DETECTOR SUBSYSTEM COLLABORATIONS

- DSC representatives
- Technical Integration Council Meeting
- May 08, 2023

dRICH

Status of the implementation of geometry/detector services/digitizer

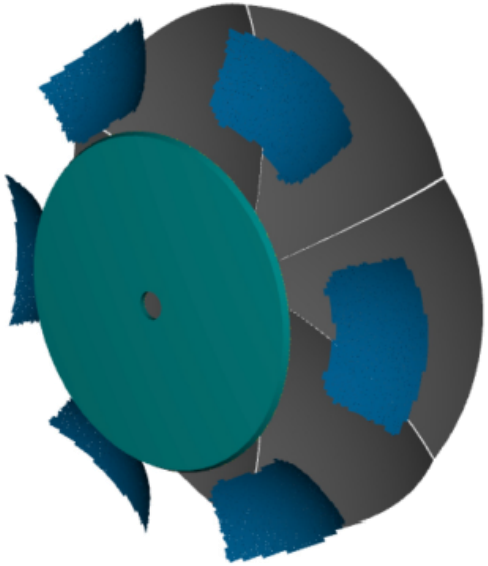
Geometry: in good shape

Working on more optimization, realistic sensor positioning including service volumes, and an enhancement of the optics with a dual mirror configuration

Detector Services: to be done as part of geometry

Digitizer: in good shape

Noise model implementation under review, unlikely to be activated for this campaign. Need Time-Over-Threshold implementation & expert help to set parameters such as time window.



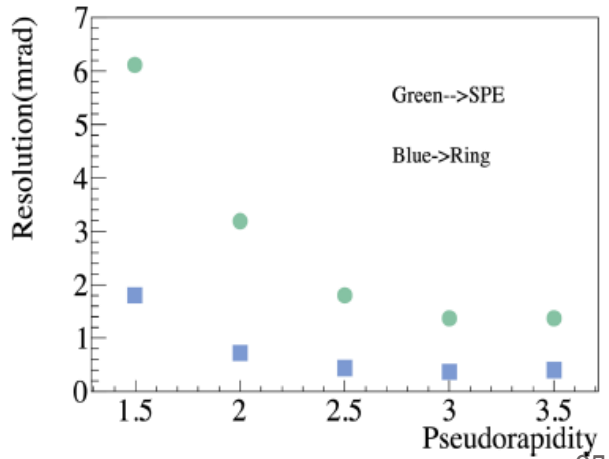
Are there open performance issues ?

Indirect Ray Tracing: needs more tuning and porting into EPIC

Likely will not be enabled for this campaign.

dRICH performance: working version available

Detector performance is reasonable, but could be improved with further tuning of sensor, mirror and radiator geometry and optical description.



dRICH

Are there any issues to be addressed ?

Not any showstoppers

See our Github project page for issue and pull request tracking:
https://github.com/orgs/eic/projects/4/views/5

Who will be responsible for the tasks?

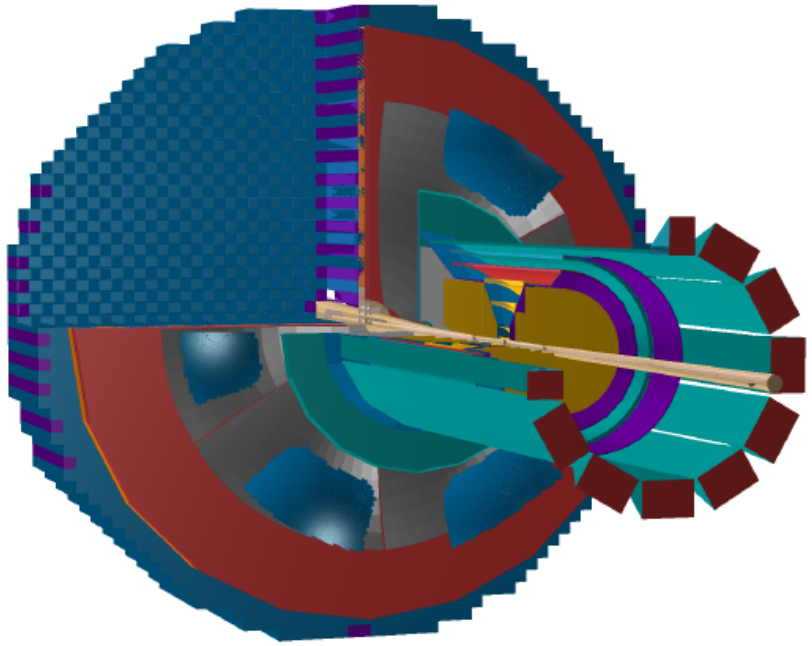
Chandradoy Chatterjee (INFN) and Christopher Dilks (DUKE) are leading the effort

