“An alternative Super-ferric design for ILC QD0”

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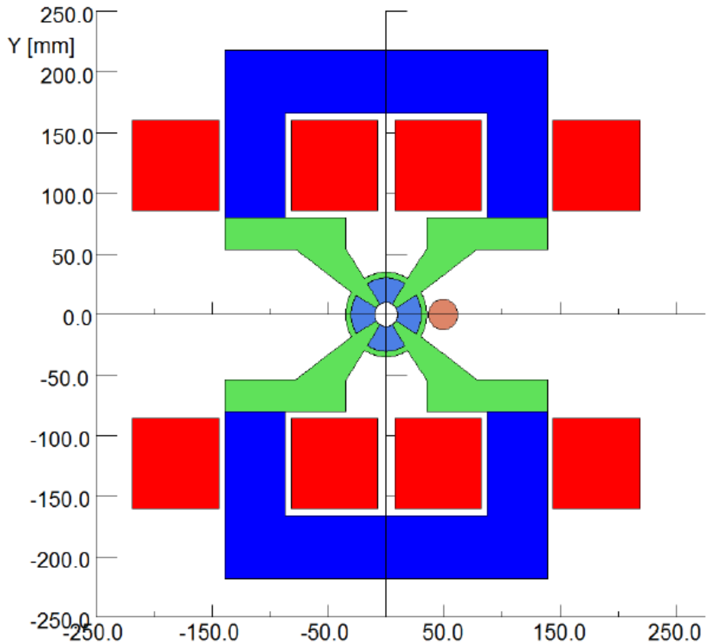
Referring to a contribution presented last year at LCWS13 in Tokyo…

A hybrid QD0 for ILC ?



On the left, a basic sketch for the hybrid CLIC QD0 adapted to the ILC parameters:

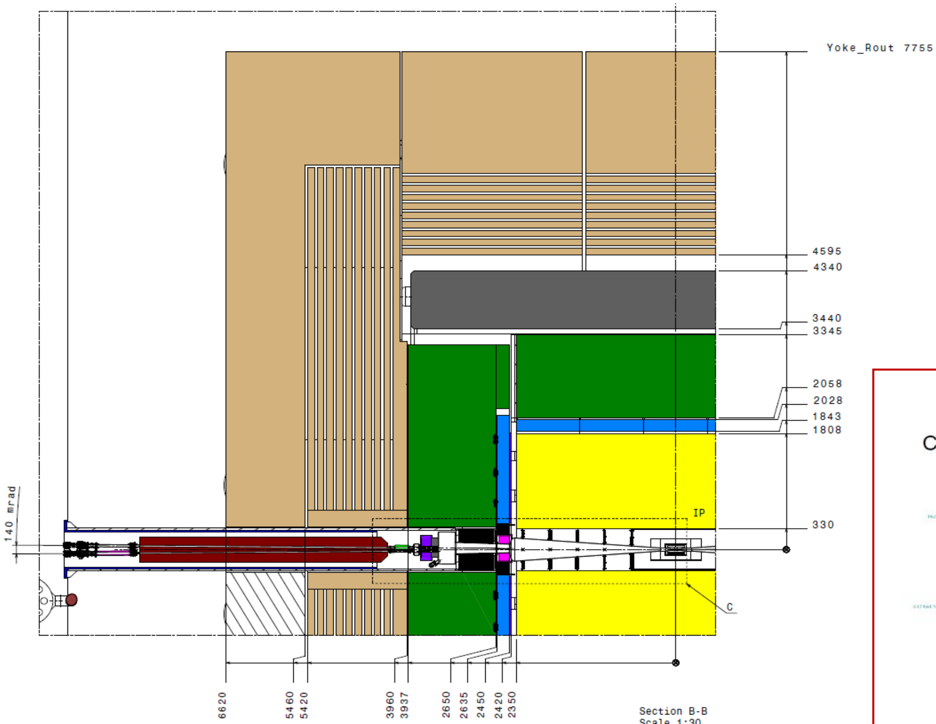
- As for CLIC case, this solution minimises vibrations; coils are sized for a current density J ~ 0.9 A/mm (→ no water cooling).
- Overall dimension are in the range of 500 x 500 mm.

