

East Asian ALMA Community Workshop: ALMA2040 Science and Technology Perspectives

July 15 – July 17, 2026, NAOJ

Opening, Workshop Overview

Bunyo Hatsukade
(NAOJ, ALMA Project)





Previous Workshops

- Developing future plans requires sustained, long-term commitment
- Held continuously since 2011 (start of full scientific operations) to discuss future development and scientific requirements
- These efforts shaped the ALMA Development Roadmap toward the 2030s

Date	Topic
March 9-10, 2022	Science Archive
March 11-13, 2020	ALMA 2030 Vision: Design Considerations for Digitizers, Backend and Data Transmission System
December 10-11, 2019	High frequency (Band 8,9,10) observations and development
December 14-15, 2018	Wide IF
October 3-5, 2017 (ALMA Long Baseline Workshop)	Long baseline





Previous Workshops

- ALMA Development Workshop:
Prospects for radio interferometry
in the 2040s
 - October 8-9, 2024, NAOJ
 - Language: Japanese
- Kickoff meeting for the Japanese
community toward ALMA2040

ALMA Development Workshop: 2040年代の電波干渉計の展望

【趣旨】

アルマ望遠鏡が2011年に本格運用を開始して以降、研究者コミュニティによって数多くの成果が生み出されてきました。この間、国内外の研究者コミュニティと協力して2011年に三鷹で開催した「ALMA Development Workshop」を皮切りに、その集大成となる2030年代に挑むべき科学目標と機能強化をまとめた「アルマ望遠鏡将来開発ロードマップ」を策定し、2023年度より「アルマ2計画」を実施しています。将来計画の策定には、このような長期にわたる継続的な取り組みが不可欠です。サイエンスのフロンティアのさらなる開拓に向けて、2040年代以降を見据えた科学目標・技術目標の検討は（特に若手世代にとって）喫緊の課題です。2040年代の天文学、特にサブミリ波・ミリ波・センチ波帯での電波干渉計を用いたサイエンスでは、いったい何が鍵となるのか？それを実現するための技術開発にはどのような困難や進化が予測されるのか？本研究会では、国内の専門家をお招きして、サイエンスと技術の両面から2040年代の展望について議論します。

【日程、会場および形態】

- 2024年10月8日、9日
- 国立天文台 大セミナー室（Zoomでの配信も予定）
- 口頭発表は招待講演のみとなりますが、ポスター発表を募集いたします。



<https://www2.nao.ac.jp/~eaarc/Meetings/ALMADW2024/>





This Workshop

- This workshop will launch East Asian discussions on future mm/submm interferometers in the 2040s
- The goal is to build a shared long-term vision for future planning and development
- Ambitious, forward-looking ideas from both science and technology perspectives to gather a broad range of ideas from the community



**East Asian ALMA Community Workshop:
ALMA2040 Science and Technology Perspectives**
July 15 (pm) – July 17, 2026

East Asian ALMA Data Analysis Workshop 2026
July 13 – July 15 (am), 2026
National Astronomical Observatory of Japan
Language: English

Home ALMA 2040 Program Data Analysis WS Registration Info. for Participants

Since the start of full scientific operations in 2011, ALMA has delivered transformative results across a wide range of astrophysical fields. These achievements have been supported by sustained, community-driven development efforts. Over the past decade, the East Asian community has worked closely with international partners, holding a series of workshops to identify long-term priorities. These efforts culminated in the formulation of the ALMA Development Roadmap, which defines key scientific goals and capability enhancements to be pursued toward the 2030s.

To further expand the frontiers of astronomy, it is essential to begin discussing scientific and technical goals that look toward the 2040s and beyond. This workshop will serve as a kick-off meeting for the East Asian ALMA community to explore long-term perspectives for future millimeter/submillimeter interferometers, under concepts often referred to as "ALMA2040", "Beyond WSU", or "ALMA3". We will invite ambitious, forward-looking presentations from both science and technology perspectives and encourage contributed talks to gather a broad range of ideas from the community. This workshop aims to gather broad input, stimulate cross-disciplinary discussion, and lay the groundwork for a shared long-term vision to guide future planning and development.

