Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT OF ENERGY

B2pF Q3 Superconducting Corrector Package (initial investigations)

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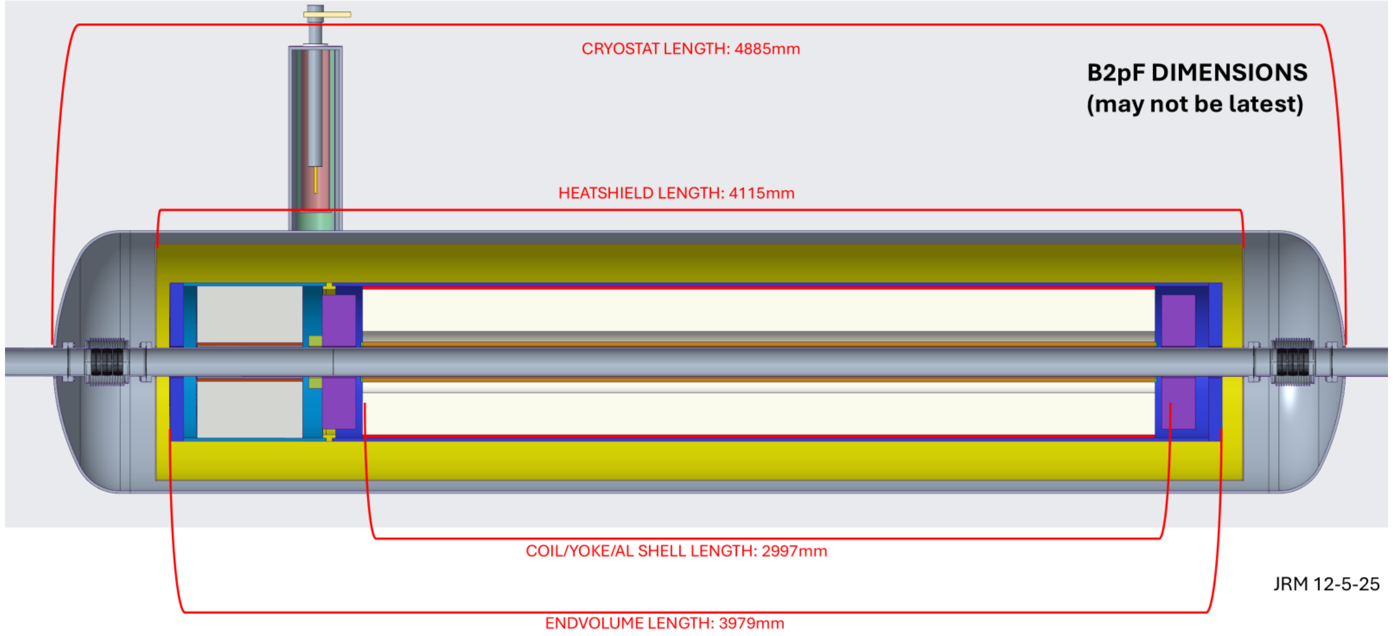
Electron-Ion Collider

INTRODUCTION

Case for making the warm Q3 corrector package superconducting:

Take advantage of the B2pF cryostat next to it to make it a shorter superconducting multi-layer corrector package. Valuable space saved can be used at many places.

- B2pF can be longer, making it a 4.5 K or single layer dipole with reduced yoke od
- ZDC can be shifted out
- Other costumers?

