



EUROPEAN ARC
ALMA Regional Centre || Italian



ALMA REGIONAL CENTRE ITALY
is Bologna

Experience ALMA with The Italian ALMA Regional Centre

Jan Brand – INAF-IRA & ALMA Regional Centre, Italian node



28 November 2017

ICT-meeting, Bologna

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“ALMA” operates in the (sub-)mm region

ALMA observes the cool (10's – 100's K) universe – thermal radiation at (sub)mm wavelengths: dust (continuum) and molecules (rotational transitions).

... and we want to do that at a comparable angular resolution to that, attainable at other wavelengths.

In the optical/near-IR, for example, the ‘hot(ter)’ universe is observed at sub-arcsecond angular resolution.



Optical/near-IR

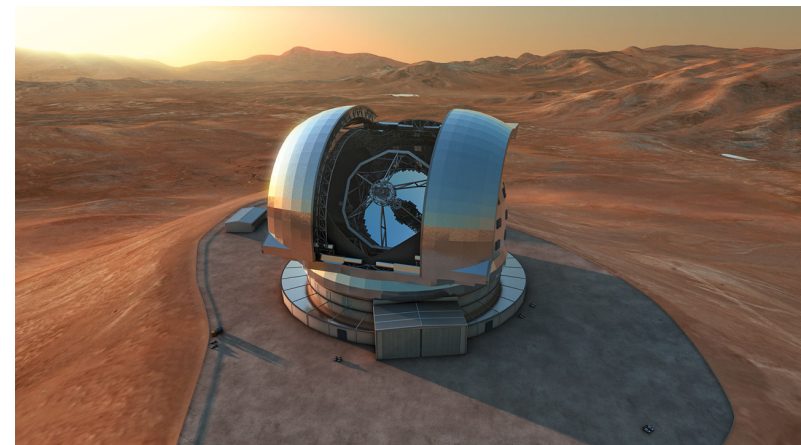


TNG 3.6-m
resolution \leq few $0''.1$ @ $2\mu\text{m}$ with AO

ELT 39-m
resolution $0''.005$ @ 500nm with AO



VLT 8.2-m
resolution $0''.05$ @ $2\mu\text{m}$ with AO





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millimeter
regime



KOSMA 3-m
resolution 130" @1 mm



IRAM 30-m
resolution 11" @1 mm



SEST 15-m
resolution 23" @1 mm



LMT 50-m
resolution 7" @1 mm

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To reach that kind ($\leq 0''.1$) of resolution at 1mm, an antenna would have to have a diameter of $\geq 2.5\text{km}$!



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Interferometry is a (the) solution: *simulate* a large antenna by observing with a number of *individual* antennas.

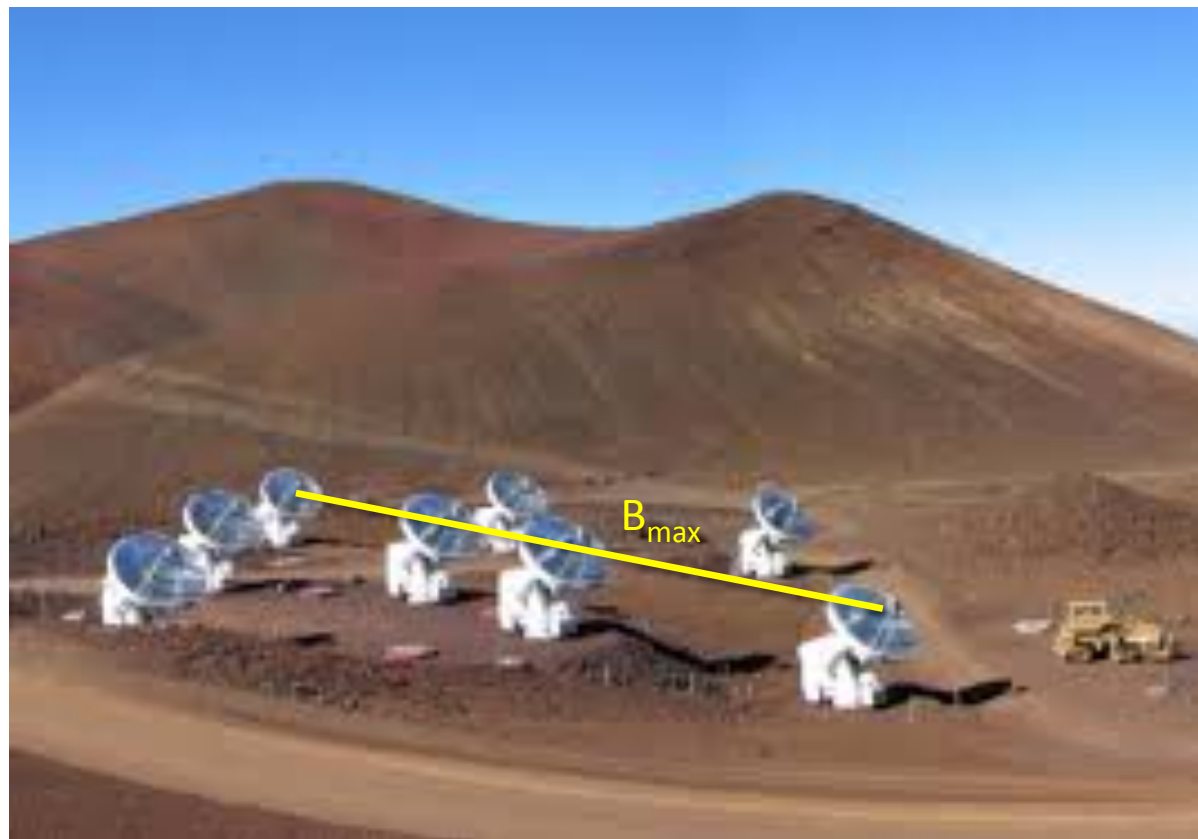




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Resolution array:

