The septa magnet for the APEX experiment

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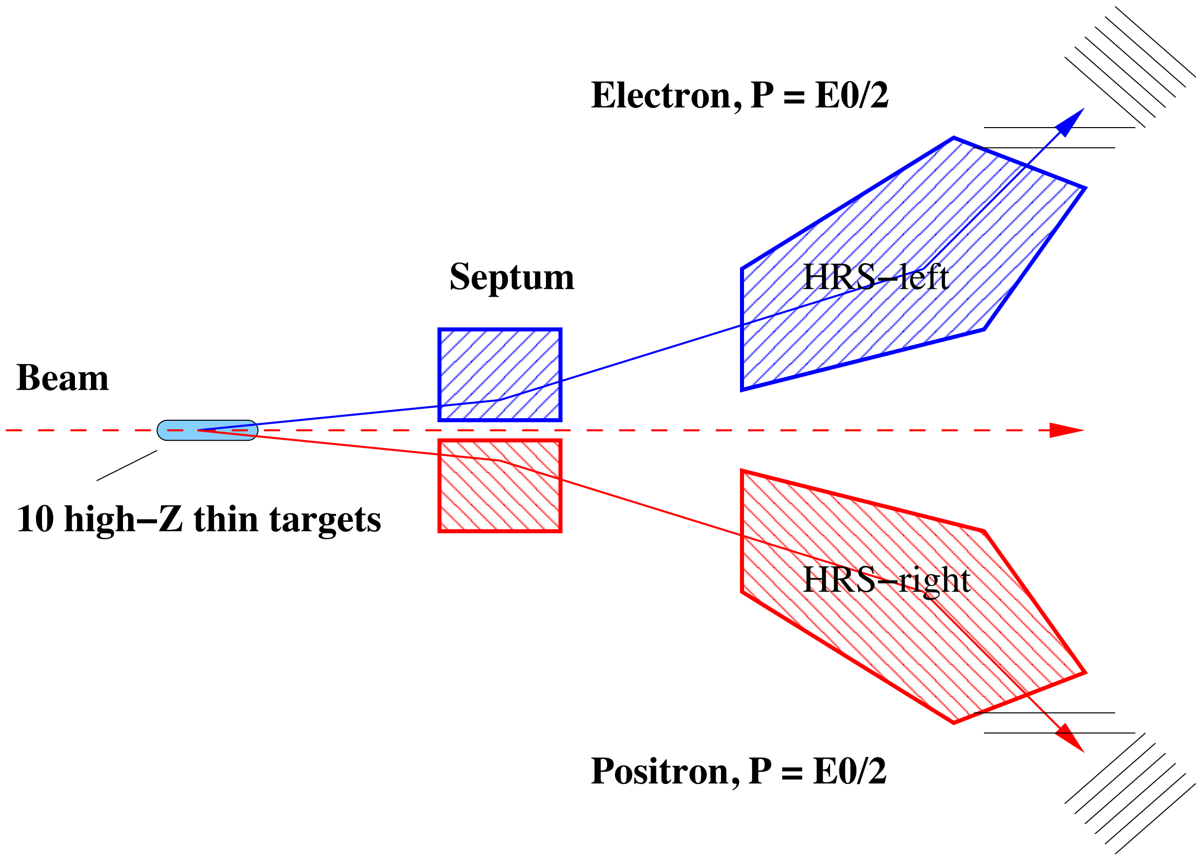
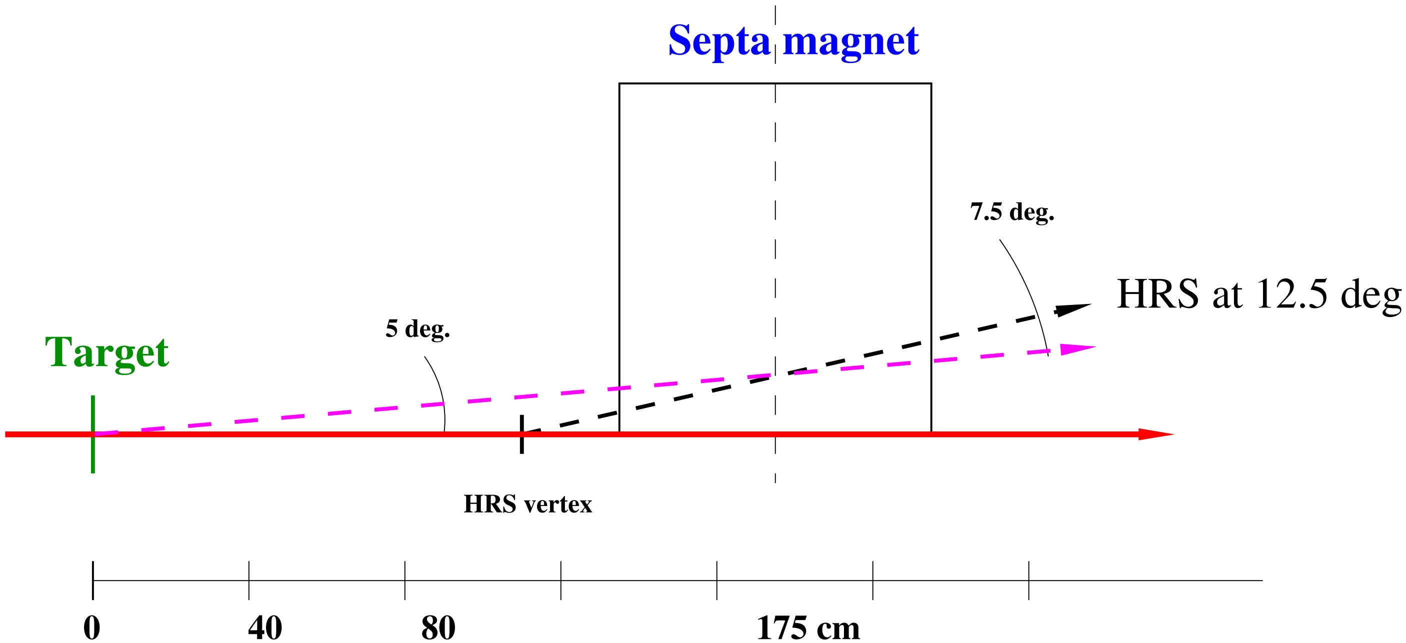
- Concept of the septa magnet for HRS
- Requirements in the APEX experiment
- Design of the magnet and calculations
- Acceptance of the HRS with the septa
- Construction status and delivery schedule

