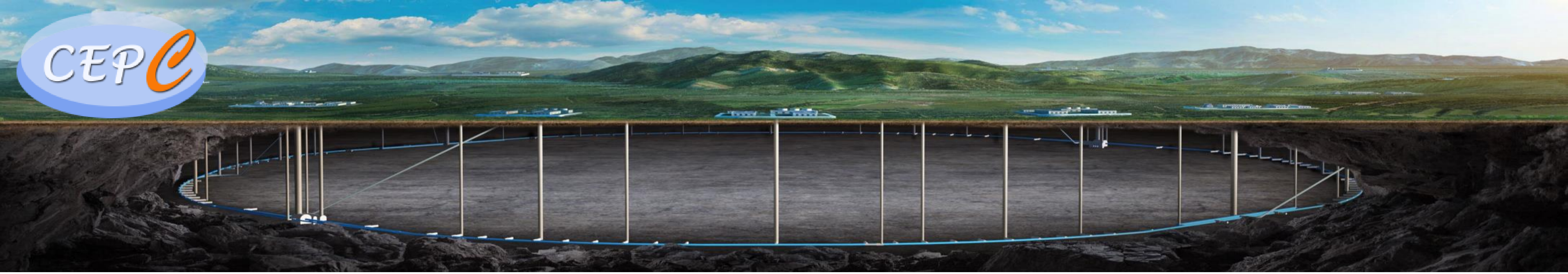

CEPC Beam Backgrounds Status & MDI Updates

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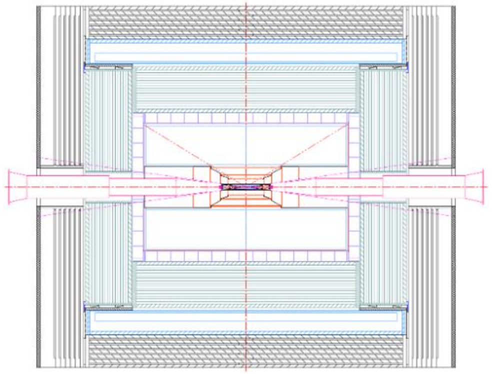
Content

- Introduction
- Sources, tools, mitigation methods
- Impacts Estimation
- Shielding of the BIB
- Summary & Outlook

Introduction

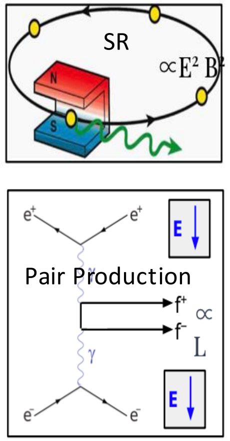
- Reasonable Estimation of Beam-induced background levels
  - Based on the 50-MW design of CEPC Accelerator TDR
  - Keep updating with the Ref-TDR detector
  - Higgs, Low-Lumi-Z, High-Lum-Z(3T for all)
- Estimation of the Noise on Detector due to Backgrounds, Normal Operation
  - Hit Rate/Occupancy
- Estimation of the Radiation Environment: contributions from Backgrounds in normal operation(the failure case, contributions from the signal will be considered later)
  - Radiation Damage to the Material(Detector, Accelerator, Electronics, etc…)
  - Radiation Damage to the personnel and the environment
  - Absorbed Dose, 1 MeV Si-eq fluence, Hadron fluence…
- Mitigation Methods

	Higgs	W	$t\bar{t}$	Z	Low-Lumi-Z
Number of IPs	2				
Solenoid(T)	3				
Circumference (km)	99.955				
Half crossing angle at IP (mrad)	16.5				
Bending radius (km)	10.7				
SR power per beam (MW)	50				12.1
Energy (GeV)	120	80	180	45.5	45.5
Energy loss per turn (GeV)	1.8	0.357	9.1	0.037	0.037
Damping time $t_x/t_y/t_z$ (ms)	44.6/44.6/22.3	150/150/75	13.2/13.2/6.6	816/816/408	816/816/408
Piwinski angle	4.88	5.98	1.23	29.52	24
Bunch number	446	2162	58	13104	3978
Bunch spacing (ns)	277.0	138.5	2585.0	23.1	69.2
[× 23.08 ns]	12	6	112	1	3
Train gap [%]	63	10	55	9	9
Bunch population (10^{11})	1.3	1.35	2.0	2.1	1.7
Beam current (mA)	27.8	140.2	5.5	1345.2	325.0
Phase advance of arc FODO (°)	90	60	90	60	60
Momentum compaction (10^{-5})	0.71	1.43	0.71	1.43	1.43
Beta functions at IP b_x^*/b_y^* (m/mm)	0.3/1	0.21/1	1.04/2.7	0.2/1.0	0.13/1.0
Emittance e_x/e_y (nm/pm)	0.64/1.3	0.87/1.7	1.4/4.7	0.27/5.1	0.27/5.1
Betatron tune n_x/n_y	445/445	317/317	445/445	317/317	317/317
Beam size at IP s_x/s_y (um/nm)	14/36	13/42	39/113	6/72	6/72
Bunch length (natural/total) (mm)	2.3/4.1	2.5/4.9	2.2/2.9	2.6/9.8	2.5/8.8
Energy spread (natural/total) (%)	0.10/0.17	0.07/0.14	0.15/0.20	0.04/0.15	0.04/0.13
Energy acceptance (DA/RF) (%)	1.6/2.2	1.05/2.5	2.0/2.6	1.2/1.7	1.0/1.7
Beam-beam parameters x_x/x_y	0.015/0.11	0.012/0.113	0.071/0.1	0.0046/0.074	0.0053/0.082
RF voltage (GV)	2.2	0.7	10	0.12	0.12
RF frequency (MHz)	650				
Harmonic number	216720				
Longitudinal tune n_s	0.049	0.062	0.078	0.035	0.035
Beam lifetime (Bhabha/beamstrahlung) (min)	40/40	60/195	81/23	120/280	150/180
Beam lifetime requirement (min)	20	25	18	81	68
Luminosity per IP (10^{34} cm^{-2} s^{-1})	8.3	26.7	0.8	95.2	26

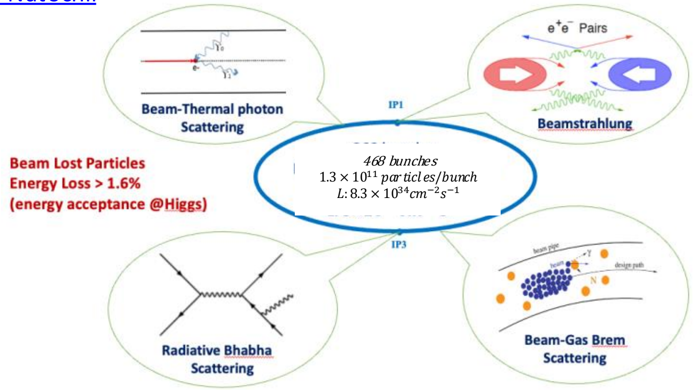


Sources and Simulation Tools

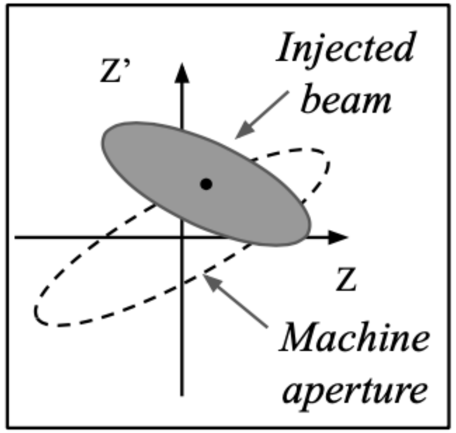
- **Single Beam**
  - Touschek Scattering
  - Beam Gas Scattering(Elastic/inelastic)
  - Beam Thermal Photon Scattering
  - Synchrotron Radiation
- **Luminosity Related**
  - Beamstrahlung
  - Radiative Bhabha Scattering
- **Injection(Will be considered future)**



A. Natochii



A. Natochii



Photon BG

Beam Loss BG

Injection BG

Background	Generation	Tracking	Detector Simu.
Synchrotron Radiation	BDSim/Geant4	BDSim/Geant4	
Beamstrahlung/Pair Production	Guinea-Pig++		
Beam-Thermal Photon	PyBTH[Ref]		
Beam-Gas Bremsstrahlung	PyBGB[Ref]	SAD	CEPCSW/FLUKA
Beam-Gas Coulomb	BGC in SAD		
Radiative Bhabha	BBBREM		
Touschek	TSC in SAD		

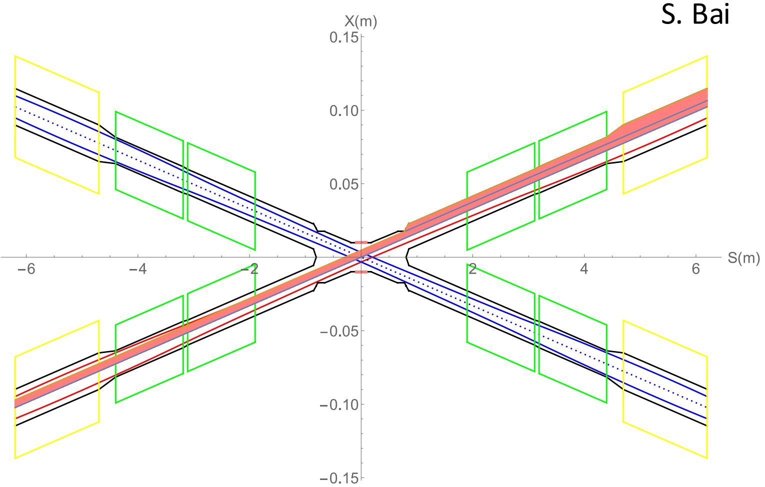
SR BG & Mitigation

IDRC

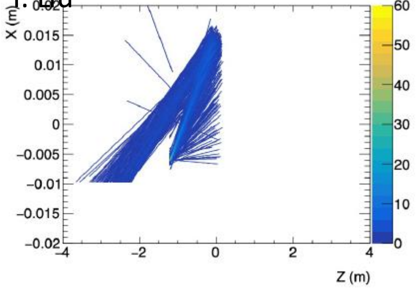
- The central beam pipe was carefully designed to avoid the direct hitting of the SR photons
- The masks are implemented to further mitigate the secondaries, the design is still on going.
  - Several ways has been attempted, including the shrinking of the incoming beam pipe and different position/material/design of the mask.
  - We are still modeling the magnetic field map in our simulation tool.
  - We are also thinking some new methods like photon absorber in QDb, more study needed.

