Open heavy flavor study updates for the EIC yellow report preparation

Xuan Li on behalf of the Los Alamos National Laboratory

Outline

- The updated detector geometry for the proposed forward silicon tracking detector in fast simulation.

  - Tracking performance in fast simulation.

- Updated open heavy flavor physics simulation results with the updated detector geometry.

  - Kinematic distribution of heavy flavor hadrons.

  - Reconstructed D meson in signal/background ratio with different detector design.

- Plan for the EIC YR Pavia meeting.
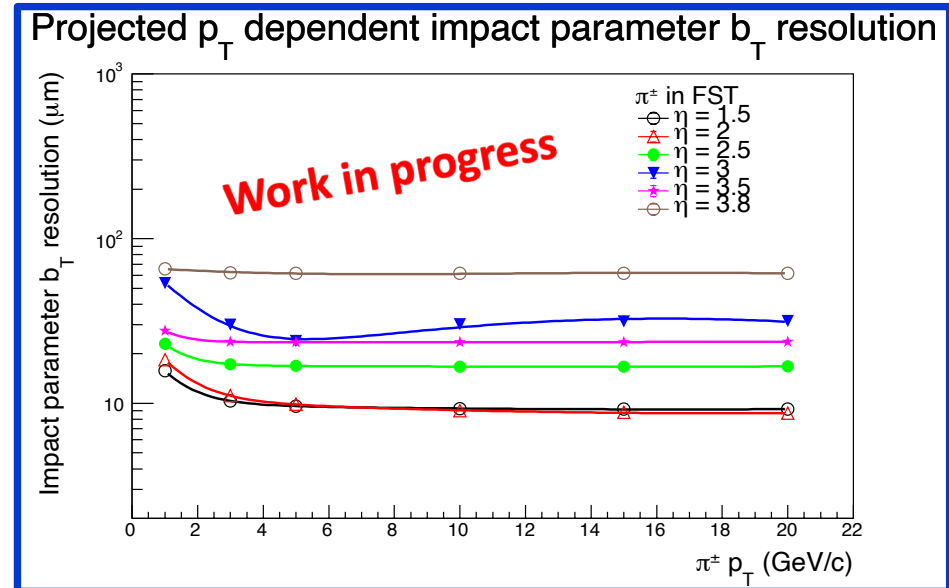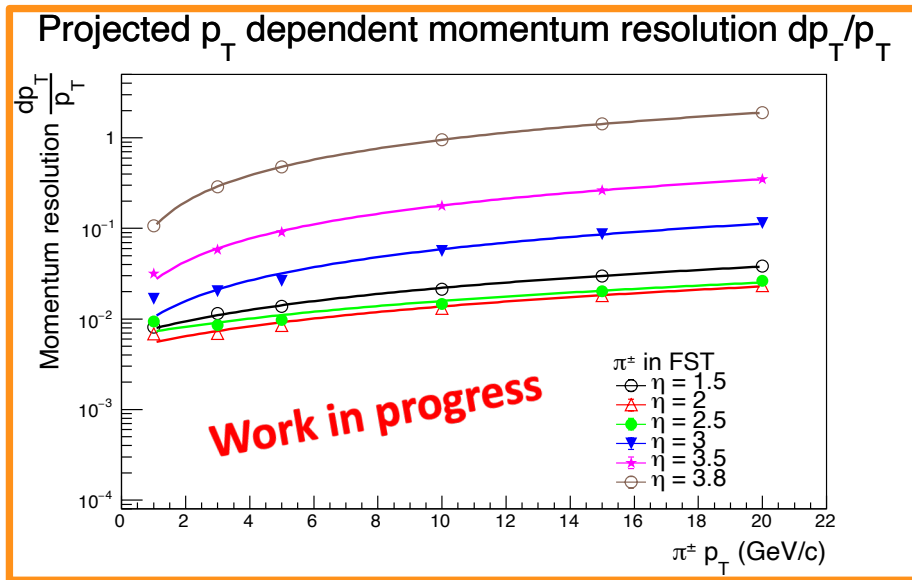
LANL EIC program simulation status:

- ## Detector design in fast simulation (version 1):
  - Assumed 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 + 4 forward planes silicon detector. Update the geometry to leave space for the PID and calorimeter systems.

