# Recent work on SDT with CEPCSW

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- On behalf of the SDT team -

CEPCSW meeting August 17th, 2020

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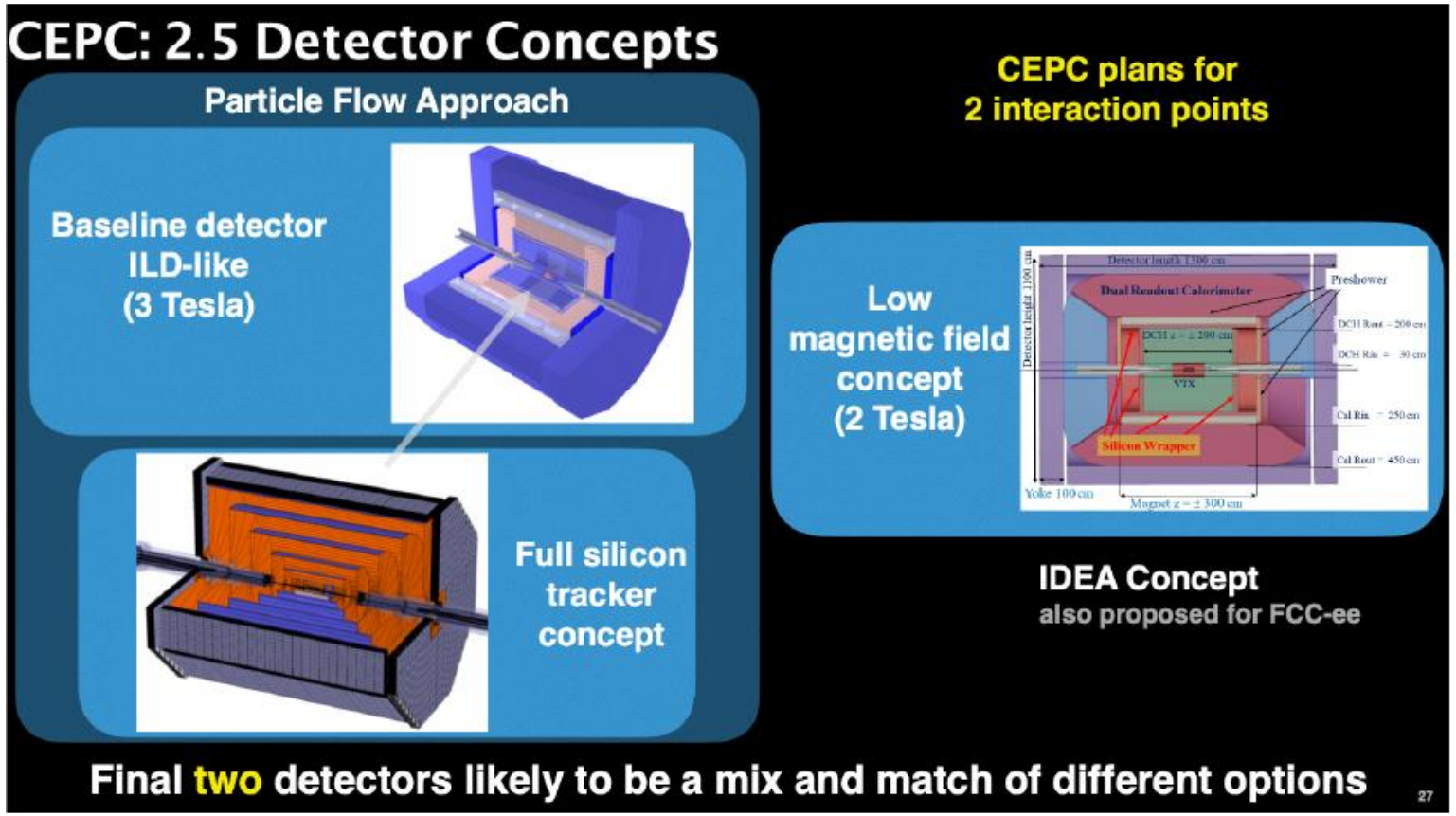
# Introduction of SDT

- Exploring , Silicon + Drift chamber Tracker, option for the CEPC

- Aiming for comparing the performance with already proposed detector configurations.

