# Beam-background impact in the IDEA drift chamber

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FCC-ee physics & experiments:

Machine detector interface (review)

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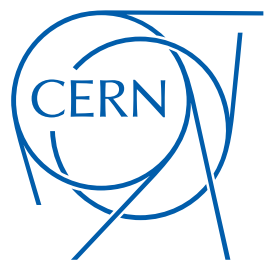
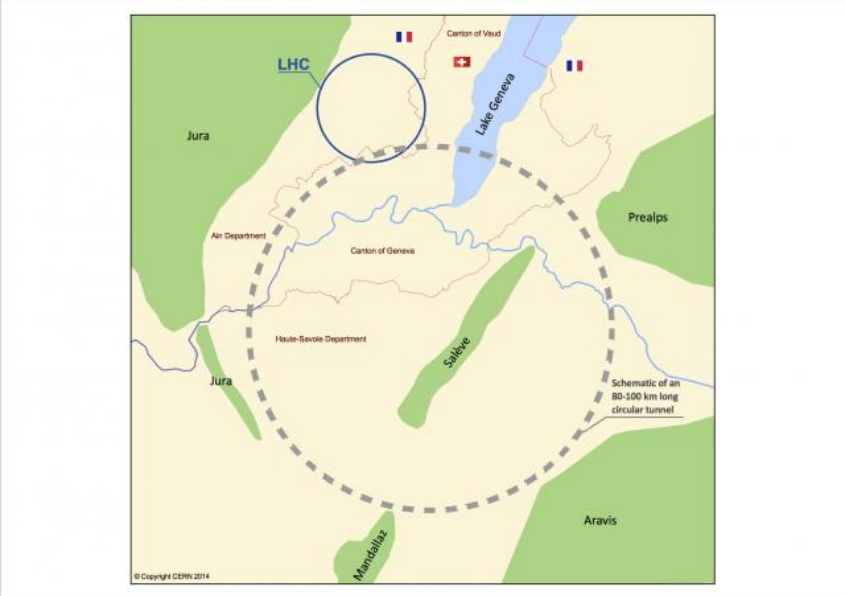


# Introduction

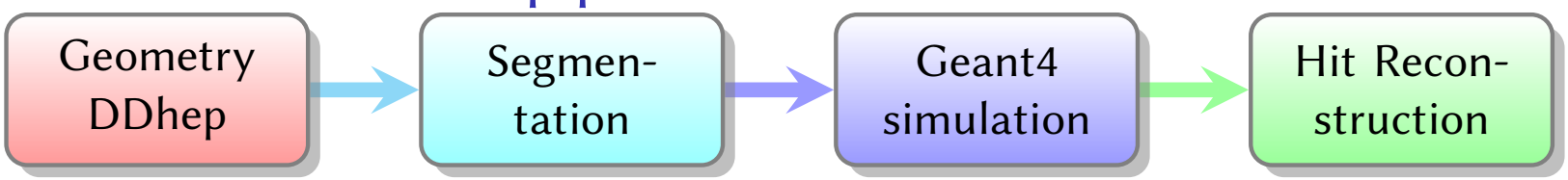
1. FCC experiment and FCCSW
2. IDEA detector concept
3. Drift chamber
4. Geometry implementation
5. Segmentation and validation
6. Simulation
7. Material budget scan
8. Background studies

# FCC Software

- Common software for all FCC experiments
  - ee, hh & eh
- Detector and physics studies
  - Fast & full simulations
  - One software stack from event generation to physics analysis
- Collaborative approach
  - LHC: Gaudi
  - CLIC: DD4hep



