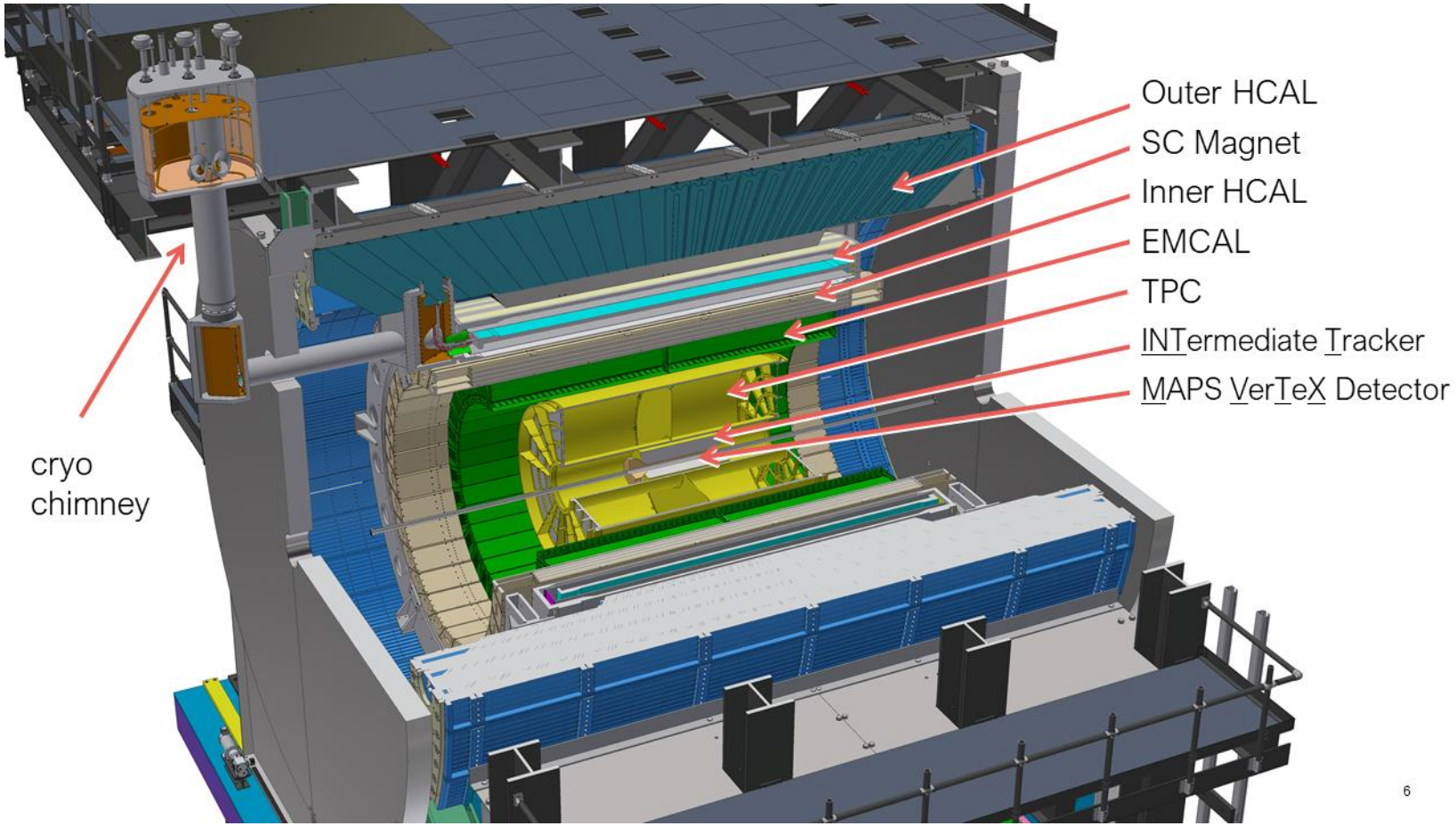
Cold QCD Physics with sPHENIX

Desmond Shangase (University of Michigan) on behalf of the sPHENIX Collaboration

Hard Probes 2020 - June 5th 2020

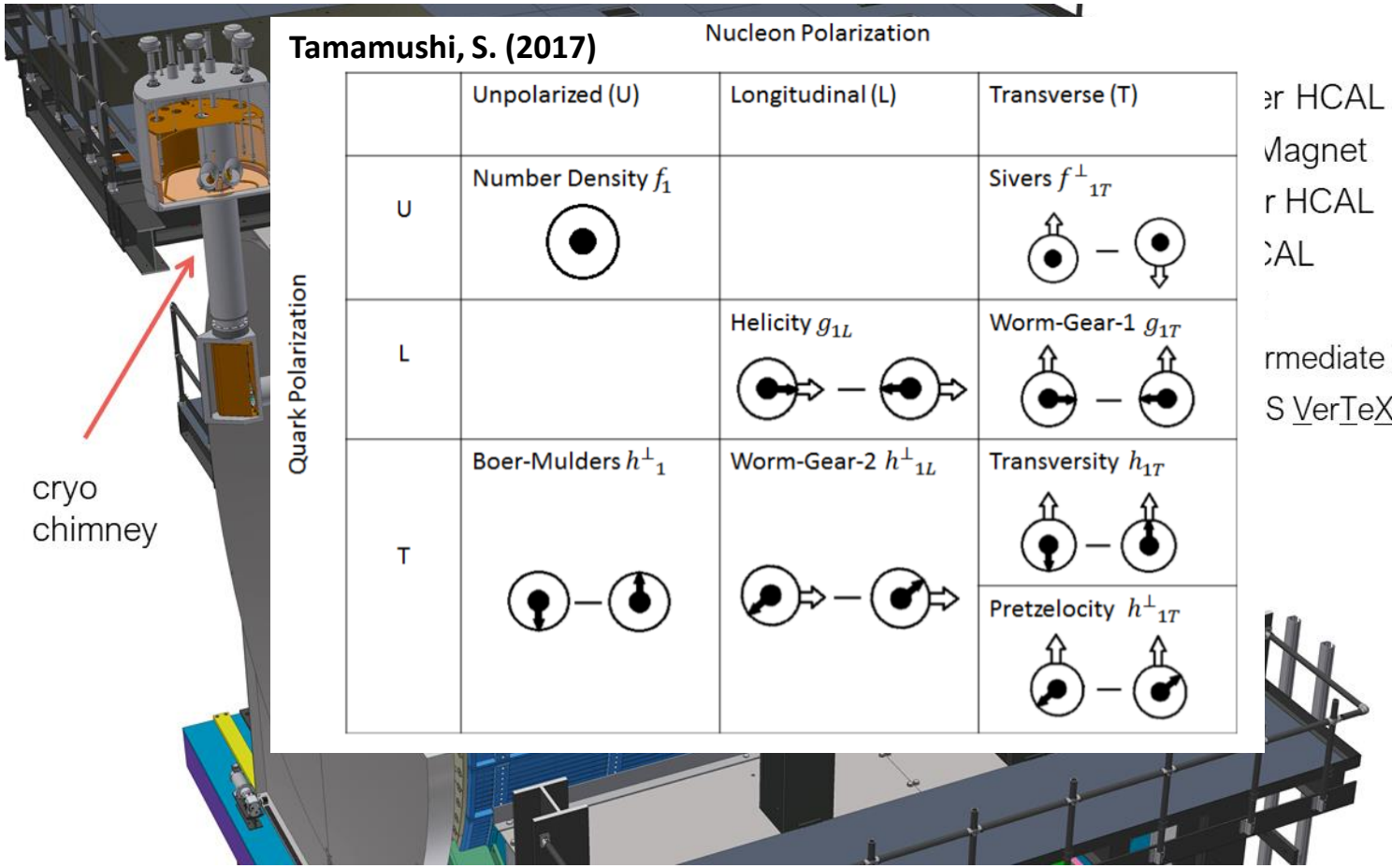
U.S. DEPARTMENT OF ENERGY | Office of Science



sPHENIX Detector

- Full azimuthal detector (Central Barrel)
- To be installed at RHIC
  - Will exploit RHIC capabilities of colliding polarized protons
- Cold QCD Physics Program
  - Proton/Nucleus Structure (PDFs)
  - Parton Dynamics (TMD PDFs)
  - Hadronization (FFs)
- Data collection expected to begin 2023

6



Tamamushi, S. (2017)

Nucleon Polarization