- with CEPCSW framework

**proposed detector concept in the CDR**




Joao da Costa

# Confirmation of the CEPCSW circumstance

- Forked the repository https://github.comCEPCSW , prepared by Tao

Following the guide

- Run the example script
  -- Examples/options/helloalg.py
  -- Examples/options/tut_detsim.py

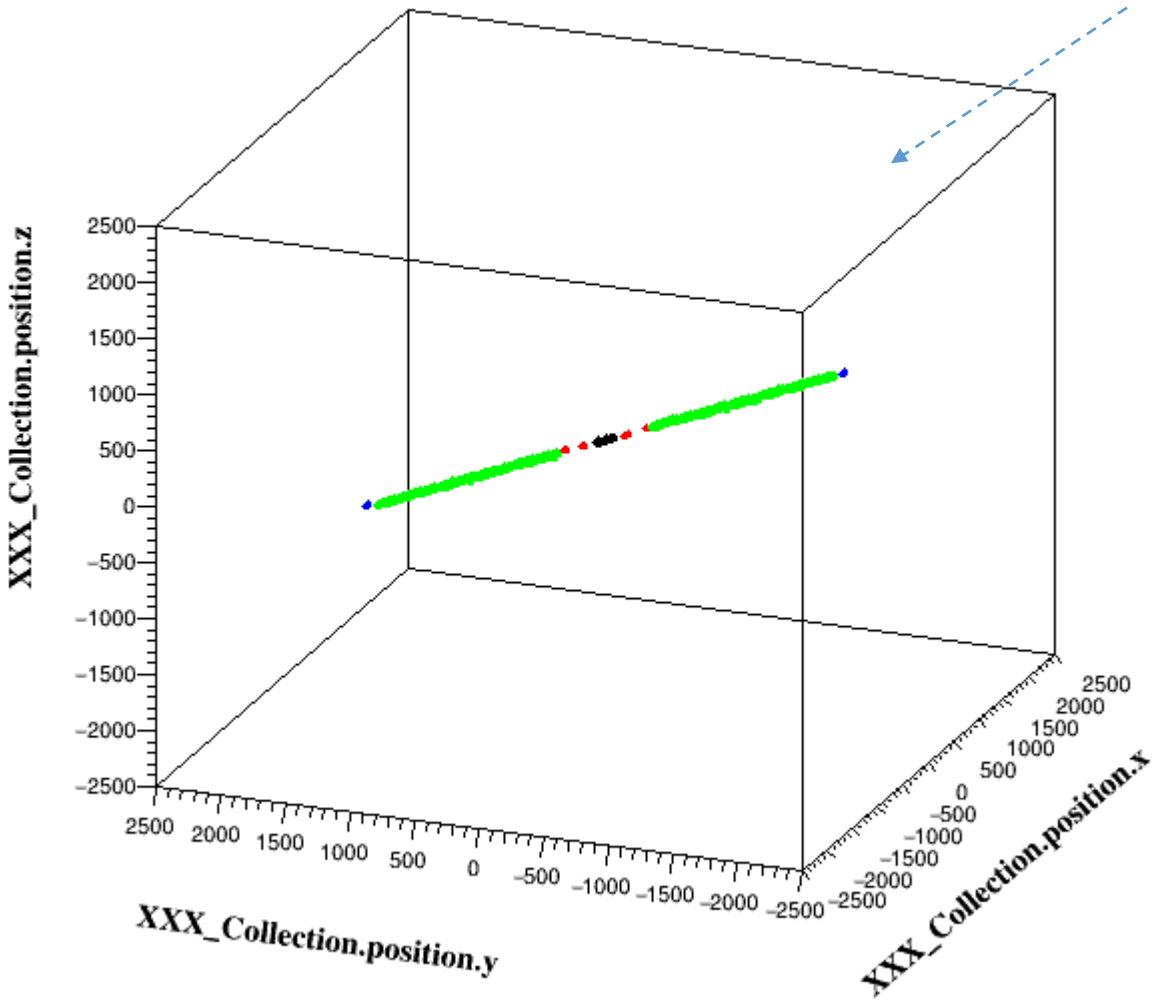
➢ As described in the Readme,
  > cd ./build/
  > ./run/gaudirun.py ../Examples/options/tut_detsim.py

