DIS Electron Finding in ePIC

Daniel Brandenburg (point of contact)
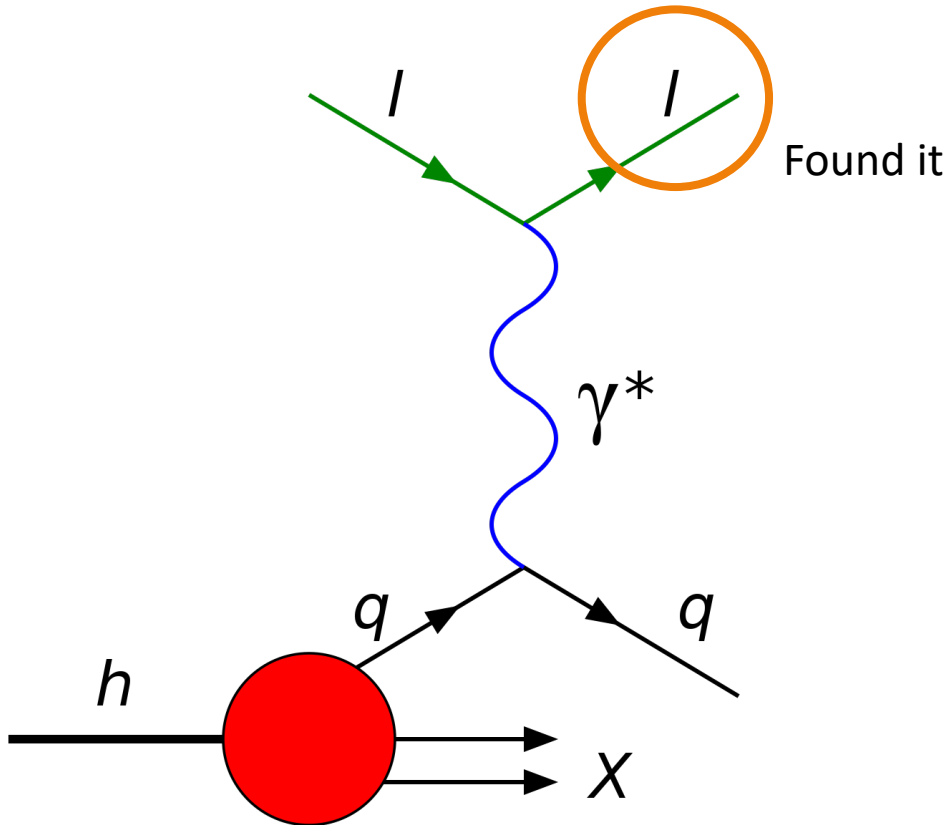
Goal of this meeting:

- 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*
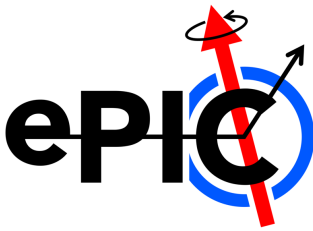

Major Goals:
- Develop unified electron identification
- Implement DIS lepton finder algorithms

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

DIS lepton algorithms

DIS Lepton Finder Algorithms

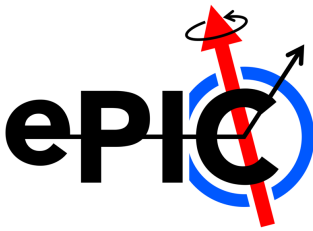- Goal: identify the DIS lepton using only final state information

In case of one electron anything will work. In case of multiple electrons even a simple rule, such as take electon with "maximal" energy/pz /etc. will work for 50+% cases if only 2 electrons are present. Basically, implemented in Rivet.

Challenges:

- How to select **the** DIS electron when there are multiple candidates? **Essentially check the hadronic final state kinematics is consistent with the kinematics of each electron, i.e. combine multiple measurements [1].**

- How to associate the semi-hard radiation from the electron with the electron? **Try to cluster** *some* **energy from the calorimeter deposits with the electron. Cluster the photons from the interaction point if they are angularly close to the electron?**