$$\Theta \approx \lambda / B_{\max}$$





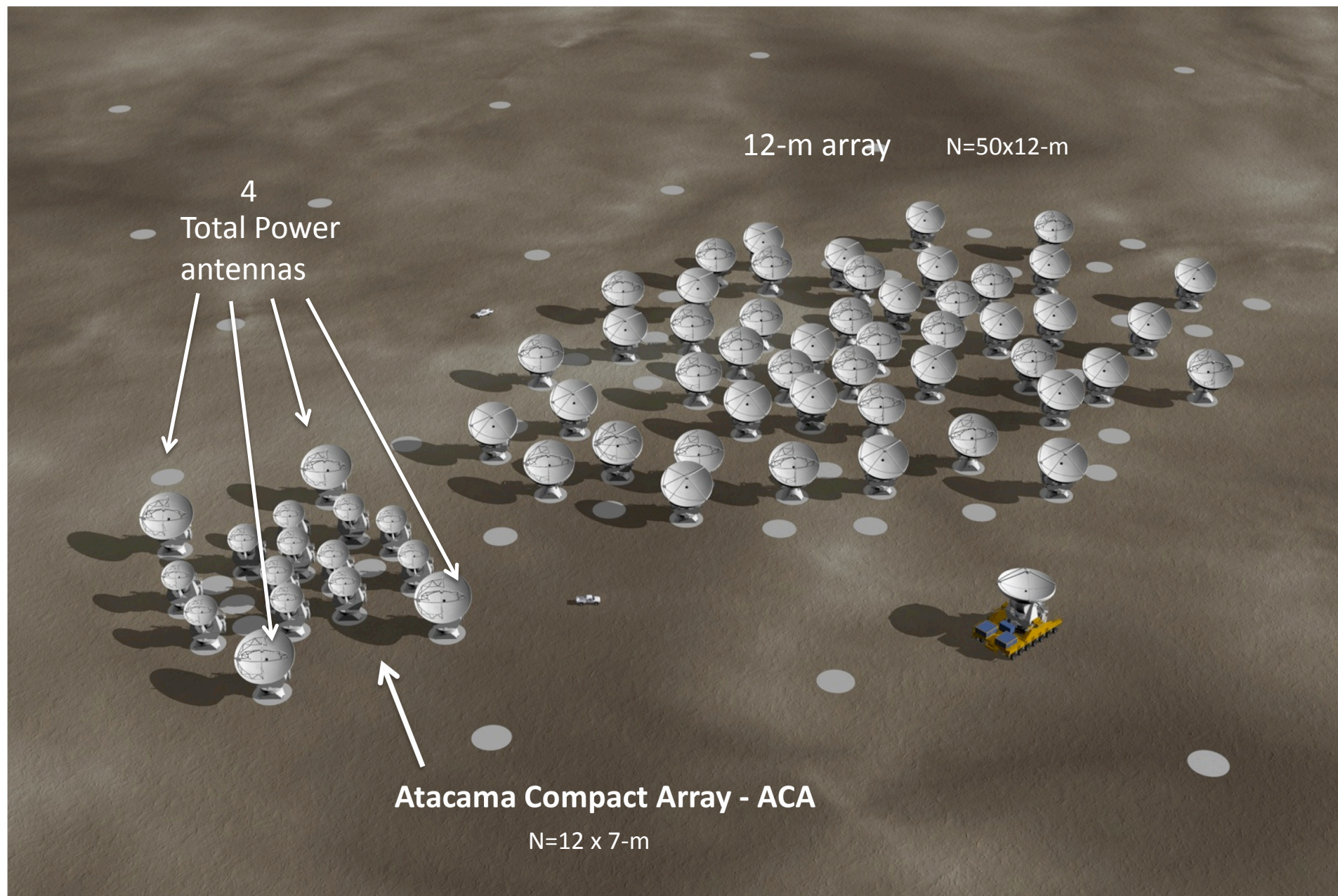
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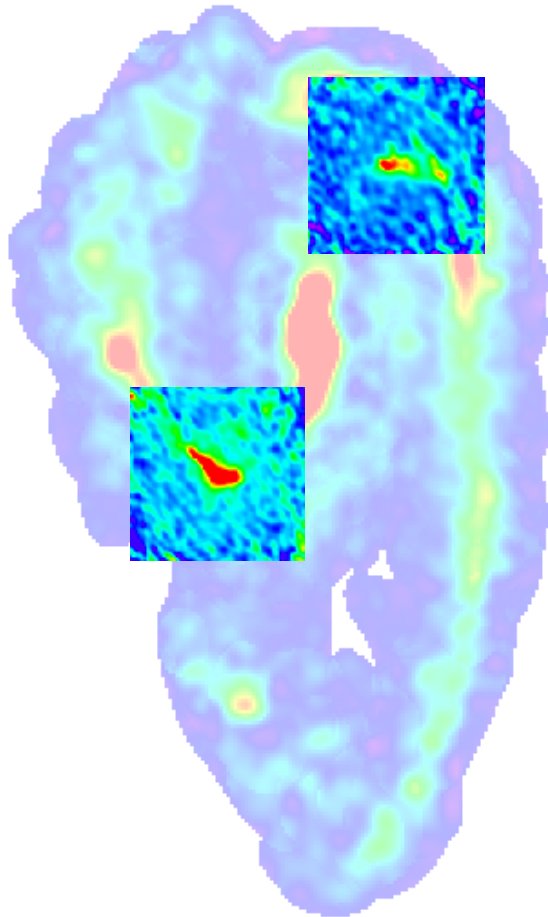
IRAM PdBI (6 antenna's)
resolution $0''.26$ @1 mm