  -- For trials, change “tut_detsim.py” ( execution script ) and/or “ExampleAnaElemTool.cpp”

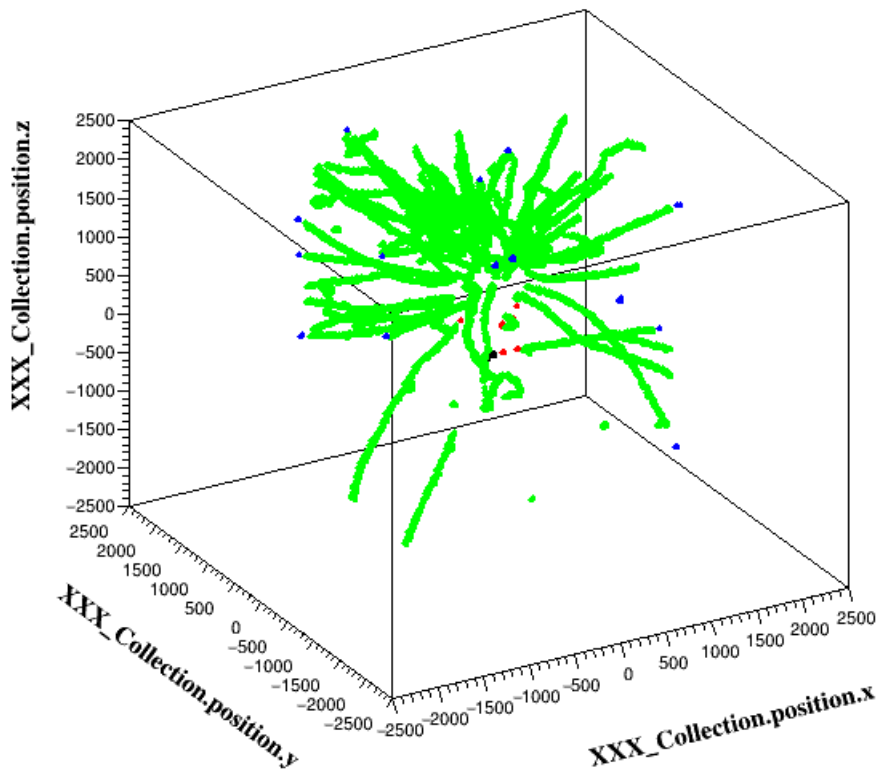
- Geometry option :
  -- geometry_option = "CepC_v4-onlyTracker.xml"

# Confirmation of the hit position

Black: VXD, Red: SIT, Green: TPC, Blue: SET




**Hit Position（an example event）**




**Hit Position（another event）**

# Drift Chamber Module

- Referring the IAEA DCH module

  -- Information : (provided by Chengdong )

