Initial Tests with Noise Source II
Project TBASErdn021210, December 10, 2002

Roger Norrod

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Initial test with DCR

First try of new test noise source, which incorporates a TTL controlled noise cal with adjustable level. Injecting it into the AF Rack SF modules 1-4. Set bandwidth to 200MHz. Initial test with DCR.

$\tau = 1sec$; T=120sec; TPwCal; recording A9-A12. Scans 1-20 (adjusted cal attenuator during scan 3). Data (Figure 1) shows ripple due to Equipment Room temperature cycling. (See TBASErdn021209).

Spectrometer Mode 1W1-00-200

Began using spectrometer at scan 21. $\tau = 20sec$, T=120sec, 2 phases, 1sec switching time, blanking time 0.010sec, =¿ 6 integrations (records) per scan.

Mode 1W1-00-200: One sampler, HSS0 from SF1, Bank A, Quadrant 1, 16384 lags, 200MHz. Scan 21 st @ 15:35:55 Scan 30 fi @ 15:57:05

Figure 2 plots the mean spectral power (10-190MHz) for each record, normalized to the "mean of the means". Figure 3 shows the spectrum in units of dB with respect to the mean power, for scan 21 CalOn phase. Figure 4 shows the unnormalized CalOff and CalOn spectra (linear scale).

Figure 5 shows T_a/T_{sys}, or $(Sig - Ref)/Ref$, taking scan 21 as Ref and scans 22-30 in sequence (starting at the bottom trace) as Sig. The plots are offset by 0.01 units for clarity. A mean is NOT subtracted from the traces. The standard deviation of the nine traces is $14.87 \pm 0.1 \times 10^{-4}$. For the bandwidth and integration time, the radiometer equation predicts

$$\frac{\sigma}{T_{sys}} = \frac{1.235}{\sqrt{1.21 * (T/2) * (BW/Nlags)}} = 13 \times 10^{-4}$$

The tenth (topmost) trace in Figure 5 is the average of the nine lower traces. The noise did not integrate down, but I realized later that is to be expected since the common reference spectrum produces correlated noise in the difference spectra. (See discussion related to Figure 12 below.)

Spectrometer Mode 1W2-001-200

Reconfigured spectrometer to Mode 1W2-001-200: Two samplers, HSS0 from SF1 and HSS1 from SF5, Bank A, Quadrant 1, 8192 lags. Same integration and scan times.

Scan 31 st @ 16:04:02 Scan 40 fi @ 16:25:15

Figure 6 shows the mean spectrum power for each integration. The red trace is from HSS0 and the green trace is from HSS1. Figure 7 shows the normalized spectra in dB. Note the mode label in the title is incorrect. Figure 8 shows the T_a/T_{sys} traces. The radiometer equation predicts $Sigma/T_{sys}$ of 9.3×10^{-4}, while the nine difference spectra have standard deviation of $10.6 \pm 0.1 \times 10^{-4}$.

Spectrometer Mode 1W2-023-200

Reconfigured spectrometer to Mode 1W2-023-200: Two samplers, HSS2 from SF2 and HSS3 from SF6, Bank A, Quadrant 1, 8192 lags. Same integration and scan times.

Scan 41 st @ 16:26:53 Scan 50 st @ 16:48:05

Figure 9 shows the mean spectrum power for each integration. The red trace is from HSS2 and the green trace is from HSS3. Figure 10 shows the normalized spectra in dB. Figure 11 shows the T_a/T_{sys} traces. The radiometer equation again predicts $\sigma/Tsys = 9.3 \times 10^{-4}$, while the nine difference spectra have standard deviation of $10.5 \pm 0.1 \times 10^{-4}$. Figure 12 is T_a/T_{sys} but taking alternate scans as reference and signal spectra. The upper trace is the average of the other five, and its standard deviation is 4.7×10^{-4}, exactly $1/\sqrt{5}$ the noise in the components.

