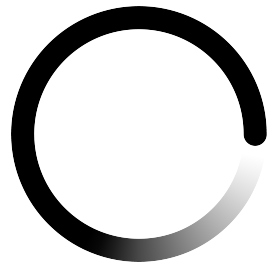# FCC Full Sim

What Physics can we do with it?
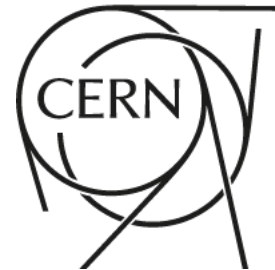
Brieuc Francois (CERN)
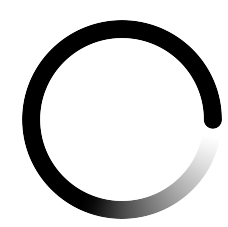
Physics Performance Meeting
March 18th, 2024
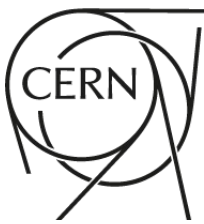
Introduction

- Many Full Sim tools are being prepared or already available

  - We now need people to exercise, stress-test and challenge them

    - Spot bugs, reveal impracticalities, validate the tools
    - Good software can only be designed with end users involved!
    - We write software to do physics, not for the pleasure of maintaining it :-P

  - The Feasibility Study Report writing is starting

    - Studies that we want to document have to be mature by September 2024 (release of the first FSR draft) → they should start ~now

- There are **many exciting things that can be done** with what is available!

- This short talk collects examples of open tasks that are ready to be started

  - Focusing on physics studies, leaving aside core software developments (if you are also interested in this, get in touch with us)
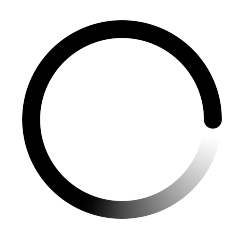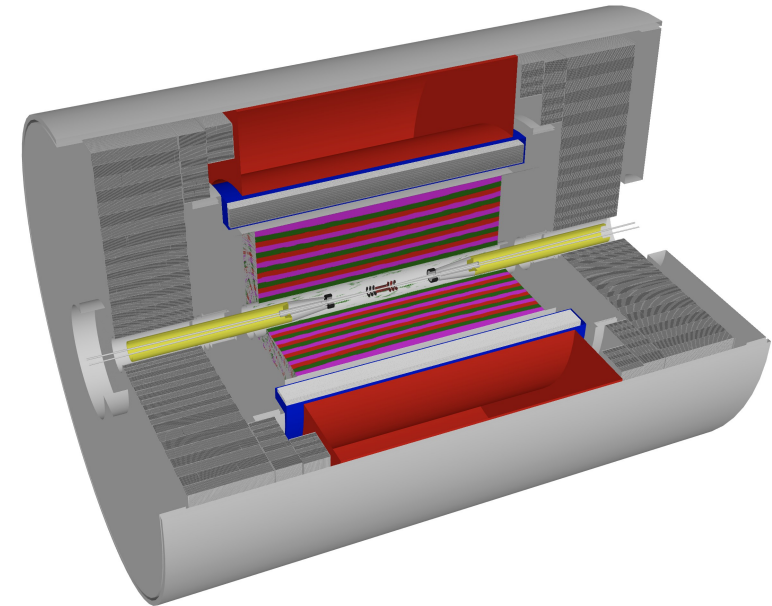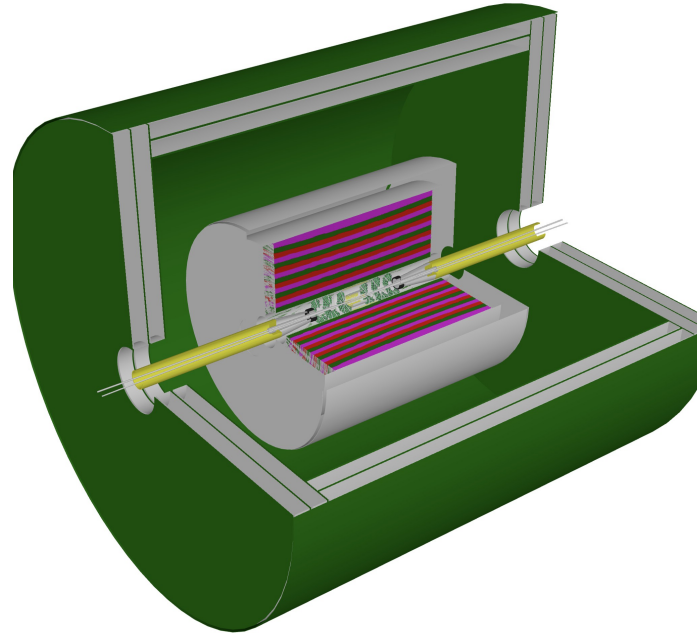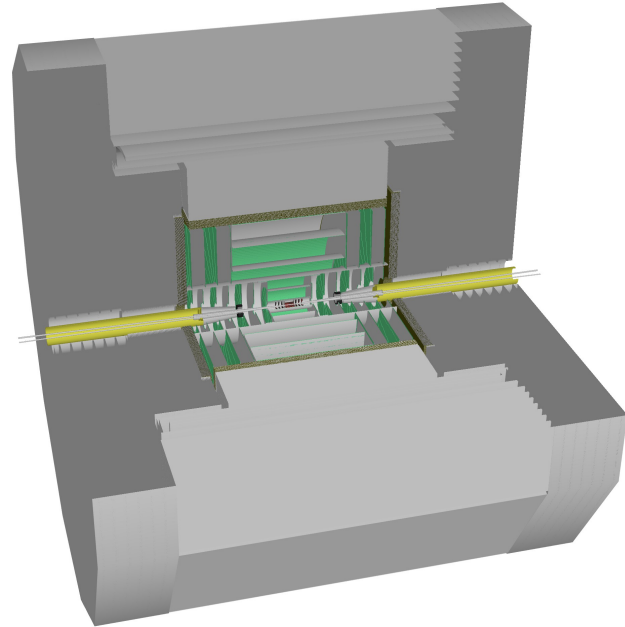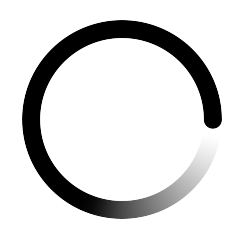
FCC-ee Detectors

