EUROPEAN ARC
ALMA Regional Centre || Italian

ALMA REGIONAL CENTRE ITALY
is Bologna

ALMA: in preparation of Cycle 6

Prepared by the Italian ALMA Regional Centre

23 March 2018, IRA Bologna - presented by Jan Brand

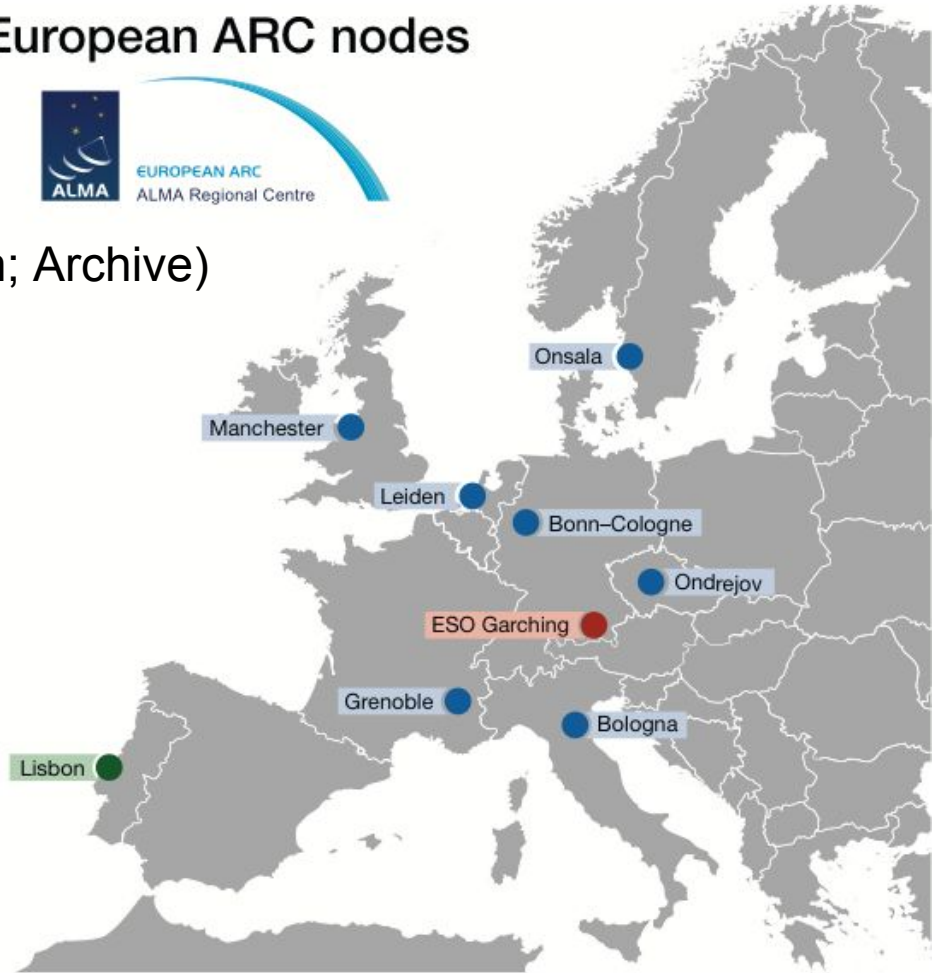
Italian ALMA Regional Center

http://www.alma.inaf.it/

Jan Brand (coordinator)
Marcella Massardi (manager)

Matteo Bonato (ARI; support)
Sandra Burkutean (interferometer/SD combination; Archive)
Andrea Giannetti (ARI)
Elisabetta Liuzzo (mm-VLBI w. ALMA; Archive)
Rosita Paladino (polarization)
Kazi Rygl [iALMA] (mm-VLBI; ALMA Archive)

New arrival (July 2018)
Eugenio Schisano (galactic science; Herschel).



MEET YOUR ALMA REGIONAL CENTRE NODE
ALMA-RELATED DEVELOPMENT PROJECTS
AND
SCIENCE AT THE ITALIAN ARC

1.

One of the core-tasks of the ALMA Regional Centre (ARC) in Bologna, and indeed of the EU-ARC network as a whole, is to provide support to the astronomical community with writing ALMA proposals, preparing observations, and with reducing (imaging) and, if needed, analyzing the data. Creating and sustaining a community and educating a new generation of astronomers working in the mm-wavelength range is another cornerstone of our existence. At the same time we are very much involved in tecnological en scientific ALMA-related projects, that aim to develop and move forward the ALMA project.

2.

The people at the ARC also carry out their own research projects. In this poster we introduce ourselves, the ALMA-related development projects that we are involved in, and the research topics that we are interested in.

3.

ARC-people: tasks, science

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Jan Brand

ARC-coordinator (planning, funding, staffing)
Student supervision; AENEAS
Scientific interests:
Physics and chemistry of the galactic ISM;
Properties of molecular clouds and SF across the Galaxy, CMF, IMF;
Earliest phases massive star formation;
circumstellar envelopes: masers - variability; flares

ARI; Student supervision
Scientific interests:
Physics and chemistry of the galactic ISM;
Properties of SFRs across the Galaxy, CMF, IMF;
Earliest phases of massive star formation;
Chemical models;
Application of statistical methods to astronomical problems.

Andrea Giannetti

4.

ARC-people: tasks, science cont'd

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User support; QA2; mm-VLBI with ALMA; Archive
Scientific interests:
Low- and high-mass star formation;
Masers in SFRs: parallaxes;
GAIA astrometry of OB stars

Kazi Rygl

Rosita Paladino

User support; polarimetry w. ALMA; QA2; Formation & Outreach;
Student supervision
Scientific interests:
Star formation in nearby galaxies;
Magnetic fields and cosmic rays in the ISM;
Environmental effects on the star formation processes.

5.

ARC-people: tasks, science cont'd

EUROPEAN ARC
ALMA Regional Centre || Italian

ARC manager
User support; QA2; Formation & Outreach; ARI; AENEAS
Student supervision
Scientific interests:
Galaxy formation & evolution; Extragalactic radio sources;
High-z galaxies; galaxy clusters and SZ effect;
Instrumental calibration.

Marcella Massardi

Elisabetta Liuzzo

User support; QA2; mm-VLBI; Software development; Formation & Outreach; Archive; Student supervision
Scientific interests:
AGN & AGN jets;
NIR properties of Quasars;
Extra-galactic radio sources

6.

ARC-people: tasks, science cont'd

EUROPEAN ARC
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Sandra Burkutean

User support; QA2; SD/array combination; Software development; Archive
Scientific interests:
Galaxy clusters: SZ effect, X-ray observations;
Shocks in the ICM.

User support; ALMA Archive; ARI
Scientific interests:
Galaxy formation & evolution; modeling
Statistical properties of galaxies

Matteo Bonato

Claudia Mancuso

Archive; ARI
Scientific interests:
AGN & AGN jets; Galaxy formation & evolution;
Extra-galactic radio sources

7.

ALMA-related projects, developments

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The ALMA Re-Imaging (ARI) development study Poster Massardi
ALMA Upgrade proposal. Feasibility study to re-image Archival data (Massardi PI; Stöhr (ESO) Co-I; Giannetti (ARC). Incl. It, UK, Nordic nodes).

Archive Key-word Filler (AKF) See poster by Liuzzo et al.
Liuzzo, Rygl, Massardi

Keywords of Archived FITS-images Exploder (KAFE) Poster by Burkutean et al.
All

Array and single dish combination
Burkutean

ALMACAL
Deep (sub)mm multi-freq survey using ALMA calibrator data.
Liuzzo, Bonato, Massardi

8.

ALMA-related projects, developments, cont'd

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Polarimetry (guide, manual, calibration)
Paladino: casa guide, manual for QA2 analysts. Calibration strategy tests (with Fomalont); calibrator pol. info from PI-data.

Advanced European Network of E-infrastructures for Astronomy with the SKA
INAF-IRA (Massardi) is leader of WP5 in this accepted H2020 proposal for a EU SKA Science Data Centre (Brand and Nanni IRA-participants; + Umana, Becciani, Costa (CT), Smareglia, Knapic, Taffoni (TS)). See poster Massardi

BlackHoleCam entry imminent
Liuzzo, Rygl – writing pipeline for CASA

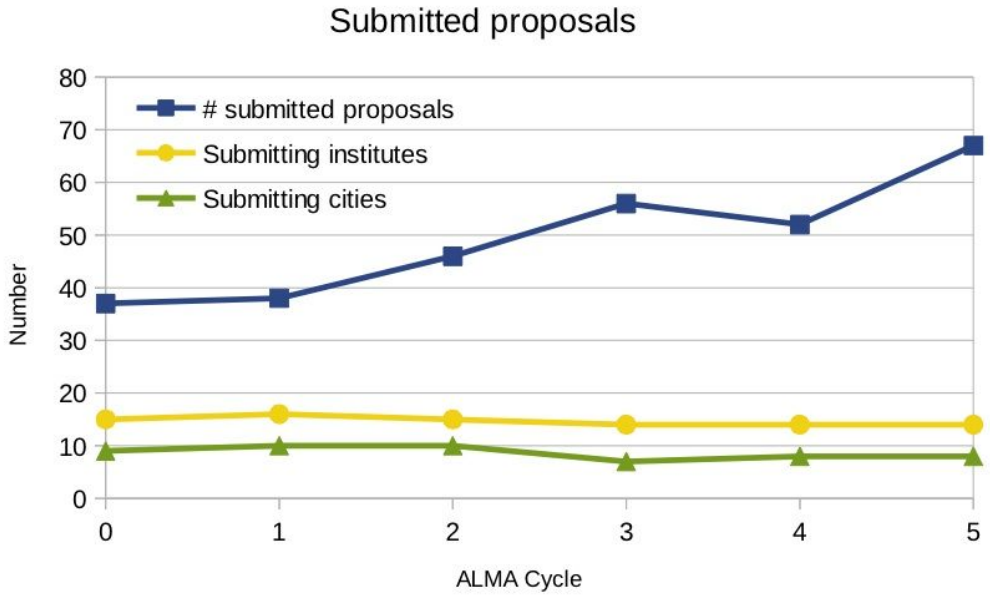
Come find us also for science support and collaborations!

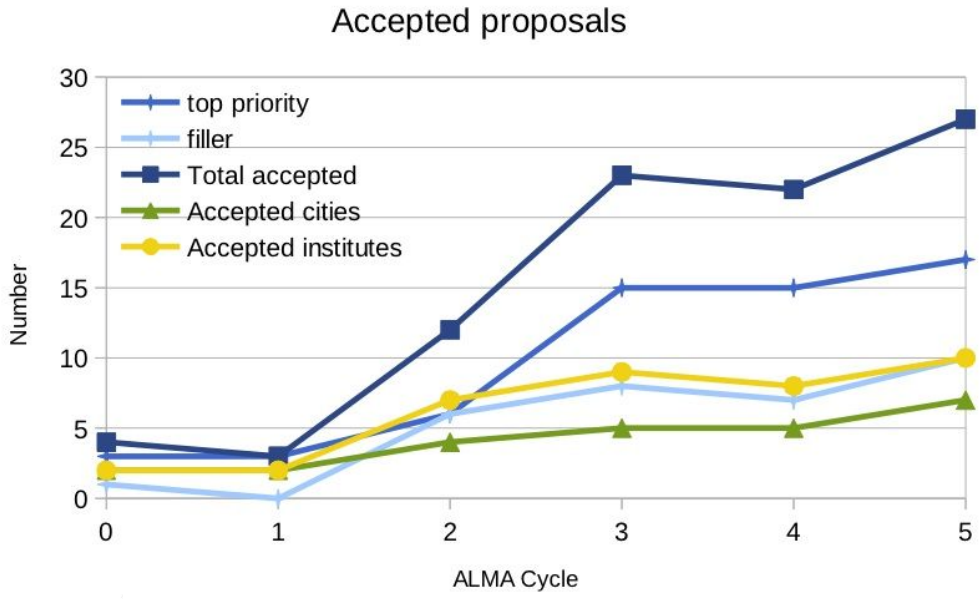
Also see our contributions to the 4th Workshop on mm-astronomy (11/2017):

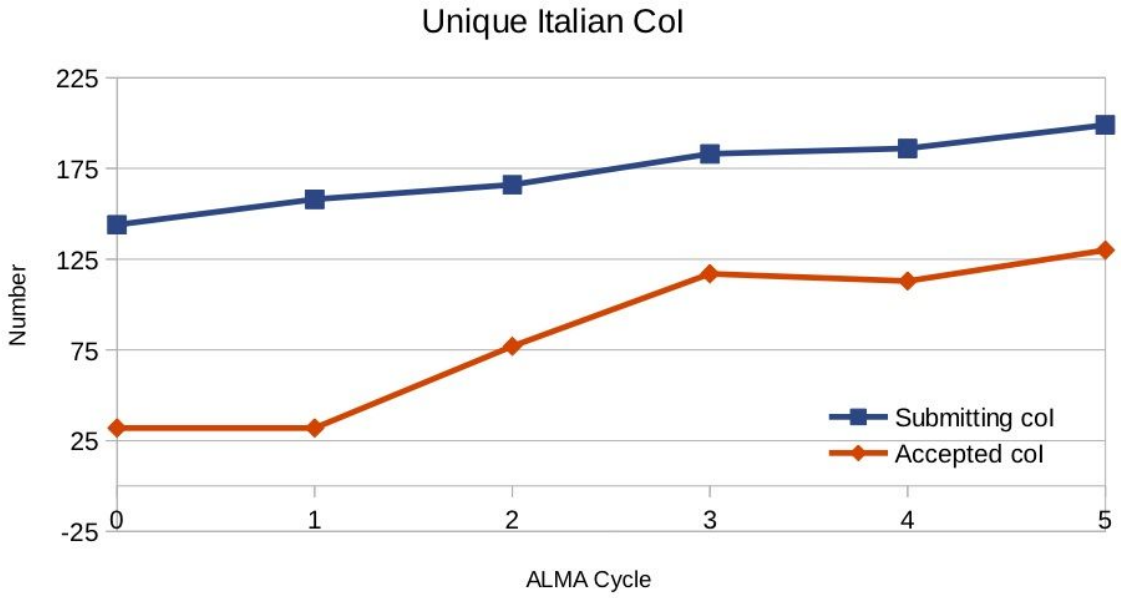
https://zenodo.org/communities/itmmws_iv/search?page=1&size=20

Proposal statistics for Italy

for all 6 Cycles







Cycle 5:

Italian PI's submitted 9.6% of all EU-proposals

Accepted A+B: 11.3%

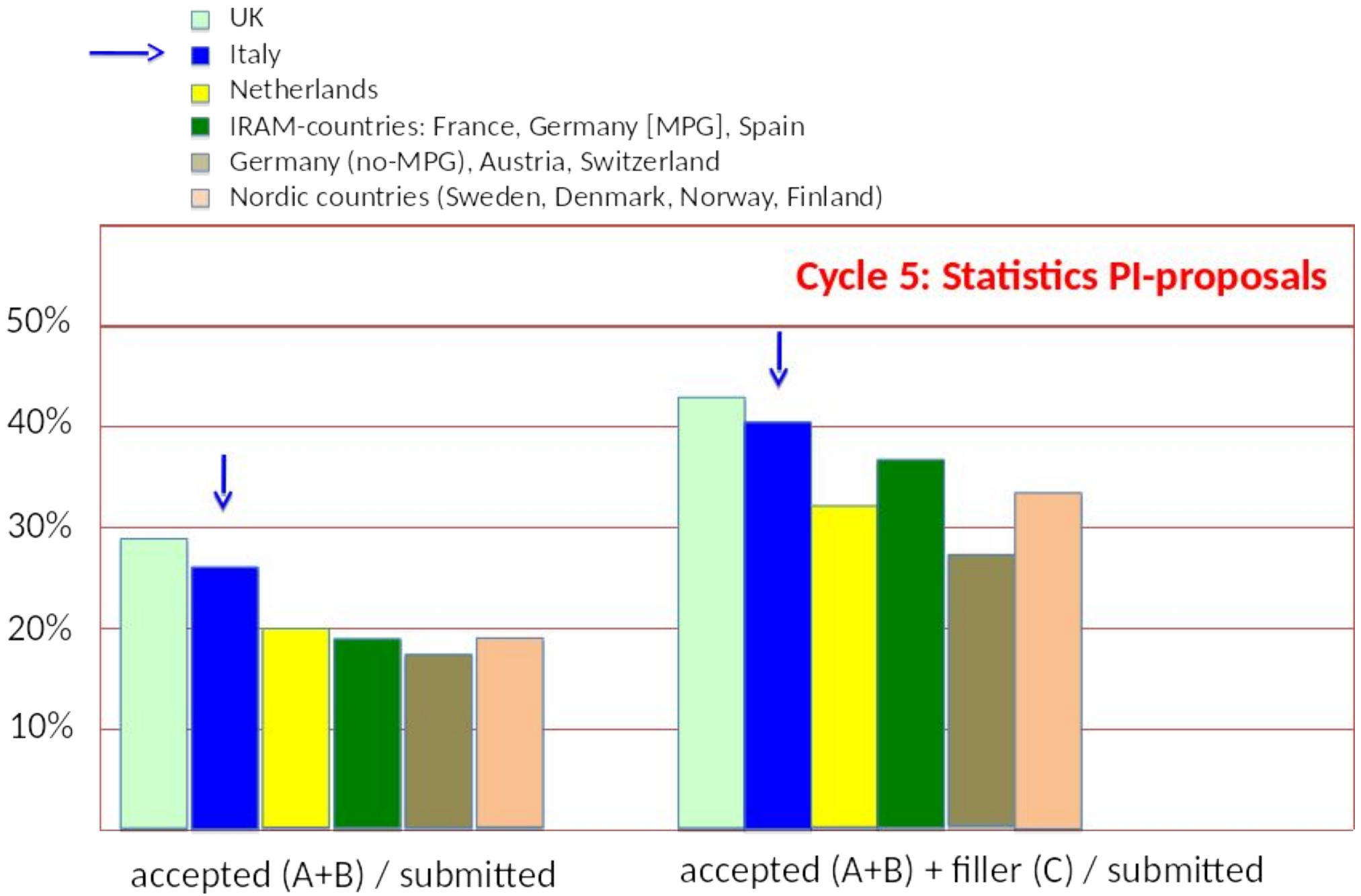
Accepted A+B + fillers: 10.4%

Over all cycles 0-5:

Submitted 8.5%

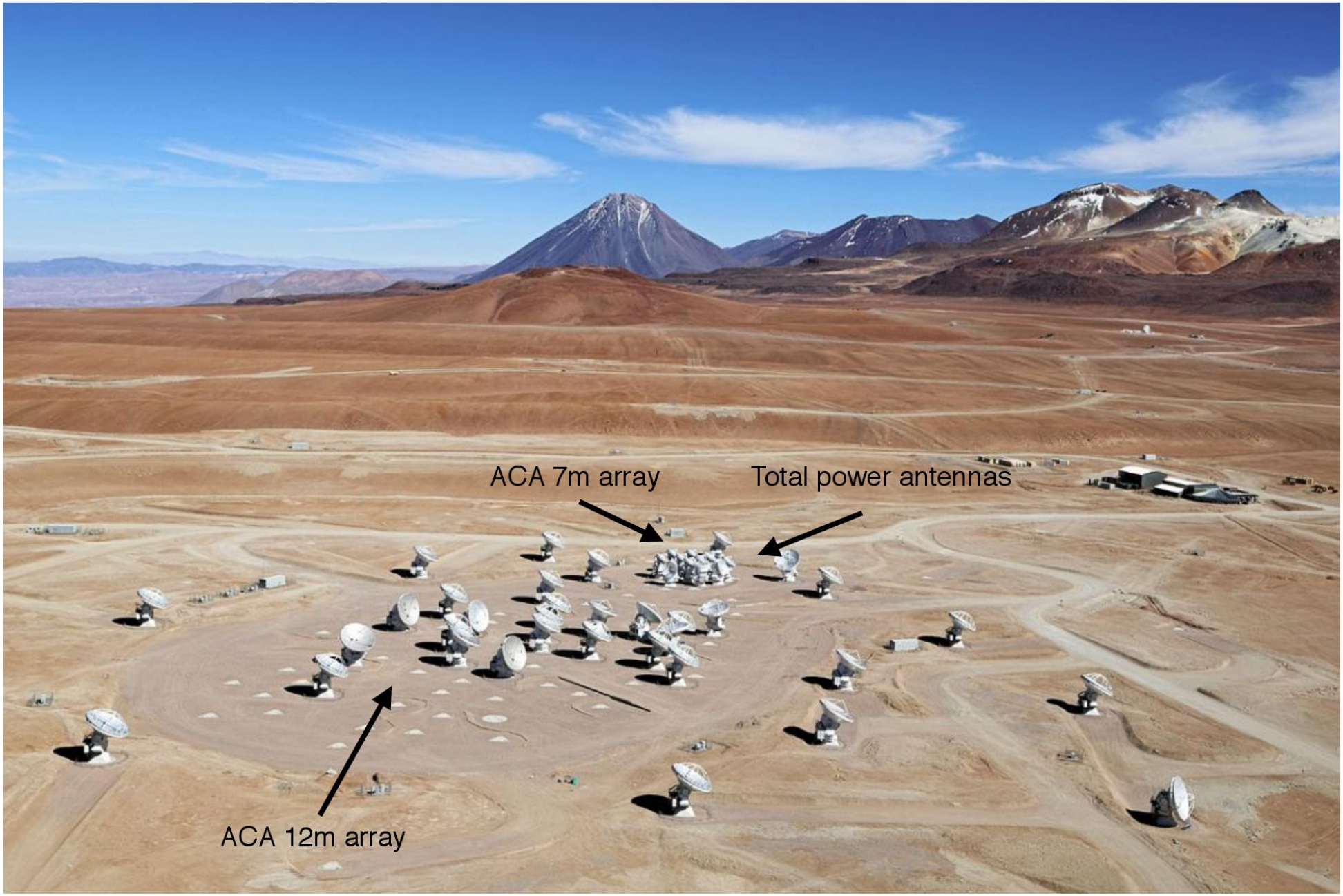
Accepted A+B: 9.1%

Accepted A+B + fillers: 8.5%

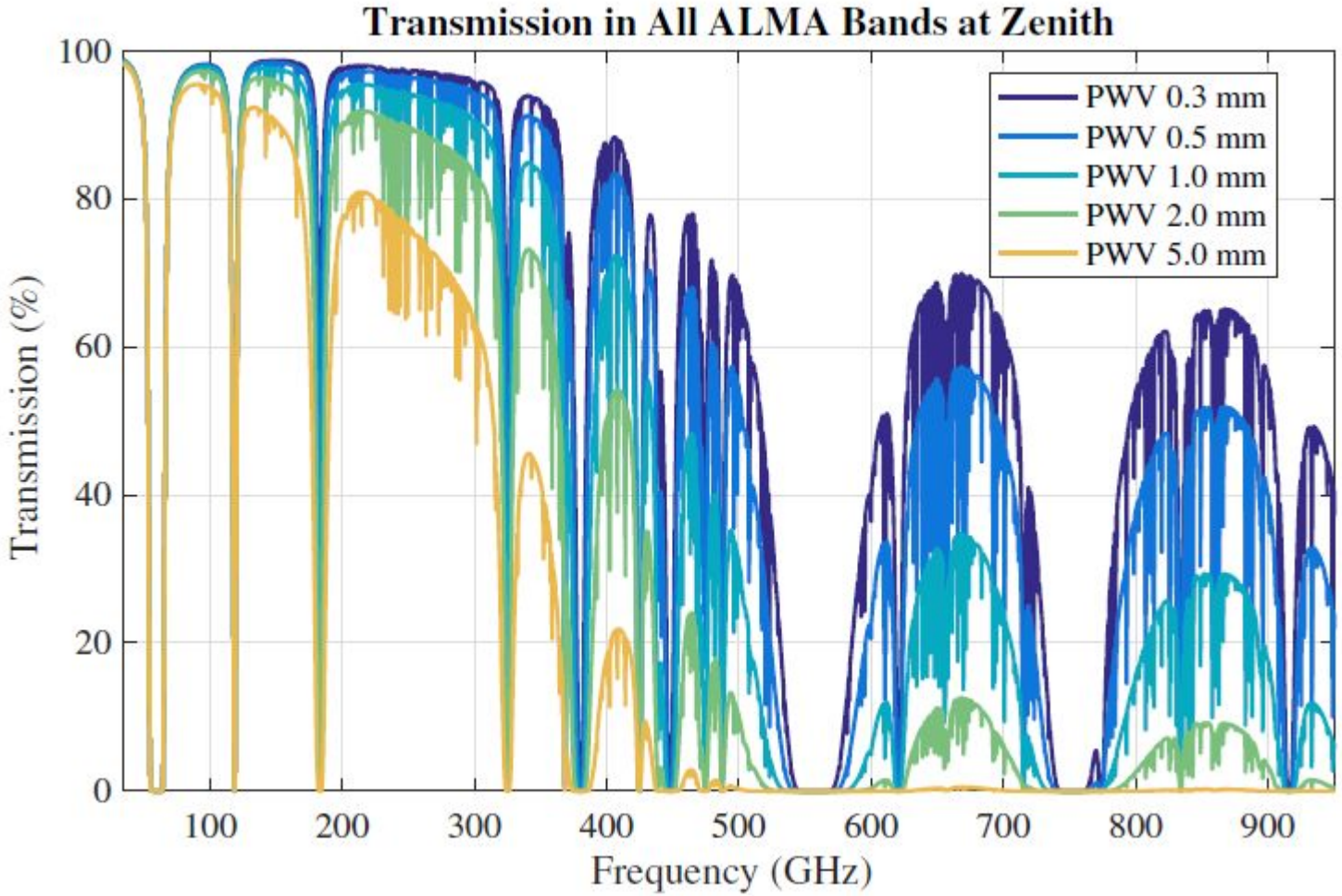

UK
Italy
Netherlands
IRAM-countries: France, Germany [MPG], Spain
Germany (no-MPG), Austria, Switzerland
Nordic countries (Sweden, Denmark, Norway, Finland)
Cycle 5: Statistics PI-proposals
50%
40%
30%
20%
10%
accepted (A+B) / submitted
accepted (A+B) + filler (C) / submitted

Outline

- ALMA cycle 6 call for proposals
- ALMA cycle 6 capabilities
- Observing tool
- Simulations


ACA 7m array
Total power antennas
ACA 12m array

ATMOSPHERIC TRANSMISSION



ALMA Cycle 6 call for proposals

https://almascience.eso.org/

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

Log in

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Search Site

Observatory News

ALMA Cycle 6 Call for Proposals is Now OPEN!
Mar 20, 2018

Additional Information for Cycle 6 Proposals
Feb 01, 2018

New Science Verification data are now available for download
Jan 22, 2018

More…

EU ARC News

Researcher position available at the Nordic ARC node
Jan 10, 2018

Post-doc position available at the Italian ARC-node
Dec 20, 2017

2017 European Radio Interferometry School
May 11, 2017

More…

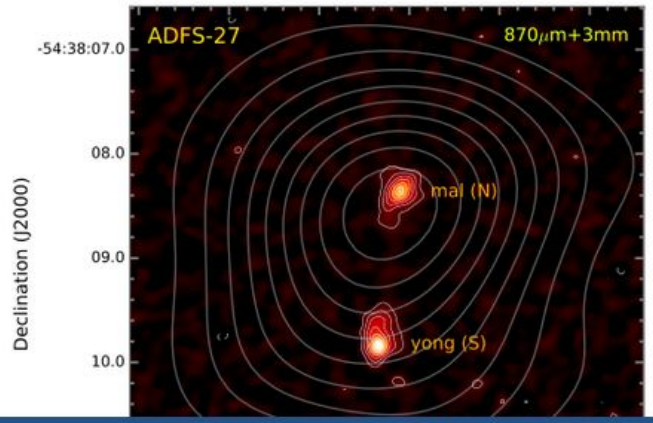
Status

Cycle 6 Call for Proposals
Cycle 6 Proposer's Guide

Refereed publications: 969
Last observed source: Ser_S68N
Current configuration: C43-4

More...

