X-band Continuum Source Baselines
Project TBASERDN031010, October 10, 2003
and
Project TBASERDN031023, October 23, 2003

Rick Fisher, Roger Norrod, Dana Balser

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Introduction

This report describes baseline test observations taken October 10 and 23, on the X-band receiver using on-off measurements of NGC 7027. It is a follow-up on tests conducted on September 26, 2003.

Setup

At the beginning of these tests the receiver LO1 was set to 12 GHz, and the LO2 synthesizers driving CM9, 10, 13, and 14 were set to 12300 MHz to tune the spectrometer center channel to 9000MHz (Banks A and B). The other LO2 synthesizers were offset to 12900 and 11700 MHz to tune Bank C center to 8400MHz, and Bank D center to 9600MHz, respectively. The system connections on October 10 were:

LCP	ODM6	CM9	SF1	Bank A, J1, Sampler 1
		CM10	SF2	Bank B, J3, Sampler 1
		CM11	SF3	Bank C, J5, Sampler 1
		CM12	SF4	Bank D, J7, Sampler 1
RCP	ODM8	CM13	SF5	Bank A, J2, Sampler 2
		CM14	SF6	Bank B, J4, Sampler 2
		CM15	SF7	Bank C, J6, Sampler 2
		CM16	SF8	Bank D, J8, Sampler 2

On October 23, CM12 and CM16 were not available, so Bank D was fed by the following. The other connections were the same.

LCP	ODM1	CM4	SF4	Bank D, J7, Sampler 1
RCP	ODM3	CM8	SF8	Bank D, J8, Sampler 2

The data of September 26 were taken without the front-end 9.0/2.5 GHz bandpass filters that normally resides between the room-temperature postamps and the front-end mixers. Without this filter some degradation of image rejection is expected, depending on the amount of gain rolloff in the preceeding amplifiers, and could result in increased susceptability to RFI. The measurements in this report were taken with the filters installed, and the first few observations were repeats of the September 26 measurements to determine whether any of the reported results from that run could have been affected by an unwanted image response.

RFI

RFI was present in most of the data taken during these tests between about 9330 and 9385 MHz. Data for this frequency range are blanked in most of the spectrum plots. At least at the beginnig of the run the RFI did not appear to be as strong as it was on September 26.

General Stability

The weather during these tests was partly cloudy, mainly moderately high clouds in a relatively thin layer. To test the total system stability, including sky noise effects, a ten-minute scan while tracking cold sky was run using 30-second data dumps from the spectrometer. Figures 1 and 2 show the drift in spectrum power over the duration of the ten minutes. A drift of about 0.5 percent in total power and a distortion of the spectra on the order of 0.1 to 0.2 percent is seen during this time period. Weak ripples with periods near 40 MHz appear to have developed toward the end of the ten minutes in the low frequency spectra coming from ODM6-CM11-SF3-Bank C connected to the LCP receiver channel. Ripples with a period of about 60 MHz can be seen in the ceter frequency range of the RCP spectra from ODM8-CM13-SF5-Bank A. Some longer period ripples can also be seen developing in the center frequency LCP channel (ODM6-CM9-SF1-Bank A) and the high frequency RCP channel (ODM8-CM16-SF8-Bank D). If these drifts were characteristic of the tests during the remaining of the evening, they should not have affected the general conclusions to follow.

Continuum Source Spectra

The radio source NGC 7027 was used to measure the spectral response of the GBT system to continuum input to the receiver. This source has a flux density at 9 GHz of about 6 Jy, which will produce an antenna temperature of a bit over 10 Kelvins or roughly 40 percent of the system temperature. Before the following series of on-off spectrum measurements were taken the DCR was used

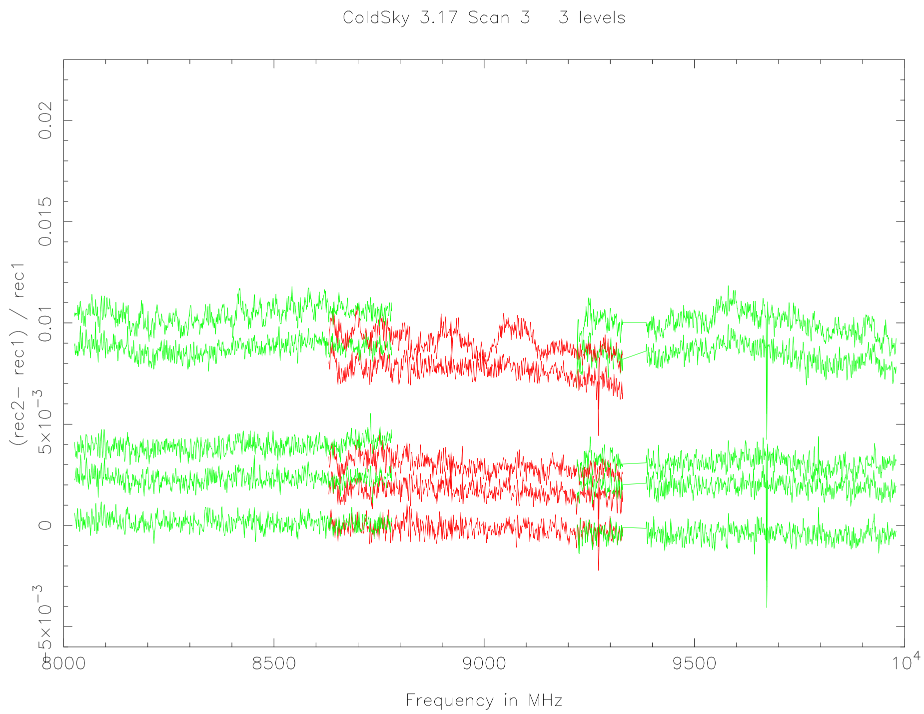

Figure 1: Scan 3: (recN - rec1) / rec1 for the LCP receiver channel. The bottom plot is 30-second record 2 minus record 1, and the successively higher plots are for records 5, 10, 15, and 20. The green traces at lower and higher frequencies are from spectrometer banks C and D, respectively, and the center red trace is from bank A. Plots from successive records are each offset higher by 0.001 from its neighbor so that the top plot should be offset by 0.005 from the bottom plot, if there where no drift in total power.

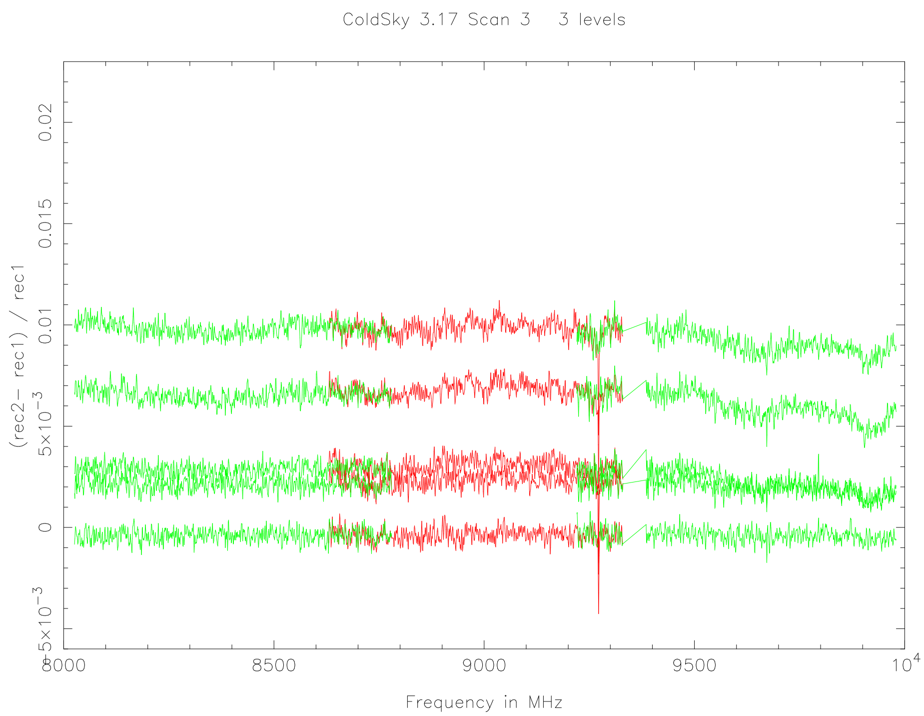

Figure 2: Scan 3: (recN - rec1) / rec1 for the RCP receiver channel. The bottom plot is 30-second record 2 minus record 1, and the successively higher plots are for records 5, 10, 15, and 20. The green traces at lower and higher frequencies are from spectrometer banks C and D, respectively, and the center red trace is from bank A. Plots from successive records are each offset higher by 0.001 from its neighbor so that the top plot should be offset by 0.005 from the bottom plot, if there where no drift in total power.

to determine pointing offsets of +8 arcseconds in cross-elevation and +25 arcseconds in elevation, which were used as local pointing offsets for the rest of the observing run. Figure 3 shows the Tsrc/Tsys spectra for NGC 7027 from the eight spectrometer channels with four connected to the LCP receiver channel and four to the RCP channel. To check the consistency of these measurements a second on-off scan pair was taken with the same receiver and IF setup, and the results from the two scan pairs is show in Figure 4. The spectra are essentially the same except for a small scale factor.

These spectra can also be compared with on-off spectra taken on September 26 with the identical receiver, IF, and spectrometer setup, and the results are shown in Figure 5. The match is almost perfect down to the finest detail except for a scale factor offset and some variation on frequency scale lengths of about 50 MHz and greater. Figure 6 is a blow-up of the center frequency range of the LCP channel spectra.

To repeat the comments in the September 26 report, there are a number of remarkable aspects of these spectra. First, the two spectrometer channels that share common frequencies and receiver and IF components through to the fiber receivers show significantly different Tsrc/Tsys spectra. Some general features appear to match, but the spectra disagree in detail. Second, there appears to be as much similarity between spectra from different front-end channels as between spectra from the same front-end and fiber channel but different converter/analog-filter/spectrometer channels. Third, spectra from the same receiver channel but different frequency ranges can be quite different in the overlap frequency ranges. Fourth, there is an offset in measured Tsrc/Tsys of up to 10 percent between spectra from the same front-end channel in the overlap regions. Fifth, there is a precipitous drop in Tsrc/Tsys near 10 GHz in the LCP channel spectrum. Finally, there are quite a few rather sharp features in these spectra, and it is a little hard to say what is RFI and what is intrinsic to the receiving system.

