Local Area Monitoring System (LAMS) for Microgrid Project at IIT
Funded by Korea Electrotechnology Research Institute

Synchrophasor Engineering Research and Training (SERT) Project at IIT
Funded by US Department of Energy DE-OE0000656

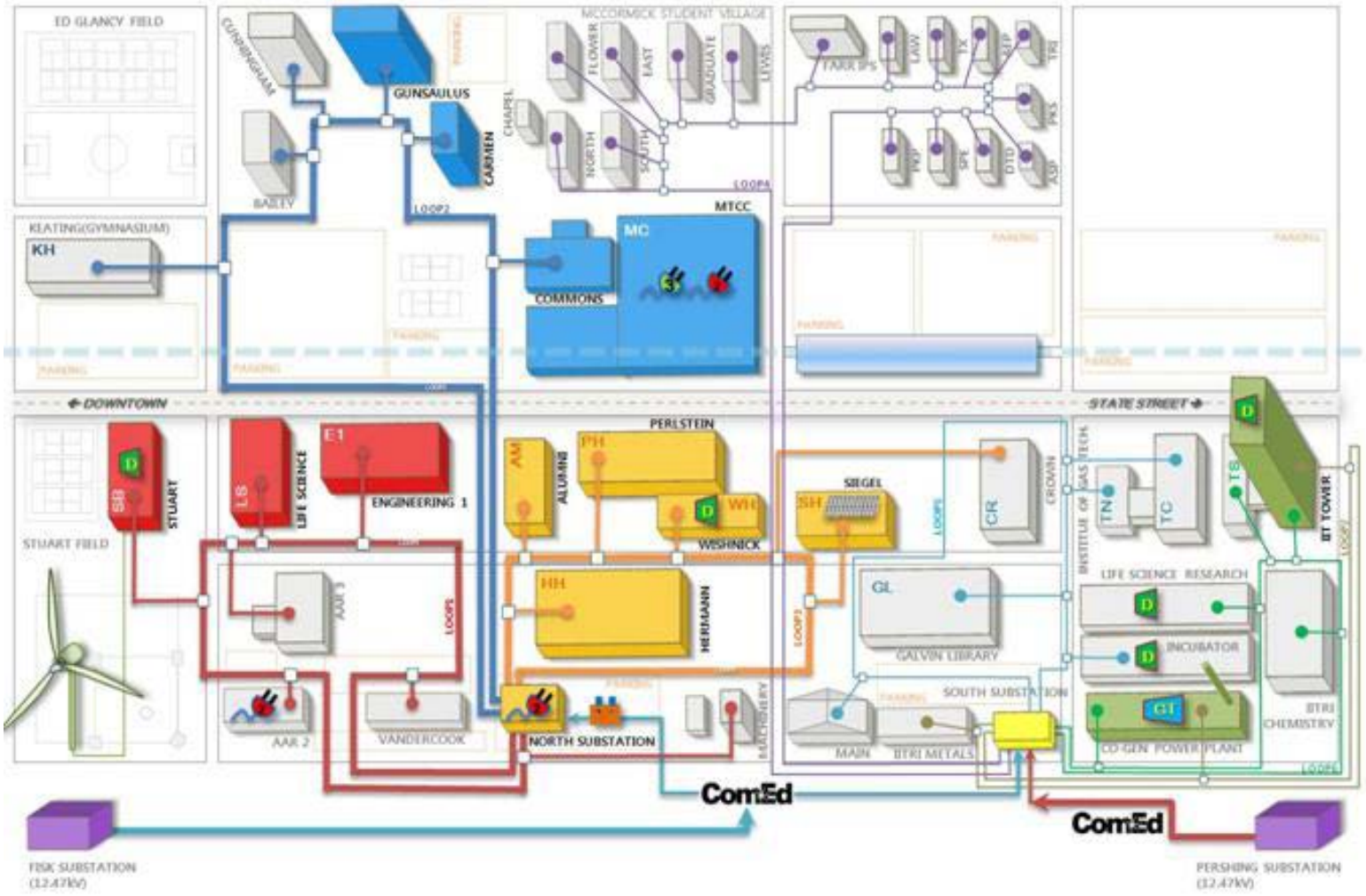
Dr. Alexander J. Flueck, Illinois Institute of Technology
Joint work with Ms. Yinyin Ge, PhD candidate

Improving Reliability with Synchrophasors from Distribution Networks and Microgrids

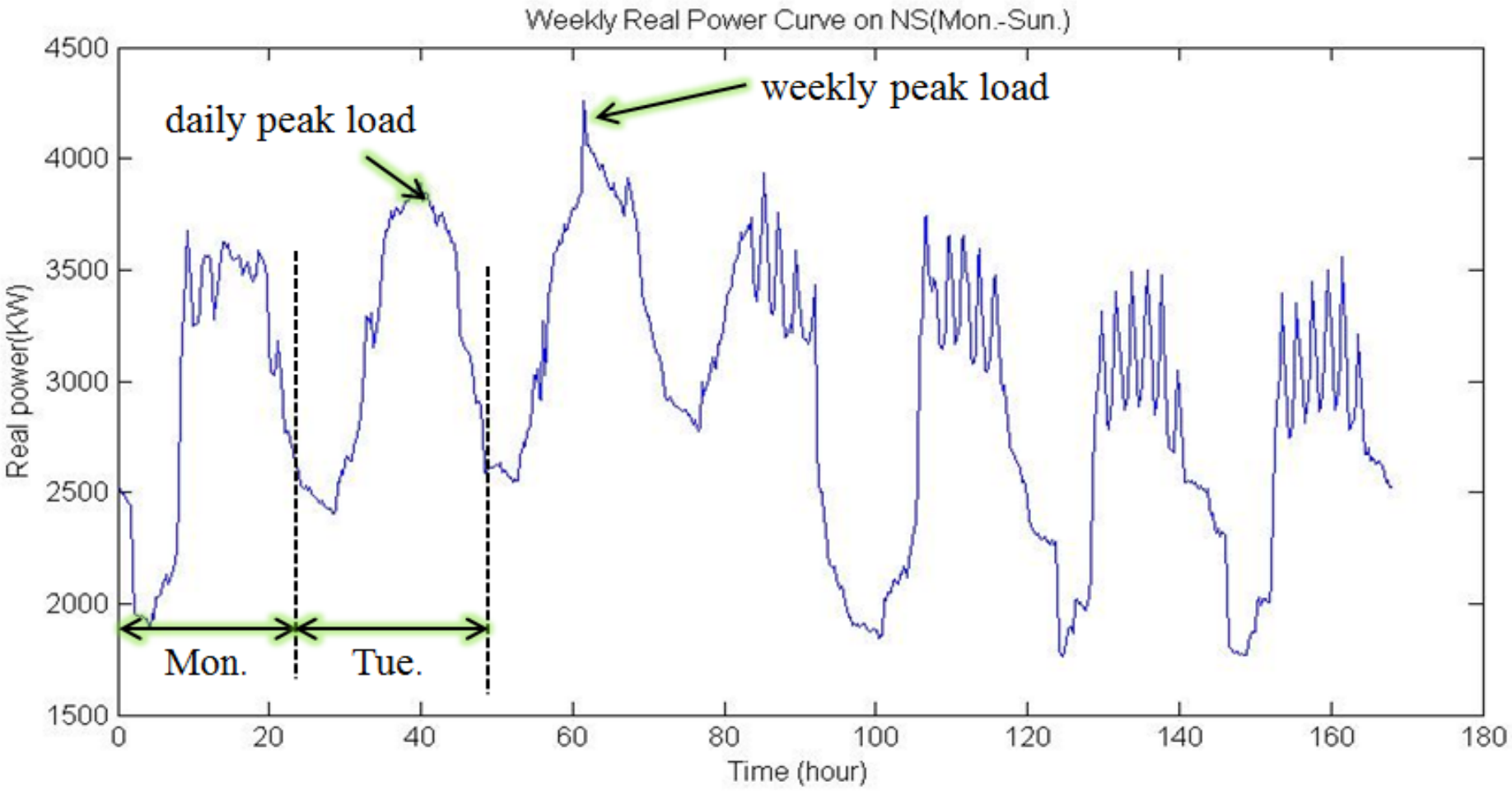
Outline

- IIT Microgrid (DOE Perfect Power)
- Local Area Monitoring System (LAMS) for Microgrid (2 papers in IEEE T-SmartGrid)
  - Korea Electrotechnology Research Institute
  - Event Detection
  - Data Archival
  - Model Validation
- DOE SERT (paper submitted to IEEE T-SG)
  - ComEd Transmission, Naperville Distribution, IIT Microgrid, SEL synchrophasor equipment

