

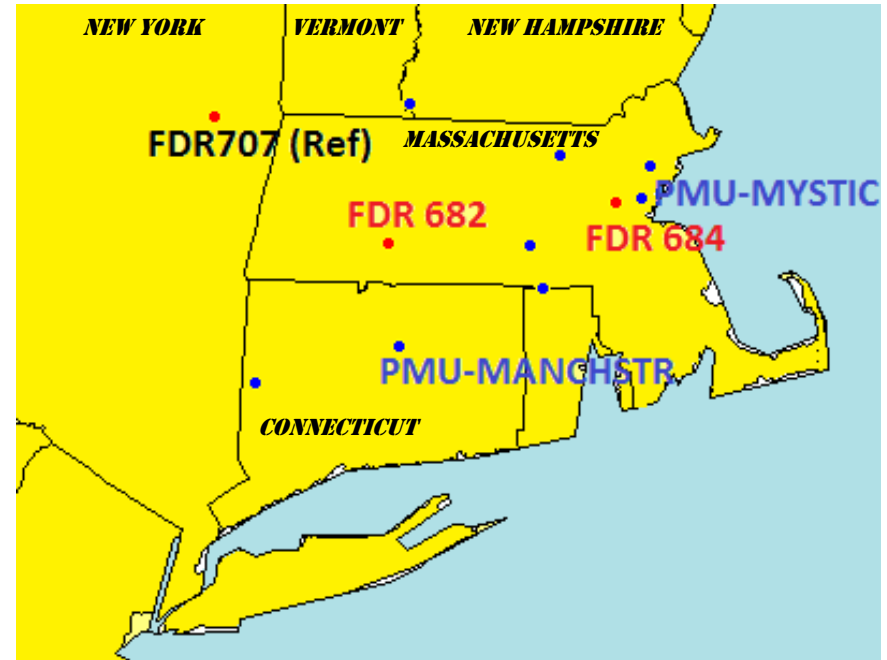
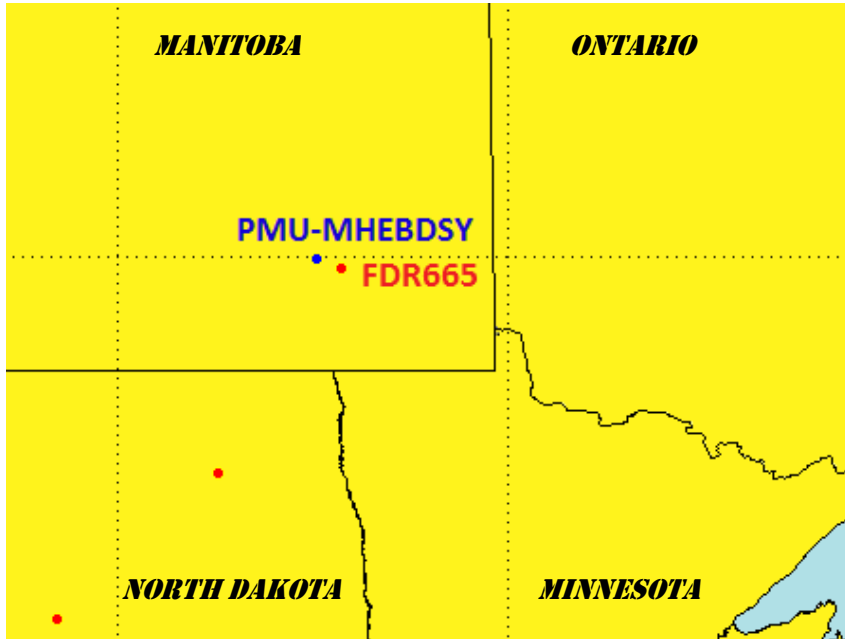
May 14th Oscillation Event and Online Ambient Monitoring

