The sPHENIX Experiment At RHIC

Anthony Hodges

For the sPHENIX Collaboration

HP2024 NAGASAKI

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

sPHENIX

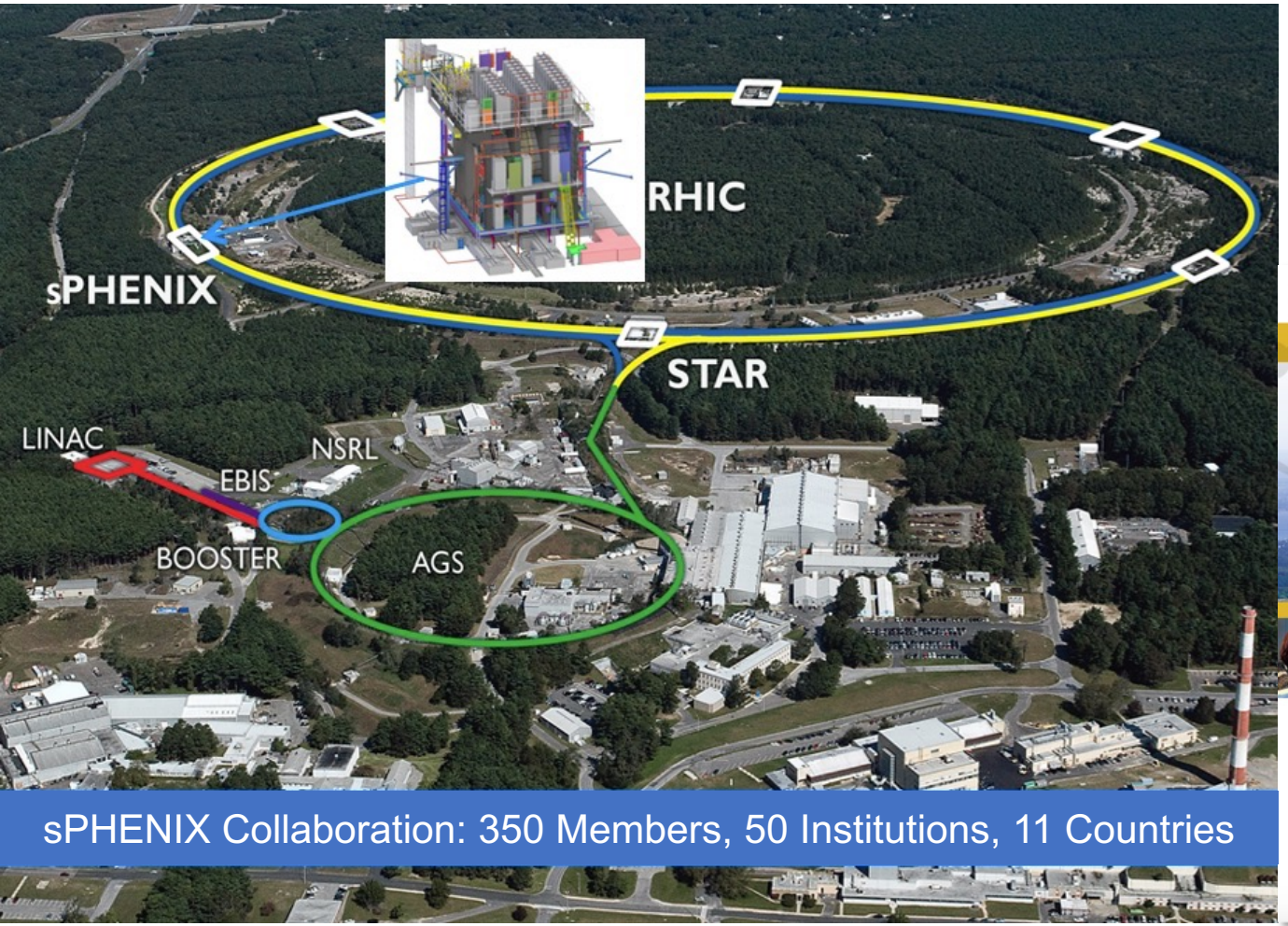
NSF

NSF Ascend Fellow

The sPHENIX Experiment at RHIC

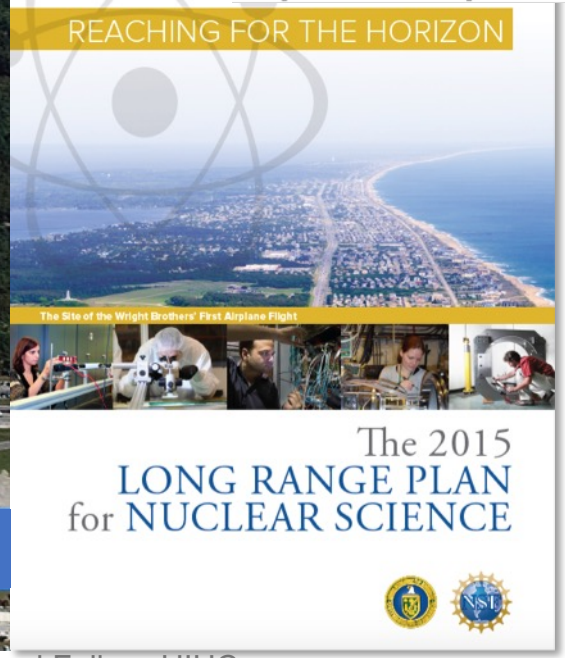
First new detector at RHIC in 20 years

Key to fulfilling the RHIC science mission



sPHENIX Collaboration: 350 Members, 50 Institutions, 11 Countries

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.**



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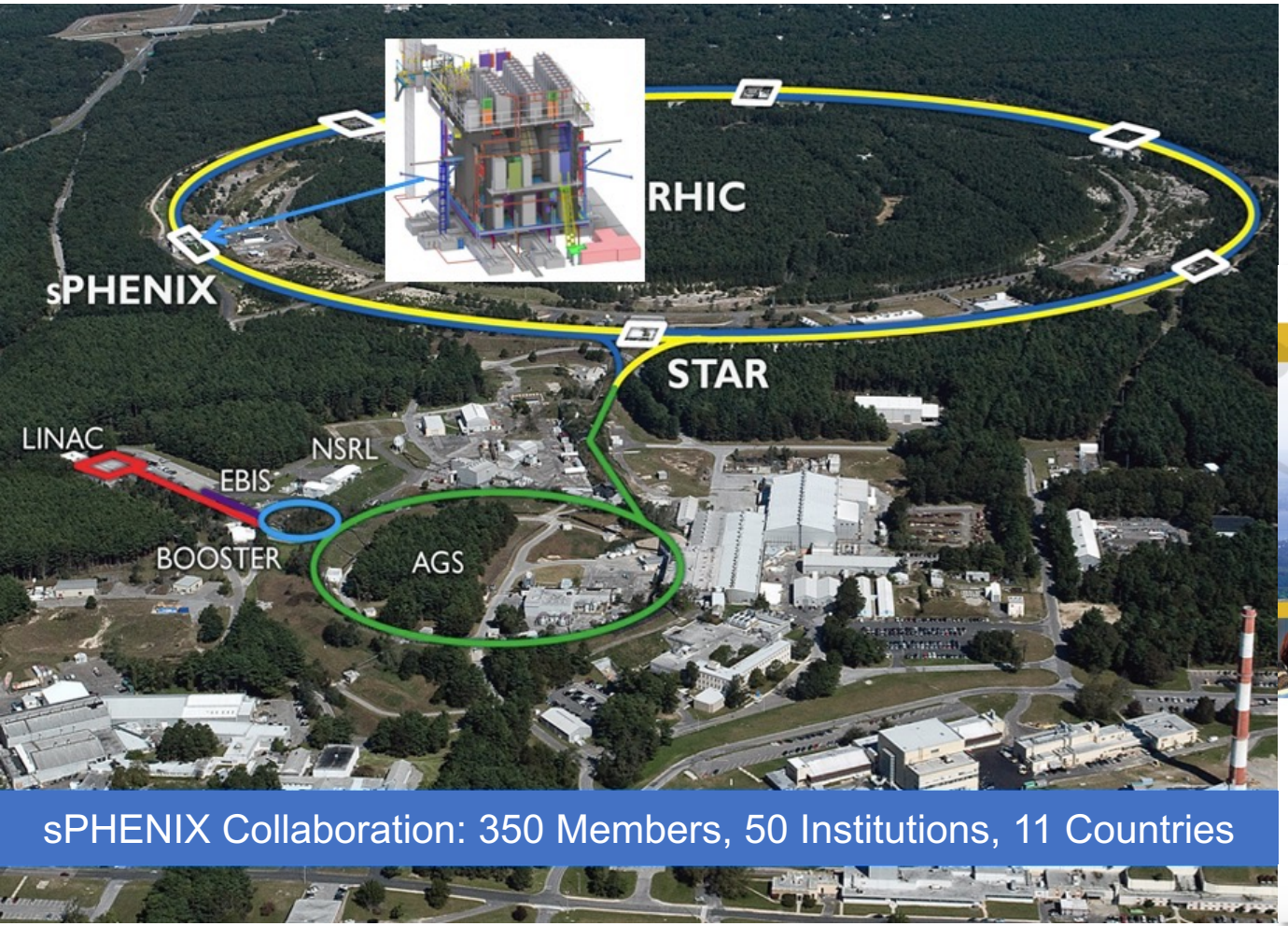

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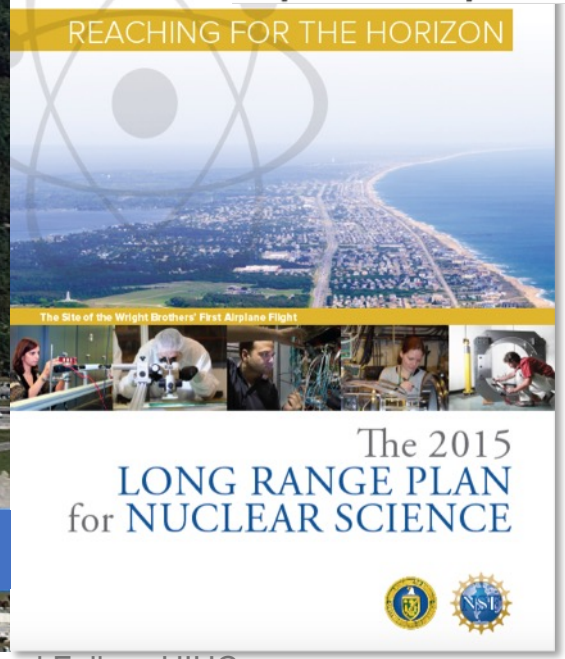
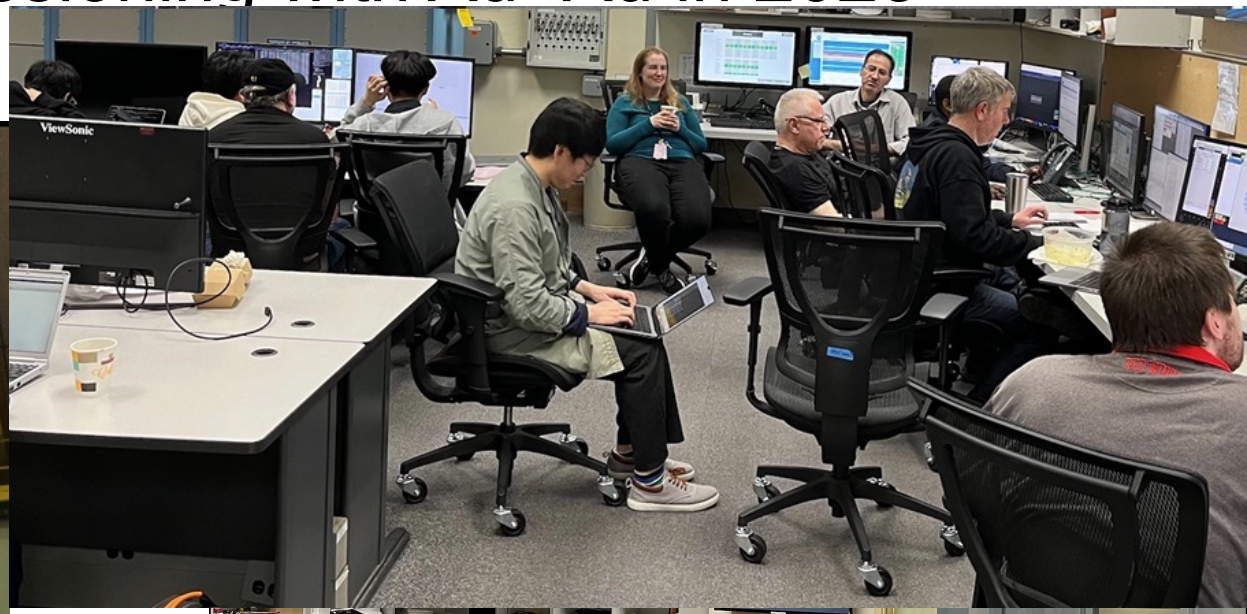


Reaffirmed in 2023 US LRP!

