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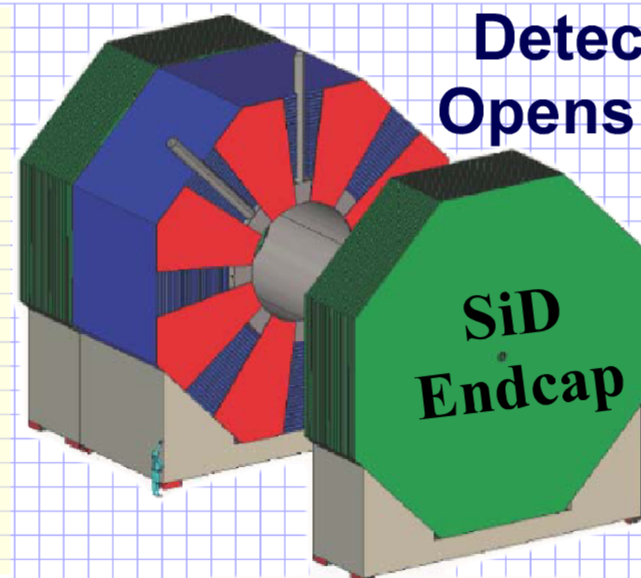
Superconducting Magnet Division

Accelerator Physics: Special MDI Issues.

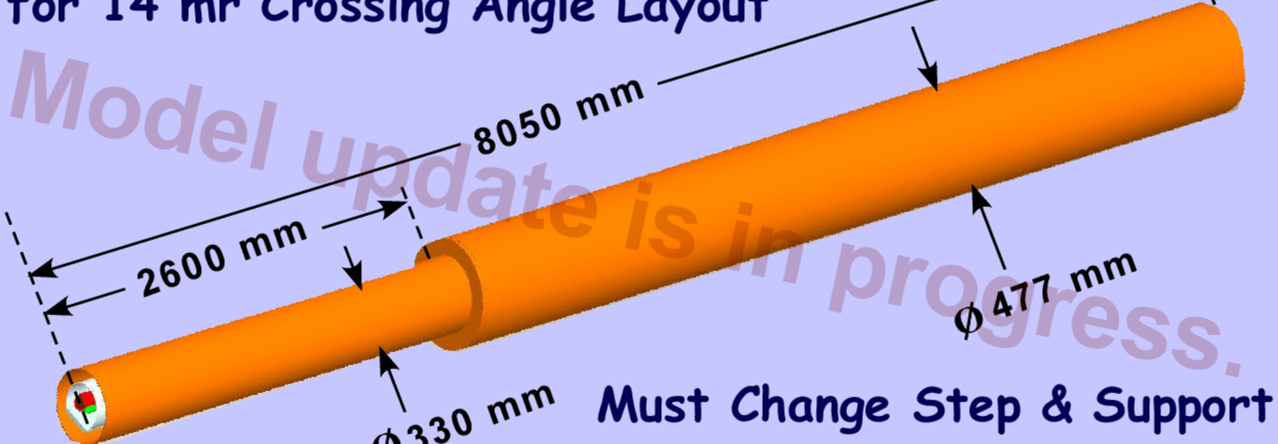
The interaction between accelerator and detector physics issues requires special attention for ILC performance, operation and reliability goals.

Presently we are working out realistic space requirements with SiD taking installation & maintenance into account.

Detector Opens 2 m



Original (Obsolete) Cryostat Dimensions for 14 mr Crossing Angle Layout



Must Change Step & Support Tube OD to Open Detector 2 m

Developing realistic designs for the anti-solenoid and DID magnets is now of critical importance!

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Finding Anti-Solenoid Design Requirements Compatible with SiD.

Key Numbers (summary made by T. Markiewicz, 22-May-06)

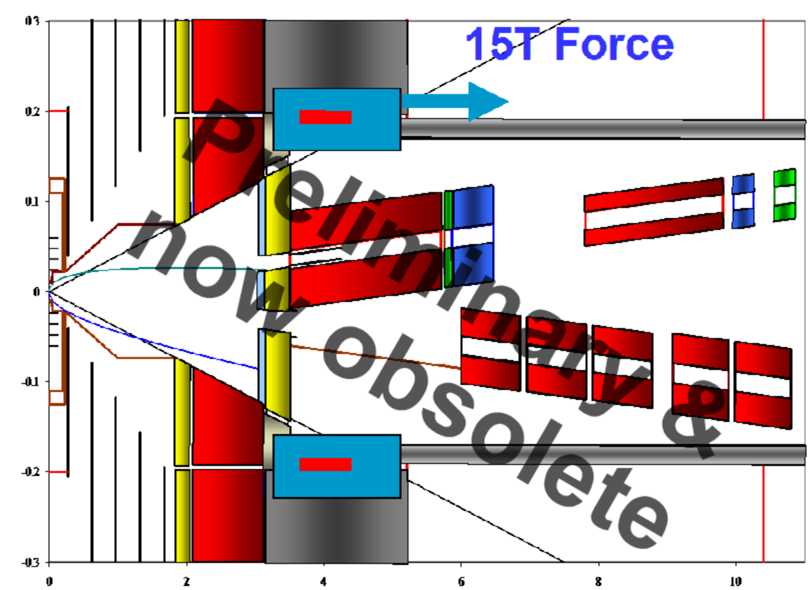
- Door opens 2m
- Lip in support tube at z=4.8m
  - Back of Endcap HCAL at 4.775m when door open
  - OD of support tube quess-timated at 60cm for now
  - Overlap of small OD support tube & large OD tube (4cm for now)
  - Wall assumed 2cm as usual with no justification
- FD Cryostat
  - details of flange & cold-warm being worked on (drawn 3.5m now) lip begins at z=4.850 from IP

