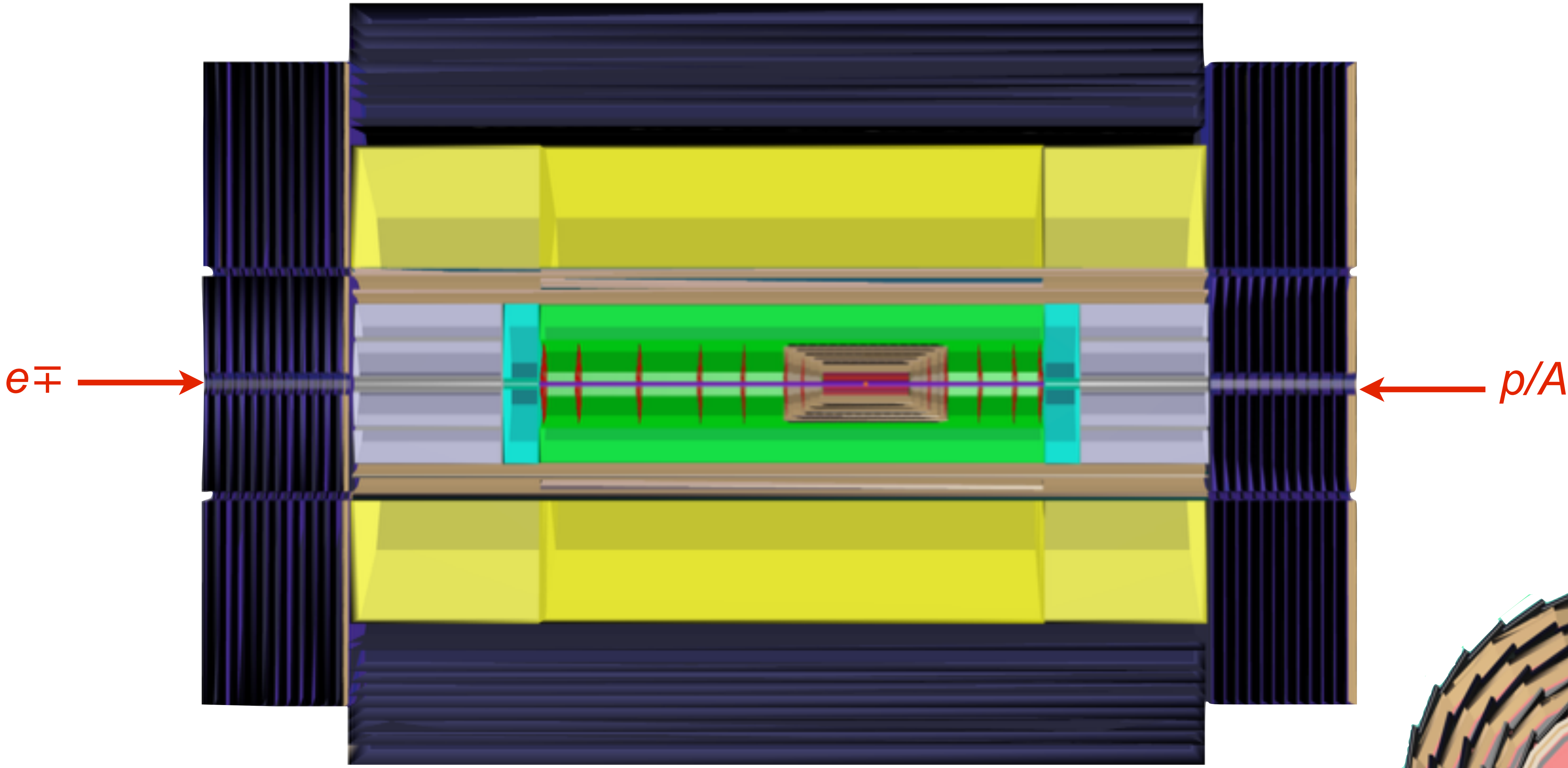
