Boundary conditions on the EIC central detector design

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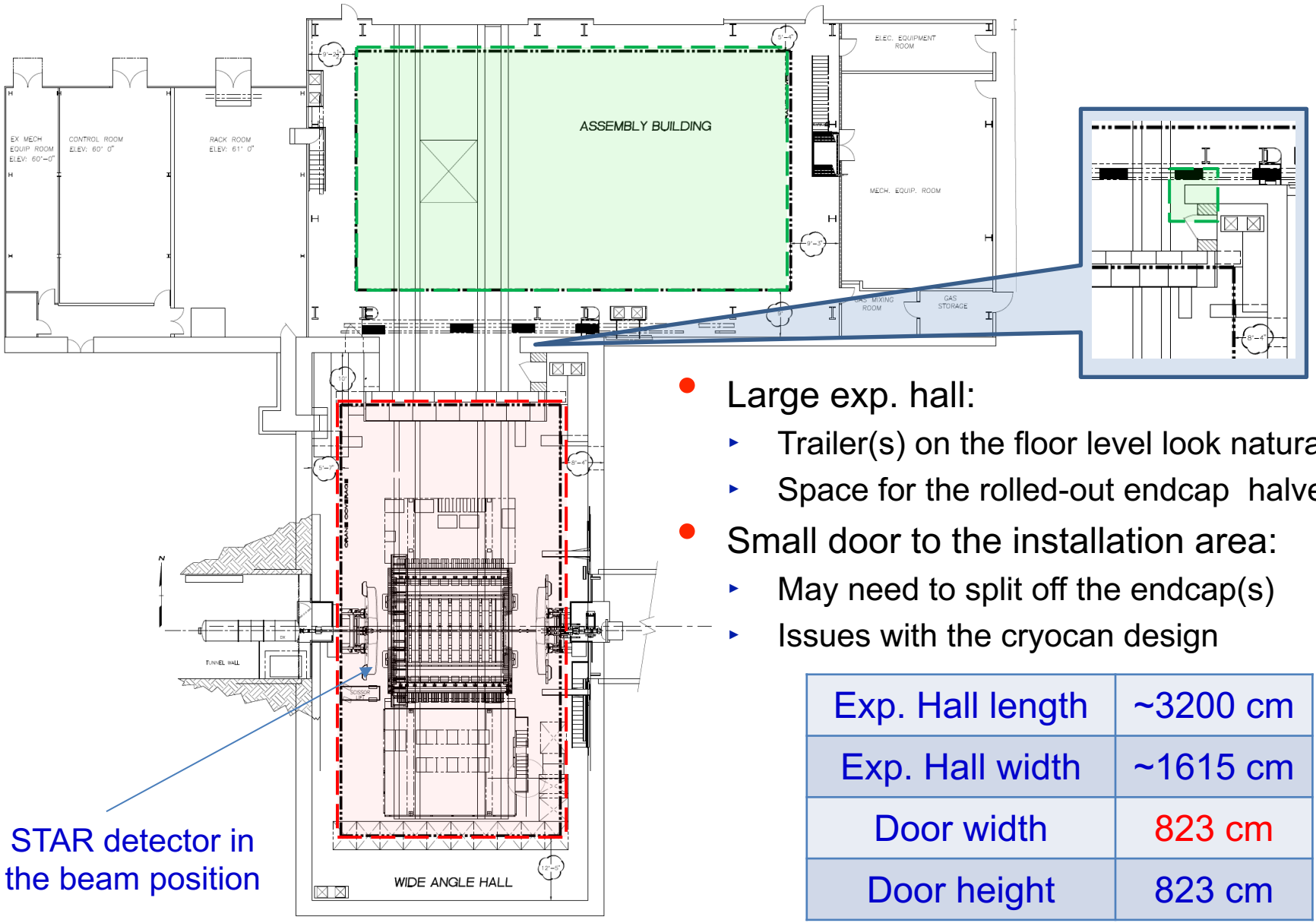
YR DWG convener meeting September 14, 2020

Topics

- Experimental halls
- EIC IR design
- Detector maintenance considerations
- IR vacuum chamber
- Central detector solenoid