Theta	OD1	OD2
14 mrad	290mm	477mm
20mrad	305mm	512mm

This work needs to be repeated for each detector concept and for each crossing angle FD

Replies from concept groups indicated that work to incorporate these coils needs to be done

Four 24cm individual powered 6mm coils, 1.22m total length, r_{min}=19cm



- Antisolenoid Cryostat arbitrarily place 1cm outside OD of back of support tube and dimensions assumed unchanged from Parker 2004 numbers for now

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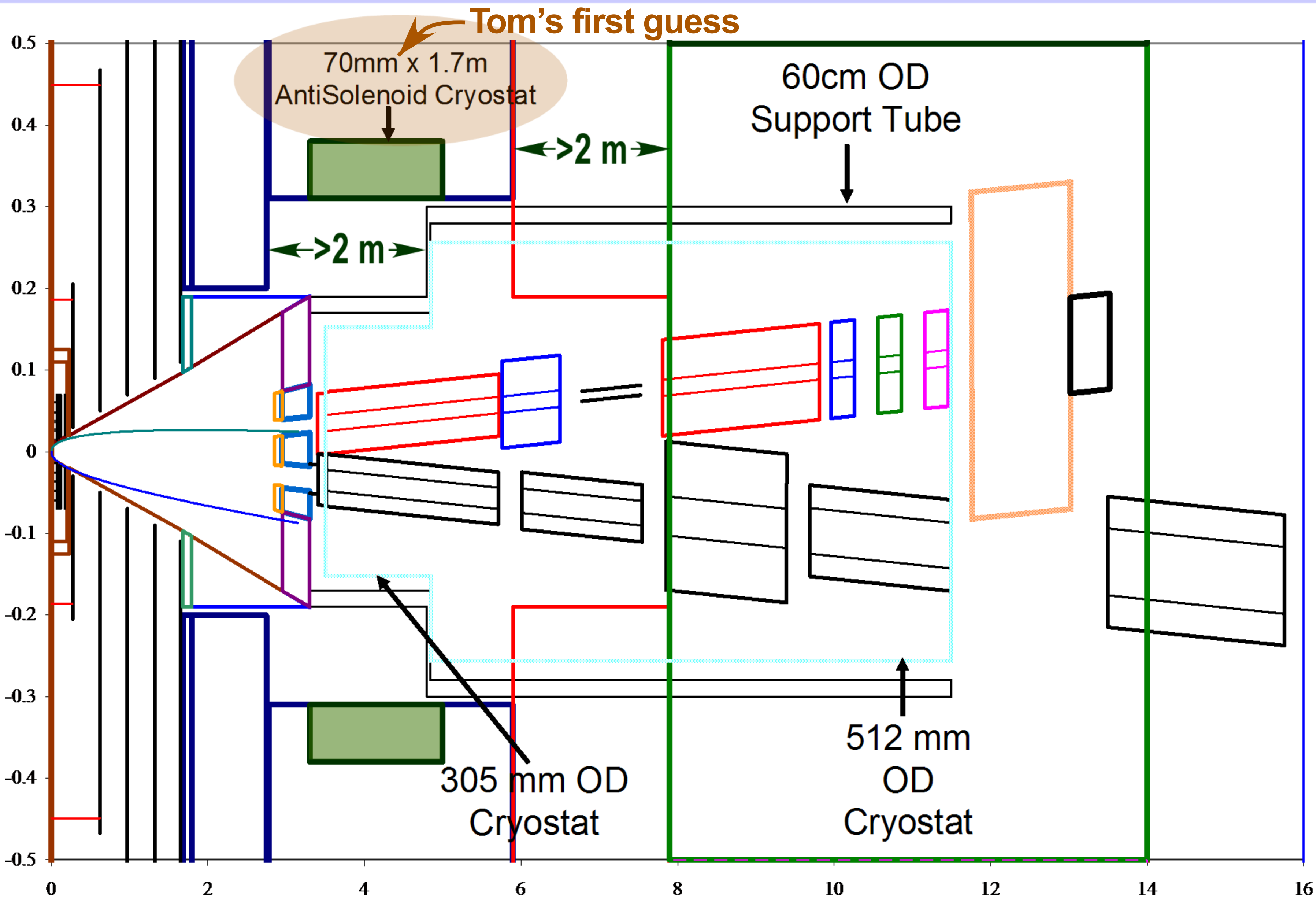
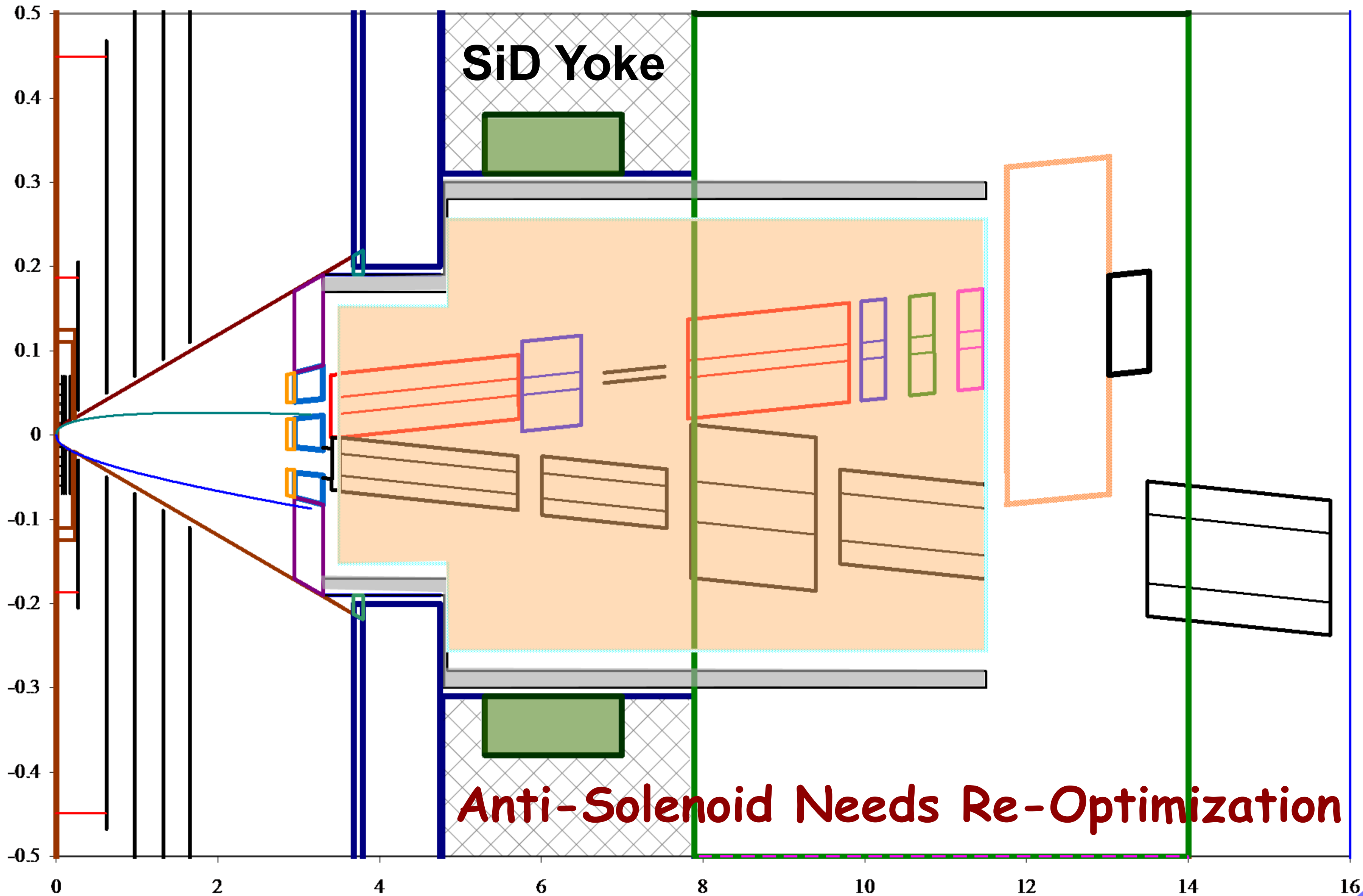
2006-05-07 BNL Discussion: SiD Closed.