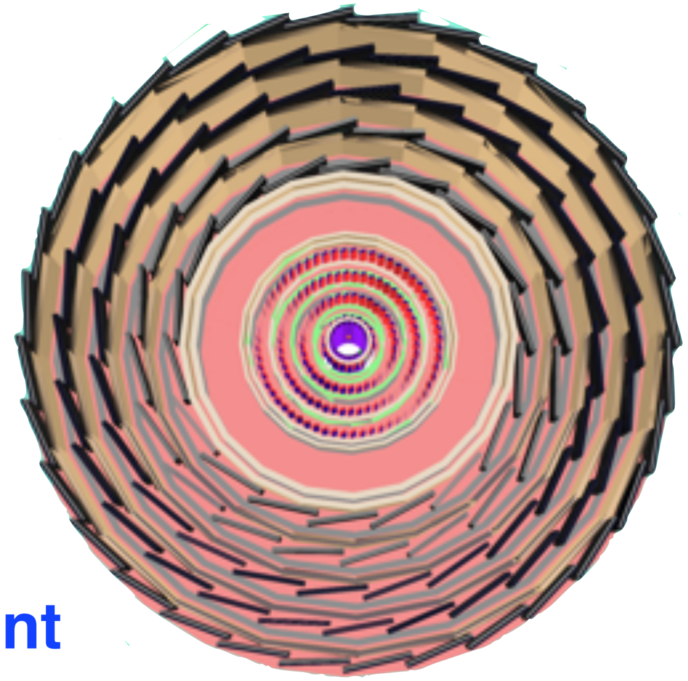
Detector-Software-Development