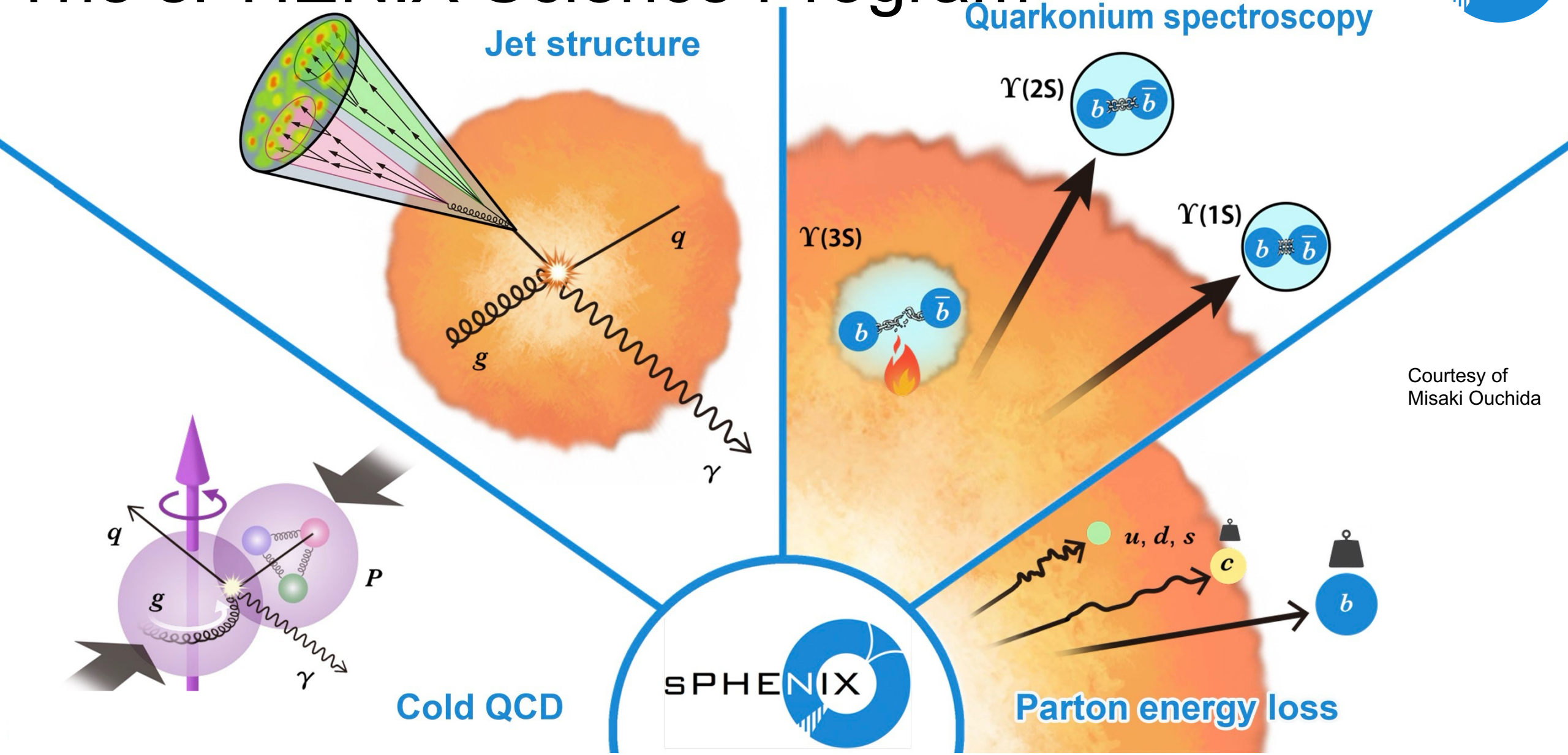
sPHENIX Up and Running

Construction completed, began commissioning with Au+Au in 2023

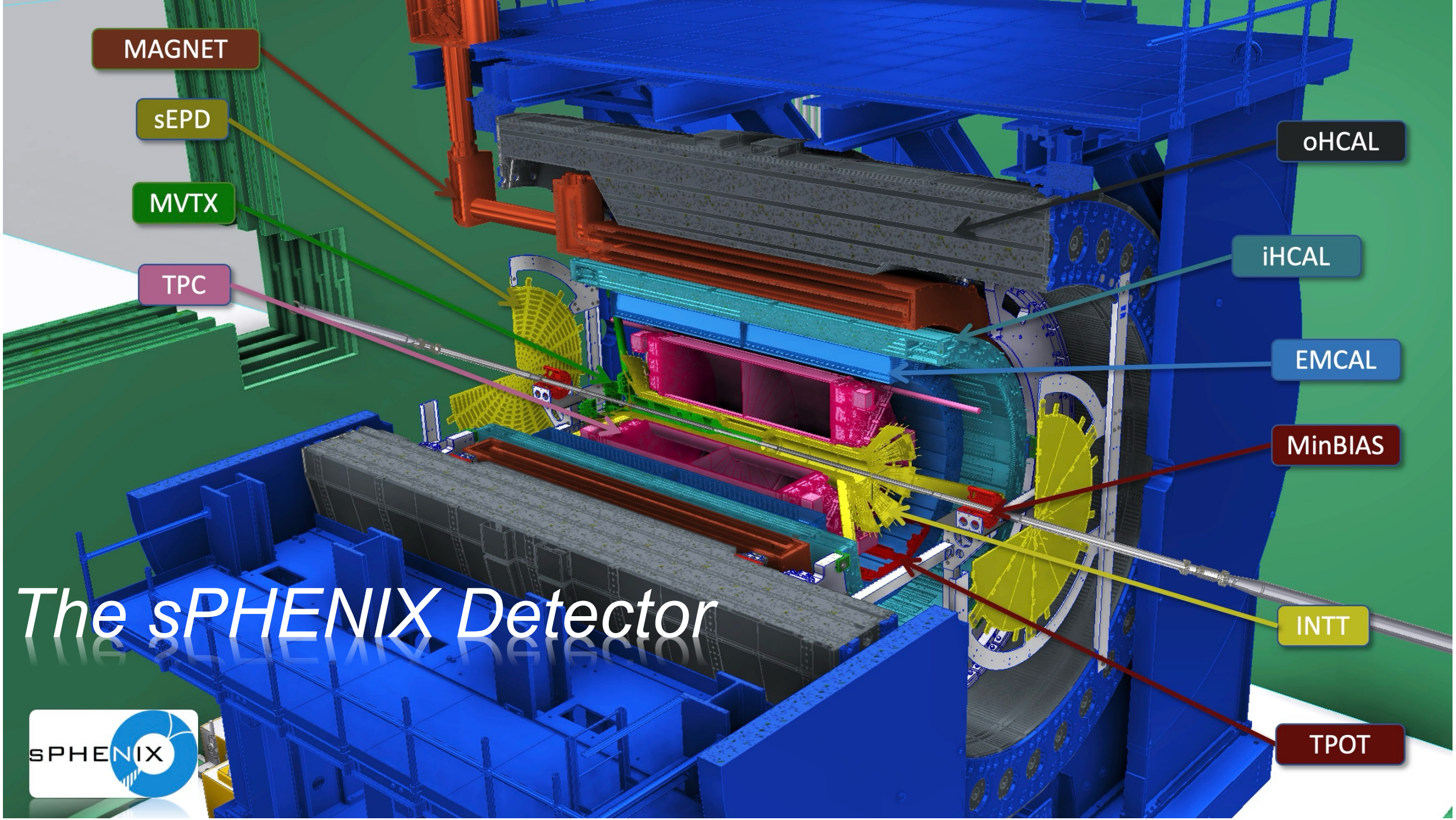
Now currently taking baseline *p*+*p* data



