SIDIS Kinematic Reconstruction with ML at ePIC

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ePIC AI Town Hall Meeting

Aug. 30, 2023

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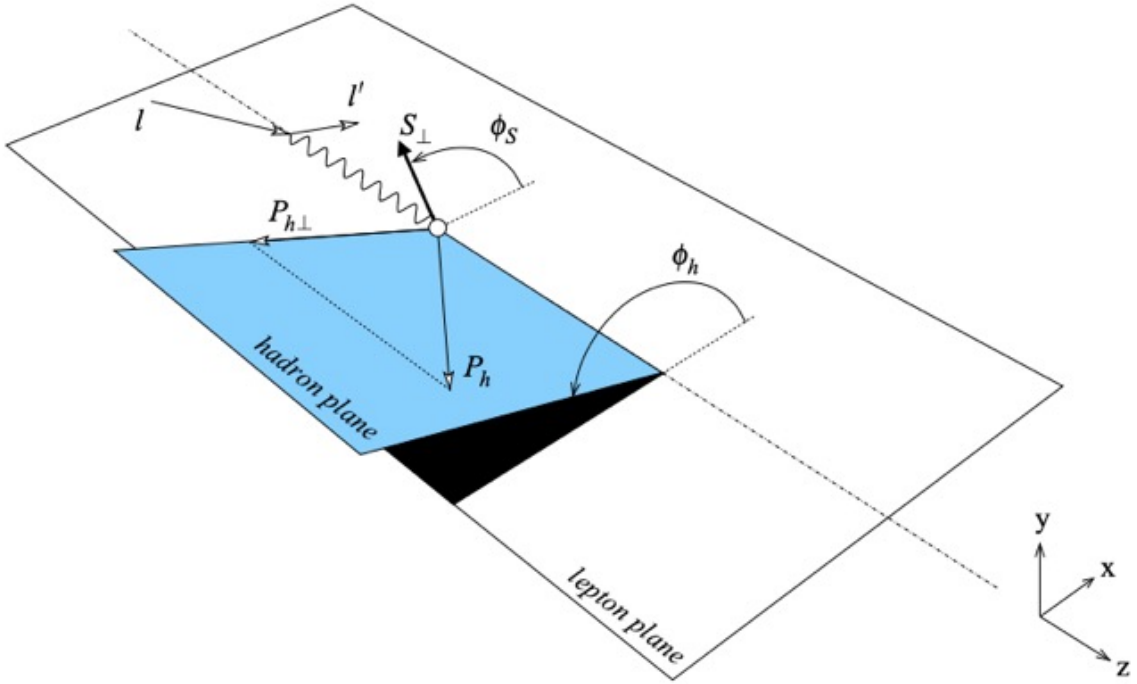
Semi-inclusive DIS kinematics

$$e(k) + A(P) \rightarrow e' + h(p) + X$$

- $\sigma \propto \sigma_{pert} \otimes PDF \otimes FF$
- Kinematics defined around virtual photon four-momentum q
- In addition to inclusive x, Q^2, need to measure:
  - Transverse momentum: $\boldsymbol{p_{h,\perp}}$, transverse to q
  - Fractional energy: $\boldsymbol{z_h} = \frac{\boldsymbol{P \cdot P_h}}{\boldsymbol{P \cdot q}}$
  - Azimuthal angles: e.g. $\boldsymbol{\phi_h}$, pictured right



Phys.Rev. D70 (2004) 117504

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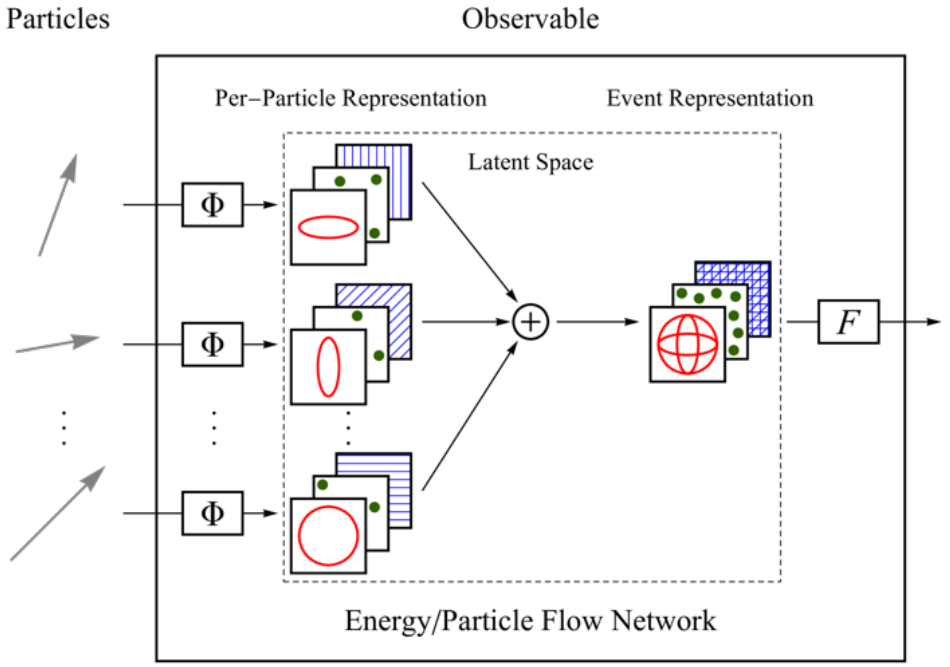
Improving reconstruction with ML

