Fiber Gain Stability Tests with DCR and IF Noise Source
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Setup

The narrow-band IF noise source was used as the input signal to all eight IF rack channels. The IF rack filters were set to 2360 to 3640 MHz passband, and the analog filter rack outputs were set to 800 to 1600 MHz passband. All DCR channels were used with channels 1-8 connected to the IF rack outputs ODM1-8 and DCR channels 9-16 connected to analog filter rack outputs SF1-8. Only four of the IF rack outputs to the DCR are useful at one time since the IF noise source can be routed to either the odd or even numbered outputs but not both. Each of the four active fiber channels were routed to two converter rack and analog filter rack channels, each of which appeared in a separate DCR channel. The DCR channels 9-16 connection matrix is shown in Table 1. Optical fiber modules 4 and 7 were out of service, and optical fiber module 8 was a direct-modulated unit. All others used external laser modulation. An integration time of 1 second was used for all measurements.

Antenna Stationary

The first two scans were 15 minutes long with the antenna not moving at Azimuth=44.15, Elevation=77.85. Scan 2 had the odd numbered IF rack outputs

Table 1: IF Rack to DCR Connection Matrix

OR odd	OR even	CM	SF	DCR
1	2	1	1	9
1	2	2	2	10
5	6	11	3	11
5	6	12	4	12
3	4	5	5	13
3	4	6	6	14
7	8	15	7	15
7	8	16	8	16

connected to the DCR with fiber 7 out of service. Scan 3 had the even numbered IF rack outputs connected to the DCR with fiber 4 out of service.

Figure 1 shows the results of 15 minutes of total power monitoring of fiber channels 1, 3, and 5. The red, green, and dark blue traces show the powers at the respective inputs to the fibers, and the orange, blue-green, and violet traces show the corresponding signals after passing through the fibers, converter modules, and analog filter modules. The signals are somewhat less stable after passing through the fibers and converter and analog filter modules, particularly fiber channel 5, which uses converter modules 11 and 12 and analog filter modules 3 and 4. There is significant short-term correlation in the fluctuations of the two violet curves, which suggests that much of this added gain instability is due to fiber link 5. The long-term correlations between curves within the fiber 3 and 5 downstream signal pairs may be due to common response of the converter modules to 8-minute period room temperature fluctuations as found with a test noise source earlier in the day.

Figure 2 shows a similar plot for the even numbered fiber channels. The signals on these channels are clearly less stable after the fibers and converter and analog filter modules, particularly fiber channels 2 and 8. Fiber channel 2 shows considerable short term fluctuation correlations between the outputs of its two converter module channels, which indicates that this fiber link may be the source of much of this instability. A somewhat weaker short term correlation can be seen in fiber 8's downstream signal powers (violet curves).

Antenna Moving in Azimuth

Figures 3 and 4 show the same quantities that were plotted in Figure 1 for fibers 1, 3, and 5, but with the antenna moving in azimuth at 35 degrees/minute from lower to higher azimuths during the scan. Figures 5 and 6 show the same quantities as plotted in Figure 2 for fiber channels 2, 6, and 8 but with the antenna moving in azimuth. This time the two azimuth scans are in opposite directions with Figure 5 increasing in azimuth and Figure 6 having azimuth decrease with time. Once again, the after-fiber signals are markedly less stable in fiber channels 2 and 5 than in the other 4. The correlations in short term fluctuations of the two signals from the same fiber are even tighter than in the stationary antenna results. There is no evidence that azimuth motion of the antenna has any effect on total power stability in any of the IF channels, but small variations could be hidden by the other gain instabilities. Fiber channel 8 used the direct modulated laser, and it does not appear to be remarkably less stable than the externally modulated laser links with or without azimuth motion. It's not quite as good as the best link but certainly not the worst.