RHIC IP6 Hall (STAR): the default option

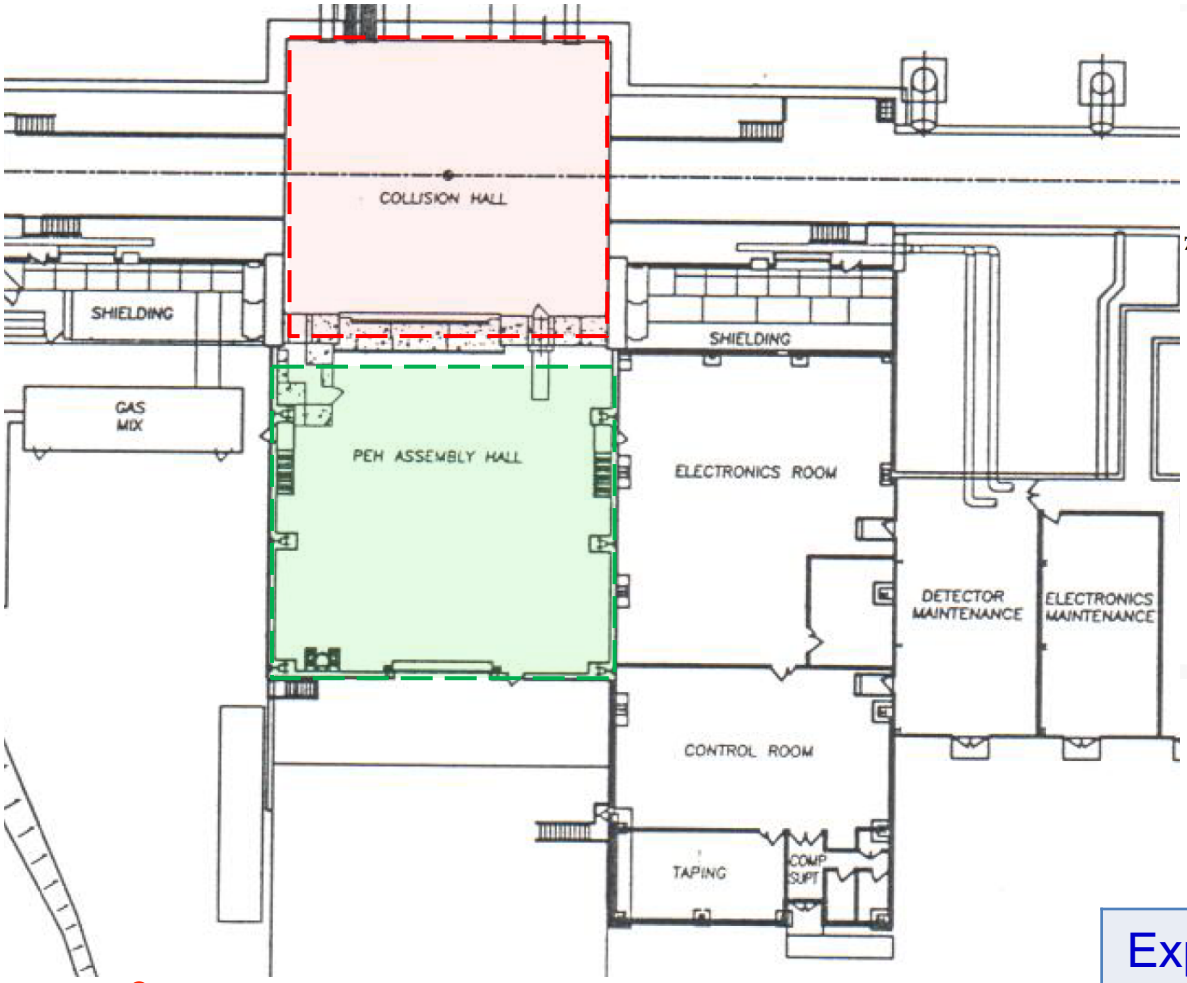


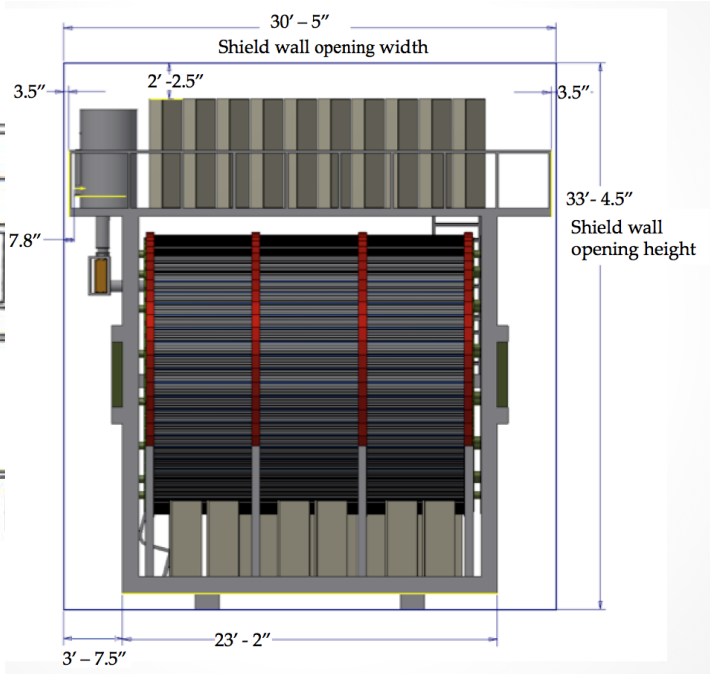
- Large exp. hall:
  - Trailer(s) on the floor level look natural
  - Space for the rolled-out endcap halves
- Small door to the installation area:
  - May need to split off the endcap(s)
  - Issues with the cryocan design

