Summary of Software Workshop

Towards a common Turnkey Software Stack

Frank Gaede, DESY
IAS HEP Conference, Hongkong UST, January 21, 2020

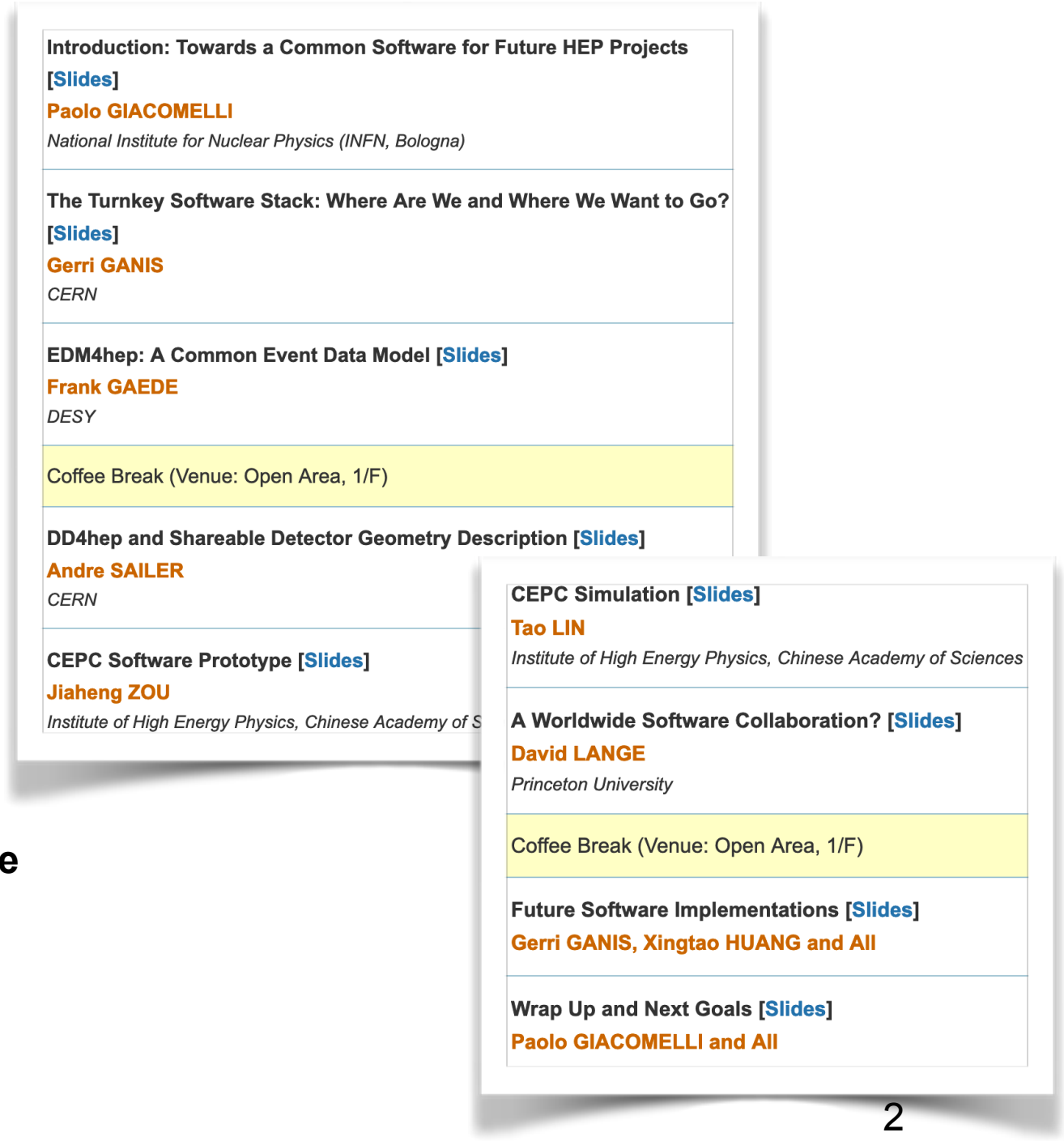
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

Mini-Workshop

Requirements of Software for e+e- Colliders

- one day workshop
- with software experts from all four e+e- Collider Projects: CEPC, CLIC, FCC and ILC
- follow-up on the **Future Collider Software Workshop** held in June 2019 in Bologna
- were the first steps towards a **common software stack for all four e+e- colliders** were taken



Introduction: Towards a Common Software for Future HEP Projects [Slides]
Paolo GIACOMELLI
National Institute for Nuclear Physics (INFN, Bologna)

The Turnkey Software Stack: Where Are We and Where We Want to Go? [Slides]
Gerri GANIS
CERN

EDM4hep: A Common Event Data Model [Slides]
Frank GAEDE
DESY

Coffee Break (Venue: Open Area, 1/F)

DD4hep and Shareable Detector Geometry Description [Slides]
Andre SAILER
CERN

CEPC Software Prototype [Slides]
Jiaheng ZOU
Institute of High Energy Physics, Chinese Academy of S

CEPC Simulation [Slides]
Tao LIN
Institute of High Energy Physics, Chinese Academy of Sciences

A Worldwide Software Collaboration? [Slides]
David LANGE
Princeton University

Coffee Break (Venue: Open Area, 1/F)

