

An Introduction to ALMA

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DA-59

DA-21

DA-59

DA-41

DA-22



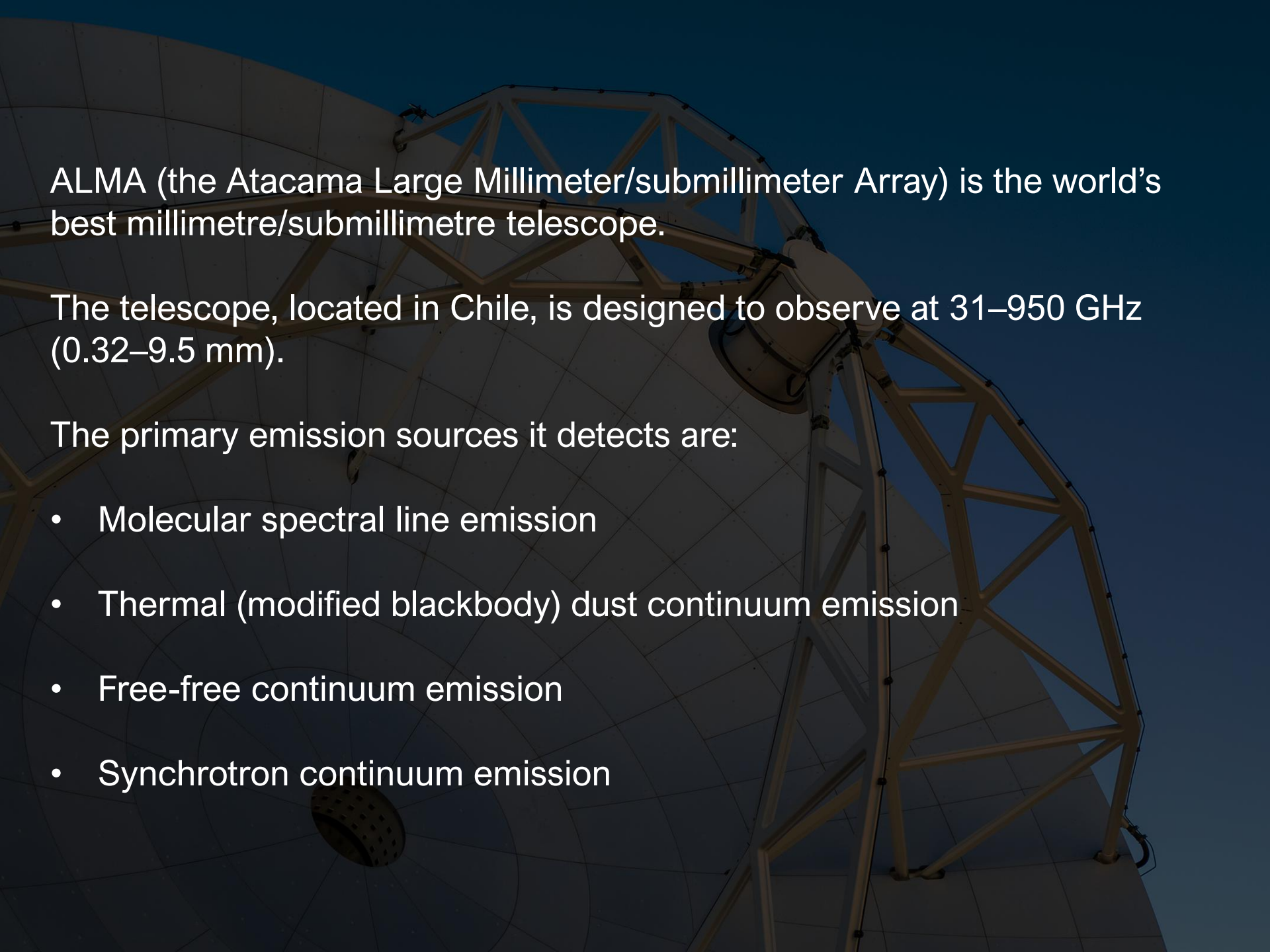


DA-63

DA-51







ALMA (the Atacama Large Millimeter/submillimeter Array) is the world's best millimetre/submillimetre telescope.

The telescope, located in Chile, is designed to observe at 31–950 GHz (0.32–9.5 mm).

The primary emission sources it detects are:

- Molecular spectral line emission
- Thermal (modified blackbody) dust continuum emission
- Free-free continuum emission
- Synchrotron continuum emission

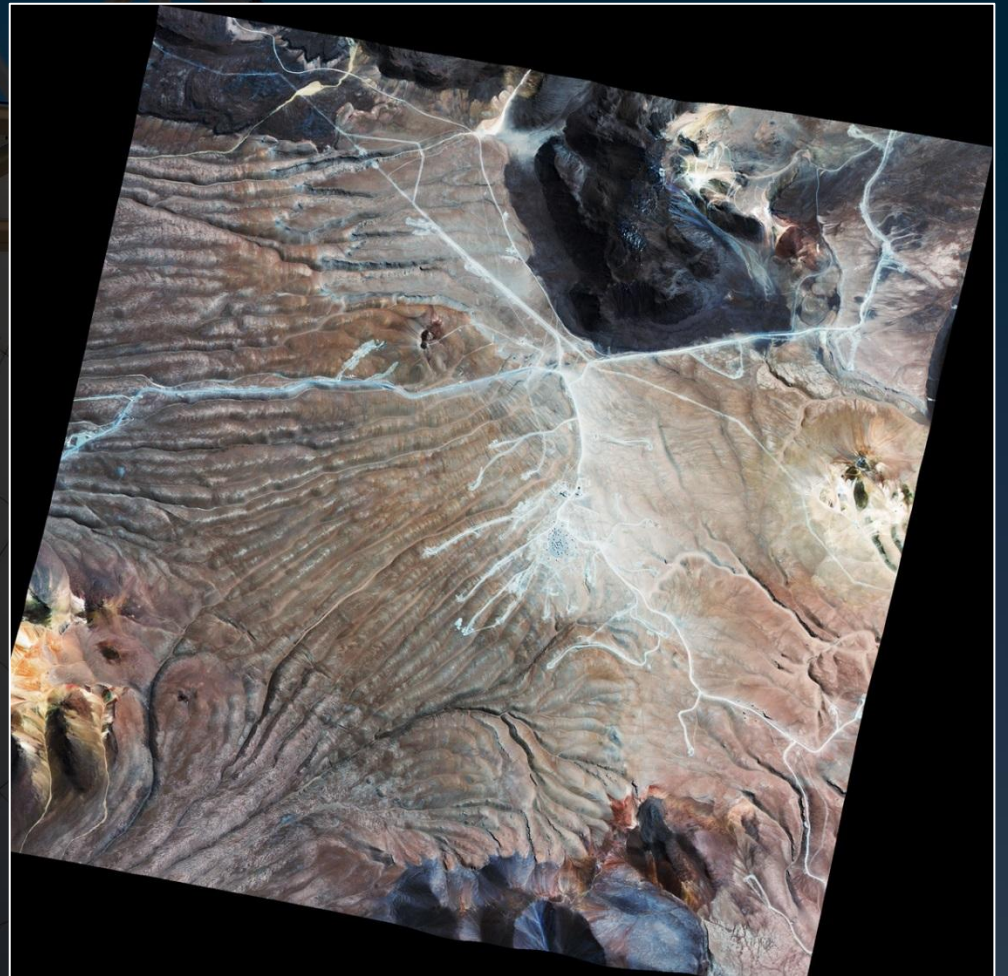
A large, white, segmented radio telescope dish is shown against a clear blue sky. The dish is supported by a complex metal truss structure. The image is slightly dimmed to allow text to be overlaid.

Some of the science performed with ALMA includes:

- Detecting dust emission from high-redshift galaxies (up to $z=10$)
- Using CO to measure redshifts for distant galaxies
- Imaging molecular gas and dust in nearby galaxies
- Examining the formation of protostellar objects in molecular clouds
- Identifying the chemical composition of molecular gas around protostellar objects
- Resolving protoplanetary disks
- Observing the formation of molecules and dust grains around evolved stars and supernovae
- Studying the physics of the Sun

ALMA is located in the Atacama Desert, a high-altitude desert in Chile.

Because the air is cold and dry, the site is ideal for observing in submillimetre and millimetre bands.

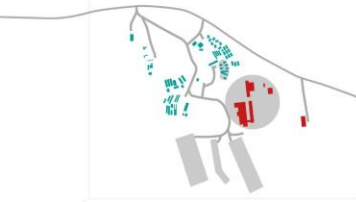


(Credit: Aerophotogrammetry Service, Chilean Air Force)

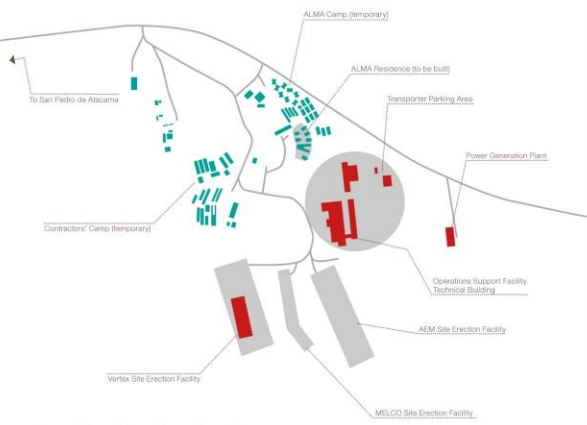
ALMA



Operations Support Facility (2900m altitude)

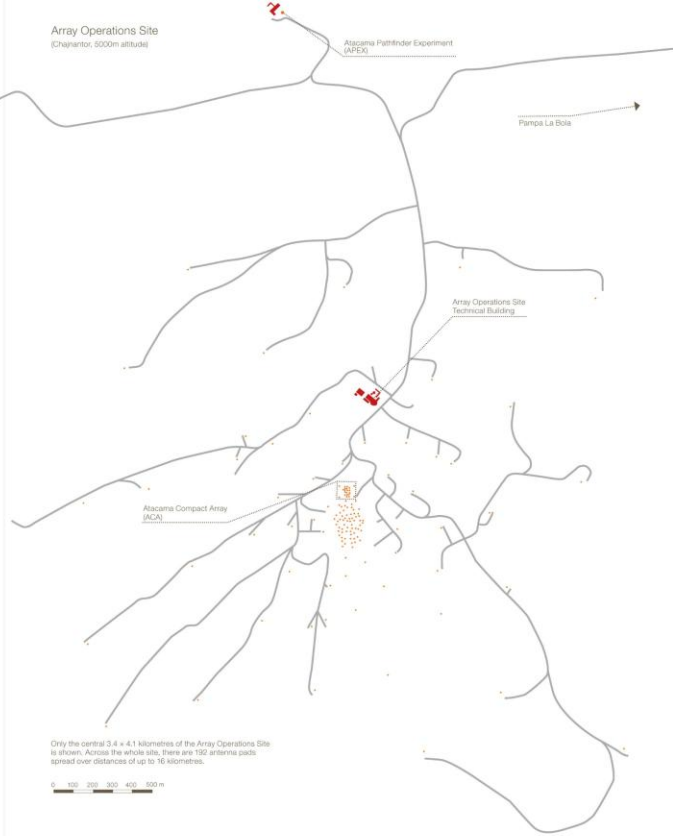


Not all of the 20-kilometre route between the Operations Support Facility and the Array Operations Site is shown.