Many of the narrow features in the spectra repeat in frequency and amplitude from the two dates which may indicate that they are intrinsic to the receiving system rather than external RFI. Many of the spikes are resolved in frequency and are one or two MHz wide.

To separate front-end effects from IF and back-end effects to the Tsrc/Tsys spectra another scan pair with the first LO frequency offset by 50 MHz was taken. The results are shown in Figures 7 and 8. The results are essentially the same as for a similar test on September 26. Most of the narrow spectral features line up at constant sky frequency, which points to their coming into the system ahead of the first mixer. Also, the waves in the lowest frequency spectra with a period of roughly 400-MHz seem to line up in sky frequency. However, many of the intermediate-scale features appear to match better when the spectra are not offset (align at constant IF frequency), which strongly suggests that their origin is at or after the first mixer.

The next test was to return LO 1 to its original frequency and offset LO 2 by 50 MHz to attempt to separate spectral feature induced before the second mixer from those produced after this mixer. The results are shown in Figures 9 and

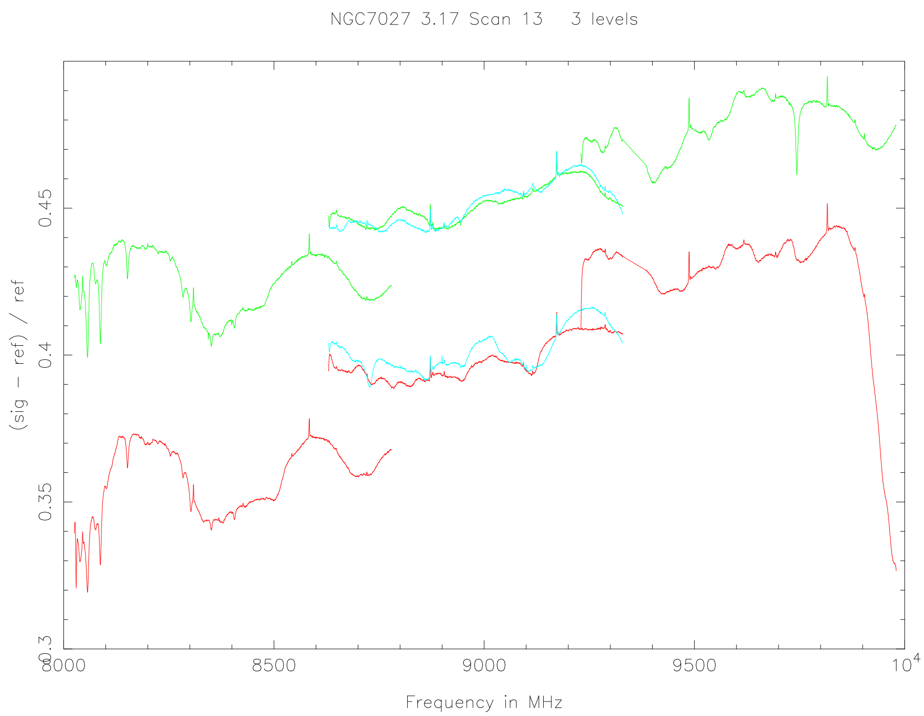

Figure 3: Scans 12-13: (on - off) / off, i.e. Tsrc/Tsys, spectra for the continuum source NGC 7027. The red traces are for the LCP receiver and the green traces for RCP. The lowest and highest frequency traces are from spectrometer banks C and D, respectively. The red and green center traces are from bank A and the blue-green traces are from bank B from the receiver channel to which they are closest.

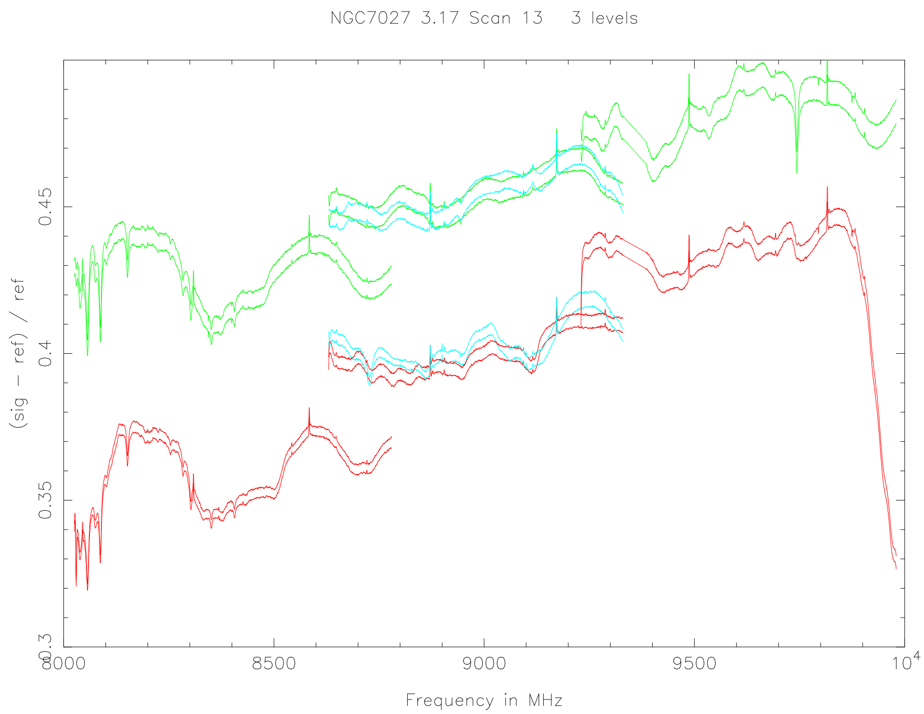

Figure 4: Scans 12-15: (on - off) / off, i.e. Tsrc/Tsys, spectra for the continuum source NGC 7027 with scan pair 14-15 overplotted on scan pair 12-13 from Figure 3. The red traces are for the LCP receiver and the green traces for RCP. The lowest and highest frequency traces are from spectrometer banks C and D, respectively. The red and green center traces are from bank A and the blue-green traces are from bank B from the receiver channel to which they are closest. In all cases the top trace of two plots from the same channel is from scan pair 14-15.

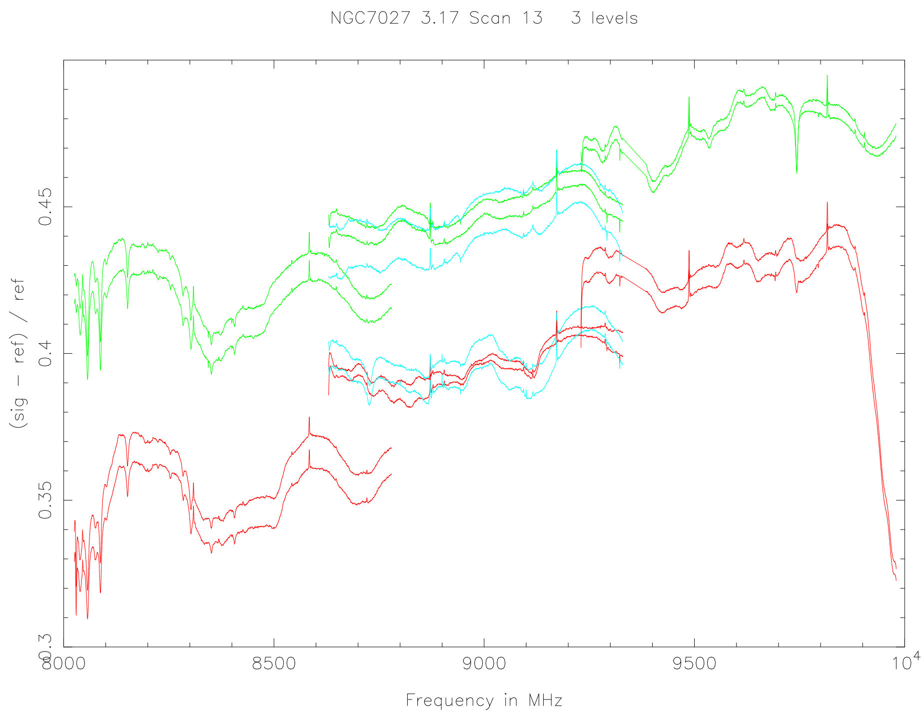

Figure 5: Scans 12-13 of Oct. 10 and scans 14-15 of Sept. 26: (on - off) / off, i.e. Tsrc/Tsys, spectra for the continuum source NGC 7027 with scans from Sept. 26 overplotted on scan pair 12-13 from Figure 3. The red traces are for the LCP receiver and the green traces for RCP. The lowest and highest frequency traces are from spectrometer banks C and D, respectively. The red and green center traces are from bank A and the blue-green traces are from bank B from the receiver channel to which they are closest. In all cases the lower trace of two plots from the same channel is from the Sept. 26 scan pair.

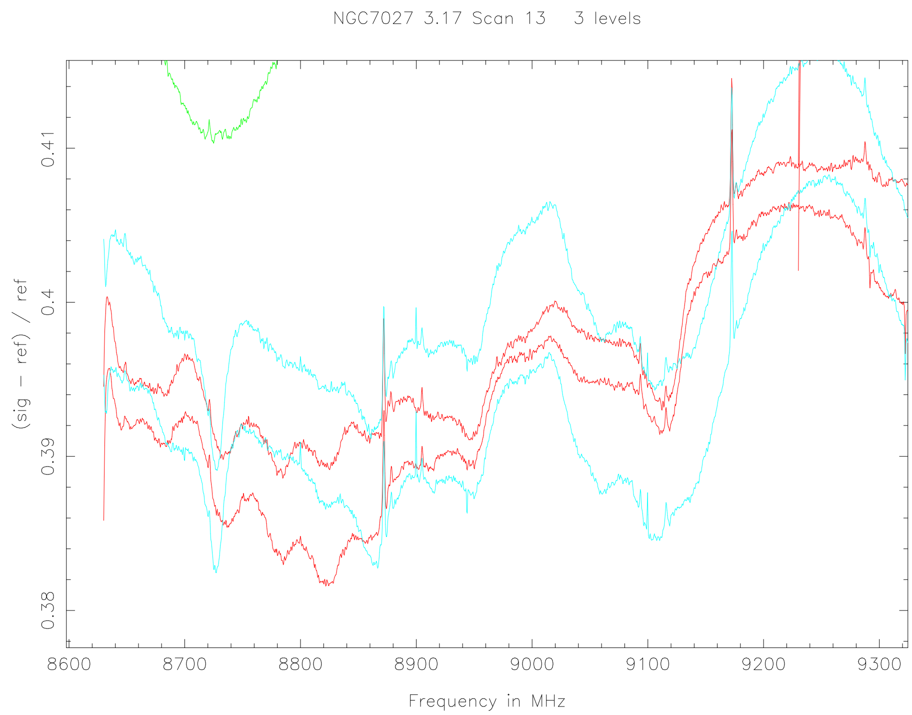

Figure 6: Scans 12-13 of Oct. 10 and scans 14-15 of Sept. 26: A zoom into the center frequency range of the LCP channel in Figure 5.

