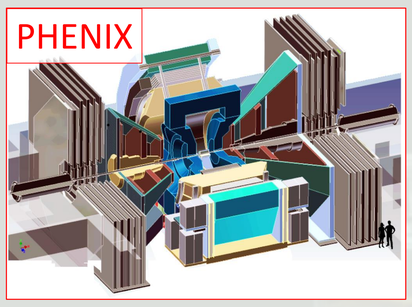
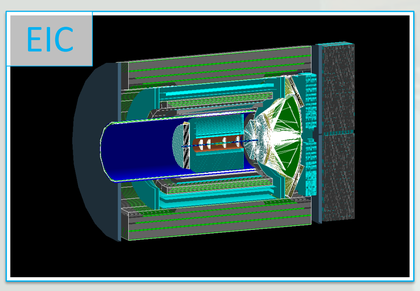
Studying Proton Structure, the Partonic Structure of Nuclei, and Hadronization at sPHENIX

Chong Kim, *for the sPHENIX Collaboration*

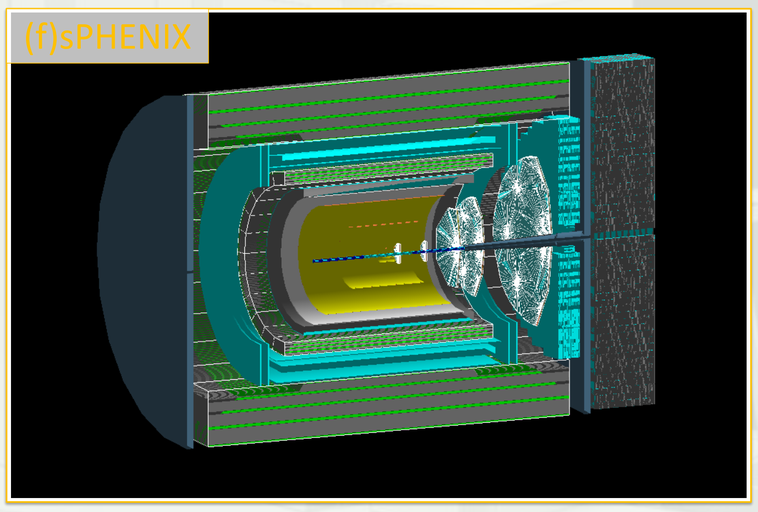
The sPHENIX: new experiment at RHIC at the future Electron-Ion Collider



- PHENIX: 2000 - 2016 (finished)
- p+p, p+A, and A+A with max. √s = 510, 200, and 200 (GeV)
- Longitudinally or Transversely polarized protons with $\langle P \rangle$ = 55 %



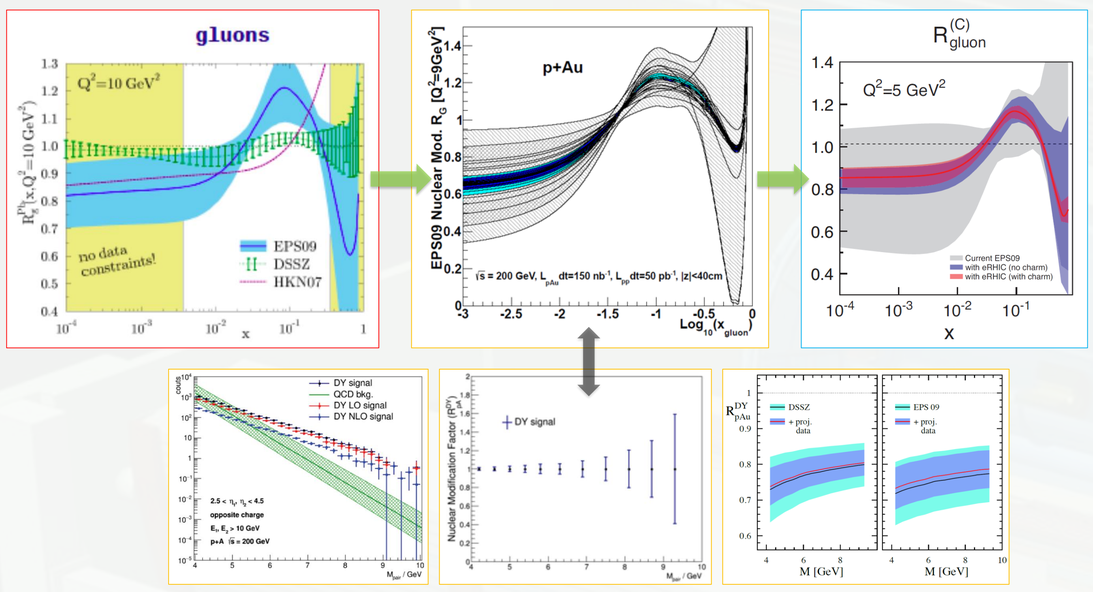
- Late 2020s
- First detector at polarized e+p / e+A collider
- Additional detectors:
  - GEM trackers + EMCal in e-going direction
  - Particle ID



