Preliminary Study of Possibility of HTS Use in ILC Extraction Quadrupole

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Why HTS Super-ferric Magnets?

This presentation is not intended to cover this topic.

Basically we are trying to find out if there is a region where HTS medium field magnets can be competitive in terms of "cost of ownership (capital + operation)" as compared to "water cooled copper magnets" and/or super-ferric magnets made with convention "Low Temperature Superconductors (LTS)".

HTS magnets offer several other benefits as well.

- In case of RIA, HTS quadrupole for fragment separator region also turned out to be cheaper in cost as compared to water-cooled copper magnet. The original reason for choosing HTS was a better technical solution (higher gradient).
- HTS quad operating at ~30 K was preferred over LTS to remove large energy (15 kW in first quad) economically at ~30 K rather than at ~4 K.

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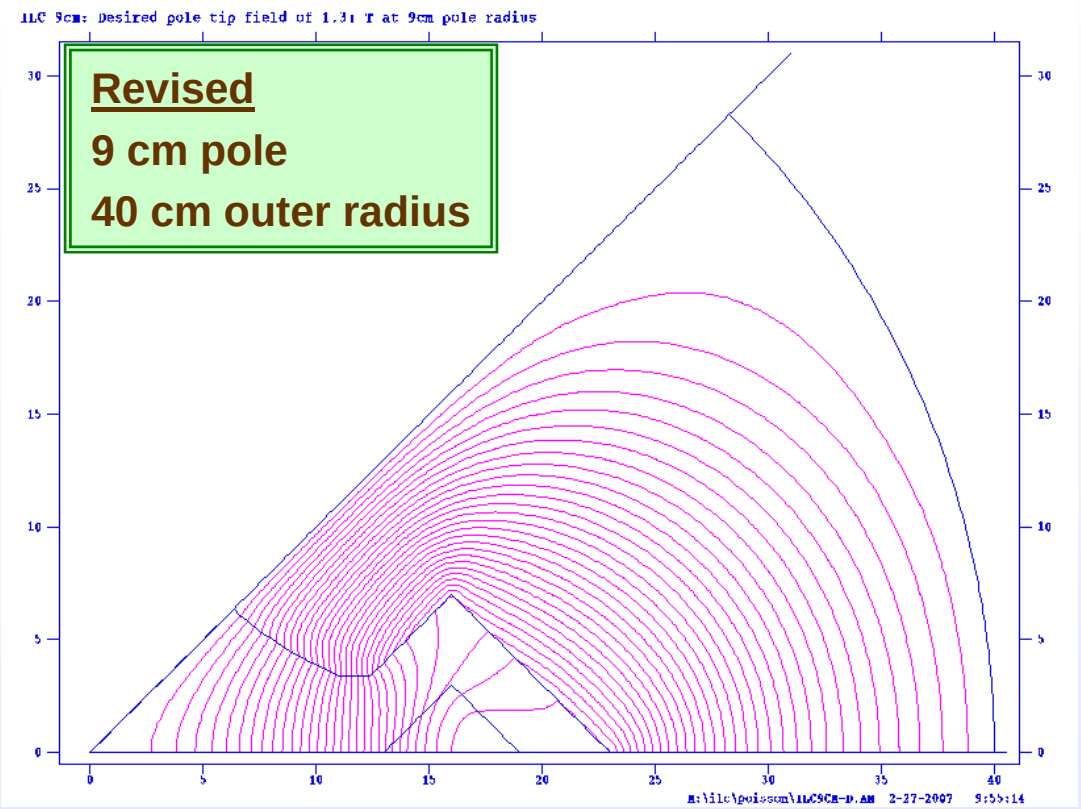
Preliminary Investigation of HTS Quadrupole for ILC (QFEX4B-4E)



Design goals of this investigation:

- Use 2nd generation HTS (YBCO).
- Operate at 65 K or above (use sub-cool nitrogen or cryo-coolers).
- Design with the conductor available today (improved performance would reduce conductor cost and coil size).
- Warm iron compact design with low fringe field (seems to meet ILC spec).

HTS magnets would be more compact plus energy efficient as compared to water cooled magnets; and would allow larger temperature excursions as compared to LTS magnets.

