EicC Vertex & Tracking Detector Simulation and Performance Study

Aiqiang Guo, Yuming Ma,

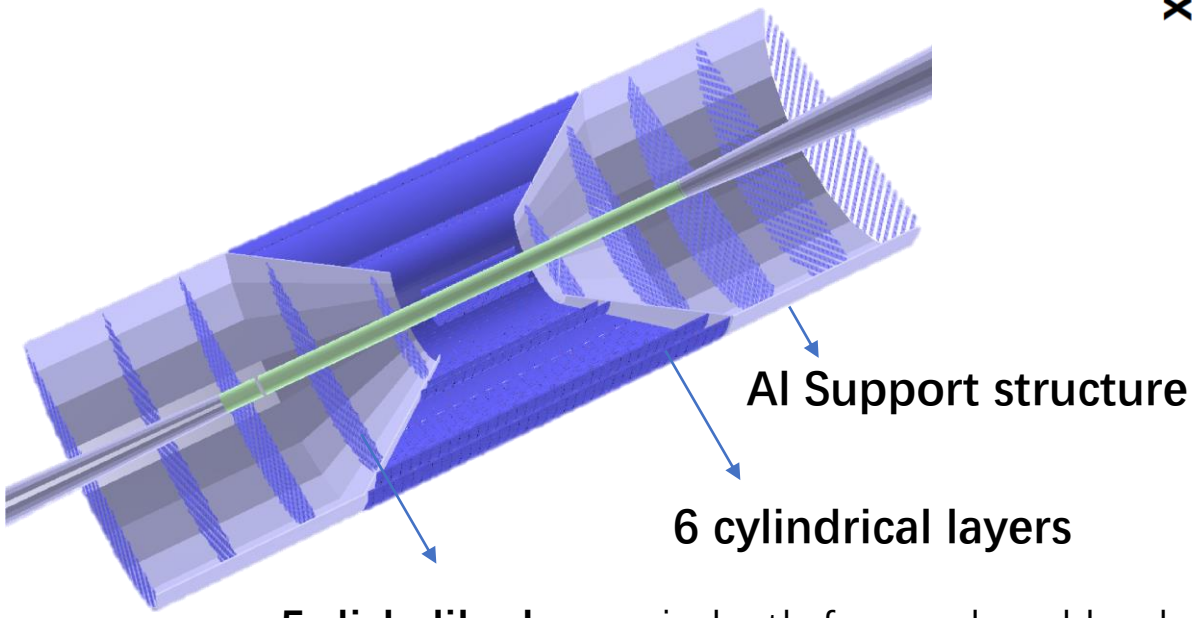
Yutie Liang, Yuxiang Zhao

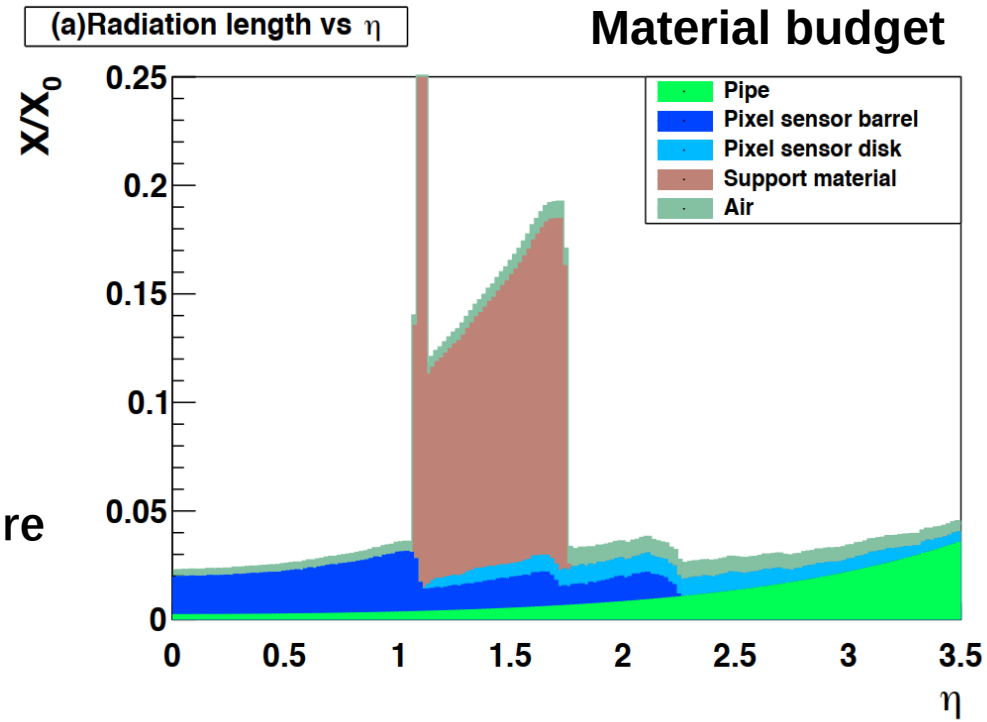
Institute of Modern Physics, CAS

The 3rd EicC CDR Workshop

Review of detector design (det_v0)

- All-Silicon Tracking Detector design
  - Based on ITS2
  - Pixel size: 10x10 micron

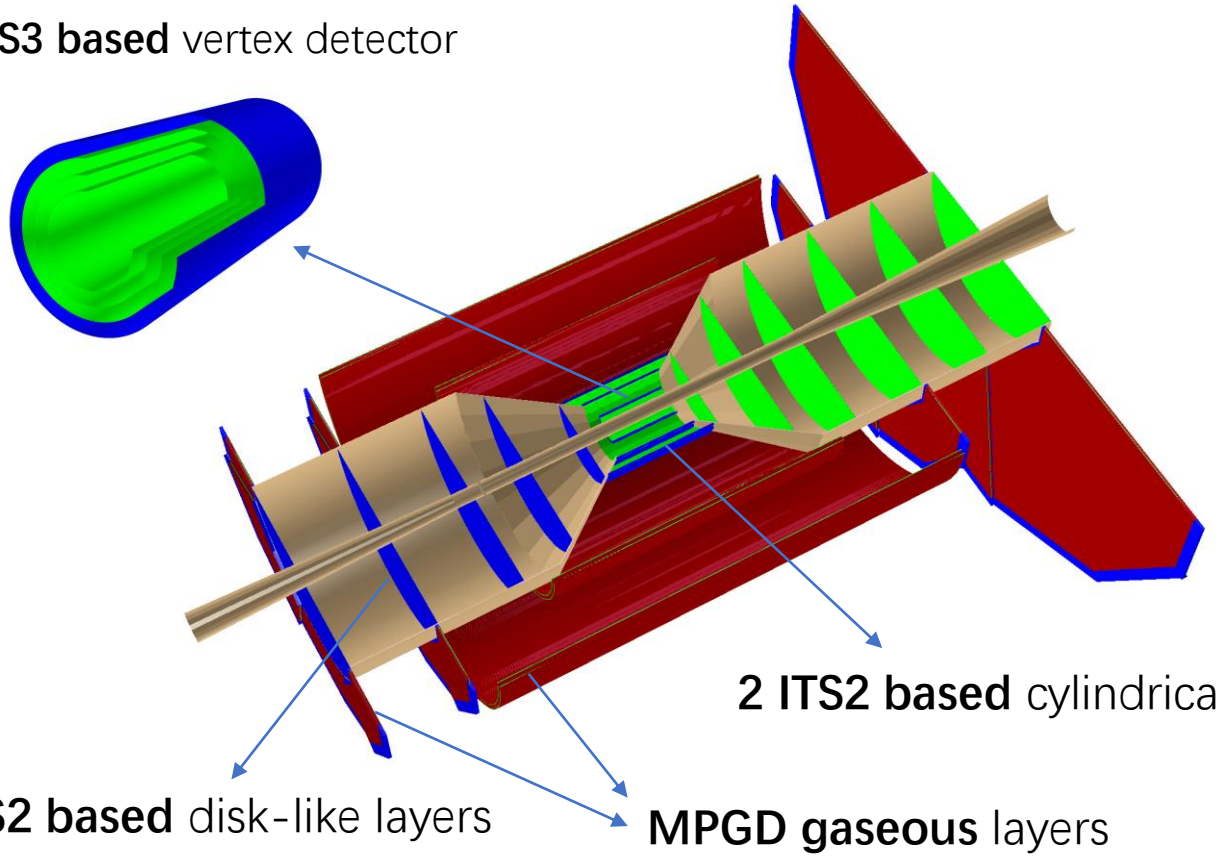


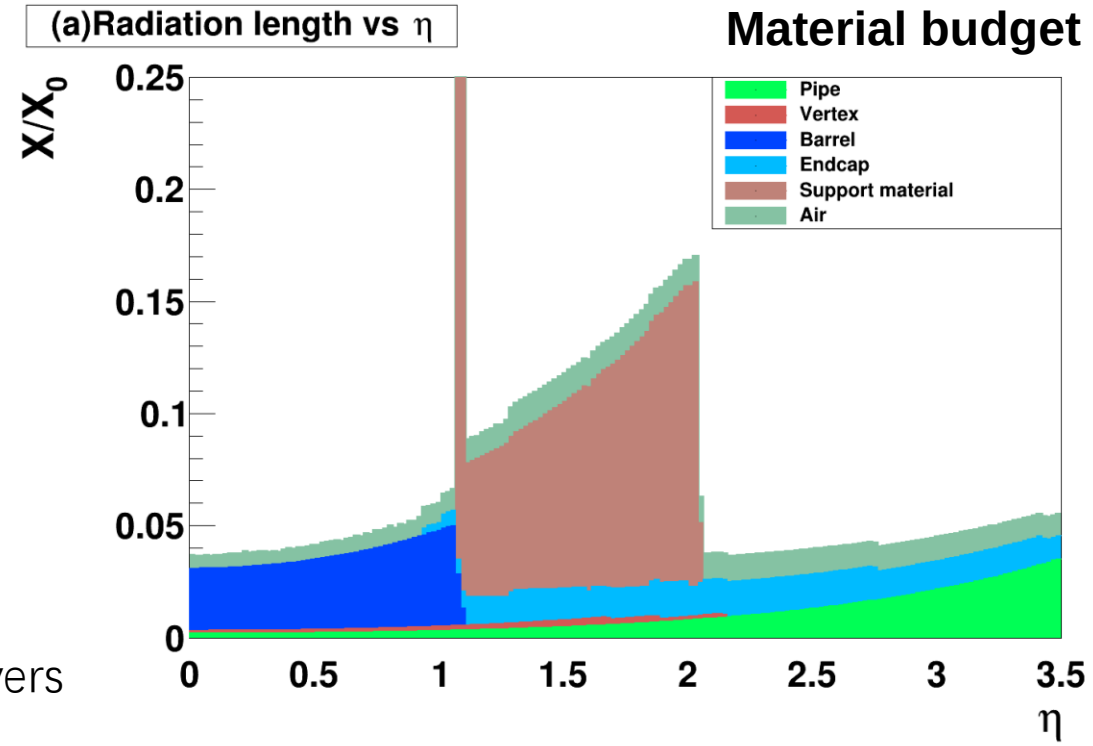


5 disk-like layers in both forward and backward

Review of detector design (det_v1/2)

