The PHENIX Experiment at RHIC
Decadal Plan 2011–2020

- replace central magnet with solonoid
- replace central arms with compact EMCal & HCal
- replace South muon arm with DIS-style electron spectrometer

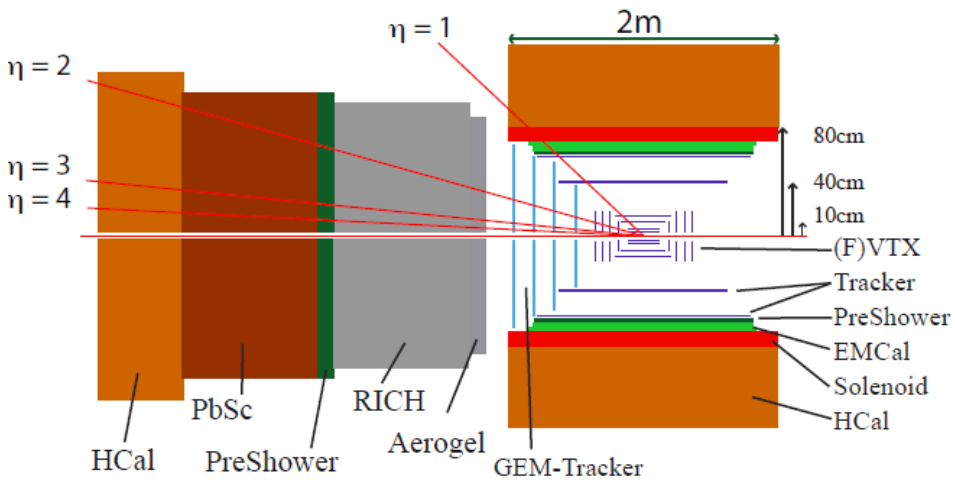
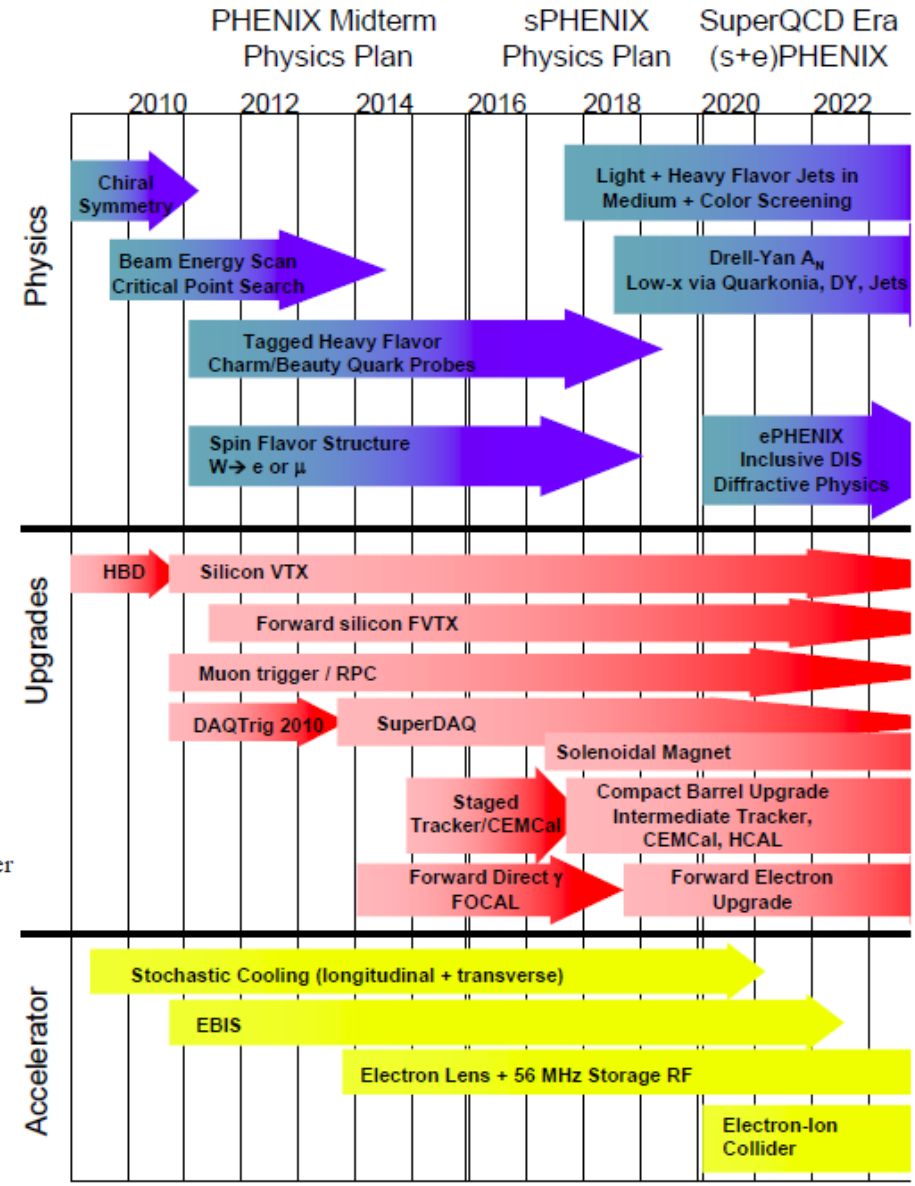
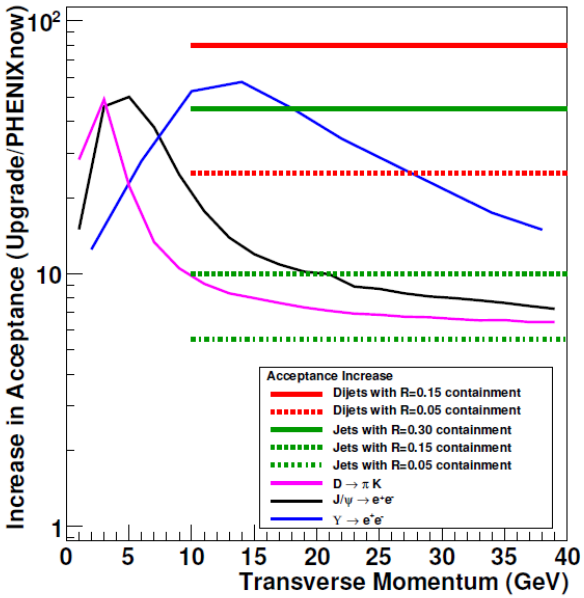
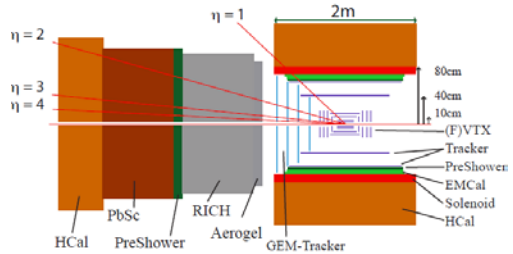


