Power Systems/High Voltage/Controls Emphasis Area

Teaching/Research Activities

New Graduate Student Orientation

August 14, 2020

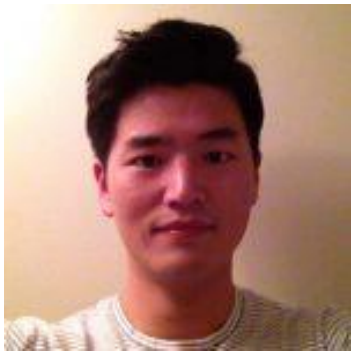
Power Systems/ High Voltage/ Controls

Dr. Randy Follett
Associate Professor

Dr. Yong Fu
Professor

Dr. Masoud Karimi
Associate Professor

Dr. Seungdeog Choi
Associate Professor



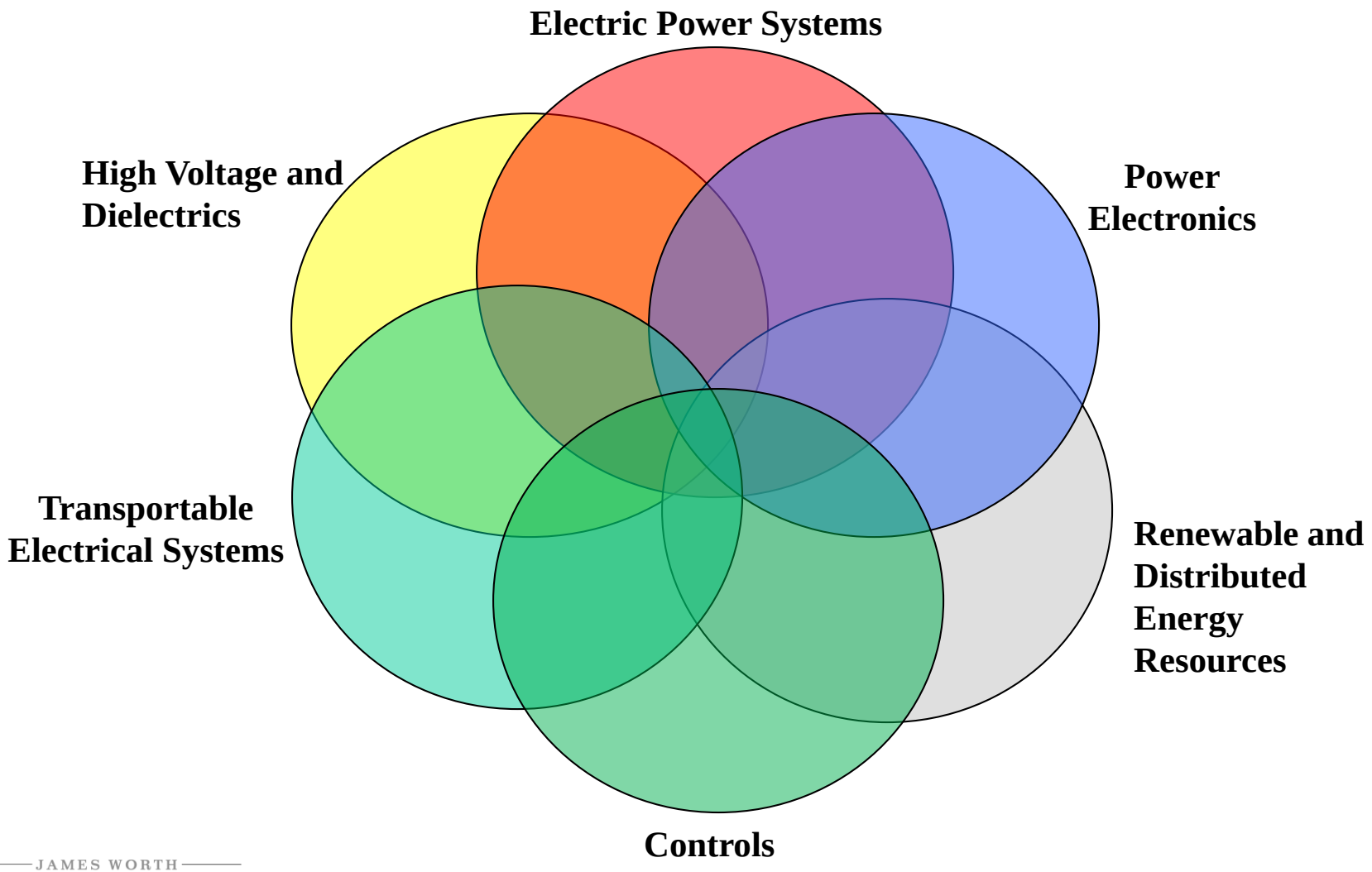
Dr. Chanyeop Park
Assistant Professor

Dr. Junbo Zhao
Assistant Professor

Dr. David Wallace
Manager, HV Lab

Power Systems/ High Voltage/ Controls

Areas of Expertise



Recent Research Activities and Interactions with Federal Agencies, Utilities, and Industry

Federal Agencies

Office of Naval Research, Electric Ship

NSF

DoD, Radar Power

Homeland Security

DoE –OE, EERE

National Labs: ORNL, PNNL, LLNL, ANL and NREL

Industries

ABB **Kuhlman** **GE**

Calvert **Maysteel** **Turner Electric**

Exxon Chevron Siemens Altech

Schweitzer Westinghouse **Alstom**

Kimberly-Clark DuPont Cooper

Thomson Consumer Electronics

EnerNex

Utilities

TVA **Entergy**

Southern Company **PG&E**

Consumers Energy

Alabama P&L

Mississippi Power

PacifiCorp ISO-New England

Eversource Energy

Coursework related
Power Systems/High Voltage/Controls

Split-Level Courses 4000/6000

- ECE 4323/6323 - Electromagnetic Compatibility
- ECE 4613/6613 - Power Transmission Systems
- ECE 4633/6633 - Power Distribution Systems
- ECE 4643/6643 - Power Systems Relaying and Control
- ECE 4653/6653 - Introduction to Power Electronics
- ECE 4663/6663 - Insulation Coordination in Electric Power Systems
- ECE 4673/6673 - Fundamentals of High Voltage Engineering
- ECE 4913/6913 - Feedback Control Systems I
