News from DD4hep
(& DDG4, DDSim)

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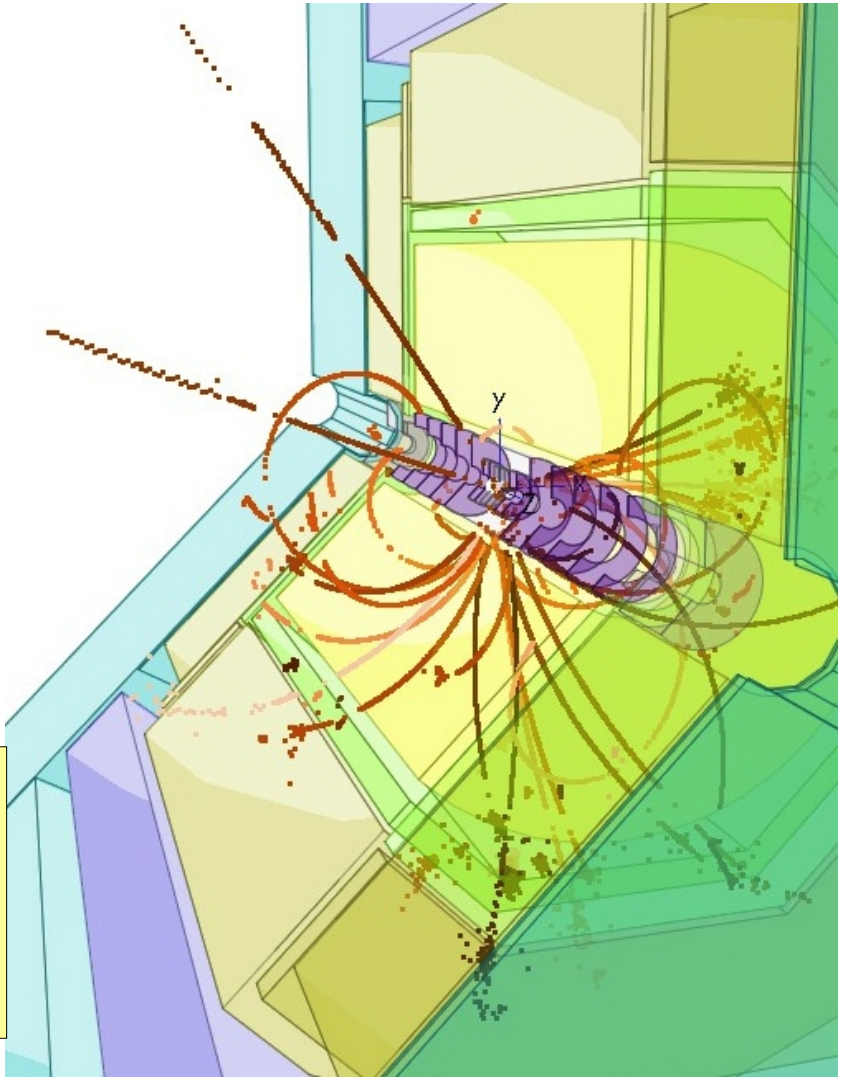
ILD Software and Analysis Meeting

