CEPC Silicon Drift Chamber Tracker

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

Xin Shi

Gang Li, Ryuta Kiuchi, Mingyi Dong, Jianchun Wang

Mini-workshop on crystal ECAL - 2020.07.23

Outline

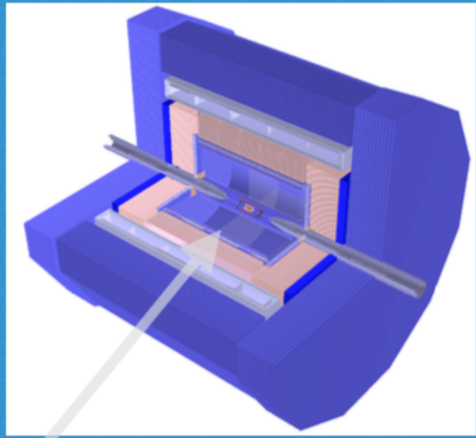
- Introduction to SDT
- SDT v1.0: Baseline configure with two Drift Chambers
- SDT v1.1: Small Tracker Options
- SDT v2 Plan

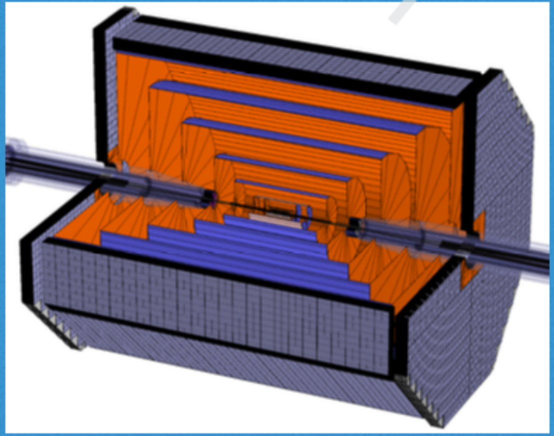
CEPC: 2.5 Detector Concepts

CEPC plans for
2 interaction points

Particle Flow Approach

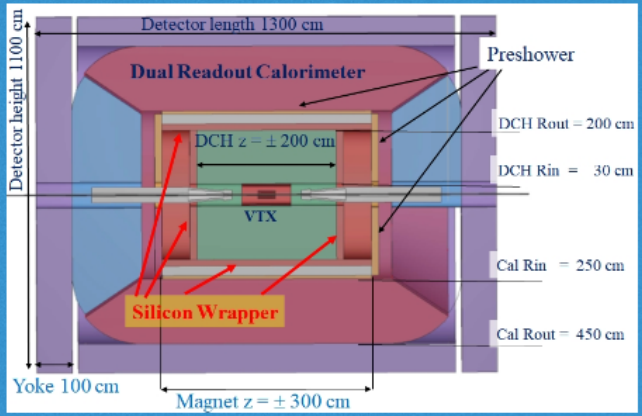
Baseline detector
ILD-like
(3 Tesla)





Full silicon
tracker
concept

Low
magnetic field
concept
(2 Tesla)