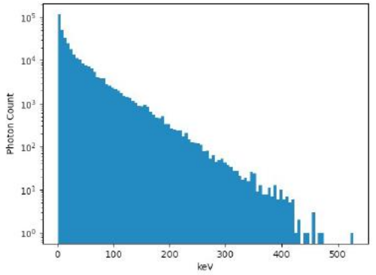
Y. Tang

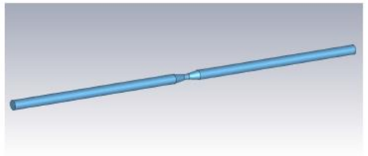
S. Bai

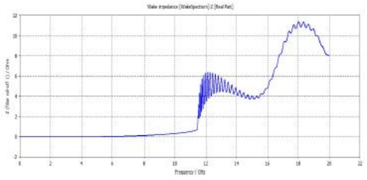


Y. Liu









Shielding Methods	SR Backgrounds Level at VXD(Last Dipole Only)
Original	5795157
-1.9m-4mm	4512
5um Au	717973
-1.9m-4mm+5um Au	3051
-1.9m-4mm+5um Au+-4.3m mask	465
-1.9m-2mm+5um Au+-4.3m mask	1022
-1.9m-5mm+5um Au+-4.3m mask	**71**

SR BG & Mitigation

- The central beam pipe was carefully designed to avoid the direct hitting of the SR photons
- The masks are implemented to further mitigate the secondaries, the design is still on going.
  - Several ways has been attempted, including the shrinking of the incoming beam pipe and different position/material/design of the mask.
  - We are still modeling the magnetic field map in our simulation tool.
  - We are also thinking some new methods like photon absorber in QDb, more study needed.

Shielding Methods	SR Backgrounds Level at VXD(Last Dipole Only)
-1.9m-5mm+5um Au+-4.3m mask	**71**

~1MHz/

Q: Refine the SR masks for the Ref-TDR configuration, incorporating simulations of tip scatterings, bounces within the beam pipe, and SR originating from the beam halo in quadrupoles

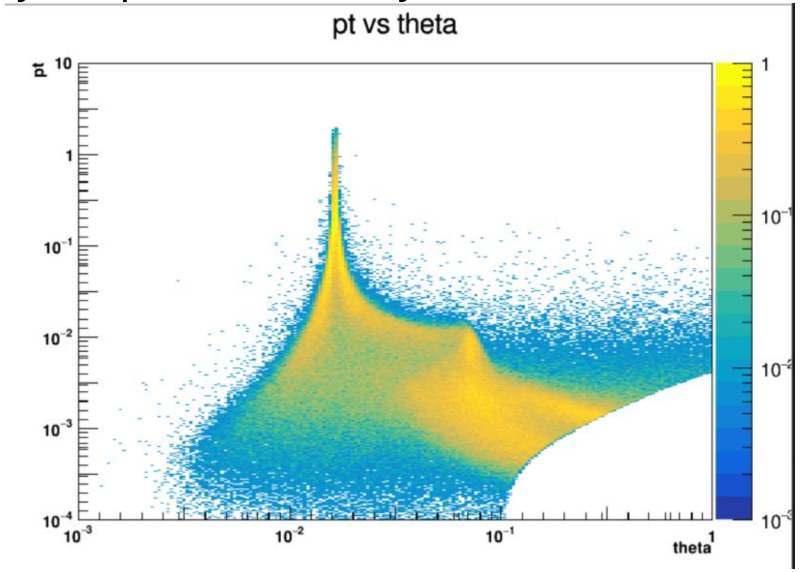
A: The SR masks has been updated to TDR-rd configuration as list here.
The SR masks has been implemented into CEPCSW geometry, therefore all the interactions including the tip scatterings and bounces within the beam pipe has been studied.
Till now, the hit rate on VTX is ~1MHz/cm^2, would by acceptable at Higgs mode. The other modes need more study.
The SR originating from the beam halo has been implemented with some assumptions(~10σ), not the real profile. We still solving the interfaces between different tools.

Pair Production(Beamstrahlung)

- Luminosity related backgrounds
- One of the dominant backgrounds at the CEPC, may lead to two different impacts:
  - The impacts on detector, caused by the electrons/positrons produced by photons
  - The impacts on accelerator components outside of the IR, caused by the photons directly.
- Hard to mitigate

Parameter	Symbol	ILC-500	CLIC-380	CEPC-Z	FCC-Z	CEPC-W	FCC-W	CEPC-Higgs	FCC-Higgs	CEPC-top	FCC-top
Energy	E[GeV]	250	190	45.5	45.5	80	80	120	120	180	182.5
Particles per bunch	N[1e10]	3.7	2	14	24.3	13.5	29.1	13	20.4	20	23.7
Bunch Number				11934	10000	1297	880	268	248	35	40
Bunch Length	sigma_z [mm]	0.3	0.07	8.7	14.5	4.9	8.01	4.1	6.0	2.9	2.75
Collision Beam Size	sigma_x,y [um/nm]	0.474/5.9	0.149/2.9	6/35	8/34	13/42	21/66	14/36	14/36	39/113	39/69
Emittance	epsilon_x,y [nm/pm]	1e4/3.5e4	0.95e3/3e4	0.27/1.4	0.71/1.42	0.87/1.7	2.17/4.34	0.64/1.3	0.64/1.29	1.4/4.7	1.49/2.98
Betafunction	beta_x,y [m/mm]	0.011/0.48	0.0082/0.1	0.13/0.9	0.1/0.8	0.21/1	0.2/1	0.3/1	0.3/1	1.04/2.7	1/1.6
Factor	[1e-4]	612.7	6304.6	2.14	1.7	3.0	2.4	4.8	5.2	5.6	7.10
n_gamma		1.9	4.34	1.0	1.36	0.45	0.59	0.4	0.64	0.22	0.26
Relative loss per particle	%/BX	19.3		0.0041	0.0092	0.0067	0.0072	0.0096	0.0161	0.0062	0.0093

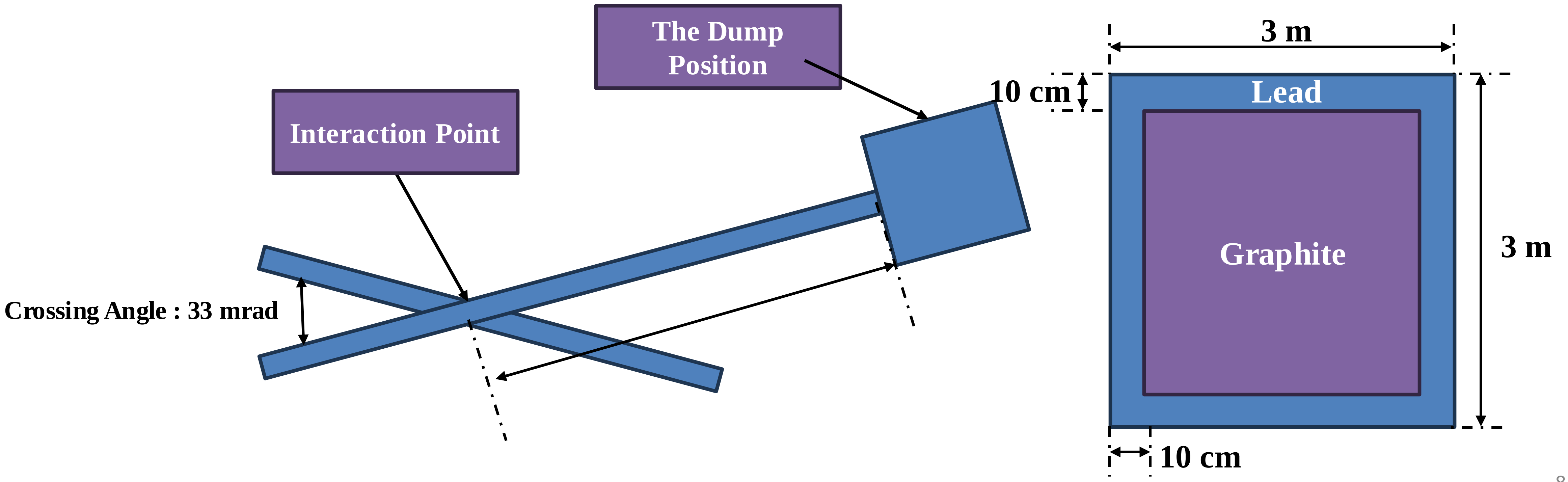
Y. Tang



Mode	Higgs	Z(10MW)
Pairs/BX	~2200	~850

Special Topic: Photon Dump

- We have completed the preliminary study on the photon dump and have already developed a reference design for it.
  - The extraction line and the modification of the bending magnets have not yet been incorporated into the design. The whole system design is on going.
  - The ambient equivalent dose constraint has been met, with a value of less than 5.5 mSv/h.



