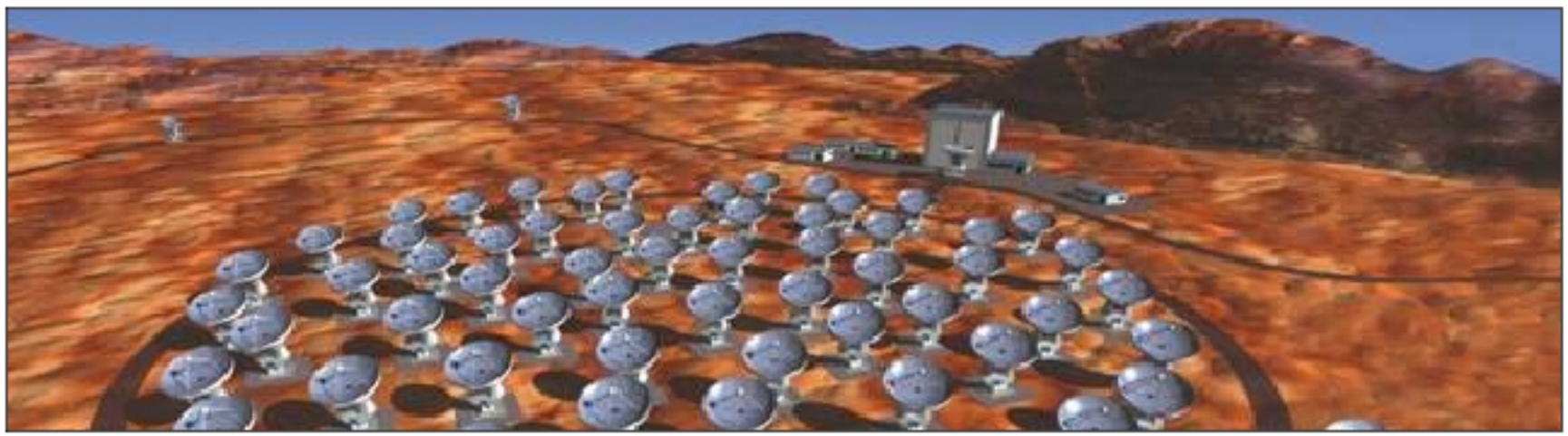
EUROPEAN ARC
ALMA Regional Centre || IRAM

ALMA

Frédéric Gueth, IRAM Grenoble
ALMA Science Advisory Committee
IRAM node of the ALMA Regional Center



ALMA

- **The ALMA project**
- ALMA construction : status as of Sept. 2010
- ALMA Operations & Early Science
- The IRAM ARC node

ALMA

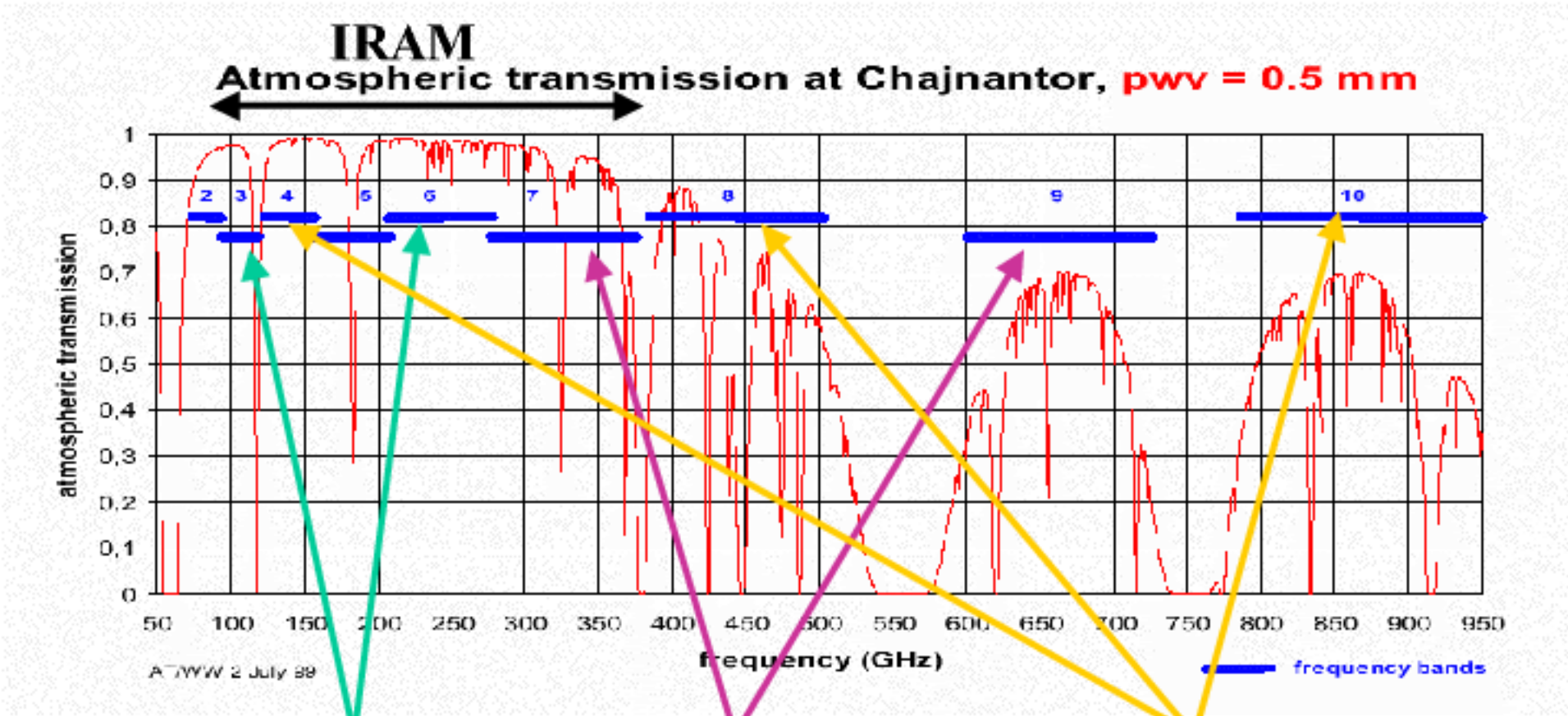
- **Atacama Large Millimeter/Submillimeter Array**

- World-wide collaboration between Europe (**ESO**) – North America (USA, Canada, Taiwan) – Eastern Asia (Japan, Taiwan) – Chile

  - Main array: 50 X 12 m antennas
  - ALMA Compact Array (ACA): 4x12m + 12x7m
  - Frequency range: 30—900 GHz (0.3—10 mm)
  - 16 km max. baseline (<10 mas ang. resolution)
  - ALMA is a spectro-imager instrument providing data cubes

Level 0 requirements

1. The ability to **detect spectral line emission from CO or CI** in a normal galaxy like the Milky Way at a **redshift of 3**, in less than 24 hours of observation.
2. The ability to **image the gas kinematics in protostars and protoplanetary disks** around young Sun-like stars at a distance of 150 pc.
3. Provide **precise images at 0.1 arcsec resolution**.

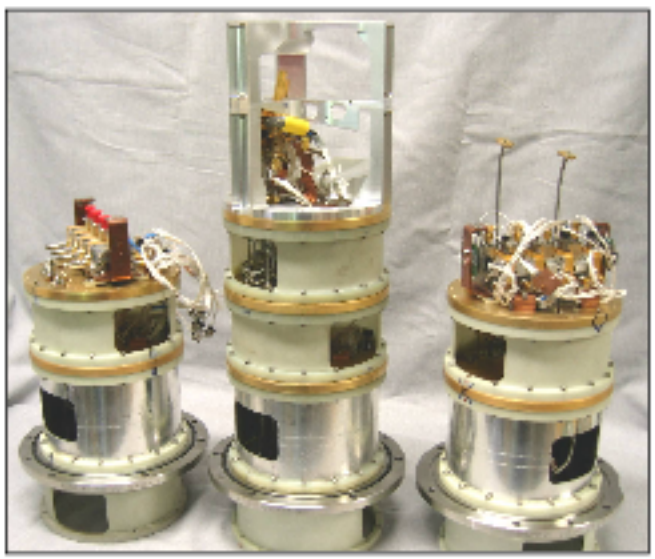


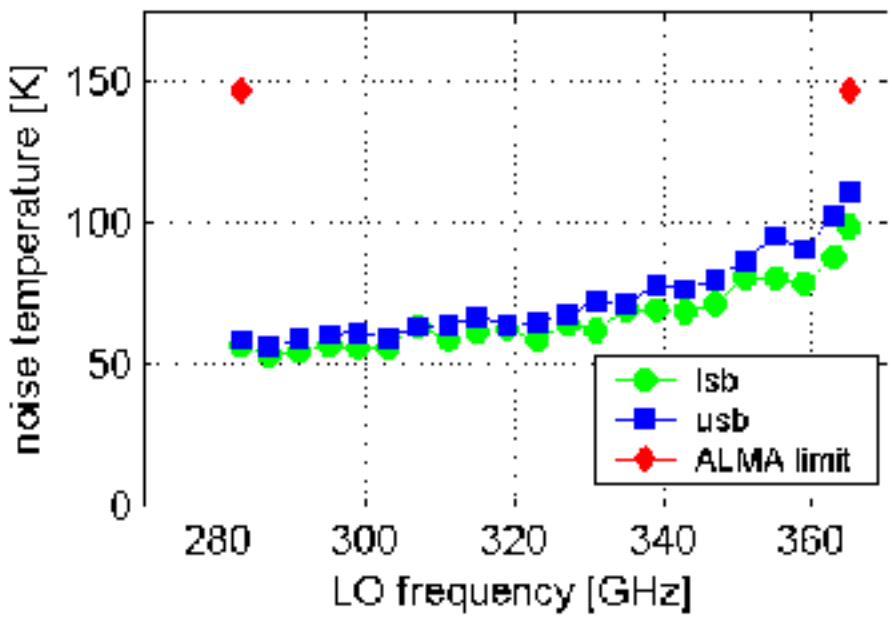
North America	Europe	Japan
Band 3 (84-116 GHz)	Band 7 (275-373 GHz)	Band 4 (125-163 GHz)
Band 6 (211-275 GHz)	Band 9 (602-720 GHz)	Band 8 (385-500 GHz)
		Band 10 (787-950 GHz)

Freq. coverage: **30—900 GHz**

Bandwidth: **8 GHz x 2 polarizations**

Band 7 @ IRAM





All bands installed in one single cryostat (Front-End integration Centers)

Correlator

- The ALMA correlator provides ~70 modes
  - Process 8 GHz bandwidth x 2 polarizations
  - One, two, or four polarization products
  - Various sampling options

- Usual **tradeoff bandwidth vs. resolution**
  - 4x2 GHz bandwidth @ 244 kHz resolution
  - 4x32 MHz bandwidth @ 3.8 kHz resolution
    (0.005 km/s @ 230 GHz)