Future Software Implementations [Slides]
Gerri GANIS, Xingtao HUANG and All

Wrap Up and Next Goals [Slides]
Paolo GIACOMELLI and All

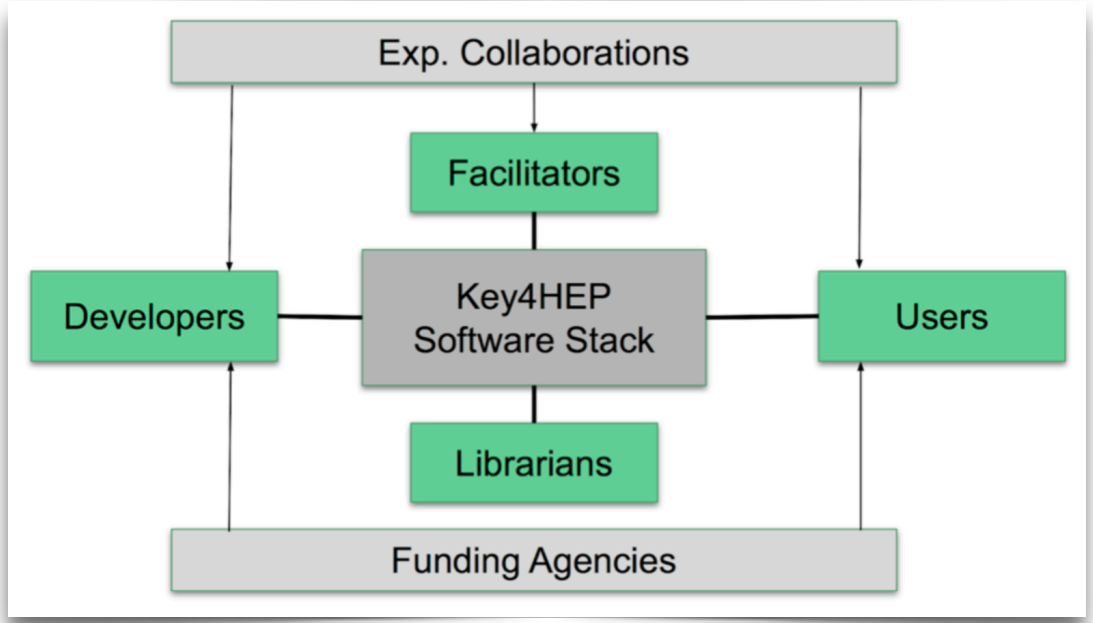
Introduction

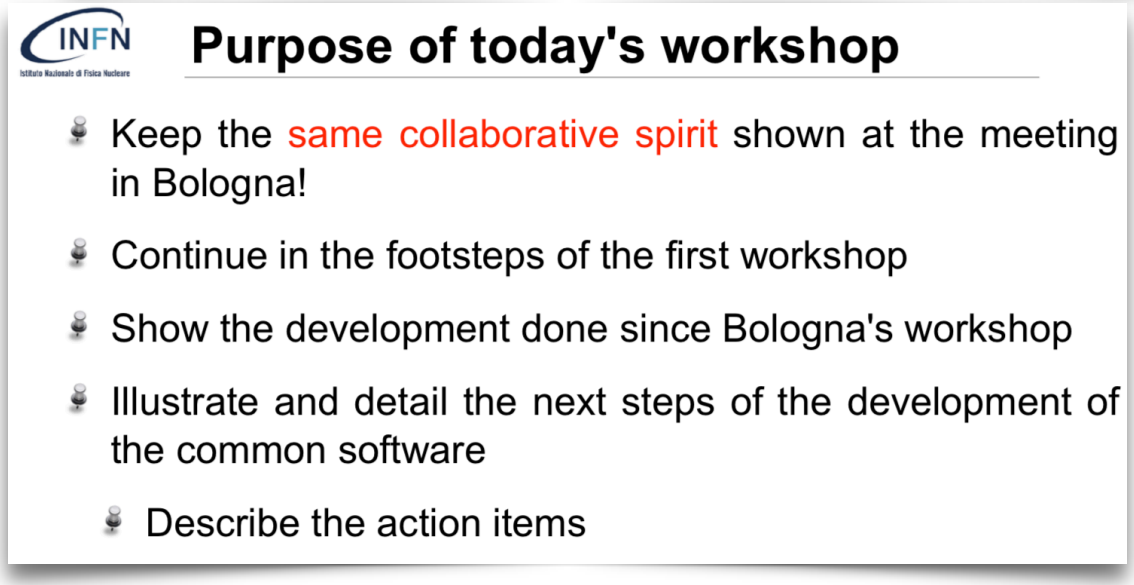
Outcome of the Bologna Meeting

P.Giacomelli

- many software experts from future collider collaboration and working groups: ILC, CLIC, FCC, CEPC, SCTF,…
- at the end of the workshop there was the overall agreement that we should try and work towards a common turnkey software stack: **Key4hep**
- based on:
  - standard HEP and external libraries like ROOT, Geant4, HepMC, VecGeom, boost, Eigen,…
  - **DD4hep, PODIO, ACTS, PandoraPFA,…**
  - new common Event Data Model: **EDM4hep**
  - use the primarily the **Gaudi** framework

note that this is a **quite remarkable** outcome and at the same time a rather **ambitious** goal





The Turnkey Software Stack

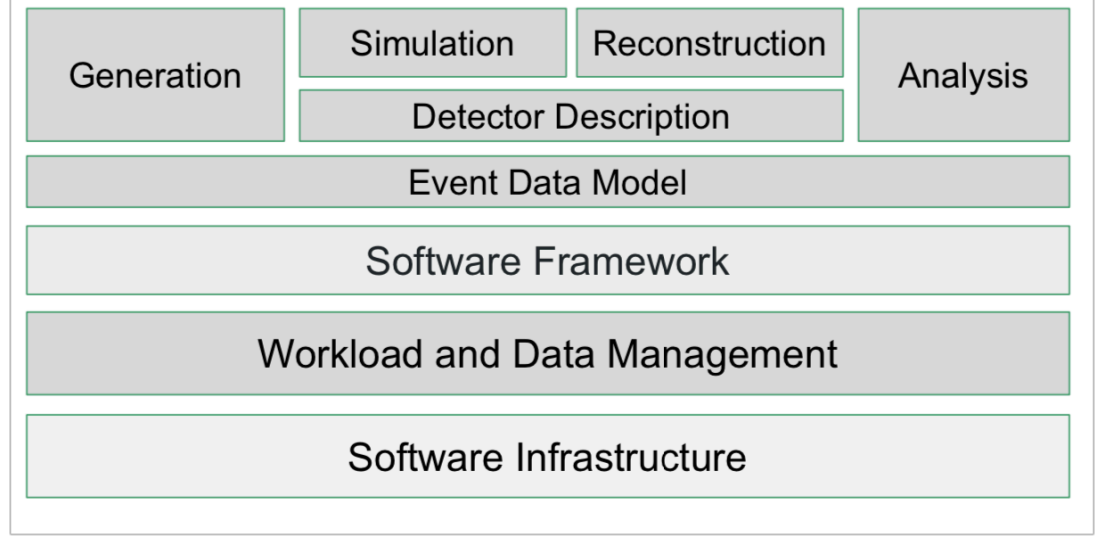
G.Ganis

work on Key4hep has started - mostly at CERN:

- Manpower *quest*
  - AIDA++ software submissions included Key4hep as R&D line
  - EP software R&D working package got concrete
    - A fellow hired, started Jan 2020 (V Volkl)
  - Second CERN fellow hired on CREMLIN PLUS funds
    - starting in March 2020
- Dissemination of the idea
  - Collaboration meetings: FCC, CLIC, ...
  - Talk at CHEP 2019

important to have dedicated manpower assigned to the overall integration of Key4hep

A generic Software Stack in HEP:

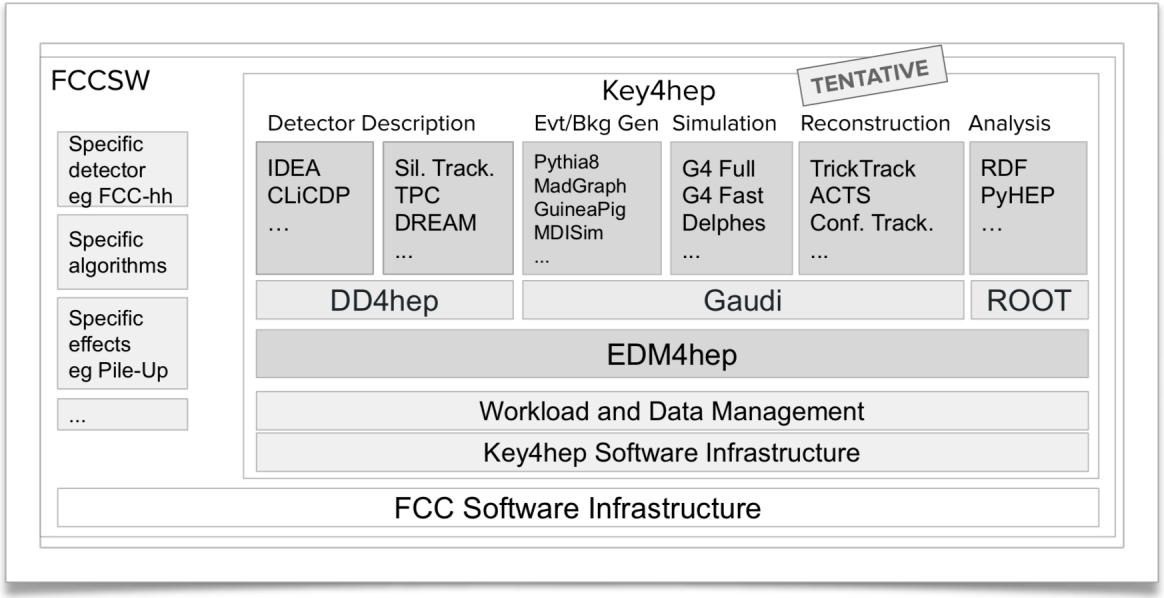


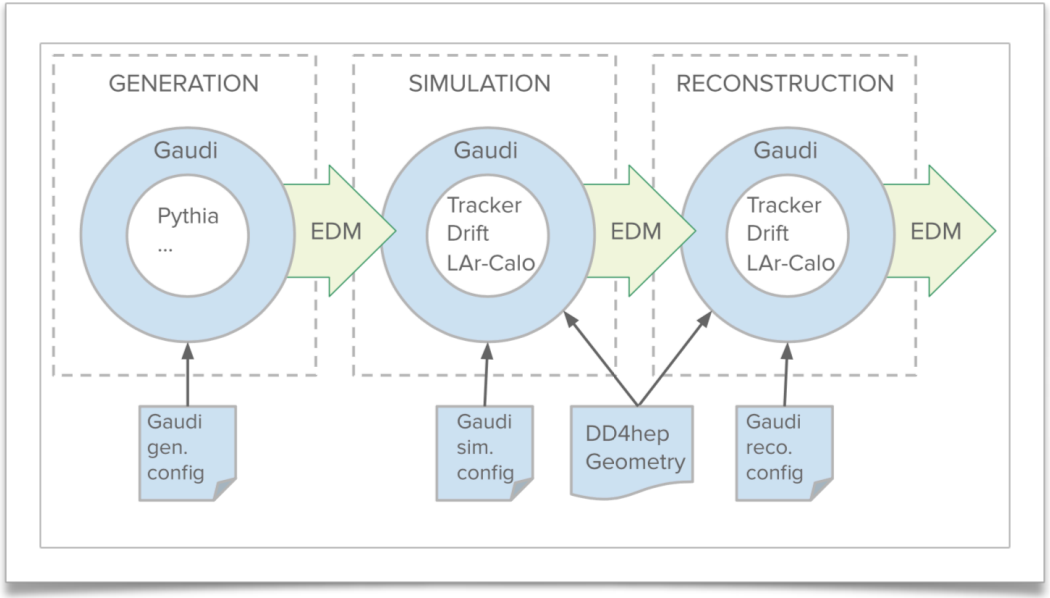
this needs to be filled with life using the agreed upon components

The FCC Software Framework

G.Ganis

- FCC already has setup a software framework with most of the core components envisaged for **Key4hep**
- yet missing are **reconstruction tools**:
  - tracking tools
  - PandoraPFA
  - HLR tools: flavour tagging, jet finding, PID,…
- -> **all of this is already available in the LC Marlin world**
- and **EDM4hep** is not yet used (available)

