Jet physics measurements in sPHENIX

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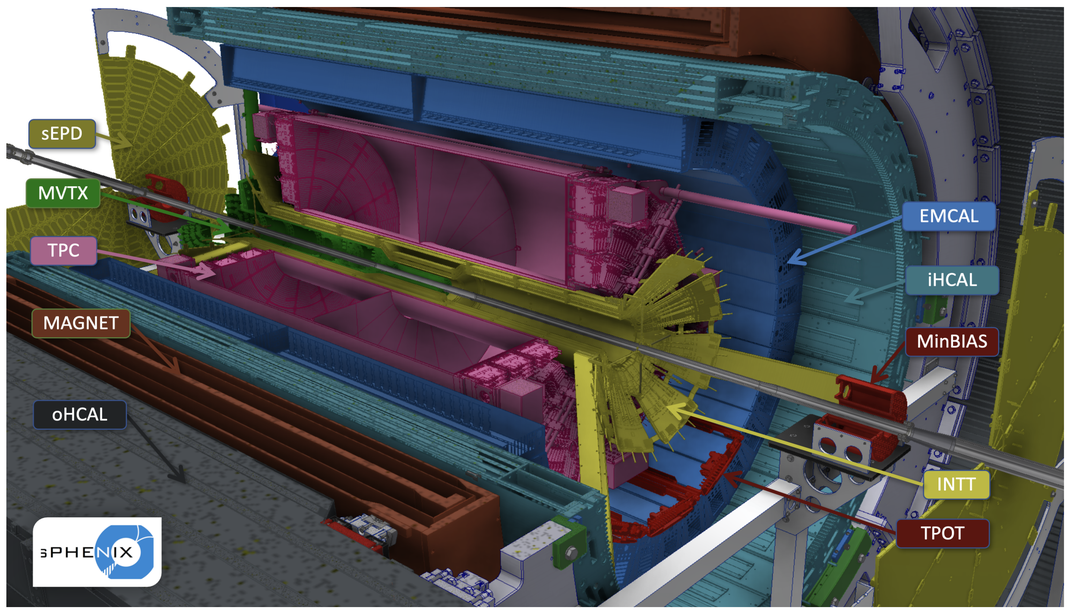
on behalf of the sPHENIX Collaboration

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 with 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



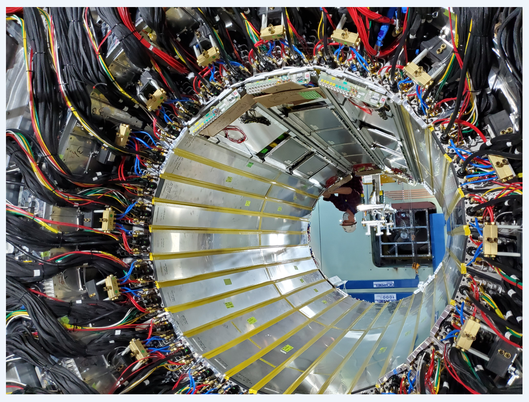
Calorimeters: Inner and outer hadronic calorimeters (IHCal, OHCal), electromagnetic calorimeter (EMCal)

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), event plane detector (sEPD)