IDEA Concept
also proposed for FCC-ee

Final two detectors likely to be a mix and match of different options

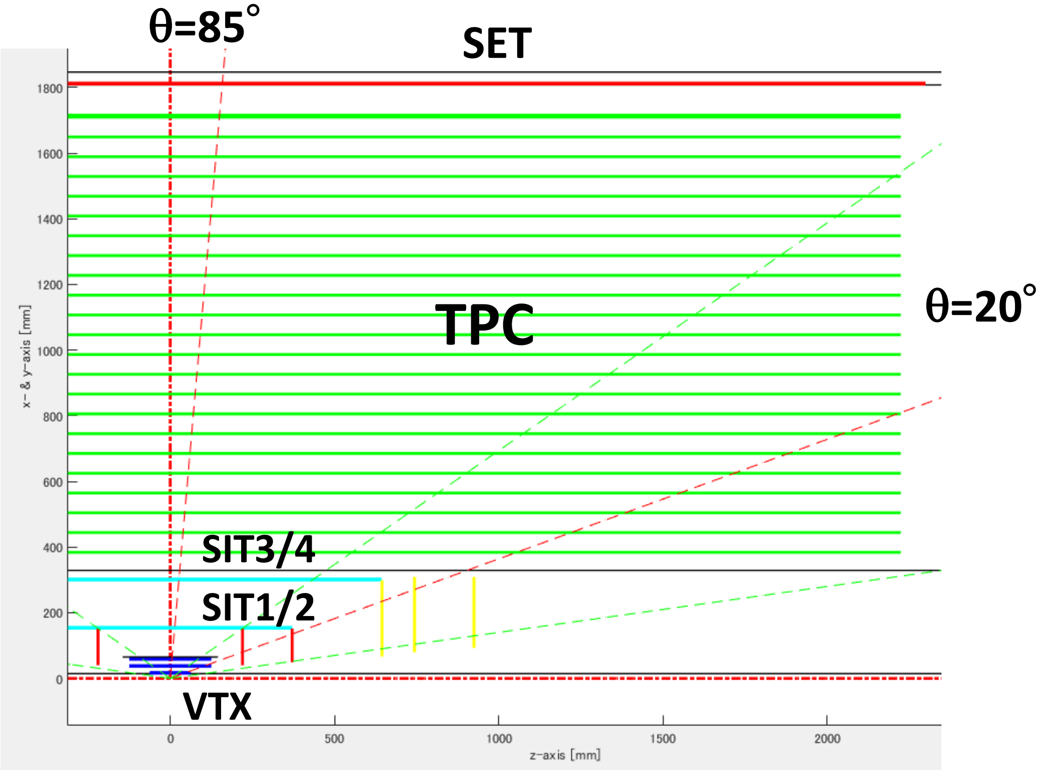
Joao da Costa

Motivation for Silicon + Drift Chamber Tracker

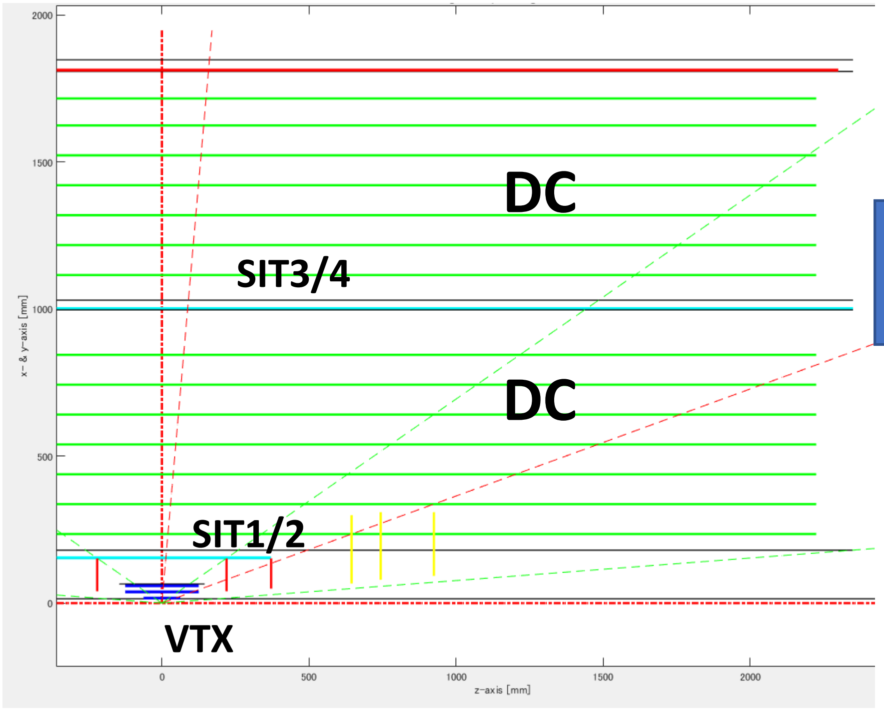
- Explore a different tracker option for CEPC
- Capable for both tracking and particle ID (flavor, JES, jet flavor,...)
- Combine the Silicon technology (strip, CMOS) and Drift chamber technology (IDEA, dE/dx, cluster counting, ...)
- Provide concrete platform to integrate smaller crystal ECAL
- Open path for better particle ID with future timing layer (LGAD) between SDT and crystal ECAL

CEPC Silicon + Drift Chamber Tracker: v1.0

- Based on the baseline Silicon + TPC
- Replace TPC layers with two drift chamber layers
  - SIT 3&4 set at R=1.0m / larger cell size of DC than TPC



