K-band Cold Sky Focus Offsets
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Introduction

This report desribes baseline test observations on the K-band receiver using the IF noise sorce, cold sky drift scans, and one on-off measurement of 3C123

Setup

The K-band circularly polarized receiver has four feeds, channels L1, R1 and L2, R2 for the 18-22.5 GHz band and channels L3, R3 and L4, R4 for the 22-26 GHz band. The low-band spectra were taken at a center sky frequency of 20,000 MHz and at 23,000 MHz at high-band. These were connected to fibers 1, 3, 5, and 8, respectively. The IF rack filters were set to the 5360 to 6640 MHz passband. The analog filter rack outputs were set to 800 to 1600 MHz passband. The spectrometer was set up for 800 bandwidth, 3-level, 4 samplers, 2 banks, 2048 channels per IF, configuration (1W2-1XY-800). The signal path connections are shown in Table 1. Beam switching between L1/L3 and L2/L4 and R1/R3 and R2/R4 was in effect for most of the observations. Table 2 shows the FITS file spectrum phase assignments. An integration time of 30 seconds was used for all measurements. All spectra were Hanning convolved.

The Measurements

Figure 1 shows thee total power spectra of the four IF channels using the IF noise source. Spectra A1 and A2 show particularly noticeable ripple with a period of about 17 MHz. Figures 2 and 3 show FFT's of the total power spectrum of

Table 1: IF Rack to Spectrometer Connection Matrix

Rcvr(Sig)	OR	CM	SG	Sampler	Bank/Spectrum
L1/L3	1	1	1	1	A1
R1/R3	3	5	5	2	A2
L2/L4	5	10	2	3	B1
R2/R4	8	14	6	4	B2

Table 2: FITS file spectrum phase assignments

Phase	Sig/Ref	Cal
1	Ref	On
2	Sig	On
3	Ref	Off
4	Sig	Off

channel A2 with different scale expansions. Figure 2 shows two ripple features at 2.4 meters equivalent one-way reflection distance corresponding to a ripple period of 61 MHz and at 8.6 meters or 17.5 MHz period. IN Figure 3 we can see features at 62.9 meters (2.38 MHz period), 65.4 meters (2.29 MHz), and 125.8 meters (1.19 MHz). The first and third are from the optical modulator, and the same pair of features can be seen in the FFT's of the total power spectra of the other IF channels. The second feature is probably also be from the optical modulator since it was seen in other ACF's of the IF system (e.g., TBASEDSB021211). If this weren't a spectrum of the IF noise source one would be tempted to ascribe the 65.4-meter feature to the subreflector/main reflector reflection path of 65 meters. Hence, a note of caution in interpreting spectrum FFT's.

Figures 4 through 7 show the change in spectrum shapes over the 10-minute period of the IF noise source test scan. All four spectra chnge by 1 to 1.5% of the total power in ten minutes, and the shapes of the later spectrum differences are quite similar, which might indicate that the IF noise source was changing during the scan. There are differences in the spectra of the different IF channels so there was probably some individual IF spectrum shape drifts.

Figures 8, 9, and 10 are the cold sky equialents of Figure 1, 2, and 3 taken with the IF noise source. In the FFT plots the IF noise source traces are oer plotted in blue for comparison. Most of the FFT features are similar in the cold sky and IF noise source, albeit somewhat different in amplitude in the short-period ripples, so they are probably produced by the IF system rather than the IF noise source or the receiver. Figure 11 is an expansion of the region around the 2.4 MHz ripple period spikes.

Figures 12 through 15 show the spectrum changes during the first ten minutes of the cold sky drift scan for the four receiver channels of the low-K-band front-end. The amplutude of the total power drifts are considerably less than the drifts in the equivalent spectra taken with the IF noise source, which tends to confirm the suspicion the the IF noise source output was drifting during scan 1. Figures 16 through 19 show the spectrum changes during 50 minutes of the cold sky drift scan.

Figures 20 through 23 show the spectrum changes during the first ten minutes of the cold sky drift scan for the four receiver channels of the high-K-band front-end (receivers L3/R3 and L4/R4). Figure 22 shows quite a bit of 30 to 60 MHz scale roughness in the spectra of channel L3/OR5/CM10/SG2/Samp3/B1. Figures 24 through 27 show the spectrum changes during 50 minutes of this cold

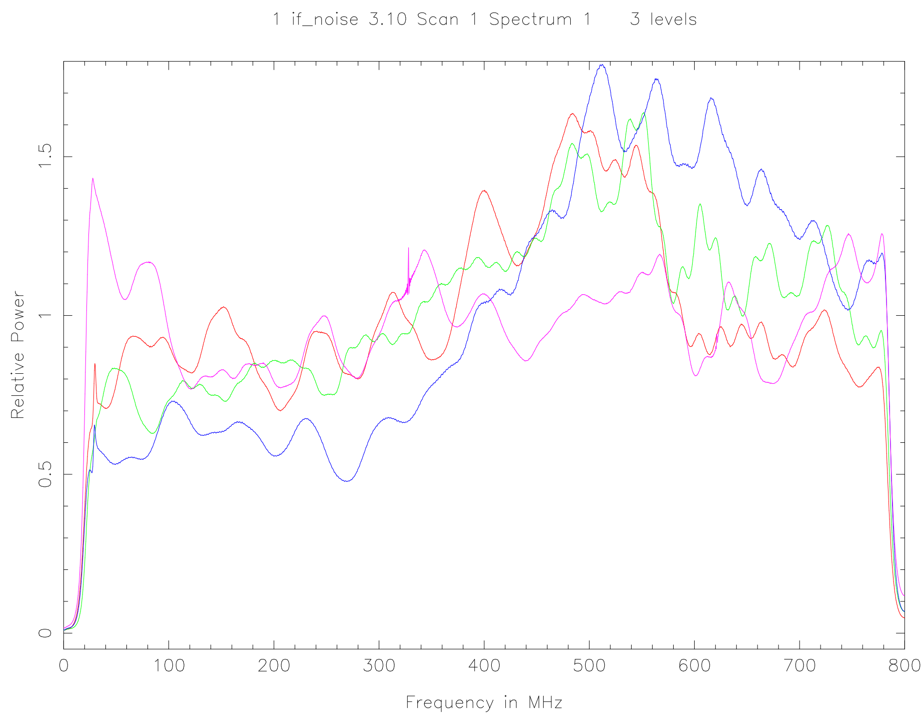

Figure 1: Scan 1, total power spectra of the IF noise source for record 1, phase 1, OR1/CM1/SG1/Samp1/A1 (red), OR3/CM5/SG5/Samp2/A2 (green), OR5/CM10/SG2/Samp3/B1 (blue), and OR8/CM14/SG6/Samp4/B2 (violet).

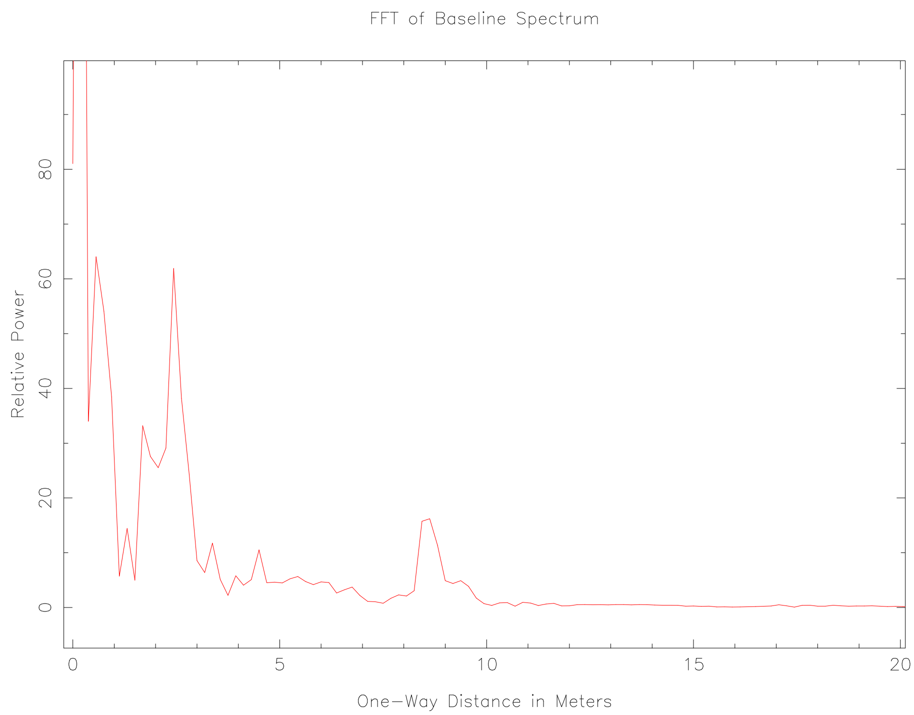

Figure 2: Scan 1, FFT of the total power spectrum for channel A2 (OR3/CM5/SG5/Samp2) shown as the green curve in Figure 1. The ripple period of a feature in this plot is 150 MHz divided by the one-way distance given on the horizontal axis. The peak at 2.4 meters corresponds to a ripple period of 61 MHz, and 8.6 meters corresponds to 17.5 MHz.