- Early 2020s
- Continue unique p+p & p+A
- sPHENIX (midrapidity):
  - Inner/Outer trackers + EMCal + Inner/Outer HCal based on BaBar Solenoid
  - CD0 granted (Sep. 2016)
- Forward sPHENIX:
  - GEM trackers + EMCal + HCal
  - Under design/simulation

Studying QCD system and process in Cold Nuclear Matter

Nuclear PDFs & Hadronization



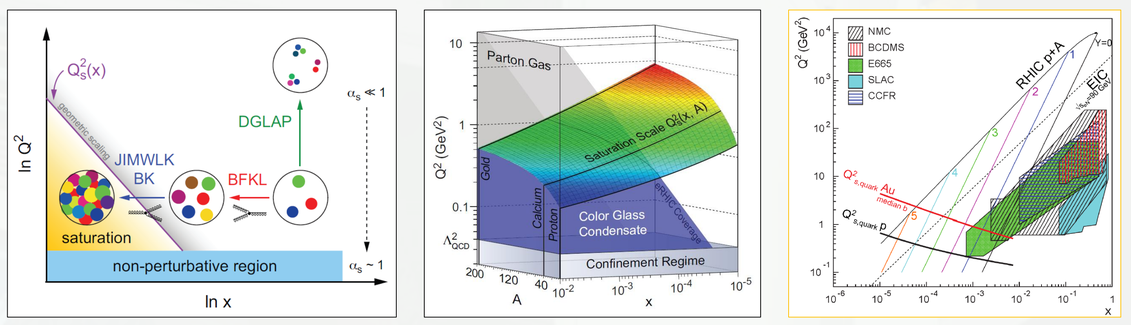
Nuclear PDFs

- Study the initial conditions of heavy ion nucleus <u>before</u> the collision:
  - Essential, but still very limited understanding
  - R_{dA}: only existing direct probe for gluons in the nucleus, but suffering from nuclear effects in the final state → R_{pA} (DY)
- Uniqueness of RHIC:
  - <u>Appropriate</u> kinematic regime (medium-to-low x with moderate Q^2)
  - <u>Varying</u> nucleus in p+A: no pQCD prediction

