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ALMA EDM Document	AEDM 2023-074-O
Distribution	<b>Ordinary Session</b>

**Subject:** ASAC Report-  
October 2023

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**Purpose of Document:** To provide the ALMA Board with the October 2023  
ASAC Report

**Status:** To be noted by the Board in the November 2023 Meeting

## **ALMA Science Advisory Committee (ASAC) Report to the ALMA Board - Fall 2023**

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### **General considerations**

The Fall ASAC meeting of 2023 was held virtually during three two-hour-long sessions on October 4-6. To maximize the discussion time, all presentations were pre-recorded and made available two weeks prior to the meeting. The presenters attended the meeting and answered questions from ASAC. ASAC warmly thanks all the presenters for their work preparing the presentations and for their time answering questions. ASAC appreciates the high quality of the material that was prepared for the meeting.

The meeting included presentations by ALMA director Sean Dougherty, acting Department of Science Operations head Sergio Martín, Observatory Scientist John Carpenter, Proposal Handling Team Lead Andrea Corvillón, 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 plus an ad-hoc charge related to the balance between ALMA projects of different time lengths.

The current chair, Mario Tafalla, ends his term this year, and following the traditional rotation between regions, the next chair should belong to the NA community. ASAC proposes Stefanie Milam (current NA vice-chair) as the new ASAC chair starting January 2024. Nami Sakai is proposed to continue as EA vice-chair while Serena Viti is proposed to become EU-vice chair.

**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 celebrates that the Band 1 receivers will be offered during Cycle 10, and that the implementation of full Stokes observations is planned for Cycle 11. ASAC recommends the release of the science verification data from Band 1 observations as soon as possible to promote the use of these new receivers by the community.
- Progress on the WSU seems rapid and strong, and a number of important milestones are expected for 2024. As the WSU timeline becomes better defined, it is clear that it is very ambitious and tight. ASAC is concerned about the challenge of balancing resources between scientific operations and WSU progress, and recommends the Board to follow this issue closely.
- Cycle 10 offered for the first time the possibility of joint proposals with JWST, VLA, and VLT. A total of 42 joint proposals were submitted, indicating a significant level of interest from the community. The fraction of time awarded, however, was much lower than that offered, although the numbers were similar in the partner telescopes. ASAC recommends that JAO monitors closely the results of future cycles to understand how the community is using this new observing option.

*Cycle 10 new capabilities.* The recently-started Cycle 10 has brought a number of new capabilities to ALMA. These include Band 1 observations on the 12m array (I-Stokes only), spectral scans that include total power observations, 4x4-bit spectral modes for improved sensitivity on the 12m array, solar observations in full polarization in Band 3 using only the 12m array, phased array mode in Bands 1, 3, 6, and 7 (capped at 50 hours), and VLBI in Bands 1, 3, 6, and 7, including flexible tuning for spectral lines. ASAC celebrates the offering of these new capabilities, and in particular the Band 1 observations, which should be possible from March 2024. The Science Verification data for the Band 1 receivers have already been taken, and the data are currently being analyzed. ASAC encourages ALMA to release the Band 1 SV data as soon as possible, so the community can be aware of its potential when thinking on proposals for Cycle 11.

*Cycle 11 capabilities.* While the commissioning of new capabilities has been stopped to allow work on the Wideband Sensitivity Upgrade (WSU), the future Cycle 11 is expected to offer two new scientific capabilities: full Stokes polarization observations in Band 1 and sub-arraying of 7m observations on the Baseline Correlator. The first capability results from the commissioning of the Band 1 receiver, while the second one is required by the obsolescence of the ACA correlator. ASAC understands and supports the priority of the WSU work over the development

of future scientific capabilities, and in future reports Charge #1 will likely focus on the WSU progress. Since the community may perceive the lack of new capabilities in future cycles as a sign of technical stagnation, ASAC encourages ALMA to make a special effort to publicize the progress on the WSU, maybe through a dedicated section in the web page. This would help the community understand the enormous effort, and exciting promise, that the WSU represents.