baseline

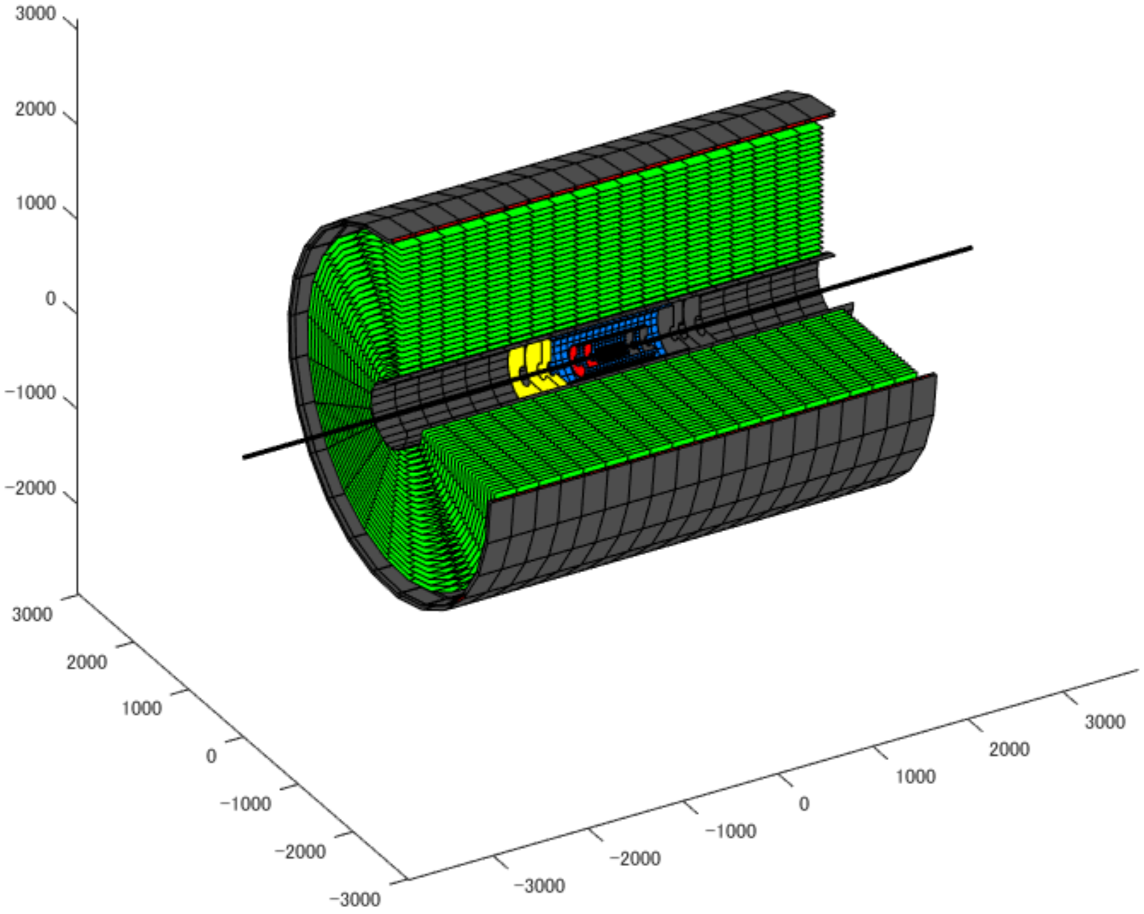


SIT 3,4 @ R=1.0m

SDT v1: Geometry of the detector layers

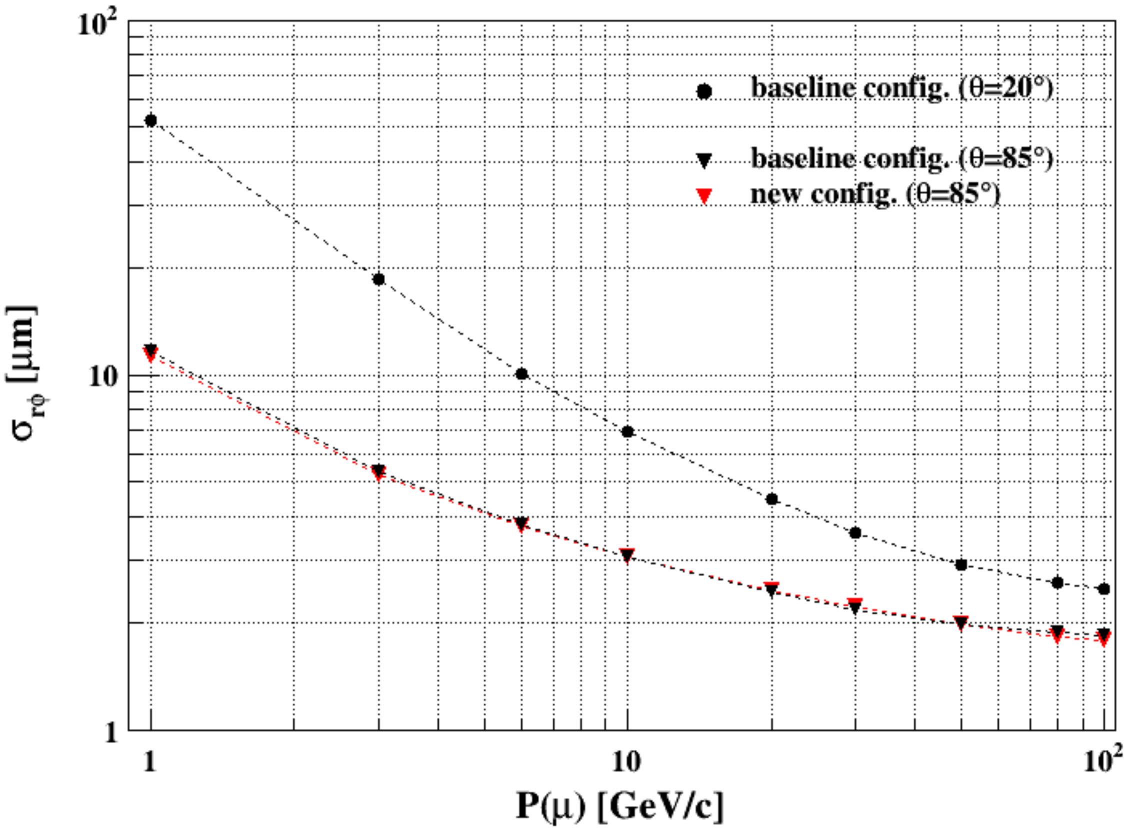
- Fast Simulation Tool :
  LiC Detector Toy 2.0 (LDT) developed for design studies and optimizing the detector configuration

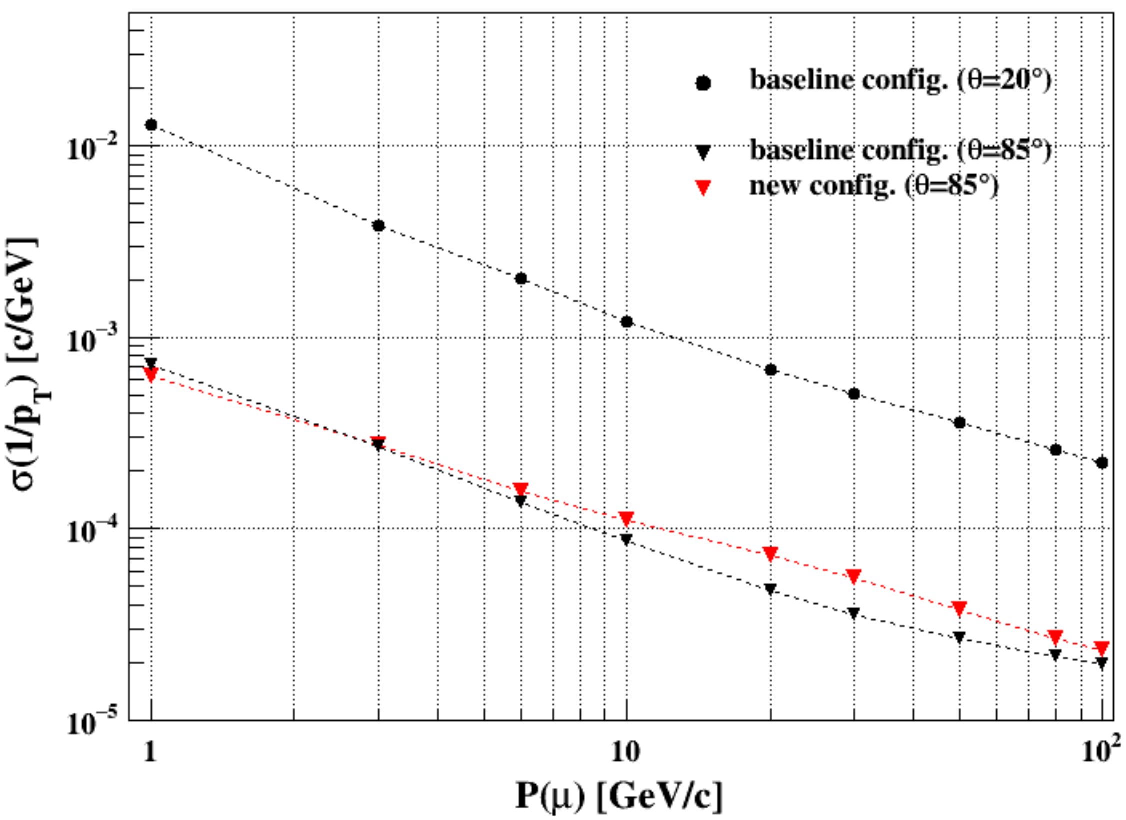
- Reflecting the geometry (tracking part) of the baseline concept



A layout of the tracking system set in the simulation

Impact parameter and momentum resolution





- No change for impact para. reso. and slight degradation for barrel momentum reso.