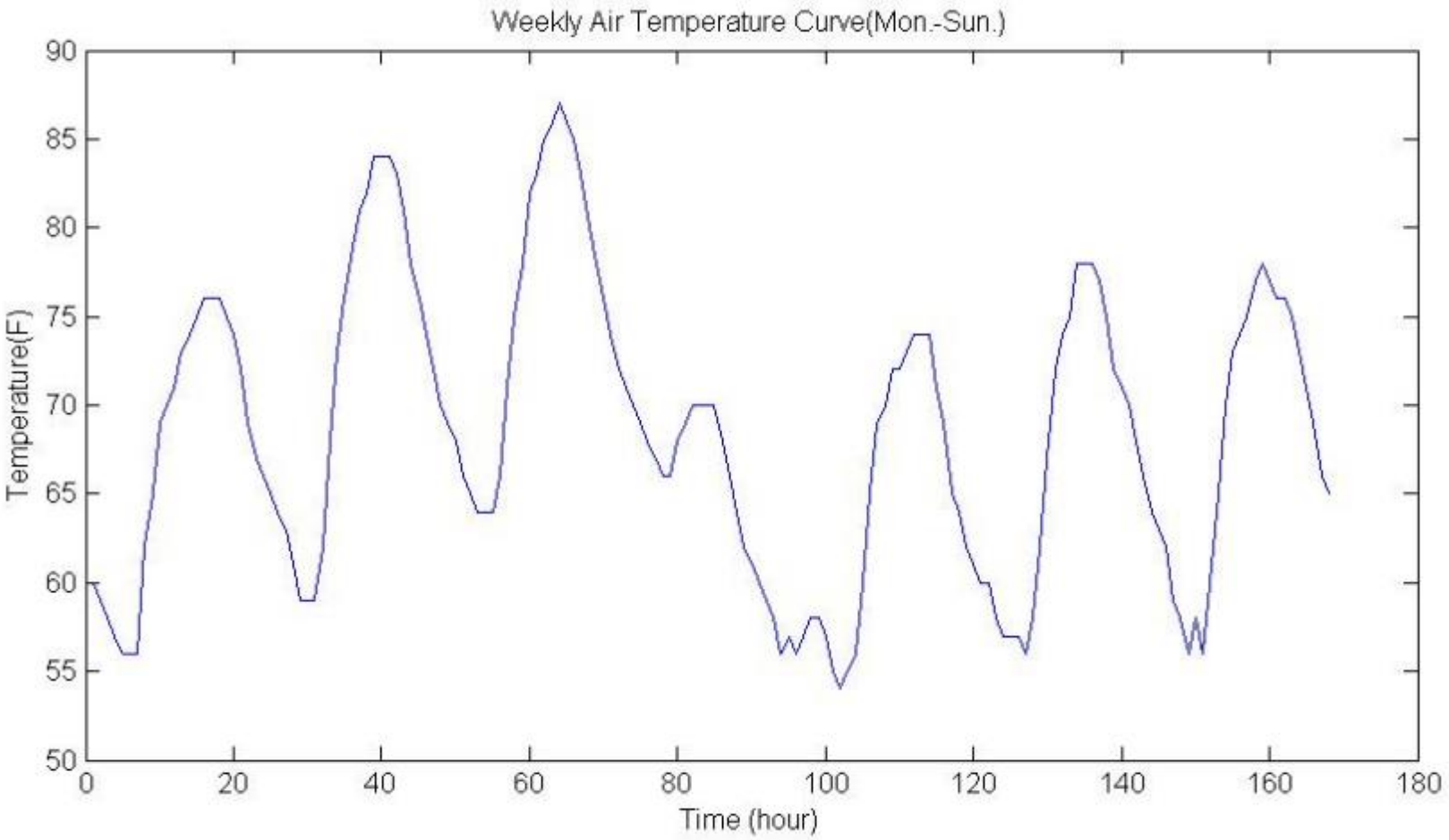
IIT Microgrid (DOE, KERI & Procom)



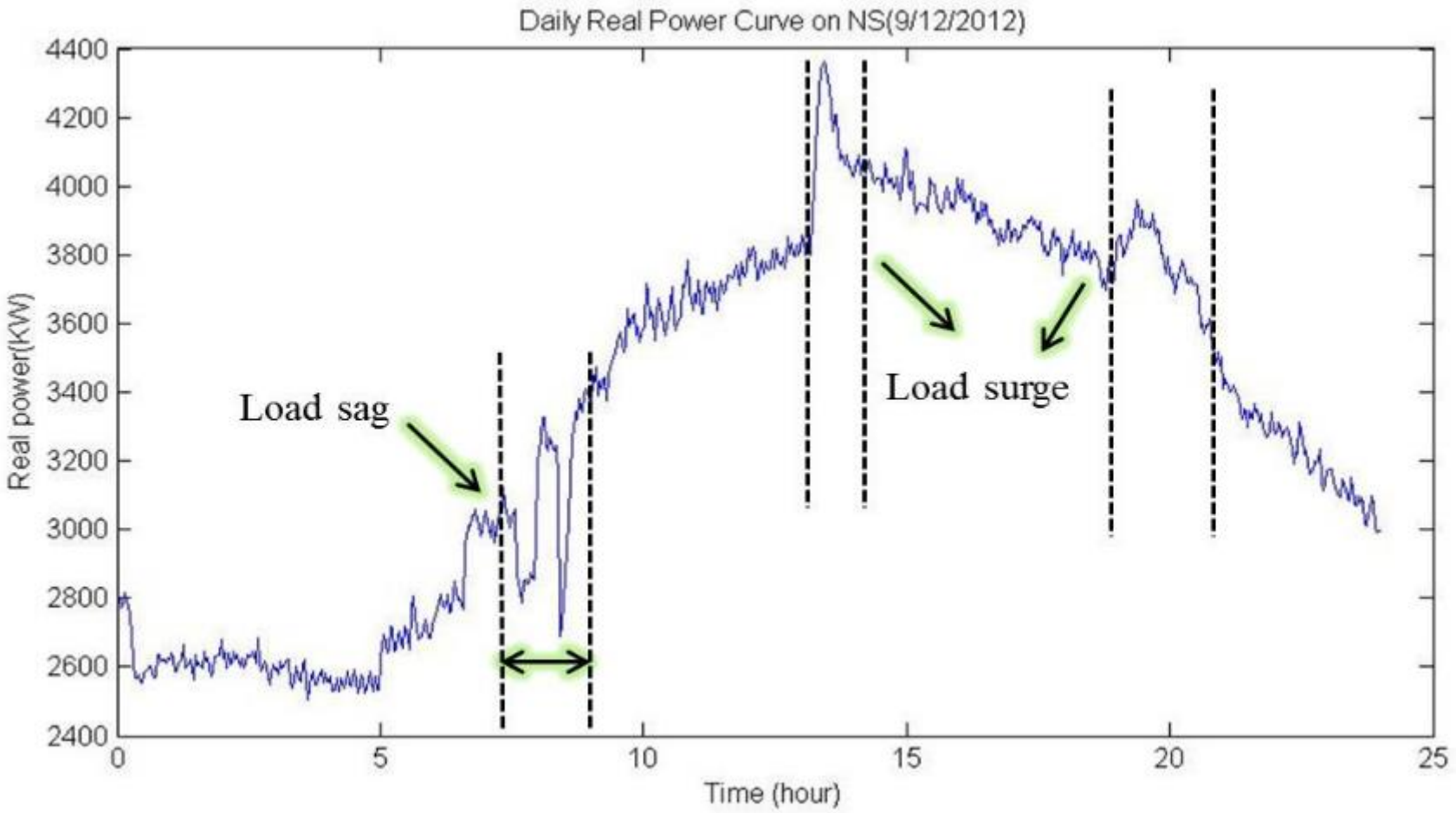
IIT North Sub Power (week in Sep)



