X-band Baseline in Lab II
Project TRXRDN030605, June 5, 2003

R. Norrod

June 9, 2003

Introduction

The GBT X-band (8-10GHz) receiver was removed from the telescope and placed in the Equipment Room near the Spectrometer for baseline testing. Today, testing continues along the same lines as that reported under project TRXRDN030602. The general goal is to investigate baseline effects that have earlier been shown to originate before the first mixer, and to have amplitudes which increase with continuum source temperature.

The Spectrometer was used in an four-bank, eight sampler, 800MHz mode, with 10 second records. Connections were the same as on 6/2/2003. The X-band IF signals were connected into the backs of OR1 and OR3, which were then connected to CM1 and CM5 and then to two of the samplers. The IF Rack noise source was connected to other samplers. Hardware connections are shown in Table 1.

Tests

During the 6/2/2003 tests, the receiver was not fully cold. So, the initial tests today repeated the tests done using the noise cals with a shorting plate over the dewar waveguide window.

Figures 1 and 2 show the baselines for the initial group of scans. The system was undisturbed, and the scan times were 60 seconds.

Table 1: Hardware Connection Map

ACSBank	Sampler	SF	CM	OR	Source
1	0	1	1	1	XL
1	1	5	5	3	XR
2	2	2	2	2	NS
2	3	6	6	4	NS
3	4	3	11	5	NS
3	5	7	12	7	NS
4	6	4	15	5	NS
4	7	8	16	7	NS

A series of scans were then taken while manually controlling the receiver noise sources. During the first pair, both the low cal and the high cal sources were off. During the second pair, the low cal was on. During the third pair, the high cal was on. During the fourth and final pair, both cals were again off. Figures 3 and 4 show the resulting scan ratios for the LCP channel for this sequence of scans, and Figures 5 and 6 for the RCP channel. While there is large ripple when scan pairs with the noise sources on and off are ratioed, there is little evidence of extremely sharp frequency structure like that seen on the antenna in baselines taken on and off continuum sources. For this receiver the low cal is about 2.5K and the high cal is 15-30K, as measured in the lab. While the noise cal is injected past the polarizer, one would expect a standing wave between the LNA isolators (return loss about 20dB) and the waveguide shorting plate that would show the frequency structure seen on the telescope, if it were generated in the receiver.

The dewar window short was then removed, and the feedhorn installed. A metal plate was placed over the feed aperture, and copper tape with conductive adhesive used in an attempt to seal the cover to the feedhorn. We noticed that the system total power increased by about 2dB compared to the window short in place. Two scans were run, and the raw spectra from one scan are shown in Figure 7. It is clear that emission from the equipment room is leaking into the feedhorn, but it is unclear whether all of this is around the aperture cover plate, or whether some could is also leaking into joints within the feedhorn or circular waveguide. We then disassembled the feedhorn, cleaned all flange faces, and removed the radome material and the support tube from the feed aperture. After reassembling the feed, we decided to take some data with 300K absorber over the aperture.

Figure 8 shows the raw spectra with the absorber in place. Only a few large spikes are visible with the 300K system temperature. Figure 9 shows the baselines for a sequence of scans during which the high cal noise source was turned on and off.

The absorber was then removed and the metal cover taped back over the feed aperture. Figure 10 shows the raw spectra for this condition, and the results are similar but not an exact replication of the previous results shown in Figure 7. Despite the plethora of spikes, we repeated the sequence of cal off and on measurements. Figure 11 shows a portion of the baseline for the LCP channel, for the low cal off and on.

Conclusions

It does not seem possible to draw definitive conclusions from these results. The many spikes seen with the cover plate over the feed aperture could have been the result of leakage around the cover plate, or some could have been due to leakage at the feedhorn flanges. It is not even clear how much of the frequency structure is due to the characteristics of emissions in the room, and how much is due to joint resonances. After these tests were completed, we did find one joint in circular waveguide at which the integral alignment boss fit poorly, resulting

