



DIS Electron Finding in ePIC



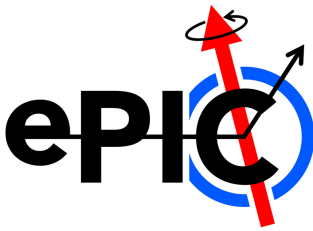
Daniel Brandenburg (point of contact)

Goal of this meeting:

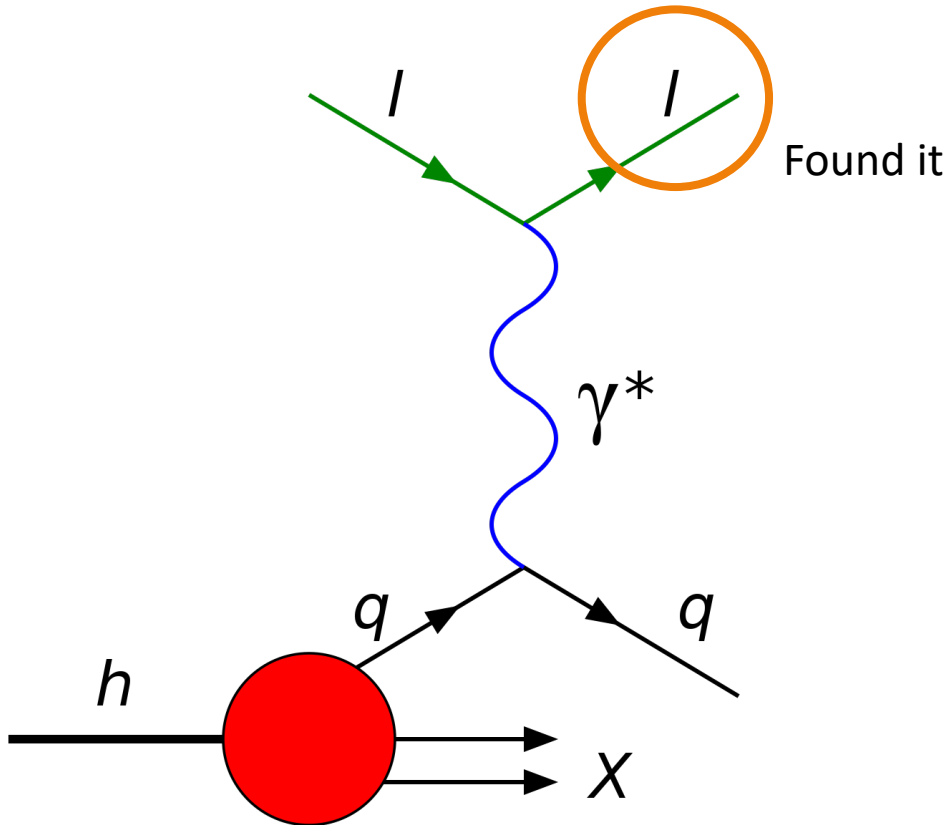
- Identify tasks
- Get people involved
- Plan moving towards TDR



DIS Electron Finder



- Charge: *Developing an efficient and accurate algorithm for identifying electrons and identifying the scattered electron of the DIS process*

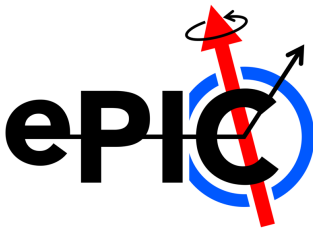


Major Goals:

- Develop unified electron identification
- Implement DIS lepton finder algorithms

Realistic DIS lepton finding is crucial for many benchmarks and analyses needed to inform detector design

DIS Electron Finder | Approaches



- Taking two “parallel” approaches

“Truth”

