Compact GLD

A possible modification of GLD

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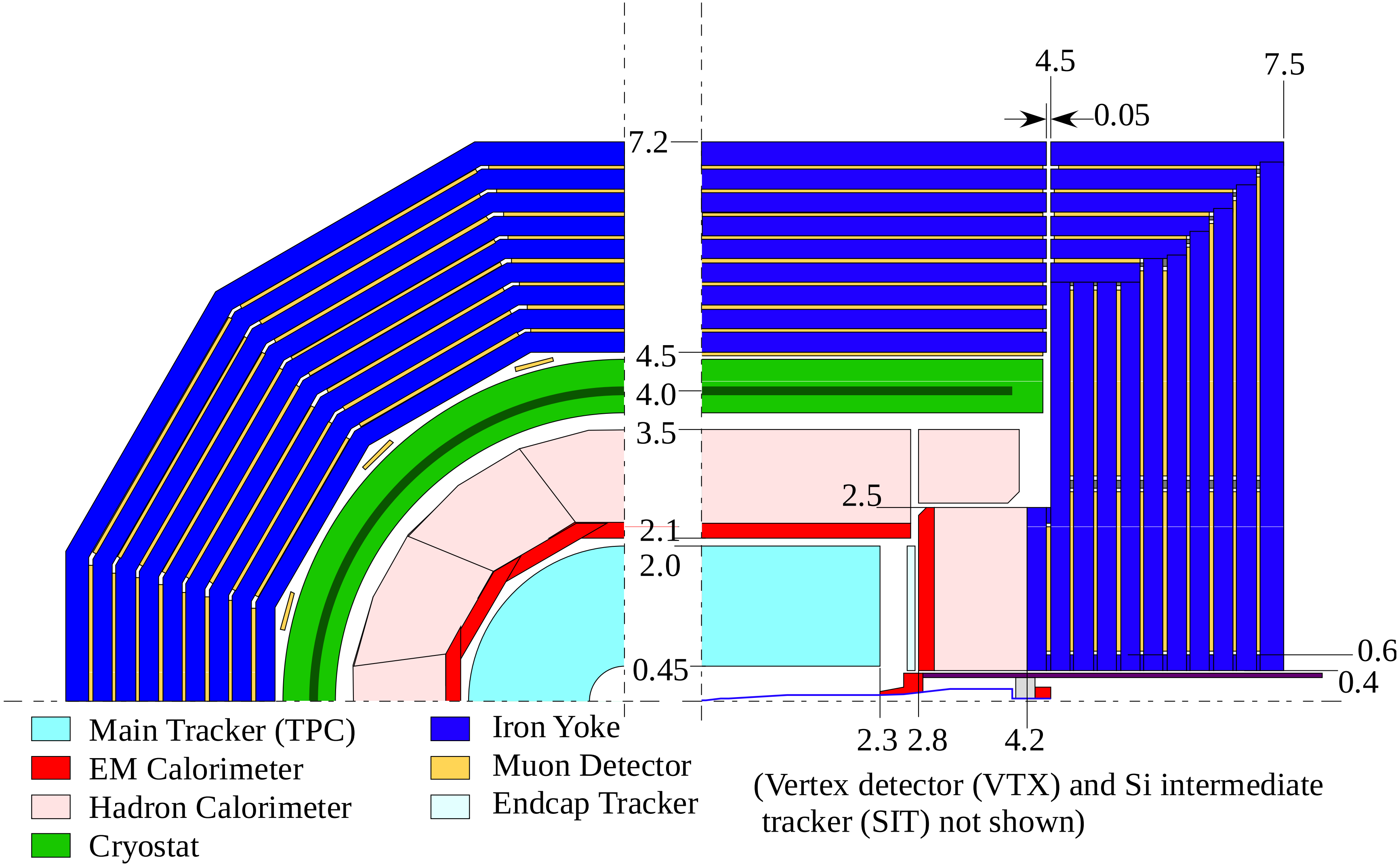
Motivation