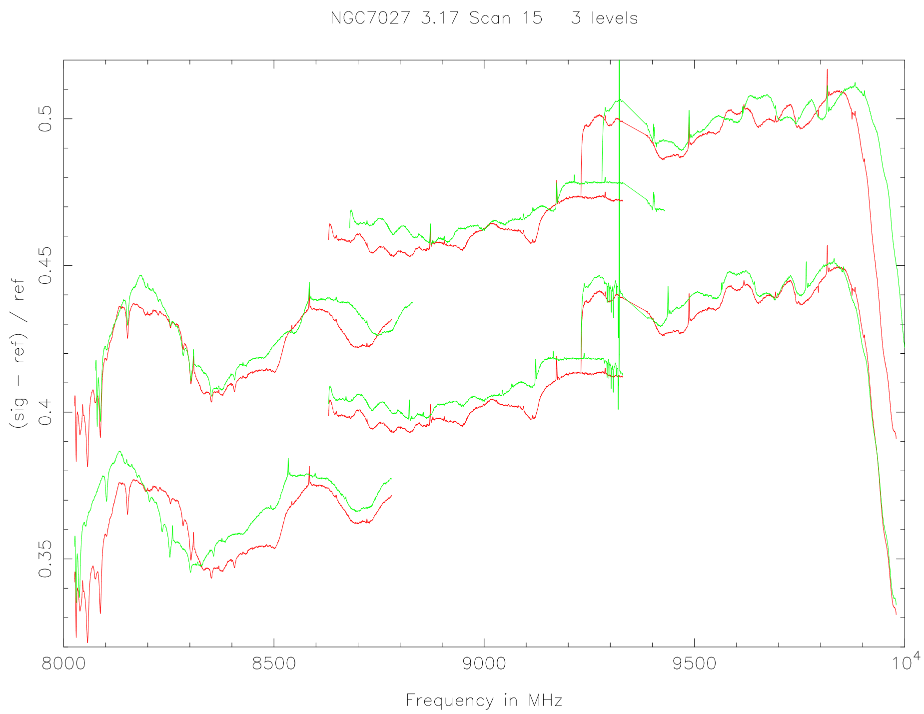

Figure 7: Scans 14-17: (on - off) / off, i.e. Tsrc/Tsys, spectra from the LCP receiver channel. The red traces are the same as in Figure 3. The green traces are spectra taken with the first LO set so that the sky center frequencies of all spectra were 50 MHz higher. The bottom set of spectra are plotted without offset so that spectral features introduced down-stream of the first mixer will line up in frequency. The top set of spectra are offset to maintain sky frequency alignment so that spectral features introduced ahead of the first mixer will line up.

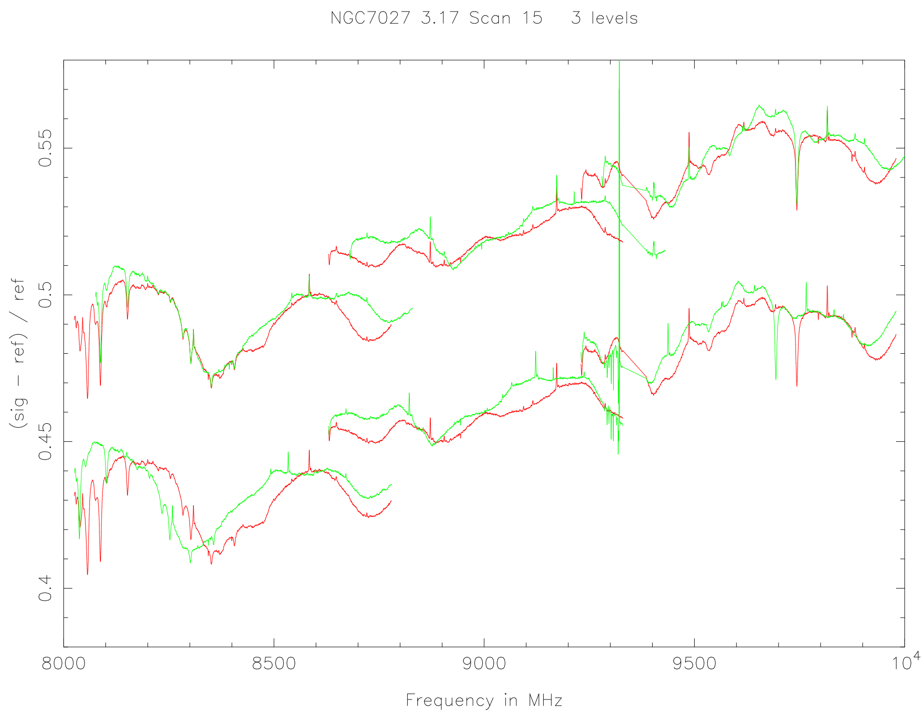

Figure 8: Scans 14-17: (on - off) / off, i.e. Tsrc/Tsys, spectra from the RCP receiver channel. The red traces are the same as the green traces in Figure 3. The green traces are spectra taken with the first LO set so that the sky center frequencies of all spectra were 50 MHz higher. The bottom set of spectra are plotted without offset so that spectral features introduced down-stream of the first mixer will line up in frequency. The top set of spectra are offset to maintain sky frequency alignment so that spectral features introduced ahead of the first mixer will line up.

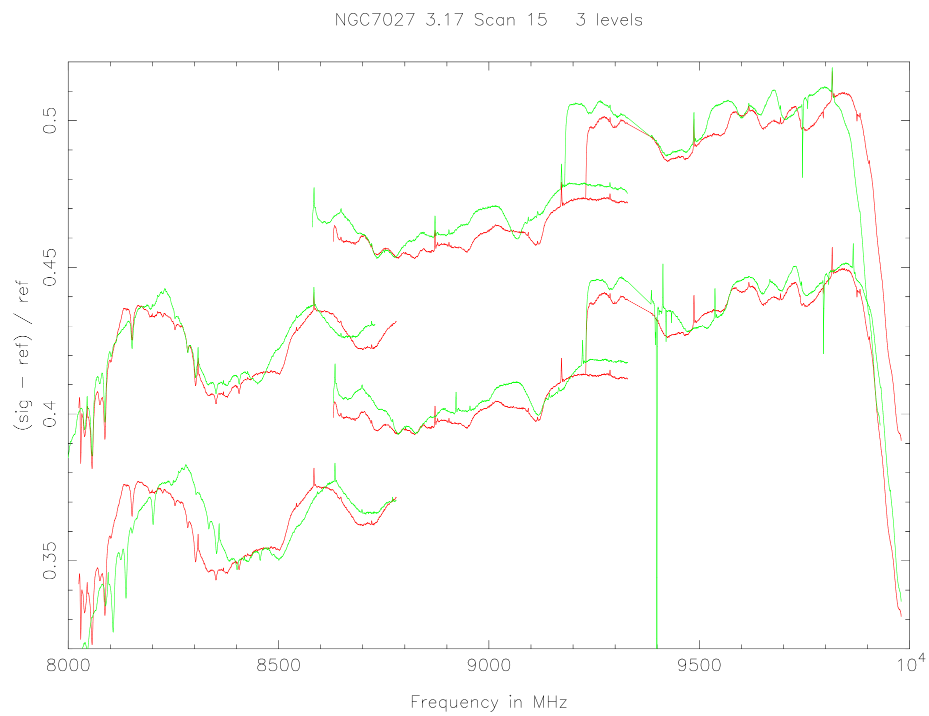

Figure 9: Scans 14-15, 18-19: (on - off) / off, i.e. Tsrc/Tsys, spectra from the LCP receiver channel. The red traces are the same as the top traces in Figure 4. The green traces are spectra taken with the second LO set to 12350 MHz so that the sky center frequencies of all spectra were 50 MHz lower. The bottom set of spectra are plotted without offset so that spectral features introduced downstream of the second mixer will line up in frequency. The top set of spectra are offset to maintain sky frequency alignment so that spectral features introduced ahead of the second mixer will line up.

10. Some of the features match better when the after-second-mixer frequencies are lined up, particularly in ripple scale lengths in the 40-70 MHz range, while other features, particularly in the mid and low frequency ranges of the RCP channel, match better when the before-mixer frequencies are lined up.

Next, we set all of the LO2 frequencies to 12300 MHz and left LO1 at 12000 MHZ so that all spectrometer samplers were looking at the same IF and sky frequency range to look at the differences betwen spectra from the same front-end and fiber signal path but different IF paths following the fiber receiver power splitter. The results are show in Figures 11 and 12. The general shapes and some fine-scale features of the spectra are similar within one front-end channel, but the spectra are quite different in detail at intermediate frequency scale lengths.

