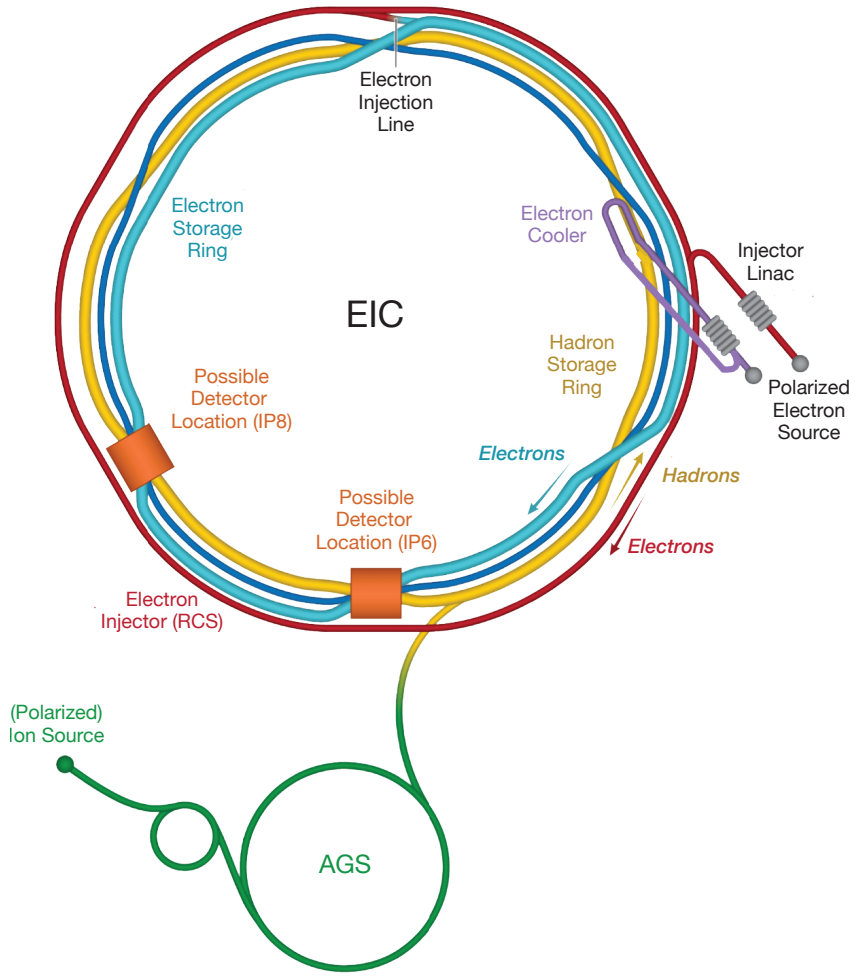
The Electron-Ion Collider (EIC)



Frontier accelerator facility in the U.S.