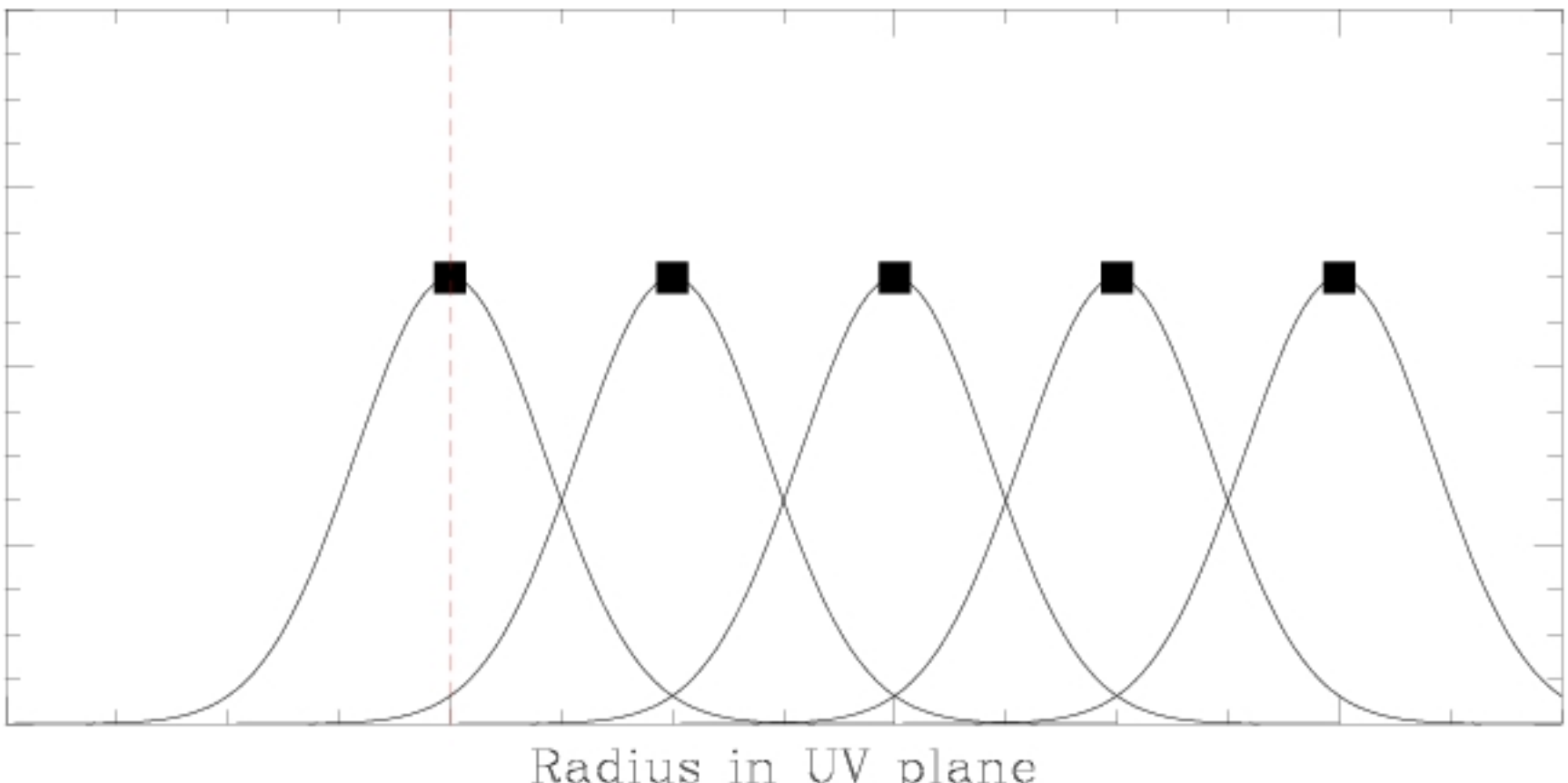
Imaging

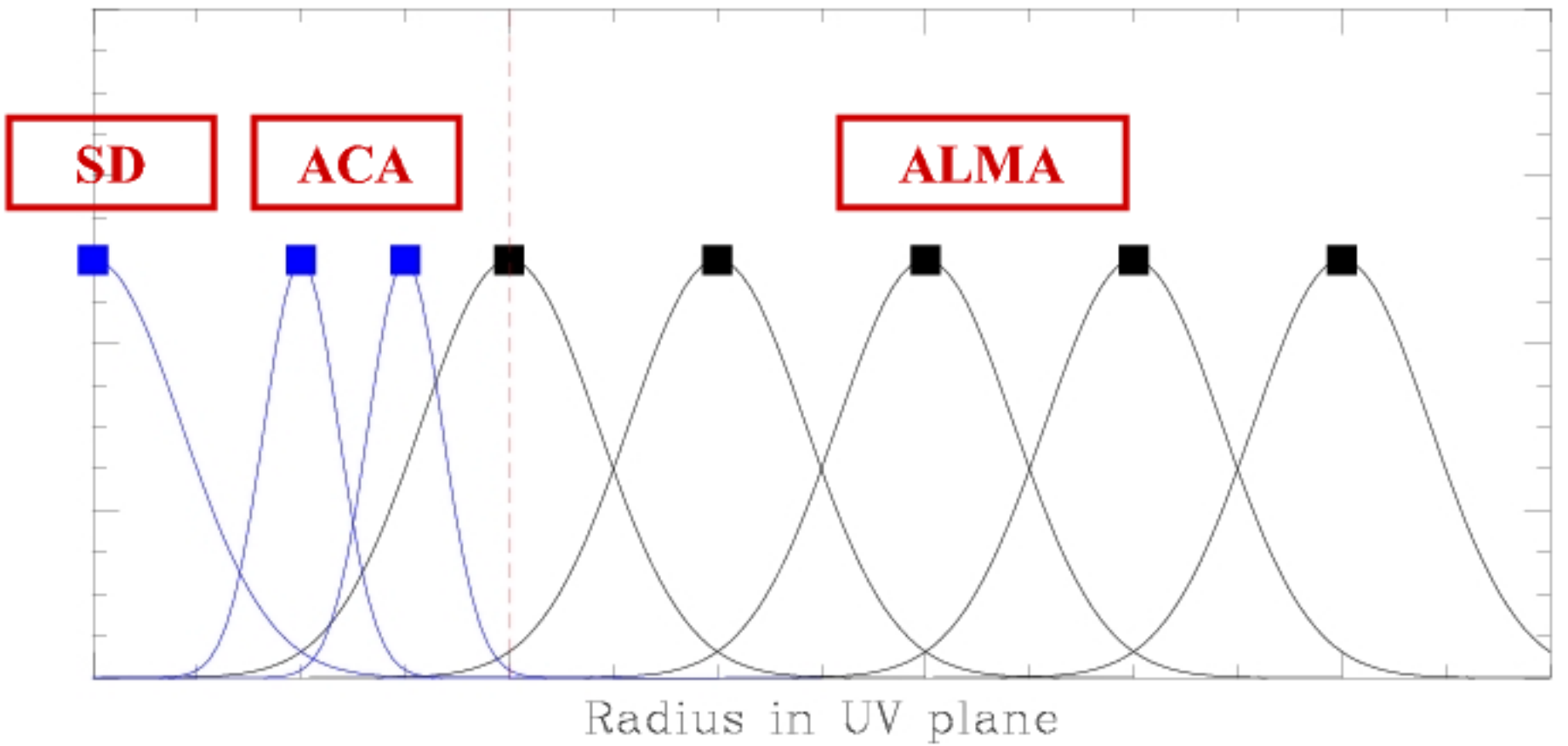
- 50 antennas, 1225 baselines
- ALMA imaging simulateur in GILDAS and CASA

- **28 different antenna configurations, from compact to ~16 km, continuous reconfiguration**
- Angular resolution λ/B down to 40 mas (100 GHz), 5 mas (900 GHz)

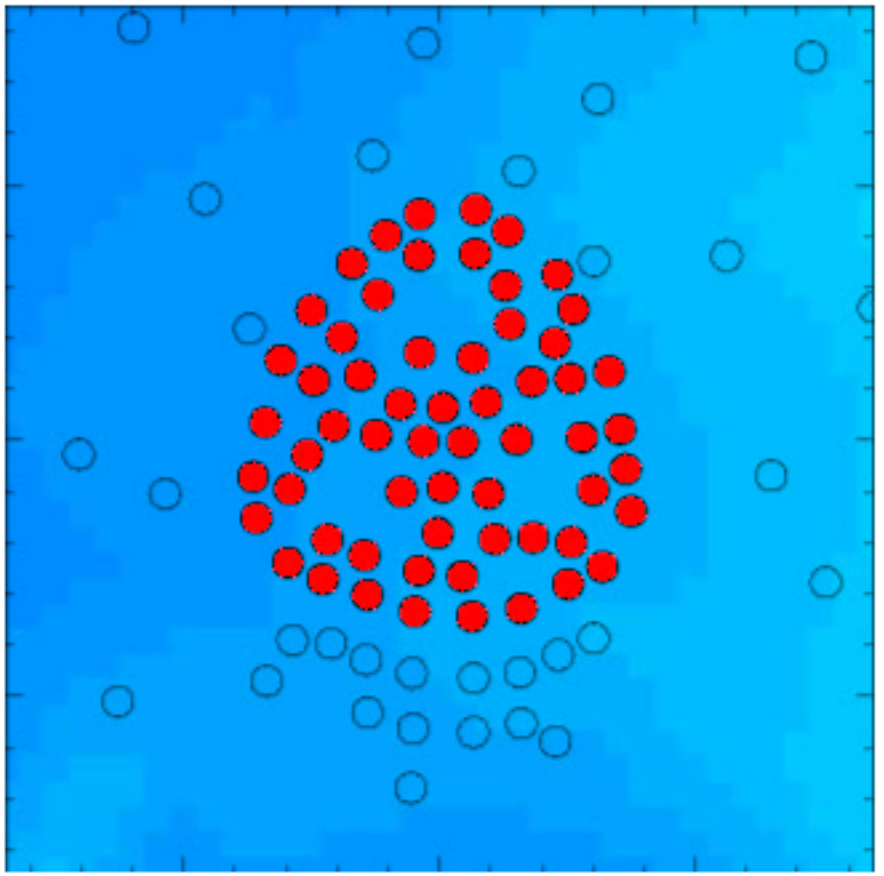
- **Short spacings: ACA** observations + 4 single-dish antennas

Caution: not all projects can have ACA data!

