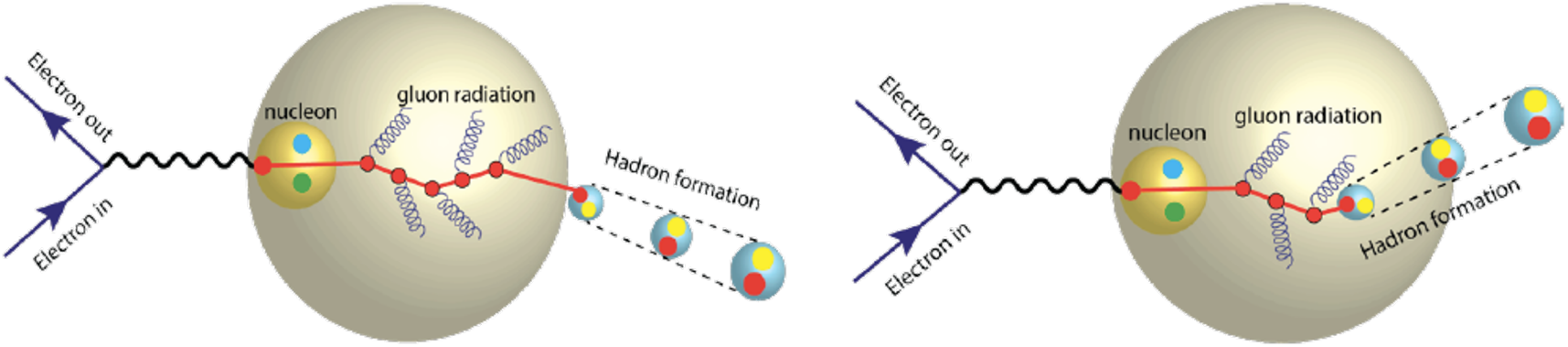
Los Alamos NATIONAL LABORATORY

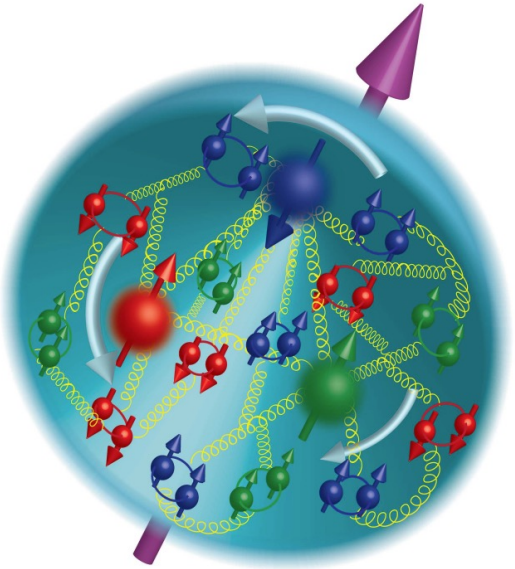
Update from HF and Jets Working Group

Cheuk-Ping Wong & Wangmei Zha

10-11-2021

EIC Physics via HF and Jets





- Propagation of energetic quarks through matter
- Tomographic imaging of quarks and gluons
- 3D imaging in momentum space

Proposed Plots for Detector Proposal

- Propagation of energetic quarks through matter
  HF and jet ReA
  Xinbai Li and Wangmei Zha of USTC
  Xuan Li of LANL
  Raymond Ehlers of ORNL

- 3D imaging in momentum space
  η_{jet} vs. z_{jet} using Centauro algorithm
  jet q_{prep}vs. z_{jet}
  jet charge Distribution of u-quark and d-quark jets
  John Lajoie of ISU

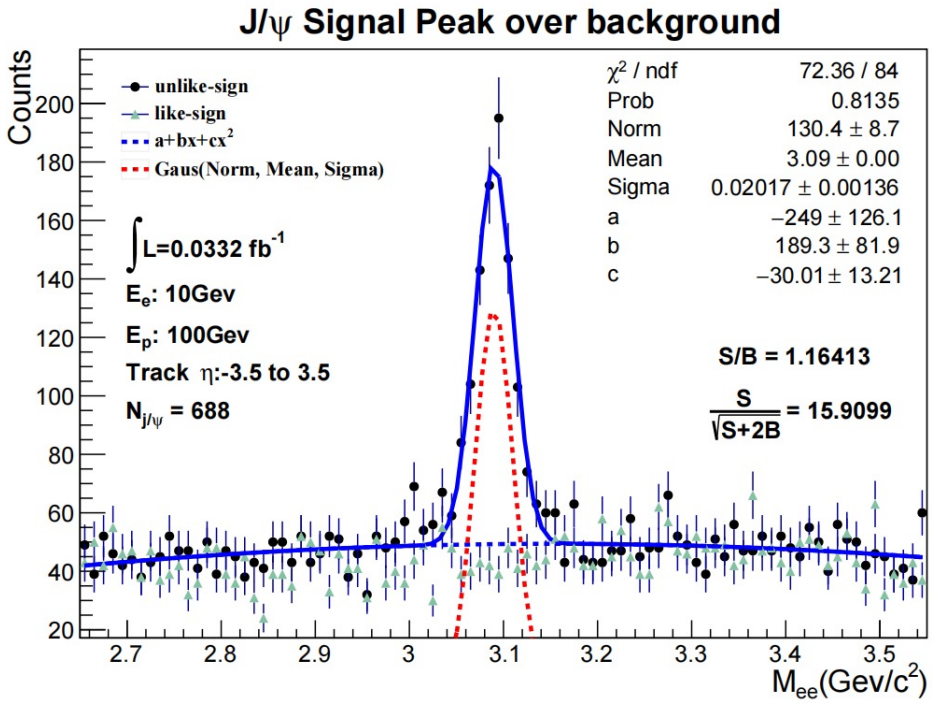
- Tomographic imaging of quarks and gluons
  Dihadron azimuthal angle correlation
  Nathan Grau of Augie

