

TOF simulation Meeting

2024/6/18

Shinshu university M1

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Introduction

➤ Final goals

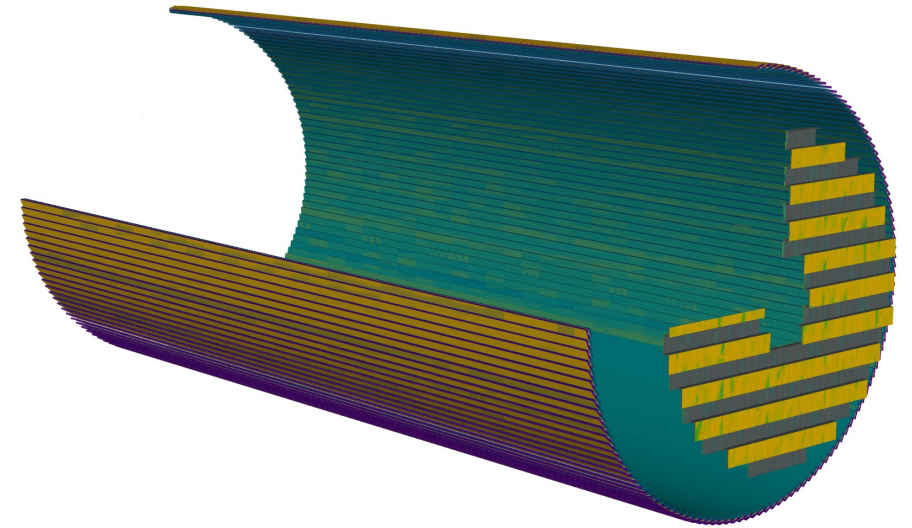
- Examination of the TOF performance with beam backgrounds by ePIC simulation

➤ What is TOF simulations with beam backgrounds?

- Beam gas interactions
 - Synchrotron radiation
- ePIC simulation is not included

➤ To do to achieve goals

- Track reconstruction (with / without TOF hits and beam background)
 - Can we use track reconstruction with Plugins? (e.g.track efficieny, TOF efficiency)



TOF detector in EIC

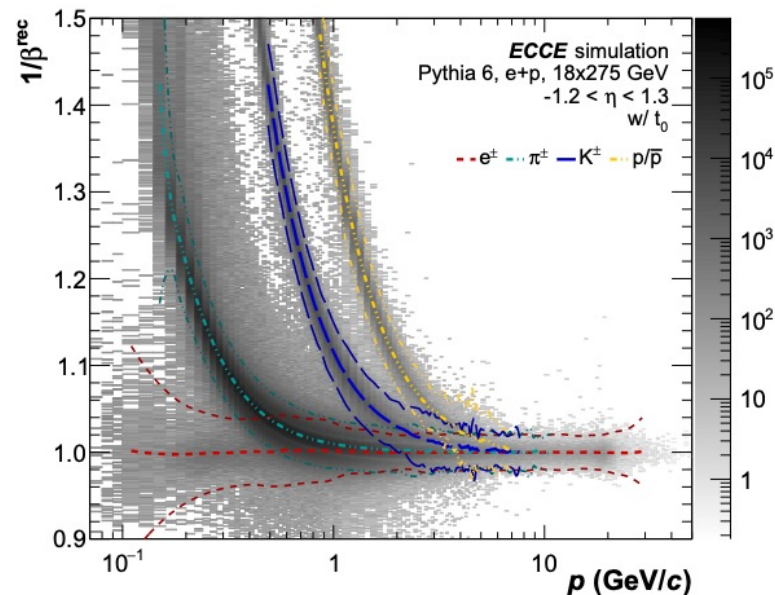
Recreating PID performance

➤ The first task

- Recreating velocity β vs momentum distribution of particles as a measure of TOF ability to identify particles

$$\beta = \frac{l}{\tau \cdot c}$$

- To calculate β , we need the value τ of the time of entry into the TOF and the length of the flyway l
→ importance to understand the track reconstruction algorithm



[PID performance in barrel TOF](#)