- Technical Buildings (Red dot)
- Lodging and offices (Green dot)
- Roads (Grey line)
- Antenna pads (Orange dot)

Array Operations Site (Chajnantor, 5000m altitude)



Only the central 3.4 x 4.1 kilometres of the Array Operations Site is shown. Across the whole site, there are 152 antenna pads, spread over distances of up to 16 kilometres.

(Credit: ESO)

The Array Operations Site (AOS) is located at an elevation of 5000 m.

Access to the site is highly restricted, even for people working with the observatory.



(Credit: ALMA (ESO/NAOJ/NRAO)/A. Caproni (ESO))

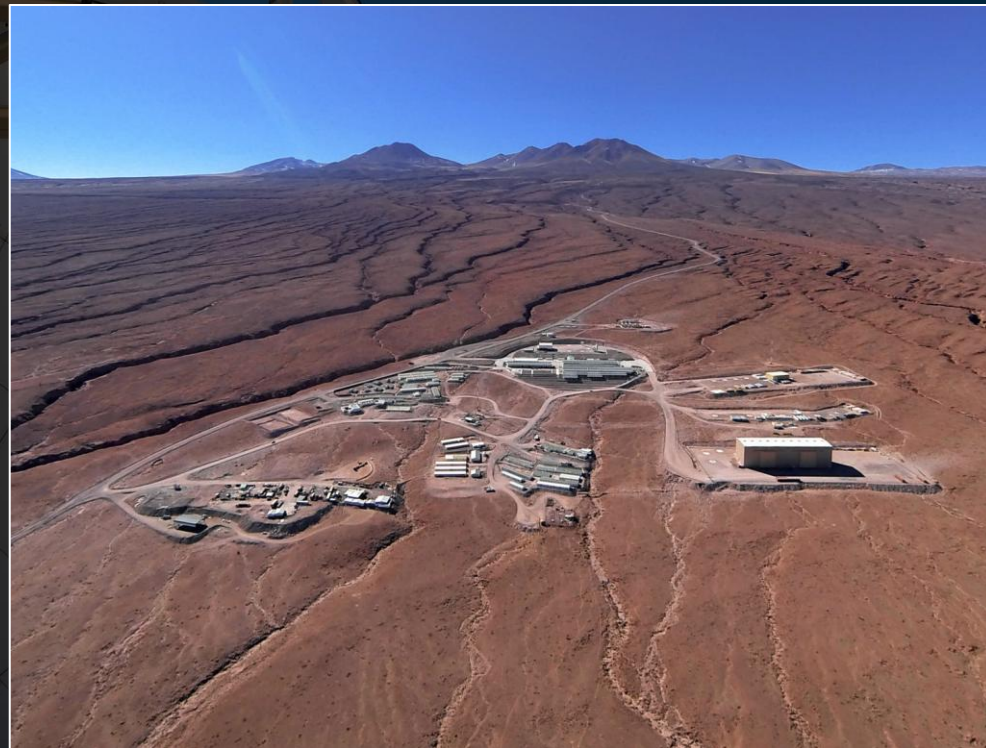
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(Credit: ESO/S. Fandango)

Workshops for the telescope are located at the Observation Support Facility (OSF) at an elevation of 2900 m.



(Credit: ESO)

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(Credit: ESO)

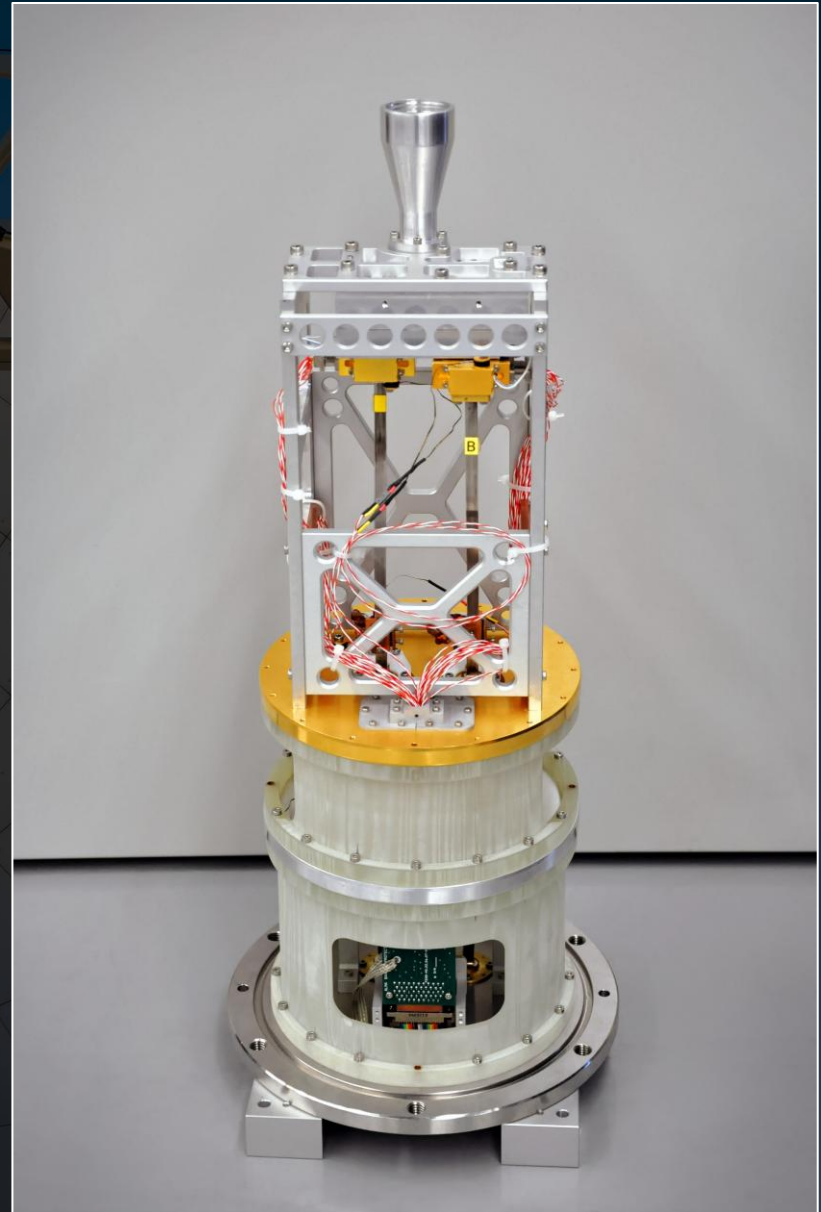
ALMA operations are managed from the Joint ALMA Observatory on the European Southern Observatory campus in Santiago.



(Credit: ESO & ALMA (ESO/NAOJ/NRAO))

ALMA uses multiple sets of heterodyne receivers.

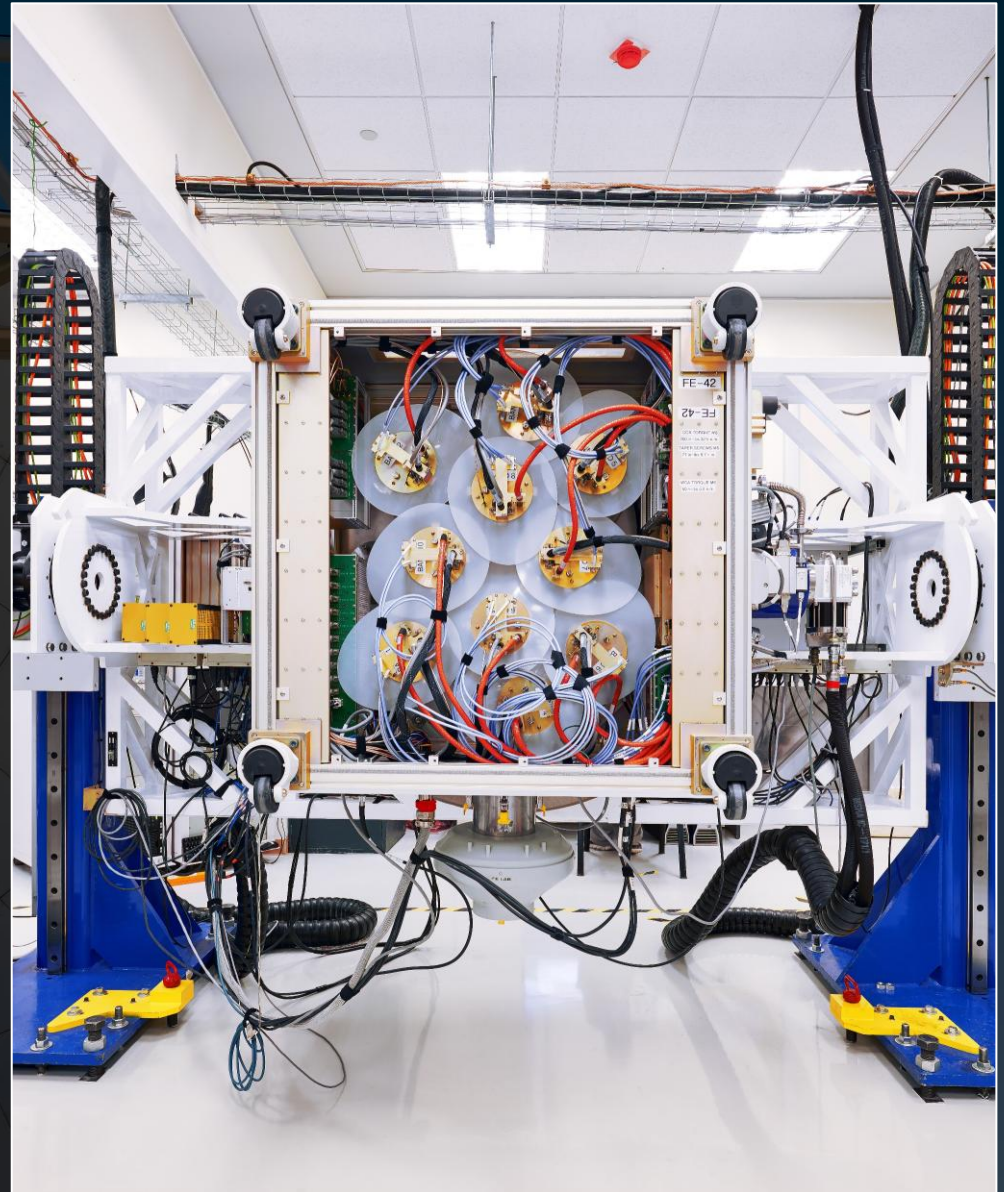
10 bands are available in Cycle 12.