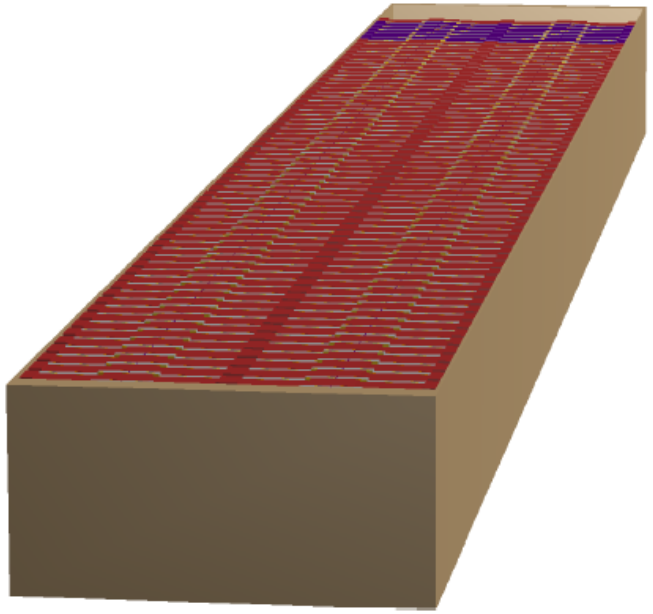
Real material/acceptance vs average material/acceptance

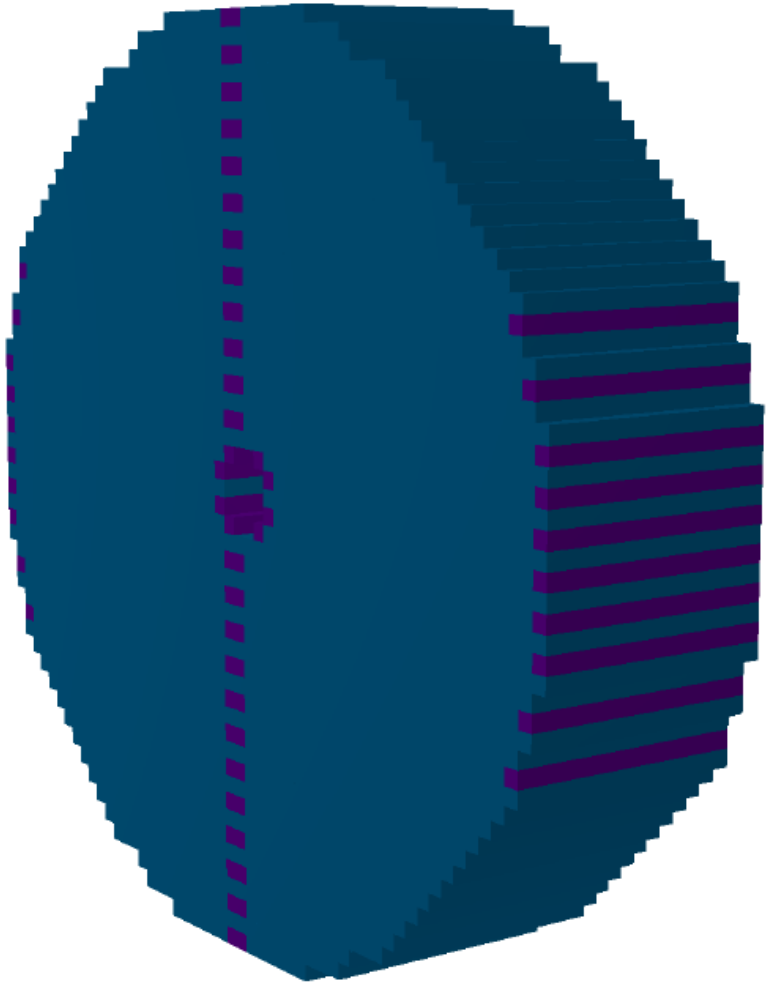
Decent description of radiators (aerogel, gas)
Improvement needs for mirrors and sensors
To be done: mechanic structures & services

General remark: there is a potential bottleneck in the importing procedure from the DS private branches (more advanced) and the main EPIC repository
expert manpower needed to timely review and validate the changes