- Detector performance study
  Jet energy scale and resolution
  Jet momentum and angular resolution
  Tristan Protzman and Rosi Reed of Lehigh

Invariant mass of J/ψ→e+e-

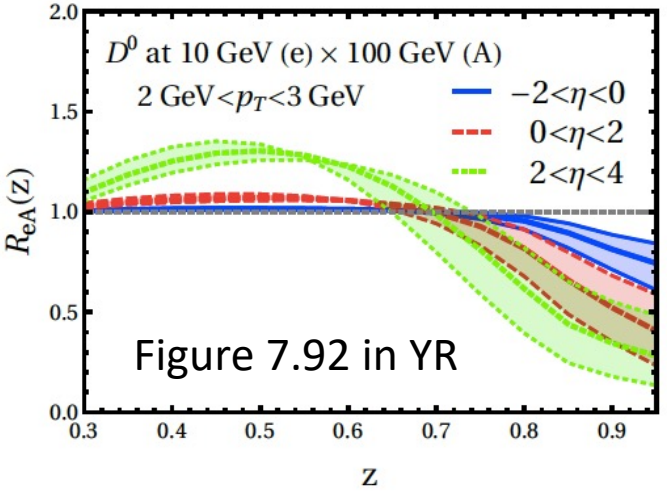
Using track evaluator from the 1st simulation campaign with perfect eID

Pythia 8, 10x 100 ep

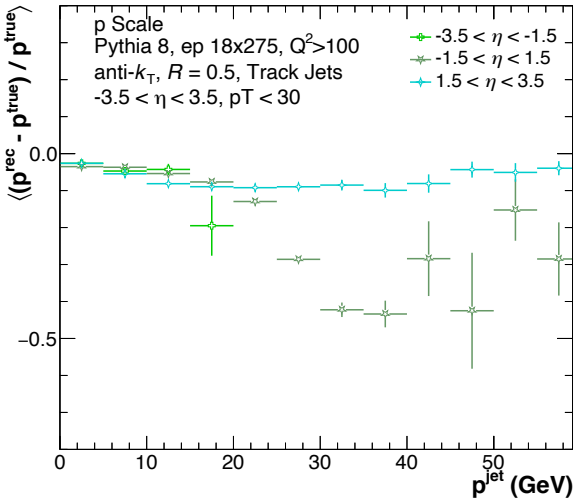


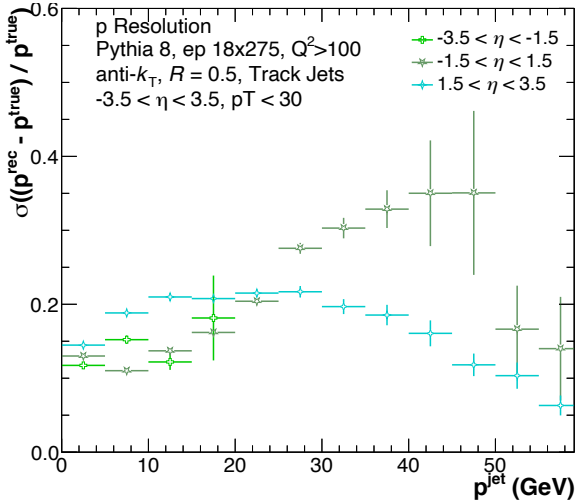
- Light cone cut applied to remove beam electrons
- Veto e± from light hadron decay
- Clear J/ψ peak with S/B=1.16

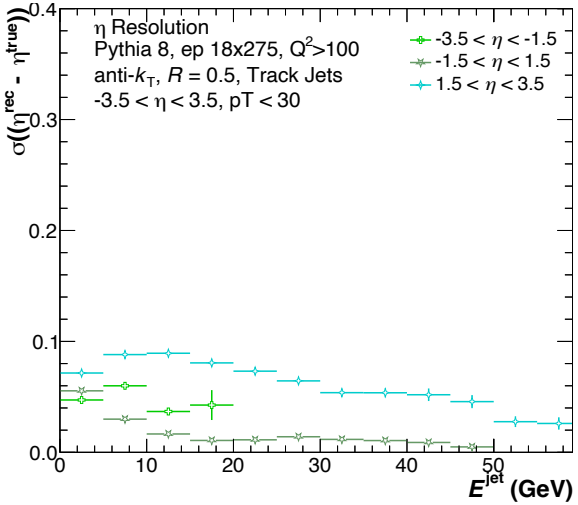
Goal: $R_{eA}(z)$
Working on extracting z

