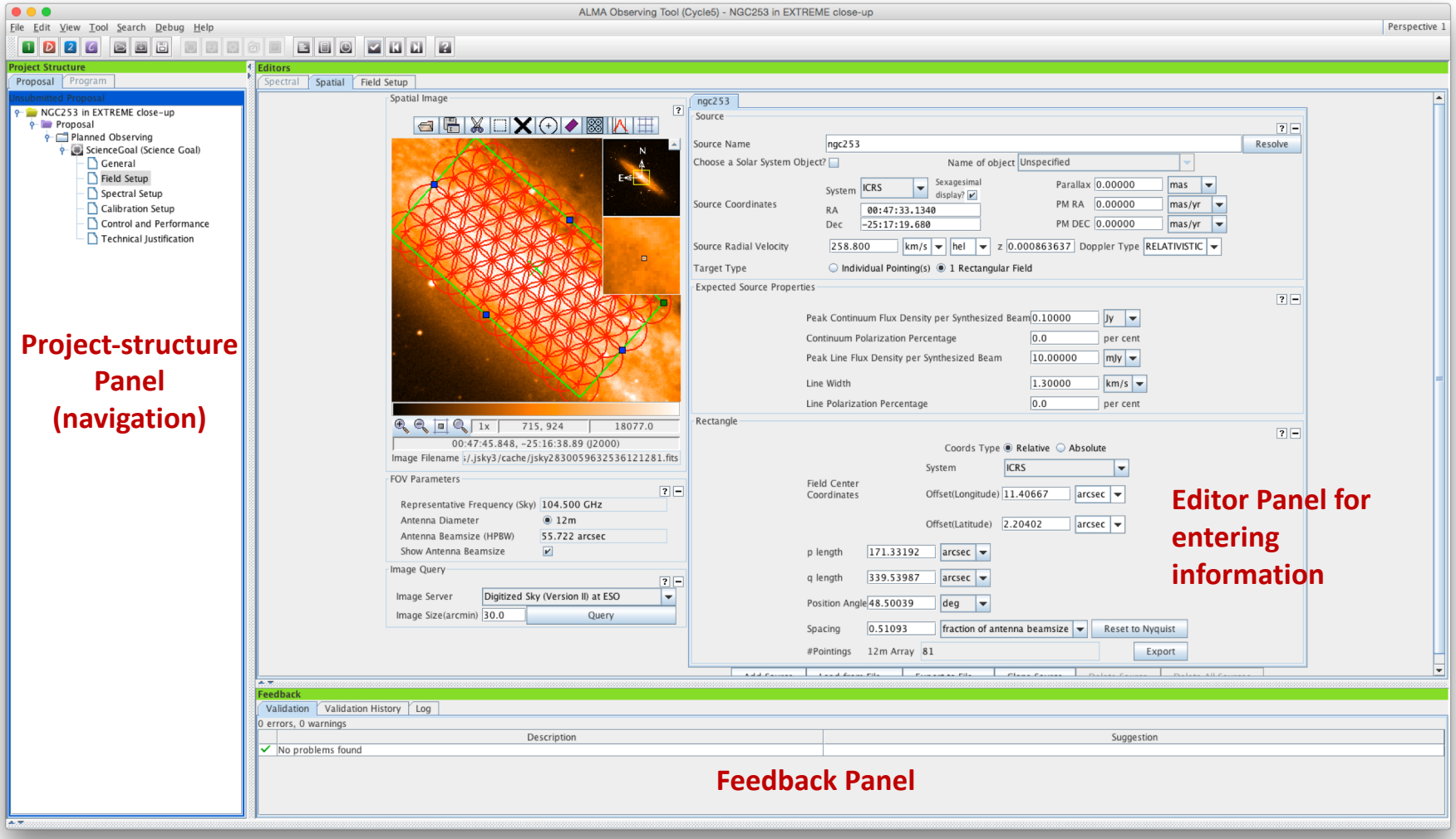
ALMA is moving to Java 11 this year and this doesn't include Web Start
A different installer option will be used instead ("InstallAnywhere")

Java Help

- Troubleshooting page in Science Portal
  - *https://almascience.eso.org/proposing/observing-tool/troubleshooting*

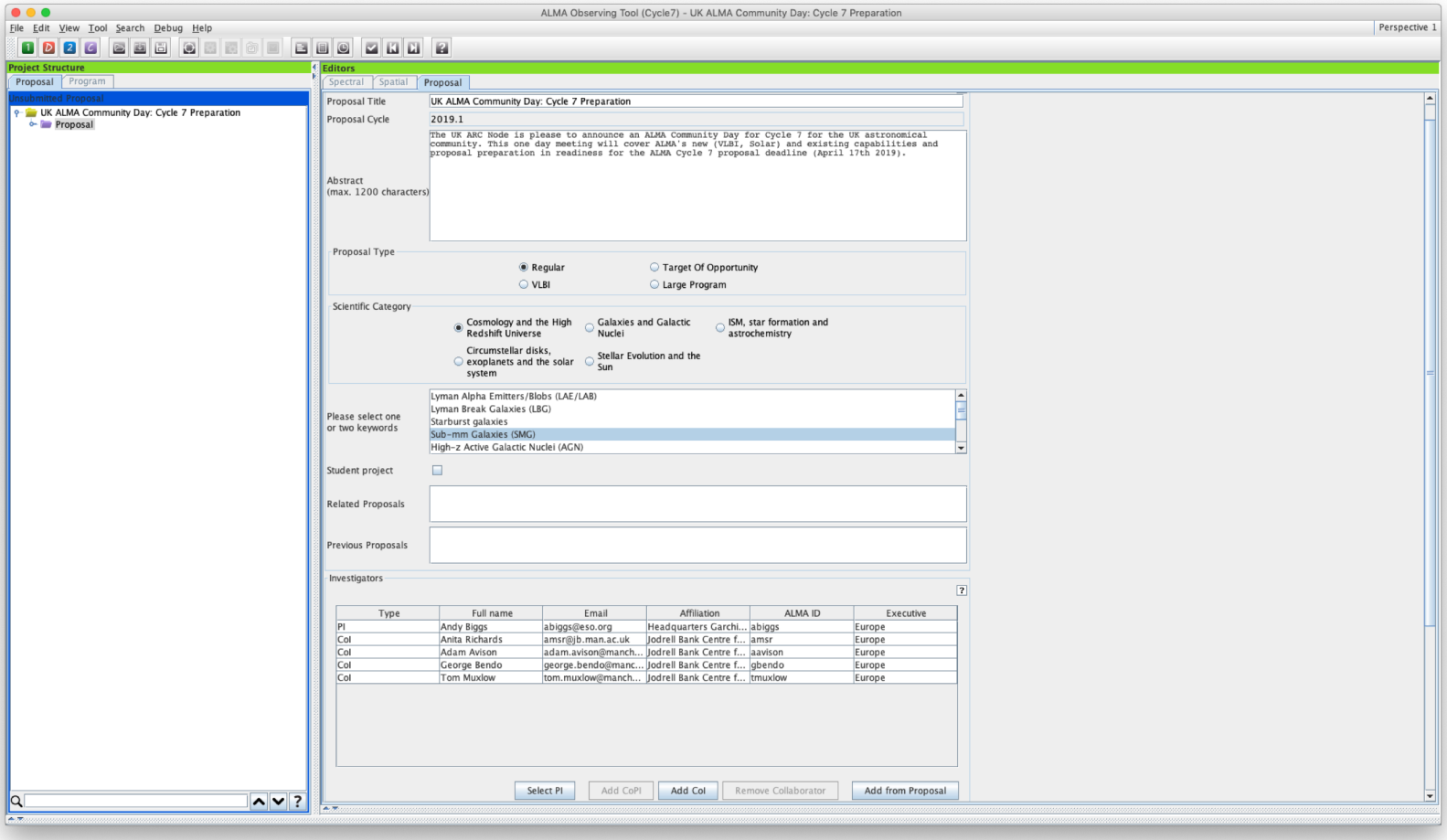


Layout


ALMA Observing Tool (Cycle5) - NGC253 in EXTREME close-up
File Edit View Tool Search Debug Help
Perspective 1
Project Structure
Proposal Program
Unsubmitted Proposal
NGC253 in EXTREME close-up
Proposal
Planned Observing
ScienceGoal (Science Goal)
General
Field Setup
Spectral Setup
Calibration Setup
Control and Performance
Technical Justification
Project-structure Panel (navigation)
Editors
Spectral Spatial Field Setup
Spatial Image
ngc253
Source
Source Name ngc253 Resolve
Choose a Solar System Object?
Name of object Unspecified
Source Coordinates
System ICRS
Sexagesimal display?
RA 00:47:33.1340
Dec -25:17:19.680
Parallax 0.00000 mas
PM RA 0.00000 mas/yr
PM DEC 0.00000 mas/yr
Source Radial Velocity 258.800 km/s hel z 0.000863637 Doppler Type RELATIVISTIC
Target Type Individual Pointing(s) 1 Rectangular Field
Expected Source Properties
Peak Continuum Flux Density per Synthesized Beam 0.10000 Jy
Continuum Polarization Percentage 0.0 per cent
Peak Line Flux Density per Synthesized Beam 10.00000 mJy
Line Width 1.30000 km/s
Line Polarization Percentage 0.0 per cent
Rectangle
Coords Type Relative Absolute
Field Center Coordinates
System ICRS
Offset(Longitude) 11.40667 arcsec
Offset(Latitude) 2.20402 arcsec
p length 171.33192 arcsec
q length 339.53987 arcsec
Position Angle 48.50039 deg
Spacing 0.51093 fraction of antenna beamsize Reset to Nyquist
#Pointings 12m Array 81 Export
1x 715, 924 18077.0
00:47:45.848, -25:16:38.89 (J2000)
Image Filename :/.jsky3/cache/jsky2830059632536121281.fits
FOV Parameters
Representative Frequency (Sky) 104.500 GHz
Antenna Diameter 12m
Antenna Beamsize (HPBW) 55.722 arcsec
Show Antenna Beamsize
Image Query
Image Server Digitized Sky (Version II) at ESO
Image Size(arcmin) 30.0 Query
Editor Panel for entering information
Feedback
Validation Validation History Log
0 errors, 0 warnings
Description Suggestion
No problems found
Feedback Panel

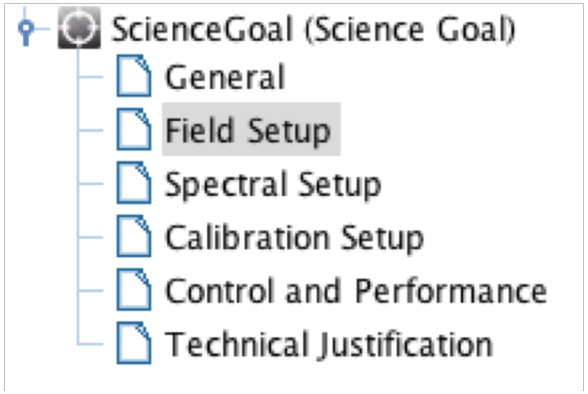
Proposal details

- Add PI, co-I's, title, abstract and scientific justification (PDF)