Conclusions

The three modes checked today worked without a hitch. The difference spectra show excellent flatness. The noise is about 13% higher than theoretical, perhaps due to gain fluctuations in the SF modules or in the samplers.

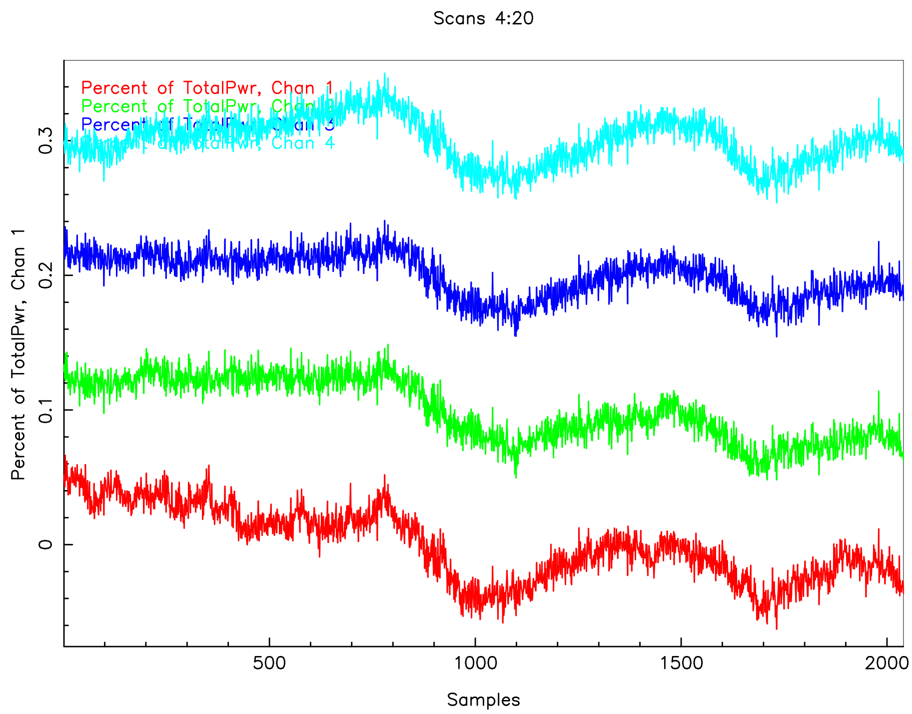

Figure 1: SF1-4 total power measured by the DCR. Each sample is a one second integration.