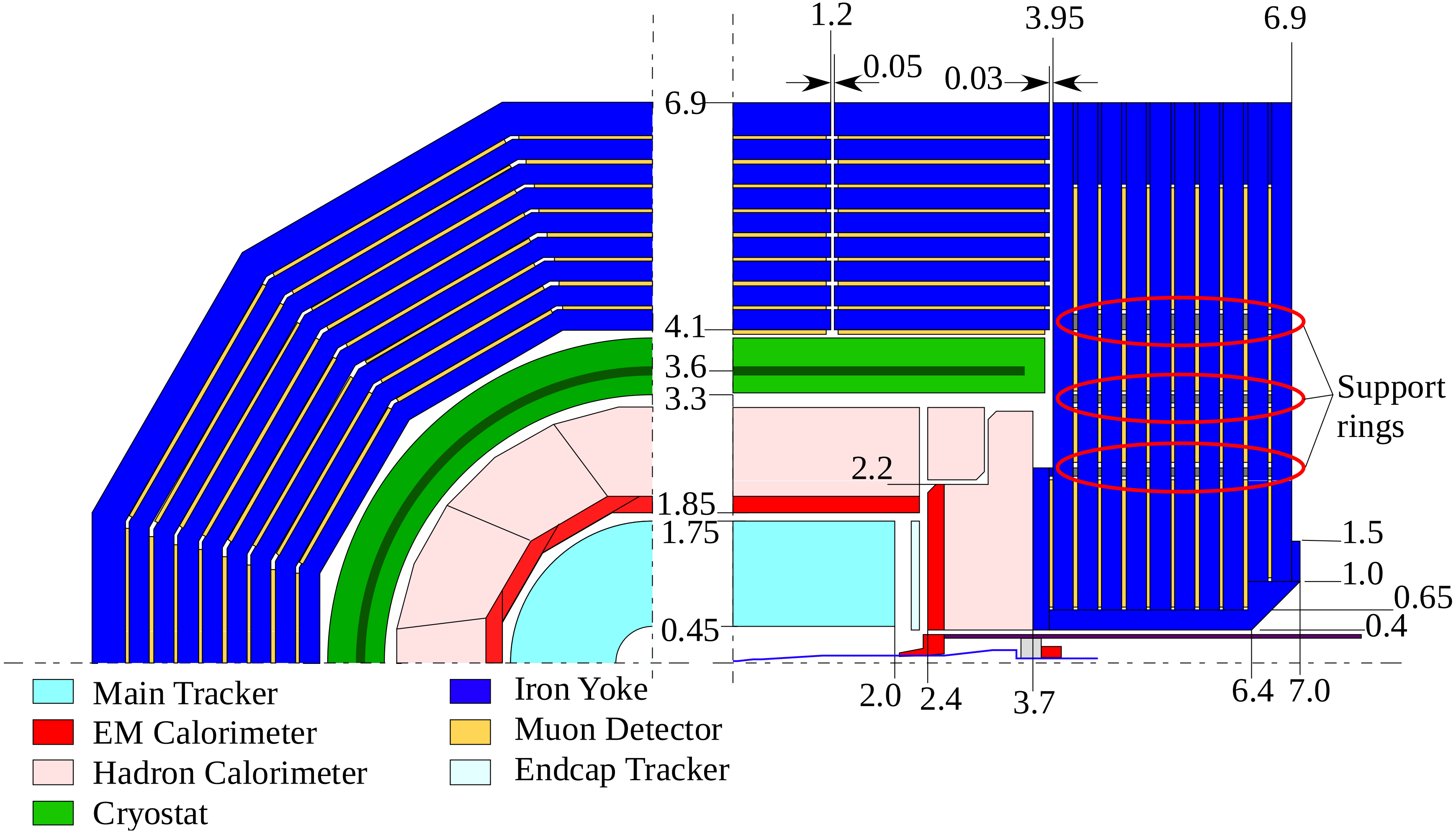
- GLD and LDC will write a common LoI
- The detector design should have common parameters
- Modified design of GLD with the central values for B and R_{CAL} between original GLD and LDC is made as a "gedanken experiment" (Common parameters should be determined based on detailed simulation study)
- B=(3+4)/2=3.5 T
- R_{CAL}=(2.1+1.6)/2=1.85 m

GLD



(Vertex detector (VTX) and Si intermediate tracker (SIT) not shown)

