

Q2pF Yoke Cross-section (15 mm cable @ 2K)

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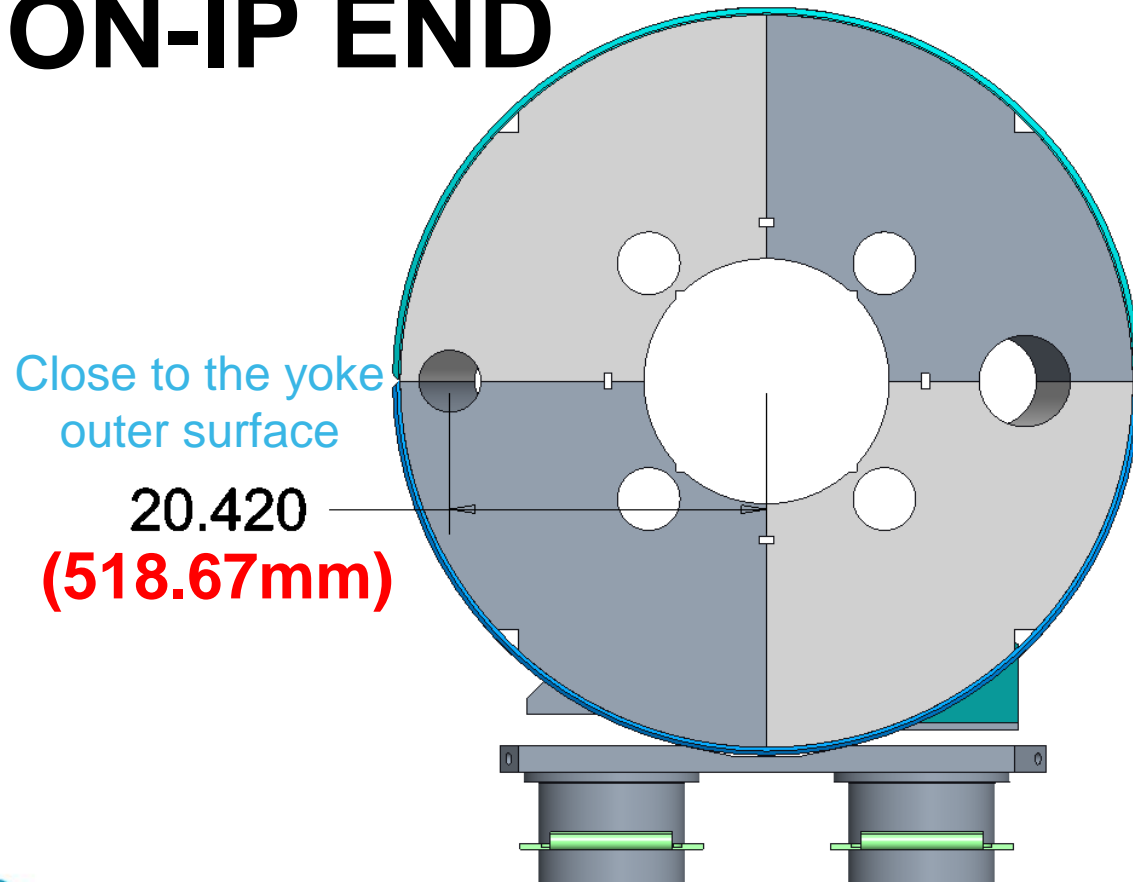
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Status of the cross-section design of Q2pF for 2K operation

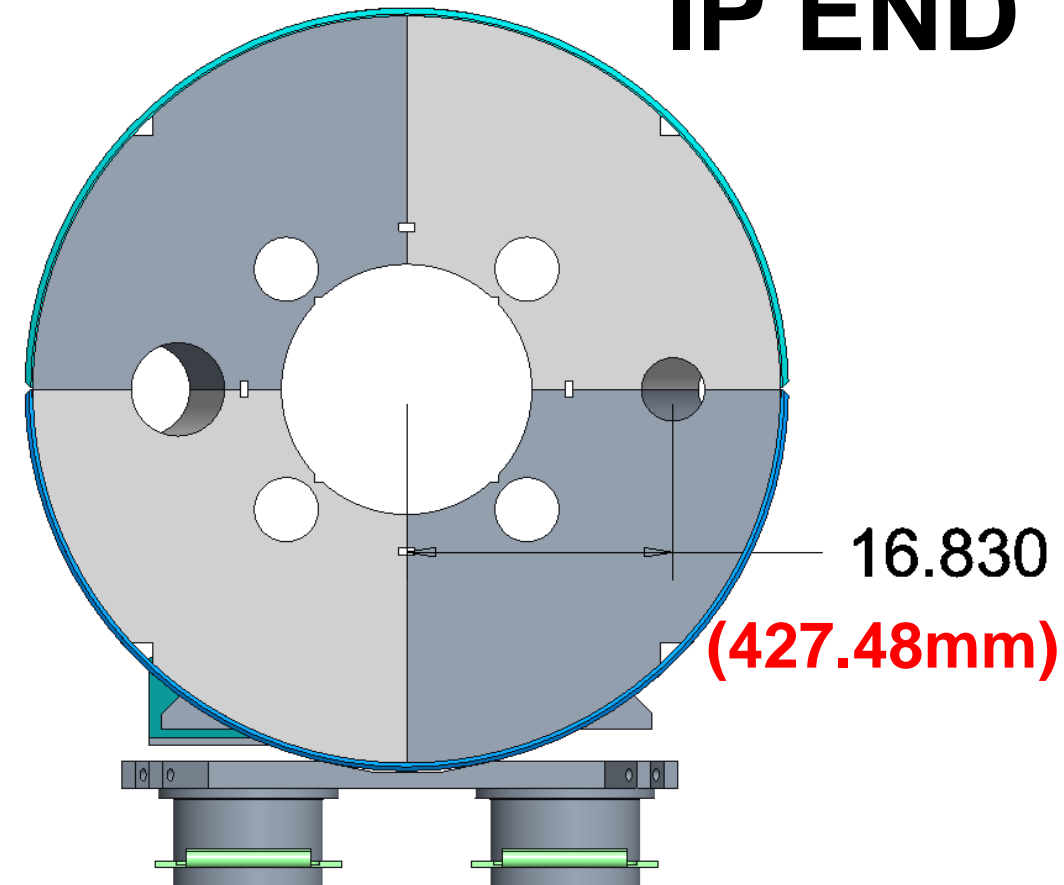
- Impact of additional holes for 2K cryo-system examined for holes for the size and location suggested by the engineering group.
- Saturation-induced harmonics must remain low in the EIC design range of operation (41 GeV to 275 GeV – a factor of 6.7).
- Field and field harmonics must remain low in the electron hole.