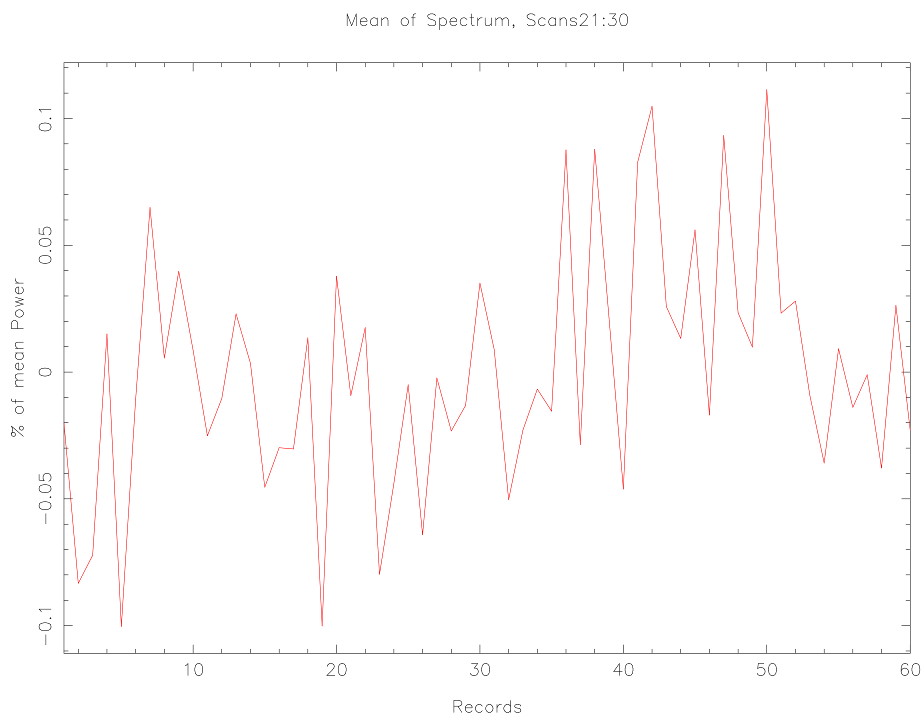

Figure 2: Spectrometer mode 1W1-00-200 total power from SF1 and HSS0.

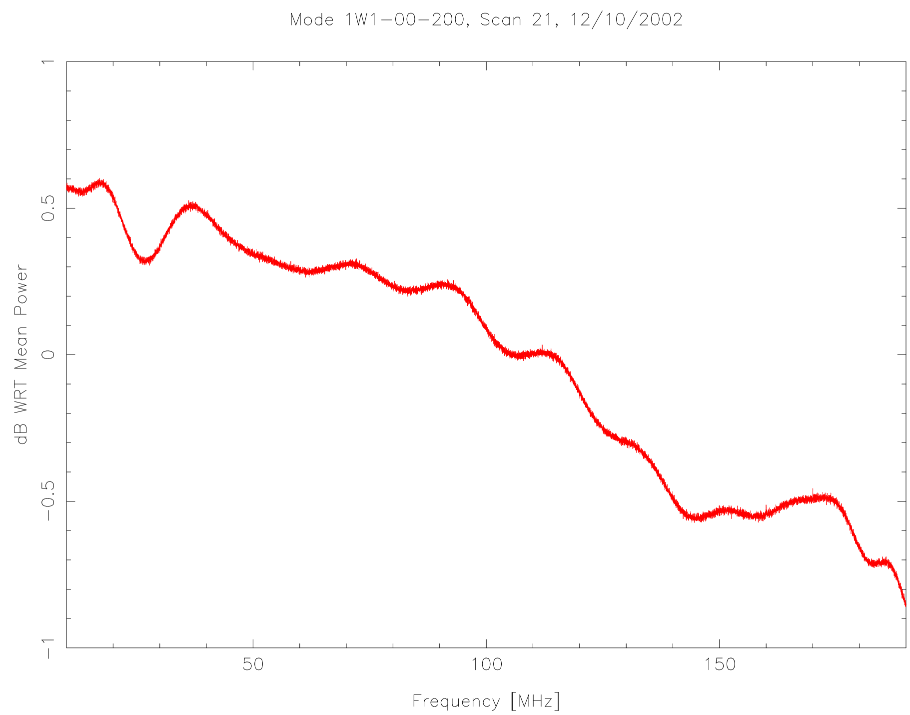

Figure 3: Spectrometer mode 1W1-00-200 spectrum for scan 21 CalOn phase in units of dB with respect to the mean power.