Sep 24, 2014

Outline

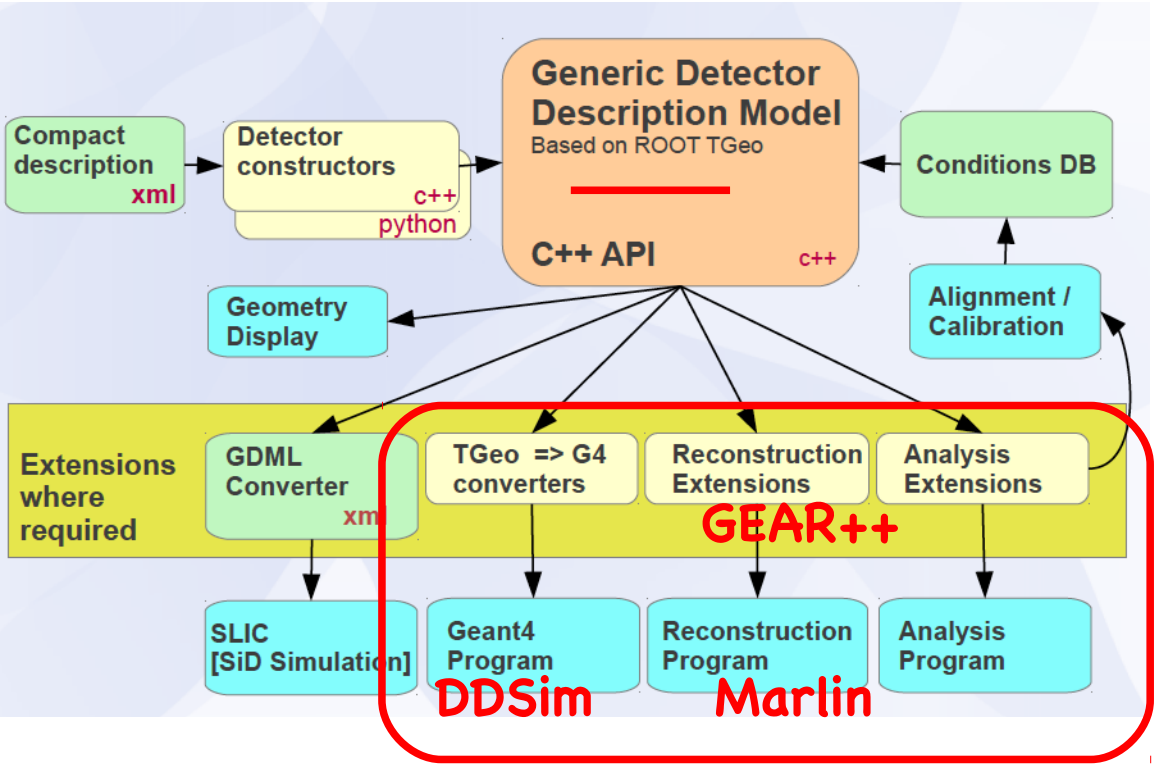
- Introduction:
  - DD4hep, DDG4 and DDRec
- recent developments
- MC truth treatment
- DDSim
  - -> new ILD simulation model
- Summary/Outlook



report on work by:
M.Frank, C.Grefe, A.Sailer, N.Nikiforou, S.Lu, M.Petric, F.G.

DD4hep - overview

- **DD4hep** common detector geometry description
  - developed in AIDA WP2 (CERN, DESY)
- will be used by CLICdp, FCC and ILD
- advantages of DD4hep:
  - better, more consistent description of detector geometry with one unique source
  - possibility to simulate misalignment to study **alignment** strategies for ILD
  - cooperation w/ CLICdp (and SiD)



- **DD4hep** common detector geometry description
  - developed by CERN (+DESY) in AIDA WP2
- interface to geant4 simulation:
  - proposal to use in memory conversion and DDG4 (-> DDSim)

