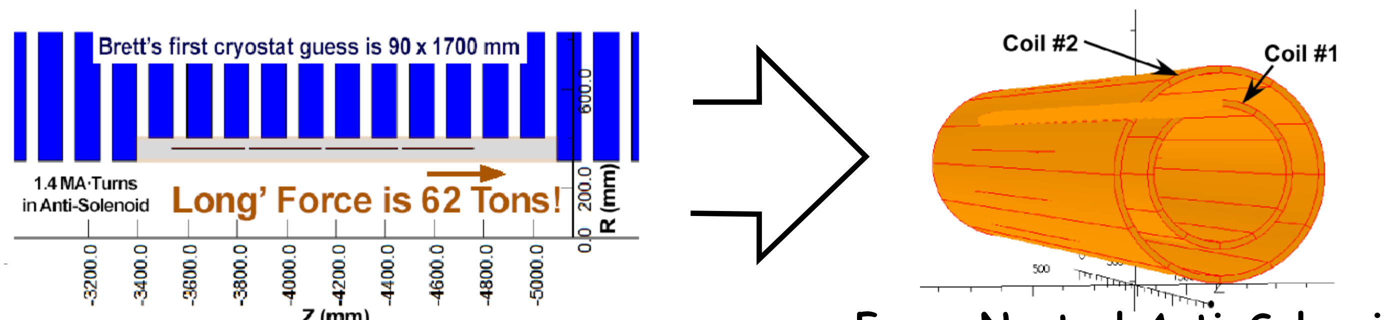
2007 INTERNATIONAL
LINEAR COLLIDER WORKSHOP
May 30 until June 3, 2007

Worldwide Study of the Physics and Detectors for Future Linear e^+e^- Colliders

A Force Neutral Anti-Solenoid In the QD0 Cryostat.

reported by Brett Parker, BNL



Force Neutral Anti-Solenoid

Joint Session of the LCWS: MDI and ILC: BDS Workgroups held at DESY on 1 June 2007.

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

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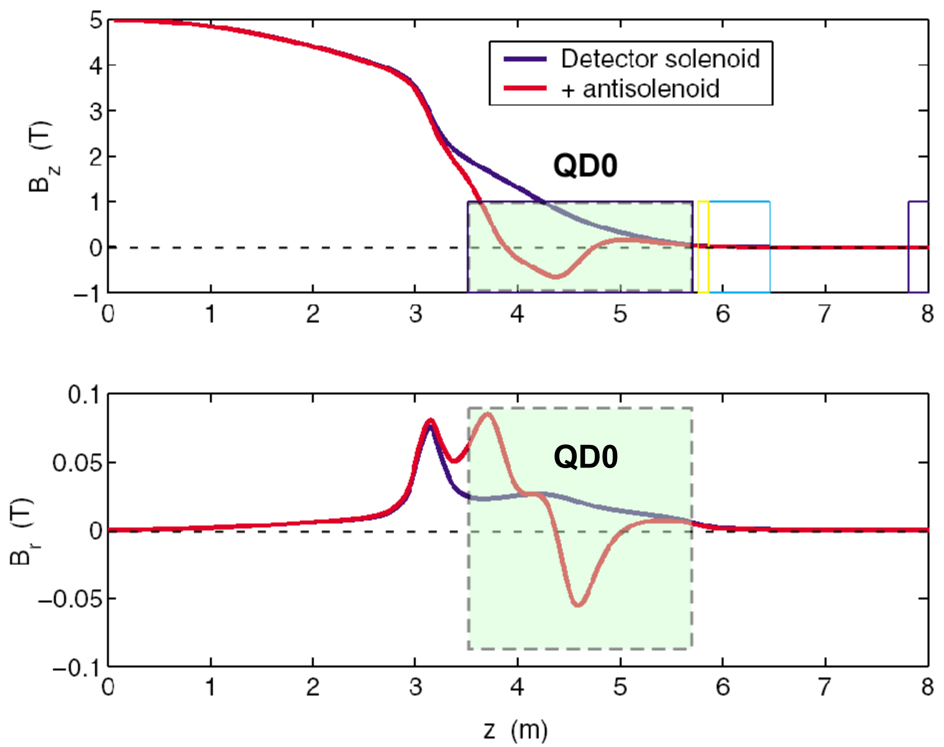
Nosochkov and Seryi, *Compensation of Detector Solenoid Effects on the Beam Size in a Linear Collider*, **Phys. Rev. Special Topics – Acc. and Beams, 8, 021001 (2005).**



- 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.

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

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

Luminosity loss is due to a subtle interplay between overlapping solenoidal and quadrupole fields; so it should not be surprising that a subtle change in the fields is sufficient to restore luminosity. We can use a weak anti-solenoid for simple local compensation that does not change with beam energy.

