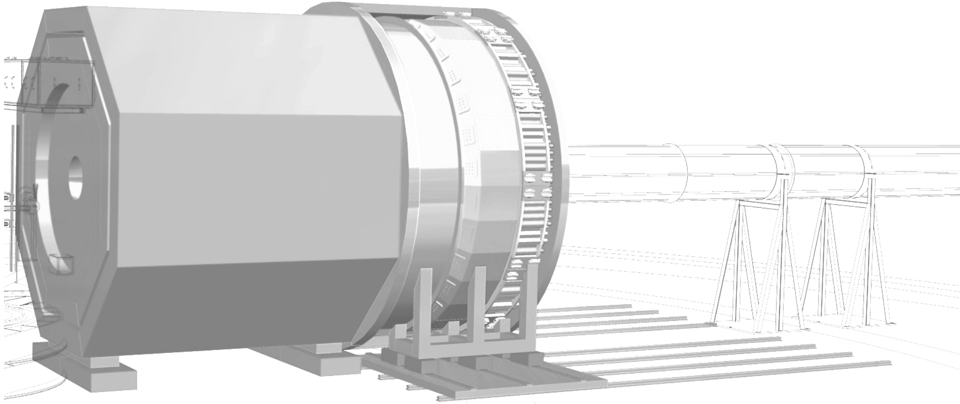
SoLID Collaboration Meeting 2025/01

# Status and Plan of the SoLID Software Framework



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# Using EIC Software for SoLID

- Modern software toolchain
  - Modular, easy to implement SoLID-specific development
  - Designed to utilize HPC resources
  - Being maintained and improved by active developers from NP/HEP community

- Mutual Beneficial
  - Share development of digitization/reconstruction
  - Test and implementation of streaming, AI/ML in simulation/analysis
  - Collaboration between SoLID and ePIC (Markus's talk)

