Full simulation of the FCC-ee IDEA detector with FCCSW

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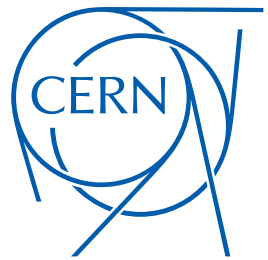
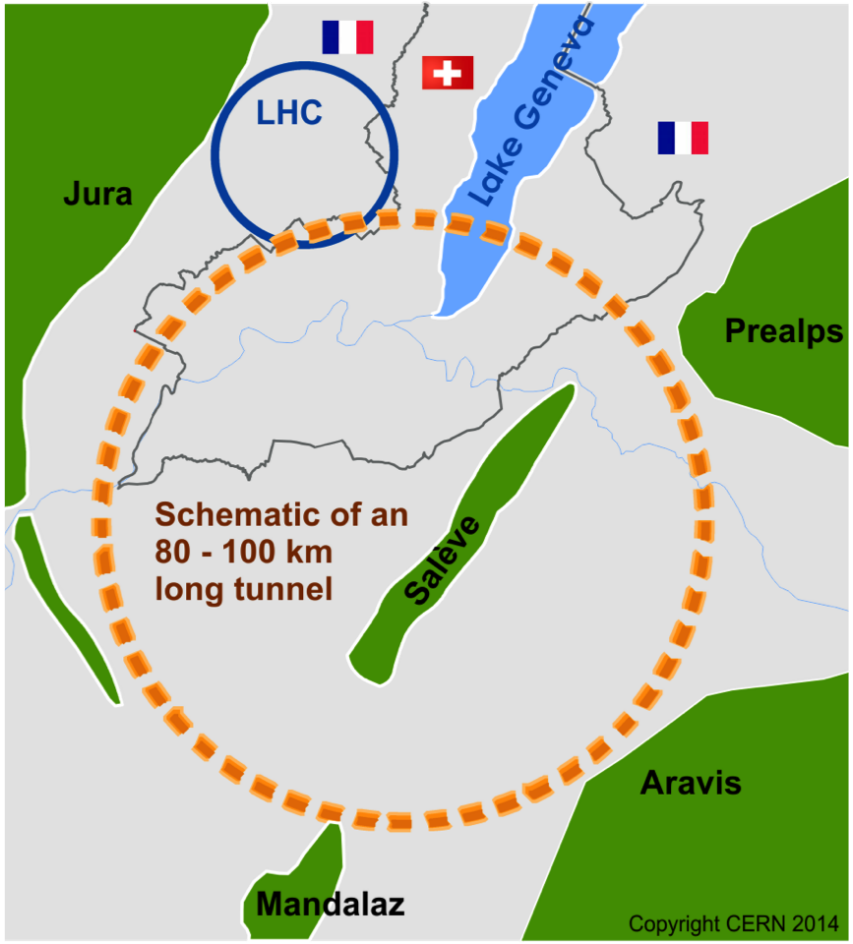