<https://www2.nao.ac.jp/~eaarc/Meetings/EAALMA-ALMA2040>

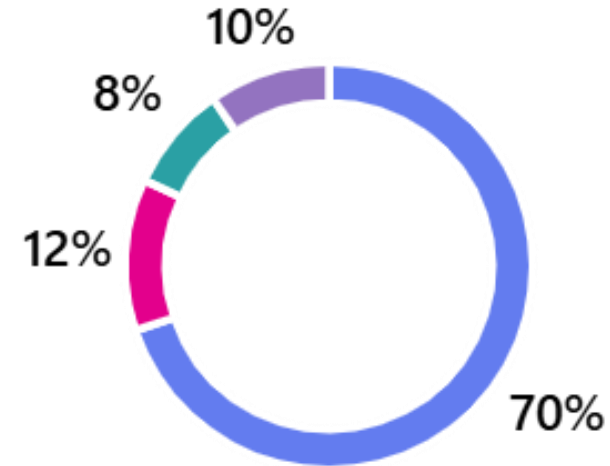




Participants

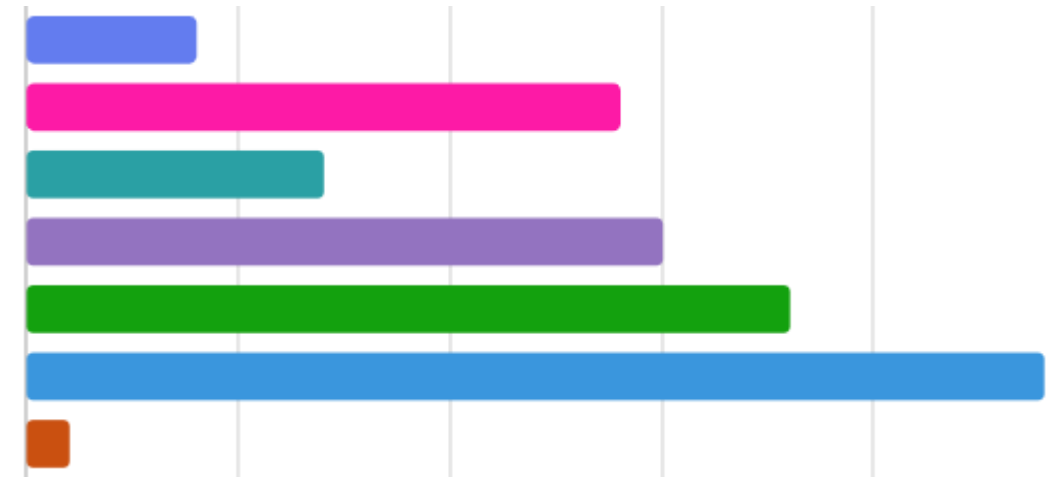
- Country

- Japan 57
- Korea 10
- Taiwan 6
- Other 8
 - China, France, Germany, India



- Stage of Career

- Student (Undergraduate) 4
- Student (Graduate) 14
- Early stage (1-5 yrs after obtaining degree) 7
- Early stage (~5-10 yrs after obtaining degree) 15
- Mid stage (~11-20 yrs after obtaining degree) 18
- Advanced stage (>~20 yrs after obtaining degree) 22
- other 1





Request to participants

- We encourage everyone to actively participate and share your opinions and feedback
 - sharing the views of the EA community and helping shape the direction of mm/submm interferometers in the 2040s
- Please share ambitious ideas that look ahead to the 2040s
 - rather than the extensions of current research or interferometers





Request t

- We encourage everyone to act on opinions and feedback
 - sharing the views of the EA community on mm/submm interferometers in the future
- Please share ambitious ideas to improve the ALMA project
 - rather than the extensions of current plans

The ALMA Telescope Becomes the ALMA Space Telescope

In search of better observing conditions, the antennas were launched beyond the Earth's atmosphere, achieving performance that isn't affected by weather. Those involved are enthusiastic, saying this will finally catch the attention of JA (abbreviation for "rocket-loving kids"). #AprilFools



国立天文台 アルマ望遠鏡

@ALMA_Japan

アルマ望遠鏡は、アルマ宇宙望遠鏡へ。

より良い観測条件を求めて、大気圏外までアンテナを打ち上げ、天候にも左右されない性能を実現。関係者は、これでJA（略 ロケット好きの子供たちを振り向かせられると意気込みを語っています。#エイプリルフール



エイプリルフール
Aprilfool



LOC Announcements



East Asian ALMA Community Workshop: ALMA2040 Science and Technology Perspectives

July 15 – July 17, 2026, NAOJ



Afternoon session will resume at 13:20





Announcements from LOC

- Reception & Name Badges
 - Please check in at the reception in front of the venue to receive your name badge
- Workshop dinner
 - 18:00–20:00, July 16, at the cafeteria on campus
 - If you registered for the dinner, please pay the fee at the reception desk
 - 2,000 yen for students and 4,000 yen for other participants
 - Payment must be made in cash



Panel Discussion





Panel Discussion: Question 1

Which capability should be the highest priority to enable the next generation of key science cases in the 2040s?

