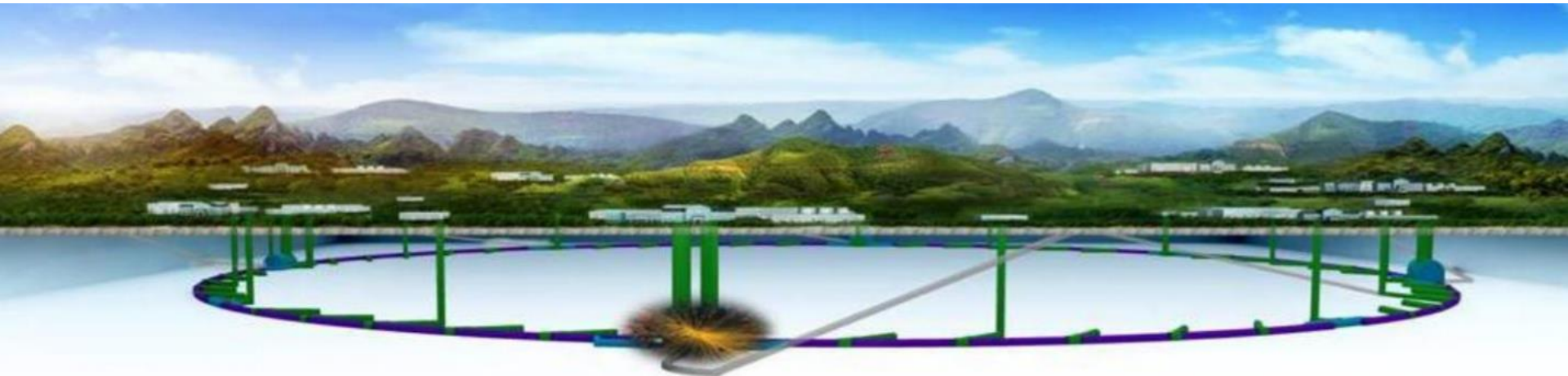# CEPC-ACTS Integration Status

Workshop on A Common Tracking Software

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For the CEPC-ACTS study group

May 25, 2020

Circular Electron Positron Collider (CEPC+SppC)

- The Higgs – only spin-0 elementary particle

    Questions on the Higgs

    Is it elementary? any partners? EW phase-transition? ... self-coupling, Yukawa coupling, new properties?

- CEPC physics case: Higgs as a probe to search new physics, as well as precision EW study, QCD, and flavor physics, etc.

- Ideal plan

    - ee collider CEPC（2022-2028）：

        - 100km circumstance Higgs factor@240 GeV

        - $L = 3 \times 10^{34}$/cm.s

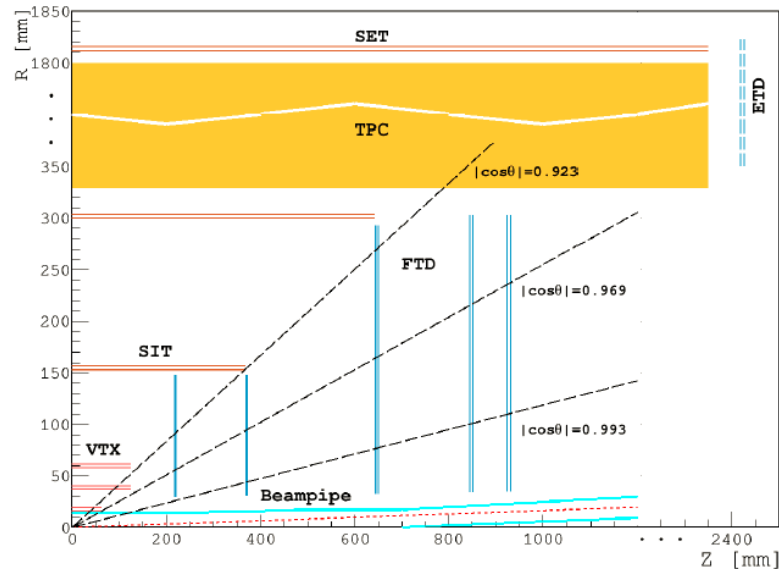   - pp collider SppC（2035-2042）in the same tunnel

