

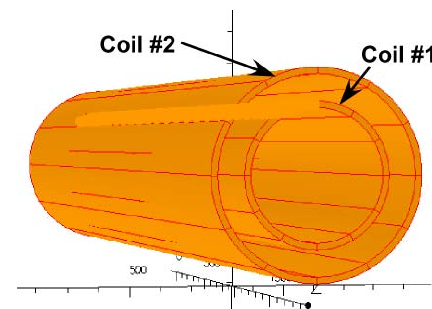
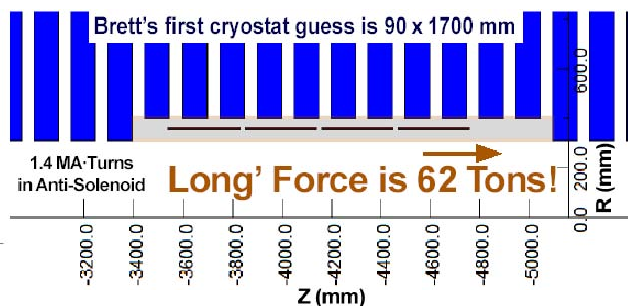


FCAL Workshop at the SiD Meeting Fermilab, April 9-11, 2007.



The Anti-Solenoid Design: Work in Progress.

as reported by Brett Parker, BNL

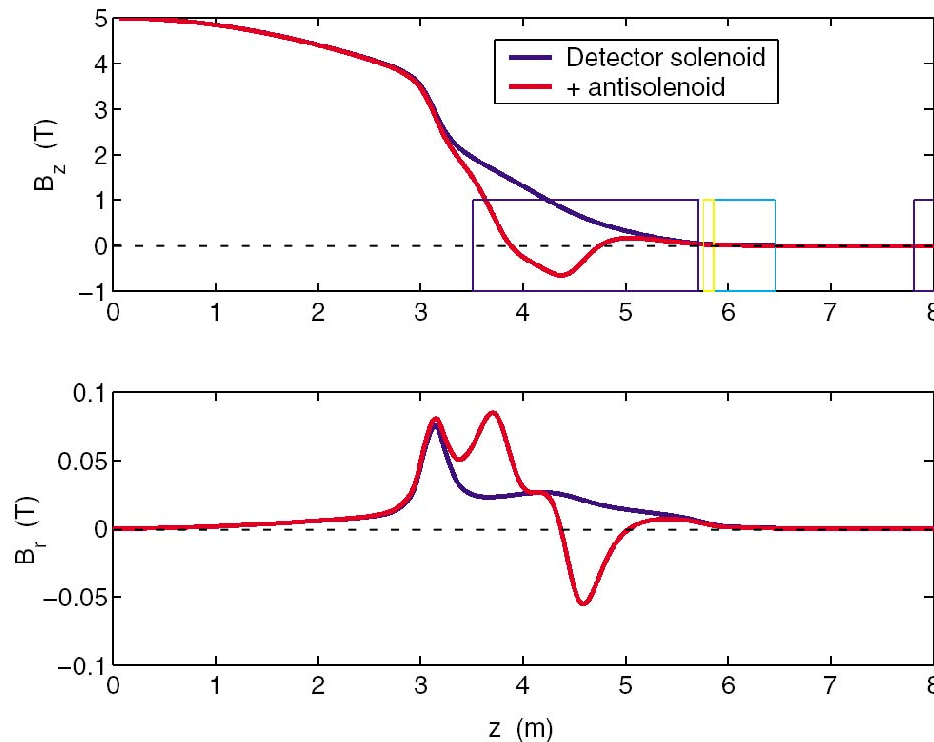


Force Neutral Anti-Solenoid



Overlap of FF and Detector Fields: Anti-Solenoid to Maintain Luminosity.

Nosochkov and Seryi, *Compensation of Detector Solenoid Effects on the Beam Size in a Linear Collider*, Phys. Rev. Special Topics – Acc. and Beams, 8, 021001 (2005).



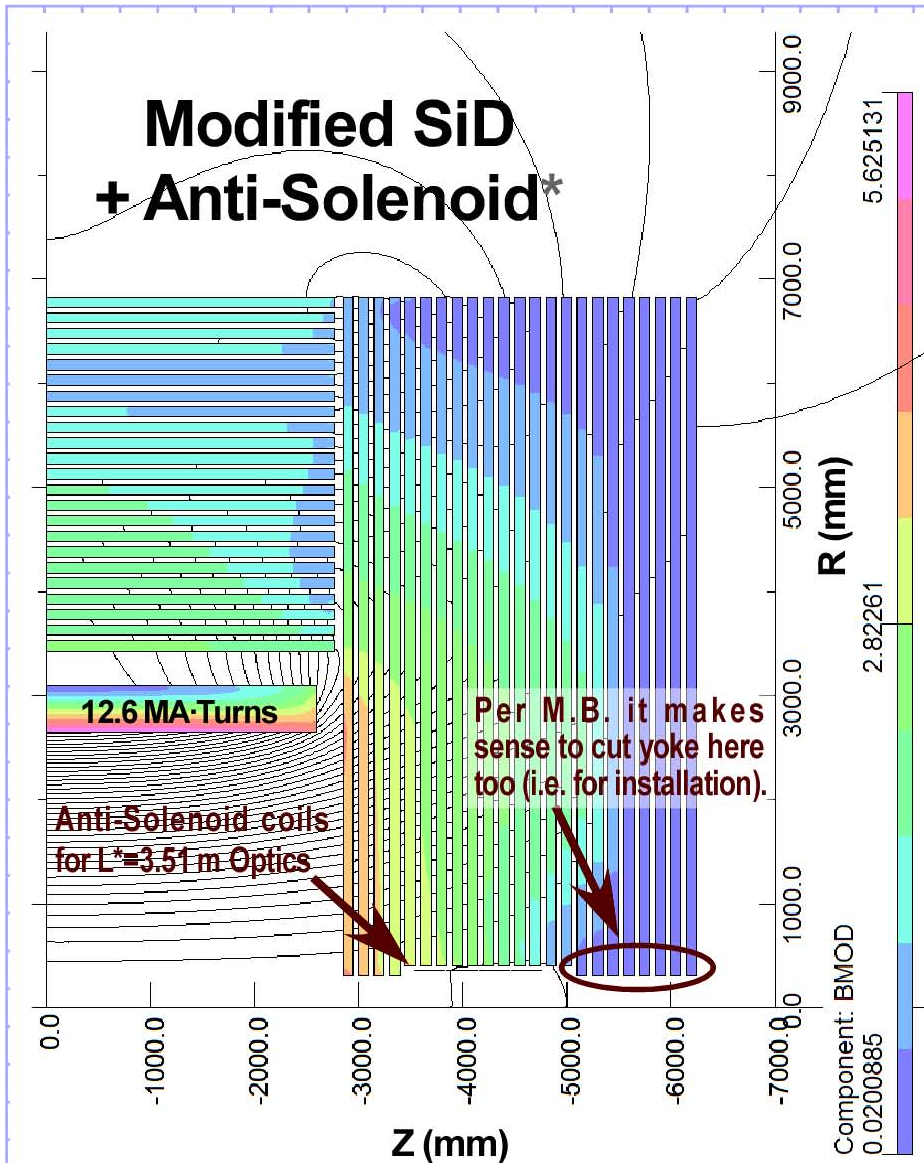
- Beam size increase due to field overlap.
- Not X-ing angle dependent (i.e. an issue for 14 mr as well as for head-on).
- Very effective local compensation with AS.
- Do not have to zero the solenoidal field; only zero a few matrix elements via weak AS.

