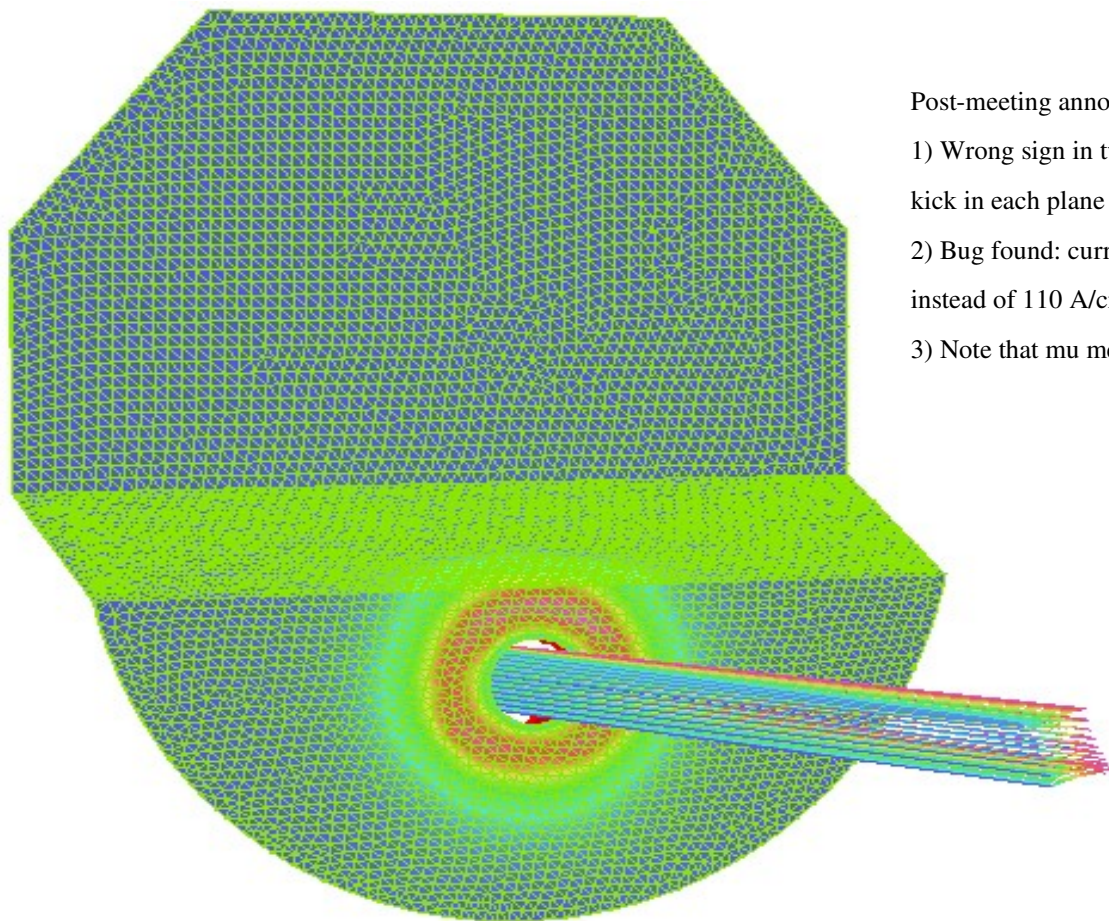




Initial Results from a 3D Magnetic Model of the Injector Cryomodule Entrance Shield

