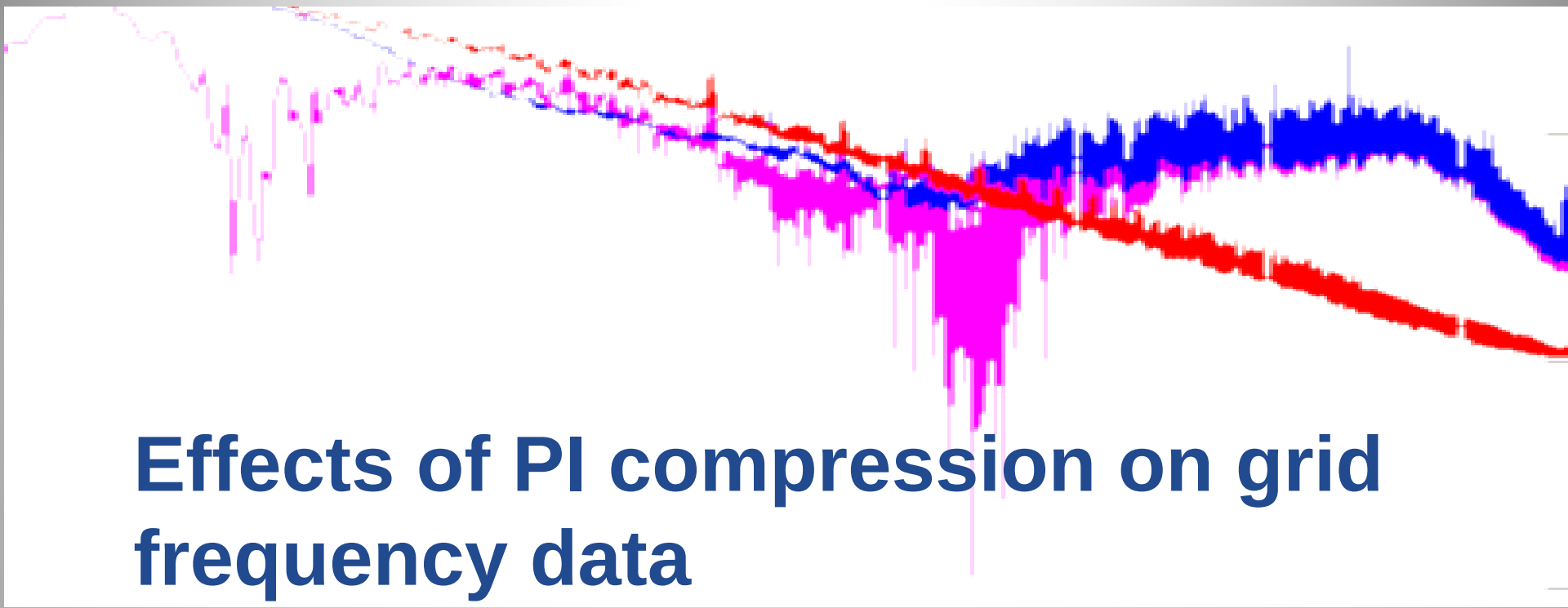

Effects of PI compression on grid frequency data

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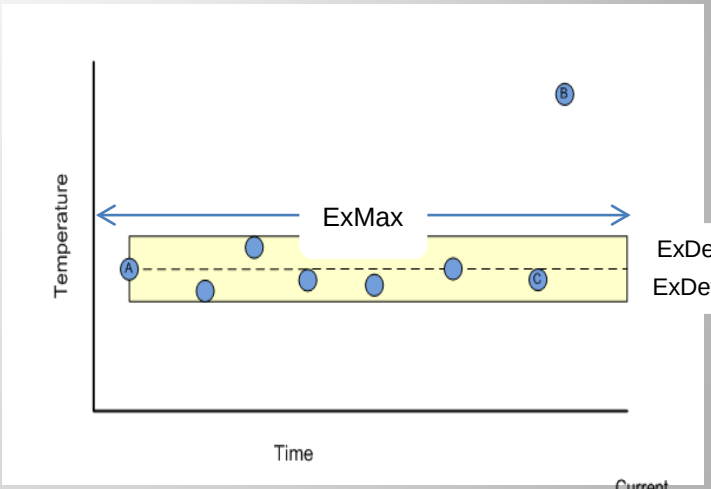
LLNL

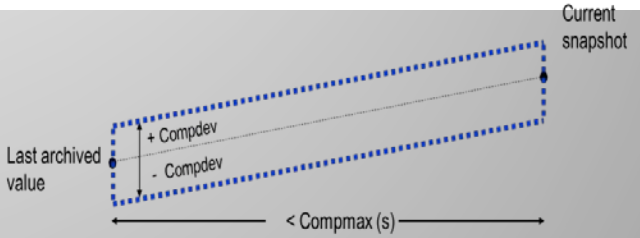
Acknowledgement

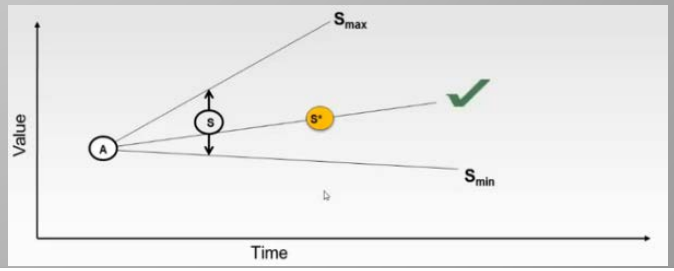
- Other contributors:
  - Chuck Wells (OSISoft)
  - Steve Kenyon (LLNL)
  - Aaron Lott (LLNL)

Compression in PI

- Why compression?
  - Disk space, network traffic, Performance
- Exception test
  - Filter obvious noise (within instrument precision)
    - Define a dead band (ExMax & ExDev)
- Compression test
  - Compression can have a slope
  - Swings to match the slope of the data (swinging door)
  - Using three values (most recent, current snapshot, incoming value)
  - Keep the new incoming value if within the angle between the min & max slope
  - Recalculate the slope.
  - The dropped values are within the parallelogram created by the compression deviation parameters.







The question

- How does compression change the characteristics of the signal?
  - Frequency data from PMU device
    - Arbiter Systems, model 1133A power Sentinel
- Applications:
  - HPC energy efficiency
    - Micro level energy scheduling
    - Demand response for HPC facilities
  - Track and analyze distribution system events