- ECE 4923/6923 - Feedback Control Systems II
- ECE 4933/6933 - State Space Design and Instrumentation

Coursework related
Power Systems/High Voltage/Controls

Graduate-Level Courses 8000

- ECE 8623 - Stability and Control of Power Systems
- ECE 8633 – Control of DER Systems
- ECE 8663 - High Voltage Engineering
- ECE 8683 - Power System Operations and Control
- ECE 8693 - Power Systems Seminar
- ECE 8923 - Nonlinear Control Systems
- ECE 8933 - Random Processes in Automatic Control
- ECE 8943 - Optimal Control of Dynamic Systems
- ECE 8963 - Digital Control Systems
- ECE 8990 - Special Topics: High Voltage Measurement Techniques
- ECE 8990 - Special Topics: Advanced Power Electronics
- ECE 8990 - Special Topics: Smart Grid
- ECE 8990 - Special Topics: Renewable Energy Integration
- ECE 8990 - Special Topics: Power Quality
- ECE 8990 - Special Topics: Power System Economics and Deregulation
- ECE 8990 - Special Topics: Computational Methods for Power System Analysis

Graduate-Level Courses Offered in Fall 2020

- ECE 6613 Power Transmission Systems (Dr. Yong Fu)
- ECE 6663 Insulation Coordination in Electric Power Sys (Dr. Chanyeop Park)
- ECE 6643 Power Systems Relaying and Control (Dr. David Wallace)
- ECE 6913 Feedback Control System I (Dr. Masoud Karimi)
- ECE 6943 Automation, Data Acquisition, and PLCs (Dr. Randy Follett)
- ECE 8623 Stability and Control of Power Systems (Dr. Junbo Zhao)
- ECE 8943 Optimal Control Systems (Dr. Masoud Karimi)
- ECE 8990 Power System Economics and Deregulation (Dr. Yong Fu)

- **Seek permission from the faculty advisor**
  - ECE 8000 Research/Thesis for MS Students
  - ECE 9000 Research/Diss. for PhD Students
  - ECE 7000 Direct Individual Study (DIS)