APEX experimental layout

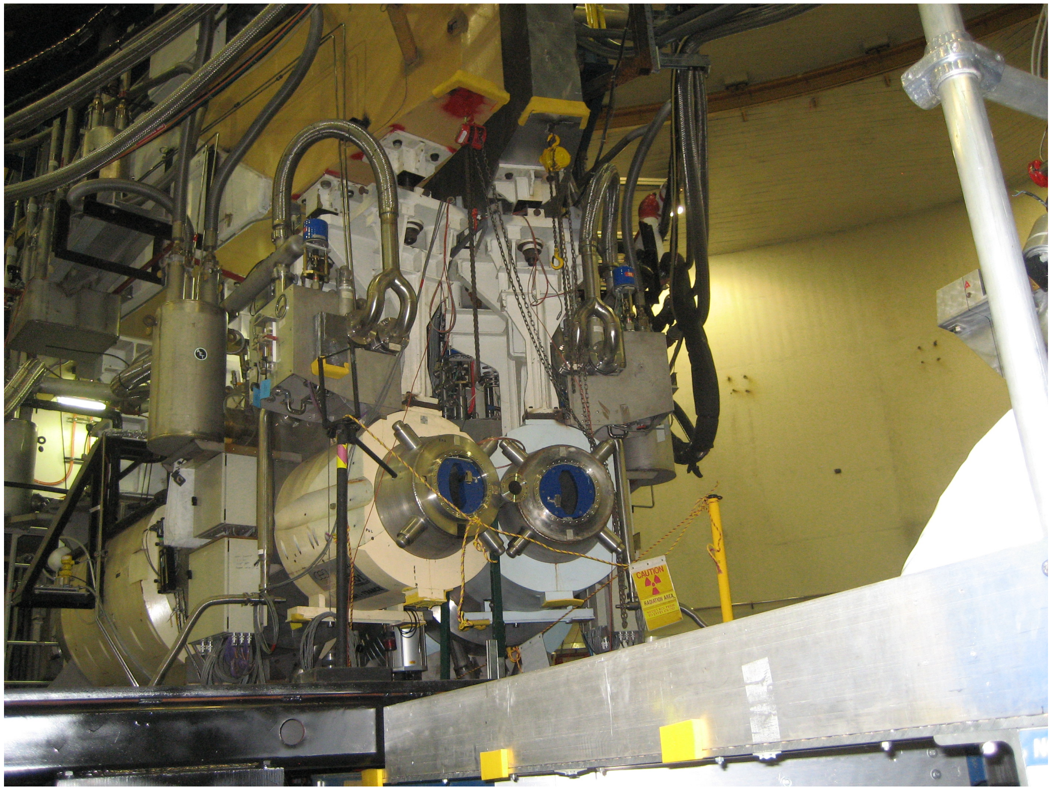


Septum magnet concept



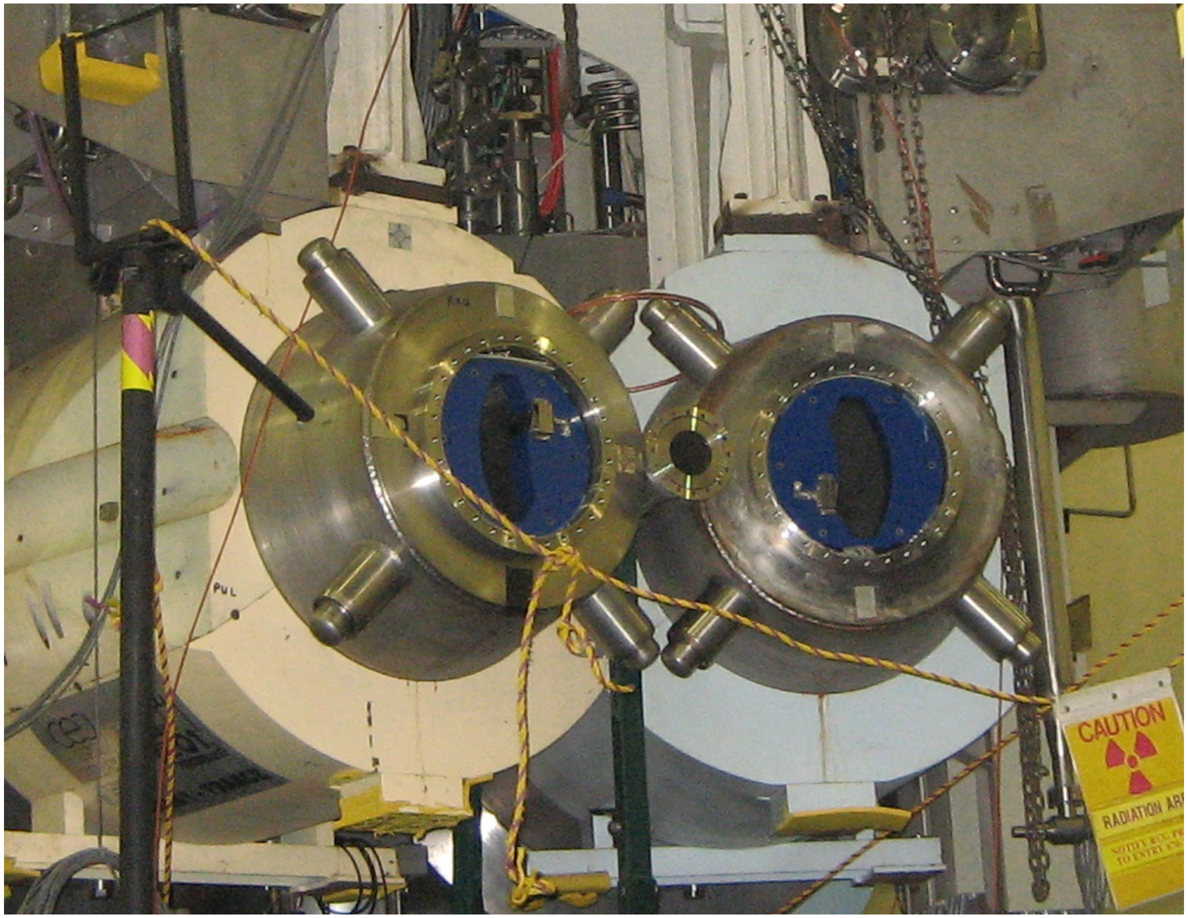
Septa works well for Δp/p << 1. In HRS Δp/p is of 0.09
Required field integral is 0.44 Tesla-m per 1 GeV/c
APEX is approved to run with 1.1, 2.2, 3.3, and 4.4 GeV beam energies, which requires 0.55, 1.1, 1.65, and 2.2 GeV in HRS

Pictures of the equipment



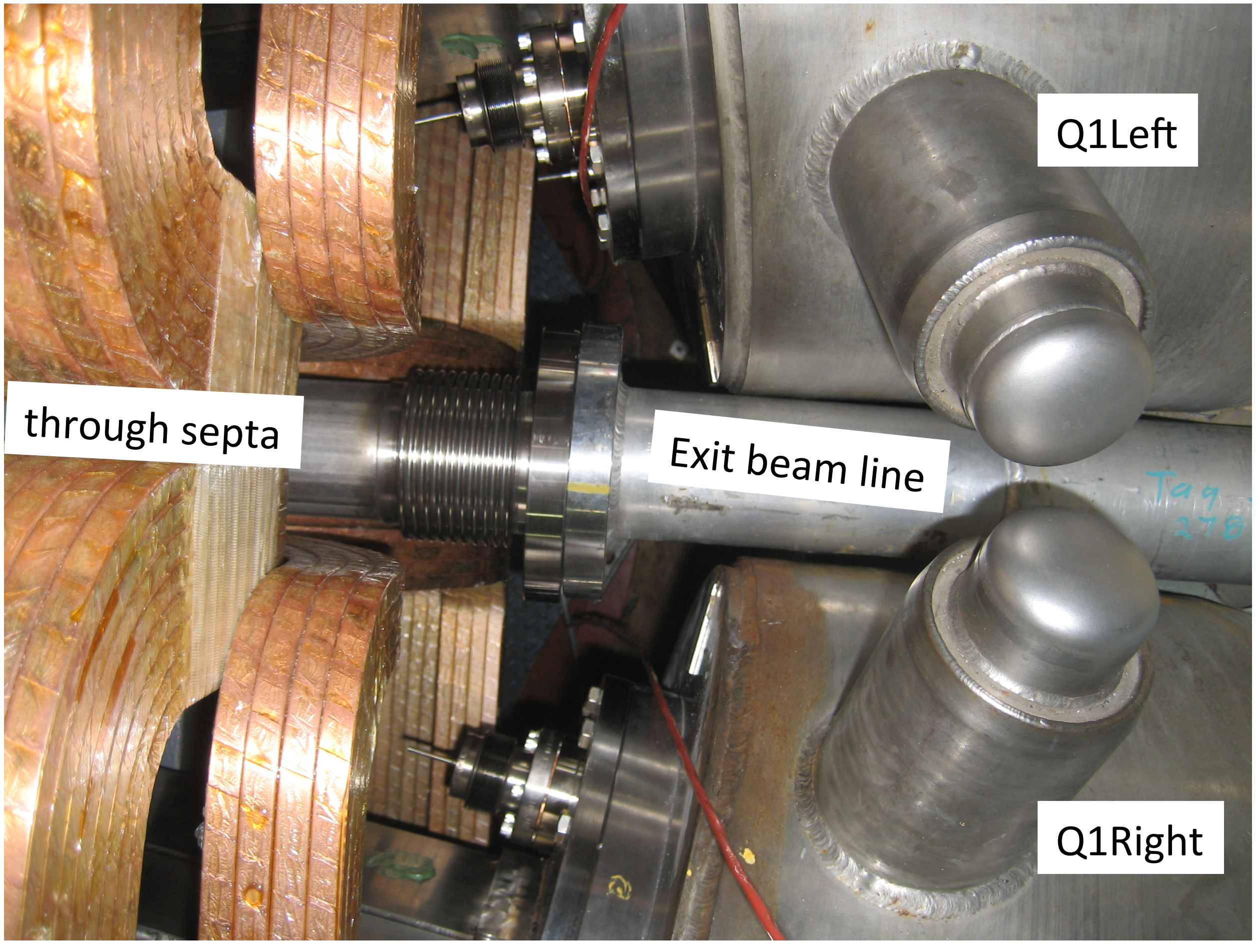
Combined field of Q1s, Q2s, Dipoles on the beam line requires attention
Limiting aperture of the beam line for upstream target causes add. radiation

Pictures of the equipment



Limited space between Q1s for the beam line pipe
Minimum angle for HRS is 12.5 degrees

Pictures of the equipment



Considerations for the septum

i) The angle, 5 deg., directed toward the HRS acceptance (12.5 deg.)

ii) Acceptance of HRS, vert. = +/- 2.9 horiz. = +/- 1.4 deg. (4.3 msr)

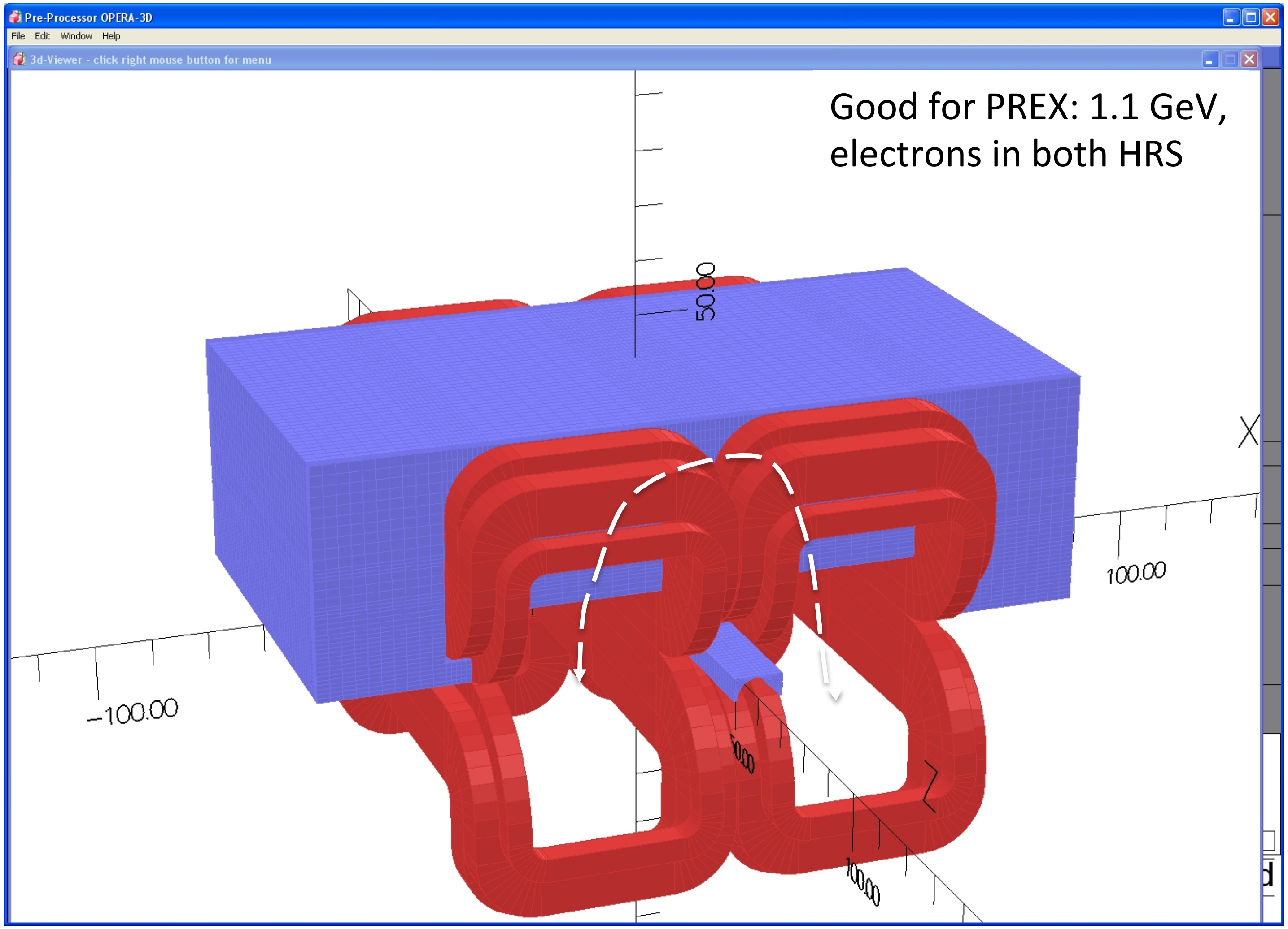
iii) "Zero" field on the beam line (within at least +/-0.9 degrees)