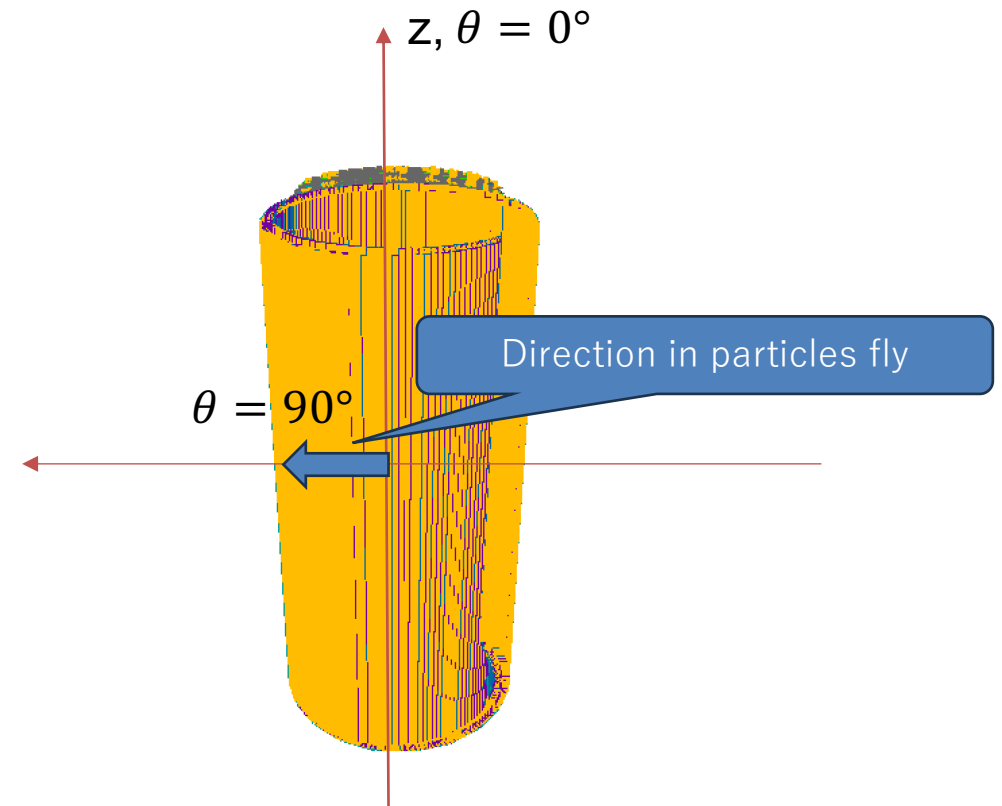
Checking for barrel TOF hits

➤ Hit specific barrel TOF locations without Plugins

- Using a particle gun to launch particles in the direction you want them to go