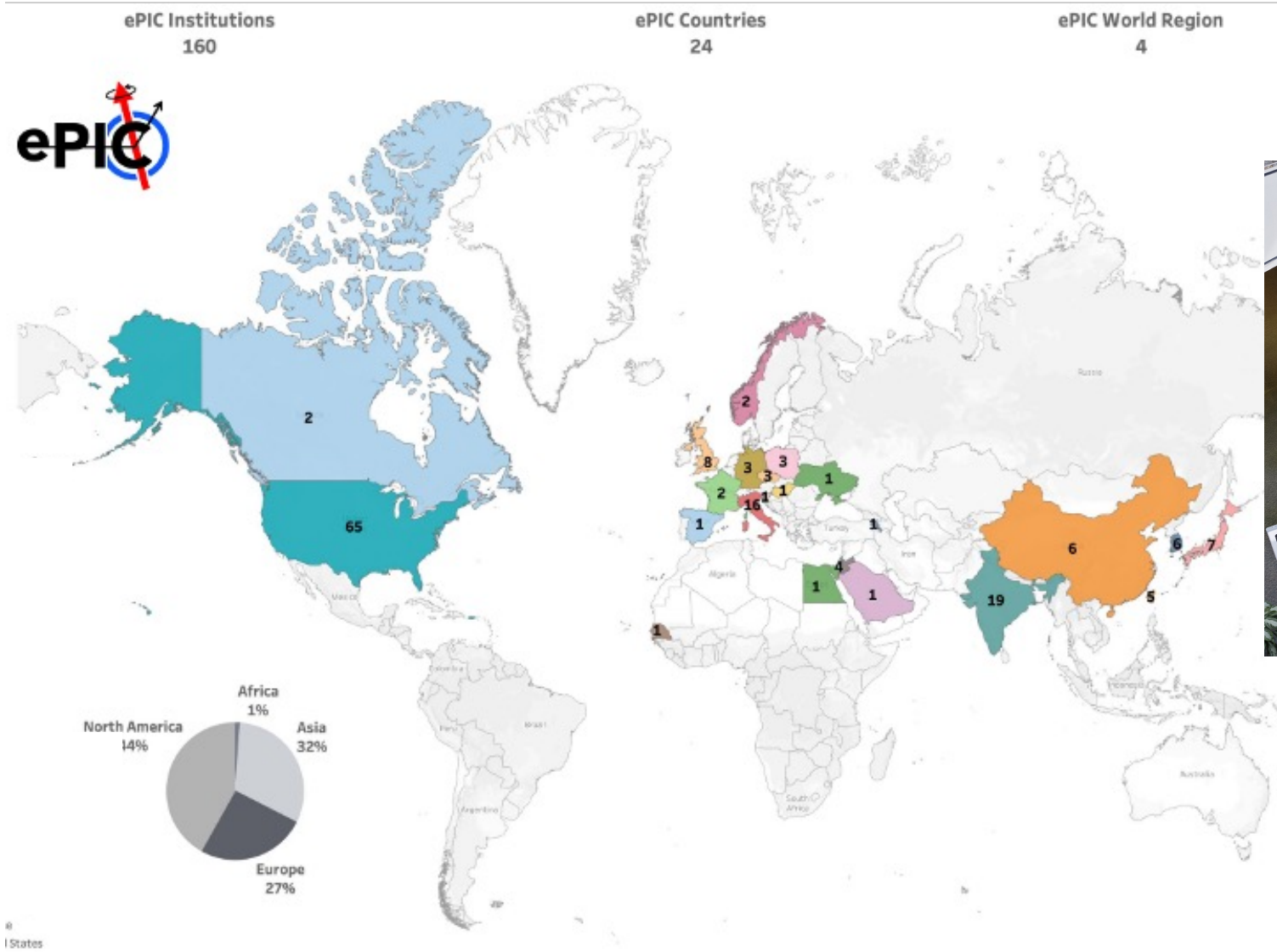
- **World's first collider of**:
  - Polarized electrons and polarized protons,
  - Polarized electrons and light ions (d, ^{3}He),
  - Electrons and heavy ions (up to Uranium).

- The EIC will enable us to embark on a **precision study of the nucleon and the nucleus at the scale of sea quarks and gluons**, over all of the kinematic range that is relevant.
- The **EIC Yellow Report** (Nucl.Phys.A 1026 (2022) 122447) describes the physics case, the resulting detector requirements, and the evolving detector concepts for the experimental program at the EIC.

- BNL and Jefferson Lab will be host laboratories for the EIC Experimental Program. Leadership roles in the EIC project are shared.
- EIC operations will start in about a decade.

