Coherence Between LLO and LHO

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This note discusses inter-site correlations. The analysis was done using the tfcoh package for calculating the long-term coherence between two channels. Four channel pairs were studied. The variance on coherence is estimated by:

$$\sigma^2_{\gamma^2} = \frac{2\gamma^2(1-\gamma^2)^2}{N} \tag{1}$$

where N is the number of averages. In this analysis, 117712 10-sec segments were used, yielding 0.1 Hz resolution - the only exception is the H1ASQ-L1ASQ pair, where a number of processes failed (memory allocation requests failed) so we had only 81923 chunks.

1 H1:LSC-AS_Q vs L1:LSC-AS_Q

Figure 1 shows the coherence between the two AS_Q channels. The plot seems well behaved, although the coherence at a number of frequencies is above the $4\sigma_{\gamma^2}$ value. The only obvious line (apart from 60 Hz) is at 376 Hz. When splitting the run into 10 intervals of equal length (see Figure 2), we observe no surprizes except that the 376 Hz line appears only in the last interval. Finally, if we plot the line amplitude as a function of the job number (see Figure 3), we observe it only in a hand-full of jobs at the end of the run. Checking against the ILOGs, we find that a strong (binary system) pulsar hardware injection was turned on at the end of the run - the times are consistent with the outlier jobs in the Figure 3.

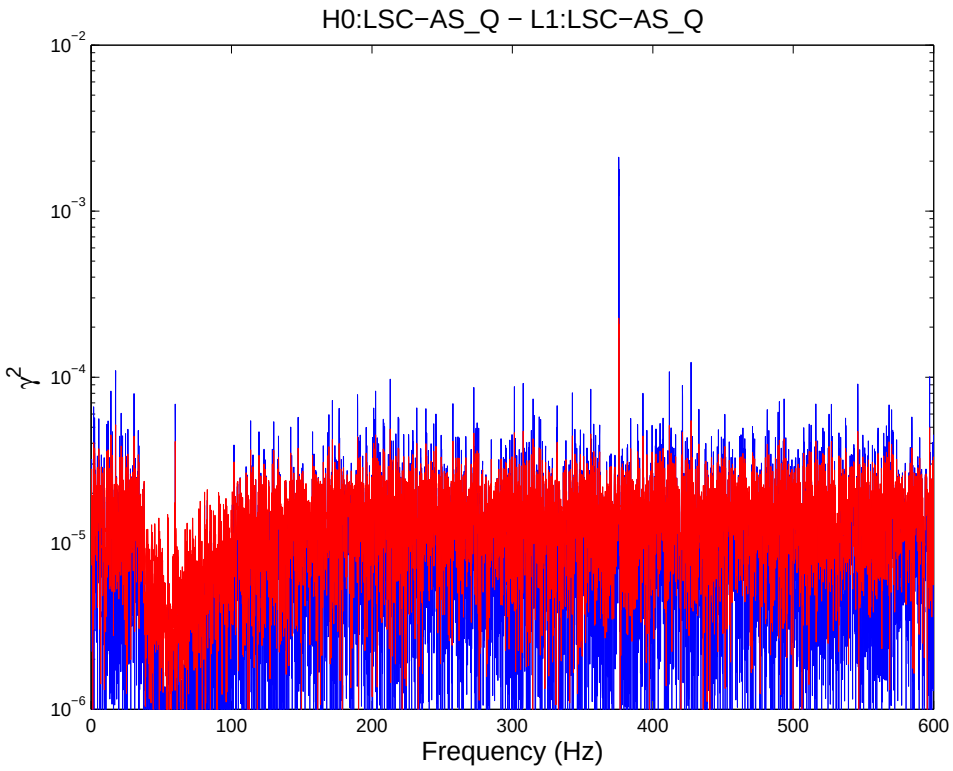

Figure 1: Coherence over all of S4 is shown in blue, $4\sigma_{\gamma^2}$ is shown in red.

