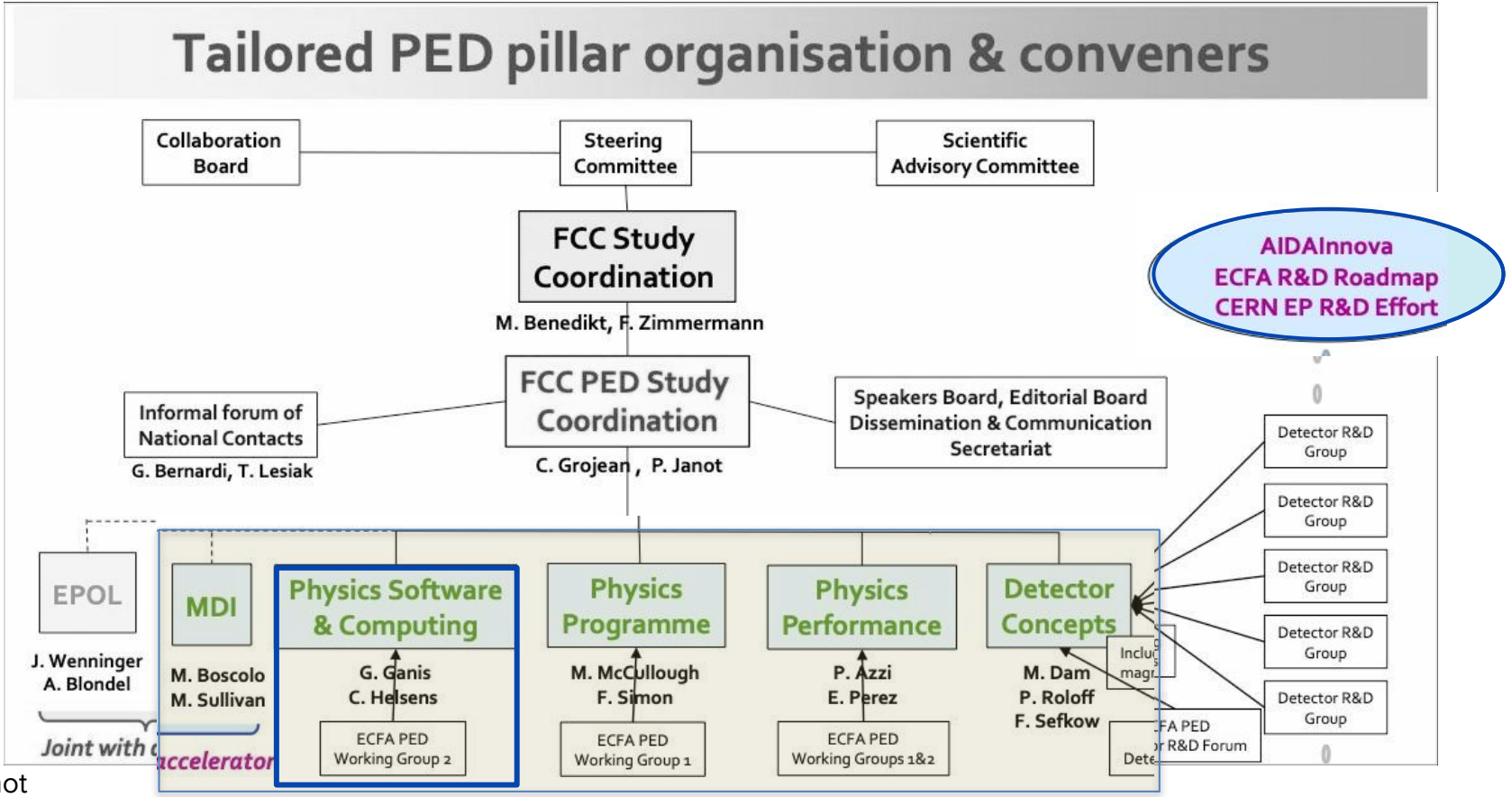
Software for PED studies: the road ahead