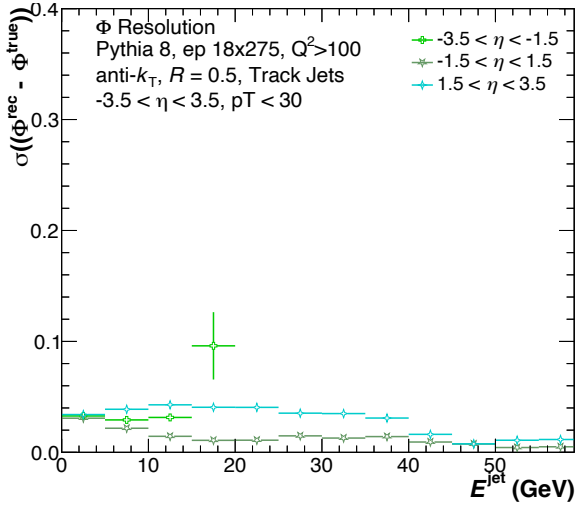


Performance of Track Jet Reconstruction





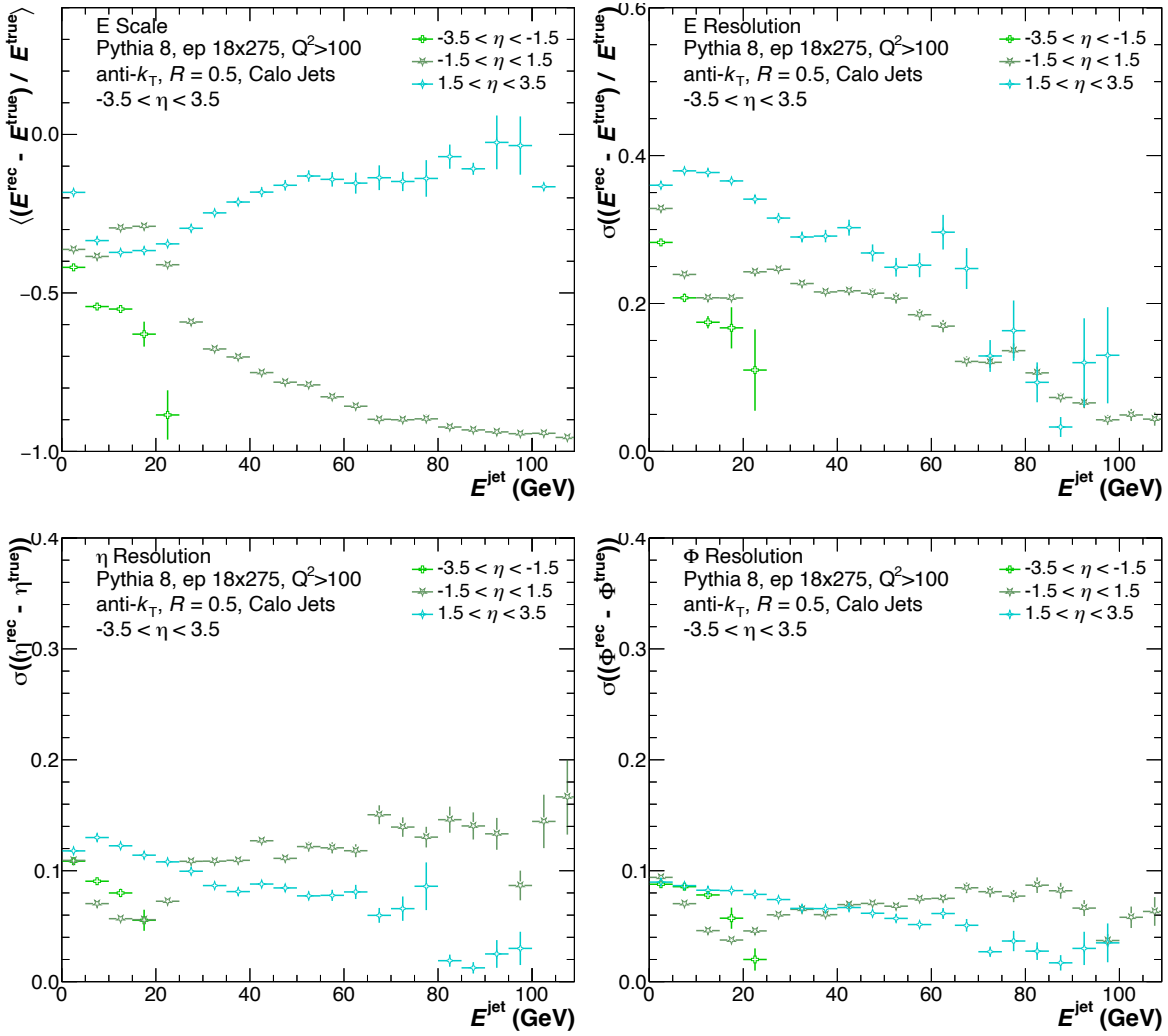




- July concept, Pythia 8
- 18x275 GeV ep collisions
- Q^2>100 GeV^2
- Jet R=0.5
- $|\eta| < 3.5$
- p_T<30 GeV

- Momentum scale and momentum resolution of track jets gets worse at higher p_{jet} (p_{jet}>20 GeV)
- η and ϕ resolutions are under 10% and 5%, respectively