(Credit: ASIAA/NAOJ/ESO/S. Guisard (www.eso.org/~sguisard))

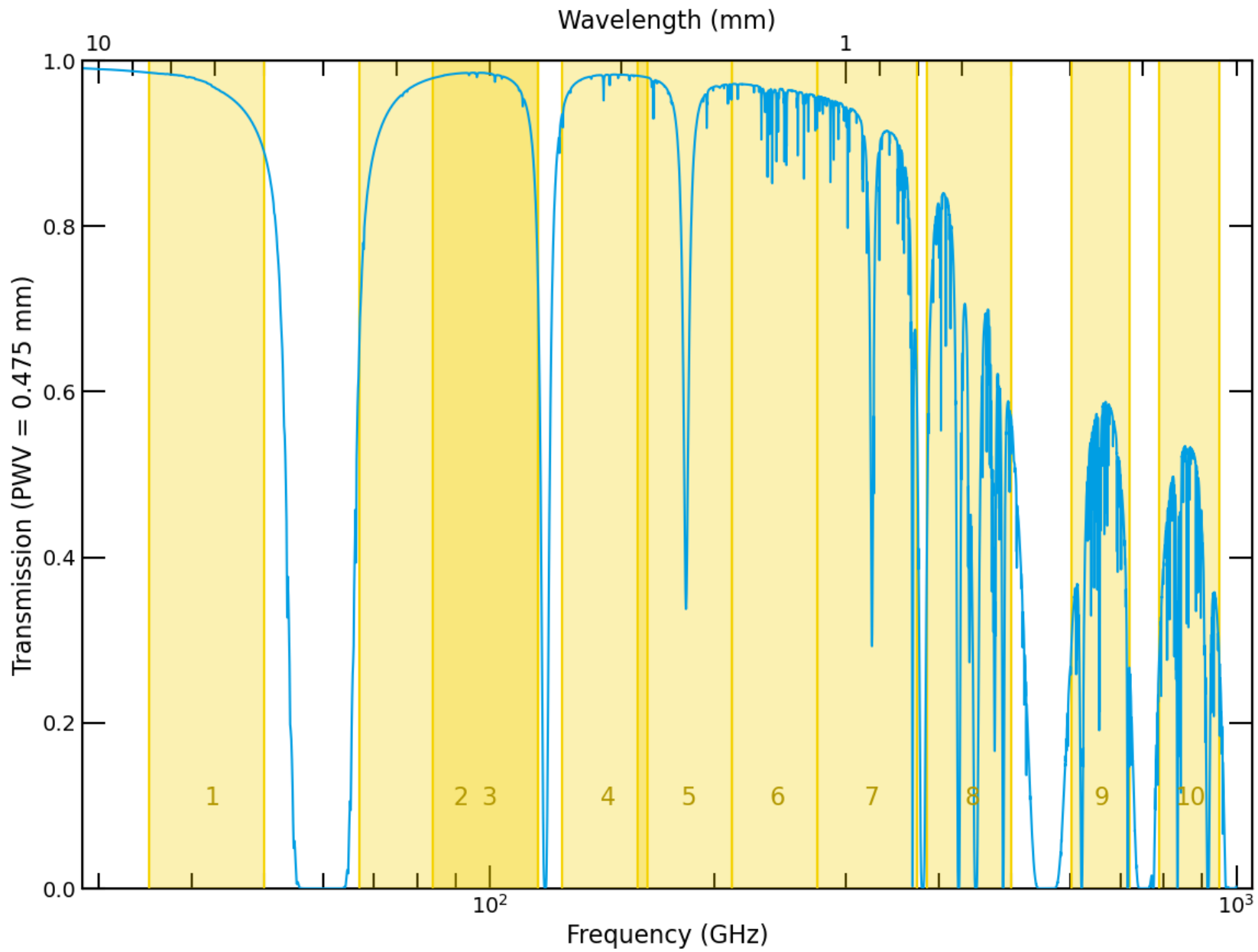
ALMA uses multiple sets of heterodyne receivers.

10 bands are available in Cycle 12.



(Credit: Enrico Sacchetti/ESO)

Band	Frequency (GHz)	Wavelength (mm)	12-m Array Primary Beam (arcsec)	12-m Array Angular Resolution (arcsec)	
				Compact Configuration	Extended Configuration
1	35-50	6-8.5	142	8.6	0.230
2	67-116	2.6-4.5	72	4.0	0.111
3	84-116	2.6-3.6	63	3.5	0.097
4	125-163	1.8-2.4	43	2.4	0.067
5	163-211	1.4-1.9	30	1.9	0.053
6	211-275	1.1-1.4	25	1.4	0.039
7	275-373	0.80-1.09	19	1.1	0.029
8	385-500	0.60-0.78	14	0.78	0.021
9	602-720	0.42-0.50	9.2	0.52	0.014
10	787-950	0.32-0.38	7.1	0.40	0.011



ALMA has three subarrays that observe different-sized structures:

- The 12-m Array (50 antennas with 12m diameters)
- The 7-m Array (12 antennas with 7m diameters)
- The Total Power antennas (4 antennas with 12m diameters)



(Credit: ESO)

The 12-m Array can be reconfigured in different ways to achieve different angular resolutions.

- Compact configurations image extended emission.
- Extended configurations resolve small structures.



(Credit: ESO/P.Martinez)

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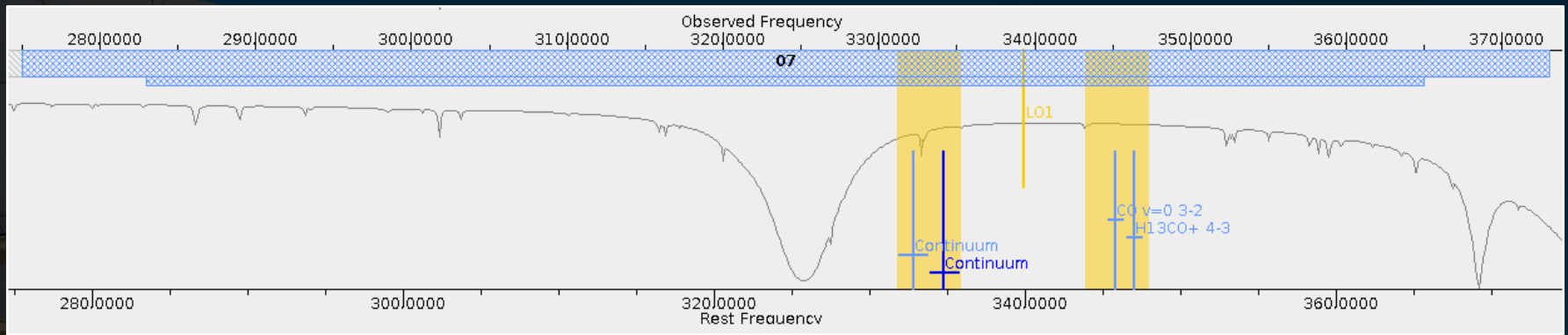
(Credit: ESO)

The 7-m Array is used to image large-scale structures that are usually resolved out by the 12-m Array. It can also be used as a stand-alone array when resolving structure is unimportant.



The Total Power antennas are used to detect large-scale line emission resolved out by both the 12-m and 7-m Arrays.



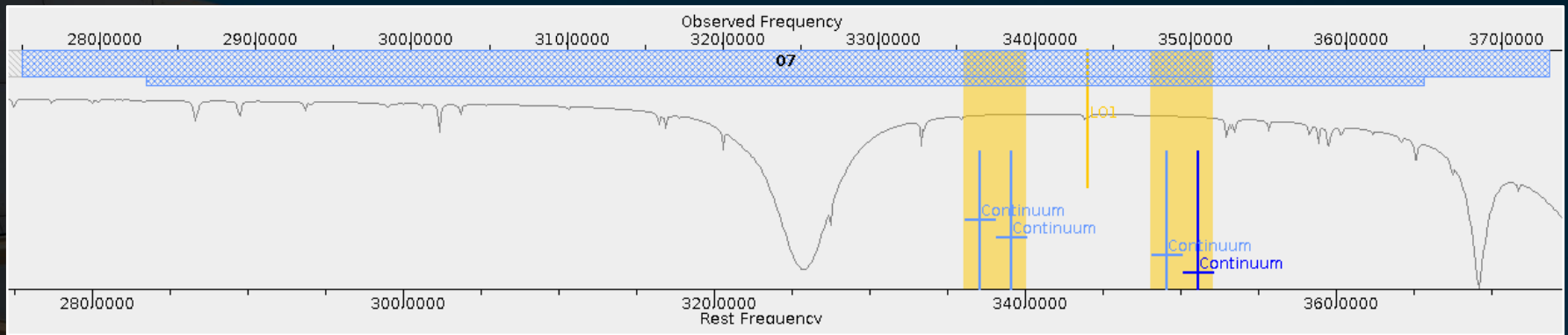


ALMA currently offers three types of spectral set-ups.

- Spectral line imaging mode
- Continuum mode
- Spectral scan mode

In all three modes, each observation is normally performed with 4 or more spectral windows (spws), with two spws on each side of a local oscillator signal (except for Bands 9 and 10, where all the spws are on one side of a local oscillator but can also be switched to the other side during observing).

Each spw can contain up to 3840 channels (or 4096 for the 7-m Array).