Jason Guo, Yin Lei, Yilu Liu, UTK/ORNL

Tony Weekes, Manitoba Hydro

David Bertagnolli, ISO-NE

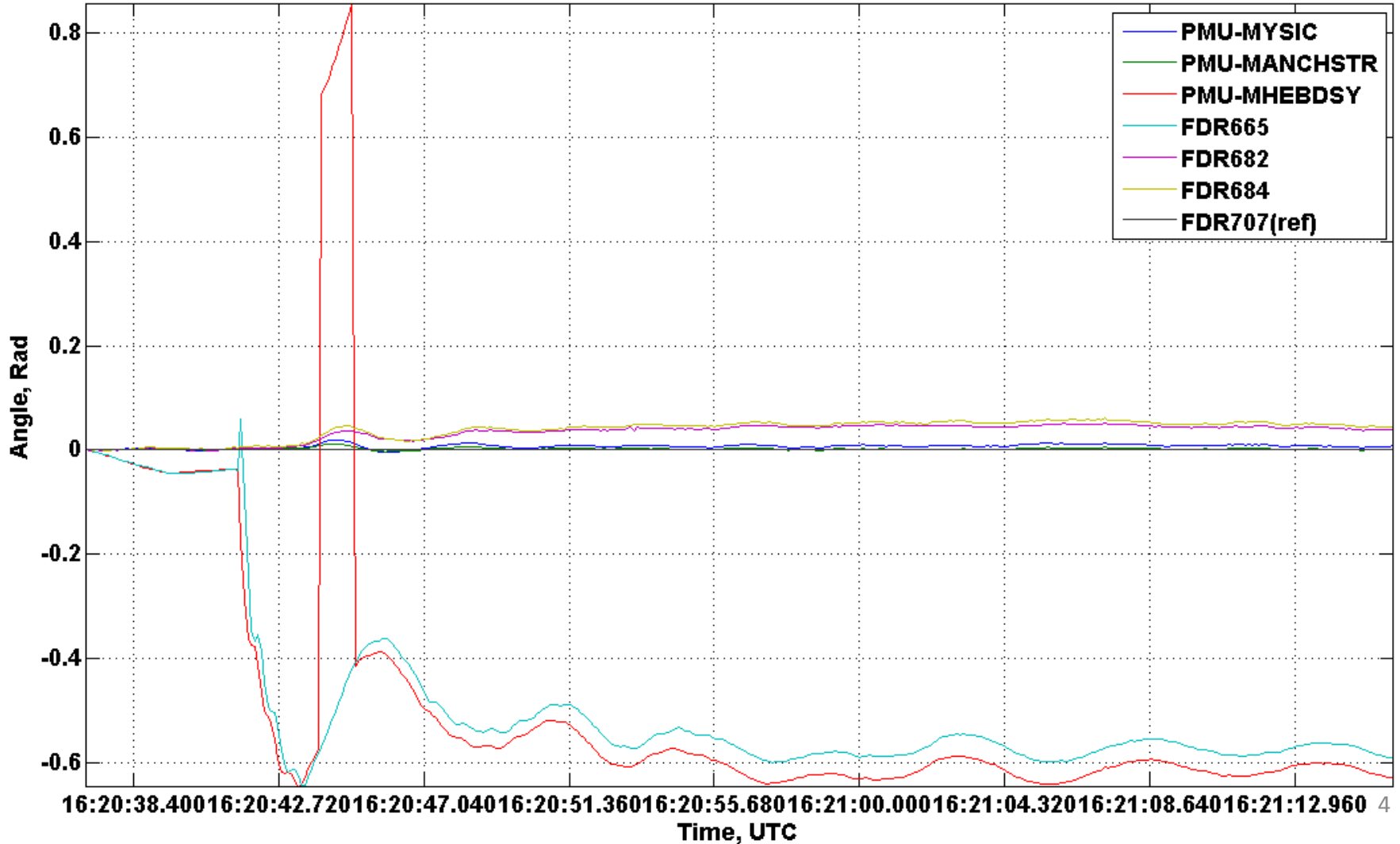
Manitoba and New England PMU/FDR Locations



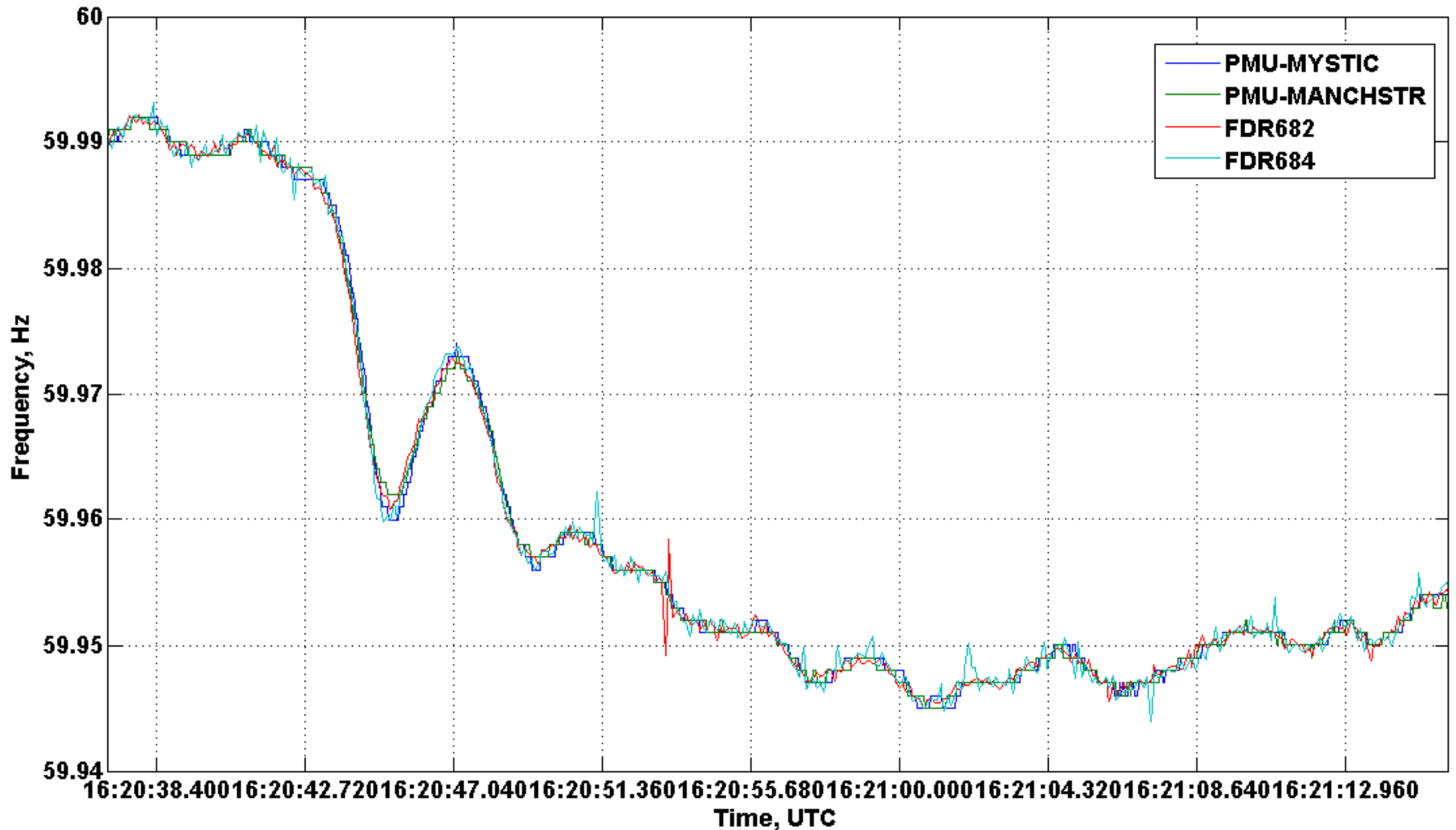
Frequency - PMUs and FDRs (both locations)



