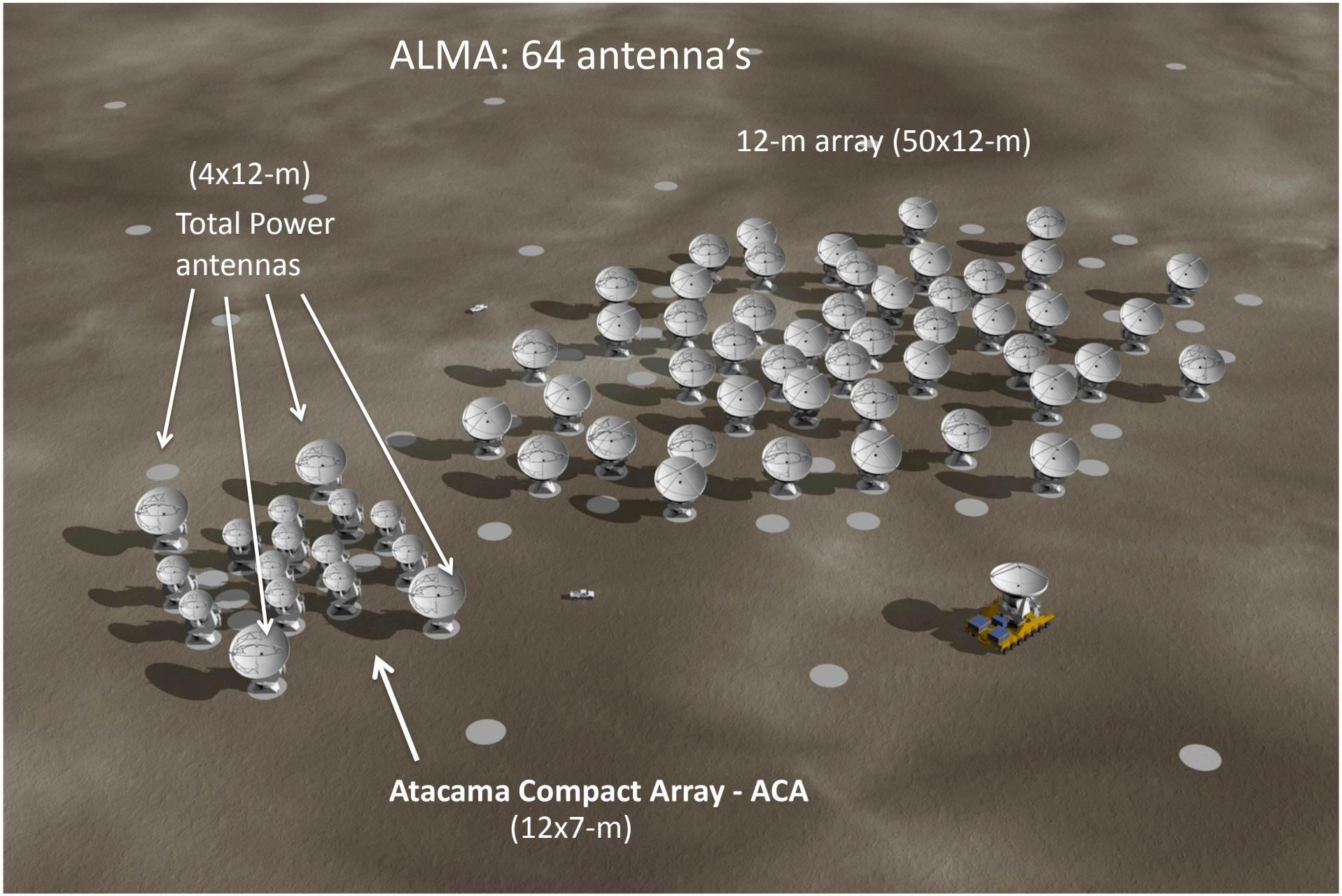
EUROPEAN ARC
ALMA Regional Centre || Italian

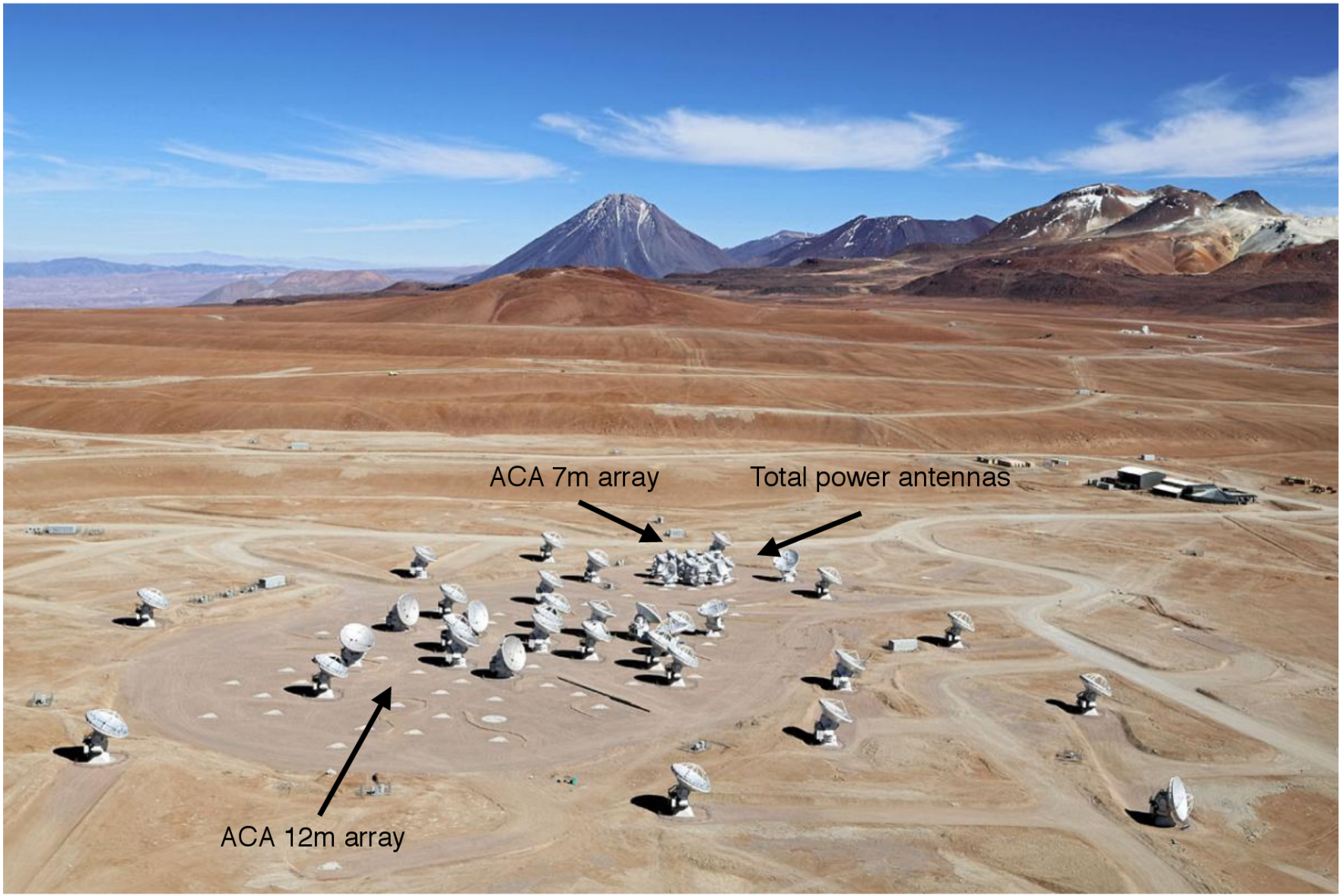
ALMA REGIONAL CENTRE ITALY
is Bologna

Introduction to ALMA

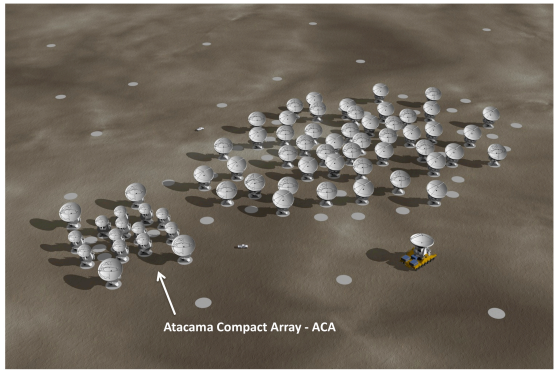
preparing for Cycle7 and statistics

Jan Brand – ALMA Regional Centre, Italian node


ALMA: 64 antenna’s
12-m array (50x12-m)
(4x12-m)
Total Power
antennas
Atacama Compact Array - ACA
(12x7-m)


ACA 7m array
Total power antennas
ACA 12m array

THE AMBITIOUS ALMA PROJECT



- Dry site (low pwv)
- low T_{sys}
- > 6500 m^2 effective area
- 1225 baselines (main array)
- short spacings with ACA, TP-ants.

