

ASAC Report to the ALMA Board

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General considerations

There have been several changes to the ASAC that now operates under the new Terms of Reference (ToR). Prof. Manuel Aravena and Prof. Jongsooh Kim have joined ASAC and Dr. Roberto Neri has been re-appointed as ASAC member, while Dr. Jesus Martin-Pintado left ASAC. Further Dr. Eva Schinnerer has been appointed as new ASAC chair till June 2018. ASAC elected Dr. Rachel Osten and Dr. Munetake Momose as deputy chairs to ensure a good representation of potential regional issues.

The ASAC Face-to-Face meeting was held at the European Southern Observatory headquarters, Garching, Germany, on October 17th and 18th, 2016, with all the ASAC members present (except for Dr. R. Osten). In addition, the JAO Director and Observatory Scientist were present, as well as the three regional Project Scientists. ESO ALMA staff attended part of the meeting.

ASAC discussed its organization under the new ToR; it would like to continue informative telecons with JAO with a frequency of about two between its face-to-face meetings. In order for ASAC to fulfill its mandate, ASAC identified a standard set of plots (mostly based on KPIs monitored by JAO) that it would like to review at each telecon/meeting:

- Number of antennas operational (12m, 7m, TP)
- Time evolution of the execution/observing/science efficiency
- OUS and project completion number separated by rank per cycle
- Time evolution of the data delivery time and the backlog

ASAC was extremely happy to receive most of the documentation and presentation well ahead of the ASAC face-to-face meeting with several documents (including a comprehensive response to the recommendations from the previous ASAC report) being already available for the regional SAC face-to-face meetings (EASAC, ESAC). This allowed for informed and efficient discussions. We applaud JAO, in particular the Observatory Scientist, for their efforts to making this happen.

ASAC was impressed by progress made in several areas and would like to point out in particular the following positive developments and highlights from ALMA:

- ALMA's spectacular deep field results and multitude of resolved proto-stellar disks
- A 24% increase in Cycle3 science observing time than announced (2600 h vs. 2100 h)
- The smooth start of Cycle 4 operations

ASAC received presentations by ESO ALMA staff on the status and future planning for the ALMA archive, SnooPI and the OT. ASAC welcomed the opportunity to interact with the people responsible for this important user interfaces and found it very useful. ASAC hopes to continue this useful exercise when it is meeting at the other regional ARCs.

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:

- ASAC was impressed by the good progress and ambitious 5yr plan for the archive. It notes that the future deployment of new features (awaited by the community) are mostly manpower limited.
- ASAC urges the observatory to define the imaging products to be stored in the archive and delivered to the PI. ASAC would welcome an opportunity to comment on this.
- ASAC re-iterates the need to provide calibrated data in the archive. The lack of a backward compatibility of CASA is now starting to become a threat to the long-term usability of the archive.
- ASAC re-iterates the significant scientific interest in efficient observations using spectral scans. It urges the observatory to seek ways to implement such a possibility on short terms.
- ASAC looks forward to a presentation on the implementation of the 5 yr plan at its next face-to-face meeting.

The distinction between topics related to charge #1 and charge #2 is sometimes not straightforward, therefore ASAC decided to split topics between these two charges based on the fact if it felt that they were more scientifically or technically motivated.

Archive The ASAC was presented with a forward-looking 5-year plan for the development of the archive by Felix Stoehr. The first phase of changes will be deployed soon, with the addition of a number of search capabilities and a richer and more user friendly display of results. Longer term development includes SQL querying and integration of ADMIT. The ASAC's impression of the plan was extremely positive. Its implementation is limited by manpower, and the ASAC would like to see it supported as much as possible to ensure timely deployment: it seems that the developments would benefit of the addition of 0.5 FTE.

There are two outstanding points that require urgent attention.

1. The availability of calibrated data in the archive
2. The definition of the imaging data products

Calibrated Data in the Archive The ASAC has repeatedly stated that it is impossible to have an archive that is viable on the long-term without it containing some form of calibrated data. We say it here again: distribution of only raw data with calibration scripts, which are entirely specific to a particular version of CASA (which changes twice a year), is an outstanding threat to the long-term usability of the archive and the legacy and productivity of ALMA. If, for reasons of size, the archive cannot contain the calibrated data products, *it should at the very least distribute calibration tables of a stable format that can be directly applied to the raw data with a one-step, stable CASA*

task that is compatible across all future CASA versions. The current situation is simply unacceptable for a good scientific productive archive.