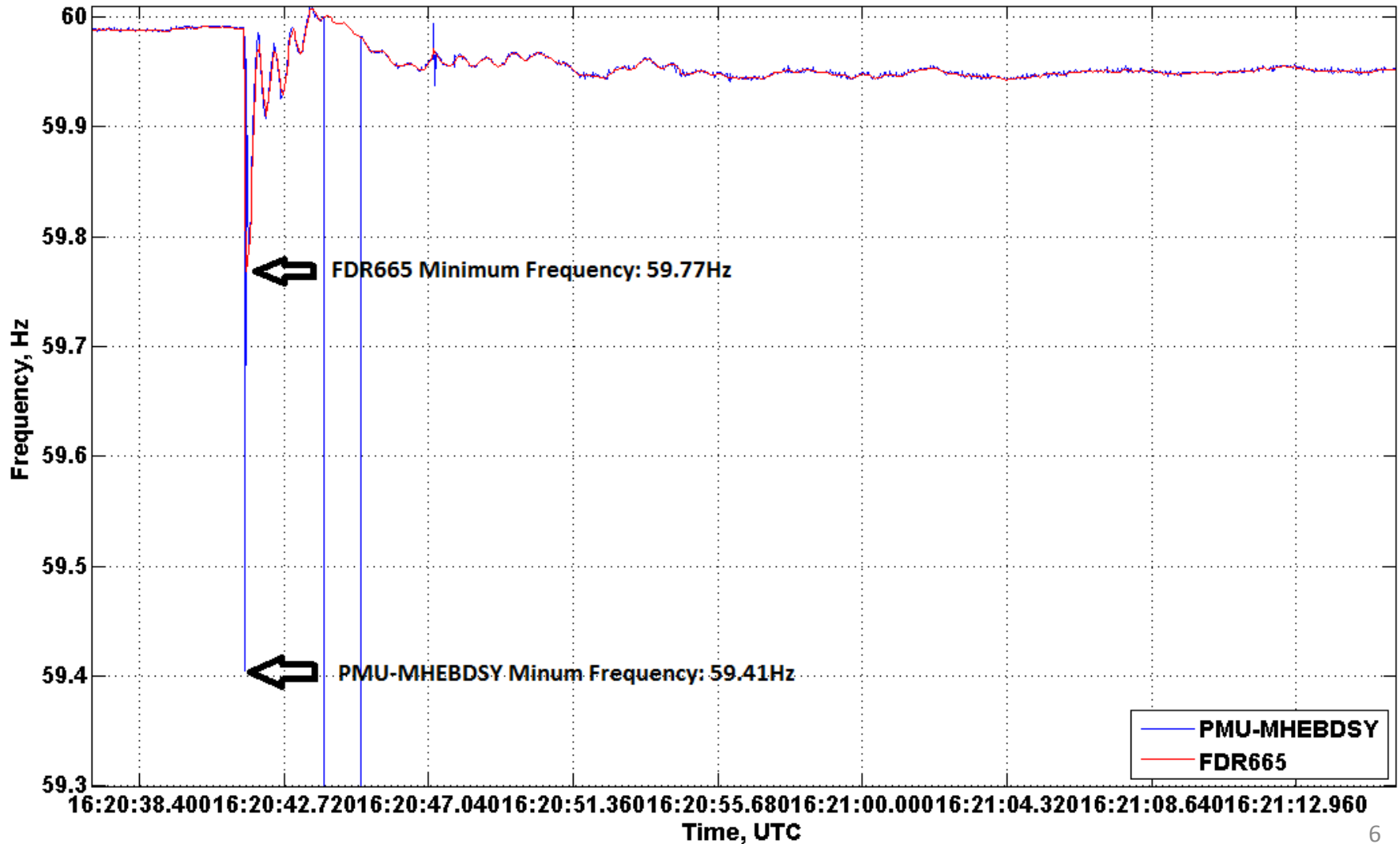
Angle - PMUs and FDRs (both locations)