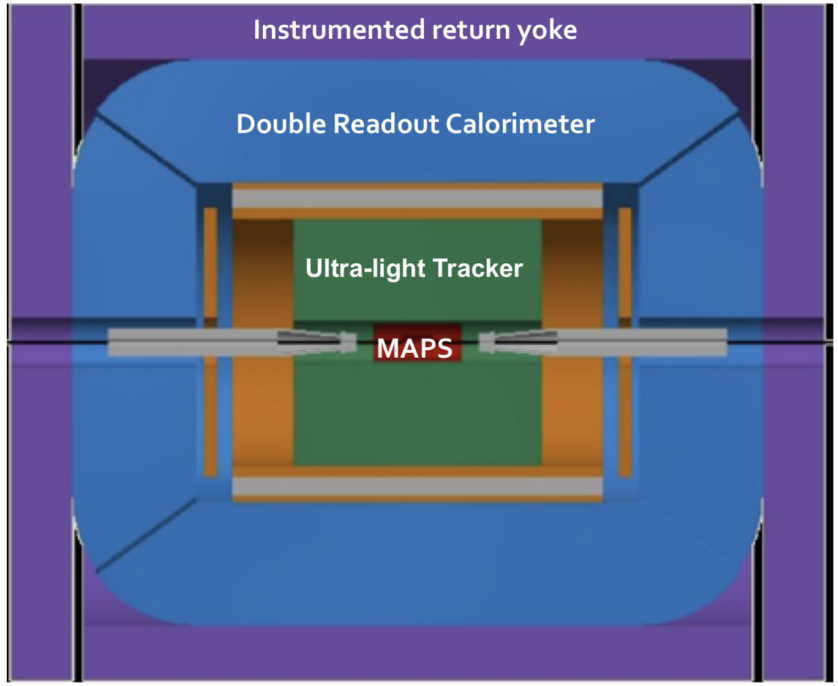

## FCCSW simulation pipeline



# FCCee: IDEA detector concept

## Ultimate Goal

- Vertex detector: MAPS
- Ultra-light drift chamber with PID
- Pre-shower counter
- Double read-out calorimetry
- 2 T solenoidal magnetic field
- Instrumented return yoke
- Surrounded by large tracking volume (R$\sim$8 m) for very weakly coupled (long-lived) particles



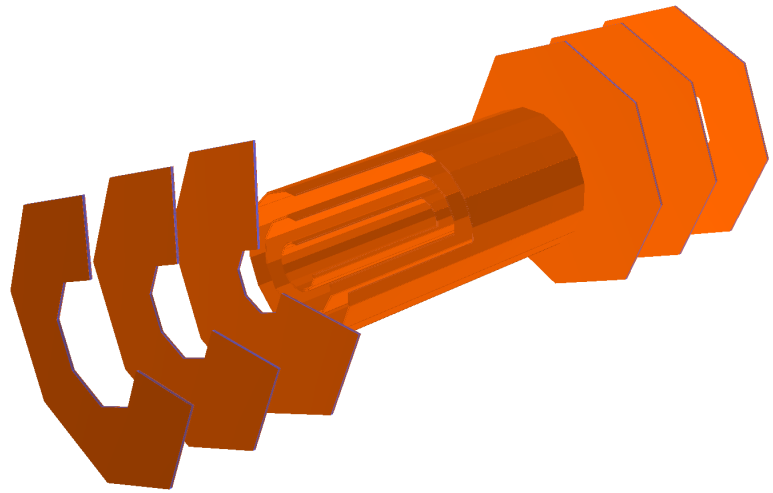

## Implementation in FCCSW

- Beam-pipe and interaction region (IR) taken from the CLD concept.
- Vertex detector also taken from the CLD concept.
- The drift chamber implemented from scratch in FCCSW.

# Vertex Detector

## Geometry

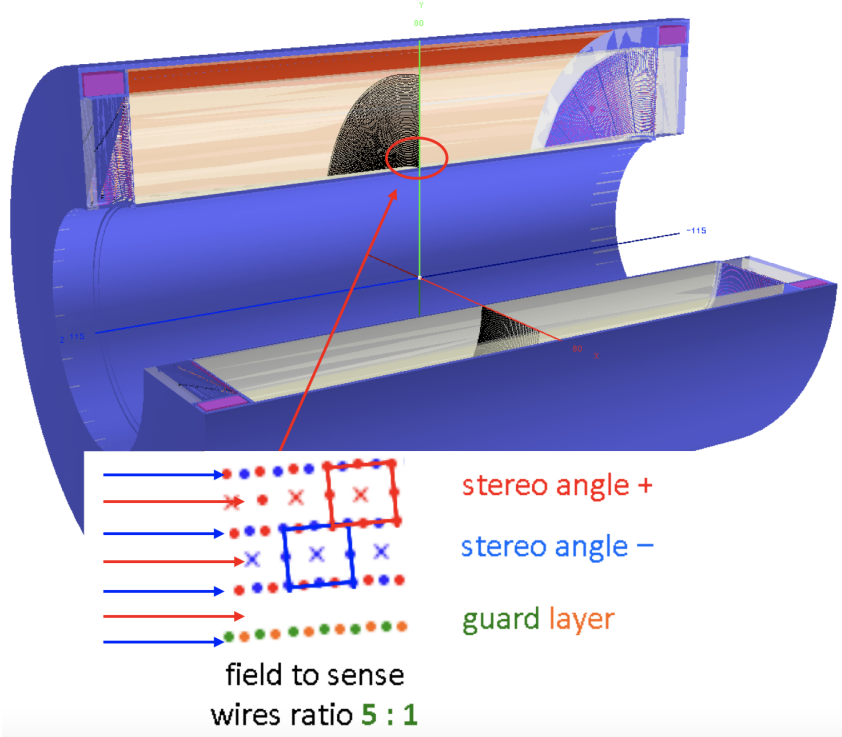
- Barrel: 3 double-sided layers
- Endcap: 3 double-sided disks



