Jet physics measurements in sPHENIX

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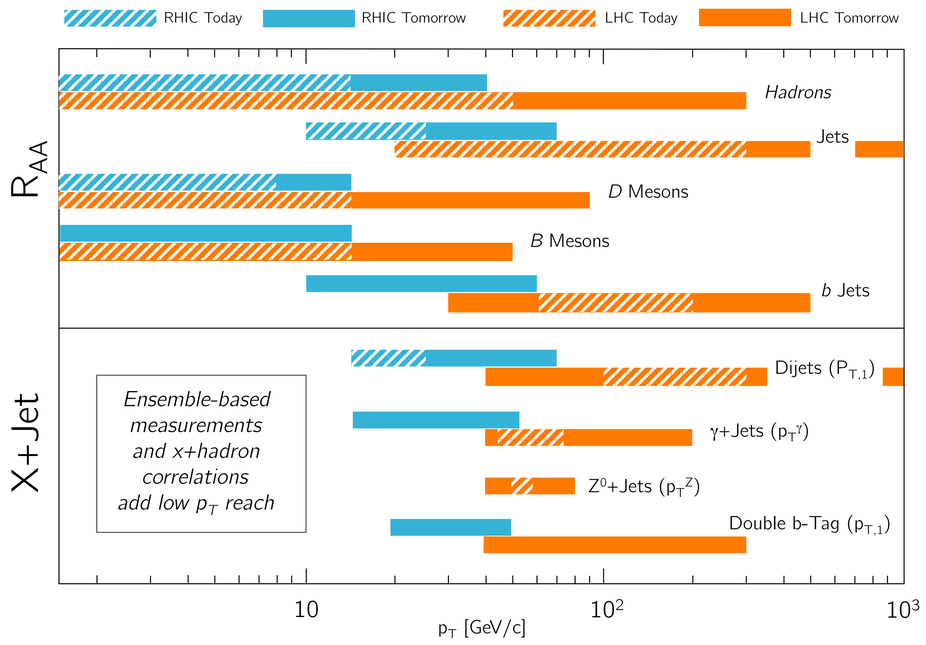
on behalf of the sPHENIX Collaboration

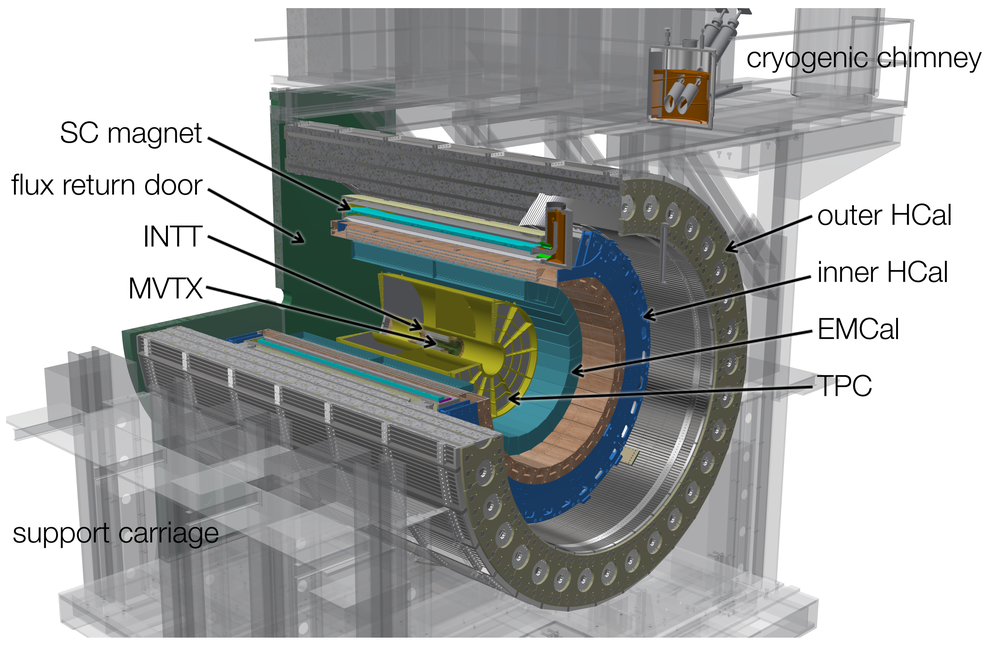
Introduction

The sPHENIX detector — currently under commisioning at the BNL Relativistic Heavy Ion Collider (RHIC) — will make jet measurements with a kinematic reach that not only overlaps those performed at the LHC, but extends them into a new, low-p_T regime where quenching effects are large.

Jet observables are a particularly useful probe of the Quark Gluon Plasma (QGP) formed in heavy-ion collisions since the hard scattered partons that fragment into final state jets are strongly quenched through interactions with the medium they traverse.



