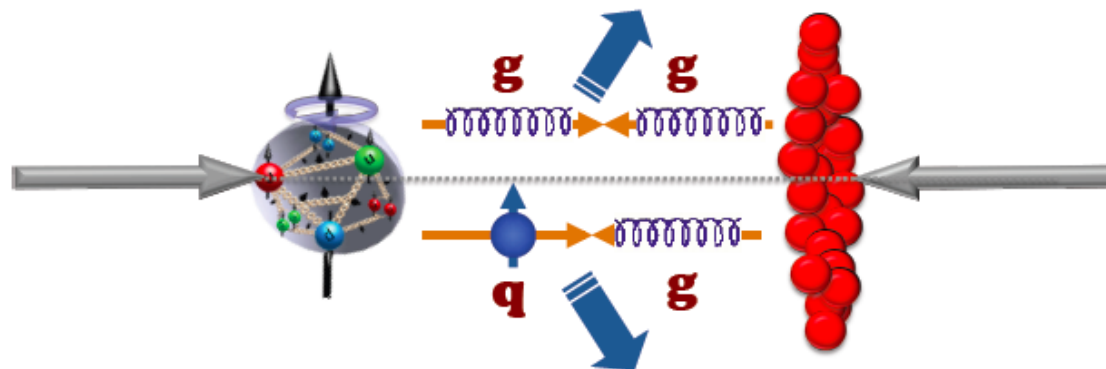


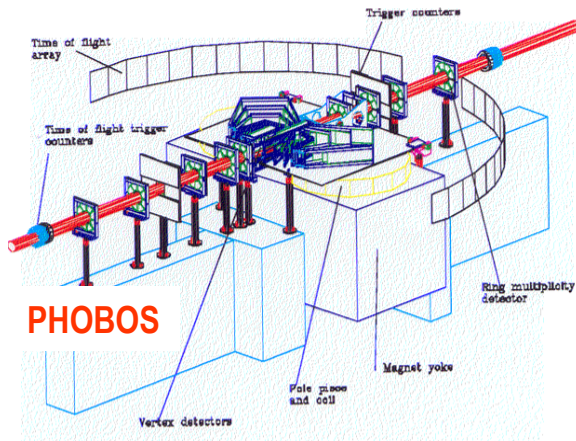
p-A Collisions at RHIC

T. Ludlam
January 7, 2013

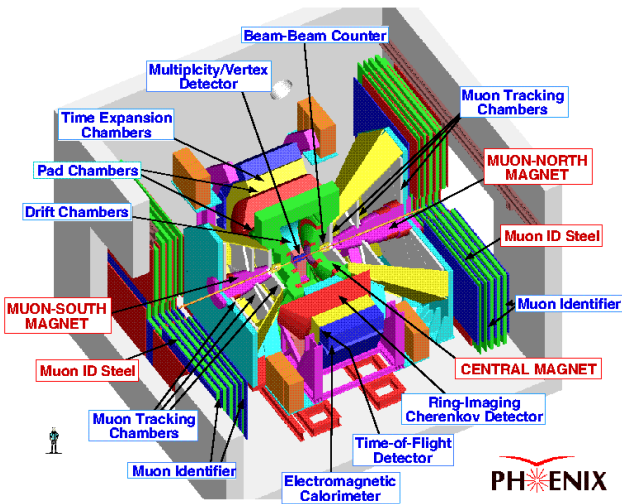
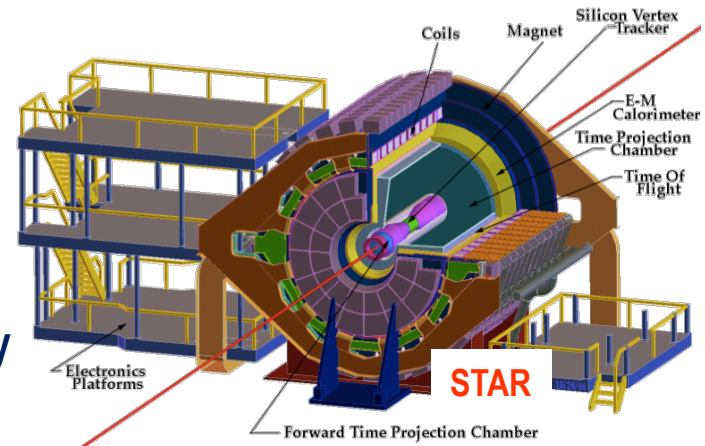


In the Beginning:

RHIC experiments configured to focus on hot nuclear matter in the central region

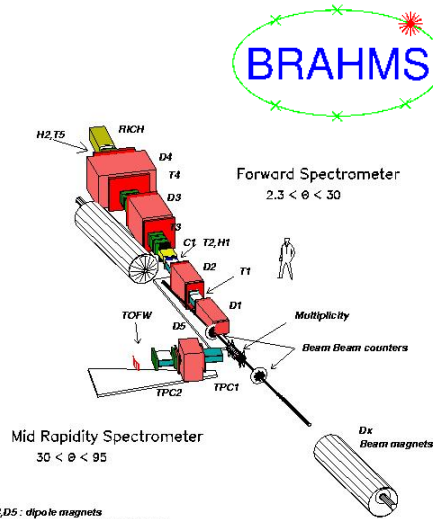


Little attention to the study of cold matter in nuclei-- interest primarily as a "baseline"



Not much detector coverage in the forward direction.

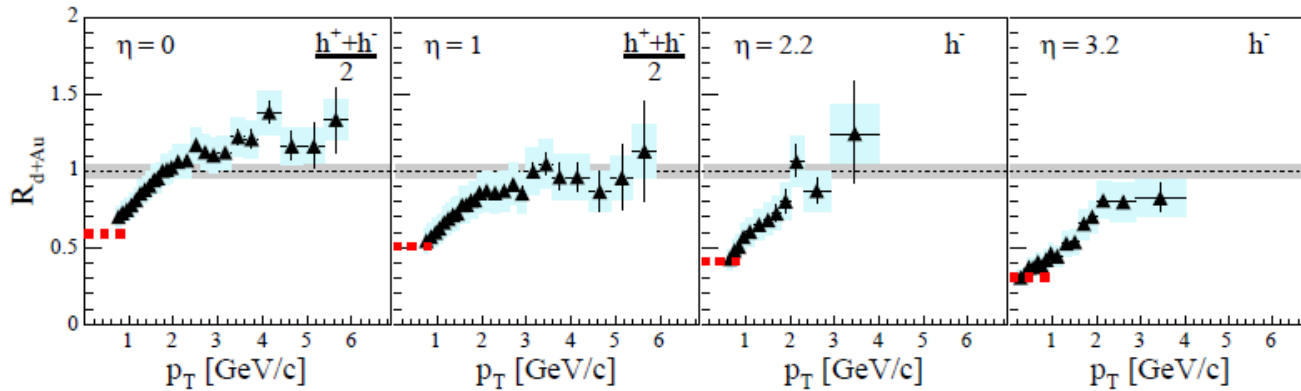
Provision for asymmetric beams in the RHIC rings was designed in, but not as a forefront capability.



D1, D2, D3, D4, D5: dipole magnets
T1, T2, T3, T4, T5, TPC1 TPC2: tracking detectors
H1, H2, TOFW: Time-of-flight detectors
RICH, GASC: Cherenkov detectors

Early surprises with probes of Cold Nuclear Matter at RHIC

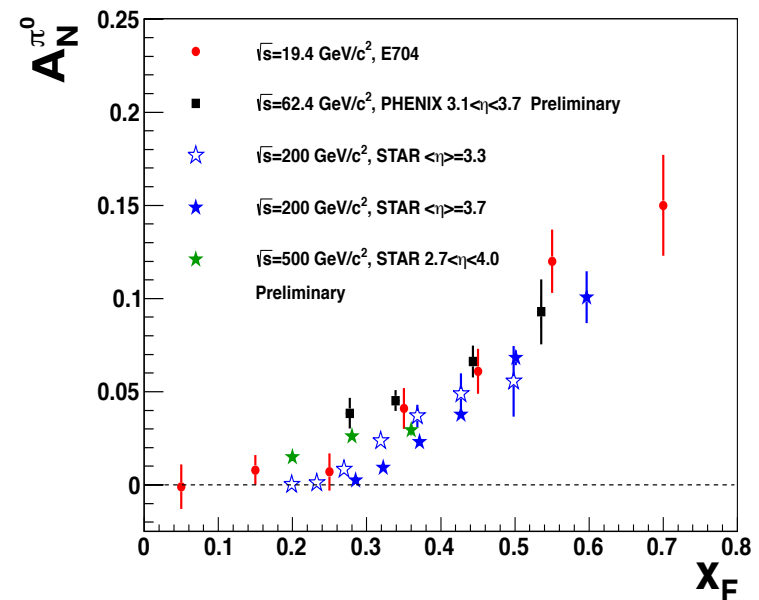
BRAHMS result from 2003 d + Au Run



Color Glass
Condensate?

