# IF Baseline Experiments
# Project TBASERDN030417, April 17, 2003

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## Introduction

Over the past few weeks, baseline ripples with periods of about 60 MHz have been isolated to the Converter Racks

The Spectrometer was used in an four-bank, eight sampler, 800MHz mode, with 10 second records, and 60 scan times. Initially four converter modules in each rack were used; later in the day, all eight modules in Converter Rack A were used. Hardware connections are shown in Tables 1 and 2.

## Baseline Ripple and Cable Lengths

Cleo was used to run sequences of scans. After some initial problems with the setup and with software problems, Scans 17-76 were taken. After the end of scan 76, a SMA connector saver was inserted at the CM1 input to induce a 1.8 cm change in the cable length between OR1 and CM1. Scans 77-78 were run with SMA saver, and then 79-81 taken after the saver was removed.

Examining baselines using scans 17-76 as the system was "undisturbed", one finds that baseline ripple with amplitudes up to a few tenths of a percent come and go as time goes by. When the connector saver was inserted, the passband ripple changed significantly, inducing large baseline ripples. Figures 1 shows baselines for the CM1 channel, taking scan 75 as the reference, and 76-79 as signal scans. Figure 2 shows similar results for the CM2 channel. Note that

Table 1: Hardware Connection Map (Scans 1-154)

| ACSBank | Sampler | SF | CM | OR |
|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 5 | 5 | 3 |
| 2 | 2 | 2 | 2 | 1 |
| 2 | 3 | 6 | 6 | 3 |
| 3 | 4 | 3 | 11 | 5 |
| 3 | 5 | 7 | 15 | 7 |
| 4 | 6 | 4 | 12 | 5 |
| 4 | 7 | 8 | 16 | 7 |

Table 2: Hardware Connection Map (Scans 158-170)

| ACSBank | Sampler | SF | CM | OR |
|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 5 | 5 | 3 |
| 2 | 2 | 2 | 2 | 1 |
| 2 | 3 | 6 | 6 | 3 |
| 3 | 4 | 3 | 3 | 1 |
| 3 | 5 | 7 | 7 | 3 |
| 4 | 6 | 4 | 4 | 1 |
| 4 | 7 | 8 | 8 | 3 |

Table 3: Ripple Frequencies

| ACSBank | Sampler | SF | CM | OR | Freq(MHz) |
|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | 68 |
| 2 | 2 | 2 | 2 | 1 | 58 |
| 3 | 4 | 3 | 3 | 1 | 68 |
| 4 | 6 | 4 | 4 | 1 | 68 |
| 1 | 1 | 5 | 5 | 3 | 54,63 |
| 2 | 3 | 6 | 6 | 3 | 58,68 |
| 3 | 5 | 7 | 7 | 3 | 68 |
| 4 | 7 | 8 | 8 | 3 | 63 |

changing the cable length in the CM1 path also introduced baseline ripples in the CM2 path. This likely is due to crosstalk through the 4-way power splitter within the Optical Receiver module.

It is possible to do a FFT on the baseline traces, measuring the ripple frequencies quite accurately. (Note: The routine written to do this is "plotTaFft()" within /home/scratch/rnorrod/spectAnalysis/ac2.g). Figures 3 and 4 show the FFT of baselines from all eight channels, taken while the system was "undisturbed". As is indicated in these figures, baseline ripple amplitudes throughtout these tests tended to be much lower in CM1 and CM5-8, than in CM2, CM3, and CM4. The major frequency components for each channel are given in Table 3. Figures 5 and 6 show the FFT of baseline ripple induced by the cable delta insertion. The ripple frequency is the same in both the CM1 and CM2 channels (54 MHz), but not the same as the ripple frequencies seen when the system is undisturbed.

## Baseline Ripple and Temperature

Figure 7 shows a sequence of baselines for scans 80-88 taking scan 79 as the reference. During scan 82 (the third trace from the bottom), the rear door of Converter Rack A was opened. All four channels in Rack A that were recorded show similar results. For comparison, Figure 8 shows data from CM11 in Rack B during the same period. Opening the rack door disturbs the air flow, and a temperature sensor we have in the rack air stream shows about a 2C increase in temperature when the door is opened. It does appear that the ripples that accumulate in the undisturbed system is linked to the temperature within the Converter Racks.