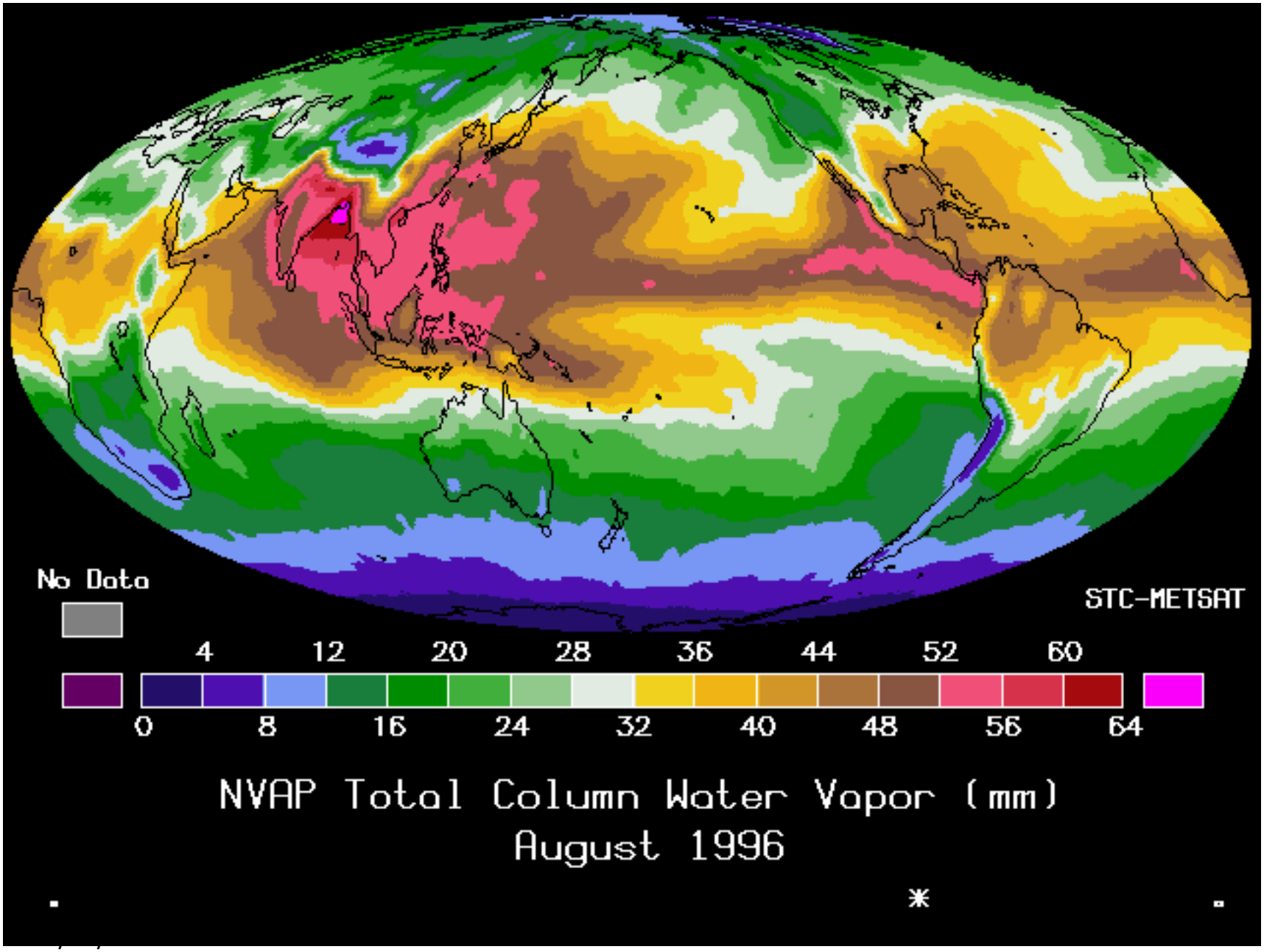
Excellent instantaneous uv-coverage and high sensitivity:
< 0.05 mJy @ 100 GHz in 1 hr

- baselines up to b_{max} = 16 km

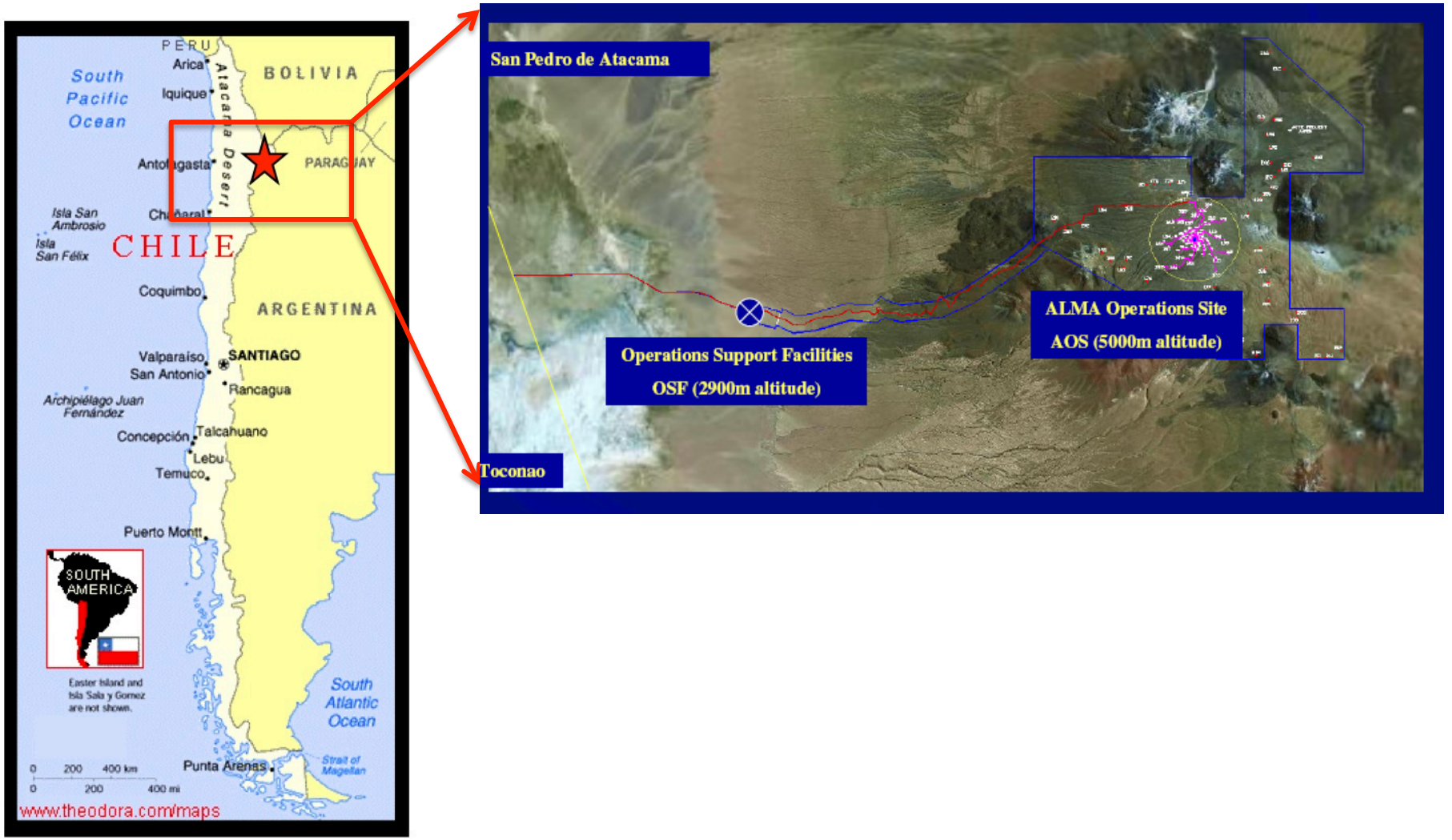
Sub-arcsec resolution:
40 mas @ 100 GHz
5 mas @ 900 GHz

- 10 spectral bands 30-950 GHz
- 70 correlator modes

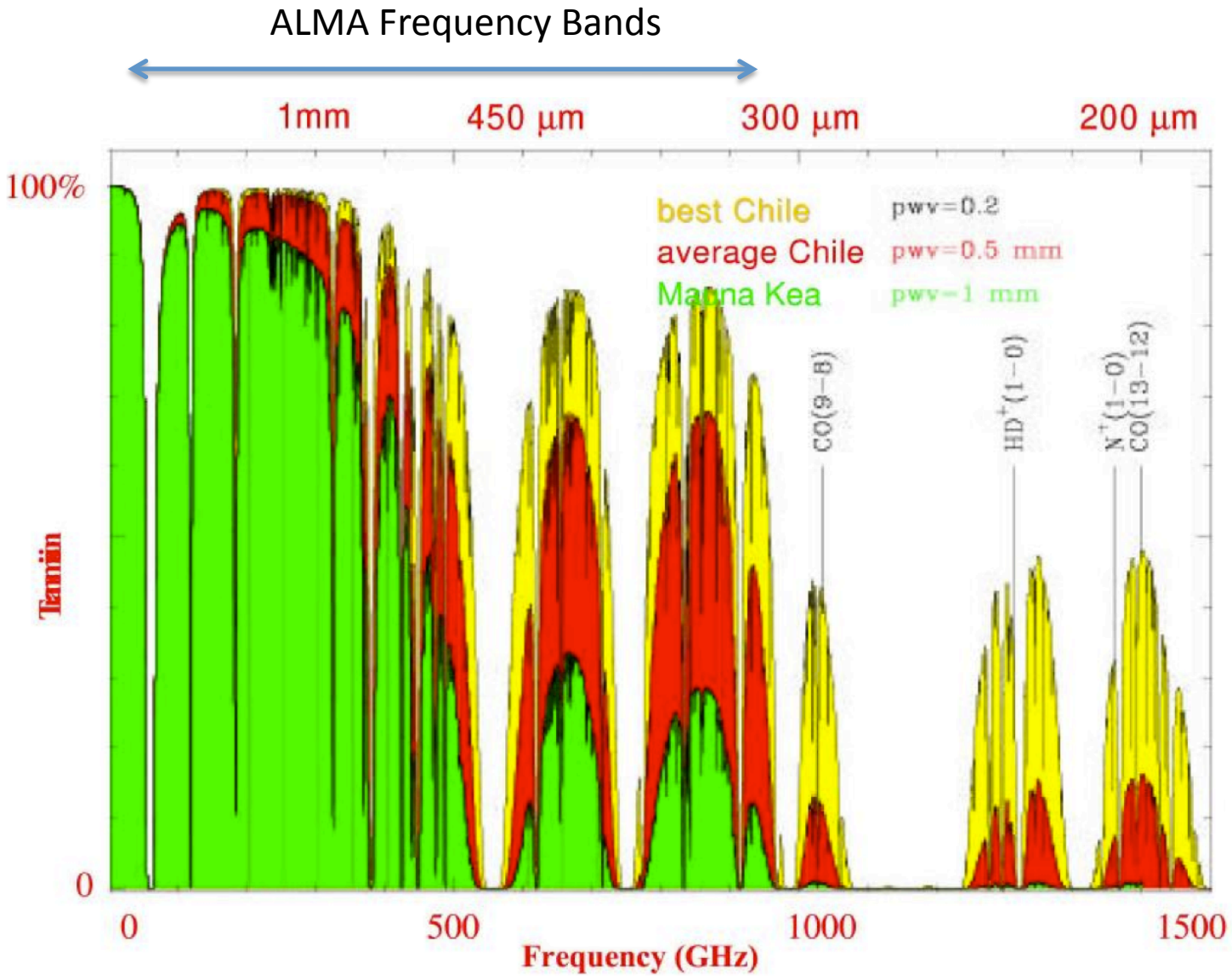
High flexibility in spectral studies


No Data
STC-METSAT
4
12
20
28
36
44
52
60
0
8
16
24
32
40
48
56
64
NVAP Total Column Water Vapor (mm)
August 1996

