Sample of Baseline Stability of the 18-22 GHz GBT Receiver
Project TBASEJRF021120, November 20, 2002

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Setup

This test run was done between 18:00 and 21:15 EST, Wednesday, November 20 using the R1/L1 feed of the K-band (18.0 - 22.5 GHz) receiver, IF and optical fiber channels 1 and 3, and converter modules 1 and 5. The IF filters were set to a passband of 5360 to 6640 MHz. The sky center frequency was 21,500 MHz, the receiver polarization was circular, and the spectrometer bandwidth was 800 MHz with 2048 spectral channels using samplers 0 and 1. The switching configuration was set to cal off/on, 2 phases. Integration times of 30 seconds were used for all measurements. The weather mostly clear with high scattered clouds, 30 degrees F at 20:00 EST with increasing cloudiness later in the evening.

IF Noise Source Test

The second scan, 3, used the broadband IF noise source as the signal input in place of the receiver to check the IF stability. The scan was 30 minutes long. Figure 1 shows IF channel 1's (recordN - record1) / record1 spectra for records 2, 10, 20, 30, 40, 50, and 60 in the scan. Figure 2 shows the same sequence for IF channel 2. After a few minutes channel 1 shows evidence of a baseline ripple with a period of about 70 MHz, and after 20 minutes it is quite prominent. Channel 2 develops baseline curvature after about 5 minutes which grows with time, and the spectrum becomes fairly rough after 20 minutes. A plot of the average total powers across the central 90% of each spectrum as a function of record number are shown in Figure 3. The two channels track fairly closely and show a total change of about 0.5% in 30 minutes.

Sky Drift Scan

The first scan, 2, was taken with the receiver connected and the telescope stationary at high elevation. Figures 4 and 5 show the spectra of (recordN - record1) / record1 for records 2, 10, 20, 30, 40, 50, and 60 corresponding to time intervals of 30 through 1800 seconds. In channel 1 the total power variation in 30 minutes is about 5 times that seen on the IF noise source, but the same development of a 70-MHz period ripple after about 10 minutes is seen. Channel 2 also shows about 5 times the total power variation as seen on the IF noise source, and a roughly 200-MHz period ripple develops after about 5 minutes. Figure 6 shows the total power integrated in frequency for the 30-second spectra as a function of record number. The toal power variations are well correlated between the two channel, possibly because of changes in sky noise. The total variation over 30 minutes is about 2% in both channels.

On-Off Measurement of IF Noise Source

The next test was to take a 5-minute on-off pair with the telescope but with the IF noise souce in place of the front-end. The results are shown in Figure 7. Channel 1 shows the same 70-MHz ripple period as seen in Figures 1 and 4. Channel 2 shows some large scale baseline waviness and a hint of 70-MHz period ripple at the low frequency end.

On-Off Measurement of Cold Sky

The next test was to take a 5-minute on-off pair on cold sky. The results are shown in Figure 8. Channel 1 again shows a roughly 70-MHz ripple period with about the same amplitude as seen on the IF noise source. Channel 2, however, dropped about 2% in total power between the on and the off scans, and a strong 30- to 35-MHz ripple can be seen in the difference spectrum in Figure 8. The 2% level drop occurred between scans because the total powers are steady with each scan.

On-Off Measurement of Continuum Source NGC 7027

The final test of the evening was to take a 5-minute on-off pair on the continuum source NGC 7027, which has a flux density of about 5.5 Jy at 21.5 GHz. The results are shown in Figure 9. The spectra in both channels have a fair bit of structure, including a couple of narrow spikes around 21.6 GHz and a broad dip around 21.83 GHz. Channel 2 also shows some of the 30- to 35-MHz period ripple seen in the cold sky measurement of Figure 8. Further measurements with several first-LO settings are needed to begin to separate the sources of continuum spectral baseline features before and after the first mixer.