Figure 2: Layout of the upgraded PHENIX detector (sPHENIX).

(2016-2018)







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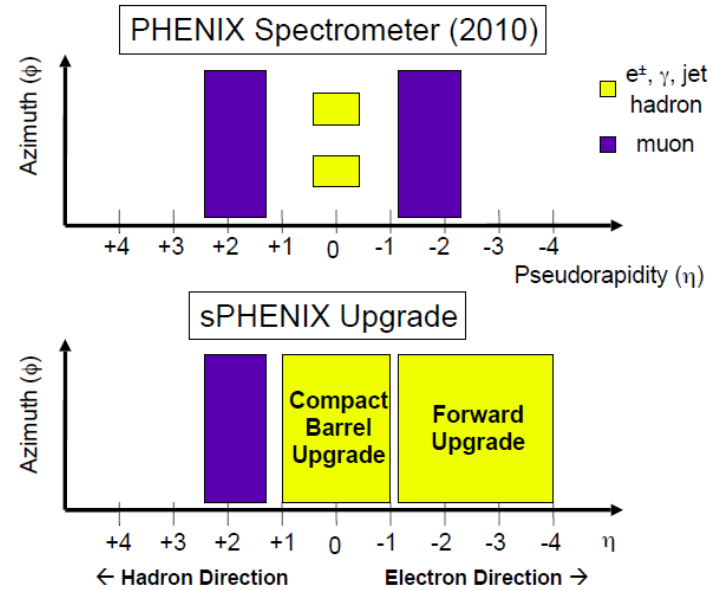
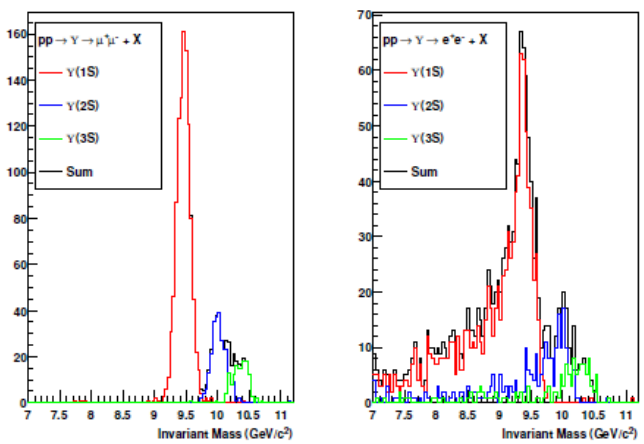