FCC Week 2022
Campus des Cordeliers, Sorbonne University, Paris, France

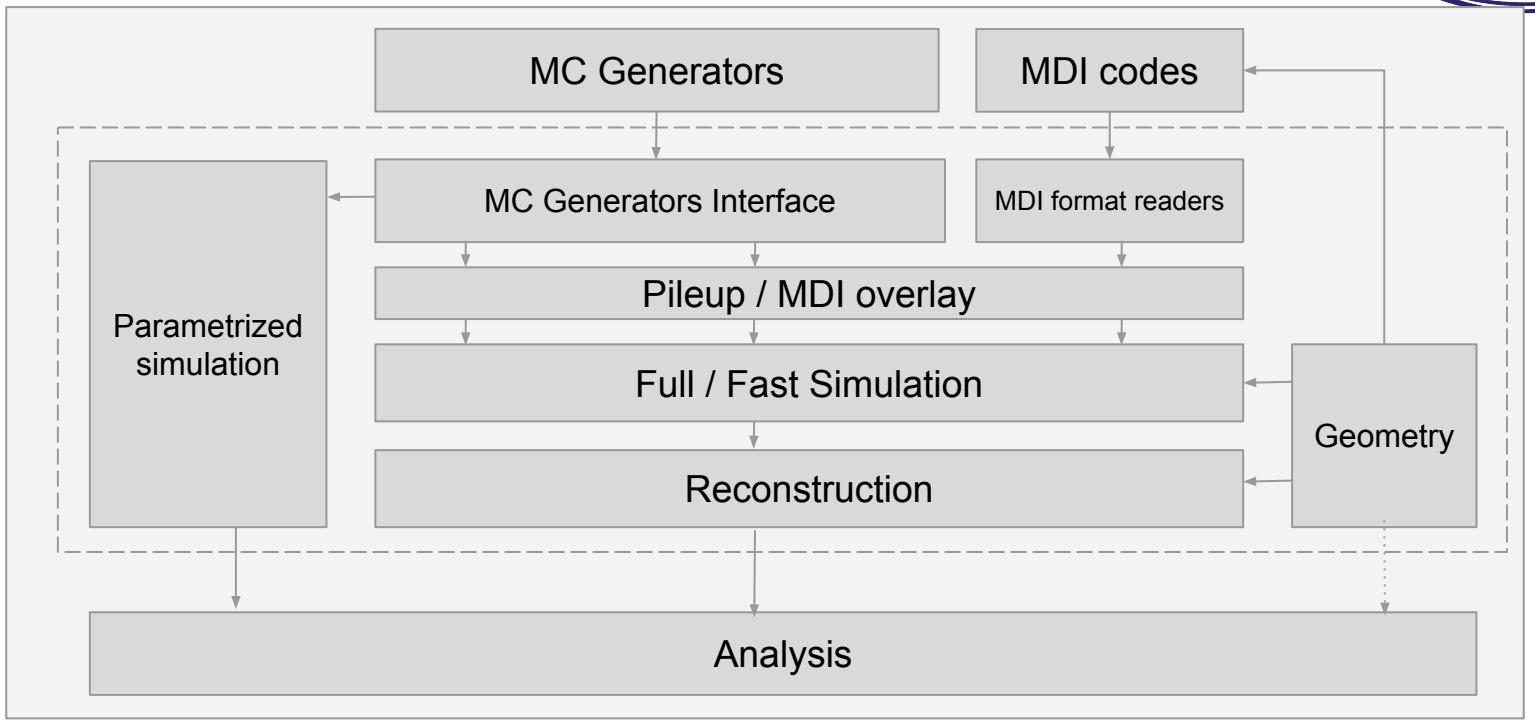
May 30, 2022
G Ganis, CERN-EP
C Helsens, KIT

S&C relation with other groups



P Janot

Typical workflows to support



Software Infrastructure (Build/Test/Deploy)

Workload and Data Management

FCC S&C approach

Driving considerations

- One software to support all case (hh, ee, eh)
  - Modular structure to allow for evolution

Adopted strategy

- Adapt existing solutions form LHC
  - Look at ongoing R&D projects (AIDA, …)

Priorities differ from those of LHC

- Privilege low-barrier of entry, agile support for detector concept evolution
  - Correctness, easy-of-use, commonality, interoperability
- LHC Infrastructure, lessons-learned, best practices are nonetheless very important

FCC S&C challenges

Software:

- Get the functionality right while remaining modular and agile
- In particular
  - Parametrized simulation with output format equivalent to full simulation
    - Allows to design/develop algorithms ready for the full simulation
  - Sub-detector Plug&Play mechanism: easy switch of detector concepts/solutions
    - E.g. test drift chamber based tracking w/ LAr calorimeter and/or dual readout

Computing:

- Full simulation of all cases is unrealistic
  - Precise determination of size/content of the samples required for a realistic estimation of physics potential of a given detector solution
- Interplay full/fast/parametrized simulation crucial
  - Synergy with Physics Performance and Detector Concepts working groups is essential