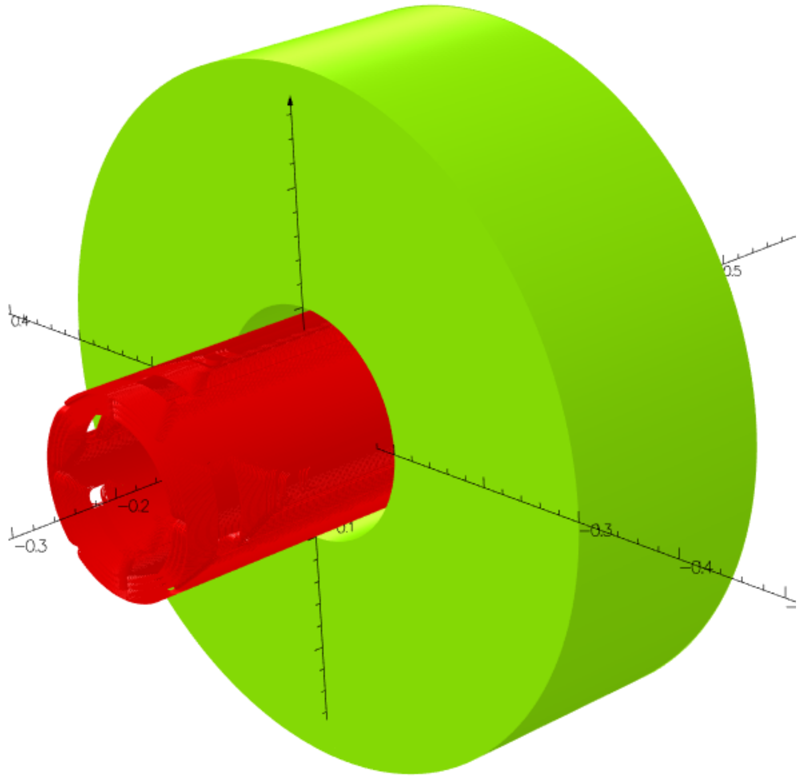


Stated corrector requirements:

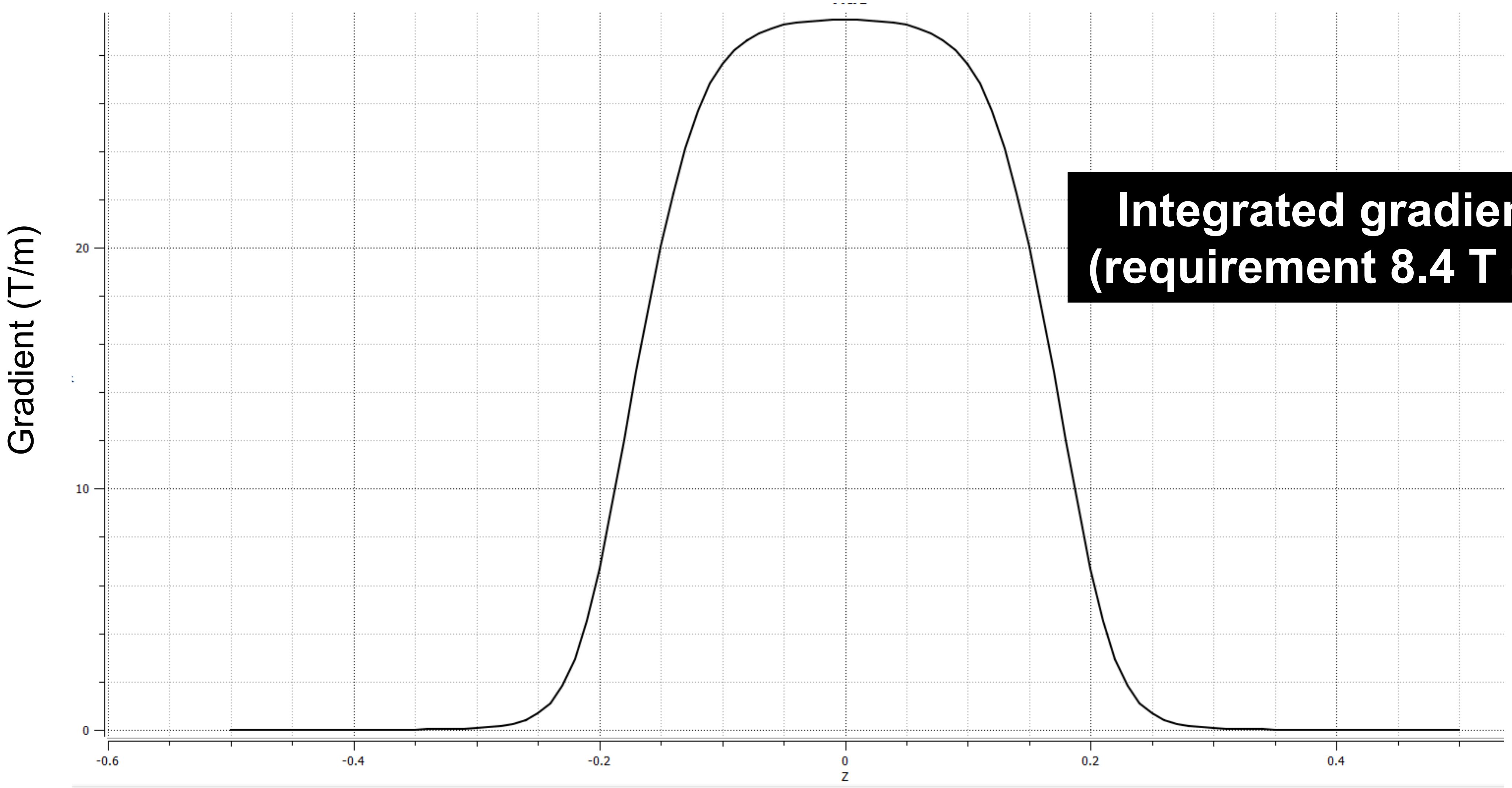
- **0.1 T-m horizontal corrector**
- **0.1 T-m vertical corrector**
- **3 T skew quadrupole**
- **8.4 T normal quad**
  - ➢ **Are these numbers firm?**