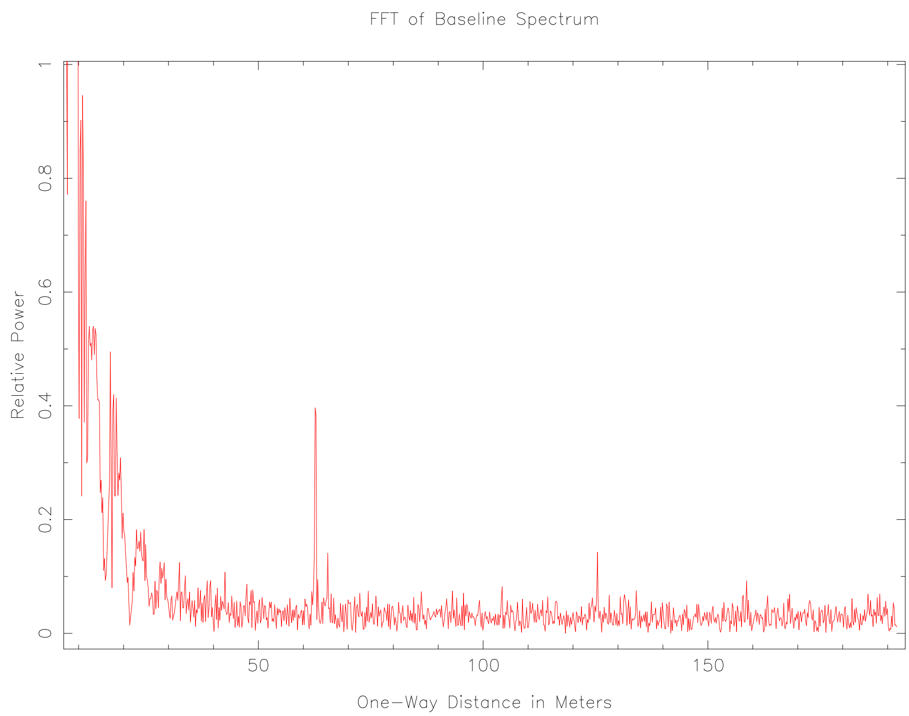

Figure 3: Scan 1, same FFT shown in Figure 2 but expanded in the vertical direction and showing a larger range of distances. The peak at 62.9 meters (2.38 MHz period) and its harmonic are probably due to the optical modulator. The smaller peak at 65.4 meters (2.29 MHz) could also be due to the optical modulator. The same pair of features can be seen in the FFT's of the total power spectra of the other IF channels.

sky drift scan. Between 13 and 30 minutes into the scan the total power gradually increased by about 8% in all four channels, possibly due to a change in atmospheric noise.

Figures 28 and 29 show the (on - off) / off spectra for the continuum source 3C123. The amplitudes of these spectra seem to be about a factor of three low, which may be due to a pointing error since time was running out in the allotted telescope time. The spectral structure with scale lengths between about 30 and 70 MHz may have been mostly due to electronics drifts since some of this structure can be seen in the record differences within one scan. The 'on' and 'off' scan were 8 minutes apart, instead of the usual 5-1/2, because of a problem with the observing script.

Figures 30 and 31 show the ratio of Tcal/Tsys as a function of frequency for the 'off' scan of the 3C123 scan pair. There are two spectra for each receiver in these figures, one in the 'sig' phase of the beam switch and one in the 'ref' phase. The sig and ref phases use different uncooled RF amplifiers, IF channels, and spectrometer samplers. The two spectra in each case are similar but certainly not exactly the same. One would doubt that the differences are due to electronics drift since the cal switching was relatively fast. The differences warrant investigation.

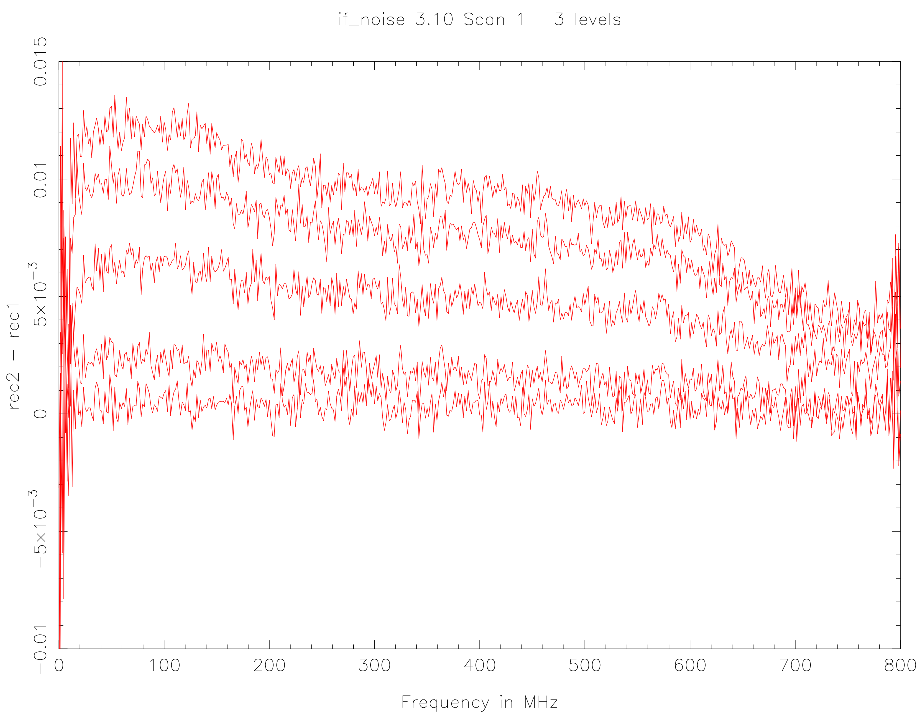

Figure 4: Scan 1, (recordN - record1) / record1 for channel A1 (OR1/CM1/SG1/Samp1). The bottom trace is for recordN = record2, and the next higher spectra are for records 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

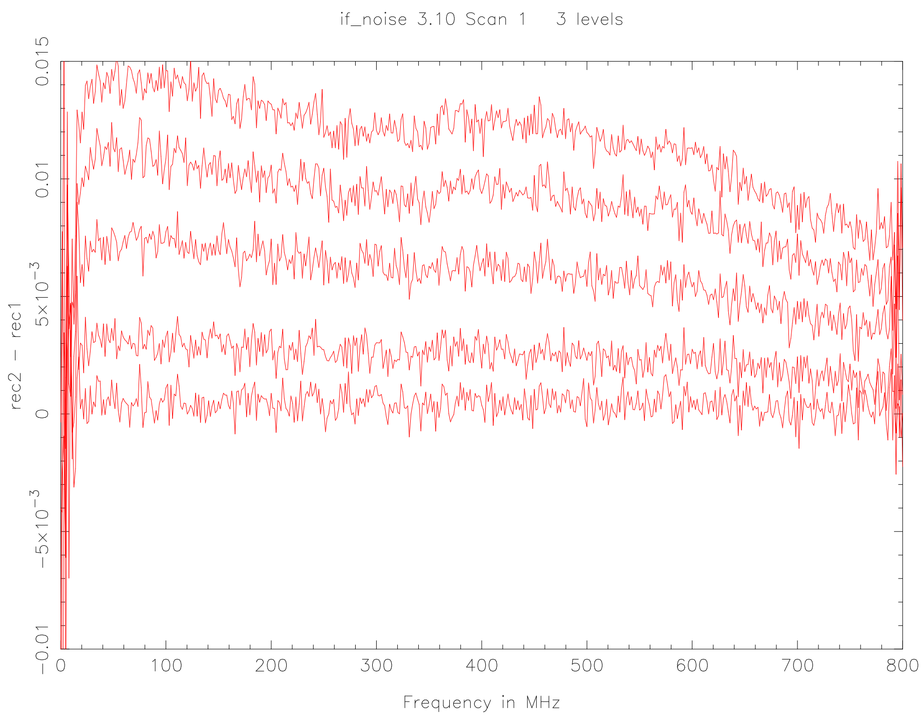

Figure 5: Scan 1, (recordN - record1) / record1 for channel A2 (OR3/CM5/SG5/Samp2). The bottom trace is for recordN = record2, and the next higher spectra are for records 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

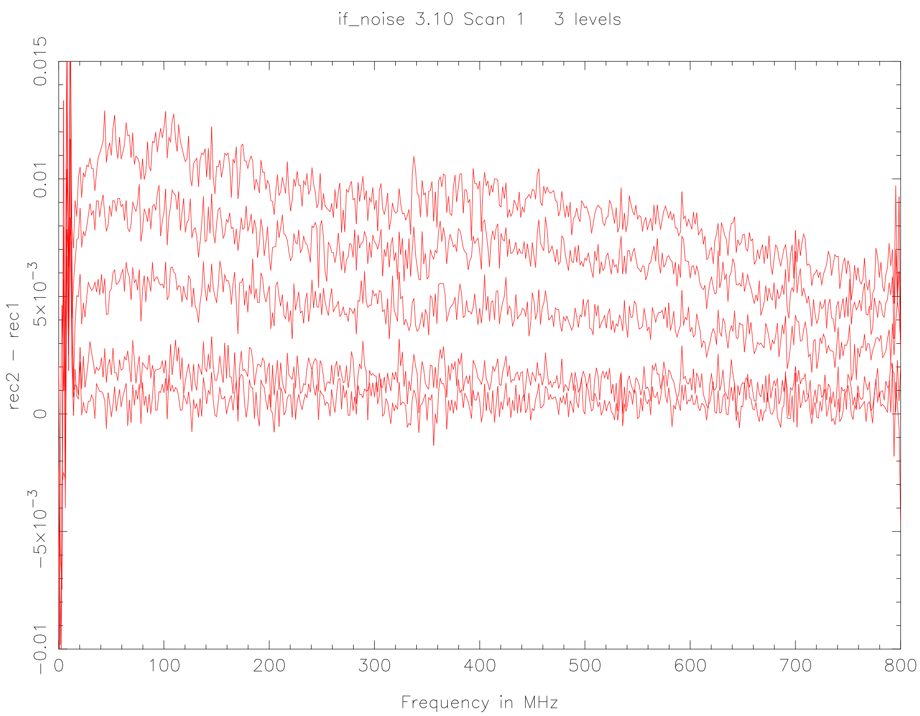

Figure 6: Scan 1, (recordN - record1) / record1 for channel B1 (OR5/CM10/SG2/Samp3). The bottom trace is for recordN = record2, and the next higher spectra are for records 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

