

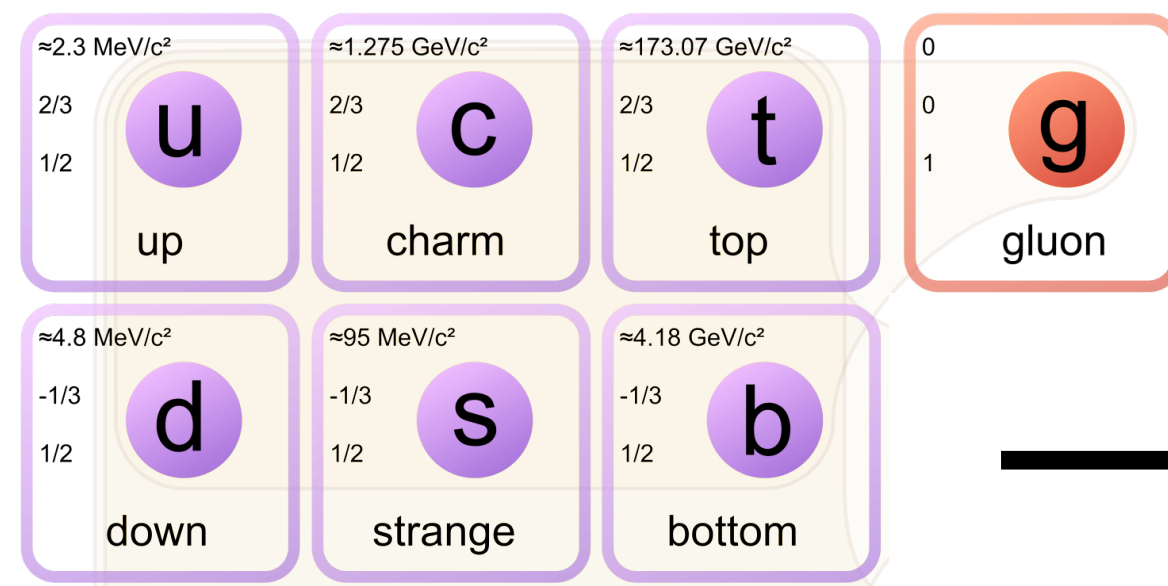
SPHENIX Experiment Status

**RHIC/AGS Open Forum
APS Division of Nuclear Physics Meeting**

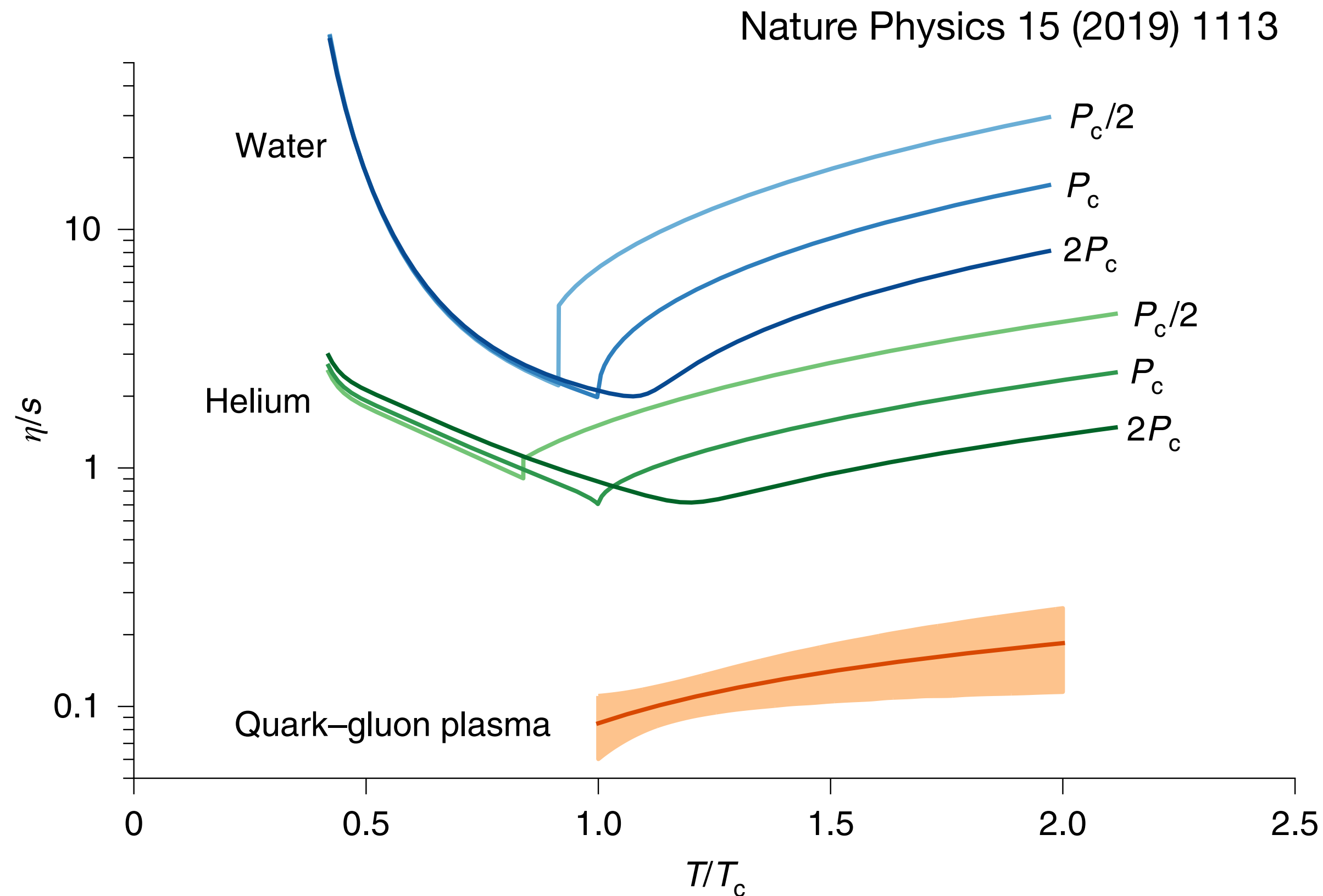
**28 October 2022
New Orleans, LA
Dennis V. Perepelitsa (University of Colorado Boulder)**