Science Goals (SGs)

- A Science Goal captures basic **scientific** requirements
  - Direction in which to observe
  - Frequency at which to observe
  - Bandwidth
  - Angular resolution
  - Largest structure to image
  - Required sensitivity

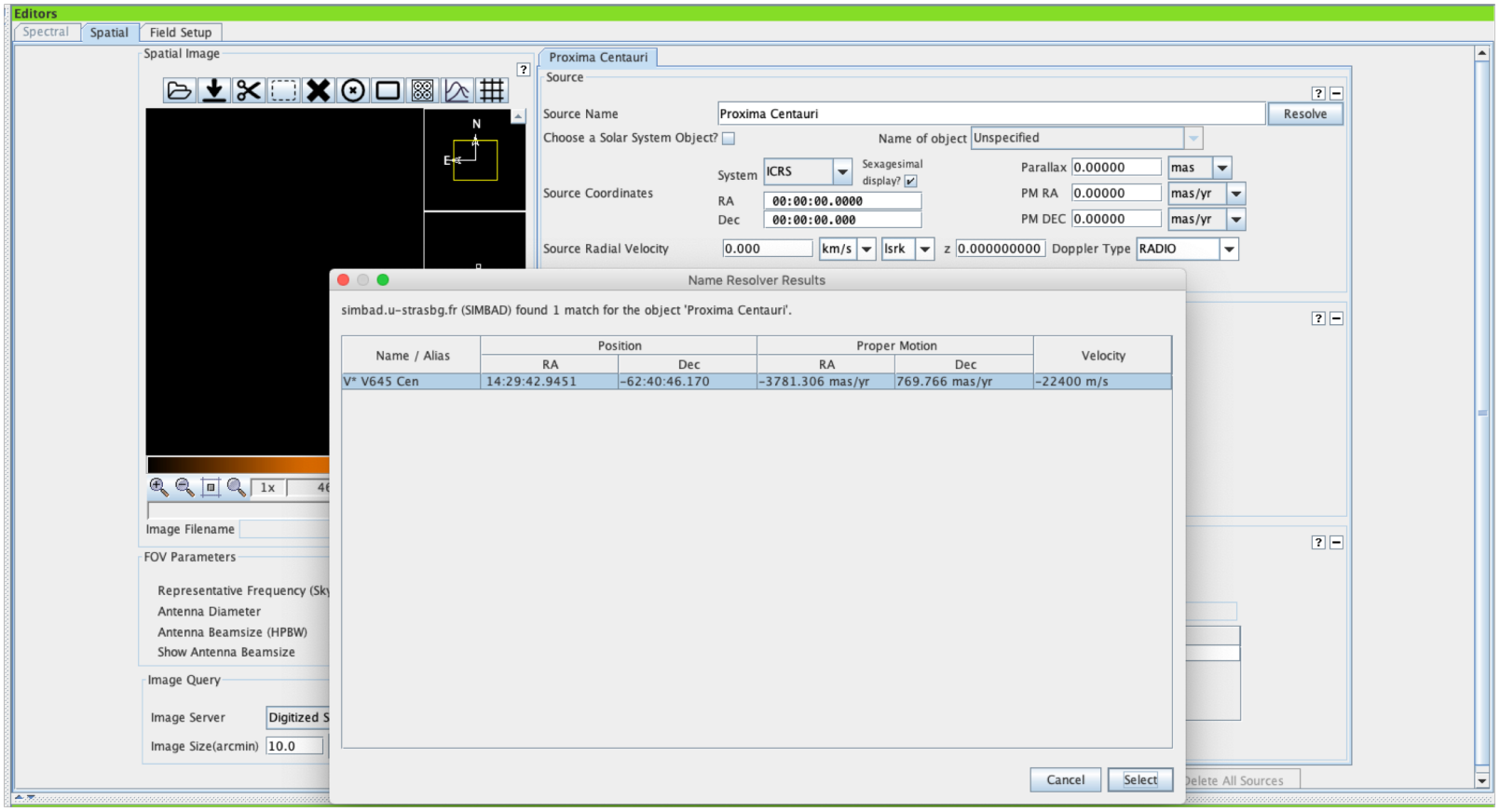


No experience of radio astronomy or interferometry necessary!

- Multiple SGs often required
  - e.g. observations in different bands, different sensitivities
- OT calculates tunings, configurations and time estimate

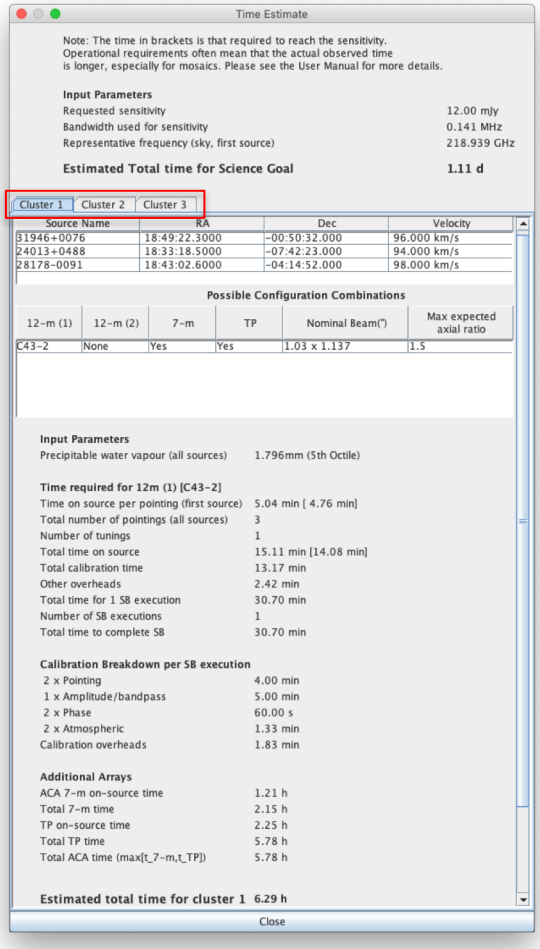
Source finder

- Use *Resolve* button once source name is entered
  - Queries Simbad first, will try NED if no match found
  - Can enter position, velocity and proper motion (beware proper motions of quasars!)



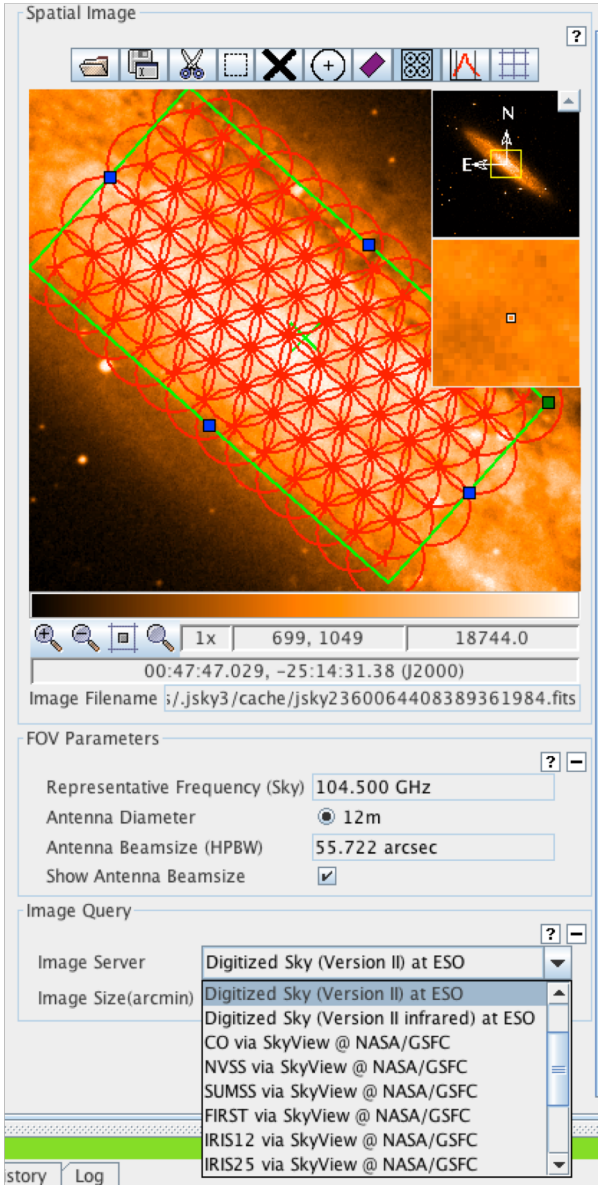
Source clustering

- Up to 150 pointings can be added per SG
- These can be distributed over up to 150 sources
- Sources can be anywhere on the sky
  - OT splits sources into multiple clusters
  - Uses a “hierarchical clustering” algorithm
- Radius of each cluster is…
  - 10 degrees for “normal” Science Goals
  - 1 degree for long-baseline SGs (need closer phase calibrator)



