

# VERTEX DETECTOR

Pythia Minbias EIC ( $Q^2 > 10^{-6}$ )  $\sigma \sim 200 \mu\text{b}$  (HERA  $\sim 165 \mu\text{b}$ )

$N \text{ events} = \sigma \cdot L \sim 2 \cdot 10^6 \text{ ev. per sec (2MHz)} \sim 2 \text{ events} / \mu\text{s}$  or  $\sim 20 \text{ events per readout}$

ZEUS/HERA(ep) =  $165 \cdot 10^{-30} \cdot 2 \cdot 10^{31} \sim 3.3 \cdot 10^3 \text{ per sec } (\sim 3\text{kHz})$

## MAPS:

ALICE:

1 layers (with support)

$\approx 1 \% X/X_0$

10 millions pixels

Integration time  $30\mu\text{s}$

STAR:

1 ladder  $0.39\% X/X_0$

50 $\mu\text{m}$  thickness

Pixel size  $20.7 \times 20.7 \mu\text{m}^2$

356 millions pixels

$R_1 = 2.8 \text{ cm}$ ,  $R_2 = 8 \text{ cm}$

Integration time  $185.6 \mu\text{s}$

## DEPFET

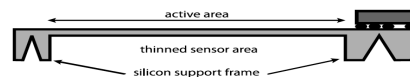
PXD BELLE-II:

-8 millions pixels

-1 ladder :  $0.19 \% X_0$

-thickness 50 $\mu\text{m}$

(self-supporting)

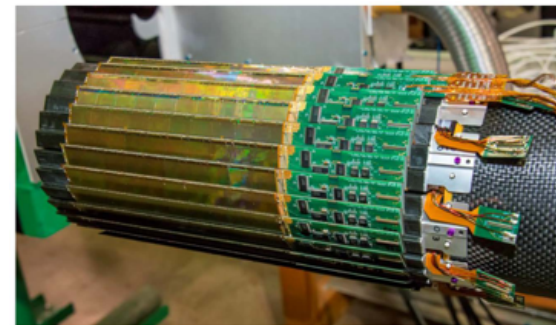


-Integration time  $\sim 10\mu\text{s}$

-price for vertex  $\sim R$

(2.5 M\$ for L  $\sim 12 \text{ cm}$  R  $\sim 1 \text{ cm}$ )

