



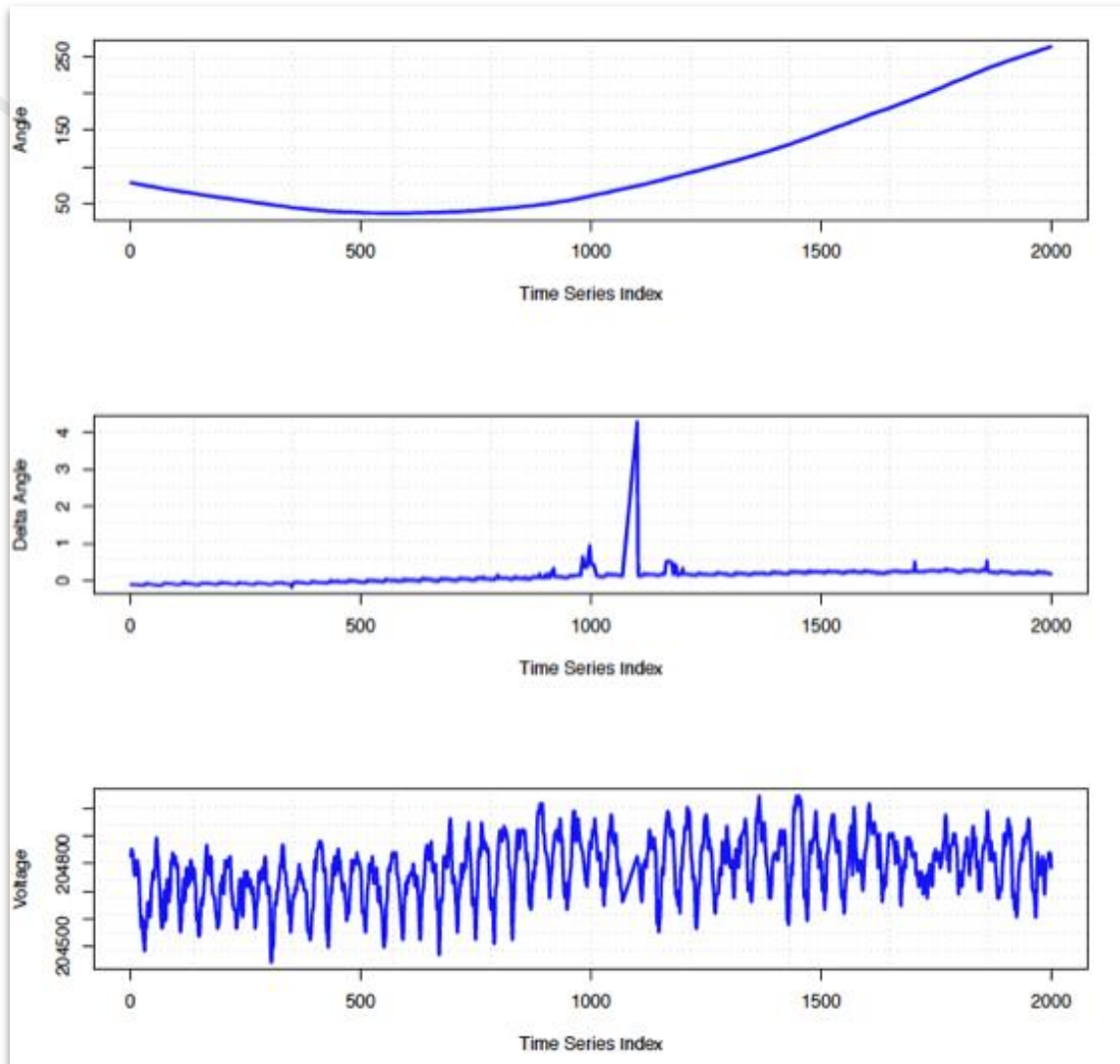
Synchrophasor Research and Education at ComEd

