



# ALMA Cycle 10 Capabilities

**Presenter: Emily Moravec**

Slide Author: Catherine Vlahakis



# ALMA Capabilities in Cycle 10

- **Observing Time**

- 4300 hours anticipated on the 12-m Array + 4300 hours on the ACA (4300 each for the 7-m Array and Total Power Array)
- **Cycle 10 will *not* include a Supplemental CfP for stand-alone ACA observations**
- The community is **encouraged** to submit **ACA stand-alone proposals** for targets, especially in the LST range of 20h to 10h, for the May 2023 deadline
- The community is also **strongly encouraged** to submit proposals in the **highest frequency bands, Bands 8, 9 and 10**

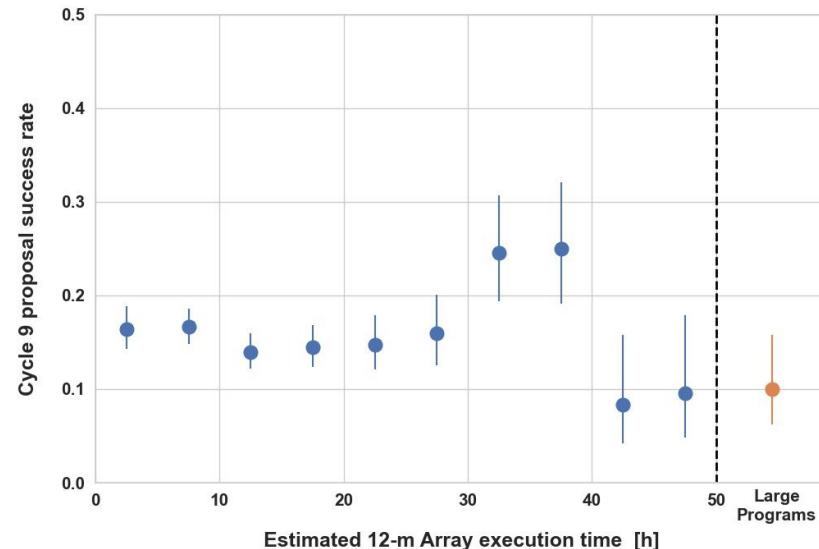
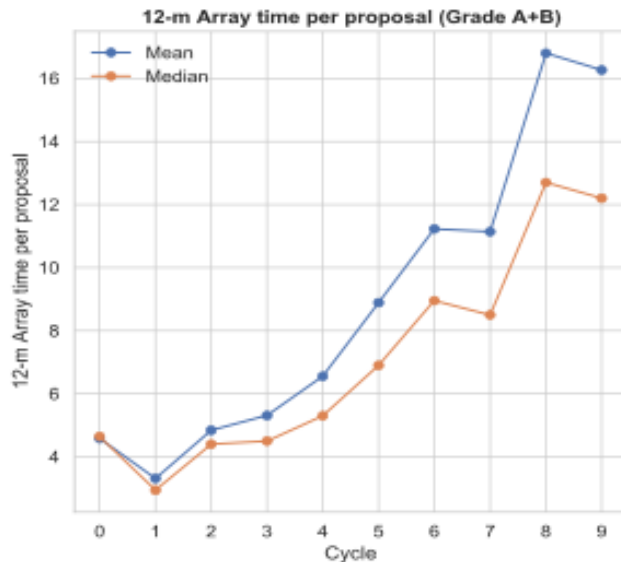
- **Proposal Review Process**

- All proposals that are not Large Programs will be reviewed via **Distributed Peer Review**
- Large Programs (>50 hours on the 12-m Array, >150 hours on the 7-m Array), will be reviewed by a panel
- All Cycle 10 proposals will be **dual-anonymous** (it is the responsibility of investigators to preserve their anonymity when writing proposals)

# ALMA Capabilities in Cycle 10

Encourage “Medium size” proposals between 25 – 50 hours

- “But ALMA doesn’t accept long proposals. I have a better chance of submitting a shorter proposal because it will be accepted, right?!?!?” → **WRONG!!!!**
- Most Cycle 9 proposals requested between 2 and 20 hours of 12-m Array time but the average time per proposal has increased over the cycles and the success rate of proposals was independent of proposal length up to at least 30 hours and maybe even higher up to about 40 hours



**Figure 1:** Cycle 9 - (Left) Requested 12-m Array time per proposal assigned Grade A or B. (Right) Fraction of proposals (with 1s confidence intervals) that are assigned Grade A or B as a function of the estimated 12-m Array time.

