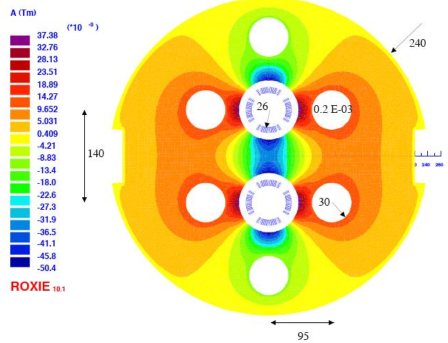
Magnet Options for Q1 and Q2 Revisited

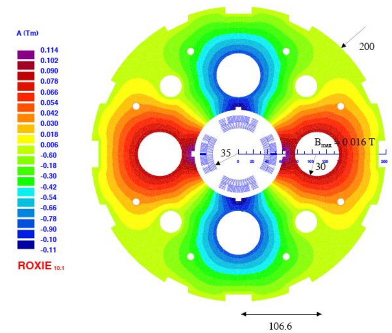
S. Russenschuck
CERN – MSC - MM
20.01.2014

Magnet Options Investigated in 2010-2011

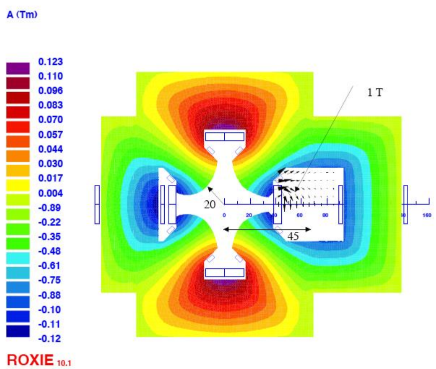
Ring-Ring option2, double aperture, MQY cable, 7400 A



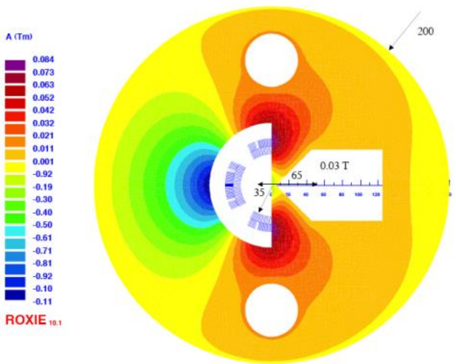
Ring-Ring option. Single aperture magnet for two proton beams, 127 T/m, 4600 A, MQY cable



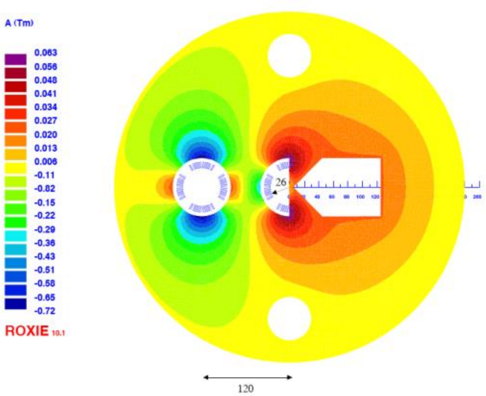
Ring-ring superferric (KEKb type) magnet



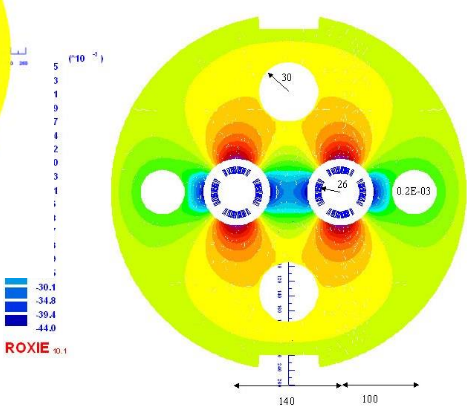
Ring-ring option half-quadrupole, 4900 A, Gradient 137 T/m,
+ 2.5 T dipole field from feeddown