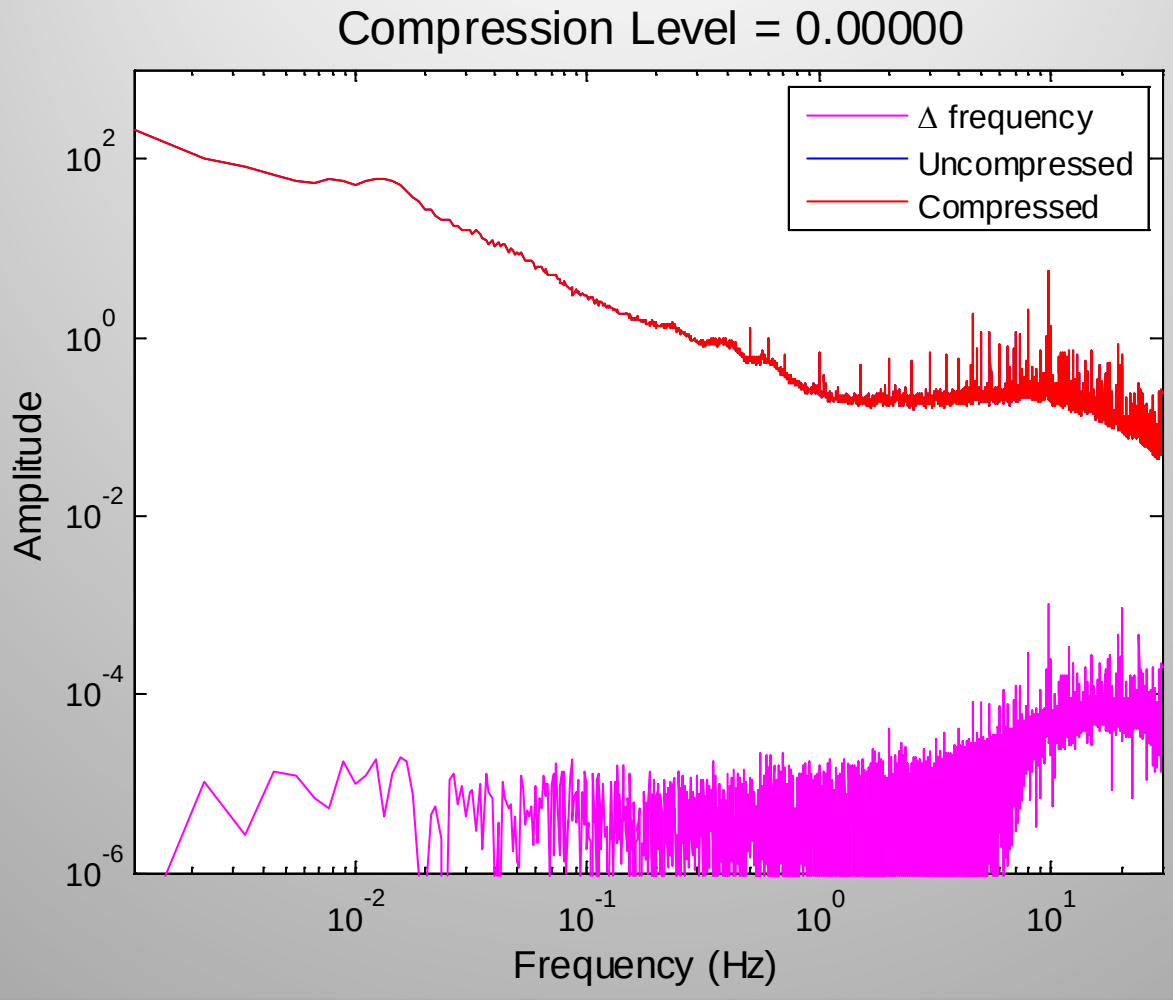
Experiment

- Collect raw data and store it in binary format on the file system
- Collect data into PI with different levels of compression
- Use FFT analysis to compare the signal with no compression and different levels of compression
  - Averaging 6 hours over 15 minute window

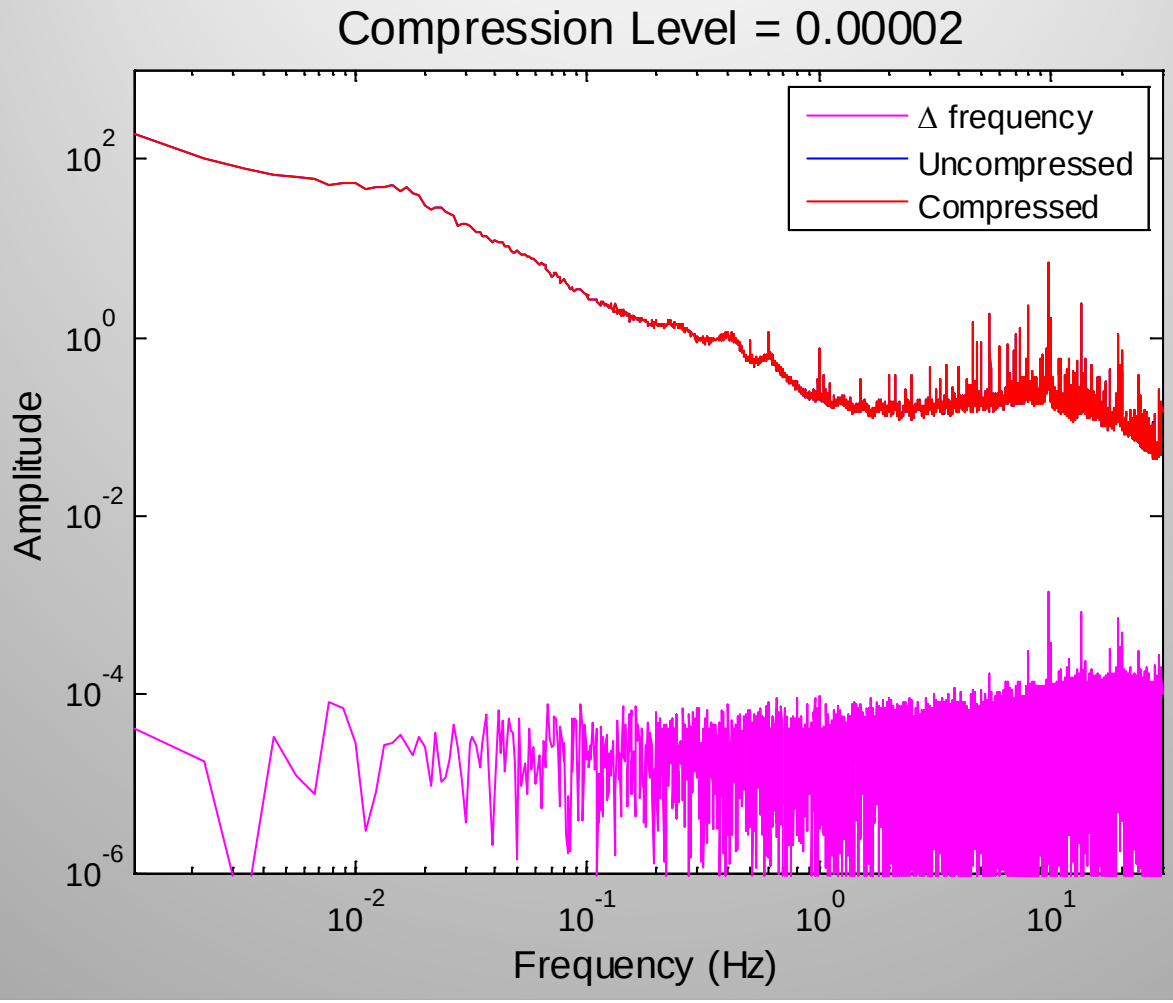
Data storage and retrieval

- Data is retrieved directly into R or MATLAB
  - Data precision problems (Excel & CSV files)
  - Large size data transfer
- HDF5 is binary and can be easily read into MATLAB or R