Performance of Calorimeter Jet Reconstruction



- July concept, Pythia 8
- 18x275 GeV ep collisions
- Q^2>100 GeV^2
- Jet R=0.5
- $|\eta| < 3.5$

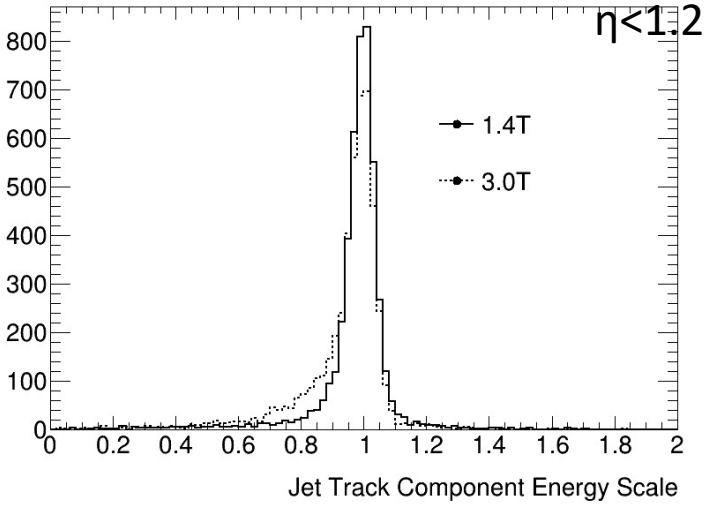
- Jet energy scale of the calorimeter jets gets worse at higher E_{jet} (E_{jet}>20 GeV)
- η and ϕ resolution are under 20% and 10%, respectively

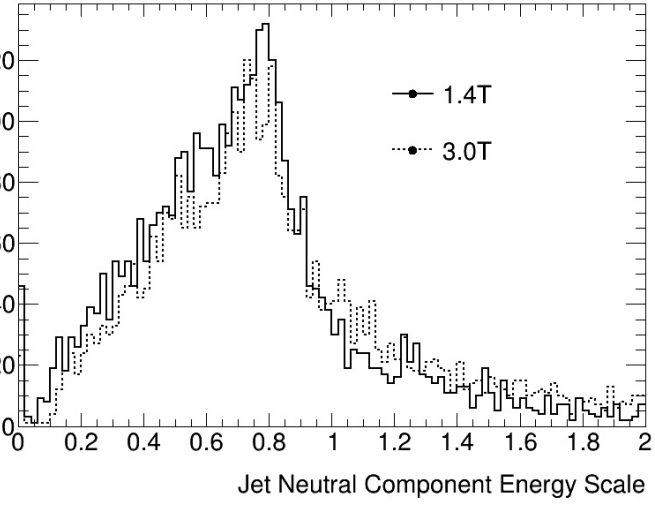
Next: understand the causes of the worsening JES and jet momentum reconstruction