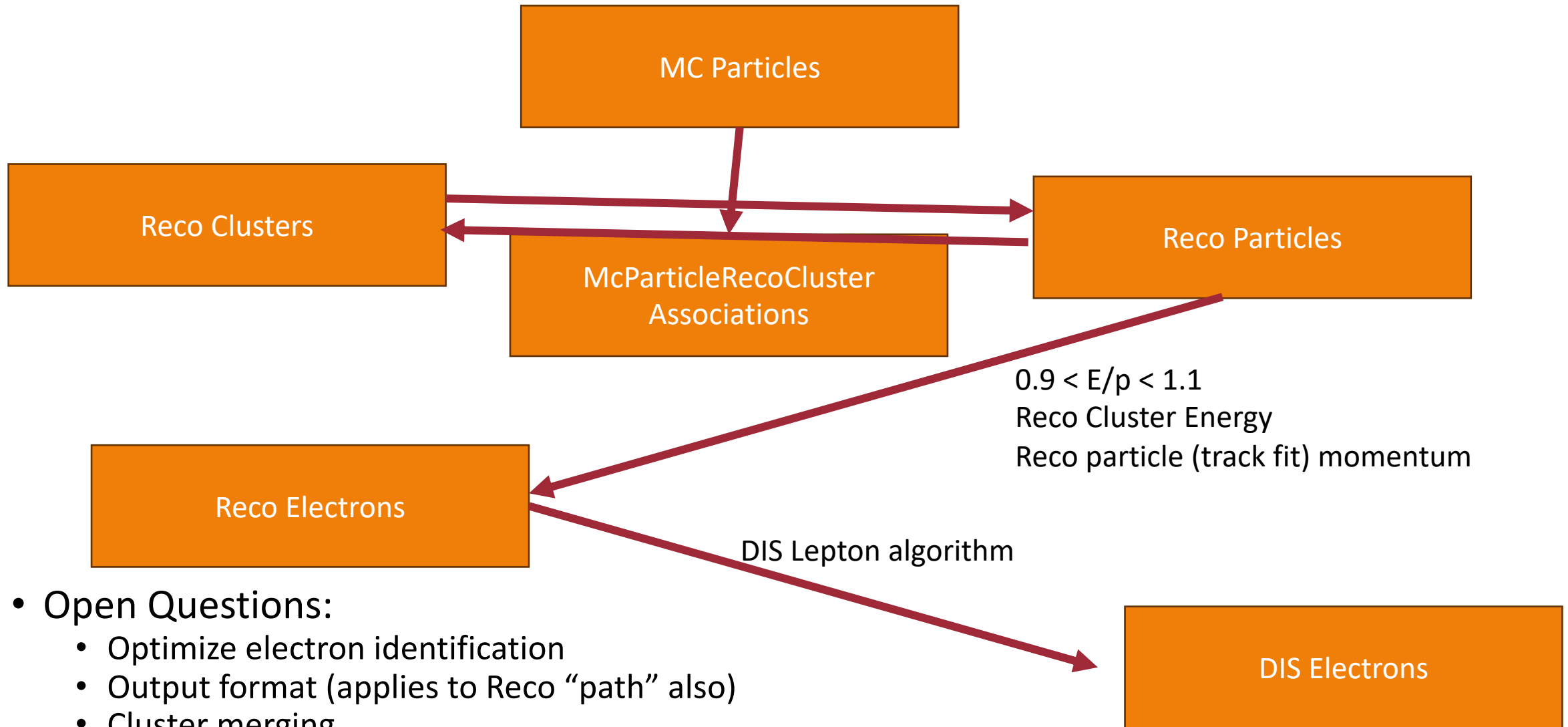
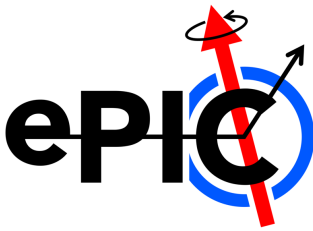
Use truth associations

- Particle-to-Cluster associations utilize “truth” information
- Select electron using E/p utilize momentum from tracking and energy from reco Cluster
- + Similarly “truth” informed DIS lepton finder

“Reco”

- Track projections to Calorimeters
- Track to Cluster matching
- Electron identification utilizing full PID capabilities
- ...
- + Realistic DIS lepton finder

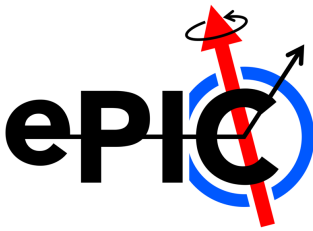
ElCRecon Truth "Path"



- Open Questions:

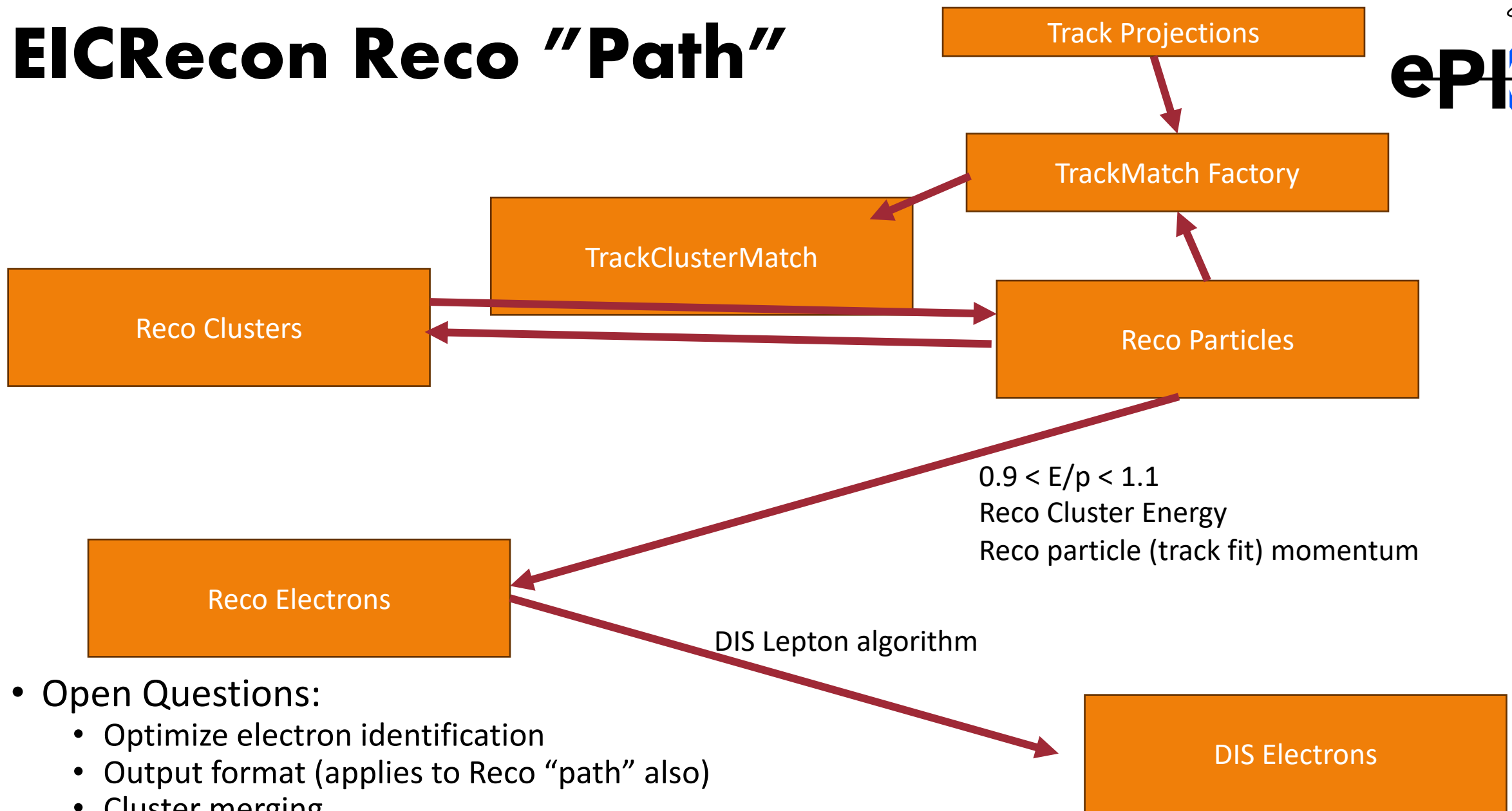
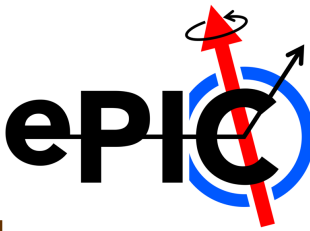
- Optimize electron identification
- Output format (applies to Reco "path" also)
- Cluster merging
- Hadron rejection

DIS Electron Finder | Progress Timeline



- ✓ Truth level Particle \leftrightarrow Cluster associations (S/C team, esp. Wouter)
 - PR #666 (merged on June 24)
- ✓ Electron Identification framework strawman
 - Provides “ReconstructedElectron” collection
 - Currently implements E/p cuts utilizing ECAL info
 - Uses “Truth” associations
- ✓ Track Projection Factory (Tyler Kutz)
 - Provides track projections to common surfaces (each ECAL / HCAL etc.)
 - EDM4EIC updates to accommodate projection
- ⇒ Track-to-cluster matching
 - Provides processor for matching (see [PR#606](#))
 - Data model changes already proposed ()
 - In progress implement as factory (PR tomorrow)
- ⇒ “Baseline” DIS finder algorithm
 - In progress implementing as a factory (PR today/tomorrow)
 - Output format is ReconstructedParticle

ElCRecon Reco "Path"