$$R_{32} \propto \int_{QD0} \mathbf{B}_z \sin(\mu_x) \sin(\mu_y) \sqrt{\beta_x \beta_y} dz = 0$$

$$R_{36} \propto \int_{QD0} \mathbf{B}_z \eta_x \sin(\mu_y) \sqrt{\beta_y} dz = 0$$

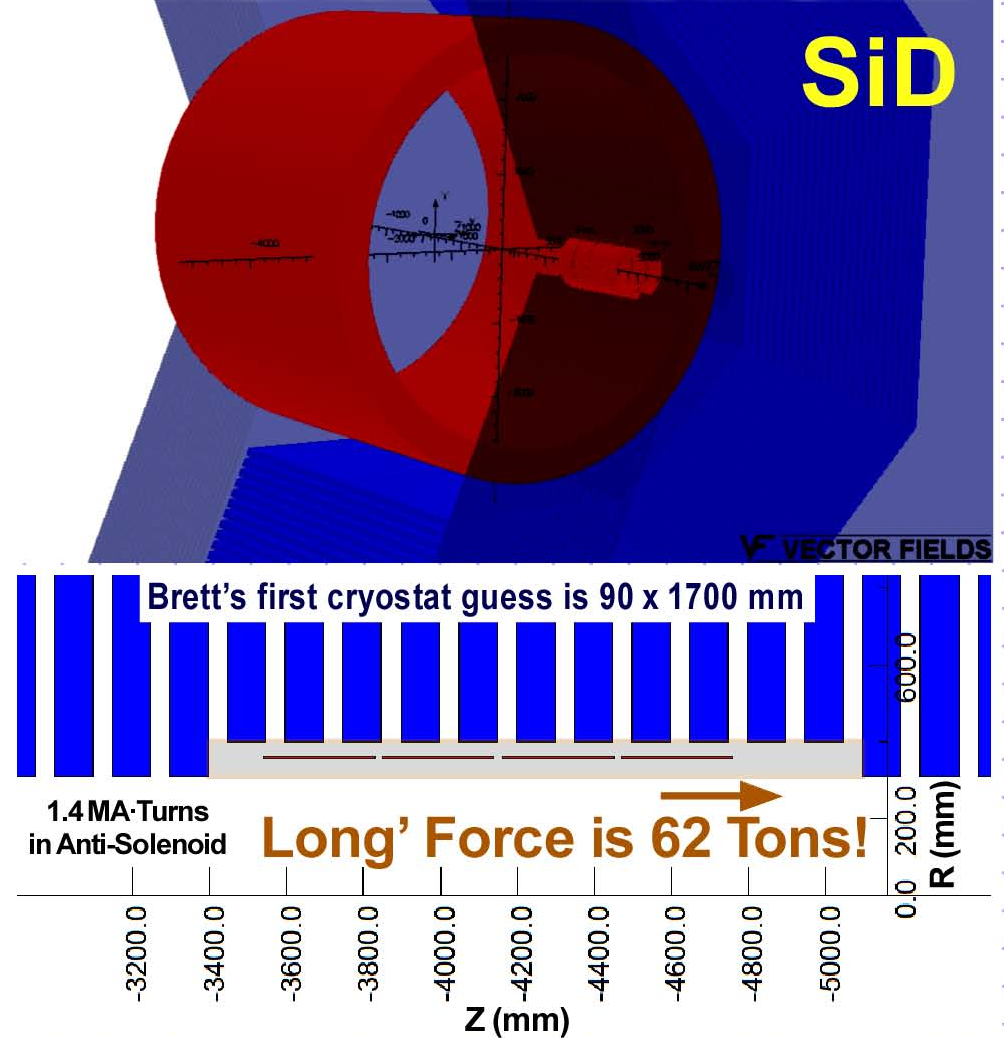


First Generation Anti-Solenoid Design (Some Design Features and Drawbacks).



*Anti-solenoid strength must be adjusted to meet optics requirements.

AS has major impact on endcap configuration.



Too much force to share QDO cryostat!



New Concept: The Force Neutral Anti-Solenoid.