Antenna Moving in Elevation

Figures 7 and 8 show the same quantities that were plotted in Figures 1 and 2, respectively, but with the antenna moving in elevation during the scan. In this relatively short scan the signals detected after passing through the fibers 1, 3, and 5 and their converter and analog filter modules seem only slightly less stable in total power than they are at the input to the fibers. The signal from fiber 2 still has the poorest short term stability of the six measured. The variation in the outputs of fibers 6 and 8 suggests an elevation dependence of the insertion loss of these two fiber channels, but an elevation scan in the reverse direction from 20 to 85 degrees shown in Figure 9 does not provide a good confirmation of this suspicion.

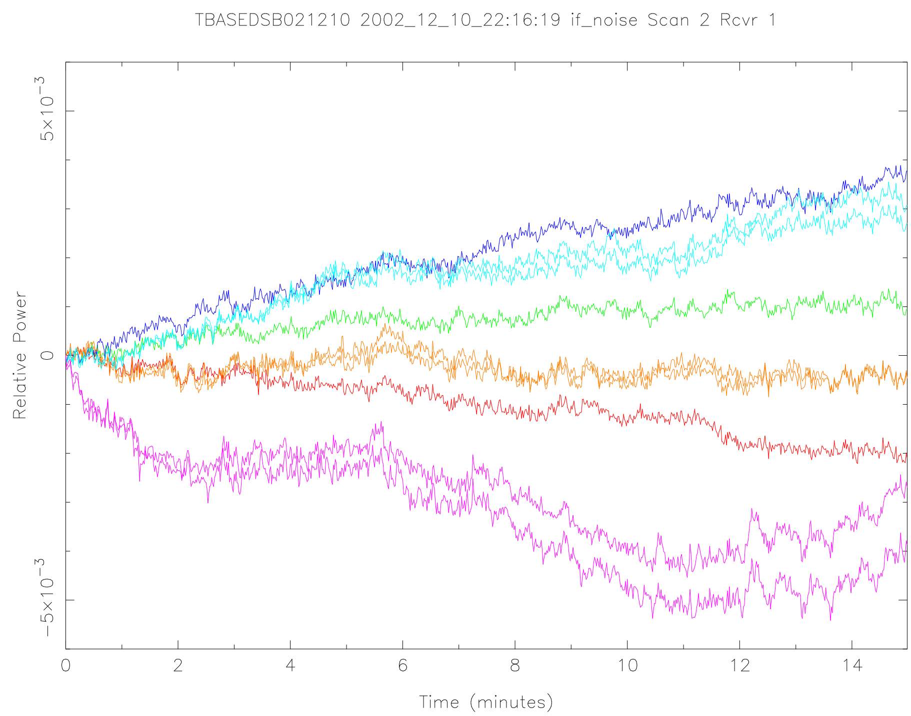

Figure 1: Scan 2, Odd numbered fibers, antenna stationary. The red and orange curves show total powers measured on fiber channel 1 at the output of the IF filter rack (before fiber) and the analog filter rack (after fiber and converter modules), respectively. The green and blue-green curves are corresponding plots for fiber channel 3, and the dark blue and violet curves are for fiber channel 5. Two curves of the same color are for the same fiber channel split and sent to different converter and analog filter modules channels. All curves are normalized to the first data value, where the vertical axis is the fraction of the first data value.

