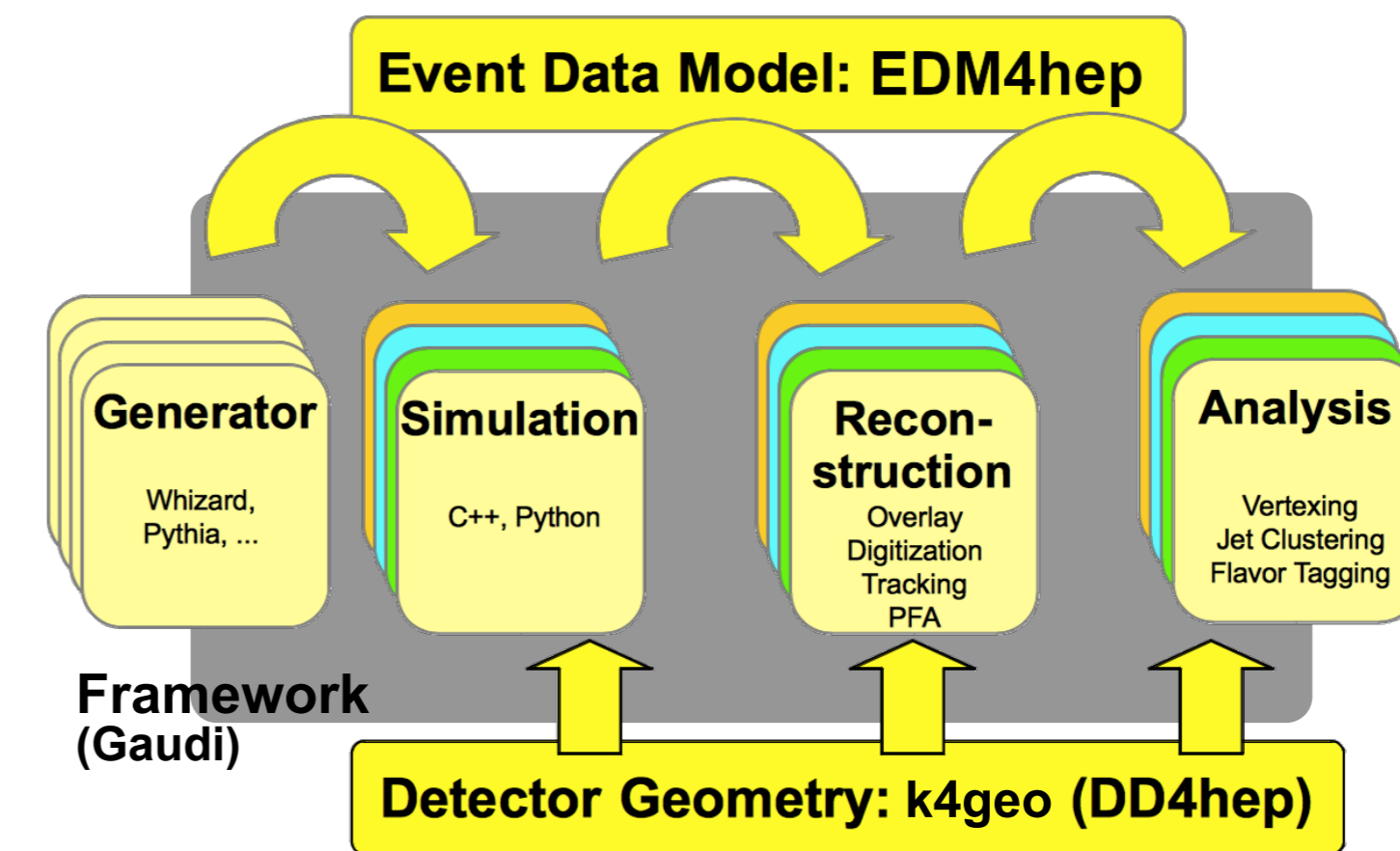


Key4hep: A Turnkey Software Framework for Future Collider Experiments

Juan Miguel Carceller (CERN) on behalf of the Key4hep authors

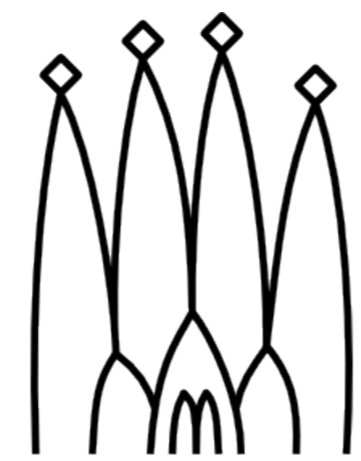
Introduction

- **Turnkey software framework:** Key4hep provides a complete data processing framework, from Monte Carlo generation to data analysis
- **Share components** across different experiments and communities and avoid duplication of effort
- **International community** with participants from CEPC, CLIC, EIC, FCC, ILC and the Muon Collider from CERN, DESY, IHEP, INFN and other institutes