DDG4 - built in Geant4 gateway

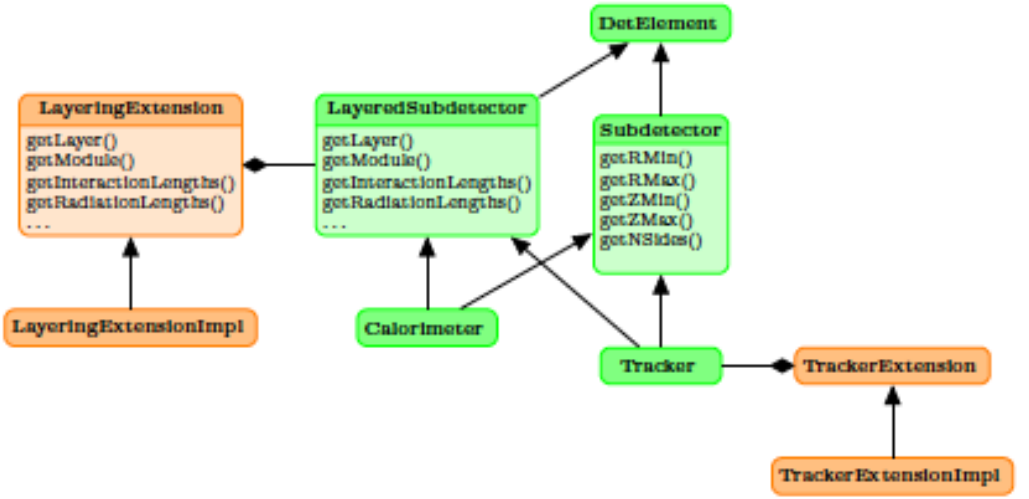
- in memory conversion of TGeo geometry to Geant4 geometry
- modular design using plugin mechanism for
  - sensitive detectors, Geant4 user actions : stepping, tracking,...
  - input (generator files) and output (LCIO,...)
- configure mechanism with xml, python or CINT:
  - physics lists, limits, fields,...
  - define sequences for
    - input, sensitive detectors, user actions, output,...
- faeatures :
  - full flexibility in sensitive detectors
  - can use extension code in simulation and reconstruction
  - supported by CERN for FCC and CLICdp
- => suggested that ILD uses DDG4

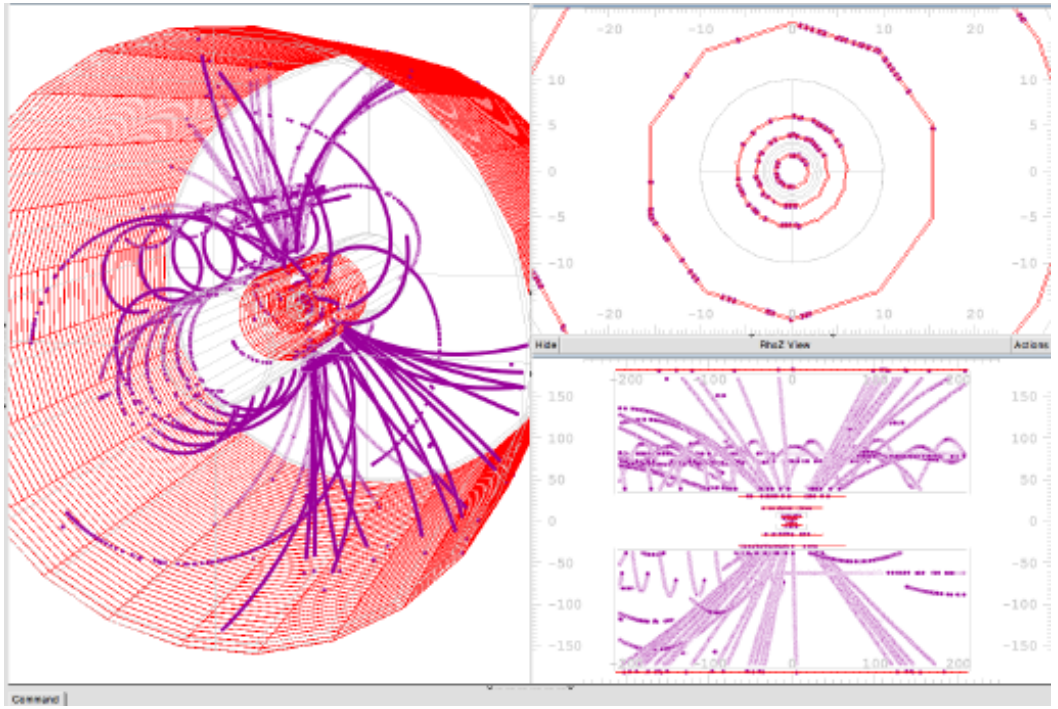
recent developments in DD4hep

- implemented data classes (EDM) for MC truth and sim tracker/calorimeter hits analogue to LCIO classes:
  - MCParticle, SimTrackerHit, SimCalorimeterHit
- provide input and output modules for LCIO (and possibly others, e.g. ROOT I/O)
- this allows DD4hep to:
  - be independent of LCIO for non LC communities
  - implement logic such as MC-Truth link only once, independent of the data model that is used to write the hits
- implemented MC-Truth linking algorithm
- implemented 'canonical' sensitive detectors for trackers and calorimeters that work with LCIO SimTracker/CalorimeterHits and "arbitrary" segmentations

