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Eastern Interconnection Oscillations

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RELIABILITY | ACCOUNTABILITY




Oscillations in Eastern Interconnection

- Ambient oscillations are normal
  - Constantly occurring
  - System “breathing”
- Long-know oscillation modes
  - 0.5 Hz family – New York oscillations – not sure against what
  - 0.25 Hz family – New England
- First major usage by NERC of PMUs began in mid-2007
  - 2008 South Florida event heavily analyzed

EI Oscillation Analysis

2007 Broad River Disturbance

- 0.52 Hz Damping = ~4.2% (not too good!)

2007 MRO Disturbance

- 0.5 Hz family Multiple times with variable damping

2008 Florida Disturbance

- 0.05 Hz Damping = ~52% (really good damping)
- 0.25 Hz Damping = ~17% (good damping)
- 0.51 Hz Damping = ~4.5% (not too good!)

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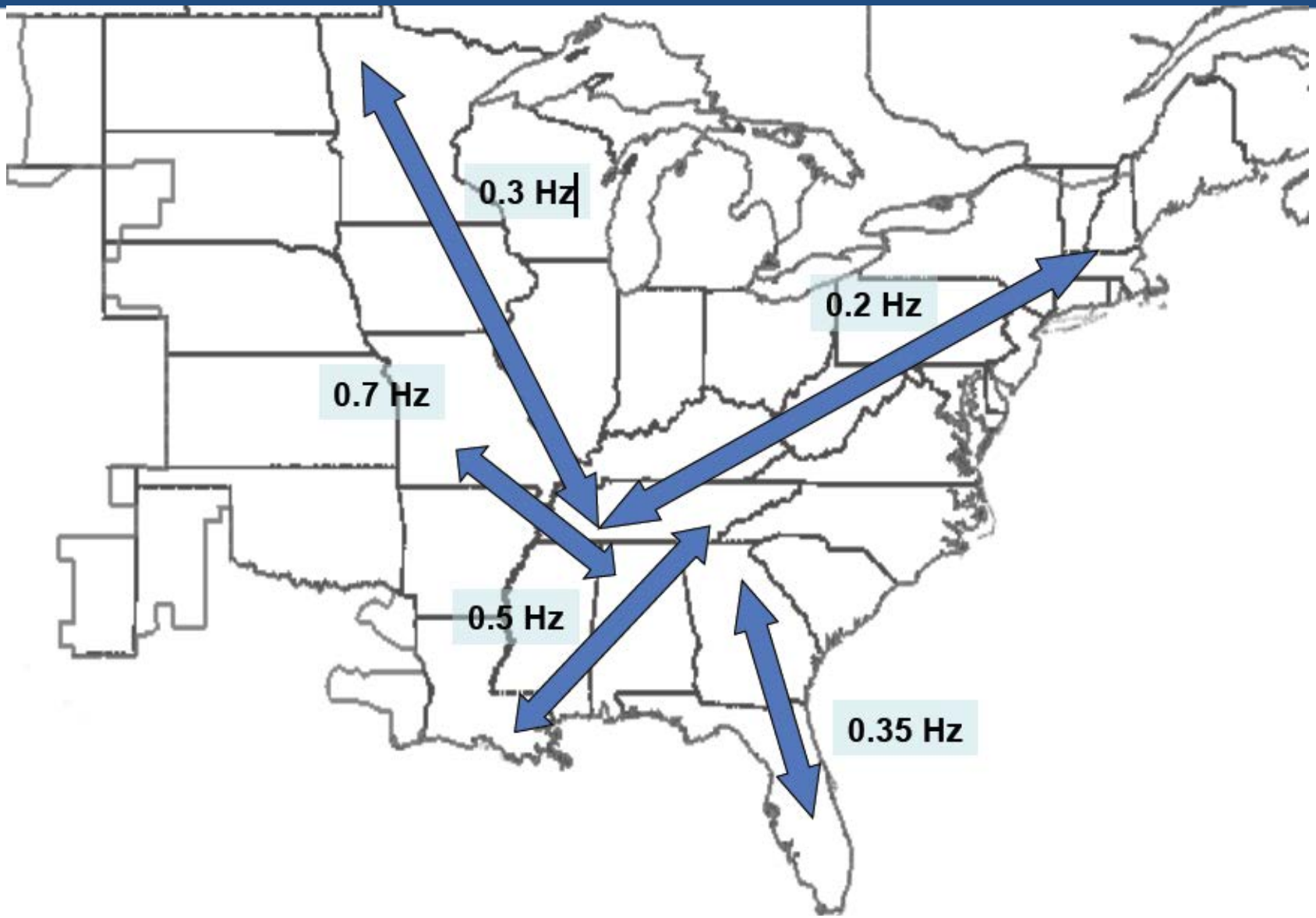
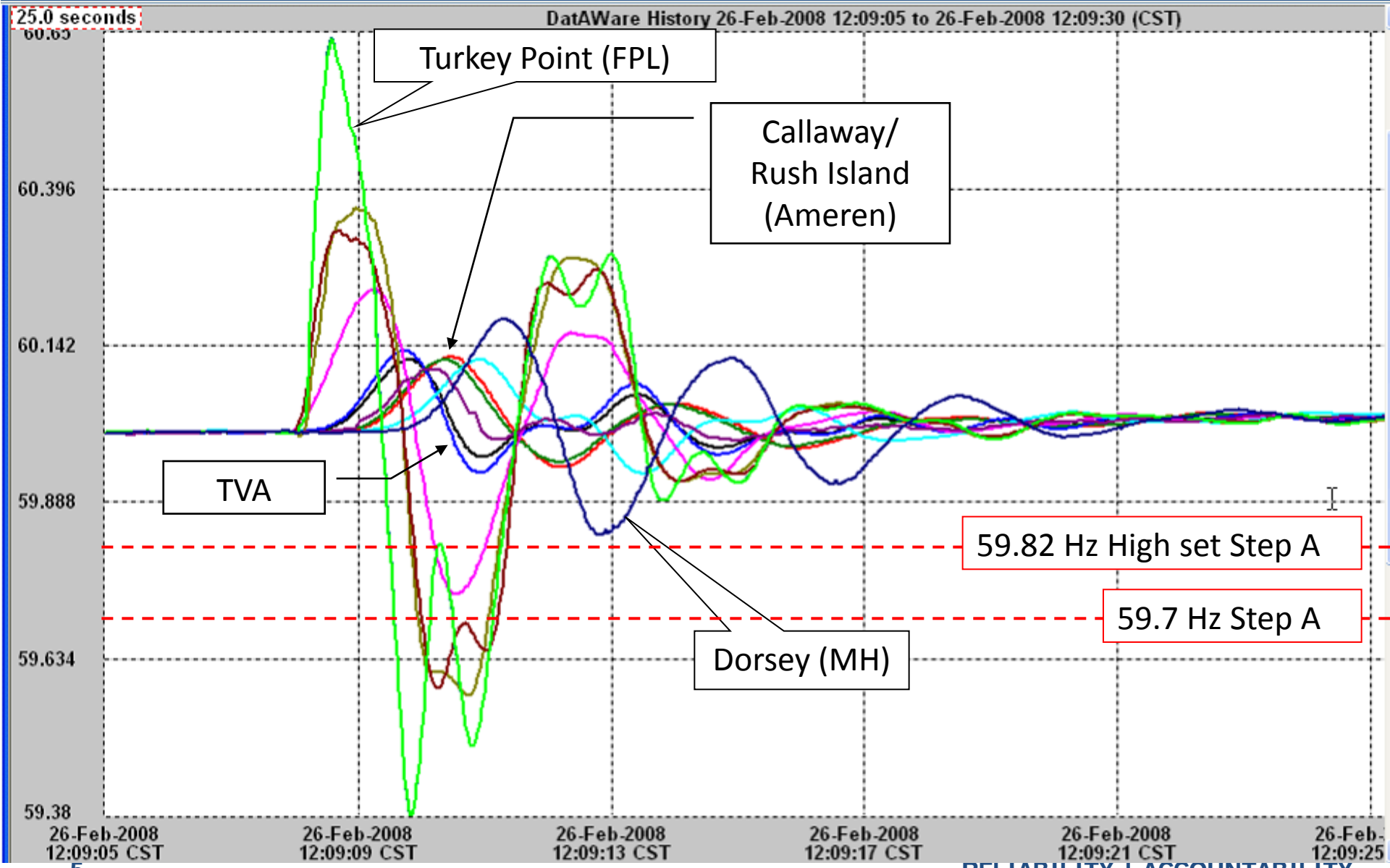
EI Oscillation Modes (work in progress)



