Design of a drift chamber tracking system for the IDEA experiment at FCC-ee

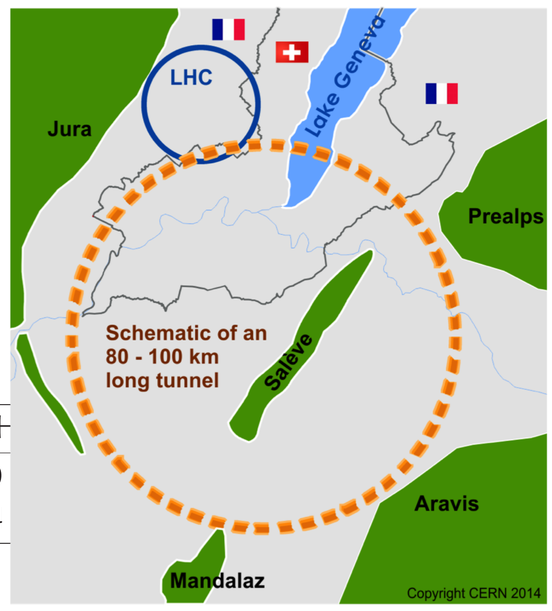
Niloufar Alipour Tehrani (CERN), Benedikt Hegner, Giovanni Francesco Tassielli, Francesco Grancagnolo

2018 IEEE Nuclear Science Symposium and Medical Imaging Conference, Sydney, Australia

The Future Circular Collider Experiment (FCC)

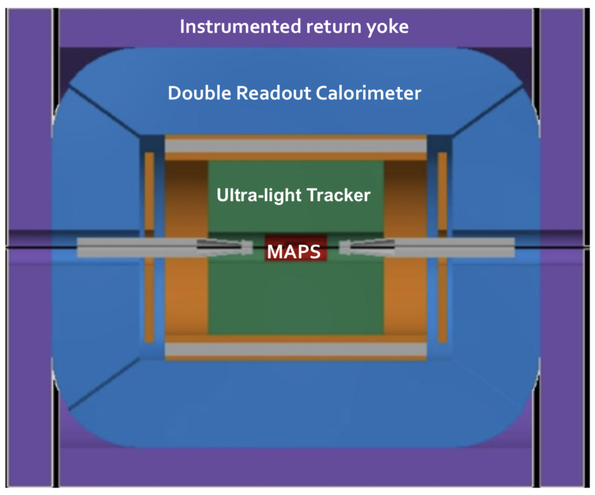
- A future possibility for the post-LHC era
- 3 options of circular colliders
  - FCC-ee: electron - positron collisions
  - FCC-hh: proton - proton collisions
  - FCC-eh: electron - proton collisions
- ∼100 km tunnel in Geneva area
- FCC-ee collider parameters:

Stages	Z	WW	H (ZH
Beam energy [GeV]	45.6	80	120
Average bunch spacing [ns]	19.6	163	994



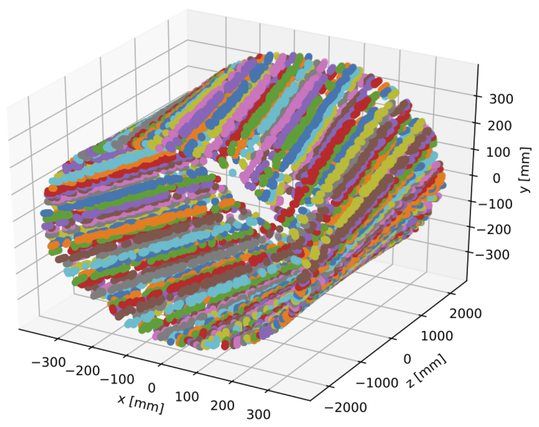
The IDEA detector concept for FCC-ee

- Two detector concepts for the FCC-ee collider
  1. The IDEA detector concept (focus of this poster)
  2. A CLIC-based (silicon-based) detector
- Ultimate goal for the IDEA detector concept
  - Vertex detector: MAPS
  - Ultra-light drift chamber with particle identification
  - Double readout calorimetry
  - Aditional silicon disk layers placed in the space between the drift chamber and the dual readout calorimeter to increase the forward coverage
  - 2 T solenoidal magnetic field
  - Instrumented return yoke
  - Large tracking volume (R ∼ 8 m) for very weakly coupled (long-lived) particles

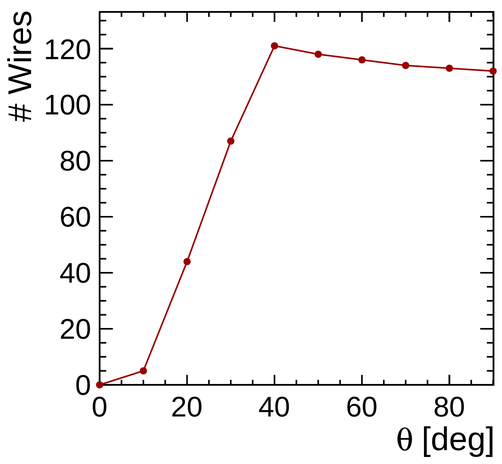


The simulation of the drift chamber & coverage

- The first layer of the drift chamber
- Wires are illustrated using different colors
- The wires are rotated by a stereo angle to increase the hit resolution



- In the barrel region, the drift chamber has a high coverage of ∼ 112 wires in average.
- In the forward region, silicon disks are foresean to increase the number of layers measuring the tracks.