Key4hep, the common software vision

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

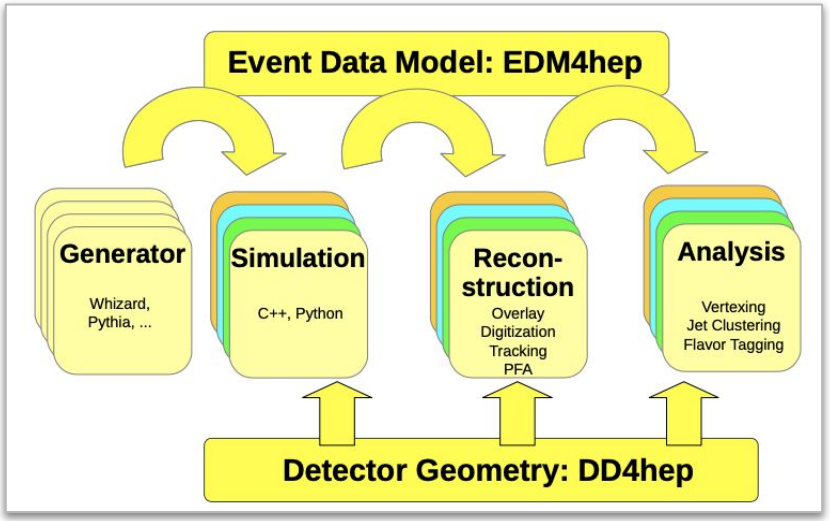
Common Core ingredients

- 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

FCC S&C mandate reviewed for 2021-2025

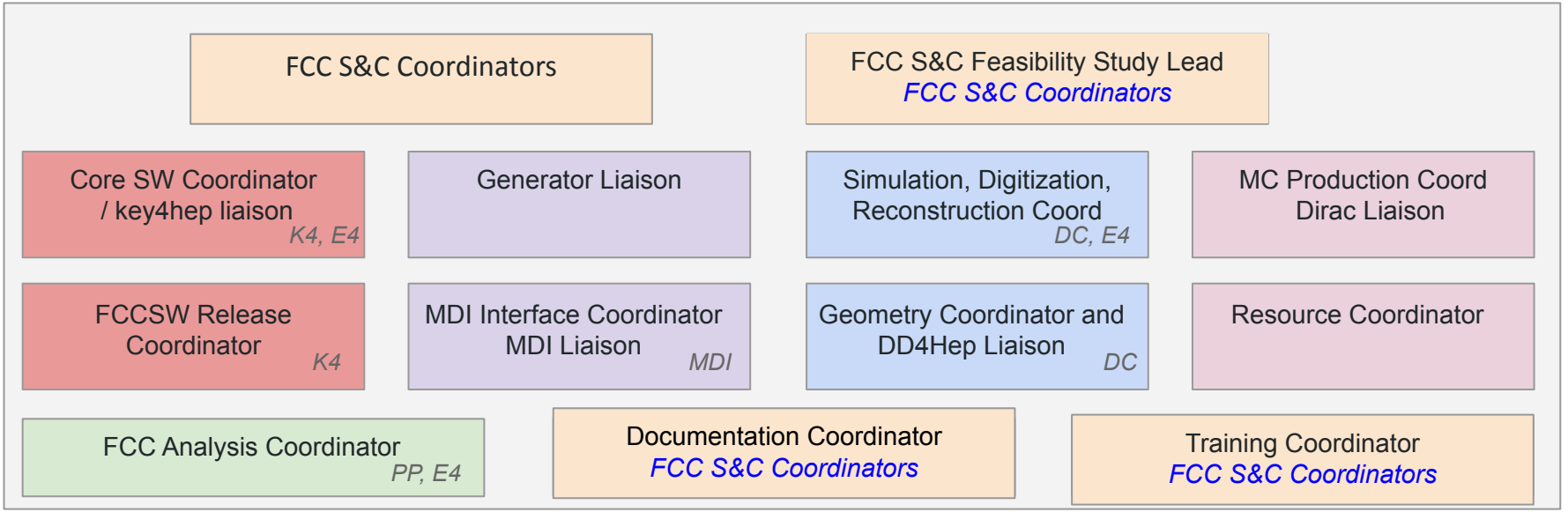
Inter-community Task Force (LHC, LC, FCC-PED)

- Get best experience, spread knowledge, raise interest

Two-fold target

- Review status of the software ecosystem
  - Current approach based on key4hep is a solid base for FSR and beyond
  - Recommendations: identify missing parts, foster synergy with Physics Performance and Detector Concepts, Facilitate software distribution and availability, ensure extensive and updated documentation
  - Foster training, user forum discussions, engage in the community (e.g. ECFA, HSF, …)
- Establish computing resource requirements for FSR (and beyond)
  - Scale driven by Z-pole running, needs similar to full HL-LHC
    - Multiple ways event reconstruction and MC simulation will be required to address systematics
  - Recommendations: build on existing analyses of computational needs, using LHC facilities as reference
    - Establish timeline for gathering/updating inputs from detectors/analysis experts to assess resources requirements and anticipate sources of uncertainty

