Λ_c simulation in the future EIC

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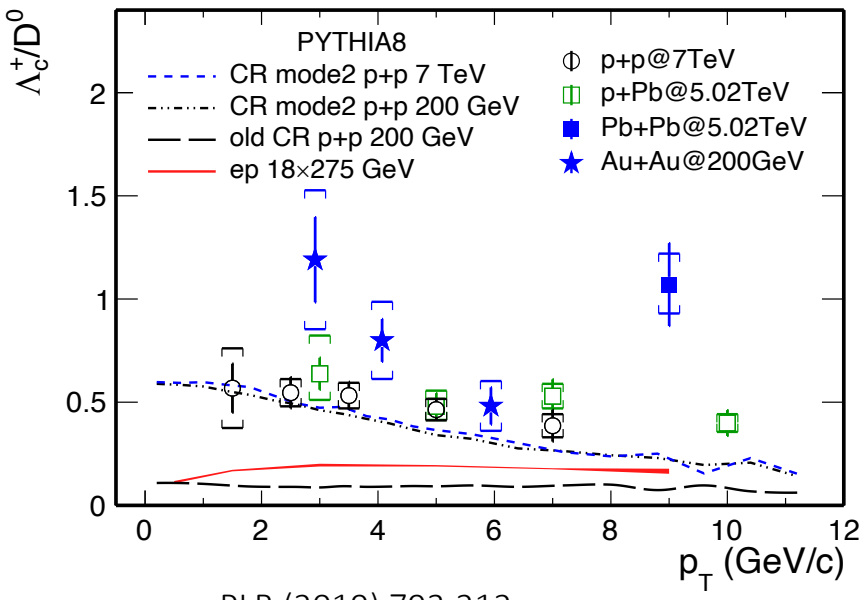
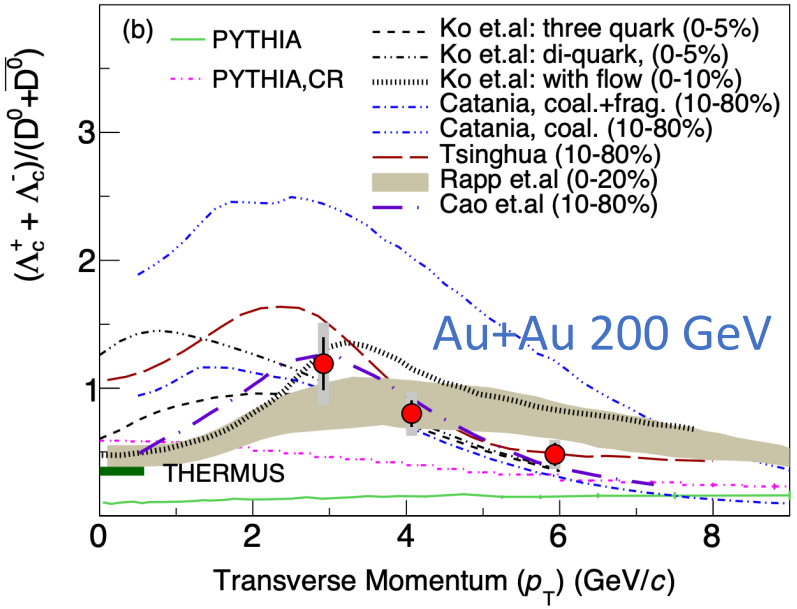
Motivation

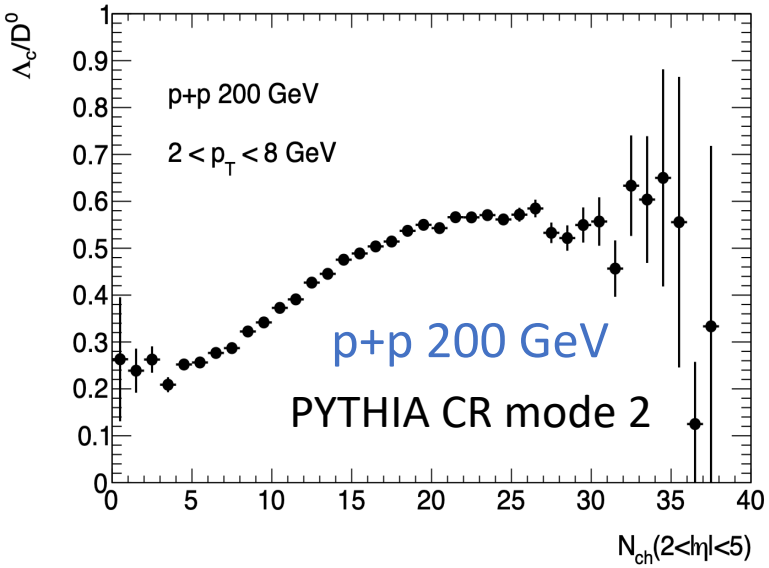
- Charm hadronization
  - Fragmentation failed to describe Λ_c^+/D^0 in p+p and A+A collisions
  - A+A collisions - quark coalescence
  - p+p collisions - color reconnection (CR) J. Christiansen JHEP (2015) 8:003