Perfectly fluid QGP

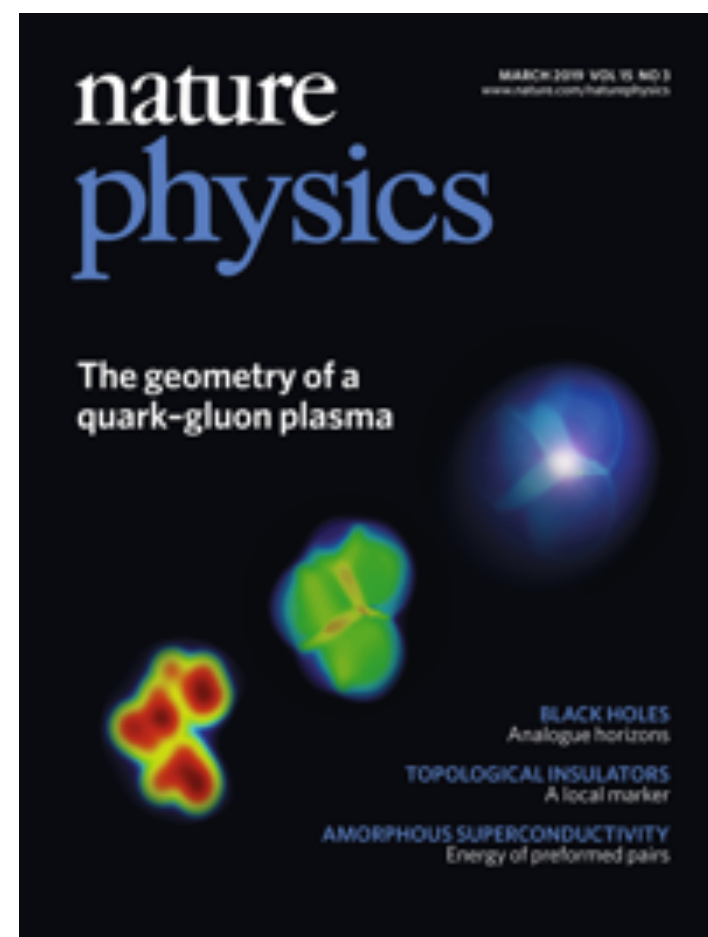


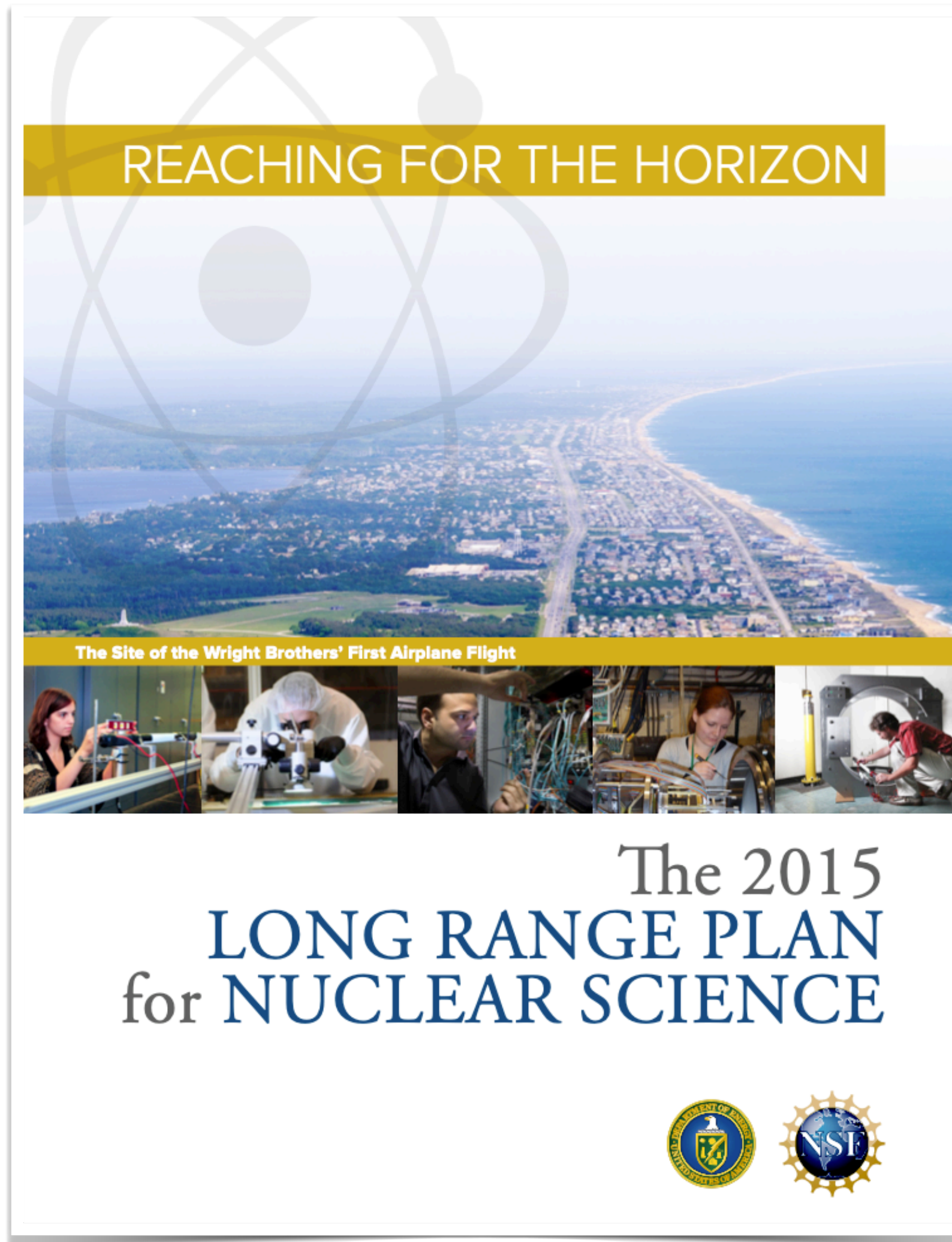
$$\mathcal{L}_{\text{QCD}} = -\frac{1}{4}F_{\mu\nu}^C F_C^{\mu\nu} + \sum_f \bar{\psi}_f \left(i\gamma^\mu D_\mu - m_f \right) \psi_f$$



Landmark scientific discovery of the RHIC physics program

➔ How does the *lowest specific viscosity* (η/s) of any known material arise from its microscopic QCD degrees of freedom?





There are two central goals of measurements planned at RHIC, as it completes its scientific mission, and at the LHC: **(1) Probe the inner workings of QGP by resolving its properties at shorter and shorter length scales. The complementarity of the two facilities is essential to this goal, as is a state-of-the-art jet detector at RHIC, called sPHENIX.** **(2) Map the phase diagram of QCD with experiments planned at RHIC.**

[2015 US NP LRP](#)

sPHENIX recognized by the U.S. Nuclear Physics community as an *essential* tool for QGP microscopy at RHIC