ALMA Site

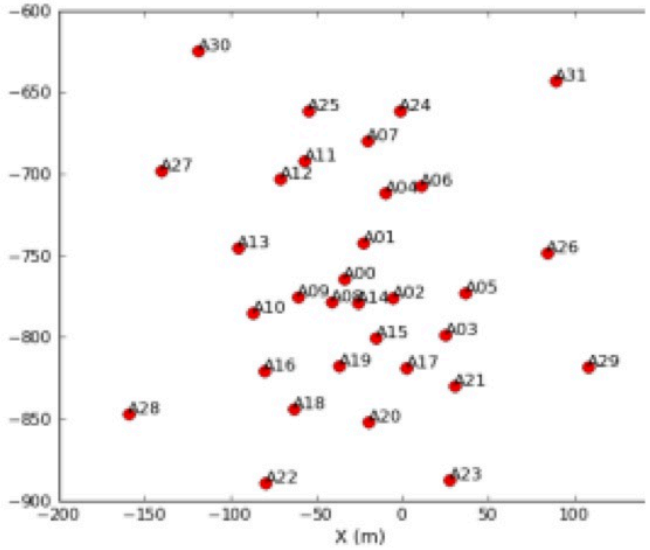

PERU
BOLIVIA
PARAGUAY
CHILE
ARGENTINA
South Pacific Ocean
South Atlantic Ocean
Arica
Iquique
Antofagasta
Atacama Desert
Isla San Ambrosio
Isla San Félix
Coquimbo
Valparaíso
San Antonio
SANTIAGO
Rancagua
Archipiélago Juan Fernández
Concepción
Talcahuano
Lebu
Temuco
Puerto Montt
Punta Arenas
Strait of Magellan
SOUTH AMERICA
Easter Island and Isla Sala y Gomez are not shown.
0 200 400 km
0 200 400 mi
www.theodora.com/maps
San Pedro de Atacama
ALMA Operations Site
AOS (5000m altitude)
Operations Support Facilities
OSF (2900m altitude)
Toconao