Upsilons



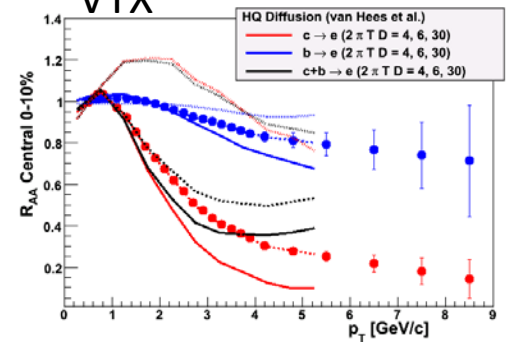
New mid-rapidity detector layers

Detector	Technology	Segmentation	R (cm)	N_{chan} ($\times 10^6$)
Inner Tracking	VTX Pixels	$50\,\mu m \times 425\,\mu m$	2.5	1.5
			5	3
Inner Tracking II	VTX Strip Pixels	$80\,\mu m \times 0.1$ cm	10	1.6
			14	2.2
Outer Tracking	New Strips	$80\,\mu m \times 3$ cm	40	1
			60	2.2
Compact EMCal PS	Si-W	$300\,\mu m \times 6$ cm	61	0.3
Compact EMCal	Si-W E1	0.75 cm $\times 0.75$ cm	61–64	0.110
	Si-W E2	1.50 cm $\times 1.50$ cm	64–68	0.03
Hadronic Cal	Fe-Sc	$0.1\eta \times 0.1\phi$	80–142	0.0012

Heavy Ion Physics: Midterm Physics Plan

- We will investigate the restoration of approximate chiral symmetry and its impact on vector meson spectral functions via dielectron measurements with the Hadron Blind Detector.
- We will explore the mechanisms of parton energy loss for heavy quarks (charm and beauty) and their coupling to the medium with the new silicon vertex detectors (the VTX and FVTX).
- We will search for a QCD critical point with a continued systematic low energy scan.
- We will look for further evidence of gluon saturation at low x with the FVTX and potentially with new forward calorimetry, referred to as the FOCAL.