Nov 14, 2018, CEPC CDR release

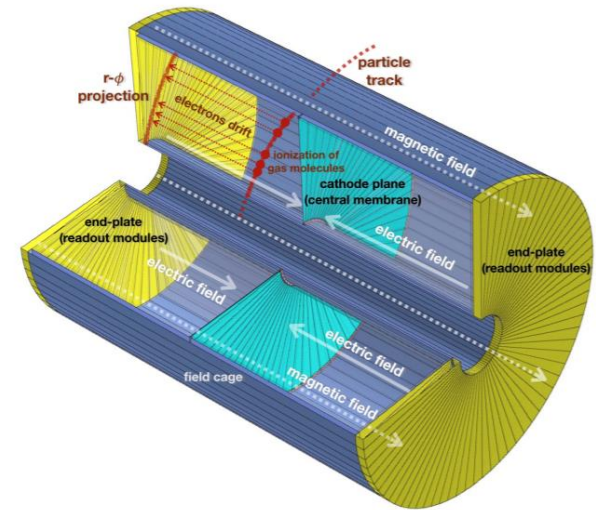- CEPC conceptual design report released in 2018

The Higgs may
hold keys to the unknowns
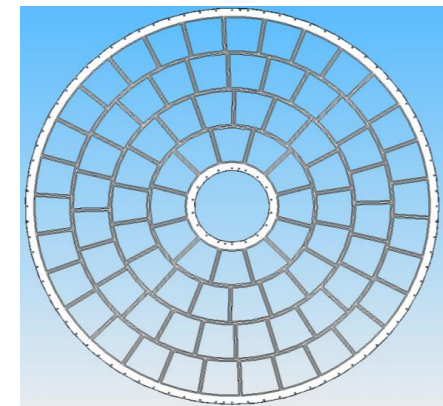
Cepc Tracking detectors – Baseline design

CEPC detector baseline design

Sketch of the TPC detector

Full size design of TPC endwall
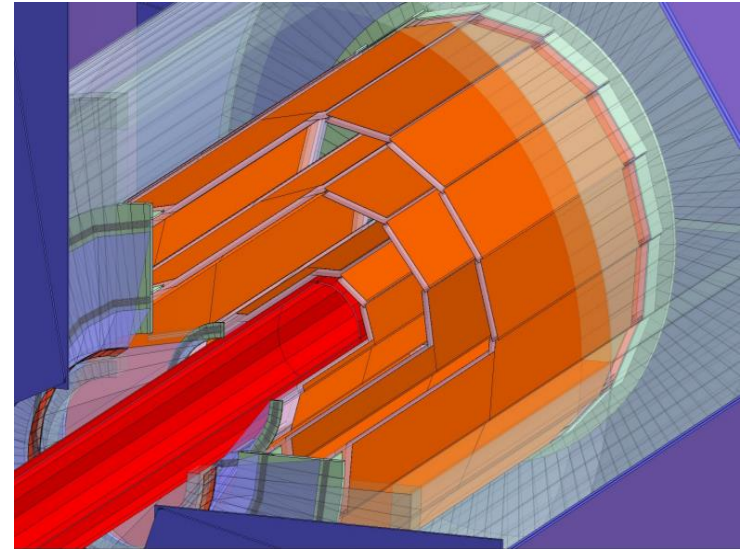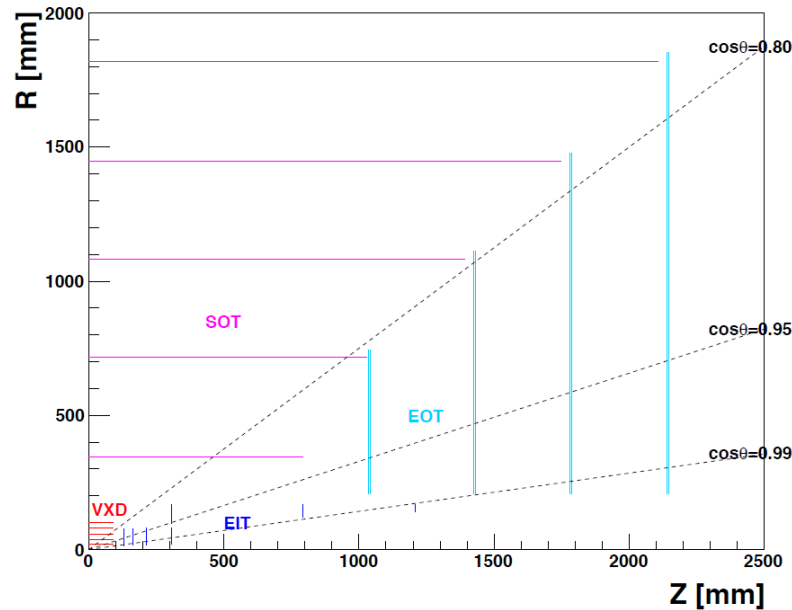

