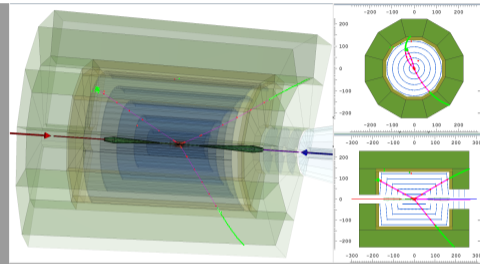


Initial experience with Acts TOPSiDE and SoLID detectors



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Introduction

- Goal: Full end-to-end simulation and reconstruction
- Software Toolkit and Strategy
- SoLID detector example
- Initial Acts experience

Software Toolkit

Primary Toolkit

- **DD4hep** – Detector description
- **Acts** – A Common Tracking Software
- **PODIO** – Data model tool

Our tools:

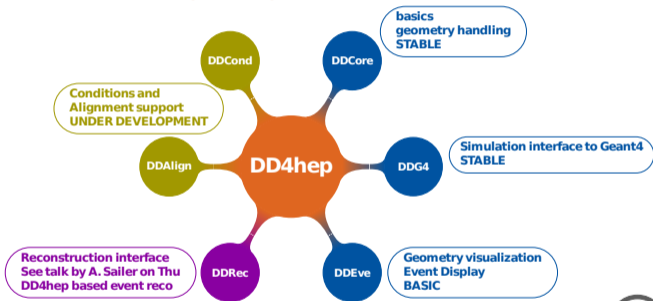
- **NPDet** – Generic (dd4hep) Detector Library
- **EIC Container** – Software Container Build

DD4hep

Detector Description

The result of a study from the *Advanced European Infrastructures for Detectors at Accelerators* ([EU AIDA 2020](#)) initiative.

Structure and packages



- Thoughtfully designed for future (thread-safe)
- Simulation interface with **full access to Geant4 features**
- **Single source of geometry**
- Simple geometry hook
→ **better algorithm development**
- Full geometry definition defined in human readable compact detector description file
- Works well with external tools.

DD4hep solves the "geometry problem" for end-to-end simulation and reconstruction.

Nearly all big HEP experiments, current and future, are [moving to DD4hep](#).

Data Model DD4hep and PODIO

DD4hep Built-in SD types

- calorimeter
- tracker
- *maybe a photon detector in the future...*

Uses built-in data model

dd4hep::Geant4Tracker::Hit

dd4hep::Geant4Calorimeter::Hit

Added PMT hit class for cherenkov detectors:

npdet::PhotoMultiplierHit

External Event Data Model: LCIO2

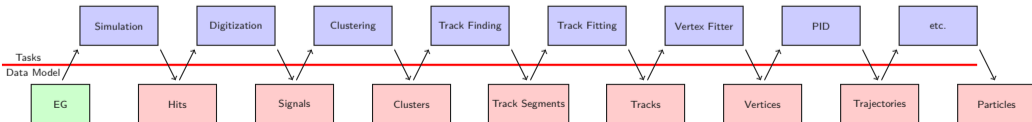
Currently using a modified LCIO data model

PODIO builds LCIO2 classes from YAML file:

```
lcio2::RawCalorimeterHit:
  Description: "LCIO raw calorimeter hit"
  Author: "F. Gaede, B. Hegner"
  Members:
    - int64_t cellID0 // The detector specific (geometrical) cell id.
    - int64_t cellID1 // The second detector specific (geometrical) cell id.
    - int64_t amplitude // The amplitude of the hit in ADC counts.
    - int64_t timeStamp // The time stamp for the hit.

lcio2::CalorimeterHit:
  Description: "LCIO calorimeter hit"
  Author: "F. Gaede, B. Hegner"
  Members:
    - int64_t cellID0 // The detector specific (geometrical) cell id.
    - int64_t cellID1 // The second detector specific (geometrical) cell id.
    - float energy // The energy of the hit in [GeV].
    - float time // The time of the hit in [ns].
    - std::array<float, 3> position // The position of the hit in world coordinates.
    - int type // The type of the hit
  OneToOneRelations:
    - lcio2::RawCalorimeterHit rawHit // The RawCalorimeterHit
```

A good Event Data Model (EDM) defines task boundaries and decouples algorithms/frameworks.