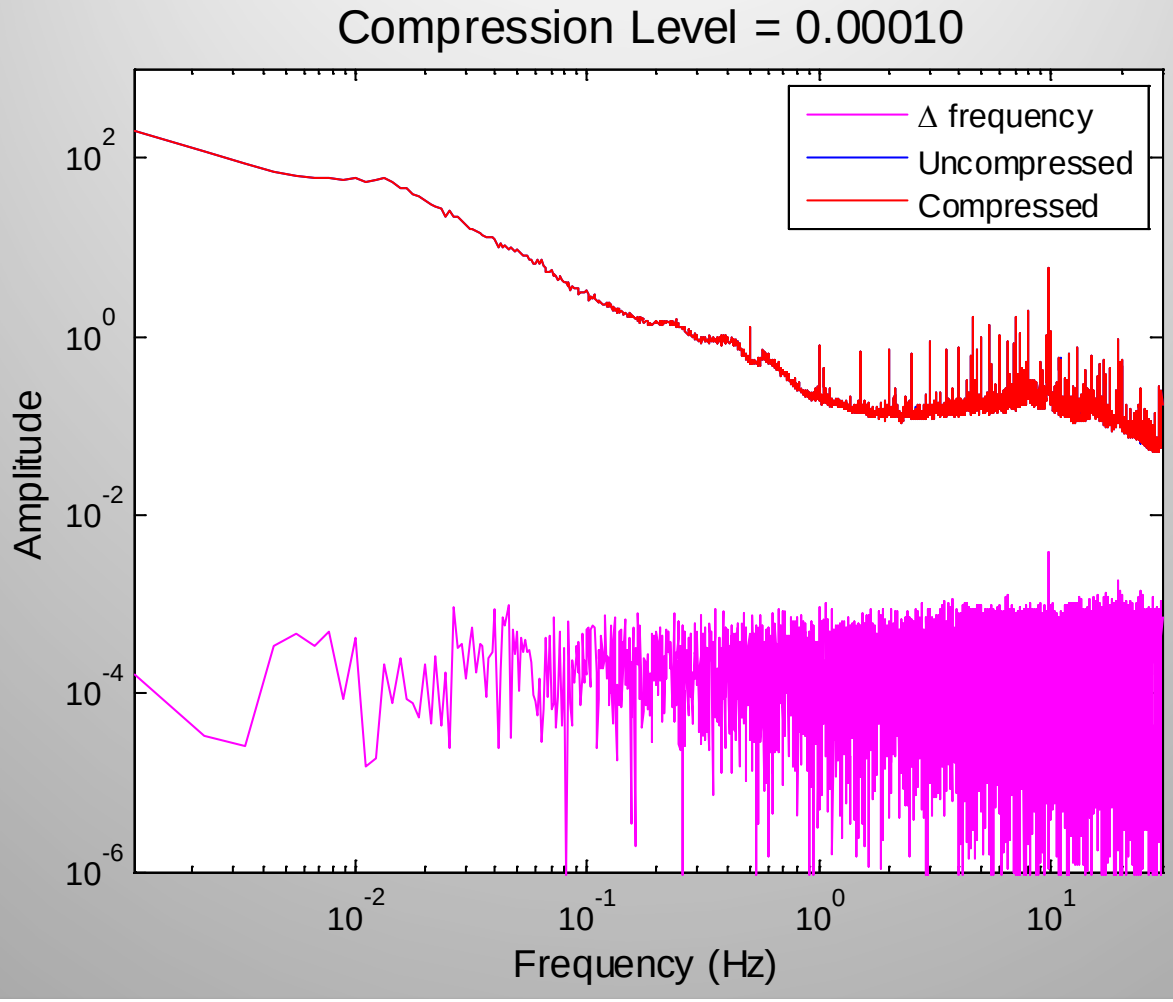
Distortion and compression level



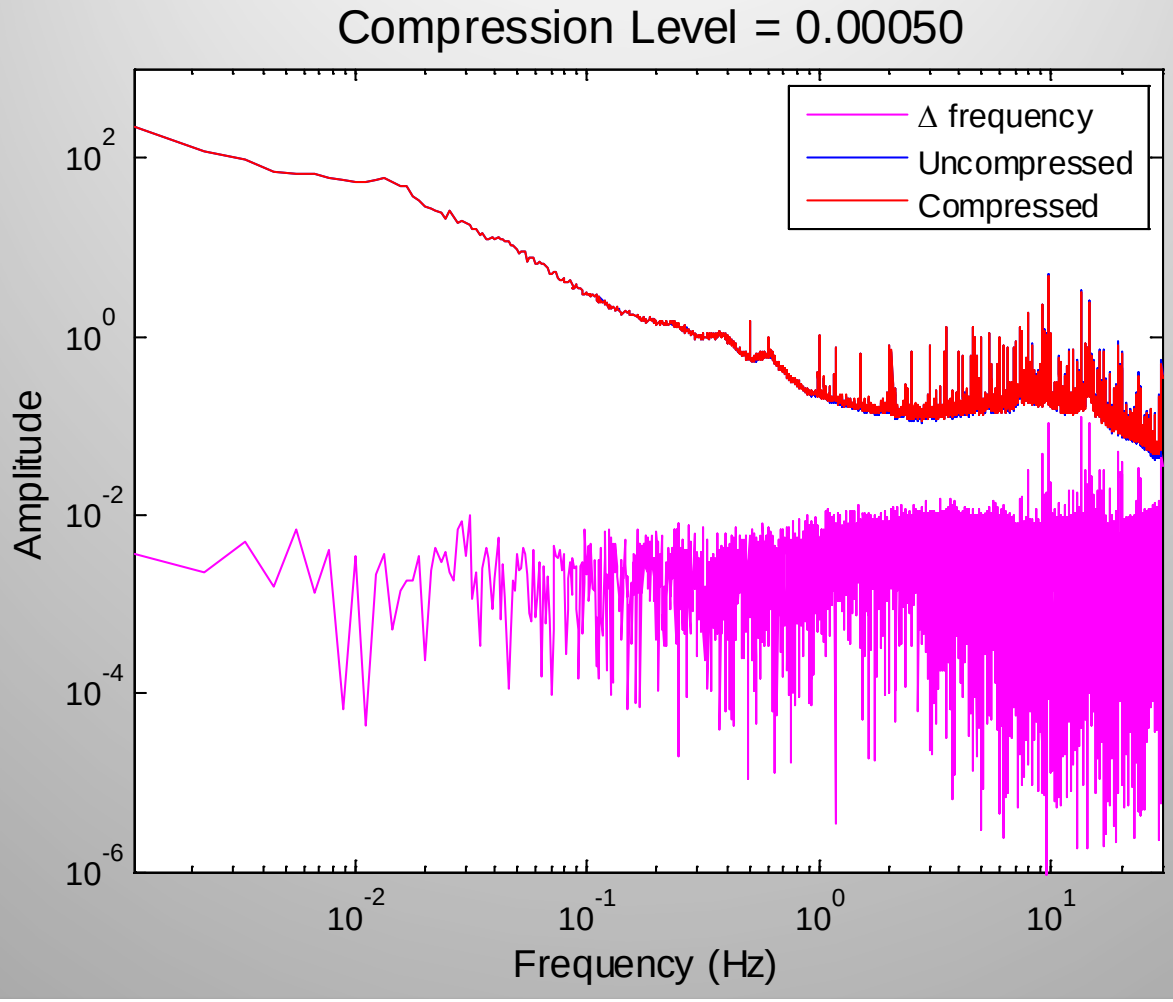
Distortion and compression level



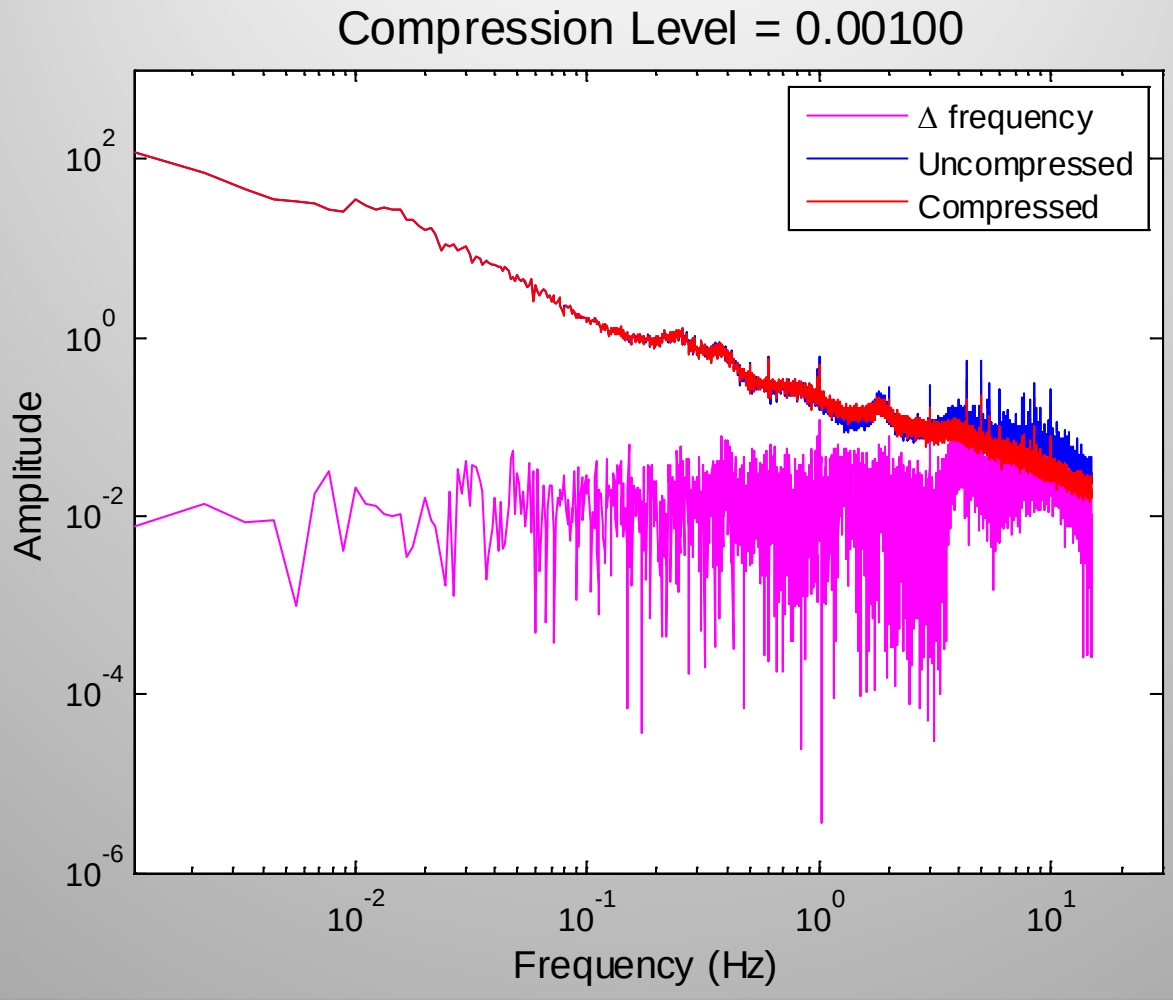