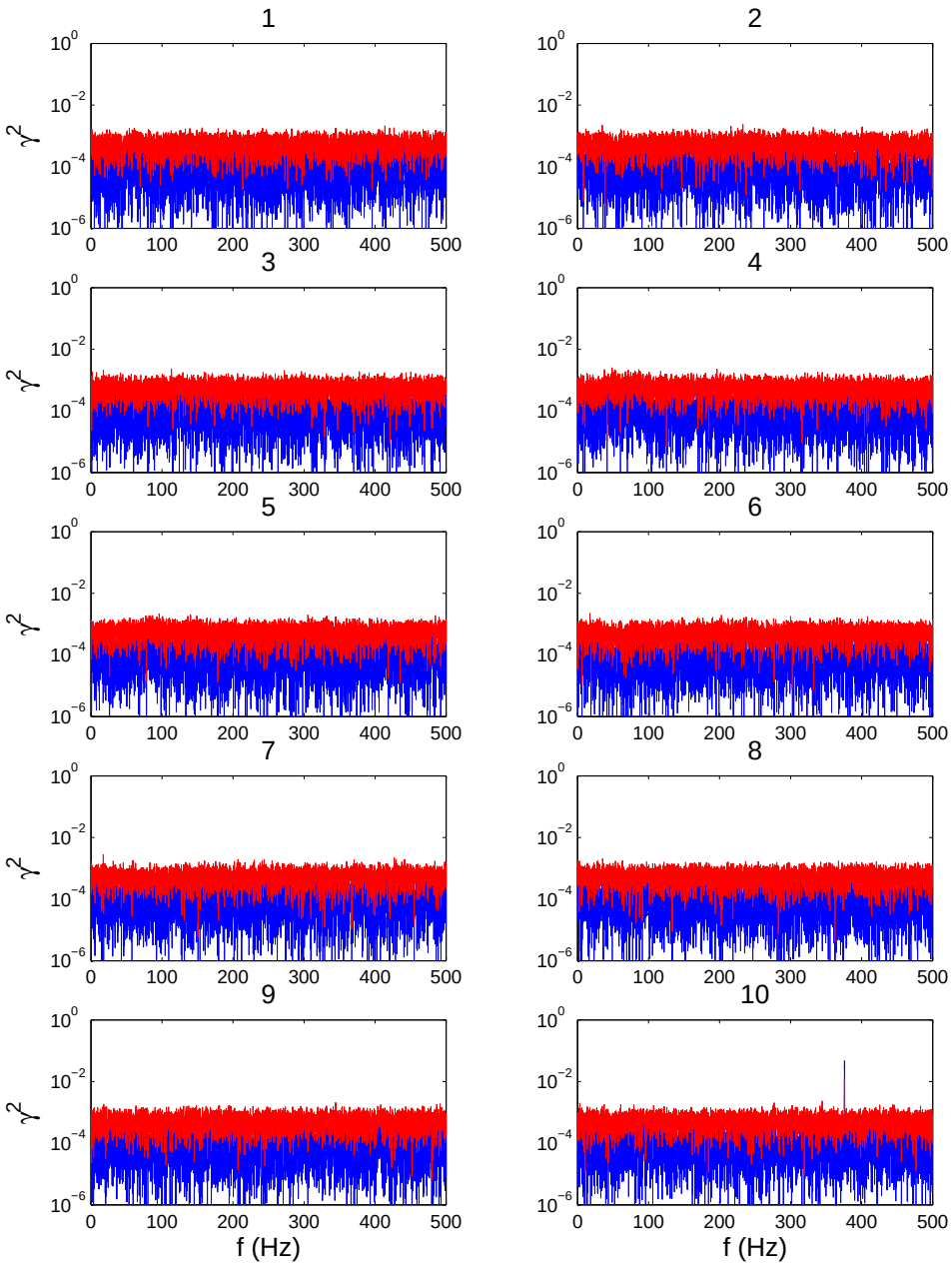

Figure 2: Coherence for 10 intervals of roughly equal length is shown in blue, $4\sigma_{\gamma^2}$ is shown in red.

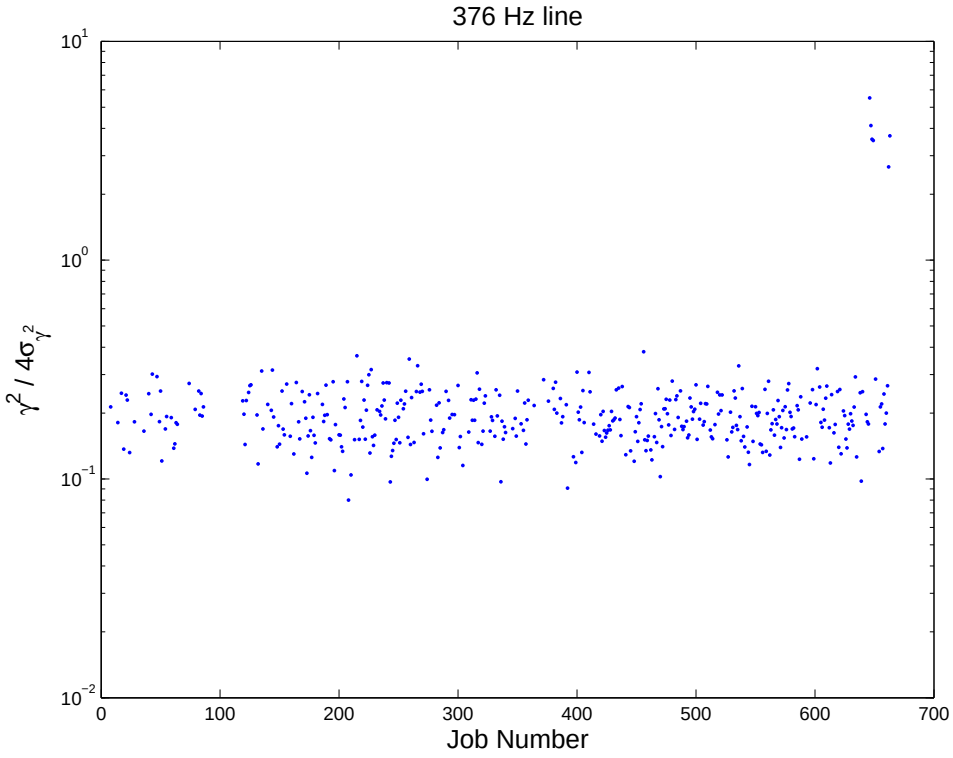

Figure 3: Trend of $\gamma^2/4\sigma_{\gamma^2}$ for the 376 Hz line. Each point corresponds to one job.