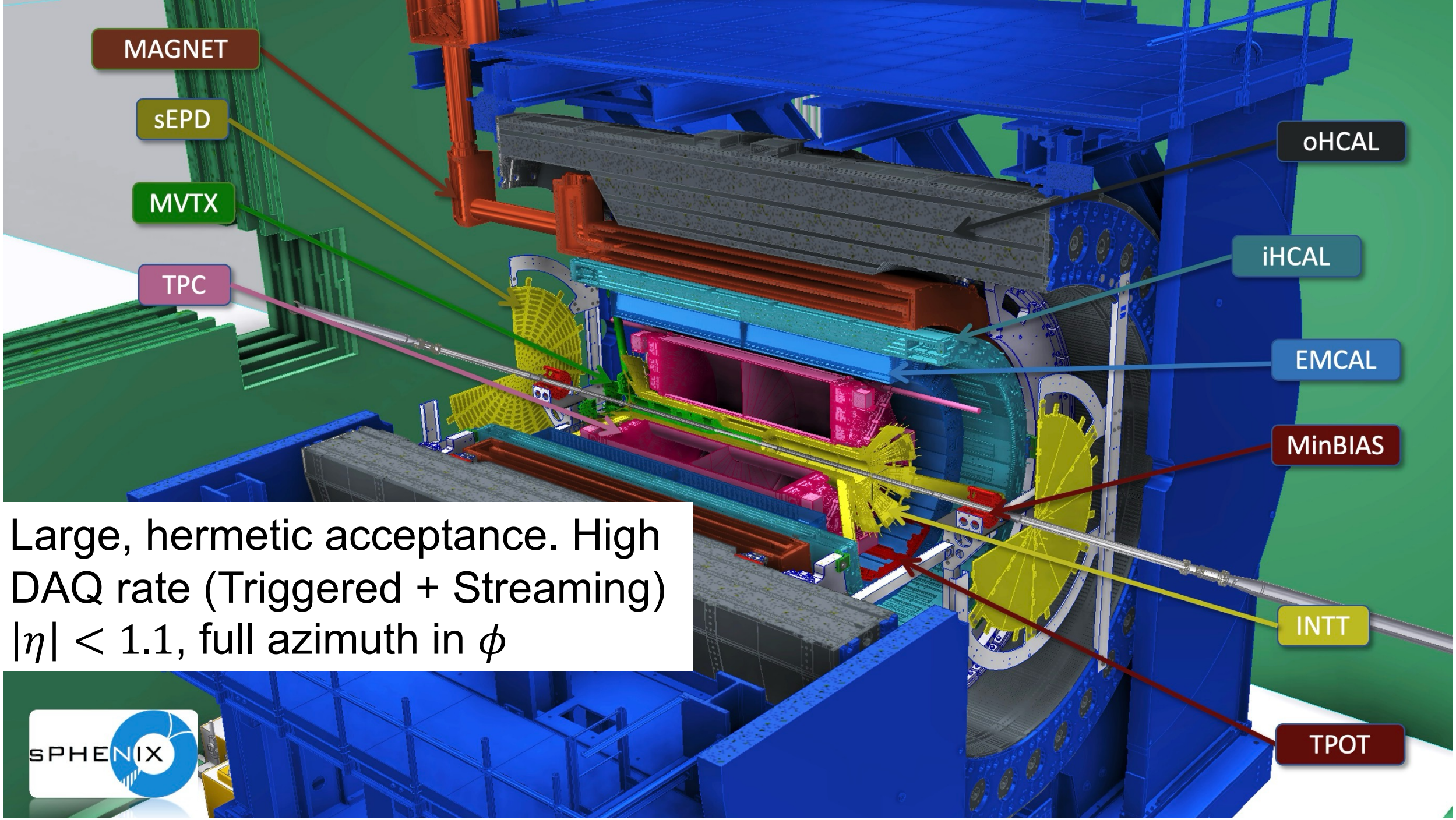
The sPHENIX Science Program



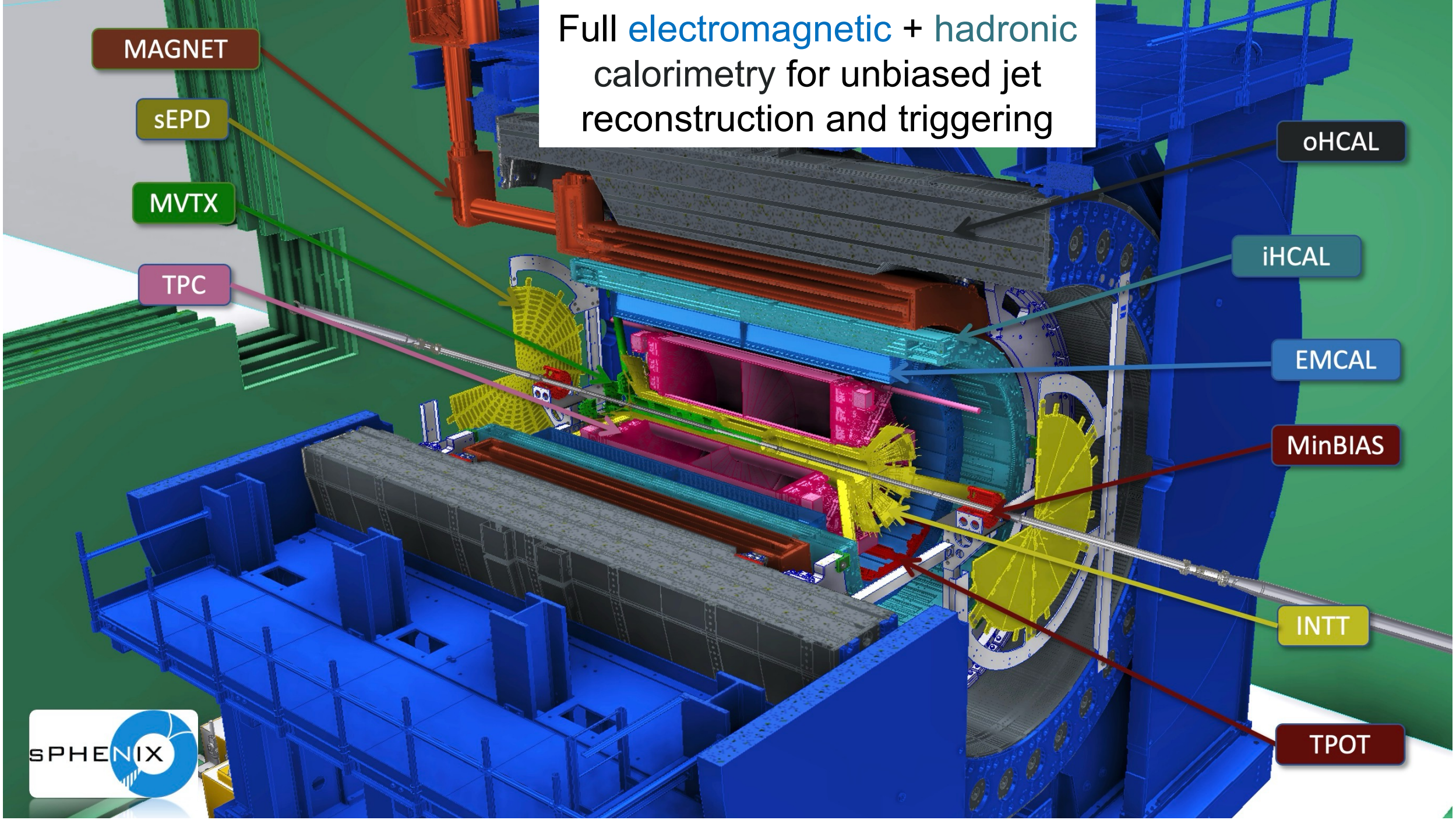
Courtesy of
Misaki Ouchida

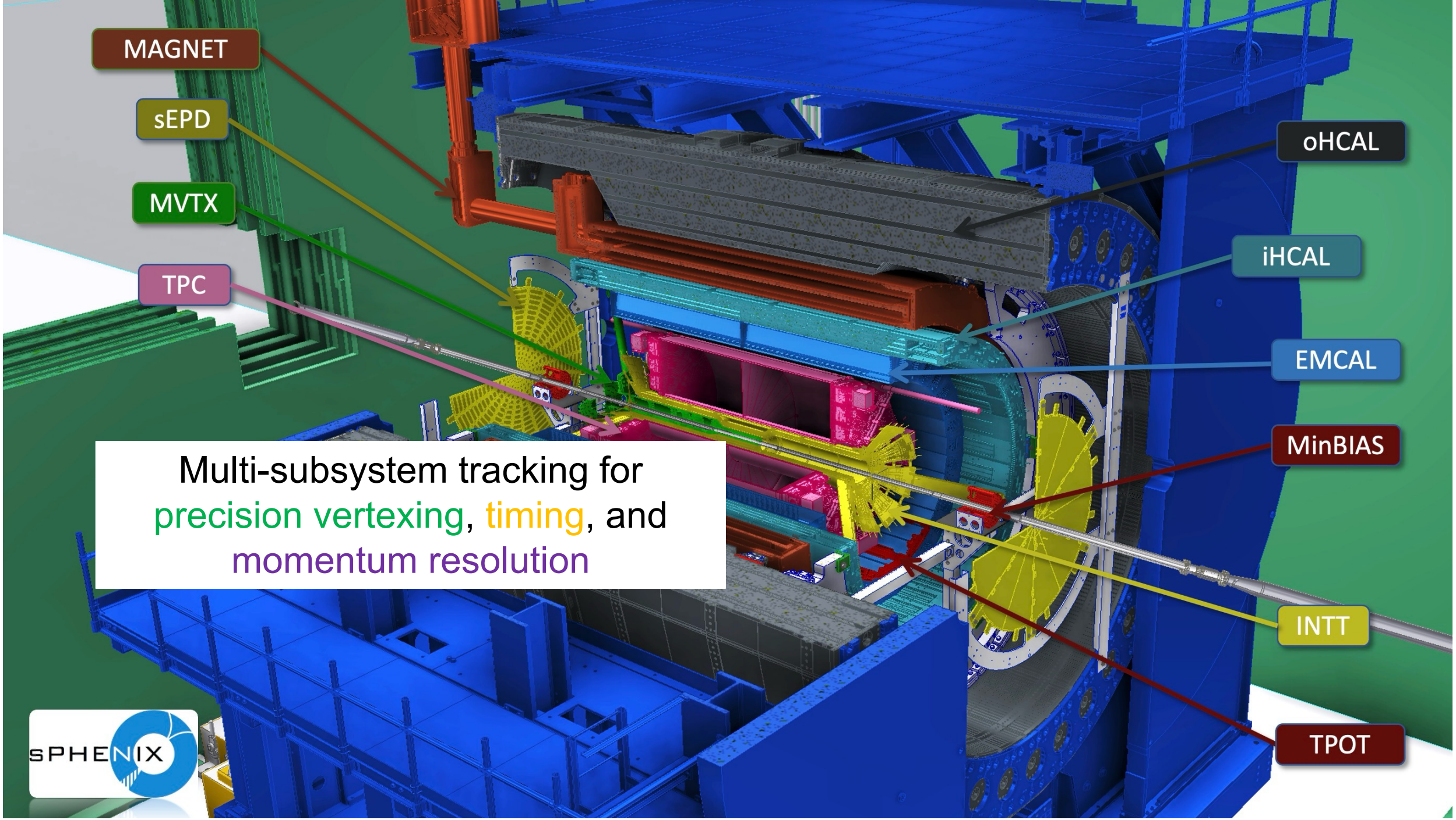


The sPHENIX Detector



Large, hermetic acceptance. High DAQ rate (Triggered + Streaming)
$|\eta| < 1.1$, full azimuth in ϕ


Full electromagnetic + hadronic calorimetry for unbiased jet reconstruction and triggering
MAGNET
sEPD
MVTX
TPC
oHCAL
iHCAL
EMCAL
MinBIAS
INTT
TPOT
sPHENIX


MAGNET
sEPD
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EMCAL
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Multi-subsystem tracking for
precision vertexing, timing, and
momentum resolution
sPHENIX

Data Taking Timeline

Year	Species	$\sqrt{s_{NN}}$	Cryo-Weeks	Goal
2023	Au+Au	200GeV	10.5	Commissioning and RHIC standard candles
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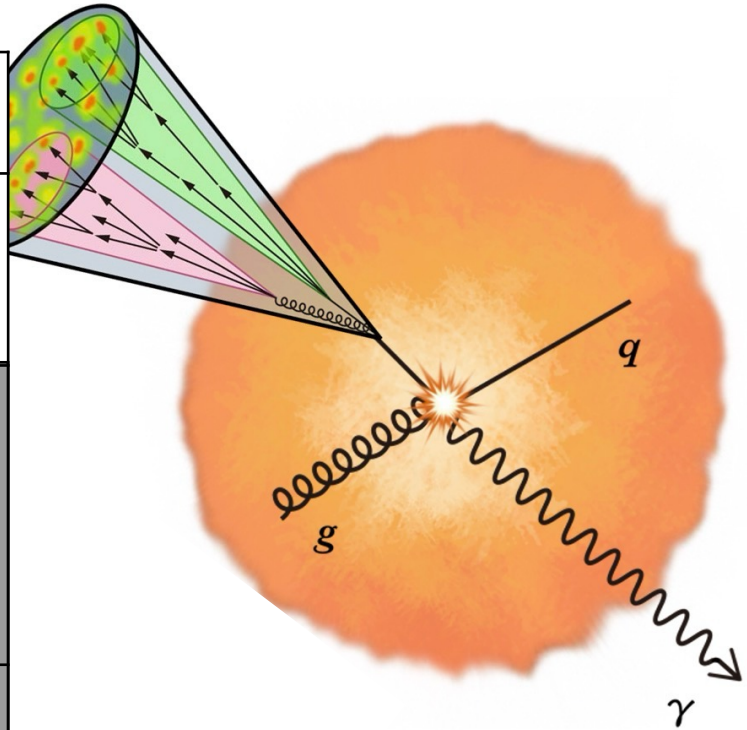
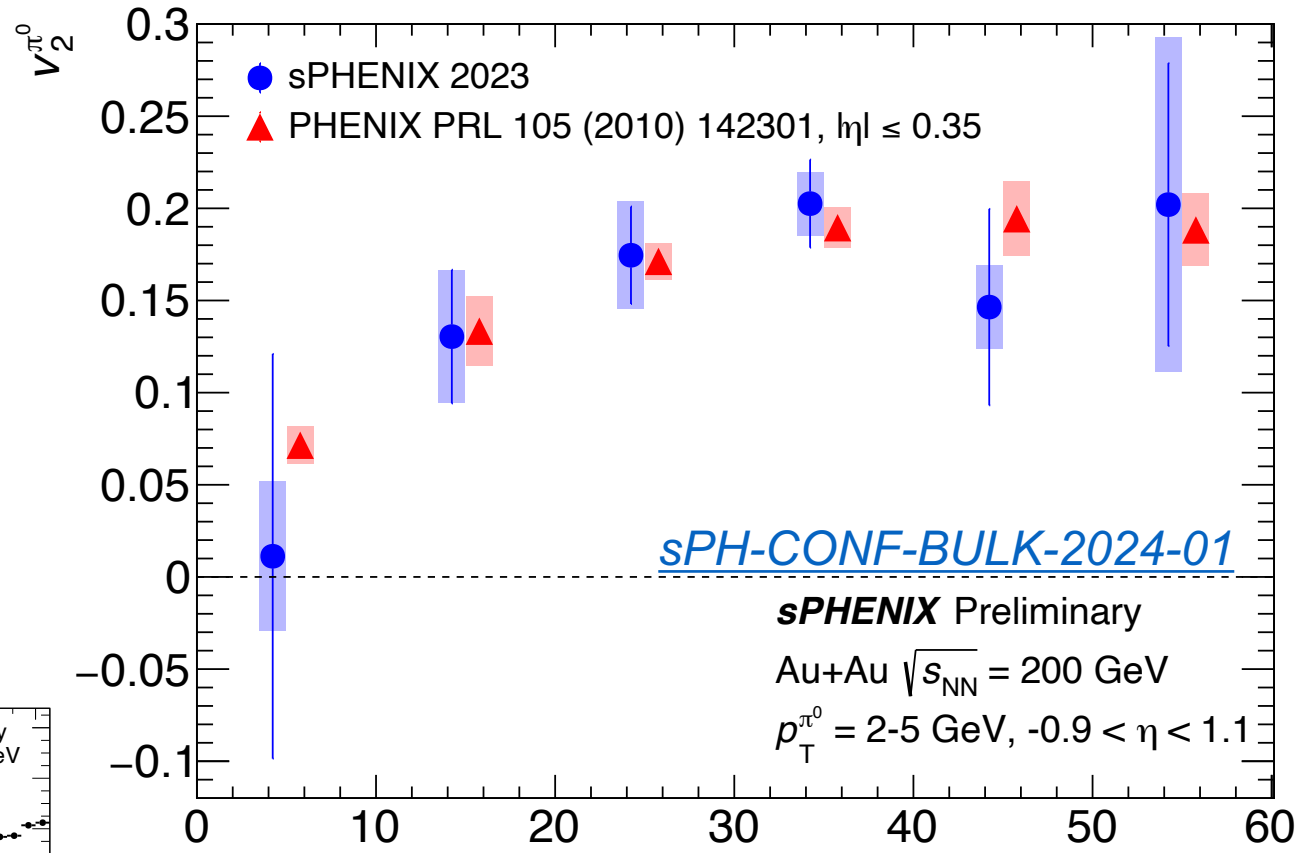


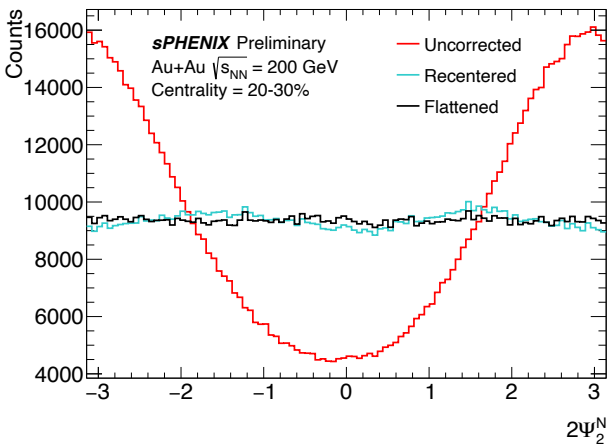
Standard Candle: Neutral Pion v_2

v_2 of π^0's measured via scale product method:

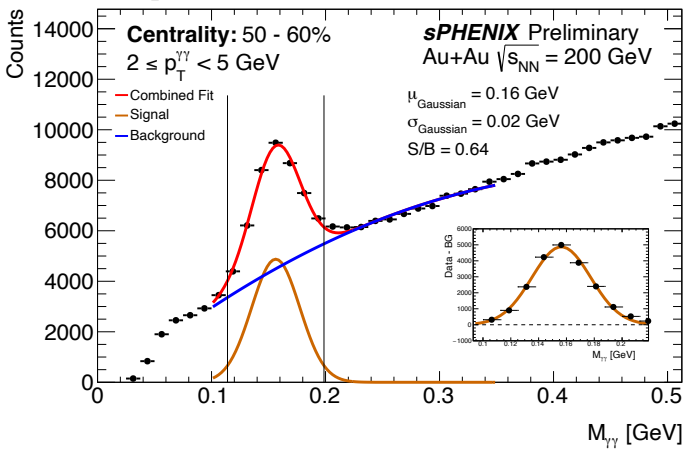
$$v_n\{SP\} \equiv Re\frac{\left\langle \vec{q}_{n,j}\vec{Q}_n^{S|N^*}\right\rangle}{\sqrt{\left\langle \vec{Q}_n^S\vec{Q}_n^{N^*}\right\rangle}}$$