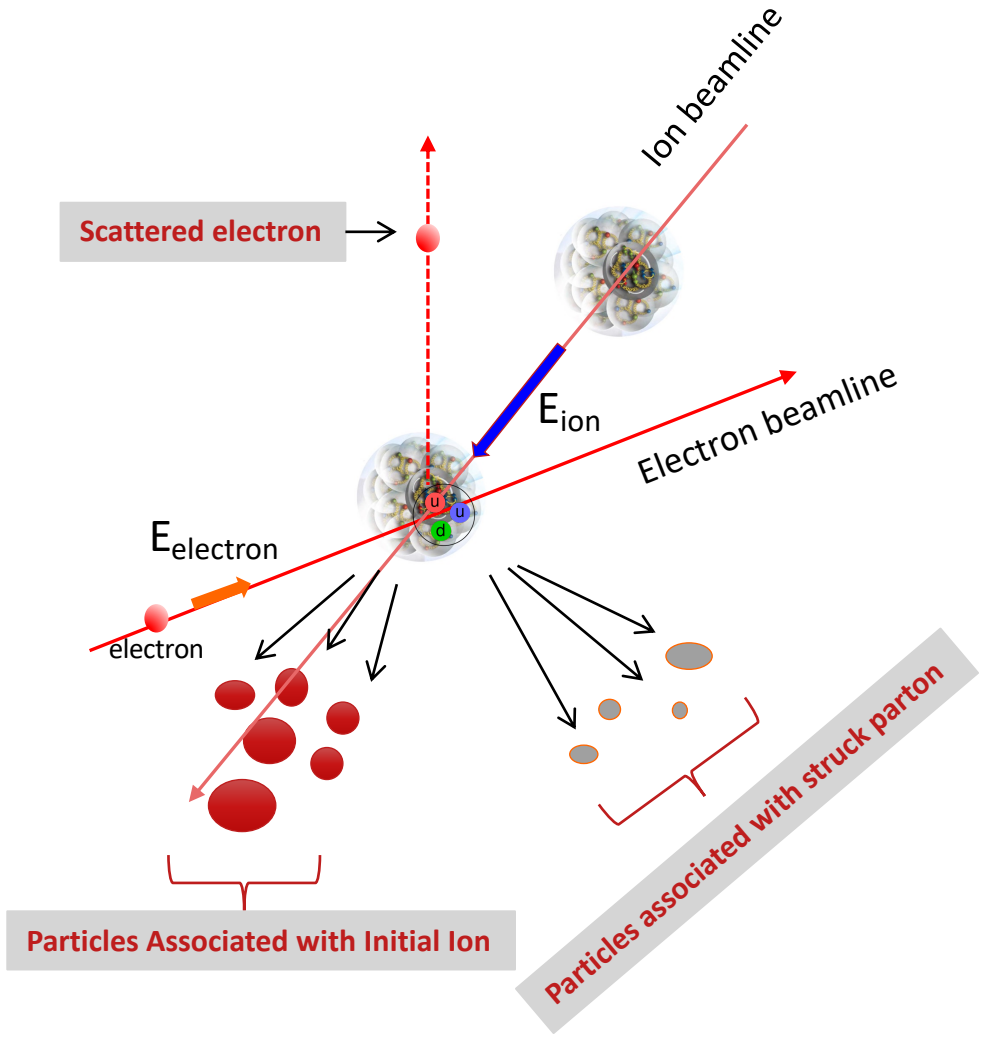
ePIC Collaboration to Realize EIC Project Detector