## MAPS

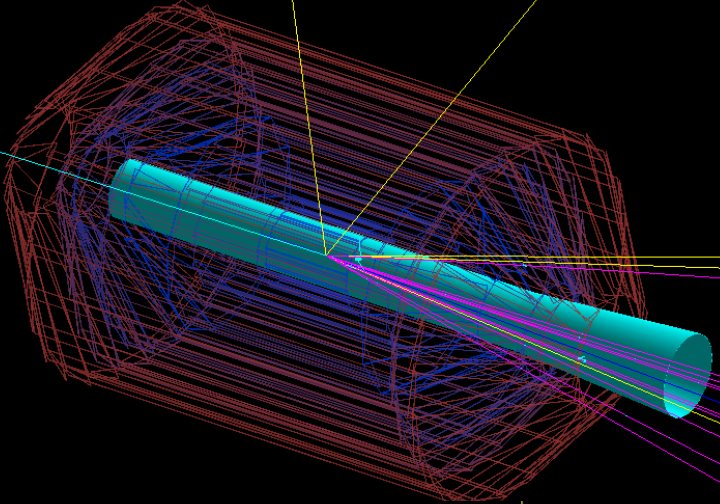


## DEPFET

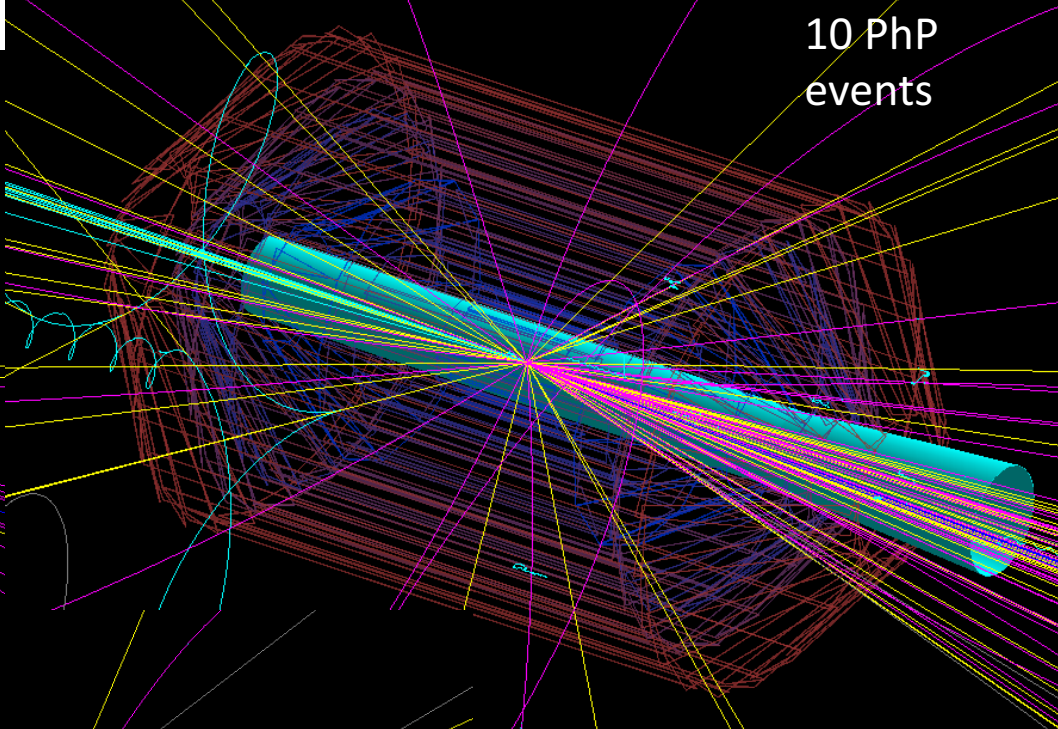


# GEANT4 (1.5 TESLA)

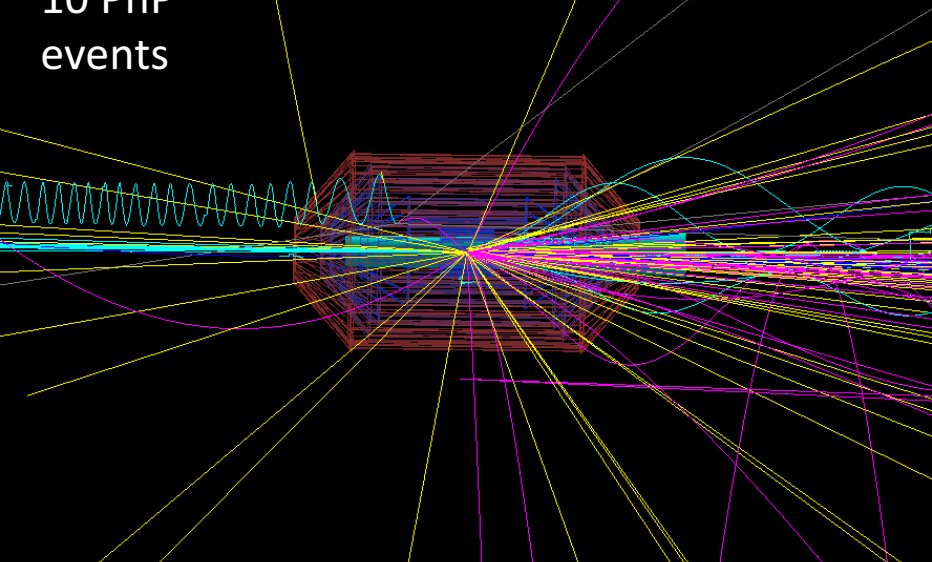
1 PhP event



10 PhP events



10 PhP events



# GEANT4 (1.5 TESLA)

The screenshot displays the GEANT4 TestEm10 interface. The main window shows a 3D visualization of a particle detector with a central beam pipe and various detector components. A particle beam is shown entering from the left, and its path is traced through the detector, with secondary particles and tracks visible. The interface includes a command tree on the left, an output window at the bottom, and a search bar at the top.