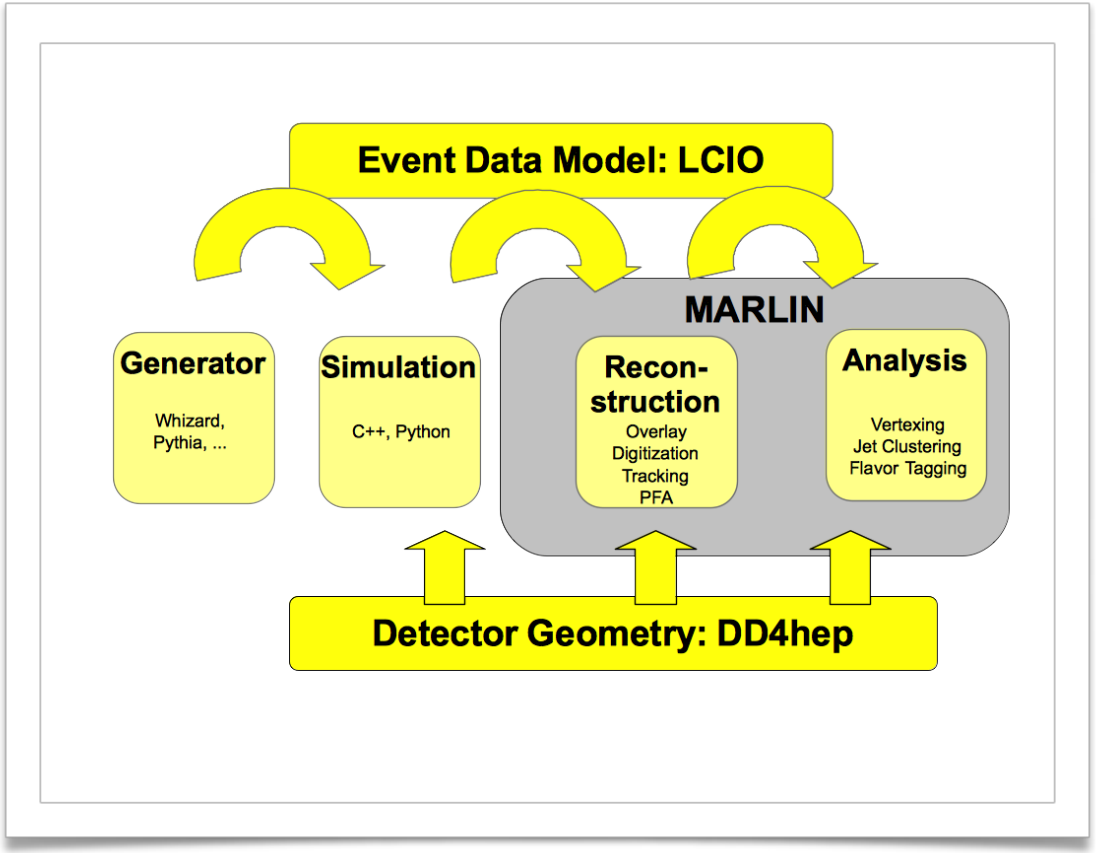




open question:
should generator and simulation be run in Gaudi or standalone ?
-> **should be flexible and allow both approaches in Key4hep**

The ILC software framework

- the ILC community has started with common software tools already in 2003 with the development of the common event data model **LCIO**
  - four different experiments with four different frameworks at the time
- this has developed into **iLCSoft** which is now used by ILC, CLICdp, CEPC, partly FCC-ee, Calice, LCTPC, HPS,…
- it uses the **Marlin** framework and **DD4hep** for the geometry description (and Geant4 simulation)
- a **complete suite of digitisation, tracking, PFA and HLR tools** exist
- these have been battle proven in several **large Monte Carlo campaigns**



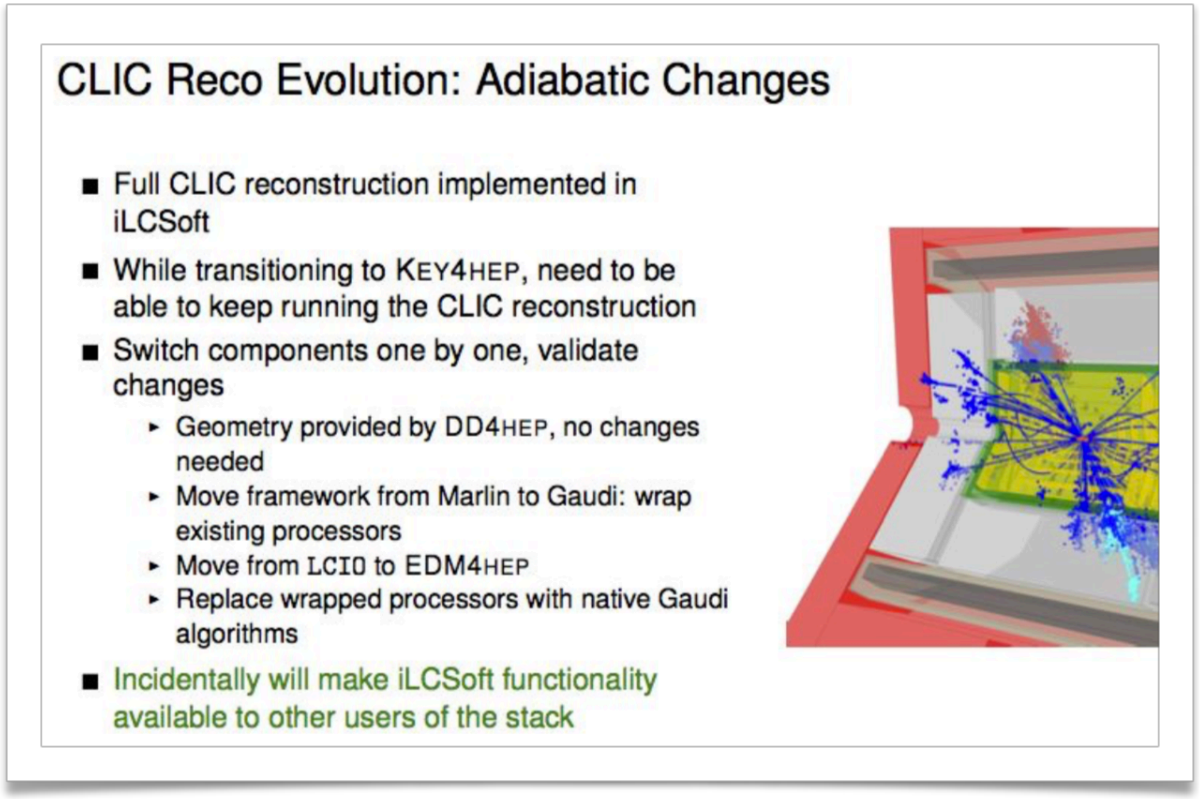
it is important for the ILC community to preserve all the existing functionality when moving to Key4hep

The CLIC software framework

A.Sailer

- CLICdp uses also the iLCSoft framework
- mostly the same algorithms as used for ILC, tuned and optimised for the CLIC detector
- also some specific algorithms for CLIC, e.g.
- ConformalTracking: pattern recognition algorithm based on **conformal mapping** and **cellular automatons**
  - rather geometry agnostic -> could easily be adapted to other (Si-tracking) detectors

- developed a programme based on **adiabatic changes** to move from iLCSoft to Key4hep
  - based on **Gaudi-Marlin wrapper**