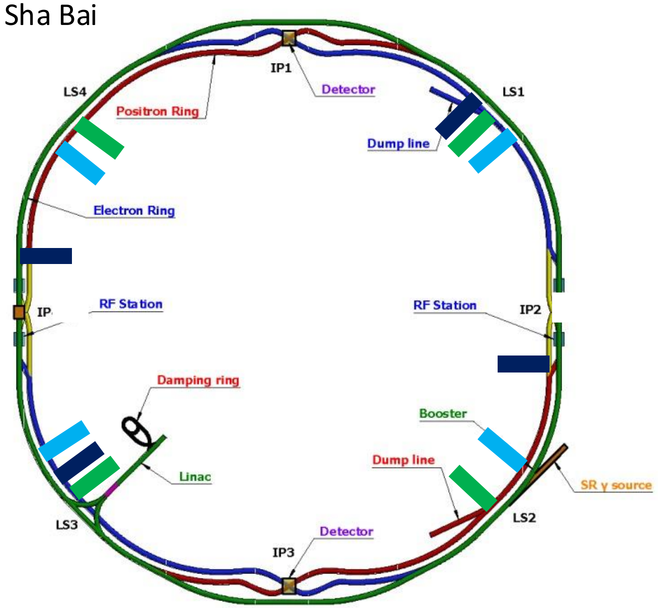
Mitigation of the BIBs

- The sources of the BIBs has two groups:
  - From IP, luminosity related(pair-production, radiative Bhabha)
  - From anywhere around the ring, less in IP(single beam losses and SR)
- Previously, we have several methods of shielding(or mitigation)
  - Using collimators to block single beam loss outside of the IR
  - Using mask to block SR outside of the Be beam pipe
  - Using heavy metal(like W) somewhere in the IR(like outside the cryomodule)
  - Using paraffine at both ends of the yoke(together with concrete wall maybe) to block the upstream single loss entering the IR

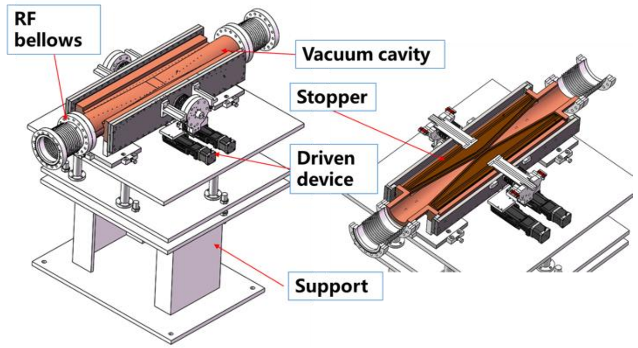
Collimators

- Collimators were implemented to reduce IR loss caused by single beam.
  - 19 sets of collimators were implemented for MDI purpose with updated position
  - 12 sets of collimators were installed for passive machine protection and will also contribute to mitigating beam background.
  - With the implementation of collimators, multi-turn beamstrahlung and radiative Bhabha loss particles have been effectively shielded outside the interaction region.
  - Design Requirements:
    - Beam stay clear region: 18 σ_x+3mm, 22 σ_y+3mm
    - Impedance requirement: slope angle of collimator < 0.1

Xiaohao Cui, Yuting Wang, Sha Bai



Peng Zhang, Haijing Wang



for H betatron collimator

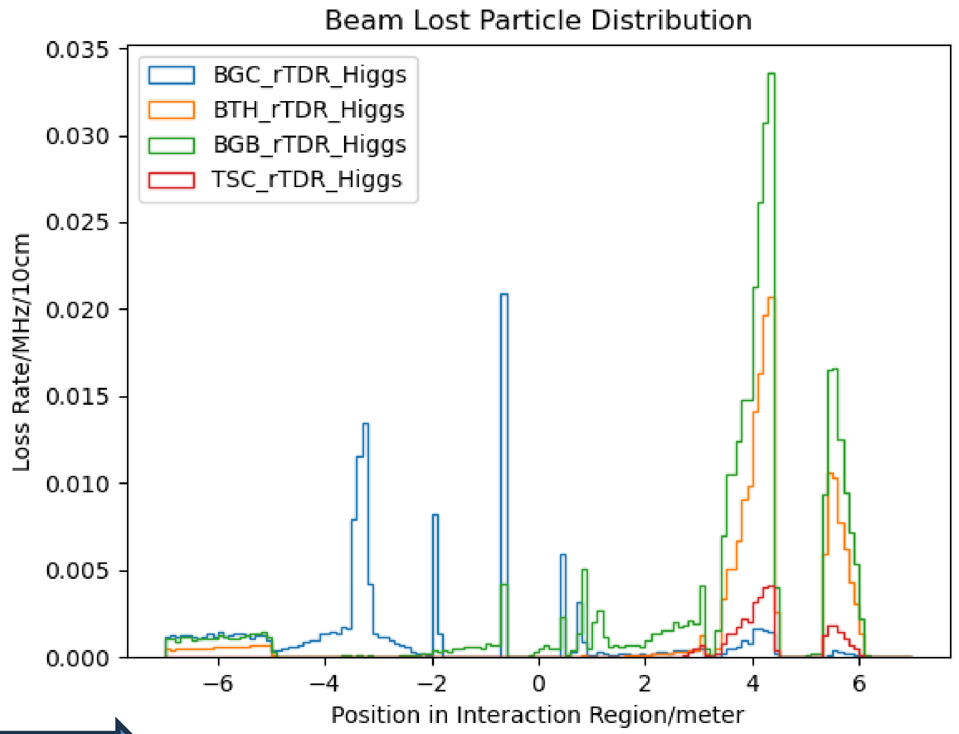
for momentum collimator

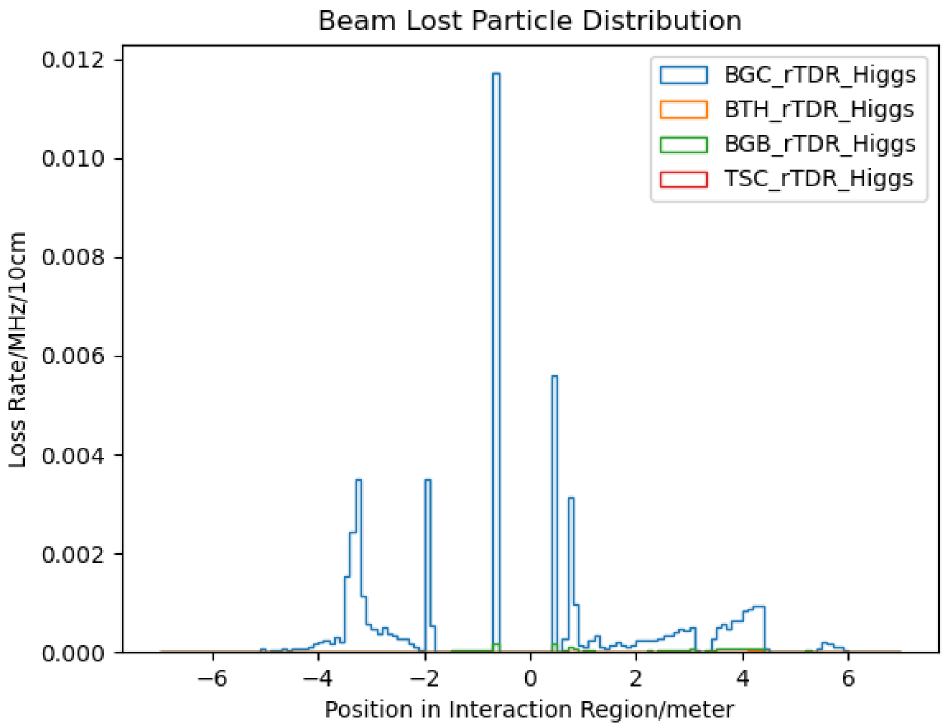
for vertical collimator

Loss Map at the IR @ Higgs

- Single Beam only
- Errors implemented
  - High order error for magnets
  - Beam-beam effect

$$Loss\ Rate = \frac{Loss\ Number}{Loss\ Time} = \frac{Bunch\ number * Particles\ per\ Bunch * (1 - e^{-1})}{Beam\ Lifetime}$$





Beam Way

Loss Map at the IR @ Higgs

- Single Beam only
- Errors implemented
  - High order error for magnets
  - Beam-beam effect

$$Loss\ Rate = \frac{Loss\ Number}{Loss\ Time} = \frac{Bunch\ number * Particles\ per\ Bunch * (1 - e^{-1})}{Beam\ Lifetime}$$

	50MW Higgs, 346ns/BX
Pair Production	~1.82GHz in IR
Beam Thermal Photon	~0.30MHz/beam in IR
Beam Gas Bremsstrahlung	~0.04MHz/beam in IR
Beam Gas Coulomb	~0.23MHz/beam in IR
Touschek Scattering	~0.06MHz/beam in IR
SR	~630 PHz/beam generated at last bending magnet

