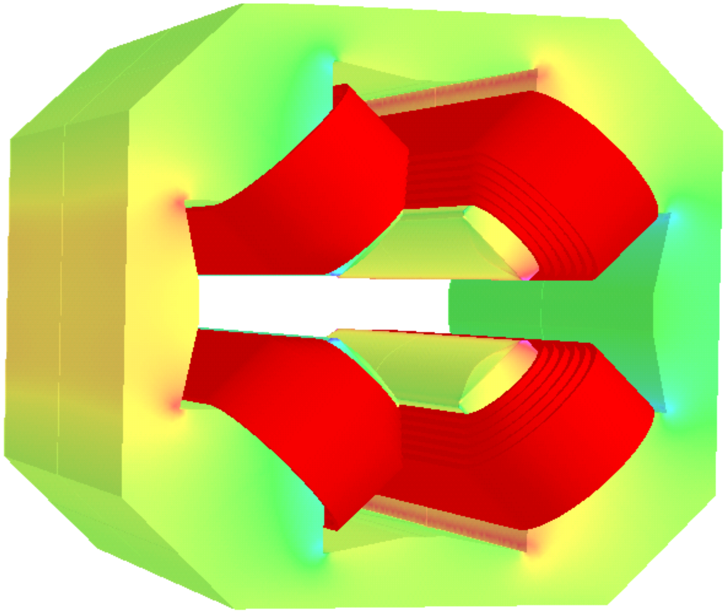
CORNELL UNIVERSITY LEPP
LABORATORY FOR ELEMENTARY-PARTICLE PHYSICS

J.A. Crittenden

Design for the Large-Aperture Quadrupole Magnet



I. Pole Design Algorithm

II. Design Performance

III. Coil Design, Power Supply and Control

IV. Summary

Pole Design Algorithm

I. Modify existing CESR 2D quadrupole magnet lamination layout

A. Redesign hyperbolic/flat pole tip shape to fit inside existing silhouette

1. Bore radius 4.0 cm $\Rightarrow$ 7.5 cm

2. Ensure beam pipe clearance

B. Adjust 2D model: field deviation $\lesssim \mathbf{3 \times 10^{-4}}$, satisfying original CESR specifications