LFHCal: Geometry Implementation for EPIC



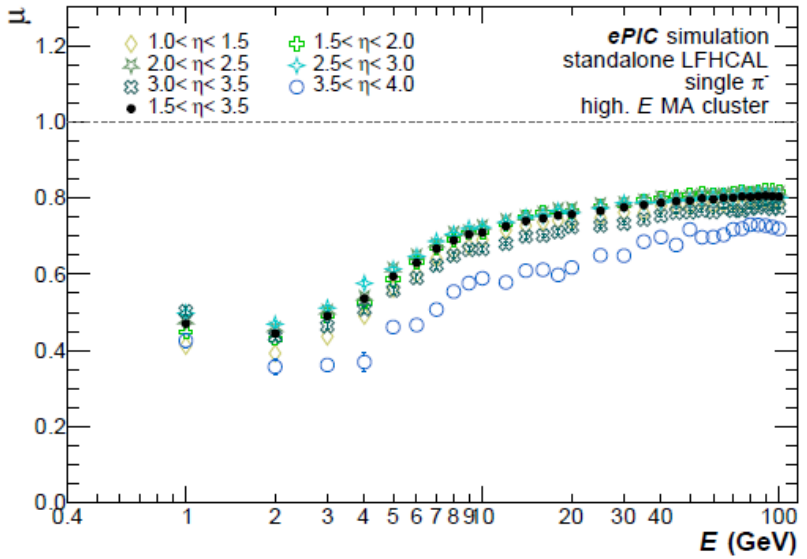


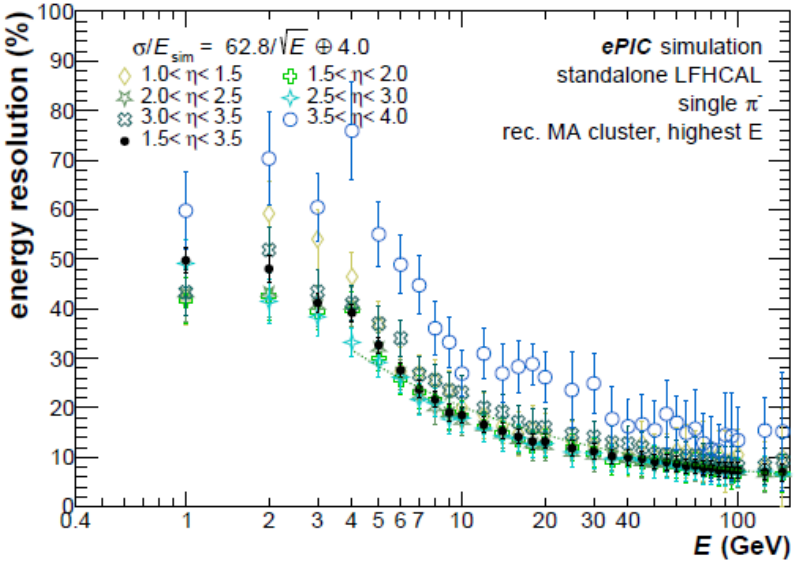


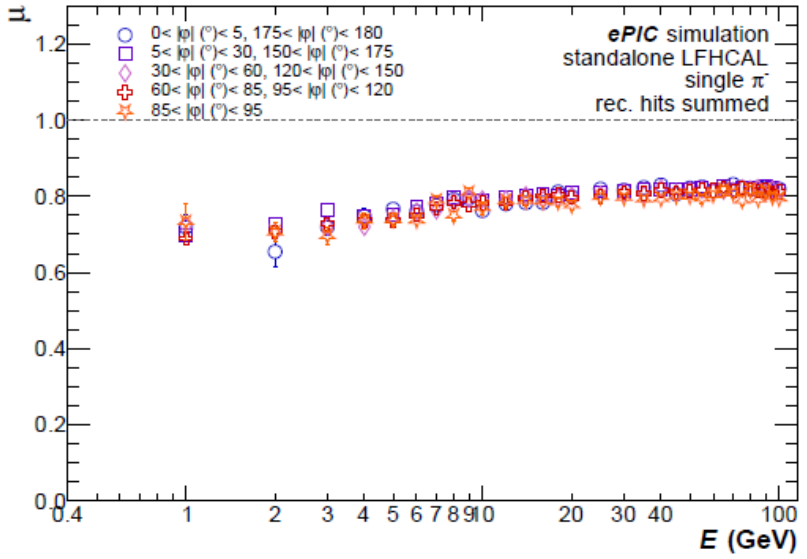
- Changes merged in PR-406
- Readout now correctly structured in x, y, and 65 z layers (7 readout)
- Reasonable digitization, including timing cut of 100ns
- Sampling fraction correctly adjusted for W & Fe segments
- Two options: with or without insert

