Los Alamos NATIONAL LABORATORY EST.1943

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Open heavy flavor study updates for the EIC yellow report preparation

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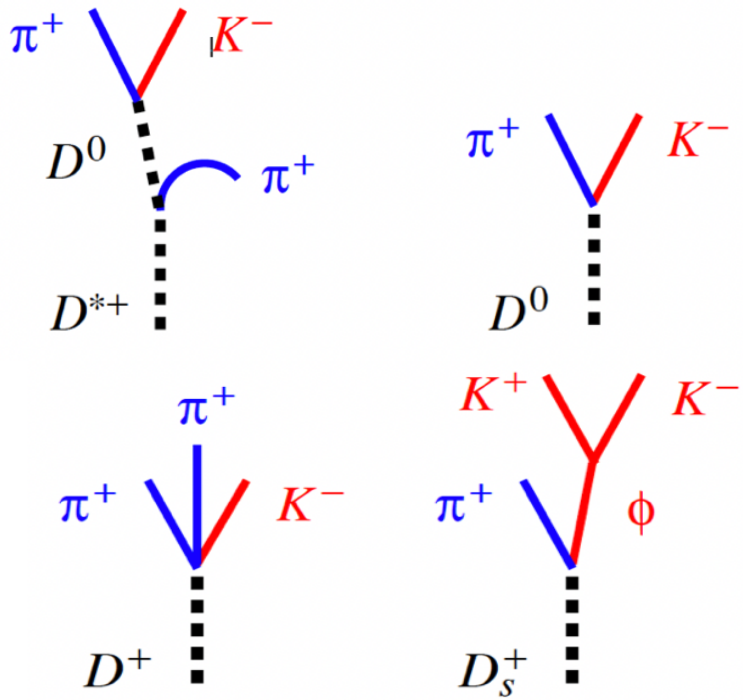
LANL EIC heavy flavor simulation studies (I)

- Study the heavy flavor hadron and jet reconstruction with the proposed Forward Silicon Tracker for the EIC.
- The full analysis framework which includes the event generation, detector response in fast simulation, background embedding, and hadron reconstruction has been setup.
  - One triggered event (trigger rate at 500kHZ) is embedded with on average 0.02 p+p (~12kHZ) background events. Need to add other background such as synchrotron radiation later.
  - Single track efficiency set at 95%.
  - Minimum Q^2 = 10 GeV/c^2.
  - PID at 100%.