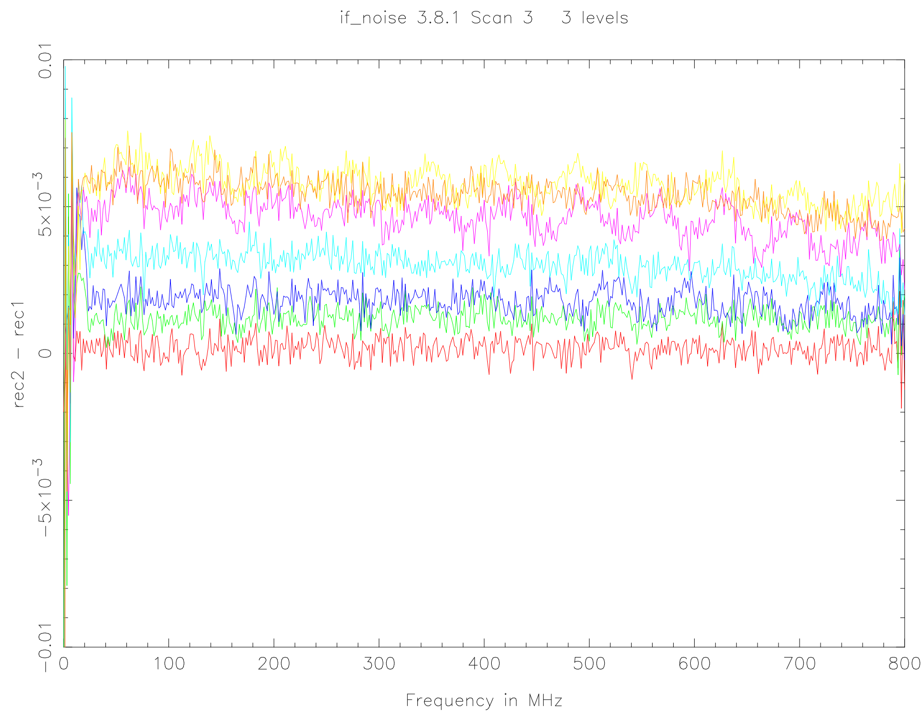

Figure 1: Scan 3, IF channel 1. IF Noise source 30-second spectra of (recordN - record1) / record1 for records 2, 10, 20, 30, 40, 50, and 60 in the scan using colors red, green, dark blue, blue-green, violet, yellow, and orange, respectively. The vertical scale is fraction of total power. These spectra have been smoothed by truncating the autocorrelation function to the first 512 lag values.

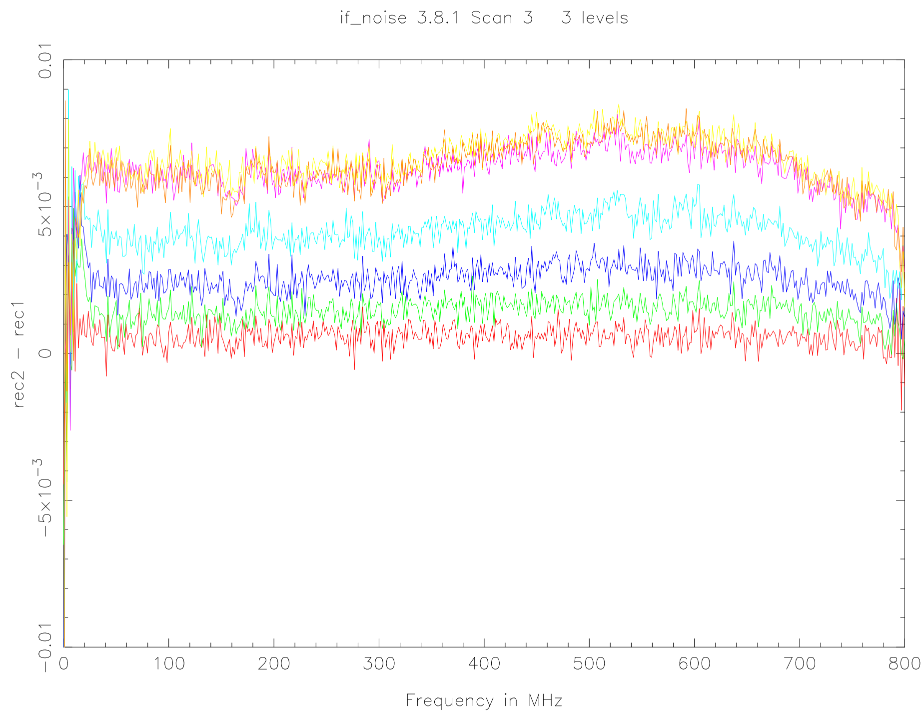

Figure 2: Scan 3, IF channel 2. IF Noise source 30-second spectra of (recordN - record1) / record1 for records 2, 10, 20, 30, 40, 50, and 60 in the scan using colors red, green, dark blue, blue-green, violet, yellow, and orange, respectively. The vertical scale is fraction of total power. These spectra have been smoothed by truncating the autocorrelation function to the first 512 lag values.