Other solutions to minimise the cross-section, could be envisaged:

- *A coils cooling system could be added if not detrimental to magnet stability (micro-vibration)*
- *Even more interesting, a "**super-ferric**" solution could be envisaged; (I had very interesting discussions with **Akira Yamamoto** on this two weeks ago, and this could become a very interesting subject to be developed…)*

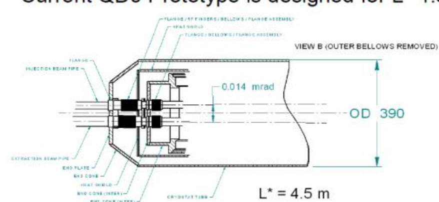
We decided to develop the conceptual design for this super-ferric solution considering the space availability inside the ILD and SID Detector under study for ILC. The layout of the two experiments were also presented last year at LCWS13. We take those dimensions as input.

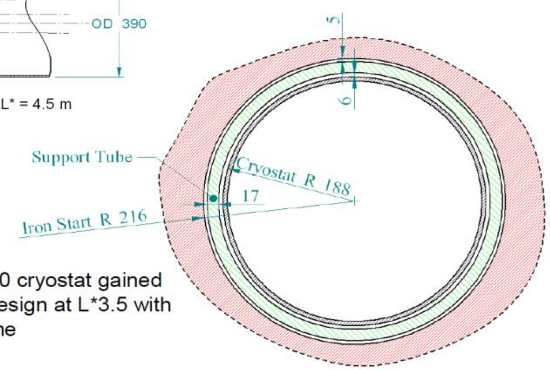
ILD Dimensions



Space Requirements

Current QD0 Prototype is designed for L* 4.5 m





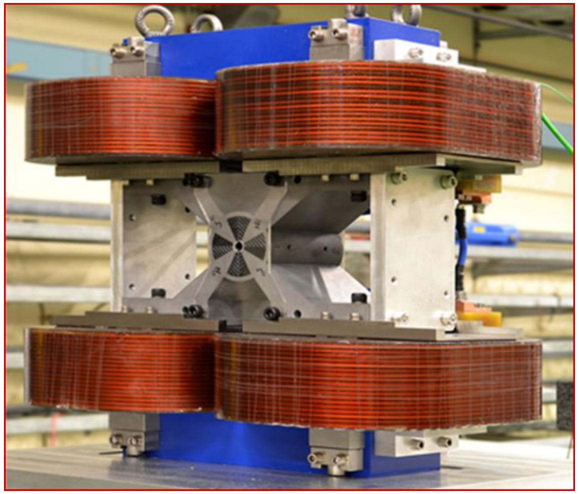
14 mm reduction of the QD0 cryostat gained moving the present QDO design at L*3.5 with the 14mrad crossing scheme
(1 m x 14 mrad = 14 mm)

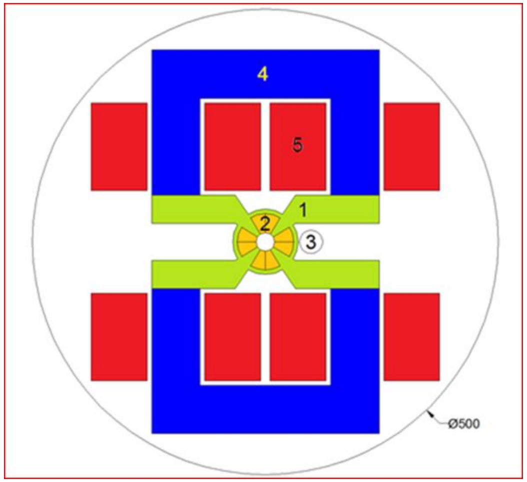
L* 3.5 m cross section

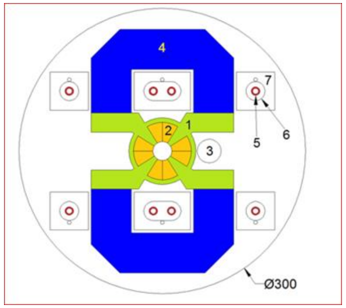
ILD (top) and SID (right) MDI layouts:
QD0 supporting cylinder inner diameter: 376 mm in SID and 600 mm in ILD