Florida Disturbance – Non-Local Impacts



April 2012 Oscillations

- FNet alarm indicated
  - 1,800 MW plant tripped
  - FDR triangulation location Minnesota / North Dakota
- Triggered FNet Oscillation Alarm
  - 0.25 Hz family between MRO and New England
- Signature was that of a Dorsey-Forbes 500 kV line trip with a Dorsey DC converter run-back

- Known unit trip – Plant Vogtle Unit 1 (Georgia) tripped
  - Net output ~1,100 MW

FNet Event Alarm

FNET Event Report

Recorded Event: 2012-04-14 17:46:47 EI

InterConnection:EI

Estimated Reliability Coordinator: MRO NPCC

Event Date: 2012-04-14

Event Time: 17:46:47 UTC

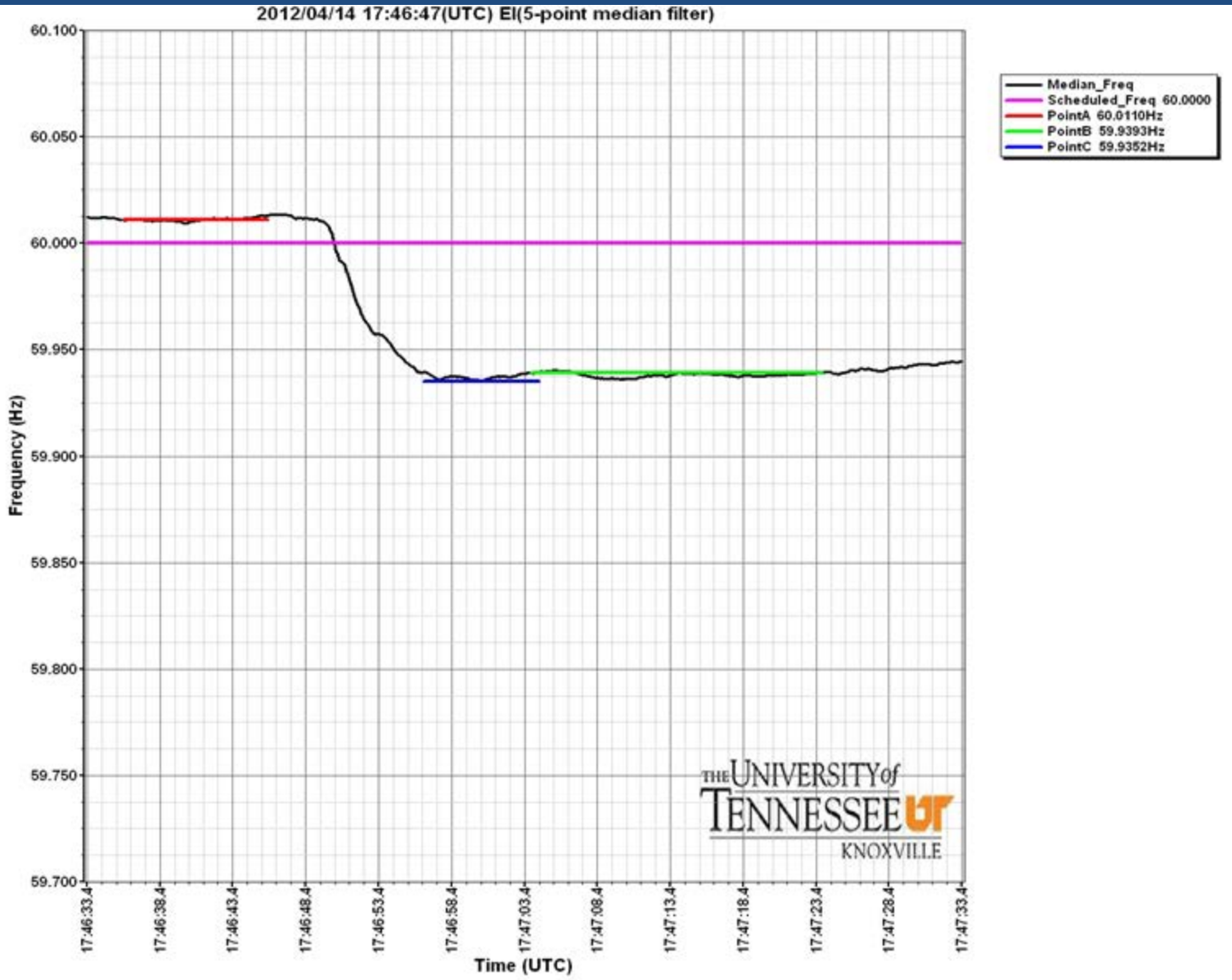
Event Type: Generation Trip

Estimated Amount: 1800.0 MW

Point A: 60.0110 Hz **Point B:** 59.9393 Hz **Point C:** 59.9352 Hz

Unit Detection Order (the first 6 units):
CaMbKelsey893,UsMnCrystal747,UsMnGre790,UsMnOtpc720,UsNdDevilslake740,UsSdBigstone739

