Overview of the FCC software

FCCSW Hands-on Tutorial October 2022
CERN

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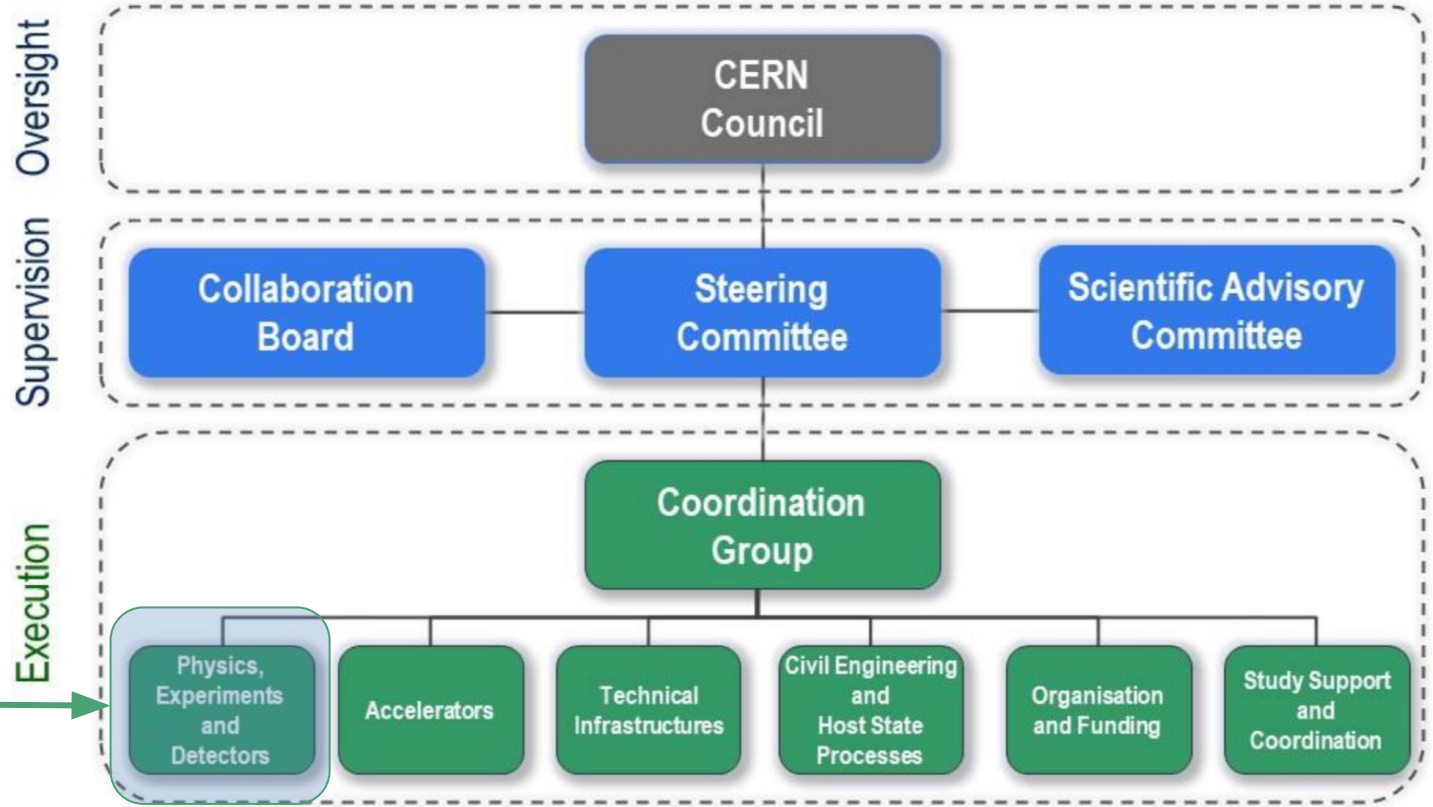
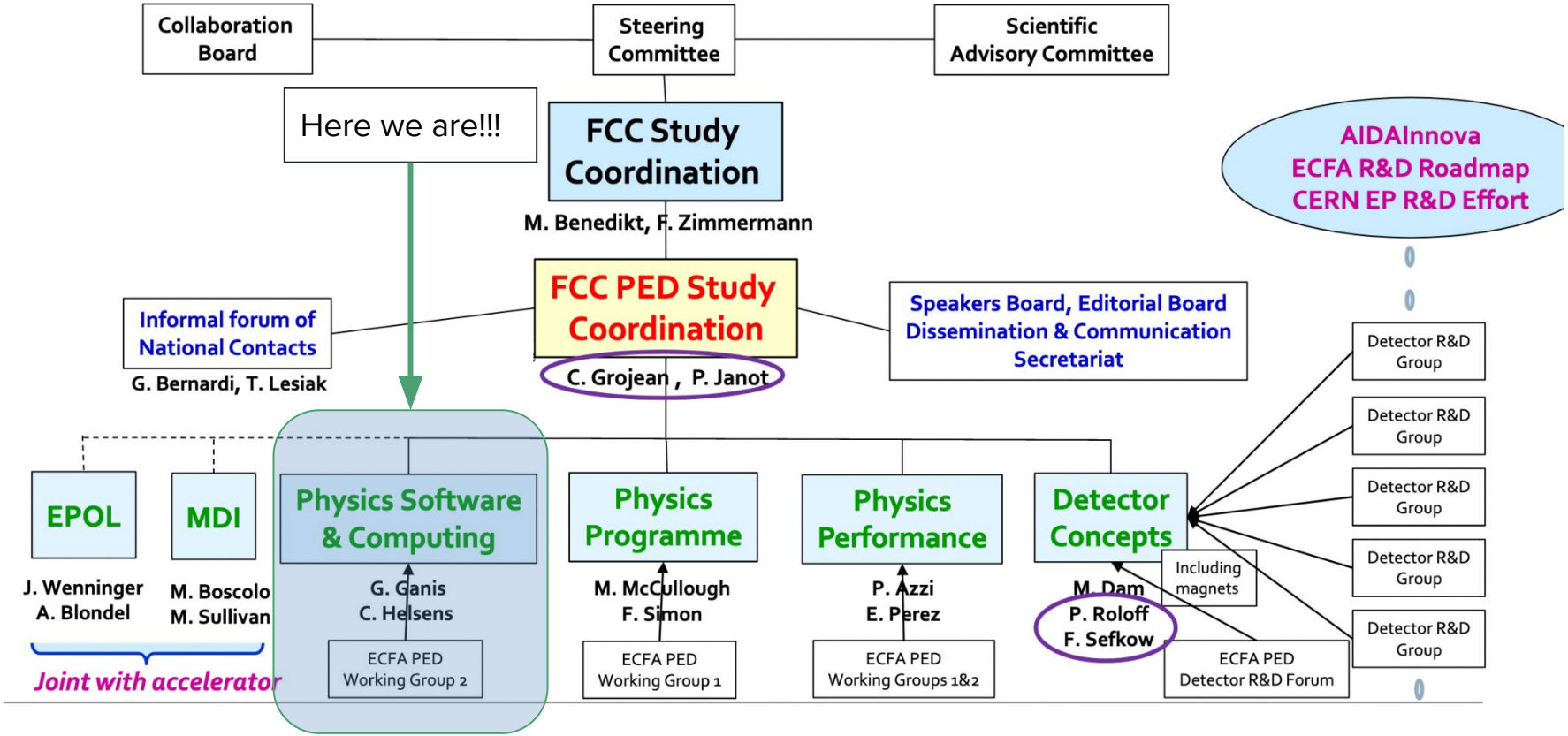
FCC S&C coordinators