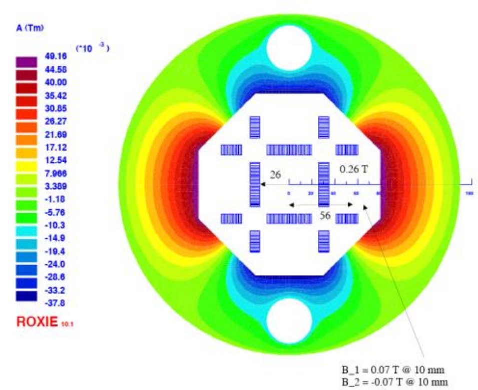
Two-in-one configuration with half-quadrupole, 6600 A



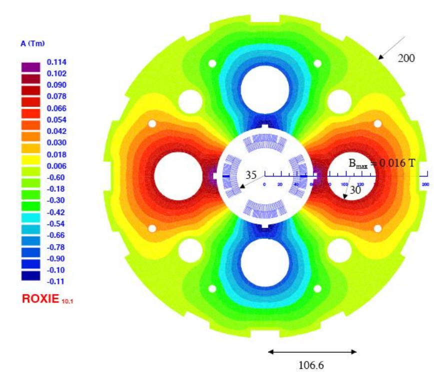
ption 3: MQY cable, 7400 A



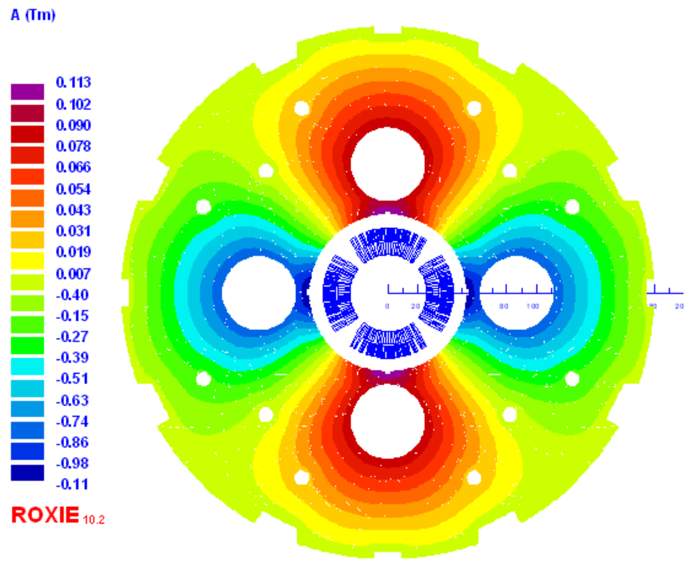
Ring-ring option with racetrack coils, MQY non-keystoned cable, 5400 A

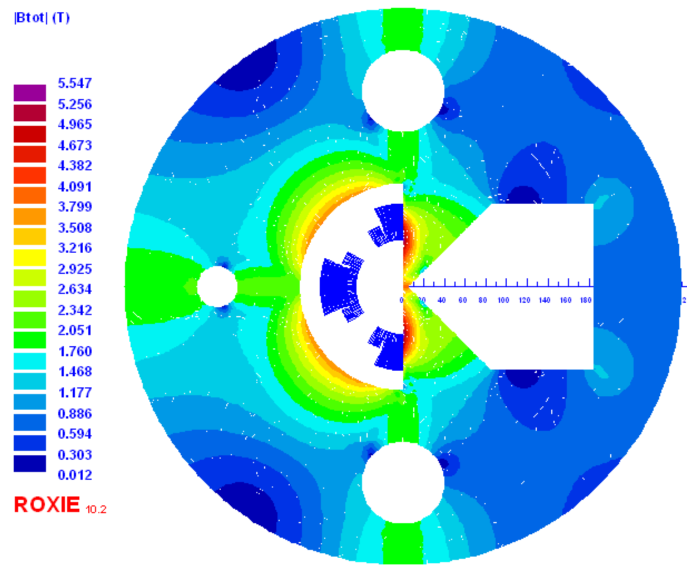


Ring-Ring option. Single aperture magnet for two proton beams, 127 T/m, 4600 A, MQY cable