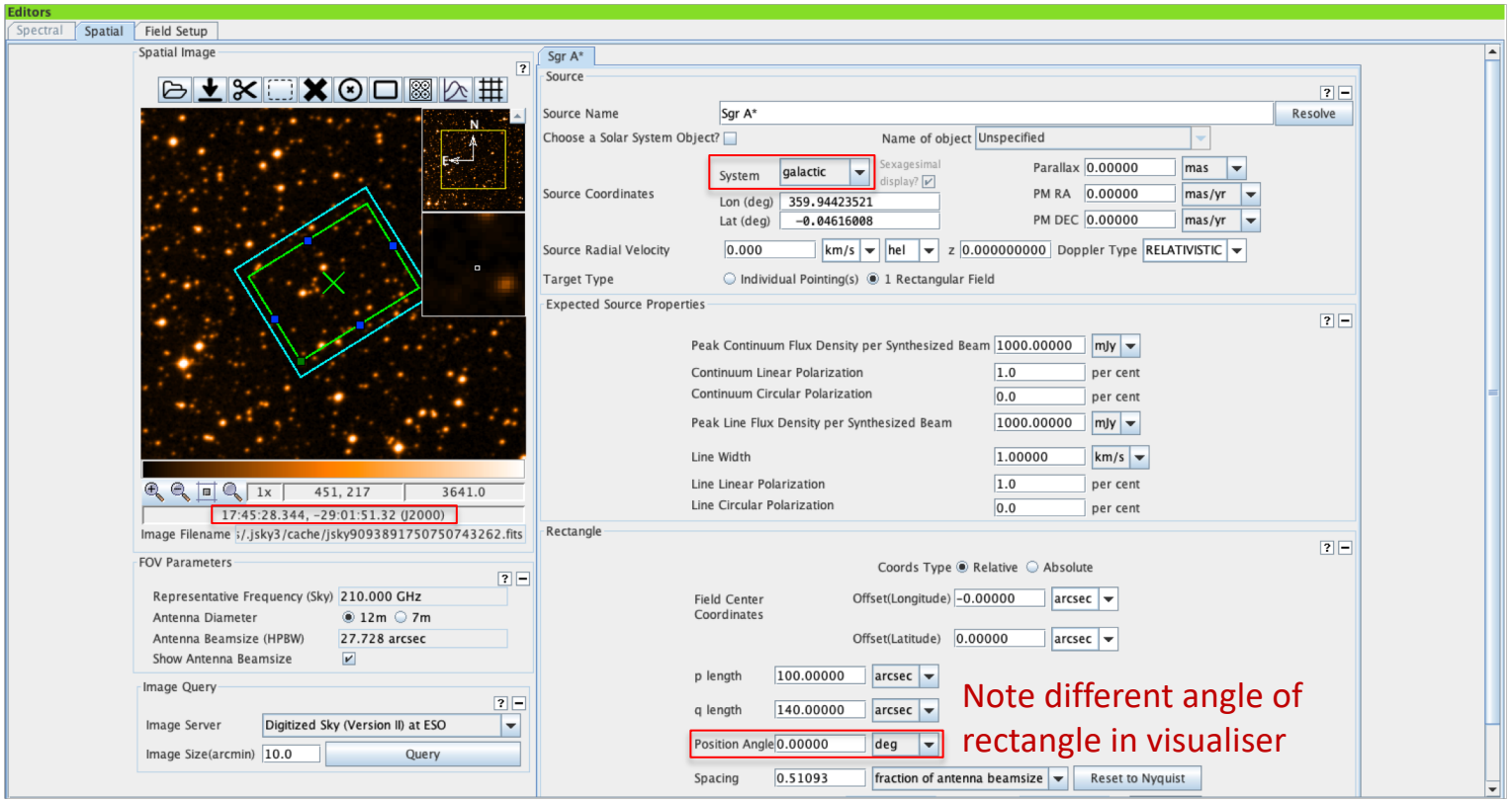
Spatial Visualiser

- Displays astronomical images
  - Download from various servers
  - Open own FITS file
- Shows telescope pointings
  - Rectangles
  - Individually defined pointings
- Can be used interactively
  - Draw and edit (resize/rotate) rectangle
  - Add or delete individual pointings



Galactic coordinates

- OT converts coordinates to ICRS during SB generation
- Can use different systems in text and visual editors
  - Rectangle will be rotated appropriately

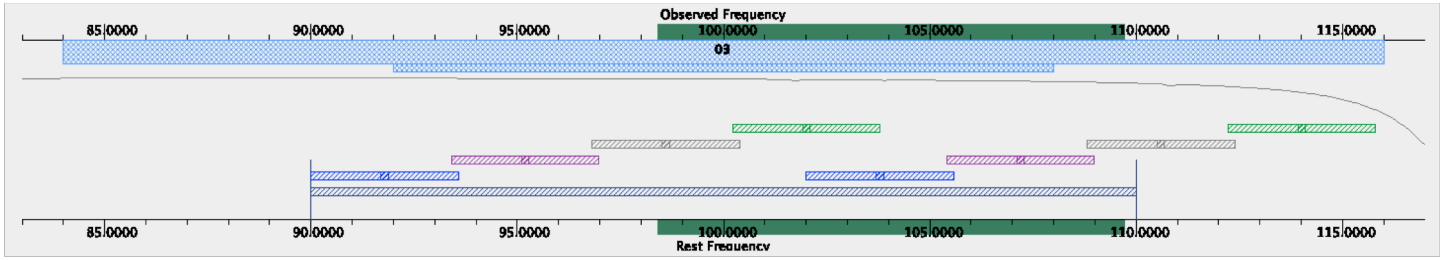


Spectral Setup

- Users define spectral windows
  - A Spectral Line Picker tool is available (uses the Splatalogue)
  - Spws can also be added manually

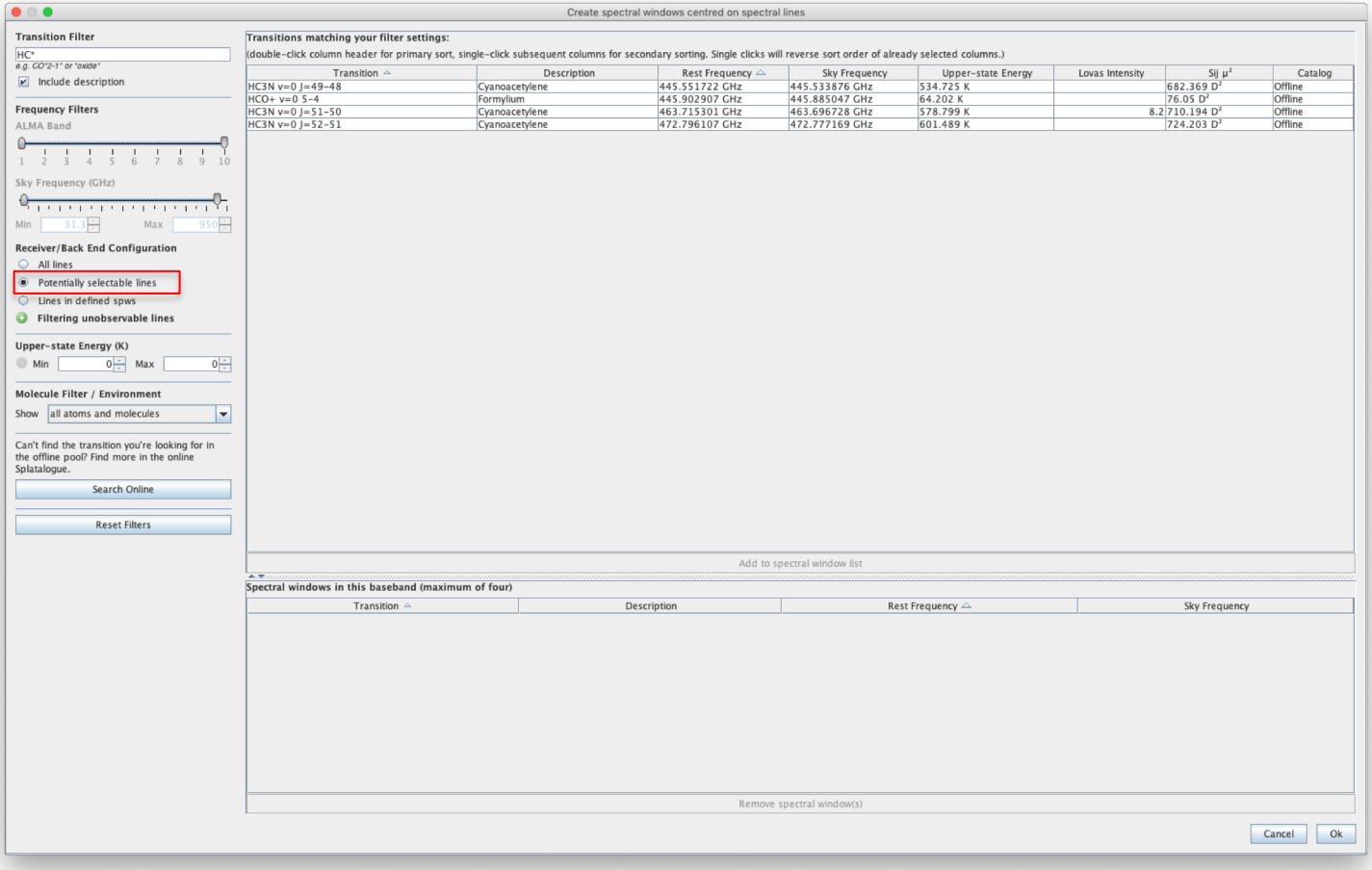
www.splatalogue.net

- OT will try to finding a tuning solution
  - Spws will need to be moved if errors are reported
- Three options
  - Spectral Line (gives the most flexibility)
  - Single Continuum (shortcut to maximum-bandwidth setup)
  - Spectral Scan (sets up multiple tunings automatically)