2 H1:LSC-AS_Q vs L0:PEM-COIL_MAGX

We now study the coherence of the H1ASQ channel and the magnetometer channel at LLO. This channel was suggested by Robert Schofield as the most sensitive to the magnetic sources. Figure 4 shows the coherence between the two channels over all of S4. We observe some of the 60 Hz harmonics and some of the 100 Hz harmonics (expected by R. Schofield due to data-logging). If we zoom in on one of these peaks (see Figure 5), we observe the 1 Hz harmonic side-bands. Finally, Figure 6 shows the coherence in 10 intervals of equal length. One can observe some fluctuation over time in these peaks.

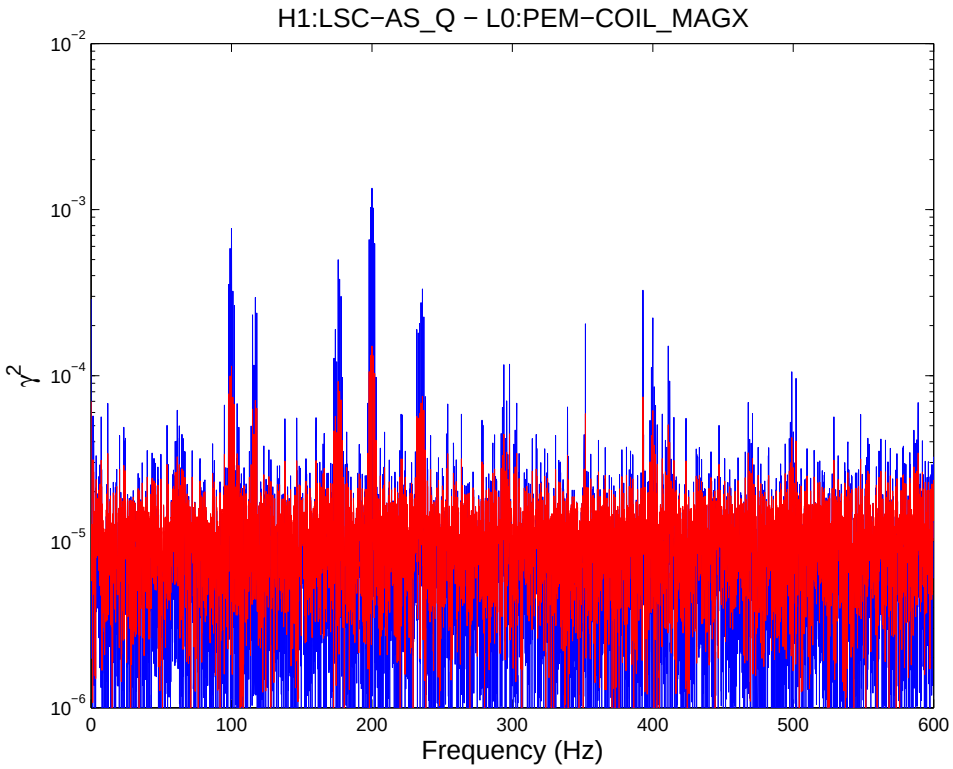

Figure 4: Coherence over all of S4 is shown in blue, $4\sigma_{\gamma^2}$ is shown in red.