    - new CR mode, junction reconnection -> enhance baryon production



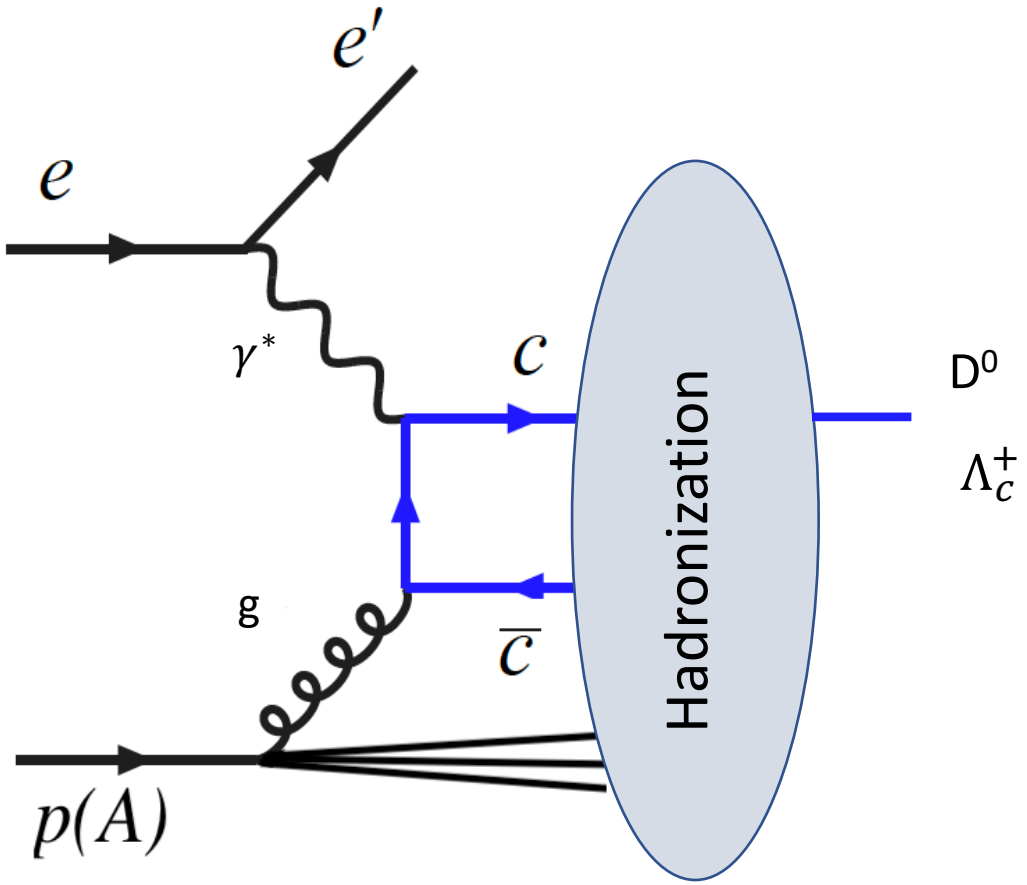
PLB (2019) 793:212
JHEP (2018) 04:108
PRL (2020) 124:172301





