Highlights of the 2021 Workshop on CEPC Detector & MDI Mechanical Design

Quan JI, Haoyu SHI

CEPC Physics and Detector Plenary Meeting

2021.10.27

Talks

- 2 days, 23 talks in total. Covers all sub-detectors, MDI related issues, Mechanical designs and other topics.
- https://indico.ihep.ac.cn/event/14392/

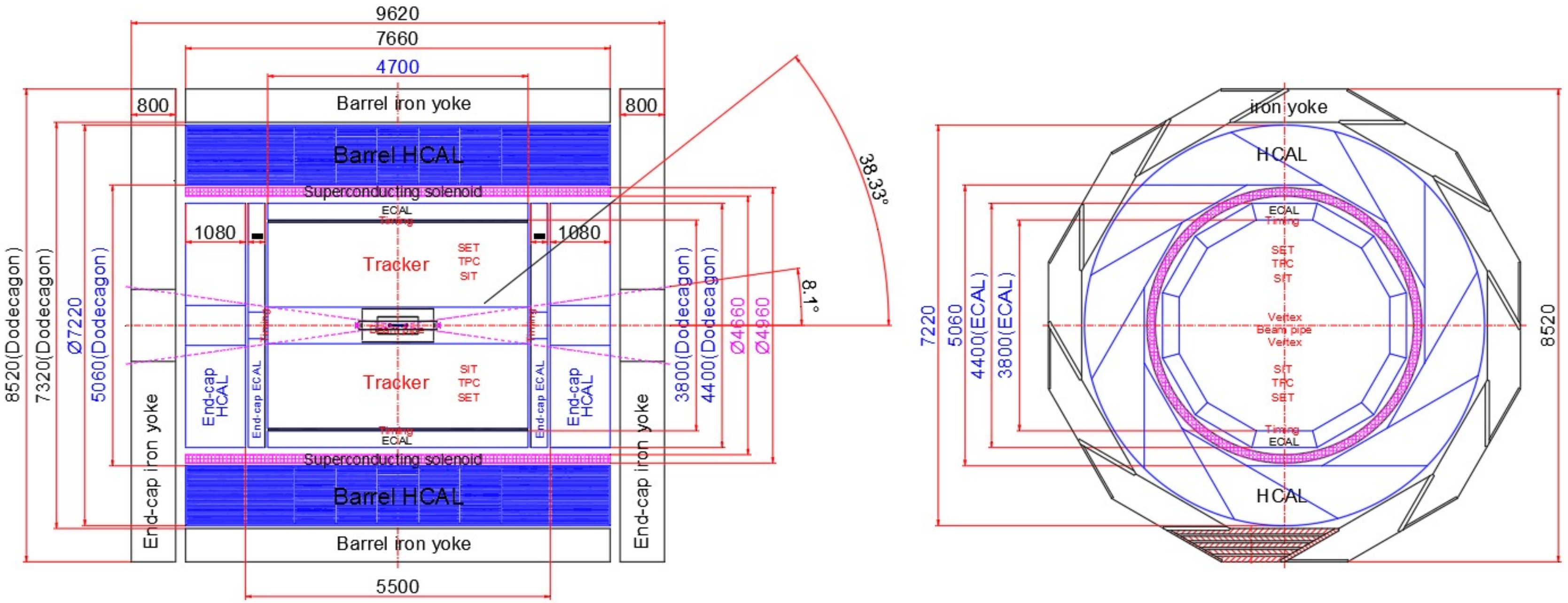
Day 1(10.22)	
Session 1	Gang CHEN
Openning Remark	Xinchou LOU
CEPC Physics and Detector	Haijun YANG
CEPC Accelerator	Yuhui LI
Group Photo+Coffee Break	
Session 2	Jianchun WANG
Muon Detector	Xiaolong WANG
Calorimeter	Yong LIU
Drift Chamber	Mingyi DONG
Lunch Break	
Session 3	Jianchun WANG
Time Projection Chamber	Huirong QI
Silicon Tracker	Yiming LI
Vertex Detector	Zhijun LIANG
Tea Break	
Session 4	Hongbo ZHU
LumiCal	Suen HOU
CEPC MDI	Haoyu SHI
Discussion	

Day 2(10.23)	
Session 1	Yuhui LI
MDI Mechanical Design	Haijing WANG
MDI SC Magnet	Yingshun ZHU
Croystat	Miaofu XU
HOM	Yudong LIU
Coffee Break	
Session 2	Zheng WANG
Preliminary design of CEPC detector installation scheme	Songwen XIAO
Heat transfer analysis of CEPC beampipe	Youlian LU
Mechanical design of VTX prototype	Jinyu FU
Lunch Break	
Session 3	Zhijia SUN
Light materials in beam pipe	Shaohong WEI
Be Corrosion and application in CSNS	Ning HE
Yoke & SC Mechanical Design	Junsong ZHANG
Tea Break	
Session 4	Haijun YANG
Summary+Discussion	Quan JI
Closing Remark	Jie GAO

Outline

- Detector:
  - Mechanical Design of sub-detectors
  - Integration & Installation Scheme of the Detectors

- MDI:
  - Physical Design of the baseline
  - Some Mechanical Design



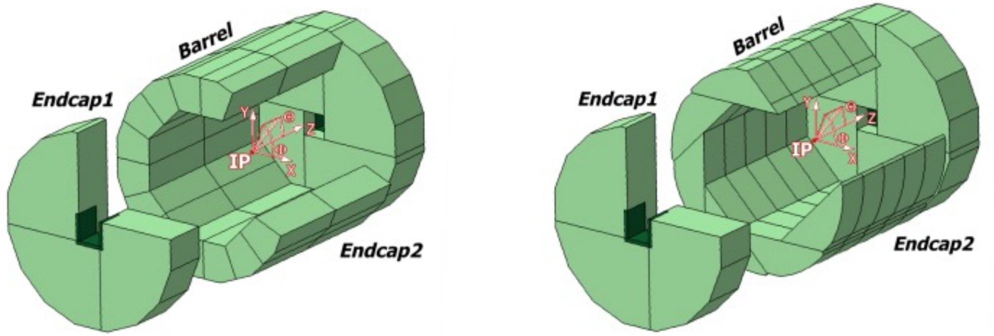
Detector

- Mechanical Design of sub-detectors
- Integration & Installation Scheme of the Detectors

Sub-detectors

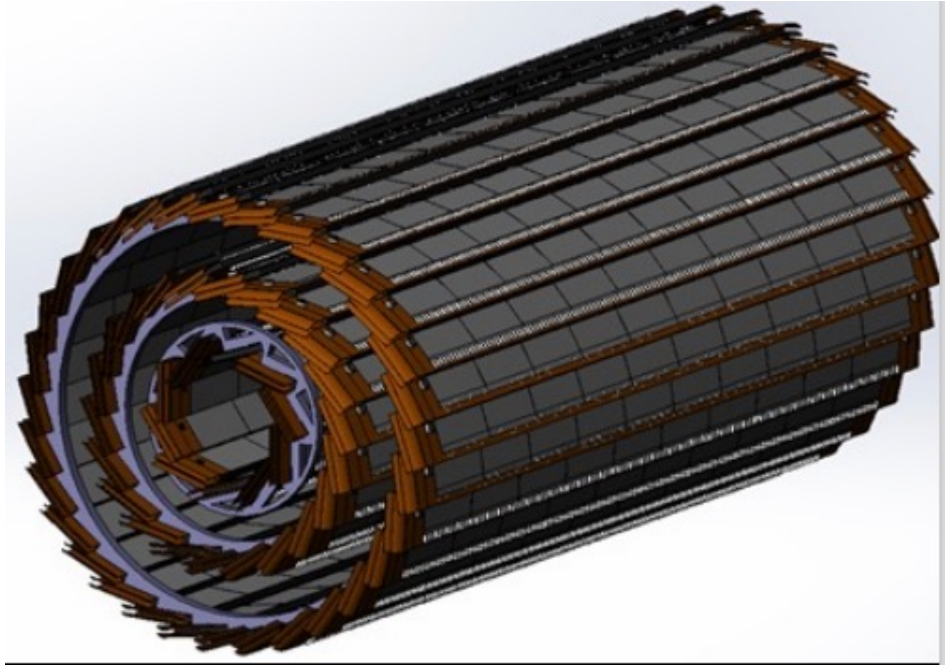
- All the sub-detectors presented the physical design
- Some of them presented the preliminary mechanical design

Yong LIU



Layout 1: symmetric barrel   Layout 2: asymmetric barrel

Zhijun LIANG
Jinyu FU



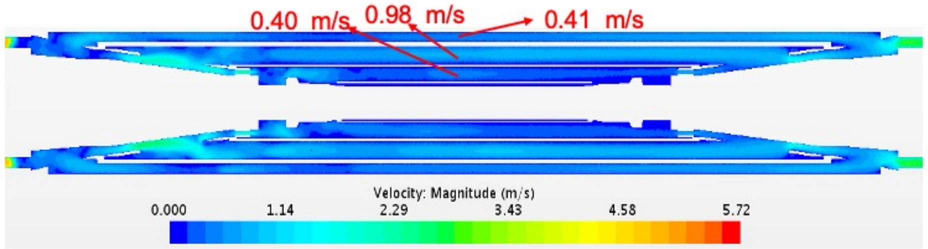
Integration

- The integration of vertex detector and the beampipe may need further study.

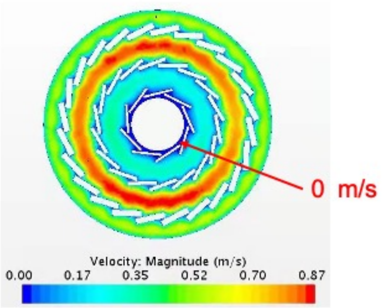
Youlian LU

（2）**Velocity distribution**

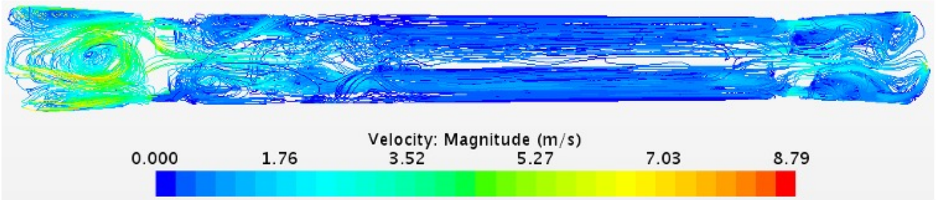
✓ The average velocity in detector cavity is very low.



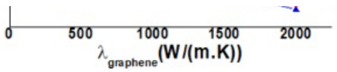
Velocity distribution



Velocity distribution
(cross section)

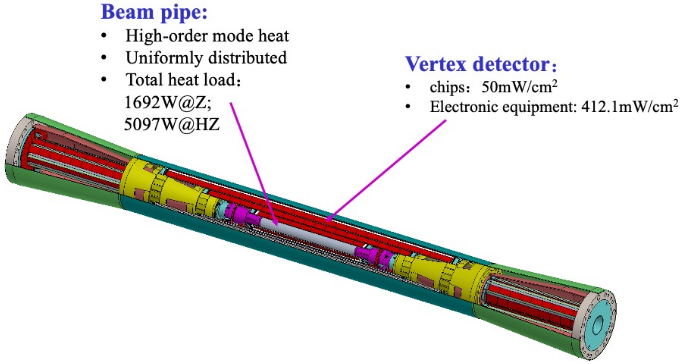


Streamline



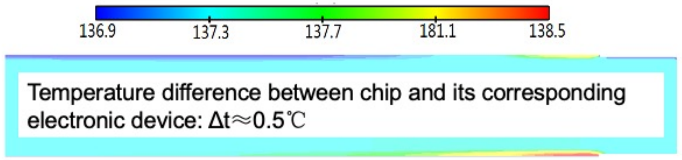
The maximum temperature of chip VS graphene conductivity

✓ The max. temperature of chip: 46.5C°



New calculation

Surface temperature distribution



Temperature distribution of central cross section

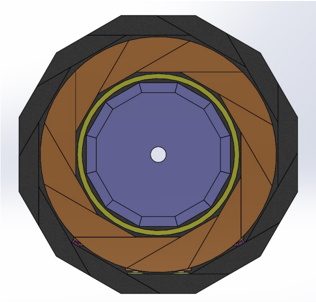
✓ The max. temperature of chip: 138.5C°.
✓ The temperature difference in the chip is very large.

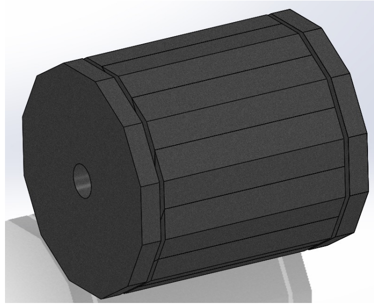
Integration & Installation

- The parameters of the detector from mechanical side.