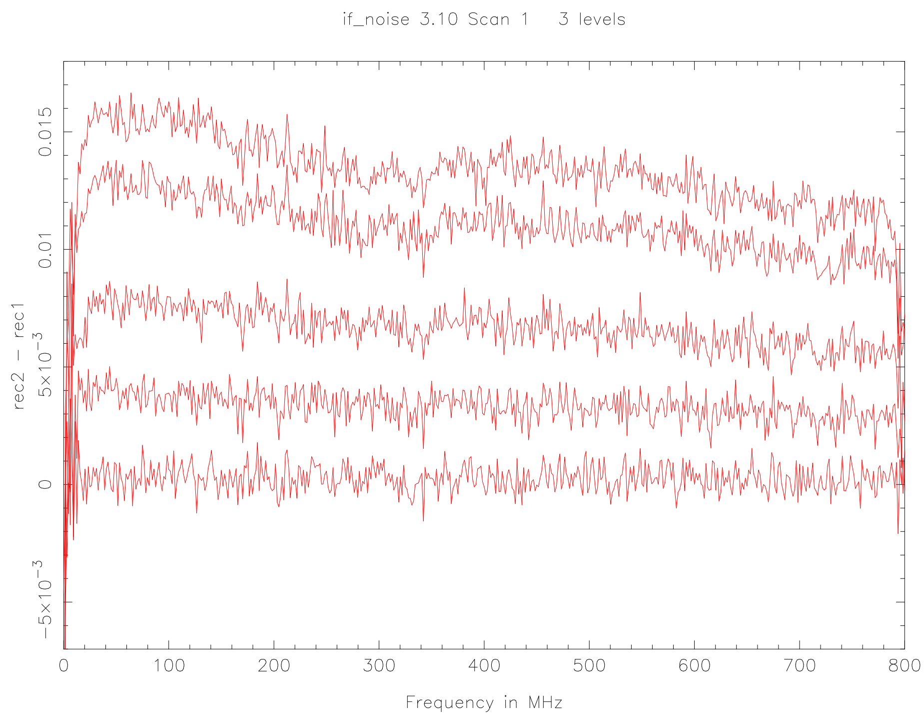

Figure 7: Scan 1, (recordN - record1) / record1 for channel B2 (OR8/CM14/SG6/Samp4). The bottom trace is for recordN = record2, and the next higher spectra are for records 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

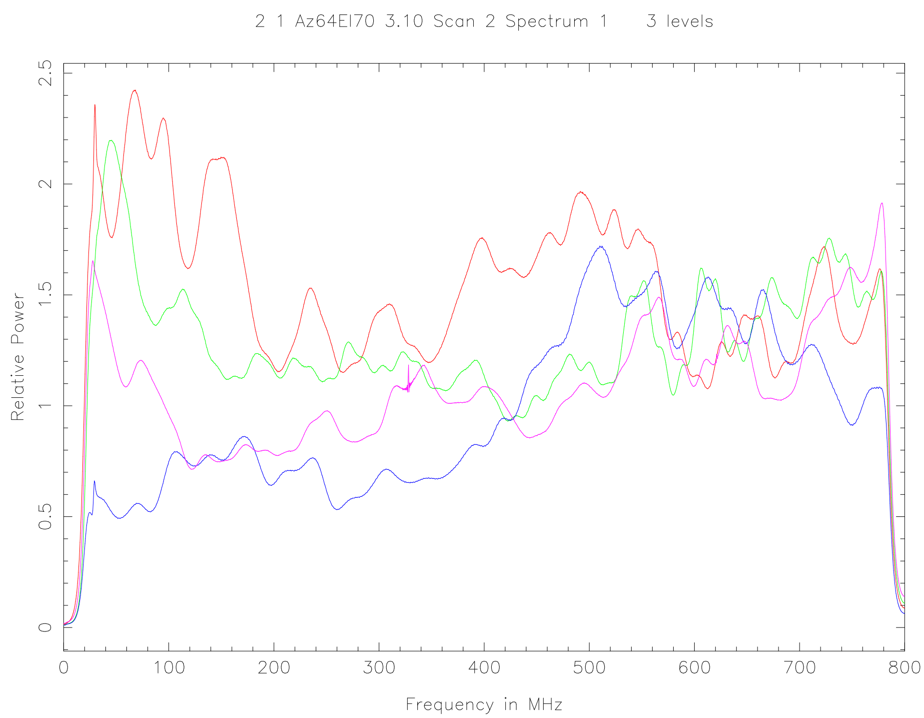

Figure 8: Scan 2, total power spectra of cold sky for record 1, phase 1, L1/OR1/CM1/SG1/Samp1 (red), R1/OR3/CM5/SG5/Samp2 (green), L2/OR5/CM10/SG2/Samp3 (blue), and R2/OR8/CM14/SG6/Samp4 (violet).

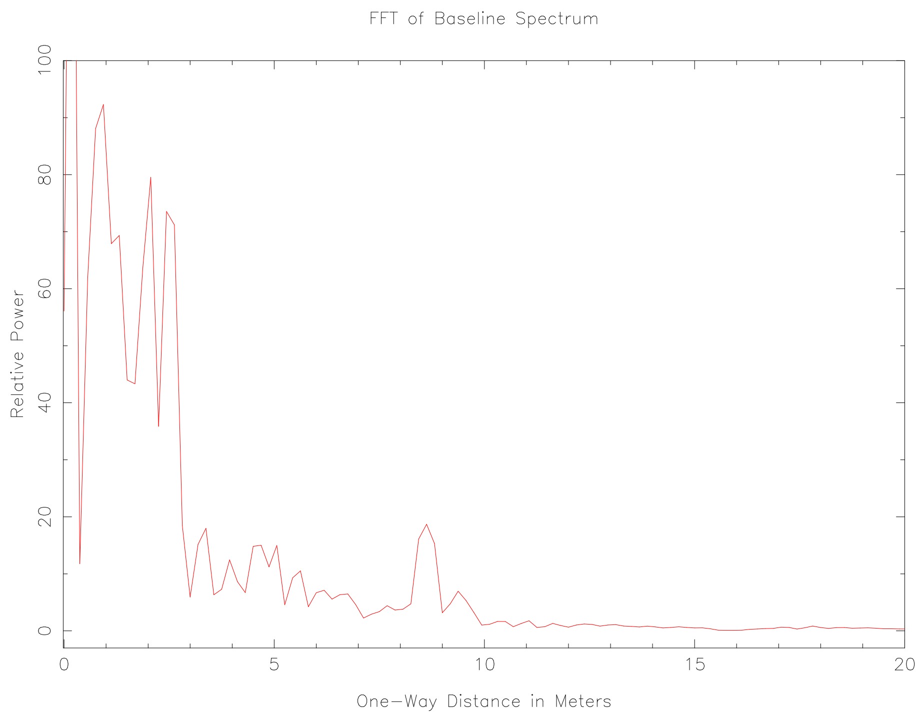

Figure 9: Scan 2, FFT of the total power spectrum (red trace) for channel A2 (R1/OR3/CM5/SG5/Samp2) shown in Figure 8. This is from a cold sky scan and can be compared with a similar FFT plot using the IF noise source shown in Figure 2 (blue trace).

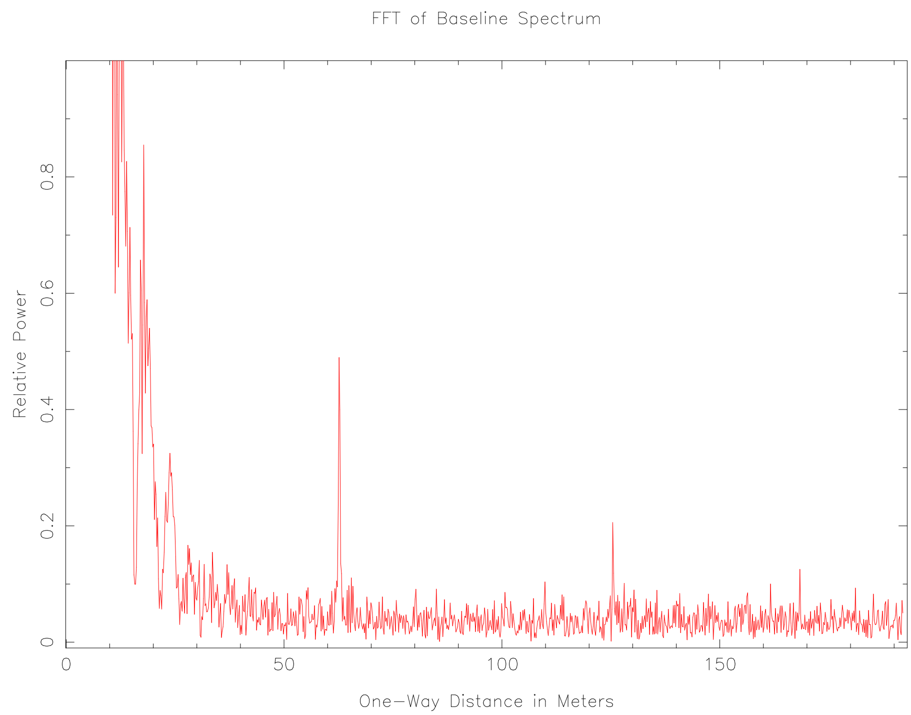

Figure 10: Scan 1 and 2, same FFT shown in Figure 9 (red trace) but expanded in the vertical direction and showing a larger range of distances. This is from a cold sky scan and can be compared with a similar FFT plot using the IF noise source shown in Figure 3 (blue trace).