VTX



FVTX x coverage

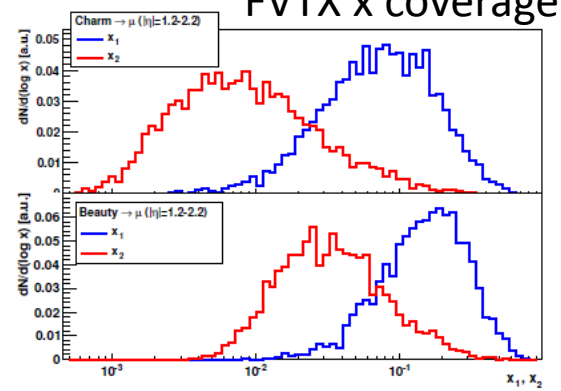
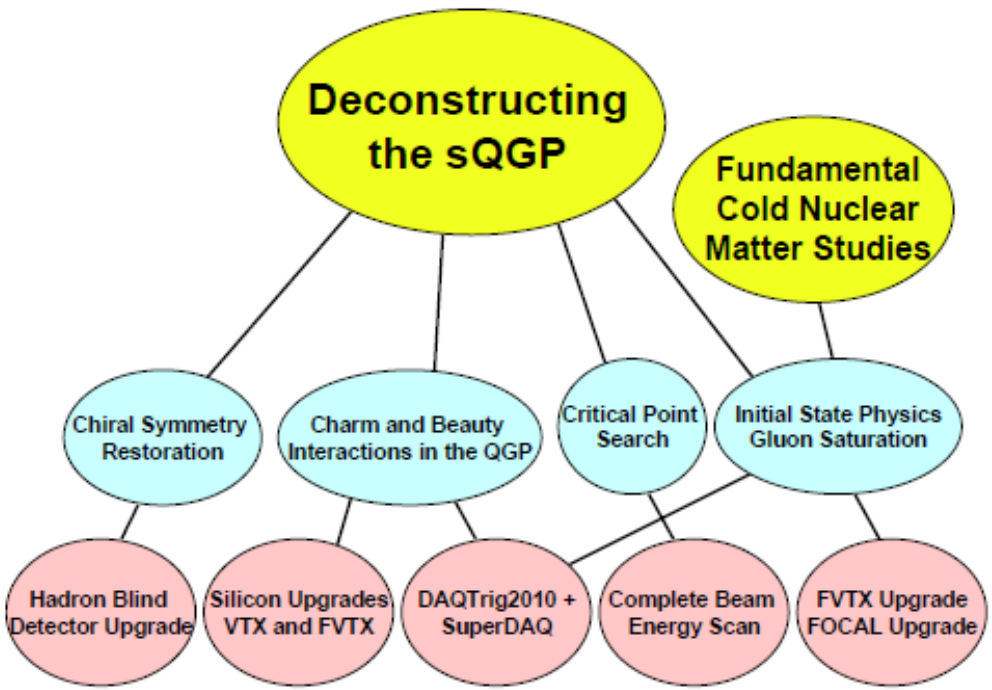
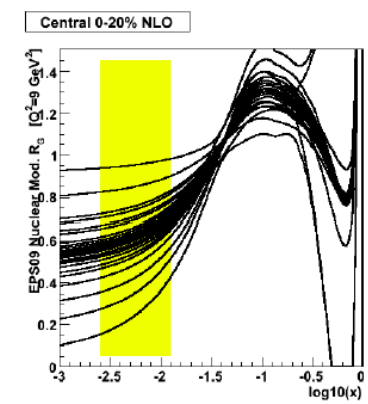


Figure 2.14: Coverage in x_2 and x_1 for detection of charm and beauty with the Forward Vertex detector (FVTX).



FOCAL??



Heavy Ion Physics: sPHENIX Physics Plan

- Are quarks strongly coupled to the quark-gluon plasma at all interaction distance scales?

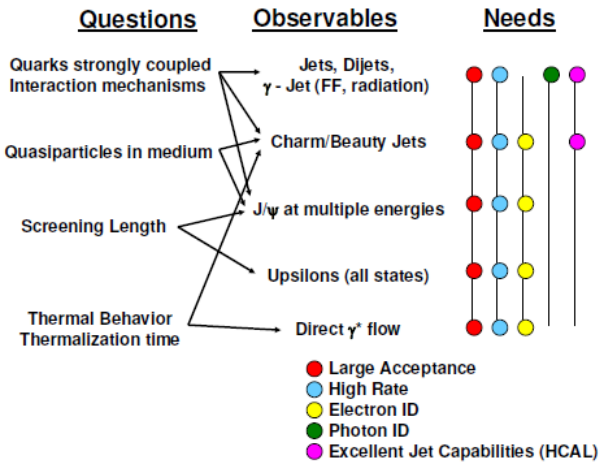
- What are the detailed mechanisms for parton-QGP interactions and responses? Are the interactions coherent over the entire medium length scale, what are the dominant energy loss mechanisms?

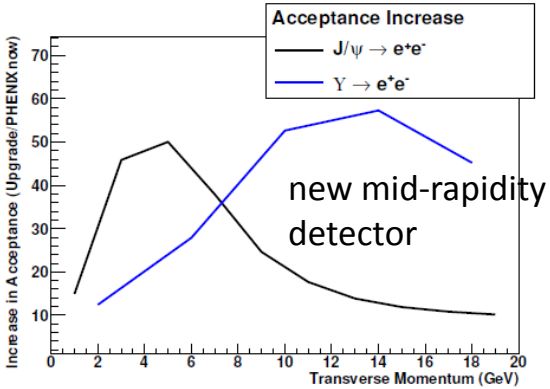
- Are there quasi-particles in the medium? What is their mass and width?