Λ_c in e+p/A collisions

- Better understand and controlled initial state condition



Λ_c reconstruction in future EIC

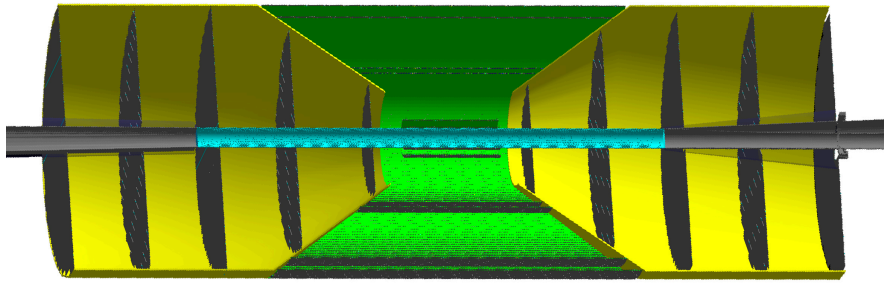
ep 18x275 GeV from PYTHIA6 with EIC tune → Fast simulation Detector response on single tracks → Reconstruction

https://eic.github.io/software/pythia6.html

$\Lambda_c^+ \to pK^-\pi^+$ (B.R.=6.28%)

$\Lambda_c^+ \;\; c\tau \sim 60\ \mu m$

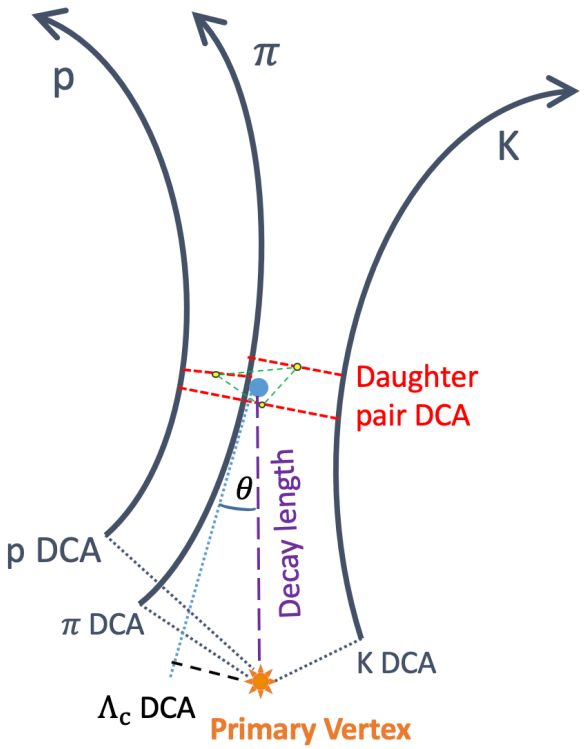
All-Silicon Tracker detector for the Electron Ion Collider