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

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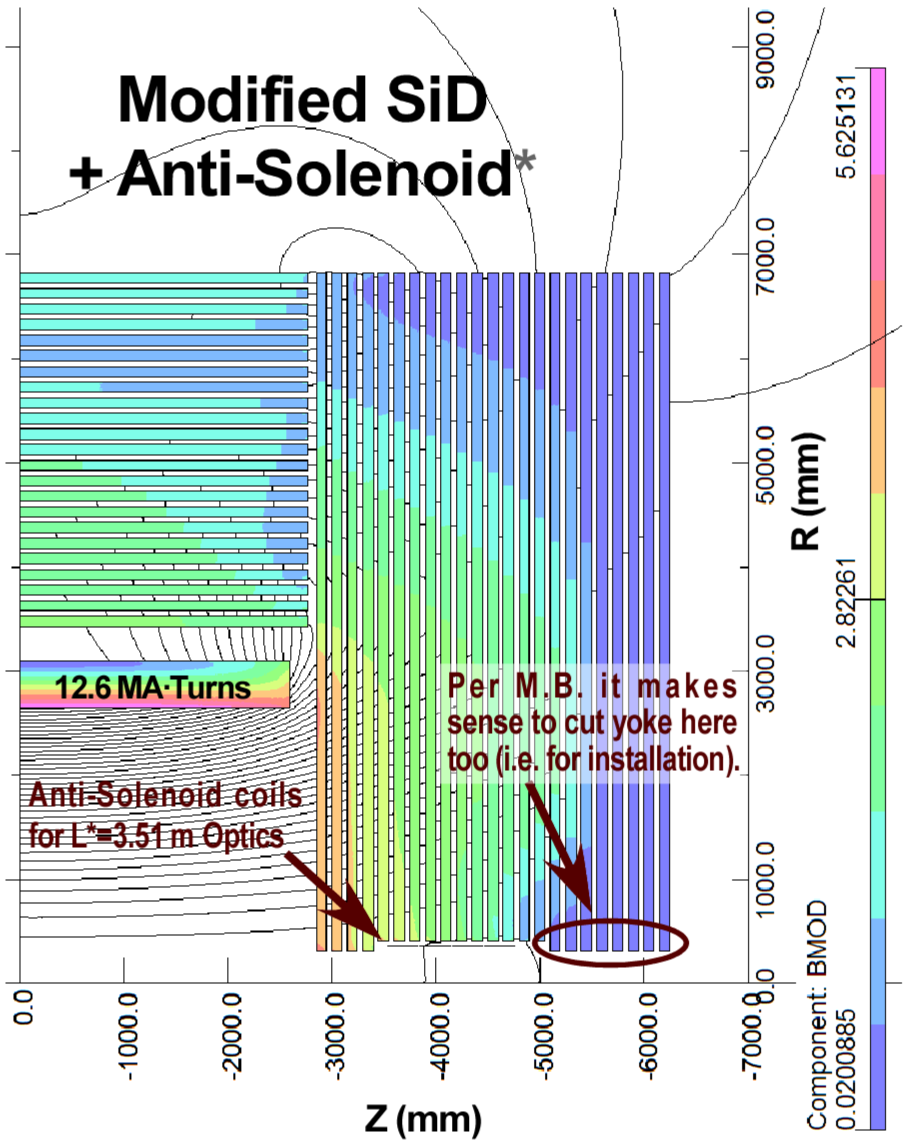
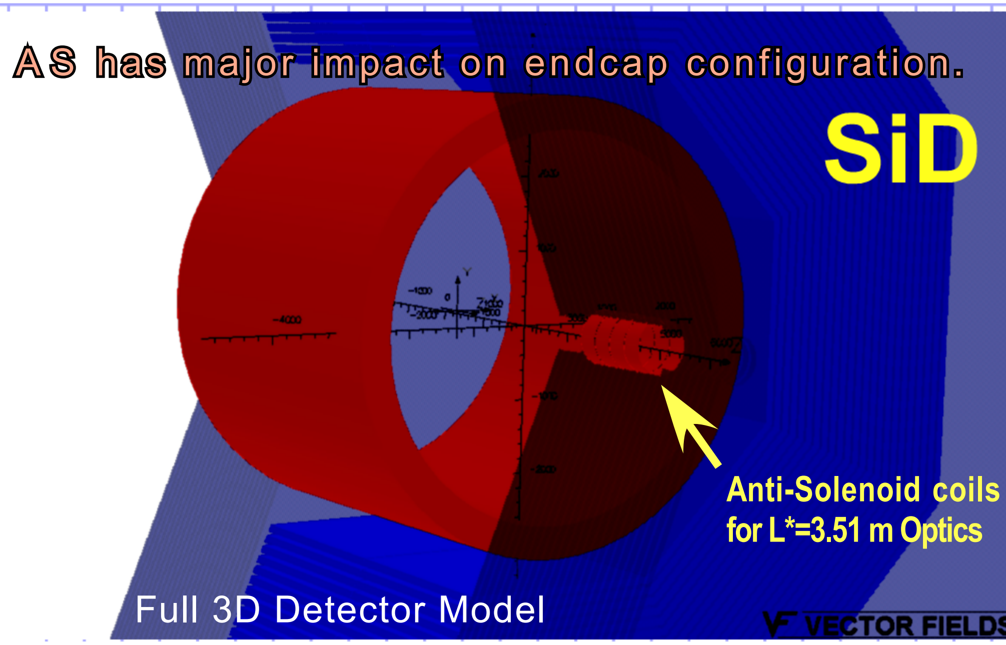
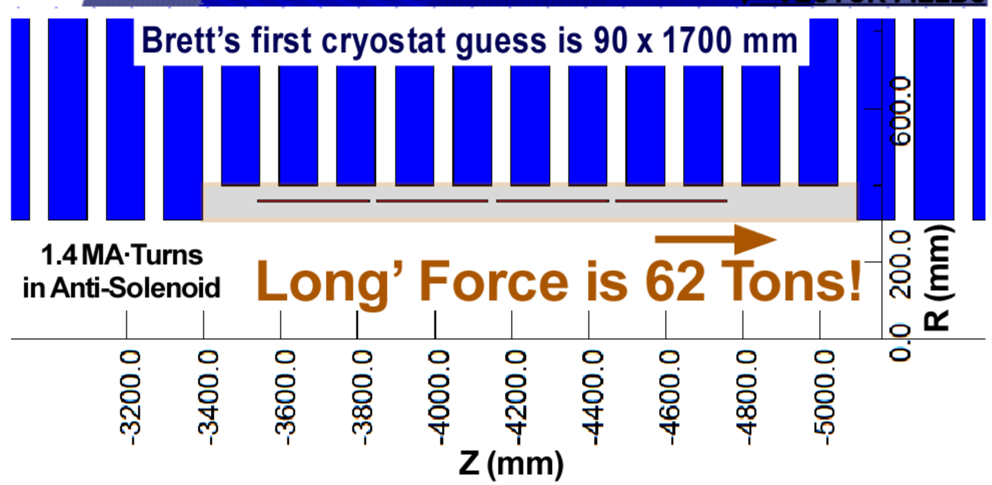