FNet Frequency Response Plot



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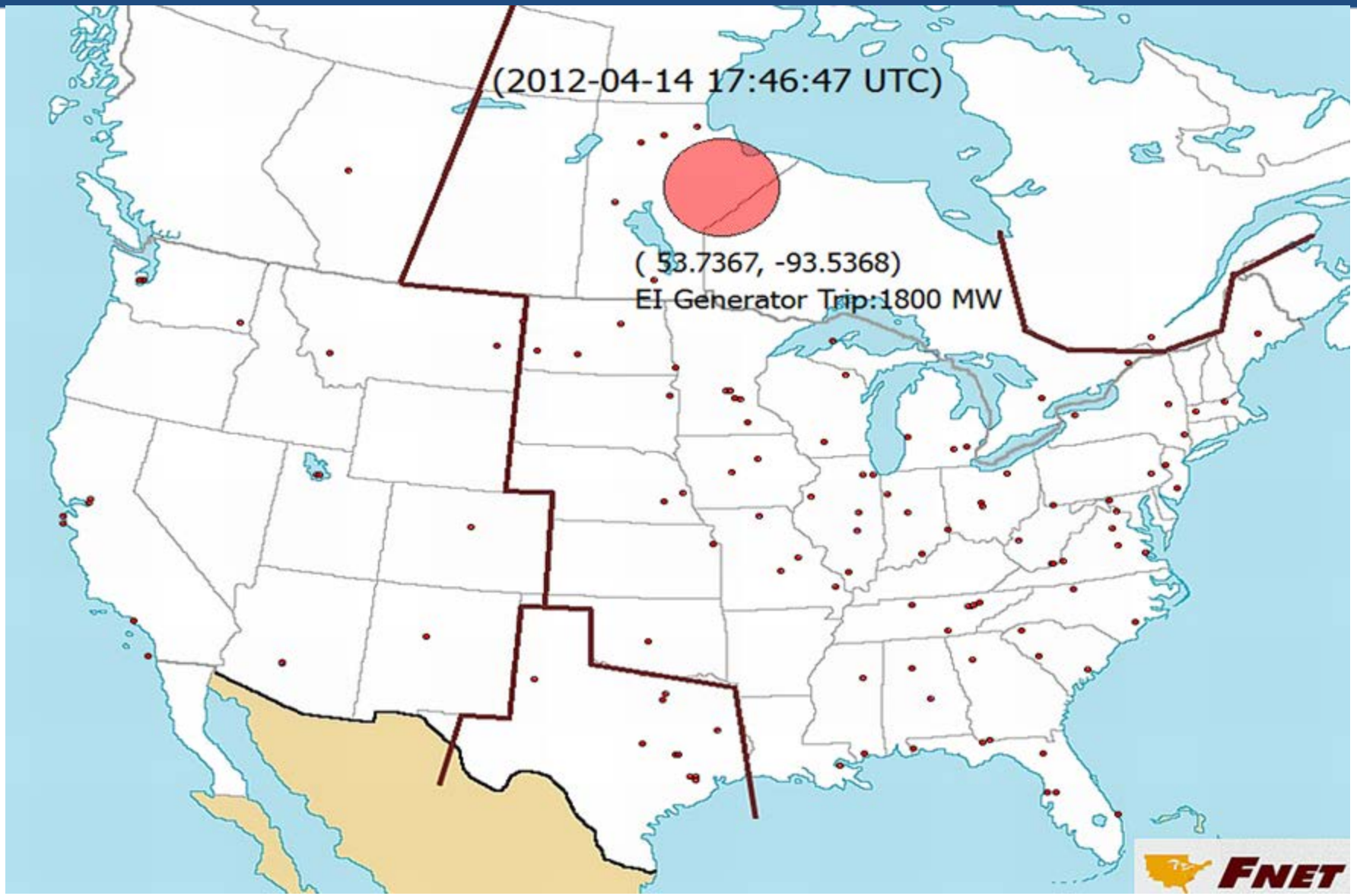
FNet Triangulation