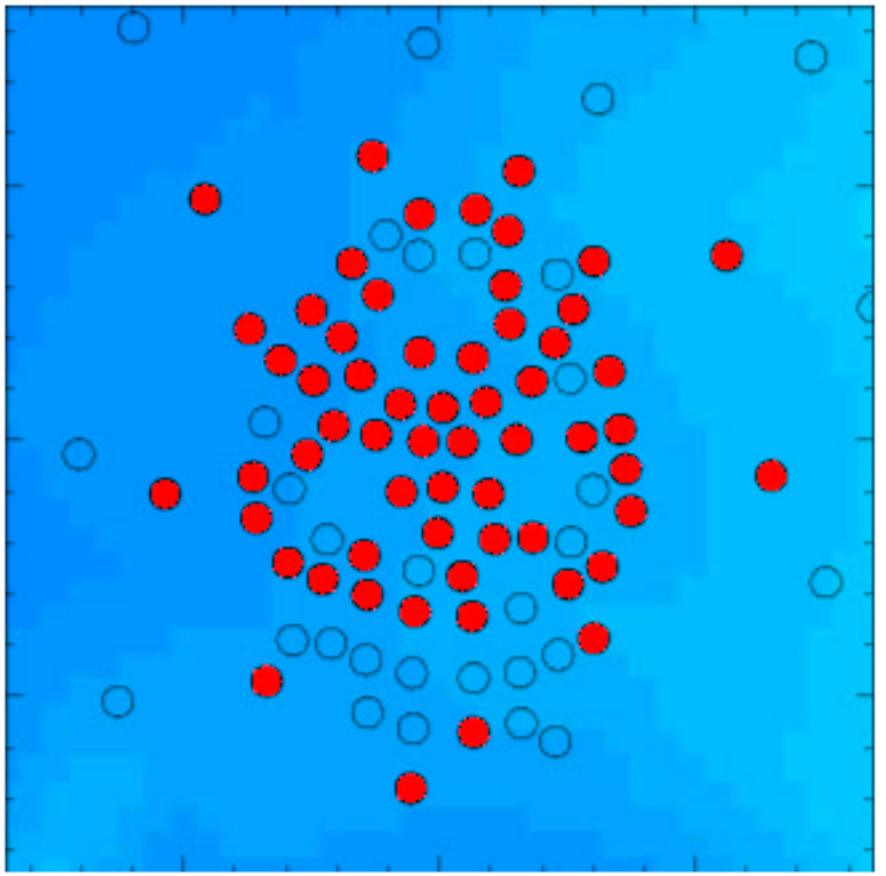

Radius in UV plane


SD
ACA
ALMA
Radius in UV plane

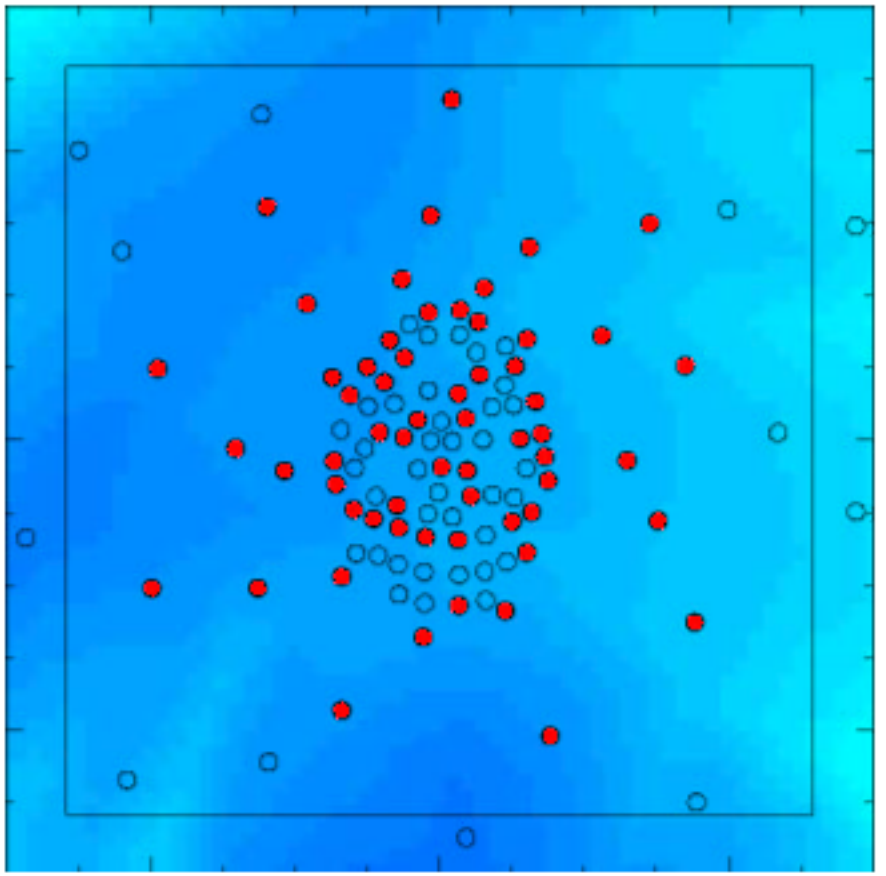
Configurations ALMA



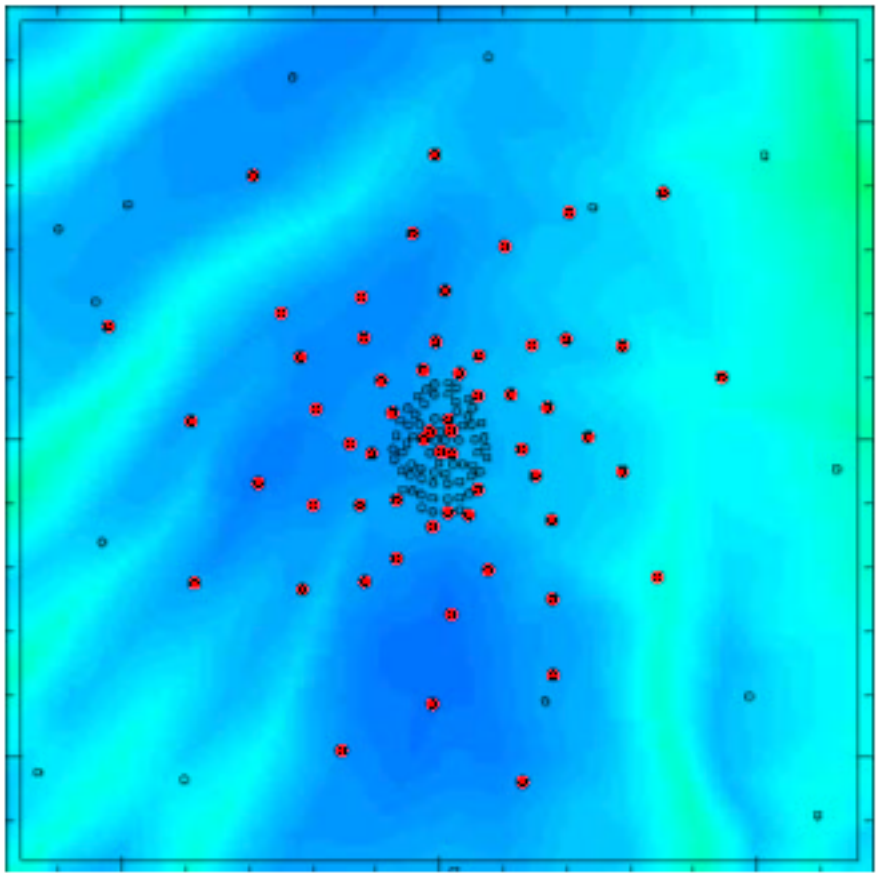
Configurations ALMA



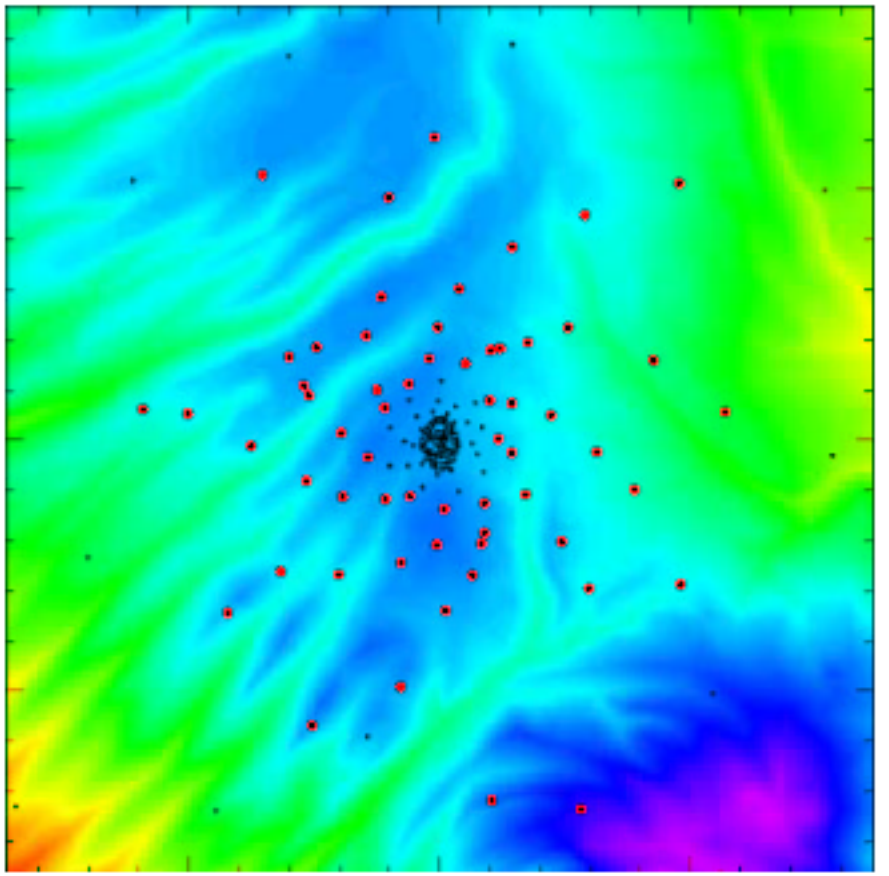
Configurations ALMA



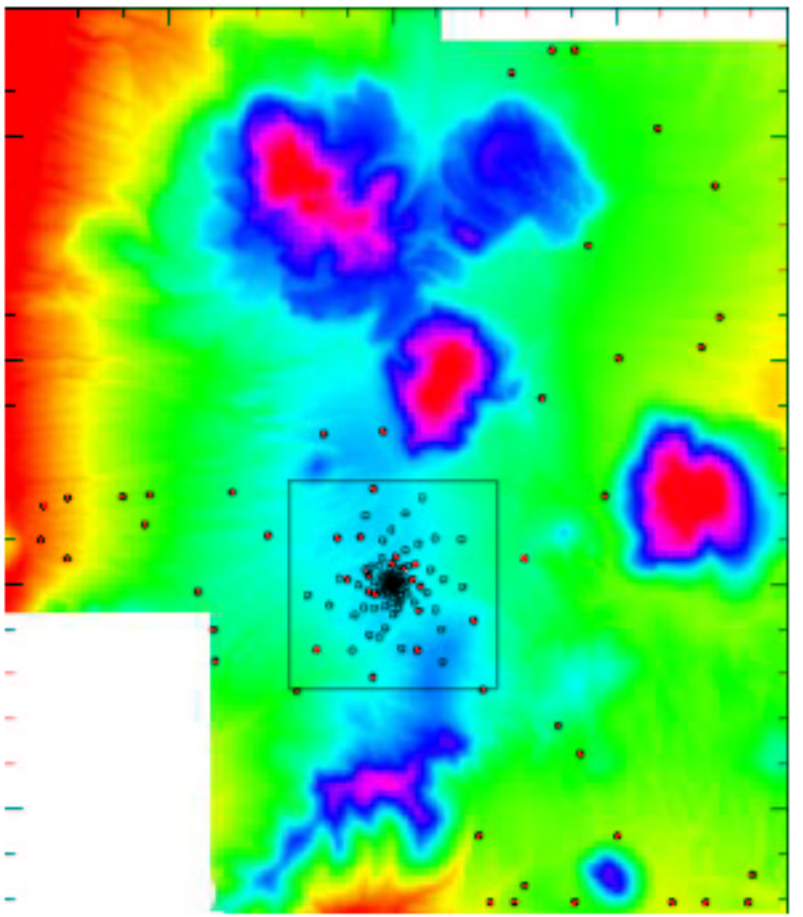
Configurations ALMA



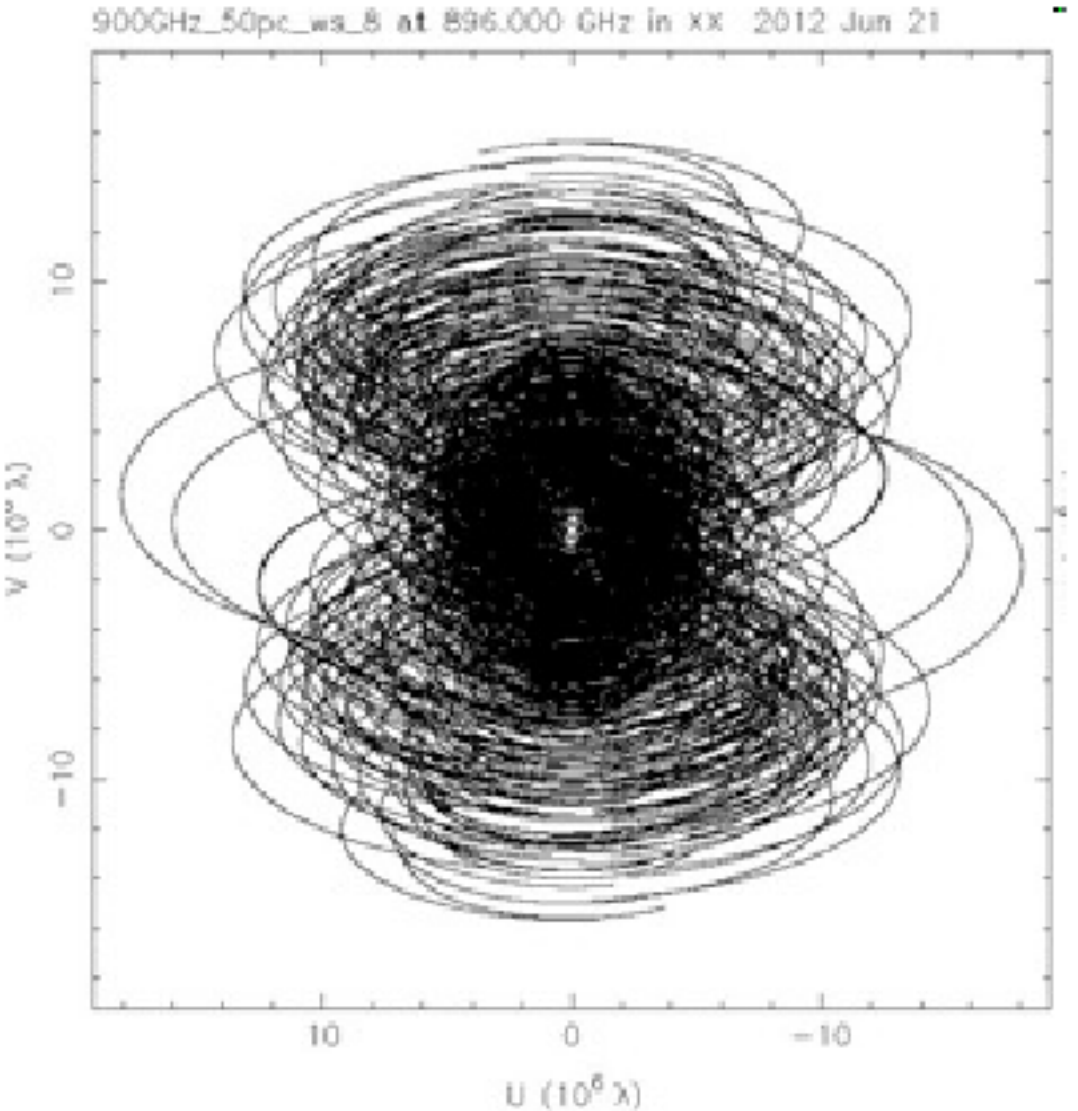
Configurations ALMA



Configurations ALMA



UV coverage


900GHz_50pc_ws_8 at 896.000 GHz in xx 2012 Jun 21
10
0
−10
V (10^6 λ)
10
0
−10
U (10^6 λ)