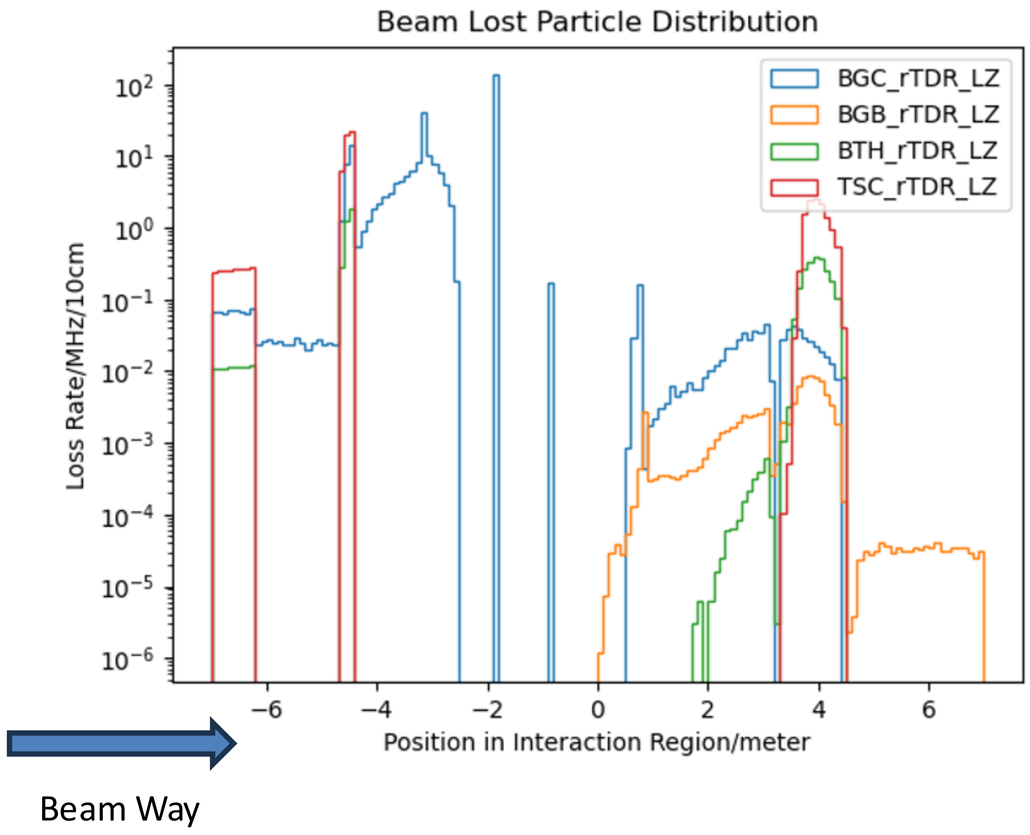
→

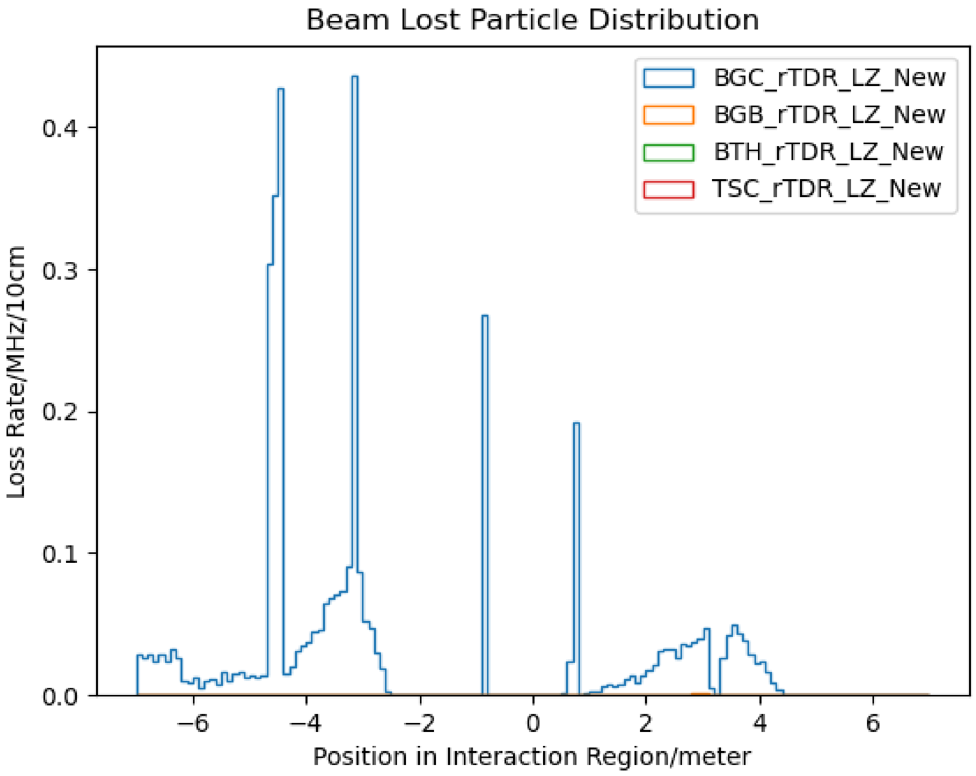
	50MW Higgs, 277ns/BX
Pair Production	~1.82 GHz in IR
Beam Thermal Photon	~0.3 kHz/beam in IR
Beam Gas Bremsstrahlung	~4.1 kHz/beam in IR
Beam Gas Coulomb	~87.8 kHz/beam in IR
Touschek Scattering	~0.3 kHz/beam in IR
SR	~630 PHz/beam generated at last bending magnet

Loss Map at the IR @ Low-Lumi Z

- Single Beam only
- Errors implemented
  - High order error for magnets
  - Beam-beam effect

$$Loss\ Rate = \frac{Loss\ Number}{Loss\ Time} = \frac{Bunch\ number * Particles\ per\ Bunch * (1 - e^{-1})}{Beam\ Lifetime}$$





Loss Map at the IR @ Low-Lumi Z

- Single Beam only
- Errors implemented
  - High order error for magnets
  - Beam-beam effect
- Assume that the beam lifetime is same as High-Lumi Z

$$Loss\ Rate = \frac{Loss\ Number}{Loss\ Time} = \frac{Bunch\ number * Particles\ per\ Bunch * (1 - e^{-1})}{Beam\ Lifetime}$$

	10MW Z, 69ns/BX
Pair Production	~3.2GHz in IR
Beam Thermal Photon	~3.4MHz/beam in IR
Beam Gas Bremsstrahlung	~2.5MHz/beam in IR
Beam Gas Coulomb	~272MHz/beam in IR
Touschek Scattering	~62MHz/beam in IR

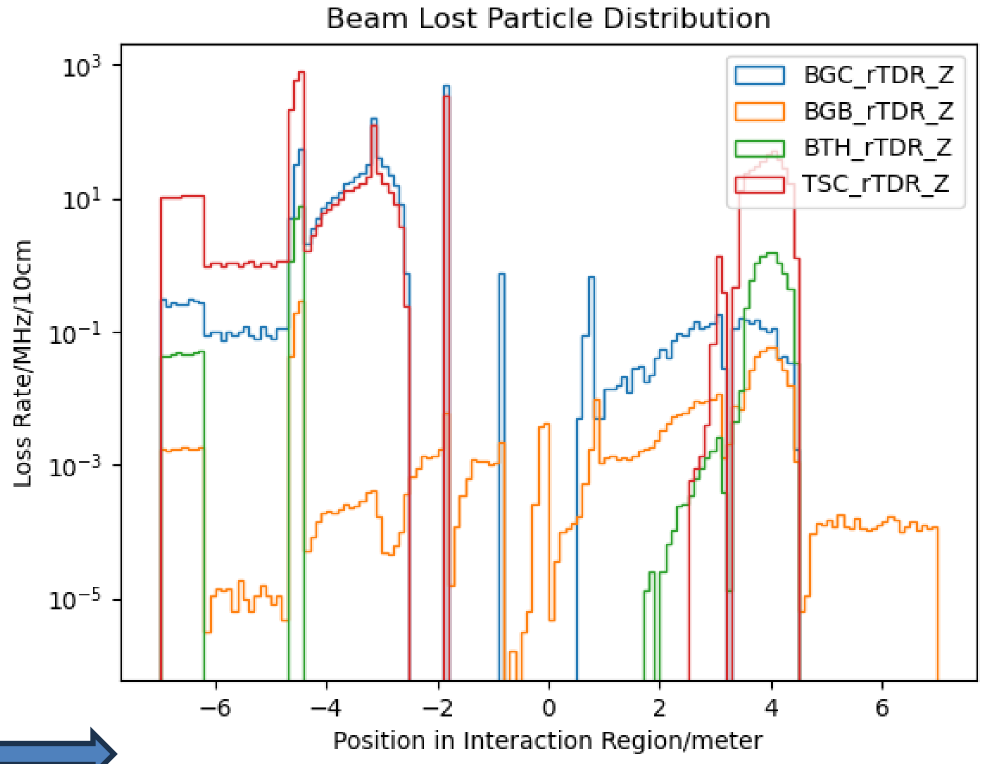
→

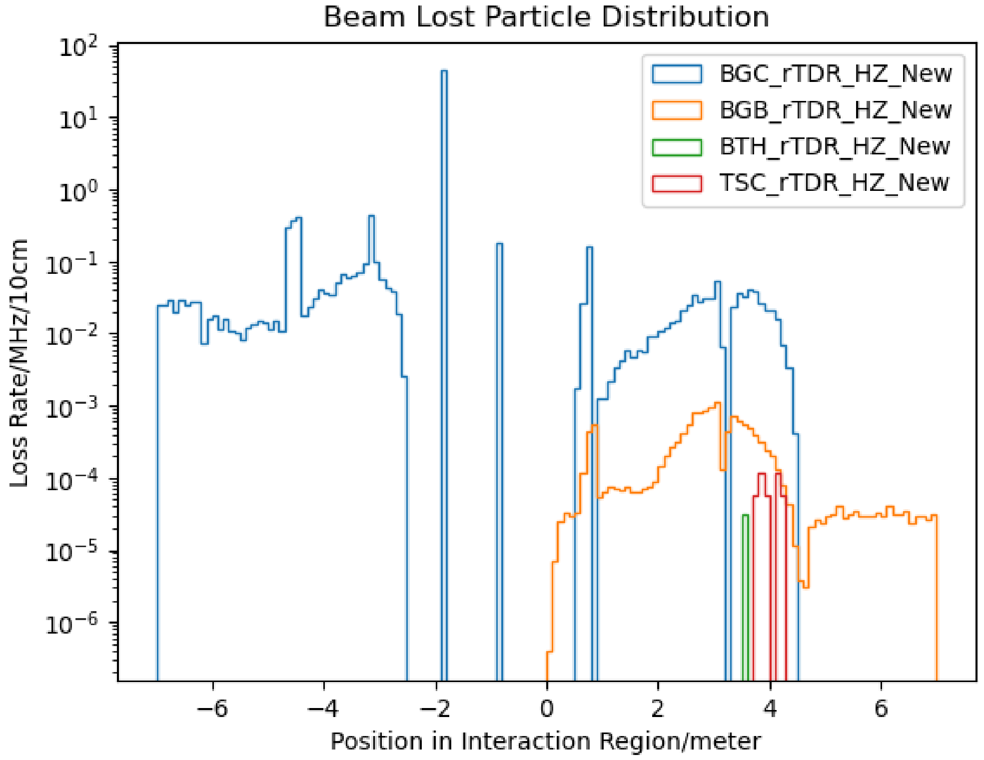
	10MW Z, 69ns/BX
Pair Production	~3.2GHz in IR
Beam Thermal Photon	~24.83 Hz/beam in IR
Beam Gas Bremsstrahlung	~17.9 kHz/beam in IR
Beam Gas Coulomb	~20.8 MHz/beam in IR
Touschek Scattering	~1.3 kHz/beam in IR

Loss Map at the IR @ High-Lumi Z

- Single Beam only
- Errors implemented
  - High order error for magnets
  - Beam-beam effects

$$Loss\ Rate = \frac{Loss\ Number}{Loss\ Time} = \frac{Bunch\ number * Particles\ per\ Bunch * (1 - e^{-1})}{Beam\ Lifetime}$$