Research Activities

- **Electric Power Systems**
  - Power system **optimization and economics**
  - Power system **dynamics and stability**
  - **Wide area monitoring and control** of power system
  - **Integration of renewable energy** into the power grid
  - Development of **smart-grid** for electric power systems
  - **Synchrophasors, State estimation, Cyber security**
  - **Machine learning** and data analytics for smart grid
- **Control of Power Electronic Converters**
  - **Multi-functional** power electronic converter systems
  - **Modeling, Design and Control of DERs** (PV, Wind, Battery etc.)
  - **Microgrids**: modeling controls, dc/ac hybridization
  - **Nonlinear, Robust, Multivariable and Optimal** Controls
  - Advanced Signal Processing, Phase-locked loops

Research Activities

- **Power Electronics**
  - **Reliability of power electronics** system: Online condition monitoring, degradation modeling, EMI modeling, design, and intelligent control of next generation power electronics system in various micro grids
  - Design of high reliability, high efficiency, high power density, and high-speed **electric machine and drive system in transportation application**
  - Game changing designs and applications of emerging **wide-band gap device** (GaN and SiC power switches) in wider power electronics systems
  - **AI/ML application** to power electronics for intelligent and autonomous operation
- **High Voltage and Dielectrics**
  - **DC Partial Discharge (PD) Detection** for MVDC systems
  - **Dielectric Material Development** for PD mitigation
  - **Lightning Tolerant Composites** for aircraft and wind turbine applications
  - Material based **Electromagnetic Interference (EMI) Reduction**
  - **Dielectric Material Aging** under high dv/dt and mixed mode electrical stresses

Research Activities

- **Automotive Electrical Systems**
  - Modeling and simulation of **hybrid vehicles**
  - **Control system** for hybrid vehicles
  - **Battery management** for hybrids
  - Evaluation of advanced alternator concepts
  - Power electronics circuit design and integration

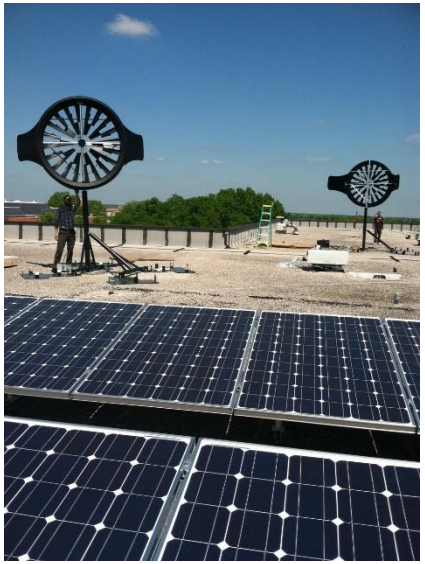
- **Electric-Ship Power Systems**
  - Reconfiguration and adaptive control of ship power systems
  - Impact of **distributed generation** on terrestrial and shipboard power systems
  - Feasibility of medium voltage dc for distribution

Power System Laboratory
Equipment and Hardware Resources – RTDS Lab

- 2 RTDS racks with PB5 processor and GT-WIF cards
- 2 SEL 351S Overcurrent Relays
- 1 SEL 421 Distance Relay/PMU
- 2 SEL 487B Differential Relays
- 1 SEL 330G Generator Relay
- SEL 2407 GPS clock
- SEL 3306 Synchrophasor Processor
- GE N60 Relay/PMU
- GE D60 Line Distance Protection Relay/PMU
- GE P30 Phasor Data Concentrator
- OMICRON 3-Phase Voltage&Current Amplifier
- MU-4000 Network Analyser
- Vision Smart Meter Demonstration Unit

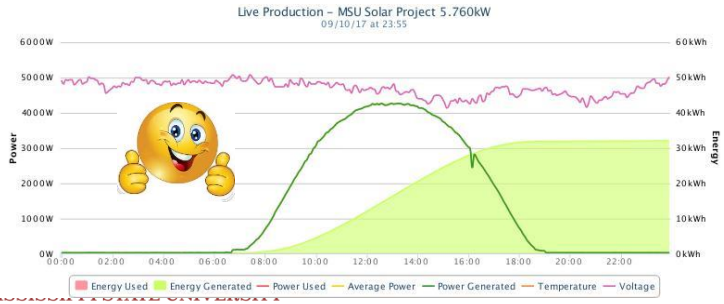
Real Time Digital Simulators (RTDS®) performs fully digital Electromagnetic Transient Power System Simulation in real time

