

Overview of ALMA capabilities

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What is ALMA?

- ALMA = Atacama Large Millimeter/submillimeter Array
- **Imaging and spectroscopic** instrument operating at millimetre/submillimetre wavelengths
- The main scientific objectives are the origins of galaxies and the origins of stars and planets
- ALMA is 10-100 more sensitive and has 10-100 times better angular resolution than its predecessors
- ALMA is built and operated by Europe (ESO), North-America (NRAO) and East-Asia (NAOJ)



A global project

- * ALMA Partners: Europe, North America, East Asia
- * Chile is the host country and Chilean astronomers have 10% of the observing time
- * More than 20 countries are involved in ALMA
- * Construction cost: US \$1600 millions



**Inaugurated 13 March 2013
Five years ago!**

ALMA Cycle 6 timeline

ALMA Cycle 6

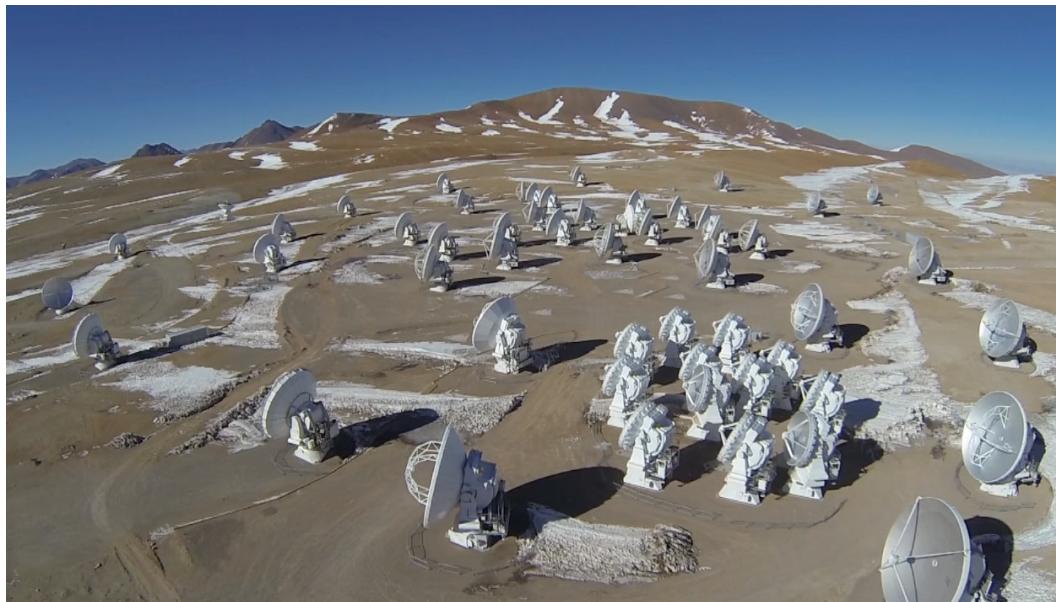
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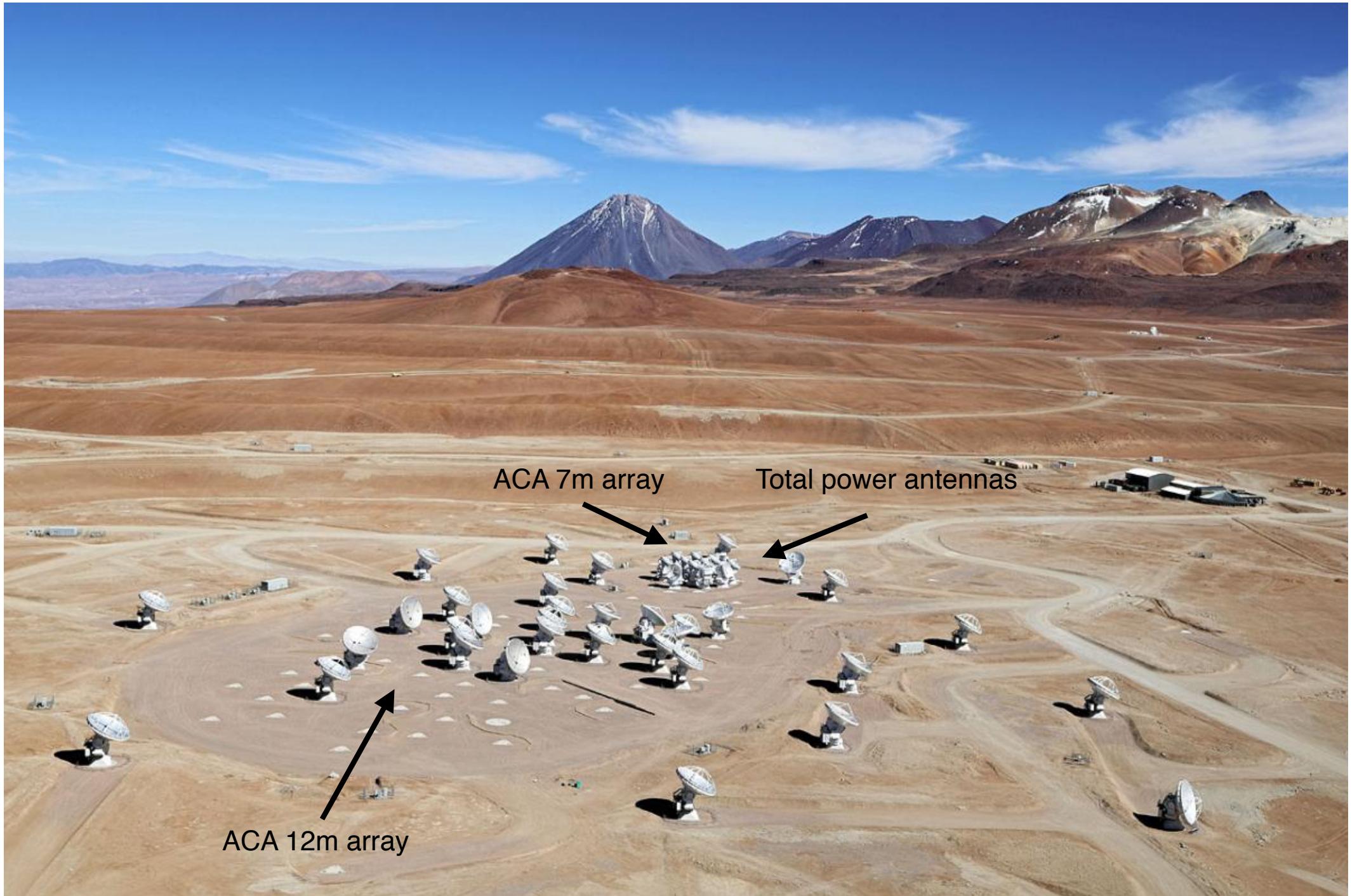
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ALMA: three arrays