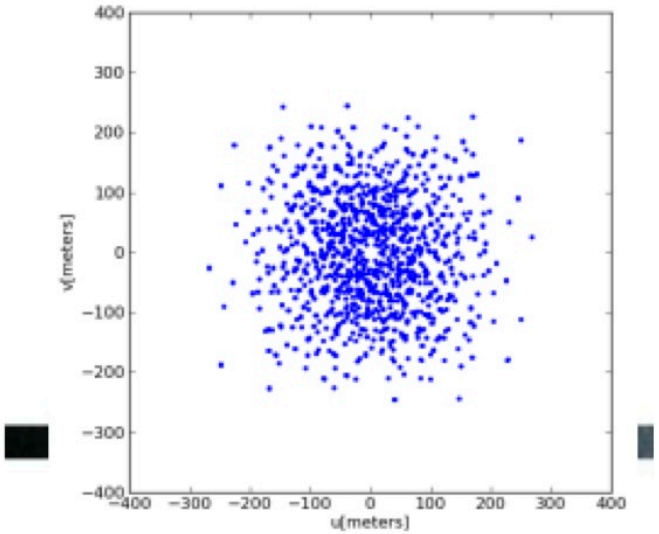
ATMOSPHERIC TRANSMISSION



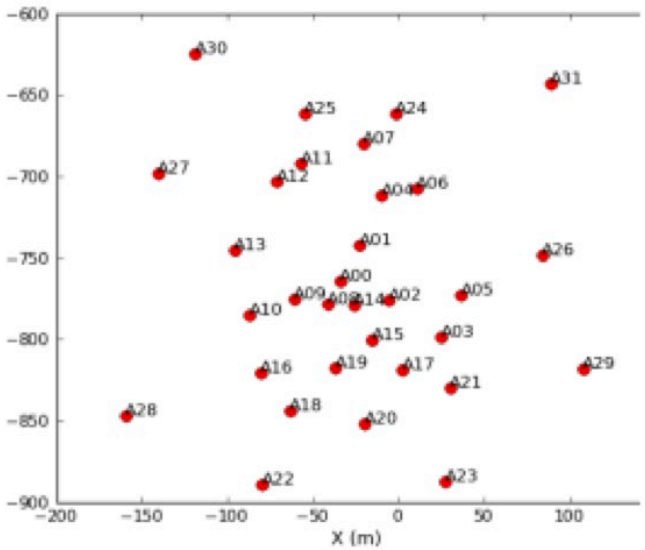
ALMA – 32 antennas

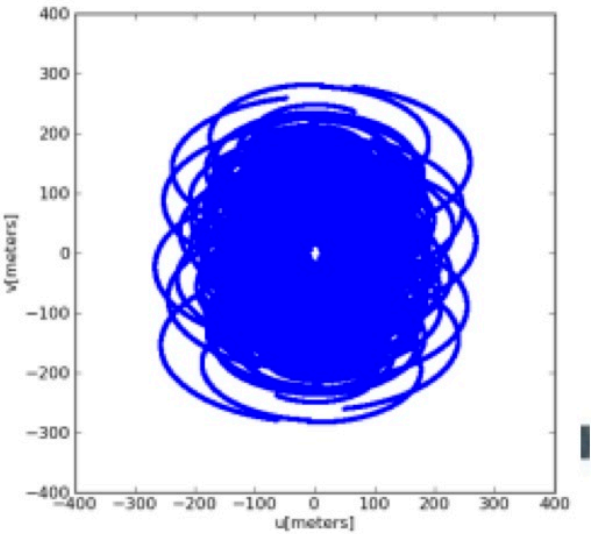
uv-distribution
intantaneous



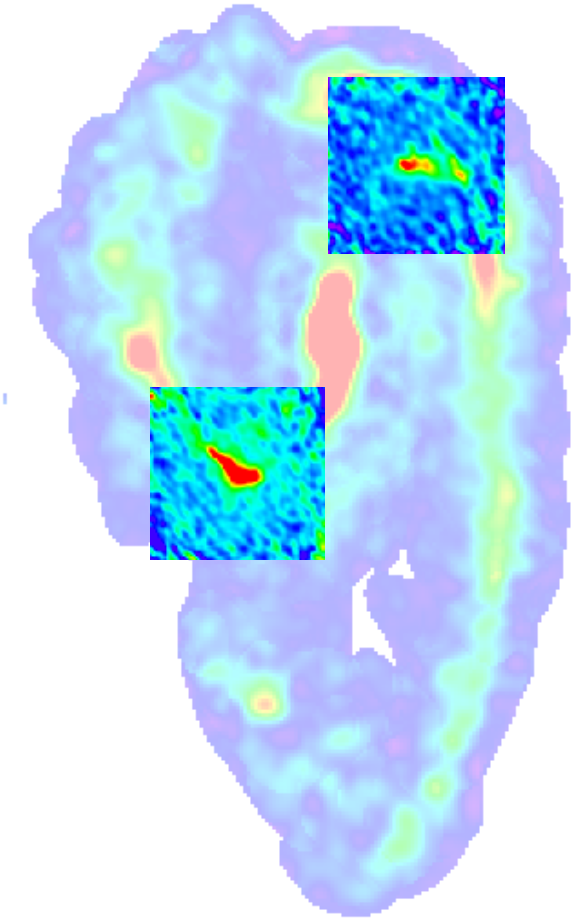


uv-distribution
after 8 hours

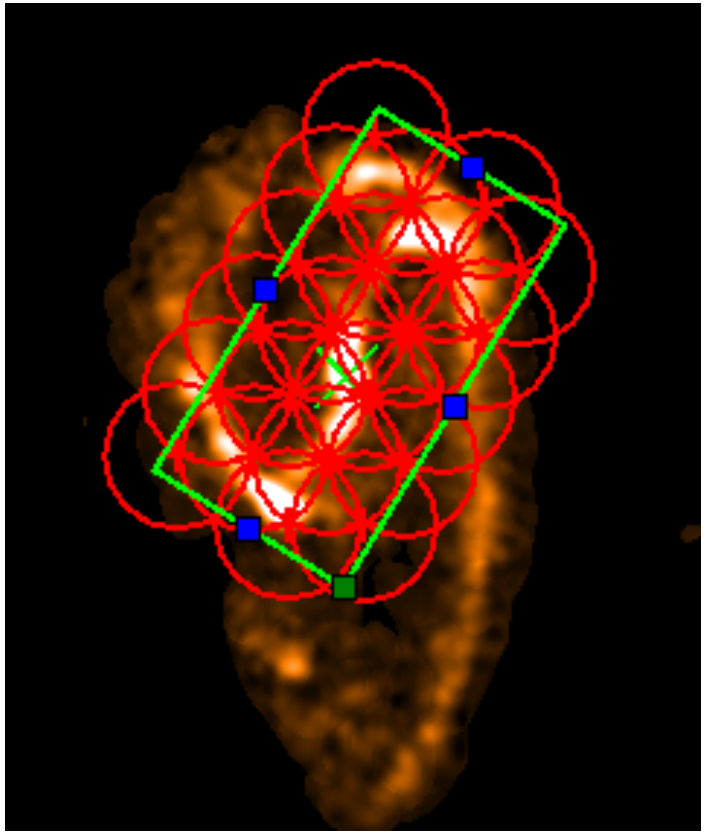




ALMA's incredible sensitivity: NGC3627 ALMA Cycle 3 proposal Rosita



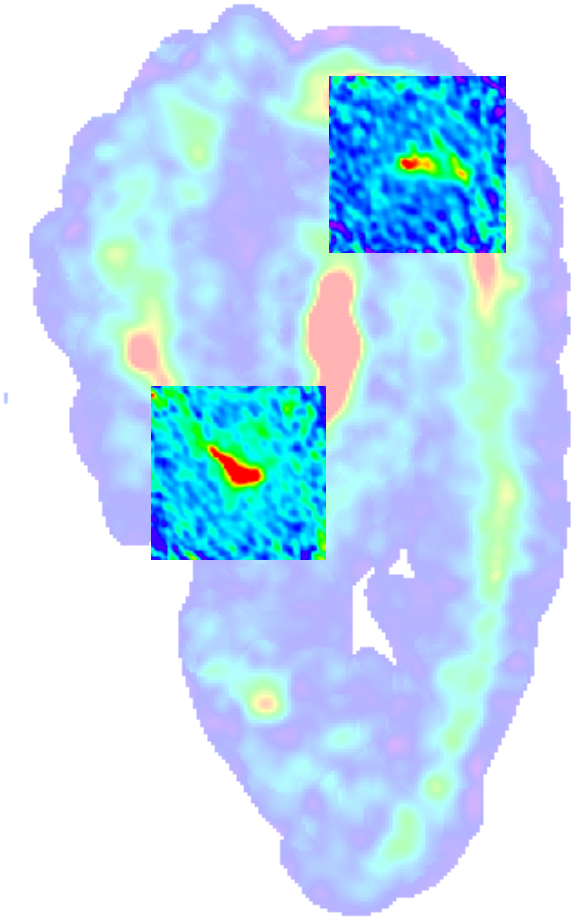
CO(1-0) with IRAM PdBI



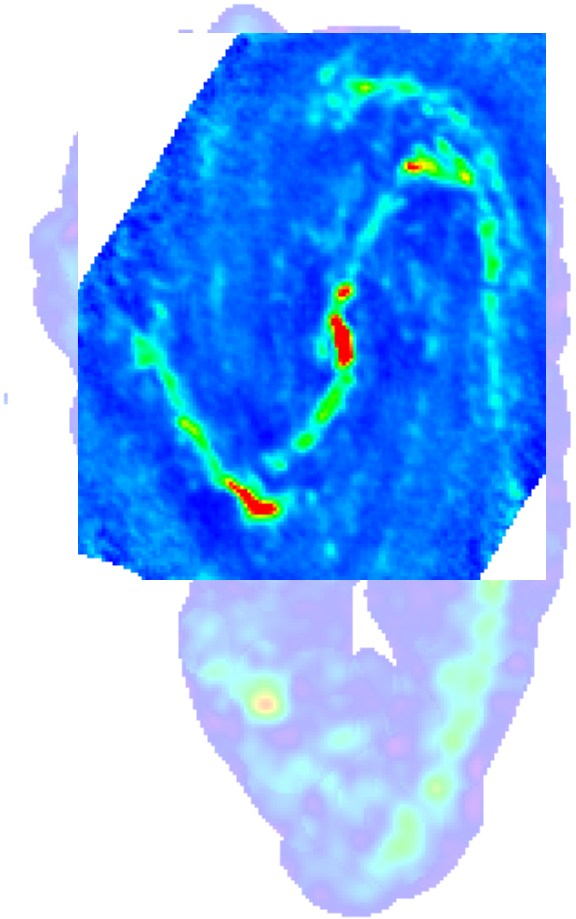
Proposal ALMA Cycle3
Mosaic of 22 pointings in band 3

Paladino et al., 2008 A&A 485

NGC3627 ALMA compact configuration data



CO(1-0) with IRAM PdBI
Resolution ~ 2 arcsec ~ 100 pc
8 hrs per pointing



CO(1-0) with ALMA
Resolution ~ 2 arcsec ~ 100 pc
Observing time 1.5 hrs

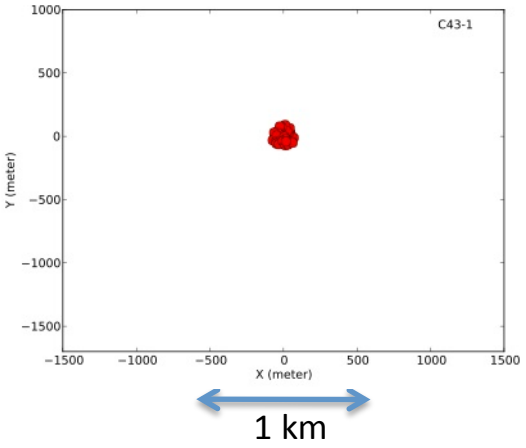
Paladino et al.

ARRAY CONFIGURATIONS

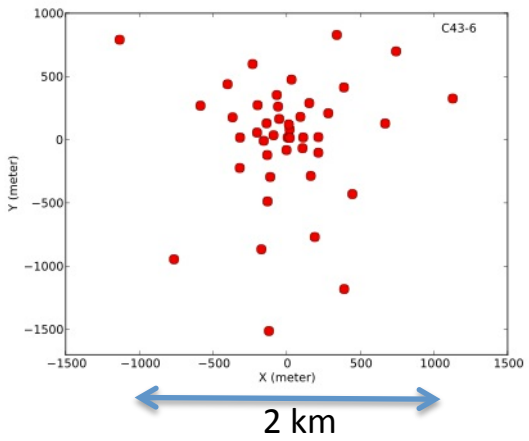
ALMA is a reconfigurable interferometer for (sub)mm astronomy.

There will be ca. 10 reconfigurations during Cycle7 at the end of which the array is expected to have imaging properties similar to one of the ten representative configurations used to characterize the advertised imaging capabilities and to estimate the observing times. Some configurations are visited more than once.

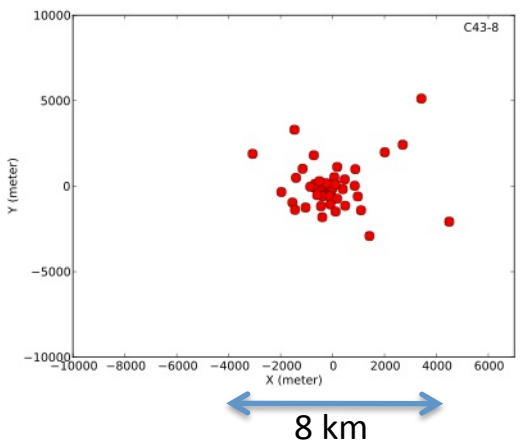
C43-1 15-161 m



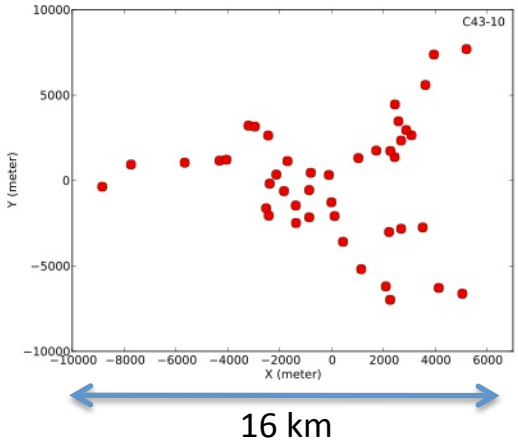
C43-6 15-2500 m



C43-8 110-8500 m



New configuration every 3-4 weeks.