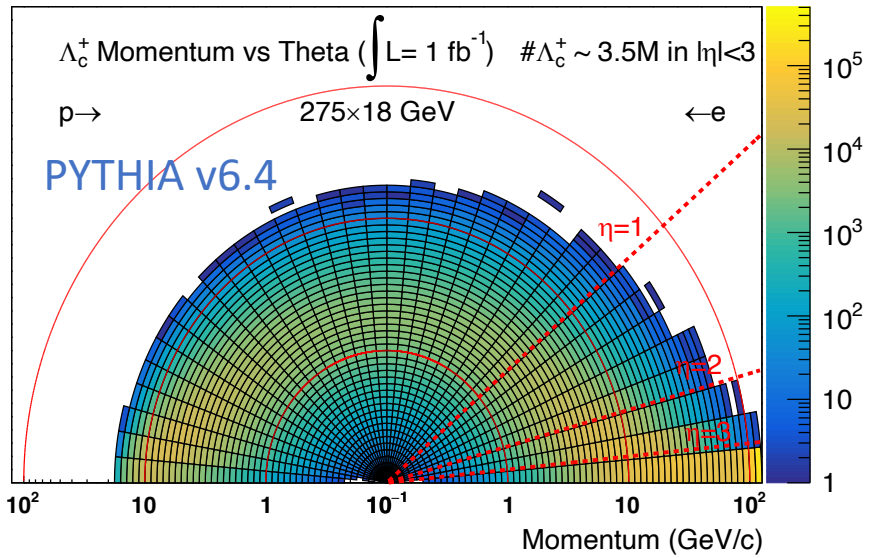
detailed introduction in Reynier's talk

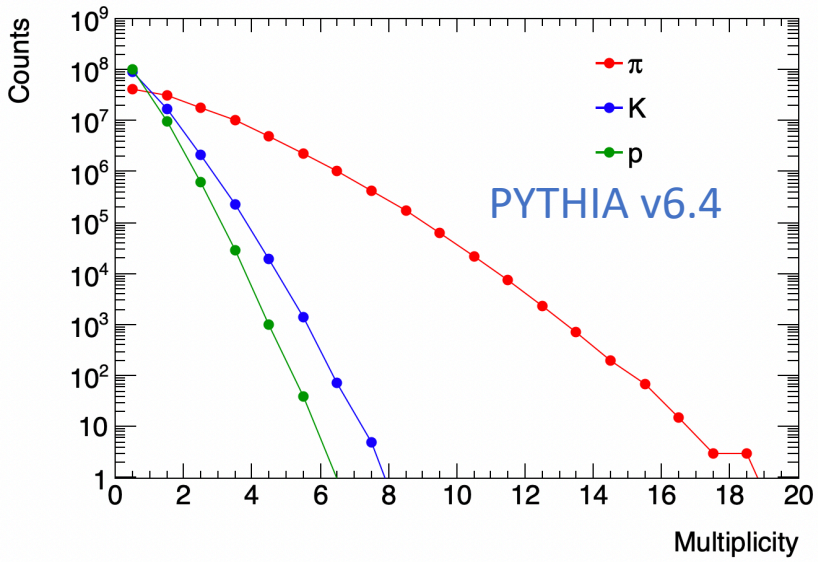
Detector set up parameters same as Matthew's talk

- Pointing resolution
- Momentum resolution based on B = 3 T
- Primary vertex resolution from full Geant4
- Tracking efficiency from full Geant4
- PID scenario https://physdiv.jlab.org/DetectorMatrix/