Basic design parameters (as per slac-pub-1159, updated by C. Spencer):

Good field radius = 85 mm; Gradient ~11.8 T/m

Above quad is designed for a minimum pole radius = 90 mm; Gradient = 13+ T/m

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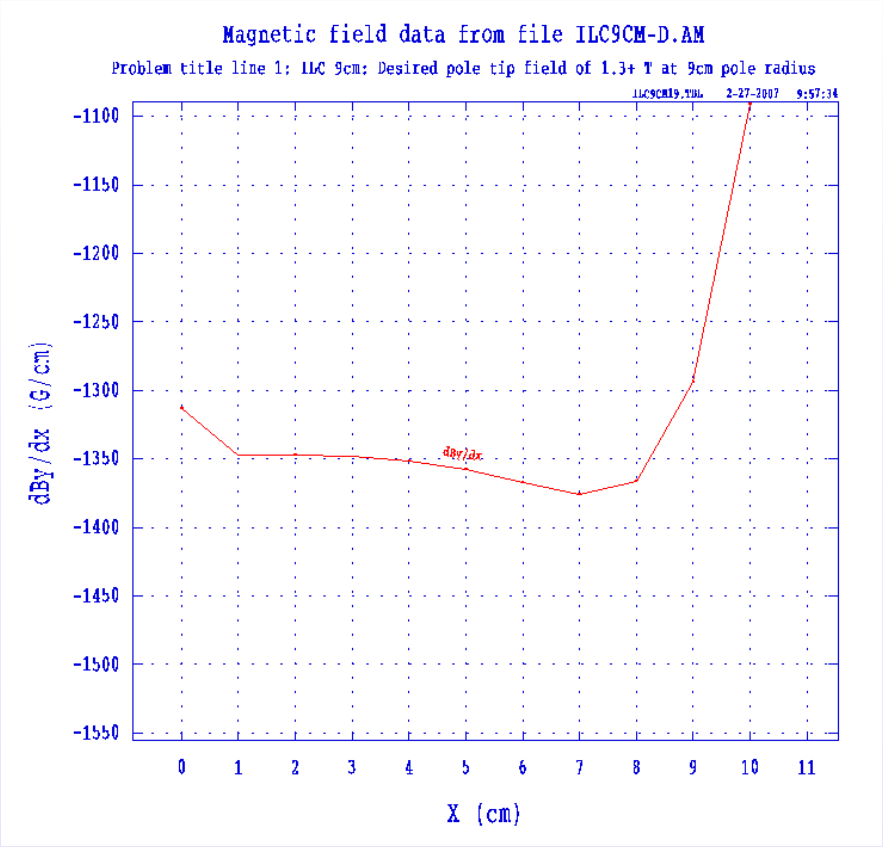
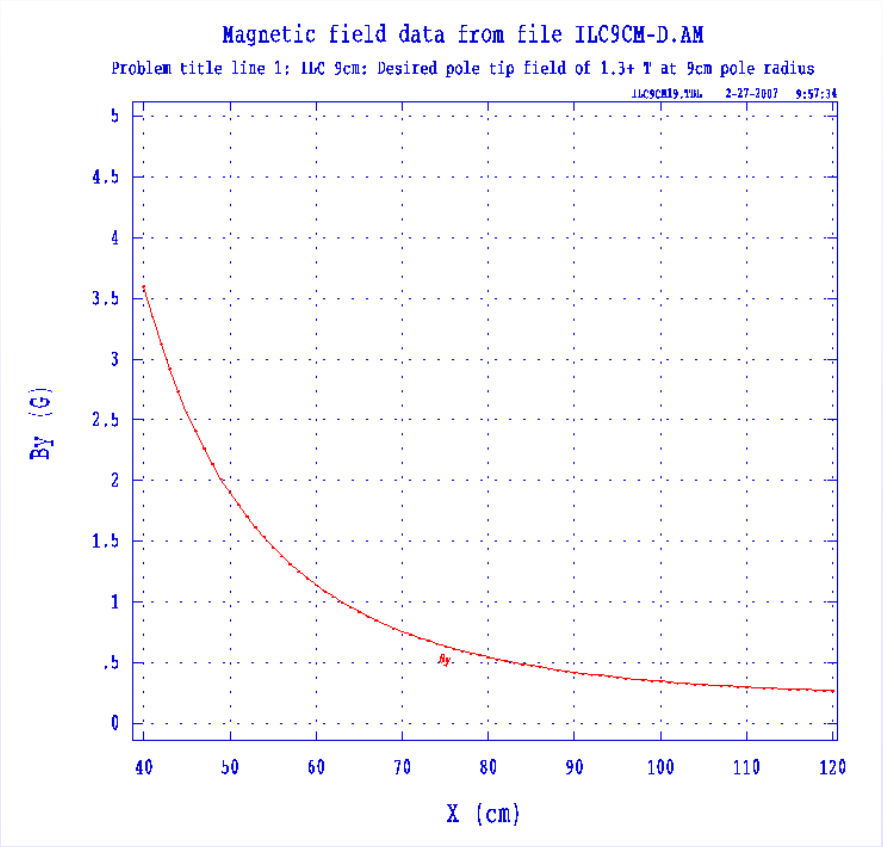
Preliminary Design