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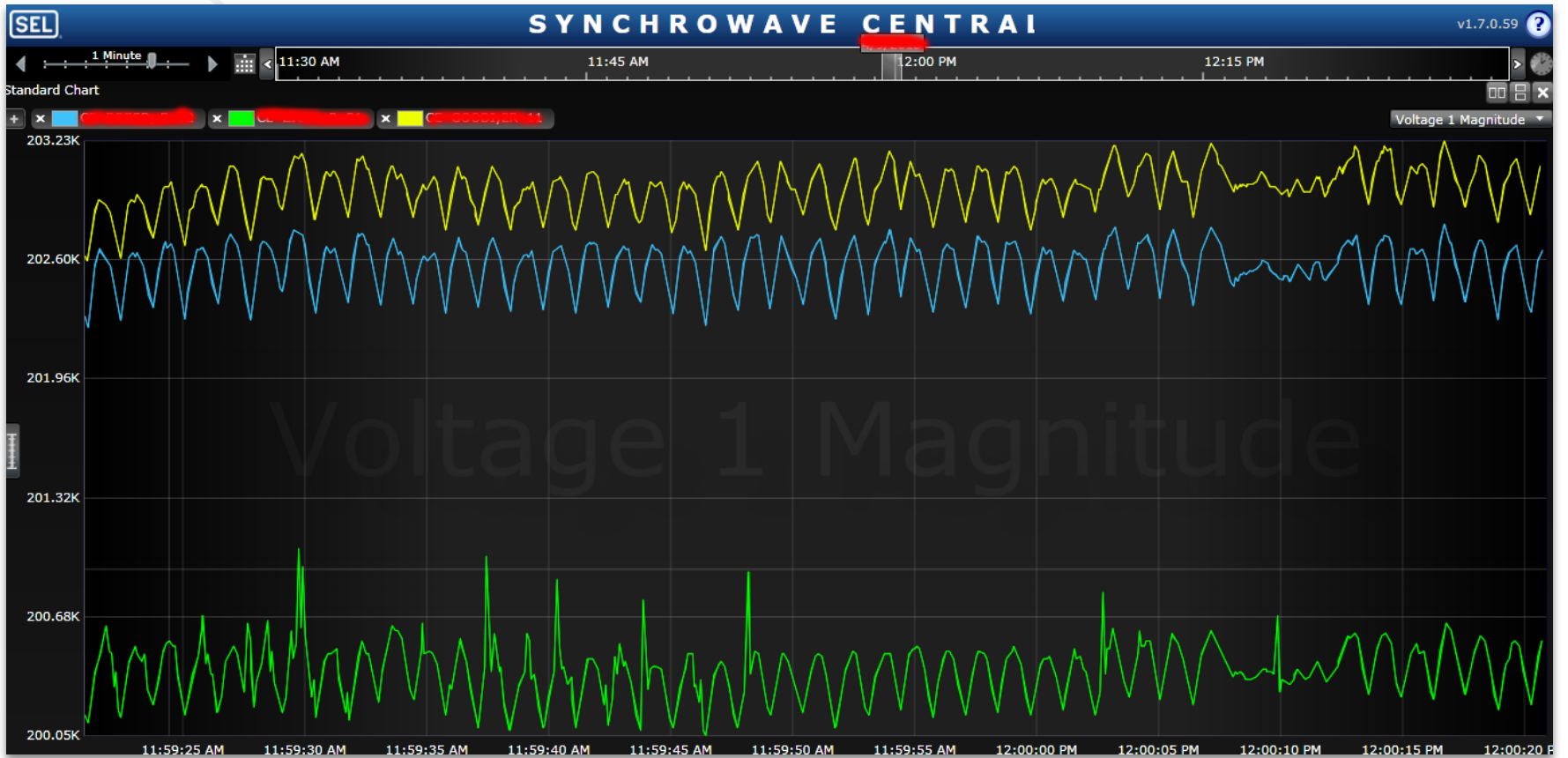
ComEd/Argonne Effort

- Event Detection
- Spectral Analysis
- Determining “normal” state of the transmission system