- Kinematic reconstruction poor at low-y (inelasticity)
  - Lepton energy loss small, harder to resolve
- Hadronic final state (HFS) information can also constrain q
- Using **Particle Flow Networks** (arXiv:1810.05165) to optimally combine full HFS information + electron to **reconstruct virtual photon four-momentum** q
  - HFS tracks: momentum, energy input to Φ layers, summed over
  - DIS electron track: momentum, energy and reco. (Q2,x) concatenated with latent space before F layers



Particle Flow Networks, JHEP 01 (2019) 121

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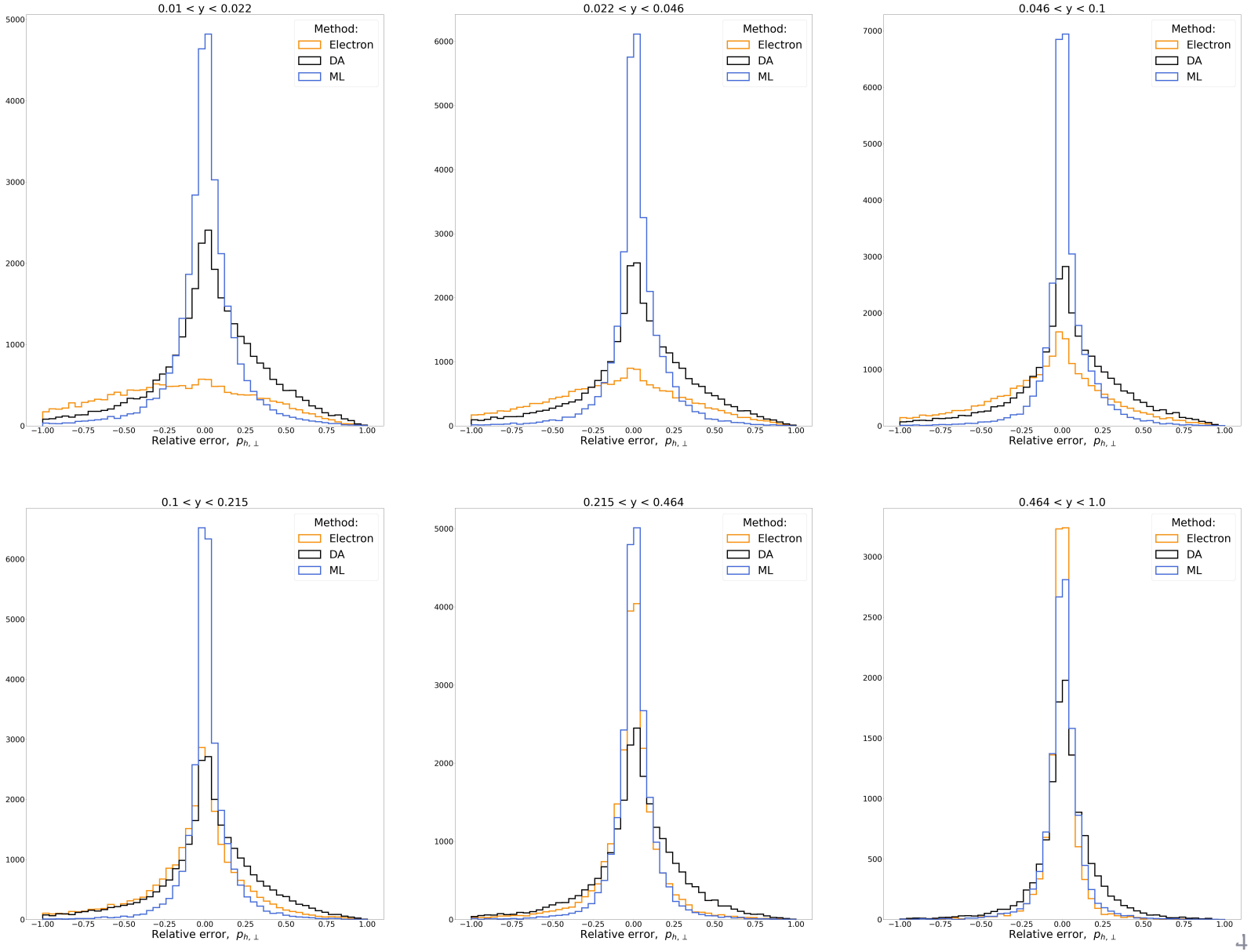
Performance on ePIC simulation 23.07.1

SIDIS $\boldsymbol{p_{h,\perp}}$ resolution, increasing y-bins

π+, $z > 0.2, Q^2 > 1\text{GeV}^2$:

- PFN trained to reconstruct q outperforms electron method across all but highest y-bin



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