**Command Tree:**

- Scene tree, Help, History
- Scene tree | Help | History
- Search :
- Command
  - control
  - units
  - process
  - geometry
  - tracking
  - event
  - cuts
  - ▾ run
    - particle
    - initialize
    - beamOn**
    - verbose
    - printProgress
    - numberOfThreads
    - useMaximumLogicalCores
    - pinAffinity
    - eventModulo
    - dumpRegion
    - dumpCouples
    - optimizeGeometry
    - breakAtBeginOfEvent
    - breakAtEndOfEvent
    - abort
    - abortCurrentEvent
    - geometryModified
    - reinitializeGeometry
    - physicsModified
    - constructScoringWorlds
    - storeRndmStatToEvent
    - setCut
    - setCutForAGivenParticle
    - getCutForAGivenParticle
    - setCutForRegion
  - random
  - ▾ particle

Choose a command in the command tree

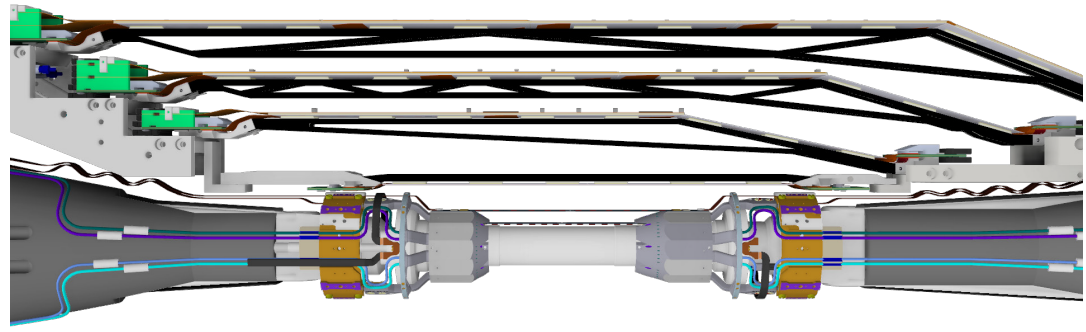
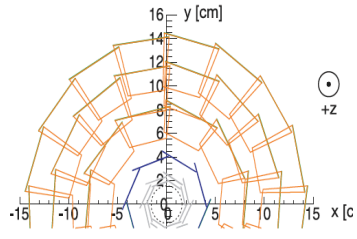
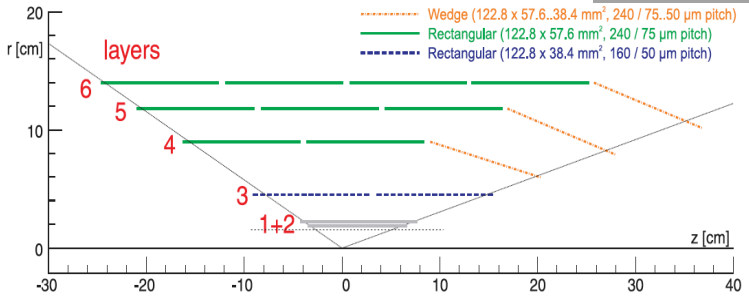
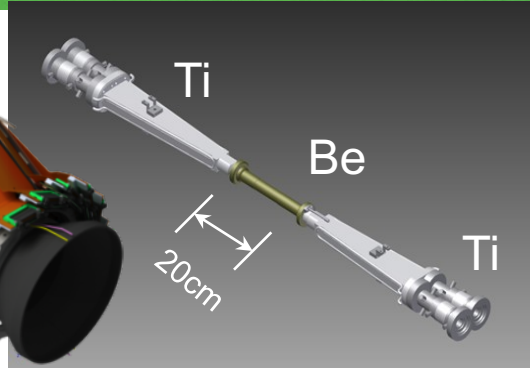
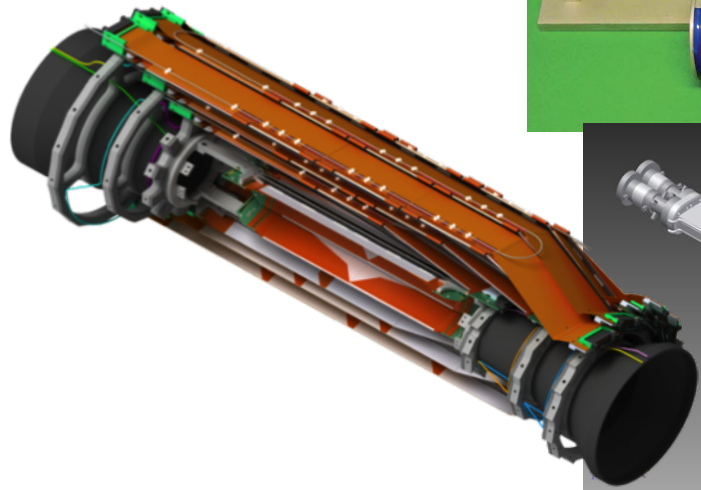
**Output:**

```
end of Run TotNbofEvents = 1
mean charged track length in absorber=0 +- 0 mm
mean energy deposit in absorber=0 +- 0 MeV
mean number of steps in absorber (charged) =0 +- 0
mean number of steps in absorber (neutral) =0 +- 0
mean number of charged secondaries = 0 +- 0
mean number of neutral secondaries = 0 +- 0
mean number of e-s =0 and e+s =0
(number) transmission coeff=0 reflection coeff=0
/vis/viewer/update
```