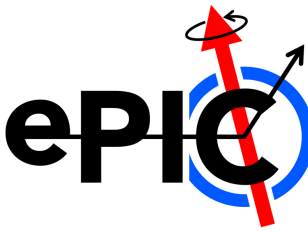
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- Optimize electron identification
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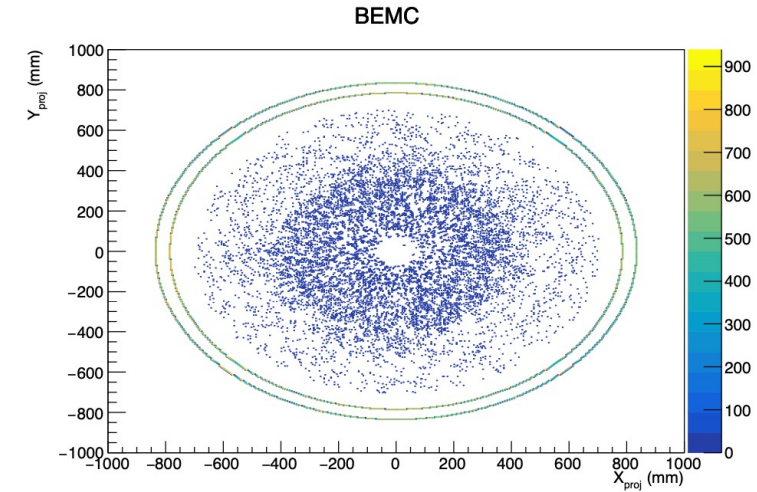
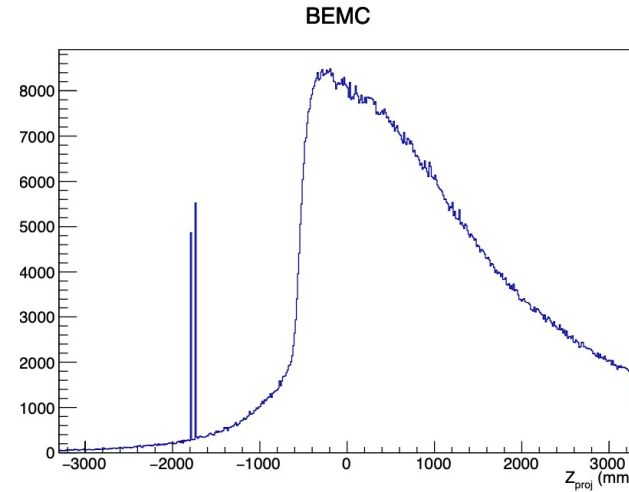
Track projections

- Calorimeter track propagation factory implemented in EICrecon (included in September campaign)
- Propagating to two surfaces per calorimeter:
 - Innermost calorimeter surface (closest to IP)
 - Offset to average cluster depth (currently 5 cm for ECAL, 15 cm for HCAL)
- Propagated points identified by system & surface ID
- Open issues:
 - Add track association
 - Modify material map to account for calorimeter material

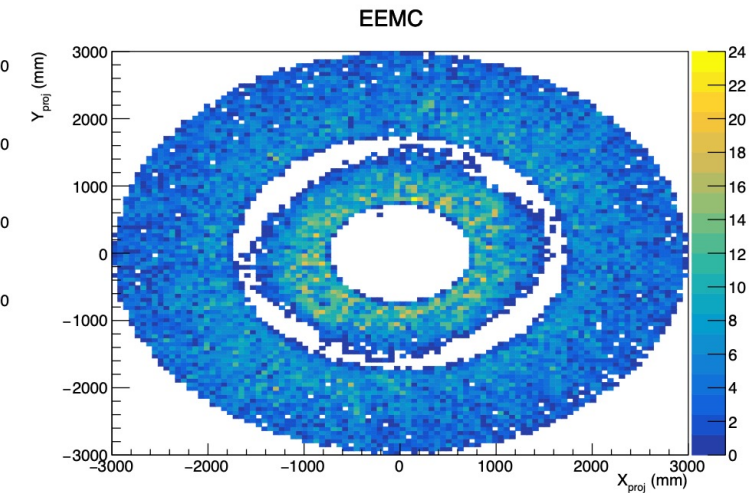
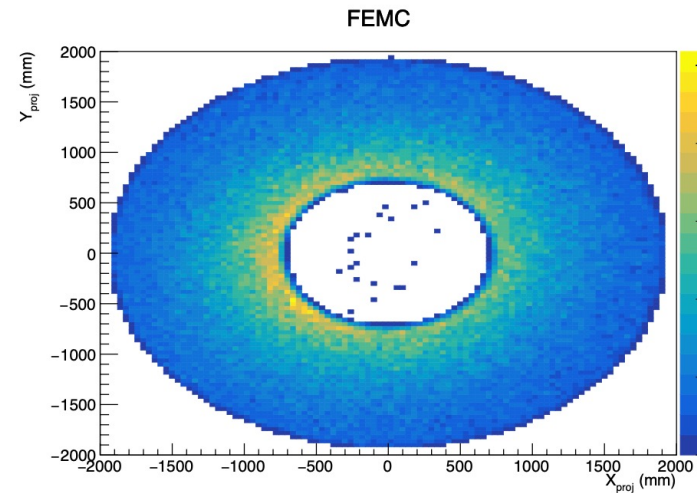
Track projections