DDRec - interface to reconstruction

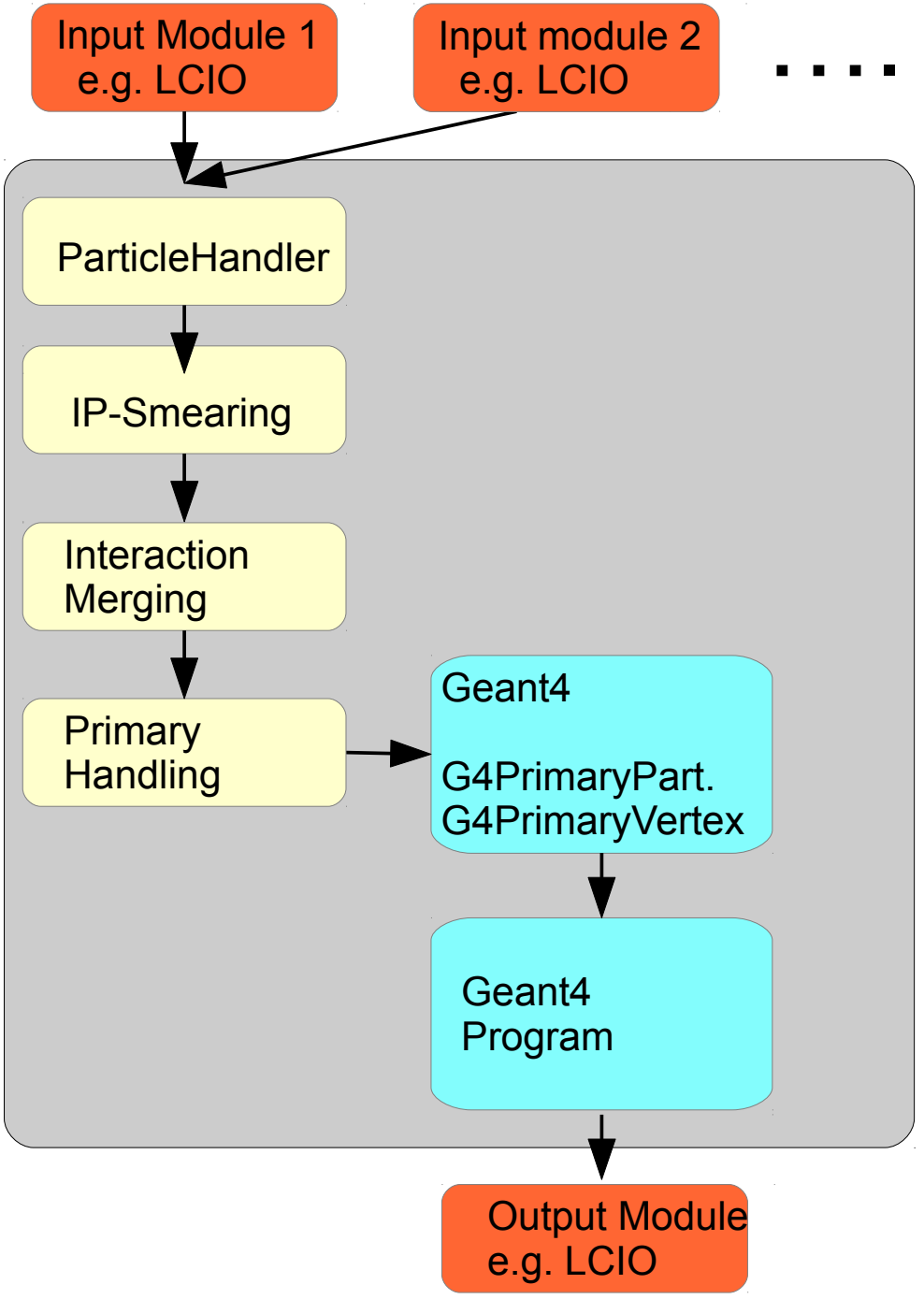
- extension mechanism is used to define interface for reconstruction
- calorimeters and trackers defined as LayeredSubdetectors
  - use to eventually replace GEAR
  - work in progress ...
- for tracking additional Surfaces provide:
  - u,v,normal and origin
  - inner and outer (averaged) material incl. thickness
- -> planes and cylinders allow for simple navigation in detector geometry for the tracking