One possible cause of the difference in spectra from different IF and sampler

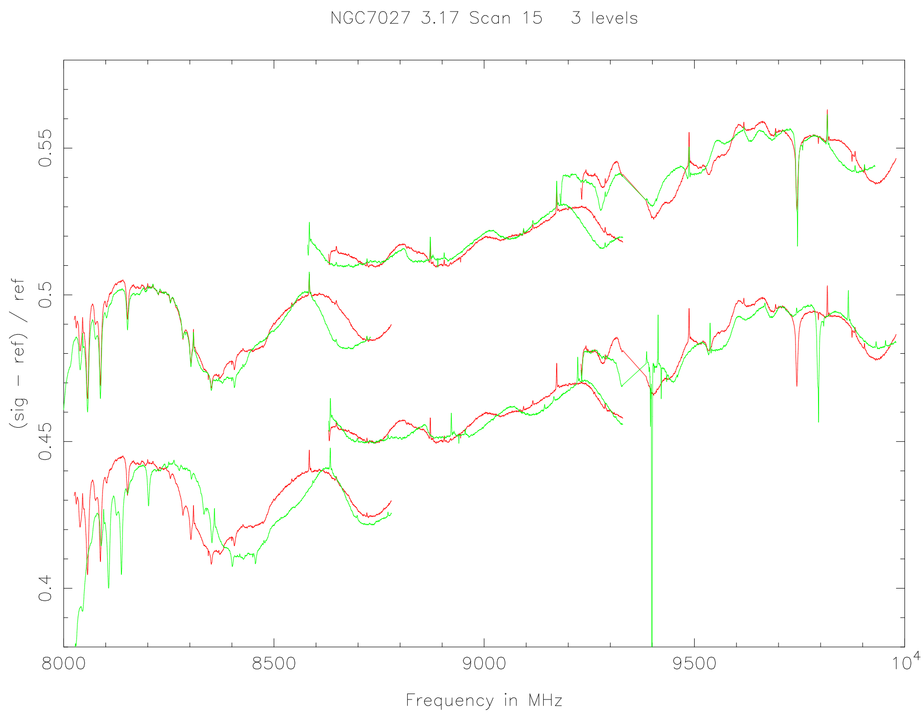

Figure 10: Scans 14-15, 18-19: (on - off) / off, i.e. Tsrc/Tsys, spectra from the RCP receiver channel. The red traces are the same as the top traces in Figure 4. The green traces are spectra taken with the second LO set to 12350 MHz so that the sky center frequencies of all spectra were 50 MHz lower. The bottom set of spectra are plotted without offset so that spectral features introduced downstream of the second mixer will line up in frequency. The top set of spectra are offset to maintain sky frequency alignment so that spectral features introduced ahead of the second mixer will line up.

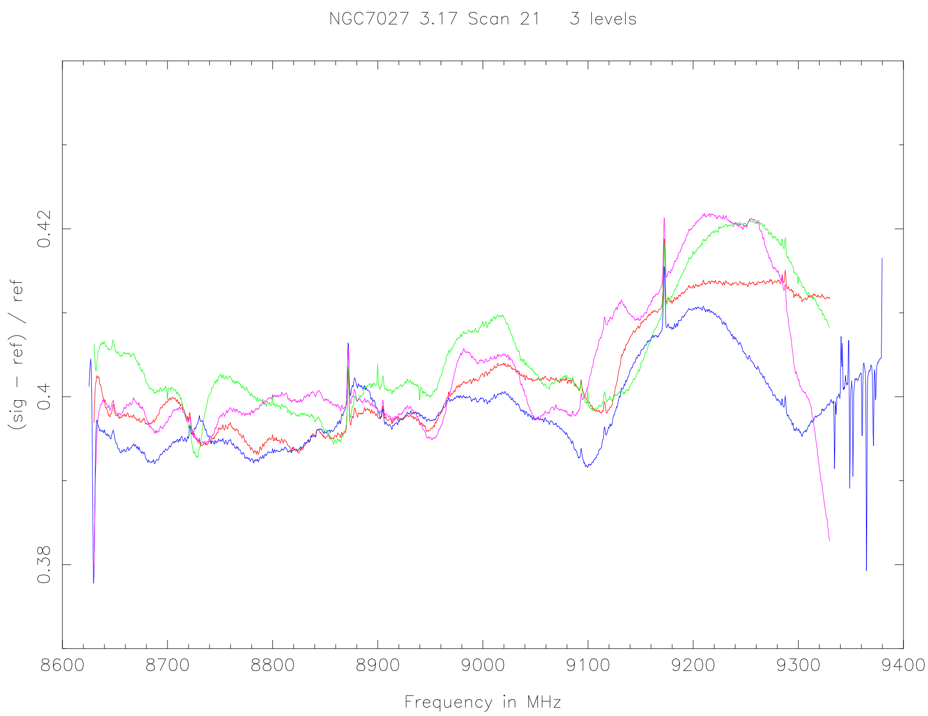

Figure 11: Scans 20-21: (on - off) / off, i.e. Tsrc/Tsys, spectra from the LCP receiver channel using the same LO2 frequency for all channels. The red trace is from spectrometer Bank A, green from Bank B, blue from Bank C, and violet from Bank D.

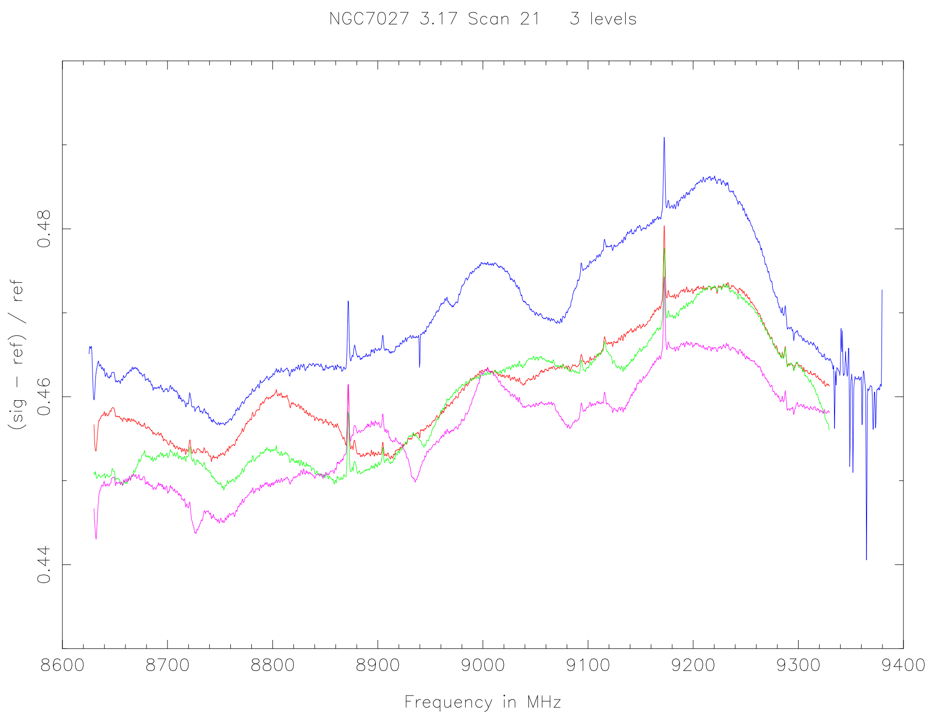

Figure 12: Scans 20-21: (on - off) / off, i.e. Tsrc/Tsys, spectra from the RCP receiver channel using the same LO2 frequency for all channels. The red trace is from spectrometer Bank A, green from Bank B, blue from Bank C, and violet from Bank D.

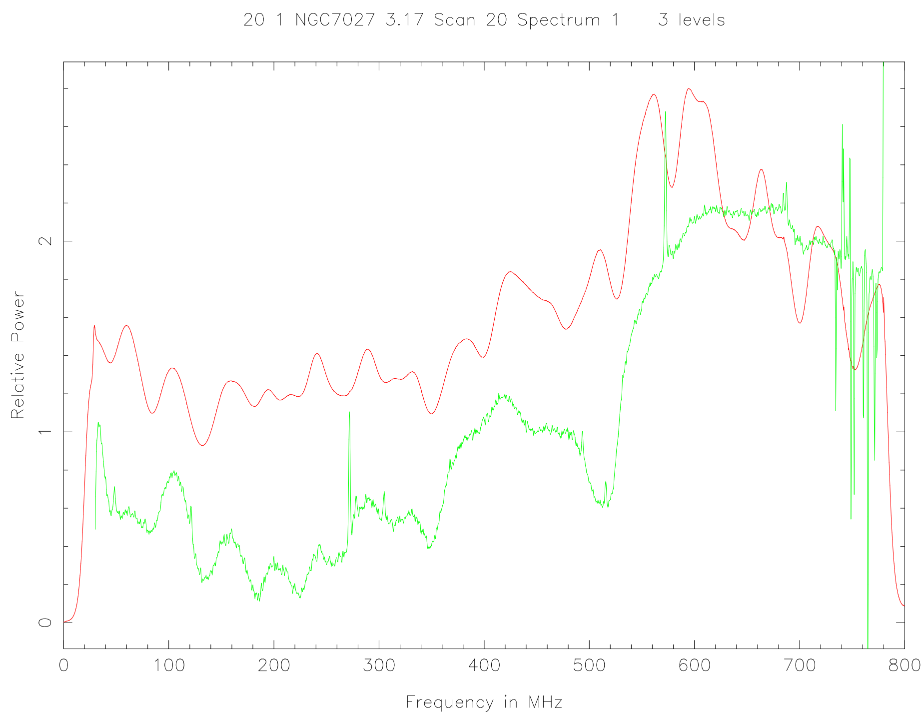

Figure 13: Scan 20: Total power spectrum (red) and 100 times the (on - off) / off spectrum of NGC 7027 (green) from the LCP receiver channel and spectrometer Bank A. The frequency scale is for baseband and corresponds to the inverted sampler input frquency range of 1600 to 800 MHz.

channels is that there is a small but significant amount of noise added by amplifier stages in the IF system. This would show up as a slightly higher system temperature (hence, a lower (on-off)/off specrum value) at frequencies where the preceding gain is relatively lower than at other frequencies. A suggestion of this possibility is shown in Figures 13 and 14 where the total power spectrum and a 100-times expanded (on-off)/off spectrum of NGC 7027 are plotted together. If we assume that the total power spectrum is a good indication of the frequency dependence of the system gain, there is, indeed, a pretty good correspondence between low gain and low values in the continuum source spectrum, particularly in the frequency scale length range of 30-60 MHz.