- ALMA has three subarrays that observe different-sized structures:
 - The main array (43+ antennas with 12m diameters)
 - The Atacama Compact Array (10 antennas with 7m diameters)
 - The total power antennas (3 antennas with 12m diameters)

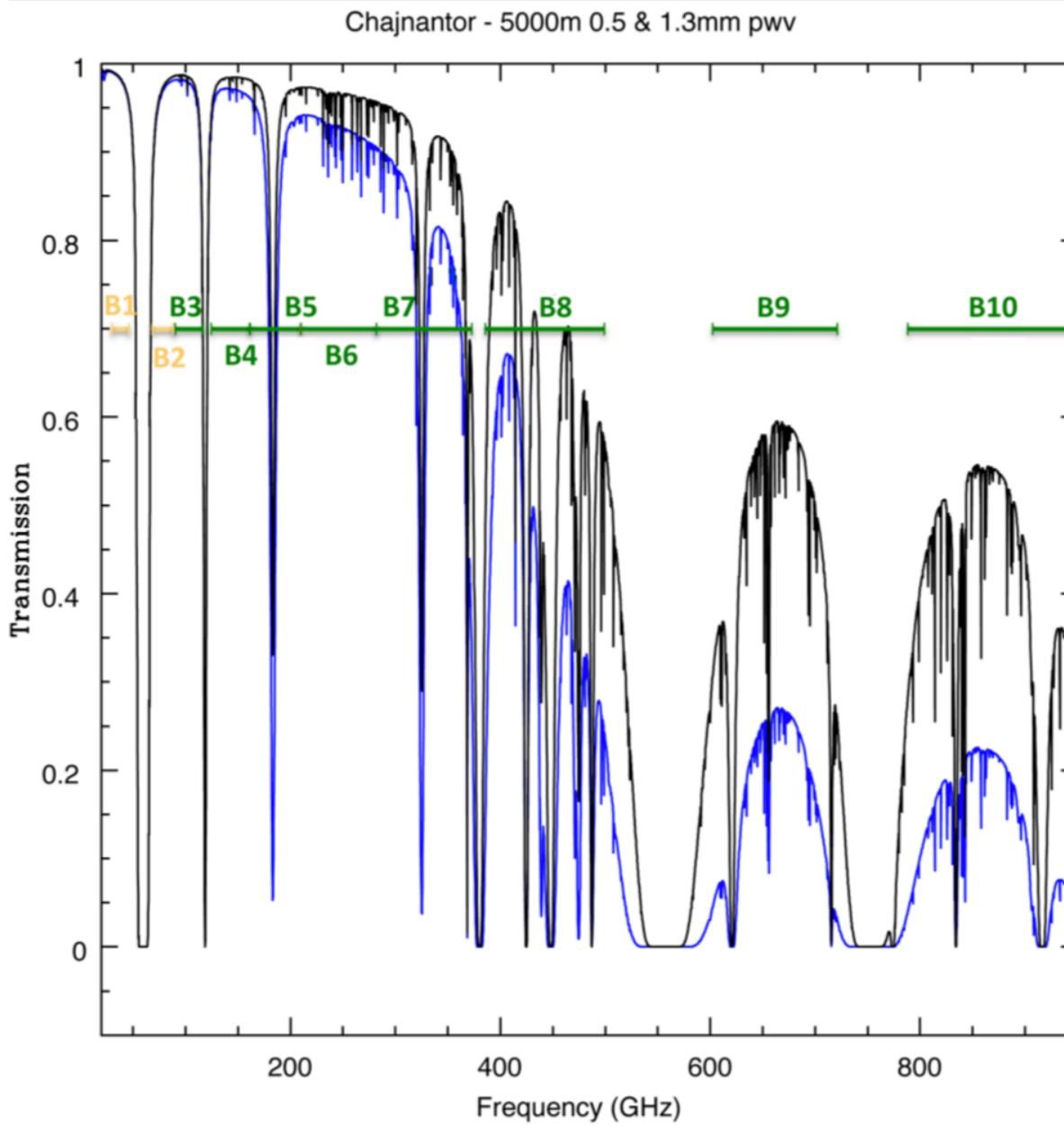




Cycle 6 capabilities summary

- At least **43 antennas** in the 12-m Array, plus ten 7-m and three 12-m antennas in the ACA
- Receiver **Bands 3 to 10**, covering 84 to 950 GHz (3.6 cm to 300 μ m)
- Baselines **up to 16 km** for Bands 3 - 6; up to 8.5 km for Band 7; and up to 3.6 km for Bands 8, 9 & 10
- **Single field interferometry** in all bands **and mosaics** at bands 3 through 9
- **Full polarization capability**, including circular polarization, at Bands 3 through 7 in both continuum and spectral line mode
- Solar observations and millimeter-wavelength VLBI at Bands 3 and 6
- **Mixed correlator modes** allowing both high- and low-spectral resolution in the same observation