Overall Organisational Structure

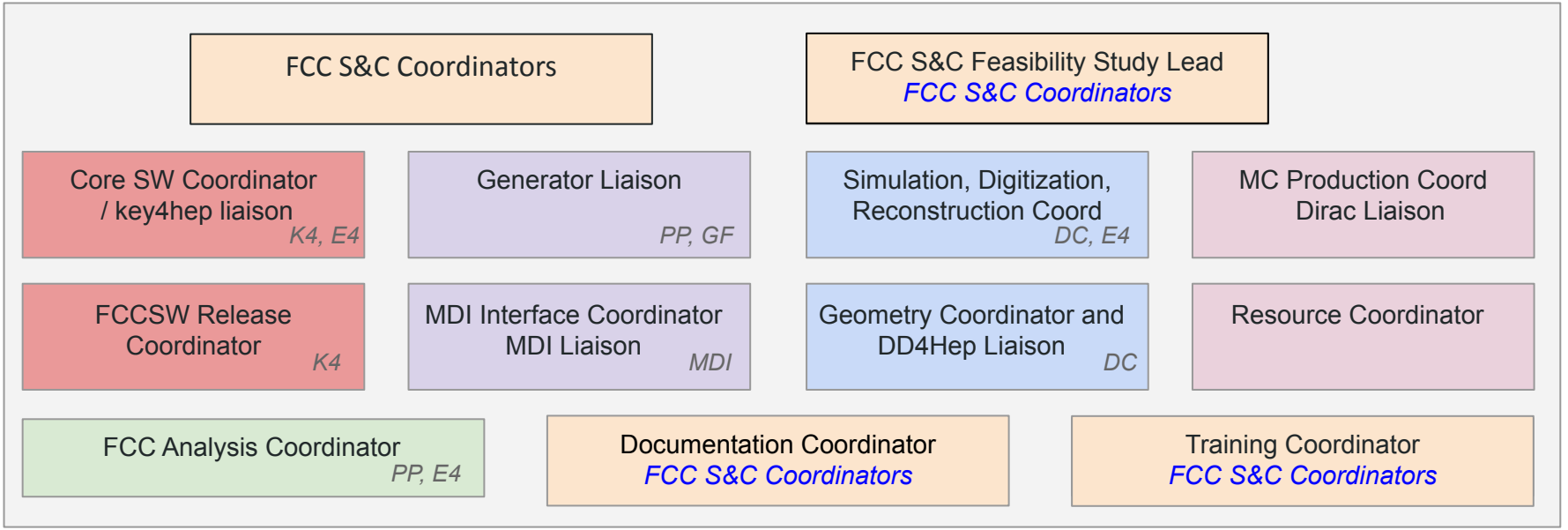


This is where we are

Physics and Detector Work Package



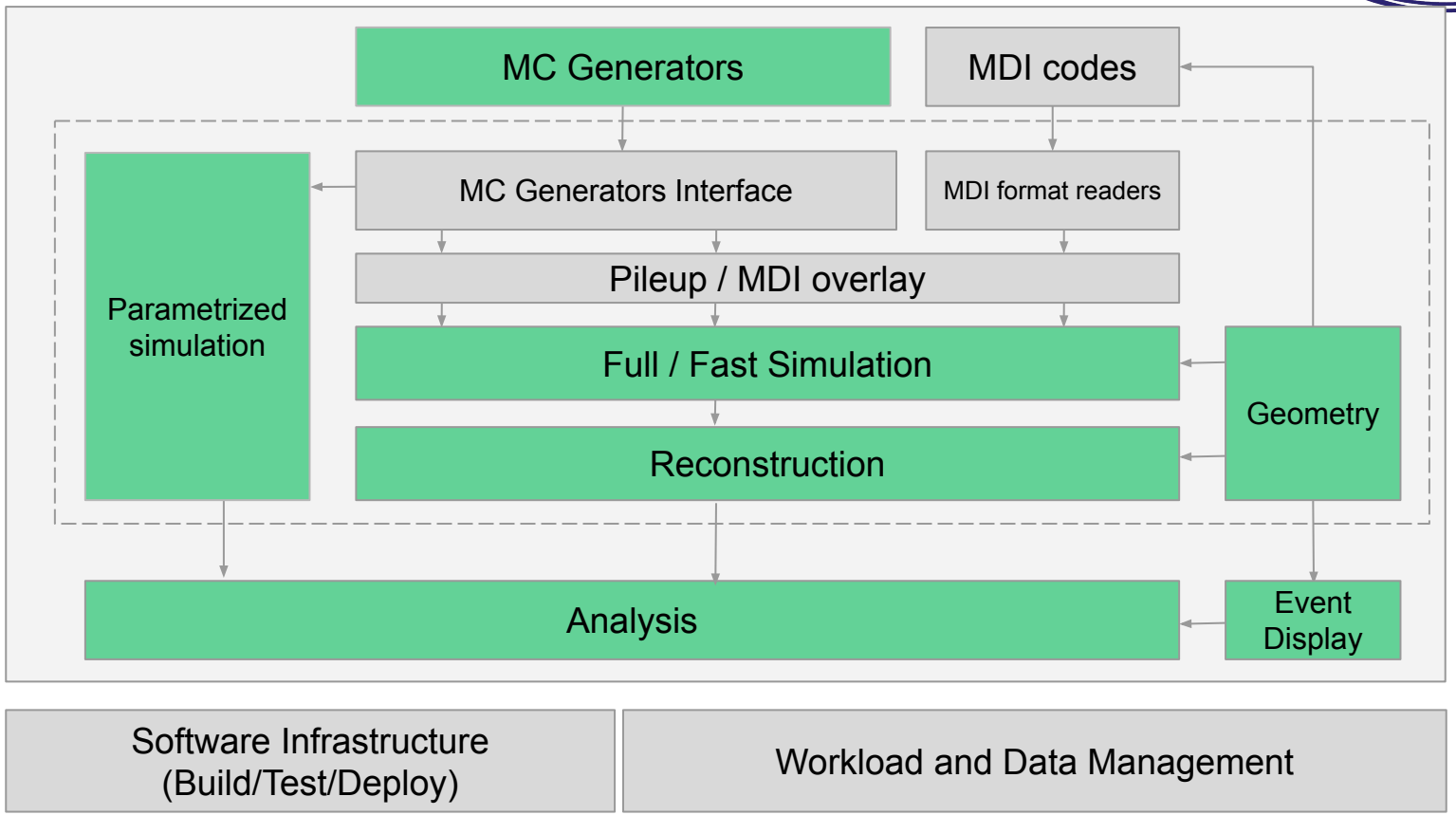
FCC Software & Computing Structure



- Core software group at CERN
- External contributions warmly encouraged
- Connection with other PED groups

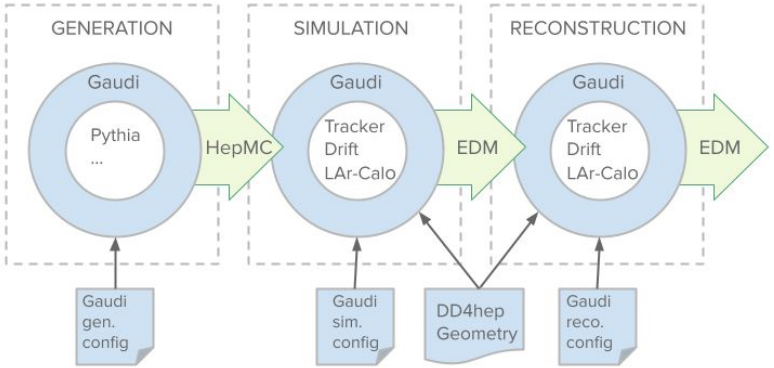
PP	Physics Performance
DC	Detector Concepts
MDI	Machine Detector Interface
K4	Key4hep
E4	EDM4hep
GF	Generator Forum

Typical workflow to support



FCCSW approach

- Started in 2014
- Driving considerations
  - One software stack to support all the cases (hh,ee,eh), all the detector concepts
  - Need to support physics and detector studies
    - Parametrised, fast and full simulation (and mixture of the three)
  - Modularity: allow for evolution
    - Component parts can be improved separately
  - Allow multi-paradigm for analysis
    - C++ and Python at the same level
- Adopted Strategy
  - Adapt existing solutions from LHC (Gaudi, …)
  - Look at ongoing common R&D projects (AIDA)
  - Invest in streamlining of event data model
- Focus on FCCee after CDR (2019)



key4Hep

Create a software ecosystem integrating in optimal way various software components to provide a ready-to-use full-fledged data processing solution for HEP experiments

