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UNIVERSITY OF WISCONSIN–MADISON

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Research Project: Development of a pulsed high-temperature superconducting electromagnetic energy storage device for naval applications

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Motivation

- The U.S. Navy is seeking to replace existing capacitor banks aboard ships with a smaller, more reliable energy storage devices
- The final design must store up to 3 megajoules of energy, and discharge it in less than 1 second
- We are developing a large superconducting electromagnet designed to meet these performance requirements

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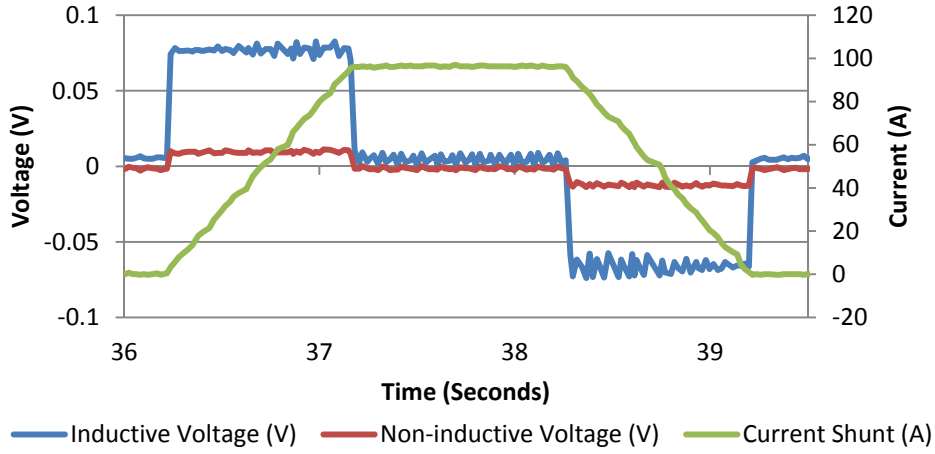
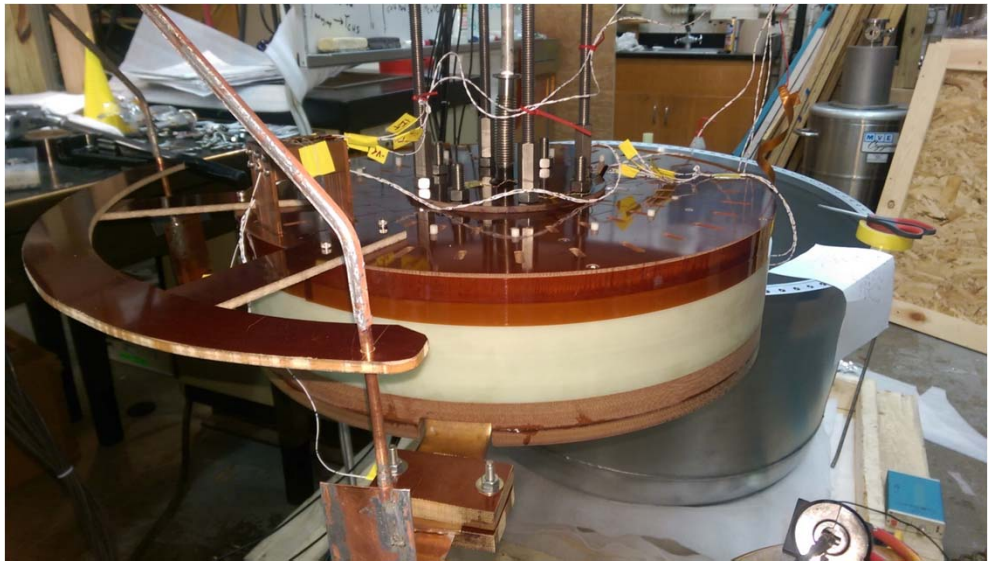
Electromagnet

- Large amounts of energy storage in an electromagnet requires high electric current
- High current results in significant heat generation
- Using superconductor for the magnet windings eliminates resistive heating that would otherwise destroy the magnet, allowing for much greater energy storage in the magnetic field due to higher current



Zero voltage (zero resistance) in superconductor during steady 100 amp current



Cooling System

- The superconductor must be cooled to cryogenic temperatures to remain superconducting (non-resistive) using a cryogenic helium gas refrigeration system
- The system incorporates a cryocooler, heat exchangers, recuperator, and compressor
- The electromagnet temperature is maintained at ~50 Kelvin