# ALMA Capabilities – NEW in Cycle 10!!!

In Cycle 10, NEW technical capabilities will include:

- **Band 1 on the 12-m Array.** Observations for Stokes I only (no Stokes Q/U/V). Band 1 is anticipated to be available from March 2024 so is only available in configurations C-1 to C-6 (*not C-7 and C-8*). Frequency range 35-50 GHz (8.5-6 mm)
- **Spectral scans that include Total Power observations**
- **4x4-bit spectral mode for improved sensitivity on the 12-m Array (dual polarization only).** 4x4 bit mode significantly reduces the time required for specific spectral-line observations to reach a given rms, by 25% (or a 12% increase in sensitivity for fixed spectral resolution and integration time). 4x4 bit mode is *not* recommended for continuum observations because it reduces the available bandwidth compared to the standard 2x2 bit mode.
- **Solar observations with full polarization in Band 3 using only the 12-m Array**
- **Phased array mode in Bands 1, 3, 6 and 7.** The total time available for this mode will be limited to 50 hours.
- **VLBI (continuum and spectral line) in Bands 1, 3, 6 and 7,** including flexible tuning.

Joint Proposals also offered in Cycle 10 (see later slide)

# ALMA Capabilities in Cycle 10

- The Cycle 10 capabilities are be fully described in Appendix A of the ALMA Proposers Guide available at <https://almascience.nrao.edu/proposing/proposers-guide> (Cycle 10 version available from April 12). In summary:
- **Number of antennas**
  - At least forty-three (43) antennas in the 12-m Array
  - At least ten (10) 7-m antennas (for short baselines) and three (3) 12-m antennas (for making single-dish maps) in the ACA
- **Receiver bands**
  - Receiver Bands 1, 3, 4, 5, 6, 7, 8, 9, and 10 (wavelengths of about 7.5, 3.0, 2.0, 1.6, 1.3, 0.85, 0.65, 0.45, and 0.35 mm, respectively) → **Band 1 (7.5 mm) offered for the first time in Cycle 10, anticipated to be available from March 2024**
- **12-m Array Configurations**
  - Cycle 10 includes configurations C-1 through C-8. **(C-7 and C-8 not available in Band 1)**
  - Maximum baselines between 0.16 km and 8.5 km depending on array configuration
  - <https://almascience.nrao.edu/observing/observing-configuration-schedule/long-term-configuration-schedule>
  - Files containing **representative** antenna configurations for the 12-m and 7-m Arrays suitable for Common Astronomy Software Applications (CASA) simulations are available from the ALMA Science portal (<https://almascience.nrao.edu/tools/casa-simulator>)

# ALMA Capabilities in Cycle 10 - Configurations

Config	min - max baseline (m)	beam (") <sup>1</sup>	maximum recoverable scale (") <sup>1</sup>
C-8	110-8500	0.096"	1.4"
C-7	64-3600	0.21"	2.6"
C-6	15-2500	0.31"	4.1"
C-5	15-1400	0.54"	6.7"
C-4	15-784	0.92"	11.2"
C-3	15-500	1.4"	16.2"
C-2	15-314	2.3"	22.6"
C-1	15-161	3.4"	29.0"

# ALMA Array Configuration Schedule (Cycle 10)

- Maximum baseline in Cycle 10 will be 8.5 km in configuration C-8.
- Configurations C-9 and C-10 with maximum baselines of 13.9 km and 16.2 km, respectively, will NOT be available until Cycle 11.
- **NOTE: No PI observing takes place in February – maintenance shutdown!**
- The forward-looking configuration schedule (through Cycle 11) can be found at: <https://almascience.nrao.edu/observing/observing-configuration-schedule/long-term-configuration-schedule>

## Cycle 10

Start Date	Configuration	Longest baseline	LST: Best conditions
1-Oct-2023	C-8	8.5 km	22-10
20-Oct-2023	C-7	3.6 km	23-11
10-Nov-2023	C-6	2.5 km	1-13
1-Dec-2023	C-5	1.4 km	2-14
20-Dec-2023	C-4	0.78 km	4-15
10-Jan-2024	C-3	0.50 km	5-17
1-Feb-2024	No observations due to maintenance		
1-Mar-2024	C-1	0.16 km	8-21
26-Mar-2024	C-2	0.31 km	9-23
20-Apr-2024	C-3	0.50 km	11-0
10-May-2024	C-4	0.78 km	12-2
31-May-2024	C-5	1.4 km	13-4
23-Jun-2024	C-6	2.5 km	15-6
28-Jul-2024	C-5	1.4 km	17-7
18-Aug-2024	C-4	0.78 km	19-8
10-Sep-2024	C-3	0.50 km	20-9

