DOE/OE Transmission Reliability Program

Model Validation

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Project Objectives
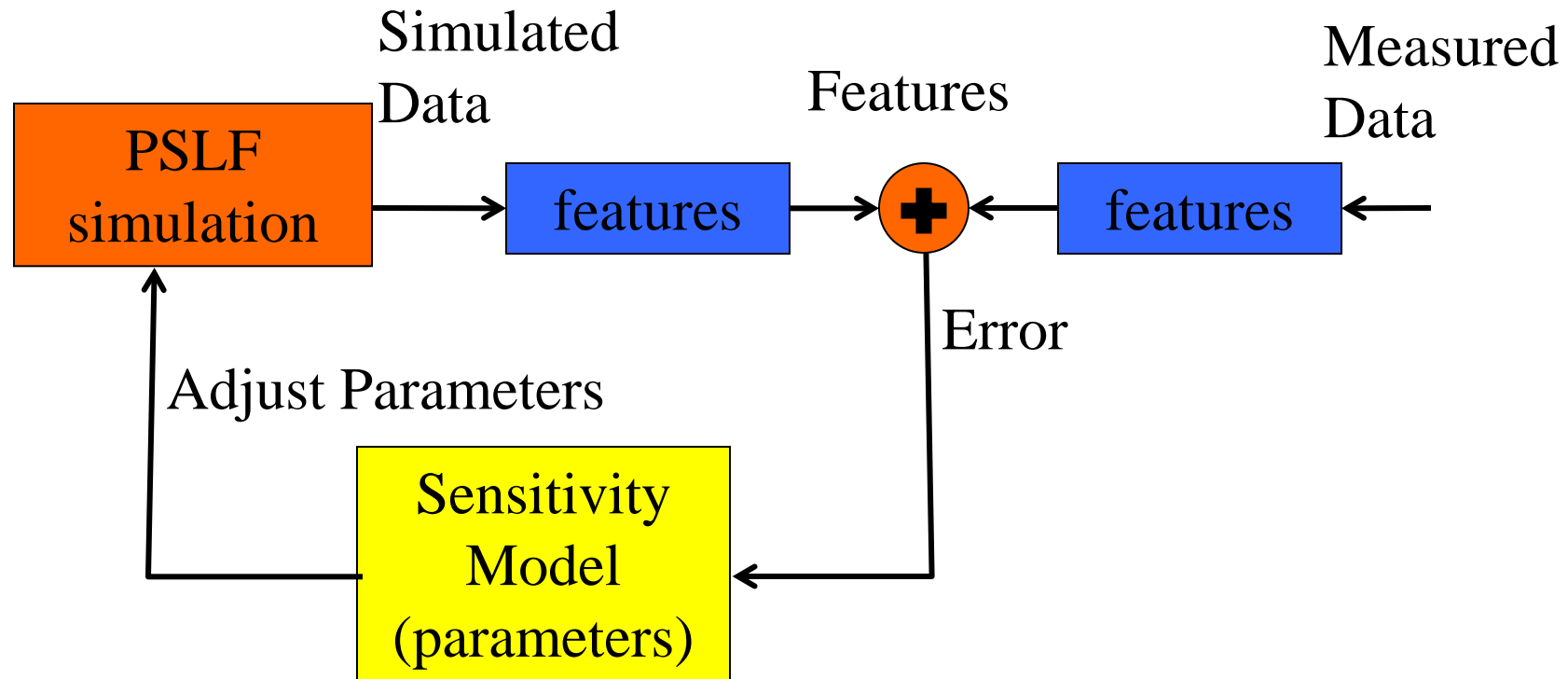
To Develop techniques and tools for PMU- and feature-based power system model validation.

Background: Our prior proof-of-concept research demonstrated that feature-based sensitivity models can be used to calibrate power system dynamic models. This was applied to the WECC composite load model for oscillatory and FIDVR events.