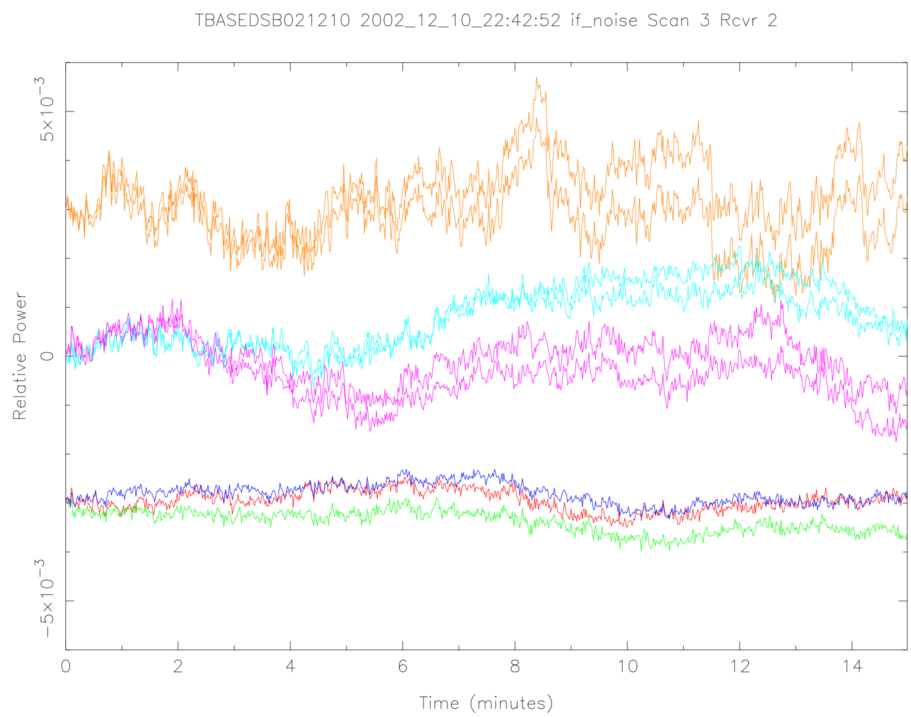

Figure 2: Scan 3, Even numbered fibers, antenna stationary. The red and orange curves show total powers measured on fiber channel 2 at the output of the IF filter rack (before fiber) and the analog filter rack (after fiber and converter modules), respectively. The green and blue-green curves are corresponding plots for fiber channel 6, and the dark blue and violet curves are for fiber channel 8. Two curves of the same color are for the same fiber channel split and sent to different converter and analog filter modules channels. All curves are normalized to the first data value, where the vertical axis is the fraction of the first data value. The before-fiber curves are offset by -0.003, and fiber 2's after-fiber curves is offset by +0.003 for clarity.

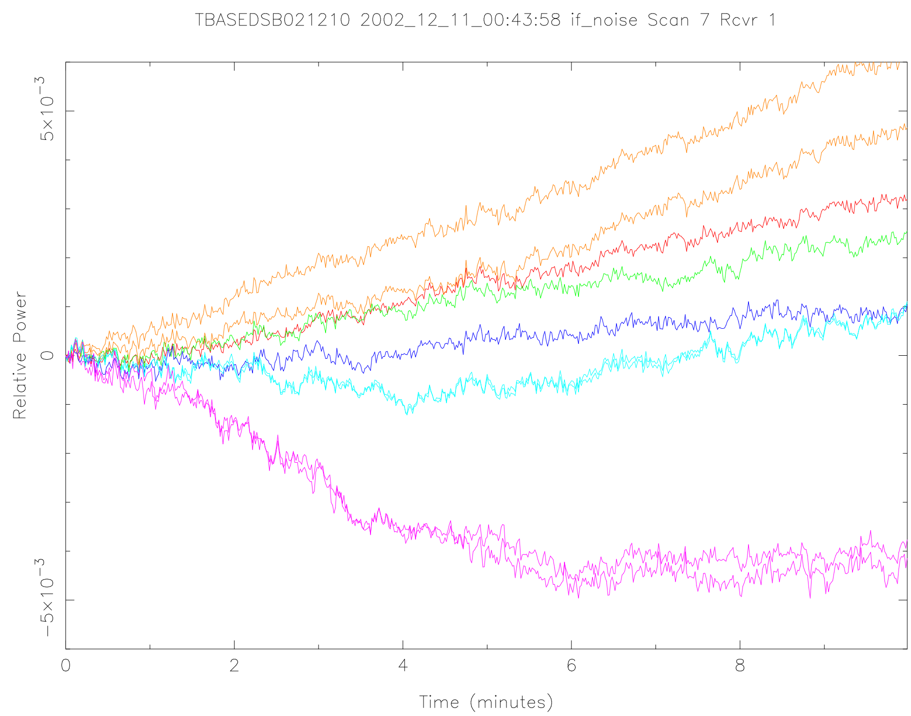

Figure 3: Scan 7, Odd numbered fibers, antenna moving in azimuth from 0 to 360 degrees during the scan. The red and orange curves show total powers measured on fiber channel 1 at the output of the IF filter rack (before fiber) and the analog filter rack (after fiber and converter modules), respectively. The green and blue-green curves are corresponding plots for fiber channel 3, and the dark blue and violet curves are for fiber channel 5. Two curves of the same color are for the same fiber channel split and sent to different converter and analog filter modules channels. All curves are normalized to the first data value, where the vertical axis is the fraction of the first data value.