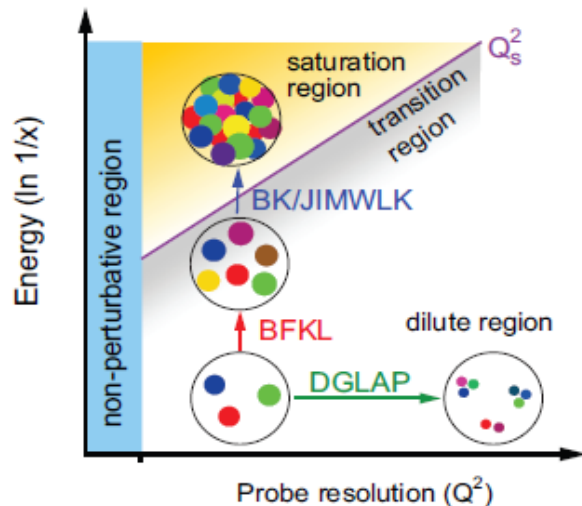
High Pt hadrons are suppressed at very forward angles in d-Au collisions:
hint of initial-state gluon saturation .

Transverse Single Spin asymmetries are large at
RHIC energies:
New experimental probe of color interactions;
potential to distinguish initial and final state
effects.



QCD at extreme parton densities

Attention has now turned to the fundamental importance of the saturated gluon state.
p – A collisions provide a smaller, simpler probe.



- Enhanced RHIC II luminosity
- p-A collisions at LHC
- Science goals for an Electron Ion Collider

Renewed focus on forward kinematics at RHIC:
Scattering of high-x valence quark off low-x gluon.

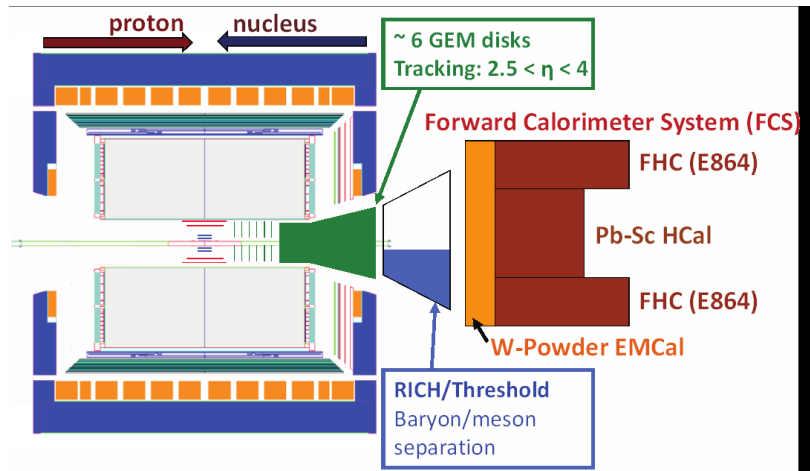
New idea:

Scattering a polarized probe on saturated gluon matter. Transverse Single Spin asymmetry may provide a further experimental test of effective theory for gluon saturation, e.g. test CGC predictions.