- ITS3+ITS2+gaseous hybrid detector design

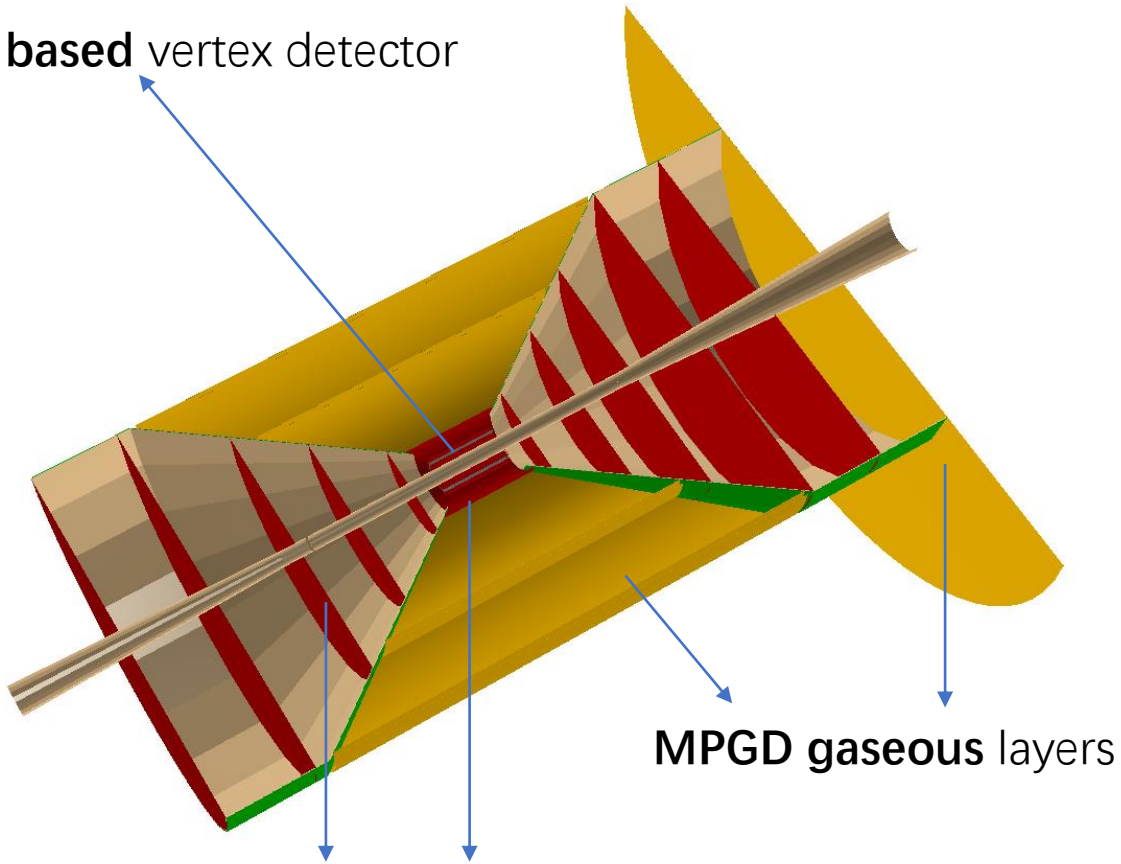


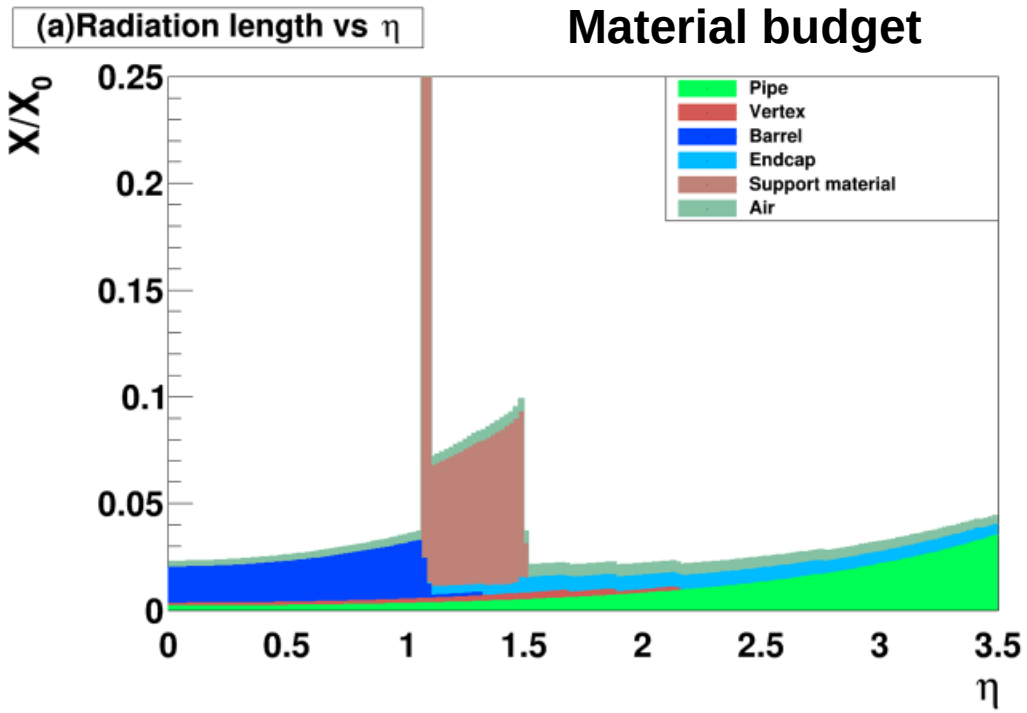


Only the pixel sizes of silicon detector are different for v1/v2.

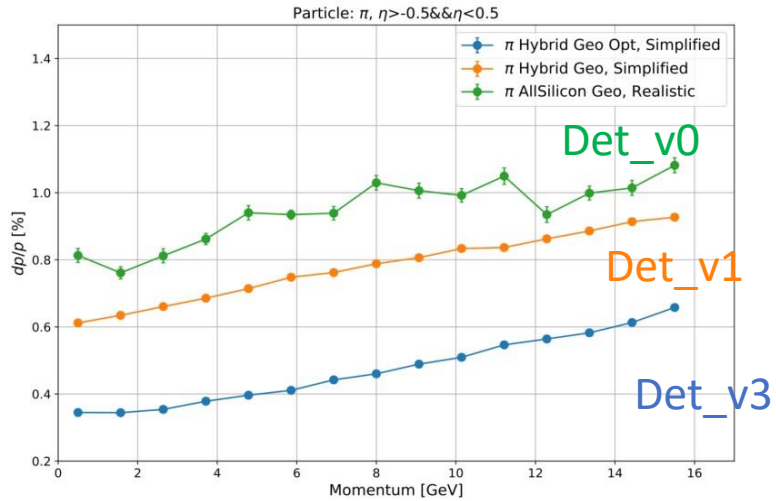
Detector design (det_v3)

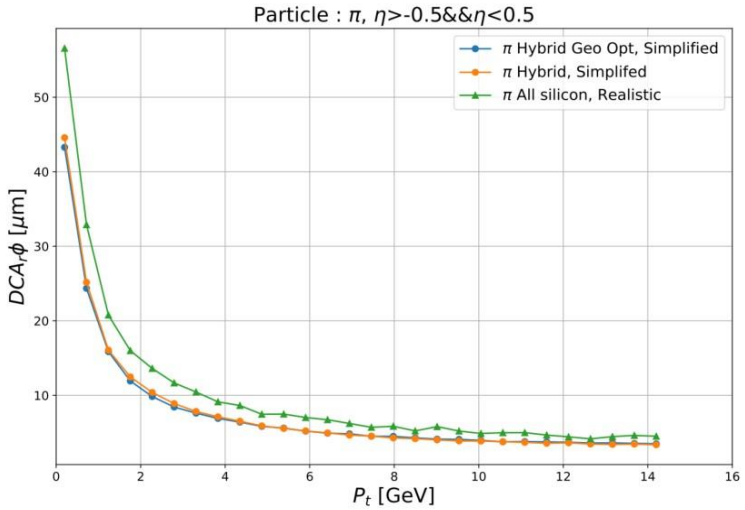
- ITS3+gaseous hybrid detector design

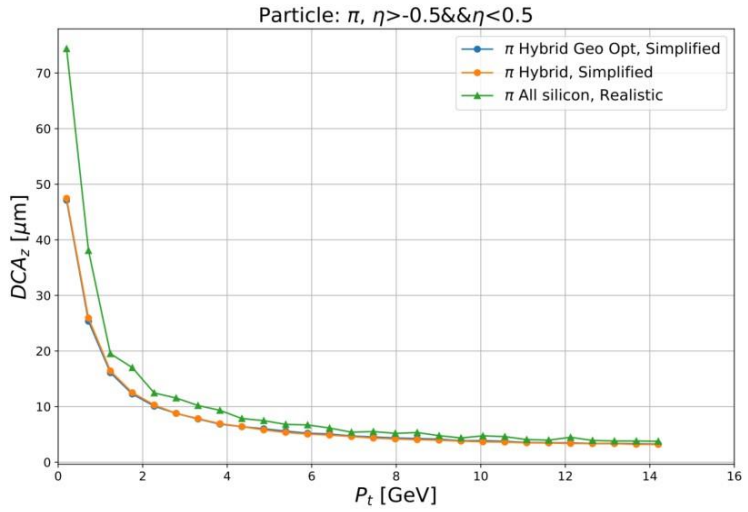


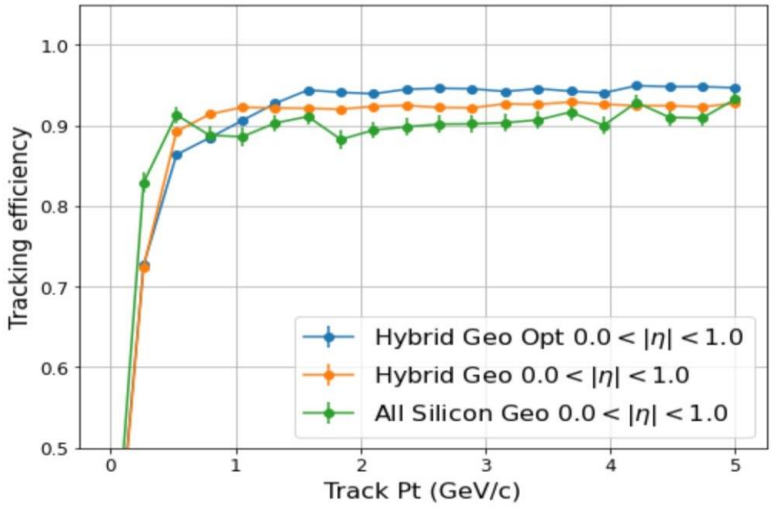


The performance comparison

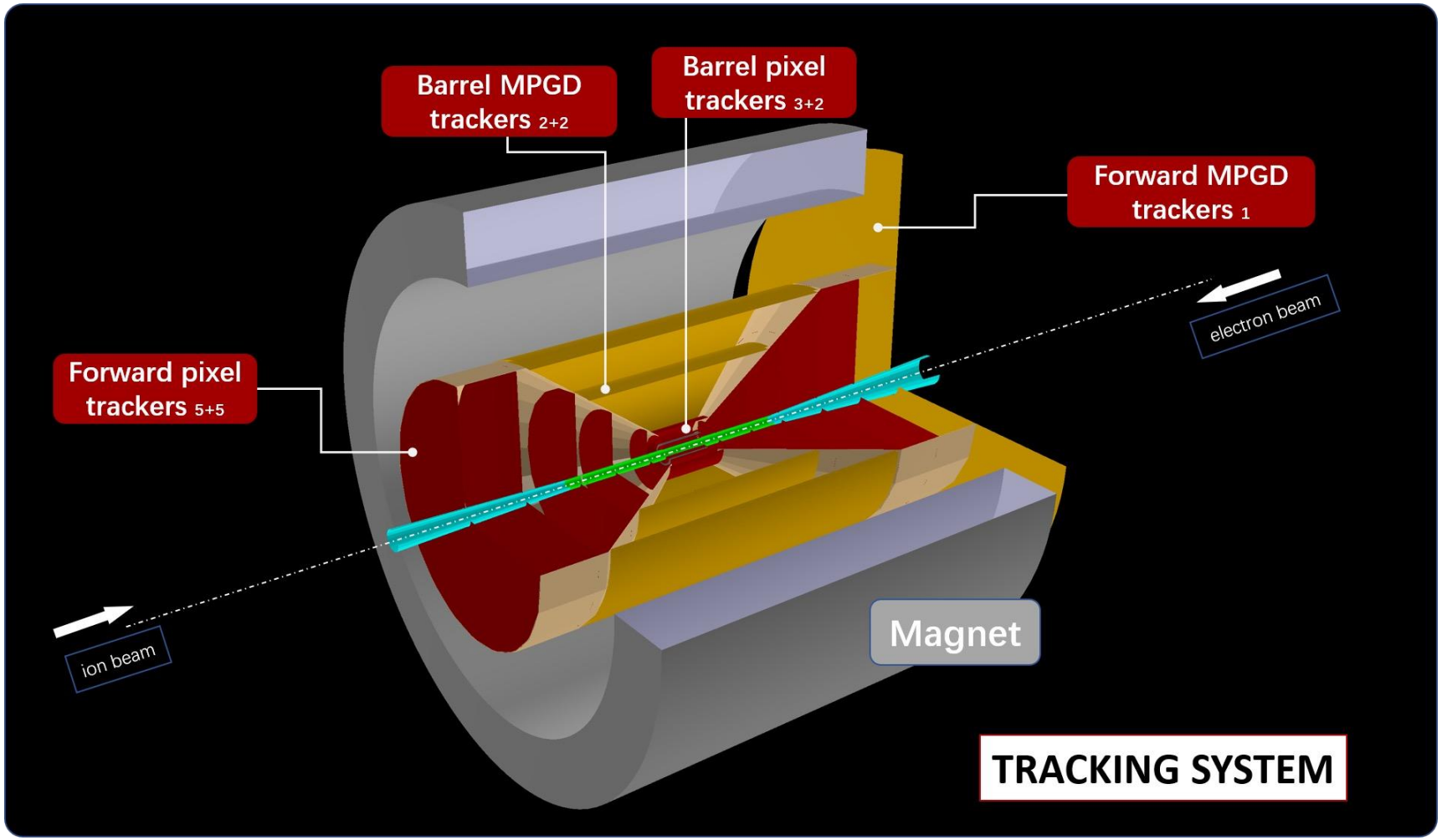








The latest design



Barrel:

R(cm)	Length(cm)	Pitch Size(μm)	Material Bedget (X/X0 %)	Tech
3.30	28	10	0.08	ITS3
4.35	28	10	0.08	ITS3
5.40	28	10	0.08	ITS3
8.00	28	10	0.08	ITS3
15.00	38.70	10	0.08	ITS3
47.72	127.47	150(rp)x150(z)	0.40	MPGD
49.57	127.47	150(rp)x150(z)	0.40	MPGD
75.61	201.98	150(rp)x150(z)	0.40	MPGD
77.46	201.98	150(rp)x150(z)	0.40	MPGD

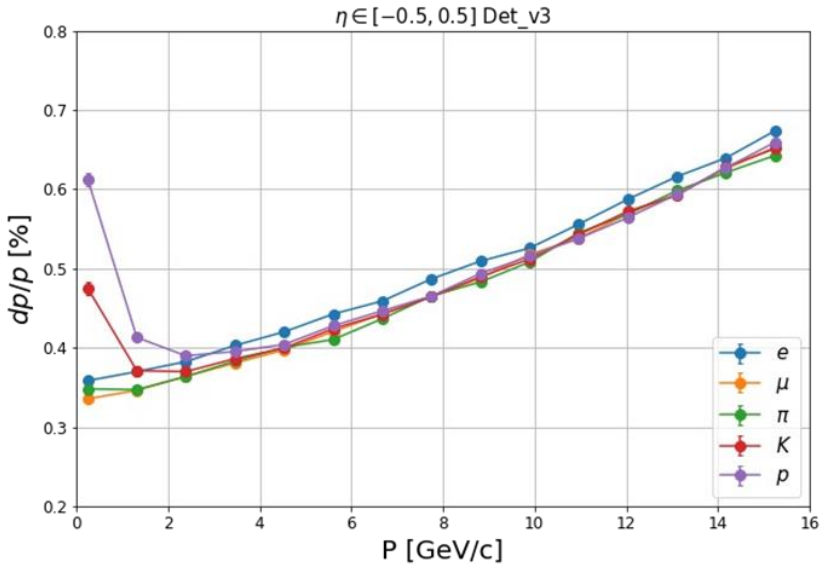
End cap p going:

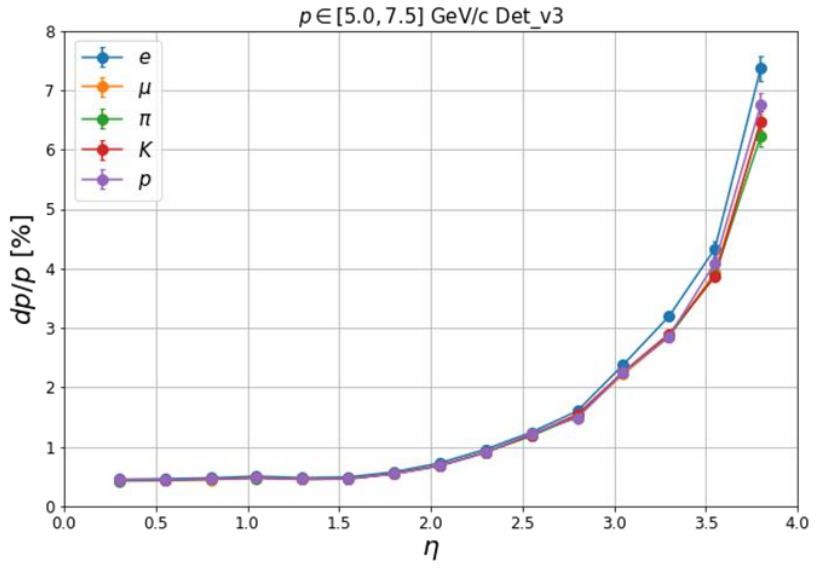
In R(cm)	Out R(cm)	Z(cm)	Pitch Size(μm)	Material Bedget (X/X0 %)	Tech
3.18	18.62	25	10	0.08	ITS3
3.18	36.50	49	10	0.08	ITS3
3.47	54.66	73	10	0.08	ITS3
5.08	77.46	103.65	10	0.08	ITS3
6.58	77.46	134.33	10	0.08	ITS3
8.16	150.00	165.00	50(rp)x250(r)	0.40	MPGD

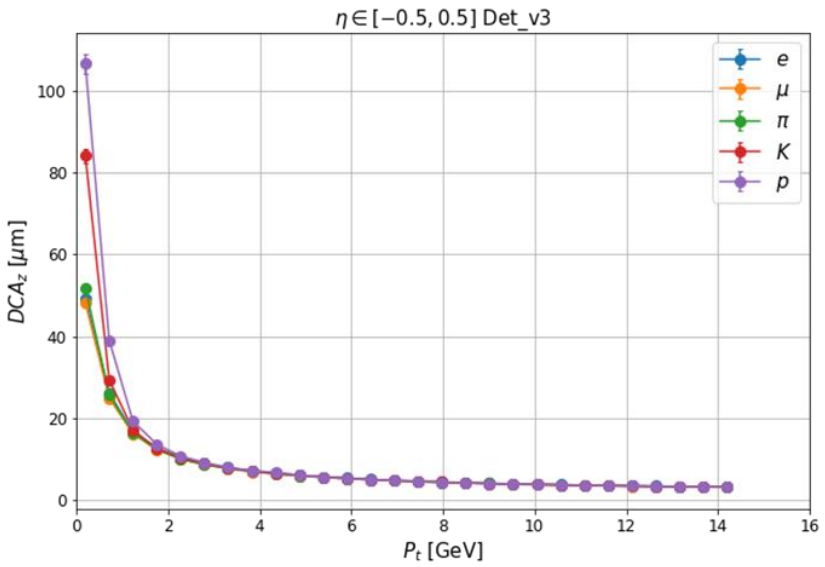
End cap e going:

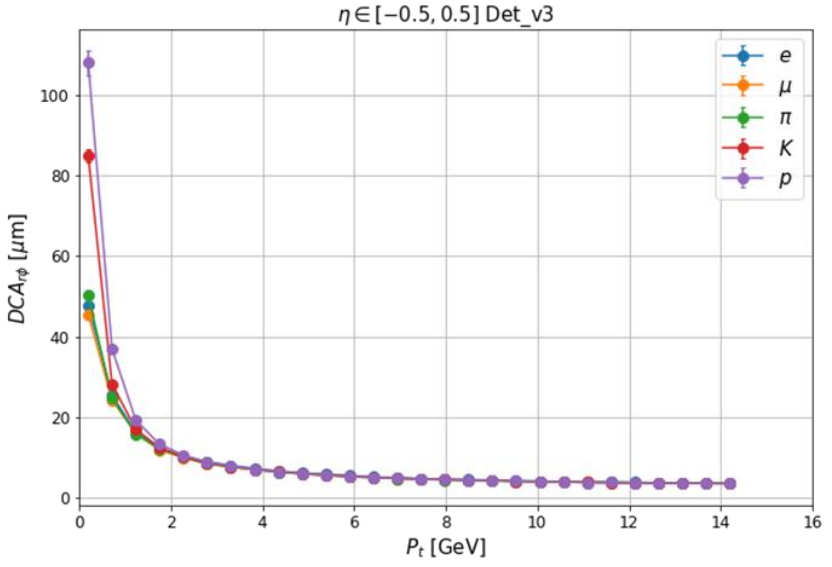
In R(cm)	Out R(cm)	Z(cm)	Pitch Size(μm)	Material Bedget (X/X0 %)	Tech
3.18	18.62	-25	10	0.08	ITS3
3.18	36.50	-49	10	0.08	ITS3
3.18	54.66	-73	10	0.08	ITS3
3.95	77.46	-109.0	10	0.08	ITS3
5.26	77.46	-145.0	10	0.08	ITS3

The performance



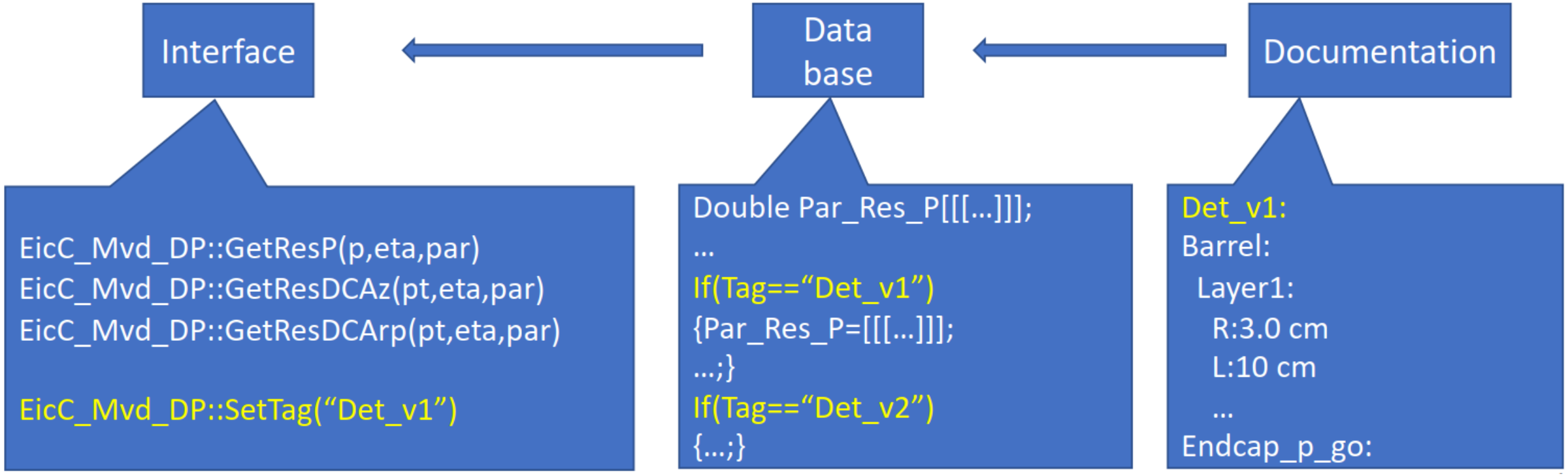






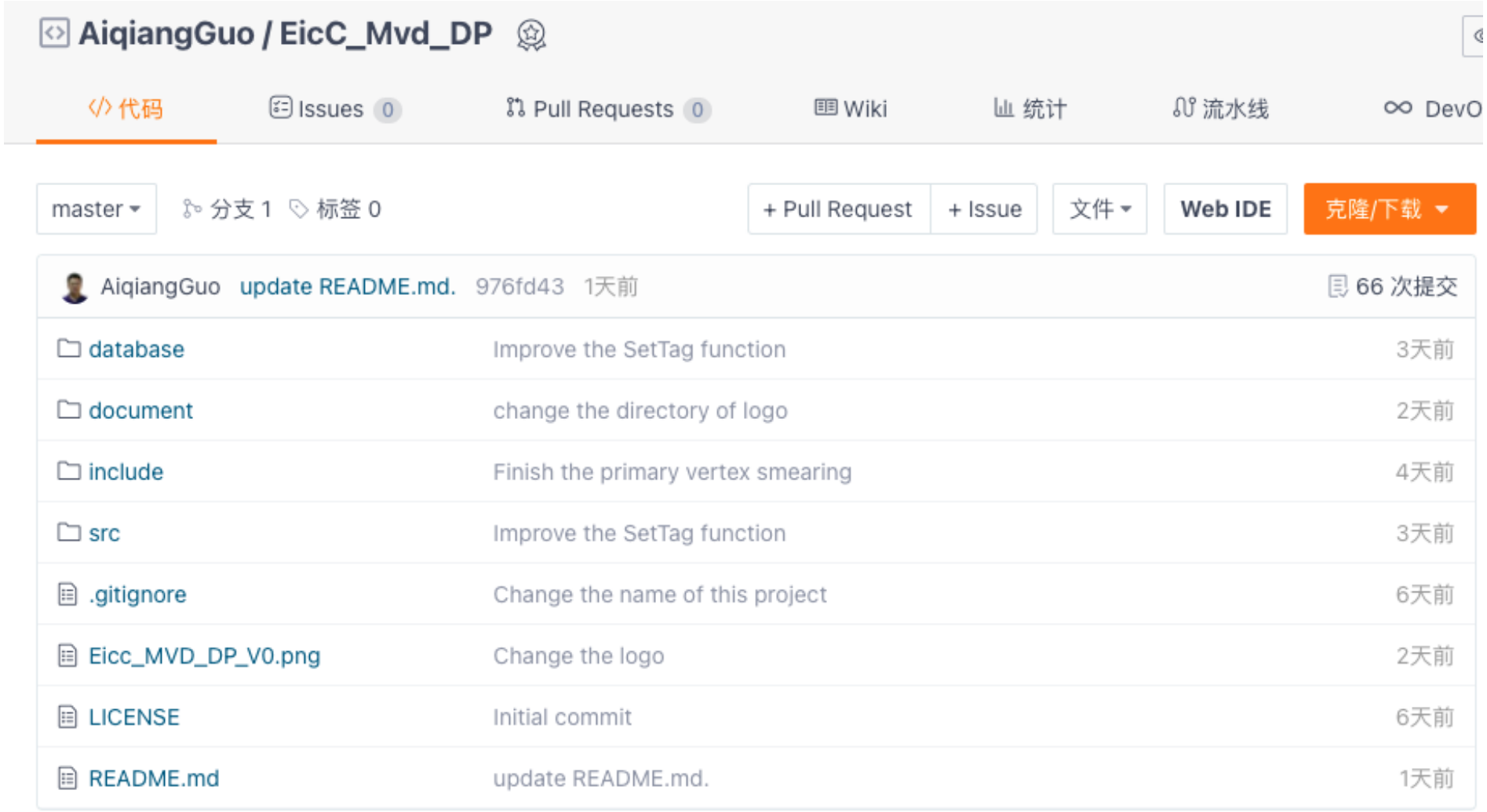
Toolkit for physics simulation

- Dedicated version control
- Parameterized performance
- Easy to use for physics simulation



Toolkit for physics simulation

https://gitee.com/aiqiang-guo/EicC_Mvd_DP



Design of the EicC Detector Performance Class

AiqiangGu

代码

master

AiqiangGuo

database

document

include

src

.gitignore

Eicc_MVD_DF

LICENSE

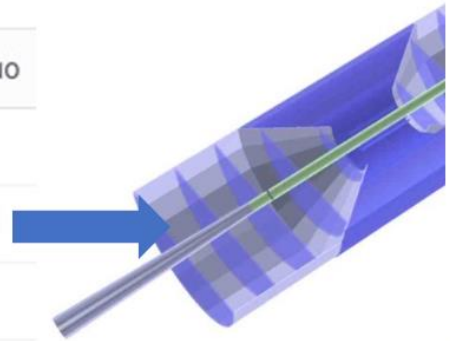
README.md

Det_v0:

Overall description:

All silicon design based on ITS2 technology.

The structure can be found below:



Barrel:

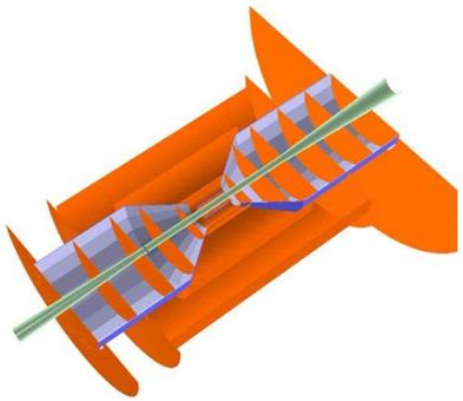
R(cm)	Length(cm)	Pitch Size(μm)	Material
3.30	30	10	
5.70	30	10	
21.00	54	10	
22.68	60	10	
39.30	105	10	
43.23	114	10	

Det_v1:

Overall description:

Silicon+MPGD design. The vertex detector is based on ITS3 technology. Tracker cor
technology.