➢ Silicon detectors
  - Vertex + SIT + SET (*barrel*) + FTD + ETD (*endcap*)
➢ Time Projection Chamber(TPC) - very interesting in ACTS
  - Enough Measurements and allows for particle identification
  - Readout by Micro-Pattern Gas Detector (MPGD) - 220 layers readout

Cepc Tracking detectors – Full silicon design(FST)

CEPC detector full silicon detector
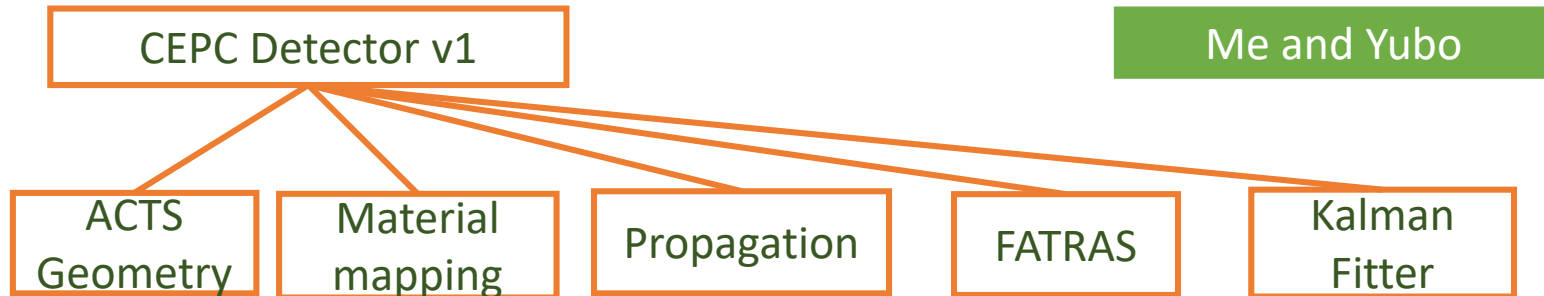

- ➢ Full Silicon detectors as an alternative

VXD + SOT (*Barrel*) + EIT + EOT(*Endcap*)

- ➢ ACTS implementation : no difficulties for the detector building

  We are going to support both designs (Baseline + FST) with ACTS

Status of Cepc-ACTS integration

Detector study

https://gitlab.cern.ch/jinz/acts-framework-cepc

CEPC Detector v1

Me and Yubo

- ACTS Geometry
- Material mapping
- Propagation
- FATRAS
- Kalman Fitter

- Two designs of DD4hep based CEPC detector is implemented (Baseline+FST)
- Baseline (silicon + TPC)
    - Silicon detector with material
    - Simplified TPC with 220 sensitive surfaces
    - Validated with examples supported in ACTS-framework
- Full silicon detector
    - Geometry and materials is under validating