B = 3T
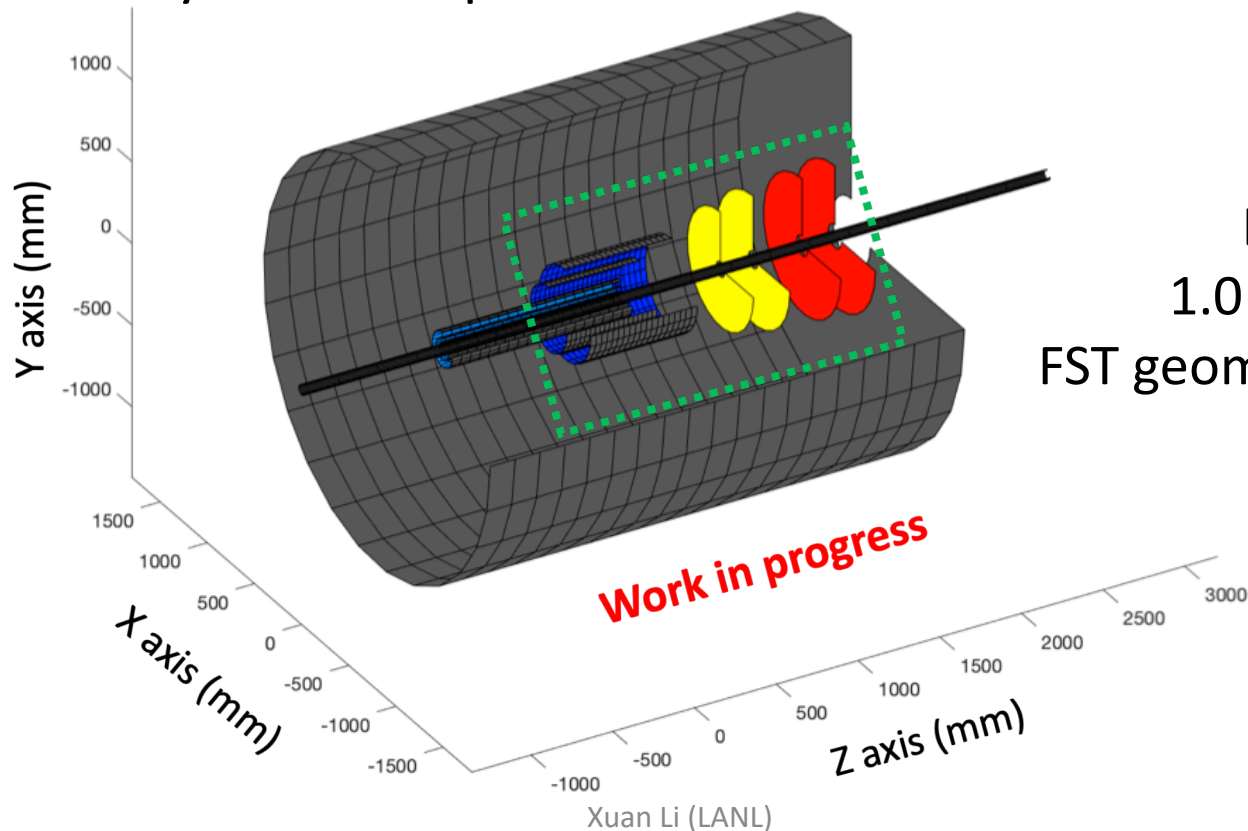
$1.0 < \eta < 4.0$

FST geometry version 1
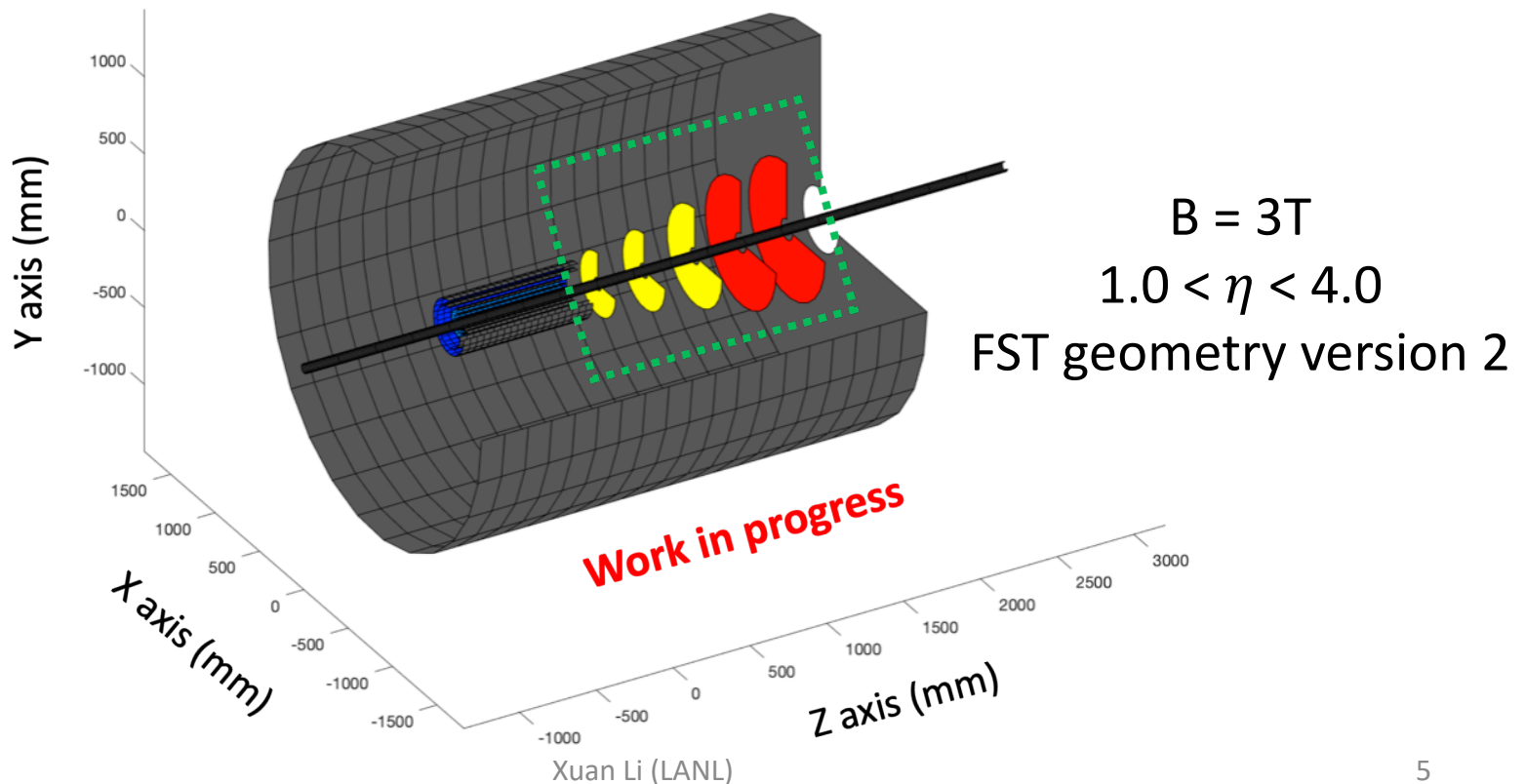
Reference run performance

- Track performance from the FST with pixel pitch 30 μm, materials per detector layer: 0.3%X_0 +0.1%X_0 service and the readout rate is at 500 kHZ, same for the central barrel layers:

Projected p_T dependent momentum resolution dp_T/p_T

Projected p_T dependent impact parameter b_T resolution

- 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<3.5 region.

- The momentum resolution dp_T/p_T are better than or consistent with the forward tracking requirements from the EIC detector handbook.

LANL EIC program simulation status:

- Detector design in fast simulation (version 2):
  - Assumed mid-rapidity silicon vertex detector: 5 barrel layers of Monolithic Active Pixel Sensor (MAPS) type detector.
  - Forward-rapidity silicon tracking detector (FST): 5 forward planes silicon detector (MAPS + HV-MAPS). Update the geometry to leave space for the PID and calorimeter systems.