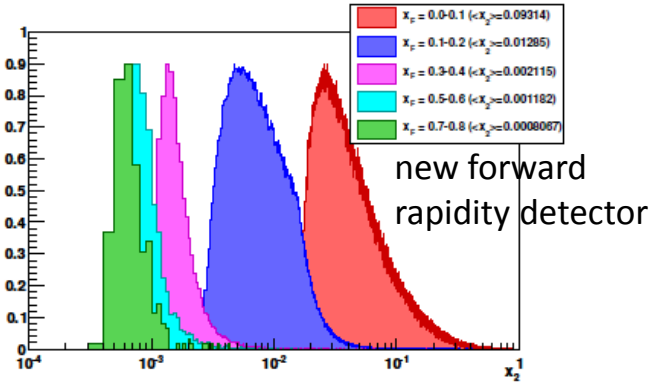
- Is there a relevant color screening length in the quark-gluon plasma?

- How is rapid equilibration and entropy production achieved?

- What is the nature of color charge in large nuclei? What role does gluon saturation and the EMC effect play in nucleus-nucleus collisions? How do these modifications evolve?







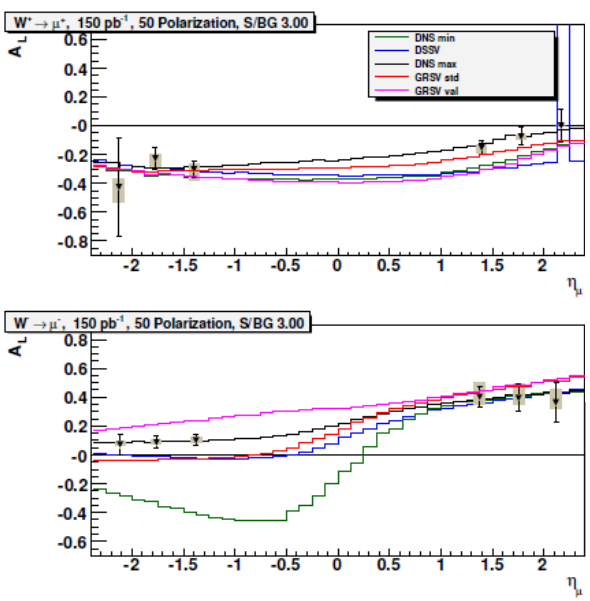
- Section 3.1: Jet and Photon-Jet Physics
- Section 3.2: Heavy Flavor Jet Physics
- Section 3.3: RHIC and LHC Complementary Roles
- Section 3.4: Quarkonia and Color Screening
- Section 3.5: Early Time Dynamics
- Section 3.6: Cold Nuclear Matter Physics

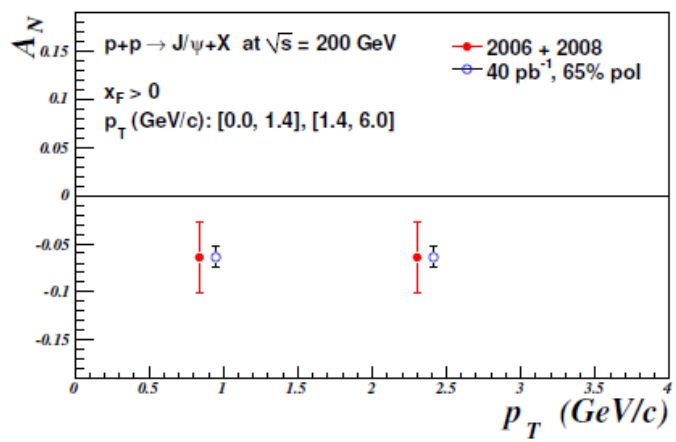
Nucleon Structure Physics: Midterm Physics Plan

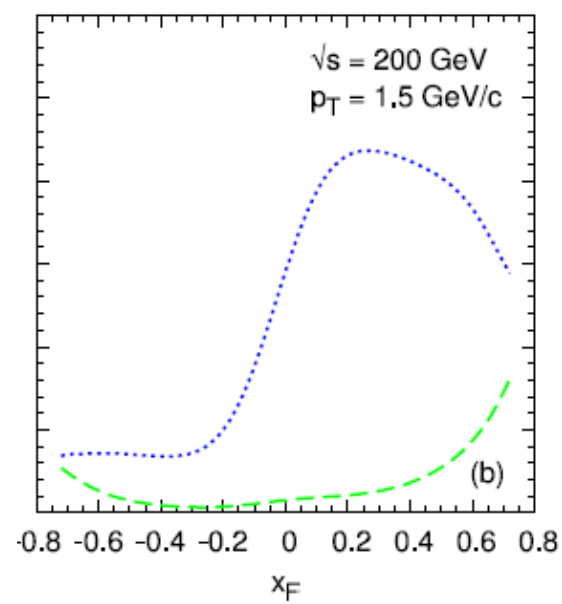
- Constraining the flavor-separated sea quark helicity distributions via W measurements in longitudinally polarized $p+p$ collisions at sqrt(s) = 500 GeV.