Number of hit layers (per track)

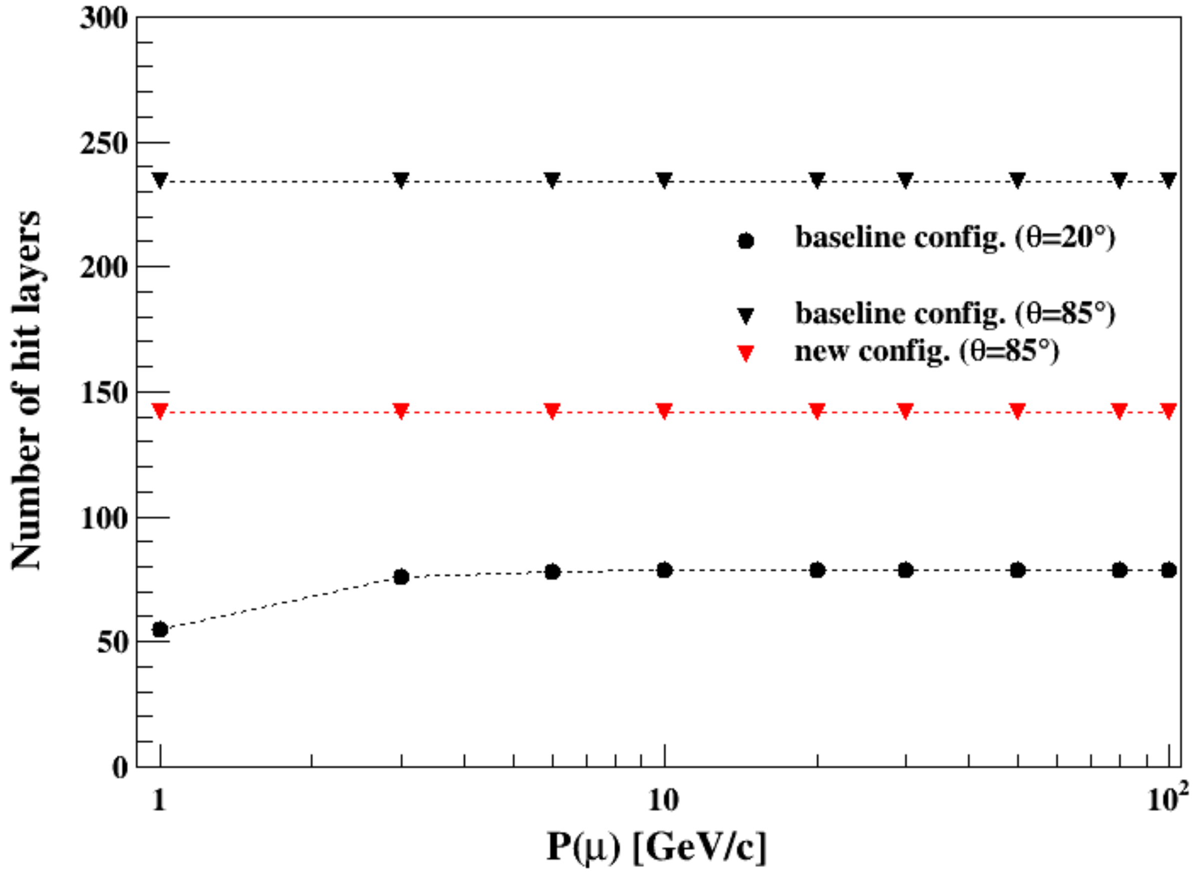
```
40 Time Projection Chamber (TPC)
41 sigma^2=sigma0^2+sigma1^2*sin(beta)^2+Cdiff^2*6mm/h*sin(theta)*Ldrift[m]
42 Number of layers              :   222
43 Radii [mm]                    :   384,1716
44 Upper limit in z [mm]         :   2225
45 Lower limit in z [mm]         :  -2225
46 Efficiency RPhi               :   1
47 Efficiency z                  :   1
48 Thickness [rad. lengths]      :   0.00005194
49 sigma0(RPhi) [1e-6m]          :   50
50 sigma1(RPhi) [1e-6m]          :   900
51 Cdiff(RPhi)  [1e-6m/sqrt(m)]  :   25
52 sigma0(z)    [1e-6m]          :   400
53 sigma1(z)    [1e-6m]          :   0
54 Cdiff(z)     [1e-6m/sqrt(m)]  :   80
```

TPC: 222 layers

```
40 Time Projection Chamber (TPC)
41 sigma^2=sigma0^2+sigma1^2*sin(beta)^2+Cdiff^2*6mm/h*sin(theta)*Ldrift[m]
42 Number of layers              :   67,63
43 Radii [mm]                    :   235,905,1085,1716
44 Upper limit in z [mm]         :   2225
45 Lower limit in z [mm]         :  -2225
46 Efficiency RPhi               :   1
47 Efficiency z                  :   1
48 Thickness [rad. lengths]      :   0.00005194
49 sigma0(RPhi) [1e-6m]          :   50
50 sigma1(RPhi) [1e-6m]          :   900
51 Cdiff(RPhi)  [1e-6m/sqrt(m)]  :   25
52 sigma0(z)    [1e-6m]          :   400
53 sigma1(z)    [1e-6m]          :   0
54 Cdiff(z)     [1e-6m/sqrt(m)]  :   80
```