FCC S&C suggested 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

FCC S&C : where we are

Current workflows

- Parametrized simulation
  - Delphes based studies
    - Improved tracking: realistic output allows to design/develop advanced algorithms
- Analysis
  - Developed a framework based on latest ROOT technology being pushed for HL-LHC
  - Fully based on EDM4hep (Key4hep)
- Full simulation
  - Workflow being consolidated together w/ Physics Performance/Detector Concepts WGs
  - Extensive experience from Linear Collider community very important

Computing

- Home based solution for MC productions
  - Mostly based on CERN in-kind resources

FCC S&C Next Priorities

Software

- Simulation
  - Streamline/automatize sub-detector Plug&Play technology
    - Synergy w/ Detector Concepts, dedicated CERN fellow from 9/2022
- Reconstruction
  - Consolidate use of algorithms developed in Linear Collider studies
  - Foster/validate integration in Key4hep of Pandora and ACTS
    - Gateways to state-of-the-art Particle Flow Algorithms and tracking, respectively
- Analysis
  - Consolidate current framework, define reduced format for simplified collection navigation (LHC)
  - Provide solid visualisation (Event Display) tool

V Volkl,
Tue, 16h18

C Helsens
Tue, 16h00

Computing

- Bring FCC@(iLC)Dirac form technology preview to production

Take away messages

- S&C plays a crucial role in PED studies
  - Needs to adequate support by the FCC community
- FCC fully engaged in community supported common efforts (Key4hep)
  - The benefits of such approach are already visible
- New WG structure being put in place to better address the challenges
  - Following the advice of a dedicated task force

- Synergy with ‘stakeholder’ WG (Physics Performance, Detector Concepts, …) is essential to make the evaluation of the FCC physics potential as realistic as possible

Backup

Useful pointers

Project repositories

- GitHub: https://github.com/HEP-FCC, https://github.com/key4hep
- CernVM-FS: /cvmfs/sw.hsf.org, /cvmfs/fcc.cern.ch

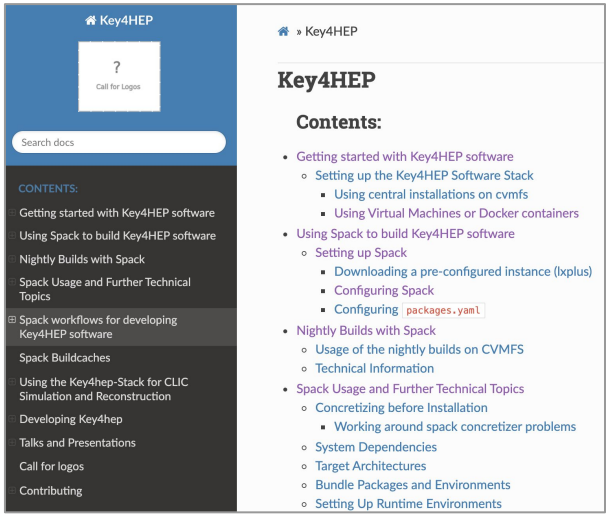
Forum: https://fccsw-forum.web.cern.ch/

Existing documentation: https://hep-fcc.github.io/fcc-tutorials/index.html

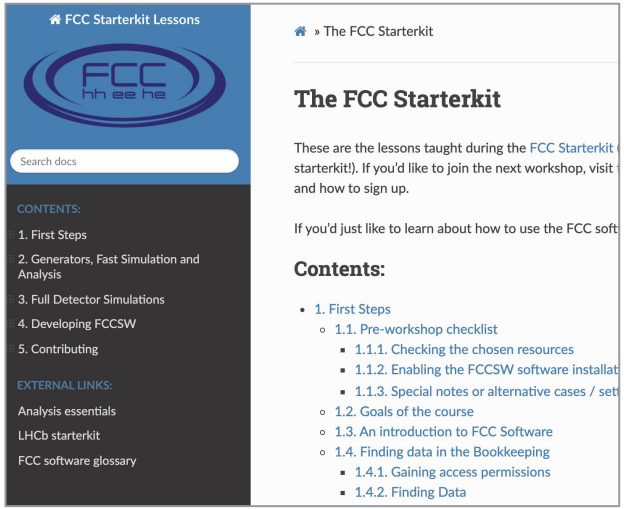
EPJ+ Software & Computing contributions (Part IV)

- Accelerator-related codes and their interplay with the experiment's software
- Online computing challenges: detector and readout requirements
- Offline Computing resources for FCC-ee and related challenges
- Key4hep, a framework for future HEP experiments and its use in FCC

Documentation, tutorials, …



Key4hep [GitHub Project]
[Main documentation page]
[Doxygen software documentation]



FCCSW [GitHub Project]
[Main documentation page]