Songwen XIAO

SN	Name	Total weight (ton)	Number	Weight of each (ton)	Boundary Dimension	mounting clearance
1	Barrel iron yoke	1200	12	100	Φ8520， L:7660mm	/
2	HACL	1200	12	100	Φ7220， L:7660mm	50mm
3	Superconducting solenoid	30	1	30	Φ4960， L:7660mm	50mm
3	ECAL	120	12	10	Φ4400， L:4700mm	50mm
4	SET+TPC+SIT	？	Entirety	？	Φ3800， L:4700mm	/
5	End-cap iron yoke	500	5	100	Φ8520， L:800mm	180mm
6	End-cap ECAL	100	1	100	Φ7220， L:1080mm	50mm

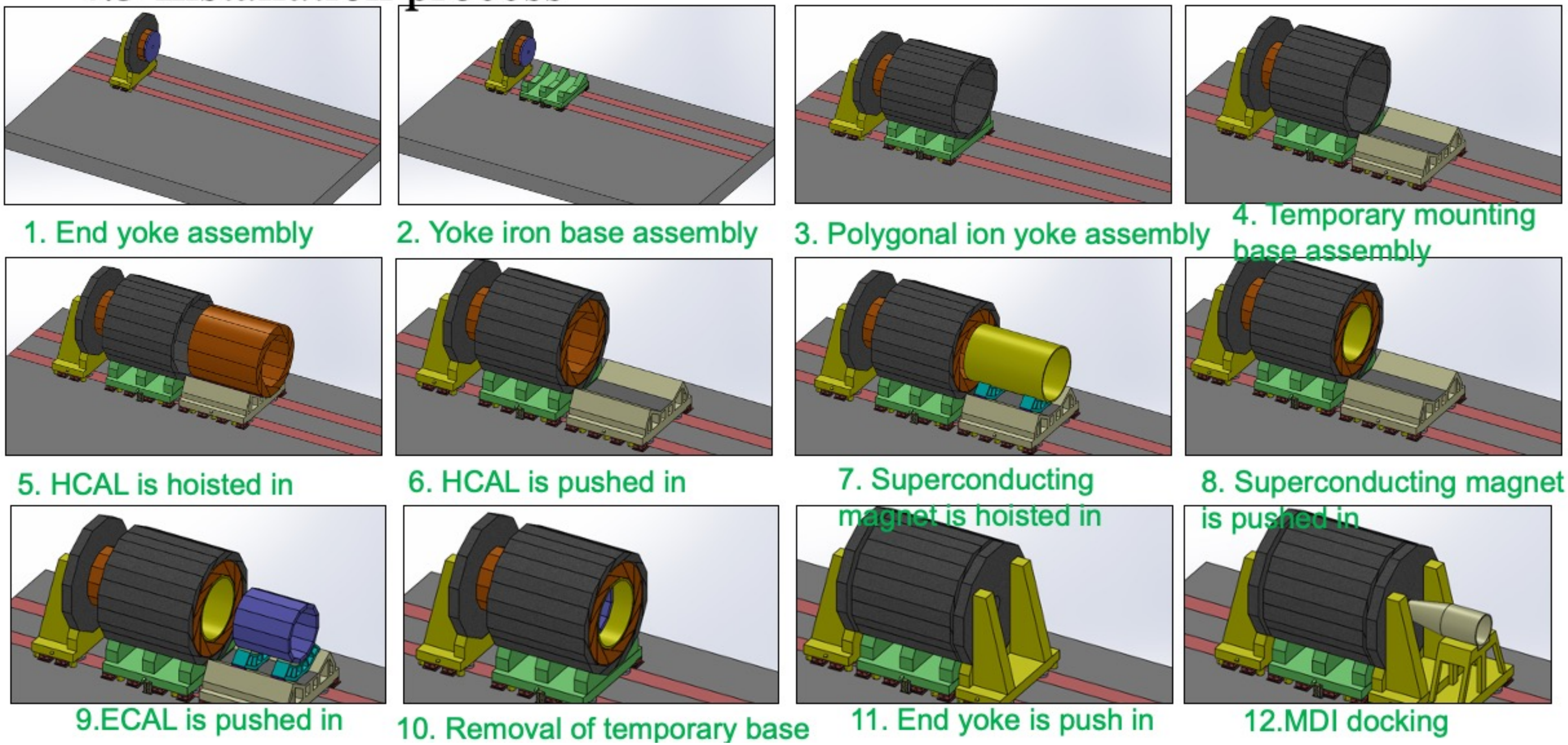




Installation

4.3 Installation process

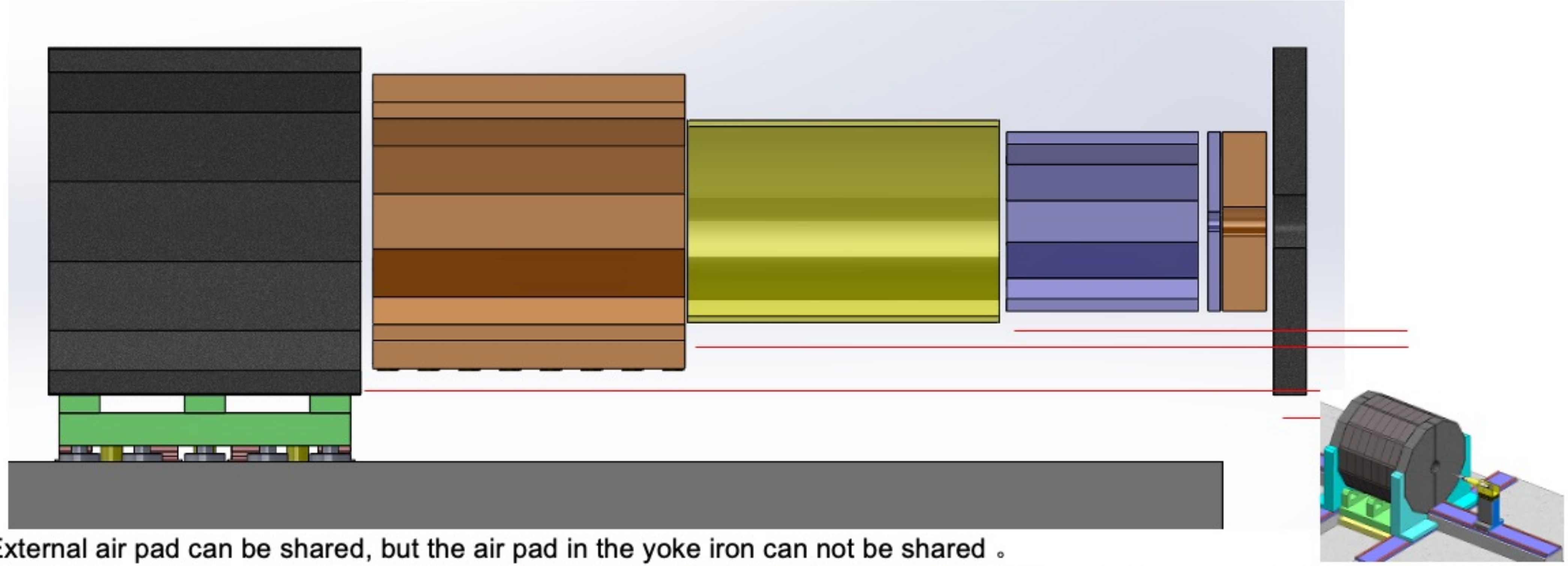
Songwen XIAO



Installation

4.4 Technical difficulties of sharing guide rail

Songwen XIAO



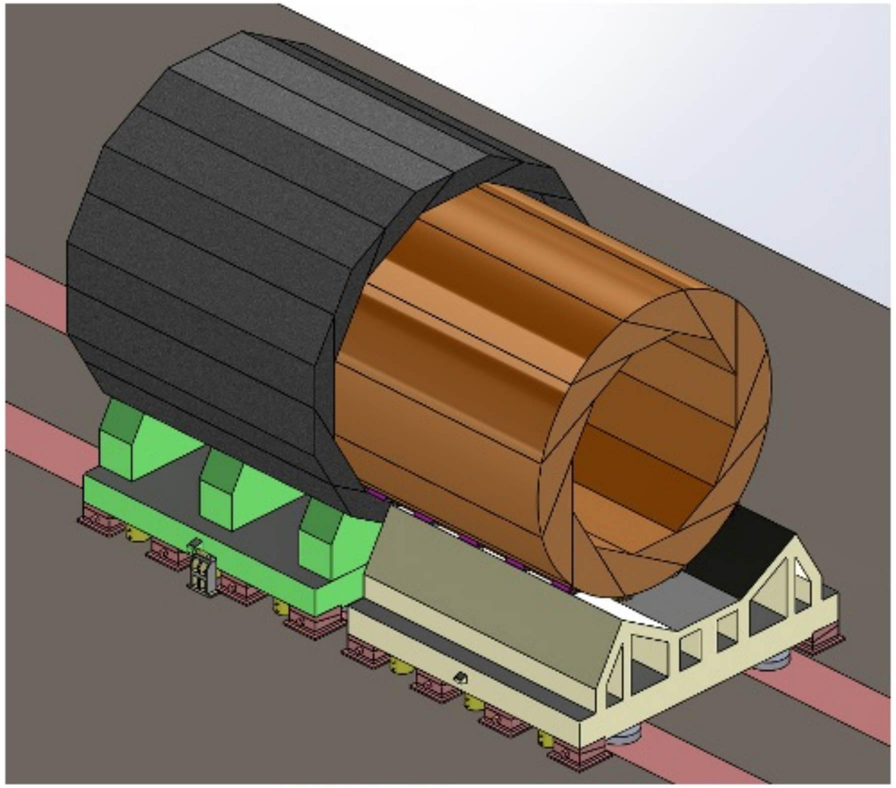
1. External air pad can be shared, but the air pad in the yoke iron can not be shared 。
2. Each part must be pushed in, and the bottom height of each part is inconsistent, which make temporary tooling must be used。
3. The end yoke height is the lowest and the temporary mounting base must be lifted to push the end yoke next to the barrel yoke。
4. It is very difficult to push the ECAL into iron yoke with the weight of 1200Ton 。

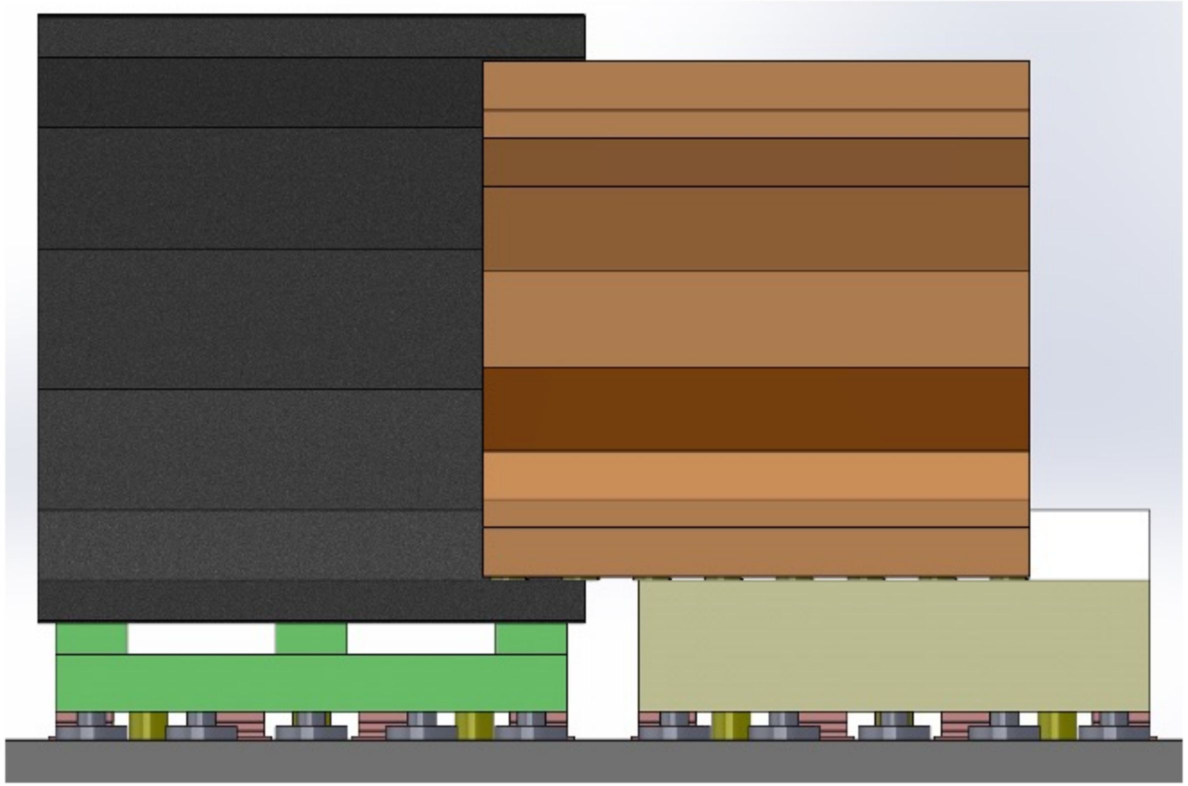
Another idea: the end yoke is flat open, the difficulty is that the end yoke thickness is only 800mm

Installation

4.4 Technical difficulties of sharing guide rail

Songwen XIAO





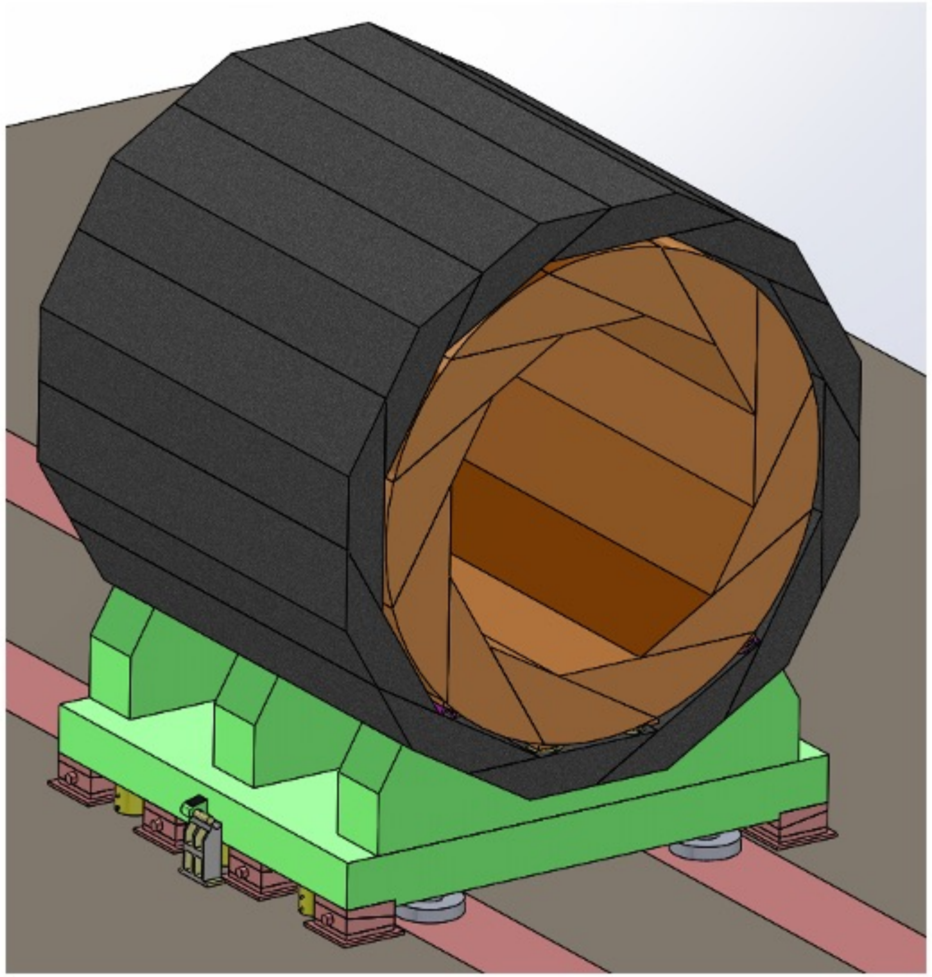
Difficult： It is very difficult to push the HECAL into iron yoke with the weight of 1200Ton