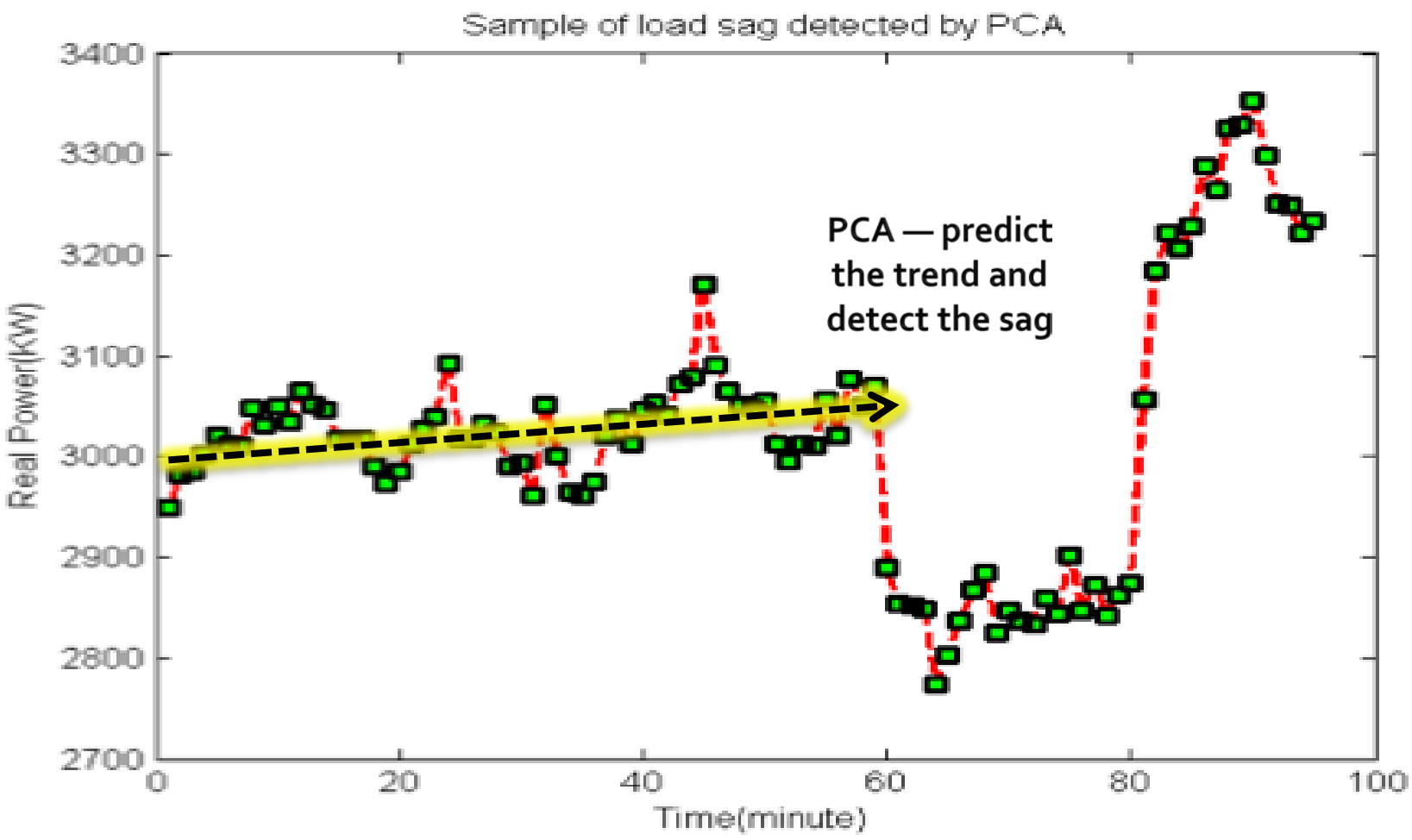
Temperature at MDW (week in Sep)



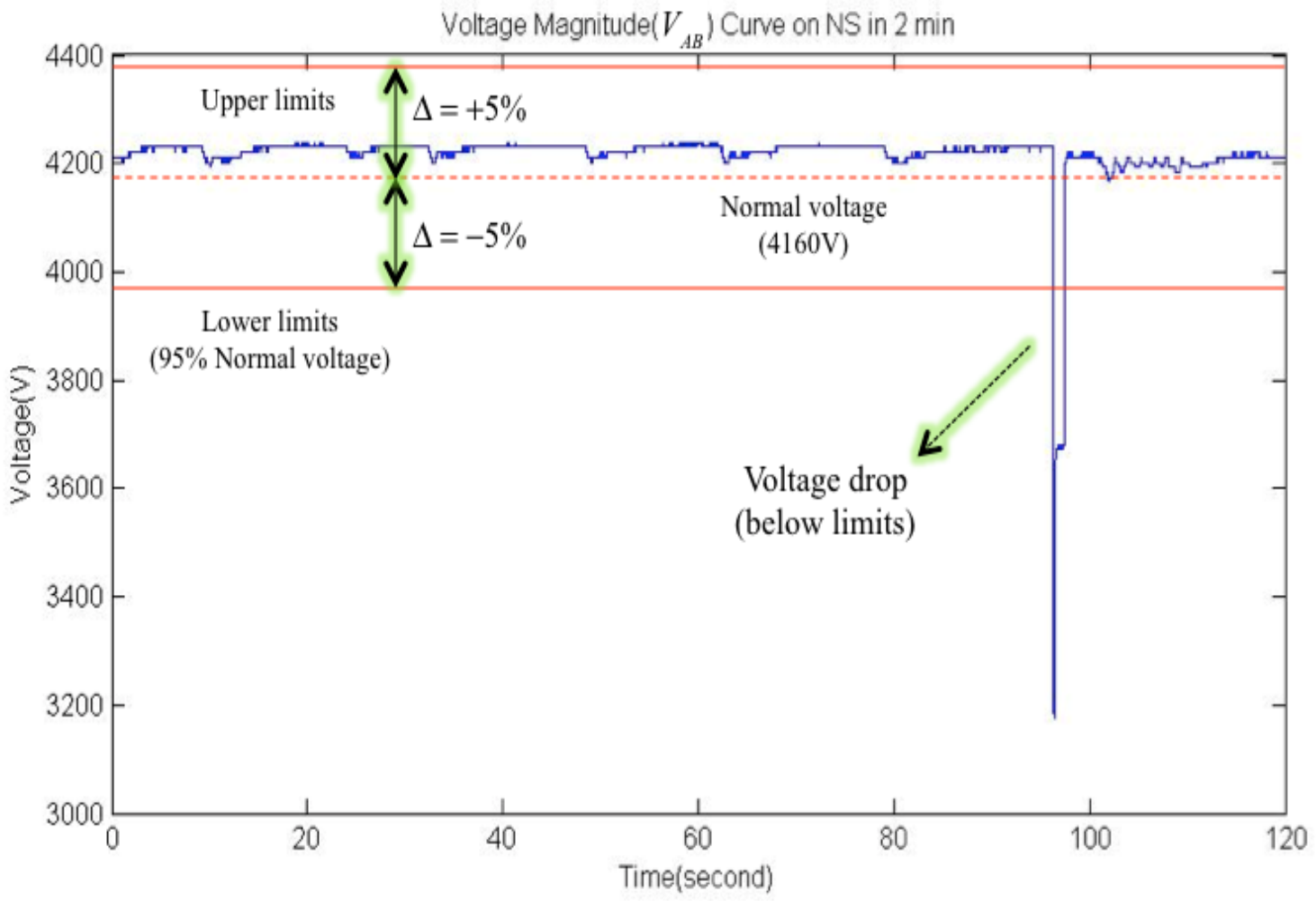
Daily N Sub Power (12 Sep 2012)