# ALMA Capabilities in Cycle 10

	Band	3	4	5	6	7	8	9	10
	Frequency (GHz)	100	150	185	230	345	460	650	870
Configuration									
7-m	$\theta_{res}$ (arcsec)	12.5	8.35	6.77	5.45	3.63	2.72	1.93	1.44
	$\theta_{MRS}$ (arcsec)	66.7	44.5	36.1	29.0	19.3	14.5	10.3	7.67
C43-1	$\theta_{res}$ (arcsec)	3.38	2.25	1.83	1.47	0.98	0.74	0.52	0.39
	$\theta_{MRS}$ (arcsec)	28.5	19.0	15.4	12.4	8.25	6.19	4.38	3.27
C43-2	$\theta_{res}$ (arcsec)	2.30	1.53	1.24	1.00	0.67	0.50	0.35	0.26
	$\theta_{MRS}$ (arcsec)	22.6	15.0	12.2	9.81	6.54	4.90	3.47	2.59
C43-3	$\theta_{res}$ (arcsec)	1.42	0.94	0.77	0.62	0.41	0.31	0.22	0.16
	$\theta_{MRS}$ (arcsec)	16.2	10.8	8.73	7.02	4.68	3.51	2.48	1.86
C43-4	$\theta_{res}$ (arcsec)	0.92	0.61	0.50	0.40	0.27	0.20	0.14	0.11
	$\theta_{MRS}$ (arcsec)	11.2	7.50	6.08	4.89	3.26	2.44	1.73	1.29
C43-5	$\theta_{res}$ (arcsec)	0.55	0.36	0.30	0.24	0.16	0.12	0.084	0.063
	$\theta_{MRS}$ (arcsec)	6.70	4.47	3.62	2.91	1.94	1.46	1.03	0.77
C43-6	$\theta_{res}$ (arcsec)	0.31	0.20	0.17	0.13	0.089	0.067	0.047	0.035
	$\theta_{MRS}$ (arcsec)	4.11	2.74	2.22	1.78	1.19	0.89	0.63	0.47
C43-7	$\theta_{res}$ (arcsec)	0.21	0.14	0.11	0.092	0.061	0.046	0.033	0.024
	$\theta_{MRS}$ (arcsec)	2.58	1.72	1.40	1.12	0.75	0.56	0.40	0.30
C43-8	$\theta_{res}$ (arcsec)	0.096	0.064	0.052	0.042	0.028	0.021	0.015	0.011
	$\theta_{MRS}$ (arcsec)	1.42	0.95	0.77	0.62	0.41	0.31	0.22	0.16
C43-9	$\theta_{res}$ (arcsec)	0.057	0.038	0.031	0.025	0.017	0.012	0.0088	-
	$\theta_{MRS}$ (arcsec)	0.81	0.54	0.44	0.35	0.24	0.18	0.13	-
C43-10	$\theta_{res}$ (arcsec)	0.042	0.028	0.023	0.018	0.012	0.0091	-	-
	$\theta_{MRS}$ (arcsec)	0.50	0.33	0.27	0.22	0.14	0.11	-	-

Table 7.1: Angular resolution ( $\theta_{res}$ ) and maximum recoverable scale ( $\theta_{MRS}$ ) values for different 7-m Array and 12-m Array configurations are shown for one representative frequency in each ALMA receiver band. The value of  $\theta_{MRS}$  is computed using the 5<sup>th</sup> percentile baseline (L05) from Table 7.2 and Equation 7.6. The value of  $\theta_{res}$  is the mean size of the interferometric beam obtained through simulations with CASA. Computations were done for a source at zenith; for sources transiting at lower elevations, the North-South angular measures will increase proportional to  $1/\sin(\text{elevation})$ . Calculations are based on the notional C43-X and 7m configurations with Briggs weighting and a robust parameter of 0.5.