Complete set of tools

- Generation, simulation, reconstruction, analysis
- Build, package, test, deploy, run

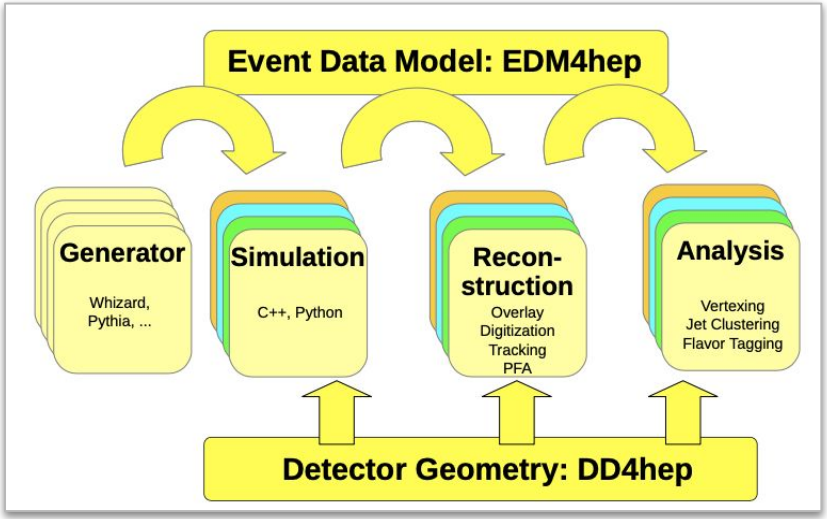
Common Core ingredients

- PoDIO for EDM4hep, based on LCIO and FCC-edm
- Gaudi framework, devel/used for (HL-)LHC
- DD4hep for geometry, adopted at LHC
- Spack package manager, lot of interest from LHC

Community project

- Unifying communities, synergetic enterprise
- Contributions from CLIC, ILC, FCC, CEPC and EIC

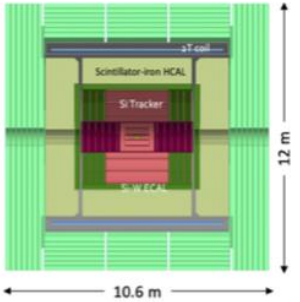
Full support by ECFA, AIDA, CERN EP R&D



Kick-off meetings Bologna (6/2019), Hong Kong (1/2020)
Weekly working meetings
Deliverables already used in large scale production

Detector Concepts Fast Overview

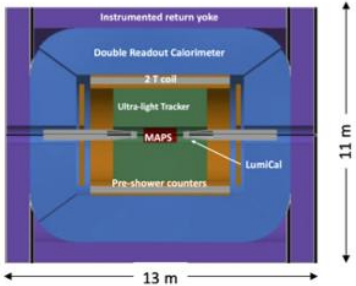
CLD



- Well established design
  - ILC -> CLIC detector -> CLD
- Full Si vtx + tracker; CALICE-like calorimetry; large coil, muon system
- Engineering still needed for operation with continous beam (no power pulsing)
  - Cooling of Si-sensors & calorimeters
- Possible detector optimizations
  - σ_p/p, σ_E/E
  - PID ($\mathcal{O}$(10 ps) timing and/or RICH)?
  - …

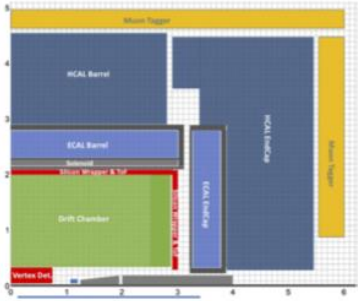
CDR

IDEA



- Less established design
  - But still ~15y history: ILC 4th Concept
- Si vtx detector; ultra light drift chamber w powerfull PID; compact, light coil; monolitic dual readout calorimeter; muon system
  - Possibly augmented by crystal ECAL
- Very active community
  - Prototype designs, test beam campains, …