- Probing Delta-g(x) down to lower momentum fractions in longitudinally polarized p+p collisions at sqrt(s) = 500 GeV.

- Explore several transverse spin measurements in transversely polarized p+p collisions at sqrt(s)=200 GeV and lower energies.

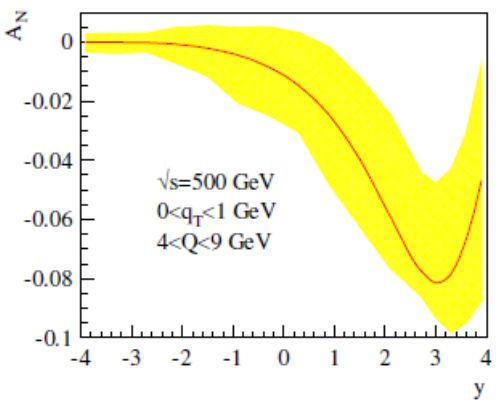


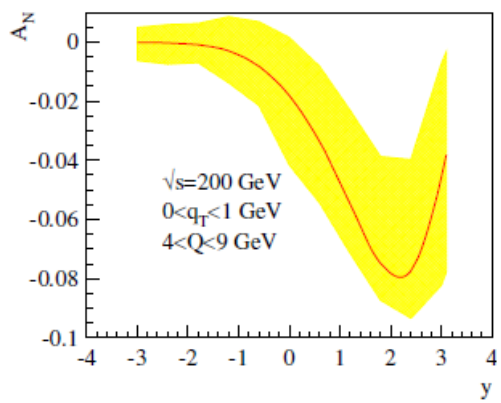


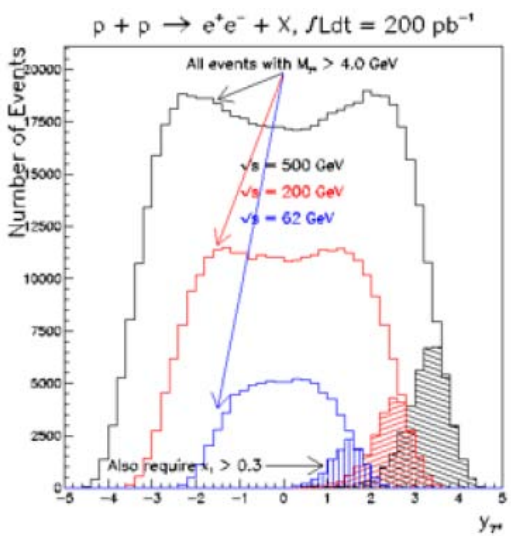


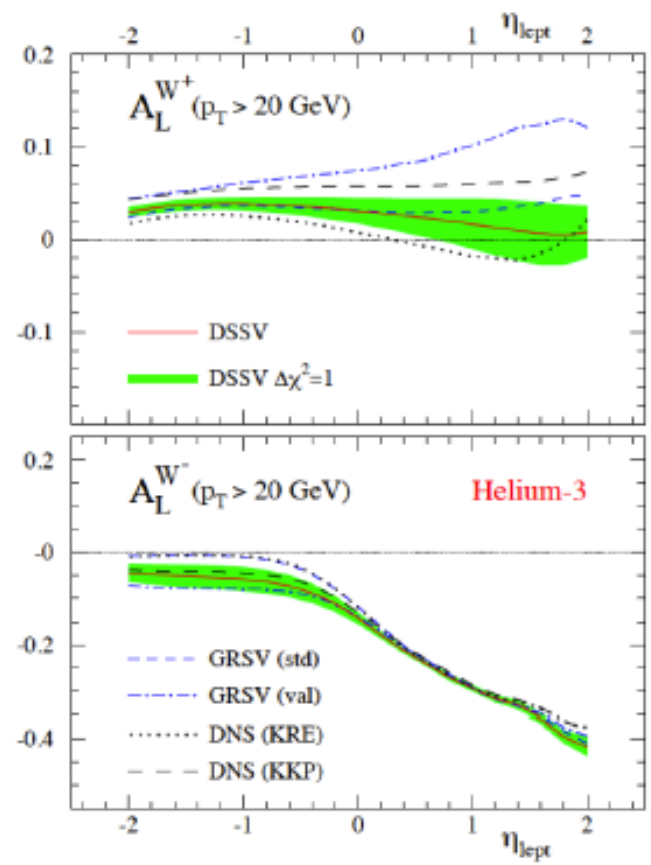
Nucleon Structure Physics: sPHENIX Physics Plan