Proposed Location of 4" diameter Hole for the EIC Forward Side 2K Heat Exchanger in Q2pF

NON-IP END

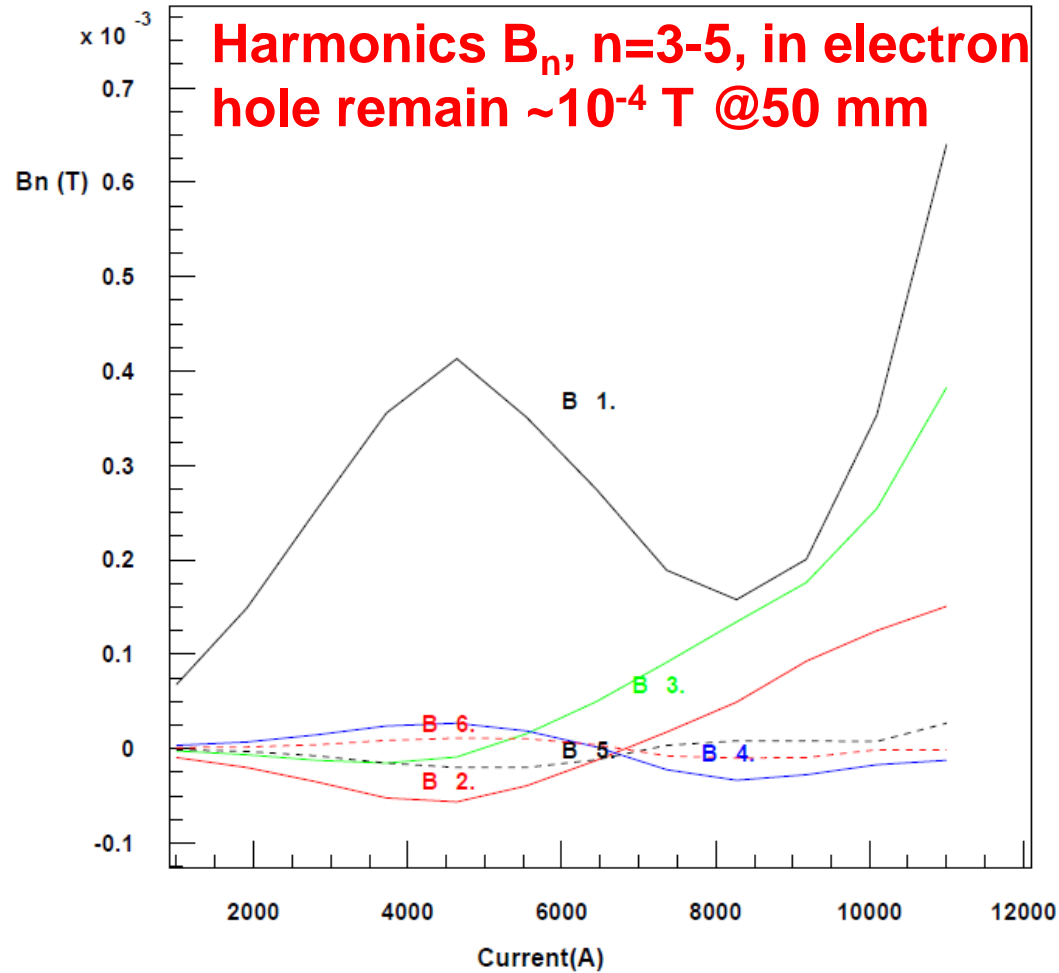


IP END

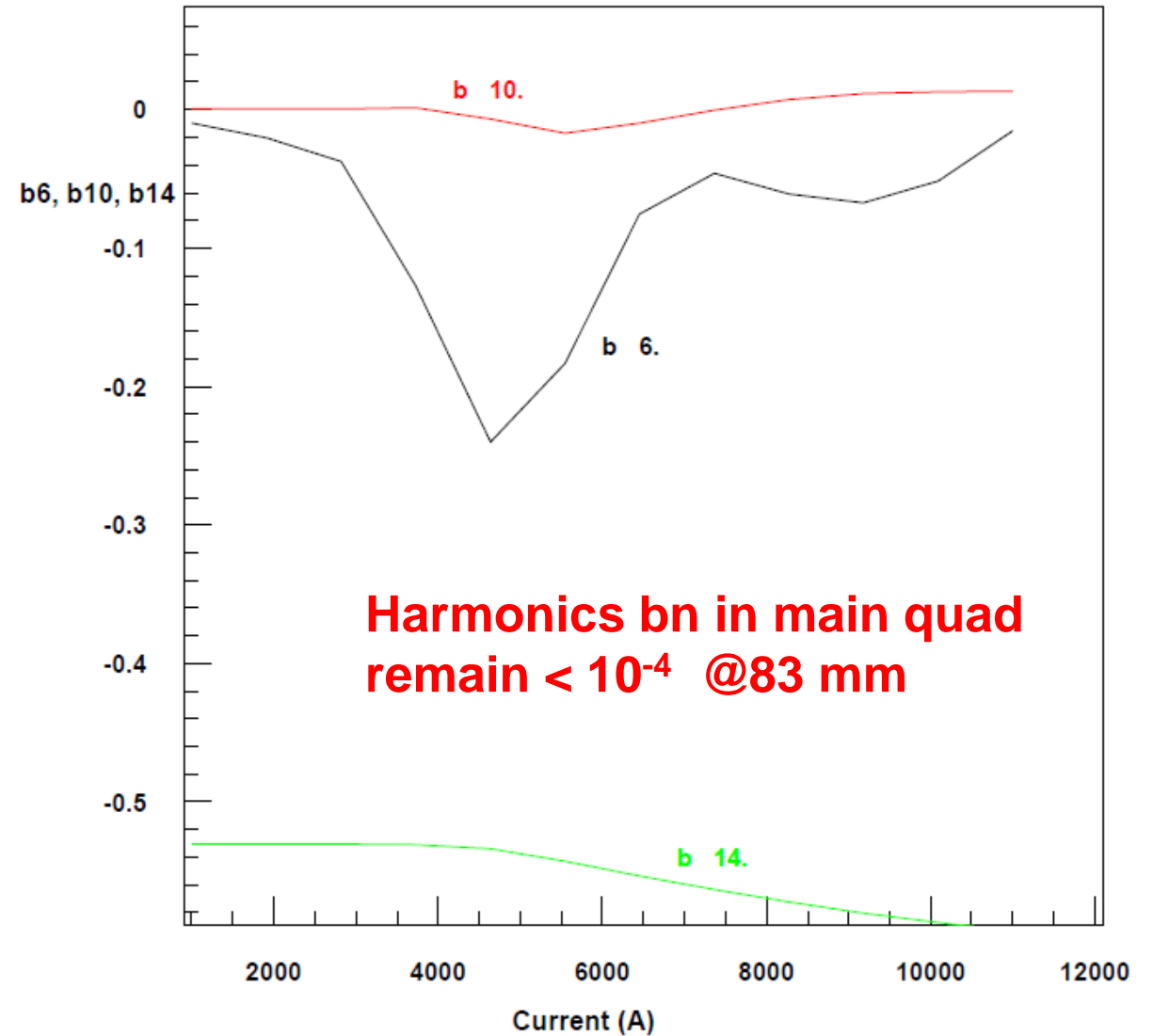


Field Harmonics without 2K Hole at IP-End (yoke or=600mm)