Hadronization

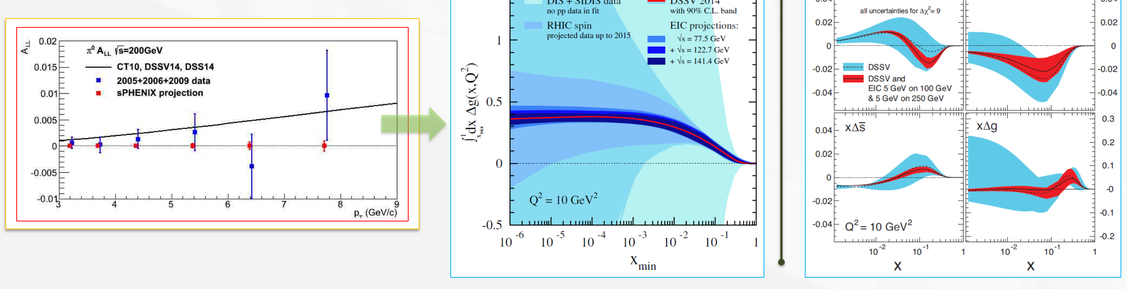
- Discrepancy in SIDIS identified hadron production rate btw e+p & e+A
- Does effect in CNM persist in higher √s and Q^2?

Gluon saturation



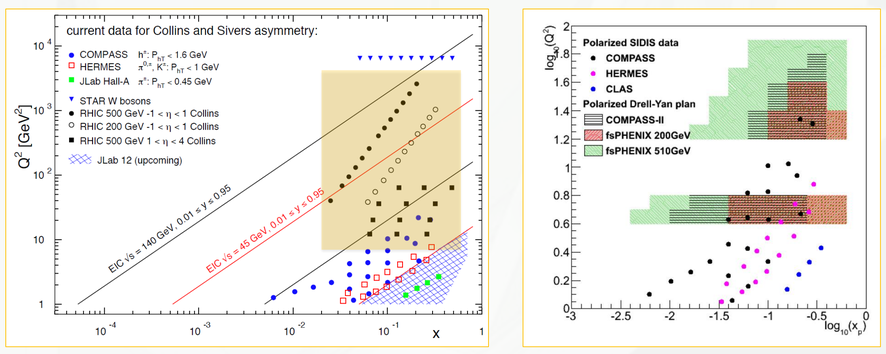
- Definitive constraint of gluon saturation regime:
  - Precise test of theoretical expectations
  - Benefits understanding small-x evolution of TMDs
- <u>Q_s (Saturation scale) vs. x</u> and <u>Q_s vs. A</u>:
  - Growth of PDFs with decreasing x: $Q_s^2 \propto (1/x)^{1/3}$
  - Parton concentration in limited transverse plane: $Q_s^2 \propto A^{1/3}$
- Complete the scheme with p+A:
  - Complementary measurement before EIC
  - Requires forward detector to reach low x collisions
  - Final state effect free measurement via R_{pA} (DY)

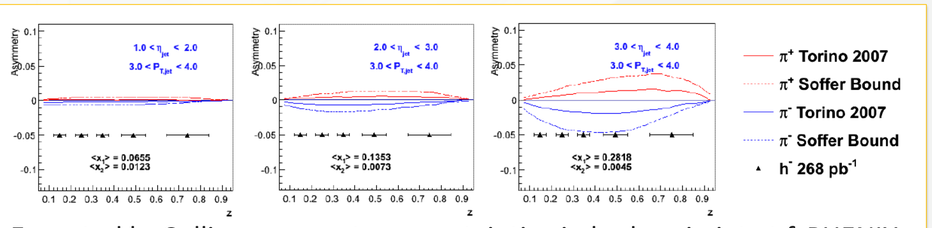
Longitudinal spin structure of the proton



- Jaffe-Manohar spin sum rule: $S_p = \frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_z$
- Unique and Precise measurements at RHIC: ΔG via jet/π^0, $\Delta\bar{q}$ via W/Z^0
- Further constrain of ΔG at smaller x expected at the EIC

Transverse spin phenomena in the proton





<u>Expected</u> h- Collins asymmetry uncertainties in hadron in jet at fsPHENIX

- Origin of large transverse A_N in forward rapidity?
- Separate intrinsic property & interaction dependent dynamics
- Competing & complementing frameworks: TMD and Collinear Twist-3

Office of Science U.S. DEPARTMENT OF ENERGY
NSF
UC RIVERSIDE UNIVERSITY OF CALIFORNIA
BROOKHAVEN NATIONAL LABORATORY