Distortion and compression level



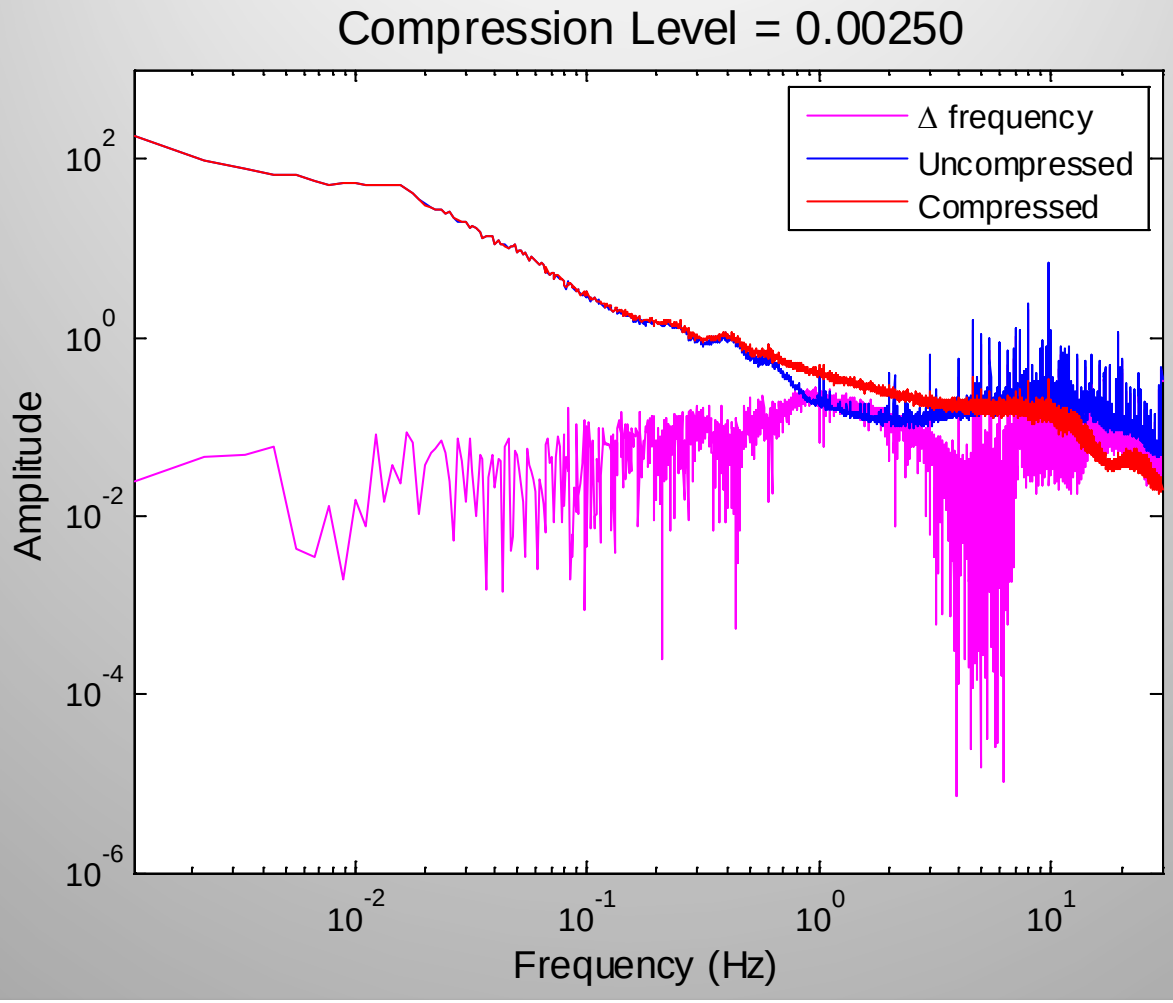
Distortion and compression level



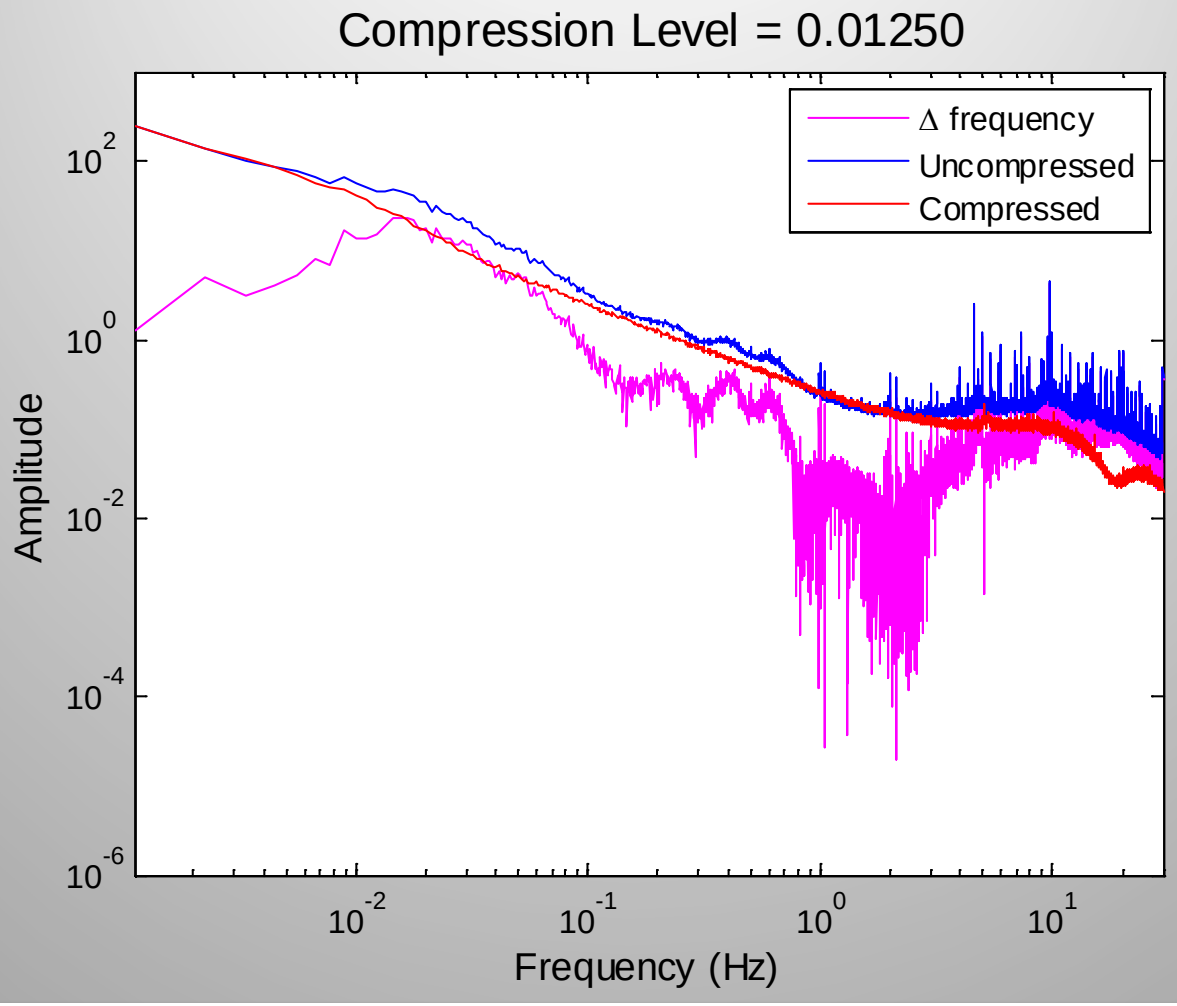
Distortion and compression level