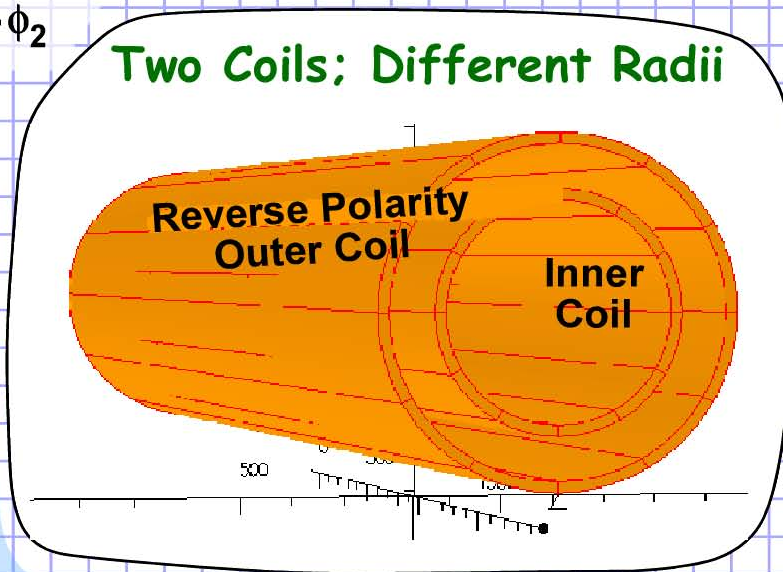
For a loop of circumference C carrying current I the longitudinal force is proportional to Br , thus

$$\text{We want } \sum_{j=1}^{N_1} (I_1 C_1 Br_1)_j + \sum_{k=1}^{N_2} (I_2 C_2 Br_2)_k = 0$$

Since $C \propto R$ and $Br \propto R$, so $CBr \propto R^2$ and for $I_1 = -I_2$ we have

$$N_1 \bar{A}_1 = N_2 \bar{A}_2 \text{ or } \phi_1 = -\phi_2$$

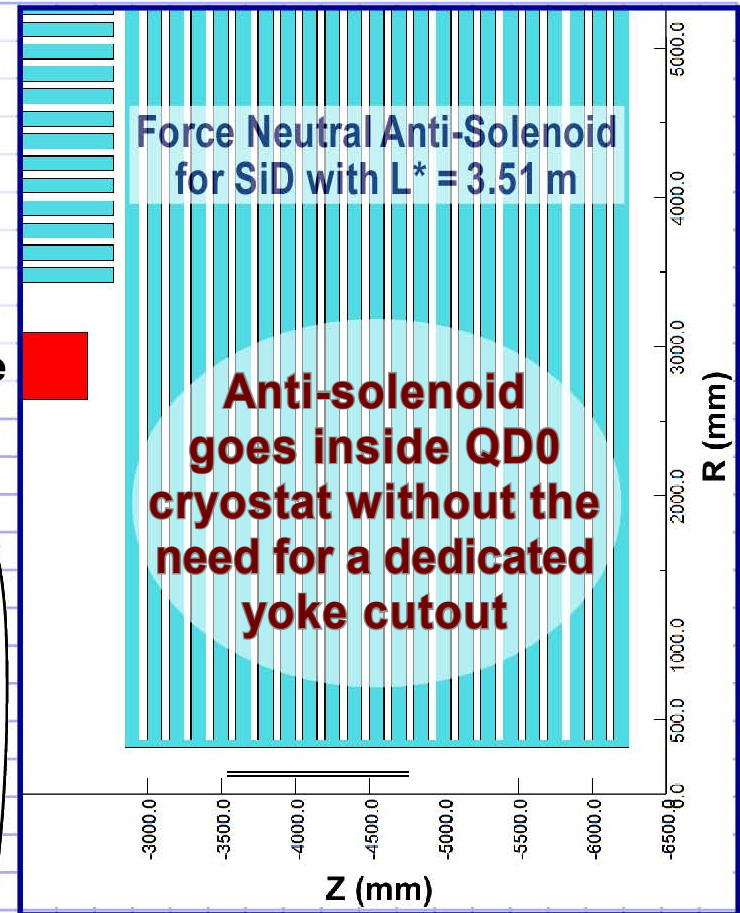
Two Coils; Different Radii



We can arrange for the sum of the forces on the inner and outer coils to

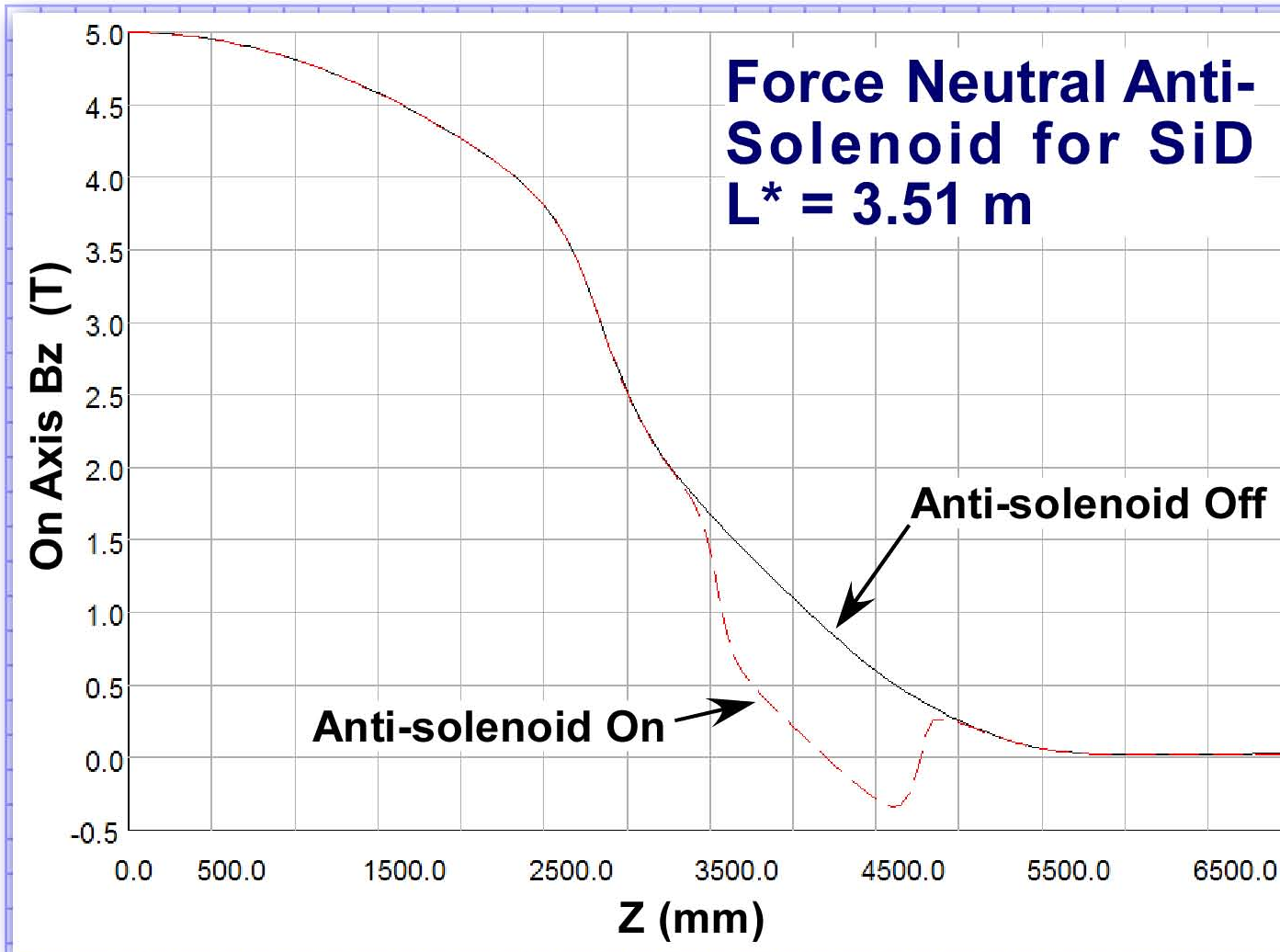
fully cancel... but still have a net anti-solenoidal field inside the inner coil.

