

Simulation of Beam background at Crystal ECAL endcap

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Introduction

- CEPC Experiment: future lepton collider as W/Z/Higgs/top factory
 - plan to have 2.6 Million Higgs, 130 Million W, 2.5 Tera Z and 0.4 Million top (@ 30 MW).

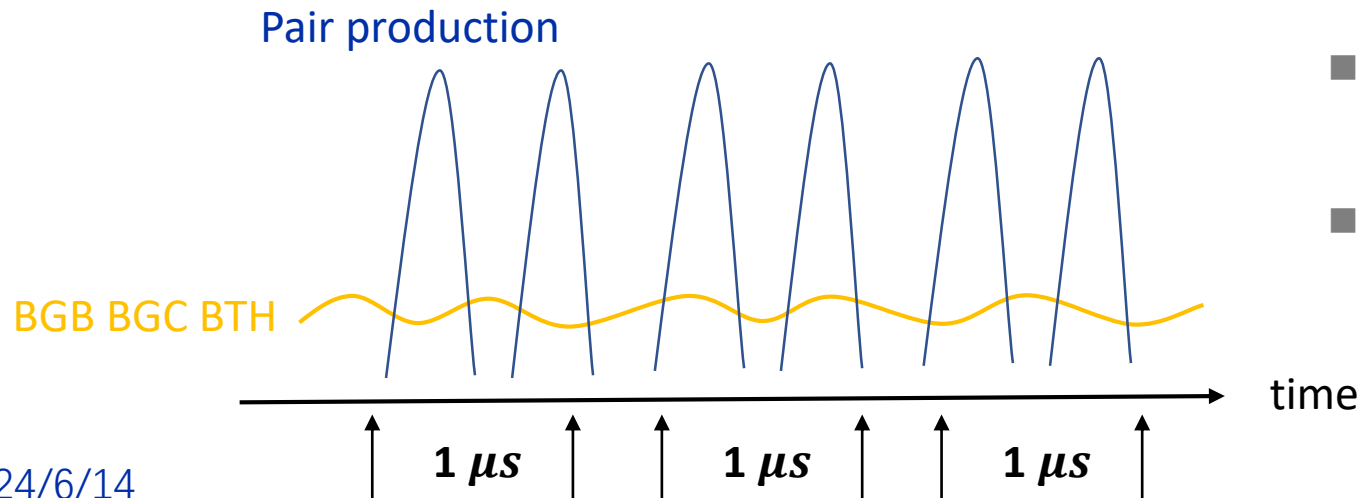
	Energy /GeV	Luminosity / $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$	Bunch spacing / ns	Physics process rate / Hz
Higgs	240	5.0	591	< 100
Z	91	115	23	< 50k

*from <CEPC baseline parameters in TDR>

Physics Process @ Higgs mode	σ (pb) @ $\sqrt{s} = 240 \text{ GeV}$	Rate (Hz)	Physics Process @ Z mode	σ (nb) @ $\sqrt{s} = 91.2 \text{ GeV}$	Rate (Hz)
ffH signal	0.203	0.10			
Bhabha	930	46.5			
$e^+e^- \rightarrow q\bar{q}$	54.1	2.7	$e^+e^- \rightarrow q\bar{q}$	30.20	34.7k
$e^+e^- \rightarrow W^+W^-$	16.7	0.84	$e^+e^- \rightarrow \mu^+\mu^-$	1.51	1.73k
$e^+e^- \rightarrow \mu^+\mu^-/\tau^+\tau^-$	5.3	0.26			
Total signal		~50	Total signal		<50k
Beam bunch		1.57×10^6	Beam bunch		40×10^6