Science Highlights - Detection of a z~6 Starburst Galaxy with the ALMA Spectral Scan Mode



The ALMA spectral scan mode offers the ability to pinpoint the redshift of luminous gas-rich galaxies at high redshift. In a recent study, Dominik Riechers and his collaborators made use of this mode to measure the redshift of an extremely red galaxy merger, and to derive several basic properties of the system. For extremely high-redshift dusty galaxies, the peak of their far-infrared spectral energy distribution is shifted to very long wavelengths, thus sampling the observer-frame emission from these galaxies with *Herschel* and ground-based bolometer arrays (APEX/LABOCA) in the 250-870 micron range yields increasing red energy distributions. The authors make use this fact to identify "870 micron

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Important dates

Date	Event
20 March 2018	Release Call for Proposals Cycle 6 + Documentation & Tools
19 April 2018 15:00 UT	**Proposal submission deadline**
End of July 2018	Announcement outcome review process
6 September 2018	**Submission Phase2 material by PIs**
October 2018	Start observations Cycle 6
September 2019	End of Cycle 6

CYCLE 6: What's Available

Antennas: **43 in 12-m array**
10 x 7-m + 3 x 12-m TP in ACA

Receiver bands: **3, 4, 5, 6, 7, 8, 9, and 10**

Time: **4000 hrs with 12-m array + 3000 hrs ACA**
[PI+DDT+Cycle5 priority A carry-overs]
Feb and May 2018 not available

≤ 20% non-standard (including ≤ 5% mm-VLBI)
≤ 15% Large Programs
≤ 5% DDT

CYCLE 6 Available receivers

Band	Frequency (GHz)	Wavelength (mm)	FOV (arcsec)	Cont Sens (mJy/beam)
3	84 – 116	2.6 – 3.6	73 – 53	0.088
4	125 – 163	1.8 – 2.4	49 – 38	0.12
5	163 – 211	2.4 – 1.1	38 – 22	0.12
6	211 – 275	1.1 – 1.4	29 – 22	0.12
7	275 – 373	0.8 – 1.1	22 – 16	0.22
8	385 – 500	0.6 – 0.8	16 – 12	0.42
9	602 – 720	0.4 – 0.5	10 – 8.5	2.0
10	787 – 950	0.3 – 0.4	7.8 – 6.5	4.6

CYCLE 6: observing mode

- **Spectral line and continuum observations in all bands**
  with the 12-m Array and the 7-m Array
- **Single field interferometry (all bands)** with the 12-m Array and the 7-m Array
- **Mosaics (Bands 3 to 9)** with 12-m Array and the 7-m Array
- **Single dish spectral line observations in Bands 3 to 8**
  No stand-alone TP-array (and no TP at all for B9, 10)
- **ACA stand-alone** (standard mode only).

  ACA stand-alone in Band 8 NEW
- **Solar observing mode**; Bands 3, 6. Only scheduled in certain periods.
- **Simultaneous observations** ACA and main array

CYCLE 6: polarization capabilities
non standard mode

Full polarization for Bands 3, 4, 5, 6 and 7 on the **12-m Array (including circular)**
for continuum and spectral-line, single-field, **on-axis**, observations.
Not offered for spectral scan or mosaics

NEW

The field of view is limited to:
the inner **1/3** of the primary beam **for linear polarization**
the inner **1/10** of the primary beam **for circular polarization**

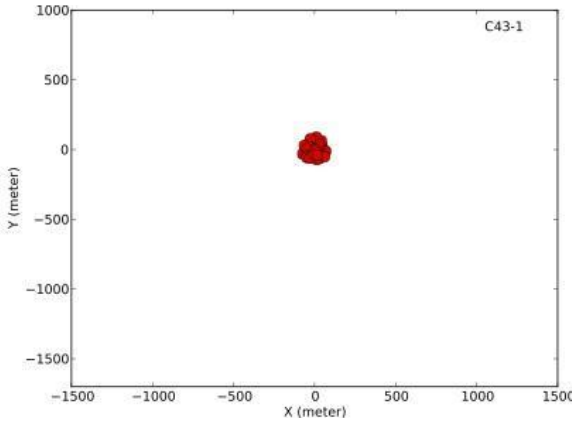
The minimum detectable degree of circular polarization is currently 1.8% of the peak flux for both continuum and spectral-line data.

For a proper calibration full polarization observations require about three hours of parallactic angle coverage. **Each Science goal will have the time estimate set to 3 hrs.**

Cycle 6 : configurations and baselines

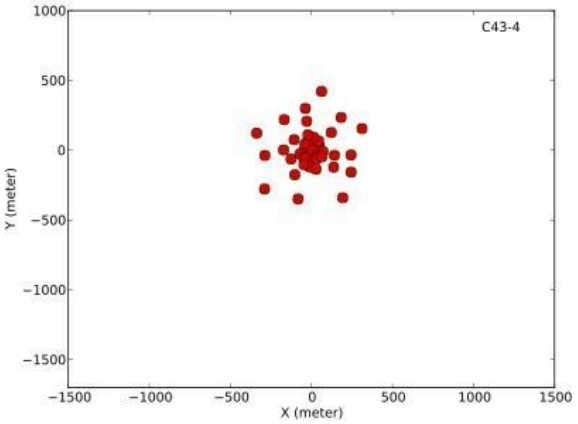
Bands 3 - 6 b_{max} = **16 km**
Band 7 b_{max} = **8.5 km**
Band 8, 9, 10 b_{max} = **3.6 km**

C43-1

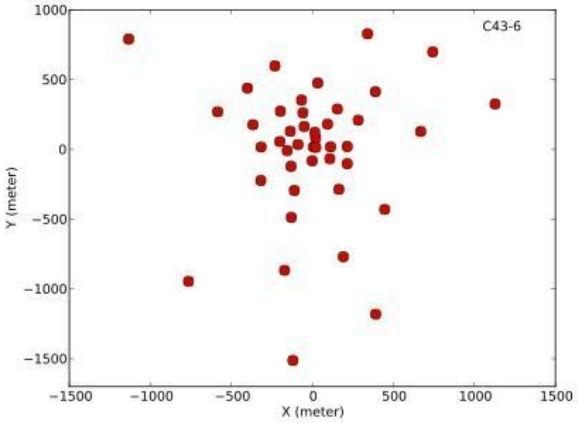


3 km

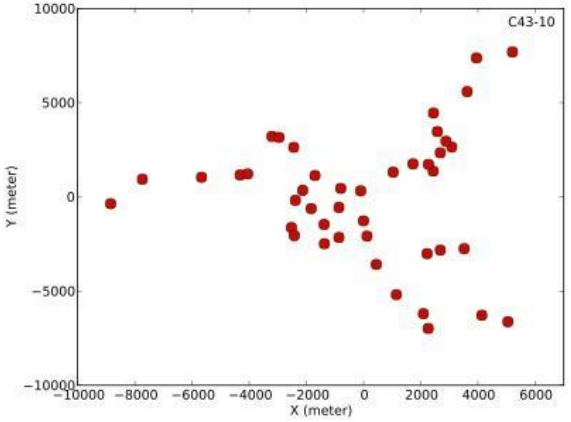
C43-4



C43-6



New configuration every 2-4 weeks.



C43-10

16 km

CYCLE 6 standard/non standard

Standard modes have been well characterized and the observations are calibrated with the ALMA data reduction pipeline. Non-standard modes are not as well characterized and require manual calibration by ALMA staff.

Up to 20% of the observing time in Cycle 6 will be allocated to proposals requesting **non-standard modes**, which include:

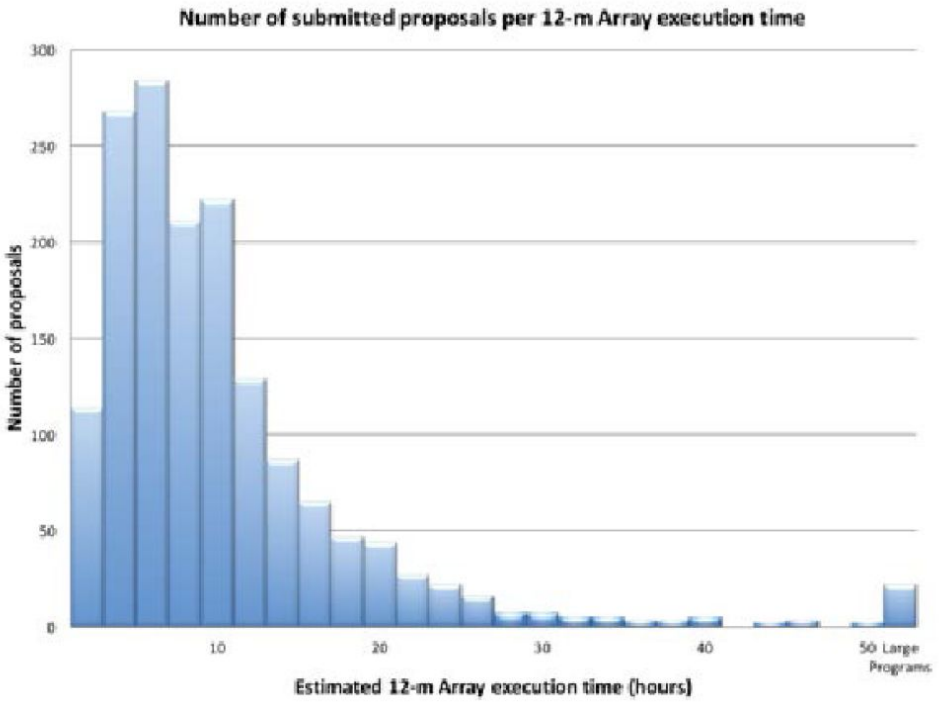
- **Band 9 and 10 observations**
- **Band 7** observations with maximum baselines **> 5 km**
- **All polarization observations**
- **Spectral scans**
- **Bandwidth switching projects** (less than 0.9375 GHz aggregate bandwidths over all spectral windows)
- **Solar observations (Bands 3 and 6)**
- **VLBI observations**
- **User-specified calibrations**
- **Astrometry**

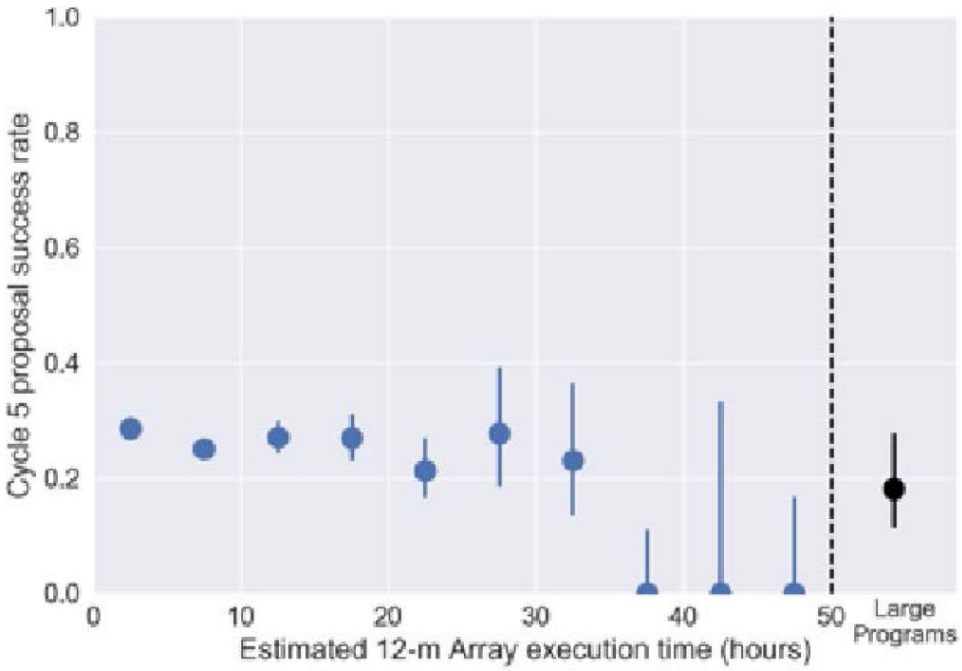
CYCLE 6: PROPOSAL TYPES

- **Regular proposals**.

  < 50 hrs (12-m) or < 150 hrs (ACA standalone).

  Can be standard & non-standard, time-critical, multi-epoch, monitoring.





The requested time of the majority of Cycle 5 proposals is between two and ten hours of 12-m Array time.

The success rate of proposals was roughly constant up to at least 30 hours of requested 12-m Array time

ALMA continues to encourage the community to submit Regular Proposals that request over 10 hours of 12-m Array time.

CYCLE 6: PROPOSAL TYPES

- **Target of Opportunity (ToO)** As regular proposal, but the target list can be specified at the moment of triggering.
  Submit at regular deadline.

- **Director's Discretionary Time (DDT)** **Can be submitted any time**; special policies.
  < 5% of the available time

- **mm-VLBI**; Bands 3, 6;
  Band 3 in concert with Global Millimeter VLBI Array (proposal deadline 1/2/18);
  Band 6 in concert with the Event Horizon Telescope Consortium (ALMA deadline)
  <5% total time (included in the 20% for non standard);
  fixed period (March/April 2019, compact config: b_{max} < 700m)

- **Large programs**. Cannot be done as series of normal proposals;
  > 50 hrs on the 12-m Array (with or without accompanying ACA time)
  > 150 hrs on the ACA in stand-alone mode
  Only standard obs modes and no time-critical or ToO obs's
  Contact ARC nodes
  Up to 15% of the time may be allocated to Large Programs:
  600 hrs for the 12-m Array and 450 hrs for ACA stand-alone
  scheduling constraints based on LST and configs **(consult documentation)**

Resubmission

New proposal to observe SGs from an active program.
Is considered a *resubmission* if SGs are duplications (=not different enough; details on next slide) *and* PI of either proposal appears as investigator on the other one.

Note that: if observations successfully completed in Cycle 4/5, relevant portions Cycle 6 proposal will be cancelled. Obs's started in prev. cycle and accepted in Cycle 6 will be *observed with same setup* as in prev. cycle, even though it has "slightly changed" in current cycle.