Jim Crittenden

ERL General Meeting, 2 April 2009

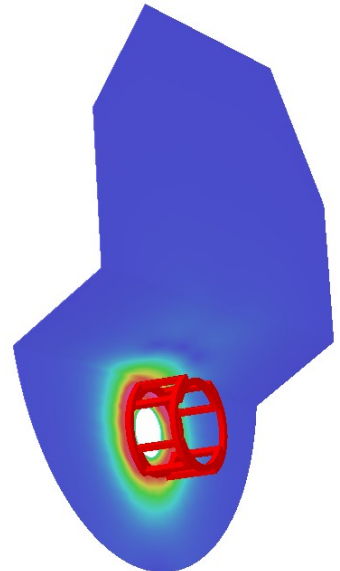
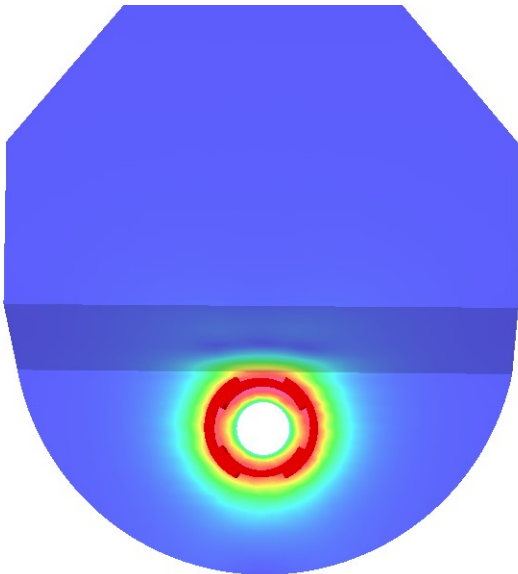
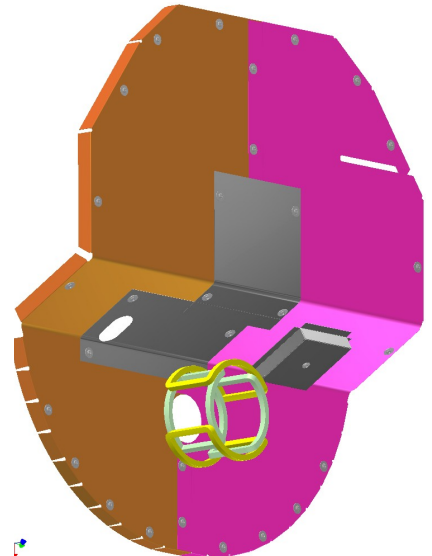
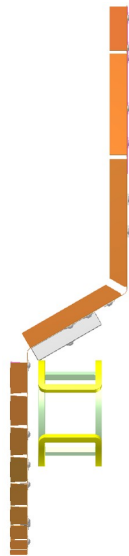
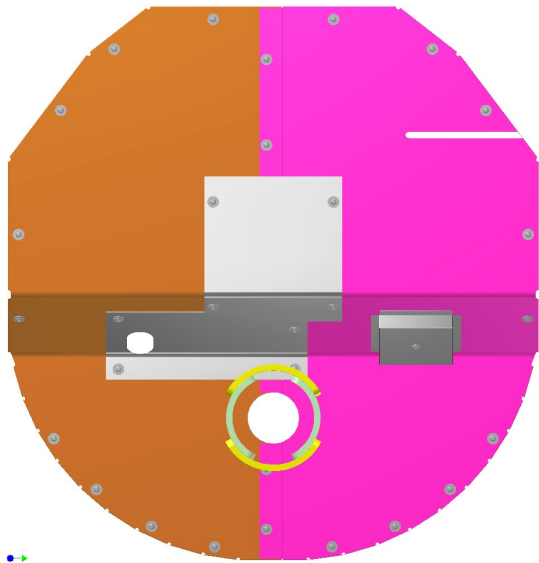


Post-meeting annotations:

- 1) Wrong sign in two coils resulted in zero net kick in each plane
- 2) Bug found: current densities were 200 A/cm^2 instead of 110 A/cm^2
- 3) Note that mu metal thickness is 50 mils