Panel Discussion: Question 1



<https://forms.cloud.microsoft/r/qRXvVZRVNa>





Panel Discussion: Question 2

What level of line sensitivity upgrade is required?

Panel Discussion: Question 2



<https://forms.cloud.microsoft/r/tHaLHeeZcK>





Panel Discussion: Question 3

What level of improvement in angular resolution is required?

Panel Discussion: Question 3



<https://forms.cloud.microsoft/r/rkeFcQhT5v>





Panel Discussion: Question 4

- Given the massive data volumes expected, what kind of data reduction environment do we envision?
- How can we effectively integrate AI and automated pipelines?





Panel Discussion: Question 5

- How should ALMA2040 leverage synergies with other major upcoming facilities?
 - AtLAST, BHEX (Capella), ngEHT, ngVLA, SKA





Panel Discussion

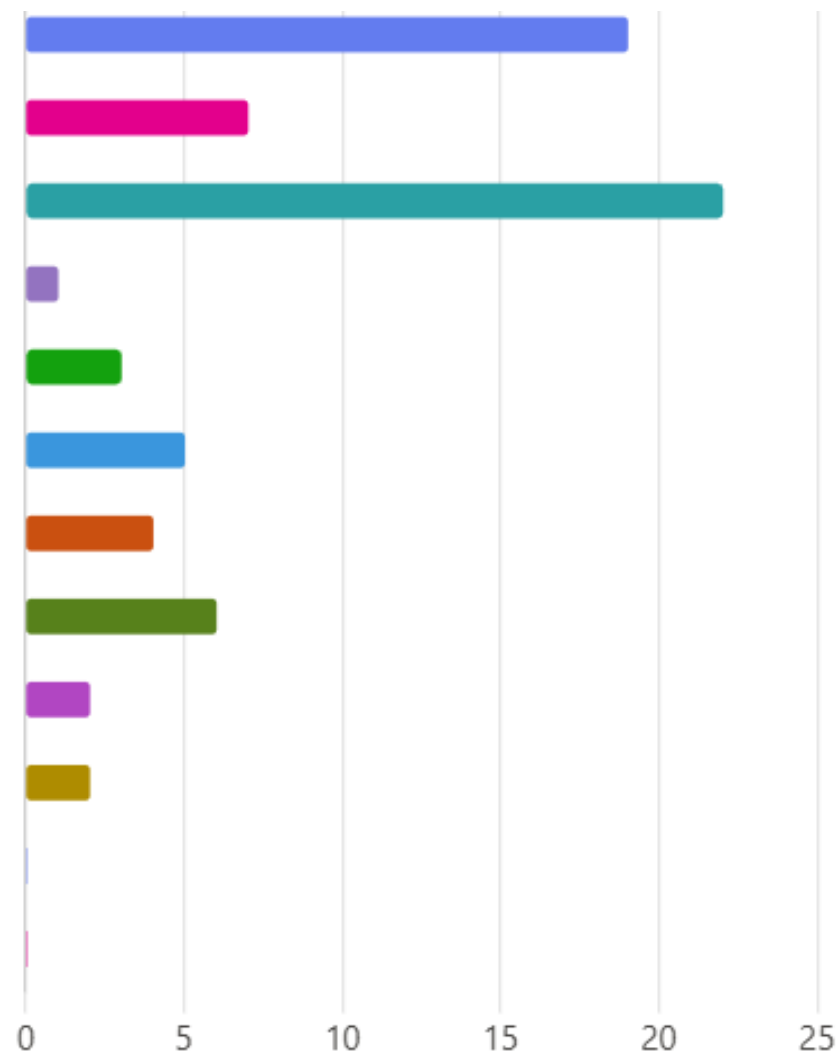
1. Which capability should be the highest priority to enable the next generation of key science cases in the 2040s?
2. What level of sensitivity upgrade is required (compared to the current ALMA)?
3. What level of improvement in angular resolution is required (compared to current ALMA)?
4. Given the massive data volumes expected, what kind of data reduction environment do we envision? How can we effectively integrate AI and automated pipelines?
5. How should ALMA2040 leverage synergies with other major upcoming facilities?
 - e.g., AtLAST, BHEX (Capella), ngEHT, ngVLA, SKA