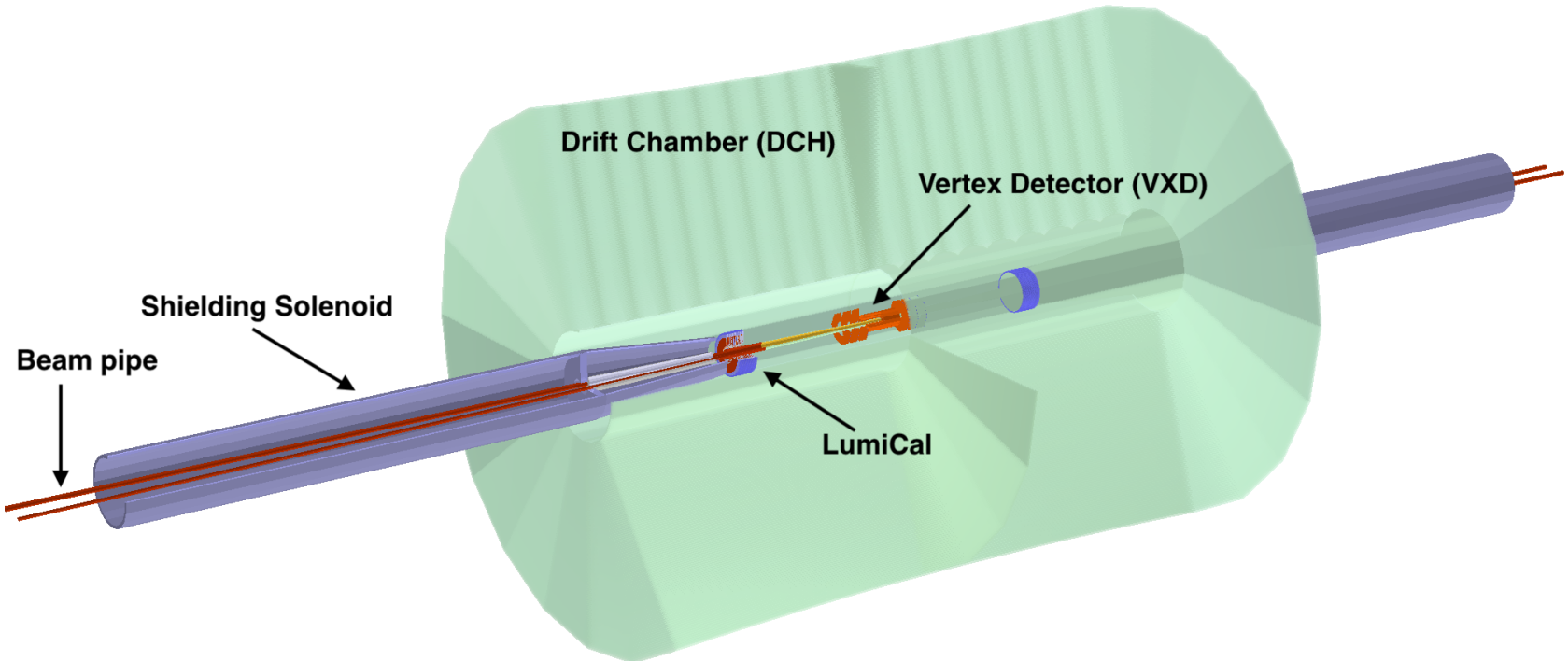
# Drift Chamber

## Parameters

| | |
|---|---|
| Length | 4500 mm |
| Inner radius | 345 mm |
| Outer radius | 2000 mm |
| Nb. layers | 112 |
| Cell size | 12 mm to 14.7 mm |
| Total nb. of sensitive wires | 56448 |
| Total nb. of field wires | 282240 |
| Total nb. of wires | 338688 |
| Gas | GasHe_90Isob_10 |
| Wire material | Aluminum |
| Single cell resolution | 0.1 mm |



# Geometry implementation in DD4hep

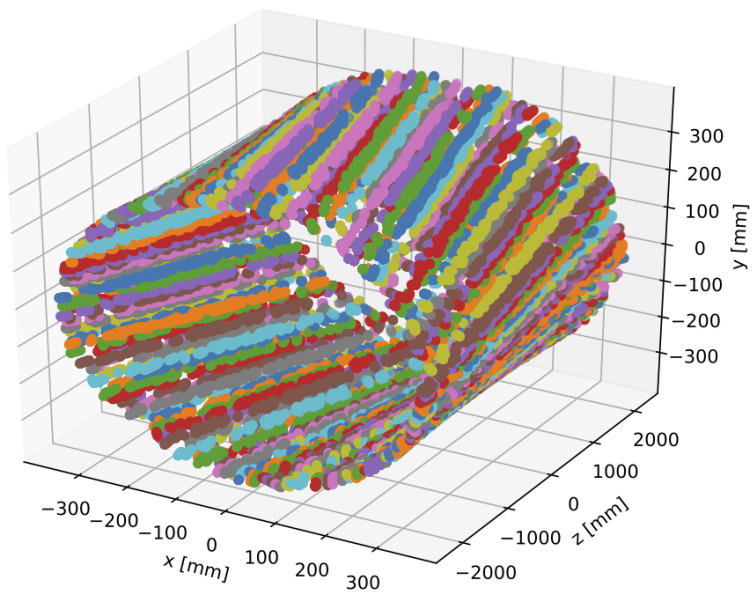


# Segmentation

- Information on the location of the wires
- Associates a unique wire ID (cellID) to the wires
- Different granularity for different layers in the DCH
- The segmentation information is created while building geometry