Project Objectives

Technical Approach

Project Objectives

Current Research: Use PMU data to calibrate power plant models.

Four Tasks:

1. Perform Calibration Studies

2. Examine Parameter Identifiability

3. Expand Methods to Enhance Baseline Tests

4. Technology Transfer

5. Modal Feature Analysis (Ringdown Features) NEW!

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Accomplishments

- Have performed three power plant model calibrations:
    - Power plant validation 1. Satisfactory.
    - Power plant validation 2. Satisfactory *and identified that the power system stabilizer stopped working.*
    - Power plant validation 3. Satisfactory (BPA supplied simulation-based test)
- Currently analyzing a multi-generator plant.
- Have identified potential limitations with regard to uniqueness of parameter estimation, and ways to characterize relation between parameter estimates.
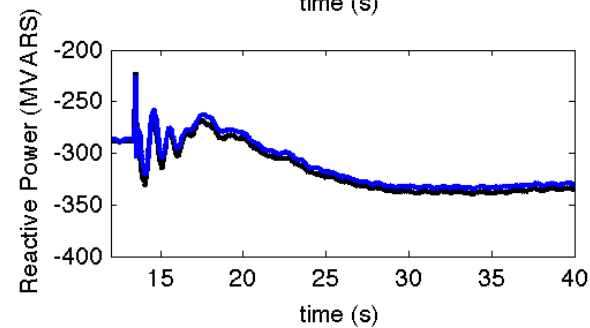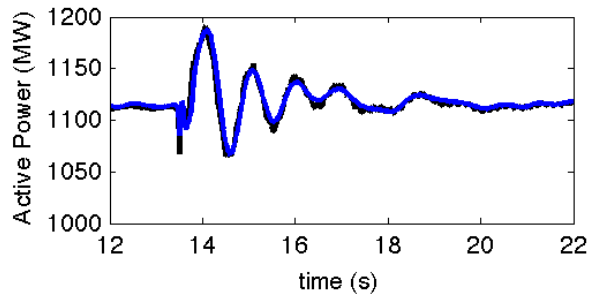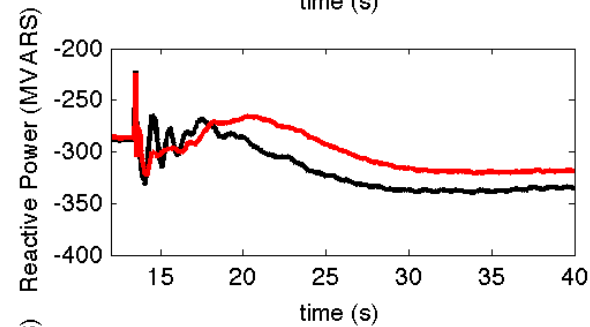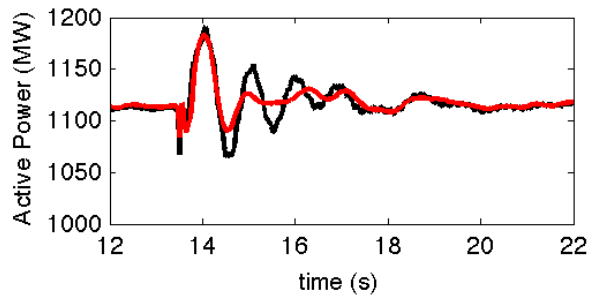
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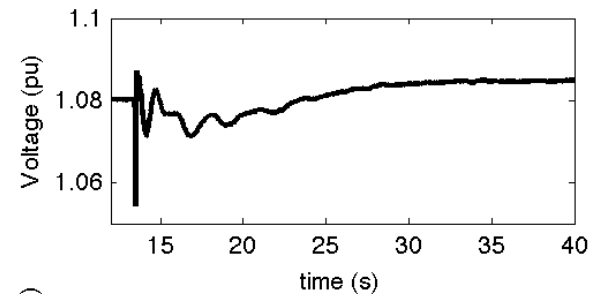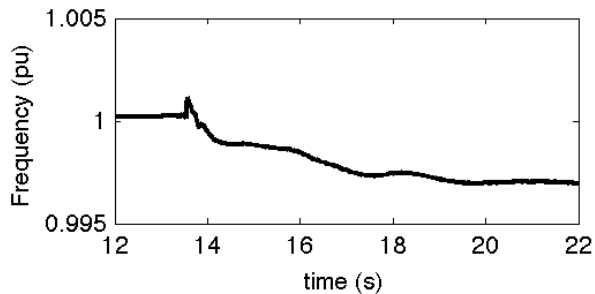CONSORTIUM FOR ELECTRIC RELIABILITY TECHNOLOGY SOLUTIONS