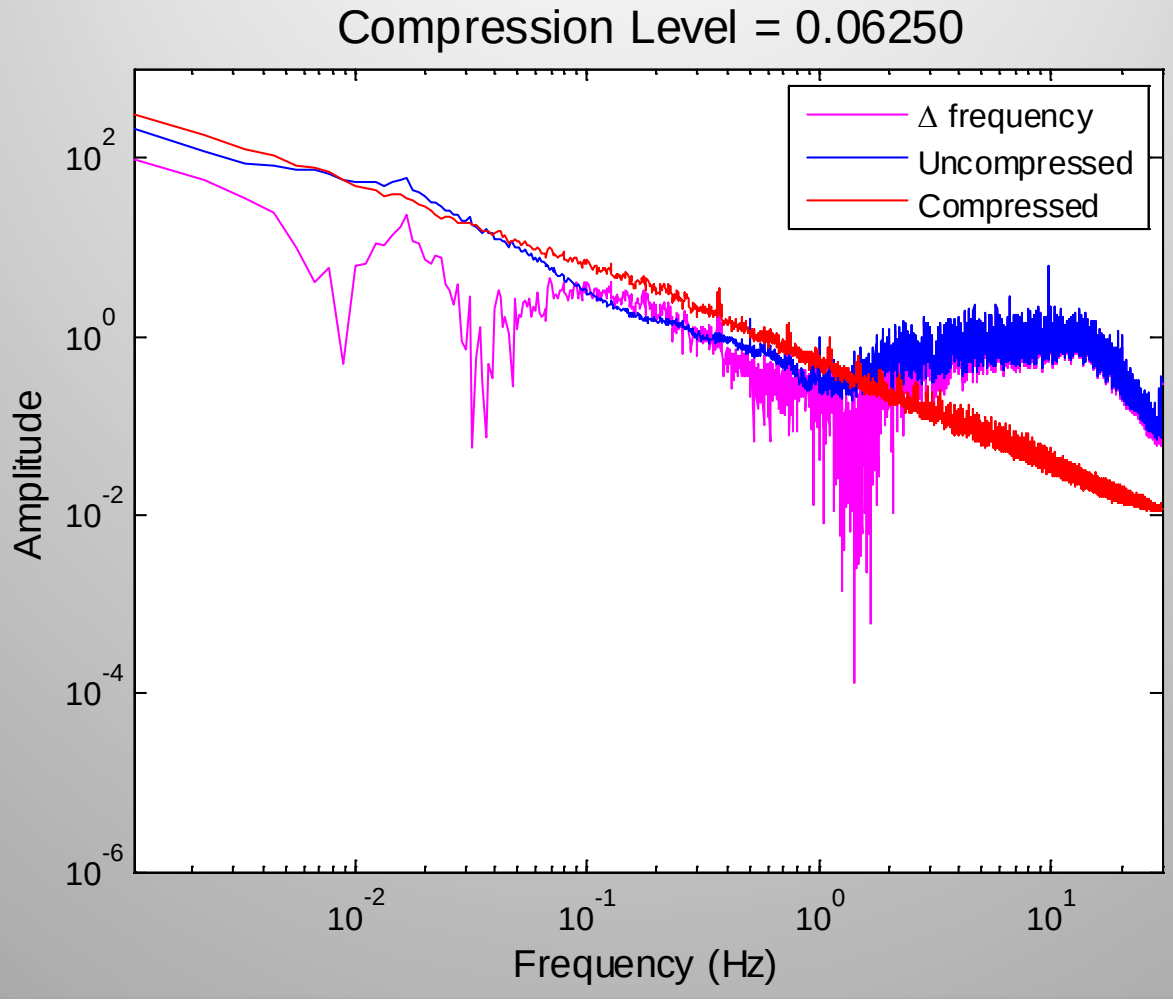
Distortion and compression level



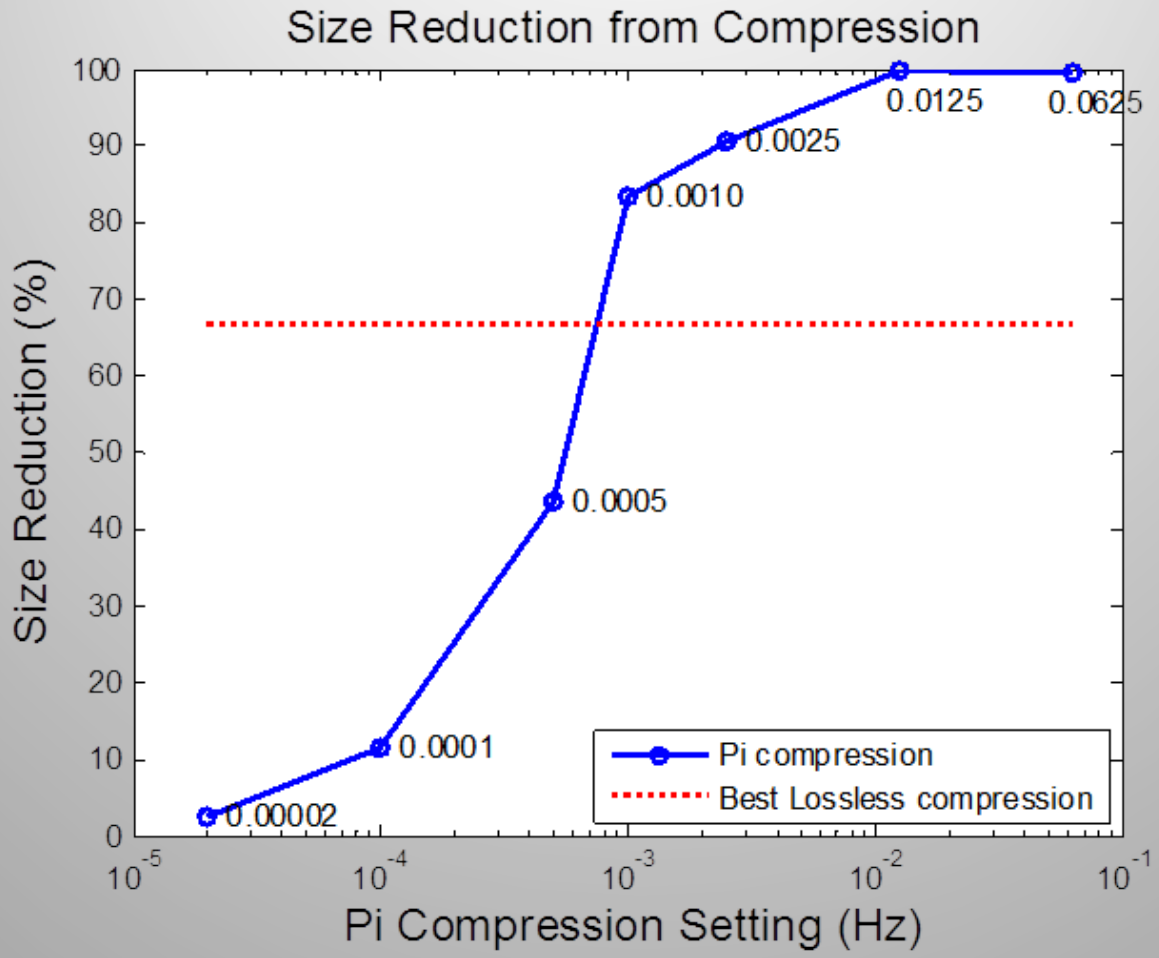
Distortion and compression level



Distortion and compression level