Quark Polarization	Unpolarized (U)	Longitudinal (L)	Transverse (T)
U	Number Density f_1		Sivers $f^{\perp}{}_{1T}$
L		Helicity g_{1L}	Worm-Gear-1 g_{1T}
T	Boer-Mulders $h^{\perp}{}_1$	Worm-Gear-2 $h^{\perp}{}_{1L}$	Transversity h_{1T}
			Pretzelocity $h^{\perp}{}_{1T}$

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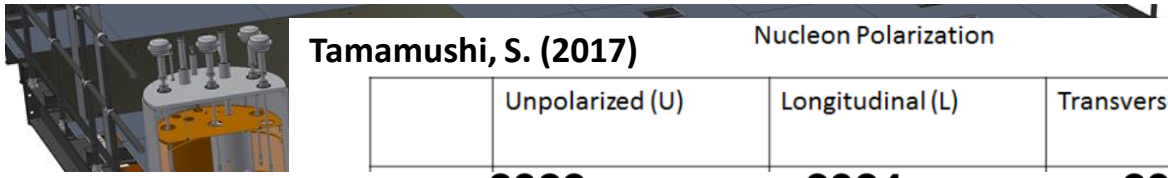

Tamamushi, S. (2017)

Year	Species	Energy [GeV]	Phys. Wks	Rec. Lum.	Samp. Lum.	Samp. Lum. All-Z
Year-1	Au+Au	200	16.0	7 nb^{-1}	8.7 nb^{-1}	34 nb^{-1}
Year-2	p+p	200	11.5	—	48 pb^{-1}	267 pb^{-1}
Year-2	p+Au	200	11.5	—	0.33 pb^{-1}	1.46 pb^{-1}
Year-3	Au+Au	200	23.5	14 nb^{-1}	26 nb^{-1}	88 nb^{-1}