Basic Design Parameters and Choices

- Coil i.d.: ~133 mm, coil length: 400 mm, space in cryostat ~500 mm
- Optimum Integral Design (OID) to minimize coil length.
- Results of the initial model and analysis:
  - Normal quad with three coil sets (6 layers)
  - Skew Quad with one coil set (2 layers)
  - Horizontal dipole with one layer (OID allows it)
  - Vertical dipole with one layer (gap at midplane will avoid interference in coil winding).
- The models presented here are for a bit larger i.d. coil (135.3 mm) and a smaller wire.
- Next iteration will have 133 mm coil i.d. and wider wire for more margin. Overall outcome will not change.

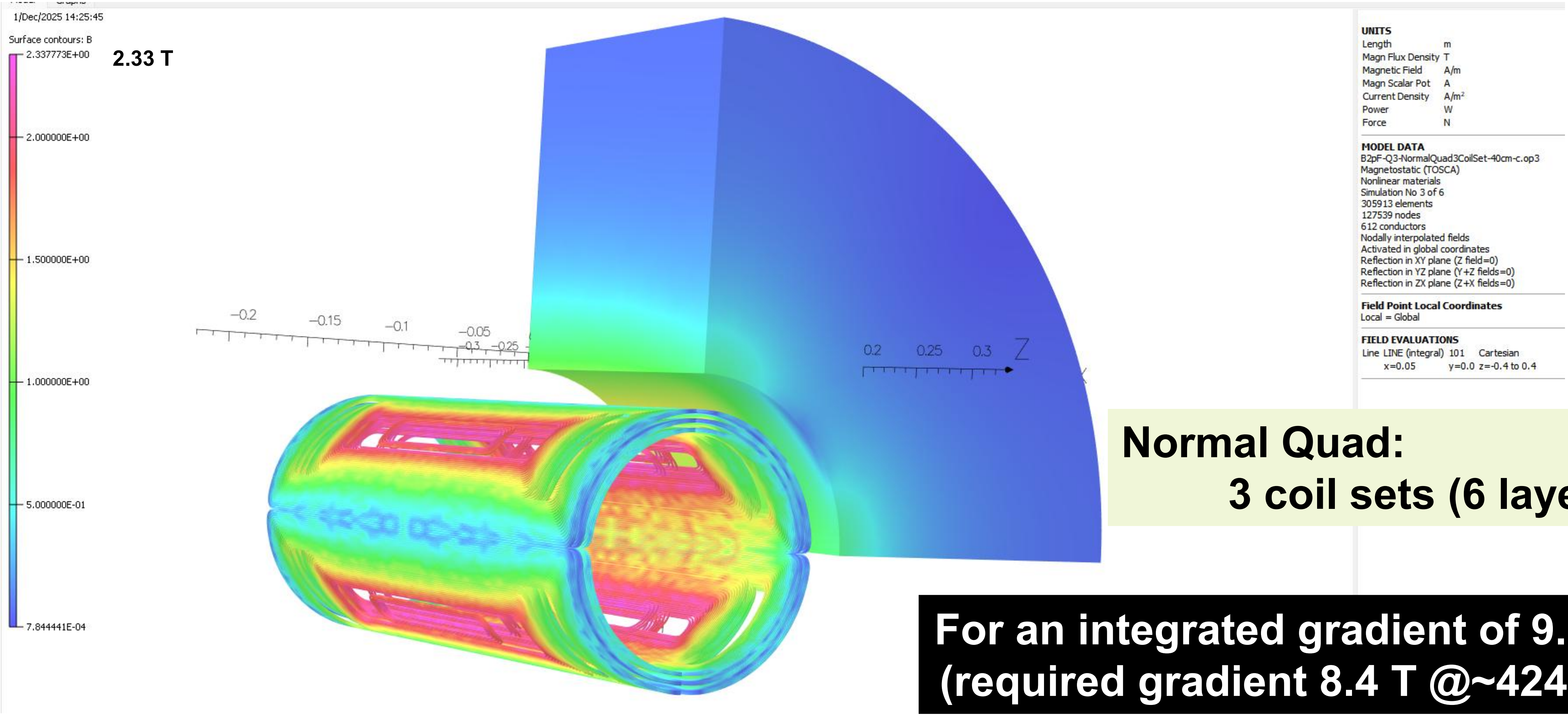


Gradient along z-axis at 500 A



Integrated gradient : 9.9 T
(requirement 8.4 T @~424 A)