FCC Software: FCCSW

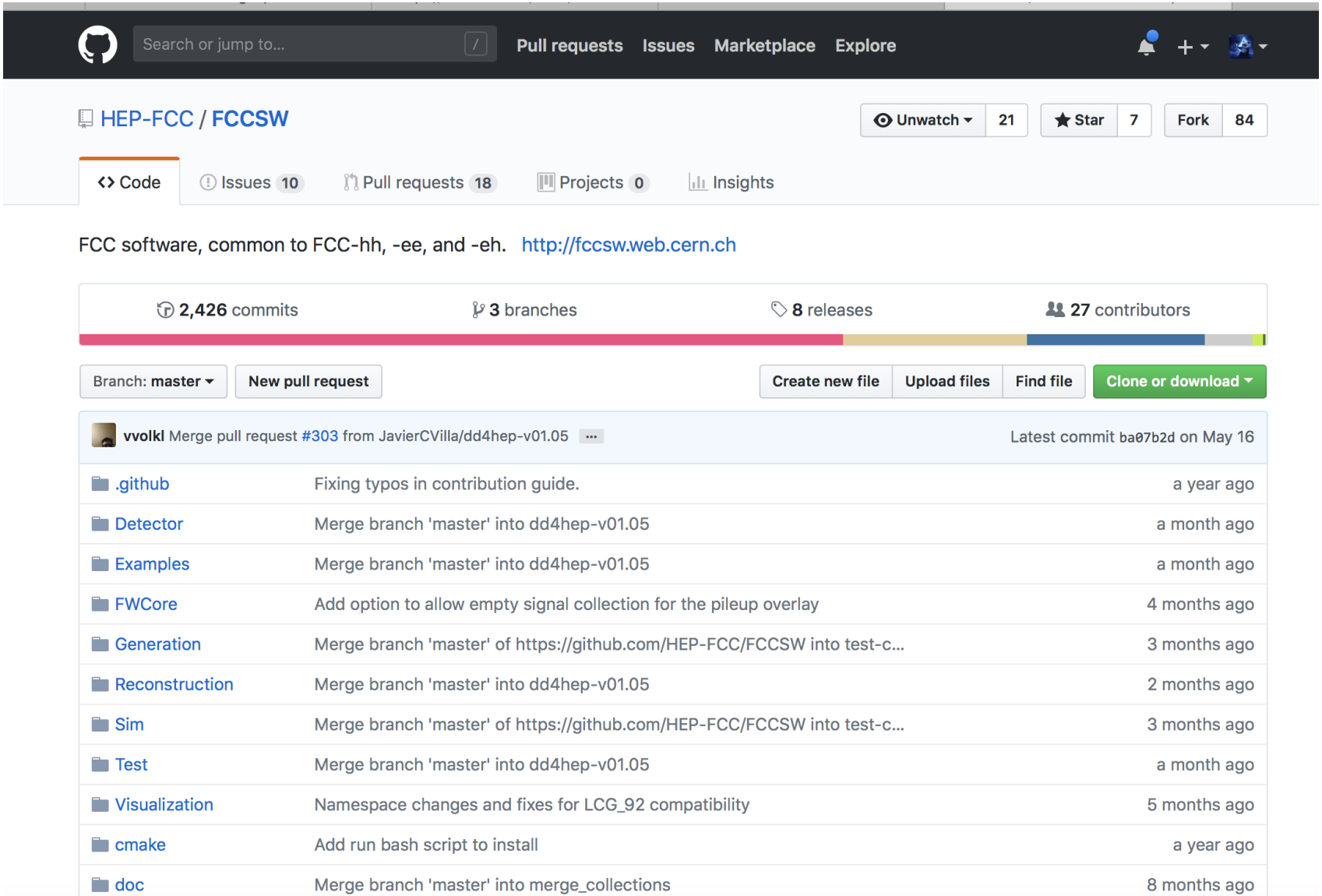
- Common software for all FCC experiments
  - ee, hh & eh
- Detector and physics studies
  - Fast & full simulations
  - One software stack from event generation to physics analysis
- Collaborative approach
  - LHC: Gaudi
  - CLIC: DD4hep
  - New solutions ⇒ where needed



- The IDEA concept is under development within FCCSW
  - Impact of beam-induced background is under study

