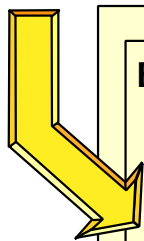
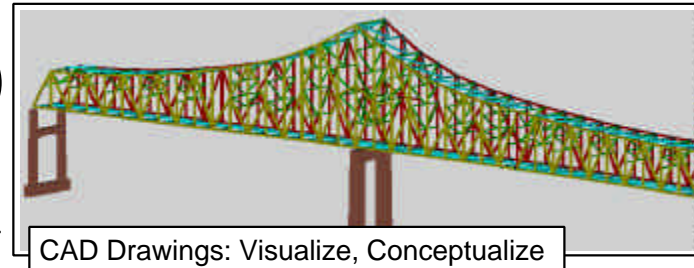
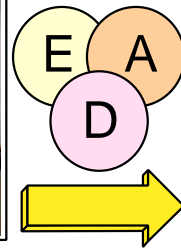


CIVE 790-670

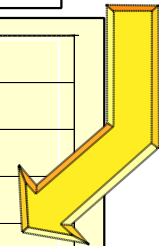
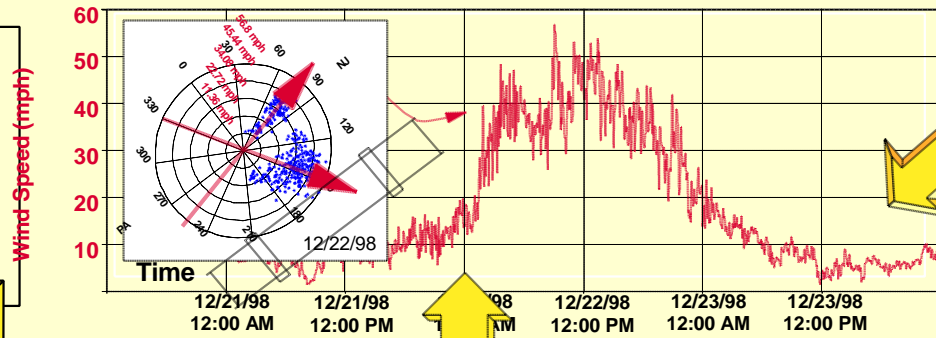
Prepared by Dr. F. Necati Catbas

Structural and Loading Systems Identification



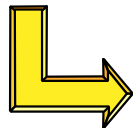
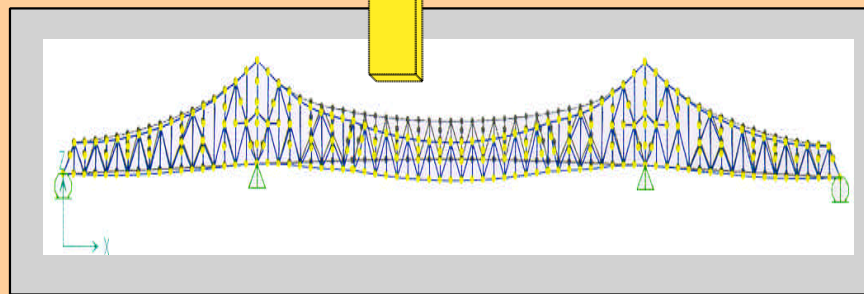
EXPERIMENT

- Load Test: Static, Dynamic
- Local: NDE, Material Test
- Long Term Monitoring: Intermittent, Continuous, Integrated, Real Time



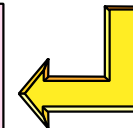
ANALYSIS

- Analytical Modeling: Numerical, Geometric, Statistical/Stochastic,
- Calibration, Simulation
- Prediction



DATA-INFORMATION-KNOWLEDGE

- Data Integration, On-line Detection, Warehousing
- Display, Data Fusion, Data Mining, Correlation, Neural-Net
- Decision and Management Applications



General Tasks

- Preparations
 - Inspect grid, obtain existing models, review of material,
 - Determine damage scenarios
 - Number of tests and sequence
- Dynamic Test
 - Instrument the grid w/ accels
 - Conduct ambient, impact and forced excitation test
- Load Test
 - Install SWP sensors
 - Prepare Optim for testing
 - Prepare actuators
- Finite Element Modeling
 - Obtain model and take measurements, improve/create FE model
- Data Processing
 - Dynamic test data
 - Load test data
 - FE simulations
 - Correlations
- Documentation and Archival
 - Raw data
 - Image documentation of the grid, tests, equipment etc

To Do List for the Team

- April 24-26
 - Preparations
 - Dynamic test instrumentation
 - SWP installation
 - Get FE Model
 - Decide & plan for damage scenarios
 - Logistics for actuator testing
- April 27- May 3
 - FEM preparation
 - Prepare VIX and Optim
 - Finish SWP installation
 - Conduct
 - Ambient, forced and impact test
 - Conduct load
 - With weights
 - With actuators after moving
 - Preliminary simulations

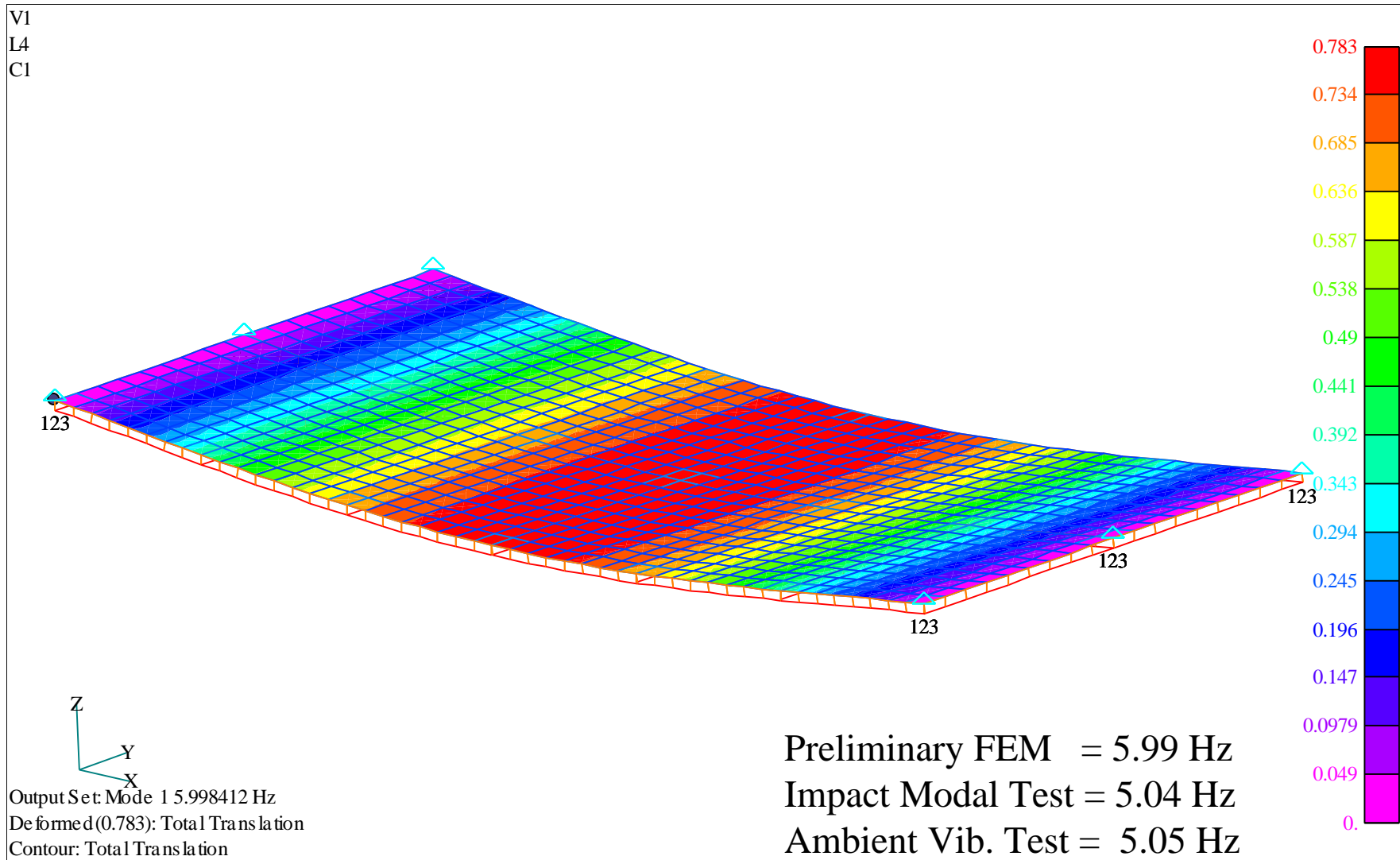
To Do List for the Team

- May 4 – 10
 - Data Processing
 - Dynamic test
 - Load test
 - FE simulations
 - Correlations of test results with FE Model simulations
 - Induce damage
- May 11 – 17
 - Conduct
 - Ambient, forced and impact test
 - Conduct load
 - With weights
 - With actuators after moving
 - Data Processing
 - Experimental-Analytical correlations

