



ALMA BOARD

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ALMA Science Advisory Committee (ASAC) Report to the ALMA Board - Spring 2024

Yuri Aikawa, Sean Andrews, Sara Ellison, Maryvonne Gerin (EU Vice-Chair), Viviana Guzmán, Ágnes Kóspál, Li-Hwai Lin, Stefanie Milam (Chair), Kazushi Sakamoto, Hideo Sagawa (EA Vice-Chair), Mario Tafalla

General considerations

The Spring ASAC meeting of 2024 was held virtually during three two-hour sessions on March 18-20, 2024. All presentations were pre-recorded and available to the committee prior to the meeting in order to maximize the discussion time and provide the ALMA staff with some questions prior to the meeting as well as during the discussion. ASAC thanks all the presenters for their work and timely delivery of presentations and addressing our questions efficiently.

The meeting included presentations by the ALMA Director Sean Dougherty, DSO head Sergio Martín, Observatory Scientist John Carpenter, ALMA Deputy Director for Development Alvaro Gonzalez, EA ALMA Program Scientist Bunyo Hatsukade, EU ALMA Program Scientist María Díaz Trigo, and NA ALMA Program Scientist Crystal Brogan. The material from the presentations and the content of the meeting discussions have been used to prepare this report. We address the six ASAC permanent charges here.

Stefanie Milam, from the NA community, began her term as the ASAC chair. The two elected vice-chairs from last fall are both no longer serving on ASAC (Nami Sakai from EA and Serena Viti from EU). ASAC nominated two new vice-chairs during this meeting: Maryvonne Gerin as the vice-chair from EU and Hideo Sagawa as the vice-chair from EA. ASAC also recognizes and commends the efforts of the former chair, Mario Tafalla, and would like to thank him for his service in that role.

Permanent Charge #1. Assessment of the performance of ALMA scientific capabilities: The ASAC shall indicate what information is required from the Joint ALMA Observatory (JAO) to perform this assessment.

Recommendations/issues:

- ASAC congratulates the organizers and participants for the successful “ALMA at 10 years” conference organized in Puerto Varas in December 2023. The science output of ALMA, as measured in the number of published papers, is impressive and

yearly publication rates are on par with other large facilities such as the VLT and the HST.

- ASAC is happy to see that after an inefficient start of Cycle 10 observations, data acquisition was accelerated with record high observing hours on the 12m array in December 2023, and that data acquisition on the 7m array and TP antennas are also on or above target. ASAC commends the high Cycle 10 data delivery completion rates and the fast timescale of automatic delivery.
- ASAC welcomes the start of Band 1 observations planned for March 2024 and awaits a prompt delivery of the remaining Band 1 Science Verification and Observatory Project data which will promote and offer on-sky performance metrics for Band 1 proposals.
- ASAC acknowledges that the acceptance rate of joint proposals is close to what is expected based on the oversubscription rates. ASAC recommends these programs are monitored for success and science impact.
- ASAC is happy that Cycle 11 will offer for the first time full polarization in Band 1 on the 12m array and Band 1 on the 7m array (for Stokes I only), as well as high frequency observations on long baselines. The 4x4 bit spectral mode on the 7m array is another new capability enabled in Cycle 11. ASAC recommends that ALMA promotes these capabilities and monitors the proposal pressure of these as well as the success of the programs.
- ASAC was pleased with the updates on the Wideband Sensitivity Upgrade (WSU) and that this effort is on track with management and organization as well as the significant progress that has been achieved since last fall. ASAC encourages ALMA to be open and provide routine updates to the community on the schedule and progress of WSU and supports the efforts proposed to do so (e.g. website, emails, etc).

Cycle 10 status. Cycle 10 observations started on time on 1 October 2023. A number of technical issues affected the initial performance of the array (antenna bus master freezing, 4-bit mode amplitude and phase jumps, etc) and led to a significant loss of observing time. Part of this loss has been made up thanks to very efficient observations during December and January, and now that the array has re-started observations after the February maintenance shutdown, it is only 70 hours behind schedule. If all goes as expected, the Observatory is on track to reach 4000 hours of observations by the end of the cycle.

Joint proposals. While the proposal acceptance rate of joint proposals seemed low, it is understood that this rate is consistent with the oversubscription rate of the observatory. ASAC encourages ALMA to closely monitor the proposal statistics for these programs.

Additionally, the success and impact of these programs should also be tracked to ensure the effort and significance of employing two facilities is not wasted.

