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Superconducting Magnet Energy Storage System with Direct Power Electronics Interface

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Project Team

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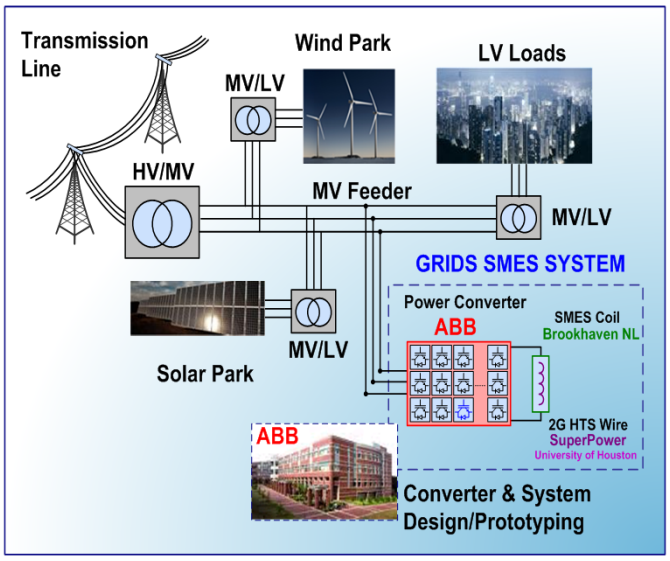
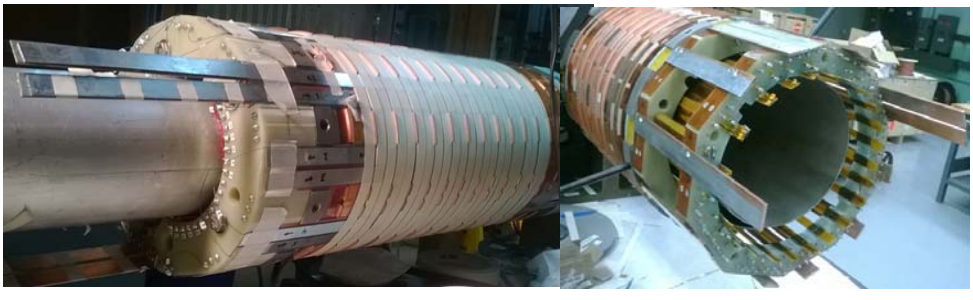


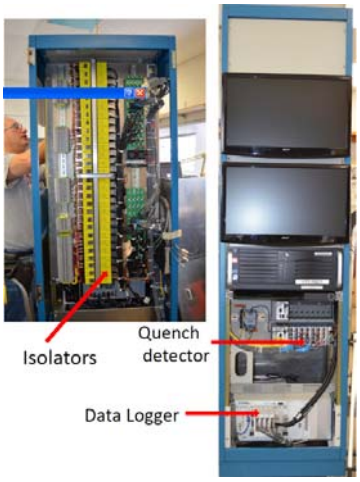
Tech Development Goal

- Competitive, fast response, grid-scale MWh superconducting magnet energy storage (SMES) system
- Demonstrated through a small scale prototype, (20 kW, 2.5 MJ) and direct connection power electronics converter (with Si-based devices)

Project Accomplishments

- State-of-the-art considerably advanced in the SMES System components – power electronics, magnet Coil, bypass/ persistence switch, 2G HTS wire manufacturing enhancements
- Full SMES system designed, built, and verification tested.
- Capabilities of new PA-MOCVD successfully demonstrated





SMES Magnet Coil Design and Testing

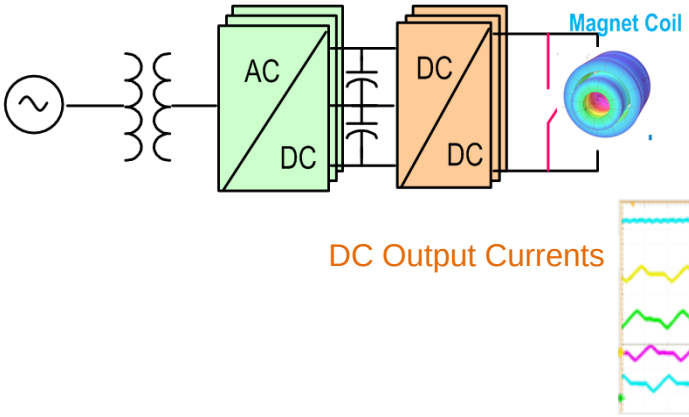
- Magnet designed for 700 amp, 25 T, 100 mm i.d.,1.7 MJ at 4 K
- Testing complete to 350 amp, 12.5 T at 27K – a record field for HTS magnet at such a high temperature (> 10 K)

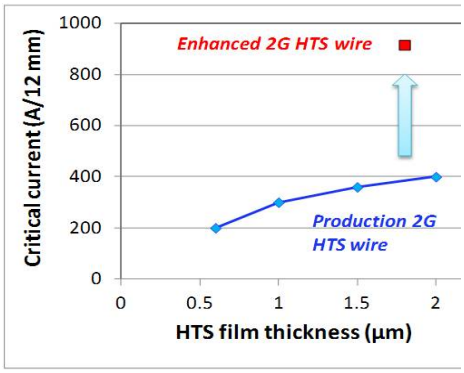
Quench Detection and Protection System

- Advanced quench protection system for HTS magnet built and successfully tested

SMES bypass switch

- Fast and efficient superconducting switch designed and tested successfully (77 K, > 600 A)
- Innovative SC switch concept; all solid-state electronics developed and tested as able to be scaled up for high off-resistance
- Demonstrated long-term (> 13 hrs) energy storage in SC coils at 77 K. Round trip efficiency > 99%





Power Electronics Interface

700 A dc output, 230 V_{ac} input, 15 kW max

- Development of a high efficiency (94.6%) high power-quality utility-scale AC/DC converter concept based on multiple parallel 3-Level interleaved converter channels suitable for SMES applications
- Design and construction of a low scale AC/DC 3-Level interleaved converter prototype based on three AC/DC and six DC/DC parallel channels
- Successful field demonstration of AC/DC 3-Level interleaved converter prototype on a 230V 3-phase grid and 600 A load current

Conductor Manufacturing and Process Modeling

- 2G HTS conductor deliveries complete (~ 9.2 km/12 mm)
- Achieved record-high single-pass critical current of 950 A / 12 mm in PA-MOCVD processed 2G-HTS sample
- Successful film deposition of (RE)BCO up to 2 µm; Achieved up to 5 µm thick film with no a-axis grains
- Increased precursor to film conversion efficiency by a factor of 2.5, which would lead to higher throughput and lower cost