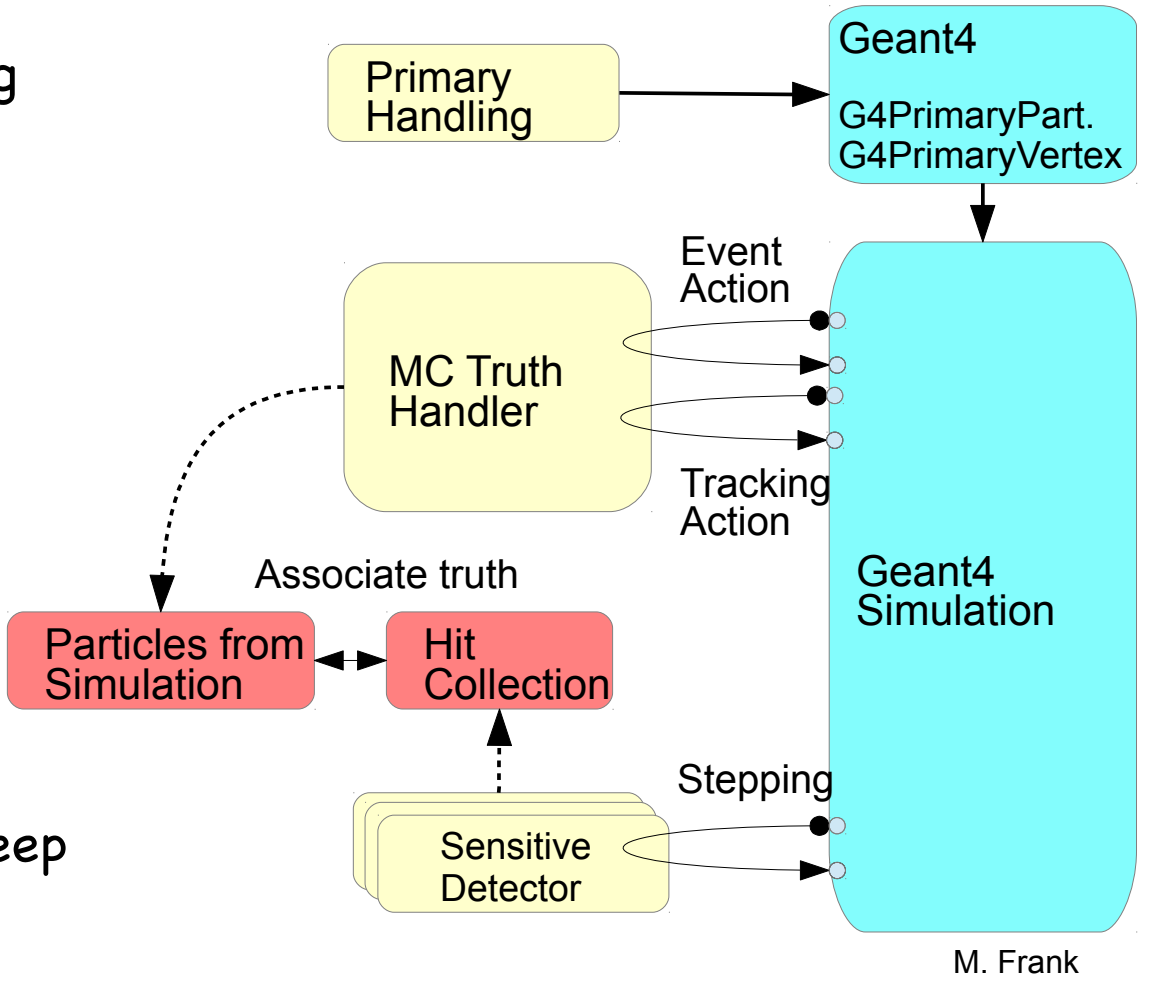
DD4hep input/output modules

- new modules for treatment of MC truth particles
  - IP-Smearing
  - merging (overlay)
  - MC-truth linking
- logic can be reused for any type of (compatible) input format:
  - stdhep
  - HepEvt
  - HepMC
  - ...



MC-Truth handling

- keep track of particles depositing energy in stepping action
- add new particles as new particles are created by geant4:
  - delta electrons
  - EM & nuclear interactions
  - decays
- decide at end of tracking actions which particles to keep and persist in output file (MCParticle collection)
- assign hits to the particles that are kept