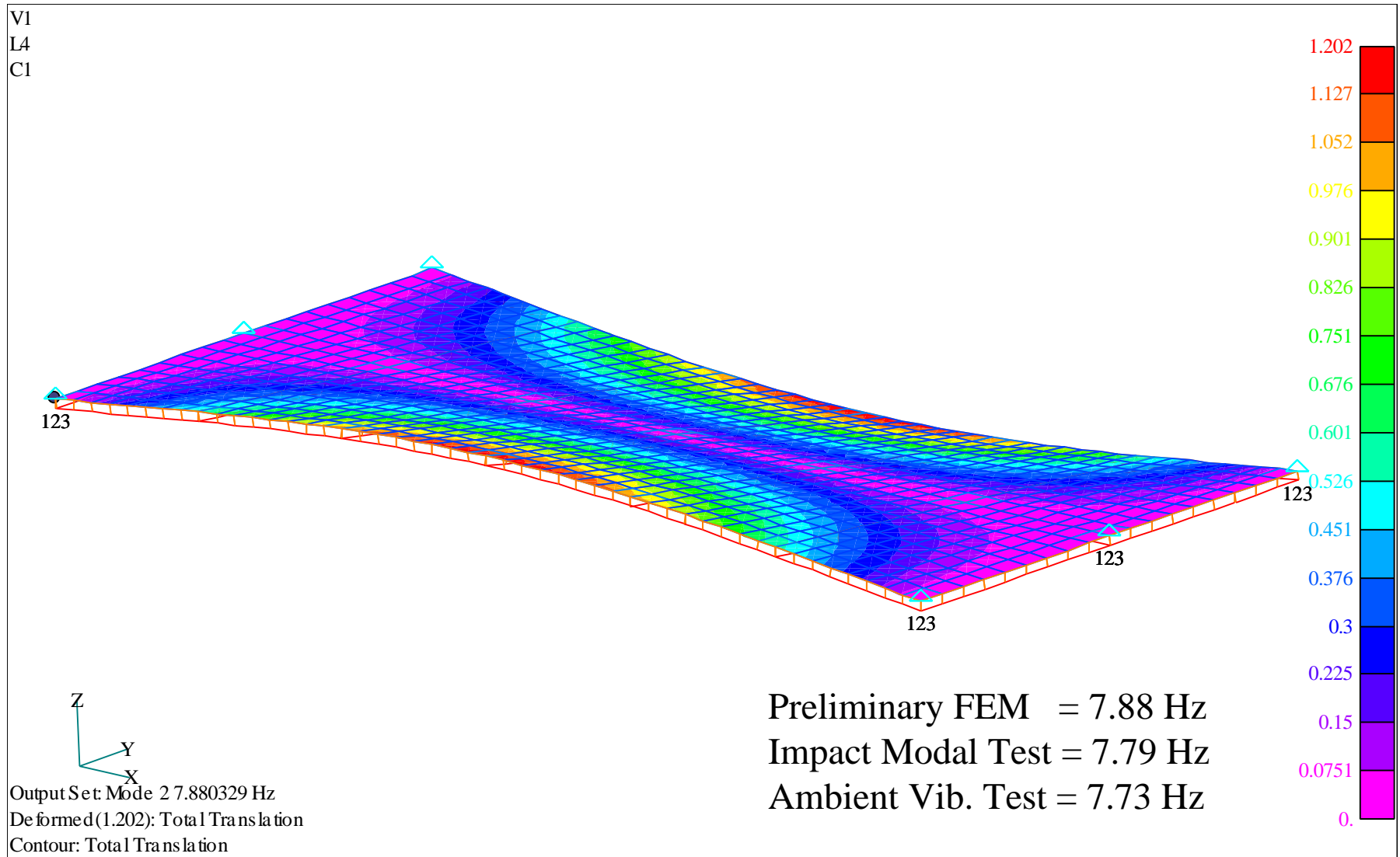
To Do List for the Team

- May 18 – 24
 - Data processing
 - Model calibration
- May 25 – 30
 - Final report
 - Documentation

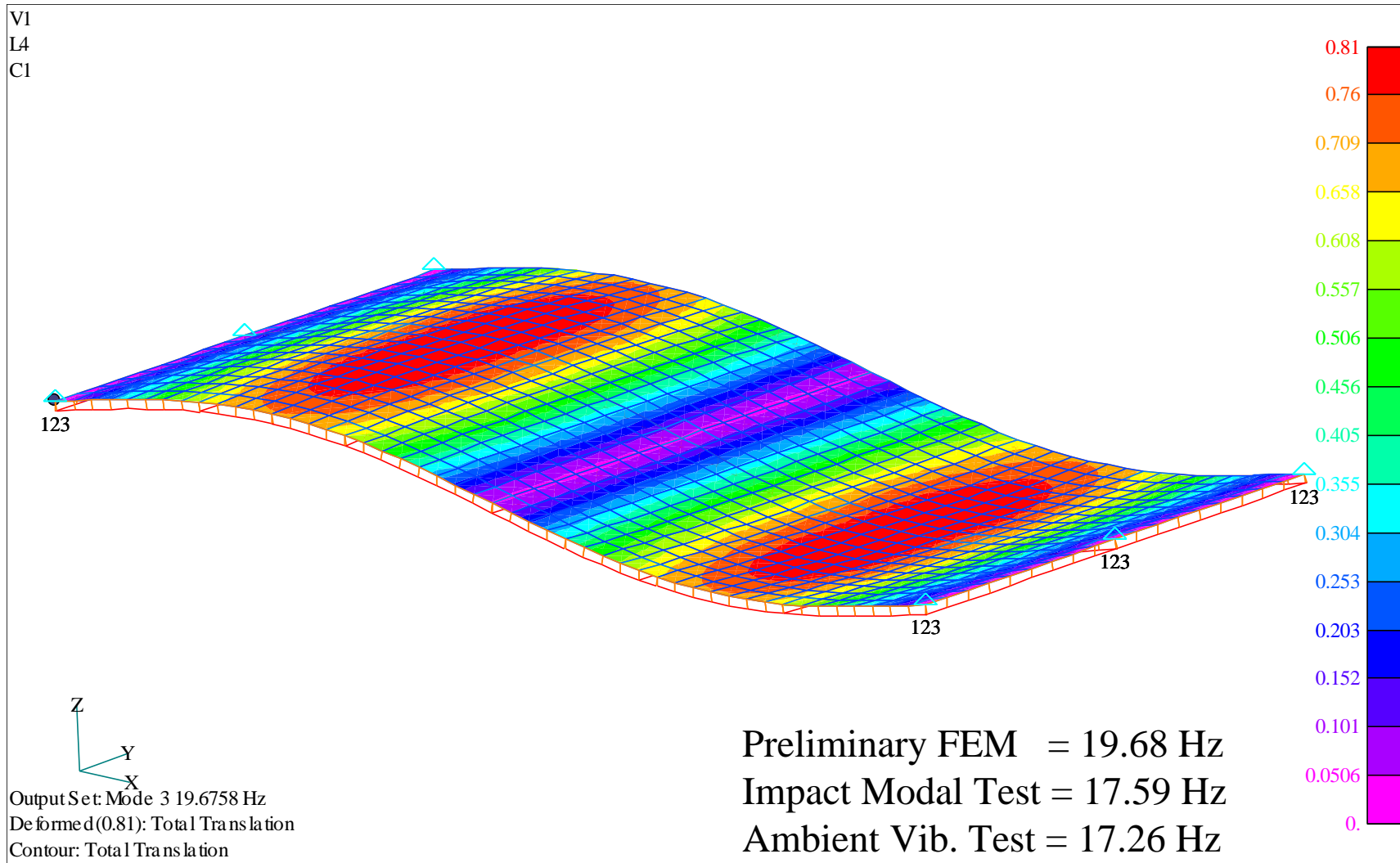
First Mode of the Grid (Bending Mode)