Compact GLD - GLDc



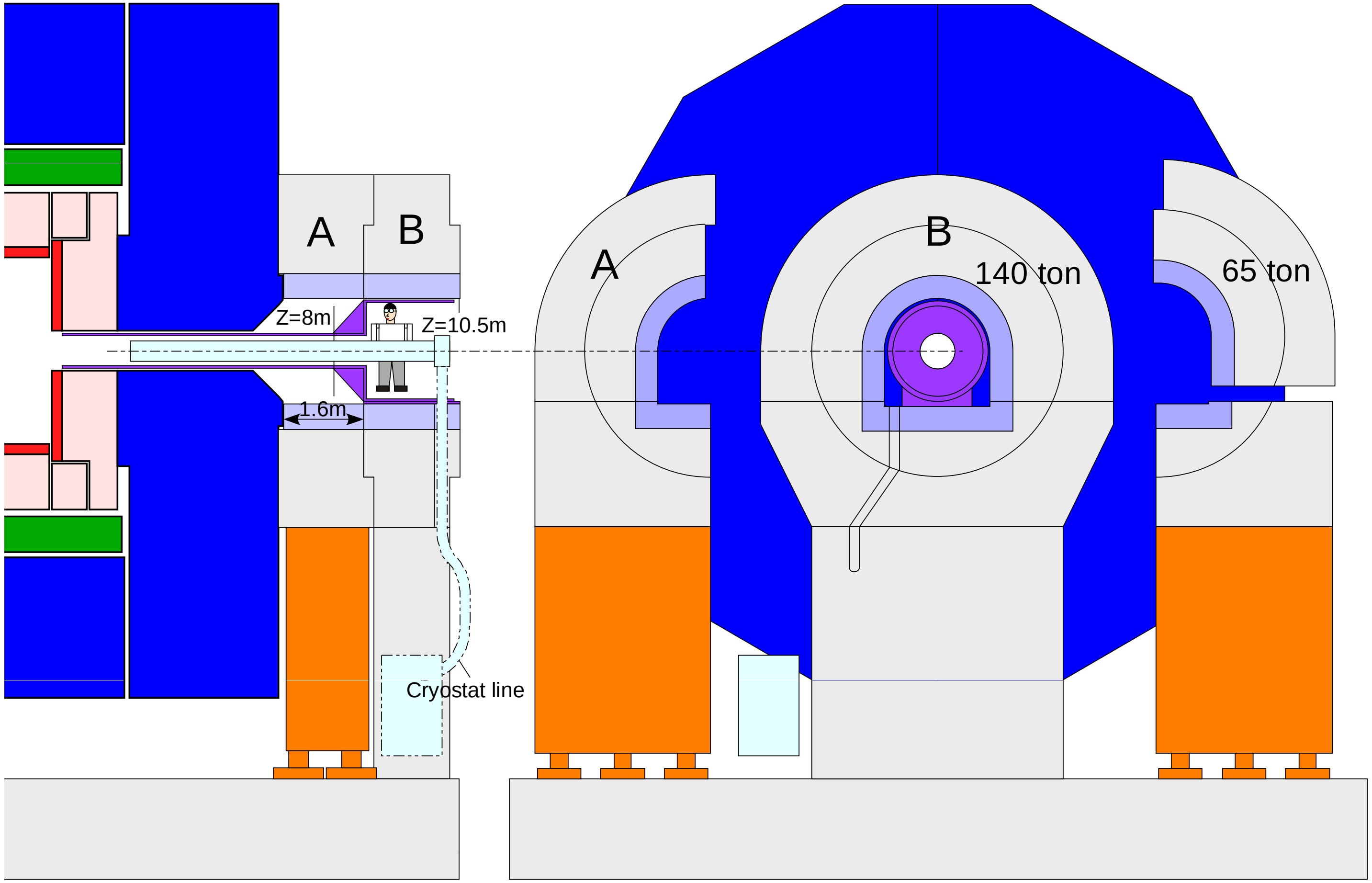
Parameters (1)

			GLD	GLDc
Iron Yoke	Barrel	Rout	7.2 m	6.9 m
		Rin	4.5 m	4.1 m
		Weight	6090 t	5080 t
	E.C.	Zin	4.2/4.5 m	3.7/3.95 m
		Zout	7.5 m	6.9 m
		Weight	3260 t / side	3050 t / side
Solenoid	B		3 T	3.5 T
	R		4 m	3.6 m
	Z		4 m	3.6 m
	E		1.6 GJ	1.7 GJ
Stray field @Z=10m			70 G	120 G