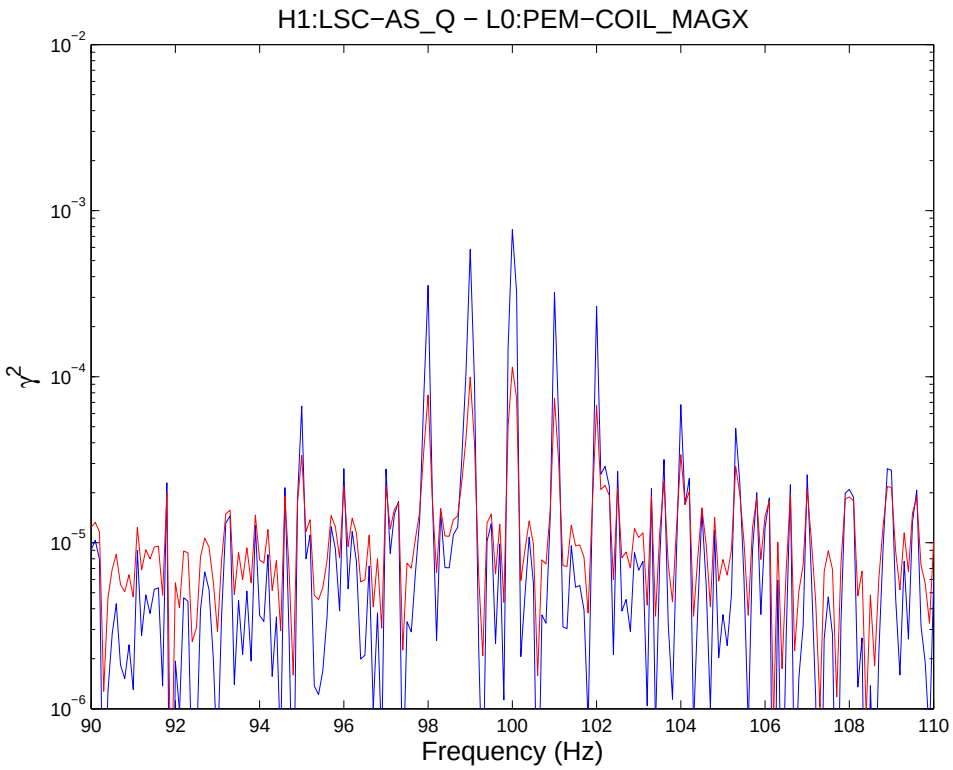

Figure 5: Coherence over all of S4 is shown in blue, $4\sigma_{\gamma^2}$ is shown in red. Zoomed in on 100 Hz peak.

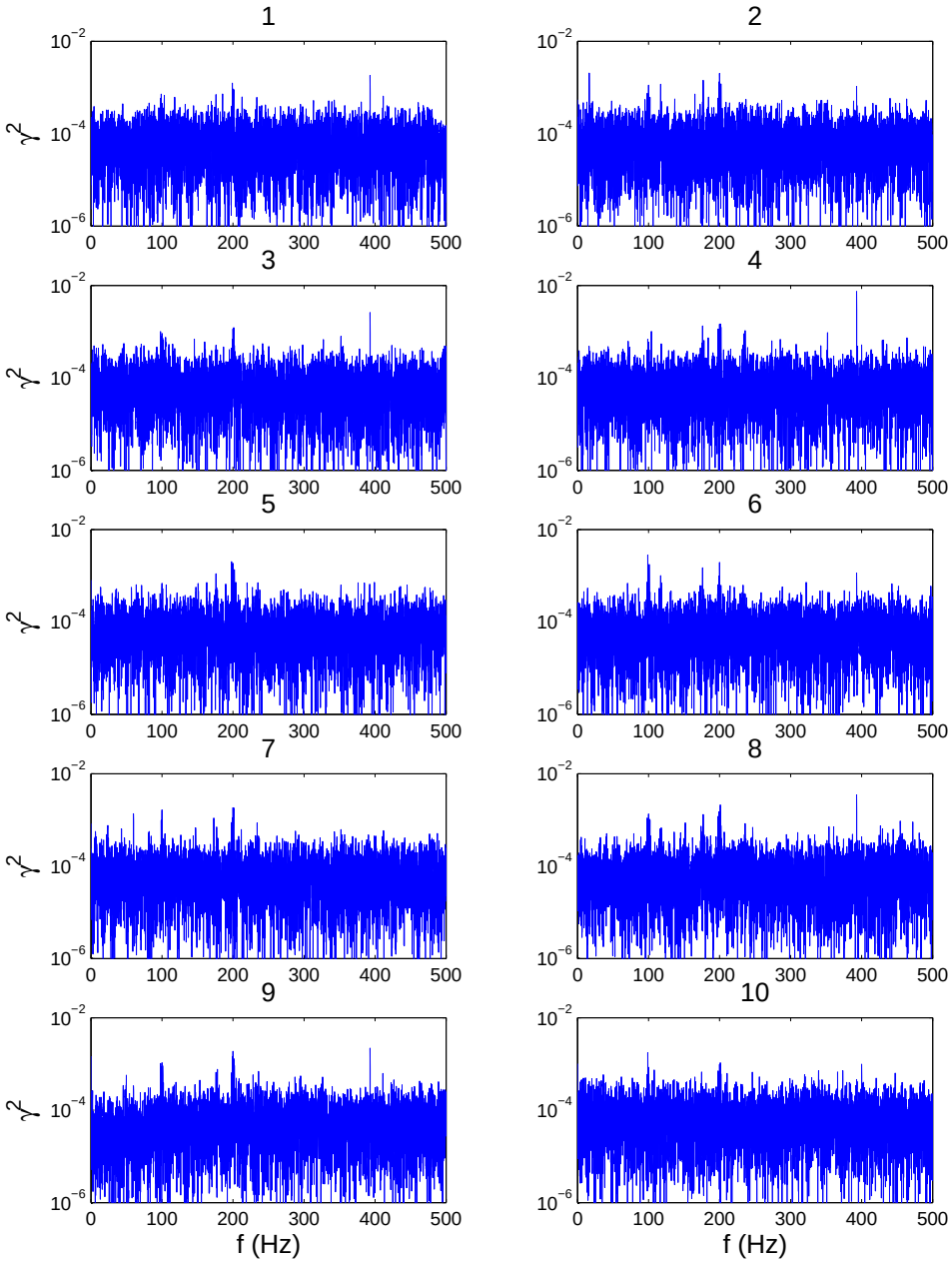

Figure 6: Coherence for 10 intervals of roughly equal length is shown.