Duplication

A project is considered a **duplication** if the observation is similar to an already existing ALMA observation (public/non-public) present in the ALMA archive.
Definition of similar in ALMA User policy document, appendix A:

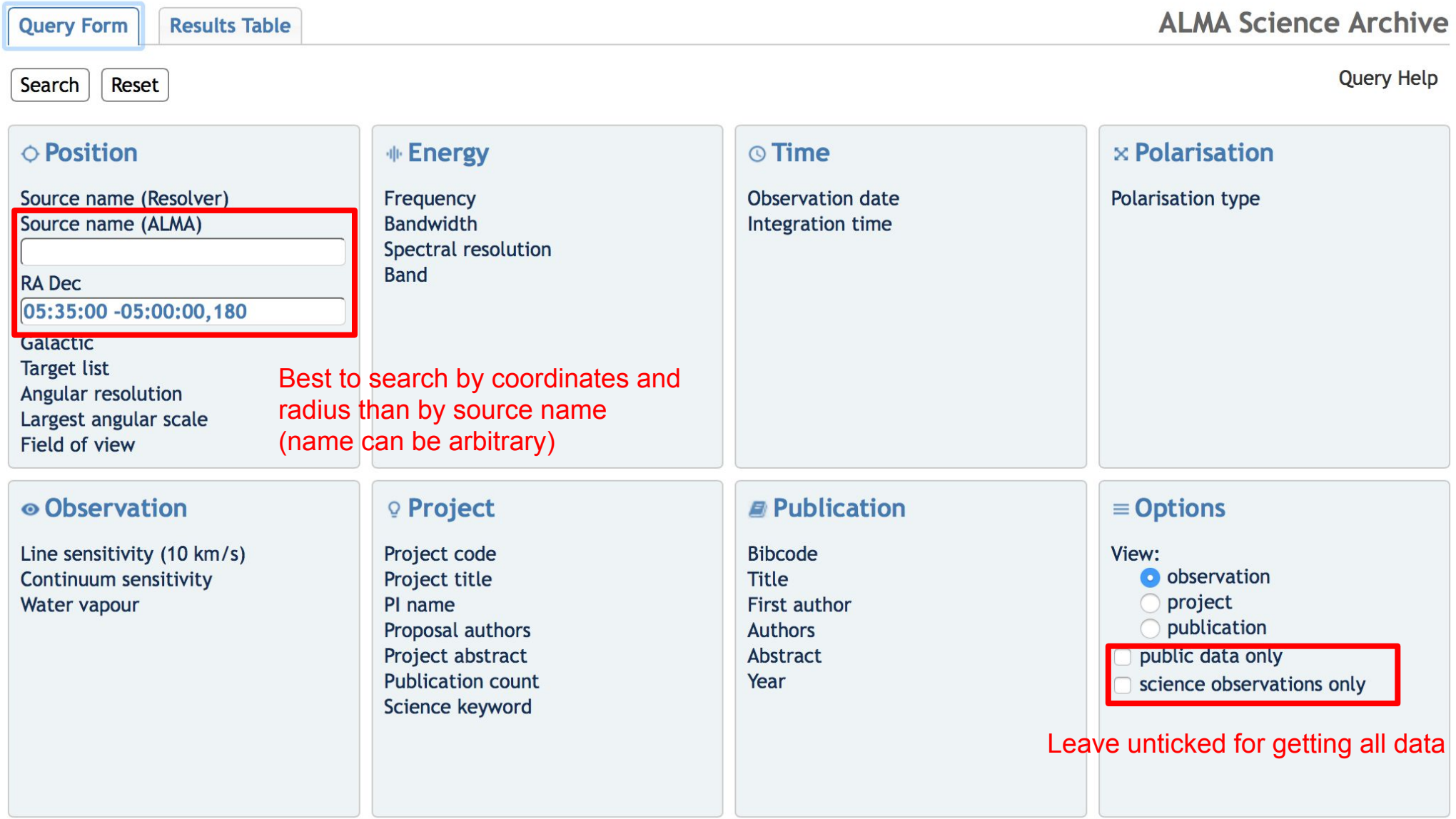
- **angular resolution is within a factor ≤ 2 of archival data**
- **single pointing: coordinates overlap within HPBW of archival data**
- **mosaic: 50% of pointing are within HPBW of archival data**
- **line: central frequency within spw of archival data and sensitivity per channel (after smoothing to the same resolution) is within a factor ≤ 2 of archival data**
- **continuum: sensitivity is within a factor ≤ 2 of archival data and requested frequency is within a factor 1.3 of the archival one**
- solar observation non checked for duplicates.

https://almascience.eso.org/proposing/duplications

PIs are responsible for checking their proposed observations against the Archive and the list of Cycles 4 and 5 Grade A programmes provided by ALMA:

Check the ALMA archive
https://almascience.eso.org/alma-data/archive

Consulting archival images/observations



or try to use **astroquery** a python based query interface to the ALMA archive (not an ALMA tool)
https://astroquery.readthedocs.io/en/latest/alma/alma.html

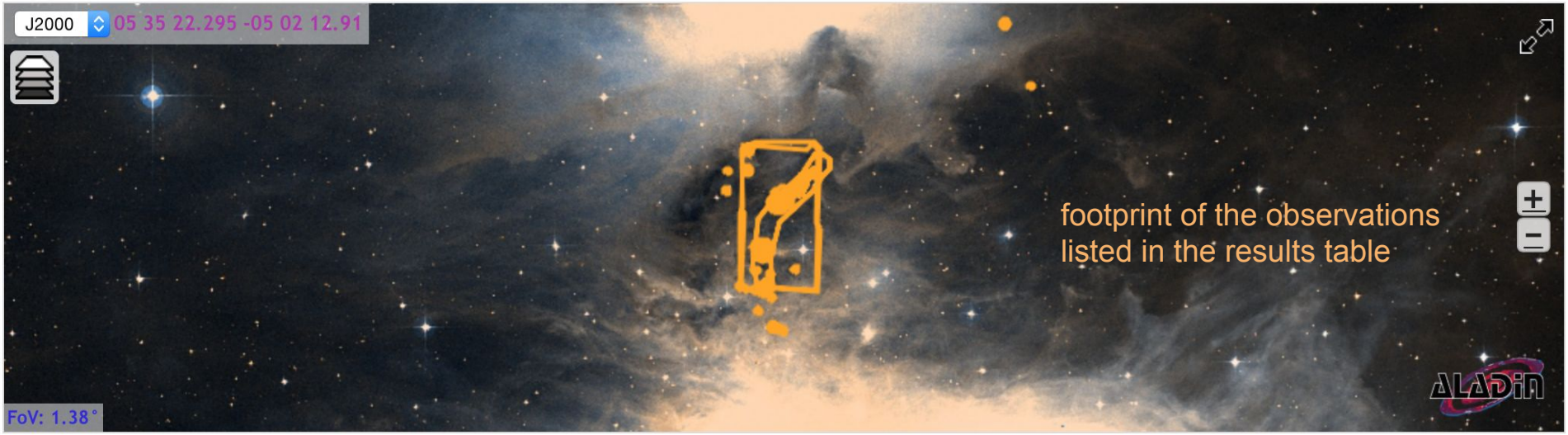
Consulting archival images/observations

Query Form | Results Table

ALMA Science Archive

Submit download request

Close Viewer Results Bookmark Export Table Results Help



More columns Showing 97 of 97 rows.

	Project code	Source name	RA	Dec	Band	Integration	*Release date*	Velocity resolution	Frequency support	Pub
Filter:			H:M:S	D:M:S		seconds		m/s		
	2013.1.00662.S	OMC-2	05:35:22.29	-05:02:12.9	3	1052.803	2016-05-04	196.35	90.62..93.19GHz	0
	2013.1.00662.S	OMC-2	05:35:22.29	-05:02:12.9	3	159.718	2016-12-07	196.32	90.62..93.20GHz	0
	2013.1.00231.S	MMS1	05:35:18.03	-05:00:17.8	7	544.320	2017-03-11	53309.11	335.49..351.49GHz	0

unfortunately, only a small part of the list is visible and one has to scroll down to see all observations

Consulting archival images/observations

Download the products of your selected ALMA observation. These will include the fits images made for quality assessment either by the analyst or the pipeline.

Consulting archival images/observations

When pipeline calibrated, you can find the weblog in the /qa directory: detailed information of observation and calibration

ALMA 2013.1.00105.S | Home | By Topic | By Task

Observation Overview

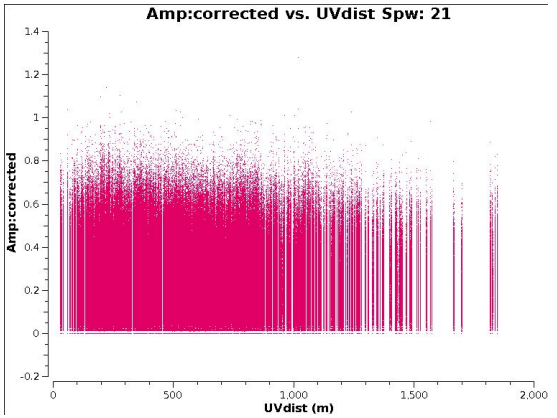
Project	uid://A001/X10d/X17
Principal Investigator	akeson
OUS Status Entity id	uid://A001/X12e/X23f
Observation Start	2015-09-18 08:58:05 UTC
Observation End	2015-09-18 09:41:13 UTC

Pipeline Summary

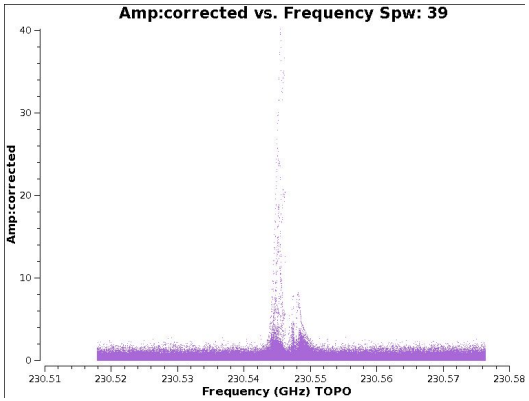
Pipeline Version	34044 (Pipeline-Cycle3-R1-B)
CASA Version	4.3.1 r32491
Pipeline Start	2015-10-07 21:00:28 UTC
Execution Duration	2:52:45

Observation Summary

Measurement Set	Receivers	Num Antennas	Time (UTC) Start	Time (UTC) End	Time (UTC) On Source	Baseline Length Min	Baseline Length Max	Baseline Length RMS	Size
Observing Unit Set Status: uid://A001/X12e/X23f **Scheduling Block ID:** uid://A001/X12e/X22e									
Session: session_1									
uid___A002_Xaa4256_X309a.ms	ALMA Band 6	34	2015-09-18 08:58:04	2015-09-18 09:41:13	0:18:47	41.4 m	2.1 km	811.4 m	14.0 GB



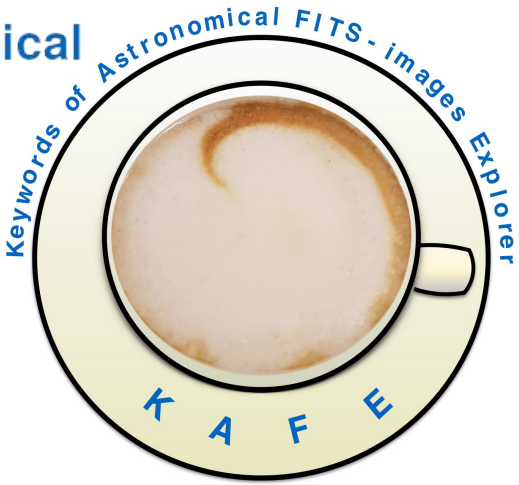
calibration plots



source spectra and uv plots

When you have downloaded archival products you can visualize them using

KAFE: Keywords of Astronomical FITS-images Explorer

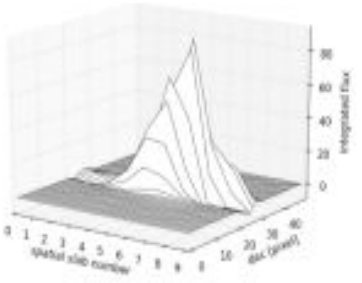


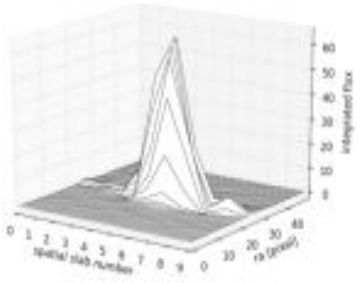
Burkutean et al. submitted

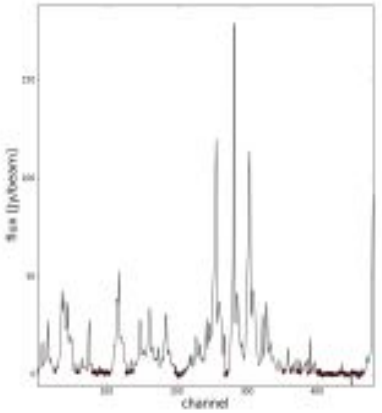
Please write to kafe@ira.inaf.it for access information to the web interface and the KAFE cookbook.

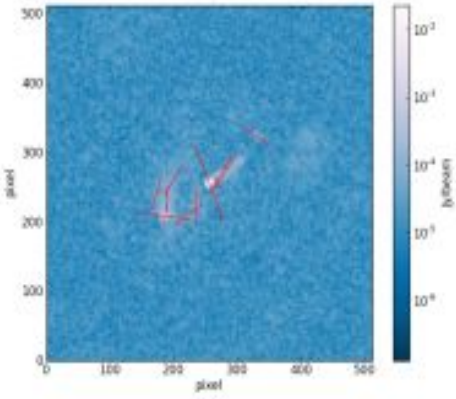
AIMS:

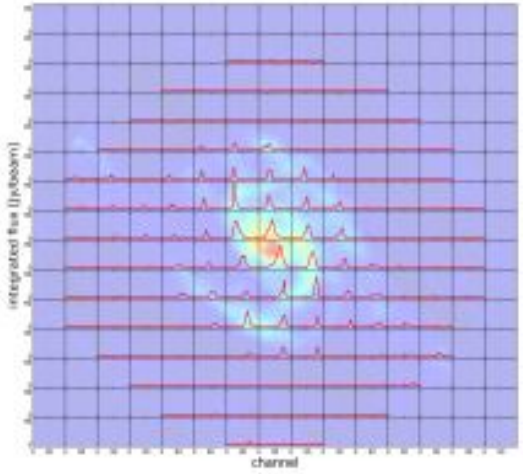
- provide advanced image analysis diagnostic plots in the spatial, spectral and temporal domain for user input FITS images
- offer AKF (Liuzzo et al. subm) keyword computation
- provide catalogue cross-matching
- minimal user input required (just tick the boxes) - the image computations and the required parameter settings are fully automated

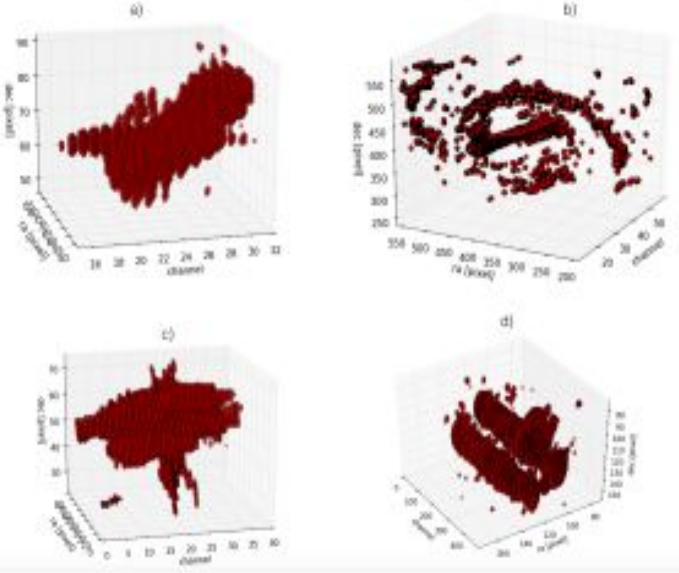

integrated flux
spatial slab number
dec (pixel)