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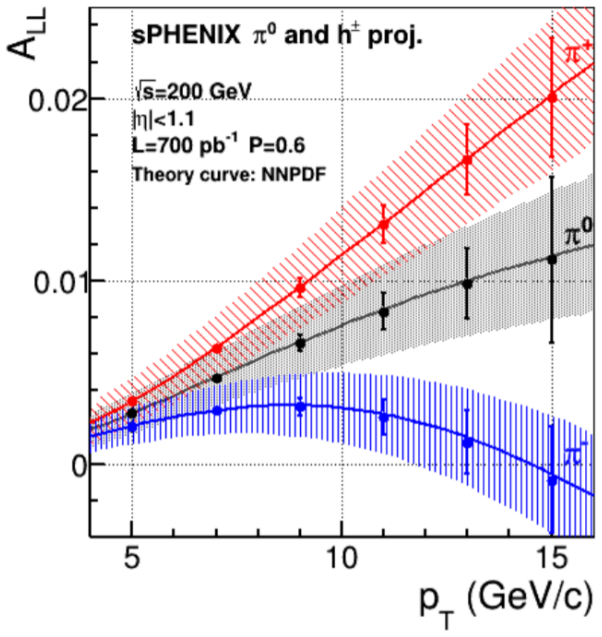
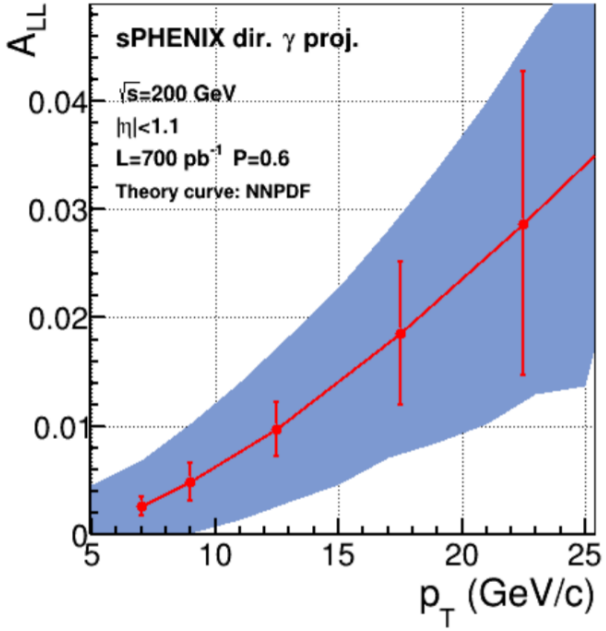
Probing Proton Structure

- Exploit polarized proton beam capabilities to access TMD PDFs
- Double-Helicity Asymmetries of hadrons (*gg*, *qg*, *qq* scattering) and photon production (*qg*, *qq-bar*) can probe Gluon Helicity Function, ΔG
  - This is because gluonic interactions dominate these cross-sections
- Expected to reduce uncertainty in 0.05 < x < 0.4 region
  - Luminosity may vary from plots, impacting precision of higher-pt measurements

π0 and h±



Dir. Photons



sPH-cQCD-2017-002

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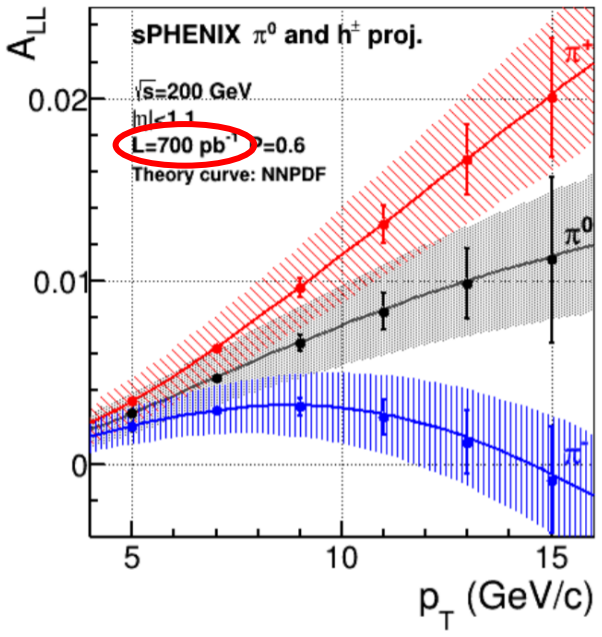