Calorimeters

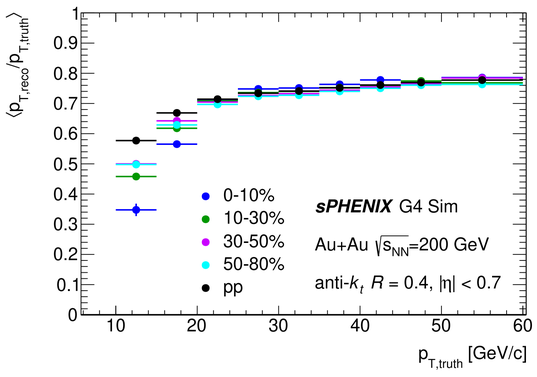
OHCal, magnet, and IHCal



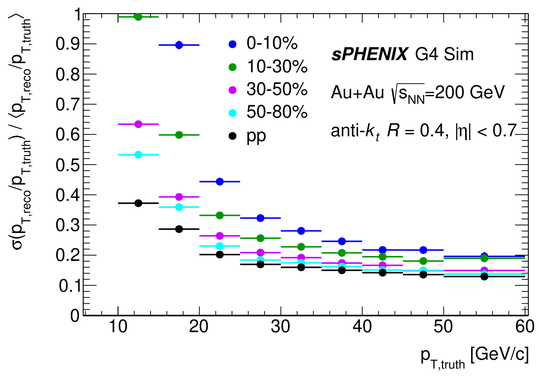
EMCal

Calorimeter jets in sPHENIX

Jet Energy Scale

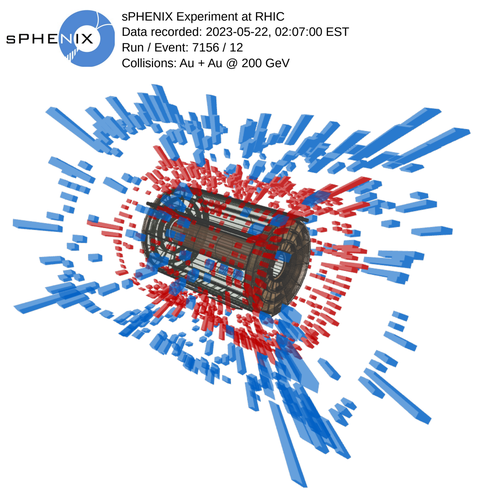


Jet Energy Resolution

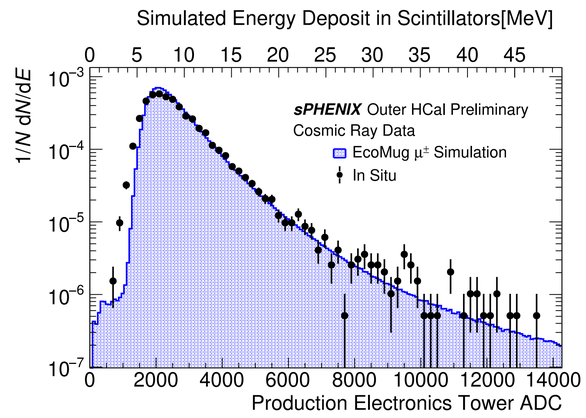


- jets from clusters of calorimeter towers
- event-by-event underlying event subtraction
- (above plots: EM-scale jets, no flow subtraction)

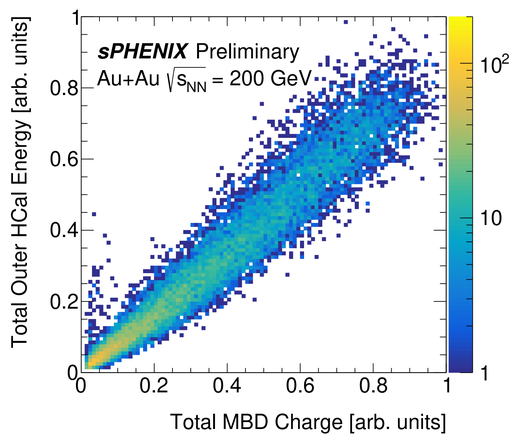
First results from commissioning data



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

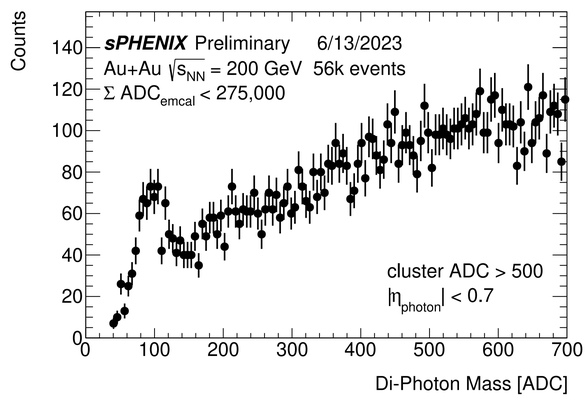


Cosmic muons in the outer HCal (random trigger)