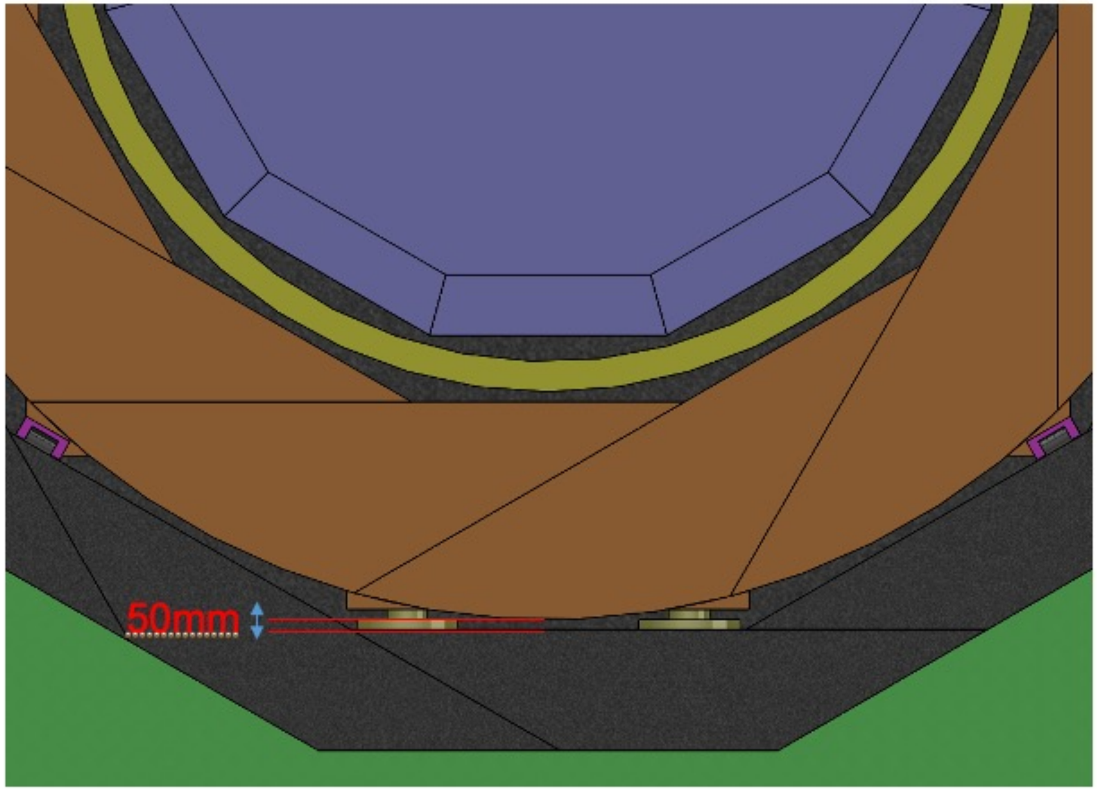
Another idea: Open cover construction with iron yoke and HCAL.
Another idea: Iron yoke and HCAL form a whole and are divided into several parts.

Installation

4.4 Technical difficulties of sharing guide rail

Songwen XIAO



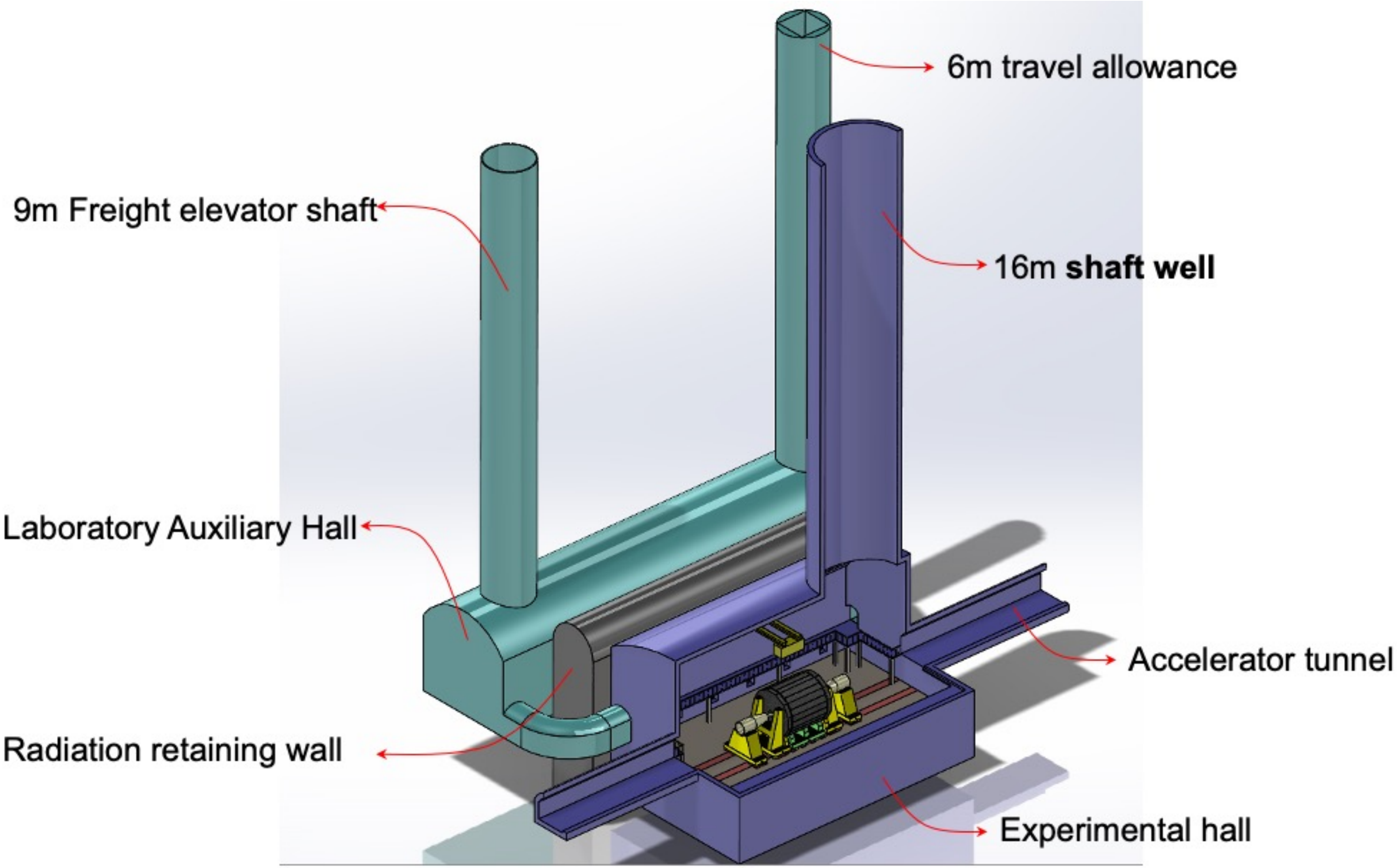


Difficult： There is not enough space for support and adjustment mechanism within 50mm clearance.