FCCSW

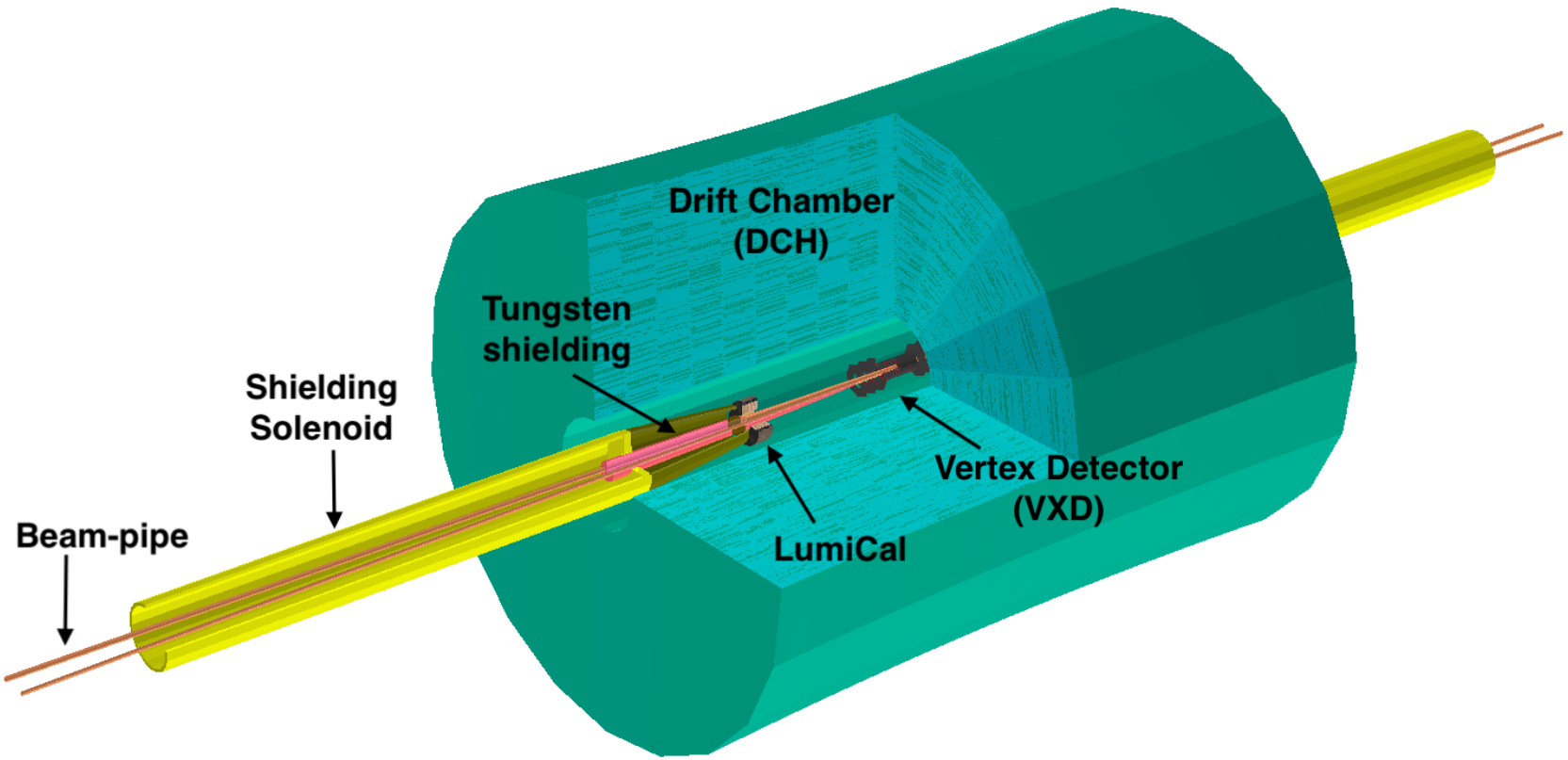
- Webpage and tutorials: http://fccsw.web.cern.ch/fccsw
- GitHub link for the code: https://github.com/HEP-FCC/FCCSW