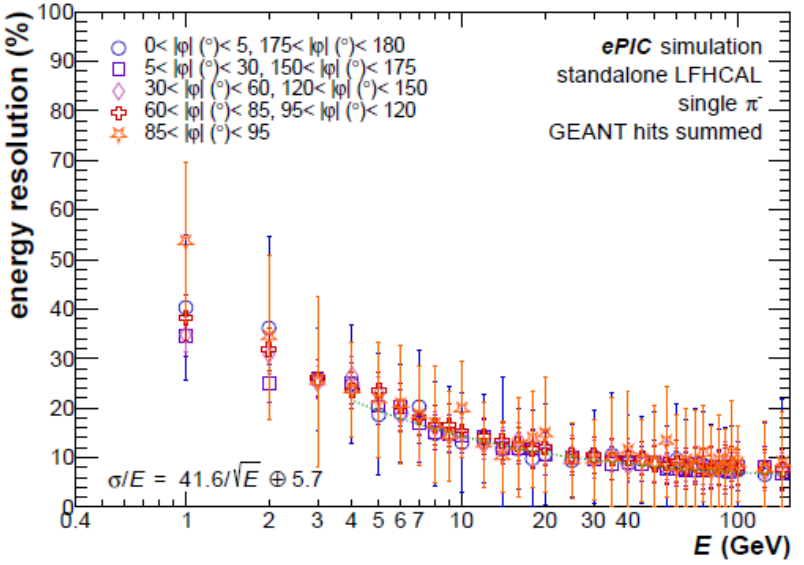
LFHCal: Performance single particle

- Clustering implemented and first calibration seems reasonable for single pions/ electrons
- Full performance with other detectors up-front to be studies
- Cluster associations still under investigation & test
- In general ready for simulation campaign



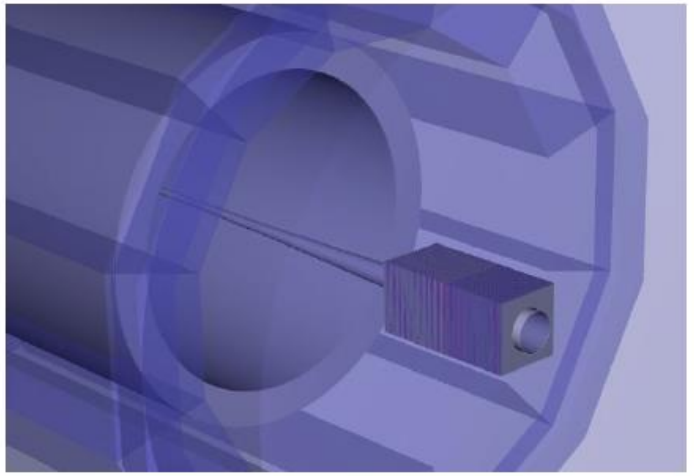






Status of Calorimeter Insert in ePIC simulation

Bryce Canyon

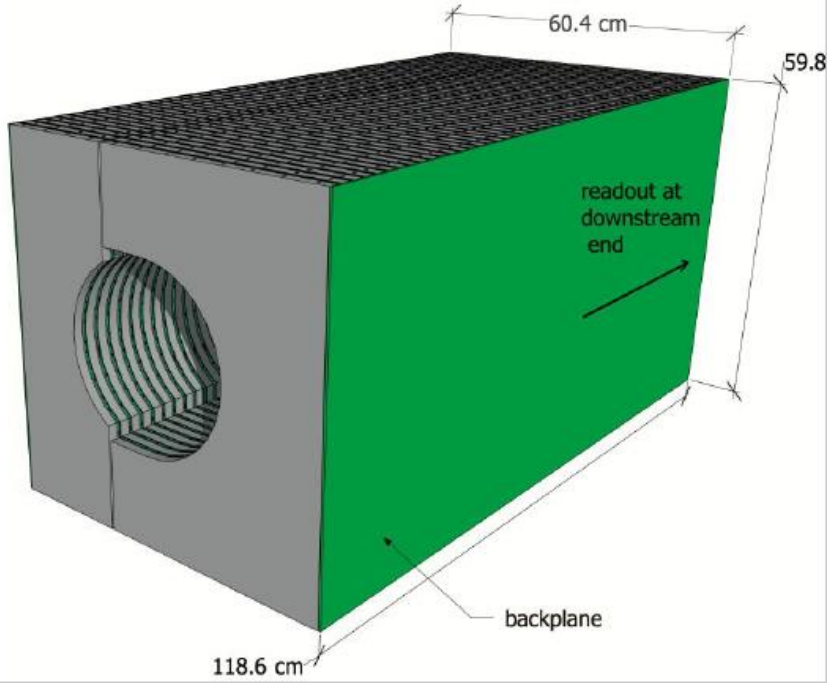


Status of the implementation of

Geometry: Absorber layers, which varies layer by layer to keep 40 mm distance to beampipe, is implemented in EPIC and is ~final (optimal, maximum acceptance possible).
Scintillator geometry matches absorber layer by layer.

Services: Minimal, just PCB running parallel to the electron beam for readout at the rear end of endcap and small connectors.
Currently not implemented in DD4HEP.