Q1. Which capability should be the highest priority to enable the next generation of key science cases in the 2040s?*

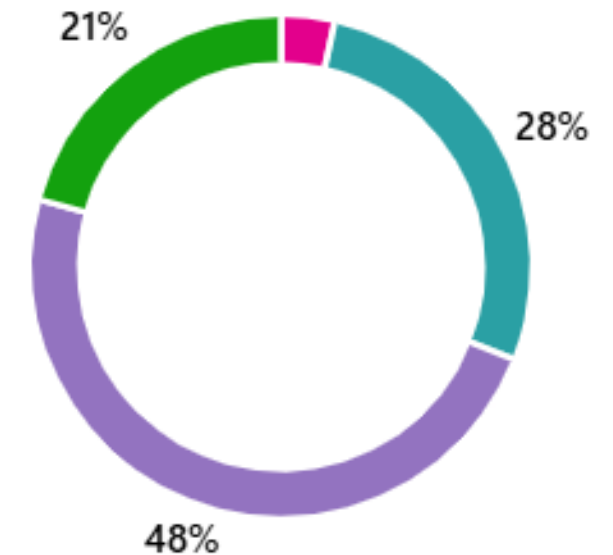
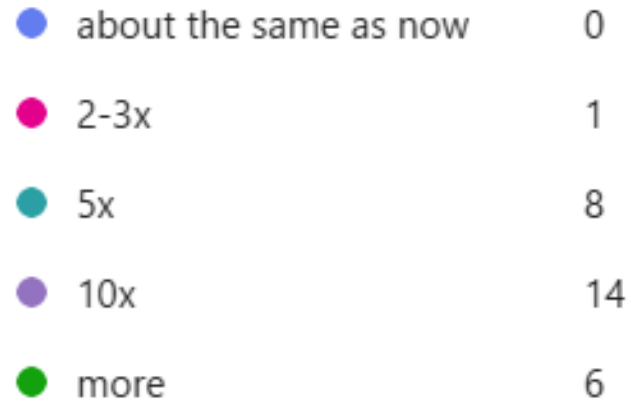
Angular resolution	19
Continuum sensitivity	7
Line sensitivity	22
Field of view	1
Multi-beam	3
Multi-band	5
Polarization	4
Image fidelity	6
Amplitude accuracy	2
THz (>Band 10)	2
Phased array	0
Other	0



* Select up to two



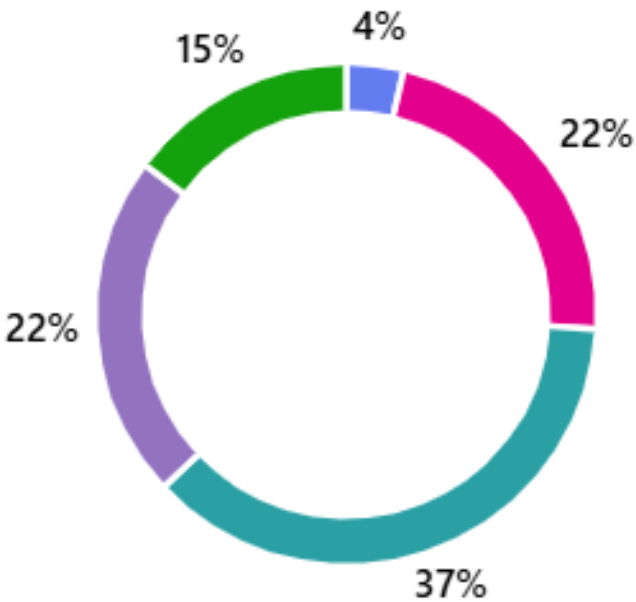
Q2. What level of sensitivity upgrade is required? (compared to the current ALMA)





Q3. What level of improvement in angular resolution is required? (compared to the current ALMA)