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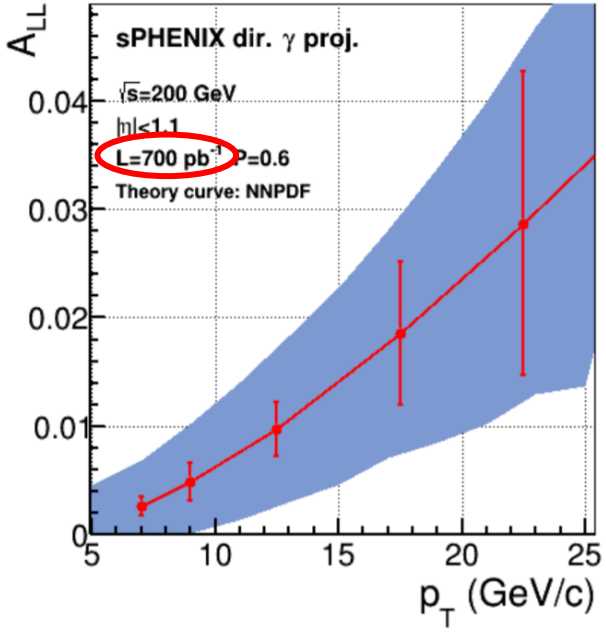
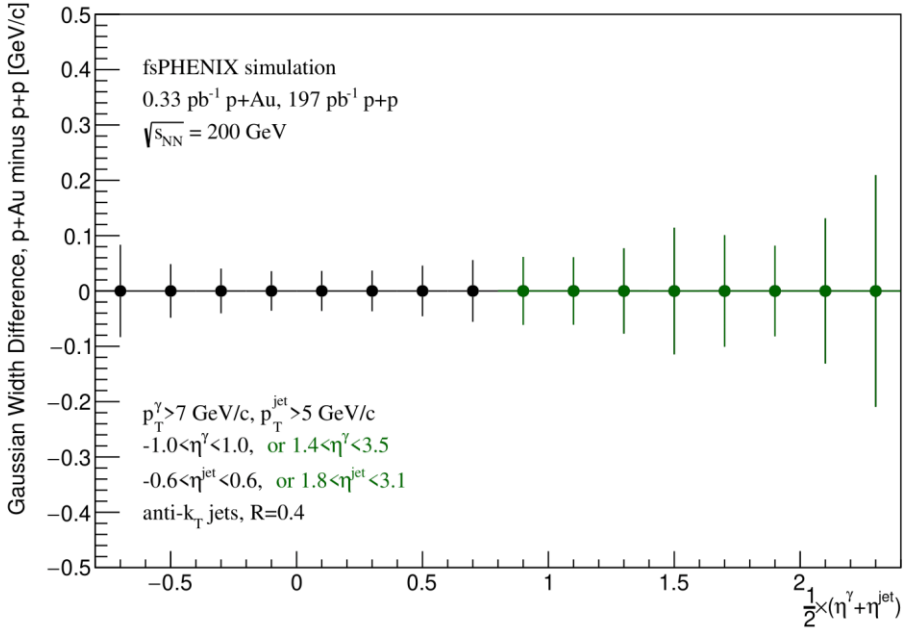


