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# New Probes for Cold QCD physics with sPHENIX and potential forward upgrades

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The sPHENIX detector at BNL's Relativistic Heavy Ion Collider (RHIC) will enable a spectrum of new or improved cold QCD measurements, enhancing our understanding of the initial state for nuclear collisions. With its excellent tracking and full calorimetry (hadronic and electromagnetic) in the central pseudo-rapidity region, sPHENIX provides excellent opportunities for the studies of the partonic structure and dynamics in nucleons and nuclei. This includes the studies of the polarized structure of the proton utilizing RHIC's polarized proton collisions. With enhanced RHIC luminosity anticipated in 2020+, and sPHENIX high rate capabilities, the expected precisions will far exceed that achieved at RHIC by now. Among such measurements are high precision polarized gluon distribution in the proton utilizing jet, hadron and direct photon probes, gluon dynamics studies in protons and nuclei through twist-3 correlation functions with heavy flavor measurements, and studies beyond the collinear distributions involving intrinsic transverse momentum kT and fragmentation transverse momentum jT through the correlation measurements. A potential upgrade to sPHENIX with forward instrumentation could significantly enhance these physics capabilities, expanding the probed kinematic range to lower and higher parton momentum fraction x. Nuclear parton distributions will be constrained from direct photon and Drell-Yan electron-positron pair measurements. A unique opportunity to study nuclear effects with polarized probes will be utilized through the high precision measurements of transverse spin asymmetry in hadron production in p+p versus p+A collisions over a wide kinematic range. These and other Cold QCD physics measurements for the proposed sPHENIX midrapidity detector as well as the enhanced program enabled with forward upgrades will be presented.

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