

Report from the ALMA Scientific Advisory Committee
Face-to-Face meeting, Edinburgh
2013 October 9-10

Alberto Bolatto (U. Maryland, Vice-Chair), John Carpenter (Caltech), Simon Casassus (U. Chile), Rob Ivison (U. Edinburgh, Chair), Kelsey Johnson (U. Virginia), Kotaro Kohno (U. Tokyo), Huib Jan van Langevelde (JIVE/Leiden U.), Jesus Martin-Pintado (CSIC Madrid), Raphael Moreno (LESIA Observatoire de Paris Meudon), Kentaro Motohara (U. Tokyo), Roberto Neri (IRAM), Tomoharu Oka (Keio U., Vice-Chair), Richard Plambeck, (UC Berkeley), Douglas Scott (UBC)

Executive summary

The primary immediate concern of the ASAC is the persistent problem with the Permanent Power Supply and distribution system. ASAC recommends the creation of a tiger team whose goal should be to improve observing efficiency, primarily by providing a stable power system, but also by considering how to reduce the recovery timescale following outages and storms.

Science from ALMA is proving as exciting and innovative as we hoped, with a considerable number of high-profile results being published from CSV and Cycle 0. Scientific productivity is consistent with world-class observatories such as VLT, HST and VLA at comparable points in their development.

The Project Tracker and the Data Reduction Pipeline have made considerable progress since our last meeting, and software improvements have increased the observing efficiency. In most other regards, however, progress in Cycle 1 has fallen considerably short of everyone's expectations. We are 80% through its original duration and 1.5% of the approved projects and scheduling blocks have been completed, despite a 3-month science moratorium designed to tackle major technical issues. Since there is more hunger for ALMA data than for new modes, ASAC recommends that the balance between time spent taking science data and commissioning new capabilities be explored with an open mind.

ASAC feels that planning and prioritization need to improve; in particular, ASAC is worried about the lack of a plan to maintain steady operation of 50 antennas.

ASAC continues to believe that long proposal cycles will reduce interest in ALMA amongst the broader community with which it seeks to engage. Improving

transparency is also important – keeping the community better informed about problems as well as progress.

ASAC notes the recent progress towards a long-term vision for ALMA in the 2020s, and with the ALMA Development Programme generally.

I. Introduction

Monthly ASAC telecons over the summer of 2013 dealt with issues concerning Duplication and the timing and duration of the Call for Cycle 1. This period culminated with a busy face-to-face meeting at the Royal Observatory, Edinburgh, on 2013 October 9–10. Six Charges from the ALMA Board were discussed at this meeting, together with some ad hoc items.

Some of our recommendations are more forthright than of late. It is not a given that the problems described here will be resolved by the end of Cycle 1, or even Cycle 2. The reputation of the facility is in danger, and of submm astronomy more generally, particularly amongst the new, broader community to which ALMA has reached out.

The ASAC will hold its next face-to-face meeting in Chile, either at the AOF or in Santiago, probably on 30-31 January 2013 or thereabouts.

II. Response to Charges

Charge 1: Pursuant to standing charge 1, ASAC should continue to assess the scientific outcomes and impact from Cycle 0. This should include some preliminary quantitative assessments, such as numbers of papers published and quantitative impact metrics, along with a qualitative assessment. Coordinate with the JAO and the regional ARCs, who would collect the necessary information.

The ASAC was presented with ALMA publication statistics by the ALMA regional scientists. As of October 3, 2013, 65 papers have been published (with volume and page numbers in refereed journals), with 10% in Science or Nature.

Overall, these publications have been well balanced between regions, in accord with the fraction of ALMA time available to each partner, though it is worth noting that some modest datasets have resulted in multiple refereed papers (including

several from SV, which has produced an impressive 29 papers in total). Overall, the publications are also well balanced with respect to research area.

The time-to-publication for ALMA data appears to be satisfactory. As of Oct 3, 2013, 24% of the 119 projects for which data have been delivered have already resulted in a refereed publication. Many of these datasets were not released to the PIs until the beginning of 2013, so these data had a typical time-to-publication of only ~9 months.

The ASAC were shown comparisons for productivity in years 0 through 2 for ALMA, VLT and *HST*, and ALMA measured up satisfactorily. ASAC would like to see similar statistics for other observatories during their initial years of observations, particularly interferometers, and including both ground- and space-based facilities (e.g. post-upgrade VLA, LOFAR, ATCA, SMA, IRAM PdBI, *Spitzer*).

