EIC tracking simulations and hardware interests

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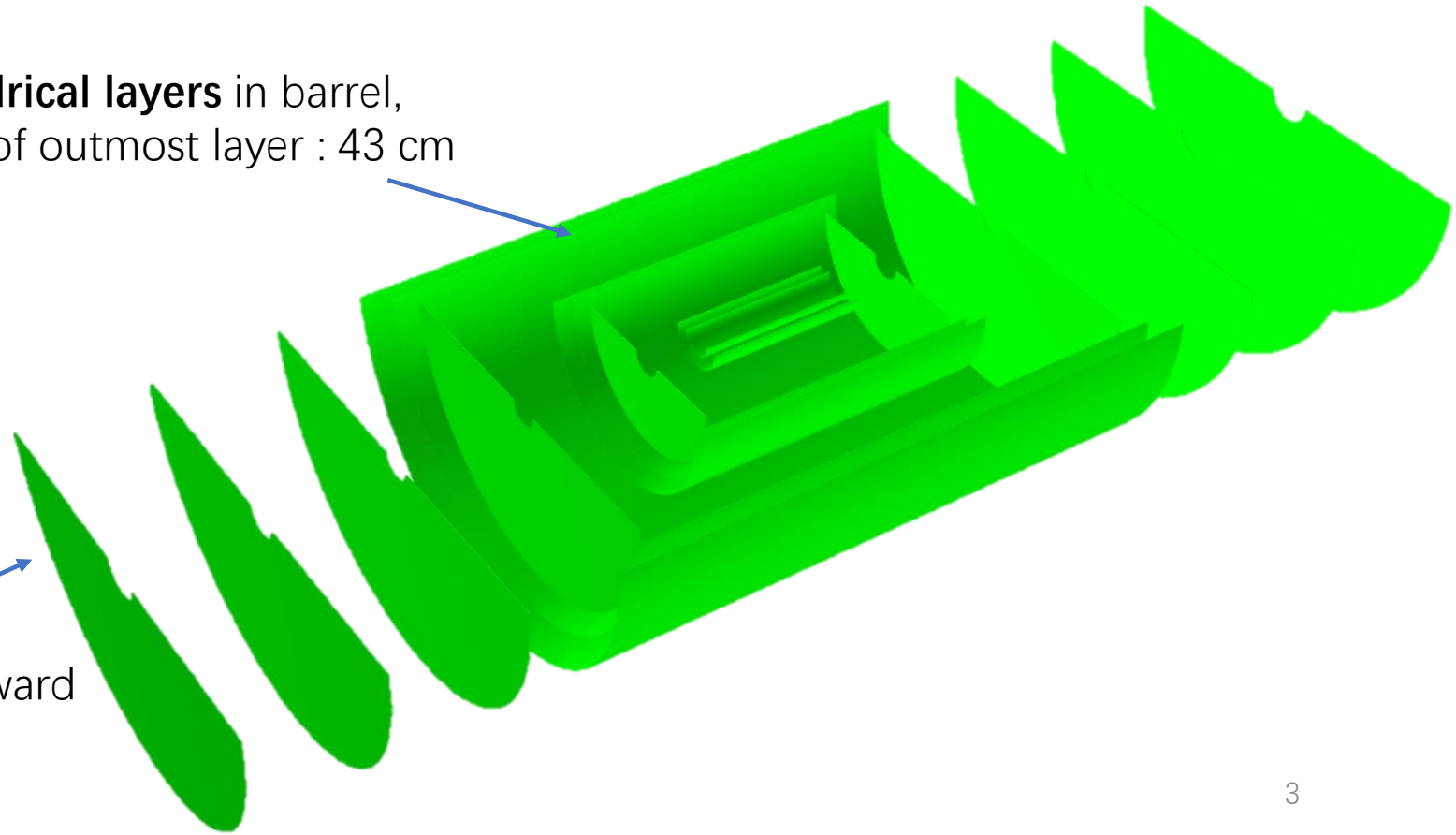
Tracking simulation