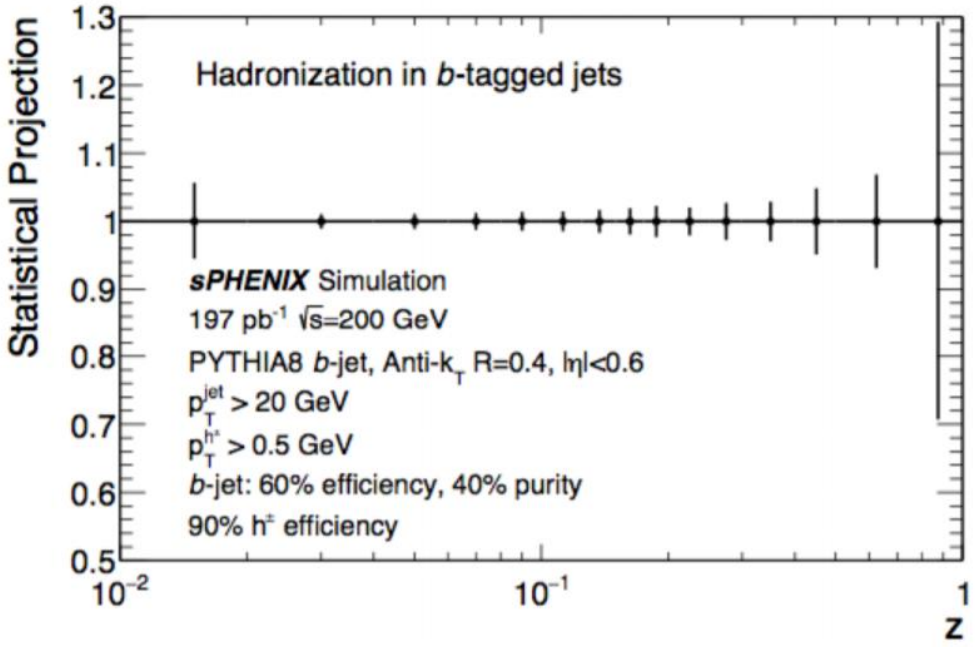
sPH-cQCD-2017-002

Looks Into Nuclear vs Proton Environment

TRANSPORT COEFFICIENT



IN-JET HADRONIZATION



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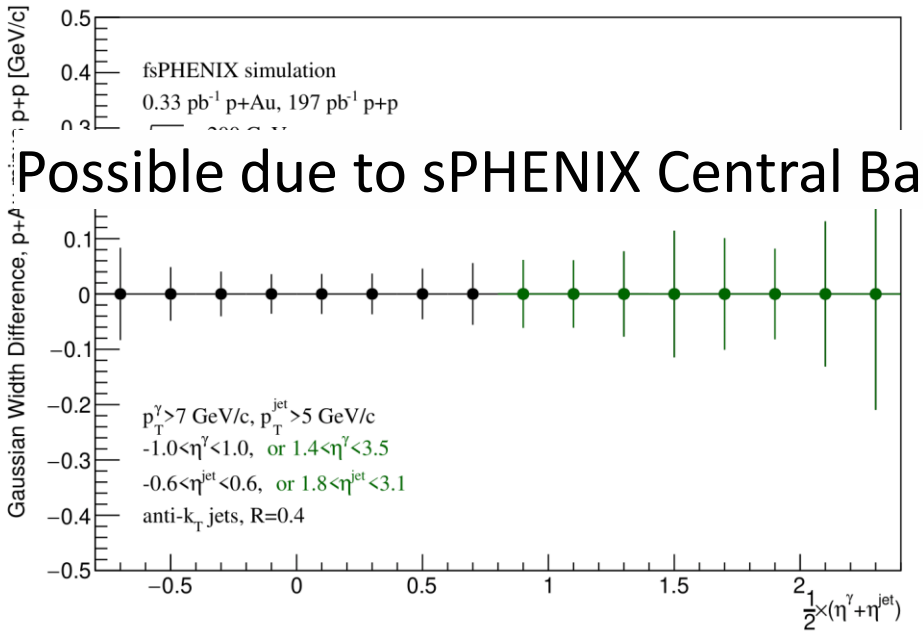

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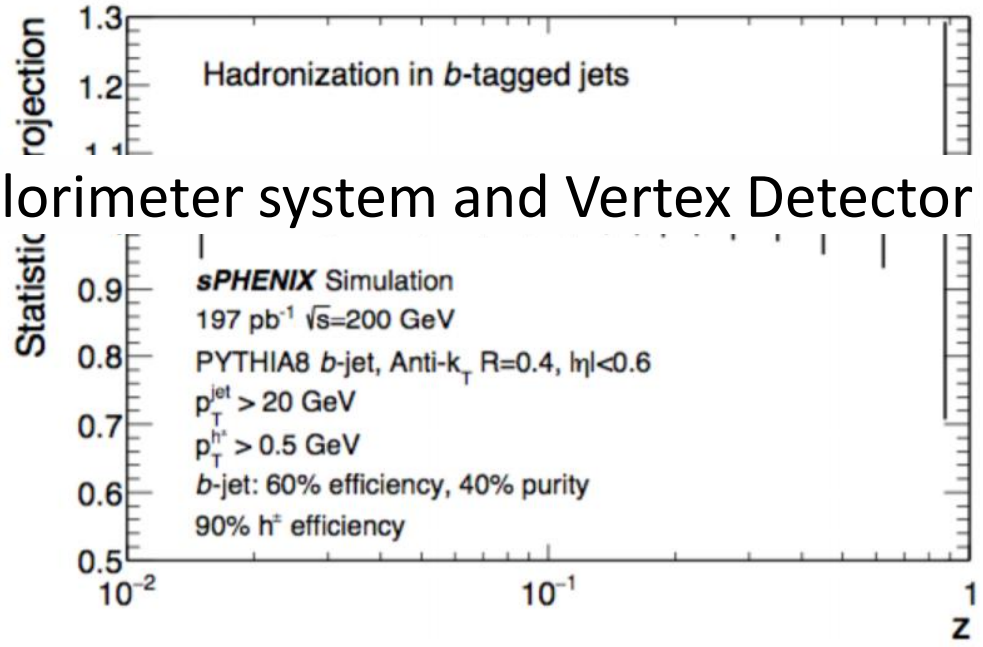
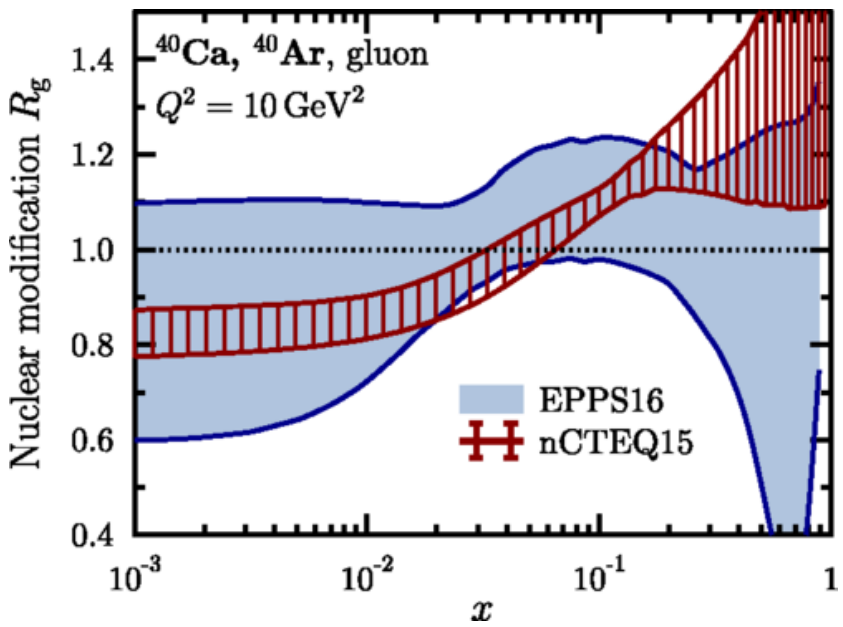
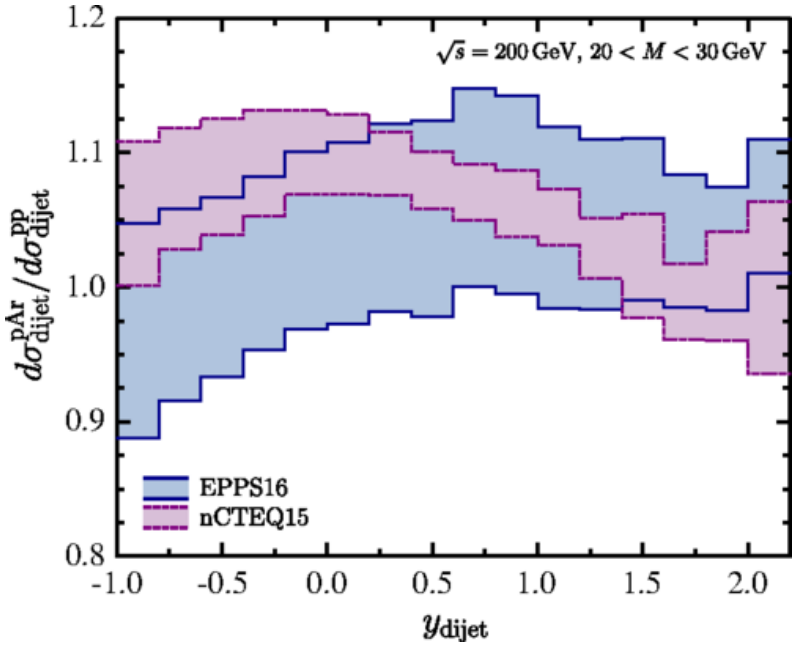