Exp. Hall length	~3200 cm
Exp. Hall width	~1615 cm
Door width	823 cm
Door height	823 cm

perhaps ~2 feet more

RHIC IP8 Hall (PHENIX): the "2-d IR" option



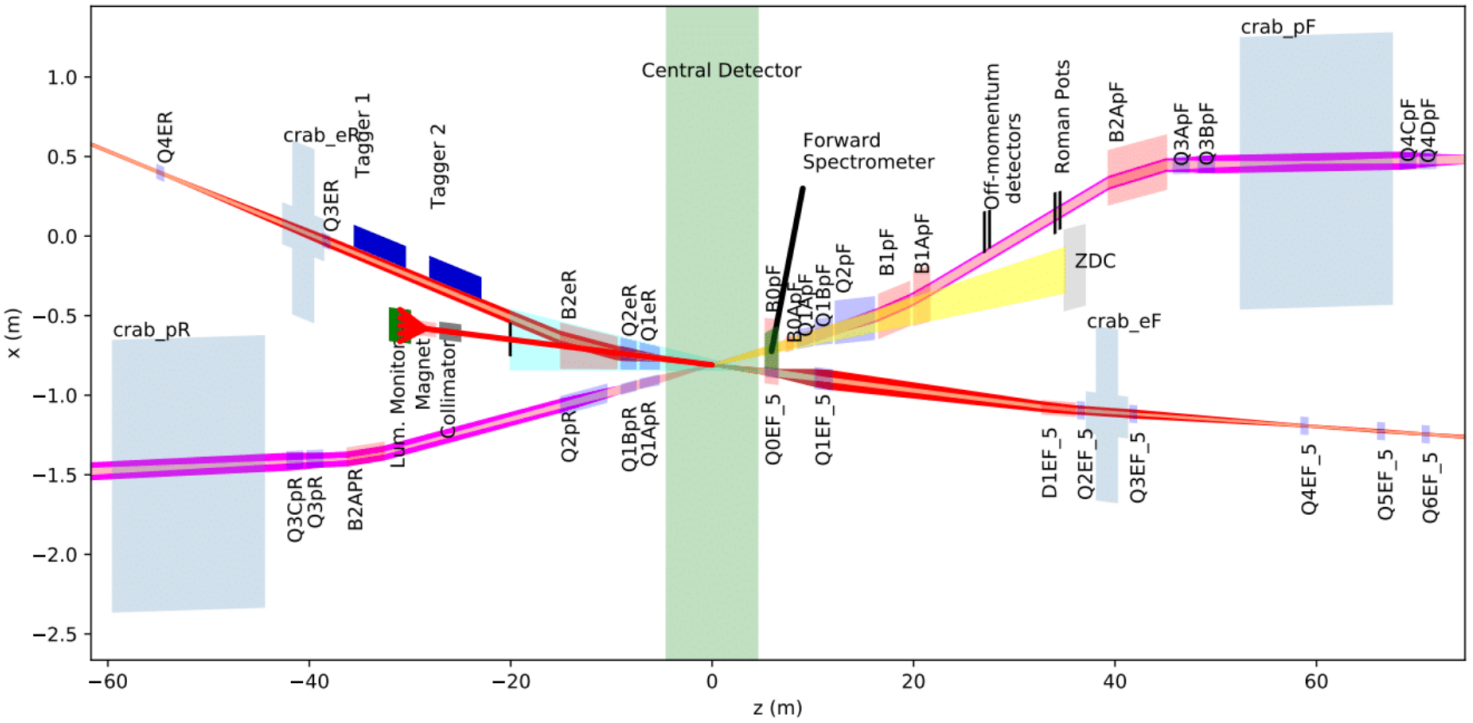


sPHENIX in IP8 doorway

- Small exp. hall:
  - Trailer on top of the detector looks natural
- Large door to the installation area:
  - No need to split off the endcaps

Exp. Hall length	~1740 cm
Exp. Hall width	~1860 cm
Door width	927 cm
Door height	1017 cm