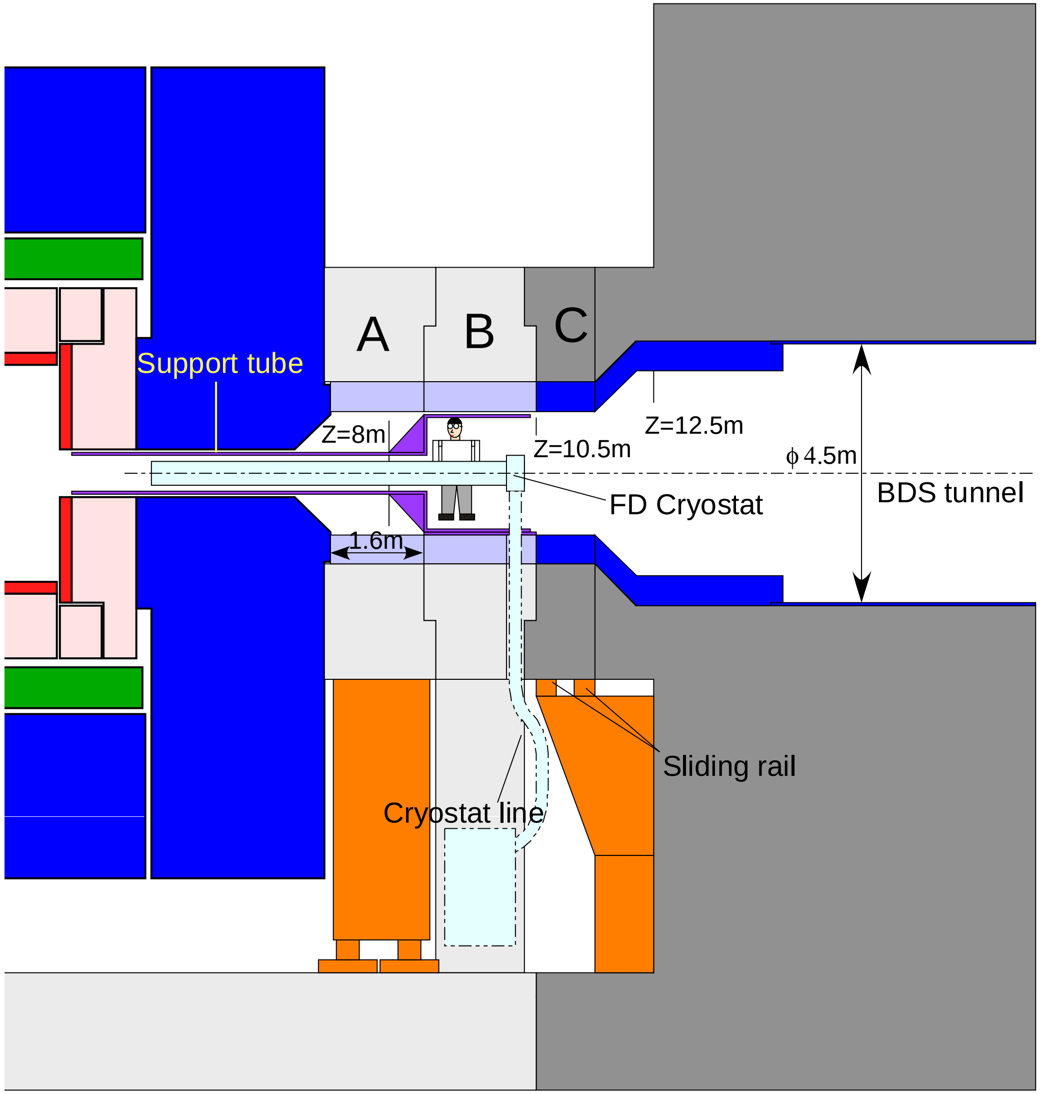
Parameters (2)

			GLD	GLDc
TPC	Rin		0.45 m	0.45 m
	Rout		2.0 m	1.75 m
	Zmax		2.3 m	2.0 m
Barrel CAL	ECAL	Rin	2.1 m	1.85 m
		Rout	2.3 m	2.05 m
		$BRin^2$	13.2 Tm^2	12.0 Tm^2
	HCAL	Rout	3.5 m	3.15 m
		Thickness	1.2 m	1.1 m
EC CAL	ECAL	Zmin	2.8 m	2.4 m
		Zmax	3.0 m	2.6 m
	HCAL	Zmax	4.2 m	3.7 m
		Thickness	1.2 m	1.1 m