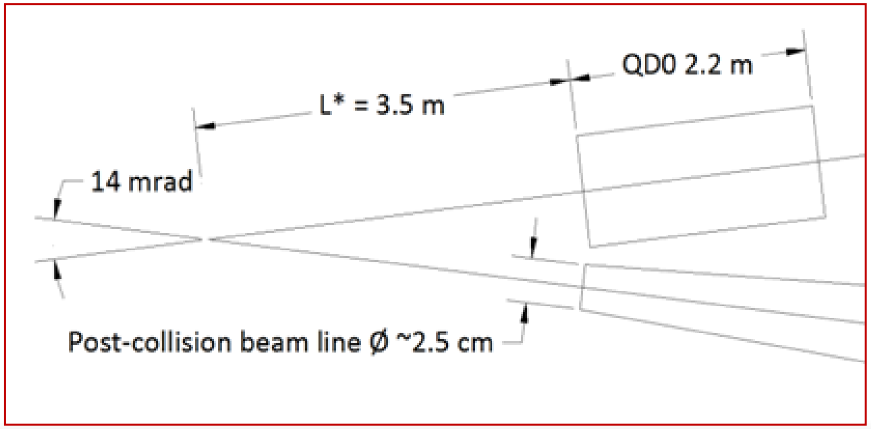
(courtesy M.Oriunno and K. Buesser)

The super-ferric variant (i.e. same hybrid core design but with small superconducting coils at the place of the low current density resistive coils) will solve the problem of minimize the cross section (dimensions and weight) preserving the most interesting aspects that is: iron part is “visible” and accessible making easier and much precise the alignment and eventually the stabilization the FF quadrupole.

