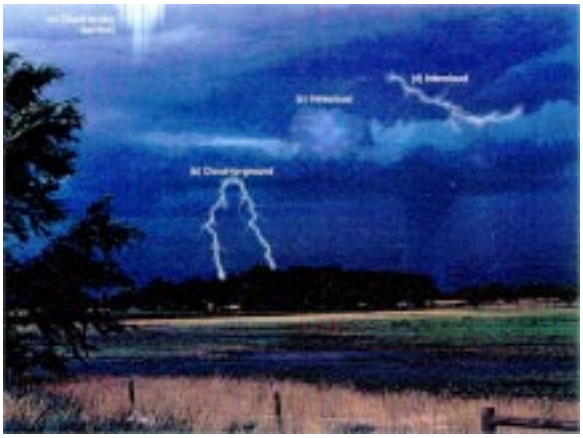
Intersite Environmental Correlations: E3 and E4 Investigations

Part 2: Bursts



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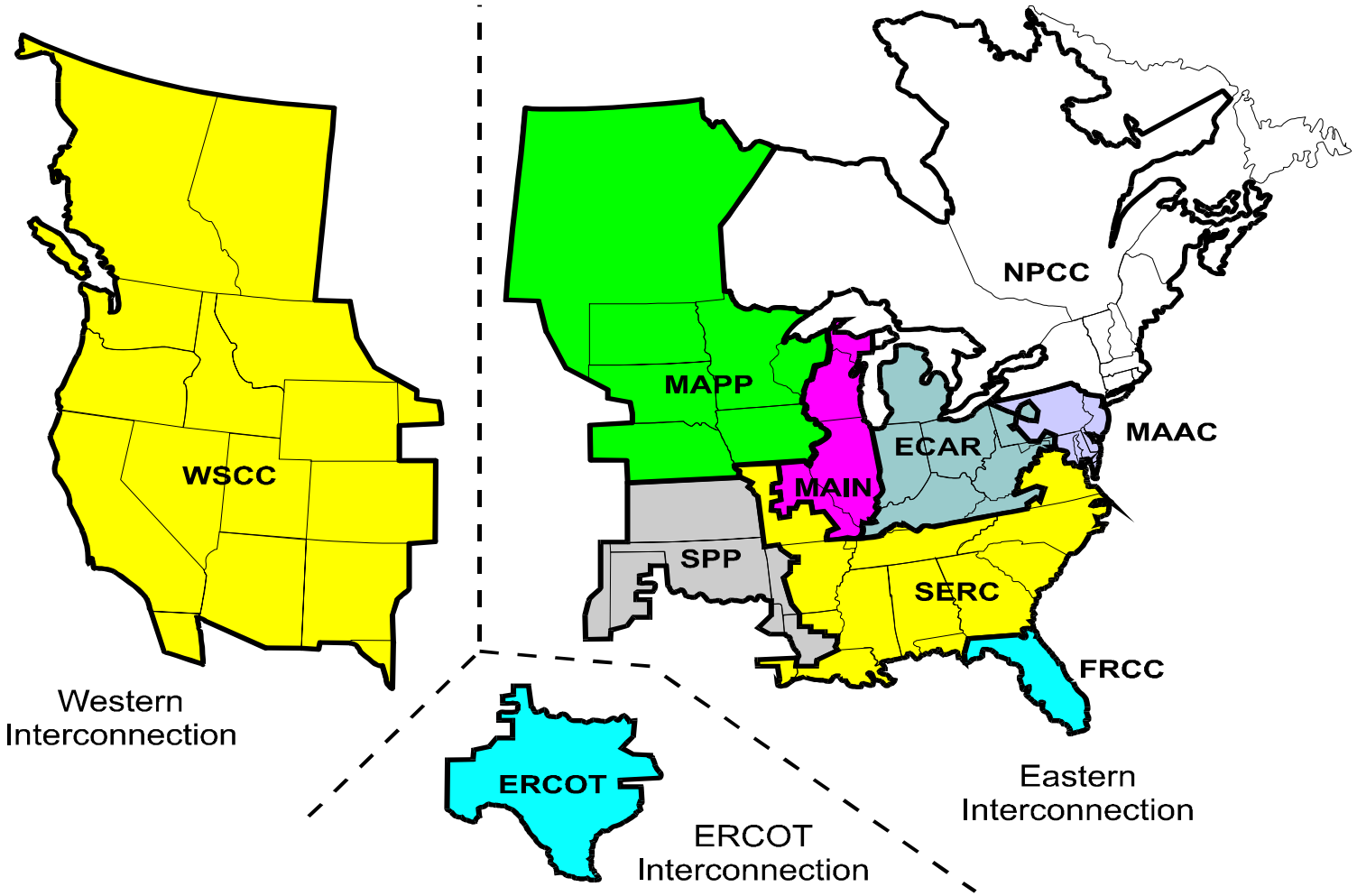
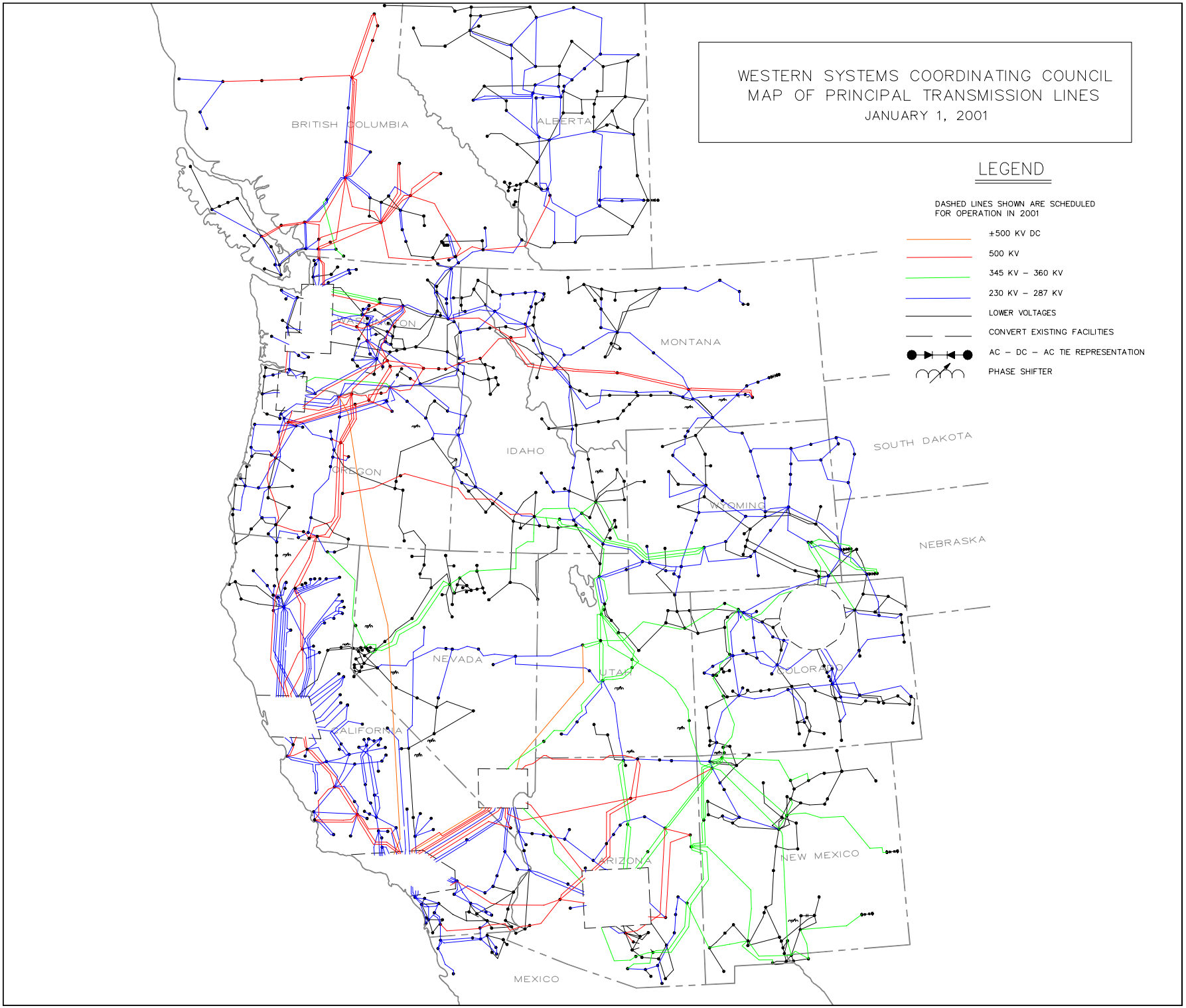

