Implementation of Full Silicon Geometry

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CEPC Software Analysis Workshop

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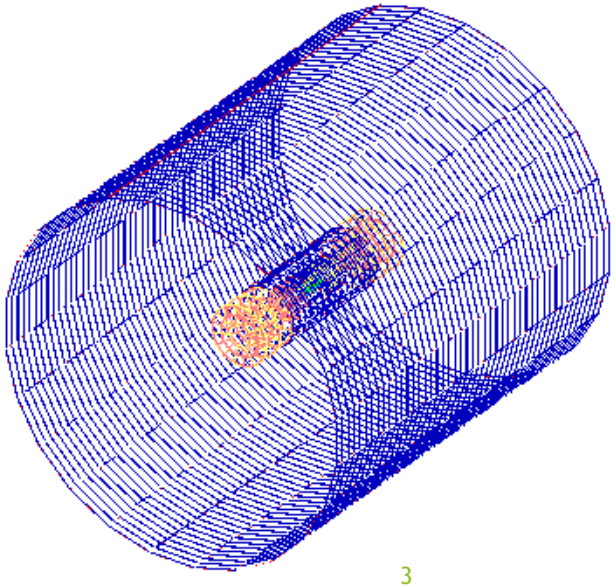
- Software
- Structure & Material
- Hits output
- Discussion and conclusion

Software

- Overview of tracker of cepc_vx in original Mokka
  - VXD: 6 layers (3 doubly layers)
  - SIT: 4 layers (2 doubly layers)
  - TPC
  - SET: 2 layers (1 doubly layer)
  - FTD: 2 pixel layers + 3 strip layers (double-side)

- Silicon parts are all planar-composed
  - Barrel (VXD, SIT, SET): ladder
  - Endcap (FTD): petal