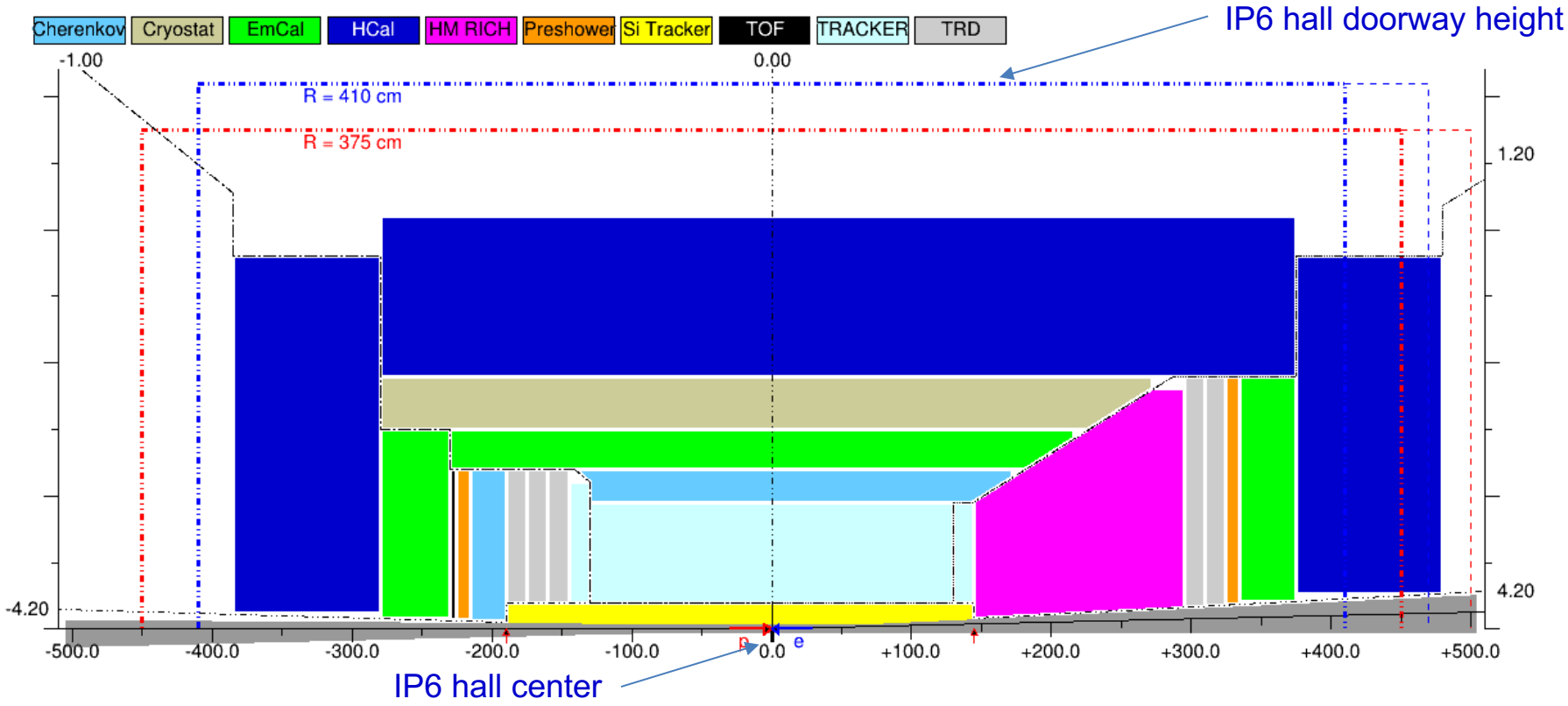
EIC IR design and installation timelines



- +/-4.5 m for the central detector: want to minimize L* (for higher luminosity)
- IP6 vs IP8: IR magnet installation is done through the exp. hall
  - STAR and sPHENIX running schedule
  - Extra time to disassemble the muon wall in IP8

Detector model placed into IP6

"Realistic" detector space allocations (but no support structures, etc.)