NPCC
MAPP
MAAC
ECAR
MAIN
SPP
SERC
FRCC
WSCC
ERCOT
Western
Interconnection
ERCOT
Interconnection
Eastern
Interconnection


WESTERN SYSTEMS COORDINATING COUNCIL
MAP OF PRINCIPAL TRANSMISSION LINES
JANUARY 1, 2001
LEGEND
DASHED LINES SHOWN ARE SCHEDULED FOR OPERATION IN 2001
±500 KV DC
500 KV
345 KV – 360 KV
230 KV – 287 KV
LOWER VOLTAGES
CONVERT EXISTING FACILITIES
AC – DC – AC TIE REPRESENTATION
PHASE SHIFTER
BRITISH COLUMBIA
ALBERTA
WASHINGTON
MONTANA
IDAHO
OREGON
SOUTH DAKOTA
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
CALIFORNIA
ARIZONA
NEW MEXICO
MEXICO

A search for coincident intersite environmental bursts

- **Searched for threshold-exceeding events that occur at both Hanford and Livingston within a time window (about 30ms).**

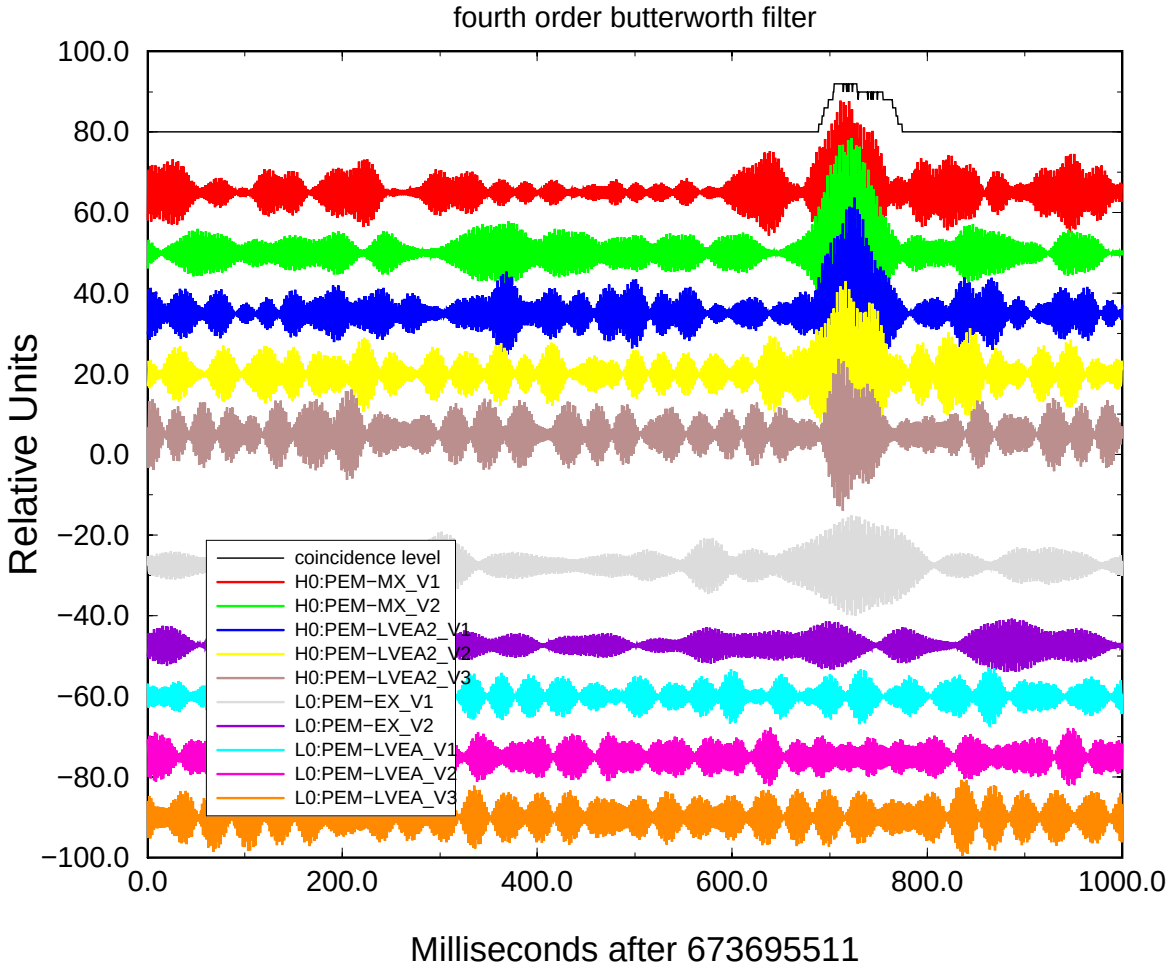
- **Demanded that there be within-site as well as between-site coincidences in order to lower thresholds and maintain managable numbers of events.**