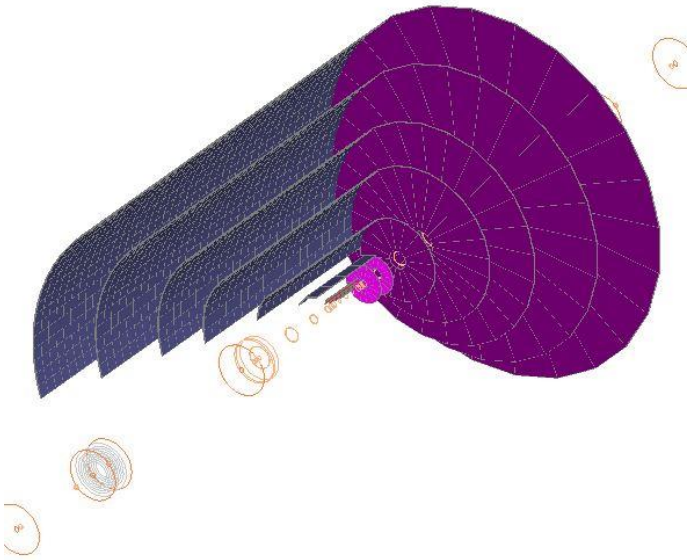


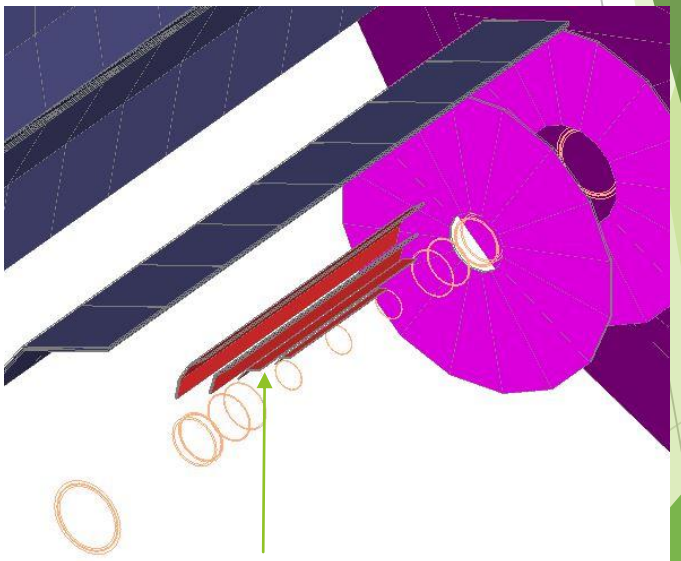
Software – motivation

- Goal: full silicon tracker
  - Replace TPC with more silicon-layer planar
- Sub-detector composition is easy to change through rmSubDetector and addSubDetector in Mokka
- There are two ways to change the structure of sub-detector
  - Database: directly (SIT, SET, FTD)
  - globalModelParameter: converter to update database buffer (VXD)
- But structure of sub-layers are fixed mostly
  - VXD:
    - Support layer: metal_traces + flex_cable + foam_spacer
    - Sensistive layer: silicon
  - SIT/SET:
    - Support layer: database defined
    - Sensistive layer: database defined
  - FTD:
    - Support layer: carbon fiber
    - Sensistive layer: silicon

Software- modified Mokka

- A new sub-detector type **SiTrack01**
  - Devolop simple tube-layers to planar same as cepc_vx
  - VXD, SIT/SET and FTD are included





In order to keep away from beam pipe, the 2nd VXD layer is moved a little.

Structure

- Defined in steering file (.macro) through globalModelParameter
- A stop-gap measure, better way is to input by xml
- Flexible to modify structure
  - Layer number and layer position
  - Ladder/petal number

VXD,15.9,78,10;VXD,25,125,10;VXD,36.9,150,11;

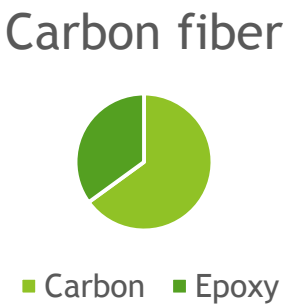
  - sub-layer structure
    - A support can be implemented by a layer without sensistive sub-layer easily
    - Example:

SIT,**Si:-0.15**,Si:0.0024,Peek:0.1,CarbonFiber:0.08,Rohacell50D:0.9,Epoxy:0.08,CarbonFiber:0.08

Now, flexibility is limited by following reconstruction—Marlin.

Material of sub-layer

- Any composition of sub-layer material (predefined) is possible/easy
- If un-defined material, one way to approximate



1 mm thickness

Carbon:0.2,Epoxy:0.8

$$frac\_t_1 = \frac{n - n_2}{n_1 - n_2}$$

- 1 mm Carbon fiber with 50% density

  CarbonFiber:0.5,Air:0.5

Similar in simple calorimeter (SiCal)