Session :

# BELLE-II VERTEX DETECTOR

- price for pixel detector  $\sim R$  (2.5 M\$ for L  $\sim 12$  cm R  $\sim 1$  cm)
- 1-2 PXD: DEPFET pixel sensors
- 3-6 SVD: double-sided strip sensors
- Low material budget
- Very good resolution
- Good integration with beam-pipe
- Radiation hard (including electronics)
- Cooling





# GEANT4 VTX

- **BEAM-pipe**

R=3.1 cm

Ca. 50 cm straight section

$\frac{1}{2}$  (50mrad) crossing angle

Space for VERTEX det. R~ 20cm

- **Pixel detector** 2 layers

2x10 (11) cm ladders (Box)

20um pitch, 50um thickness

2 layers

1st layer- 12 ladders

2nd layer- 14 ladders

- **Strip detector**

- **Barrel** 5 layers

ladders 12/12/18/20/24 (Box)

length 24/24/36/40/48

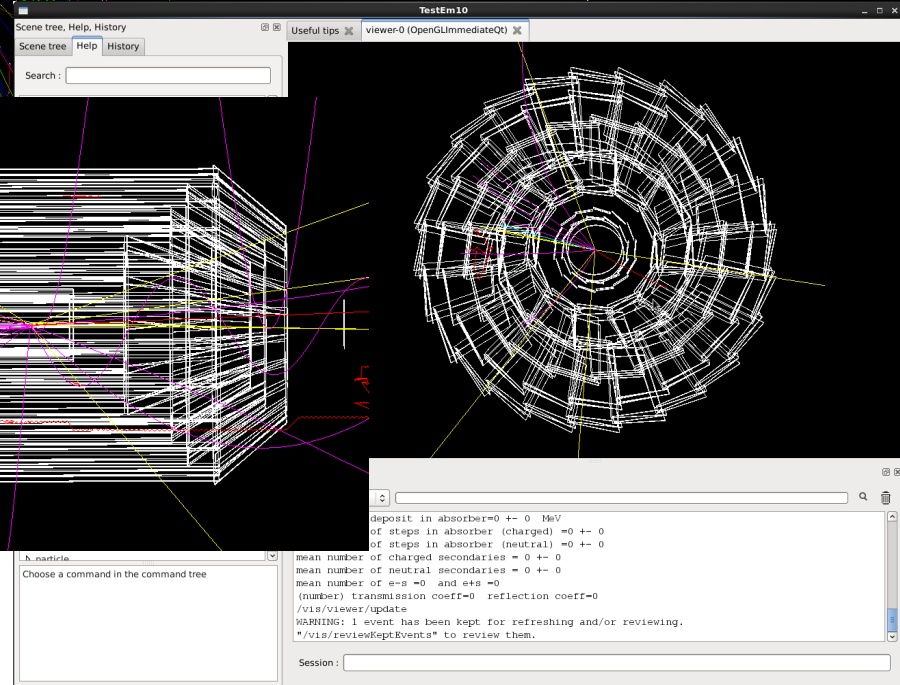
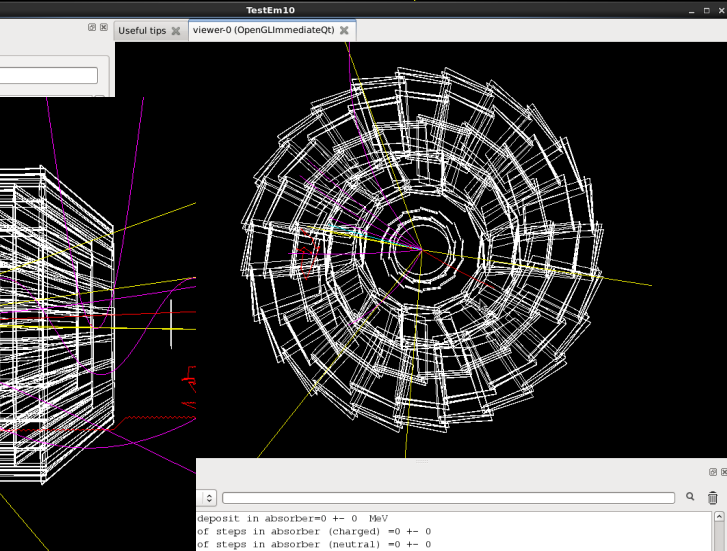
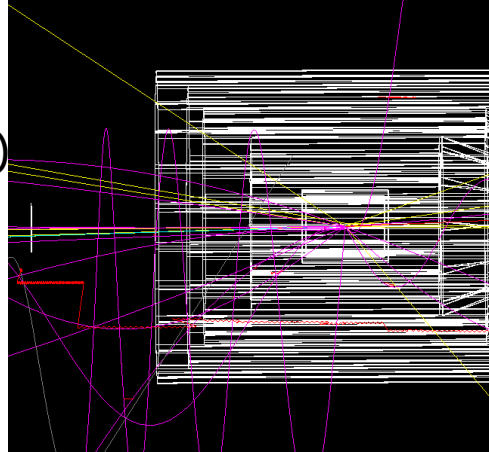
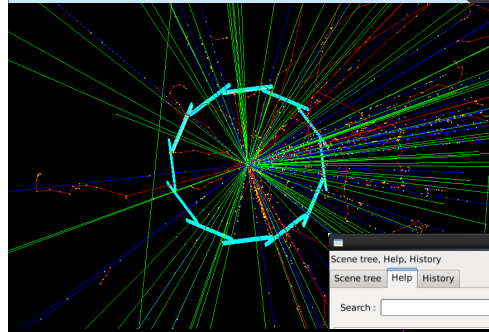
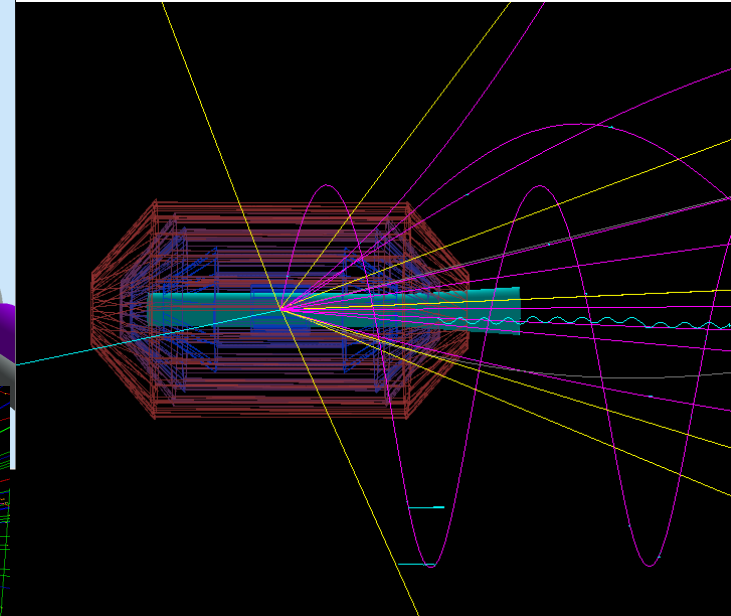
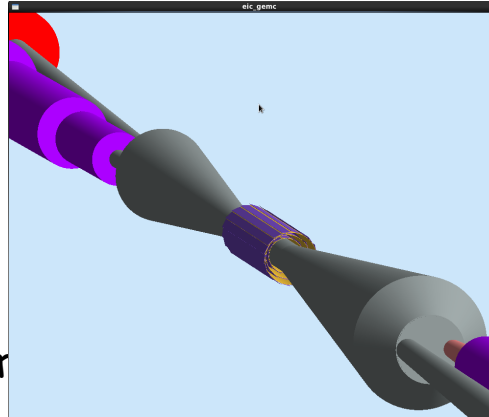
width 4/6/6/6/6

