# Fast calorimeter simulation

- Developing frozen shower (FS) method for calorimeter fast simulation
- During the FS simulation the low-energy particle are substituted with pregenerated shower from the library
- The purpose of the FS library is to store the shower and the condition, with which this shower was generated
- When asked, the library should return the shower with the generation conditions as close to the required, as possible
- > FS in steps:
  - Library creation: Need to be performed only once. Library is created with respect of the shower properties

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• Fast simulation: Showers from the library is used instead of fully simulated showers



# FS fast calorimeter simulation

- First try with making the frozen shower library of electron (or positron) for ECAL barrel
- Getting start point (x,  $\theta$ ,  $\phi$ , E) of shower particle using Geant4 simulation from single  $\gamma$  (1-100 GeV) events
- Doing Geant4 simulation according to the obtained start points and save the simulated hits
- Shower library: energy range (150 MeV to 1 GeV), θ range(50°to 90°), φ range (-20° to 20°), x range (1850 to 2000 mm)
- ✤ Library size is ~ 20 GB, saved in uncompressed ROOT file.
- Currently the FS work is under LCIO CEPC software framework.

# FS fast calorimeter simulation

- Check physics performance of  $\gamma$  for the FS simulation
- ECAL and HCAL are used in the simulation
- Using pandora for the reconstruction, same for following results



- The concatenate regions for different staves are still simulated by Geant4
- The gap regions between different towers are also simulated by Geant4

# physics performance check (rec E)

• Check physics performance of  $\gamma$  for the FS simulation



- Currently, FS only consider the shower in ECAL part. Due to the energy leakage in HCAL part, ~ 1% energy scale is applied for FS library.
- In order to have a better agreement in E resolution, 10% energy smear is applied for FS library.

#### physics performance check (rec E)





### physics performance check (rec $\phi$ )



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#### physics performance check (rec $\theta$ )



 $E_{pfo}^{\gamma}$  (GeV)

 $\theta_{pfo}^{\gamma}$  (degree)

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# Time performance check

#### • Check time performance of single $\gamma$ event simulation



The processing time in stave concatenate regions are similar with Geant4.
In FS simulation region, around 1 time speed up can be obtained.



## physics performance check (rec $\phi$ )



> Check the  $\sigma(\Delta \phi)$  using simple center mass method to do the reconstruction for  $\gamma$ .

# Pandora for key4hep

- Make a git repository for pandora <u>https://github.com/wenxingfang/CEPCSW\_Pandora</u>
- The repository includes:
  - Pandora: source code for pandora client
  - Service: provide gear service
  - Examples: option file example