Reco. Jet Properties in Different Field Strengths

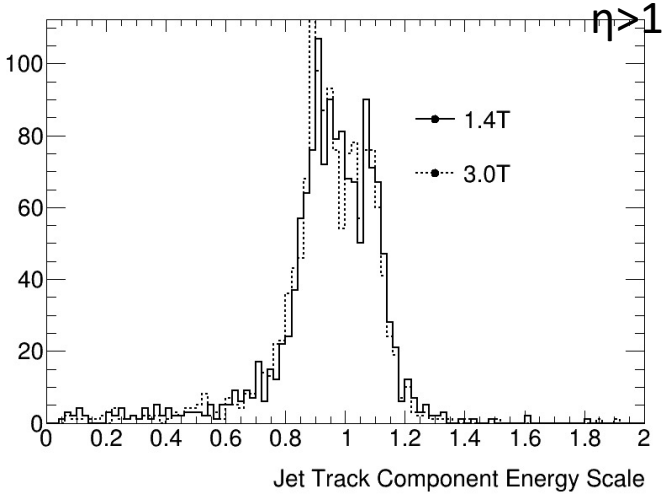
Using Centauro Algorithm

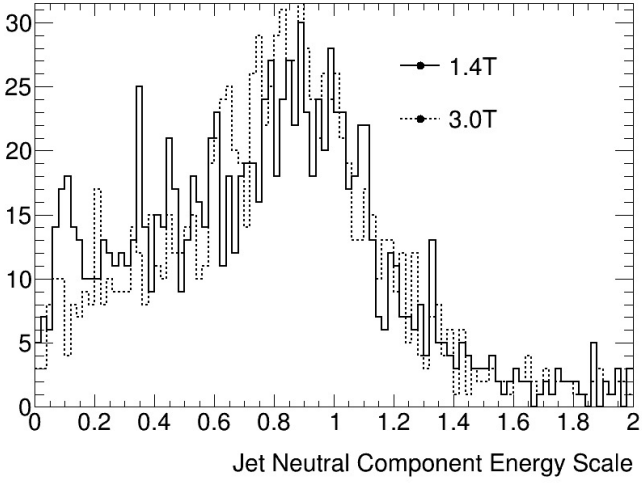
η<1.25





η>1.25

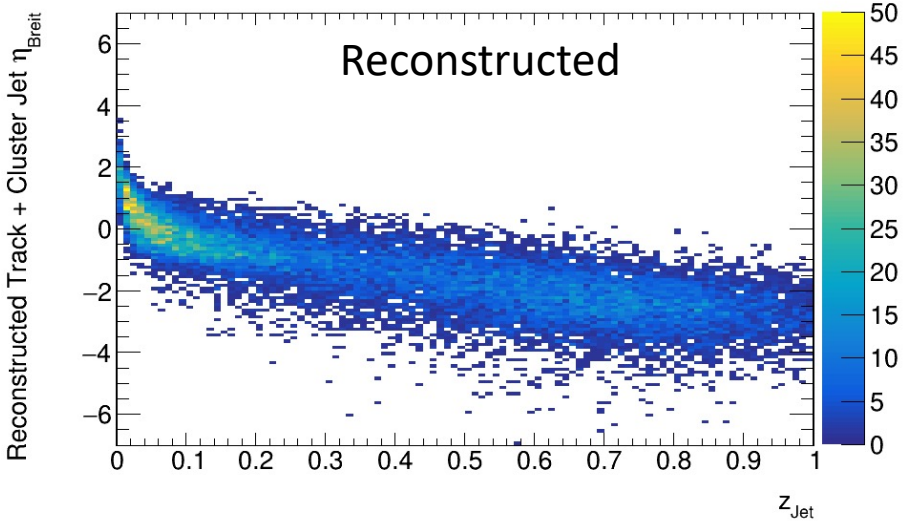




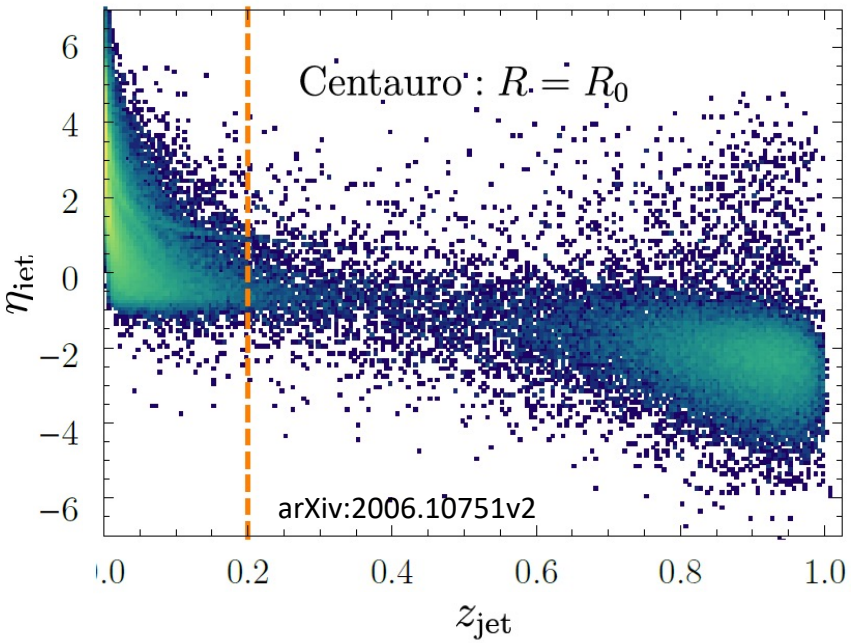
Jet energy resolution worsen slightly with 3T magnetic field in the barrel region