Beam Way

Loss Map at the IR @ High-Lumi Z

- Single Beam only
- Errors implemented
  - High order error for magnets
  - Beam-beam effect
- Assume that the beam lifetime is same as High-Lumi Z

$$Loss\ Rate = \frac{Loss\ Number}{Loss\ Time} = \frac{Bunch\ number * Particles\ per\ Bunch * (1 - e^{-1})}{Beam\ Lifetime}$$

	50MW Higgs, 23ns/BX
Pair Production	~25.5GHz in IR
Beam Thermal Photon	~0.26GHz/beam in IR
Beam Gas Bremsstrahlung	~0.01GHz/beam in IR
Beam Gas Coulomb	~2.36GHz/beam in IR
Touschek Scattering	~6.24GHz/beam in IR

→

	50MW Z, 23ns/BX
Pair Production	~25.5GHz in IR
Beam Thermal Photon	~0.1 kHz/beam in IR
Beam Gas Bremsstrahlung	~0.007 GHz/beam in IR
Beam Gas Coulomb	~0.2 GHz/beam in IR
Touschek Scattering	~1.6 kHz/beam in IR

Higgs – No Shield

- We have obtained a preliminary estimate of the beam-induced background levels in Higgs mode
  - Assume an operational time of 7000hr/yr

BIB Rates Considered @ Higgs

Vacuum Level: 10^{-7} Pa, H_2

	50MW Higgs, 346 ns/BX
Pair Production	~1.82 GHz in IR
Beam Thermal Photon	~0.3 kHz/beam in IR
Beam Gas Bremsstrahlung	~4.1 kHz/beam in IR
Beam Gas Coulomb	~87.8 kHz/beam in IR
Touschek Scattering	~0.3 kHz/beam in IR

Sub-Detectors	Ave. Hit Rate(MHz/cm2)	Max. Hit Rate(MHz/cm^2)	Max. Occupancy(%)
Vertex	1.063	1.195	0.003
ITK-B/E	0.000729/0.00350	0.00192/0.02471	6.34e-5
TPC	0.0052	0.018	0.11
OTK – B/E	0.00123/0.0016	0.00179/0.00692	
Ecal-B/E	0.019/0.079	0.893/2.876	0.79/3.19
Hcal-B/E	0.00018/0.0066	0.006/0.326	0.00049/0.017
Muon – Endcap	0.00000169	0.000374	0.26
LumiCal – Si/LYSO	12.33/1.10	253.95/3.43	-/11.69

Low Lumi Z – No Shield

- We have obtained a preliminary estimate of the beam-induced background levels in Low-Lumi-Z mode
  - Assume an operational time of 7000hr/yr

BIB Rates Considered @ Low-Z

Vacuum Level: 10^{-7} Pa, H_2

	10MW Z, 69ns/BX
Pair Production	~3.2GHz in IR
Beam Thermal Photon	~24.83 Hz/beam in IR
Beam Gas Bremsstrahlung	~17.9 kHz/beam in IR
Beam Gas Coulomb	~20.8 MHz/beam in IR
Touschek Scattering	~1.3 kHz/beam in IR

Sub-Detectors	Ave. Hit Rate(MHz/cm2)	Max. Hit Rate(MHz/cm^2)	Max. Occupancy(%)
Vertex	4.408	8.551	0.002
ITK-B/E	0.00156/0.009	0.00479/0.06871	4.75e-5
TPC	0.0060	0.021	0.13
OTK – B/E	0.00234/0.00189	0.00344/0.01087	
Ecal-B/E	0.019/0.091	0.464/6.915	0.18/1.00
Hcal-B/E	0.00065/0.0064	0.0012/0.225	0.00015/0.003
Muon – Endcap	0.00000222	0.00001025	0.08
LumiCal – Si/LYSO	46.52/10.43	2862.17/36.66	-/6.48

High Lumi Z – No Shield

- We have obtained a preliminary estimate of the beam-induced background levels in High-Lumi-Z mode
  - Assume an operational time of 7000hr/yr

BIB Rates Considered @ High-Z

Vacuum Level: 10^{-7} Pa, H_2

	50MW Z, 23ns/BX
Pair Production	~25.5GHz in IR
Beam Thermal Photon	~0.1 kHz/beam in IR
Beam Gas Bremsstrahlung	~0.007 GHz/beam in IR
Beam Gas Coulomb	~0.2 GHz/beam in IR
Touschek Scattering	~1.6 kHz/beam in IR

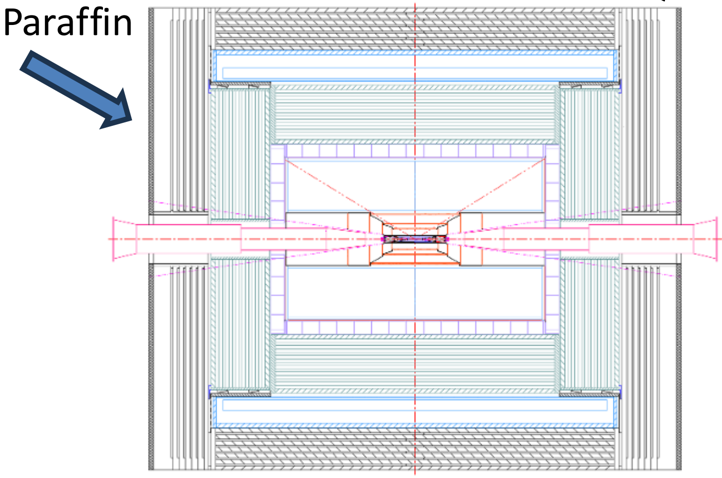
Sub-Detectors	Ave. Hit Rate(MHz/cm2)	Max. Hit Rate(MHz/cm^2)	Max. Occupancy(%)
Vertex	13.597	26.463	0.002
ITK-B/E	0.00508/0.02728	0.01622/0.21027	1.93e-4
TPC			
OTK – B/E	0.00725/0.00897	0.01041/0.03569	
Ecal-B/E	0.051/0.245	1.147/21.913	0.79/3.19
Hcal-B/E	0.002/0.02	0.035/0.616	0.00012/0.0036
Muon – Endcap	0.000007	0.00003587	0.09
LumiCal – Si/LYSO	129.35/28.52	7824.42/100.45	-/10.97

Mitigation of the Backgrounds

- Shielding has been implemented at both ends of the yoke using the 10 cm of paraffin, and also 10mm W outside of the LumiCal-LYSO. The shell of cryo-module also used as shielding.

Q. Ji

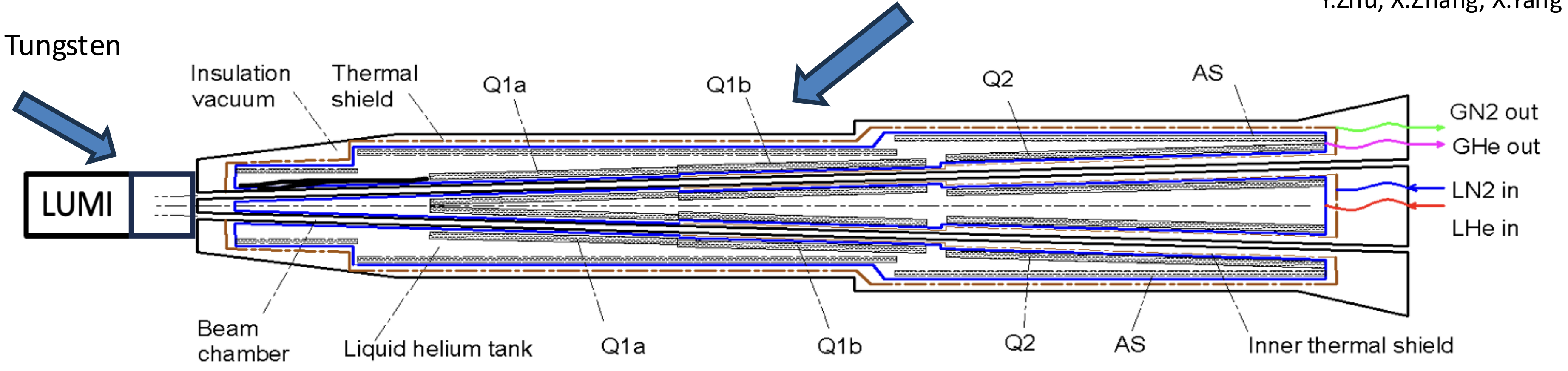
10cm Paraffin



15mm Stainless Steel Shell and Shielding

Y.Zhu, X.Zhang, X.Yang

10mm Tungsten



Estimation of Impacts in the MDI

- We have obtained a preliminary estimate of the beam-induced background levels in Higgs mode
  - Assume an operational time of 7000hr/yr(may change to 7500hr/yr according to Acc TDR)
  - No Safety Factor
  - ~50% mitigated by the shielding.