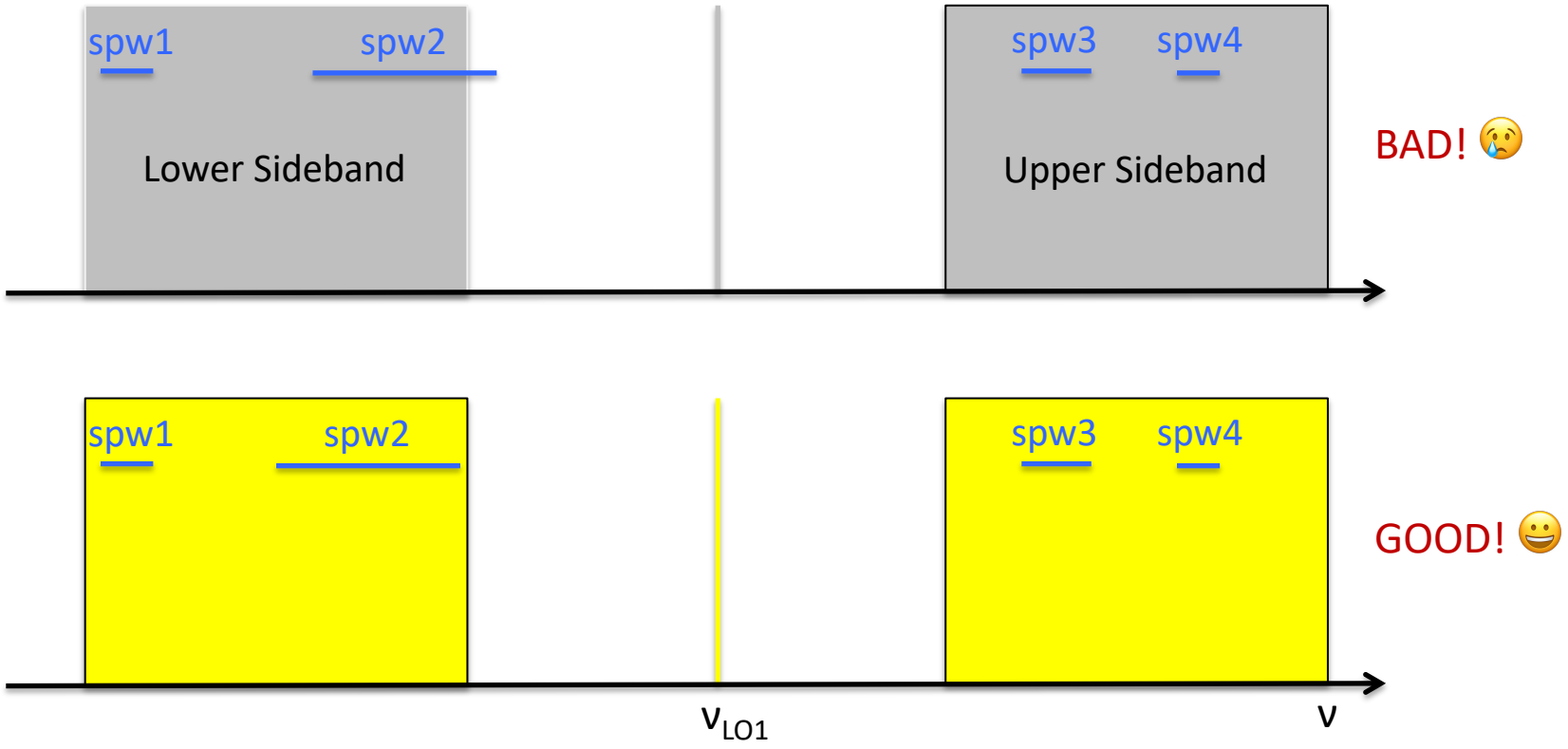
Spectral Line Picker

- Enter text (e.g. ‘CO’) and tool will show all lines that match
- Various filters are provided e.g. only those that would still give a tuning



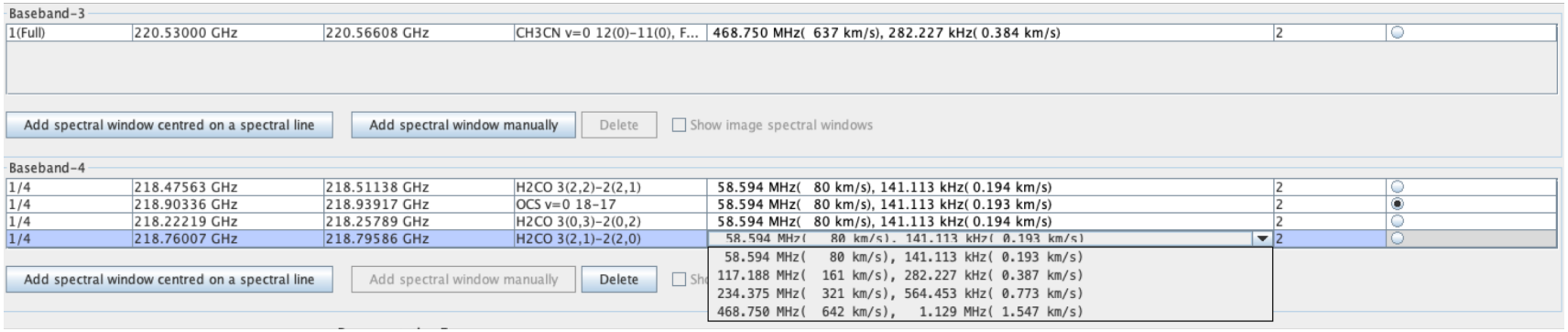
Sidebands

- All spws must lie within the sidebands
  - These are **generally** 4-GHz wide and separated by 8 GHz (e.g. Bands 3, 4, 5, 7 and 8)

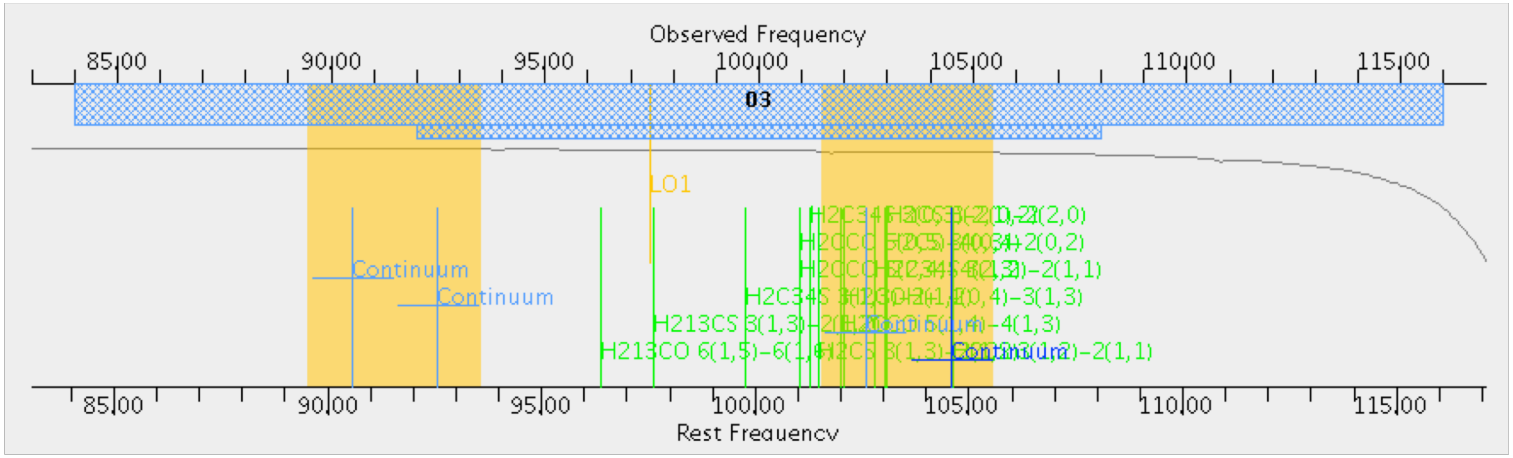


Basebands/Correlator modes

- Spws lie in basebands of which there are four
  - Each is 2-GHz wide
  - Up to four can be defined per baseband
  - Each baseband can use a different correlator mode
- A correlator mode must be chosen for each spw
  - Six FDM (high spectral resolution – 60 to 1875-MHz bandwidth)
  - One TDM (low spectral resolution – 1875-MHz bandwidth)
- Spectral averaging is possible for FDM (N=1,2,4,8,16)



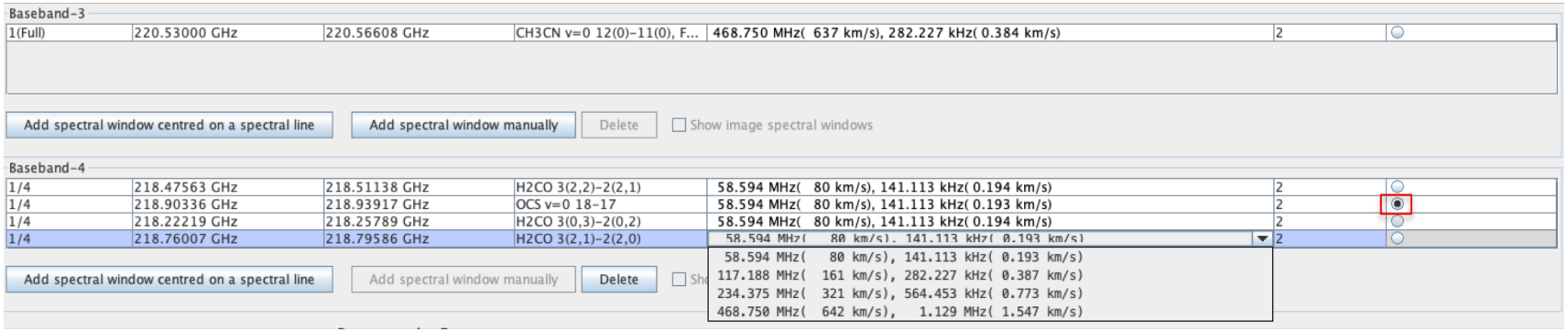
Spectral Visualiser



- Shows details of tuning setup
  - Spectral windows (blue – these show the data!)
  - Sidebands (yellow so a tuning was found)
  - Overlaid spectral-lines (green – visual aid)
  - Atmospheric transmission (corresponds to automatically chosen PWV)
  - Observed and rest frequencies shown (based on source velocity)

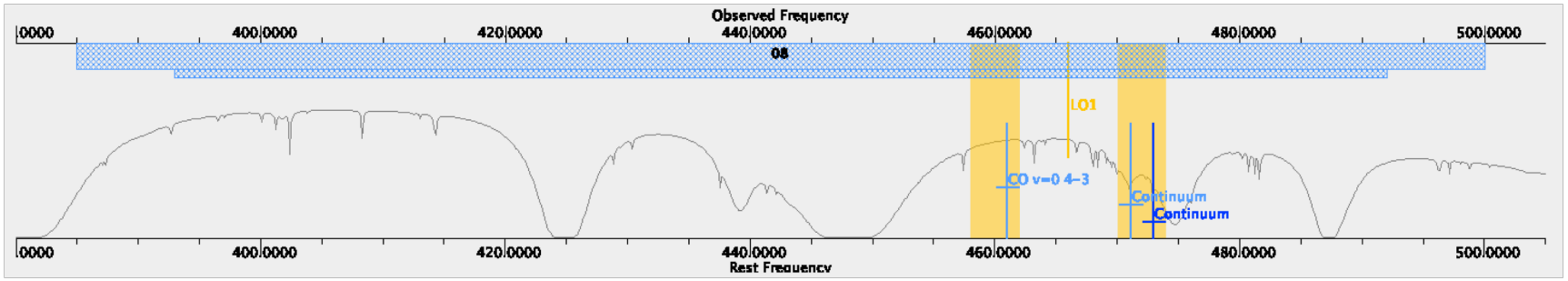
Representative Frequency

- One spw must be chosen as the “representative” one
  - Representative Frequency can be defined anywhere within this
- The time estimate is calculated at this frequency
  - Sensitivity of other spws may be different
  - Be careful in regions of varying atmospheric transmission



Varying transmission

- Band 8 is an example of where the transmission varies greatly
  - Can be difficult to place all spws in areas of good transmission