*Anti-solenoid strength must be adjusted to meet optics requirements.





Too much force to share QD0 cryostat!

New Concept: The Force Neutral Anti-Solenoid.

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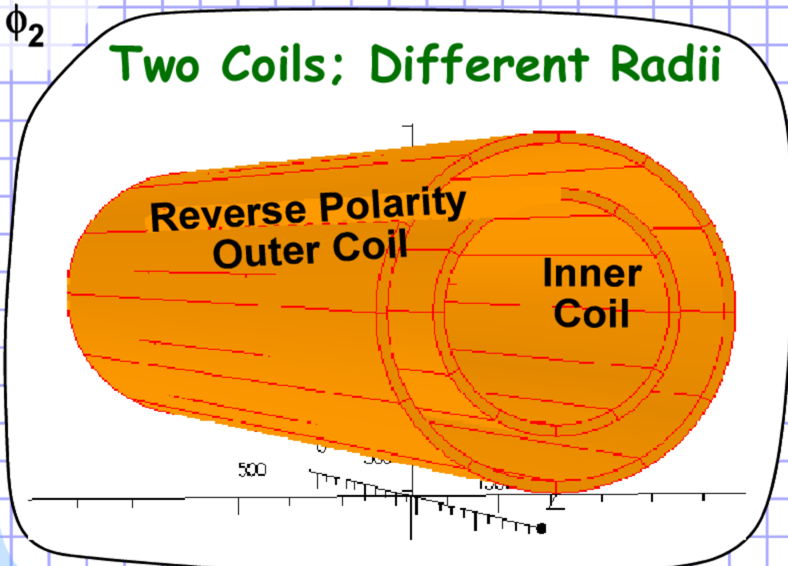
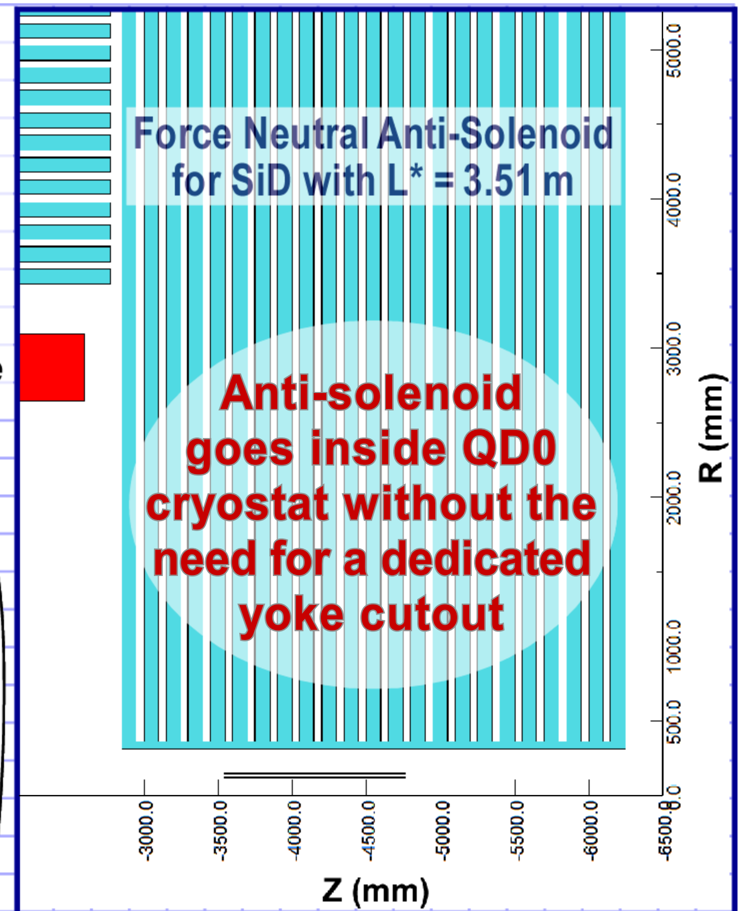
For a loop of circumference C carrying current I the longitudinal force is proportional to Br, thus