Harmonics B_n (Tesla) in the hole

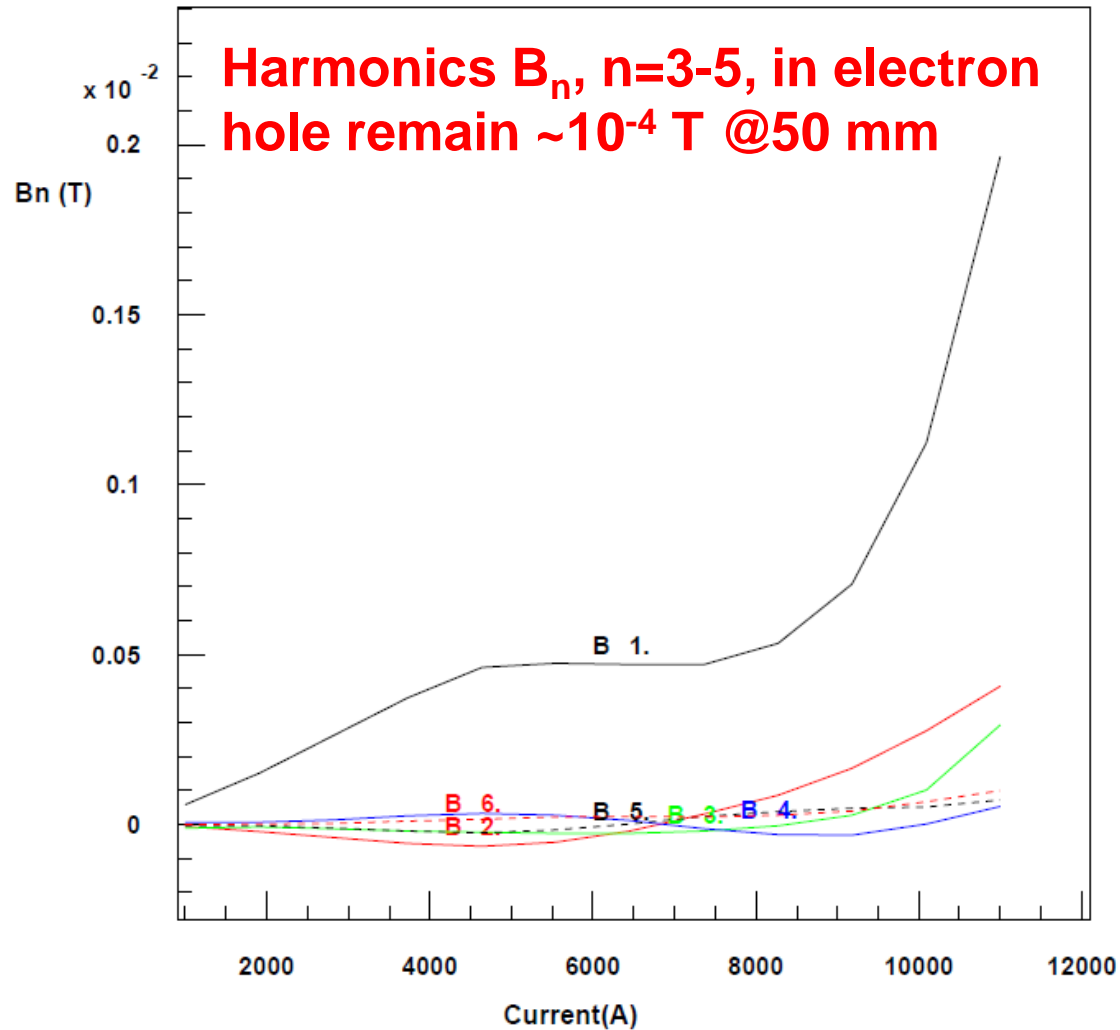


Allowed harmonics

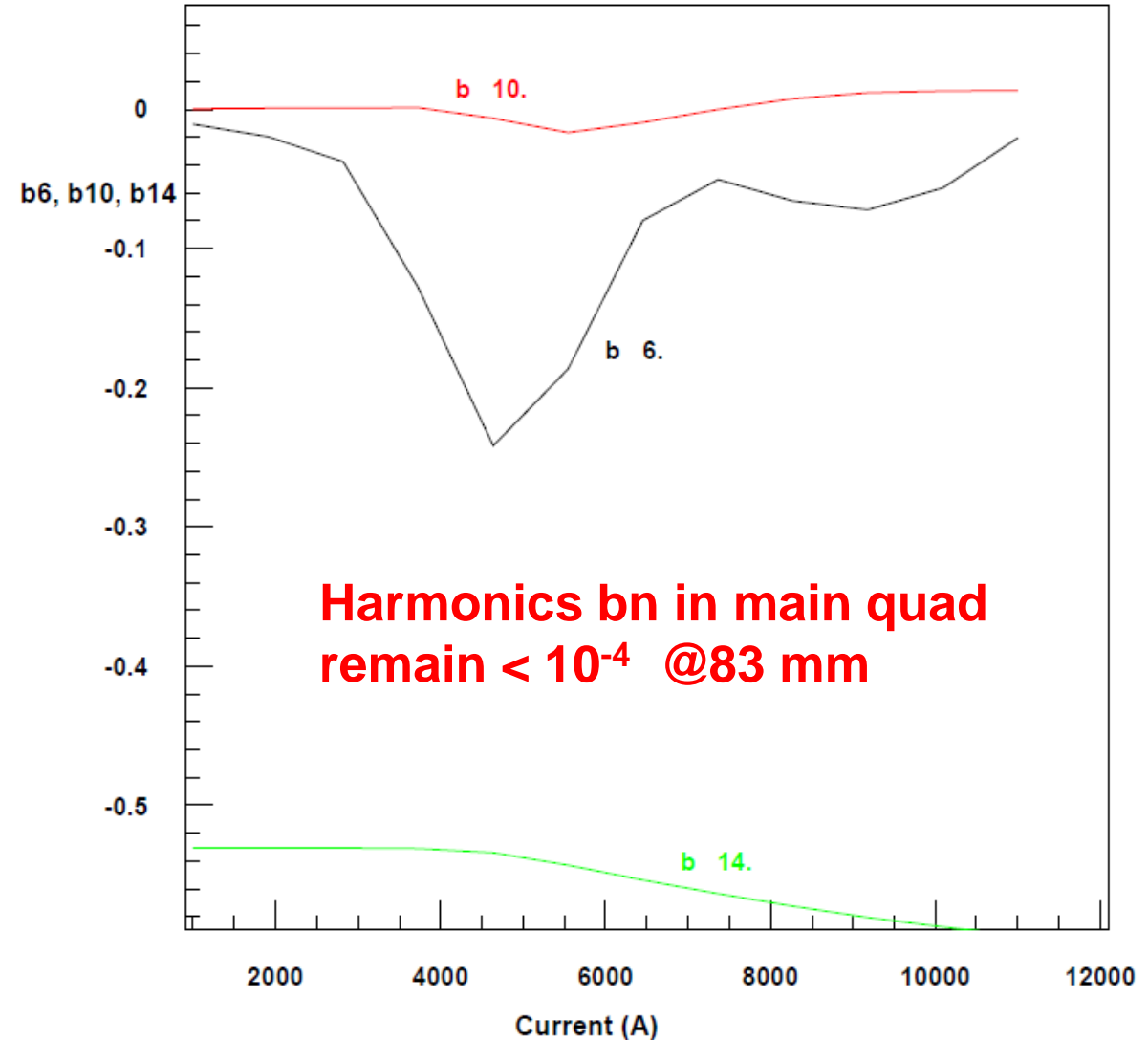


4" diameter 2K Hole at IP-End (yoke or=600mm)