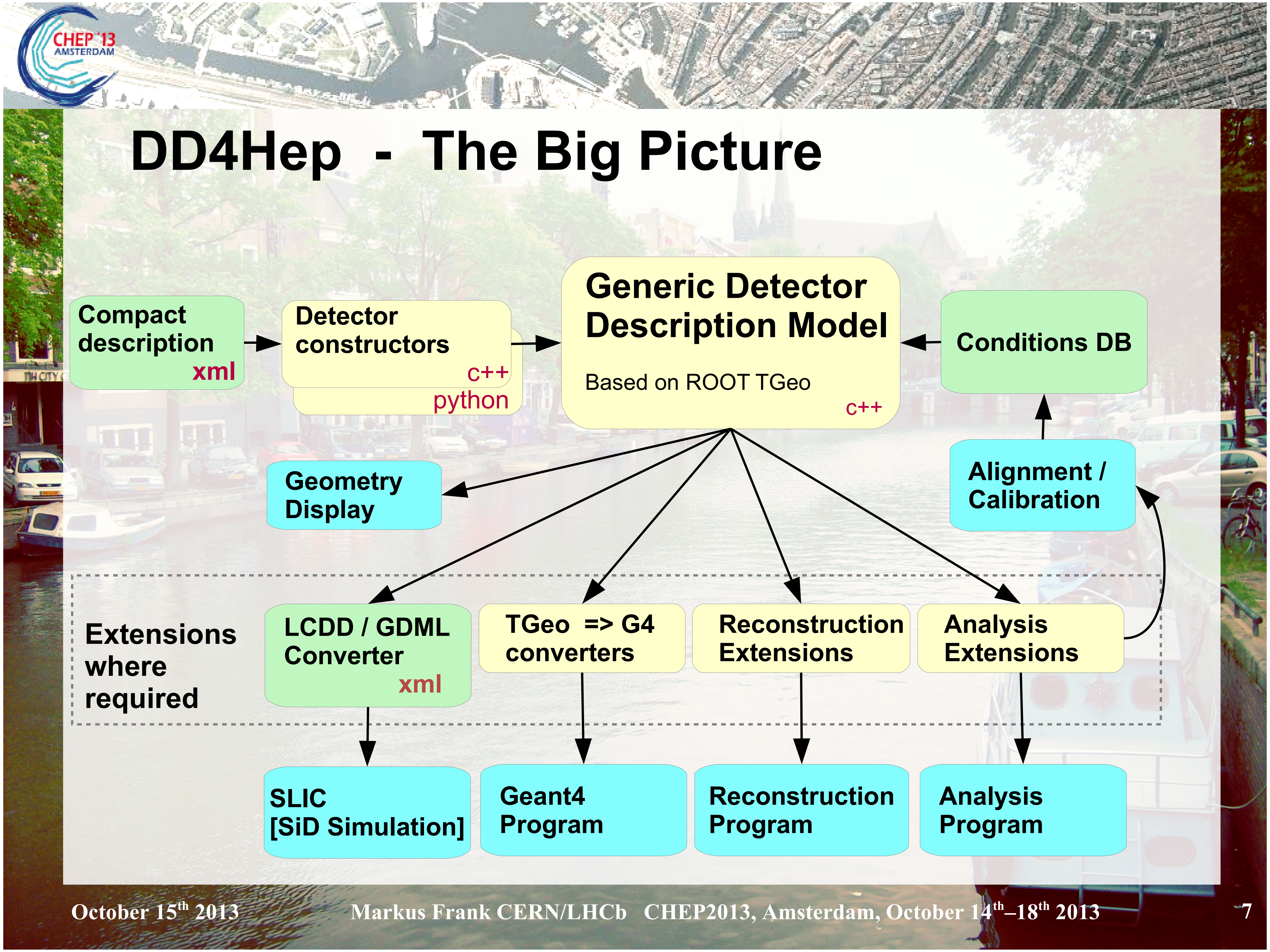




Detector Design / Simulation / Reconstruction Environment

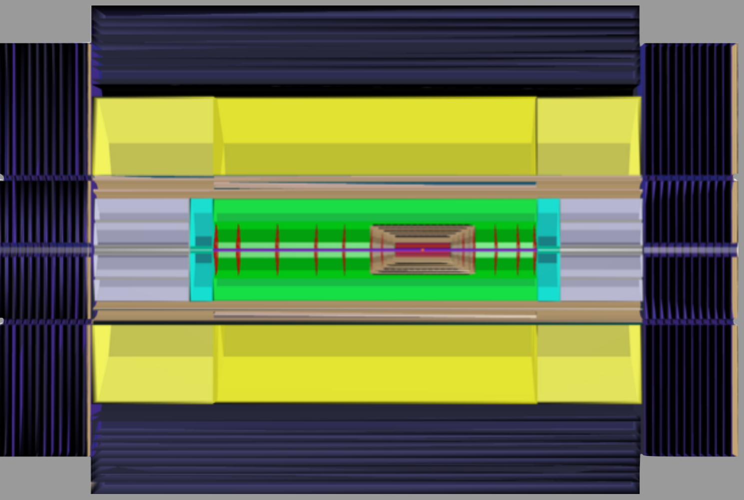