We want $$\sum_{j=1}^{N_1} (I_1C_1Br_1)_j + \sum_{k=1}^{N_2} (I_2C_2Br_2)_k = 0$$

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

$N_1 \overline{A_1} = N_2 \overline{A_2}$ or $\phi_1 = -\phi_2$

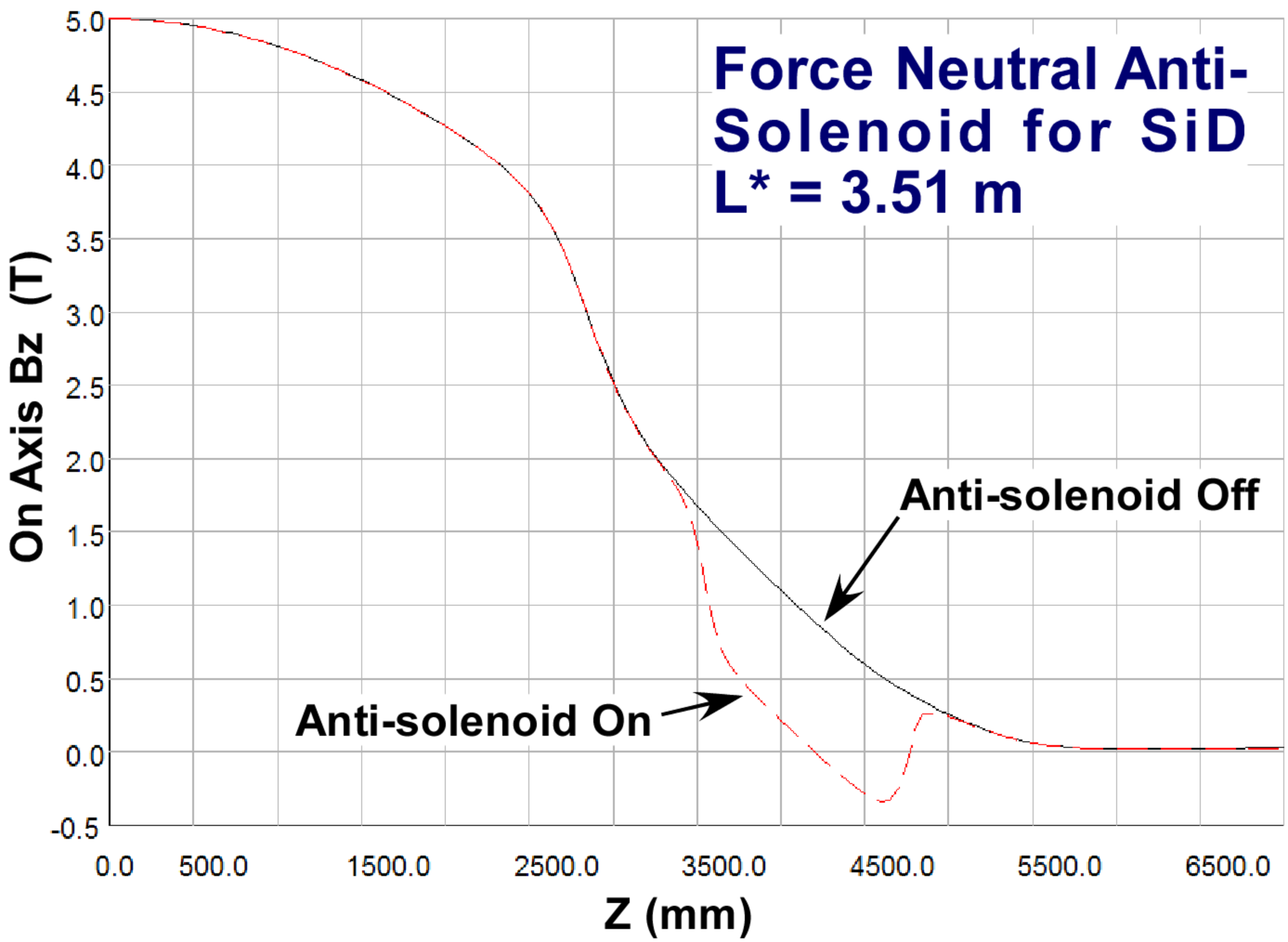




We can arrange for the sum of the forces on the inner and outer coils to fully cancel... but still have a net anti-solenoidal field inside the inner coil.