# Software Framework Overview

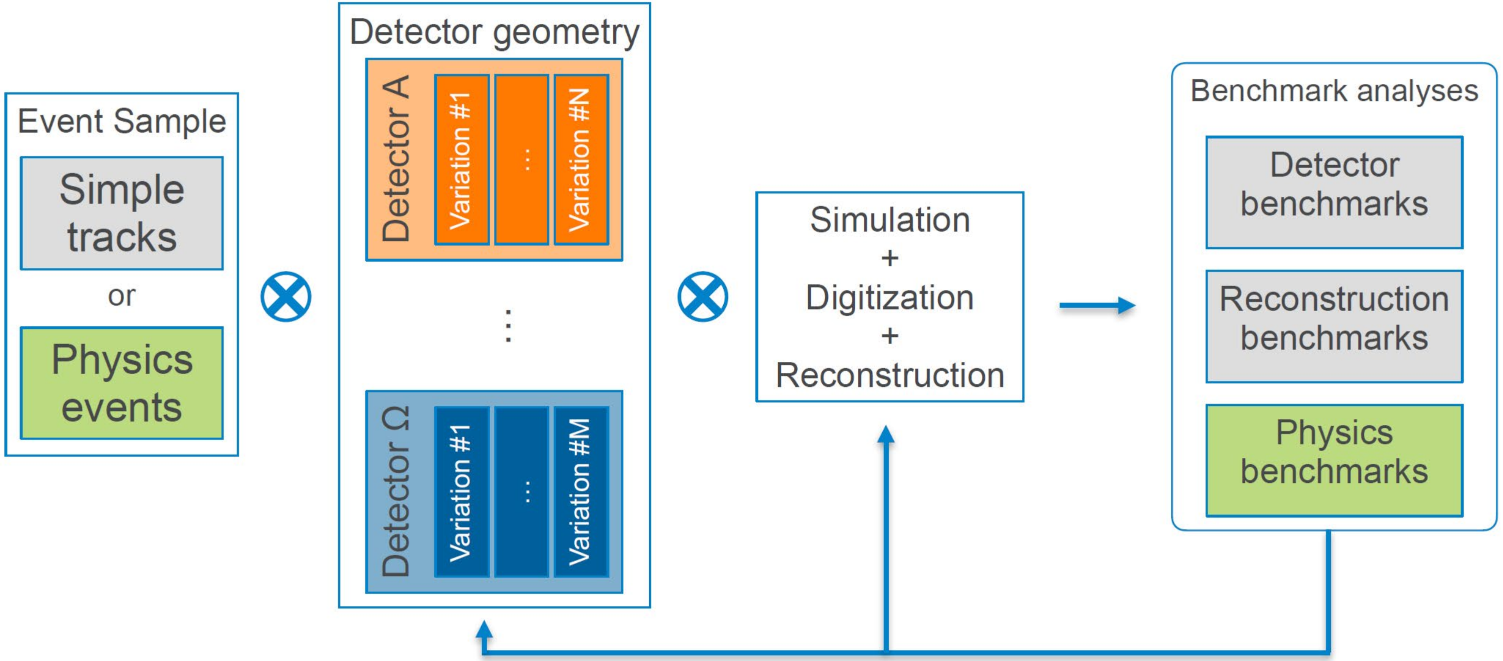


Figure courtesy: S. Joosten

# Key Components of the Toolchain

- **EDM4hep**: Generic event data model for HEP
- **DD4hep**: a consistent detector description for simulation, reconstruction, and analysis
  - Geant4 geometry from plugin library
  - Configurable with xml file
- **ACTS**: Experiment-independent tracking toolkit for HEP in modern C++
  - Built-in support for DD4hep geometry description (via plugin)
- **EICRecon (JANA2)/Juggler (Gaudi)**: Generic event processing framework

# Geometry Description – DD4hep

https://github.com/AIDASoft/DD4hep

- Full detector description (ROOT geometry libraries)
  - Geometry, materials, visualization, readout, alignment, calibration, etc
  - Parameterization with plugins (C++) + compact files (xml)
- Full experiment life cycle