Sensitivity

- Collecting area = 7200 m^2 (~5x Bure), excellent site
  → Ex: rms = 8 **μJy** in 6h (8 GHz continuum, 230 GHz)
  → On-line sensitivity estimator:
  http://www.eso.org/projects/alma/science/bin/sensitivity.html

- Point-source sensitivity: gain of ~1 order of magnitude compared to current PdBI
- Resolution: gain of >1 order of magnitude vs. PdBI
- Surface brightness sensitivity: **depends on angular resolution**

ALMA

- The ALMA project
- **ALMA construction : status as of Sept. 2012**
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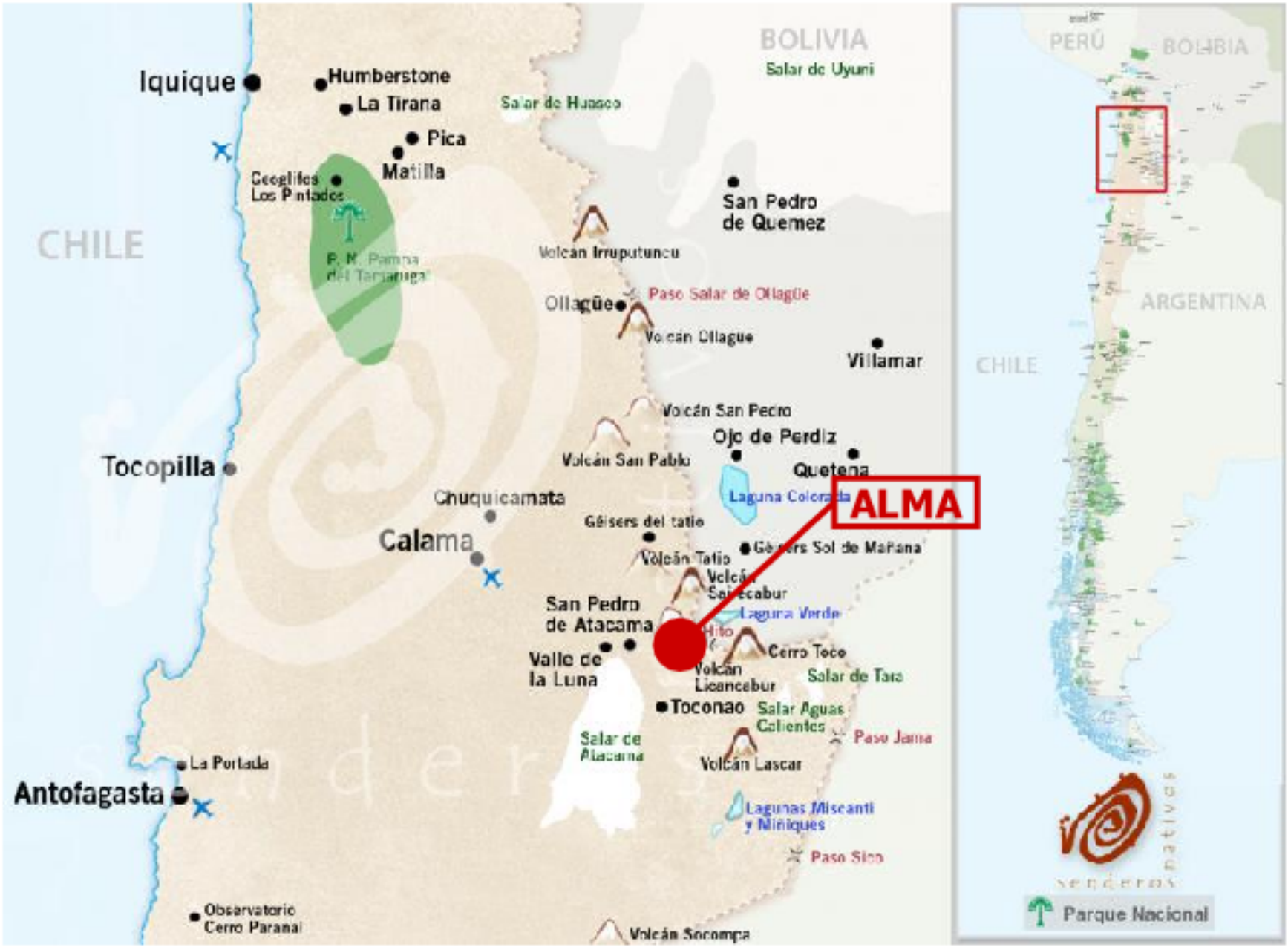
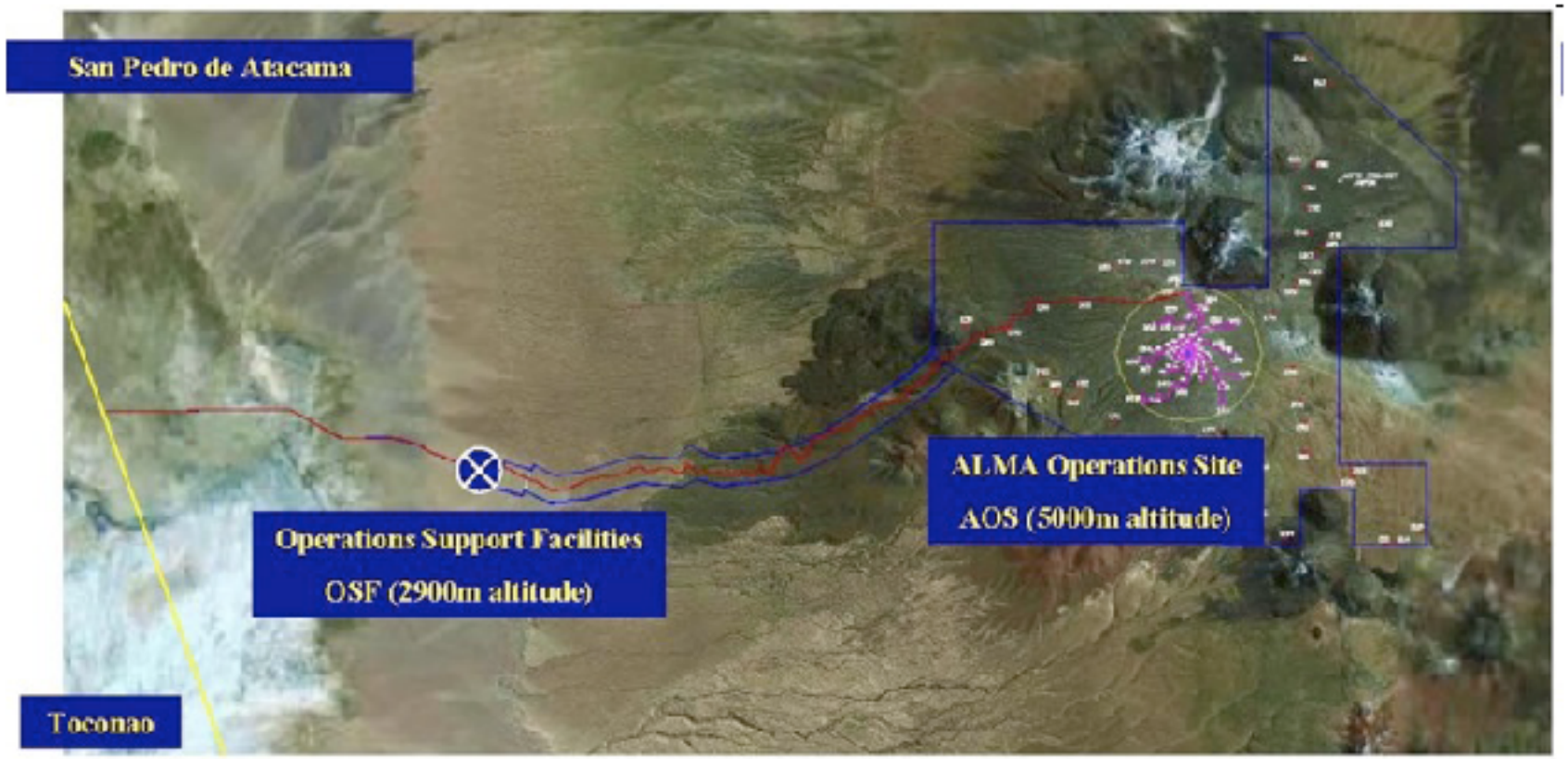
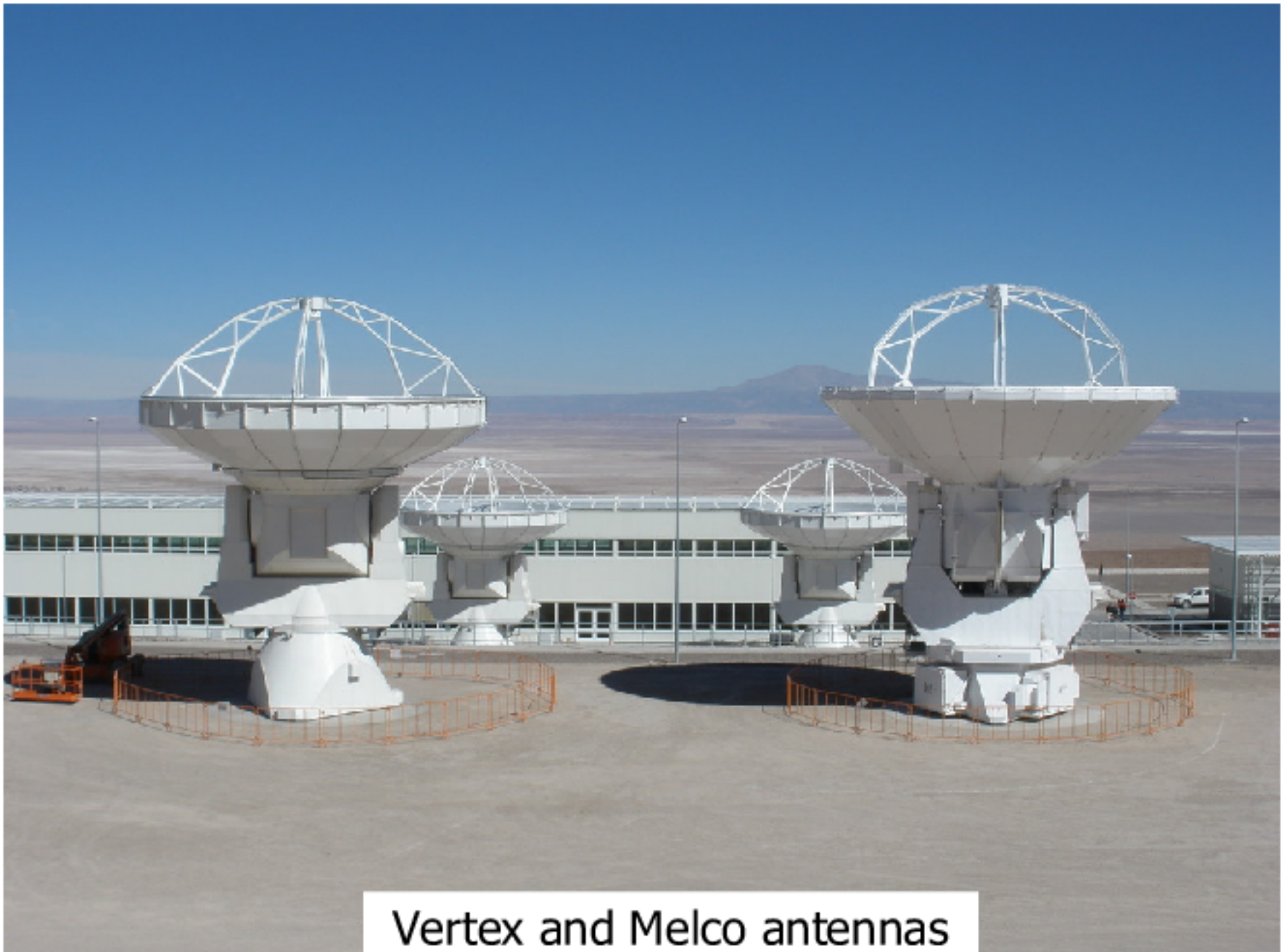