ACTS

A common tracking software.



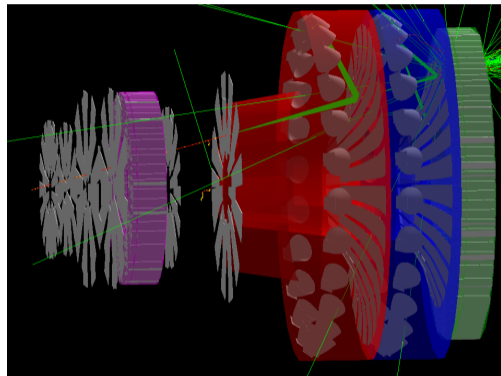
Initial observations:

- Development is very active (recently moved to github)
- Focused on performance, not framework
- Modern C++ (Yay!)
- **DD4hep and Acts should work together nicely!**
- **Acts documentation**, examples, and tests growing by the day.
- Acts rapidly becoming the center of tracking development in the HEP/NP software community

Our strategy relies on integrating Acts with dd4hep through ActsExtension plugin.

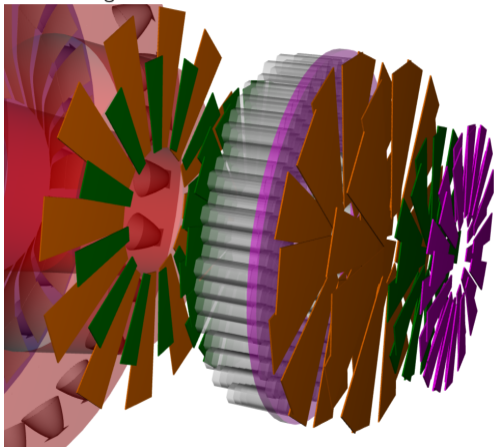
SoLID Simulation

- Full solid detector implemented
- Magnetic field from maps complete
- Light and heavy gas Cherenkov detectors complete.
- Hexagonal Shashlyk EM Calorimeter complete
- GEM Modules (3 different sizes) complete
- GEM strip readouts implemented



GEM Tracker with Acts

SIDIS configuration:



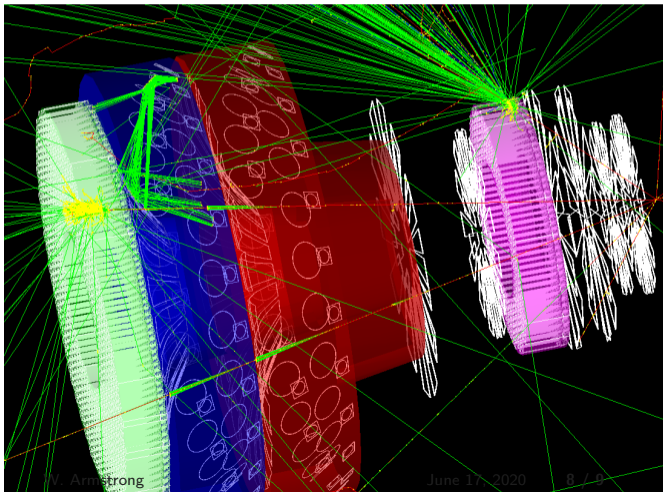
- 6 tracking disks made from overlapping GEM modules.
- Initially just a thin cylinder disk tagged with extension as "barrel"
- `Acts::convertDD4hepDetector()` geometry conversion seemed to work.
- Detailed geometry (as shown) does not work.
- Is this an "endcap" or a "barrel" → not a collider experiment

DD4hep and Acts

- At first glance, `Acts::convertDD4hepDetector()` does not use all the dd4hep information (segmentations, surfaces).
- Acts examples do not include full simulation (DD4hep + geant4), only DD4hep + Fatras. Maybe we can help here.

Summary and Outlook

- Full SoLID (geant4) simulation with DD4hep.
- Integration with Acts is a in progress.
- Looking forward to using/contributing to a more robust DD4hep and Acts interface



Thank You!