To investigate the possibility of sigificant noise from the IF amplifiers the last three experiments of this session tried redistributing the gain within the IF system. Six-dB pads were added at the inputs of four (J1, J3, J6, and J8) of the eight spectrometer samplers. The first experiment rebalanced the sampler input levels by removing attenuation in the Converter Rack modules. Hence, the signal levels between the Converter Rack attenuators and the sampler inputs were 6 dB

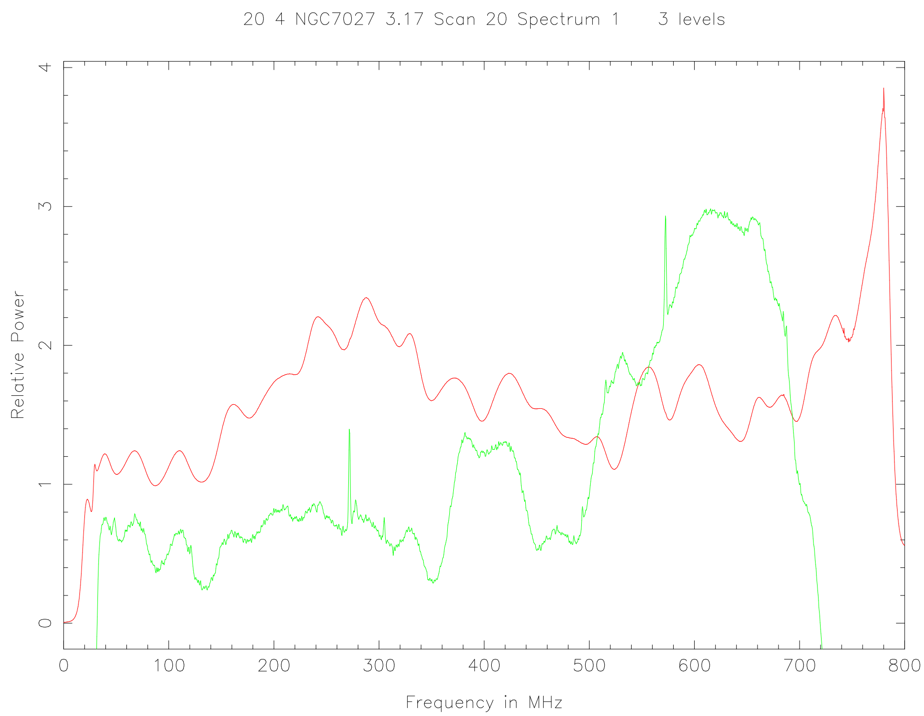

Figure 14: Scan 20: Total power spectrum (red) and 100 times the (on - off) / off spectrum of NGC 7027 (green) from the LCP receiver channel and spectrometer Bank D. The frequency scale is for baseband and corresponds to the inverted sampler input frquency range of 1600 to 800 MHz.

higher than in the measurements shown in Figures 11 and 12. The comparisons of NGC 7027 spectra measured before and after this gain redistribution are shown in Figures 15 through 18. Very little difference between the spectra before and after the gain distribution change is seen, which indicates that the IF stages between the Converter Rack attenuators and the sampler input are not the dominant cause of the observed spectral features.

In the next measurement the same 6-dB pads were left at the four sampler inputs, but, instead of removing 6 dB in the Converter Rack attenuators, 6 dB was removed from the IF Rack variable attenuators. Hence, the signal levels all the way from the IF Rack attenuators to the sampler inputs were 6 dB higher than in the measurements shown in Figures 11 and 12. The comparisons of NGC 7027 spectra measured before and after this gain redistribution are shown in Figures 19 through 22. Again, relatively little difference between the spectra before and after the gain distribution change is seen, which indicates that the IF stages between the IF Rack attenuators and the sampler input are not the dominant cause of the observed spectral features. The main differences between the spectra are on frequency scales greater than 100 MHz and could have been caused by small drifts in the system in the time between the two scan pairs.

The final test was to increase the attenuations in the IF Rack by 3 dB without rebalancing the sampler levels so that the signal level throughout the entire system after these attenuators is 3 dB lower than in the scan pair 24-25. The comparisons are shown in Figures 23 through 26. In this case we see a big difference in the spectra in the sense that lower signal levels produce larger abplitiude variations in the continuum source spectrum as a function of frequency. Since changing signal levels before the samplers made little difference, it appears that either the samplers are contributing a significant amount of noise or there is a non-linearity in the spectrometer that has not been accounted for.

Another test of the effect of changing the sampler input level was performed on October 23 using the same setup as for the data shown in Figures 23 through 26, but this time the sampler input levels were increased by 3 dB over their nominal operating points. The results are overplotted on the Figure 23 through 26 data and shown in Figures 27 through 30. These plots clearly show that the baseline variation on a strong continuum source are higher when the sampler input is lower. This would be consistent with noise in the sampler, but there could be other causes.

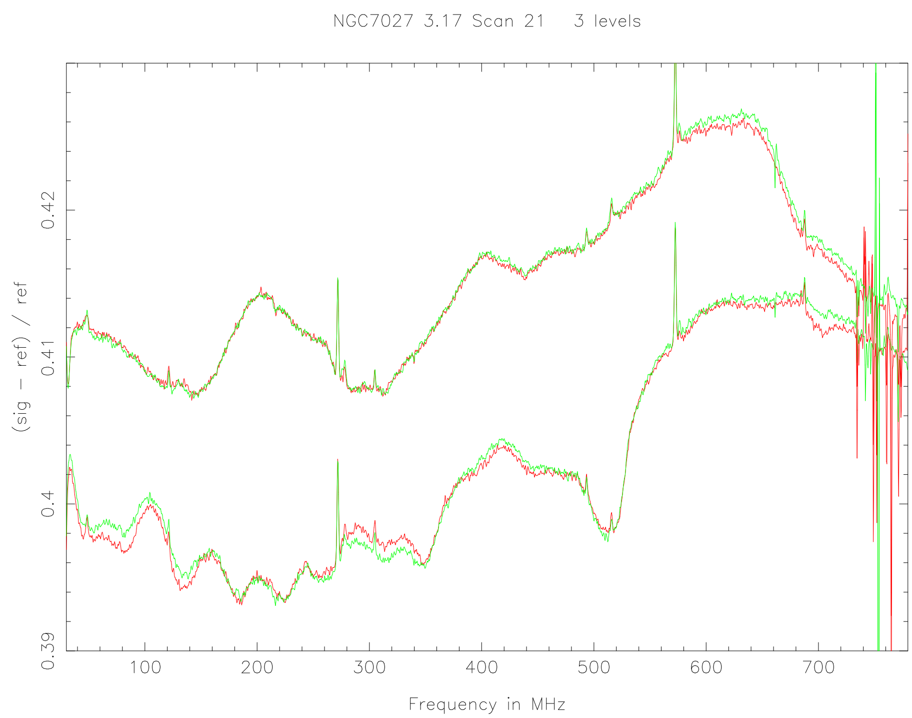

Figure 15: Scans 20-23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank A. The red traces are from the original gain distribution, and the lower (LCP) green trace has 6 dB higher signal level between the Converter Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 2 or 3 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

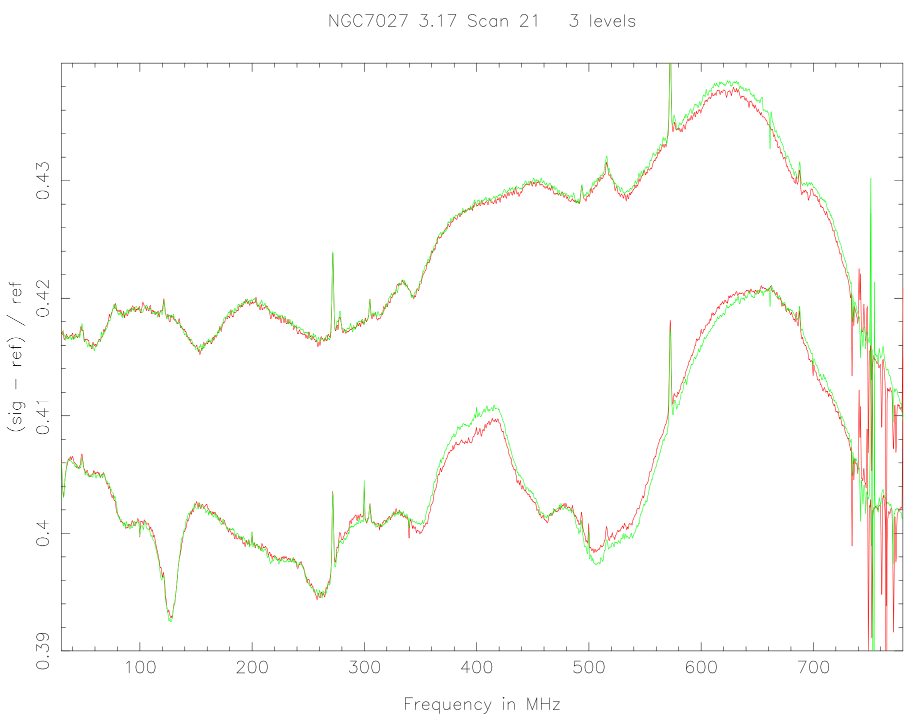

Figure 16: Scans 20-23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank B. The red traces are from the original gain distribution, and the lower (LCP) green trace has 6 dB higher signal level between the Converter Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 2 or 3 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

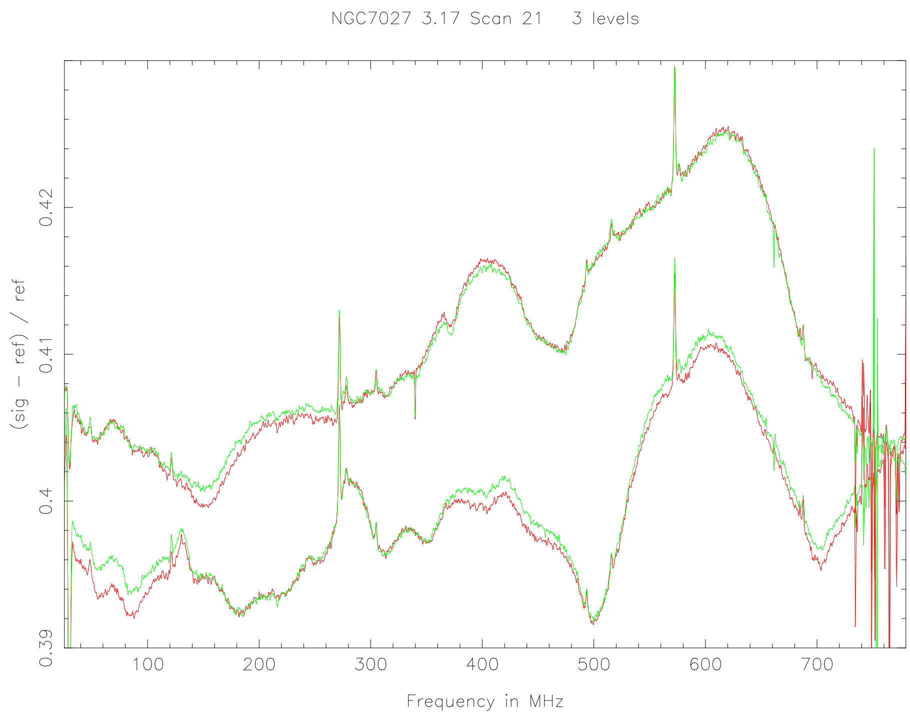

Figure 17: Scans 20-23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank C. The red traces are from the original gain distribution, and the upper (RCP) green trace has 6 dB higher signal level between the Converter Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 2 or 3 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