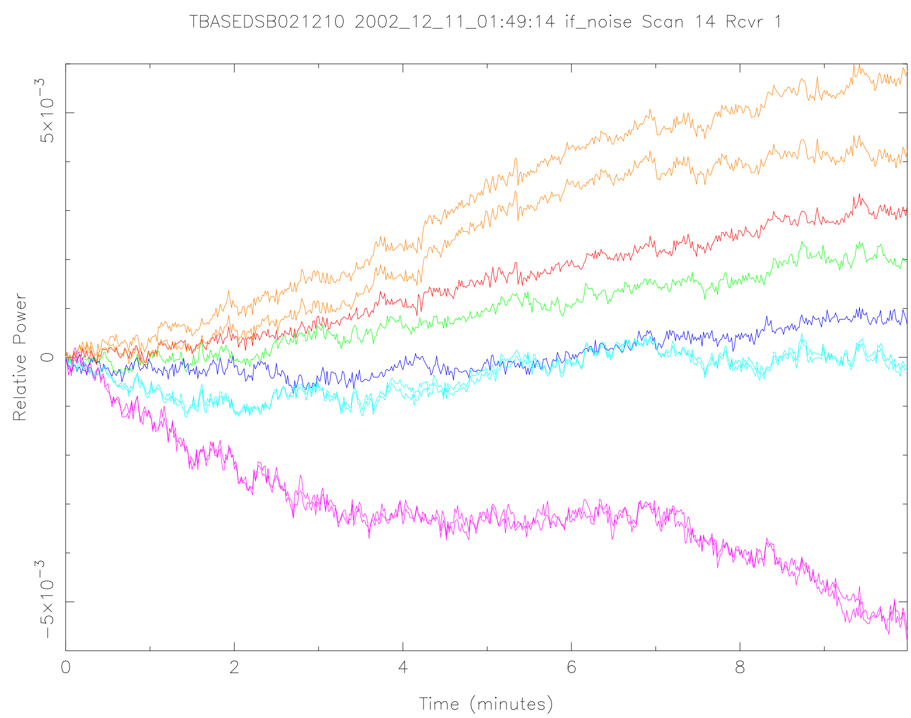

Figure 4: Scan 14, Odd numbered fibers, antenna moving in azimuth from 30 to 360 degrees during the scan. This is essentially a repeat of the scan shown in Figure 3 later in the evening