Detector Design/Sim/Rec - AIDA / DD4Hep

Reminder



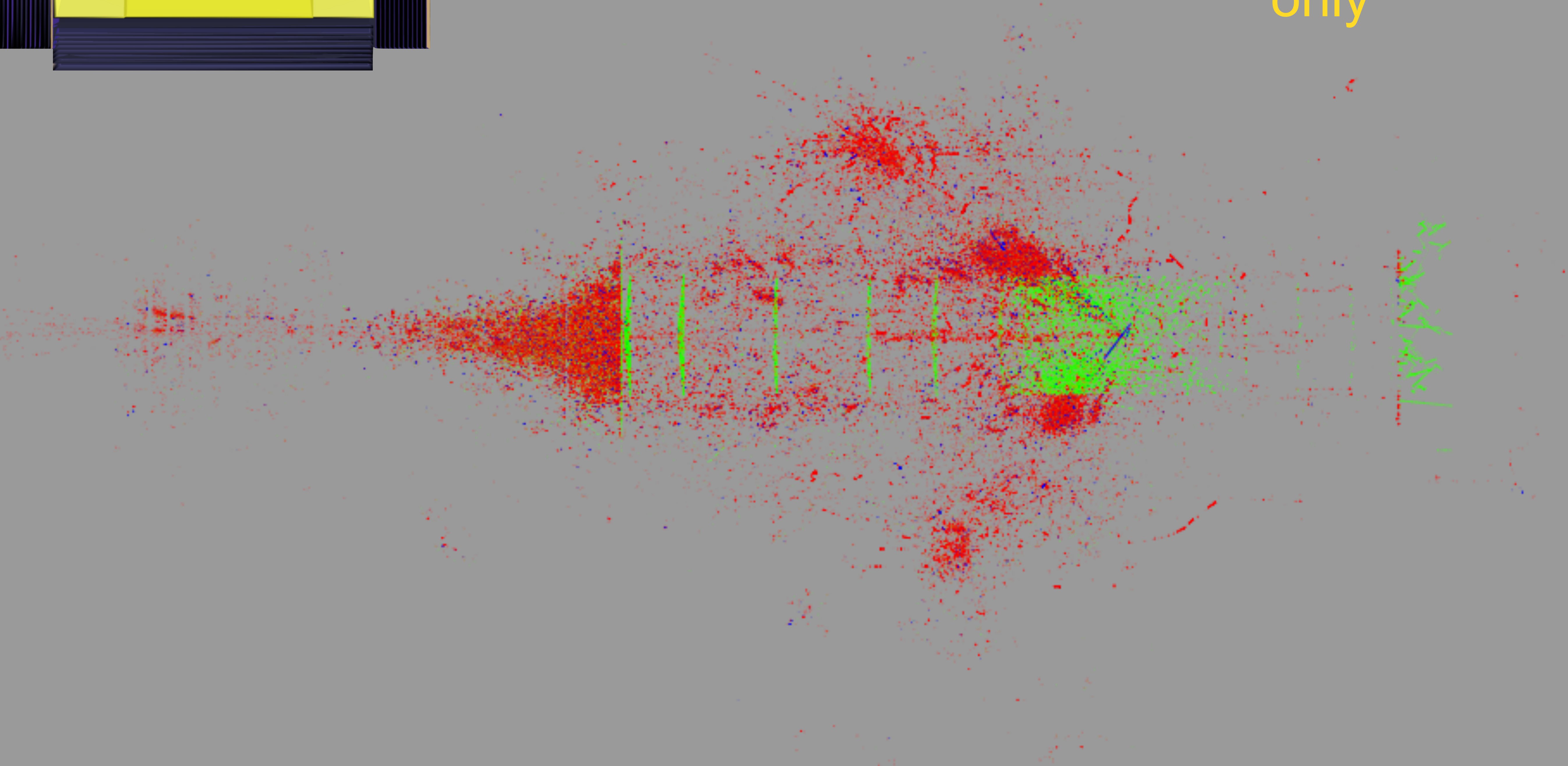
ROOT file I/O
as other ROOT
services "build-in"