2006-05-07 BNL Discussion: SiD Open 2m.



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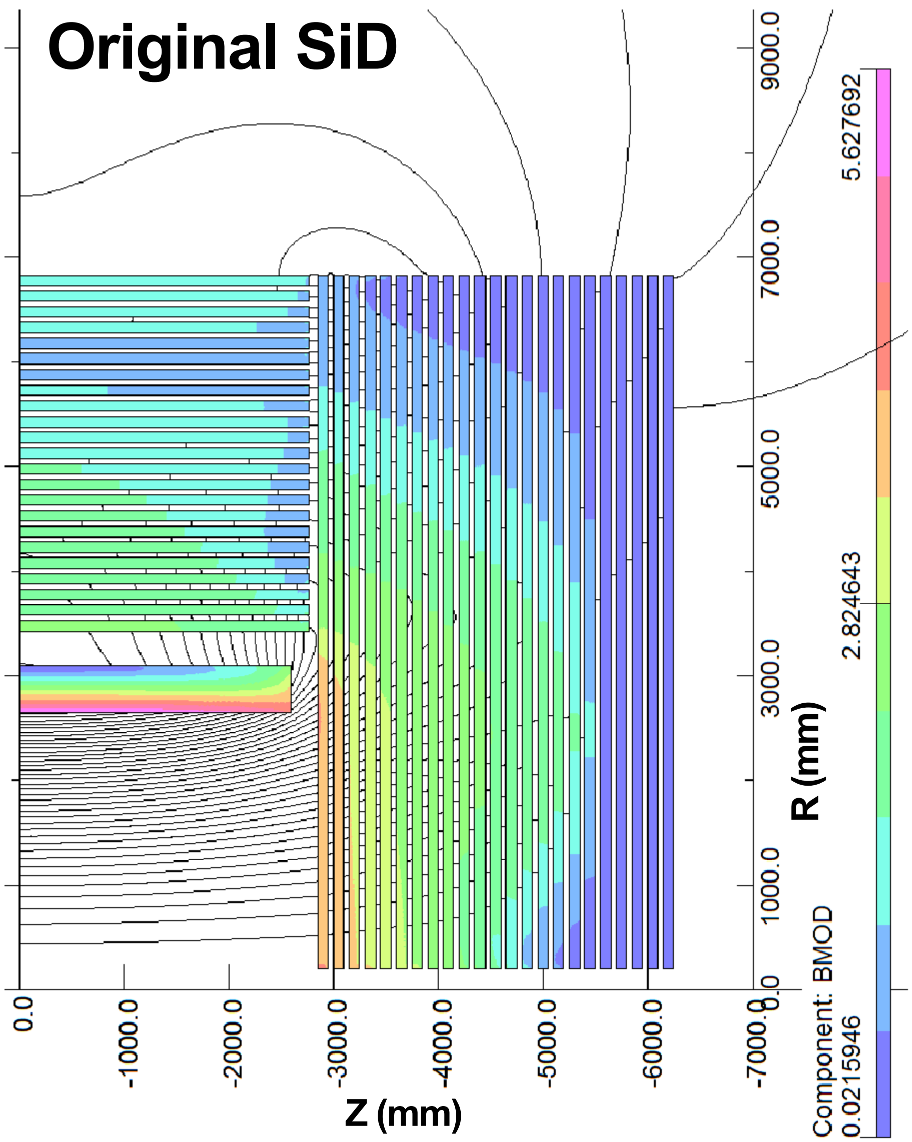
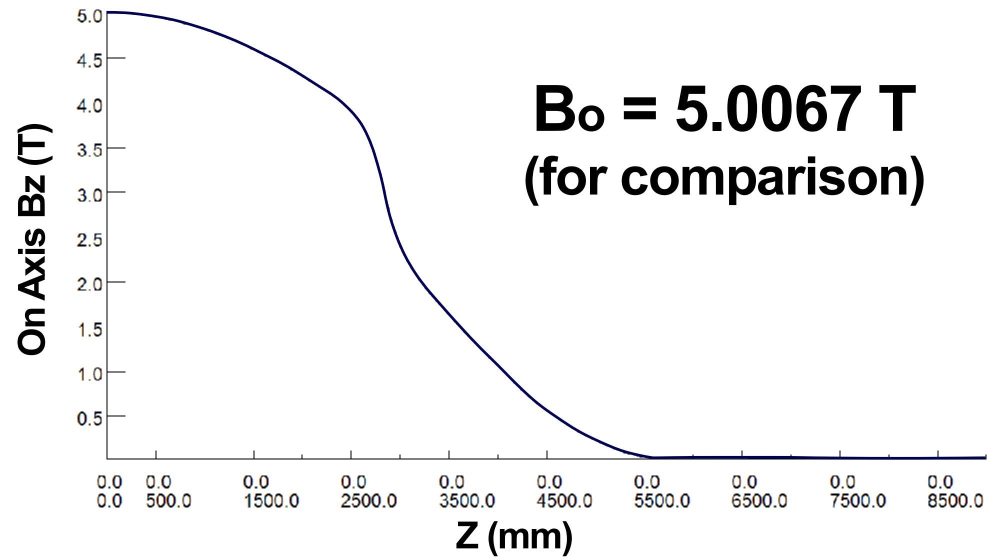
A First Pass Look at Redesigned Anti-Solenoid in SiD (Slide: 1/3).





B_o = 5.0067 T
(for comparison)

Start by recreating original SiD solenoid design with 5 T central field, 100 mm plates spaced 50 mm apart and 200 mm yoke opening as basis for comparison.

Note fringe field at Z=12 m is 153 gauss.