Formed in 2022–2023

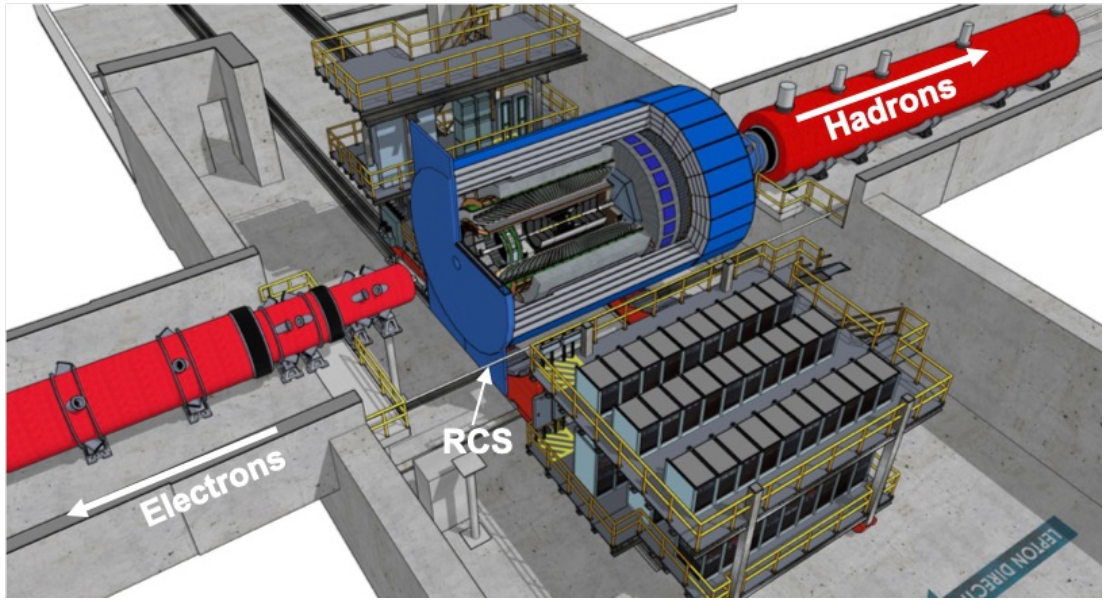


ePIC Collaboration Meeting at Jefferson Lab in January 2023

General Purpose Detector for ePIC



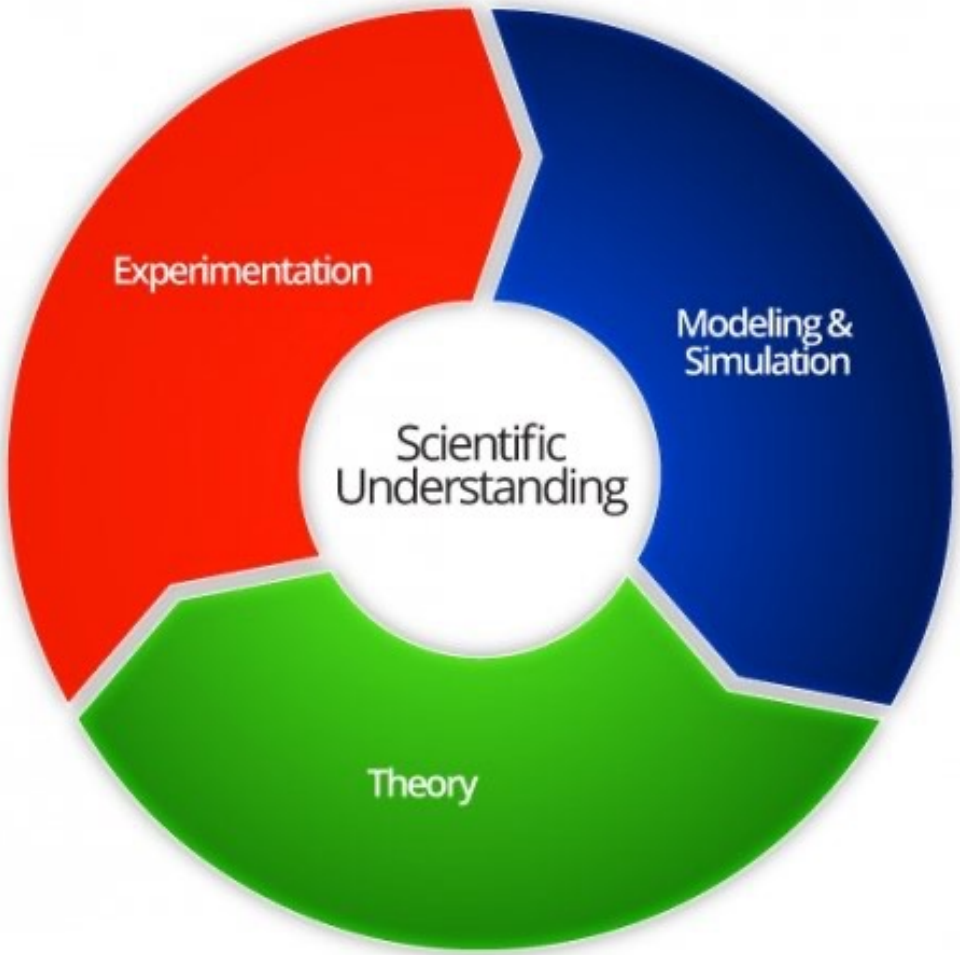
Integrated interaction and detector region (+/- 40 m) to get ~100% acceptance for all final state particles, and measure them with good resolution.