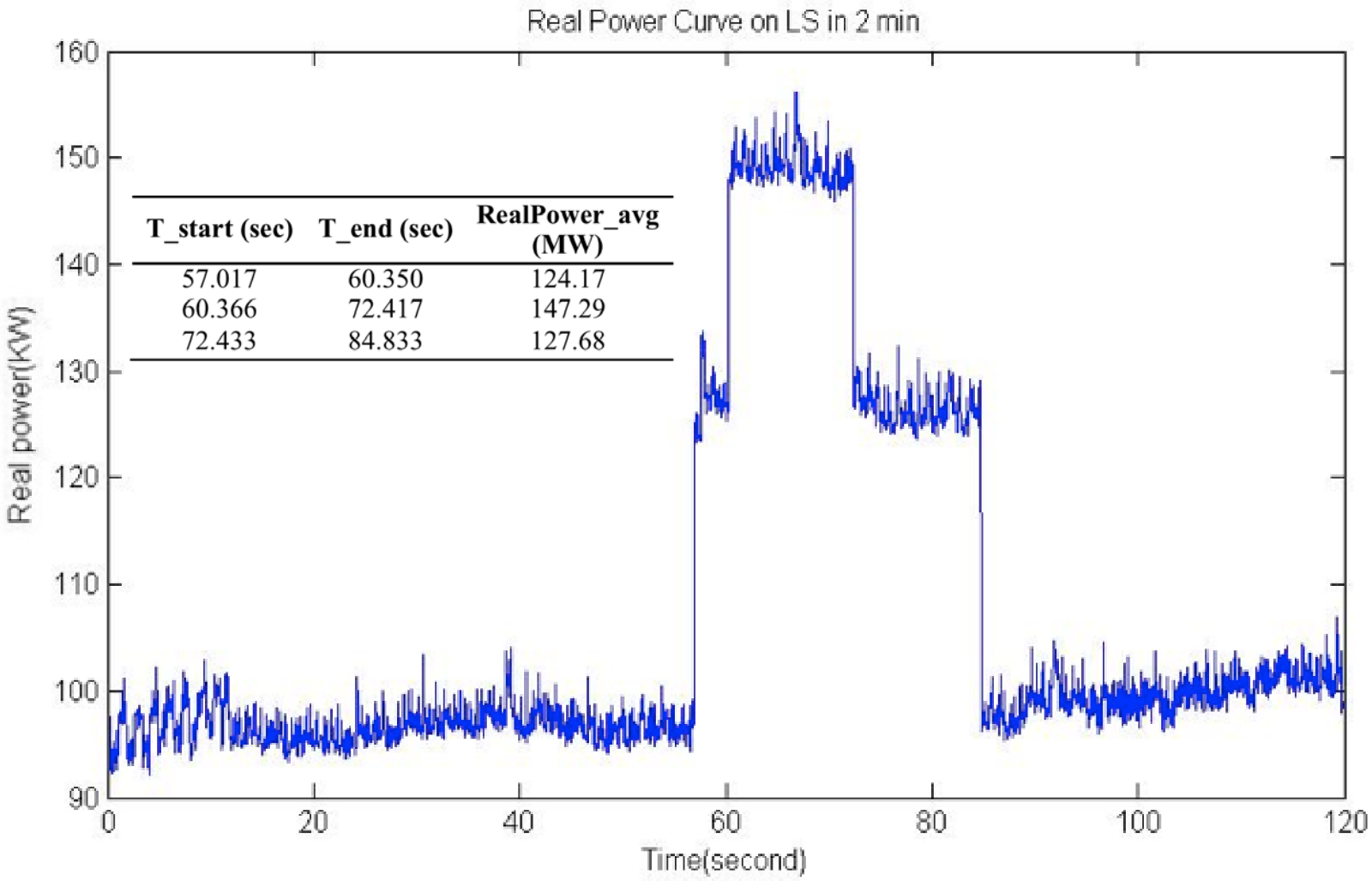
Principal Component Analysis



Voltage is Easier? (May want real-time relative limits…)