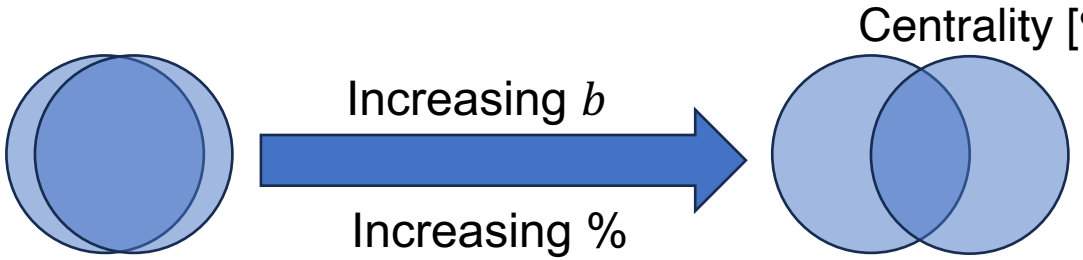


$\vec{Q}$ → MBD information



$\vec{q} \rightarrow \pi^0$ information





Standard Candle: Calorimeter $d\mathrm{E_T}/d\eta$

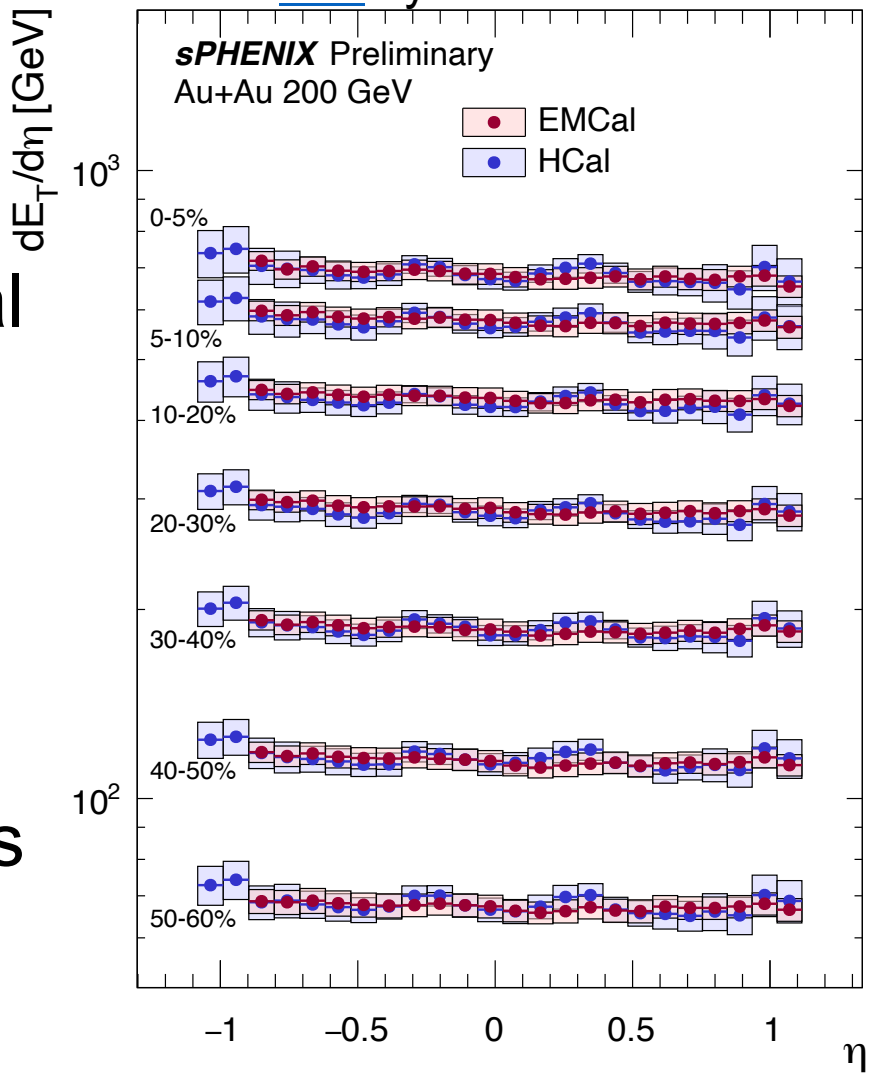
See Talk by Genki Nukazuka

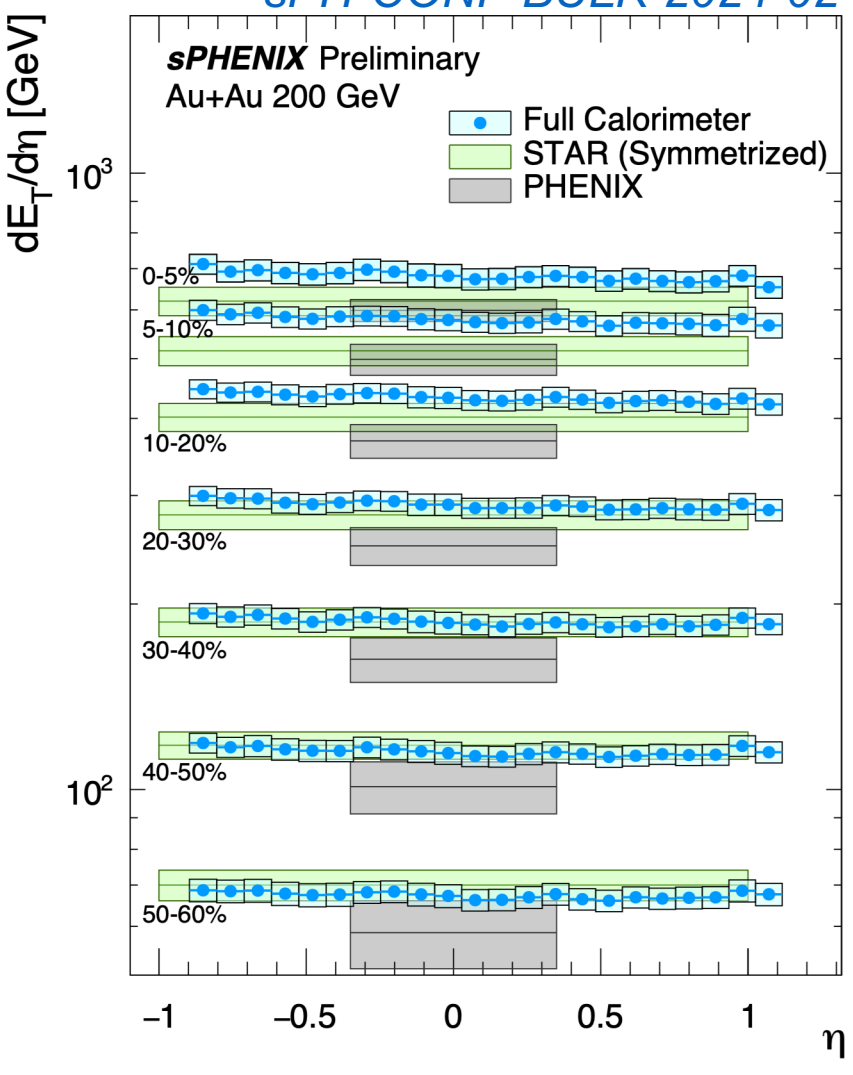
sPH-CONF-BULK-2024-02

Fully corrected transverse energy across EMCal and HCal

Excellent agreement between EMCal + HCal

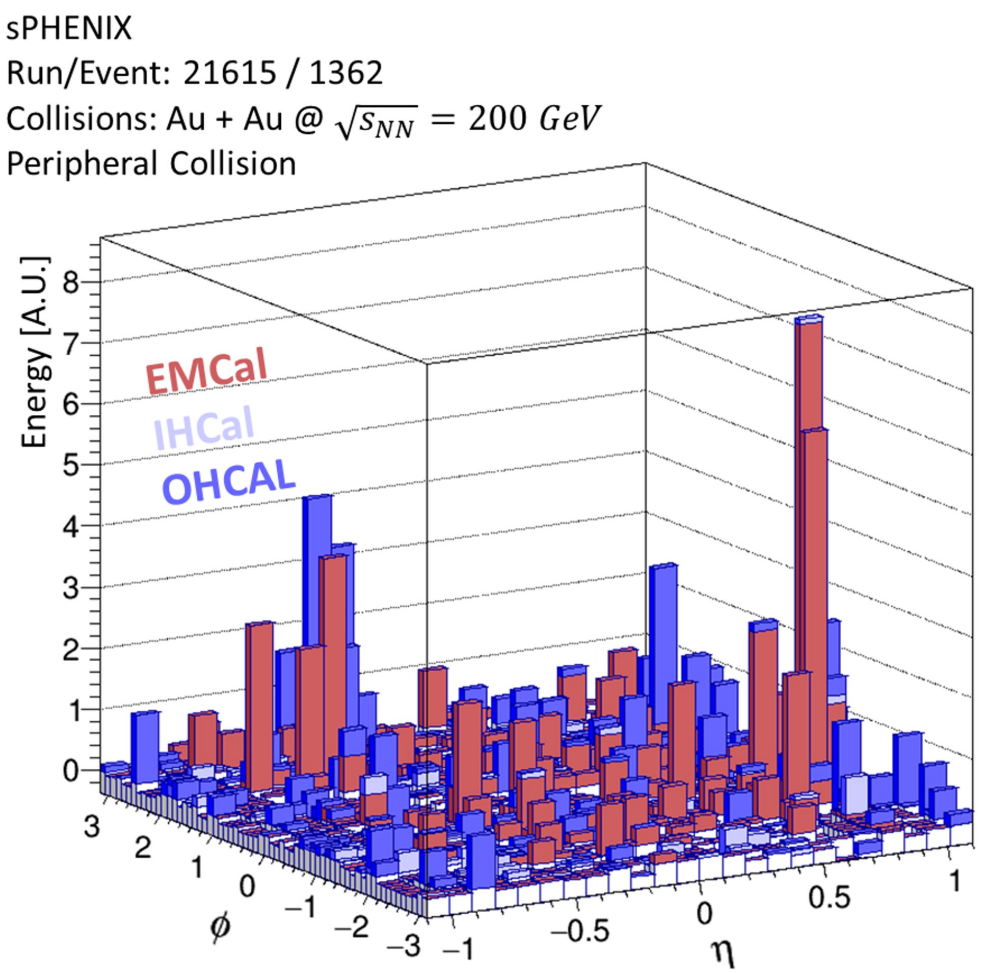
Good comparison to previous measurements at RHIC

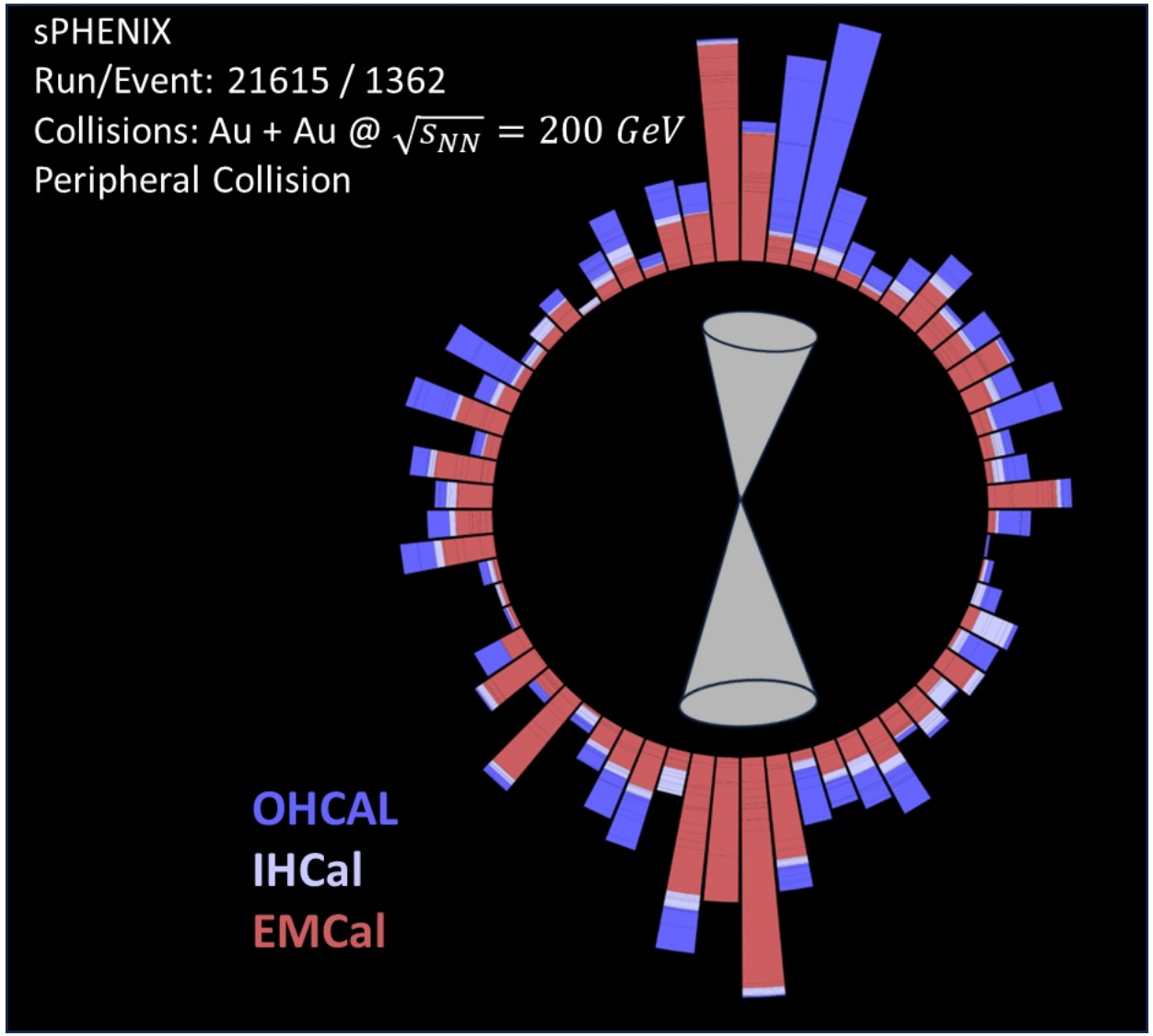




sPHENIX Jet Program - First Light

- First fully calorimetric dijets at RHIC!