- Simulation setting

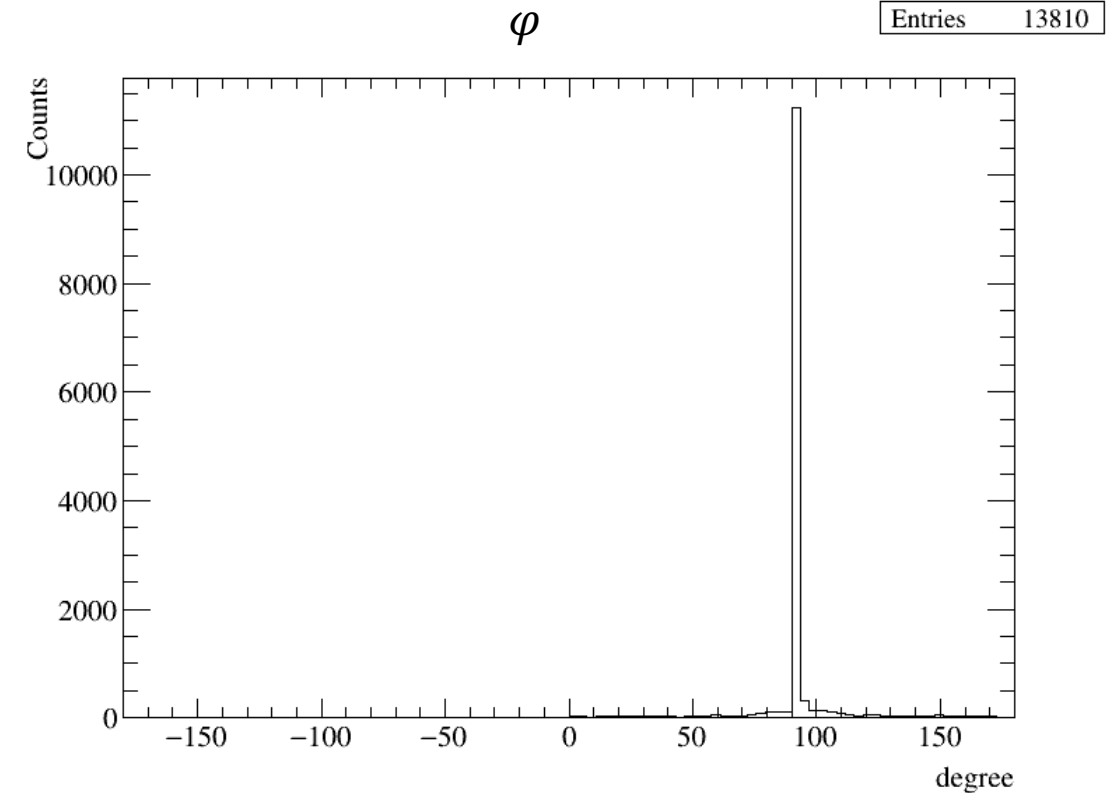
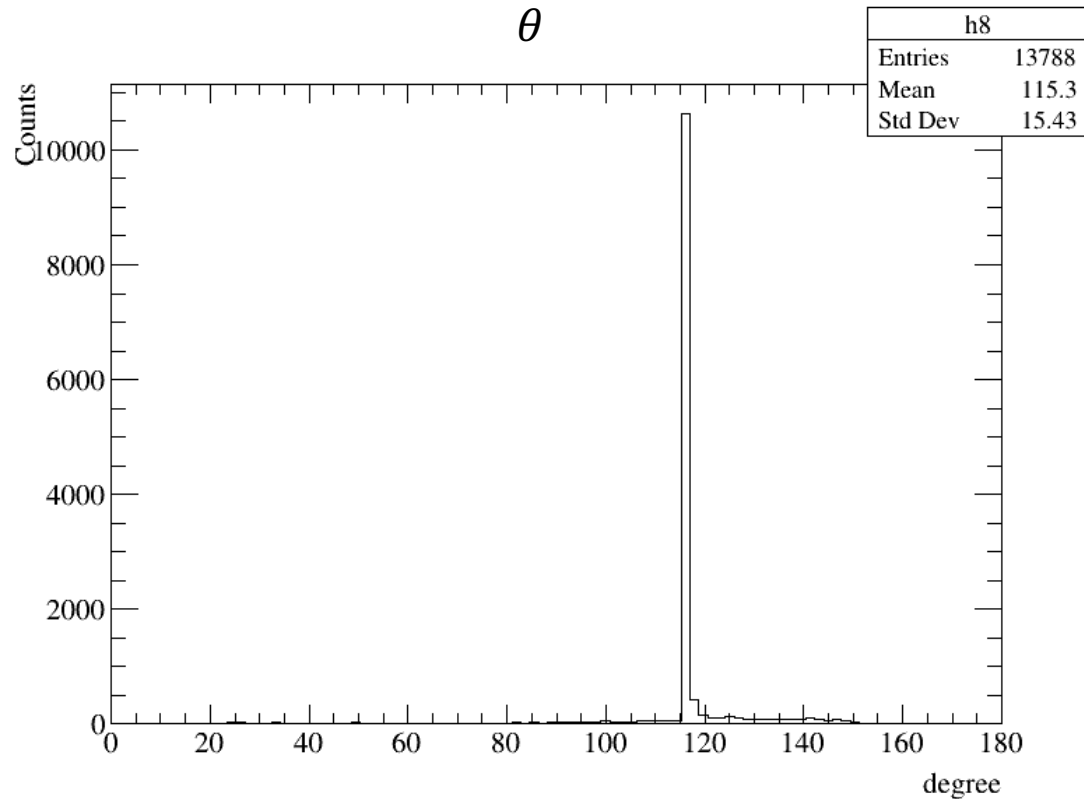
- Particles : π^-
- Momentum : 0.9 GeV
- φ Angle : 30 degree
- θ Angle : 90 degree
- Number of events : 10000



