X-bands Baselines Revisited
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Introduction

As was discussed in reports from June 2 and 5, the GBT X-band (8-10GHz) receiver was recently removed from the telescope in an attempt to locate and correct the cause of extremely ratty baselines (see reports by D. Balser from January 3 and 17, 2003). A majority of the baseline structure had been shown to originate in the front-end and was not associated with the GBT optics. Lab measurements on the receiver from the vacuum window down failed to replicate the baseline structure seen on the GBT. However, close inspection of the feedhorn identified several concerns that were corrected. Today was the first opportunity to observe sources since the receiver was reinstalled on June 17.

The Spectrometer was used in an four-bank, eight sampler, 800MHz mode. Connections were the same as on 6/2/2003. The X-band IF signals were connected through ODM/OR 6 and 8 and then through CM 9 and 13. The measurments described below were taken between 17:00 and 20:00 EDT, and unused outputs of OR6 and 8 were terminated. The weather was warm and clear with essentially no wind.

Tests

We had three goals: Observe the receiver baseline structure on a source with significant continuum level, repeat the test with the feedhorn Goretex radome and support cylinder removed, and observe the effects of water droplets on the radome.

Figure 1 shows the results of an on-off observation of 3C218, and for comparison Figure 2 reproduces a figure from Dana's report on the January 17th observations, on 3C48. Figure 2 results are typical of those which have been seen through May with this receiver. The vertical range of Figures 1 and 2 are the same, as a fraction of the source temperatures. The baselines today, while certainly not flat, are significantly smoother than earlier ones. The reasons this might be are discussed in the next session.

The feedhorn radome and supporting cylinder were then removed, and the observations repeated. At first, there seemed to be measurably higher efficiency without the radome, but upon reinstalling it the efficiency stayed high. It probably was a pointing difference (we were working around sunset, and because of the necessity to go on and off the structure between observations there was quite a delay between the measurements). In the end, we concluded the radome and support had no measurable effect.

After replacing the radome, Rick took a scan at Access on cold sky, and then we sprinkled water on the radome surface. Probably 1/4th to 1/3rd of the radome area was covered with droplets. Subsequent measurements found that the system temperature was approximately doubled with the water present. However, by the time we got off the tipping structure and the antenna tipped to 35 degree elevation to observe 3C218, most if not all the water evidently had disappeared. The performance had returned to normal.

During the course of the testing, some total power instability was noticed in the LCP (red in the figures) channel. Subsequent troubleshooting identified a broken IF cable which probably was the source of the instability. This could have had an effect on the baseline flatness seen on that channel.

Discussion

Possible reasons the baseline performance of this receiver improved deserves some discussion. Between the time the receiver was removed and when it was reinstalled, several bits of work were done:

- One joint in circular waveguide between the feedhorn and the vacuum window was found to have a mistake that resulted in a 0.015 inch gap in the waveguide wall. The joint was re-machined.
- Several (10-12) metal chips were found in the feedhorn corrugations. These were evidently left from the feed fabrication process.
- The cromate surface finish on the aluminum feedhorn is generally non-conductive, and we became 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. (The horn is fabricated in four sections with bolted joints.)
- A second waveguide joint had a noticable oily film between the flanges. An investigation concluded this was cutting oil from the installation of some helicoil threads when the receiver was off in December 2002, and obviously the joint was not properly cleaned.
- The vacuum window was rebuilt. However, the old window failed after the receiver was removed from the antenna, the new window used the same materials and techniques. It seems unlikely that this could have produced the performance difference seen.
- The defrost blower tubes were removed from around the horn. These could be put back just to make sure they have no effect, but it is thought unlikely.