Gang

Framework integration

acts-core
ACTS-framework

→

acts-core
CEPC-framework

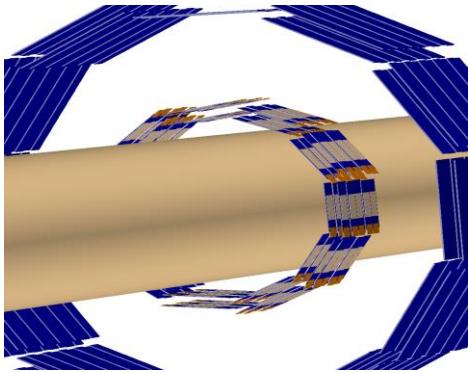Peixun and possibly other institute

Cepc Tracker Geometry building – Baseline

DD4hep based geometry to describe CEPC inner tracker

```xml
<detector id="3" name="Tracker_3" type="DD4hep_SubdetectorAssembly" vis="BlueVisTrans">
  <composite name="Barrel_SIT_layer_2"/>
  <composite name="ftd_endcap_pos3"/>
  <composite name="ftd_endcap_neg3"/>
</detector>
<detector id="4" name="TPC_" type="DD4hep_SubdetectorAssembly" vis="BlueVisTrans">
  <composite name="TPC"/>
</detector>
<detector id="5" name="ETD" type="DD4hep_SubdetectorAssembly" vis="BlueVisTrans">
  <composite name="Barrel_SET_layer"/>
  <composite name="etd_endcap_pos"/>
  <composite name="etd_endcap_neg"/>
</detector>
```
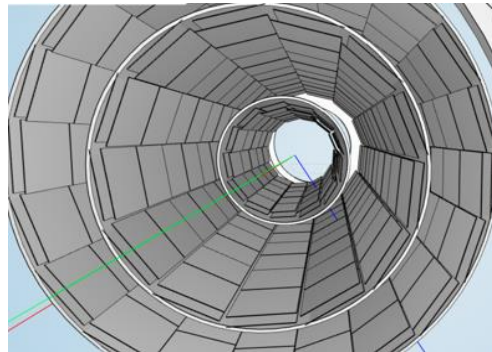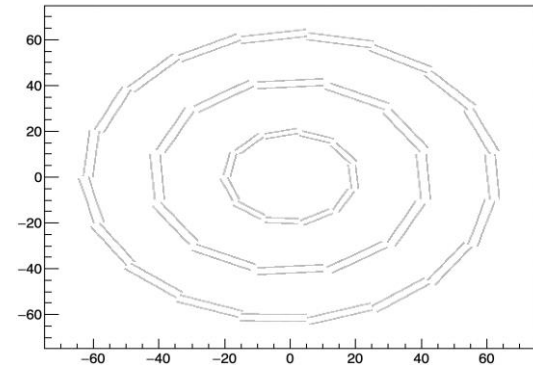
Double-sided pixel detector