  - Detector concept development and optimization
  - Construction
  - Operation
- Single-source detector description
  - Simulation (GEANT4), reconstruction , analysis

# Event Processing Frameworks

- EICrecon
  - JANA2 based
  - Used by ePIC collaboration, in active development
- Juggler
  - Event processing framework based on Gaudi
  - Gaudi was developed for LHCb event processing
  - Concurrent event processing
  - Plugins for algorithms and services

SOFTWARE https://github.com/eic/EICrecon

https://eicweb.phy.anl.gov/EIC/juggler

https://lhcb.github.io/DevelopKit/03a-gaudi

Developed algorithms can be used with both frameworks

# SoLID Software Transition

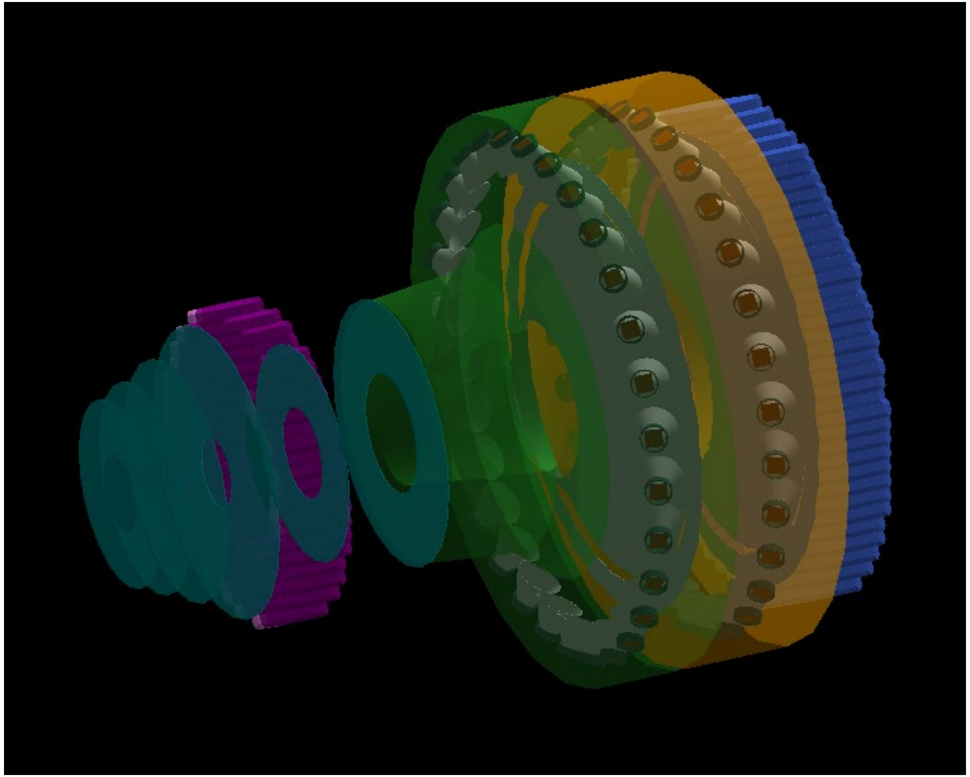
- Transition to EIC software
  - From GEMC based simulation
  - To the modern software toolchain for simulation, event reconstruction, and analysis
  - EDM4hep + DD4hep + ACTS + EICrecon