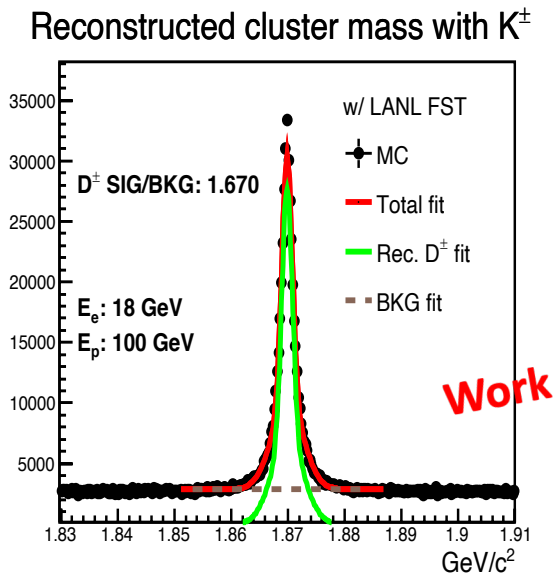
E.g. D-meson decay channels

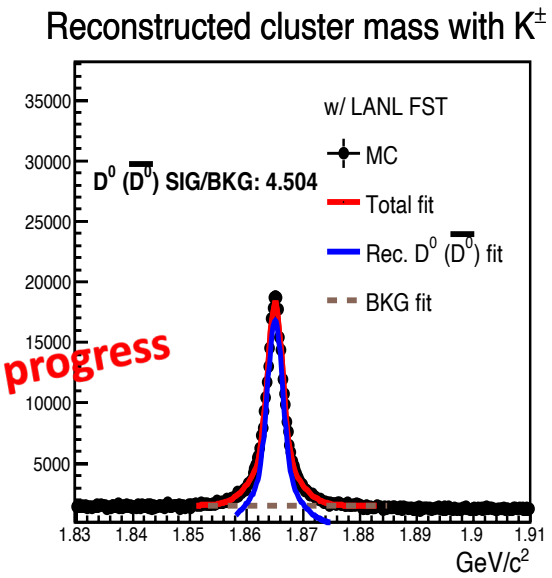


Reconstructed D mesons in PYTHIA8 simulation

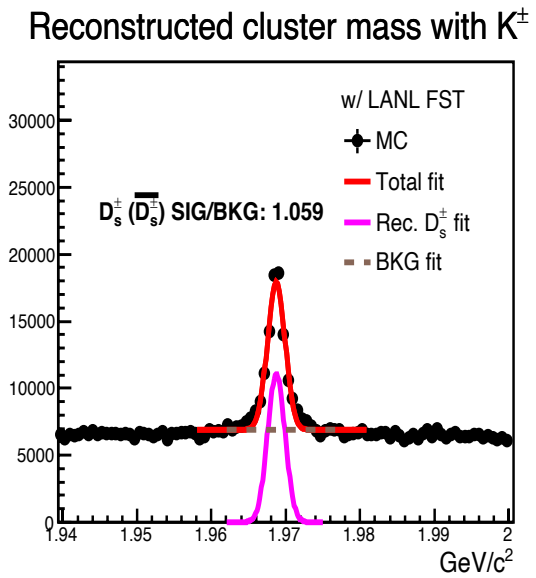
- Mass distributions of clusters with track transverse decay length matching between charged tracks. Clusters are required to have at least one $K^{\pm}$ tracks.
- The performances are based on 100% PID separation.
- Silicon tracking detector options: pixel pitch 30 μm, materials per detector layer: 0.4%X_0 and the readout rate is at 500 kHZ.

Track η -1 to 4 and integrated luminosity: 10 fb^{-1}





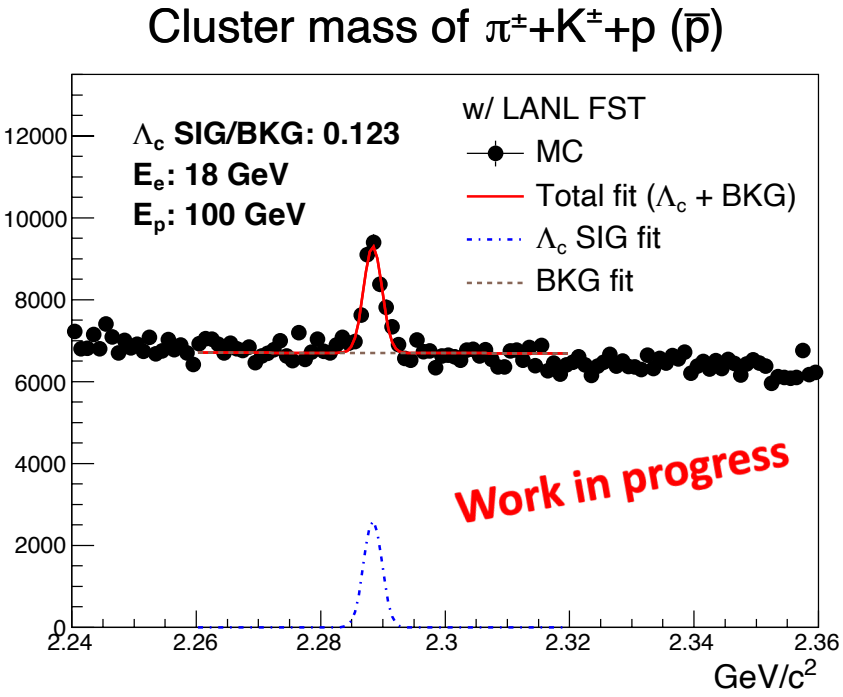
Work in progress



To extract the signal/background ratio for reconstructed D mesons.

Reconstructed Λ_c hadrons in PYTHIA8 simulation

- Mass distributions of clusters with track transverse decay length matching between charged tracks. Clusters are required to have at least one $K^{\pm}$ tracks.
- The performances are based on 100% PID separation.
- Silicon tracking detector options: pixel pitch 30 μm, materials per detector layer: 0.4%X_0 and the readout rate is at 500 kHZ.