- Dynamical Origins of Spin-Dependent Interactions
- New Probes of Longitudinal Spin Effects
- Measurements with Polarized He^3 and Increased Energies







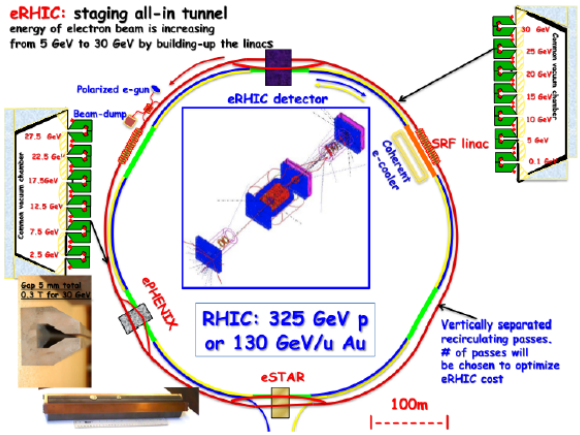


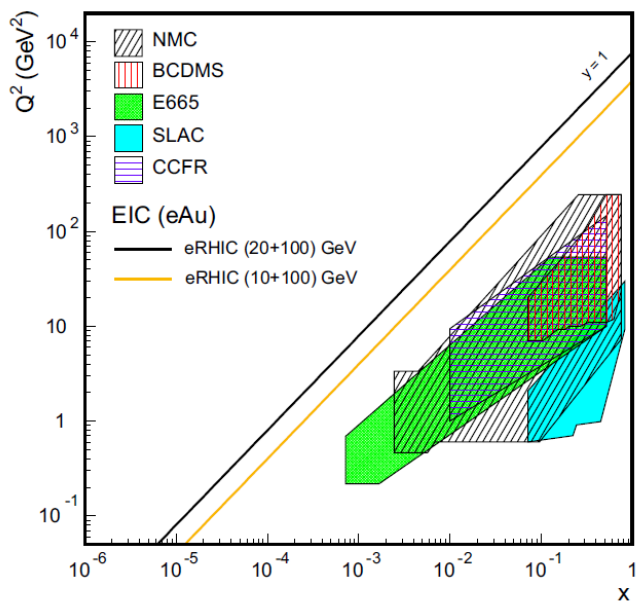
e-A Physics with sPHENIX

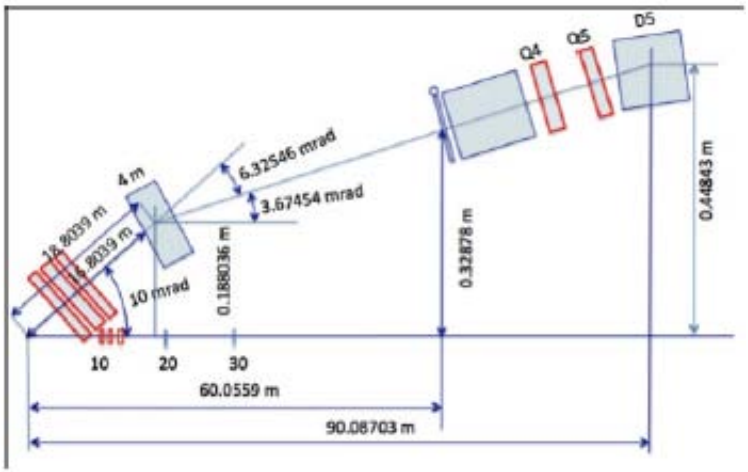
- Inclusive e+p physics to measure polarized and unpolarized structure functions. For the polarized case, these measurements will significantly advance our knowledge of the contributions of quarks and gluons to the proton spin.

- Inclusive e+A physics to measure unpolarized structure functions and derive nuclear parton distribution functions nPDFs. These measurements are particularly relevant to studies of gluon saturation effects.