Noble Liquid ECAL based

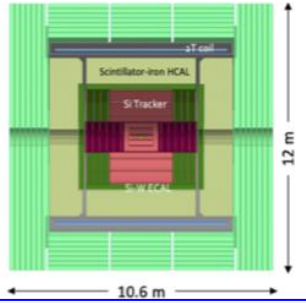


new

- A design in its infancy
- High granularity Noble Liquid ECAL is core
  - PB+LAr (or denser W+LKr)
- Drift chamber (or Si) tracking; CALICE-like HCAL; muon system.
- Coil inside same cryostat as LAr, possibly outside ECAL
- Very active Noble Liquid R&D team
  - Readout electrodes, feed-throughs, electronics, light cryostat, …
  - Software & performance studies

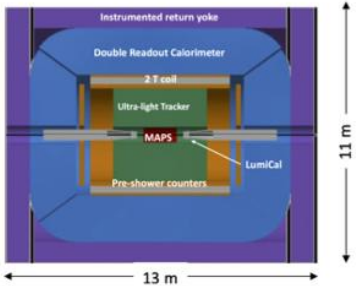
Detector Concepts Fast Overview

CLD

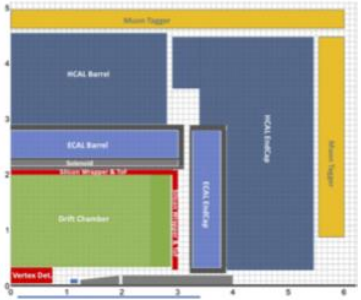


CDR

IDEA



Noble Liquid ECAL based



new

- *Full Sim*
  k4 w/ DDSim
  Reco
  k4 w/ iLCSoft@Wrapper

- *Full Sim*
  Vertex, DC: standalone
  DR Calo: k4 w/ k4SimG4
  Reco
  Vertex, DC: standalone
  DR Calo: ?

  Muon: in the works
  Simplified Vertex+DC
  Full Sim: k4 w/ k4SimG4
  Reco: k4 w/ iLC@Wrapper ?

- Full Sim:
- Simplified Vertex+DC,
- ECAL: k4 w/ k4SimG4
- Reco:
- Tracker: k4 w/ iLC@Wrapper ?
- ECAL: k4

  HCAL, muon: in the works

- continous beam (no power pulsing)
  - Cooling of Si-sensors & calorimeters
- Possible detector optimizations
  - σ_p/p, σ_E/E
  - PID ($\mathcal{O}$(10 ps) timing and/or RICH)?
  - ...

Mogens Dam / NBI Copenhagen

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Basics: This afternoon

Welcome and set things up

- Make sure that everybody
  - Could properly connect to the relevant machine
  - Has the necessary rights
  - Is able to run very simple commands from the software stack

Tutorials:

Gerardo Ganis in tutorial #1 Thursday 9h - 10h30
https://hep-fcc.github.io/fcc-tutorials/fast-sim-and-analysis/FccFastSimGeneration.html

Emmanuel Perez in tutorial #2 Thursday 11h - 12h30 (but also used in #1, #6)
https://hep-fcc.github.io/fcc-tutorials/fast-sim-and-analysis/fccanalyses/doc/starterkit/FccFastSimVertexing/Readme.html

Juraj Smiesko in tutorial #3 Thursday 14h - 15h30
https://hep-fcc.github.io/fcc-tutorials/detector-design-tools/Visualization.html

Andre Sailer in tutorial #4 Thursday 16h - 17h30 (also used in #5)
https://hep-fcc.github.io/fcc-tutorials/developing-fcc-software/DevelopingDD4hep.html

Brieuc Francois in tutorial #5 Friday 9h - 10h30
https://hep-fcc.github.io/fcc-tutorials/full-detector-simulations/FccCaloPerformance/CaloFullSimExercise.html

Clement Helsens in tutorial #6 Friday 11h - 12h30
https://hep-fcc.github.io/fcc-tutorials/full-detector-simulations/FCCeeCaloPhotonPi0Discrimination/FCCeeCaloPhotonPi0Discrimination.html