

# An introduction to ALMA and the AOT

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Horizon 2020 research and innovation programme under grant  
agreement No 730562*

# ALMA

*ALMA is a submm telescope designed to observe at 0.32-9.5mm (31-950 GHz)*

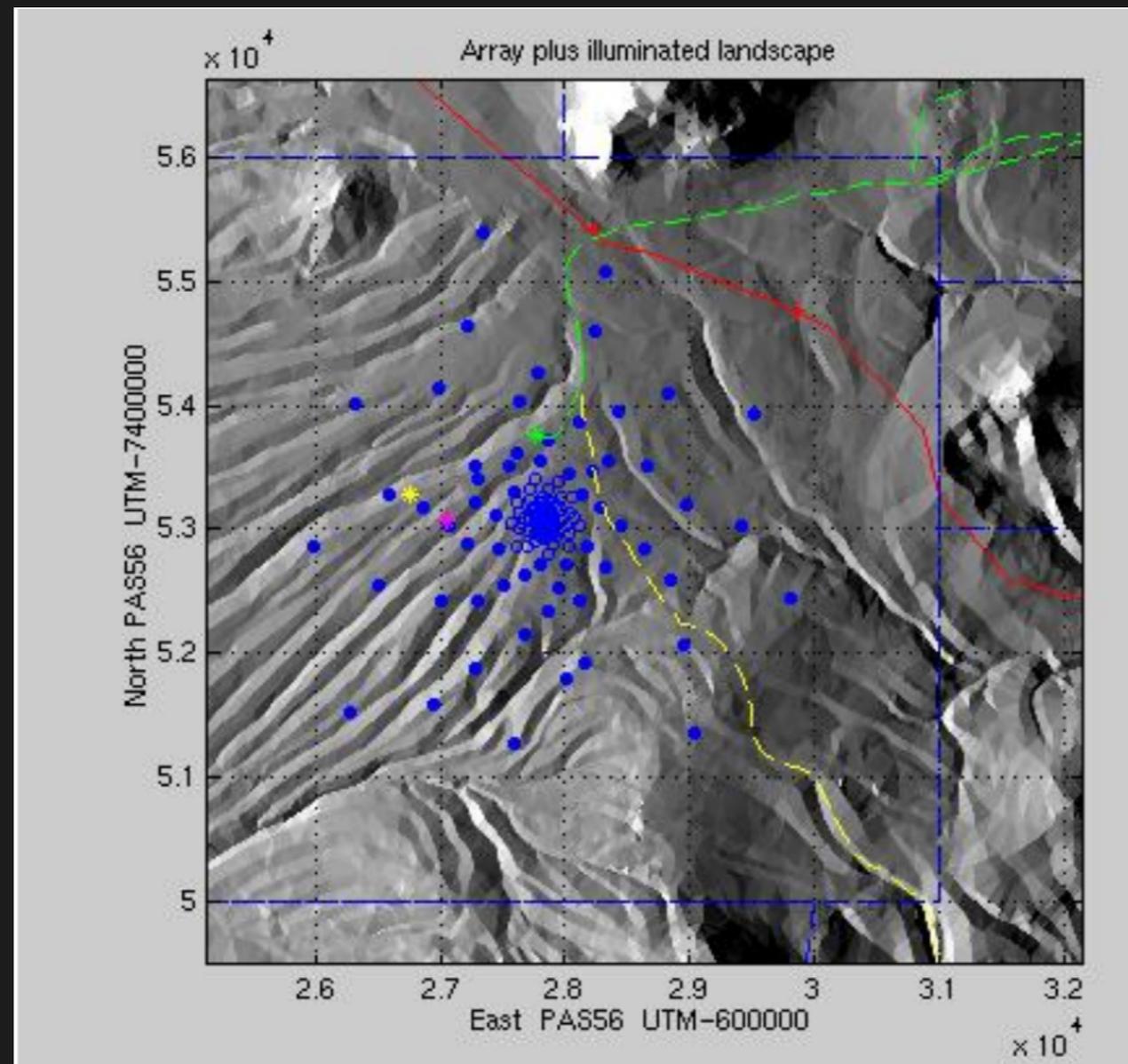
- It is located in Chile at 5000 m of altitude*
- 66 reconfigurable high-precision antennas*
- angular resolution as small as 0.005"*
- velocity resolution 0.008 km/s*



# ALMA

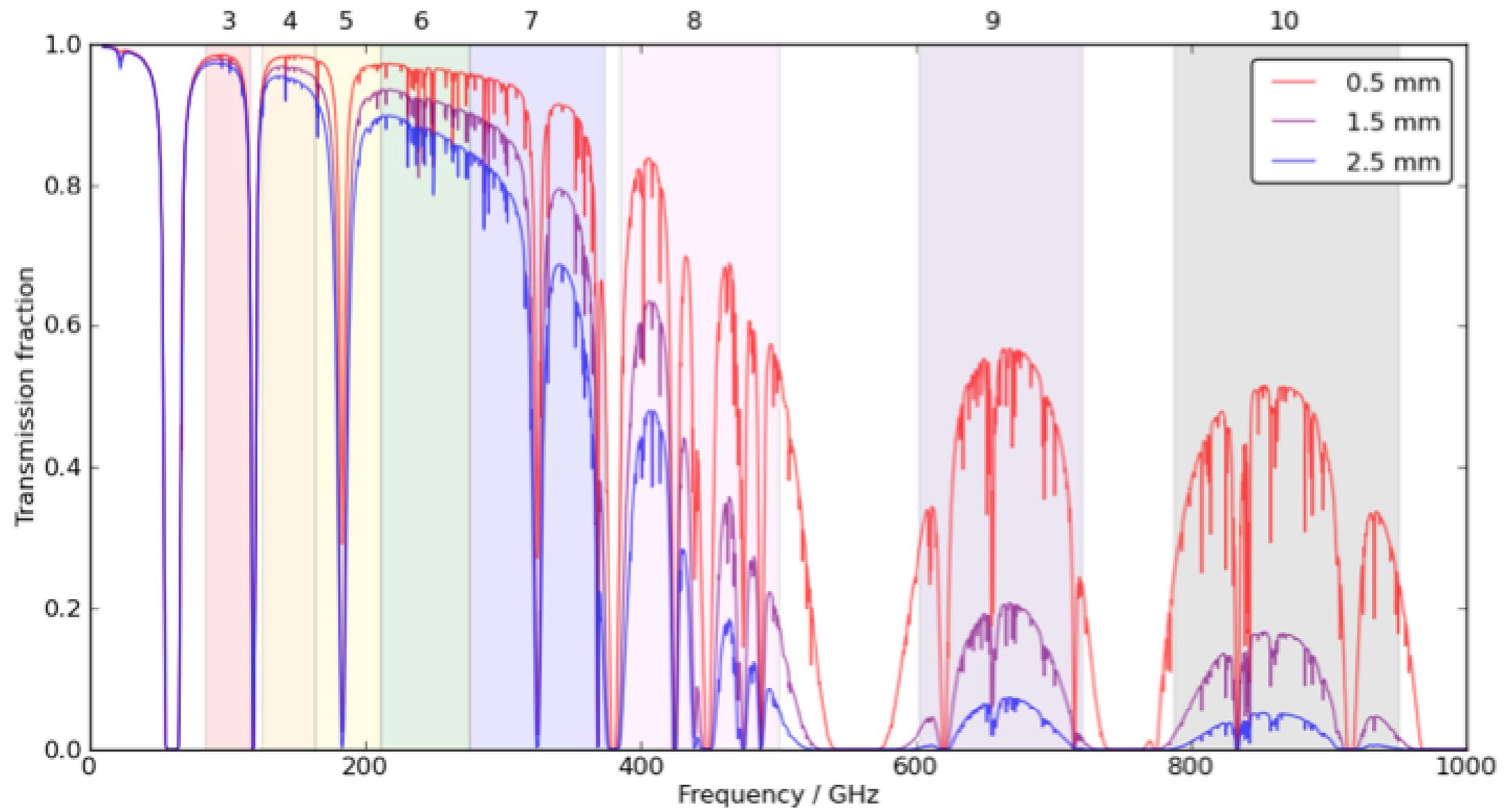
*ALMA is a submm telescope designed to observe at 0.32-9.5mm (31-950 GHz)*