The IDEA interaction region in FCCSW

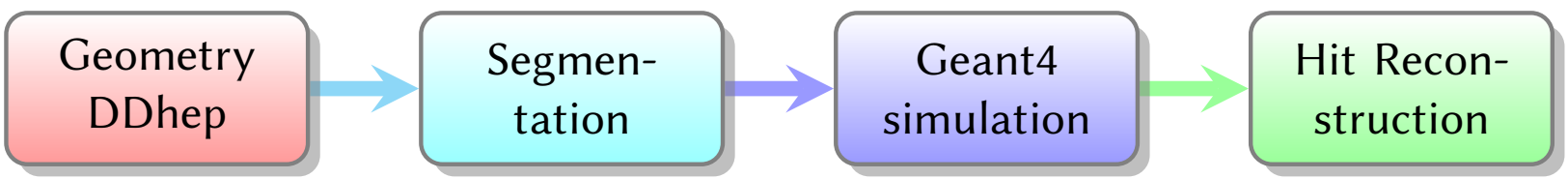
- Beam-pipe, beam instrumentations and the vertex detector are taken from the CLD concept
  - Temporary design of VXD for the IDEA detector ⇒ ultimate goal: MAPS
- The DCH implemented from scratch in FCCSW
- Missing elements
  - Alice-like ITS, solenoid magnet, dual-readout calorimeter, instrumented return yoke

Visualisation with FCCSW



FCCSW simulation chain

1. Detector geometry description with DD4hep
2. Segmentation of the sensitive areas:
   - Speed up the simulation
   - Example: information on the position of the sense wires instead of placing physical volumes
3. Geant4 simulation:
   - Calculate the E_{dep} in sensitive volumes
4. Hit reconstruction:
   - Combination of individual hit calculations from (3)
   - Calculation of the drift, diffusion and signal in the wire

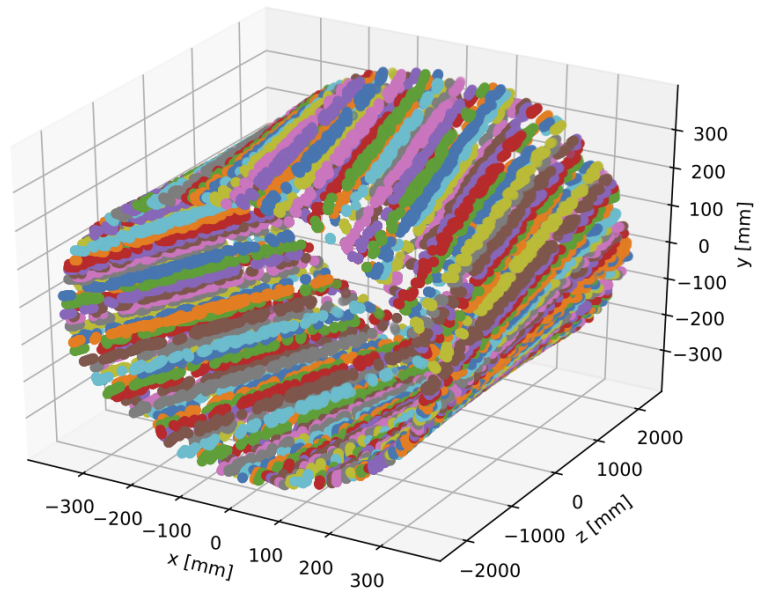


The drift chamber (DCH)

Parameters of the DCH

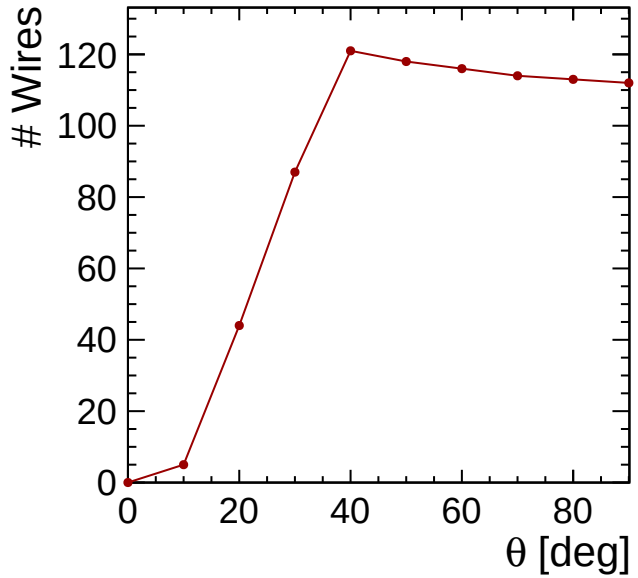
Length	4500 mm
Inner radius	345 mm
Outer radius	2000 mm
Number of sensitive wires	56448
Single cell resolution (transverse plane)	0.1 mm