Another idea: CMS experience

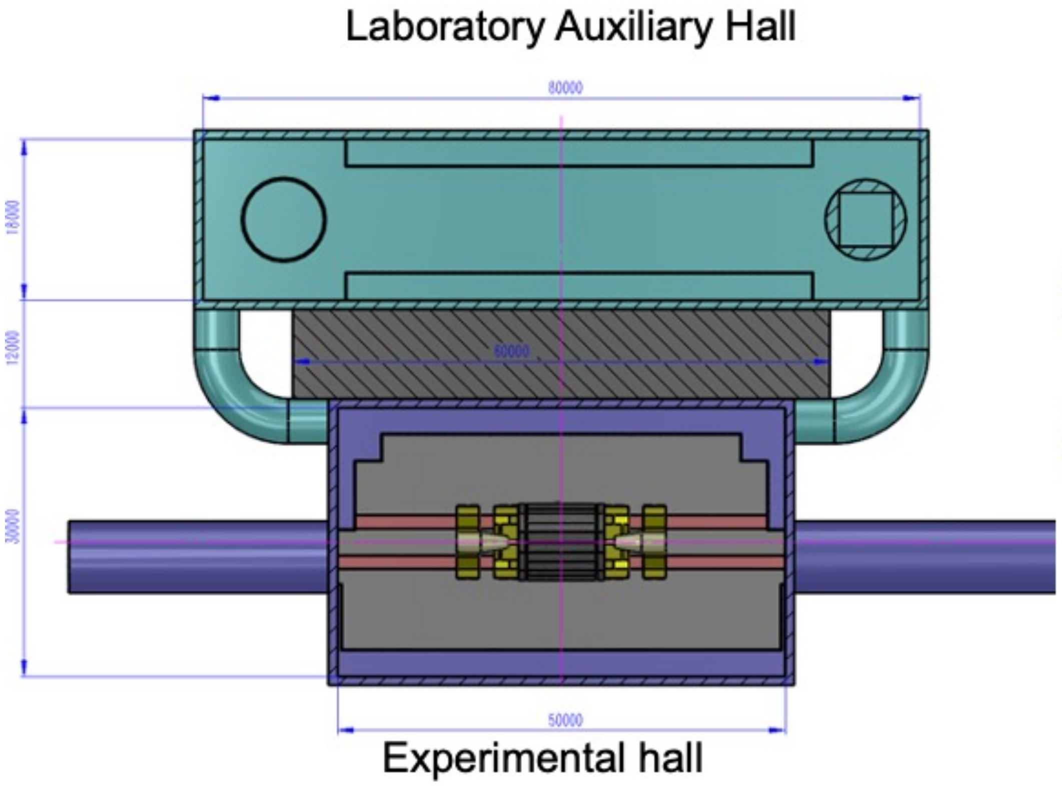
Experiment Hall

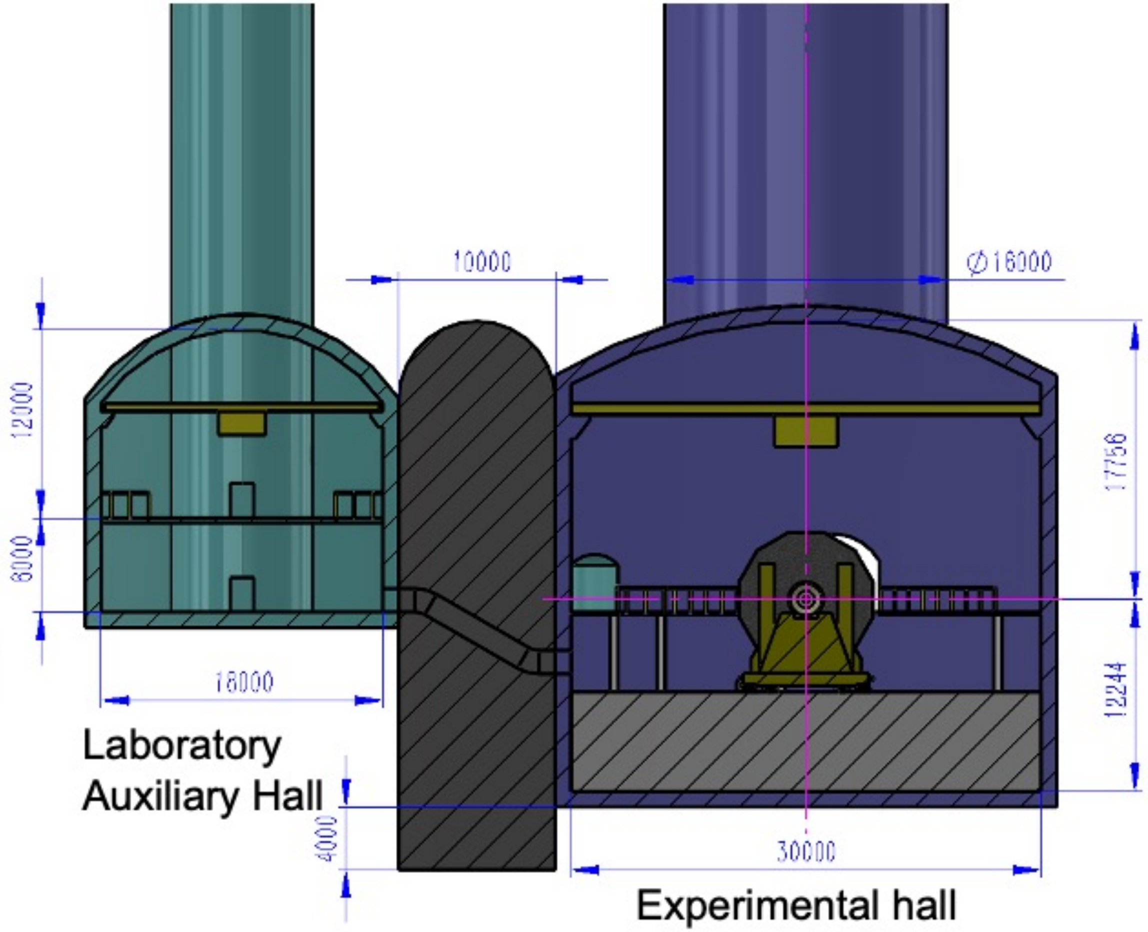
Songwen XIAO

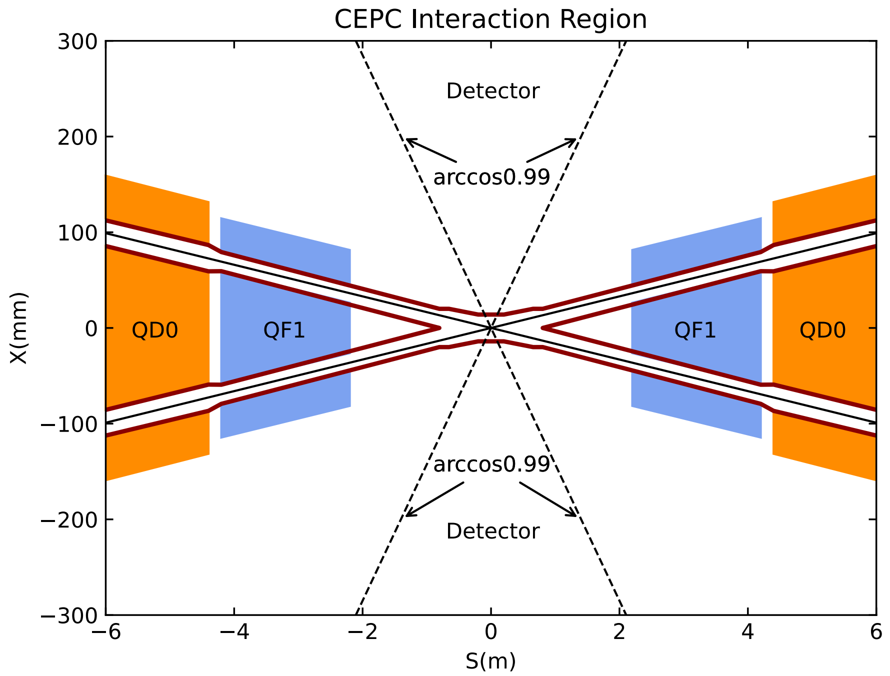


Experiment Hall

Songwen XIAO







MDI

- Physical Design of the baseline
- Some Mechanical Design

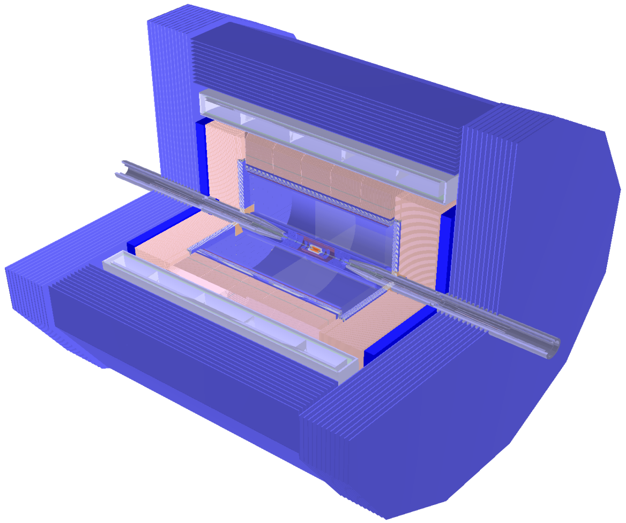
The inputs of baseline design

- Dedicated to CDR parameters of the accelerator, and the baseline design of the detector.
  - 28mm Be beam pipe

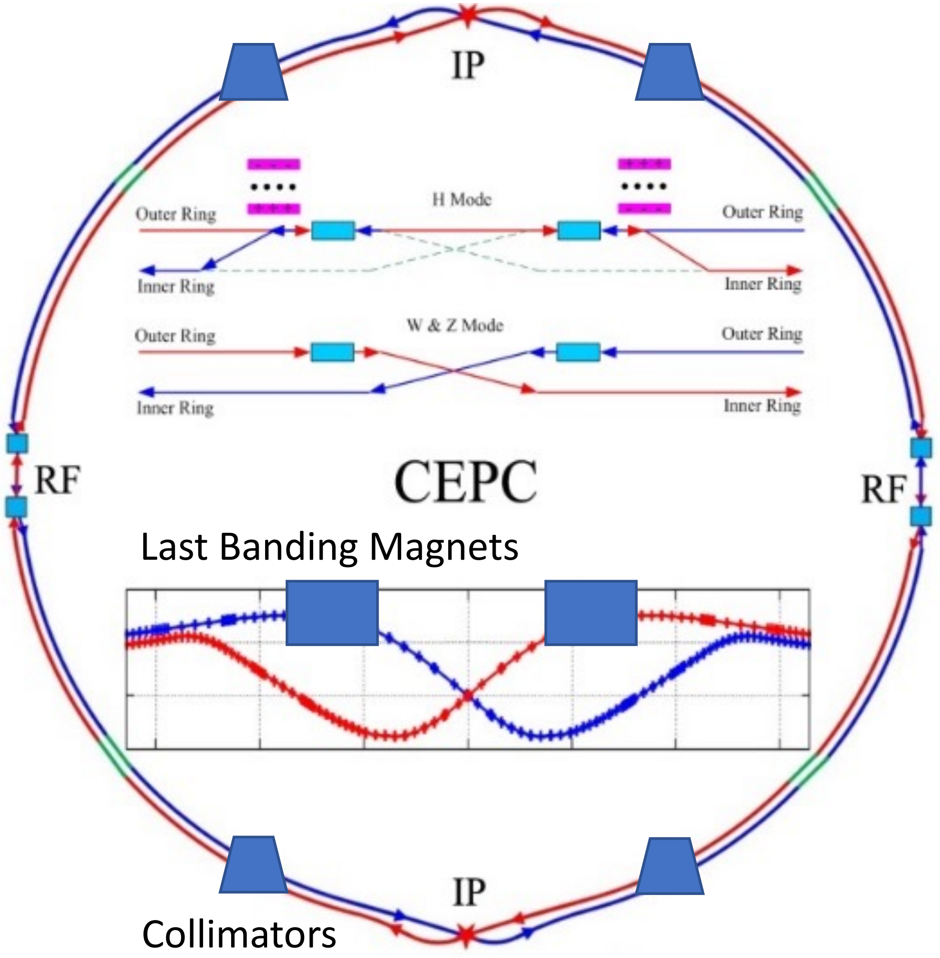
CDR Parameters(2T for Z)

	Higgs	*W*	*Z (2T)*
Number of IPs		2	
Beam energy (GeV)	120	80	45.5
Circumference (km)		100	
Synchrotron radiation loss/turn (GeV)	1.73	0.34	0.036
Half Crossing angle at IP (mrad)		16.5	
Piwinski angle	2.58	7.0	23.8
Number of particles/bunch N_e (10^{10})	15.0	12.0	8.0
Bunch number (bunch spacing)	242 (0.68μs)	1524 (0.21μs)	12000 (25ns+10%gap)
Beam current (mA)	17.4	87.9	461.0
SR power /beam (MW)	30	30	16.5
Bending radius (km)		10.7	
Momentum compact (10^{-5})		1.11	
β function at IP β_x^* / β_y^* (m)	0.36/0.0015	0.36/0.0015	0.2/0.001
Emittance $\varepsilon_x/\varepsilon_y$ (nm)	1.21/0.0031	0.54/0.0016	0.18/0.0016
Beam size at IP σ_x/σ_y (μm)	20.9/0.068	13.9/0.049	6.0/0.04
Beam-beam parameters ξ_x/ξ_y	0.031/0.109	0.013/0.106	0.0041/0.072
RF voltage V_{RF} (GV)	2.17	0.47	0.10
RF frequency f_{RF} (MHz) (harmonic)		650 (216816)	
Natural bunch length σ_z (mm)	2.72	2.98	2.42
Bunch length σ_z (mm)	3.26	5.9	8.5
Natural energy spread (%)	0.1	0.066	0.038
Energy acceptance requirement (%)	1.35	0.4	0.23
Energy acceptance by RF (%)	2.06	1.47	1.7
Lifetime (hour)	0.67	1.4	2.1
Luminosity/IP L ($10^{34}cm^{-2}s^{-1}$)	2.93	10.1	32.1

Baseline Detector



Map of the MDI Study



Accelerator

- IP Feedback
- BG Simulation
- LumiCal
- HOM absorber
- Vacuum Chamber
- SR Masks
- QD0/QF1
- Anti-Solenoid
- Cryostats
- BPMs
- Instability&Impendance
- Cooling
- Shielding
- Assembly&Supporting
- Alignment
- Connecting System
- Vacuum pumps
- Last Bending Magnet
- Collimators
- Control

Detector

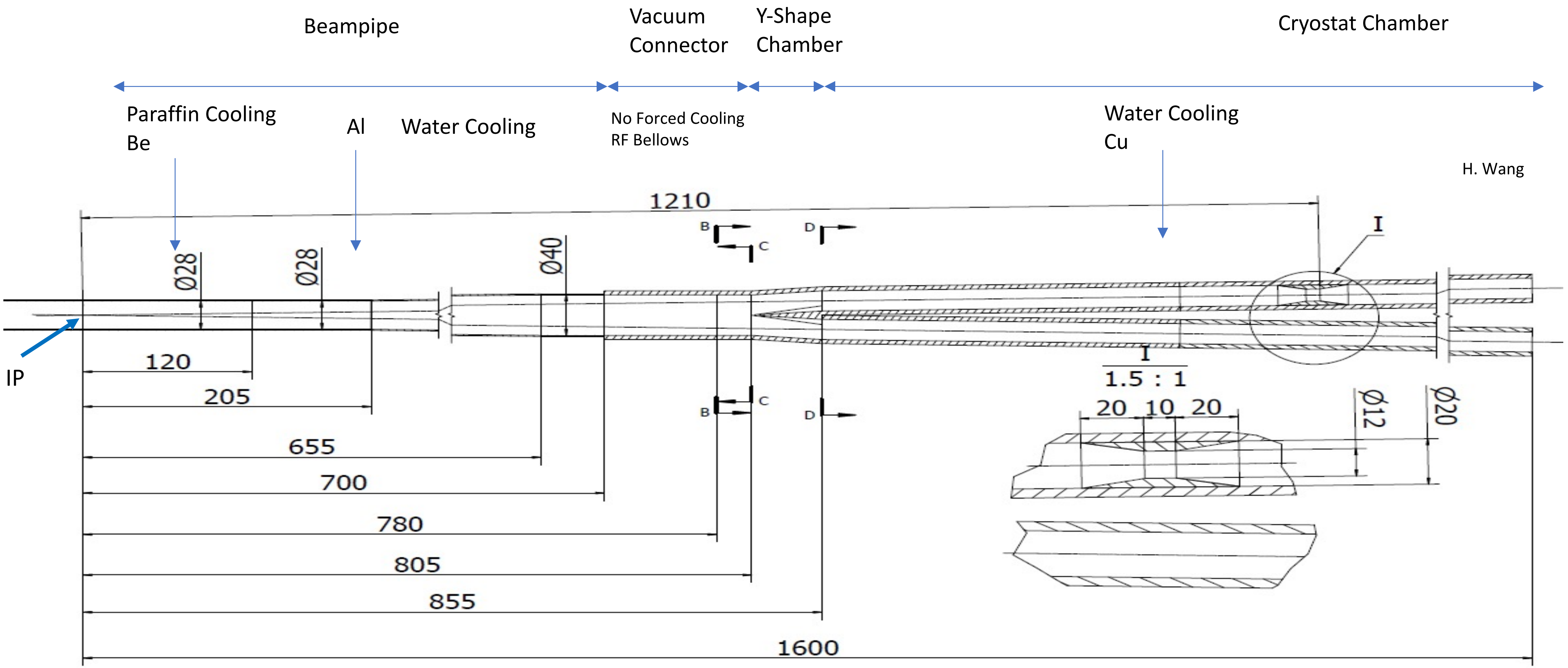
- Central Beam Pipe
- Vertex Detector
- LumiCal
- Silicon Tracker
- TPC
- Hcal
- Ecal
- Solenoid
- Yoke
- Muon Detector
- Hall
- BG Simulation&Shielding
- Software Geometry
- Alignment&Assembly
- Electronics
- Cryogenic
- Radiation Protection
- Booster

The MDI Table

	Range	Peak field in Coil	Central Field Gradient	Bending angle	Length	Beam Stay Clear Region	Minimal distance between two aperture	Inner diameter	Outer diameter	Critical Energy(Horizontal)	Critical Energy(Vertical)	SR power(Horizontal)	SR Power(Vertical)
L^*	0~2.2m				2.2m								
Crossing angle	33mard												
MDI Length	±6m												
Opening angle	13.6												
QD0		3.2T	136T/m		2m	19.51mm	72.61mm	40mm	53mm	1.3MeV	527keV	639W	292W
QF1		3.8T	110T/m		1.48m	26.85mm	146.2mm	56mm	68mm	1.6MeV	299keV	1568W	74W
Lumical	0.805 ~ 0.855m												
Anti-solenoid before QD0		7.26T			1.1m			120mm	390mm				
Anti-solenoid QD0		2.8T			2m			120mm	390mm				
Anti-solenoid QF1		1.8T			1.48m			120mm	390mm				
Beryllium pipe					±12cm			28mm					
Last BM upstream	67.66~161.04m			1.1mrad	93.38m					45keV			
First BM downstream	46.06~107.04m			1.54mrad	60.98m					97keV			
Beampipe within QD0					2m			20mm					
Beampipe within QF1					1.48m								
Beampipe between QD0/QF1					0.23m								