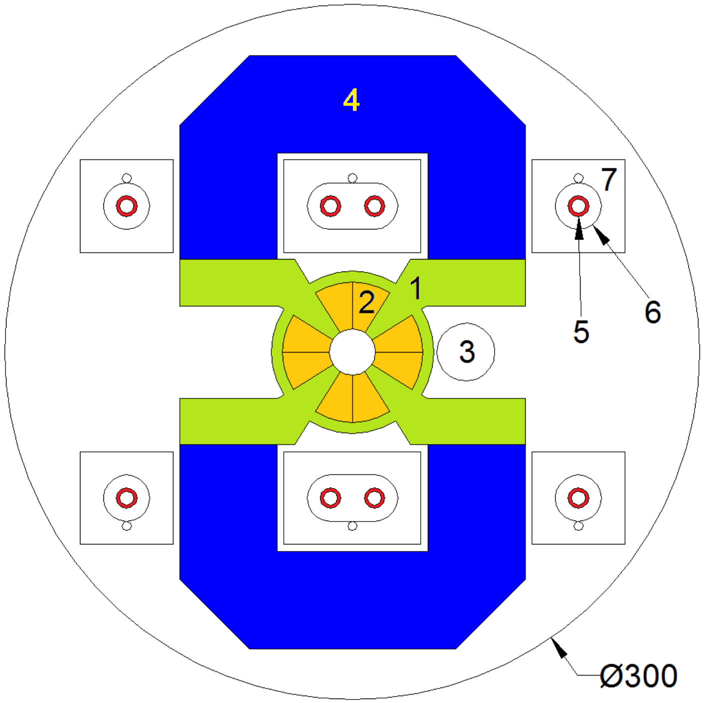


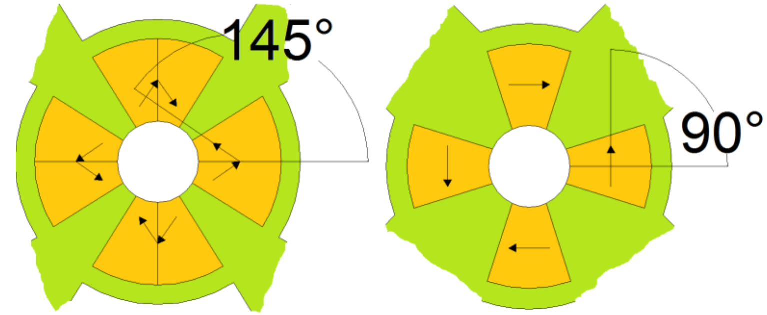






Gradient	127 T/m
Aperture radius	10 mm
Ampere-turns	5 kA



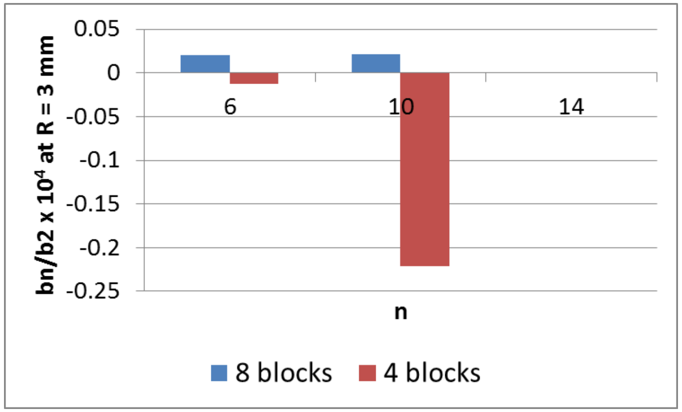


8 PM blocks   4 PM blocks

NI [A]	0	1250	2500	3750	5000
G [T/m]	34.494	42.807	68.333	98.196	127.30
b6	63.206	46.397	20.332	7.049	0.021
b10	0.219	0.166	0.083	0.041	0.022
b14	-0.001	0.000	0.001	0.001	0.001
b18	0.027	0.020	0.009	0.003	0.000

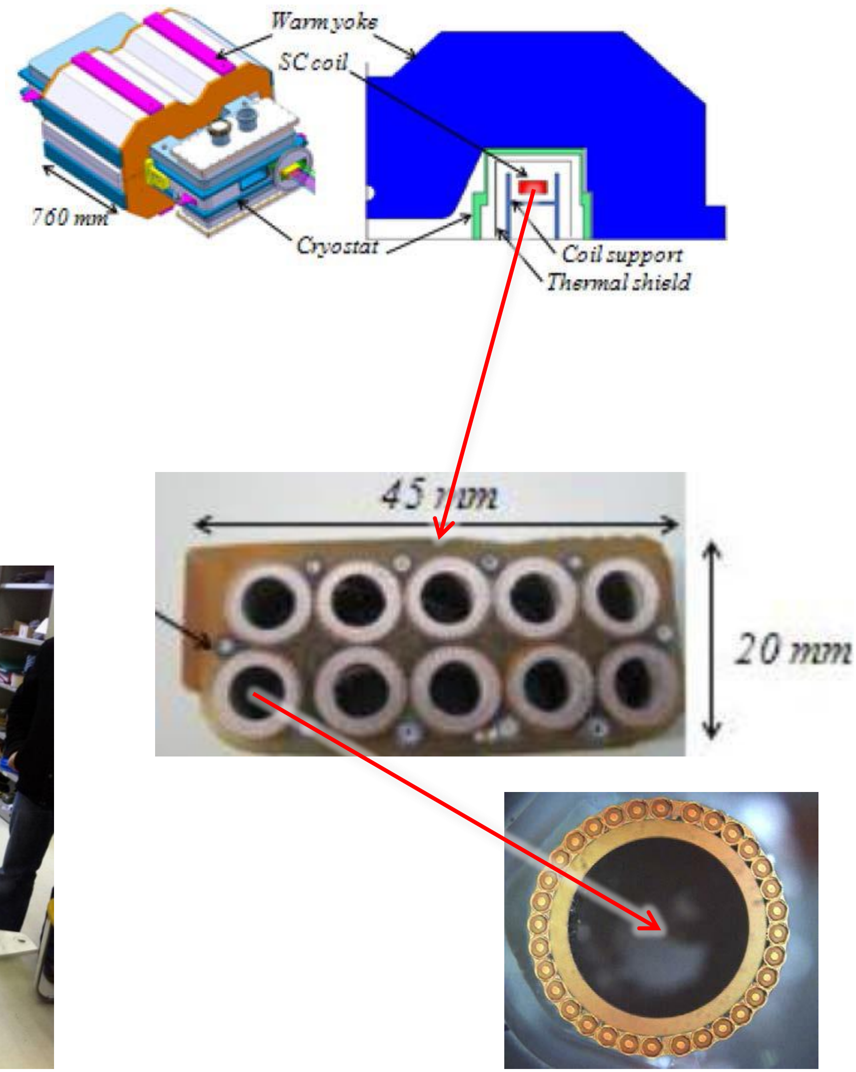
magnetic field harmonic content with 8 PM blocks configuration