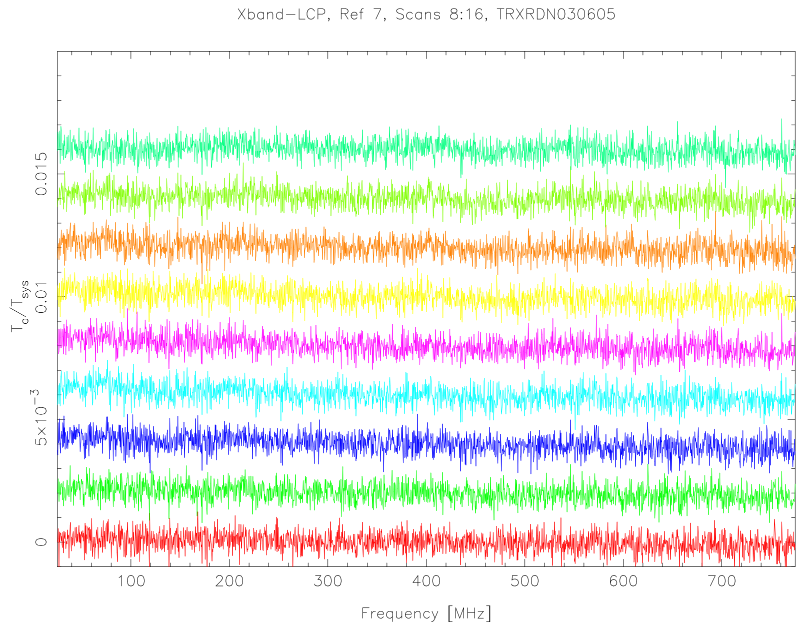

Figure 1: $(sig - ref)/ref$, for the X-band LCP channel, taking each of scans 8-15 as the reference, and the following scan as the signal. The system was undisturbed during this time. The scan times were 60 seconds.

in a small discontinuity in the waveguide wall. That has been corrected, but it remains to be seen whether it was significant. We also noted that the cromate on the aluminum feedhorn is generally non-conductive, and we are concerned that this thin dielectric layer on the flange faces could be a detrimental factor. Hence, we mechanically removed the chromate coating from all the joint flange faces, and have reassembled the feedhorn. A repeat of these tests will be done as soon as possible.

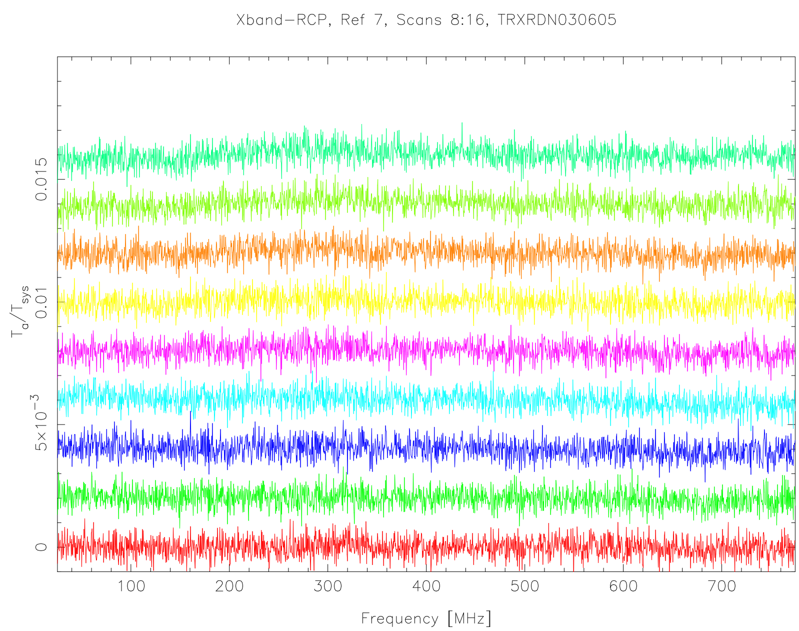

Figure 2: $(sig - ref)/ref$, for the X-band RCP channel, taking each of scans 8-15 as the reference, and the following scan as the signal. The system was undisturbed during this time. The scan times were 60 seconds.