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 QD0.

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*.

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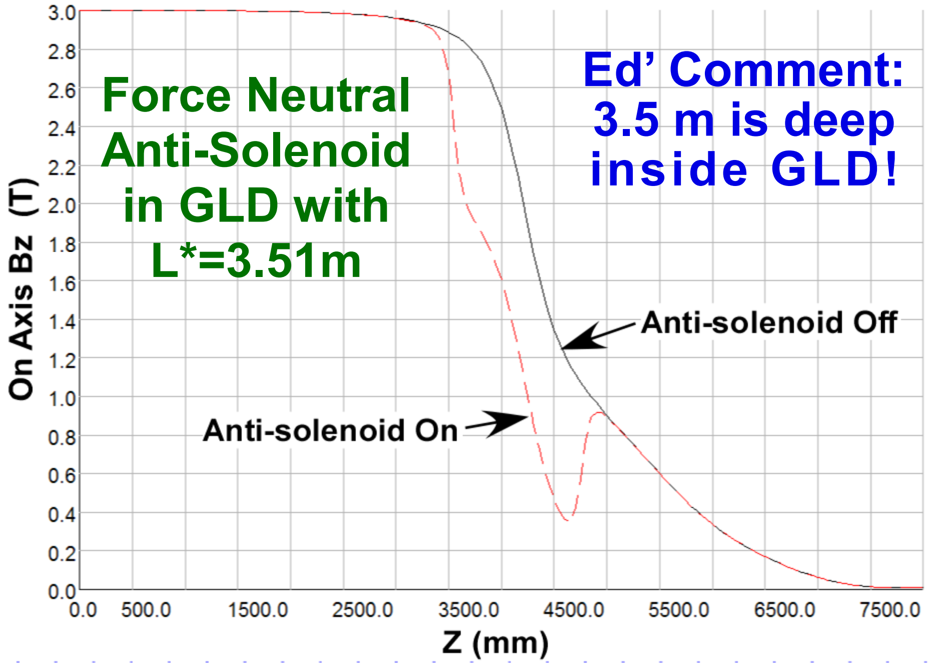
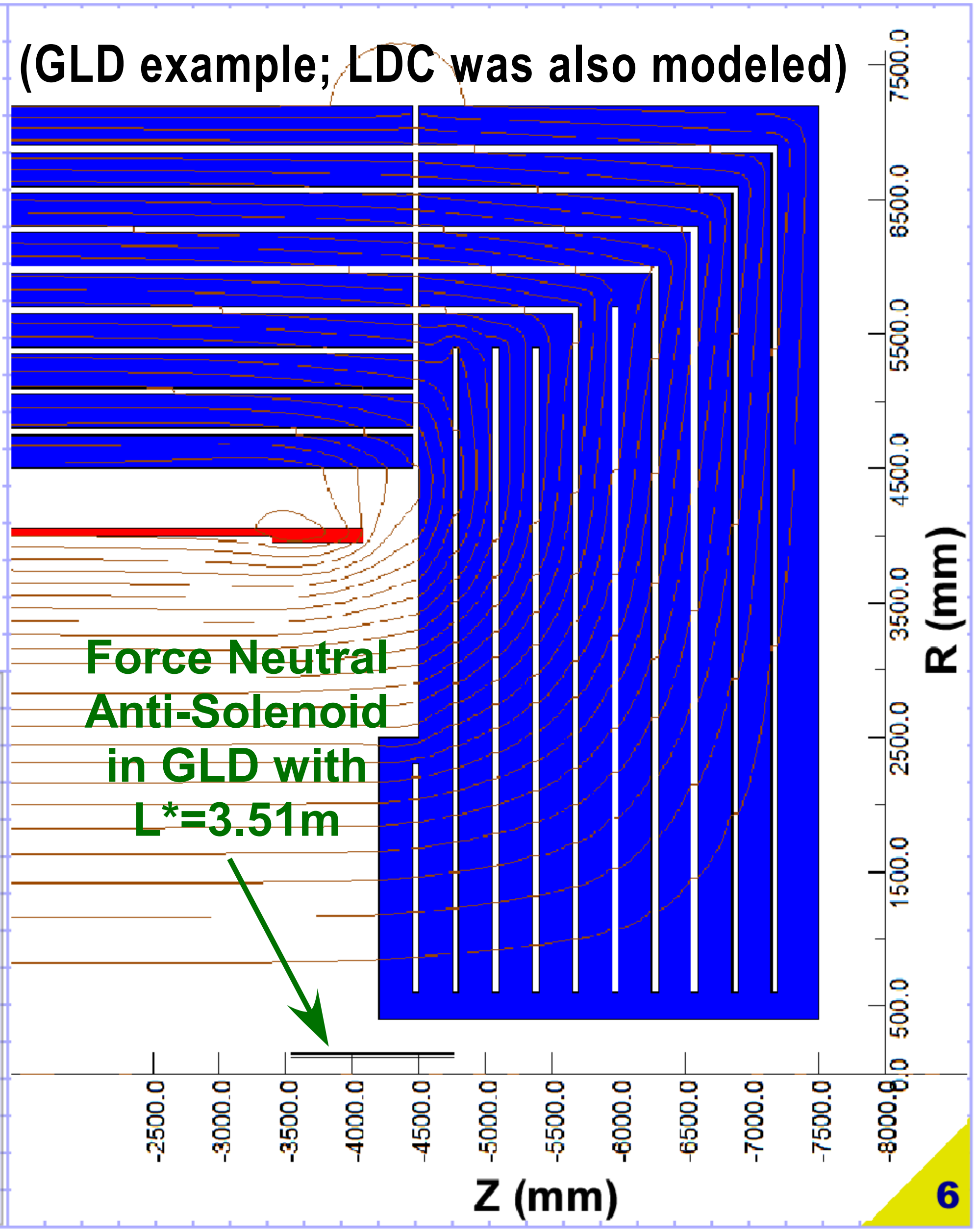