Comparison Q1 for Ring-Ring and Linac-Ring





NbTi: 6700 A, 248 T/m at 88% LL Nb3Sn: 8600 A, 311 T/m, at 83% LL	NbTi: 4500 A, 145 T/m, 3.6 T at 87% Nb3Sn: 5700 A, 175 T/m, 4.7 T at 82% on LL
23 mm aperture 87 mm septum	46 mm (half) aperture 63 mm septum (space for p and e-beams)
0.03 T, 3.5 T/m in e-beam pipe 0.09 T, 9 T/m in e-beam pipe	0.37 T, 18 T/m 0.5 T, 25 T/m

Development in Nb_3Sn Technology

Assumtions 2010-201:

Nb3Sn in accordance with measurements on single strands for CLIC wiggler development (HFM46) and **goals** for the development of cables for HE-LHC, inner-triplet upgrade, 2500 A/mm^2 at 12 T and 4.2 K and operation at about 80% on the load-line.

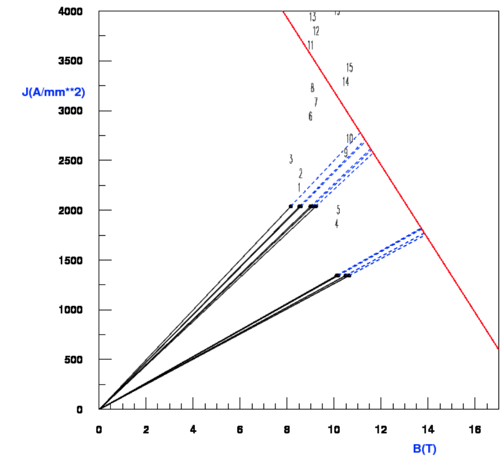
3 Years later :

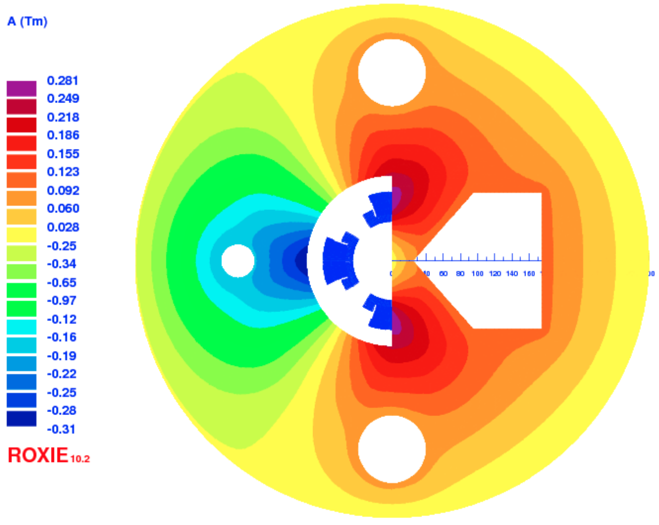
Increase L* to 15 m (Rogelio, Luke, Emilia) to avoid magnets on cantilevers and to decrease synchrotron radiation -> larger aperture but lower gradient and larger beam separation.

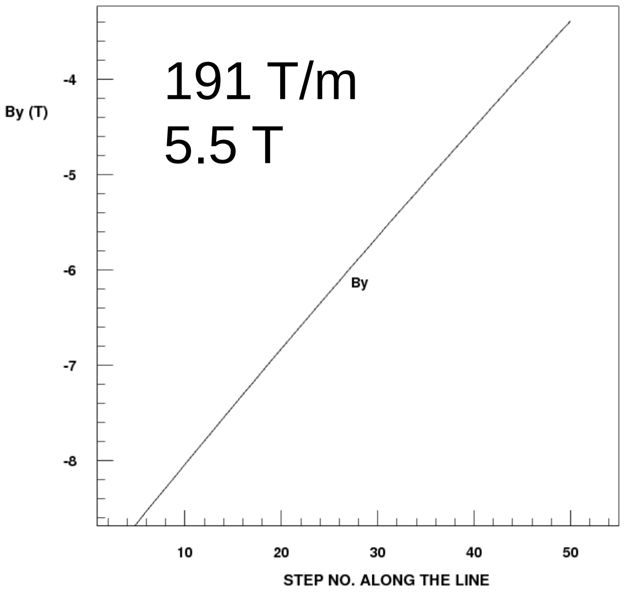
Performance of the today specified Nb3Sn 0.85 mm diameter strand for the MQXF quadrupole, 2450 A/mm^2 at 12 T and 4.2 K. External diameter: 0.85 mm, Cu/non Cu ratio = 1.2. We are presently receiving strands with better performance, about 2800 A/mm^2 at 12 T and 4.2 K (Amalia).