During a sequence of scans running from scan 89 to 142, various components within CM1 was sprayed with canned freeze-it. Access was not very convenient, so the spray was not perfectly localized.

**Scan 100** The pin diode switch at the input of CM1 was sprayed.

**Scan 105** The first mixer in CM1 was sprayed.

**Scan 111** The pad between CM1 input switch and the first mixer was sprayed.

**Scan 121** The 8.5-10.5GHz bandpass filter following the first mixer in CM1 was sprayed.

**Scan 136** The digital attenuator in CM1 was sprayed.

Figure 9 shows CM1 baseline sequences for the period the above actions were done. The large baseline pertubations do appear to be associated with application of the cold spray, but it is difficult to conclude what exactly is the affected component. Figure 10 shows CM1 baselines during the earlier undisturbed period at the same scale as Figure 9. Figures 11 and 12 show data from CM2 during the same periods. Again, the large baseline pertubations coincide with the cold spray applied to CM1. CM2 is mounted just below CM1, so some chilling of CM2 could have occurred, or it may be that again interactions through the 4-way splitter in OR1 is a factor.

## Summary

Today's tests indicate that the "60MHz" baseline ripple that seems to be linked to the Equipment Room temperature is not directly related to the length of cable in the Optical Receiver to Converter Module path – the frequencies do not match exactly. We also found that crosstalk through the 4-way power divider in the optical receivers is a factor. And, temperature variations within the Converter Rack does trigger significant baseline variations. However, we were not able to tie down the problem to a specific component.

More investigations are anticipated.

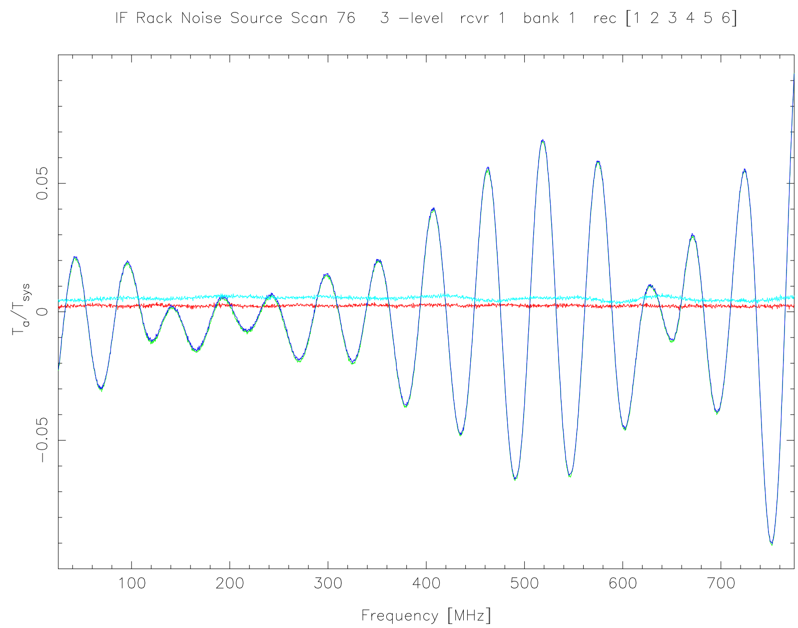


Figure 1: $(sig - ref)/ref$, for the OR1/CM1/SF1 IF path, taking scan 75 as the reference, and scans 76-79 as signals. The red trace are 75 and 76, before a delta was inserted in the cable between OR1 and CM1. The green and blue traces (with large ripple) are scans 75 to 77 and 75 to 78, showing the effect of the cable delta. The cyan trace is scan 75 to 79, after the delta was removed.