WSU Progress. ASAC is encouraged to see that the Wideband Sensitivity Upgrade (WSU) is on track with management and organization as well as the significant progress that has been achieved since last fall. The WSU is a major undertaking that puts a significant workload on most of the ALMA staff. ASAC thanks the dedication and efforts of the people involved in the WSU and encourages the JAO to ensure the workload remains at a sustainable level. ASAC welcomes the idea of a dedicated WSU News website to inform the community of this very important upgrade, and to provide routine commissioning updates and scheduling especially regarding the significant impact on science operations from Cycle 13 in 2026.

Permanent Charge #2. Assessment of the technical aspects of the ALMA system performance: The ASAC shall indicate what information is required from the JAO to perform this assessment.

Recommendations/issues:

- ASAC is concerned about the status of the antenna transporters and its possible impact on the array operations. An update on the plans for transporter maintenance and efficient operations during these periods would be greatly appreciated.
- ASAC commends JAO for its timely delivery of data to PIs and the start of the automatic data delivery, although it notes that manual processing is generally significantly behind the target schedule.
- ASAC commends JAO for the implementation of new measures to promote high-frequency and other weather-critical observations and reiterates the importance of these types of projects for ALMA.

Transporters. An issue of concern for ASAC is the status of the transporters. One of them (Lore) has not been operational since August 2023, although is expected to be repaired by the end of March 2024. The other transporter (Otto) is not fully nominal and can only be used to relocate antennas at the AOS. This has made it impossible to move antennas between the OSF and the AOS and could potentially affect the deployment of the longer baselines if Lore is not repaired on time.

Data delivery. Data delivery to PIs during Cycle 10 has proceeded at a relatively fast pace. For pipeline-processed data, the percentage delivered within 30 days has been 96%, which is better than the 90% goal. For manually processed data, the percentage delivered within the 45 days required for the 90% goal has only been 45%. Part of the success delivering pipeline-processed data is due to the new automatic delivery started last December. This delivery does not require human intervention and is the result of years of development and

testing. It can be best applied to ACA observations and short baselines, but is not available for new modes, like Band 1 observations.

High-frequency observations. The need to increase the completion rate of high-frequency observations is an old and well-accepted issue. During Cycle 9, JAO implemented a number of measures to promote high-frequency and other weather-critical observations. ASAC was informed that the success of these measures has been mixed, and that several new measures will be implemented during Cycle 10. In addition, high frequency observations are now possible during daytime, which may increase the number of observable projects. ASAC encourages JAO to continue implementing measures to promote high-frequency observations and reiterates their importance.

Permanent Charge #3. Assessment of the science outcomes from ALMA: Statistics on publications, citations, press releases, web sites, etc. collected by the Executives shall be collated by the JAO, and analyzed by the ASAC.

Recommendations/issues:

- ALMA at 10 years conference: ASAC congratulates the SOC and LOC for organizing a very successful conference that highlighted the science done with ALMA in the past 10 years.
- ASAC is happy with the level of publications in the past year, in particular with the number of publications using archival data, which is increasing every year.
- ASAC is concerned with the increasing publication fees of top tier journals, which could potentially affect the publication of ALMA results for certain regions. ASAC encourages the Board to consider ways in which such inequities in Author Page Charge funding could be mitigated.
- Statistics of thesis using ALMA data could be an option to measure the impact of ALMA on young generations (e.g. thesis using ALMA data). Such information could be collected by ARCs.
- ASAC recommends compiling the statistics for a more granular "impact per program" (and perhaps per hour of observing time), in terms of number of publications and citations. Beyond the overall distributions, these metrics could be explored as a function of time, region, science category, proposal type, and observing band.
- ASAC recommends JAO to track the statistics for publications from joint proposals.

ALMA Conference: ASAC is pleased with the outcome of the ALMA conference held in Puerto Varas last December and appreciates all the efforts done by the organizing committees, in particular the LOC, to have the meeting run smoothly in a hybrid format.

Publications: ASAC is happy to see that the number of publications using ALMA data remains healthy in 2023. The fact that 81% of papers are now multiregional is positive, but ASAC would like to know if this multiregional aspect is also present at the proposal stage. ASAC is also pleased to see that the use of archival data continues to grow, as reflected in the number of publications using archival data.

ASAC is also concerned with access to publishing in top tier journals. Author Page Charges (APCs) are largely now inevitable and yet there is great regional variation in accessible funding for these charges. This potentially generates inequity between the capacity for different partners to effectively disseminate their results.

Statistics: ASAC appreciates the statistics provided on publications and proposals. Details on joint proposals would be appreciated. Additionally, information on the impact for next generation scientists and how ALMA data is being used in student publications or thesis projects. ASAC is also interested in the return on investment - or the impact per hour. Statistics on how many publications/citations are coming per hour or program (especially large programs) would be useful.

Permanent Charge #4. Recommendation of ways to maximize ALMA's scientific impact: This includes review of the scientific effectiveness of the Proposal Review Process after each Proposal cycle.