# ALMA Capabilities in Cycle 10

- **Spectral line, continuum, and mosaic observations**
  - Spectral line and continuum observations with the 12-m Array and the 7-m Array Bands 3-10. Band 1 only with the 12-m Array (spectral line and continuum).
  - Single field interferometry (Bands 3-10) and mosaics (Bands 3 to 9) with the 12-m Array and the 7-m Array. Band 1 only with the 12-m Array.
  - Single-dish spectral line observations in Bands 3 to 8
- **Polarization**
  - Single-pointing, on-axis, full linear and circular polarization for both continuum and full spectral resolution observations in Bands 3 to 7 on the 12-m Array. The field of view of linear and circular polarization observations is limited to the inner one third and the inner one tenth of the primary beam, respectively.
  - Mosaicking of continuum linear polarization observations in Bands 3 to 7 with the 12-m Array.
  - Single-pointing, on-axis, linear polarization with the stand-alone 7-m Array in Bands 3 to 7. The field of view is limited to the inner third of the primary beam. A maximum of 75 hours is offered for this mode.
    - Combined 7-m Array and 12-m Array polarization observations are *not* supported.

# ALMA Capabilities in Cycle 10

## Band-to-band phase calibration

- Observations in Bands 7-10 with the 12-m Array (new: any configuration) or the 7-m Array may require band-to-band (B2B) calibration in order to find a suitable nearby and sufficiently bright phase calibrator, to ensure phase calibration quality.
- The ALMA OT will *automatically* check the availability of suitable phase calibrators during proposal validation and will automatically trigger B2B where needed.
- Some science targets – especially in Band 10 and with the longest baselines (C-8 in Cycle 10) – may not be observable even with B2B. The ALMA OT will give an error and won't validate the proposal if a target does not have a suitable calibrator.
- It is recommended to begin preparing High Frequency proposals – and validate in the OT – early to ensure there is a suitable phase calibrator available.
- A maximum of 65 hours is available for Band-to-Band on the 12-m Array; and a maximum of 85 hours on the 7-m Array.

# ALMA Capabilities – Joint Proposals

- ALMA has entered into agreements with JWST, VLA and VLT.
- Joint Proposals must require observations with two or more observatories to achieve their scientific goals.
- A Joint Proposal is submitted to a single observatory, so it is no longer necessary to submit two separate proposals to each observatory, avoiding “double jeopardy” – just reviewed once.
- Starting in Cycle 10, ALMA will be able to allocate up to:
  - 115 hours of JWST time
  - Up to 5% of the available time on the VLA.
  - 50 hours of VLT time
- JWST can allocate up to 115 hours of ALMA time per cycle (starting with JWST cycle 2; Nov 2022; VLT and VLA can allocate up to 50 hours per year starting with Period 112 and Semester 2023B (CfP Feb & Jan 2023), respectively.
- See <https://almascience.nrao.edu/news/alma-announces-joint-proposal-agreements-for-jwst-vla-and-the-vlt>

# ALMA Capabilities – Joint Proposals

- More information can be found in the respective Calls for Proposals.
- For ALMA, see the Cycle 10 Proposer’s Guide.
- For VLA, see:
  - <https://science.nrao.edu/observing/call-for-proposals/2023b/new-opportunity-joint-observations-with-alma> and <https://science.nrao.edu/observing/call-for-proposals/2023b/joint-proposals>
- For VLT, see: <https://www.eso.org/sci/observing/phase1/JointVLT-ALMA.html>
- For JWST, see [here](#).
- Some important notes:
  - Proposals need to clearly demonstrate that *both* ALMA and the other observatory observations are scientifically required.
  - Proposals must be submitted to the observatory that requires the most observing time (“Main observatory”).
  - Proposals may not be submitted to both observatories at the same time.
  - If two or more non-ALMA observatories are required, ALMA must be the “Main observatory”.
  - Joint Proposals submitted to ALMA must be explicitly specified as such using the “Is this a Joint Proposal?” button in the ALMA OT.

# ALMA Capabilities in Cycle 10

## Proposal types in Cycle 10 will include:

- Regular, VLBI, Phased Array, Target of Opportunity, and Large Programs.
- VLBI proposals work in concert with the Global mm-VLBI Array (GMVA) or Event Horizon Telescope (EHT). **GMVA programs also had to submit a proposal to the GMVA by its 1 February 2023 deadline.**

## Restrictions on certain modes or proposal types:

- The distinction between “standard” and “non-standard” modes was removed starting in Cycle 8 2021 (in earlier cycles there was a 20% cap on the time request for non-standard modes)
- There are still some time caps on certain modes, however. Namely, high frequency observations requiring Band-to-Band phase calibration or full polarization observations on the 7-m Array.