Option 1

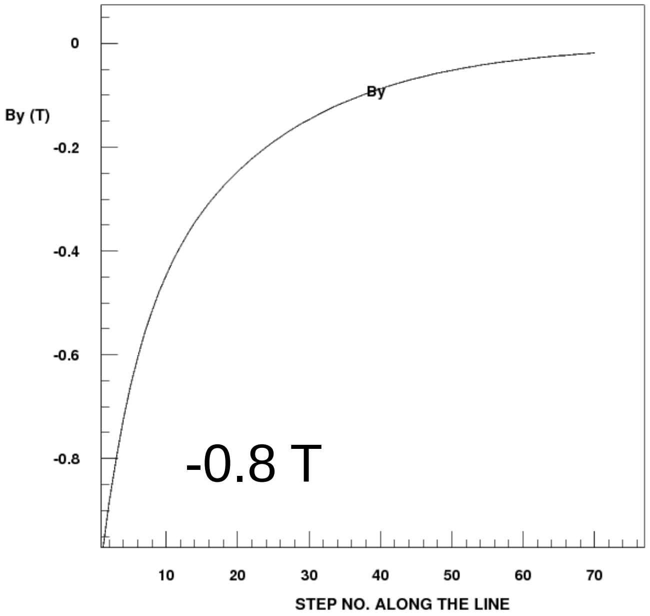
Stick to L* = 10 m, using a Q1 gradient of 185 - 190 T/m, we have a half-quad design with stray quadrupole field of about 7 T/m.