- Milestones
  - ✓ Implementation of SoLID geometry in DD4hep
  - ➢ Detector benchmarking and comparison study with original simulation
  - □ Reconstruction benchmarking and integrated reconstruction
  - □ Physics simulation and analysis

# Geometries for Major Subsystems

https://github.com/JeffersonLab/solid_dd4hep

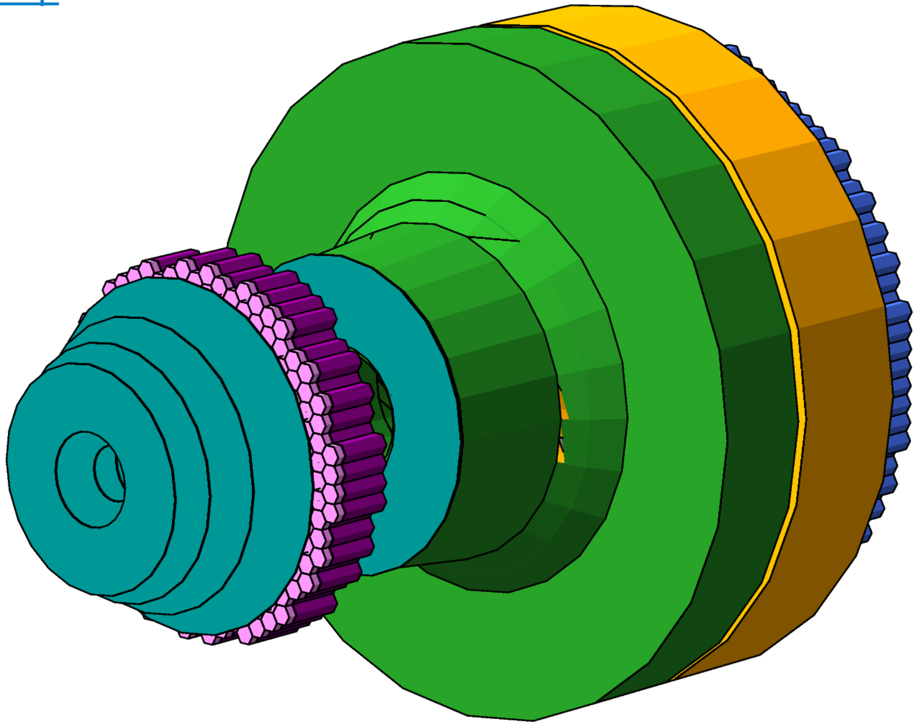
- Rough geometries have already been implemented in DD4hep
  - FAEC, LAEC
  - LGC, HGC
  - GEM trackers
  - Solenoid and some support structure (not shown)