iv) Current density in the warm coils is limited by ~1500 A/cm^2

v) Space between the septa and the HRSs is very limited

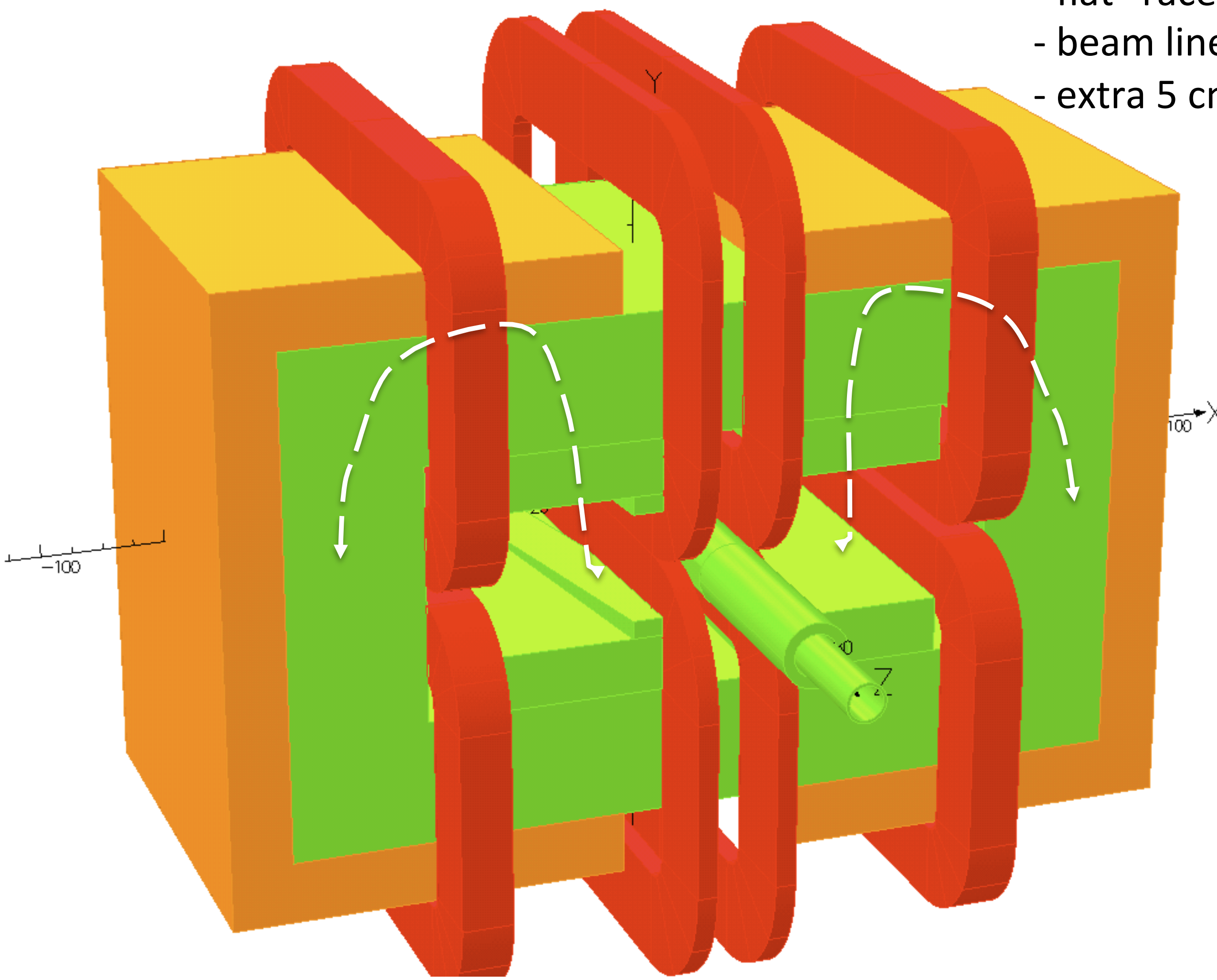
vi) Impact of the septa field on optics and hardware resolution

PREX septa model (Brindza)