oHCAL

MAGNET

iHCAL

EMCAL

TPC

sEPD

MVTX

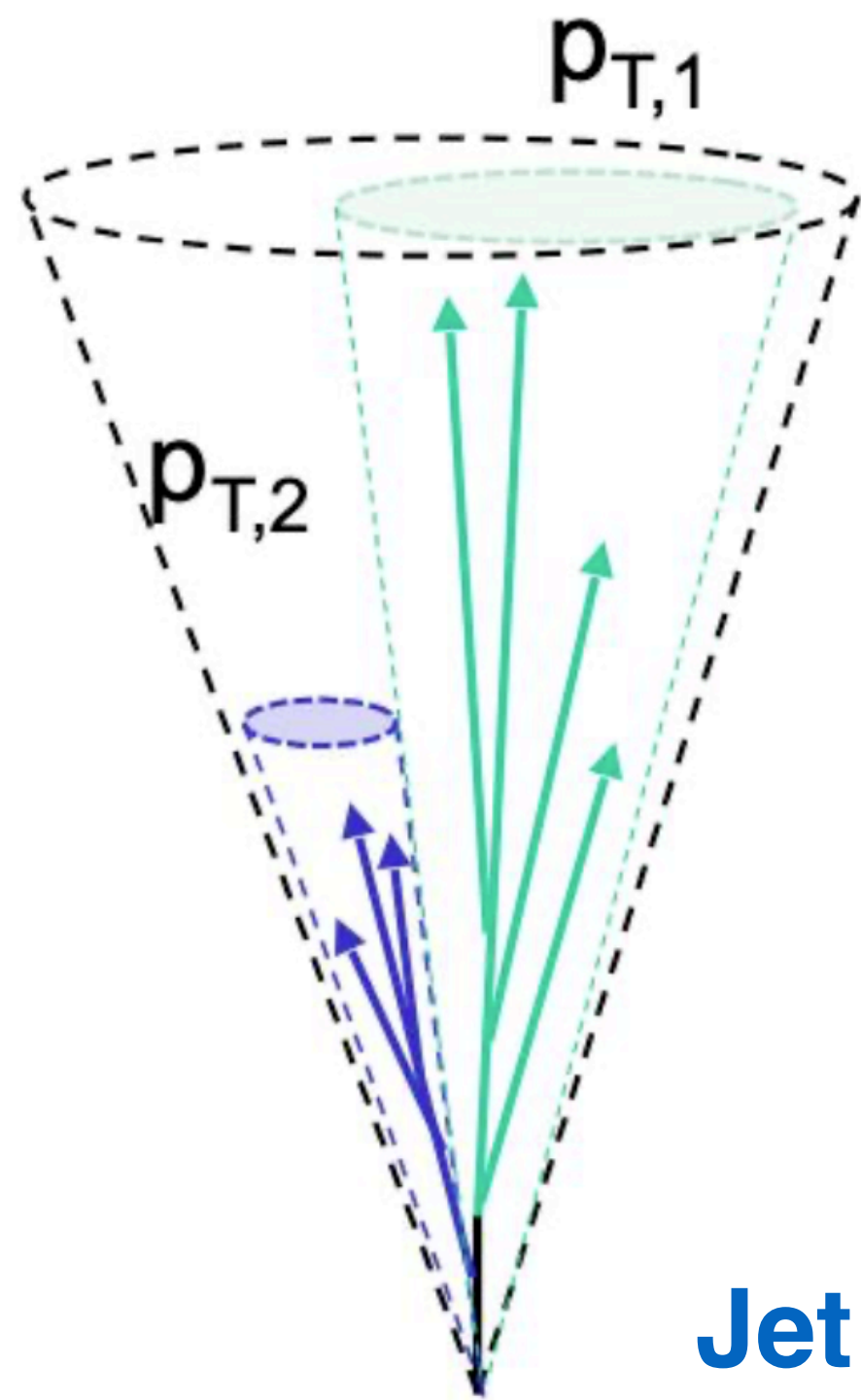
MinBIAS

INTT

TPOT

SPHENIX





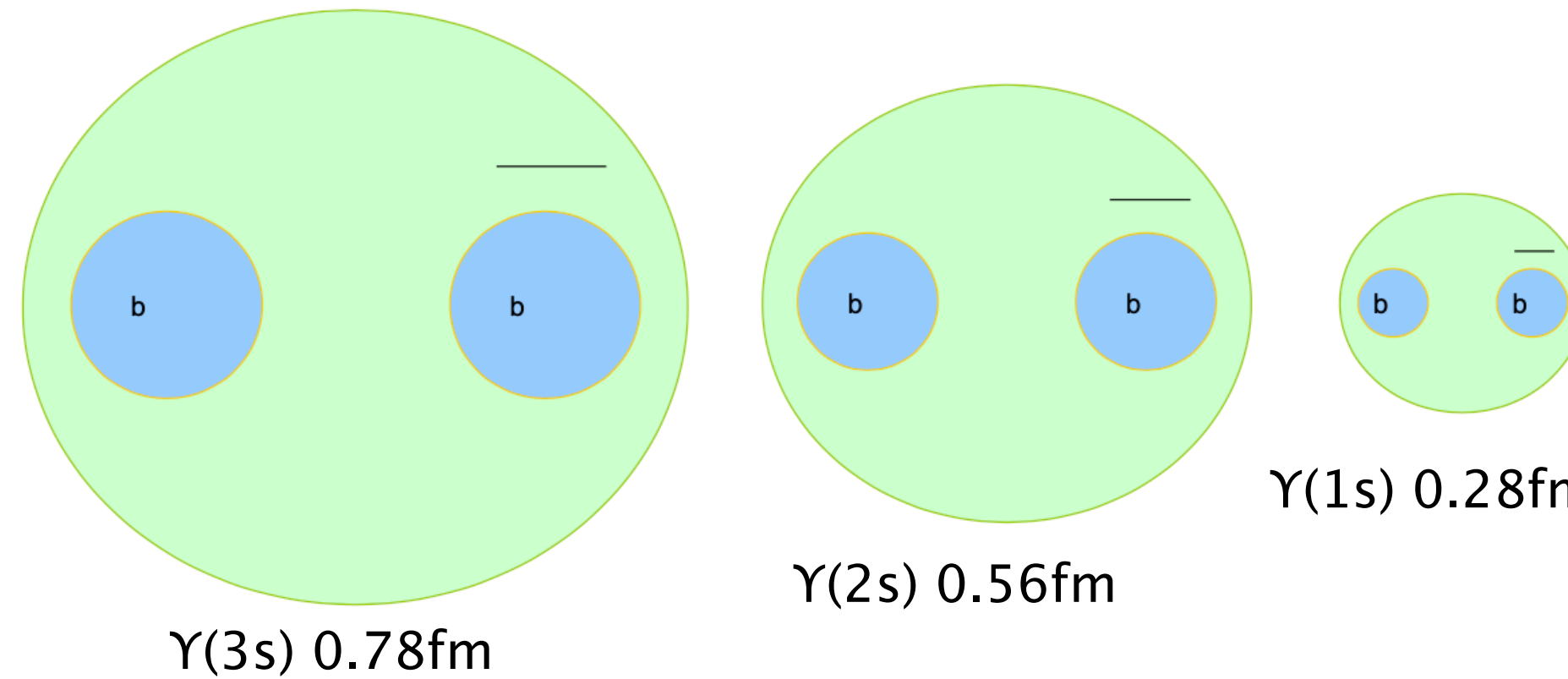
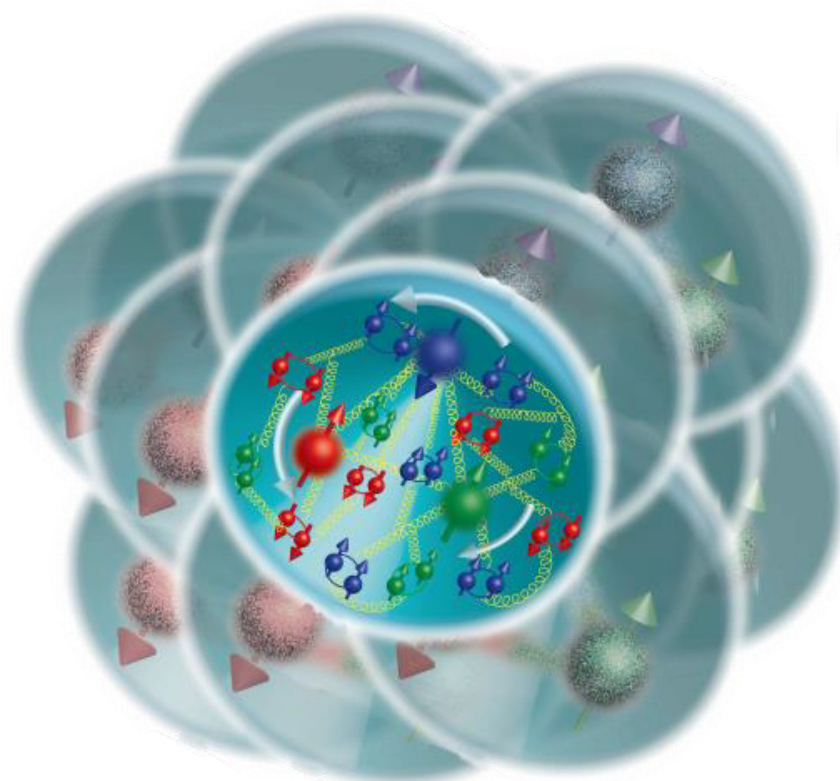
Jet structure

vary momentum/angular
scale of probe



Cold QCD

study proton spin,
transverse-momentum,
and cold nuclear effects



Quarkonium spectroscopy

vary size of probe

Heavy flavor

vary mass/momentum of probe

u,d,s

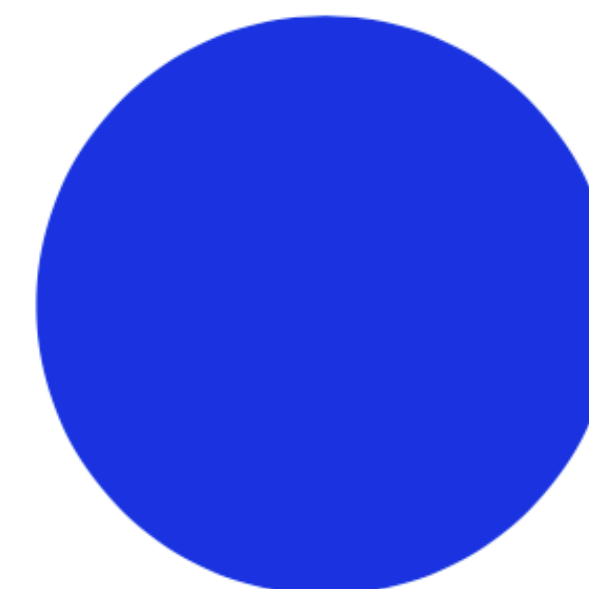


c

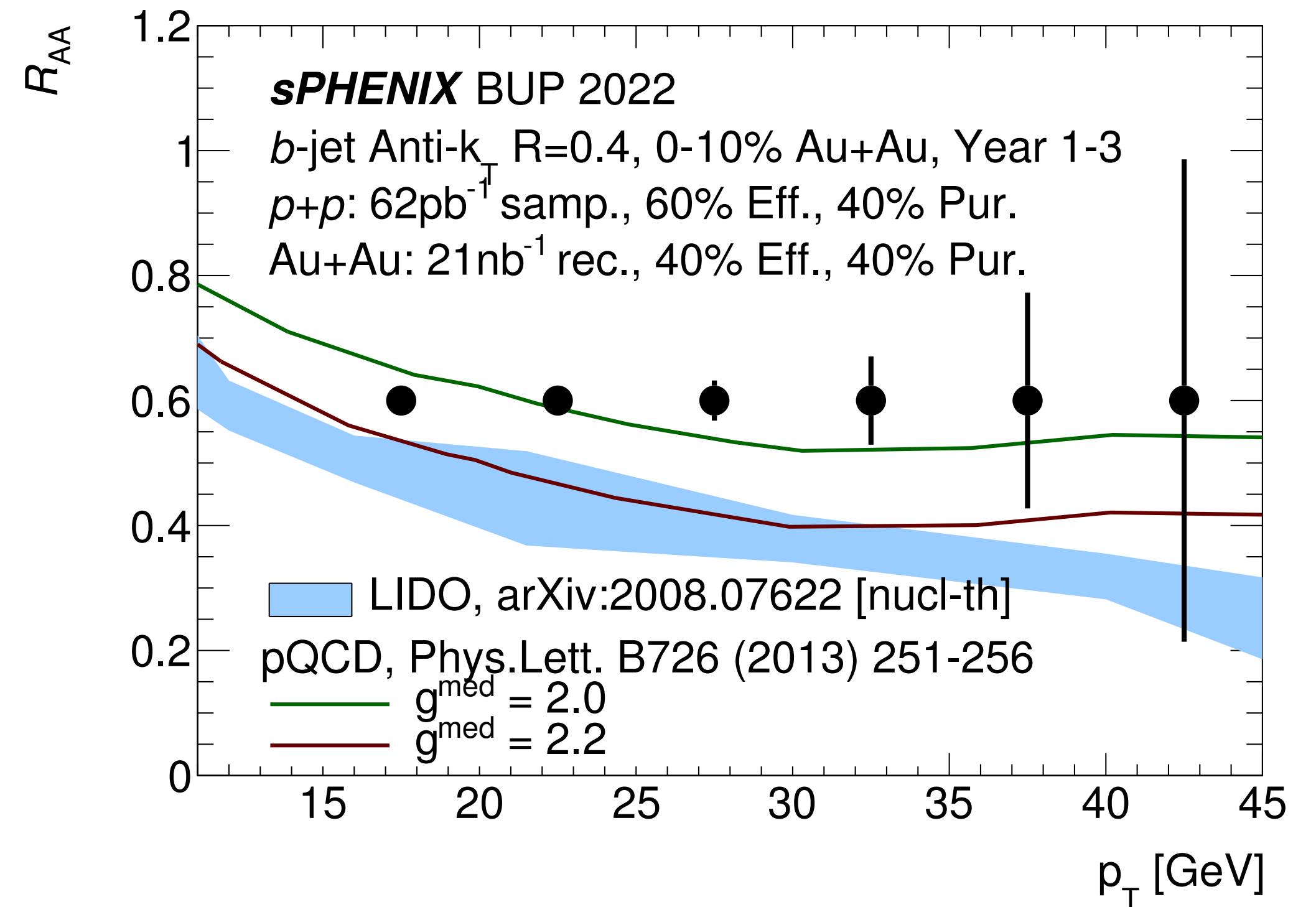
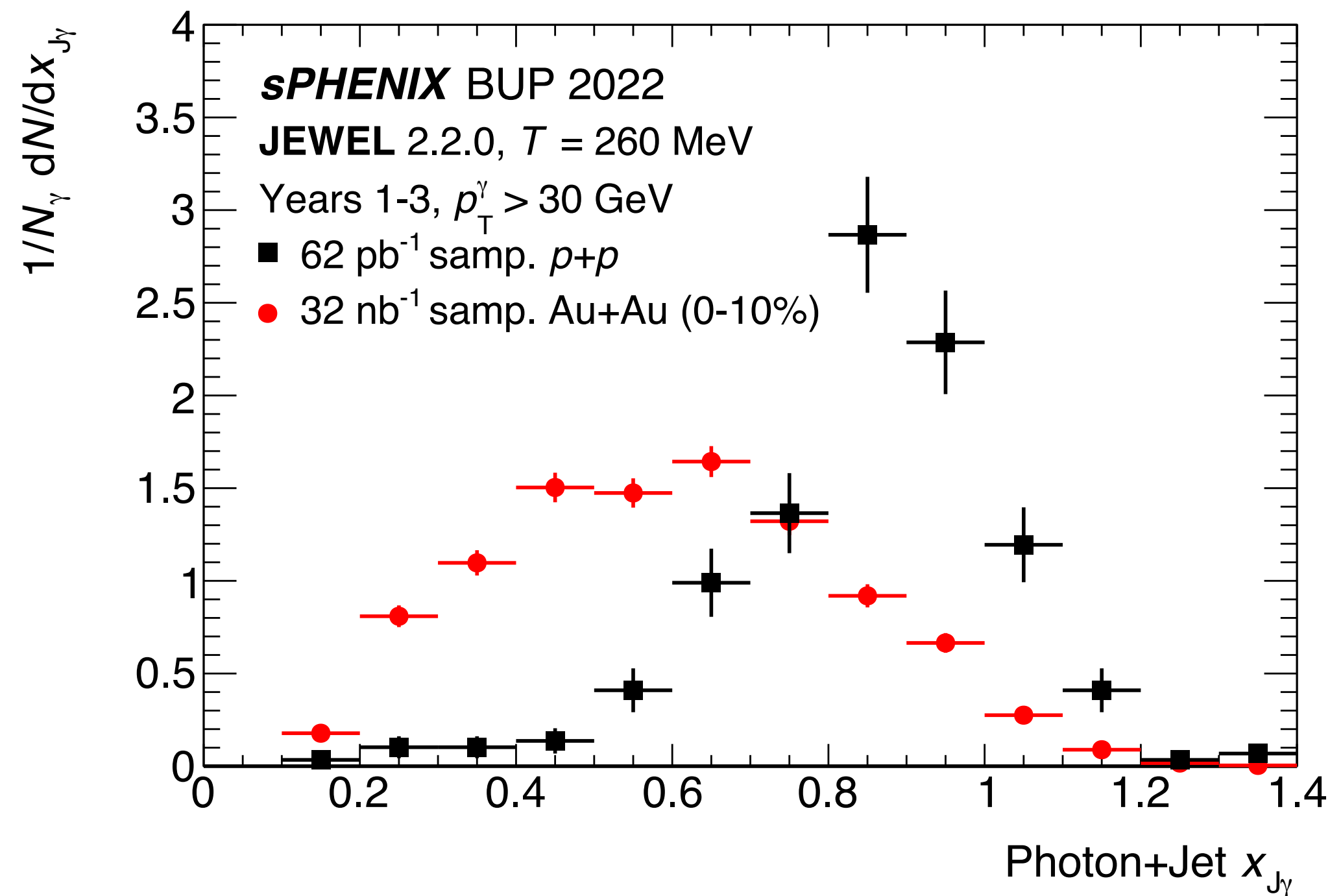


