ALMA capabilities

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EUROPEAN ARC
ALMA Regional Centre || Italian

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ALMA rationale

The design of ALMA is driven by three key science goals:

- The ability to detect spectral line emission from CO or [CII] in a normal galaxy like the Milky Way at a redshift of z=3, in less than 24 hours

-> **frequency bands, high sensitivity**
-> study of star formation in galaxies up to high redshift, galaxy formation, …

- The ability to image the gas kinematics in protostars and in protoplanetary disks around young Sun-like stars in the nearest molecular clouds (150 pc)

-> **high and low angular resolution**, **high spectral resolution**
-> study of processes of star and planet formation, stellar evolution and structure, astrochemistry, …

- The ability to provide precise high dynamic range (=|image max/image min|) images at an angular resolution of 0.1 arcsec

-> **high angular resolution and sensitivity**
-> galaxy dynamics, AGN core mechanisms, imaging of exoplanets, comets, asteroids, ...

ALMA full array

The Atacama Large Millimeter Array is a **mm-submm reconfigurable interferometer**

Inaugurated in March 2013 on the Chajinantor plain (altitude=**5000m**, Chile)

- Antennas: **50x12m** main array + **12x7m** ACA **+ 4x12m** Total Power
- Baselines length: **15m ->150m-16km** + **9m->50m**
- Frequency range: **10 bands between 30-900 GHz** (0.3-10 mm)
- Bandwidth: **2 GHz x 4 basebands**
- Polarimetry: Full Stokes capability
- Velocity resolution: **As narrow as 0.008 × (Freq/300GHz) km/s**
  ~0.003 km/s @ 100 GHz, ~0.03 km/s @ 950 GHz

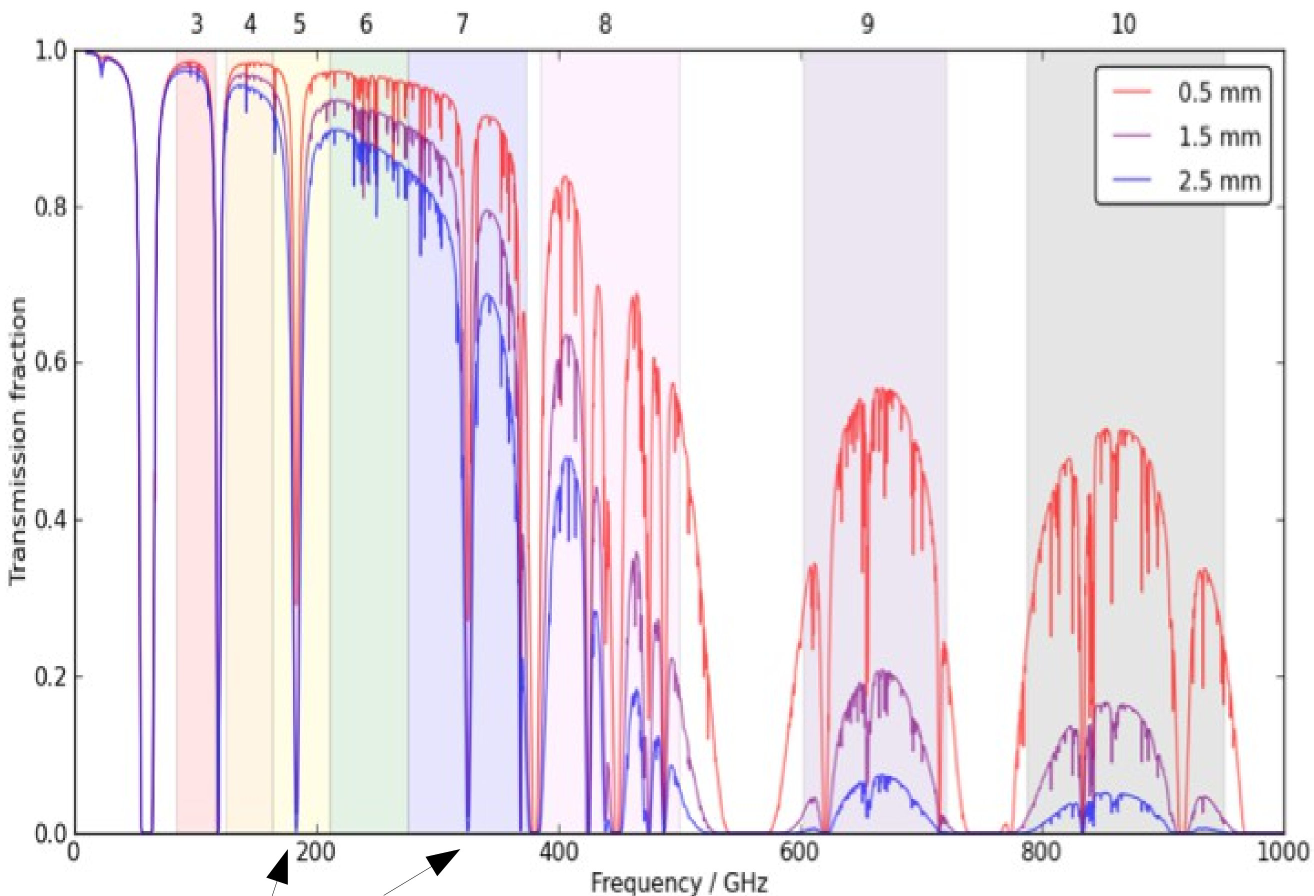
ALMA sites

- **AOS**: ALMA Operations Site (5000m): Antennas, Correlator
- **OSF**: Operations Support Facility (3000m):
  Labs, Antenna Assembly & Maintenance Operators, Astronomers
- **SCO**: Santiago Central Office:
  - Call for Proposals
  - Running ALMA
  - Data Reduction Pipeline
  - Initial Quality Assessment

ALMA observing site & bands

Band	Frequency (GHz)	Wavelength (mm)
1	31.3-45	6.7-9.5
2	67-90	3.3-4.5
3	84-116	2.6-3.6
4	125-163	1.8-2.4
5	163-211	1.4-1.8
6	211-275	1.1-1.4
7	275-373	0.8-1.1
8	385-500	0.6-0.8
9	602-720	0.4-0.5
10	787-950	0.3-0.4

Chajinantor transmissivity chart at various PWV conditions

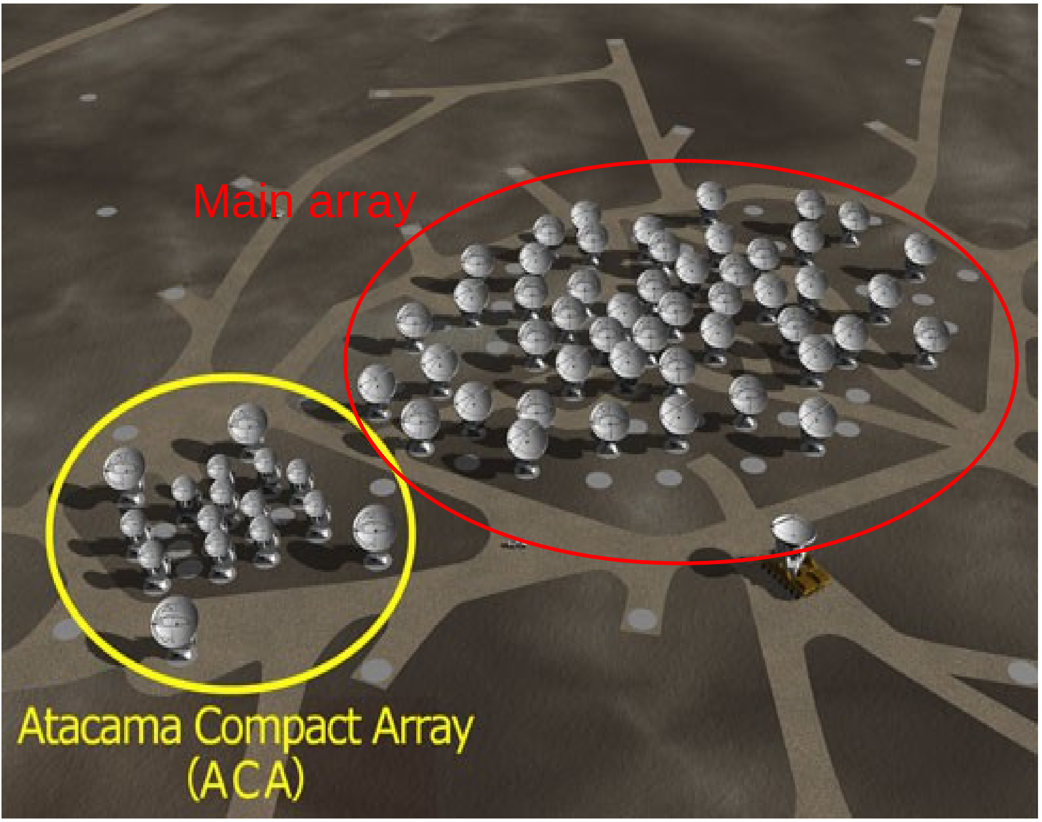


Atmospheric absorption lines.

Red=good weather
Blu=Bad weather

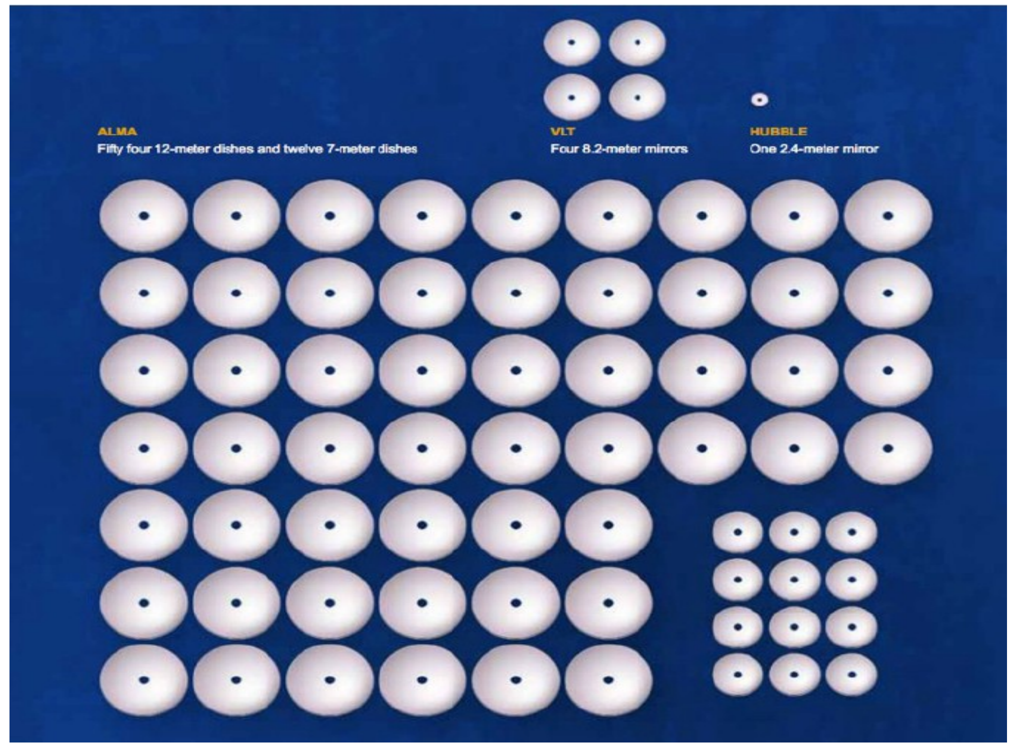
Dry site → lower Tsys and higher frequencies observable

ALMA array(s)



Main Array: 50x12m
Reconfigurable between
15m → 150m-16km

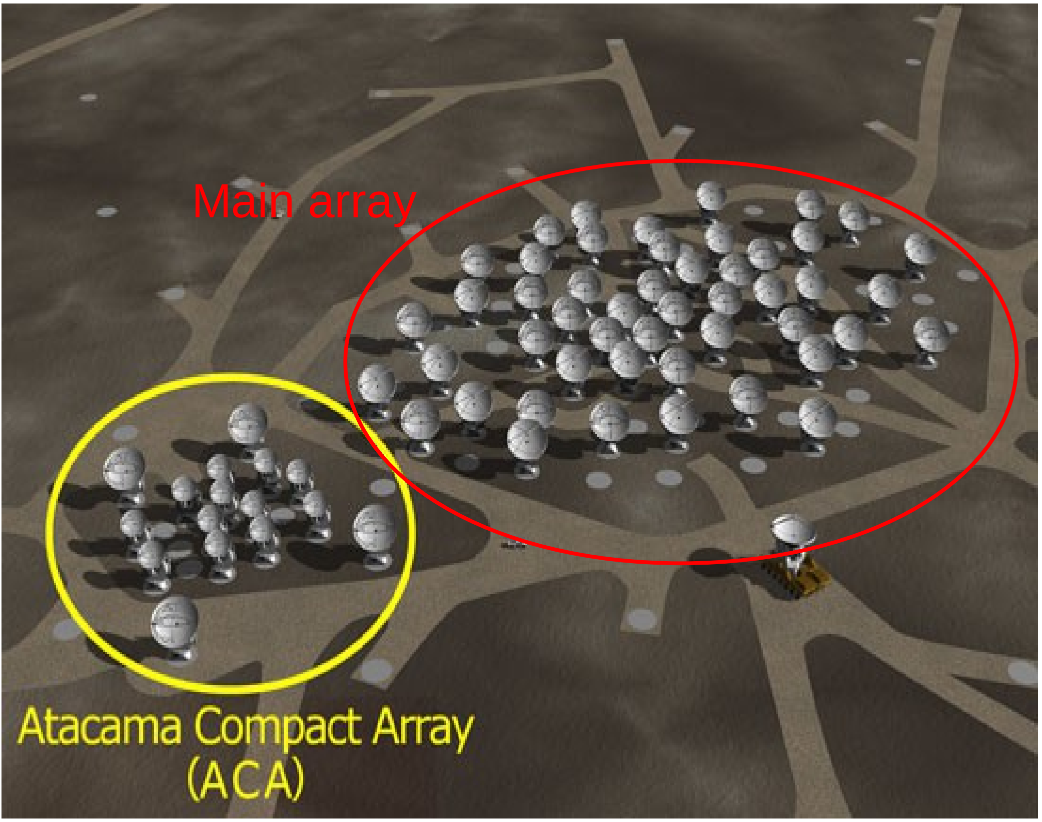
Atacama Compact Array:
12x7m between 9 → 50m
+4x12m single dish



$$\sigma_{\mathrm{S}} = \frac{2\,k\,T_{\mathrm{sys}}}{\eta_{\mathrm{q}}\eta_{\mathrm{c}}A_{\mathrm{eff}}\sqrt{N(N-1)\,n_{\mathrm{p}}\,\Delta\nu\,t_{\mathrm{int}}}}$$

Large number of antennas → large collecting area → high sensitivity

ALMA array(s)



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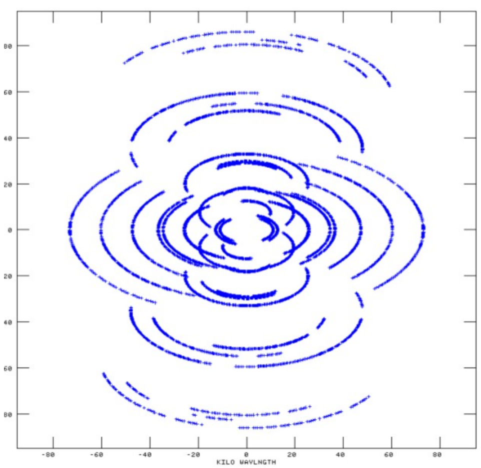
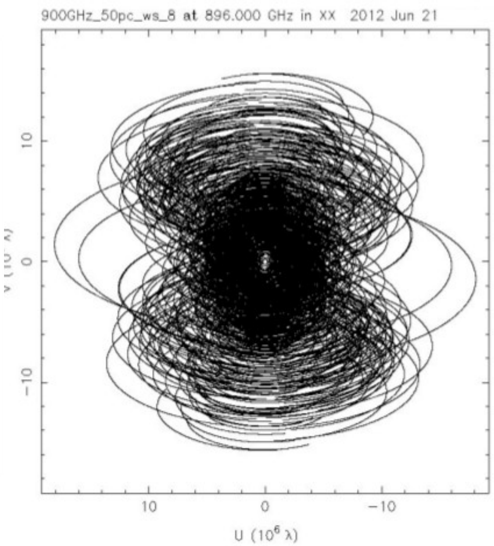