- It is located in Chile at 5000 m of altitude*
- 66 reconfigurable high-precision antennas*
- angular resolution as small as 0.005"*
- velocity resolution 0.008 km/s*
- maximum baseline from 150 m to 16 km*



# ALMA

*ALMA is a submm telescope designed to observe at 0.32-9.5mm (31-950 GHz)*



# ALMA

*The design of ALMA has 3 key goals:*

*1 - 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*

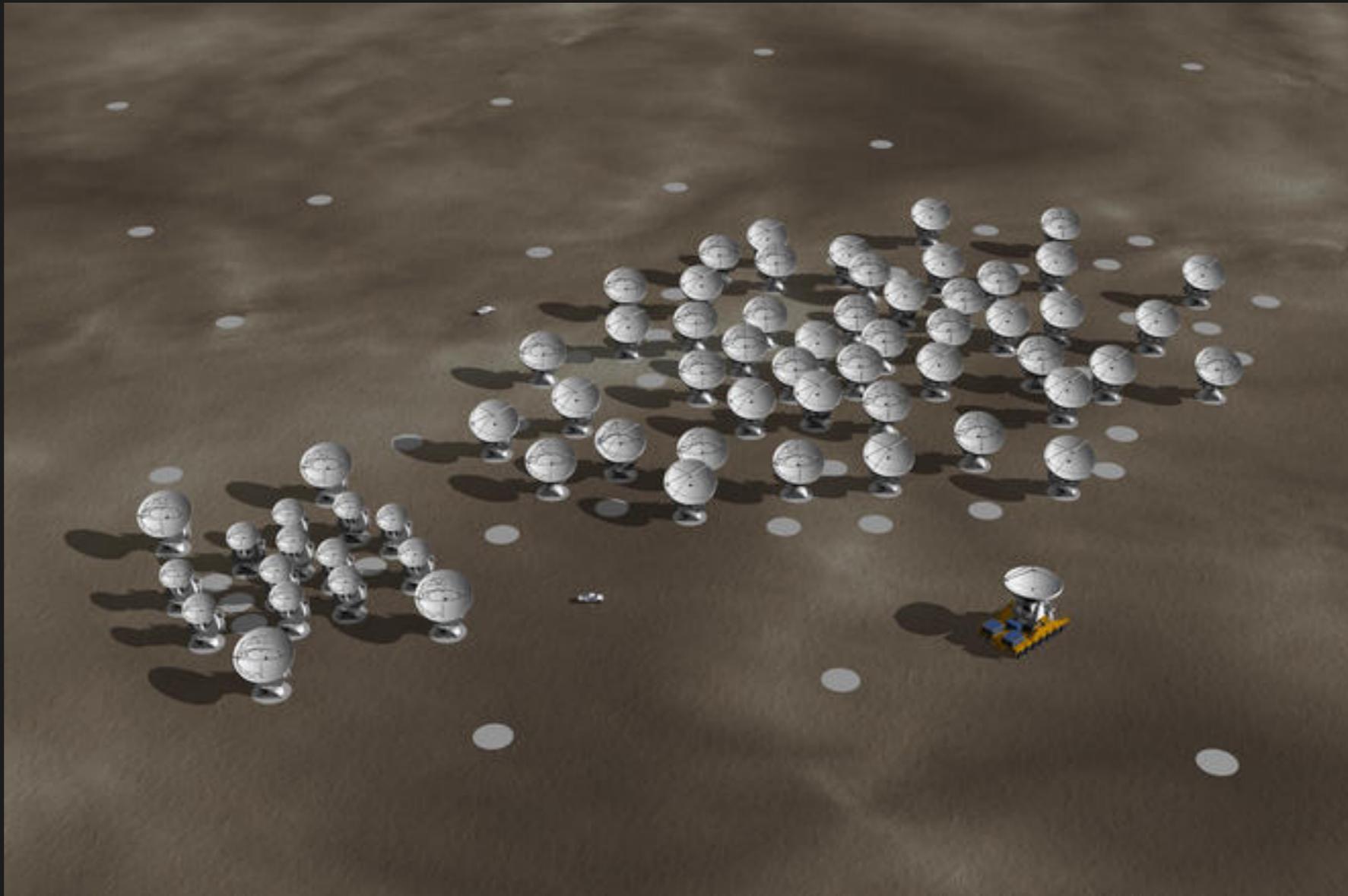
*2 - The ability to image the gas kinematics in protostars and in protoplanetary disks around young Sun-like stars in the nearest molecular clouds (150 pc)*

*3 - The ability to provide precise high dynamic range images at an angular resolution of 0.1 arcsec.*

# ALMA

*ALMA has 3 subarrays with different size structures:*

- *Main array: 50 ant. with  $D = 12\text{ m}$*
- *ACA Atacama Compact Array (12 ant. with  $D = 7\text{ m}$ )*
- *The total power antennas (4 ant. with  $D = 12\text{ m}$ )*