Note: This solution does not require detector changes for different L^* .





Force Neutral Anti-Solenoid: SiD, $L^* = 3.51$ m (One Example).



Thanks to cancellation between the external fields of the inner and outer coils, the force neutral anti-solenoid has very little impact on the detector field away from QDO.

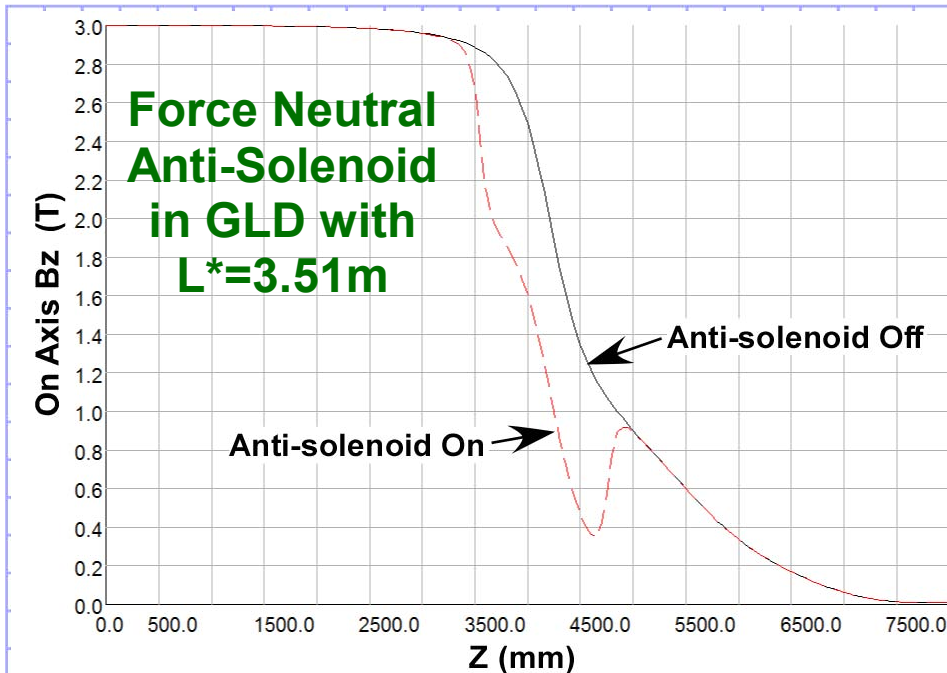
Note: we will use trim currents to fine tune the field shape for optics optimization while remaining force neutral.

This is a flexible configuration that can be adapted to various values of L^* .

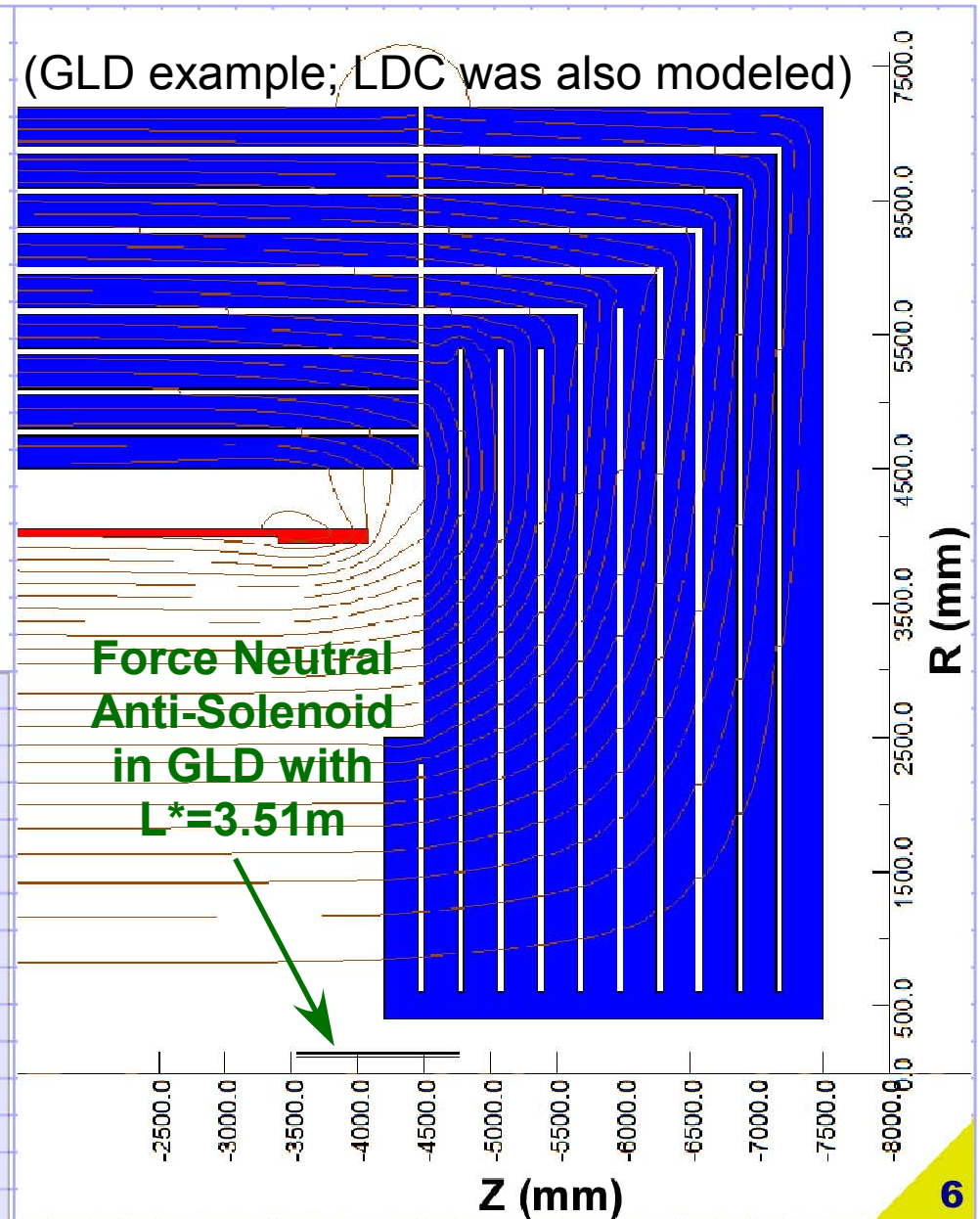
The force neutral anti-solenoid has very little external field, unlike the open coil first generation design.