# Geometries for Major Subsystems

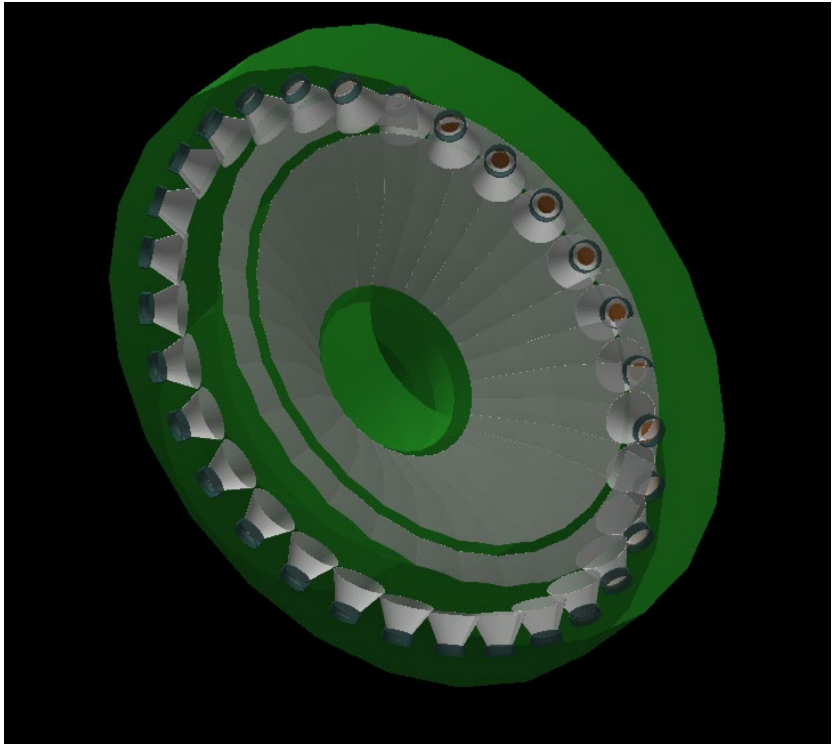
https://github.com/JeffersonLab/solid_dd4hep

- Visualization tools implemented for geometry development and checks
  - GEANT4
  - DAWN
  - ROOT



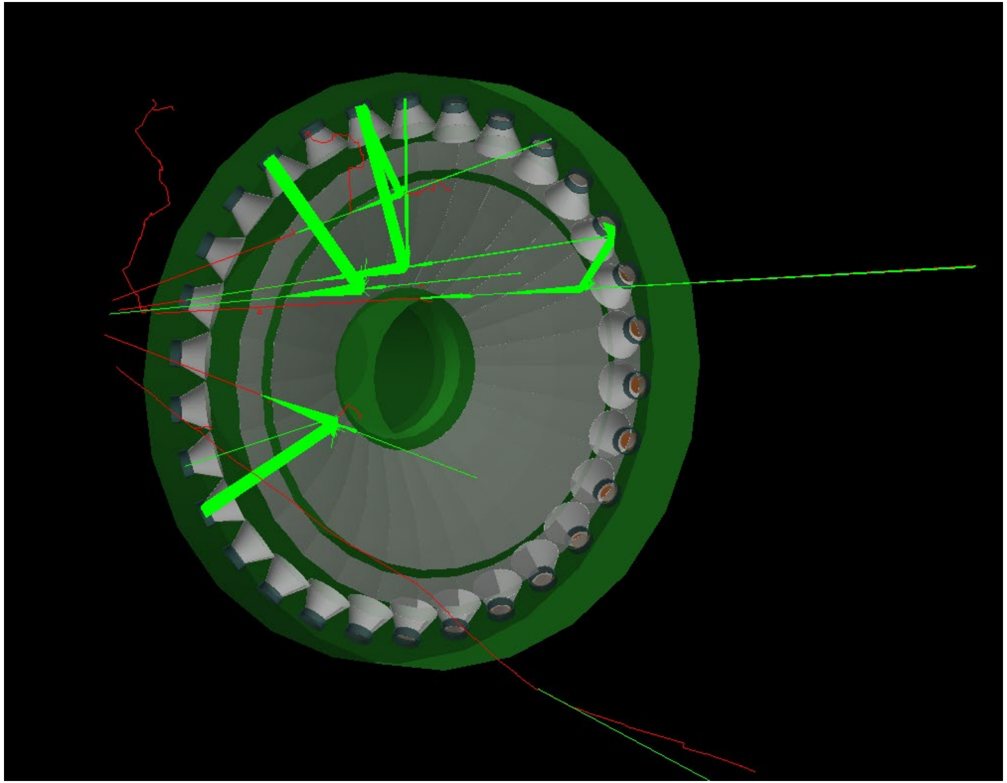
# Geometry and Detector Benchmark: LGC

- Implemented according to the latest design and GEMC simulation
- Realistic simulation
  - Quantum efficiency
  - Reflectivity
  - Refractive indices of gases
- Detector benchmarking
  - Optical photon detection