B = 3T

$1.0 < \eta < 4.0$

FST geometry version 2

Reference run performance

- Track performance from the FST with pixel pitch 30 μm, materials per detector layer: 0.3%X_0 +0.1%X_0 service and the readout rate is at 500 kHZ, same for the central barrel layers:
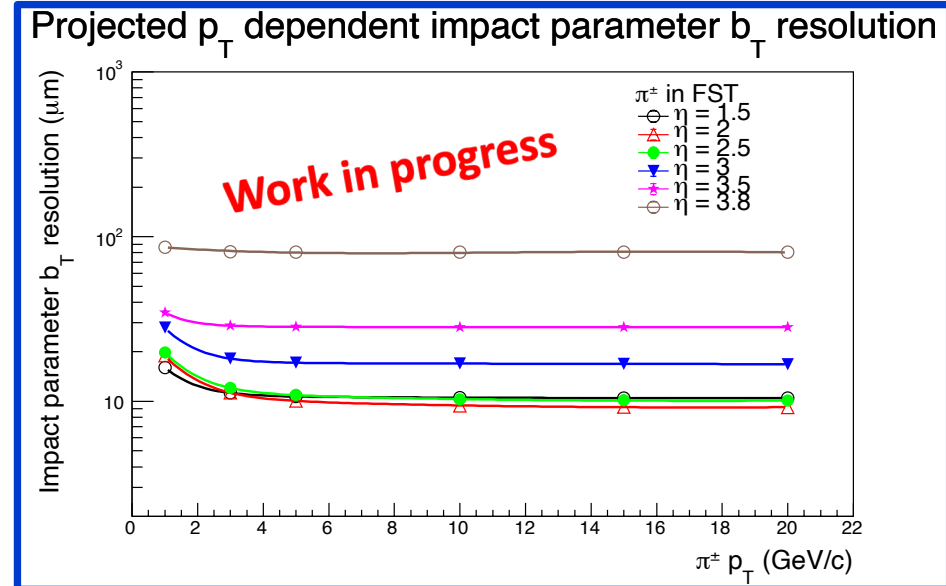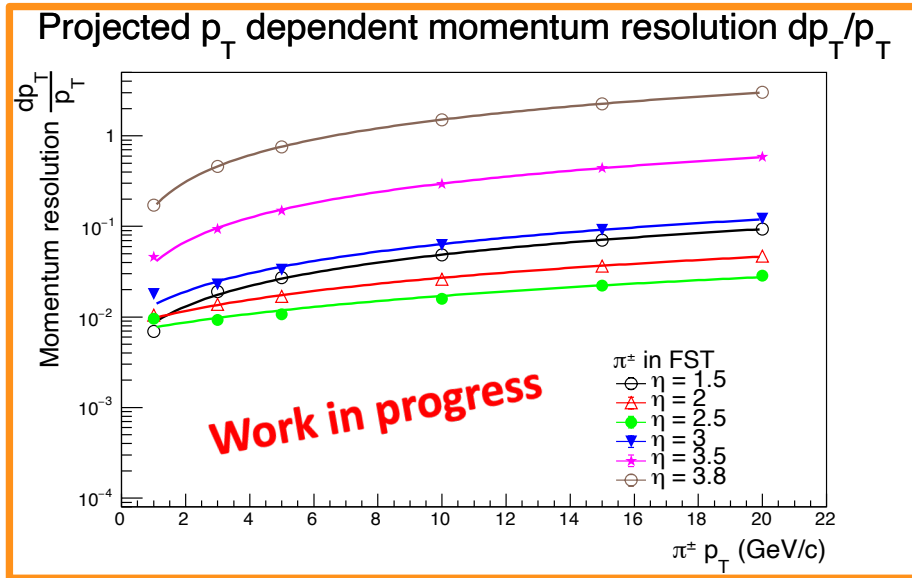

- Better than 70 μm resolution can be achieved by the initial FST design for the transverse decay length b_T measurements for tracks with p_T > 1 GeV/c over the 1.5<η<3.5 region.

- The momentum resolution dp_T/p_T are better than or consistent with the forward tracking requirements from the EIC detector handbook.

Updated reconstructed D meson yields in PYTHIA8 simulation with the new detector design

- Mass distributions of clusters with track transverse decay length matching between charged tracks and K$^\pm$ tracks with the reference parameter setting are shown below. The performances are based on 100% K/π/p separation.