barrel TOF and θ response

Result (barrel TOF hits)

➤ θ, φ result



- There are a lot of particles flying in one specific direction
- Both θ and φ do not fly to the set angle
 - The particles were set at π^- , so did they bend and change angles?
→ I would like to hit another particle

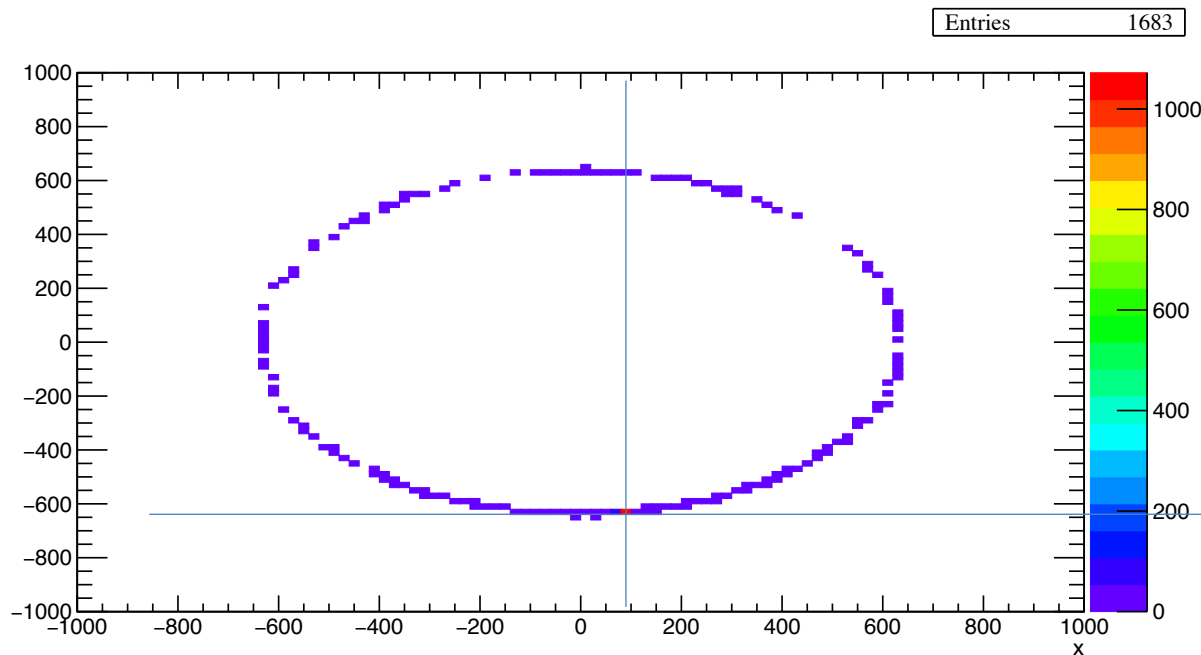
Analysis using Plugins result (TOF efficiency)

➤ TOF Efficiency:

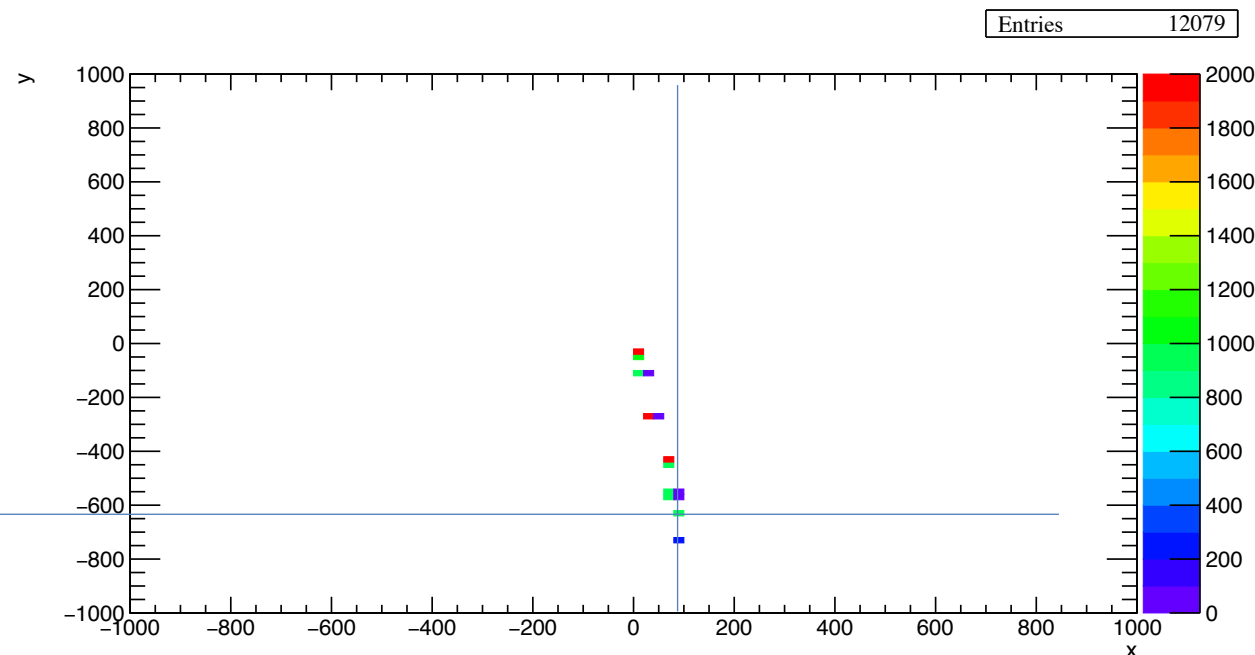
Helps in analyzing tracking performance and accuracy of TOF measurements

- Provides information on TOF hits
- Provides information on Tracker hits per segment.