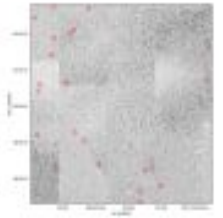

integrated flux
spatial slab number
ra (pixel)

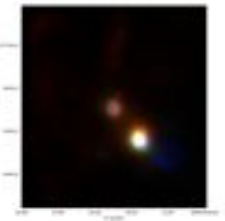

flux (Jy/beam)
channel

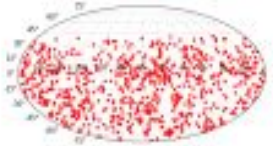

pixel
pixel
Jy/beam

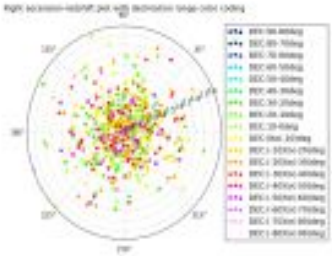

integrated flux (Jy/beam)
channel

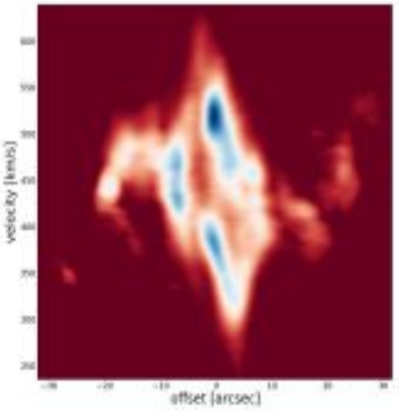

a)
b)
c)
d)
channel

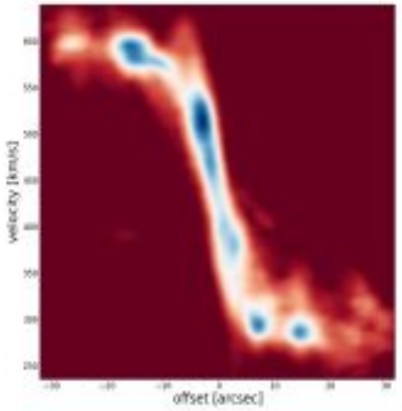




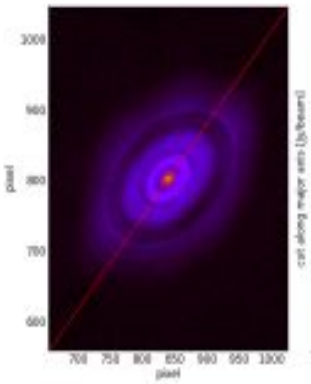


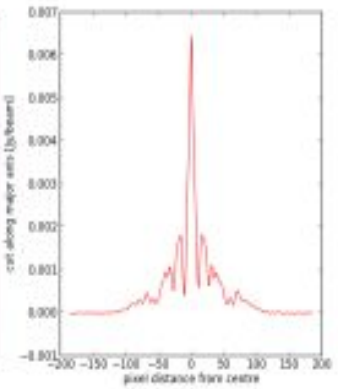



velocity (km/s)
offset (arcsec)


velocity (km/s)
offset (arcsec)

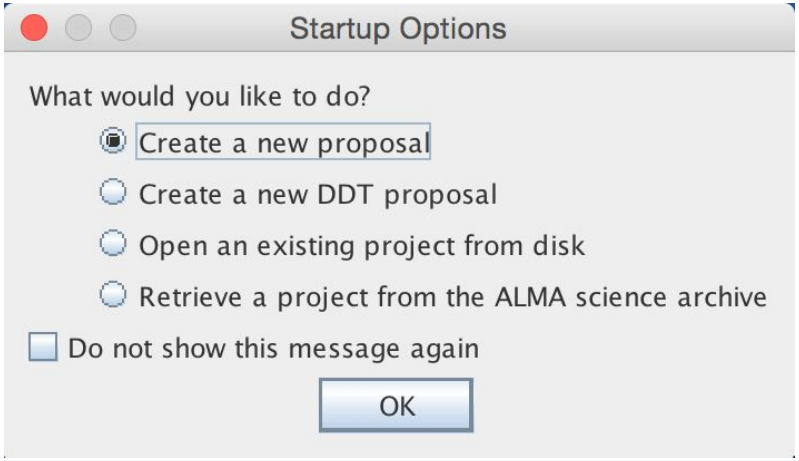

test.fits
RA: 20.916 deg
DEC: 33.256 deg
SPATRES: 0.002 arcsec
BNDCTR: 5022427500.0 Hz
BNDRES: 64000000.0 Hz
BNDWID: 64000000.0 Hz
CHANRMS: 6.14e-05 Jy/beam
DYNRANGE: 26.24
FLUXTOT: 0.0023 Jy
DATAMAX: 0.0016 Jy/beam
DATAMIN: -0.0001 Jy/beam
STOKES: [I]
test2.fits
RA: 18.258 deg
DEC: 33.3560846833 deg


pixel
pixel


cut along major axis (Jy/beam)
pixel distance from centre

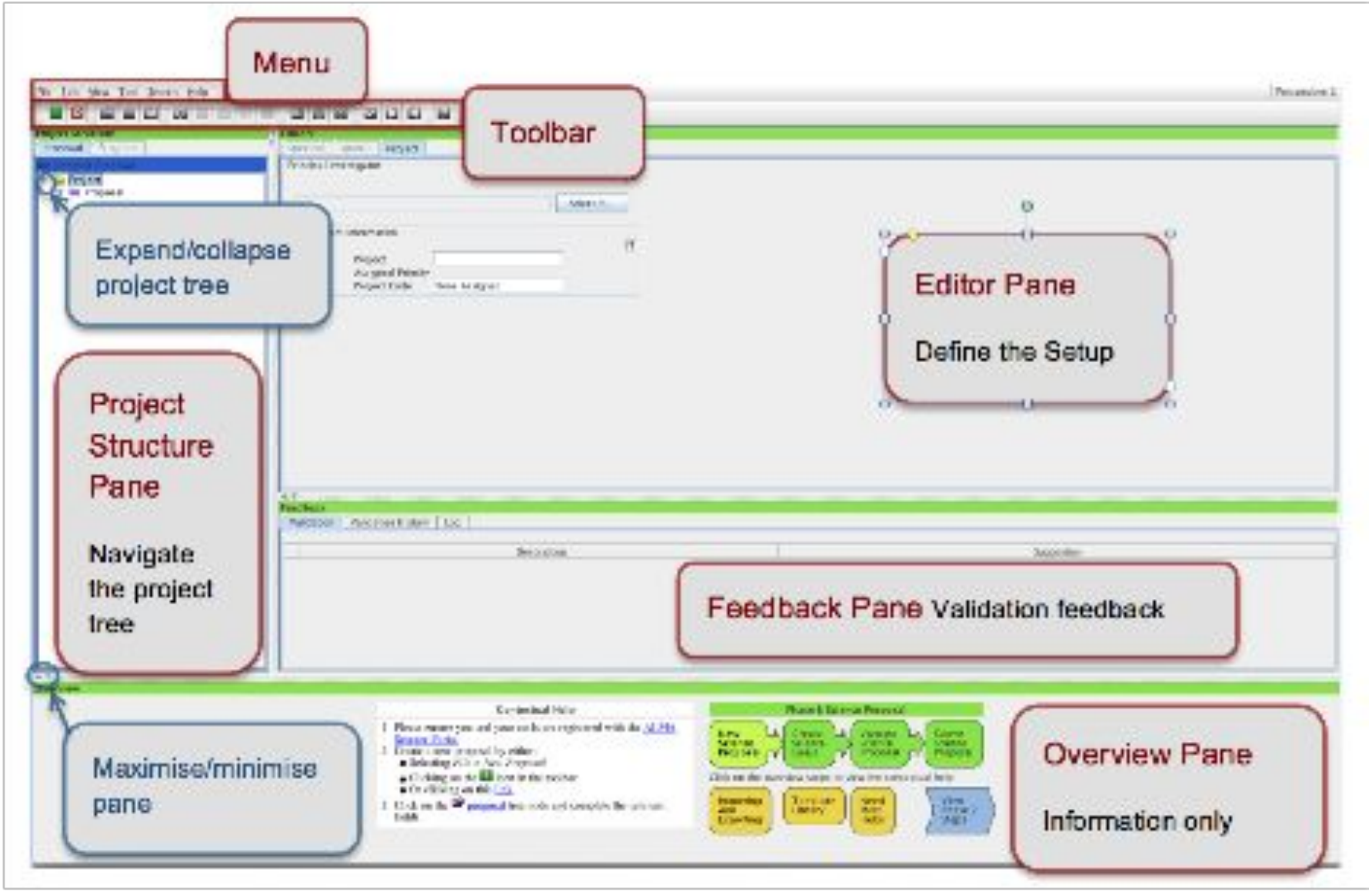
Starting up the OT

https://almascience.eso.org/proposing/observing-tool

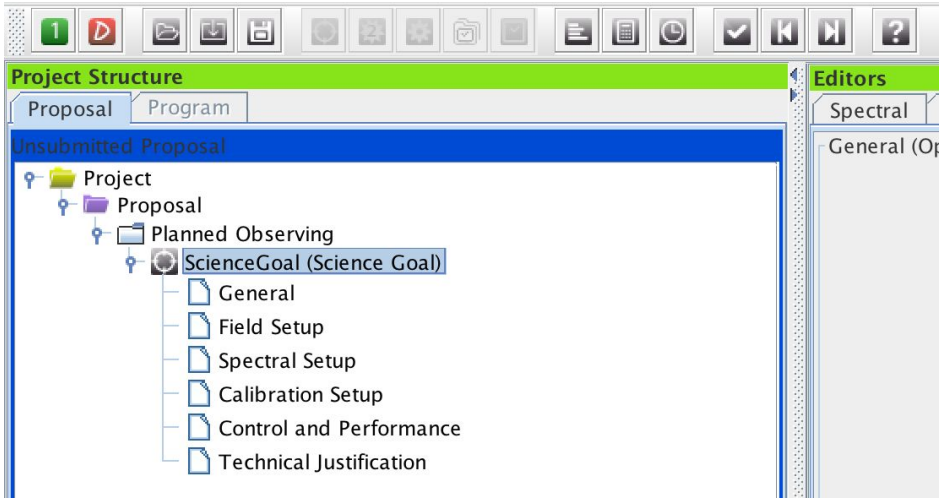


- PI/CoI have to registered on almascience website
- select proposal type (regular, VLBI, ToO, large program)
- select scientific category
- if resubmission of previous Cycle, enter the project ID

OT graphical interface



Science Goals



In a SG, all sources have:

- same angular resolution, sensitivity, LAS, receiver band;
- same field setup;
- same spectral setup (rel. placement and properties of spws.)

- For sources distributed widely in the sky the SG will be split by the OT into different “clusters”.
- Each grouping all sources within **10 degrees** (1 degree for long-baseline projects).
- No restriction on the total number of sources in a SG, but **for each grouping within the SG, the total number of pointings must be less than or equal to 150**
- Max 5 tunings per given group of sources (spectral scan)

Field setup

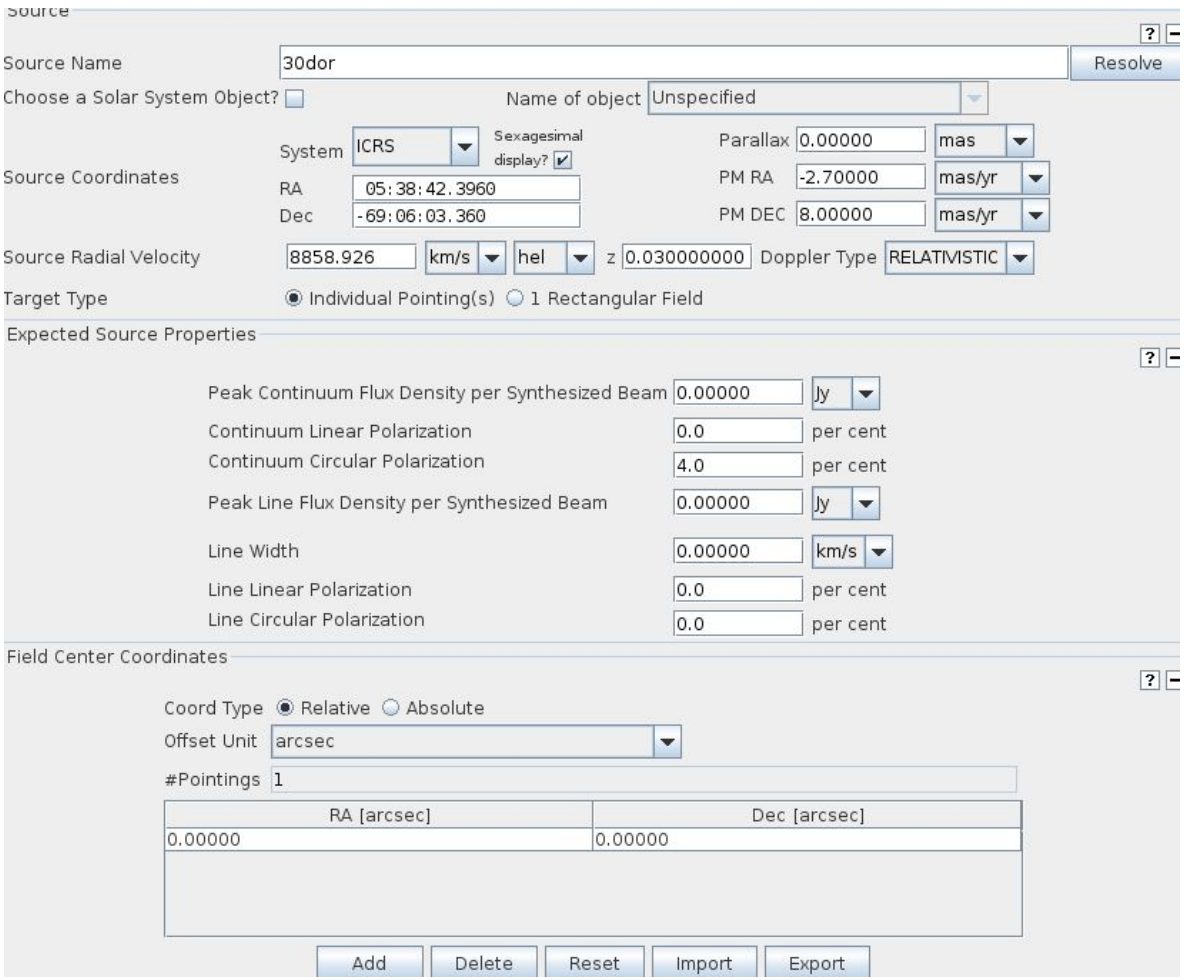
- Resolve by Source Name (NED, Simbad)
- SSO incl. Sun (tick box, select object, *Sun, Ephemeris: upload ephemeris file*)
- upload Sources from file