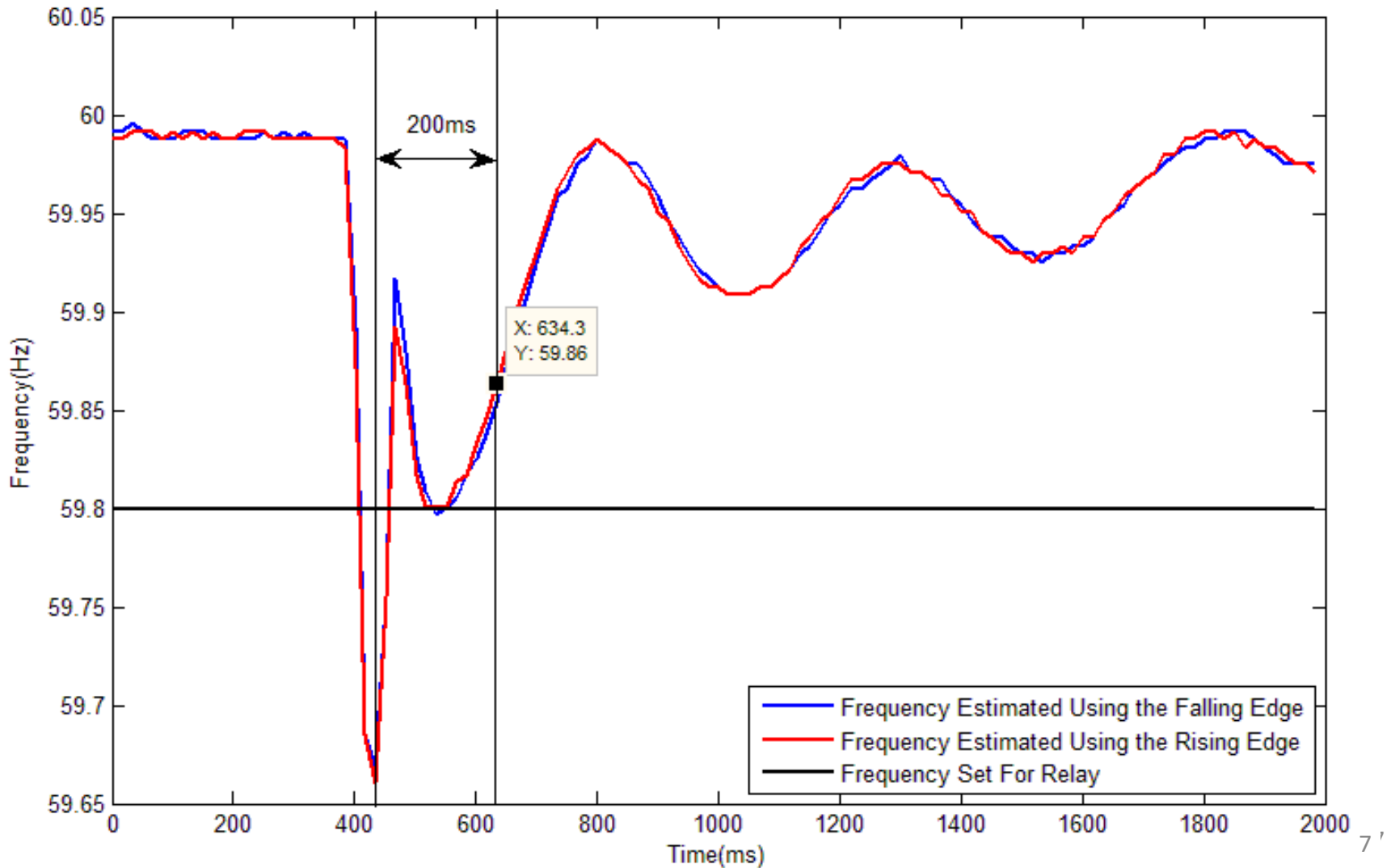
Frequency - New England PMU & FDR



Frequency - Manitoba PMU and FDR



Frequency Estimated by Relay Using Zero-crossing Method (3 cyc window)