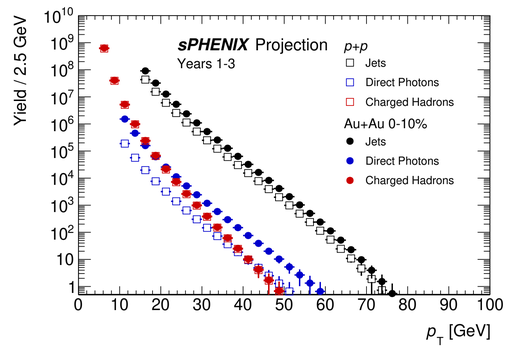
Data collected with MBD coincidence trigger

Correlation between the outer HCal and the MBD



Diphoton mass distribution pi0 peak around 100 ADC

Jet physics projections



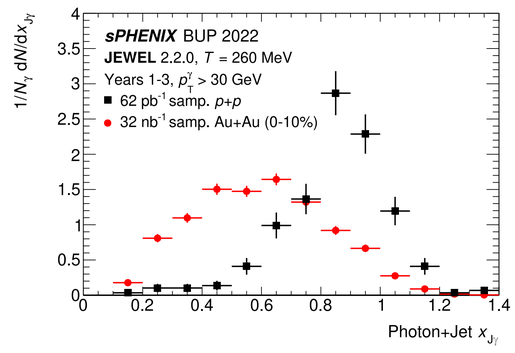
Expected yields for proposed 2023-2025 data taking

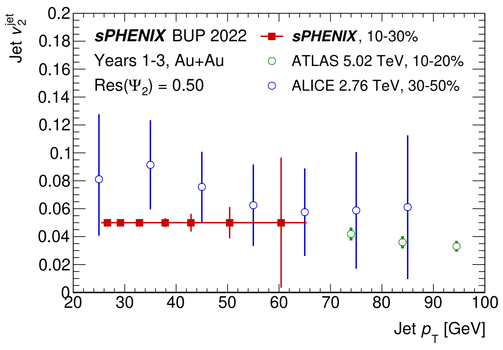
Signal	Au+Au 0–10% Counts	p+p Counts
Jets p_T > 20 GeV	22 000 000	11 000 000
Jets p_T > 40 GeV	65 000	31 000
Direct Photons p_T > 20 GeV	47 000	5 800
Direct Photons p_T > 30 GeV	2 400	290
Charged Hadrons pT > 25 GeV	4 300	4 100

- jet-to-photon p_T balance:

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

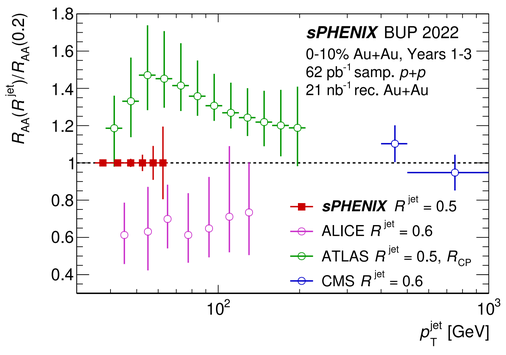
- $x_{J\gamma}$ distribution for Au+Au shift towards lower values because of jet quenching





- jet v_2 measurement projection
- most theoretical calculations could not simultaneously describe suppression and anisotropy at RHIC → azimuthal dependence of jet quenching is of particular interest

- interplay of out-of-cone energy loss and the angular distribution of medium response effects
- LHC experiments in significant tension → sPHENIX expects high statistics in this region



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