2 config OVRO

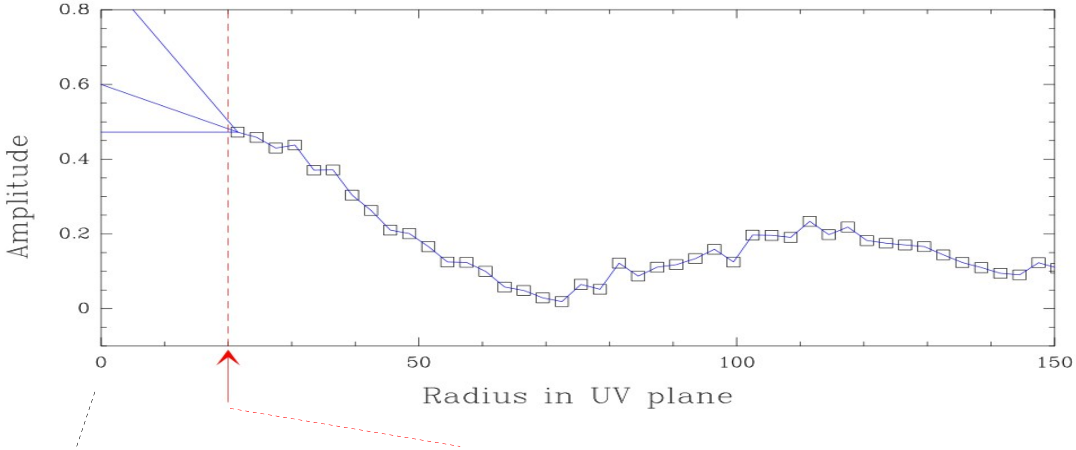


Same time 1 config ALMA

Large number of antennas → **large number of baselines**
→ **good istantaneous uv-plane coverage**
→ **good imaging in short time**

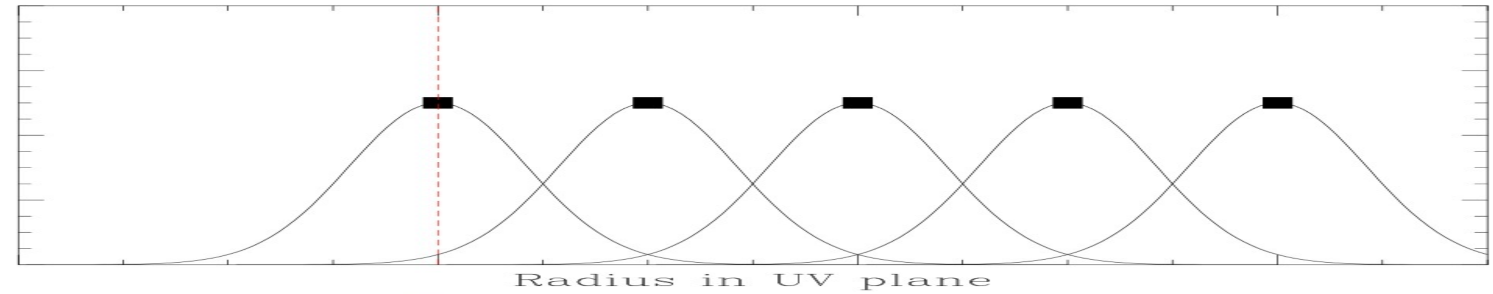
(See tutorial on UV plane)

ALMA arrays

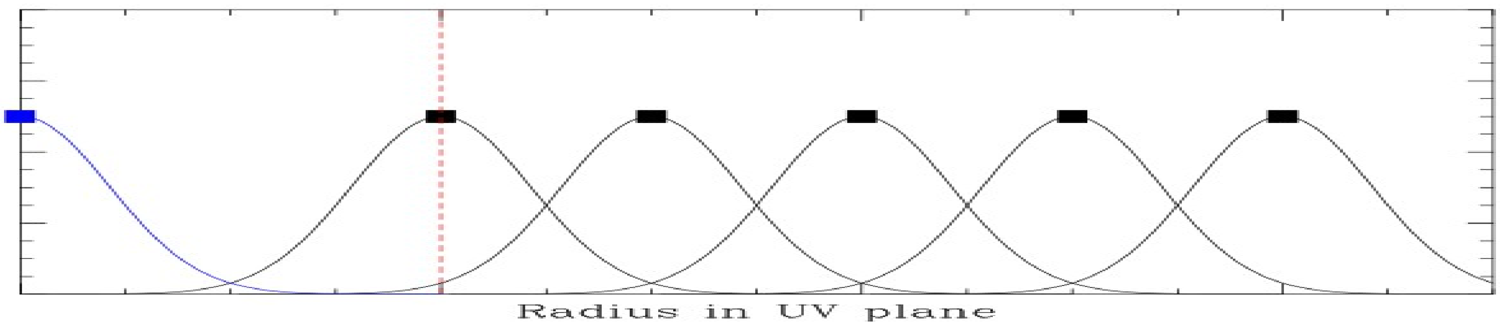


If we have an interferometer we can only "guess" what is over scales above the LAS (i.e. spacings shorter than the shortest baseline)

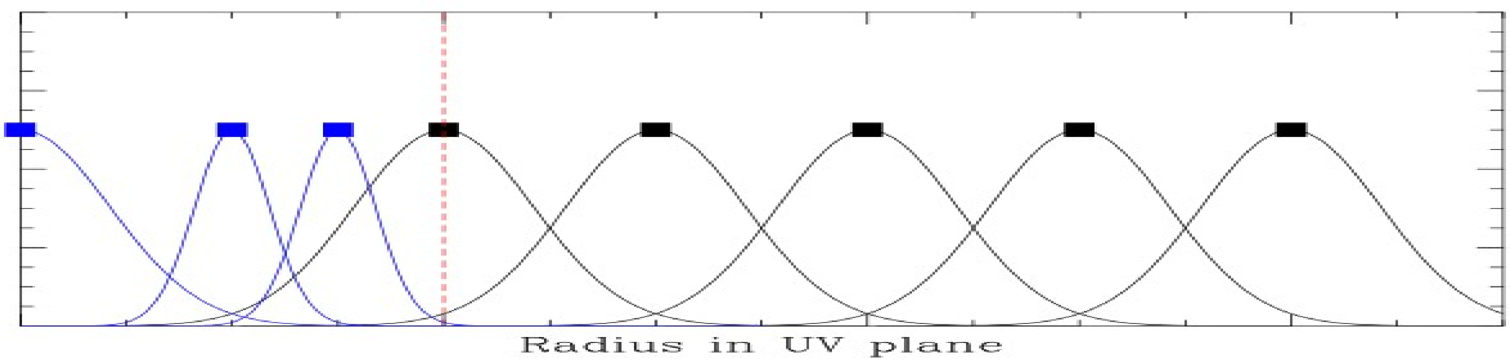
The best guess is done during imaging processes.



Extended interferometer with large antennas

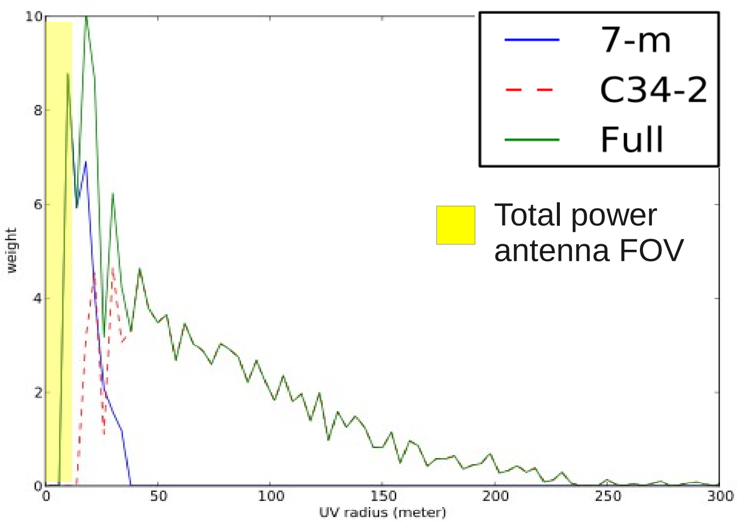


Adding single dish same size

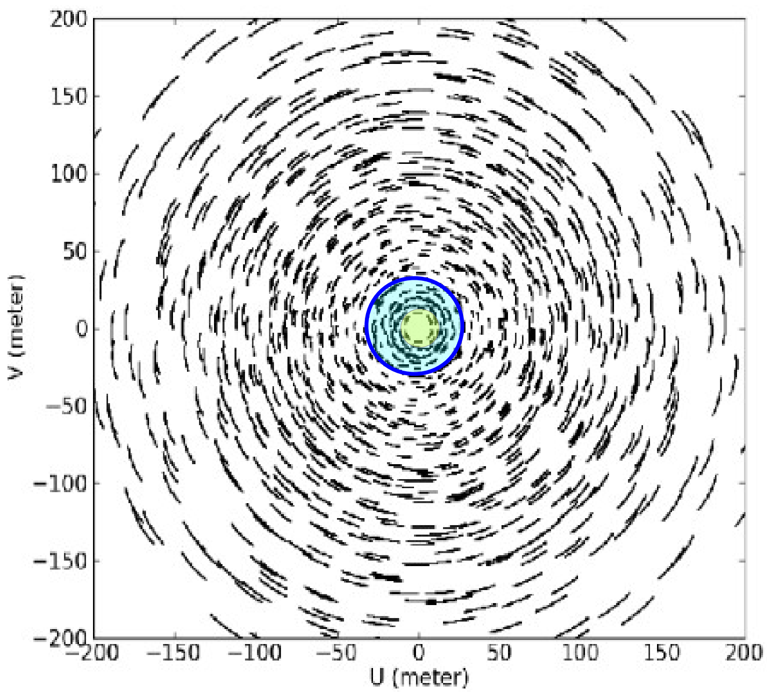


Adding compact interferometer with small antennas

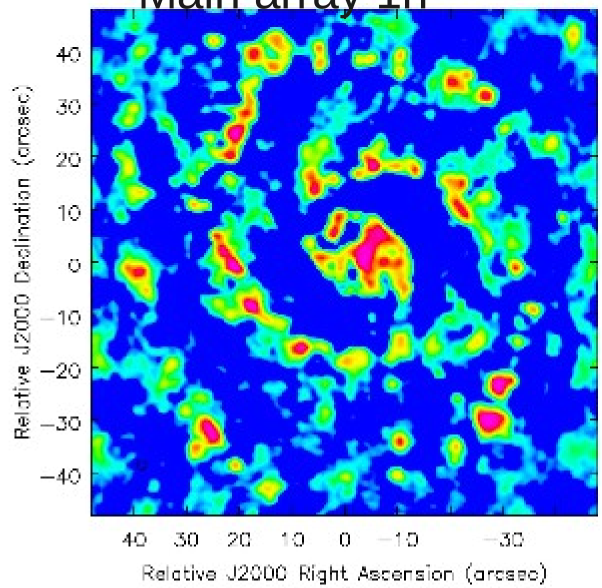
ALMA array(s)