Digitizer: Parameters already tuned to needed dynamic range (0.1-200 MIPs) with 12 ADC bits (HGROC).
Already on EICrecon

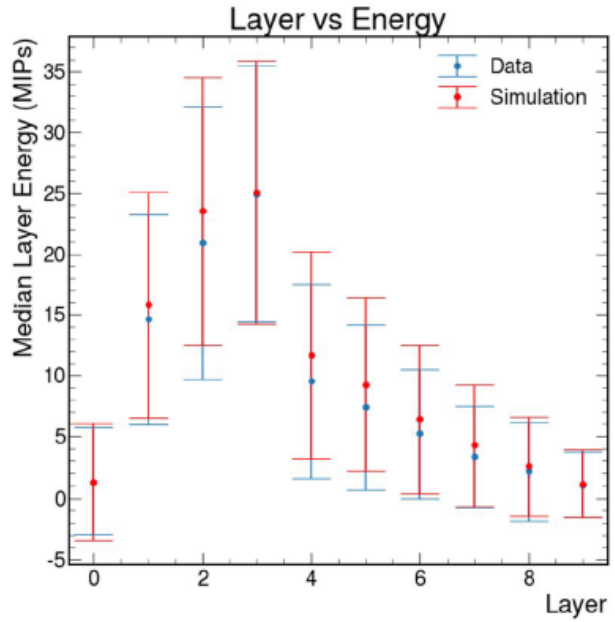


Status of Calorimeter Insert in ePIC simulation, part II

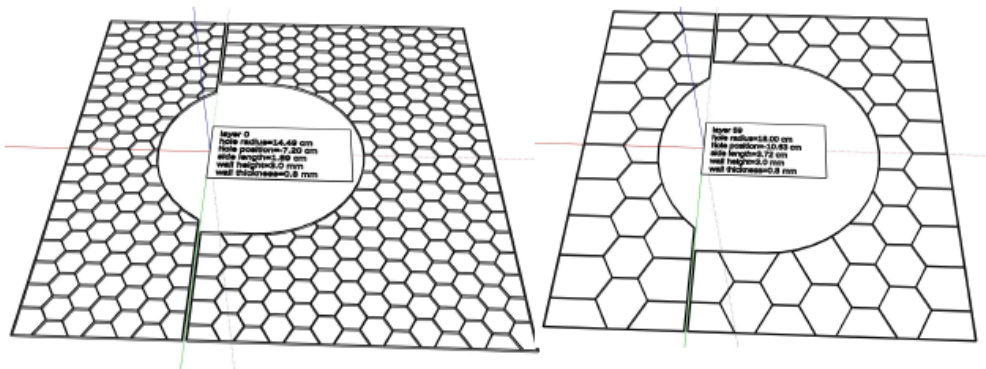
- are there open performance issues?
DD4Hep simulation of insert has been validated by cross checking framework and assumptions against CALICE Fe/Sc and W/Sc test-beam data, as well as our own test-beam data (see below). Open issues: integration with greater HCAL endcap (in progress)

- are there any issues to be addressed? who will be responsible for the tasks?
Yes, we are working on implementing the detail of scintillator layers (see below). It requires some development on tessellations in DD4HEP. UCR group is working on it.

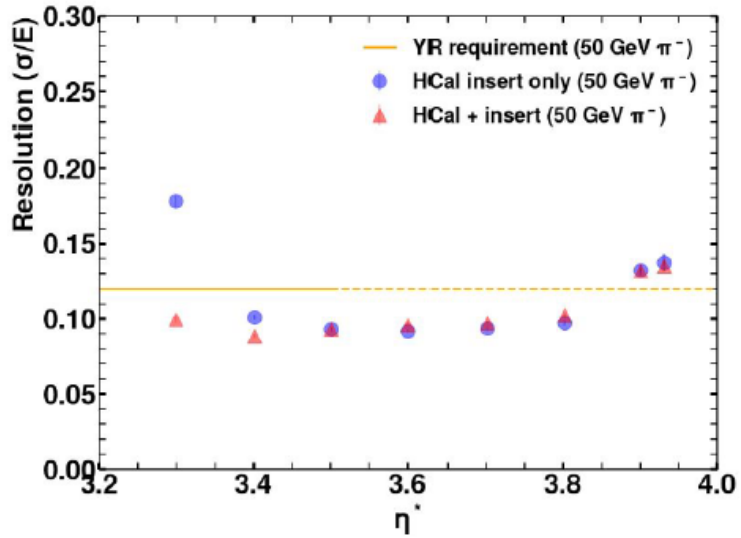
- real material/acceptance vs average material/acceptance
Acceptance reaches YR requirement of η=4.0 (see below). All relevant material already in DD4Hep.