  https://github.com/HEP-FCC/FCCSW/blob/master/Detector/doc/DD4hepInFCCSW.md

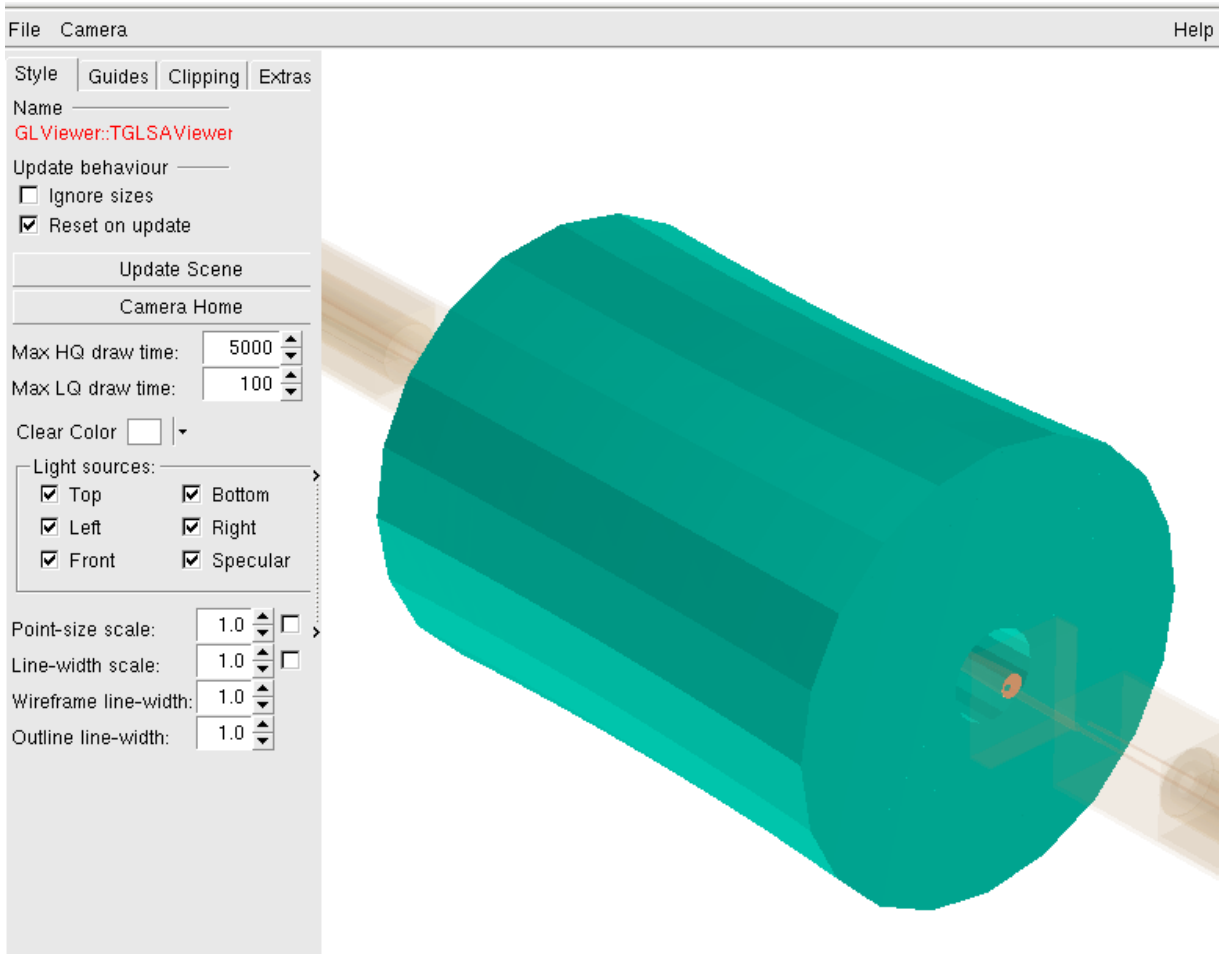
  https://cds.cern.ch/record/2670936/files/CERN-ACC-2019-0043.pdf

  -- then,,, copy main components under CEPCSW for a trial

  ./FCCSW/Detector/DetFCCeeIDEA/compact/DriftChamber.xml
  ./FCCSW/Detector/DetSegmentation/src/GridDriftChamber.cpp
  ./FCCSW/Detector/DetSegmentation/DetSegmentation/GridDriftChamber.h
  ./FCCSW/Detector/DetFCCeeIDEA/src/parametrised_DriftChamber.cpp
  ./FCCSW/Detector/DetSensitive/DetSensitive/SimpleDriftChamber.h
  ./FCCSW/Detector/DetSensitive/src/SimpleDriftChamber.cpp
  ./FCCSW/Detector/DetCommon/src/Geant4PreDigiTrackHit.cpp
  ./FCCSW/Detector/DetCommon/DetCommon/Geant4PreDigiTrackHit.h
  … and others