BIB Rates Considered @ Higgs

Vacuum Level: 10^{-7} Pa, H_2

	50MW Higgs, 346 ns/BX
Pair Production	~1.82 GHz in IR
Beam Thermal Photon	~0.3 kHz/beam in IR
Beam Gas Bremsstrahlung	~4.1 kHz/beam in IR
Beam Gas Coulomb	~87.8 kHz/beam in IR
Touschek Scattering	~0.3 kHz/beam in IR

Acceptable

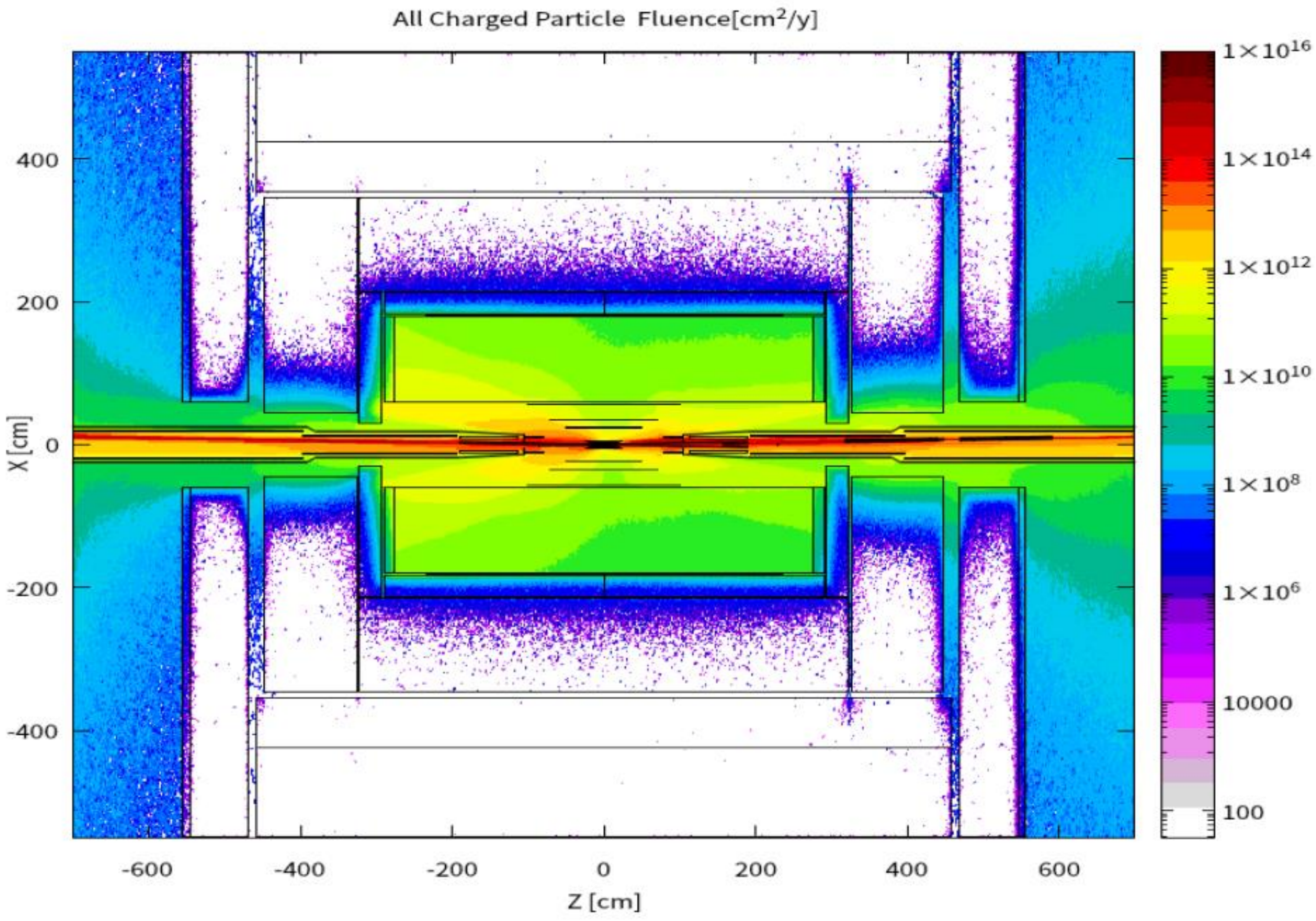
Sub-Detectors	Ave. Hit Rate(MHz/cm2)	Max. Hit Rate(MHz/cm^2)	Max. Occupancy(%)	Ave. TID(Gy/yr)—Oct24
Vertex	1.117	1.255	0.003	~21000
ITK	0.00063/0.00277	0.001/0.01306	3.78e-5	128
TPC	0.0034	0.011	0.066	23.4(Supporting)
OTK – B/E	0.00068/0.00093	0.00105/0.00692		
Ecal-B/E	0.011/0.045	0.424/2.87	0.57/2.4	0.322
Hcal-B/E	0.0002/0.0053	0.0058/0.221	0.00046/0.013	0.044
Muon – Endcap	0.00000140	0.00000285	0.20	0.21
LumiCal – Si/LYSO	12.33/1.10	253.95/3.43	-/11.69	

To Be Updated

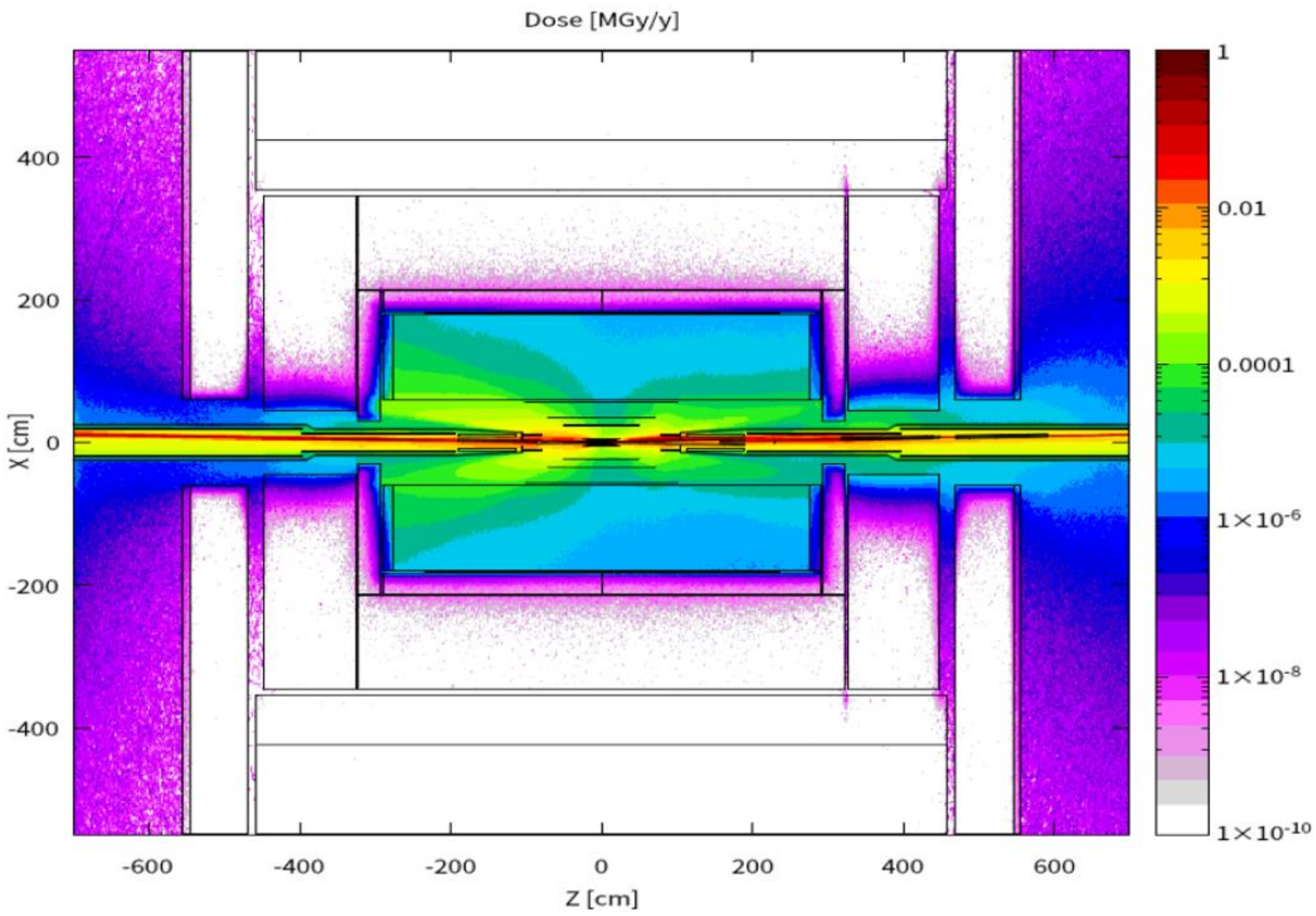
Radiation Map @ Higgs – Charge Particle Fluence(Pairs only)