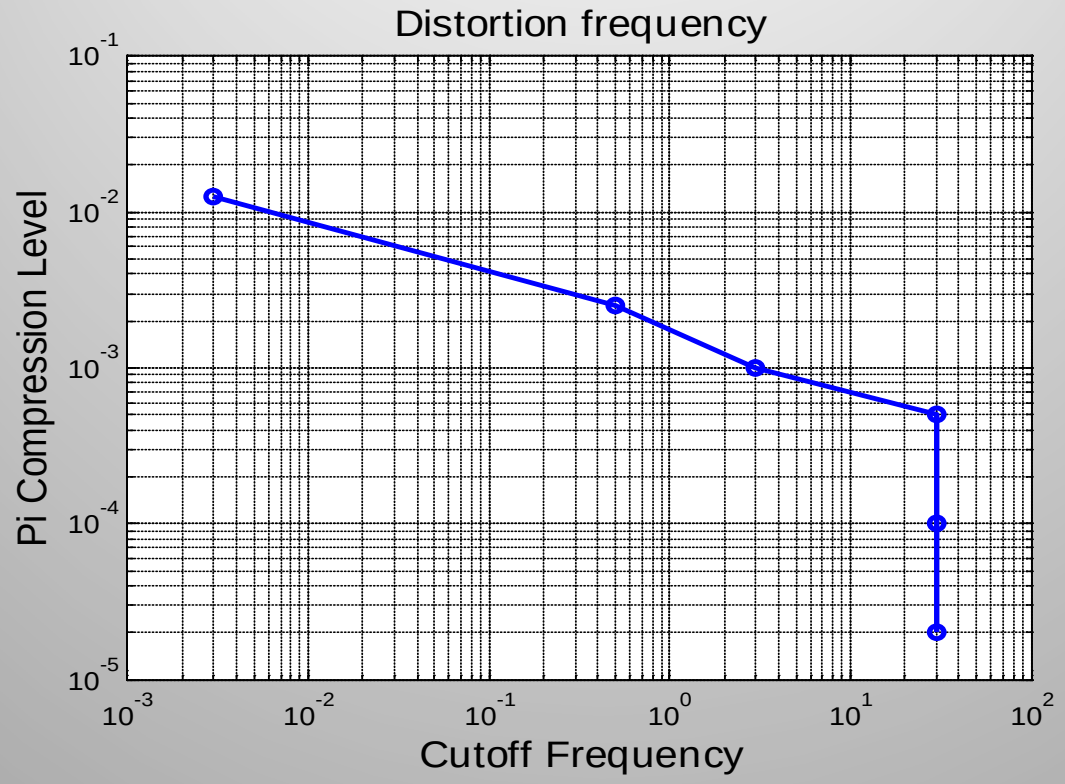


Compression Ratios

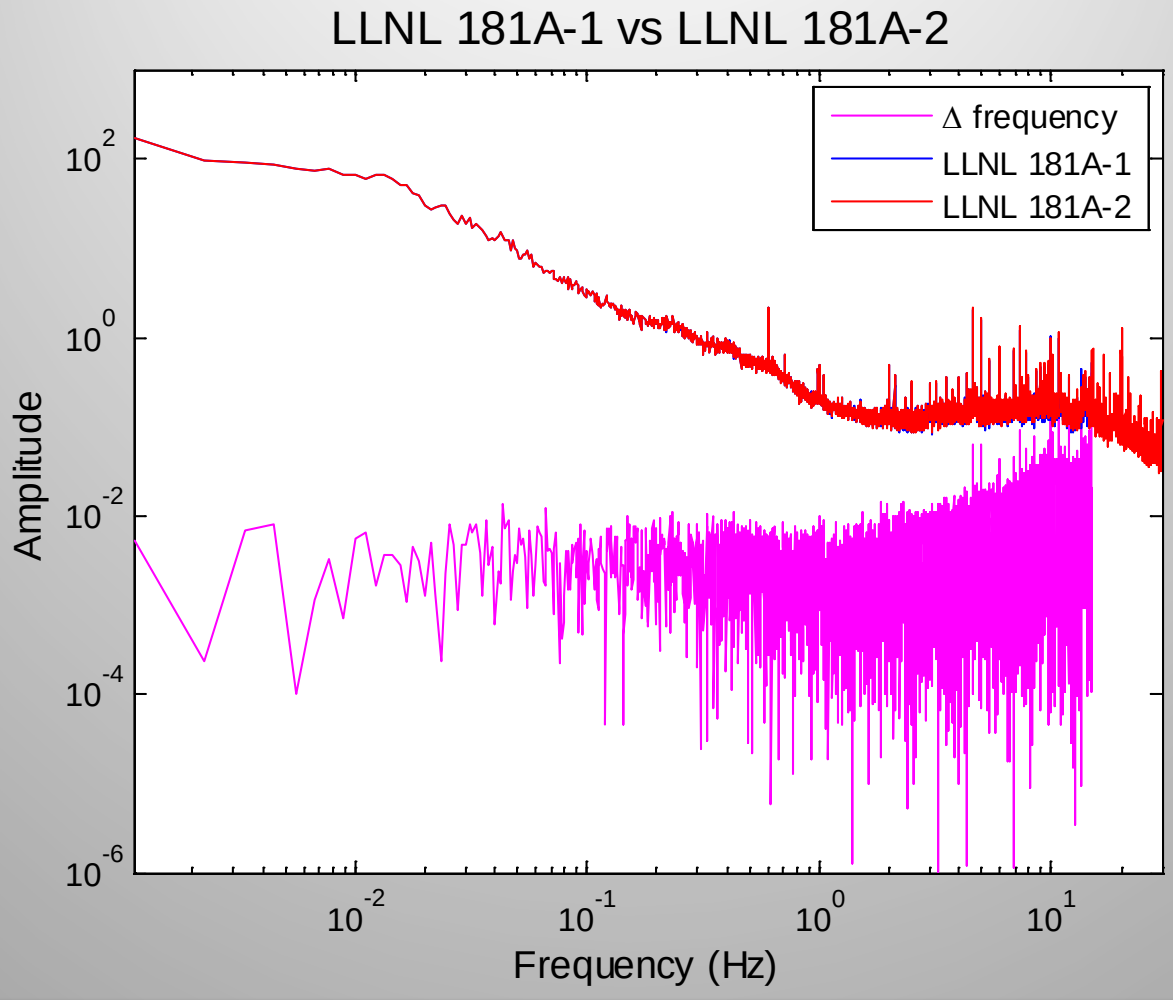


Distortion frequency

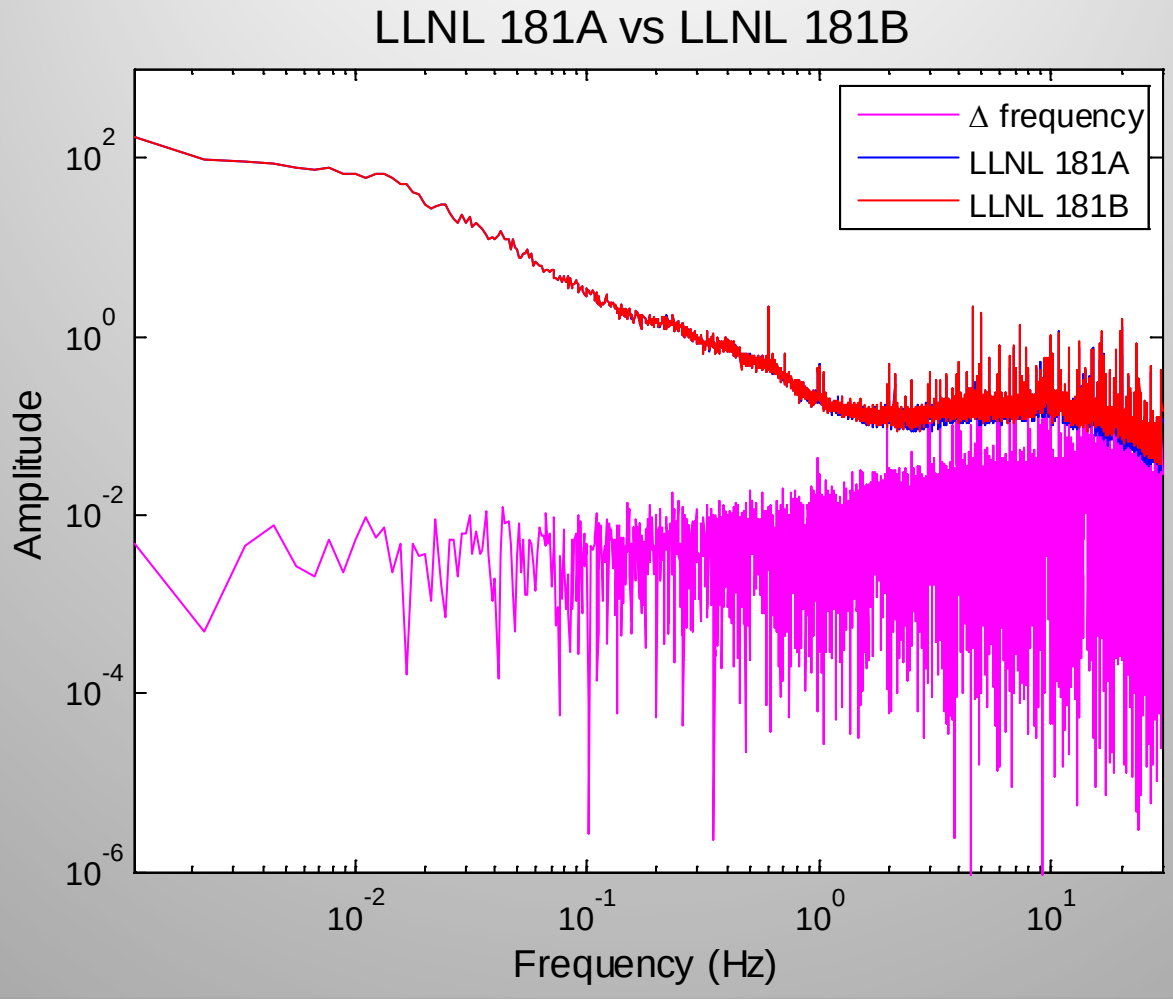