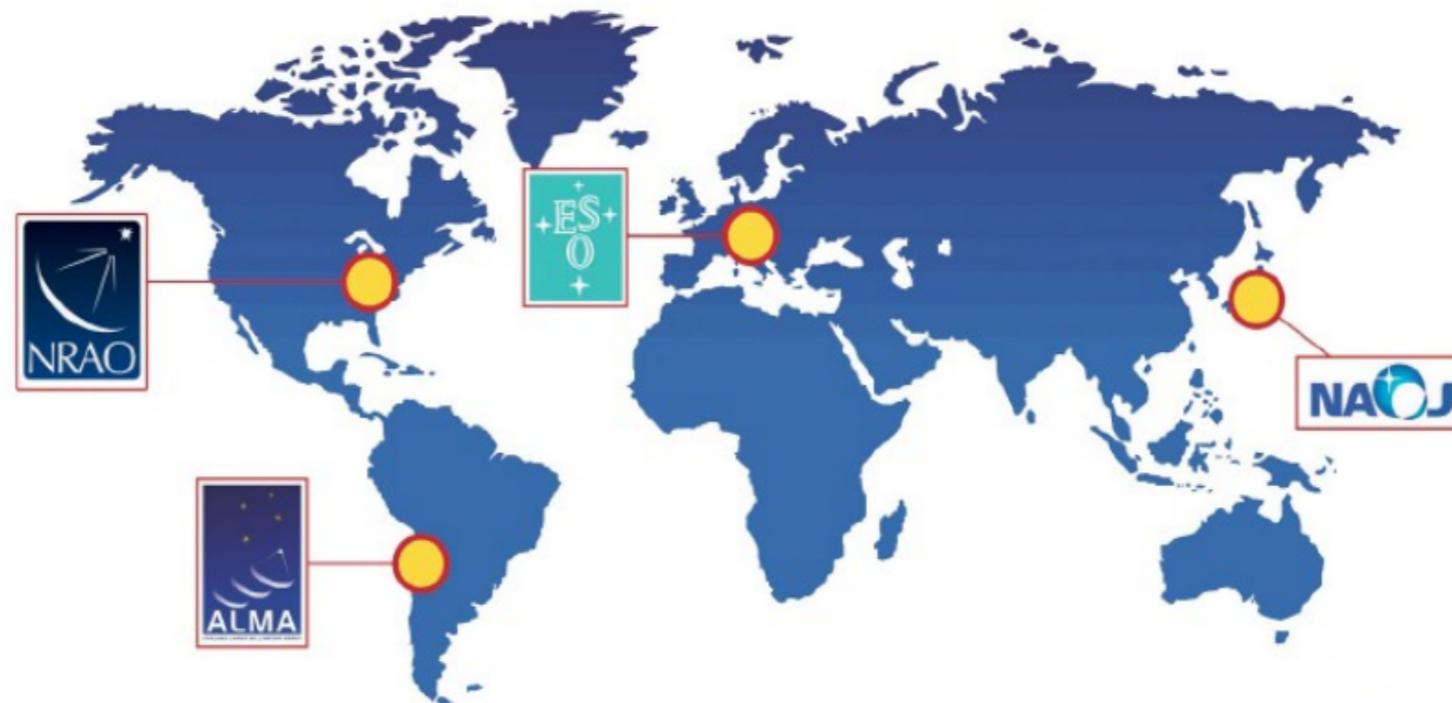
# ALMA

*The management of ALMA is quite complex because it involves 4 institutions, whose 3 pre-existed before ALMA, and had already their own internal management.*

## ALMA organization

### ALMA is a world wide collaboration

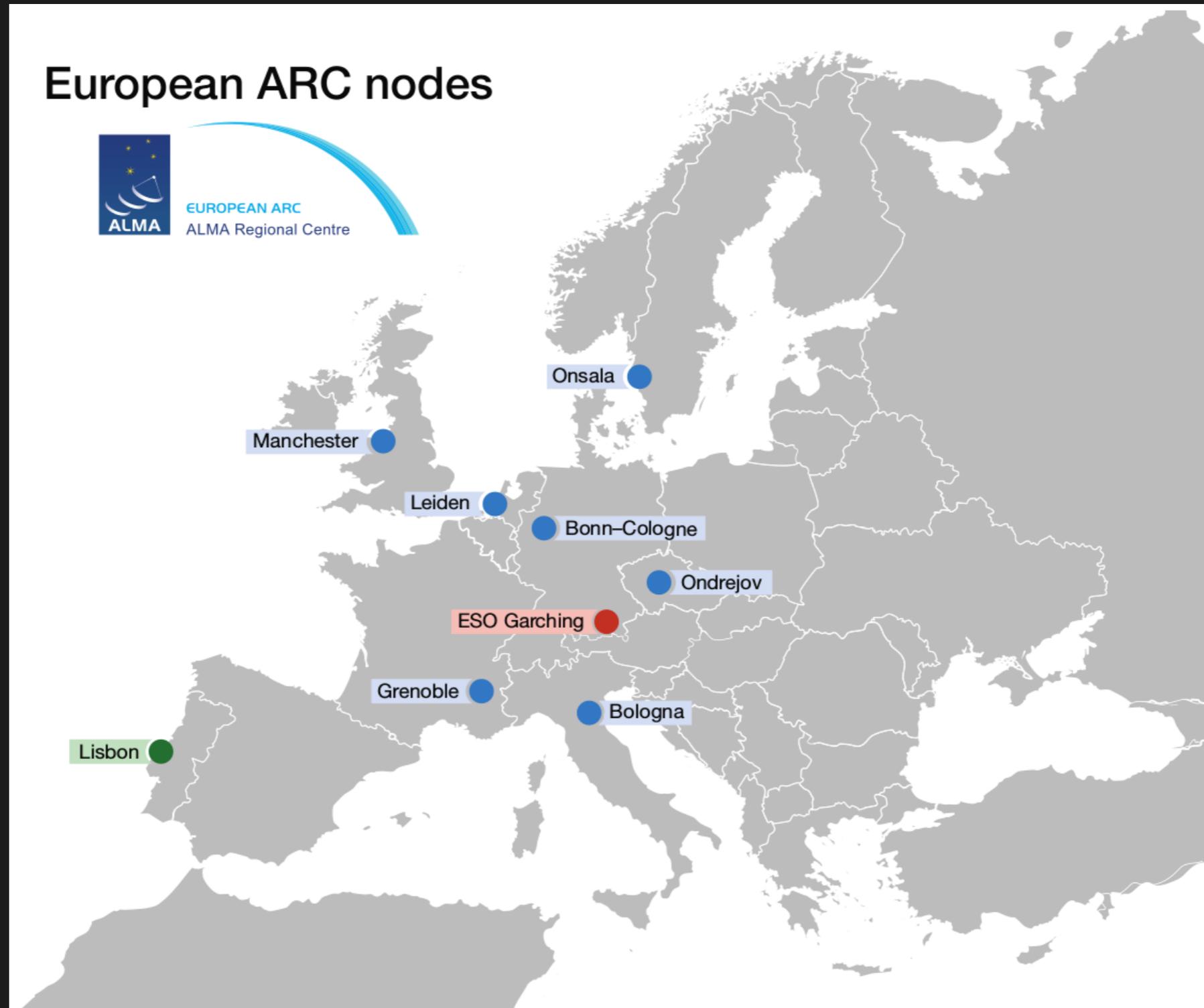
Contributors share the observing time and host a mirror of the archive



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

# ALMA

*In this context Europe, i.e. the ESO, proposed a different approach, building a network of ALMA Regional Center, to optimize the different expertise developed within the different European countries*

