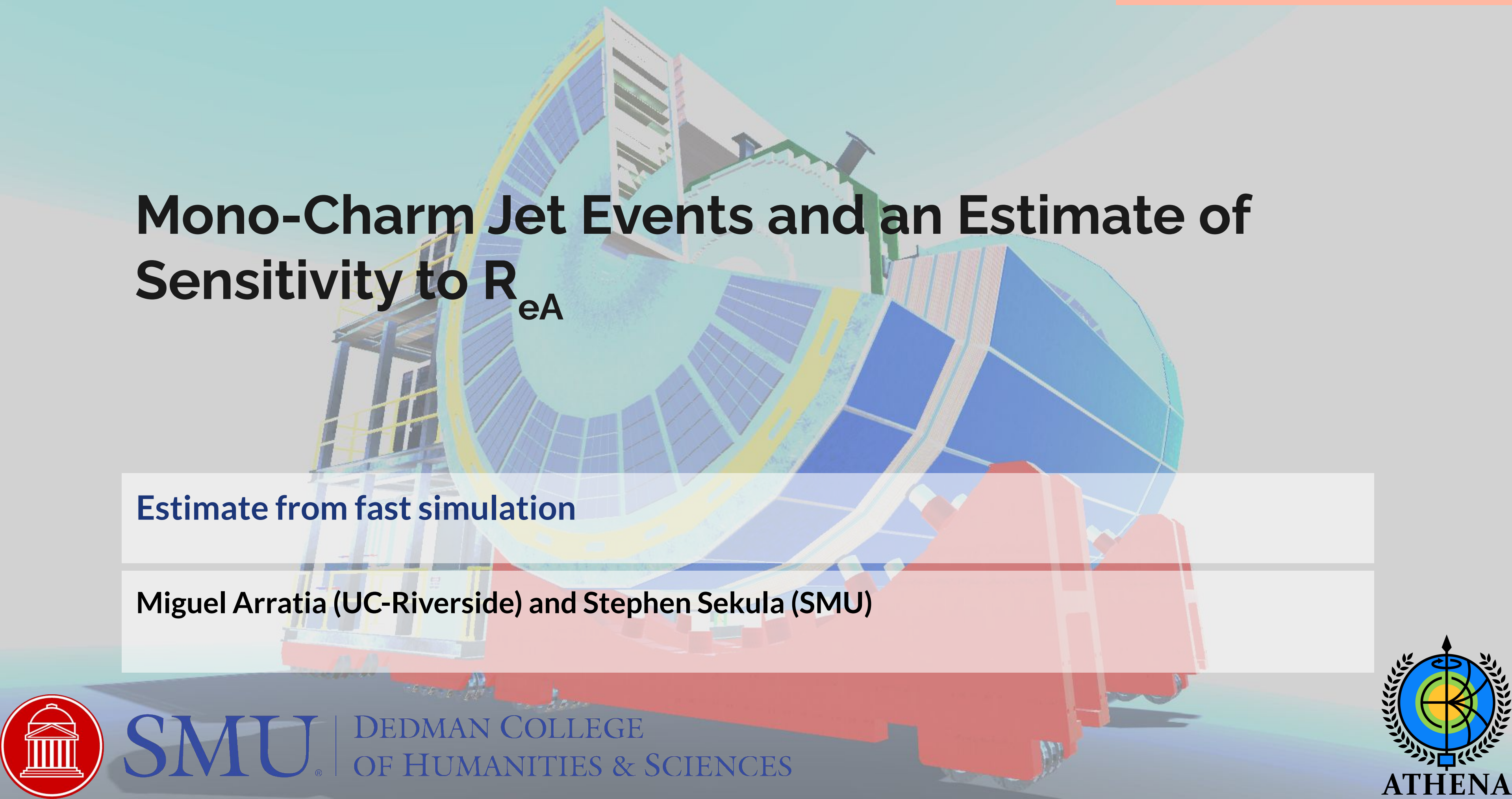


Virtual Reality visuals by Sean Preins

Mono-Charm Jet Events and an Estimate of Sensitivity to R_{eA}

Estimate from fast simulation

Miguel Arratia (UC-Riverside) and Stephen Sekula (SMU)