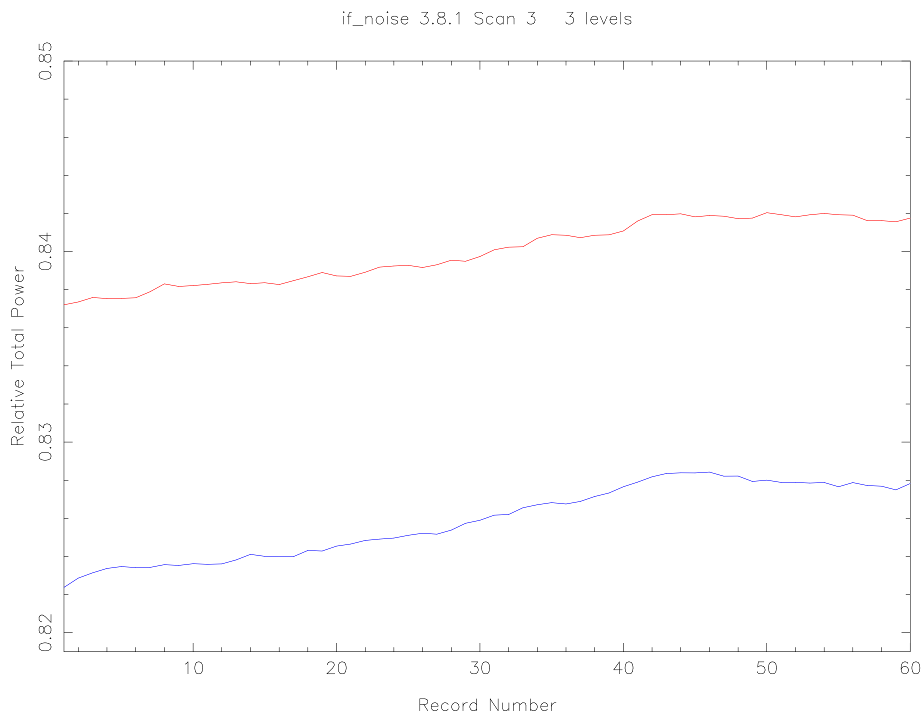

Figure 3: Scan 3, IF Noise source total power as a function of record number. Each record is 30 seconds long. IF channel 1 is the red line, and IF channel 2 is the blue line. The sampler input level for channel 2 was not very close to optimum so the total power values for this channel were multiplied by 1.275 to show the two channels on the same expanded scale.