gluon

b



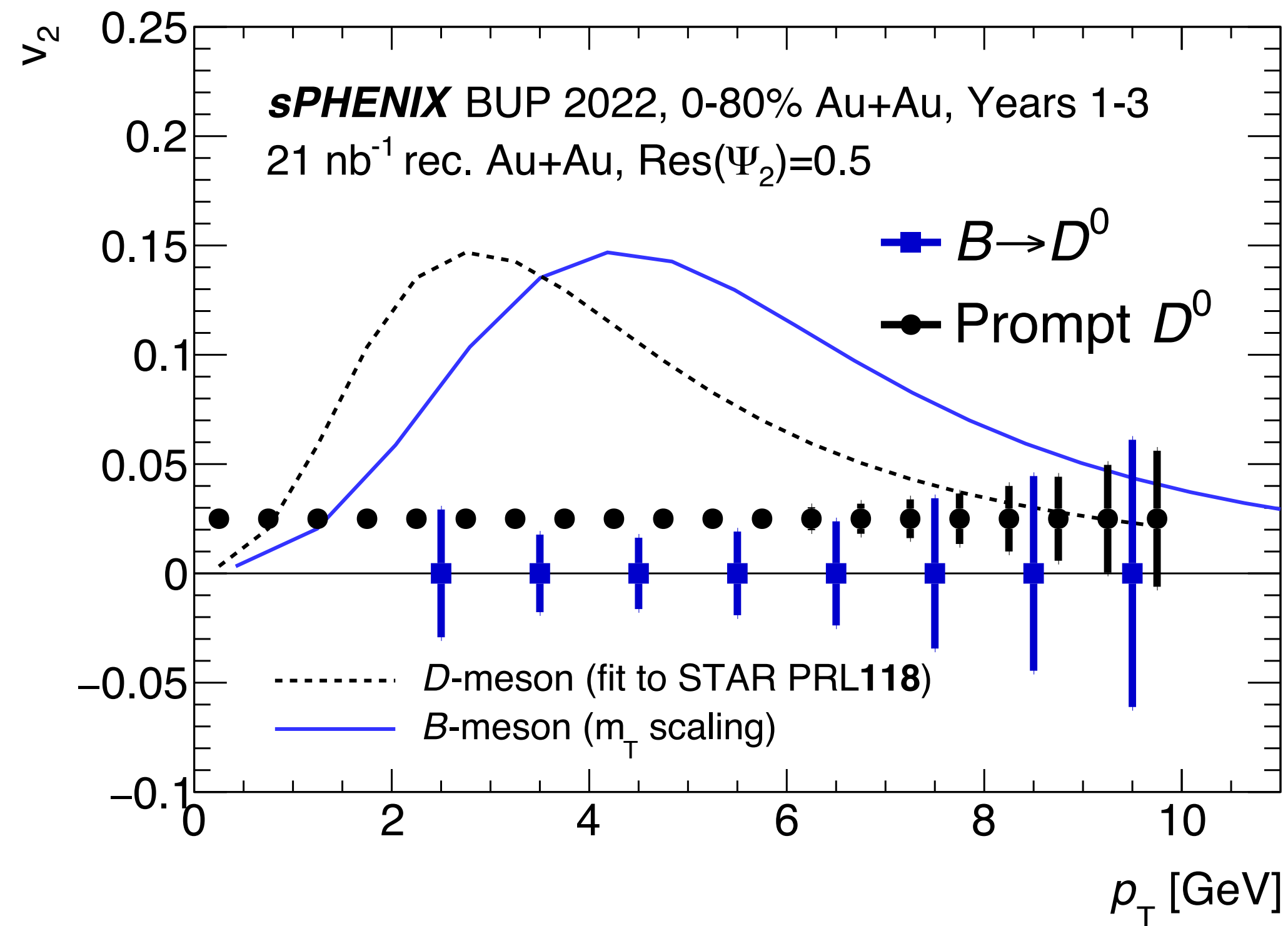
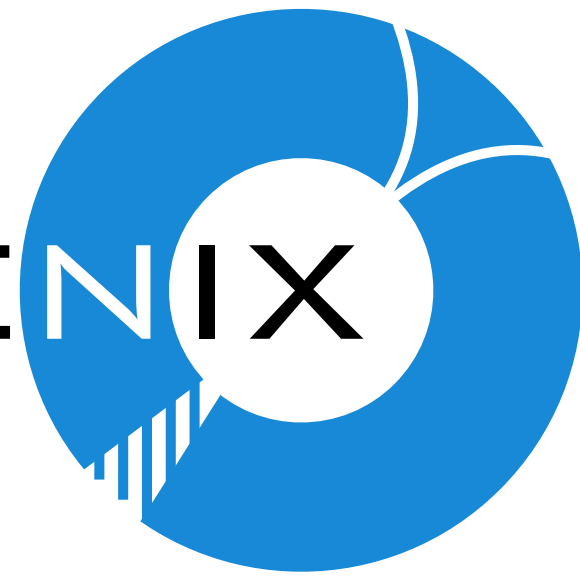
Potential **sPHENIX** “firsts” (1/2)