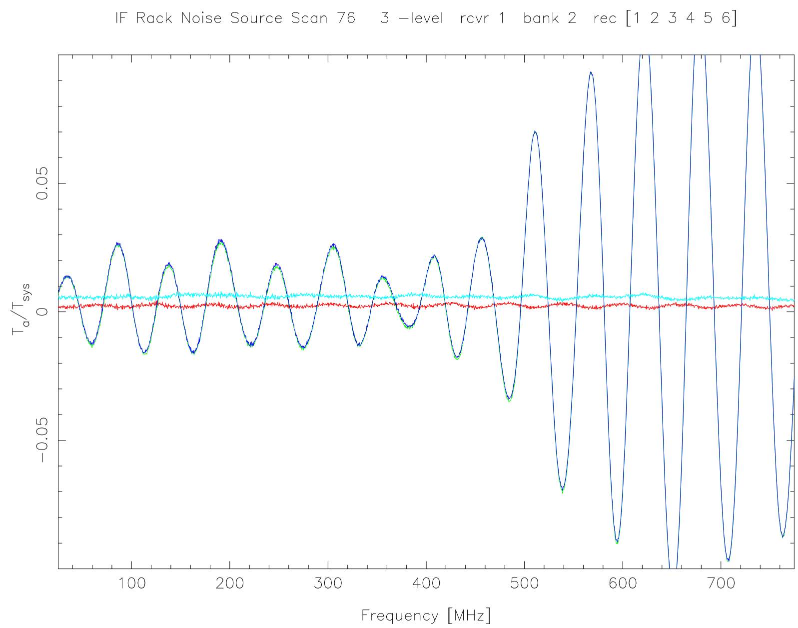


Figure 2: $(sig - ref)/ref$, for the OR1/CM2/SF2 IF path, and the same scans as Figure 1.

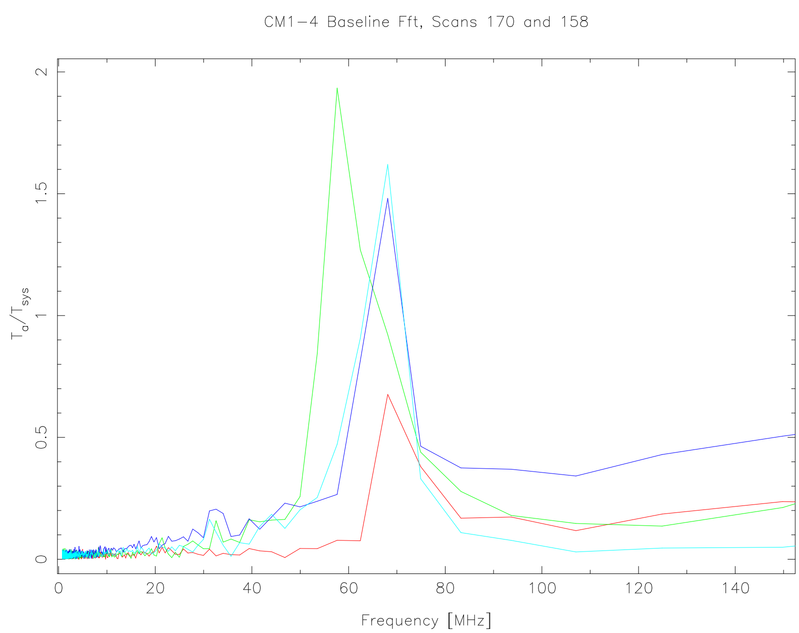


Figure 3: FFT of the baseline traces for scans 158 and 170, for channels containing CM1 (red), CM2 (green), CM3 (blue), and CM4 (cyan).