Accomplishments

- Have developed a proto-type tool for Ringdown Modal Analysis, with help from engineers at BPA.
  - Uses variable projection method
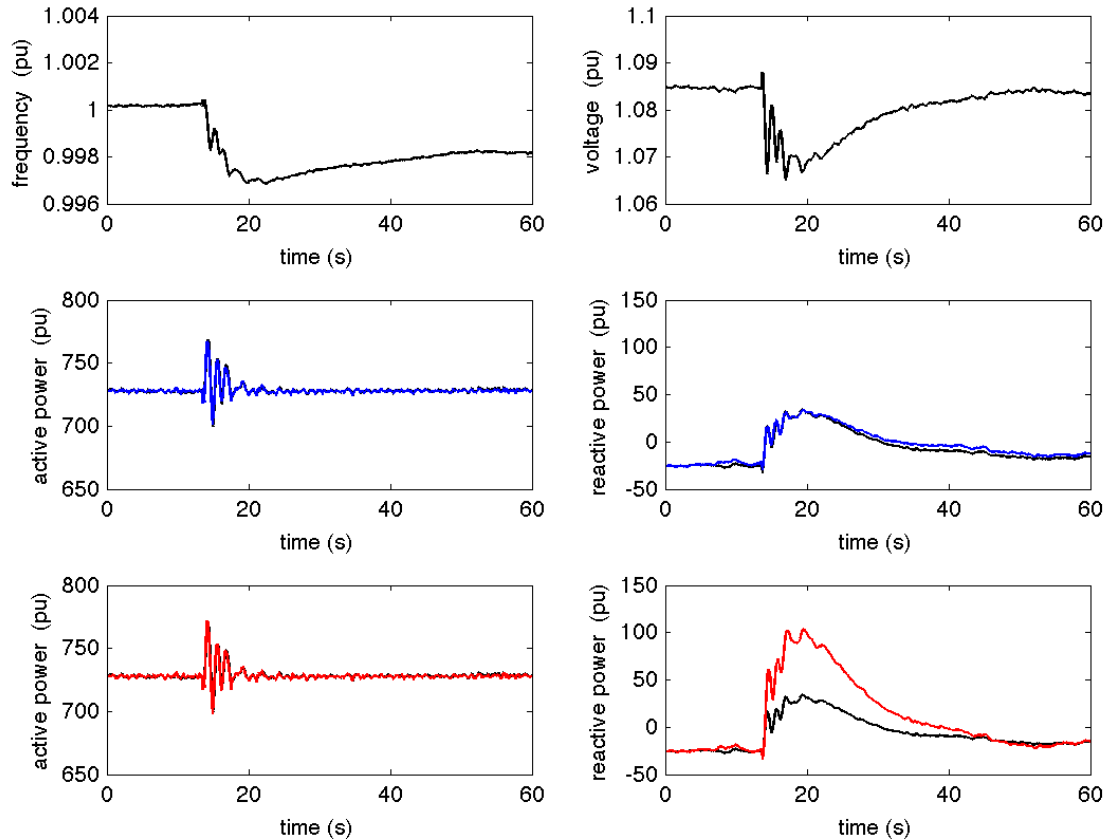 - More robust than traditional methods