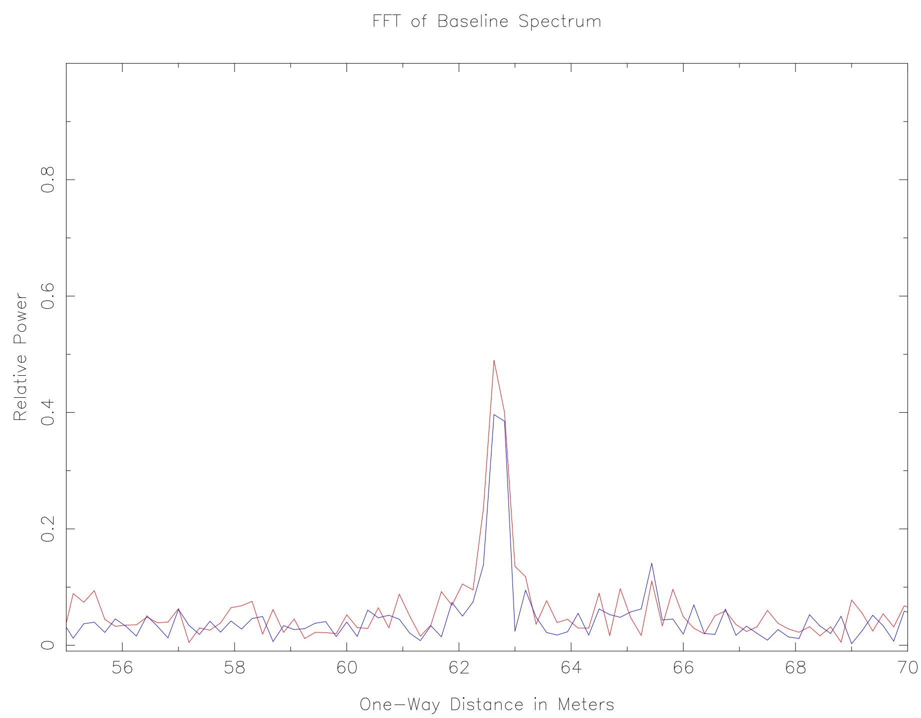

Figure 11: Scans 1 and 2, same FFT's shown in Figures 3 and 10 but expanded around the features at 62.9 meters (2.38 MHz period) and 65.4 meters (2.29 MHz).

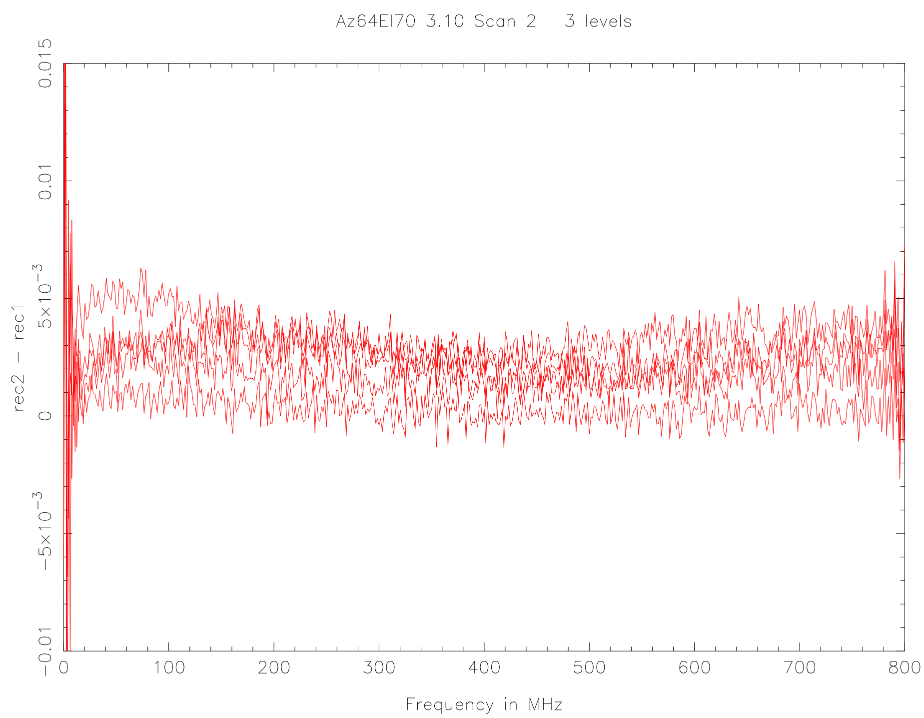

Figure 12: Scan 2, (recordN - record1) / record1 for receiver channel L2 (L2/OR1/CM1/SG1/Samp1/A1) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

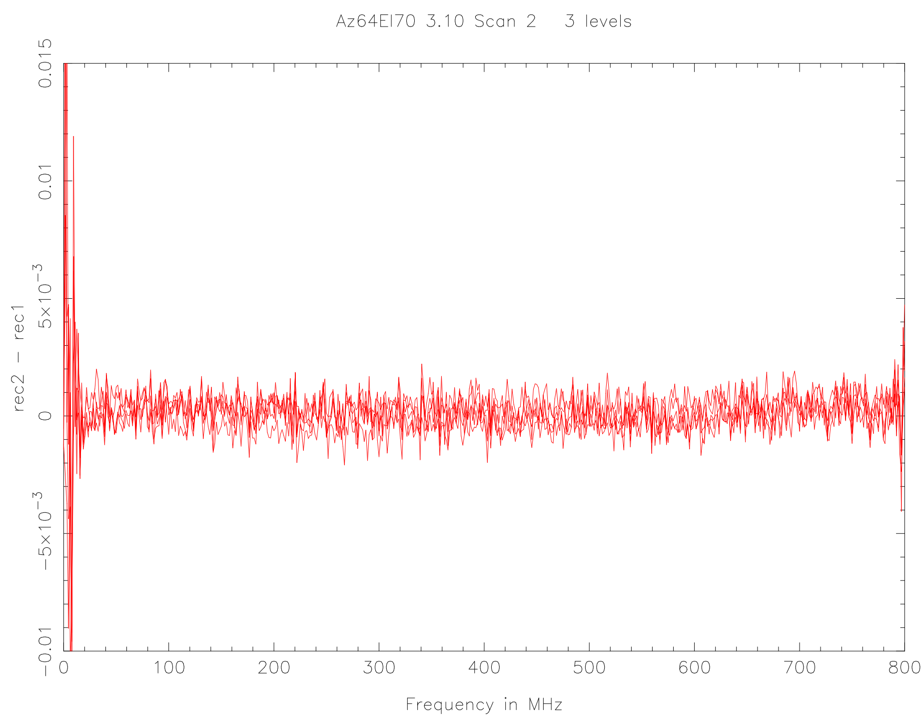

Figure 13: Scan 2, (recordN - record1) / record1 for receiver channel R2 (R2/OR3/CM5/SG5/Samp2/A2) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

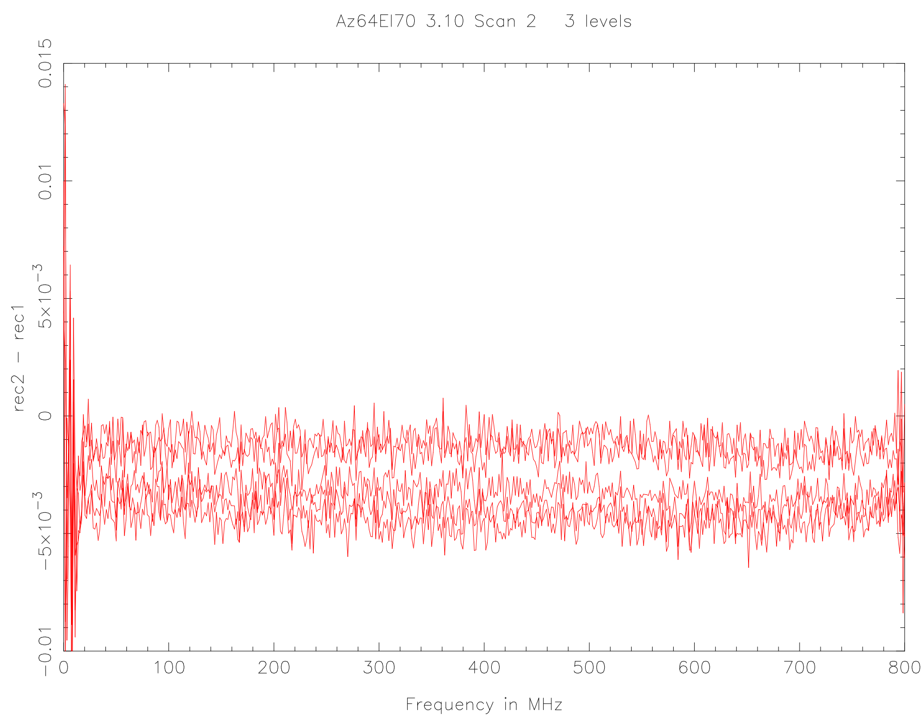

Figure 14: Scan 2, (recordN - record1) / record1 for receiver channel L1 (L1/OR5/CM10/SG2/Samp3/B1) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