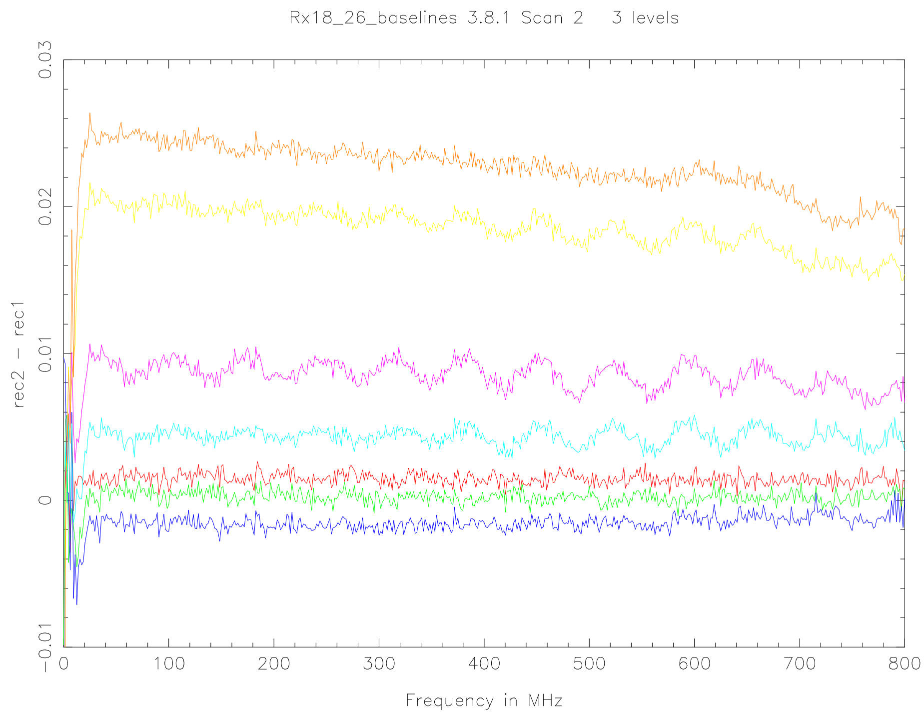

Figure 4: Scan 2, IF channel 1. Sky drift scan 30-second spectra of (recordN - record1) / record1 for records 2, 10, 20, 30, 40, 50 and 60 in the scan using colors red, green, dark blue, blue-green, violet, yellow, and orange, respectively. The vertical scale is fraction of total power. These spectra have been smoothed by truncating the autocorrelation function to the first 512 lag values.

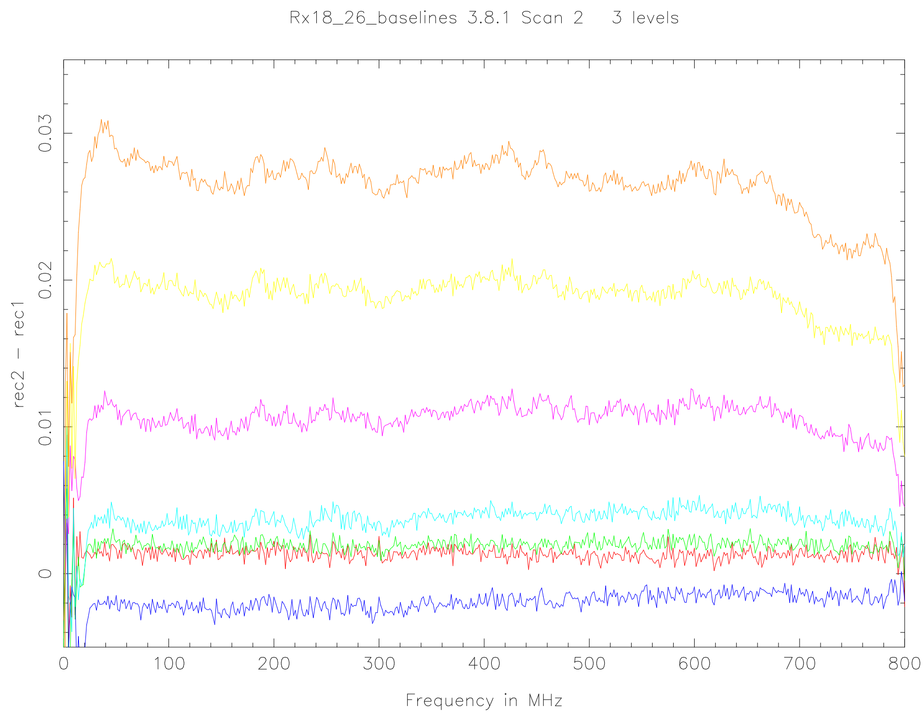

Figure 5: Scan 2, IF channel 2. Sky drift scan 30-second spectra of (recordN - record1) / record1 for records 2, 10, 20, 30, 40, 50 and 60 in the scan using colors red, green, dark blue, blue-green, violet, yellow, and orange, respectively. The vertical scale is fraction of total power. These spectra have been smoothed by truncating the autocorrelation function to the first 512 lag values.