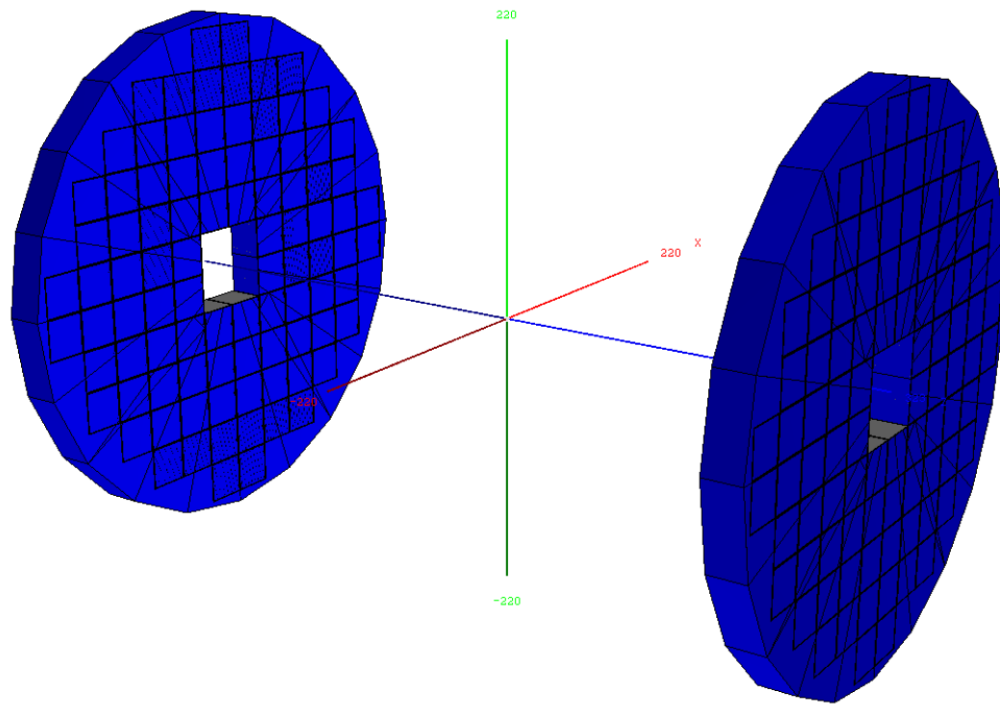
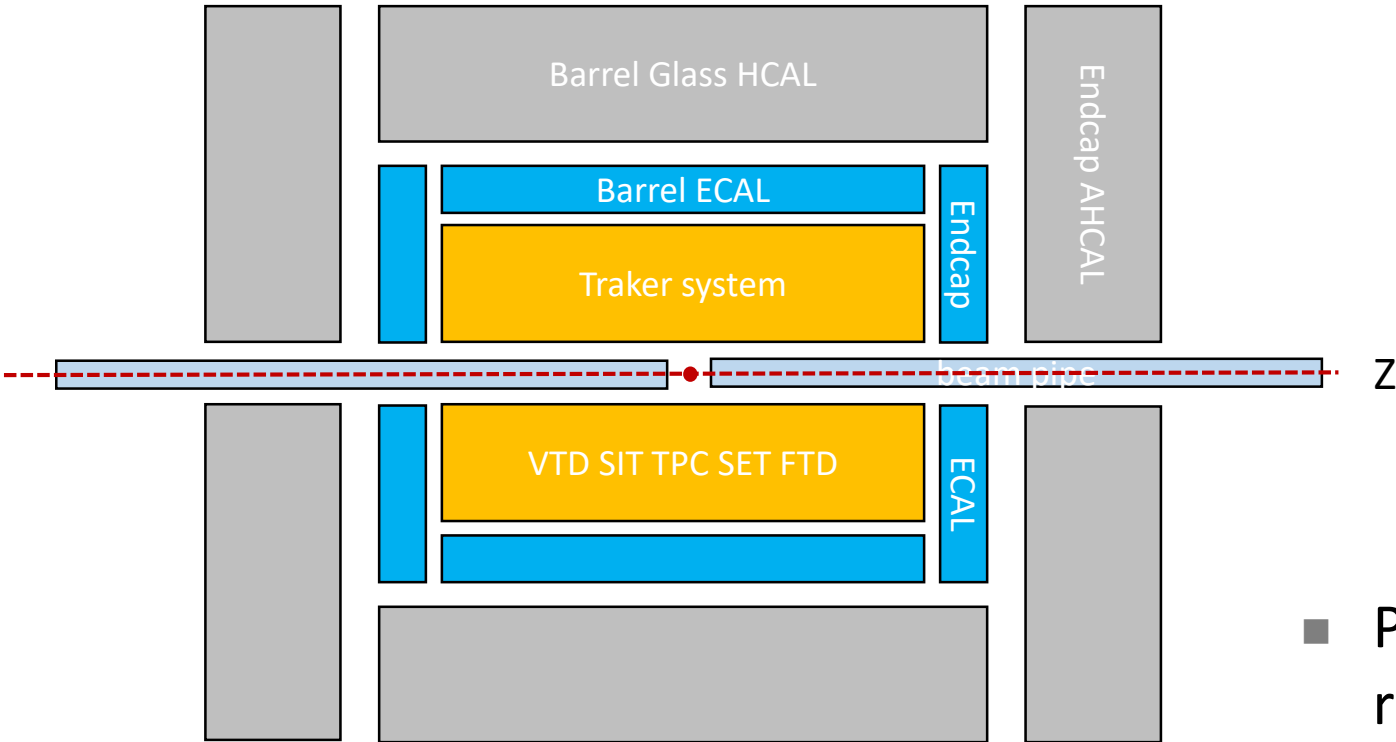
Beam background