The structure can be found below:



Barrel:

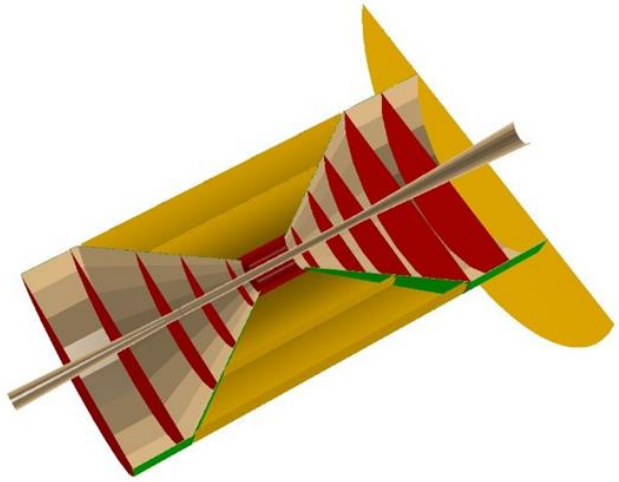
R(cm)	Length(cm)	Pitch Size(μm)	Material Bedget (X/X0 %)	Tech
3.30	28	10	0.05	ITS3
4.35	28	10	0.05	ITS3
5.40	28	10	0.05	ITS3
13.34	34.34	10	0.55	ITS2
17.96	46.68	10	0.55	ITS2
47.72	127.47	150(rp)x150(z)	0.40	MPGD
49.57	127.47	150(rp)x150(z)	0.40	MPGD
75.61	201.98	150(rp)x150(z)	0.40	MPGD
77.46	201.98	150(rp)x150(z)	0.40	MPGD

Det_v3:

Overall description:

The optimized version of Hybrid design, all the sillicon part is based on ITS3 technology with pixel size of 10 μm

The structure can be found below:

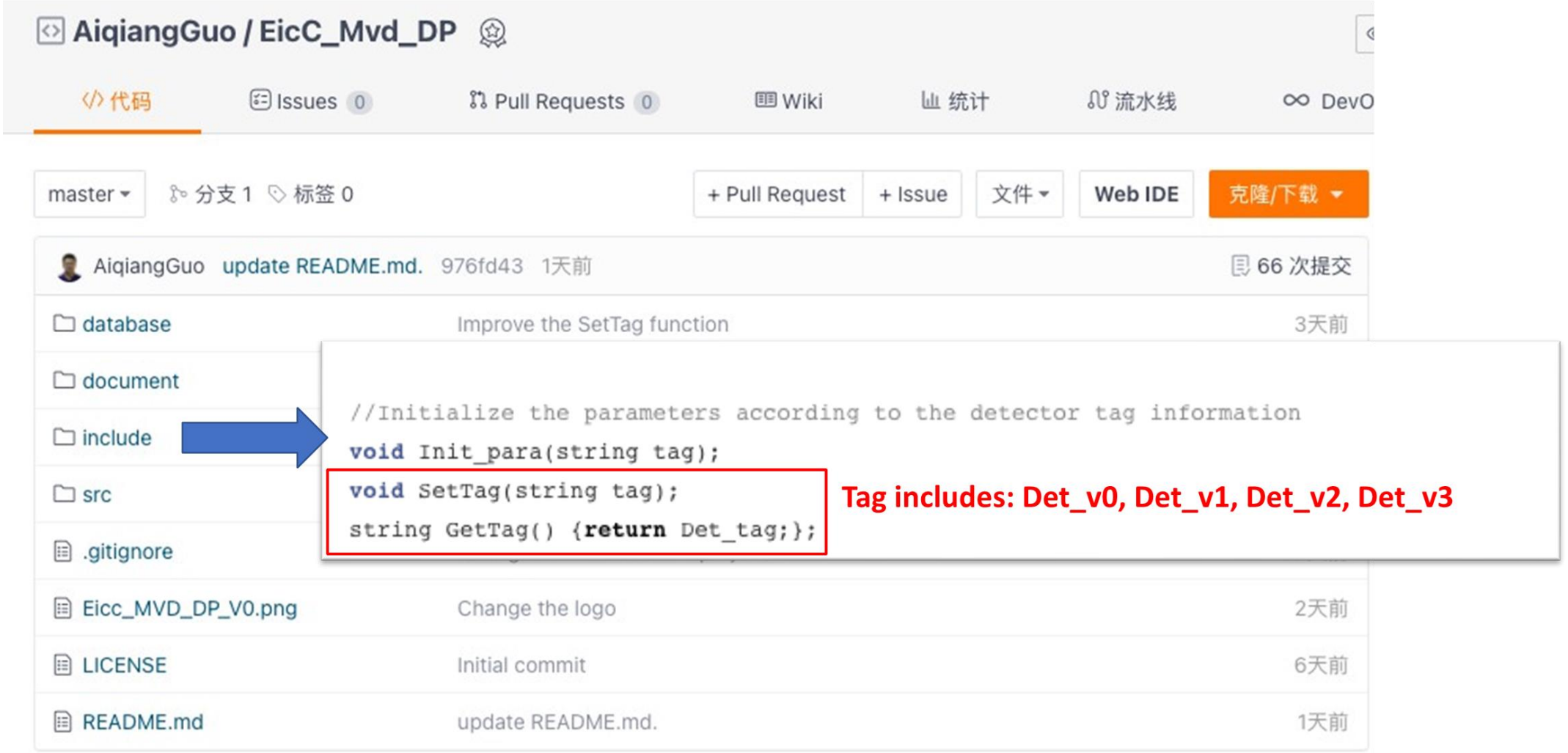


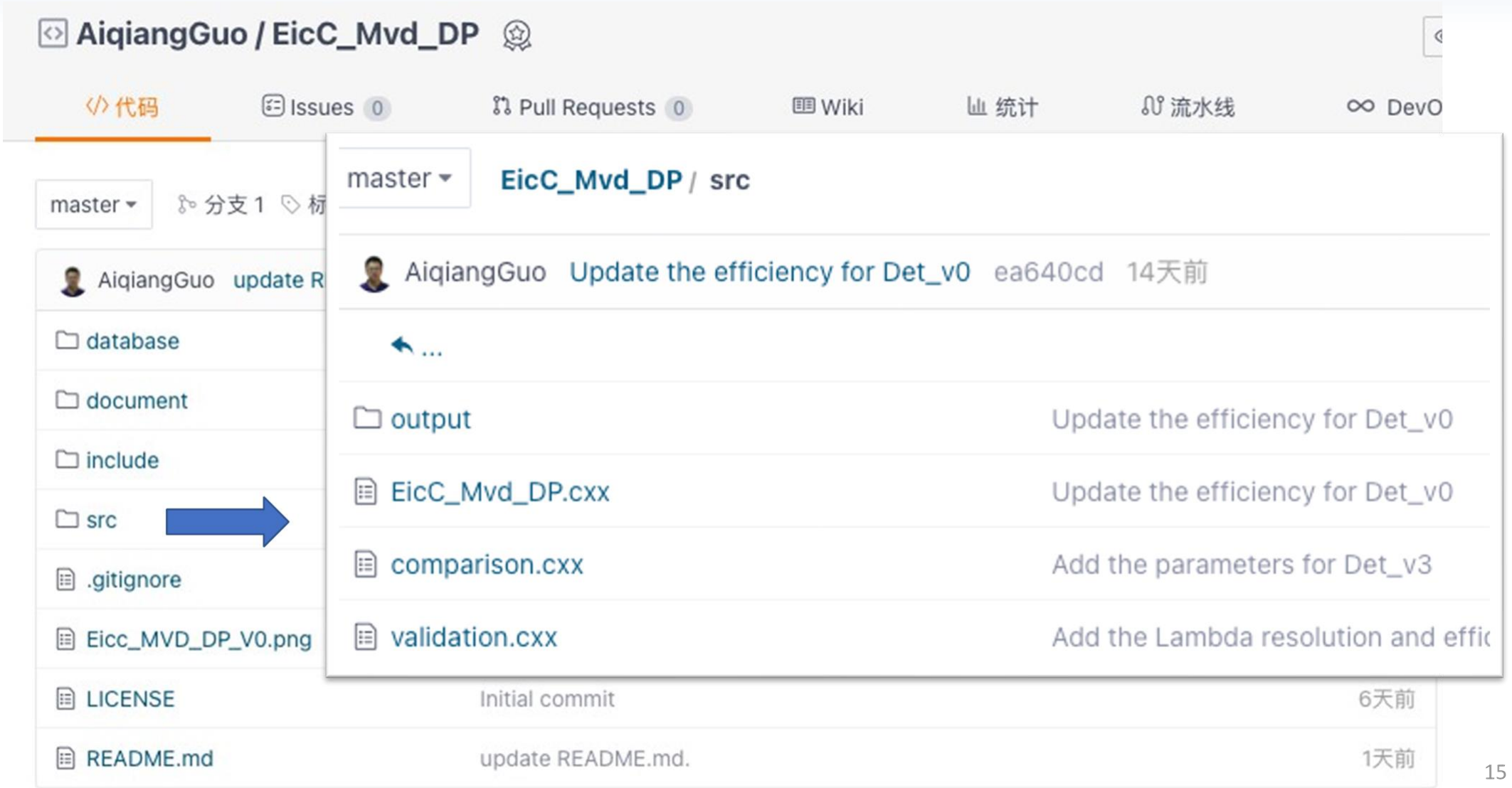
Barrel:

R(cm)	Length(cm)	Pitch Size(μm)	Material Bedget (X/X0 %)	Tech
3.30	28	10	0.08	ITS3
4.35	28	10	0.08	ITS3
5.40	28	10	0.08	ITS3
8.00	28	10	0.08	ITS3
15.00	38.70	10	0.08	ITS3
47.72	127.47	150(rp)x150(z)	0.40	MPGD
49.57	127.47	150(rp)x150(z)	0.40	MPGD
75.61	201.98	150(rp)x150(z)	0.40	MPGD
77.46	201.98	150(rp)x150(z)	0.40	MPGD

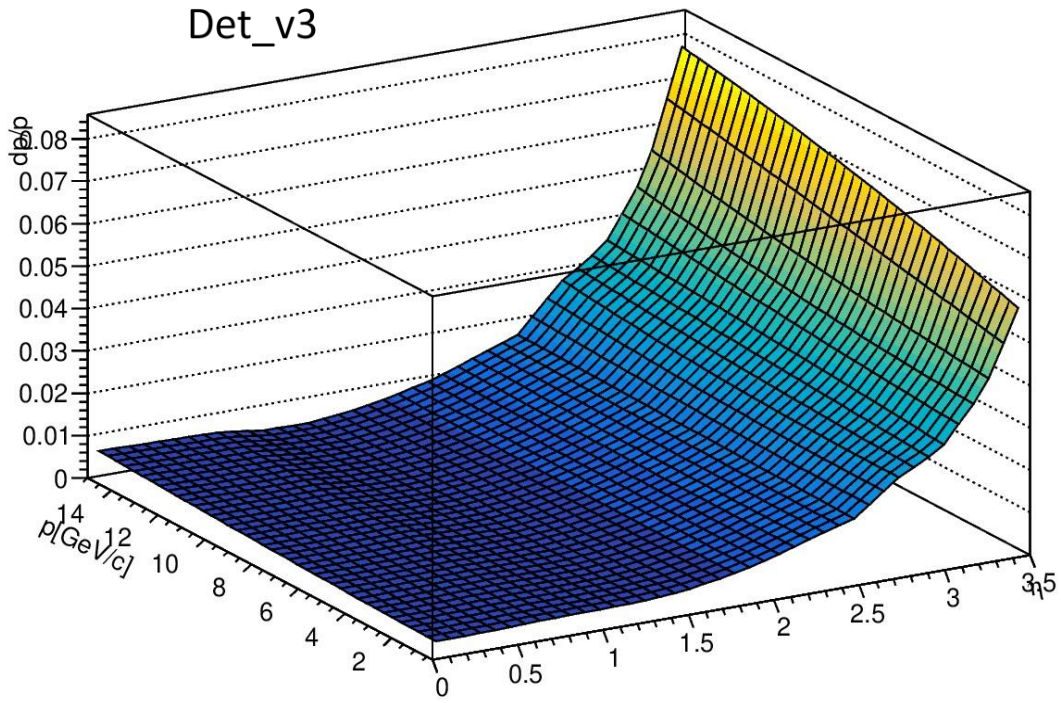
Design of the EicC Detector Performance Class

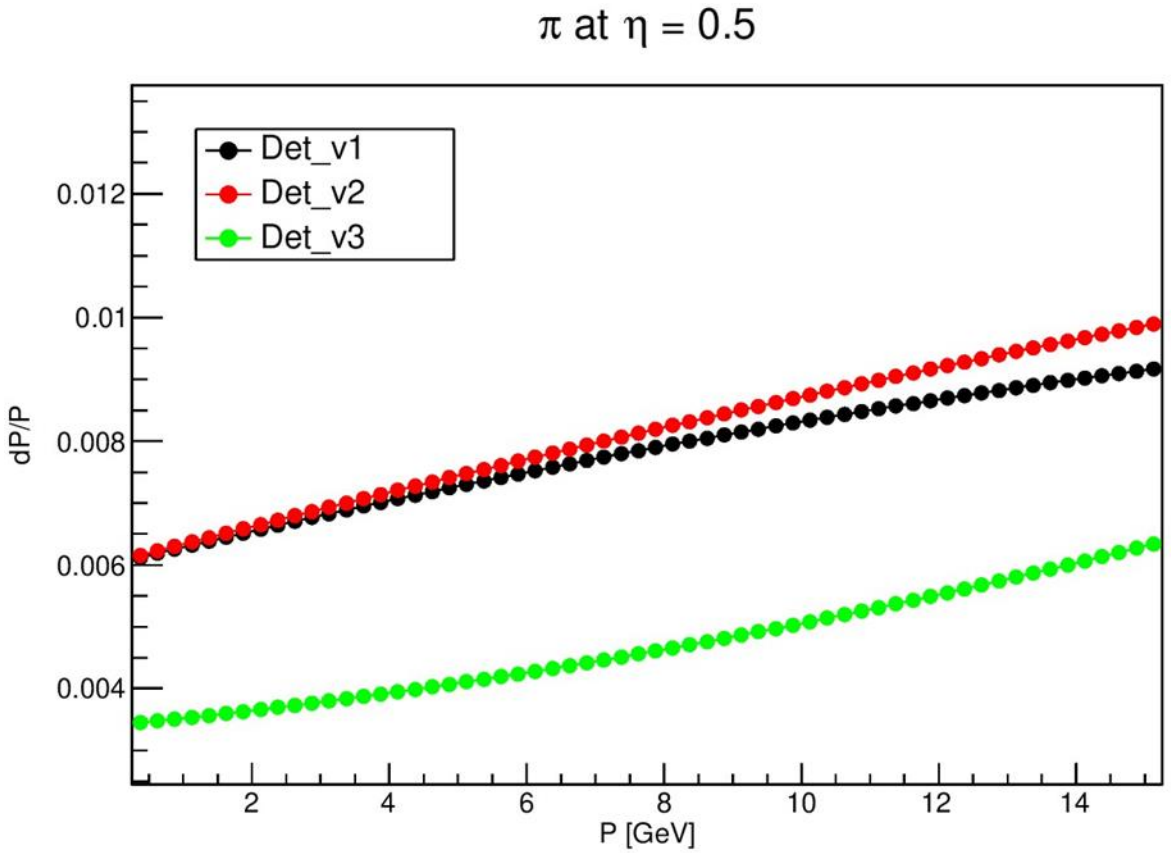
https://gitee.com/aiqiang-guo/EicC_Mvd_DP