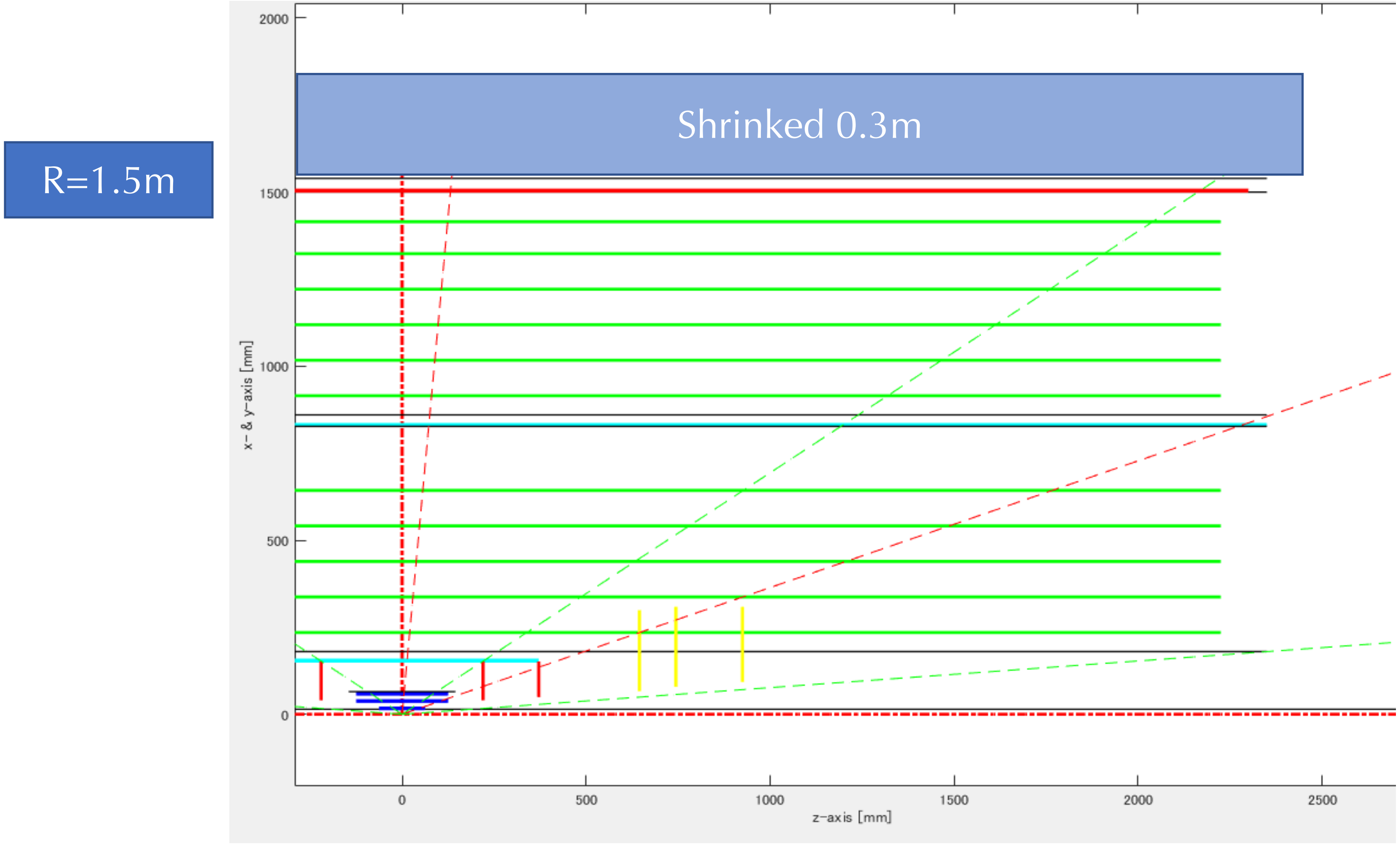
DC x 2
135 layers

- ~ 90 decrease for barrel with SDT v1.0



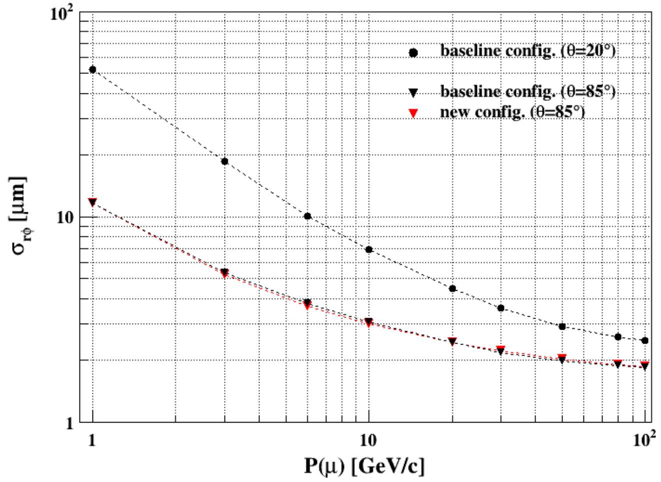
Silicon + Drift Chamber Tracker: v1.1

- Smaller radius : R = 1.5 m (reduced size for crystal ECAL)