C. Reproduce 2D field gradient uniformity result with 3D model on central transverse plane

II. Design end face bevel to restore field gradient uniformity for field integral

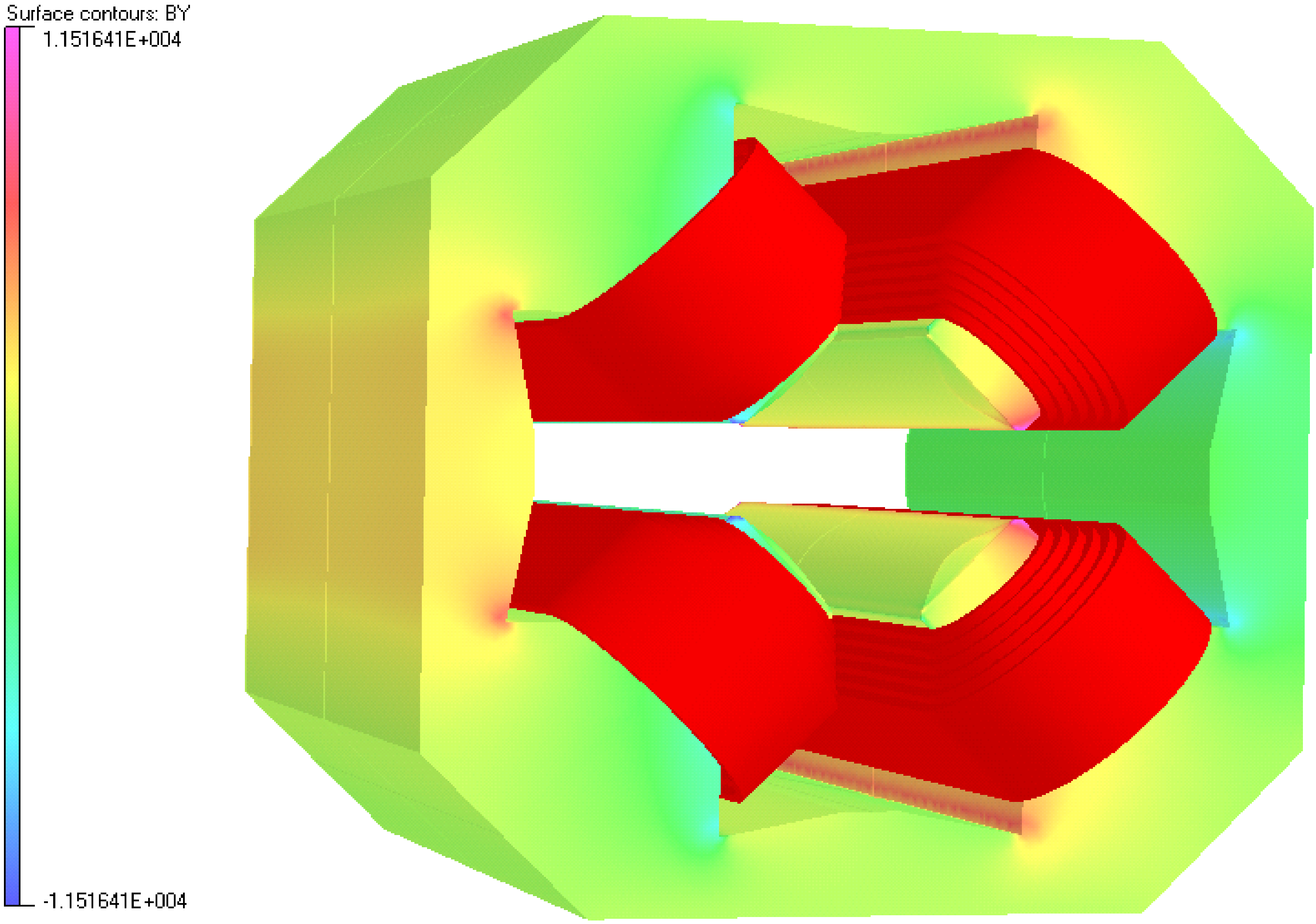
A. Cut back pole tip only as far as flat region of pole tip shape

B. Adjust bevel angle to obtain integrated field gradient uniformity $\lesssim \mathbf{3 \times 10^{-4}}$

C. Verify that this uniformity is preserved for excitations between 1.5 and 5.3 GeV

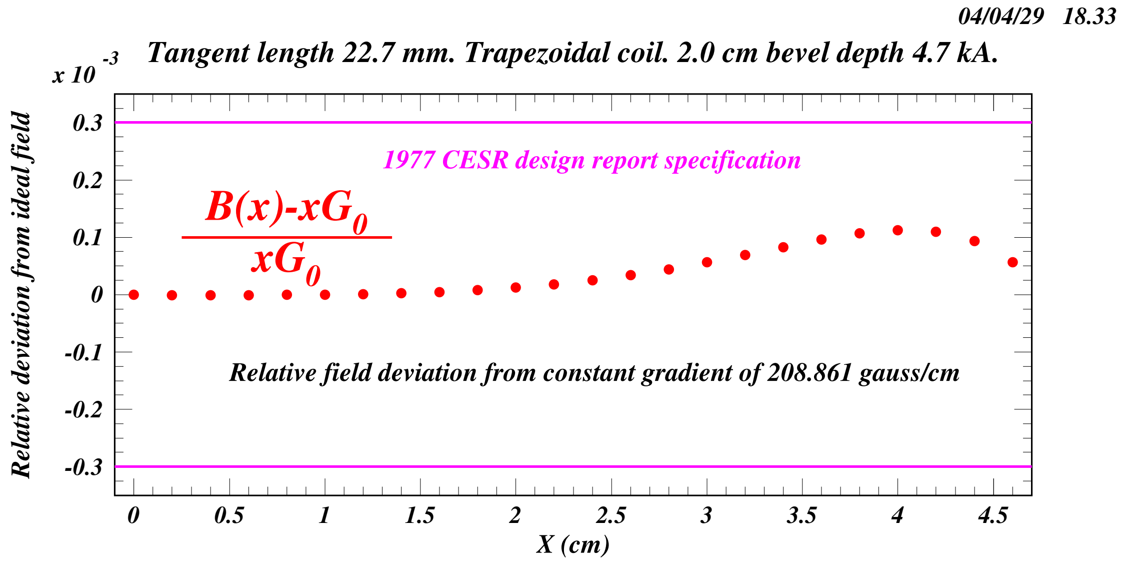
The model described here was designed for 1.88 GeV and checked at 5.3 GeV.