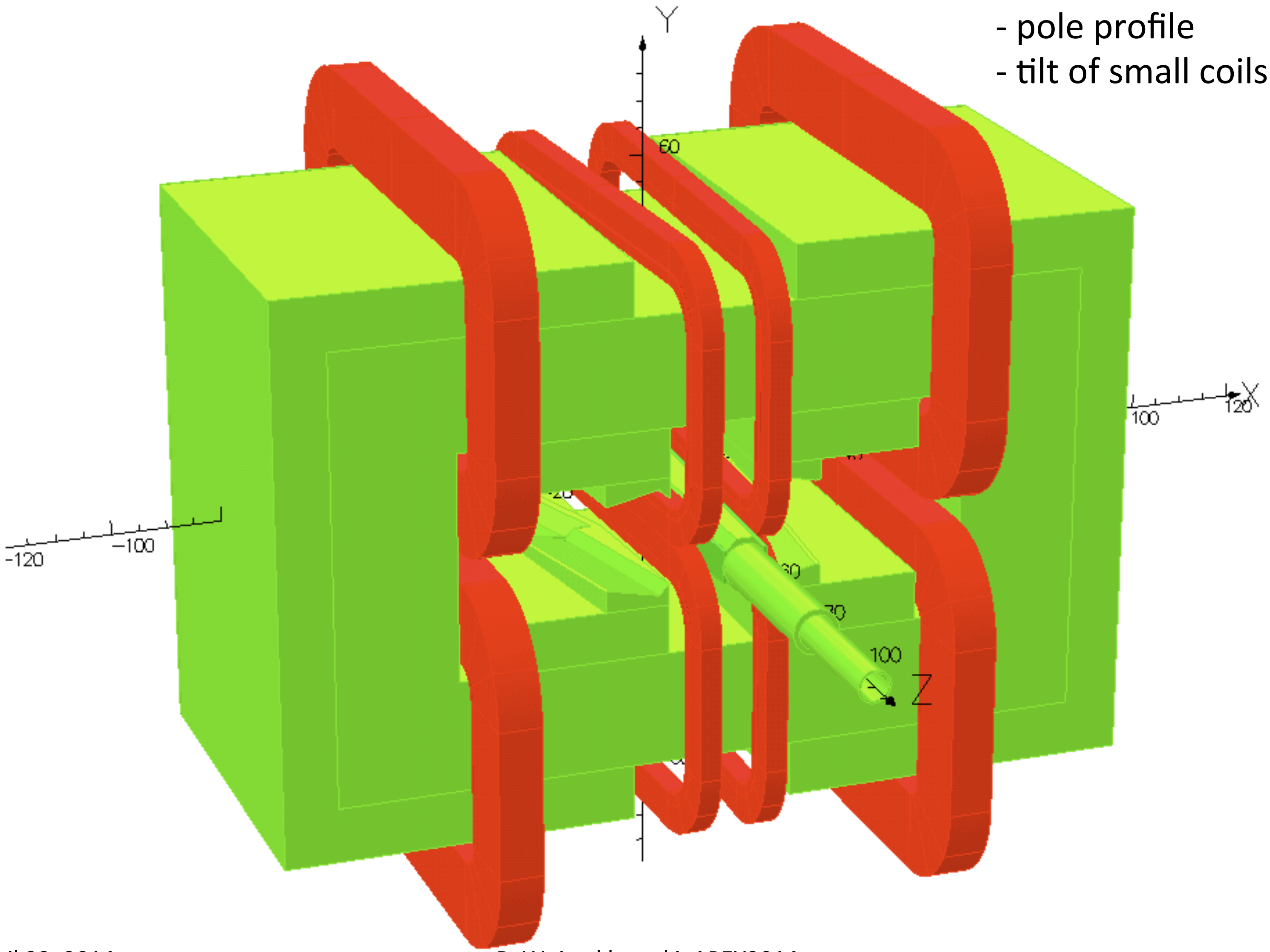
Nov. 2012 design

- flat “racetrack” coils
- beam line double shield
- extra 5 cm iron yoke



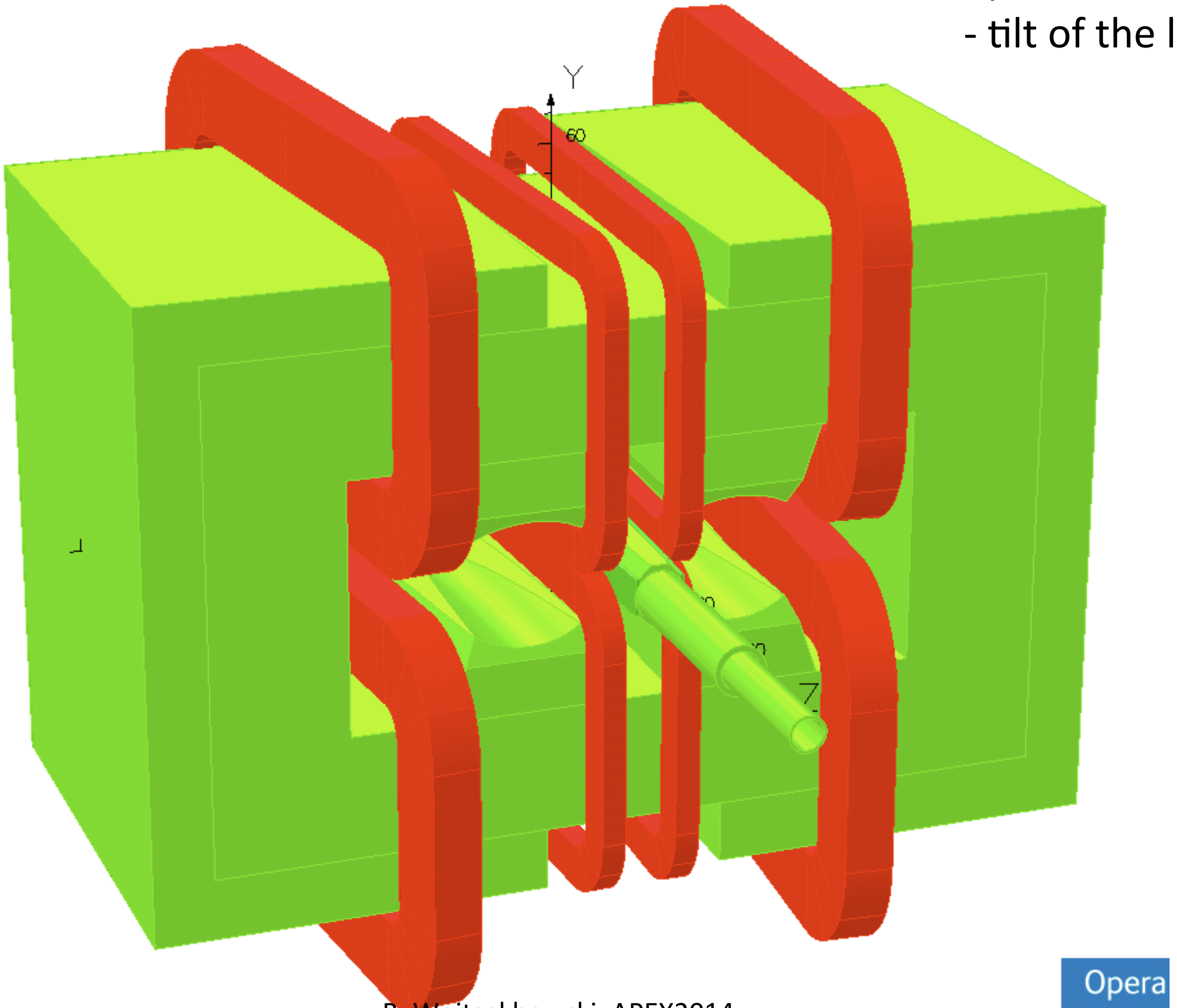
Jan. 2013 design

- pole profile
- tilt of small coils by 2 deg



Feb. 2013 design

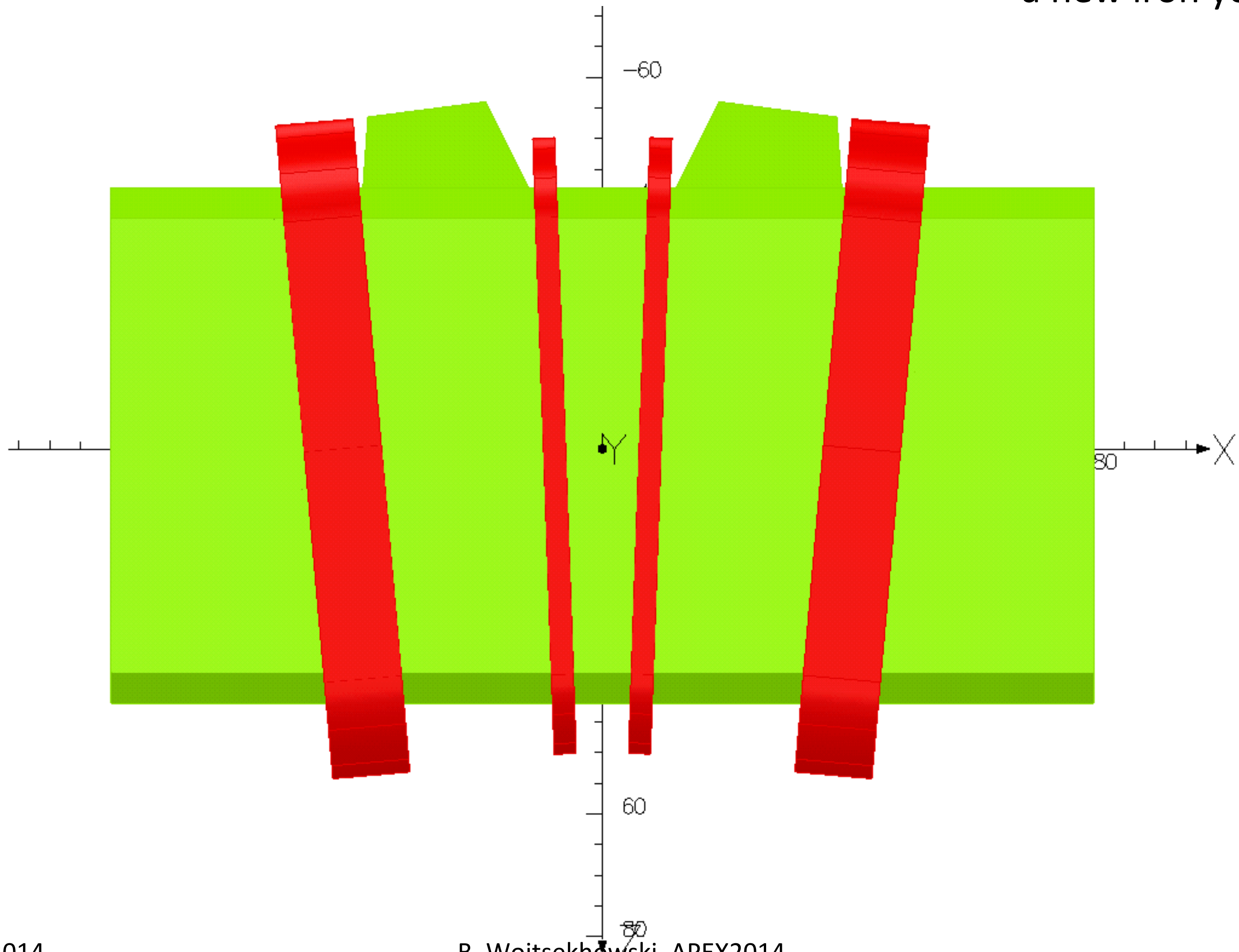
- max use of B flux: pole
- permendur in the shield
- tilt of the large coils



May 2013 design

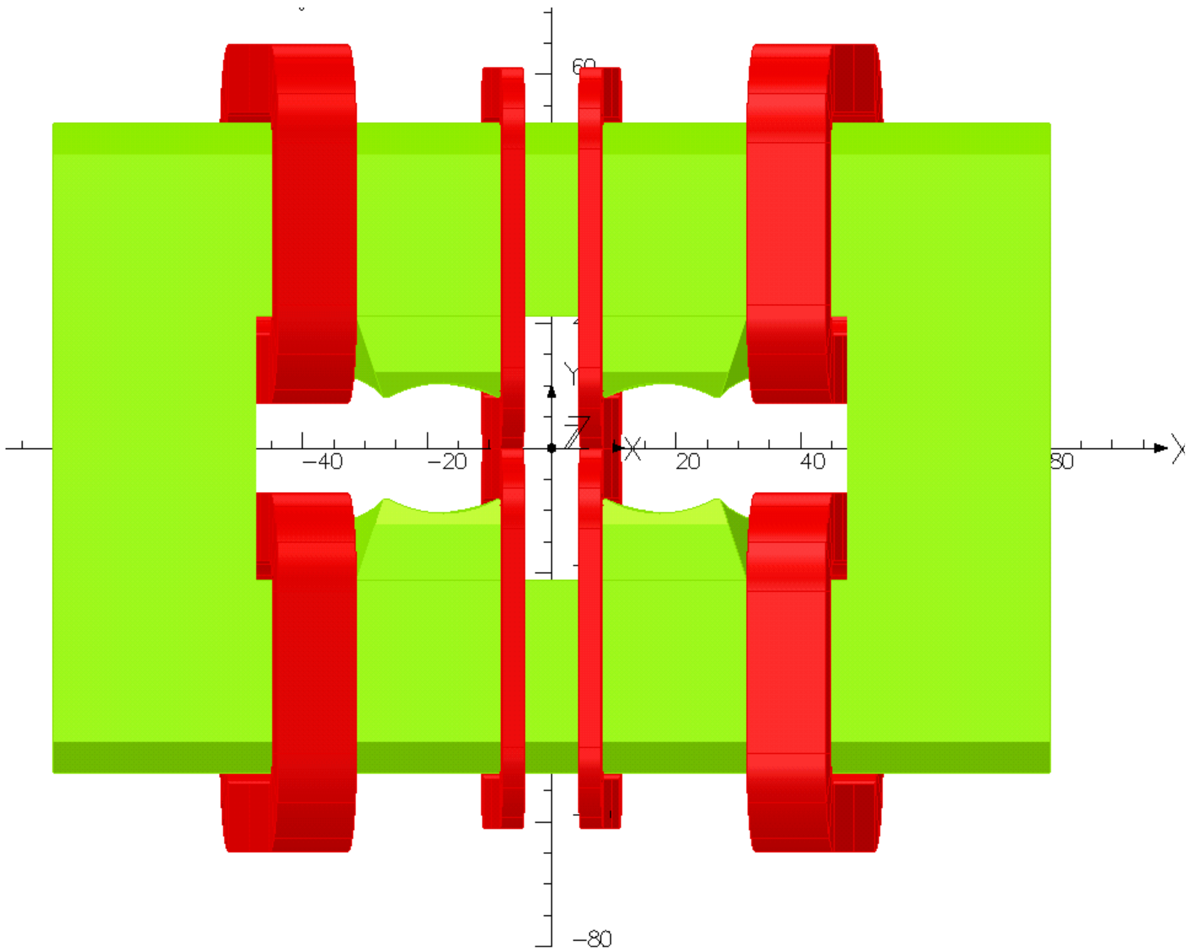
- nose extensions to HRS
- a new iron yoke

