

3mm Receiver Module 1: Project Status

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Date: April 2, 2004

1. Technical Issues

Gain Compression, Amplitude Calibration

The second RF amplifier will be in compression when a room-temperature load is placed over the feed. Of the many solutions proposed, it was decided that we would place 6 dB (adjustable) attenuators between the two RF LNAs to partially alleviate the compression. Still, the nonlinearity will be large enough to preclude the use of standard lab calibration techniques. Among the possible solutions for the lab calibration problem are the use of semi-transparent vanes, and liquid argon or liquid helium thermal loads.

Gain and Phase Ripple

Mating of WR-12 and WR-10 components within the differencing assembly will introduce gain and phase variations (in the frequency response) that will degrade the performance of the radiometer. Mismatch can be diminished through the use of waveguide tapers, but these will contribute noise (in the case of those used in front of the first LNA) due to their insertion loss.

2. Procurement

W-band LNAs

CDL has four of the ten completed, and will commit to building six more by 12/04. Gerry Petencin said that there may be a scheduling conflict, as Todd (the builder of W-band amps) is very busy with ALMA tasks.

Quartz Vacuum Windows

CDL built two, which have been sitting on a shelf for some time. Laminates have peeled away from the quartz during the storage period, therefore they must be rebuilt. CDL (Koller) understands the reason for the peeling, and has a plan to improve his fabrication technique. However, it will be some time before CDL can resume work on these windows. In fact, they cannot yet predict when they will have the time.

Dewar

Aluminum and stainless-steel has not been purchased. Typical cost for dewar materials is \$800, but it's very likely (according to Hedrick) that we can make use of surplus metal that they have on hand - thus reducing the cost considerably. It turns out that the completion of the dewar is a very important milestone in project schedule's critical path. Delaying its construction will have a direct influence on the final completion date of the receiver. Note: The cost for a turret mounting plate, and for receiver mounting rails, is included in the \$800 estimate.

We have purchased the necessary OFHC copper for the cryostat's cold plates.

Quarter-Wave Plate

Before we can support VLBI, or any other experiment that requires circular polarization, we would need to build a quarter wave plate. My plan was to use teflon, which would cost approximately

\$100. The proposed waveplate would provide reasonable axial ratio over a 10 or 20% bandwidth, suitable for VLBI work.

PC Boards, and Associated Components

PC boards for LNA bias, diode protection boards, sensor cards, cal control, phase switch driver (yet to be designed), and all of the associated components, are needed for this receiver and have not been purchased. We do have a supply of spare cards and components,

Sensor	5
6-stage bias	8
half-amp	4
LO Det Cal Contr	7
Control	2
½-amp/LED/Sw	0

Rather than to deplete our supply of spares, it may be desirable to build up boards specifically for the 3mm receiver. We have all of the necessary boards and parts for everything EXCEPT the 6-stage bias cards, diode protection boards, and phase switch driver. Total costs for boards and components are given below:

<u>Description</u>	<u>Qty</u>	<u>Cost</u>
6-stage bias	8	680.
diode protection	10	50
phase driver	2	50

Miscellaneous Waveguide Flanges and Coaxial Connectors

\$500

3. Risk Assessment

Gain/Phase matching

The decision to use WR-10 (rather than WR-12) waveguide transitions on the LNAs will degrade the phase and gain matching between the two arms of the differencing assembly.

Gain Compression

The second stage RF amplifier will not be in its linear range when a warm load is placed in front of the feed. This will require us to use alternative techniques for thermal calibration - in the lab, and possibly on the telescope. Two approaches that have been discussed are: (a) to characterize the amplifier nonlinearity, and if stable, use this information to correct data that has been taken in the nonlinear regime, and (b) to use multi-temperature cold loads (cold load(s) within the dewar, semi-transparent vanes, etc.) - thus avoiding gain compression altogether. These alternative schemes present some risk, in that they may compromise the accuracy of the thermal calibration.

Note: CTC estimate of \$12K was published on October 3, 2002, which included about \$1K for beam-steering optics.

Variable Attenuators for Cryogenic Use

We plan to use variable attenuators the 15K stage of the cryostat, which will serve to equalize the gain imbalance between arms of the differencing assembly, and to diminish the magnitude of standing waves between the RF LNAs. These variable attenuators, manufactured by Aerowave,

have never been used at cryogenic temperatures, and we were concerned about the risk of a hard failure, or the degradation of electrical performance. After discussions with Aerowave concerning the appropriate choice of materials and assembly techniques, we believe that our risk is low.

4. Remaining Tasks (Electronics Division)

1. Create mechanical drawings for dewar and cold plates.
2. Tune/test OMTs.
3. Test components: 2nd mixer assy, RF filters, noise source, detectors.
4. Create mechanical drawings for radome support, turret mounting plate, receiver mounting rails.
5. Write MCB specification.
6. Create drawings for card cage.
7. Design driver circuit for phase switches.
8. Create drawing for split-block 90-degree bend, and a square waveguide load.
9. Finish procurement (6-stage bias boards and associated components, diode protection boards, metal for dewar, o-rings, WR-12 directional couplers and attenuators.
10. Construct differencing assembly, test warm. Add on the mixer assy, test all warm.
11. Build bias cards, diode protection boards, other PC boards such as Sensor, Control, etc.
12. Build wire harnesses. Wire the back-plane of the card cage.
13. Assemble dewar. Measure leak rate.
14. Cool the entire front-end electronics. Perform tests. Review results, prepare reports, hold CDR.
15. Implement any changes following CDR, finish mounts and infrastructure, install receiver on GBT, prepare final reports and update schematics and other documentation.
16. Prototype, test WR-12 waveguide vacuum windows.

4. Schedule

The attached schedule is a modified version of the most recent one, available in the project documentation archive: /home/doc/gbt/subsys/gbt3mmrx1/schedule/3mmRx_1.mpp, dated September 28, 2001. In modifying the old schedule, all of the task durations and dependencies were kept the same, and the start date of incomplete tasks simply shifted to 4/1/04. In addition, a constraint was added that there will be no additional procurement until 10/1/04.

With these constraints, the modified schedule shows a project completion date of September 7, 2005 – approximately one month before the 10/1 goal. Note that this schedule leaves a 5-month time span (7/30/04 through 1/7/05) in which Stennes is not actively working on the project, and that he is fully occupied during the summer of '04, thus limiting his involvement in any K-band upgrades or repairs. By redefining some of the task dependencies and start dates, the 5-month down time can be shifted to the summer of '04, allowing Stennes to spend more time on other receivers.