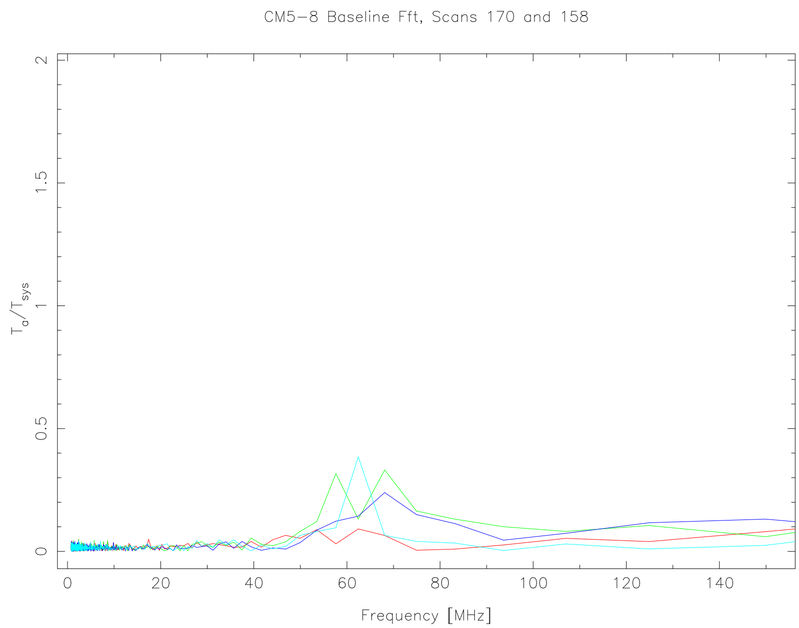


Figure 4: FFT of the baseline traces for scans 158 and 170, for channels containing CM5 (red), CM6 (green), CM7 (blue), and CM8 (cyan).

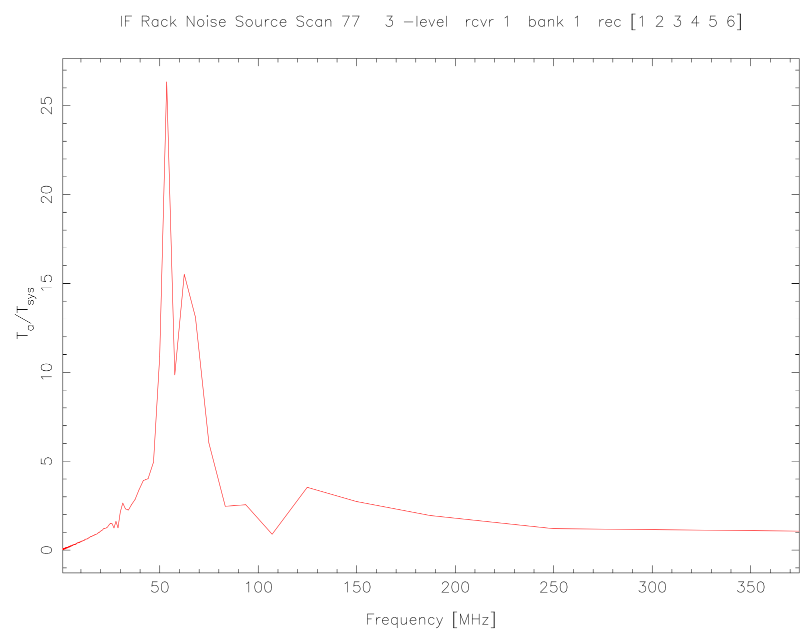


Figure 5: FFT of the baseline trace in the CM1 channel for scans 75 and 77, with ripple induced by a cable length delta between OR1 and CM1. The major frequency component is at 54 MHz.