longest baseline 760 m

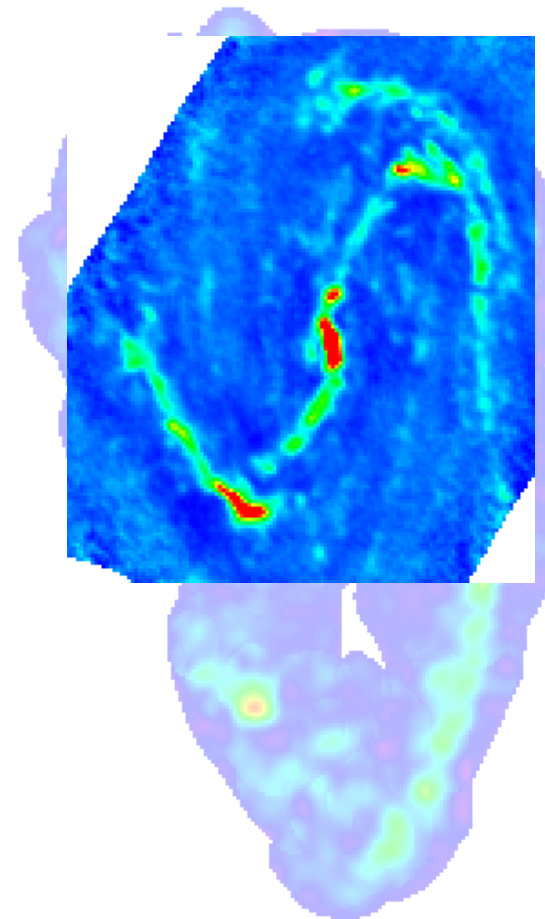
NOEMA: 12 antenna's
 $B_{\max} = 1.6 \text{ km} \Rightarrow 0''.13$



NGC3627 ALMA compact configuration data



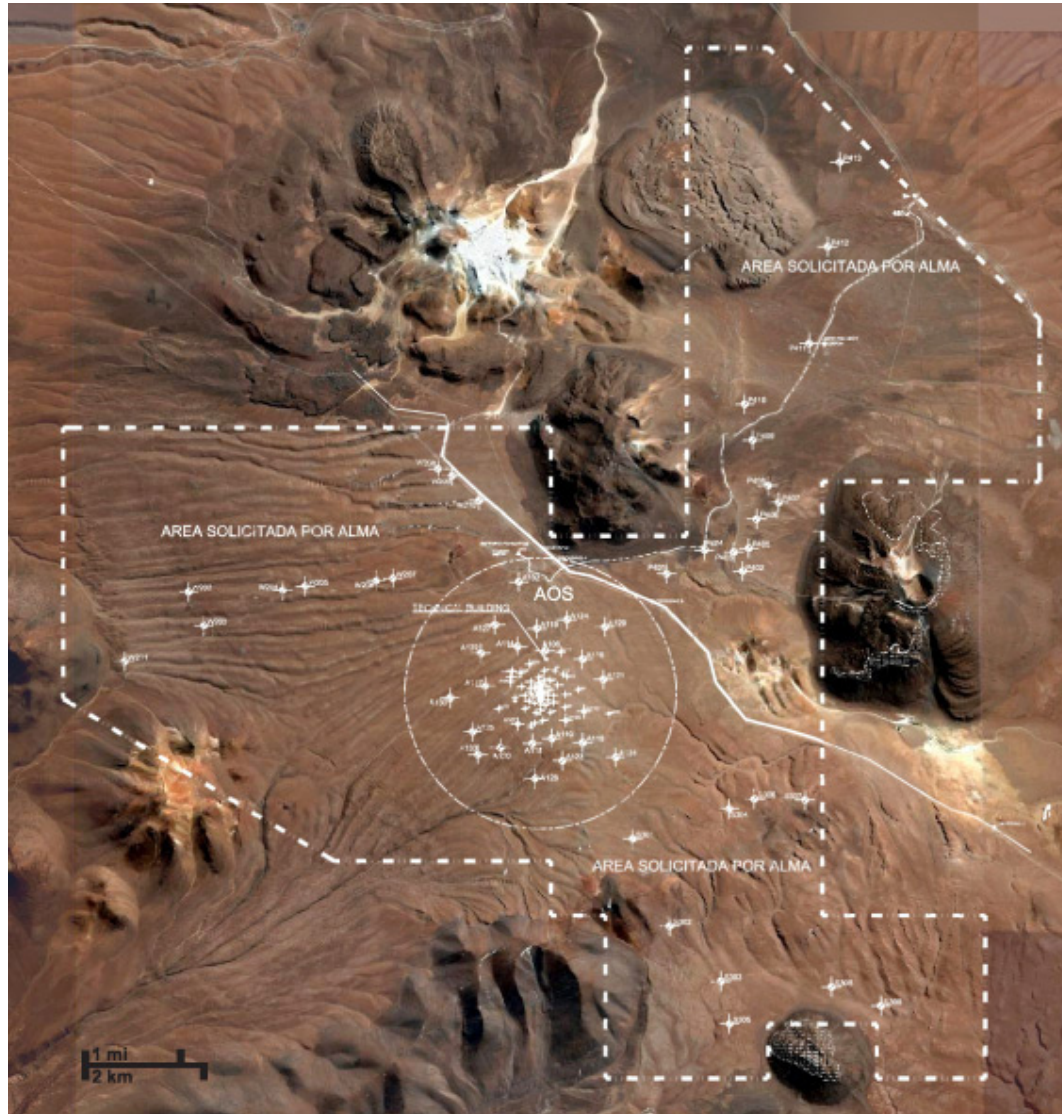
CO(1-0) with IRAM PdBI
Resolution ~ 2 arcsec ~ 100 pc
8 hrs per pointing



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

Paladino et al.