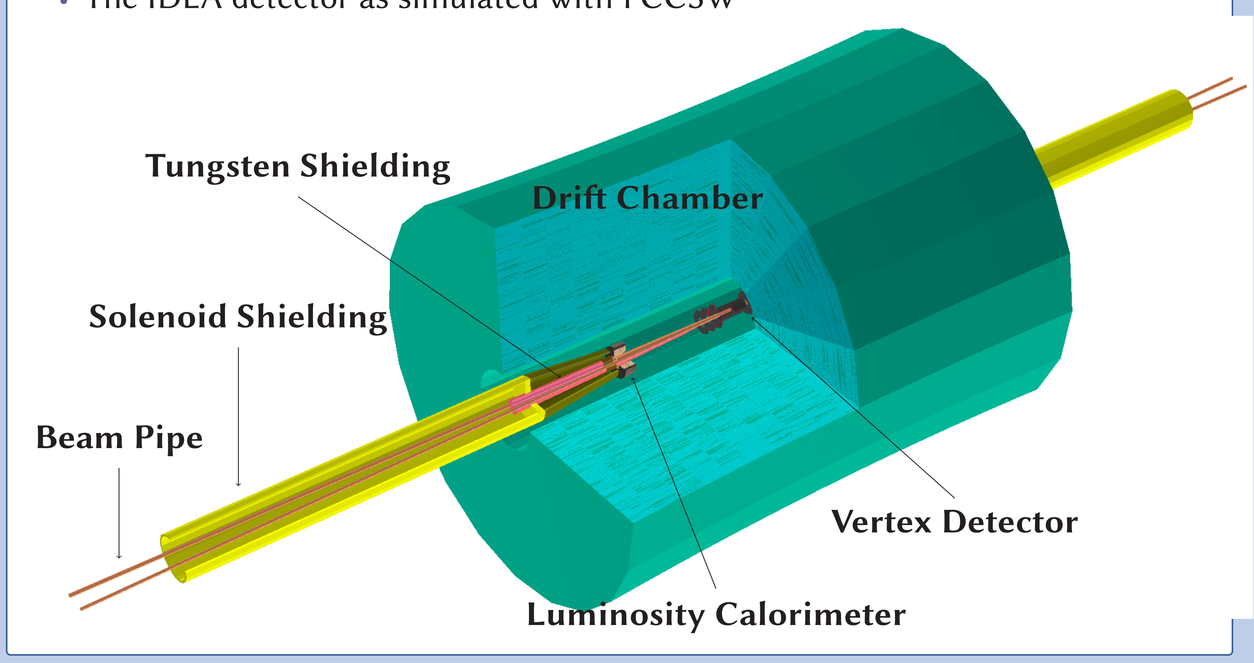
FCCSW: Physics and Detector simulations with FCCSW

- 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 with other CERN experiments
  - Gaudi from LHC
  - DD4hep from CLIC & LHCb
  - New solutions where needed

Geometry DDhep → Segmen-tation → Geant4 simulation → Digiti-zation

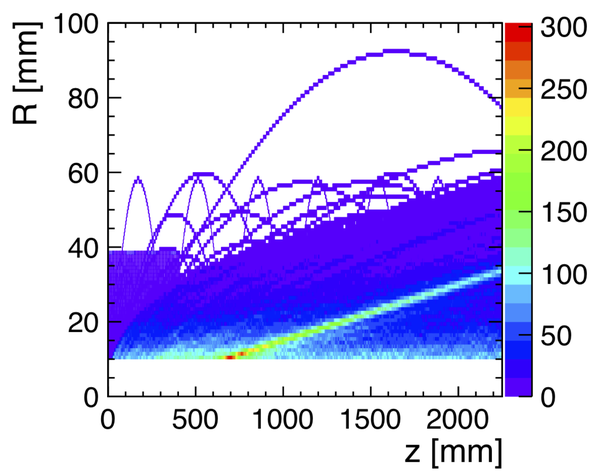
Simulation of the drift chamber within FCCSW

- The IDEA detector as simulated with FCCSW



Main sources of beam-induced backgrounds

- Three main sources of beam-induced backgrounds
  - Incoherent e^+e^- pairs du to bremstrahlung photons ⇒ highest source of background
  - $\gamma\gamma \rightarrow$ hadrons ⇒ Expected to have a very low impact
  - Synchrotron radiation (SR) ⇒ Dictates the design of the interaction region (IR)
    - Defines the beampipe radius, the design of the shielding (in Tungesten)
    - Mostly stopped by the shielding, few SR photons can hit the detector
- The trajectory of the e^+e pairs in a 2 T magnetic field.



Summary of beam-induced backgrounds & conclusions

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%

- The overall impact remains low and the results are promising for the track reconstruction with this detector.

3 main sources of beam-induced backgrounds at the top stage

- Incoherent e^+e^- pairs
- $\gamma\gamma \rightarrow$ hadrons
- $\gamma\gamma \rightarrow$ hadrons