Report of SixtyHertzMon Status

SixtyHertzMon is a newly developed DMT monitor which intends to identify sidebands associated with the powerline frequecy 60 Hz, and its harmonics 120Hz & 180Hz. Its basic working principle is to use the fact that the powerline frequencies (60,120,180Hz) are not fixed. They change with time slightly within a small range. Hence if there is a pair of sidebands associated with a powerline frequency, the frequencies of the sidebands should change accordingly. If we add the power spectra of many data segments sampled at different times, the sideband peaks would appear wider and lower in the summed spectrum, since the sidebands are always moving. On the other hand, we can measure the powerline frequency of each data segment and use it to heterodyne its spectrum (so that in the heterodyned spectrum sidebands frequency would remain fixed, as well as the powerline frequency). We add up all the heterodyned spectra, and then in the summed spectrum, the corresponding sidebands should appear higher and narrower. By comparing these two different summed spectrums, heterodyned and unheterodyned, we can decide if a peak is a sideband or not.

At this time SixtyHertzMon is running on stone & delaronde. The one running at stone is detecting sidebands in H1 & H2 channel near 60Hz and the one running on delaronde is detecting sidebands in L1 channel near 60Hz. After two weeks' test run, SixtyHertzMon already discovered rich sideband structure in L1 channel. This phenomenon is published in recent LLO elog.

SixtyHertzMon has two kinds of output. First it generates web pages which contain a summary of the sidebands it found in the recent data (typically the data of the latest 24 hours). These web pages can be accessed from spi page. The other kind of output is averaged power spectrum. They are available from DMT viewer. Some potential sidebands, if not strong enough to be distinguished from random noise, will not be identified by SixtyHertzMon as sidebands and they will not be contained in the web pages. In this situation, the spectrum plots, by the help of human judgments, can be a useful tool to decide if those weak peaks are real sidebands or not. In fact power spectrum plots contain much more information than the web pages. It not only shows where the sidebands are, but also how they look, and how relatively strong they are compared with each other.

The current version of SixtyHertzMon running on stone and delaronde has some shortcomings. The first problem is that it can not handle the calibration line very well. SixtyHertzMon has a checking system to make sure bad data are not used. Particularly it will generally consider any sudden change in the spectrum as a sign of bad data. Therefore if a calibration line is turned on suddenly, it will confuse SixtyHertzMon. The second problem is if the voltage monitor channel is disconnected, SixtyHertzMon would crash, because it did not anticipate this. The third problem is that it can only handle one heterodyne frequency at a time. The current one running on stone and delaronde monitors 60Hz sidebands. However in practice we may need to monitor three heterodyne frequencies simultaneously.

To fix the problems mentioned above, a new version is developed in marble and is still under testing. Right now this new version is working well and it does not have any of those problems. For example, it is now monitoring 60Hz, 120Hz and 180Hz sidebands in H1 at the same time at marble. And the web pages can be viewed at www.ligo-wa.caltech.edu/~jyzhang, which is author's home directory. If there are no further problems, we plan to move this new version to stone and delaronde at Feb 6 or 13 for a two week test run.

Another striking result found by SixtyHertzMon is that there are many sidebands related 180Hz in H1 channel. The web pages generated indicated there are more than ten sidebands:

