Baseline Ripple Characteristic Frequencies at Certain Cable Locations

Baseline Project TBASErdn030221

Roger Norrod

February 24, 2003

1 Introduction

It has been shown that baseline ripples can be generated by small length or phase changes in transmission line cables operating between networks with non-zero reflection coefficients. (See the report related to baseline project IFLINgw030203.) The ripple characteristic frequency is given by:

$$f = \frac{v}{2l}$$

where v is the velocity of propagation in the line, and l is the length of the line. It may be useful to know the ripple frequency associated with certain specific GBT RF cables, and this can be done by deliberately inserting small lengths at specific points. The resulting ripple can then be measured using the spectrometer. On February 21, 2003 this procedure was followed for three cases which will be described here.

2 Test Procedure and Discussion

The system input signal sources were the IF outputs of the GBT 12-15 GHz front-end then located in the Equipment Room for testing, although any stable broadband noise source would have served. The IF was connected in the following fashion:

L1 → OR1 → CM1 → SF1 → HSS0
R1 → OR4 → CM5 → SF5 → HSS1

The front-end IF signals were connected into the Optical Receiver RF inputs by coaxial cable, substituting for the normal fiber photodiode outputs. The spectrometer was setup in a one-bank, two-sampler, 800MHz mode. The project ID was TBASErdn030221, and the relevant scans are 27-33.

The procedure followed for each case was to do three 60 second spectrometer scans, the first and third scans with the normal connections, and the middle scan with a short length of transmission line inserted at the point of interest. By then comparing the resulting baselines when the three scans ($normal1$, $Delta$, $normal2$) were combined as $(normal1 - normal2)/normal1$ and $(normal1-Delta)/normal1$, the ripple due to the inserted length is obvious. The inserted cable delta consisted of a SMA "connector saver", approximately $1.31cm$ physical length and $1.90cm$ electrical length.

Figure 1 shows the baselines for scans 27-28, and 27-29. The cable delta was inserted at the input of CM1 during scan 28. The dominant ripple frequency is 63MHz, although the ripple is obviously quite complicated. The cable involved here is driven by a microwave amplifier followed by a 4-way power divider in the Optical Receiver, and is followed by a SPDT PIN switch and a mixer within the Converter Module. The cable itself consists of a segment of 141 coax about 8 inches long within the OR module, a SMA bulkhead feedthrough, a segment of 1673 flexible coax about 20 inches long, a SMA bulkhead feedthrough, and a segment of 141 coax about 25 inches long within the Converter module. Each connection will introduce some signal reflection, but likely the largest reflections will be at the microwave amplifier output and the mixer input ports. This portion of the system was operating at $3GHz$ center frequency.

Figure 2 shows the baselines for scans 29-30, and 29-31. The cable delta was inserted at the ouput of CM1 during scan 30. The predominant ripple frequency is 21MHz. This portion of the system consists mainly of a long segment of 1673 flexible coax connecting the Converter module to the Sampler/Filter module in the Analog Filter rack, and operates at $800 - 1600MHz$ for the spectrometer $800MHz$ mode.

Figure 3 shows the baselines for scans 31-32, and 31-33. The cable delta was inserted at the J1 input connector of the spectrometer during scan 32. The predominant ripple frequency is 23MHz. This portion of the system consists mainly of a long segment of 1673 flexible coax connecting the Sampler/Filter module to the spectrometer input port, and a segment of 141 coax within the spectrometer rack connecting the rack's top plate to the sampler inputs. The operating frequency is also $800 - 1600MHz$.

3 Summary

The characteristic ripple frequencies associated with three specific IF interconnecting cables within the GBT Equipment Room were measured. While only one channel was measured, parallel channels generally should exhibit similar ripple frequencies because of construction similarities. Ripples similar to the measured frequencies have been seen in GBT baseline tests, and correlated with Equipment Room temperature changes. We plan to locate less temperature sensitive coaxial cables and evaluate these in all three paths.

Similar cables connect the Converter modules to Converter/Filter modules and then to the spectrometer low-speed samplers, and the Converter modules to the Spectral Processor. They probably will also be changed to more phase stable cable types, but since they operate at lower frequencies at approximately