The ASAC was presented with rough plans for the next major ALMA science conference, to be held in a large auditorium in Tokyo in late 2014 or early 2015. The ASAC welcomes this development and makes the following recommendations:

- at least one general public talk should be incorporated;
- the science programme for individual days should contain a mixture of topics to encourage attendees to stay more than 1-2 days;
- an optional excursion on the Saturday following the meeting may also encourage people to stay for the duration;
- talks on future development should not be relegated to the final day;
- a mid-week excursion (e.g. Wednesday afternoon) should be planned.

Charge 2: Pursuant to standing Charge 2 and in light of the current situation at ALMA, ASAC should comment on the status of Cycle 1 observations and on the timeline and progress made towards the Cycle 2 call for proposals. For Cycle 1, is the predicted completion fraction of approved Cycle 1 programs consistent with the best efforts approach to early science? For the completed programs, are the data being released to the PIs in a timely fashion? For Cycle 2 preparations, is the OT keeping up with the capabilities of the array likely to be listed in the call? Does the support from the ARCs continue to meet users' needs?

Cycle 1 science began in 2013 January. Since then, 7% of SBs have been executed, with only 1.4% passing QA2. No observations have been made since 2013 July 23 due to power cuts, bad weather, a strike, and a problem with cabling to the long-baseline pads. So far, only data from software acceptance tests have been delivered (delivery took place after software acceptance on July 23). Cycle 1 science observing was expected to start on 2013 October 16, but a failure of the power supply has led to 2-3 weeks of further delay.

At the time of our face-to-face meeting, JAO predicted a completion fraction of 56% for Cycle 1, with this completion fraction varying from 0-100% as function of band, LST and configuration. In general, lower frequency projects and/or those requiring compact configurations are more likely to be observed, as one might expect.

Arguably, “best efforts” implies only that a completion rate of 100% is not guaranteed. However, a completion fraction of 56% is certain to be met with dissatisfaction amongst a community that is hungry for data. At the time of writing (October 30), 56% looks optimistic; achieving only half of this, or less, remains a plausible outcome.

After transferring the unfinished Cycle 1 projects (up to 800 hr) to Cycle 2, the final completion fraction will increase significantly, assuming that the difficulties plaguing Cycle 1 have been addressed. The ASAC applauds the decision to roll forward high-priority Cycle 1 projects, and to release metadata from those projects for duplication analysis.

Information on the release of data from the 33 SBs executed in Cycle 1 to the PIs shows that 17 days pass between an SB being available for assignment and QA2/delivery. ASAC applaud this 4x decrease in the timescale for data being released to PI compared to Cycle 0.

The ARCs are proving to be a real asset, with their support generally recognised as excellent. They are also involved in QA2, OT/CASA testing, and CSV. Perhaps most importantly, given the problems with transparency described elsewhere in this report, they are engaging well with community.

Looking beyond Cycle 1, we note that the number of antennas promised for Cycle 2 observations (34) is not very different than the number promised for Cycle 1 (32). We were surprised by a lack of timelines and milestones to improve antenna availability.

In Cycle 2, 10% of accepted proposals will be ranked “A”, and these will be eligible for transfer to Cycle 3 in the event that they cannot be finished. JAO will rank Cycle 2 “A” proposals higher than transfers from Cycle 1. This may result in anomalies and some common-sense interventions may be appropriate.

The deadline for final versions of Cycle 2 documentation was 2013 Oct 16. The Call for Proposals, the release of the OT and supporting documentation, and the opening of the Science Archive for proposal submission happened on 2013 Oct 24. The proposal submission deadline is 2013 December 5. ASAC reviewed the OT, to be used during the Cycle 2 and believes it will be ready to handle the Cycle 2 capabilities of the array.

Most of the new capabilities for Cycle 2 have been tested in CSV (e.g. on-axis polarisation, single-dish observations, mosaicing, bands 4 and 8) or will be tested soon. Concerning the important extended configurations, the repair of the pads started on 2013 October 7 and is due to be finished by 2013 December. The commissioning of the long baselines (i.e. ~ 3km) is planned for 2014 Sep-Nov. ASAC re-affirms that provision of the longest baselines remain the highest scientific priority and endorses the plan to spend 2-3 months commissioning these during Cycle 2. ASAC is ready to help prioritise other CSV tasks.