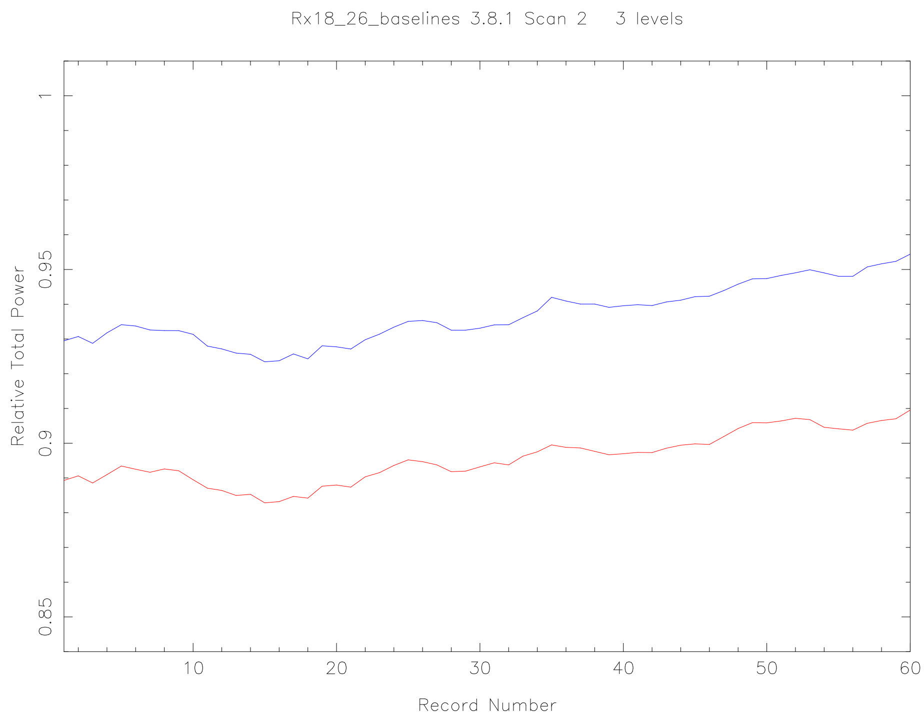

Figure 6: Scan 2, Sky drift scan total power as a function of record number. Each record is 30 seconds long. IF/receiver channel 1 is the red line, and IF/receiver channel 2 is the blue line. The sampler input level for channel 2 was not very close to optimum so the total power values for this channel were multiplied by 1.6 to show the two channels on the same expanded scale.

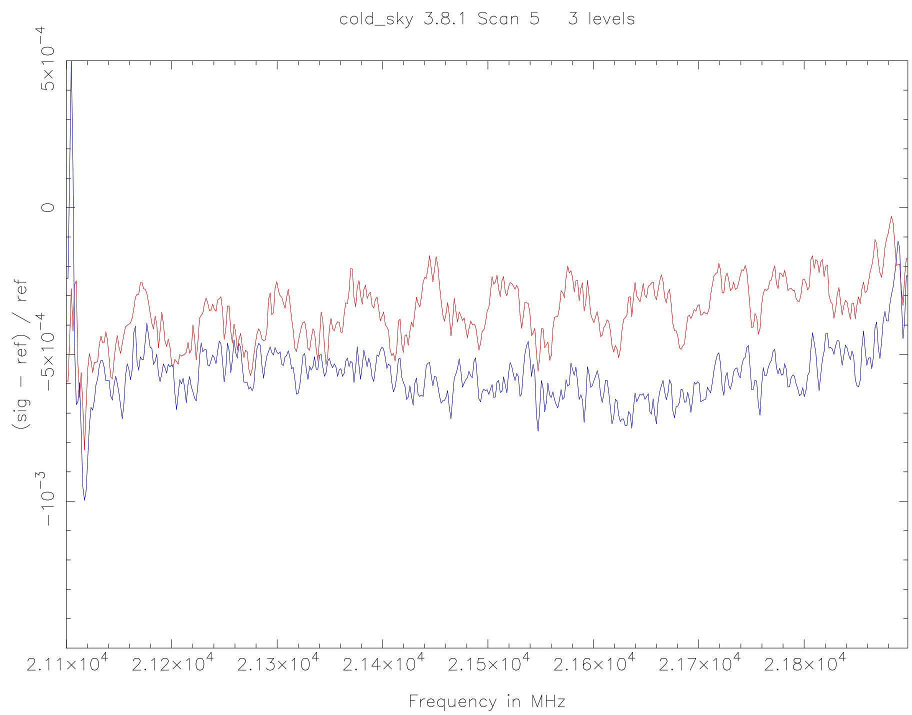

Figure 7: Scans 4 and 5. Each spectrum is 5 minutes "on", 5 minutes "off" with the system connected to the IF noise source. The red spectrum is (on - off) / off for IF/receiver channel 1, and the blue spectrum is the same scan pair for IF/receiver channel 2. The spectra have been smoothed by truncating the autocorrelation function to the first 512 lag values and then Hanning convolved.