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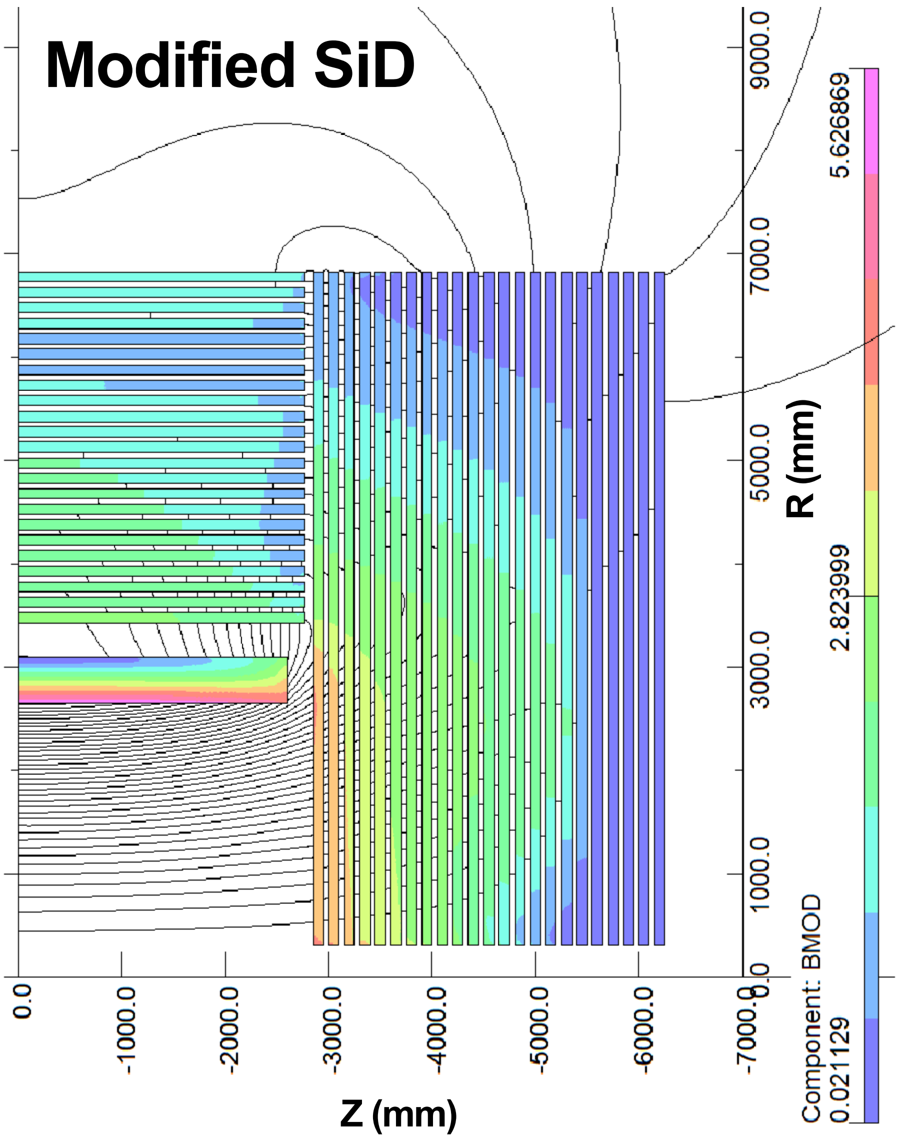
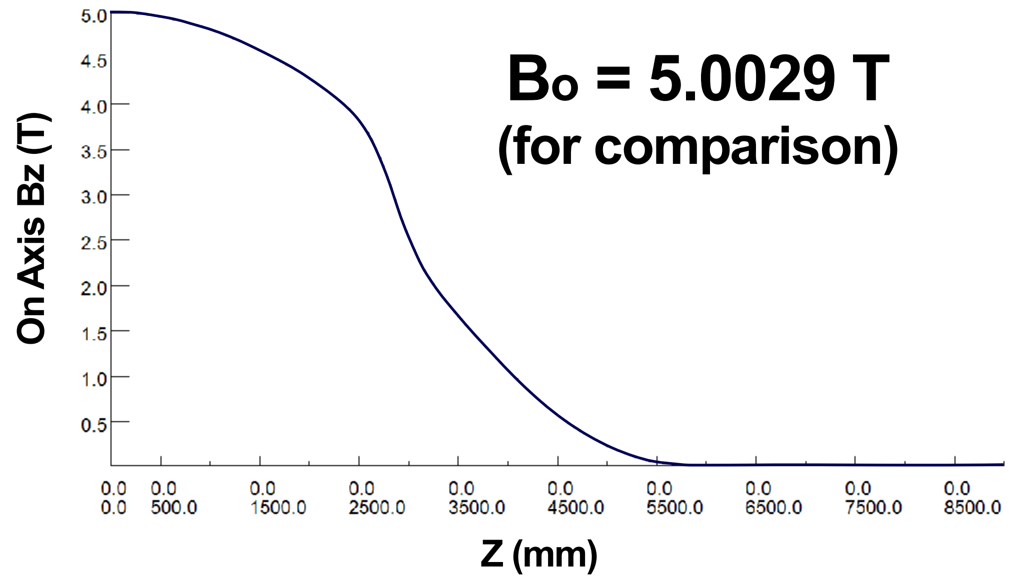
A First Pass Look at Redesigned Anti-Solenoid in SiD (Slide: 2/3).