Needless to say, ASAC is concerned that both science and CSV activities have been crippled by power outages over the past few months. To compound matters, recovering from power outages and snowstorms also seems to be a very slow process. We heard a number of ideas that might help get the array back into operation more quickly after such events – e.g. installing remote power switches, and visiting the antennas on snowcats to clear off the dish surfaces. We hope that implementing some of these solutions will improve the observing efficiency at relatively low cost.

ASAC recommends that achieving stability of the power system be given the highest possible priority. Since we were not presented with a comprehensive, systematic plan to address this issue, we recommend the creation of a tiger team whose goal should be to improve observing efficiency, primarily by providing a stable power system, but also by considering how to reduce the recovery timescale following outages and storms.

Charge 3: With Cycle 0 and Cycle 1 proposal evaluation cycles completed, it is now of high importance to have a clear policy in place regarding the definition of duplicate observations for Cycle 2. The ASAC should work with the JAO and other interested parties to define what constitutes a "duplicate" observation.

At the time of writing, JAO intends to check for duplication only between Cycle 2 proposals, rather than against rolled-over Cycle 1 proposals.

Two projects are considered in "duplication" if ALL the following conditions are met: [for single pointings] common field (< HPBW); [for mosaics] >50% overlap of field; >50% overlap of spectral window; spatial resolution, sensitivity and spectral resolution within a factor 2.

Although this list of criteria is generally good, ASAC believes that duplication should be handled on the basis of individual targets rather than Science Goals, and is concerned about how to handle situations when only a few conditions defined in the document are fulfilled, since partial duplications have the potential to cause problems and/or waste array time.

Only detailed comparison of the targets and Science Goals between proposals with partial duplications will allow the PRP to decide whether or not the partial duplication is important. The ASAC therefore recommends indicating partial duplications (and the degree of duplication) to the review panels, then letting those panels solve possible conflicts.

The ASAC recommends that the user community be provided with a simple on-line tool to check target coordinates and line lists proposed for Cycle 2 against high-priority Cycle 1 proposals.

Lastly, the ASAC recommends that an analysis of Cycle 1 – Cycle 2 duplications, along the same lines as those provided for Cycle 2 – Cycle 2 duplications, be delivered to the PRP. Panel members cannot be expected to do this for ~100 proposals.

Charge 4: The regional project scientists and the JAO will provide ASAC with materials, such as summaries, status updates, and other information of the completed and ongoing Development studies. ASAC should assess the scientific merit of these studies (e.g. discuss the uniqueness

for ALMA, the advantages and drawbacks of each capability, etc.), which will serve as a basis for further dialogue of the ALMA Development Plan.

The regional project scientists provided the ASAC with a summary of the development activities in their respective regions. NA has received the results of the first set of Development Studies (8 proposals were awarded last year) and put out a new call for both Development Studies and Projects, receiving 9 proposals for studies and 8 for projects that are being evaluated. There are 3 developments currently funded (band 5 oscillator production; fiber optic connectivity; ALMA phasing project). Several of the project proposals were follow-ups of completed studies.

EU reported on the progress of the completed developments (Band 5 production study; Band 9 sideband separating prototype; bandwidth increase study) and ongoing developments (phasing white paper, supra-THz interferometry study, band 2+3 study).

The recent June call for EU development studies resulted in 9 proposals on a wide range of topics. ESAC have endorsed support for 3 proposals and partial support of 4 others (Very-high-speed digitisation; Combined band 2+3 receivers [2 groups]; Cryocooler improvements; Advanced data analysis; Operational concept for mm/VLBI; Solar research). In addition, ESAC suggested that partial support should be extended to the non-hardware portion of an SRON/Leiden study on phase calibration of high-frequency data.

Two of the selected EU studies address the design of Band 2+3 receivers and similar work is funded by the NA ALMA development budget. While examining different approaches and technical solutions is useful at the study stage, ASAC recommends that ESO and NRAO explore, jointly, whether some new combination of these teams can provide an improved path to Bands 2 and 3.

EA reported its regional activities, which include a Band 1 PDR, an artificial source that is being commissioned, and a study for Band 11. A recent regional ALMA Development conference resulted in a report posted in the wiki, "Prospects for EA ALMA Future Development," which includes a large range of ideas of interest to the community.