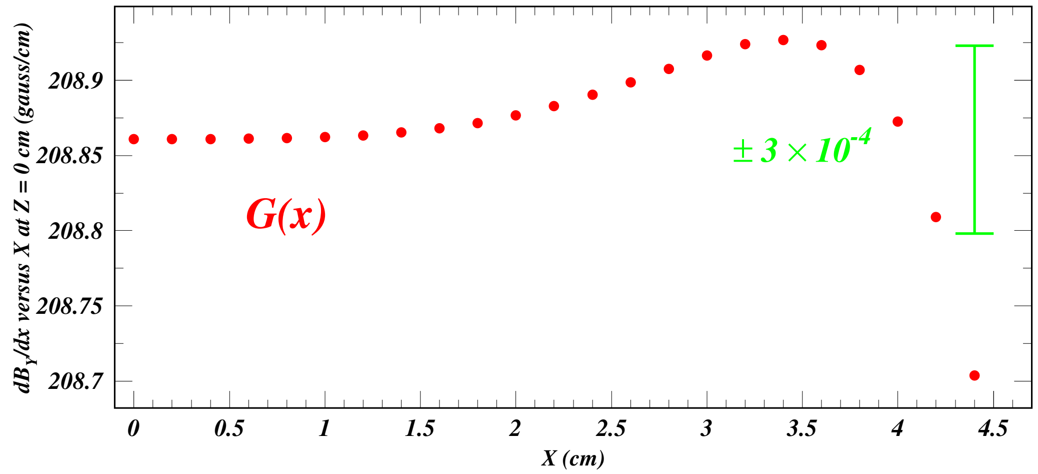
Current Design Status



Design Performance (I)