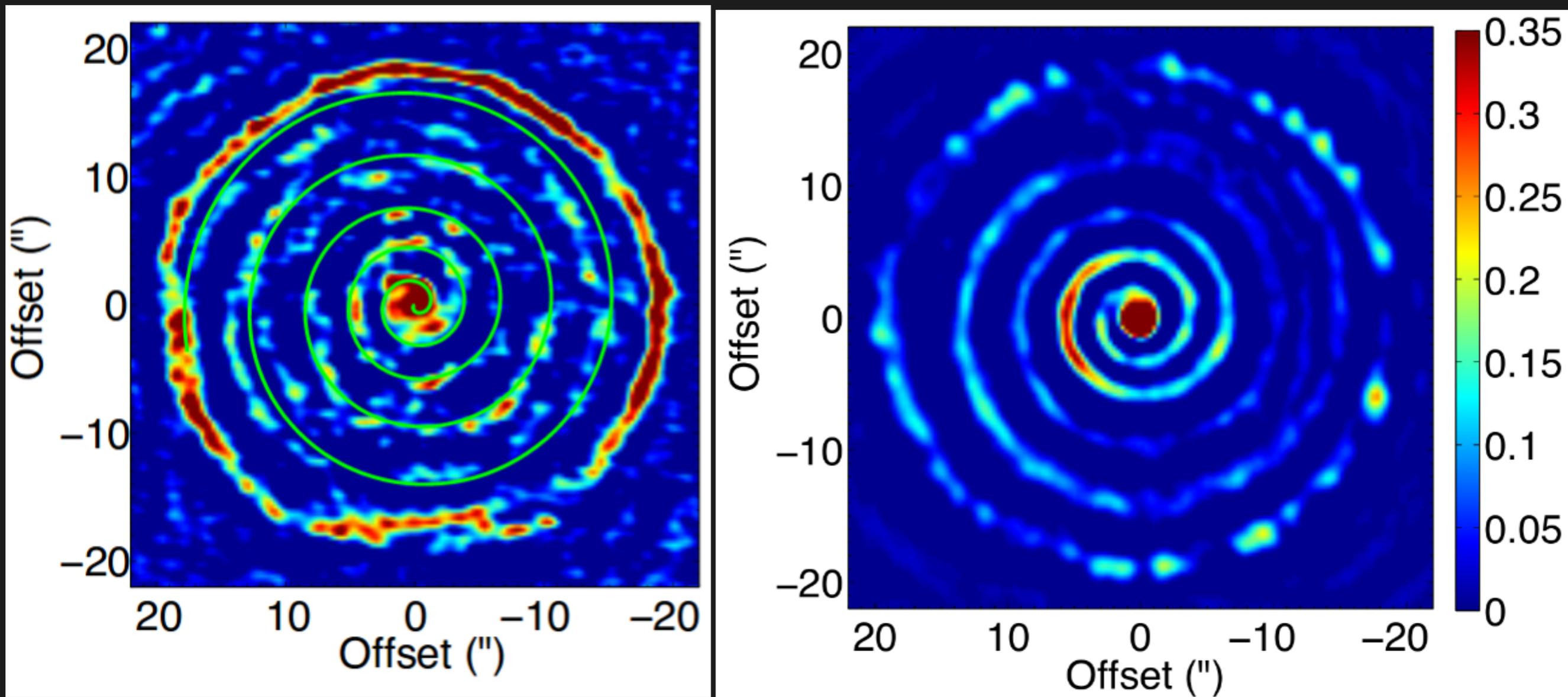


***Does it worth the effort?***

# Highlight from ALMA

*AGB star R Sculptoris loses shells of gas and dust during its thermal pulses phase.*

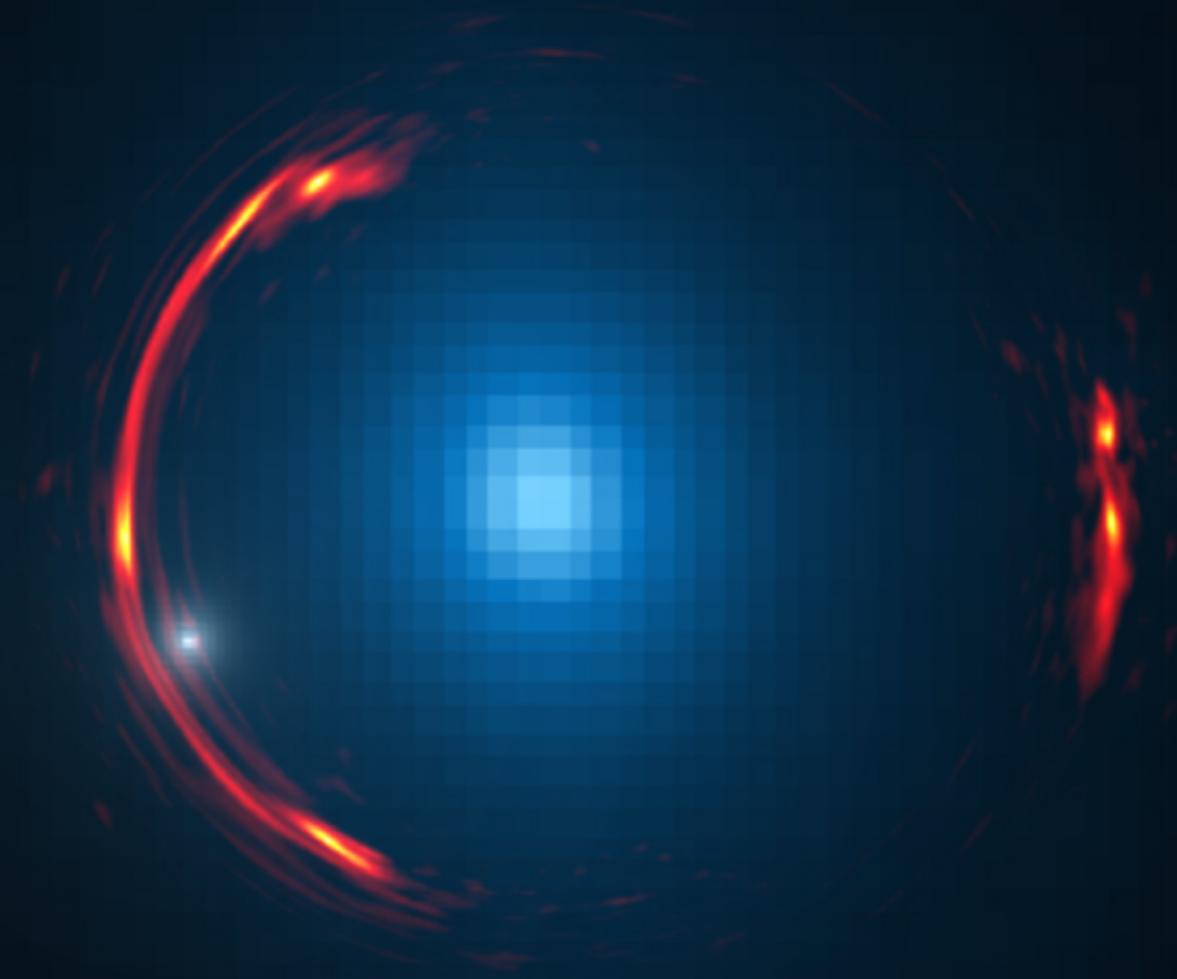
*15 ant. - 4 hs - Band 7 (CO 3-2) - Res 1.3''*