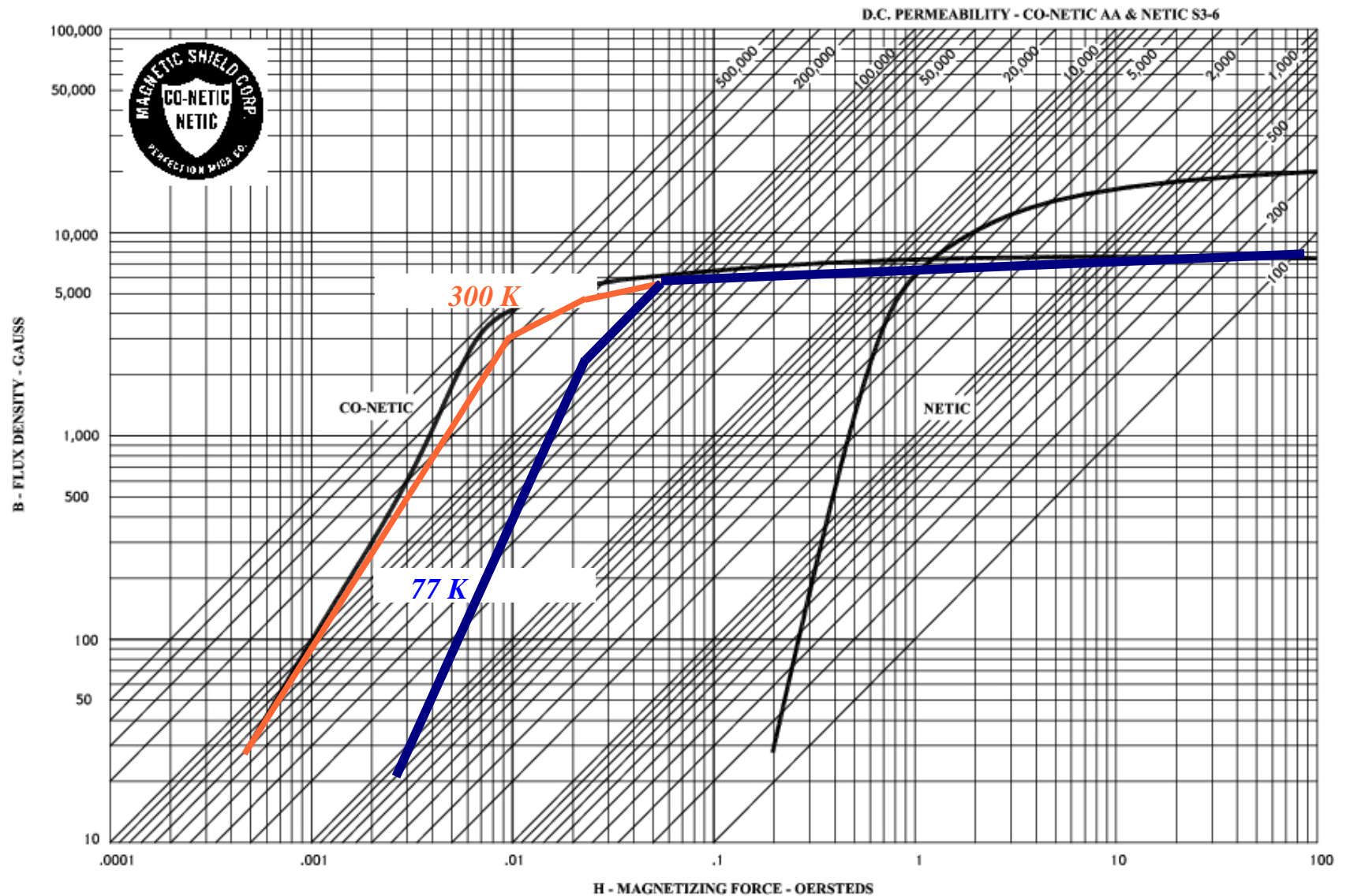
CAD pictures from Eric Chojnacki





B-H Curve for AD-MU 80

Information and reasoning by Eric Chojnacki. "Magnetic Shielding in a Cryogenic Environment" by Arentz, Johnson and Dant





**100 Amps in both
horizontal and vertical
corrector coils.**

Shield at $Z = 0$ cm

$-25 < Z < 25$ cm

Horizontal Component

$$0 < B_x < 0.011 \text{ Gauss}$$

Integral: -0.08 Gauss-cm
(Calculation accuracy)

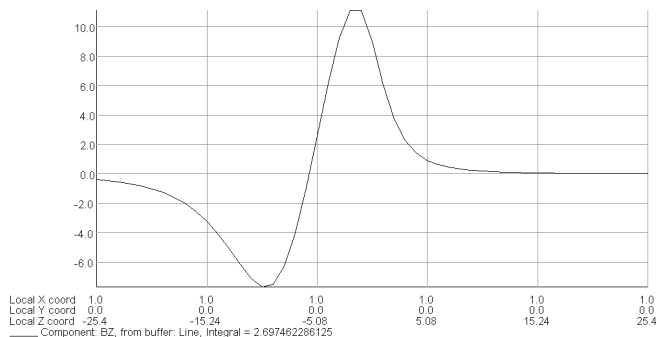
Vertical Component

$$-0.02 < B_y < 0.2 \text{ Gauss}$$

Integral: -2.7 Gauss-cm
(Contribution by shield)

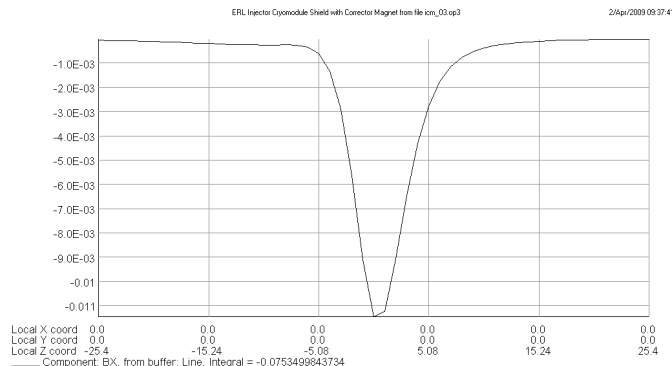
ERL Injector Cryomodule Shield with Corrector Magnet from file cm_03.ep3