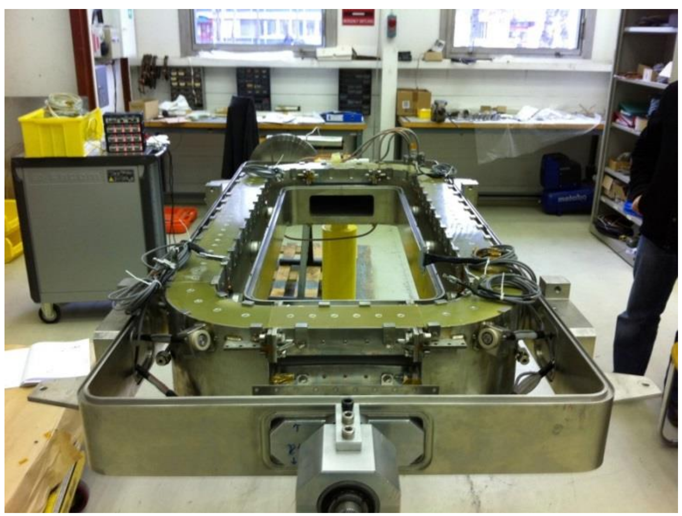
1. Quadrupolar core in Permendur
2. SmCo PM inserts
3. Post-collision line vacuum chamber
4. Return iron yokes
5. Coil packs: 9 NbTi SC wire turns wound around the 4.5 K LHe cooling circuit pipe.
6. Cryostat @75K shield
7. Cryostat assembly



6 vs.4 blocks magnetic field harmonic content (at nominal current)

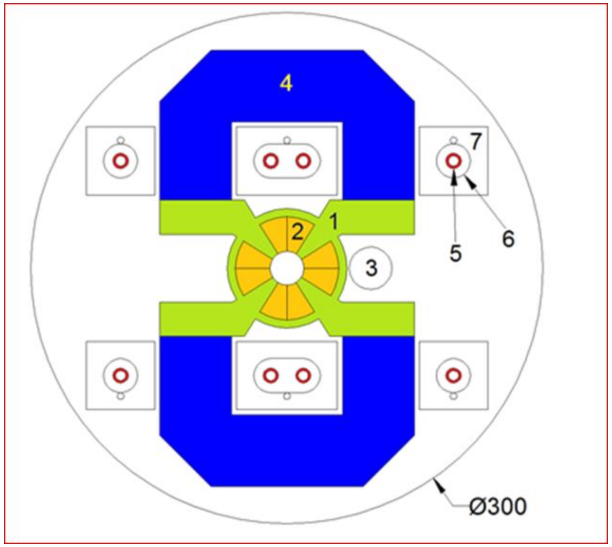
This design takes advantage of the recent experience on manufacturing the Fast Cycling Magnet super-ferric prototype, where performances similar to ones required in the super-ferric QD0 were successfully achieved on very compact cryostat dimensions.





Some magnet design details:

- The required 5000 ampere-turns are carried by 9 turns of "F24" type Nb-Ti wire from the company Bruker with a cross-section of 1.8 mm2 and with 24 Nb-Ti filaments (5).
- The cryostat assembly (7) with its intermediate shield @75K (6) will be composed by two halves assembled around the coil packs made by the 9 SC wire turns wound around the 4.5 K LHe cooling circuit pipe (5).
- Thermal shields and coil casings will be covered by a low emissivity surface protection (no multi-layer insulation presence).
- First calculations show that, with a protection resistance of 200 mΩ, in case of quench the coil temperature will remain acceptable in the range of 30 K.
- The other main components are like in the resistive coils version: a core part in Permendur (1); the eight SmCo PM inserts (2); design compatible with the presence of the post-collision line chamber (3); return iron yokes (4).



Note: The work was presented at IPAC14 Conference (June14 in Dresden):
M. Modena, A. Aloev, H. Garcia, L. Gatignon, R. Tomas, CERN, Geneva, Switzerland: "CONSIDERATIONS FOR A QD0 WITH HYBRID TECHNOLOGY IN ILC"

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Thanks for your attention