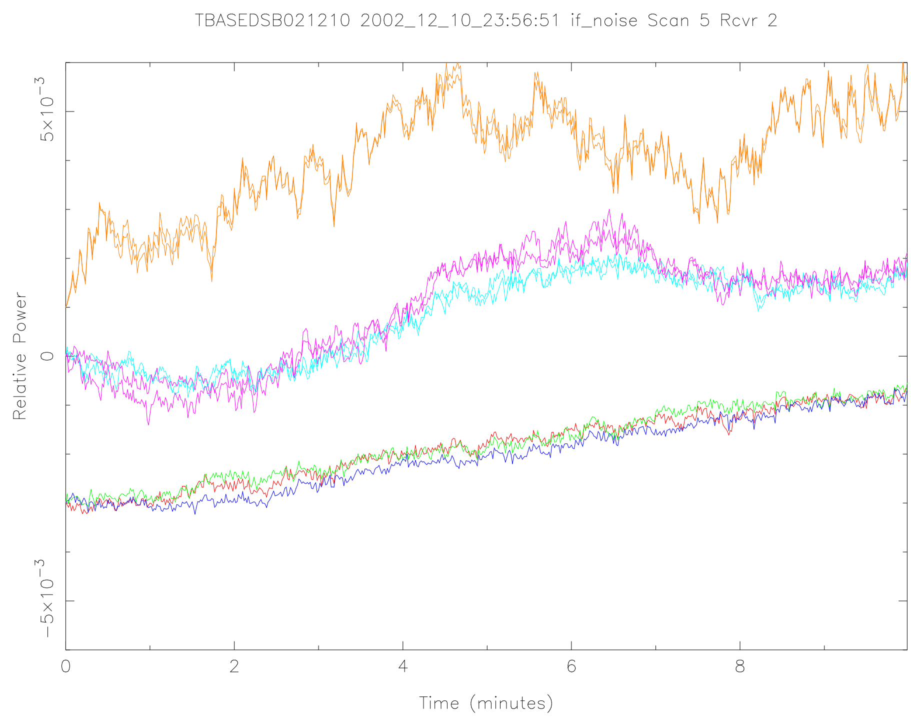

Figure 5: Scan 5, Even numbered fibers, antenna moving in azimuth from 5 to 360 degrees during the scan. The red and orange curves show total powers measured on fiber channel 2 at the output of the IF filter rack (before fiber) and the analog filter rack (after fiber and converter modules), respectively. The green and blue-green curves are corresponding plots for fiber channel 6, and the dark blue and violet curves are for fiber channel 8. Two curves of the same color are for the same fiber channel split and sent to different converter and analog filter modules channels. All curves are normalized to the first data value, where the vertical axis is the fraction of the first data value. The before-fiber curves are offset by -0.003, and fiber 2's after-fiber curves is offset by +0.002 for clarity.

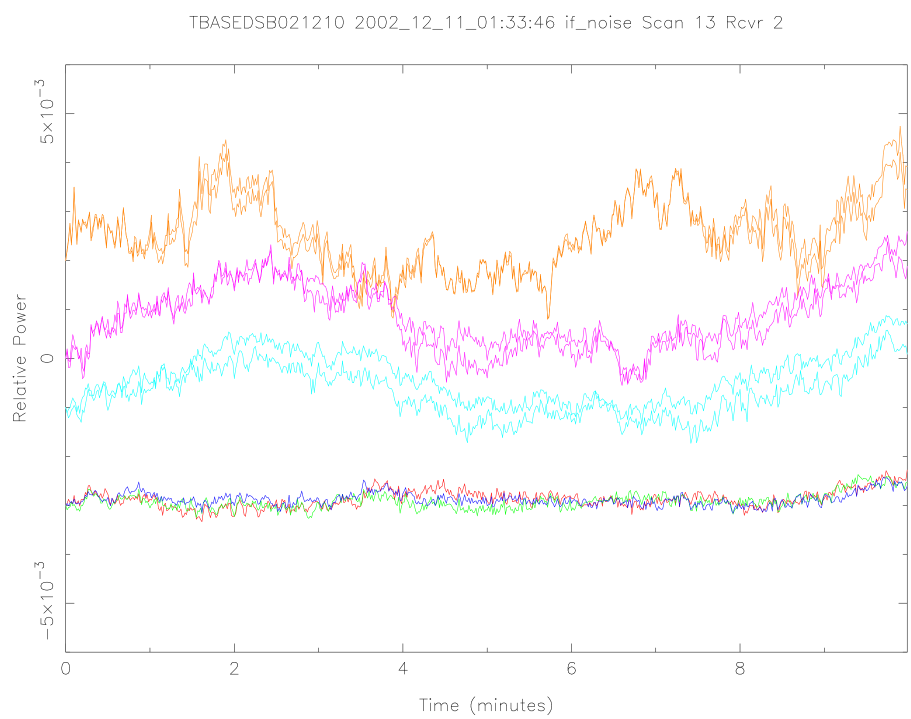

Figure 6: Scan 13, Even numbered fibers, antenna moving in azimuth from 360 to 0 degrees during the scan. This is essentially a repeat of the scan shown in Figure 5 later in the evening except that the antenna moved in the opposite direction.

