Antisolenoids for SiD

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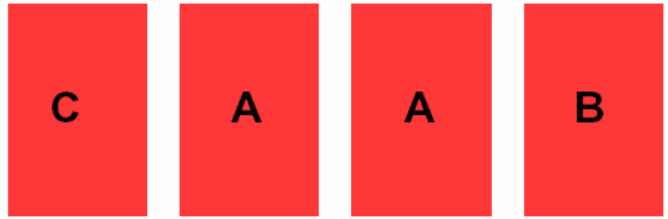
Antisolenoids for SiD

- Major effect of solenoid on the beam size is due to overlap of its field with FD quads
- Weak antisolenoids allow compensating the effect of the main solenoid on the beam size for all beam energies
  [Phys.Rev.ST Accel.Beams 8:021001,2005]
- Effective position, width and strength of the compensating field need to be adjustable

Anti-Solenoid Split Into Four Subcoils

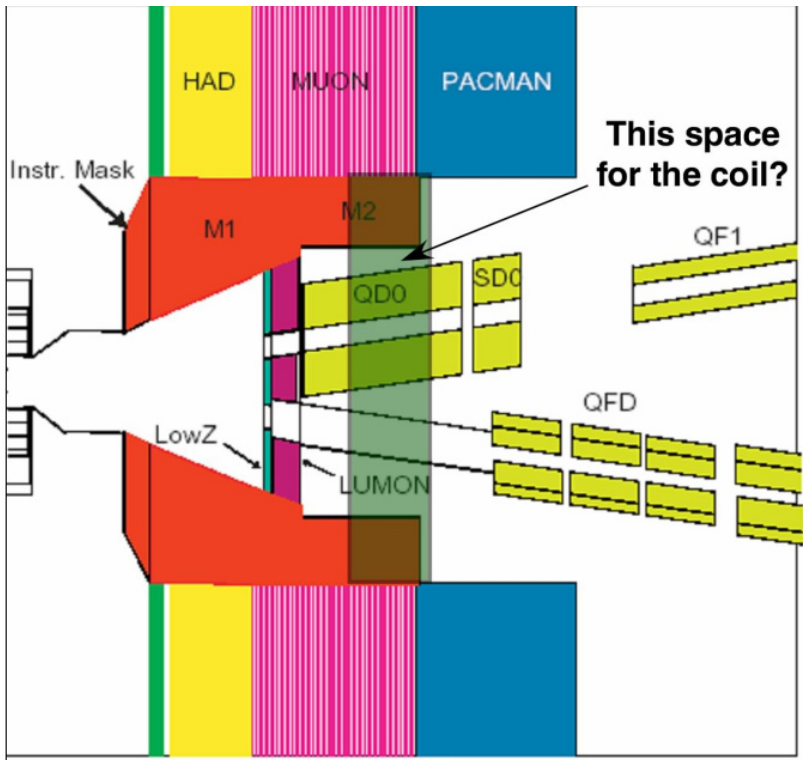


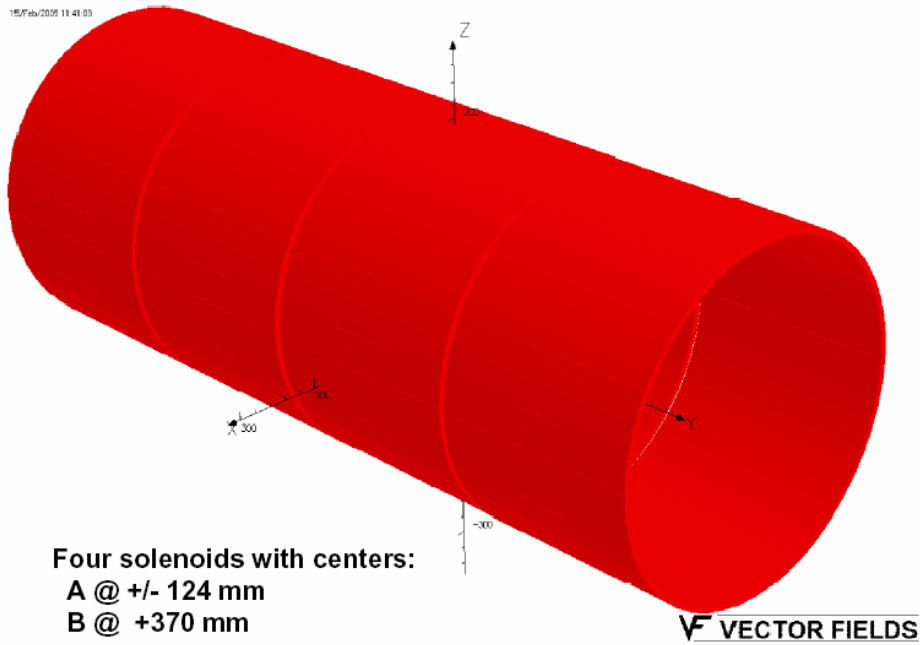
$$I_a = I_o + I_1$$

$$I_b = I_o - I_1 + I_2$$

$$I_c = I_o - I_1 - I_2$$

If each subcoil has the same number of turns then overall strength is determined by I_o. Modify width via trim I_1 and asymmetry via trim current I_2.