Recommendations/issues:

- ASAC remains concerned about the limited use of the Stage 2 opportunity to improve the DPR process. We recommend that JAO guides ALMA PIs to participate more in the Stage 2 review in Cycle 11. The option to comment on other reviews that may include obvious misunderstandings or mistakes (e.g. put a flag to be checked by the reviewer and/or JAO before/during the Stage 2 process).
- ASAC was informed of the outcome of the investigation by JAO of similar proposals and is happy with the clarification written in the Cycle 11 call for proposals.
- ASAC recommends that the public data from the Observatory Projects should be made available to everyone at the same time. A prior announcement of the time and date of each data release would accomplish this.

- ASAC welcomes the change in the proposal forms for ALMA large programs , with the management plan included in the proposal form and proper justification of data processing resources.
- ASAC recommends that the Observatory consider ways to permit (even limited) Large Program proposals for transient science soon (ideally before Cycle 13), to take maximum advantage of the progress expected from the Vera Rubin Observatory.
- ASAC is happy with the increased use of the ALMA archive and recommends to survey ALMA archive users for their experience to identify the current issues and understand the needs for the future.

Barriers to access ALMA data: The high oversubscription rate may discourage new people from joining ALMA. ASAC wants to keep an eye on the percentage of proposals (and possibly publications) by the new users. Currently, the first-time proposer is about 15 %. Feedback from the community indicates that there may be challenges with using the ALMA archive and related resources for projects requiring intensive data mining (i.e. large numbers of targets). There may also be regional differences in the barriers faced. The advent of WSU will add a further challenge. Assessing these challenges in a systematic way would be advantageous for the observatory as it moves into an era of archive maturity in which more ambitious archival projects become both more tractable and likely more common. Developments of the ALMA archive and associated tools are key for maintaining the scientific interest in ALMA and for the preparation of observing proposals. A survey to ALMA archive users for input on their experience with the current archive and to identify the current barriers and understand the needs for the future would provide useful guidance on how to best approach this concern.

ALMA proposal review process: ASAC remains concerned about the limited progress in the use of the Stage 2 review process in DPR. While only a small percentage (~10%) of the reviewers change their score after the 2nd-stage review, meaning that the potential for 1 reviewer changing their score among 10 proposals, which may be critical in the current high oversubscription rate. Minor science areas may suffer in the restricted comparison of 10 proposals as the topics could appear less interesting or are less understood during the stage 1 DPR process. Comments in the stage 2 process may help the reviewer to better understand the science objectives of the proposals, especially for minor science areas, hence allow the reviewer to use all information in their ranking. One way to provide this opportunity would be to offer the option to comment on other reviews or flag a review for re-evaluation if an obvious misinterpretation is present.

Another disadvantage of the DPR is the lack of discussion for programmatic balance leading to proposals with very similar science cases being accepted, which results in a loss of diversity in science. This also applies to overlapping contents raised in the previous ASAC report. ASAC acknowledges that *similar* proposals from the same team will be

discouraged in the Cycle 11 proposal guide and recommends that this is monitored for impact and encourages the JAO to consider ways to ensure diverse science.

ASAC encourages ALMA to consider joint proposals to be reviewed by the TAC panel for discussion to maintain common practice as the partner telescopes (VLT, JWST, VLA) which review most of them (if not all) in panels.

ALMA Observatory Projects and science verification data: ASAC commends the JAO for its efforts to publicly release the reduced data from the Observatory Projects that were recently observed in low-frequency bands with long baselines to fill schedule gaps. We note that some of the observations may lead to immediate publications. In order to maximize scientific output through fair competition, the data *must* become available to all users at the same time. The proposed method of announcing data releases by sending an email notice to ALMA users *after* each data release has some limitations regarding simultaneous access to these announcements. Some users will find them after others due to different time zones and local holidays. JAO could mitigate this problem by announcing the time and date of each data release a reasonable number of days in advance; the timing for each release could be determined after it has completed the data reduction. While any time will inevitably be inconvenient for someone, with advance notice, will help alleviate the imbalance of opportunity. ASAC recommends that JAO considers such a procedure.

ALMA observing modes: Although the resources to implement new observing modes are limited due to the priority of implementing the WSU, ASAC reiterates the interest of the community in multi-cycle programs. With the increased interest across the scientific community with time-domain science, ASAC suggests investigating whether such projects could be proposed as large programs.

The Vera Rubin Observatory is slated to start science operations in 2025. We can expect this to precipitate a dramatic shift in the volume of transient research in many scientific areas, with an enhanced interest in complementary ALMA observations. Some of the associated progress could be foreclosed if users remain unable to consolidate a coherent large program campaign with ALMA. Recognizing that effort to facilitate new capabilities is restricted by WSU commissioning, ASAC recommends that ALMA explore options for permitting transient Large Program proposals starting in Cycle 12 with appropriate boundaries to avoid a significant burden for observatory staff to implement this.