Harmonics B_n (Tesla) in the hole

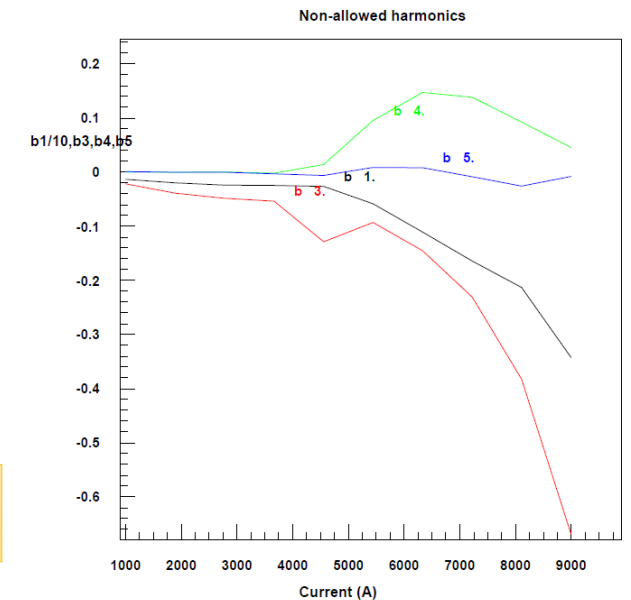
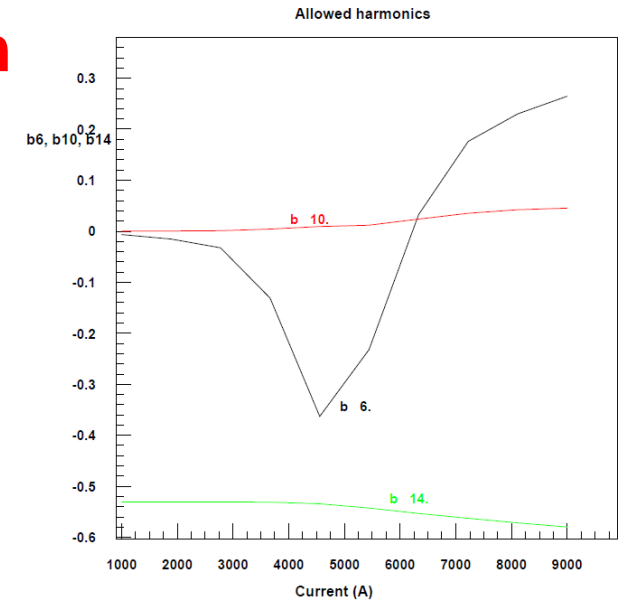
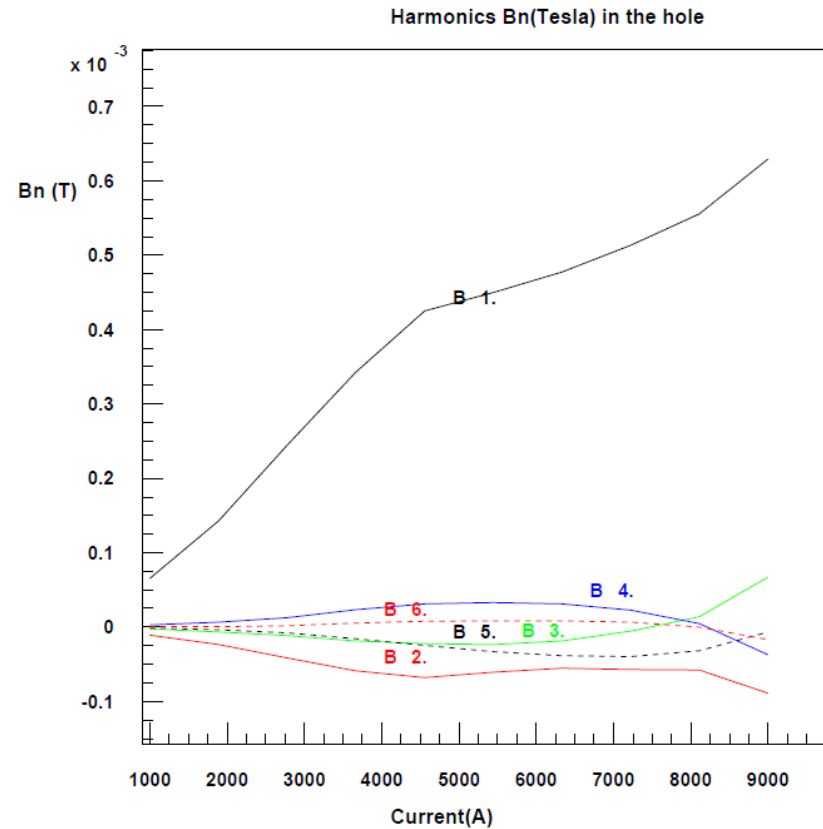
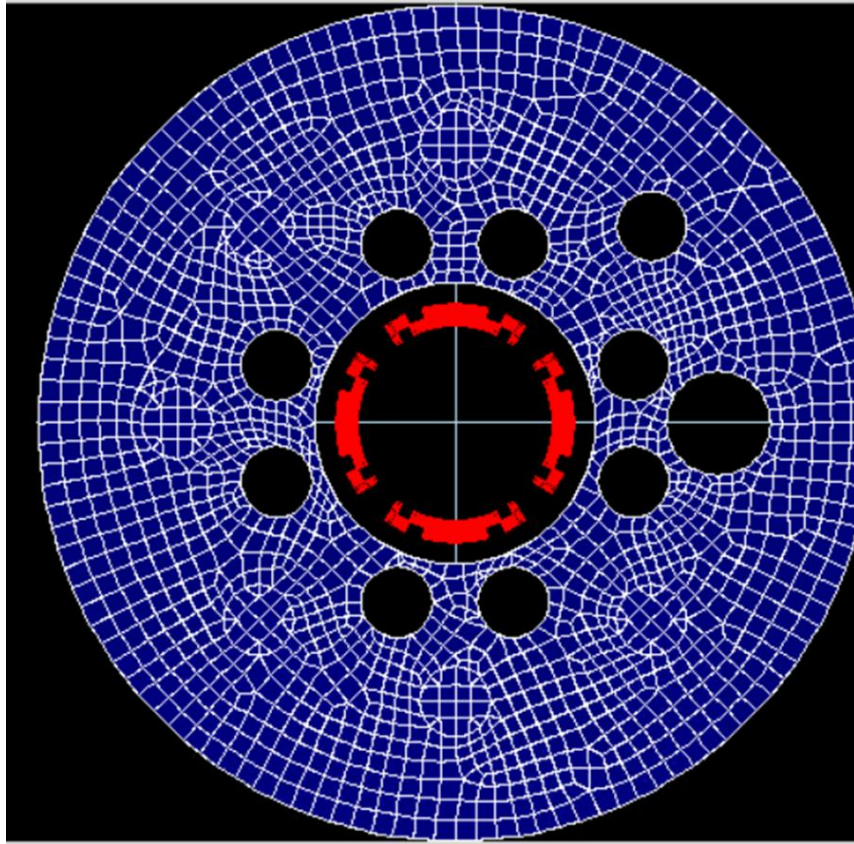