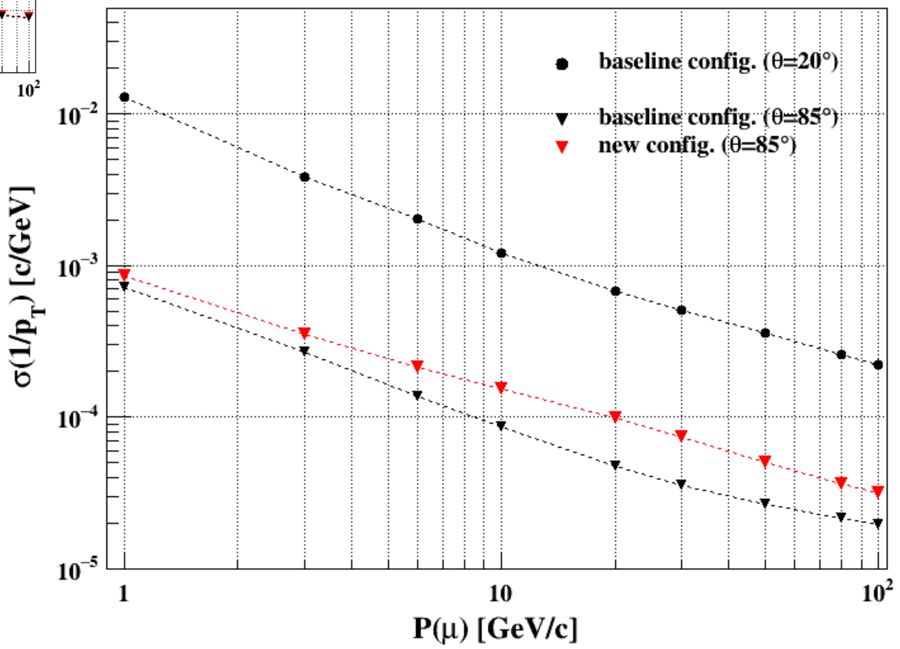


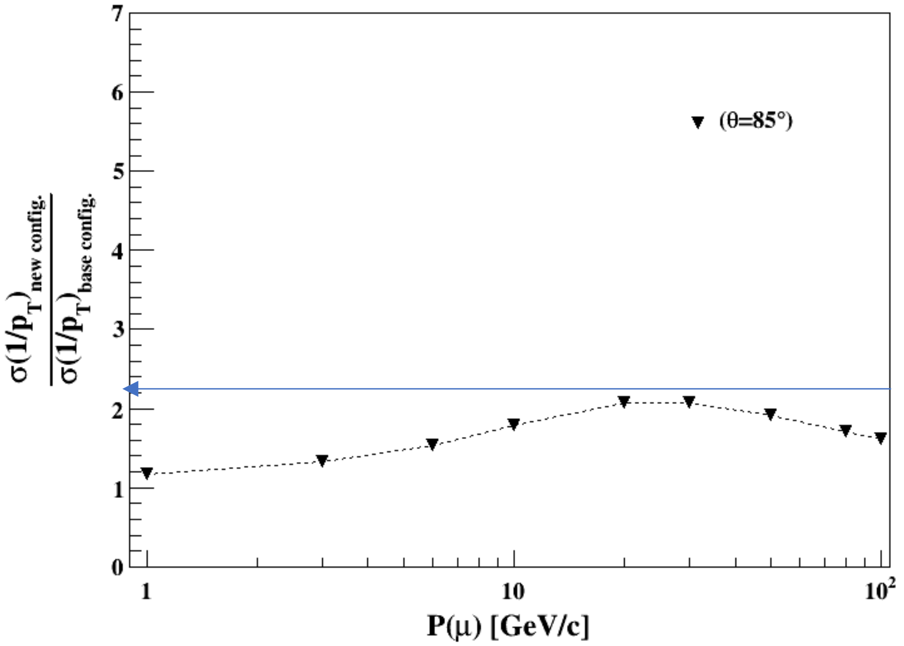
Performance comparison v1.1 vs. baseline

- No change for impact para. reso.

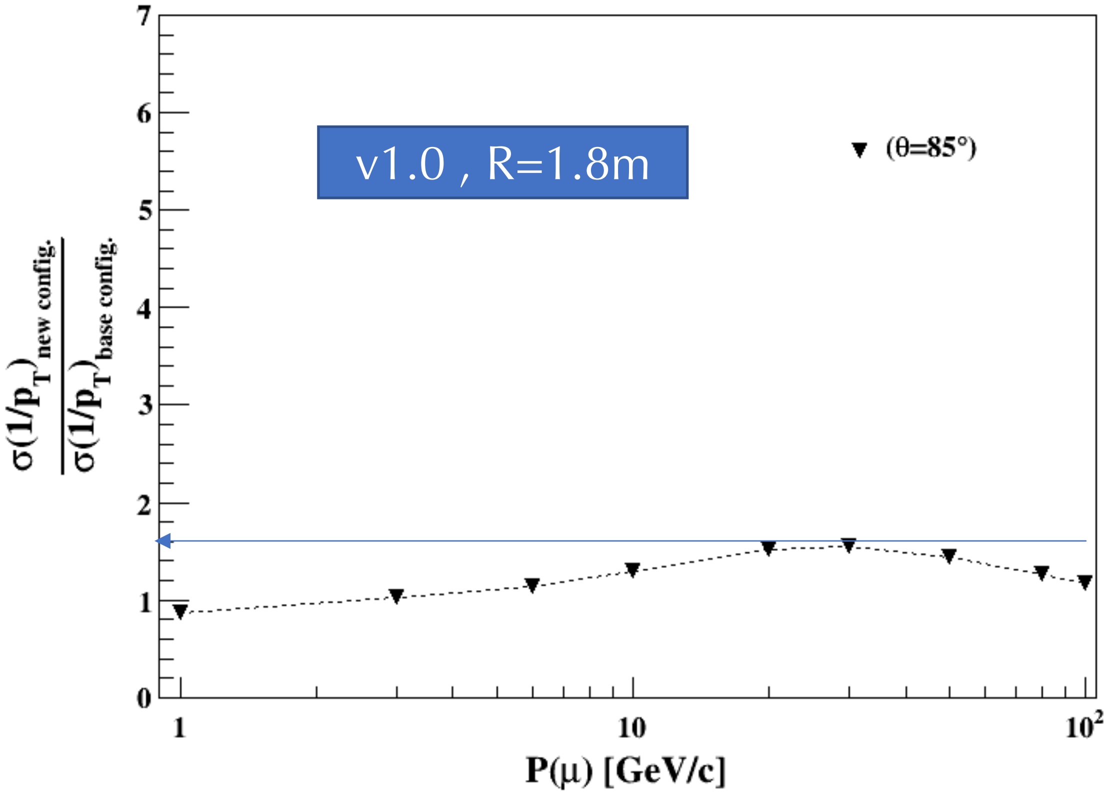


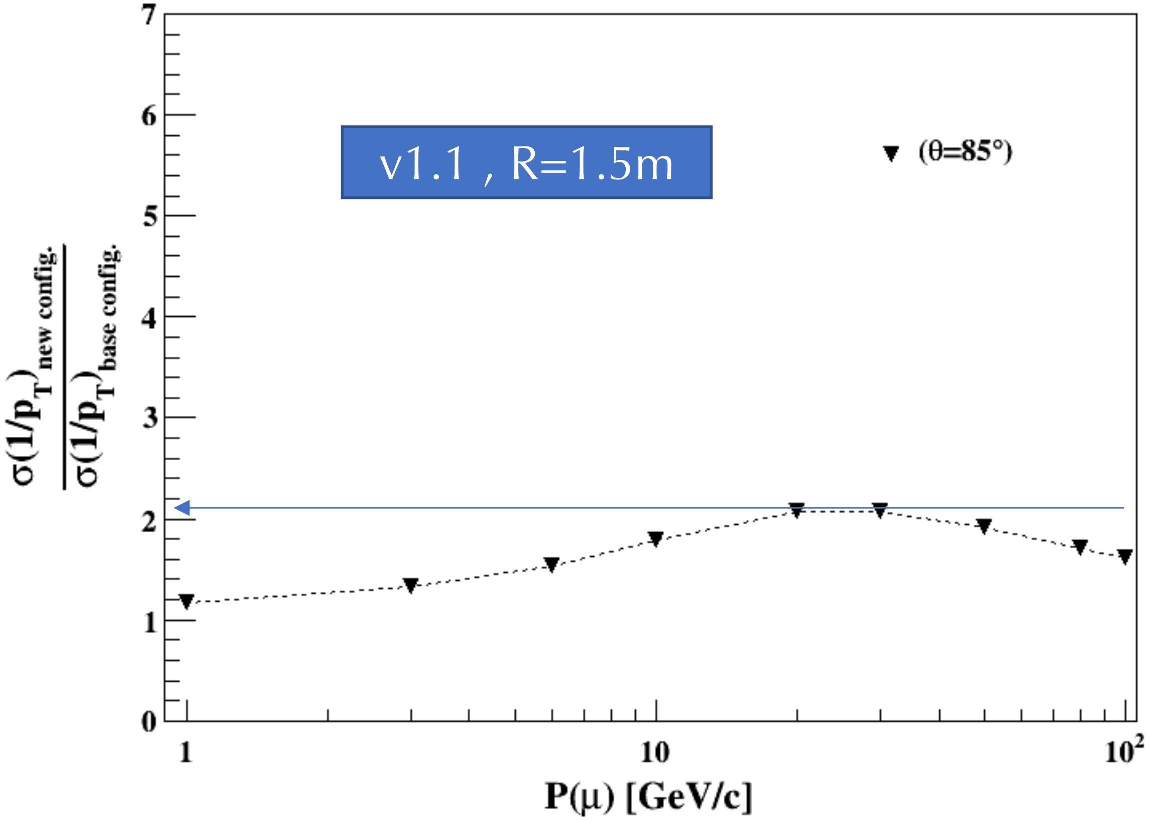
- Slightly increase for momemtum reso. (<~ 2)