Top view

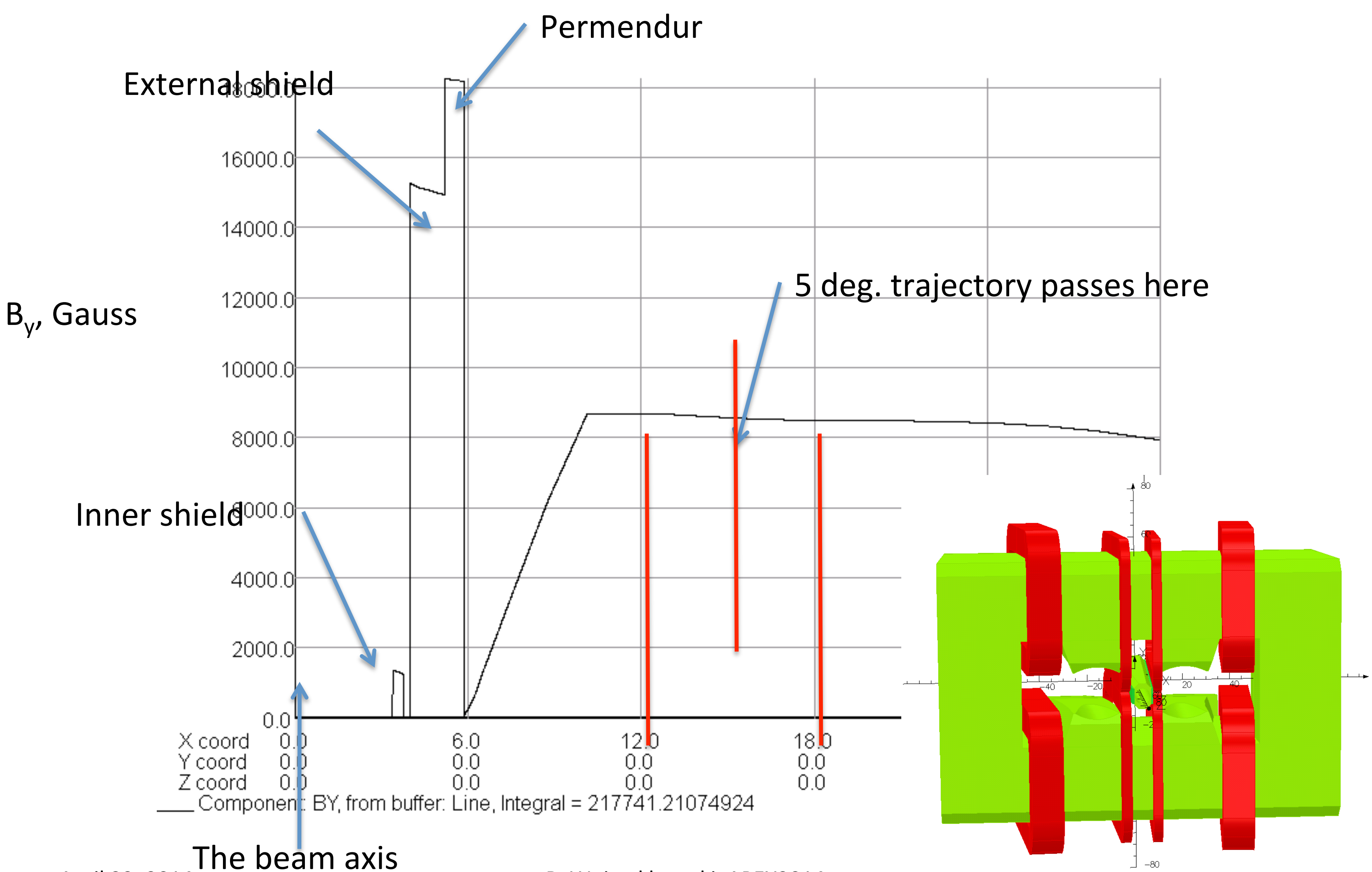


May 2013 design

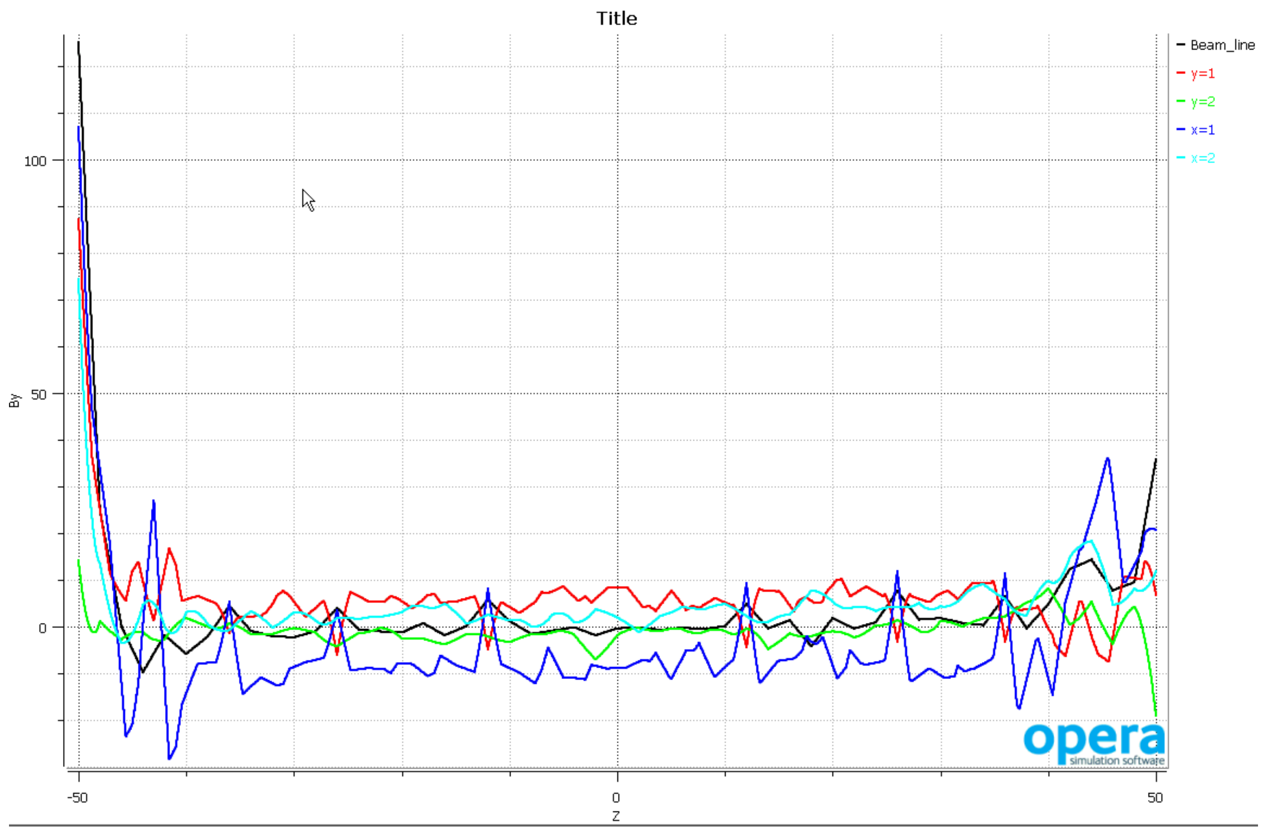
Front view



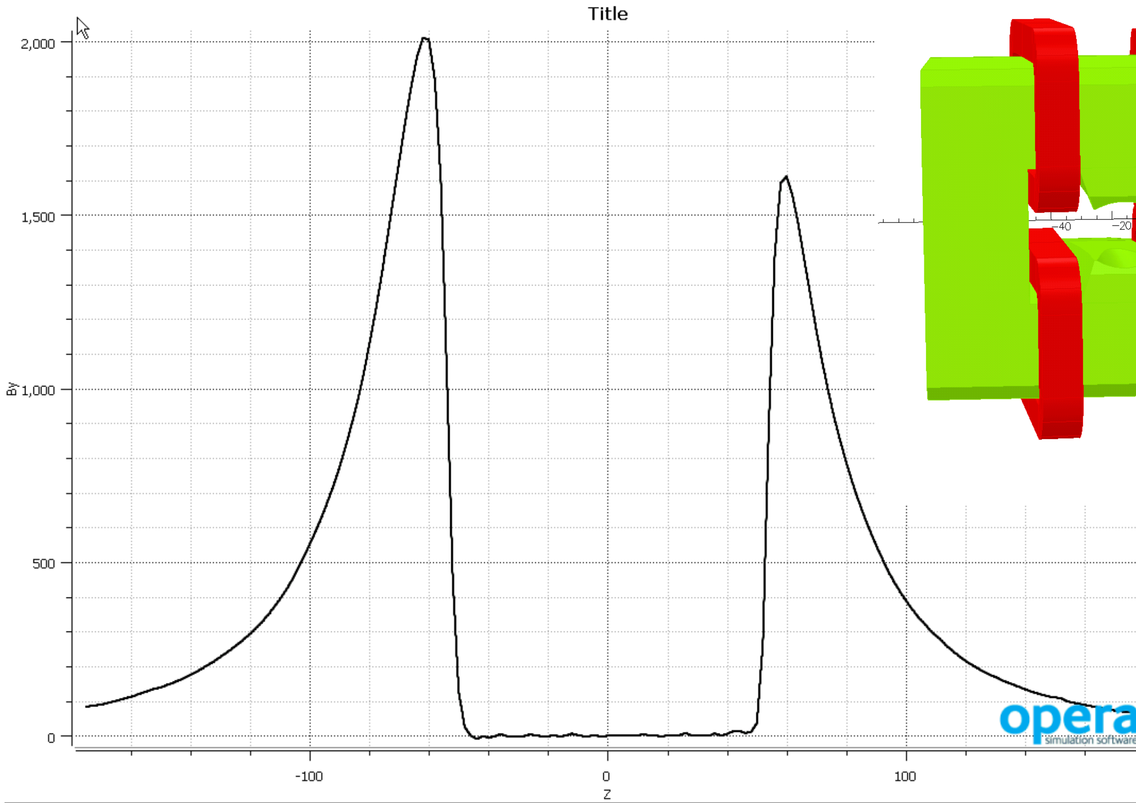
Field vs. distance from the beam, in the septa middle plane