AiqiangGuo / EicC_Mvd_DP
代码
Issues 0
Pull Requests 0
Wiki
统计
流水线
DevO
master
分支 1
AiqiangGuo update R
database
document
include
src
.gitignore
Eicc_MVD_DP_V0.png
LICENSE
Initial commit
6天前
README.md
update README.md.
1天前
master
EicC_Mvd_DP / src
AiqiangGuo Update the efficiency for Det_v0 ea640cd 14天前
...
output
Update the efficiency for Det_v0
EicC_Mvd_DP.cxx
Update the efficiency for Det_v0
comparison.cxx
Add the parameters for Det_v3
validation.cxx
Add the Lambda resolution and effic

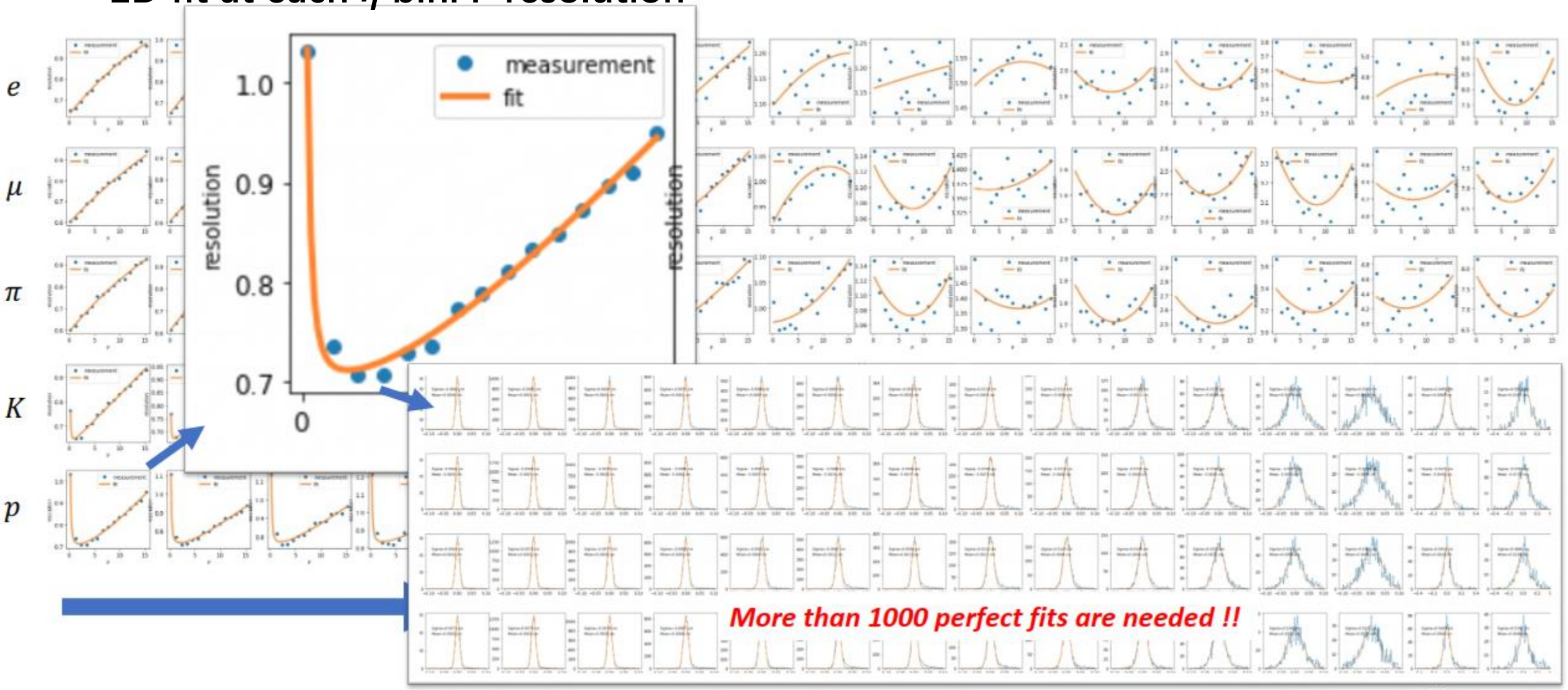
Validation and comparison





The performance parameterization

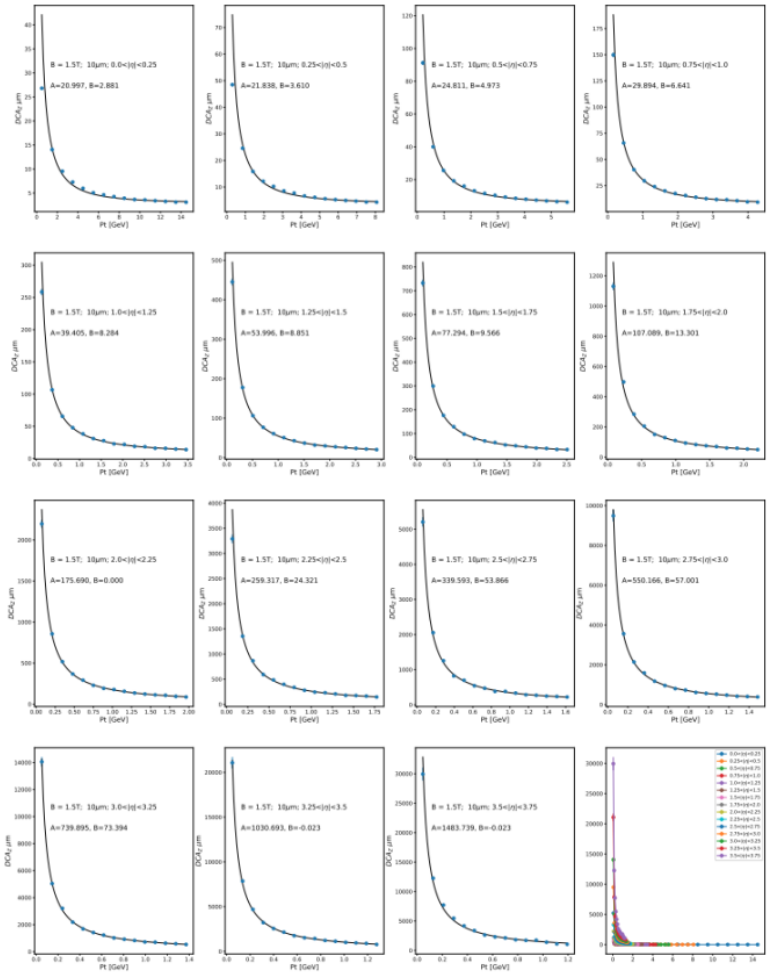
1D fit at each η bin: P resolution



The performance parameterization

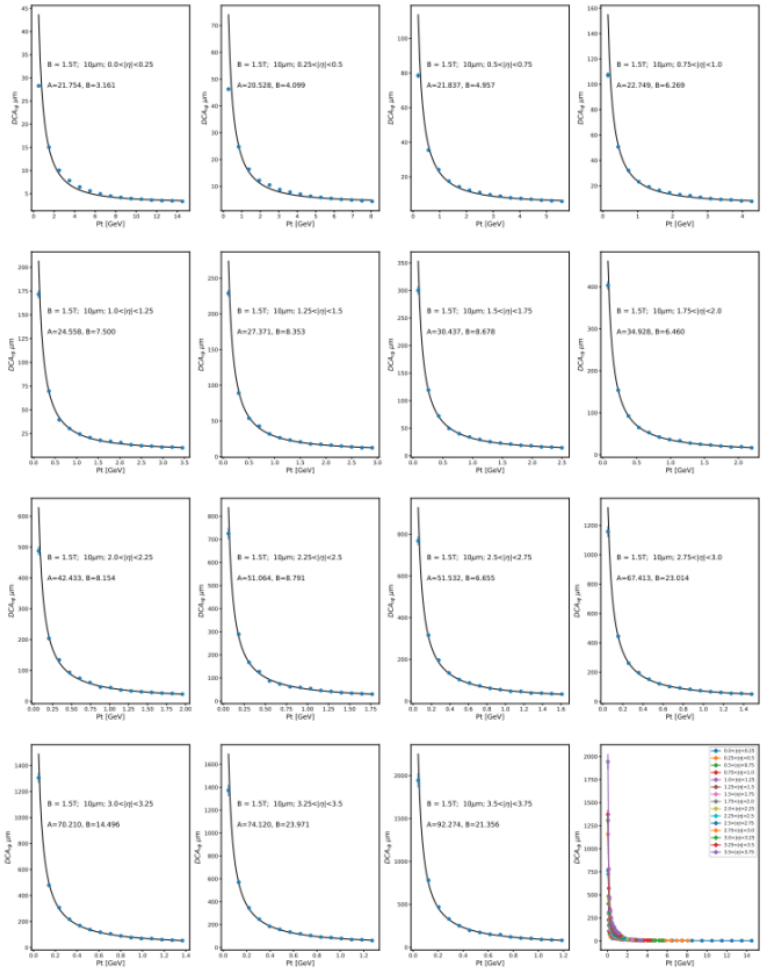
1D fit at each η bin: DCA resolution

e



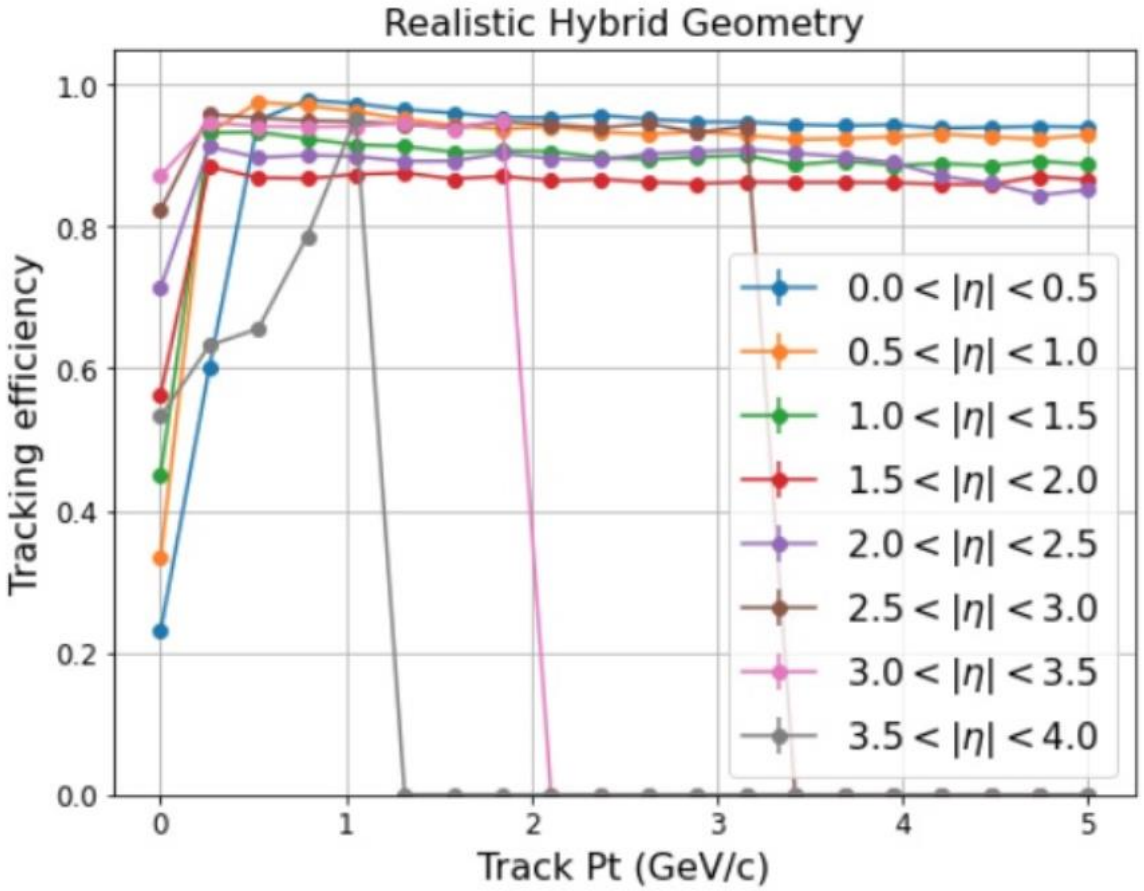