The anti-solenoid must overlap QD0, therefore its impact depends upon L^* .



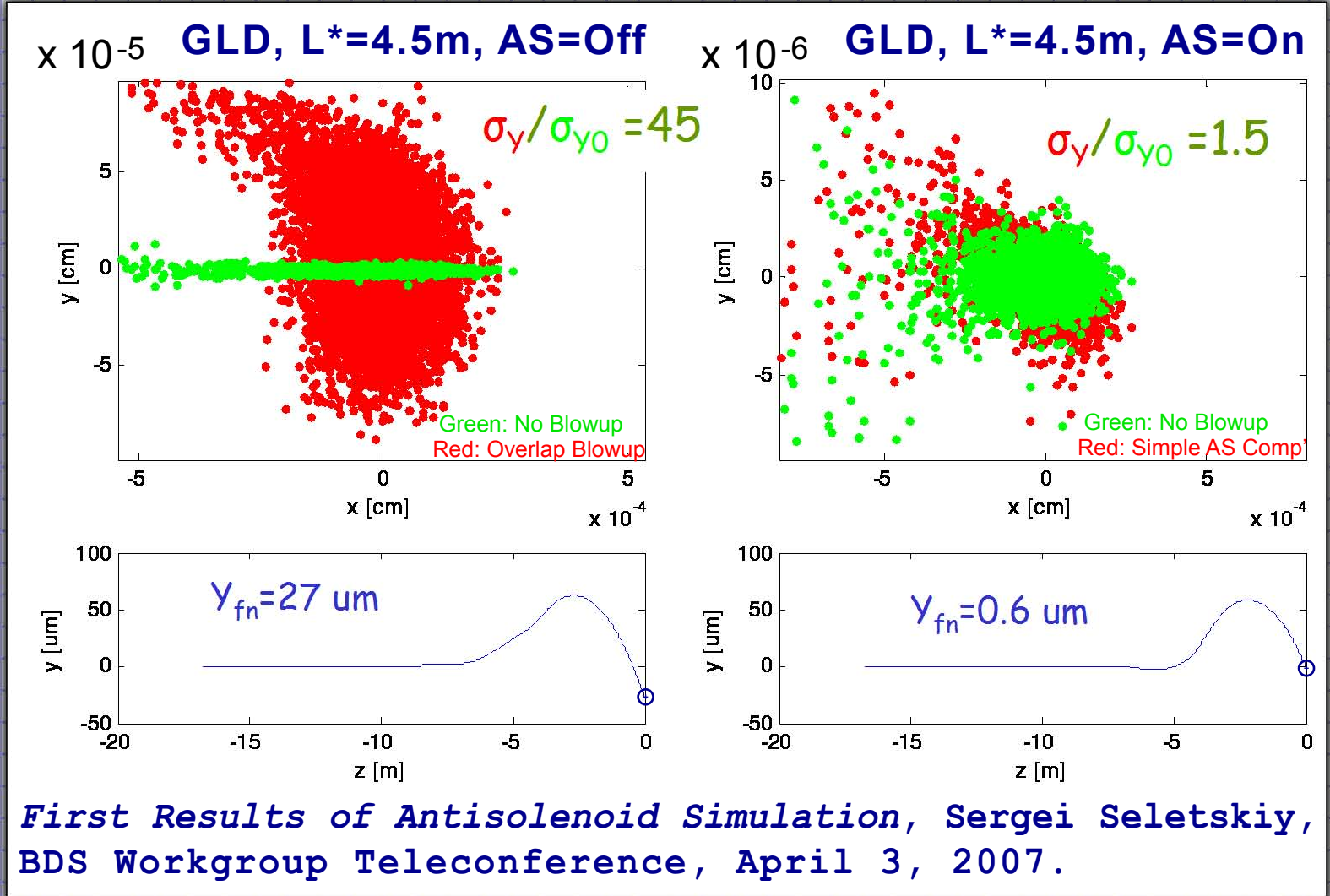
From a beam optics viewpoint, a force neutral anti-solenoid also works well for other detectors, LDC, GLD and even 4th, but obviously the anti-solenoid's impact on an experiment depends sensitively on the QD0 L^* .





Work is again in progress to refine the anti-solenoid design requirements.

New codes have been created and work is now in progress to optimize the anti-solenoid design.