(Pythia → DD4hep) → GEANT4

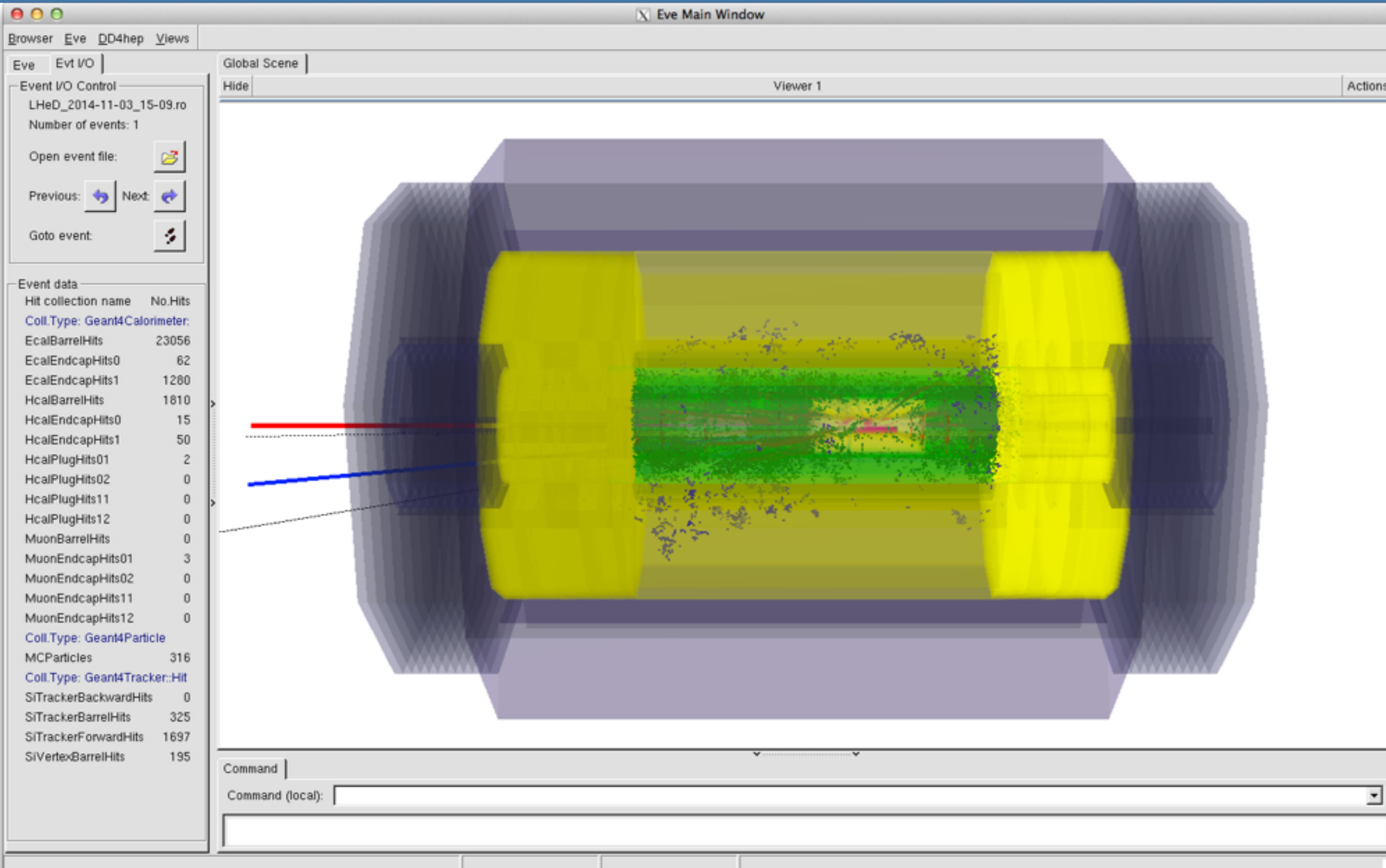


Higgs → bb

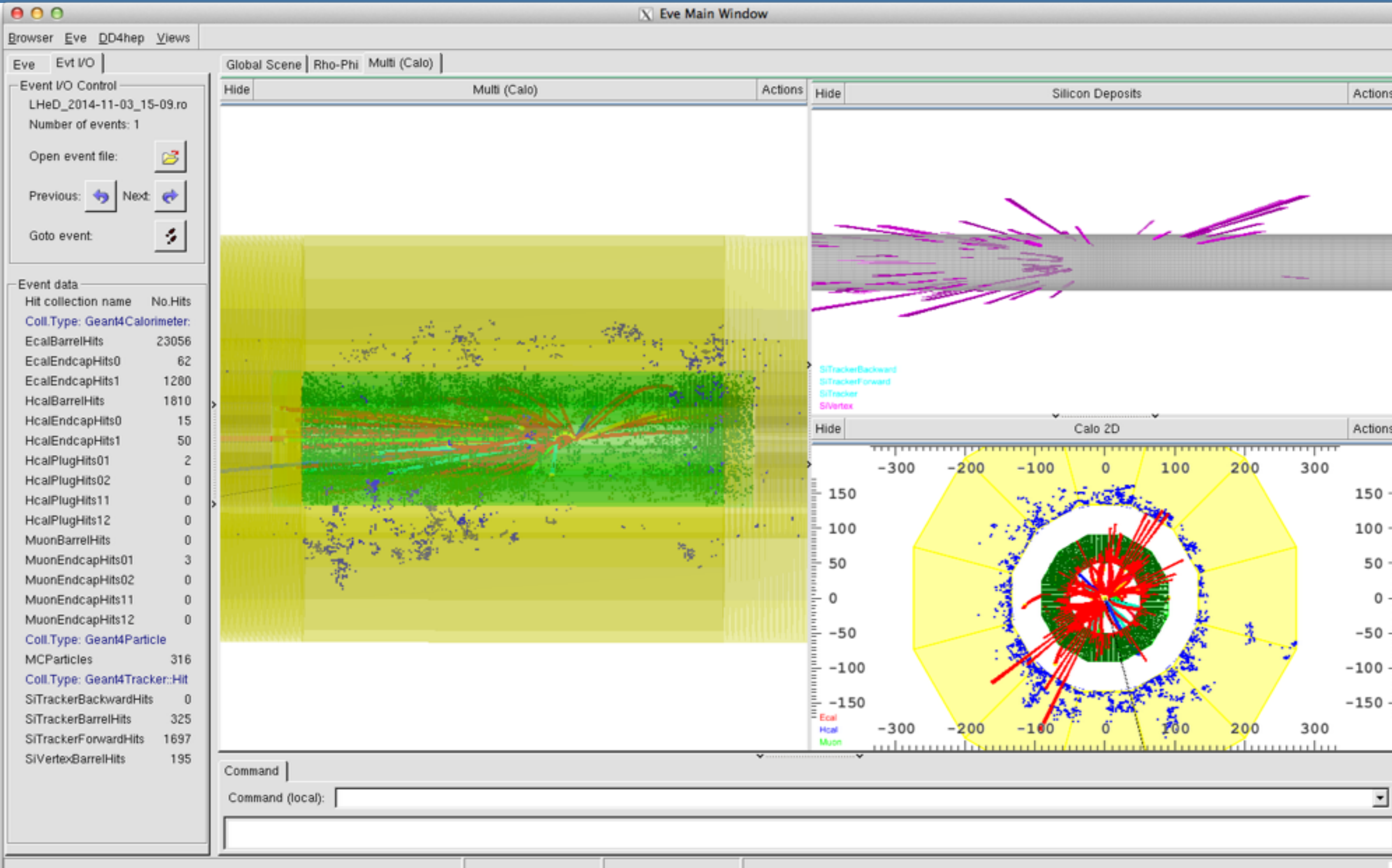
detector response only



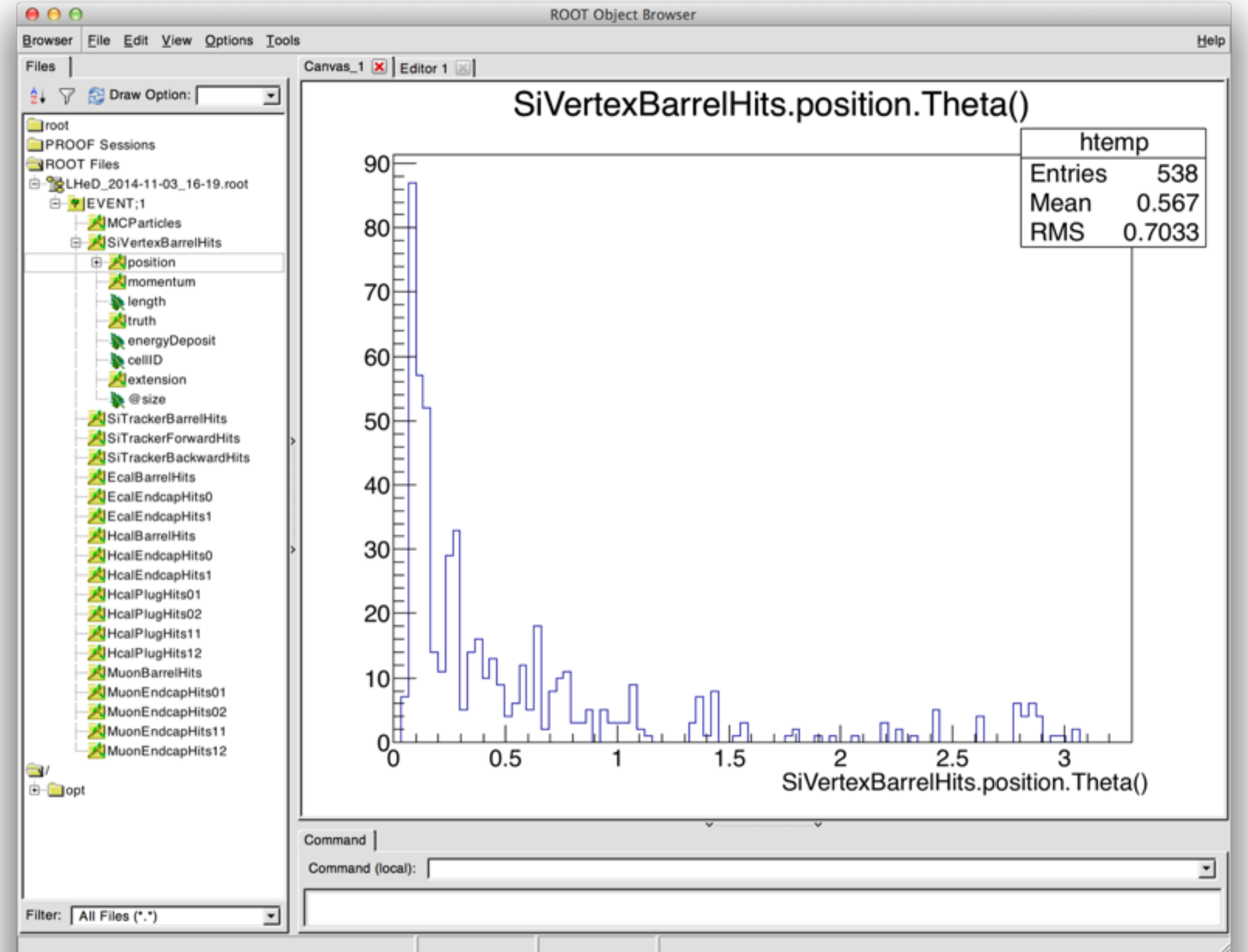
Pythia → Higgs-bb$_{(uta.klein)}$ → DDG4 → DDEve   1



Pythia → Higgs-bb$_{(uta.klein)}$ → DDG4 → DDEve 2



Pythia → Higgs-bb$_{(uta.klein)}$ → DDG4 → DDEve 3



DD4hep/DDG4 Developer Base

DD4hep/DDG4 - driven by ILC based developers

- many thanks for guidance & support from
M.Frank, F.Gaede, C.Graefe

- roots illustrated by LCIO event data model; interface to GEAR
  detector description input for standard ILC software modules (interfacing Merlin, replacing Mokka (temporarily))
- LCIO - standard event data model connecting all modules in DD4hep/DDG4, … (see slide 2)
- generator output into the framework - stdhep- and hepmc-file formats
  slides before based on Pythia stdhep-file directly processed
- Python, XML, CINT (obsolete with ROOT6) (besides C/C++/Java int./ext.)
  - all 3 approaches for LHeC-Detector functioning:
    geometry (not optimised), material (by far not all), R/O description
    ongoing: segmentations and surfaces
    - ingredients for reconstruction (framework to be decided)
  - DDEve - event display tool for quality judgment and control

FCC Software Effort

Based at CERN, driven by hh-community (ATLAS)

recent documents: https://twiki.cern.ch/twiki/bin/viewauth/FCC/FccSoftware
http://indico.cern.ch/event/337673/session/5/contribution/22