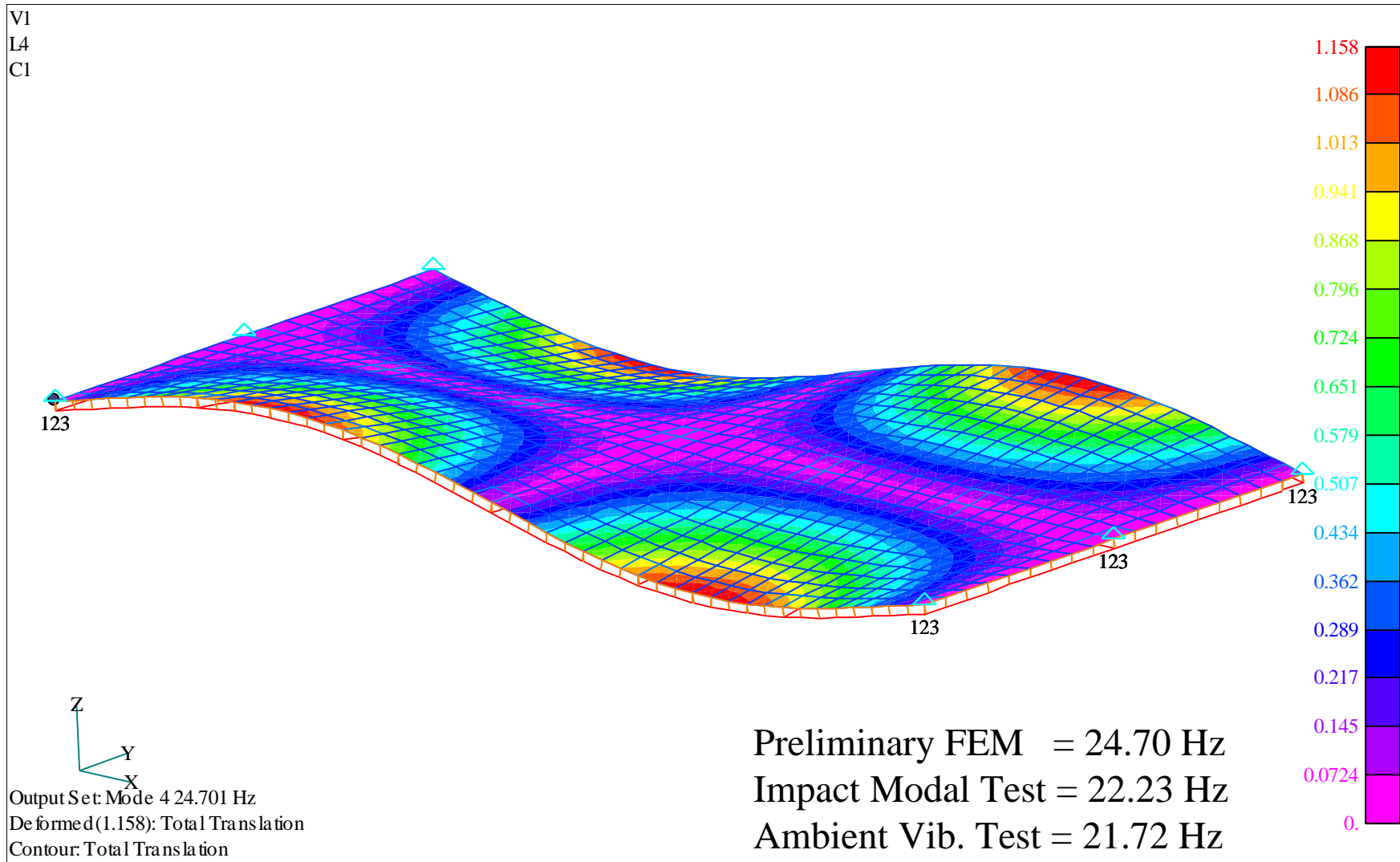
Second Mode of the Grid (Torsional Mode)



Third Mode of the Grid (Asymmetric Bending Mode)

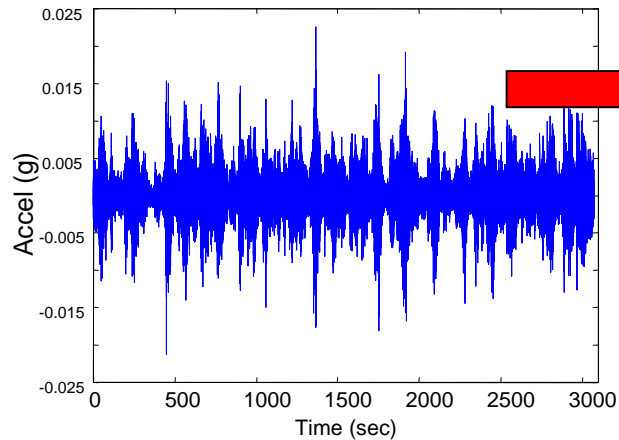


Fourth Mode of the Grid (Asymmetric Bending/Torsion Mode)

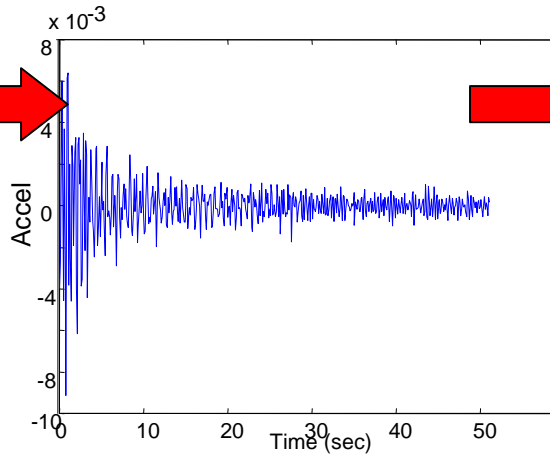


System Identification using Ambient Vibration Data

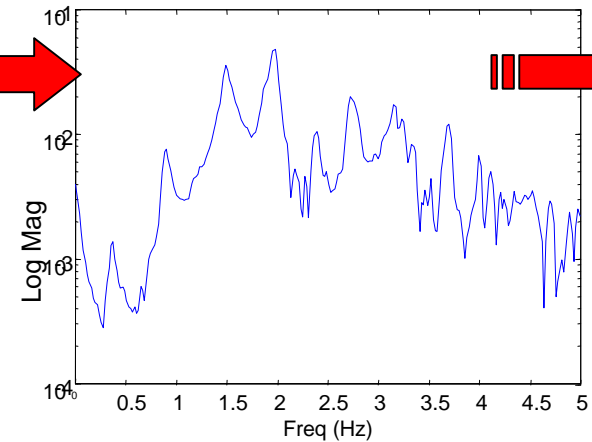
Time Domain Measurements Under Ambient Conditions