Accomplishments

Example Power Plant Calibration

Accomplishments

No PSS

Events 1-3 (of 8) show PSS working

Accomplishments
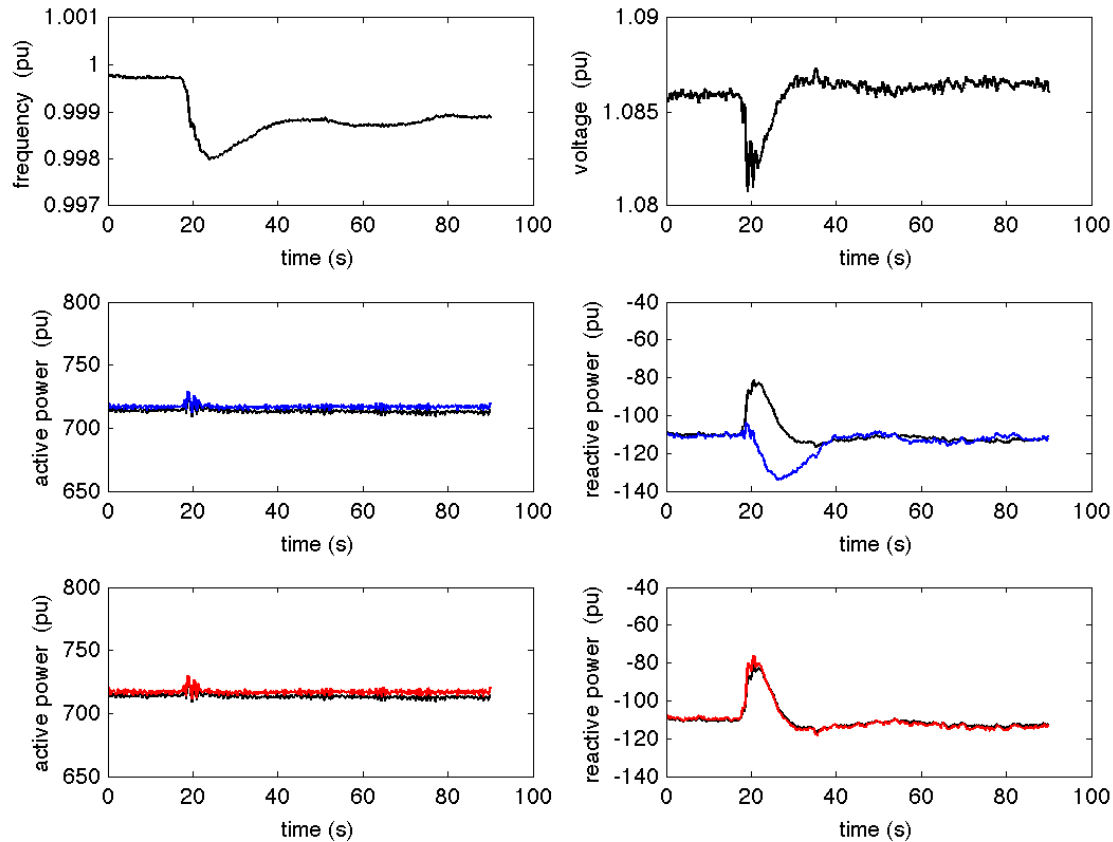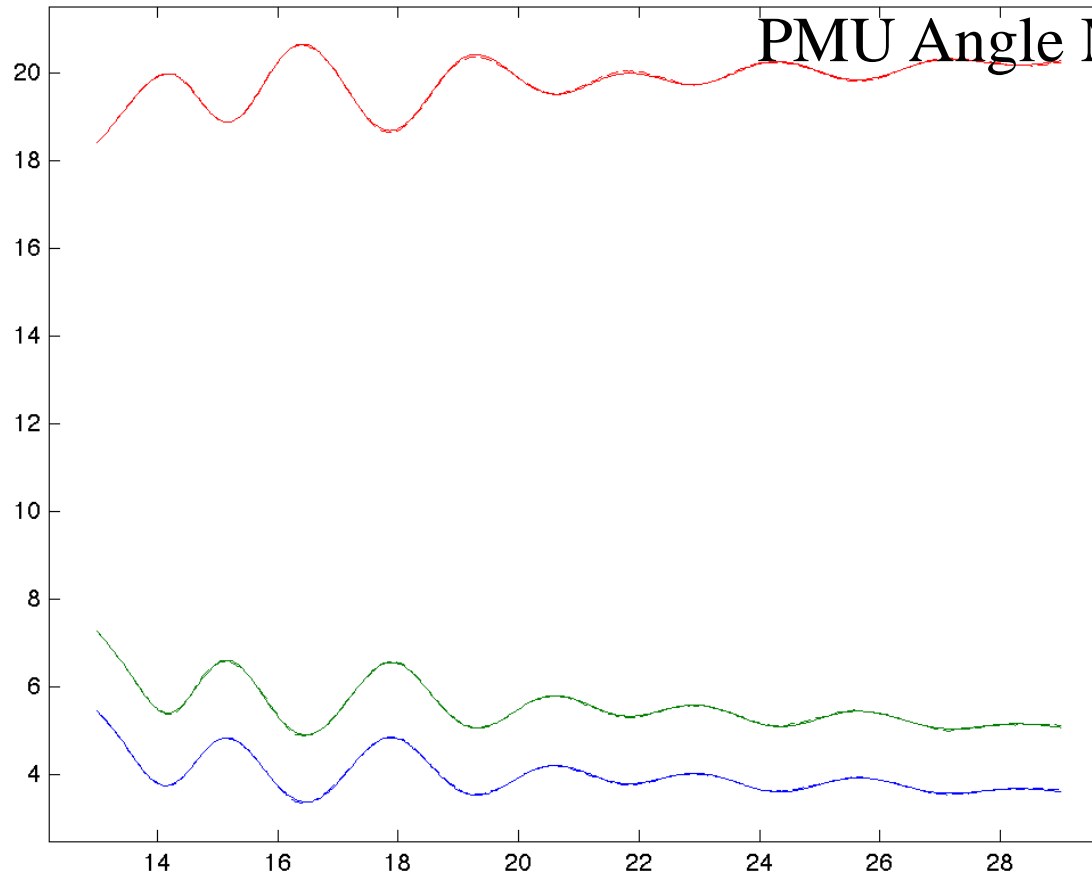