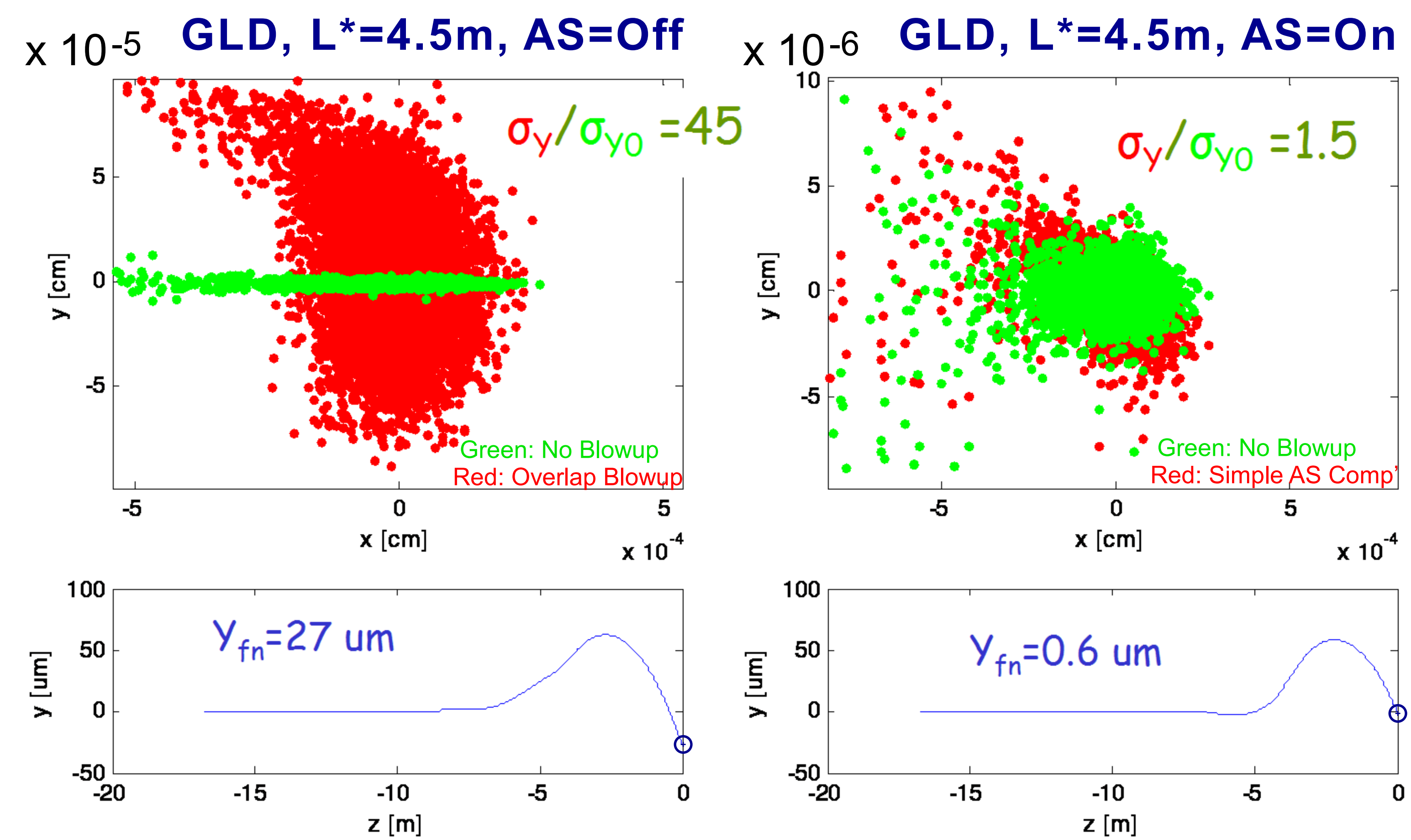
(GLD example; LDC was also modeled)



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 Antisolenoid Simulation, Sergei Seletskiy, BDS Workgroup Teleconference, April 3, 2007.

