# FCC Input on Detector Simulation

Community input on the European Strategy for Particle Physics Update by HSF

FCC simulation status

- The FCC software fully embraces Key4hep
- First geometry implementations for three FCC-ee detector concepts are there: CLD, IDEA, ALLEGRO
  - Started to use those models in physics studies (e.g. beam induced background)
  - Digitization and reconstruction ongoing
  - Validation/tuning of the simulation, including test beam data comparison ongoing/upcoming
  - First central production on the GRID (ILCDirac) but no 'mass' production at the LHC scale so far
  - The FCC project is in an early stage → most needs are yet to be identified!
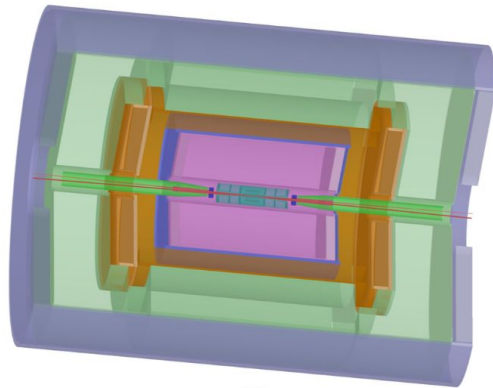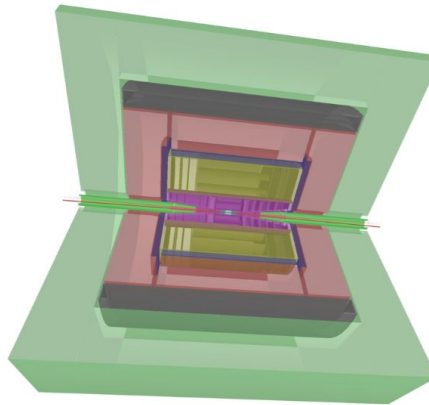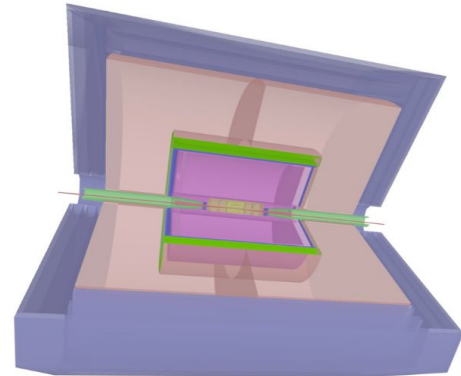
Flexibility and Interfaces to Geant4

- Somewhat different needs than operating experiments
- FCC detectors are being designed
  - **Baseline** geometries of sub-detector **change all the time** (and will keep changing for decades)
  - **Optimization of sub-detectors** requires simulation under different scenario
  - Optimization of **full detector concepts** requires to study many **different combination of sub-detectors**
  - → **Flexibility is a must!**
- For **all FCC detectors**, geometries are implemented in **dd4hep** and simulation is run through **ddsim**
  - Convenient plug and play approach
  - Having a single common tool is also a must for FCC to maximizes synergies (small community)
  - Will need a strong support, on the long run, on Geant4 interfaces

FCC simulation needs

- From the current studies (for the Feasibility Study Report) we can anticipate the following needs **FCC-ee**:
  - Very **large statistics** (6×10^{12} Z bosons i.e. LEP$\times 10^5$) + very **clean environment** → enables **ultra-precise measurements**
    - May reveal sensitivity to tiny effects neglected e.g. in hadron collisions
    - Will need simulation to be fast but without jeopardizing **accuracy**
  - Modeling of **high intensity beam effects**
    - E.g. synchrotron radiation interaction with beampipe done with Geant4 ([BDSim](#)), needed a more precise treatment of X-ray reflection: [link](#)
      - Under validation
  - Several gaseous detectors proposed for FCC-ee
    - R&D and simulation activities heavily rely on detailed modeling of signal formation
    - Need to secure long-term support for tools such as Garfield++
- FCC-hh (longer term) at ~ 100 TeV: particles with unprecedentedly high energy
  - Fast multi-TeV calorimeter shower simulation

General comments

- The community should encourage groups to **upstream to Geant4** relevant developments done internally and advertise them, with long term visibility
  - Otherwise those developments are lost for the community…
- **Document Geant4 configurations** used by experiments so that the future projects can benefit from accumulated knowledge
- **DRD's** and the community
  - A lot of simulation related **developments** will occurred in the context of the DRD's
  - The DRD's will produce **test beam datasets** very valuable for e.g. simulation **validation**

→ DRD's should be encouraged to adopt a **common software framework** for data preservation and to maximize the synergies with the entire community