➤ Result



TOF barrel hits xy



Tracker hits xy

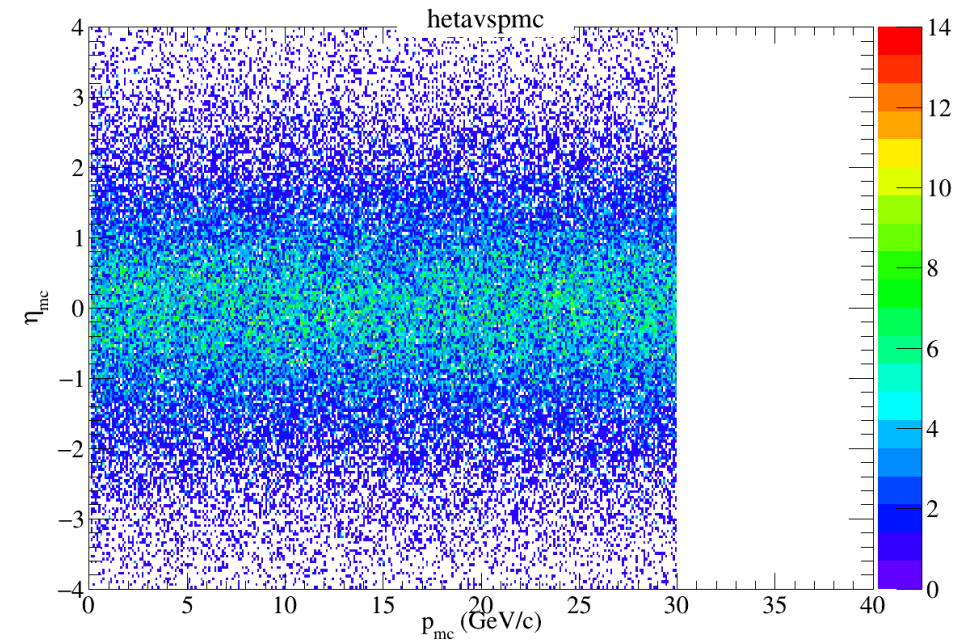
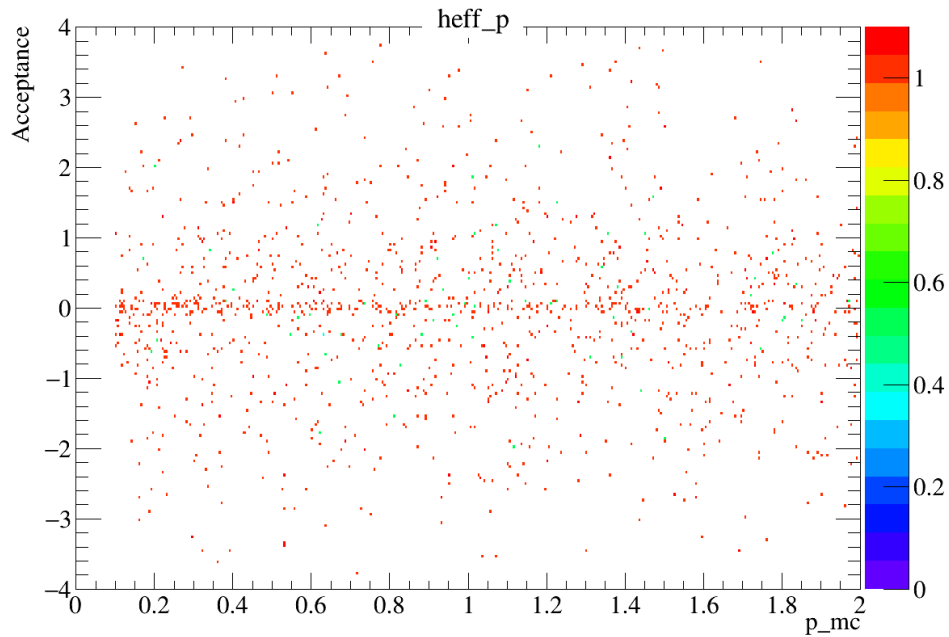
Analysis using Plugins result (track efficiency)

➤ Track efficiency:

I am not sure what it represents

This result used pythia data as input file

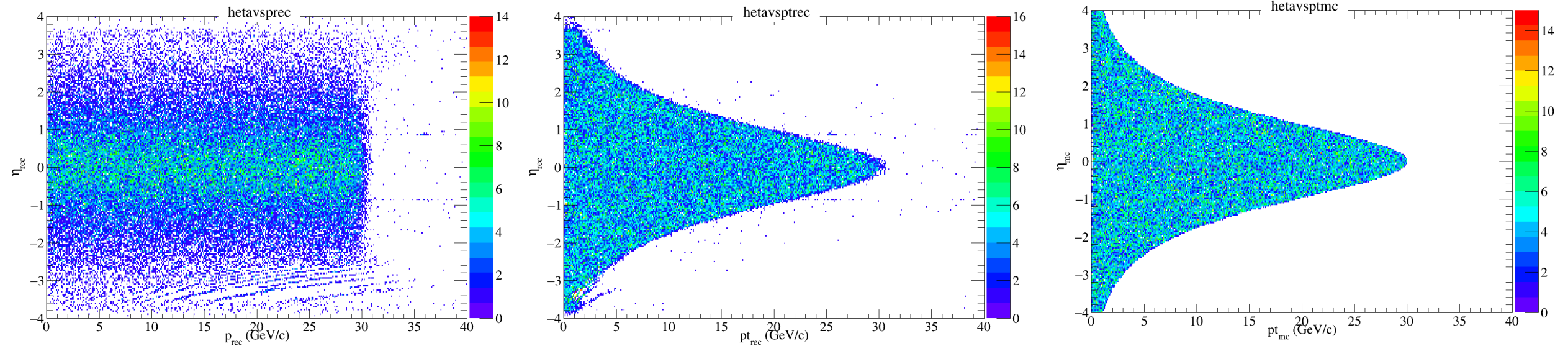
➤ Result



I would like to find out what it represents

Analysis using Plugins result (track efficiency)