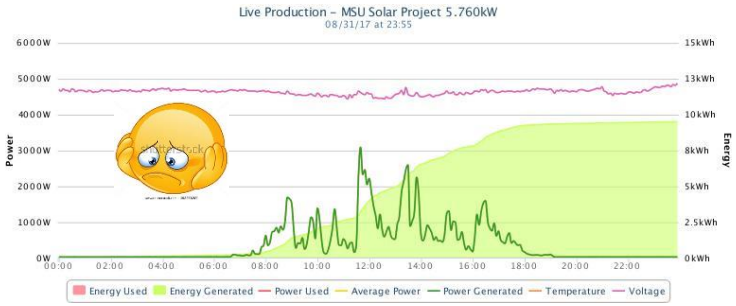
Power System Laboratory
Equipment and Hardware Resources – Renewables



- 2 1.5 kW Honeywell wind turbines
- Outback Grid-tied w/Battery back-up inverter
- 4 12V AGM batteries
- MATE3 Advanced System Display and Controller

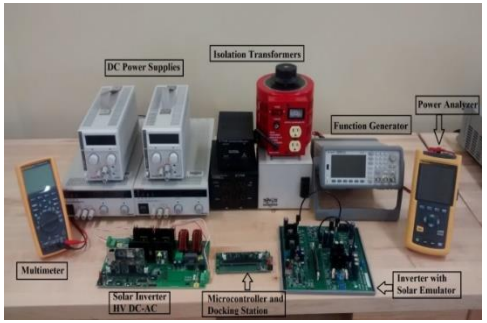
- 5.76 kW, 24 Sharp Solar, NU-U240F2, 240 Watt Monocrystalline PV Module
- SMA America, SB5000US (240V), 5000 Watt Grid Tied PV Inverter
- Sunny WebBox Web Enabled Data Logger & Control
- SMA Communication Card, RS-485 Module, SB RS 485-N

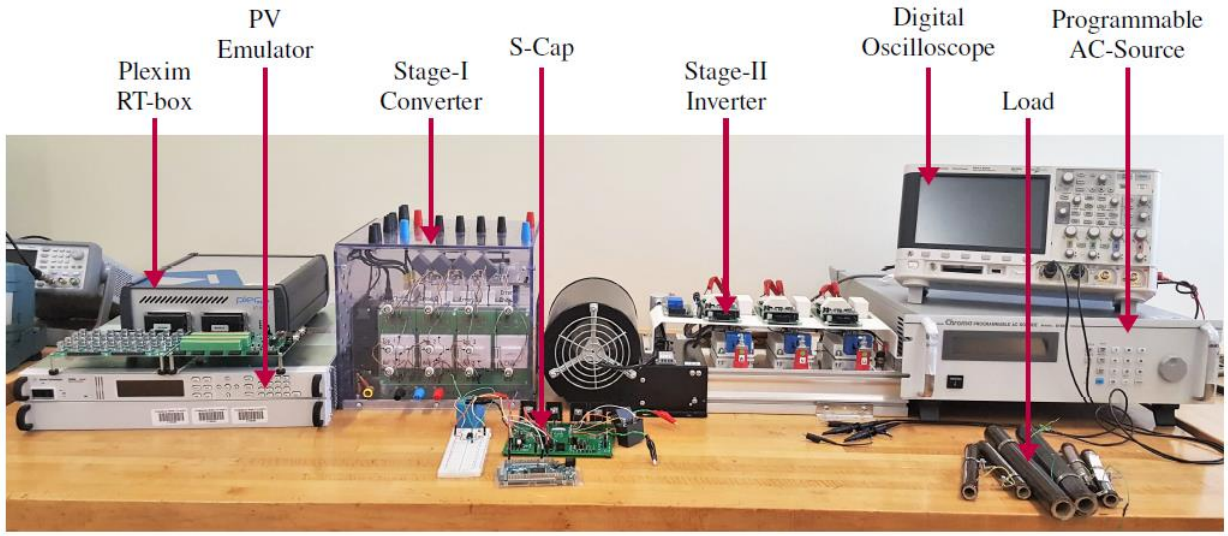




DER Controls Laboratory

- **State-of-the-art software tools** for simulation of power systems and power electronics.
- **Solar panel simulators** to emulate solar panels at different operating conditions.
- **Plexim RT-Box** for real-time simulation of power electronics and HIL testing
- **AC and DC power supplies**
- **Programmable electronic load** to realize various loads (resistive, inductive, capacitive, nonlinear).
- Oscilloscopes, function generator, power quality analyzer, multi-meters, voltage/current probes, etc.