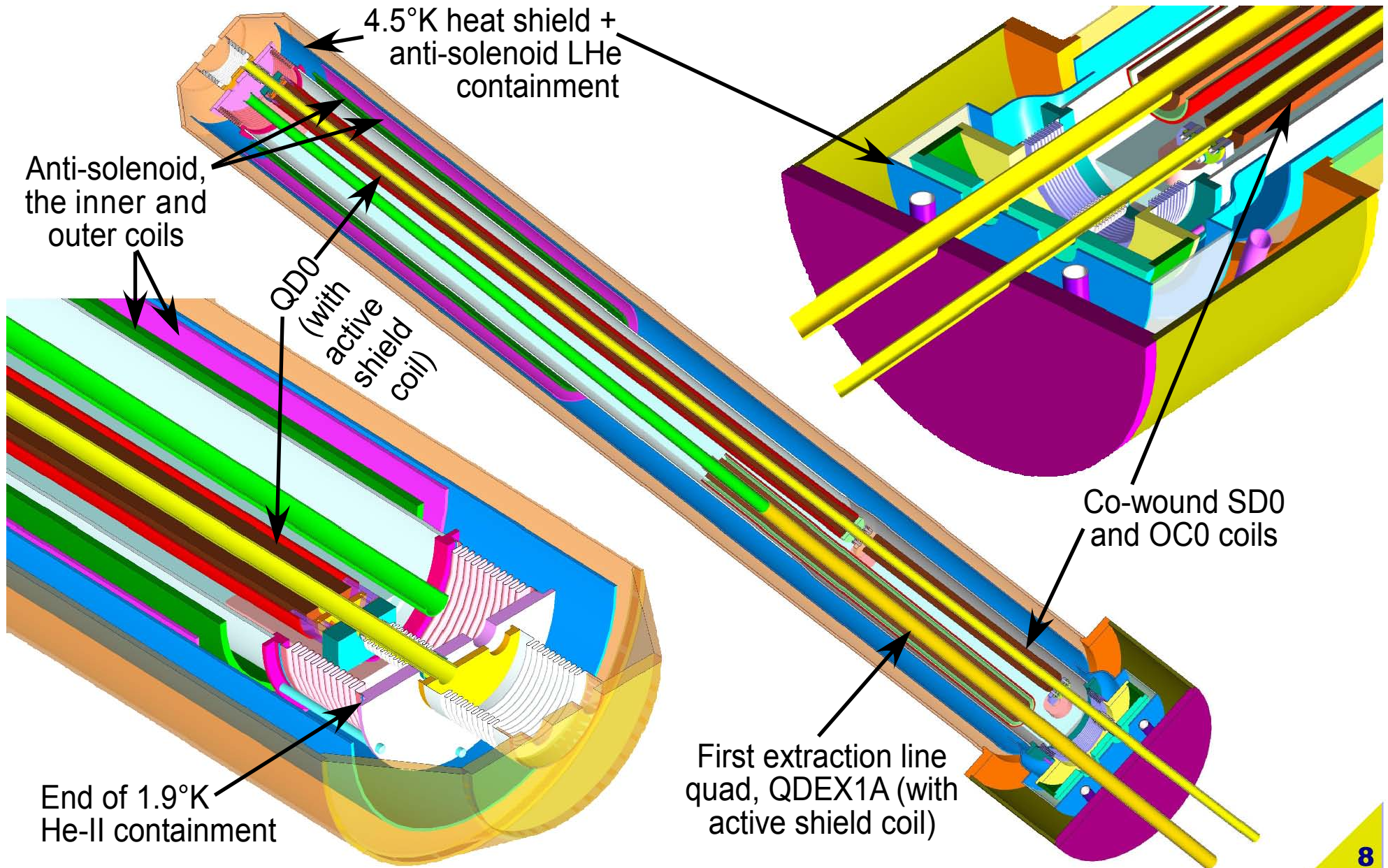


First Results of Antisolensoid Simulation, Sergei Seletskiy, BDS Workgroup Teleconference, April 3, 2007.

Now it should be possible to develop anti-solenoid requirements for each $L^* \approx 3.5-4.5 \text{ m}$ and for each detector.

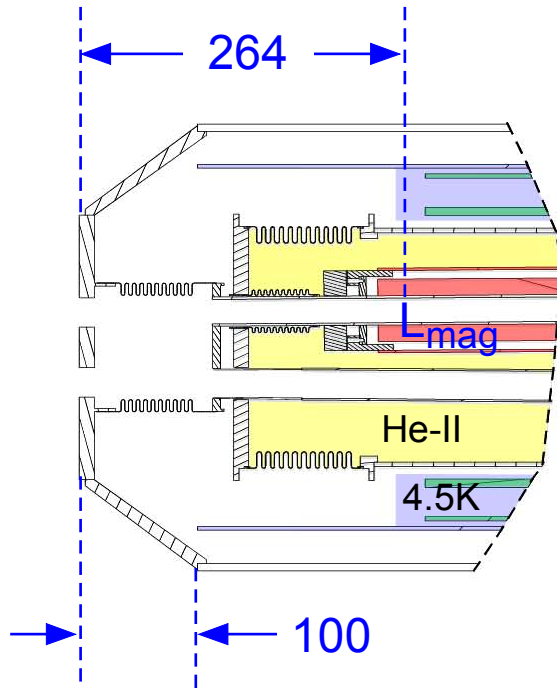


Incorporating a Force Neutral Anti-Solenoid Into the QD0 Cryostat.