Credit: Andrii Verbytskyi

DIS Lepton Finder Algorithms

- Goal: identify the DIS lepton using only final state information
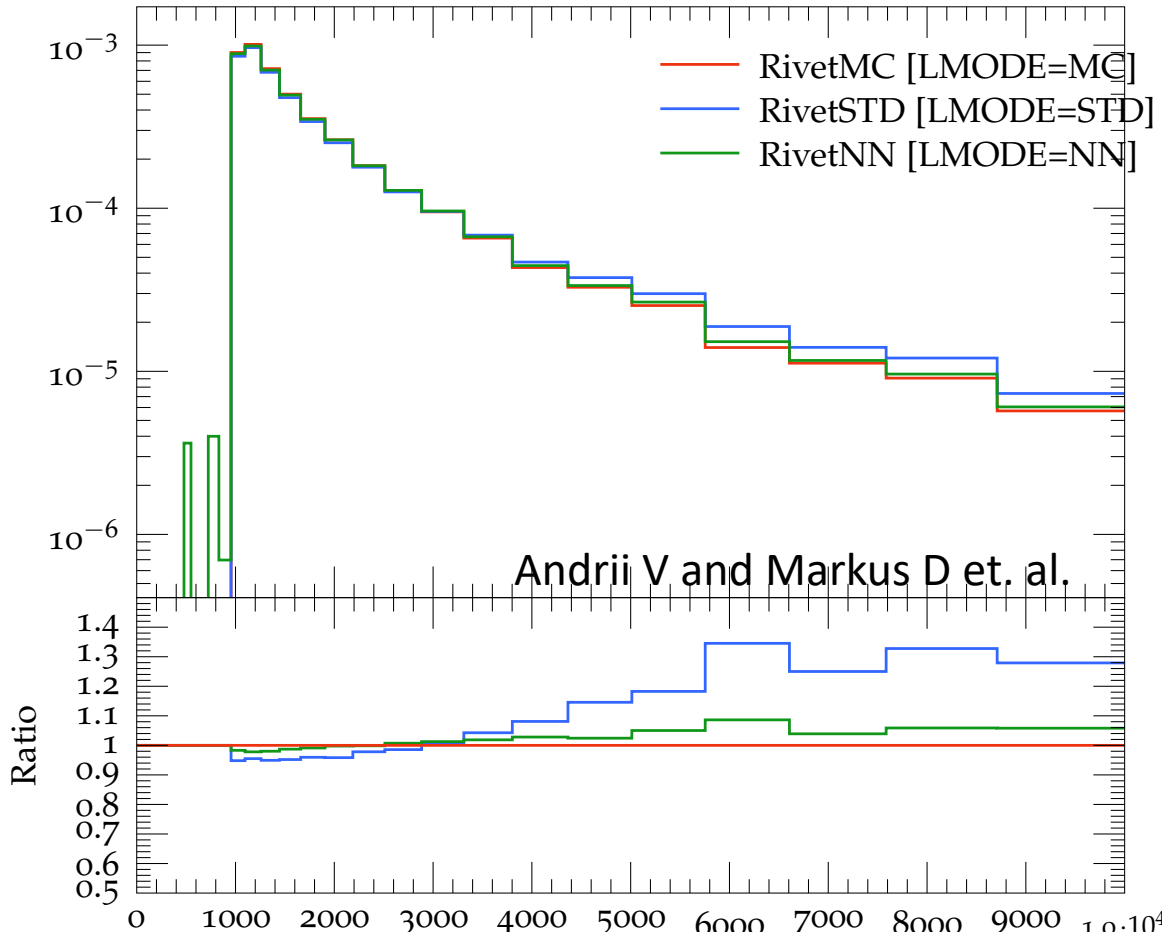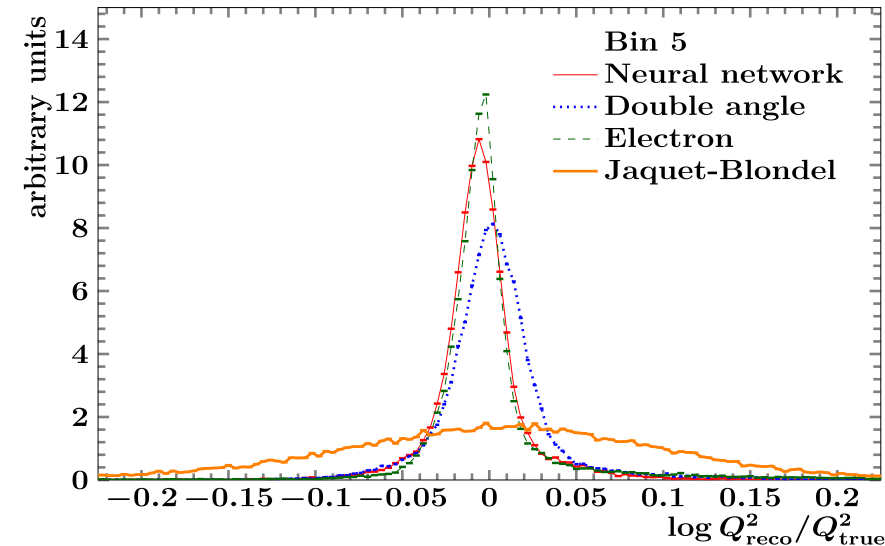