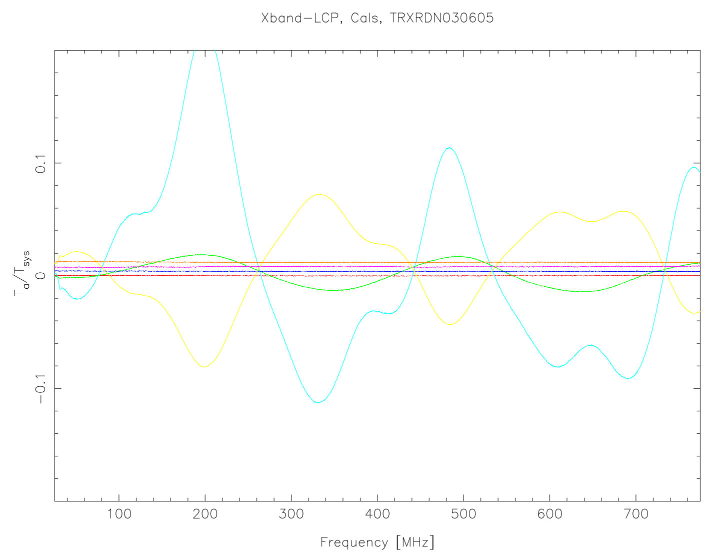

Figure 3: $(sig - ref)/ref$, for the X-band LCP channel, for various states of the receiver noise cal sources. Cases are: Cals Off for both scans (red); Low cal off for ref and on for sig (green); Low cal on for both (blue); Low cal on for ref and high cal on for sig (cyan); high cal on for both (magenta); High cal on for ref, and both cals off for sig (yellow); and both cals off for both ref and sig (orange - the top flat trace). The cal off phase only was processed, and the scan times were 300 seconds.

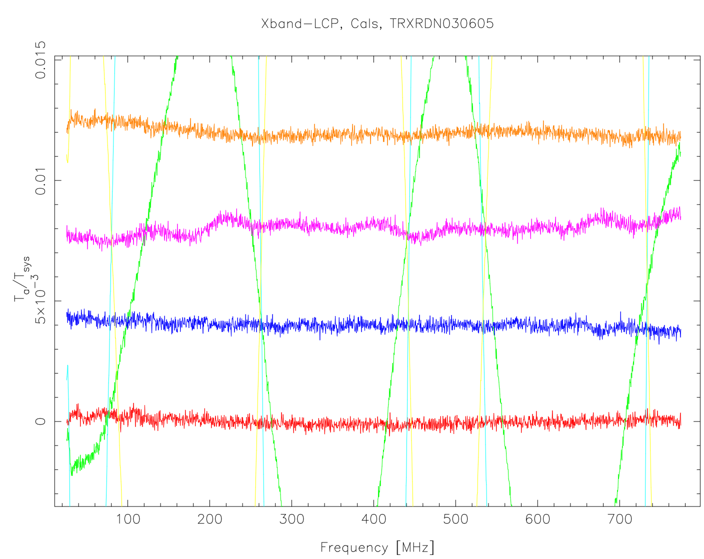

Figure 4: A zoom of the central portion of the previous figure.

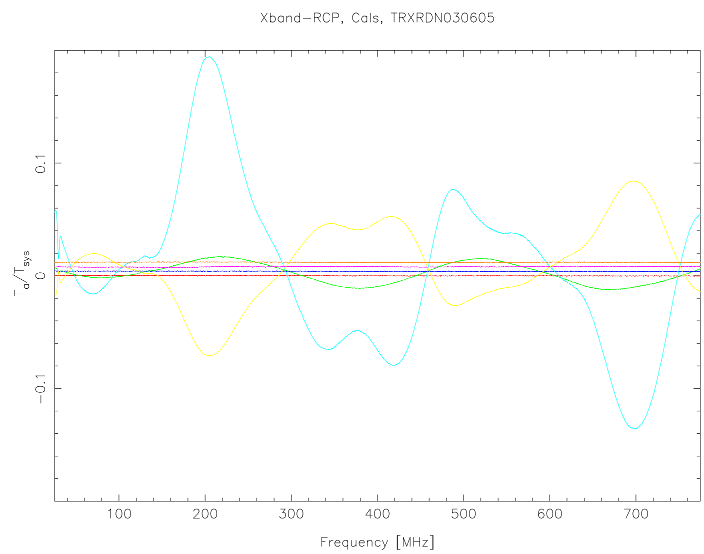

Figure 5: $(sig - ref)/ref$, for the X-band RCP channel, for various states of the receiver noise cal sources. Cases are: Cals Off for both scans (red); Low cal off for ref and on for sig (green); Low cal on for both (blue); Low cal on for ref and high cal on for sig (cyan); high cal on for both (magenta); High cal on for ref, and both cals off for sig (yellow); and both cals off for both ref and sig (orange - the top flat trace). The cal off phase only was processed, and the scan times were 300 seconds.