Event Processing with Gaudi

- Gaudi is an **event-processing framework**, used by ATLAS, LHCb and others
- Key4hep provides an interface to Gaudi, enabling the execution of **algorithms that read or write EDM4hep data**
- There are **more interfaces:** to Monte Carlo Generators, Geant4, Delphes and others
- **Ongoing work in other integrations or algorithms**
 - ACTS, for track reconstruction
 - Pandora Particle Flow Algorithm
 - Porting existing algorithms to work with EDM4hep, like a background overlay algorithm
- Support for **multithreading** has been added recently

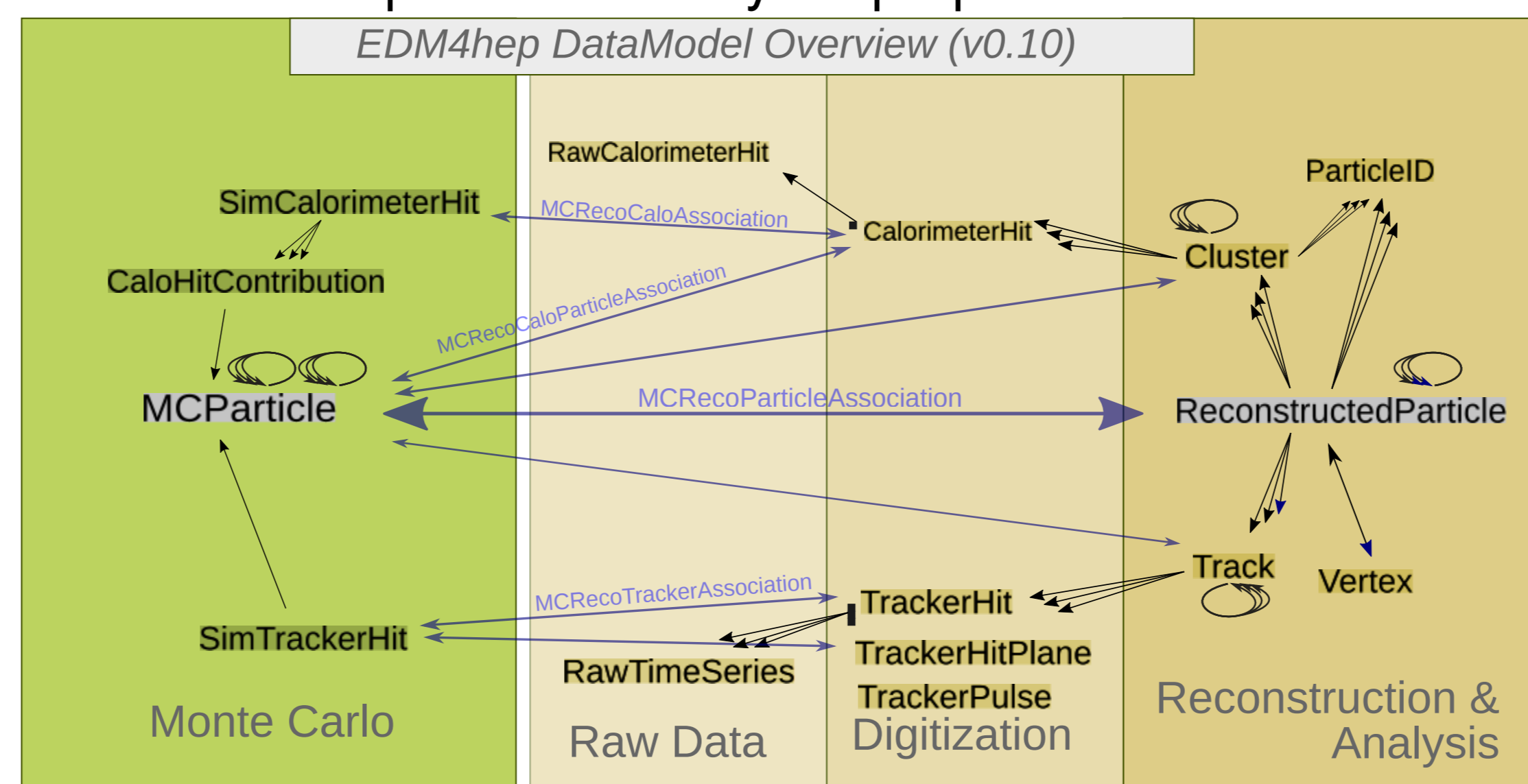


Detector Studies

- Key4hep uses the **DD4hep** detector description framework based on Geant4
- The geometries of the detectors are stored in a **common repository** and deployed on cvmfs
- Users can easily test them and their different versions
 - Steering files to run a full reconstruction chain are often provided
 - **Validation pipeline** involving simulation and reconstruction to detect potential issues as the detector evolves