DD4Hep vs insert first test-beam data (JLab). Error bar represents RMS of energy distribution per layer



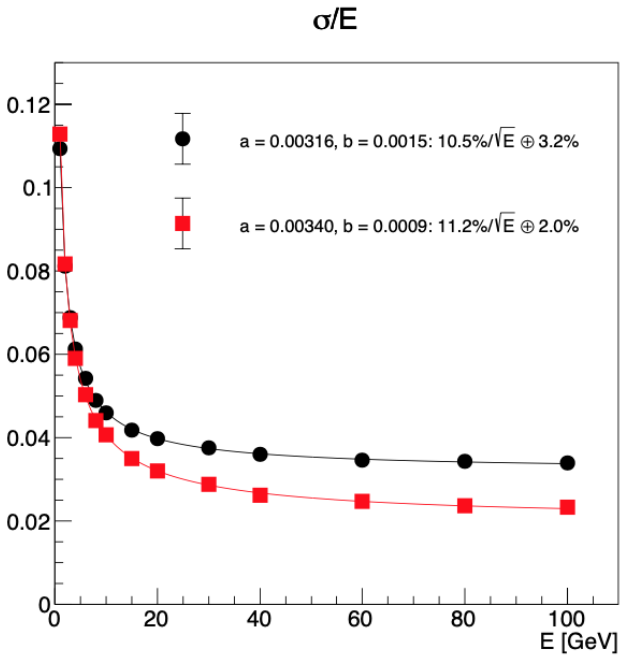
Scintillator layout in high-granularity and coarse granularity layers (in SketchUp), remain to be incorporated into DD4Hep

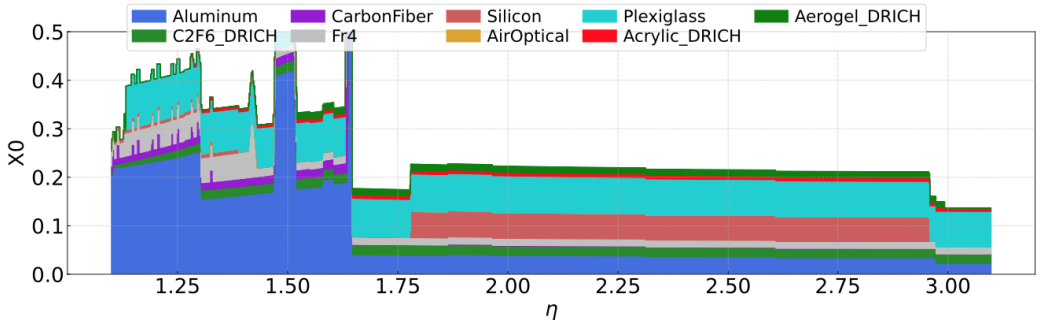


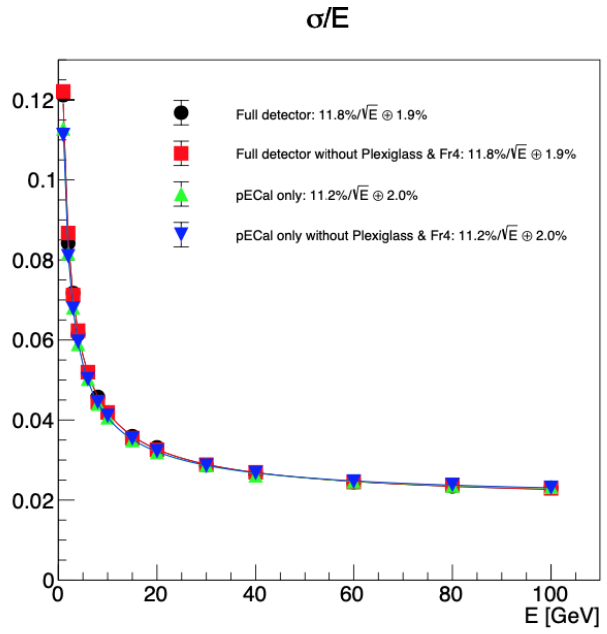
Performance vs pseudorapidity, showing insert geometry enable us to reach the YR requirement to cover up to η=4

fECal, TIC 05/08/23 O.Tsai

- status of the implementation of geometry/detector services/digitizer
  simplified geometry (mixture), smearing to test beam results, services – approximations, digitizers approximations.
- are there open performance issues? - No
- are there any issues to be addressed? – not at this stage
- who will be responsible for the tasks? – Zhongling Ji (UCLA)
- real material/acceptance vs average material/acceptance – approximations, study of energy resolution vs different materials upfront of ecal shows almost no degradation. (material currently in ePIC geometry). See https://indico.bnl.gov/event/19173/ Zhongling's talk.