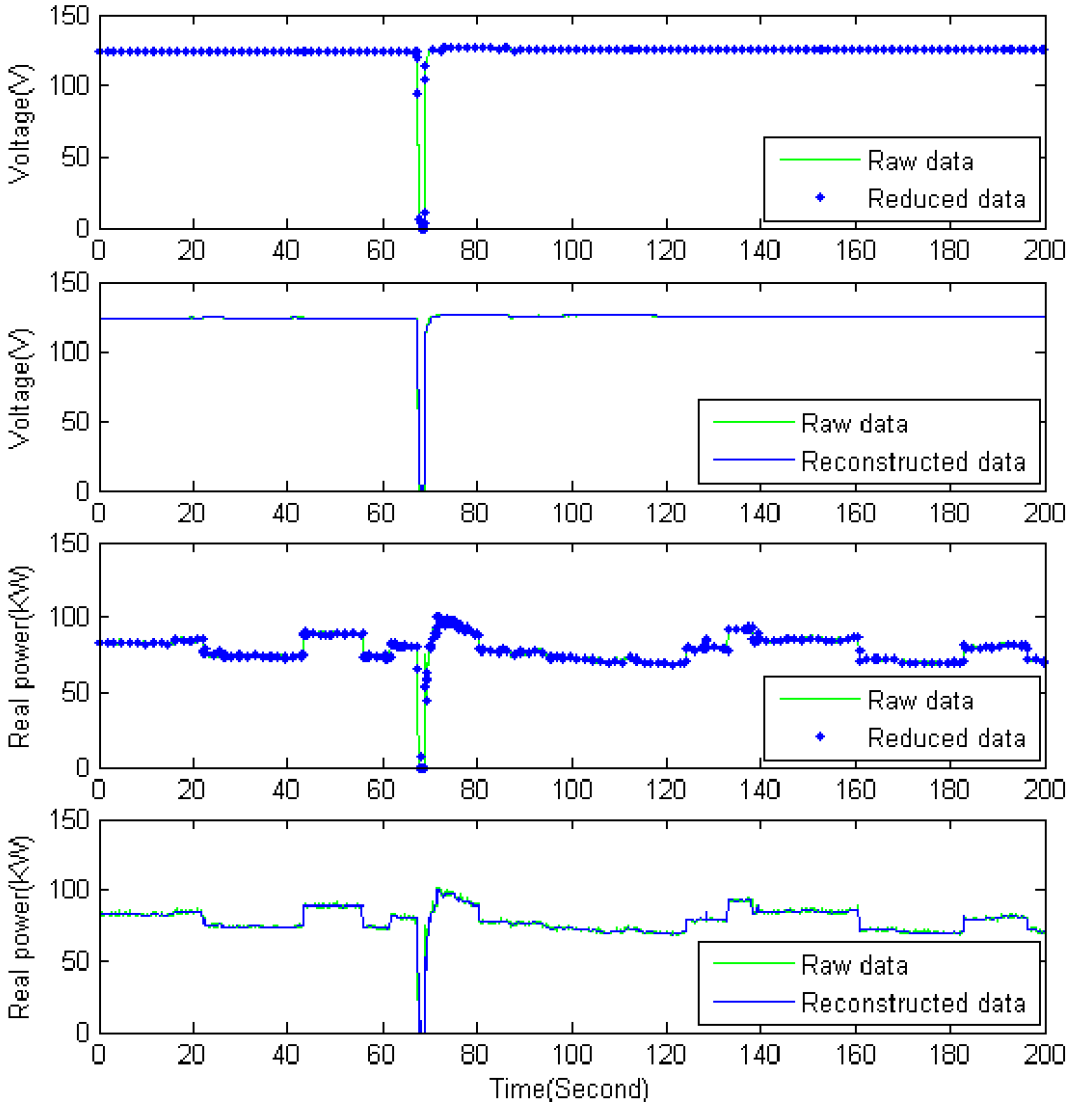


Power: 4160-208 V Transformer



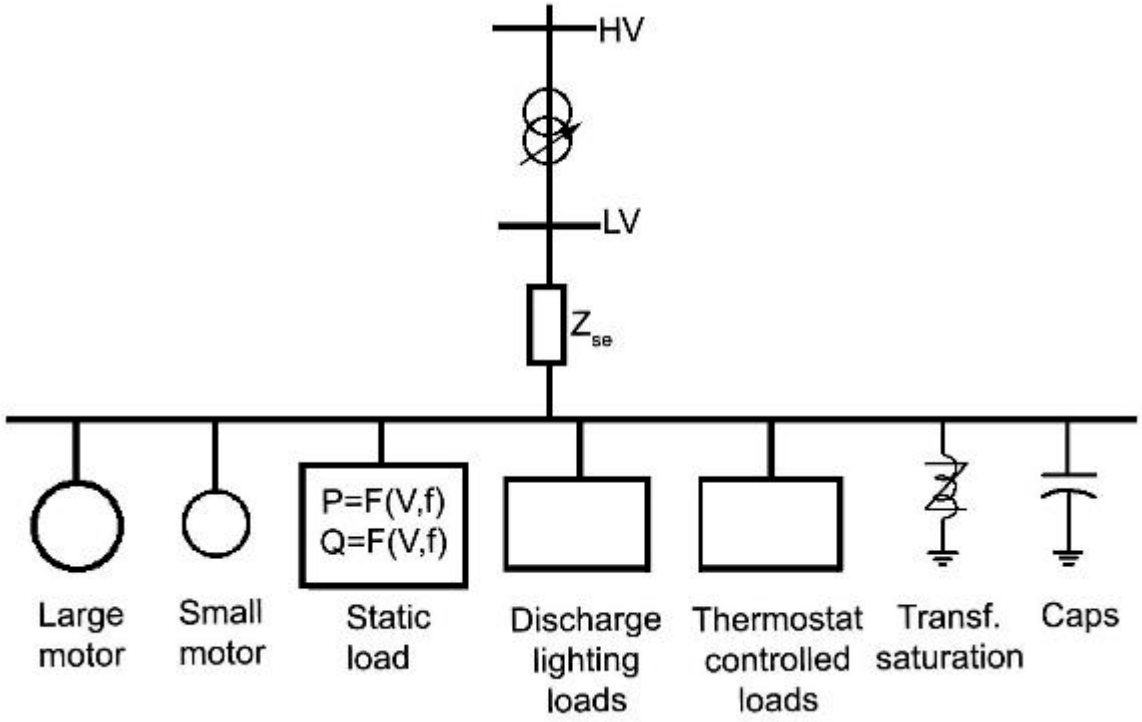
T_start (sec)	T_end (sec)	RealPower_avg (MW)
57.017	60.350	124.17
60.366	72.417	147.29
72.433	84.833	127.68

Data Archival – (100x benefit) Event Based Adjustable Sliding Window



Dynamic Load Models – Tough!

- How to know load parameters?



Induction Motor Model

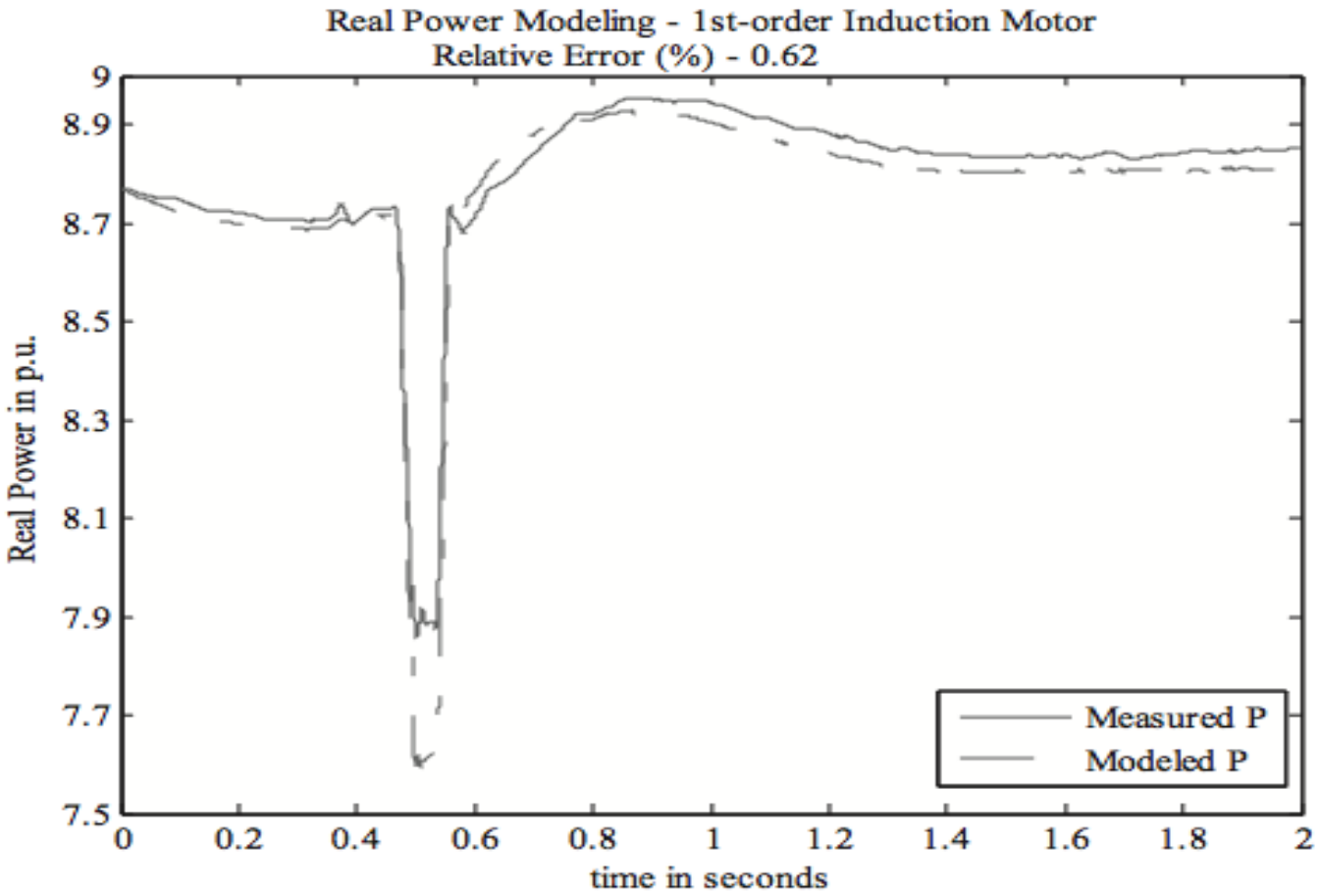
- Linear 1st-order induction motor model with five parameters

$$\Delta P_d + T_{pp}\frac{\mathrm{d}\Delta P_d}{\mathrm{d}t} = K_{pv}\left(\Delta V + T_{pv}\frac{\mathrm{d}\Delta V}{\mathrm{d}t}\right)$$