The latest beampipe design

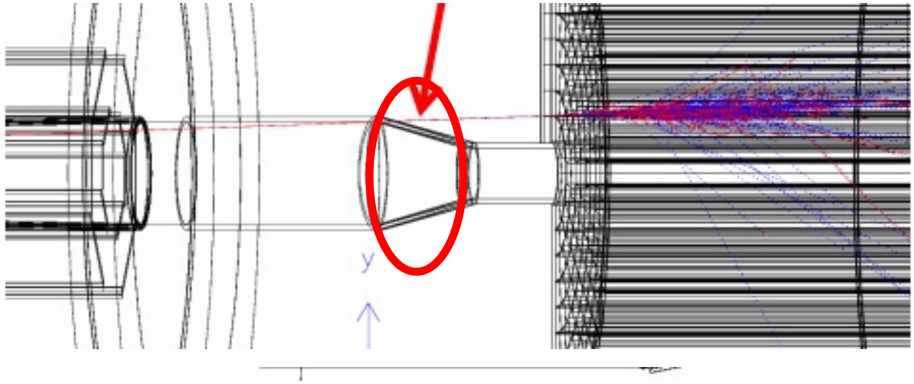
Nearly 20 versions tried in since last summer

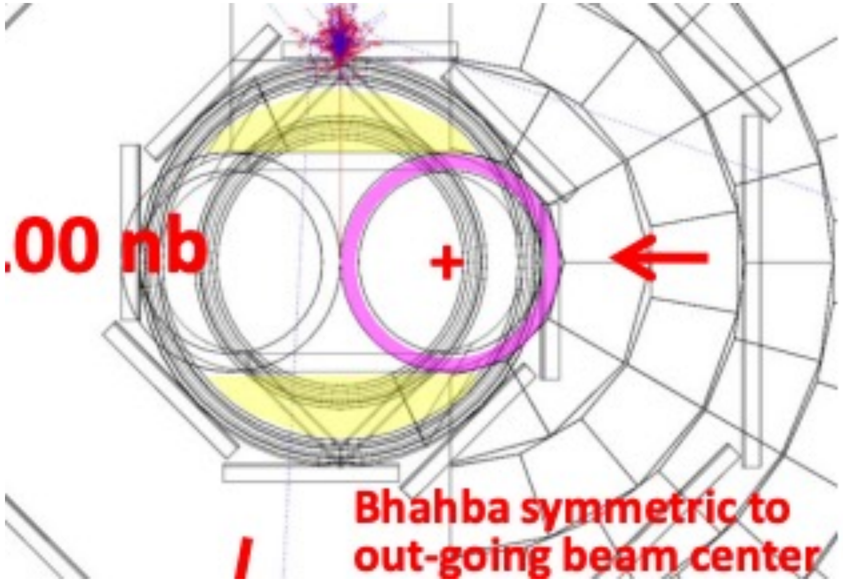


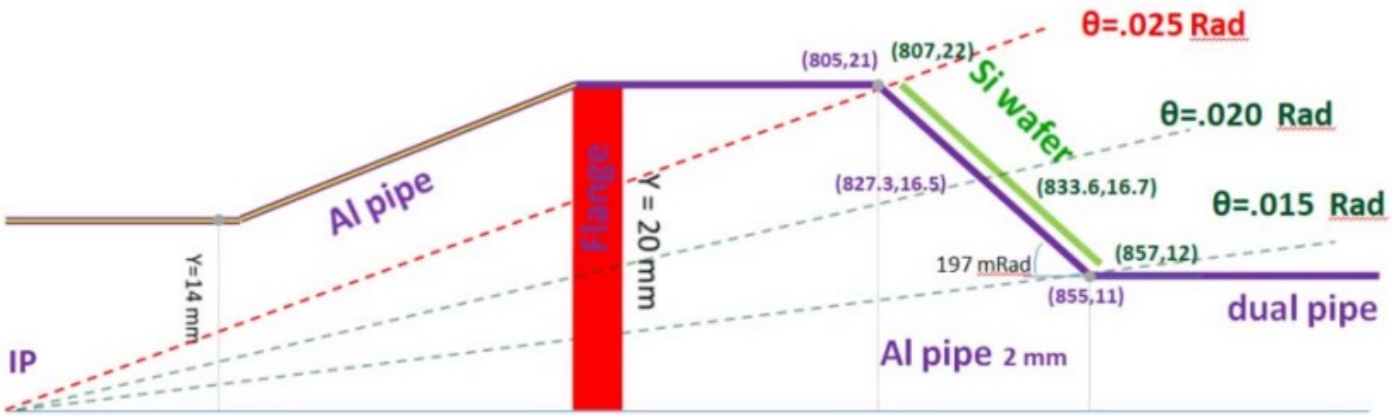
LumiCal

- LumiCal is necessary to achieve precision luminosity measurement as required for precision Higgs/EW measurement
- The new position of LumiCal has been chosen.
- Detector design and integration into IR

40 -> 20 on Y axis *Suen HOU*



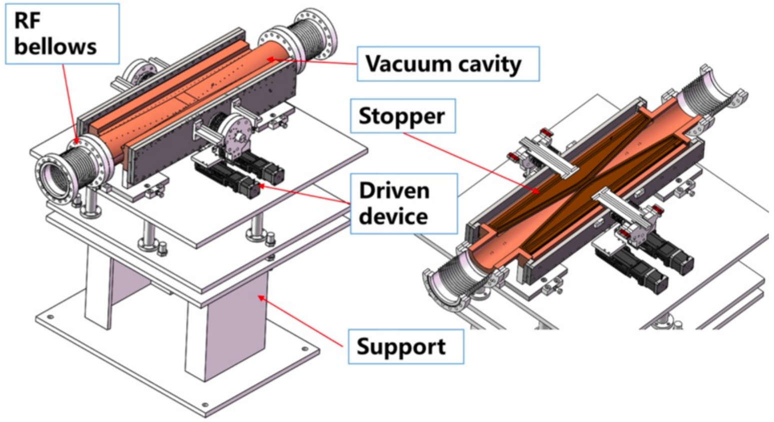


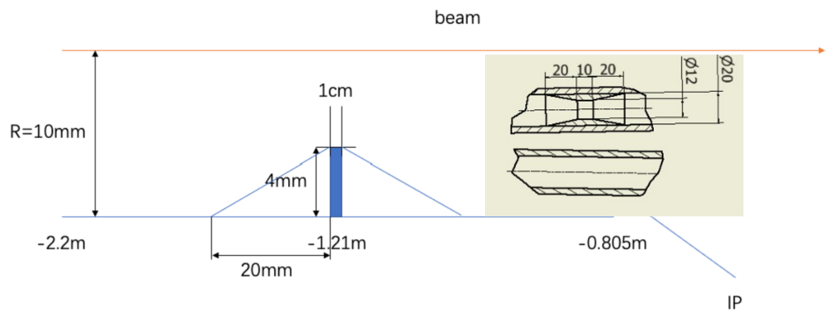


Collimators & Masks

- Collimators & Masks are indispensable for BG suppressing.
- Collimators may also design for Machine Protection.
- 4 sets of horizontal collimators per ring till now(No MPC).
  - Upstream beam loss have been reduced to low level.
  - Preliminary design of the movable collimator has been done.
- 4 SR Masks per ring till now.
  - -4.2m/-1.21 per IP.

H. Wang

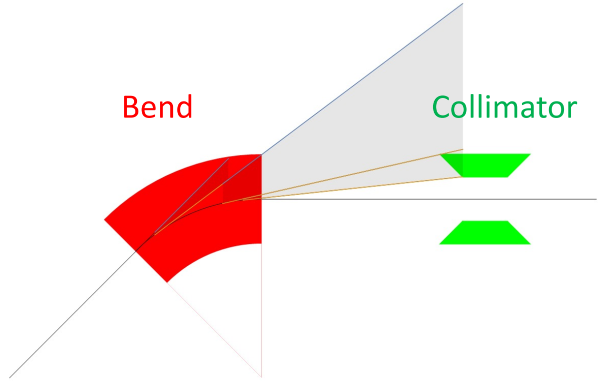


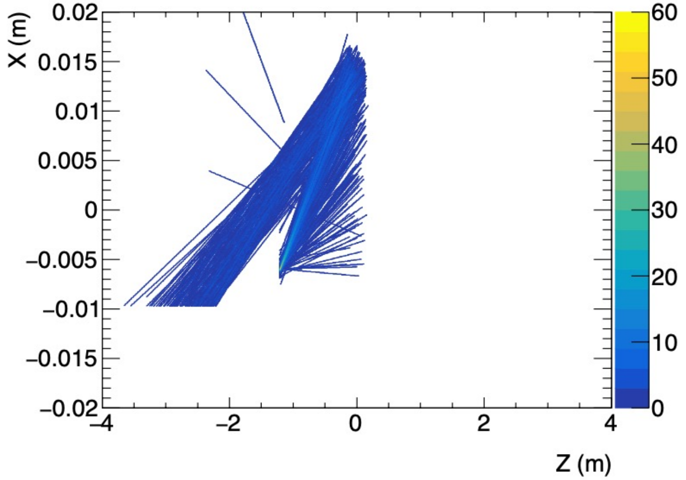


S. Bai

Name	Location	From IP
APTX1	D1I.1897	2139.06
APTX2	D1I.1894	2207.63
APTX3	D1O.10	1832.52
APTX4	D1O.14	1901.09

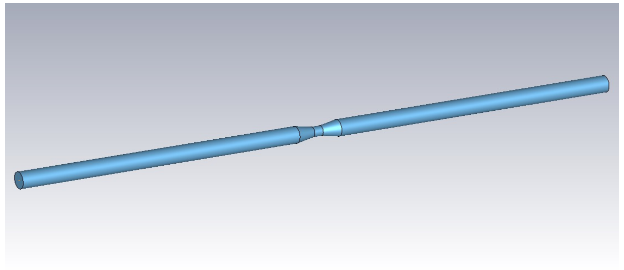
S. Bai





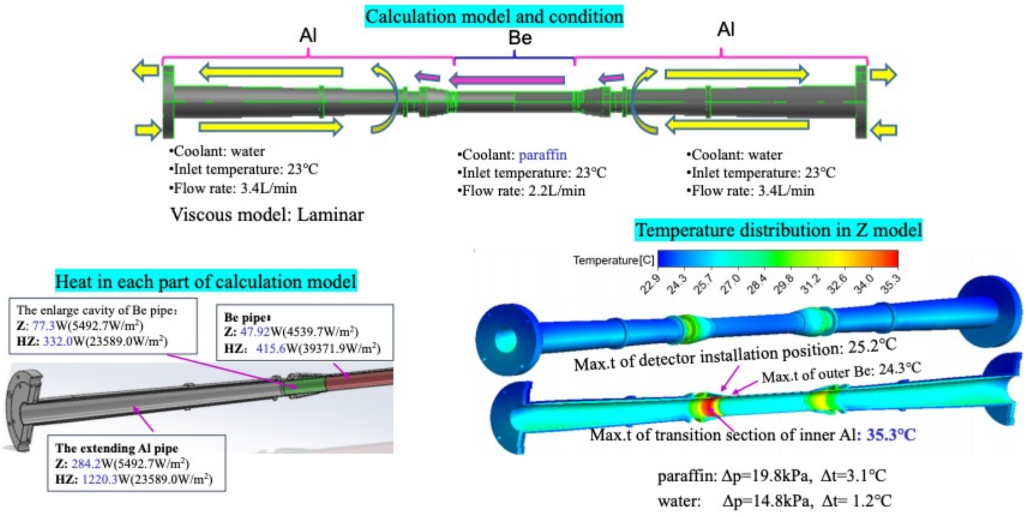
Safety Check?