*WSU progress.* ASAC was given a detailed summary on the progress of the WSU. A series of high-level milestones and a timeline have been established, several working groups have completed reports, and new working groups have been created to form high level science operation requirements. In addition, a deputy director for development has been hired (Álvaro González, from NAOJ). According to the plan, 2024 will be a crucial year for the project with a number of planned Preliminary Design Reviews (ATAC, Digitizer, Band 6v2 prototype, etc.). Overall, ASAC is happy with the progress of the WSU and with the detailed information provided by ALMA. It is clear, however, that the project is very ambitious, and that the timelines are tight. This may lead in the future to a need to balance resources between scientific operations and WSU development, both in terms of personnel and hardware. ASAC advises the Board to be vigilant on this issue.

*Joint proposals.* Cycle 10 offered for the first time the possibility of requesting additional observations using one of the three partner observatories, JWST, VLA, and VLT. A total of 42 joint proposals were submitted to ALMA, indicating a good level of interest. The number of accepted proposals was 4 (2 at JWST and 2 at VLA), which is approximately what should be expected given the oversubscription factor. In total, ALMA awarded 3.6 hours of JWST time. This number is much lower than the total time available for Joint Proposals (115 h), but is of the same order as the ALMA time awarded by JWST (6.24 h). ASAC recommends closely monitoring the success rate of the joint proposals in future cycles to understand how the community is using this new observing mode.

**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 applauds ALMA for a quick recovery from the cyber attack and for a timely start of Cycle 10 despite the compressed schedule. ASAC also celebrates that ALMA reached configuration 10 in Cycle 9 for the first time.
- ASAC agrees on the need to use Observatory Projects as a last resort option to fill gaps in the schedule. Still, ASAC would like to minimize the need to use this option given the high oversubscription rates and the fact that these projects may not maintain regional balance. ASAC suggests putting language in the next call for proposals to encourage projects for particular frequencies, configurations and/or RAs that are anticipated to be

undersubscribed. ASAC encourages ALMA to keep an eye on the number of hours and the regional balance of observatory projects over the next few cycles.

- ASAC is pleased to see the increase in success rate and execution of high frequency projects as a result of giving them higher priority. We encourage JAO to continue to monitor these projects and to look for ways to keep increasing their number.

*Observing efficiency.* ASAC applauds ALMA for such a quick recovery from the cyber attack. It is impressive to see things back on schedule for Cycle 10 despite the compressed software delivery and validation. Reaching 4300 hours of 12-m observations in a year seems within reach and we look forward to seeing ALMA reach this important milestone. ASAC is also impressed by the number of hours of observations with the 7-m and TP arrays during Cycle 9, and celebrates that ALMA reached Configuration 10 for the first time and on schedule.

*Observatory projects.* ASAC recognizes the need for Observatory Projects to fill gaps in the schedule. While this is a relatively small amount of time currently (~100 hours), it is still significant given the high oversubscription. ASAC encourages ALMA to avoid larger numbers of Observatory Project hours going forward by putting language in the call for proposals that encourages proposals for particular frequencies, configurations and/or RAs that are anticipated to be undersubscribed. ASAC also encourages ALMA to keep an eye on the regional balance of Observatory Projects to make sure that the time charge works out fairly over several cycles. If a gap of the same magnitude occurs in the future, we recommend exploring alternative ideas, such as calling for DDT proposals as a means for the community to fill any schedule gaps.

*High frequency projects.* ASAC is happy to see an increase in high frequency projects as a result of making them a priority and suggest that ALMA continues monitoring how these projects are scheduled at the telescope.

**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.**

*Publications.* The statistics on publications are considered once per year and they will be revisited at the Spring 2024 ASAC meeting.

*10 Years conference.* ASAC was glad to serve as part of the Scientific Organizing Committee for the ALMA@10 conference. ASAC recognizes the difficult decisions that were made to achieve balance across the regions, gender, career stage, and science category. In future conferences that ASAC supports in this way, the committee recommends having a live meeting with the primary organizers to offer input in the finalization of the program.