# Status

*VXD (original Cepc VXD)+ Drift Chamber (IDEA-proto)*




With a merged geometry file : CepC_v4-onlyVXD_DCH.xml

**hits are somehow confirmed though there need further code fixing works.**

```
ToolSvc.Example...   INFO  cast to G4THitsCollection<dd4hep::sim::Geant4Hit>.
ToolSvc.Example...   INFO 11 hits cast to dd4hep::sim::Geant4TrackerHit.
ToolSvc.Example...   INFO 0 hits cast to dd4hep::sim::Geant4CalorimeterHit.
ToolSvc.Example...   INFO Collection DriftChamberCollection #1 has 1005 hits.
ToolSvc.Example...WARNING Failed to convert to collection DriftChamberCollection
DetSimAlg.G4Pri...   INFO Start a new event:
DetSimAlg.G4Pri...   INFO 0 : [ 5 ];
DetSimAlg.G4Pri...   INFO 1 : [ 6 ];
DetSimAlg.G4Pri...   INFO 2 : [ 7 ];
DetSimAlg.G4Pri...   INFO 3 : [ 8 ];
DetSimAlg.G4Pri...   INFO 4 : [ 9 ];
DetSimAlg.G4Pri...   INFO 5 : [ ];
DetSimAlg.G4Pri...   INFO 6 : [ ];
DetSimAlg.G4Pri...   INFO 7 : [ 10 ];
DetSimAlg.G4Pri...   INFO 8 : [ 10 ];
DetSimAlg.G4Pri...   INFO 9 : [ ];
DetSimAlg.G4Pri...   INFO 10 : [ 11 12 ];
DetSimAlg.G4Pri...   INFO 11 : [ 13 14 ];
DetSimAlg.G4Pri...   INFO 12 : [ 15 16 ];
DetSimAlg.G4Pri...   INFO 13 : [ 17 18 ];
DetSimAlg.G4Pri...   INFO 14 : [ ];
DetSimAlg.G4Pri...   INFO 15 : [ ];
DetSimAlg.G4Pri...   INFO 16 : [ ];
DetSimAlg.G4Pri...   INFO 17 : [ ];
DetSimAlg.G4Pri...   INFO 18 : [ ];
ToolSvc.Example...   INFO Event 1
ToolSvc.Example...   INFO mcCol size: 19
ToolSvc.Example...   INFO Readout DriftChamberCollection
ToolSvc.Example...   INFO Readout VXDCollection
ToolSvc.Example...   INFO Collection VXDCollection #0 has 19 hits.
ToolSvc.Example...   INFO  cast to G4THitsCollection<dd4hep::sim::Geant4Hit>.
ToolSvc.Example...   INFO 19 hits cast to dd4hep::sim::Geant4TrackerHit.
ToolSvc.Example...   INFO 0 hits cast to dd4hep::sim::Geant4CalorimeterHit.
ToolSvc.Example...   INFO Collection DriftChamberCollection #1 has 345 hits.
ToolSvc.Example...WARNING Failed to convert to collection DriftChamberCollection
ApplicationMgr       INFO Application Manager Stopped successfully
End Run of detector simultion...
outputalg            INFO Data written to:  'filename':test-detsim10.root
EventLoopMgr         INFO Histograms converted successfully according to request.
ToolSvc              INFO Removing all tools created by ToolSvc
ApplicationMgr       INFO Application Manager Finalized successfully
ApplicationMgr       INFO Application Manager Terminated successfully
-bash-4.1$
```

# Next plans

Very near term

- Constructing own drift chamber module

  -- Simple version first. Not complicated.

  -- we might ask helps regarding the CEPCSW

- Evaluation of dE/dx performance

  -- the way, we are under discussions ( see next pages )

- Evaluation of the tracker performance from dE/dx and IP/momentum resolution

# Resolution of dE/dx

[ Idea A ]

http://pdg.lbl.gov/2020/reviews/rpp2020-rev-particle-detectors-accel.pdf

- Straight forward way would be . . .

  -- dE/dx (per unit cell) is proportional to the number of electron/hole pairs typical number is ~ 100 ( per cm )

  -- signal multiplication ( = gain ) factor, $10^4$ ~ $10^5$ , the total number of carriers, within the drift time is obtained.

  -- need to consider the electronics response: the filter ( RC filter ), amplifier, and electronics noise ( important )