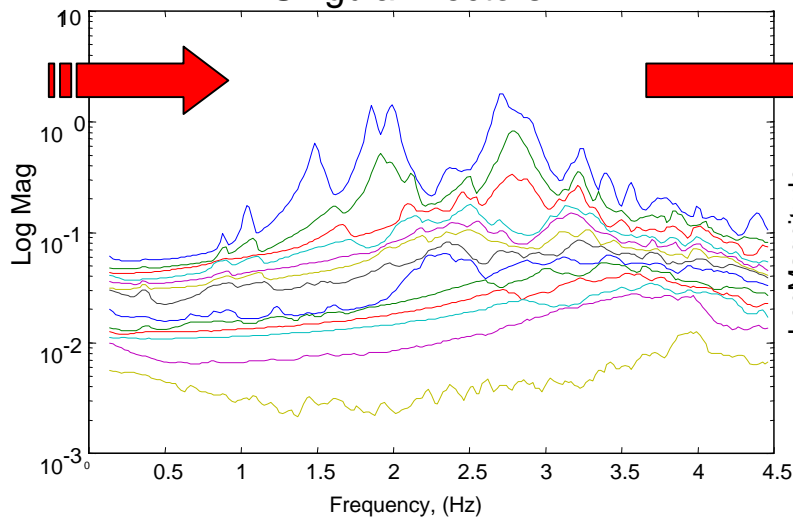
Pre-Process to Obtain Random Decrement Data



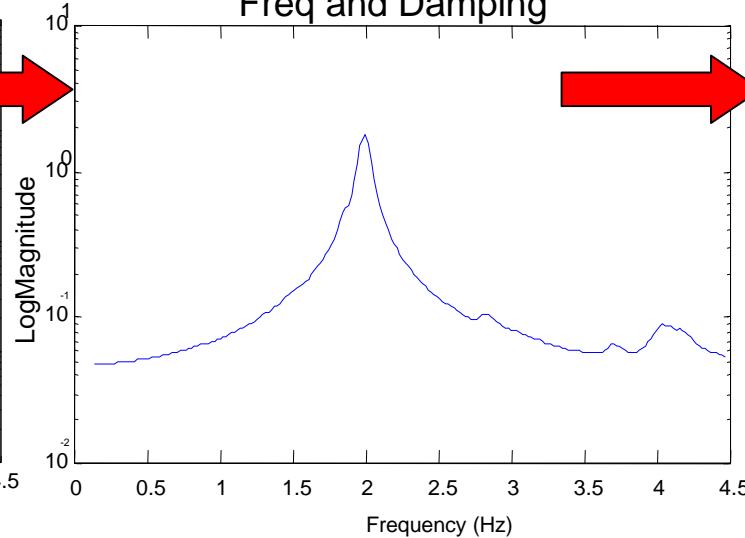
Frequency Domain Data from Pre-Processed RDs



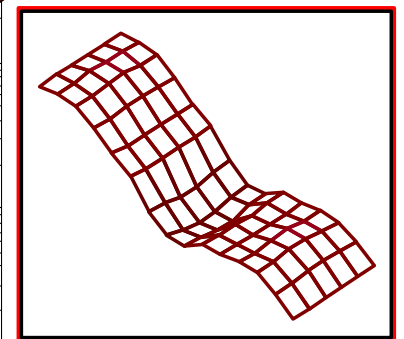
CMIF for All Data Combined, Determine Mode Shapes from Singular Vectors



Transformation from Physical to Modal Space by Modal Filtering, Determine Freq and Damping



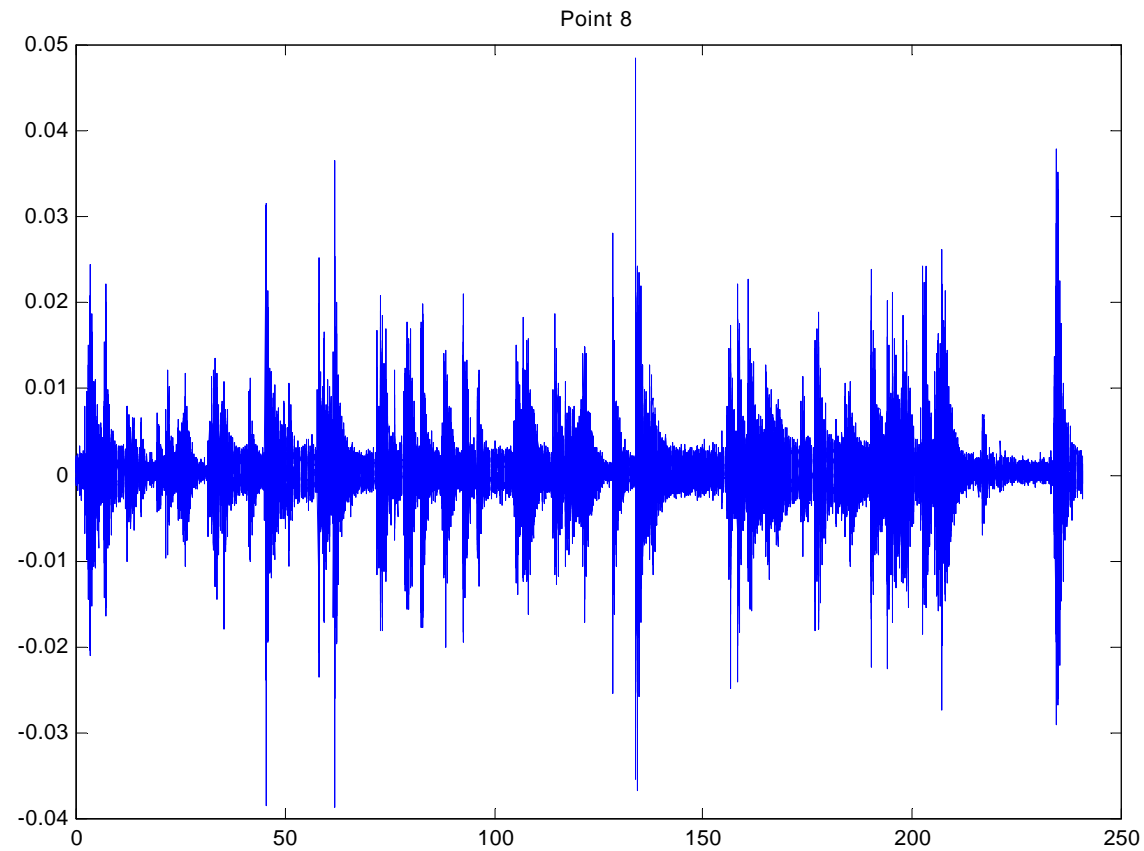
Modal Parameters
Mode Shapes: $\{\Phi\}$
Freq and Damping:
 ω and σ