- **Modified Masahiro Ito's glitchMon to input multiple channels and output time series for events that met the threshold and coincidence criteria.**

E4 voltage channels; coincidence level: 6; σ: 3.5

Apparent event at Livingston, but the 1 event at Hanford may be coincident by chance.
Top 5: Livingston; bottom 5: Hanford

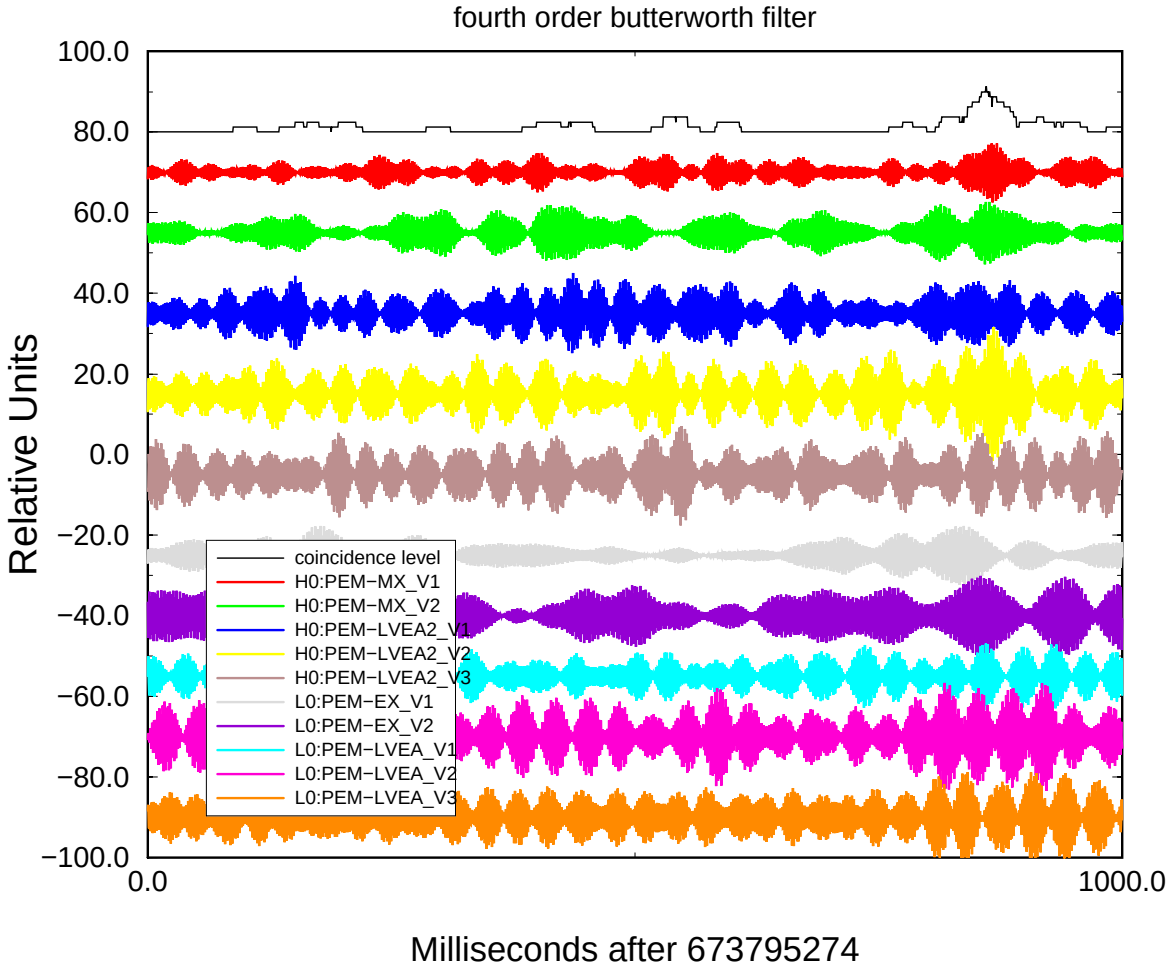
Output from 560−580 Hz band: timing good to about 50 ms.