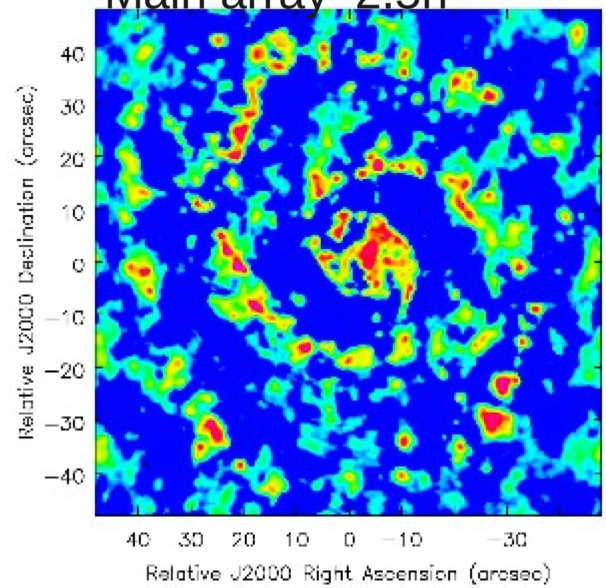
$(u^2+v^2)^{1/2}$

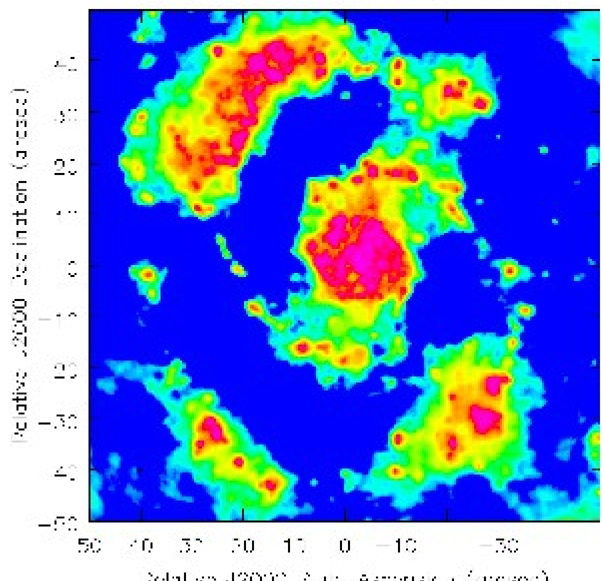


Main array 1h

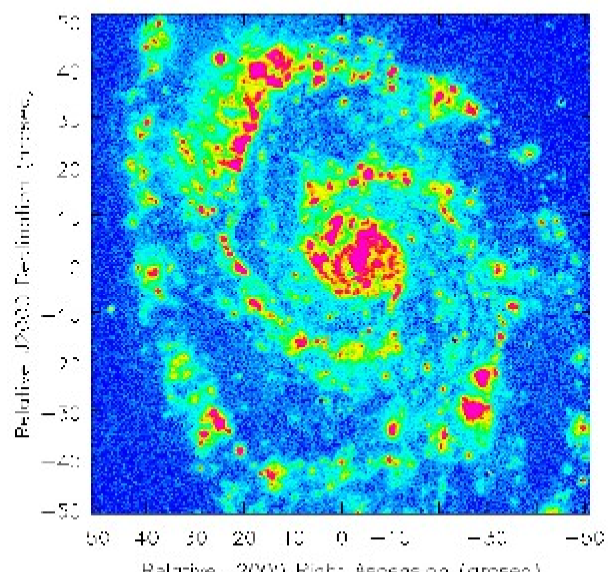


Main array 2.5h



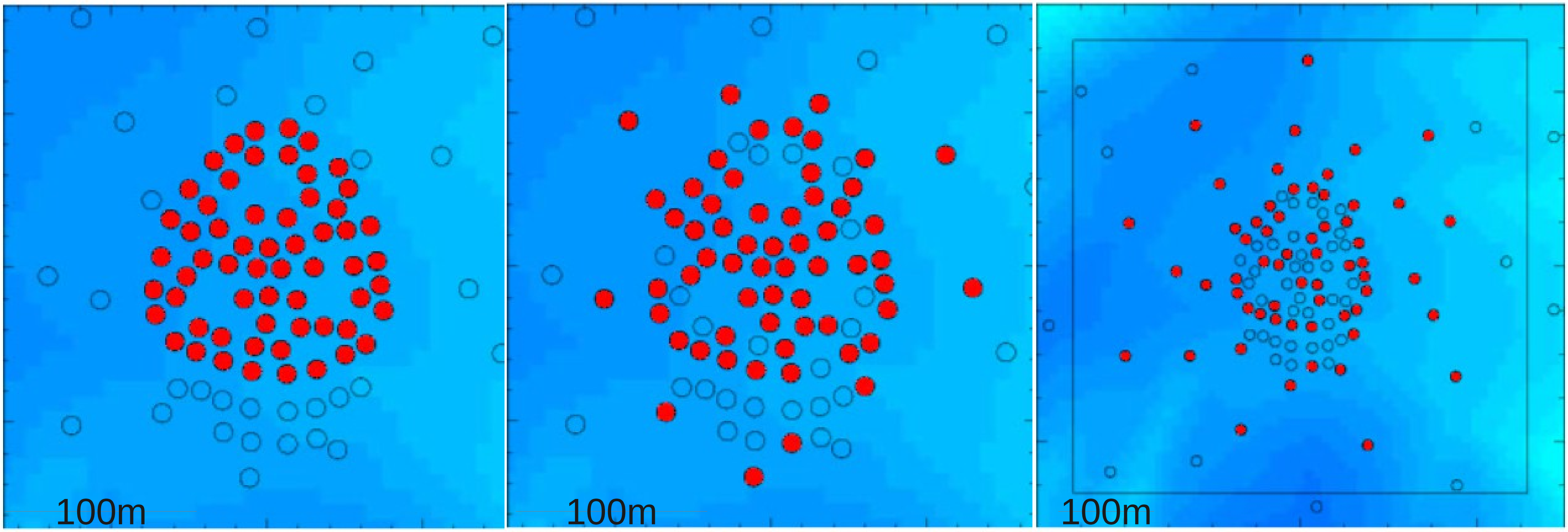


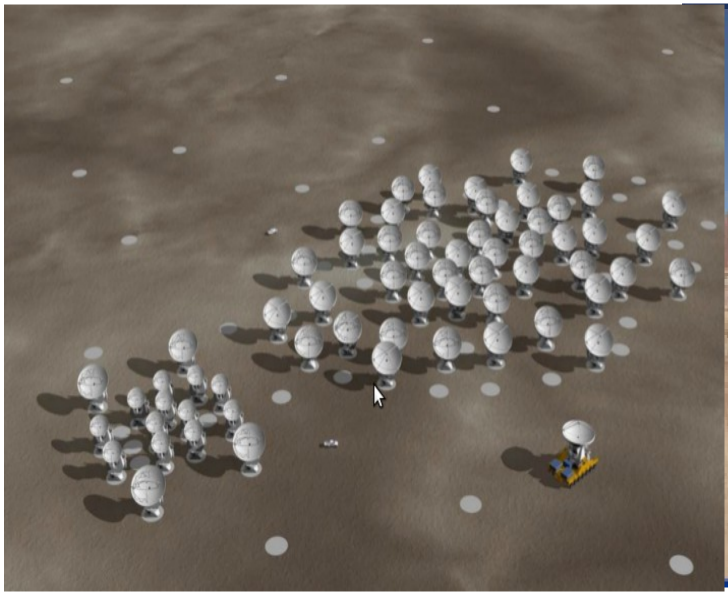
Main array+ ACA

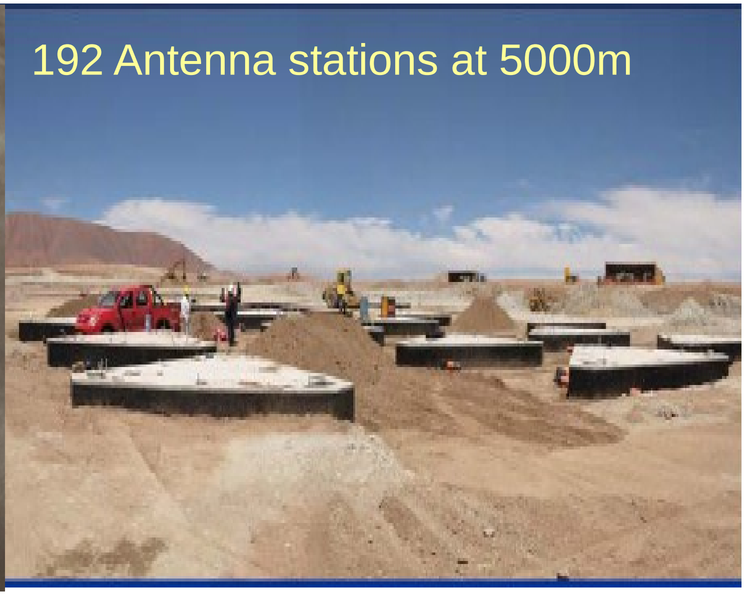


Model M51

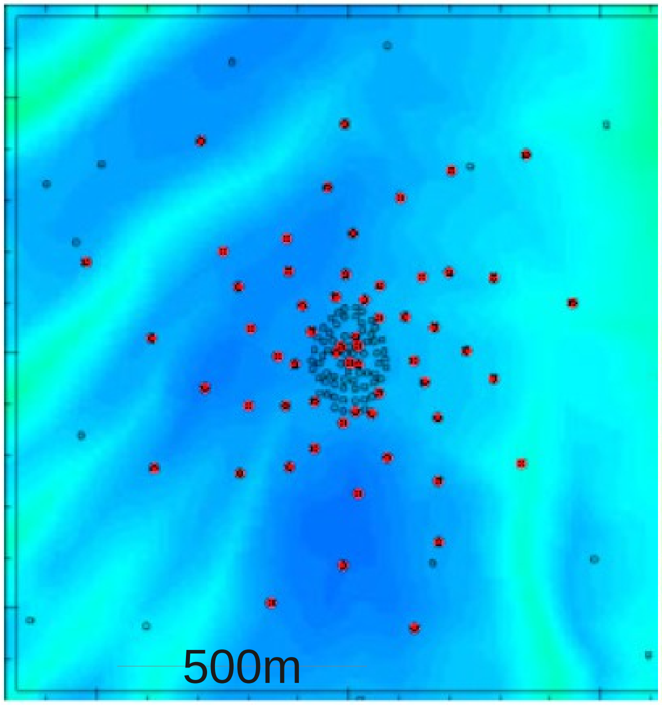
ALMA main array reconfiguration

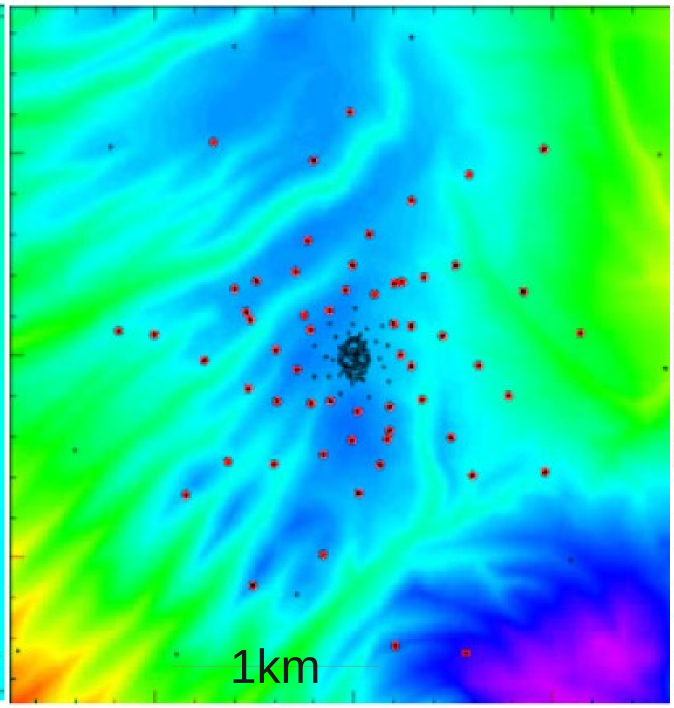


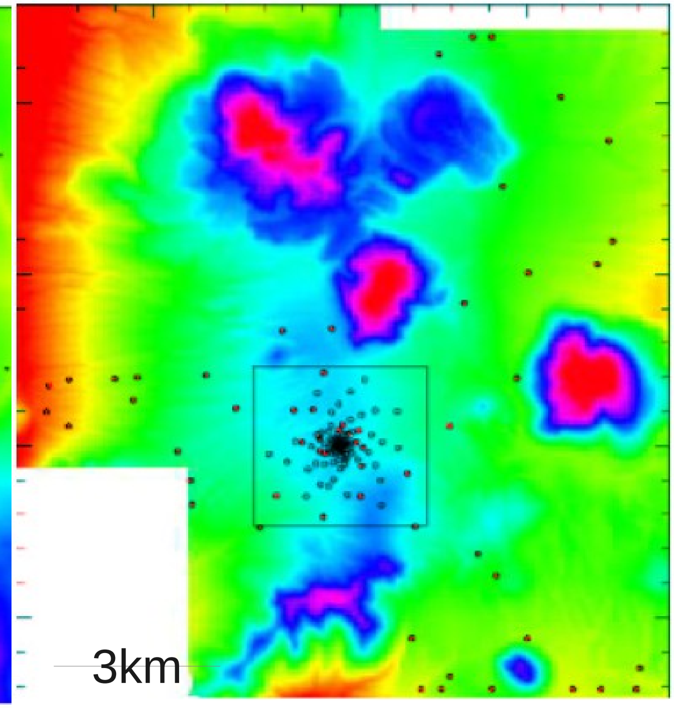


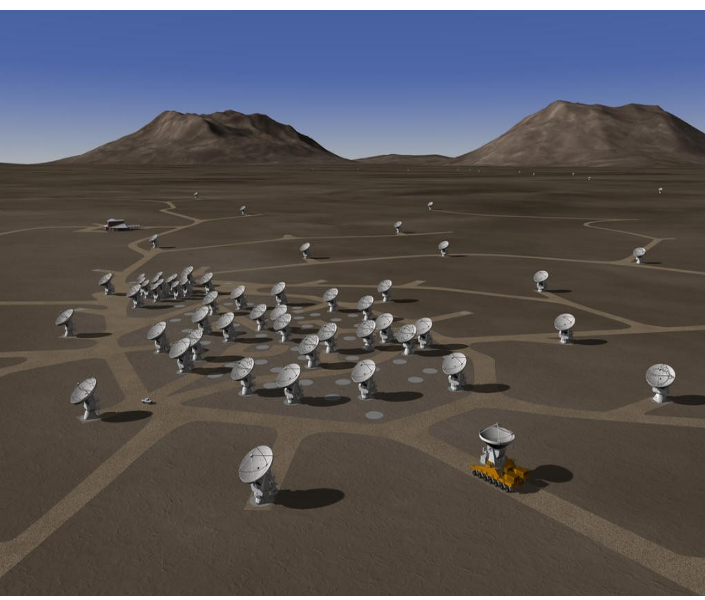


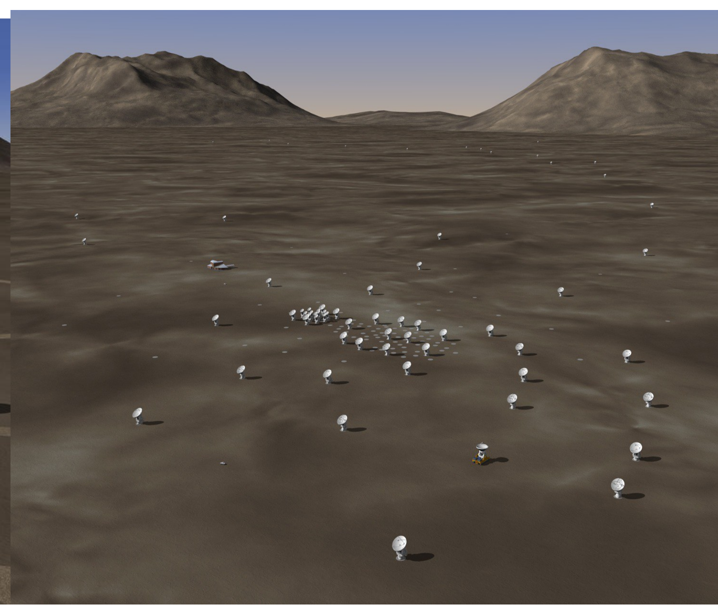
ALMA main array reconfiguration

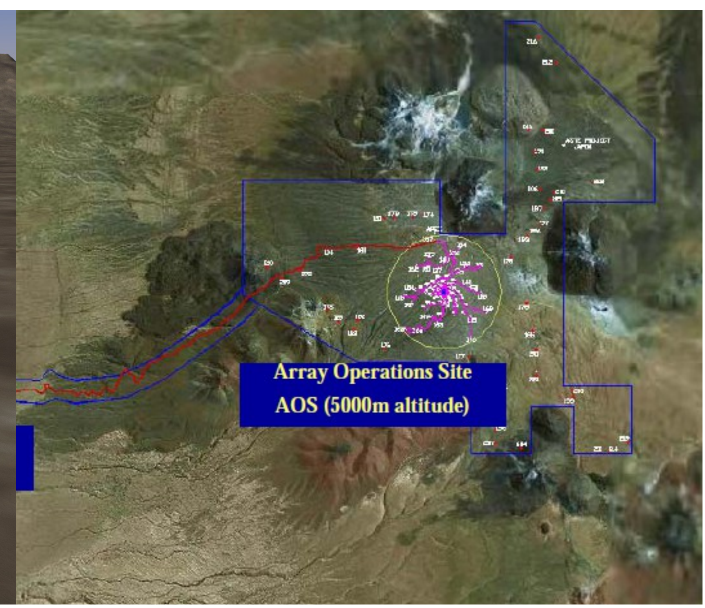












ALMA resolution & LAS

$$\theta = k\lambda / D$$

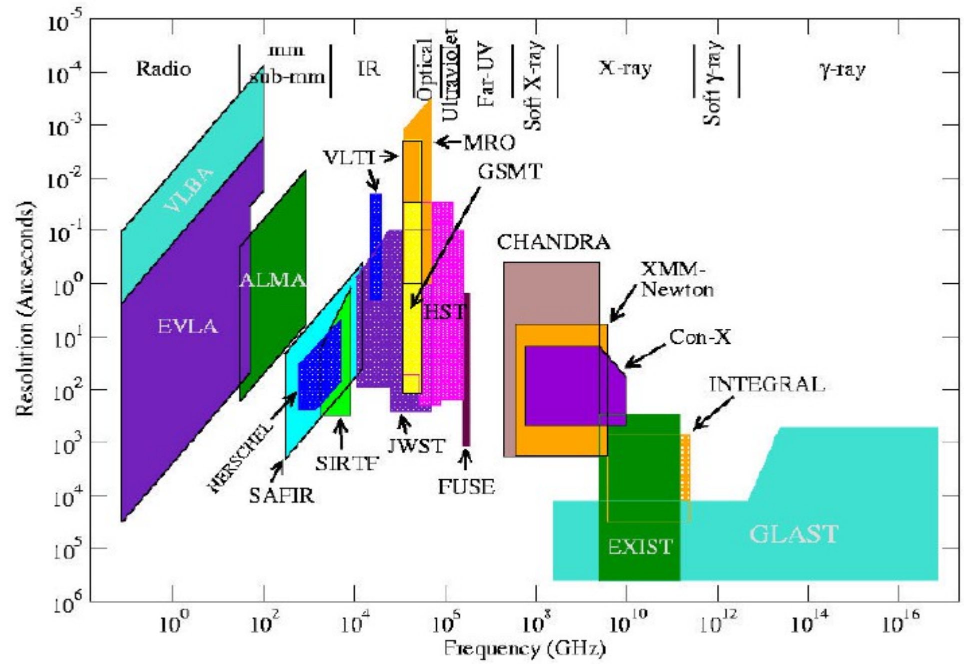
- **Baselines length: 15m → 150m-16km main array**
  9m → 50m ACA

- **Resolution:**
  0.2” x (300GHz / freq) x (1km / max_baseline)

- **Largest angular scale:**
  1.4” x (300GHz / freq) x (150m / min_baseline)

- **FOV 12m array: 17” / (300GHz / freq)**

- **FOV 7m array: 29” / (300 / freq)**



Maximum Recoverable Scale[1] and Coarsest and Finest Angular Resolutions[1] for the Cycle 3 12-m Array configurations

Frequency	Maximum Recoverable Scale without ACA[2,3]	Coarsest allowed angular resolution[2,3,4]	Finest achievable angular resolution[2,3,5]
(GHz)	(arcsec)	(arcsec)	(arcsec)
100	25.3	6.8	0.075
150	16.9	4.6	0.050
230	11.0	3.0	0.030
345	7.3	2.0	0.034
460	5.5	1.4	0.060
650	3.9	1.0	0.040
870	2.9	0.8	0.030

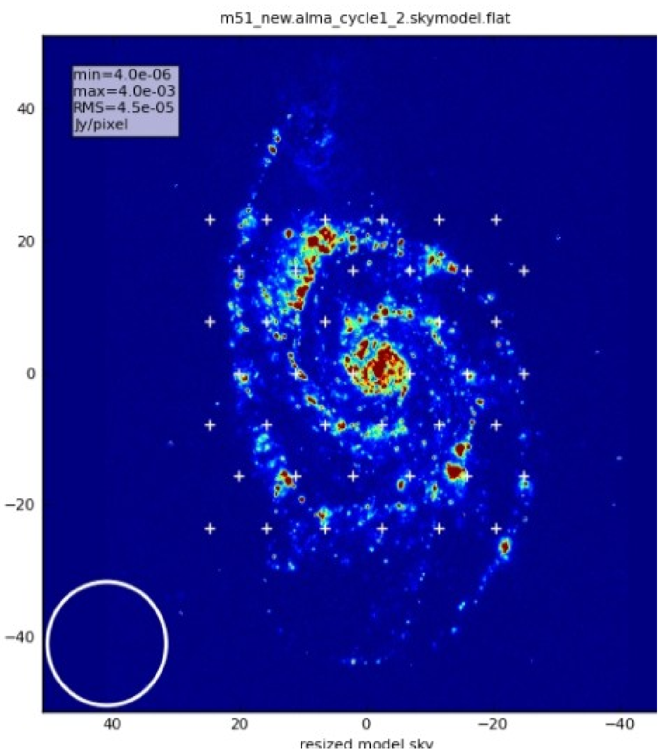
Maximum Recoverable Scales for ACA 7-m

Frequency (GHz)	Maximum Recoverable Scale[1,2] (arcsec)
100	42.8
150	28.5
230	18.6
345	12.4
460	9.3
650	6.6
870	4.9

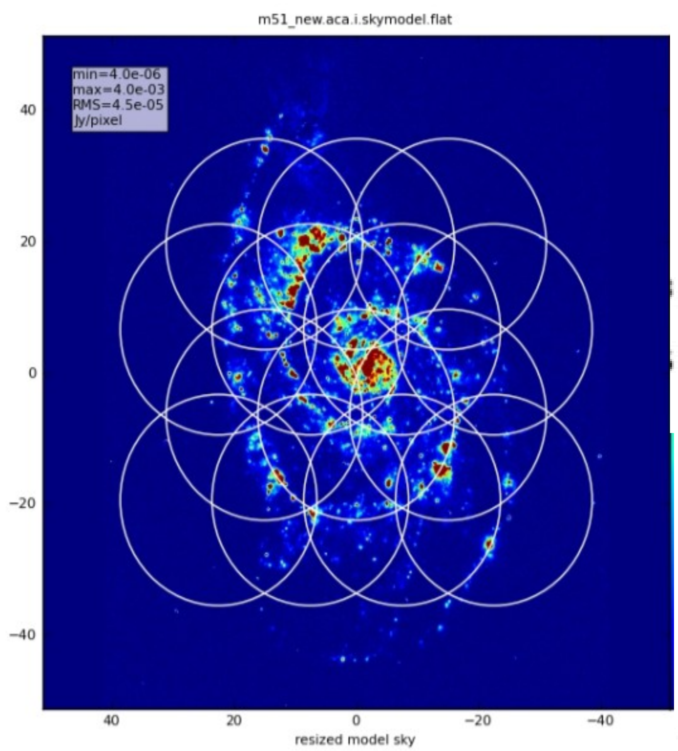
Mosaicking

Largest angular scales than that available to the shortest baseline cannot be observed.