Overall detector requirements:

- Large rapidity (-4 < h < 4) coverage; and far beyond in far-forward detector regions.
- Large acceptance solenoid of 1.7 T (up to 2 T).
- High control of systematics: luminosity monitor, electron and hadron polarimetry.

Event Generators for the EIC



Monte Carlo Simulation of

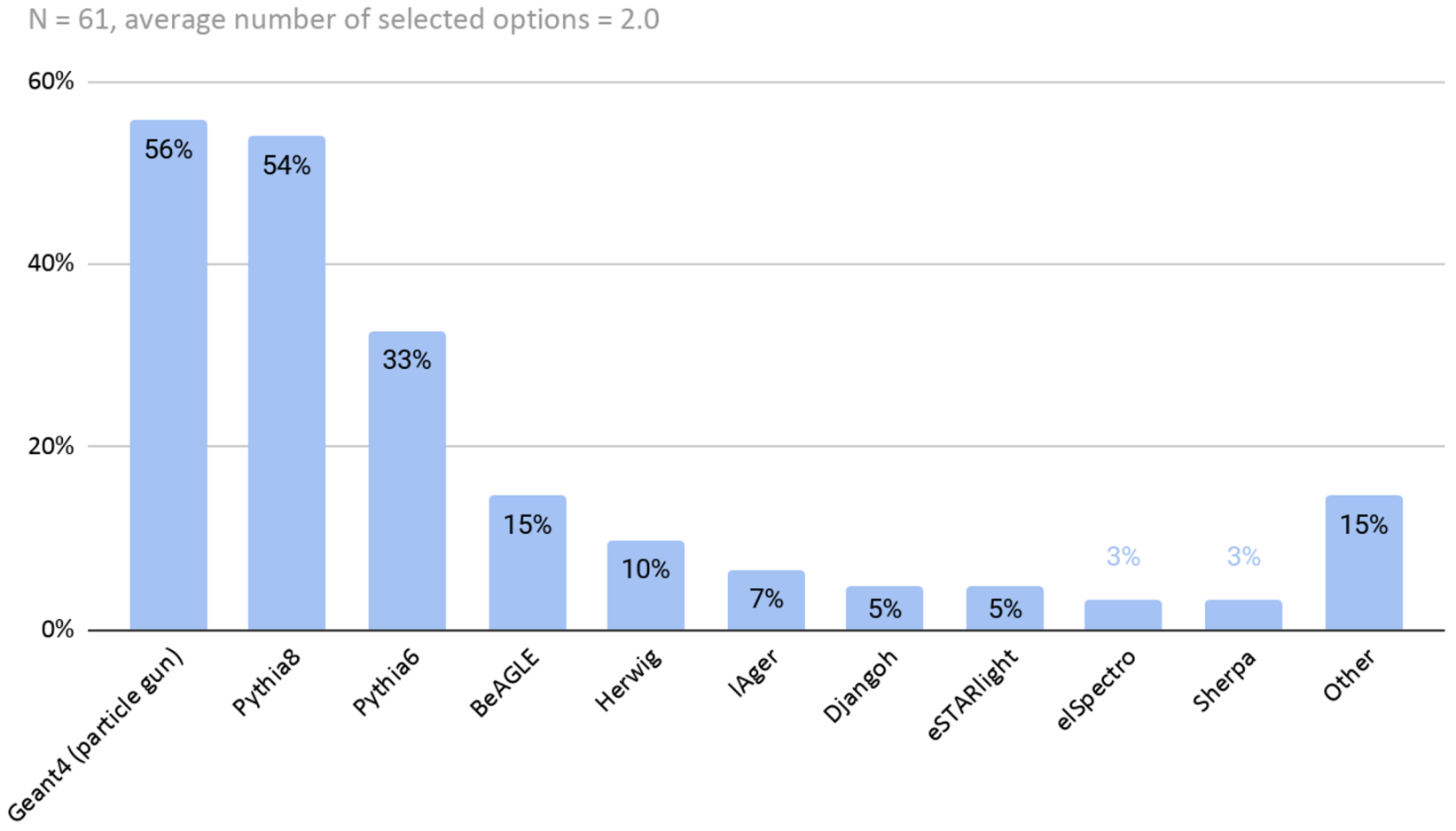
- electron-proton (ep) collisions,
- electron-ion (eA) collisions, both light and heavy ions,
- including higher order QED and QCD effects,
- including a plethora of spin-dependent effects.