(see help for file format)

-

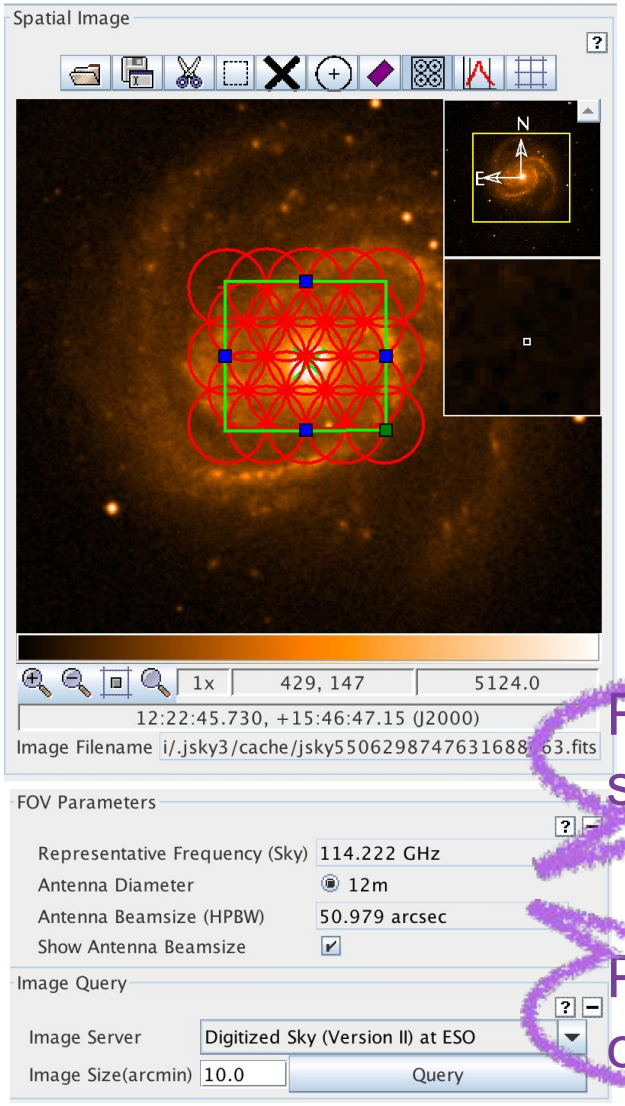
➷ important:

expected source properties



Spatial setup, once the spectral setup is done

Rectangular field (mosaic)

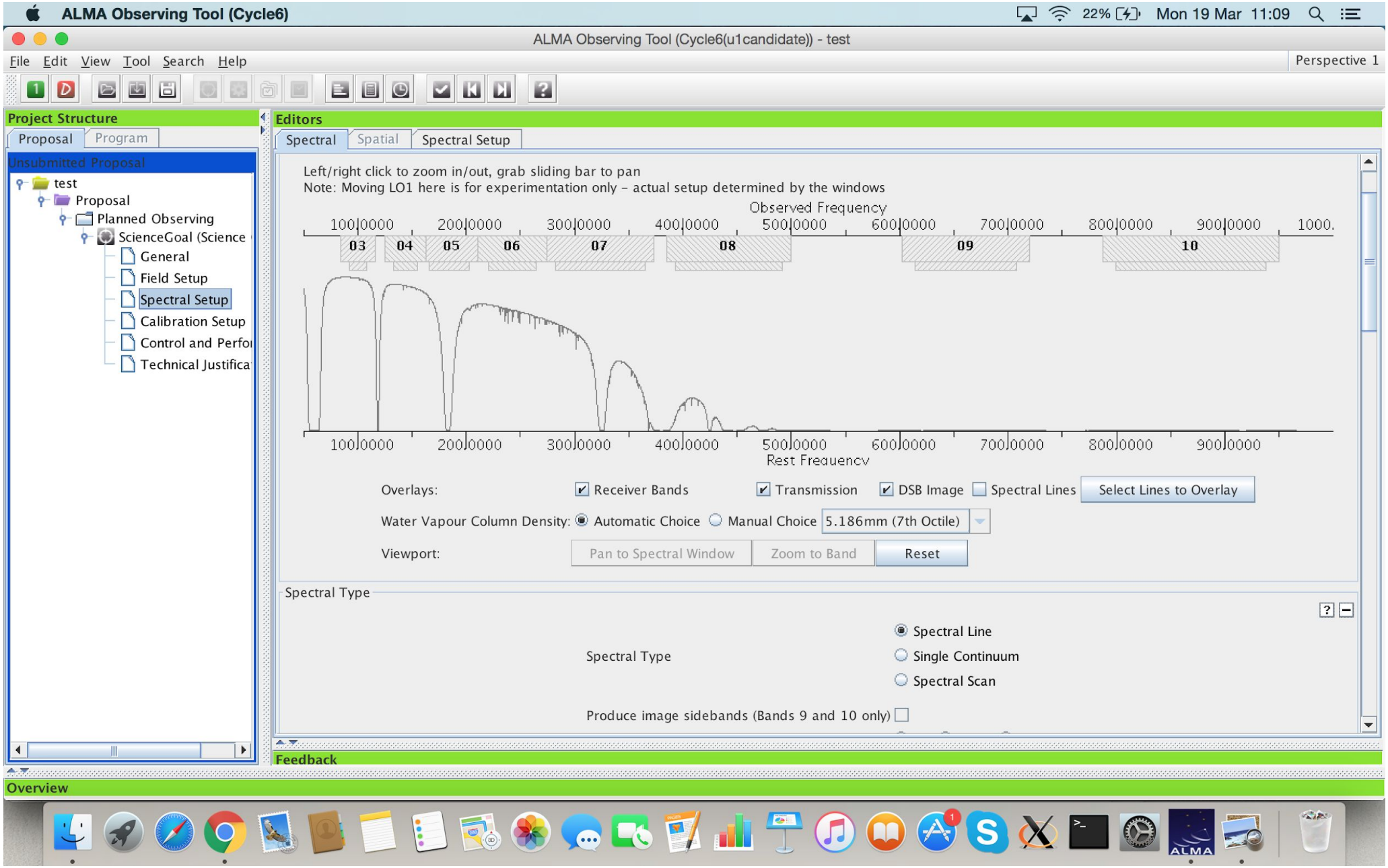


Multiple non overlapping pointings for a target must be multiple sources

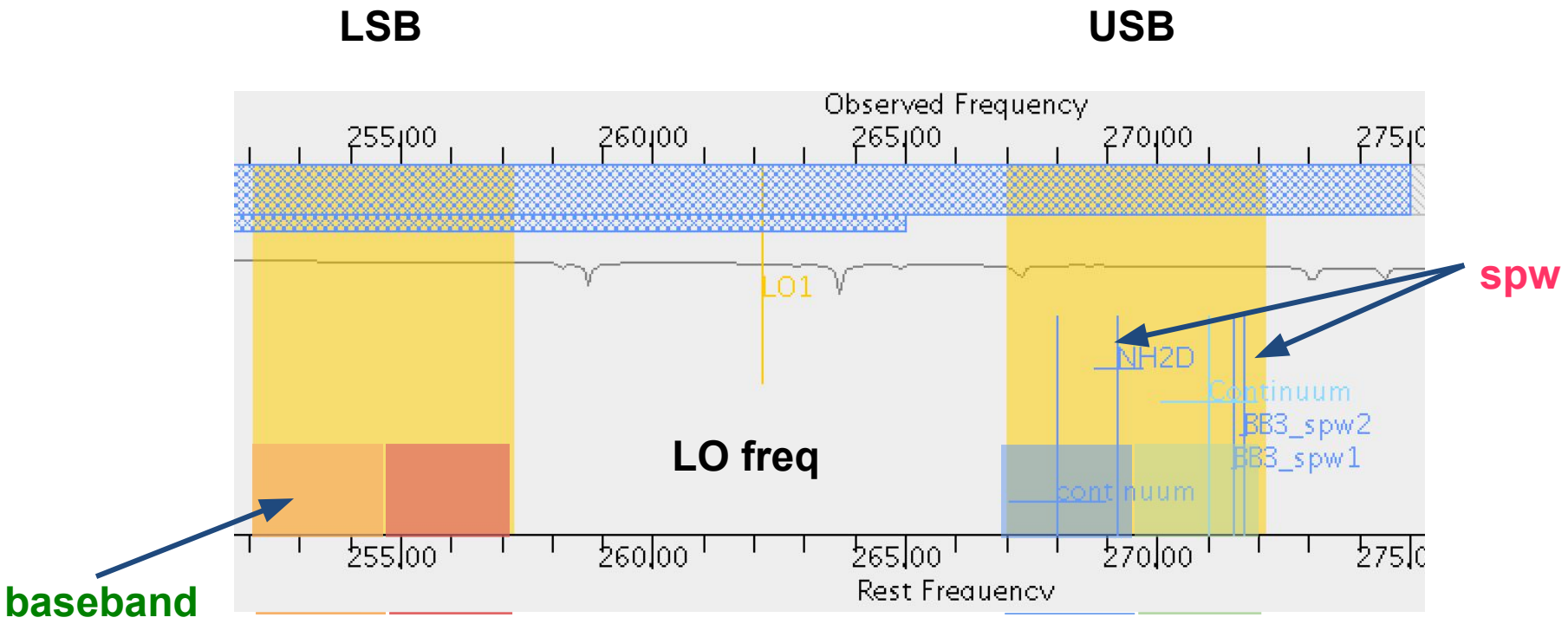
Repr. freq from spectral setup

Primary beam or FOV ~ λ/D

Spectral setup



Spectral setup



4 **basebands** (BBs), each max 2GHz, to be placed in two sidebands (SBs).

SB-width differs per band (band 3,4,5,7,8: 4GHz; band 6: 5.5GHz; band 9,10: 8 GHz)

Up to 4 **spectral windows** (spw) per BB, to observe lines or continuum.

Carefully select the representative spw: will be used for all frequency/spectral resolution dependent calculations, such as FOV, MRS, angular resolution, atmospheric opacity

CYCLE 6 correlator setup

You can set the resolution of each spw according to this table

TDM time division mode

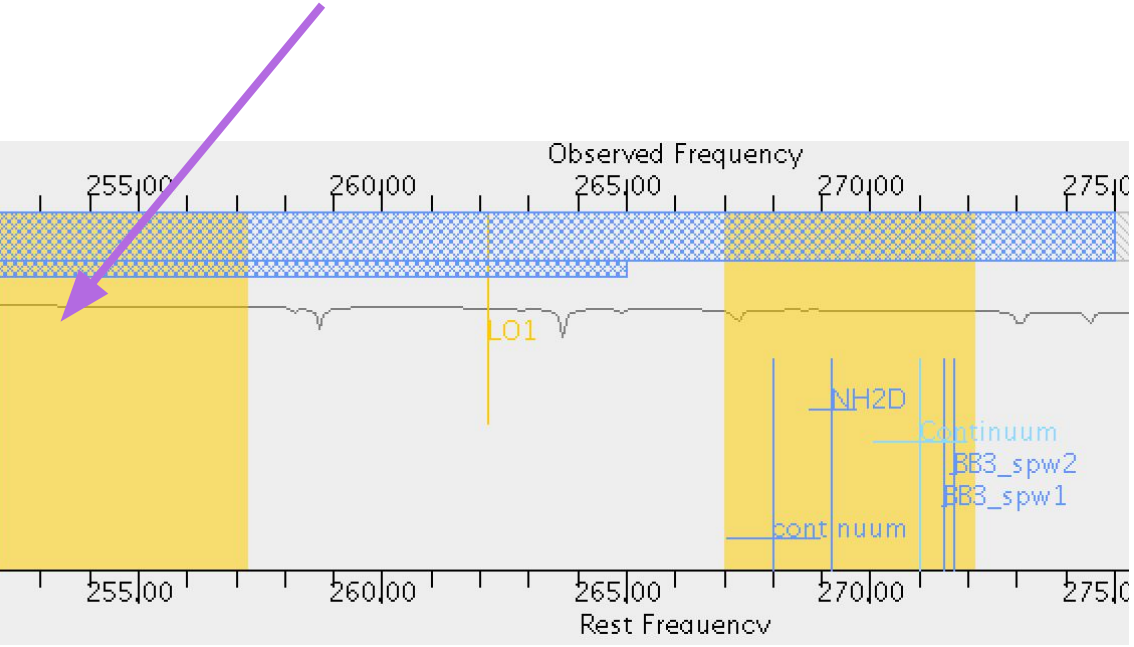
Dual Polarization		
Bandwidth (MHz)	Spectral res @ 300 GHz (MHz)	Number of channels
1875	31.2	120
58.6	0.0305	3840
117	0.061	3840
234	0.122	3840
469	0.244	3840
938	0.488	3840
1875	0.976	3840

FDM frequency division mode

NB: resolution = 2x channel spacing because of default Hanning smoothing in correlator.