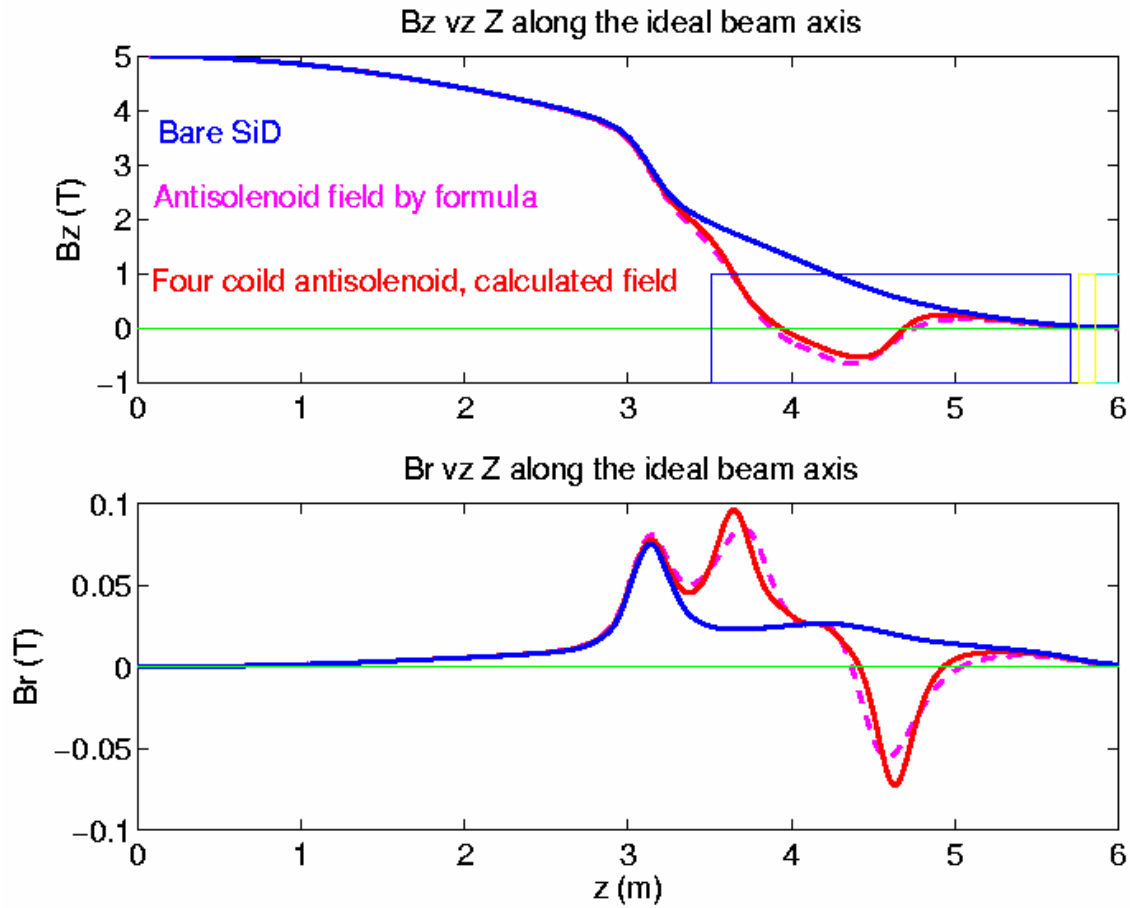




Four solenoids with centers:
A @ +/- 124 mm
B @ +370 mm
C @ -370 mm

L_s = 240 mm, R_{inner} = 190 mm, Thickness = 6 mm, J = -235 A/mm^2