- Starting point: eRD25 All-Silicon Tracking design

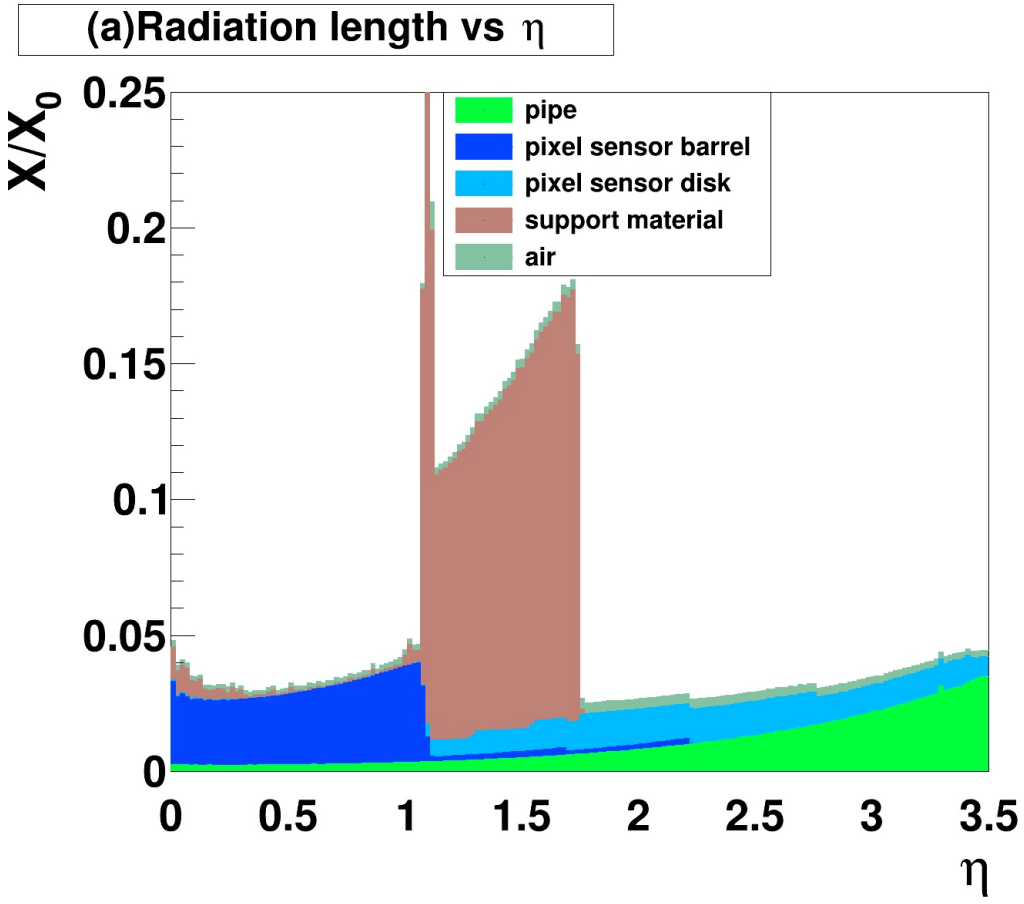
arXiv: 2102. 08337

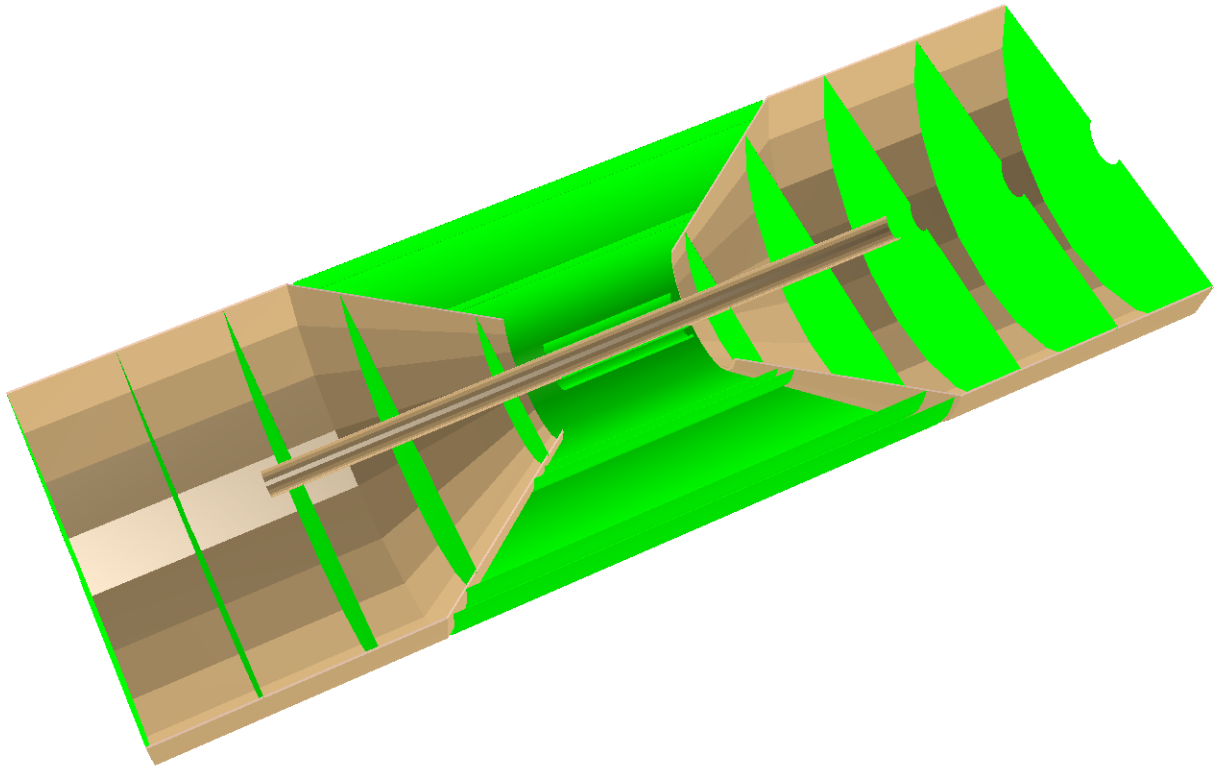
6 cylindrical layers in barrel,
Radius of outmost layer : 43 cm



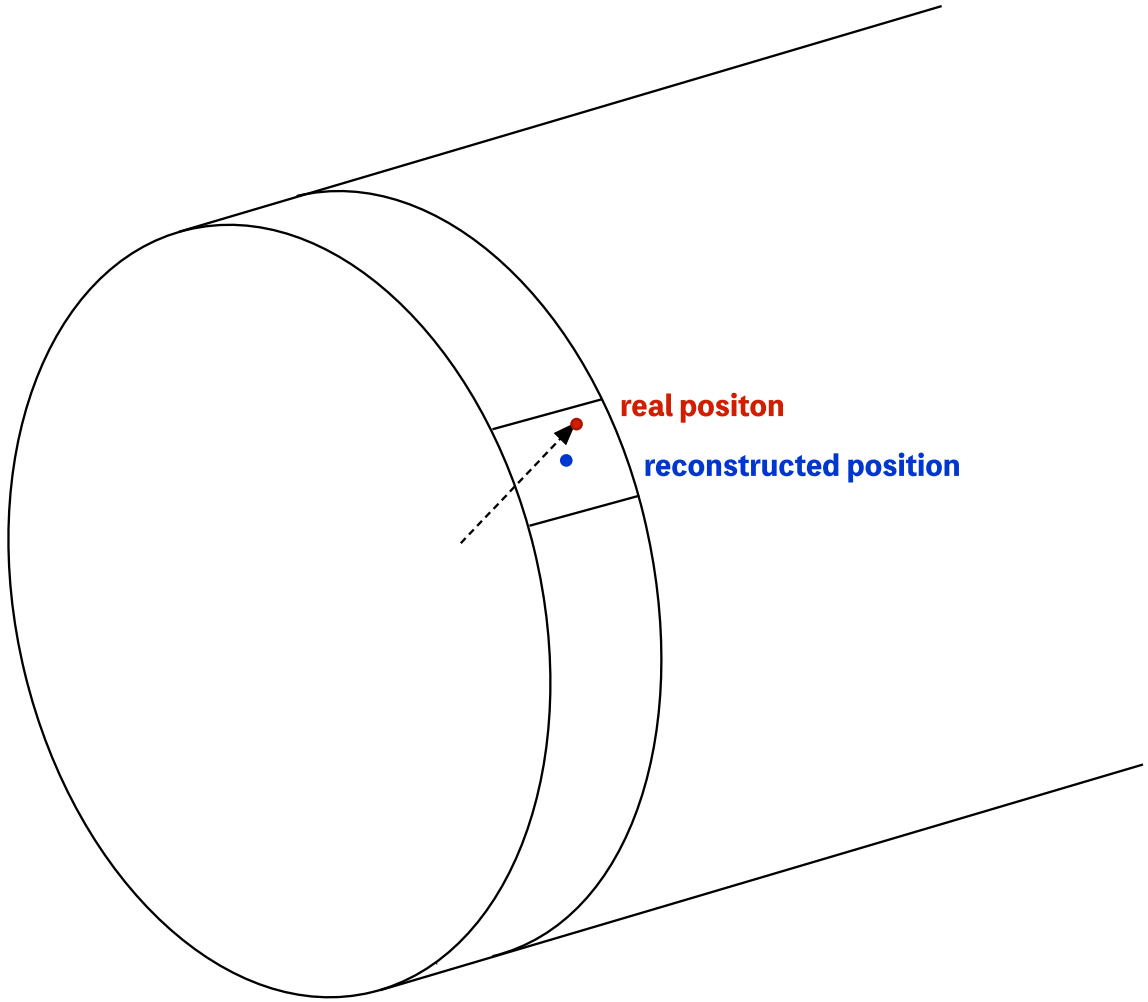
5 disk-like layers in both forward and backward
Z @ ±25, ±49, ±73, ±97, ±123 cm