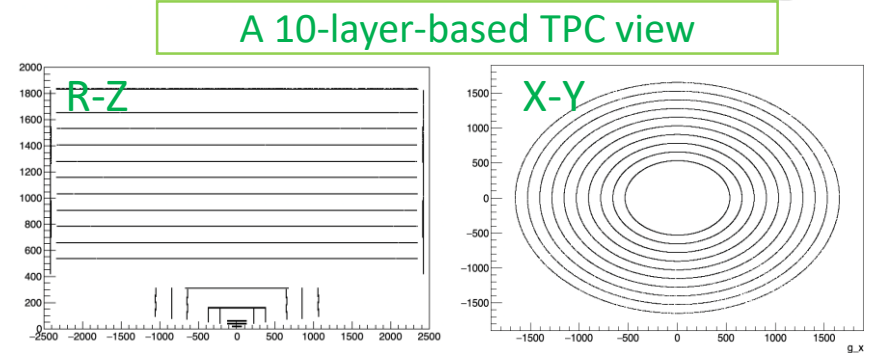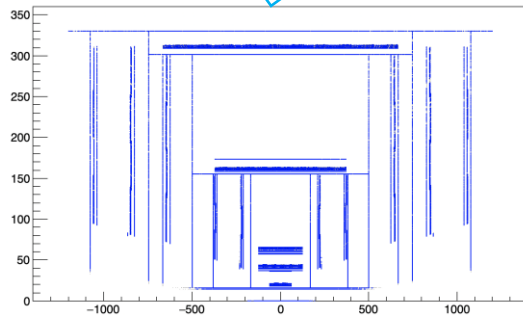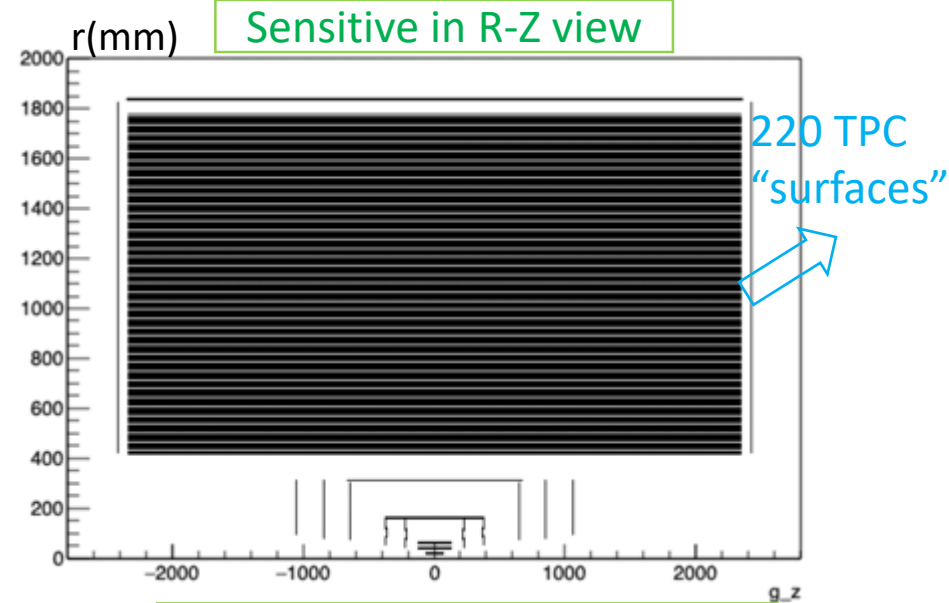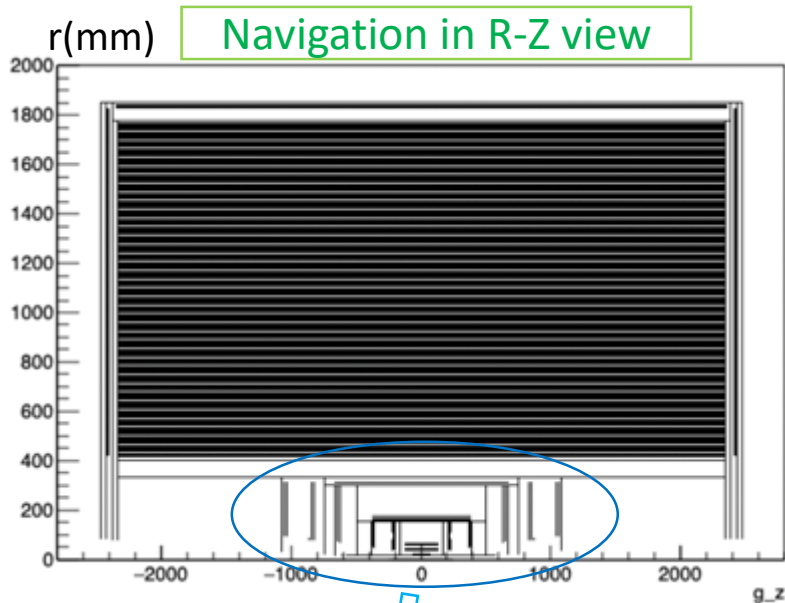| DD4hep view	ACTS output obj	ACTS sensitive

TPC

- Simply constructed with 220 sensitive tube surfaces
- Possibly changed to other gaseous detector implementation