SiD with and without antisolenoids

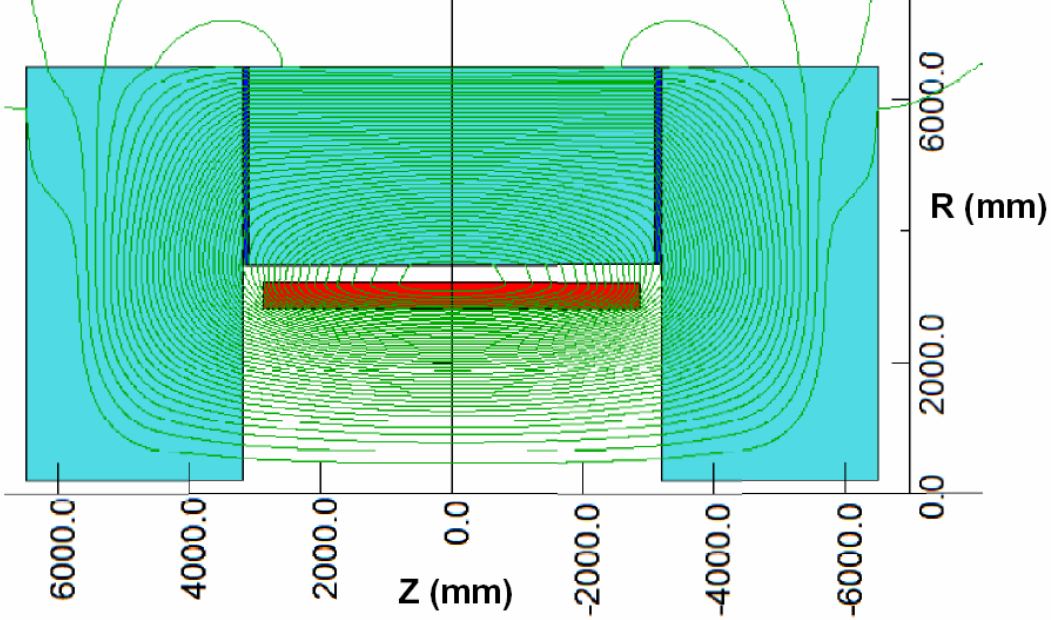


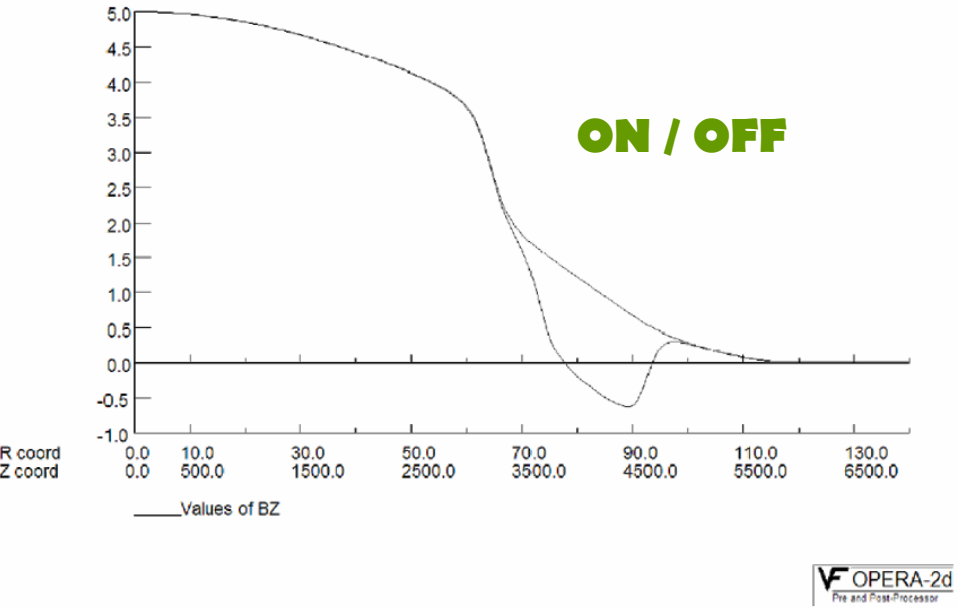
Beam size is compensated with

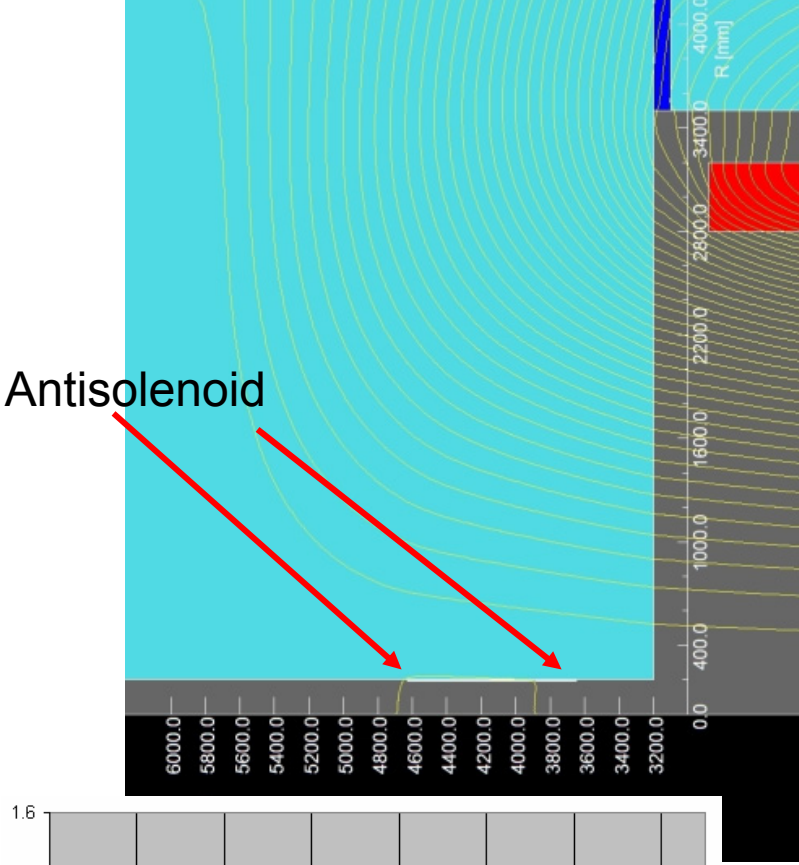