Possible due to sPHENIX Central Barrel Calorimeter system and Vertex Detector

Improving nPDF Confidence



Phys. Rev. D 100, 014004



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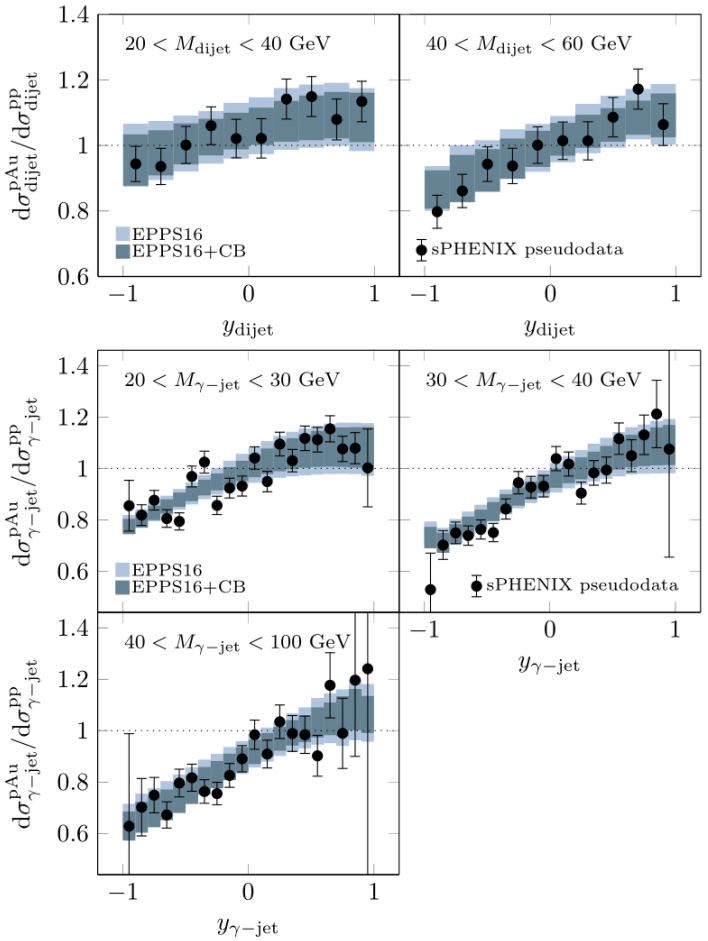