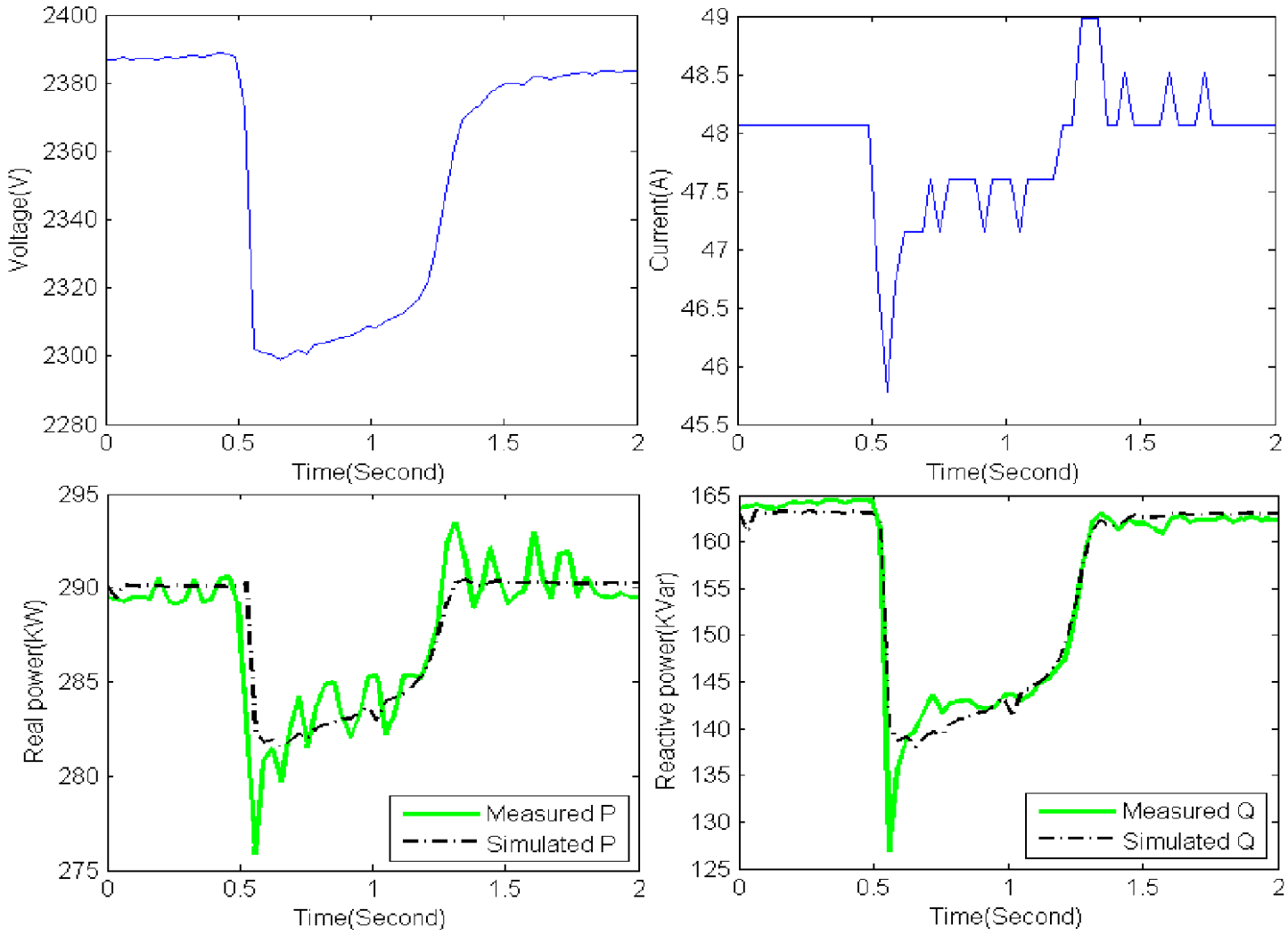
$$\Delta Q_d = K_{qv}\Delta V + K_{qp}\Delta P_d$$

$$\boldsymbol{p} = [T_{pp}, T_{pv}, K_{pv}, K_{qv}, K_{qp}]^{\mathrm{T}}.$$

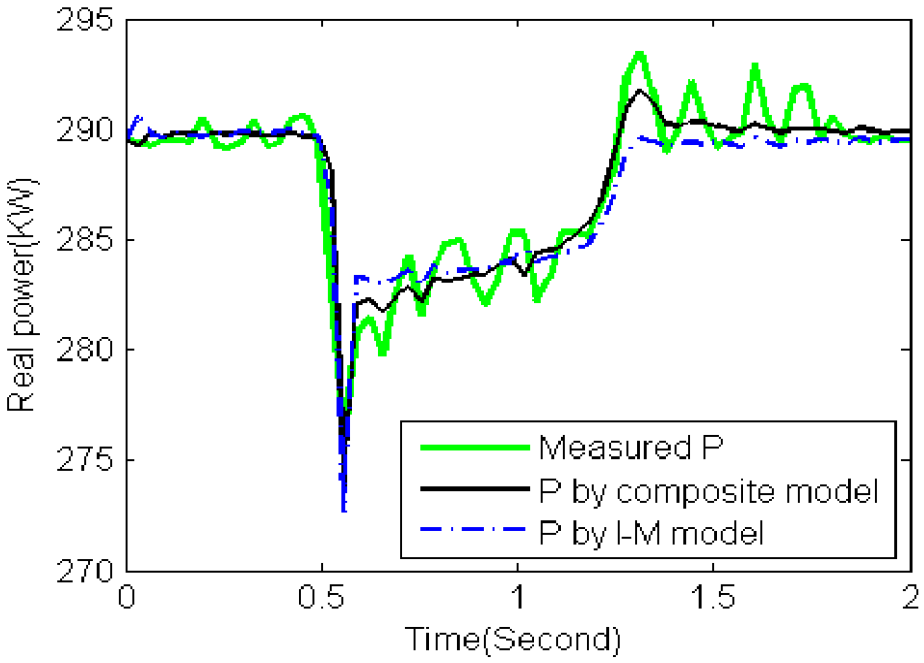
Dynamic Load Model Validation

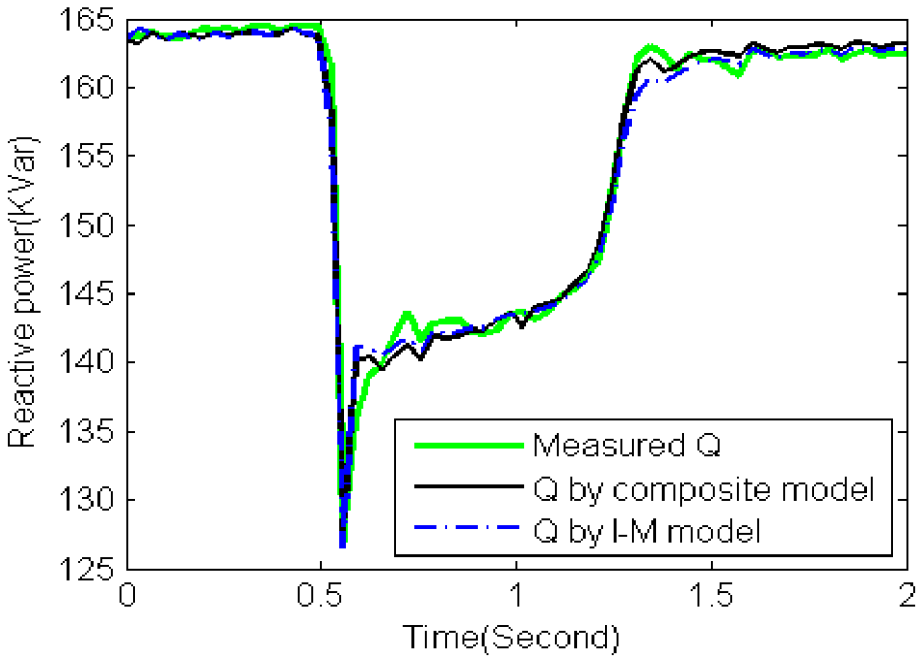


Static ZIP Load Model (4% V drop)