a) Field approximation by formula: $\sigma_y/\sigma_{yo} = 1.38$

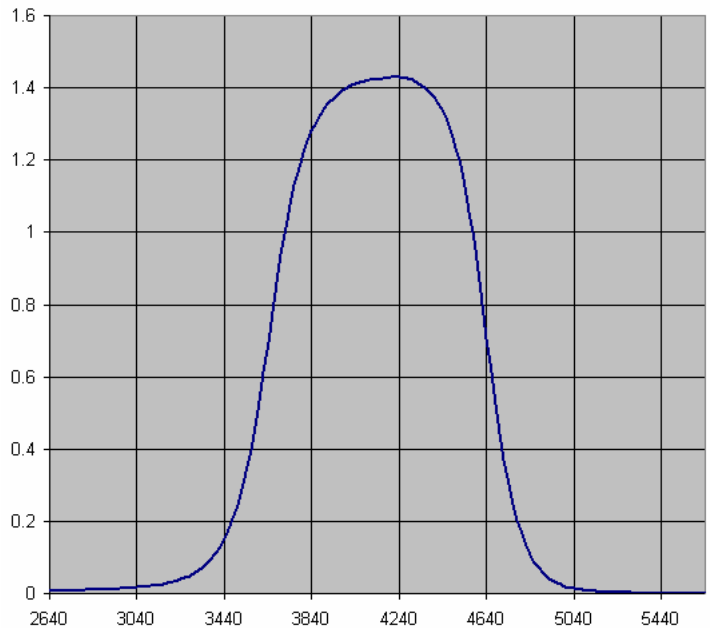
b) Calculated (in air) coils: $\sigma_y/\sigma_{yo} = 1.45$ (not yet using the current knobs)

