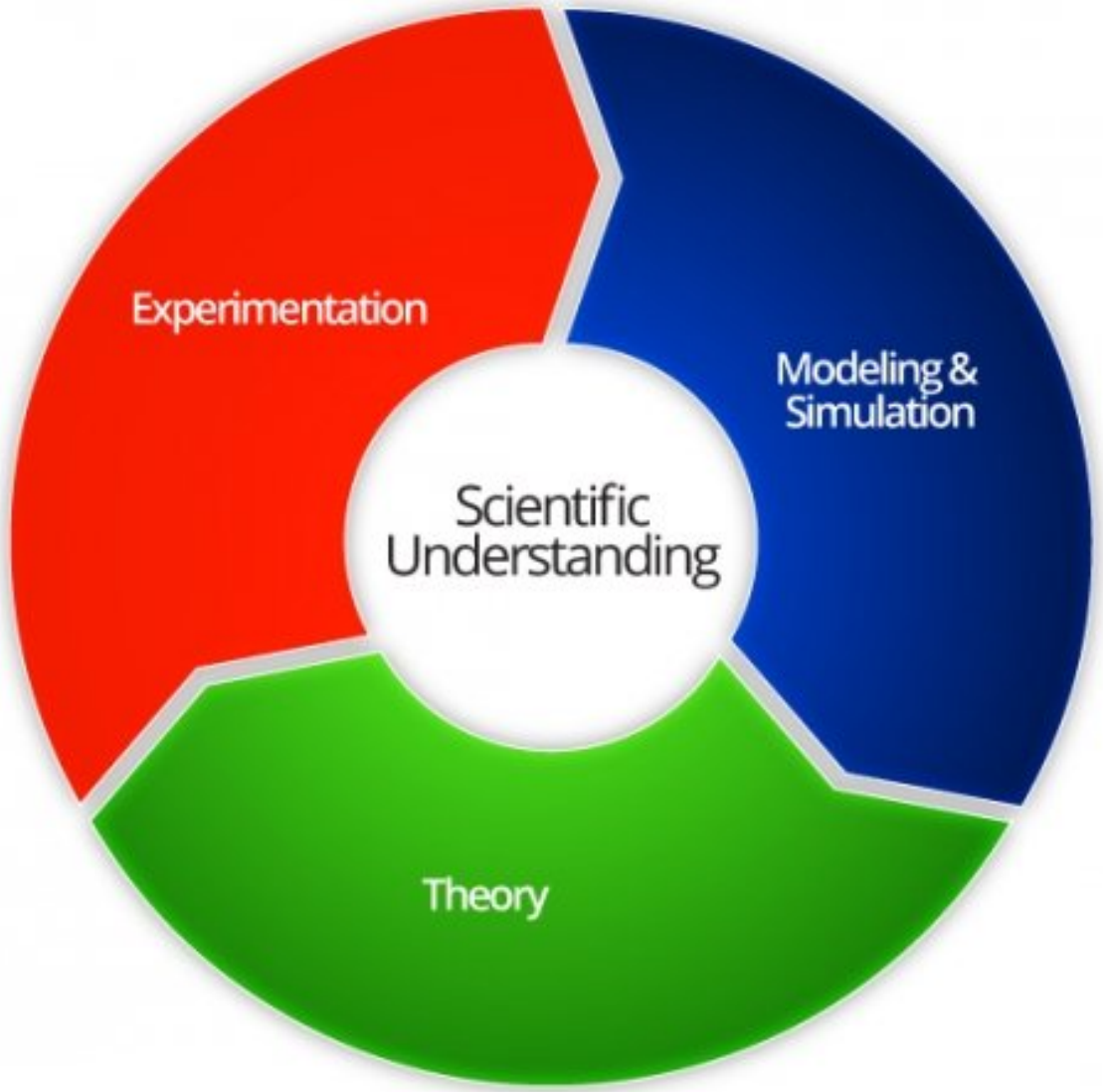
Discussion on Monte Carlo Event Generators for the EIC



← MCEGs

Measurements and Simulations

Measurement

Simulation

Role of Simulations

MC event generator → **Detector simulation** → **Digitization** → **Reconstruction** → **Physics Analysis**

Design Experiments Design and develop detectors and large-scale detector systems based on key measurements / physics reach and background estimates. Optimize the design.