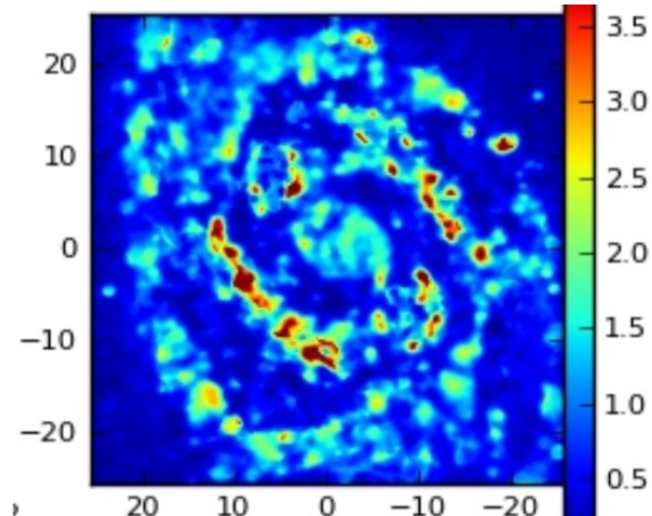
Details in the ranges available to the given baselines can be observed on larger region of the sky by mosaicking the region.



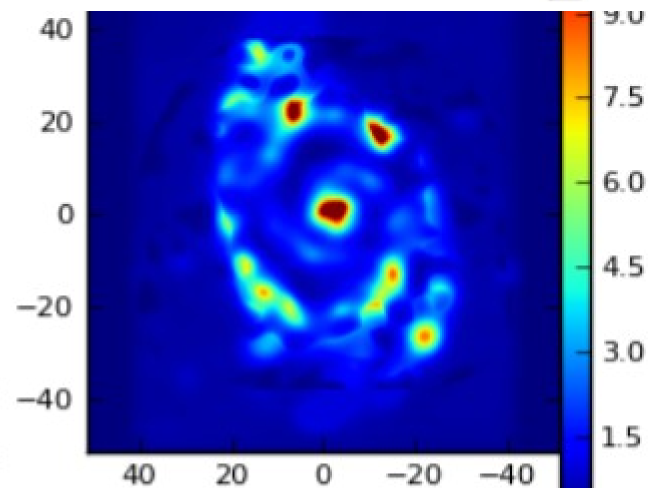
Model & 12m FOV



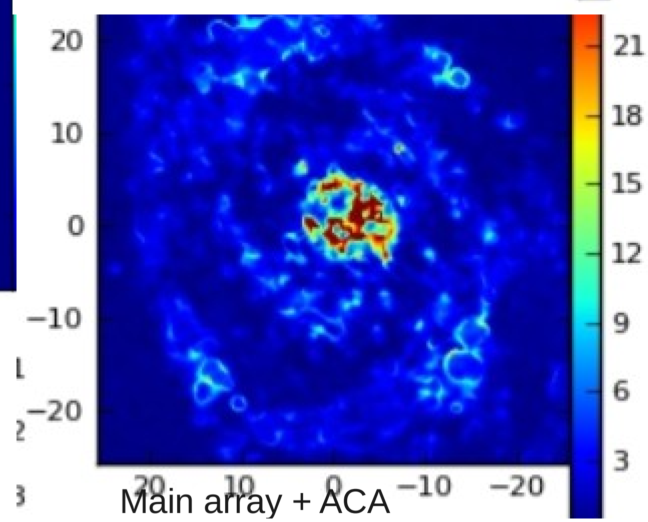
ACA Pointing map



Main array



ACA



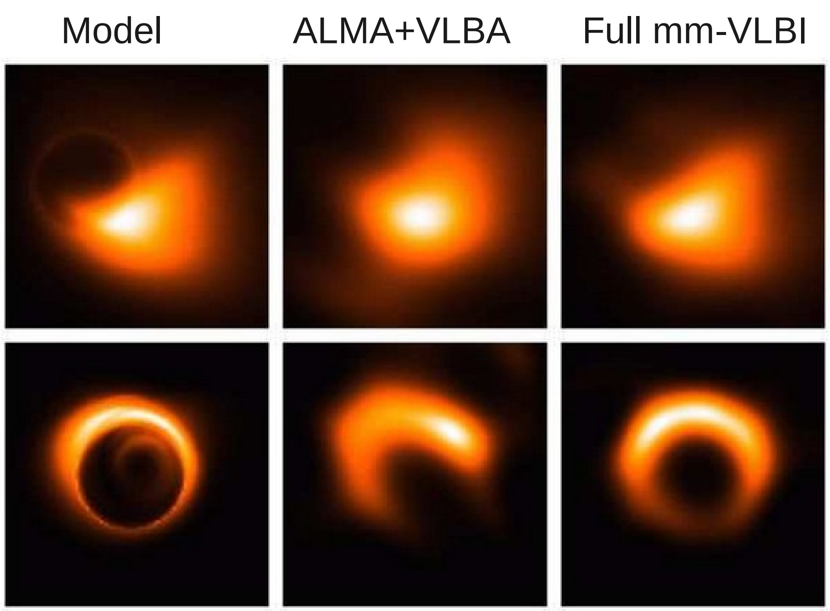
Main array + ACA

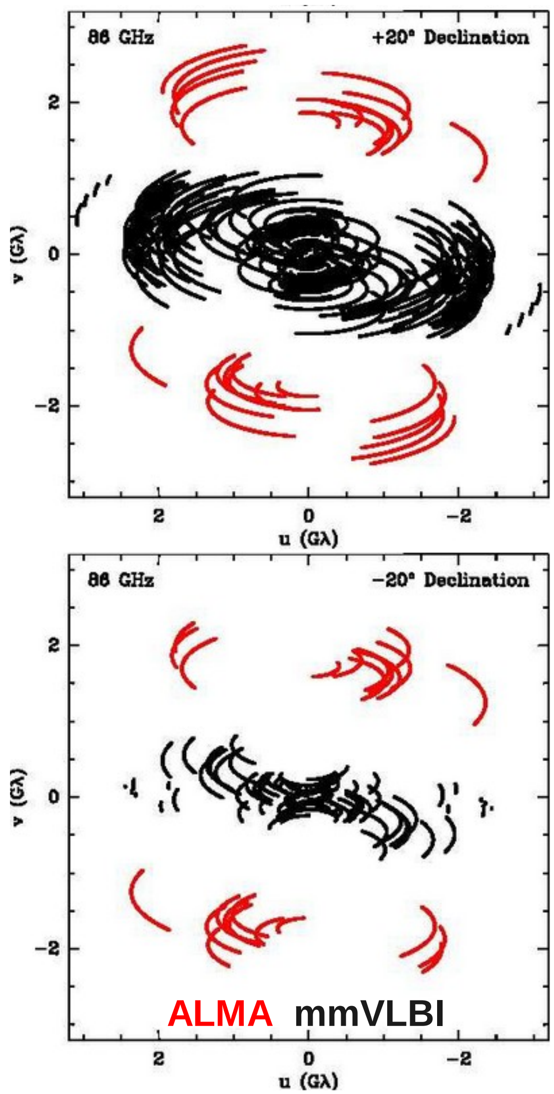
mm-VLBI with ALMA

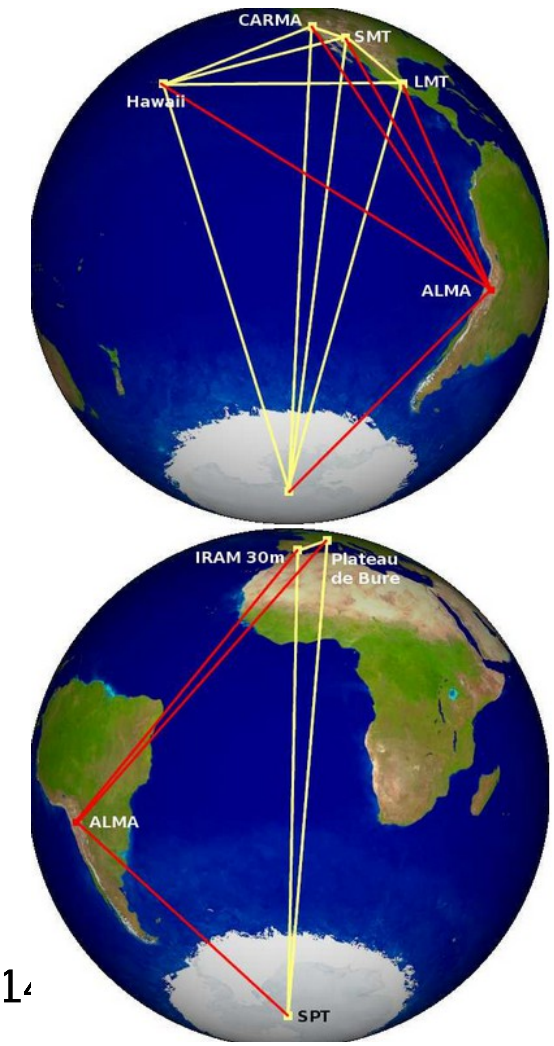
VLBI is a worldwide network of telescopes that matches simultaneous observations in different sites, exploiting the phase information to construct a world-wide interferometer.

At 1 mm and a baseline of 9000 km offers resolution of about 20 microarcseconds
ALMA will increase the sensitivity by more than an order of magnitude

This capability will allow the shadow of the event horizon in the black hole at the Galactic Centre , the relativistic jet flows in AGN and the dusty winds near stellar surfaces to be imaged







ALMA spectral properties: receivers

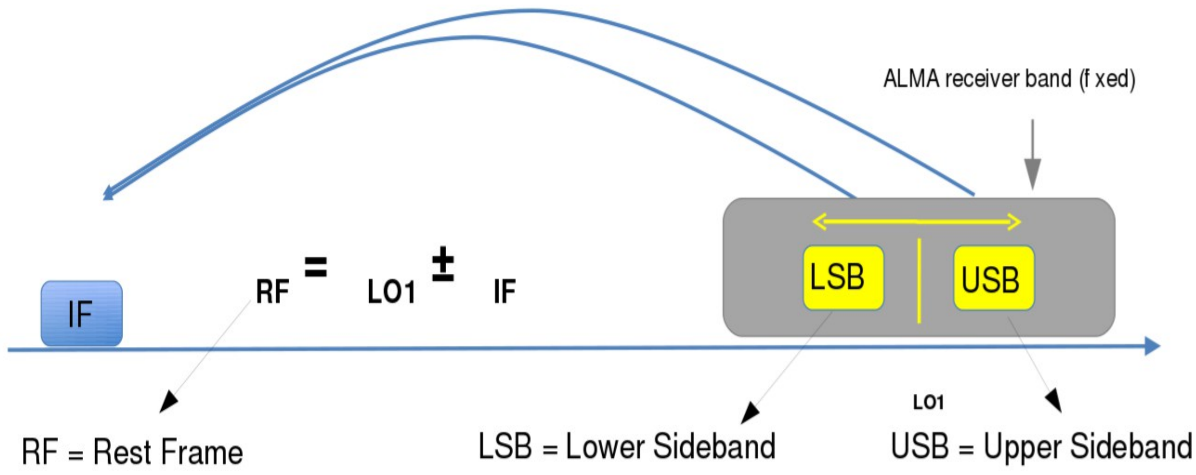


Table A-4: Properties of ALMA Cycle 3 Receiver Bands

Band	Frequency range[1] (GHz)	Wavelength range (mm)	IF range	Type
3	84 – 116	3.6 – 2.6	4 – 8	2SB
4	125 – 163	2.4 – 1.8	4 – 8	2SB
6	211 – 275	1.4 – 1.1	5 – 10	2SB
7	275 – 373	1.1 – 0.8	4 – 8	2SB
8	385 – 500	0.78 – 0.60	4 – 8	2SB
9	602 – 720	0.50 – 0.42	4 – 12	DSB
10	787 – 950	0.38 – 0.32	4-12	DSB

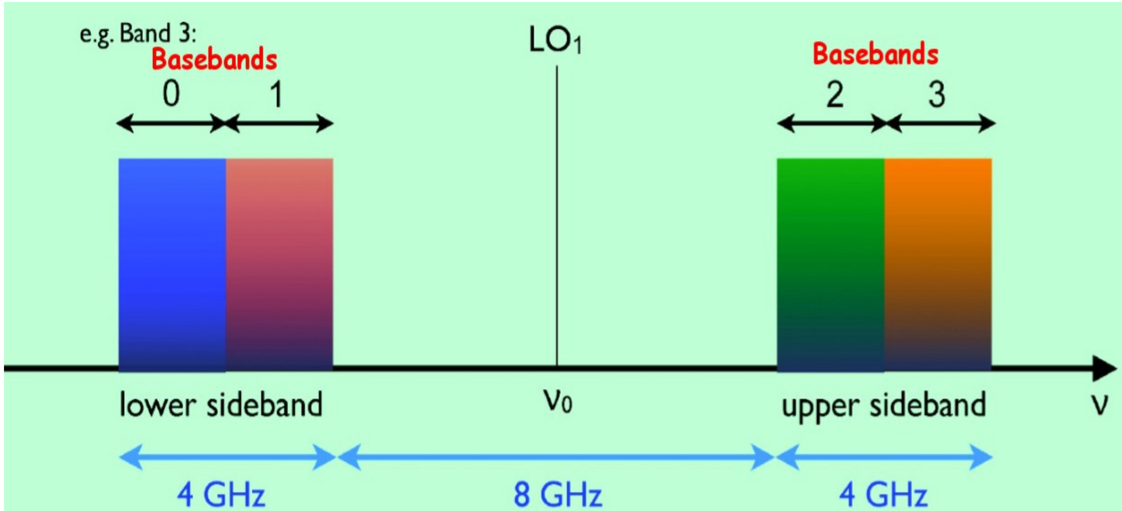
Receivers are couple of dipoles,
so split the signal into **2 polarizations**
By combining the indipendent
polarizations chains it can reconstruct
all the Stokes parameters

The coherent receivers
map two frequency regions
to an fixed Intermediate Frequency
by mixing the signal with a
Tunable Local Oscillator.

Hence the set up is constituted by
a Lower Sideband,
a gap, and
an Upper sideband
centered at a certain rest frequency

The gap size and the width
of the sidebands are fixed
(depends on the IF) but might
be different in different bands
The PI can chose the RF
(i.e. tune the LO)

ALMA spectral properties: receivers



The receivers allows up to **4 x 2 GHz-wide Basebands** that can be placed in one sideband or distributed between the 2 Sidebands.

A maximum available 8 GHz bandwidth
is achieved when the 4 basebands are chosen not to overlap by the PI.