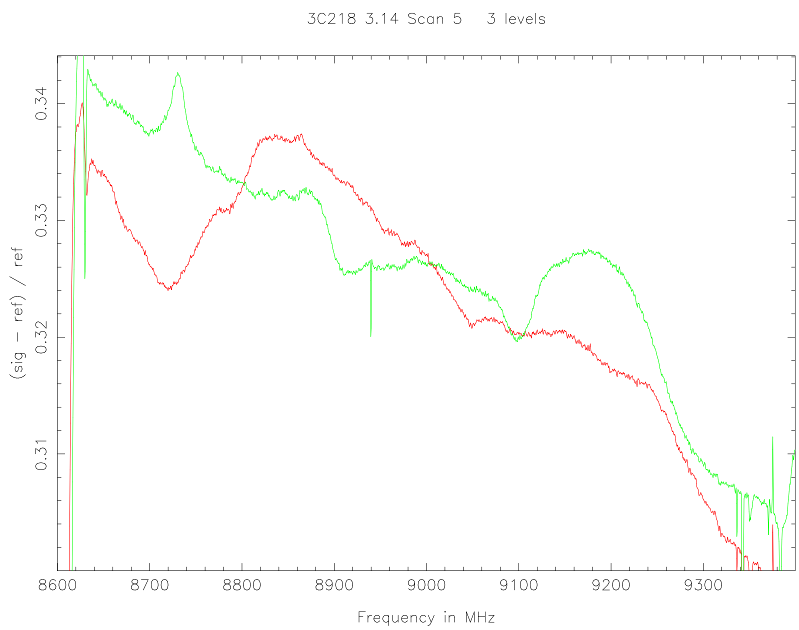

Figure 1: $(sig - ref)/ref$, for the X-band LCP (red) and RCP (green) channels, measured on-off 3C218 on June 25. Compare with Figure 2.

The most likely explanation for the improvement in continuum source baselines is that the clean-up of the waveguide joints eliminated highly irregular losses at these joints (or one could think of it as noise with lots of frequency structure leaking into the receiver). The (On - Off)/Off calibration causes any irregularities (even at the fractional kelvin level is significant) in the system noise to showup in the baseline response. Since it is almost impossible to measure in the lab feedhorn loss with the degree of precision needed to see these effects, there is no substitute for extreme care in fabrication, quality control, cleanliness, and assembly of the receiver input waveguide and feedhorn.

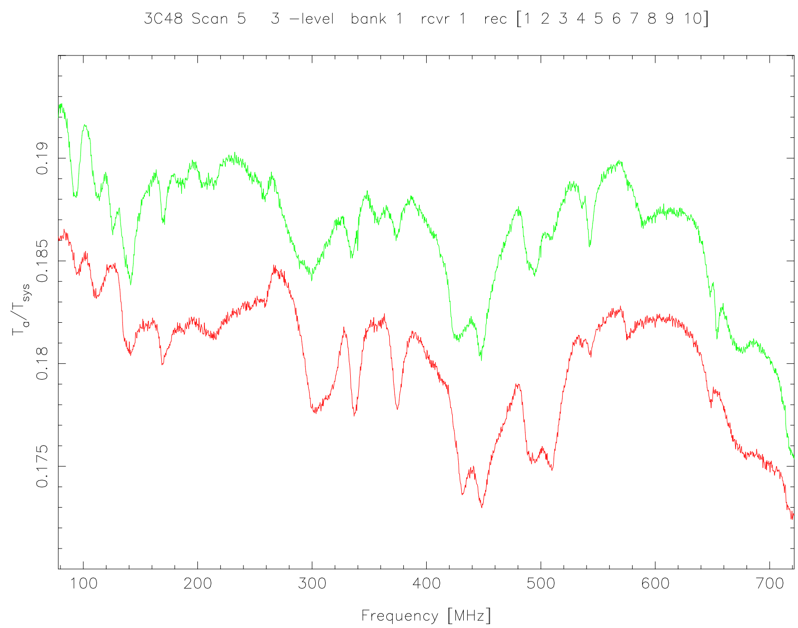

Figure 2: A reproduction of Figure 3 from the report on TBASEDSB030117, January 17, 2003 by Dana Balser. Like Figure 1, the plot is centered at 9GHz.