It has been unclear up to now what the final destination of the Development Study reports should be. The regional project scientists proposed that the final report of a Development Study become an ALMA memo, after removing possibly

sensitive proprietary information that the report may contain. The ASAC agrees this is an excellent idea.

In parallel with these activities, the ALMA Development Steering Committee (ADSC) created, at the initiative of the project scientist, a working group charged as follows:

Charge 1: Provide an outline of the science demands for future ALMA development in the context of other existing and future observatories. The relevant timescale to be considered is up to the year 2025.

Charge 2: Identify some clearly differentiated and internally coherent major themes for the ALMA long term development (up to the year 2025), such as “New observing capabilities”, “Increase of sensitivity”, “Enhancements to improve reliability and efficiency”, etc.

Charge 3: Collect options for dedicated development projects corresponding to the major themes of Charge 2.

The working group (WG) comprises the 3 regional project scientists, the JAO project scientist, and the representative of the ASAC to the ADSC. The latter, currently Alberto Bolatto, chairs the WG. The group has started work on a report, “Pathways to Developing ALMA”, describing possible technical and usability enhancements to the observatory, with the goal of producing a compact and descriptive description of each development including benefits and drawbacks, its scientific, technical, and operational implications, and a cost estimate useful for broad-picture cost-benefit analysis. The ALMA regional scientists will feed into this process the knowledge gained from the Development Studies pursued in each region.

The ASAC will provide scientific input throughout the process of putting together the report, in what we expect will be a fluid exchange of ideas between the WG, the ADSC, and the ASAC. A very initial draft of the ongoing report was presented to the ASAC. The WG has been tasked with presenting an interim report to the ADSC in April 2014, and a final report by the end of 2014, as well as discussing its findings at the regular ASAC telecons and f2f meetings. A goal of this process is to document a number of concrete development pathways for the ASAC to evaluate and report on.

Charge 5: As of December 2012, data from Cycle 0 are entering the archive for community use. ASAC should comment on the utility of the archive and also the usefulness of current user software, such as CASA. How easy is it to access and use data from the archive? Are there critical functionalities missing from CASA? ASAC should also comment on data management plans for large data sets.

It is too soon to describe CASA as the 'package of choice' for interferometric data reduction since a section of the community (not exclusively the dinosaurs) remains indifferent to its user interface and its performance. CASA is, however, fast becoming the package most commonly used for reduction of data from the most powerful arrays. Because it is used by the ALMA and VLA data pipelines, even its detractors must become familiar with its functionality, or they face losing a key tool. ASAC is not aware that any critical functionality is missing.

ASAC received a hands-on demonstration of the ALMA data archive. The interface works well and data can be downloaded with relative ease, modulo local firewall issues. Parallel data download is available through the ALMA Request Handler and users have successfully downloaded in excess of 1TB. ASAC did not receive a presentation relating to data management plans for large data sets, but subsequent enquiries suggest that adequate planning and resourcing is in place. ASAC will schedule a telecon to look at this issue again before its next face-to-face meeting.

Charge 6: Now that Early Science observations have been underway for well over a year, it is important to have a systematic assessment of the reproducibility of the array. The ASAC should comment on a plan from the JAO to test the reproducibility through repeated observations of well-characterised targets with a range of relevant properties.

The ASAC reviewed the array-reproducibility plan from Stuartt Corder, the CSV Project Scientist, and was impressed by its quality and comprehensiveness; its objectives are in line with ALMA's long-term strategic targets and requirements and will ensure consistent data quality. Monitoring of performance indicators will lead to more reliable and efficient operation of ALMA, and will be important for equipment safety and maintenance. The committee therefore endorses the development and implementation of these repeatability metrics and performance

standards.

While supporting the array-reproducibility plan, the ASAC recommends that the JAO identifies critical targets and estimates the time required for their implementation. Given the difficulties encountered during ALMA Cycle 1 science operations, and the risk of overloading the CSV team, ASAC recommends that all non-critical developments proposed in the array-reproducibility plan be carefully balanced against competing priorities and resource constraints.

Ad hoc Charge: Evaluation of progress made in developing and implementing the project tracker (PT) tool.