SMU Dedman College of Humanities & Sciences

ATHENA

OVERVIEW

- Simulation and Methods
- Preliminary Results and Outlook

Simulation and Methods

- Generate NC DIS events with $Q^2>25$ ($\sigma_{PYTHIA8}$ = 24.817nb) with 18x275 configuration → in 100fb^{-1} of EIC data, expect about 2.5B events.
  - Generate 25M events w/ PYTHIA8, CT18NNLO, and the `WeakBosonExchange:ff2ff(t:gmZ)` process only.
  - Scale yields up by 100 for subsequent calculations
- Fast-simulate ATHENA response with DELPHES and delphes_EIC/ATHENA.tcl
- Reconstruction:
  - For this study, given the minimum Q^2, reasonably assume the tagging electron will nearly always be in the detector.
  - Require exactly on R=1 jet with $p_T>5$ GeV and $|\eta^j|<3.0$, reconstructed in each event.
  - Require jet pass cut-based charm tagging using displaced tracks or kaons (see https://wiki.bnl.gov/athena/index.php/JetsHF), which is ~23% efficient on real charm jets)

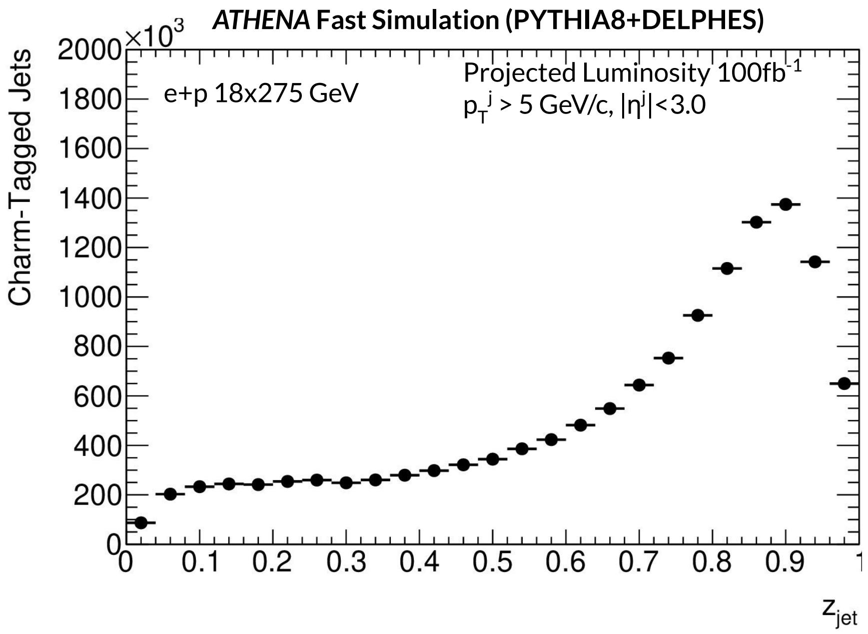
Selection	**Relative Efficiency**
None	100%
Monojet *[True Mono-Charm]*	36.6% *[11.1%]*
Charm-Tagged Monojet *[True Mono-Charm]*	1.62% *[59.8%]*