Propagation Example

A powerful tool to debug the tracking geometry is correctly built

r(mm)   Navigation in R-Z view
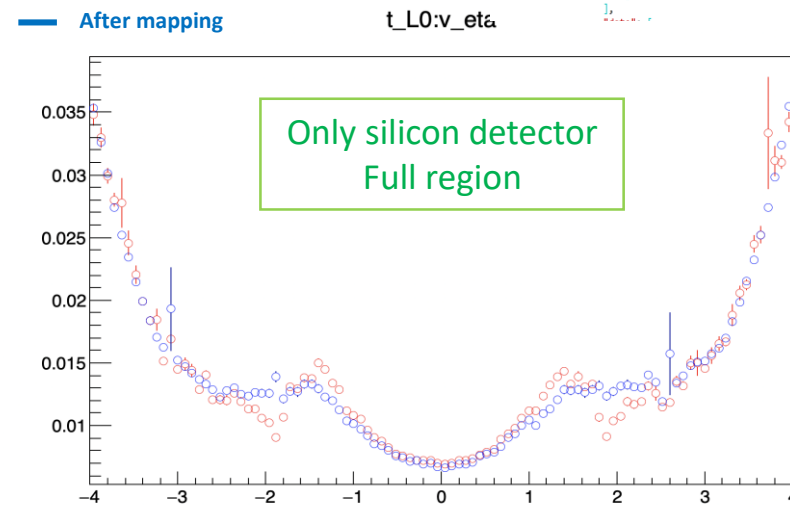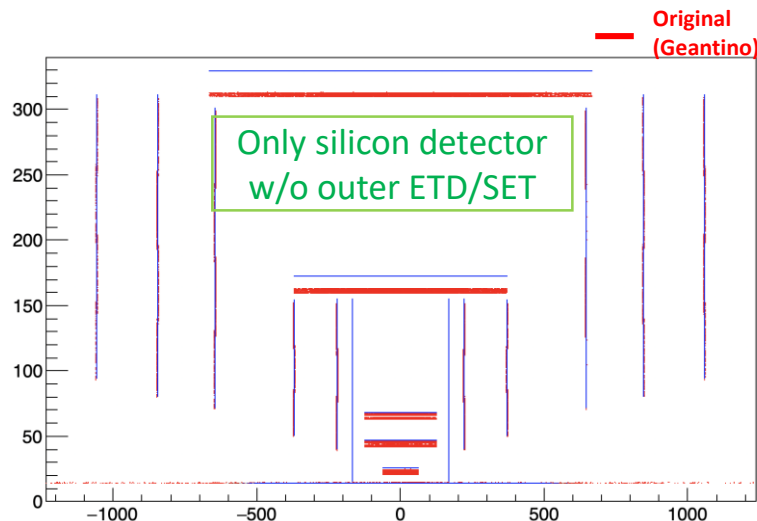
r(mm)   Sensitive in R-Z view

220 TPC "surfaces"

A 10-layer-based TPC view

R-Z

X-Y

Material Mapping Example

- Details Materials is in the xml file – primary version
- Layer representing surface and boundary surface mapping are included
- Geantino to record the original material
- TPC volume material mapping is to try
- Take the *OpenDataDetector* as a reference

Jason output

```
<dimensions rmin="15.9*mm" rmax="72.0*mm" dz="135.*mm"/>
    <boundary_material surface="negative" binning="binPhi,binR" bins0="1" bins1="25"/>
    <boundary_material surface="outer" binning="binPhi,binZ" bins0="1" bins1="200"/>
```

"volumes": {
  "14": {
    "Geoid": "[14 | 0 | 2 | 0 | 0]",
    "Name": "",
    "layers": {
      "2": {
        "Geoid": "[14 | 0 | 2 | 0 | 0]",
        "representing": {
          "bin0": [
            "binPhi",
            "closed",
            1,
            [
              -3.1415927410125732,
              3.1415927410125732
            ]
          ],
          "bin1": [
            "binR",
            "open",
            25,
            [
              70.0999984741211,
              300.9956970214844
            ]
          ],