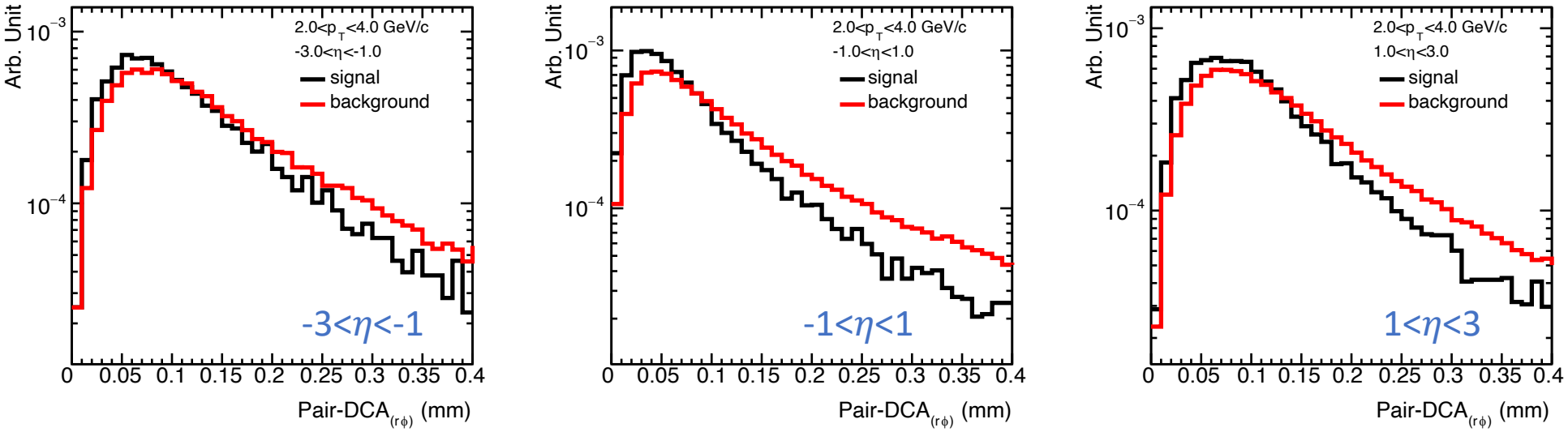


Acceptance and selected topology performance



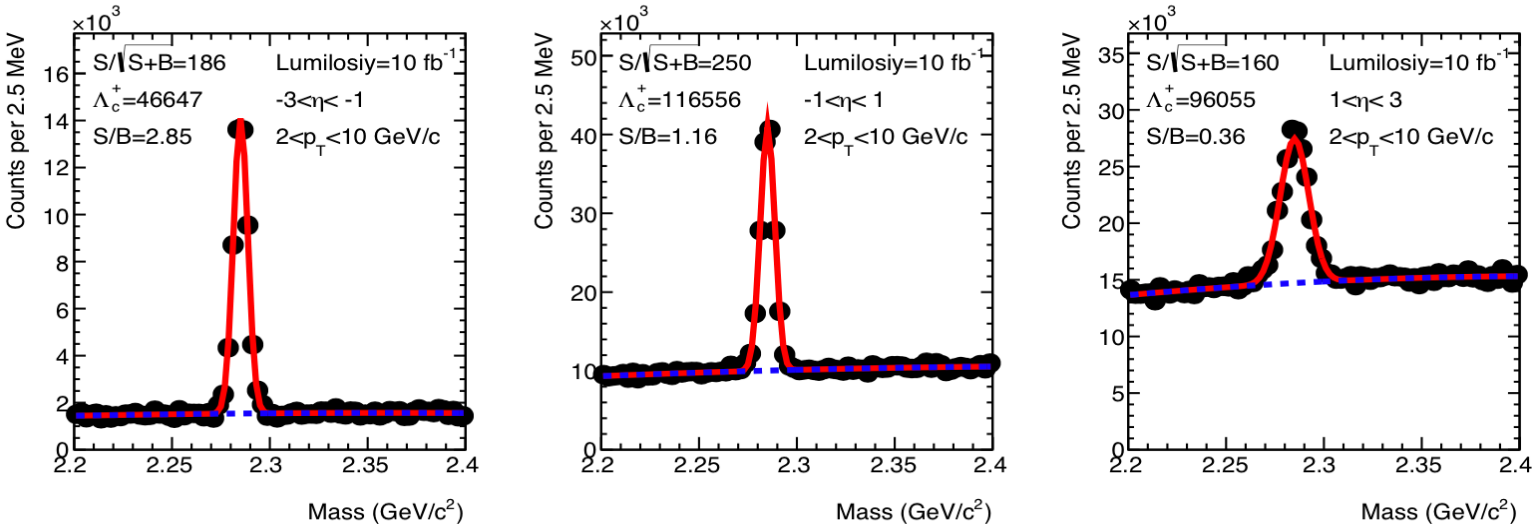


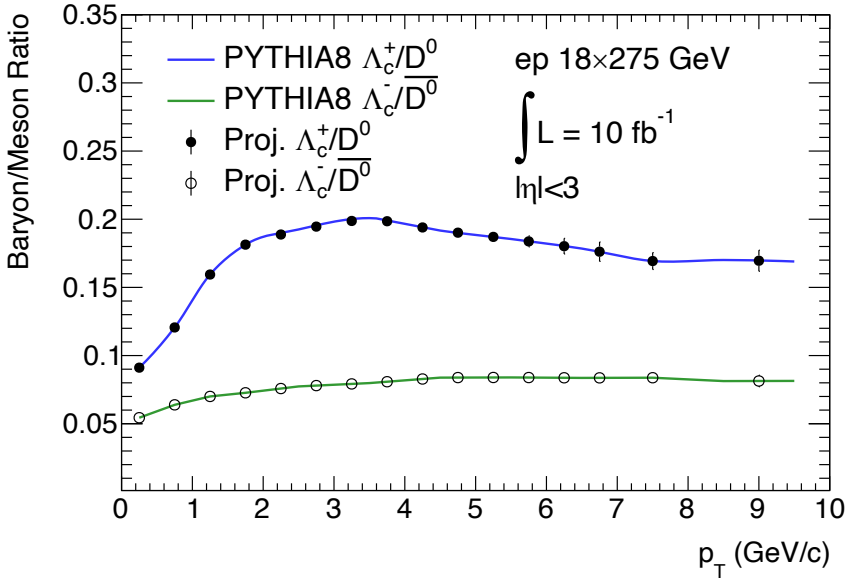
Expect lower combinatorial background level than pp collisions