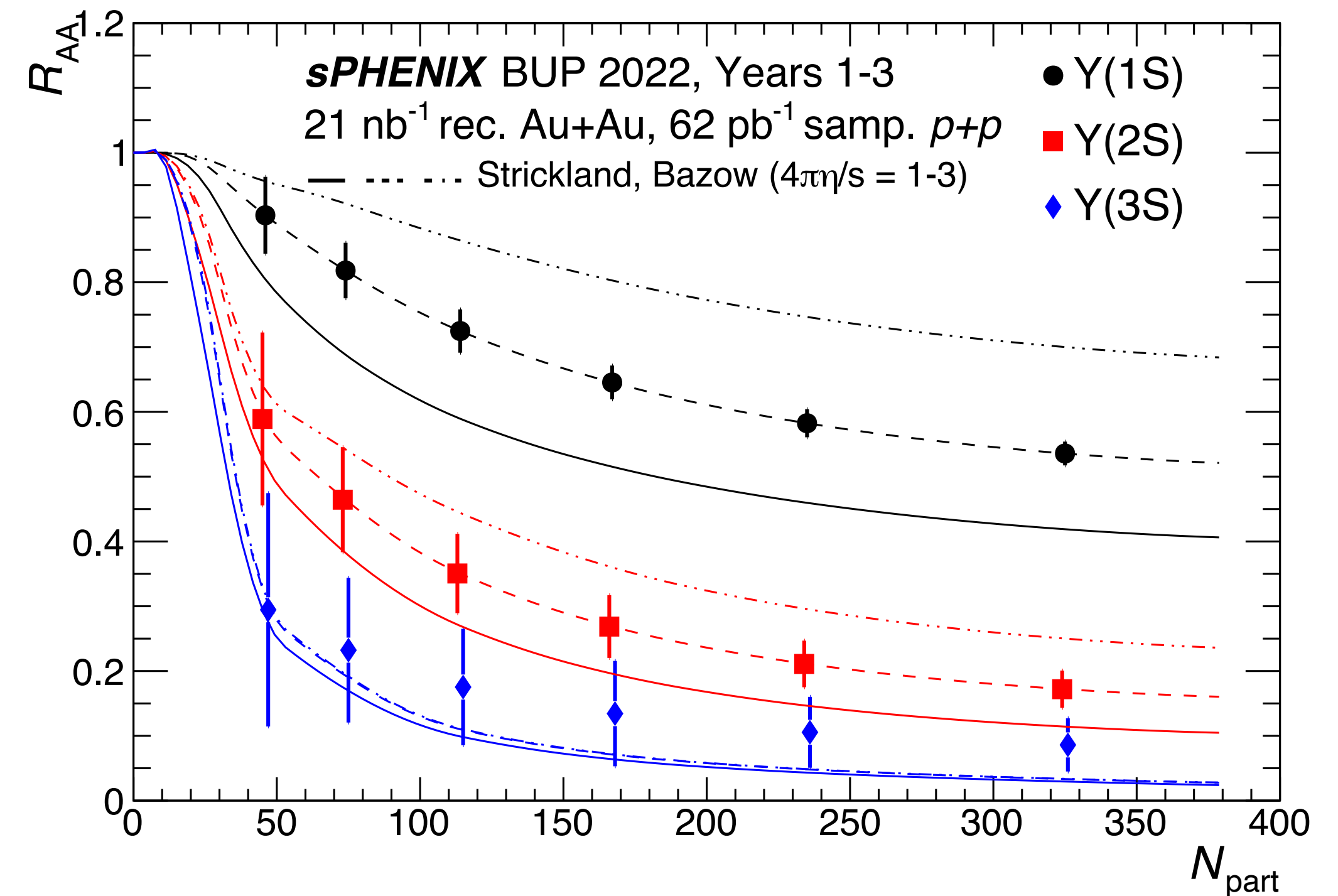
Production, structure, correlations of
full calorimeter jets over an
 exceptional kinematic range

Measurements of **fully**
tagged b -jets

Potential *s*PHENIX “firsts” (2/2)



Modification and flow of **fully reconstructed B hadrons**



Differential suppression of **all three fully resolved Upsilon states**



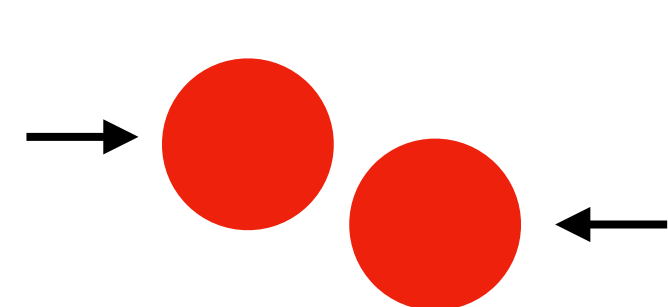
Run Plan

Year	Species	$\sqrt{s_{NN}}$ [GeV]	Cryo Weeks	Physics Weeks	Rec. Lum. $ z < 10$ cm	Samp. Lum. $ z < 10$ cm
2023	Au+Au	200	24 (28)	9 (13)	3.7 (5.7) nb ⁻¹	4.5 (6.9) nb ⁻¹
2024	$p^\uparrow p^\uparrow$	200	24 (28)	12 (16)	0.3 (0.4) pb ⁻¹ [5 kHz] 4.5 (6.2) pb ⁻¹ [10%- <i>str</i>]	45 (62) pb ⁻¹
2024	p^\uparrow +Au	200	–	5	0.003 pb ⁻¹ [5 kHz] 0.01 pb ⁻¹ [10%- <i>str</i>]	0.11 pb ⁻¹
2025	Au+Au	200	24 (28)	20.5 (24.5)	13 (15) nb ⁻¹	21 (25) nb ⁻¹

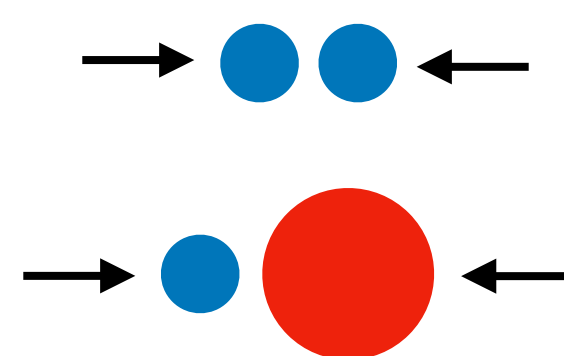
Year-1 (2023): Commission
beginning March/April
+ first physics from high-
luminosity Au+Au data-taking

Year-2 (2024): Transversely
polarized $p+p$ and p +Au for AA
baseline + Cold QCD program

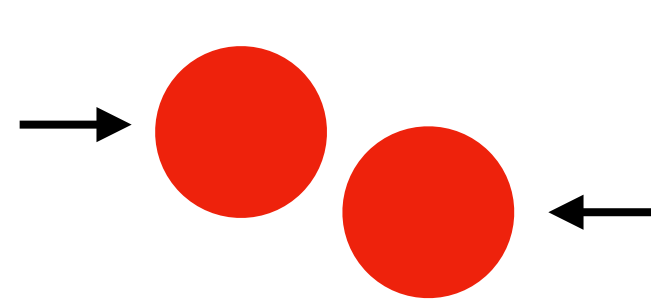
Year-3 (2025): Ultra high-
luminosity, “archival” Au+Au
dataset (>140B min bias events)



Year-1



Year-2



Year-3

SPHENIX Collaboration



More than 360 members from 82 institutions in 14 countries

World-class expertise in physics, silicon, TPCs, calorimeter, electronics, computing, ...

Diversity, Equity, Inclusion as a core Collaboration value

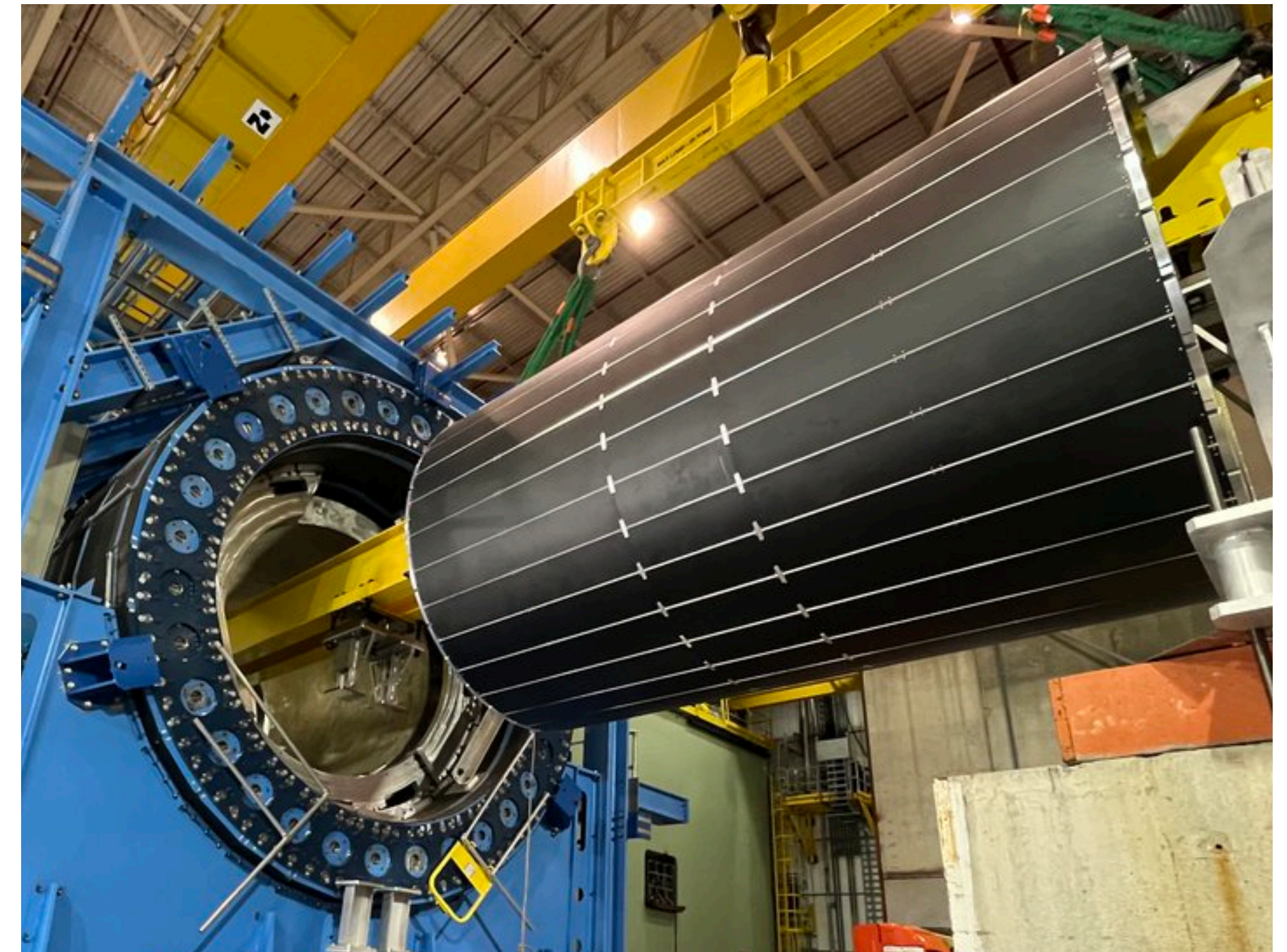
Graduate students, post-docs, REU students gathering at BNL for first data-taking!