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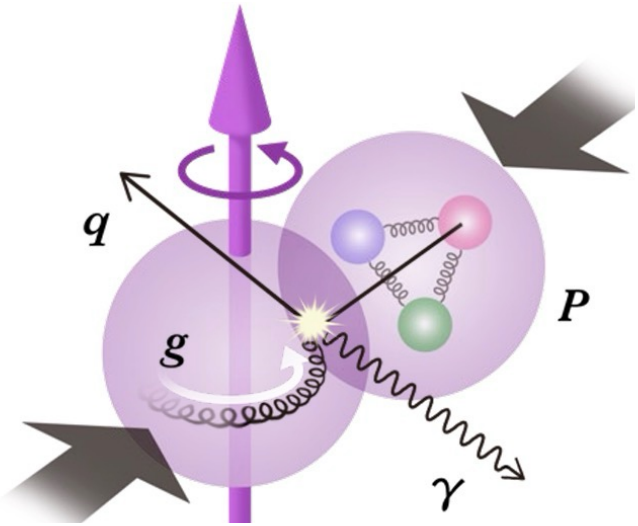

Ongoing!

Run 24: Luminosity Optimization

Run 23 ends early due to machine failure of RHIC

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No time to properly commission tracking subsystems

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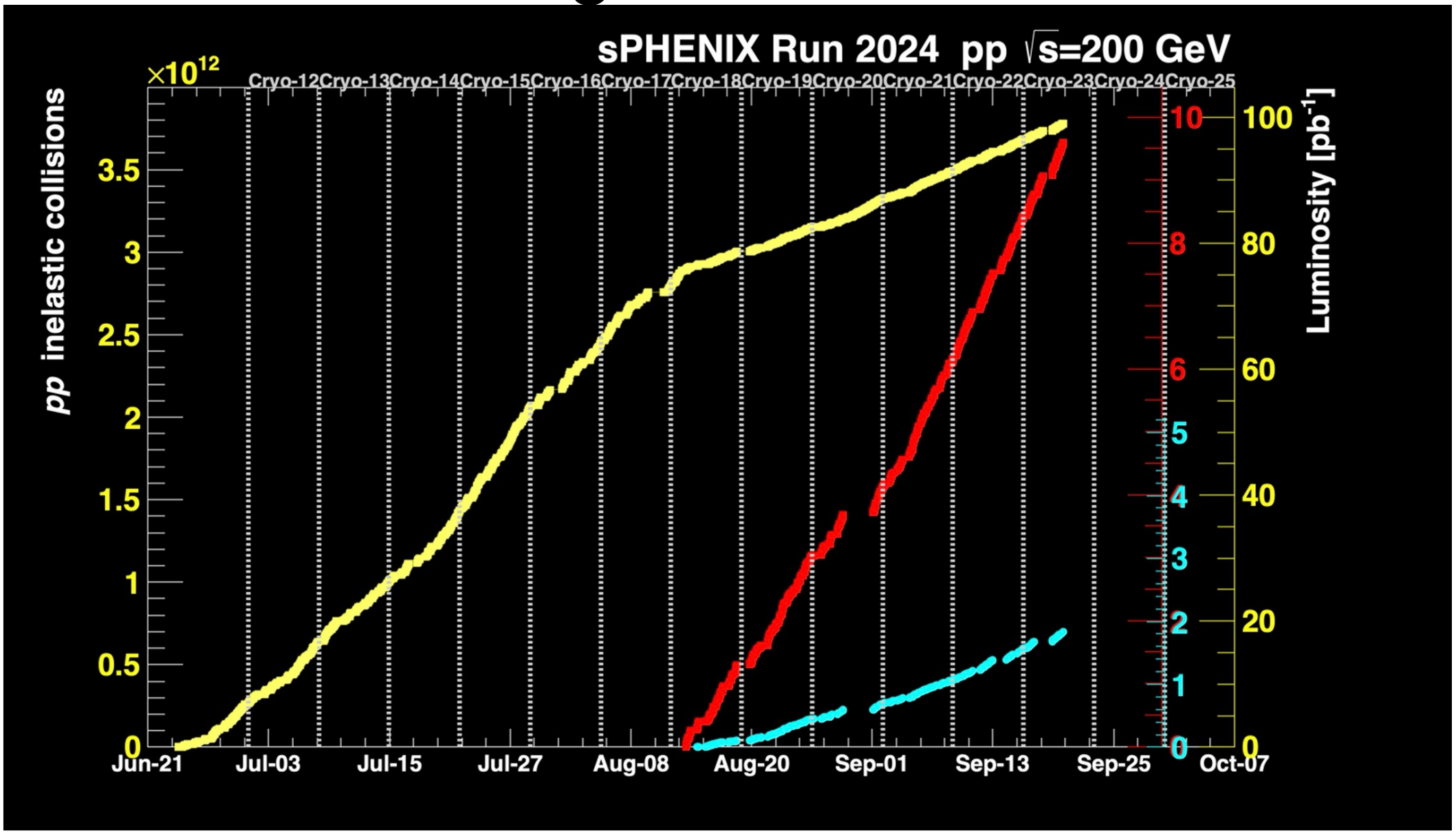
Run 23 ends early due to machine failure of RHIC

No time to properly commission tracking subsystems

Solution: Optimize for calorimeter rare probes program early in the run, and re-optimize for tracking when ready

Run 24 Data Taking



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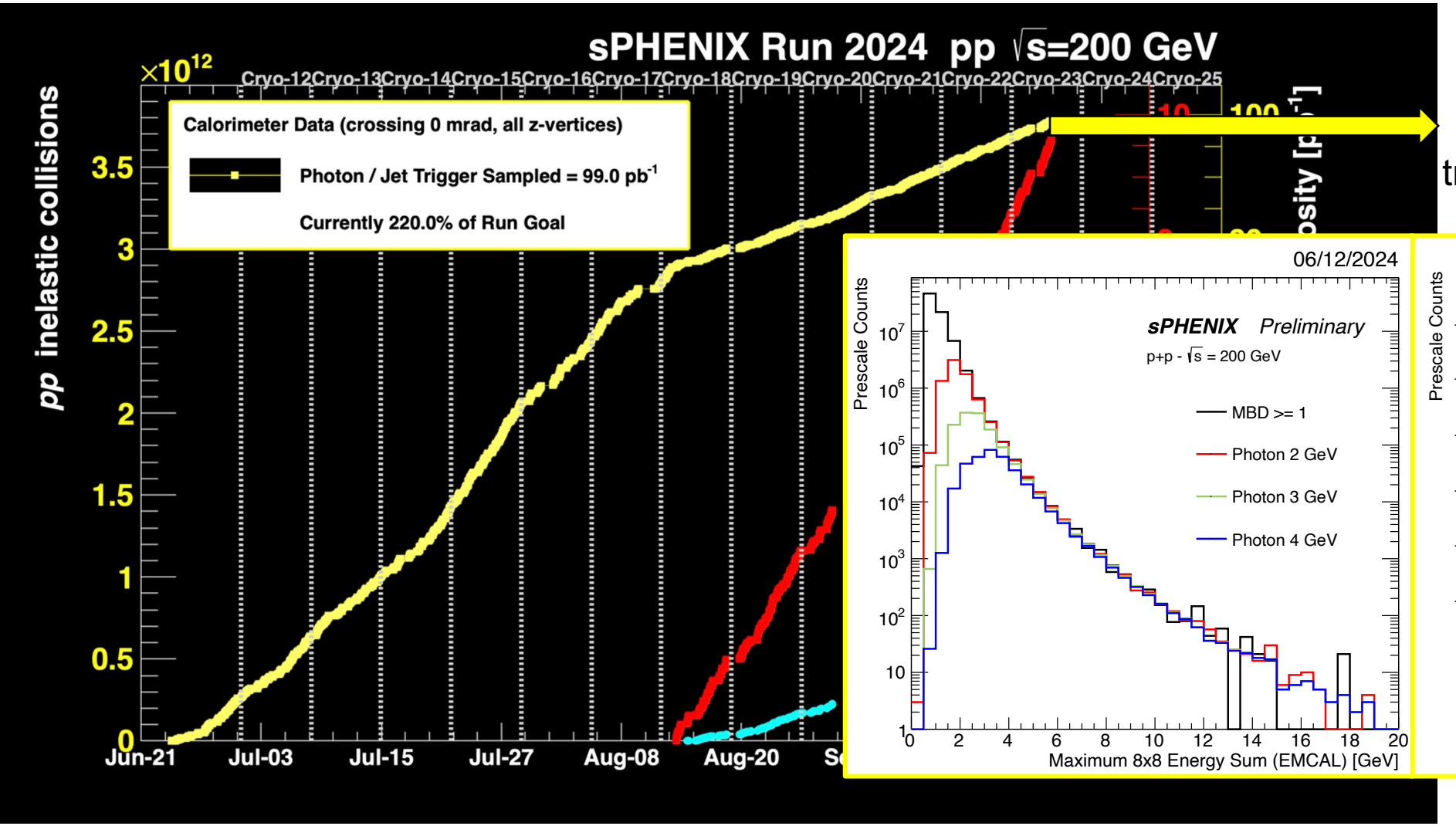
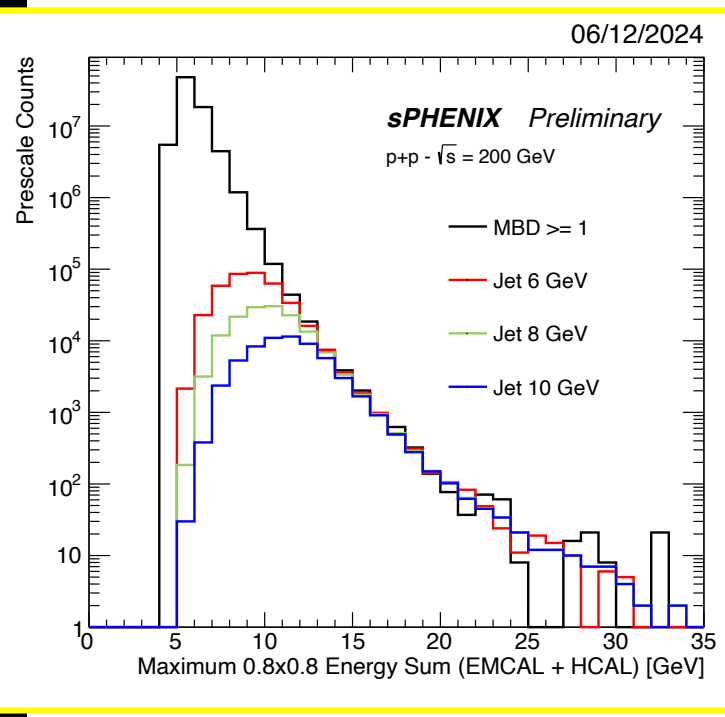


High-energy EMCal and combined EMCal/HCal triggers exceed 200% of goal



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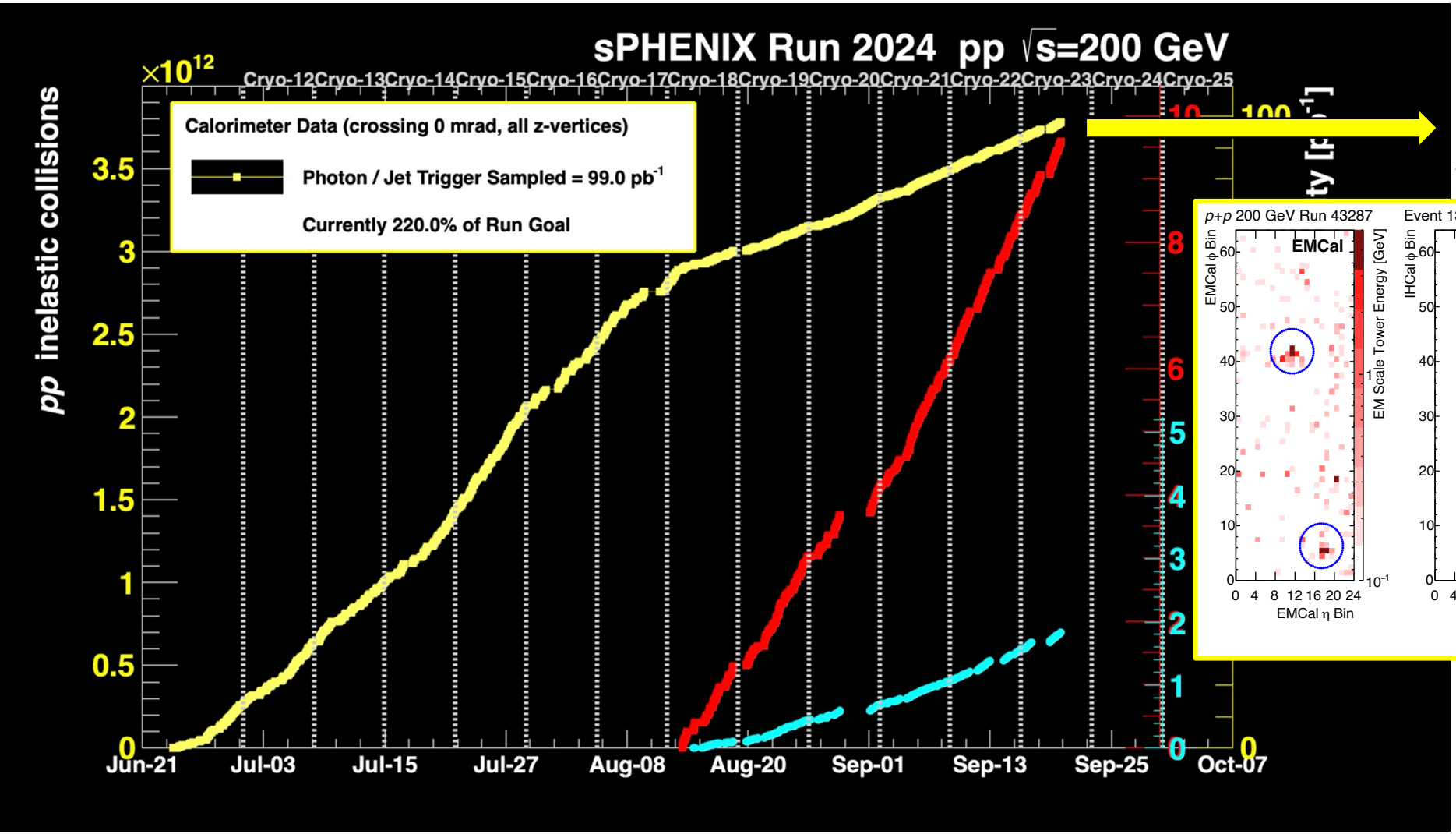