Now it should be possible to develop anti-solenoid requirements for each L*≈3.5-4.5 m and for each detector.

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

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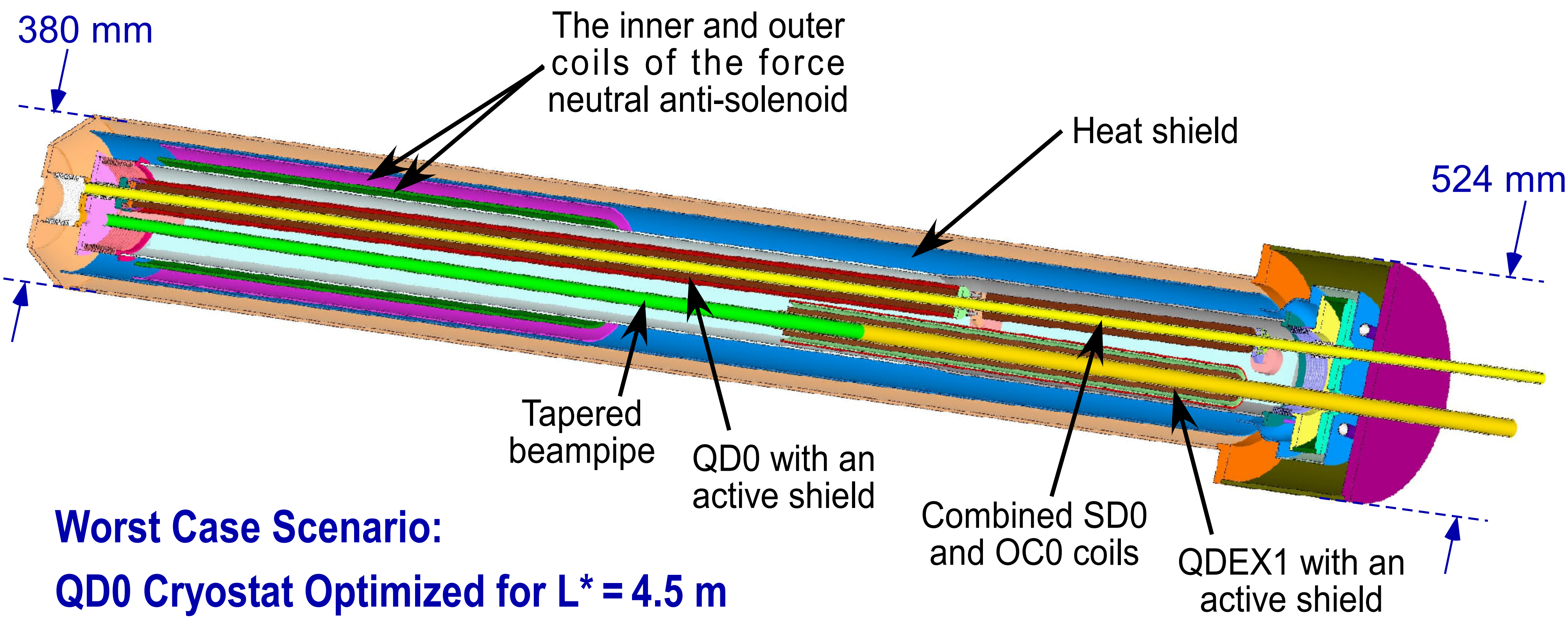
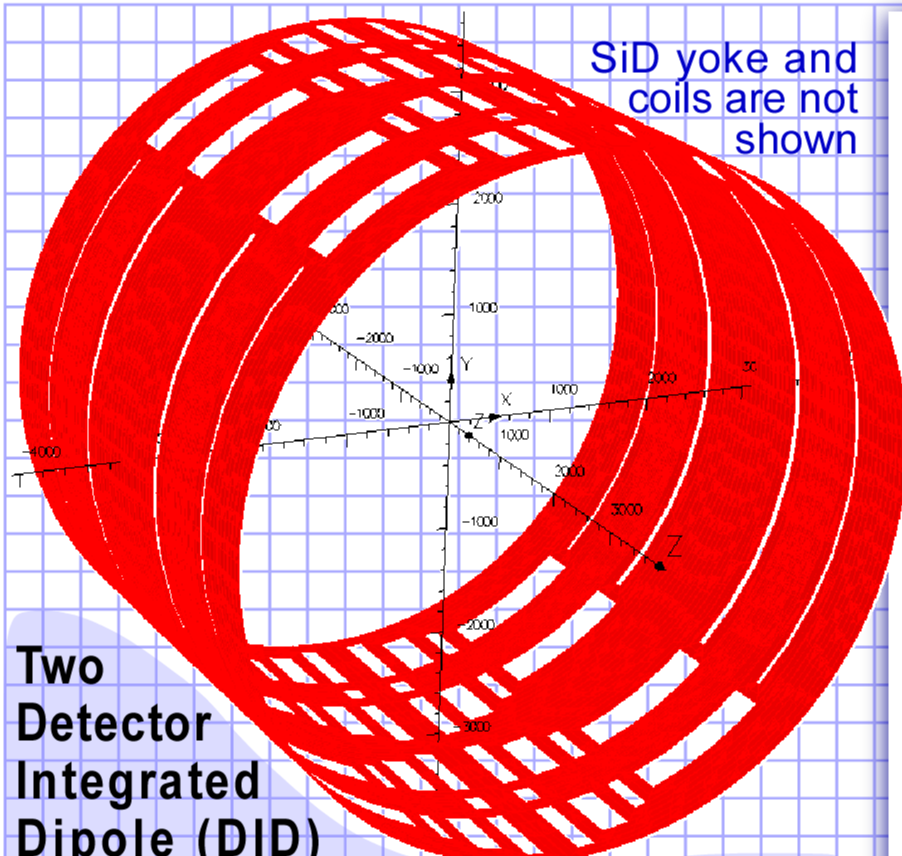