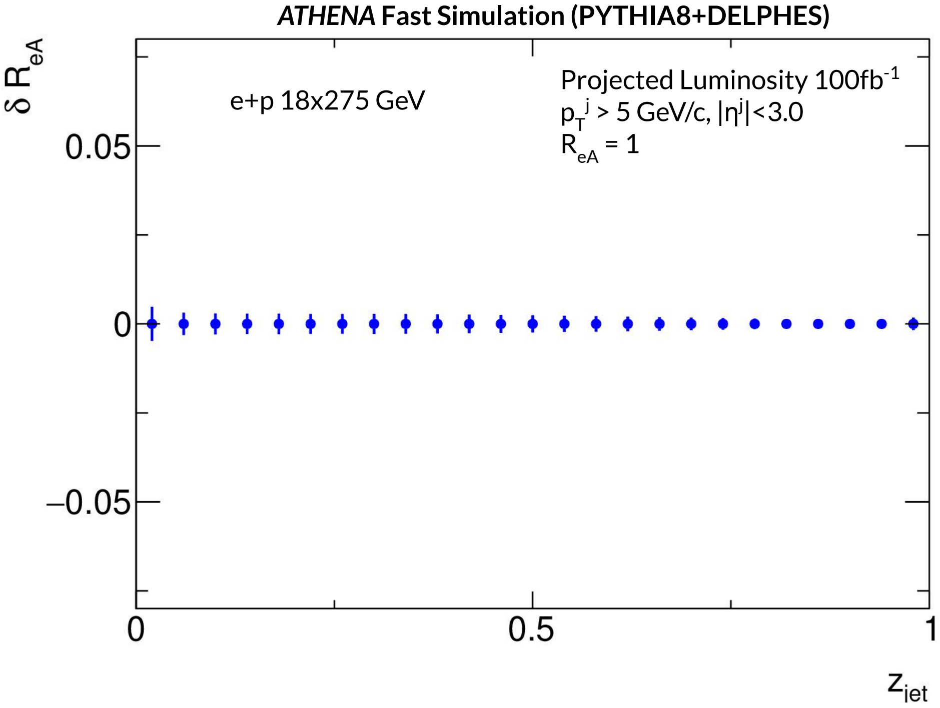
Error Estimate for R_{eA}

For now, simulate only unpolarized e-p collisions and infer error on R_{eA} from this alone. Although intensity of e-A collisions will be lower by about 1/A but cross-section will increase by ~A, so integrated luminosity of e-A will be comparable to e-p. Error on charm-jet events in e-p collisions, including background subtraction, will be $\sqrt{(S_{ep} + B_{ep})} = \sqrt{N_{ep}}$. Thus:

$$N_{eA} = R_{eA} N_{ep} \longrightarrow \delta R_{eA} = \sqrt{\frac{2R_{eA}}{N_{ep}}}$$

Just need from e-p simulation the yield of charm-tagged monojet events (N_{ep}) and assume a value for R_{eA}.





Charm-tagged jet distribution in z_{jet} consistent with previous studies on this population (c.f. arXiv:2006.10751). Error on R_{eA} projected using hypothesis for R_{eA}. In 100fb^{-1} of e-p NC DIS events, PYTHIA8+DELPHES+ATHENA model predicts a total of almost 15 million charm-tagged mono-jet events, almost 60% of which are true charm.

OUTLOOK

Conclusions and Outlook

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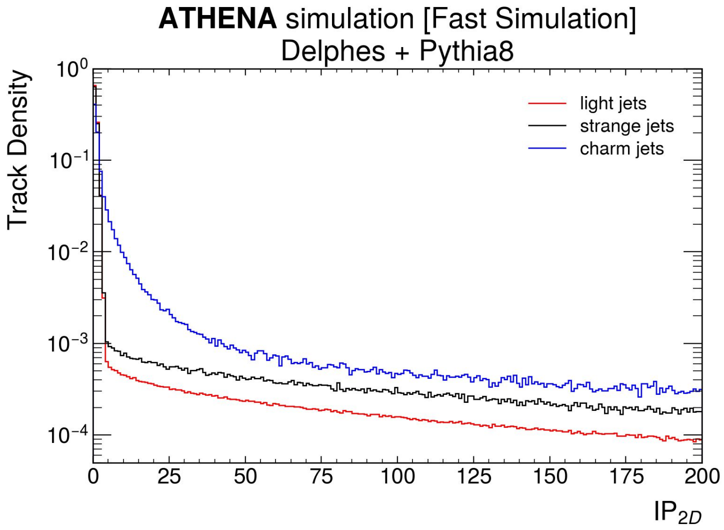
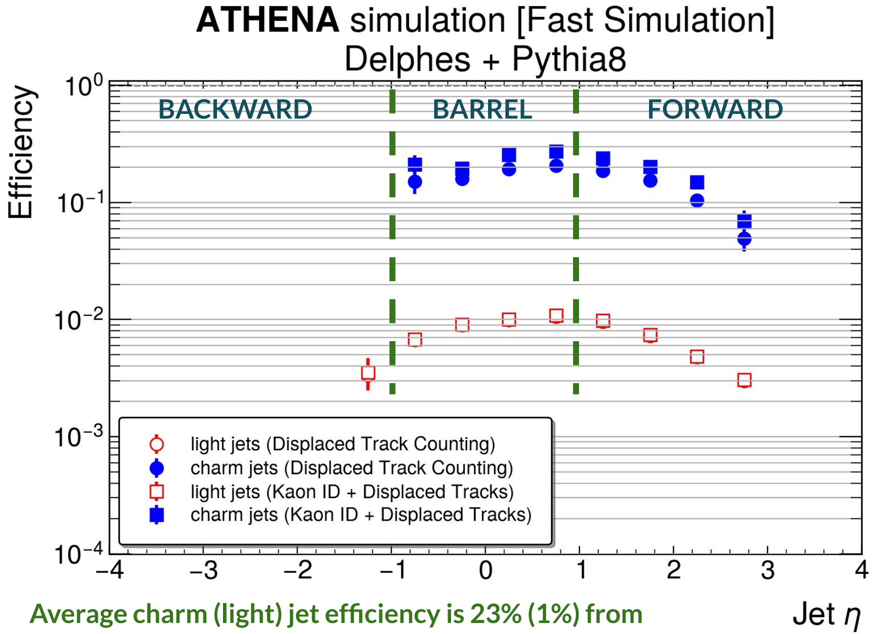
APPENDIX