ANTENNA FOUNDATIONS LOCATIONS



ALMA

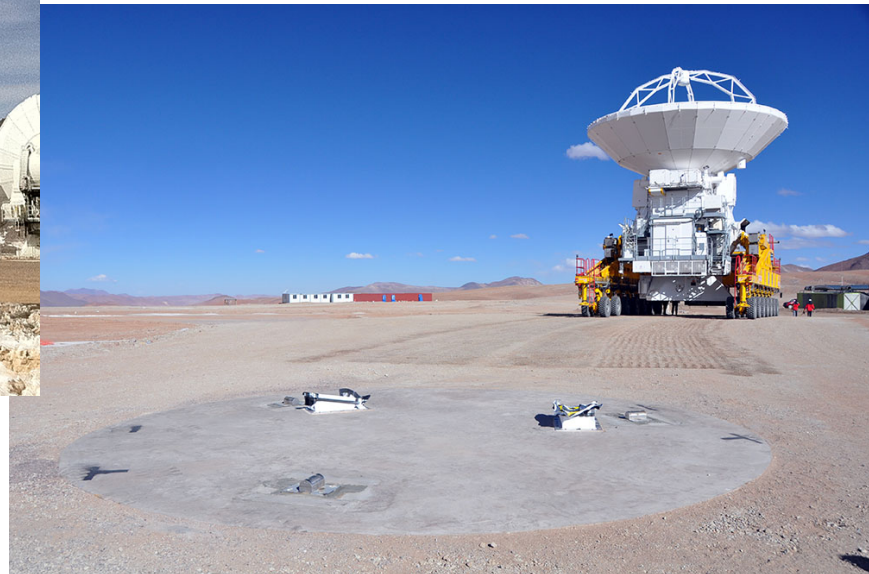
resolution $0''.013 @ 1 \text{ mm}$

longest baseline 16 km

resolution:

$$0''.2 \times (300 / \text{freq}[\text{GHz}]) \times (1[\text{km}] / B_{\text{max}})$$





THE AMBITIOUS ALMA PROJECT

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



Excellent instantaneous uv-coverage
and high sensitivity:
 $< 0.05 \text{ mJy @ } 100 \text{ GHz in } 1 \text{ hr}$

- # baselines up to $b_{\text{max}} = 16 \text{ km}$

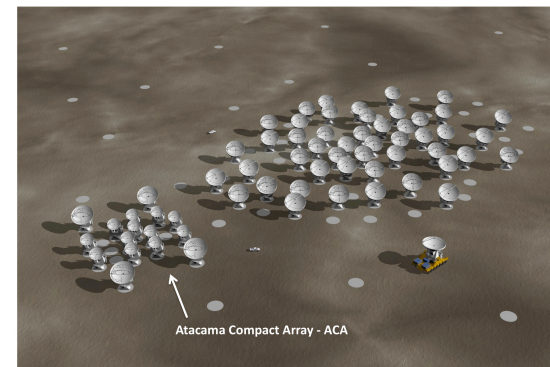


Sub-arcsec resolution:
 $40 \text{ mas @ } 100 \text{ GHz}$
 $5 \text{ mas @ } 900 \text{ GHz}$

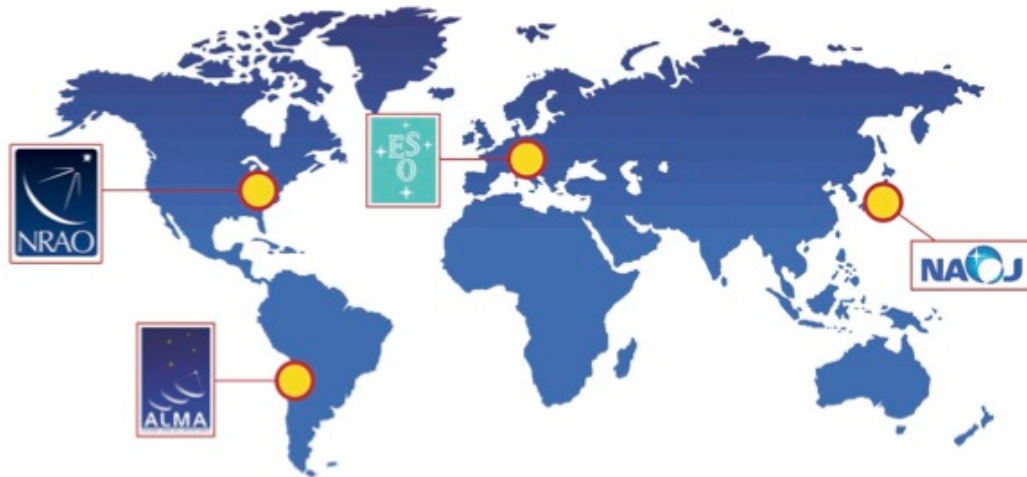
- # 10 spectral bands 30-950 GHz
- # 70 correlator modes