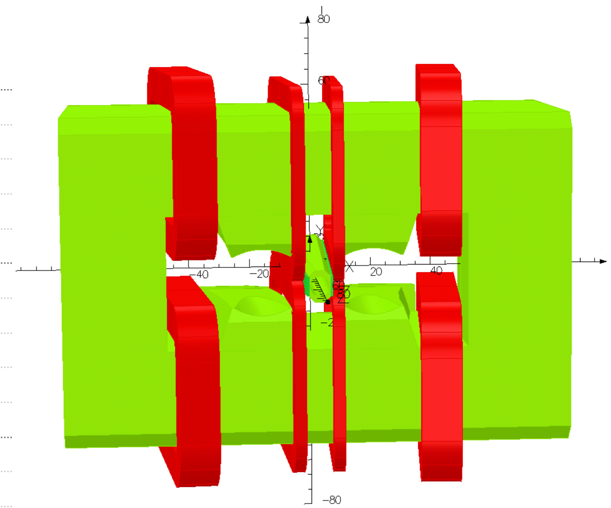


Field on the beam line (+/- 1, 2 cm) inside the septa

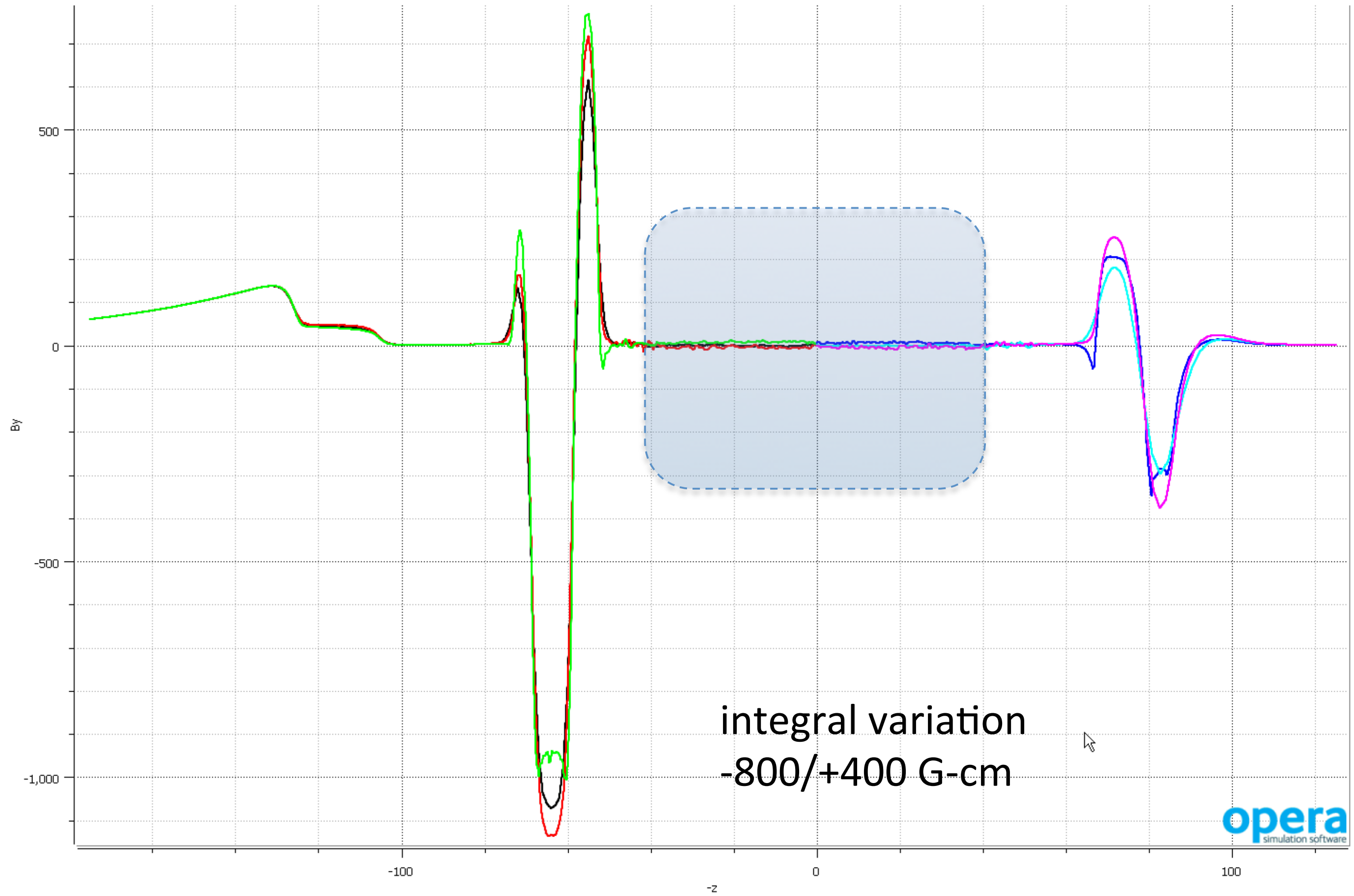


Field on the beam line with the septa w/o correctors and external shielding

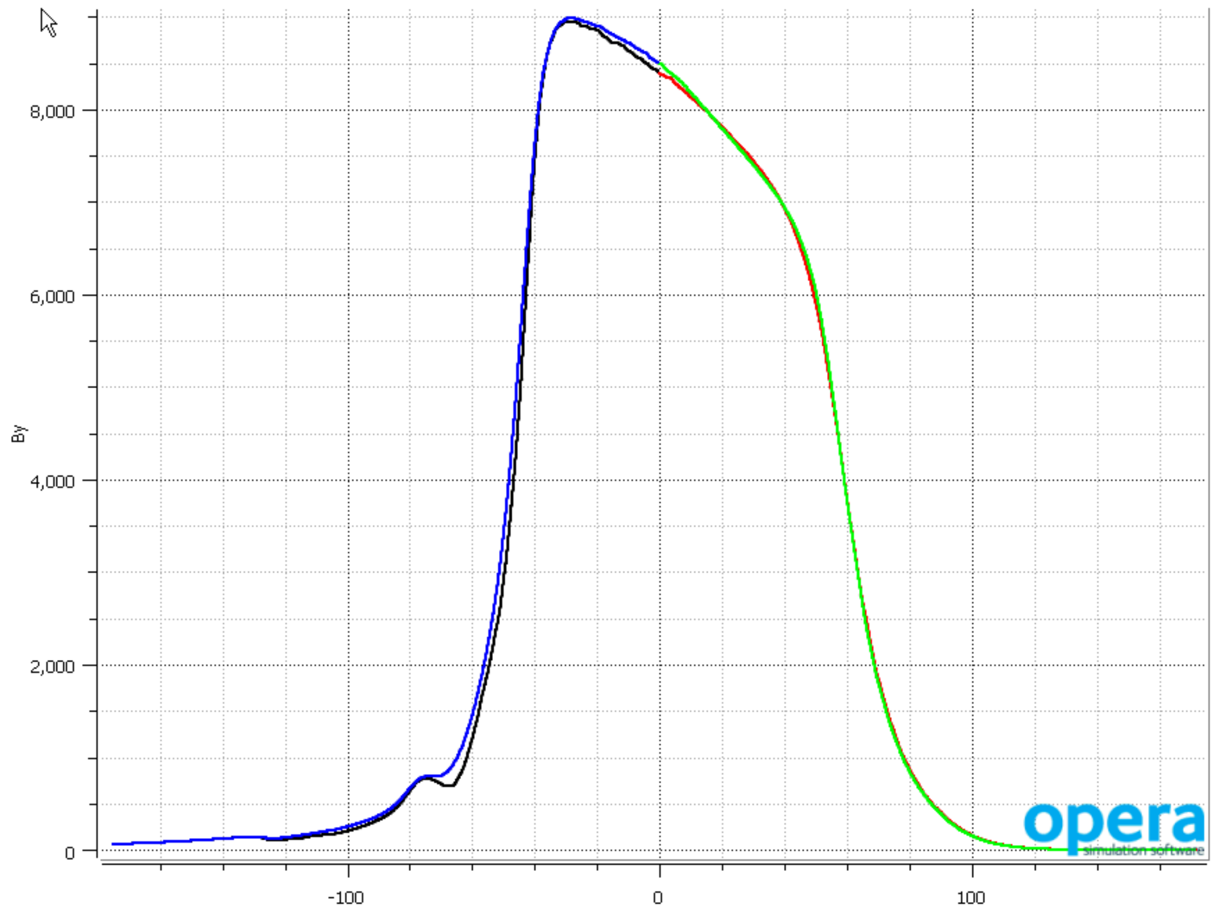




Field on the beam line (+/- 0.9 deg.) with the septa plus correctors and the external shielding



Field along the 4 and 5 deg. trajectories



0.459 + 0.486
Integral, T-m

Field integral map, S10

	X= 4 deg	X= 5 deg	X= 6 deg	X= 7 deg
Y= 3 deg	+8.5%	-2.7%	+1.0%	+5.7%
Y= 2 deg	+3.6%	+0.8%	+0.7%	+1.3%
Y= 1 deg	+0.0%	+0.0%	-0.5%	-1.8%
Y= 0 deg	-1.4%	-0.7%	-1.2%	-3.2%

hor. 4 to 6 deg.

Difference of the integral (By x dl) normalized to the value at 5./1.