Simplified geometry with material budget





The work flow



Simulate event in FairRoot framework, get the hit position. Energy loss, multi-scattering and B field are considered

Smear the position of hit according to the pixel size

Feed the smeared measurement to GenFit2, perform the track fitting

Extract the track parameters and calculate residual, momentum, vertex resolution

The tools we are using

Generator

FairRoot framework:
- Generator:
  - EvtGen
  - BoxGen

Track finding

Using MC truth
- Hough transform method in future

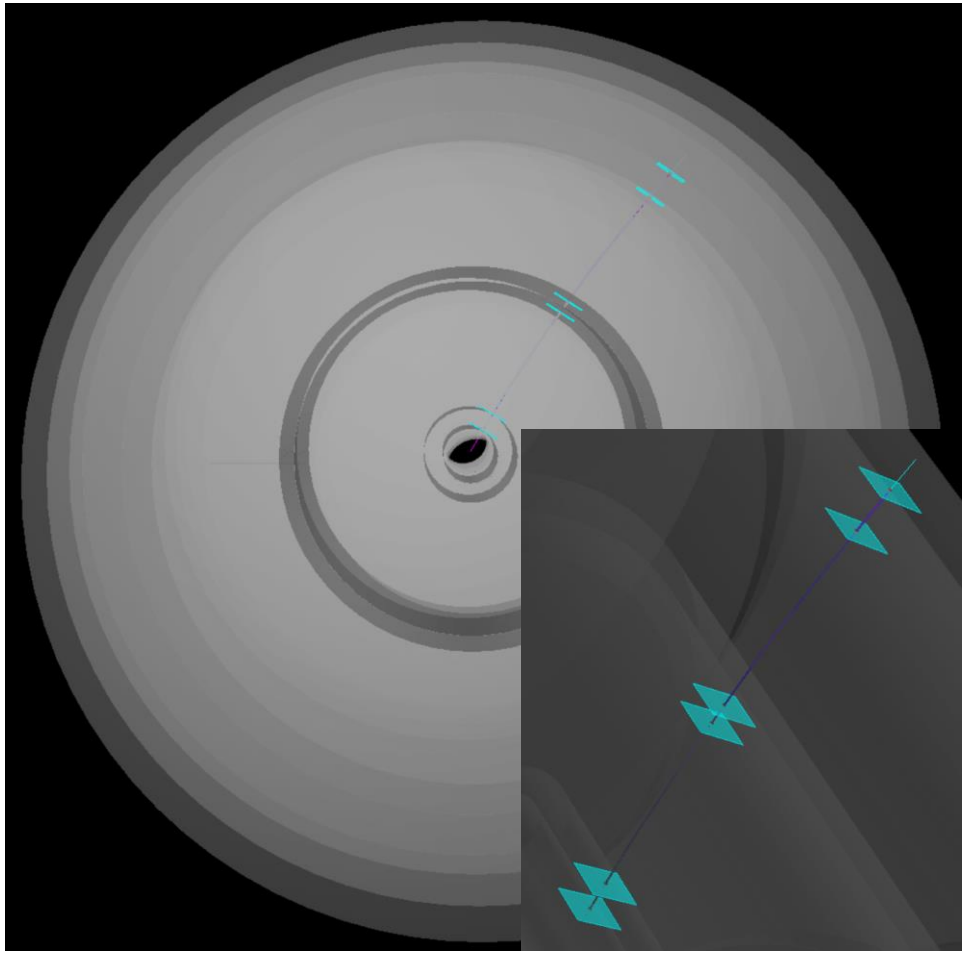
Track fitting

GenFit2
- experiment-independent track-fitting toolkit
- consist of fitting algorithms, track representations, and measurement geometries
- suited for various kinds of tracking detectors

Vertex finding

Rave
- detector-independent toolkit for vertex reconstruction
- ease of use, flexibility for embedding into existing software frameworks

Produced Single track



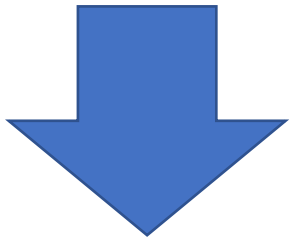
Extract helix parameters using GenFit2

Study of detector performance with different design

- We can use the setup with simple geometry to investigate the different configuration of the detector
  - Pixel size
  - Magnetic field intensity
  - Material budget

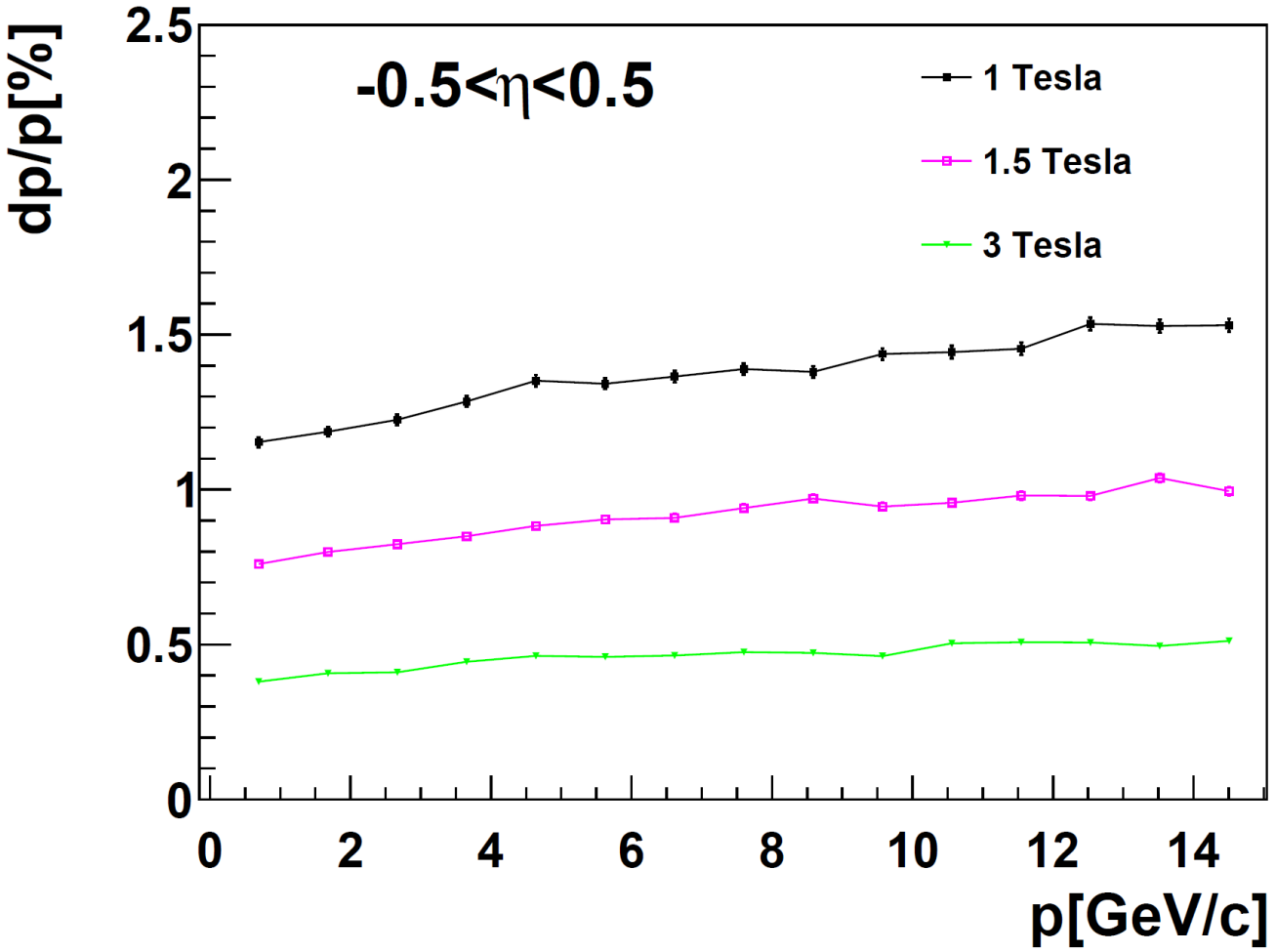
- Vary these parameters one by one, and compare the momentum and vertex resolution