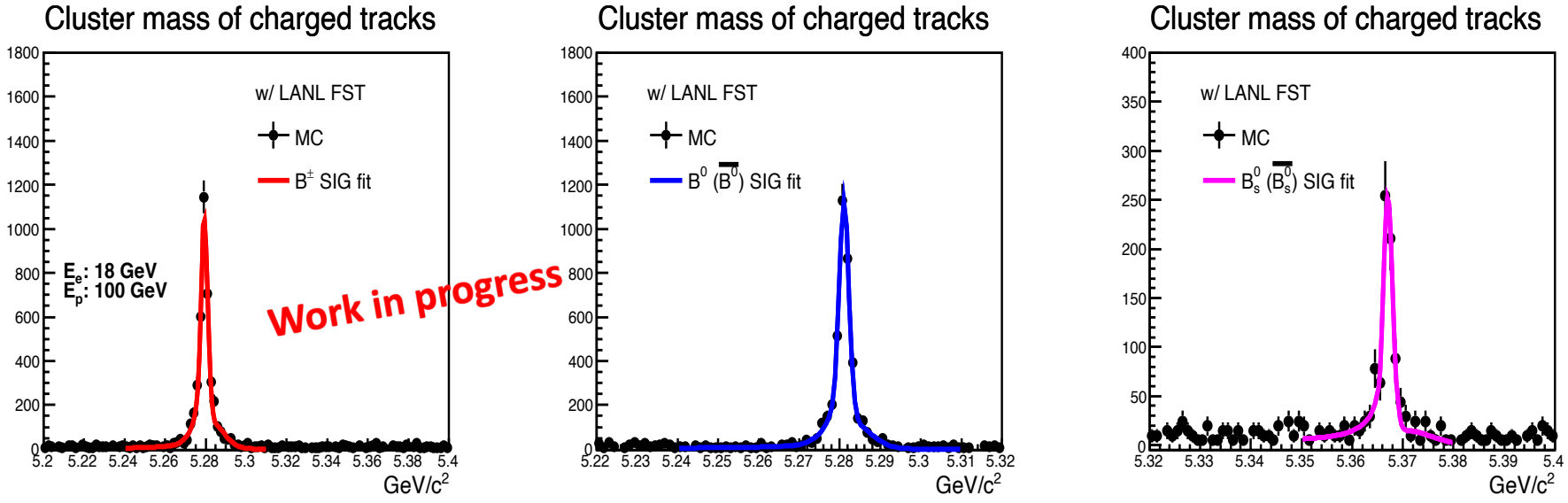
Track η -1 to 4

Integrated luminosity: 10 fb^{-1}

Reconstructed B mesons in PYTHIA8 simulation

- Mass distributions of clusters with track transverse decay length matching between charged tracks.
- The performances are based on 100% PID separation.
- Silicon tracking detector options: pixel pitch 30 μm, materials per detector layer: 0.4%X_0 and the readout rate is at 500 kHZ.

Track η -1 to 4 and integrated luminosity: 10 fb^{-1}

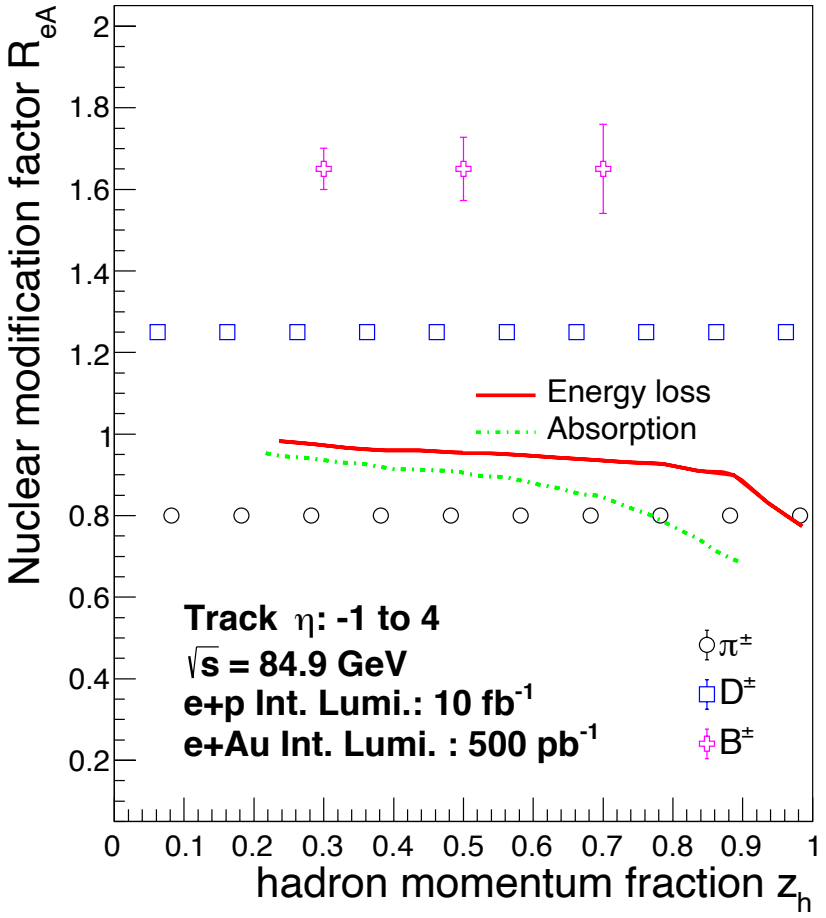


To extract the signal/background ratio for reconstructed B mesons.