  $\Rightarrow$ Accessible in every step of the simulation

- First layer of the DCH
- Hits having the same wire ID are shown by the same color
- Validates the segmentation



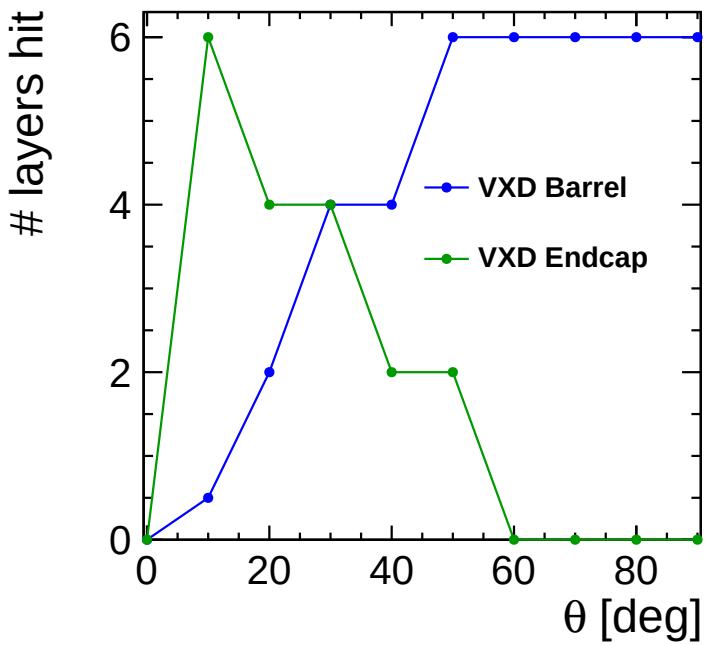
# Simulation of the DCH

- Stepping in the gas with a step length of 2 mm
- Reject ionisation acts with:
  - $E_{dep} < 10$ eV
  - G4Step length $< 5\mu$m
- Drift the $E_{dep}$ to the nearest wire
  - Distance of the closest approach
  - Assume a constant drift velocity of 2 cm/$\mu$s
  - Calculate drift time
- For each wire, merge the $E_{dep}$ with a drift time smaller than the maximum drift time in the cell

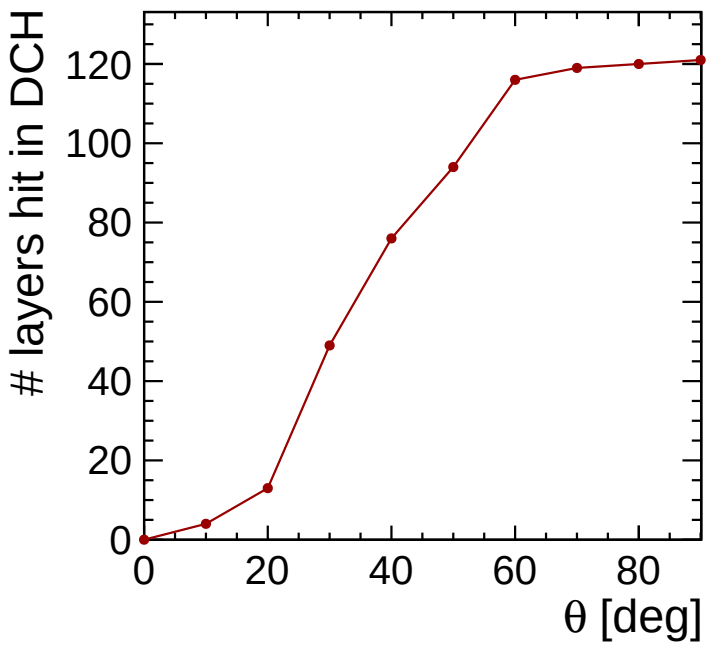
# Number of layers vs. $\theta$

- Number of layers hit by 100 GeV $\mu-$
  - $\theta = 0^\circ$: very forward direction
  - $\theta = 90^\circ$: in the barrel
  - Averaged over $\phi$