April 2012 Oscillations

- Triggered FNet Oscillation Alarm
  - 0.25 Hz family between Winnipeg, Manitoba and New England

- Oscillation triggering continued about 300 times per day for several days

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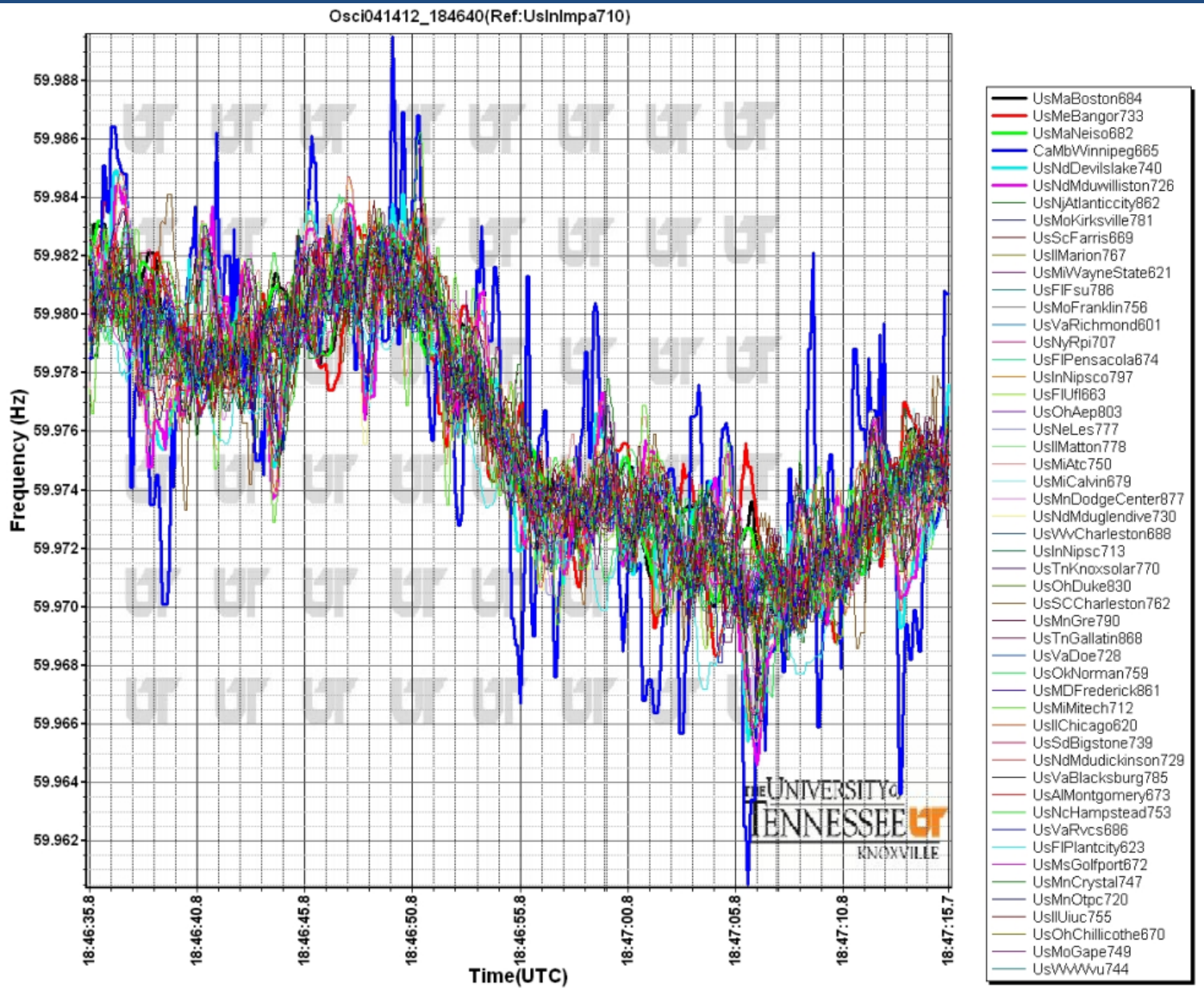
FNet Oscillation Sample



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April 2012 Oscillations

- 0.25 Hz family mode shapes exist between
  - Southeast and Northwest EI – determined in the South Florida EA
  - Manitoba and New England – often observed and active damping done by Dorsey DC Bi-Pole converter (Winnipeg, Manitoba) and Forbes SVC
- Both mode shapes share units in MRO that participate in the oscillatory behavior
- Common mode frequency
- Manitoba-New England shape more dominant
  - Reflective wave at edge of the interconnection