Andrii V and Markus D et. al.

Figure: the true Q^2 from the full MC event record, the standard Rivet algorithm from the final state (STD) and the NN algorithm from the final state. The cases fro multiple electrons.

[1]   Diefenthaler, Markus and Farhat, Abdullah and Verbytskyi, Andrii and Xu, Yuesheng, Deeply learning deep inelastic scattering kinematics. Eur. Phys. J. C **82**, 1064 (2022). arXiv:2108.11638.

Preliminary electron ID

- Simple E/p electron finder implemented over the summer
  - Reconstructed E and p, but truth-level association
- Initial requirement of $0.9 < E/p < 1.2$ (needs to be optimized)
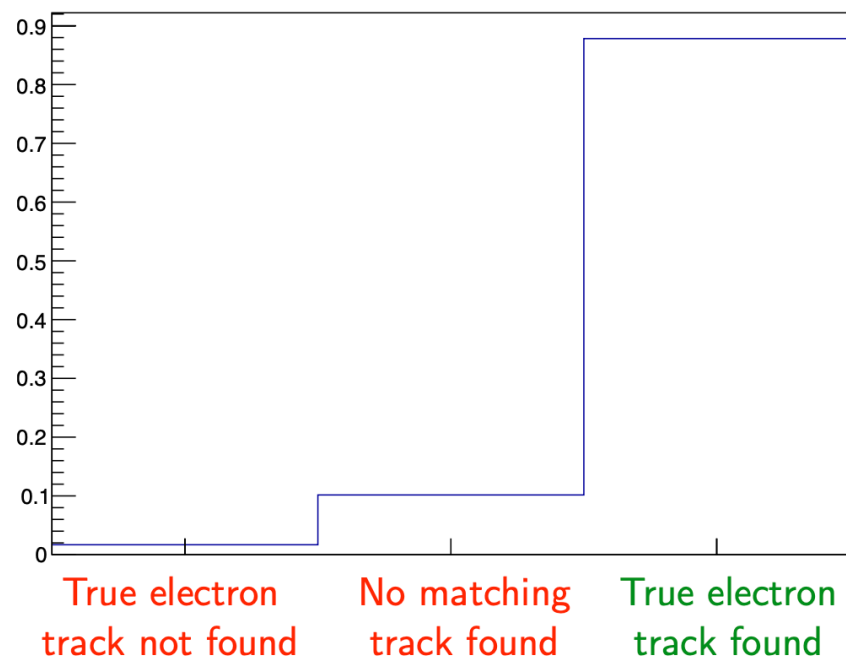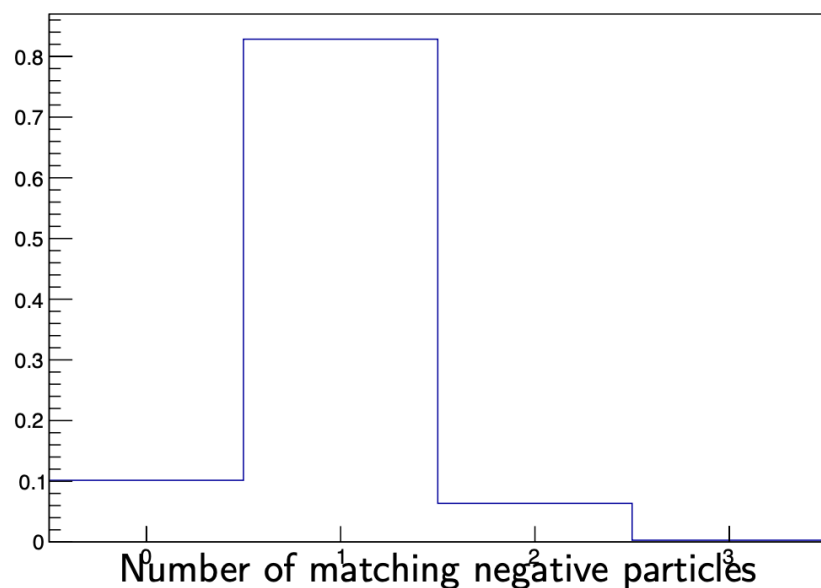
Towards a fully reconstruction-based electron ID
(D. Brandenburg)