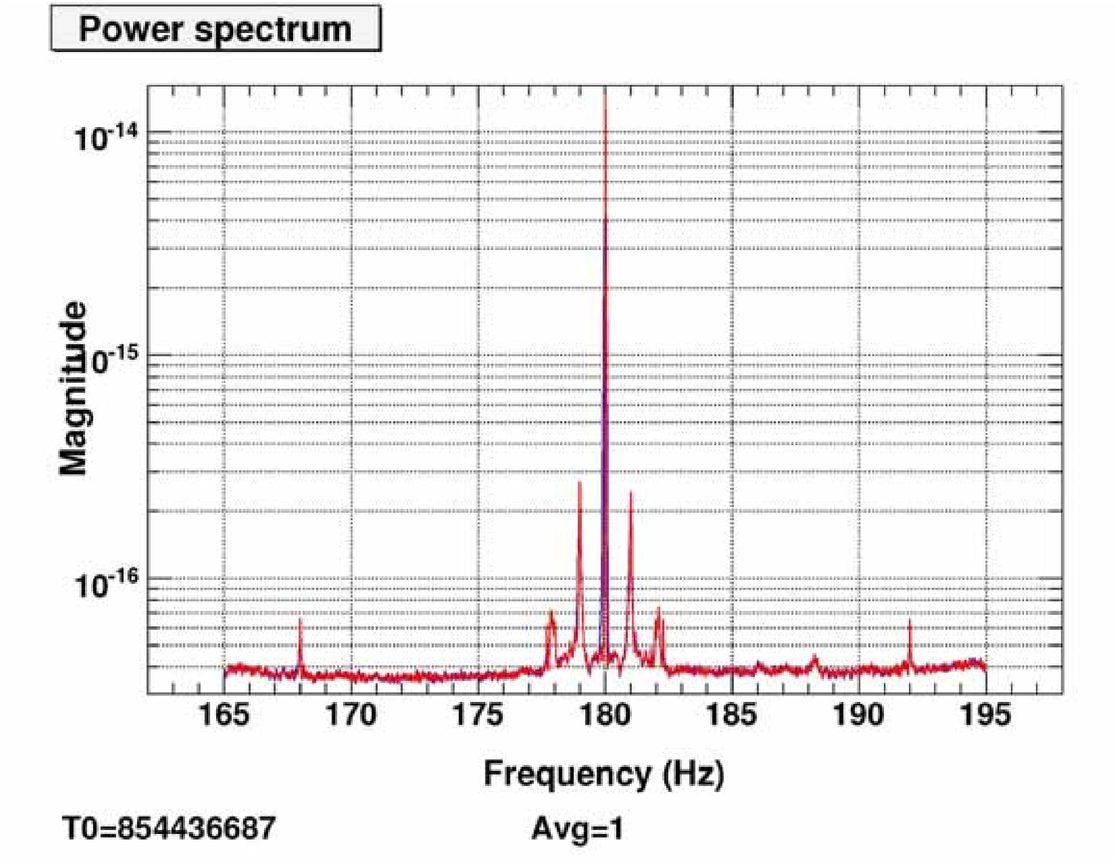
GPS time: 854380887

180±0.73	180±1.007	180±1.189	180±1.812	180±1.986	180±2.115	180±2.294	180±11.99
179.27,180.729	178.992,181.008	178.811,181.197	178.188,181.805	178.014,181.984	177.885,182.111	177.705,182.295	168.004,191.996