Analysis Develop and verify analysis methods and tools: Does the analysis method or tool give the correct result? Estimate systematic uncertainties.

Verify Measurements Detailed simulations essential for commissioning experiments and verify analyses.

MCEGs for the EIC

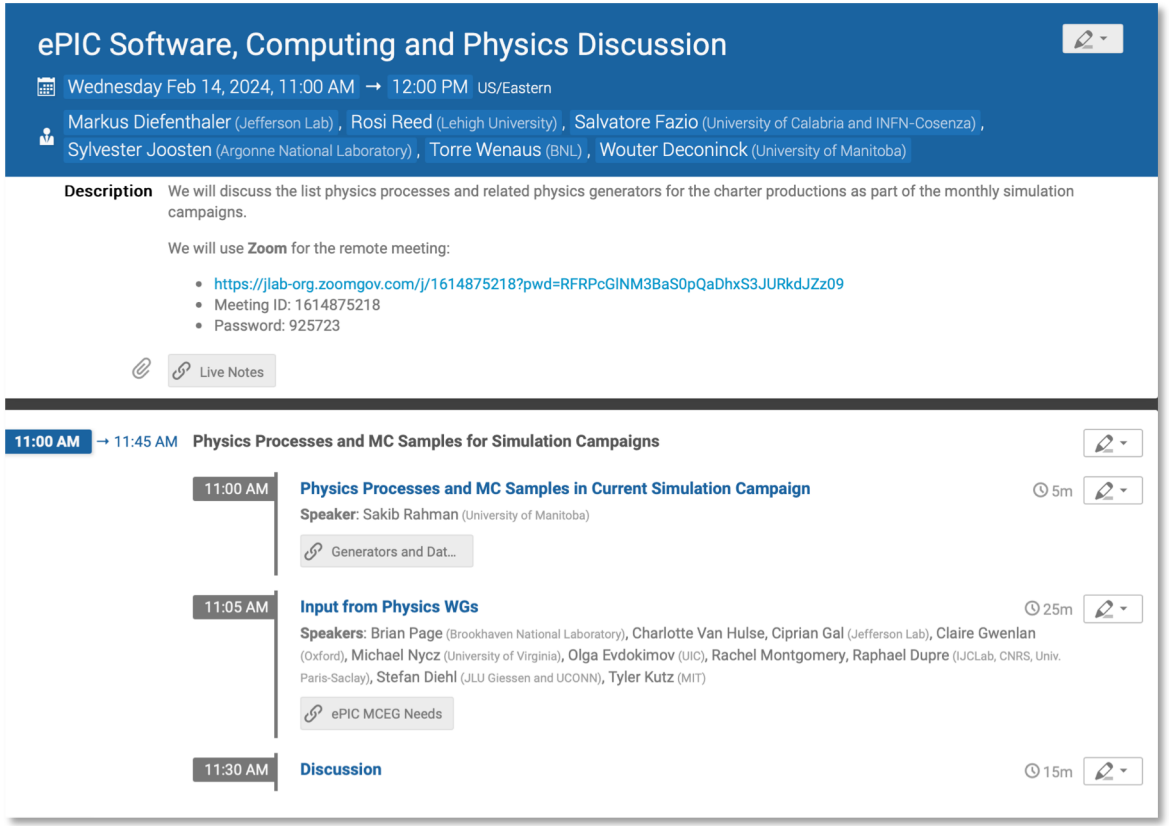
Monte Carlo Simulation of

- 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.

Cross-Cutting Challenges: **High-precision QCD measurements require high-precision simulations**.