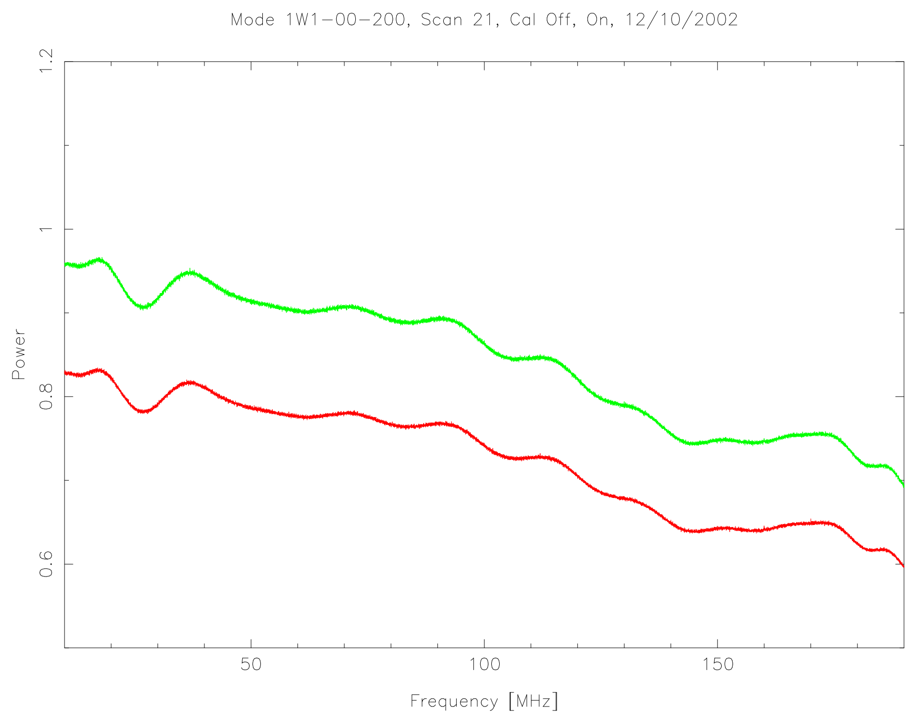

Figure 4: Spectrometer mode 1W1-00-200 unnormalized CalOn and CalOff spectra.

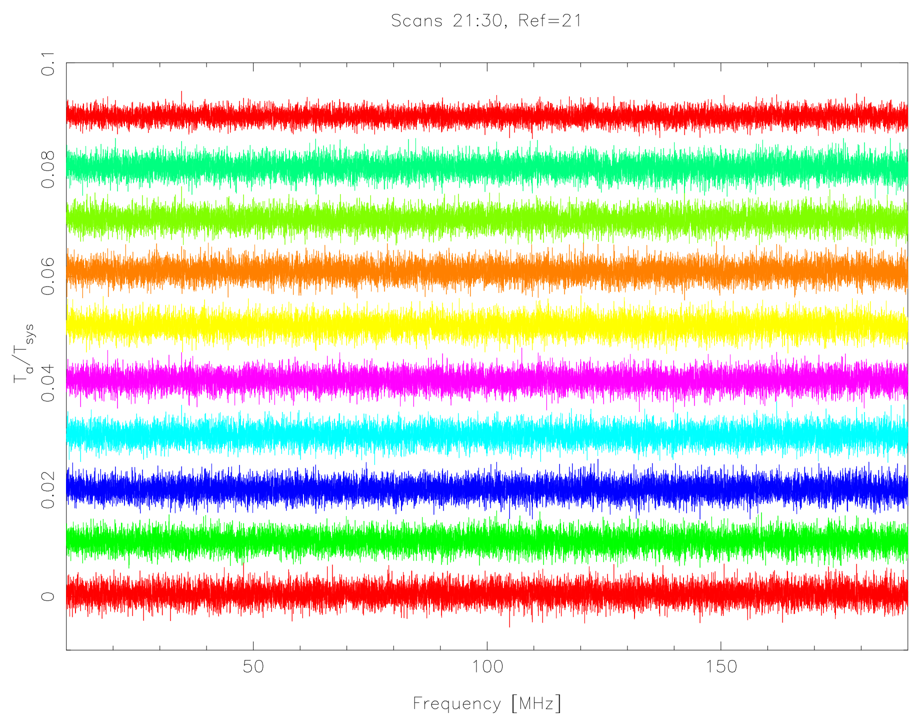

Figure 5: Spectrometer mode 1W1-00-200 T_a/T_{sys} taking scan 21 as ref and scans 22-30 as ref in sequence.