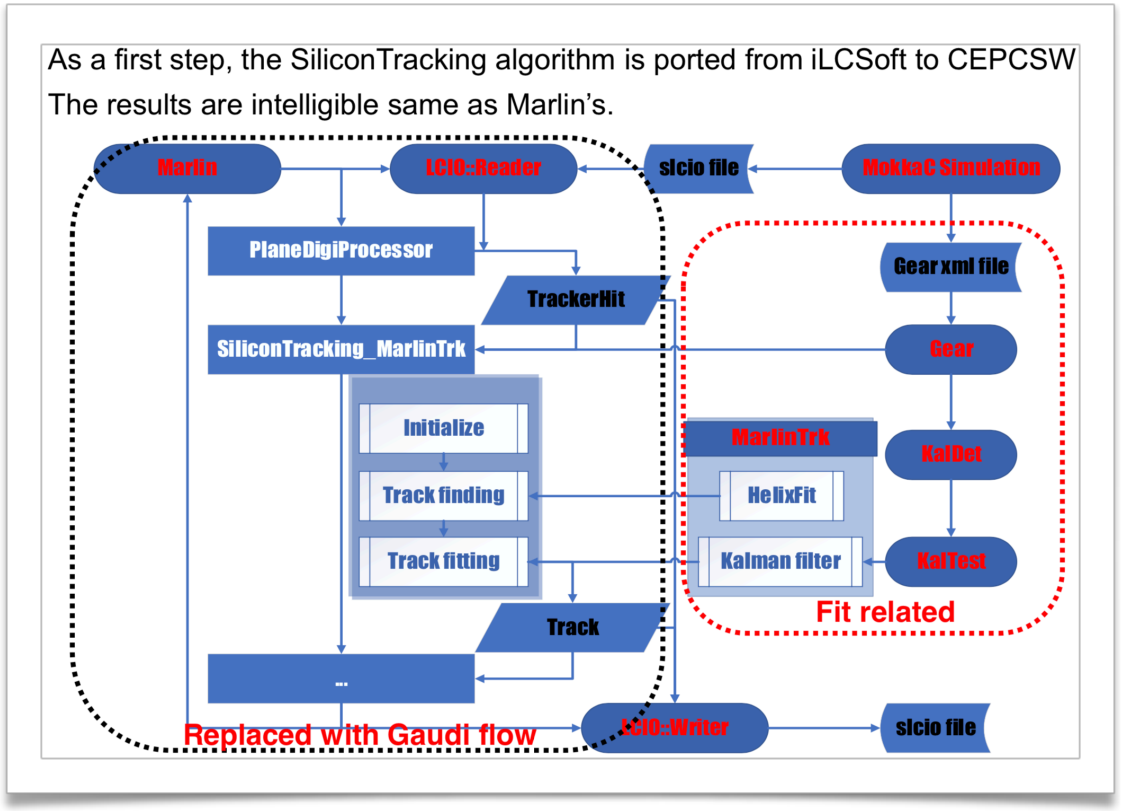


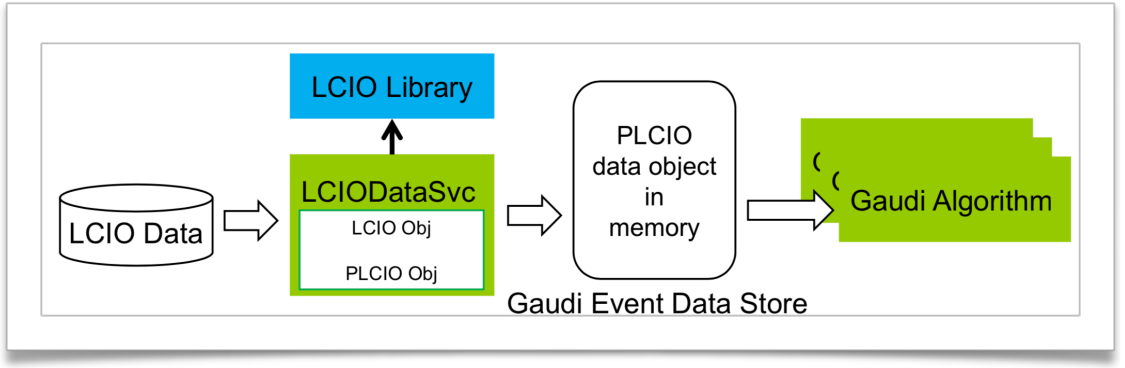
also CLICdp community needs to preserve
all the existing functionality when moving to Key4hep

The CEPC software framework

J.Zou

- started out from using **iLCSoft** (and ILD detector)
  - used for CDR (2018)
- now planning to use Key4hep eventually
  - started with using **pLCIO** and porting algorithms from Marlin to Gaudi
  - developed **LCIODataSVC -> pLCIO** object in memory
- ported **SiliconTracking** from **MarlinTrk** into Gaudi
- also ported **DDPlanarDigi** to DDPlanarSrv