## Large Program Observing Modes are **STILL** restricted. They **CANNOT** include:

- Time Critical or ToO Observations
- Full Polarization observations
- Solar observations
- VLBI or Phased Array observations
- Bandwidth switching projects (having <1 GHz aggregate bandwidths over all spectral windows)
- Band-to-Band calibration projects
- Astrometric Observations
- Band 1 (in Cycle 10 )

# ALMA Capabilities in Cycle 10

## Large Program Preparation and Support

- If you are planning to submit a Large Program, it is strongly recommended to contact your local ARC for support NOW to help with preparing your large programs.
- The ARCs have both proposal preparation and data processing support available.
- Large Programs require a Management Plan. This needs to describe both the team and their responsibilities within the project and the computing resources the team has access to for processing and storing the data. The ARCs offer access to computing resources. If it is the intention to utilize those resources, it is recommended you discuss and agree your computing needs with the ARC well in advance so you can include the use of these resources in the Management Plan.
- Review the documentation off the science portal on how to prepare “value added” data products.

# ALMA Capabilities for Cycle 11++

- **Receiver bands:**
  - Band 2 (Band 2 summary report from 2019: <https://zenodo.org/record/3240407>)
- **Baselines:**
  - All observing bands out to 16 km.
- **Observing Modes:**
  - Full operations include full Stokes plus circular polarization at all observing bands including mosaics and Total Power

**ALMA is getting a major upgrade in the next several years – the **Wideband Sensitivity Upgrade** – that will bring many new capabilities. See e.g. :**

- <https://public.nrao.edu/news/alma-correlator-upgrade/>
- <https://arxiv.org/abs/2211.00195>
- [https://science.nrao.edu/facilities/alma/science\\_sustainability/March22\\_WSU\\_Webinar\\_NAASC.pdf/view](https://science.nrao.edu/facilities/alma/science_sustainability/March22_WSU_Webinar_NAASC.pdf/view)

→ **This may potentially limit the rollout of other new capabilities in the short term.**

# ALMA Timelines and Milestones

## The ALMA Cycle 10 Timeline

Date	Milestone
<b>12 April 2023 (15:00 UT)</b>	Release of Cycle 10 Call for Proposals, Observing Tool, and supporting documents, and opening of the Archive for proposal submission
<b>10 May 2023 (15:00 UT)</b>	Proposal submission deadline for Cycle 10 Call for Proposals
<b>28 June 2023 (15:00 UT)</b>	Deadline to submit reviews for the distributed peer review system
<b>August 2023</b>	Announcement of the outcome of the proposal review process
<b>1 October 2023</b>	Start of ALMA Cycle 10 Science Observations (anticipated)
<b>30 September 2023</b>	End of ALMA Cycle 10



# WARNING!!!!

## THERE IS NO SUCH THING AS A “LATE” PROPOSAL

- “My internet is down...”
- “My proposal won’t validate...”
- “My power went out...”
- “I thought the time was 16UT not 15UT...”
- “My dog ate my proposal...”