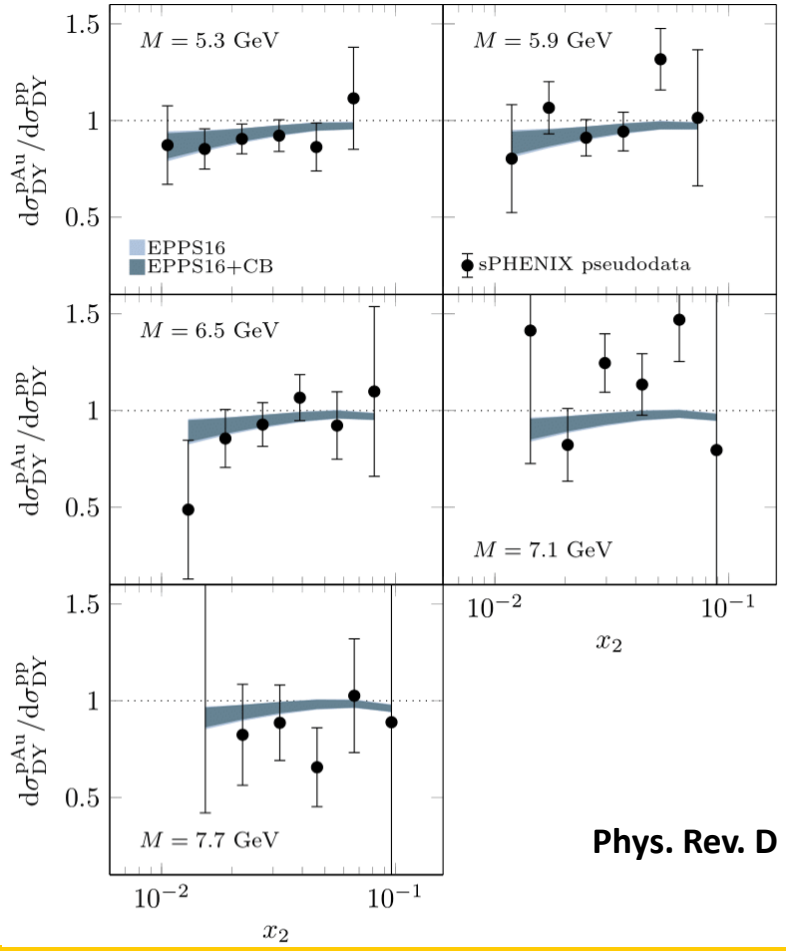

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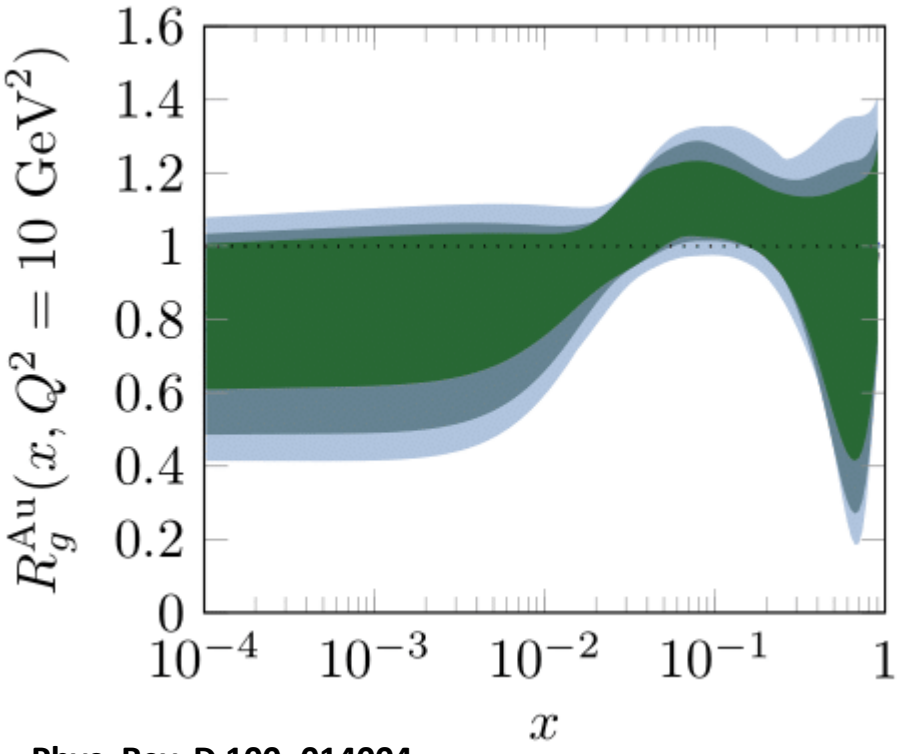