Default Single Continuum setup

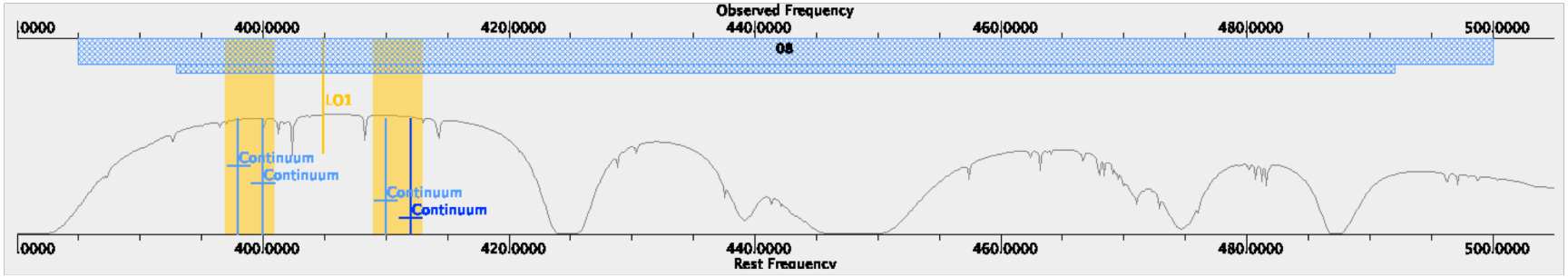


Image sidebands in Bands 9 and 10

Band 9 and 10 are Double Sideband (DSB) receivers – there is an "image" of every spw in the other sideband (reflected around LO1)

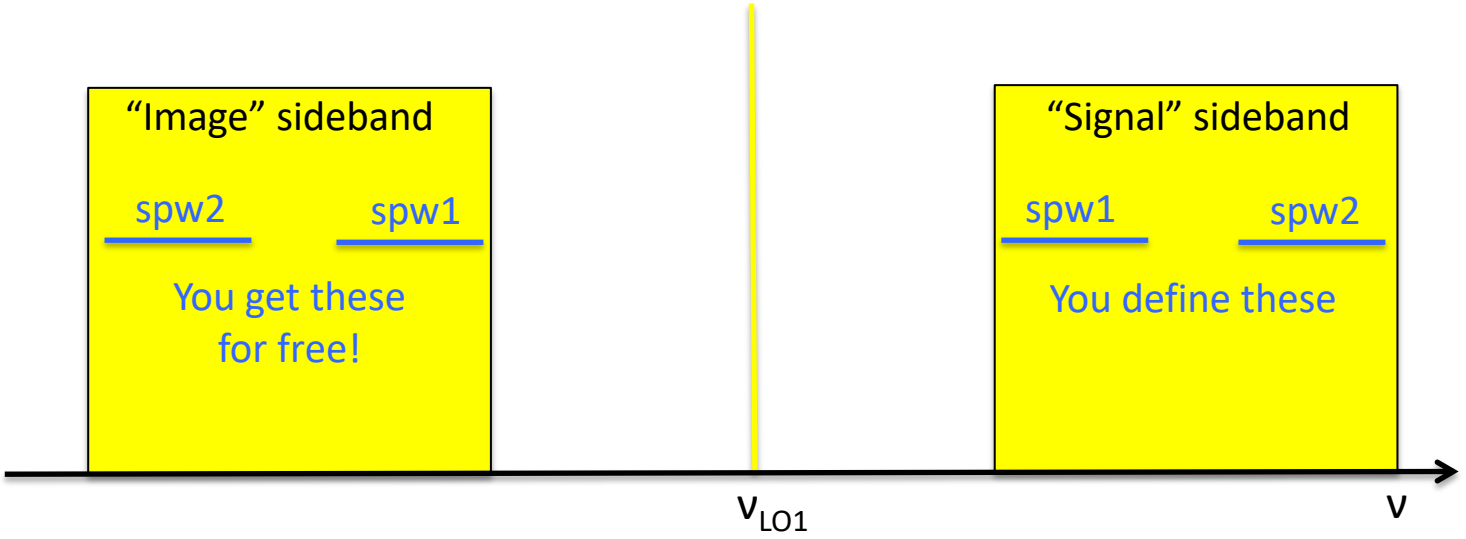
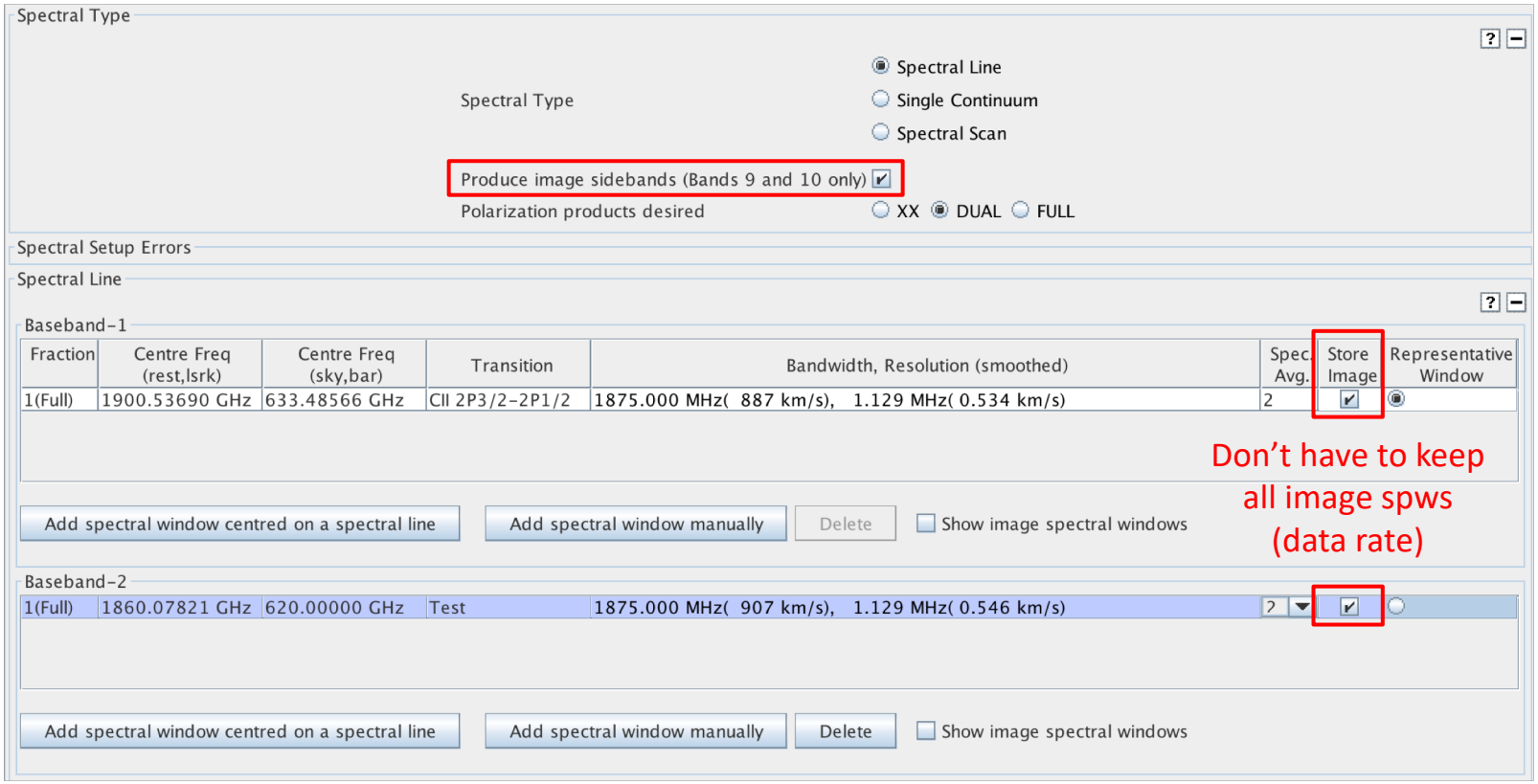


Image spws were previously suppressed by correlator, but **90-degree Walsh switching** now allows both to be recovered

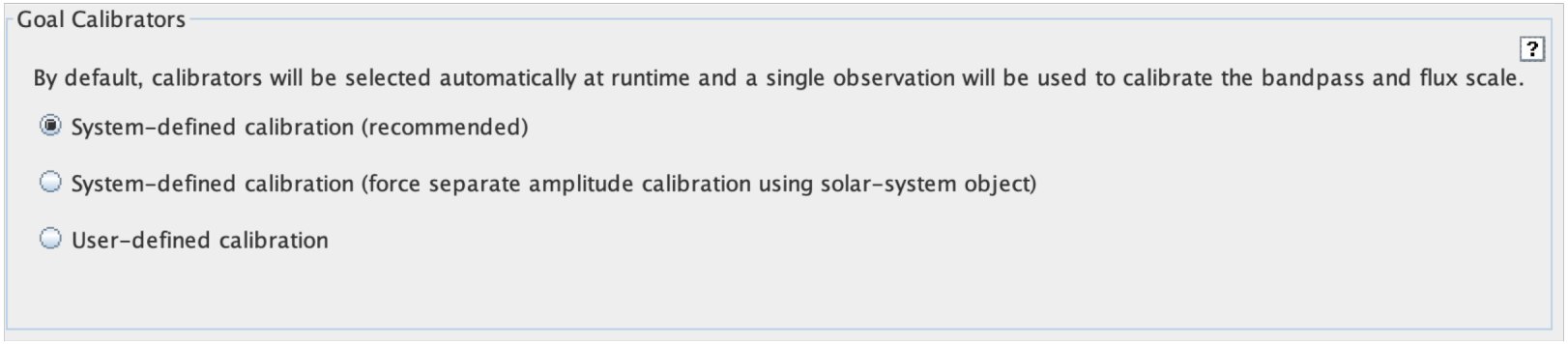
90-Degree Walsh switching

Used automatically for single continuum – doubles the bandwidth (15 GHz)
Now activated by default for “Spectral Line”