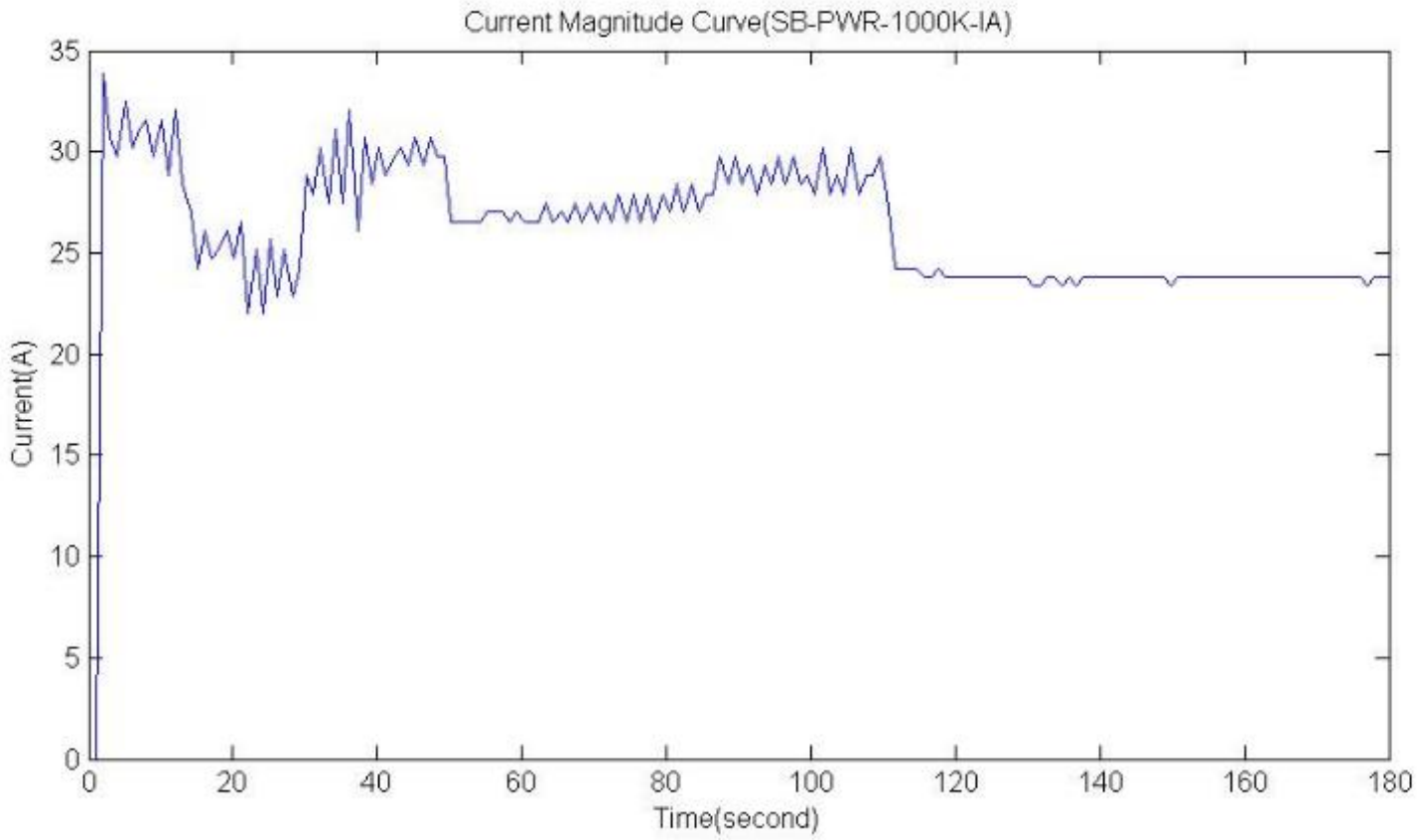


Dynamic Load Model (4% V drop)





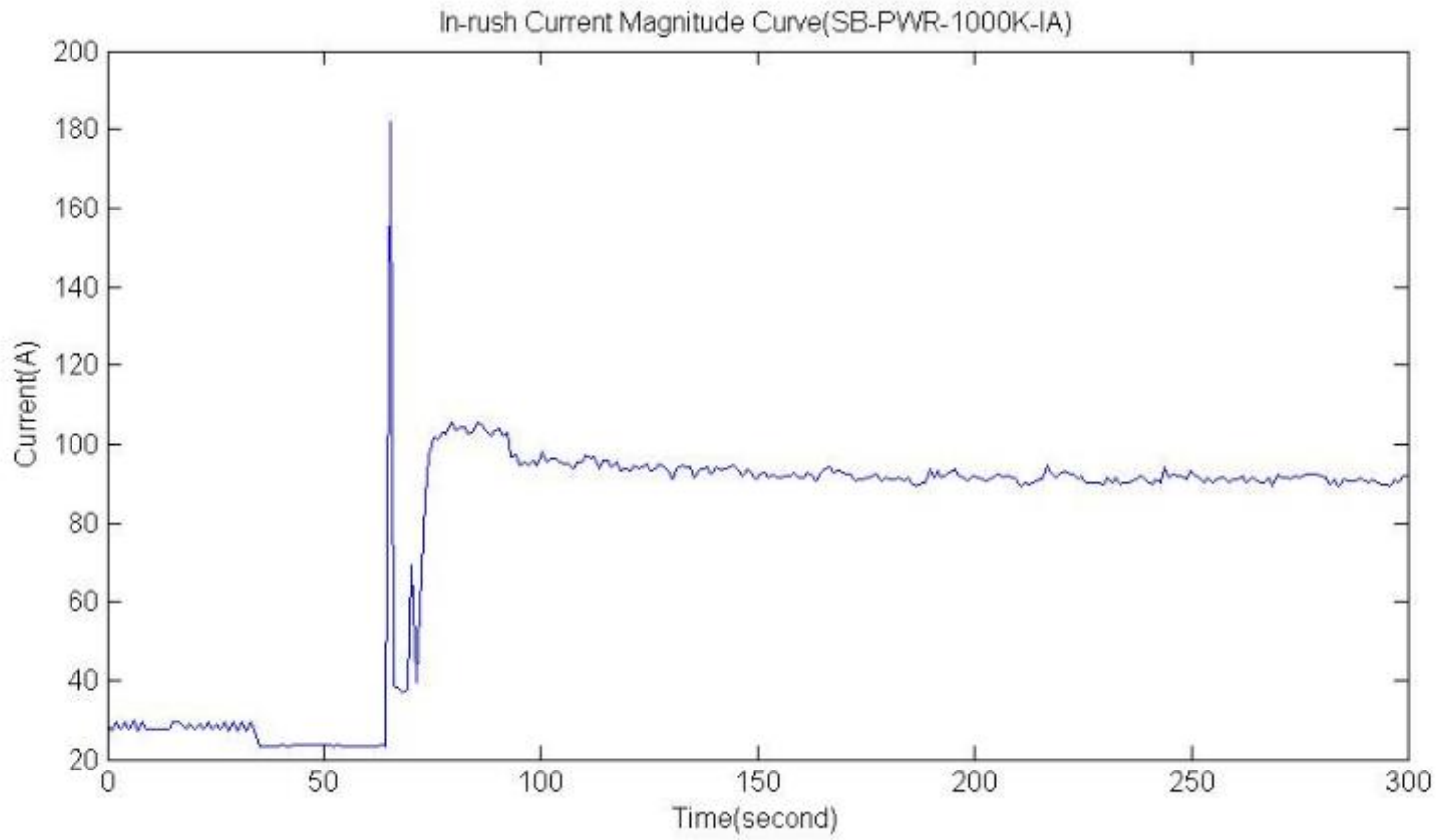
Island Test: Stuart 480V Transf.