(For comparison: without antisolenoid: $\sigma_y/\sigma_{yo} = 27.6$ for ILC parameters)









Effect of iron: slight asymmetry

Four independent a-solenoids + DID allow to compensate beam size, and minimize both the IP angle and SR beam size growth

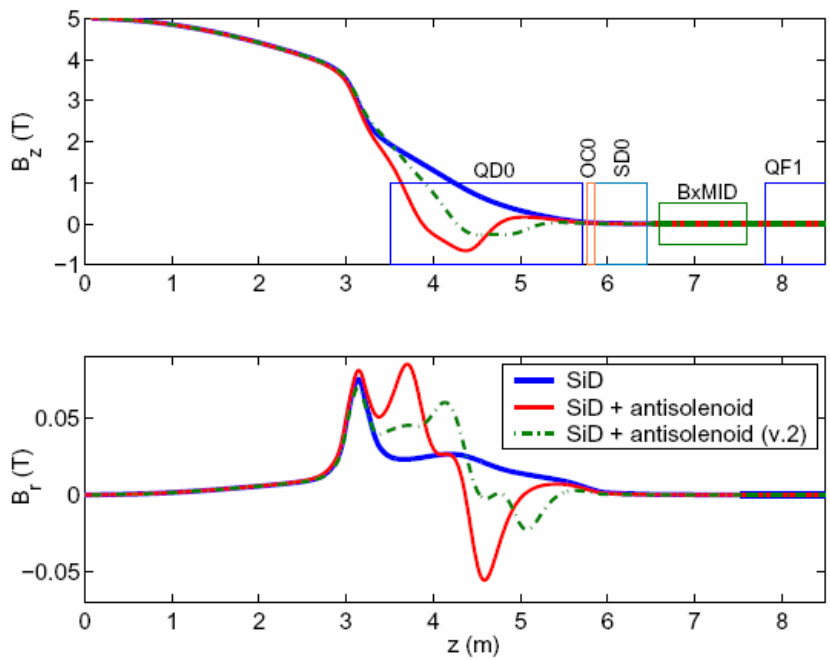


FIG. 3: Longitudinal and radial magnetic field in SiD calculated by ANSYS, without and with the weak antisolenoid which cancels the beam distortions produced by the detector solenoid. The red line shows the field with the antisolenoid parameters suggested in [1], and the green dot-dashed line shows the field with another configuration of the antisolenoids, optimized to reduce SR effects (see text). The radial field is at the nominal beam trajectory with half crossing angle $\theta_c = 10$ mrad. Locations of the Final Doublet elements (quadrupoles QD0 and QF1, sextupole SD0, octupole OC0 and an optional dipole corrector BXMID) are also shown. The IP is at $z = 0$ m.

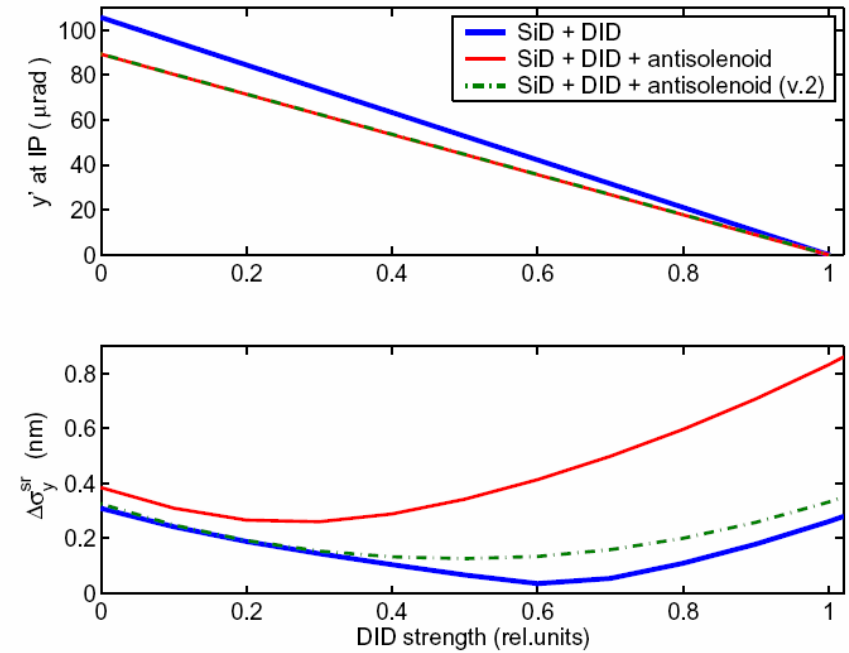


FIG. 9: Vertical angle at the IP (top) and the beam size growth due to synchrotron radiation (bottom), versus strength of the DID corrector, without antisolenoid (thick blue line), with the antisolenoid with parameters suggested in [1] (red line), and with the antisolenoid optimized to reduce the SR effects (green dash-dotted line).