Number of Pair vs Single is ~ 34000:1

Deposited Energy from Pair vs Single is ~ 280:1

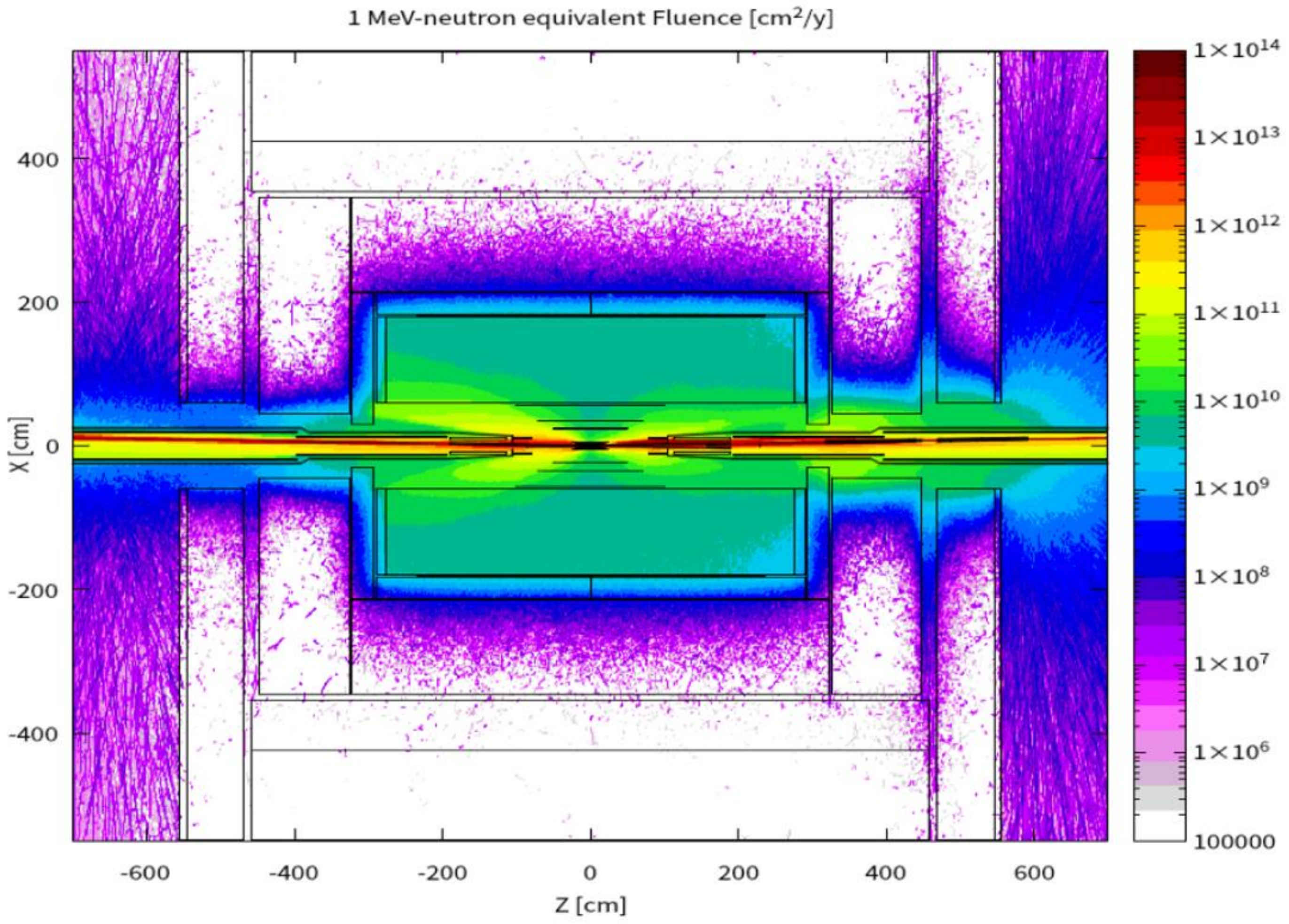


Radiation Map @ Higgs – TID (Pairs only)



<1MGy/yr

Radiation Map @ Higgs – 1 MeV Si-eq Fluence (Pairs only)



~10^{12}/yr at VTX

~10^{14}/yr at Lumi

Estimation of Impacts in the MDI

- We have obtained a preliminary estimate of the beam-induced background levels in Low-Z mode
  - Assume an operational time of 7000hr/yr
  - ~50% mitigated by the shielding.

BIB Rates Considered @ Low-Z

Vacuum Level: 10^{-7} Pa, H_2

	10MW Z, 69ns/BX
Pair Production	~3.2GHz in IR
Beam Thermal Photon	~24.83 Hz/beam in IR
Beam Gas Bremsstrahlung	~17.9 kHz/beam in IR
Beam Gas Coulomb	~20.8 MHz/beam in IR
Touschek Scattering	~1.3 kHz/beam in IR

Sub-Detectors	Ave. Hit Rate(MHz/cm2)	Max. Hit Rate(MHz/cm^2)	Max. Occupancy(%)	Ave. TID(Gy/yr)
Vertex	4.408	8.551	0.0024	
ITK	0.00102/0.00398	0.00279/0.01973	7.58e-6	
TPC	0.0037	0.013	0.078	
OTK – B/E	0.00121/0.00156	0.00189/0.00664		
Ecal-B/E	0.015/0.065	0.335/6.699	0.29/0.78	
Hcal-B/E	0.0007/0.0082	0.012/0.249	0.00018/0.00458	
Muon – Endcap	0.00000178	0.00001025	0.08	
LumiCal – Si/LYSO	46.52/10.43	2862.17/36.66	-/6.48	

To Be Updated

Estimation of Impacts in the MDI

- We have obtained a preliminary estimate of the beam-induced background levels in High-Z mode
  - Assume an operational time of 7000hr/yr

BIB Rates Considered @ High-Z

Vacuum Level: 10^{-7} Pa, H_2

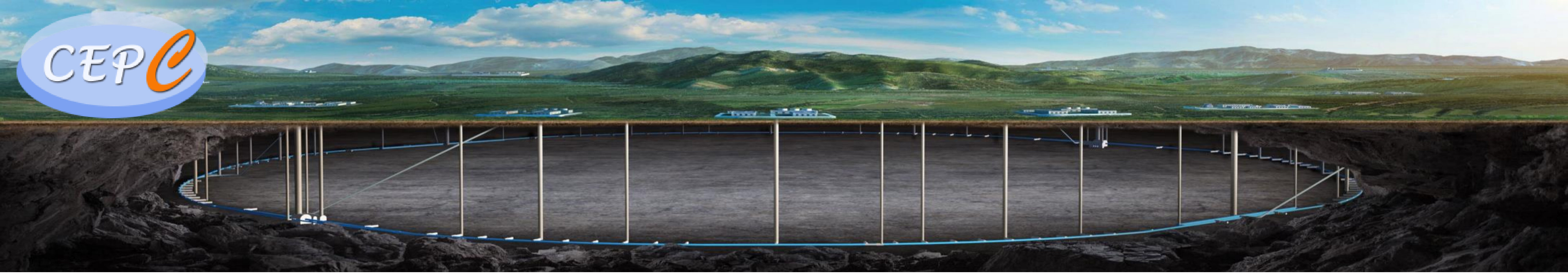
	50MW Z, 23ns/BX
Pair Production	~25.5GHz in IR
Beam Thermal Photon	~0.1 kHz/beam in IR
Beam Gas Bremsstrahlung	~0.007 GHz/beam in IR
Beam Gas Coulomb	~0.2 GHz/beam in IR
Touschek Scattering	~1.6 kHz/beam in IR

Sub-Detectors	Ave. Hit Rate(MHz/cm2)	Max. Hit Rate(MHz/cm^2)	Max. Occupancy(%)	Ave. TID(Gy/yr)
Vertex	13.597	26.463	0.0025	
ITK	0.00379/0.01430	0.0147/0.0723	6.91e-6	
TPC				
OTK – B/E	0.00375/0.00487	0.006/0.042		
Ecal-B/E	0.077/0.334	2.104/34.528	0.29/1.1	
Hcal-B/E	0.0022/0.053	0.044/2.148	0.00018/0.0085	
Muon – Endcap	0.00000591	0.00003075	0.09	
LumiCal – Si/LYSO	129.35/28.52	7824.42/100.45	-/10.97	

To Be Updated

Summary & Outlook

- The estimation of beam induced background level at Higgs and Low/High-lumi-Z is almost finished, together with the mitigation methods
  - The updated collimators look promising. All single beam backgrounds have been mitigated at least one order of magnitude.
  - The dose estimation using FLUKA is on going, we have pair from Higgs and are doing other cases. We formed a dedicated working group working on this(1 staff from IMMU+ 1 student from NKU).
  - We have the simulation results based on CEPCSW-TDR25.1.1.
- For future work of BG Study:
  - We plan to have simulation results at Higgs/Low-Lumi-Z and High-Lumi-Z using CEPCSW-TDR 25.3.6(ongoing, for noise hit), and FLUKA(ongoing, for radiation map) before April Review.
  - In future simulation study, there will be several things could be optimized, including the optimization of collimators, the study on Beamstrahlung Cut, the real vacuum profile, the extension of MDI region in simulation, the full map of other operation modes, and the new methods to mitigate SR.
  - We are also planning the BG experiment on BEPCII-U.
  - The design of monitoring system is also need to be considered. IARC



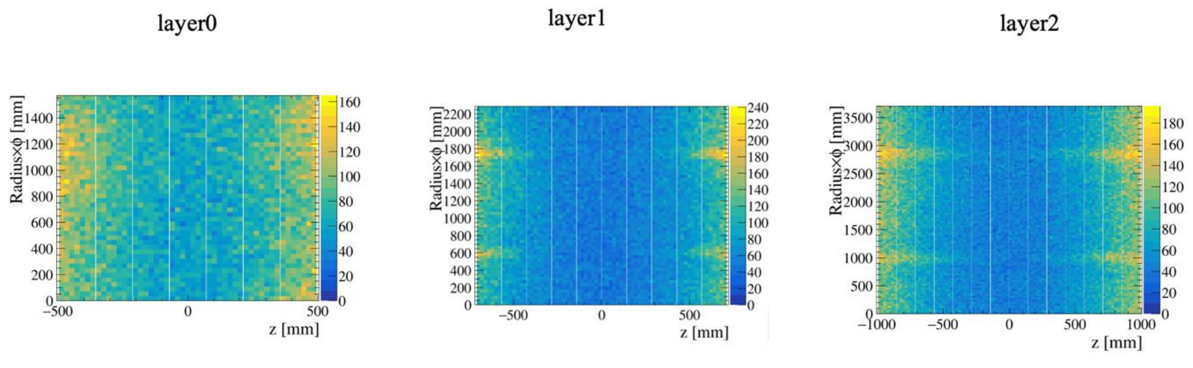
Thank you for your attention!