Archive data reflect the PI choices

Query Form | Results Table

Submit download request

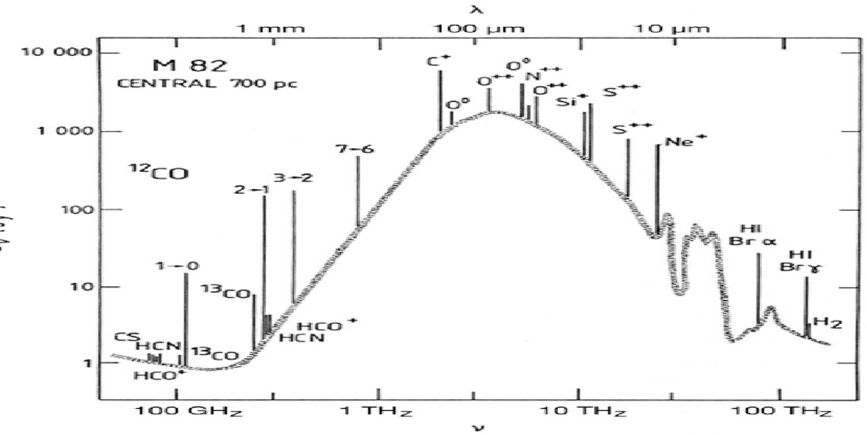
Results Bookmark Export Table Results Help

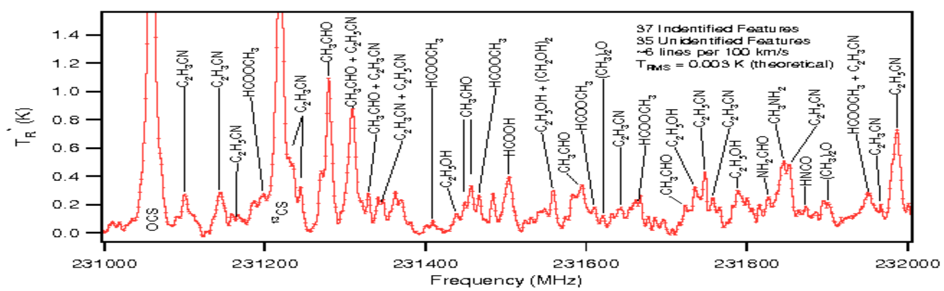
Showing 28 of 28 rows. More columns

	Project code	Source name	RA	Dec	Band	Integration	Release date	Velocity resolution	Frequency support
Filter:								m/s	
☐	2011.0.00020.S	NGC 1614	04:34:00.03	-08:34:44.6	7	120.96	2013-01-12	834.09	344.15..357.85GHz
☐	2011.0.00020.S	NGC 1614	04:34:00.03	-08:34:44.6	7	120.96	2013-01-12	851.55	336.17..351.86GHz
☐	2011.0.00768.S	NGC1614	04:34:00.03	-08:34:44.6	7	120.96	2013-10-15	846.76	337.97..353.59GHz
☐	2011.0.00768.S	NGC1614	04:34:00.03	-08:34:44.6	7	120.96	2013-10-15	846.76	337.97..353.59GHz
☐	2011.0.00768.S	NGC1614	04:34:00.03	-08:34:44.6	7	120.96	2013-10-15	846.76	337.97..353.59GHz
☐	2011.0.00182.S	NGC 1614	04:34:00.03	-08:34:45.2	9	151.2	2013-12-21	13784.20	675.82..683.31GHz
☐	2011.0.00182.S	NGC 1614	04:34:00.03	-08:34:45.2	9	151.2	2013-12-21	13784.20	675.82..683.31GHz
☐	2013.1.01172.S	ngc_1614	04:34:00.05	-08:34:59.0	6	151.2	2015-08-08	2625.60	214.12..232.20GHz
☐	2013.1.01172.S	ngc_1614	04:34:00.05	-08:34:45.2	6	151			214.12..232.20GHz
☐	2013.1.01172.S	ngc_1614	04:34:00.05	-08:34:31.5	6	151			214.12..232.20GHz
☐	2013.1.01172.S	ngc_1614	04:34:00.05	-08:34:45.2	3	30.			98.68..114.41GHz
☐	2013.1.00991.S	NGC_1614	04:34:00.03	-08:34:44.6	3	60.			98.62..114.42GHz
☐	2013.1.00991.S	NGC_1614	04:34:00.03	-08:34:44.6	3	60.			93.75..109.42GHz
☐	2013.1.00991.S	NGC_1614	04:34:00.03	-08:34:44.6	3	120			98.66..114.48GHz
☐	2013.1.00991.S	NGC_1614	04:34:00.03	-08:34:44.6	3	120			98.66..114.48GHz

Frequency	Resolution	Polarization
98.62..100.62GHz	125000.00kHz	XX YY
100.44..102.44GHz	125000.00kHz	XX YY
110.67..112.55GHz	3906.25kHz	XX YY
112.54..114.42GHz	3906.25kHz	XX YY

Continuum vs spectral line



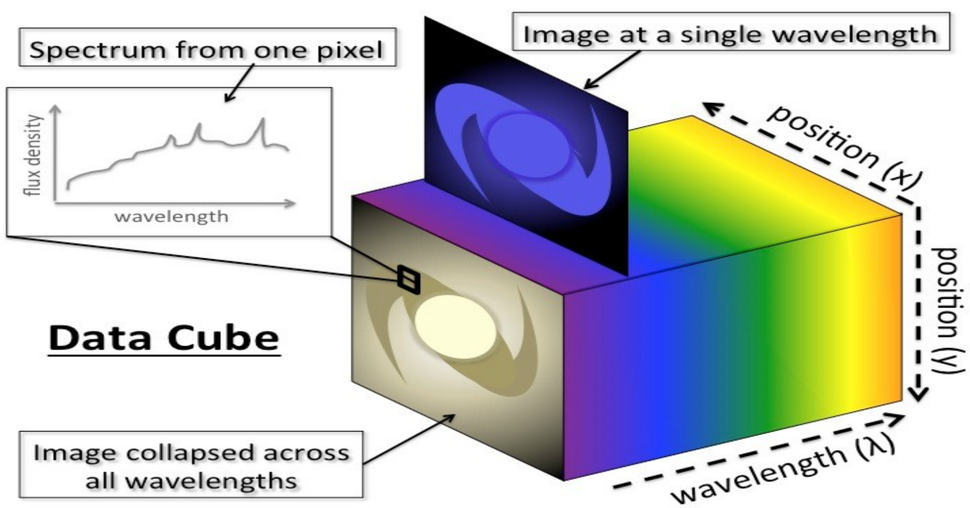


Digital correlators can be set up to different bandwidth and spectral resolution.

Continuum can be observed with large bandwidth and low spectral resolution (broad frequency channels)

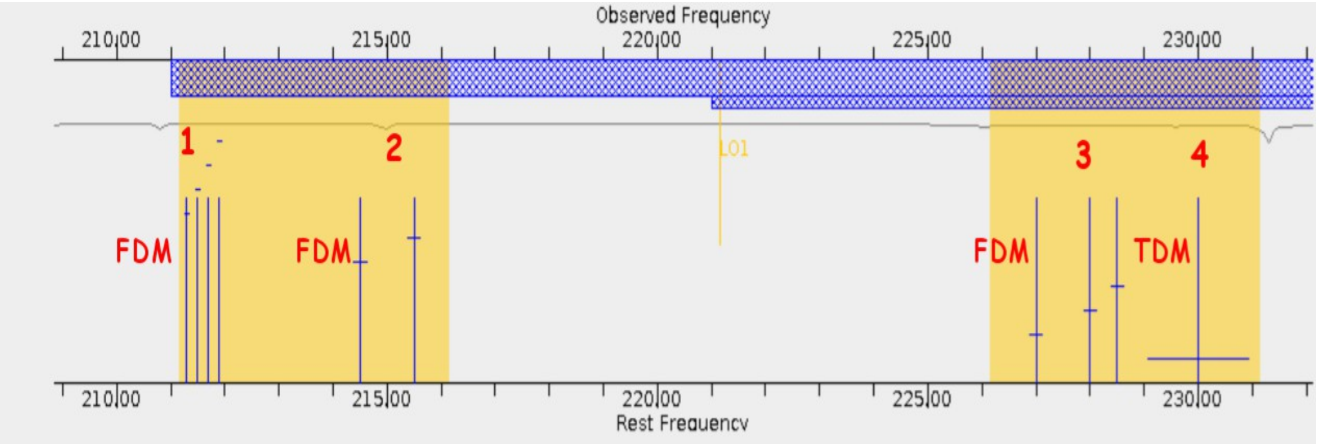
The narrower are the spectral lines the higher is the spectral resolution requested to sample it.

Hence data products are always 4D cubes:
Ra, dec, frequency channels, polarization products



Polarization products

ALMA spectral properties: correlator



Each baseband may be divided in up to 4 spectral windows by allocating a fraction of the correlator resources (up to 3840 channels in double pol) to each window.

Typical purposes:

	Mode	Polarization	Bandwidth per baseband (MHz)	Number of channels per baseband	Channel Spacing (MHz)	Velocity width at 300 GHz (km/s)
Spectral scans	7	Dual	1875	3840	0.488	0.48
	8	Dual	938	3840	0.244	0.24
Targeted imaging of moderately narrow lines: cold clouds / protoplanetary disks	9	Dual	469	3840	0.122	0.12
	10	Dual	234	3840	0.061	0.06
	11	Dual	117	3840	0.0305	0.03
	12	Dual	58.6	3840	0.0153	0.015
	6	Single	58.6	7680	0.00763	0.008
"Continuum" or broad lines	69	Dual	2000	128	15.625	15.6
	71	Single	2000	256	7.8125	7.8

Frequency division mode:
small bandwidth
high resolution
(spectral lines)

Time division mode:
large bandwidth
low resolution
(continuum)

The PI can request to bin the channels at the correlator stage (i.e. reduce the resolution in the data) to reduce the data rate

Large number of modes → high flexibility for different science cases

ALMA sensitivity

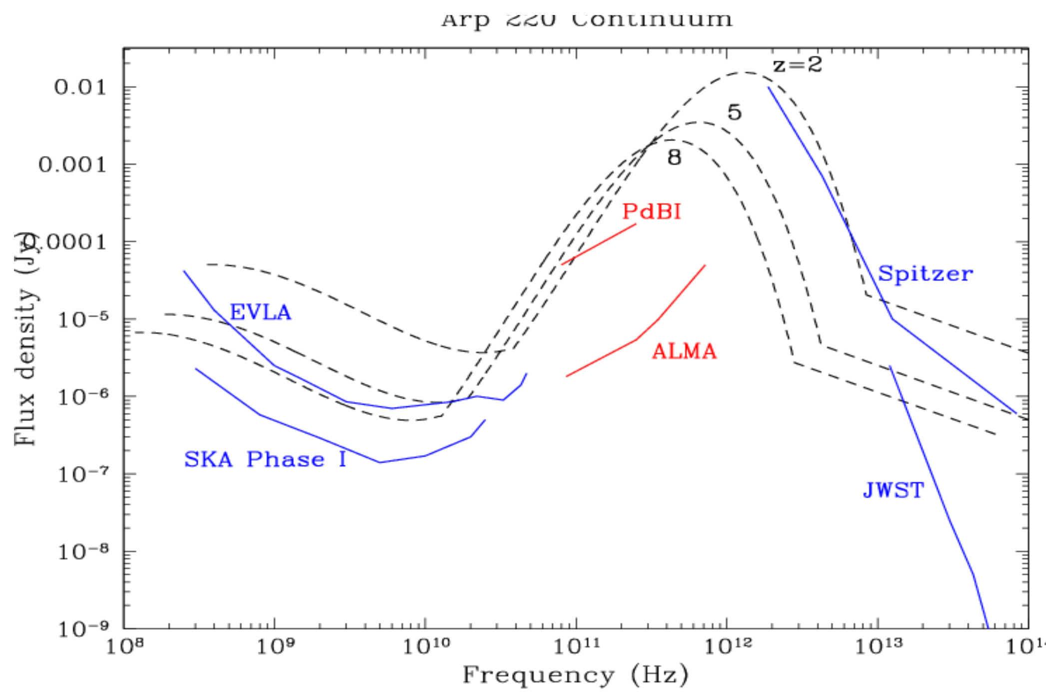
High sensitivity is the combination of

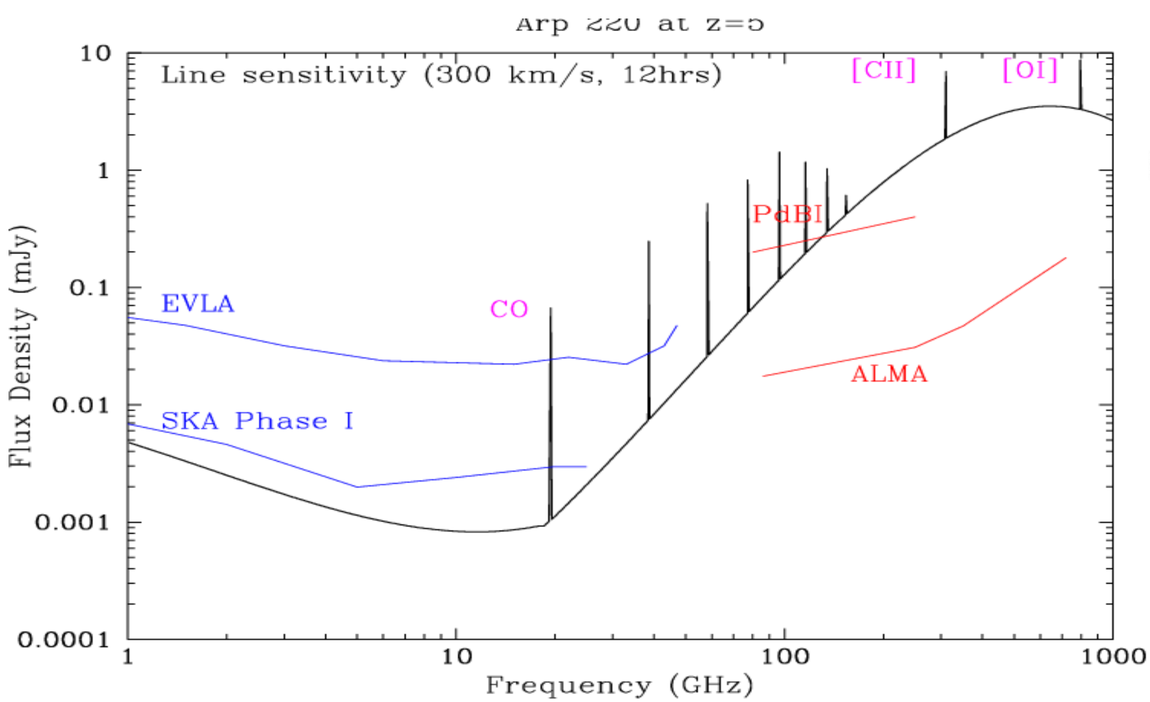
- dry site, low pwv, low Tsys,

- >6500sqm of effective area
and 1225 baselines for the 12m array
+ Short spacings and TP with ACA

- large bandwidth (for continuum)

Sensitivity is always referred to a frequency range chosen by the PI.





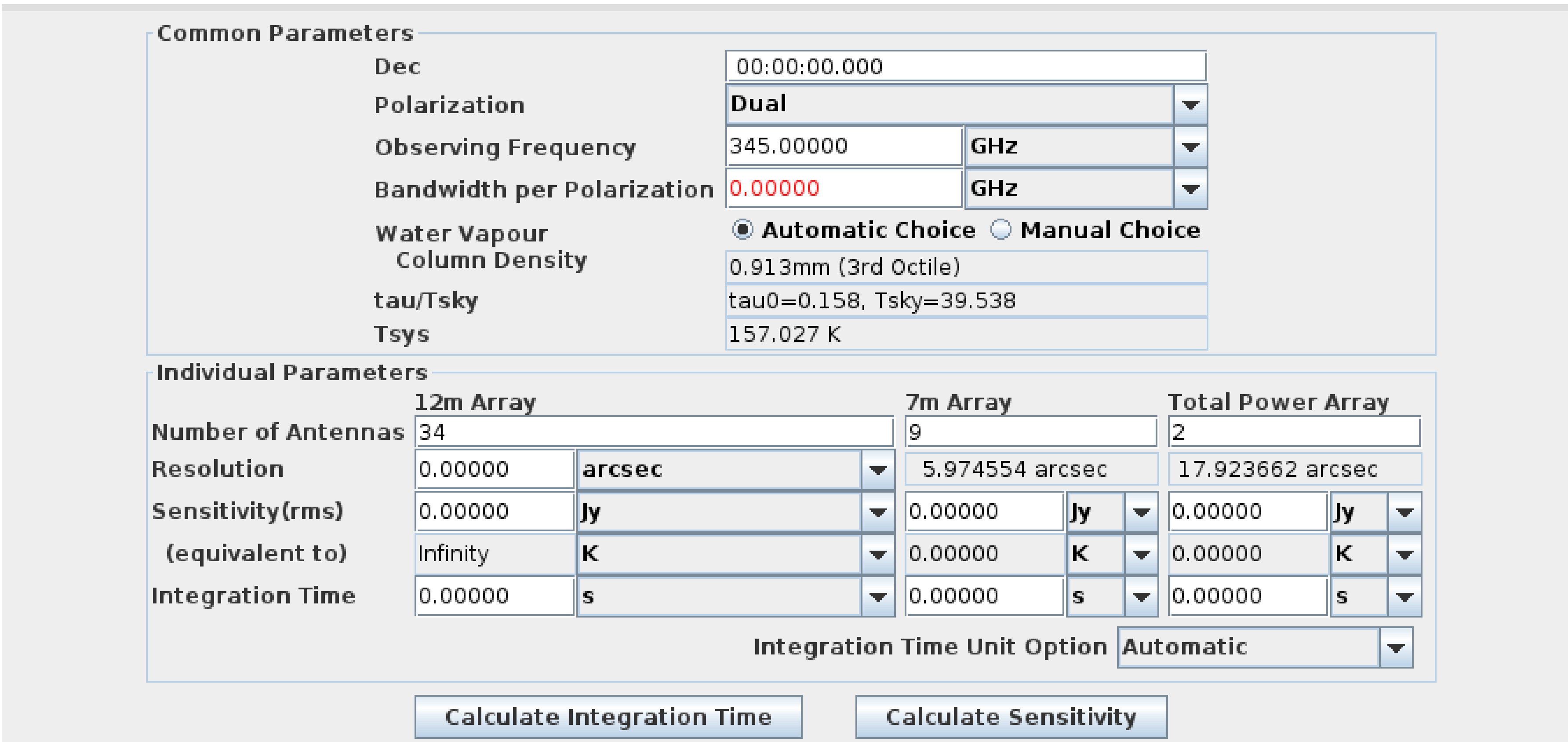
$$\sigma_S = \frac{2\,k\,T_{sys}}{\eta_q \eta_c A_{eff} \sqrt{N(N-1)\,n_p\,\Delta\nu\,t_{int}}}$$