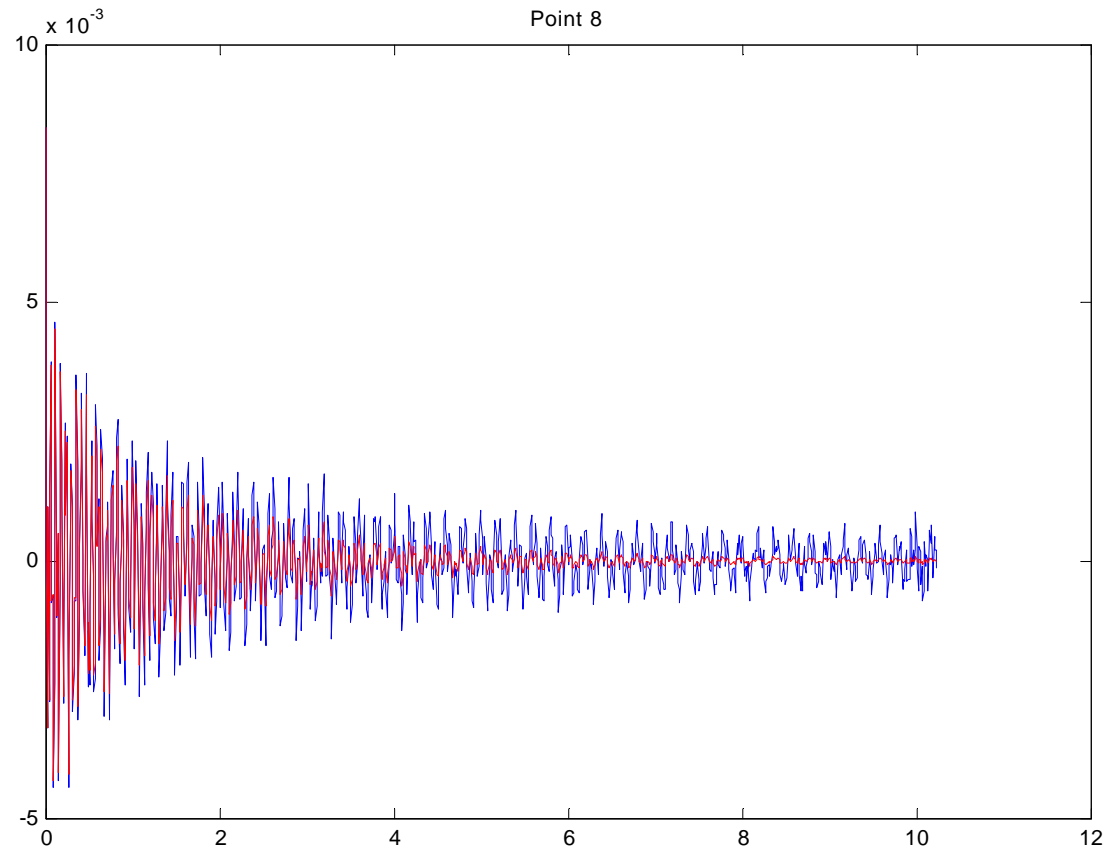
Test and Analysis Method

- $N_o=5$
- Random input at different locations of the structure
- $F_{\text{samp}}=100$ Hz, no sub-sampling of the data
- Random Decrement method used with 1.5Std , $N=1024$ spectral lines, exponential window $(1024,6,\Delta t \times 1023)$
- Pseudo MIMO test set-up with $N_i=5$ and $N_o=5$

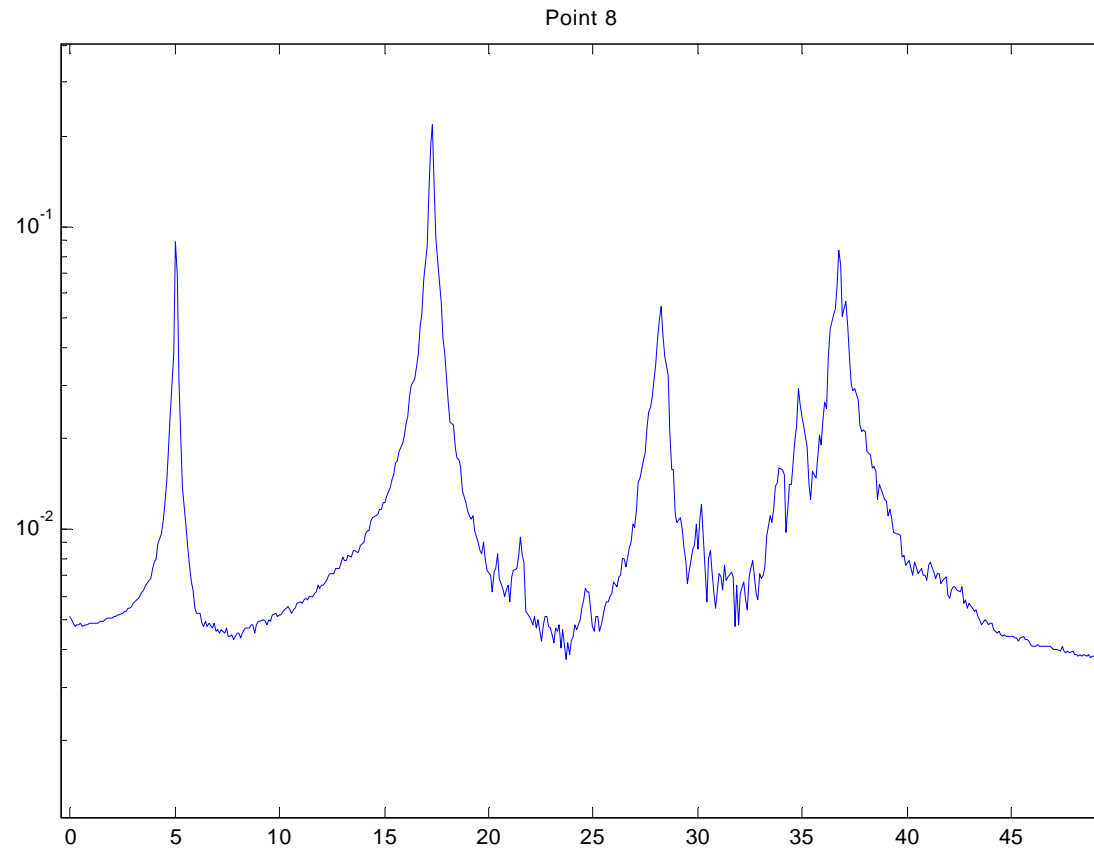
Vibration Response due to Random Input



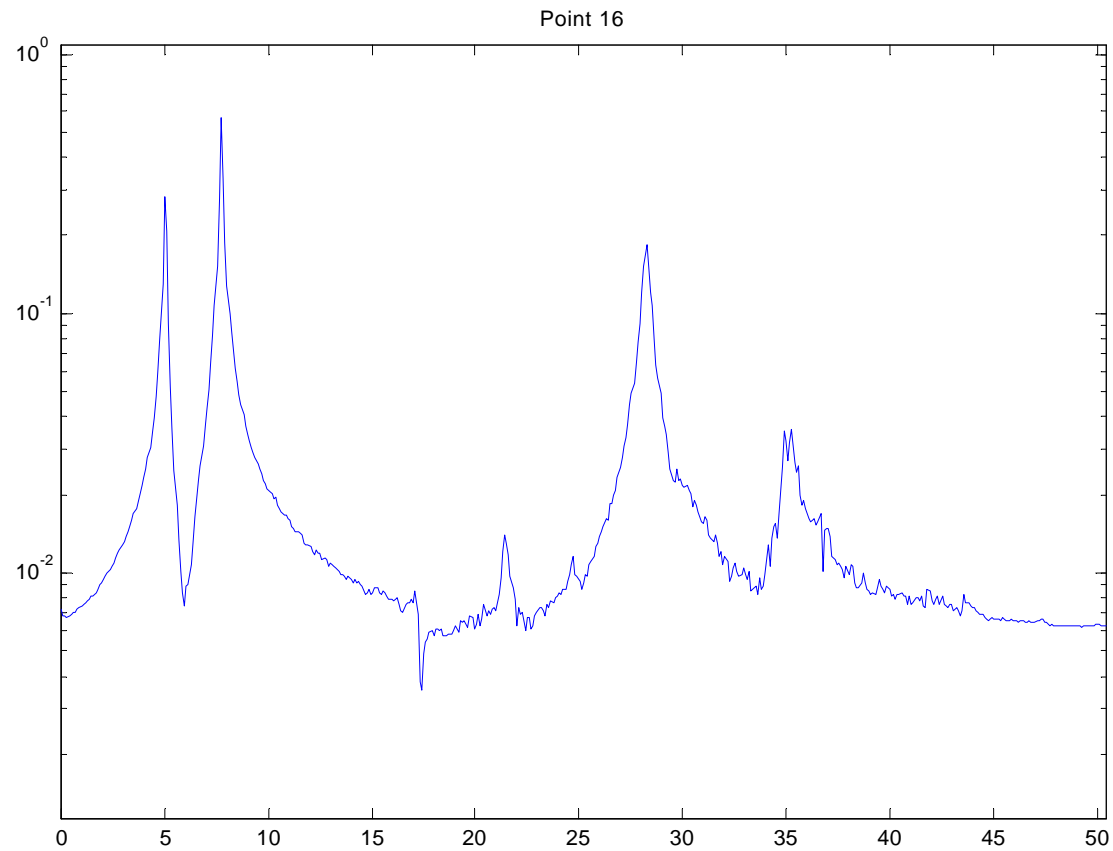
Pre-processed data using Random Decrement Technique



