Deep inelastic scattering (DIS) and diffractive scattering are used to probe the internal structure of hadrons in accelerator physics. During the design of experiments, such high-energy processes are simulated using Monte-Carlo (MC) event generators such as RAPGAP which use random numbers to rapidly replicate the complex interactions in such collisions.

New information from these simulations is needed to design a detector for the proposed Electron Relativistic Heavy Ion Collider (eRHIC) at Brookhaven National Laboratory (BNL), set to be completed by 2020. Millions of electron-proton (e+p) collision data events were produced by RAPGAP, simulating both DIS and diffractive collisions at energies of 4 on 100, 4 on 250, 10 on 100, 10 on 200, 10 on 250, and 20 on 250 GeV, after which C++ code using intrinsic ROOT functions was edited and run to read the data, calculate kinematic variables, and organize the results into a data tree. Additional ROOT codes were modified to produce customized plots to visually represent the massive amounts of data and to help understand the realistic quality of the simulator. Over time these codes can be easily modified to plot information as needed, and can be applied to newly produced MC generator data simulating collisions between electrons and heavy ions.

Significant differences were found between DIS and diffractive physics in the distribution of momentum and scattering angle for electrons, pions, and kaons. From these results, we obtained a better idea of the acceptance range the EIC detector will need to cover to simulate millions of e+p collisions and produced data listings showing the parent particle, momentum components, energy, and mass of each particle for every event. Over time these codes can be easily modified to plot information as needed, and can be applied to newly produced MC generator data simulating collisions between electrons and heavy ions.

Conclusion

From these results we obtained a better idea of the acceptance range the eRHIC detector will need to cover to best sense pions, kaons, and scattered electrons that radiate from high-energy e+p collisions.

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Results for Pi+ & K+ Momentum vs. Angle Distributions

- For diffractive events, 10-100 GeV, pions show a smooth, symmetric distribution between 20 and 160 degrees while kaons are projected in forward/backward jets
- Electrons in DIS events are more likely to scatter at a larger angle relative to initial lepton beam direction (180 degrees) and with larger momentum
- Diffractive events show a wider range in the momentum of the scattered lepton while DIS events are more concentrated at a specific value

Data Simulation

We used RAPGAP to simulate millions of e+p collisions and produced data listings showing the parent particle, momentum components, energy, and mass of each particle for every event. Macros written in C++/ROOT organize this output into a data tree and produce plots.