

ALMA Front End - Preliminary Design Review

Held at NRAO Tucson, 19 and 20 February 2001

Recommendations of the Review Committee

Following ALMA review guidelines, the review panel was asked to answer five questions and give additional comments and recommendations. The following recommendations are listed in the order in which the questions were asked. At the end, specific comments (which were received after the review) by individual reviewers are included.

1. Are the top level requirements for the front end subsystem complete and adequate ?

The science requirements have not been translated sufficiently into front end engineering specs. The review panel notes that the top level requirements do not reflect specifications that can realistically be achieved within the tight schedule to first light.

In particular, the panel is extremely concerned about the stringent requirement of total power stability of 1 part in 10^4 in 1 sec and urges the front end and science groups to study the implications on complexity, cost, and reliability as well as the science implications if this stability cannot be reached.

The panel identified missing top level requirements on availability, reliability and maintainability as well as an operational concept for the receivers. They need to be available in time for the delta-PDR.

2. Are the detailed requirements for the front end subsystem complete and adequate ?

The panel is seriously concerned about the amount of TBD items in the receiver area. It recommends that the receiver team leaders in consultation with the JRDG take decisions as soon as possible (within a time frame of not more than 2 months). There should be some time to consider objections by other concerned ALMA groups and ASAC (within ~ 1 month), after which the decisions should be adopted.

The panel sees a very high risk that by CDR some front end specs may not be met for some bands. The panel realizes that the schedule must be met. It recommends that the different groups be encouraged or instructed to take the schedule seriously and be asked to produce plans for what can reasonably be achieved by CDR. It also recommends that the different groups provide detailed schedules with milestones.

Referring to the proposed delivery time for the band 9 final LO multiplier (engineering model by Dec 2002, qualification model by Oct 2003), the panel recommends that alternate sources for a band 9 tripler be pursued with vigor before CDR by the group responsible for LO multipliers, even if this means reduced

bandwidth. In this case, selection of the center frequency should be done in consultation with ASAC.

**3. Have the correct design solutions been selected for study and development ?
Are there important alternate solutions that are not being studied ?**

The panel is impressed with the amount of design work done and the progress made. The panel found the proposed design concepts for the optics, dewar, cryogenics, and overall cartridge layouts sound and adequate. All viable solutions seem to have been studied. However, the panel feels that the front end design as a whole is not yet at PDR level, but exceeds the conceptual design level. In order to get from the present status to PDR, the following is required:

- final front end specifications (including operational concepts)
- final ICDs
- risk analysis
- draft test plan
- cost analysis
- a plan how to get from PDR to CDR
- handling and testing concept

The panel would like to see a delta-PDR be held in the June/July time frame, but recommends that the front end group leaders review the feasibility of this date. The panel anticipates that 12 months would be needed from PDR to CDR.

The panel recognizes that the work required (especially for the top level system definition and detailed design) to reach PDR and CDR cannot be achieved with the current level of effort and urges the AEC to address this as a matter of urgency.

4. Are the interfaces to other subsystems and within the front end subsystem defined adequately and completely ?

The panel notes that the interfaces to other subsystems are only partially defined. Some interface definitions are missing, and those which are defined are incomplete. It is important to note that no definitions for interfaces *within* the front end sub-system exist at present. This should be changed as soon as possible.

5. Has adequate attention been given to the produceability and maintainability of the front end subsystem ?

The panel feels that enough attention has been given to produceability at this stage of the design, but not to maintainability and diagnostic monitoring of the front end subsystem.

Specific comments by individual reviewers received after the review

By A. Russell, ATC:

1) The committee recommend that a decision on the choice of cryocooler be made now. Assuming this is the Sumitomo device we urge that a test cooler be purchased soon and that a full evaluation is made of its performance and reliability well before CDR.

2) We strongly urge that RAL team to examine the use of truss structures for the cartridges. This will be considerably more efficient in terms of the thermal/structural trade-off than the current design. This could have a significant impact on the thermal budget of the cartridges. Additionally it will be simple to remove a set of trusses and allow open easy access to the inside of the cartridge.

By R. Guesten, MPIfR:

(1) programmatic:

I think – similar to top level requirements – we need for all subsystems (here, the LO) proper PDR level documentation. In particular, a development & verification plan is a must – outlining schedule, critical path(s), decision points between technologies etc. ALMA is a space-type project (by complexity, volume, costs) and we must adopt some of the procedures developed for those multinational projects. We need a serious PDR for the LO (baseline) – whether June-July is the right timeframe, I doubt a bit – because this is too early for the photonics activities. This may require a delta-PDR in autumn/winter.

(2) technical:

- band 9: critical assessment of InP drivers (schedule, performance). prepare for fall-back along HIFI scheme (3 doublers) working on existing drivers (JPL). compromise: the lower 20 GHz or so, of the band will likely not be covered (check transmission and with scientists).
- LO power handling for bands using power amps: I estimate that a min of 25 dB is needed (spec TBD), given the variation of output power across RF that John W. showed. it was suggested that power levelling could be done in the low-frequency part of the source unit. maybe, maybe not. for HIFI we face the same problem and – up to date – no measurement has been performed with the JPL/TRW drivers that addressed the LO noise issue if the power amp is not driven saturated. action item for John W. should I get results from JPL at an earlier time (which I doubt) I will keep you in the loop.
- along this line, I'm a bit reluctant about the concept of driving 2 multiplier chains with one power amp. there is barely any tool of power adjustment.
- isolators (input, output of power amp) and probably between the first and second multiplier stage need to be included. there may be spin-off from HIFI developments (e.g. I have a contract with Millitech on WR-05/06 isolators, JPL is supposed to provide WR-10). to be checked and included in budget

- for the PDR a more detailed breakdown of gain/losses along the LO chains shall be presented, including a noise budget

By P. Napier, NRAO:

The tolerance on allowable feed tilt angle was established on the basis of aperture efficiency loss. An error in feed tilt angle will also cause a variation in phase across the antenna primary beam which will complicate interferometer phase calibration. It is possible that this effect will be more important than loss of efficiency and it should be analysed to see if the planned tolerance is adequate.

(Prepared by W. Wild, 12 March 2001)