- **Endcap** 4 layers

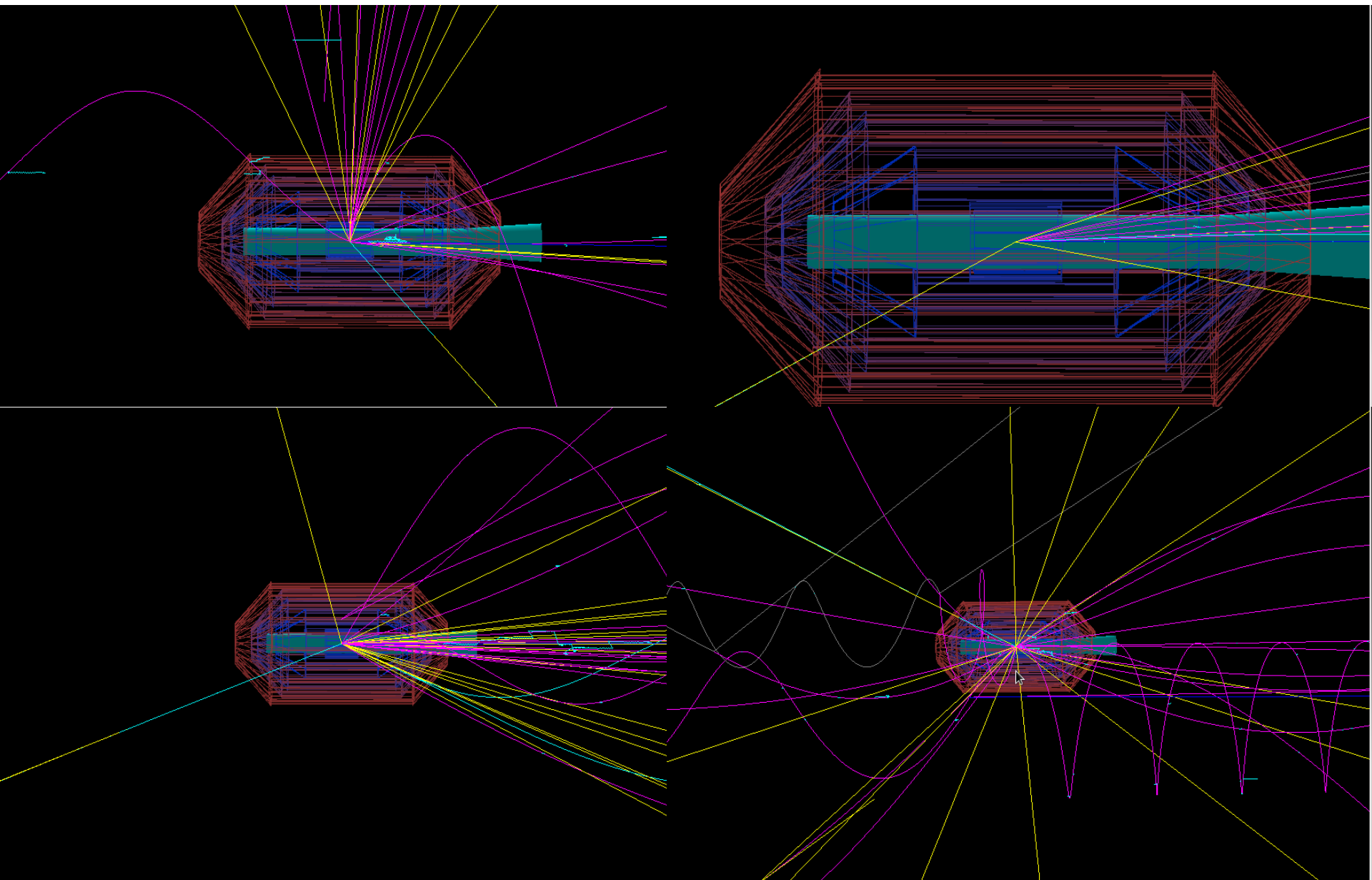
ladders 12/18/20/24(Trap)