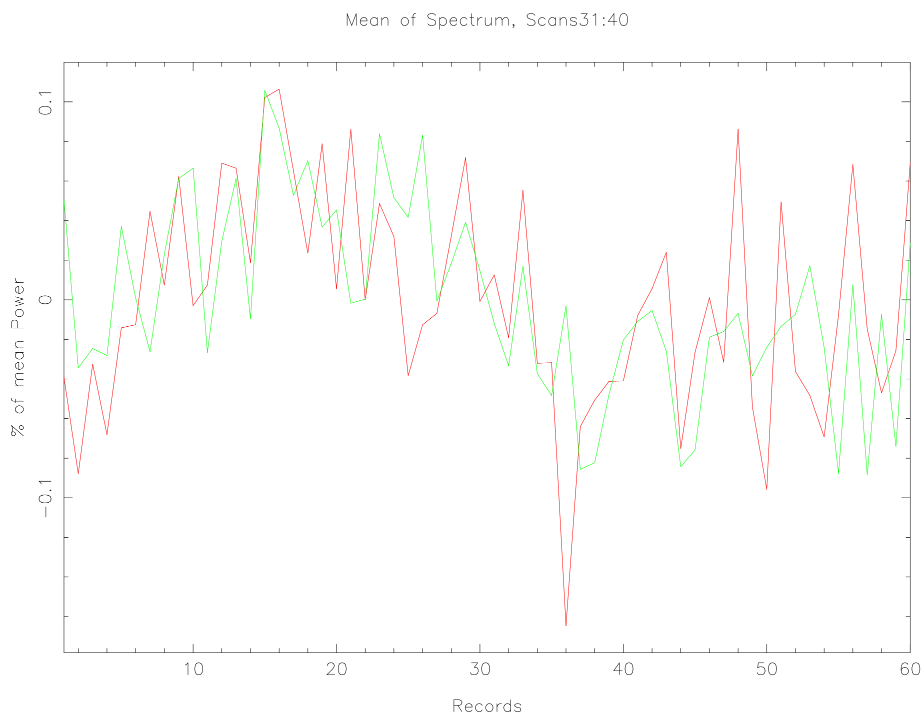

Figure 6: Spectrometer mode 1W2-001-200 mean spectral power for HSS0 (red) and HSS1 (green).

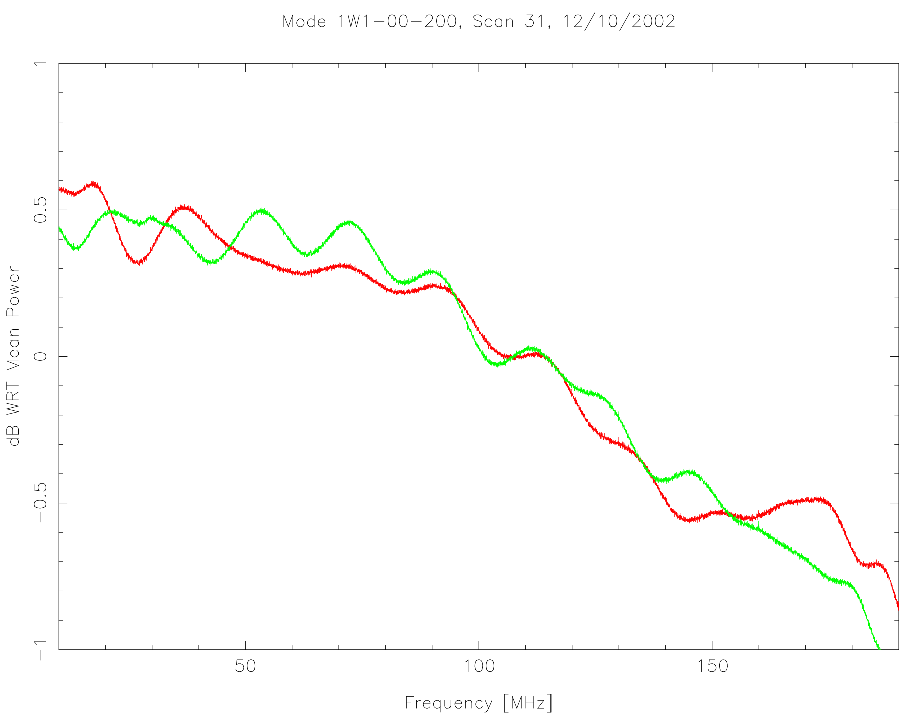

Figure 7: Spectrometer mode 1W2-001-200 normalized spectra.