➤ Result



I would like to find out what it represents.

To do

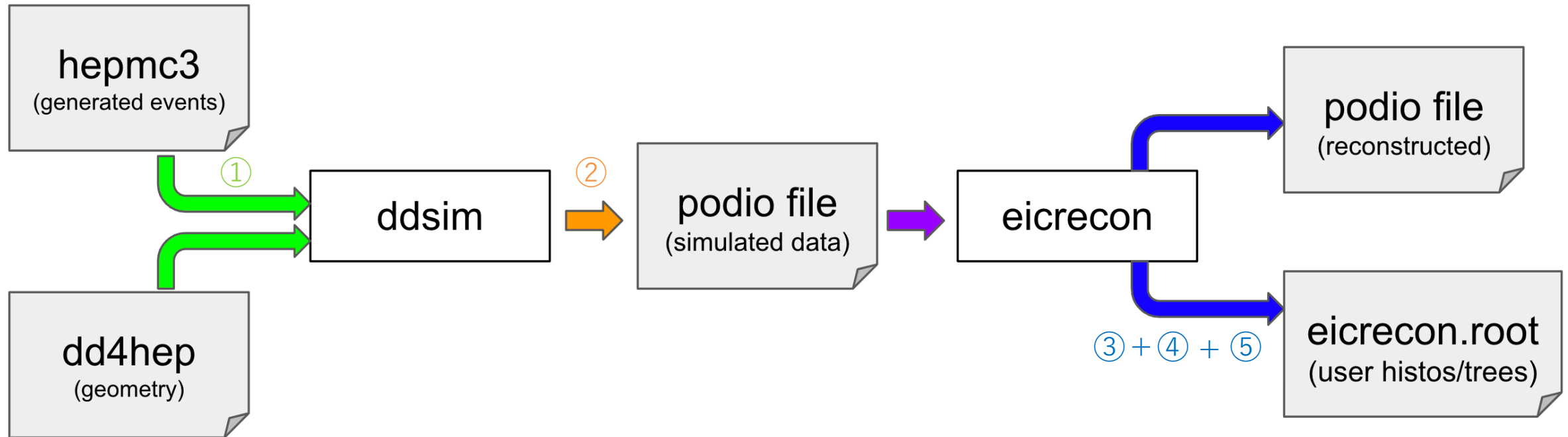
- 1. Understanding of track reconstruction algorithm with Plugins**
 - Understanding the results of Plugins
 - Rewrite the plugin to create a PID performance and reconstruction efficiency
- 2. Creation of simulation data considering beam background**
- 3. Reconstruction efficiency and PID performance with and without beam background**

BACKUP

Setting File

```
1  from DDSim.DD4hepSimulation import DD4hepSimulation
2  from g4units import GeV
3  import math
4  SIM = DD4hepSimulation()
5
6  SIM.gun.distribution = "uniform"
7  SIM.gun.position = (0.0, 0.0, 0.0)
8  SIM.gun.phiMin = 30
9  SIM.gun.phiMax = 30
10 SIM.gun.thetaMin = 90
11 SIM.gun.thetaMax = 90
12 SIM.gun.particle = "pi-"
13 SIM.numberOfEvents = 10000
14 SIM.random.seed = 1
15
```

ePIC Simulation Flow



- ① Generated events : Event generation based on steering file, compact file
- ② Simulation : MC simulation
- ③ Digitization : Convert simulation signals to a format similar to the actual detector
- ④ Reconstruction : Reconstruction based on reconstruction algorithm
- ⑤ Analysis : Analyze using podio file or plugin output files