Frequency coverage



Band	Frequency range ¹ (GHz)
3	84 – 116
4	125 – 163
5	158 – 211
6	211 – 275
7	275 – 373
8	385 – 500
9	602 – 720
10	787 – 950

Typical spectral resolutions

- Typically **1 km/s** \times (300/v GHz)
- As narrow as **0.015 km/s** \times (300/v GHz) (R=20,000,000)
- A total **bandwidth** of 8 GHz can be observed (=24000 km/s in band 3)
- Up to ~16000 **channels** (= spectral resolution elements)
- “The **back-end** is very flexible”: user can select many overlapping or disjoint spectral regions with different resolutions

Typical spatial resolutions of main array

- in a compact configuration (161 m):
 - ▶ from 0.4" at 870 GHz to 3" at 100 GHz
- in most extended configuration:
 - ▶ 0.042" at 100 GHz (16 km maximum baseline)
 - ▶ 0.024" at 870 GHz (3.6 km maximum baseline)
- ▶ **Angular resolution: $0.2'' \times (300/f \text{ GHz}) \times (1 \text{ km} / \text{max. baseline})$**

*This is the **synthesized beam**: the inverse Fourier transform of a (weighted) $u-v$ sampling distribution: “**point spread function**”*

*The **primary beam** is the average of the response to incident power as function of the angle away from antenna axis: “**field of view**”. This is only dependent on frequency and antenna size, so independent of configuration.*

- ▶ For 300 GHz: primary beam=17"