3 H0:PEM-COIL_MAGX vs L1:LSC-AS_Q

We now repeat the same analysis using the L1ASQ and the LHO magnetometer. Figure 7 shows the coherence between the two channels over all of S4. In this case, we do not observe the 60 Hz harmonics, but we do observe some of the 100 Hz harmonics (without the 1 Hz sidebands). As above, the coherence at a number of frequencies exceeds the $4\sigma_{\gamma^2}$ values. Figure 8 shows the coherence over 10 intervals of equal length in S4. Again, we see some small fluctuations in the amplitudes of the 100 Hz harmonics.

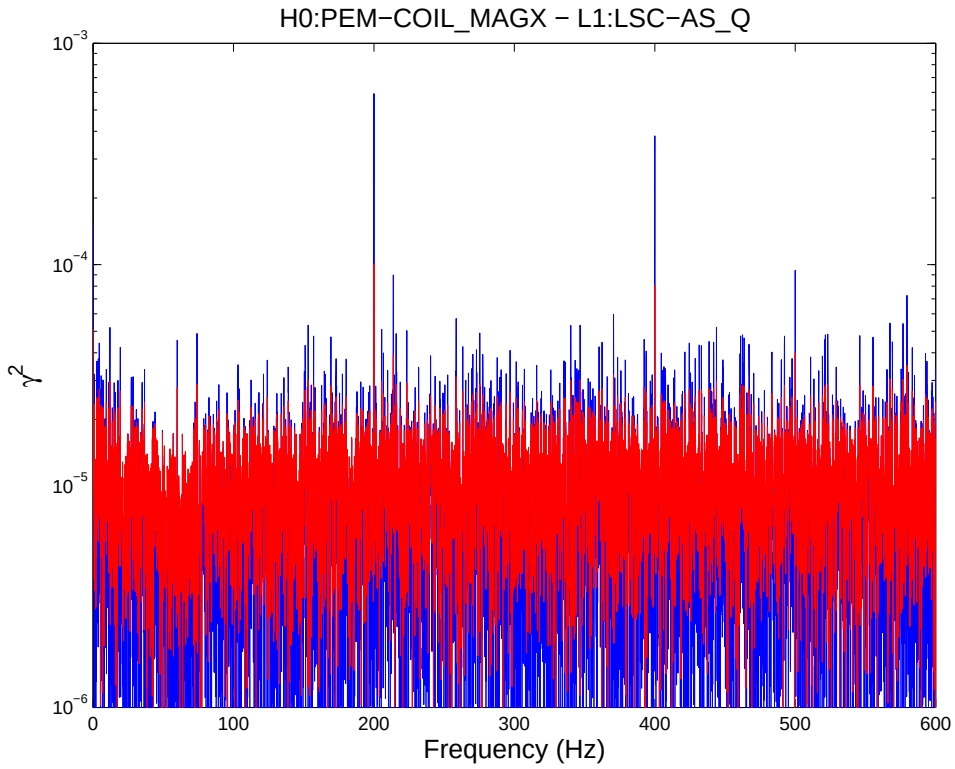

Figure 7: Coherence over all of S4 is shown in blue, $4\sigma_{\gamma^2}$ is shown in red.