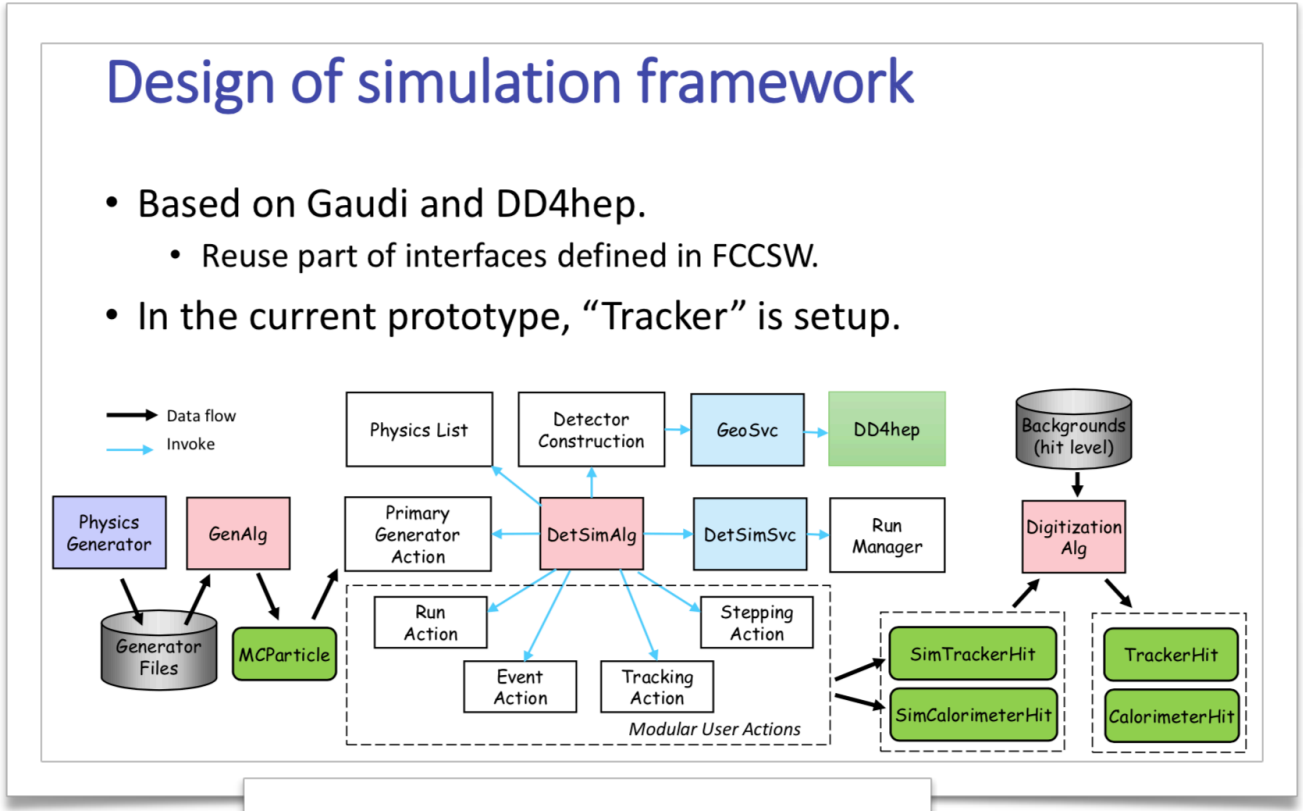


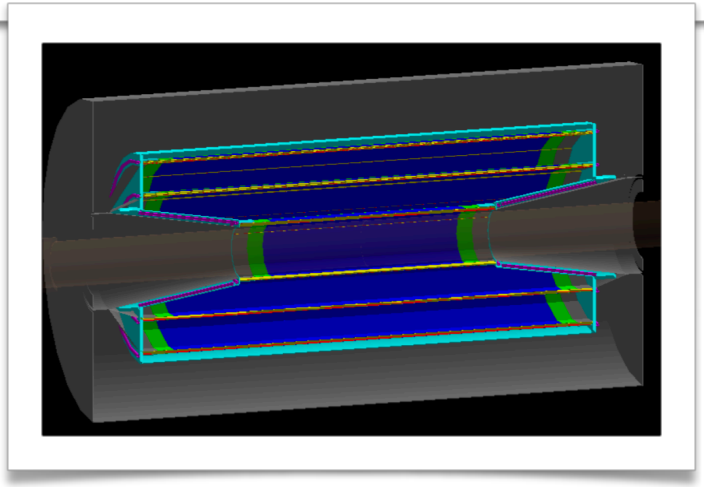
very useful alternative route for the transition from **iLCSoft** to **Key4hep**
need to make sure that we soon integrate the different transition solutions from FCC,CLIC and CEPC

CEPC Simulation

T.Lin

- started to port the detector simulation model from the (old) iLCSoft Mokka simulation tool to DD4hep
- run the Geant4 simulation within the Gaudi framework
- developed a number of **GenTools** for reading generator information, conversion to *MCParticle*, a particle gun, etc
- Note: most of this and more plugins for MCTruth linking etc. are already available in DD4hep/DDG4 and used by ILC/CLIC <-> need to understand differences
- CEPC also working on parallelising the simulation with MT and MPI (for HPC resources)
  - interesting for Key4hep