2/Apr/2009 09:37:52



UNITS	
Length	cm
Magn Flux Density	gauss
Magn Field	oriented cm
Magn Vector Pot	gauss cm
Elec Flux Density	C/cm ²
Elec Field	V/cm ²
Conductivity	S/cm ²
Current Density	A/cm ²
Power	W
Force	N
Energy	J
Mass	g

PROBLEM DATA	
cm_03.ep3	
TOSCA Magnetostatic	
Linear materials	
Simulation No 1 of 1	
2957247 elements	
512258 nodes	
4 conductors	
Fields by integration	
Activated in global coordinates	
Field Point Local Coordinates	
Local = Global	
FIELD EVALUATIONS	
Line LINE (integral) SI Cartesian	
x=0.0, y=0.0, z=-25.4 to 25.4	



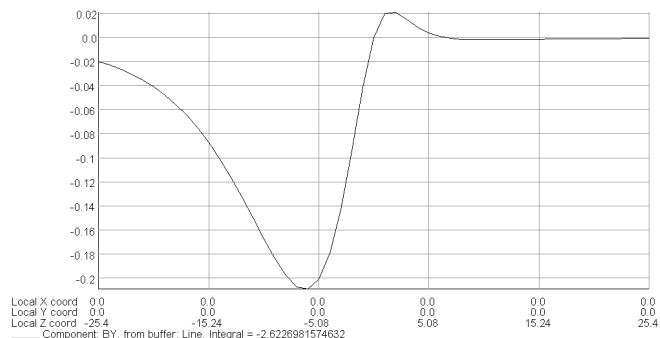
2/Apr/2009 09:37:41

UNITS	
Length	cm
Magn Flux Density	gauss
Magn Field	oriented cm
Magn Vector Pot	gauss cm
Elec Flux Density	C/cm ²
Elec Field	V/cm ²
Conductivity	S/cm ²
Current Density	A/cm ²
Power	W
Force	N
Energy	J
Mass	g

PROBLEM DATA	
cm_03.ep3	
TOSCA Magnetostatic	
Linear materials	
Simulation No 1 of 1	
2957247 elements	
512258 nodes	
4 conductors	
Fields by integration	
Activated in global coordinates	
Field Point Local Coordinates	
Local = Global	
FIELD EVALUATIONS	
Line LINE (integral) SI Cartesian	
x=0.0, y=0.0, z=-25.4 to 25.4	

ERL Injector Cryomodule Shield with Corrector Magnet from file cm_03.ep3

2/Apr/2009 09:37:47



UNITS	
Length	cm
Magn Flux Density	gauss
Magn Field	oriented cm
Magn Vector Pot	gauss cm
Elec Flux Density	C/cm ²
Elec Field	V/cm ²
Conductivity	S/cm ²
Current Density	A/cm ²
Power	W
Force	N
Energy	J
Mass	g

PROBLEM DATA	
cm_03.ep3	
TOSCA Magnetostatic	
Linear materials	
Simulation No 1 of 1	
2957247 elements	
512258 nodes	
4 conductors	
Fields by integration	
Activated in global coordinates	
Field Point Local Coordinates	
Local = Global	
FIELD EVALUATIONS	
Line LINE (integral) SI Cartesian	
x=0.0, y=0.0, z=-25.4 to 25.4	

Longitudinal Component

$$-7 < B_z < 11 \text{ Gauss}$$

Integral: 2.7 Gauss-cm
(Contribution by coil)