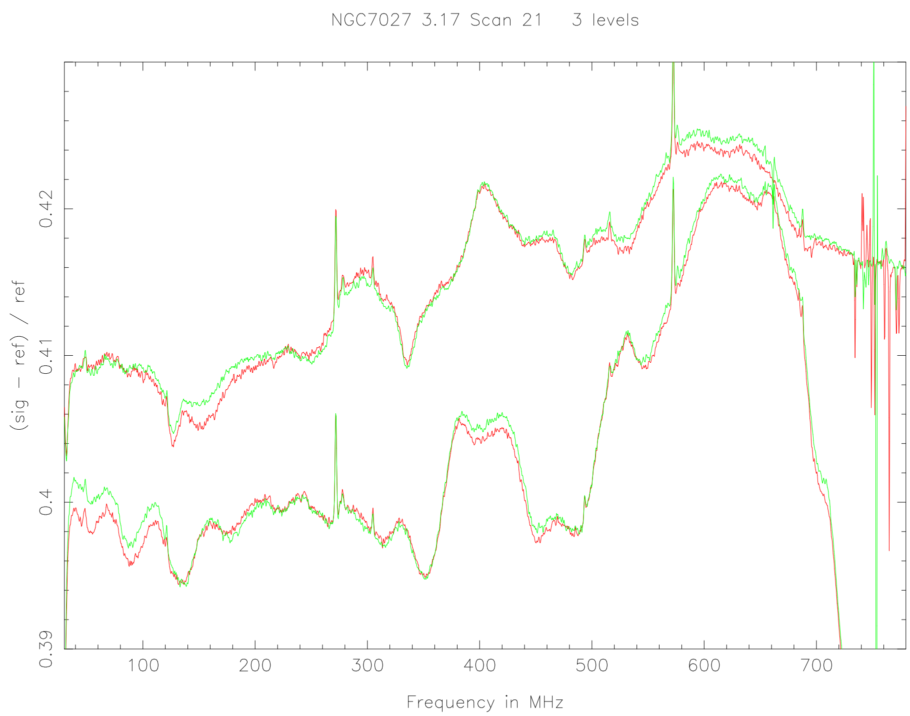

Figure 18: Scans 20-23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank D. The red traces are from the original gain distribution, and the upper (RCP) green trace has 6 dB higher signal level between the Converter Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 2 or 3 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

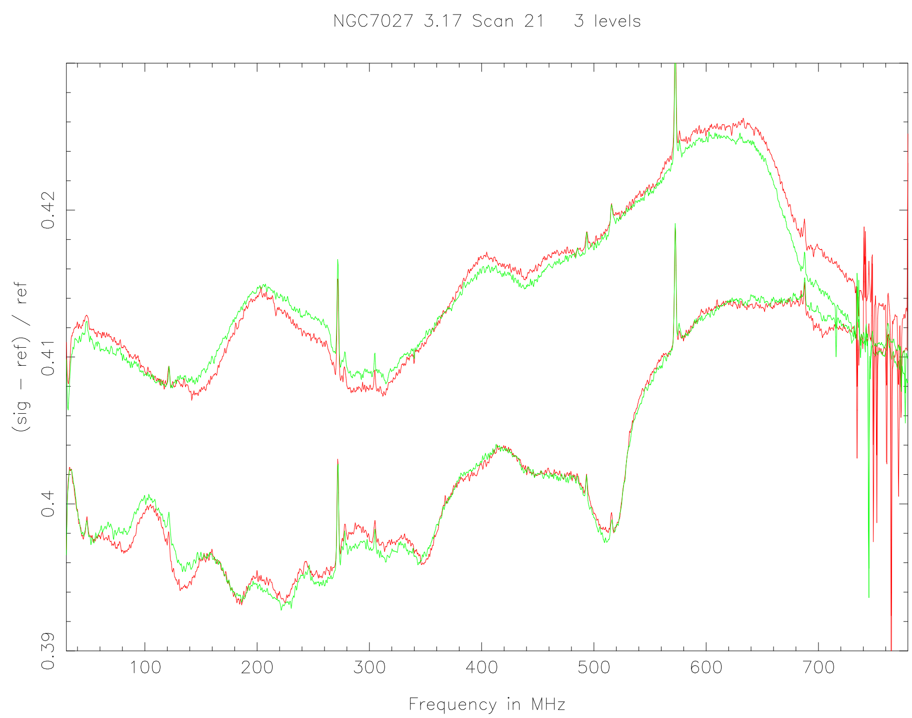

Figure 19: Scans 20-21, 24-25: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank A. The red traces are from the original gain distribution, and the lower (LCP) green trace has 6 dB higher signal level between the IF Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 3 or 4 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

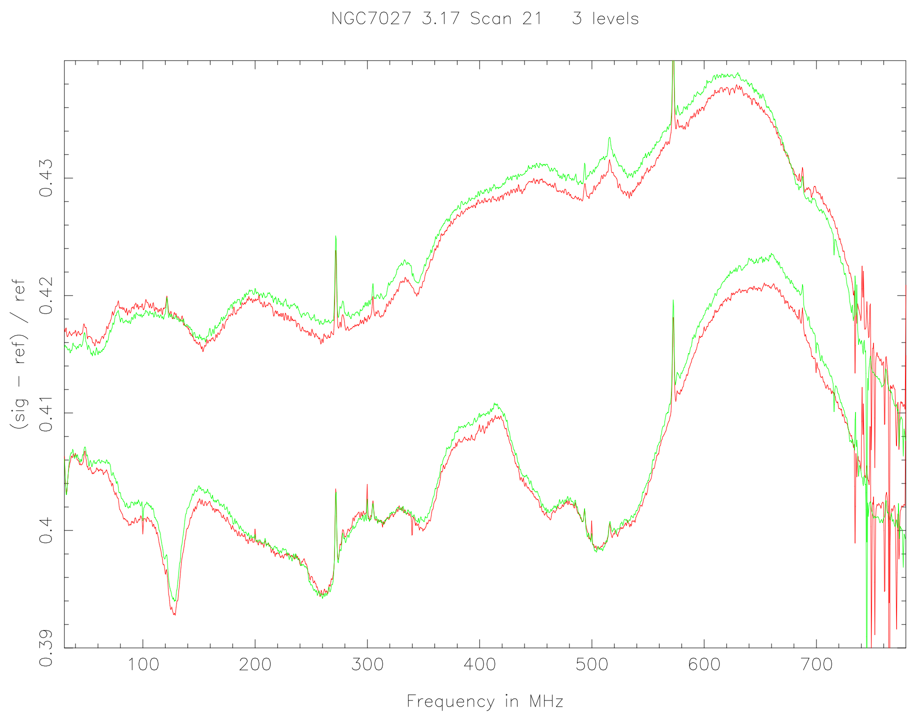

Figure 20: Scans 20-21, 24-25: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank B. The red traces are from the original gain distribution, and the lower (LCP) green trace has 6 dB higher signal level between the IF Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 3 or 4 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

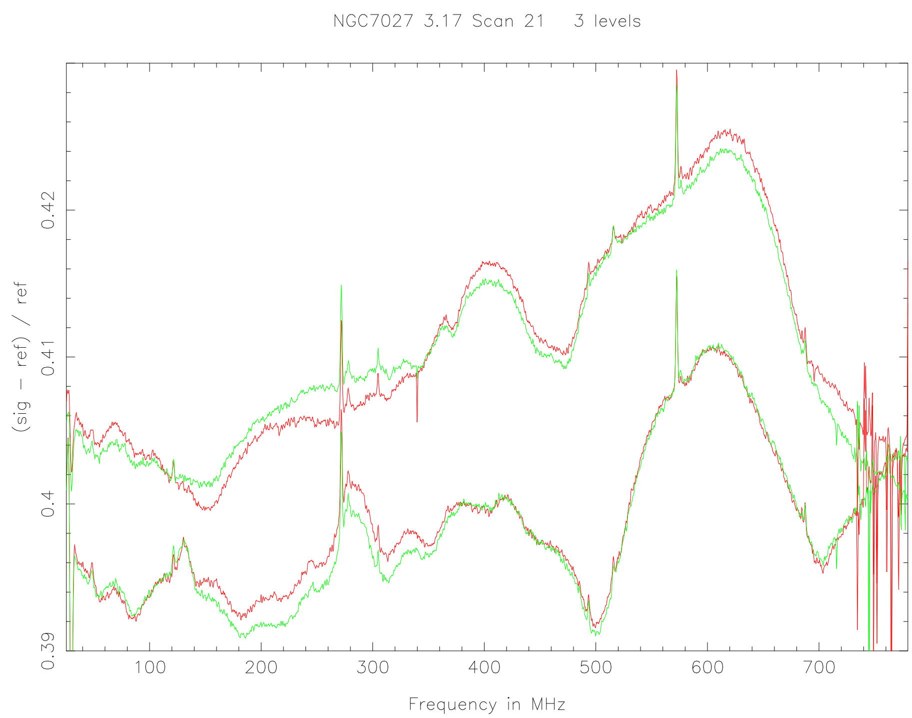

Figure 21: Scans 20-21, 24-25: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank C. The red traces are from the original gain distribution, and the upper (RCP) green trace has 6 dB higher signal level between the IF Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 3 or 4 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