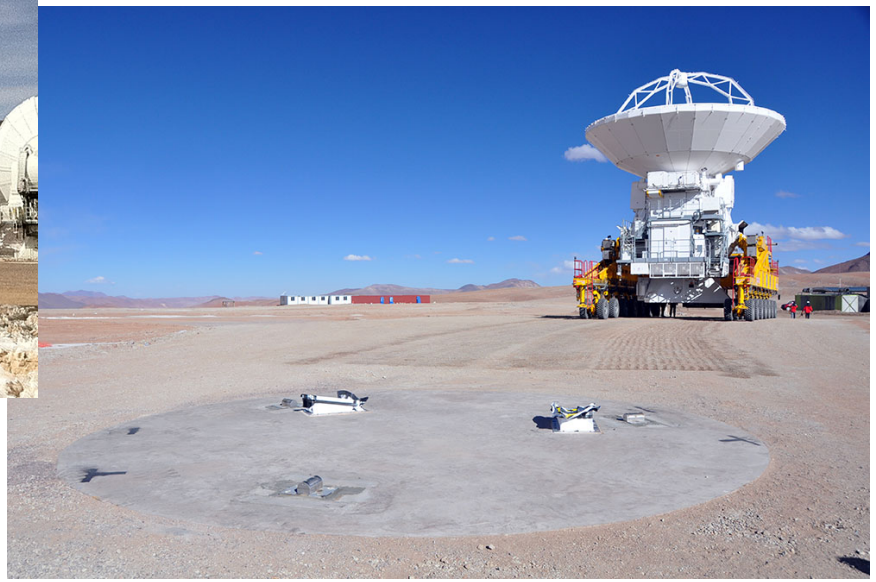
C43-10

244-16200 m

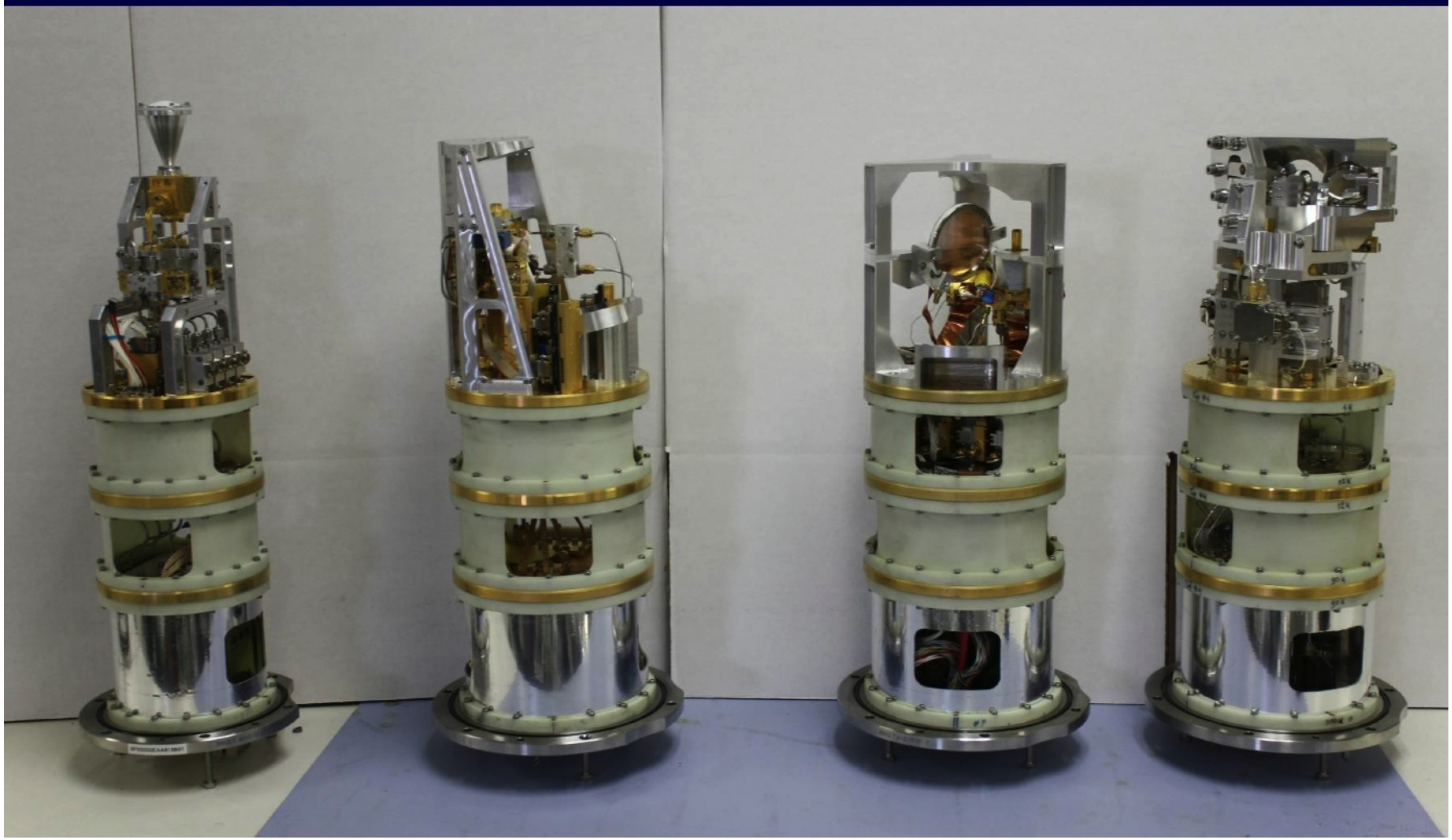
The ALMA Antenna Transporter

ESO Press Photo 45b/07 (5 October 2007)


First Move of an ALMA Antenna
(July 8, 2008)



Bands 3 (84-116 GHz), 6 (211-275 GHz), 7 (275-373 GHz), and 9 (602-720 GHz) SIS "cartridges"



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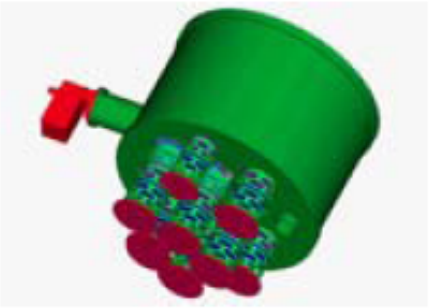
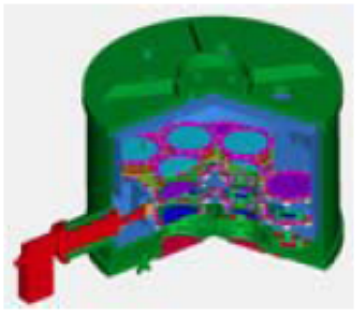
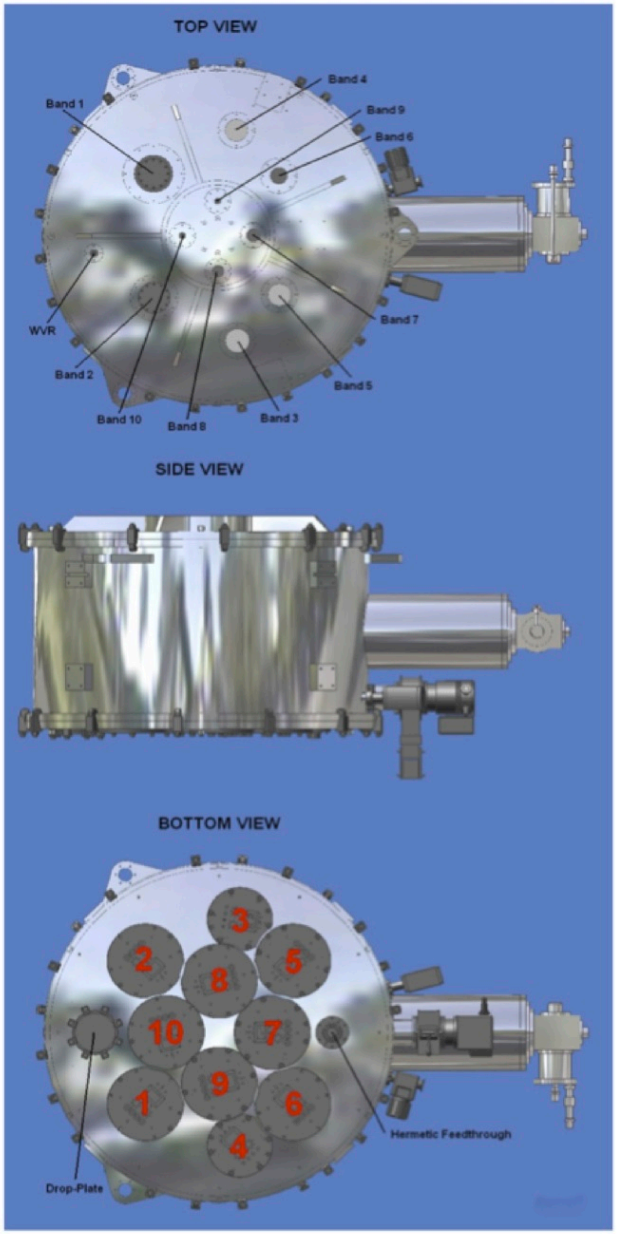
Front End Design







- Diameter ~ 1 m
- External optics top of dewar
- 10 Cartridges plugged from bottom
- Each cartridge contains one frequency

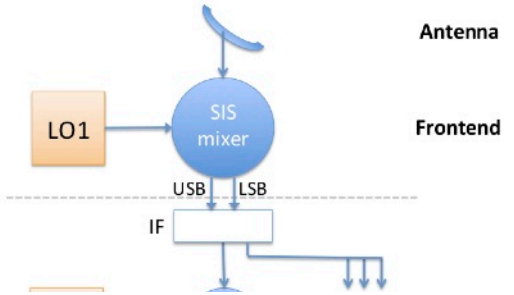
Spectral setup: sidebands, basebands & spectral windows

Observed sky frequencies need to be down-converted before being sent to the correlator.

For this to occur, the signal from the source is mixed with that of a (set of) Local Oscillator(s) which results in the creation of 2 sidebands, 'upper' and 'lower':

For the lower sideband (LSB): (F_{LO1} - IF_{lo}) to (F_{LO1} - IF_{hi})
For the upper sideband (USB): (F_{LO1} + IF_{lo}) to (F_{LO1} + If_{hi})

NB: for <u>both</u> polarizations!



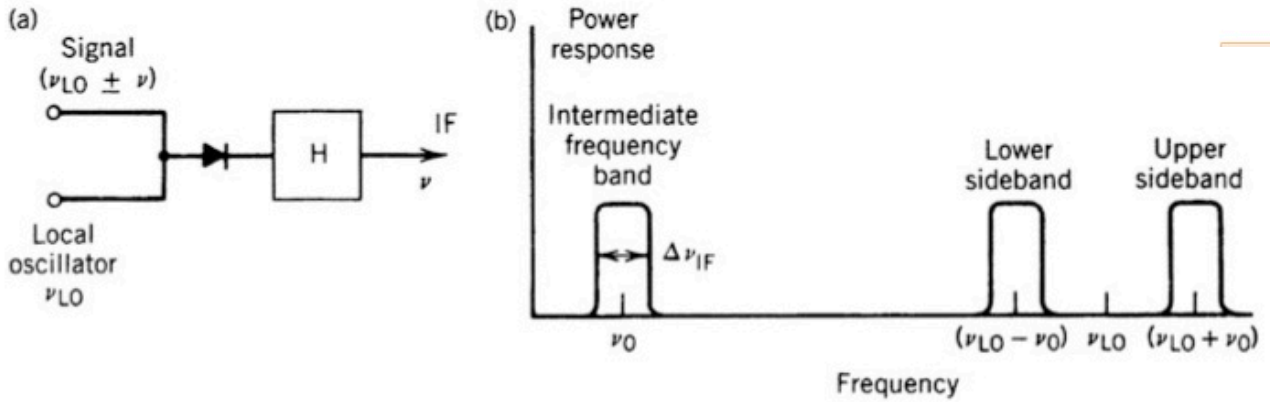


Fig. 6.1 Frequency conversion in a radio receiving system. (**a**) Simplified diagram of a mixer and a filter H that defines the intermediate-frequency (IF) band. The nonlinear element shown is a diode. (**b**) Signal spectrum showing upper and lower sidebands that are converted to the IF. Frequency ν_0 is the center of the IF band.