*100 Amps in both
horizontal and vertical
corrector coils.*

Shield at $Z = 0$ cm

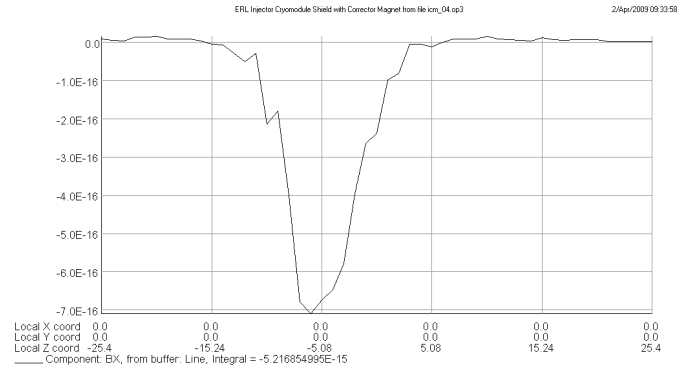
$-25 < Z < 25$ cm

Horizontal Component

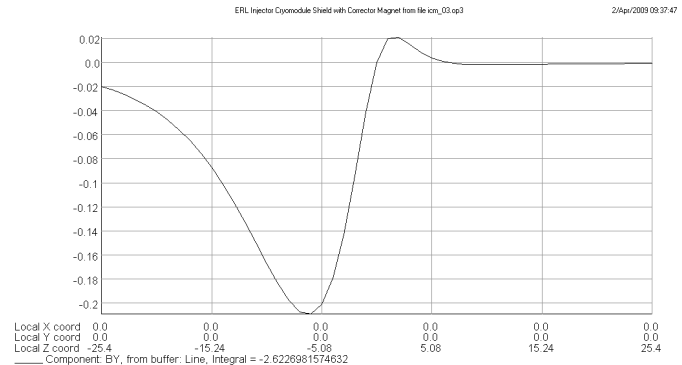
$B_x < 10^{-15}$ Gauss
(Calculation accuracy)

Vertical Component

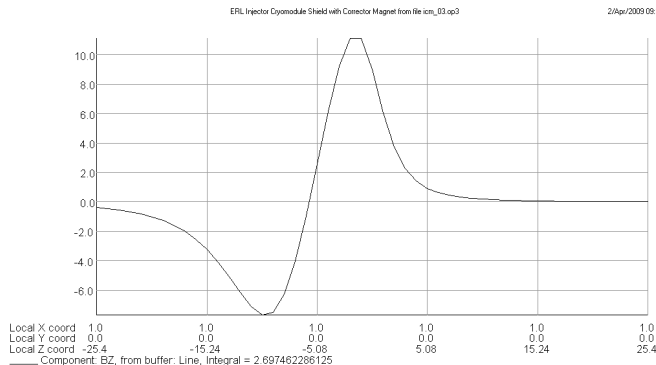
$B_y < 10^{-15}$ Gauss
(Calculation accuracy)



Vector Fields



Vector Fields



Vector Fields

Longitudinal Component

$-8 < B_z < 8$ Gauss
(Contribution by coil)

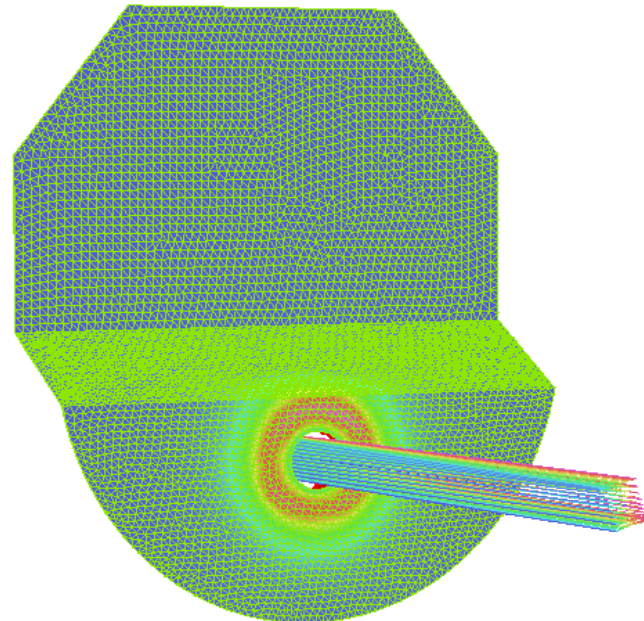
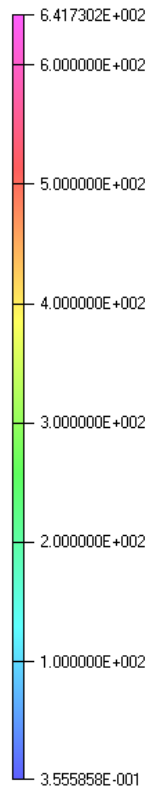


250 keV electrons

11 x 11 entrance grid over 2 x 2 cm tracked for 75 cm

2/Apr/2009 13:18:36

Surface contours: BMOD



UNITS

Length	cm
Magn Flux Density	gauss
Magn Field	oersted
Magn Scalar Pot	oersted cm
Magn Vector Pot	gauss cm
Elec Flux Density	C cm ²
Elec Field	V cm ⁻¹
Conductivity	S cm ⁻¹
Current Density	A cm ⁻²
Power	W
Force	N
Energy	J
Mass	g

PROBLEM DATA

icm_03.op3
TOSCA Magnetostatic
Linear materials
Simulation No 1 of 1
2997247 elements
512258 nodes
4 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates

Local = Global



- *The shape of the shield does not introduce as much distortion in the electron trajectories as observed*
- *The 3D model is available for further development*
- *All suggestions welcome*