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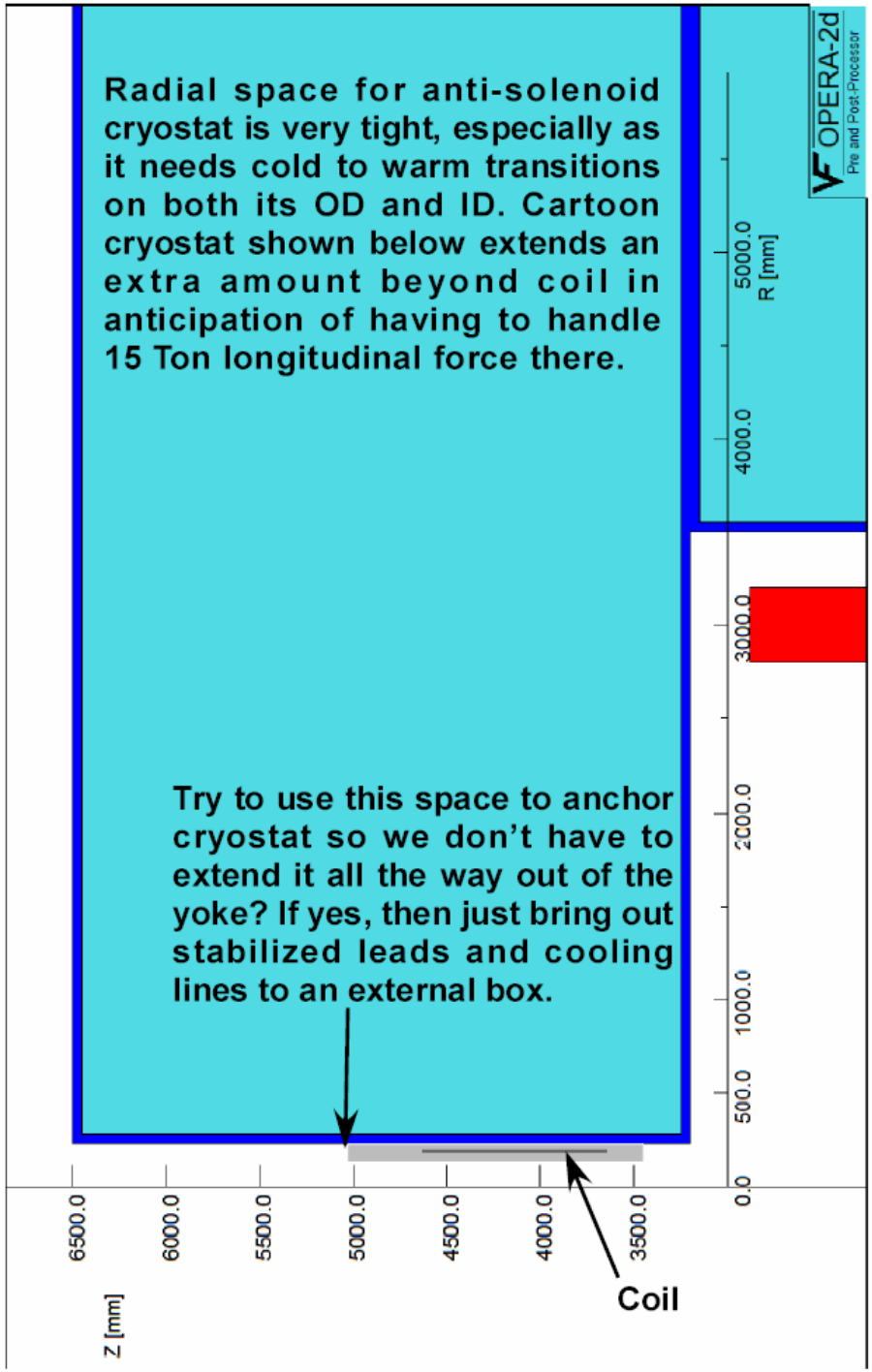
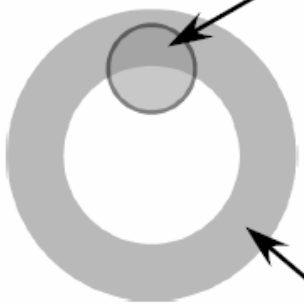
(Position of antisolenoids was not exactly the same as in latest layout, but very similar)