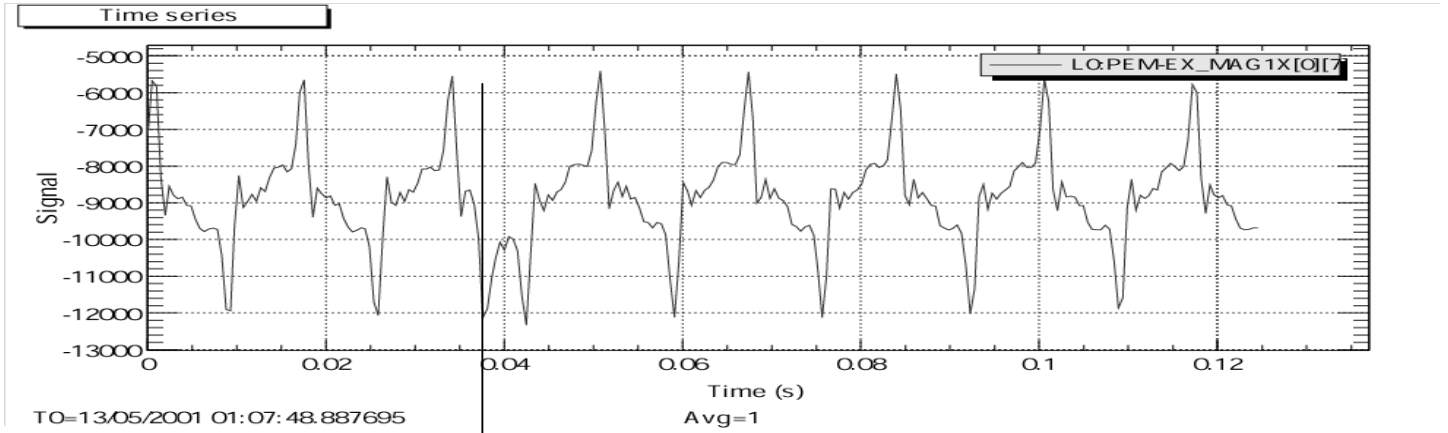


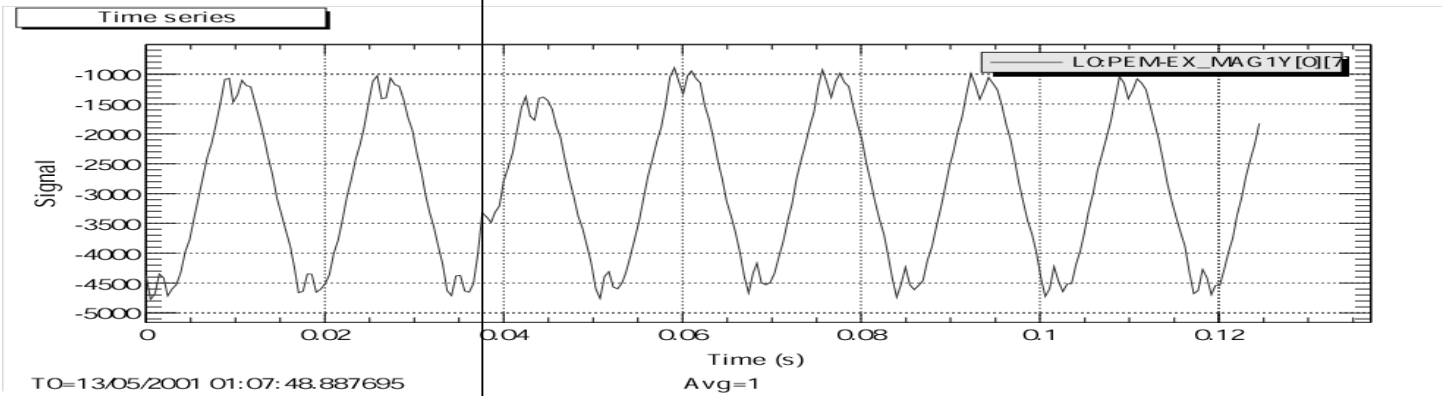
E4 voltage channels; coincidence level: 8; σ: 2.5

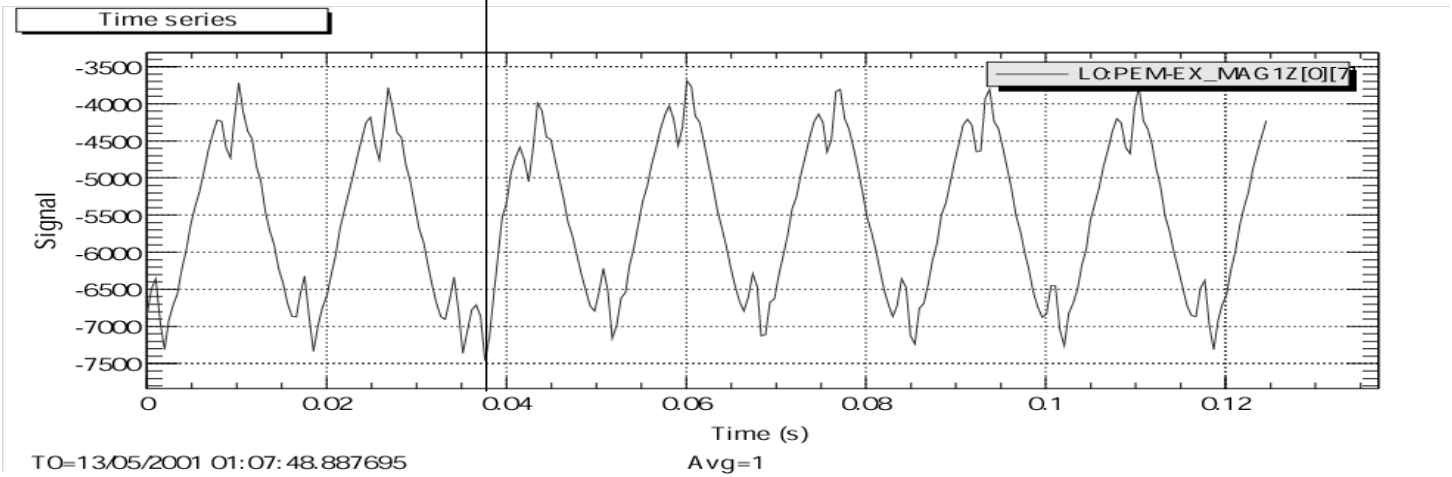
Top 5: Livingston; bottom 5: Hanford

Output from 560−580 Hz band: timing good to about 50 ms.