High flexibility in spectral studies



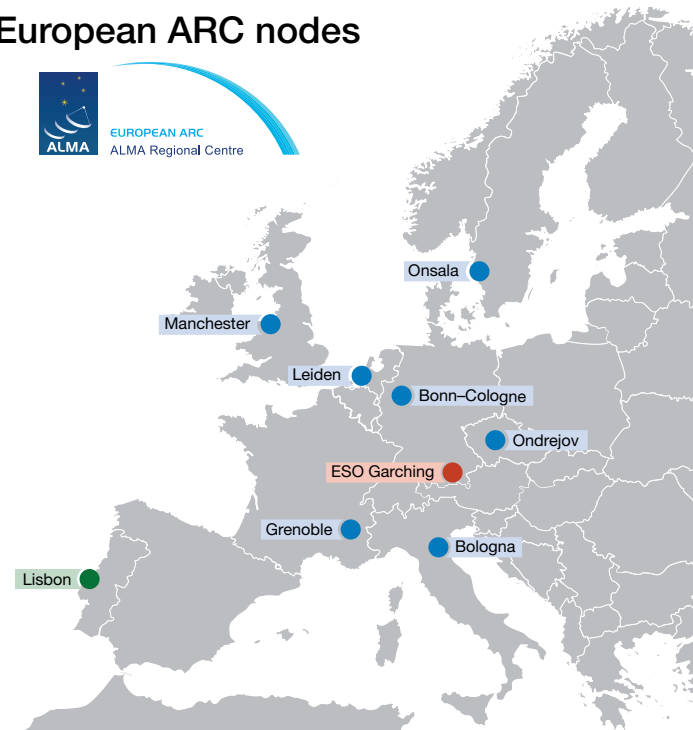
ORGANIZATIONAL STRUCTURE



Joint ALMA Observatory:

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

European ARC nodes



In Europe:

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



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Total current **staff levels** in EU ARC network

	total staff	ARC related
ESO astronomers/scientists (12) + 7 fellows + 3 paid associates	22 people	11.95 fte (+archive+admin)
ARC nodes management, staff, postdocs, software, IT	48 people	~19 fte
Total EU ARC network	70 people	~31 fte

M. Zwaan @ ARC all-hands, 2017



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Italian ALMA Regional Centre *Personnel*



Jan Brand
coordinator



Marcella Massardi
manager



Rosita Paladino



Elisabetta
Liuzzo



Andrea
Giannetti



Kazi Rygl



Sandra
Burkutean



Matteo Bonato

What do the ARC-nodes do?

Tasks are outlined in an MoU between ESO and the nodes, their representatives and funding agencies.

- * User support services: practical, technical, scientific (f2f; Contact Scientist)
- * Developing and capitalizing our expertises (polarimetry, mm-vlbi)
- * Contributing to the ALMA project (participating in EOC, data quality assessment, software development, data archiving, specialized workshops, development plan proposals – [see separate slide](#))
- * Building, maintaining and informing a community of potential ALMA users
- * Educating the next generation of mm-astronomers
- * Science

What does the ARC do...

To help and inform the community?

- **Proposal Preparation Days** / Community Days (since 2007)
- **Tutorials** (CASA, OT. Stand-alone or as part of a School, e.g. ERIS; data handling and archive mining)
- **Seminars** at institutes/observatories in Italy (scientific results + capacities new Cycle + opportunity for f2f help).
- **Workshops**: scientific, e.g. mm-astronomy in Italy series (2012, 2015, 2017)
specialised/technical, e.g. polarimetry w. ALMA; mm-VLBI w. ALMA;
self-calibration and advanced imaging
- **Face-to-face support** + via Helpdesk, phone, e-mail.
for proposal preparation, data reduction, archive mining
- An up-to-date **web page**: <http://www.alma.inaf.it>

What does the ARC do...

To educate the community and the next generation?

- International **Training School** (Astrochemistry with ALMA, 2011; Lucchin, 2015)
- **Supervise theses**: Masters (at ARC or in collaboration); PhD
<http://www.alma.inaf.it/index.php/Theses>
- **University courses**
Astrophysics Laboratory on interferometry, hands-on reduction ALMA data
Univ. of Bologna, from academic year 2013-14 onwards. 5th time in 2017/18
On (sub)mm astronomy and ALMA (SISSA, Trieste) 4th time in 2017
On radioastronomy and interferometry (Univ. Bologna, Catania, Torino)
- Support **post-doc fellowships**
- Co-proposers on accepted **premiere project *iALMA***.
Includes WP 'ARC node development' (mm-VLBI => postdoc: Rygl) and
WP 'Advanced Training' (=> 3 PhD's: Bologna, Firenze, Catania)

ALMA-related projects, developments



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The ALMA Re-Imaging (ARI) development study

ALMA Upgrade proposal. Feasibility study to re-image Archival data (Massardi PI; Stoehr (ESO) Co-I; Giannetti (ARC). Incl. It, UK, Nordic nodes). **Talk by Giannetti**

Archive Key-word Filler (AKF)

Liuzzo, Rygl, Massardi

Keywords of Archived FITS-images Exploder (KAFF)

Burkutean + all . A flexible image analysis tool

Talk by Burkutean

Array(s) and single dish combination

Burkutean

ALMACAL

Deep (sub)mm multi-freq survey using ALMA calibrator data.

Liuzzo, Bonato, Massardi

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

Talk by Massardi

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)).