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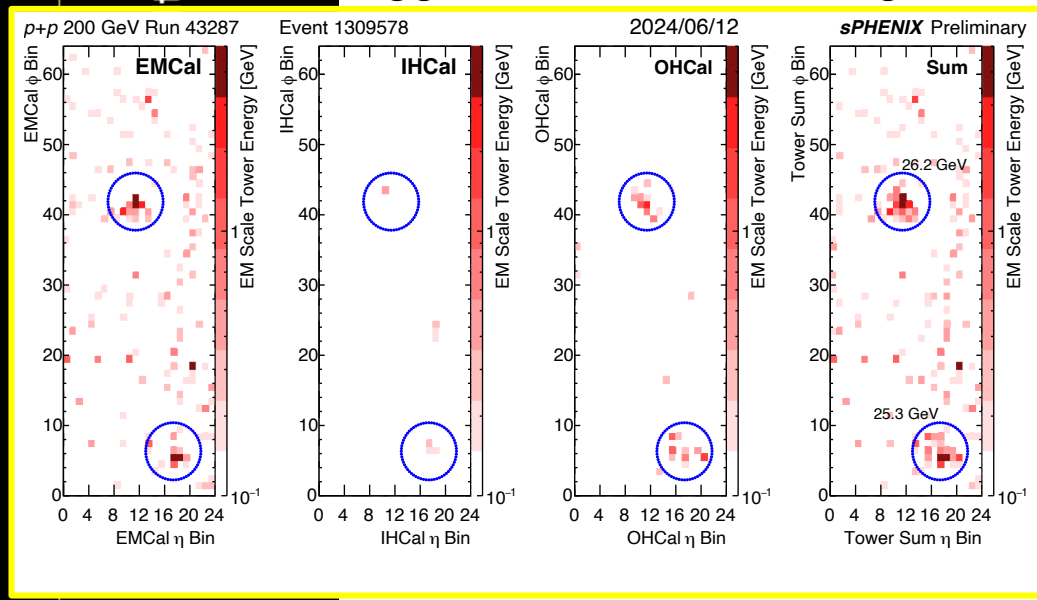

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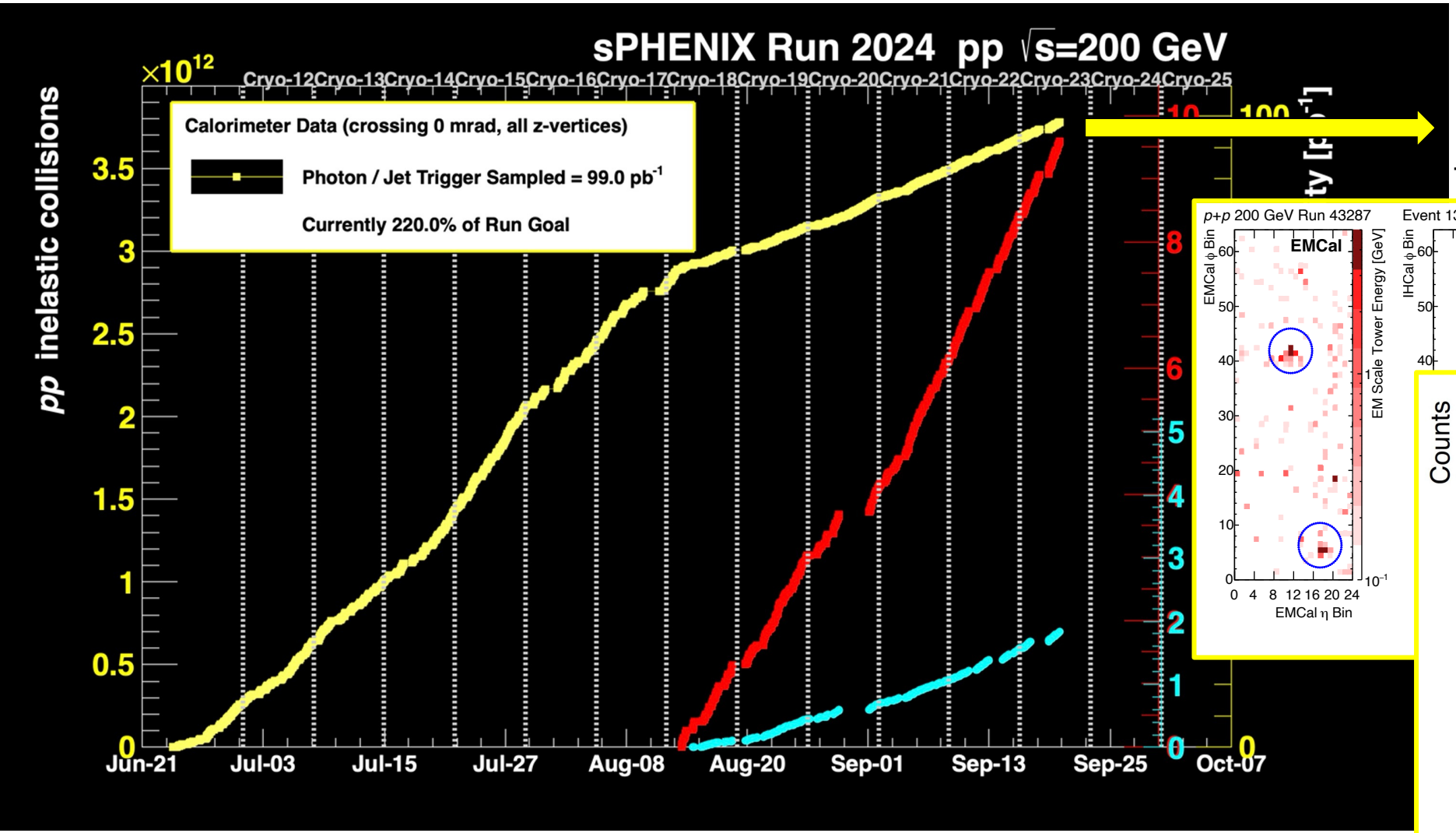

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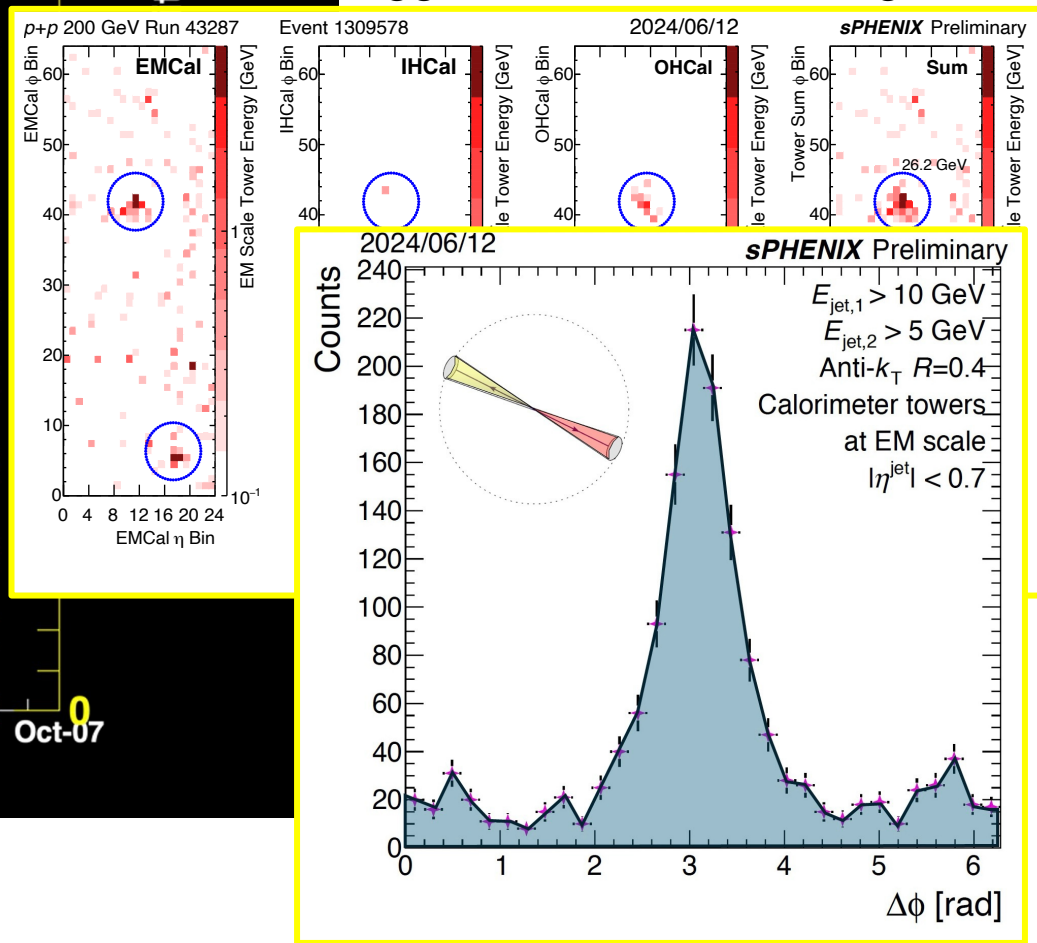

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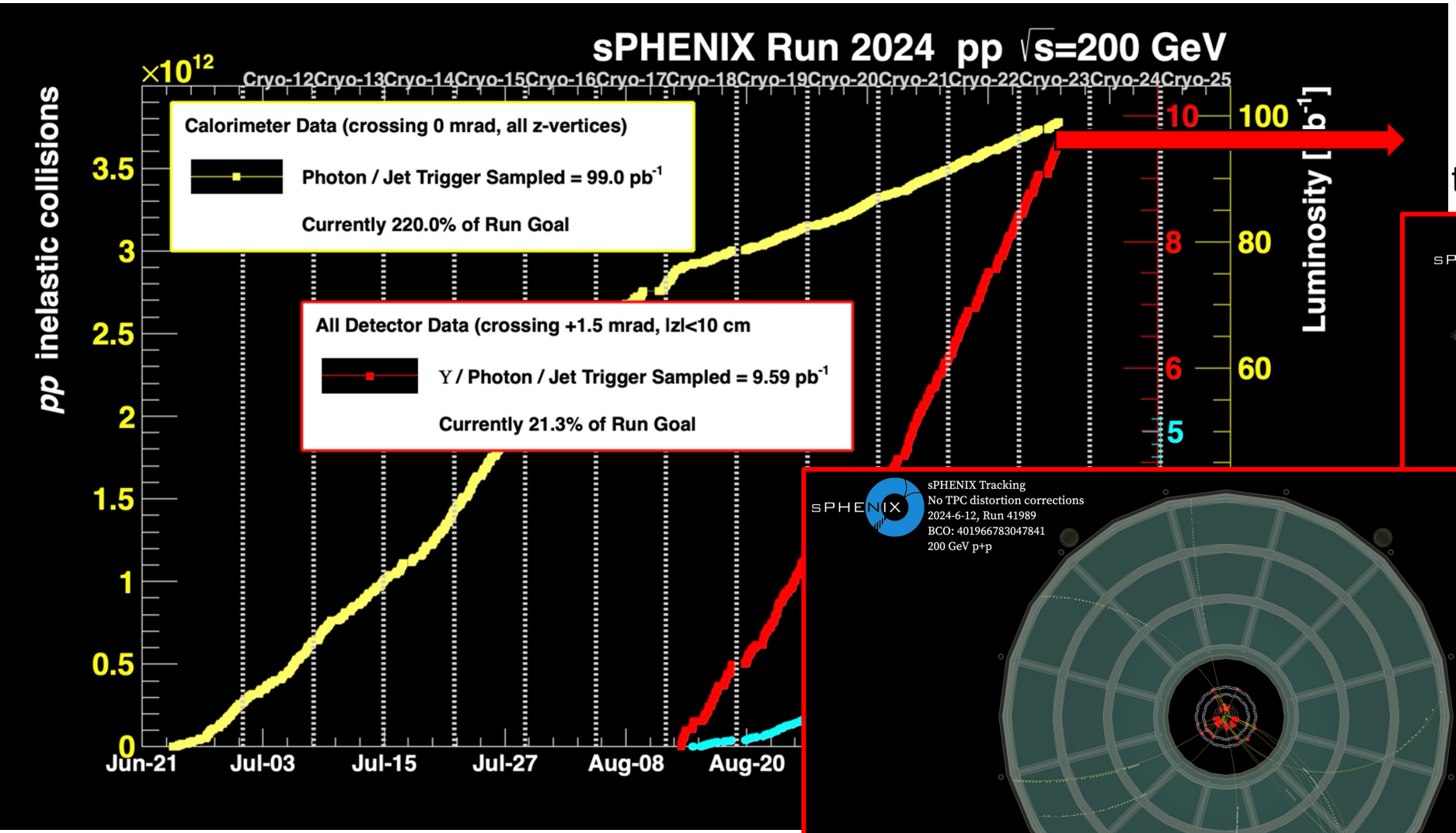
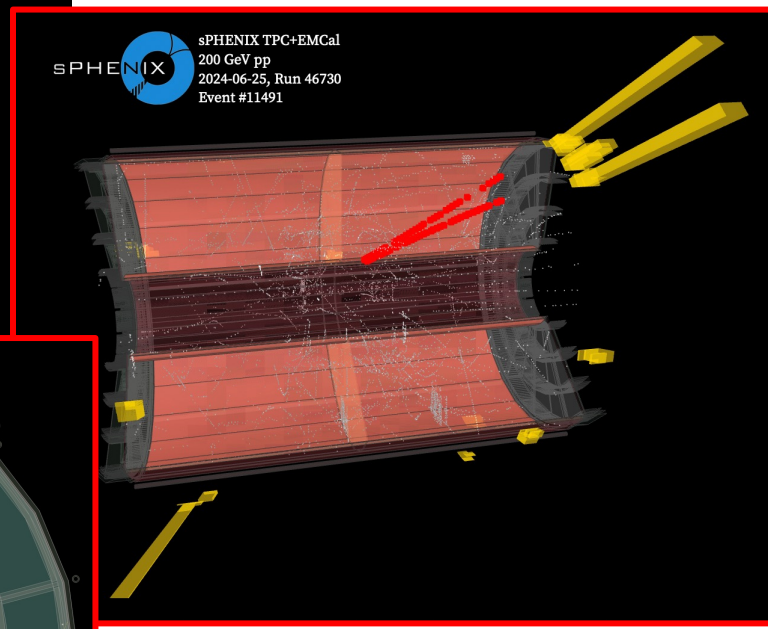