2D Field and Field Gradient Uniformity on Central Plane at 1.88 GeV

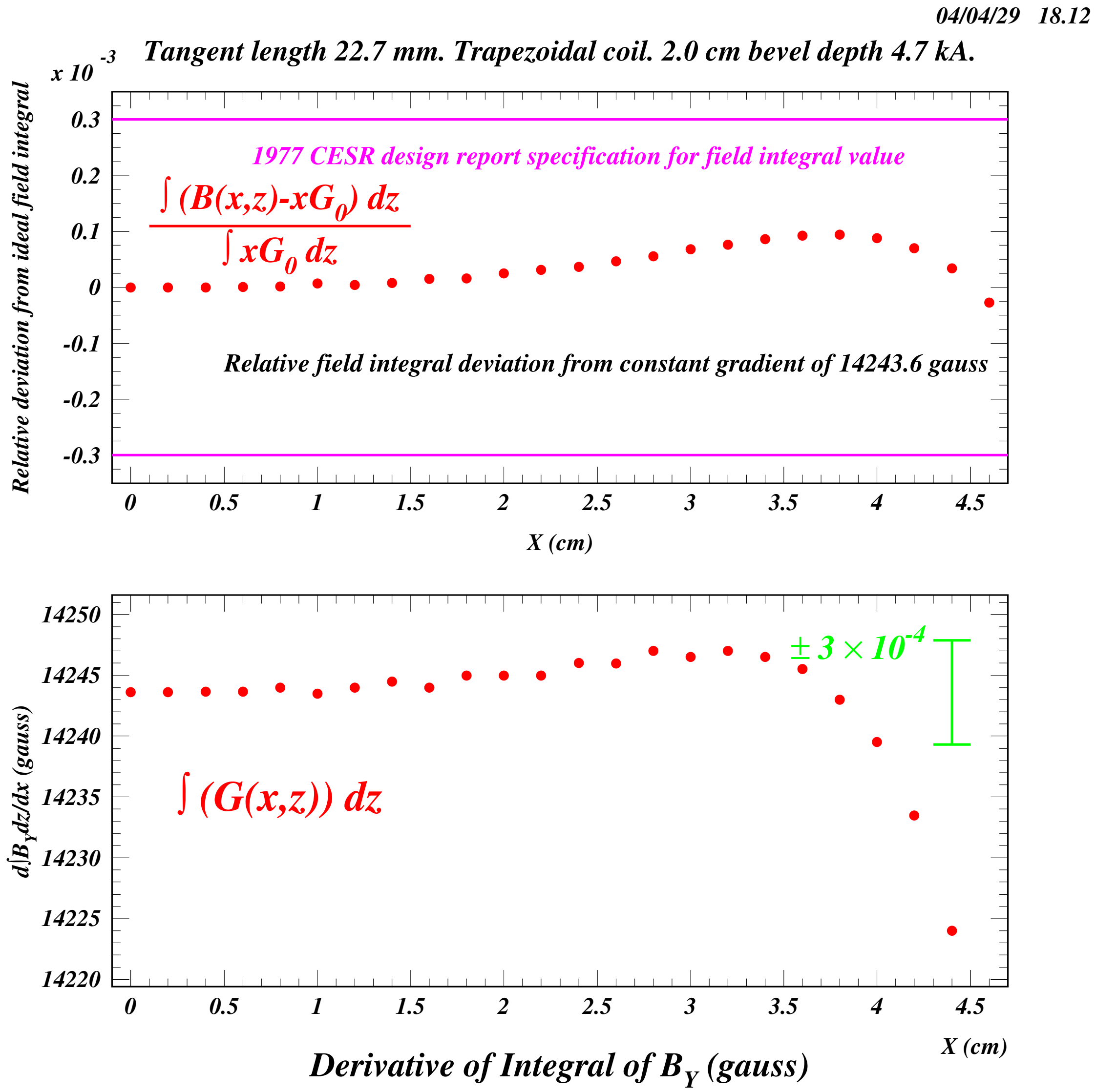




⇒ Central gradient uniformity at 4.7 kA: $\pm\ 3 \times 10^{-4}$ out to 4.2 cm

Design Performance (II)

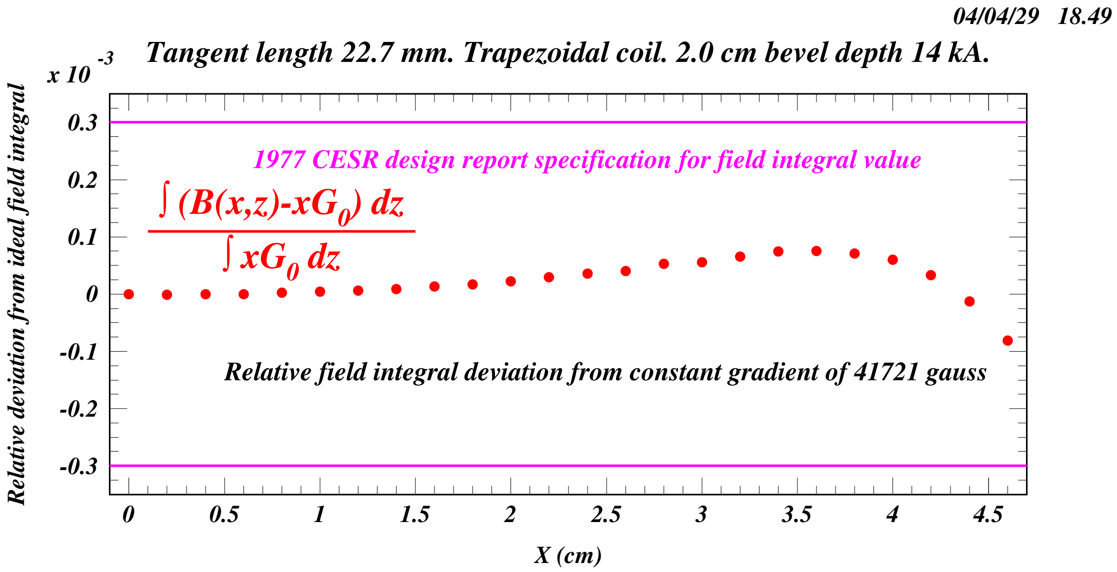
Longitudinally Integrated Field and Field Gradient Uniformity at 1.88 GeV