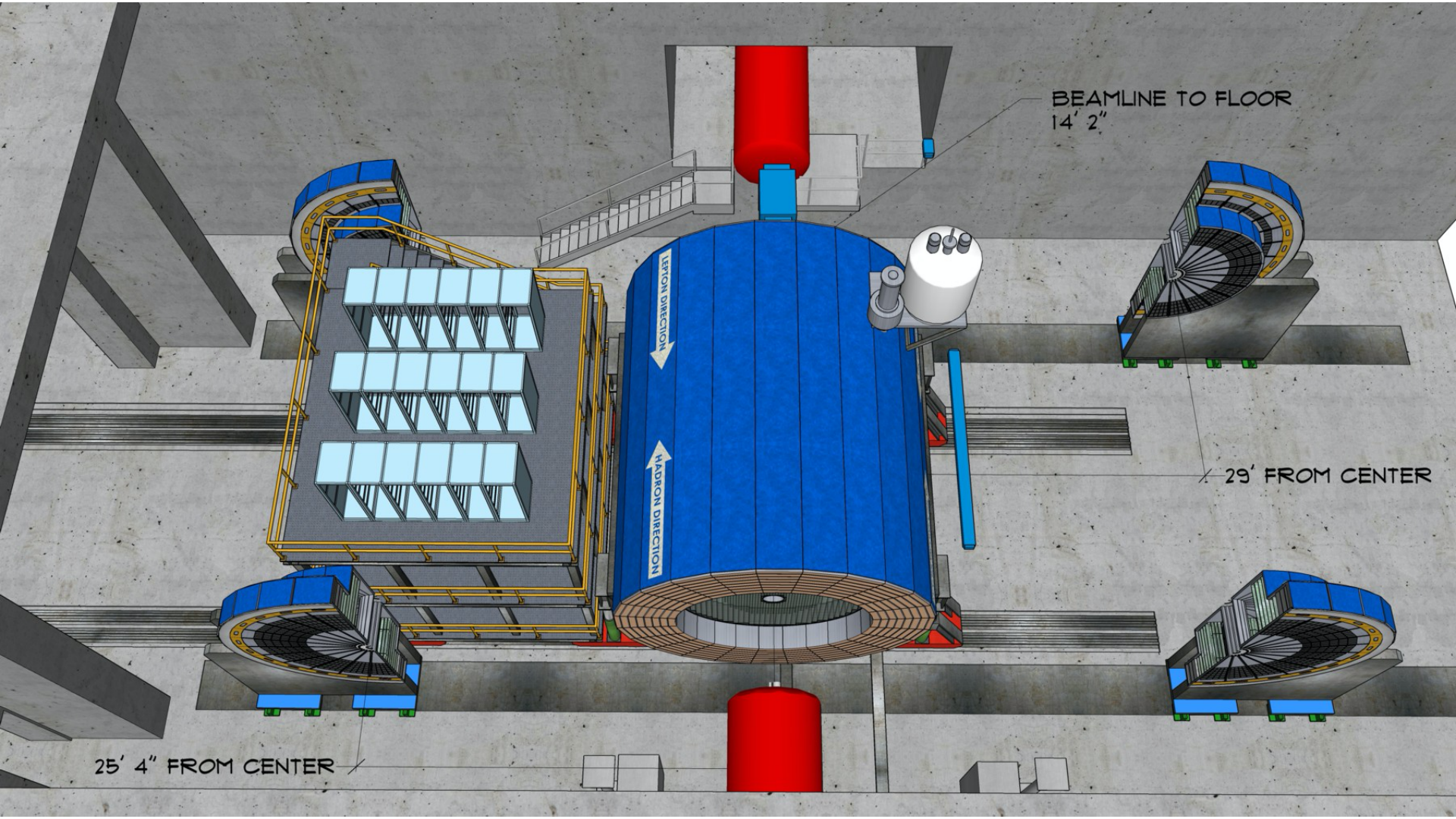


- Blue lines: +/- 410 cm (IP6 hall doorway width and height)
  - Can probably be extended by ~2 feet on the hadron-going side (if really requires only "minor" construction work)
- Red lines: +/- 450 cm (9 m space allocated for the main detector)
  - Can probably be extended by 50cm on the hadron-going side (requires "moderate" IR layout modifications in the accelerator design; work in progress)

Maintenance modes & access options

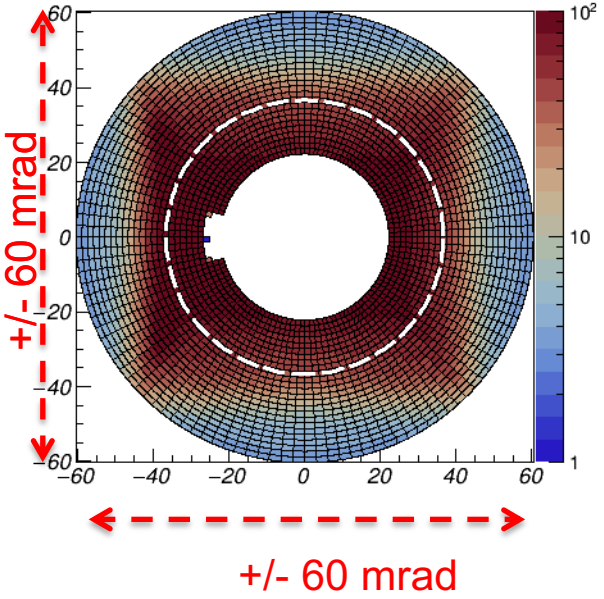
- Short access (hours) – no major disassembly actions
  - Electronics trailer
  - HCal frontend electronics
  - Cryocan
- Longer access (days to weeks) – endcaps rolled out in halves
  - EmCal frontend electronics
  - B0 magnet detectors (silicon tracker and EmCal)
  - Outer part of the central detector (planar trackers, perhaps the gaseous RICH electronics, perhaps DIRC electronics – if installed)
- Regular maintenance (months) – detector moved to the assembly hall
  - The only option to access the central tracker …
  - … and the forward / vertex / backward silicon trackers