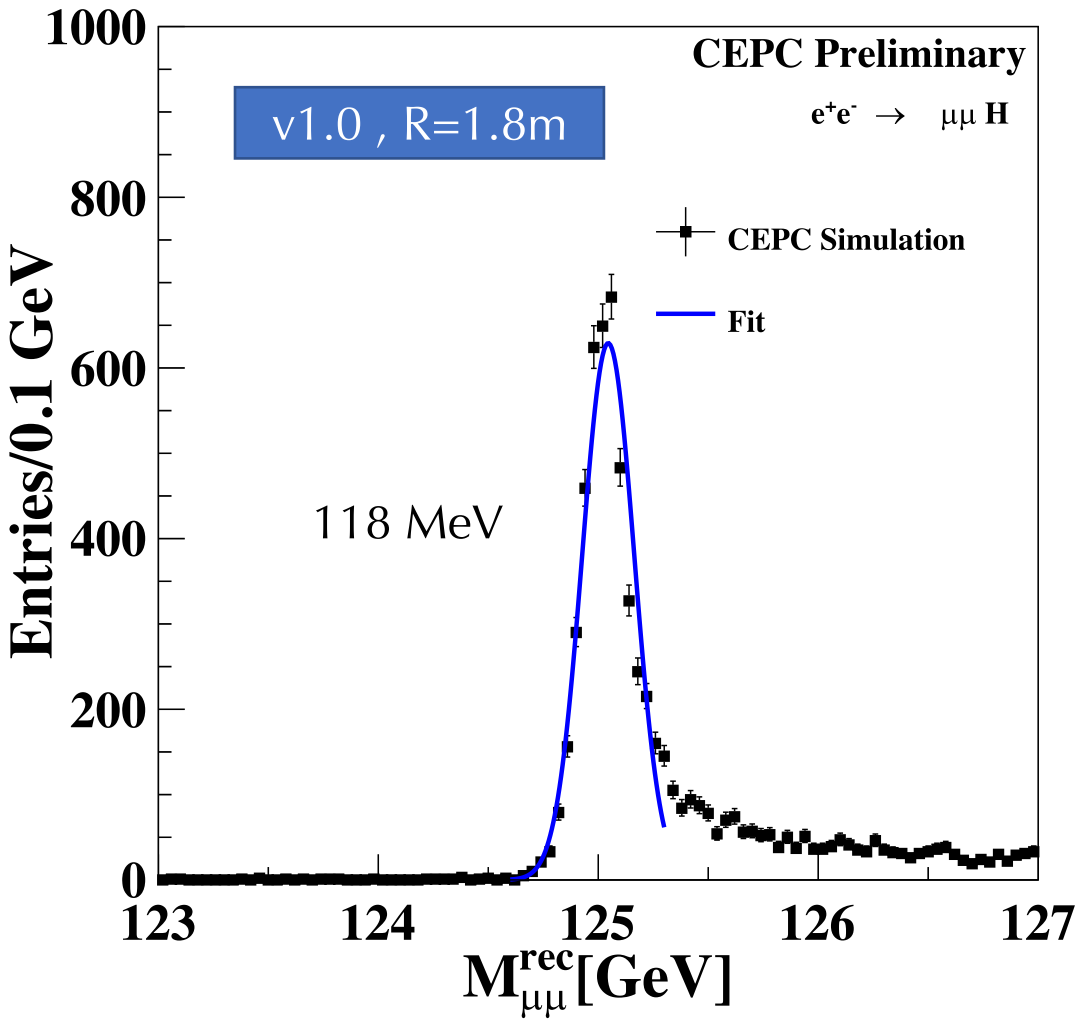
Performance comparison v1.0 and v1.1 vs. baseline