Imaging Data Products in the Archive ASAC notes that there is a large diversity in the quality of delivered data products to PIs. This inconsistency is potentially damaging the science output of the telescope and making it difficult for novices to use ALMA data. It is very important that JAO makes explicit and detailed guidelines on what kind of products ALMA will deliver to PIs. In particular, the definition of the “standard” imaging data products is a long-standing issue that needs to be resolved. Currently users are still delivered “evaluation” imaging products that are in many cases unusable for science, and that are of a quality that varies greatly from project to project. This is a matter of increasing concern. The ASAC believes that it is time for the project to make a push at delivering scientifically useful imaging data. While we understand and appreciate some stated goals of uniformity (as in, imaging every channel for every science goal at the original spectral resolution), we caution that there is a tension between uniformity and usefulness. *Policies that enforce consistency and uniformity do not necessarily maximize the usefulness of the products of make the best use of the resources.* The ASAC believes that the optimal approach *falls on the side of incorporating PI-provided information to maximize the usefulness of the data products.* In this context, the archive should be as “consistent” as possible without hurting the usefulness of the data for its primary science goals as defined by the PI in the proposal.

Observing ALMA is becoming an increasingly efficient observing machine, which is in part the cause of the data backlog. We appreciate the systematic use of a number of metrics to evaluate execution and observing efficiency, and the use of mock scheduling to determine what proposals are accepted and with what rank. *We note, however that blind application of these metrics could drive the observatory to become too conservative in order to maximize execution efficiency.* This could happen if high frequency science, a key component of ALMA from conception, were deprecated because it is harder to observe. The observatory should be mindful of this threat and strive for a balanced approach. A Band 10 ‘science demonstration’ dataset might help to promote science at these frequencies.

Spectral scans ASAC reiterates the importance of offering an efficient spectral scan mode and is concerned to learn the hardware developments are likely required. Until resolved, ASAC recommends the implementation of a flexible calibration scheme that allow the PI to 1) choose whether simultaneous execution of the entire scan is required or not, and 2) choose the quality of the passband calibration. This is only a temporary solution, however, and the final solution needs to be arrived at quickly.

Observatory’s 5 yr plan The JAO presented goals for cycle 5 and a multi-year plan for extension of capabilities (EoC) to focus on improvements in data delivery, high frequency observing efficiencies, survey speed, and calibration overheads. ASAC was very happy to hear that sessions will be implemented. *We applaud the planning and enthusiastically support the plan presented.* We also look forward to the presentation of a 5-year plan at the next Face-to-Face meeting..

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:

- The ASAC recommends that the JAO keeps close attention on the progress of the plan to solve the data backlog and shorten the time to delivery, and maintains this as a very high priority until it is solved.
- If the 4-week goal for data delivery cannot be attained on a reasonable timescale, ASAC recommends the observatory considers more drastic measures such as to change the set up to deliver raw data to the PIs immediately after QA0 while continuing through the QA2 and imaging process.
- ASAC requests the addition of a science efficiency metric to the KPIs reported by the observatory to ASAC to assess the magnitude of the over-calibration problem. This is defined as the percentage of the time that the telescopes spends on the science targets.
- ASAC looks forward to hear an up-date about progress on the Vertex antenna astigmatism at its next Face-to-Face meeting.

Data backlog ASAC is extremely concerned about the long-term build-up of a substantial backlog in PI data and sees this as a tremendous problem for the observatory. Stuartt Corder presented a JAO plan to address the backlog, which appears reasonable. ASAC commends ALMA for recognizing the problem and prioritizing it, but were not convinced that the proposed plans will resolve the issue. In the short term it does seem reasonable for the ARCs to help with the calibration, but this is likely to result in even less consistent data products delivered to PIs. In the midterm, adding FTEs to the calibration team also seems reasonable, though it was not clear to the ASAC how the number of required new FTEs had been estimated. In the longer term, this issue can only be resolved by an improved calibration pipeline, which does not require the current level of intervention. We caution, however, that previous plans appear not to have worked, and that the timescale to solve the backlog is rather long. ASAC recommends that in parallel with resolving the existing backlog, improving the calibration pipeline is given highest priority.

Observing efficiencies ASAC endorses the stated goal of 85/75% observing/execution efficiency. It is difficult to assess the current efficiencies achieved in Cycle 3 because of a fold-in of EOC, but it seems certainly lower than the stated goal. Going forward ASAC requests that a science efficiency metric (the percentage of the time that the telescope spends on the science targets) is added to the reports from the observatory. This metric is requested to better assess the magnitude of the over-calibration problem, which appears to be large, i.e. overheads of 200%+ appear common. ASAC also requests that the completion percentage of A and B graded projects is monitored as one of the KPIs.