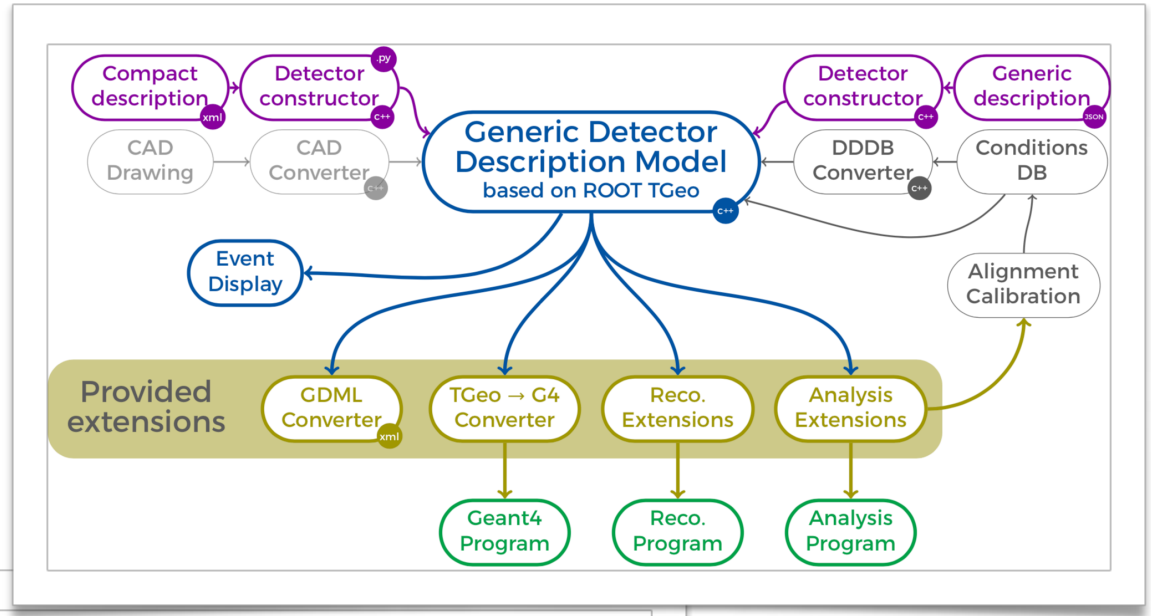
VXD detector implemented in DD4hep

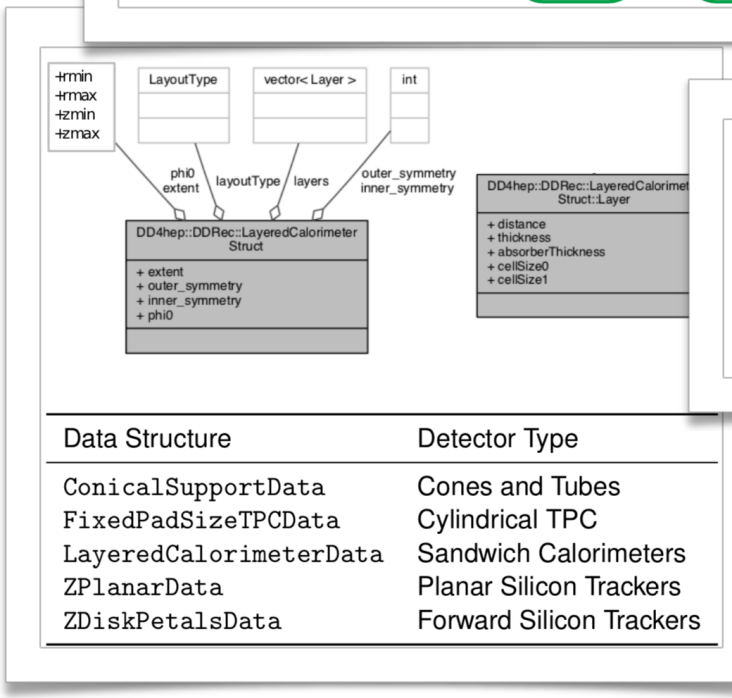
DD4hep

Detector Description for all of HEP

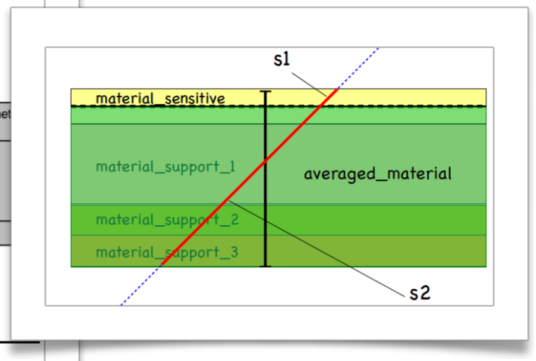
A.Sailer

- DD4hep originally developed in context of ILC/CLIC
- provides complete solution for **detector description, simulation, interface to reconstruction,** conditions and alignment
- large palette of **sub-detector drivers** exist - generic and CLICdp, ILD specific
  - to be extended as needed, e.g.
  - **drift chamber** and **dual readout calorimeter**
- DDRec: interface to geometry as needed for reconstruction
  - surfaces and generic detector classes
  - to be extended in a generic way





Data Structure	Detector Type
ConicalSupportData	Cones and Tubes
FixedPadSizeTPCData	Cylindrical TPC
LayeredCalorimeterData	Sandwich Calorimeters
ZPlanarData	Planar Silicon Trackers
ZDiskPetalsData	Forward Silicon Trackers



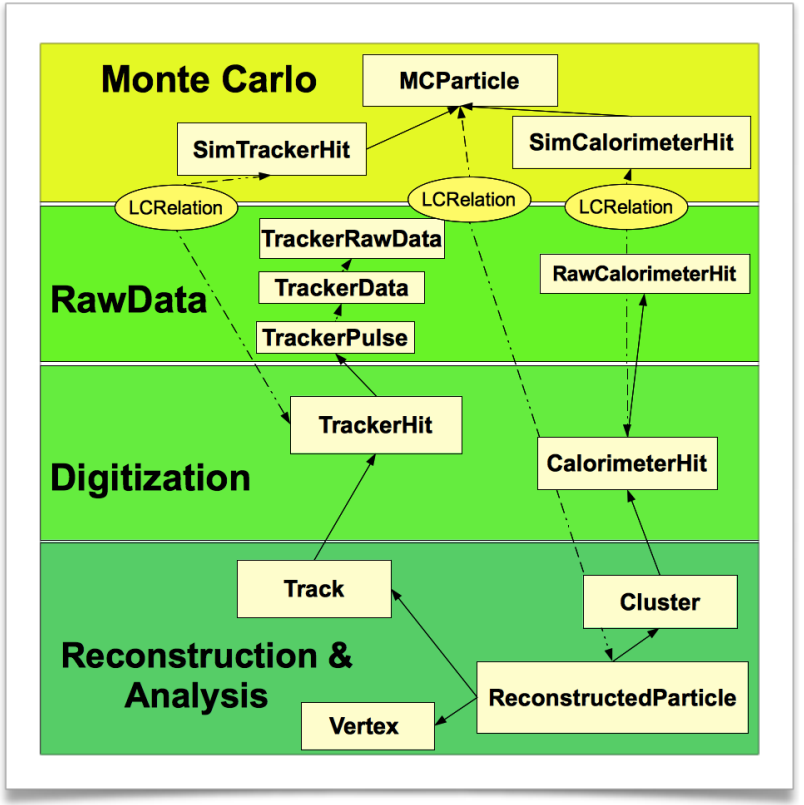
ddrec::Surface geometry for track reconstruction

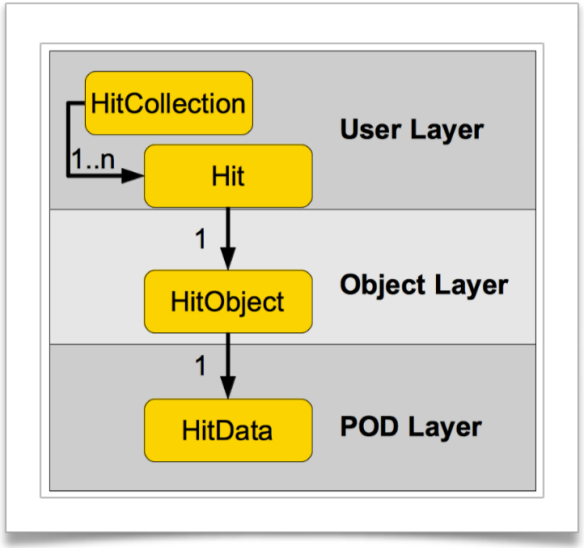
EDM4hep

The common Event Data Model for HEP

- the LCIO EDM has been a great success for the common software framework iLCSoft of the linear collider community
- it provided the basis for collaboration for more than 15 years
- **EDM4hep** should be a successor with **modernised EDM and better I/O performance**
  - based on LCIO and the fcc-edm
  - implemented using **PODIO**
- PODIO: EDM tool based on storing PODs with ROOT I/O
  - already used in the FCCSW and by pLCIO
  - pLCIO: almost complete re-implementation of LCIO in PODIO
- started with Simulation model: *MCParticle SimTrackerHit, SimCalorimeterHit* - next: **tracking classes**

involve experts from **all four colliders** in defining the EDM
try to be **close to LCIO** to preserve all the existing code base