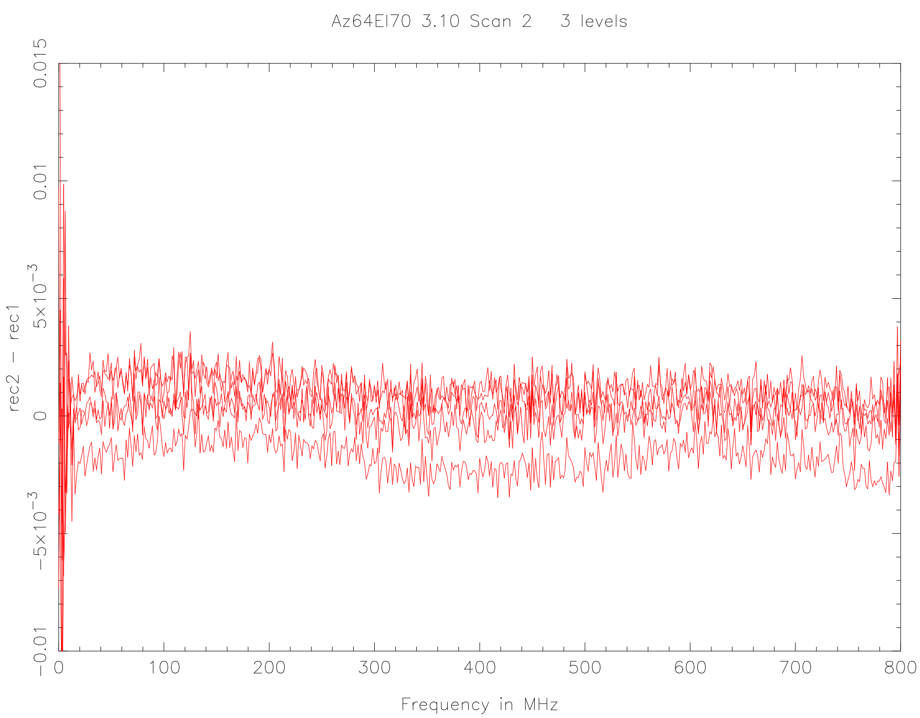

Figure 15: Scan 2, (recordN - record1) / record1 for receiver channel R1 (R1/OR8/CM14/SG6/Samp4/B2) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

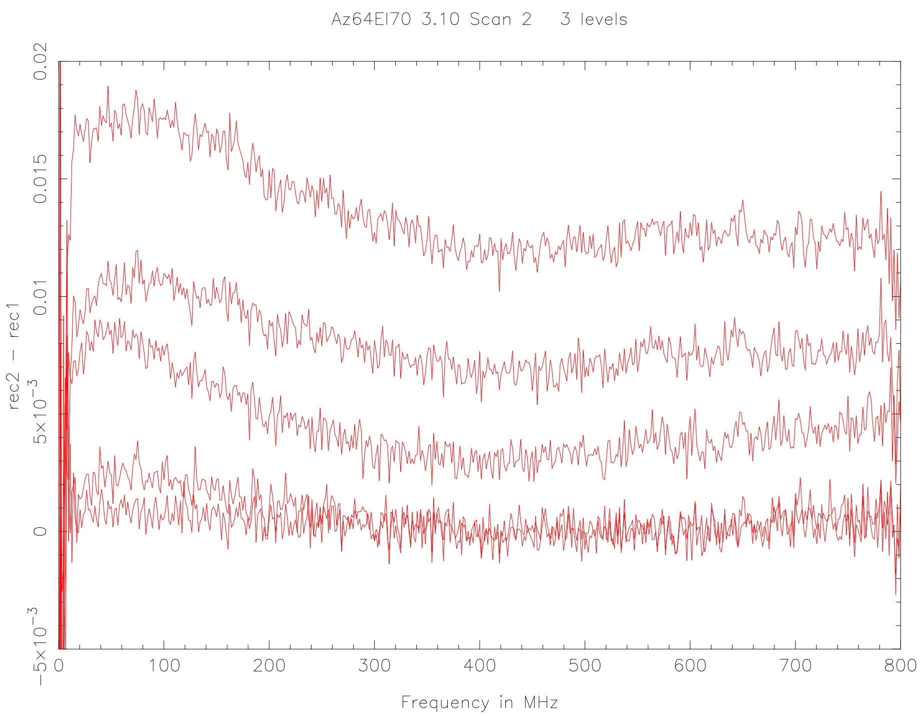

Figure 16: Scan 2, (recordN - record1) / record1 for receiver channel L2 (L2/OR1/CM1/SG1/Samp1/A1) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

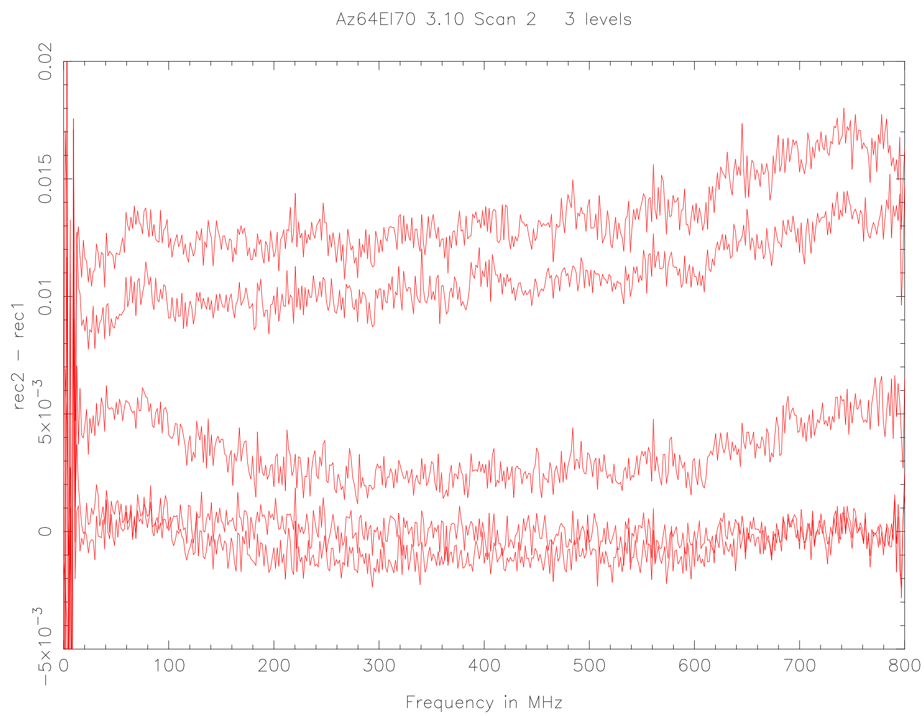

Figure 17: Scan 2, (recordN - record1) / record1 for receiver channel R2 (R2/OR3/CM5/SG5/Samp2/A2) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

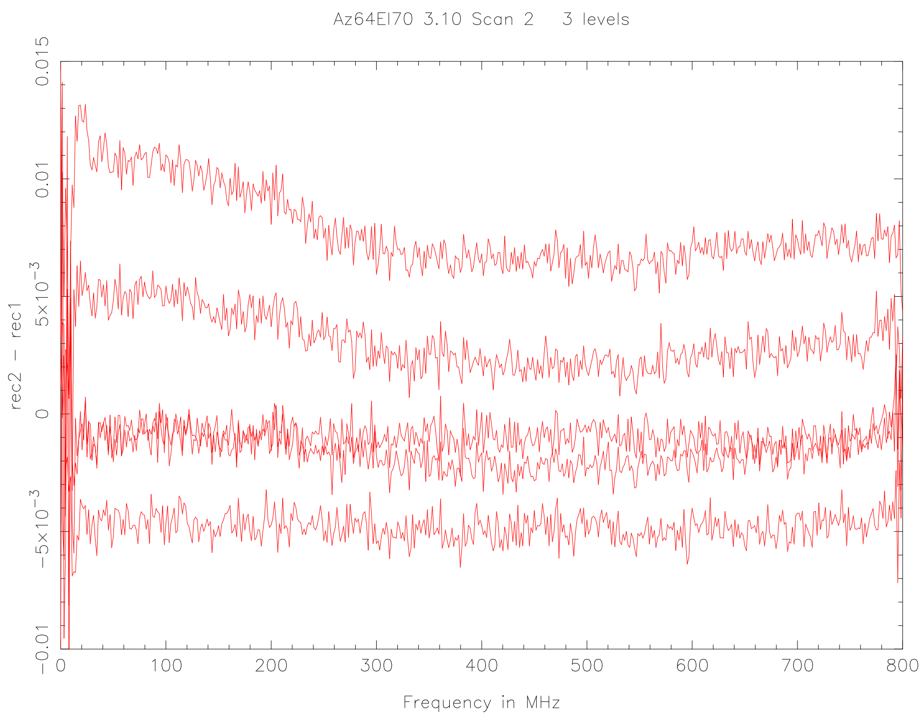

Figure 18: Scan 2, (recordN - record1) / record1 for receiver channel L1 (L1/OR5/CM10/SG2/Samp3/B1) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

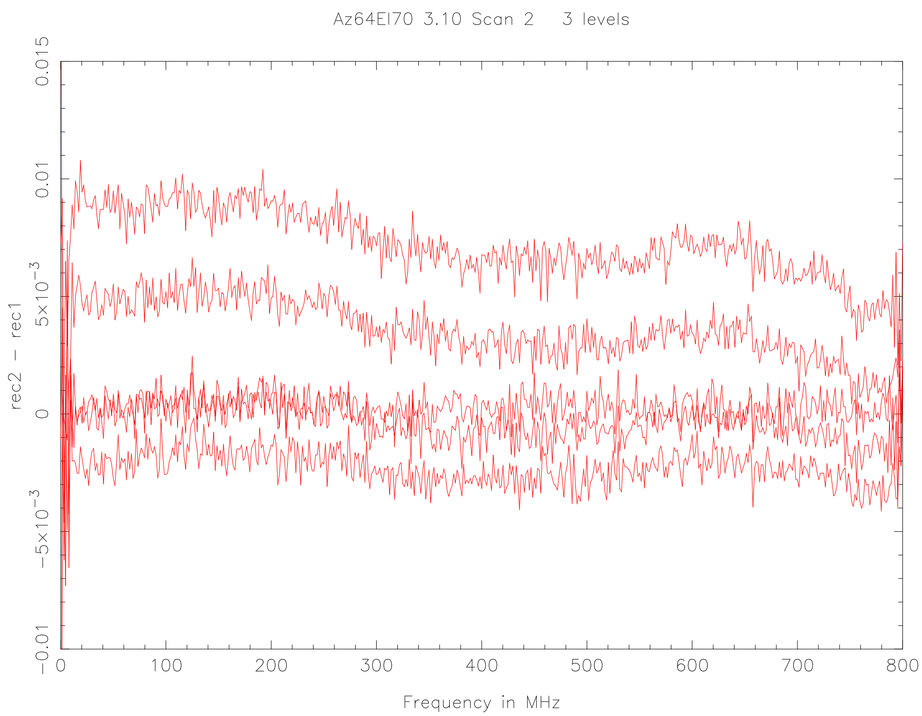

Figure 19: Scan 2, (recordN - record1) / record1 for receiver channel R1 (R1/OR8/CM14/SG6/Samp4/B2) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