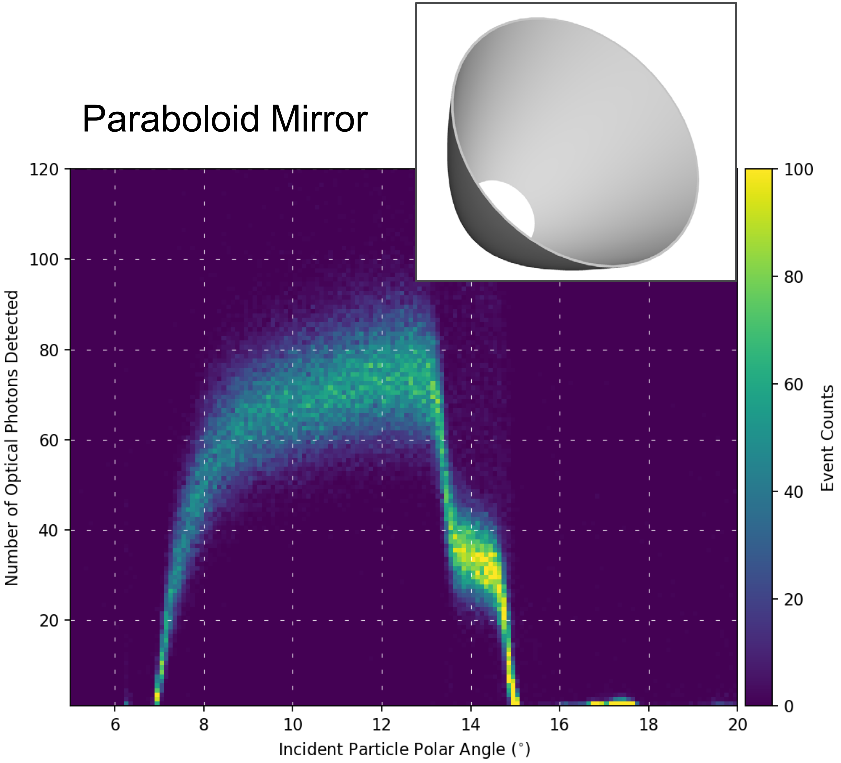
# Geometry and Detector Benchmark: LGC

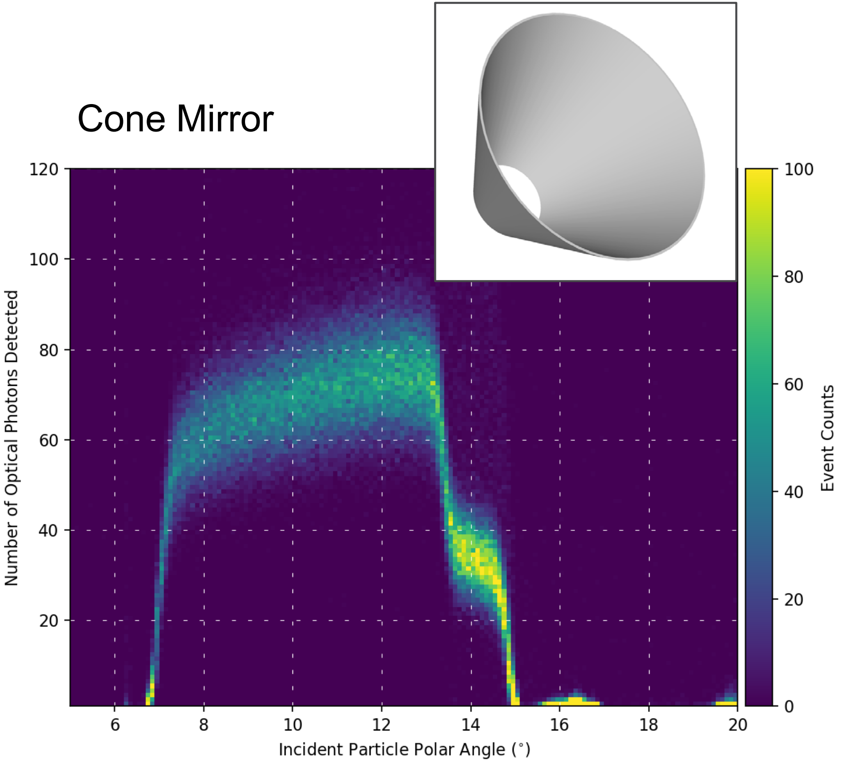
- Optical photon physics lists enabled in simulation
- Mirror surfaces implemented
  - Reflectivity curve
- Sensitive volume for optical photon detection
  - Optical photon destroys and deposit all energies
  - Q.E. vs. photon energy