- Elastic diffractive physics, i.e. elastic vector meson production and deeply virtual Compton scattering (DVCS). In $e+p$ a tomographic picture of the proton will become possible, while diffractive $e+A$ pins down the initial state for heavy ion collisions. Most of the measurements require the addition of "Roman pot" detectors.







Projected Luminosities & Strawman PHENIX Run Plan

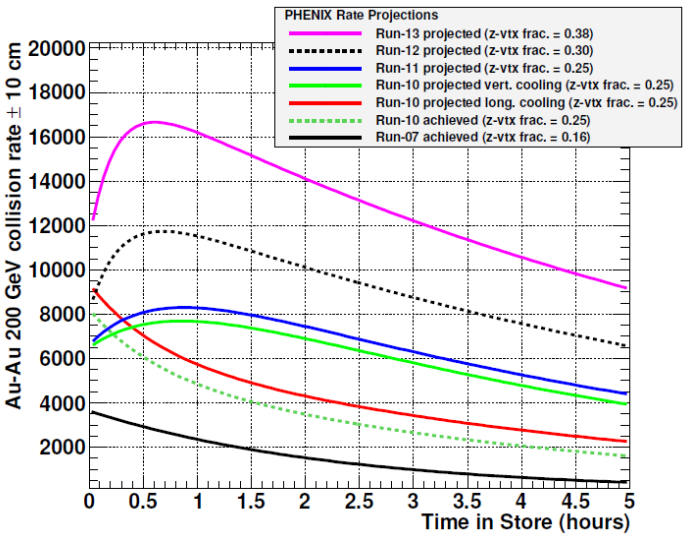


Table B.1: PHENIX run plan for the years 2010–2015. Longitudinal polarization is indicated by (L), transverse by (T).

run	Species	$\sqrt{s_{NN}}$	Wks	$\int L\,dt$ $\lvert z\rvert < 30$ cm	$\int L\,dt$ $\lvert z\rvert < 10$ cm	Pol.	Comments
11	$p+p$	500	10	$50\,pb^{-1}$	$20\,pb^{-1}$	50% (L)	W program + ΔG
	Au+Au	200	8		$0.7\,nb^{-1}$		heavy flavor (VTX)
	Au+Au	18	1.5	$5.5\,\mu b^{-1}$			energy scan
	U+U	192	1.5		$0.03\,nb^{-1}$		explore geometry
12	$p+p$	500	8	$100\,pb^{-1}$	$35\,pb^{-1}$	50% (L)	W program + ΔG
	$p+p$	200	5	$13.1\,pb^{-1}$	$4.7\,pb^{-1}$	60% (T)	HI comparison
	Au+Au	200	7		$0.8\,nb^{-1}$		heavy flavor (F/VTX)
	Au+Au	27	1	$5.2\,\mu b^{-1}$			energy scan
13	$p+p$	500	10	$200\,pb^{-1}$	$74\,pb^{-1}$	60% (L)	W program
	U+U	200	5		$0.57\,nb^{-1}$		} geometry
	Cu+Au	200	5		$2.4\,nb^{-1}$		
14	$p+p$	200	10	$34\,pb^{-1}$	$12\,pb^{-1}$	65% (T)	} HI comp., transv.
	$p+p$	62	3	$0.6\,pb^{-1}$	$0.2\,pb^{-1}$	60% (T/L)	
	d+Au	200	8	$260\,nb^{-1}$	$150\,nb^{-1}$		} CNM/FOCAL
	d+Au	62	2	$6.5\,nb^{-1}$	$3.8\,nb^{-1}$		
15	Au+Au	200	10		$2.8\,nb^{-1}$		High Bandwidth
	Au+Au	62	4		$0.13\,nb^{-1}$		HF vs $\sqrt{s_{NN}}$
	$p+{}^3$He	132	5			(T)	Test Run

The PHENIX Experiment at RHIC

Decadal Plan 2011–2020

Brookhaven National Laboratory

Relativistic Heavy Ion Collider

October, 2010

PHENIX

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Executive Summary

(about 5 pages)

The first decade of operations at the Relativistic Heavy Ion Collider (RHIC) has provided striking new insights into Quantum Chromodynamics (QCD) and has revealed new and surprising connections to other disciplines of physics. The PHENIX experiment has been at the forefront of these advances, while at the same time training the next generation of scientists. PHENIX has published over 90 refereed journal articles with nearly ten thousand citations and granted over 100 Ph.D's. The measurements described in those articles, together with theoretical modeling, are converging towards a coherent picture of

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