Original (Geantino) — After mapping   t_L0:v_eta

Only silicon detector w/o outer ETD/SET
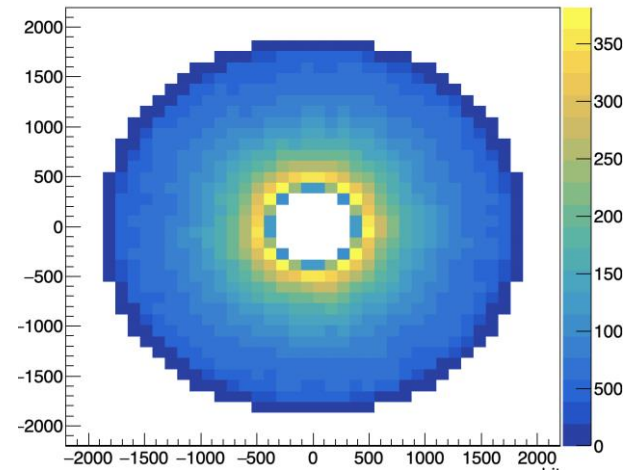
Only silicon detector Full region

Kalman filter fitting Example

- Fatras to generate simulated hits
- Hit smearing + Kalman truth fitting
- No digitization included yet
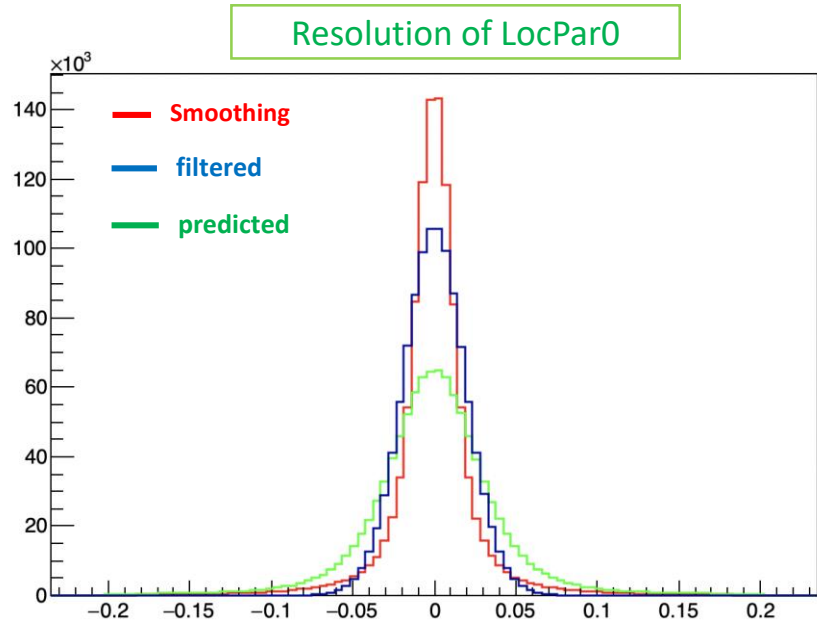
TPC fatras hit distribution in X-Y view

Resolution of LocPar0

Yao is studying the Cepc digitization part

More details study is under going on by Yebo and Hongbo and Gang

Experiences and Discussions

➢ As a user and developer,
  • It's a great experience to touch and learn all tracking parts from ACTS

➢ CEPC – ACTS study group (mainly from IHEP, other institutes are showing their interested)
  • ~ 1 year weekly(bi-weekly) meeting to share the tracking experiences from ACTS
  • More people are interested – more than 10 people attend our weekly-meetings
  • Increasing people are starting to work on the CEPC-ACTS integration part and some show their interested in contributing to ACTS project
  • Still works to do – material and layout learning, specific detector modules, Framework integration

➢ Several discussions – from CEPC point of view
  • Gas chamber - TPC/Wire chamber ?
  • Low transvers momentum tracks ? – for CKF, it can be a problem
  • Long vertex tracks – if we fully relies on the in-out CKF finder, these tracks seem to loss possibly

Thank you