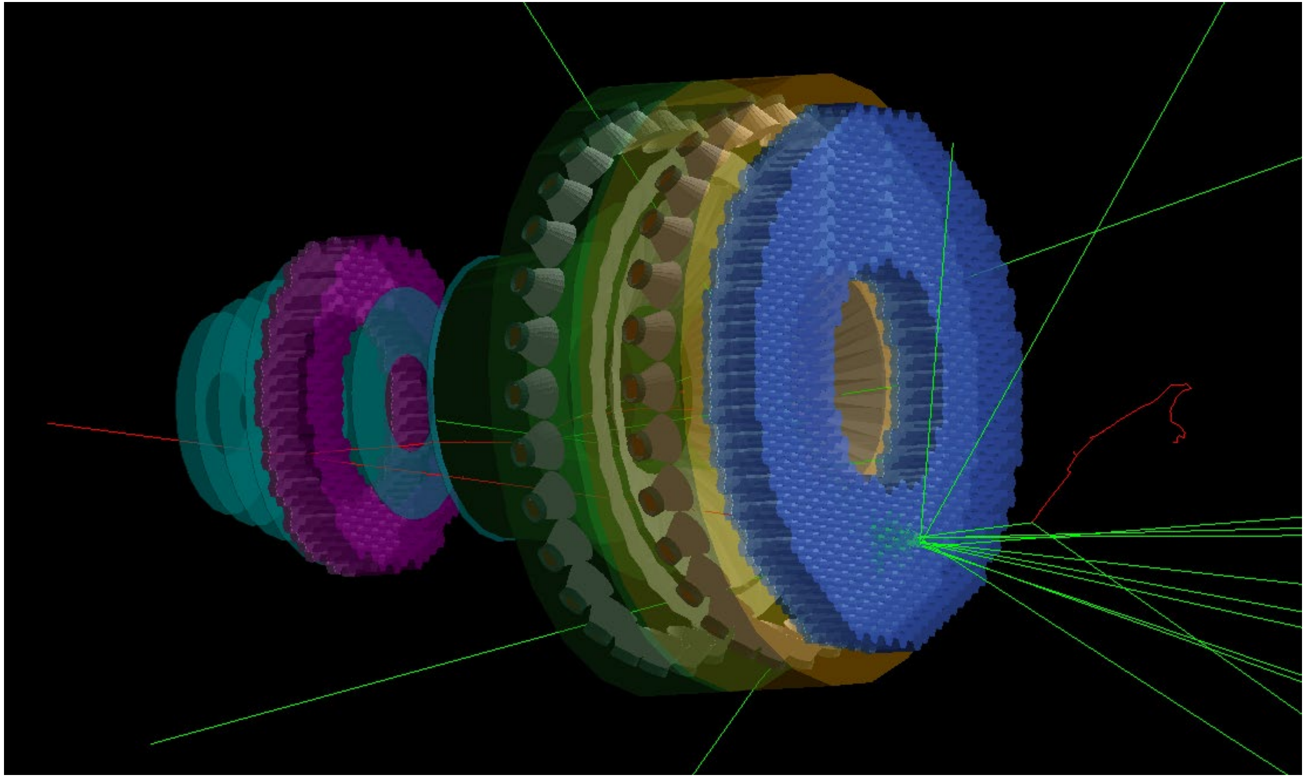
# LGC Optics Simulation

Talk from Michael Paolone


Paraboloid Mirror

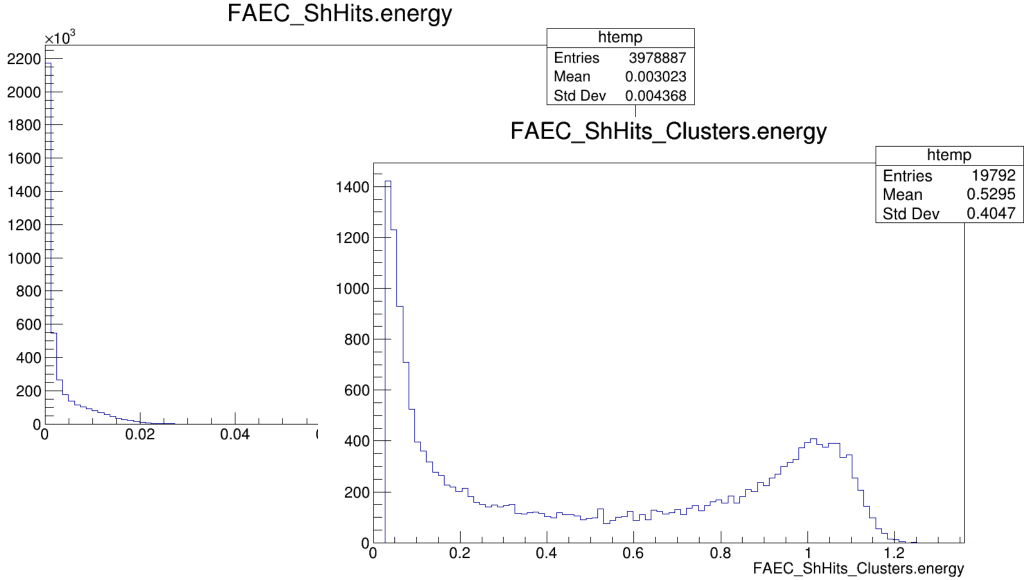

Cone Mirror

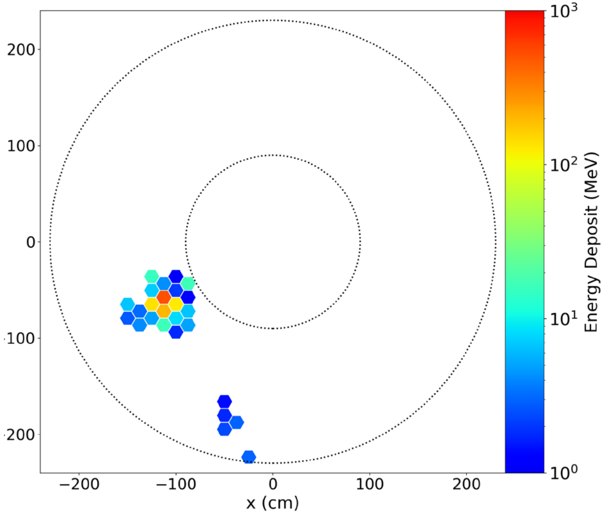
# Geometry and Detector Benchmark: ECal



# Geometry and Detector Benchmark: ECal

- Raw energy deposit of hits and clusters (FAEC Shower)