Field integral map, S10

	X= 4 deg	X= 5 deg	X= 6 deg	X= 7 deg
Y= 3 deg		-2.7%	+1.0%	+5.7%
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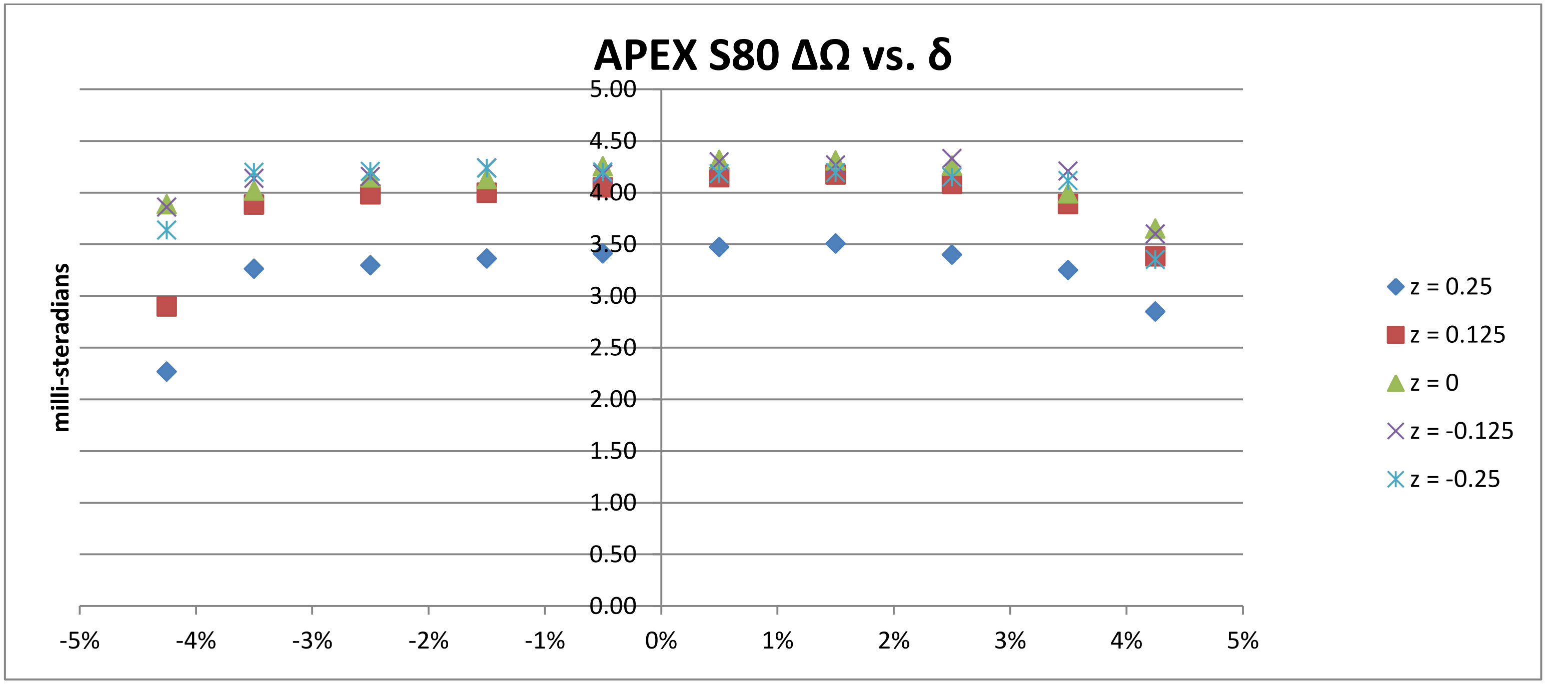
Y= 1 deg	+0.0%	+0.0%	-0.5%	-1.8%
Y= 0 deg	-1.4%	-0.7%	-1.2%	-3.2%

hor. 4 to 6 deg.

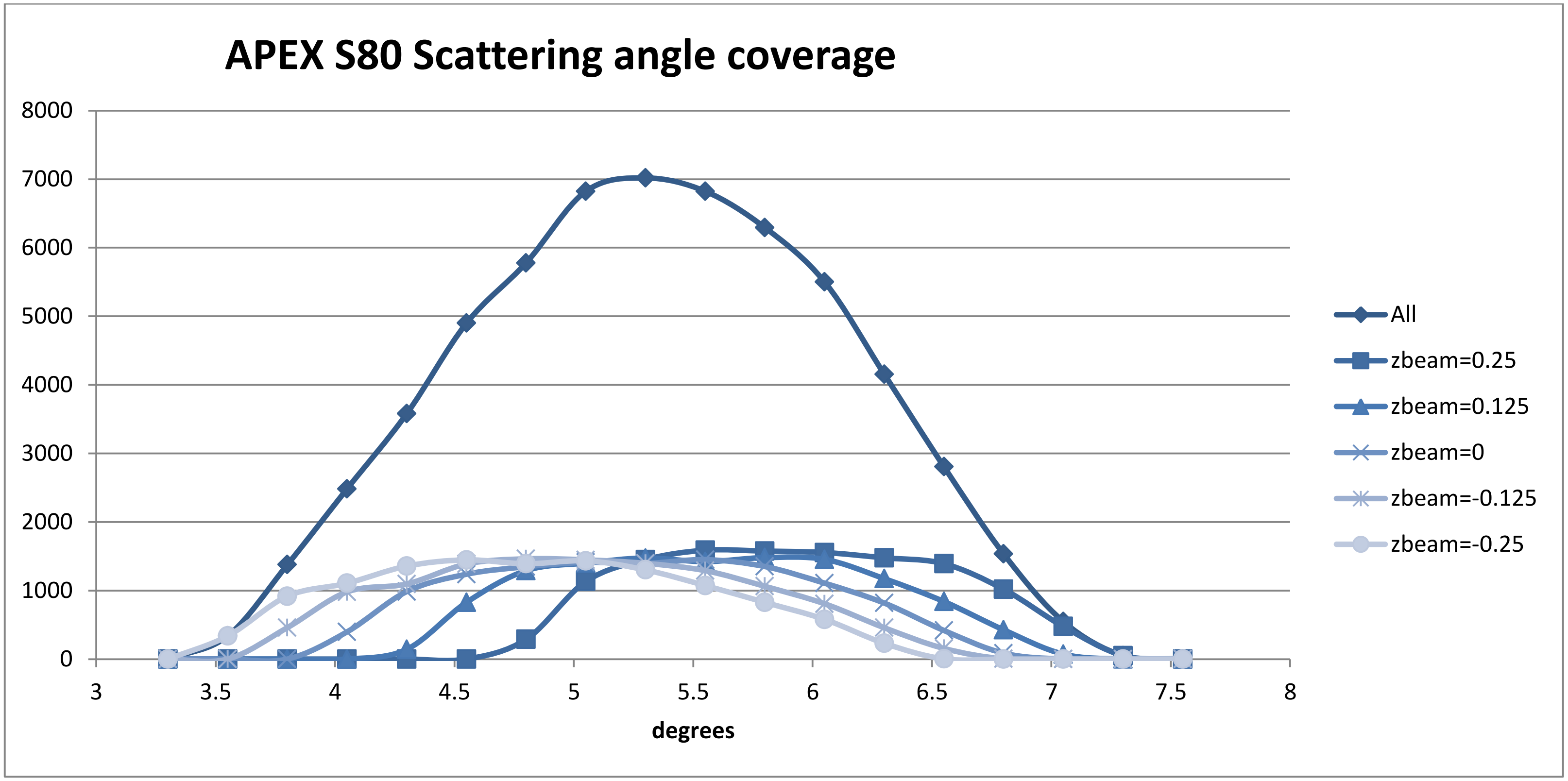
Difference of the integral (By x dl) normalized to the value at 5./1.