- Get the optimal configuration and the corresponding performance

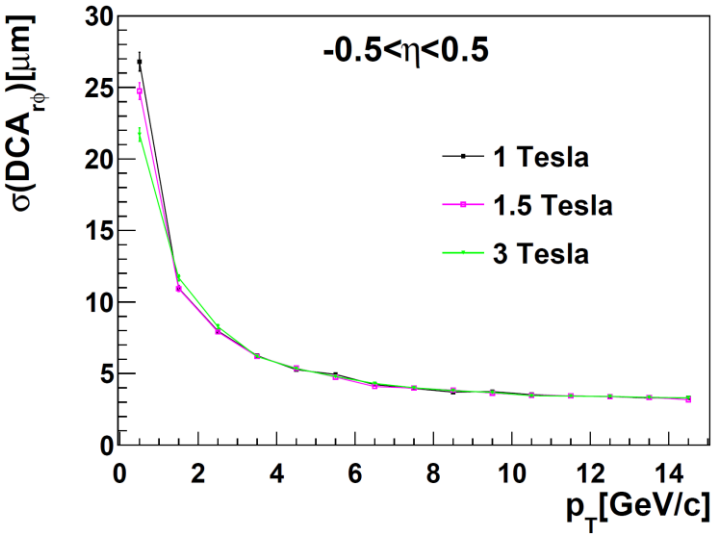


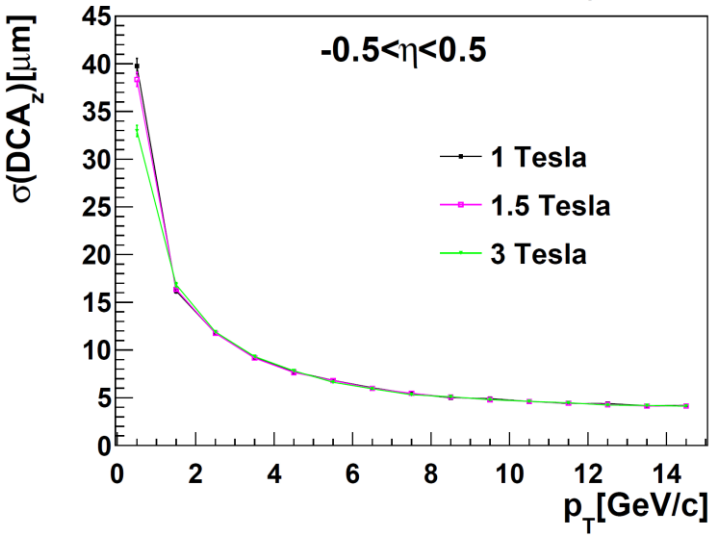
Detailed/realistic geometry setup for the fine tuning

At different magnetic fields



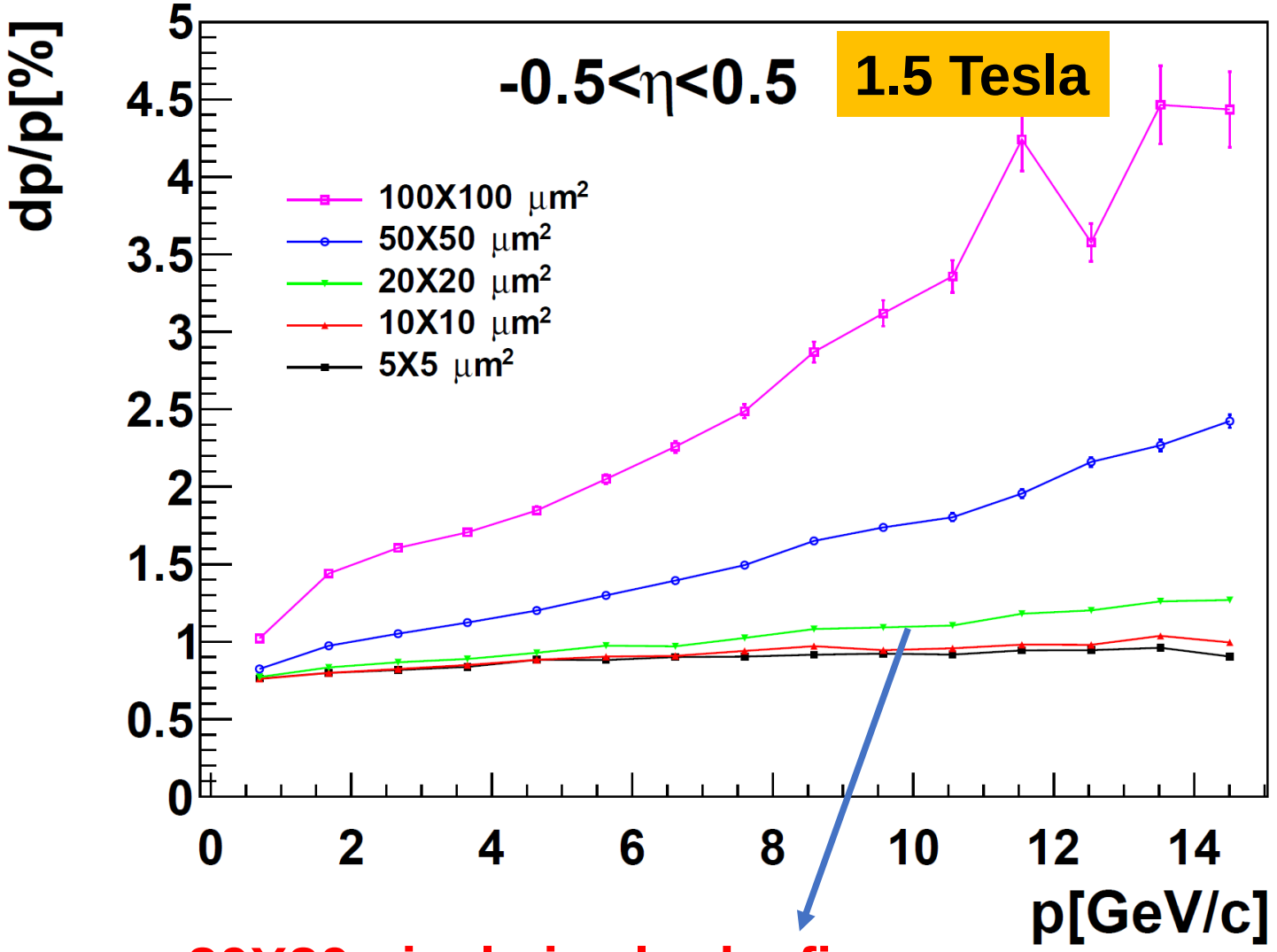
B field will mostly affect the momentum resolution