# Highlight from ALMA

*Lensed submm galaxy at  $z = 3.042$  (lens at  $z = 0.299$ )*

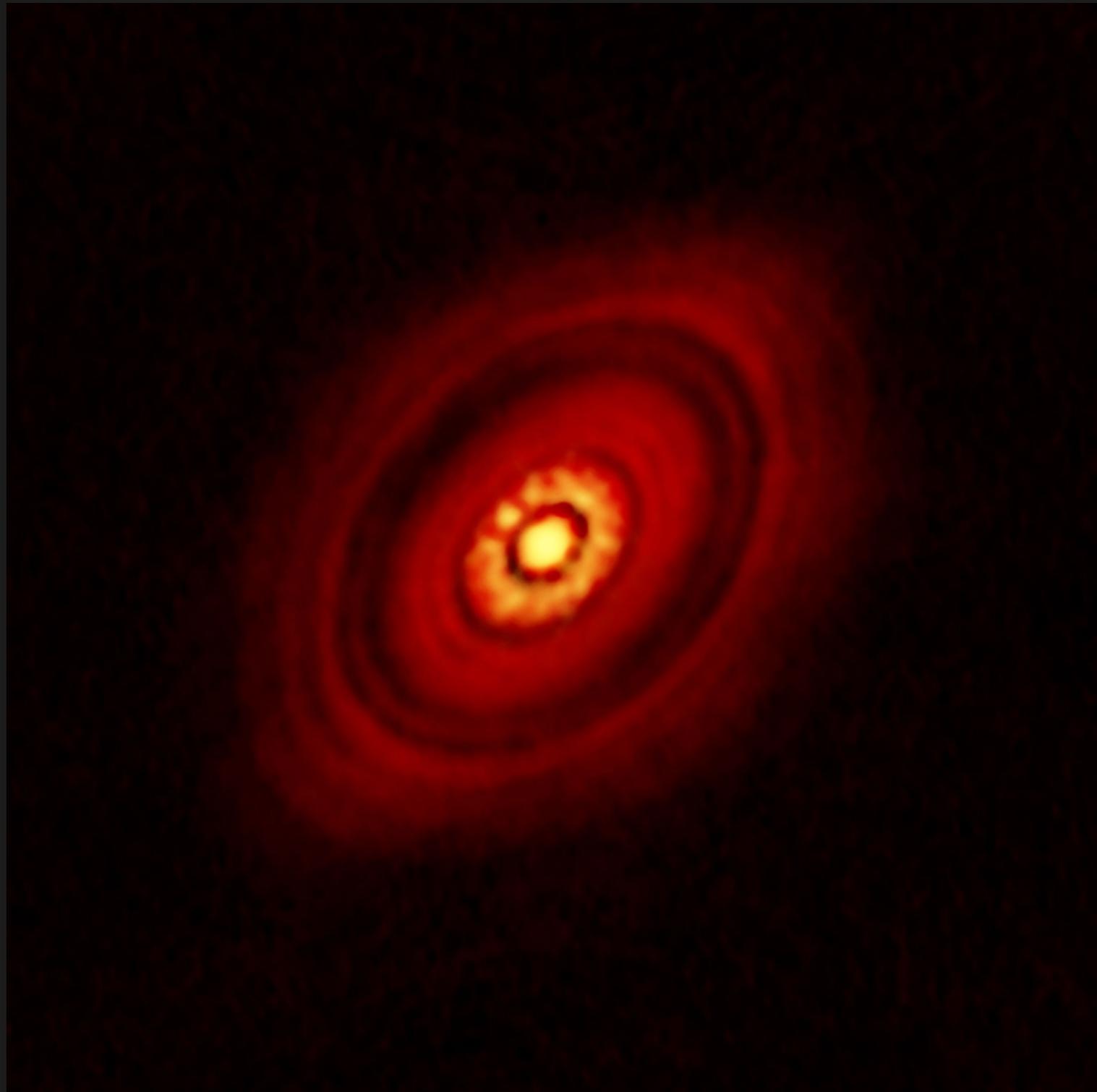
*Long Baseline campaign -  $31 \times 23$  mas = 10-20 pc - Band 6*



# Highlight from ALMA

*HL- Tau – Young T-T star*

*Long Baseline campaign – 30 x 19 mas – Band 3, 6, 7 continuum*



# ALMA website

*almascience.org*

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

Search Site

ESO NRAO NAOJ Log in | Register | Reset Password | Forgot Account

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Knowledgebase/FAQ

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- NA ARC
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## Welcome to the Science Portal at ESO

**Overview**

The **Atacama Large Millimeter/submillimeter Array (ALMA)** is a major new facility for world astronomy. When completed in 2013, ALMA will consist of a giant array of 12-m antennas, with baselines up to 16 km, and an additional compact array of 7-m and 12-m antennas to greatly enhance ALMA's ability to image extended targets. ALMA will be outfitted with state-of-the-art receivers that cover atmospheric windows from 84–950 GHz (3mm – 300 micron). Construction of ALMA started in 2003 and will be completed in 2013. The ALMA project is an international collaboration between Europe, East Asia and North America in cooperation with the Republic of Chile. More details can be found via the **About ALMA** link in the left menu.

This is the website for **The ALMA Science Portal**, served from one of the **ALMA Regional Centers (ARCs)** of the ALMA partner organizations: ESO, NRAO or NAOJ. You may switch between the different instances of the portal through the links to the appropriate ALMA partner at the top banner. Through this portal you can find details about the technical capabilities of ALMA, how to propose for observing time, and how to access ALMA data. It includes links to all official ALMA documents and tools, including those for preparing and submitting proposals and processing ALMA data. In order to access some of the tools, users must register with the project and login to the portal via the links at the top banner.

### ALMA Newsletter

Newsletter No. 9  
May 23, 2012  
More...

### General News

ALMA Early Science Cycle 1: Outcome of the Proposal Review Process  
Nov 27, 2012

New release of ALMA Science Verification data  
Oct 23, 2012

Announcement of intent to release a new installment of Science Verification data  
Oct 16, 2012

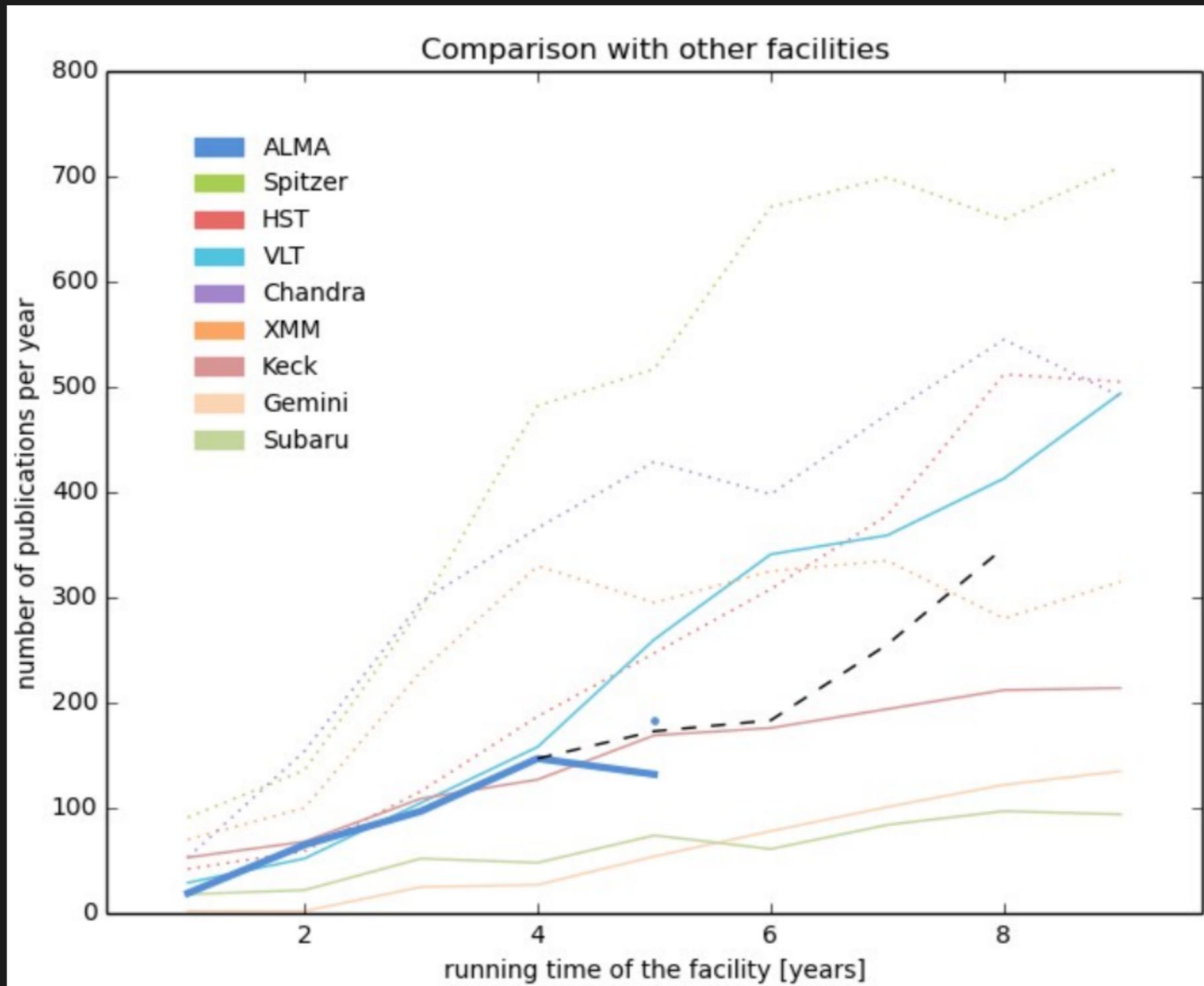
Update on ALMA Cycle 0 observations  
Oct 08, 2012  
More...