length 12/14/16/18

width1 4, width2 6



# VERTEX WITH CHARM EVENT $Q_2 > 10$ , 1.5 TESLA



# GENFIT

**Eve Main Window**

Browser Eve

Eve Files Draw Control Refit Contr Viewer 1

Go to event: 9 Redraw Event

Hide Viewer 1 Actions

Draw Options

- Draw geometry
- Draw detectors
- Draw hits
- Draw planes
- Draw track markers
- Draw track
- Draw reference track
- Draw track errors
- Draw forward fit
- Draw backward fit
- Auto-scale errors
- Manually scale errors
- 1 Error scale

TrackRep options

- Draw cardinal rep
- Else draw rep with id

The main window displays a 3D visualization of a detector structure with a track passing through it. The track is shown as a series of points connected by lines, with error bars and fit lines. The detector is composed of several concentric layers of rectangular segments.

**Eve Main Window**

Browser Eve

Eve Files Draw Control Refit Contr Viewer 1

Go to event: 5 Redraw Event

Hide Viewer 1 Actions

Fitting options

- Refit
- 0 debug level

Fitter type:

- Simple Kalman
- Reference Kalman
- DHF w/ simple Kalman
- DHF w/ reference Kalman

Multiple measurement handling in Kalman

- weighted average
- unweighted average
- weighted, closest to reference
- unweighted, closest to reference
- weighted, closest to prediction
- unweighted, closest to prediction
- weighted, closest to reference for
- unweighted, closest to reference for
- weighted, closest to prediction for
- unweighted, closest to prediction for

Use square root formalism (simple Kalman)

0,001 delta pVal (convergence criteria)

0,2 rel chi<sup>2</sup> change (non-convergence)

1 min chi<sup>2</sup> change for re-calculation

2 Minimum nr of iterations

4 Maximum nr of iterations

-1 Maximum nr of failed hits

Resort track

Command

Command (local):

The main window displays a 3D visualization of a detector structure with a track passing through it. The track is shown as a series of points connected by lines, with error bars and fit lines. The detector is composed of several concentric layers of rectangular segments.

**Eve Main Window**

Fit Contr Viewer 1

Event: Hide Viewer 1 Actions

Command

Command (local):

The main window displays a 3D visualization of a detector structure with a track passing through it. The track is shown as a series of points connected by lines, with error bars and fit lines. The detector is composed of several concentric layers of rectangular segments.