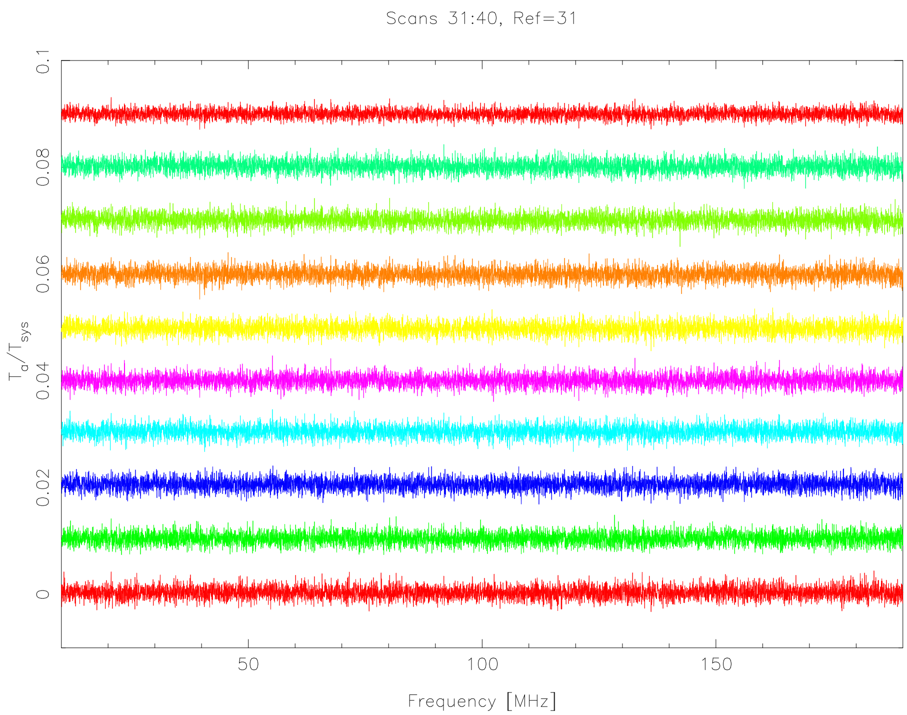

Figure 8: Spectrometer mode 1W2-001-200 T_a/T_{sys}.