DCA_z

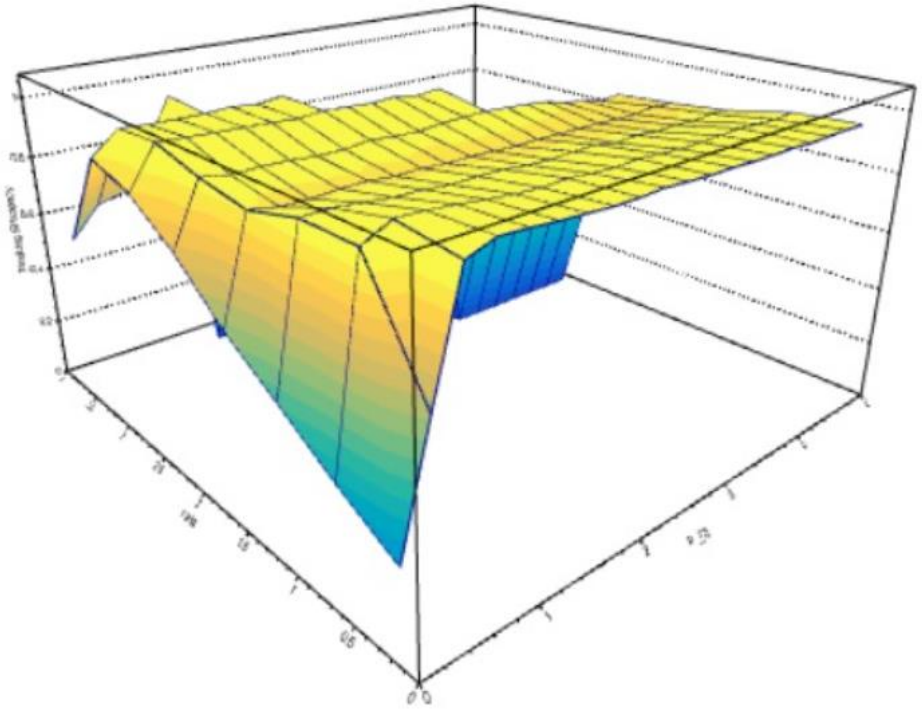
e



$DCA_{r\phi}$

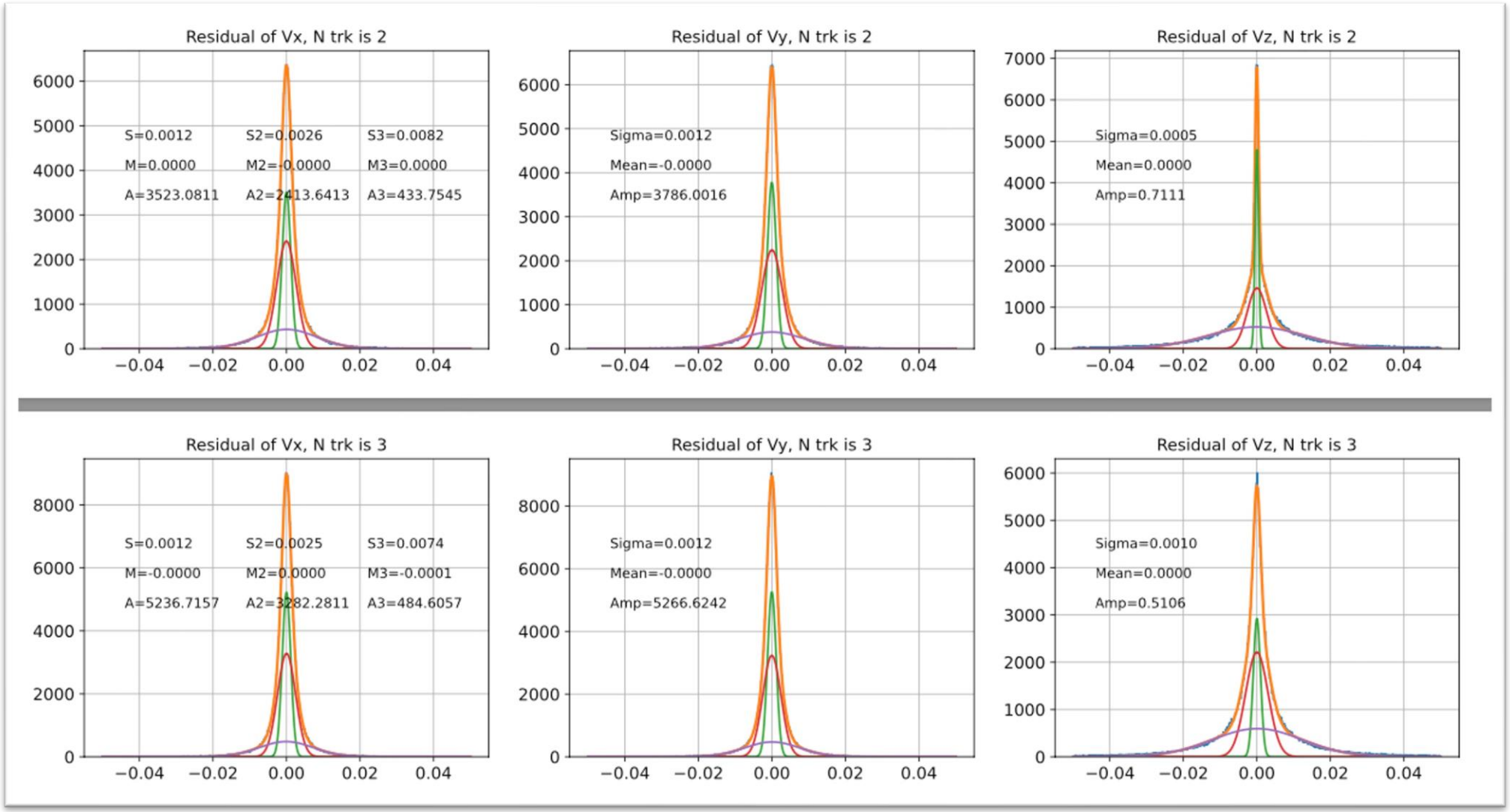
Tracking efficiency



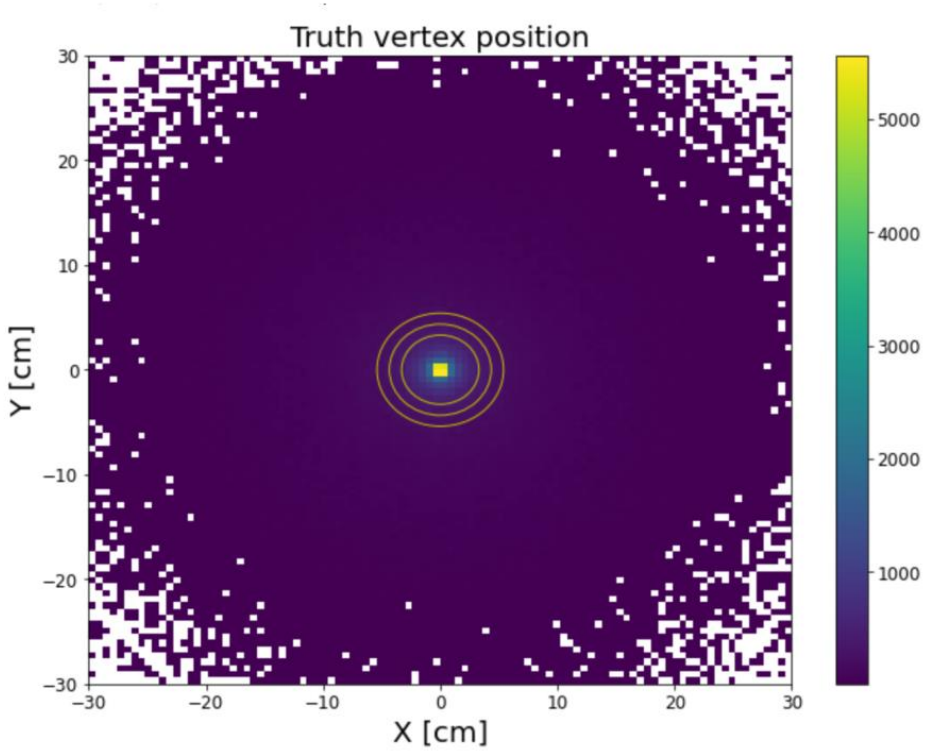


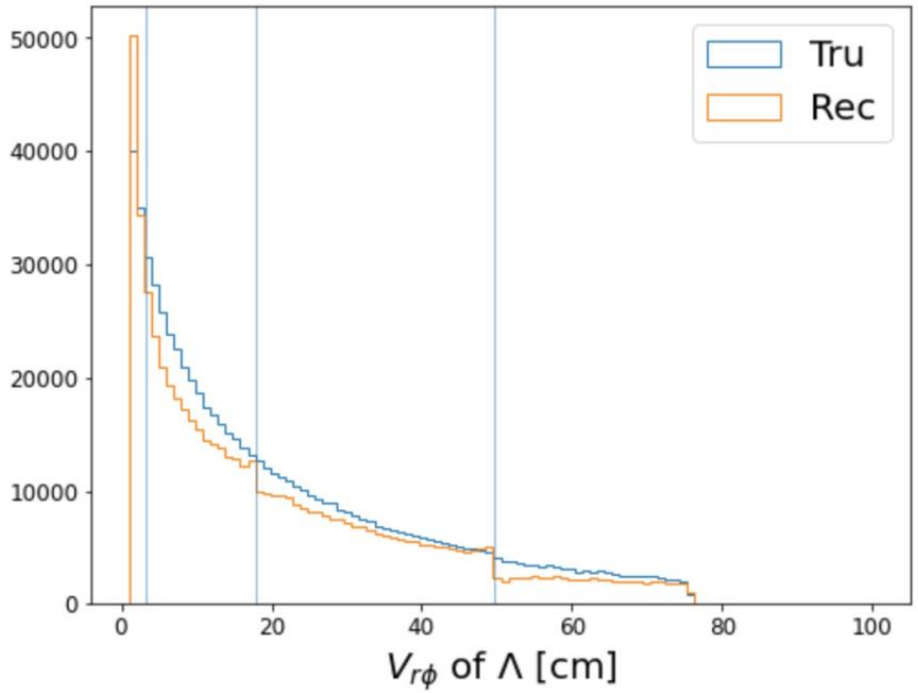
H2D_Eff	
Entries	160
Mean x	2.291
Mean y	1.619
Std Dev x	1.405
Std Dev y	0.9870

Vertex resolution vs multiplicity



Performance study for Λ decay (0~15GeV)

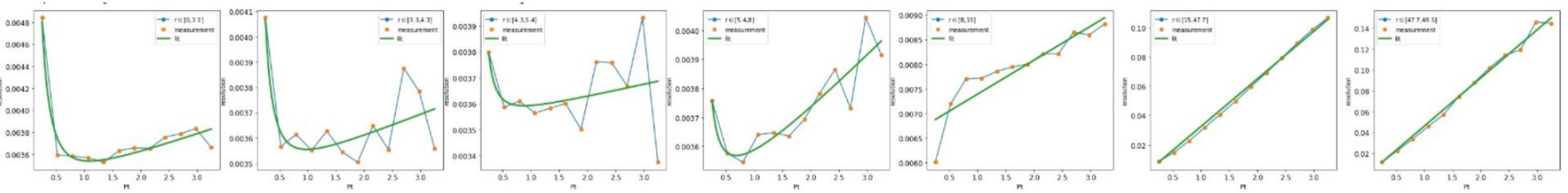




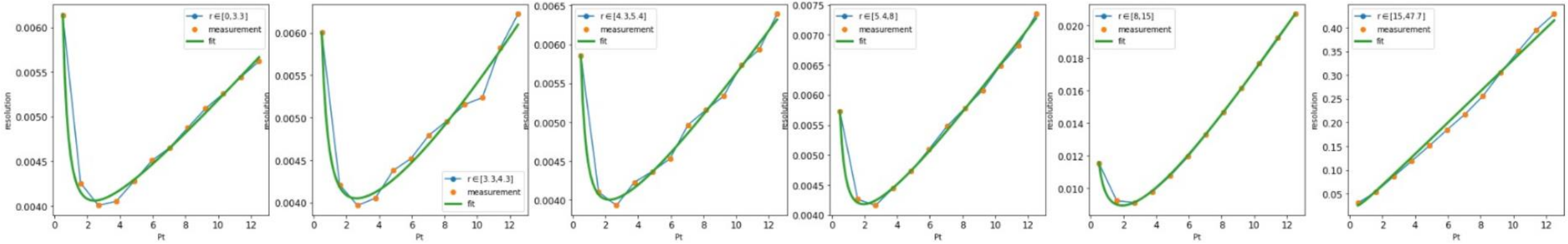
- **Separate the barrel and end-cap region**
- **Separate the particle type**
- **Study the momentum as function of Vr (barrel) or Vz(endcap) and Pt**

Parameterization (barrel)

π

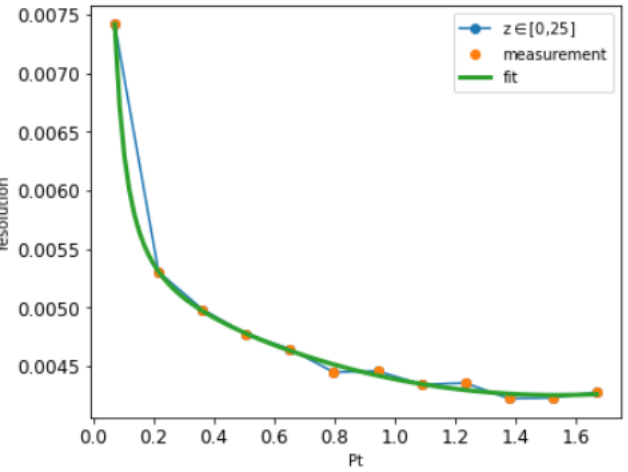


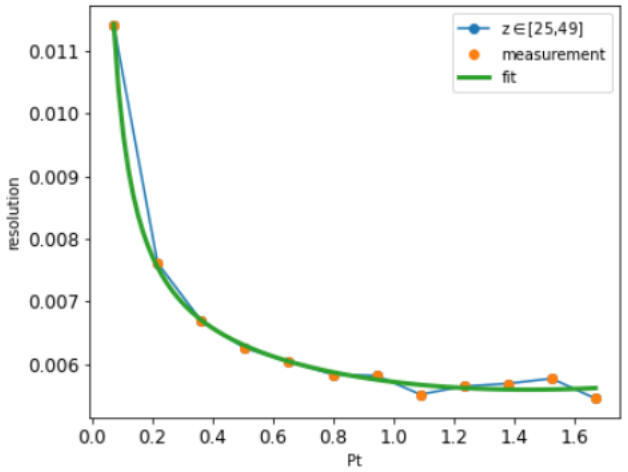
p

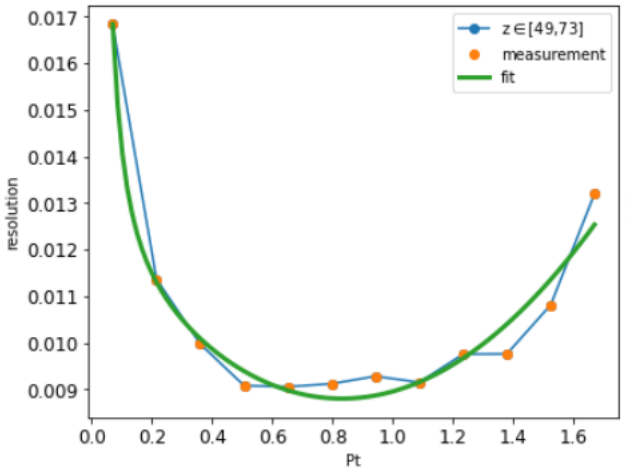


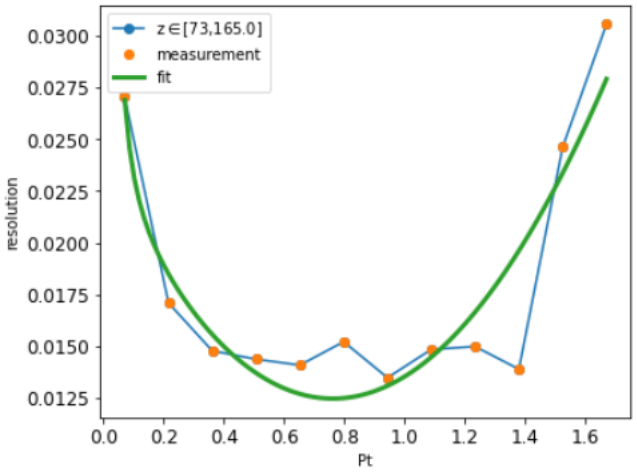
Parameterization (end-cap)