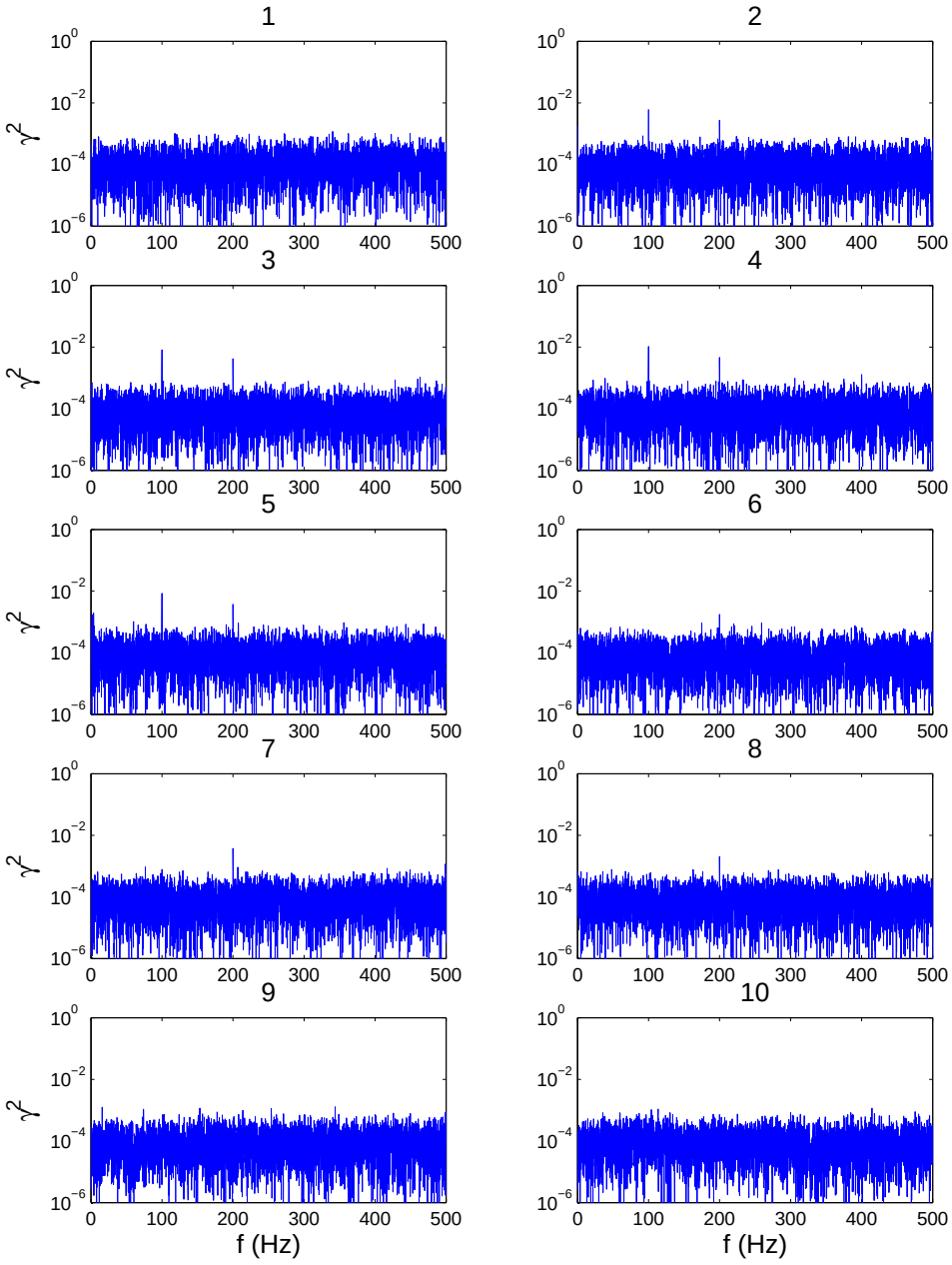

Figure 8: Coherence for 10 intervals of roughly equal length is shown.

4 H0:PEM-COIL_MAGX vs L0:PEM-COIL_MAGX

Finally, we look at the coherence between the two magnetometer channels, at the two sites. Figure 9 shows the coherence over the whole run. We observe the 100 Hz harmonics from the data logger. However, the broad-band coherence seems also very high (much larger than the estimate of $4\sigma_{\gamma^2}$). Splitting the run into 10 intervals of roughly equal length does not reveal much. As shown in Figure 10 the broad-band coherence seems significant in most of the intervals. Figure 11 shows trends in two frequency bands - one can observe large long-term fluctuations. Finally, to make sure that this is not a problem with the code I am using, I calculated the coherence between these two channels using DTT - I used the data starting at 795610002 and made 2110 averages. Figure 12 shows that even with DTT we observe a similar effect.

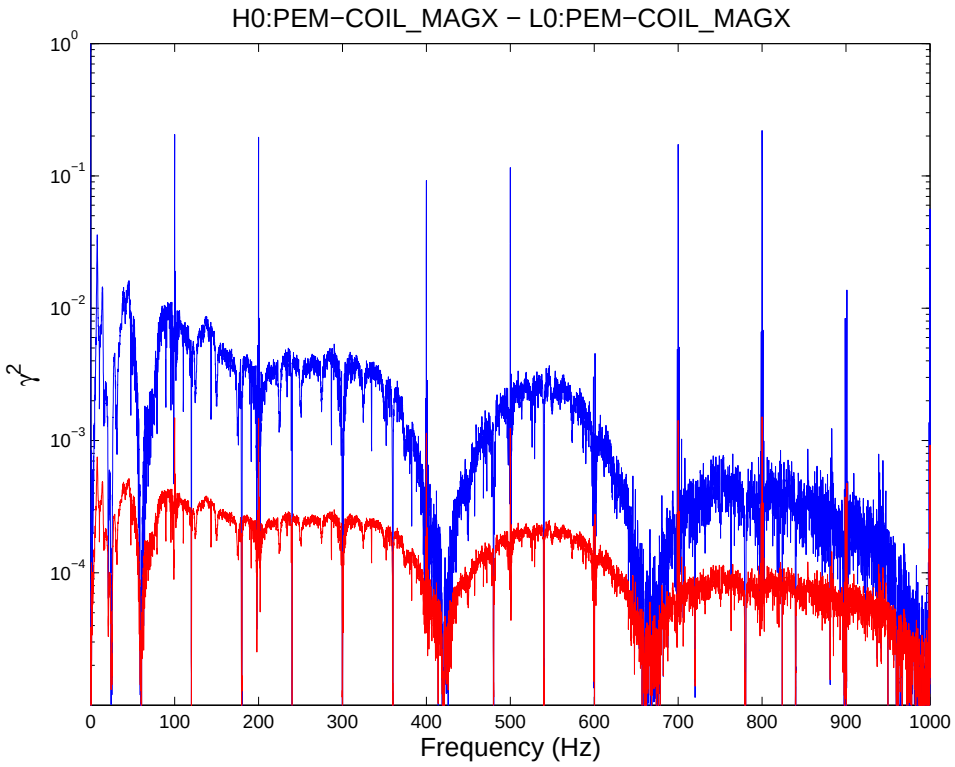

Figure 9: Coherence over all of S4 is shown in blue, $4\sigma_{\gamma^2}$ is shown in red.