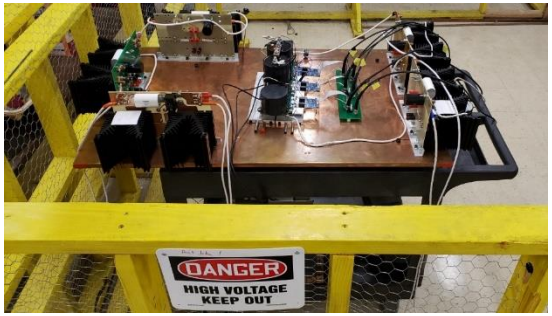


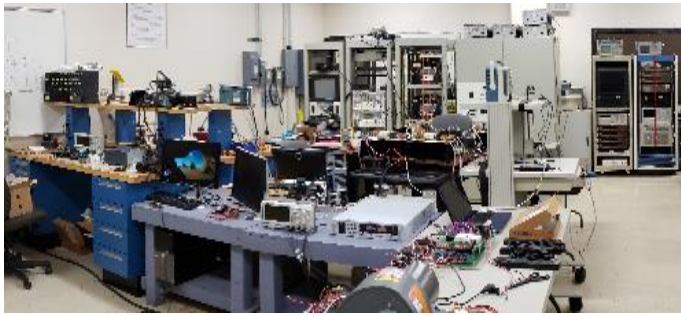


Power Electronics Laboratory

Power Electronics and Energy System

- Development of electro magnetic field (**EMI) modeling and mitigation techniques** in emerging electrified **transportation systems**.
- **Design and control of electrified propulsion systems** (machine, power converters, and battery) using emerging wide bandgap power switches.
- Design of **wireless power charging systems** for vehicle, train, aircraft, drones, truck, etc.
- **ML/AI applications** to power electronics and energy systems for intelligent and autonomous operations.





JAMES WORTH BAGLEY COLLEGE OF ENGINEERING
MISSISSIPPI STATE UNIVERSITY

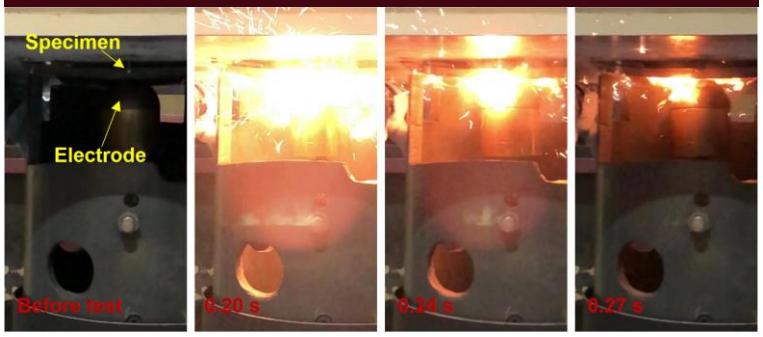
Figs. (Left to right) (i) propulsion machine prototypes, (ii) medium voltage CM EMI testbed, and (ii) picture of power electronics lab.