BlackHoleCam entry imminent

Liuzzo, Rygl – writing pipeline for CASA

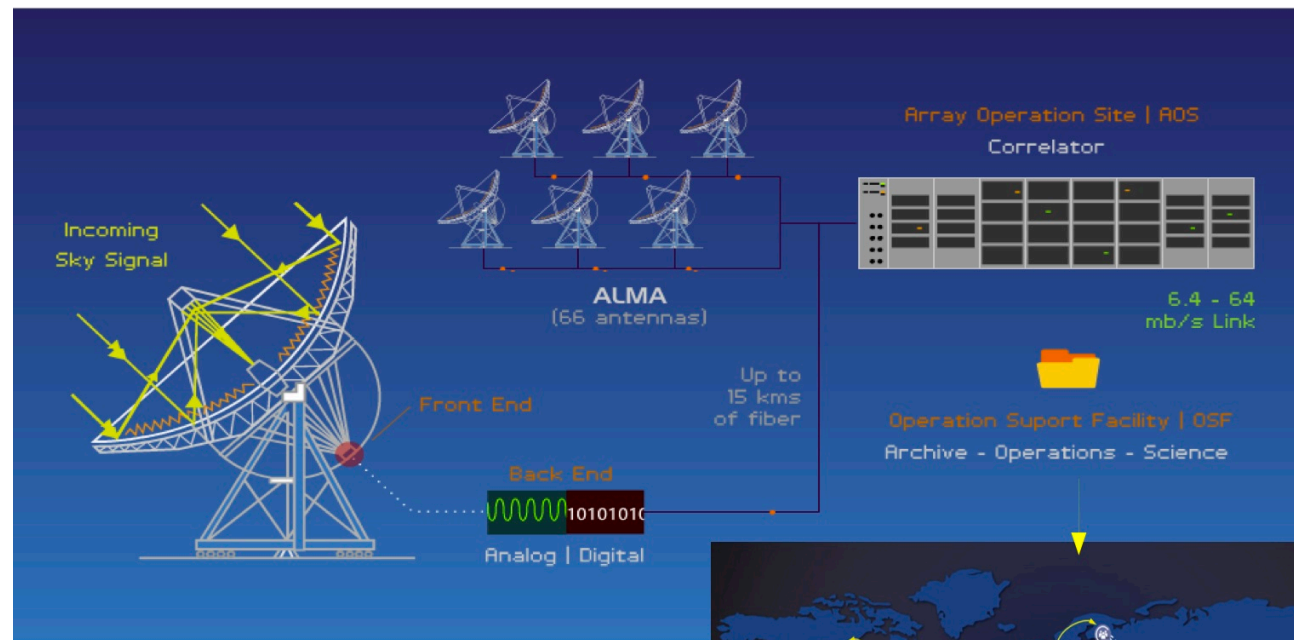
ALMA Data flow and archive

Individual projects have sizes 10-100 Gb

ALMA science data archive grows by ca. 200 Tb/year.

Compare: HST science data processing generates 10 Tb/yr.

Total HST archive ($\geq 1.3 \times 10^6$ observations made since 1990): ≥ 140 Tb.



Data is collected, reduced and archived.
All the “almost” raw data is archived.

Each ARC hosts an archive mirror.





Italian ALMA Regional Centre *Computing facilities*

Italian ARC computer cluster

Storage: 110 Tb

14-nodes cluster, 120 cores

Internal network 10 Gbit/s

Link to GARR 1 Gbit/s

Really need:

- small machines on which few people can work simultaneously on large data sets;
- big machine on which many can work simultaneously on small data sets (e.g. for a tutorial or a laboratory course)

name	ram	cores	scheduler	speed	notes
arcbl01	32G	16	N	3500	
arcbl02	8G	8	Y	2100	
arcbl03	8G	8	Y	2100	
arcbl04	8G	8	Y	2100	
arcbl05	8G	8	Y	2100	
arcbl06	8G	8	Y	2100	
arcbl07	8G	8	Y	2100	
arcbl08	8G	8	N	2100	
arcbl09	8G	8	N	2100	
arcbl10	32G	16	N	3500	
arcbl11	8G	8	N	2100	
arcbl12	16G	8	N	2100	
arcbl13	16G	4	N	2800	
arcbl17	16G	4	N	2800	



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How are Italian-PI ALMA-proposals performing?