FD Support / Shield block

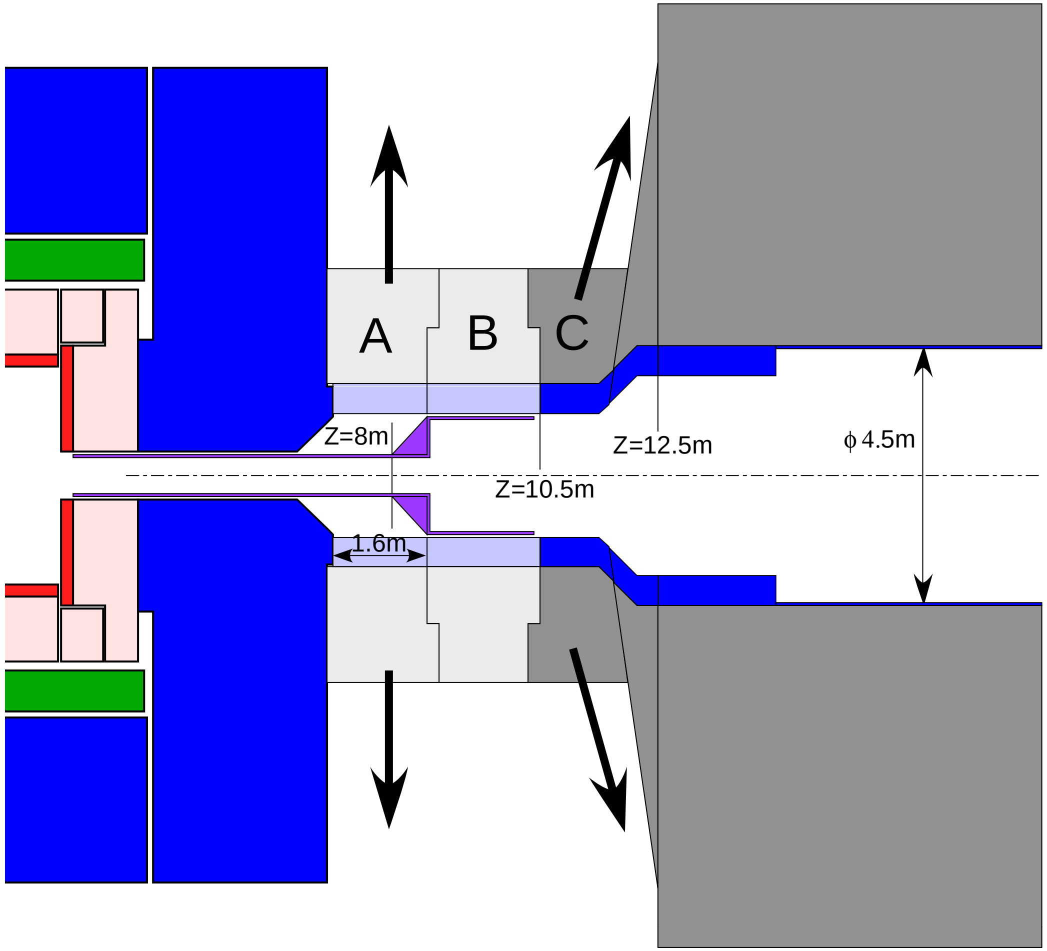


Shield



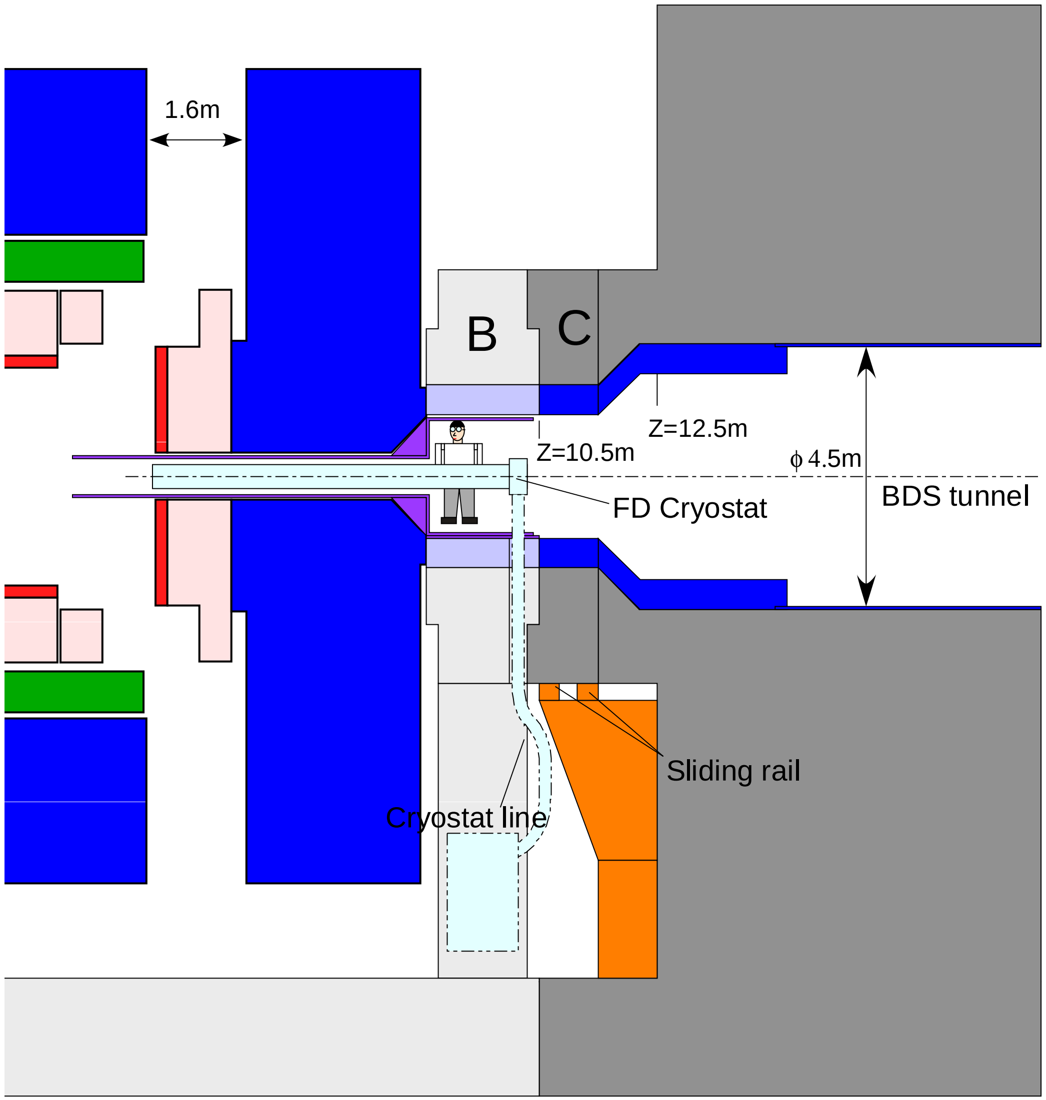
- Endcap opening
  - Remove A horizontally by air pad
  - Open the endcap
- Push-pull
  - Disconnect beam pipe at Z~10.5m
  - Slide C horizontally
  - Slide the platform