<0.05mJy @100 GHz in 1 hr

The PI requests a sensitivity in a certain setup of spectral and angular resolutions

The Science Goal: Sensitivity Calculator

http://almascience.eso.org/call-for-proposals/sensitivity-calculator



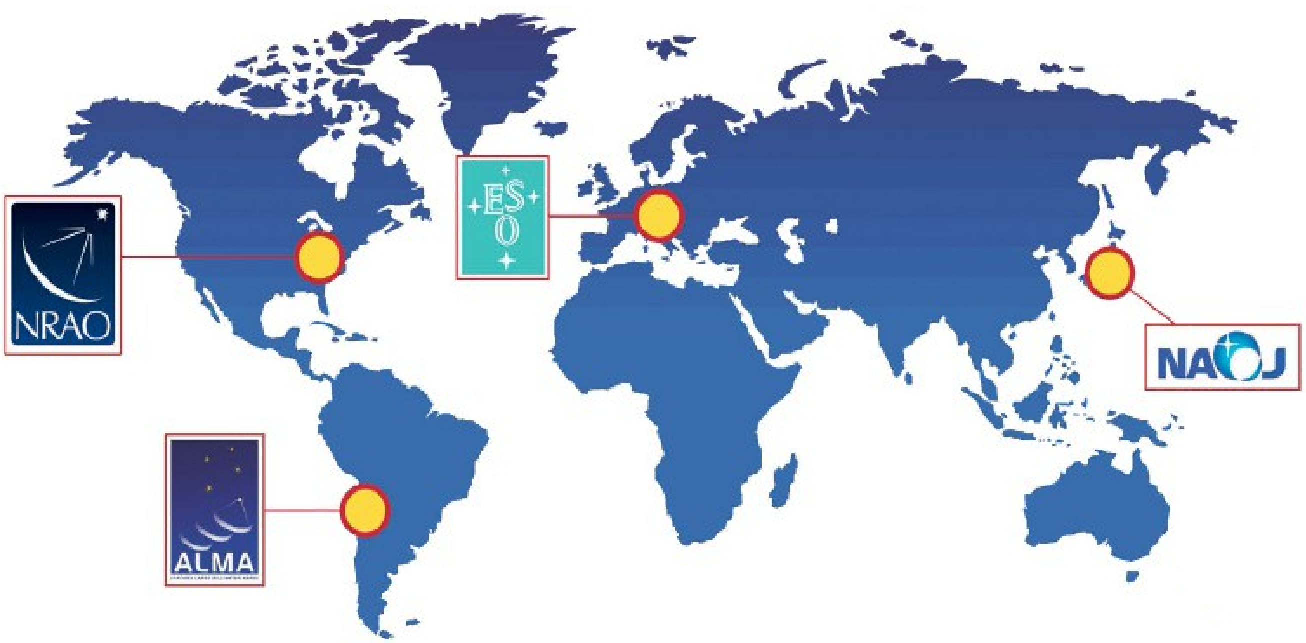
(See tutorial on Sensitivity Calculator)

ALMA organization

ALMA is a world wide collaboration

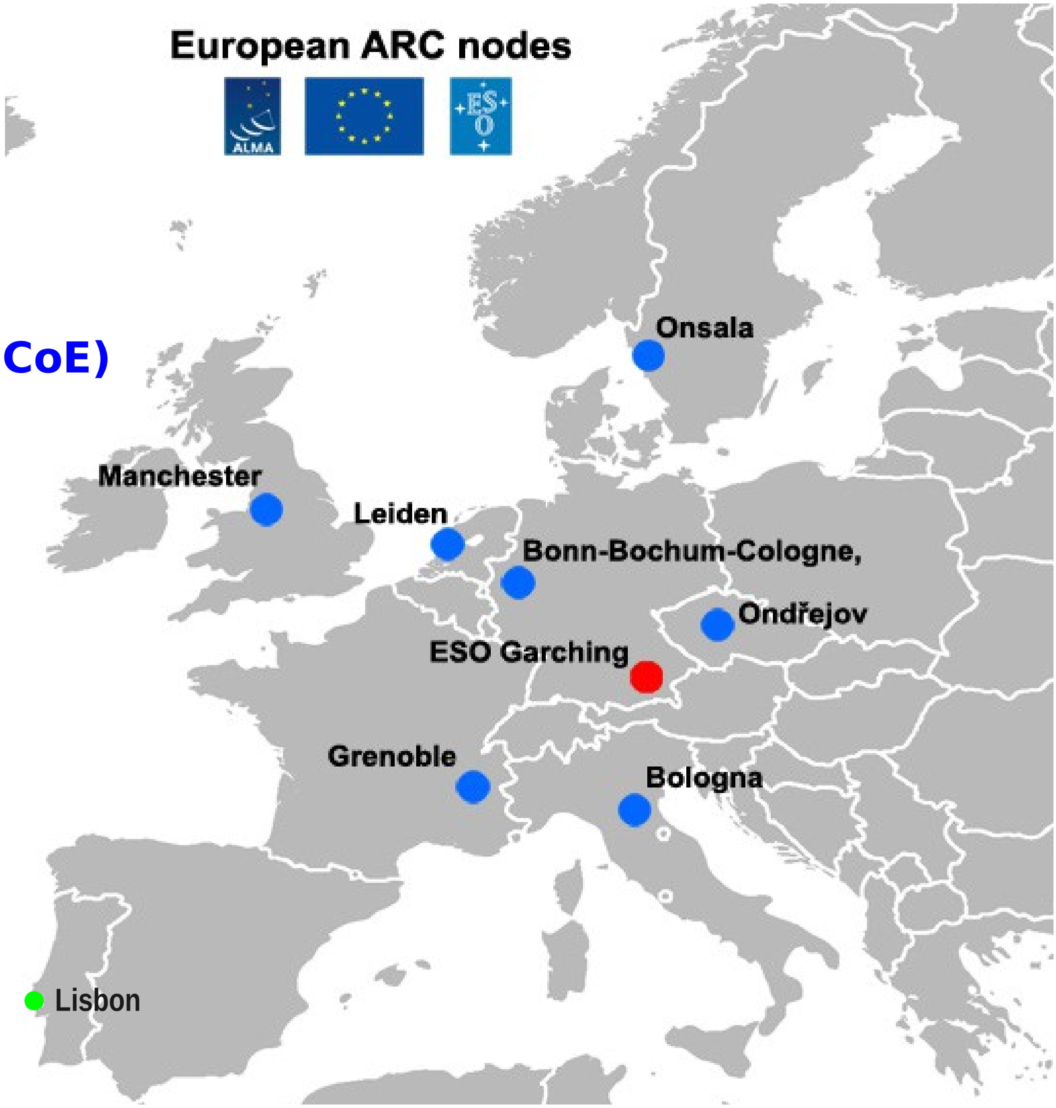
Contributors share the observing time an host a mirror of the archive

- Europe: **ESO** (14 countries) → 30%
- North America: **NRAO** (USA, Canada) → 30%
- East Asia: **NAOJ** (Japan, Taiwan) → 20%
- Chile → 10%

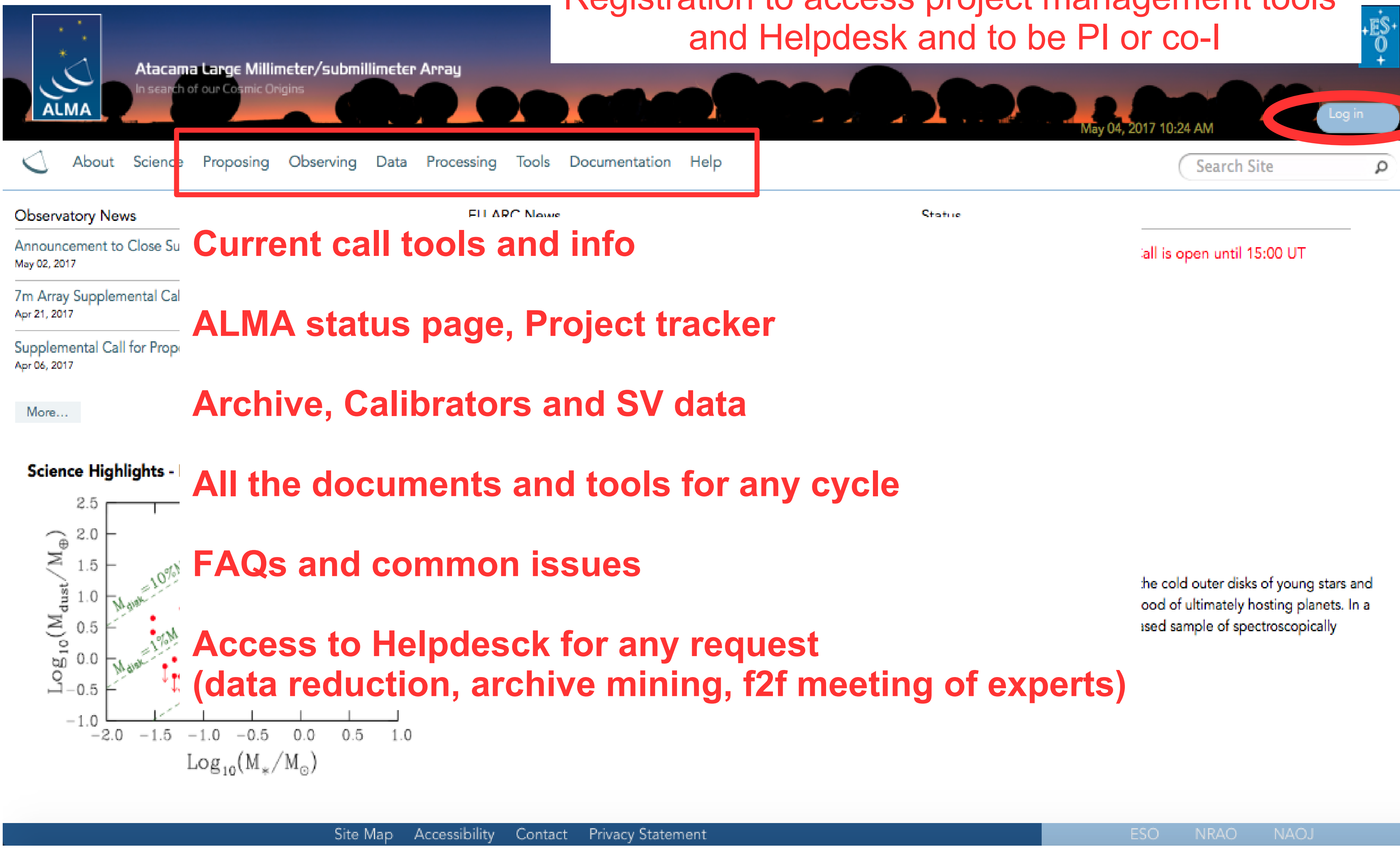


The ALMA Regional Centres (ARCs)

- **Interface between JAO and users**
- 1 ARC per Partner:
  - NRAO for North America
  - NAOJ for East Asia
  - **ESO for Europe (split in 7 nodes + 1CoE)**
- Operation support
  - Archive replication
  - Astronomer on duty
  - Software tools
- User support
  - Community formation and outreach (schools, workshops, tutorials, ...)
  - Phase 1 (proposal preparation)
  - Phase 2 (scheduling block preparation)
  - Data analysis, Archive mining
  - F2F user support, Helpdesk



Enter the ALMA world through the ALMA Science Portal
http://almascience.eso.org/



Registration to access project management tools and Helpdesk and to be PI or co-I

Current call tools and info

ALMA status page, Project tracker

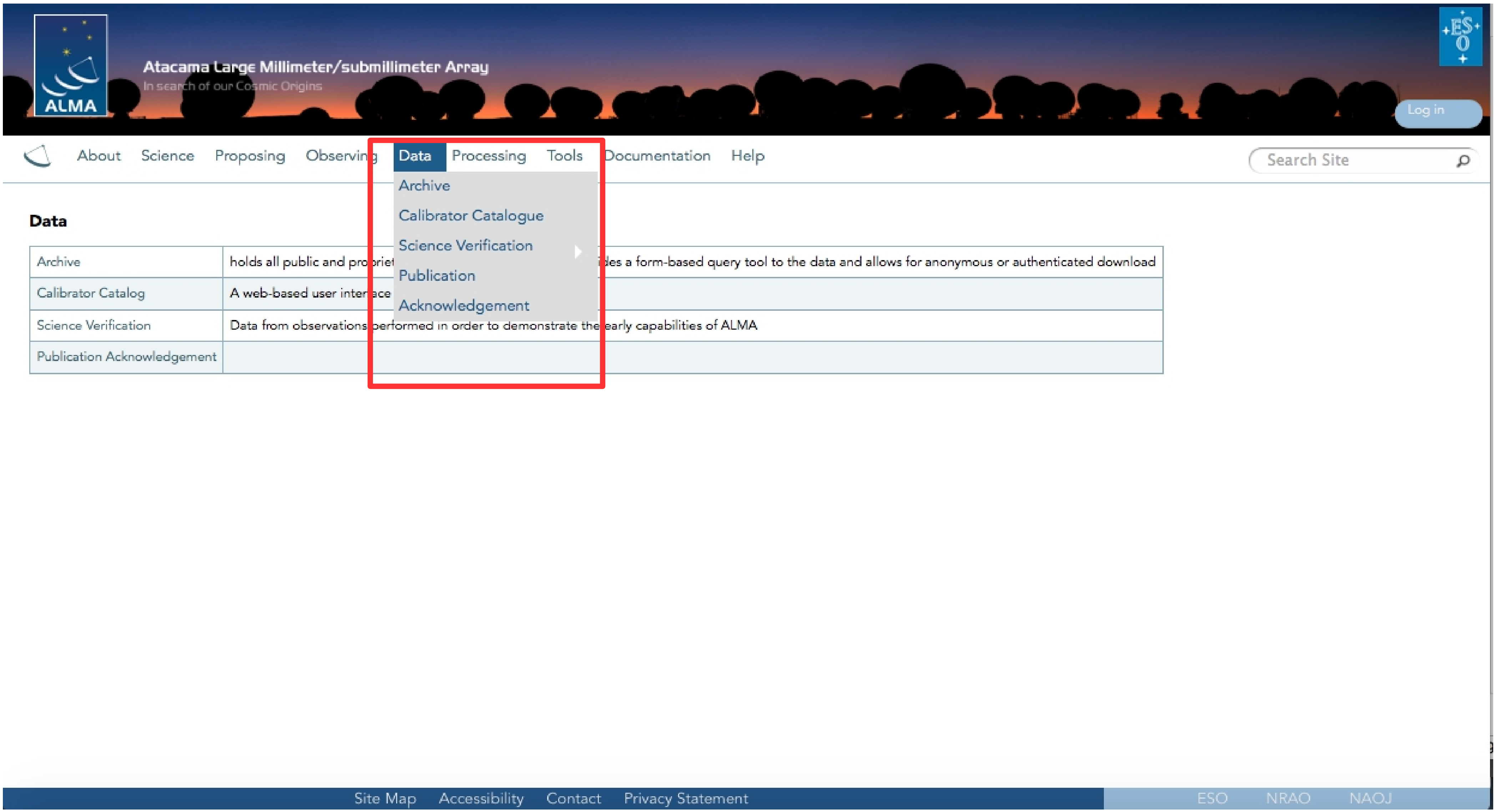
Archive, Calibrators and SV data

All the documents and tools for any cycle

FAQs and common issues

Access to Helpdesck for any request (data reduction, archive mining, f2f meeting of experts)

Access the ALMA data
http://almascience.eso.org/alma-data



Access the documents
http://almascience.eso.org/documents-and-tools

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

Log in

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

Cycle 5 Docs
Present Cycle
Previous Cycles

Search Site

Documentation

Call for Proposals

Documentation supporting the current ALMA Call for Proposals – **Cycle 5**. Documents from previous Cycles are provided here.