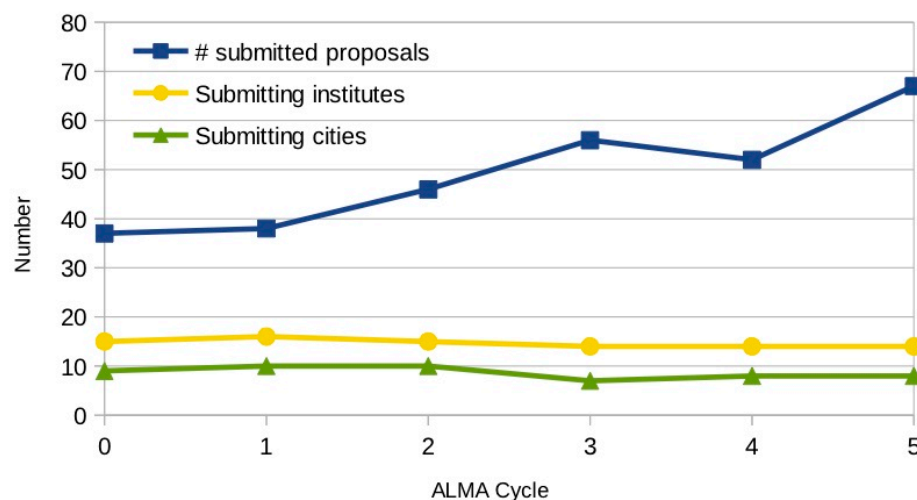
Proposal statistics for Italy

for all 6 Cycles

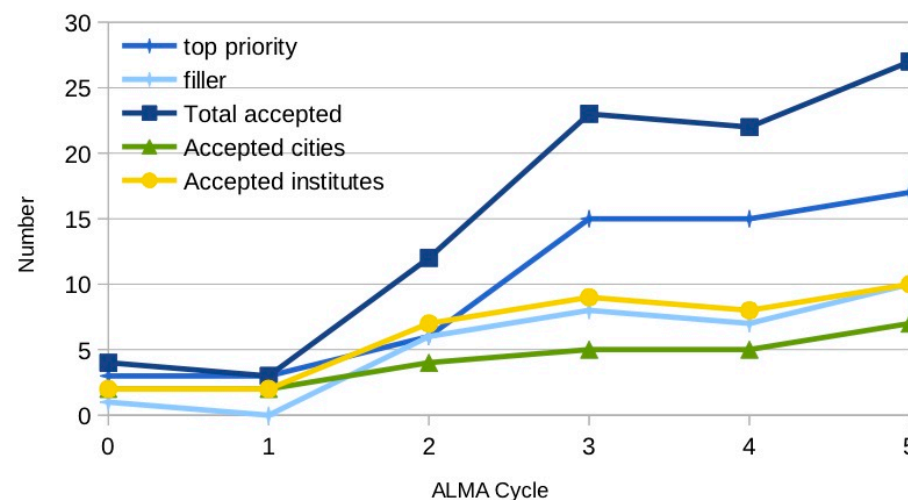


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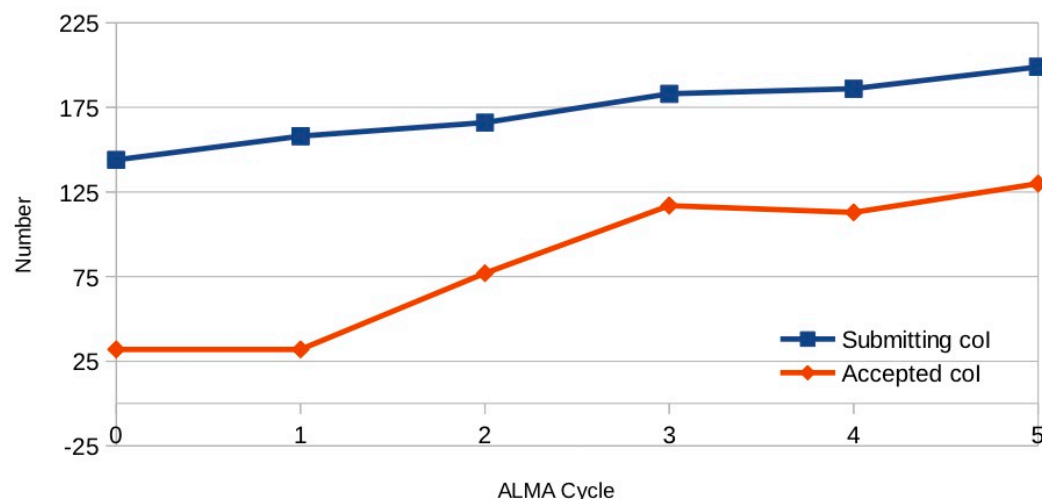
Submitted proposals