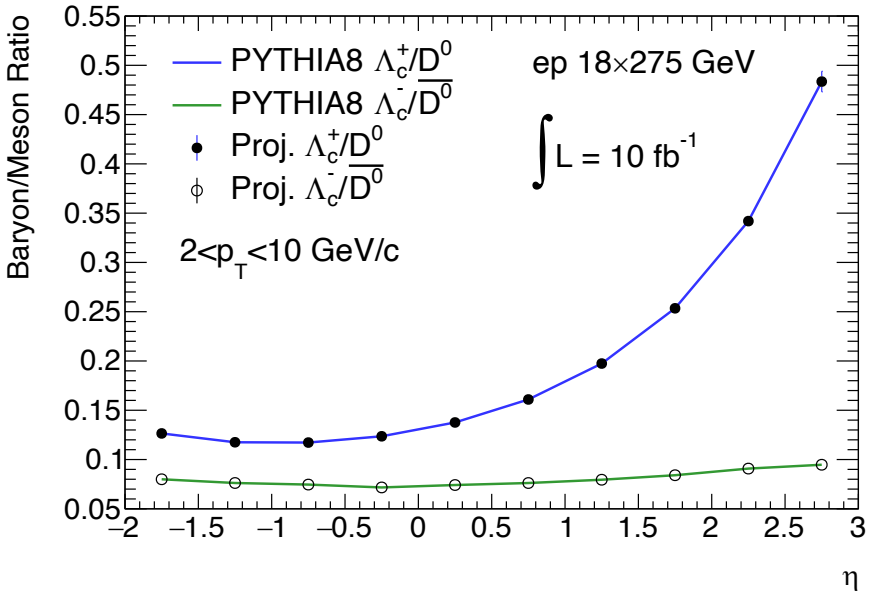


Normalized Pair-DCA distribution in different η regions

Physics projections



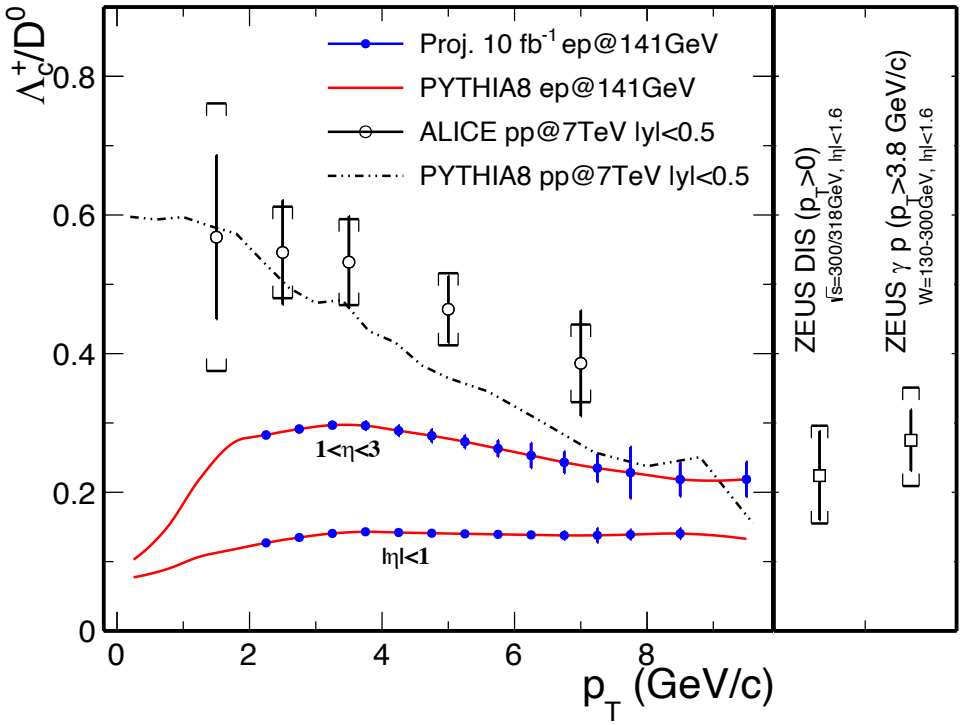




- Precise $\Lambda_c^{\pm}$ measurements over board momentum and η range

Summary

- Λ_c^+/D^0 measurements – charm hadronization
  - p+p: current knowledge - color reconnection with baryon junction
  - e+p and e+A ?
- Simulation on Λ_c reconstruction in e+p 18+275 GeV collisions
  - Precise measurements of charm baryon over board momentum and η range in the future EIC