Antenna efficiencies ASAC was happy to hear that the global issue with antennae being set to non-optimal temperature is being addressed with a successful high-site correction strategy. ASAC looks forward to hear about the outcome of the meeting with Vertex to address the Vertex antenna astigmatism, which is still not resolved.

Project completion The expected Cycle 3 completion rate of 70-75% is unfortunate. The low completion rate is attributed to a combination of unusually bad weather and sub-optimal scheduling. ASAC commends ALMA for implementing a new scheduler.

Imaging pipeline ASAC is happy to hear that a version of the imaging pipeline is working, but is concerned about the lack of definitions of what the final imaging product should be (see Charge #1). It is difficult to assess quality of the pipeline if the goal is unclear, and ASAC recommends that imaging heuristics are developed as soon as possible.

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:

- ASAC suggests inclusion of demographic data to assess the success in attracting non-traditional sub-mm users in the proposal and publication process. ASAC would like to hear an up-date on the demographics survey/data.

ASAC appreciates the efforts (particularly by Felix Stoehr) to make statistics available for characterizing ALMA's science outcomes. ASAC agrees that the number and impact of papers is at the level we would expect from a new major observatory. Although the list of highest impact ALMA papers is still dominated by Cycle 0/1 results, it is expected that this will evolve as papers using the new capabilities demonstrate the currently high productivity of ALMA.

ASAC believes it would be good to investigate the cause of significant delay between the data delivery and publication of first publication from a project when it arises. However, we appreciate that the situation for ALMA is similar to what is seen for other astronomical facilities.

It is important to assess how the ALMA user-base is evolving. Specifically, ASAC would like to know whether new users from outside the traditional mm/submm community are successful in obtaining observing time. This performance indicator could be investigated, by combining information from the demographic survey in the ALMA Science Portal and information in the Science Archive. ASAC would like to hear an up-date on the demographics survey/data.

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:

- ASAC agrees that special measures must be taken to ensure that the Large Projects (LPs) are successful. ASAC would like to hear an up-date on the progress of the two scheduled LPs at its next face-to-face meeting.
- ASAC recommends the JAO takes proactive steps to encourage the community to submit proposals for longer projects, and to instruct the evaluation panels on the need to not artificially penalize longer proposals.
- ASAC finds the proposed duplication check for Cycle 5 adequate that foresees the PIs to use the Archive plus a spreadsheet for Cycle 4 projects. However, JAO should try the best to implement a final solution where a current cycle's proposals are ingested into the archive for the Cycle 6 deadline.
- ASAC recommends to change time threshold on large ACA stand-alone proposals and to change priority rule between ACA-only and 12m proposals. In addition offering ACA stand-alone in Band 8 through Band 10 should be considered to increase scientific usage of the ACA.
- The JAO is advised to inform the VLBI networks about how it will treat proposals on targets for which the data has not been made available as resubmissions.

Proposal Process The cycle 4 proposal process appears to have proceeded smoothly, and improved over previous cycles on many fronts. An example is the duplication checking, which several APR chairs indicated worked more smoothly than in previous cycles where it was a significant drag on the panels. Significantly, we applaud the initiative of the observatory and the Observatory Scientist in producing a document containing specific recommendations on how to improve the process further. ASAC considers that recommendations made by Proposal Review Working Group seem reasonable. Regarding how to treat resubmission of proposals, JAO should be ready to handle all VLBI proposals that are likely to be resubmitted in Cycle 5.

Large Projects We see the initiation of the Large Projects (LPs) as a very positive step for the observatory. We note that only two such programs were accepted in this first cycle, resulting in a total of hours considerably below the maximum offered (210 hrs. vs. 500 hrs.). *This under-allotment of LPs has caused some consternation among the community, as there were 27 LPs proposed. The observatory should be mindful of sending a negative message to the proposers: the LP proposals are more complex and require considerably more logistic work than normal proposals, so they represent a significant investment for both the proposer and the observatory. Keeping in mind that panels tend to be conservative (and ALMA panels are no exception, see below), it is key to ensure that the panels and particularly the APRC receive consistent instructions that do not bias them against the selection of LPs.* In any case it is important that the accepted Large Projects are completed successfully in Cycle 4, thus JAO should give more priority to these projects including giving them special treatment (e.g. in the QA2 process) if necessary.