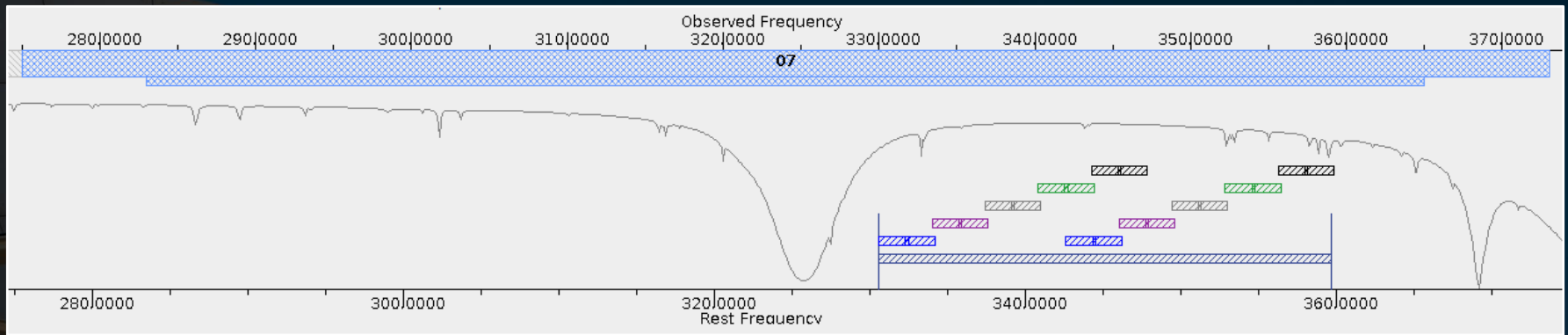


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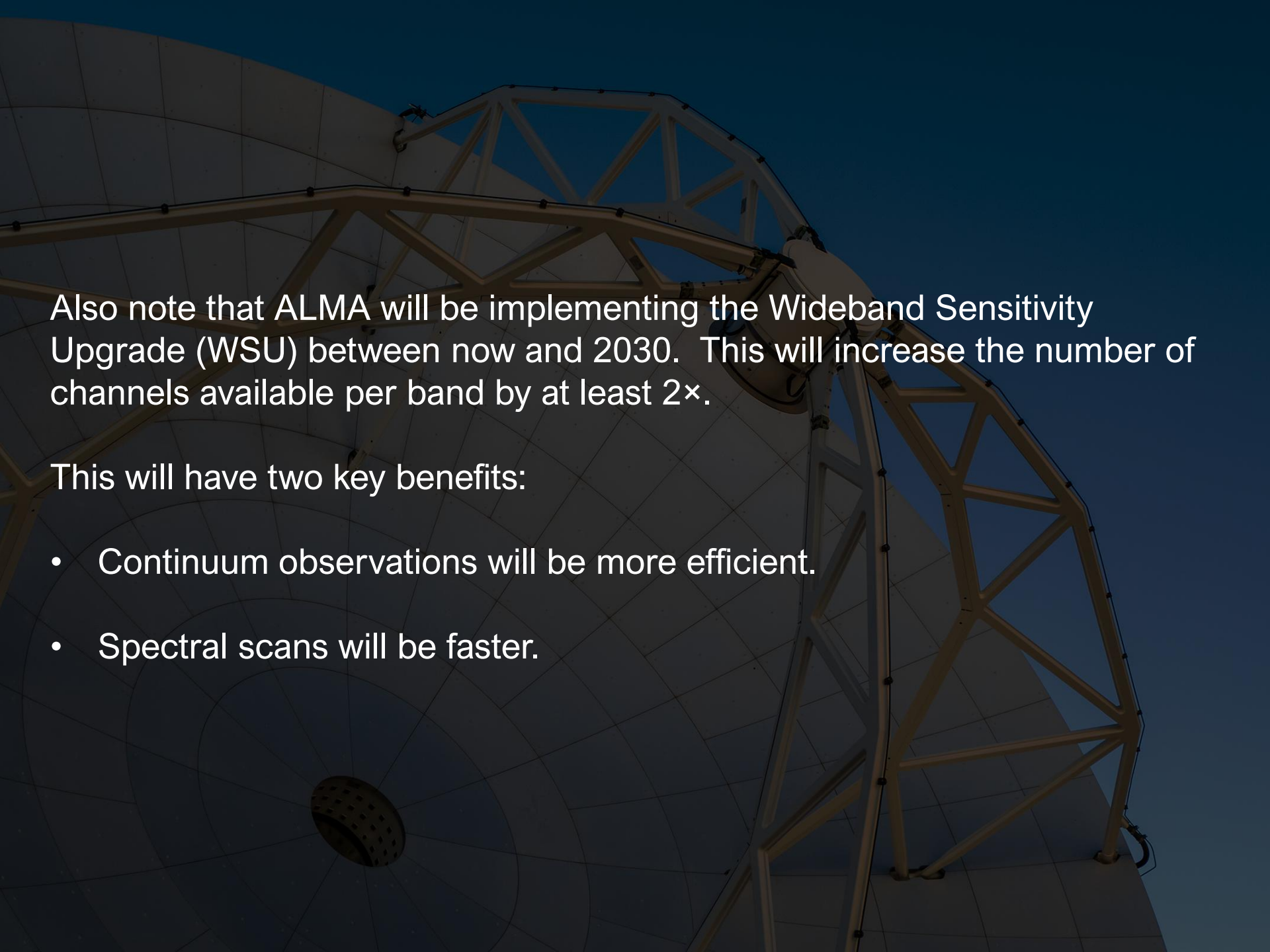


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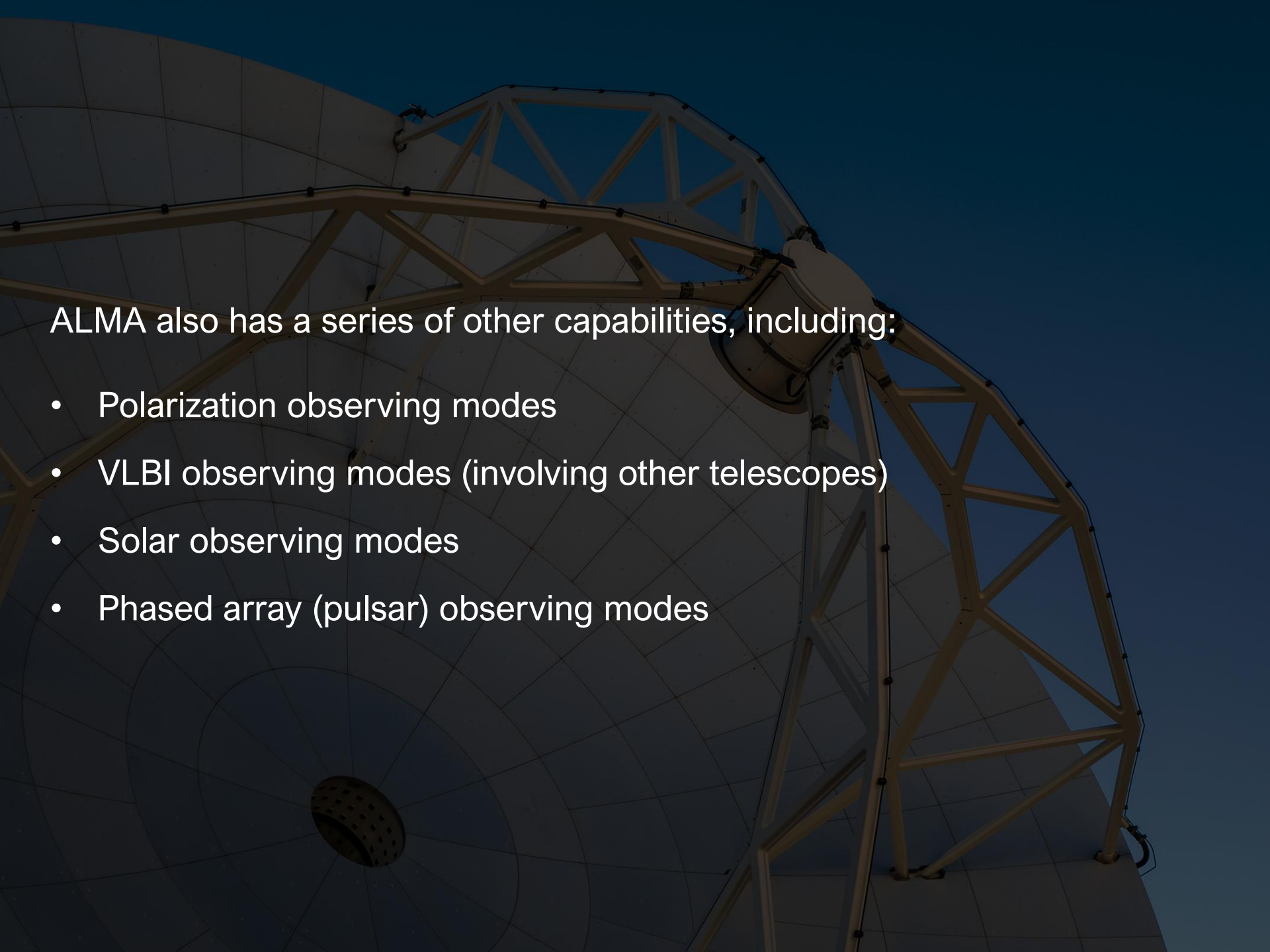
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Also note that ALMA will be implementing the Wideband Sensitivity Upgrade (WSU) between now and 2030. This will increase the number of channels available per band by at least 2×.

This will have two key benefits:

- Continuum observations will be more efficient.
- Spectral scans will be faster.