BOLIVIA
Salar de Uyuni
Iquique
Humberstone
La Tirana
Salar de Huasco
Pica
Matilla
Geoglifos
Los Pintados
CHILE
P. N. Pampa
del Tamarugal
San Pedro
de Quemez
Volcan Irruputuncu
Ollagüe
Paso Salar de Ollagüe
Volcan Ollague
Villamar
Volcán San Pedro
Ojo de Perdiz
Volcán San Pablo
Quetena
Tocopilla
Chuquicamata
Laguna Colorada
ALMA
Géisers del tatio
Calama
Géisers Sol de Mañana
Volcán Tatio
Volcán
Sairecabur
San Pedro
de Atacama
Laguna Verde
Hito
Cerro Toco
Valle de
la Luna
Volcán
Licancabur
Salar de Tara
Toconao
Salar Aguas
Calientes
Paso Jama
Salar de
Atacama
Volcán Lascar
La Portada
Antofagasta
Lagunas Miscanti
y Miniques
Paso Sico
Observatorio
Cerro Paranal
Volcán Socompa
PERÚ
BOLIBIA
ARGENTINA
CHILE
Parque Nacional


San Pedro de Atacama
Operations Support Facilities
OSF (2900m altitude)
ALMA Operations Site
AOS (5000m altitude)
Toconao

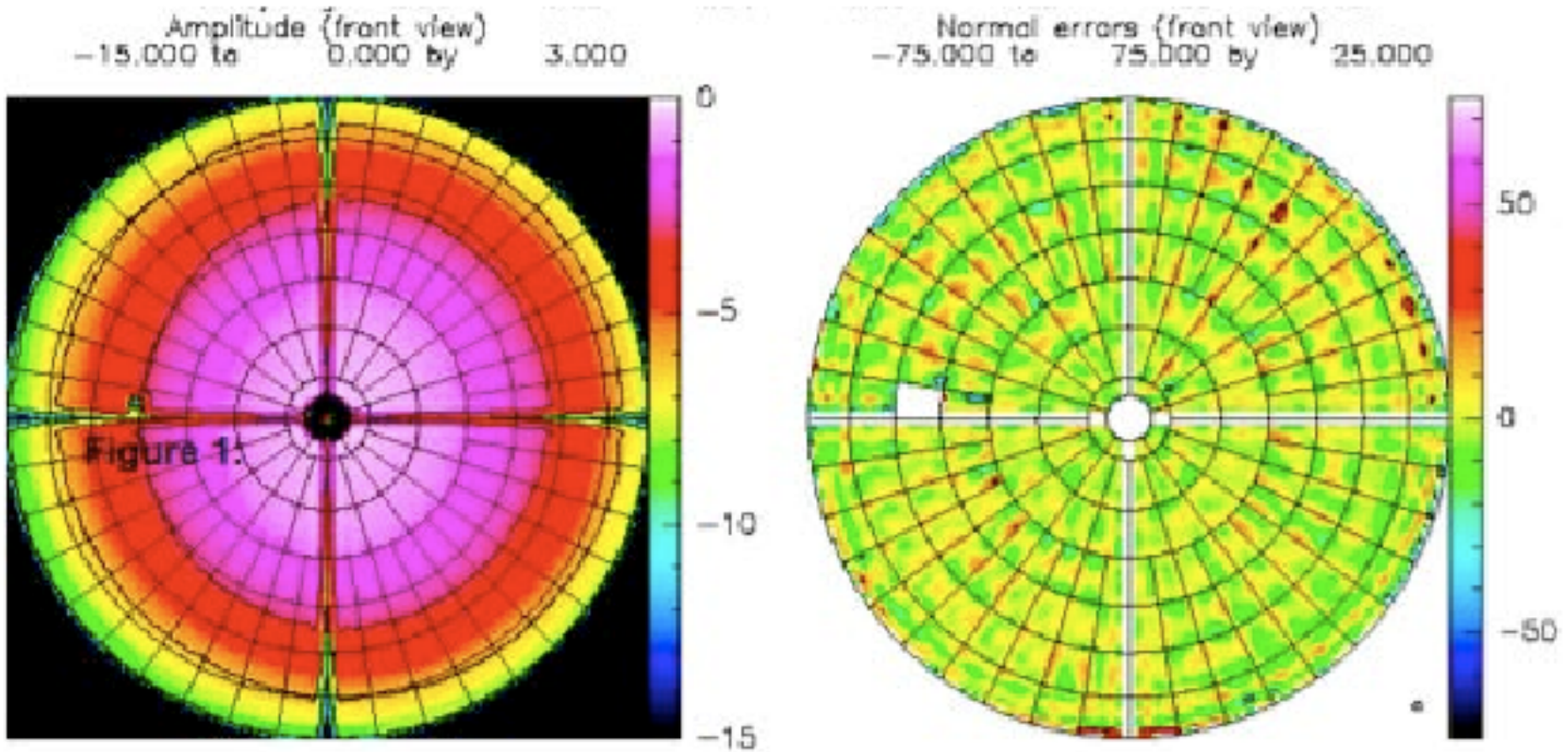
OSF Site @ 2900 m altitude

OSF Site @ 2900 m altitude



Vertex and Melco antennas

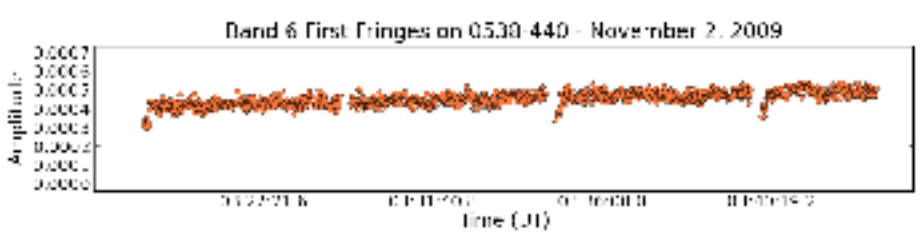
European antenna (AEM)

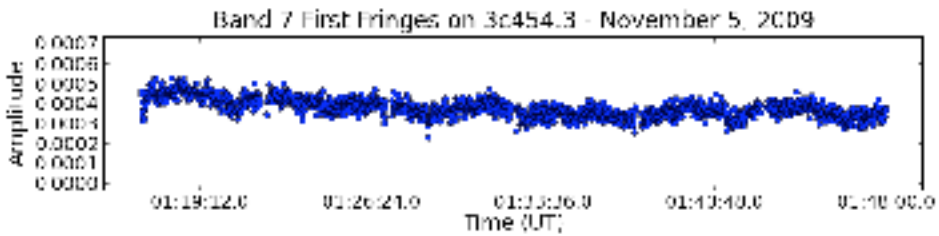


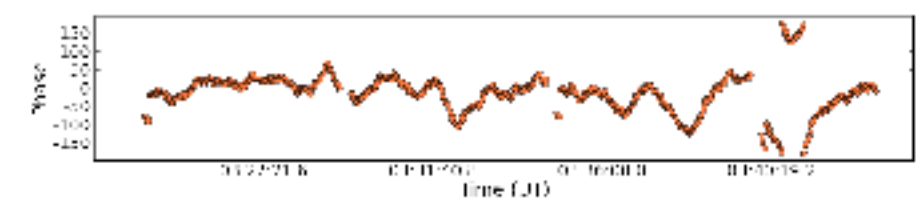
Antenna surface rms < 25 μm

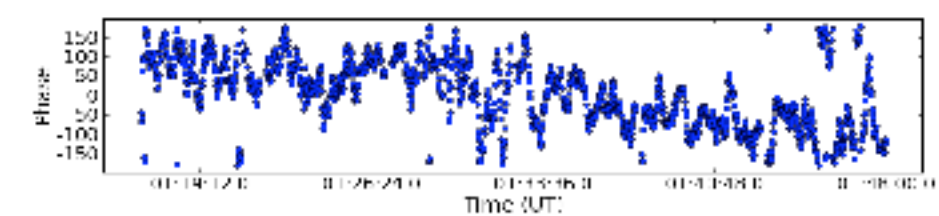
AOS – ALMA Operation Site (5000 m)