### Local News

Cycle 1 preparation workshops throughout

# ALMA Archive

*The ALMA archive is growing and the more and more scientists are using this huge data set for their investigation.*



# ALMA Archive

*To have a preliminary introduction:*

*<https://almascience.eso.org/alma-data/archive>*

*For the access:*

*<https://almascience.eso.org/aq/>*

# ALMA Archive

## ALMA Science Archive Query

Query Form

Results Table

Search

Reset

[Query Help](#)

### Position

Source name (Resolver)

Source name (ALMA)

SDC335.579-0.292

RA Dec

Angular resolution

Largest angular scale

### Energy

Frequency

Bandwidth

Spectral resolution

Band

### Time

Observation date

Integration time

### Polarisation

Polarisation type

### Observation

Water vapour

### Project

Project code

Project title

PI name

Project abstract

Publication count

### Publication

Authors

Title

Abstract

### Options

View:

raw data

project

publication

public data only

science observations only

# ALMA Archive

## ALMA Science Archive Query

Query Form

Results Table

Submit download request

[Results Bookmark](#) [Export Table](#) [Results Help](#)

Showing 3 of 3 rows.

[More columns](#)

<input type="checkbox"/>	Project code	Source name	RA	Dec	Band	Integration	Release date ▲	Velocity resolution	Frequency support	Pub
Filter:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/> m/s ▼	<input type="text"/>	<input type="text"/>
<input type="checkbox"/>	<a href="#">2011.0.00474.S</a>	SDC335.579-0.292	16:30:56.48	-48:43:36.4	3	1938.178	2014-03-01	184.58	<a href="#">90.62..105.14GHz</a>	<a href="#">1</a>
	<a href="#">2016.1.00810.S</a>	SDC335.579-0.292	16:30:59.21	-48:43:48.1	3	4838.4	In Progress	2774.69	<a href="#">90.61..106.01GHz</a>	<a href="#">0</a>
	<a href="#">2016.1.00810.S</a>	SDC335.579-0.292	16:30:59.21	-48:43:48.1	3	12413.808	In Progress	2774.70	<a href="#">90.61..106.01GHz</a>	<a href="#">0</a>

# ALMA Schedule

*Mid-March: Call for Proposals*

*Mid-April: deadline*

*August: Proposal Review*

*September: Submission Phase 2*

*End of September: End of the observations for the previous cycle*

*October: New Cycle*

*NB = All the proposals must be submitted electronically using the ALMA Observing Tool software (AOT)*

# Download ALMA AOT

*Two flavours: webstart and tarball. Warmly suggested to use webstart*



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



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ARCs

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- ALMA Calendars
- ELL ARC

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## Observing Tool

The ALMA Observing Tool (OT) is a Java application used for the preparation and submission of ALMA Phase I (observing proposal) and Phase II (telescope runfiles for accepted proposals) materials. It is also used for preparing and submitting Director's Discretionary Time (DDT) proposals. The current Cycle 3 release of the OT is configured for the Early Science Capabilities of ALMA as described in the [Cycle 3 Call For Proposals](#). Note that in order to submit proposals you will have to register with the ALMA Science Portal beforehand.

Note that preparation of Cycle 2 Phase II and DDT proposals needs to be done using the Cycle 2 version of the Observing Tool. This version of the OT can be found in the [DDT page](#), or the Phase II menu.

## Download & Installation

The OT will run on most common operating systems, as long as you have **Java 8** installed (see the [troubleshooting page](#) if you are experiencing Java problems). The ALMA OT is available in two flavours: Web Start and tarball.

The **Web Start** application is the recommended way of using the OT. It has the advantage that the OT is automatically downloaded and installed on your computer and it will also automatically detect and install updates. There are some issues with Web Start, particularly that it does not work with the Open JDK versions of Java such as the "Iced Tea" flavour common on many modern Linux installations. The Sun/Oracle variant of Java should therefore be installed instead. If this is not possible, then the tarball installation of the OT is available.

The **tarball** version must be installed manually and will not automatically update itself, however there should be no installation issues. For Linux users, we also provide a download complete with a recommended version of the Java Runtime Environment. Please use this if you have any problems running the OT tarball install with your default Java.

Webstart

Tarball

## Documentation

Extensive documentation is available to help you work with the OT and optimally prepare your proposal:

- If you are a novice OT user you should start with the [OT Quickstart Guide](#), which takes you through the basic steps of ALMA proposal preparation.
- Audio-visual illustrations of different aspects of the OT can be found in the [OT video tutorials](#). These are recommended for novices and advanced

# ALMA AOT

The screenshot shows the ALMA AOT interface with several key components highlighted by callouts:

- Menu:** Located at the top left, containing File, Edit, View, Tool, Search, and Help.
- Toolbar:** Located below the menu, containing various icons for file operations and editing.
- Project Structure Pane:** Located on the left side, showing a tree view of the project structure (Unsubmitted Proposal, Project, Proposal). It includes a callout for "Expand/collapse project tree" and "Navigate the project tree".
- Editor Pane:** Located in the center, containing a form for "Principal Investigator" information, including fields for Project, Assigned Priority, Project Code, and Staff Only options. It includes a callout for "Define the Setup".
- Feedback Pane:** Located below the editor pane, containing a table for "Validation feedback" with columns for Description and a callout for "Validation feedback".
- Overview Pane:** Located at the bottom, containing a "Contextual Help" section with instructions on how to create a new proposal, and a "Phase I: Science Proposal" flowchart showing steps: New Science Proposal, Create Science Goals, Validate Science Proposal, and Submit Science Proposal. It also includes buttons for "Importing And Exporting", "Template Library", "Need More Help?", and "View Phase 2 Steps".