New EIC physics observables are under study

- Competing models of nuclear modification in DIS reactions with nuclei (e.g HERMES data). Differentiation not possible with light hadrons.
  - Hadronization inside nuclear matter (dashed lines).
  - Energy loss of partons, hadronization outside (solid lines).
- The statistical precision of reconstructed hadrons can help separate different models of the nuclear modification on hadronization processes.
- Heavy flavor measurements at the EIC will enhance the sensitivity of the nuclear transport properties.

Projected hadron RAA vs z_h



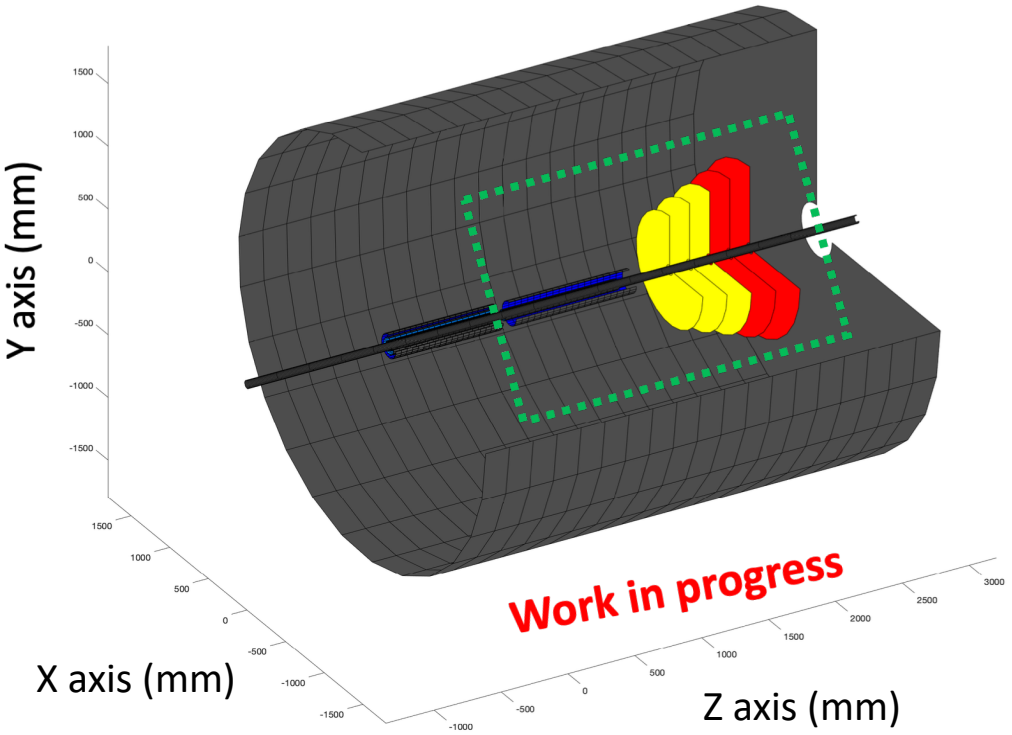
Conclusions and plan

- Initial projections of nuclear modification factor of flavor dependent reconstructed hadrons in e+A collisions have been achieved.
- Will develop new heavy flavor and jet observables and provide theoretical predictions for the EIC Yellow Report preparation.
- Will evaluate and implement the tracking detector and other detector (e.g. PID) performance and implement into the physics simulation studies.
- Need inputs from the tracking detector and other sub-system performance.

Backup

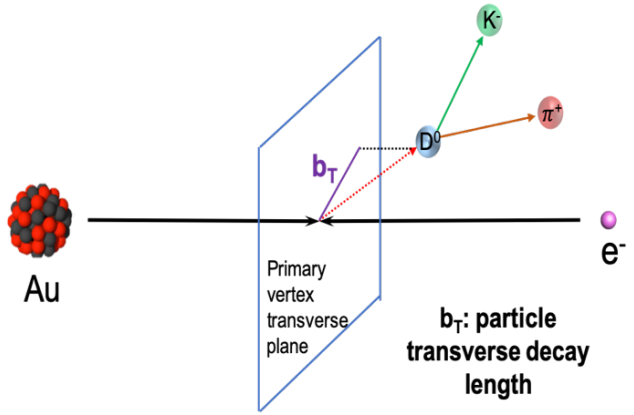
LANL EIC program progress (I)

- Initial detector design in fast simulation:
  - Mid-rapidity silicon vertex detector: 3 barrel layers of Monolithic Active Pixel Sensor (MAPS) type detector.
  - Forward-rapidity silicon tracking detector (FST): 2 barrel layers of MAPS + other silicon detector and 5 forward planes of MAPS + other silicon detector.