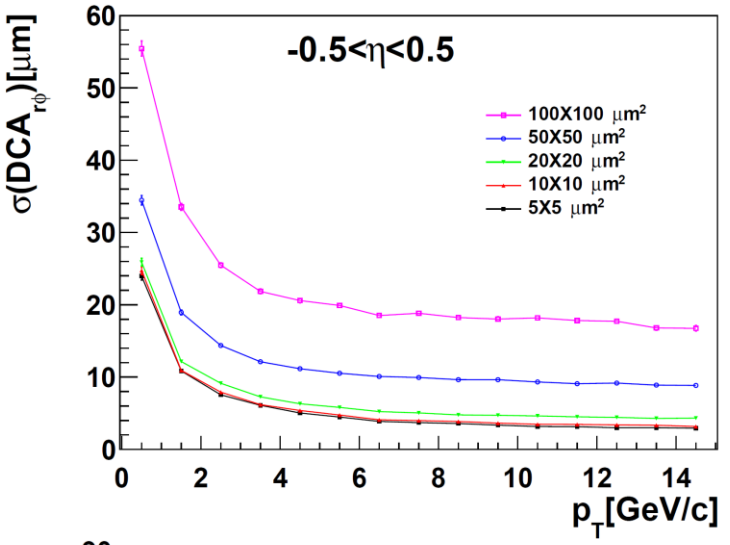


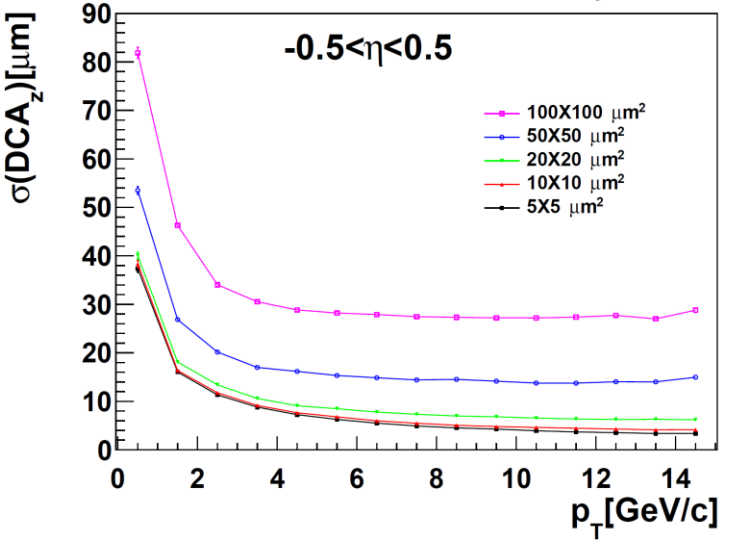
Almost no influence !