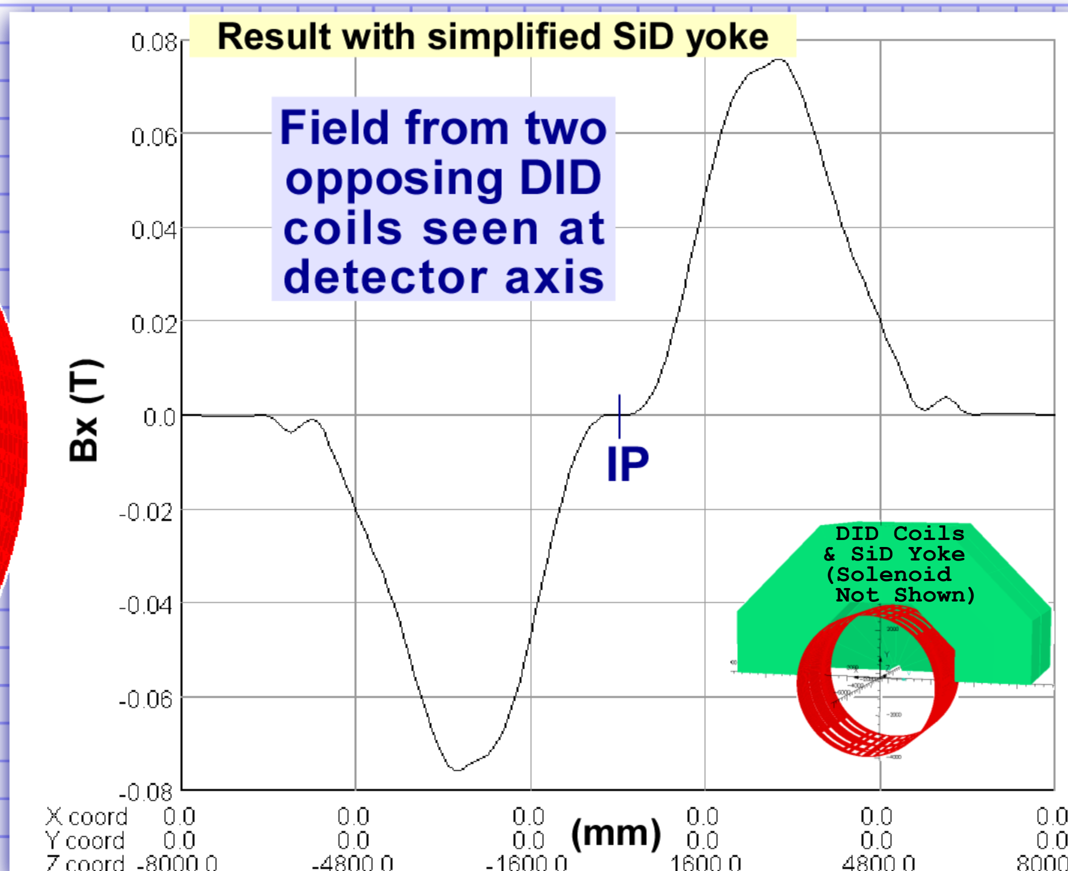
Worst Case Scenario:

QD0 Cryostat Optimized for L* = 4.5 m

First idea was to integrate anti-solenoid cooling with the 4.5 K heat shield. But this complicates the heat shield design and may require flowing helium to more finely control the temperature. Now believe we can integrate the anti-solenoid coils with the He-II containment. Work is in progress.

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





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

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).

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- 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 QD0 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).