The sPHENIX detector



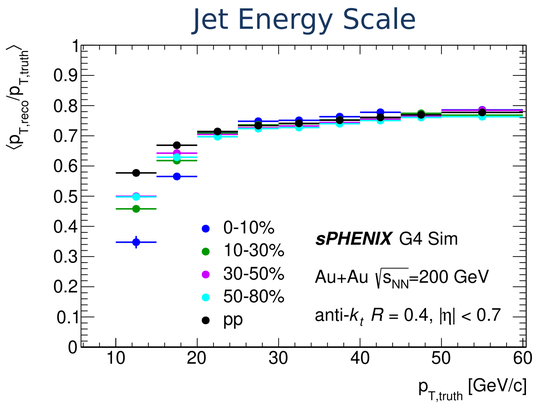
Calorimeters: Inner and outer hadronic calorimeters (IHCal, OHCal), electromagnetic calorimeter (EMCal)

Tracking: Time projection chamber (TPC), TPC outer tracker (TPOT, not depicted), intermediate silicon tracker (INTT), MAPS-based vertex detector (MVTX)

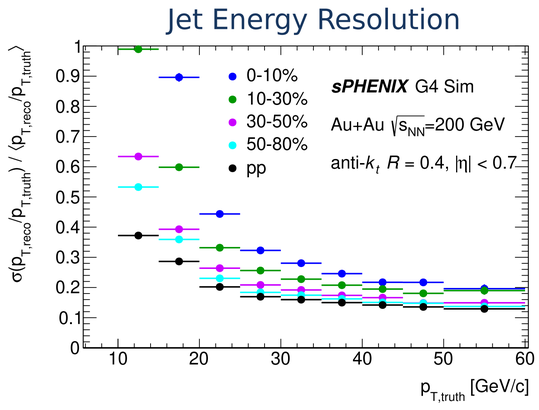
Event characterization: minimum bias detector (MBD, not depicted), event plane detector (sEPD, not depicted)

Calorimeter jets in sPHENIX

Jet Energy Scale

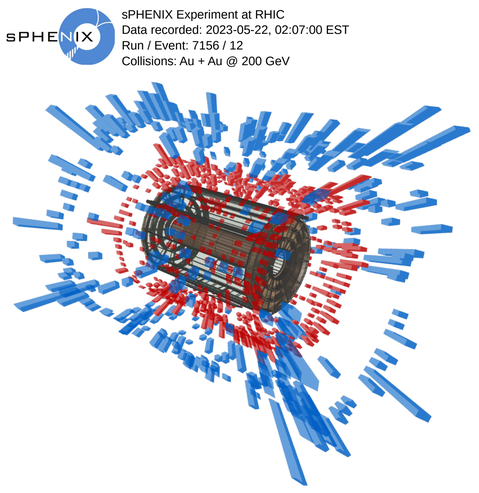


Jet Energy Resolution

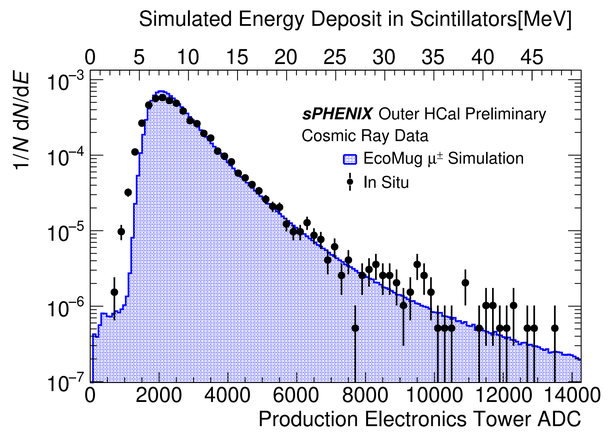


- jets from calorimeter towers with 3D topoclustering
- event-by-event underlying event subtraction
- (above plots: uncalibrated jets, no flow subtraction)