Document	Description
ALMA Proposer's Guide	Contains all pertinent information regarding the ALMA Call for Proposals
ALMA Technical Handbook	A comprehensive description of the ALMA observatory and its components
ALMA Users' Policies	The long-term core policies for use of the ALMA and ALMA data by the science community
Observing With ALMA - A Primer	Introduction to interferometry and how to use ALMA
ALMA Proposal Template	LaTeX format. Recommended but not mandatory
ALMA Proposal Review Process	An updated ALMA Principles of the ALMA Proposal Review Process

Contents

Phase 1 & 2

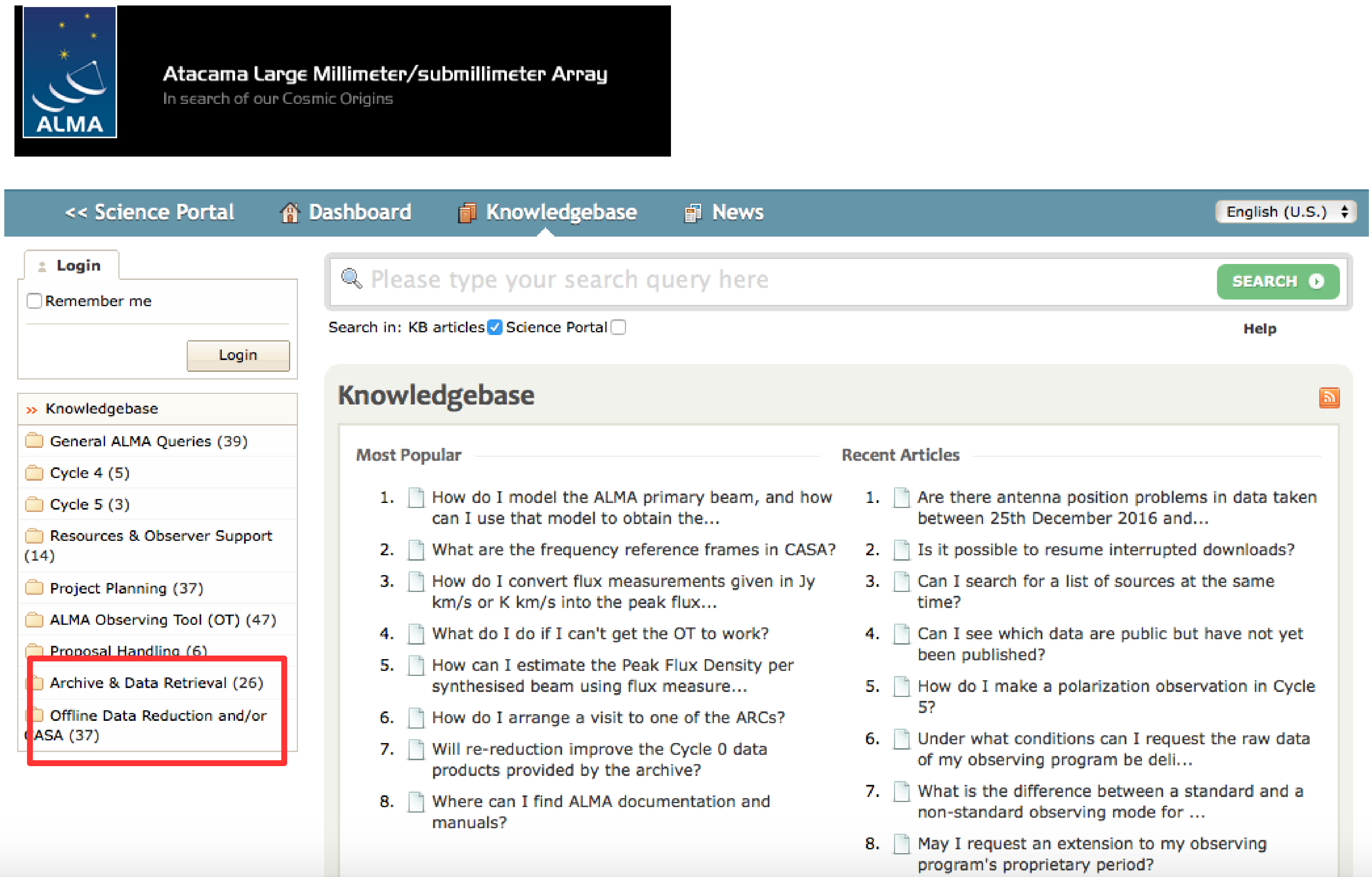
ALMA Phase 1 (observing proposal) and Phase 2 (telescope runfiles for accepted proposals) materials are submitted through the ALMA Observing Tool (OT). Below are documentation which will aid the created and submitted of Phase 1 and Phase 2 with the OT.

Document	Description
OT Quickstart	A Quick Start Guide for using the Observing Tool
OT User Manual	Describes how to use the Observing Tool for preparing ALMA proposals
OT Reference Manual	An in-depth description of the Observing Tool

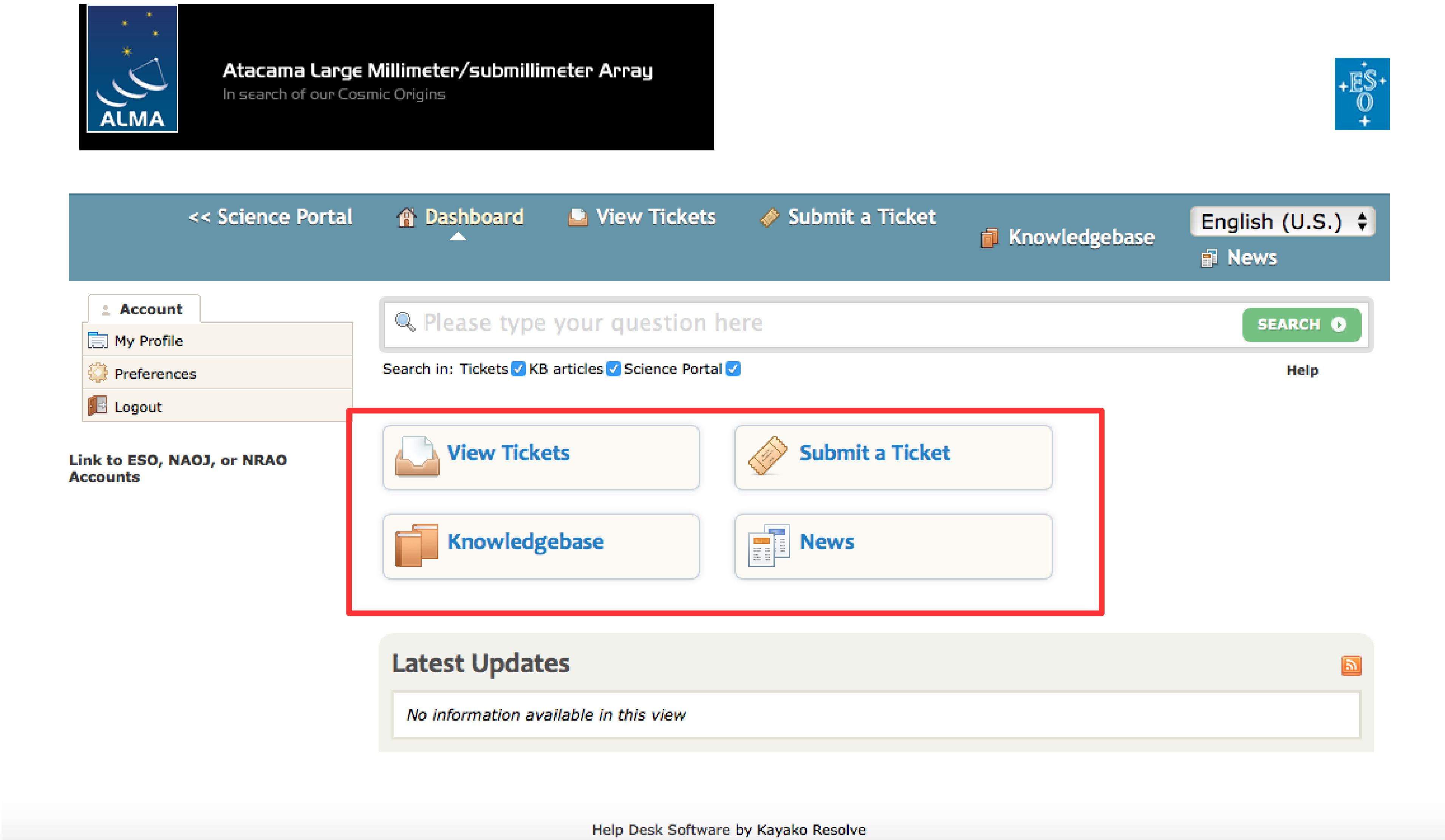
Site Map Accessibility Contact Privacy Statement ESO NRAO NAOJ

Access the FAQ - Knowledgement

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



Access the Helpdesk
Register on the SP to access!!!
https://help.almascience.org/index.php?/eu



A project lifetime: phase 1 Proposal submission

PI has a good idea!	
PI estimates feasibility	Simulations are not compulsory (Sensitivity Calculator, OST, CASA)
PI splits project in Science Goals	**Minimum proposed observational unit including targets in the same sky region that roughly share the same calibration and spectral setup**
PI writes the science case in pdf and register to the Science Portal	Max 4 page, font no smaller than 12, all included (<20MB) www.almascience.org
PHASE I – Proposal submission	With the ALMA Observing Tool (OT) A copy of the project with the project ID must be saved and should be used for any resubmission within the deadline
TAC evaluation	**A**=high ranked pass to Cycle 4 if not finished **B**=high ranked but not passed over **C**=maybe filler (depends on time shares and ranking)

Project ID (assigned at first submission):

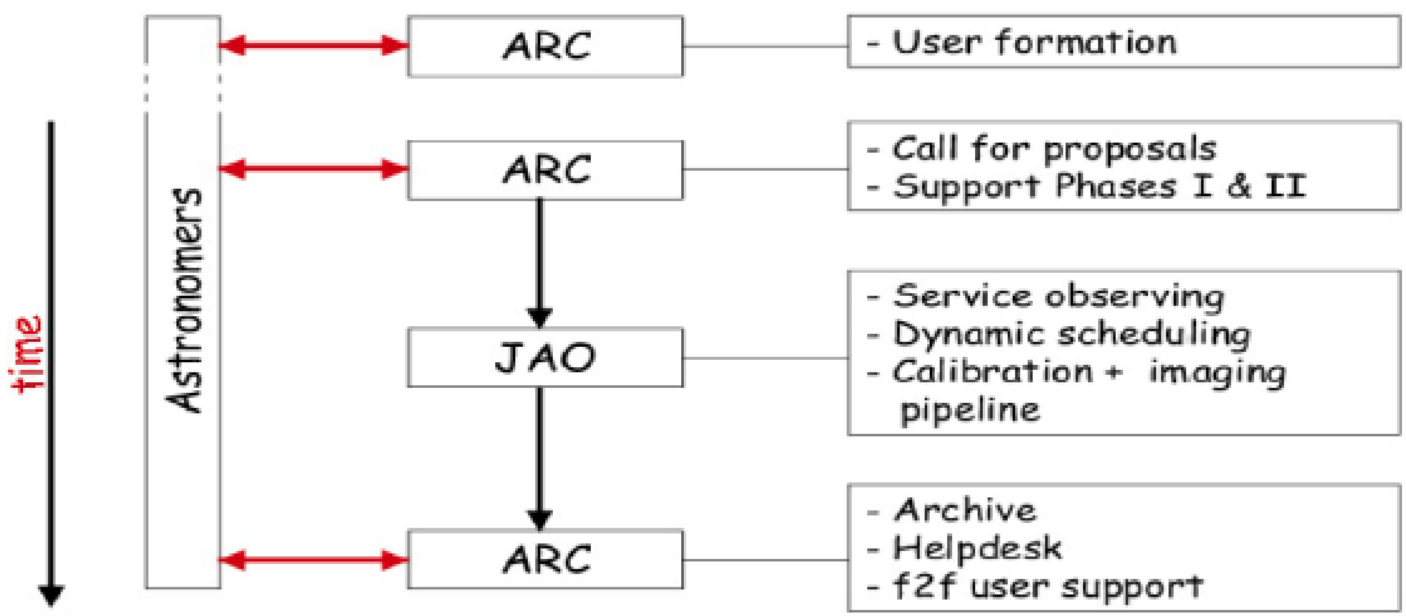
YYYY.R.CCCCC.X

YYYY= submission year
R= number of call for the submission year
CCCCC= sequential number of submitted
X= type of proposal

A project lifetime: phase 2 Observing process

PHASE II – Observing process

Scheduling Block	Each SG is converted into a **Scheduling Block, an observational unit including targets in the same sky region and their Calibrators to be observed with the same instrumental setup.** They are the minimum set of instructions to perform an observation.
Observations	**Projects are dynamically scheduled according to telescope configuration, weather, ranking, project status...**
Quality assessment	**QA0 and 1 = telescope conditions** **QA2 = Check for PI sensitivity requests performed by ARC staff**
Data archival and delivery	**1 yr of proprietary period before data are public through the archive**



(See talk on Archive)

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 2019 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.

NEW

Not offered for spectral scan or mosaics

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**

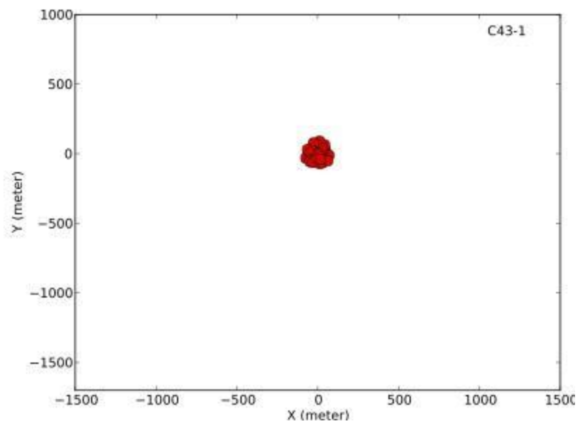
The minimum detectable degree of circular polarization is currently 1.8% of the peak flux for both continuum and spectral-line data.

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

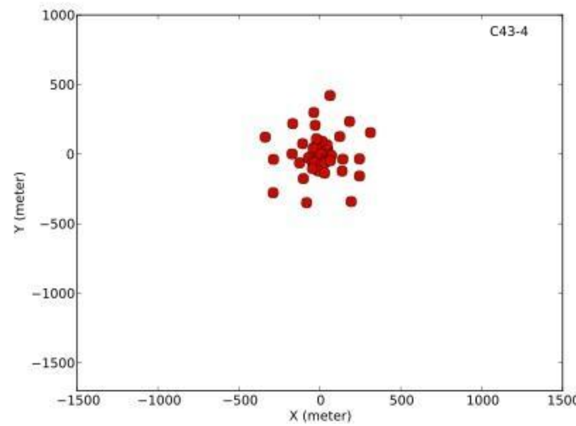
Bands 3 - 6 b_{max} = 16 km
Band 7 b_{max} = 8.5 km
Band 8, 9, 10 b_{max} = 3.6 km

C43-1

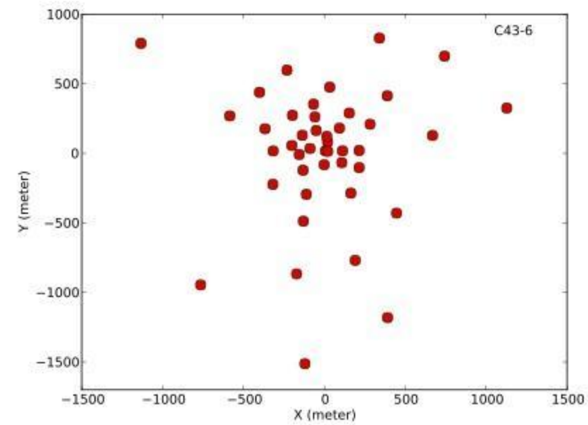


3 km

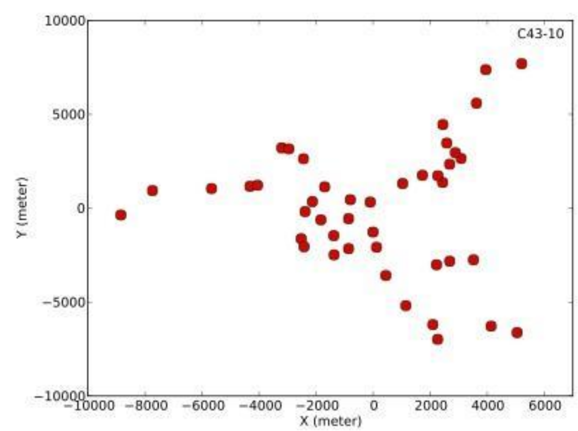
C43-4



C43-6



C43-10



16 km

New configuration every 2-4 weeks.