IP6: detector in the “longer access” maintenance

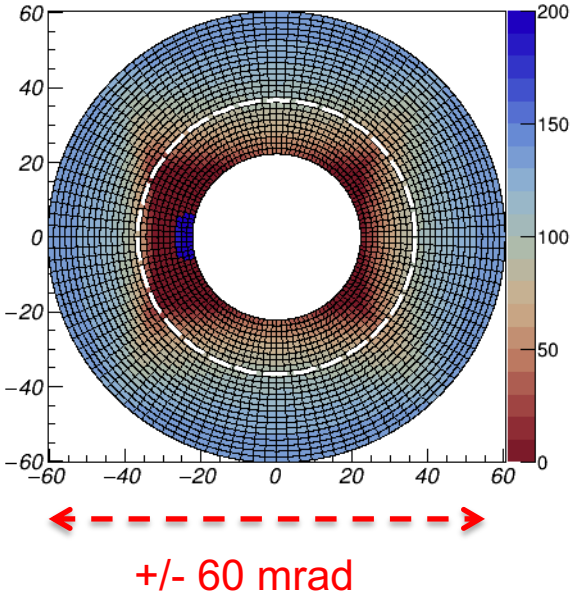


IR vacuum chamber: e-endcap

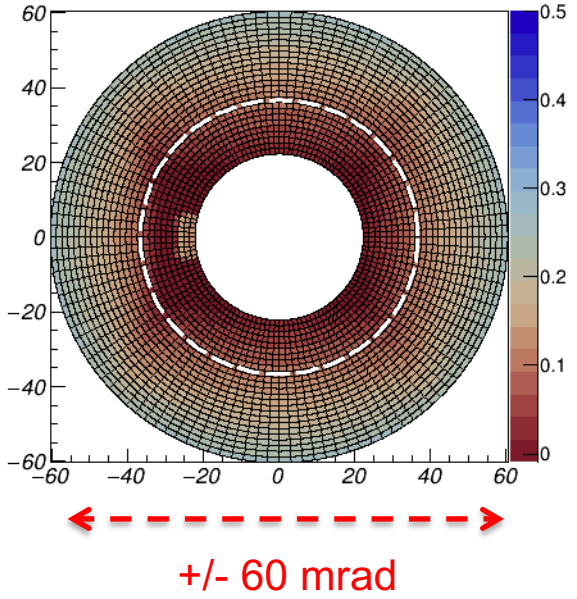
Material in acceptance, [%]



Max space available for Si tracker, [cm]

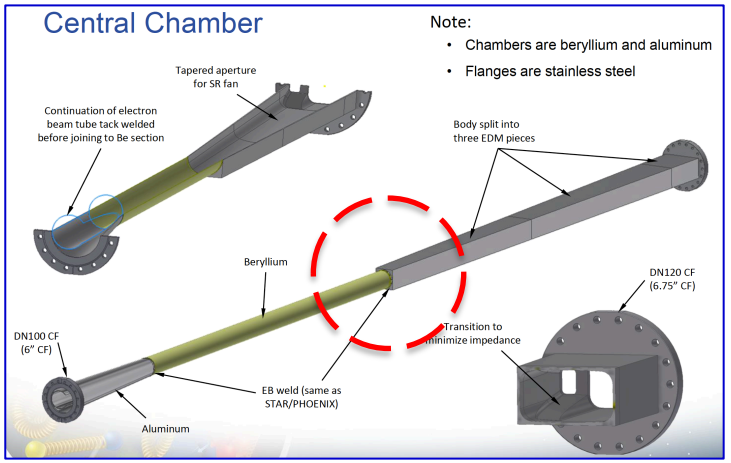


Max B*dl for Si tracker, [T*m]



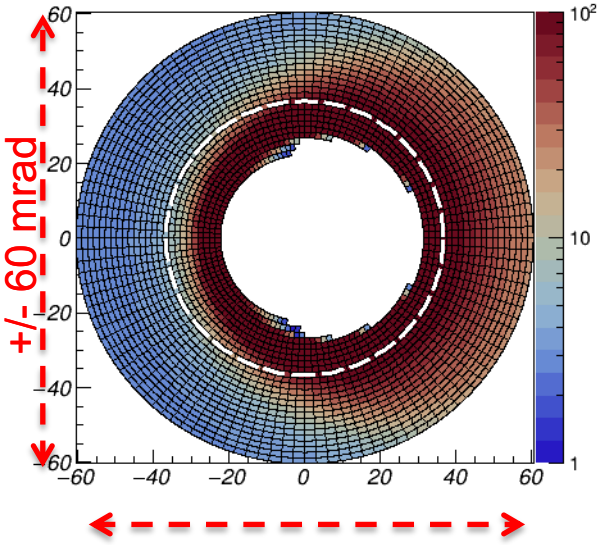
- Plots: -4.5 < η < -3.5
- White circle: η = -4.0

- Obviously need to extend the beryllium part, but in general η ~ -4.0 must be within reach

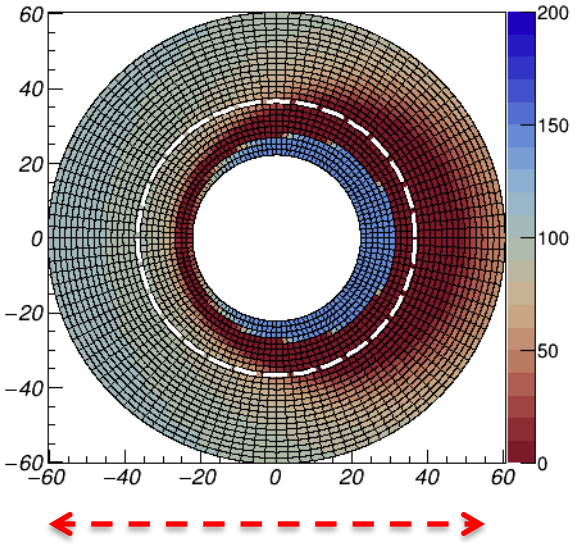


IR vacuum chamber: h-endcap

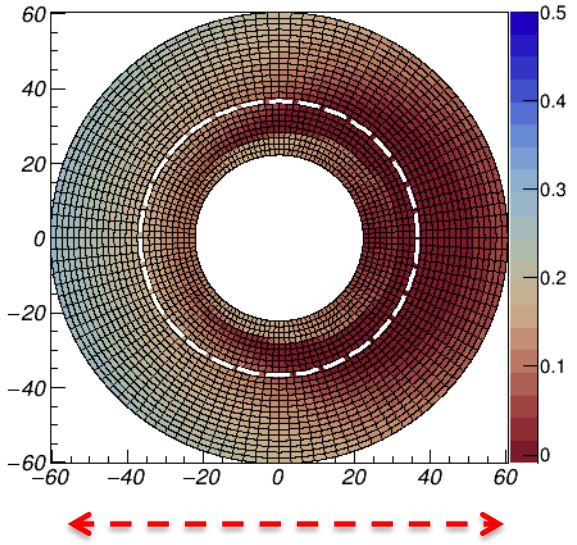
Material in acceptance, [%]