π









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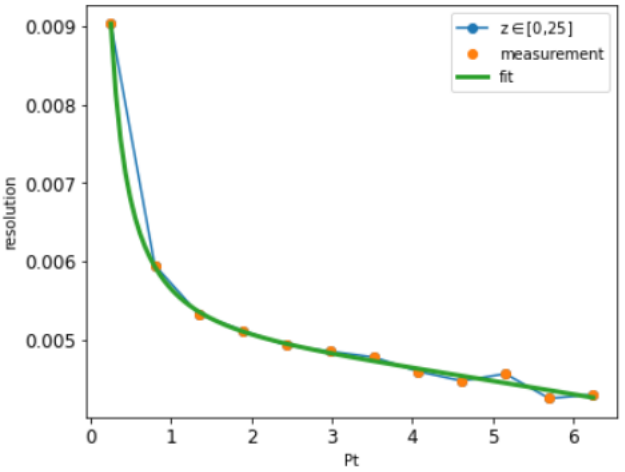
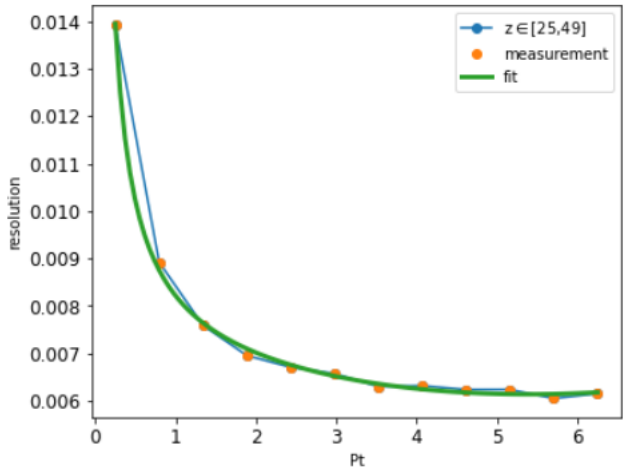
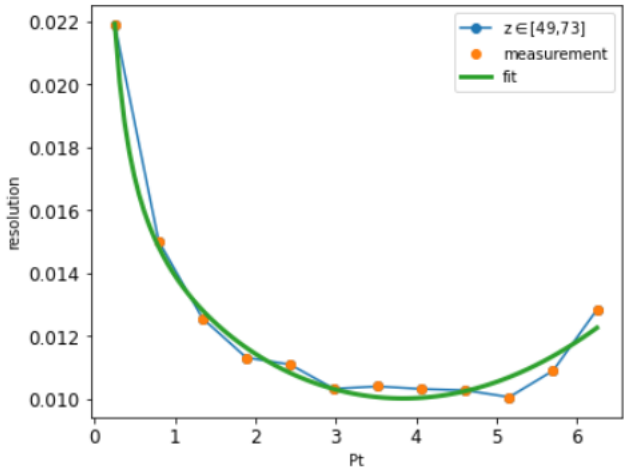
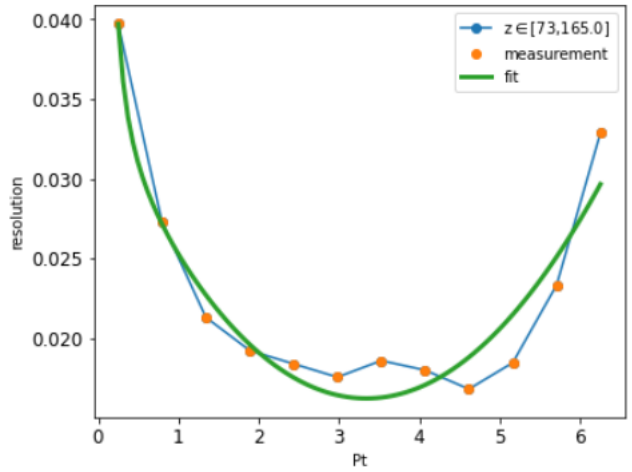
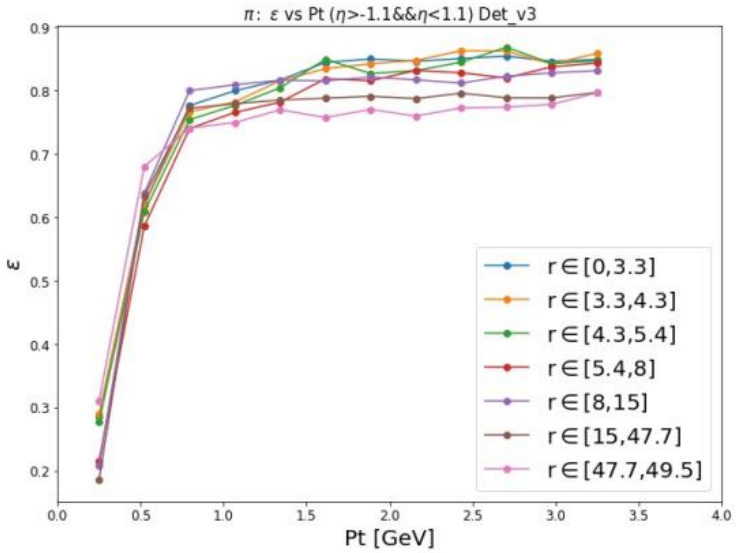


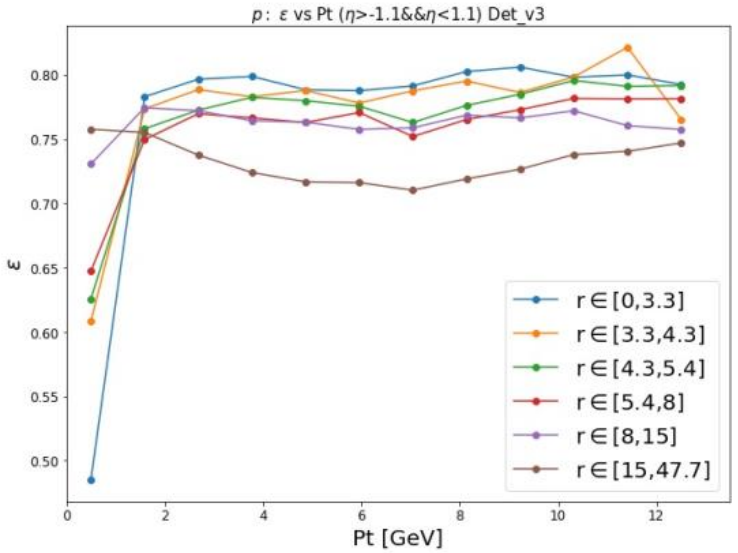


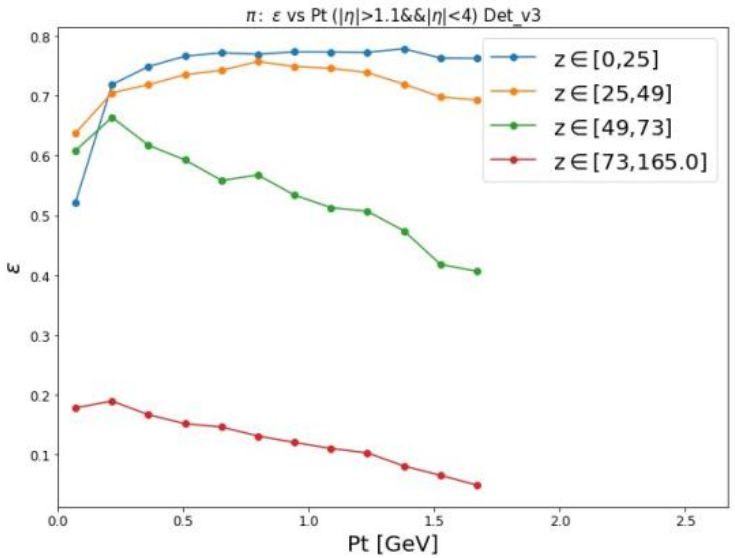


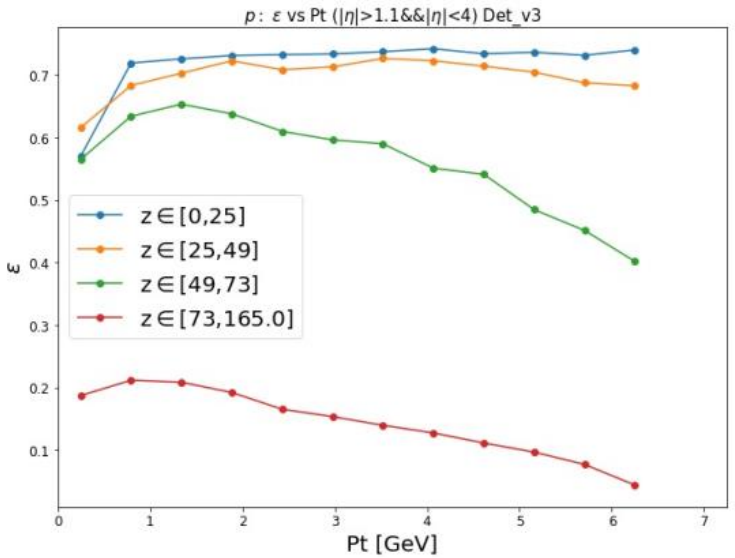


Efficiency

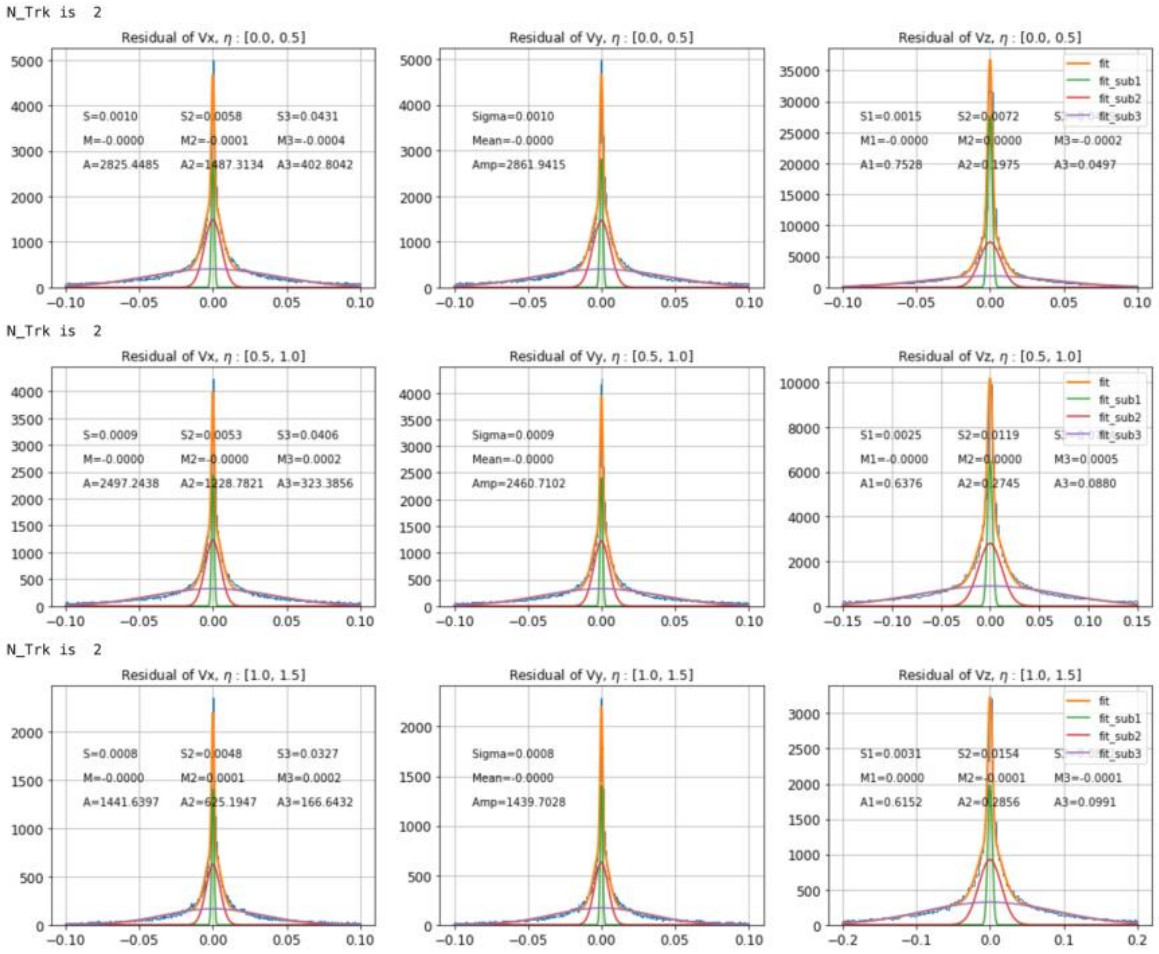

π: ε vs Pt (η>-1.1&&η<1.1) Det_v3
ε
Pt [GeV]
r∈[0,3.3]
r∈[3.3,4.3]
r∈[4.3,5.4]
r∈[5.4,8]
r∈[8,15]
r∈[15,47.7]
r∈[47.7,49.5]