At different pixel sizes

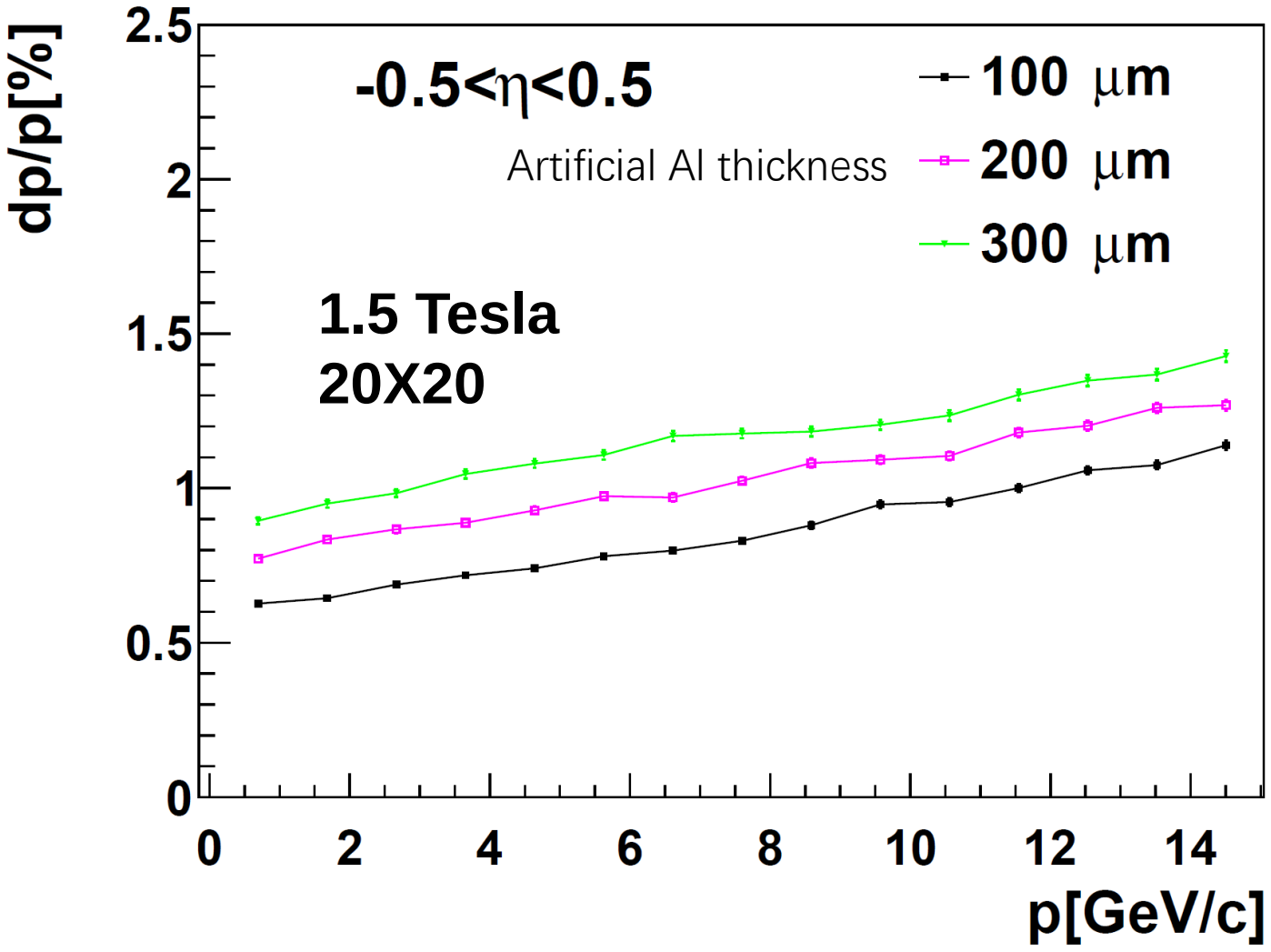


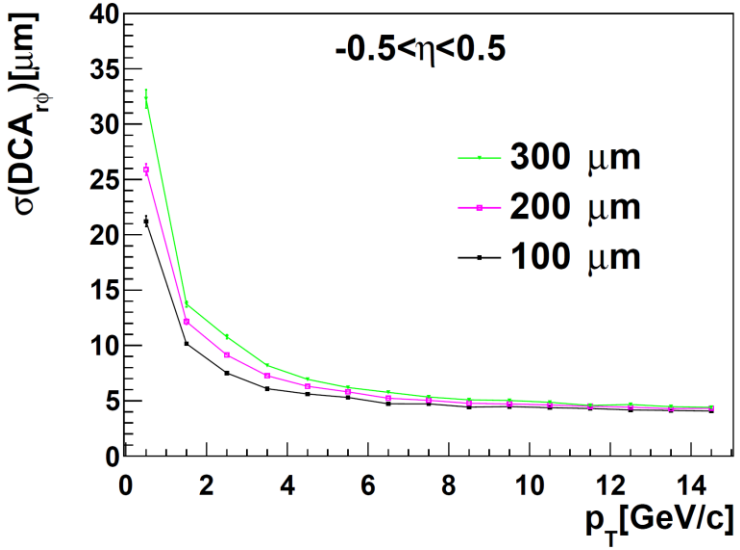
20X20 pixel size looks fine

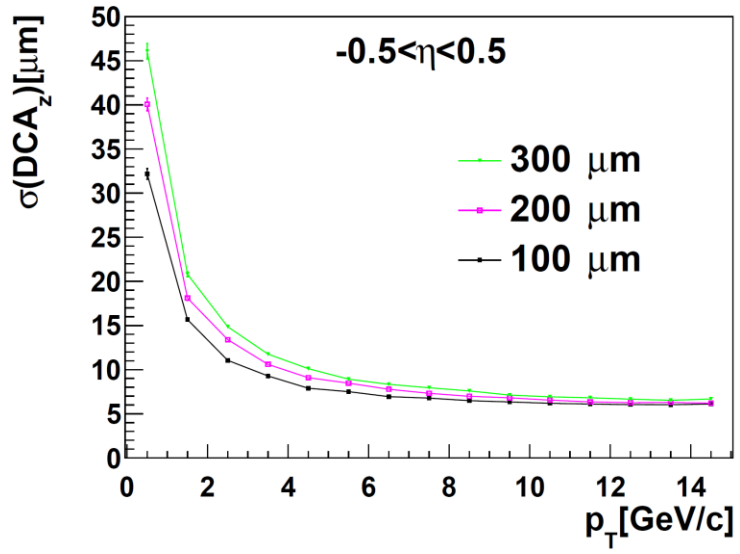




Impacts of different material budget







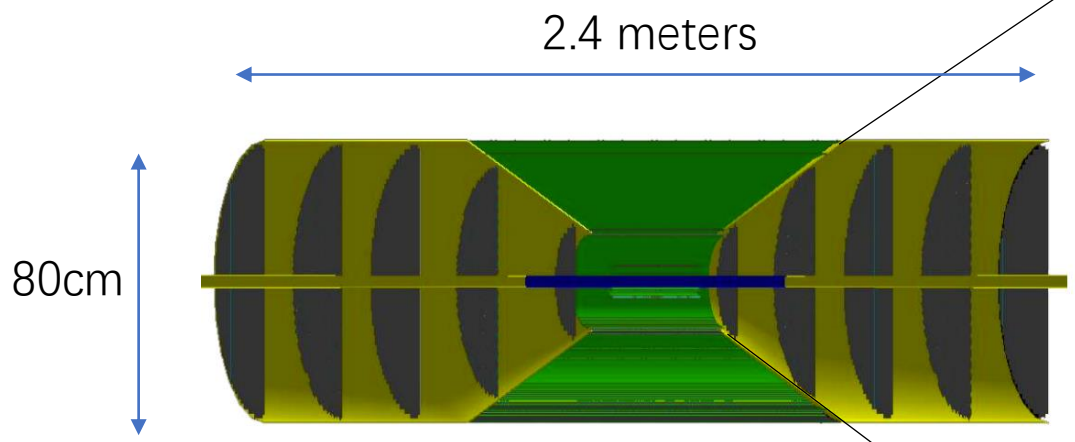
To-do list (1)

tracking system

Silicon

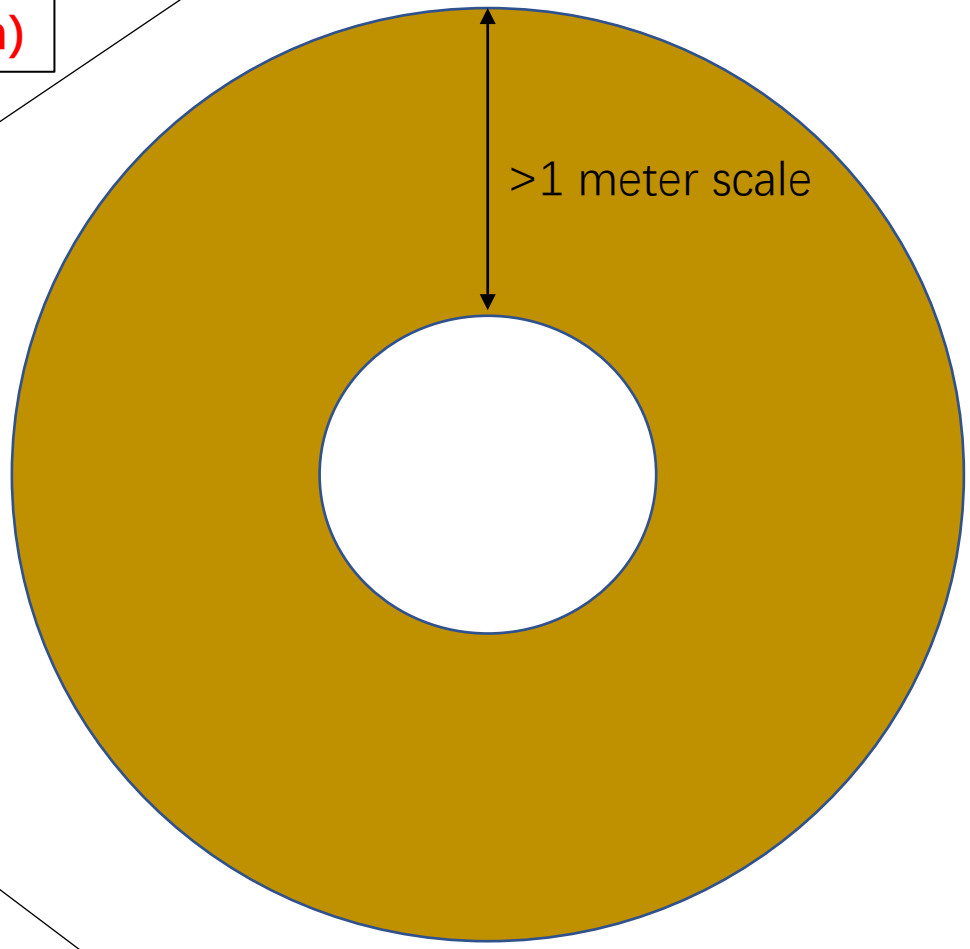
+

Endcap MPGDs outside Si disks (position optimization)