- Back ups

Λ_c reconstruction in future EIC

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https://eic.github.io/software/pythia6.html

Fast simulation
Detector response on single tracks

Detector set up

- Pointing resolution (DCA resolution)
- Momentum resolution based on B = 3 T
- Primary vertex resolution from full Geant4
- Tracking efficiency from full Geant4
- PID scenario

Pointing resolution (Transverse)

	Resolution (XY) (μm)
$\lvert\eta\rvert$<1	$5 \oplus 20/p_T$
1<$\lvert\eta\rvert$<2	$20 \oplus 30/p_T$
2<$\lvert\eta\rvert$<3	$40 \oplus 30/p_T$

Momentum resolution

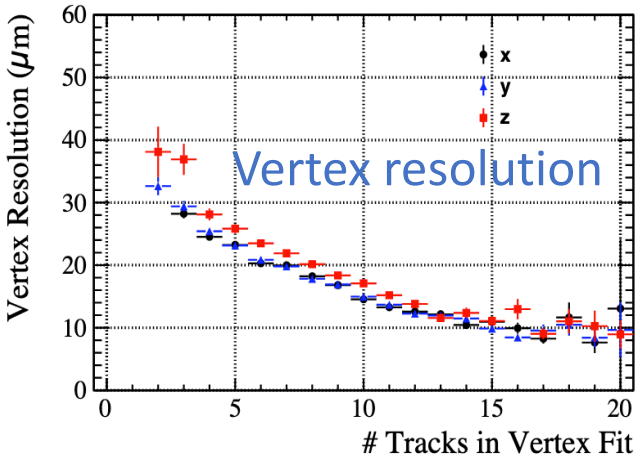
η	Resolution %
-3.5<η<-2.0	$0.1 \cdot p \oplus 0.5$
-2.0<η<1.0	$0.05 \cdot p \oplus 0.5$
1.0<η<2.5	$0.05 \cdot p \oplus 1.0$
2.5<η<3.5	$0.1 \cdot p \oplus 2.0$

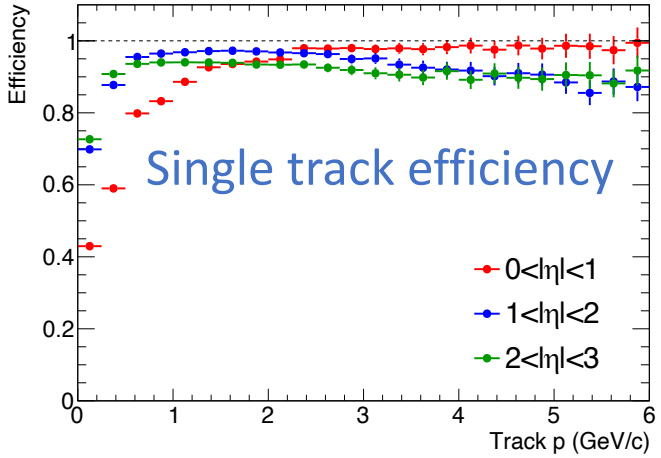
Assumed 3σ separation between π/K/p

η	Momentum
-3 <η<-1.0	p < 10 GeV/c
-1.0<η<1.0	p < 6 GeV/c
1.0<η<3.0	p < 50 GeV/c

Full Geant4 simulation from Matthew

https://indico.bnl.gov/event/9398/contributions/41400/attachments/30474/47775/Kelsey_EICJetsHF_21Sep2020.pdf





Λ_c reconstruction in future EIC

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- Reconstruction channel

Other channels:
$\Lambda_c^+ \to pK_s^0$ (1.58%)

Signal:

Λ_c^+ decay in PYTHIA — Scale to total B.R.=6.28%

$\Lambda_c^+ \to pK^-\pi^+$ non-resonant 2.96% (PDG 3.4%)

$\to \mathrm{p}\overline{K^{*0}}$ ~0.5% (PDG 1.94%x66.7%)

$\to \Delta^{++}K^-$ ~0.65% (PDG 1.07%x99.4%)

$\to \Lambda\pi^+$ missing $\Lambda \to pK^-$ (PDG 2.2%x22.5%)

Combinatorial background

- Combinations of $pK^-\pi^+$ triplets with right-sign (mis-PID if particles cannot separated)
- Reject Λ_c^+ resonance channel signals