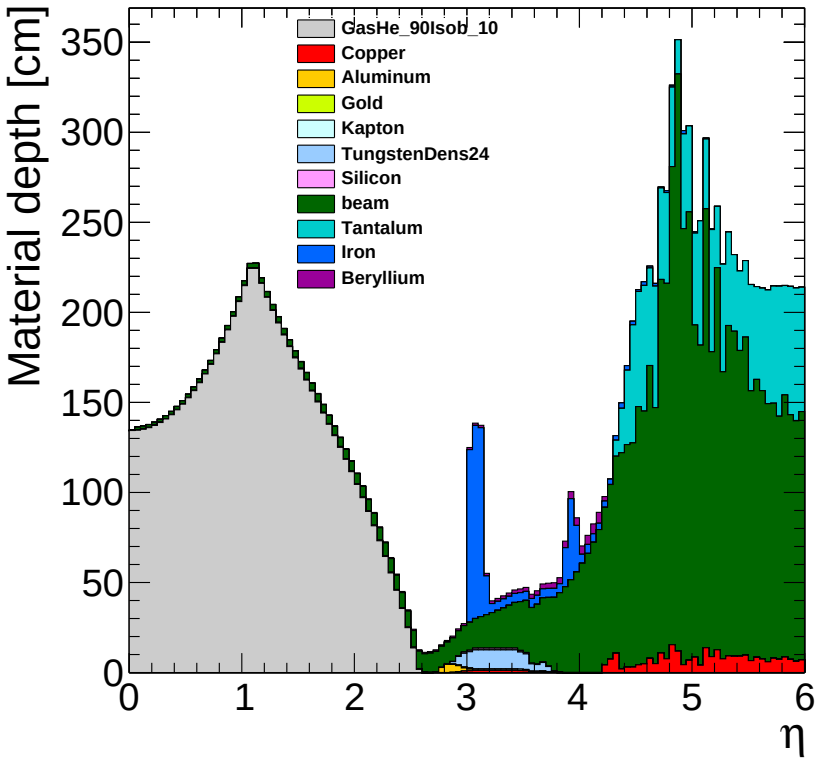
## VXD

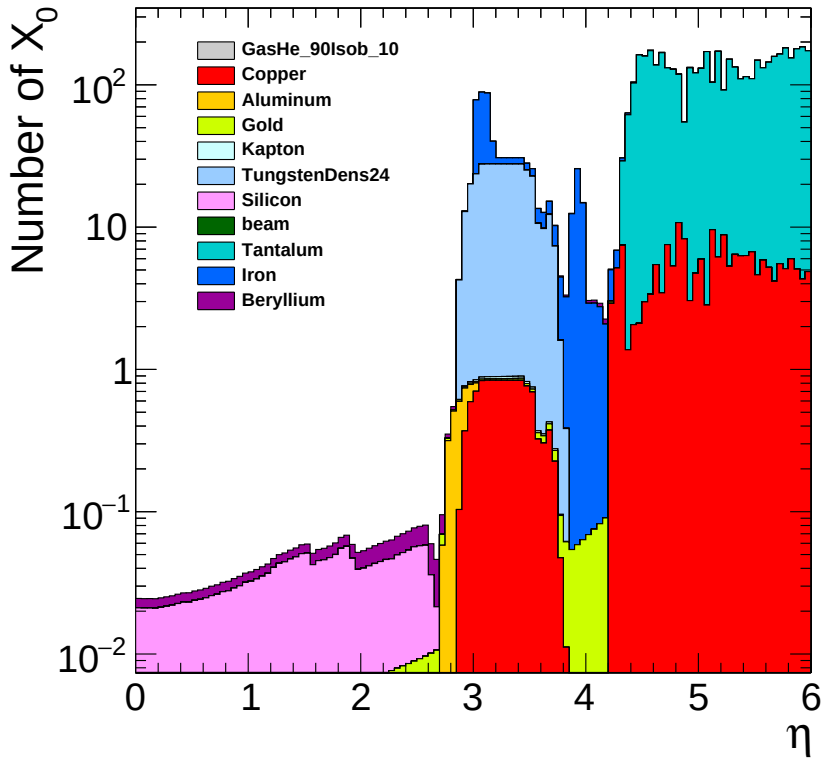



## DCH



# Material Budget Scan: work in progress

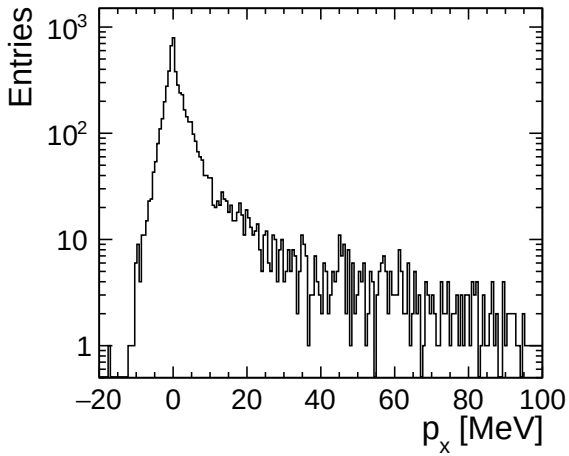


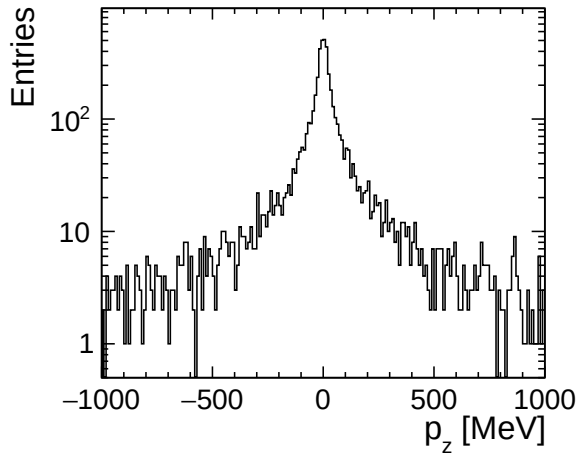