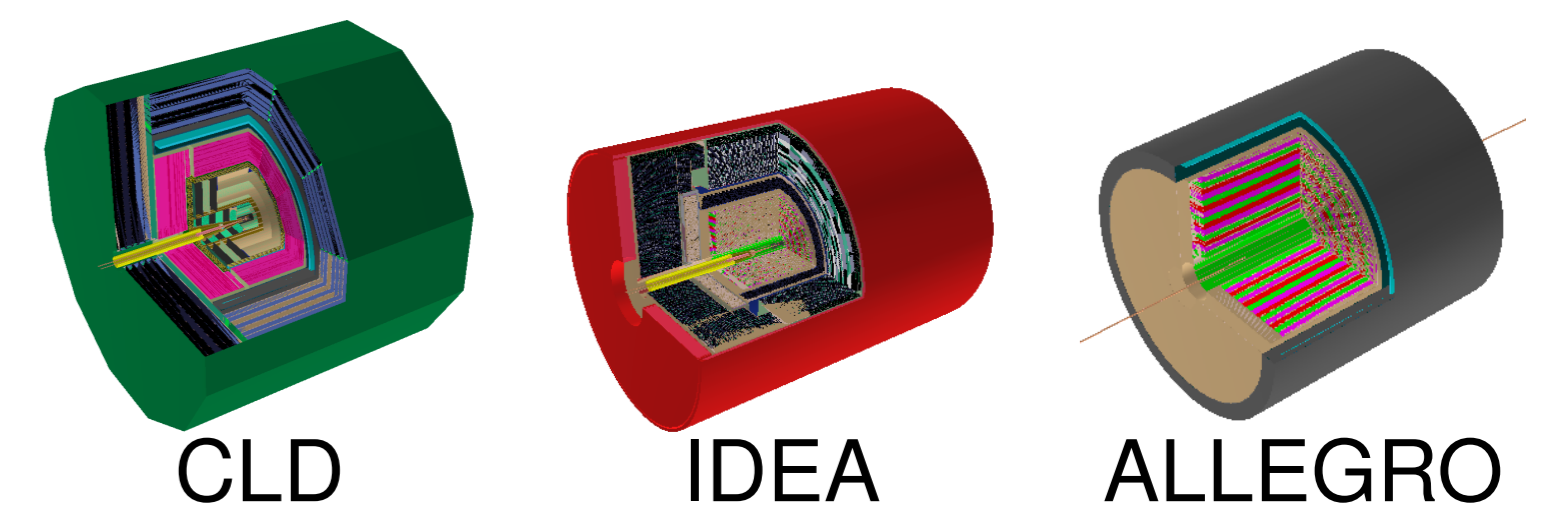
EDM4hep

- EDM4hep is an **Event Data Model** and the core component of Key4hep
- **Common language** that all the components in Key4hep speak