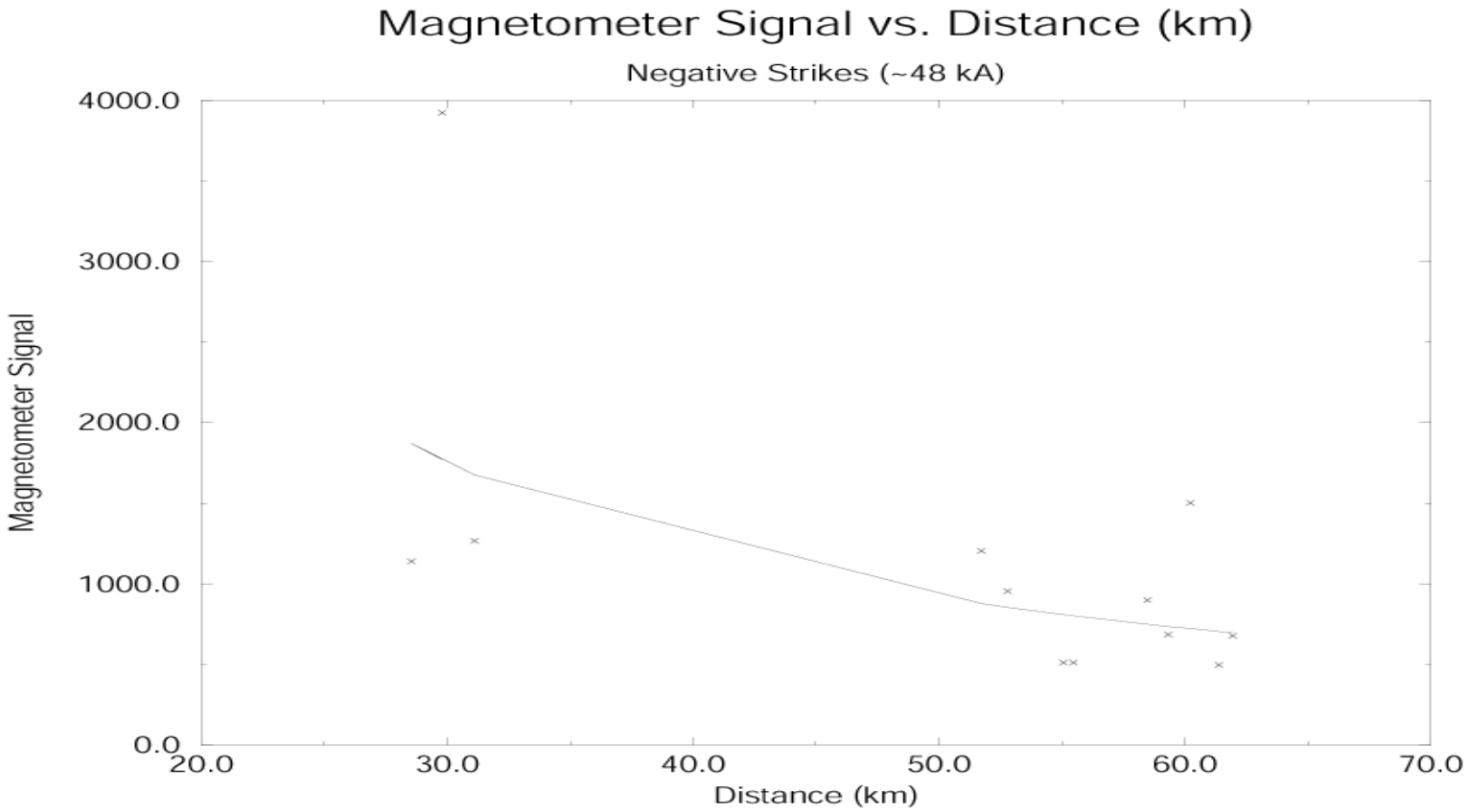



Time series
LO:PEM-EX_MAG1X[O][7
-5000
-6000
-7000
-8000
-9000
-10000
-11000
-12000
-13000
Signal
0
0.02
0.04
0.06
0.08
0.1
0.12
Time (s)
TO=13/05/2001 01:07:48.887695
Avg=1


Time series
LO:PEM-EX_MAG1Y[O][7
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
-5000
Signal
0
0.02
0.04
0.06
0.08
0.1
0.12
Time (s)
TO=13/05/2001 01:07:48.887695
Avg=1


Time series
LO:PEM-EX_MAG1Z[O][7
-3500
-4000
-4500
-5000
-5500
-6000
-6500
-7000
-7500
Signal
0
0.02
0.04
0.06
0.08
0.1
0.12
Time (s)
TO=13/05/2001 01:07:48.887695
Avg=1