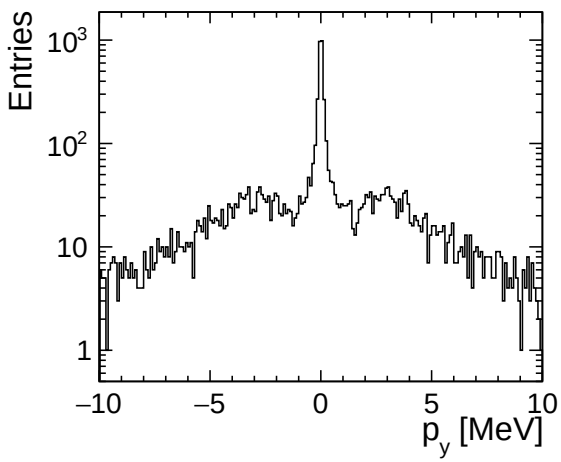
# Background studies

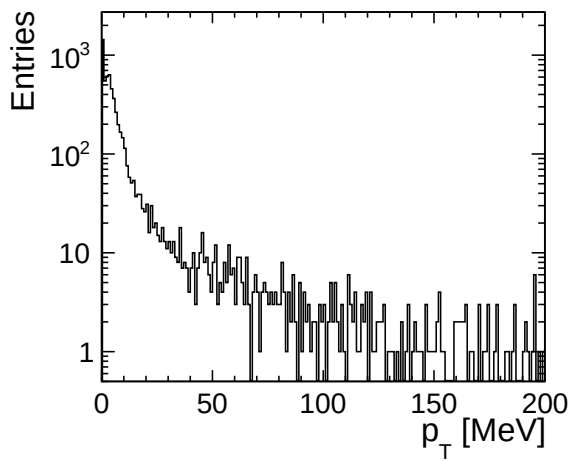
- The effect of incoherent $e + e-$ pairs on the interaction region (IR)
- $E_{cm}$ = 365 GeV
- Total nb. of particles: $\sim$ 6200