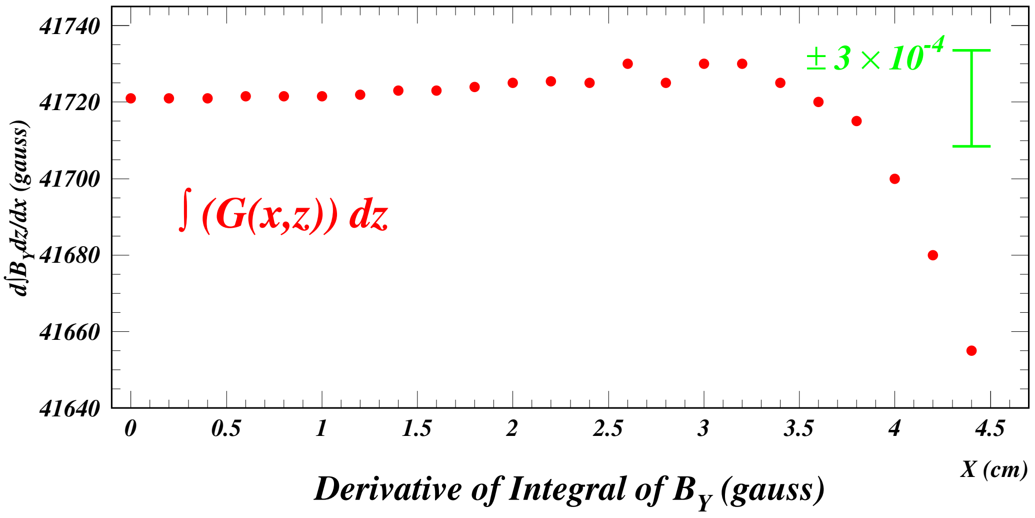


$\Rightarrow$ Integrated gradient uniformity at 4.7 kA: $\pm\ 3 \times 10^{-4}$ out to 4.0 cm

Design Performance (III)

Longitudinally Integrated Field and Field Gradient Uniformity at 5.3 GeV





$\Rightarrow$ Integrated gradient uniformity at 14 kA: $\pm\ 3 \times 10^{-4}$ out to 3.8 cm

Coil and Power Supply Design Parameters

Parameter	Value	
	1.88 GeV	5.33 GeV
Field Gradient	212 G/cm	600 G/cm
NI	4825 Amp-Turns	13600 Amp-Turns
Turns per coil	72	
Conductor	1/4" x 1/4" with square hole (0.04" wall)	
R_{coil}	0.066 Ω	
R_{magnet}	0.26 Ω	
Current	67 A	188 A
Magnet Voltage Drop	17.4 V	49 V
Power per coil	292 W	2.3 kW
Water flow@30 psi	0.31 Gal/min	
Coil temperature rise	3.5°C	28°C

Summary

⇒ **Design algorithm established**

⇒ **Model meeting design specifications exists**

⇒ **Some design refinements under consideration**

⇒ **On schedule for final design by May 28**