PID performance の再現

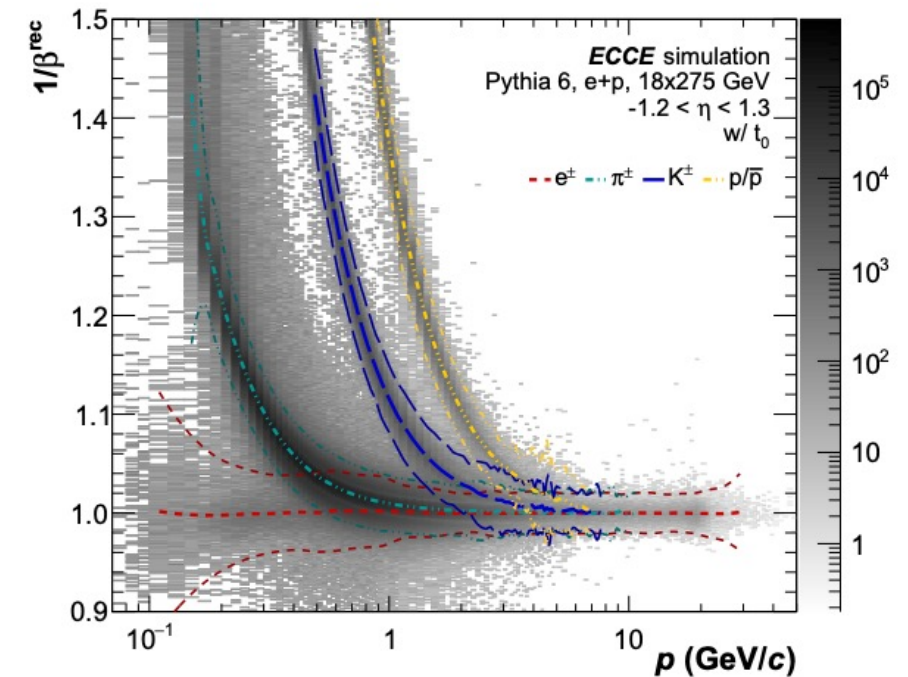
➤ 粒子の速度 β vs 運動量分布（右下図）の再現を試みている

- β の算出には、突入時間の値 τ と飛跡の長さ l が必要

$$\beta = \frac{l}{\tau \cdot c}$$

- EICrecon によって再構成されたbarrel TOFに関する情報は左下図のようになっている

```
['TOFBarrelRecHit.cellID',  
'TOFBarrelRecHit.position.x',  
'TOFBarrelRecHit.position.y',  
'TOFBarrelRecHit.position.z',  
'TOFBarrelRecHit.positionError.xx',  
'TOFBarrelRecHit.positionError.yy',  
'TOFBarrelRecHit.positionError.zz',  
'TOFBarrelRecHit.time',  
'TOFBarrelRecHit.timeError',  
'TOFBarrelRecHit.edep',  
'TOFBarrelRecHit.edepError']
```



[PID performance in barrel](#)

TOFに関するPluginを使用してヒット情報を得る

➤ track segments とは？

- track segments のブランチは、右図のように定義されている
- track segments は、トラックに沿った1つ以上の点
- length は、初めから最後までまでの長さ？

```
edm4eic::TrackSegment:  
Description: "A track segment defined by one or more points along a track."  
Author: "S. Joosten"  
Members:  
- float          length          // Pathlength from the first to the last point  
- float          lengthError     // Error on the segment length  
OneToOneRelations:  
- edm4eic::Track  track          // Track used for this projection  
VectorMembers:  
- edm4eic::TrackPoint points     // Points where the track parameters were evaluated
```

➤ 現状の理解

- track segments は、ある領域（なんらかのモジュール）通過後の情報を持つ点
- track segments を元に再構成アルゴリズムが実行されると粒子の飛跡の長さをみることが可能になる？
- length にこういった値が入っているかは今の所わかっていない