Correlator

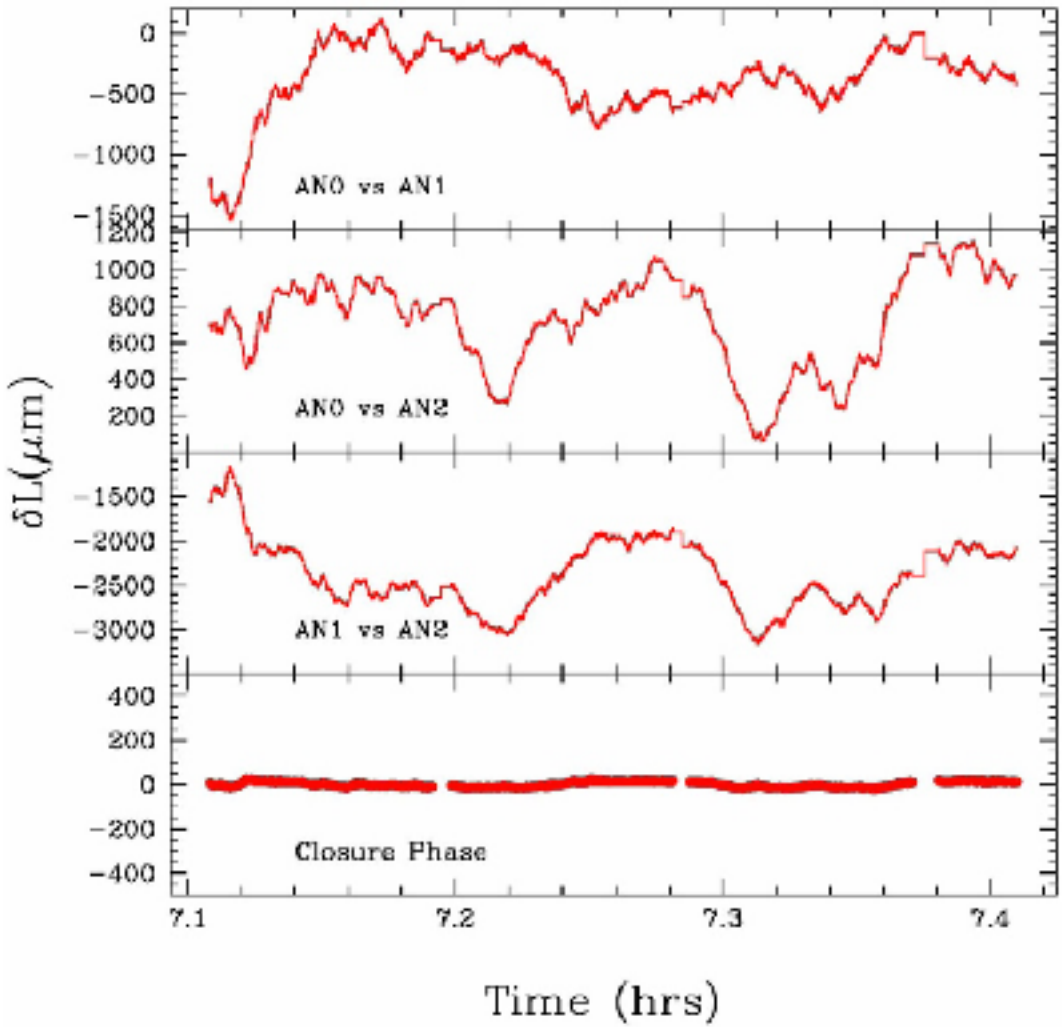




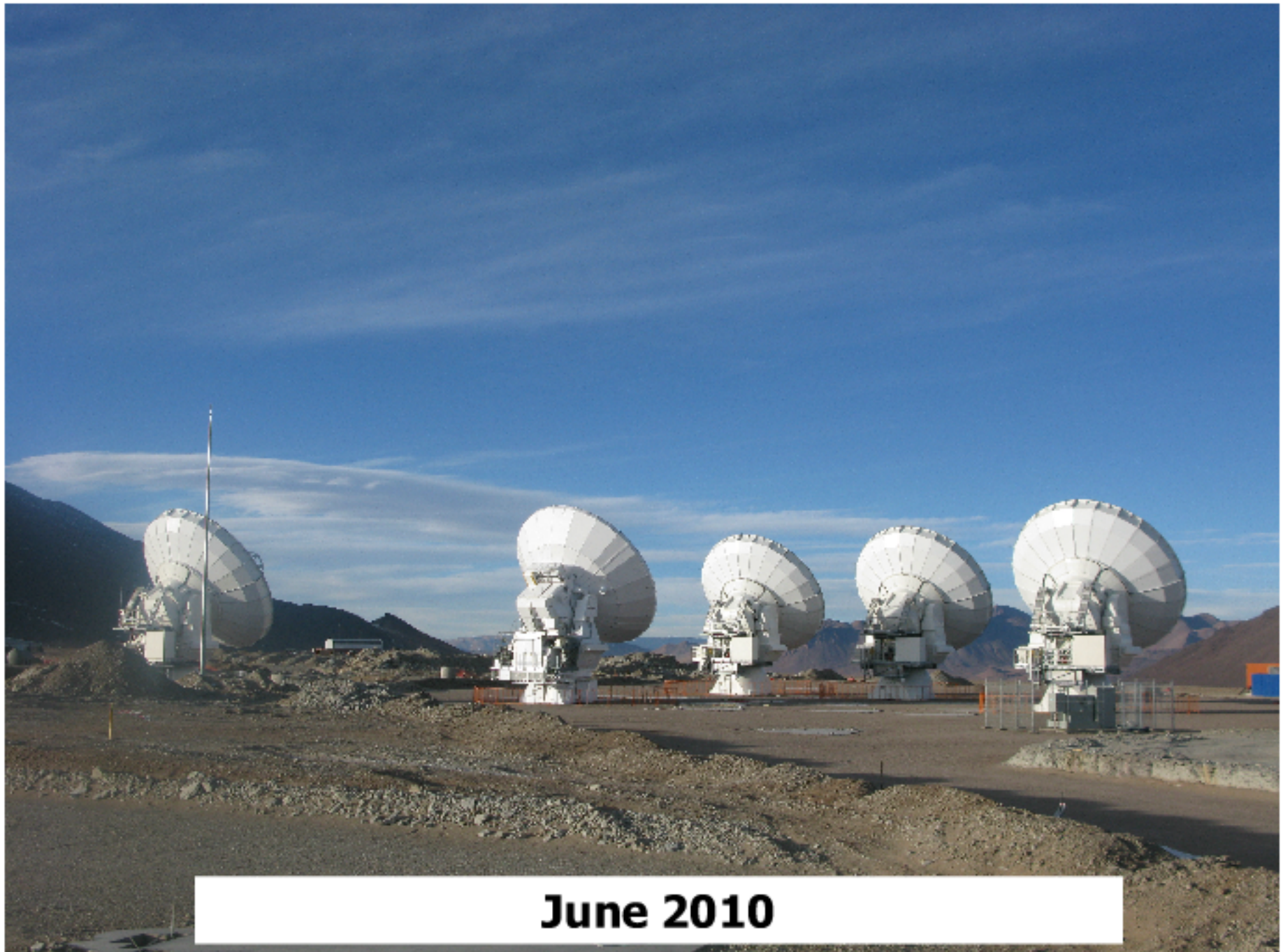


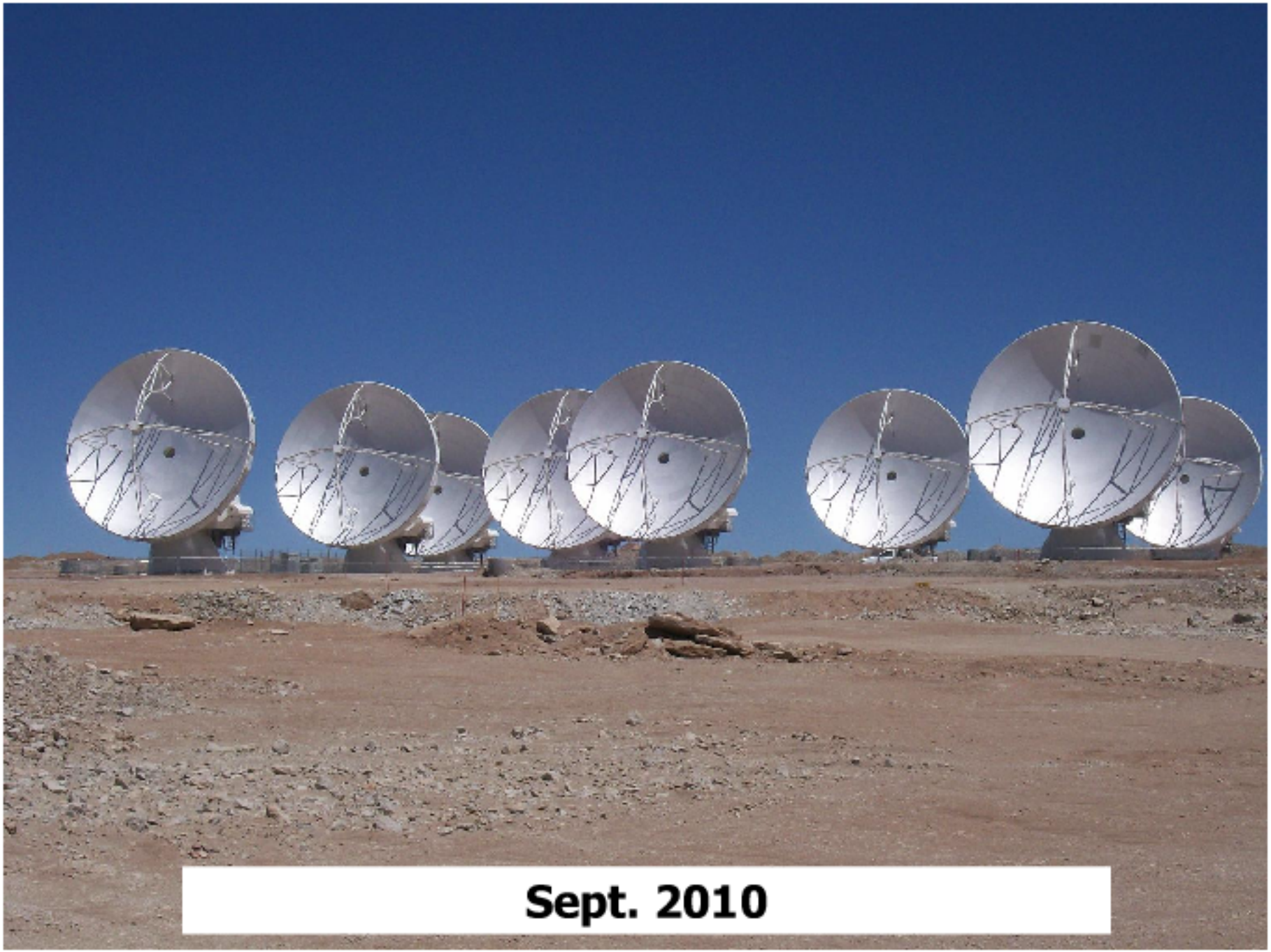


Two antennas interferometry (Nov. 2009)

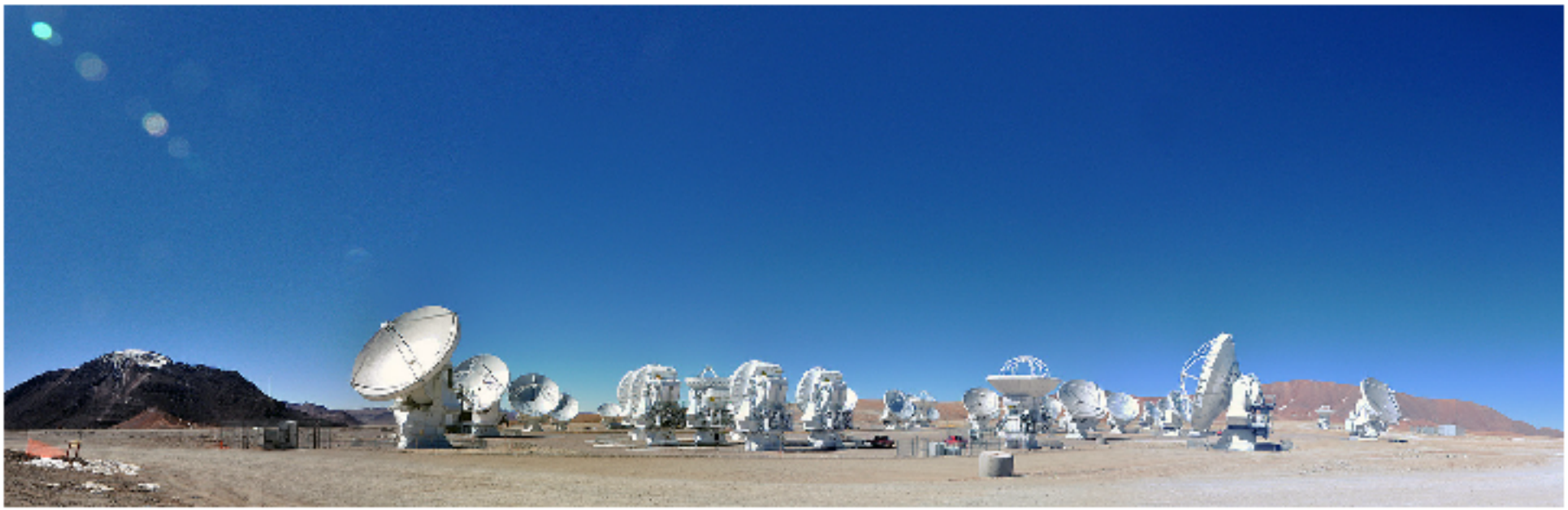


Three antennas interferometry (Dec. 2009)