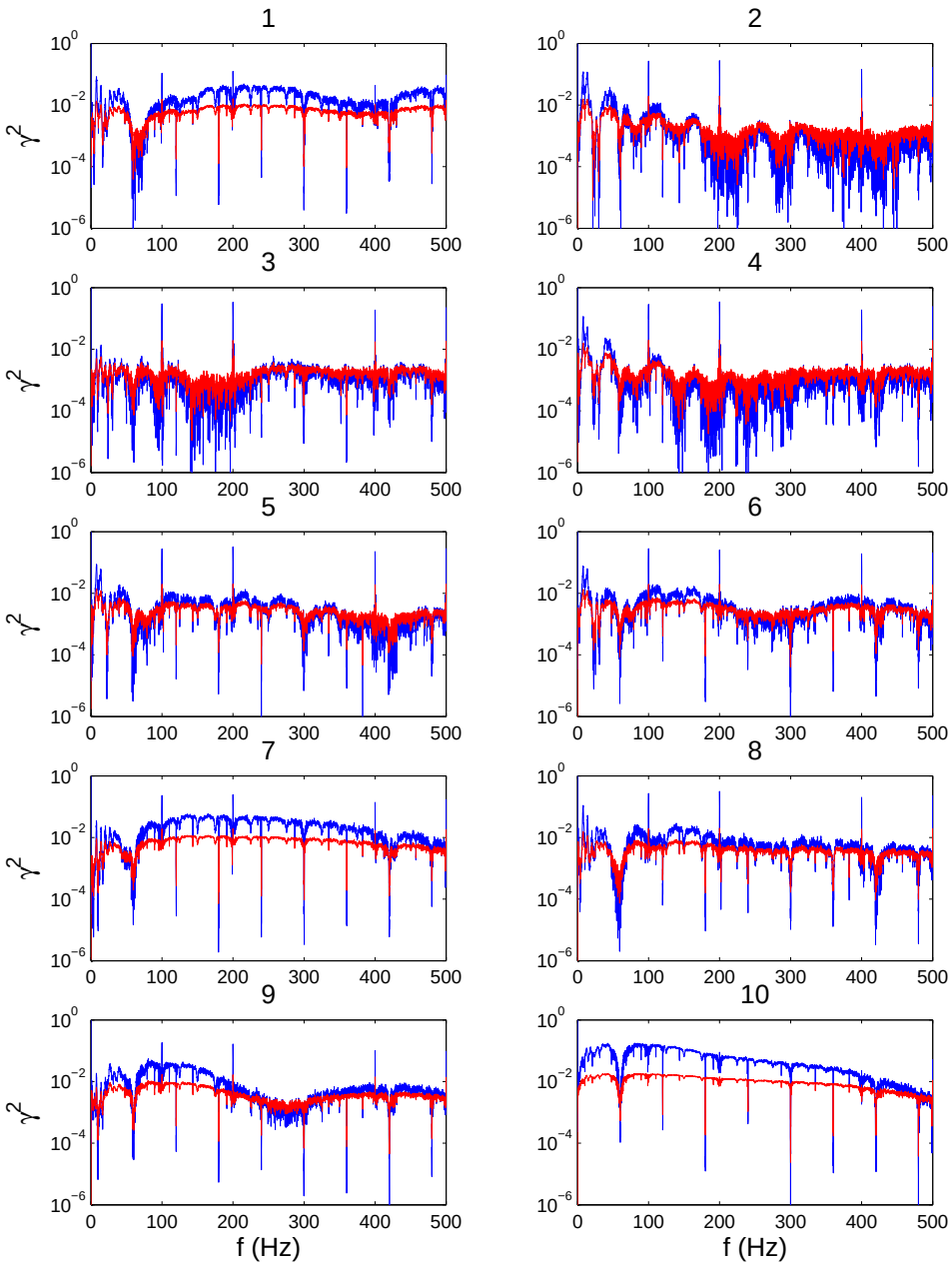

Figure 10: Coherence for 10 intervals of roughly equal length is shown in blue, $4\sigma_{\gamma^2}$ is shown in red.