- The segmentation concept is used to access the information on the positions of the wire

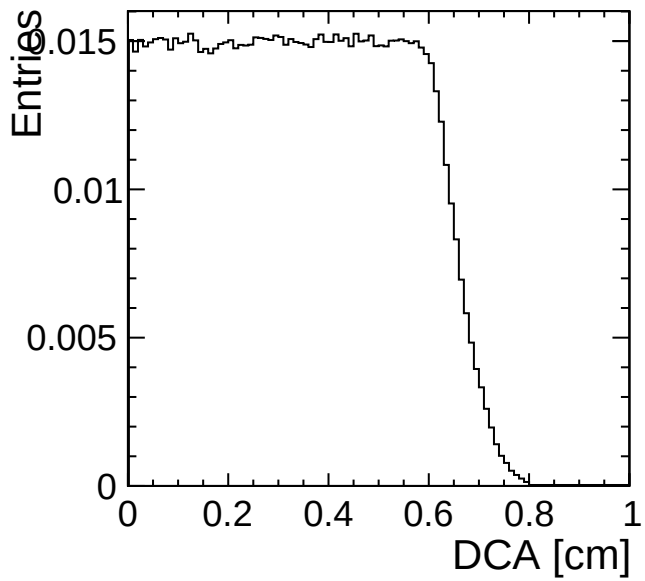


Coverage of the drift chamber

- The number of wires as a function of θ
- The coverage in the forward region will be improved by the placement of disks



- The distance of the closest approach (DCA)
- Provides the information on the drift time
- Maximum drift time (corresponding to the corners): 400 ns

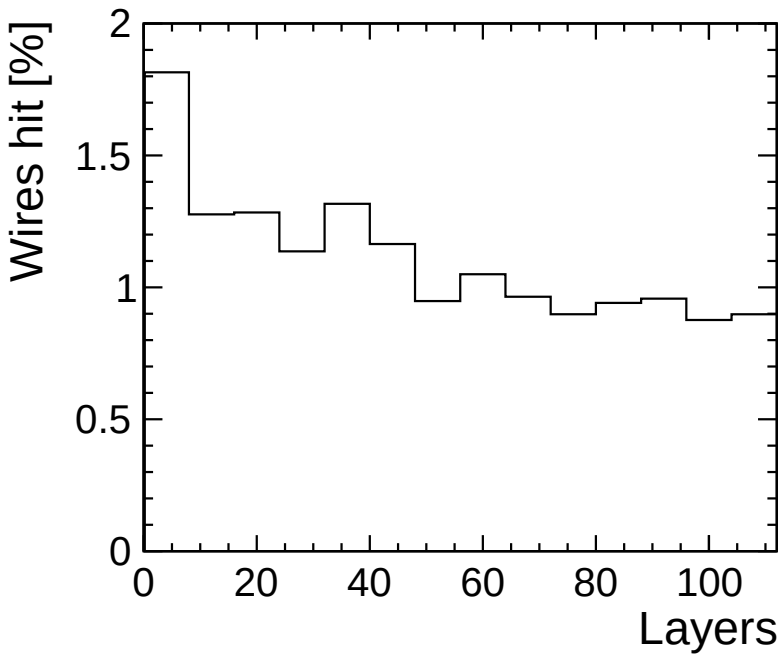


Beam-induced backgrounds at FCC-ee

- Incoherent e^+e^- pairs
  - Produced in $\gamma\gamma$ interactions from beamstrahlung
  - Forward region
- $\gamma\gamma \to$ hadrons
  - Possibly results in jets in the detector
- Synchrotron radiation (SR)
  - Photons from the last bending magnet