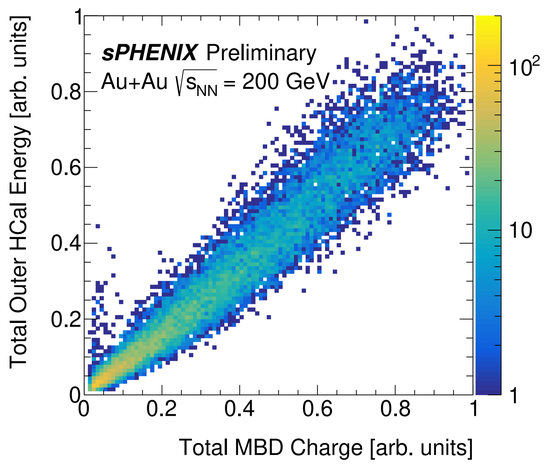
Recent results from commissioning

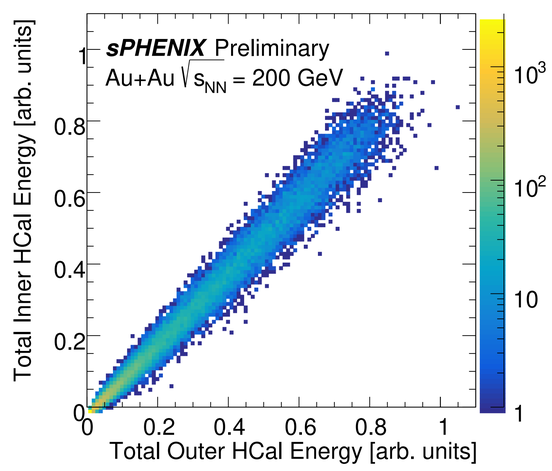


Central Au+Au collision energy deposits in the HCal (MBD coincidence trigger)



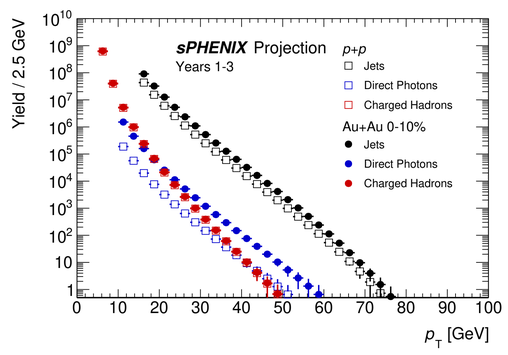
Calibration of the outer HCal with cosmic muons (random trigger)





Data collected with MBD coincidence trigger
Correlation between:
- left: the outer HCal and the MBD
- right: the outer and inner HCal

Jet physics predictions



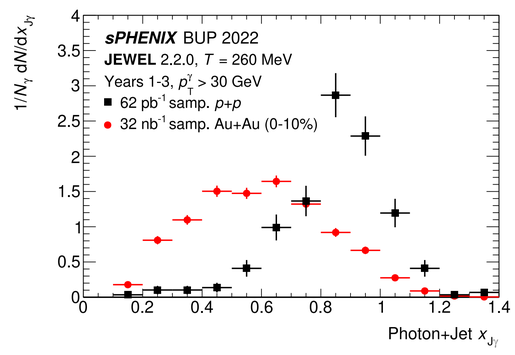
Expected yields for proposed 2023-2025 data taking

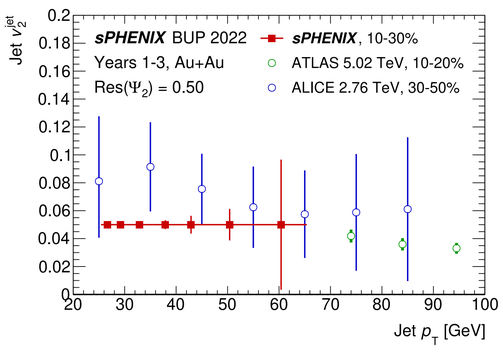
Signal	Au+Au 0–10% Counts	p+p Counts
Jets p_T > 20 GeV	22 000 000	11 000 000
Jets p_T > 40 GeV	65 000	31 000
Direct Photons p_T > 20 GeV	47 000	5 800
Direct Photons p_T > 30 GeV	2 400	290
Charged Hadrons pT > 25 GeV	4 300	4 100

- jet-to-photon p_T balance:

$$x_{J\gamma} = p_T^{jet} / p_T^{\gamma}$$

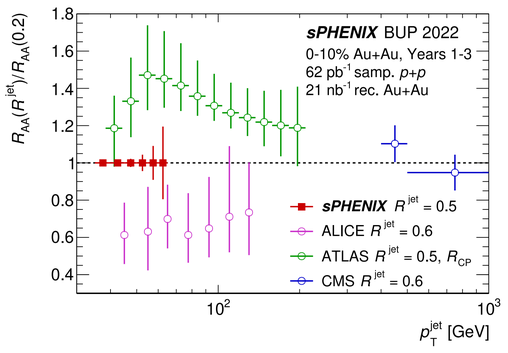
- $x_{J\gamma}$ distribution for Au+Au shift towards lower values because of jet quenching





- jet v_2 measurement projection
- high statistics at low p_T
- most theoretical calculations could not simultaneously describe suppression and anisotropy at RHIC

- interplay of out-of-cone energy loss and the angular distribution of medium response effects
- LHC experiments in significant tension
- sPHENIX can make an accurate measurement in this region



sPHENIX Collaboration, "sPHENIX Beam Use Proposal", sPH-TRG-2022-001, May 13, 2022

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