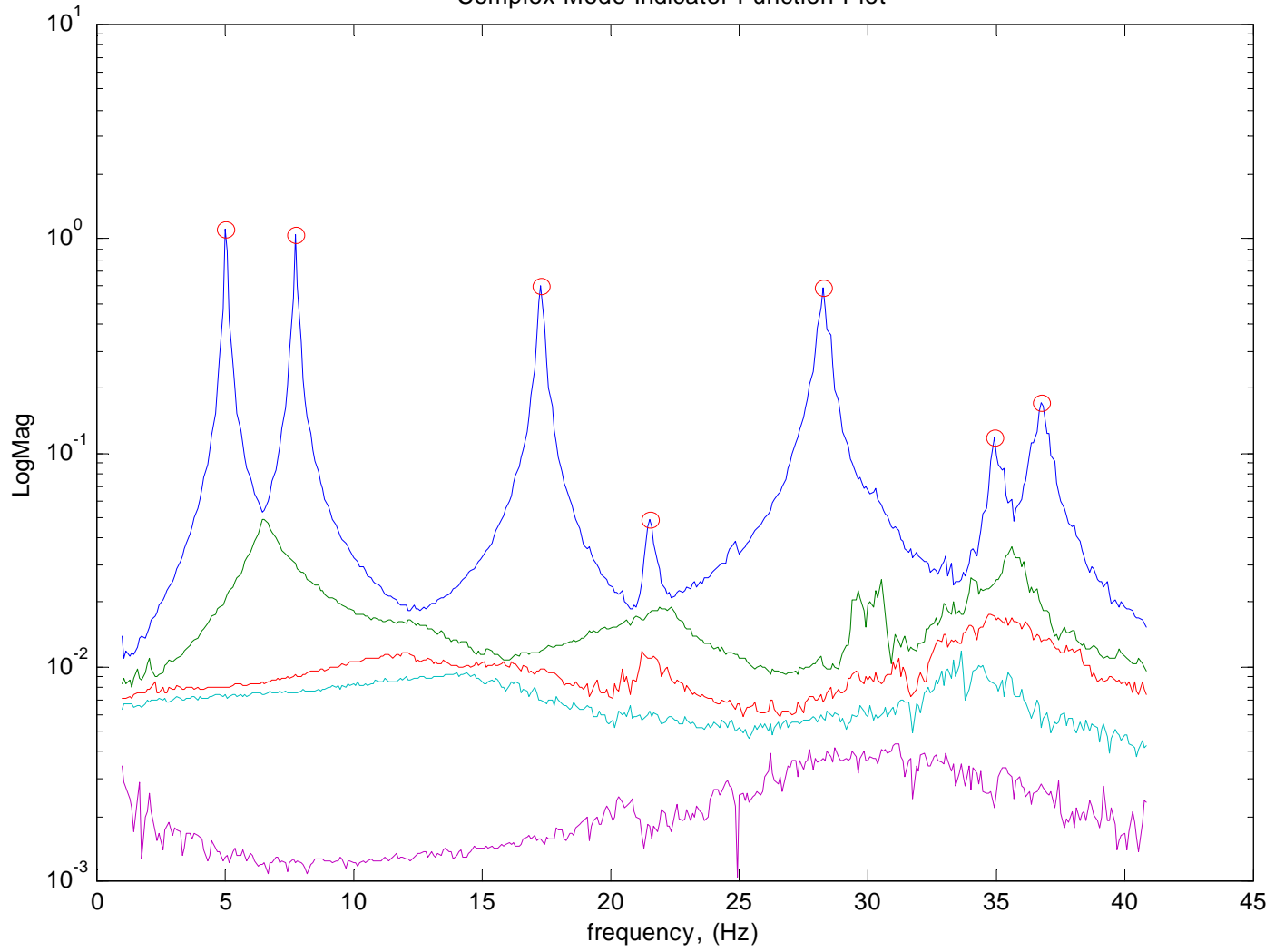
Ni= pt 8, No= pt 8 (pseudo FRF)



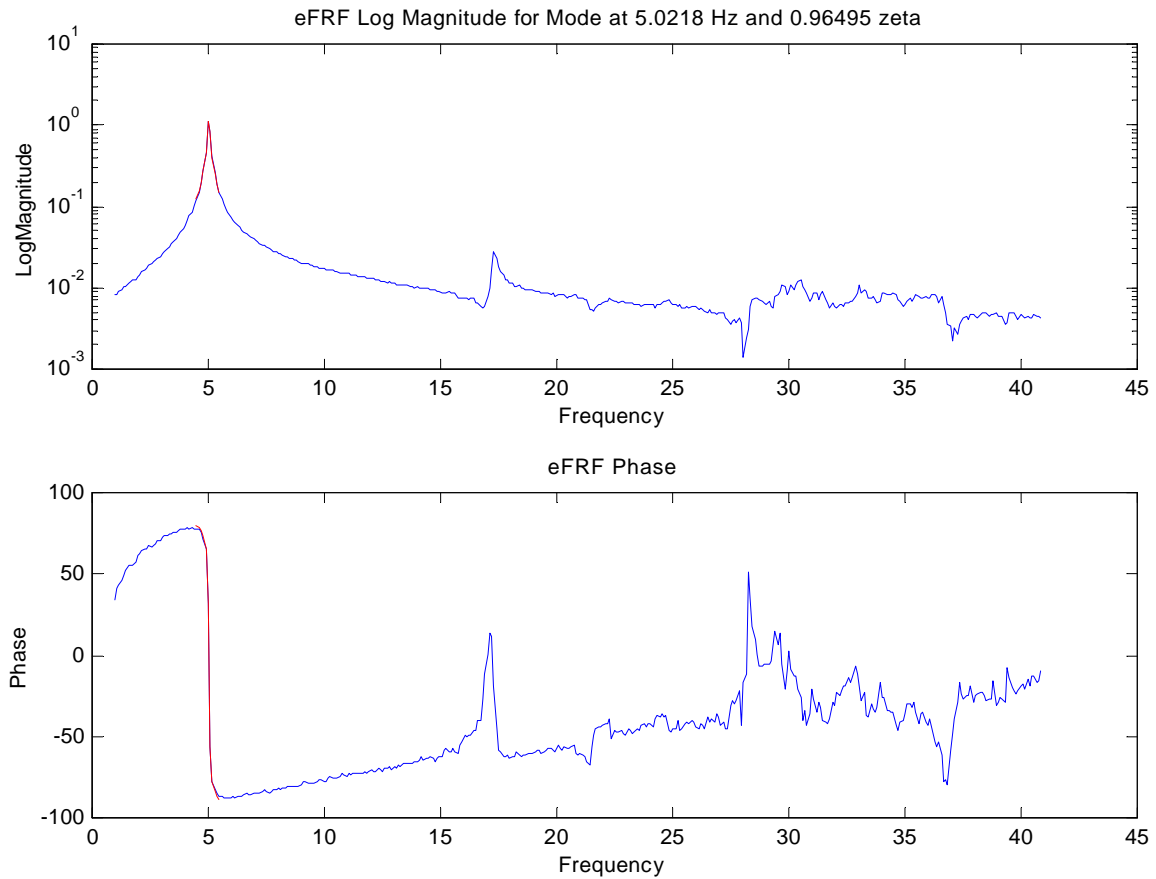
Ni= pt 16, No= pt 16 (pseudo FRF)