Hadronic Calorimeter

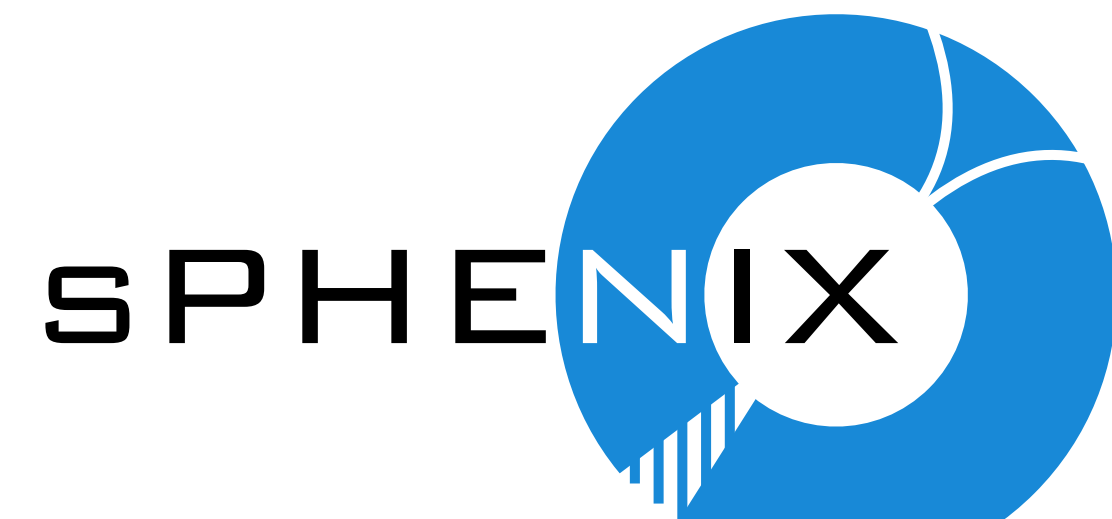


Outer HCal assembly at BNL



Inner HCal insertion into magnet

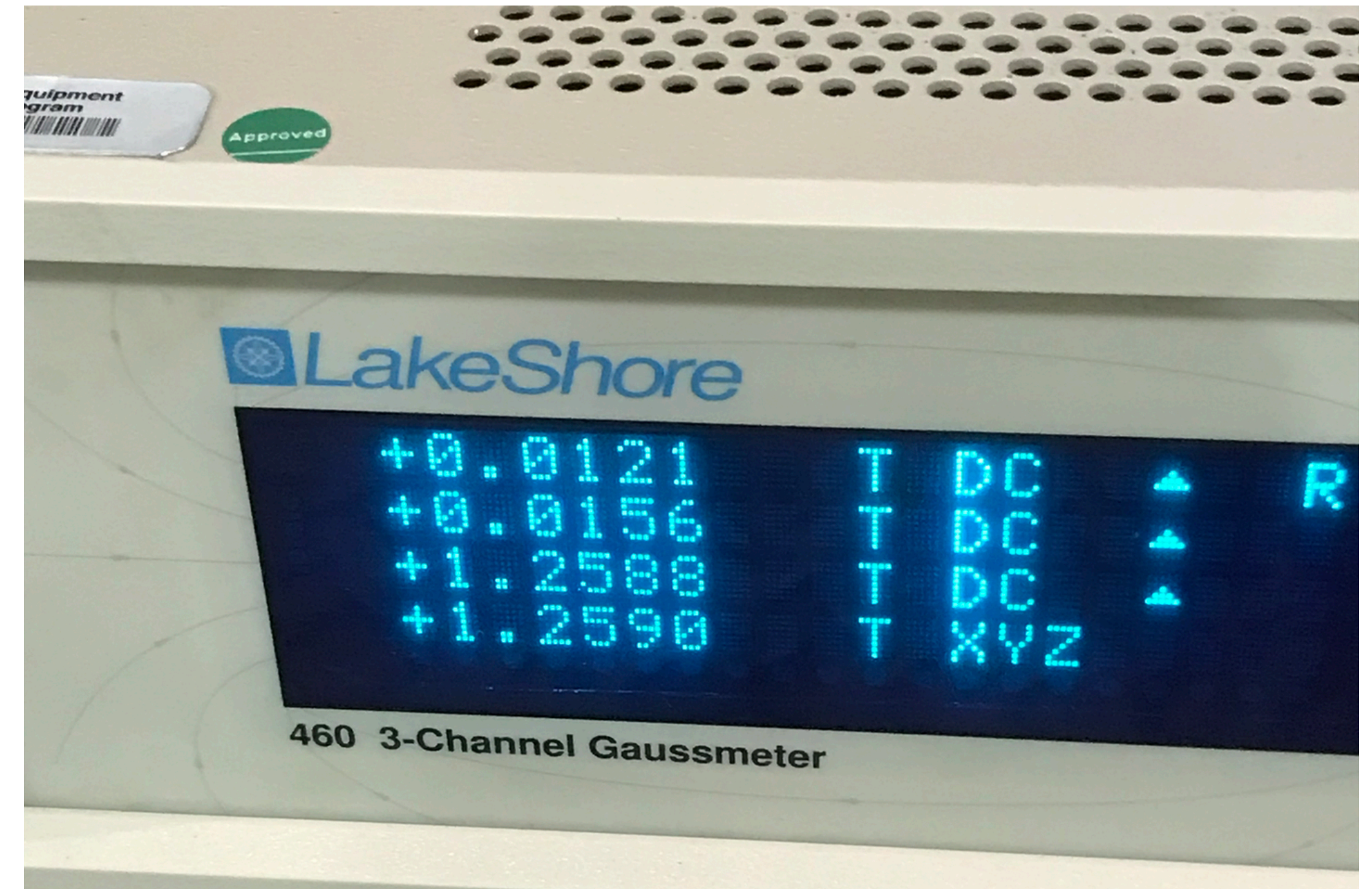
$\sim 5 \lambda_0$ total, $|\eta| < 1.1$, 2π acceptance, 0.1×0.1 segmentation
 \Rightarrow excellent acceptance and resolution for jet measurements



Superconducting Magnet



BaBar solenoid installed in sPHENIX IR (October 2021)

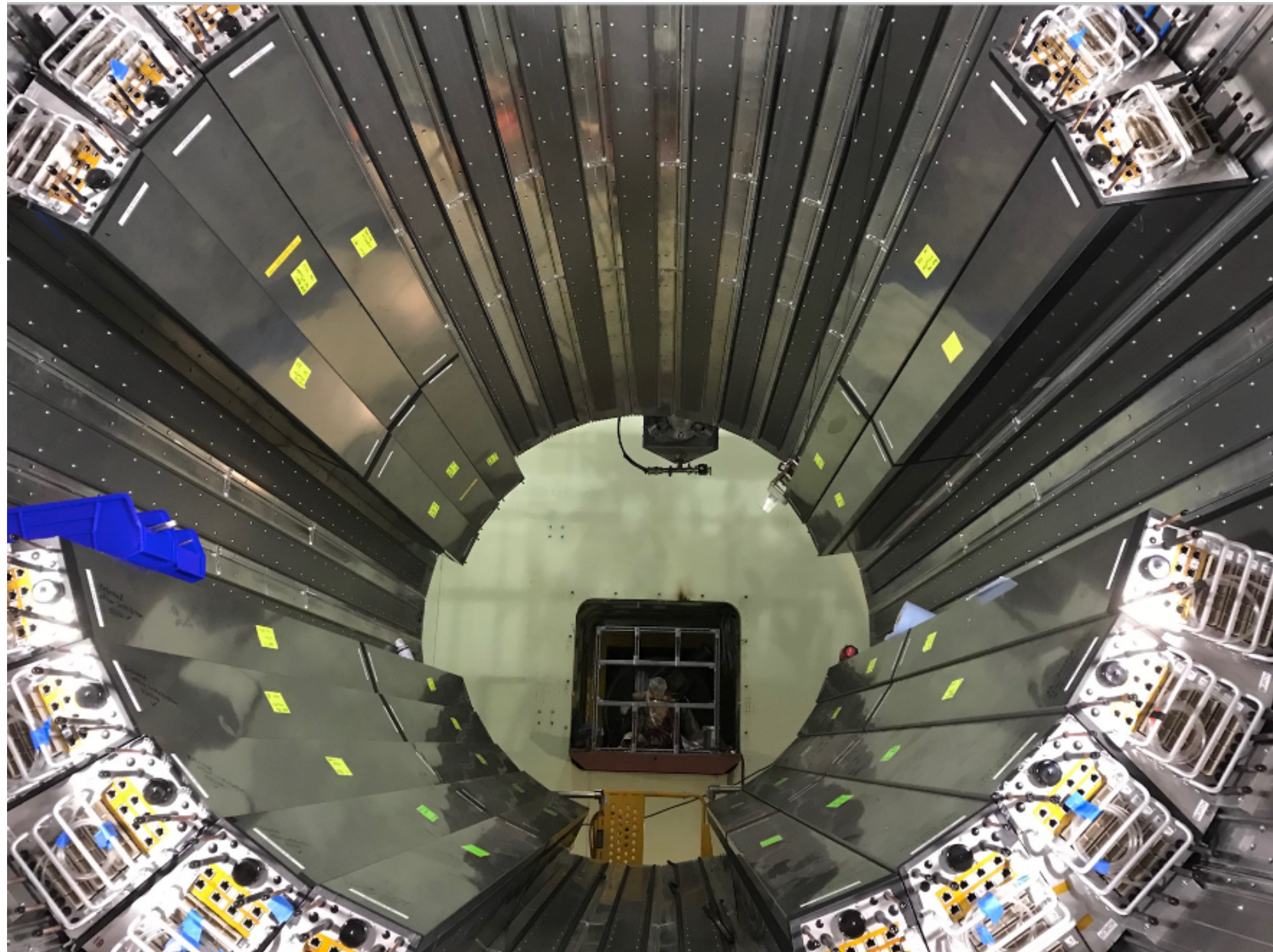


Successfully ramped to full current in position (this week)