- Track matching next milestone for fully reconstruction-based E/p cut

- Further ePID refinement with addition of $E - p_z$ cut (thanks to K. Tu for help on implementation)

- Implementation of EICrecon algorithm/ factory underway

- Still considering best output format, how to handle multiple DIS electron candidates, etc.
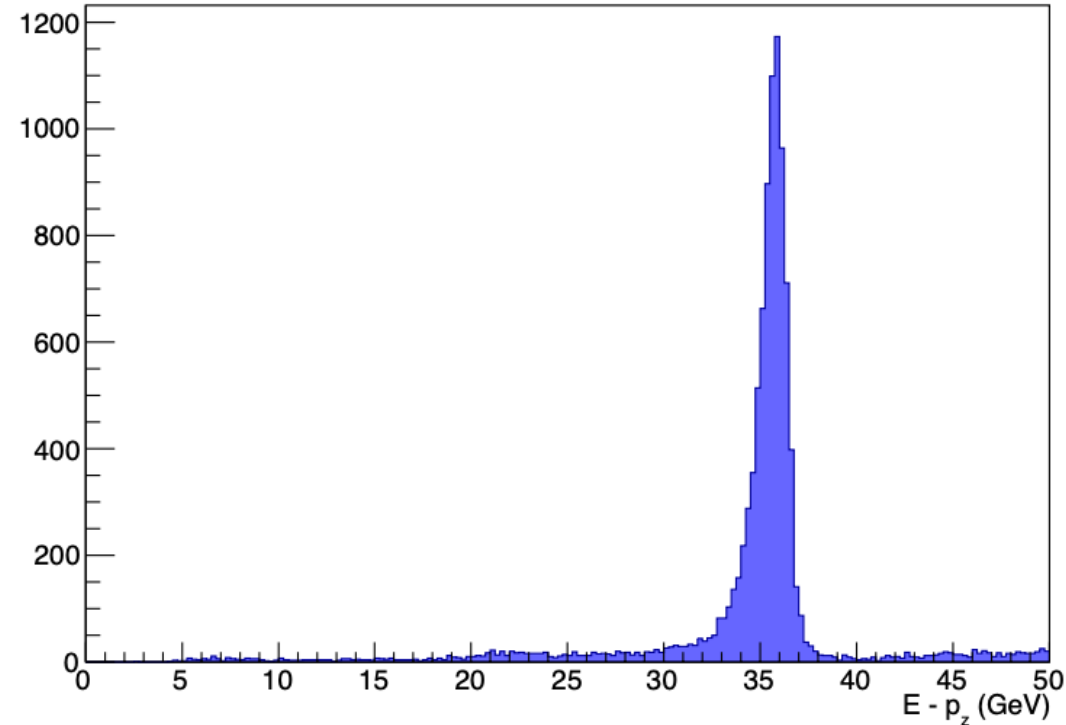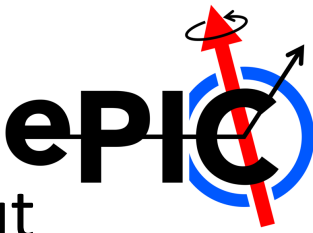
DIS lepton algorithms
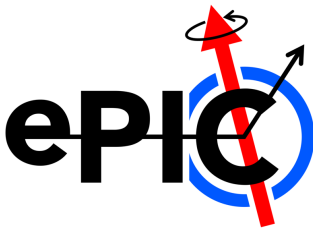
- Baseline algorithm
  - E/p electron id (0.9<E/p<1.1)
  - E-pz cut (needs to be optimized)
- ML algorithms
- Handle multiple algorithms?
- Handle events without electron candidate / multiple
- How to compare algorithms
- What is needed to train ML algorithms, avoid bias, etc.

Truth approach

- PR #751 Add reconstructed electron factory, algorithm utilizing E/p cut
  - https://github.com/eic/EICrecon/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