NIST / DoE Workshop: Superconductor Price / Performance Improvements

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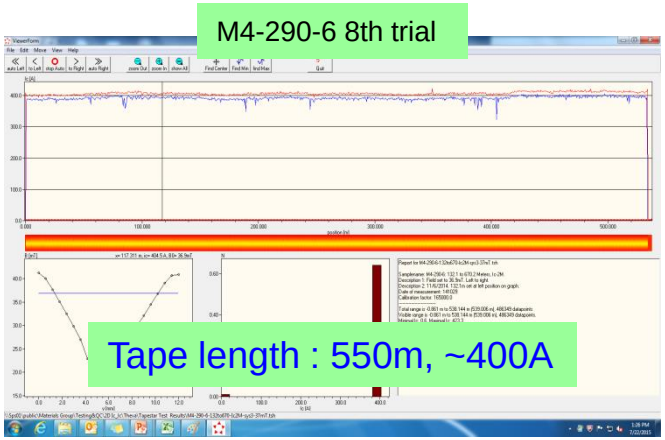
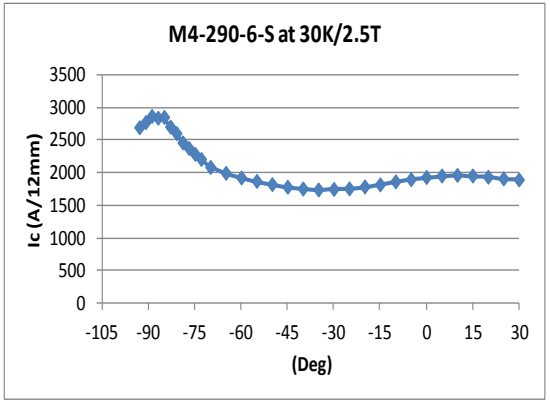
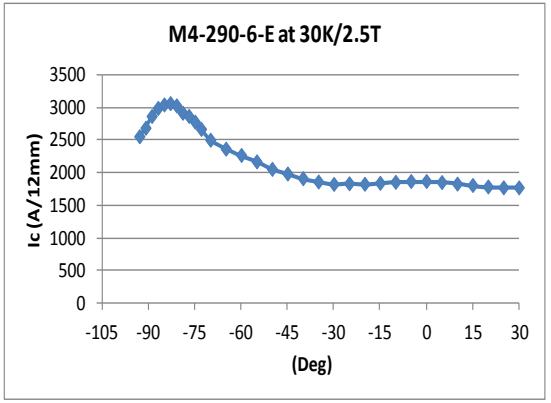
SuperPower Conductor Price/Performance

- The success of the ARPAE REACT project has laid the groundwork for future advancements towards commercialization of 2G HTS in critical energy related technologies.
  - ARPA-E funding enabled conductor improvements in Ic performance, increased single piece length output and improved lift factor.
  - R&D efforts now focused on improving the conductor production consistency while maintaining high Ic's and lift factors.
    - Multiple tapes with 15% Zr were produced with Ic levels above 1500A (30K, 2.5T) over 100+ meters







Piece samples from the long tape show an Ic of over 1700A at 30K/2.5T

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From the laboratory into manufacturing

- Developments at UH

15% Zr doping & process improvements	20%+ Zr doping & process improvements	Next step pinning & process improvements

- Implementation at SP

- Long (500m) length - 15% Zr demo leading to introduction to market	Samples - Long length - 20%+ Zr demo leading to introduction to market	Long length production - Incorporation of process improvements to standard mfg. practices, - next generation mfg. equipment

ARPAE REACT

FOLLOW ON EFFORT

Coupled with R&D improvements being proven at UH under Dr. Venkat Selvamanickam, a 4X improvement over 2012 baseline in conductor $ per kA-meter is expected by 2017 (30K, 2.5T)

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ARPA-e REACT – SuperPower Conductor Improvements

- Price / Performance results:
  - SuperPower believes that the following table remains true thru 2017.

Production conductor cost analysis	2012	2015	2016	2017
Base (12mm width)				
Ic (77K,sf) - A	300			
Price $/kA-m (77K,sf)	$384			
Ic (30K, 2.5T) after 2x standard lift factor	600			
Price at operating conditions (30K,2.5T) w/ 2x lift factor $/kA-m	$192			
Improvements				
Base Ic (77K,sf)		400	500	600
Price $/kA-m (77K,sf)		$288	$230	$192
Ic (30K,2.5T) after 4x REACT lift factor and base Ic improvement - Amps		1600	2000	2400
Price at operating conditions (30K,2.5T) – 4x lift factor - $/kA-m		$72	$58	$48

REACT ⟷

Higher manufacturing materials costs are expected to be offset by yield improvements and market pressure on price