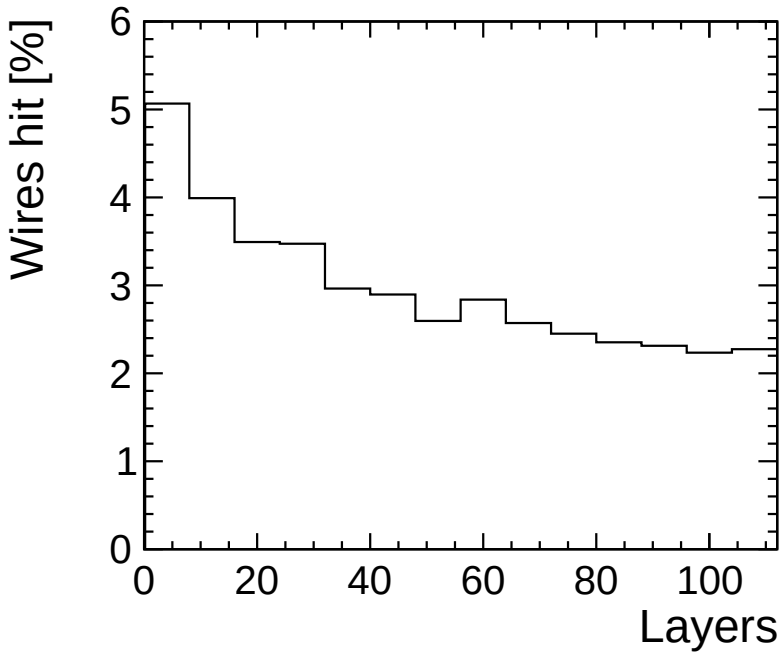
Incoherent e^+e^- pairs

E_{cm} = 91.2 GeV (Z stage)



- Average occupancy: 1.1%

E_{cm} = 365 GeV (top stage)

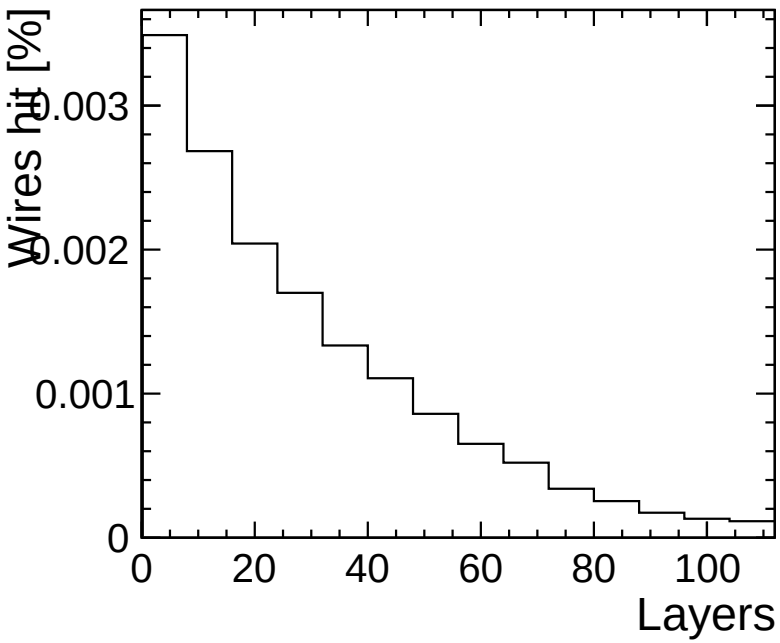


- Average occupancy: 2.9%

- The effect of this background does not pose problem for the track reconstruction.