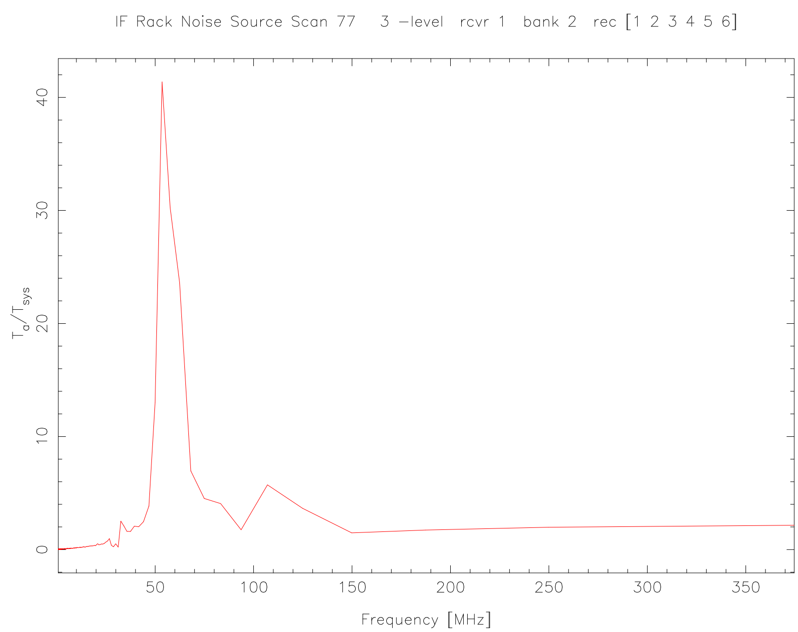


Figure 6: FFT of the baseline trace in the CM2 channel for scans 75 and 77, with ripple induced by a cable length delta between OR1 and CM1. The major frequency component is at 54 MHz.

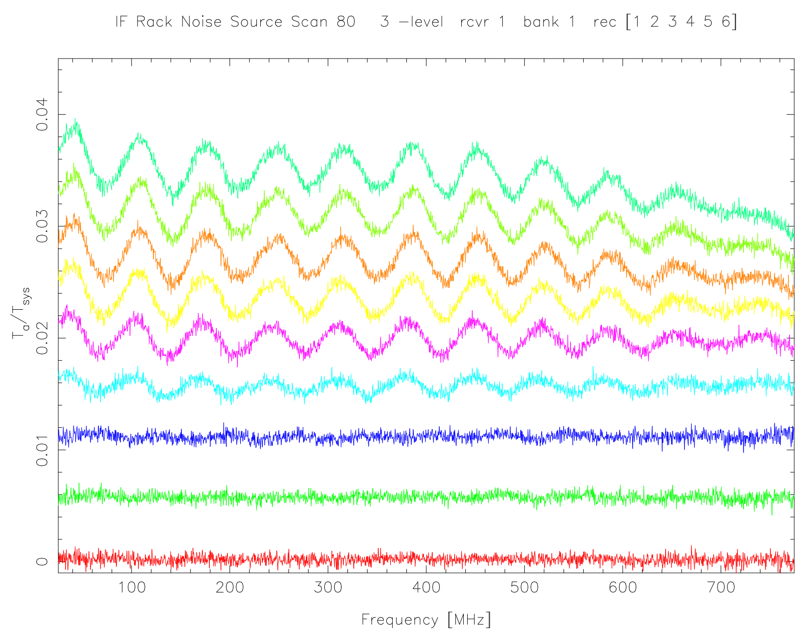


Figure 7: Baselines in the CM1 channel for scans 79 and 80 to 88. The door of Converter Rack A was opened during scan 82 (the third from the bottom). The major ripple frequency component is at 68 MHz.