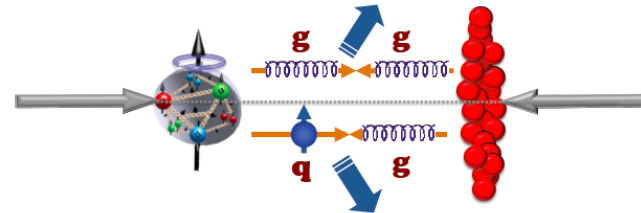


Need forward upgrades to the detectors

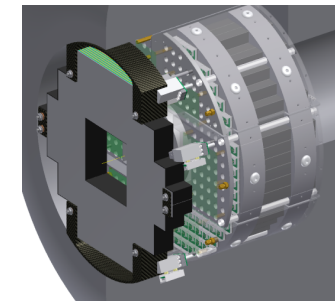
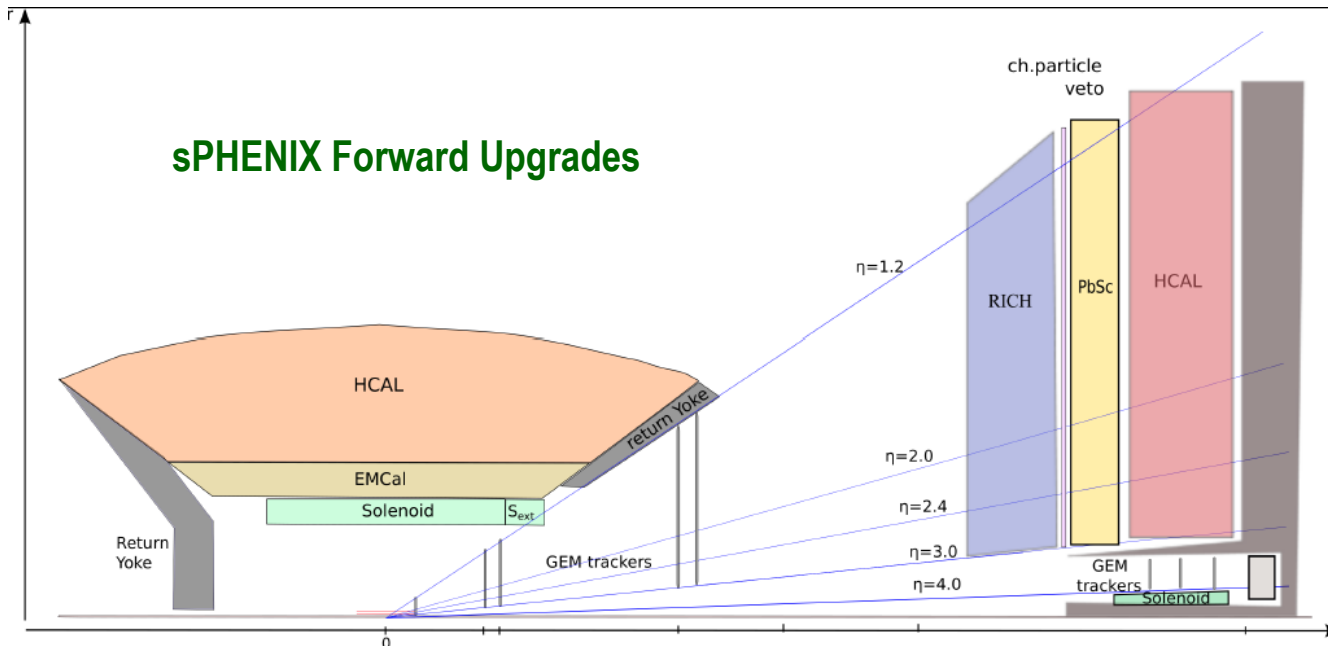
STAR Forward Upgrades



Forward Upgrades STAR and PHENIX



sPHENIX Forward Upgrades



PHENIX MPC-EX

RHIC Timeline for the next Decade

From the White Paper “The Case for Continuing RHIC Operations”

Years	Beam Species and Energies	Science Goals	New Systems Commissioned
2013	<ul style="list-style-type: none"> • 500 GeV $\vec{p} + \vec{p}$ • 15 GeV Au+Au 	<ul style="list-style-type: none"> • Sea antiquark and gluon polarization • QCD critical point search 	<ul style="list-style-type: none"> • Electron lenses • upgraded pol'd source • STAR HFT
2014	<ul style="list-style-type: none"> • 200 GeV Au+Au and baseline data via 200 GeV p+p (needed for new det. subsystems) 	<ul style="list-style-type: none"> • Heavy flavor flow, energy loss, thermalization, etc. • quarkonium studies 	<ul style="list-style-type: none"> • 56 MHz SRF • full HFT • STAR Muon Telescope Detector • PHENIX Muon Piston Calorimeter Extension (MPC-EX)
2015-2017	<ul style="list-style-type: none"> • High stat. Au+Au at 200 and ~40 GeV • U+U/Cu+Au at 1-2 energies • 200 GeV p+A • 500 GeV $\vec{p} + \vec{p}$ 	<ul style="list-style-type: none"> • Extract $\eta/s(T_{\min})$ + constrain initial quantum fluctuations • further heavy flavor studies • sphaleron tests @ $\mu_B \neq 0$ • gluon densities & saturation • finish p+p W prod'n 	<ul style="list-style-type: none"> • Coherent Electron Cooling (CeC) test • Low-energy electron cooling • STAR inner TPC pad row upgrade
2018-2021	<ul style="list-style-type: none"> • 5-20 GeV Au+Au (E scan phase 2) • long 200 GeV + 1-2 lower \sqrt{s} Au+Au w/ upgraded dets. • baseline data @ 200 GeV and lower \sqrt{s} • 500 GeV $\vec{p} + \vec{p}$ • 200 GeV $\vec{p} + A$ 	<ul style="list-style-type: none"> • x10 sens. increase to QCD critical point and deconfinement onset • jet, di-jet, γ-jet quenching probes of E-loss mechanism • color screening for different $q\bar{q}$ states • transverse spin asyms. Drell-Yan & gluon saturation 	<ul style="list-style-type: none"> • sPHENIX • forward physics upgrades