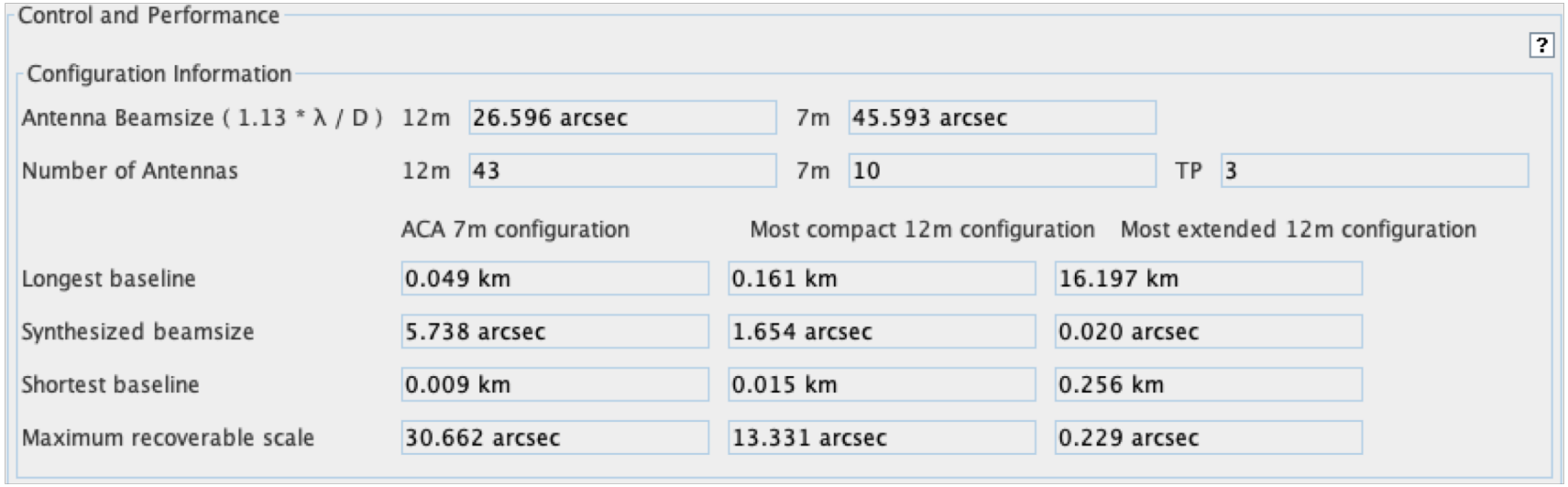
Calibration Setup

- This can normally be ignored
- Most useful option is for more accurate flux calibration
  - Uses a solar-system calibrator instead of a QSO
- Can define specific calibrators
  - SG becomes non-standard
  - Very rarely necessary! Calibrators are chosen automatically



Control & Performance

- Information about array properties shown at top
  - Gives e.g. allowed range of angular resolution
- Max. recoverable scale drives choice of smallest array
  - In example below: if LAS = 31″ then the TP array is needed

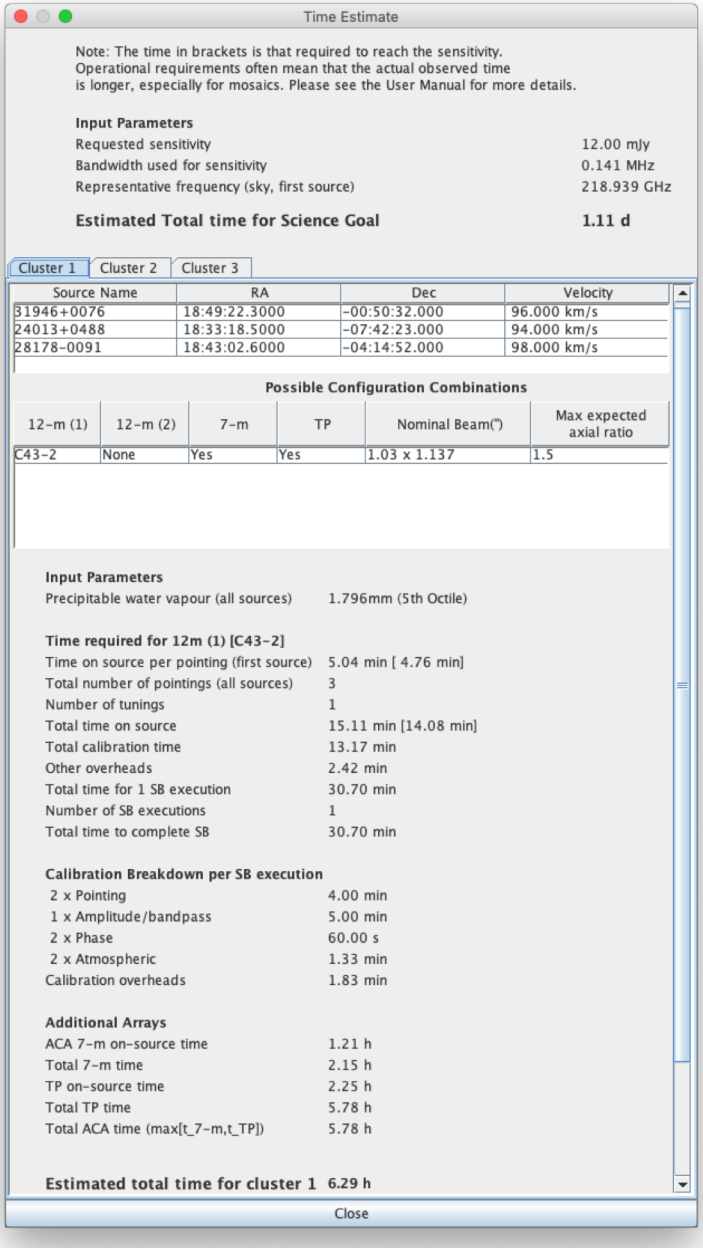


Control & Performance

- Define angular resolution, not configurations
  - “Any” is also possible (excludes long-baseline configurations)
  - AR determines largest configuration required
- Largest Angular Scale of source
  - Determines smallest configuration required
  - Up to two 12-m configurations plus ACA (7-m and TP) possible
- Sensitivity
  - Pretty self-explanatory
  - Can also be defined in kelvins

Time Estimate

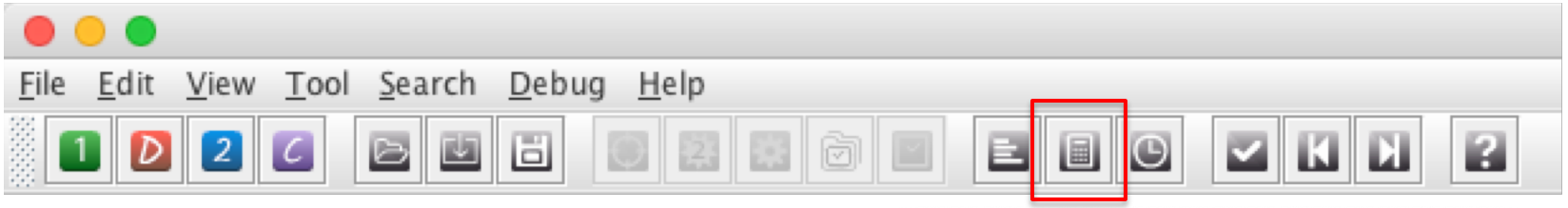
- Shows details of the calculation
  - Assumed column of water vapour
  - On-source time
  - Calibration time
  - Required configurations
  - Clustering of sources
  - Beam ellipticity
- Details only for largest array
  - Smaller arrays use time multipliers of largest array's on-source time
  - These are derived from simulations



Time multipliers

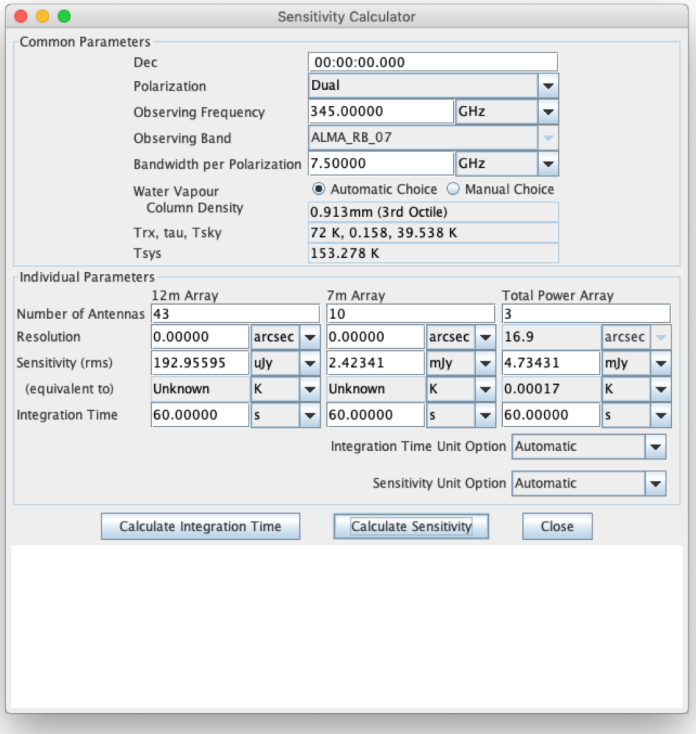
Configurations	Time ratio
C43-1 : 7-m	1 : 7.0
C43-2 : 7-m	1 : 4.66
C43-3 : 7-m	1 : 2.40
C43-4 : C43-1 : 7-m	1 : 0.34 : 2.38
C43-5 : C43-2 : 7-m	1 : 0.26 : 1.21
C43-6 : C43-3 : 7-m	1 : 0.25 : 0.60
C43-7 : C43-4	1 : 0.23
C43-8 : C43-5	1 : 0.22
C43-9 : C43-6	1 : 0.21
7-m : TP	1 : 1.7