Allowed harmonics



Impact of 4" diameter Hole in Iron @45°

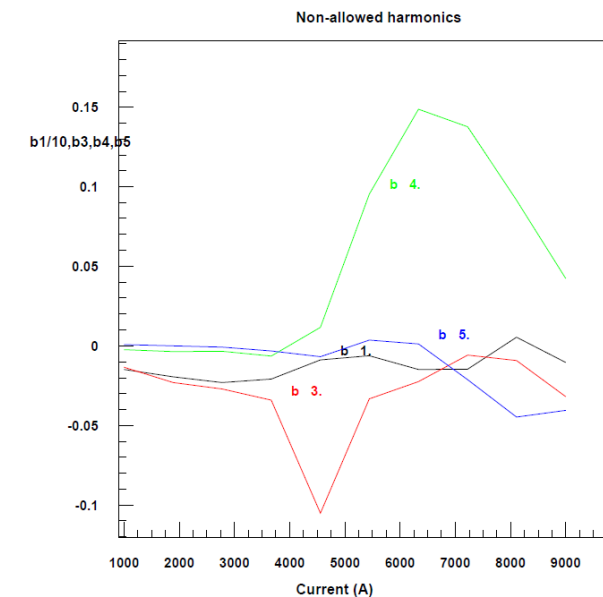
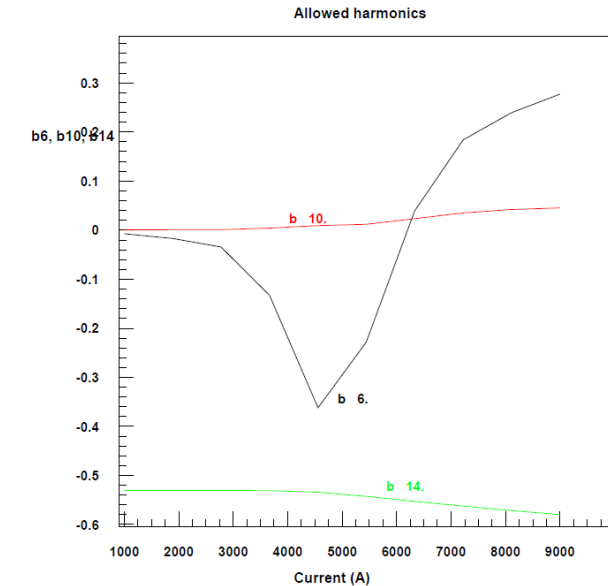
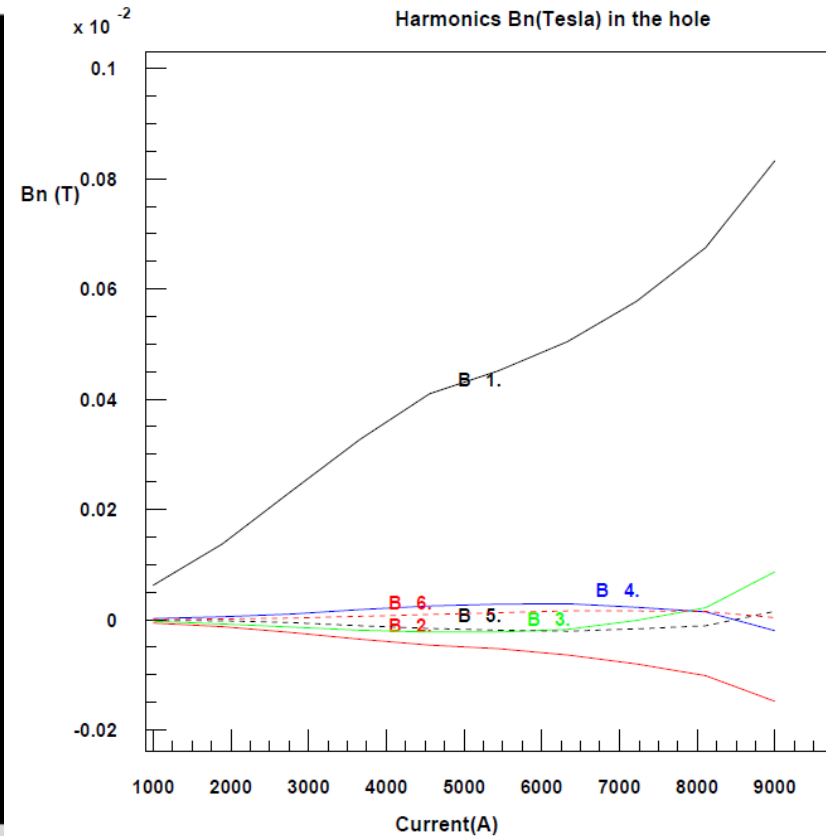
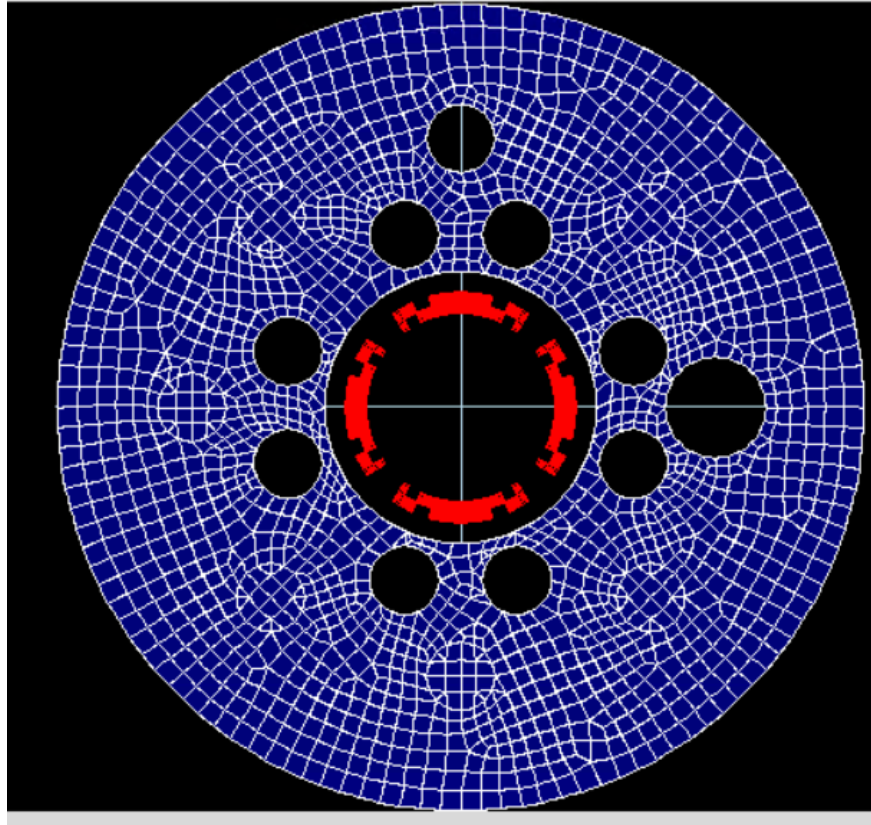
- Harmonics (B_n) in electron hole remain $< 10^{-4}$ T @50 mm
- Harmonics (b_n) in main quad remain $< 10^{-4}$ @83 mm