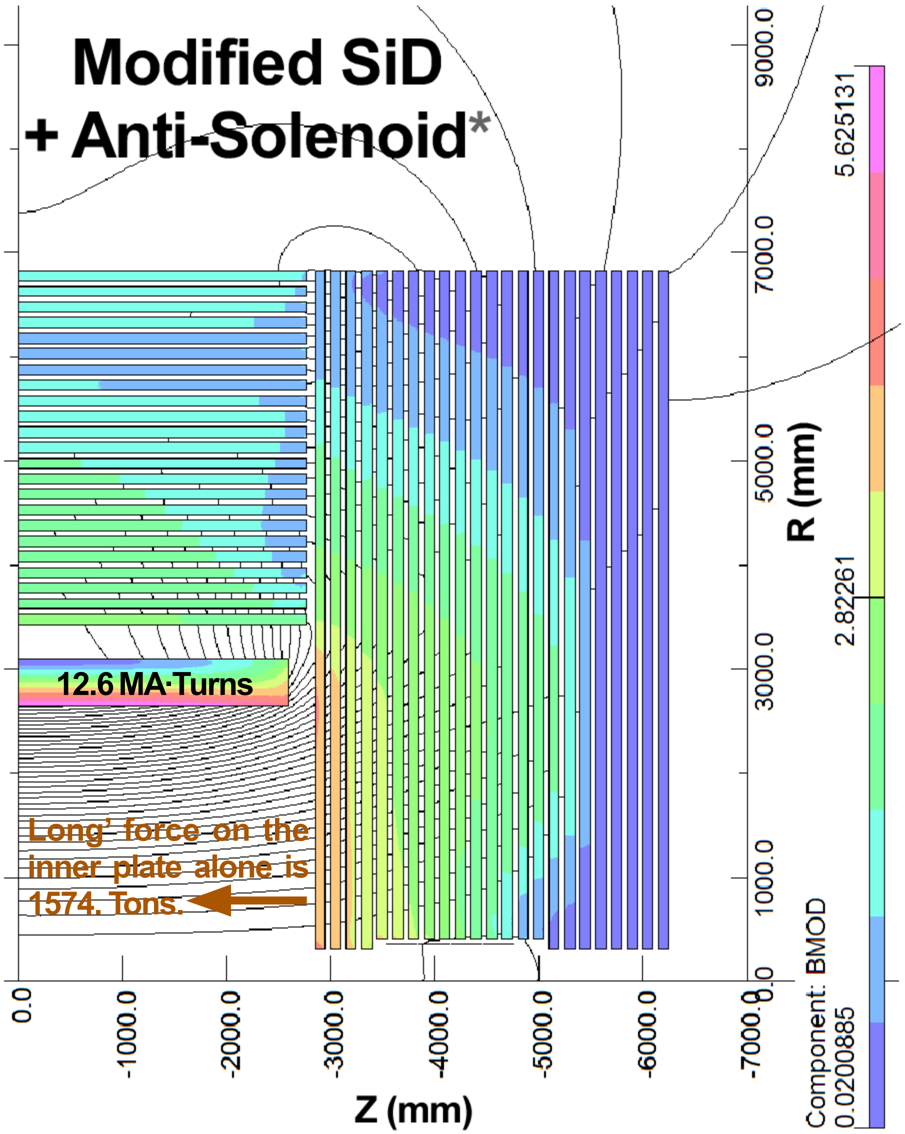


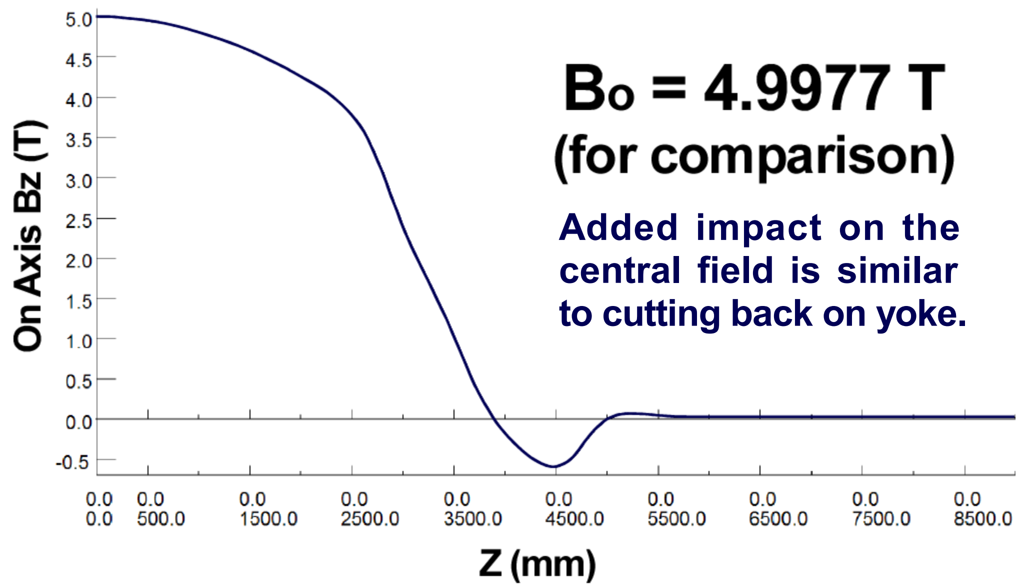


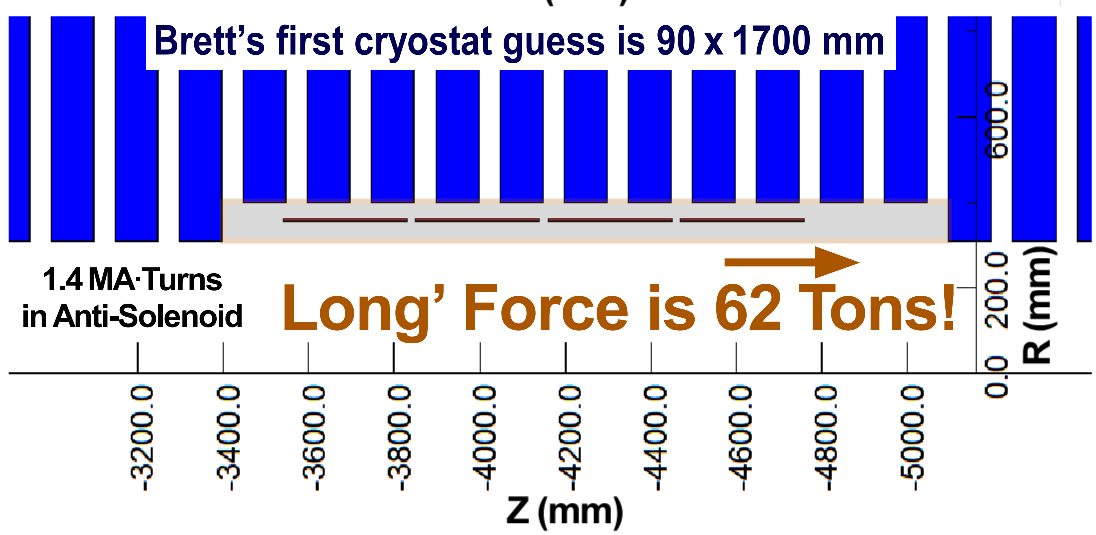
Modify SiD solenoid design, still with same excitation current, 100 mm plates, 50 mm spacing but now a 310 mm radius yoke opening and compare the results.

