

A Review of ALMA's Commissioning and Science Verification Plan

A review of the ALMA Commissioning and Science Verification Plan was held on September 2 and 3 at the OSF. The review panel consisted of Robert Wilson (chair), Nario Kuno, Peter Schilke and Melvyn Wright with Claire Chandler as an external adviser attending by video link.

The panel was asked to try to answer six questions,. The questions followed by the panel's answers are:

1) Do the plans include all the issues that need to be addressed during the commissioning phase?

The panel did not uncover issues which are not planned for. Plans for the commissioning of the ACA were not discussed, but we were assured that they are in place.

2) Please comment on the way in which it is proposed to organize and carry out the work. Is this likely to lead to an efficient execution of the commissioning program and does it take proper account of the practicalities such as the location of the site and the state of the equipment?

The management structure is a form of matrix management (that is known to have problems). This arrangement seems to be working well in this case since the three current managers are cooperating well to achieve the common goal. We heard no complaints from the people working in the system, so we would not suggest changing anything, but the situation bears watching as CSV is officially started and competition for resources increases or if any of the managers are replaced.

The actual working arrangements seem to be well adapted to the difficult conditions. We heard frustration from the scientists with an engineering background because they loose time and some directness because they are not allowed to touch the equipment, but appreciate that responsibilities have to be assigned in a large, complex multi-vendor project like ALMA.

3) Is the schedule realistic and has an appropriate amount of contingency been included? Are the assumptions that have been made in drawing up the schedule clear and realistic? Is the status of the system that is to be delivered by AIV sufficiently well defined and is that also the case for the handover to Operations?

The schedule was described by someone as “success oriented” and indeed there does not seem to be much contingency in it. When we did a rough comparison with the FTE people years that the existing observatories used for commissioning, it was similar. The situations, however, are sufficiently different that comparisons are difficult.

There was no discussion of whether to accept schedule slip or reduce goals if unrecoverable time losses occur. On the positive side there seems to be sufficient flexibility to substitute other tasks when many of the failures occur.

Since there seems to be some concerns about schedule and staffing as described above, we recommend making the following provisions:

- (1) Prioritization of the commissioning tasks: Maintaining schedule is important so we recommend having CSV plans with intermediate time scale goals and, perhaps monthly, reviews of progress. There should also be a prioritized fallback list for each important milestone such as “Call for early science”, “Start of early science”, and “Inauguration”. This needs to be done in a way which does not reduce the current can-do spirit and pressure to succeed in the commissioning teams.
- (2) Evaluation of the required staff numbers based on the effort needed for the commissioning tasks. The numbers of the required staff in the present plan seem to be designed around Turno system requirements. We recommend evaluating the numbers based on the effort needed for the commissioning tasks. To do that, check of the content of each task may be needed.
- (3) Risk analysis: We recommend to list the possible risks that have large impacts on the schedule, and to prepare how to deal with the risks.

The status of ALMA at the two handovers was well defined in principle.

4) Do we have the right number of people and do they have the necessary expertise?

There are admitted holes in the expertise coverage, but there are plans to fill those holes. That should be done as soon as possible. The staffing will still be at the low end of the levels that were discussed, however, and it might be better to add a few more people now. Adding people later if CSV is running late but closer to completion might be ineffective or even detrimental.

5) Have the interactions with the AIV activities and with Early Science been planned properly?

As far as we could tell, yes.

6) Are there appropriate support arrangements (IT, Software, Engineering, Admin, etc.) in place?

Yes, they seem appropriate.

Other issues the panel wishes to note:

- 1) The data link between the AOS and OSF is a single point of failure and may become a bottleneck. At a minimum spares should be available for the existing equipment. It is encouraging that there seems to be no problem of outages from propagation problems. Congestion control may be necessary even in the long run to avoid real time processes from being starved out by less urgent tasks, but additional capacity would be better as soon as possible. A link failure does not seem to pose serious risks to people or equipment. A high bandwidth connection has been especially useful during commissioning ATA, and will benefit ALMA during commissioning.

During ALMA's operations phase, if this link is a single point of failure, a redundant system may be called for since a lost day of operation will represent a loss of hundreds of thousands of dollars in embedded cost plus operating budget. An adequate storage array (with pressurized, filtered disks) at the high site coupled with a lower bandwidth link for command and control might allow limited operation when the main link is down, but is a less desirable solution.

- 2) The data link from the OSF to the Internet also needs much more capacity. This will improve collaboration with off-site people.
- 3) The current bandwidth and data rates will limit the science. Spectral line data averaged without inspection is lost information. ALMA's data model is 1980's vintage and since many observations will be mosaics with a need to sample at the Nyquist rate in pointing and UV space, the required data rate for the full spectral bandwidth will be higher.
- 4) The test interferometer at the OSF is a very important addition to the original AIV testing plans. It should be maintained after AIV is complete, at least until sub-arrays can be operated for engineering tests during observing with the rest of ALMA.

- 5) Richard's proposed transmitter at the high site for polarization calibration and holography would be a very good addition to the plan. If it is coherent, strong comb generator, it will also be a superb tool for debugging as one can get rapid feedback about phase changes.
- 6) The present rate of failure of sub-systems during testing is slowing progress and must be improved. It must be improved by several orders of magnitude before operation of the full ALMA can be considered.
- 7) Facilities within sight of a road are high risk. Consider moving the pad and blocking easy cross country access from the pass road while construction equipment is on site to do this.
- 8) Increase commissioning scientist investment in ALMA science verification. Actually trying to do science observations is a sure way to make ALMA into a scientific instrument. Commissioning scientists must also look to their future careers. They are well placed to make the best use of ALMA, but also need to keep their science credentials in good shape.

The committee would like to thank the scientists and staff at ALMA for well organized and informative presentations..