Harmonics of concern (B_3 - B_6) $< 10^{-4}$ T at 50 mm

Impact of 4" diameter Hole in Iron @90°

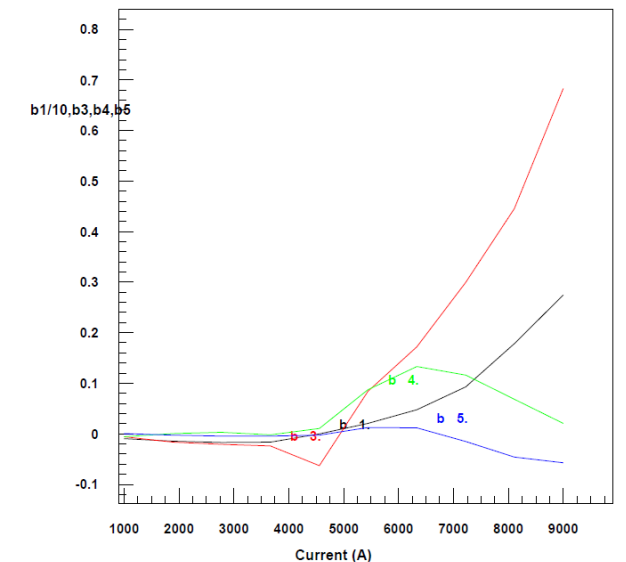
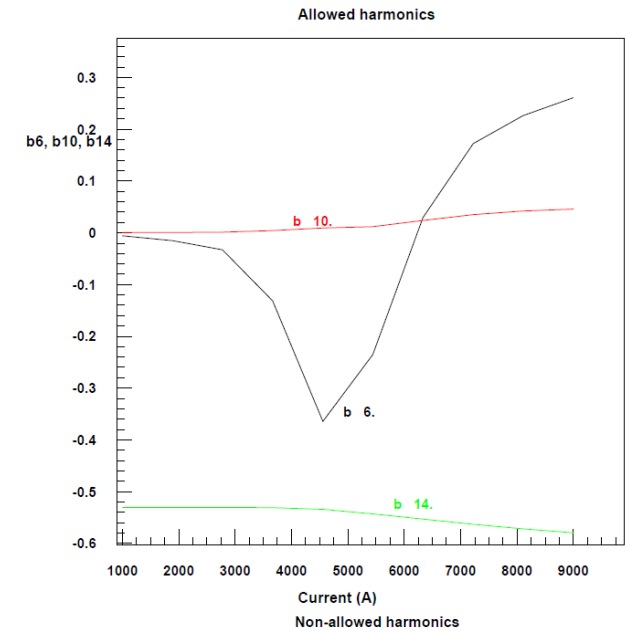
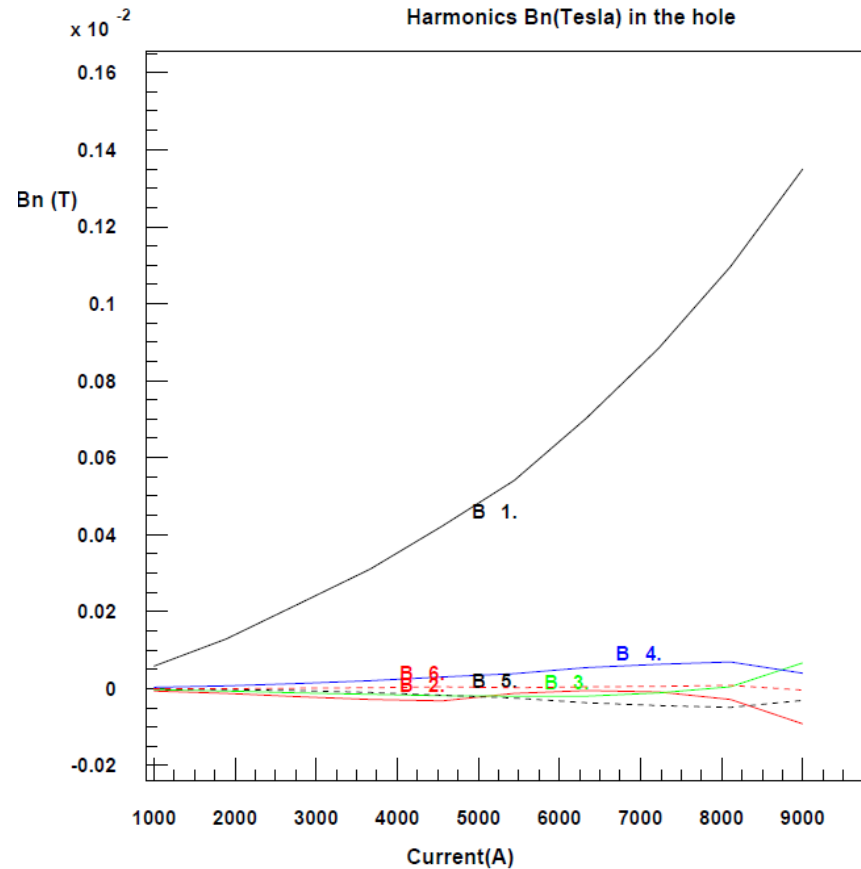
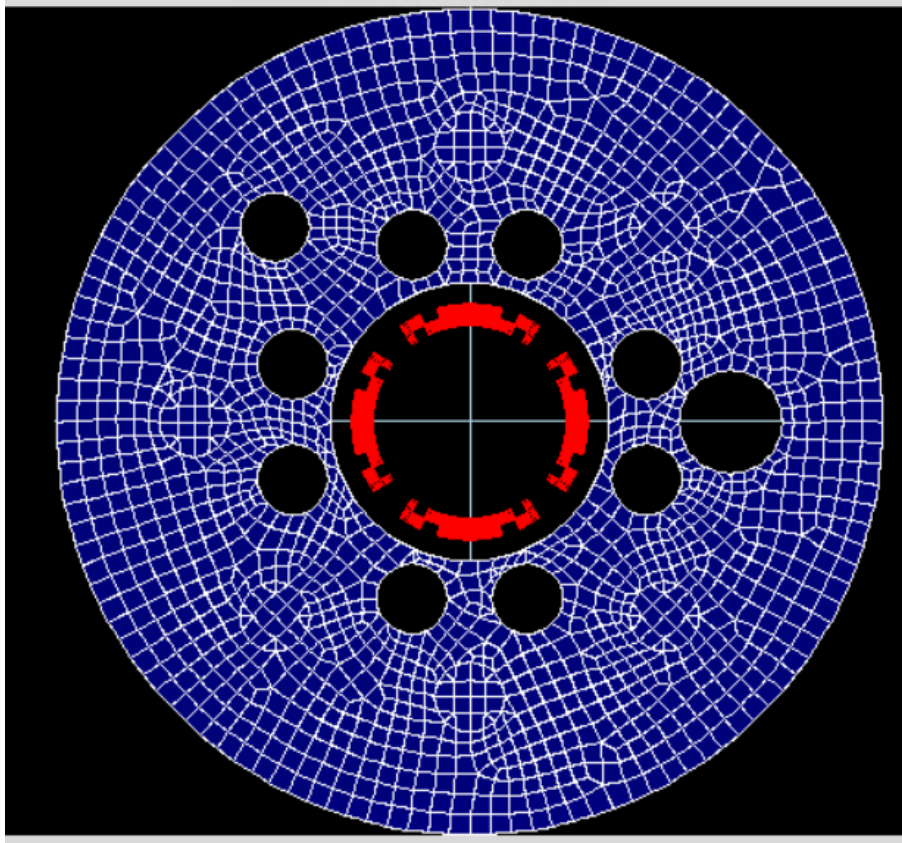
- Harmonics (B_n) in electron hole remain $< 10^{-4}$ T @50 mm
- Harmonics (b_n) in main quad remain $< 10^{-4}$ @83 mm