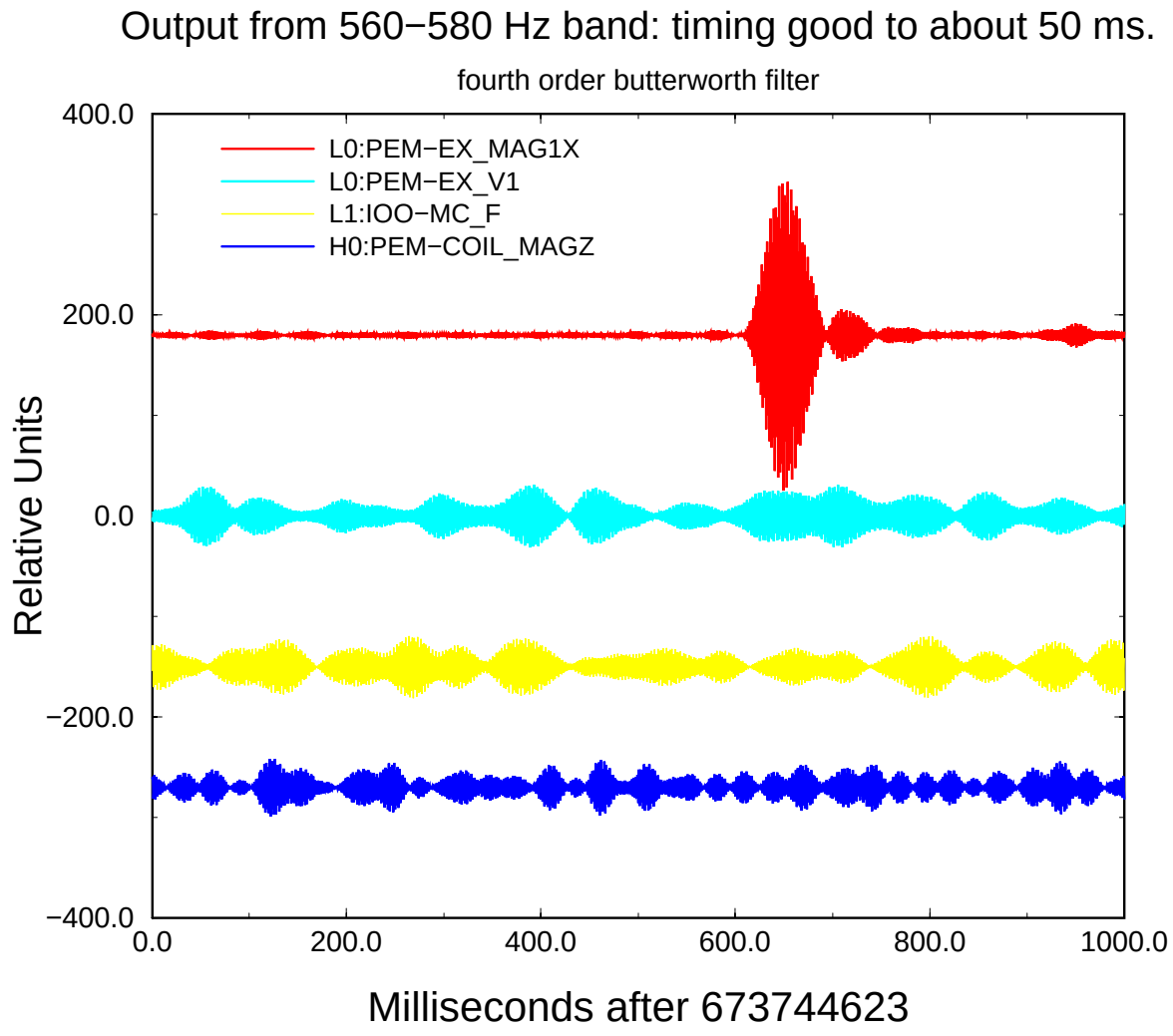
Signal vs. Distance



Number of observations = 12
Correlation coefficient = -0.65
Regression coefficient (SLOPE) = -1.3
Standard error of coefficient = 0.5

The largest tabulated I/r during E4 (129kA, 20km)

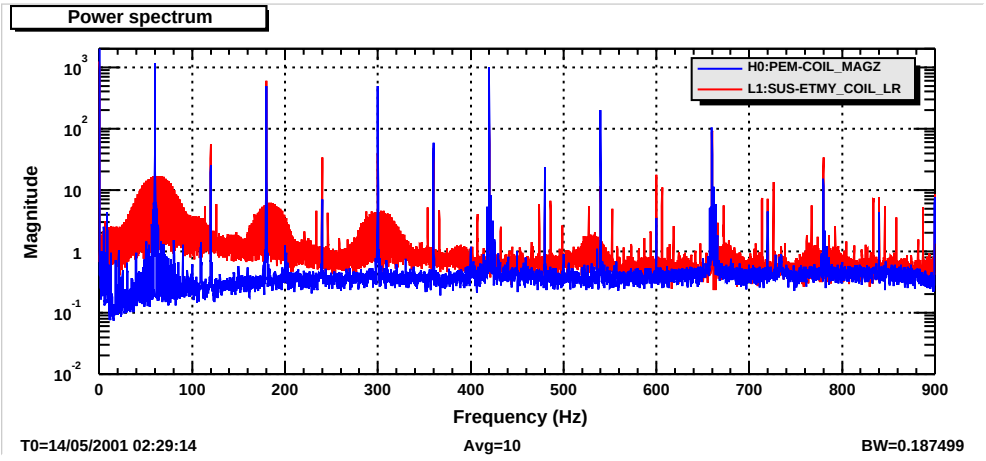
Lightning strike appears on fluxgate magnetometer but not other channels.