MC-truth link logic

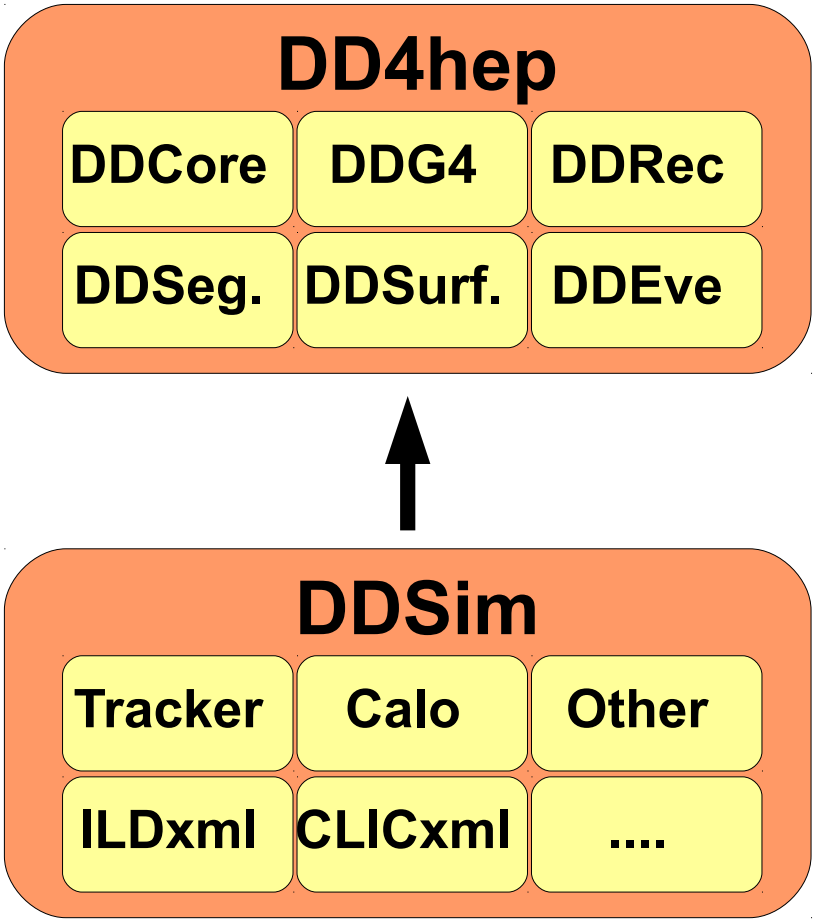
- new particles, created in simulation are added to the MCParticle list if:
  - they are created (decay, interaction,...) inside the tracking volume
  - and their energy E > E_cut
    - e.g. low energy delta electron are not created, but Bremsstrahlung photons are
    - decays in flight (K0_s) are always created
- shower particles are not created, hits are assigned to parent particle (the one entering the calorimeter)

  exceptions:
  - particles scattered back into the tracking volume
  - default shower mode is activated for dedicated studies
- algorithm very similar to the one implemented in Mokka