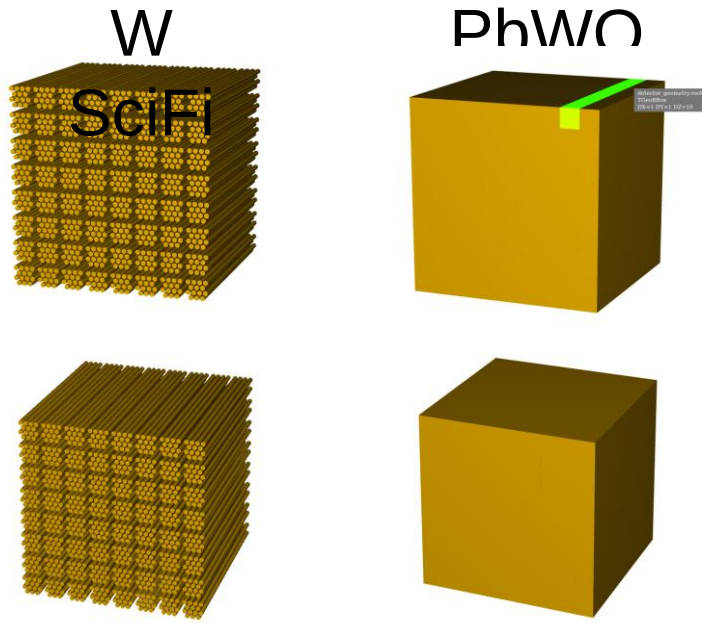


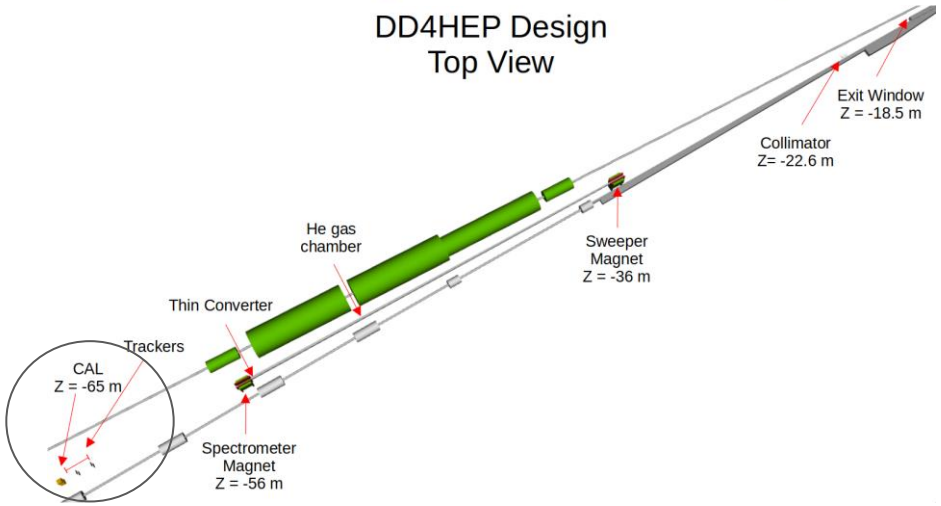


Far Backward Pair Spectrometer Detector Collaboration

- Detector Geometry implemented in DD4HEP ePIC repository
  - Trackers
  - Calorimeters
  - Sweeper Magnet
  - Analysing magnet
  - He/Vacuum chamber
  - Exit window and conversion foil

- Converging on detector technology -- no performance issues





Far Backward Pair Spectrometer Detector Collaboration

- Updates from our Task List
  - Calorimeter design — PbWO4 and W SciFi options being investigated.
  - Tracker design — Help needed for technology choice, given our constraints: integration time <~ 10 ns, material budget X0 < 1%, pixel size ~ 50 um.
  - Dipole magnets — Soon to coordinate with magnet design expert. Fringe fields need to be small at beamlines.
- Extensive investigations underway.
- Simulation campaigns: Lumi detectors rely primarily on standalone simulations and do not affect simulation campaigns (e.g. Bremsstrahlung not in pythia events)

Far-Forward Simulation Readiness

Roman pots/Off-Momentum Detector

- Digitization work in-progress.
- Matrix reconstruction code works with raw hit information.
  - Proper hit-finder still a to-do (for background rejection) → Need timing information from digi.
- Detector materials up-to-date and sensible.
  - Support structure needs work, but the CAD information is complicated and still in-progress.
- Detectors in good shape for this simulation campaign.
- **Responsible parties: Alex Jentsch, Jeet Gupta, David Ruth**

B0 Tracker + EMCAL

- Reconstruction still does not work → ACTS still cannot handle the track reconstruction.
  - This has been more than one year effort, with no resolution.
  - GenFit may need to be used if we cannot get this working soon (works fine in standalone simulation).
- Material updates will be done for next campaign – lots of outstanding engineering design work, plus question marks on the magnet itself.
- EMCAL can be used for acceptance studies.
- **Responsible parties: Zvi Citron, Sakib Rahman (ACTS), Michael Pitt (EMCAL)**

Zero-Degree Calorimeter

- Reconstruction does not work on this detector, but materials are realistic for acceptance studies (fine for incoherent vetoing studies).
- **Responsible parties: Yuji Goto, Po-Ju Lin, PNNL group**