High Voltage Laboratory

Largest university-operated high voltage lab in North America

1 MV 1MVA AC / 3 MV Lightning Impulse

250 kA 400 kJ Lightning Impulse Generator

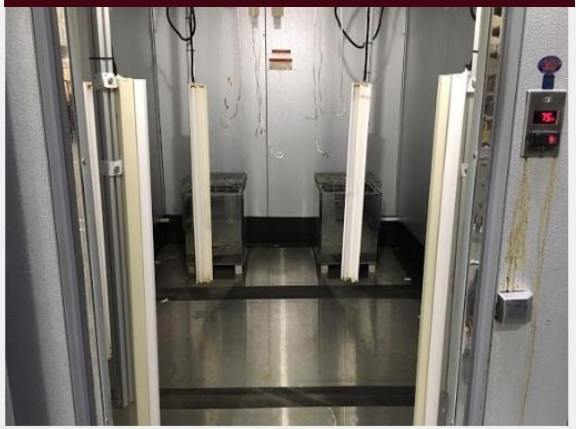


Oven

Tracking / Erosion

Breakdown / Partial Discharge

Salt Fog / UV / HT Chambers

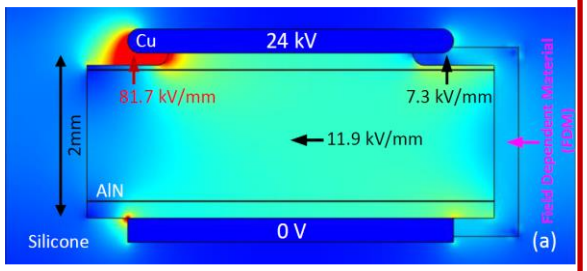


High/Low Temp.

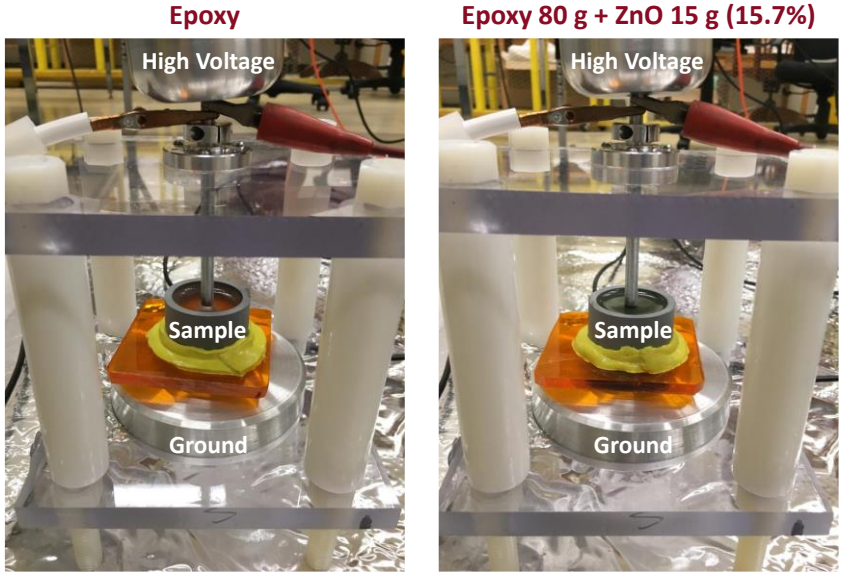
High Voltage Laboratory

Dielectric Material Development / PD Measurement

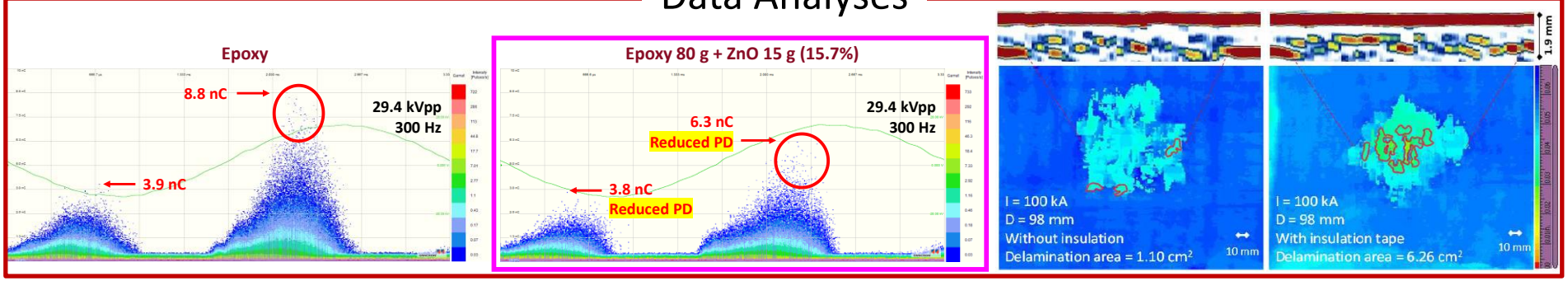
Modeling



Fabrication / Experiment



Data Analyses



Contacts

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• Dr. Junbo Zhao	5-3912, Simrall-405	junbo@ece.msstate.edu
• Dr. David Wallace	5-2009, Simrall-111	david@ece.misstate.edu