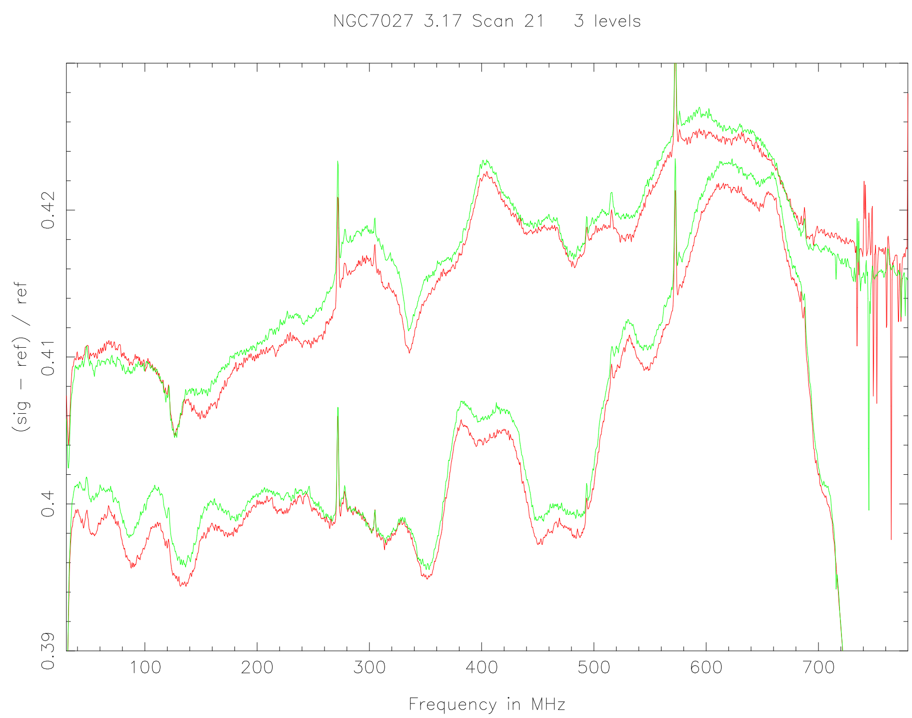

Figure 22: Scans 20-21, 24-25: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank D. The red traces are from the original gain distribution, and the upper (RCP) green trace has 6 dB higher signal level between the IF Rack attenuators and the 6 dB pad at its sampler input. The green spectra have been scaled down by 3 or 4 percent to produce a close overlay, and the RCP spectra have been scaled down by about 10 percent to put the RCP and LCP on the same graph with a slight offset. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

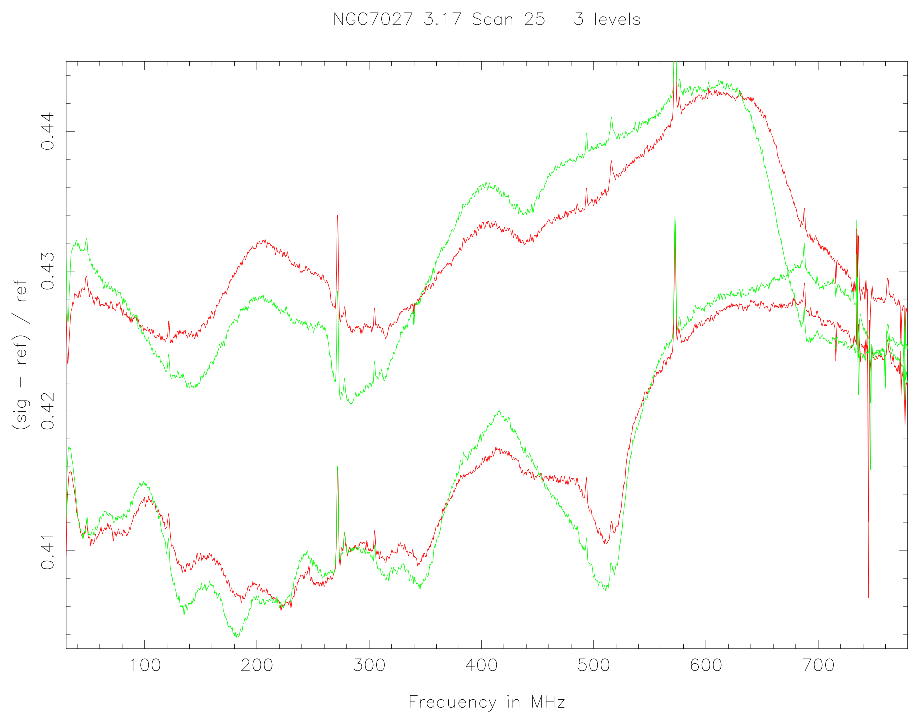

Figure 23: Scans 24-27: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank A. The red traces are from the scan pair 24-25 where the sampler levels were set to their nominal operating point, and the green traces are for scan pair 26-27 where 3 dB of attenuation has been added to the IF rack attenuators in both receiver channels to produce a factor of two lower input level to the samplers. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

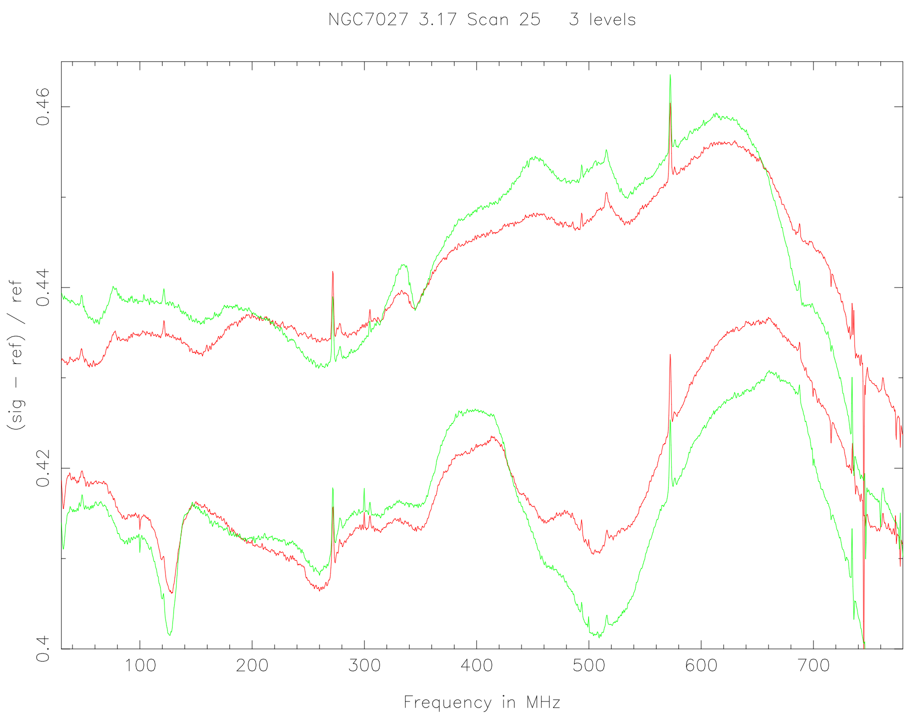

Figure 24: Scans 24-27: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank B. The red traces are from the scan pair 24-25 where the sampler levels were set to their nominal operating point, and the green traces are for scan pair 26-27 where 3 dB of attenuation has been added to the IF rack attenuators in both receiver channels to produce a factor of two lower input level to the samplers. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

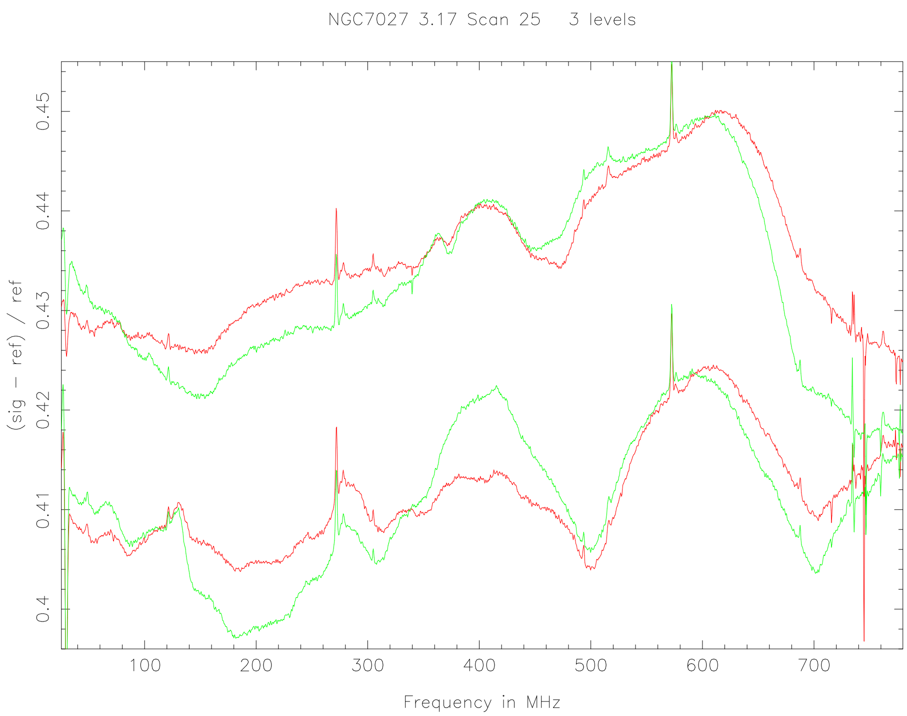

Figure 25: Scans 24-27: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank C. The red traces are from the scan pair 24-25 where the sampler levels were set to their nominal operating point, and the green traces are for scan pair 26-27 where 3 dB of attenuation has been added to the IF rack attenuators in both receiver channels to produce a factor of two lower input level to the samplers. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

Figure 26: Scans 24-27: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank D. The red traces are from the scan pair 24-25 where the sampler levels were set to their nominal operating point, and the green traces are for scan pair 26-27 where 3 dB of attenuation has been added to the IF rack attenuators in both receiver channels to produce a factor of two lower input level to the samplers. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