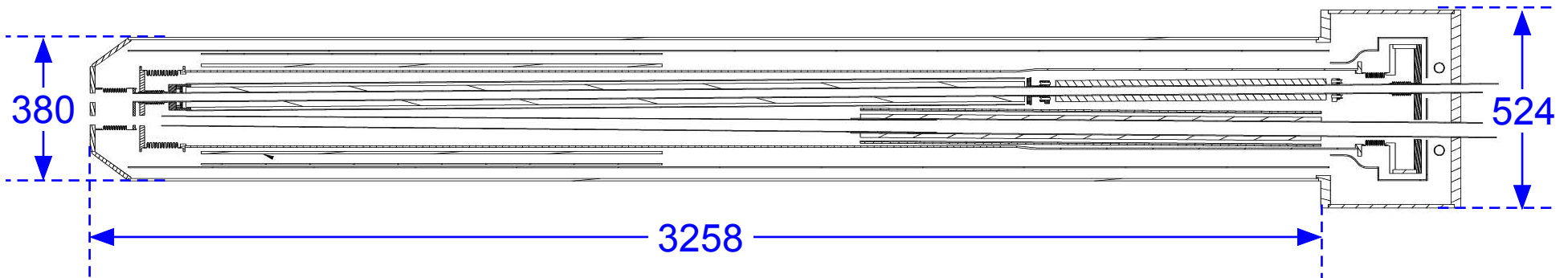
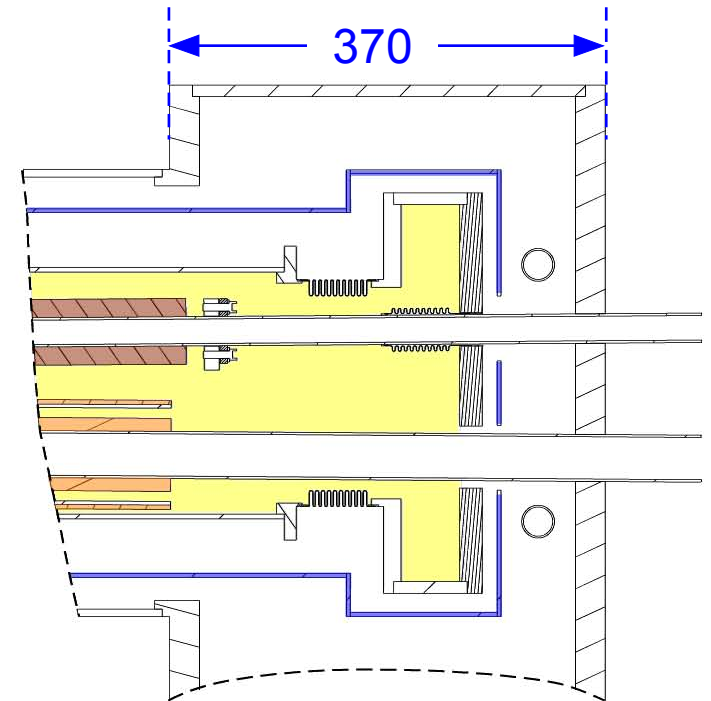




QD0 Cryostat Design Details: (Plan View).

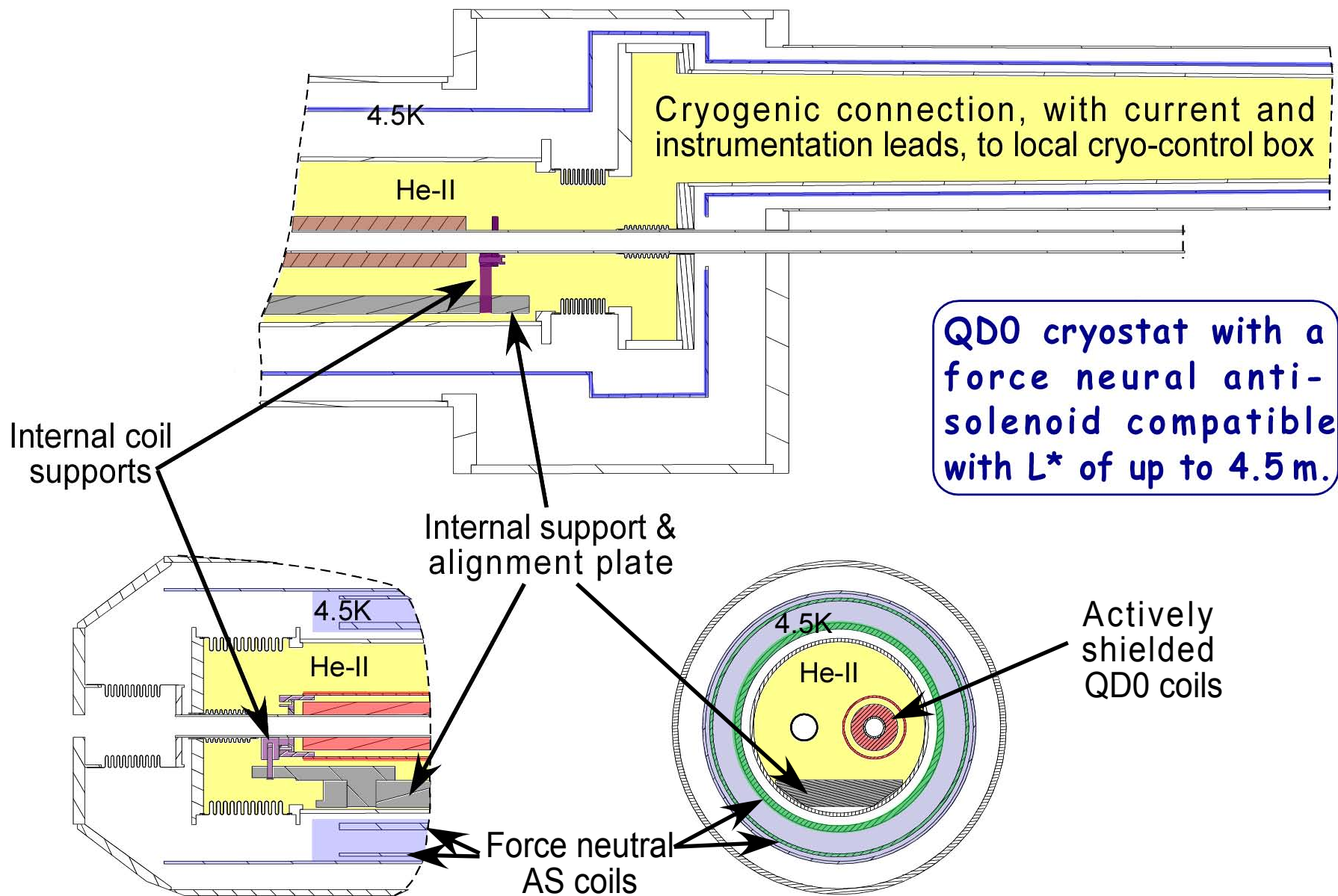


QD0 cryostat with a force neural anti-solenoid compatible with L^* of up to 4.5 m.
Plan views are drawn at beams' common midplane; dimensions are as indicated in millimeters.





QD0 Cryostat Design Details: (Elevation Views and QD0 Section).