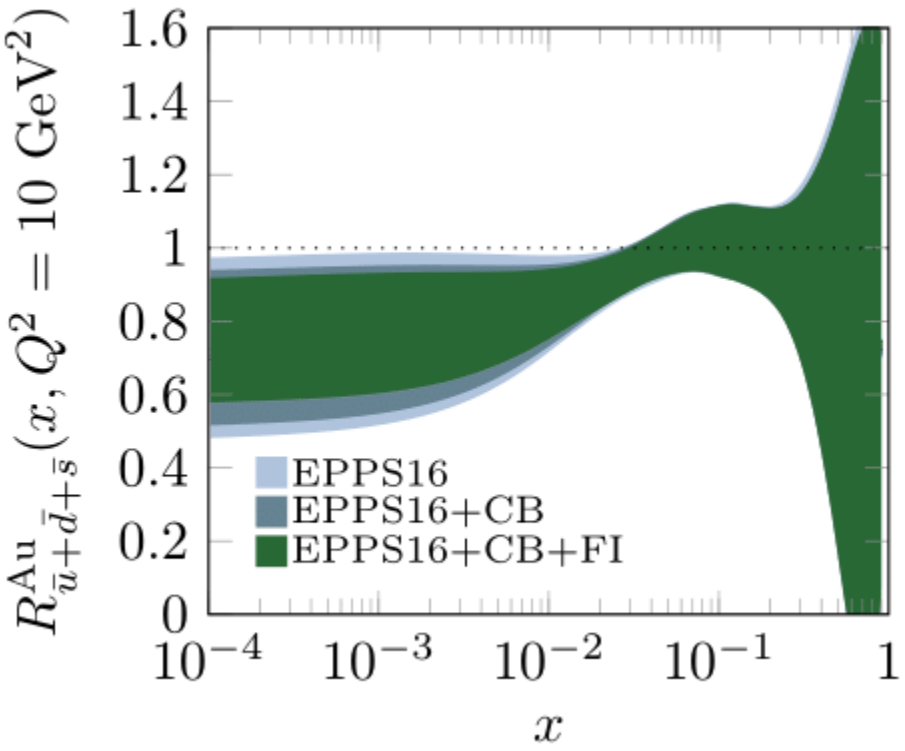

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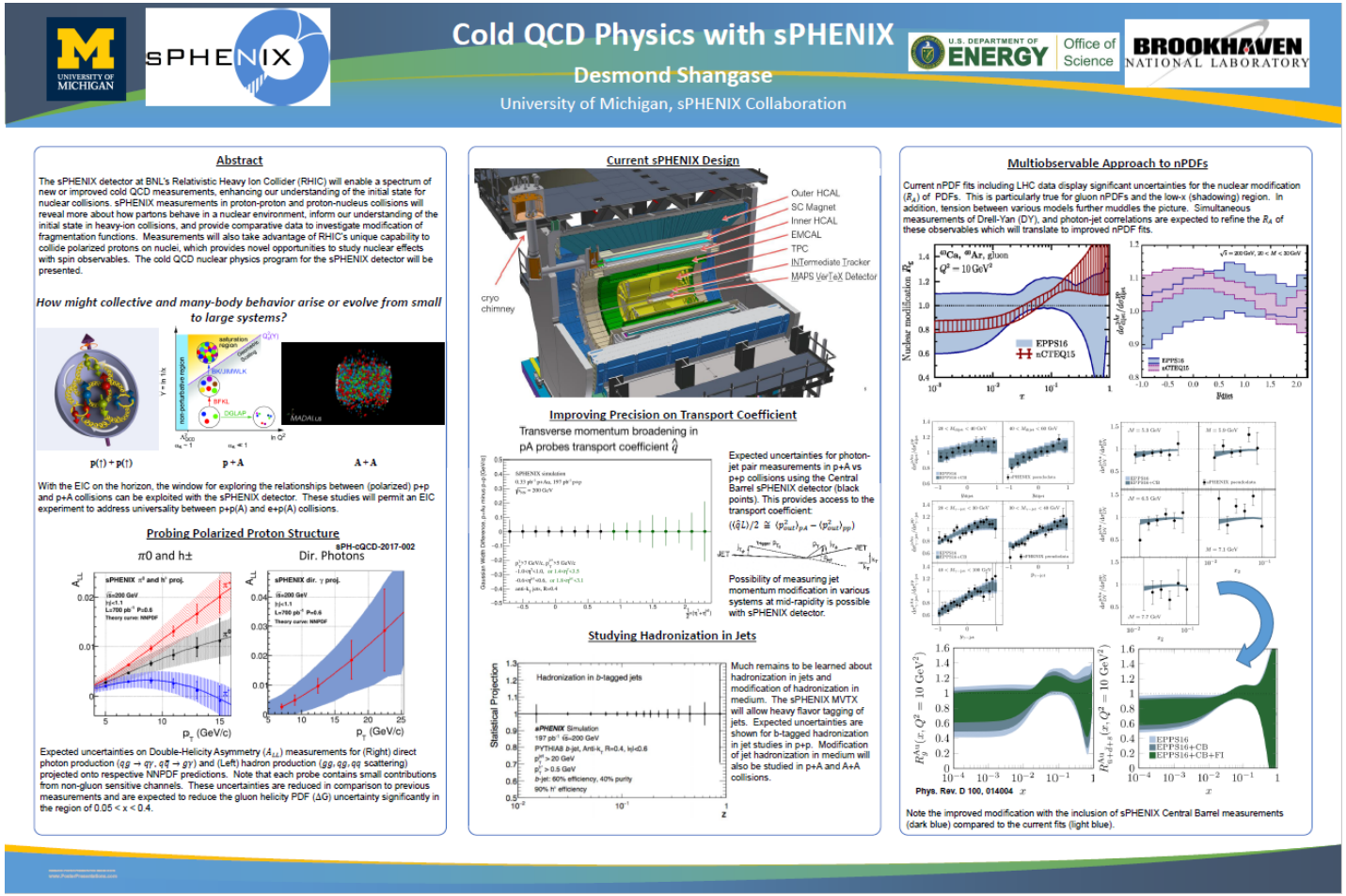
Thank You



https://indico.cern.ch/event/751767/contributions/3867324/