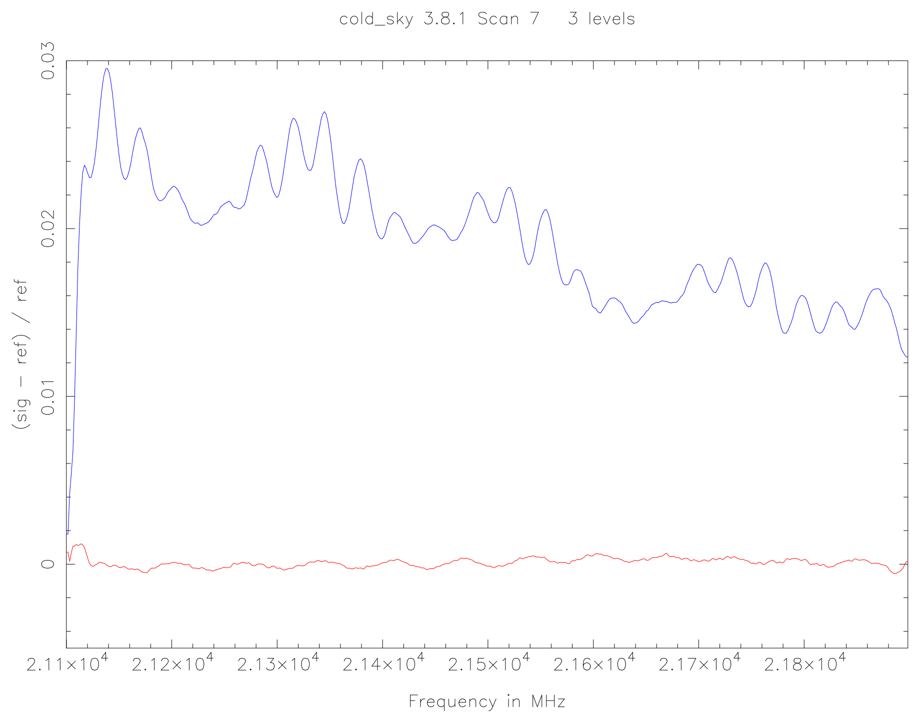

Figure 8: Scans 6 and 7. Each spectrum is 5 minutes on, 5 minutes off for two areas of blank sky. The red spectrum is (on - off) / off for IF/receiver channel 1, and the blue spectrum is the same scan pair for IF/receiver channel 2. The spectra have been smoothed by truncating the autocorrelation function to the first 512 lag values and then Hanning convolved.

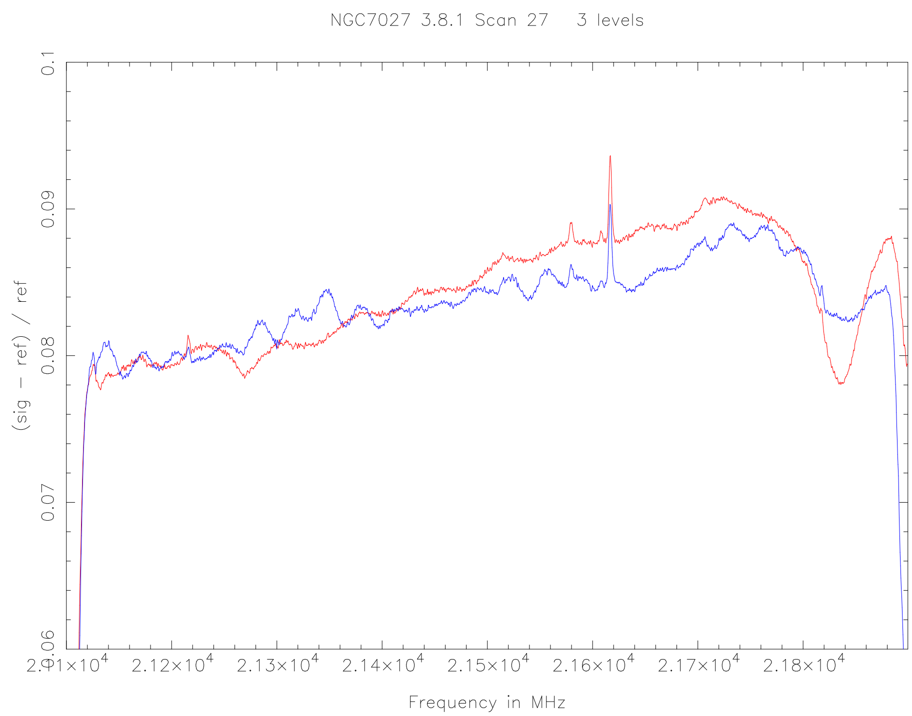

Figure 9: Scans 26 and 27. Each spectrum is 5 minutes on, 5 minutes off of the continuum source NGC 7027. The red spectrum is (on - off) / off for IF/receiver channel 1, and the blue spectrum is the same scan pair for IF/receiver channel 2. The spectra have been Hanning convolved.