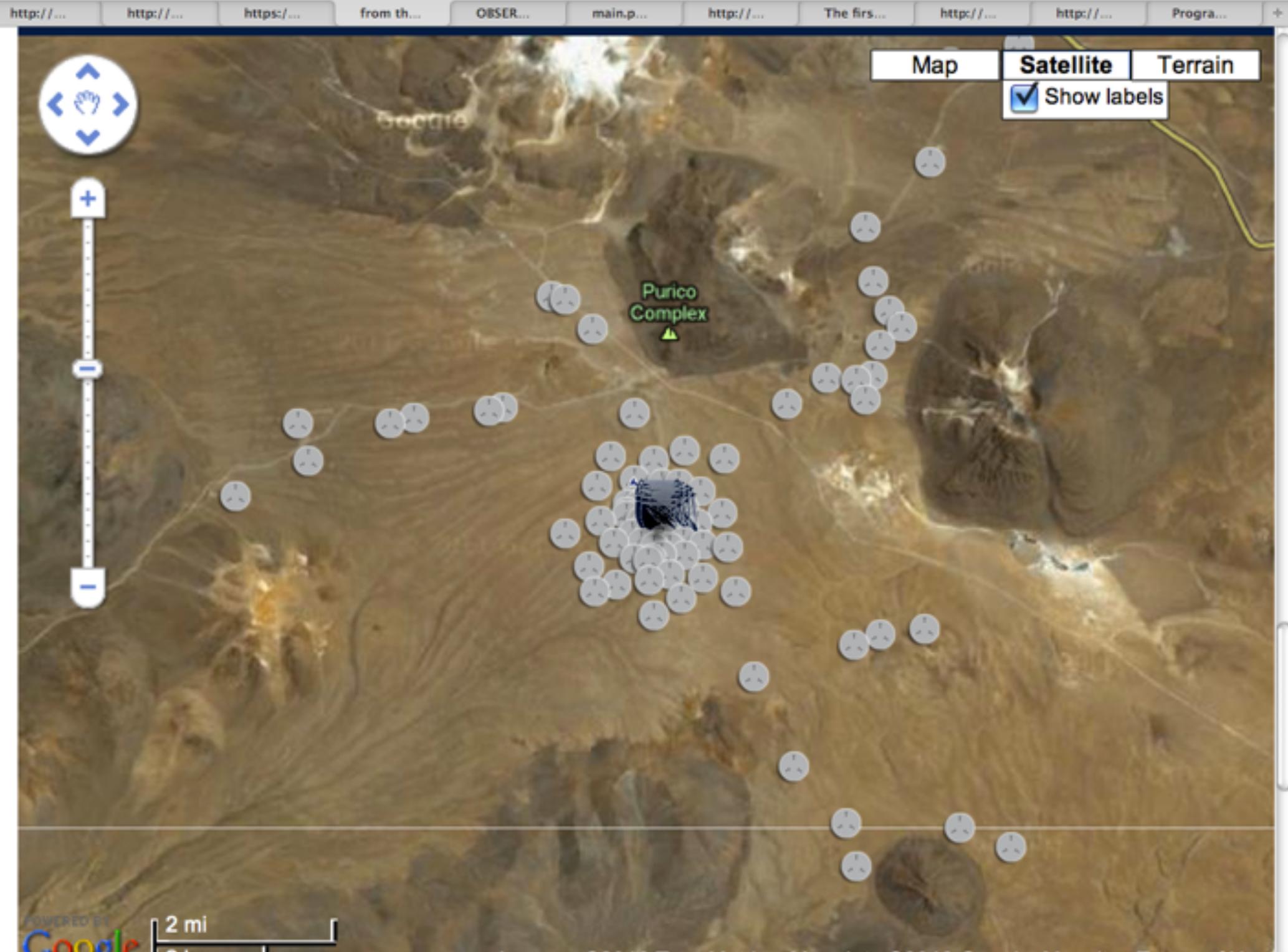


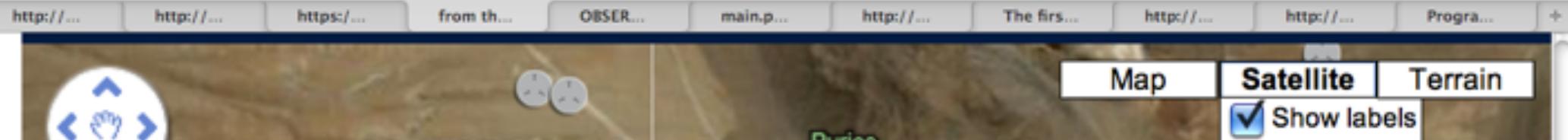
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Google