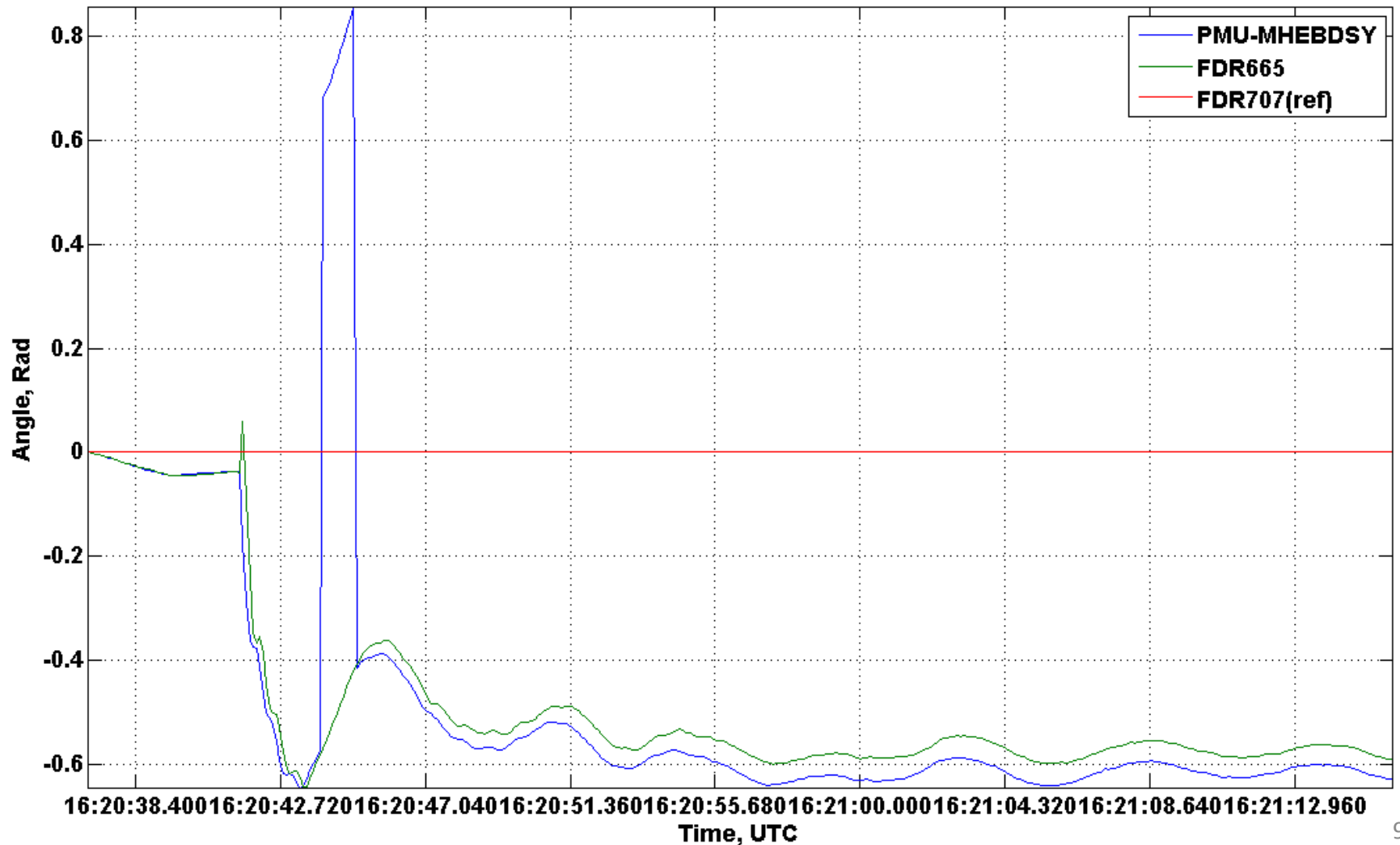


Manitoba PMU, FDR, TFR, and Relay Frequency

Eg. Minimum Frequency seen by UFLS Relay set to trip first set of load at 59.80 Hz

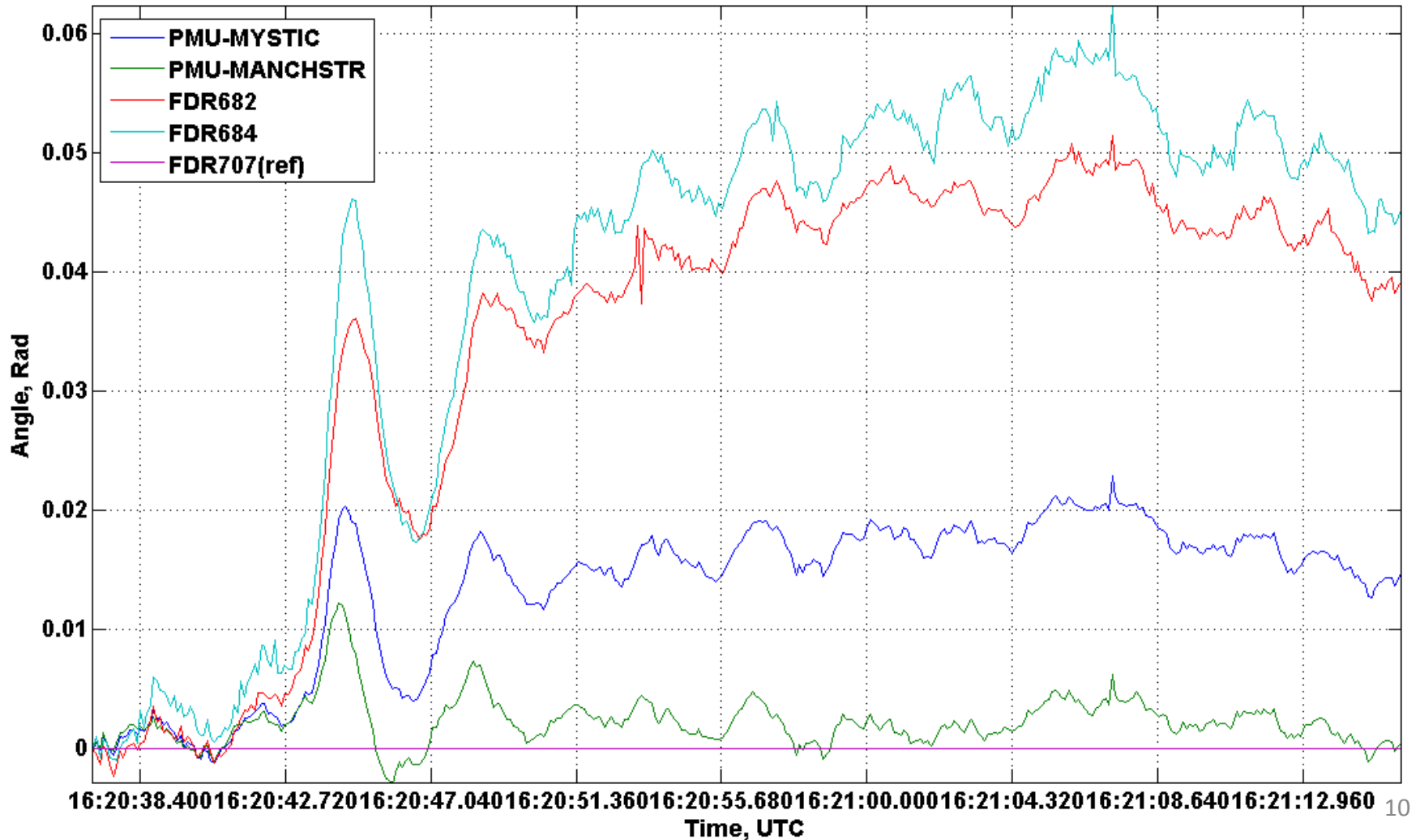
Unit Name	Minimum Frequency (Hz)	Trip (Yes?)	Comment
MB PMU	59.41	?	Depending on filtering setting
MB FDR665	59.77	?	Depending on filtering setting
MB TFR	59.43	?	Depending on filtering setting
MB UFLS Relay	59.66 Set @ 59.80 Hz	NO	Total delay for UFLS relay is 200ms, the frequency went back to 59.86Hz after time delay, so the relay won't trip.