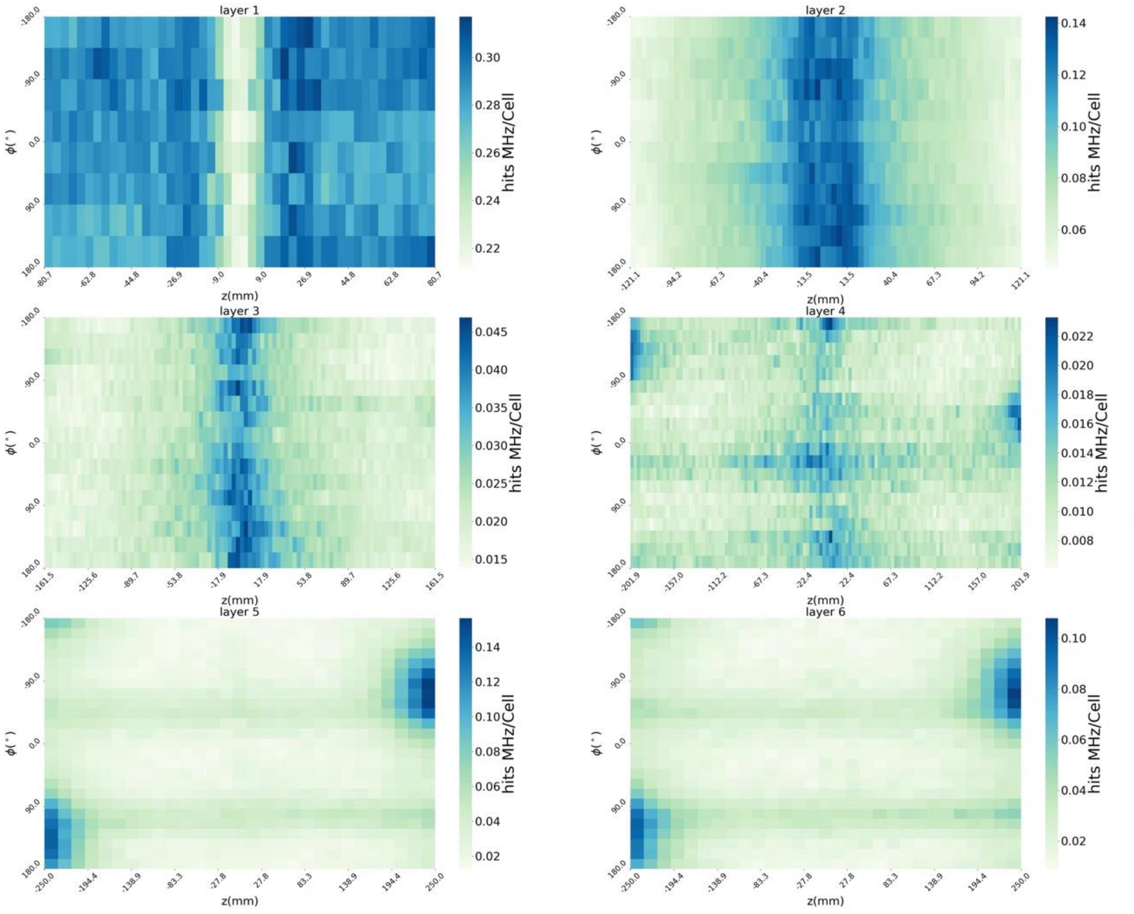
中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

Backup

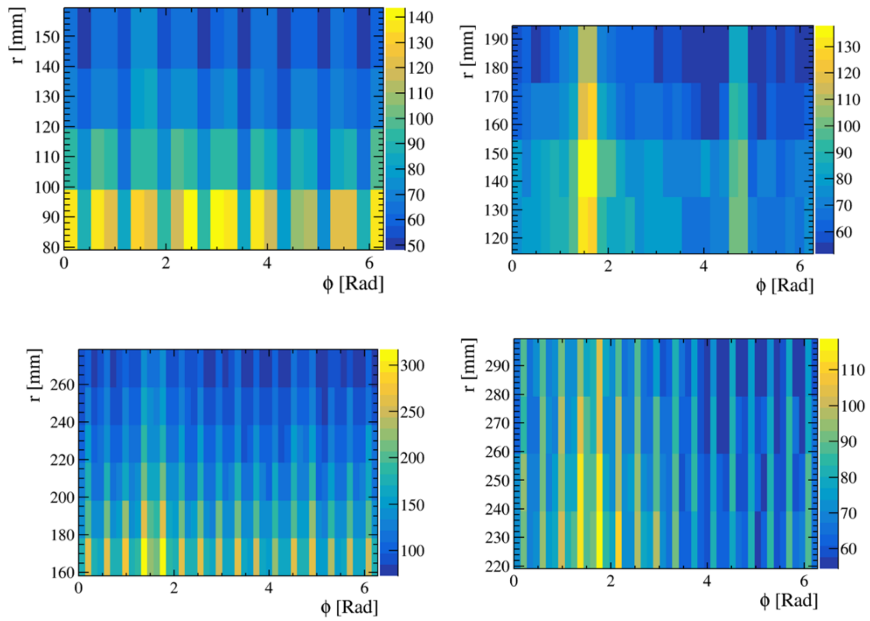
Higgs – No Shield

ITKB Hit Distribution





VERTEX Hit Distribution



ITKE Hit Distribution

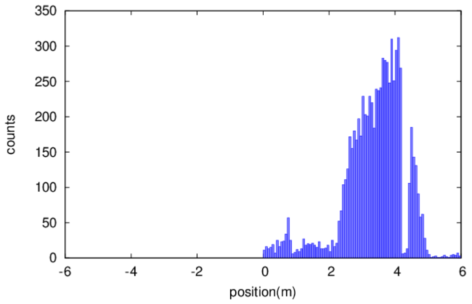
Injection Backgrounds @ Higgs

- A preliminary study on the injection backgrounds has been performed:

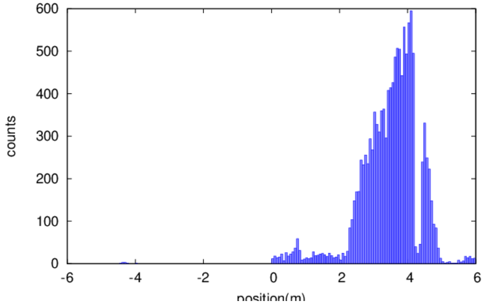
S. Bai

  – RBB is taken into account in all cases
  – A simplified model of top-up injection beam
  – Tails from imperfectly corrected X-Y coupling after the injection point
  – Some tolerances to imperfect beams from the booster (e.g. too large emittances)
  – non-Gaussian distributions existing/building up in the booster and being injected into the main

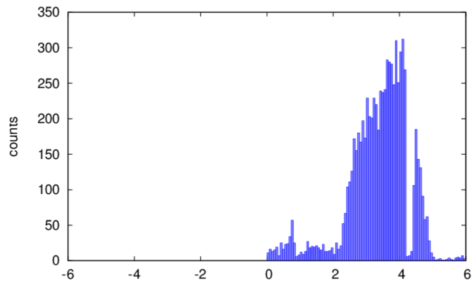
Circular beam



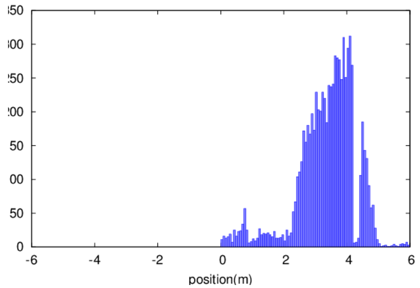
Injection beam



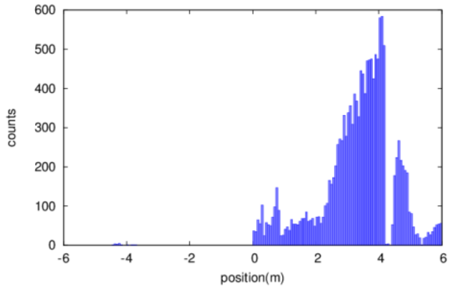
Gaussian beam with 3sigma



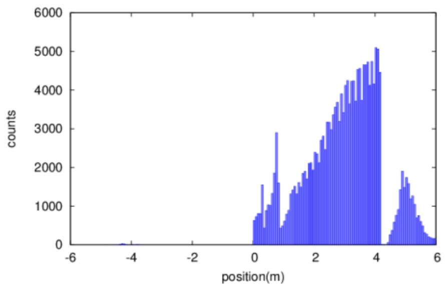
Gaussian beam with 40sigma



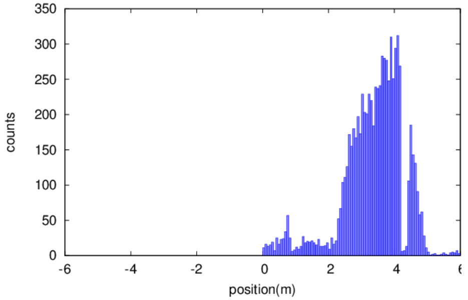
Large emittance ~10times



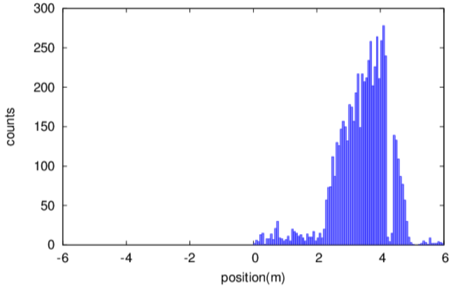
Large emittance ~1000times



Double gaussian beam



Uniform beam



Recommendations from IDRC

1. Optimize the collimators using simulations that account for secondary particle interactions.

Answer: The collimators has been updated with the secondaries considered.

2. Refine the SR masks for the Ref-TDR configuration, incorporating simulations of tip scatterings, bounces within the beam pipe, and SR originating from the beam halo in quadrupoles.

Answer: The SR masks has been updated and included in simulation.

3. Explore the feasibility of placing heavy metal masks near the interaction point (IP) to absorb particle showers effectively.

Answer: The heavy metal shielding has been added outside of the cryo-module. The BG level has been mitigated with such shielding.

Recommendations from IARC

1. The significant amount of beamstrahlung emitted at the IP during collisions was not discussed and must be considered in detail to ensure safe extraction from the vacuum pipe into a dedicated beam dump, for suitable heat extraction and radiation containment;

⇨ Sure, we've considered it and the design of the dump is ongoing.

1. The radiation tolerance of detector components should be thoroughly investigated to ensure that the current estimated beam-loss rates in the IR are acceptable;

⇨ Sure, the estimation of beam induced backgrounds level at IR is updating together of the detector. Currently, the level at Higgs mode is acceptable.

1. Beam-loss sensors within the detector, capable of issuing beam-dump request signals in case of excessive radiation, are essential to protect several key detector components. Signals from these sensors should be used with different thresholds for injection and non-injection periods;

⇨ The monitor system would be designed when the detector was fixed.

1. Check whether the reserved cabling space is sufficient for Vertex Detector (VXD) readout and power-supply cables, as well as cooling pipes, etc. Study the procedure for installation and mounting of detector components near the beam pipe and the insertion of the final-doublet cryostat taking into account the presence of the cabling;

⇨ Sure, this work needs joint effort and would be designed together with detector.

1. Arrange a focused review on MDI in the coming year, inviting members from both detector and accelerator groups with sufficient expertise and experience to cover all the relevant aspects, which would be very beneficial.

⇨ Thank you, it’s in arrangement.