BSM/EW – Short report from ePIC and EIC Physics Readiness Workshop

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BSM / EW at EIC — Summary

Leptoquark / CLFV

Charged Lepton Flavor Violation (CLFV) via e→τ transition in DIS at 18×275 GeV.

Status: Bardh (Manitoba) completed a cut-based analysis for the 3-prong hadronic τ decay. First sensitivity projection produced: coupling/mass^2 exclusion limit ~2.06 TeV^{-2} for one vector leptoquark type.

Next steps: Extend to all 13 leptoquark types. Andrew (UMass) could contribute e→τ transition using SMEFT framework for cross-comparison.

Axion-Like Particles

ALP production in e+Pb collisions; mass range ~0.1–20 GeV

Status: Generator-level kinematics validated through afterburner (IP6) and EICrecon full sim. Electron ID efficiency ~80% above pT=0.5 GeV. Issue with model below 1 GeV under investigation.

Next steps: Request background-embedded sim in next campaign. Target initial sensitivity projections by early summer.

HNLs/CLFV

HNLs motivated by neutrino mass generation; CLFV via e→τ in DIS using SMEFT operators.

Status: Theory-driven Monte Carlo events (SMEFT framework) generated. Tracking association validated on small-scale test sample (10k events). Minor beam-energy mismatch (250 vs 275 GeV) identified and corrected.

Next steps: Validate τ hadronic (3π) and leptonic (τ→μ) reconstruction; request large-scale official production at 275 GeV; produce tagging-performance studies and first sensitivity projections by mid-summer.

Discussion Takeaways

- **Raised by John Lajoie:** ECCE paper outlined comprehensive model-independent BSM constraints via Wilson coefficients / SMEFT operators, noted as a powerful, model-agnostic complement to the benchmark channel studies. Worth revisiting for the impact paper.
  - Neutral-Current Electroweak Physics and SMEFT Studies at the EIC
  - arXiv:2204.07557v2 [hep-ph]

Neutral-Current Electroweak Physics and SMEFT Studies at the EIC

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We study the potential for precision electroweak (EW) measurements and beyond-the-Standard Model (BSM) searches using cross-section asymmetries in neutral-current (NC) deep inelastic scattering at the electron-ion collider (EIC). Our analysis uses a complete and realistic accounting of systematic errors from both theory and experiment and considers the potential of both proton and deuteron beams for a wide range of energies and luminosities. We also consider what can be learned from a possible future positron beam and a potential ten-fold luminosity upgrade of the EIC beyond its initial decade of running. We use the SM effective field theory (SMEFT) framework to parameterize BSM effects and focus on semi-leptonic four-fermion operators, whereas for our precision EW study, we determine how well the EIC can measure the weak mixing angle. New features of our study include the use of an up-to-date detector design of EIC Comprehensive Chromodynamics Experiment (ECCE) and accurate running conditions of the EIC, the simultaneous fitting of beam polarization uncertainties and Wilson coefficients to improve the sensitivity to SMEFT operators, and the inclusion of the weak mixing angle running in our fit template. We find that the EIC can probe BSM operators at scales competitive with and in many cases exceeding LHC Drell-Yan bounds while simultaneously not suffering from degeneracies between Wilson coefficients.