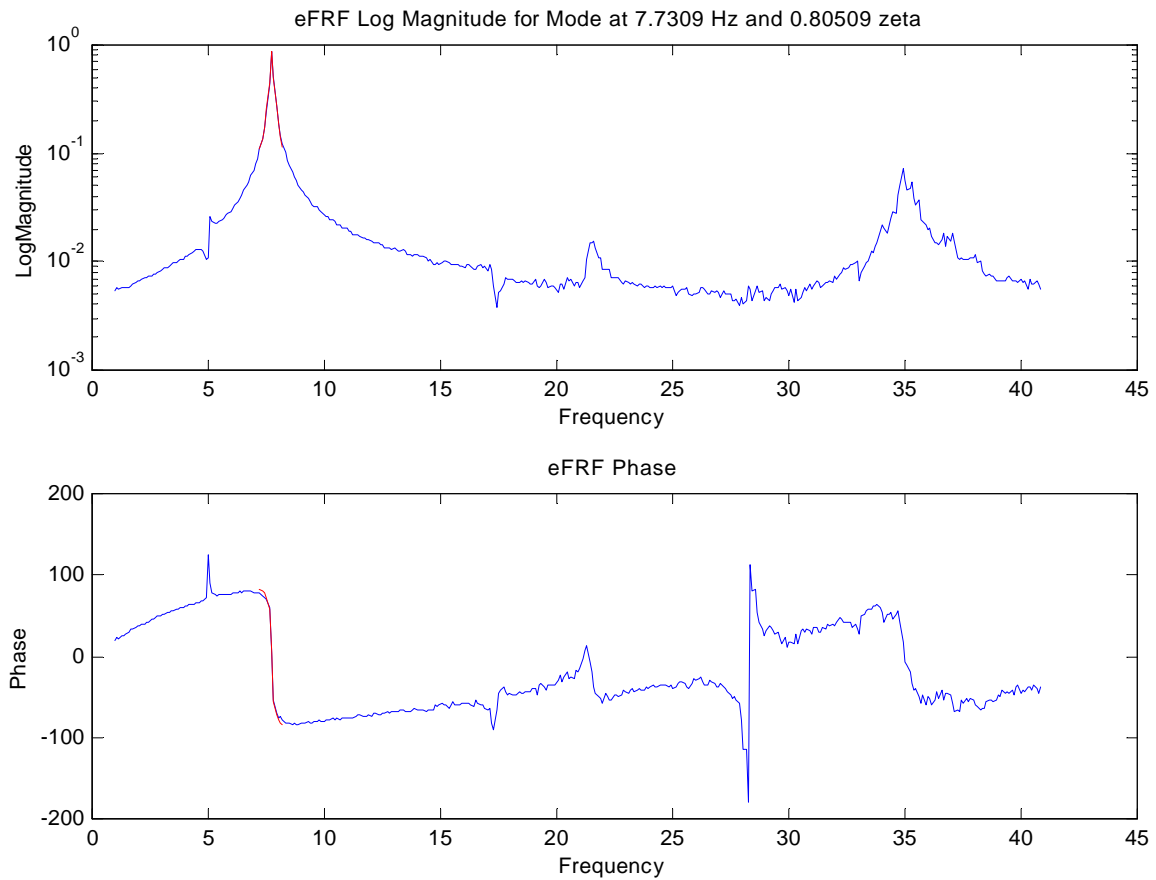
Complex Mode Indicator Function Plot



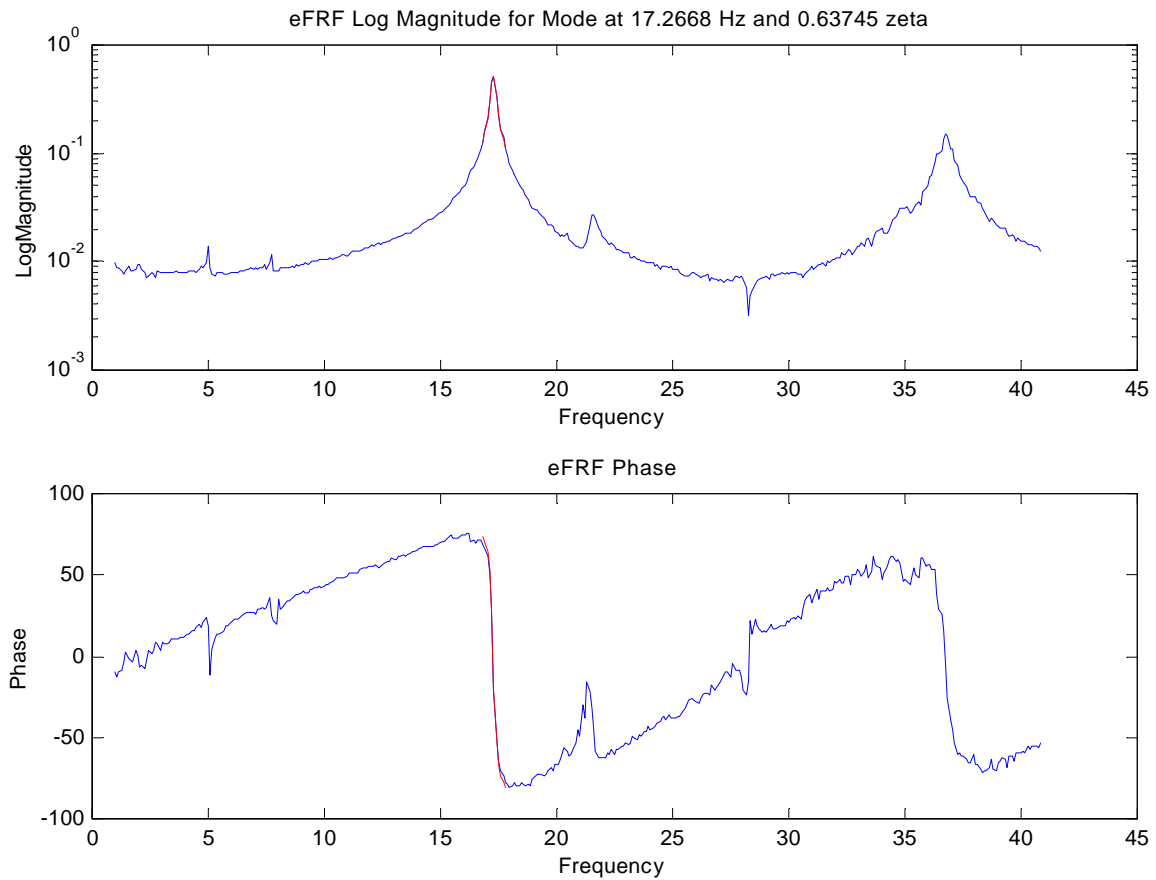
Mode 1 (Ambient)



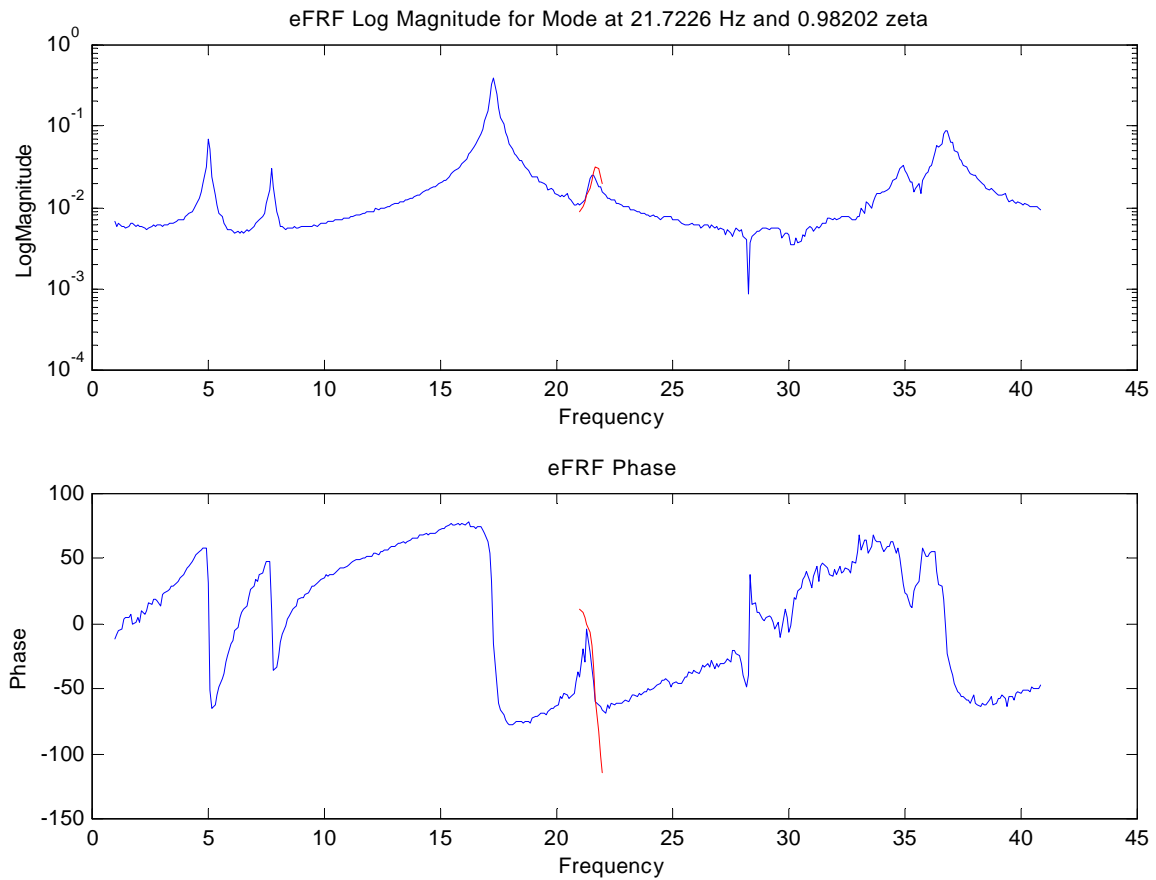
Mode 2 (Ambient)