5 mi

5 km





Purico
Complex

Map

Satellite

Terrain

Show labels

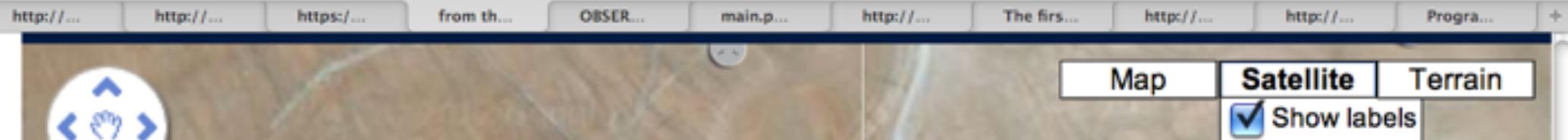


Map

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Google

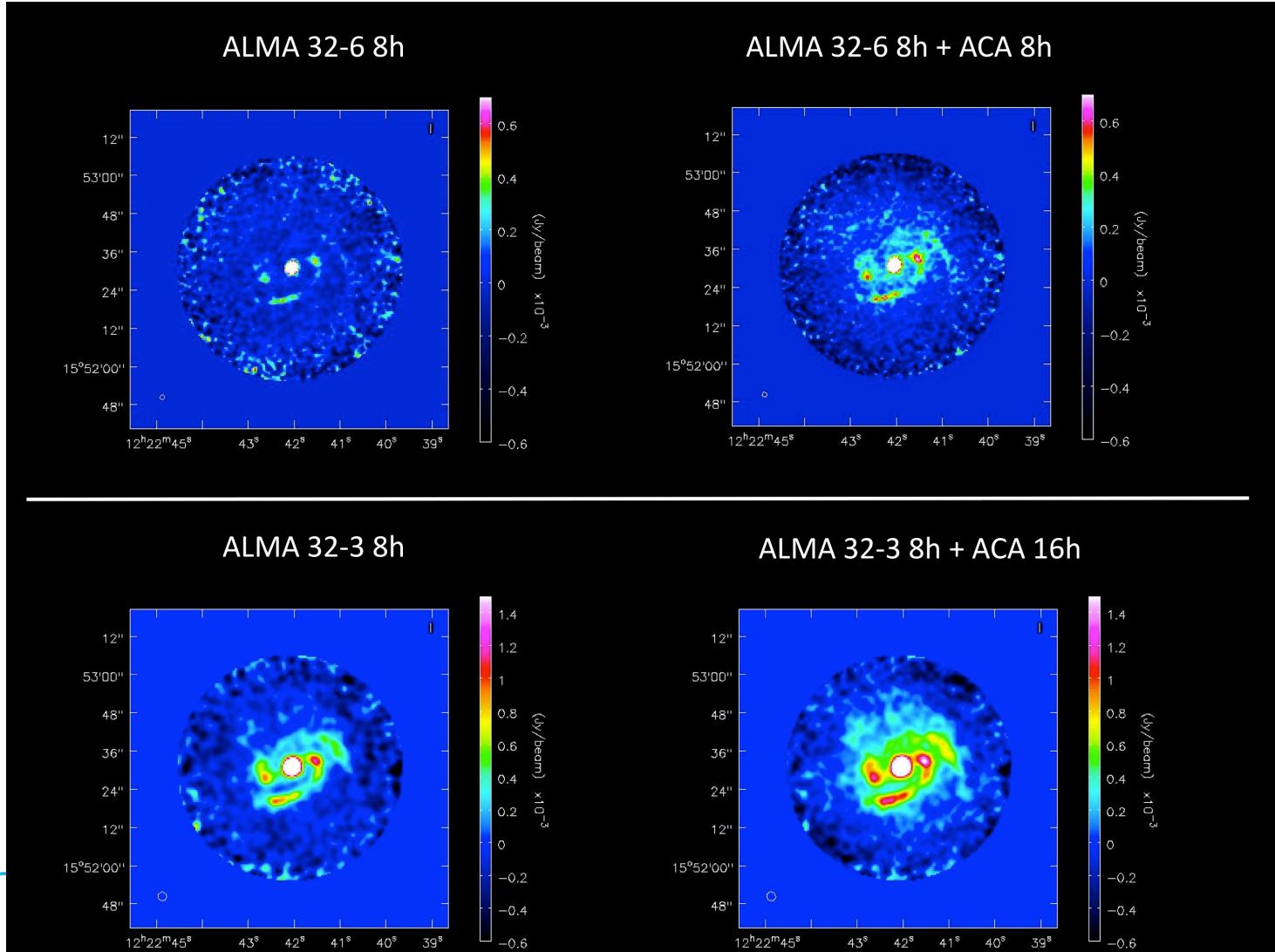
1000 ft

500 m | basemap ©2011 Google/Satellite Image, DigitalGlobe, GeoEye. Map data ©2012 Google. Maps, Inc. - Terms of Use





Combining different configurations to image different scales



Atacama Compact Array

- Consists of 7-m array and Total Power if necessary
- Can be paired with 12-m array or used in **stand-alone mode**
- Total Power antennas available
- Not all combinations between arrays allowed
- 3000 hours are available in Cycle 6
- See ‘Proposers Guide’

Most Extended configuration	Allowed Compact configuration pairings	Extended 12-m Array Multiplier	Multiplier if compact 12-m Array	Multiplier if 7-m Array needed	Multiplier if TP Array needed and
7-m Array	TP			1	1.7
C43-1	7-m Array & TP	1		7.0	11.9
C43-2	7-m Array & TP	1		4.7	8.0
C43-3	7-m Array & TP	1		2.4	4.1
C43-4	C43-1 & 7-m Array & TP	1	0.34	2.4	4.0
C43-5	C43-2 & 7-m Array & TP	1	0.26	1.2	2.1
C43-6	C43-3 & 7-m Array & TP	1	0.25	0.6	1.0
C43-4		1	0.23		