Spectral setup: sidebands, basebands & spectral windows

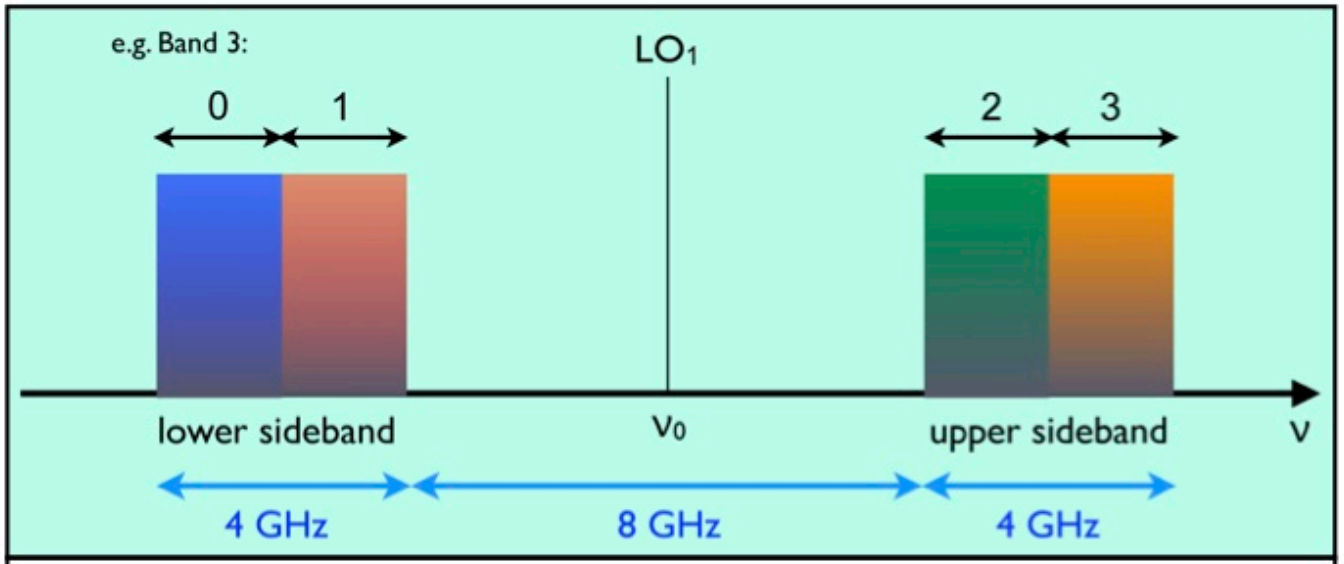


Figure 31: *A graphical view of basebands and sidebands. Basebands may be tuned to overlap if the user wishes, or may be located so as to maximize the total bandwidth (as shown). Each baseband may be further subdivided into as many as 8 spectral windows. Up to four spectral windows per baseband will be available during Cycle 6.*

Within these sidebands, ALMA produces 4 x 2 GHz basebands that can be placed inside each sideband.

NB: basebands are not independent: overlapping BBs do not reduce noise

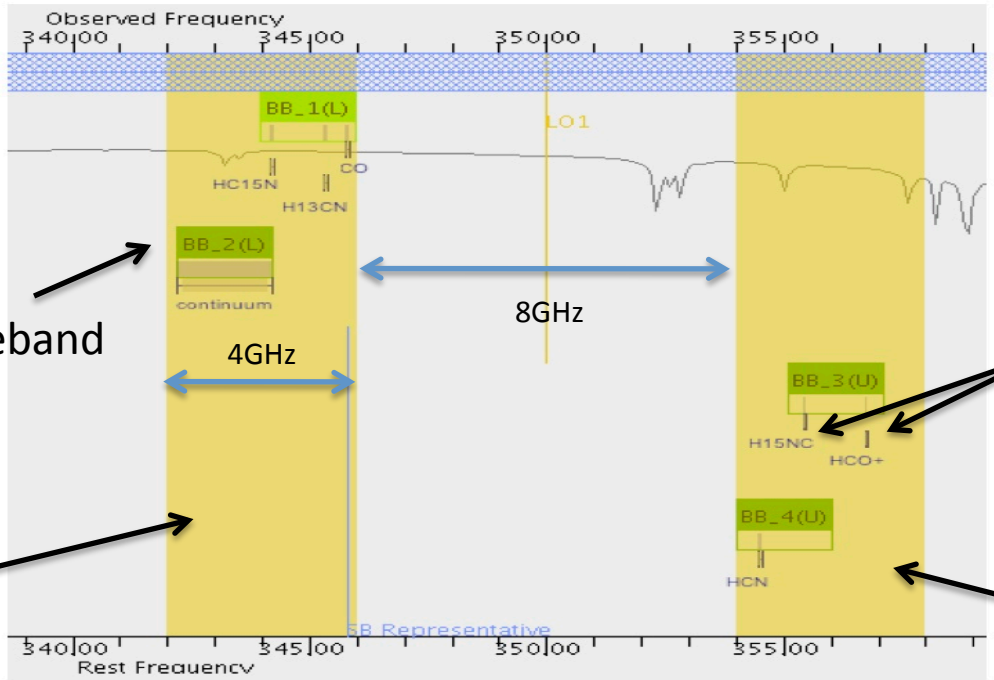
Spectral setup: sidebands, basebands & spectral windows

Bandwidth (MHz)	Spectral res (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

Continuum (BW_{tot} = 7.5GHz)

Spectral lines

Full Stokes => half the channels.
Single pol (instead of Dual): double the channels.



Baseband

LSB

spw Within each baseband up to 4 spectral windows can be placed to observe lines or continuum.

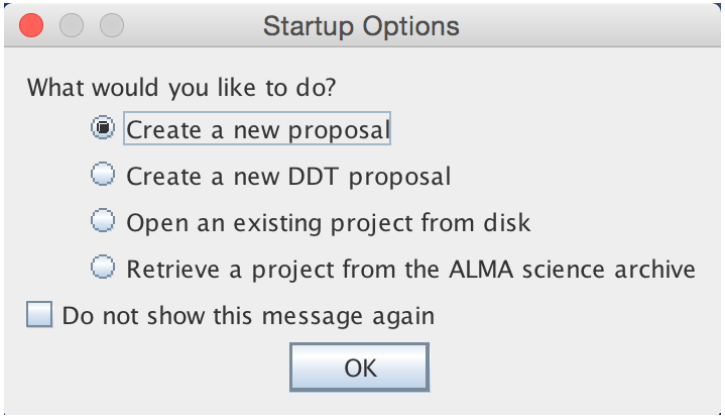
USB

Cycle 7 -- Important dates

Date	Event
19 March 2019	Release Call for Proposals Cycle 7 + Documentation & Tools
17 April 2019	**Proposal submission deadline**
End of July 2019	Announcement outcome review process
September 2019	**Submission Phase2 material by PI's** **Release ACA supplemental Call [3/9]**
October 2019	Start observations Cycle 7 **Deadline ACA supplemental Call [1/10]**
September 2020	End of Cycle 7

Starting up the OT to write your proposal

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



(See talk by Giannetti & Marchili)

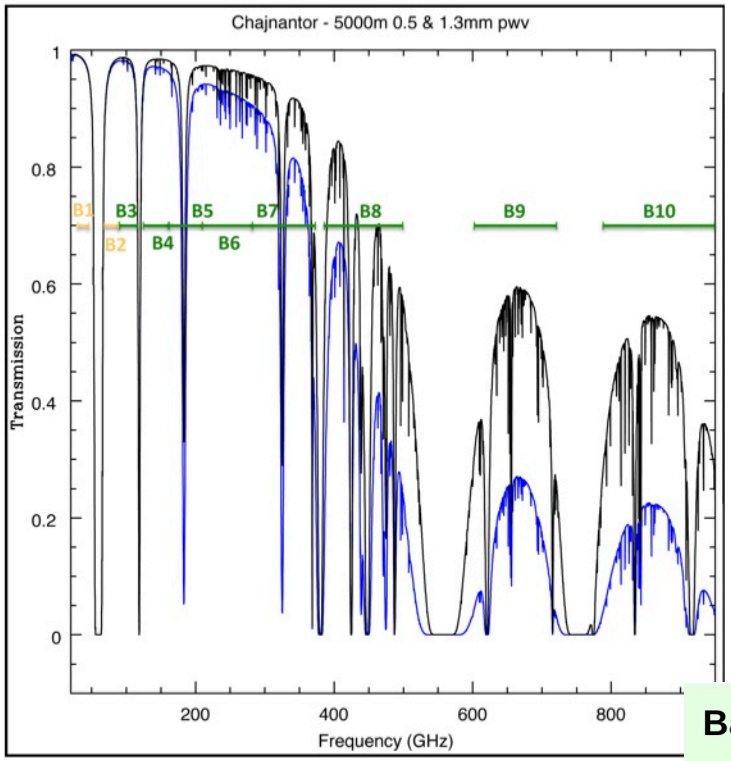
CYCLE 7: What's Available

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: **4300 hrs with 12-m array + (3000 + 750) hrs ACA**
[PI+DDT+Cycle6 priority A carry-overs]
Feb 2020 not available

≤ 20% non-standard (including ≤ 5% mm-VLBI)
≤ 15% Large Programs (i.e. 645h 12-m array; 450h ACA stand-alone)
≤ 5% DDT



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 7: observing modes

- **Spectral line and continuum observations in all bands**
  with the 12-m Array and the 7-m Array

- **Standard mode for spectral scan (25% faster)** **NEW**

- **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).

- **Solar observing mode**; Bands 3, 6 and 7. Only scheduled in certain periods.

- **Simultaneous observations** ACA and main array

CYCLE 7 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 7 will be allocated to proposals requesting **non-standard modes**, which include:

- **Band 9 and 10 observations**
- **Band 7** observations with maximum baselines **> 5 km** if calib > 5^{o} away
- **All polarization observations**
- **Bandwidth switching projects** (less than 0.9375 GHz aggregate bandwidths over all spectral windows)
- **Solar observations**
- **VLBI observations**
- **User-specified calibrations**
- **Astrometry**

How much time can you ‘safely’ ask for?