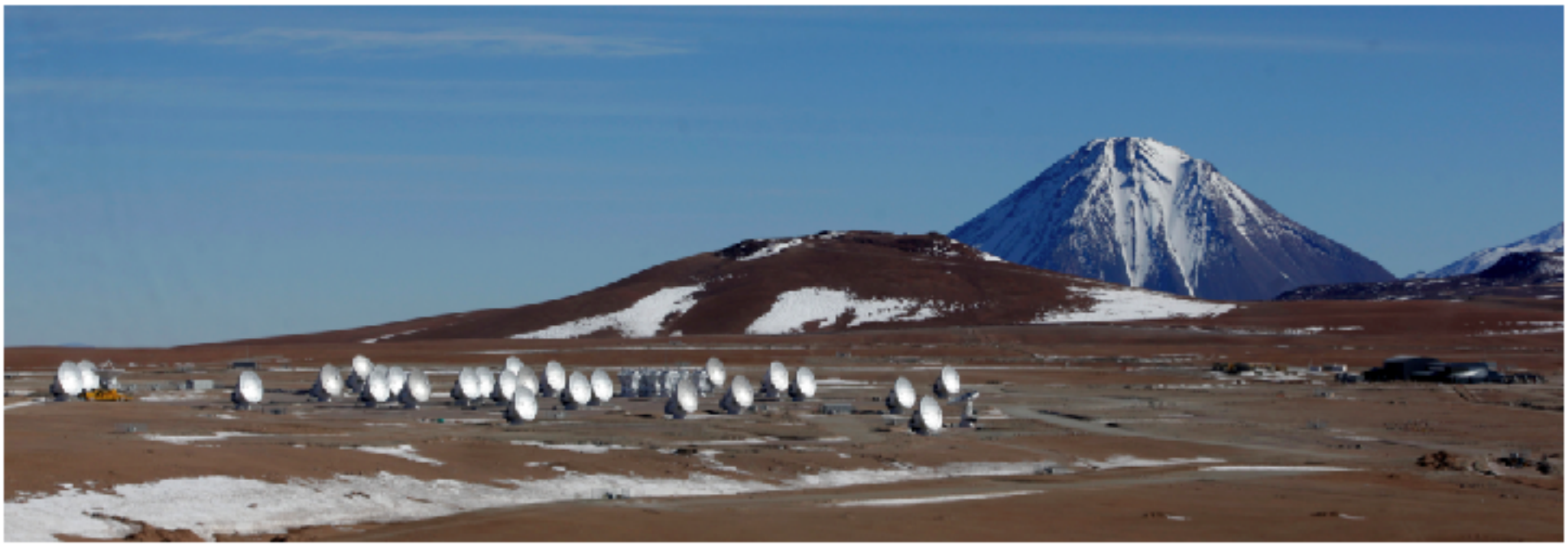

June 2010


Sept. 2010

June 2011



Summer 2012



Summer 2012


Summer 2012

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ALMA Operations

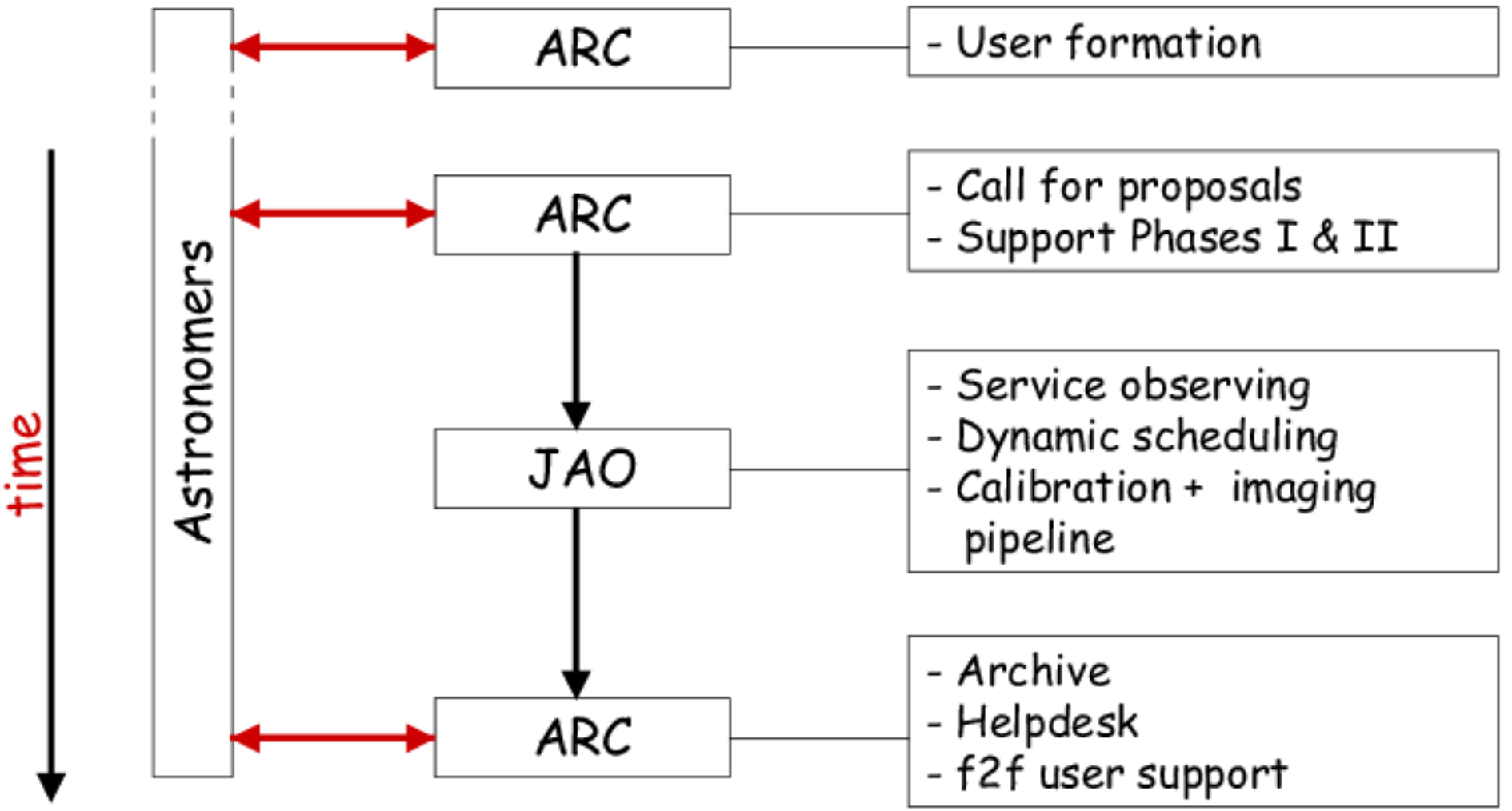
- **One call for Proposals per year**
- **One single Time Allocation Committee for NA+EU+EA**
- **Service observing**
  - PI not involved in the observations
- **Dynamic scheduling**
  - Best project in the queue determined every SB (hour scale)
  - Depends on weather + configuration + priority + balance between partners

ALMA Operations

- **Calibration and imaging pipeline**
  - Final product = data cube
- **Archive**
  - Raw data + pipeline products
  - Public after 12 months
- **ALMA Regional Centers (ARC)**
  - Scientific operations & user support outside Chile
  - Contact point between users and ALMA
  - Three ARCs

EUROPEAN ARC
ALMA Regional Centre

ALMA Regional Center



European ARC

Core tasks → ESO Garching

- Call for proposals, Phase I, Phase II
- Basic user support (helpdesk)
- Data product support = delivering data and software
- ALMA archive operations

http://www.eso.org/sci/facilities/alma/arc/

Same services are provided at Charlottesville (NAASC) and Tokyo

European ARC

Additional tasks → ARC nodes

- User formation & community development
- Face-to-face support (core task)
- Special projects (extended archive & data reduction support)
- New developments

Seven ARC nodes in Europe

- INAF Bologna (I)
- Univ. Bonn (D)
- IRAM (F,D,E)
- Leiden Obs. (NL)
- Manchester Obs. (UK)
- Onsala Obs. (S,DK,SF)
- Prague (CZ)

- All nodes open to all European scientists but target own community
- IRAM → French, German, and Spanish communities

ALMA observing time

- No guaranteed time
- One single TAC for NA+EU+EA
- A world-wide collaboration
  - EU 33.75%, NA 33.75%, EA 22.5%, Chile 10%
  - In ESO: D~21%, F~16%, E~9%
  - In ALMA: D~7%, F~5.5%, E~3%
- Huge competition

ALMA Early Science

Cycle 0

- 2011-2012; pression ~ 10

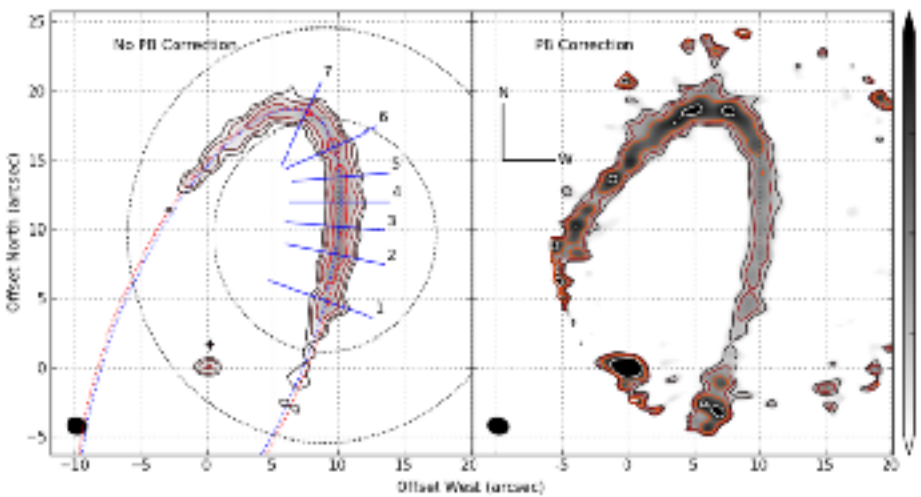
Cycle 1

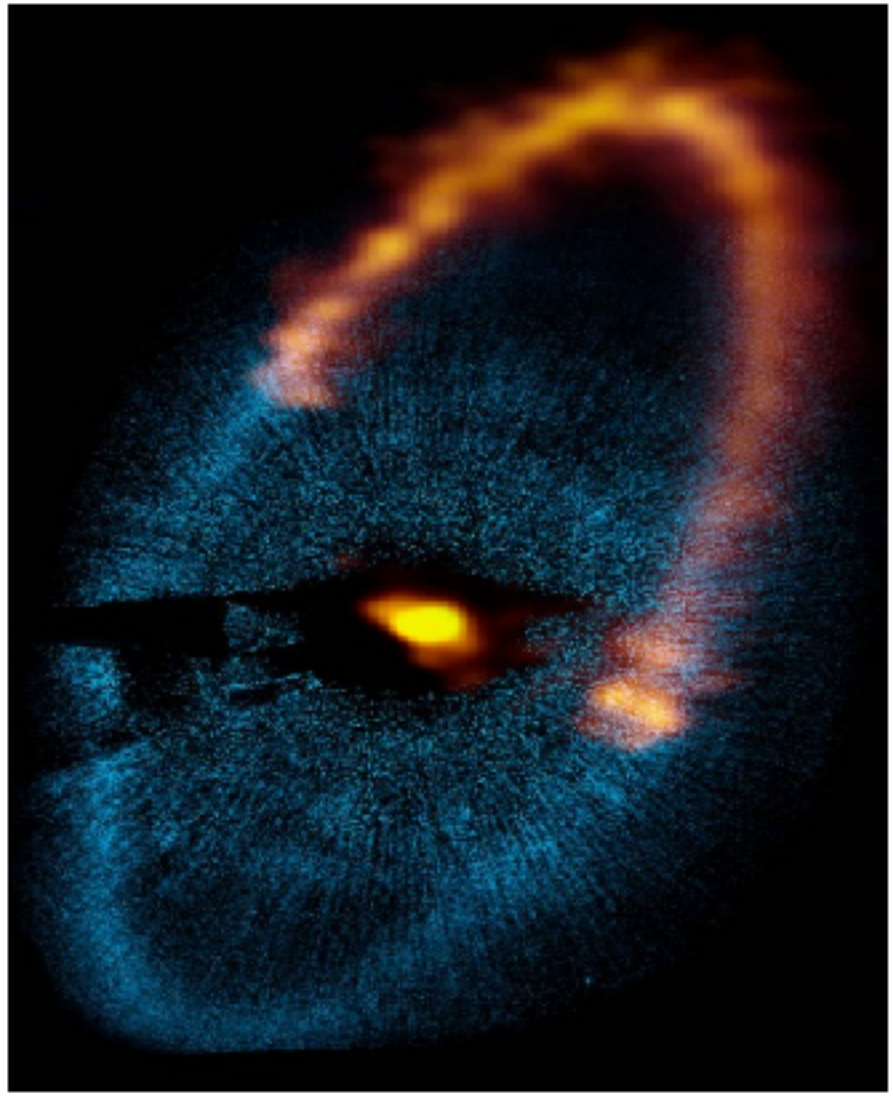
- Deadline July 2012
- Observations in 2013
- Four bands: B3, B6, B7, B9
- 32 antennas
- Baselines up to 1 km
- ACA & SD