- 18GeV electron + 100 GeV proton collisions Integrated luminosity: 10 fb^{-1}

Track η 0.5 to 4
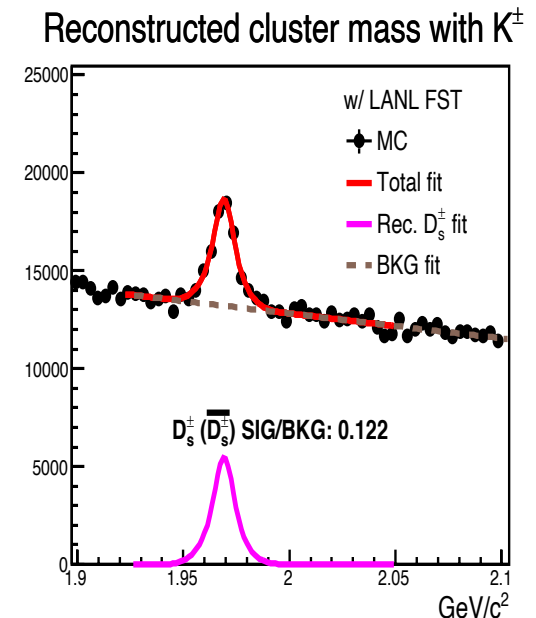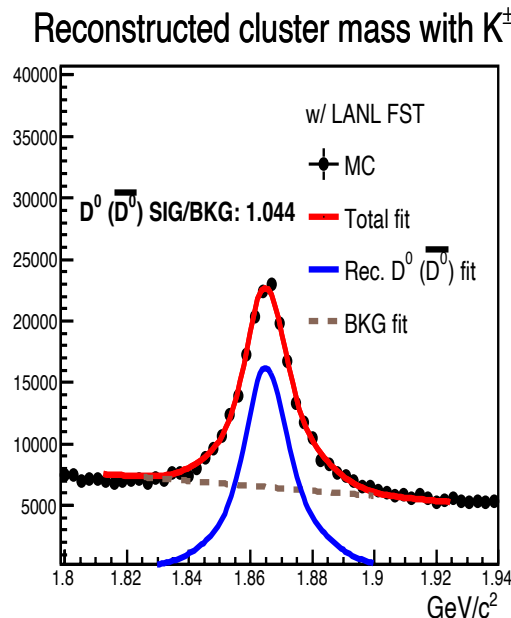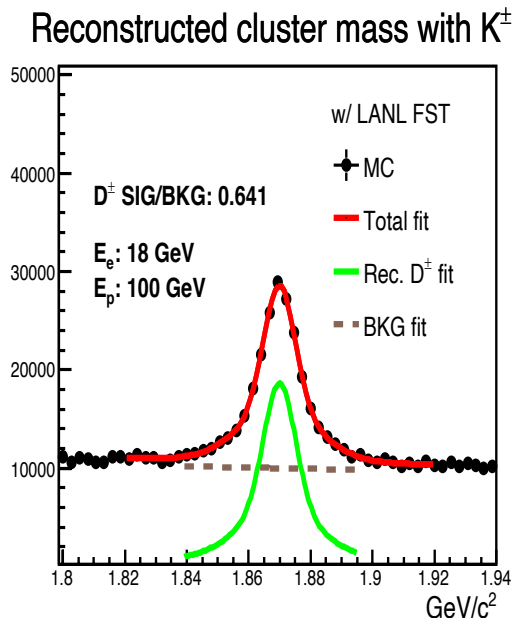
Kinematic distributions of reconstructed D-mesons

- 18GeV electron + 100 GeV proton collisions with Integrated luminosity: 10 fb^{-1} .

- Reconstructed D-meson momentum VS pseudorapidity (left) and the momentum VS pseudorapidity distribution for the D-meson decayed daughters (right).