General simulation readiness: Far-Forward detectors currently able to do studies of incoherent vetoing in e+A (essentially relying on basic acceptance in all detectors), e+p DVCS at top energy (RP + OMD), and deuteron spectator tagging (OMD) at top energy.

ePIC Gaseous Trackers DSC update

K. Gnanvo, M. Vandenbroucke

EPIC Detector TIC Weekly Meeting

May 08, 2023

Status of ePIC Gaseous Trackers (i.e. MPGDs)

- status of the implementation of geometry/detector services/digitizer
  - MPGD layers in ePIC not yet defined ➔ geometry/services/digitizer are not be defined either
- are there open performance issues?
  - Improvement of spatial resolution performances
  - Mechanical stability of large area detectors vs. low material budget
  - Improvement of operation stability of MPGDs
- are there any issues to be addressed?
  - Ongoing R&D efforts within eRD108 collaboration to address all these issues
- who will be responsible for the tasks?
  - This determination will be made once we have a better idea of MPGDs layers needed for ePIC detector
- real material/acceptance vs average material/acceptance
  - This determination will be made once we have a better idea of MPGDs layers needed for ePIC detector
  - With the new role that MPGD trackers are expected to play in ePIC detector (pattern recognition / timing layer) very low material budget is no longer critical, acceptance (dead area) will be defined by mechanical constraints for large area detectors

TOF – 5/8/2023

- Status of the implementation of geometry/detector services/digitizer
  - Real BTOF material (~1%X_0) within the acceptance -1.4<eta<1.4, missing service outside the acceptance
  - Average FTOF material (5%X_0) within the acceptance 1.7<eta<3.7, missing service outside the acceptance
  - Digitizer has the correct timing and spatial resolution, but no charge sharing
- Are there open performance issues?
  - No open issue but improvements planned (see below)
- Are there any issues to be addressed?
  - Implement real FTOF geometry by Nicholas Schmidt (ORNL)
  - Implement charge sharing by Prithwish Tribedy (BNL)
  - Implement TOF services outside the TOF acceptance by TBD
- Real material/acceptance vs average material/acceptance
  - BToF: real material within the acceptance -1.4<eta<1.4, missing service outside the acceptance
  - FTOF: average material within the acceptance 1.7<eta<3.7, missing service outside the acceptance

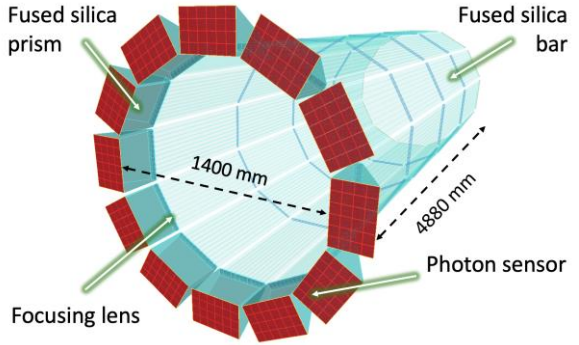
HPDIRC

- **status of the implementation of geometry/detector services/digitizer**
  - Realistic optics geometry and material properties based on prototypes, with wavelength-dependent material properties and processes with all relevant resolution terms
  - Boxes and services can be added for campaign
  - Digitization will be implemented as part of reconstruction
  - Currently implementing and validating efficiencies

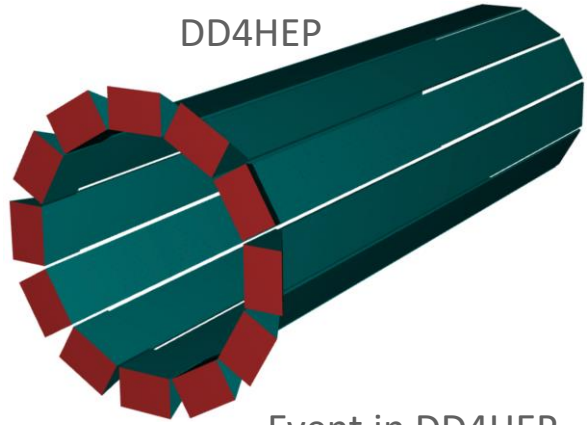
- **are there open performance issues?**
  - Reliable tracking angular resolution is critical for hpDIRC performance
  - Multiple tracks in single event in one DIRC bar/barbox
  - Backsplash from the calorimeter
  - Post hpDIRC tracking layer impact on performance (MPGD tracking layer or from the Barrel EMCal AstroPix sensor)

- **are there any issues to be addressed?**
  - Changes needed in stacking action to implement transport efficiencies and not save irrelevant paths for all generated photons
- **who will be responsible for the tasks?**
  - Nilanga Wickramaarachchi (CUA) at least temporarily and with limited time

Stand Alone Geant4



DD4HEP



Event in DD4HEP