The development status of the PT was discussed in the context of project-related communication to users and the need to provide adequate information and feedback on project status throughout the life cycle of a proposal.

The ASAC felt that good progress was made in the development and deployment of the PT, which is very positive news for users.

At the current stage of development, the committee recommends that further changes and improvements to the PT should be made in closer consultation with users. To improve and facilitate communication with users through the PT, the ASAC recommends implementing user-configurable triggers and alerts to inform users automatically via email about key tasks and deliverables being completed.

Ad hoc Charge: Observing with ALMA Phased Array/VLBI.

Prompted by lobbying from the community involved in the Event Horizon Telescope project, ASAC discussed possible issues with the timing of VLBI observations (and other applications) that will be enabled by the ALMA Phasing Project (APP).

The APP is an approved ALMA Development Project that will provide a system to phase together the array elements, creating a single large aperture, allowing ALMA to participate as a sensitive element in VLBI experiments, or to be used for pulsar/transient studies (science case: <http://arxiv.org/abs/1309.3519>).

The APP is scheduled for completion by 2015 January, during Cycle 2, though

ASAC believes this timescale might become stretched when faced with competition with other ALMA commissioning priorities. The interaction between SgrA* and the G2 cloud in 2014 can be expected to increase after pericenter passage, making 2015 an astrophysically fortuitous time. Thereafter, the number of global submm facilities is expected to decline due to pressure from ALMA capabilities and limited funding.

The first opportunity to incorporate the APP into a regular proposal Call will be Cycle 3, representing a delay of nearly a year if APP is delivered on time.

The ASAC is reluctant to endorse observations that have not been ranked against the full range of ALMA science in a regular proposal call. However, ASAC recommends that if the APP/VLBI capability were to become available many months from a proposal deadline, which is possible because of the long proposal cycles being implemented for Cycles 2-3, a Delta Call could be considered for *any APP science*, enabling *early, short* usage of such special observing modes, open to any team, and perhaps counted against DDT.

ASAC notes that the APP/VLBI capability should be useable by anyone from the ALMA community, yet is unaware of plans to ensure this outcome.

Ad hoc Charge: Large, Key, Legacy proposals.

Large/Key/Legacy proposals were not discussed at length, having been discussed on a number of recent occasions. We found no reason to change our previous recommendations, namely that they should be considered when we have “Full ALMA”.

ASAC recommends that ambitious proposals should not be discouraged. If the Cycle 2 limit has been advertised as 100hr, then proposals asking for 10s of hours must be extraordinarily good, obviously, but they should not be subjected to new, unadvertised rules, as nearly happened in Cycle 1.

Ad hoc Charge: Engaging with the community.

A common complaint among users is that they don't know what is going on with ALMA in general. Improving communication with the community is imperative. The Project Tracker will help with this problem, and the plan to generate a regular newsletter also is good. The newsletter should be forthcoming about

power outages and other difficulties.

We continue to believe that long observing cycles will be counter-productive. Infrequent proposal calls discourage users and reduce interest in ALMA amongst the broader community with which we are trying to engage.

We feel it is not essential to provide a large number of new observing capabilities with each cycle; shorter cycles, with fewer new capabilities introduced each time, would be preferable.

We urge the observatory to take full advantage of its advisory structure when faced with difficult decisions. The ASAC can serve as an interface to the community, along with the ARCs. To do so, we need to be better informed about the rationale for the decisions that are made.

Ad hoc Charge: Call timing.

When ALMA does go to a 12-month cycle, U.S. users urge that the proposal deadline be chosen so that results are available by October of each year, in advance of the deadline for submitting NSF individual investigator proposals.

Ad hoc Charge: Long-term future of power generation.

The ASAC remains committed to and unanimously supports an in-depth evaluation and costing of efforts to increase the efficiency of power generation at the ALMA site. Power costs are an increasing burden on the project, with the potential to divert significant funds from other areas.

As endorsed by the Board, a five-person 'working group' was established 18 months ago, and made good initial progress, but was hampered by an essential member (an energy expert from the Fraunhofer Institute) declining to participate. While we acknowledge that there are a number of other pressing concerns, we recommend that the Board does not lose sight of this issue. We recommend that the ALMA project re-constitutes this committee, making sure that it is adequately populated with relevant technical experts; there may be natural and important synergies between this group and the engineers working on the power system in general.