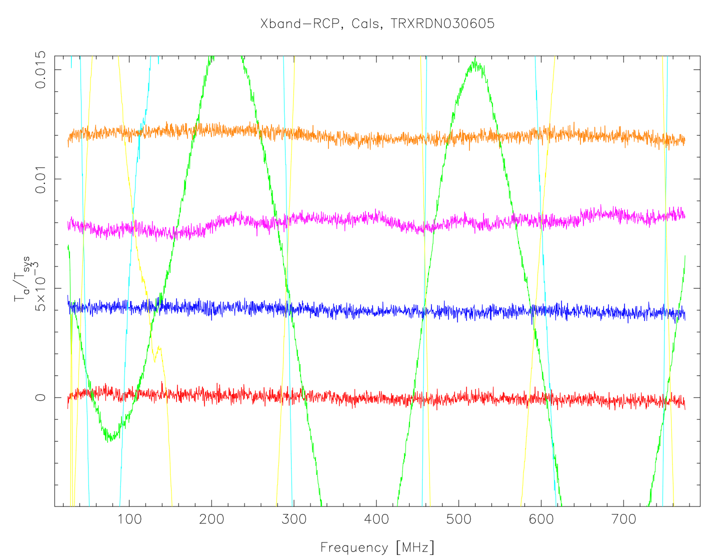

Figure 6: A zoom of the central portion of the previous figure.

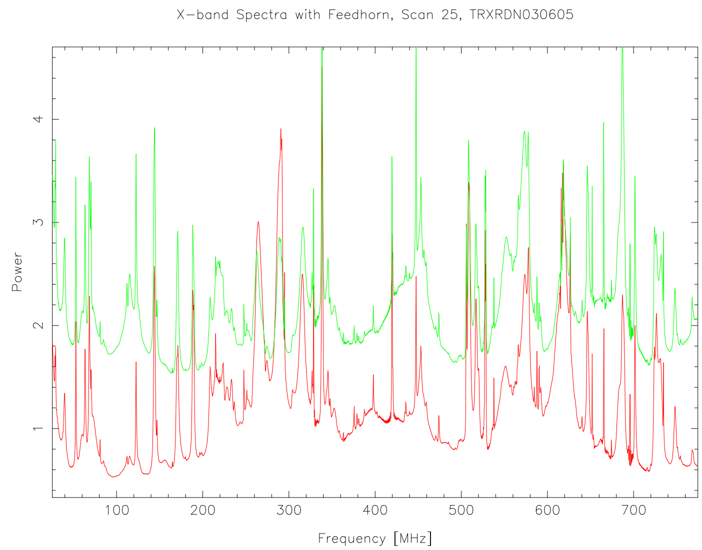

Figure 7: Raw spectra from the initial scan with the feedhorn connected and covered with a metal plate. The lower trace (red), is the LCP polarization, and the upper trace (green, offset by one unit for clarity), is the RCP polarization.

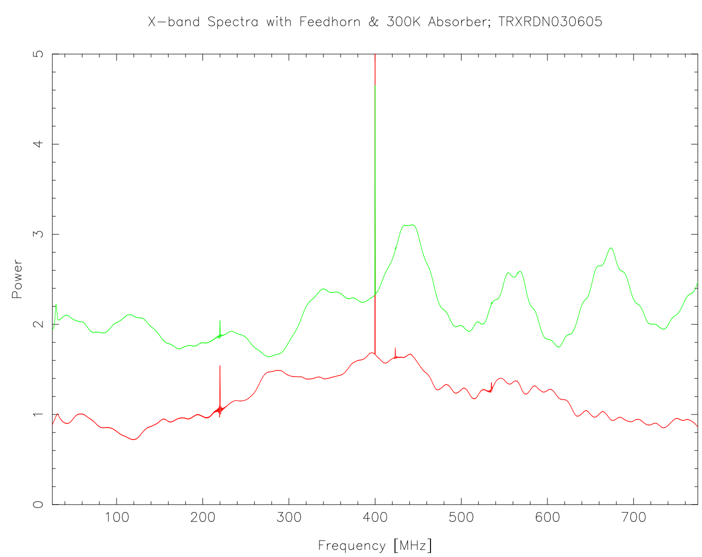

Figure 8: Raw spectra from the initial scan with the cleaned feedhorn connected and covered with absorber at 300K. The lower trace (red), is the LCP polarization, and the upper trace (green, offset by one unit for clarity), is the RCP polarization.