Manitoba PMU and FDR Angle Changes with FDR 707 as the reference



New England PMU and FDR Angle Changes

FDR707 is the reference



Oscillation Mode Shape (Matrix Pencil algorithm)

Dominant Frequency (Average): 0.1847 Hz

UnitName	Frequency(Hz)	Damping Ratio(%)	Relative Phase (Degree)
PMU-MHEBDSY	0.1861	24.923	93.7658
FDR665	0.1833	31.535	87.3629

Oscillation Mode Shape (Matrix Pencil algorithm)

Dominant Frequency (Average): 0.2423 Hz

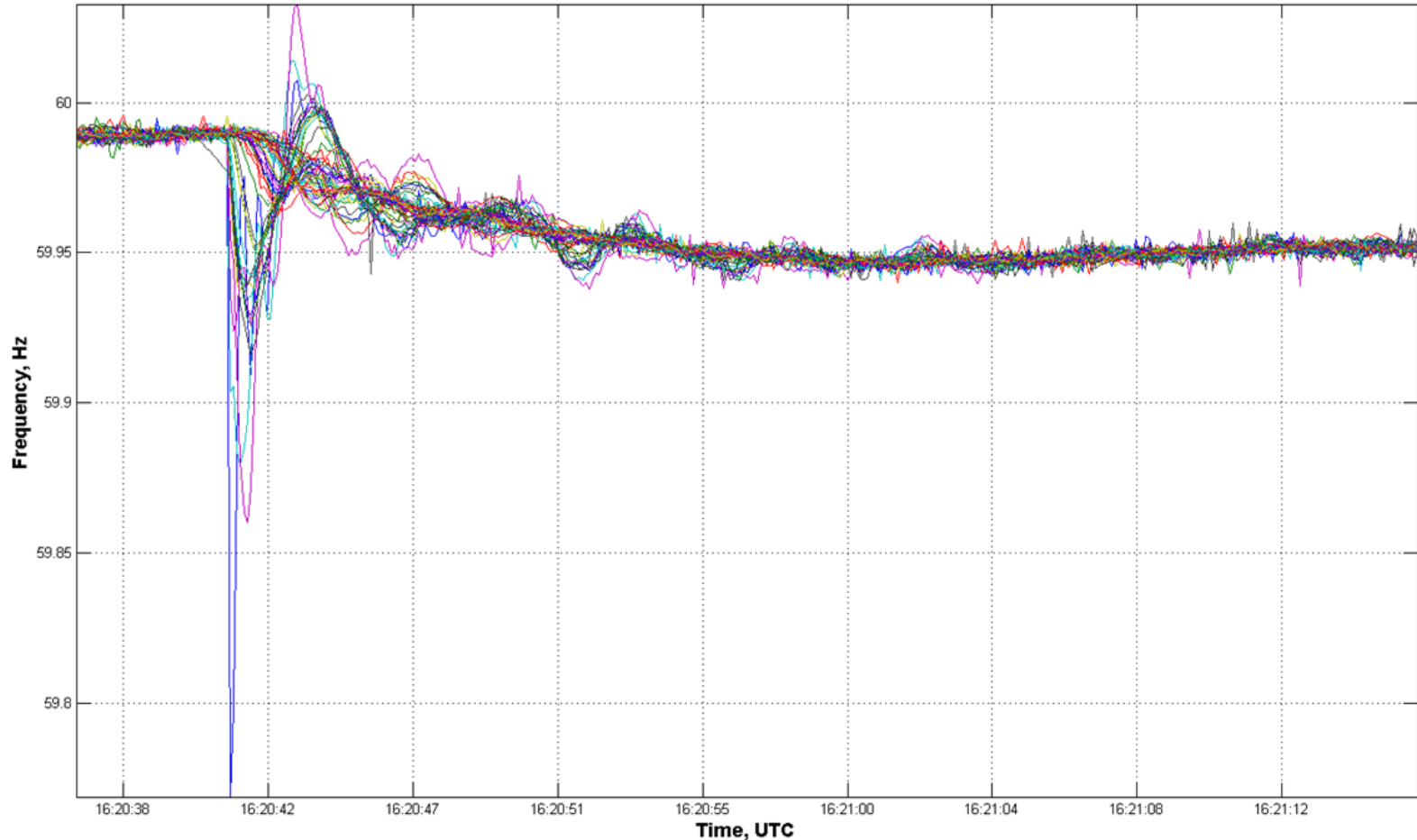
UnitName	Frequency(Hz)	Damping Ratio(%)	Relative Phase (Degree)
PMU-MYSTIC	0.2584	11.522	116.6965
PMU-MANCHSTR	0.2731	25.3232	81.760
FDR682	0.2470	15.703	107.9247
FDR684	0.2554	13.889	103.9573