Total power (TP) array

- Used to recover extended emission when mapping angular scales up to the size of the requested map areas.
- TP Array observations are included only if the required angular scales cannot be achieved with the 7-m Array
- TP Array can be used
 - ONLY together with 7-m array and
 - ONLY for spectral line observations and bands 3 to 8
- No Band 9 or Band 10 TP Array observations are offered for this cycle

ACA

- Can be used as standalone as well
 - In bands 3 to 8
- Angular resolutions:

Config	Lmax		Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
	Lmin		100 GHz	150 GHz	183 GHz	230 GHz	345 GHz	460 GHz	650 GHz	870 GHz
7-m Array	45 m	AR	12.5"	8.4"	6.8"	5.4"	3.6"	2.7"	1.9"	1.4"
	9 m	MRS	66.7"	44.5"	36.1"	29.0"	19.3"	14.5"	10.3"	7.7"

- Can be used in Large Programs as well (> 150 hours)
 - 450 hours are available



Preparing

Doc 6.1, ver. 1 | March, 2018

Observing with ALMA – A Primer (Cycle 6)



Doc 6.2, ver.1.0 | March 2018

ALMA Cycle 6 Proposer's Guide



EUROPEAN
ALMA Region

Doc 5.3, ver. 1.0 | March 21, 2017

ALMA Cycle 5 Technical Handbook



EURO
ALMA

Doc 6.8, ver. 7.0 | March 2018

Guide to the European ALMA Regional Centre



Get help from the European ARC network

- **Face-to-face user support**

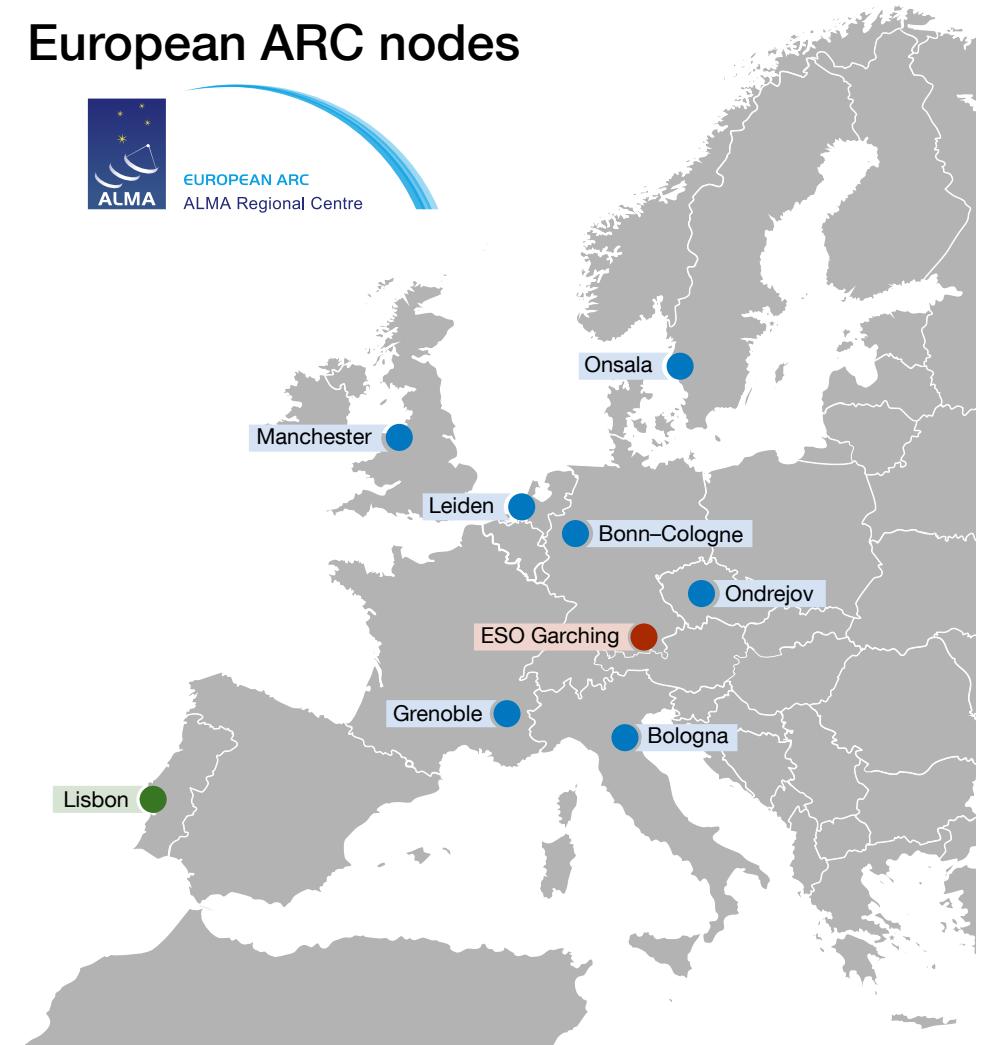
- proposal and SBs preparation
- data reduction,
- archive research