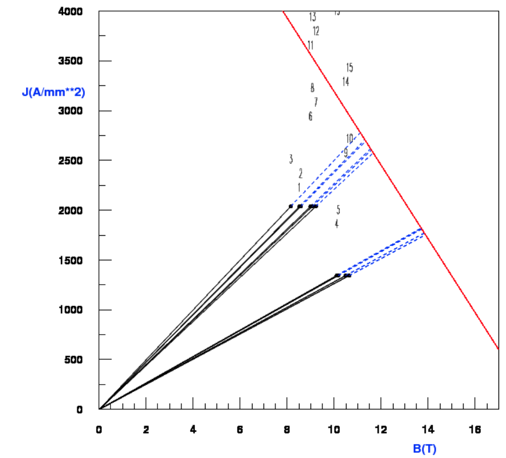


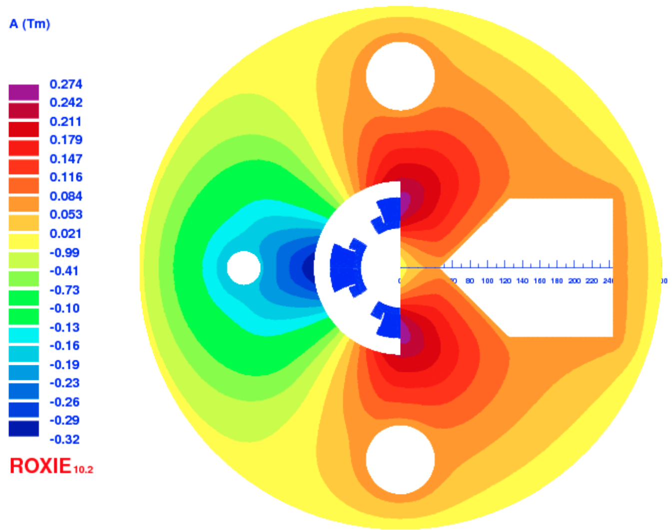
Septum 25 mm

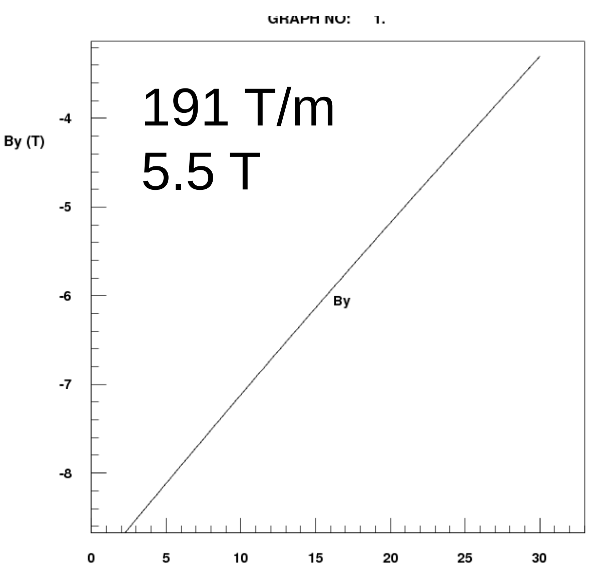


Option 1 (Effect of Increased Septum)

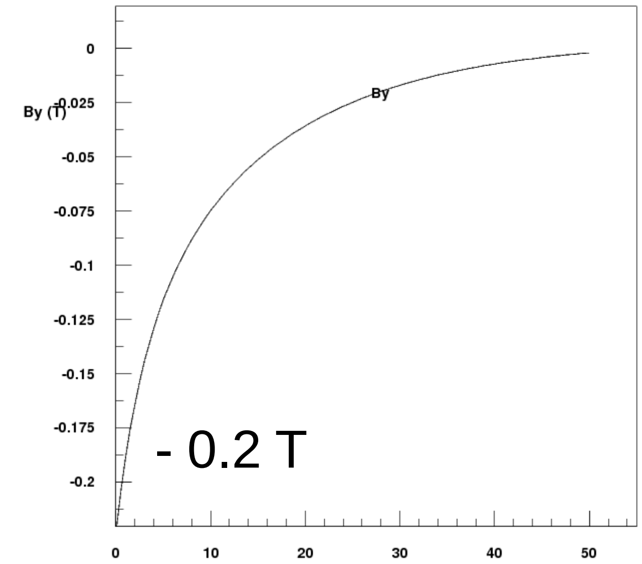
Sticking to L* = 10 m, using a Q1 gradient of 185 - 190 T/m, we have a half-quad design with stray quadrupole field of about 7 T/m.