Note fringe field at Z=12 m is 149 gauss.

A First Pass Look at Redesigned Anti-Solenoid in SiD (Slide: 3/3).







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

Note fringe field at Z=12 m is 152 gauss.

Summary (1/2)

In order to open SiD endcap by 2 m, have to make cryostat “nose” radius smaller but the outer tube larger (so need a step).

Impact of increasing endcap opening on field seems minimal.

Even if we were willing to take the large force from the anti-solenoid on the support tube, there is now no space for it to fit inside the support tube (anti-solenoid now has to go outside).

Change of detector field due to anti-solenoid is similar in magnitude to that of increasing the yoke endcap opening.

But longitudinal force on anti-solenoid goes up 4-fold (now at 62 Tons, this seems large but is just 4% of force on a single plate).

In all cases the fringe field near crab cavities is fairly large so look either to add more material outside detector or provide localized shielding near superconducting cavities (latter is more efficient).

The above statements imply some impact on muon system (MDI).

Next want to review the DID design (in concert with SiD experts).

Notes added after the 8 June presentation.

1) Cutout for anti-solenoid cryostat show on page is actually 90 x 1700 mm (not 100 x 1700 as previously indicated).

2) During the presentation Mike Harrison asked about using high temperature superconductor (HTS) for the anti-solenoid since it would be much nicer to handle a 62 Ton force at a temperature higher than 4.4°K (heat load from supports).

Later the same day Ramesh Gupta and Bill Sampson presented their results, at a BNL magnet division seminar, using HTS coils in a R&D program to make HTS magnets for the RIA project.

It now looks encouraging to use HTS coils for the anti-solenoid and thereby keep the cryostat structure simple and compact (see photographs and calculations on next slides).

Slide taken from Gupta's presentation.

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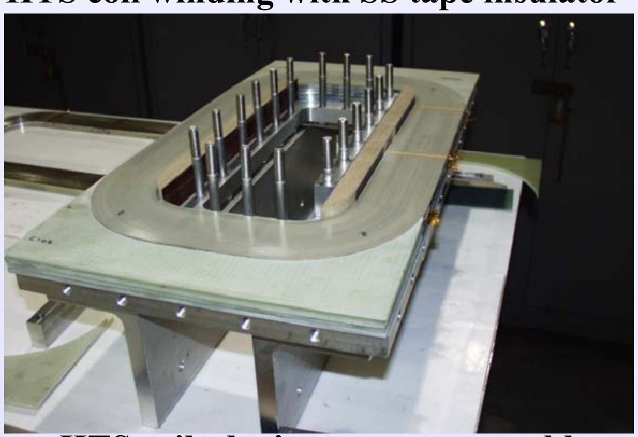
RIA HTS Quadrupole At Various Stages of Construction and Testing


HTS coil winding with SS tape insulator

The RIA HTS model magnet has been successfully built and tested at BNL.

Experiments of magnet operating with large energy depositions (tens of watts in 0.3 meter long magnet) have also been carried out.


Cold iron magnetic mirror test with six coils


HTS coils during magnet assembly


Warm iron magnetic mirror test with twelve coils

Ramesh Gupta, Test Results and Analysis of RIA HTS Magnetic Mirror Quadrupole, June 8, 2006. Slide No. 4