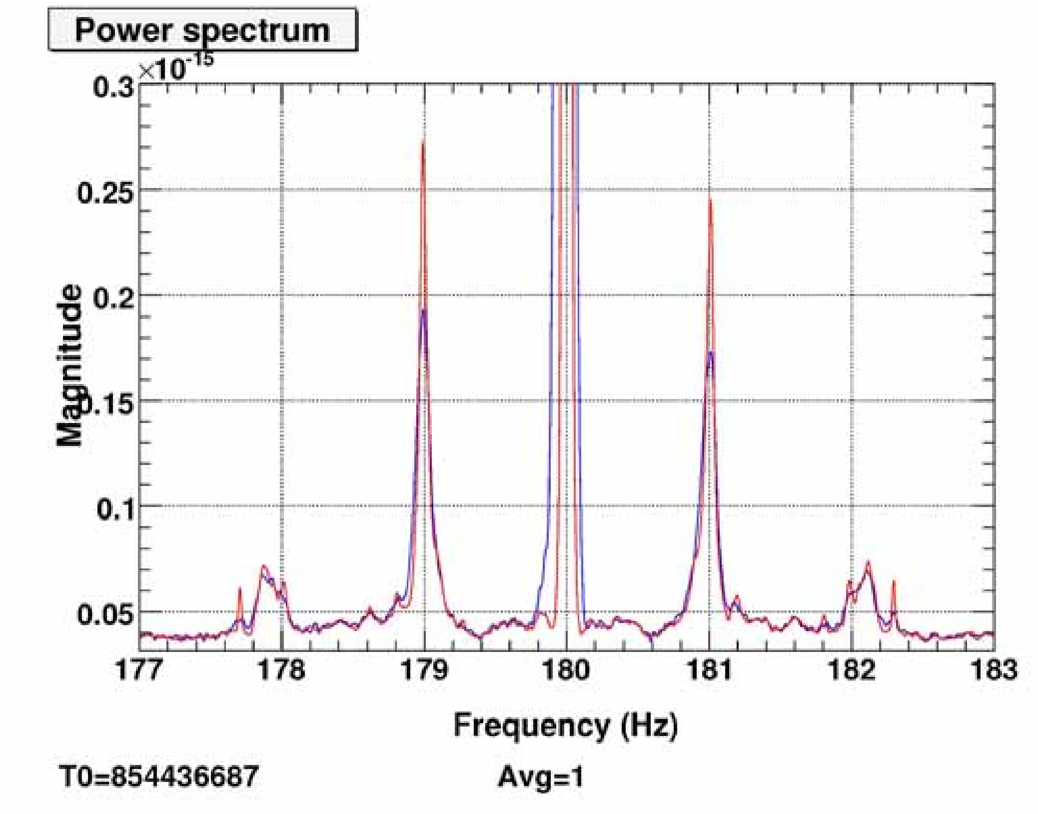
GPS time:854436687

180±1.00974	180±1.19142	180±1.98636	180±2.12694	180±2.29486	180±11.9962
178.99,181.01	178.809,181.193	178.014,181.984	177.873,182.115	177.705,182.295	168.004,191.996

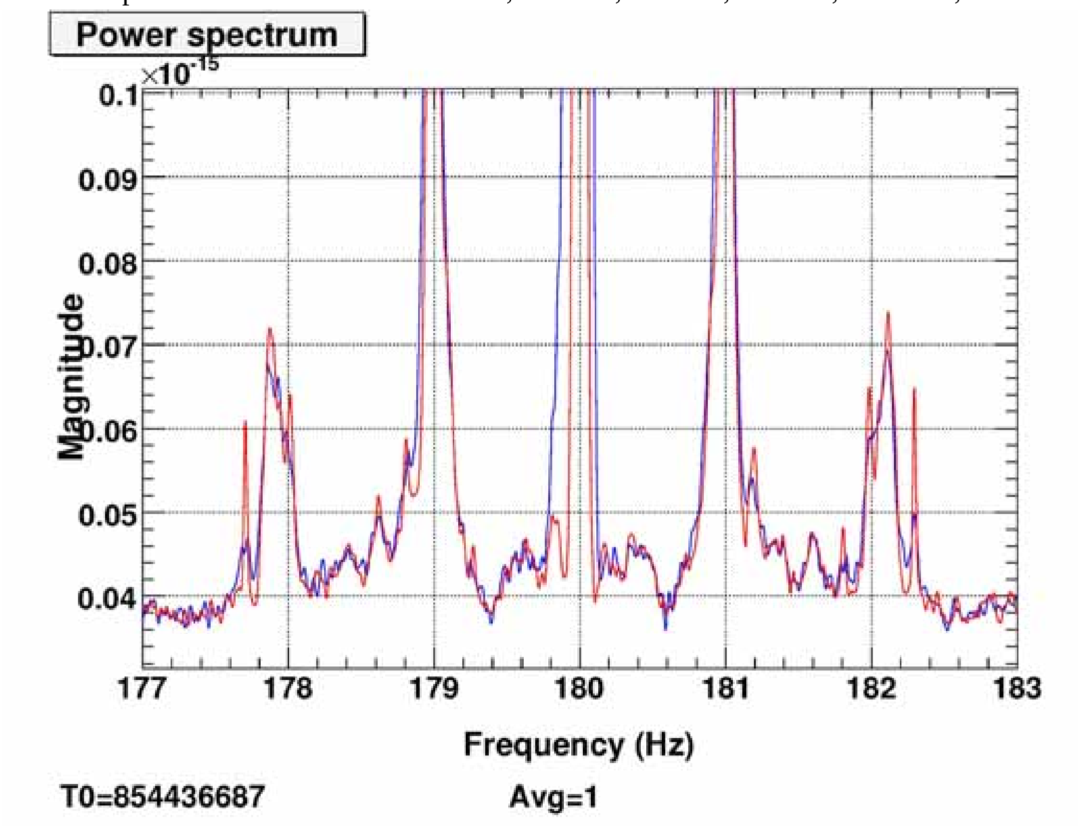
The following plots are power spectrum of GPS time 854436687