Frequencies higher than 10Hz will be distorted with compression level above 0.007



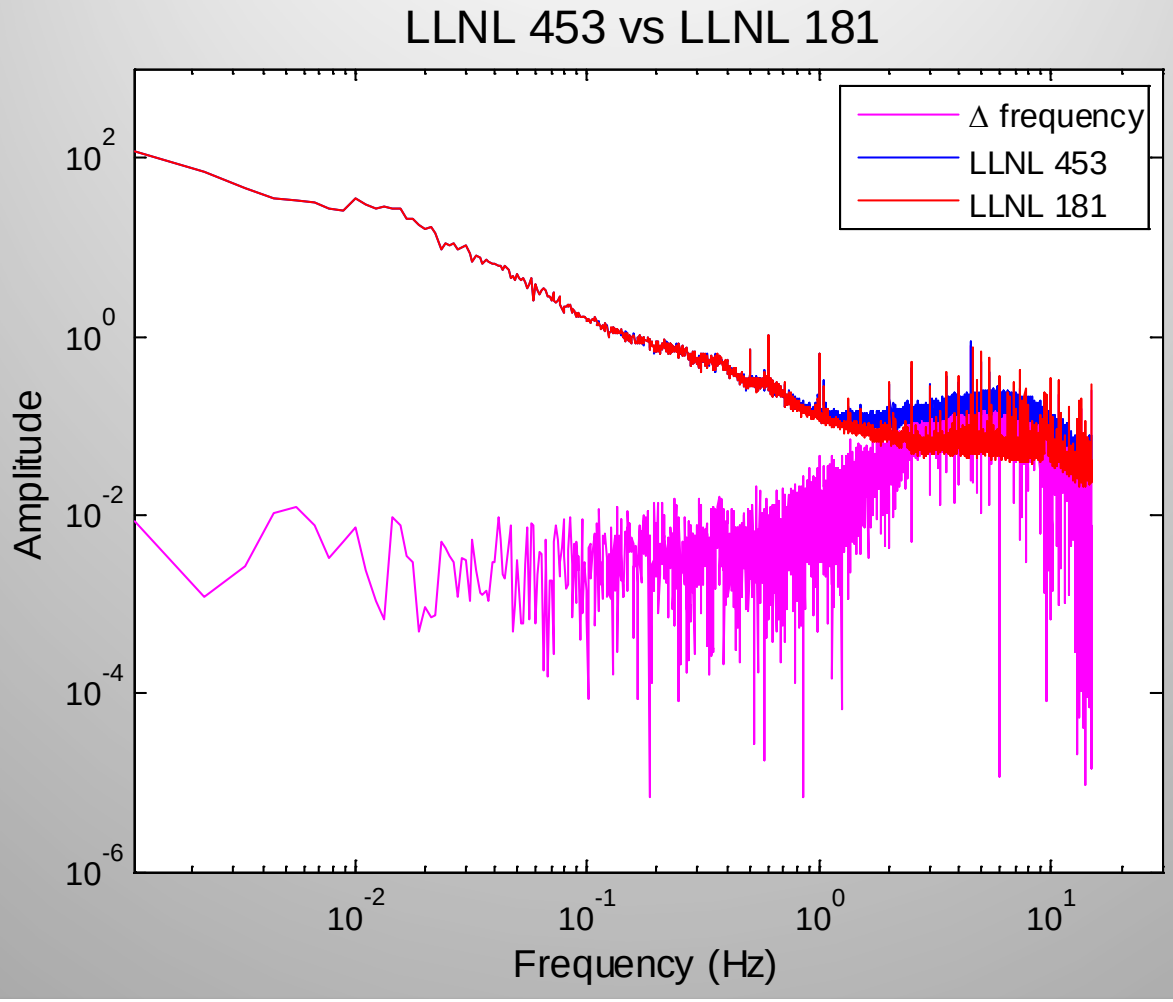
Frequency from same PMU with different sampling rates (30Hz & 60Hz)