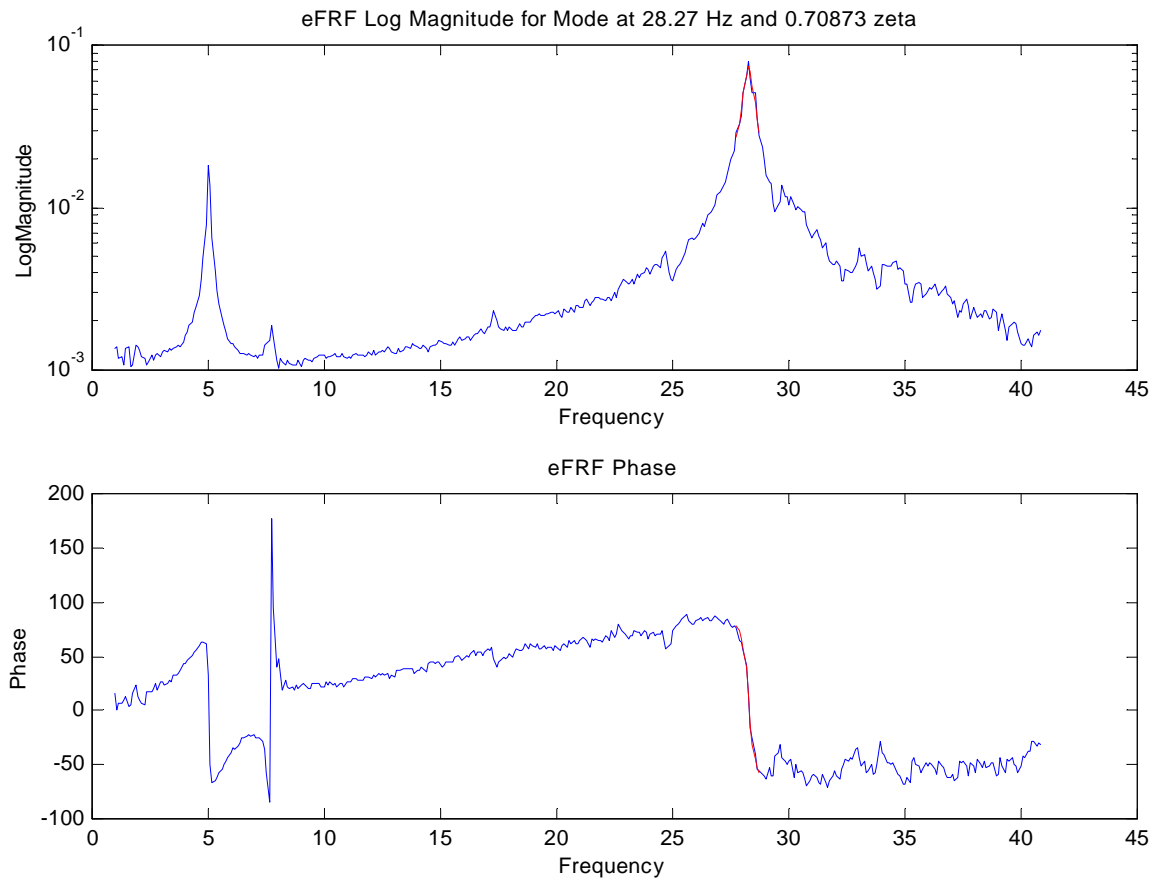
Mode 3 (Ambient)



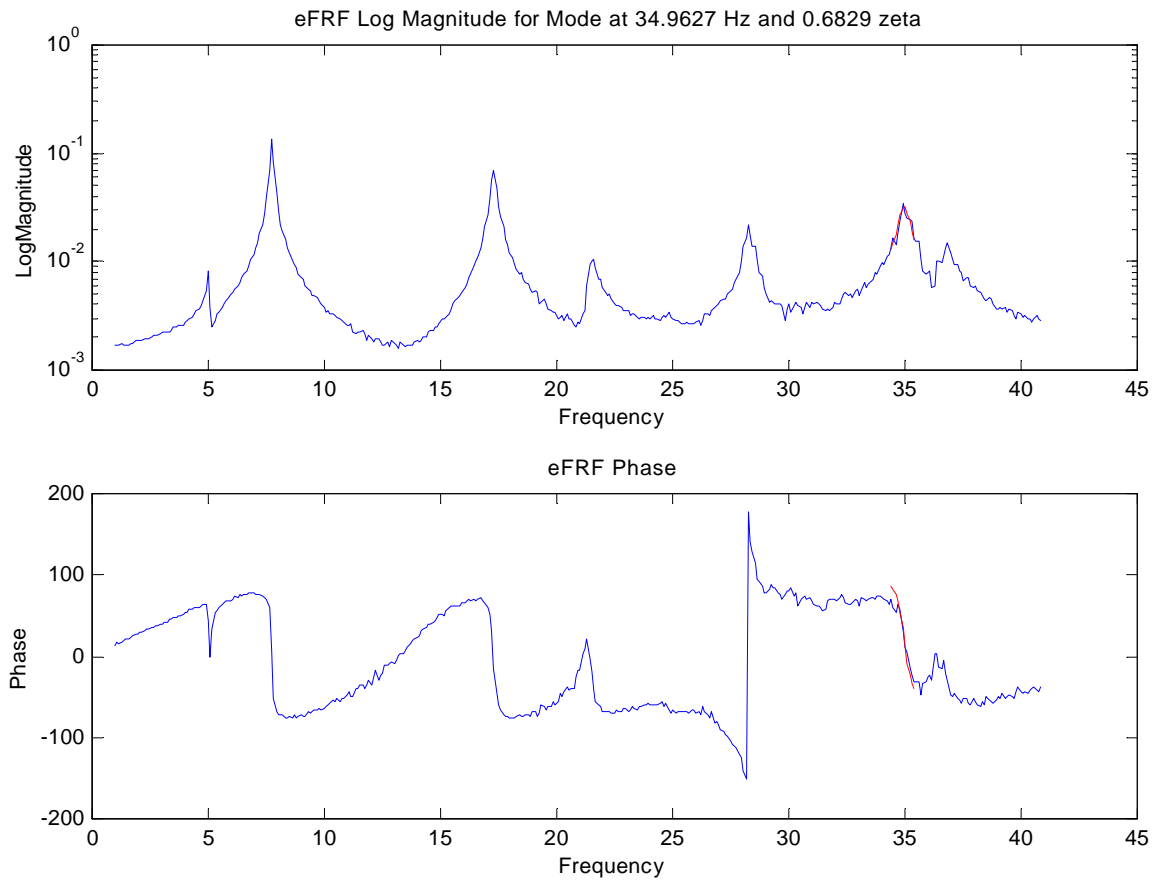
Mode 4 (Ambient)



Mode 5 (Ambient)



Mode 6 (Ambient)



Mode 7 (Ambient)