DDSim simulation package

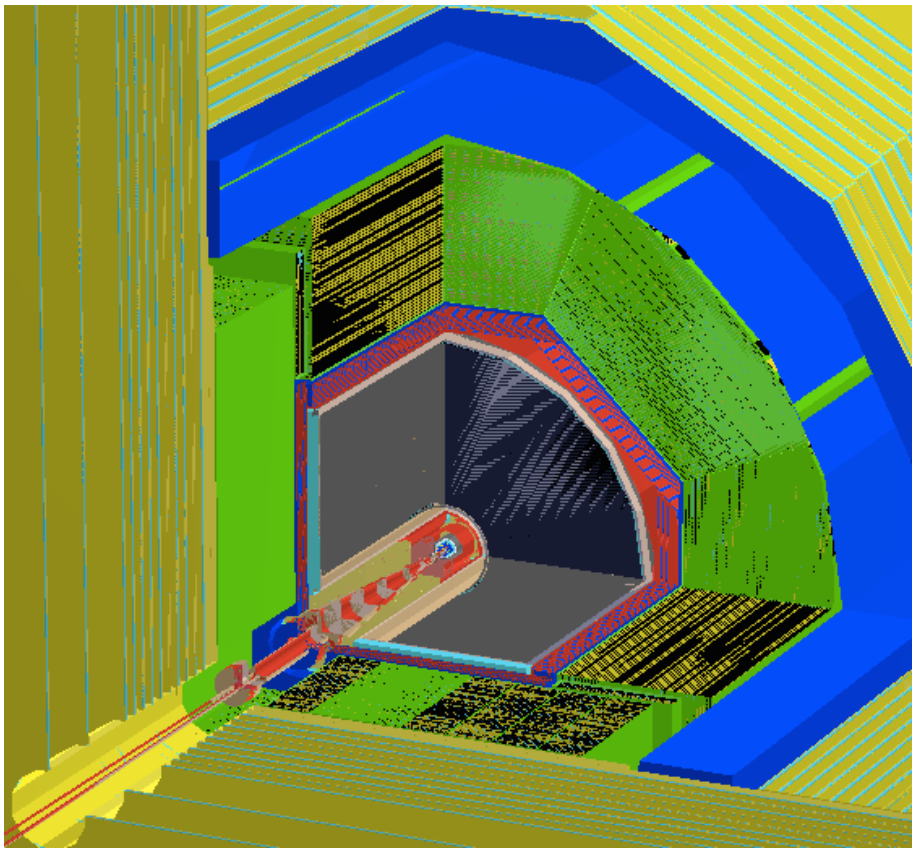
- created package DDSim as a common LC simulation package for ILD and CLIC (and SiD)
- eventually want to preserve all current Mokka models - started with ILD_o1_v05:
  - extract DB params to xml and
  - line-by-line port of geometry drivers
- will soon add CLIC models from DD4hep/examples
- for details and code:

https://svnsrv.desy.de/viewvc/ddsim/DDSim/



ILD_o1_v05 in DDSim

- complete Mokka model ILD_o1_v05 ported:
- VXD, FTD, SIT, TPC, SET, beam pipe (F.G)
- Ecal, Hcal, Yoke (Sh.Lu)
- Beamcal (A.Sailer), Lcal, LHcal (M.Petric)
- so far only few sensitive detectors



- To Do:
- reconstruction interface
  - GEAR or GEAR++
- check sensitive detectors
- test and validate everything