Not good to go in machine, but good enough for proof-of-principle

9 cm minimum pole radius, 13 T/m Gradient, 40 cm yoke outer radius



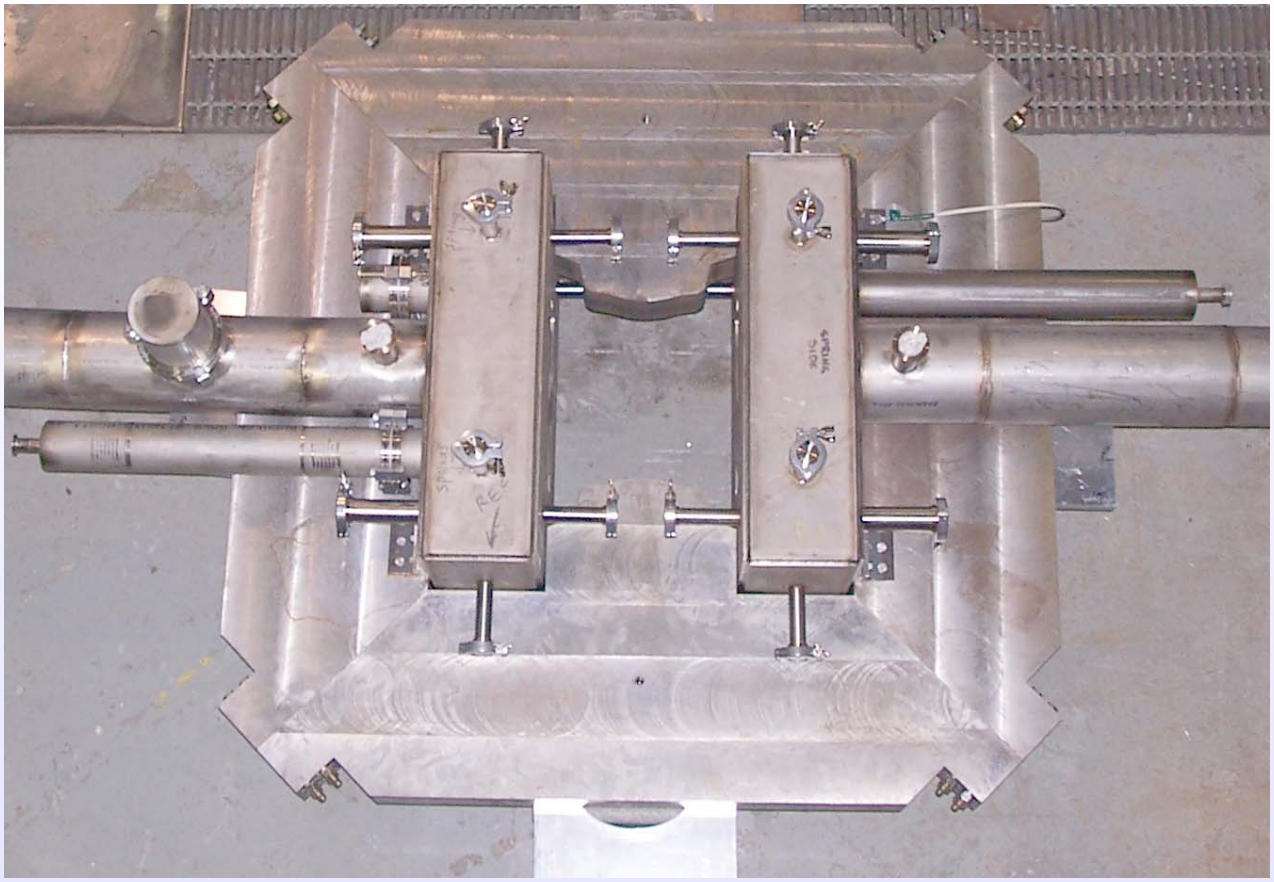
Gradient on axis (G/cm)



Fringe field (G) on X-axis

J_o = 50 A/mm^2

HTS Quadrupole For RIA



Recently we completed a successful testing HTS R&D quadrupole for RIA (Rare Isotope Accelerator)

The test also involved a 40+ minutes of stable operation at 30 K with a huge 25 W (5W/cm^3 or 5MW/m^3) heat load on coils.