Shield



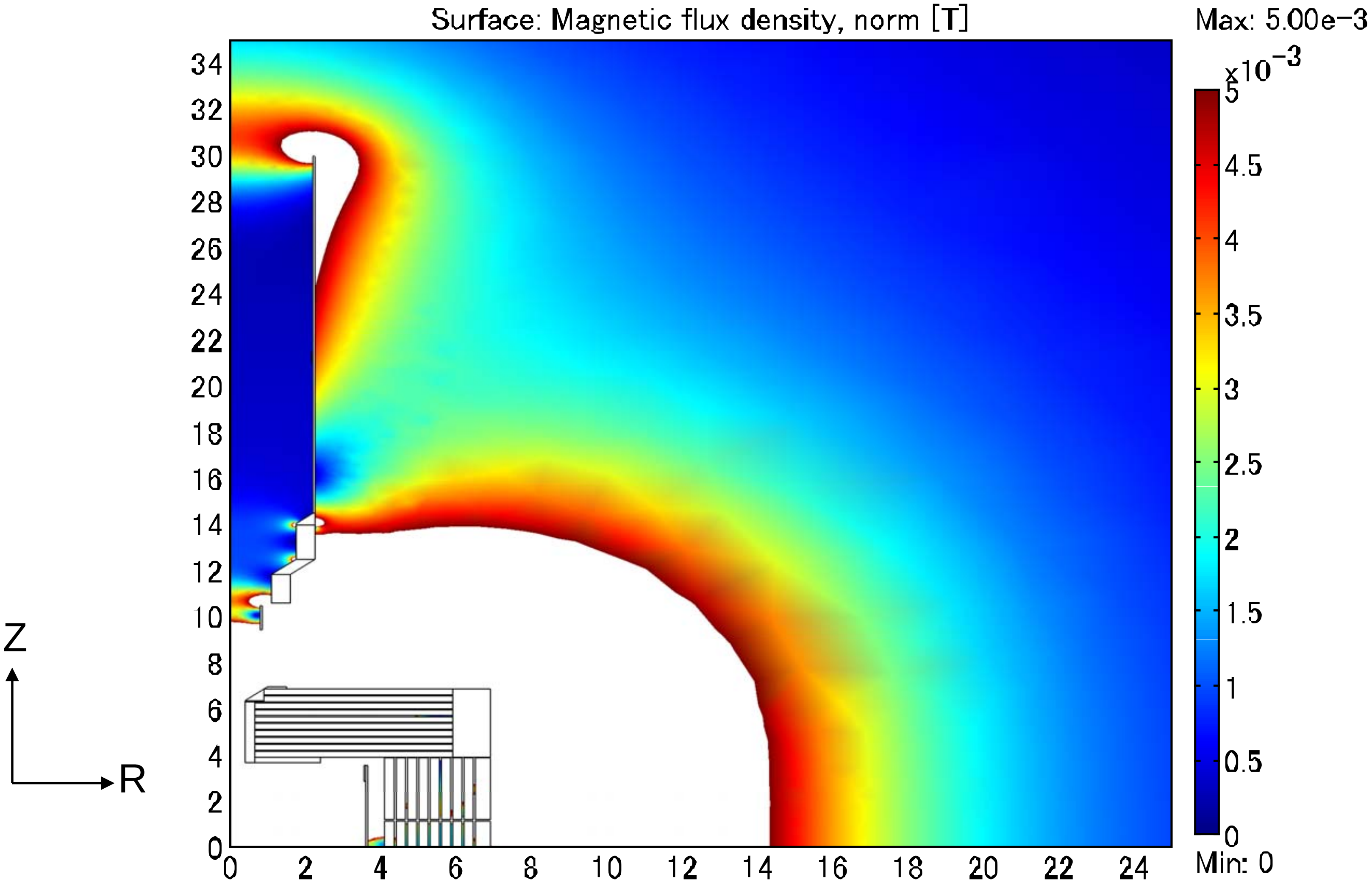
Plan view

Endcap Open



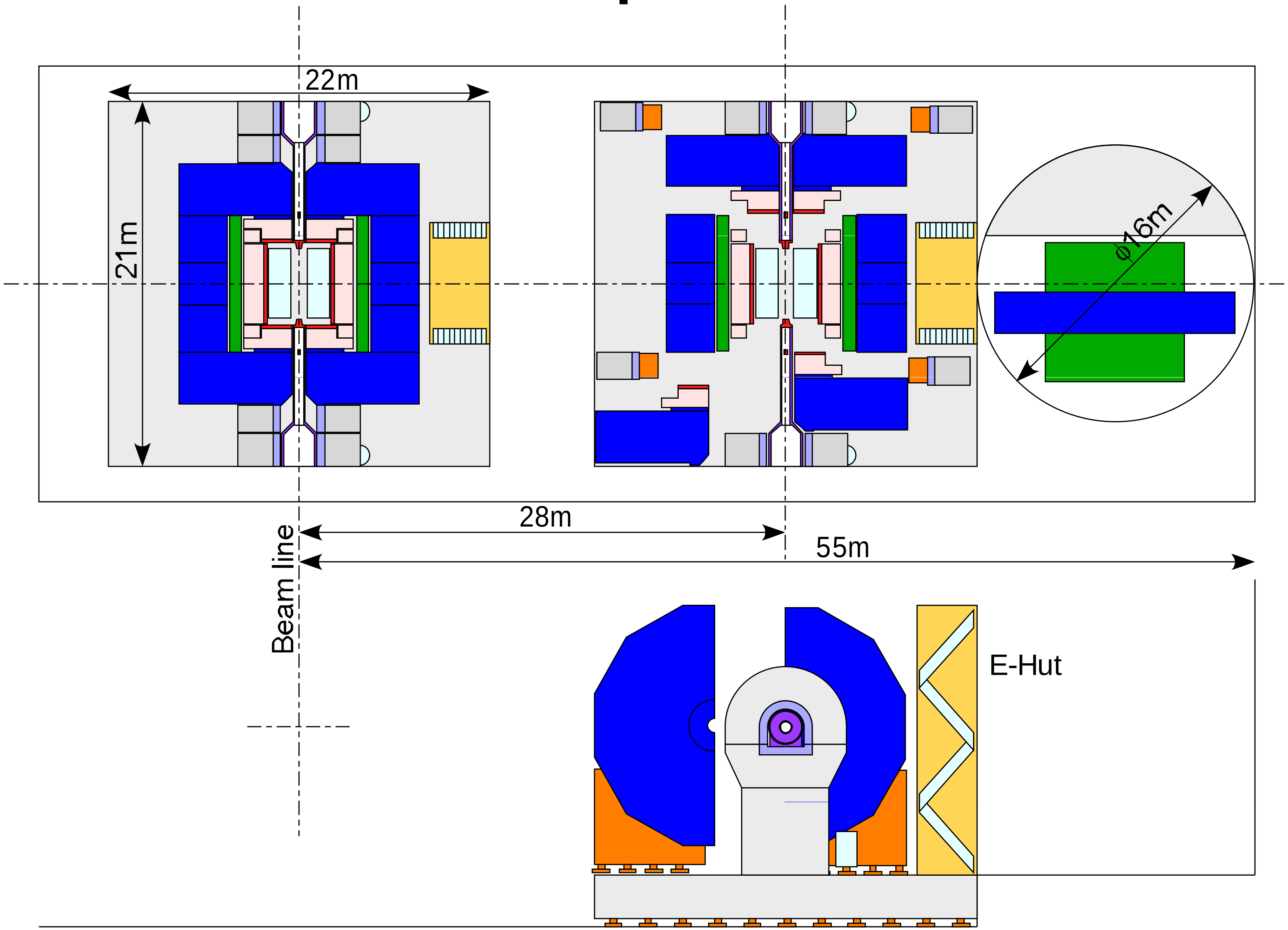
1.6m
B
C
Z=12.5m
Z=10.5m
ϕ 4.5m
FD Cryostat
BDS tunnel
Sliding rail
Cryostat line

B-field



Surface: Magnetic flux density, norm [T]
Max: 5.00e−3
x10^-3
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Min: 0
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Z
R