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

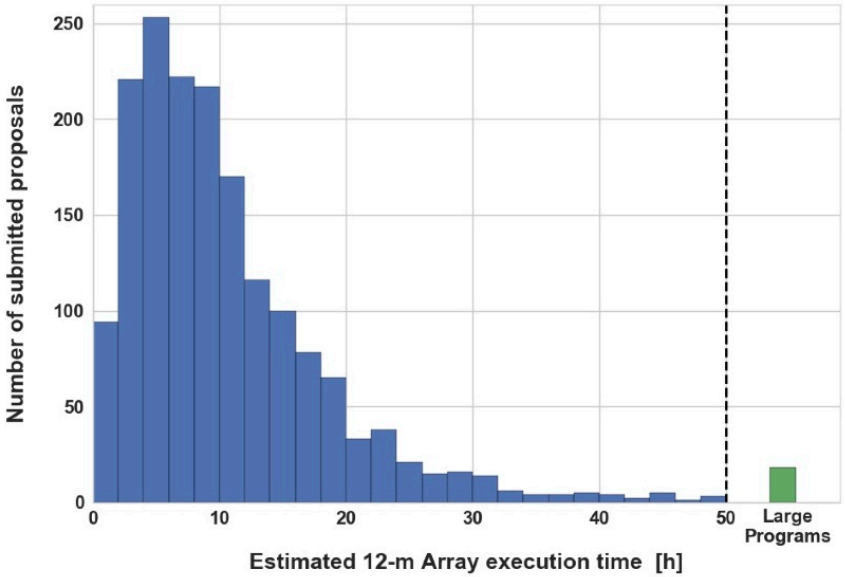
Cycle	Antennas	Hours	hours/ prop	50% asked for < than
6	>43	4000	10.7	10 hrs
5	>43	4000	9.65	9
4	>40	3100	7.8	6
3	>36	2100	5.6	5
2	>34	2000	n.a.	n.a.
1	>32	800	n.a.	n.a.
0	>12	800	n.a.	n.a.

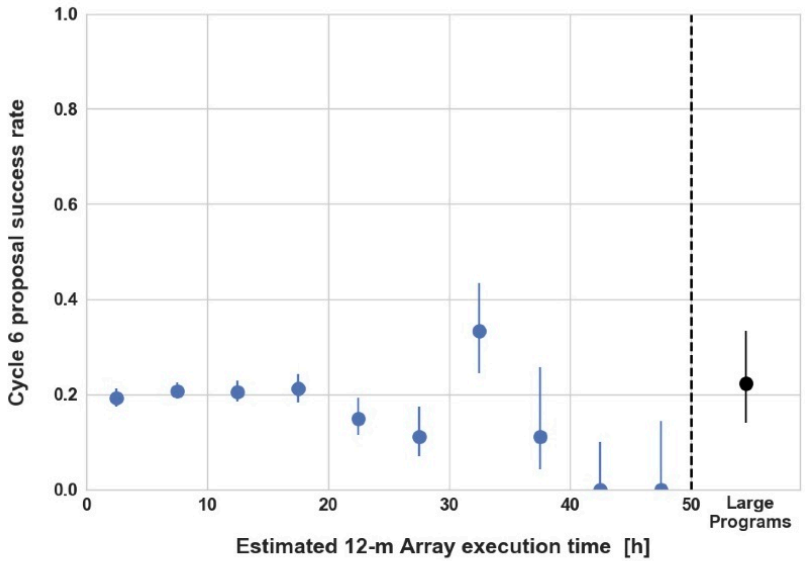
CYCLE 7: PROPOSAL TYPES

- **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 6 proposals is between two and ten hours of 12-m Array time.

The success rate of proposals was roughly constant up to about 30-40 hours of requested 12-m Array time

CYCLE 7: 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; continuum only
  Band 3 in concert with Global Millimeter VLBI Array (**proposal deadline 1/2/19**);
  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 2020, 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:
  645 hrs for the 12-m Array and 450 hrs for ACA stand-alone
  scheduling constraints based on LST and configs **(consult documentation)**

Be aware of

resubmissions – automatically recognized by OT

and

duplications.

To avoid duplications, consult the archive
See also **https://almascience.eso.org/proposing/duplications**

For more on the archive and the analysis of archival data,
see talks by Massardi & Rygl and by Burkutean & Massardi

Longest baselines (C-9 & C-10) are NOT offered in Cycle 8 [10/2010 – 9/2021]

Apply for them in Cycle 7 or wait until Cycle 9.

In Cycle 7, C-9 & C-10 will be scheduled in July – August 2020

Cycle 7

Start date	Configuration	Longest baseline	LST: Best conditions
1-Oct-19	C-4	0.78 km	22-10
20-Oct-19	C-3	0.50 km	23-11
10-Nov-19	C-2	0.31 km	1-13
30-Nov-19	C-1	0.16 km	2-14
20-Dec-19	C-2	0.31 km	4-15
10-Jan-20	C-3	0.50 km	5-17
1-Feb-20	No observations due to maintenance		
1-Mar-20	C-4	0.78 km	8-21
20-Mar-20	C-5	1.4 km	9-23
20-Apr-20	C-6	2.5 km	11-1
20-May-20	C-7	3.6 km	13-3
20-Jun-20	C-8	8.5 km	15-5
11-Jul-20	C-9	13.9 km	16-6
30-Jul-20	C-10	16.2 km	17-7
20-Aug-20	C-9	13.9 km	19-8
10-Sep-20	C-8	8.5 km	20-9

Cycle 8

Start date	Configuration	Longest baseline	LST: Best conditions
1-Oct-20	C-8	8.5 km	22-10
20-Oct-20	C-7	3.6 km	23-11
10-Nov-20	C-6	2.5 km	1-13
1-Dec-20	C-5	1.4 km	2-14
20-Dec-20	C-4	0.78 km	4-15
10-Jan-21	C-3	0.50 km	5-17
1-Feb-21	No observations due to maintenance		
1-Mar-21	C-1	0.16 km	8-21
26-Mar-21	C-2	0.31 km	9-23
20-Apr-21	C-3	0.50 km	11-0
10-May-21	C-4	0.78 km	12-2
31-May-21	C-5	1.4 km	13-4
23-Jun-21	C-6	2.5 km	15-6
28-Jul-21	C-5	1.4 km	17-7
18-Aug-21	C-4	0.78 km	19-8
10-Sep-21	C-3	0.50 km	20-9

Cycle 9

Start date	Configuration	Longest baseline	LST: Best conditions
1-Oct-21	C-3	0.50	22-10
20-Oct-21	C-2	0.31	23-11
10-Nov-21	C-1	0.16	1-13
30-Nov-21	C-2	0.31	2-14
20-Dec-21	C-3	0.50	4-15
10-Jan-22	C-4	0.78	5-17
1-Feb-22	No observations due to maintenance		
1-Mar-22	C-4	0.78	8-21
20-Mar-22	C-5	1.4	9-23
20-Apr-22	C-6	2.5	11-1
20-May-22	C-7	3.6	13-3
20-Jun-22	C-8	8.5	14-5
11-Jul-22	C-9	13.9	16-6
30-Jul-22	C-10	16.2	17-7
20-Aug-22	C-9	13.9	19-8
10-Sep-22	C-8	8.5	20-9

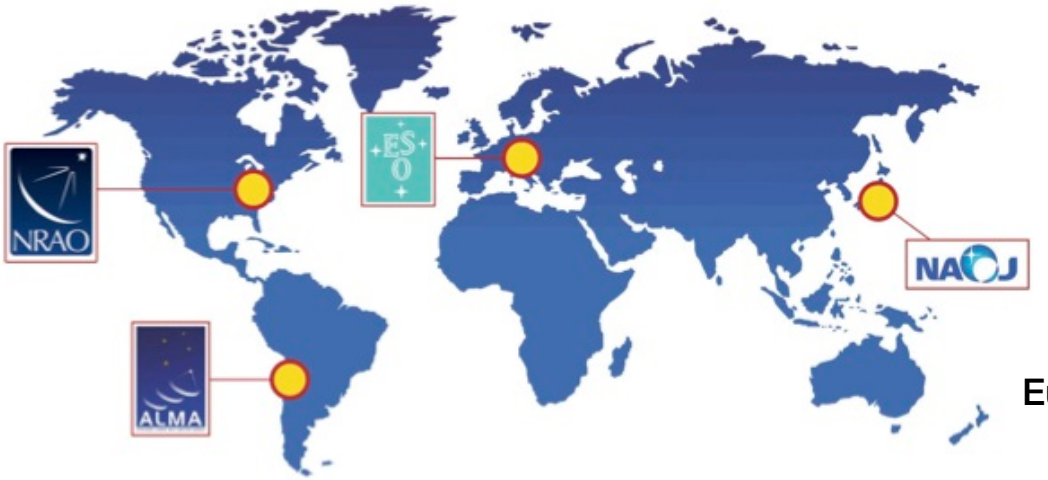
Getting help

USER GUIDES

VIDEO TUTORIALS

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

ORGANIZATIONAL STRUCTURE



Joint ALMA Observatory:

Europe (ESO): 33.75%
North America (NRAO): 33.75%
East Asia (NAOJ): 22.5%
Chile: 10%

In Europe:
A network of 7 ARC-nodes and
1 Centre of Expertise, coordinated
by the central node at ESO.

Contact us via our helpdesk:
helpdesk@alma.inaf.it

We provide support with writing your proposals.

We follow accepted projects as Contact Scientist and act as intermediate between PI and JAO.