Solid angle vs. delta, S80



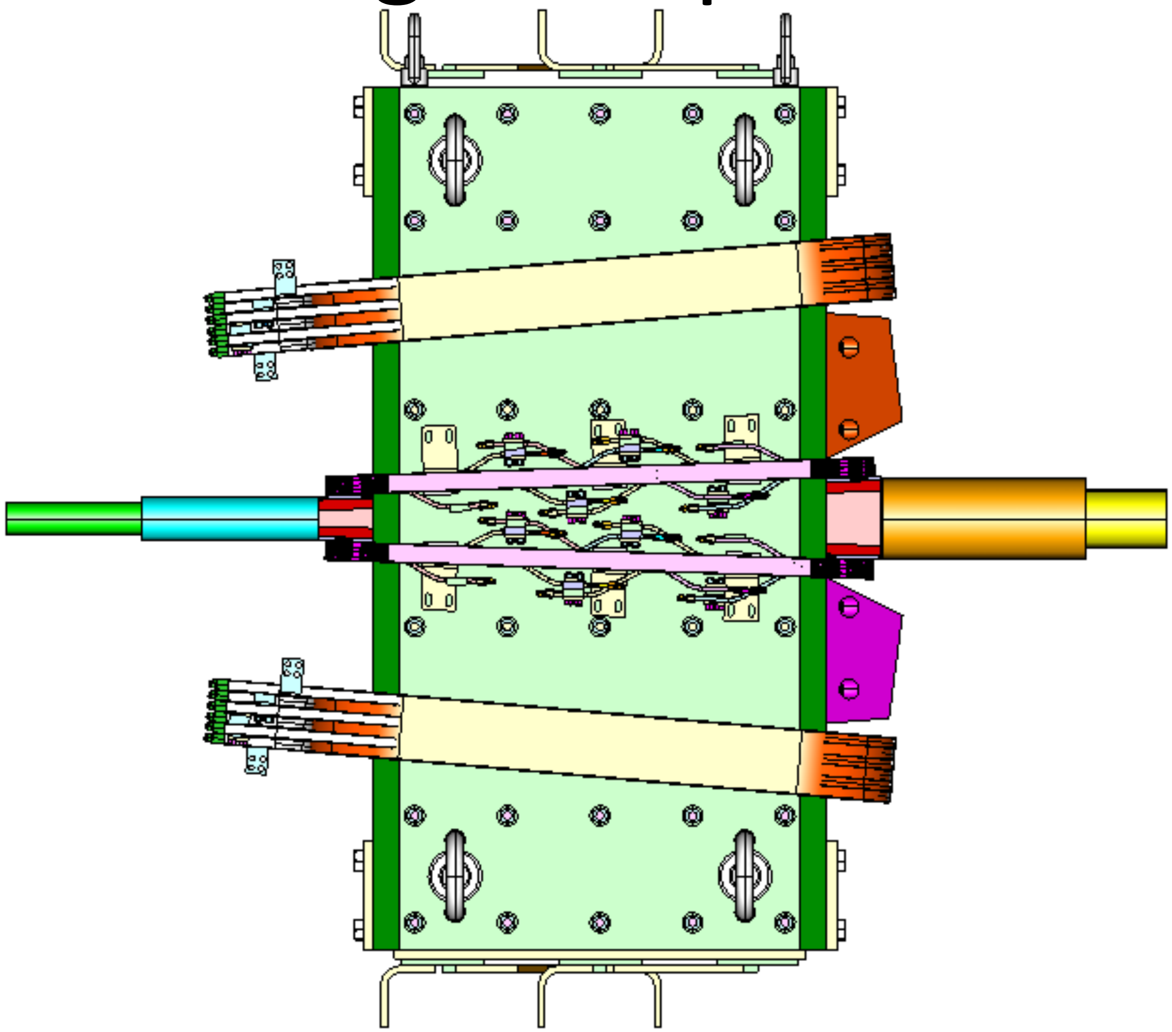
J. LeRose, S80 fields, Sept. 2013

Solid angle vs. delta, S80

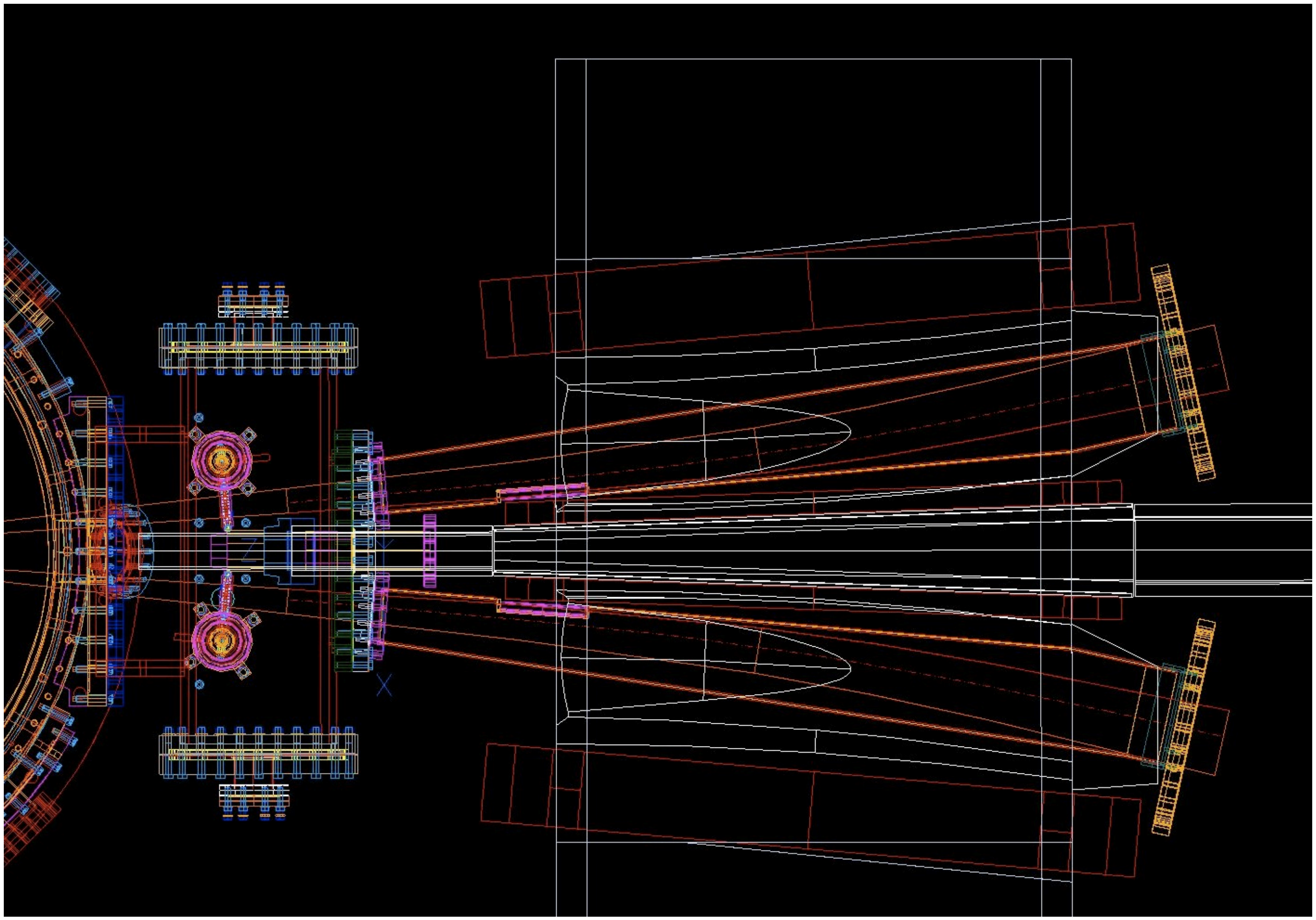


J. LeRose, S80 fields, Sept. 2013

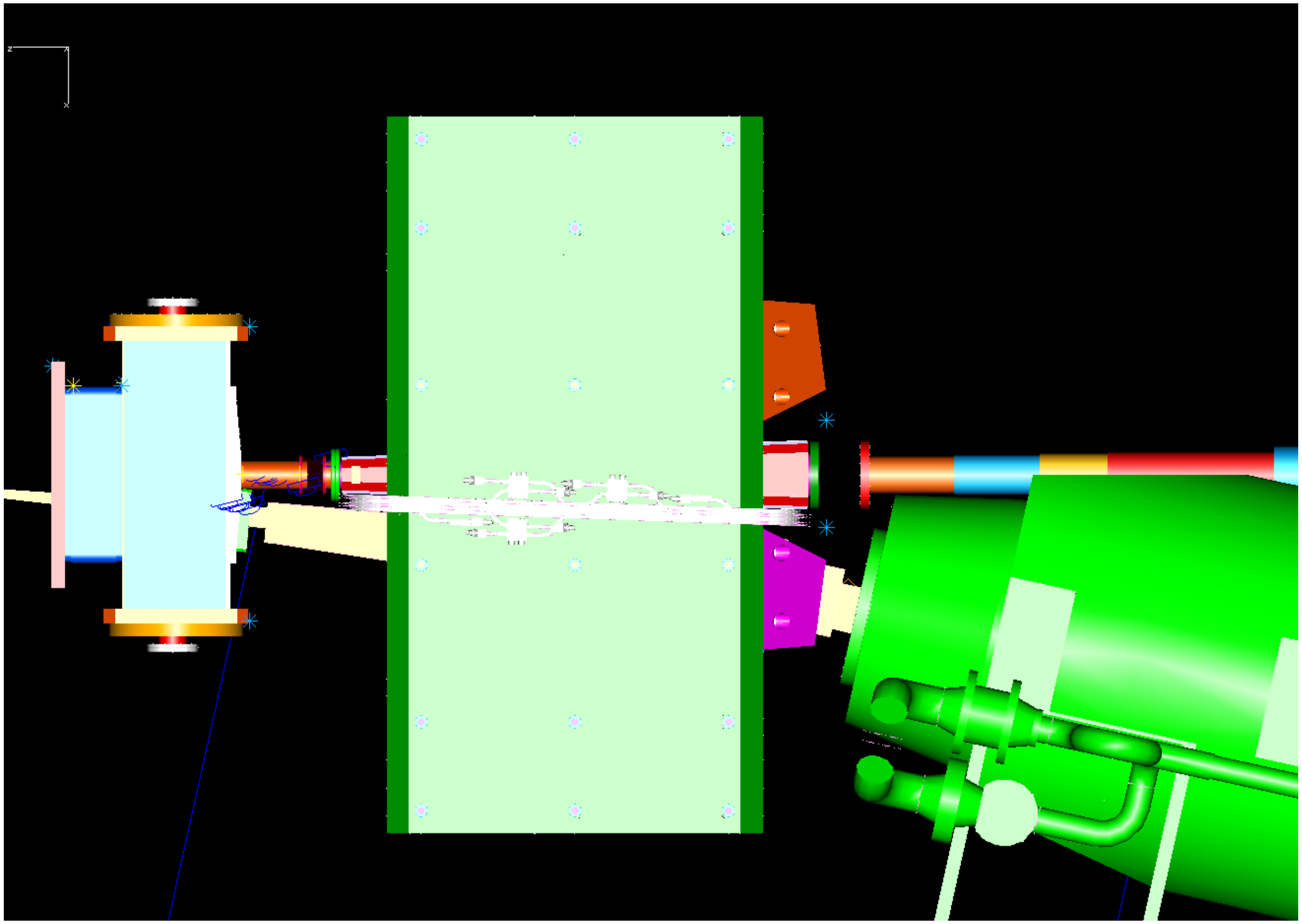
Magnet top view



Top view of the magnet and vacuum chambers



Magnet top view



Magnet procurement

Funding was provided by five universities: NCCU, CMU, CSULA, SBU, UW(Ca)

Design was completed in September 2013.

Request for quotations: Rhinestahl, Buckley Systems, Advanced Cyclotron

Project was awarded to Buckley Systems in December 2013.

Design was improved for the poles, small coils, coil clamps.

Production is proceeding now.

Magnet delivery is expected in July 2014.

Summary/Plans

1. The septa magnet for APEX is under construction
2. To do list:
   i) Magnet acceptance test
   ii) Modification of the support platform
   iii) Current bus for the magnet
   iv) Cooling water connection
   v) Safety items, documentation
   vi) 2 kA power supply test, controls