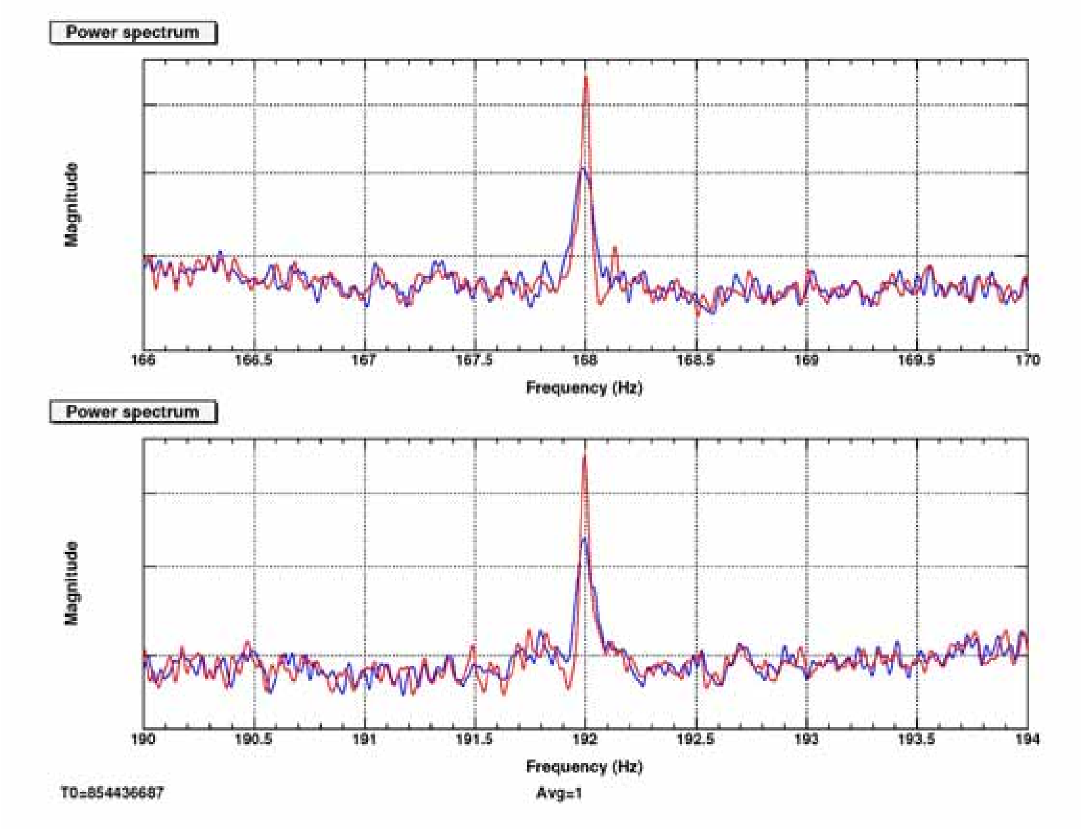
This is the whole spectrum from 165Hz to 195Hz.



From this plot we can see sidebands 180±1, 180±1.2, 180±1.4, 180±2.0, 180±2.12, 180±2.3



As we can infer from this plot, there must be some more sidebands between 179~181HZ. For instance, 180.0±0.2Hz are very likely to be a pair of sidebands. However, since 180Hz move three times faster than 60.0Hz, the 180Hz peak is very wide. In fact this peak completely tops the smaller peak at 180.0-0.2 Hz, and hence 180.0±0.2Hz are not picked out by SixtyHertzMon as a pair of sidebands and does not appear in the web page. This is an example how the spectrum plot can be used to find more sidebands.



This plots shows sidebands at 180±12Hz