**Permanent Charge #4. Recommendations 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 is pleased to see that the changes in the algorithm for the DPR reviewers led to a better match between reviewers and their expertise.
- ASAC was informed that several Cycle 10 proposals from the same team/part of the team were flagged by reviewers as having almost identical text. While at the moment there is no policy to prevent such a situation, ASAC strongly agrees that ALMA should devise one. ASAC is aware that it may not be straightforward to do so but below we suggest possible avenues, including software detection algorithms as well as clear instructions in the call of proposals, that can be considered.
- ASAC was informed that JAO is considering increasing the limit of regular programs to 100 hours. ASAC is concerned about possible undesirable effects of this change and recommends a number of measures to minimize them. These include dividing proposal sets into groups according to the requested hours and asking proposers of long programs (>50 h) to state the data-processing resources that they have available.
- ASAC is concerned about a gender bias in the success of proposals identified by JAO in Cycle 10. While it is a small effect, it is disconcerting to see that female PIs tend to have poorer ranks than male, especially in EA and EU. ASAC agrees with JAO that more analysis is needed, especially to see if this bias continues in future cycles.
- ASAC is concerned that in contrast with the success of continuum observations, no VLBI spectral line proposal was accepted in Cycle 10 despite much technical effort spent in allowing these types of observations. ASAC recommends to keep encouraging the line VLBI community to submit proposals to utilize this observing mode.
- ASAC remains concerned about the limited progress in the stage 2 review process in DPR. ASAC wishes to emphasize the critical importance of ongoing enhancements to stage 2 as a means to elevate the quality of the proposal evaluations.

*Proposal matching algorithm.* ASAC was happy to see the new two-step process in the proposal assignment for Cycle 10. The novelty of this new process is in the first step that involves the use of machine learning techniques to infer the topic of each proposal as well as the expertise of each reviewer and then compute the similarity. It was very encouraging to see that the percentage of self-declared experts increased from 45 (in Cycle 9) to 65% (in Cycle 10). It is still not clear whether the PIs themselves found the reviews more relevant and appropriate due to this new algorithm. ASAC suggests that JAO continues to put out PI surveys at every cycle with specific questions regarding the expertise of each review.

*Similar proposals.* ASAC was informed that 29 reviewers flagged 23 groups or proposals as being very similar in text. 22/23 had either the same PI or same proposer team. As there is no policy preventing applicants to re-use text or submit very similar proposals, JAO expressed

concern over this issue and ASAC is in full agreement that situations such as the above should be avoided as much as possible in the future. ASAC suggests explicitly discouraging this behavior in the call for proposals, and to start devising a new clear policy to be proposed to the ALMA board. Such a policy does not necessarily need to be rigid but may for example clearly state that self-plagiarism is not allowed and that recognition software will be used to identify similar proposals (rather than relying on reviewer flagging it). Such a new policy should be well advertised in the call of proposals.

*Extension of the regular programs.* After consultation with, and feedback from, the APRC (both in Cycle 9 and 10), JAO is considering increasing the time limit of regular programs to 100 hours, motivated mainly by the fact that the smallest of the Large Programs are too close to regular proposals. While ASAC understands the background for this decision, it has concerns about undesirable effects. One is that reviewers may not be able to clearly and objectively compare proposals that request very different amounts of time. For example one concern is that niche or smaller fields may be particularly penalized by bundling together >50hrs with few hour proposals in one set. ASAC recommends that some action is taken to avoid bias and to make the reviewers' job easier when faced with very small and very large proposals. One option is to divide proposals into "bins" or groups of proposals according to the time they request and the written feedback should reflect the difference in time requests. Another option is to ring-fence allocations to smaller proposals. Alternatively ASAC suggests for these larger regular proposals to be reviewed by APRC. Another concern is the large data-processing needs of proposals of more than 50 hours. ASAC recommends that proposers of such long programs are required to state the data-processing resources that they have available. In any case ALMA should monitor this change carefully to ensure that it does not lead to an artificial increase of the oversubscription rate.