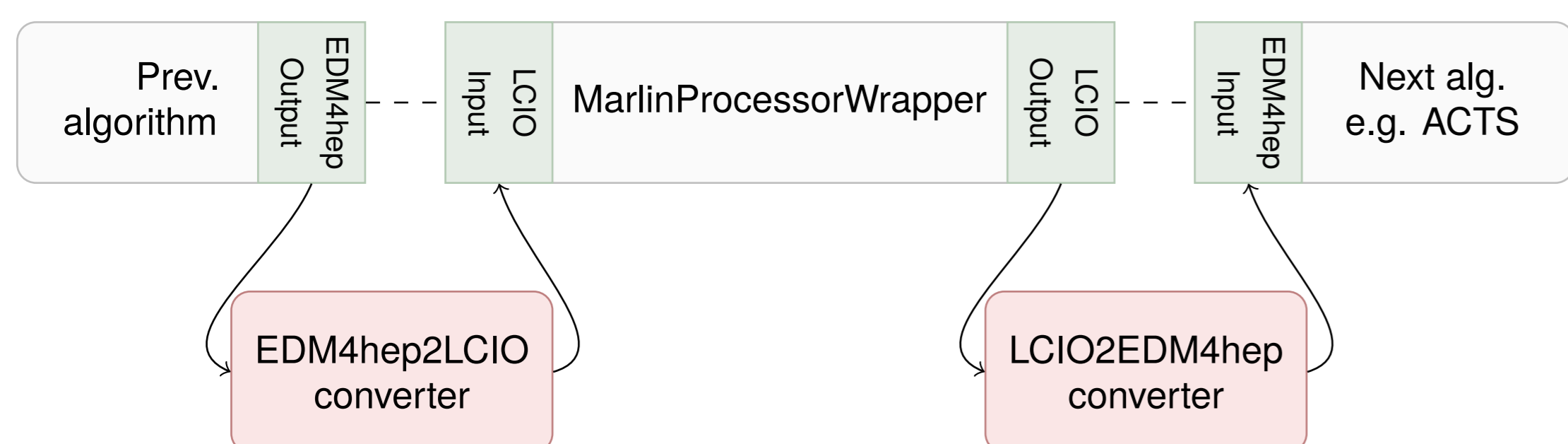
- The goal is to be both **generic** and **address all the needs** of the experiments
- EDM4hep **evolves through consensus** among all the parties involved

FCC-ee Detector Concepts



The Marlin Wrapper

- Marlin is an event-processing framework for the International Linear Collider (ILC)
- Key4hep provides an **in-memory wrapper for Marlin processors**, enabling the integration and reuse of software developed and validated for over 20 years within Key4hep



- Marlin processors can be **combined with other algorithms** from Key4hep in the same processing chain thanks to the Marlin wrapper

The Key4hep Stack

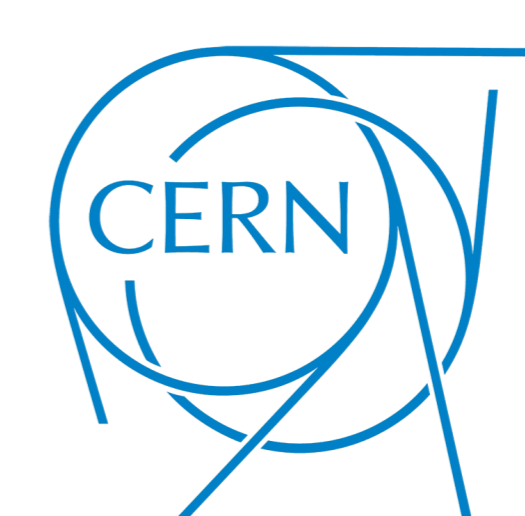
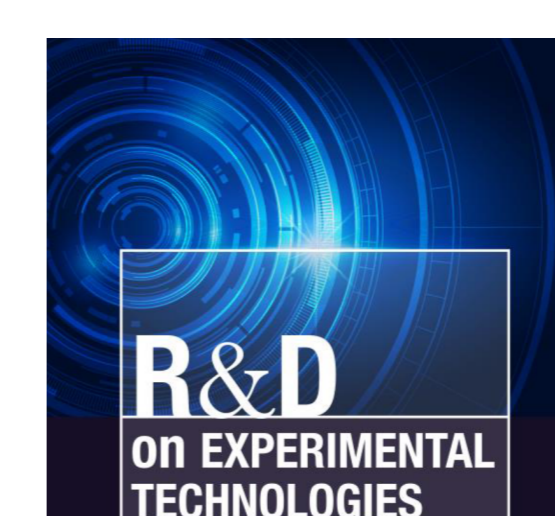
- **Complete software stack** of over 500 packages that are deployed on cvmfs
- Nightly build and stable releases
- Built with **spack**, a community-driven package manager
- **Supports multiple operating systems:** Alma 9, CentOS 7 and Ubuntu 22.04

- **Easy setup** by running one of the following commands:


```
source /cvmfs/sw.hsf.org/key4hep/setup.sh
source /cvmfs/sw-nightlies.hsf.org/key4hep/setup.sh
```
- **Utilities** to setup a working area or to select different releases easily
- **Continuous integration** system that ensures all changes are thoroughly tested and validated on both nightly and stable releases

Outlook

- Consolidate and finish a **stable version of EDM4hep**
 - Recent improvements before version 1.0, the **first stable version** of EDM4hep
 - In the future, use the **schema evolution** provided by Podio (the tool that generates EDM4hep) to evolve the data model
 - Version 1.0 planned to happen **soon**
- Participate in and benefit from the **FCC studies**
 - Already happening: today Key4hep is the software framework used for FCC studies
 - Increase the number of reconstruction algorithms available



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