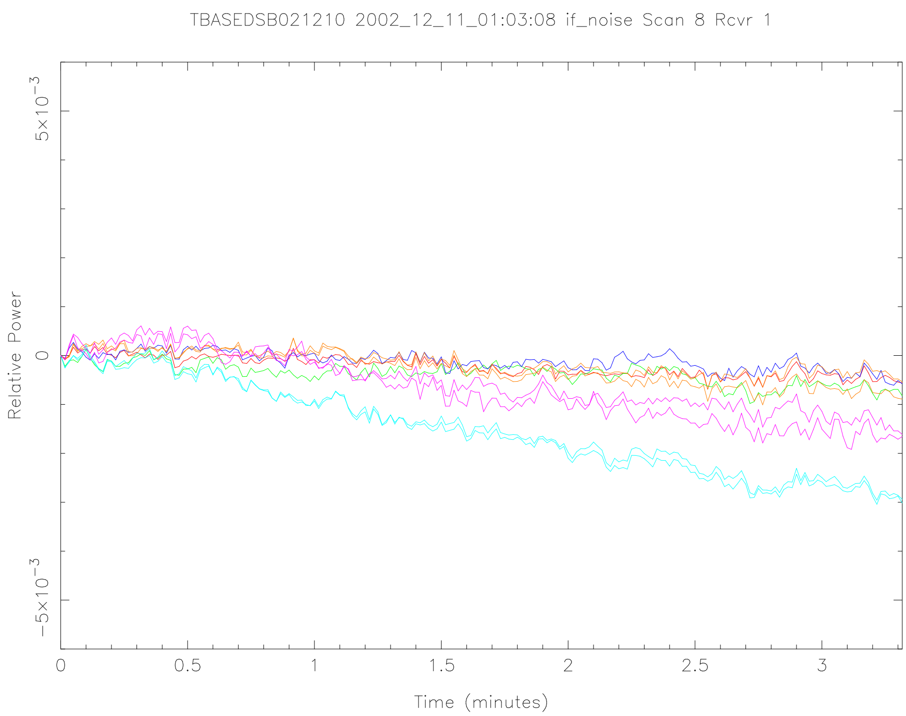

Figure 7: Scan 8, Odd numbered fibers, antenna moving in elevation from 85 to 20 degrees during the scan. The red and orange curves show total powers measured on fiber channel 1 at the output of the IF filter rack (before fiber) and the analog filter rack (after fiber and converter modules), respectively. The green and blue-green curves are corresponding plots for fiber channel 3, and the dark blue and violet curves are for fiber channel 5. Two curves of the same color are for the same fiber channel split and sent to different converter and analog filter modules channels. All curves are normalized to the first data value, where the vertical axis is the fraction of the first data value.