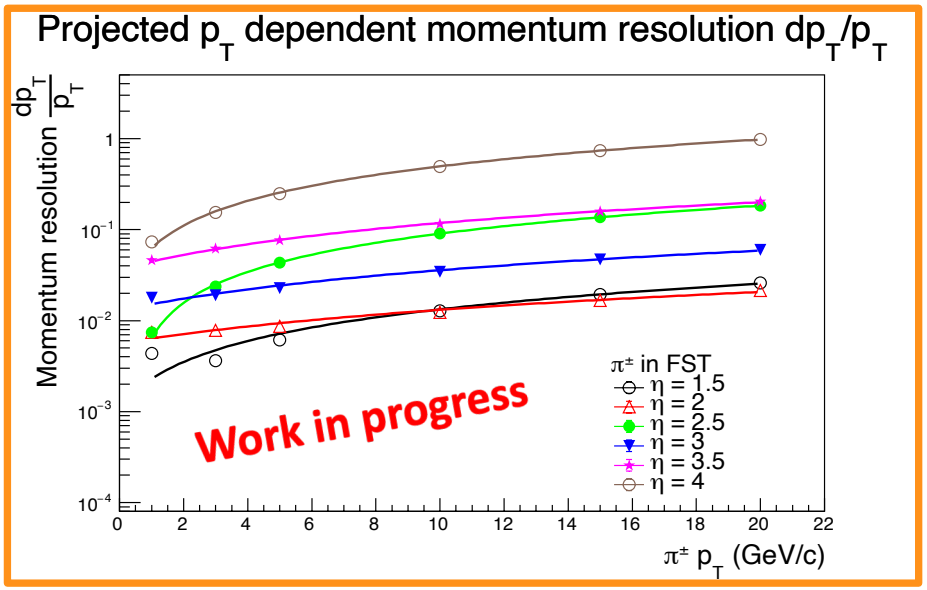
B = 3T

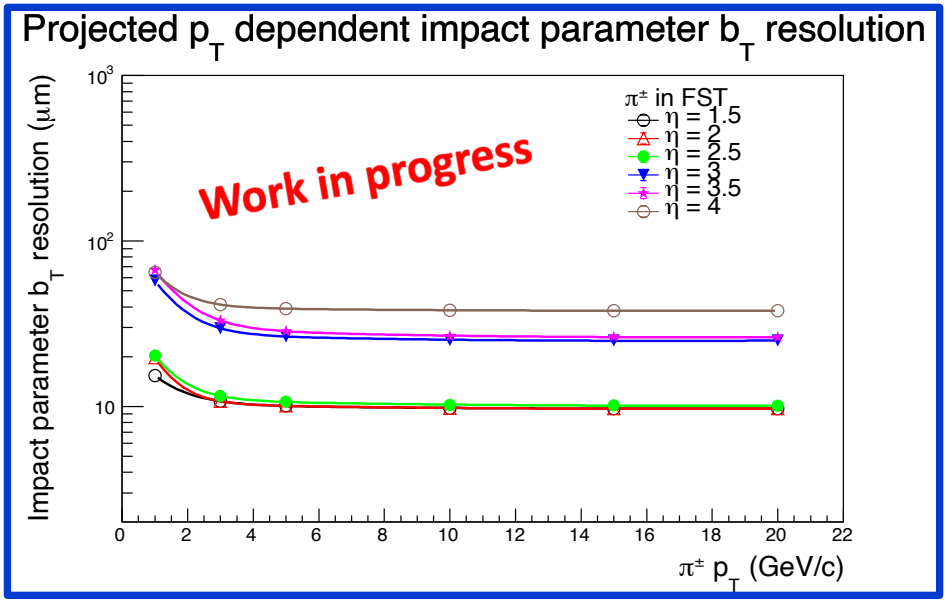
$1.0 < \eta < 4.5$



LANL EIC program progress (II)

- Initial track performance from the FST:





- Better than 70 μm resolution can be achieved by the initial FST design for the transverse decay length b_T measurements for tracks with p_T > 1 GeV/c over the 1.5<η<4.0 region.
- The momentum resolution dp_T/p_T are better than or consistent with the forward tracking requirements from the EIC detector handbook.