## Momentum distribution



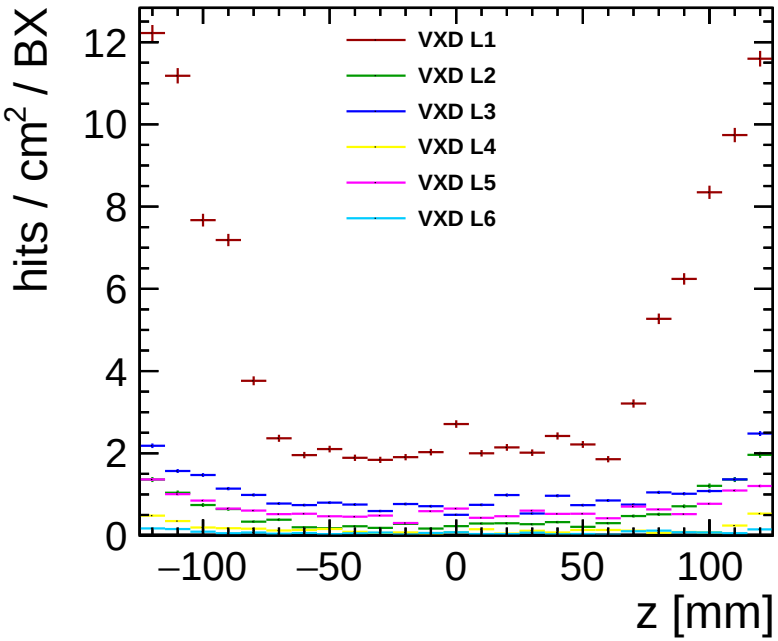



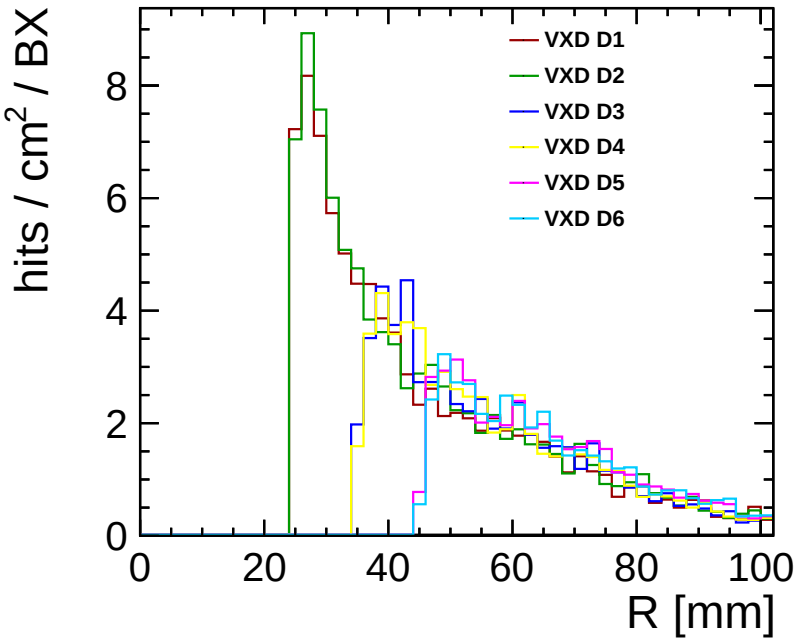



# Background studies for the VXD: work in progress

- Vertex Barrel




- Vertex Endcap

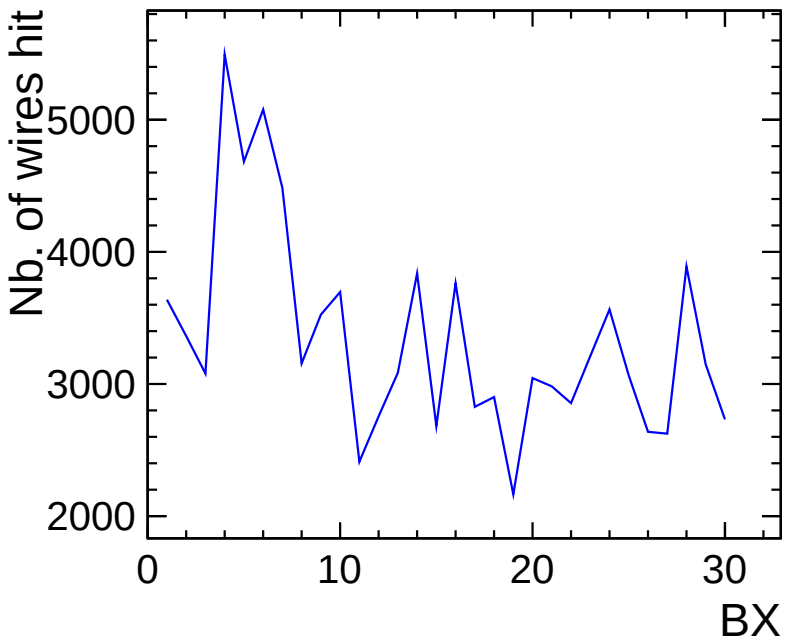



| Detector | Total nb. of hits |
|---|---|
| Hits in the VXD barrel | 2737 |
| Hits in the VXD endcap | 2537 |

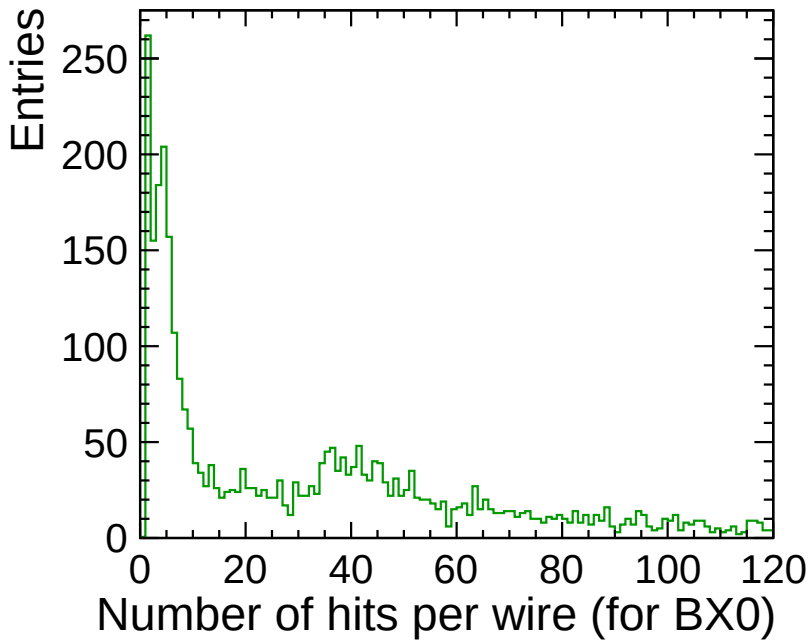
- The trend is as expected
- More investigation & tuning on the hit reconstruction and cuts in Geant4 simulations is needed