Common challenges, e.g. with HL-LHC: **High-precision QCD measurements require high-precision simulations**.

Unique challenges MCEGs for electron-**ion** collisions and **spin-dependent** measurements, including **novel QCD phenomena** (e.g., 3D quark-gluon imaging in momentum (**TMDs**) and position space (**GPDs**)).

MCEGs used for Yellow Report

Source State of Software Survey



Other (N = 9): personal computer codes (N = 2), ACT, CLASDIS, ComptonRad, GRAPE-DILEPTON, MADX, MILOU, OPERA, RAYTRACE, Sartre, Topeg, ZGOUBI

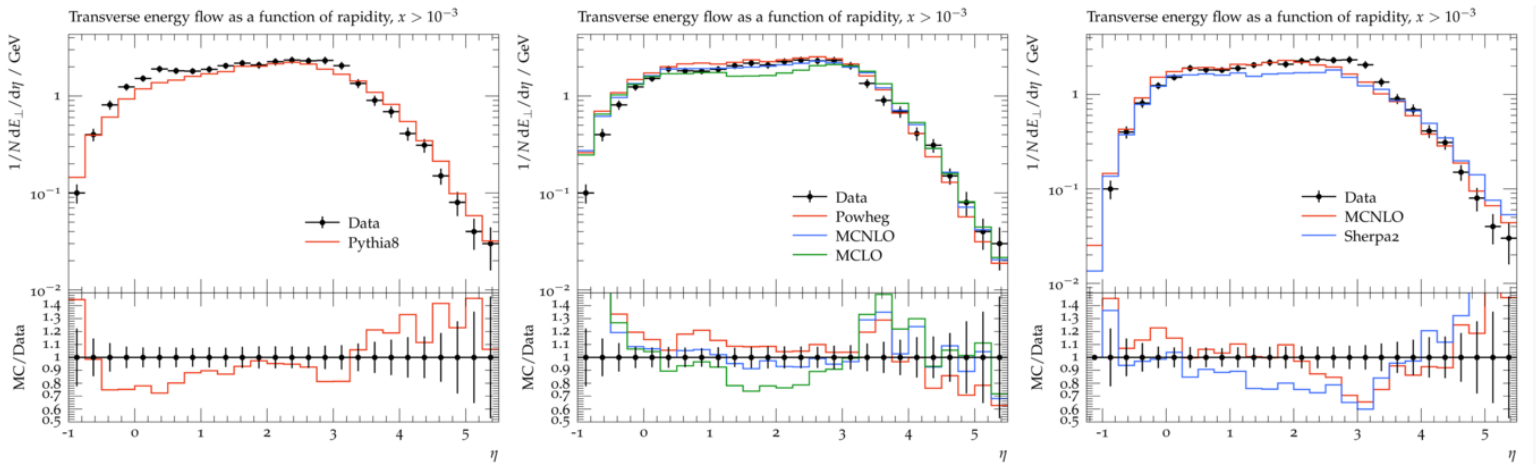
MCEG Tuning Status

Tuning of MCEGs:

- MCEGs developed by EIC community, e.g., BeAGLE, has been compared to and tuned to selected ep and eA measurements.
- Pythia6 version used by EIC community has been tuned to HERMES and other experiments in detail. Modeling in interim region, 1 GeV^2 < Q^2 < 10 GeV^2, based on HERMES data.

Ongoing activity on validation of general-purpose MCEGs:

- Comparison to published DIS results using RIVET and understand differences.
- **Provide initial findings and results in publication (work in progress):**
  - Overview of where we stand in understanding HERA data with current physics and models implement in MCEGs.
- After we understand in detail who MCEGs compare to HERA data, we will work on a global DIS tune for ePIC.



Pythia8 Herwig7 Sherpa2