6:19 AM

6:22 AM

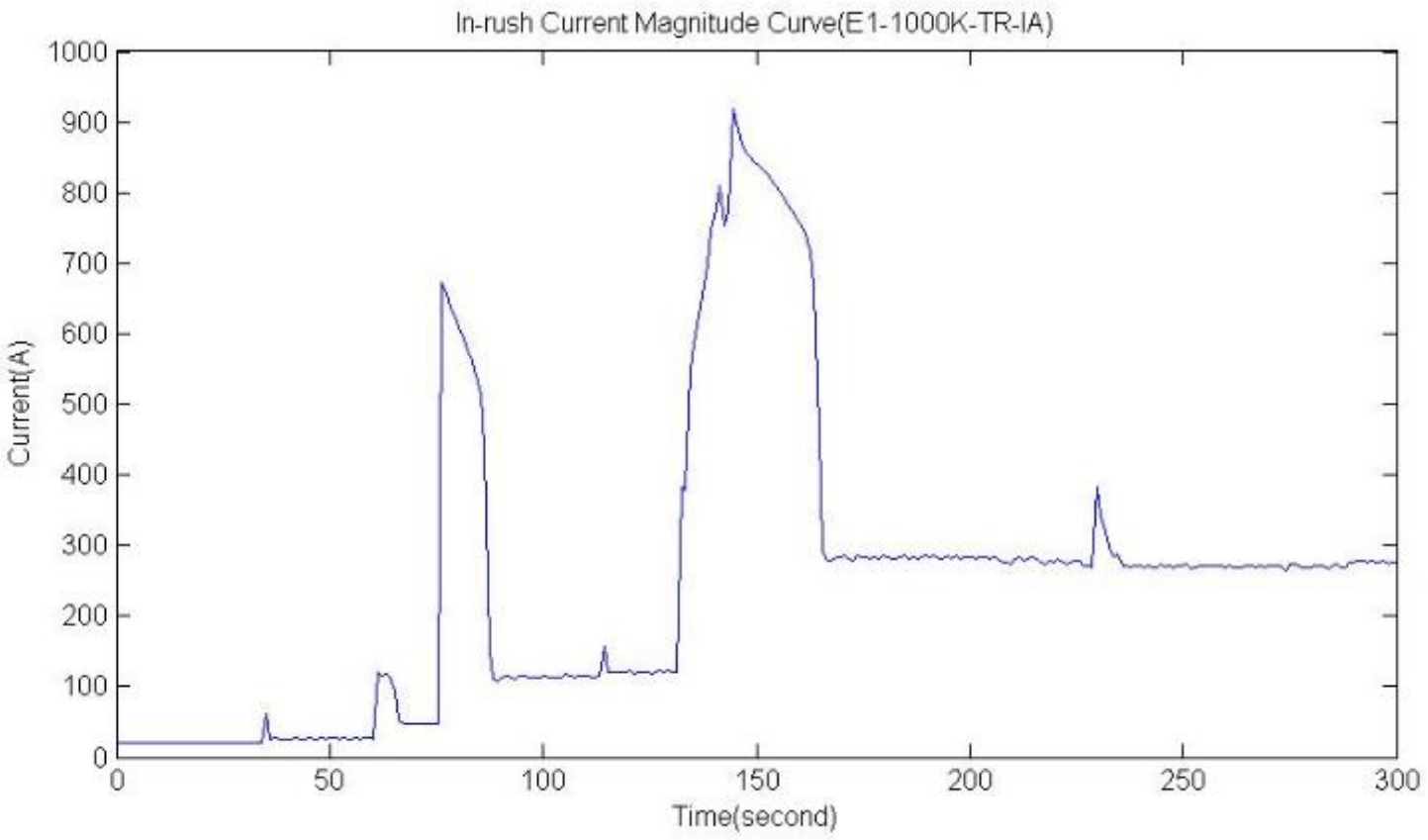
Island Test: Stuart 480V Transf.



6:28 AM

6:33 AM

Island Test: E1 480V Transformer



6:27 AM

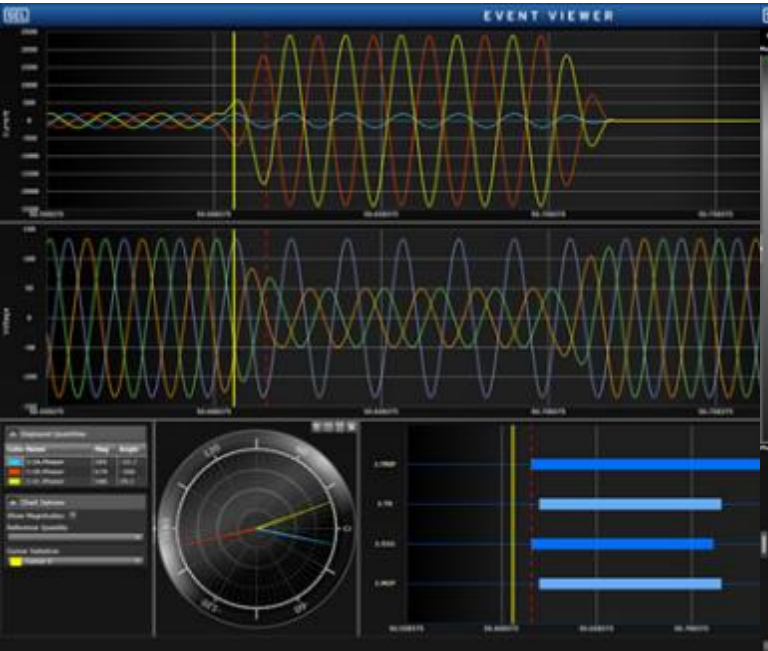
6:32 AM

DOE SERT Project

- Analyzing synchrophasor data
  - IIT Microgrid: 4kV cable network, 60 samples/sec
  - Naperville: 34.5 kV distribution, 2 samples/sec
  - ComEd: 345 kV transmission, 30 samples/sec
- Event detection for voltage and power
- Oscillation detection
- Model validation

SEL Equipment

- 351 relays, AMS, clock, PDC, SynchroWAVe Central

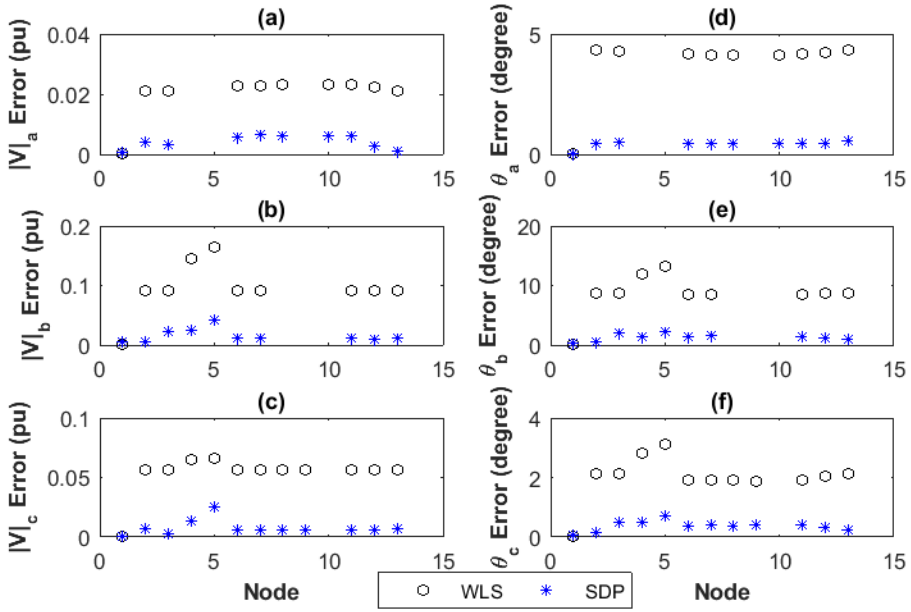


Education

- Short course – Introduction to
  - Metrology
  - Instrument transformers
  - A/D conversion
  - Synchrophasor estimation
  - IEEE C37.118
  - PMU hardware
  - Synchrophasor applications

Distribution State Estimation

- Semi-definite programming (SDP)
- Promising filter against bad data
  - IEEE 13 node feeder with bad power measurement



Naperville 34 kV Substation Tour

Got synchrophasors?

We are ready to help you explore your data.
Please contact me: flueck@iit.edu