Common coil configuration: electromagnetic calculations

T. Martinez, J. Munilla, F. Toral - CIEMAT

Thanks to R. Gupta (BNL) for his suggestions and help

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Electromagnetic design: stored energy

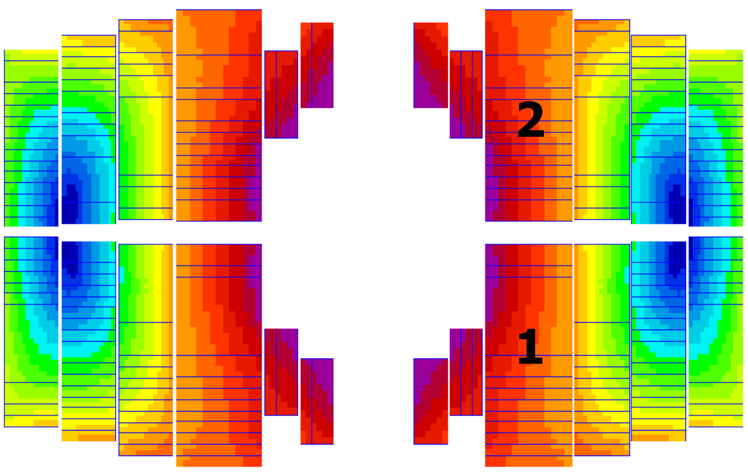
- We have found the origin of the discrepancy about the stored magnetic energy. It is a bug in the 32-bits version of Roxie: the coenergy is provided instead of energy (thanks to Susana and Bernhard for their support).
- It allows a further improvement of the design, because the quench propagation is not so critical.

Electromagnetic design: voltages

- We have kept a large value of the current, around 16 kA. We are trying to decrease the voltages during the quench.
- However, it decreases the efficiency of the superconductor.
- Parallel studies are ongoing trying to see if the voltages can be reduced with a different connection of the coils (Tiina & Marco).

Electromagnetic design: field quality

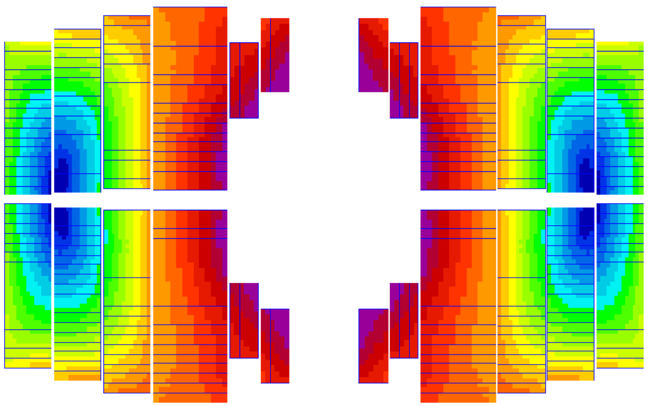
- We aim to understand the sensitivity of the field harmonics with the design variables.

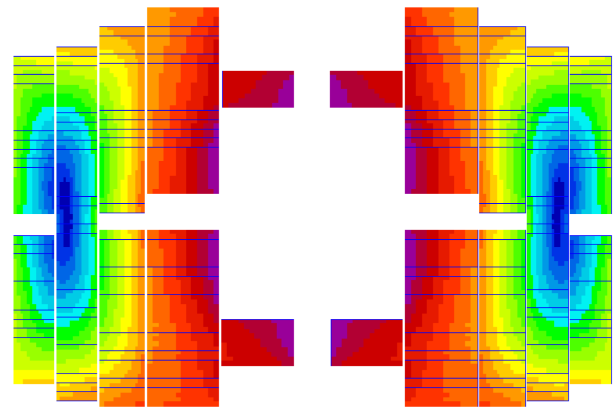


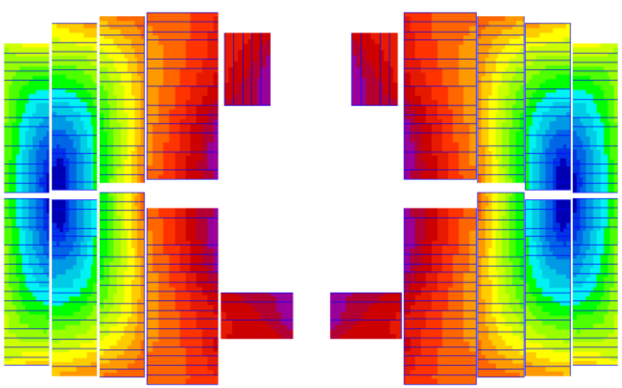
- B3: gap at midplane, outermost turns of blocks 1&2, ancillary coils
- B5: ancillary coils (close to main coils)
- B7: ancillary coils
- A2: vertical position of the main coils respect the aperture (symmetry with aperture)
- A4: vertical position of blocks 1&2
- Peak field: ancillary coils in vertical position help to decrease Bpeak/Bnom

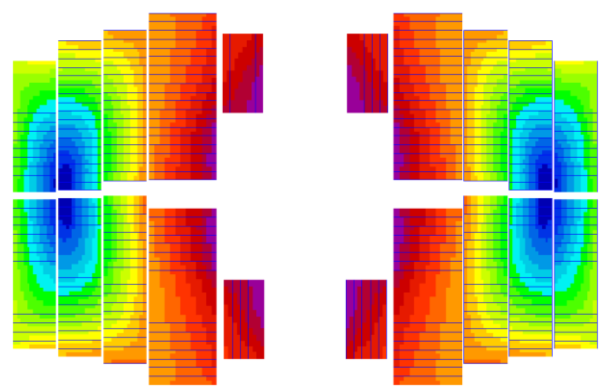
Electromagnetic design: ancillary coils

- We have studied different configurations of the ancillary coils.