● about the same as now	1
● 2-3x	6
● 5x	10
● 10x	6
● more	4

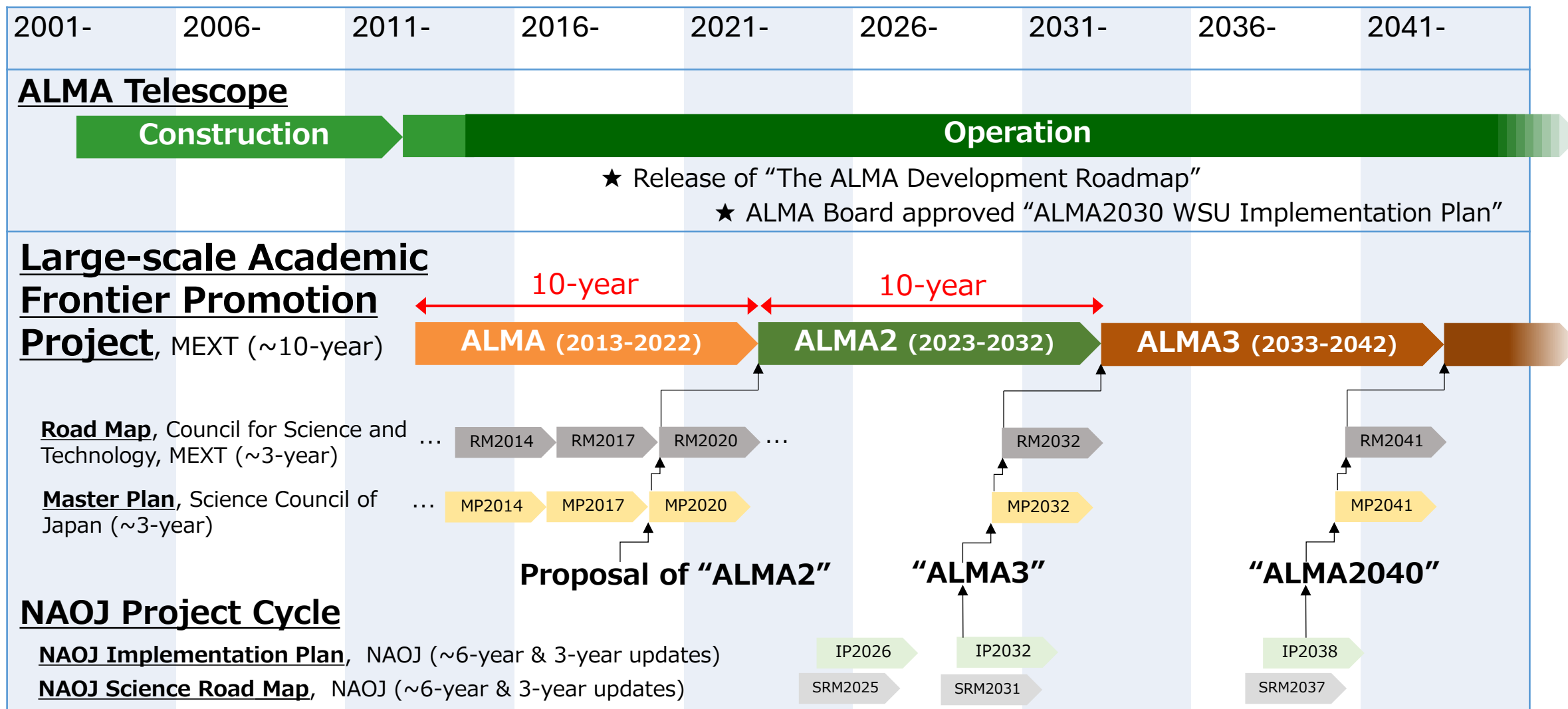


Discussion





Timeline toward ALMA2040 (and ALMA3)





Planning of ALMA2 (and ALMA2030)

- Japan has led the world in discussing future observational capabilities with the science community since 2011.
- Based on the results of these discussions, the international Working Groups and the ALMA Science Advisory Committee began discussions, agreed on science goals, development items and their priorities, and released “The ALMA Development Roadmap”.

East Asian ALMA Development WS



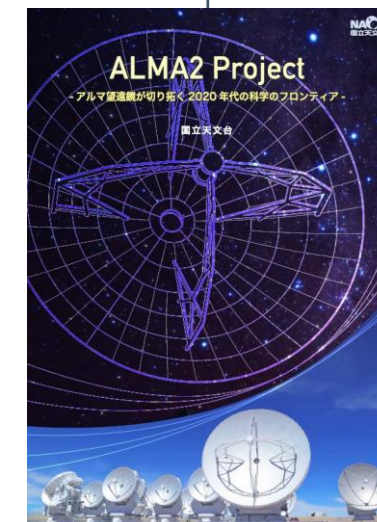
International ALMA Development WS



ALMA Long Baseline Workshop held in Kyoto in October 2017. Researchers and engineers from around the world joined together for discussions that led directly to the preparation of “The ALMA Development Roadmap”.



“The Development Roadmap” (2018). Signed by the Director of ALMA and Professor Toshikazu Onishi of Osaka Prefecture University, then Chair of the ALMA Board.