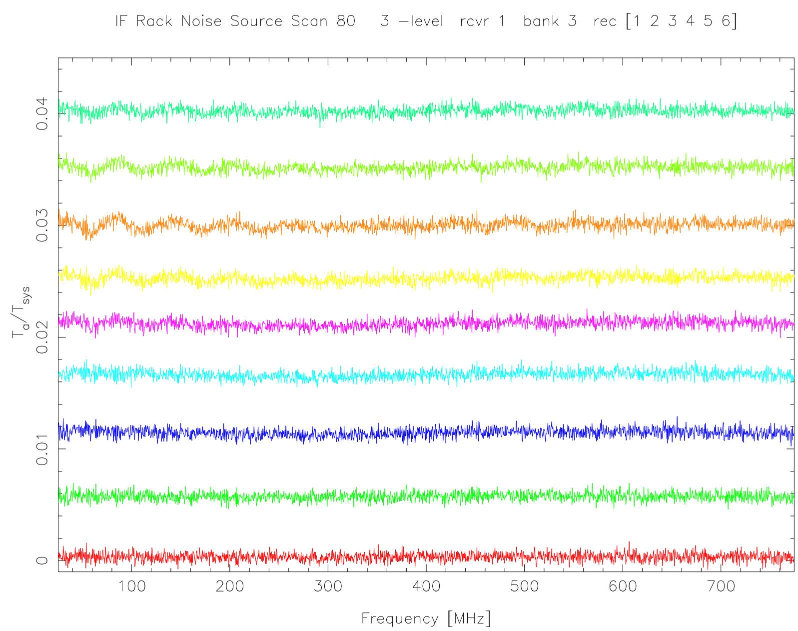


Figure 8: For comparison to the previous figure, baselines in the CM11 channel (in Converter Rack B) for scans 79 and 80 to 88. The door of Converter Rack A was opened during scan 82 (the third from the bottom).

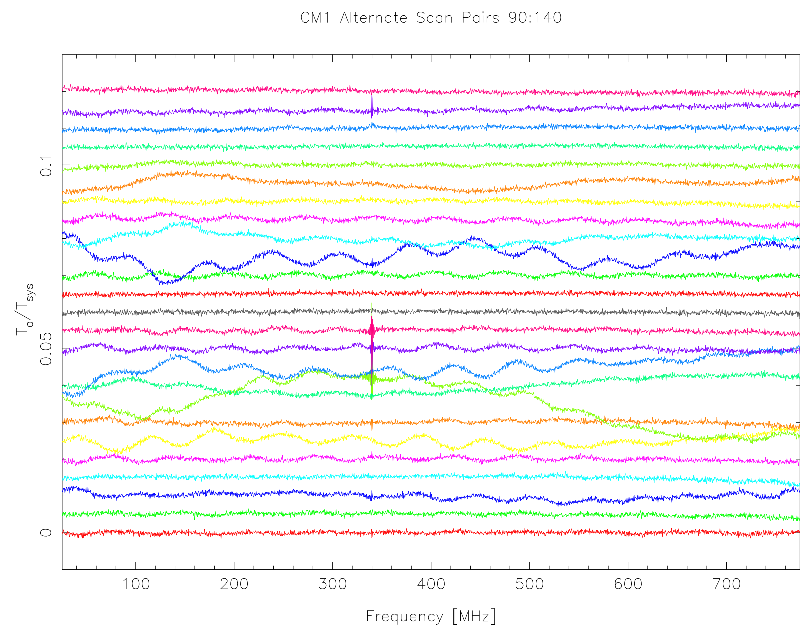


Figure 9: A sequence of CM1 baselines (from the bottom) for scans 90-91, 92-93, 94-95, etc. Various components in CM1 were sprayed with canned freeze-it as described in the text.

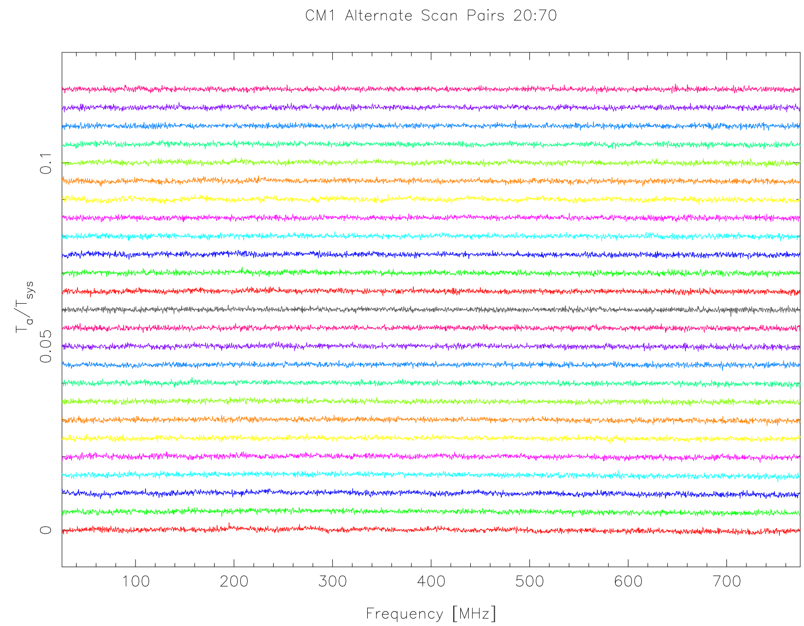


Figure 10: For comparison with the previous figure, a sequence of scans from CM1 when the system was undisturbed.