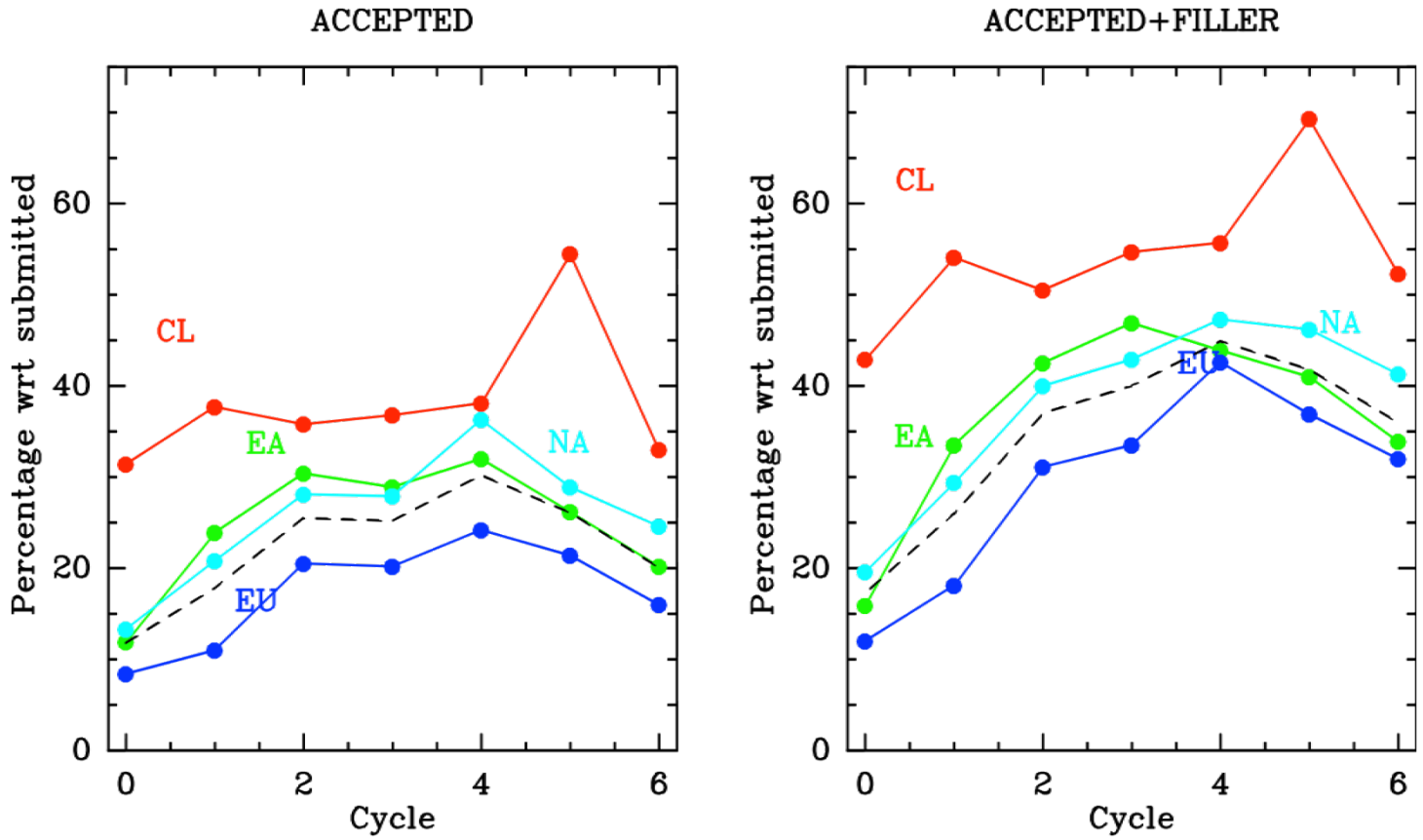
We also assist with data reduction if requested.

Come find us also for science support and collaborations!

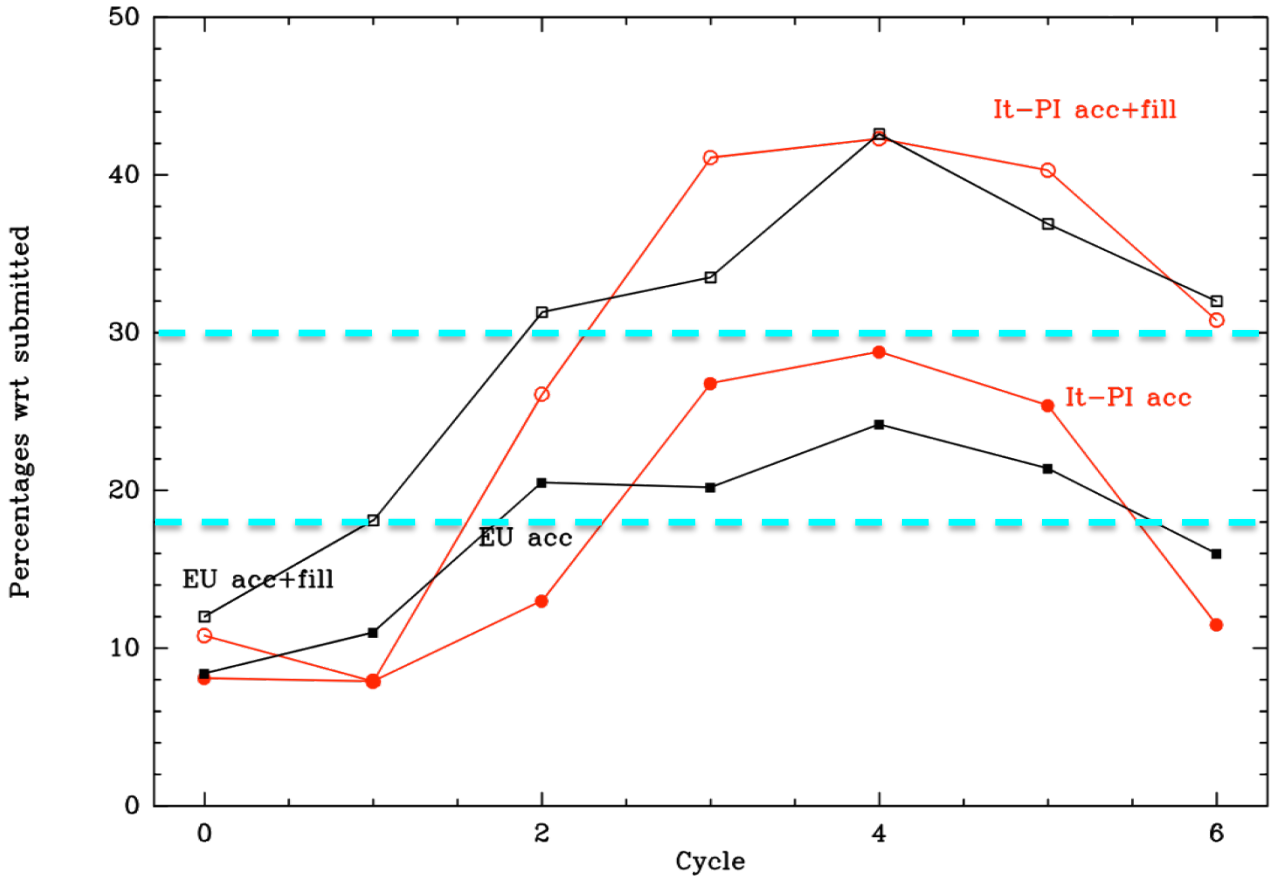
Visit our webpages at:
http://arc.ia2.inaf.it

Proposal statistics per Executive / Partner

Europe: 33.75%
North America: 33.75%
East Asia: 22.5%
Chile: 10%



Proposal statistics for Europe and Italian PI's

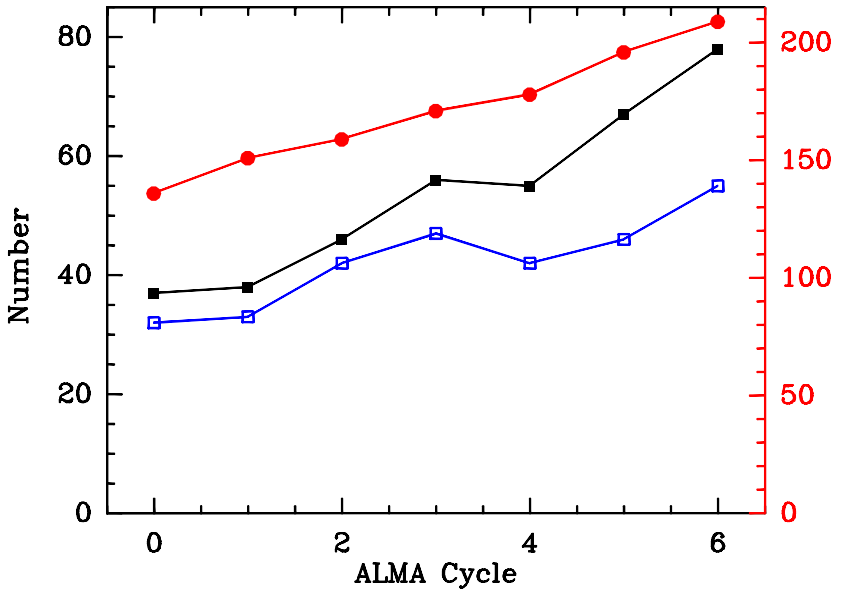


NB: people tend to ask more hours/proposal. Trend in hours is flatter.

Over 7 Cycles: It-PI's got 17.4% of their proposals accepted A+B; 28.5% incl. C (31.9% excl. Cycle1)
For EU these numbers are 17.4% and 29.5%.
Over 7 Cycles: It-PI's submitted 8.7% of all EU proposals. Of all accepted EU proposals, 8.1% are with It-PI (8.8% excl. Cycle1)

Proposal statistics for Italian PI's

Submitted proposals

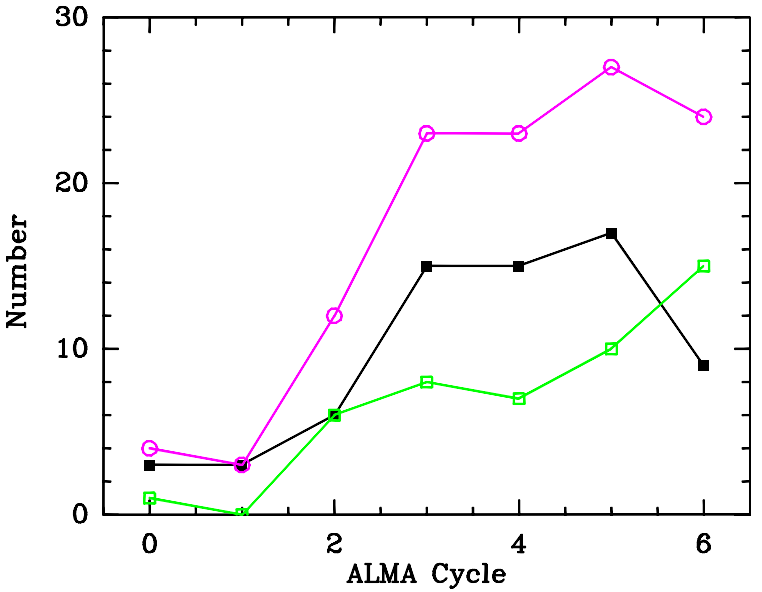


Unique Co-I's

Submited proposals

Unique PI's

Accepted proposals



Accepted proposals (A+B+C)

Accepted proposals (A+B)

Accepted proposals (C)

EUROPEAN ARC
ALMA Regional Centre || Italian

http://arc.ia2.inaf.it