All sPHENIX subsystems taking data in triggered mode



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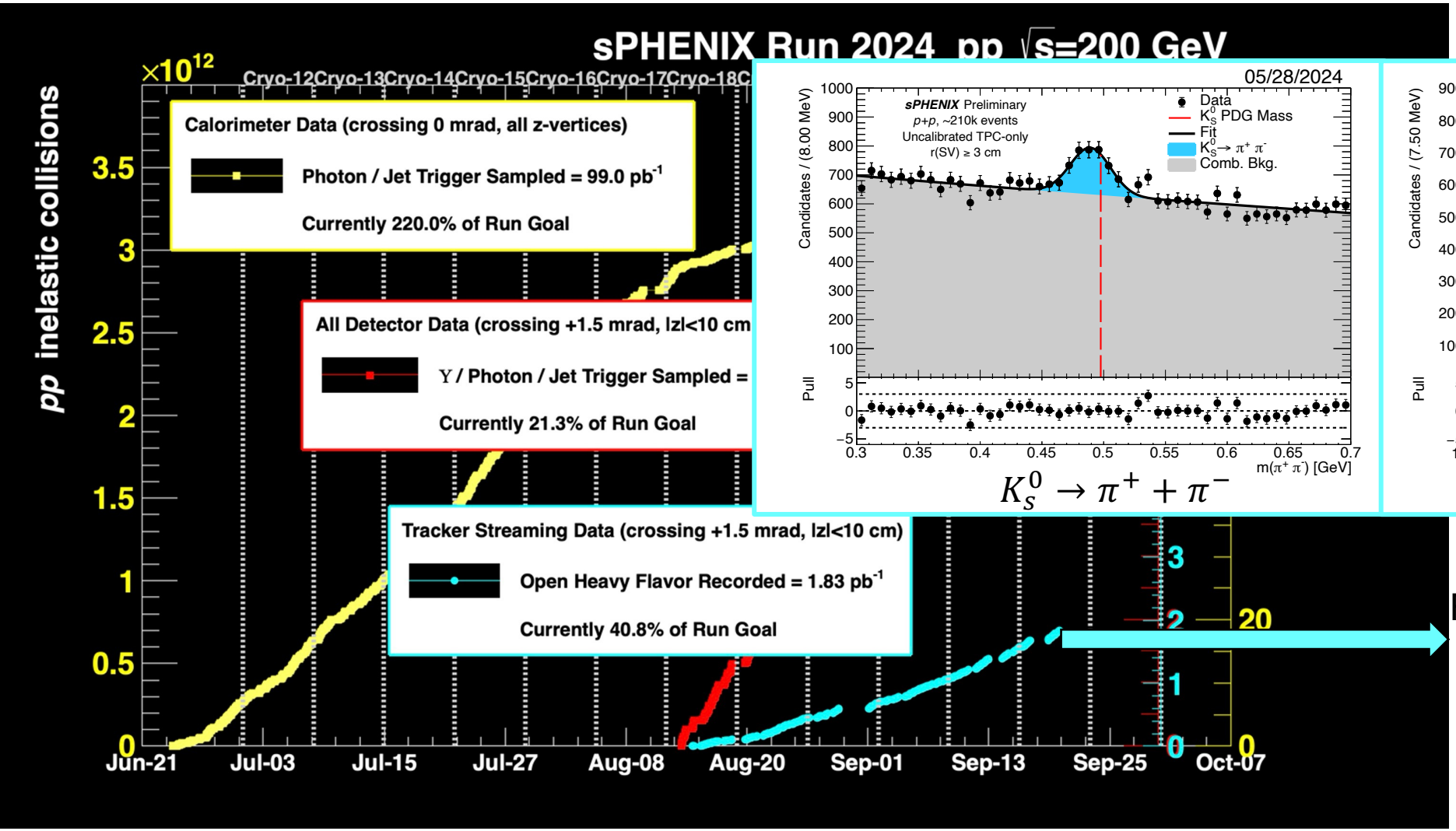

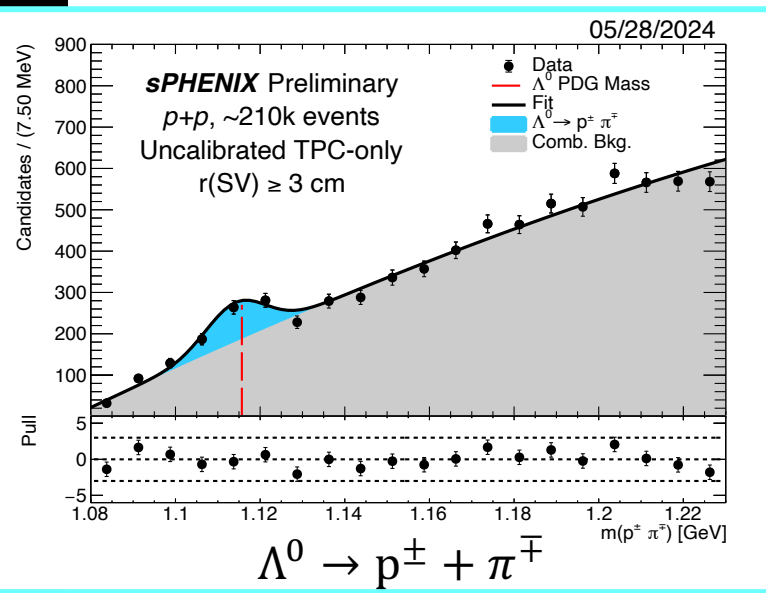

Fully streaming readout for the first time at RHIC at >10%

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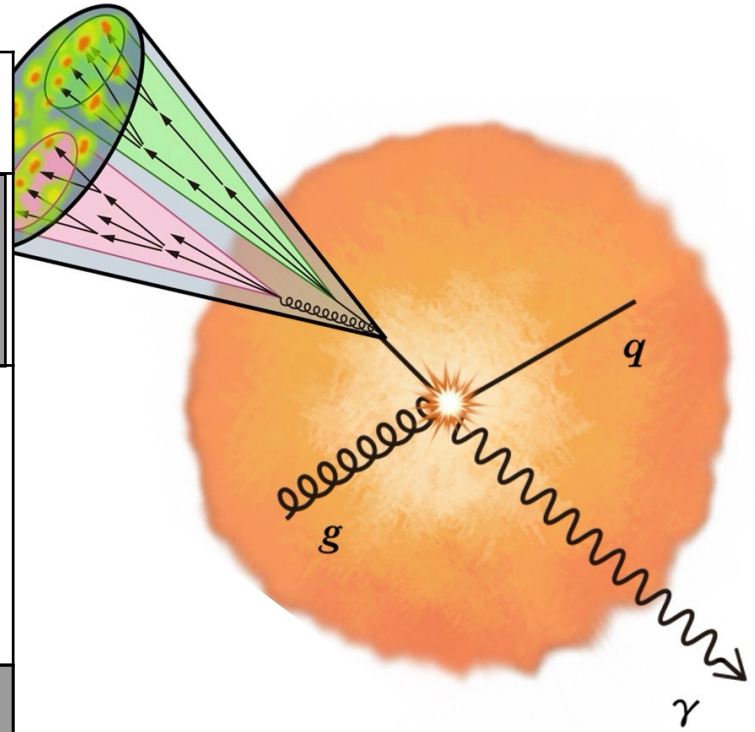

Additional 3 weeks of Au+Au in 2024 running to prepare for 2025

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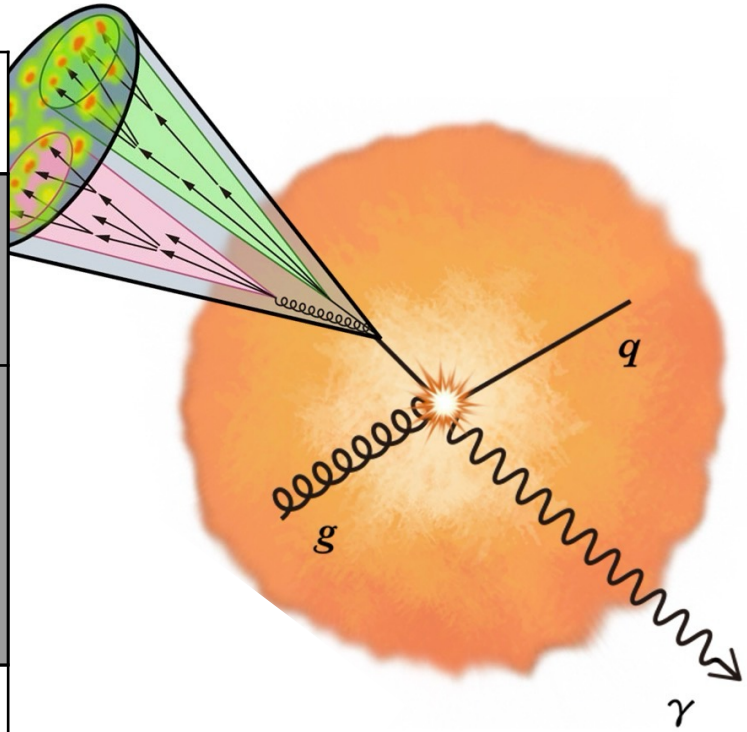
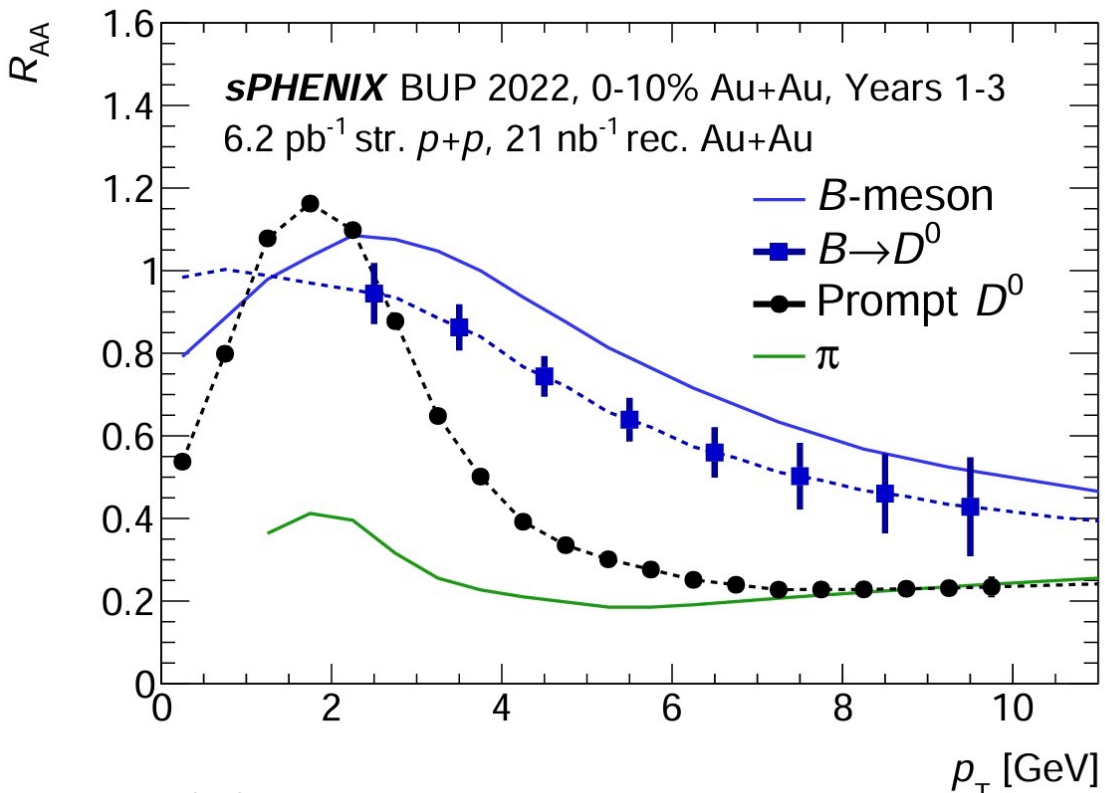
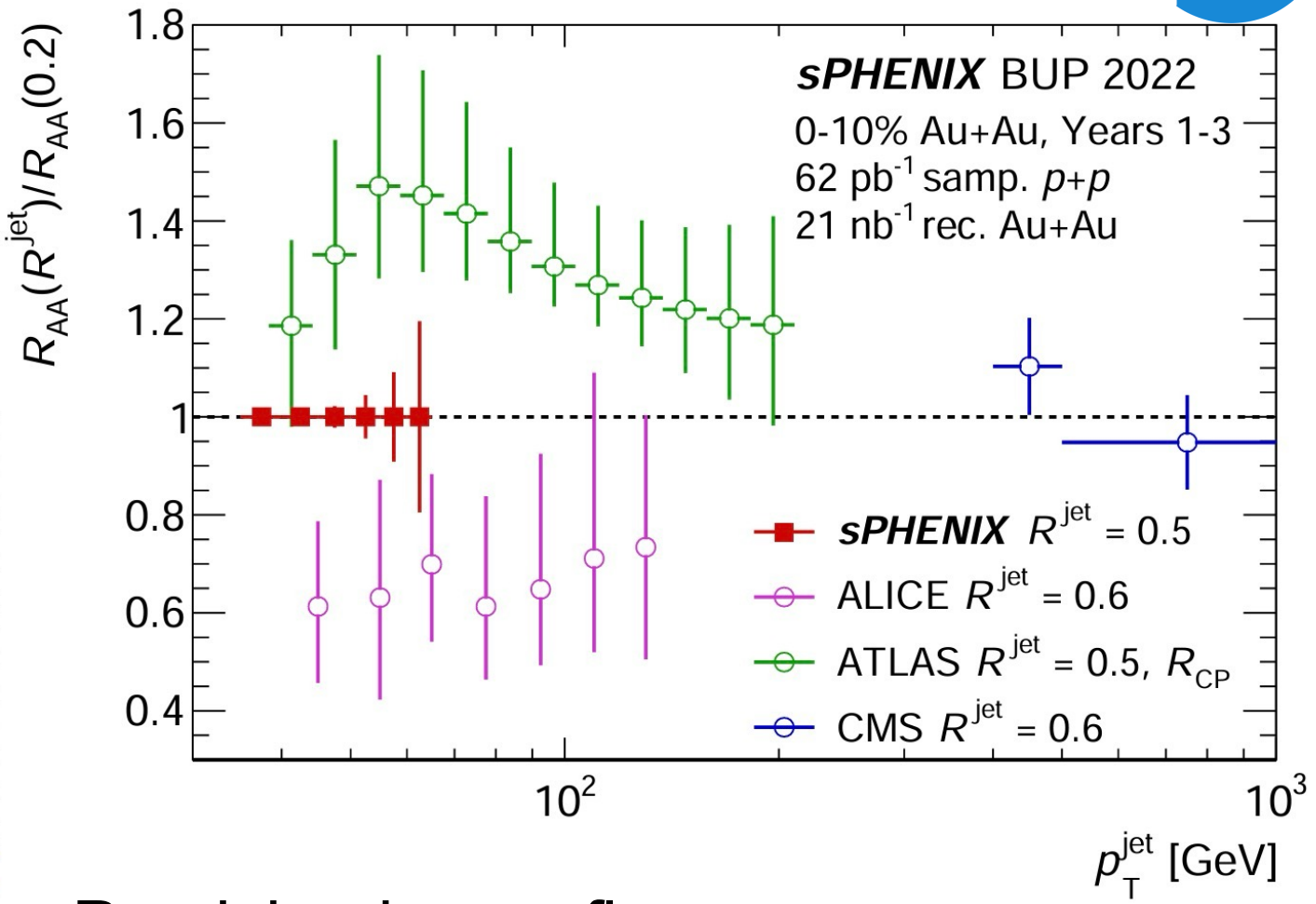