Exp hall



Impact on MDI

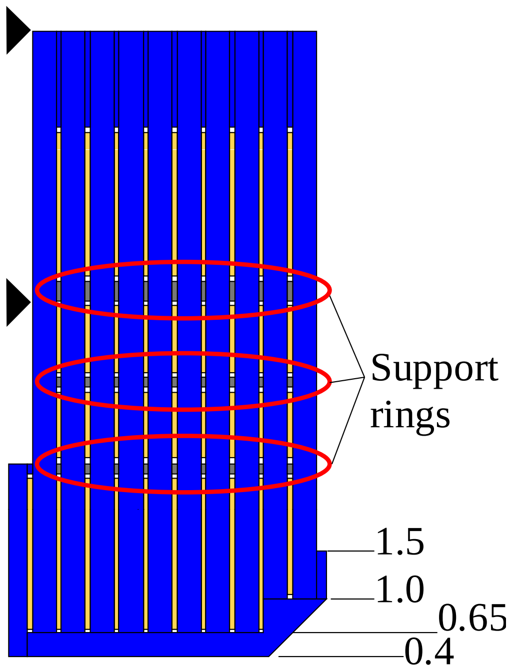
- Surface assembly
  - Barrel part (Fe return yoke + Solenoid) is lighter than 6000 ton ➔ Separation into 3 is possible for CMS style assembly
  - Heaviest component to be lifted:
    - Segments of upper parts of Fe+concrete shield ~140/N ton, or
    - FD support tube ~30 ton

    ➔ Crane capacity: 400 ton → 50~80 ton
- Push-pull scheme
  - |Z| of the detector is reduced to 6.9 m and only ΔZ=1.6m is necessary to open the endcap on the beam line
  - Supporting FD from the floor (platform) and BDS cut at |Z|~10.5 m (i.e. after QF1) make endcap-opening and push-pull operation much easier and quicker
  - 22x21 m^2 platform
- Stray B-field
  - Stray field at Z=10 m increases from 70G to 120G, but still can be reduced below 50 Gauss by inexpensive compensation coil and iron shield around beam line
- L*
  - L* of ~4.2 m would be adequate

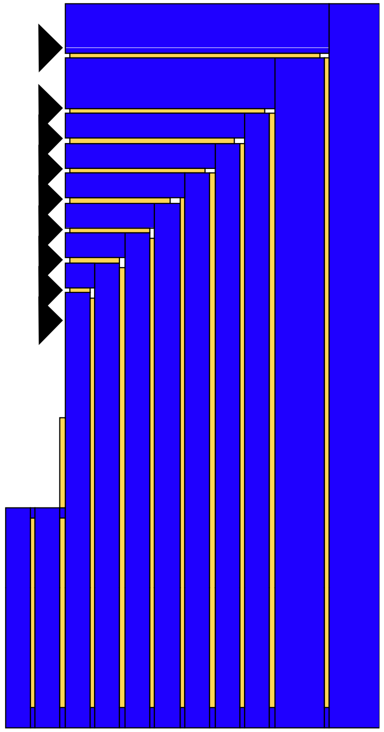
Endcap Deformation

- FEA model
  - 2D axial symmetry
  - 3D for simple structure
  - Constraint in z direction at R=4.1m and 6.9m for GLDc (Rin and Rout of barrel yoke)
  - Uniform force of 1 MN/m^3 is assumed

GLDc



GLD



Endcap Deformation

- Results

		Angle	Support ring	ΔZmax	
GLD	3D	90	No	51 mm	57 mm by Yamaoka-san
GLDc	3D	90	No	27 mm	
GLDc	3D	180	No	16 mm	
GLDc	3D	360	No	11 mm	
GLDc	2D	360	No	12 mm	
GLDc	2D	360	1 (r=4.1m)	3.7 mm	
GLDc	3D	360	1	3.2 mm	
GLDc	3D	180	1	4.1 mm	
GLDc	2D	360	2 (r=2.3, 4.1m)	1.7 mm	
GLDc	2D	360	3 (r=2.3, 3.2, 4.1m)	1.1 mm	
GLDc-SiD like	2D	360	No	90 mm	23x(10cm Fe+5cm gap)

ΔZmax is expected < 2 mm for 180 degree 3 ring case

Endcap Deformation

- Summary
  - Difference of deformation between splitting and non-splitting is not so large
  - In splitting design, installation and maintenance of muon detectors can be done from the splitting plane
  - As a consequence, support rings can be put between iron slabs without disturbing the installation and maintenance of muon detectors
  - Splitting design with support rings gives much smaller deformation than non-splitting design without support ring

Summary

- A possible scenario with compact GLD is
  - Pure CMS style assembly
  - Endcap is split into two
  - Final doublet is contained in a common cryostat, and supported from the floor of a platform through a tungsten support tube
  - In push-pull operation, BDS is cut after QF1 (~10.5m)
  - The platform has the size of 21mx22m