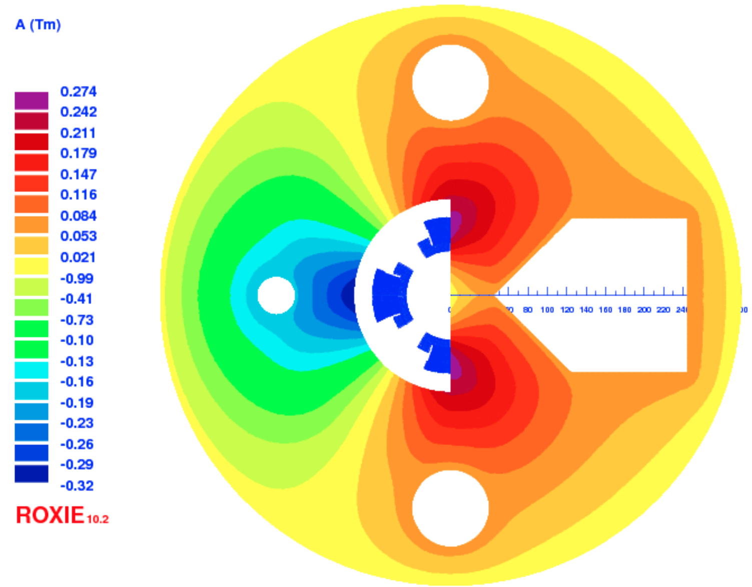




Septum 45 mm



Option 1: Multipole Field Errors

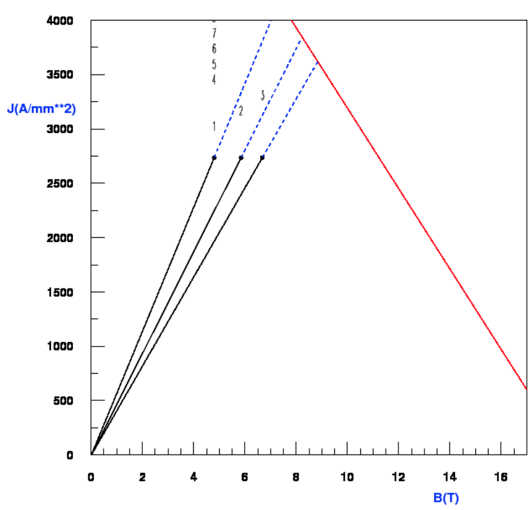


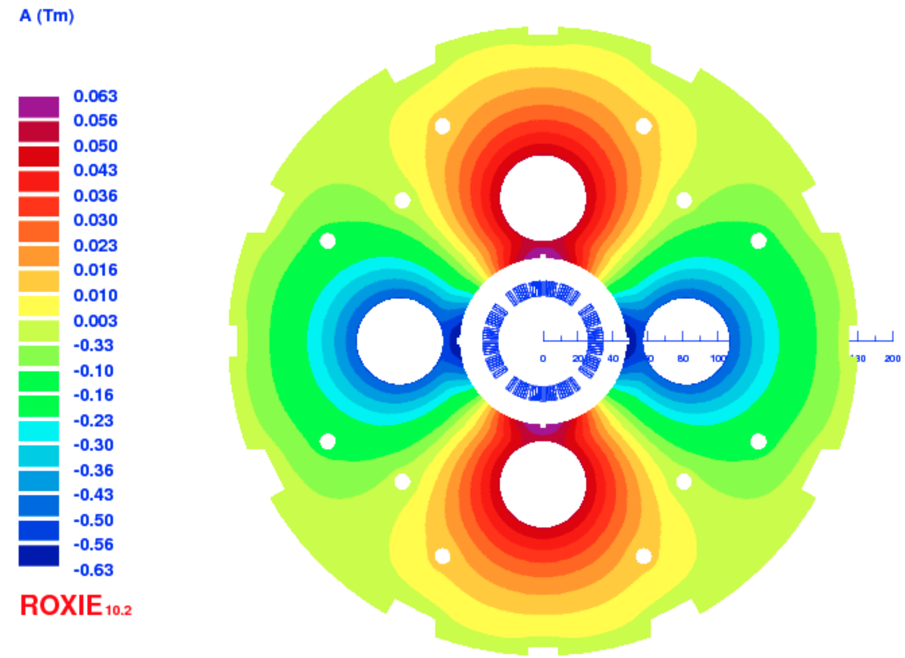
NORMAL RELATIVE MULTIPOLES (1.D-4):

b 1:	-29044.32176	b 2:	10000.00000	b 3:	-190.67548
b 4:	26.29124	b 5:	10.59001	b 6:	0.12894
b 7:	0.23314	b 8:	-0.19006	b 9:	-0.20488
b10:	-0.09527	b11:	-0.03808	b12:	-0.02584
b13:	-0.00987	b14:	-0.00388	b15:	-0.00277
b16:	-0.00167	b17:	0.00053	b18:	-0.00028
b19:	-0.00105	b20:	0.00067	b	

Option 2

L*=15m, using a Q1 gradient of 164 T/m, we can use a regular quad design with vanishing stray field in the electron aperture and about 82 mm separation. Also, no dipole field in the proton aperture





NORMAL RELATIVE MULTIPOLES (1.D-4):

b 1:	0.00063	b 2:	10000.00000	b 3:	0.00006
b 4:	0.00046	b 5:	-0.00005	b 6:	-24.87454
b 7:	-0.00000	b 8:	0.00000	b 9:	-0.00000
b10:	0.20772	b11:	-0.00000	b12:	0.00000
b13:	-0.00000	b14:	0.00170	b15:	-0.00000
b16:	-0.00000	b17:	0.00000	b18:	0.00001
b19:	0.00000	b20:	0.00000	b	