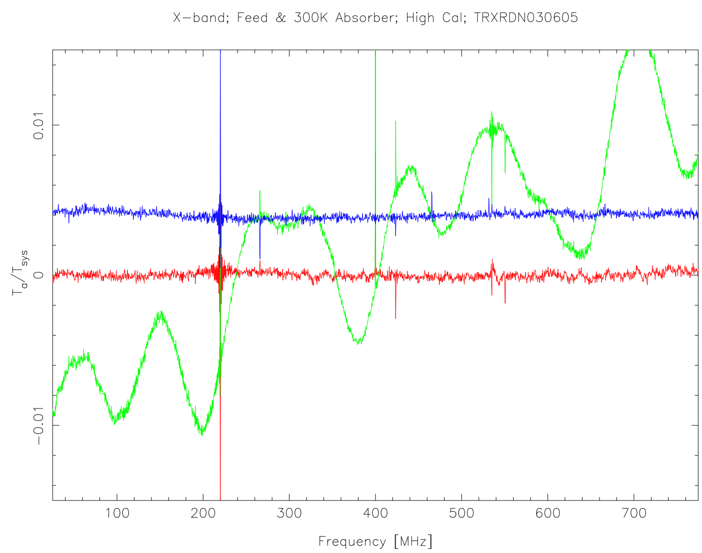

Figure 9: $(sig - ref)/ref$, for the X-band LCP channel with 300K absorber over the feedhorn, and with the high cal source switched on and off. Cases are: High cal on for both ref and sig (red); High cal on for ref, and off for sig (green); and both cals off for both ref and sig (blue). The cal off phase only was processed, and the scan times were 300 seconds.

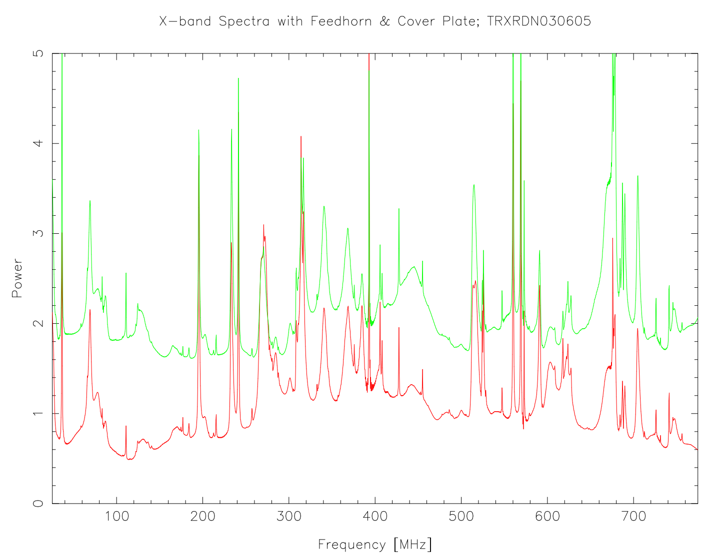

Figure 10: Raw spectra from a scan with the cleaned feedhorn connected and covered with a metal plate. The lower trace (red), is the LCP polarization, and the upper trace (green, offset by one unit for clarity), is the RCP polarization.

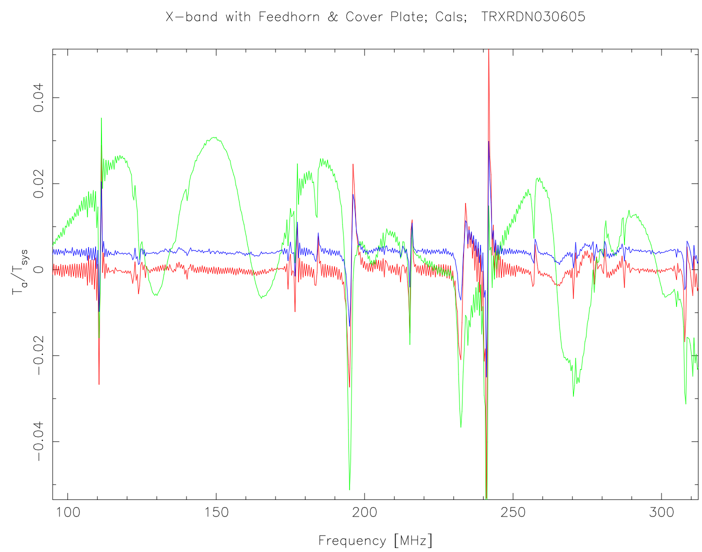

Figure 11: $(sig - ref)/ref$, for the X-band LCP channel with metal cover plate over the feedhorn, and with the low cal source switched off and on. Cases are: Cals off for both ref and sig (red); Cals off for ref, and low cal on for sig (green); and low cal on for both ref and sig (blue). The cal off phase only was processed, and the scan times were 300 seconds.