Q1BpF Design for 4K Option

Ramesh Gupta
Superconducting Magnet Division

June 30, 2020
Overview

➢ Initial design studies of Q1BpF for a possible 4.2 K operation. Several cases examined but only one will be presented.

➢ Peak field (margin), field quality and field in the electron beam region are being optimized.

➢ The design consider several fronts - geometric, mechanical, magnetic design. Anis will continue on further optimization.

➢ Strand/wire used: dia =1.065 mm, Cu/Sc =1.3 (new) and 1.6.

➢ Cable: 19.4 mm wide (19.7 with insulation) with 36 strands, min thickness: 1.788 mm, max thickness: 2.012 mm (same as before).

➢ As mentioned during the last meeting, we will “try” to use this cable (and RHIC dipole type cable) for all EIC magnets.
Coil 2 Layers, Three wedges (2+1)
54 turns/pole (24 inner, 30 outer)

- Poles of inner and outer layers aligned
- Coil poles have proper angles for collaring
- Two wedges in the inner to deal with keystone

Coil radius: 93 mm  (Q2B had 140 mm)
A reasonably good field quality is obtained with a good mechanical design (coil radius 93 mm) (all harmonics <1 unit)

Gradient
66.2 T/m
at ~10 kA
Iron Yoke - Current Design

Yoke: $ir = \sim 150 \text{ mm;}$ or $550 \text{ mm (or 500 mm)}$
Hole@ $x = 288.3 \text{ mm to 312.5 mm}$
Radius of hole = 83 mm (63 mm for electron beam)
Collar width = $\sim 20 \text{ mm for 66.2 T/m}$
Field in the electron beam region

Yoke OR = 550 mm, Hole@288.3 mm
Initial Design. What is acceptable?
Field in the electron beam region
Yoke OR = 550 mm, Hole@288.3 mm

Tricks to reduce field. Use holes, special iron? What is acceptable?
Healthy Margin: 
~20% over 66.2 T/m at 4.2K
For Cu/Sc of 1.6 (83% on loadline)
Field Margin at 4.2 K

![Field Margin Diagram](image)
Temperature Margin at 4.2 K Over Different Blocks

Temperature margin (at Jop,Bop,Top)(K)

ROXIE 10.2

June 30, 2020

Q1BpF Design for 4K Option - Ramesh Gupta
Field Margin at 4.6 K, Cu/Sc = 1.3
Field Margin
at 4.6 K, Cu/Sc =1.3

13% Margin on the loadline
15% over the design field
Discussion

➢ Initial run indicates a possible solution for a 4.2 K operation (may not be yet fully acceptable)

➢ Field quality is good.

➢ Margin is marginal. Check with the machine physicist for some tweaking in the optics. Such interactions produce an overall optimized design for the machine, optimized for the budget and performance (not just for one component of the machine)

➢ What is the acceptable value of field in the electron beam region? Some tricks and use of special material may be able to reduce the field further.

➢ Peak field (margin) and field in the electron beam region are still being optimized.