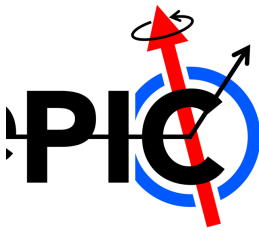
Projections
to barrel



Projections
to endcaps

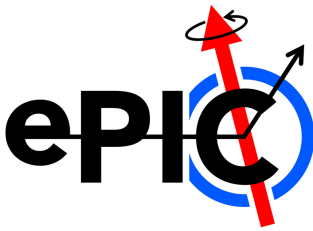


Track-cluster matching (D. Brandenburg)



- Matching coordinates:
 - $\Delta\eta$, $\Delta\phi$ in barrel
 - Δx , Δy in endcaps
- For factory development, currently taking cluster closes to projection (matching thresholds to be added later)
- Optimize matching thresholds individually based on track, calorimeter resolutions
- Output of factory will be collection of new TrackClusterMatch datatype
 - Data model addition presented in October 4 S&C meeting ([pull request](#))
- ElCrecon matching factory in-progress, to be validated with truth-based matching

DIS Lepton collection format

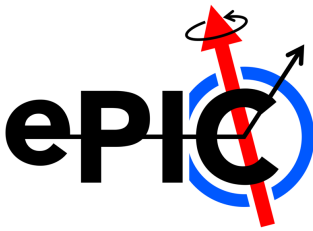


- Handle more than one candidate per event
- How to rank multiple candidates?
- Current approach: Collection of ReconstructedParticles
- At some point we want inclusive kinematics...

```
edm4eic::InclusiveKinematics:
  Description: "Kinematic variables for DIS events"
  Author: "S. Joosten, W. Deconinck"
  Members:
    - float          x          // Bjorken x (Q2/2P.q)
    - float          Q2         // Four-momentum transfer squared [GeV^2]
    - float          W          // Invariant mass of final state [GeV]
    - float          y          // Inelasticity (P.q/P.k)
    - float          nu         // Energy transfer P.q/M [GeV]
  OneToOneRelations:
    - edm4eic::ReconstructedParticle scat // Associated scattered electron (if identified)
    ## @TODO: Spin state?
    ## - phi_S?
```

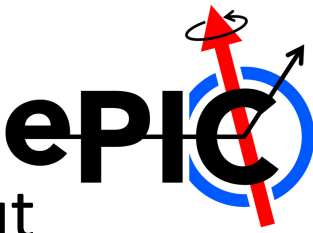
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Open Tasks



- Electron Identification:
 - e/p cut optimization (per CAL?)
 - Hadron rejection (use HCAL info) + PID info where available
 - Cluster merging , multiple matches
- Track Projections
 - Track associations + metadata
 - Study projection planes
 - Add material effects/map
- Output format for DIS lepton / multiple candidates / events without e
- Track-cluster matching
 - Optimize matching parameters ($\Delta x, y$ in endcap and $\Delta\phi, \eta$ in barrel)
 - Validate existing factory (against truth associations)
- Other:
 - Compare “truth” vs. “Reco” outputs (validation, more later)

Truth approach



- PR #751 Add reconstructed electron factory, algorithm utilizing E/p cut

- <https://github.com/eic/ElCrecon/pull/751>

- ReconstructedElectrons Factory

- Input:

```
75 | {"MCParticles", "ReconstructedChargedParticles", "ReconstructedChargedParticleAssociations",  
76 | "EcalBarrelScFiClusterAssociations",  
77 | "EcalEndcapNClusterAssociations",  
78 | "EcalEndcapPClusterAssociations",  
79 | "EcalEndcapPInsertClusterAssociations",  
80 | "EcalLumiSpecClusterAssociations",  
81 | },
```

- Output: “ReconstructedElectrons”

- Utilizes the ElectronReconstruction Algorithm

- Any track with an ECAL match
 - Accept if $0.9 < E/p < 1.2$ (needs to be studied and optimized)
 - TODO: use HCAL
 - TODO: handle multiple matches

- This is meant to be initial skeleton – keep same structure for RECO approach