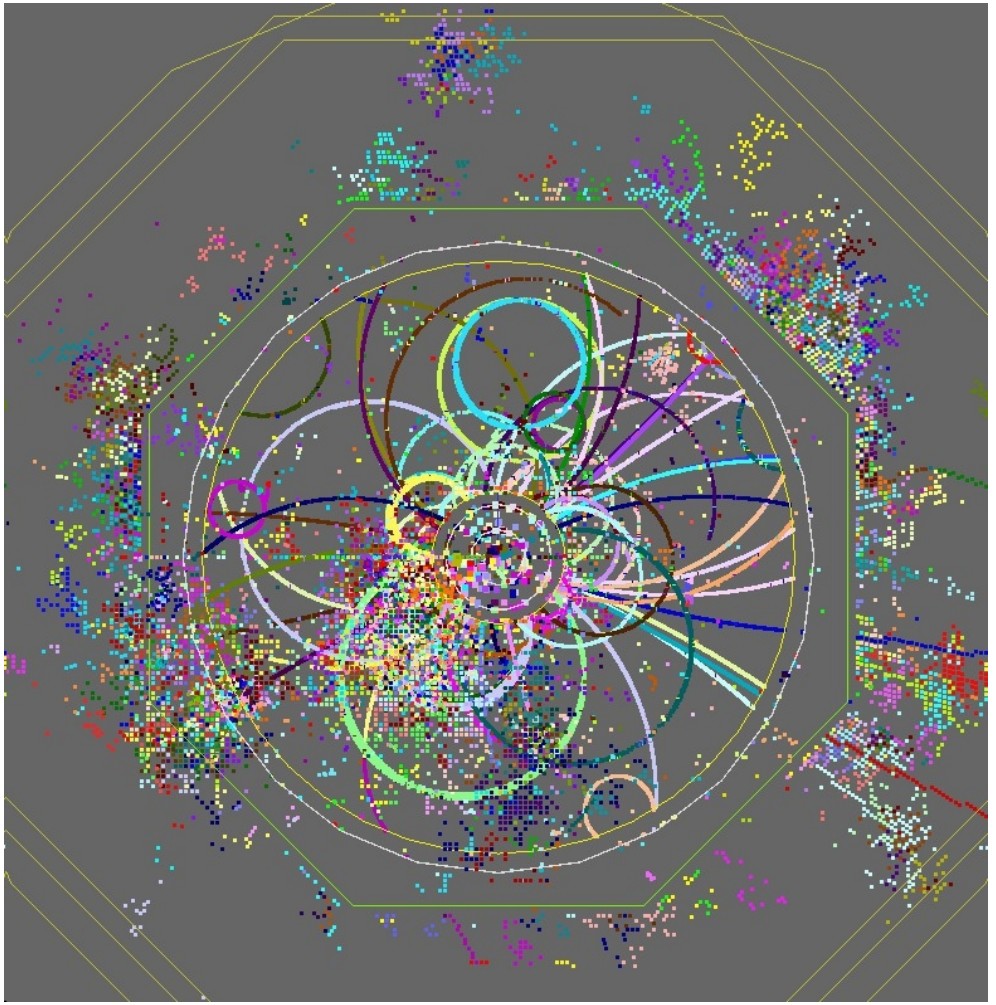
- need dedicated experts for every sub-detector from R&D groups (as for LOI/DBD)

- => can start this very soon !

putting it all together

- we have now for the first time the complete basic functionality implemented in DD4hep
- and have a first complete version of ILD_o1_v05 in DDSim

- can start Testing and Debugging now
- immediately observe issue w/ MC-truth link:
  - possible relation w/ similar problem observed in Mokka for geant4 9.6 ?
  - to be fixed (hopefully) very soon



bbudsc event from stdhep file fully simulated in DDSim/DD4hep with new ILD_o1_v05

Summary & Outlook

- DD4hep has made quite some progress:
  - complete MC-truth treatment
  - binding to LCIO SimHits and MCParticles
  - first sensitive detectors using DDSegmentation for Trackers and Calorimeters
- DDSim - new simulation package
  - has first complete simulation model ILD_o1_v05 ported from Mokka
- started to Test and Debug new functionality
- should be able to start serious validation of new model by ILD soon
  - -> need to identify sub-detector experts