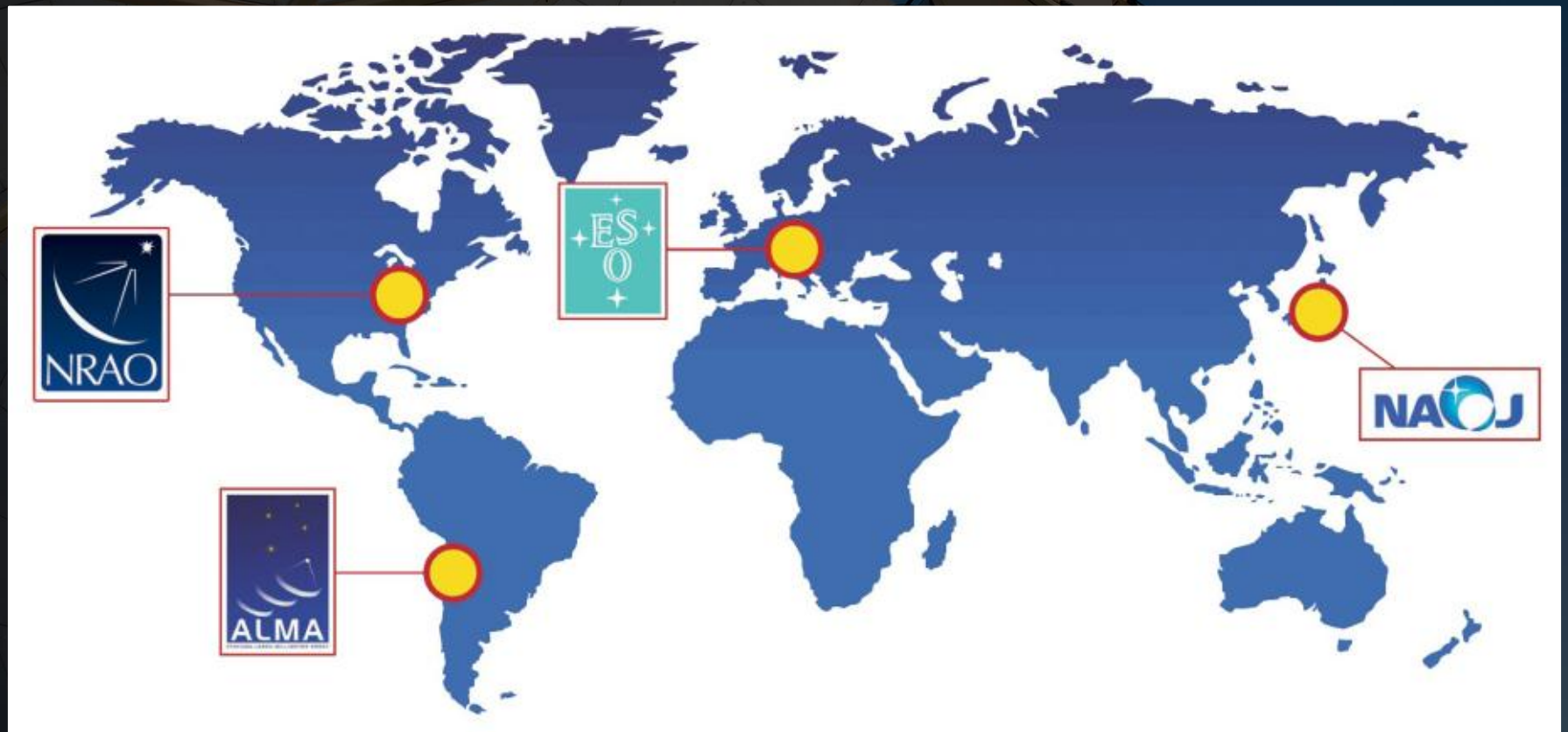


ALMA also has a series of other capabilities, including:

- Polarization observing modes
- VLBI observing modes (involving other telescopes)
- Solar observing modes
- Phased array (pulsar) observing modes

ALMA is operated by a collaboration between North America, Europe, and East Asia. Regional activities are coordinated by ALMA Regional Centres (ARCs).

The Joint ALMA Observatory (JAO) in Chile coordinates all activities.

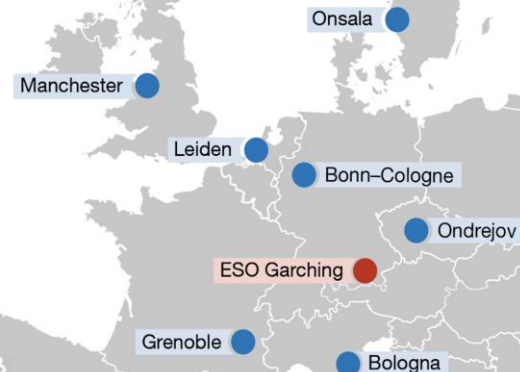


The European Southern Observatory coordinates ALMA activities in Europe.

Multiple ARC Nodes provide local user support. Staff at these nodes also participate in other support activities.

The University of Manchester hosts the ARC Node for the United Kingdom.

European ARC Network



The ALMA website for the general public is at <http://www.almaobservatory.org>.

The screenshot shows the ALMA Observatory website homepage. The browser address bar displays <https://www.almaobservatory.org/en/home/>. The page features a dark blue header with the ALMA logo and navigation menu. The main content area is divided into several sections:

- Top Left:** ALMA logo and navigation menu with options for About ALMA, News, Outreach, Multimedia, and ALMA for Scientists, Schools, and Media.
- Top Right:** A featured article titled "Gas on the run – ALMA spots the shadow of a molecular outflow from a quasar when the Universe was less than one billion years old" dated 1 February, 2024. The article includes a brief description of quasars.
- Middle Left:** A section titled "Press Releases" featuring two images of black hole shadows. The first image is dated 18 January, 2024, and the second is dated 2017 April 11 and 2018 April 21. The headline reads "M87* One Year Later: Proof of a persistent black hole shadow".
- Middle Right:** A section titled "The People" dated 16 March, 2023, featuring logos for AOA, NAOJ (National Astronomical Observatory of Japan), and NRAO. The headline reads "10 Years Transforming Together our Understanding of the Universe".
- Bottom:** A row of four small image thumbnails, each with a "Press Releases" label.

The JAO has a webpage for professional astronomers at <https://almaobservatory.org/en/scientists>.

Atacama Large Millimeter/submillimeter Array

Eng Esp

About ALMA

News

Outreach

Multimedia

ALMA for

ALMA at 10 years Conference

Scientists

Schools

Media

10 years

All Science Highlights
ALMA Conference
5 December, 2023

JAO

The Joint ALMA Observatory (JAO), located in Santiago (Chile), provides the unified leadership and management for ALMA. JAO staff are responsible for maintaining and optimizing the performance of the Radio telescope and conducting observations on behalf of the astronomical community.

JAO Science Team

The Science Team at the JAO is responsible for optimizing the scientific performance of ALMA, calibrating and imaging ALMA data, and conducting scientific research. The Science Team consists of both long-term staff members in the JAO Department of Science Operations and postdoctoral fellows.

Recent JAO Publications

December 31, 2023

BASS. XLII. The Relation between the Covering Factor of Dusty Gas and the Eddington Ratio in Nearby Active Galactic Nuclei

December 27, 2023

What Determines the Physical Size of a H₂O Megamaser Disk?

Each ARC has a professional astronomer page. The ESO ARC webpage is at <https://almascience.eso.org>.

The screenshot displays the ALMA Science Portal website. At the top, the ALMA logo is accompanied by the text "Atacama Large Millimeter/submillimeter Array" and the tagline "In search of our Cosmic Origins". A navigation bar includes links for "About", "Science", "Proposing", "Observing", "Data", "Processing", "Tools", "Documentation", and "Help".

The main content area is divided into several sections:

- Science Highlight:** Titled "Protonated acetylene in the z=0.89 absorber toward PKS1830-211", it features two contour plots of the molecule. The left plot is labeled "Diidymos-Dimorphos 345 GHz Continuum" and the right plot is "Diidymos-Dimorphos + Ejecta 345 GHz Continuum". Below the plots is a detailed text description of the discovery and a "More..." link.
- Observatory News:** Lists recent announcements such as "Announcement for early proposal planning for Cycle 11" (Dec 20, 2023), "Restart of the Cycle 10 antenna relocations" (Dec 05, 2023), and "Release of Science Verification Data for W51 in Band 1" (Nov 06, 2023).
- EU ARC News:** Includes "Upcoming workshop 'The promises and challenges of the ALMA Wideband Sensitivity Upgrade'" (Jan 10, 2024), "Postdoctoral Researcher for an ALMA ADP pipeline" (Dec 22, 2023), and "At the Allegro node: ALMA Data Reduction Training Day on 27 November 2023" (Oct 21, 2023).
- ALMA Status:** Shows the "Configuration Schedule" with statistics: "Referenced publications: 3641", "Last observed source: NGC_7252E", and "Current configuration: C-3".

At the bottom, a "Quick Links" table provides direct access to various resources:

ALMA Basics	Configuration Schedule
ALMA Science	SnooPI
ALMA Primer	DDT Proposals

The footer contains "Site Map", "Accessibility", "Contact", and "Privacy Statement" on the left, and "Region: EA EU NA" on the right.

The UK ARC Node has a website at <https://www.alma.ac.uk> that provides news and information for UK ALMA users.

The screenshot shows a web browser window displaying the website <https://www.alma.ac.uk>. The page features a header with the title "UK ALMA Regional Centre" and a banner image of the ALMA observatory. Below the banner is a search bar and a navigation menu. The main content area includes a video player titled "Meet the UK ARC Node" and a news article titled "ALMA Creates New Images with Unprecedented Angular Resolutions".

UK ALMA Regional Centre

EUROPEAN ARC
ALMA Regional Centre || UK

Search ...

Local Information

- Home
- About
- Directory
- Contact Information
- Visitor Information

Science & Support Information

- Meetings
- Newsletter
- PI Information
- Publications
- Public Outreach
- Software and Tools

External Links

- ALMA Regional Centres
- ALMA Observatory
- ESO
- NAOJ
- NRAO
- Documentation
- Proposer's Guide
- Technical Handbook
- Outreach
- ESO ALMA Image Archive
- ESO ALMA Video Archive
- UK ARC Node Twitter

Meet the UK ARC Node

Watch on YouTube

Video Credit: Ana A. Alpizar

ALMA Creates New Images with Unprecedented Angular Resolutions

Data can be downloaded from the ALMA Science Archive at <https://almascience.eso.org/aq>.

The screenshot displays the ALMA Science Archive interface. On the left, there is a spectral plot showing intensity versus frequency (GHz) from 100 to 900 GHz. The plot features several labeled lines corresponding to different molecules and isotopes, such as HCO^+ , CH_3OH , $\text{C}_2\text{H}_5\text{OH}$, HCN , CO , H_2O , SiO , and SiC . The plot is overlaid on a background image of the ALMA antenna array.

On the right, there is a table of observations. The table has the following columns: Project code, ALMA source name, RA, Dec, Band, Cont. sens., Frequency support, Release date, Publications, Ang. res., Min. vel. res., Array, Mosaic, and Max. reco. scale. The table lists several observations, including those for Fomalhaut b, R Scl, GRB021004, and various other sources.