Jet finding using Centauro Algorithm: η_{jet} vs z_{jet}

Pythia6 events from SIDIS WG, 10x100
July concept, 20k events, R=0.8



Pythia8, 10x100, Q>10, R=0.8

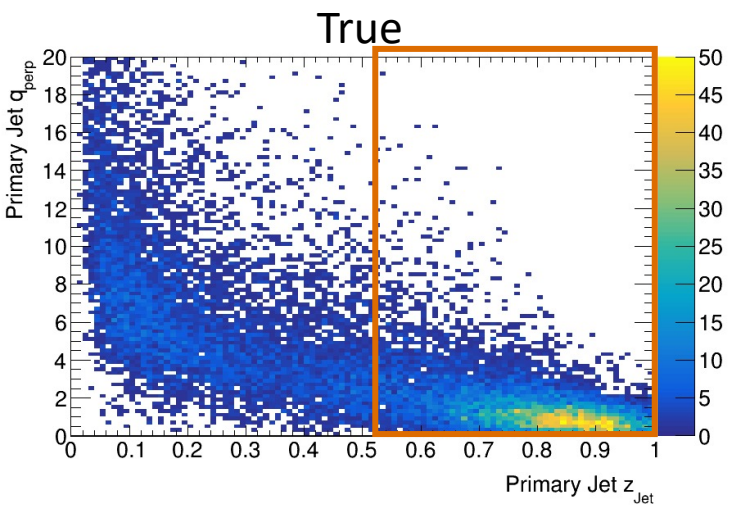


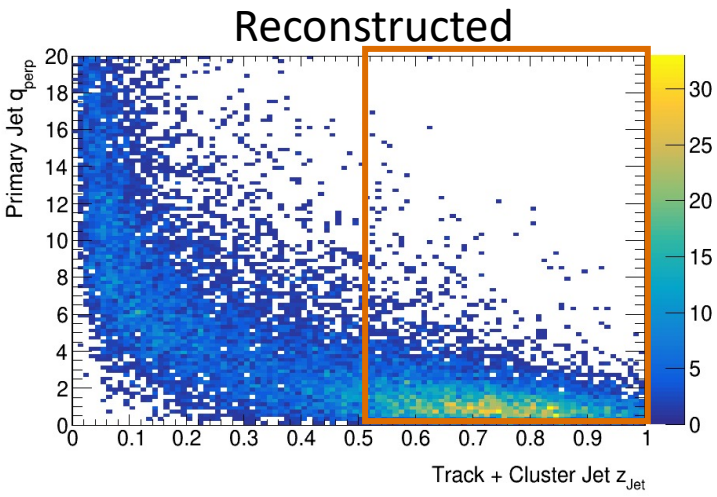
- Add in neutral clusters – isolated clusters without a track within 0.1 in $\Delta\eta$, $\Delta\phi$ space
- Smearing in z_{jet} in simulation results:
  - ECCE lab frame includes crossing angle, but the Centauro paper consider head on collisions
  - Missing energy → lower the z_{jet}
  - Different event generators

q_{Prep} vs z_{jet} and Jet Charge

Using Centauro Algorithm

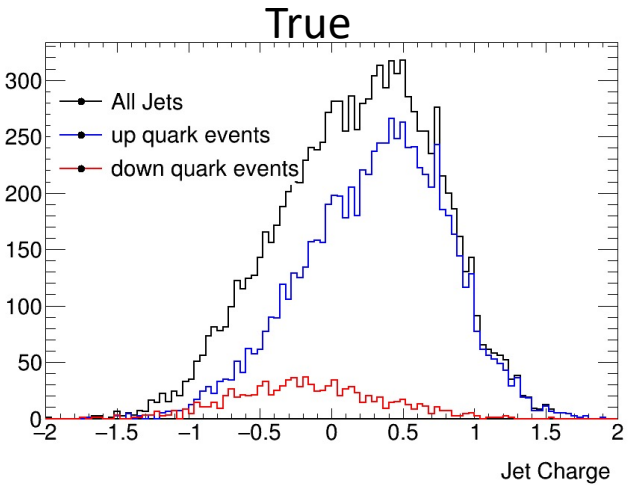
July concept (Pythia 6)

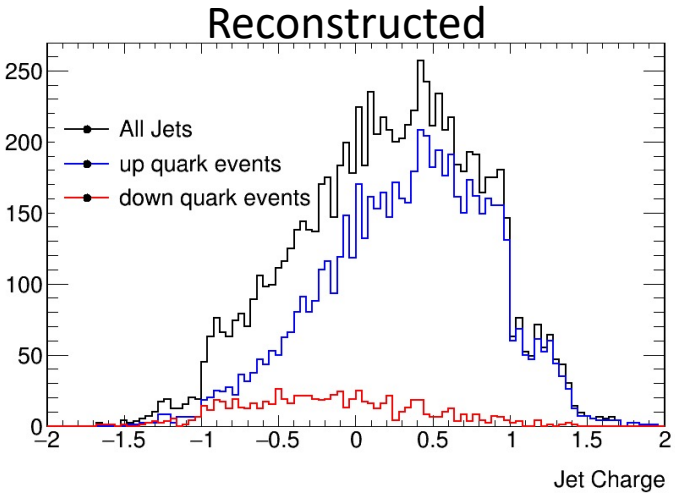




$$q_{prep} = p_{jet}^{\perp}/z_{jet}$$

q_{prep} in $0.5 < z_{jet} < 1$: this is the transverse momentum of the jet with respect to the scattered quark direction