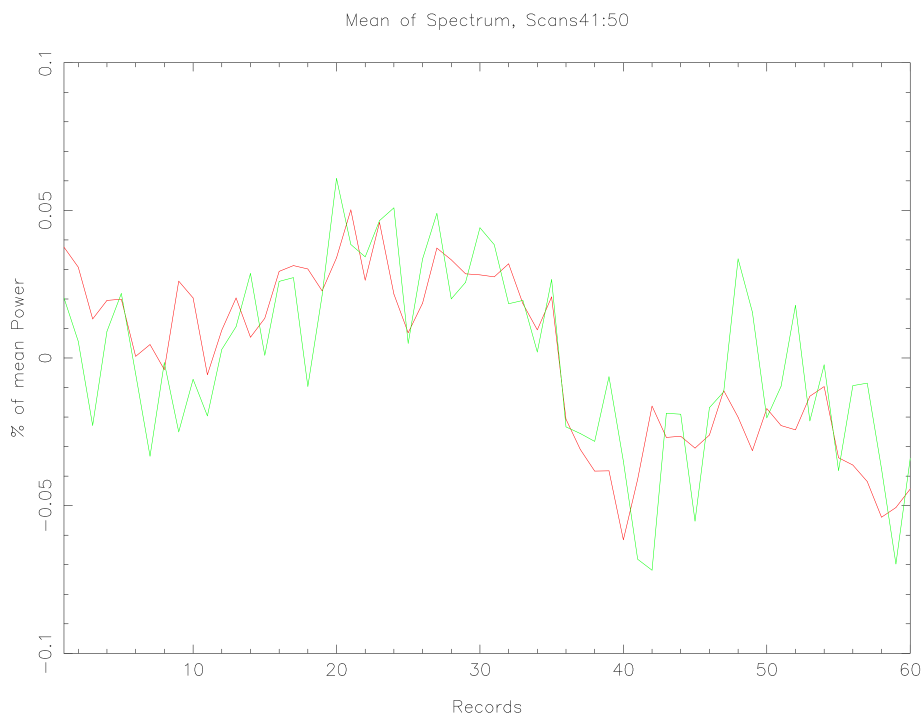

Figure 9: Spectrometer mode 1W2-023-200 mean spectral power.

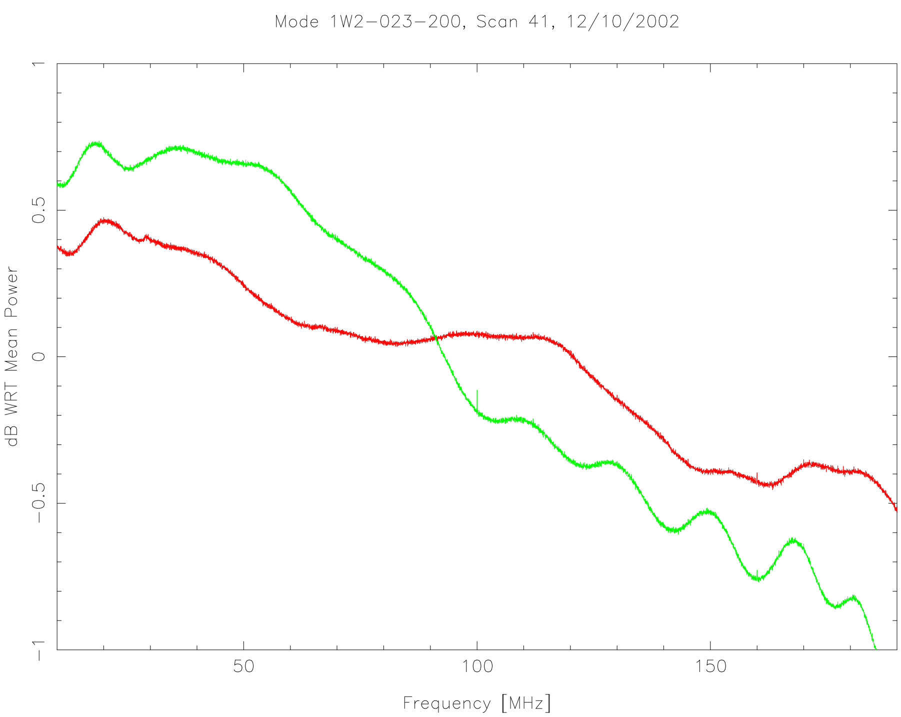

Figure 10: Spectrometer mode 1W2-023-200 normalized spectra.