Run 2025 - High Statistics Au+Au

Address open jet physics questions via complementary kinematic range →



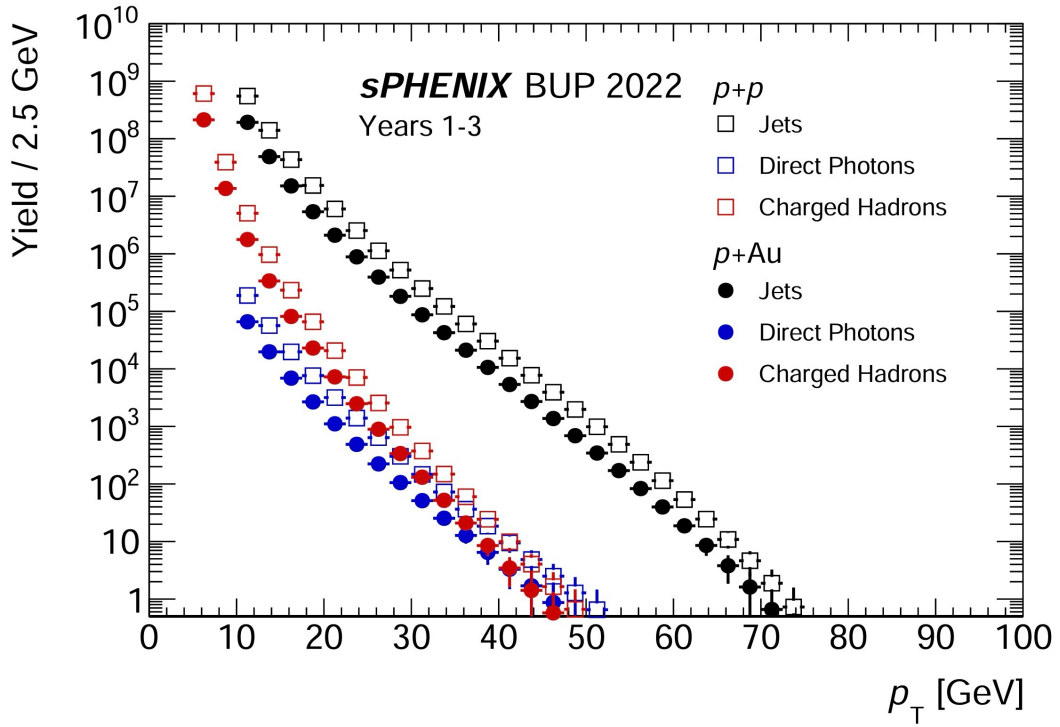


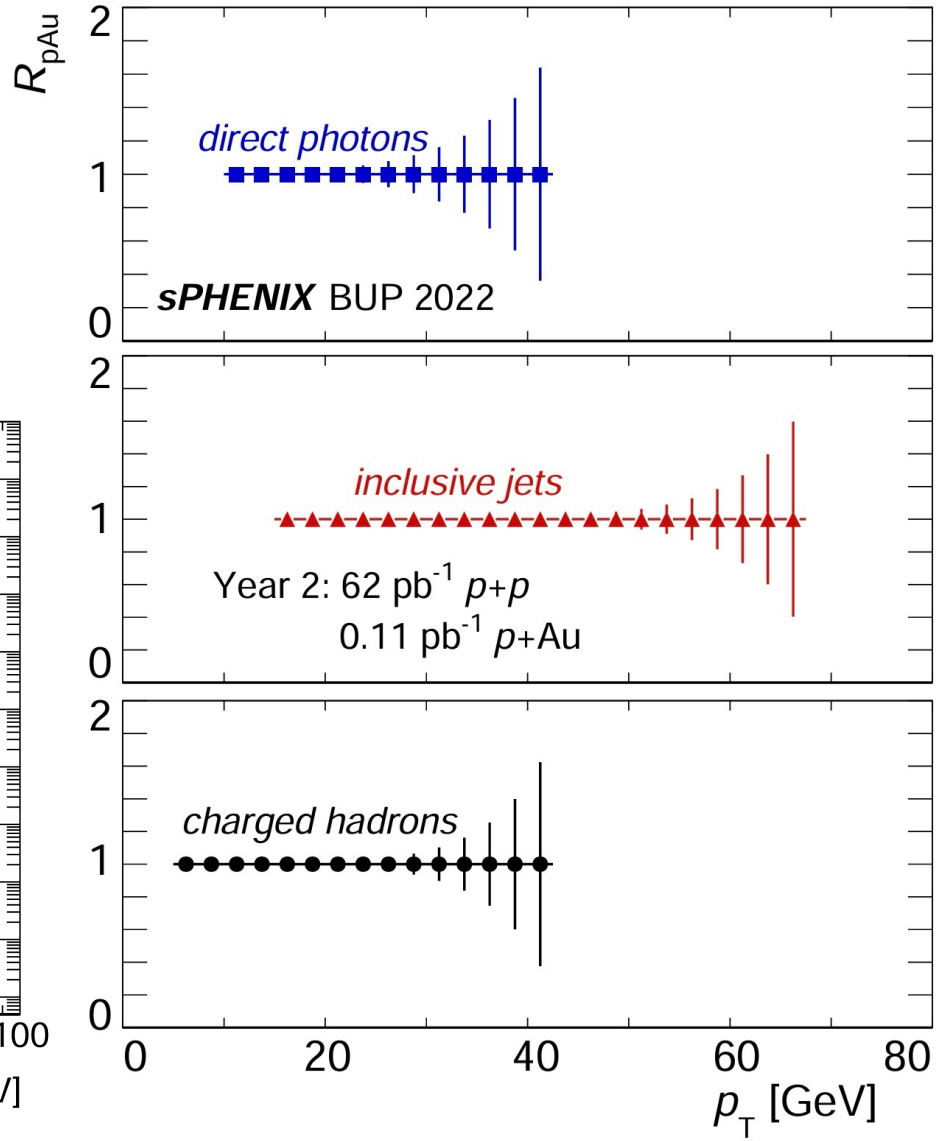
←Precision heavy flavor measurements (streaming readout in p+p is key!)

Running Beyond 2025 Au+Au

sPHENIX can make rich physics measurements beyond Au+Au and p+p!

Complementary to STAR forward upgrade program

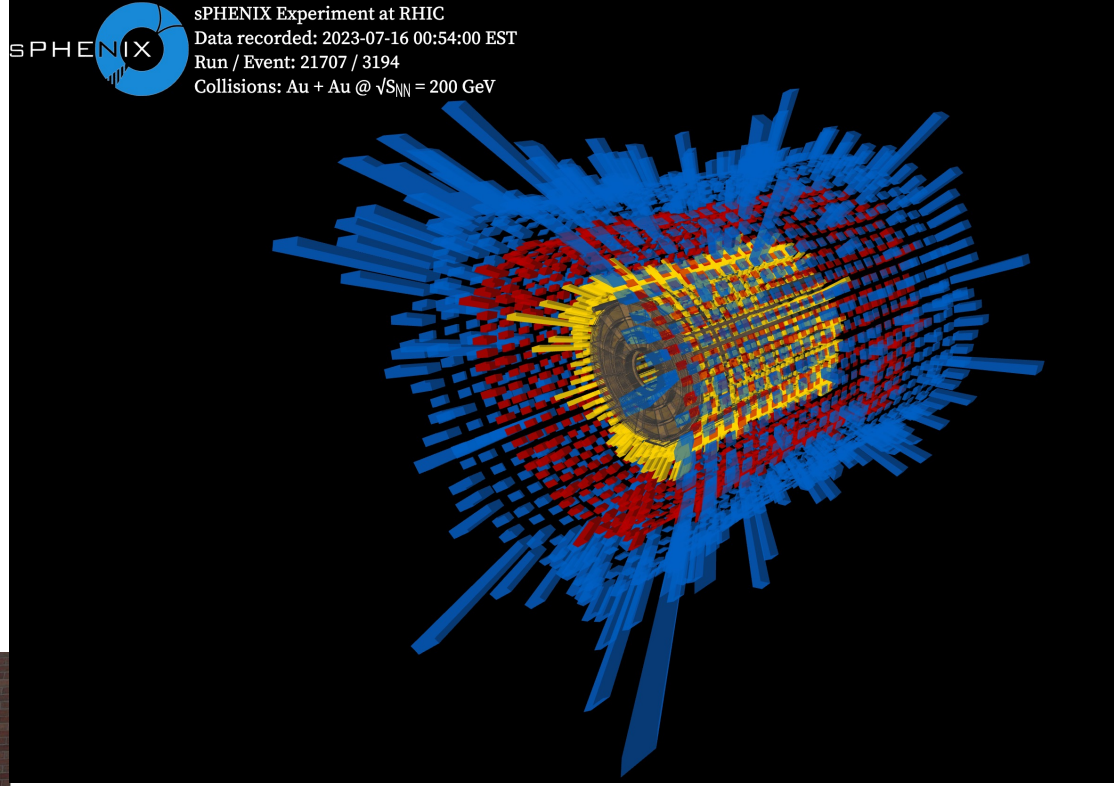




sPHENIX Outlook

sPHENIX is actively taking baseline p+p data, and in Run 25 will collect massive, archival dataset

Expect many exciting jet and heavy flavor results!



Thank You for Your Time!

More sPHENIX at Hard Probes 2024!

Talks:

“Measurement of dET/dη in Au+Au collisions at 200 GeV with sPHENIX at RHIC”, **TODAY!** 4:30PM, Parallel 7

- Genki Nukazuka

Posters:

“Intelligent experiments through real-time AI: Fast Data Processing and Autonomous Detector Control for sPHENIX and future EIC detectors”

- Hannah Bossi

“Underlying event characterization in 200 GeV Au+Au collisions for jet measurements with the sPHENIX detector”

- Benjamin Kimelman

“Novel use of generative AI for heavy ion experiments”

- Yeonju Go

“High-p_T physics with the sPHENIX calorimeters in the inaugural physics Run-24”

- Rithya Kunnawalkam Elayavalli

“Strange and heavy flavor physics with the sPHENIX trackers in the inaugural physics Run-24”

- Ming Liu

“Position alignment and vertex determination for sPHENIX INTT detector”

- Mahiro Ikemoto

“Intermediate Silicon Tracker in sPHENIX at RHIC”

- Cheng-Wei Shih

See all our public results and event displays here: https://www.sphenix.bnl.gov/PublicResults