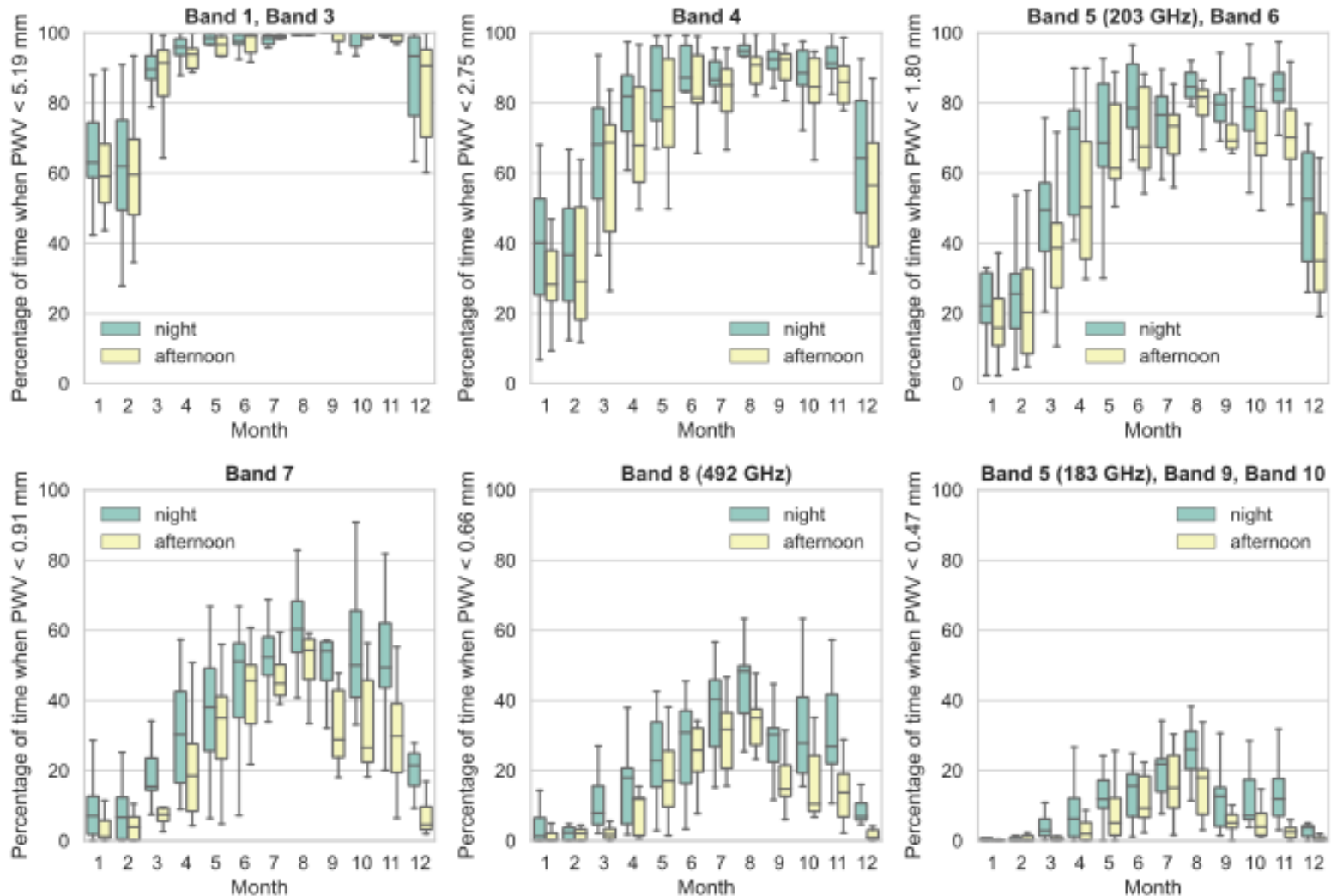
*The Observatory won’t accept late proposals in such cases.*

Submit proposals early and often. That way you:

- Always have a recent copy in the archive
- Know how long to expect validation and submission will take (in some cases, it may take much longer than you think)