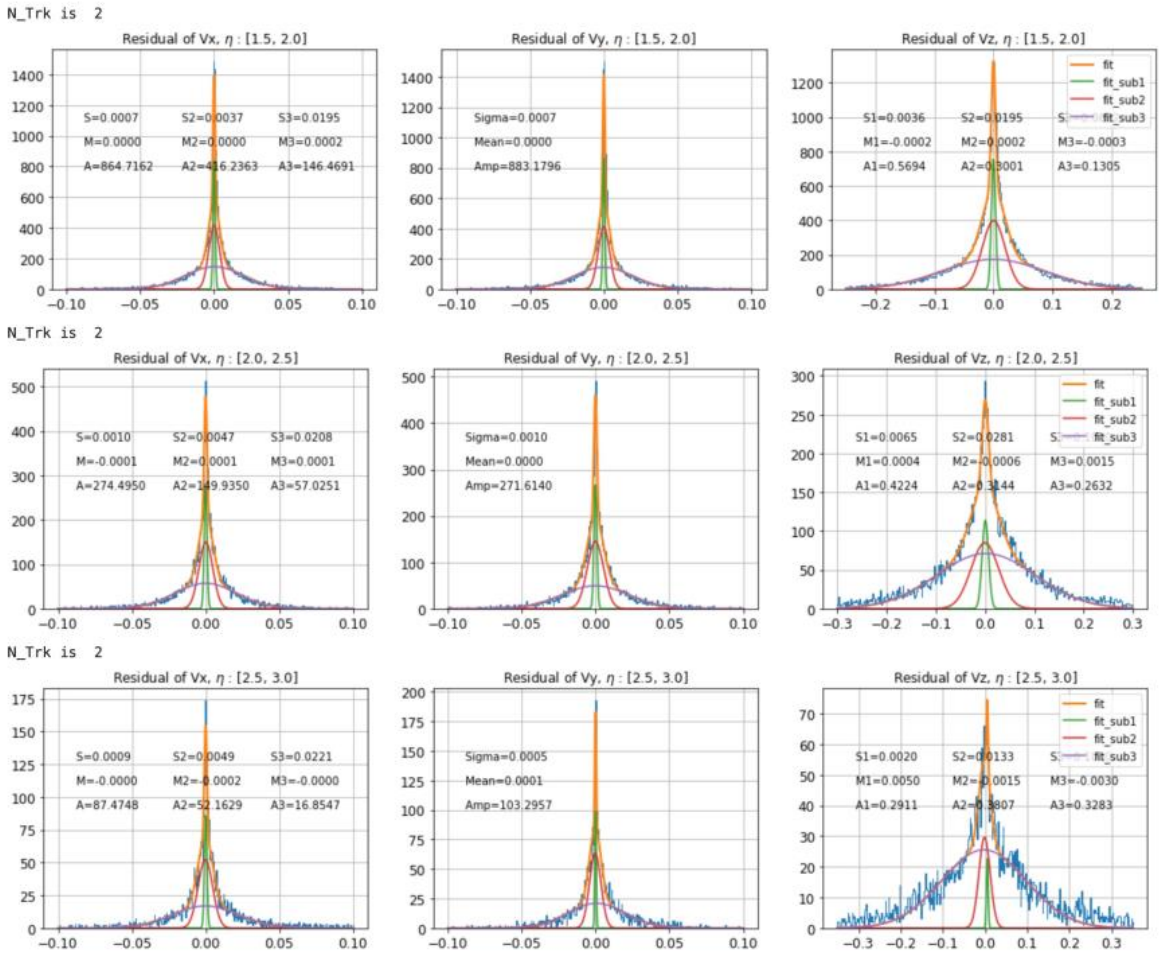

p: ε vs Pt (η>-1.1&&η<1.1) Det_v3
ε
Pt [GeV]
r∈[0,3.3]
r∈[3.3,4.3]
r∈[4.3,5.4]
r∈[5.4,8]
r∈[8,15]
r∈[15,47.7]


π: ε vs Pt (|η|>1.1&&|η|<4) Det_v3
ε
Pt [GeV]
z∈[0,25]
z∈[25,49]
z∈[49,73]
z∈[73,165.0]


p: ε vs Pt (|η|>1.1&&|η|<4) Det_v3
ε
Pt [GeV]
z∈[0,25]
z∈[25,49]
z∈[49,73]
z∈[73,165.0]

Fit to Vertex residuals vs η of Λ



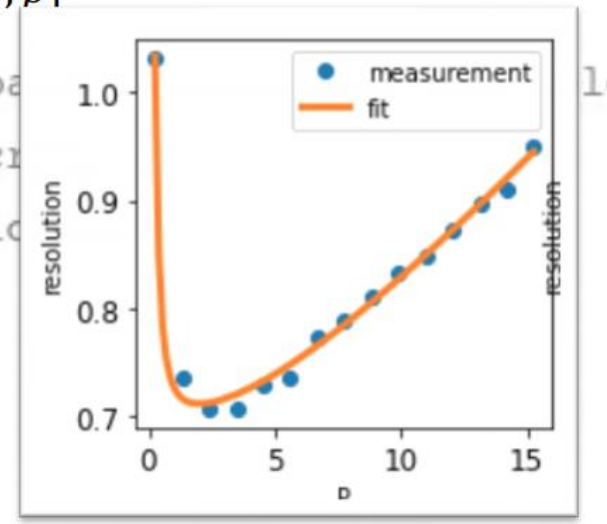


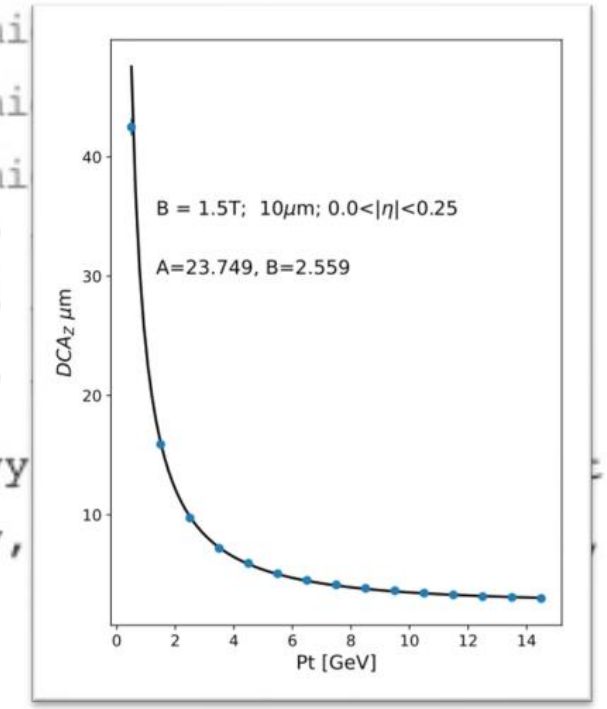
Parameterization of the performance

[0,1,2,3,4]=>$[e, \mu, \pi, K, p]$

```
//Get the detector resolutions
double GetResP(double p, double eta, int par);
double GetResDCAz(double pt, double eta, int par);
double GetResDCArp(double pt, double eta,int par);
double GetEff(double pt, double eta, int par); // Unit: 1
double GetRandomVx(int nTrk); // Unit: mi
double GetRandomVz(int nTrk); // Unit: mi
double GetLambdaRandomVx(double eta); //
double GetLambdaRandomVy(double eta); //
double GetLambdaRandomVz(double eta); //
double GetLambdaResP(double vx, double vy
double GetLambdaEff(double vx, double vy,
```

Performance of track from IP





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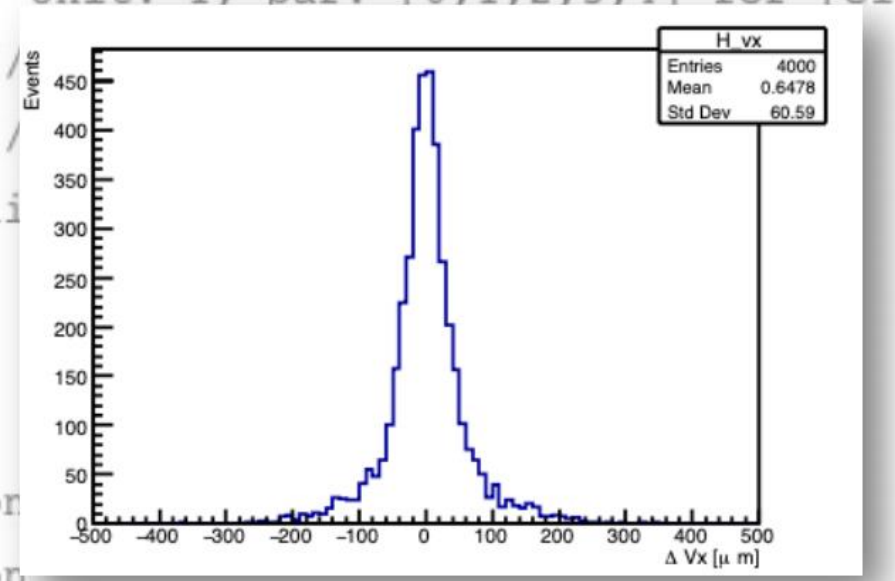
Parameterization of the performance

[0,1,2,3,4]=>$[e, \mu, \pi, K, p]$

```
//Get the detector resolutions
double GetResP(double p, double eta, int par);     // Unit: 1; par: [0,1,2,3,4] for [ele
double GetResDCAz(double pt, double eta, int par); //
                                                   //
double GetEff(double pt, double eta, int par); // Uni
double GetRandomVx(int nTrk); // Unit: micron
double GetRandomVy(int nTrk); // Unit: micron
double GetRandomVz(int nTrk); // Unit: micron
double GetLambdaRandomVx(double eta); // Unit: micron
double GetLambdaRandomVy(double eta); // Unit: micron
double GetLambdaRandomVz(double eta); // Unit: micron
double GetLambdaResP(double vx, double vy, double vz, double pt, double eta, int par);
double GetLambdaEff(double vx, double vy, double vz, double pt, double eta, int par);
```

Primary vertex resolution for inclusive event



Parameterization of the performance

[0,1,2,3,4]=>$[e, \mu, \pi, K, p]$

```
//Get the detector resolutions
double GetResP(double p, double eta, int par);     // Unit: 1; par: [0,1,2,3,4] for [ele
double GetResDCAz(double pt, double eta, int par); // Unit: micron
double GetResDCArp(double pt, double eta,int par); // Unit:: micron
double GetEff(double pt, double eta, int par); // Unit: 1
double GetRandomVx(int nTrk); // Unit: micron
dou
double GetRandomVz(int nTrk); // Unit: micron
```

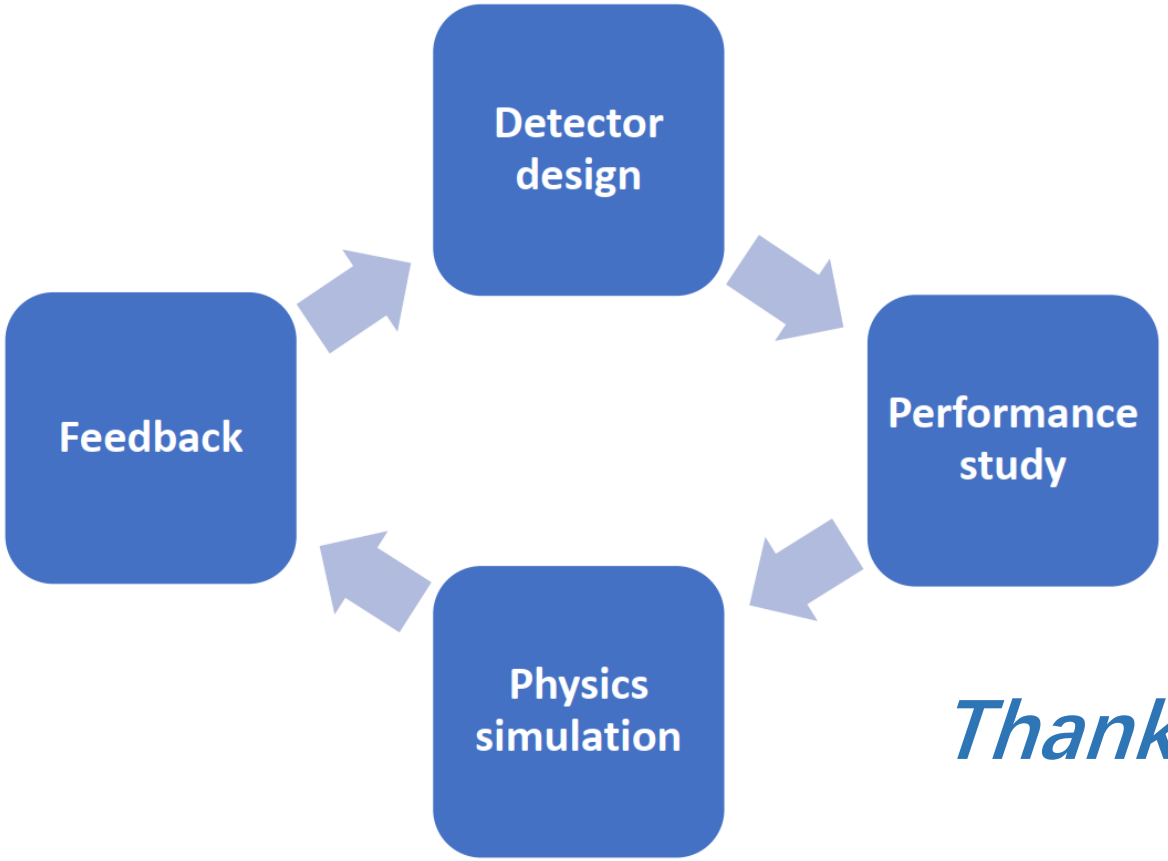
Performance for long life particle decay

```
double GetLambdaRandomVx(double eta); // Unit: micron
double GetLambdaRandomVy(double eta); // Unit: micron
double GetLambdaRandomVz(double eta); // Unit: micron
double GetLambdaResP(double vx, double vy, double vz, double pt, double eta, int par);
double GetLambdaEff(double vx, double vy, double vz, double pt, double eta, int par);
```

Position of the secondary vertex **Kinematic information of daughter particles**

Summary

- Detector design updated to V3, which is ITS3+gaseous hybrid detector. Better performance duo the reduce of material budget and geometry optimization.
- Provide a toolkit to access to detector performance parameters easily for physics simulations.



Thanks for your attention!