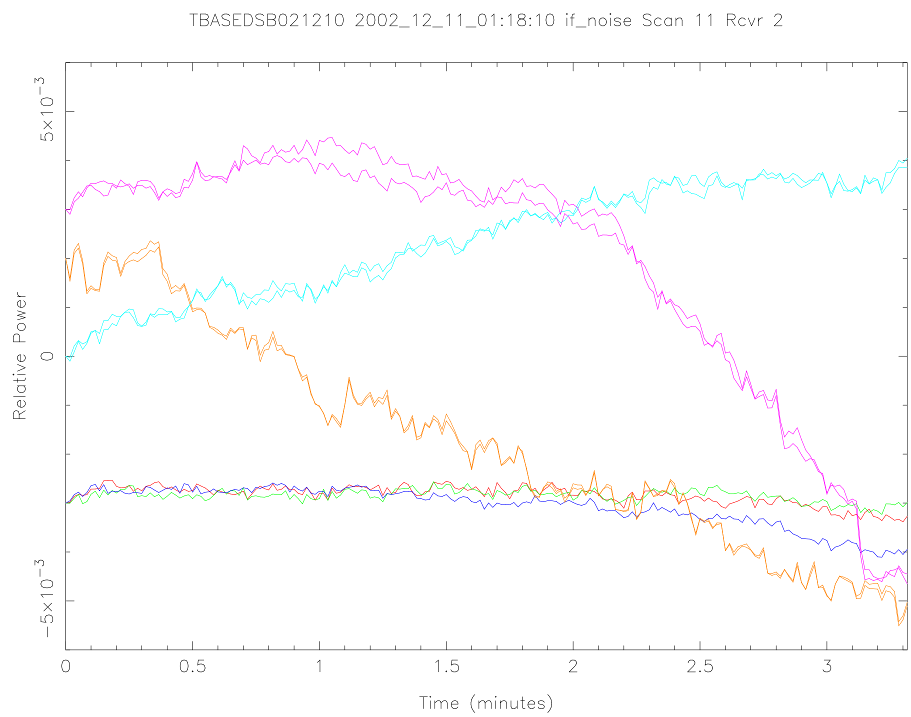

Figure 8: Scan 11, Even numbered fibers, antenna moving in elevation from 85 to 20 degrees during the scan. The red and orange curves show total powers measured on fiber channel 2 at the output of the IF filter rack (before fiber) and the analog filter rack (after fiber and converter modules), respectively. The green and blue-green curves are corresponding plots for fiber channel 6, and the dark blue and violet curves are for fiber channel 8. Two curves of the same color are for the same fiber channel split and sent to different converter and analog filter modules channels. All curves are normalized to the first data value, where the vertical axis is the fraction of the first data value. Some of the curves are offset vertically for clarity

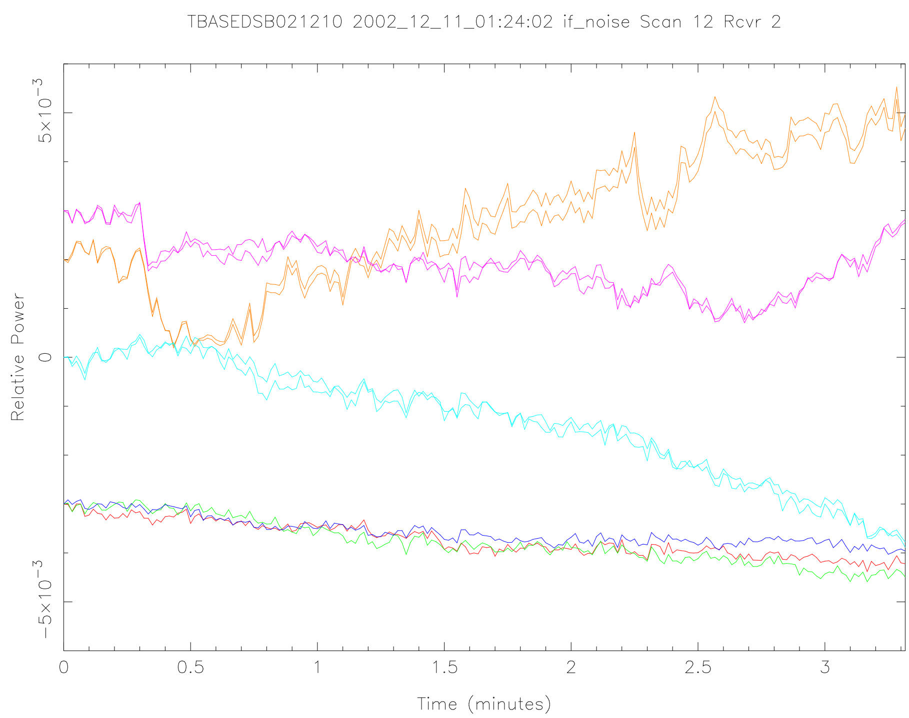

Figure 9: Scan 11, Even numbered fibers, antenna moving in elevation from 20 to 85 degrees during the scan. This is essentially a repeat of the scan shown in Figure 8 except that the antenna moved in the opposite direction.