Normal Projects *The fact that a typical ALMA proposal is still 5 hours is a matter of concern.* We worry that high impact, longer projects are being artificially chopped in smaller pieces to increase their chances of success, while at the same time the observatory does not execute more impactful, longer projects. This is a vicious cycle that the observatory should endeavor to break. *A healthy and impactful ALMA needs a combination of project lengths,* ranging from short exploratory projects and case studies to longer surveys and statistically meaningful samples. In the plots of rank vs. project length provided, it is clear that longer projects were systematically selected against in previous cycles (this was also the message sent by the observatory, which explicitly requested shorter proposals in some of the early cycles). Even in this last cycle, where this improved, there is still a measurable bias against projects longer than ~10-15 hours.

ACA Stand-Alone Projects While the ACA was initially over-subscribed, this is no longer the case with the scheduled projects. The new proposal class of ACA stand-alone projects has not resulted in sufficiently scientifically compelling projects. A threshold higher than 50 hr for large ACA stand-alone proposals as well as no penalization in the ranking for ACA stand-alone projects might result in more competitive proposals. We suggest that offering high frequencies (B8/B9/B10) for ACA-only proposals (currently not allowed) could be very beneficial from a scientific (and operational) standpoint.

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:

- ASAC suggests to consider inclusion of ARC personnel as APR reviewers if the community pool is not sufficient.
- ASAC has some concerns about the planned implementation of angular resolution ranges regarding the estimation of the required observing time.
- ASAC advised JAO to provide clear information and warning about the change in default spectral averaging.
- ASAC has further several suggestions regarding the OT.

The most obvious concern in all regions was the development of the backlog in delivery of data to PIs, dealt with under charge #2.

Initiated by the East Asian representatives there was a discussion about whether ARC staff should continue to be excluded from participation in the APR process. Although ASAC values the principle that observatory time allocation should be done by external peer review, it recognizes that in some cases there is more expertise available among ARC staff (formally part of the observatory) than can be found in the wider community. Thus, ASAC suggests that in some cases, the strict banning of ARC personnel from the pool for APR panels could be lifted.

Under charge 5, ASAC reviewed the progress with the OT. ASAC thanks Andy Biggs for his comprehensive presentation. ASAC noted the considerable progress with the OT, particularly the preparations for new modes in Cycle 5. It welcomes the improvements for large projects and resubmissions, noting that these had caused some confusion in the past Cycle. There was a discussion on new methods that are being implemented and ASAC had some concerns about the relation between the angular resolution ranges and estimated observing times. ASAC was also worried about the default spectral averaging and advises the Observatory to provide very clear guidelines on adjusting the required spectral resolution to the science case. Furthermore, ASAC learned about the plan to simplify the preparation of (phase II) SBs by asking PIs to only update or edit science goals provided by the Observatory. This seems a sensible approach. Finally, the ASAC appreciated the need to explore new technologies for future OT development. However, based on experiences elsewhere, the ASAC suggests that solutions that are not web-based are also explored.

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

Recommendations:

- ASAC recommends the implementation of the ALMA Integrated Alarm System as a project to increase the safety and operational efficiency of ALMA.
- ASAC suggests a web-based users survey to judge the impact of software development projects and to gauge the needs and interests of users for future software development projects.
- ASAC heard about the significant progress made on the Band 2+ and Band 2+3 and notes that the strategic decision is to be taken soon of which design is ultimately to be selected for full-scale production

The committee strongly endorses the ALMA Development Program as a whole and concurs that it continues to be a very successful and productive model for ALMA.

The ASAC received Erich Schmid's report on the ALMA Integrated Alarm System project. The committee was reassured to see that the safety and the operational efficiency of the ALMA observatory is top of mind, and that the development of such surveillance system had been addressed by ESO/JAO in a very accurate and efficient manner. The committee continues to fully endorse this development program.

The ASAC was particularly pleased to hear that the Band 1 project has received Board approval for full-scale production in May 2016. The committee is of the view that ALMA Band 1 will contribute to enlarge the receiver suite's scientific impact and will generate new exciting science opportunities for the benefits of the ALMA user community. We are looking forward to seeing the Band 1 receivers operational in 2019.