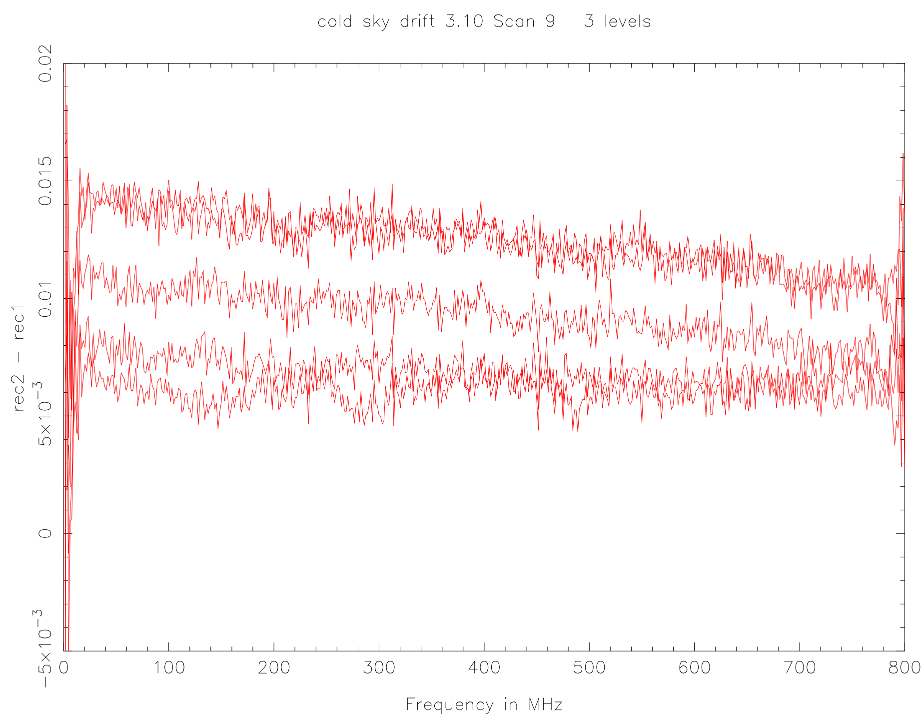

Figure 20: Scan 9, (recordN - record1) / record1 for receiver channel L4 (L4/OR1/CM1/SG1/Samp1/A1) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

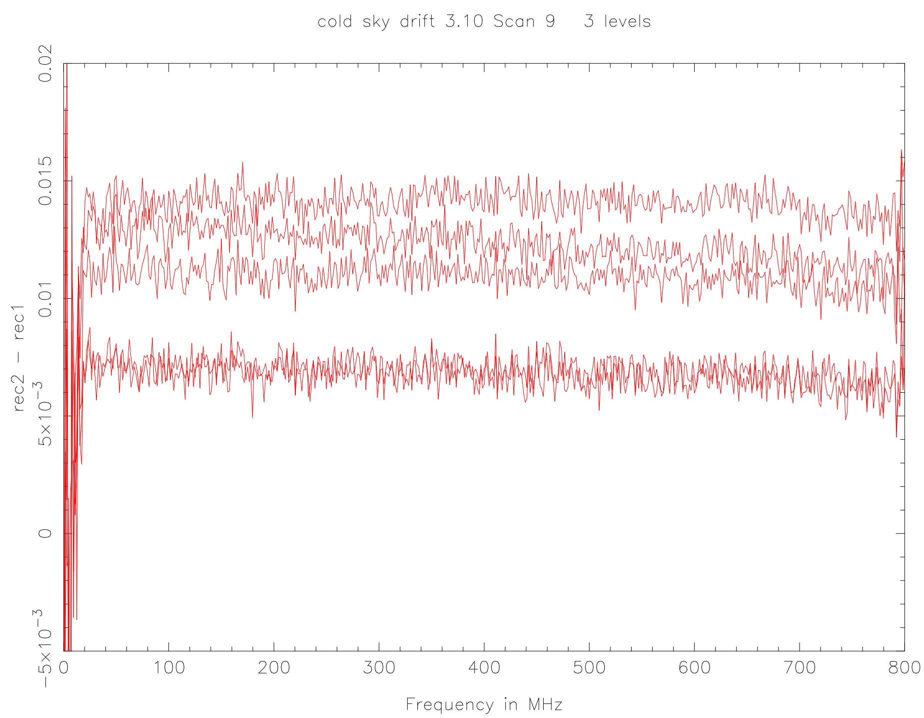

Figure 21: Scan 9, (recordN - record1) / record1 for receiver channel R4 (R4/OR3/CM5/SG5/Samp2/A2) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

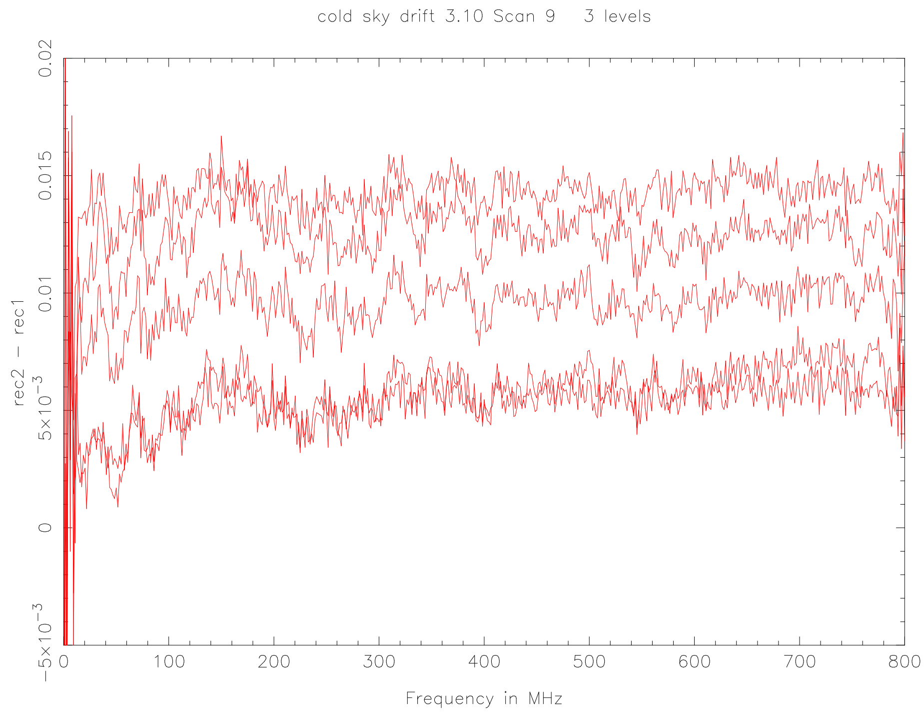

Figure 22: Scan 9, (recordN - record1) / record1 for receiver channel L3 (L3/OR5/CM10/SG2/Samp3/B1) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

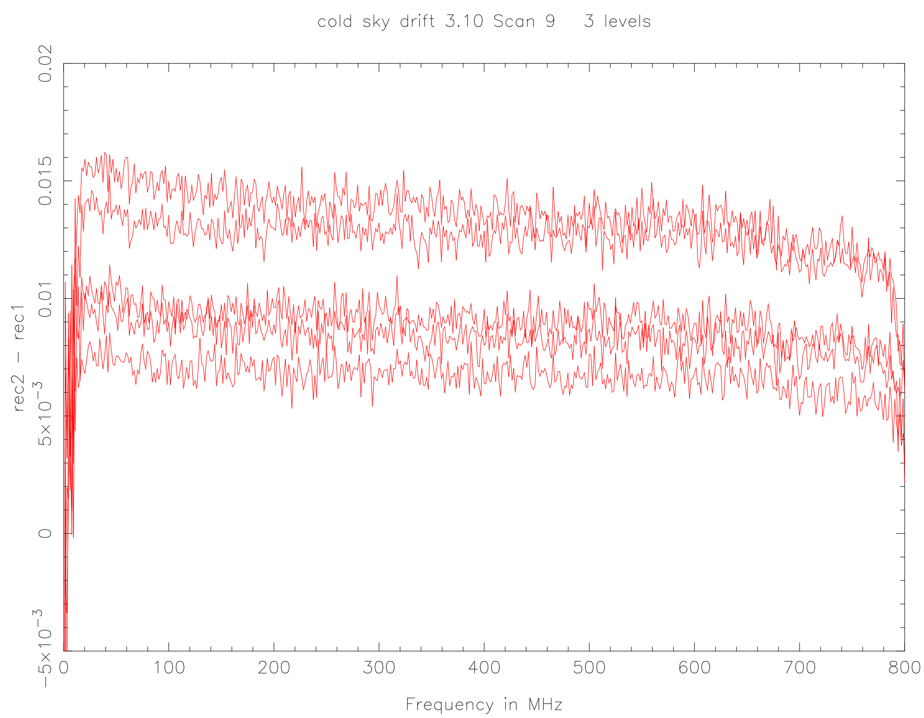

Figure 23: Scan 9, (recordN - record1) / record1 for receiver channel R3 (R3/OR8/CM14/SG6/Samp4/B2) for records 2, 5, 10, 15, and 20. The spectra have been smoothed by truncating the ACF to 512 channels.