- **Community events**

- **Helpdesk support**

help.almascience.org

European ARC nodes



EUROPEAN ARC
ALMA Regional Centre

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Observatory News

Additional Information for Cycle 6 Proposals
Feb 01, 2018

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

Announcement of intent to release a new installment of Science Verification data
Jan 08, 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

[ALMA Cycle 5 Config Schedule](#)
[Latest Cycle 6 Proposal News Item](#)

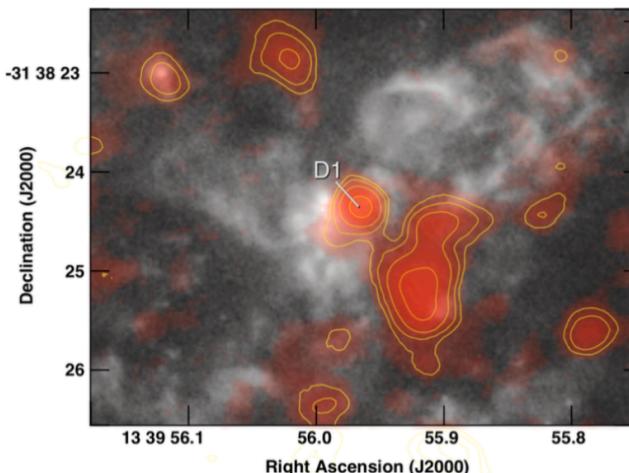
Refereed publications: 955

Last observed source: NGC3059

Current configuration: C43-5

[More...](#)

Science Highlights - Molecular Gas Within the Supernebula of the Dwarf Galaxy NGC 5253



One of the areas of extragalactic research which makes great use of ALMA's resolution and sensitivity is the study of the molecular gas properties of dwarf galaxies. In a [recent study](#) by Dr. Jean Turner and her collaborators, they make use of Band 7 ALMA observations to detect warm $^{12}\text{CO}(3-2)$ and $^{13}\text{CO}(3-2)$ emission (Cloud D1) from the core of a giant star-forming region, in the dwarf galaxy NGC 5253. This "supernebula" is the source of one-third of the galaxy's infrared luminosity and is in proximity to optical clusters with measured stellar ages of ~ 1 Myr. From radio recombination line analysis, the region is estimated to have 1400-1800 O stars..

[Full Summary...](#)

Good luck with your ALMA proposal!

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19 April 2018

Proposal deadline

2018

20 March 2018

Release of the ALMA Cycle 6 Call for Proposals and observing tool, and opening of archive for proposal submission

End of July 2018

Result of the proposal review process sent to Proposers

2019

September 2019

End of Cycle 6 observations



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