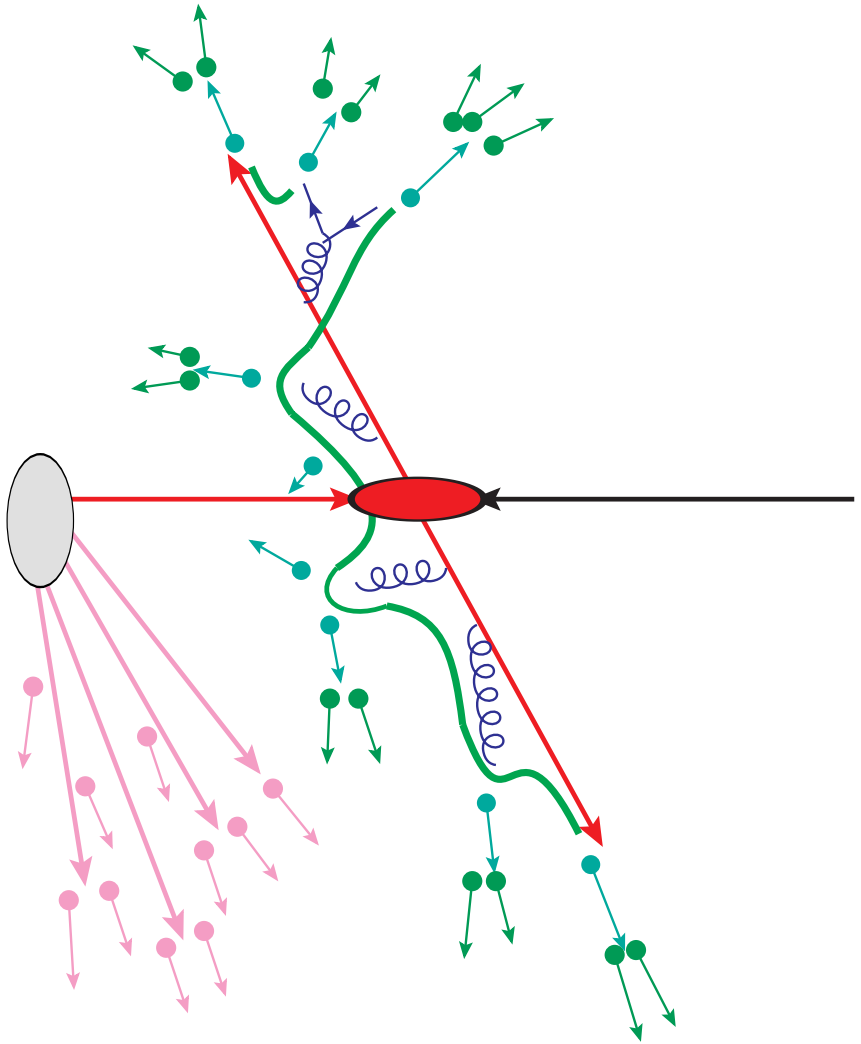
Unique Challenges: MCEGs for electron-**ion** collisions and **spin-dependent** measurements, including novel QCD phenomena (e.g., GPDs or TMDs).

Recent discussion on physics processes and related MC samples in ePIC: https://indico.bnl.gov/event/21772/



Jefferson Lab

Role of Theory



MCEG:

- faithful representation of QCD dynamics
- based on QCD factorization and evolution equations **Links to theory: Advance QCD factorization and evolution. Understand mismatches.**

MCEG Algorithm:

1. Generate kinematics according to fixed-order matrix elements and QCFs. **Links to theory: Theoretical calculations and global QCD analysis.**

2. QCD Evolution via parton shower model (resummation of soft gluons and parton-parton scatterings). **Links to theory: QCD Evolution. Merging of higher order QED and QCD.**

3. Hadronize all outgoing partons including the remnants according to a model. **Links to theory: Hadronization models.**

4. Decay unstable hadrons.

Priorities

- Training of the EIC community.
- **Validation of existing MCEGs using Rivet**:
  - Rivet analyses from HERA and CEBAF. Rivet for physics analyses from ePIC simulations?
  - Build automated workflows (CI).
- Development of a DIS tune.
- **Merging of higher order QED and QCD effects**.
- **Feasibility of shared elements between general-purpose MCEGs.**
- Roadmap for spin-dependent parton showers .
- Roadmap for spin-dependent hadronization models.
- Roadmap for eA, both light and heavy ions.
- Guidance on how to compare EIC measurements with theory: Folding and unfolding approaches.

Involvement from ePIC as well as the MCEG and the theory community essential. Need to consider organization and funding opportunities.