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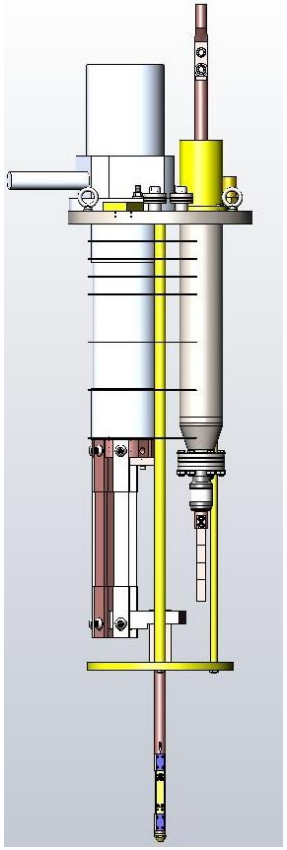
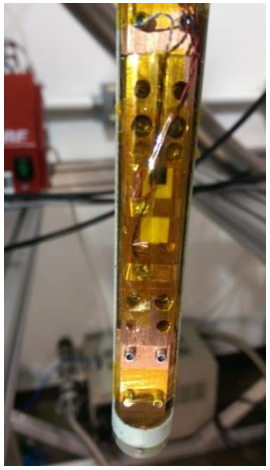
SuperPower Production Testing Advances

SuperPower has developed its own internal IcBT measurement system to support routine production of higher Zr content tapes targeted for 30K 2.5T operation. Recently upgraded to be able to measure routinely 30K-77K, 0-2.5T over ~150 degrees. Uses a 2G HTS background coil operated in LN2 at ~ 65K which can be rotated around the sample

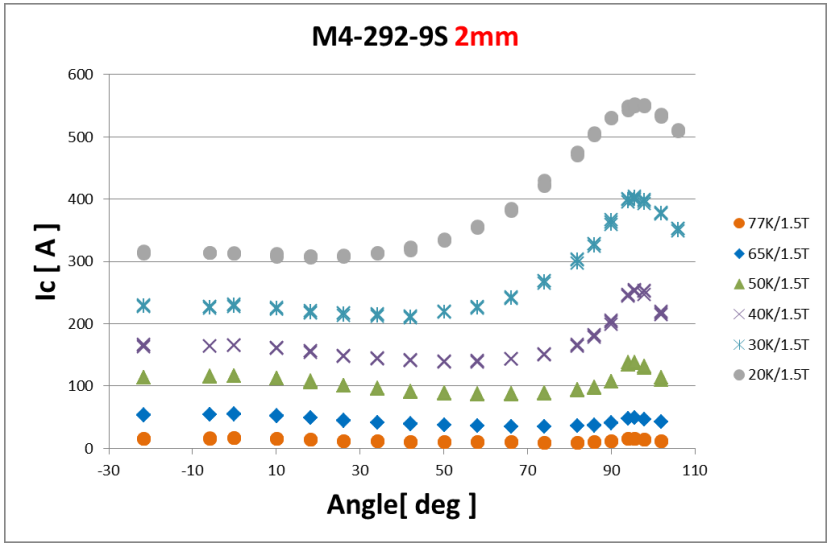


Cryocooled IcBT schematic



Sample holder

Rotatable split pair background magnet



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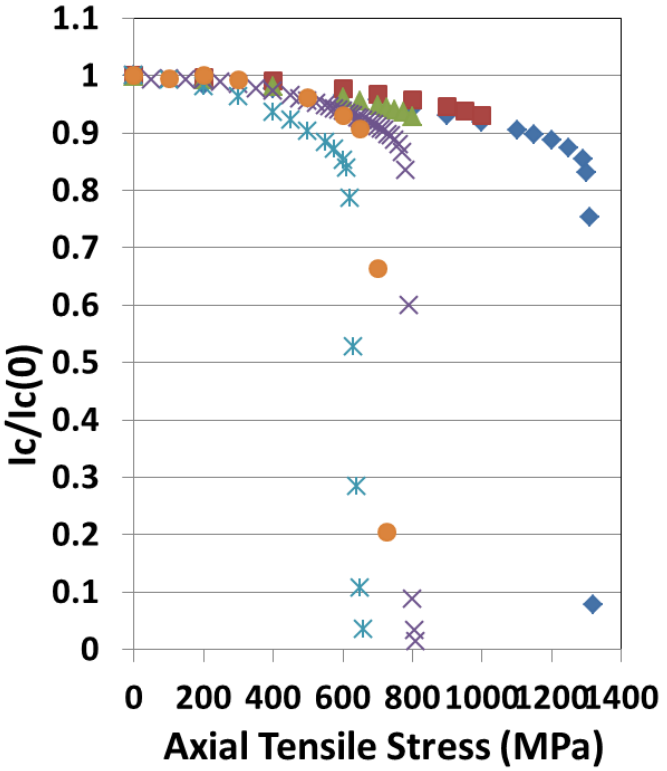
Studies on Mechanical / Electromechanical Properties

- Mechanical behaviors under various stress conditions at RT and/or 77K
- Electromechanical testing for stress (strain) dependence of Ic at 77K
- Electromechanical strength determined by critical stress with 95% Ic retention

Axial tensile
RT or 77K w/ Ic

Transverse tensile
Stud method
RT or 77K w/ Ic

Fixture for mechanical/electromechanical testing



Normalized Ic vs. axial tensile stress for

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THANK YOU

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