# ALMA AOT

*Start: Project PI and add a science goal*

The screenshot displays the ALMA AOT web interface. At the top, there is a menu bar with 'File', 'Edit', 'View', 'Tool', 'Search', and 'Help'. Below the menu is a toolbar with various icons. The main interface is divided into two main sections: 'Project Structure' on the left and 'Editors' on the right.

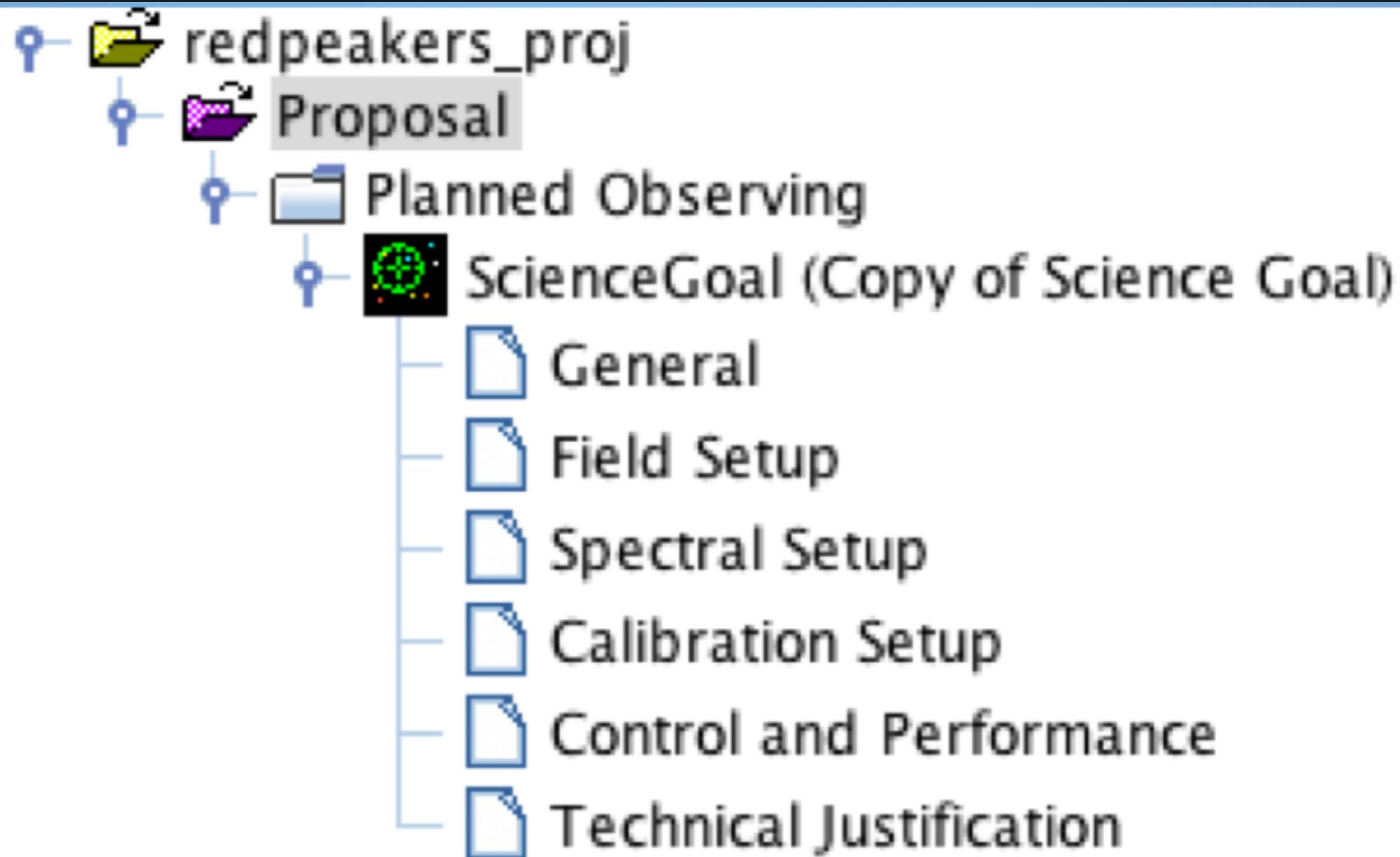
**Project Structure:** This section shows a tree view of the project. The root is 'Unsubmitted Proposal', which contains a folder 'Bother the aliens'. Inside 'Bother the aliens', there is a 'Proposal' folder, which in turn contains a 'Planned Observing' folder.

**Editors:** This section is titled 'Proposal Information' and contains several form fields and options:

- Proposal Title:** A text box containing 'Bother the aliens'.
- Proposal Cycle:** A text box containing '2013.1'.
- Abstract (max. 1200 characters):** A large text area containing the text 'Survey on the different method to bother an alien'. Below this text area is a 'Launch Editor' button.
- Proposal Type:** A radio button group with two options: 'Standard' (selected) and 'Target Of Opportunity'.
- Scientific Category:** A radio button group with five options: 'Cosmology and the High Redshift Universe', 'Galaxies and Galactic Nuclei', 'ISM, star formation and astrochemistry', 'Circumstellar disks, exoplanets and the solar system' (selected), and 'Stellar Evolution and the Sun'.
- Keywords (max. 2 keywords):** A list box containing several keywords: 'Debris disks', 'Disks around low-mass stars', 'Disks around high-mass stars', 'Exo-planets' (highlighted), and 'Solar system - Comets'.
- Student project:** A checkbox that is currently unchecked.
- Continuation:** A checkbox that is currently unchecked, with the text '(Not Applicable)' next to it.
- Related Proposals:** An empty text box.