Magnet is fully operational, expert team from CERN begins field mapping on Monday 🎃



Electromagnetic Calorimeter



EMCal partially installed inside
Inner Hadronic Calorimeter



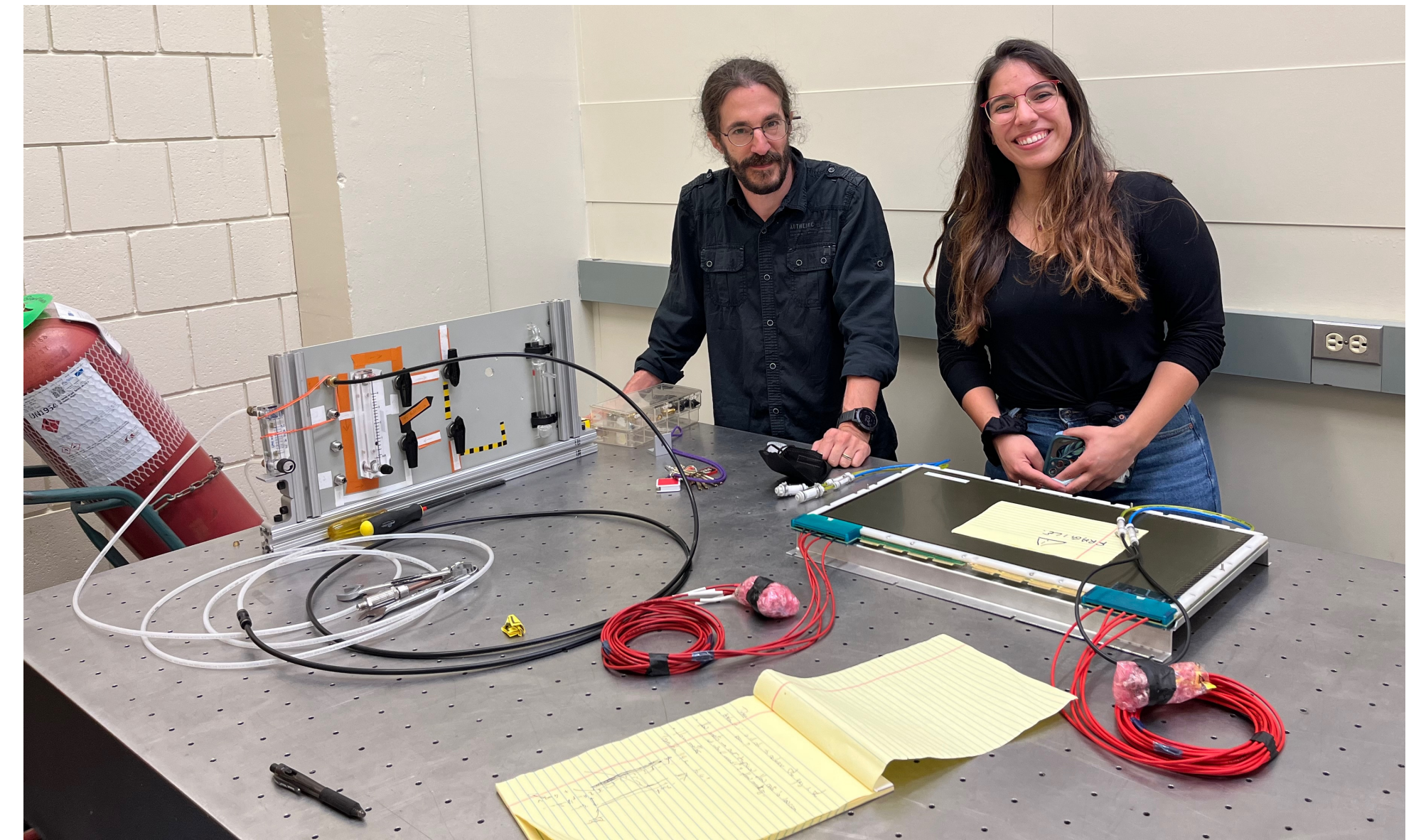
$\sim 20 X_0$, energy resolution $15\%/\sqrt{E}$
or better for photons (γ , jets),
electrons (Υ spectroscopy)



Time Projection Chamber



TPC assembled at Stony Brook University, now undergoing testing



TPC Outer Tracker (TPOT) pre-installation tests at BNL

Provides lever arm for momentum resolution (Υ & jet fragmentation program)

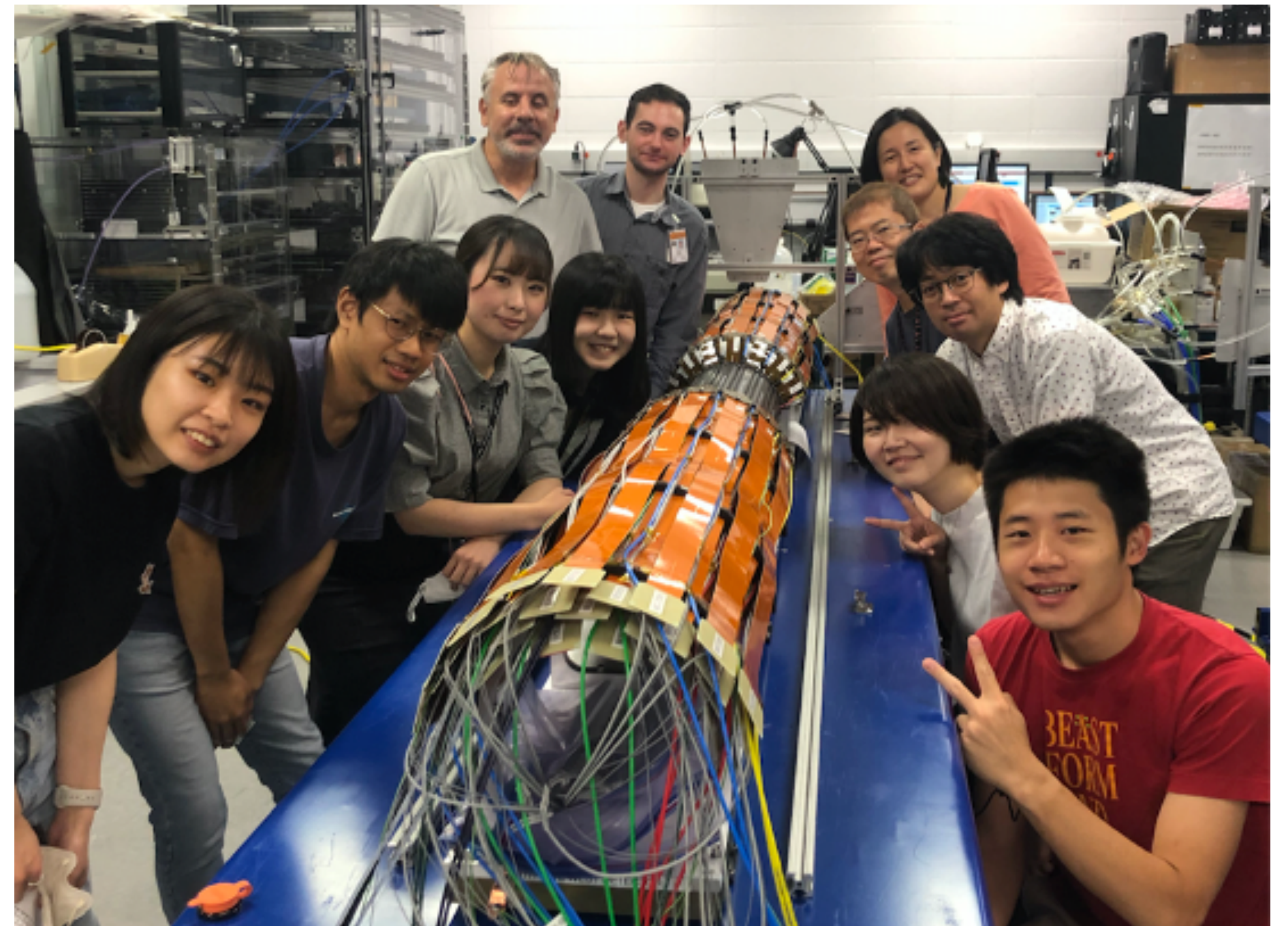


Inner Trackers



MAPS Vertex Tracker (MVTX)
arrived from Berkeley Lab & tested

Distance of Closest Approach
resolved at $< 10 \mu\text{m}$ for $p_T > 2 \text{ GeV}$