Harmonics of concern (B_3 - B_6) $< 10^{-4}$ T at 50 mm

Impact of 4" diameter Hole in Iron @135°

- Harmonics (B_n) in electron hole remain $< 10^{-4}$ T @50 mm
- Harmonics (b_n) in main quad remain $< 10^{-4}$ @83 mm



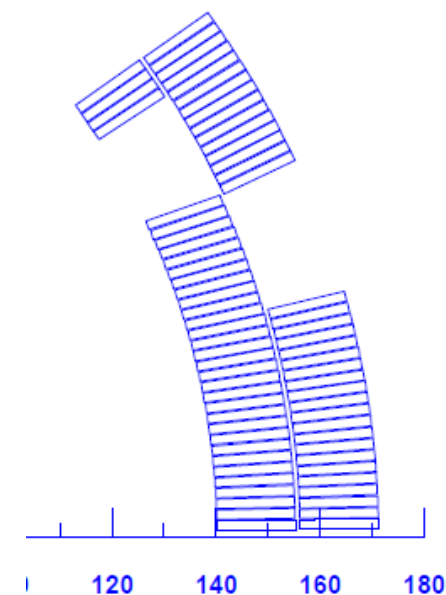
Harmonics of concern (B_3 - B_6) $< 10^{-4}$ T at 50 mm

Future Work

- Short term (within a week): Cross-check with other codes (COMSOL/OPERA) for low fields and low field harmonics in electron hole
- Medium term (with a few months, doesn't hold most other work): Internal details of yoke iron (holes for 2K helium, further optimization of field quality)
- Longer term (may not be needed): Coil cross-section iteration for dividing one big wedge in each layer to two for making them smaller and further reducing b_{14}

NORMAL RELATIVE MULTIPOLES (1.D-4) :

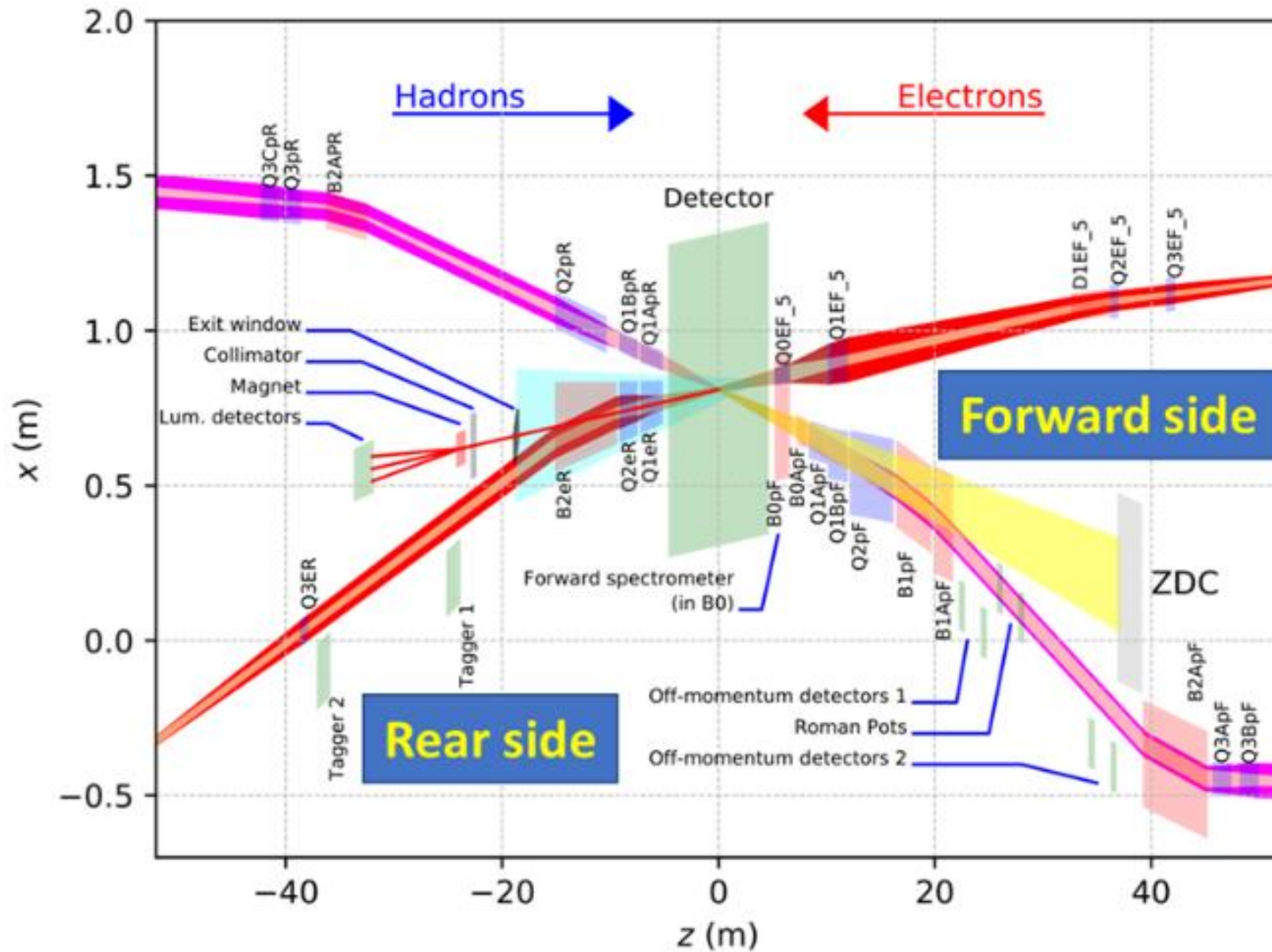
b 1:	-0.13185	b 2:	10000.00000	b 3:	-0.00388
b 4:	0.01480	b 5:	-0.00085	b 6:	-0.00623
b 7:	-0.00045	b 8:	0.00019	b 9:	0.00008
b10:	0.00051	b11:	0.00000	b12:	0.00000
b13:	0.00000	b14: →	-0.53040	b15:	-0.00000
b16:	-0.00000	b17:	-0.00000	b18:	0.01442
b19:	0.00000	b20:	0.00000	b	