Cycle 2

- Deadline mid 2013

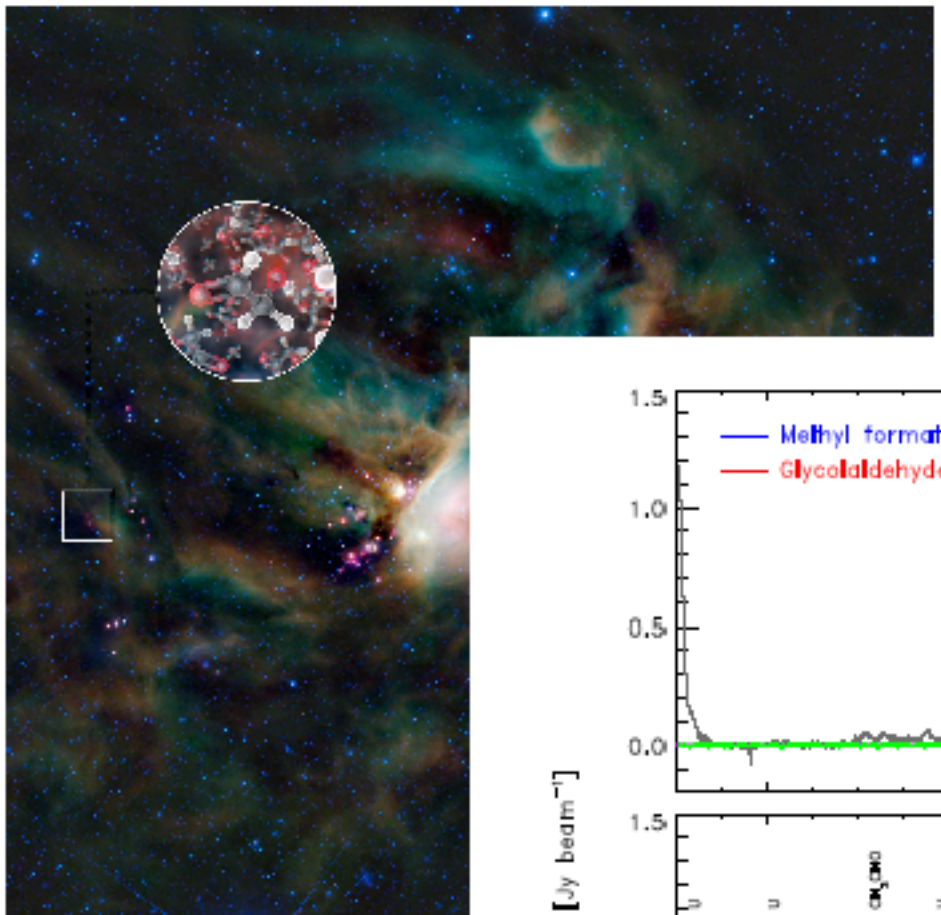
ALMA	IRAM	GHz
B3	B1	84-116
B6	B3	211-275
B7	B4	275-373
B9	--	602-720

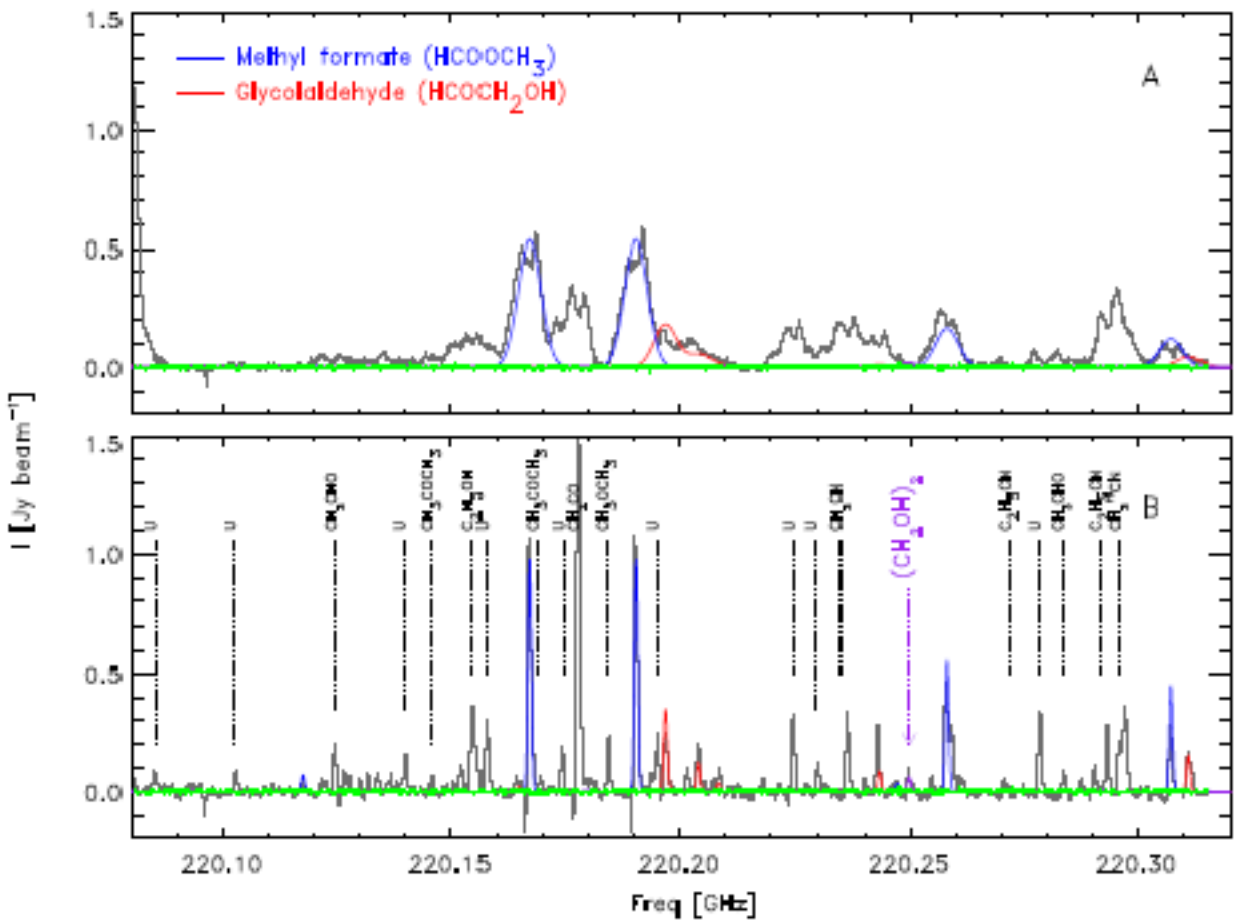




Fomalhaut,
Boley et al. 2012

Complex molecules in IRAS16293

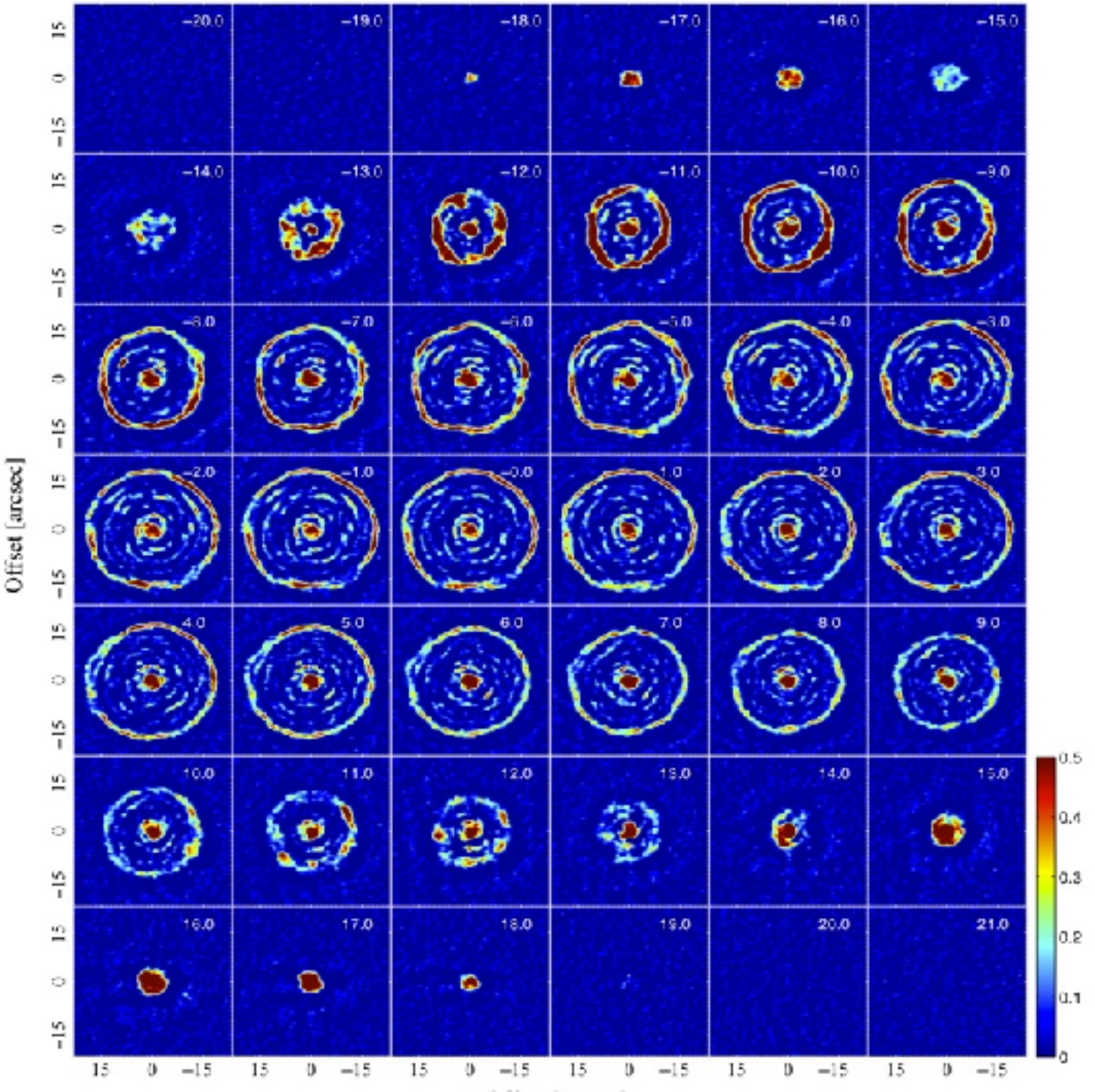




Jorgensen et al. 2012

AGB star RScl

(Maercker et al. 2012)



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ARC node @ IRAM

Why an ARC node at IRAM?

- Strong IRAM involvement in ALMA construction
- **Already existing center of expertise** in mm interferometry
  - Expertise on pipeline, calibration, imaging, atmospheric phase correction, data analysis…
  - Close link with technical groups
- **Plateau de Bure user support → only delta effort**
- IRAM users are all potential ALMA users → **IRAM community in best possible position** to get time on ALMA

ARC node @ IRAM

User formation

- Plateau de Bure
- Visitors
- Schools

Developments

- New algorithms & soft.
- ALMA software

User support

- Helpdesk
- f2f support

ARC node @ IRAM

User formation

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Developments

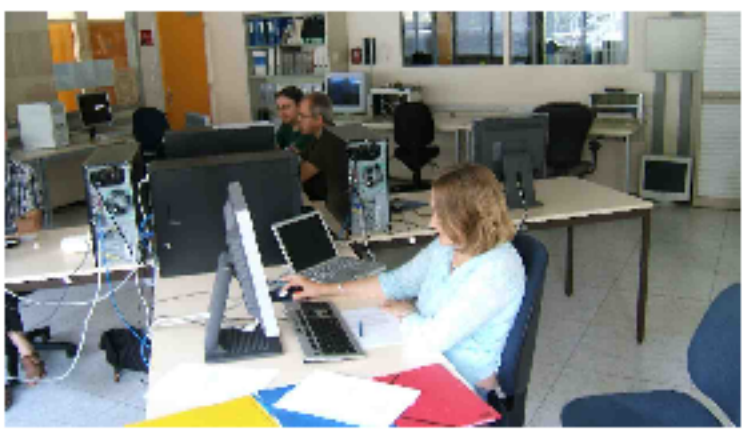
- New algorithms & soft.
- ALMA software

User support

- Helpdesk
- f2f support → Key goal

f2f support

- **Main goal of the ARC node**
- **Extend PdBI f2f support to ALMA**
  - Local contact assigned to each project
  - Use existing infrastructures and procedures
  - Travels to Grenoble will be funded by IRAM (same rules as PdBI)



f2f support

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  - Local contact assigned to each project
  - Use existing infrastructures and procedures
  - Travels to Grenoble will be funded by IRAM (same rules as PdBI)
  - Must be in place for Early Science = **end 2011**

http://www.iram-institute.org > ARC Node

ARC NODE
ALMA
RAM Node of the European ALMA Regional Center

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ARC NODE

RAM Node of the European ALMA Regional Center