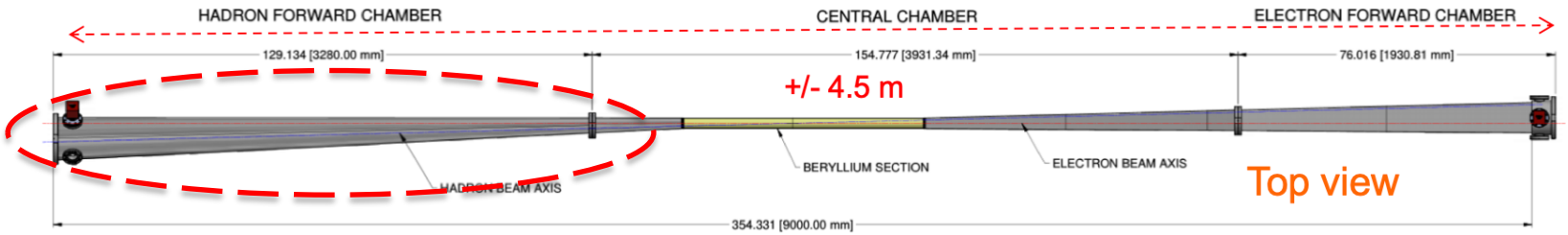
Max space available for Si tracker, [cm]



Max B*dl for Si tracker, [T*m]



- Plots: $3.5 < \eta < 4.5$; white circle: $\eta = 4.0$
- What can be the realistic η reach is a good question



Also: do not forget about the fiducial volume cut and lateral leakage close to the beam pipe

$\|\eta\|$ = 3.00	$\|\eta\|$ = 3.50	$\|\eta\|$ = 4.00	$\|\eta\|$ ~ 4.38	$\|\eta\|$ = 4.50
~99.5 mrad	~60.4 mrad	~36.6 mrad	25.0 mrad	~22.2 mrad

Azimuthal asymmetry in the h-endcap

remember: η in the h-endcap is counted relative to the hadron beam axis!

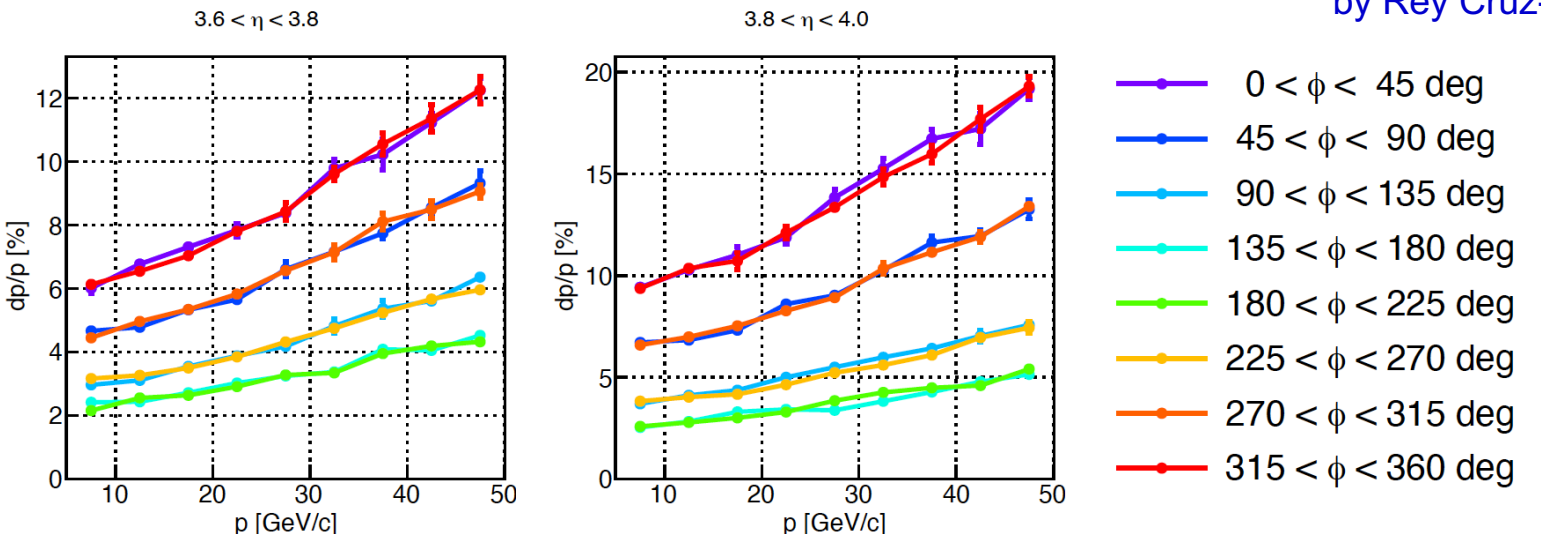
- Single axis solenoid:
  - Aligned with the incoming electron beam (want to minimize the synchrotron radiation) …
  - … therefore 25 mrad field axis slope in the h-endcap …
  - … therefore dramatically different bending for $\phi \sim 180^0$ and $\phi \sim 0^0$ at large η