*Gender bias in Cycle 10 proposals.* ASAC was concerned by the gender systematics identified by JAO in the success rate of Cycle 10 proposals. This systematics shows that female PIs tend to have poorer ranks than male, especially in EA and EU. It is especially true for category 1. ASAC agrees with JAO that more analysis is needed, especially to see if this trend continues in future cycles.

*Change in proposal cover sheets.* ASAC was informed that from Cycle 11, following on the recommendation by the APRC, there were going to be some changes to the cover sheets of all proposals and updates on the management plans for the LP. ASAC endorses such changes.

**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:

- All three regional SACs have expressed concerns about the increasingly higher oversubscription rates and their possible effect especially in minority fields. The regional SACs are also concerned that the lack of multi-cycle proposals makes it very difficult to carry out time-domain research.

- EASAC is particularly concerned about the regional unbalance seen in the Large Programs both in terms of time and number of PIs. EASAC is also concerned about the gender imbalance in the acceptance rate of proposals, which especially disfavors EA female PIs. While this is a weak effect, it seems to be systematic and deserves further study and correction.

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

Recommendations/issues

- ASAC recommends the project proposal of a Phase-1 study for the Band 8v2 receiver upgrade. The extension of IF in Band 8 is very important both in terms of scientific utility and improved observational efficiency.
- ASAC is glad to see that the next generation Observing Tool, ngOT, will be tested in Cycle 11 and be ready for release in Cycle 12. In order to understand how the ngOT will be interfaced with the WSU, ASAC would like to have more detailed information on a timeline/critical path and effort levels required for the ngOT release in parallel with the WSU integration.
- ASAC continues to support of all the ongoing studies and projects, and commends the regional executives for developing an exciting set of future capabilities.
- ASAC congratulates the Band-2 project for successfully passing the Manufacturing and Readiness Review and being approved by the Board. ASAC commends all members involved for their efforts to date.

*Band 8v2 receiver upgrade.* ASAC received a presentation on a project proposal of a Phase-1 study for Band 8v2 receiver upgrade. The IF expansion associated with this upgrade has significant scientific benefits and also improves observation efficiency of Band 8, and therefore, it is appropriately aligned with the WSU. The proposed Phase-1 study builds a prototype receiver and tests its performance to develop a production-level component. There may be a potential risk of the cost overrun in some cases, as the state-of-the-art fabrication techniques, such as high critical current density SIS junctions, is required for the prototyping. Although there are a few points of concern, such as the fact that the research plan for Phase-2 and beyond is unclear, ASAC is overall satisfied with this project proposal and strongly recommends it to the Board.

*Next generation Observing Tool.* ASAC is pleased to see that the Next Generation Observing Tool project, ngOT, has been restructured and is making significant progress under the strong leadership of ESO. The project delays over the past few years were a concern to ASAC. ASAC has been informed of the plans for testing the ngOT in Cycle 11 and for its operational release in Cycle 12, even though there are still remaining development items to be addressed. Now that the team structure is fully in place, ASAC expects the final development to proceed smoothly under the new Completion Project proposal. Meanwhile, the WSU project is also currently



underway, and ASAC is aware of its very tight schedule. In order to understand how the ngOT will be interfaced with the WSU, ASAC requests to have more detailed information at the next meeting on a timeline/critical path and on the level of effort required for the ngOT to be released in parallel with the WSU.

*Regional development studies and projects.* ASAC reviewed the ongoing development studies and projects taking place in the three regions. ASAC continues to support all the ongoing ALMA development efforts and commends the regional executives for developing an exciting set of future capabilities. ASAC is pleased to know that the development plans for each item related to the WSU, such as design study of Advanced Technology Correlator (in NA), digitizer (EU), and Phase-1 study of Band 6v2 receiver (NA), are moving forward. ASAC is also pleased with the news of the successful proof-of-concept performance of the long reach transmission using a 90-km optical fiber link for the new Data Transmission System project (led by EA, in collaboration with NA). Moreover, ASAC congratulates the successful status of the Band-2 project (led by EU) that recently achieved fringe detection in the on-sky test and, as an important milestone, passed the Manufacturing and Readiness Review. ASAC commends all members involved for their efforts to date.