Permanent Charge #5. Reporting on operational or scientific issues raised by the wider community as communicated by the three regional Science Advisory Committees (ANASAC, ESAC and EASAC).

Recommendations/issues:

- ASAC recommends that the statistics of the regional balance of the awarded and executed time continue to be monitored and made available to the broader community.

Specific concerns from EA not addressed elsewhere:

- ASAC requests statistics of the fraction of time used for LP for each region, since the fraction could be more significant for regions with smaller allocations (EA and CL).

Specific concerns from NA and EA not addressed elsewhere:

- ASAC recommends the demography of ALMA users is monitored with attention to the influx of new users.

Impact of high oversubscription rate on new users: ALMA needs to maintain an active user community to ensure continued scientific output. However, there is a growing concern that the high oversubscription rates of ALMA proposals may be discouraging new users. The anticipated increase in oversubscription during the WSU deployment may exacerbate the situation. ASAC recommends that JAO monitors the demographics of ALMA users to address this concern. Examples of the relevant statistics include the number and fraction of first-time proposal PIs in each cycle, the same for the CO-Is, and their breakdown by executive regions. It may also be informative to count the number of first-time, second-time, 3-5-time, and >5 time PIs, to see if many drop out after a few cycles. (We thank the Observatory Scientist, Dr. John Carpenter, for providing us with the plot of "Number of first-time PIs by Cycle, for each executive region" right after the ASAC meeting.) ASAC would appreciate the demography data being maintained and presented annually.

Specific concerns from ESAC not addressed elsewhere:

- ASAC recommends investigations on user challenges with data from the JAO should be made available to the community for reference and recommendations with such programs.

For its fall 2023 meeting, ESAC received a user report based on a student project at ESO where several issues with Total Power observations, analysis in CASA, and combination with 12-m and 7-m array data were discussed. JAO has investigated the issues carefully and concluded that the current observing procedures should not be changed. It is suggested that the outcome of the investigation, i.e. the high quality of total power data and the additional difficulties of observing weak and broad spectral lines with the TP antennas, is made publicly available.

Permanent Charge #6. Assessment of the scientific impacts of the ALMA Development Program, and particularly of new projects that are proposed.

Recommendations/issues:

- ASAC commends the progress made on various stage 1 programs (band 2, band 6v2, and band 8) and studies have been carried out smoothly and on schedule.

- ASAC is happy to see that 8 working groups have been established for WSU for initial impact assessments of WSU on computing and science operation subsystems and a document with an impact assessment of WSU has been prepared.
- ASAC is pleased to see that JAO has come up with a draft timeline for WSU implementation and commissioning. ASAC recommends the WSU schedule be made available to the community as soon as the plan is fixed.
- ASAC is concerned about the impact of the WSU implementation on the oversubscription rate during 2026-2028. It is also important to consider strategies of proposal allocation and scheduling during the impacted period (e.g,whether to suspend accepting Large Programs, limit baselines per cycle, etc.)
- The ASAC is concerned over the lack of a clear strategy to integrate ngOT software into the AIVC process for the WSU. Adapting ngOT to the WSU's architecture will require substantial effort (more than annual updates for a given call for proposal and limited new capabilities as is done now), and collaboration during commissioning is crucial for user functionality. Despite funding constraints, ASAC recommends initiating ngOT development for WSU capabilities in the AIVC process as soon as possible.

ASAC acknowledges that the JAO intends to communicate updates regarding the WSU through multiple channels. Given that the commissioning of the WSU will have a significant impact on science operations for approximately three years, beginning in 2026, it is crucial to timely inform the community about the implementation plan for the WSU.

ASAC remains concerned that there is not a firm strategy in place for integrating the fundamental user-facing software (ngOT) into the AIVC process from the beginning of the WSU effort. Given the typical timeframe required for modest updates in the OT each cycle to improve efficiency and add new observing modes, it seems certain that adaptation of the ngOT for the radically different architecture and flexibility that comes with the WSU will be a very substantial effort. Some iteration with the commissioning effort to improve functionality and efficiency for the users will be essential. Without a concrete plan to interface with the ngOT, there is real concern of software-related delays for community access to otherwise fully functional modes of the WSU. While acknowledging the funding and staffing limitations of the Observatory, we advise that the effort to develop the ngOT for WSU capabilities is initiated and appropriately supported in the AIVC process as soon as possible. *ASAC was provided with a few more details after the meeting and understand there is a plan in place to support WSU with ngOT but would like a more fledged out description of that plan and timeline regarding WSU.*