Toward ALMA2040

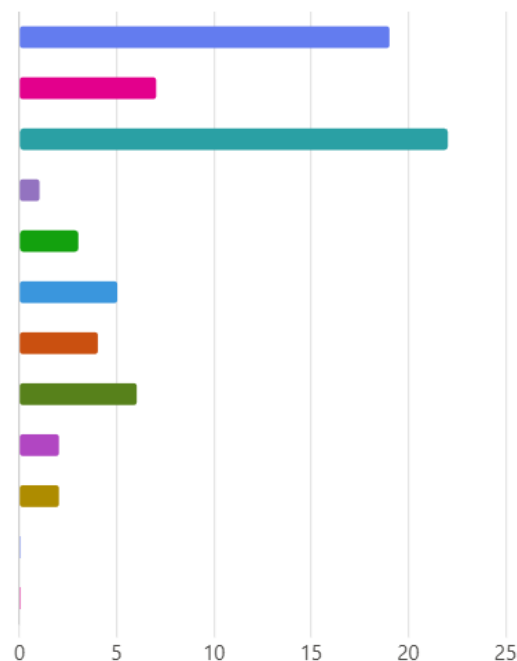
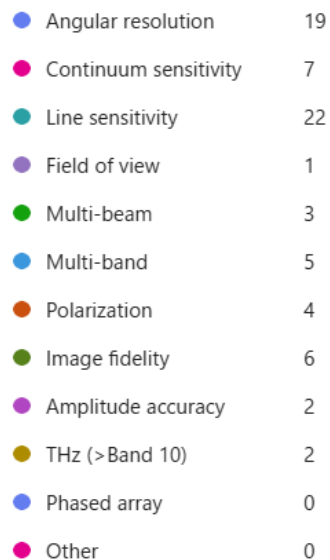
- How do we move forward toward ALMA2040 in EA?
 - What is the next step?
 - What is the best format, timeframe, and frequency for EA activities?
 - How do we link EA's activities with those in Europe and NA?



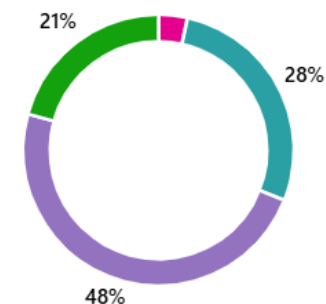
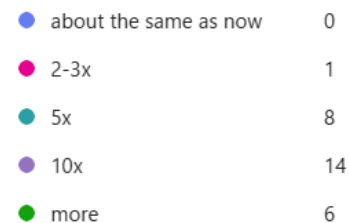


Panel Discussion on July 16

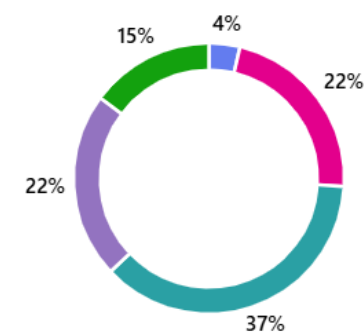
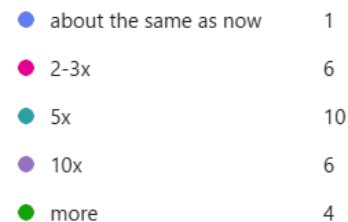
1. Which capability should be the highest priority to enable the next generation of key science cases in the 2040s? (0 点数)



1. What level of sensitivity upgrade is required to enable the next generation of key science cases? (0 点数)



1. What level of improvement in angular resolution is required? (0 点数)





Toward ALMA2040

- How do we move forward toward ALMA2040 in EA?
 - What is the next step?
 - What is the best format, timeframe, and frequency for EA activities?
 - How do we link EA's activities with those in Europe and NA?
- What will be the key science cases in EA?
 - Need to convert scientific requirements into quantitative requirements
 - Co-design loop between science requirements and technical feasibility
 - Requirements from EA appear to differ in some respects from European ALMA2040





Toward ALMA2040

- How do we move forward toward ALMA2040 in EA?
 - What is the next step?
 - What is the best format, timeframe, and frequency for EA activities?
 - How do we link EA's activities with those in Europe and NA?
- What will be the key science cases in EA?
 - Need to convert scientific requirements into quantitative requirements
 - Co-design loop between science requirements and technical feasibility
 - Requirements from EA appear to differ in some respects from European ALMA2040
- How can ALMA2040 be funded in the much broader landscape of expensive experiments in physical science (i.e., not just astrophysics)?