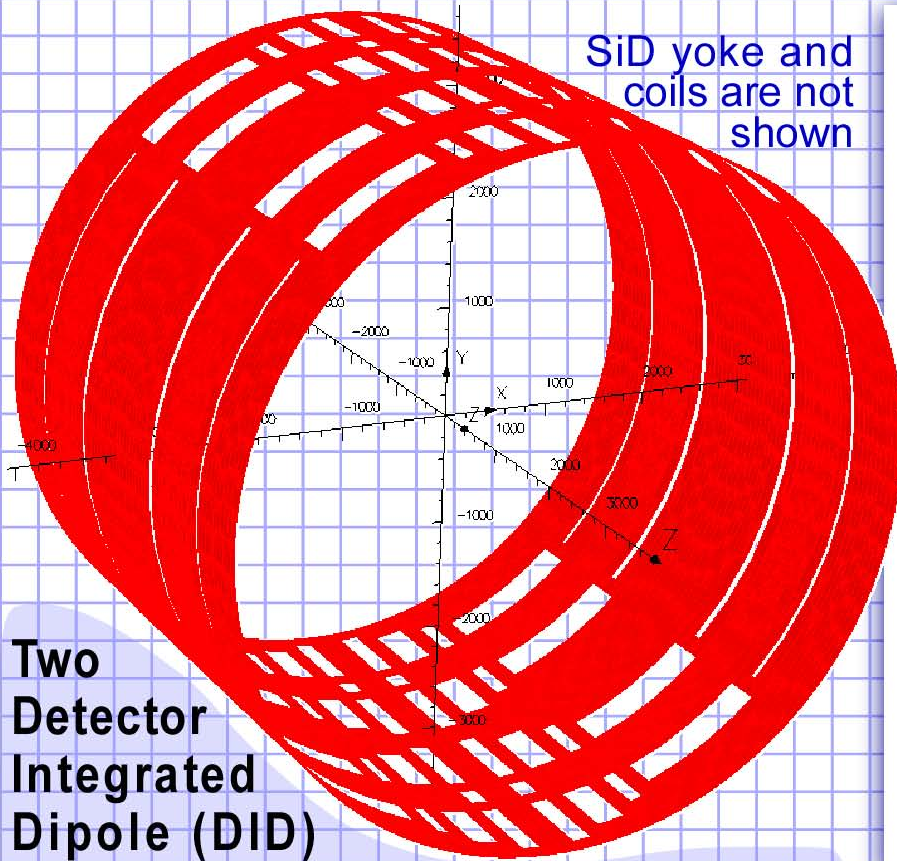


QD0 cryostat with a force neutral anti-solenoid compatible with L^* of up to 4.5 m.



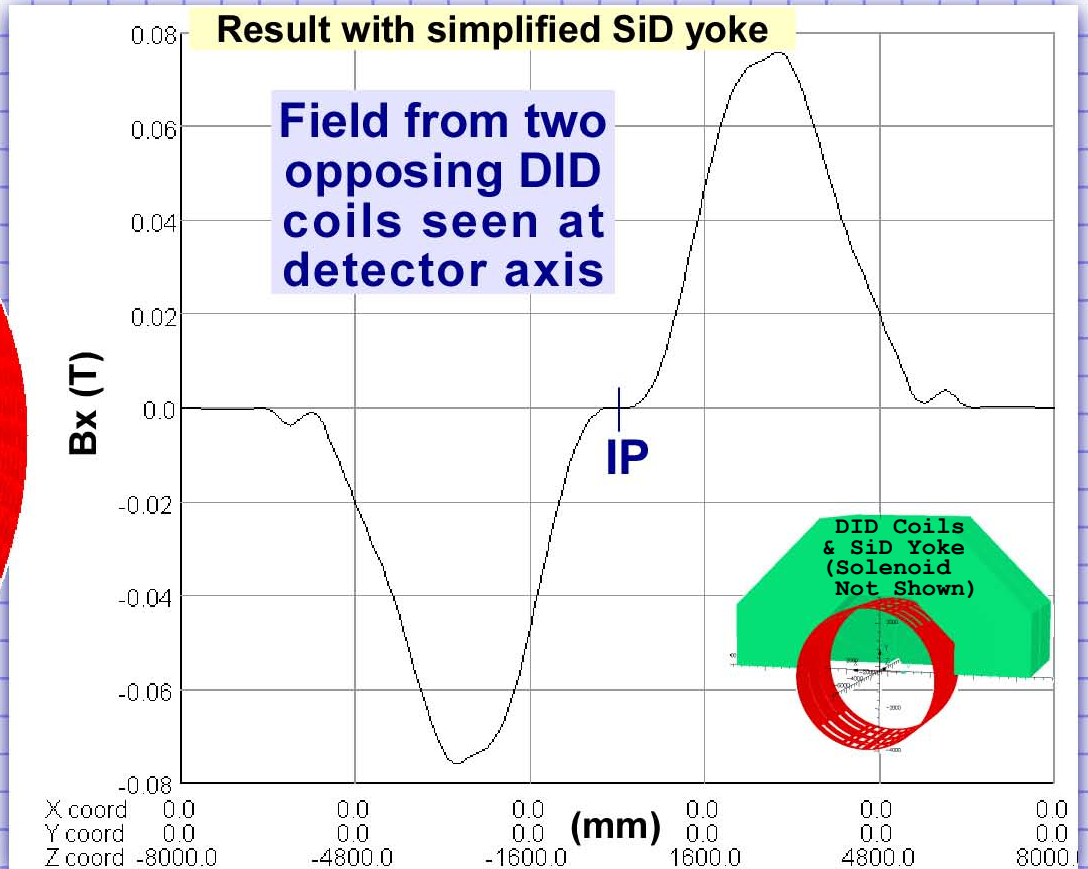
Digression... work is also in progress designing the anti-DID coil.

SiD yoke and coils are not shown



Two Detector Integrated Dipole (DID) coils can be used to improve the field uniformity near the IP (important for TPC based detectors).

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Long Term Goal: Generate field maps for the anti-solenoid and anti-DID for each detector concept.



The Anti-Solenoid Design: Work in Progress (Summary).

- **The Force Neutral Anti-Solenoid avoids many problematic issues found with initial designs.**
- **Tools are available to find AS requirements.**
- **Coil optimization and integration into the QDO cryostat is now in progress (also push-pull).**
- **Now is the time to get serious in addressing MDI issues (need coordination/cooperation between accelerator and experiments and between multiple experimental collaborations).**