No PSS

Events 4-8 (of 8) show PSS failure

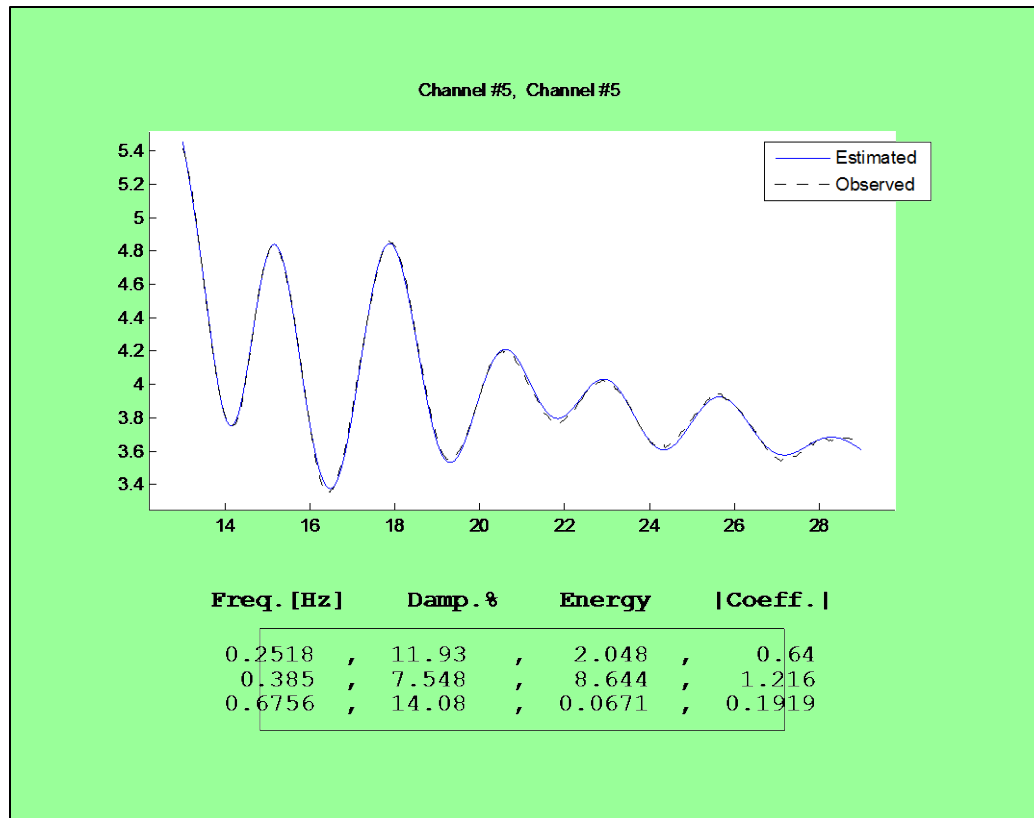# Accomplishments

Sample Ringdown Analysis of PMU Angle Measurements

Accomplishments

Sample Ringdown Analysis of
PMU Angle Measurements

Channel #5, Channel #5

Freq.[Hz]	Damp.%	Energy	|Coeff.|
0.2518	11.93	2.048	0.64
0.385	7.548	8.644	1.216
0.6756	14.08	0.0671	0.1919

Accomplishments

Presentations:
- WECC JSIS Meetings
- WECC MVWG Meetings
- North American Power Symposium

Papers (Ringdown Analysis)

"Determining Power System Modal Content from Data using Normal Forms," A.R. Borden and B.C. Lesieutre, 2012 North American Power Symposium. **(1st prize, student paper contest)**

"Variable Projecion and Prony Analysis for Power System Modal Identification," A.R. Borden, and B.C. Lesieutre, submitted to the IEEE Transactions on Power System.

"Power System Modal Analysis Tool Developed for Industry Use," A.R. Borden, B.C. Lesieutre, and J.F. Gronquist, submitted to the 2013 North American Power Symposium.

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Schedule and Deliverables

Task 1: Perform Model Calibrations. On schedule. In addition to those complete, one is in progress and we expect to complete another in FY13. Will deliver report on modal validations.

FY 14: Target three additional power plant calibrations

Task 2: Parameter Identifiability. On schedule. Learning from research on task 1. A posteriori ability to assess parameter values and relations between values. These analyses will be included in the calibration report.

FY 14: Develop A priori knowledge of parameter identifiability in terms of disturbance characteristics.

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Schedule and Deliverables

Task 3: Expand Techniques to Enhance Baseline Tests. Delayed to focus on modal features tool. Will attend WECC generator testing workshop in July.

> FY 14: Engage with Army Corps of Engineers to enhance baseline tests.

Task 4: Tech Transfer. This task is scheduled for FY 15.   On schedule.

Task 5: Modal Feature Analysis. On schedule. Prototype tool to be complete in FY13.

> FY 14: Develop Oscillation Detection Algorithm (?)

Risks and Challenges

Technical Risks and Challenges: We are far enough along in the work that we anticipate few technical challenges.

Tech Transfer Risks and Challenges: We need to investigate a business plan to ensure tech transfer of working prototypes to vendors.

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