S. Chatterji's coil magnetometers

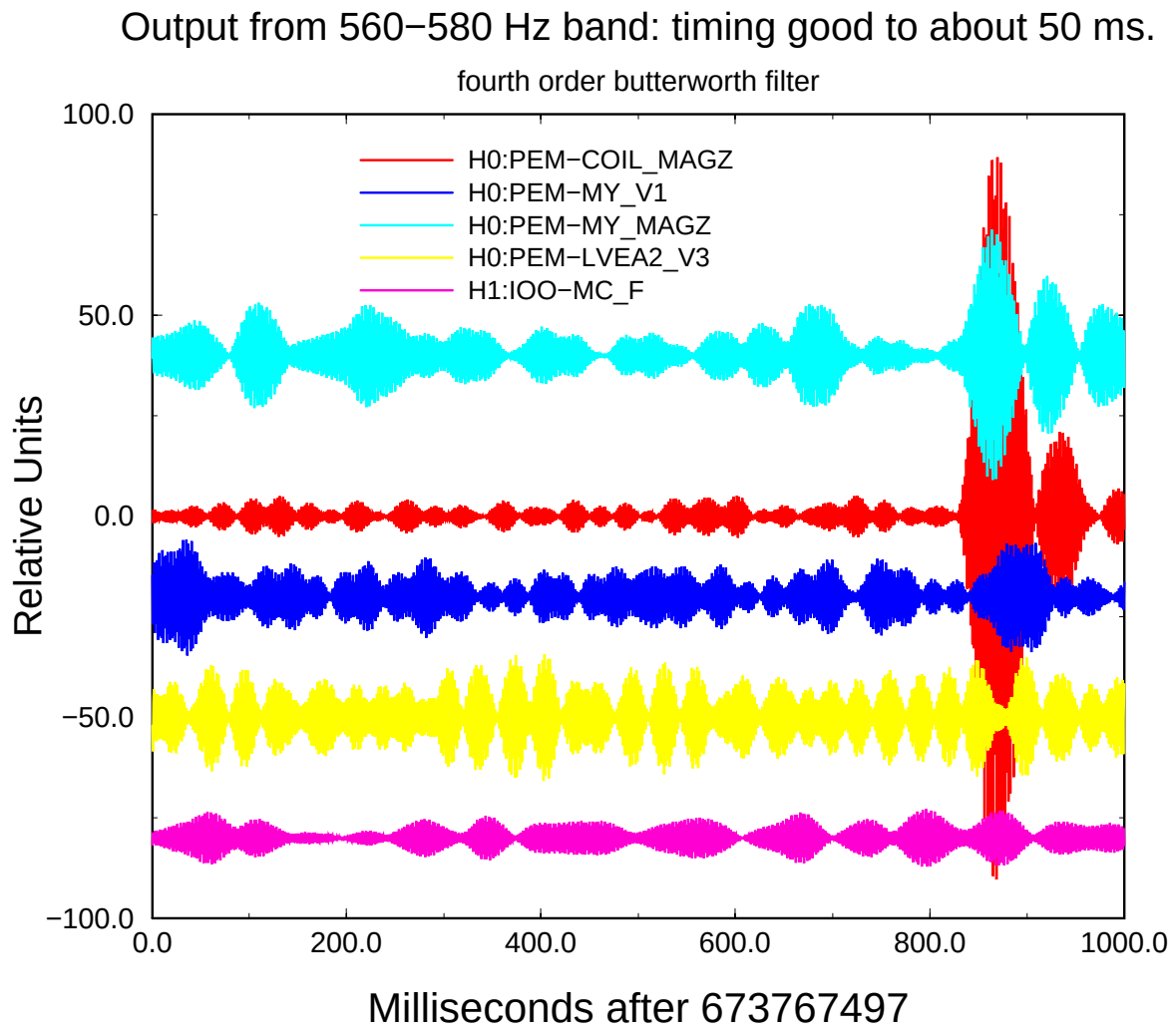
Location at Hanford for E4 and E5;

Blue: E4 Hanford; Red: E4 Livingston



Lightning (112 km, 180 kA) appears on coil and fluxgate magnetometers,

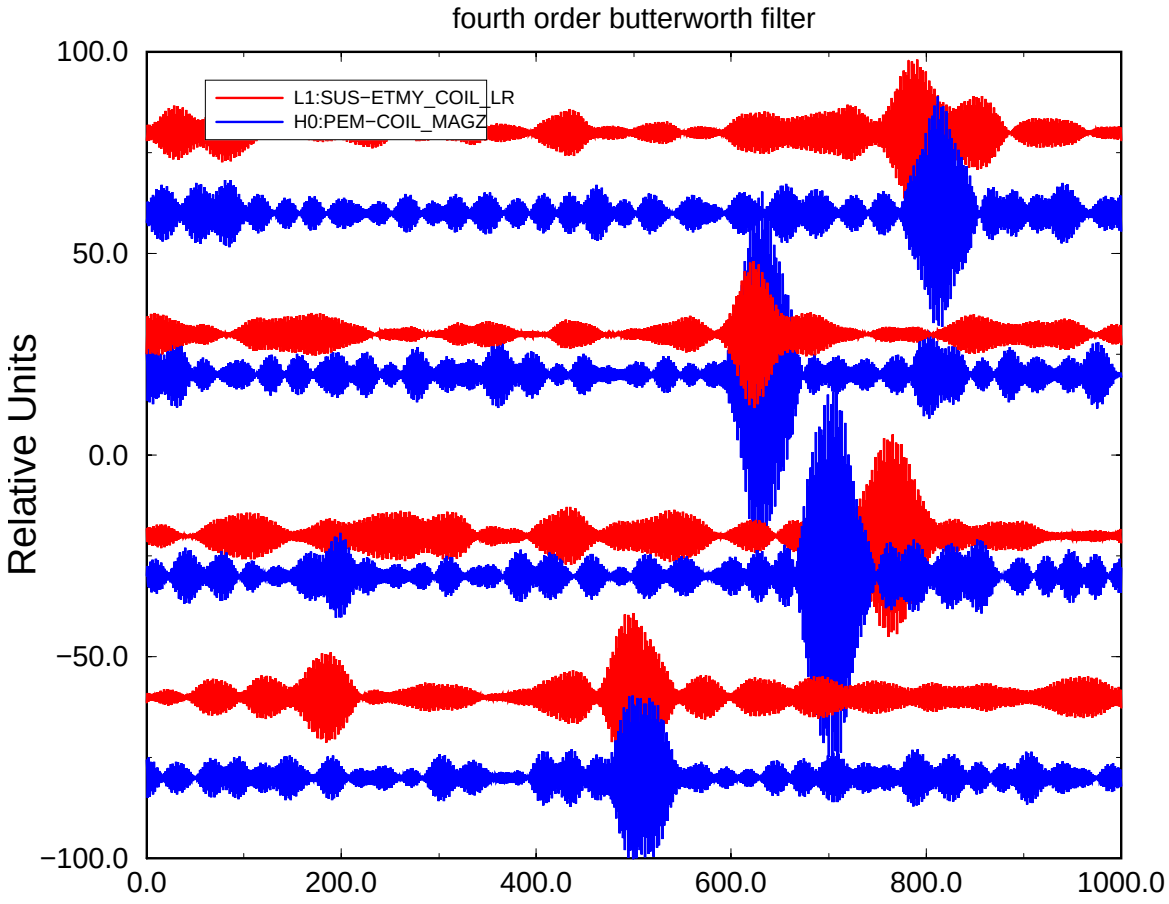
but is not evident on voltage or mode cleaner channels.