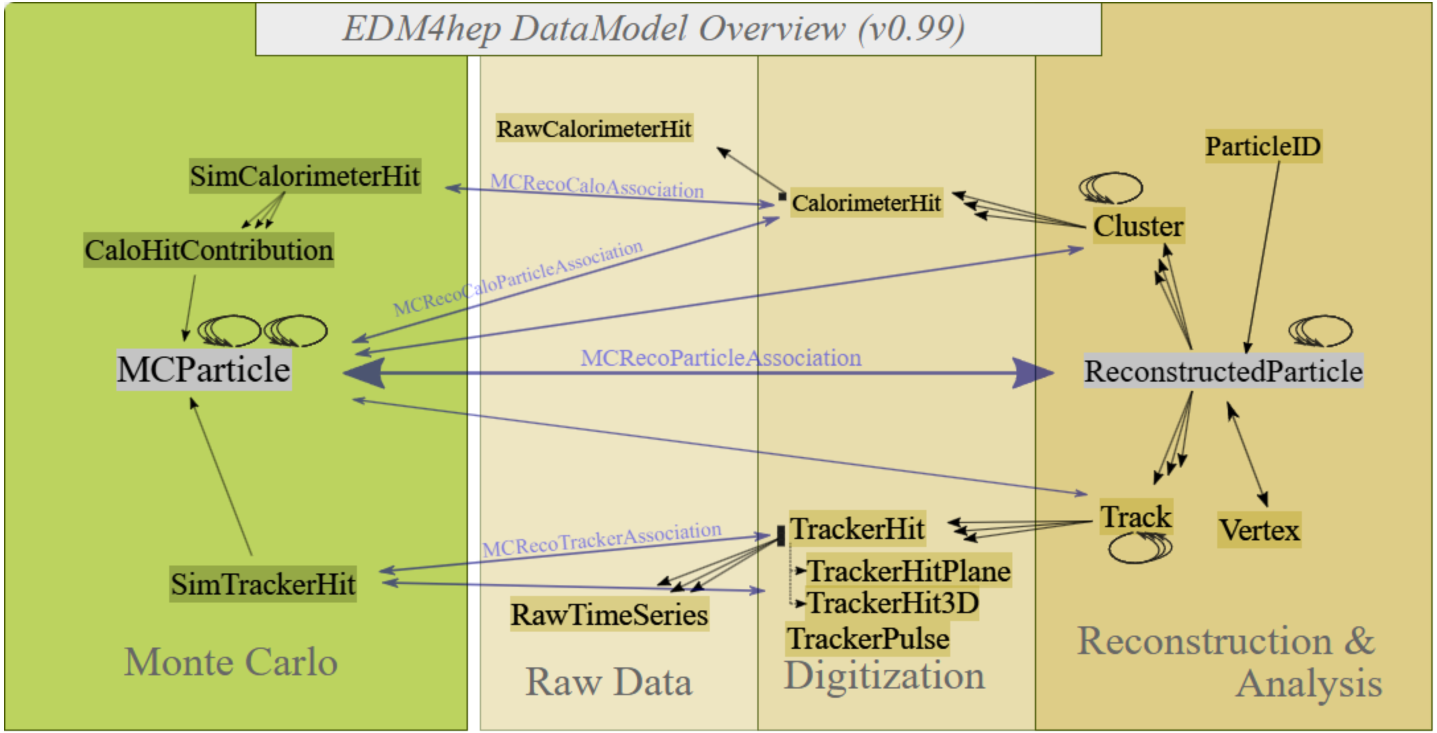
# Plan for the Development

- Detector geometry implementation and benchmarking – **0.2 FTE**
  - Detailed description for LGC, HGC, and ECal (Chao, Churamani, Zhiwen)
  - GEMs (Chao, Zhiwen)
- Reconstruction for individual detector subsystem – **0.5 FTE**
  - Clustering for FAEC/LAEC (Chao)
  - Cherenkov PID (Ye, Zhiwen)
  - Tracking (Shujie, Weizhi)
- Integrated reconstruction – **0.3 FTE**
  - Relative easier than ePIC due to a smaller number of subsystems
- Physics simulation and analysis
  - Approved experiments
  - Proposal development

# BACKUP

# Data Model – EDM4hep

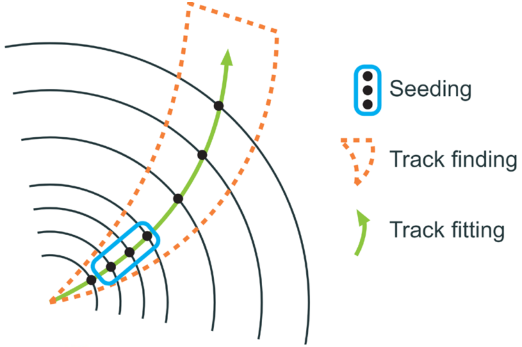
https://github.com/key4hep/EDM4hep



# Generic Tracking - ACTS

https://github.com/acts-project/acts

- Key features
  - Tracking geometry description from manual or TGeo/**DD4hep** input
  - Simple event data model
  - Common algorithms for track propagation and fitting
  - Basic seed finding algorithms
  - Common vertexing algorithms


Seeding
Track finding
Track fitting