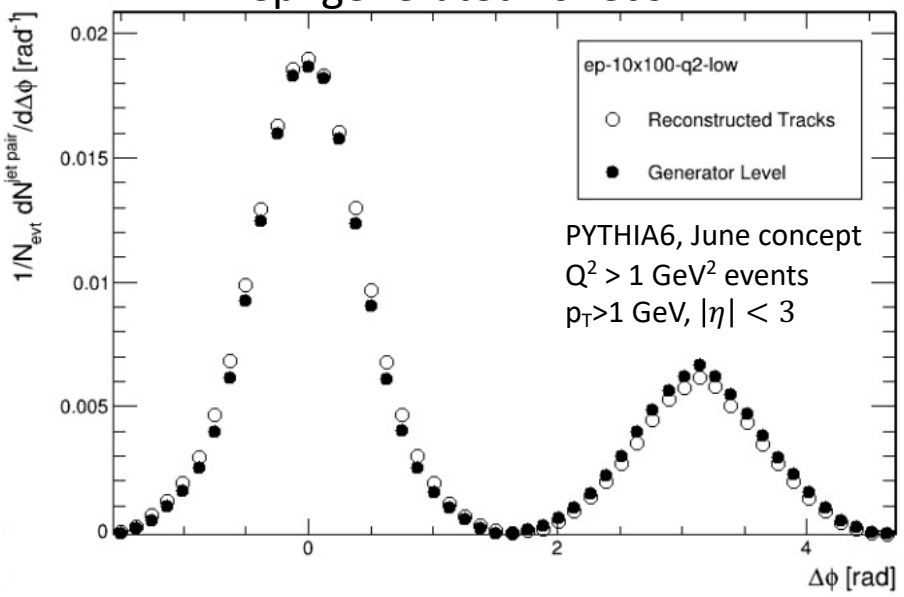


$$Q_{jet} = \frac{1}{\sqrt{p_T^{Jet}}} \sum_i q_i p_i^{0.5}$$

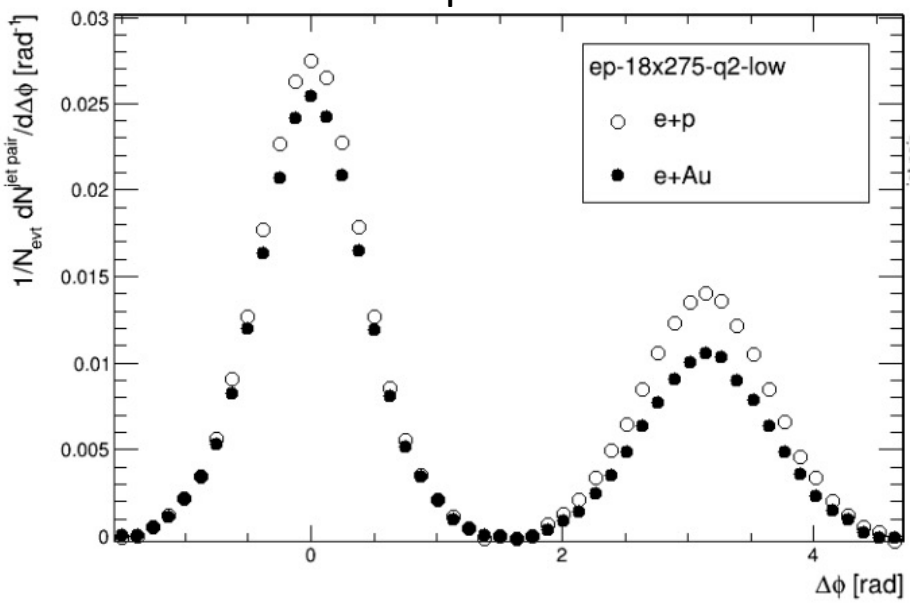
Possible to isolate statistically enriched samples of u,d quarks jets

Two-Particle Correlations

ep: generated vs reco



ep vs eA



- Tracks are boosted for the beam crossing angle
- Use EPS09 weighting to calculate the nPDF weight for eAu For each event:
  - x_{Bj} is saved in the EventEvaluator ntuples
  - Identify the scattered electron to calculate Q^2
  - Identify the struck parton as the first parton in the PYTHIA event record
  - Apply the event weight at fill-time to e+Au histograms
- Next: produce the same set of plots for 2nd simulation production

EPS09 weighting will be applied in jet R_{eA} study as well

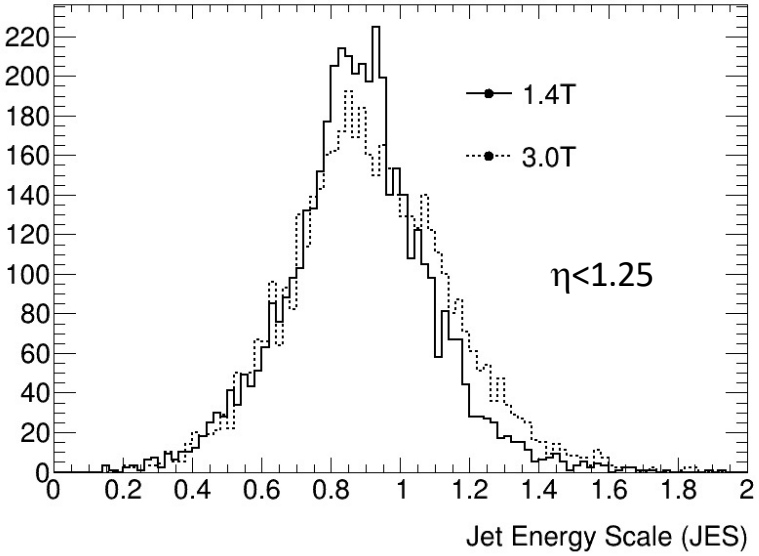
https://indico.bnl.gov/event/13133/contributions/55463/attachments/37471/61757/Grau_nPDFWeighting_20211001.pdf

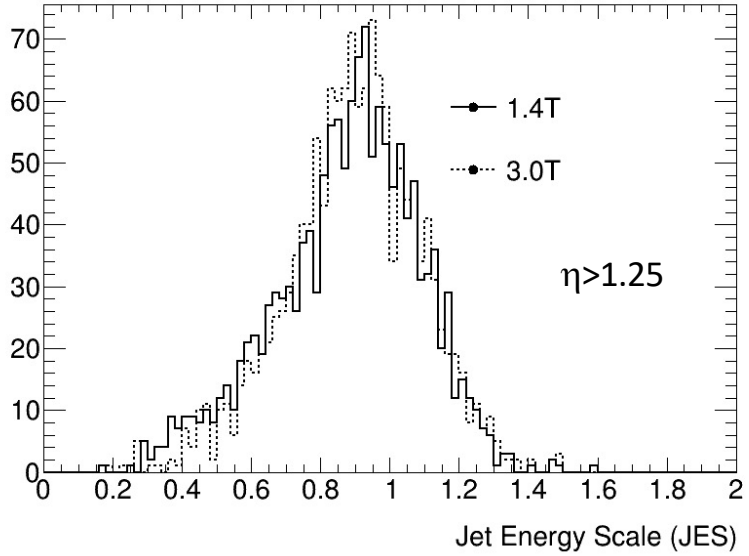
Summary

Physics plots	plan
HF R_{eA}	Working on extracting z for $R_{eA}(z)$
Jet reconstruction performance	Figure out the worsening of momentum scale, JES and JER at high jet momentum/energy
Jet R_{eA}	Apply EPS09 weighting for eA events
η_{jet} vs z_{jet}	Rerun the analysis with the second simulation production
q_{prep} vs z_{jet}	
Jet charge distribution	
Two-particle correlations	