Spectral line setups

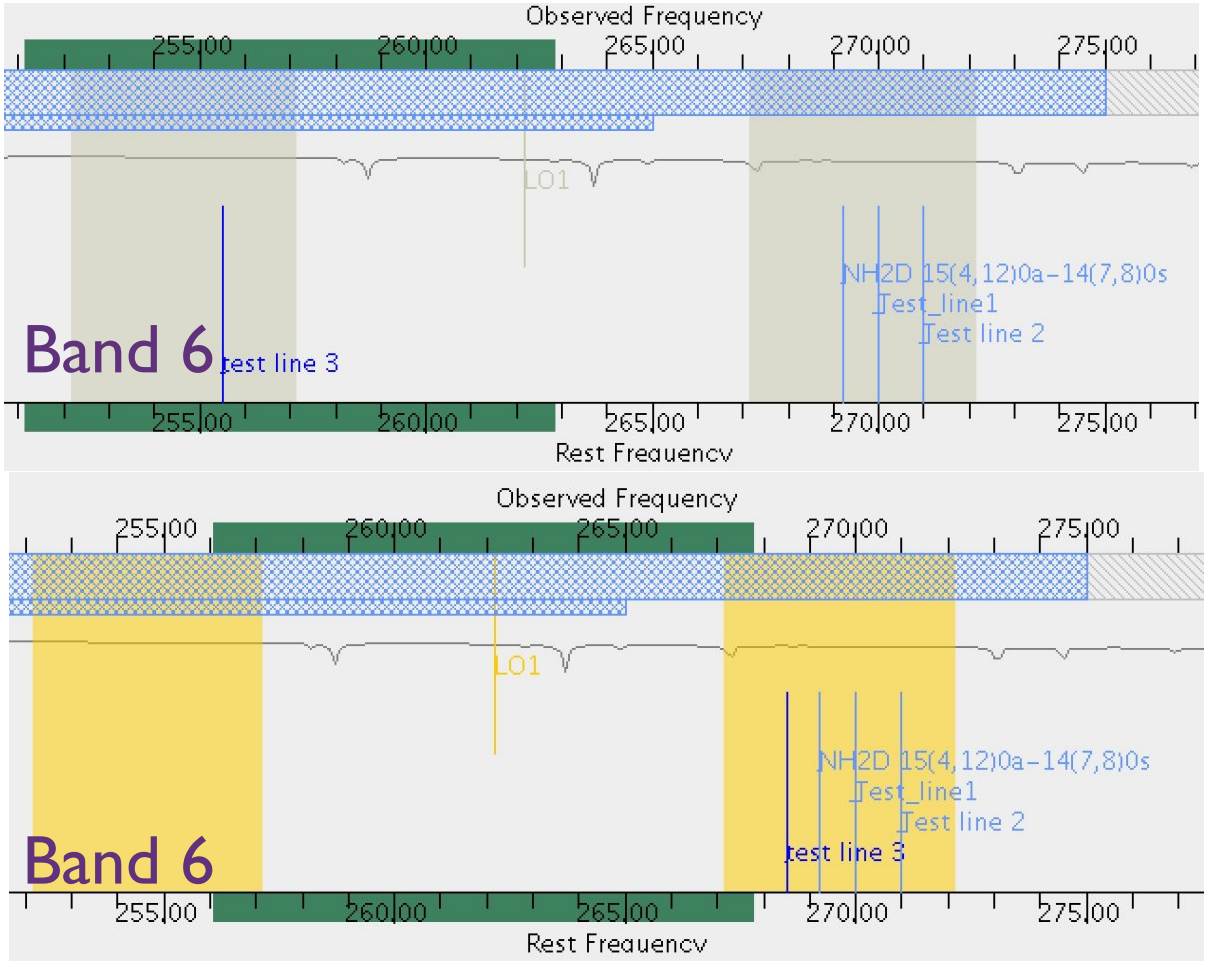
- Use the ALMA spectral line database
- Continuum BB and spectral line can be mixed (Spectral line mode)
- Set unused spws to continuum to help with calibration and continuum removal, in particular if you have narrowband spw



Higher spectral resolution may be better, but *keep data rate < 40MB/s* — the default correlator setup for FDM modes averages every two channels

Baseband limitations

- 2SB receivers (bands 3,4,5,6,7,8) cannot have 3 BBs in one sideband and 1BB in the other
- DSB receivers (bands 9,10) have no BB/sideband restrictions



Bad spectral configuration:

SBs stay gray in *spectral viewer*

Bad spectral configuration gives error messages in red

Spectral configuration OK:

Sidebands become yellow

Control and performance

- OT calculates the angular resolution/maximum recoverable scale (MRS) for the most extended and most compact 12m Array, and the ACA 7m array based on the frequency and the source declination

Enter the desired performance, **angular resolution**, **LAS**, **sensitivity** and the **bandwidth for sensitivity**

Based on the user selected resolution and MRS the **OT will choose the most suitable array(s) (incl. ACA stand alone)**

OT Time estimation uses the sensitivity calculator to derive **the total time for the SG incl. calibration**. It will divide sources with large separations in clusters that have their own calibrators, and show the number of tunings per cluster.

Synthesis array is `blind' to structures on angular scales both smaller and larger than the range of fringe spacings given by the antenna distribution.

FOV

$$FOV \sim \lambda / D$$

Resolution

$$\Theta_{res} \sim \lambda / B_{max}$$

Maximum scale observable

$$\Theta_{max} \sim \lambda / b_{min}$$

Sensitivity

$$\sigma \propto \frac{T_{sys}}{A_{eff}\sqrt{N(N-1)\Delta\nu\tau}}$$

T_{sys}	System temperature
A_{eff}	Effective area
N	Number of Antennas
$\Delta\nu$	Bandwidth
τ	Observing time

Definition of OT parameters

Typically in radio astronomy, **flux densities** are in units of **Jansky**

$$S_\nu = \int I_\nu \, d\Omega$$

1 Jy = 10^{-26} W m^{-2} Hz^{-1}
= 10^{-23} erg s^{-1} cm^{-2} Hz^{-1}

Often, brightness temperature in **Kelvin (K)**, is used to express the specific intensity.

Rayleigh-Jeans limit $$I_\nu(\theta,\varphi) = \frac{2k\nu^2}{c^2} T_B(\theta,\varphi)$$

Assuming a Gaussian beam

$$\left(\frac{T}{1\ \mathrm{K}}\right) = \left(\frac{S_\nu}{1\ \mathrm{Jy}}\right)\left[13.6\left(\frac{300\ \mathrm{GHz}}{\nu}\right)^2\left(\frac{1''}{\theta_{max}}\right)\left(\frac{1''}{\theta_{min}}\right)\right]$$

Definition of OT parameters

Point source sensitivity

Theoretical rms measured in one resolution element

Units: **Jy** (per beam)

$$\sigma = \frac{2k}{\eta} \frac{T_{\mathrm{sys}}}{\sqrt{\Delta t \Delta \nu} \sqrt{N_{\mathrm{ant}}(N_{\mathrm{ant}}-1)A}}$$

Brightness noise in K:

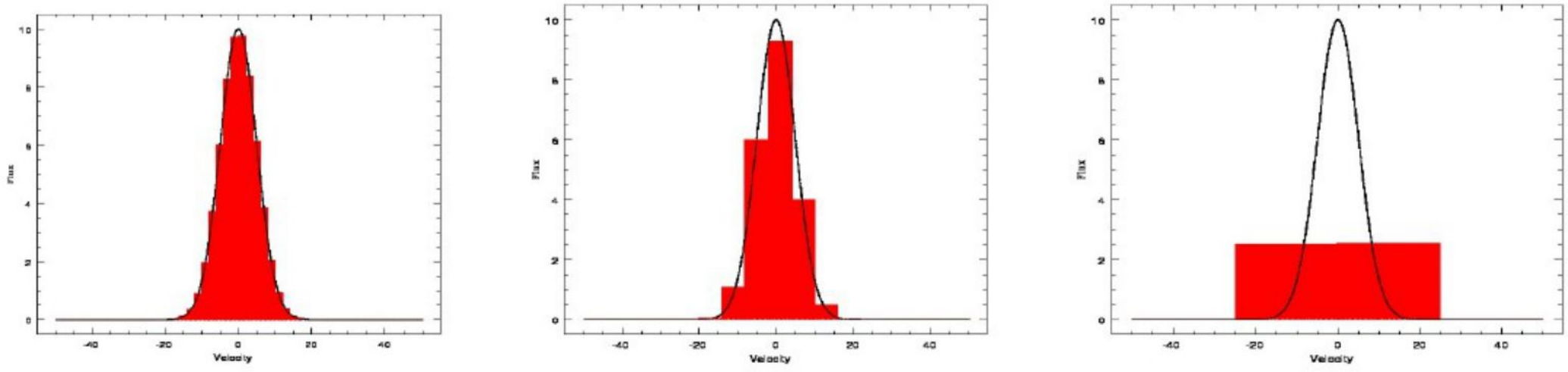
$$\delta T = \frac{\lambda^2 \sigma}{2k \Omega}$$

Ω synthesized beam solid angle

IMPORTANT
Brightness temperature sensitivity depends on synthesized beam area.

Extended low surface brightness objects may be harder to detect at higher angular resolution, as the corresponding sensitivity may be too low.

Spectral resolution: lines

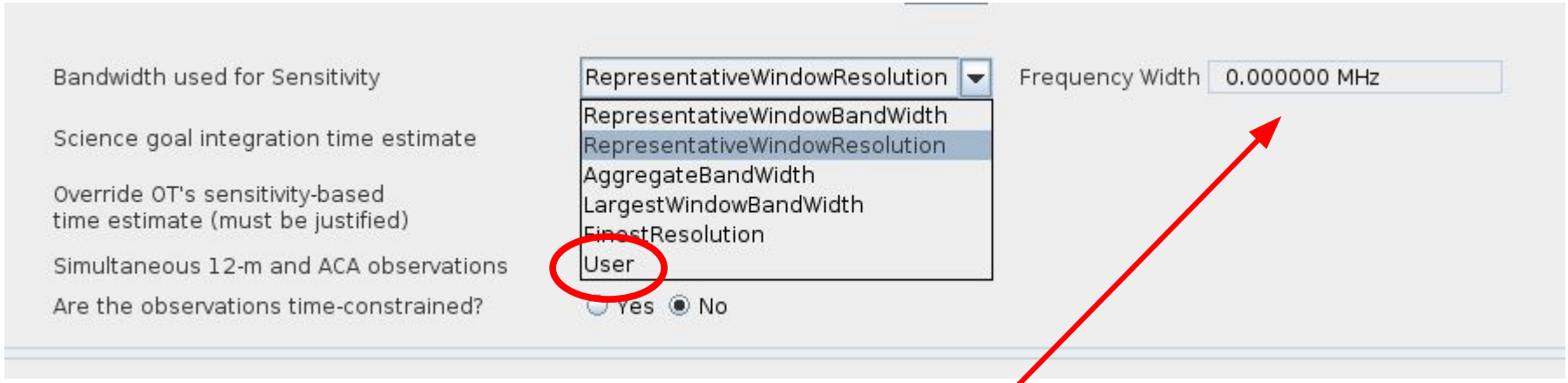


- **Choose at least 3 resolution elements per FWHM**
  But In OT spectral resolution > channel spacing !!
  Channel spacing < 2 x resolution element because of Hanning smoothing
  → Hence leave the default averaging=2 and choose 3 ch/line width

- **Sensitivity depends on spectral resolution** - $\Delta\upsilon$ [Hz] =υ [Hz] Δv [m/s] / c [m/s]

$$\sigma = \frac{2k}{\eta} \frac{T_{\rm sys}}{\sqrt{\Delta t \Delta\nu} \sqrt{N_{\rm ant}(N_{\rm ant}-1)A}}$$

In the OT: Bandwidth used for sensitivity



also in km/s

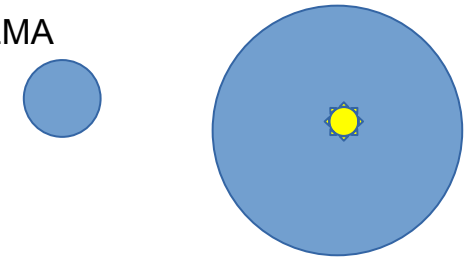
Using data from other telescope to estimate ALMA sensitivity

In the OT you must indicate the Peak Flux densities and sensitivity at the requested frequency and resolutions.

1) The source is smaller than the ALMA beam

Beam other tel = Ω_{tel}

Beam ALMA = Ω_{ALMA}



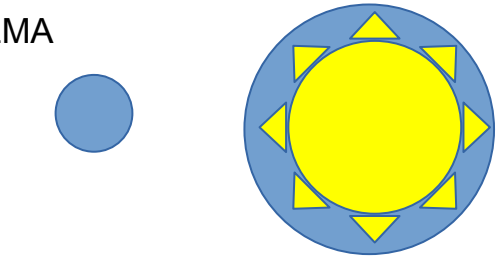
$$F_{ALMA}=F_{tel}$$

2) The source is larger than the ALMA beam,

in the worse case the emission is evenly spread over the other telescope beam

Beam other tel = Ω_{tell}

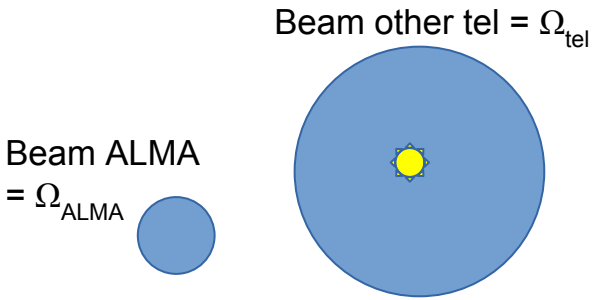
Beam ALMA = Ω_{ALMA}



$$F_{2\,ALMA}=F_{tel}(\Omega_{ALMA}/\Omega_{tel})=F_{tel}(\theta_{ALMA}/\theta_{tel})$$

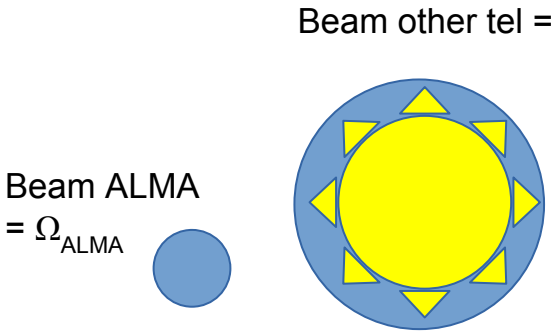
A source is observed with a single dish with
θ_{tel}=10" and has T_{tel}= 1 K at 300 GHz
Which is the sensitivity required for ALMA observations at **θ_{ALMA}=1"** resolution ?