The ASAC was very much pleased to see that the Band 5 project is making excellent progress. The committee congratulates the observatory for the remarkable progress being made in reaching first goals and objectives in the frame of the commissioning and science verification activities. Impressed by the excellent performance of the new Band 5 receivers and by the high momentum achieved in the installation and commissioning process, the committee is very supportive of all efforts directed at keeping the project on track and making sure that ALMA users are offered Band 5 observations in Cycle 5. At this stage, letting Band 5 slip to Cycle 6 would be unacceptable.

The ASAC was presented with a detailed progress report of the Band2+ and Band2+3 studies. The committee was reassured to see that both projects have been making further progress but noted that challenges in the LNA design could not yet overcome initial expectations. However, given the level of maturity of the Band2+ and Band2+3 receiver designs, the committee believes that the regions should be invited to intensify collaborations to accelerate and potentially maximize the chances of project success. The committee viewed it as very important to proceed with the assessment of values and benefits of both projects and concurs that the strategic decision is to be taken soon of which design is ultimately to be selected for full-scale production.

A concern for the ASAC is that while information provided to the committee is sufficient to evaluate the scientific impact of the instrumentation equipment programs, information is not sufficient to help the committee evaluate the use and impact of the scientific software programs. To improve on this, the committee suggests the possibility of conducting a web-based user survey to collect feedback from the communities on the scientific impact of ALMA software upgrades. Such a survey would also help to build up information on users' needs and interests in view of future software developments.

Charge #7. Review and comment on the Development Vision and Roadmap. Is the vision evolving in a way that is consistent with the ALMA2030 document?

Recommendations:

- The ASAC is looking forward to commenting a more elaborated version of the vision document and is ready to support the Working Group in the scientific assessment of the roadmap priorities on a short timescale.
- While the Development Vision and Roadmap document proposes possible incremental enhancements based on the current technical readiness, it lacks ambitious plans that may become possible in the next 10 years. There is a need to look at the potential for new scientific insights and make sure that the long-term plan is ambitious and transformational.

The ASAC received a draft document by the ALMA Development Vision Working Group (the WG hereafter). The document outlines a high-level roadmap for the long-term strategic development of ALMA and sets the top priority developments on receiver systems with larger bandwidths followed by an extension of the main array to longer baselines.

While the committee concurs that the roadmap presents a strategically sound vision, consistent with the overarching scientific and technical themes of the ALMA2030 document, it also is of the opinion that the roadmap is driven more by budgetary concerns and technical readiness than by scientific considerations. The committee notes that the WG is working on a very tight schedules but believes it is important to establish future development priorities on scientific grounds prior to balancing them with other strategic considerations, and that the vision document should challenge more the latest developments in technology.

The committee felt that more thinking is necessary prior to ranking the options - there is a need to look at the potential for new scientific insights and make sure that the long-term plan is ambitious and transformational. For the sake of completeness, the committee views it as important that the document also includes a scientific reasoning that addresses the long-term development of ALMA's science data archive and ALMA's wide-field mapping capabilities in the 2030 era.

Charge #8. Suggest specific improvements in the information given to proposers about their proposals after the review and later via project tracker.

Recommendations:

- ASAC would like to follow up this general topic and would be interested to learn about the role of the contact scientists the observatory envisions in full operations. Further it would be interested to understand how useful information arising from helpdesk tickets and/or interaction with the contact scientists is made accessible to the community.
- If there are resources available, JAO could explore the feasibility of using other (social) platform for communication with and dissemination of information to users.
- ASAC suggests two (minor) improvements to further increase SnooPI's usefulness.

The ASAC believes that in general the generic information given to proposers in the different platforms available (including documents, helpdesk platform and data access) is sufficient and comprehensive. Two major points were discussed that should be considered to further improve the proposers experience:

SnooPI is seen as a useful tools and a good replacement of the project tracker, although there are still several items that could be improved. The quick removal of project tracker after SnooPI became available caused uneasiness among the users as the community did not have sufficient time to test and get used to the new tool. It is advised to deploy new tools by providing a test period before removing previously available ones. A couple of minor suggestions to make SnooPI more useful include: (i) provide forward looking information for projects (in order to check which science blocks will be observed in the upcoming array configurations), and (ii) provide more detailed information on data reduction status of science blocks, as well as differentiating *pass* and *semi-pass* status.

(Social) platforms It is suggested to explore the feasibility of using other (social) platforms to communicate with the science users in a more direct manner that could expedite the information and feedback to the observatory, in parallel to the existence of the Helpdesk and “Frequently Asked Question” section. Possibilities could include chats, forums, sandboxes or wikis, similar to widely used platforms as “Facebook”, “Twitter”, etc.