Updated version of antisolenoid layout

In this case, the proposed radial budget tries to accommodate everything in 70 mm of radial space going from 158 to 228 mm



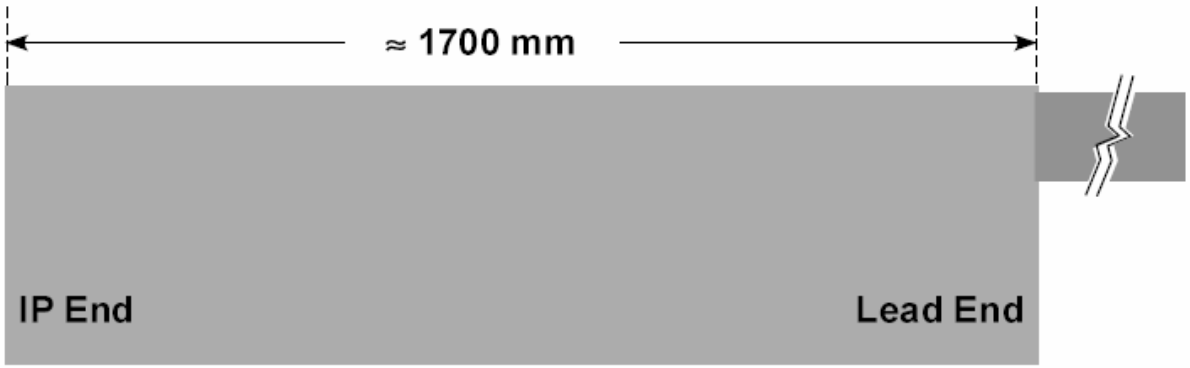
Cryostat Cartoon



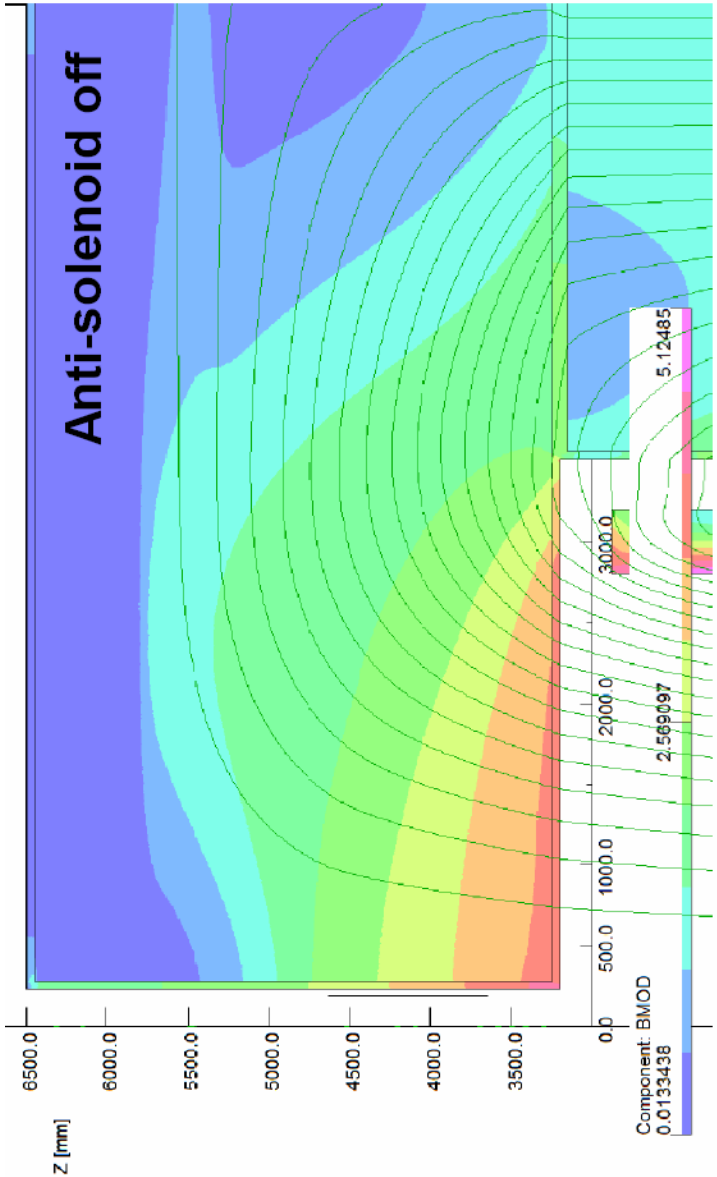
Connection to bring leads and cooling in/out.