- Thermal Analysis(including impendence)
  - Source
    - HOM Heating
    - Synchrotron Radiation
    - Other Backgrounds(Negligible)
- Backgrounds Estimation
  - Hotspot Shielding
  - Full Detector Simulation



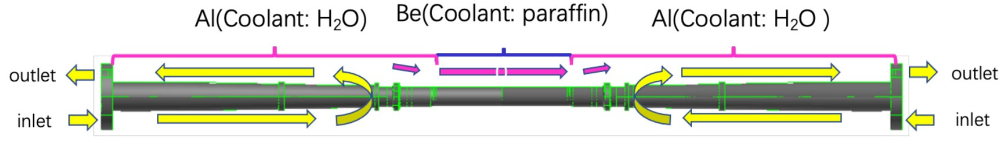
Loss factor(V/pc)	Power @Higgs	Power @W	Power @Z
$8.69*10^{-4}$	0.36 w	1.47 w	5.13w

Thermal Analysis



CDR Z parameters

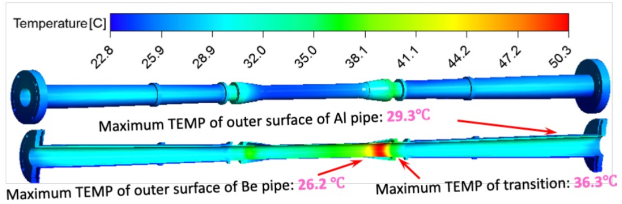
- Pressure drop:
  - Be pipe : 19.8 kPa
  - Al pipe : 19.3 kPa
- TEMP rise:
  - Be pipe : 3.2 ℃ (between the inlet and the outlet)
  - Transition: 13.3 ℃
  - Al pipe : 6.3 ℃
- Temperature rise and pressure drop are in a safe range



Calculation model: laminar

Inlet of Be pipe:
TEMP: 23C°
Velocity: 1.3 m/s
Coolant: paraffin

Inlet of Al pipe:
TEMP: 23C°
Velocity: 1.0 m/s
Coolant: H_2O



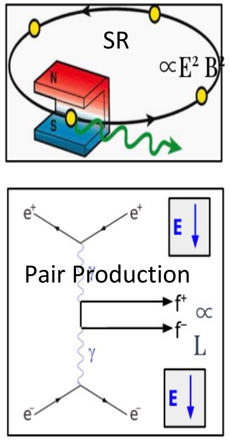
Temperature rise:
Be pipe : 3.2 ℃
Transition: 13.3 ℃
Al pipe : 6.3 ℃

Pressure drop:
Be pipe : 19.8 kPa
Al pipe : 19.3 kPa

Conclusion:
Temperature rise and pressure drop within safe range

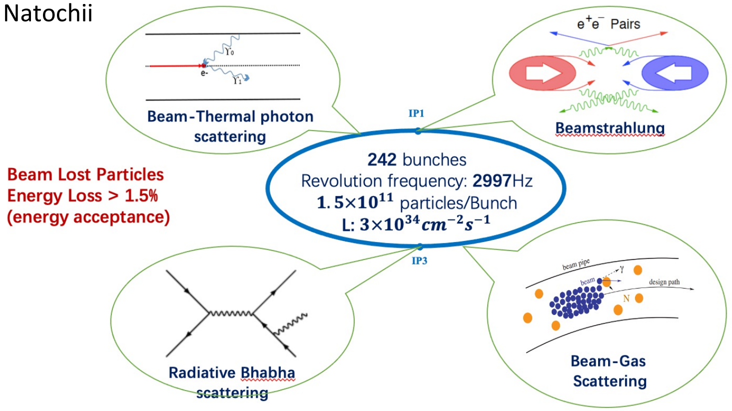
Background Estimation

- Whole-Ring generation for some BGs
- Multi-turn tracking
  - Using built-in LOSSMAP with one step ahead
  - SR emitting on
  - RF on
- Doing
  - 2 IR per ring
  - Magnet errors
    - No misalignment
    - High-order magnets
  - Integrating to CEPCSW



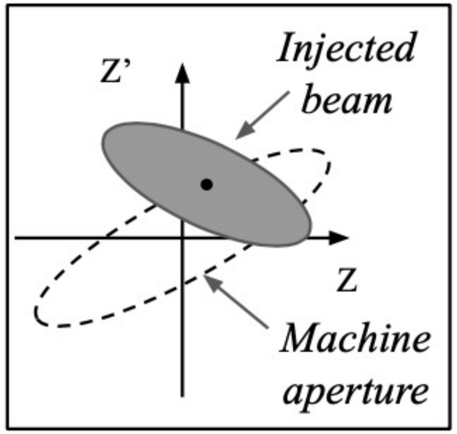
A. Natochii

Photon BG



Beam Loss BG

A. Natochii



Injection BG

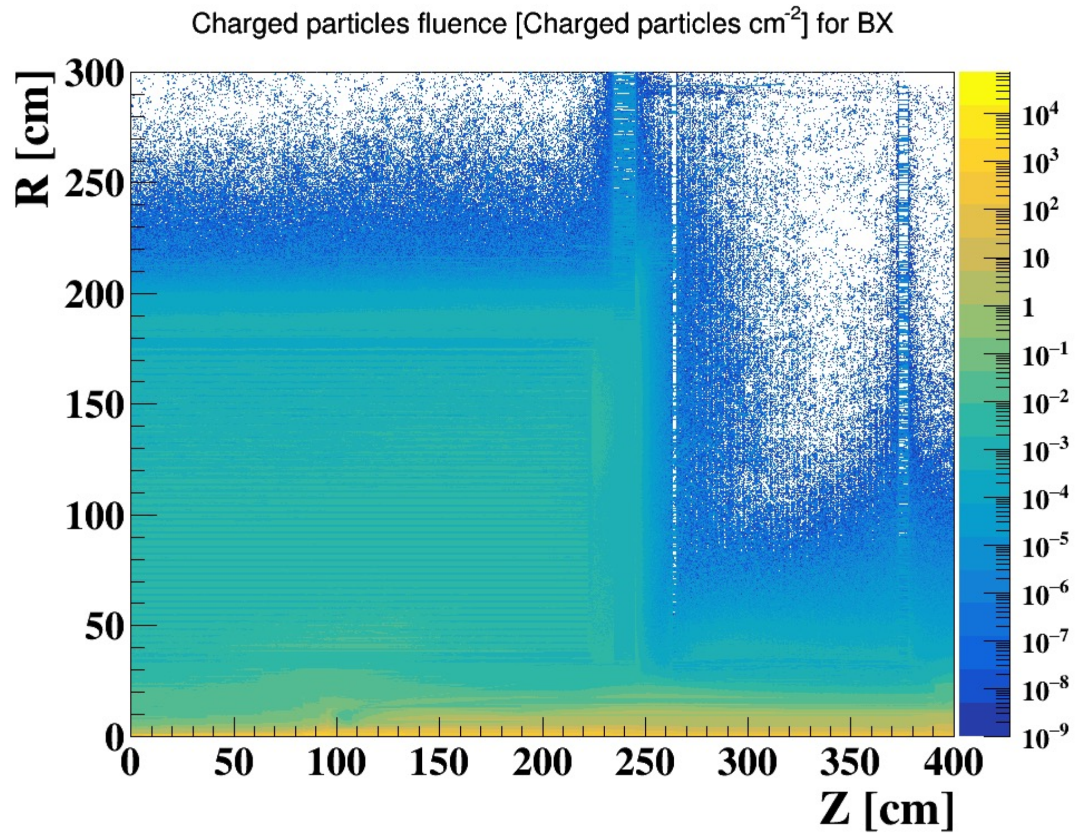
<table>
<tr><th>Background</th><th>Generation</th><th>Tracking</th><th>Detector Simu.</th></tr>
<tr><td>Synchrotron Radiation</td><td>BDSim</td><td>BDSim/Geant4</td><td rowspan="6">Mokka</td></tr>
<tr><td>Beamstrahlung/Pair Production</td><td>Guinea-Pig++</td><td rowspan="5">SAD</td></tr>
<tr><td>Beam-Thermal Photon</td><td>PyBTH</td></tr>
<tr><td>Beam-Gas Bremsstrahlung</td><td>PyBGB</td></tr>
<tr><td>Beam-Gas Coulomb</td><td>BGC in SAD</td></tr>
<tr><td>Radiative Bhabha</td><td>Bbbrem</td></tr>
</table>

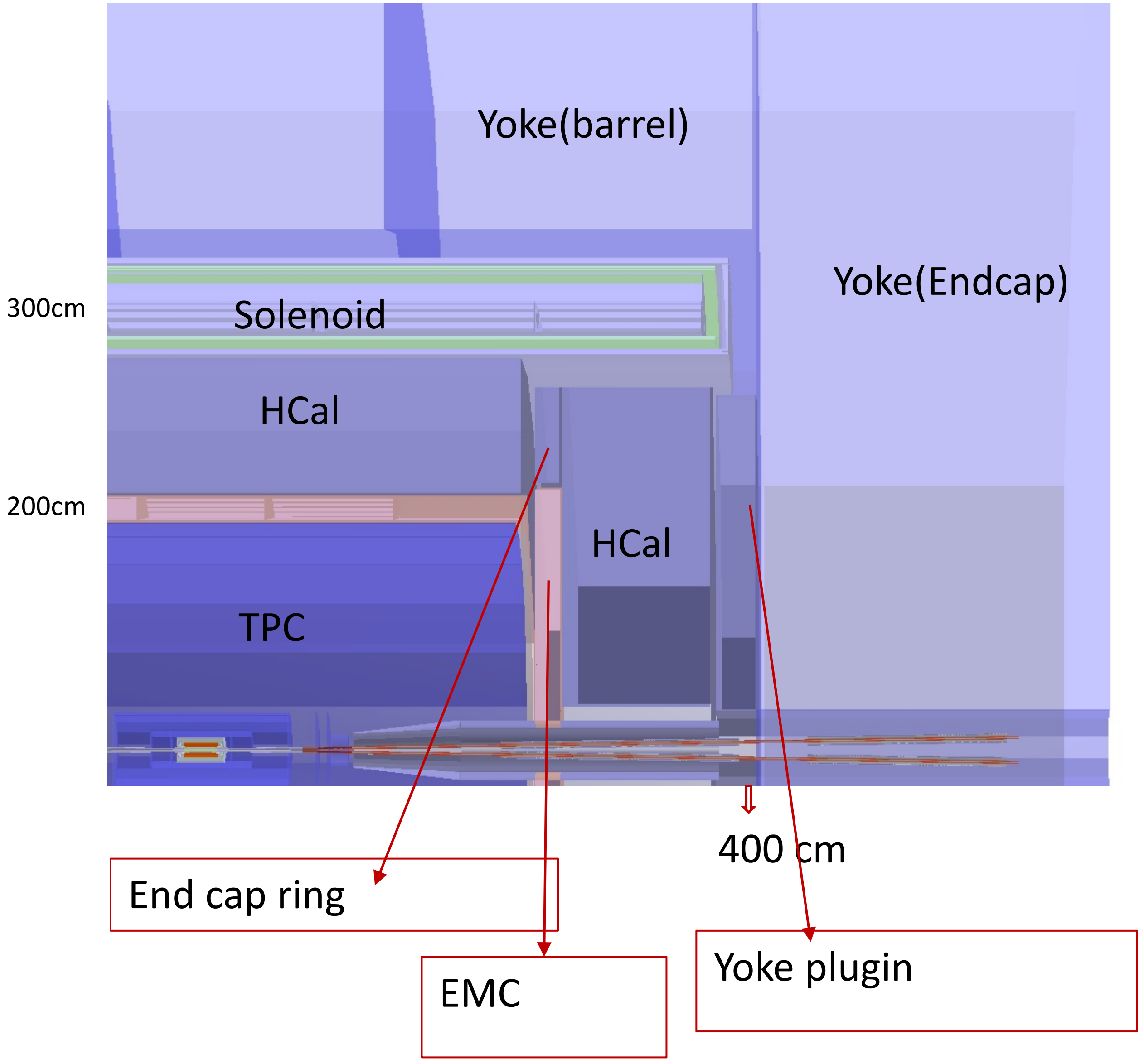
Detector Impact

- Preliminary results on 1st layer of vertex. Safety factor of 10 applied.

Background	Hit Density($cm^{-2} \cdot BX^{-1}$)			TID($Mrad \cdot yr^{-1}$)			1 MeV equivalent neutron fluence ($n_{eq} \times 10^{12} \cdot cm^{-2} \cdot yr^{-1}$)		
	Higgs	W	Z	Higgs	W	Z	Higgs	W	Z
Pair production	1.8	1.2	0.4	0.50	2.1	5.6	1.0	3.8	10.6
Beam Gas	0.4	0.4	0.2	0.36	1.3	4.1	1.0	3.6	11.1
Beam Thermal Photon	0.1	0.1	0.03	0.07	0.3	0.8	0.2	0.7	1.9
Total	2.3	1.7	0.63	0.93	3.7	10.5	2.2	8.1	23.6
Total_oCDR	2.4	2.3	0.25	0.93	2.9	3.4	2.1	5.5	6.2

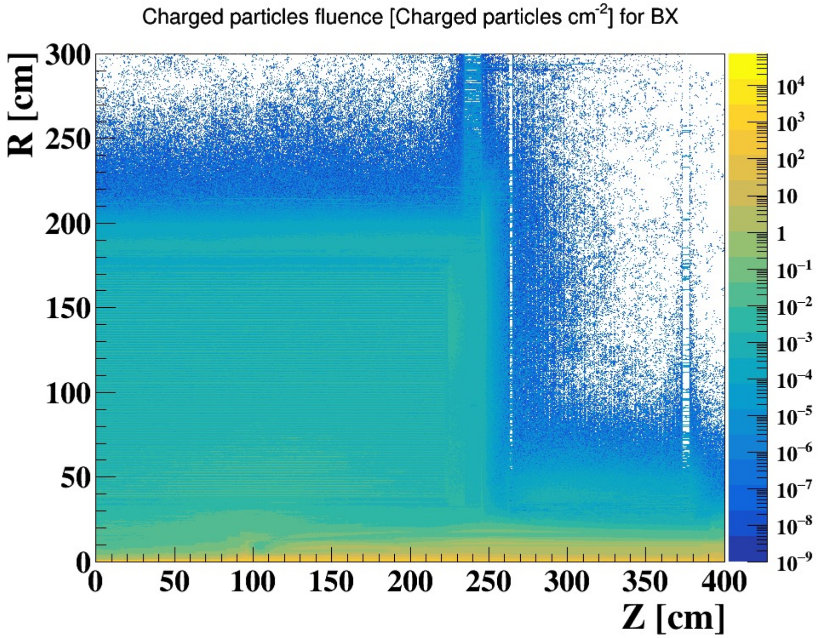
Full Detector Simulation(Higgs)