Accepted proposals



Unique Italian Col



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%

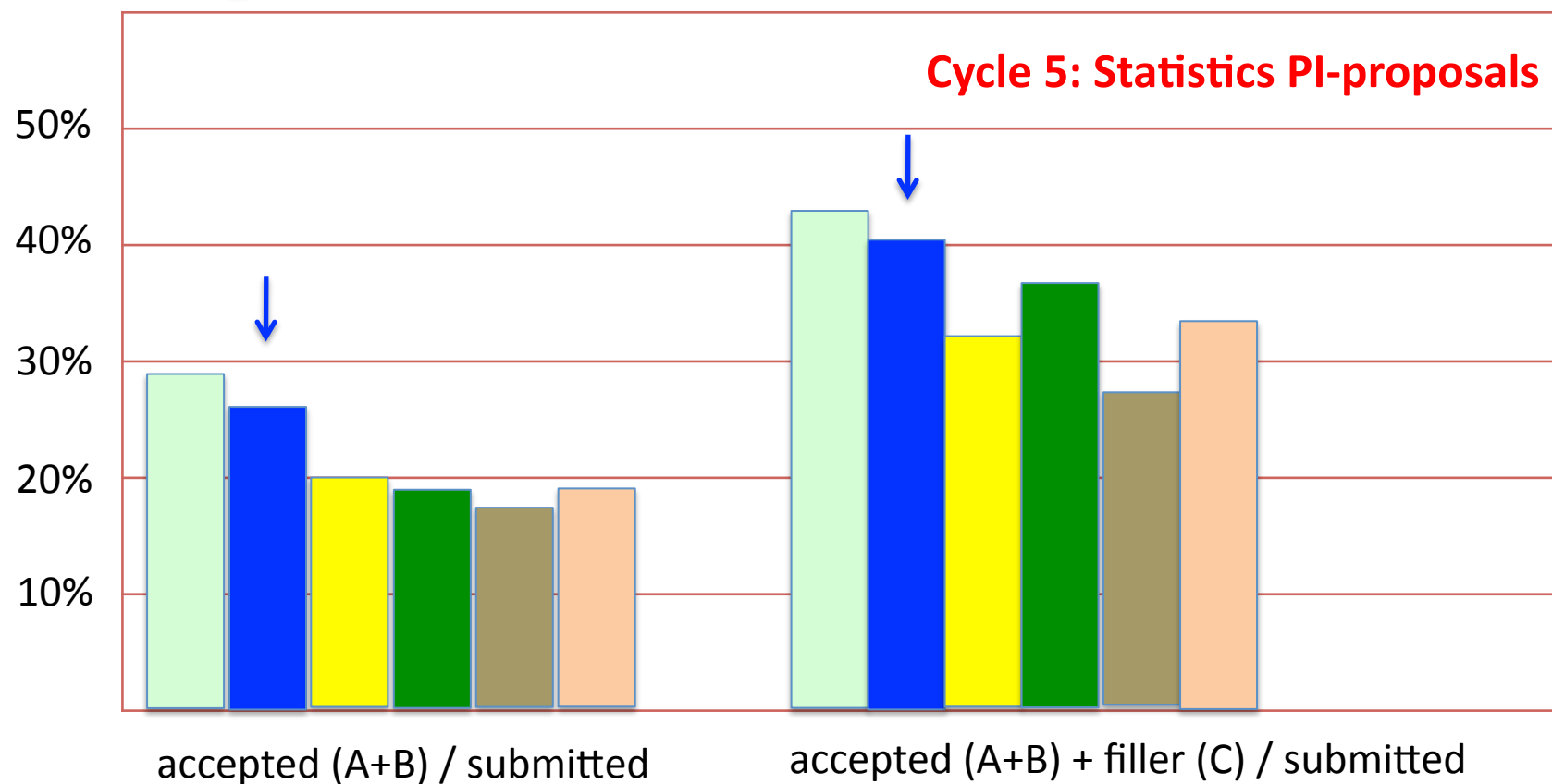
Accepted A+B: 9.1%

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)



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Italian node website: <http://www.alma.inaf.it>



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Grazie per l'attenzione.

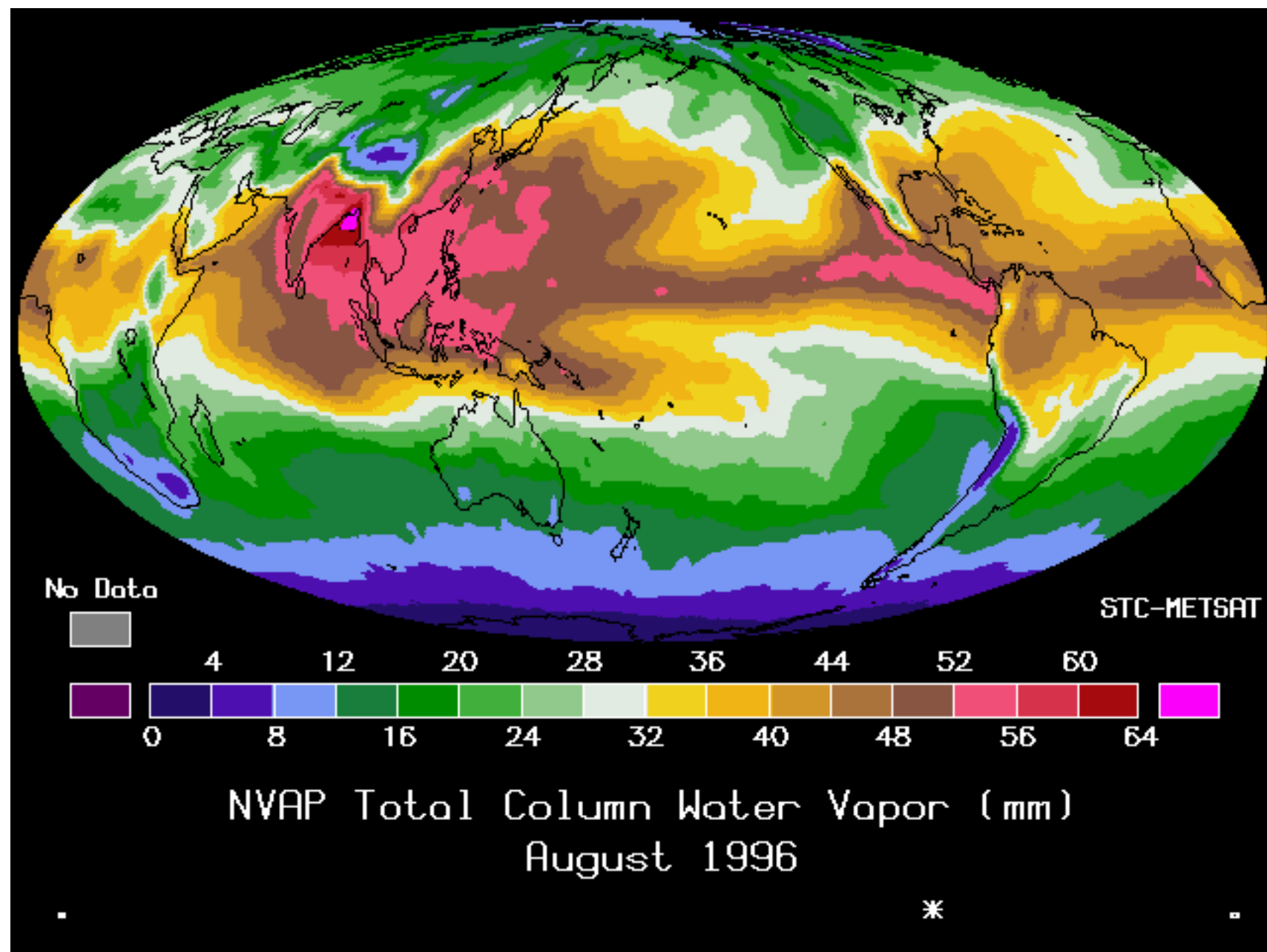
Contattateci se volete saperne di più,
se volete scrivere una proposal per ALMA,
se volete collaborare.

General information:

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

Progetti di tesi di laurea:

<http://www.alma.inaf.it/index.php/Theses>



ATMOSPHERIC TRANSMISSION