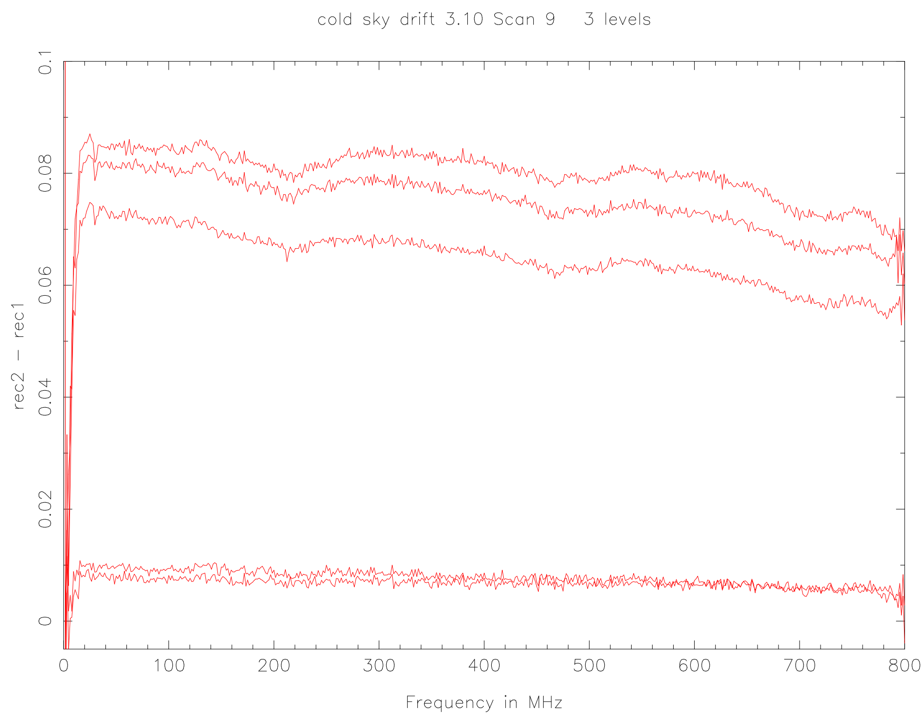

Figure 24: Scan 9, (recordN - record1) / record1 for receiver channel L4 (L4/OR1/CM1/SG1/Samp1/A1) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

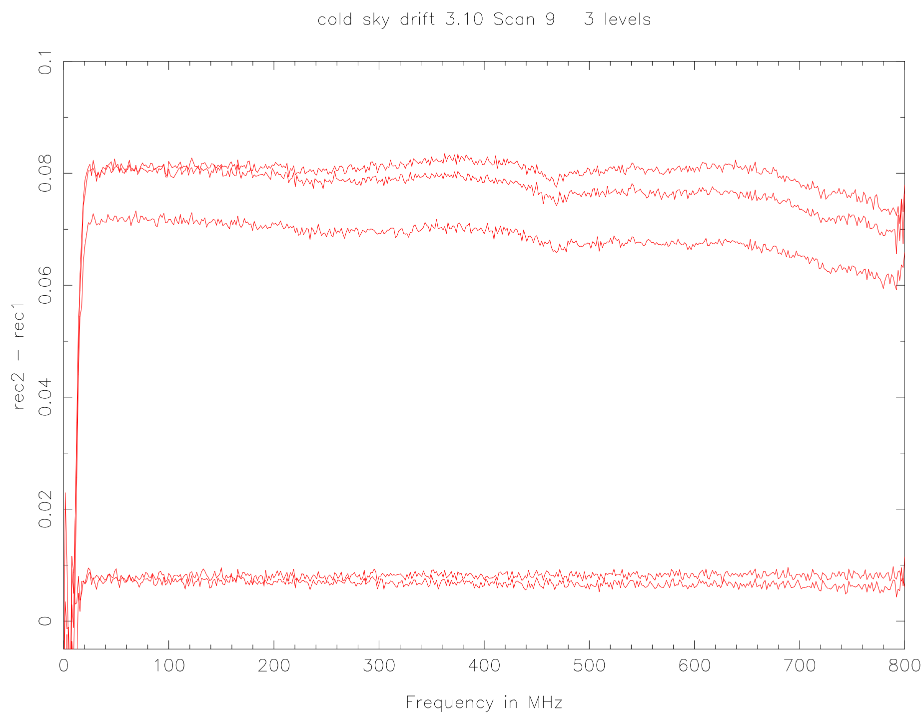

Figure 25: Scan 9, (recordN - record1) / record1 for receiver channel R4 (R4/OR3/CM5/SG5/Samp2/A2) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

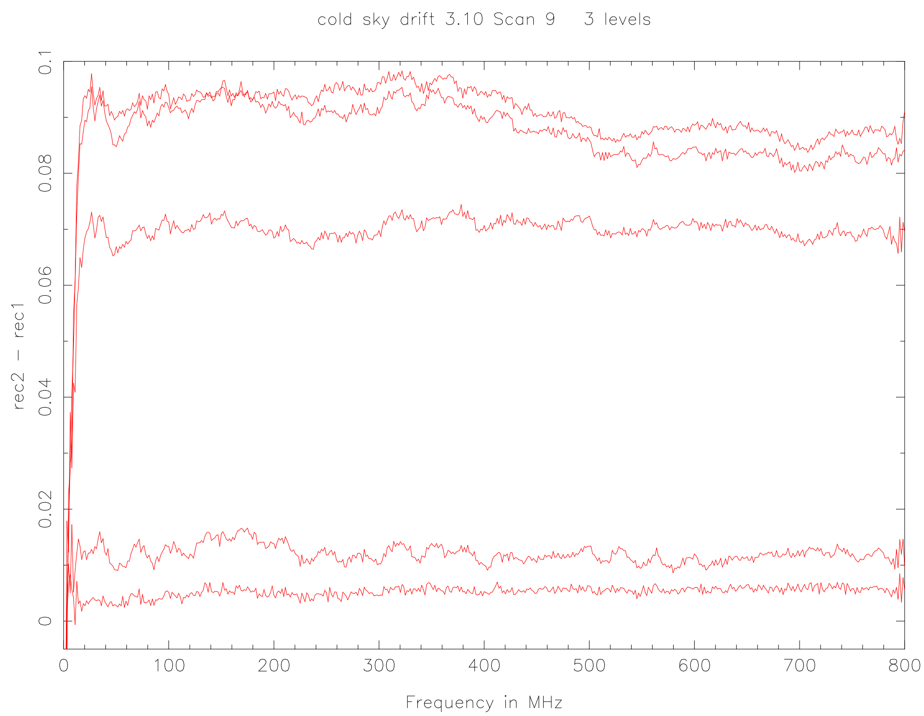

Figure 26: Scan 9, (recordN - record1) / record1 for receiver channel L3 (L3/OR5/CM10/SG2/Samp3/B1) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

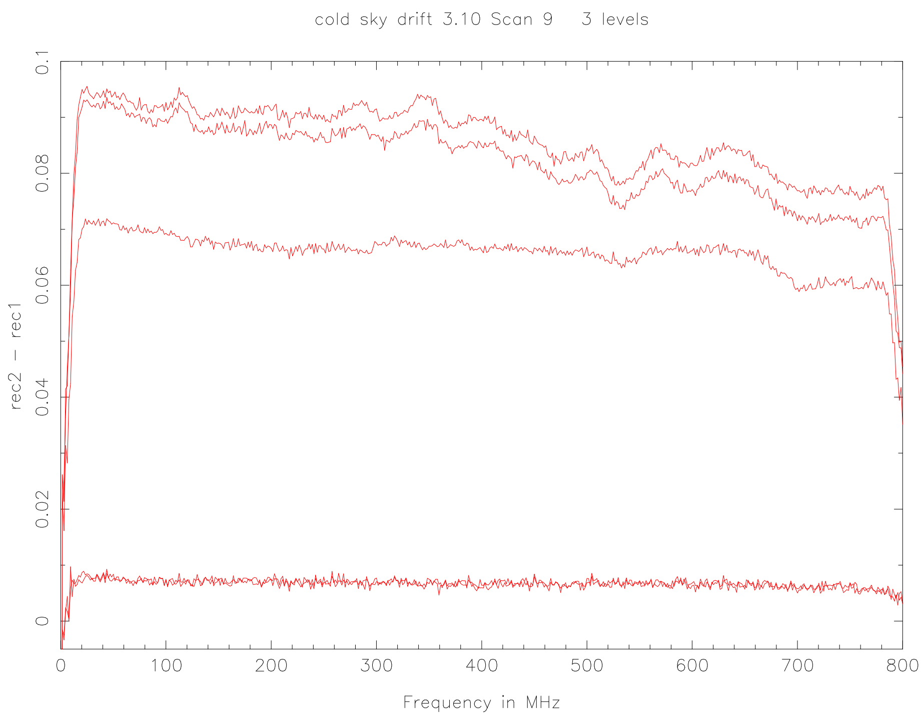

Figure 27: Scan 9, (recordN - record1) / record1 for receiver channel R3 (R3/OR8/CM14/SG6/Samp4/B2) for records 2, 25, 50, 75, and 100. The progression is from less to more wavy spectra with time. The spectra have been smoothed by truncating the ACF to 512 channels.

