LFHCal sims update

PAS/BNL, FB/ORNL / 14 Dec 2022
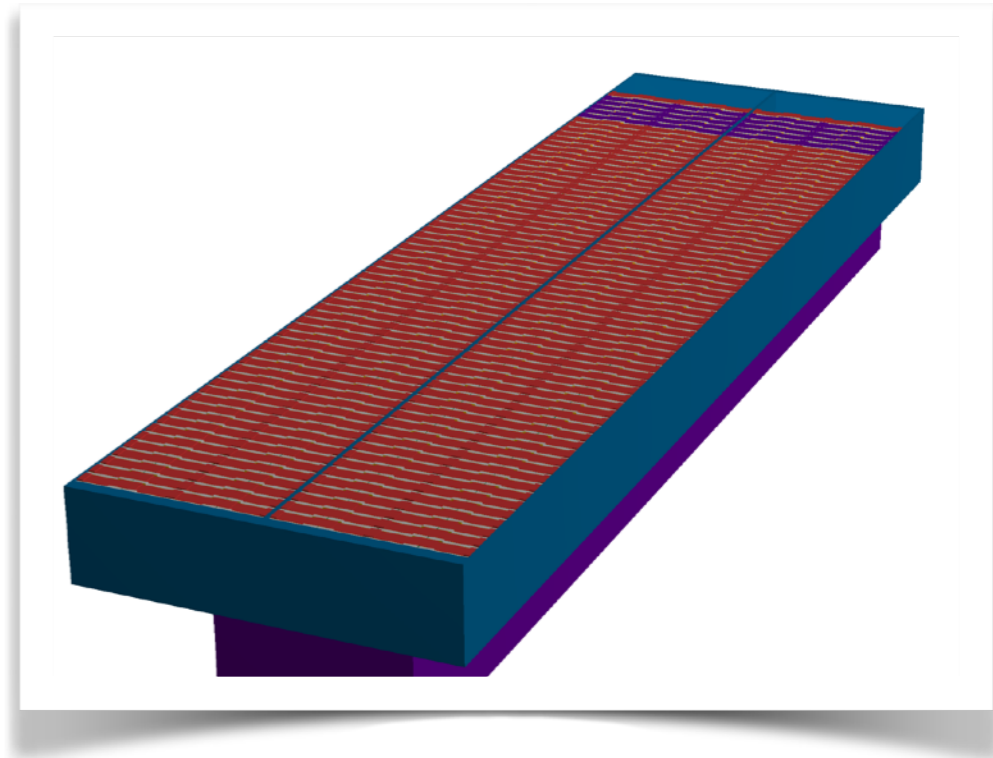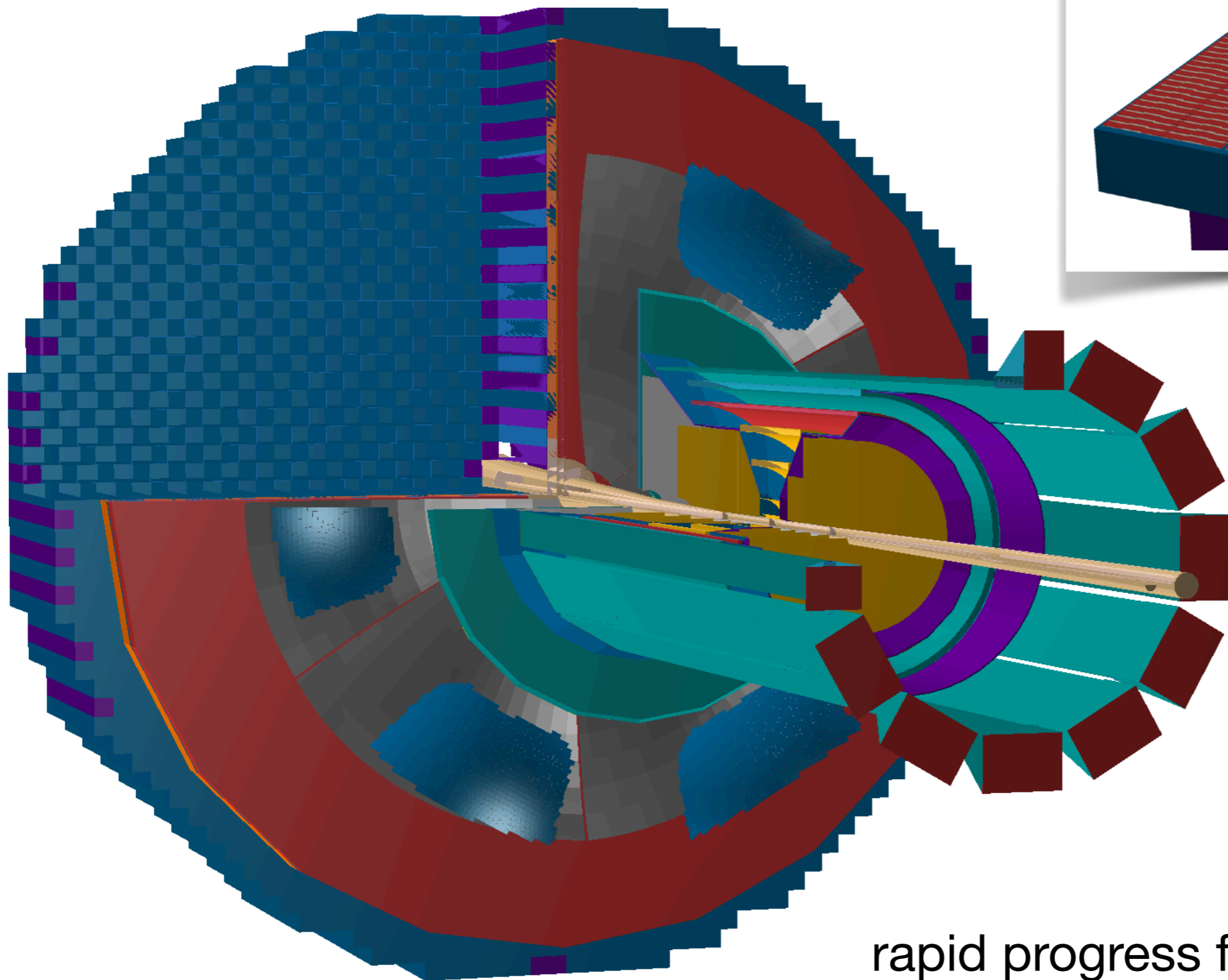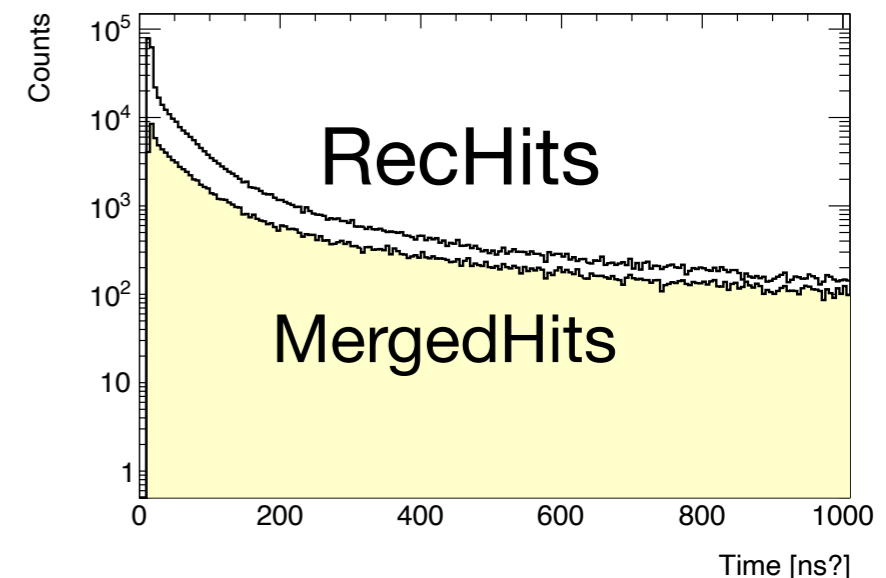
rapid progress from Fredi on
implementing LFHCal in dd4hep!