Reconstructed D p VS η

Reconstructed D daughter p VS η
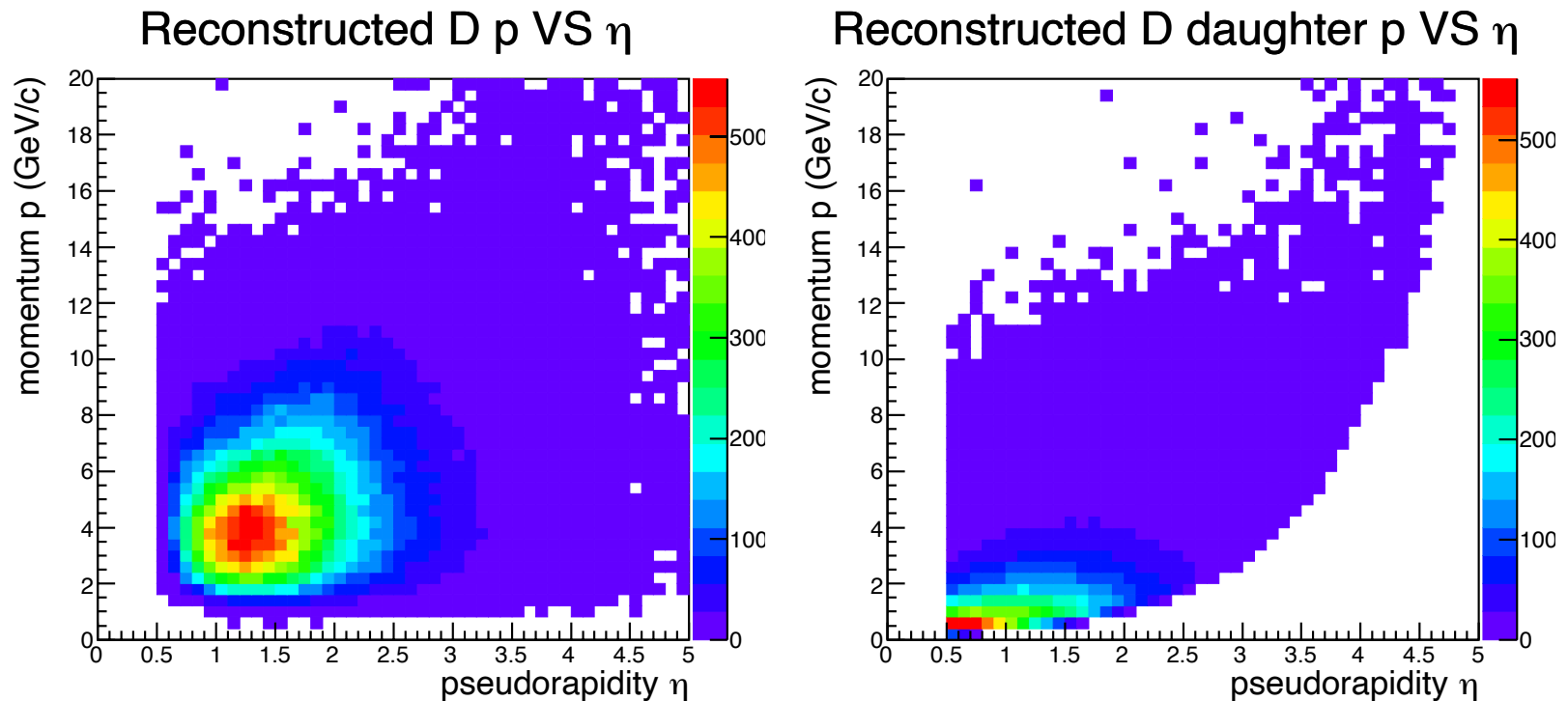
EIC Pavia plan

- The updated FST geometry has been implemented in the Fun4All framework with the Barbar magnet with the help from Jin Huang (BNL).

- We will continue optimize the design/geometry of the forward silicon tracker and evaluate the tracking performance.