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:

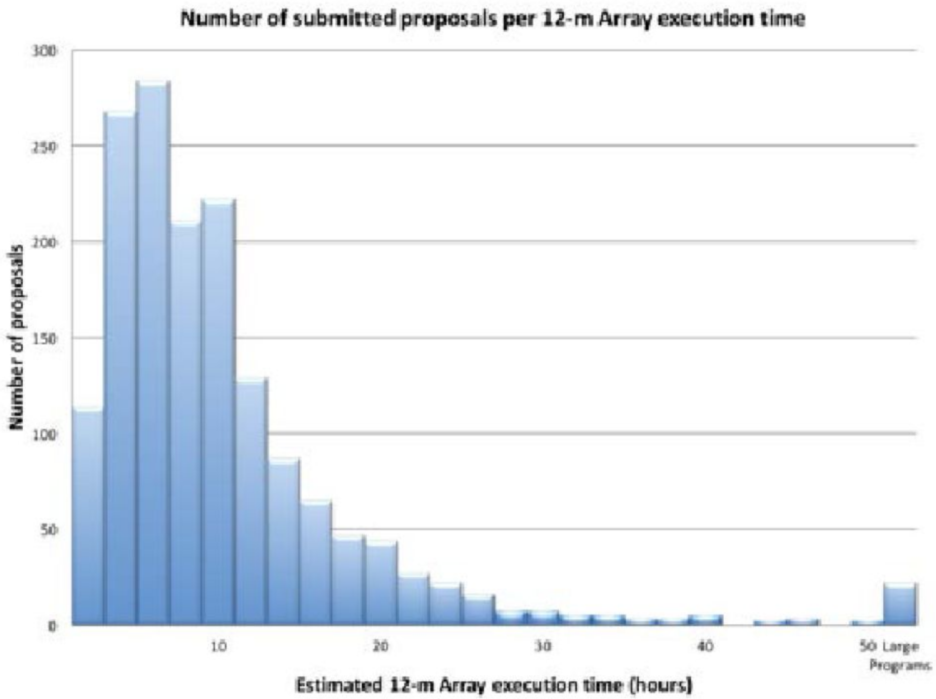
- **Band 9 and 10 observations**
- **Band 7** observations with maximum baselines **> 5 km**
- **All polarization observations**
- **Spectral scans**
- **Bandwidth switching projects** (less than 0.9375 GHz aggregate bandwidths over all spectral windows)
- **Solar observations (Bands 3 and 6)**
- **VLBI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

CYCLE 6: PROPOSAL TYPES

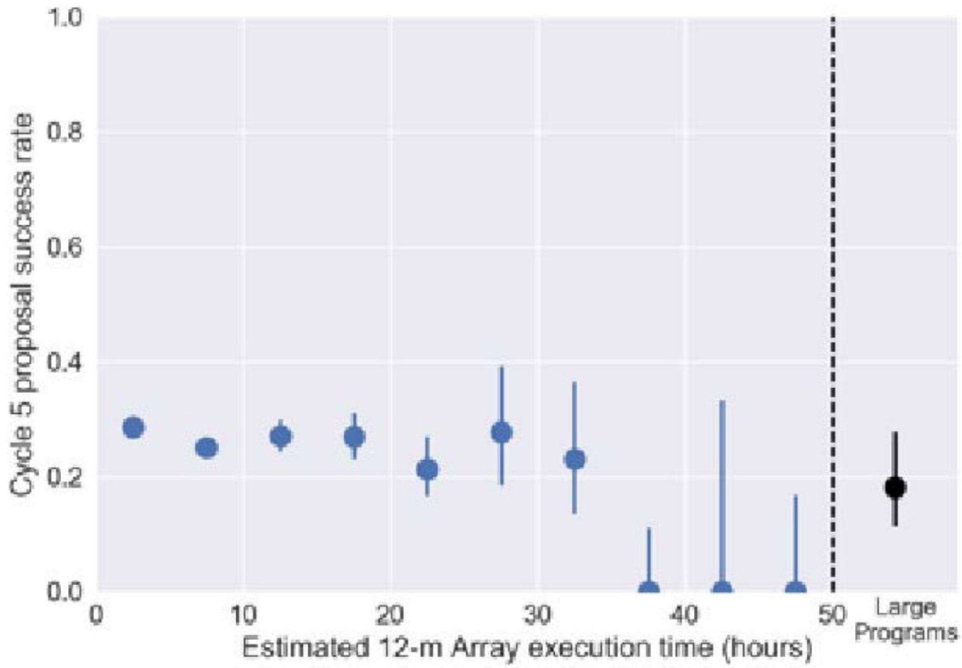
- **Regular proposals.**

  < 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: $b_{max} < 700$m)

- **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:

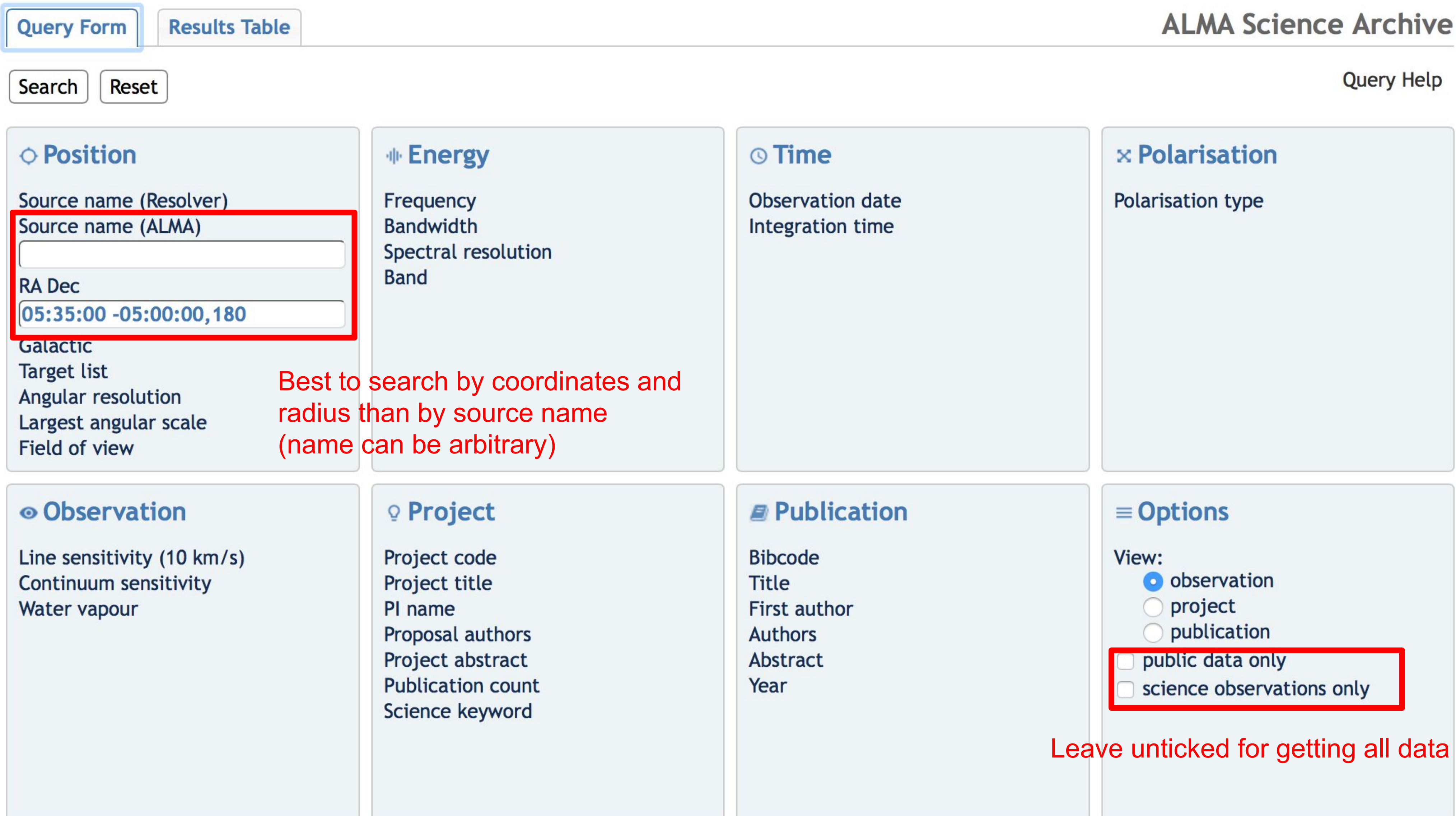
- **angular resolution is within a factor ≤ 2 of archival data**
- **single pointing: coordinates overlap within HPBW of archival data**
- **mosaic: 50% of pointing are within HPBW of archival data**
- **line: central frequency within spw of archival data and sensitivity per channel (after smoothing 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

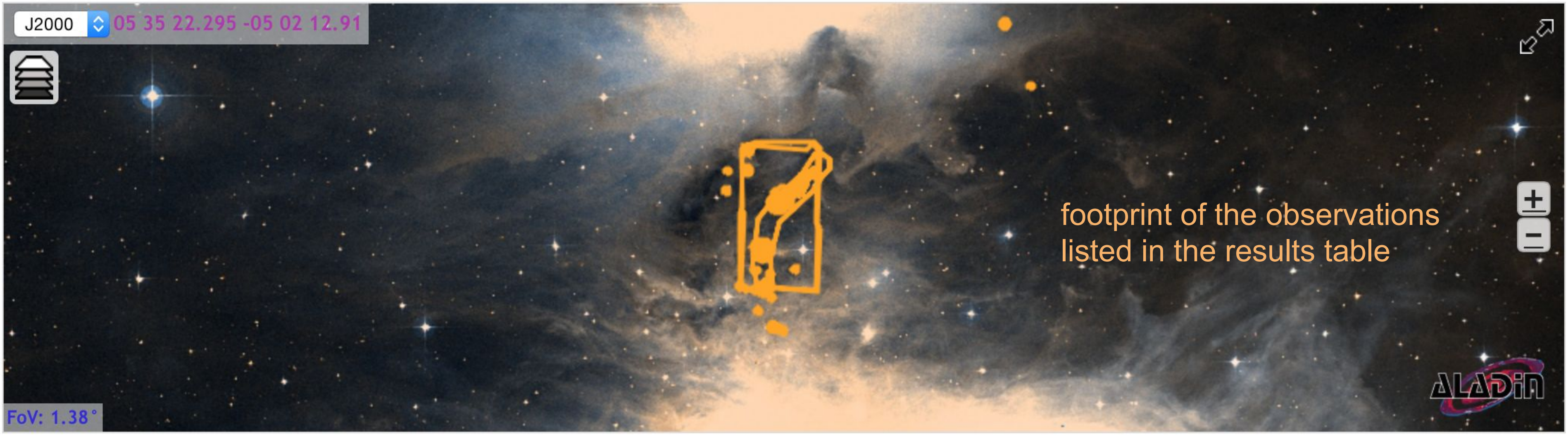
Consulting archival images/observations

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

ALMA Request Handler

Kazi Rygl

| My Requests | Logout

Kazi Rygl: Request #401451770 ✓

Request Title: Click to edit

Download Selected

☑ readme ☑ product ☐ raw ☐ raw (semipass)

Project / OUSet / Executionblock	File	Size	Accessible
Request 401451770			
Project 2013.1.00105.S			
readme	2013.1.00105.S.readme.txt		
Science Goal OUS uid://A001/X12e/X23d			
Group OUS uid://A001/X12e/X23e			
Member OUS uid://A001/X12e/X23f			
SB UX_Tau_a_06_TE			
product	2013.1.00105.S_uid___A001_X12e_X23f_001_of_001.tar	3.8GB	✓
raw	2013.1.00105.S_uid___A002_Xaa4256_X309a.asdm.sdm.tar	6.5GB	✓
		Total: 62.8GB	

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

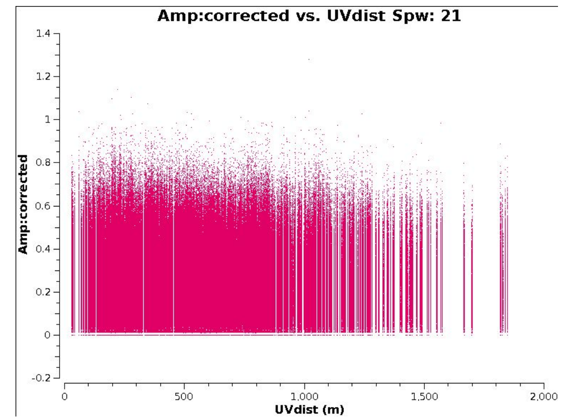
Project	uid://A001/X10d/X17
Principal Investigator	akeson
OUS Status Entity id	uid://A001/X12e/X23f
Observation Start	2015-09-18 08:58:05 UTC
Observation End	2015-09-18 09:41:13 UTC

Pipeline Summary

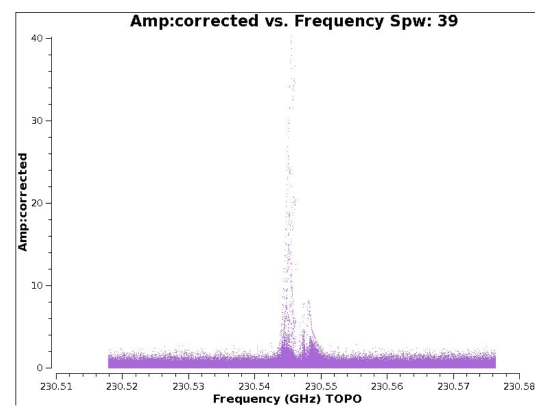
Pipeline Version	34044 (Pipeline-Cycle3-R1-B)
CASA Version	4.3.1 r32491
Pipeline Start	2015-10-07 21:00:28 UTC
Execution Duration	2:52:45

Observation Summary

			Time (UTC)			**Baseline Length**			
Measurement Set	**Receivers**	**Num Antennas**	**Start**	**End**	**On Source**	**Min**	**Max**	**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

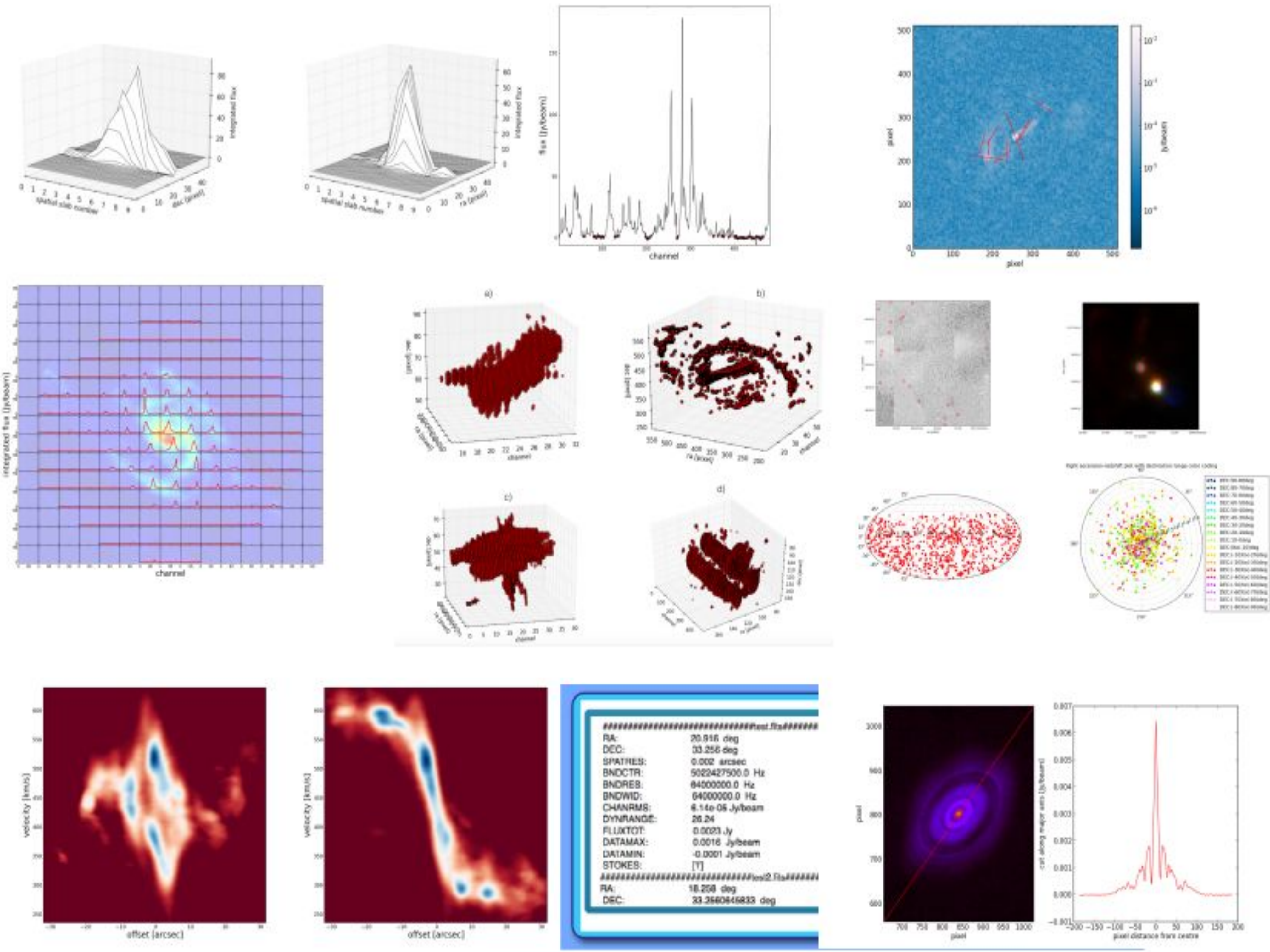
KAFE: Keywords of Astronomical FITS-images Explorer

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


spatial slab number
dec (pixel)
integrated flux
ra (pixel)
flux (Jy/beam)
channel
pixel
Jy/beam
integrated flux (Jy/beam)
a)
b)
c)
d)
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: 33.2660646833 deg
pixel distance from centre