Background	Rate/Hz	$N_{\text{MCParticle}} / \text{bunch}$ $\propto 1 \mu\text{s time window}$	Status
Pair production	-	$\sim 150 \cdot 2$	Ready
Beam-Gas Bremsstrahlung (BGB)	49,181,897.5	~ 49	Ready
Beam-Gas Coulomb (BGC)	636,290,798.6	~ 636	Ready
Beam Thermal Photon Scattering (BTH)	200,960,378.6	~ 200	Wait for sample



- Maybe $1 \mu\text{s}$ time window can be smaller?
- too many MCparticle from BKG in $1 \mu\text{s}$ time window

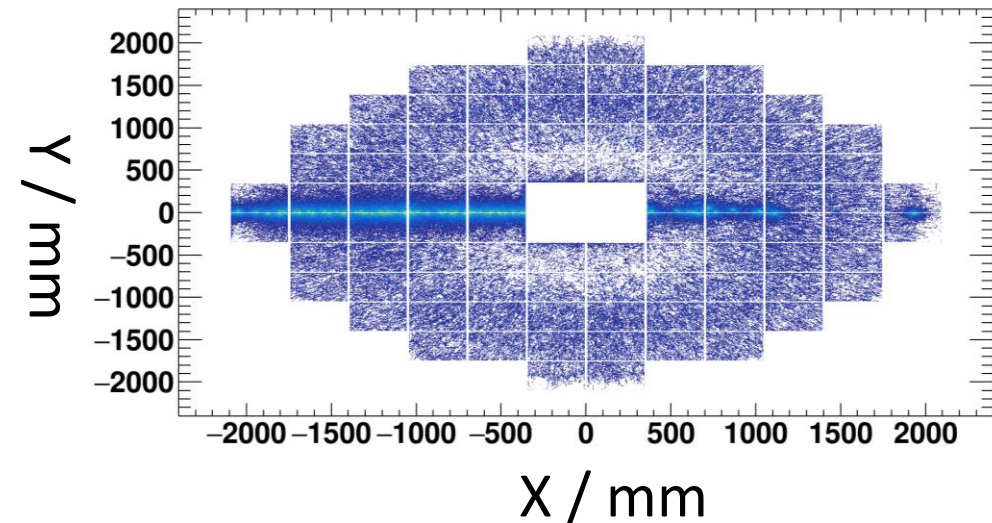
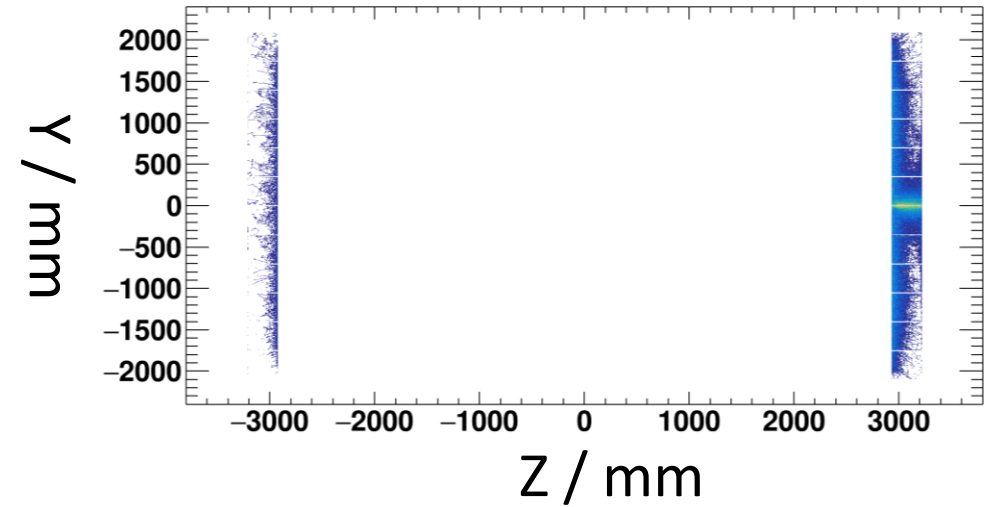
Geometry (schematic)