Online Oscillation Mode and Damping Estimation with Ambient PMU/FDR Data

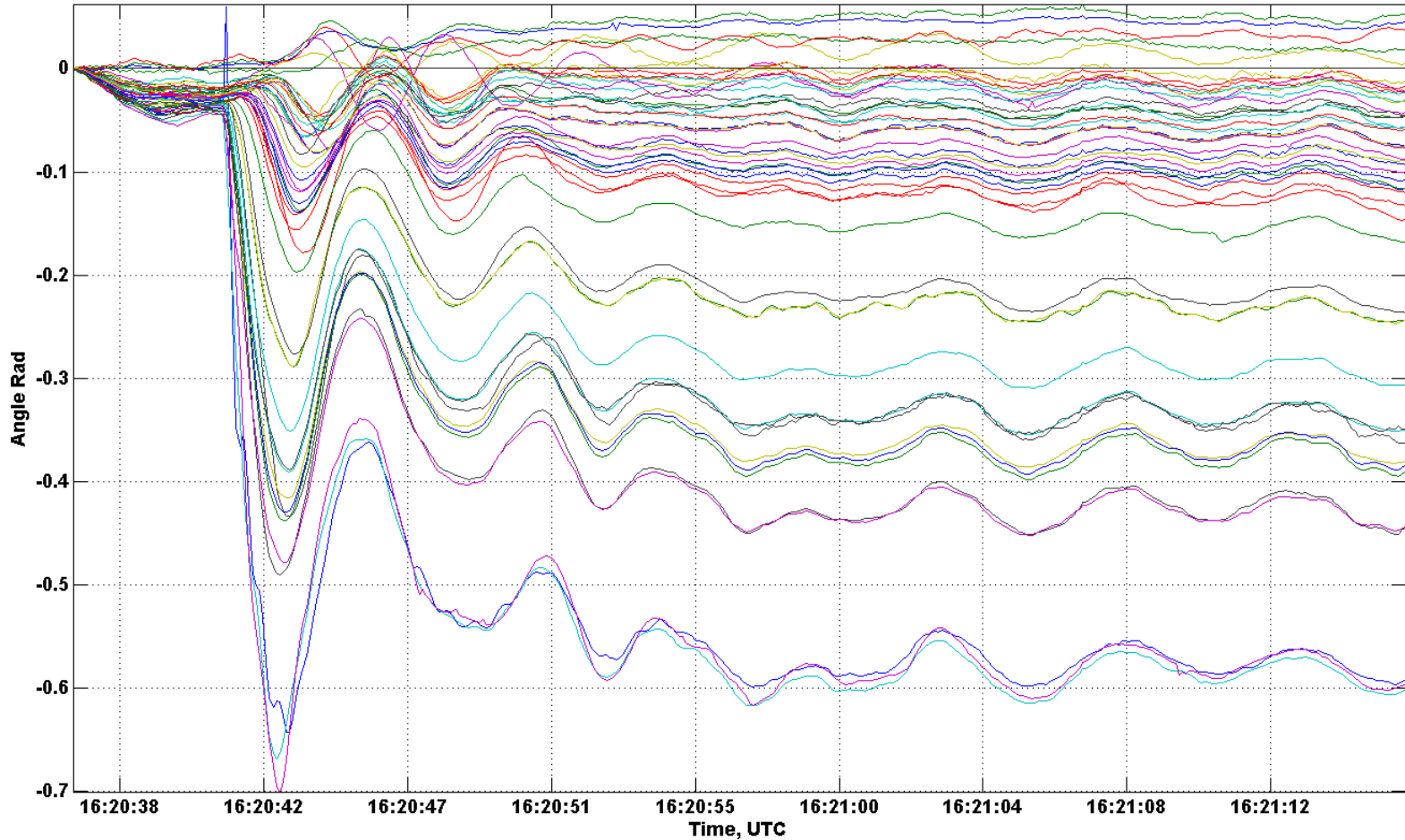
Live link beta testing site:

fnettest.eecs.utk.edu

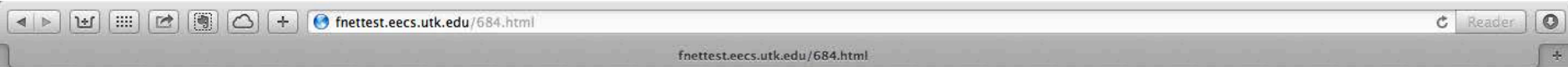
Frequency – All FDRs



Angle – All FDRs



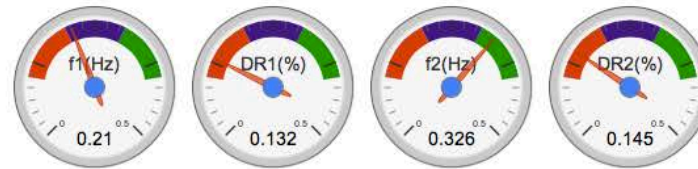
Online Mode Monitor -EI



FNET Mode Estimation Result

INTERCONNECTION: EI FDR: 684 Go

Interconnection and FDR selection

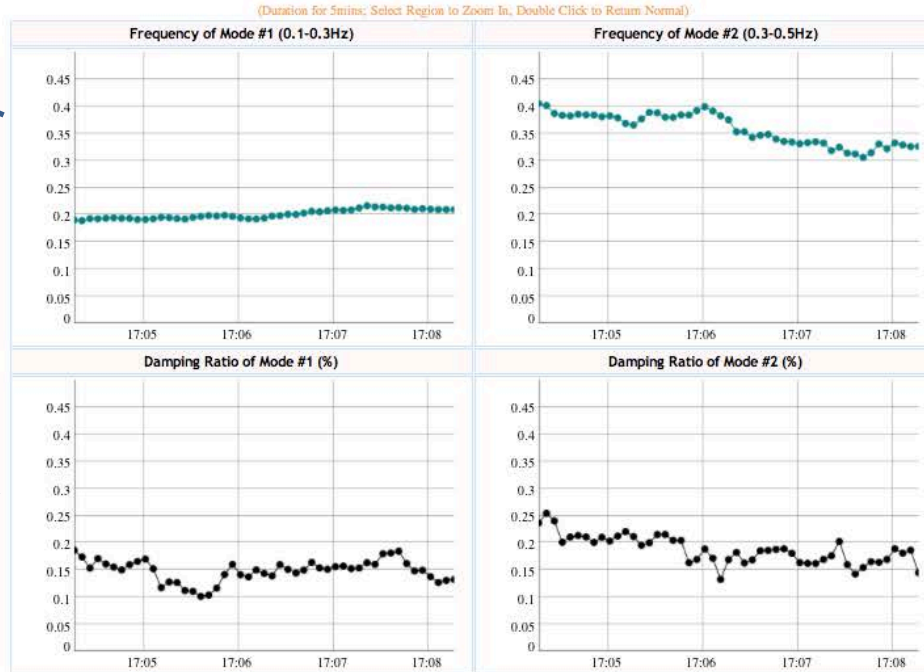


Freq #1

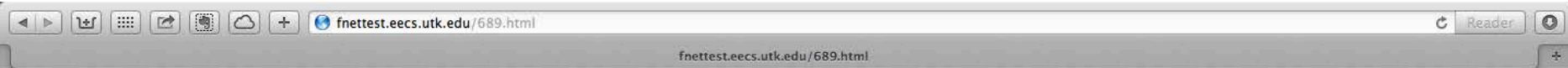
Freq #2

Damping Ratio #1

Damping Ratio #2



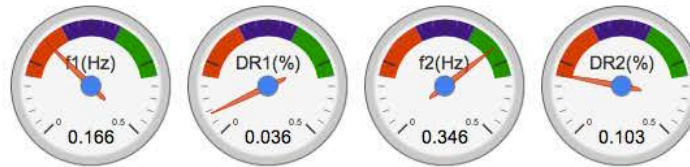
Online Mode Monitor -WECC



FNET Mode Estimation Result

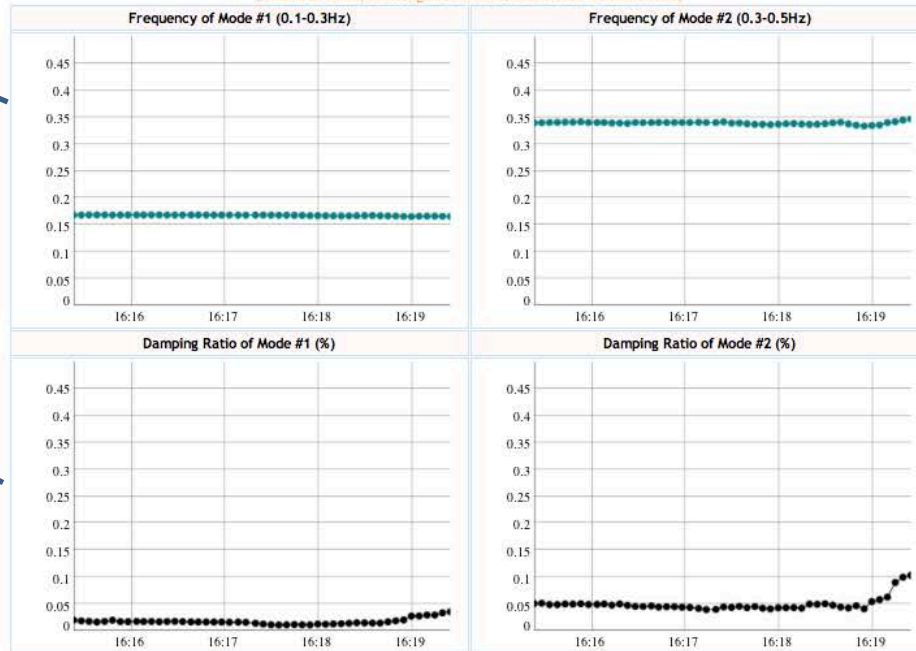
INTERCONNECTION: WECC FDR: 689

Interconnection and FDR selection



(Duration for 5mins; Select Region to Zoom In, Double Click to Return Normal)

Freq #1

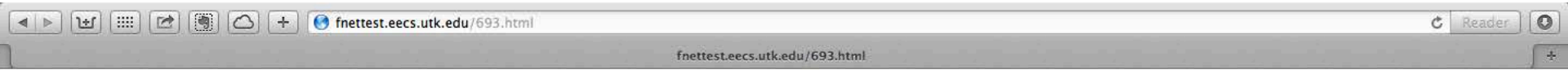


Freq #2

Damping Ratio #1

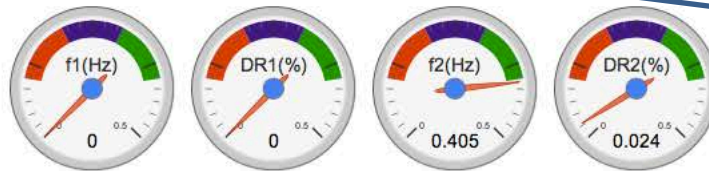
Damping Ratio #2

Online Mode Monitor - Quebec



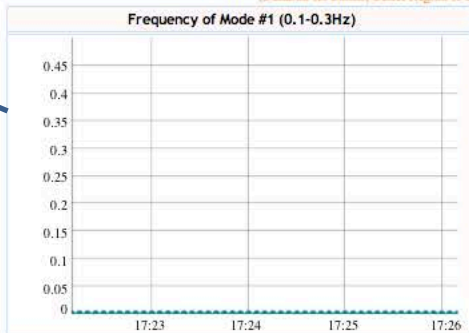
FNET Mode Estimation Result

INTERCONNECTION: Quebec FDR: 693

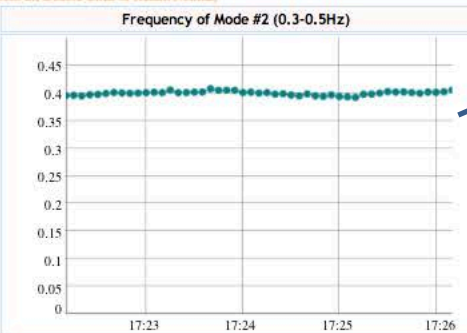


Interconnection and FDR selection

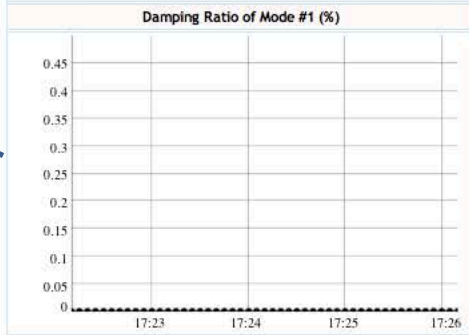
Freq #1



Freq #2



Damping Ratio #1



Damping Ratio #2