*WSU and beyond.* While development related to the WSU is currently proceeding without major problems, ASAC is also aware that the WSU potentially contains many challenges. Therefore, ASAC considers that it is important for three Regions to work closely together, as well as to share the current status of the development process with the ALMA community. It is also worth mentioning that research projects outside of the WSU are also active in each regional executive. Among them, the ALMA Phasing project, which NA has been working on so far, has led to the feasibility of VLBI spectral line observations, and the EU has begun to study the possibility of acquiring high-resolution solar images with ALMA. ASAC believes that these are important studies to promote the diversity of ALMA science.

**Ad-hoc charge #1. Evaluate the scientific impact of programs of different sizes with a focus on the optimal balance between Small, Medium, and Large Programs. Board requests ASAC to evaluate the scientific impact of programs of different sizes with a focus on the optimal balance between small and medium proposals, and Large Programs. The Board also welcomes ideas on how such an optimal balance can be realized.**

Recommendations/issues:

- ASAC has conducted some preliminary analysis of the merit for small, medium, and large programs, and recommends that a more comprehensive study of ALMA's scientific impact be carried out, as it has been done for the Hubble Space Telescope.
- A preliminary analysis of the publication metrics for programs of all scales shows that high impact science is done with ALMA by programs of all sizes. Large Programs tend to generate more citations per year than small programs, but their citation rate per

*telescope time invested* is not obviously different from that of small and medium programs.

- The statistics of ALMA proposals show that Large Programs are not the main contributors to the increasingly larger request for ALMA time, which seems to result from the increase in the average requested time per program.
- Since Large Programs have the potential to create pressure on smaller programs, ASAC recommends that ALMA guarantees a fair treatment of programs of different sizes. This could be done by allocating time according to the time requested by small, medium, and large programs. Since this balance is now achieved naturally, no correction is needed, although ASAC recommends monitoring the success rate of programs of different sizes and ensuring a fair distribution of the observing time.

ASAC thanks the Board for assigning this ad-hoc charge, which was requested in the previous report. ASAC also thanks JAO for providing valuable information to carry out a preliminary exploration of the issue. Understanding the scientific impact of a telescope is a complex task, and the analysis presented here should be considered as only a first look at the question. Since ALMA has reached a decade of operations, it is probably a good moment to address the issue more deeply, as it was done for the Hubble Space Telescope by Apai et al. (2010, PASP, 122, 808). If this is done, ASAC will be delighted to collaborate in the effort.

Using the JAO-provided data, ASAC had a preliminary look at the publication metrics for programs of different sizes. The data shows that if the success of a program is measured by its citation rate, programs of all sizes can reach similarly high levels of success. There is no correlation between the success rate of a program and its size for programs smaller than about 50 hours. Large Programs (> 50h) clearly generate more citations per year, but their citation rate per *telescope time invested* is not obviously different. This suggests that one hour of ALMA time can be used as effectively by programs of small, medium, and large size.

The data also shows that the introduction of Large Programs in Cycle 4 did not cause a significant increase in the oversubscription rate. The gradual increase in the requested time over recent cycles seems to be driven mostly by the overall increase in the requested time per project, which has more than doubled since Cycle 4. Still, Large Programs are effectively rated A (to guarantee their completion), so they could potentially put an increased pressure on smaller programs at the telescope queue. It is therefore important that ALMA keeps a level playing field for proposals of different sizes.

While any decision about the balance between programs of different sizes depends on the type of science that a telescope wants to promote, we note that telescopes such as JWST allocate their time according to time pressure. ALMA does not enforce this distribution explicitly, but the statistics of acceptance rates show that the balance is almost achieved naturally through the proposal evaluation process. For this reason, ASAC does not propose any change in the way proposals are selected, although we suggest that ALMA keeps monitoring the statistics of acceptance rate and takes action if it starts to show a bias in any direction. We note in addition that not all observing modes are offered in Large Programs, especially long baseline and high frequency observations. Keeping the current balance allows a fair access to all observing modes by the community.