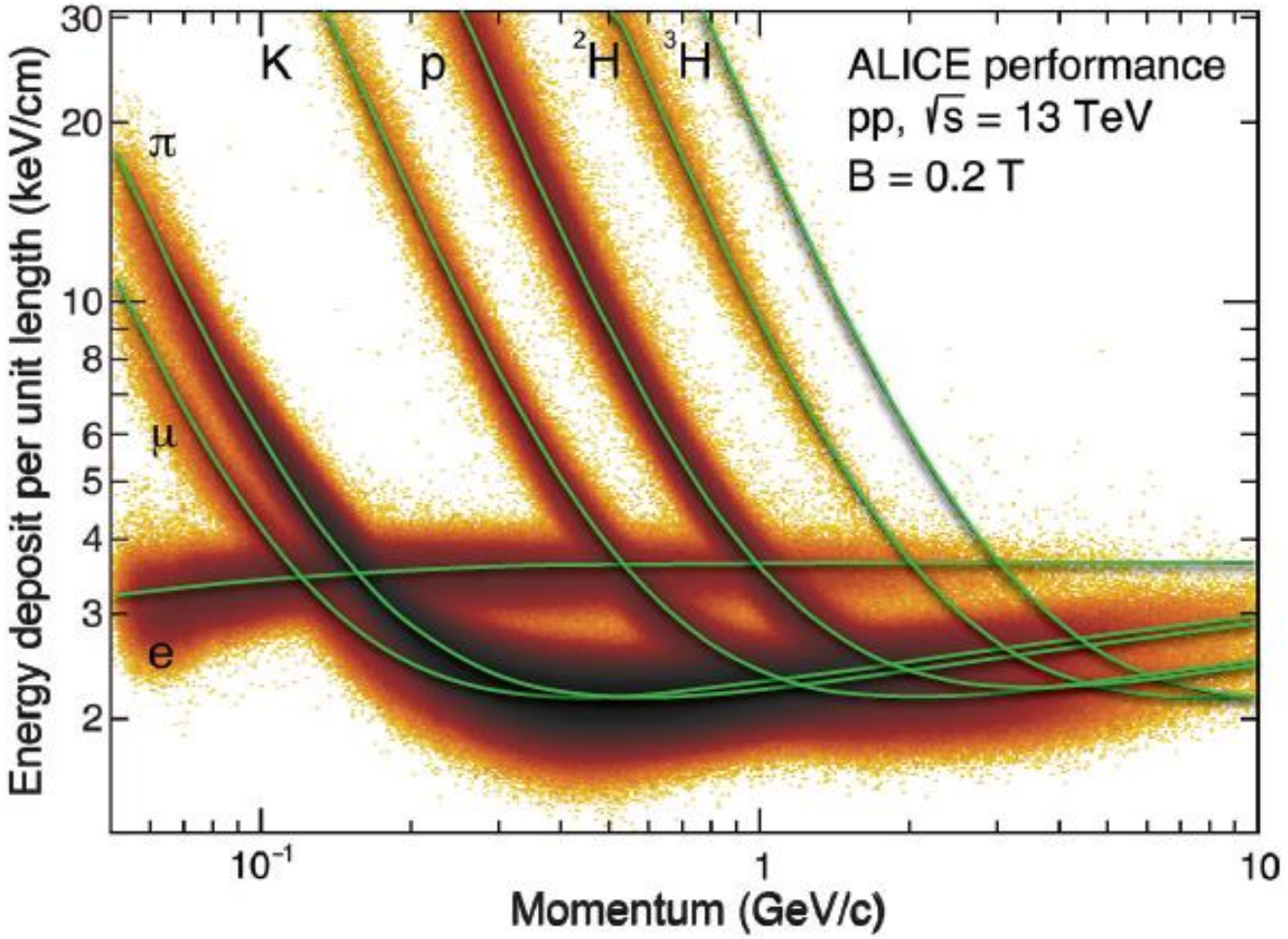



Figure 35.15: Energy deposit versus momentum measured in the ALICE TPC.

Combining those steps, we can estimate the resolution

# Resolution of dE/dx

[ Idea B ]

The dependence of the achievable energy resolution on the number of measurements $N$, on the thickness of the sampling layers $t$, and on the gas pressure $P$ can be estimated using an empirical formula [135]:

$$\sigma_{dE/dx} = 0.41\ N^{-0.43}(t\,P)^{-0.32}. \qquad (35.17)$$

Typical values at nominal pressure are $\sigma_{dE/dx} = 4.5$ to 7.5%, with $t = 0.4$ to 1.5 cm and $N = 40$ up to more than 300. Due to the high gas pressure of 8.5 bar, the resolution achieved with the PEP-4/9 TPC was an unprecedented 3% [136].

[136] H. Aihara *et al.*, IEEE Trans. **NS30**, 63 (1983).