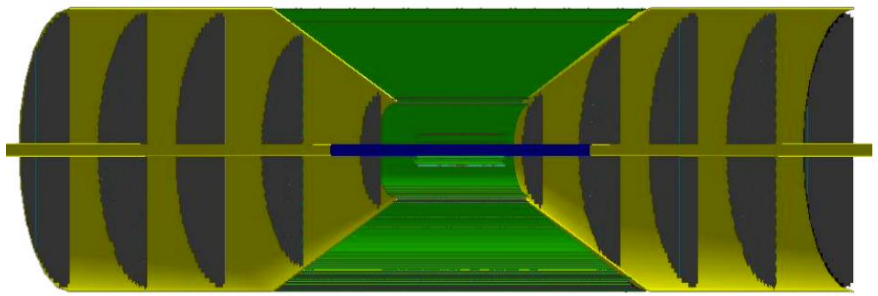
Endcap region: MPGD disks

- Large area coverage
- Resolution ~ 100 microns
- High-rate tolerance
- Cheap



To-do list (2)

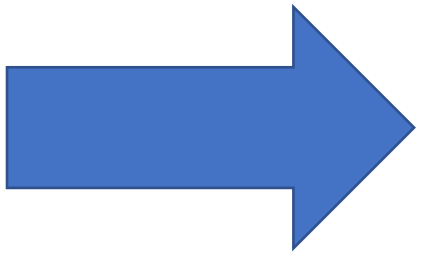
Pion/kaon PID for low momentum particles below PID detector threshold



Cylindrical MPGD → dE/dx → low momentum PID

LGAD → TOF → low momentum PID

Anything else?



Hardware Interests

- Silicon ITS3 with optimizations for EIC application
- MPGDs

Institutes VS hardware interests

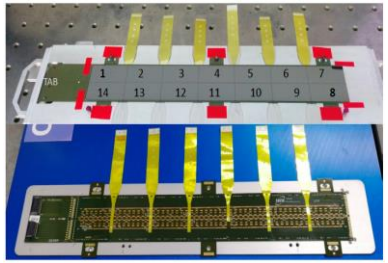
Tracking system

	ECal	MPGD	Silicon
CCNU			• Pixel detector design and assembling • electronics
IMP	Shashlik	• GEM • VMM electronics/etc	• Pixel detector assembling and test • electronics
SCNU	ZDC		
USTC		• GEM/uRWell/MM • VMM electronics/etc	

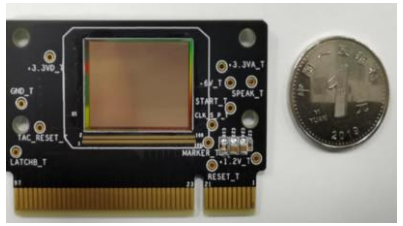
Hardware expertise

Clean rooms of ISO6 and ISO7 (in total of 200 m²), well trained technicians and faculties with expertise on the ALICE ITS2 HIC module assembly & test

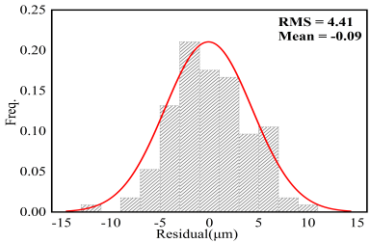
ALICE/ITS2 HIC module mass production (450 modules)



2.4cm x 1.7cm **pixel detector prototype**
MAPS 512 x 400 pixels (40um x 40um)