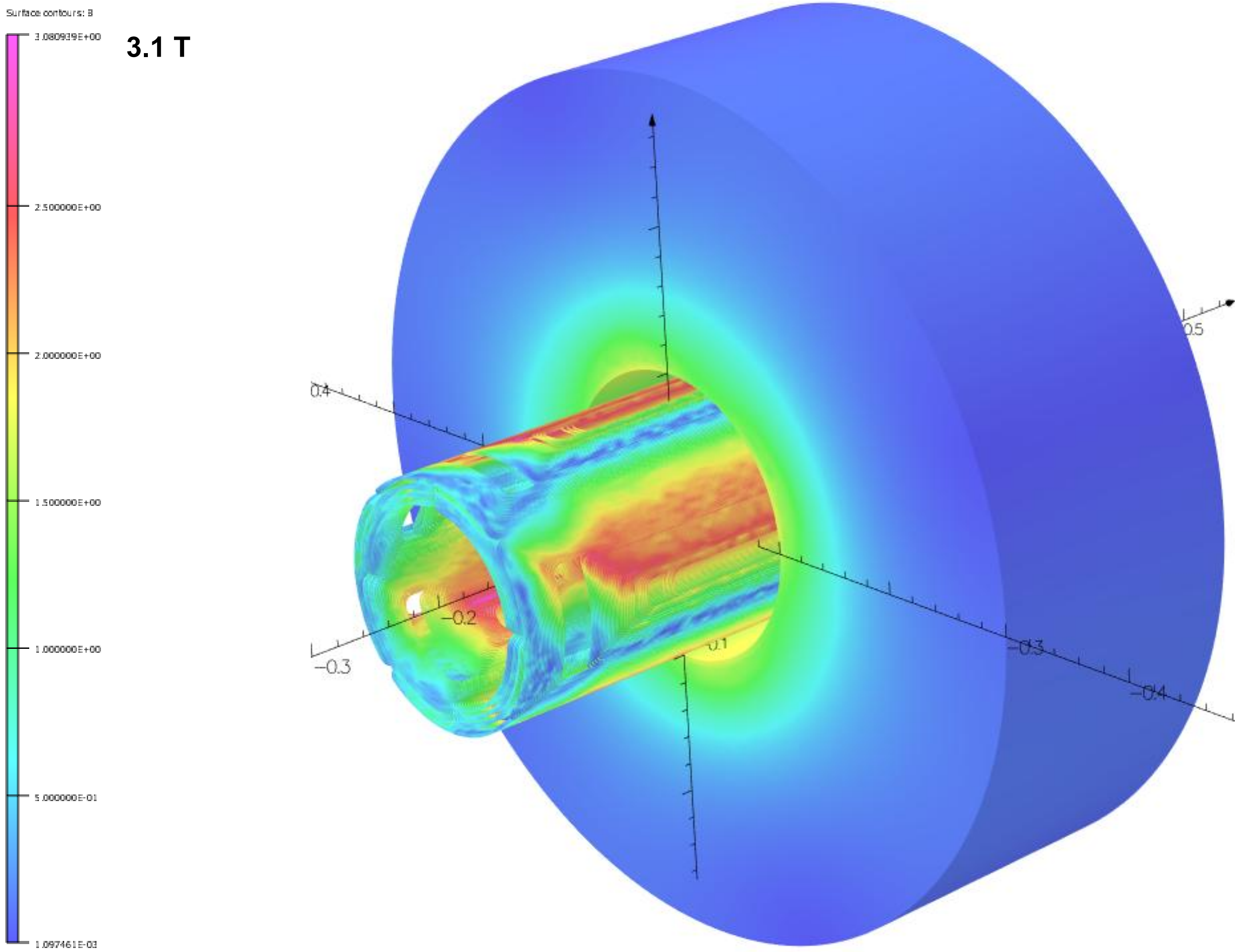
Field contours with normal quad @500 A



Normal Quad:
3 coil sets (6 layers)

For an integrated gradient of 9.9 T
(required gradient 8.4 T @~424 A)

Field contour with normal and skew quads @500 A



Normal Quad:
3 coil sets (6 layers)

Skew Quad:
1 coil set (2 layers)

SUMMARY

- Initial design calculations confirm that the specified performance of Q3 corrector package, placed in the same cryostat as the B2pF, can be obtain with a 400 mm long multilayer-direct wind coils based on the optimum integral design. Maximum space to be used ~500 mm.
- Space saved can be used by B2pF, ZDC, etc.
- One can also examine an intriguing possibility where these correctors are placed over the ends of B2pF (either on one end or half on each end), hopefully, where the field in the B2pF coil has decreased enough. This will be an involved option but if works, could release up to 0.5 meter.

Extra slides

(mostly from J.R. McNaughton)

Q3 Coil Buildup (12-08-25) AJM

Support Tube Thickness	Kapton Thickness	Substrate Barrier	Main Quad Conductor Dia.	Roving thickness	G-10 Machining Thickness
0.197	0.003	0.005	0.044	0.008	0.03
			Corrector Conductor Dia.		
			0.018		

