



ALMA CHANGE REQUEST

Date submitted: 2007-10-18

CRE #: ALMA-00.00.00.00-000-A-CRE

TITLE: Calibration Device Transition Time and Hot Load Usage

(To be completed by CR Submitter/Initiator)

Description of change (detailed description of change proposed) and Justification:

The current Calibration Device Technical Specifications (FEND-40.06.00.00-009-B-SPE, dated 2007/07/31) call for, among other things, (1) total calibration timescales and (2) use of the hot load at all ALMA receiver bands. This CRE requests two changes with regards these requirements:

(1) Total Amplitude Calibration Timescale Upper Limit:

The total calibration time to perform an amplitude calibration, including movements but excluding the integration time and control system overheads, is listed in section 4.5 of the Calibration Device Technical Specifications as not exceeding 9.0 seconds. This value appears to derive from an assumption that the move time should be less than 1% of a typical amplitude calibration interval of 15 minutes. For many circumstances, however, including for example spectral scans where the observing frequency is being changed often or observations at times when the atmospheric transparency is variable, much more frequent calibrations will be necessary. A much shorter move time is therefore highly desirable and indeed it was understood by SciIPT that this was expected. (During the amplitude calibration device review of 2005/09/07 the move time for the calibration device was described as being less than one second.) As it will be necessary to minimize the overhead associated with calibration in general, *the Science IPT requests that the requirement for the maximum time for making the moves required for an amplitude calibration be reduced to 5.0 seconds.* In mitigation it is noted that the positional accuracies required in sections 4.4 appear to be tighter than necessary. Assuming that the back-scatter from the loads is low, which it needs to be anyway, we can think of no reason why the angular tolerance and stability should be tighter than 10 mrad (i.e. factors of 20 and 50 looser) and the positional tolerances and stabilities tighter than +/-2mm (factors of between 2 and 20). In principle such a reduction in the precision required should make it possible for the movements to be faster.

(2) Use of Hot Load for Amplitude Calibration of Bands 1 and 2:

Through discussions with the Frontend IPT, the Science IPT has learned that temperature stability of the prototype hot load systems is a problem. It appears that the need to provide a hot load which meets the temperature stability requirement from 30 to 900 GHz is the main limitation. According to Patt and Murk, if the hot calibration load were not needed for Bands 1 and 2, then it would be easier to meet the overall load temperature stability requirement. Mangum made some calculations of the accuracy of the single- and dual-load calibration systems at Bands 1 (40 GHz) and 2 (80 GHz). Following the same formalism described in Load Calibration at Millimeter and Submillimeter Wavelengths: Mangum; October 18, 2002; ALMA Memo 434, the situation is directly analogous to the calculation done at 230 GHz. Assuming 50th-percentile $\tau(40)=0.02\pm 0.002$ and $\tau(80)=0.03\pm 0.003$ the single-load (traditional) chopper uncertainty is predicted to be ~1% at both frequencies under "best" conditions (as laid out in Memo 434). This means that the calibration requirements should be met with only an ambient temperature load. The total uncertainty is almost completely dominated by the uncertainty in the rear scattering and spillover plus radiative efficiencies and is not greatly improved by using a second load at a higher temperature. Note that this analysis assumes that the frontends do not suffer effects due to saturation and that no corrections for sideband ratio are needed, but both these should be true since these bands will use RF amplifiers rather than SIS mixers. *The Science IPT suggests that the requirement for hot load operation at Bands 1 and 2 be removed from the Calibration Device Technical Specifications.*

Additional information in attached documents:

Impact: Specifications Science Cost Schedule Safety Technical Other (specify):

Description of impact:

Two changes to calibration device specification.

Affected products to be modified:

Calibration Device

Affected documents to be revised:

FEND-40.06.00.00-009-B-SPE

Remarks:

Date Submitted:

Date Decision Required:

CRE Initiator: Jeff Mangum



**ALMA CHANGE REQUEST
SUMMARY STATEMENT**

Date submitted: 2007-10-18
CRE #: ALMA-00.00.00.00-000-A-CRE

Summary Statement for CRE # : ALMA-00.00.00.00-000-A-CRE

Summary of Technical Impact (state concerns and/or merit):

- (1) Reduction of upper limit to total amplitude calibration movement time from 9.0 to 5.0 seconds.
- (2) Removal of requirement that hot load be used for amplitude calibration of Bands 1 and 2.

Summary of Schedule Impact:

Summary of Budget Impact:

Remarks:

| Name | Signature | Date | App | Rej | Name | Signature | Date | App | Rej |
|---------------------|-----------|------|--------------------------|--------------------------|---------------------------------|-----------|------|--------------------------|--------------------------|
| IPT LEAD | | | <input type="checkbox"/> | <input type="checkbox"/> | NRAO CONTROLLER | | | <input type="checkbox"/> | <input type="checkbox"/> |
| IPT LEAD | | | <input type="checkbox"/> | <input type="checkbox"/> | ESO CONTROLLER | | | <input type="checkbox"/> | <input type="checkbox"/> |
| IPT LEAD | | | <input type="checkbox"/> | <input type="checkbox"/> | JAO CONTROLLER | | | <input type="checkbox"/> | <input type="checkbox"/> |
| IPT LEAD | | | <input type="checkbox"/> | <input type="checkbox"/> | | | | <input type="checkbox"/> | <input type="checkbox"/> |
| SYSTEMS LEAD | | | <input type="checkbox"/> | <input type="checkbox"/> | CCB SECRETARY | | | <input type="checkbox"/> | <input type="checkbox"/> |
| SYSTEMS LEAD | | | <input type="checkbox"/> | <input type="checkbox"/> | JAO PROJECT DIRECTOR | | | <input type="checkbox"/> | <input type="checkbox"/> |