Project code	ALMA source name	RA	Dec	Band	Cont. sens.	Frequency support	Release date	Publications	Ang. res.	Min. vel. res.	Array	Mosaic	Max. reco. scale
2011.0.00191.5	Fomalhaut b	22:57:38.685	-29:37:12.616	7	0.1181	343.077-358.839 GHz	2012-12-06	2	1.047	0.816	12m		10.640
2011.0.00131.5	R Scl	01:26:58.079	-32:32:36.424	7	0.9115	330.246-346.109 GHz	2012-12-06	5	1.043	0.846	12m	mosaic	11.517
2011.0.00101.5	GRB021004	00:26:54.680	+18:55:41.600	7	0.1136	337.009-353.001 GHz	2012-12-06	2	1.107	26.541	12m		9.258
2011.0.00397.5	J035448.24-330827.2	03:54:48.240	-33:08:27.200	7	0.4848	337.026-353.011 GHz	2012-12-20	3	1.128	26.541	12m		7.950
2011.0.00397.5	J041754.10-281655.9	04:17:54.100	-28:16:55.900	7	0.4848	337.023-353.008 GHz	2012-12-20	3	1.118	26.541	12m		7.842
2011.0.00397.5	J063027.81-212058.6	06:30:27.810	-21:20:58.600	7	0.5346	337.007-352.992 GHz	2012-12-20	3	1.183	26.541	12m		8.015
2011.0.00397.5	J061200.23-062209.6	06:12:00.230	-06:22:09.600	7	0.5346	337.005-352.989 GHz	2012-12-20	3	1.183	26.541	12m		7.819
2011.0.00397.5	J070257.20-280842.3	07:02:57.200	-28:08:42.300	7	0.5346	337.006-352.991 GHz	2012-12-20	3	1.154	26.541	12m		8.053
2011.0.00397.5	J054930.06-373940.1	05:49:30.060	-37:39:40.100	7	0.4848	337.016-353.001 GHz	2012-12-20	3	1.156	26.541	12m		7.888
2011.0.00397.5	J064228.93-272801.8	06:42:28.930	-27:28:01.800	7	0.5346	337.008-352.993 GHz	2012-12-20	3	1.165	26.541	12m		8.123

The best way to communicate with ALMA staff (including the UK ARC Node) is to use the ALMA Helpdesk at <https://help.almascience.org>.

The screenshot shows a web browser window with the URL <https://help.almascience.org>. The page header includes the ALMA logo and the text "Atacama Large Millimeter/submillimeter Array Observer Support". Below the header, there is a navigation bar with "ALMA Science" and a "Submit Helpdesk Ticket" button. A search bar with the placeholder text "How can we help you today?" is prominently displayed. Below the search bar, there are four main navigation options: "Knowledgebase" (View all articles), "Submit Helpdesk Ticket" (Get in touch for help), "My Tickets" (View your tickets), and "Face to Face Visit" (Arrange a visit). A welcome message "Welcome to the ALMA Helpdesk" is shown below these options, followed by a "News" section.

Observing with ALMA – A Primer (Cycle 12)

The documentation website (<https://almascience.eso.org/documents-and-tools>) has three documents that are very useful references:

- Observing with ALMA – A Primer
- ALMA Proposer’s Guide
- ALMA Technical Handbook



www.almascience.org

ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), NSTC and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ.

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ALMA Cycle 12 Proposer’s Guide



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Doc 12.3, version 1.0 | March 1st, 2025

ALMA Cycle 12 Technical Handbook

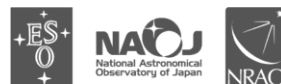


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Using ALMA archival data - A Primer

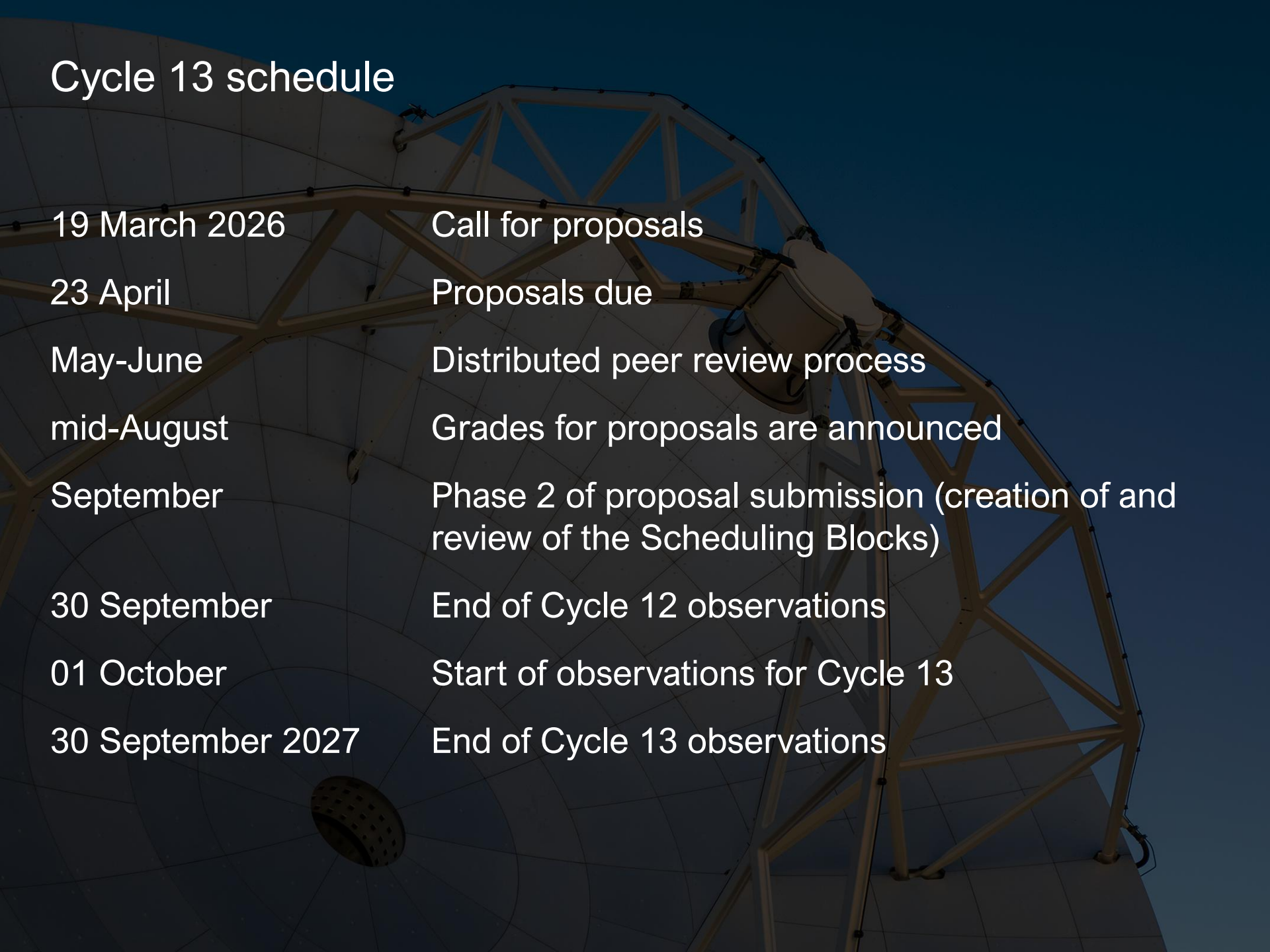
I have also worked on a document on using the ALMA Archive that is also available from <https://almascience.eso.org/documents-and-tools>.