1) The source is smaller than the ALMA beam



$$F_{tel} = 2\,k\,T_{tel}\Omega_{tel} / \lambda^2$$
$$F_{ALMA} = F_{tel} = 7.36 \text{ Jy/beam}$$

2) The emission is evenly spread over the SD beam

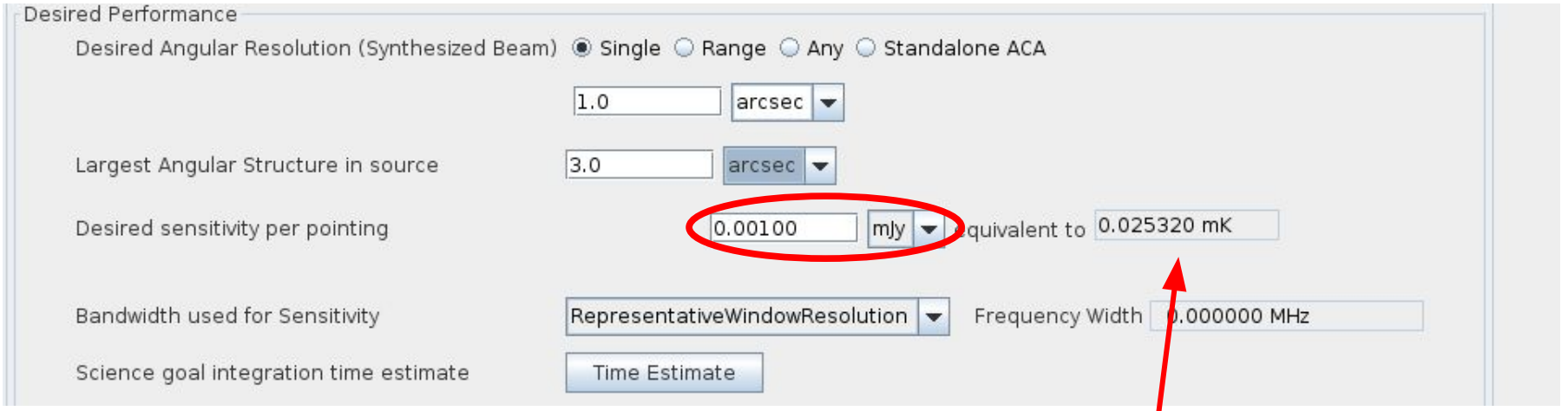


$$F_{tel} = 2\,k\,T_{tel}\Omega_{tel} / \lambda^2$$
$$F_{ALMA} = F_{tel}(\theta_{ALMA}/\theta_{tel})^2 = 0.0736 \text{ Jy/beam}$$

A factor of 100 in flux corresponds to a factor of 10000 in integration time!
So choose your resolution carefully!

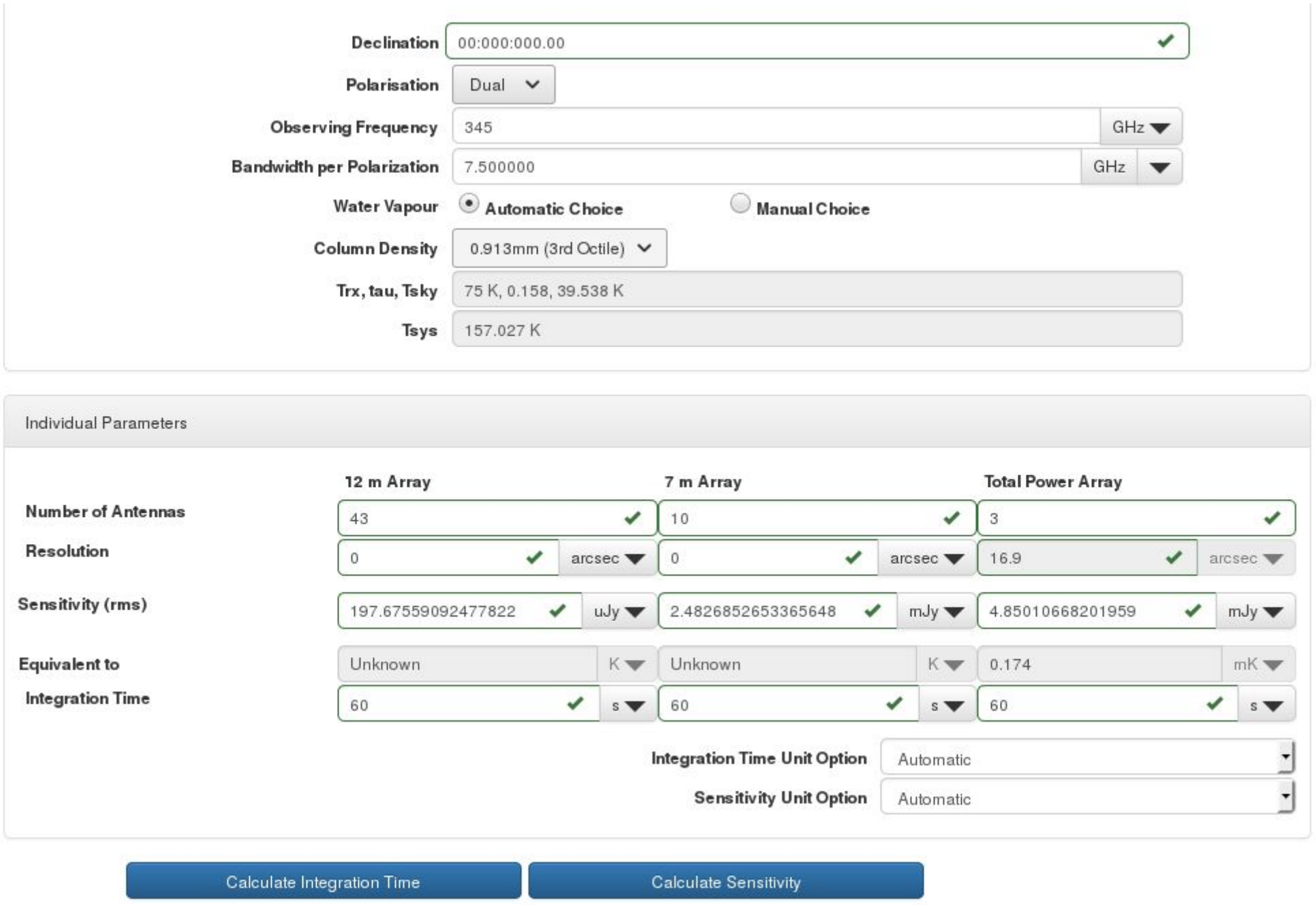
In the OT: requested sensitivity

In the selected bandwidth



in K

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



OT documentation and Help

OT contains the ALMA template library of aot files

OT Help includes the User manual and reference guide

ALMA website contains the OT quickstart guide, manual and reference guide, proposers guide, and OT video tutorials

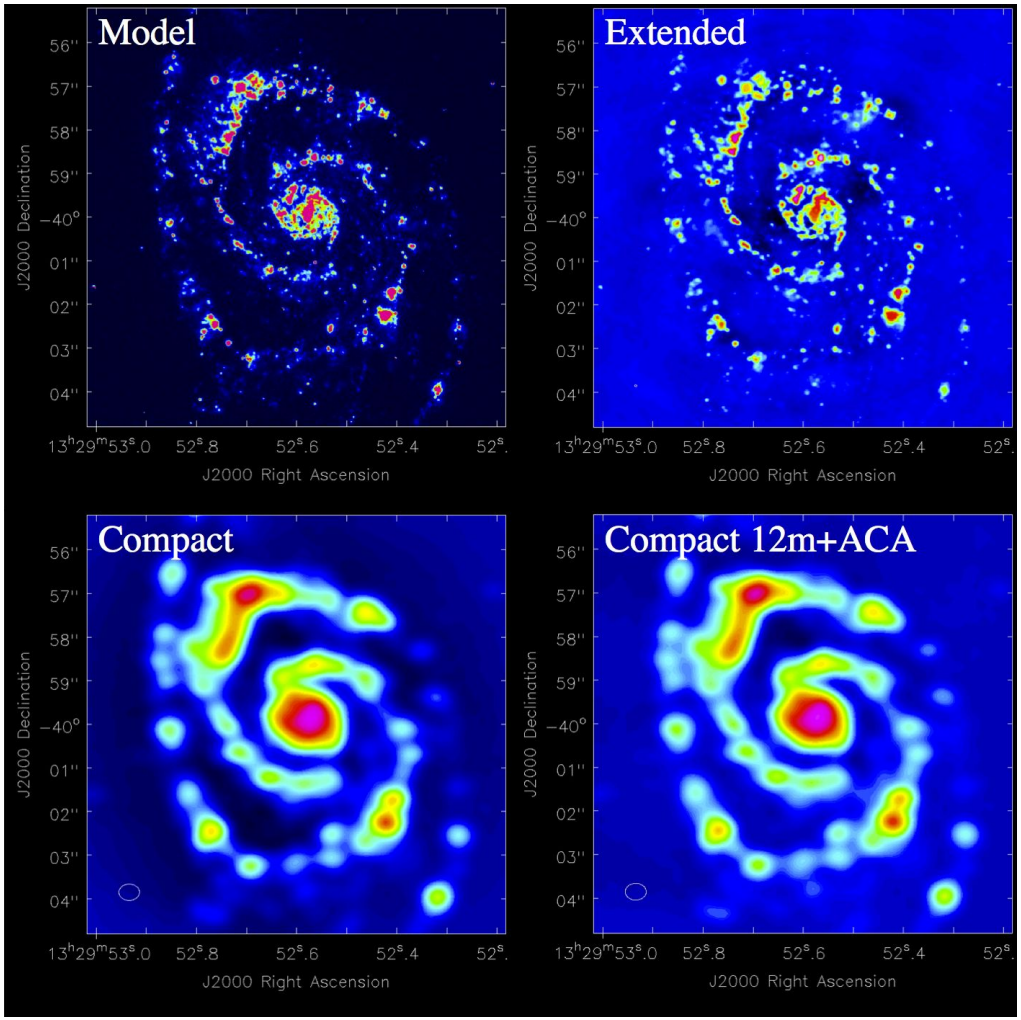
Submit questions to the ALMA Helpdesk or your ARC!

ALMA simulation tools

In planning observations of complex fields, uv-coverage can be as important to consider as sensitivity. Having a reasonable model for the source structure simulations of ALMA observations can be done.

CASA (Common Astronomy Software Application)
tasks **simobserve, simanalyze**

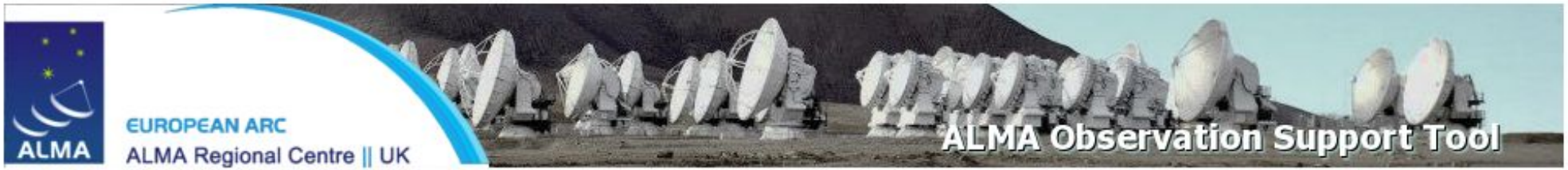
Files containing representative antenna configurations
for the 12-m and 7-m Arrays
suitable for simulations are available from the ALMA Science portal.



ALMA simulations (Observation Support Tool)

http://almaost.jb.man.ac.uk/

Submit a request for a full simulation of ALMA capabilities for your target



ALMA Observation Support Tool

Version 6.0

OST NEWS HELP QUEUE LIBRARY ALMA HELPDESK

Array Setup:

Instrument: ALMA — Select the desired ALMA antenna configuration.

Sky Setup:

Source model: OST Library: Central point source — Choose a library source model or supply your own.

Upload: Browse... No file selected. — You may upload your own model here (max 10MB).

Declination: -35d00m00.0s — Ensure correct formatting of this string (+/-00d00m00.0s).

Image peak / point flux in mJy 0.0 — Rescale the image data with respect to new peak value. Set to 0.0 for no rescaling of source model.

Observation Setup:

Observing mode: Spectral Continuum — Spectral or continuum observations?

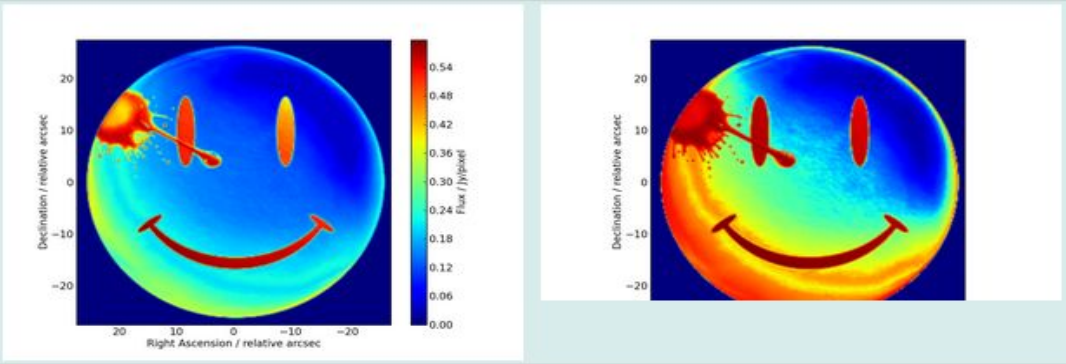
ALMA simulations (Observation Support Tool)

http://almaost.jb.man.ac.uk/

Receive the results via e-mail you can download resulting images in fits

Overview

Click thumbnails to view full-size images. Left: linear colour scale, right: with histogram equalization.

Array configuration:	ALMA out10
Source model:	All we ever see of stars are their old photographs
Input image:	
Maximum elevation:	77.88 degrees
Central frequency:	93.7 GHz (ALMA Band 3)
Total Bandwidth:	0.032 GHz
Track length:	3 hours × 1.0 visits
Hexagonal mosaic pointings :	1 required to cover requested sky area with uniform sensitivity
System temperature:	Tsys = 67.4355519482 K
PWV :	0.475 mm
Theoretical RMS noise:	6.06393581677e-05 Jy (in naturally-weighted map)
Restoring beam (resolution):	Major axis = 1.235 arcsec, minor axis = 1.044 arcsec, PA = 73.328 deg

Useful link

Italian ALMA Regional Centre @ INAF-IRA Bologna: http://www.alma.inaf.it

Science Portal: https://almascience.eso.org/

Proposer's Guide https://almascience.eso.org/proposing/proposers-guide

ALMA Primer https://almascience.eso.org/documents-and-tools/latest/alma-science-primer

Observing Tool
https://almascience.eso.org/proposing/observing-tool

Technical Handbook
https://almascience.eso.org/documents-and-tools/latest/alma-technical-handbook

Knowledgebase/FAQ
https://help.almascience.org/index.php?/default/Knowledgebase/List

Helpdesk: https://help.almascience.org/

Contact us

helpdesk@alma.inaf.it

We will have two dedicated face-to-face days:

Friday 6 Apr

Friday 13 Apr

Good luck with your proposals