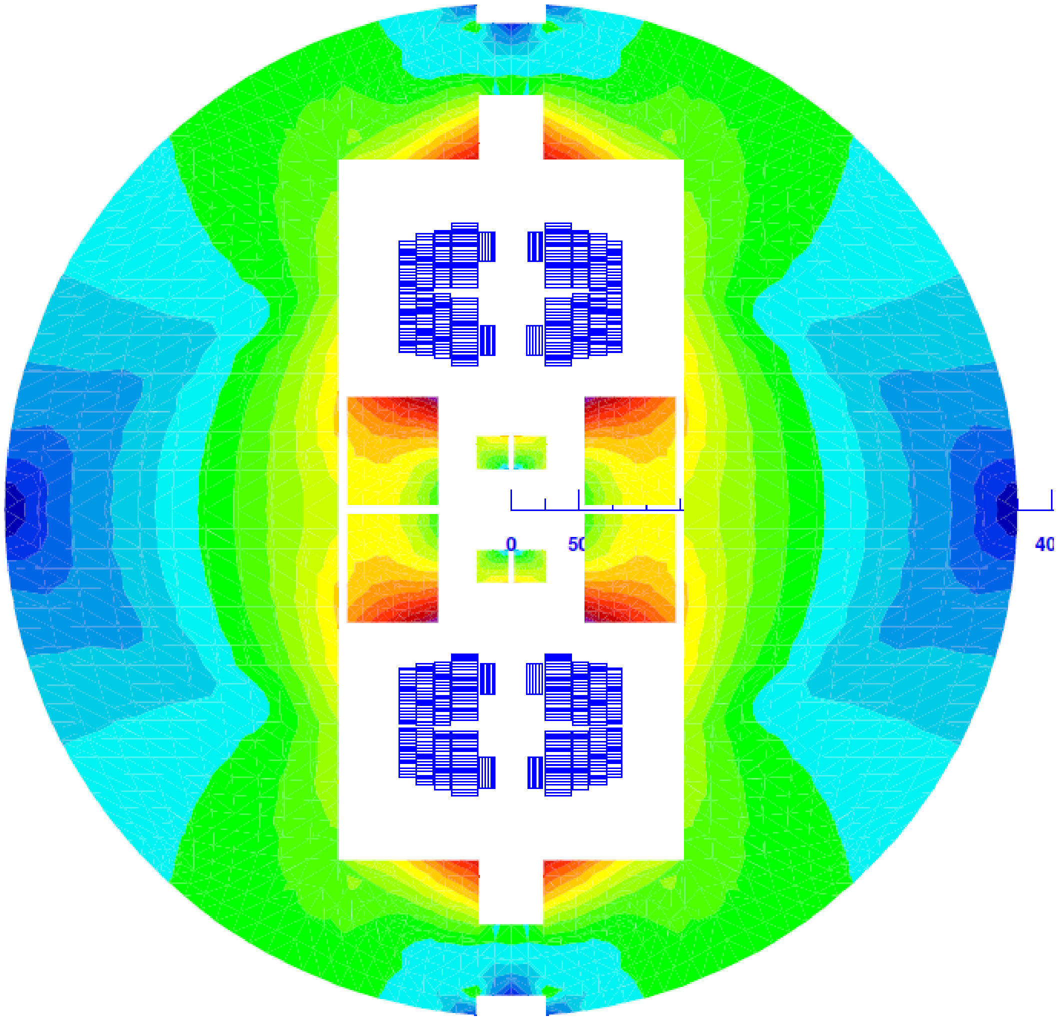








Electromagnetic design



Design Id.		v1h2_2ac4a	v1h2_1ac1
Nominal current		16400	16800
Intra-beam distance		320	320
Iron outer diameter		750	750
1st coil			
#cables		39/37	39/36
#strands		1836	1818
strand diameter		1,2	1,2
Cu:Sc		1/2.6	2,6
Cu current density		970/967	990/1142
2nd coil			
#cables		68	67
#strands		1224	1206
strand diameter		1,2	1,2
Cu:Sc		2,6	2,6
Cu current density		1127	1130
Aux coils			
#cables		18	10
#strands		540	380
strand diameter		1,2	1,1
Cu:Sc		1	1
Cu current density		970	930
Strand area per magnet		162,86	151,25
Total FCC SC weight		9276	8614
Strand area per magnet Cu:Sc=1		134,23	120,23
Total FCC SC weight Cu:Sc=1		7485	6704
margin on load line		86,04	86,12
#block		9	10
peak field		16,48	16,63
b3		1,7	-3,9
b5		-0,2	-6,1
b7		-2,6	-4,7
b9		-2,8	-5,2
a2		3,6	0,1
a4		0,9	3,4
a6		0,2	2,5
a8		0,1	0,7
inc_b3		8	4
inc_a2		6	5
Stored energy		2,92	2,97
Static self inductance		21,7	21,0
L*I		356,1	353,6
Sum_fx		14,59	13,9
Sum_fy		0,49	0,55
Stray field 50 mm		0,26	0,45
Stray field 1 m		27	28
Peak temperature (Excel)		365	387

Conclusions

- CIEMAT and BNL are collaborating on common coil design.
- It is very important to study the way to decrease the induced voltages.
- We have studied different configurations of ancillary coils: we wanted to optimize a common coil magnet… but now we have to optimize a block magnet.