Summary and Conclusion

- Coil and overall cross-section of Q2pF has been sufficiently optimized and matured enough that the next phase of work can start
- Coil design seems to have good layout (wedges and poles)
- Allowable space for collar thickness increased to 30 mm
- Field quality in the main quad remains good ($b_n < 10^{-4}$ at $r = 83$ mm) for the entire operating range (low geometric and low saturation induced harmonics)
- Field errors (measured by B_n) in the electron holes remain low ($B_n < 10^{-4}$ at $r = 50$ mm) for the entire operating range
- The flexibility in cross-section increased to allow wider adjustments from errors on parts and construction

Extra Slides



Basic Parameters of the current Q2BpF Design

Parameters from pCDR:

Table 6.6: Parameters Q2PF Magnet

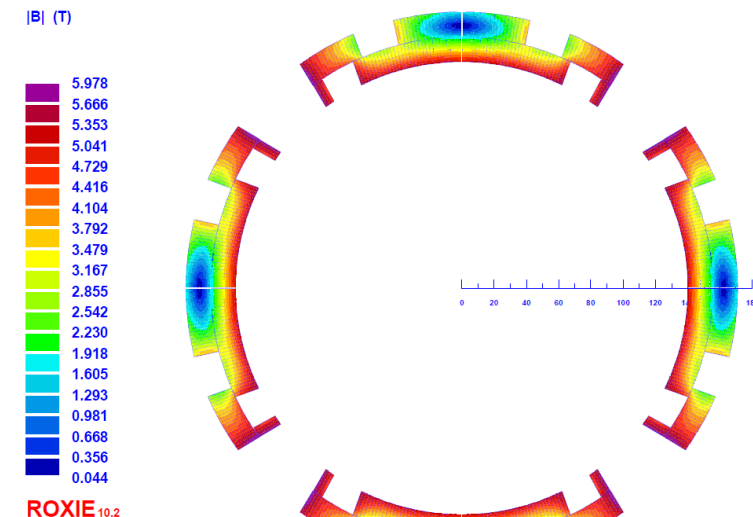
Parameter	Value
Magnetic length [m]	3.8
Maximum gradient [T/m]	40.7
Aperture diameter (front) [m]	0.262
Aperture diameter (rear) [m]	0.262
Required field quality	1×10^{-4}
Physical length [m]	3.8
Physical width [m]	0.156
Physical height [m]	0.156
Superconductor type	NbTi
Conductor	Cable 20x2mm ²
Current density [A/mm ²]	512
Cu:Sc ratio	1.3
Temperature [K]	1.8
Peak field wire [T]	6.85
Magnetic energy [MJ]	3.0
Ampere turns [kA·t]	420
Number of turns	28
Current [A]	15000
Inductance [mH]	26.67
Margin loadline [%]	32

Parameters used in the current design:

- Gradient: 36 T/m (revised from pCDR, current 36.8 T/m)
- Physical Length: 3.8 m
- Coil inner radius: 140 mm
- Estimated effective length: $3.8 - 0.14 = \sim 3.66$ m
- Estimated gradient in body: $36 * 3.8 / 3.66 = \sim 37.4$ T/m
- Cable: 15 mm
(LHC inner type)
- Cu/SC: 1.6
- Temperature: 2K

Design should be flexible to accommodate such changes

EIC Q2pF 15mm cable, 2K - or=600 mm, NO tie rods 7.5kA, hole366.8mm 22/04/01 17:33



LHC Style Cable used in Quad & Dipole (based on full keystone for Q2pF and B1ApF)

EIC →

LHC →

EIC →

LHC →

No	Name	height	width_i	width_o	ns	transp.	degrd	Comment
1	EICLHCB	15.1	1.816	1.984	28	115	5	LHC IN KEYSTOE FOR EIC DIPOLE
1	EICLHCQ	15.1	1.79	2.01	28	115	5	LHC IN KEYSTONE FOR EICIR QUAD
1	EICLHC01	15.1	1.786	2.014	28	115	5	LHC CABLE KEYSTOR FOR EIC 4.2K
2	EIC3642	19.4	1.773	2.027	36	115	3	EIC 36 STRAND @4.2K
3	EIC3618	19.4	1.773	2.027	36	115	3	EIC 36 STRAND @1.8K
4	EIC3642A	19.4	1.788	2.012	36	115	3	EIC 36 STRAND @4.2K 2 Layers
5	CABLE01	15.1	1.736	2.064	28	115	5	MB INNER LAYER,STRO1
6	CABLE02	15.1	1.362	1.598	36	100	5	MB OUTER LAYER,STRO1
7	SINGLE	0.94	0.94	0.94	1	0	0	SINGLE STRAND
8	GSI1CAB	9.74	1.061	1.271	30	74	0	GSI001 (RHIC) CABLE
9	GSI001	9.73	1.111	1.321	30	74	0	GSI001 following Wanderer
10	20MMCABLE	20	1.736	2.172	37	0	0	20mm cable
11	20MMCBNOK	20	13.8	13.8	280	0	0	7x20mm cable, no keystone
12	20MMCAB2	20	1.8	2	37	0	0	20 mm cable 2

No	Name	Cable Geom.	Strand	Filament	Insul	Trans	Quench Mat.	T_o	Comment
1	EICLHCB2K	EICLHCB	STREIC1	NBTII	ALLPOLYIL	TRANS1	NONE	2	LHC INNER FOR EIC IR QUAD @2K
2	EICLHCQ2K	EICLHCQ	STREIC1	NBTII	ALLPOLYIL	TRANS1	NONE	2	LHC INNER FOR EIC IR DIPOLE @
3	LHCIN42K	EICLHC01	STREIC1	NBTII	ALLPOLYIL	TRANS1	NONE	4.2	LHC INNER FOR EIC @4.2K
4	YELLONIN	CABLE01	STRO1	NBTII	ALLPOLYIL	TRANS1	NONE	1.9	V6-1 DESIGN DIPOLE INNER
5	YELLONOU	CABLE02	STRO2	NBTIO	ALLPOLYOL	TRANS1	NONE	1.9	V6-1 DESIGN DIPOLE OUTER

	Q2pF	B1ApF
Keystone angle for cable width << coil radius		
Cable height	15.1	15.1
Cable mid-thickness	1.9	1.9
Insul (one side)	0.12	0.12
Coil i.r.	140	185
Avg Rad	147.55	192.55
dt	0.2190	0.1678
Width_i	1.790	1.816
width_o	2.010	1.984

Note: Keystones are reduced for EIC

Cables considered for EIC: "EICLHCB2K" and "EICLHCQ2K" (EICLHCB and EICLHCQ)
Similar to LHC inner: "YELLONIN" (CABLE01)