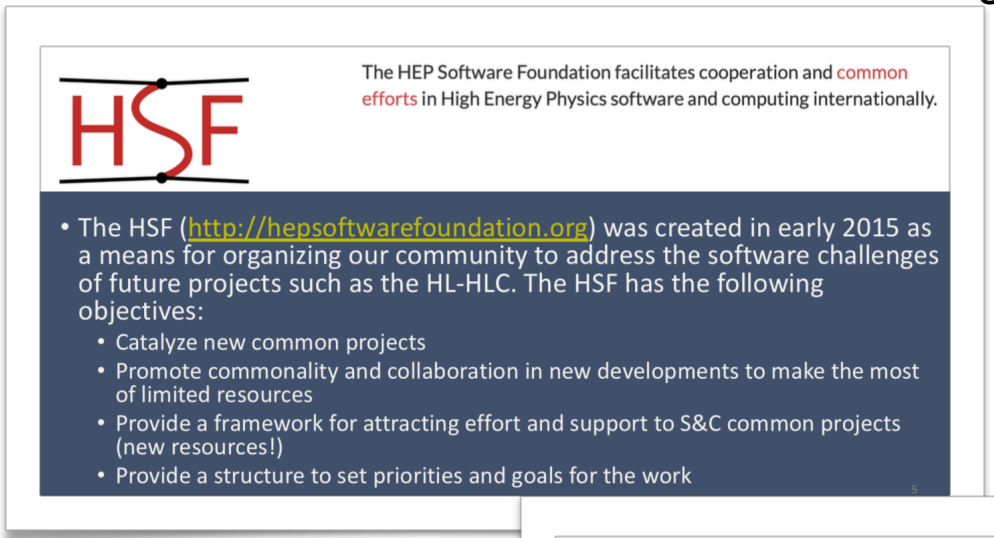
A worldwide Software Collaboration ?

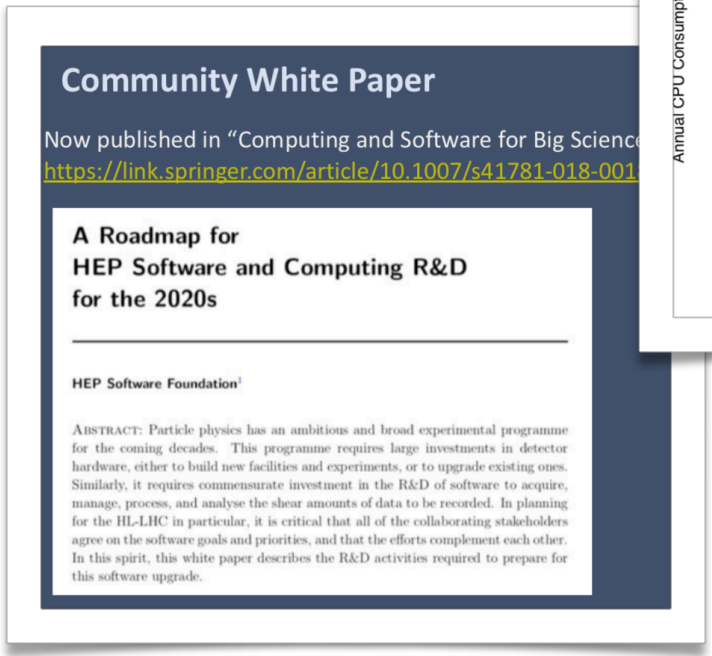
D.Lange

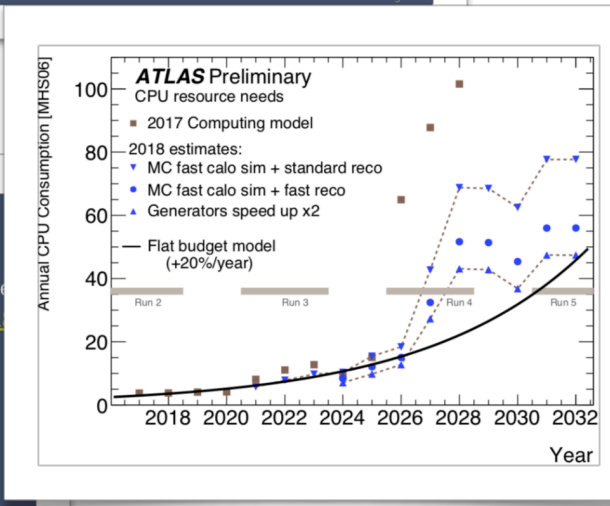
The LHC perspective on Key4hep

- LHC started with idea of having a common software stack - in the end only few common tools remained
- new common solutions arose with time, e.g: DD4hep
- HL-LHC is facing tremendous computing challenges
- HSF created to provide a platform addressing these challenges in a collaborative way - first outcome:
  - CWP process: “A Roadmap for HEP Software and Computing R&D”
- have started iris-HEP fellows programme in the US to address common HEP computing issues
  - could contribute to future collider community

Key4hep not targeted at HL-LHC - but we should of course stay close to LHC developments, even though our requirements are quite different







Conclusion

Summary of discussion at the end of the workshop

- workshop showed **quite some progress** in all four collider communities since Bologna meeting
- also many **open questions identifie**d, e.g. how to exactly go about the transition from iLCSoft/ Marlin to the new Gaudi based world
  - have seen quite different approaches
  - need to be flexible for quite some time
- however: general **agreement to continue the collaboration** and work towards a common Key4hep framework
- started to put together a long list of To-Do items in order to make progress fast
- some immediate To-Do items:
- **goal: get a first version of Key4hep with core component and a data service based on EDM4hep**
  - setup Hey4hep mailing list
  - call for regular phone meetings
  - setup **Git project Key4hep** and add new packages there, e.g.
    - FWCore component, space installation scripts, experiment specific configurations
- organise a dedicated software workshop in a few months from now

overall a very useful software workshop - but the real work is now ahead of us …