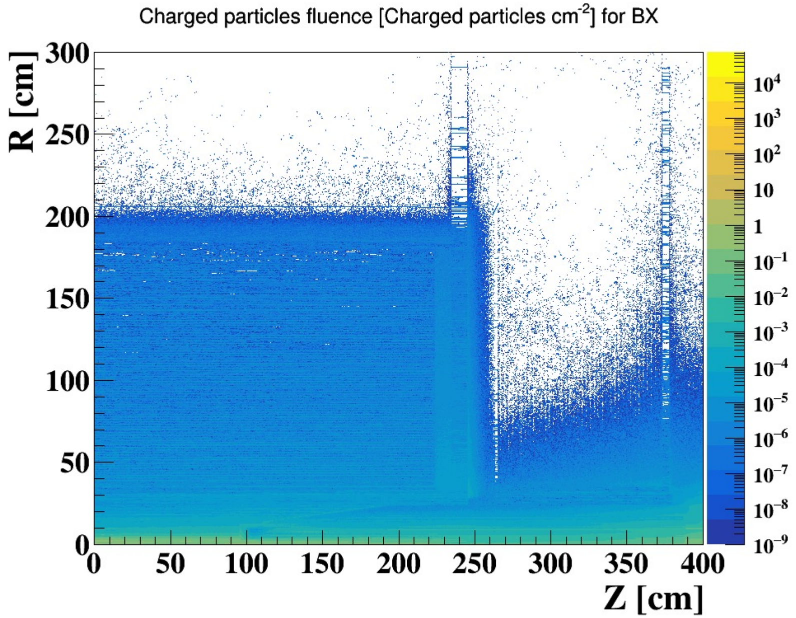


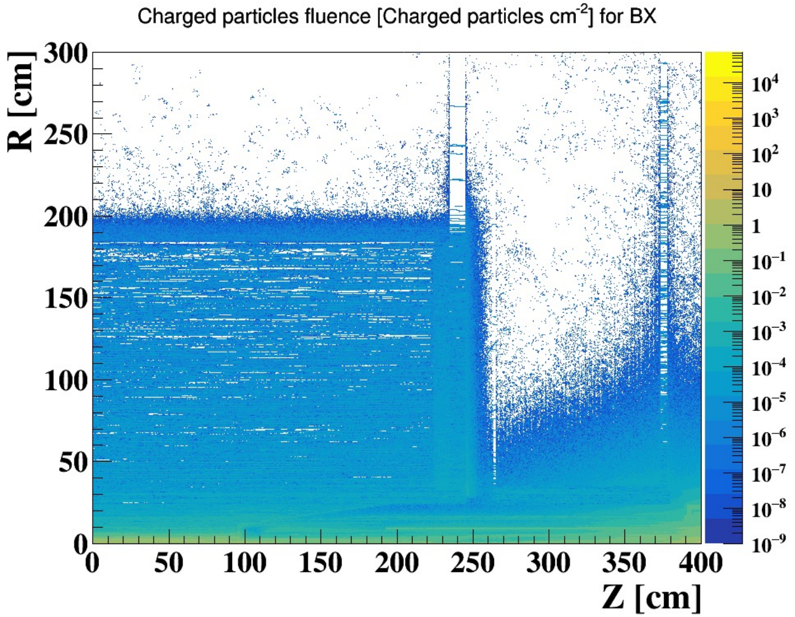


- ECal and Beyond

Full Detector Simulation(Higgs)







Pairs higher than BGB at the same level BTH

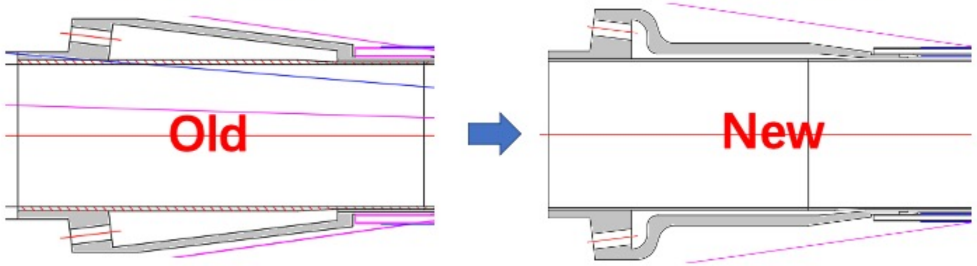
Name	Position in R	Hit/cm²/BX	Hit/cm²/s
VTX	15 mm	~2.3	~3.33e7
SIT	15 cm	~0.01	~14507
TPC	50 cm	~0.005	~7253
Ecal	200 cm	~1e-4	~145
Hcal	220 cm	~2e-6	~2.9

Mechanical Design

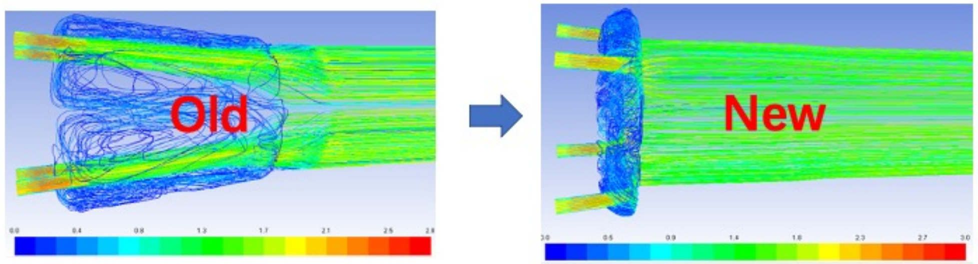
Youlian LU

Stress analysis of the latest beam tube structure			
Case	constraint	Deformation/mm	Stress/MPa
1	Ignore detector load; Fixed at one end	0.14	3
2	Add detector load; Fixed at one end	0.5	10.8
3	Add detector load; One end is fixed; The other end is radial constrained	0.002	0.3
4	Add detector load ; One end is fixed; The other end is radial constrained and axial pressured 0.2MPa	0.015	13.9

✓ With carbon fiber tube, the overall structure is stable and safe.



Structural comparison design drawing



Streamline comparison chart

Inner Be pipe: Critical pressure calculation

$$Pcr = \frac{E}{4(1-\mu^2)}\left(\frac{t}{R}\right)^3$$

E——modulus of elasticity
t——thickness
μ——Poisson's ratio
R——(R1+R2)/2

Inner diameter of vacuum tube	thickness	Inner radius	Outer radius	Critical pressure
mm	mm	mm	mm	MPa
28	0.5	14.0	14.5	3.3
	0.35	14.0	14.35	1.15
	0.3	14.0	14.3	0.73
20	0.25	10.0	10.25	1.15

Inner Be pipe:
✓ Φ28mm: 0.5mm ➡ 0.35mm
✓ Φ20mm: 0.25mm

Outer Be pipe: the maximum allowable working pressure

$$[P_W] = \frac{2\delta_e[\sigma]^t\phi}{(D_i+\delta_e)}$$

δ_e——Tube thickness, mm
$[\sigma]^t$——Allowable stress, MPa
Φ——Weld coefficient
D_i——Inner diameter, mm

Inner Be		water	Outer Be		allowable stress	weld coefficient	Maximum allowable working pressure
Diameter	thickness	thickness	Diameter	thickness			
			Di	δe	[σ]^t	Φ	Pw
mm	mm	mm	mm	mm	Mpa		MPa
28	0.35	0.5	29.7	0.25	71.25	1	1.2
				0.2	71.25	1	1.0
20	0.2	0.5	21.4	0.15	71.25	1	1.0

Outer Be pipe:
✓ Φ28mm: 0.35mm ➡ 0.25mm
✓ Φ20mm: 0.15mm

New Light Material Candidate

Shaohong WEI

- Magnesium lithium alloy is the lightest metal structural material in the world;
- Density is 1.35-1.65g/cm3, which is 1 / 4-1 / 3 lighter than ordinary magnesium alloy and 1 / 3-1 / 2 lighter than aluminum alloy;

Mg-Li合金: **Li** --- Lightest metal; **Mg**--- Lightest structural material

Characteristic

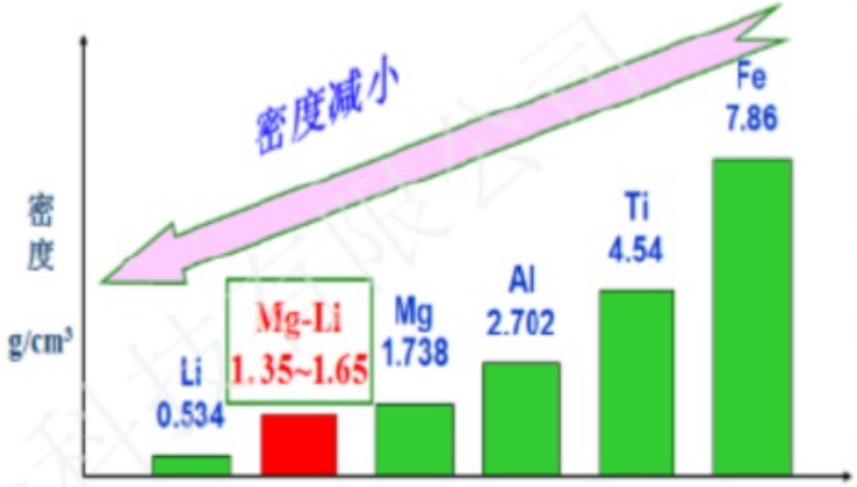
- ☐ supper light;
- ☐ High strength ;

Application area :

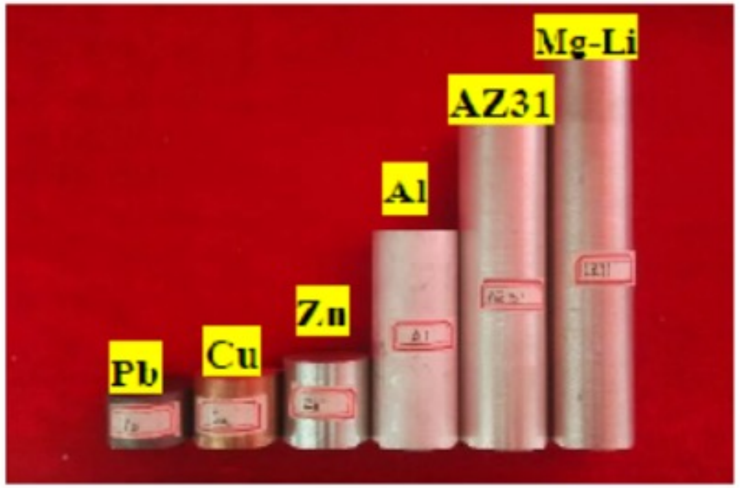
- Aerospace
- Military project
- Civil 3C

Manufacturer :

- ✓ 中铝郑州轻金属研究院;
- ✓ 东北轻合金有限公司;



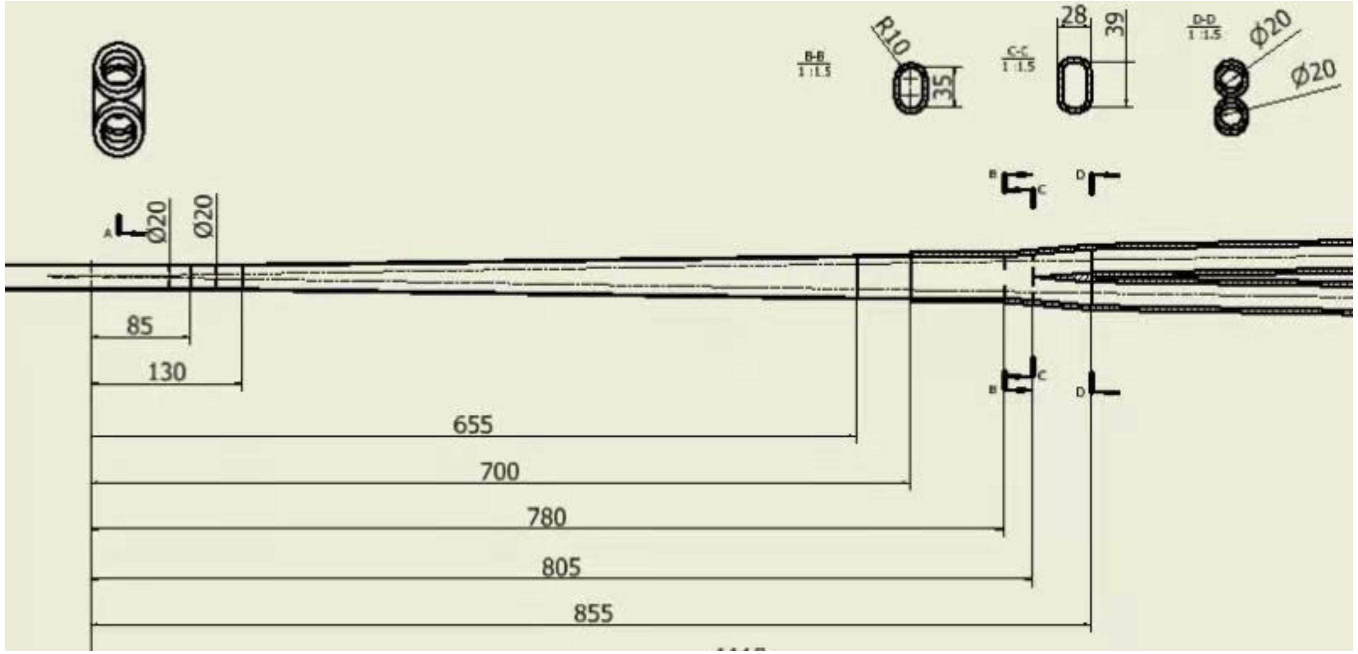
常见合金密度对比



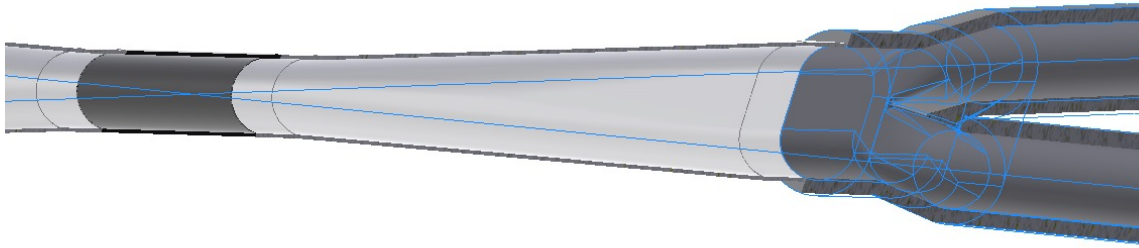
相同重量的不同合金对比

Novel Design - Shrinking to 20mm

- Smaller Be inner diameter would benefit vertex
- Preliminary Design has been performed



X direction: 20-35-(2-20)mm;
Y direction: 20-20-20mm;



What MDI Study covers now

Red means a part of "specific" MDI , Blue means its parameter is relative to MDI, while Black means it would affect by MDI

Accelerator

IP Feedback	Not Covered
BG Simulation	Doing
LumiCal	Doing
HOM absorber	No Need
Vacuum Chamber	Done
SR Masks	Done
QD0/QF1	Doing
Anti-Solenoid	Doing
Cryostats	Doing
BPMs	Doing
Instability&Impendance	Done
Cooling	Done
Shielding	Doing
Assembly&Supporting	Doing
Alignment	Doing
Connecting System	Doing
Vacuum pumps	Doing
Last Bending Magnet	Done
Collimators	Doing
Control	Not Covered

Detector

Central Beam Pipe	Done
Vertex Detector	Doing
LumiCal	Doing
Silicon Tracker	Doing
TPC	Doing
Hcal	Doing
Ecal	Doing
Solenoid	Doing, strength Fixed
Yoke	Doing
Muon Detector	Doing
Hall	?
BG Simulation&Shielding	Doing
Software Geometry	Done, check needed
Alignment&Assembly	Doing
Electronics	?
Cryogenic	?
Radiation Protection	Not Covered
Booster	Not Covered

What's next?