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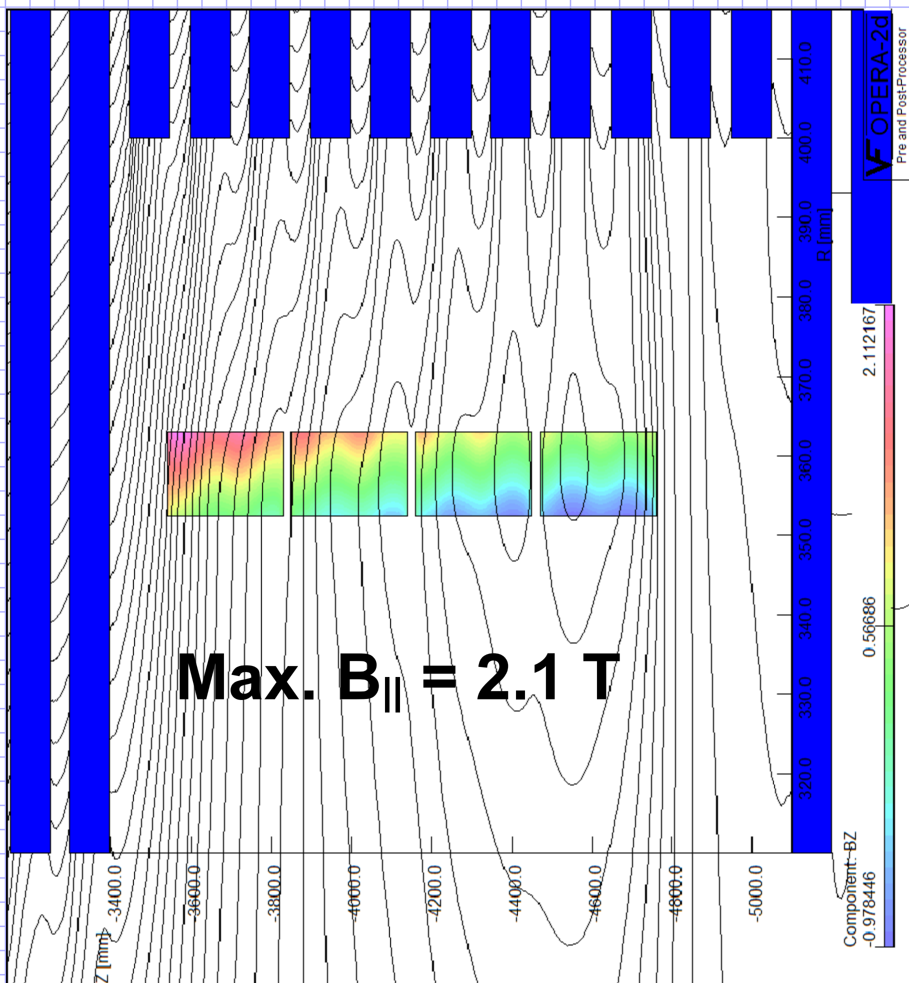
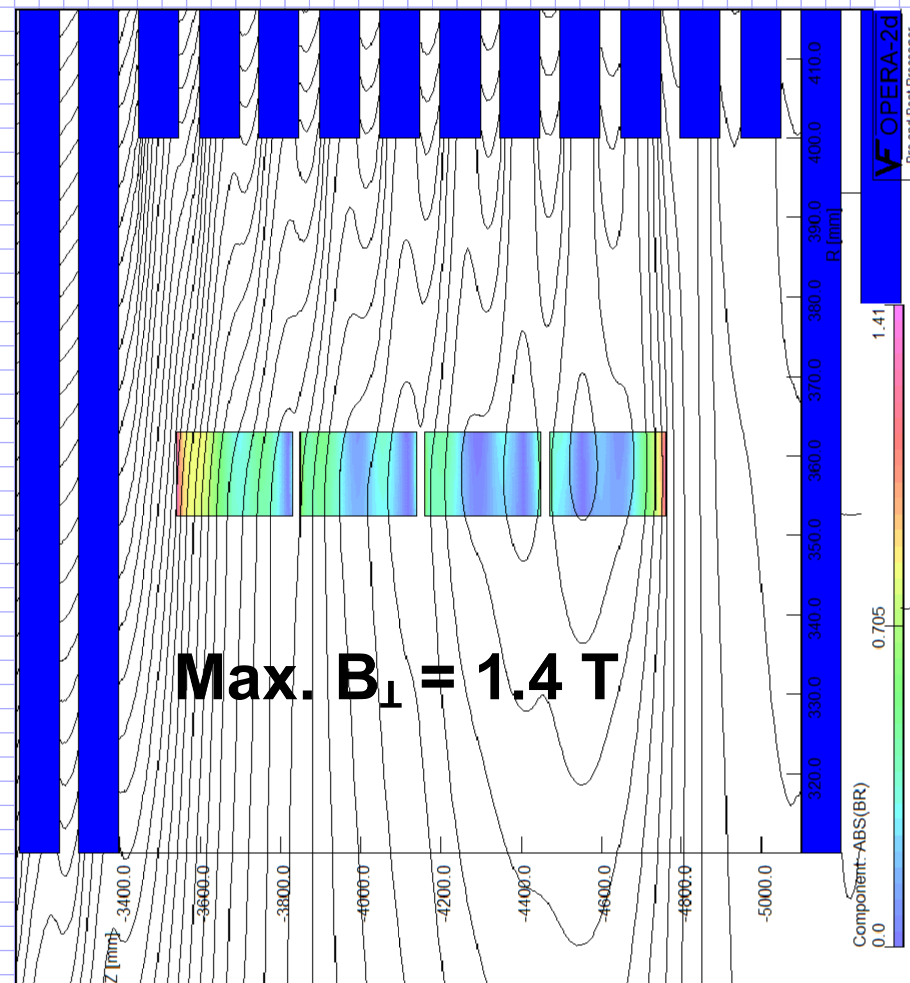
Revise the Anti-Solenoid Design to Make Use of HTS Tape Conductor (I_o = 200 A).

Map of B Parallel to HTS Tape



B Perpendicular to HTS Tape



With High Temperature Superconductor (HTS) have to keep track separately of magnetic field components parallel & perpendicular to face of the tape.

Summary (2/2) on 9 June, 2007

With a maximum perpendicular field component of 1.4 T it seems not unreasonable to expect to run the anti-solenoid at a ballpark temperature range of 20 to 35°K.

Then the cooling structure sould be quite simple. Gupta and Sampson have used both cold gas flow and even conduction cooling. Expect to save on radial space compared to low temperature superconductor (LTS). HTS working point is about LTS heat shield temperature.

Space needed to bring current leads and cryogens through the yoke to the anti-solenoid will also be much less as compared to an LTS solution.