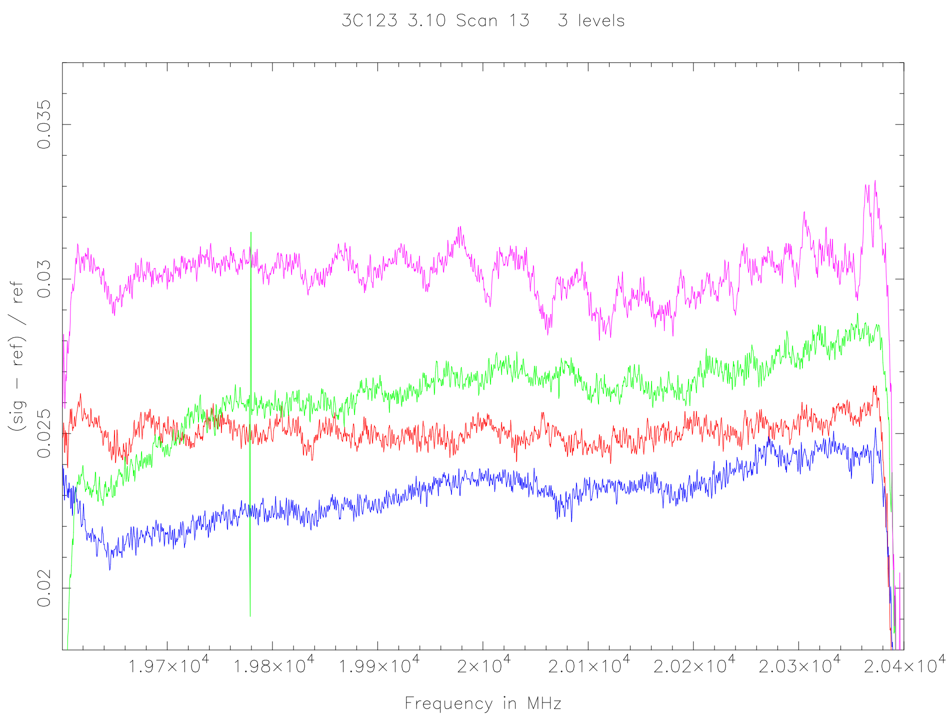

Figure 28: Scan 12 and 13, on-off scan pair on 3C123. Plotted are (on - off) / off with the cal off for receiver R1 in the sig phase of the beam switch (red), R1 in the ref phase (green), L1 in the sig phase (blue), and L1 in the ref phase (violet). The blue trace has been offset by -0.002 in the y direction for clarity.

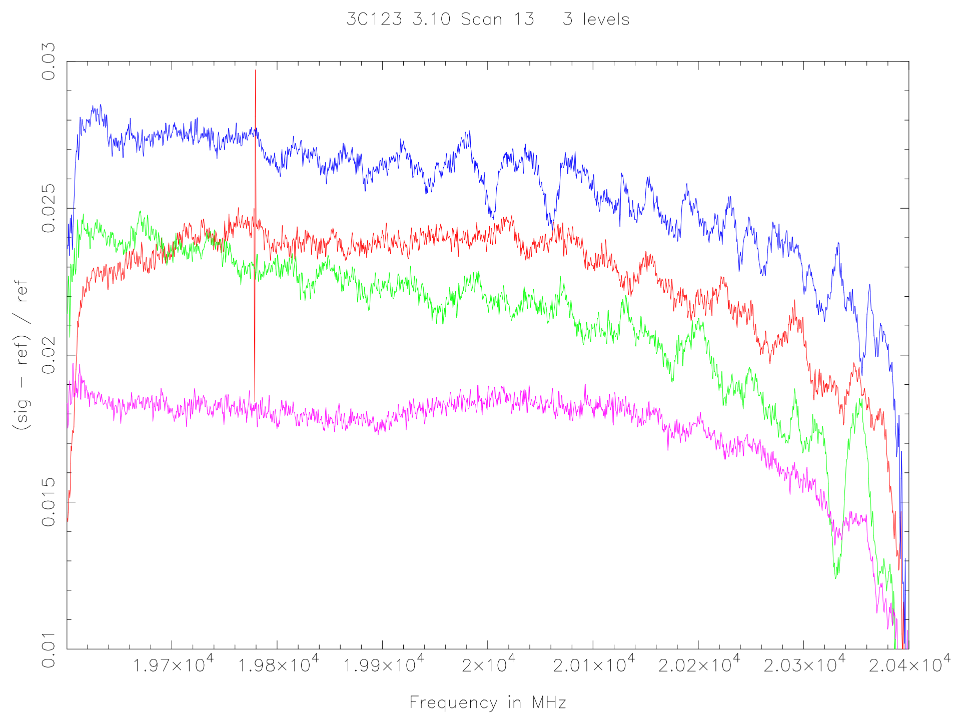

Figure 29: Scan 12 and 13, on-off scan pair on 3C123. Plotted are (on - off) / off with the cal off for receiver R2 in the sig phase of the beam switch (red), R2 in the ref phase (green), L2 in the sig phase (blue), and L2 in the ref phase (violet). The blue trace has been offset by 0.003 and the green trace by -0.0005 in the y direction for clarity.

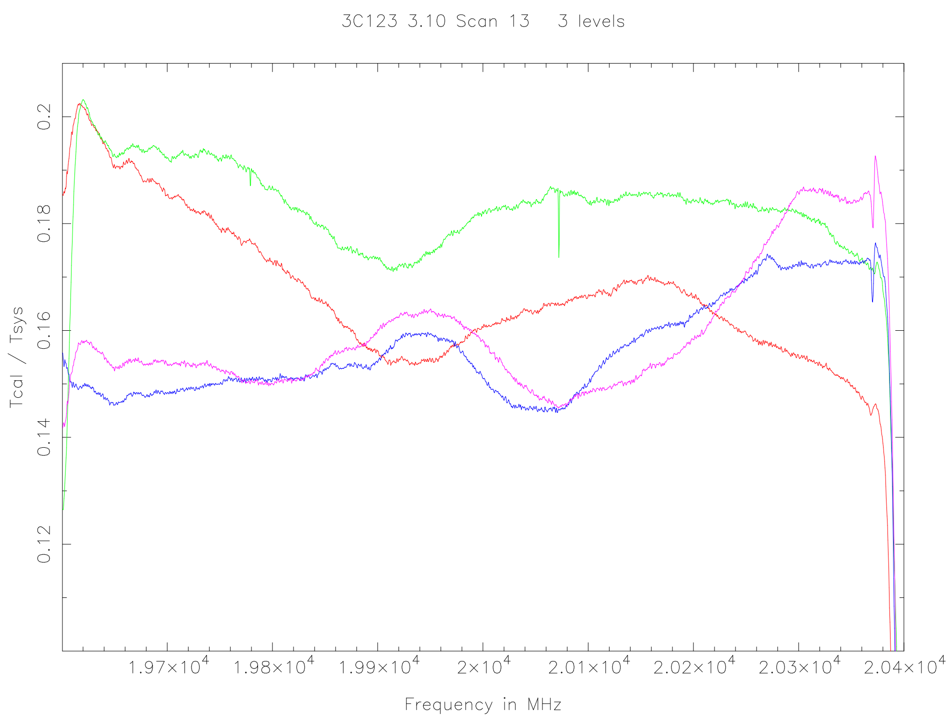

Figure 30: Scan 13 calon-caloff for the off scan of the 3C123 pair. Plotted are (calon - caloff) / caloff for receiver R1 in the sig phase of the beam switch (red), R1 in the ref phase (green), L1 in the sig phase (blue), and L1 in the ref phase (violet).

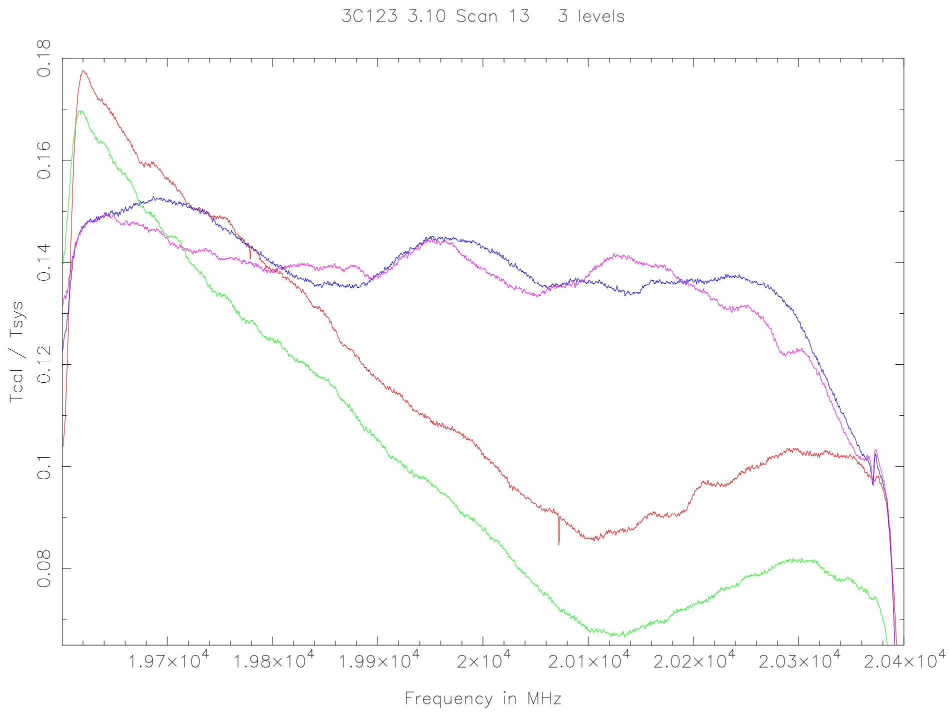

Figure 31: Scan 13 calon-caloff for the off scan of the 3C123 pair. Plotted are (calon - caloff) / caloff for receiver R2 in the sig phase of the beam switch (red), R2 in the ref phase (green), L2 in the sig phase (blue), and L2 in the ref phase (violet).