# GENFIT

Eve Main Window

Browser: Eve

Eve | Files | Draw Control | Refit Contr

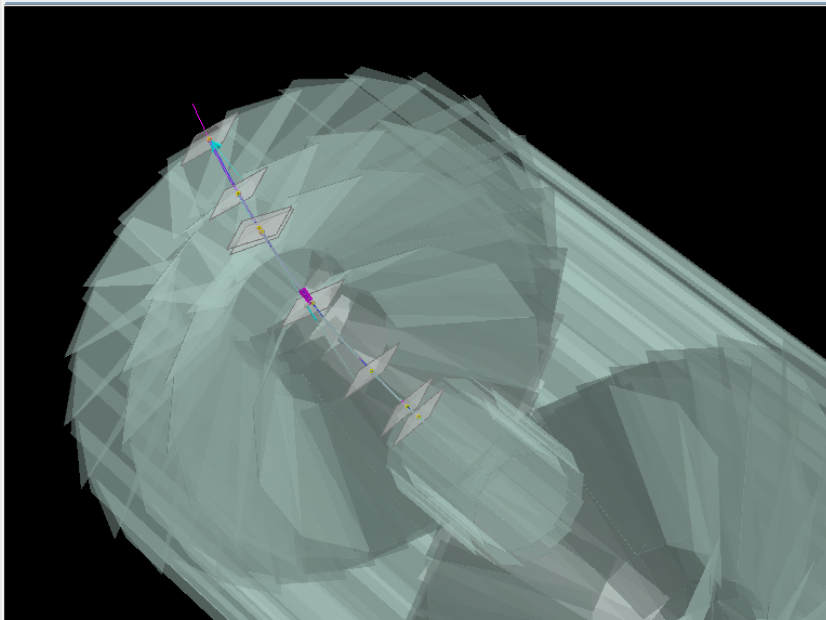
Go to event: 41 Redraw Event

Viewer 1

Hide

Viewer 1

Actions



Command

Command (local):

Multiple measurement handling in Kalman

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to prediction

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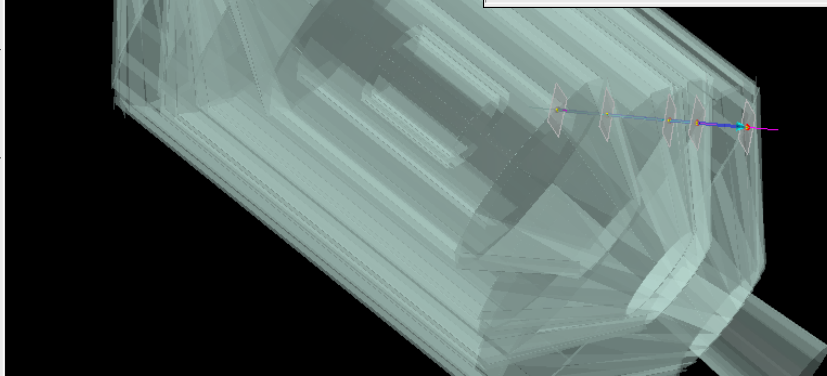
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Command

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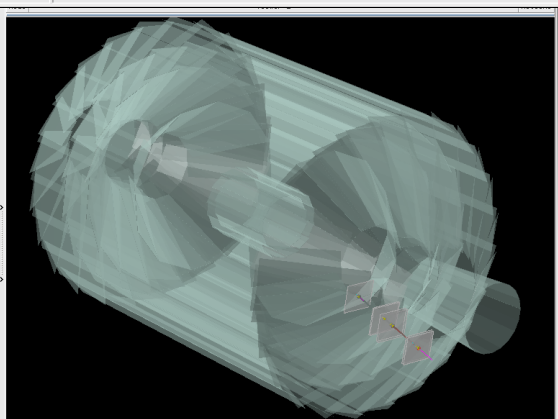
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Resort track



Command

Command (local):



# TODO:

- **GEANT4:**

- First version of VERTEX det. is ready
- Add outer tracker (TPC or MW in barrel, GEM-endcaps)

- **GENFIT**

- I/O file:
  - > Now: hits and track ID only.
  - > add MC info (org. momentum, id, etc.)
- 'Eve' Event display
  - > At the moment - track by track
  - > Create Event (multiple tracks)
  - > Use Eve as Event Display

- **RAVE** (vertex fitting)

- Have software, but have to learn how to use it

- **Analysis**

- Create "LUND" or ... file with reconstructed momenta, vertex, PID

-

# ELECTRON METHOD