April 2012 Oscillations

Contributing factors

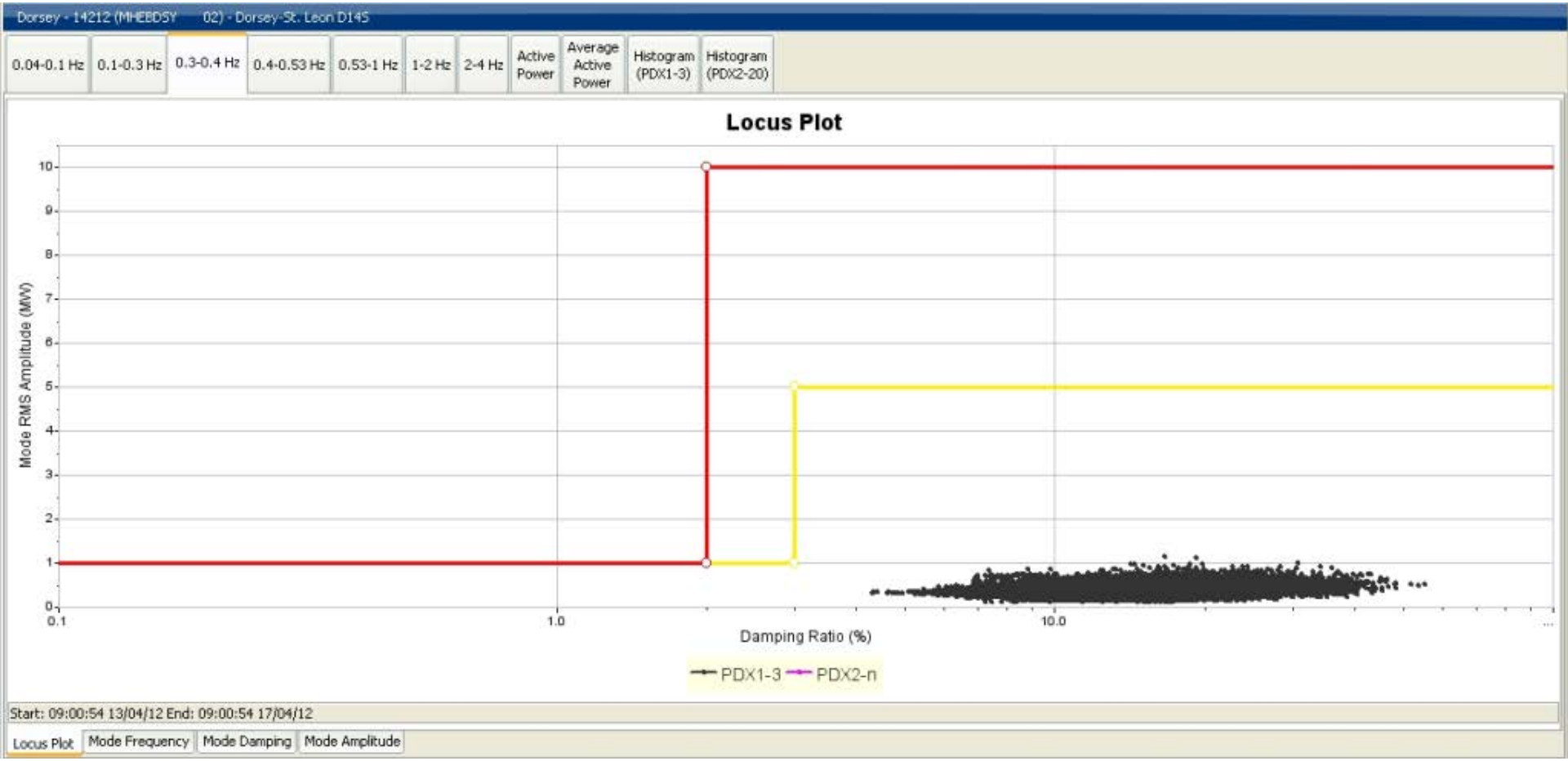
- Dorsey – Forbes 500 kV line out of service – weakened system
- Dorsey Oscillation damping effectively out of service

Analysis indicated

- Low energy oscillations
- Sufficient damping

MHEB Oscillation Analysis – 230 kV System

Damping around 10%



Questions?