- For detector mechanics, optimize the integration&installation scheme.
  - Continue the mechanical design of the yoke, SC and other sub-detectors.
  - The installation scheme of beampipe at commissioning phase.
  - The integration and installation of the whole detector as well as beampipe.
  - Optimize the design of experiment hall, auxiliary hall and other halls on ground.
- For MDI, continue finishing current design, start the design for TDR.
  - More detailed & feasible mechanical design
  - More detailed simulation and understanding of the results
  - More realistic model in simulation(fewer lacking sources, better geometry, etc.)
  - More efficient simulation

What’s next?

- At the same time, as Prof. GAO suggested,
  - Clear CEPC MDI specified subsystem target goal parameter tables should be established to guide the evaluation of the status of each subsystem and MDI as a whole one.
  - Clear CEPC MDI subsystem overlapping working relation and communication table(s) should be established to improve the communication among colleagues in MDI as a whole team.
  - Clear a version name equipped with a complete documents of current and future study of MDI in order to avoid any confusion in a complex system such as MDI(Summarize the current version when it roughly finished before we touch the new).

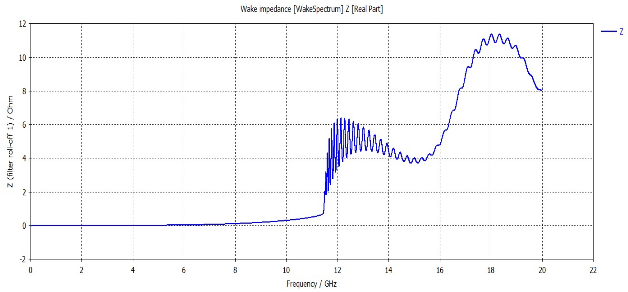
Thank You

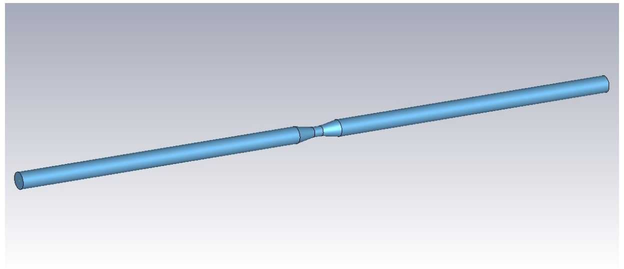
Backup

HOM & Impendence

- The Power Distribution on Higgs & Z mode has been simulated.
  - The new SR masks has been considered.

距IP距离（mm）	形状	内径(mm)	材料	内表面积(mm²)	备注	总功率&Higgs (W)	功率密度&Higgs (W/cm²)	功率分布&Higgs (W)	总功率&Z (W)	功率密度&Z (W/cm²)	功率分布&Z (W)
0 – 120	圆直管	直径28	Be	10556		6.6	0. 06	6. 60	47.92	0. 45	47. 92
120-205	圆直管	直径28	Al	7477				2. 71			39. 44
205-655	圆锥管	直径28过渡到直径40	Al	48071	taper:1.75	22.2	0. 04	17. 44	322.8	0. 53	253. 54
655-700	圆直管	直径40	Al	5655				2. 05			29. 83
700-780	圆直管	直径40	Cu	10052	远程连接装置预留			2. 60			39. 05
780-805	圆面过渡到跑道型	水平方向直径40-40，垂直方向直径40-30.7	Cu	3124		13.2	0. 03	0. 81	198.2	0. 39	12. 14
805-855	跑道型过渡到两个圆面	上游直径12 下游直径20	Cu	6932				1. 79			26. 93
855-1110	上游圆锥管 下游圆直管	上游直径12过渡到20，下游直径20	Cu	30906				8. 00			120. 08





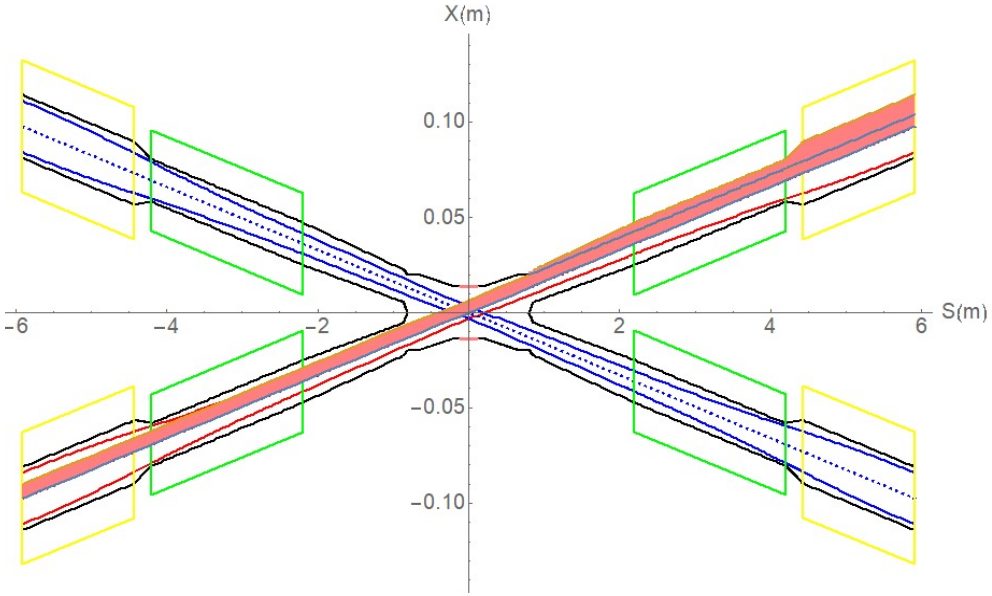
Loss factor(V/pc)	Power @Higgs	Power @W	Power @Z
$8.69*10^{-4}$	0.36 w	1.47 w	5.13w

Synchrotron Radiation

- Synchrotron radiation should be dealt with high priority at circular machines when designing the interaction region

Revised beam pipe design to achieve

No direct SR photons hitting the central beam pipe except the extreme beam conditions (e.g. beam off orbit due to magnet errors)

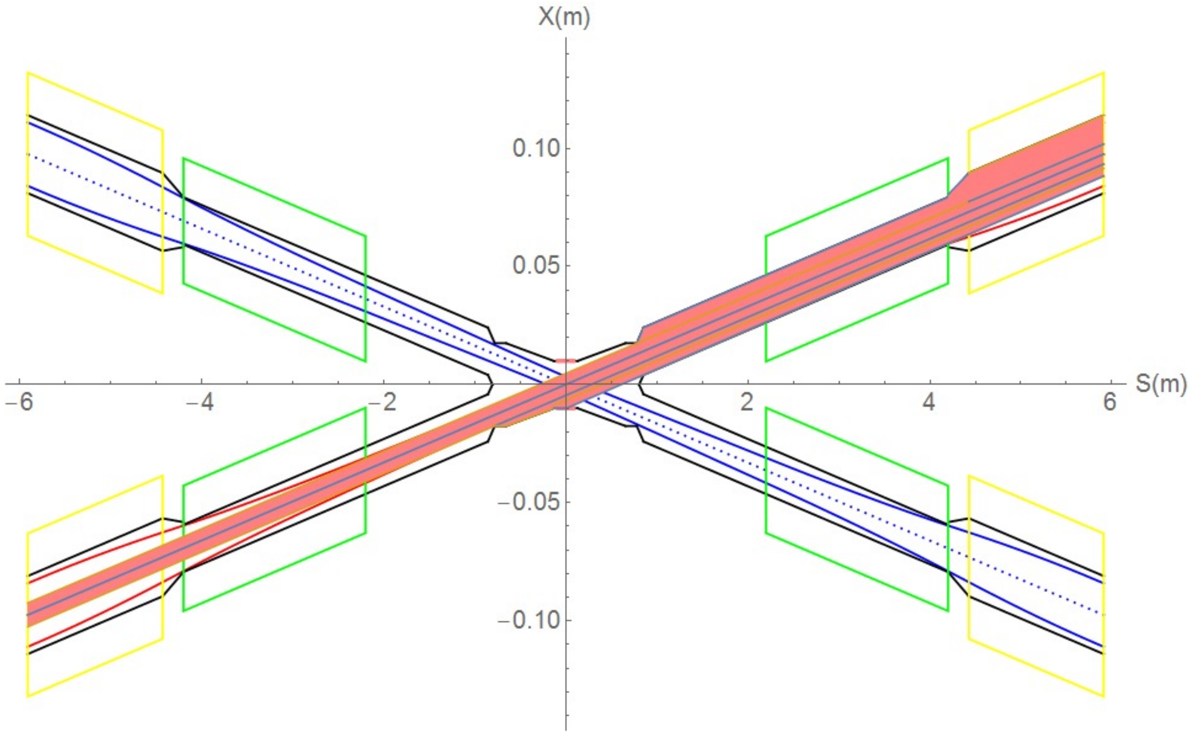


	Power Deposition	Average Power Density
0.805~0.855m	16W	88.9W/cm^2
0.855~2.2m	12.3W	2.54W/cm^2
QD0(2.2m~4.2m)	2.79W	0.39W/cm^2
QD0~QF1(4.2~4.43m)	36.1W	43.6W/cm^2
QF1(4.43m~5.91m)	3W	0.56W/cm^2

Novel Design - Shrinking to 20mm

- SR would hit Be beam pipe directly in error case
  - SR hitting Be pipe directly in (- 85mm ~ 11.4mm) range, but since instantaneously, heat load is not a problem.
  - SR photons hitting the bellows under the extreme beam conditions, temperature rise ~10C

Region	Material	SR heat load	SR average power density
-85mm ~ 11.4mm	Be	13.74W	41W/cm^2
-130mm ~ -85mm	Al	6.66W	41.1W/cm^2
-780mm ~ -655m	Al	18.3W	40.7W/cm^2



Novel Design - Shrinking to 20mm

- SR would hit Be beam pipe directly in error case
  - SR hitting Be pipe directly in (- 85mm ~ 11.4mm) range, but since instantaneously, heat load is not a problem.
  - SR photons hitting the bellows under the extreme beam conditions, temperature rise ~10C
  - Several assumptions were taken here:
    - Extreme condition, eg, if a magnet power is lost, a large distortion will appear immediately for the whole ring orbit. The beam will be lost when exceeded.
    - In extreme cases ~ at least 10 times per day. The beam will be stopped within 0.5ms when abnormal.
    - The background of the detector should not be considered under abnormal conditions.
    - The beam orbit deviation will not affect detector operation, since the high background part will be removed when data analysis is carried out.

These assumptions may need further discussion

MDI__Accelerator	Person
IP Feedback	J.H. Yue/C.H. Yu/Y.W. Wang
BG Simulation	H.Y. Shi/S. Bai
LumiCal	Suen Hou/Ivanka/Phillipe
HOM absorber	Y.D. Liu/J.Y. Zhai
Vacuum Chamber	H.J. Wang
SR Masks	H.Y. Shi
QD0/QF1	Y.S. Zhu
Anti-Solenoid	Y.S. Zhu
Cryostats	M.F. Xu/T.X. Zhao
BPMs	Y.F. Sui
Instability&Impendance	Y.D. Liu/N. Wang
Cooling	Q. Ji/H.J. Wang
Shielding	H.Y. Shi/Z.J. Ma/S. Bai
Assembly&Supporting	H.J. Wang/Q. Ji
Alignment	X.L. Wang/Q. Ji/H.J. Wang
Connecting System	H.J. Wang
Vacuum pumps	Y.S. Ma
Last Bending Magnet	Y.W. Wang
Collimators	S. Bai/H.J. Wang
Control	G. Li

MDI__Detector	Person
Central Beam Pipe	Q. Ji
Vertex Detector	Z.J. Liang
LumiCal	Suen Hou/Ivanka/Phillipe
Silicon Tracker	H. Fox
TPC	H.R. Qi
Hcal	Y. Liu
Ecal	Y. Liu
Solenoid	F.P. Ning
Yoke	F.P. Ning
Muon Detector	X.L. Wang
Hall	Z.A. Zhu
BG Simulation&Shielding	H.Y. Shi
Software Geometry	C.D. Fu
Alignment&Assembly	Q. Ji/H.J. Wang/X.L. Wang
Electronics	W. Wei
Cryogenic	T.X. Zhao
Radiation Protection	Z.J. Ma
Booster	D. Wang