Charm Identification using Displaced Track Counting and Kaon ID

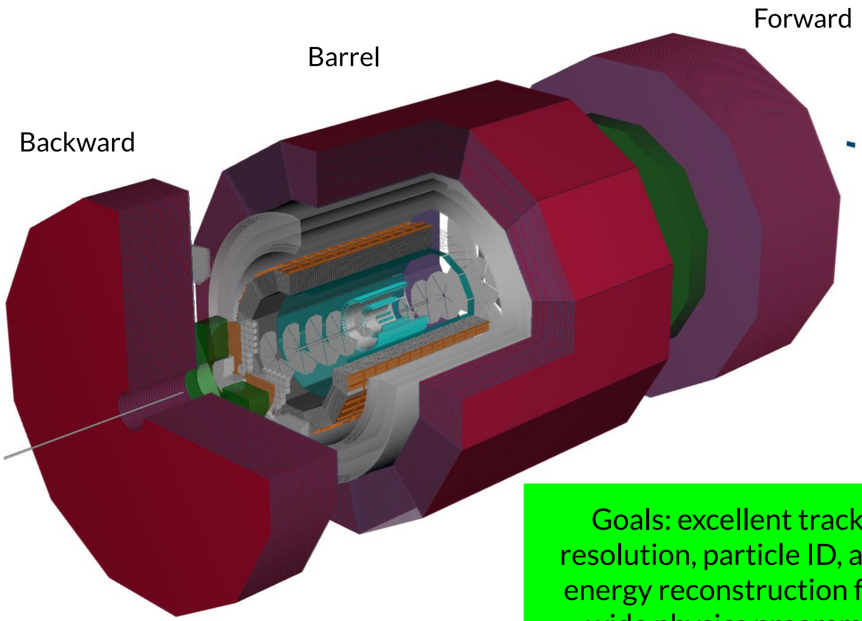


Baseline optimized displaced-track tagger requires <u>3 or more</u> tracks in a jet with p_T>0.5GeV/c and IP2D>3.



Average charm (light) jet efficiency is 23% (1%) from displaced-track tagging or displaced single kaon tagging.

The ATHENA Experiment



Goals: excellent track resolution, particle ID, and energy reconstruction for wide physics program.

Key elements of backward/central/forward parts of detector (*not shown: very low angle components along beam line*):

- **Barrel:** 3T magnet, All-Silicon Tracker + Particle ID (HP-DIRC) + Calorimeters (EMCAL + Iron-Scintillator HCAL)

- **Hadron-going direction (Forward):** Tracking (Silicon Disks + Gas Electron Multiplier Layer), Particle ID (dual RICH), and Calorimeters (Tungsten Powder/Scintillating Fiber EMCAL + Iron-Scintillator HCAL)

- **Electron-going direction (Backward):** Tracking (Silicon Disks + Gas Electron Multiplier Layer), + Particle ID (modular RICH) + Calorimeters (Lead-Tungstate iEMCAL + oEMCAL + Iron-Scintillator HCAL)

Simulation and Methods

- Generate NC DIS events with $Q^2>25$ ($\sigma_{PYTHIA8}$ = 19.532nb) with 10x275 configuration → in 100fb^{-1} of EIC data, expect about 20M events.
  - Generate 20M events w/ PYTHIA8, CT18NNLO, and the `WeakBosonExchange:ff2ff(t:gmZ)` process only.
- Fast-simulate ATHENA response with DELPHES and delphes_EIC/ATHENA.tcl
- Reconstruction:
  - For this study, given the Q^2, assume the tagging electron will nearly always be in the detector.
  - Require exactly two R=1 jets, each with $p_T>5$ GeV, reconstructed in each event.
  - Require both jets pass cut-based charm tagging using displaced tracks or kaons (see https://wiki.bnl.gov/athena/index.php/JetsHF), which is ~23% efficient on real charm jets)

Selection	**Relative Efficiency**
None	100%
Dijets *[True Di-Charm]*	1.60% *[11.2%]*
Di-Charm Tagged Jets *[True Di-Charm]*	0.193% *[60.0%]*