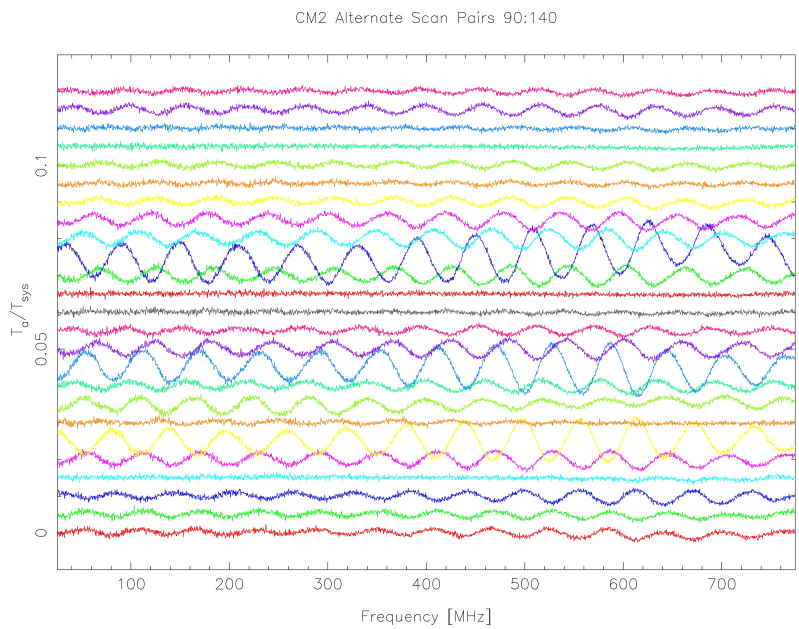


Figure 11: A sequence of CM2 baselines (from the bottom) for scans 90-91, 92-93, 94-95, etc. Various components in CM1 were sprayed with canned freeze-it as described in the text.

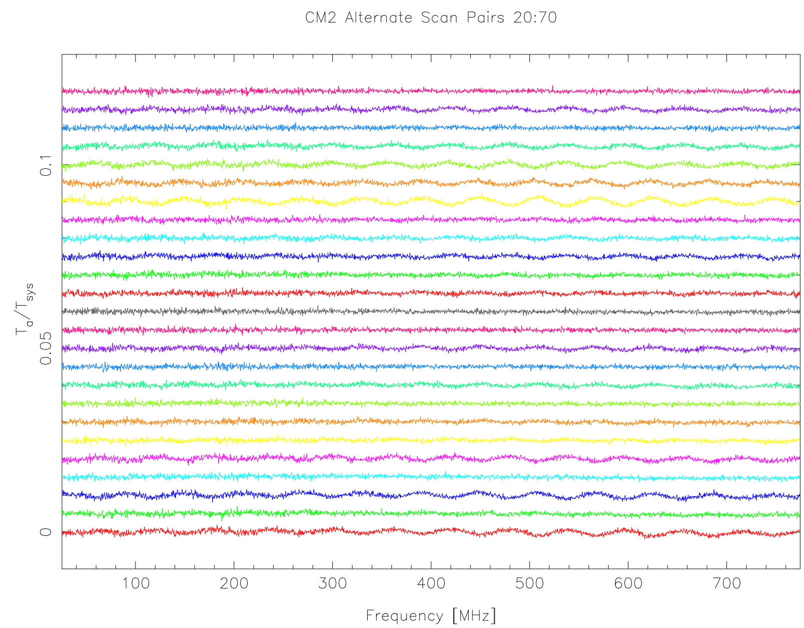


Figure 12: For comparison with the previous figure, a sequence of scans from CM2 when the system was undisturbed.