Back Up

JES By Magnetic Field Strength

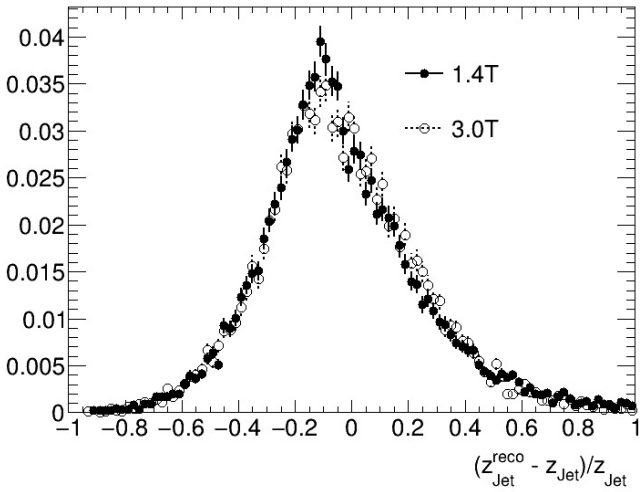


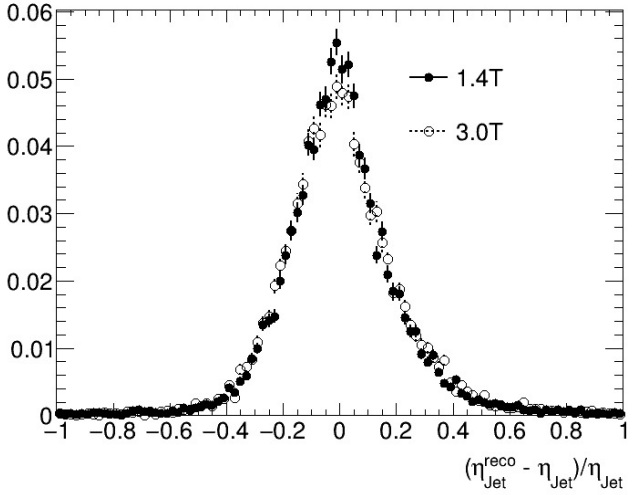


At midrapidity the JER seems to get **worse** at higher magnetic field.

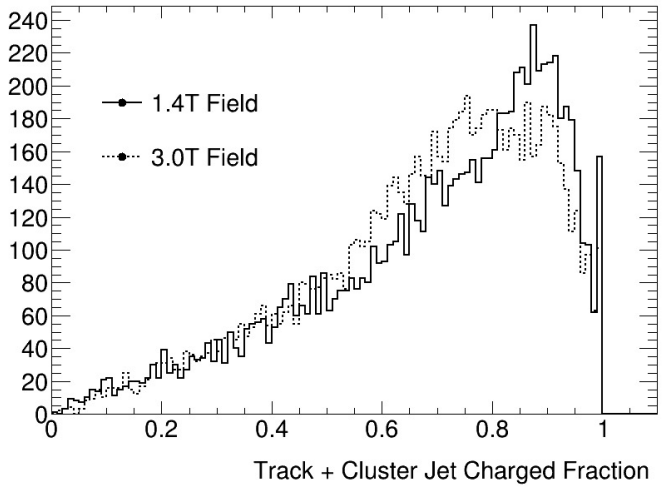
Reco. Jet Properties in Different Field Strengths

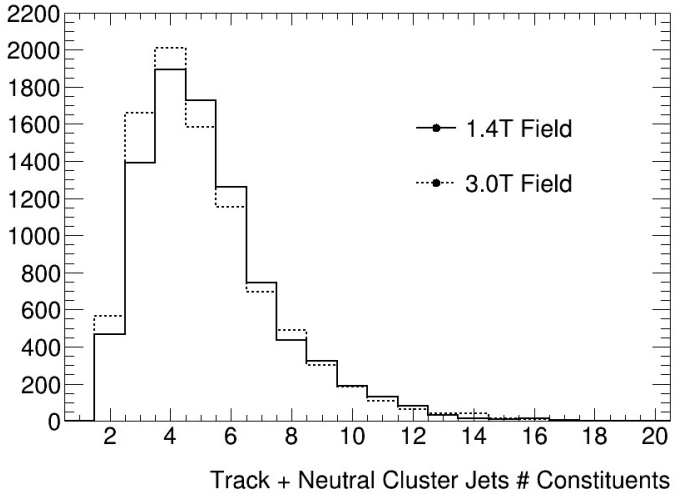
Using Centauro Algorithm





No significant differences in z_{jet} and η_{jet} of reco jets





Left: at higher magnetic field jets have fewer charged constituents