Completed Intermediate Silicon
Strip Tracker (INTT) at BNL

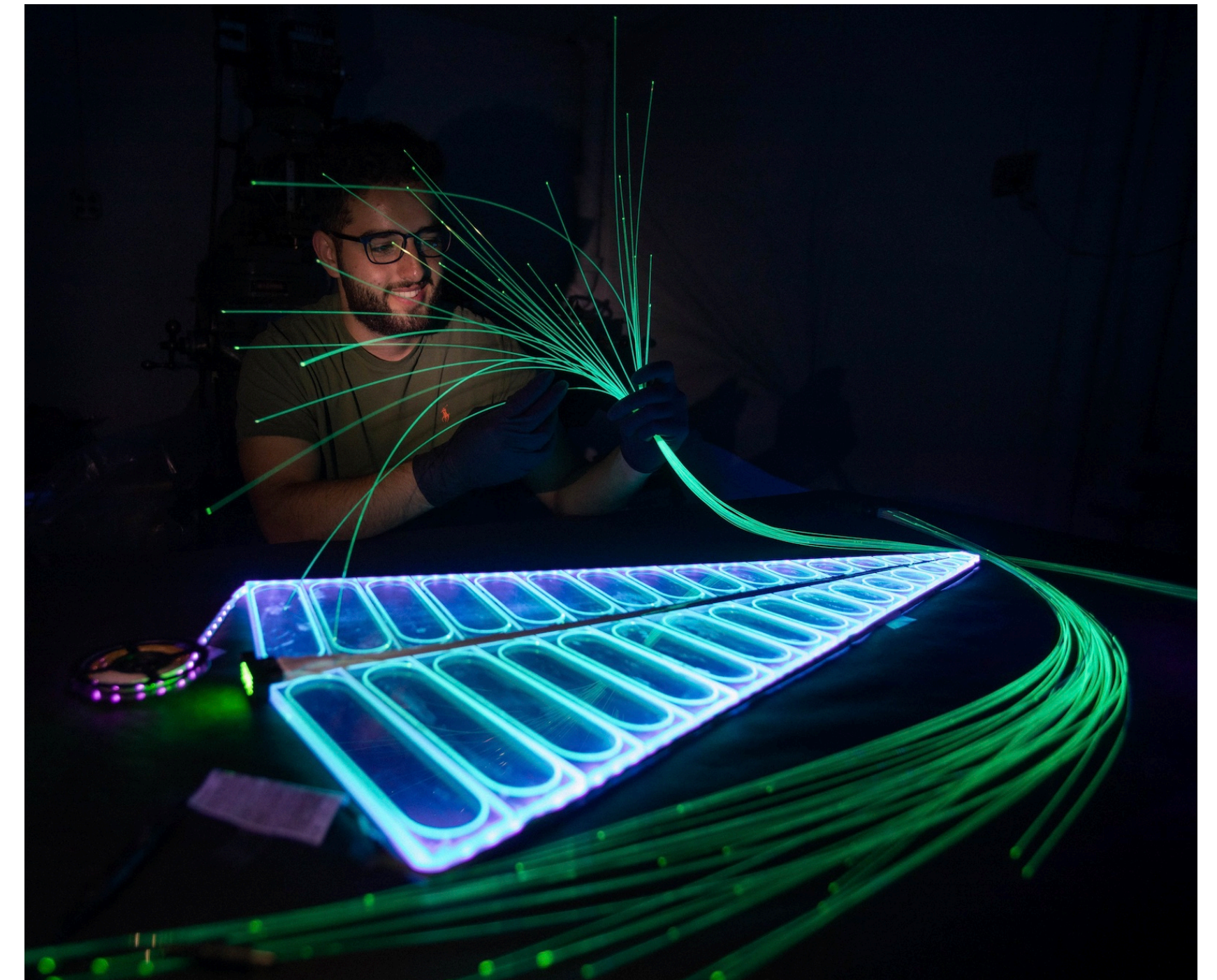
Fast (100ns) timing resolution



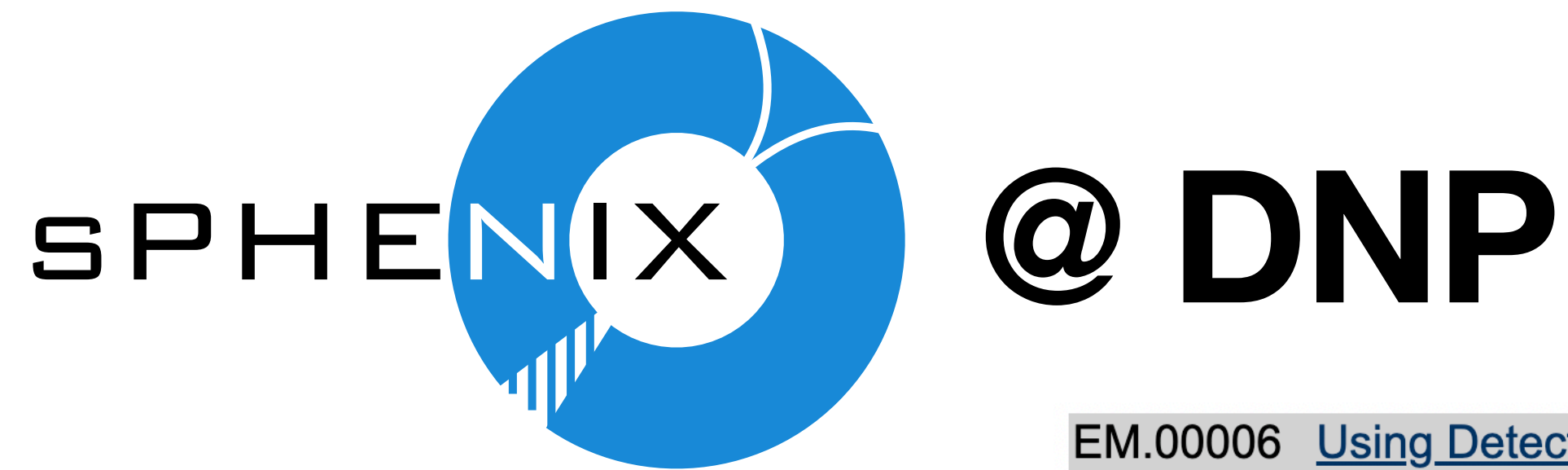
Event Plane Detector



sEPD sectors finishing assembly at Lehigh University



Event plane measurement for jet, heavy flavor, and small systems flow!



Talks

- EM.00006 [Using Detector Construction to Generate Community and Excitement over Nuclear Physics](#)
- GM.00004 [Large Collaborative Nuclear Physics at a Small College](#)
- LC.00006 [Hadronic Calorimeter Cosmic Muon Calibrations](#)
- LC.00007 [Calibrated Cosmic Muon simulations for the sPHENIX Hadronic Calorimeters](#)
- LC.00008 [Single particle energy scale calibration of the sPHENIX hadronic calorimeters](#)
- LC.00009 [Jets Substructure from Calorimeter Subjects in sPHENIX](#)
- LF.00001 [sPHENIX MVTX Detector Commissioning at Brookhaven National Laboratory](#)
- LF.00002 [sPHENIX Heavy Flavor Physics Simulation Performance](#)
- LF.00003 [An Overview of the sPHENIX Event Plane Detector](#)
- LF.00004 [Construction of the sPHENIX Event Plane Detector](#)
- LF.00005 [sPHENIX EMCal Calibrations and Reconstruction for Prompt Photon-Related Measurements](#)
- PM.00007 [sPHENIX Jet Performance Studies](#)
- PM.00008 [Calibrations of the sPHENIX Calorimeter System for Jet Reconstruction](#)

Posters

- HA.00043 [Feasibility Studies for Ultraperipheral Collision Physics in sPHENIX](#)
- HA.00044 [Cosmic Ray Testing of the New sPHENIX Event Plane Detector](#)
- HA.00045 [Evaluation of Jet Substructure Observables for sPHENIX](#)
- HA.00046 [Constraining Quark and Gluon Momentum Fractions Accessed by Observables in Polarized pp Collisions at PHENIX and sPHENIX](#)
- HA.00108 [Aging and Calibration Studies of sPHENIX Hadronic Calorimeter Scintillating Tiles](#)
- HA.00109 [Application of Machine Learning with the Minimum Bias Detector \(MBD\) in sPHENIX](#)
- HA.00110 [Physics with the sPHENIX Event Plane Detector](#)
- HA.00111 [Comparing STAR and sPHENIX Background Subtraction Routines in Particle Jet Analysis](#)
- HA.00112 [Testing and Characterization of Analog Electronics for the sPHENIX Experiment](#)
- HA.00113 [sPHENIX Electromagnetic Calorimeter Block Evaluation](#)
- HA.00115 [Leveraging Machine Learning for Jet Energy Reconstruction in Heavy Ion Collisions](#)

Many excellent presentations by sPHENIX scientists!

sPHENIX Outlook

sPHENIX is the first new detector at *any* hadron collider in over a decade

sPHENIX has unique, purpose-built capabilities never before deployed at RHIC

sPHENIX is our opportunity to collect an *archival heavy ion dataset* and finish the scientific mission of RHIC

Looking forward to the start of data-taking in Spring 2023!