Event Detection



Oscillations



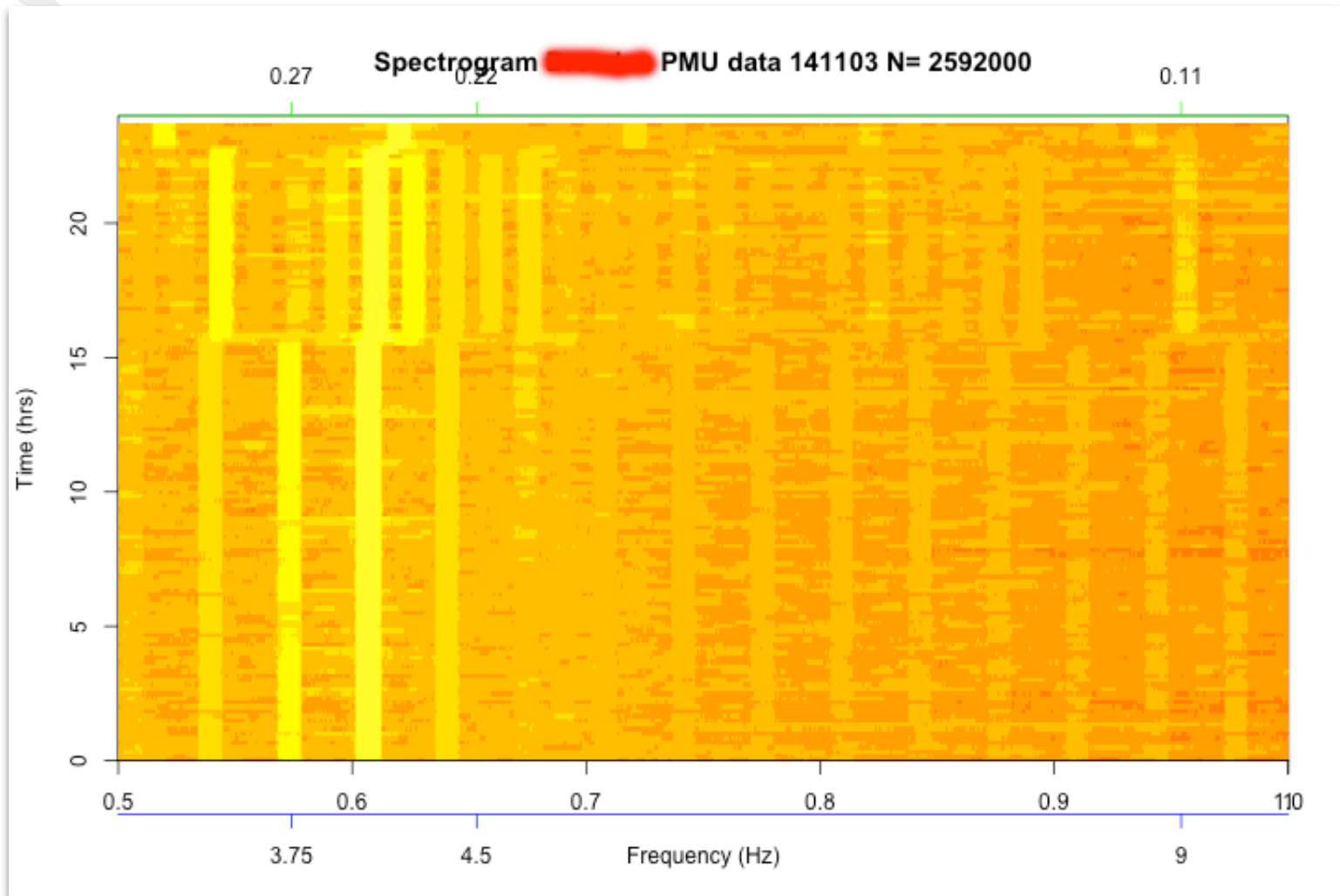
Goals and Methods

- To identify “unusual” oscillations in the PMU data and identify their sources.
- To furthermore characterize and track the spectral features over the course of several months.
- Using spectrum analysis, we characterize the frequency-domain content of the PMU signals.
- We used a particularly accurate multitaper method for the spectrum analysis on both day-long data blocks and shorter 15-min segments, to determine changes in the frequency content of the signals.