An example

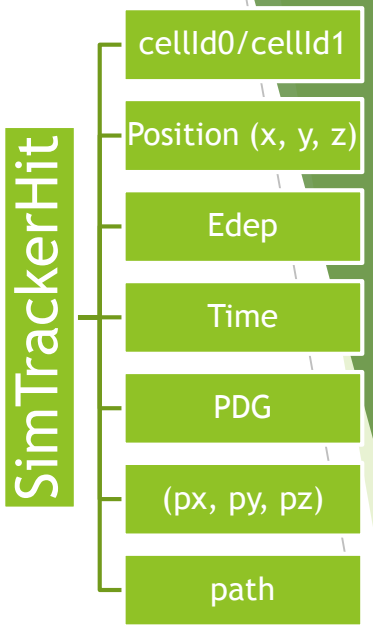
```
/Mokka/init/detectorModel CEPC_v1
/Mokka/init/EditGeometry/rmSubDetector all
/Mokka/init/EditGeometry/addSubDetector tube_cepc  0
/Mokka/init/EditGeometry/addSubDetector mask_cepc  10
/Mokka/init/EditGeometry/newSubDetector SiTracker01  100
/Mokka/init/EditGeometry/addSubDetector SEcal05    110
/Mokka/init/EditGeometry/addSubDetector SHcalRpc01 120
/Mokka/init/EditGeometry/addSubDetector SCoil03    130
/Mokka/init/EditGeometry/addSubDetector yoke05     150

/Mokka/init/globalModelParameter SiTrackerBarrel VXD,15.9,78,10;VXD,25,125,10;VXD,36.9,150,11;VXD,38,150,11;VXD,57.9,175,17;VXD,59,175,17;\
SIT,153,368,10;SIT,156,368,10;SIT,321,644,19;SIT,324,644,19;SIT,603.4,920,38;SIT,606.4,920,38;SIT,870,1104,54;SIT,873,1104,54;SIT,1160,147\
2,72;SIT,1163,1472,72;SIT,1450,1840,92;SIT,1453,1840,92

/Mokka/init/globalModelParameter SiTrackerEndcap FTD_PIXEL,30,150.76,220,16;FTD_PIXEL,50.6,150.76,371,16;FTD_STRIP,70.98,325,644,16;FTD_ST\
RIP,110,611,920,16;FTD_STRIP,120,875,1104,16;FTD_STRIP,160,1165,1472,16;FTD_STRIP,200,1455,1840,16

/Mokka/init/globalModelParameter SiTrackerLayerStructure SIT,Si:-0.15,Si:0.0024,Peek:0.1,CarbonFiber:0.08,Rohacell50D:0.9,Epoxy:0.08,Carbo\
nFiber:0.08;FTD_PIXEL,Si:-0.2,Si:0.0048,CarbonFiber:0.16,Rohacell50D:1.8,Peek:0.2;FTD_STRIP,Si:-0.15,Peek:0.2,CarbonFiber:0.16,Rohacell50D\
:1.8,Epoxy:0.175,CarbonFiber:0.16,Si:0.0048,Si:-0.15;VXD,Si:-0.05,kapton:0.05,aluminium:0.01,SiC_foam:0.94

/Mokka/init/globalModelParameter TPC_outer_radius 1520
/Mokka/init/globalModelParameter Ecal_Barrel_halfZ 1970
```

Change the outer radius and z limit of tracker to implement other sub-detector at correct position

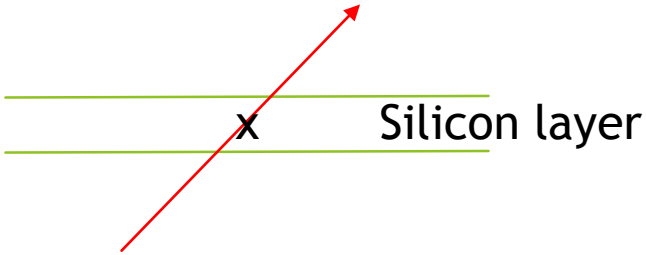
- 6 VXD layers (3 group)
  - Ladder: 10, 10, 11, 11, 17, 17
  - Longer than cepc_v1
- 12 SIT layers (6 group strips)
  - Ladder: 10, 19, 38, 54, 72, 92
- 7 FTD layers: 2 pixel and 5 double-side strip

Hits output

- Hit type: **SimTrackerHit** (lcio)
- Collection
  - VXDCollection
  - SITCollection
  - FTD_PIXELCollection
  - FTD_STRIPCollection



- Position

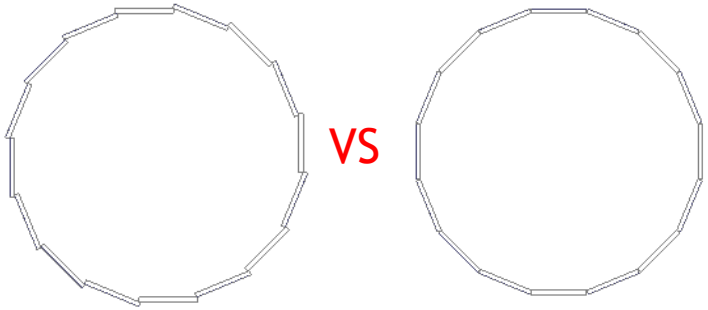


- The geometry can work now, **Weimin**'s talk will show more detail for performance check

Discussion and conclusion

- To realize flexibility, something is ignored. We should find a balance position according to requirements.

- Limit in Marlin
  - Up-limit of number of FTD layer is seven in Gear package
  - Fixed sturcture
  - And so on



- Digitization:
  - Done in Marlin now
    - Very simple: smear
    - Centre of pixels/strips?
  - Multi-hits

Thanks!