# ALMA AOT

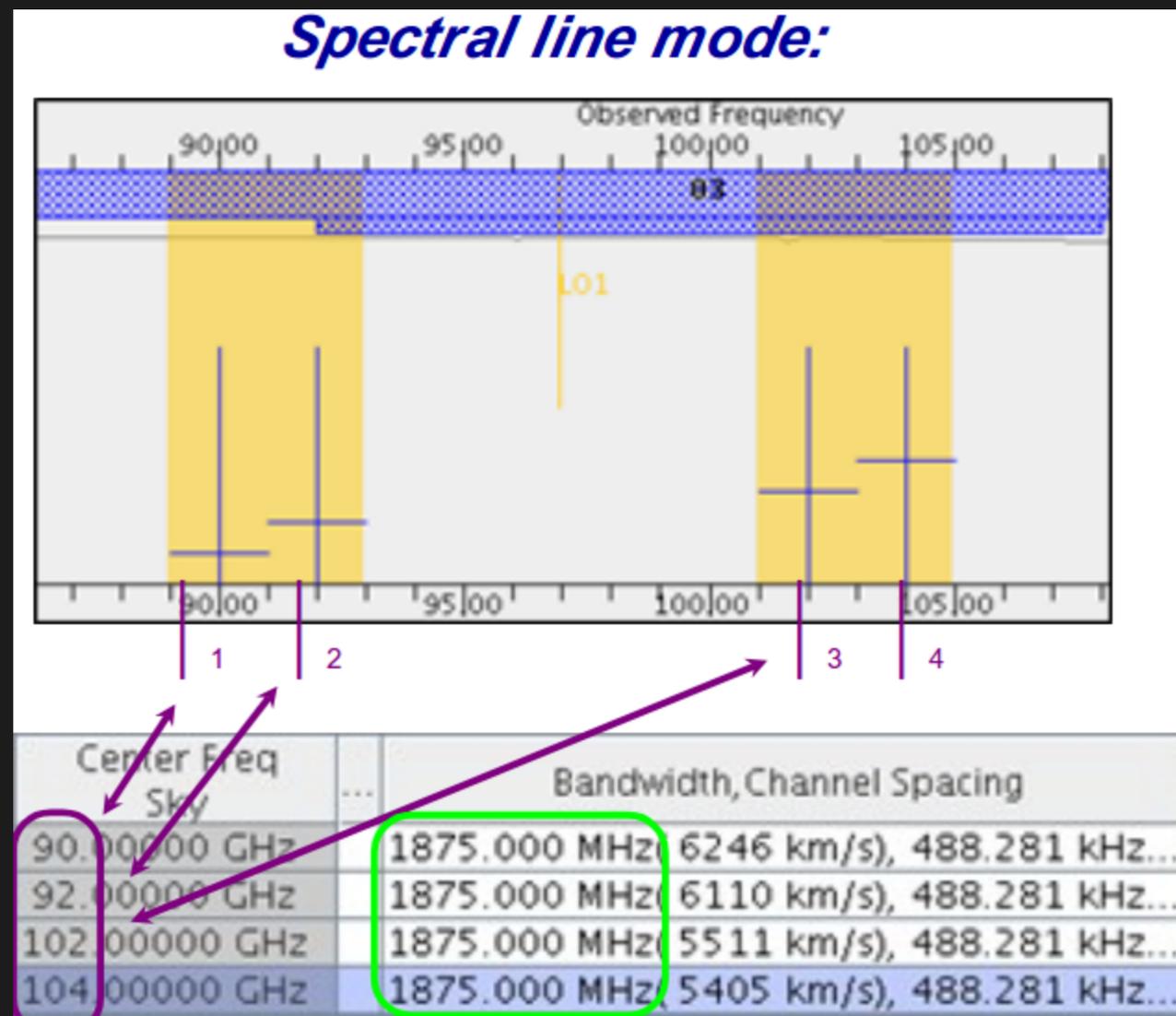
*A Science goal contains all the necessary fields to perform an observations*



# ALMA Spectral Setup

The PI defines the spectral setup according to the specifications of the ALMA receiver:

Once defined the frequency range to observe up to four 2GHz wide Basebands can be placed. Within each Basebands it is possible to place up to 4 spectral windows, with bandwidth from 59.59 MHz up to 1.875 GHz



# ALMA AOT

*In spectral setup the PI put details about the band and the resolution.*

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

Spectral Type

- Spectral Line
- Single Continuum
- Spectral Scan

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors

Spectral Scan

Requested start frequency (sky) 84.00000 GHz

Requested end frequency (sky) 114.50000 GHz

Requested range (rest) 84.5549 GHz - 115.2564 GHz

Achieved scan range (sky) 84.0625 GHz - 114.8125 GHz

Bandwidth, Resolution (Hanning smoothed) 1875.000 MHz( 5664 km/s), 7.813 MHz(23.598 km/s)

Spectral averaging 16

Representative frequency (sky) 99.43800 GHz

The representative frequency defined in the observed frame is used in conjunction with the sensitivity entered on the 'Control and Performance' page to estimate the required observing time and to set the size of the antenna beam shown in the 'Spatial Visual' editor. The representative frequency defaults to the average mid-frequency of the achieved scan range but may be subsequently set by the user to any frequency within the achieved scan range.

Tuning (Max. 5)	SPW 1 (GHz)	SPW 2 (GHz)	SPW 3 (GHz)	SPW 4 (GHz)
1	85.0000 GHz	86.8750 GHz	97.0000 GHz	98.8750 GHz
2	88.7500 GHz	90.6250 GHz	100.7500 GHz	102.6250 GHz
3	92.5000 GHz	94.3750 GHz	104.5000 GHz	106.3750 GHz
4	96.2500 GHz	98.1250 GHz	108.2500 GHz	110.1250 GHz
5	100.0000 GHz	101.8750 GHz	112.0000 GHz	113.8750 GHz

Targets

Source Name	Velocity	System	Representative Frequency (Sky)
ngc 4535	1974.0 km/s	hel	99.4380 GHz
rp2	0.0 km/s	lsrk	99.4380 GHz
rp4	0.0 km/s	lsrk	99.4380 GHz
rp6	0.0 km/s	lsrk	99.4380 GHz



# ALMA AOT

*In spectral setup the PI put details about the band and the resolution.*

The screenshot displays the ALMA AOT Spectral Setup interface. On the left, the 'Project Structure' pane shows a tree view with 'Spectral Setup' highlighted. The main 'Editors' pane is titled 'Spectral Setup' and contains a 'Visualisation' section. This section includes a text block explaining that up to 16 spectral windows can be defined, each 2GHz wide, and provides instructions on zooming and panning. Below the text is a spectral plot with 'Observed Frequency' on the top axis and 'Rest Frequency' on the bottom axis, both ranging from 100,000 to 700,000. The plot shows several spectral windows labeled 03 through 09. A yellow vertical line is positioned at approximately 250,000, and a blue shaded region highlights a spectral window around 250,000. Below the plot, there are controls for 'Overlays' (Receiver Bands, Transmission, Overlay Lines, DSB Image), 'Water Vapour Column Density' (Automatic Choice, Manual Choice), and 'Viewport' (Pan to Line, Zoom to Band, Reset). At the bottom, the 'Spectral Type' section shows 'Single Continuum' selected, and 'Polarization products desired' set to 'DUAL'.

**Project Structure**

- Proposal
- Program
- SUBMITTED
  - redpeakers\_proj
    - Proposal
      - Planned Observing
        - ScienceGoal (Copy of Science
          - General
          - View Setup
          - Spectral Setup**
          - Control and Performance
          - Technical Justification

# ALMA AOT

*In spectral setup the PI put details about the band and the resolution.*

The screenshot displays the ALMA AOT Spectral Setup interface. On the left, the Project Structure pane shows a tree view with 'Spectral Setup' highlighted. The main Editors pane is titled 'Spectral Setup' and contains a 'Visualisation' section. This section includes a plot of 'Observed Frequency' (top axis, 100,000 to 700,000) and 'Rest Frequency' (bottom axis, 100,000 to 700,000). The plot shows several shaded regions representing spectral windows, labeled 03, 04, 06, 07, 08, and 09. Below the plot, there are controls for 'Overlays' (Receiver Bands, Transmission, Overlay Lines, DSB Image), 'Water Vapour Column Density' (Automatic Choice, Manual Choice), and 'Viewport' (Pan to Line, Zoom to Band, Reset). At the bottom, the 'Spectral Type' section has radio buttons for 'Spectral Line', 'Single Continuum', and 'Spectral Scan', and 'Polarization products desired' with radio buttons for 'XX', 'DUAL', and 'FULL'. A black arrow points from the 'Spectral Setup' menu item in the Project Structure pane to the 'Select Lines to Overlay' button in the Visualisation section.





# ALMA Product

*ALMA delivers data cubes, of which the third axis is frequency. In this sense, the final data products are very much like that of an integral field unit with up to a million Spectral Pixels.*