Sensitivity Calculator

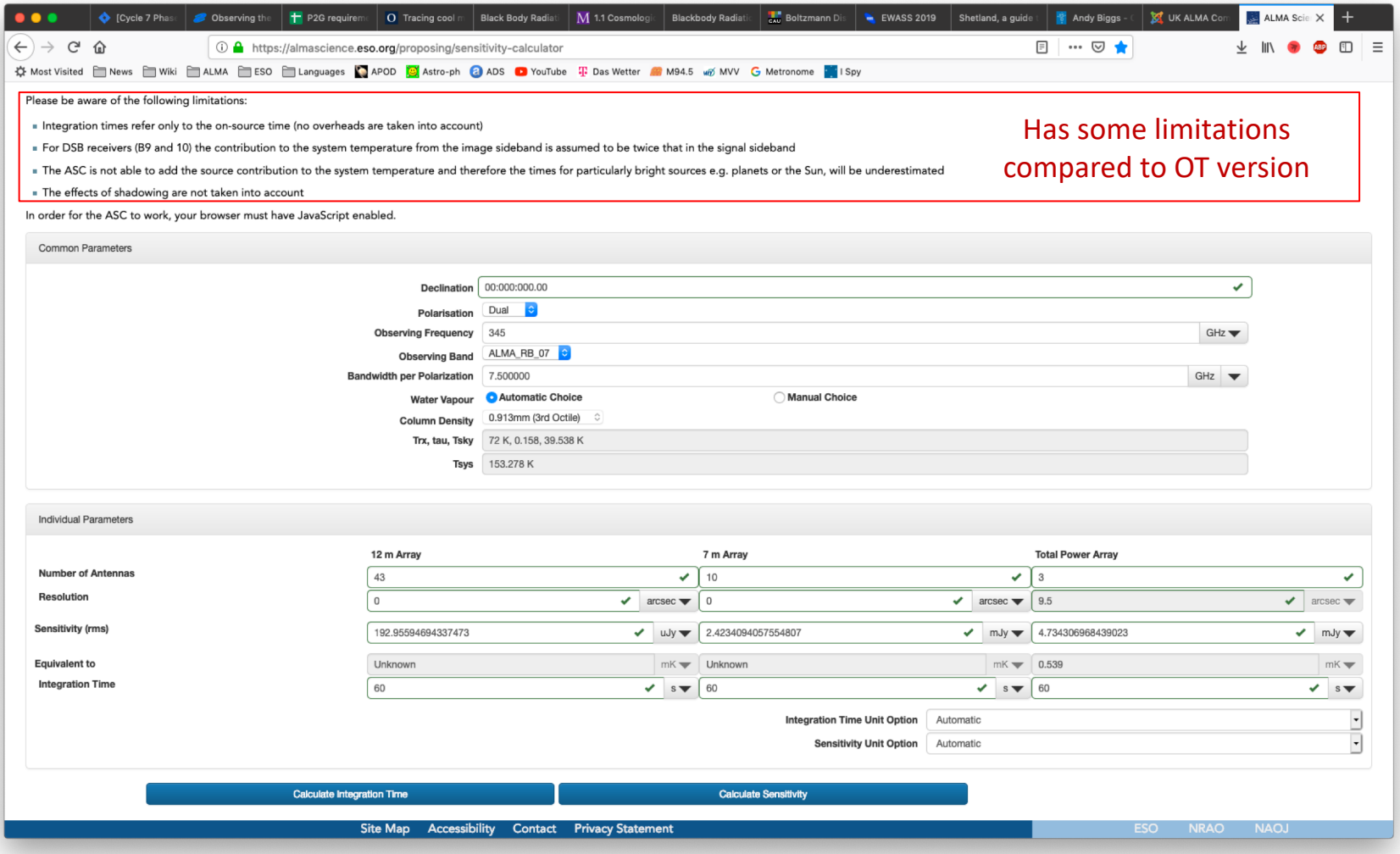


Allows you to **experiment** with sensitivity parameters

Parameters have no effect on **real** time estimate!



Web-based Sensitivity Calculator



https://almascience.eso.org/proposing/sensitivity-calculator

Technical Justification

- Requested parameters must be justified per SG
  - Use Copy and Paste (e.g. Ctrl-C, Ctrl-V) if input is very similar
- Entered values are shown and e.g. SNRs calculated
- OT blue warnings point out **possible** problems

Requested RMS over 7.500 GHz is 1.00 mJy

For a peak flux density of 100.00 mJy , the S/N is 100.0

Achieved RMS over the total 7.500 GHz bandwidth is 141.59 uJy

For a continuum flux density of 100.00 mJy , the achieved S/N is 706.3

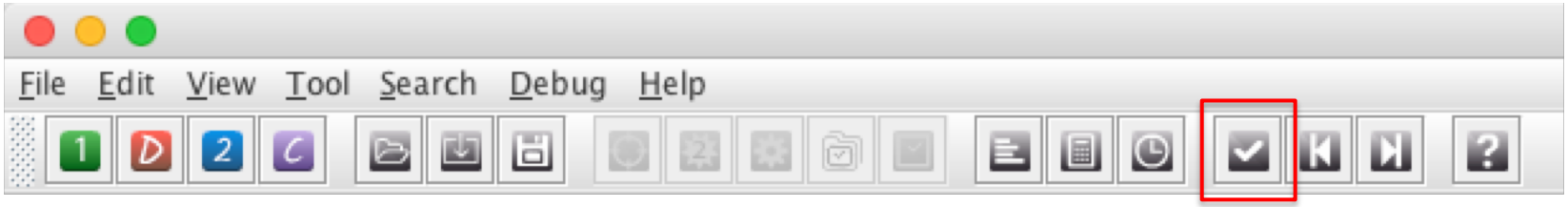
For a peak line flux of 10.00 mJy , the achieved S/N over 1/3 of the source line width (1.30 km/s / 3 = 433.33 m/s) is 0.3

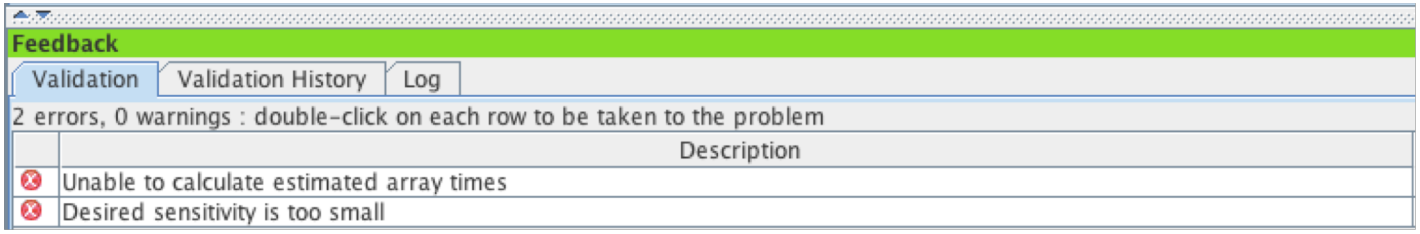
Note that one or more of the S/N estimates are < 3. Please double-check the RMS and/or line fluxes entered and/or address the issue below.

Line width / bandwidth used for sensitivity (1.30 km/s / 21516.21 km/s) = 0.00006

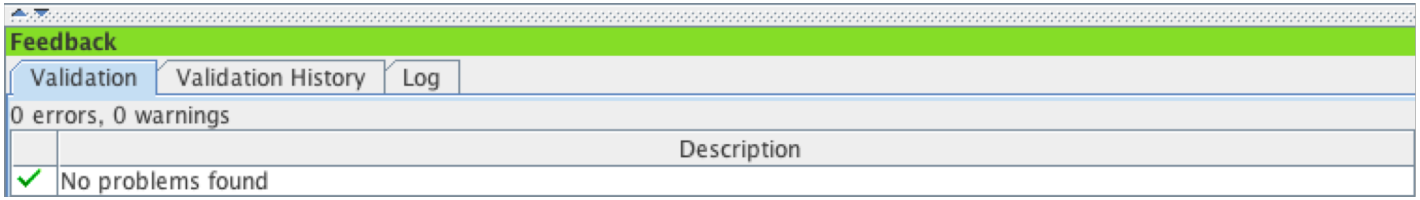
Note that the bandwidth used for sensitivity is larger than 1/3 of the linewidth.
The S/N achieved for a resolution element that allows the line to be resolved will be lower than that reported.

Validation





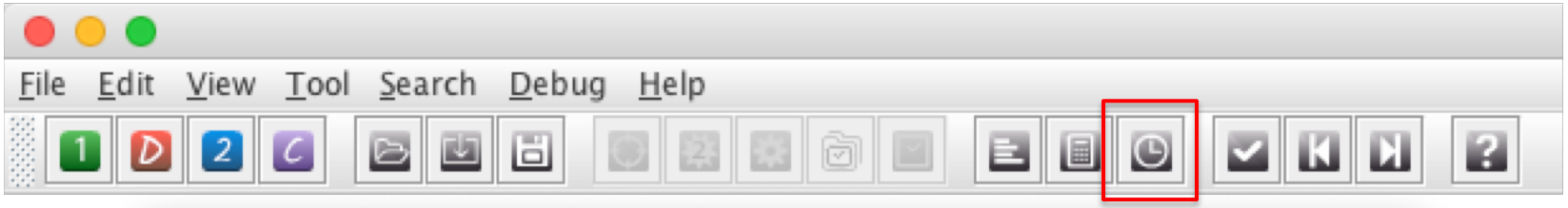
BAD! 😢



GOOD! 😀

Proposal can only be submitted if no validation errors are found

Project Time Summary



Project Summary

Total and Calibration Times

Science Goal	12-m (1)		12-m (2)		12-m (1+2)		ACA 7-m		ACA TP		Overall		Non-standard Mode
	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	Tot.	Cal.	
Sgr A* galactic rectangle	22.67 min	13.17 min	-	-	22.67 min	13.17 min	22.67 min	-	-	-	45.34 min	13.17 min	No
M1 galactic rectangle	21.84 min	13.17 min	-	-	21.84 min	13.17 min	21.84 min	-	-	-	43.68 min	13.17 min	No
M1 galactic pointings	20.37 min	13.17 min	-	-	20.37 min	13.17 min	20.37 min	-	-	-	40.75 min	13.17 min	No
MSX/ACA	-	-	-	-	-	-	45.14 min	21.93 min	-	-	45.14 min	21.93 min	No
Overall	1.08 h	39.50 min	-	-	1.08 h	39.50 min	1.83 h	21.93 min	-	-	2.91 h	1.02 h	

Data Volumes and Data Rates

Science Goal	Data Volume			Avg. Data Rate		
	12-m (1+2)	ACA 7-m	ACA TP	12-m (1+2)	ACA 7-m	ACA TP
Sgr A* galactic rectangle	1.78 GB	115.98 MB	-	1.79 MB/s	0.11 MB/s	-
M1 galactic rectangle	1.72 GB	113.75 MB	-	1.79 MB/s	0.12 MB/s	-
M1 galactic pointings	1.88 GB	117.19 MB	-	1.93 MB/s	0.12 MB/s	-
MSX/ACA	-	382.84 MB	-	-	0.16 MB/s	-
Overall	5.38 GB	729.76 MB	-			