CLD
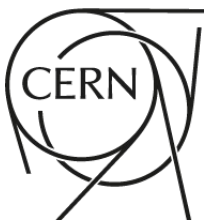
Full-silicon, optimized for particle flow

IDEA

Ultra-light tracker (drift chamber, ~5% X_0), dual readout calorimeter

ALLEGRO

Noble Liquid ECAL/TileCal HCAL with high granularity

Already a possible task: improve the display with different colors for each sub-detector :-P

Full Sim Status

CLD

- Full detector description + global reconstruction (including PFlow) available: recipe
  - Needs to be exercised, certainly some missing features
   - Identifying them well in advance will give us time for development

IDEA

- Many sud-detectors available up to the digitization
  - Calorimeter available but not included in the whole detector (performance), a version with fake calorimeter (material budget) can be made available + the calorimeter can already be used with powerful enough machines
  - Recent update: detailed muon chamber geometry (PR opened), added solenoid and magnetic field (including compensating solenoids), drift chamber digitized hit now have an association with simHits, refactoring of the drift chamber geometry ongoing

ALLEGRO

- ECAL and HCAL fully available, other sub-system from IDEA except muon chambers
- Recent updates: theta based segmentation, MVA based calibration, ECAL/HCAL interface for clustering, migration to ddsim, cross-talk emulation ongoing
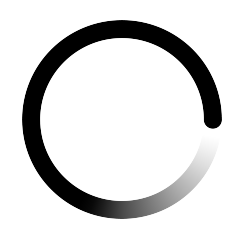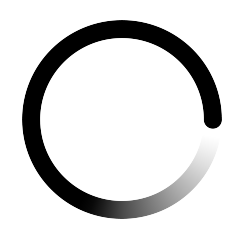
Examples of Open Projects (I)
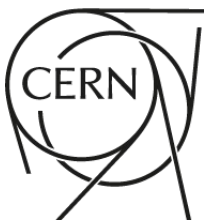
- Study multiple scattering up to muon chambers (or silicon wrapper) to set lower limit on spatial resolutions (or make the case for lighter inner detectors)

- Study the impact of wires in the drift chamber (slows down simulation, some studies might not need them)

- Validate detector implementations and tune the Geant4 physics with available test beam data
  - Drift chamber, muRWELL, dual readout calorimeter, …

- Validate Delphes cards with full sim (only CLD tracker done so far)

- Implement tracking for the IDEA detector
  - People interested (ML, intuition based), but more are welcome

- Study magnetic field implementation and impact
  - Analytical VS field maps, impact of non uniformities, etc

Examples of Open Projects (II)
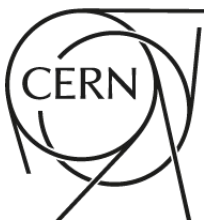
- ➢ Reproduce "low-level" detector performance studies with the latest CLD version

    - ➢ Detector level resolution, up to jet energy resolution

- ➢ Revive and evaluate performance of "high-level" reconstruction algorithms

    - ➢ Flavor tagging training, tau reconstruction, …

- ➢ Implement GNN based flavor tagging (used in Delphes so far) for full sim output

- ➢ Study impact of (available) beam induced backgrounds on various metrics

    - ➢ Exercise the background overlay tools

- ➢ Study CLD Particle Flow performance w/ and w/o PID detector

- ➢ Prepare and maintain Full Sim physics analyses (with CLD first, applied to other detectors with minimal changes)

- ➢ Your ideas!

    - ➢ Get in touch with us to evaluate its feasibility based on the tool readiness