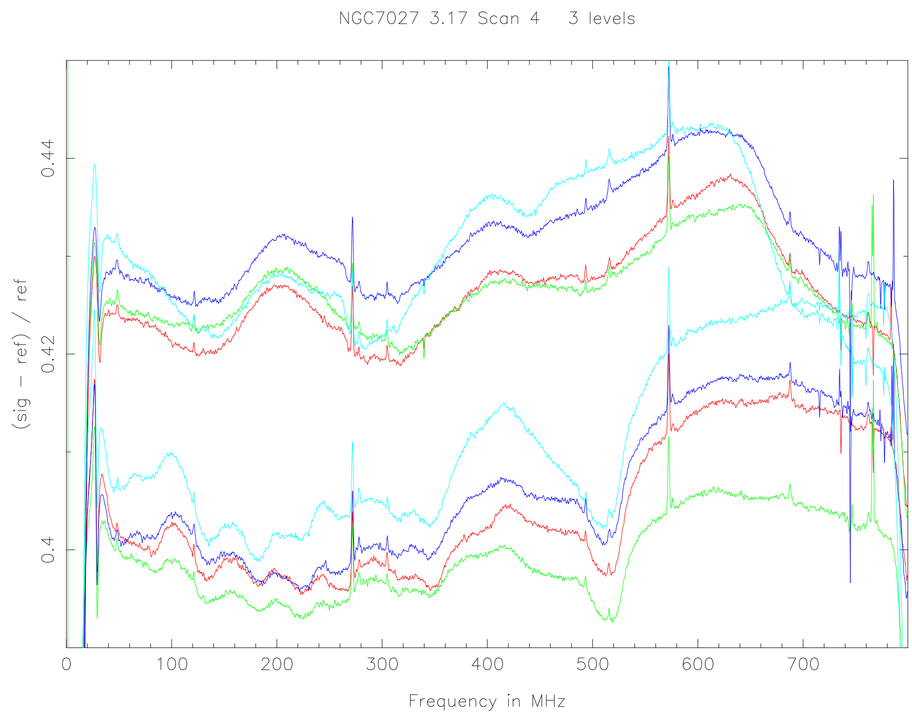

Figure 27: Scans 24-27 of October 10 and scans 3-6 of October 23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank A. The red traces are from the scan pair 24-25, and the dark blue traces are from the scan pair 3-4, where the sampler levels were set to their nominal operating points. The blue-green traces are for scan pair 26-27 where the sampler input levels were 3 dB below nominal. The green traces are for scan pair 5-6 where the sampler input levels were 3 dB above nominal. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

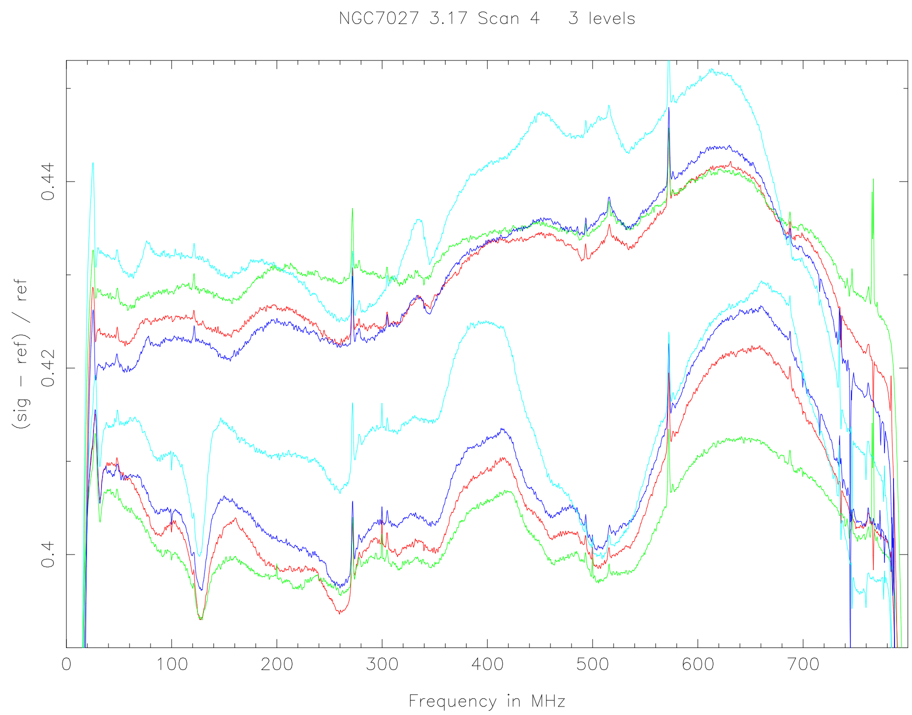

Figure 28: Scans 24-27 of October 10 and scans 3-6 of October 23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank B. The red traces are from the scan pair 24-25, and the dark blue traces are from the scan pair 3-4, where the sampler levels were set to their nominal operating points. The blue-green traces are for scan pair 26-27 where the sampler input levels were 3 dB below nominal. The green traces are for scan pair 5-6 where the sampler input levels were 3 dB above nominal. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

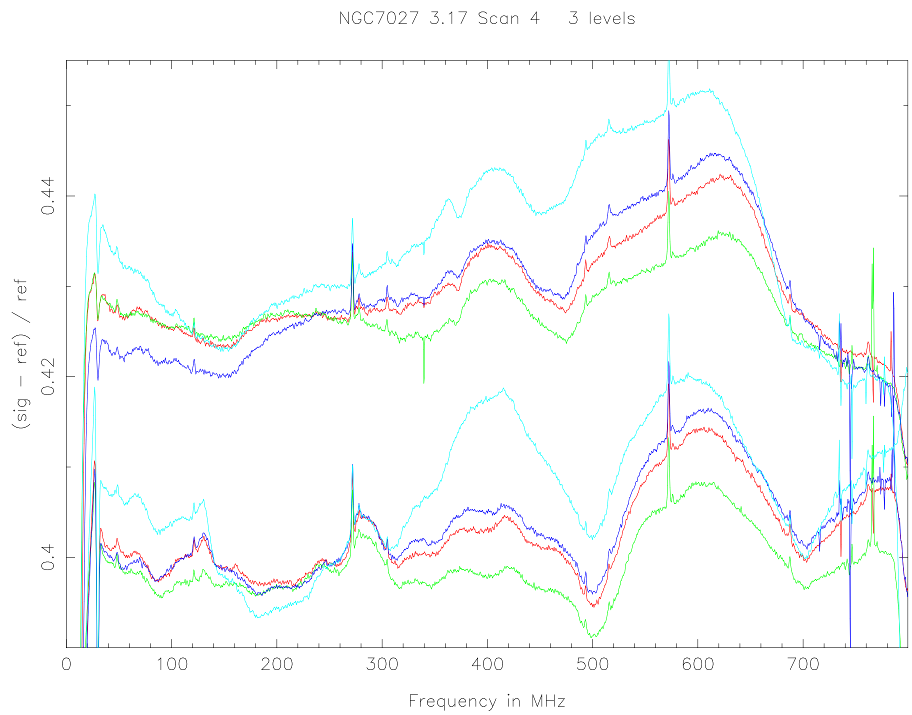

Figure 29: Scans 24-27 of October 10 and scans 3-6 of October 23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank C. The red traces are from the scan pair 24-25, and the dark blue traces are from the scan pair 3-4, where the sampler levels were set to their nominal operating points. The blue-green traces are for scan pair 26-27 where the sampler input levels were 3 dB below nominal. The green traces are for scan pair 5-6 where the sampler input levels were 3 dB above nominal. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.

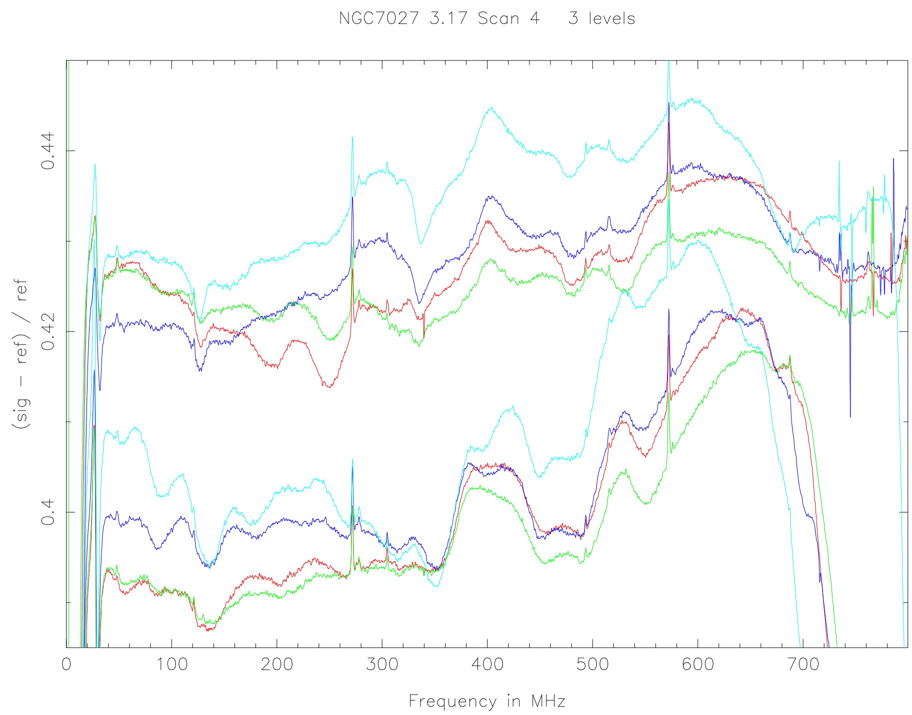

Figure 30: Scans 24-27 of October 10 and scans 3-6 of October 23: (on - off) / off spectra of NGC 7027 from the LCP (lower traces) and RCP (upper traces) receiver channels and spectrometer Bank D. The red traces are from the scan pair 24-25, and the dark blue traces are from the scan pair 3-4, where the sampler levels were set to their nominal operating points. The blue-green traces are for scan pair 26-27 where the sampler input levels were 3 dB below nominal. The green traces are for scan pair 5-6 where the sampler input levels were 3 dB above nominal. The spectra have been scaled by a few percent to get the traces to overlap for comparison and to separate the LCP and RCP traces slightly. The frequency scale is for baseband and corresponds to the inverted sampler input frequency range of 1600 to 800 MHz.