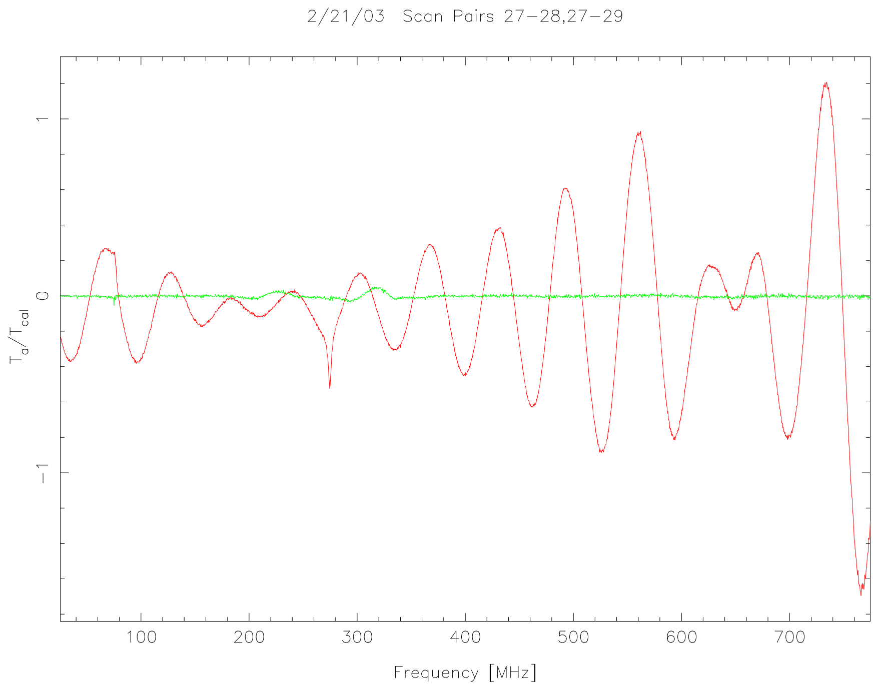

Figure 1: The baselines for scans 27-28 (red) and 27-29 (green). A cable delta was inserted at the input of CM1 during scan 28. The dominant ripple frequency is 63MHz.

the same length, the cables discussed above are thought to be of higher priority.

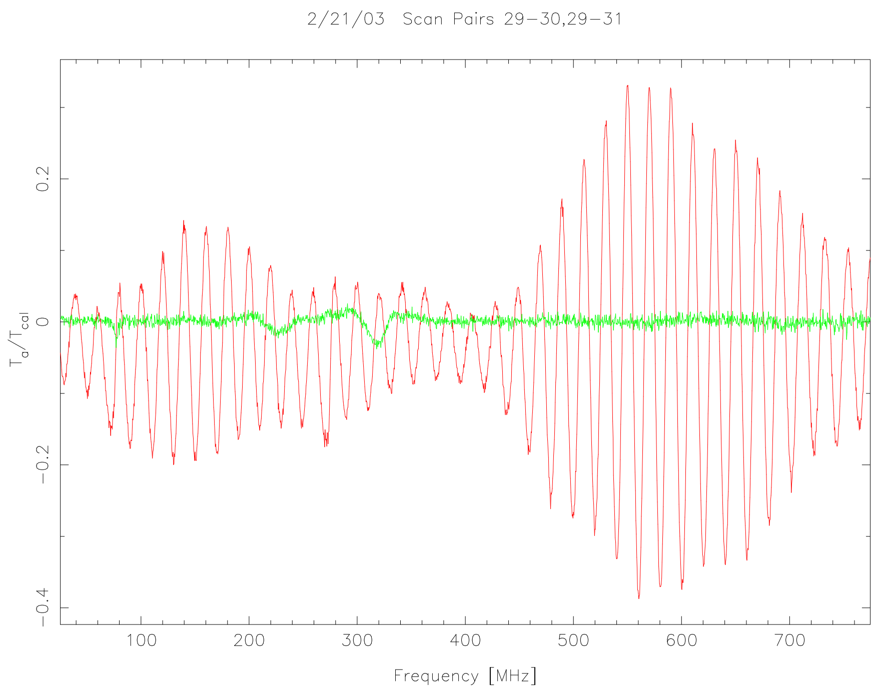

Figure 2: The baselines for scans 29-30 (red) and 29-31 (green). A cable delta was inserted at the output of CM1 during scan 30. The dominant ripple frequency is 21MHz.

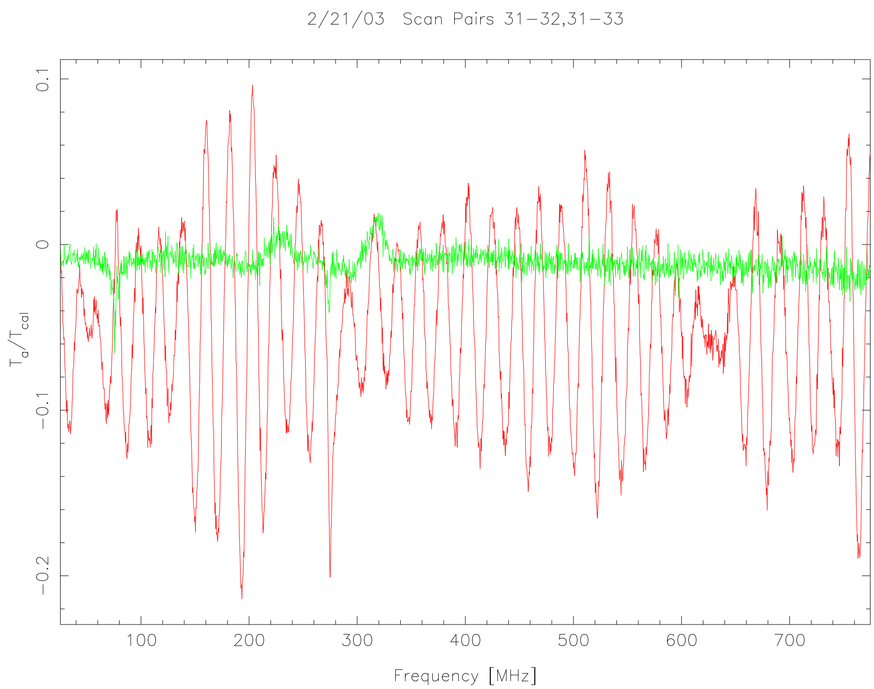

Figure 3: The baselines for scans 31-32 (red) and 31-33 (green). A cable delta was inserted at the spectrometer J1 input port during scan 32. The dominant ripple frequency is 23MHz.