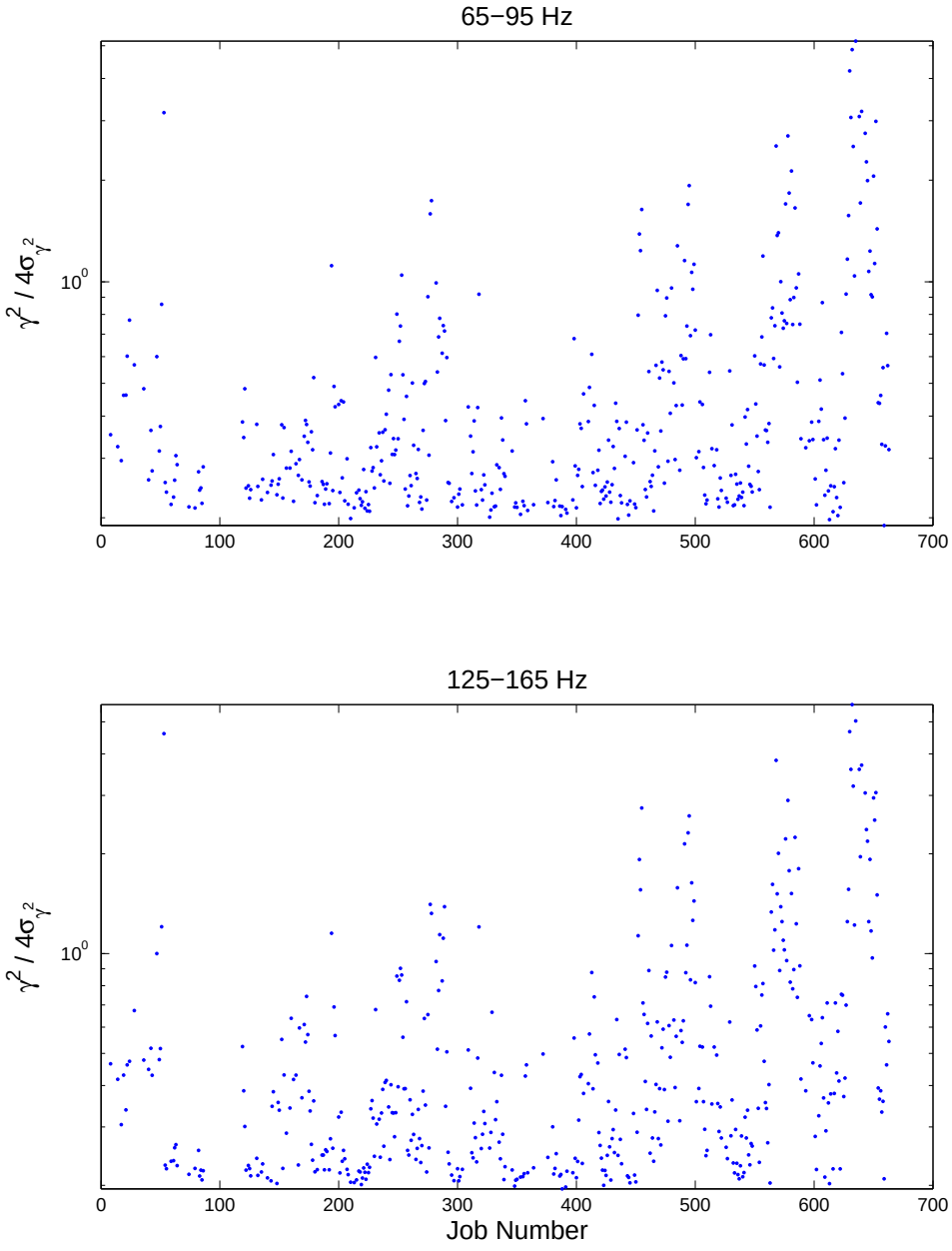

Figure 11: Trends of $\gamma^2/4\sigma_{\gamma^2}$ for two frequency bands. Each point corresponds to one job.

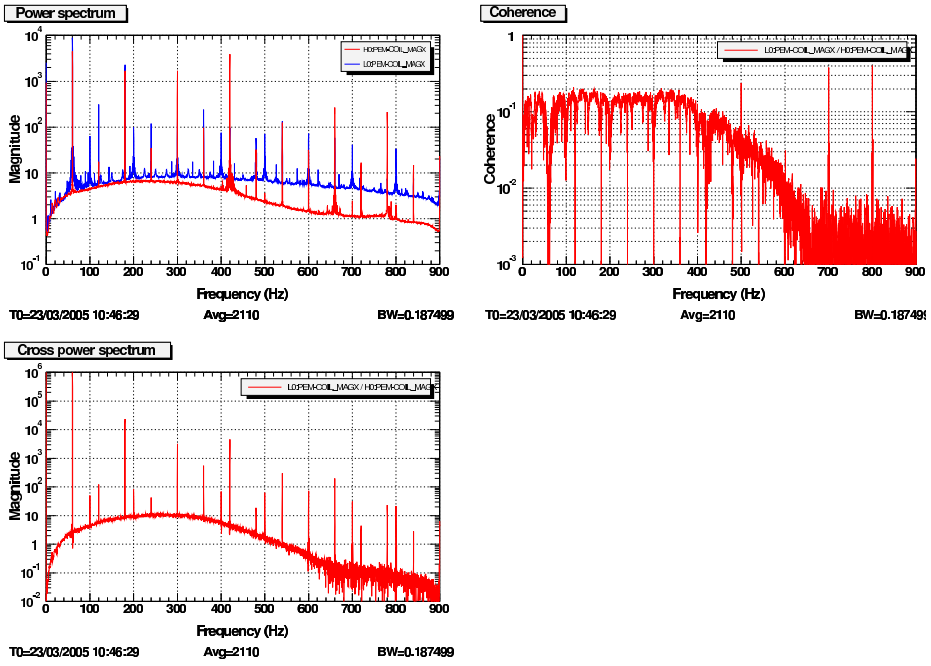

Figure 12: Results using DTT, data starting at 795610002, 2110 averages.