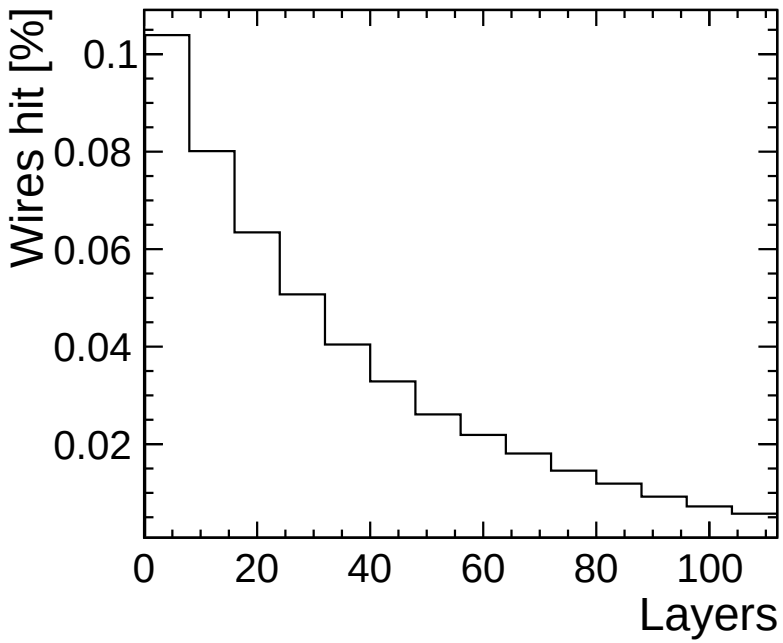
$\gamma\gamma \rightarrow$ hadrons

E_{cm} = 91.2 GeV (Z stage)



- Average occupancy: 0.001%
  - Negligible effect

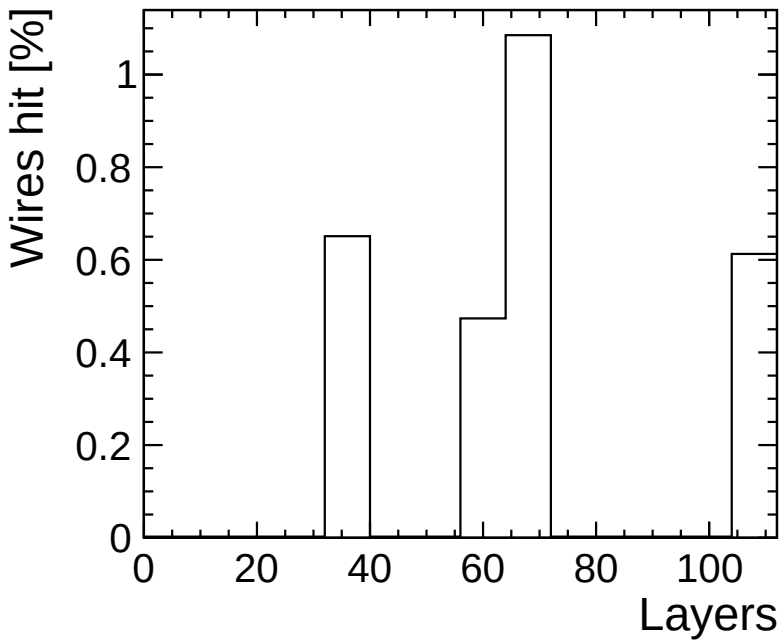
E_{cm} = 365 GeV (top stage)



- Average occupancy: 0.035%

Synchrotron radiation: E_{cm} = 365 GeV

- The shielding stops most of the SR photons.
- Average occupancy: 0.2%
- Negligible effect



Summary: background occupancy in DCH

- The overall effect of the backgrounds on the DCH remains small
- e^+e^- pair background is the largest source of background

Background	Average occupancy	
	E_{cm} = 91.2 GeV	E_{cm} = 365 GeV
e^+e^- pair background	1.1%	2.9%
$\gamma\gamma \rightarrow$hadrons	0.001%	0.035%
Synchrotron radiation	-	0.2%

Conclusions

- The FCCSW is ready for the full simulation of the IDEA detector
- Background estimations in full simulations have been performed for the drift chamber
  - Low effect
- Contributions are more than welcome
  $\Rightarrow$ Input for tracking
  $\Rightarrow$ Dual-readout calorimeter, ...

Thank you for your attention!