# Background studies for the DCH: work in progress

- Number of wires with different IDs recorded a signal
  - Average: 3345.7 wires

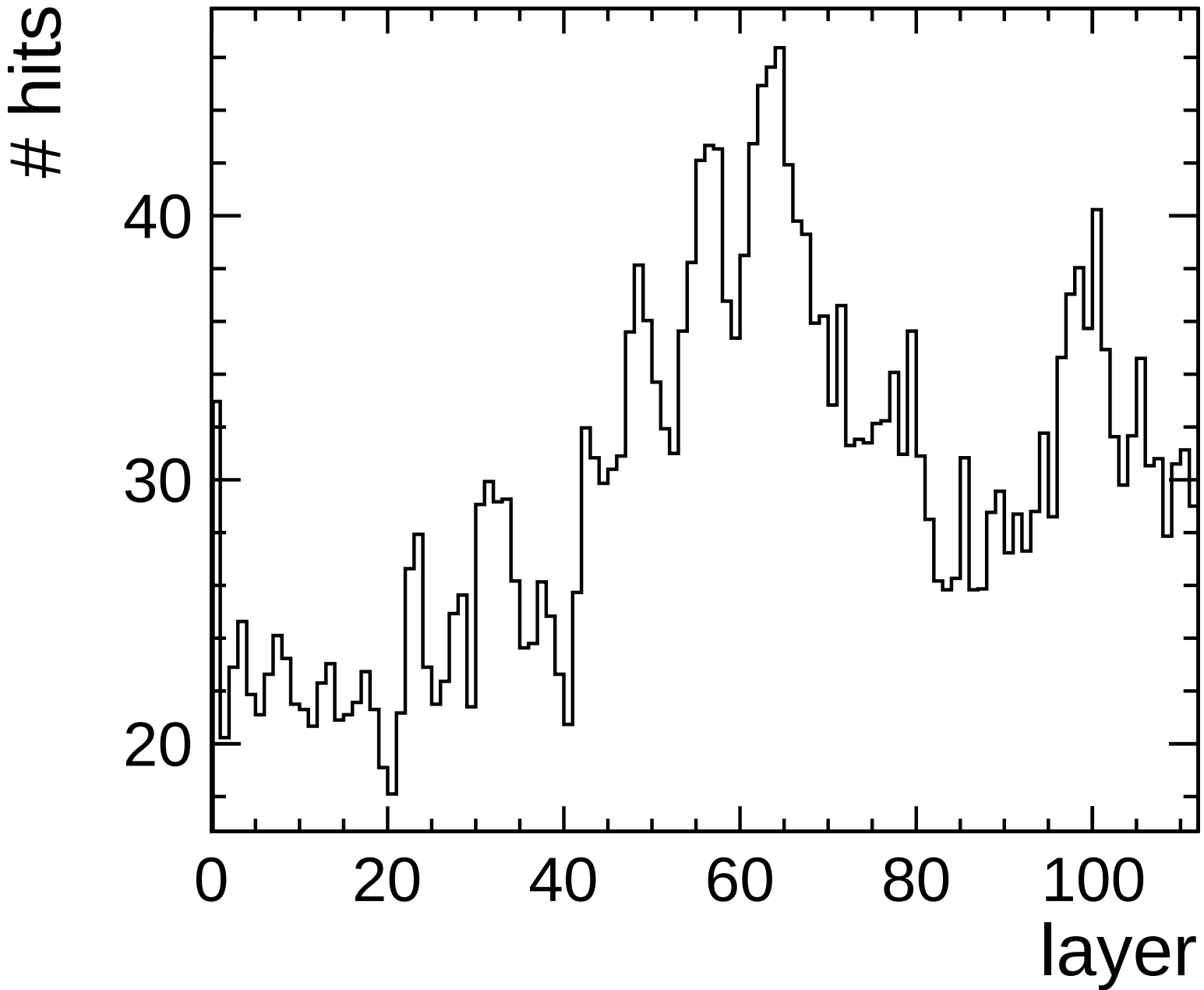



- Number of hits recorded per wire in the first BX
- Mostly 1-hit per wire
- Several hits per wire: pile-up or same




- To be investigated further: merging hits belonging to the same wire and having a drift time smaller than the maximum drift time in a cell.
- Occupancy as a function of the cell/voxel

# Background studies for the DCH: number of hits per layer



# Summary & Outlook

- FCCee-detector concept simulation with FCCSW
  - Implementation of the geometry
  - Simulation
  - Validation
- Study of beam-induced backgrounds: e+e- incoherent pairs
  - Estimation of the occupancy in the VXD and DCH