- A two-coil solenoid (with the halves aligned relative to the [eh]-going directions) is presently out of consideration:
  - Must be a very challenging design
  - Inevitable (and large) energy-dependent vertical excursion of the incoming electron beam
  - Certainly not an option for the existing BaBar magnet

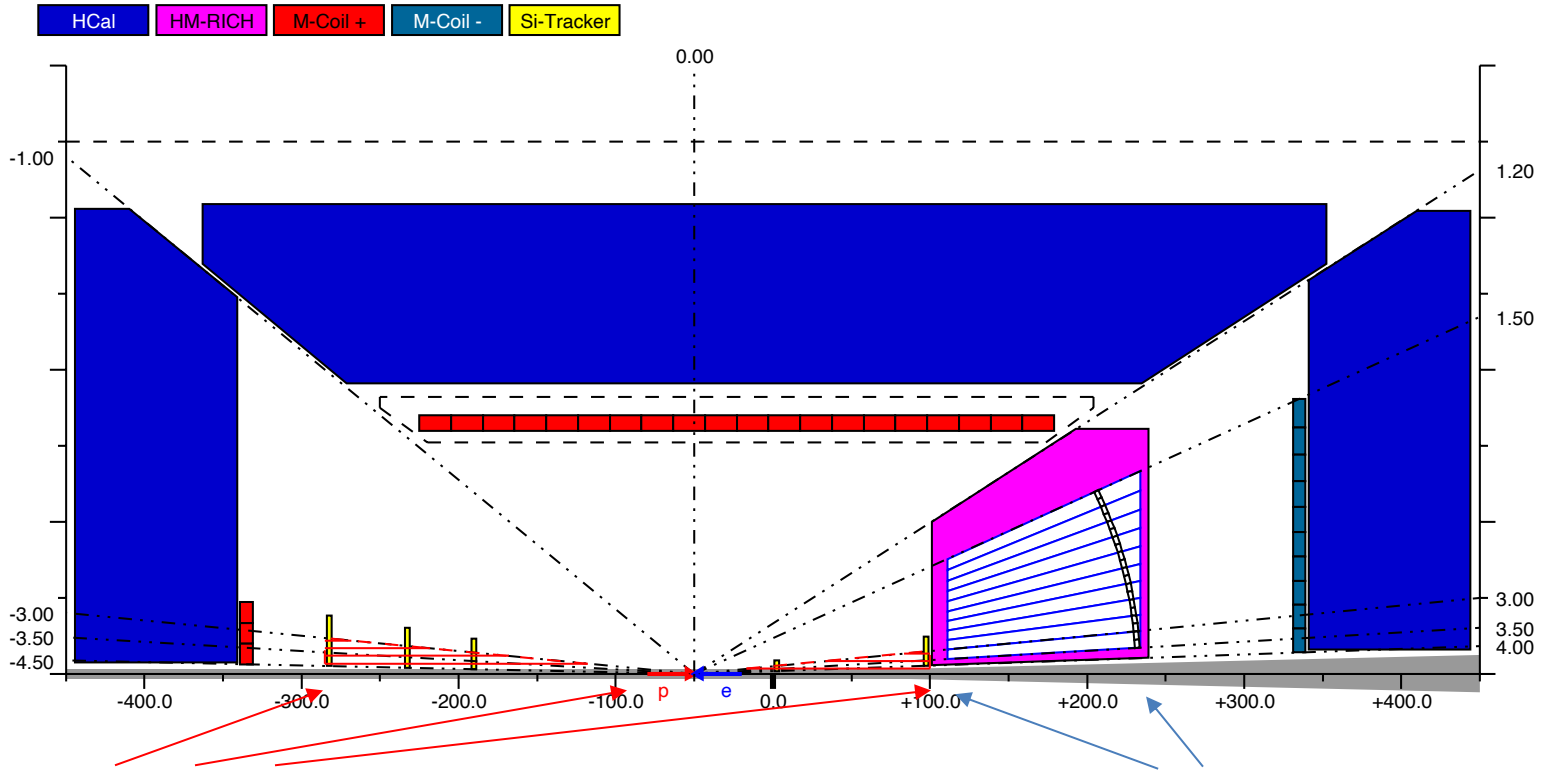
Forward silicon tracker momentum resolution study

by Rey Cruz-Torres

Assume 5 ITS2-like stations, 3T field and 1m lever arm



Solenoid magnet considerations



- These two requirements are somewhat in a contradiction, especially if the additional high-resolution tracking stations behind the RICH are desirable

- Solenoid flux return scheme strongly depends on the HCal absorber choice (magnetic or not)
- Bore diameter can hardly exceed ~4m (otherwise the barrel detector won't fit through the IP6 exp. hall door); currently considered: 3.0 m green field design, ~2.8 m BaBar magnet