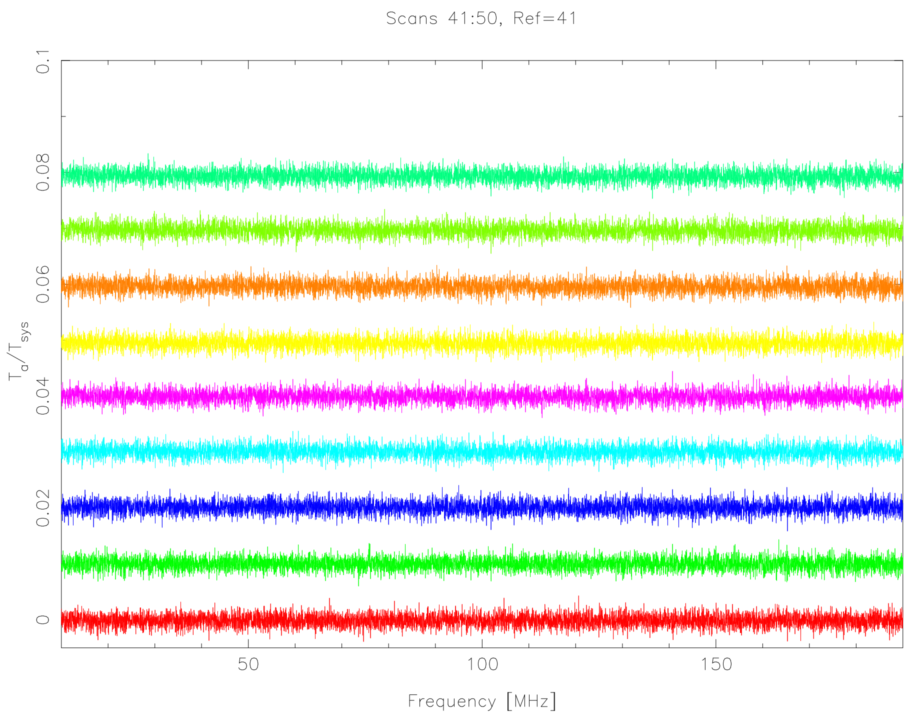

Figure 11: Spectrometer mode 1W2-023-200 T_a/T_{sys}.

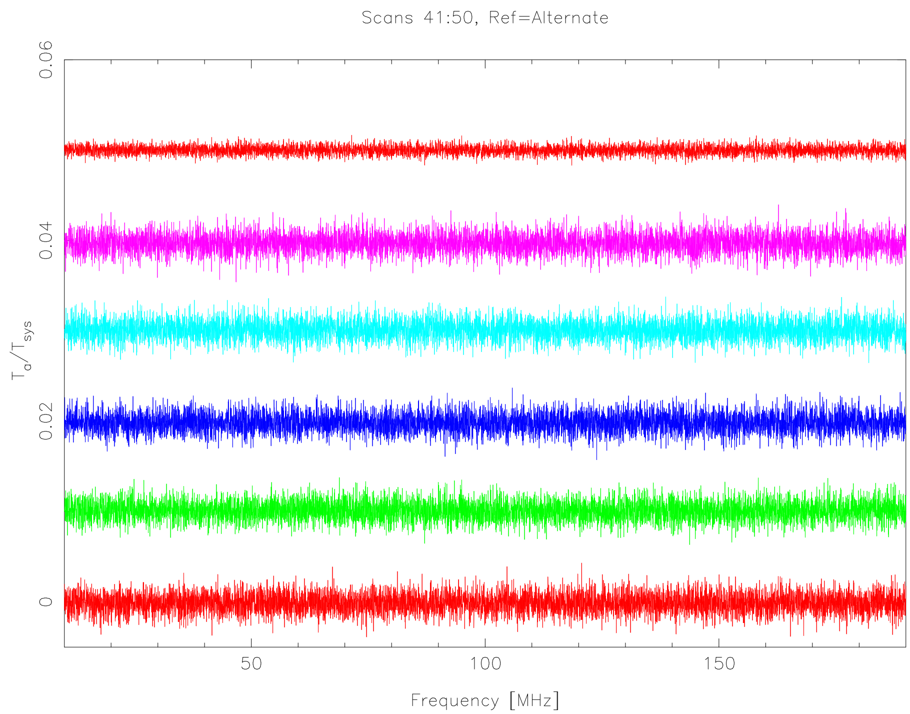

Figure 12: Spectrometer mode 1W2-023-200 T_a/T_{sys}, taking alternate scans as reference and signal spectra. The upper trace is the average of the lower five.