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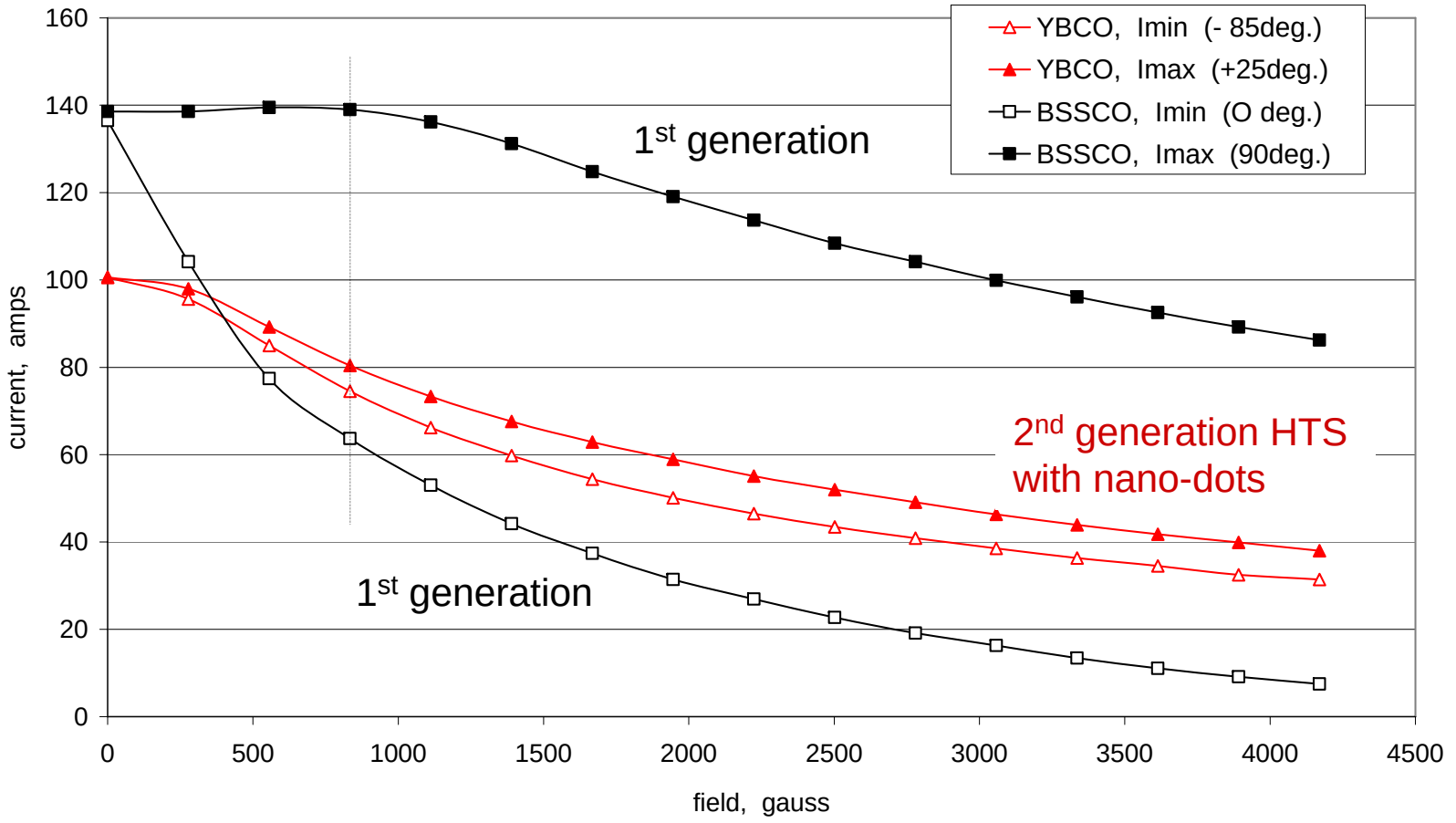
77 K Performance of First and Second Generation HTS from ASC



Conductor
w = 4.35 mm
t = 0.2 mm
(2nd generation)

Higher I_c at 65 K

Second generation HTS are new.

Expect a significant improvement in performance and reduction in cost