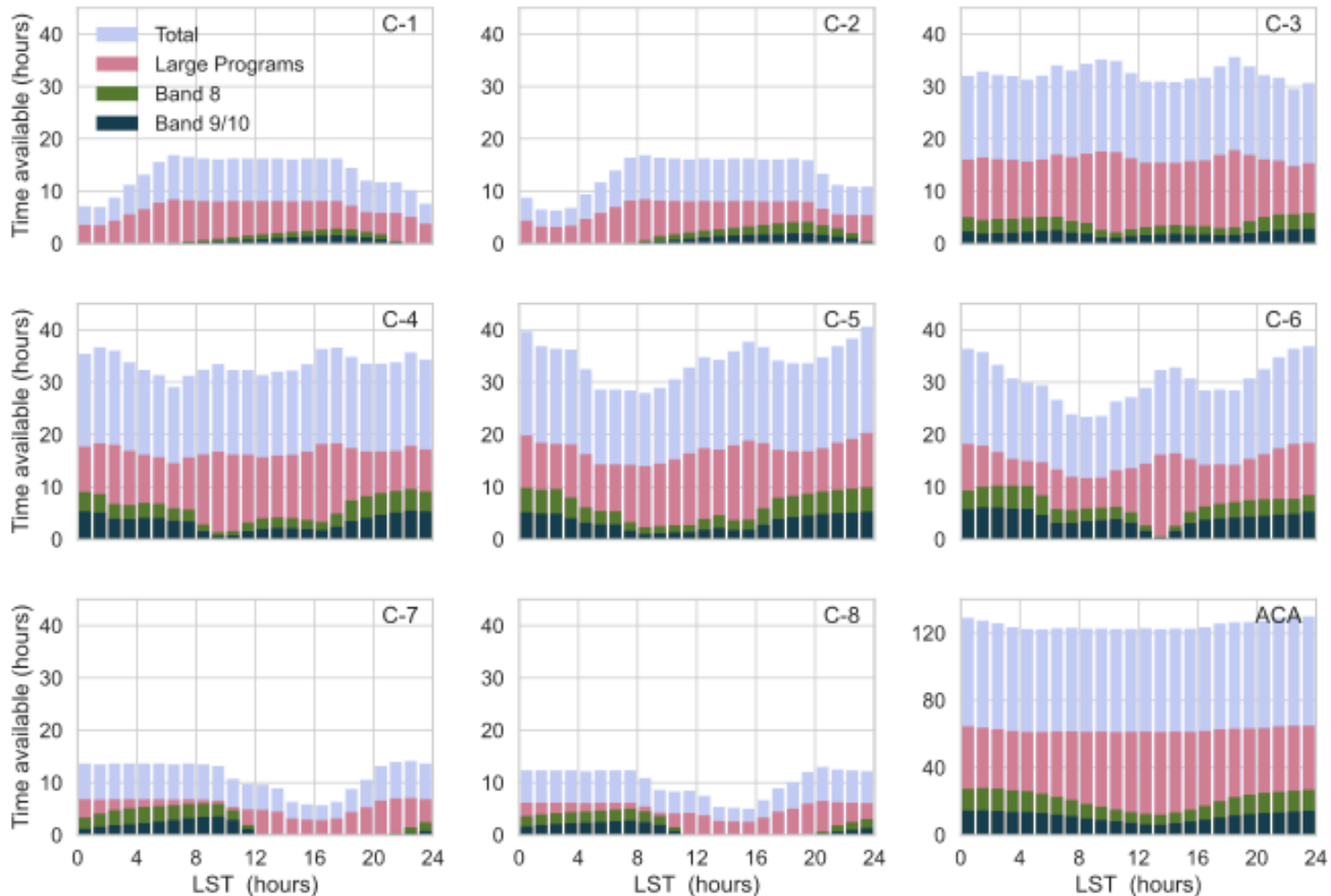
**Don’t try to submit for the first time 5 minutes before the deadline!!**

# ALMA Observing Strategies



The percentage of time when the PWV is below the observing thresholds adopted for the various ALMA bands for night-time (green) and afternoon (yellow) and for an elevation of 60 degrees. The horizontal line within the box indicates the median. Boundaries of the box indicate the 25th- and 75th-percentile, and the whiskers indicate the highest and lowest values of the results. The data were obtained with the APEX weather station, ALMA measurements, and weather forecast data between January 2010 and January 2022.

# ALMA Observing Strategies



Estimated observing time available per configuration for executing PI projects, based on precipitable water vapor (PWV) only. For example, approximately 30 hours are expected to be available in C-4 at LST 05 h for all observations and up to 15 h of those may be allocated to Large Programs. The time available for Large Programs is shown in pink and time for high-frequency observations in green and dark blue. The configuration schedule and, consequently, the total number of hours available per configuration may change in response to proposal pressure (Section 4.3.3 of the Cycle 10 PG).

# NAASC Sources of Support

- **ALMA Helpdesk:** User support is a priority so questions are usually answered within 48 hours (with around the clock staffing in the week leading up to the proposal deadline) - <https://help.almascience.org>.
  - Also can ask for a “NAASC Chat” through the f2f department which is more than a ticket but less than a full virtual f2f visit!
- **Student Observing Support:** Successful ALMA proposals will be invited to apply for up to \$35k to support undergraduate or graduate student involvement - <https://science.nrao.edu/opportunities/student-programs/sos>
- **NAASC Financial Support for Workshop/Conferences:** The NAASC invites scientists to apply for funding in support of upcoming conferences and workshops. - <https://science.nrao.edu/facilities/alma/community1/NAASC-Conference-and-Workshop-Support>