- Preliminary long crystal bar ECAL endcap is ready.
- Beam pipe + Tracker + ECAL + HCAL + Coil
 - without muon detector

Preliminary simulation results

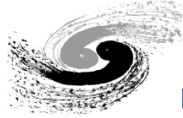
- Beam background:
 - Pair production + BGB
- Geometry:
 - Beam pipe + Tracker + ECAL + HCAL + Coil
- Some settings:
 - 1 μs time window
 - 50 events



Current status for beam background simulation in calorimeter

- Workflow in CEPCSW is ready.
- Geometry:
 - 1st version crystal bar ECAL endcap: R=2200 disk is not fully covered.
 - AHCAL endcap: CEPC CDR design.
 - Beam pipe, forward tracker and Coil are included.
 - **Missing part: MDI, Muon chamber/Yoke, LumiCal.**
- Beam processes: dominant processes are ready/very likely ready.
- Electronics:
 - Time start: bunch crossing trigger from accelerator.
 - If there is self-trigger in calorimeter, it can be triggered by over-threshold continuum beam particles.
 - Assuming a 1 μ s time window:
 - Will cover 2 bunches.
 - Too many beam particles from continuum processes. (~1k particles / bunch, large memory in simulation required)
 - **A trigger scheme design is needed: bunch trigger vs. self over-threshold trigger.**
- From simulation: too many particles and energy deposition in ECAL endcap.
 - Might be shielded by MDI? **A full detector geometry is needed.**

Backup



Status – Beam Induced Backgrounds



- Current Status towards Second Version(Based on CEPCSW):

Background	Mode	Generation	Tracking	Noise Estimation	Rad. Da. Esti.	Rad. Env. Esti.
Synchrotron Radiation	Higgs	To do	To do	To do	To do	To do
	Z	To do	To do	To do	To do	To do
Beamstrahlung/Pair Production	Higgs	Done	-	Mass Checking	To do	To do
	Z	Done	-	To do	To do	To do
Beam-Thermal Photon	Higgs	Done	Done w.o. Sol	To do	To do	To do
	Z	Done	Done w.o. Sol	To do	To do	To do
Beam-Gas Bremsstrahlung	Higgs	Done	Done w.o. Sol	Mass Production	Mass Checking	Mass Checking
	Z	Done	Done w.o. Sol	To do	To do	To do
Beam-Gas Coulomb	Higgs	Done	Done w.o. Sol	To do	To do	To do
	Z	Done	Done w.o. Sol	To do	To do	To do
Radiative Bhabha	Higgs	Done	-	To do	To do	To do
	Z	Doing	-	To do	To do	To do
Touschek	Higgs	Doing	To do	To do	To do	To do
	Z	Done	Done w.o. Sol	To do	To do	To do

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*from Haoyu 5.28

AHCAL Endcap

- SHcalSc04_Endcaps_v01_01.xml