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Updates

- **Progress in the last several weeks**
  - Submitted PR for changes from 11/16 over the weekend
  - https://github.com/eic/EICrecon/pull/388
  - Coupled with PR #365, which will eliminate having units applied *within* algorithms (which was the main problem before)

- **Trying to document the HCAL data flow, some of which is quite obscure to me!**
  - Next slide

- **Some issues, trying to address follow up to energy resolution studies (thanks to UCR gang!)**
  - Time cuts: t < 50 ns, energy cuts: E_{cell} > 0.1 MIP
    - *Somewhat different than Oskar's AHCAL talk from May (https://indico.bnl.gov/event/15792/): t < 150 ns and E_{cell} > 0.5 MIP*
    - *Need to work out MIP response in LFHCal with muon sample*
  - Where can these cuts be applied in EICrecon?
    - *This functionality not available yet - implementing now*
  - The merging step is not optimal - it seems to be summing things longitudinally (all hits at front face) and feeding that to the clustering
    - *Will look into skipping merging, or optimizing it*

- **Truth associations not functional yet**
  - I was also getting no associations at all, so I added the EMCal back, but found that it was getting sim and reco IDs that didn't look reasonable (O(1e9))
  - Is there some working sample output for reference?

Data flow

Function	Specific algo config in src/detectors/HCAL	General algo in src/algorithms/calorimetry	In→out
Generate simulated hits	Simulation		HcalEndcapPHits
Collect in calo cells, "digitize" signals	RawCalorimeterHit_factory_HcalEndcapPRawHits.h	CalorimeterHitDigi	HcalEndcapPHits → HcalEndcapPRawHits
Reconstruct digitized signals	CalorimeterHit_factory_HcalEndcapPRecHits.h	CalorimeterHitReco	HcalEndcapPRawHits→ HcalEndcapPRecHits
Merge hits (?)	CalorimeterHit_factory_HcalEndcapPMergedHits.h	CalorimeterHitsMerger	HcalEndcapPRecHits→ HcalEndcapPMergedHits
Create clusters	ProtoCluster_factory_HcalBarrelIslandProtoClusters.h	CalorimeterIslandCluster	HcalBarrelMergedHits→ HcalBarrelIslandProtoClusters
Create truth clusters	ProtoCluster_factory_HcalEndcapPTruthProtoClusters.h	CalorimeterTruthClustering	HcalEndcapPHits → HcalEndcapPTruthProtoClusters
Cluster moments, Truth associations	Cluster_factory_HcalEndcapPClusters.h	CalorimeterClusterRecoCoG	HcalEndcapPIslandProtoClusters /HcalEndcapPHits → HcalEndcapPCluster
Truth clustering	Cluster_factory_HcalEndcapPTruthClusters.h	CalorimeterClusterRecoCoG	HcalEndcapPTruthProtoClusters/ HcalEndcapPHits → HcalEndcapPTruthClusters