Coil Buildup Step	Radius *(inches)*	Diameter *(inches)*	Radius (mm)	Diameter (mm)	Conductor C/L Radius (mm)
Support Tube Inner Surface	2.37	4.74	60.20	120.40	
Support Tube Outer Surface	2.567	5.134	65.20	130.40	
Kapton (66% overlap .001")	2.57	5.14	65.28	130.56	
Normal Quadrupole					
Substrate Barrier #1	2.575	5.15	65.41	130.81	
Main Normal Quad Conductor Layer #1	2.619	5.238	66.52	133.05	65.96
Substrate Barrier #2	2.624	5.248	66.65	133.30	
Main Normal Quad Conductor Layer #2	2.668	5.336	67.77	135.53	67.21
Kapton (66% overlap .001")	2.671	5.342	67.84	135.69	
3 Layers tension Roving	2.695	5.39	68.45	136.91	
Machine Round	2.725	5.45	69.22	138.43	
Skew Quad					
Substrate Barrier #3	2.73	5.46	69.34	138.68	
Skew Quad Conductor Layer #1	2.774	5.548	70.46	140.92	69.90
Substrate Barrier #4	2.779	5.558	70.59	141.17	
Skew Quad Conductor Layer #2	2.823	5.646	71.70	143.41	71.15
Kapton (66% overlap .001")	2.826	5.652	71.78	143.56	
3 Layers tension Roving	2.85	5.7	72.39	144.78	
Machine Round	2.88	5.76	73.15	146.30	
Vertical Corrector					
Substrate Barrier #5	2.885	5.77	73.28	146.56	
Verticall Corrector Conductor Layer #1	2.903	5.806	73.74	147.47	73.51
Substrate Barrier #6	2.908	5.816	73.86	147.73	
Vertical Corrector Conductor Layer #2	2.926	5.852	74.32	148.64	74.09
Kapton (66% overlap .001")	2.929	5.858	74.40	148.79	
1 Layer Tension Roving	2.937	5.874	74.60	149.20	
Machine Round	2.967	5.934	75.36	150.72	
Horizontal Corrector					
Substrate Barrier #7	2.972	5.944	75.49	150.98	
Horizontal Corrector Conductor Layer #1	2.99	5.98	75.95	151.89	75.72
Substrate Barrier #8	2.995	5.99	76.07	152.15	
Horizontal Corrector Conductor Layer #2	3.013	6.026	76.53	153.06	76.30
1 layer Tension Roving	3.021	6.042	76.73	153.47	

B2pF-Q3-NormQuad-CoilSet2-c2.X01 | B2pF-Q3-NormQuad-CoilSet4-c1.X01 | B2pF-Q3-NormQuad-CoilSet1-c1.X01 | B2pF-Q3-NormQuad-CoilSet3-c1.X01

```
$FCNX VC2CB=.TRUE.,VC2CE=.TRUE.,MAGTYPE=4,LAYERS=2,RFEMM=100,R0MM=25.,
      RBENDMM=8,NBEND=10,maxangle=10 &end
 3 3 0.4   1.1 67.65 100 0.4 0.20
 3 3 0.4   1.1 68.86 100 0.4 0.20
B5 0.   1.
B9 0.   1.
b13 0.   1.
```

1

```
3 3 0.4   1.1 67.65 100 0.4 0.20
3 3 0.4   1.1 68.86 100 0.4 0.20
```

2

```
3 3 0.4   1.1 72.88 100 0.4 0.20
3 3 0.4   1.1 74.10 100 0.4 0.20
```

3

```
3 3 0.4   1.1 78.11 100 0.4 0.20
3 3 0.4   1.1 79.33 100 0.4 0.20
```

4

```
3 3 0.4   1.1 84.31 100 0.4 0.20
3 3 0.4   1.1 85.53 100 0.4 0.20
```

	Radius *(mm)*
Quad Conductor Layer #1	66.52

Coil Buildup Step	Radius *(inches)*	Diameter *(inches)*	Radius *(mm)*
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Normal Quadrupole			
Substrate Barrier #1	2.575	5.15	65.41
Main Normal Quad Conductor Layer #1	2.619	5.238	66.52
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