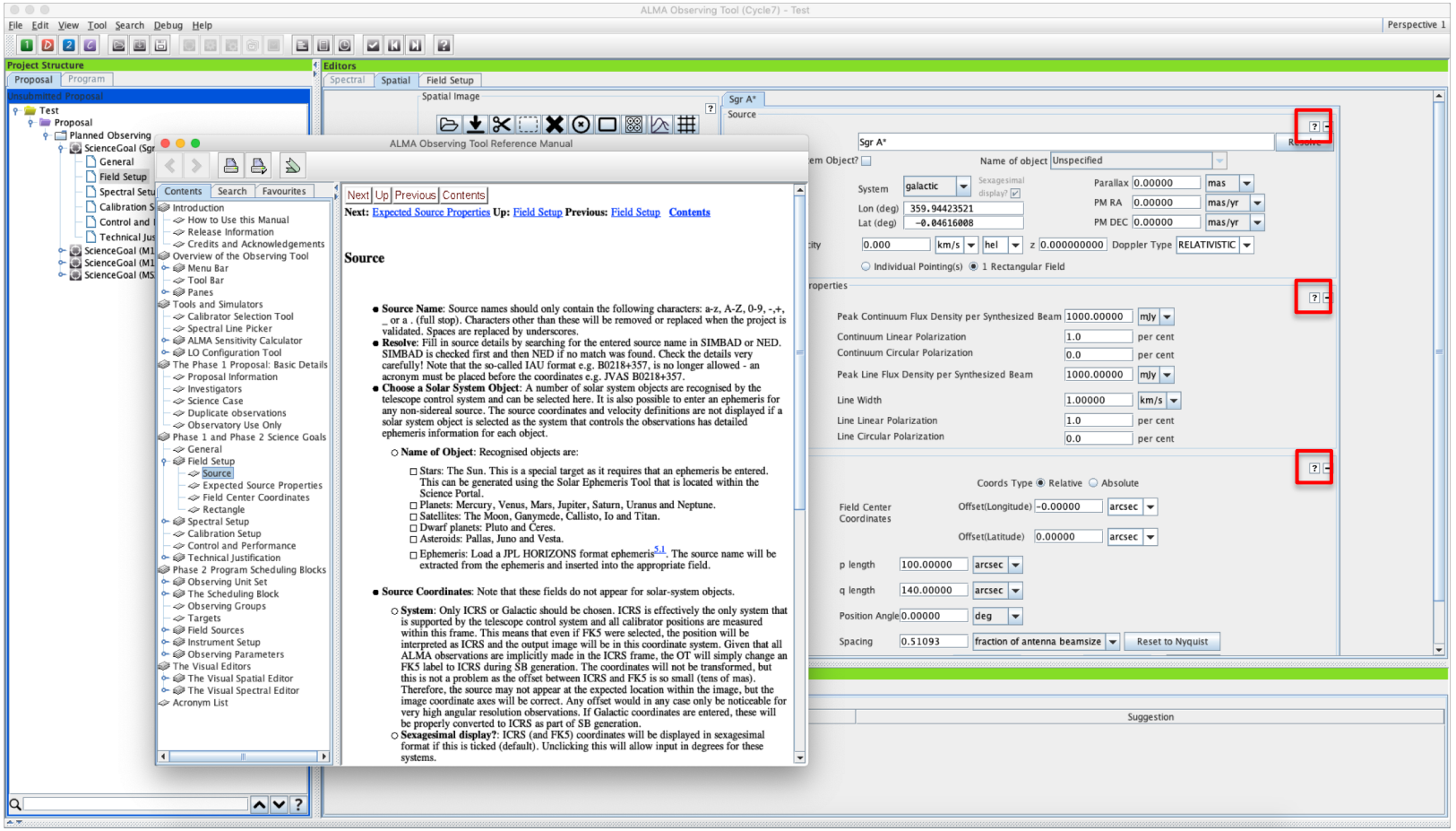
Close

Documentation

- OT-specific documentation includes
  - User and Reference Manuals
  - Troubleshooting Page
  - QuickStart Guide (highly recommended!)
- All available from:
  - Science Portal
    - *https://almascience.eso.org/documents-and-tools*
  - User and Reference Manuals available in OT

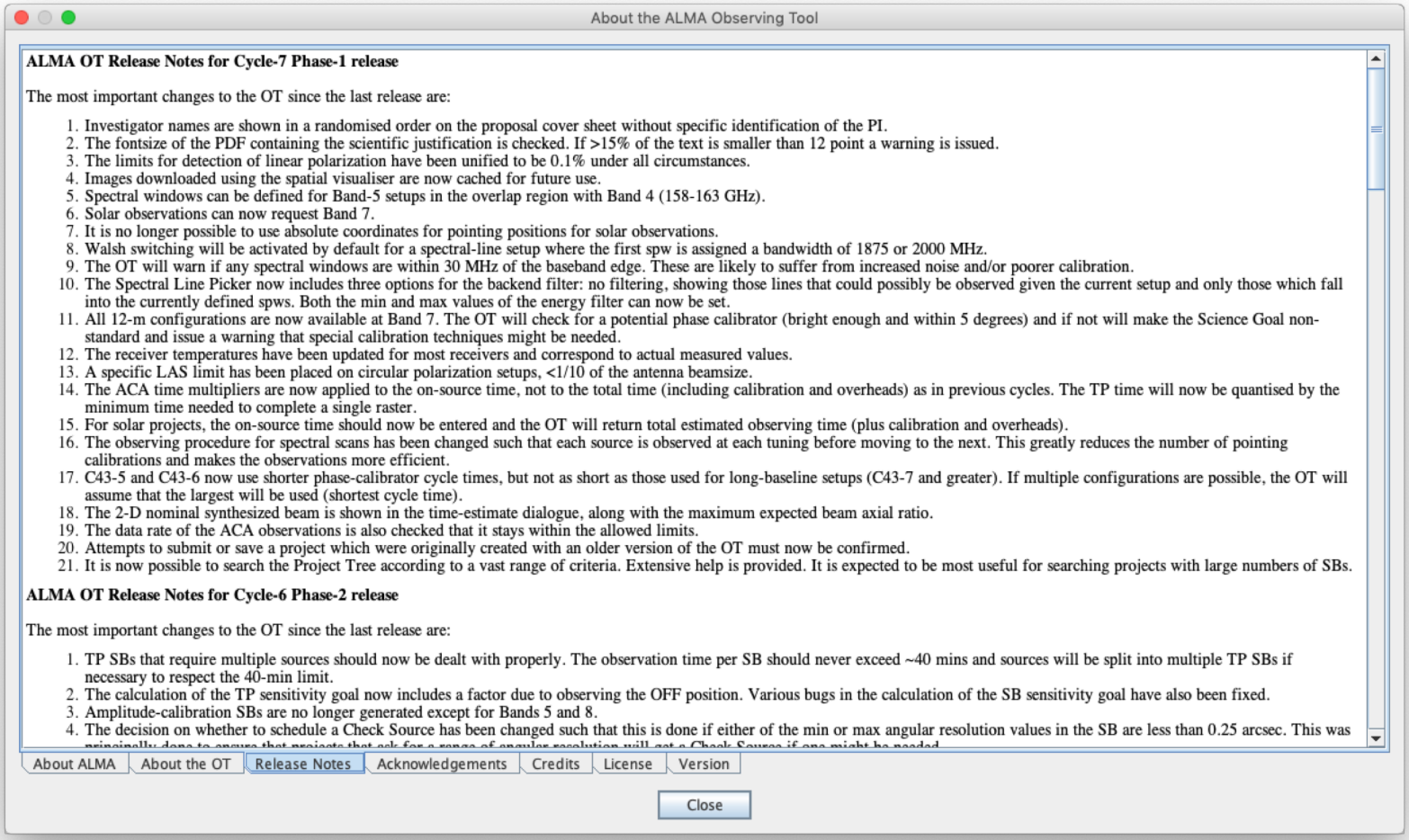
Contextual help

- The ‘?’ buttons open the Reference Manual at that section

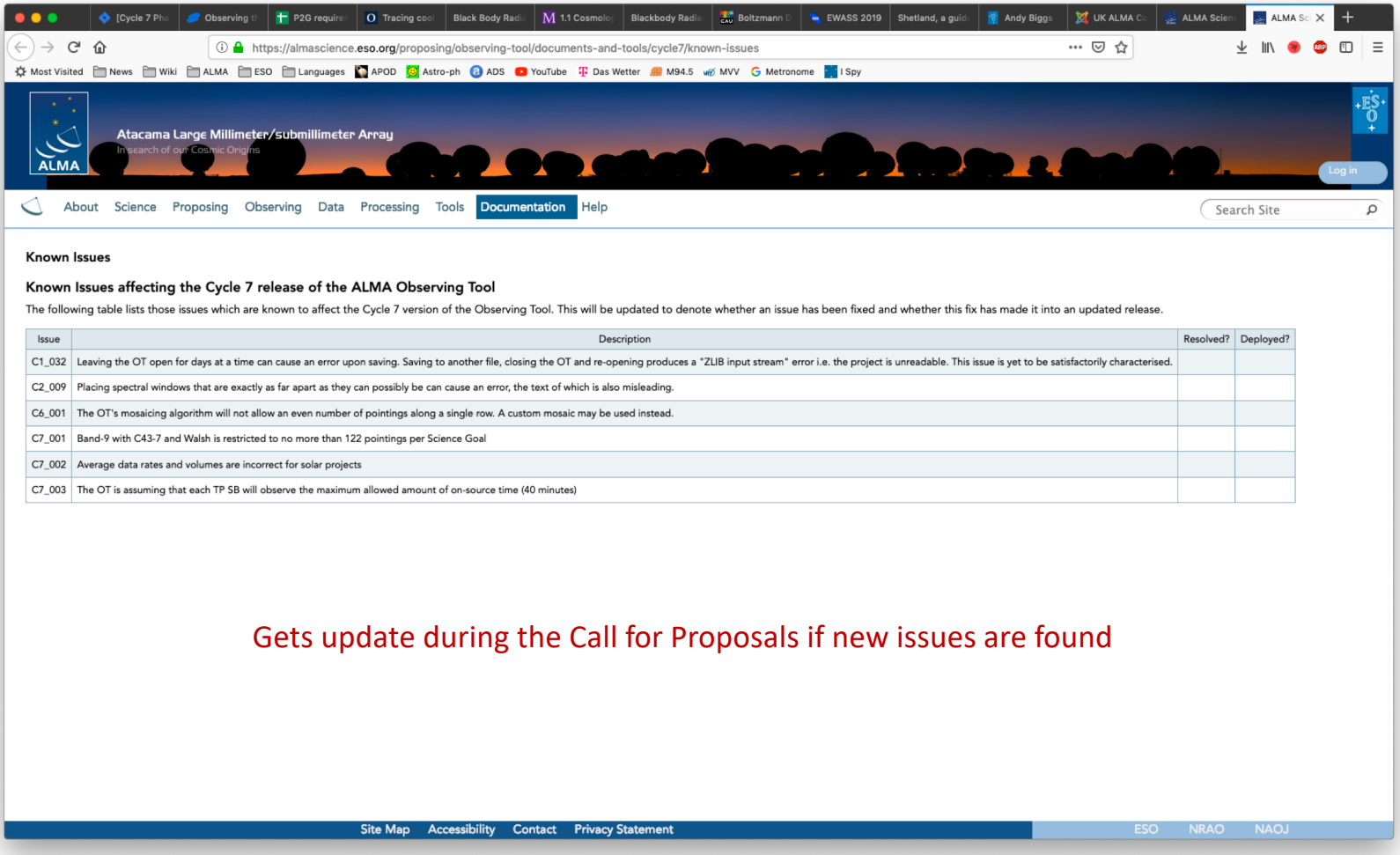


Release Notes

- Lists changes in each release - available from Help menu



Known Issues page



Gets update during the Call for Proposals if new issues are found

https://almascience.eso.org/proposing/observing-tool/documents-and-tools/cycle7/known-issues

Phase 2

- Successful PIs must submit their Phase-2 Science Goals
  - Identical to Phase-1 SGs, but in a different tab of the OT
  - Last chance to get details right!
- Scheduling Blocks are generated automatically
  - PIs don't need to worry about these – very complicated!