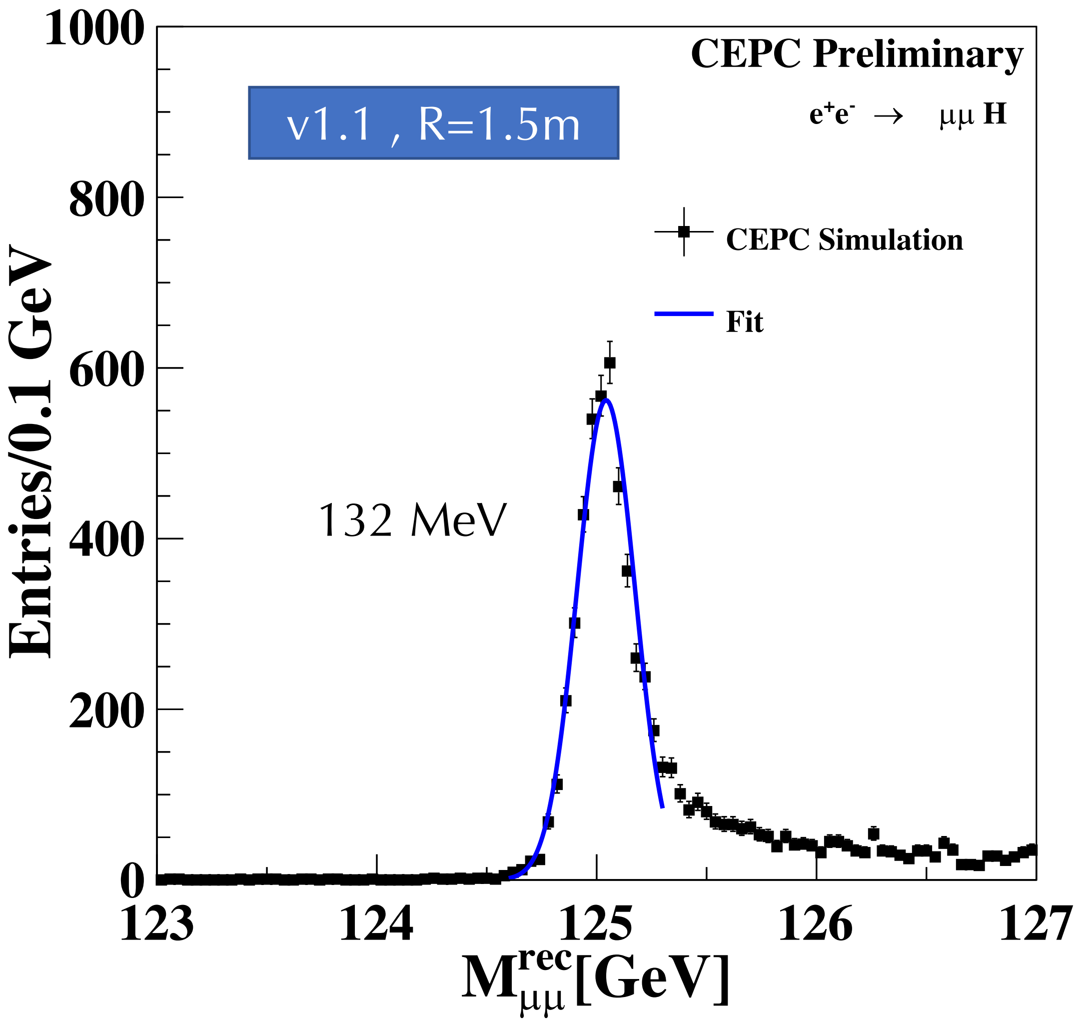




Recoil mass resolution v1.0 and v1.1

- ~12% increase

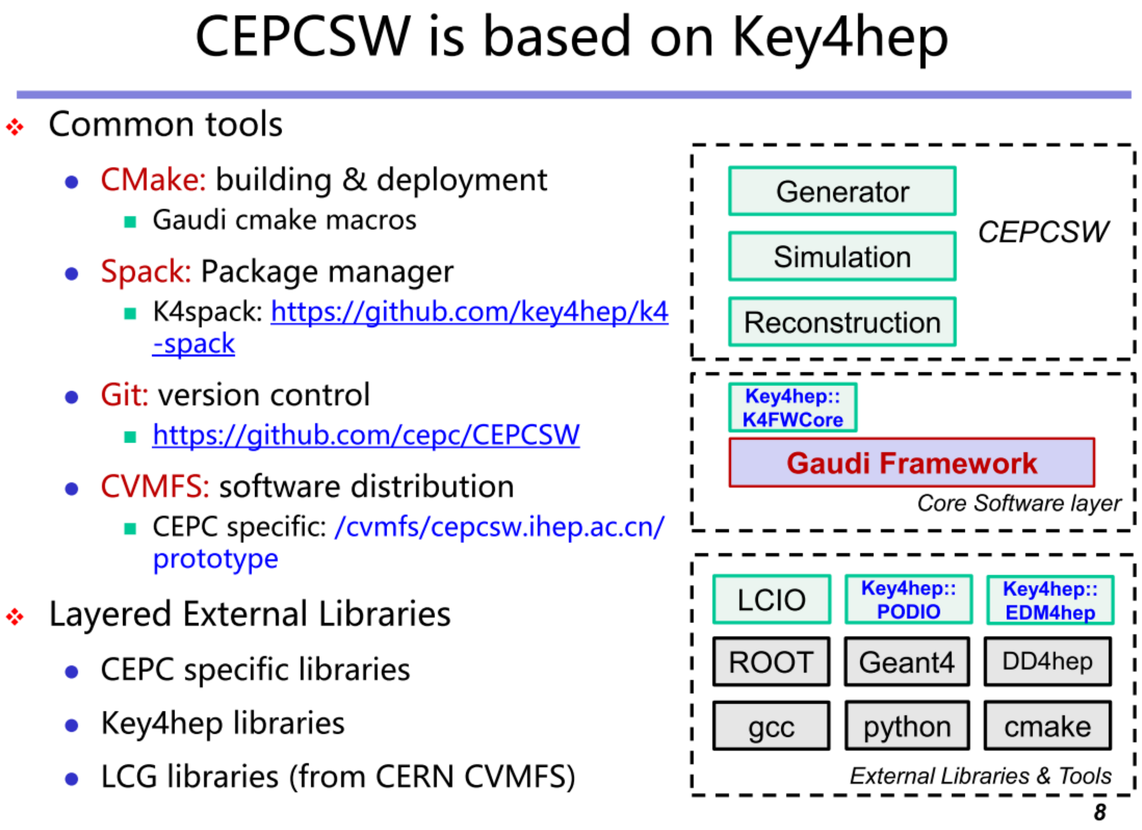




SDT v2.0

- Switch to CEPCSW: https://github.com/cepc/CEPCSW
  - Implement SDT basic config
  - Extract Hit Info from Drift Chamber

Tao Lin



Summary and Plan

- Silicon + Drift Chamber as an alternative detector concept design for CEPC for both high momentum resolution and particle ID
- SDT v1.0 with 2 Drift chambers has no change for the impact paramter resolution, but slight degradation for momentum resolution compared with baseline
  - Dereased 90 numbers of hit layers in barrel region.
- SDT v1.1 (R=1.5m) : no change for impact paramter resolution, increased momemtum resolution for certain momentum (<~2)
  - ~ 12% increase for the dimuon recoil resolution
- SDT v2: Migration to new software framework: CEPCSW
  - dE/dx, material budget, S/D layers, ...