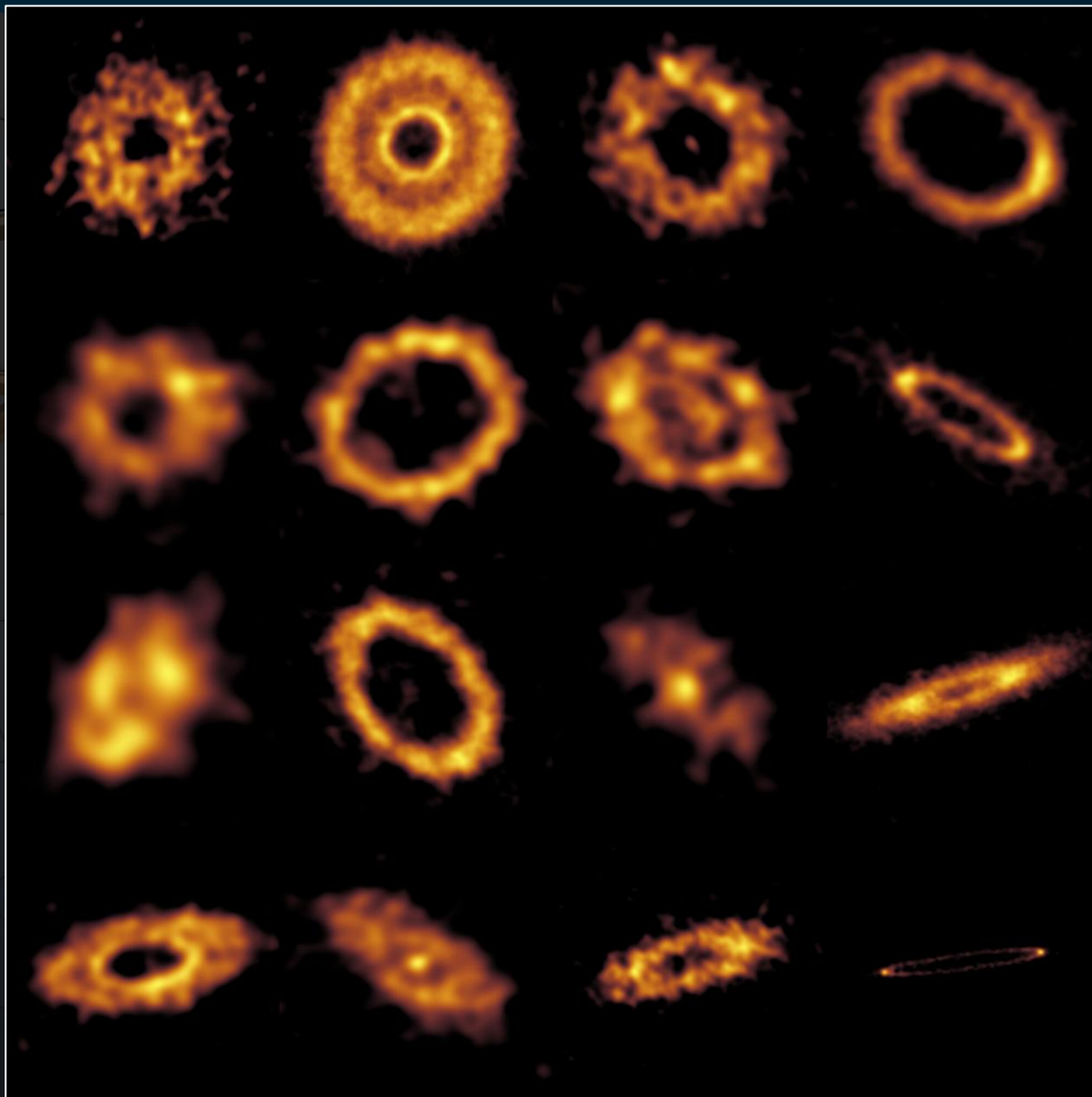
www.almascience.org

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Cycle 13 schedule

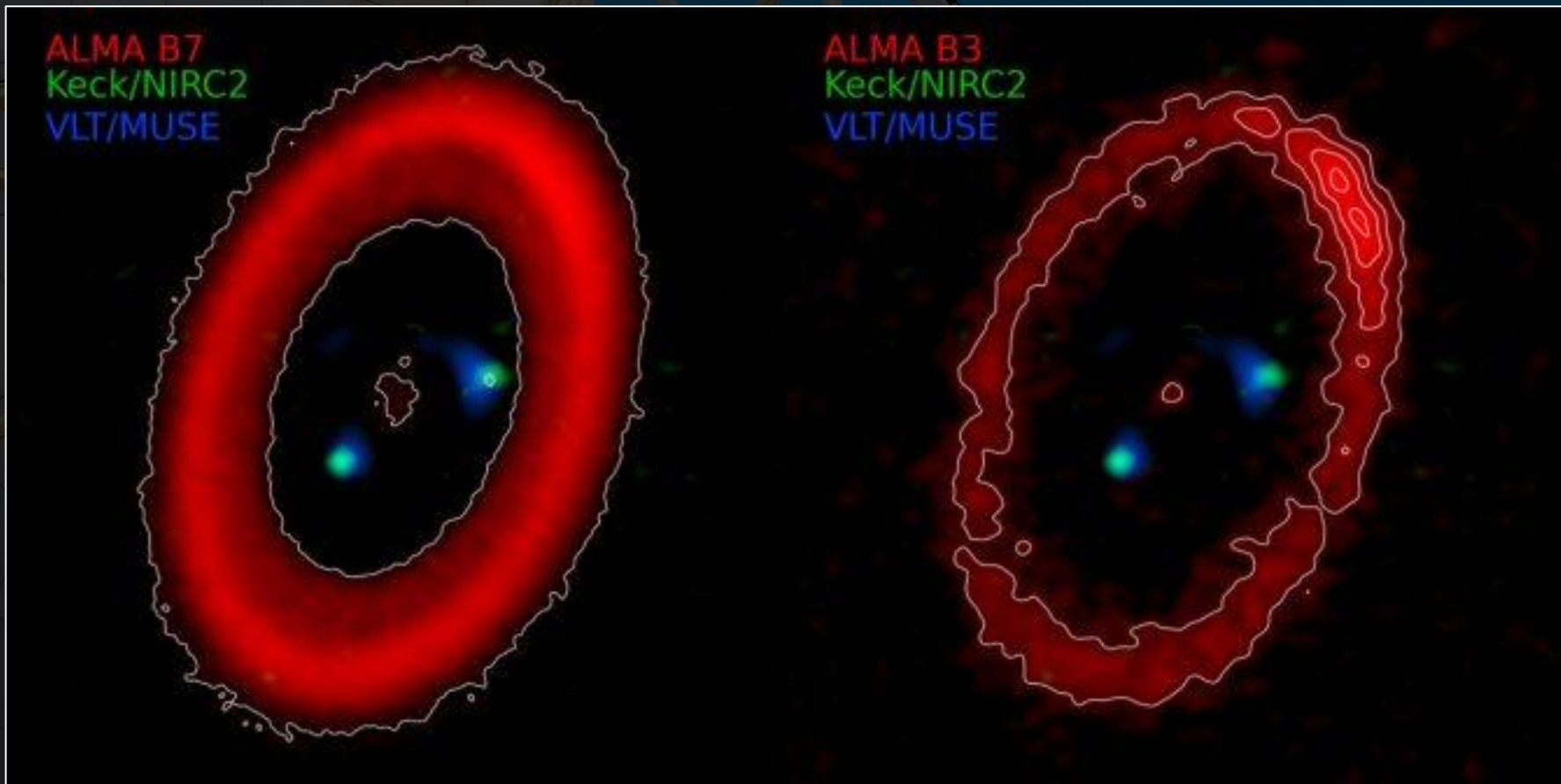


19 March 2026	Call for proposals
23 April	Proposals due
May-June	Distributed peer review process
mid-August	Grades for proposals are announced
September	Phase 2 of proposal submission (creation of and review of the Scheduling Blocks)
30 September	End of Cycle 12 observations
01 October	Start of observations for Cycle 13
30 September 2027	End of Cycle 13 observations



Debris discs observed by the ALMA survey to Resolve exoKuiper belt Substructures (ARKS).

(Credit: ALMA (ESO/NAOJ/NRAO), S. Marino, S. Mac Manamon, and the ARKS collaboration.)

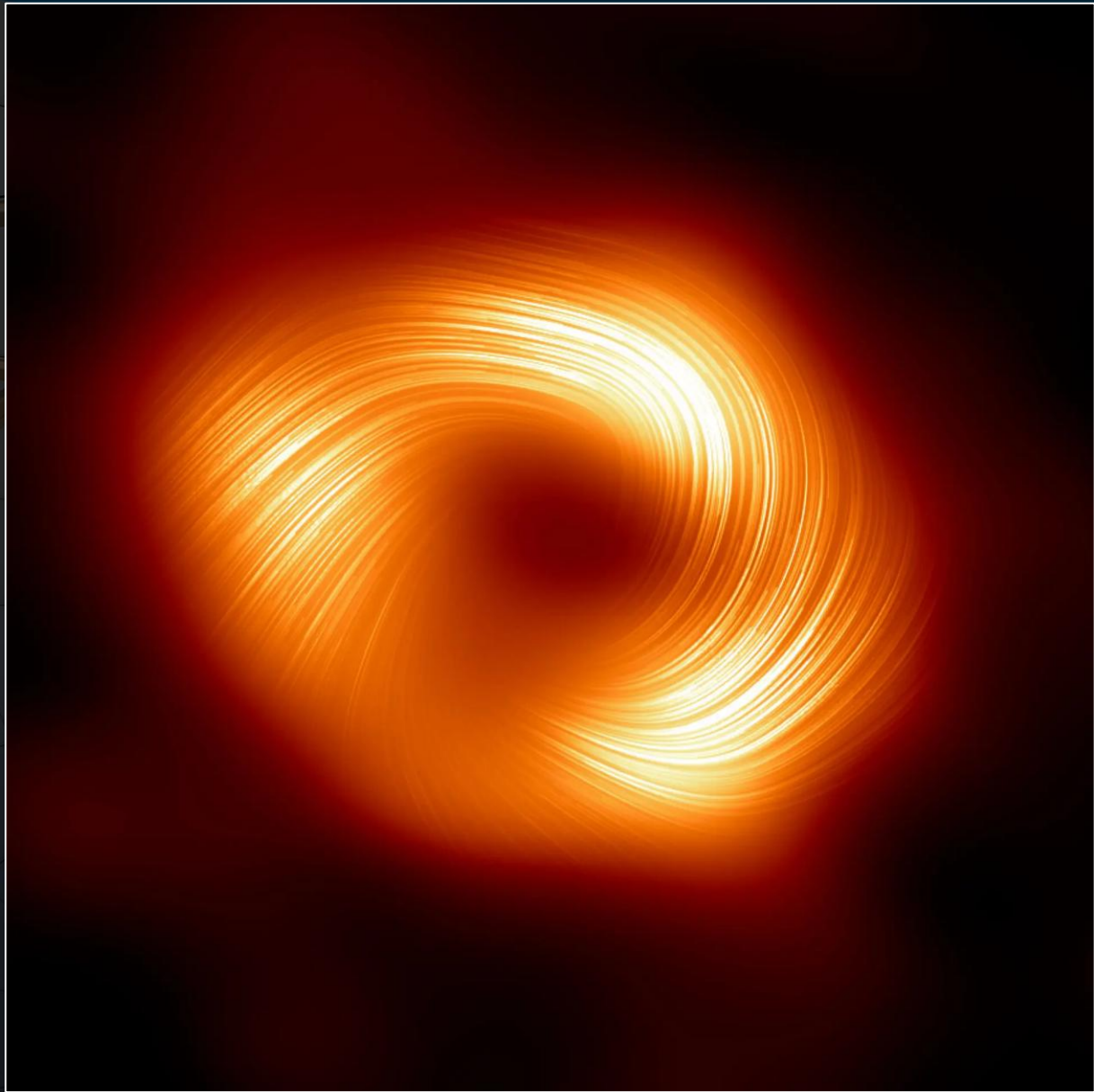


PDS 70

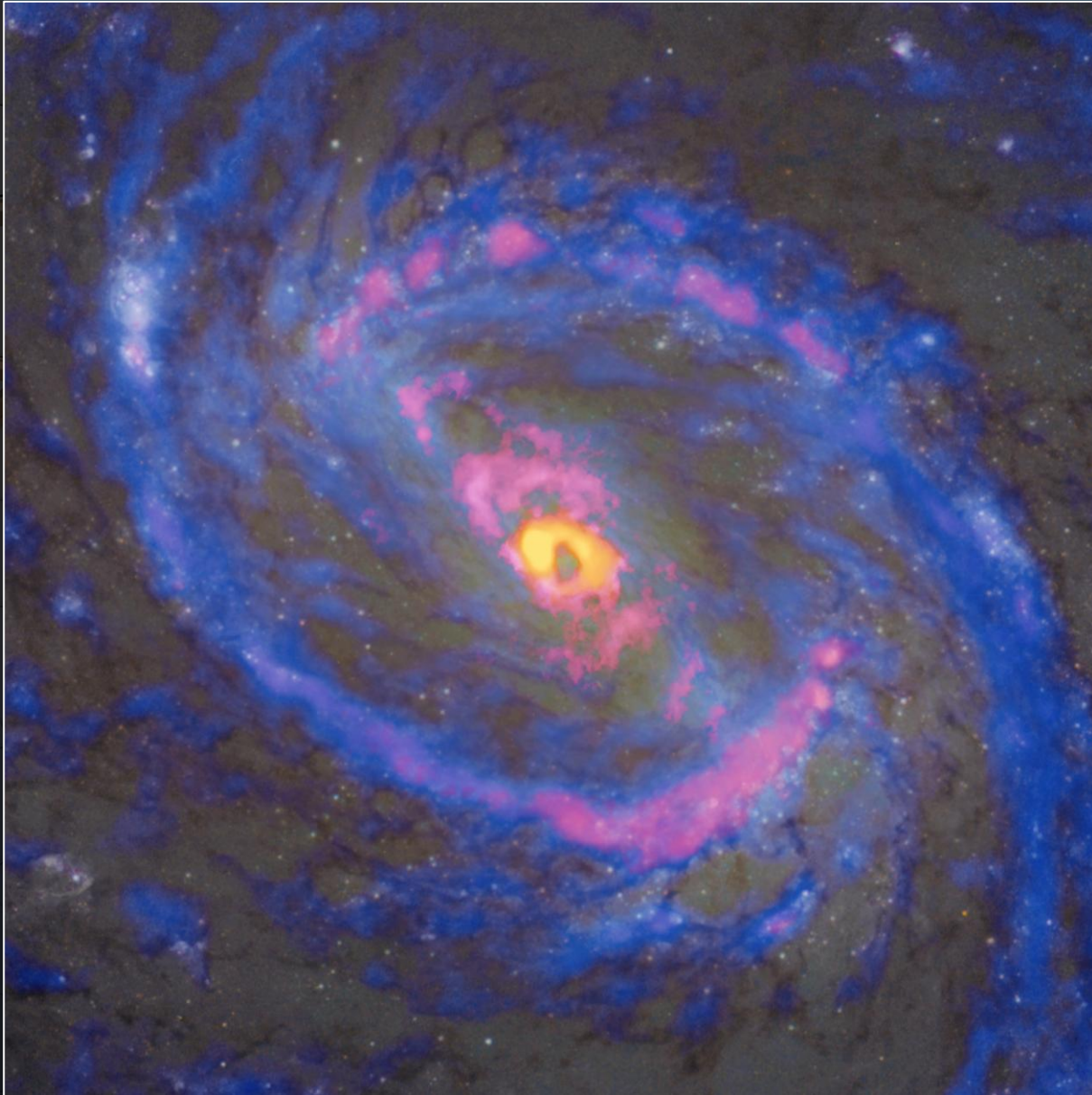
(Credit: ALMA (ESO/NAOJ/NRAO), W. M. Keck Observatory, VLT (ESO), K. Doi (MPIA).)