- In the EIC Pavia meeting, we will report
  - Updated heavy flavor reconstruction with updated detector design and performance.
  - Updated physics projection such as R_{eA}.
  - Provide detector performance requirements for tracking and PID detector.
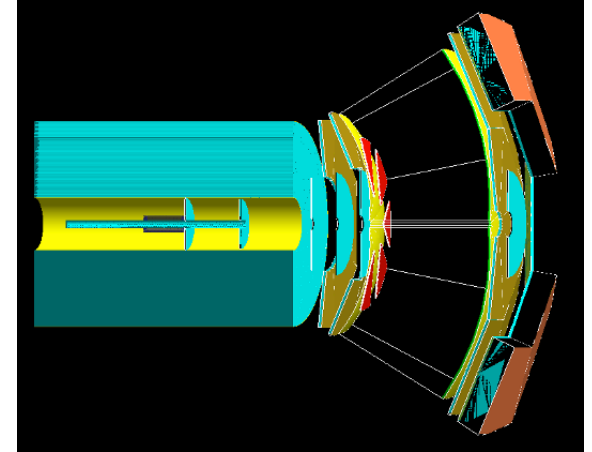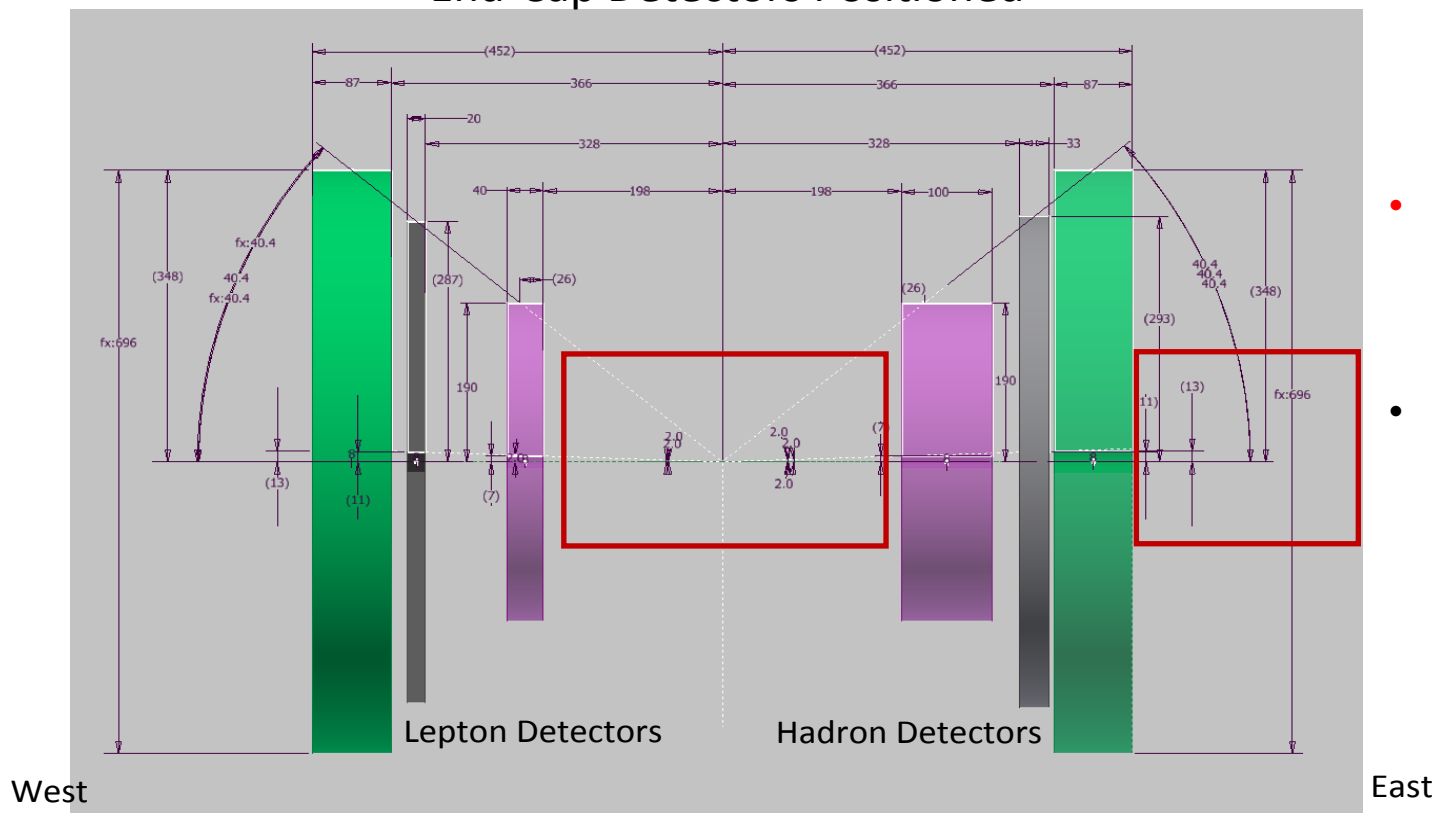
Backup

Integration requirements for EIC detector

- The EIC central detector side view:
- From EIC dector WG conveners (BNL engineer, pre-CDR, Apr. 13th).

EIC Detector Infrastructure
End-Cap Detectors Positioned

- Proposed central+forward tracking detector location.
- Updated IR and request additional space for tracking?

Lepton Detectors   Hadron Detectors

West   East

Pink = PID/RICH,   Grey = ECAL,   Green = HCAL