Let me quote (B.Hegner):

- Adapt existing solutions from LHC: – Gaudi as underlying framework
  - ROOT for I/O
  - Geant4 for simulation
  - Python for user analysis (heppy)
- Adapt software developments from ILC/CLIC
  - DD4hep for detector description
- Invest in better fast vs. full sim integration
  - Geant4 fastsim, Atlfast
- Invest in proper data model
  - The LHC experiments' ones are over-engineered ← common effort
  - The ILC/CLIC implementation isn't state of the art

  Both are significantly under-performant on modern CPU's

Weekly SW meetings with significant attendance: https://indico.cern.ch/category/5666/

FCC-hh Software Effort - Resources

- Framework
  - Core event data model, Gaudi integration, Software stack — Bernet, Hegner
- Generators
  - Integration — **People needed**
- Simulation infrastructure
  - Geant-4 (fast & full) — Carminati, Dell'aqua, Hrdinka, Salzburger, Williams, Zaborowska (Convener: Ribon)
  - Delphes integration — Hegner, **People needed**
- Reconstruction — **People needed**
- Analysis tools
  - python & C++ framework — Bernet
- Validation
  - testing and performance — Lukas Marti
- Computing
  - sample production and management — **People needed**

see: http://indico.cern.ch/event/337673/session/5/contribution/22, FCC-ee workshop, Paris 27-29 October 2014

FCC-eh Software Effort - Resources

One postdoc, Ercan Pilicer, from Bursa University (Turkey) joined in October 2014

Demanding extensions needed?

- besides ROOT and GEANT4 - has **FLUKA** to be incorporated into the DD4hep environment?
  - Generators - PYTHIA8, HERWIG, SHERPA- do not consider standard ep and even less eA processes currently
    FLUKA is handling nuclear evaporation/fragmentation
  - For eA we need a handle on radiative corrections, bigger than in ep
  - see Néstor Armesto: ***eA at the LHeC: detector requirements and simulations***: http://indico.cern.ch/getFile.py/access?contribId=8&sessionId=1&resId=0&materialId=slides&confId=281921
  - dedicated man power!

Pragmatic Approach for LHeC Software

Use of software tools as available

Follow the main developments
come to a usable framework answering physics questions

Hardware optimisation according to latest R&D (HL-LHC),
new ideas if necessary

Next Steps

Solenoid/Dipole superposition - prepared by M.Frank (yesterday)

Implementation of SR ready beam-pipe (circular-elliptical)

Vertex-Pixel detector

Surface definitions, proper Segmentation, Rec-Interface

Join the Effort

- Beam pipe adoption (see also: H.Burkardt - http://indico.cern.ch/event/337673/session/2/contribution/5)
  - Synchrotron radiation - HL-LHC optics under development still (→ common software effort with BE-ABP group → incorporation of beam dynamics/interaction region/detector response)
  - Vertex/Pixel detector geometry
- EM calorimetry optimisation
  - granularity - installation requirements - modularity!
  - very backward EM calorimetry, rates and geometry
- HAD calorimetry optimisation
  - longitudinal shower containment
  - effect of solenoid/dipole on hadronic scale
  - which granularity needed?
  - installation requirements - modularity - again: not compromising the functionality!
- Tracker - together with calorimetry: particle ID, energy flow ...
- Trigger
  - overall trigger geometry (trigger-less, round-robin L1, ...), how many levels?
  - do we need dedicated trigger detectors (up-stream background reduction)
  - heavy-flavour triggers, how, on which level?
  - trigger strategies and rates (inclusive electron+E_{miss} on L1, rest on higher levels?)

and many more …..

BACKUP

DD4Hep - Main Requirements

- full detector description
- includes geometry, materials, visualization, readout, alignment, calibration, etc.
- full experiment life cycle
- supporting all phases of the life cycle: detector concept development, detector optimization, construction, operation
- easy transition from one phase to the next
- consistent description
- single source of detector information for simulation, reconstruction, analysis
- ease of use
- only a few places to enter information - minimal dependencies