# NAASC Sources of Support

- **Page Charges:** Upon request NRAO covers page charges for authors at US institutions when reporting results from ALMA/VLA. See: <https://library.nrao.edu/pubsup.shtml>
- **ALMA Ambassadors:** You too can become an ALMA Ambassador. For program eligibility visit: <https://science.nrao.edu/facilities/alma/ambassadors-program>

# NAASC Sources of Support

- **Face-to-face Visitor Support:** Upon request NRAO will cover the travel expenses of up to 2 people from 2 teams per week to come to the NAASC to get support for data reduction, proposal preparation, etc. We also have long term visitor support as well. See: <https://science.nrao.edu/facilities/alma/visitors-shortterm>
  - You can ask for a zoom help session for any part of your proposal writing process (including the OT) at <https://help.almascience.org/>

Department \*

Face to Face Support (NA) ✓

Type of visit \*

Please choose how you would like your expert help. In person, virtually, or just a short chat. For more details, please visit <https://science.nrao.edu/facilities/alma/visitors-shortterm>

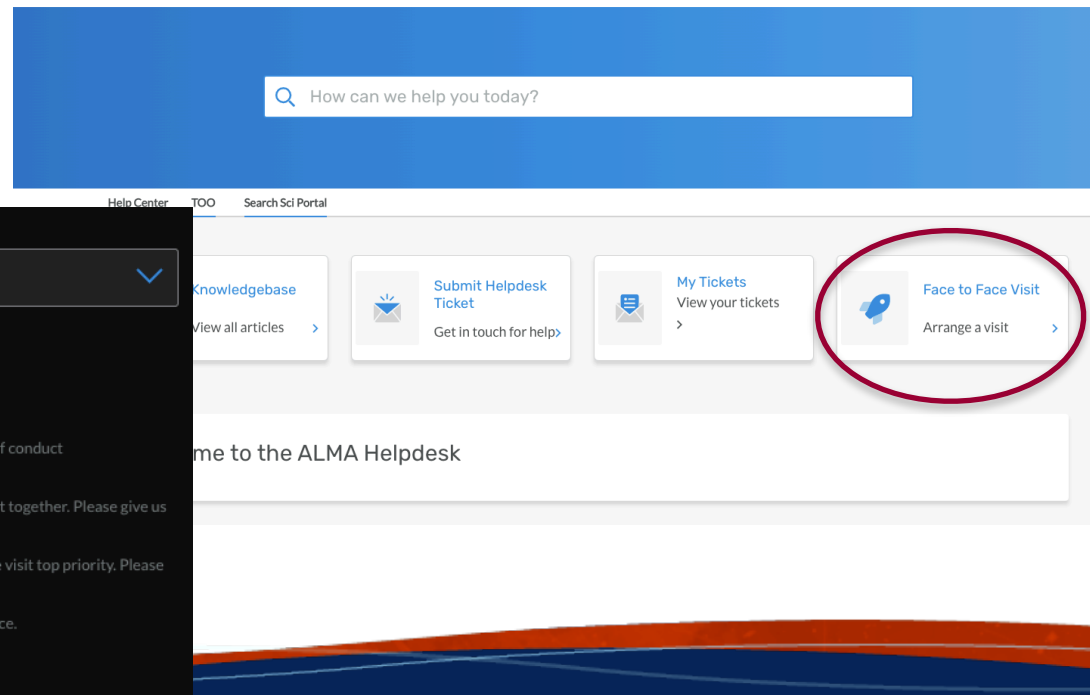
Please keep in mind that all visitors to NRAO (virtual or face-to-face) are expected to follow our code of conduct <https://info.nrao.edu/hr/Conduct>

Visit the NAASC (in person) - A week or so long visit where you come to us and we work on your project together. Please give us at minimum a month notice.

Virtual Face to Face - A week or so of a F2F, but over zoom and slack. We expect the visitor to make the visit top priority. Please give us at minimum a two week notice.

NAASC Chat - A couple hours of one on one with an expert. Please give us at minimum a one week notice.

Visit the NAASC (in person)  Virtual Face to Face  NAASC Chat





**[www.nrao.edu](http://www.nrao.edu)**  
**[science.nrao.edu](http://science.nrao.edu)**  
**[public.nrao.edu](http://public.nrao.edu)**

*The National Radio Astronomy Observatory is a facility of the National  
Science Foundation  
operated under cooperative agreement by Associated Universities, Inc.*