-- It is an old reference of the resolution for a TPC

-- Not sure(confirmed) yet, what condition should be met to apply this formula

For instance, s ~ 0.41 * 222(layers)$^{-0.5}$ * (1cm*1atm)$^{-0.32}$ = 2.8% ⟷ 5~7 ? % is somehow we can see in the references

# Summary

・ We are now using the CEPCSW for the SDT work

・ After the confirmation, under work to implement a (proto-) drift chamber module in the CEPCSW

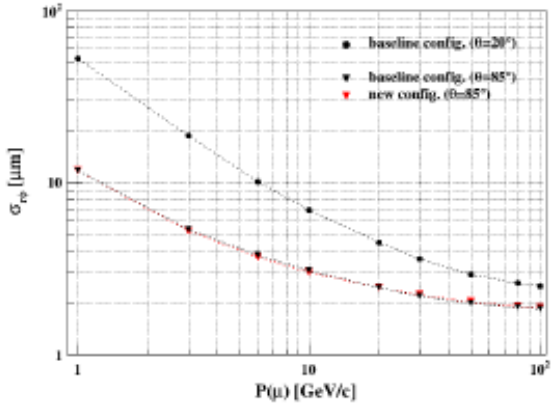
・ Handling and evaluation of the dE/dX information from a constructed drift chamber is current task we want to achieve in short term.

・ Any comments/suggestions are highly welcome !

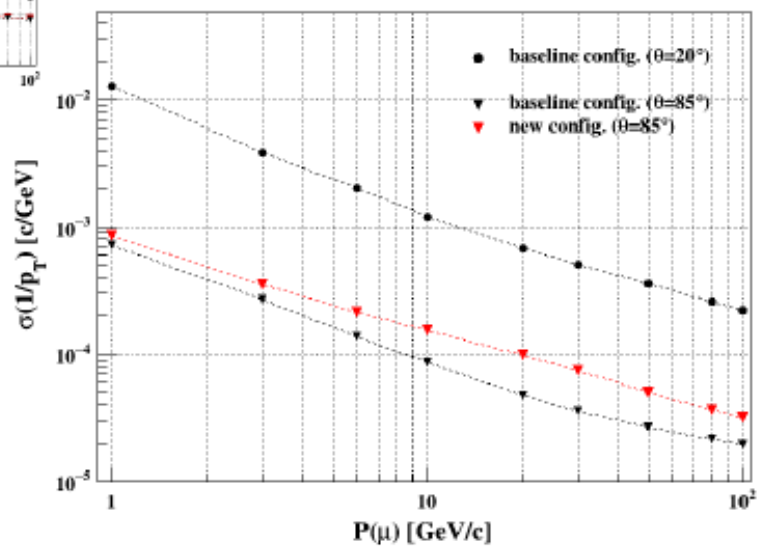
# Backup

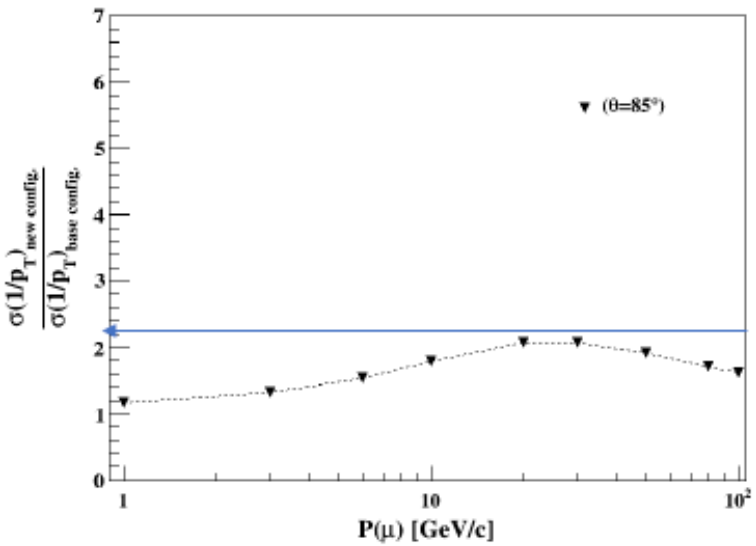
# Performance comparison v1.1 vs. baseline

- No change for impact para. reso.




- Slightly increase for momemtum reso. ( <~ 2 )

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from the slide by Xin at Mini-workshop on crystal ECAL