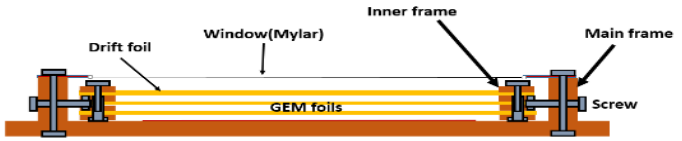


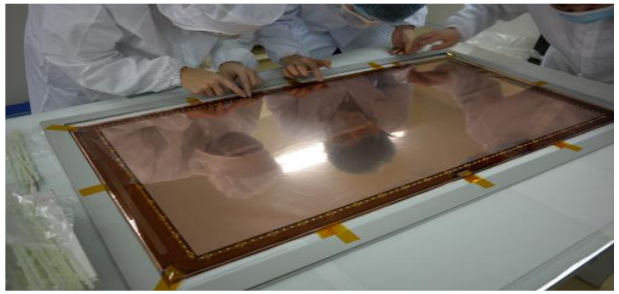
Spatial resolution ~5um



- 25cm x 25 cm **Micromegas** mass production
- R&D on 0.4m x 0.4m

1m x 0.5 m **GEM (self-stretching)**





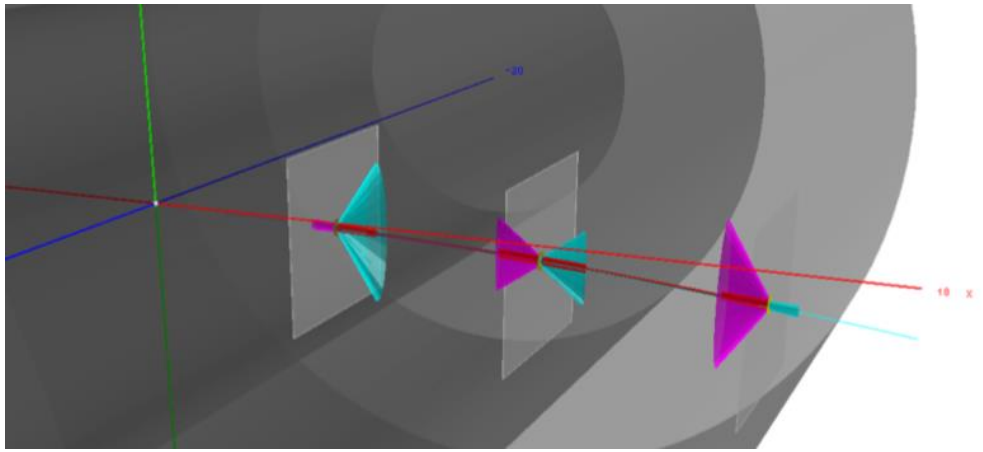
Summary

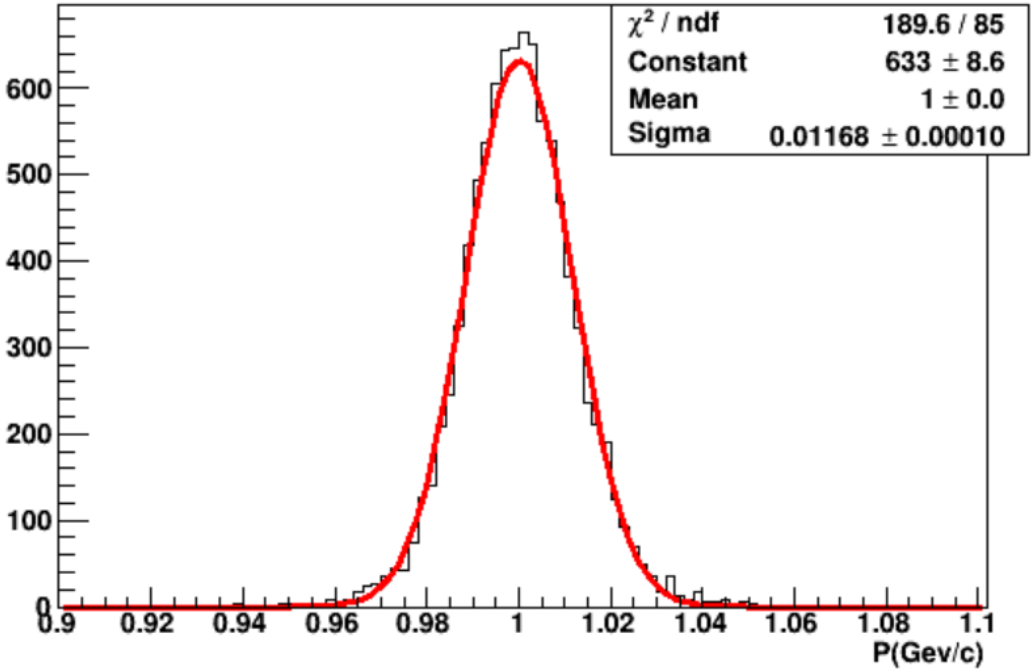
- A “tracking consortium” with several Chinese institutes
  - ✓Physics + Hardware expertise
- Simulation is ongoing focusing on Silicon + MPGD
  - Current work is based on FairRoot
  - Will also try Fun4All in the following days
- Expect non-negligible in-kind contributions to the tracking system

Backups

The momentum resolution

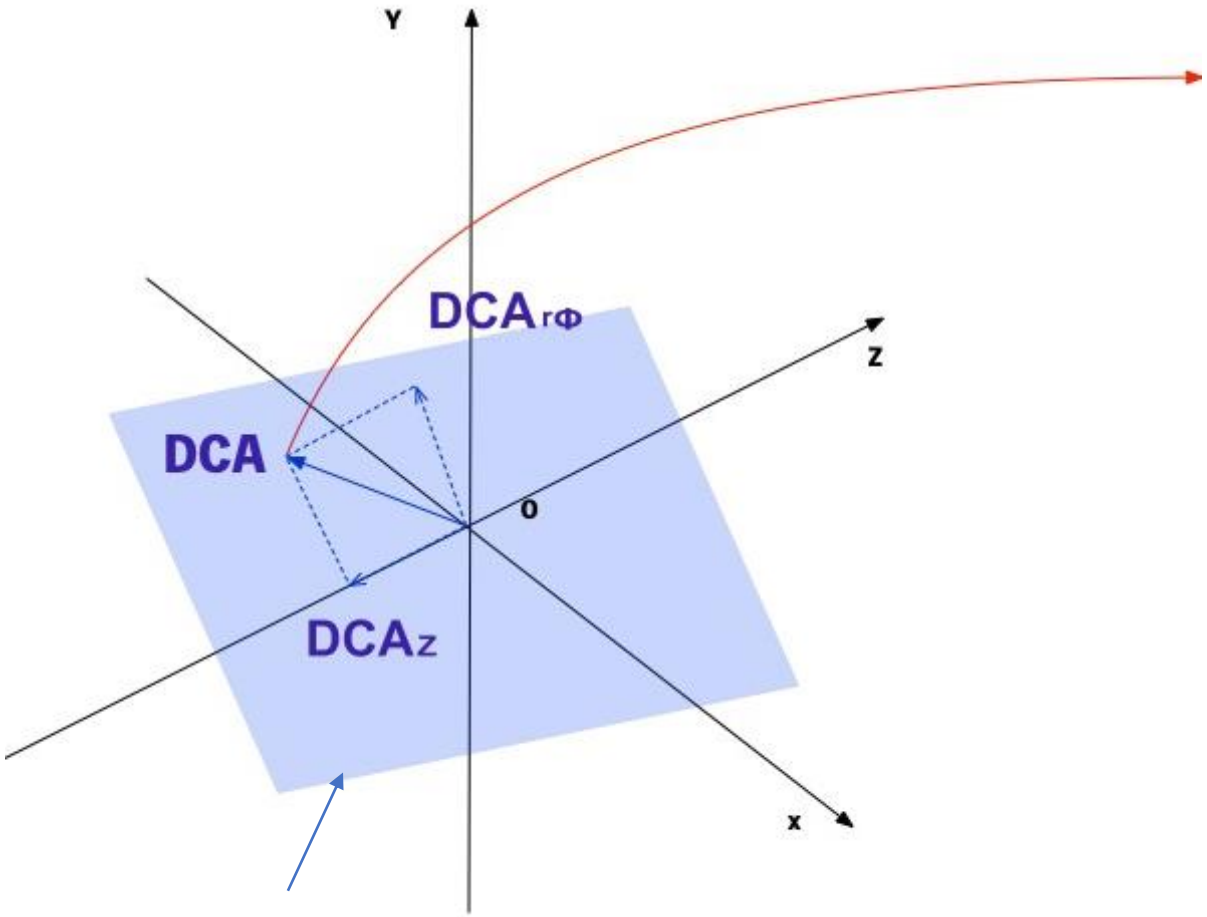
- 10k single μ (1 GeV/c) with BoxGenerator
- Magnetic field : 3T
- Fit by Genfit2
  - Fitter: Kalman Filter
  - Track represent: Runge-Kutta
  - Detector Geometry: planar detector
  - Smoothed track: weighted average between forward fit and backward fit.





- δp/p as a function of momentum
- Impact of different pixel size, number of silicon layers, detector layout, etc.

Vertex resolution



- Vertex resolution study is based on signal track events
- The procedure
  - Fit the track
  - Extrapolate to origin, get the DCA
  - Project DCA to Z and $r\phi$ plane

Cross origin and perpendicular to the momentum of the track