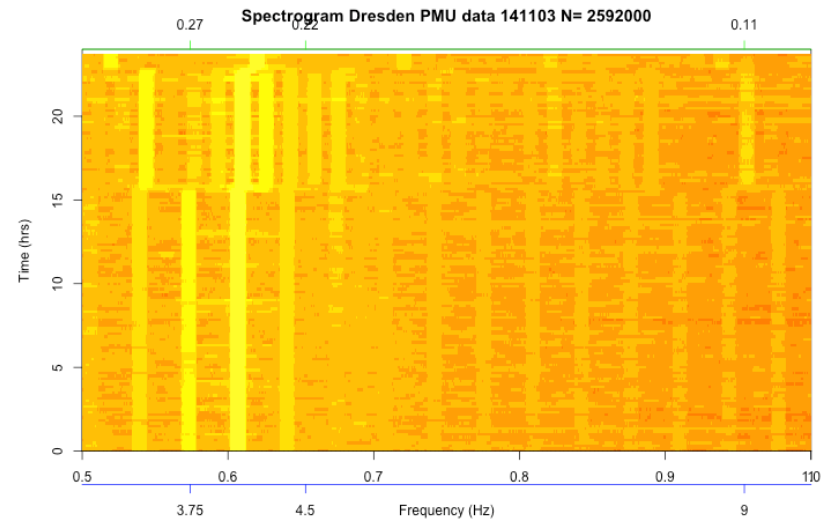
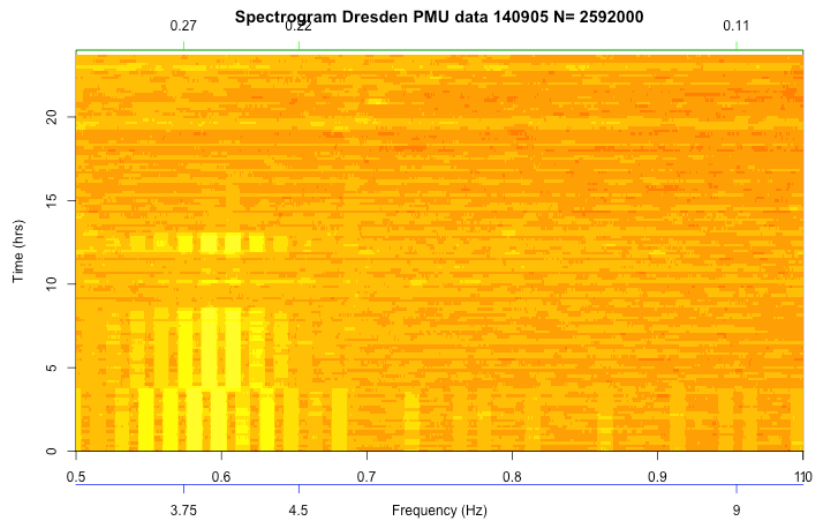
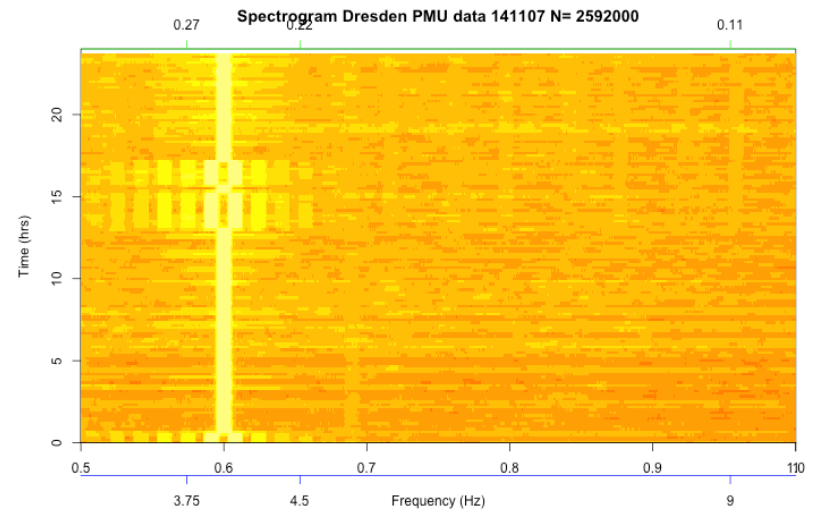
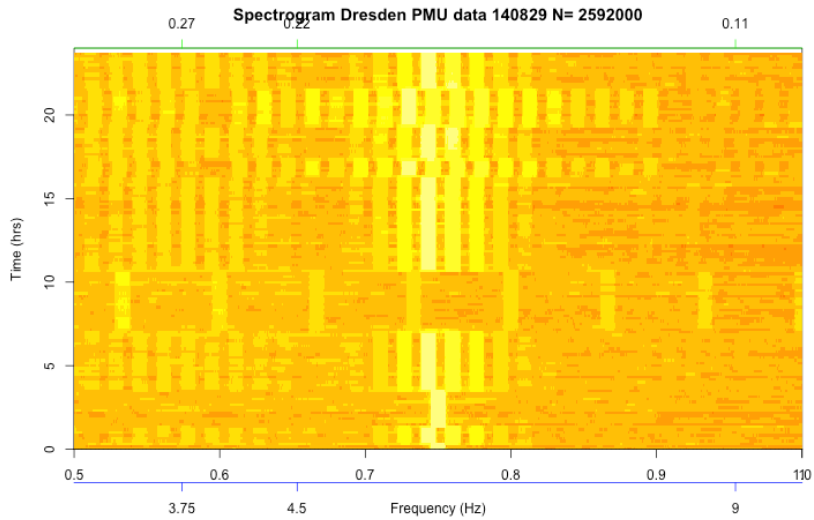
What is Multitaper?

- Multitaper spectrum estimation is an FFT-based method for calculating the spectrum which is an average of K different spectrum estimates corresponding with K different tapers. The tapers depend on the choice of a bandwidth tuning parameter, W .
- The multitaper method produces clearer estimates because the tapers are selected to reduce leakage across frequencies, and statistical consistency is obtained by averaging several independent estimates.
- For more information on spectrum analysis and multitaper methods, contact Charlotte Haley: haley@anl.gov, or Mihai Anitescu, anitescu@mcs.anl.gov.

Spectral Analysis



Additional Oscillation Examples



What is “Normal”

- Real-time evaluation of phasor angles is difficult without knowing what reasonable angles look like
- Simple polar plots don't tell us anything because there is seldom a reference
- What is “Normal” Analysis
 - N-0, N-1, N-1-1, and N-2 contingency analysis
 - Extraction of phase angles for each contingency
 - Phase angles define envelopes of historical data (N-0) and where the system has been analyzed (N-1, N-1-1, and N-2)
 - Real-time angles outside of these envelopes tell us that the system is operating beyond historical or previously studied limits