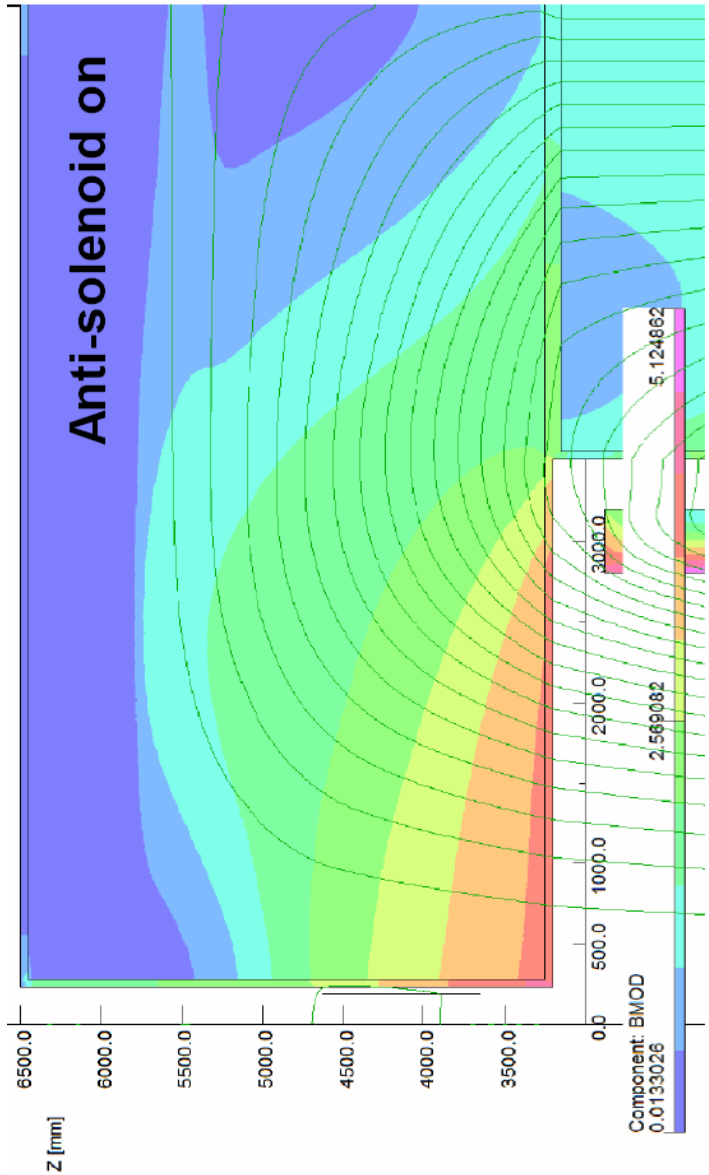
Place this at top to stay out of the way of QD0 support structure? (cryogenic flow issues?)

Ring shaped cryostat, ID ≈ 316 mm & OD ≈ 456 mm, that is anchored to the solenoid yoke?



Coil active length = 1220 mm, budget of 1700 mm gives 150 mm between coil and IP end and 330 mm at lead end. Warm to cold transition at lead end has to accommodate 15 Ton force. Expect to do this with a set of 20 mm dia. G10 rods used in compression that are 160 mm long and spaced uniformly on the cold mass flange at the lead end?





The field in the endcap does not change much with antisolenoid ON/OFF