Intersite coincident events on coil magnetometers (E4)

Possible lightning strikes; red: Livingston; blue: Hanford.

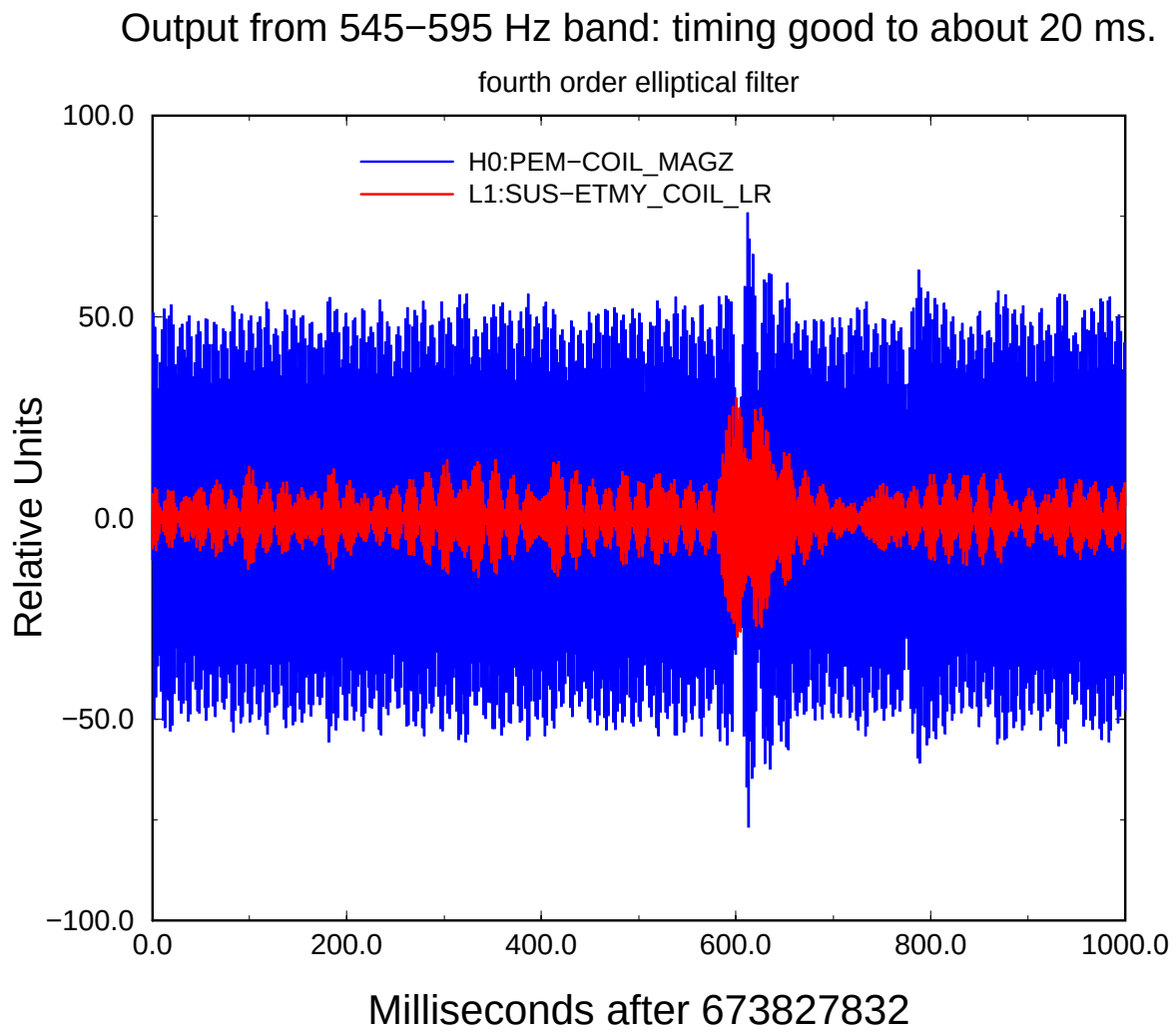
Output from 560−580 Hz band: timing good to about 50 ms.



Milliseconds after (top to bottom) 673826586, 673827832, 673828154, 673847365

Only Z-axis was available.

545-595 Hz band-pass on 673827832



Mere coincidence?

If the coil magnetometer coincidences were by chance, widening the coincidence window by a factor of 10 should increase the number of events by a factor of 10 (low event rate approximation).

Time window of 25 bins gives 83 five sigma events in 10 hours.

Time window of 250 bins gives 295 events instead of about 830.

Better than 99% confidence that excess coincidences occur in the narrow time window.

BUT this result is only a couple of days old and programs need to be checked and supporting evidence accumulated.

So I am not yet completely convinced that we are detecting certain lightning strikes at both sites.

Summary

- **Stand alone code to search for intersite coincidences has been developed.**
- **No convincing examples of power line glitches that propagated between sites were found.**
- **No evidence yet of lightning strikes on other channels**
- **Fairly convincing evidence of greater than chance coincidences in magnetometer signals that could be lightning.**
- **Continue developing code to check for coincidences in signals that are offset in time from eachother.**
- **Upper thresholds as well as lower thresholds (windows)?**