Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

$I_c(B,T)$ Fit and Other Conductor Related Input of Wires and Cables for EIC Magnets

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Overview

- Need for standardized $I_c(B,T)$ curves for each wire/cable of EIC magnets
  - Discussed it briefly during the last meeting. Everyone agrees to it.
- Data needed for the wire/cable (measurements/analytic/fit)
  - Basic fit to determine margin for each magnet (4.5 K and/or 1.92 K)
  - Higher temperature fit for quench simulation
  - Magnetization for persistent current calculations
  - Ramp rate effect: particularly in 6-around-1 cables (a) to make sure that there is no significant loss in margin or impact on field errors, and (b) impact on quench protection (advantages/disadvantages of making center wire copper)
- Places available for measuring above along with the cost/schedule
  - A list of the facilities (more can be out there)
  - We can divide work between different places
  - Some may be truncated/avoided for cost reasons with a little overall impact

A small sub-group will be formed to work on the technical details. Please let us know who can contribute? We should have first recommendation in a few months, to be be reported here.

Wire and Cable for Cable Magnets

- It seems that everyone is using the ROXIE file that I generated a few years ago.
- This (Bottura fit) is based on the cable used in the inner layer of LHC main dipole - only scaled for the I_c. Cables are the same except for the keystone angles (2).
- We should draw benefit from the LHC experience.
- Initial parameters are sufficient for margin calculations (small differences are not critical because of the healthy margin in the magnets).
- These curves must be regularly updated and shared, first based on specifications and then based on the measurements.
- Ye Bai has some on the wire (strand) at 4.2 K measurements at Florida.
- We need to discuss measurements and scaling to 1.92 K.
- Measurements at higher temperature for quench simulation?
- Magnetization measurements for persistent-current induced field errors. FSU, OSU, Fermilab? Cost doesn't seem too high (~$10k).
- Ramp rate measurements on wire? Are they critical for EIC magnets?
- Given the large margin, do we need cable measurements to determine degradation in going from wire to cable ($$$expensive$$$)?

Wire and Cable for Direct Wind Magnets

- Direct wind cable situation is tricky.
- First, we have a lot of experimental data (problem of too many).
- They have different performances.
- Good part is that the cable has lower current.
- We have measurements from FSU. Ye Bai is updating parameters for Bottura fit.
- We need to see impact of the central wire
  - Ramp rate dependence
  - Making central wire copper, etc.
  - Magnetization
  - Temperature dependence
  - a/c loss measurements

Backup Slides

Shown last time

Goals

- We need to come-up with standard I_c(B,T) curves for each wire and cable (including degradation) of EIC IR magnets. Once developed, everyone must use them.
- These curves should, as much as possible, be based on the measurements.
- Prior to (or in the absence of the complete set of) measurements, we should start with I_c(5T, 4.2K) or whatever used in the specification of the wire
  - ➢ Use fits to obtain critical current curves for other fields and temperatures
    - ❖ Keep updating them as more data from measurements become available
  - ➢ What are the best fitting parameters, will be the topic of future discussion
- We also need to determine what measurements needs to be done (critical current, magnetization, 4.2 K, 1.9 K, different wires, cable, degradation in cable, etc.)
- We have some measurements from FSU and more on the way. OSU has also offered some. What are the other options? We need measurements in the high current cables also.

A small sub-group will be formed to work on the technical details. Please let us know who can contribute? We should have first recommendation in a few months, to be be reported here.