Central Molecular Zone observed by the ALMA CMZ Exploration Survey
(Credit: ALMA (ESO/NAOJ/NRAO) / S. Longmore et al.; Background: ESO / D. Minniti et al.)

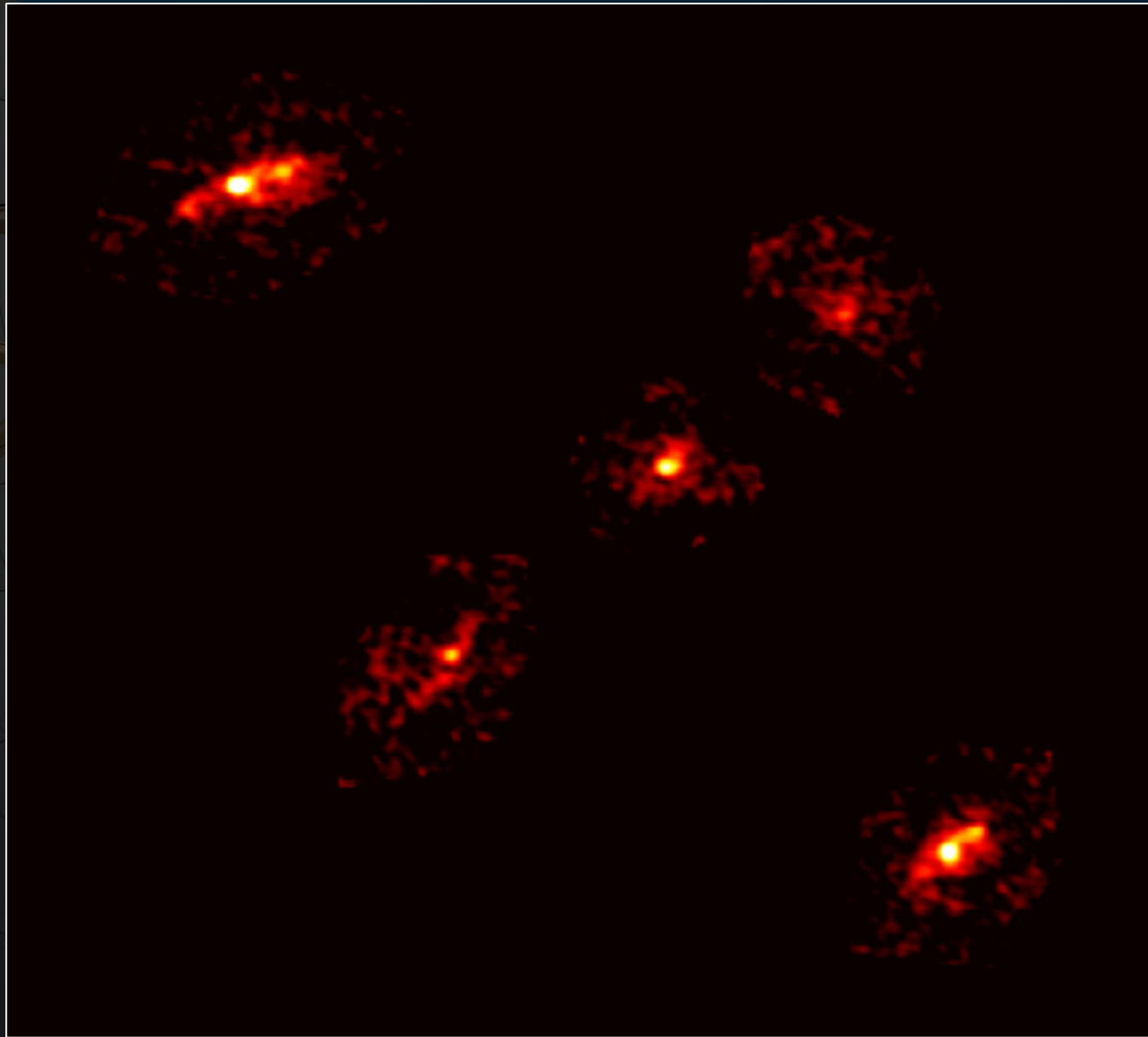


Sgr A*
(Credit: EHT Collaboration)



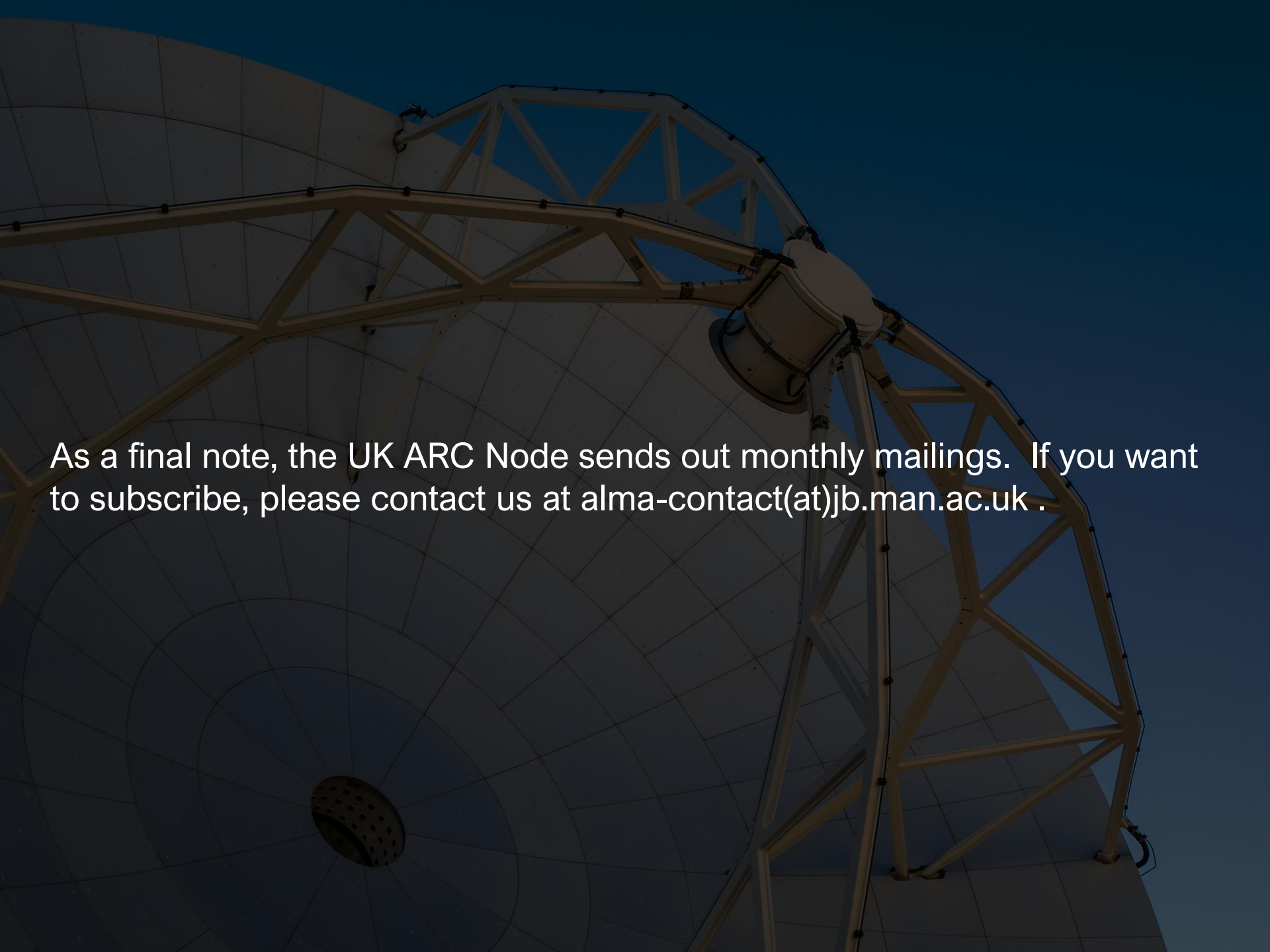
NGC 1068

(Credit: ALMA (ESO/NAOJ/NRAO), NASA/ESA Hubble Space Telescope, T. Nakajima et al.)



HerS-3

(Credit: P. Cox et al. - ALMA (ESO/NAOJ/NRAO).)

A large satellite dish antenna structure is shown against a dark blue sky. The dish is composed of a complex metal truss structure supporting a large, curved surface. The structure is illuminated from the side, creating strong highlights and deep shadows. The sky is a uniform, dark blue color.

As a final note, the UK ARC Node sends out monthly mailings. If you want to subscribe, please contact us at alma-contact@jb.man.ac.uk.