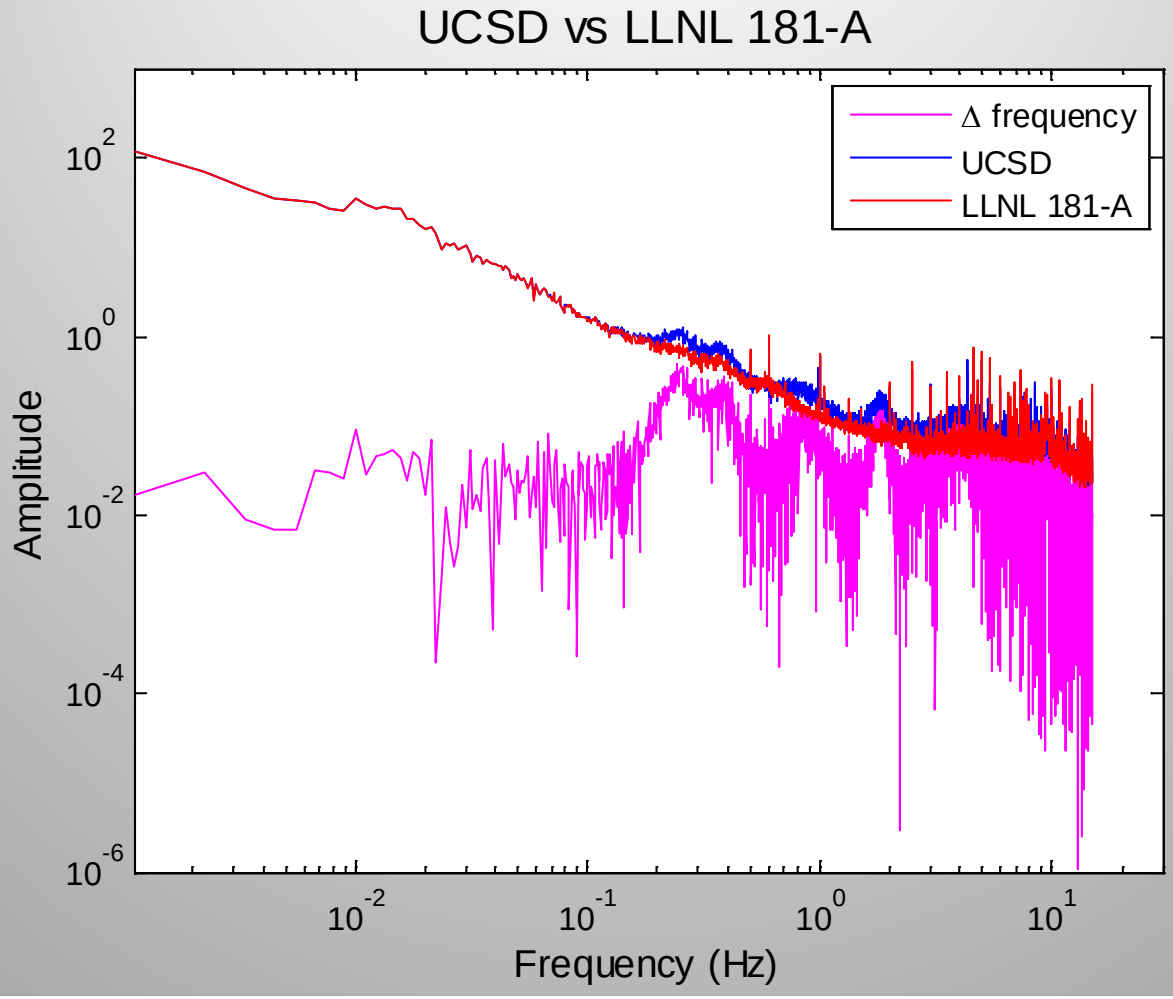
Signals from Two different PMU's in the same building



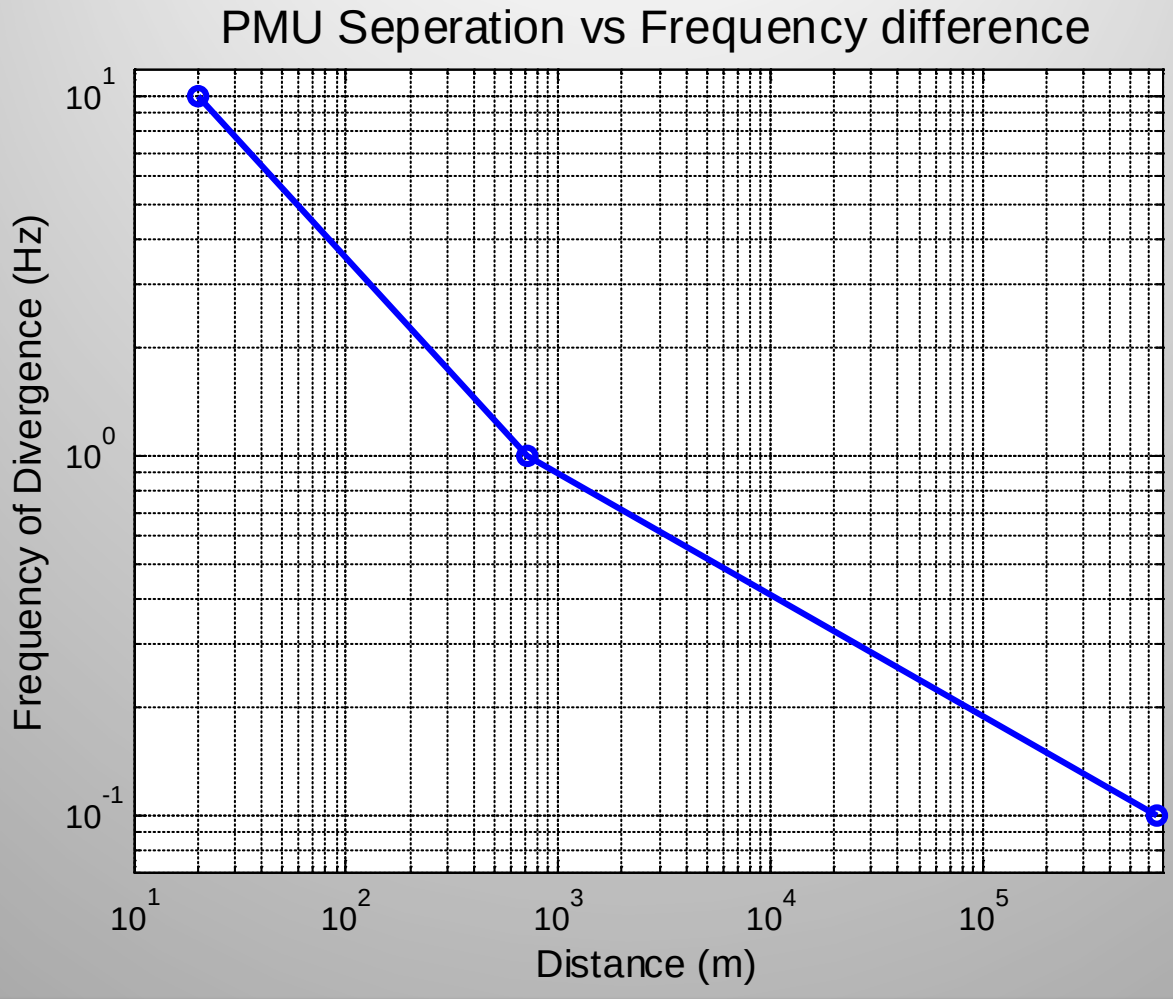
Signal from two different PMU's at different buildings at LLNL



LLNL PMU data versus PMU data collected at UCSD



Distance & signal divergence



Summary

- Collected data with different compression levels and from different locations
- Used FFT to study the effect of the different compression levels
- Compared the signals from the same PMU with different sampling rates
- Compared the signals from PMU's at different locations

Conclusions

- Based on this data the recommended value of PI compression with limited impact on the data is 0.0007 Hz, this corresponds ~ 66% space savings