Brookhaven National Laboratory

Bulk physics with sPHENIX

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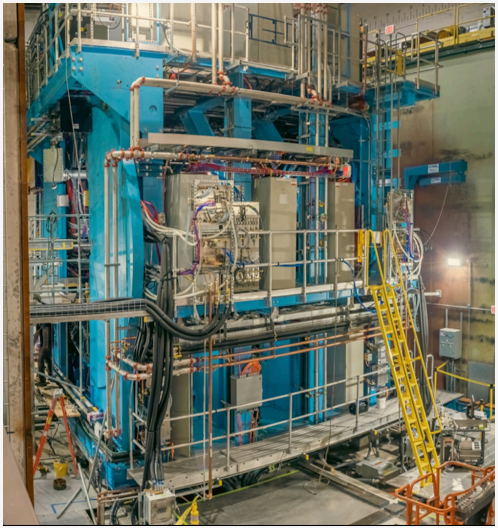
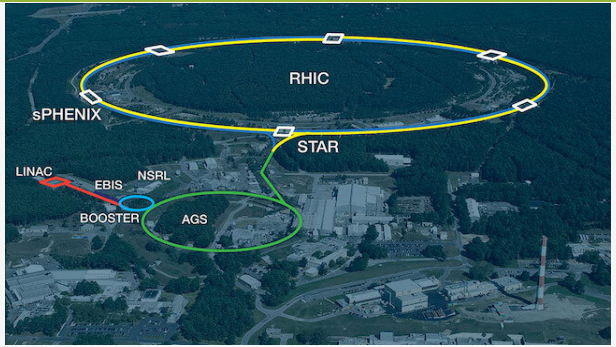
42nd International Symposium on Physics in Collision

October 12, 2023

sPHENIX

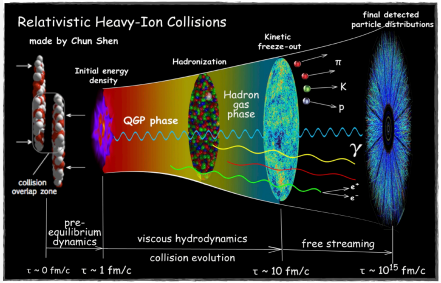
sPHENIX experiment overview

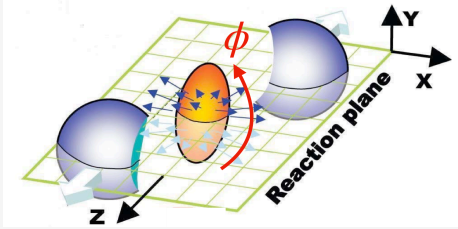




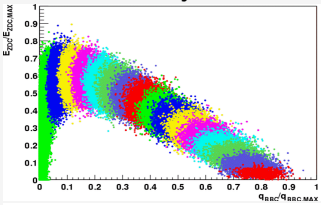
- sPHENIX is designed to study the QGP
- Installation $\approx$ completed in May 2023
- First Au-Au collisions seen in sPHENIX on May 18, 2023 primarily to commission the brand new detector. See **overview talk** by A. Hodges

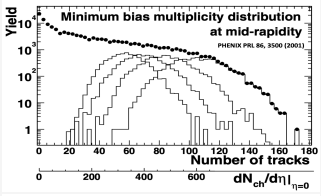
sPHENIX BULK PHYSICS

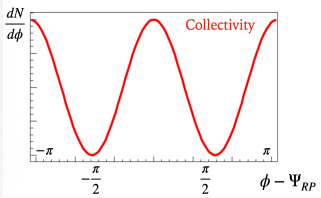


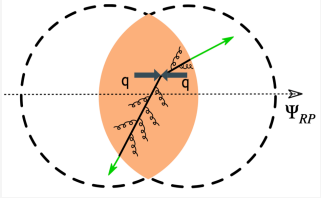


- **soft physics domain:** hadron yields, event characterization, flow and correlations ...
- also heavy flavor flow, jet v_n and more ...

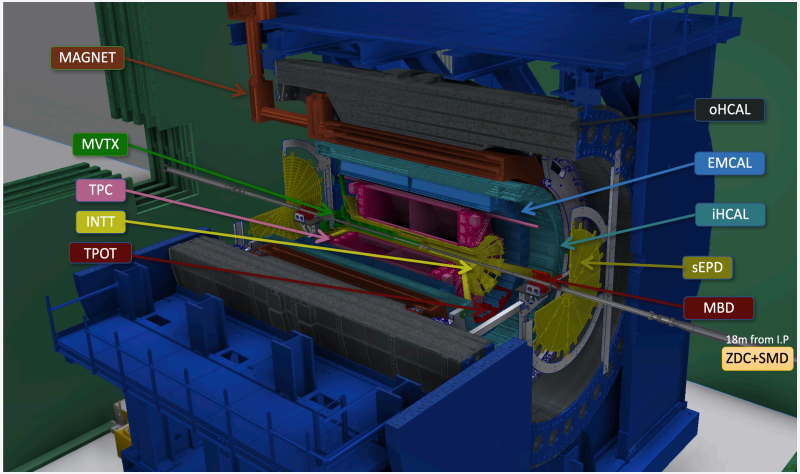






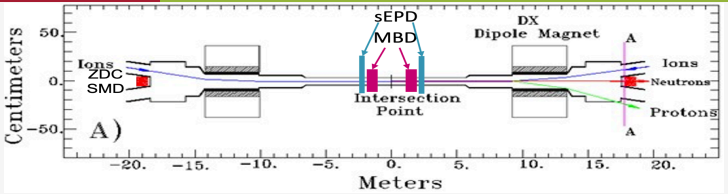


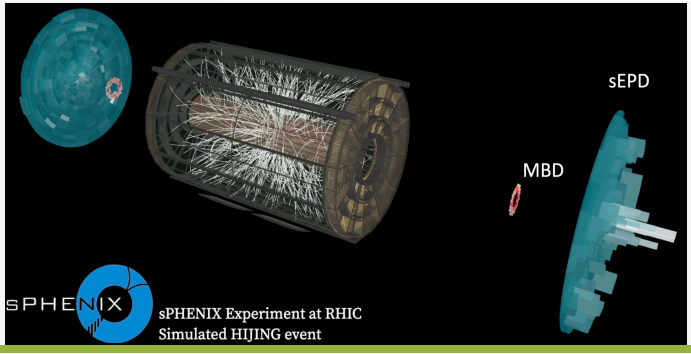
sPHENIX detector overview



- **Detector highlights:**
  - 15kHz DAQ rate
  - 1.4T magnet
  - Barrel detectors acceptance: $|\eta| < 1.1$, full azimuth
  - **Tracking:** MVTX, INTT, TPC, TPOT
  - **Calorimetry:** EMCAL, IHCAL, OHCAL
  - **Forward detectors:** MBD, sEPD, ZDC, SMD

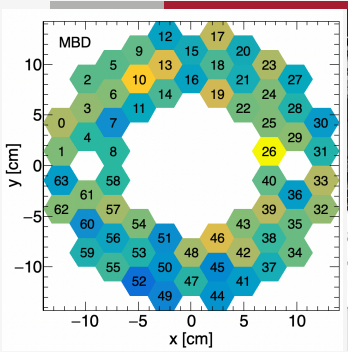
EVENT CHARACTERIZATION DETECTORS

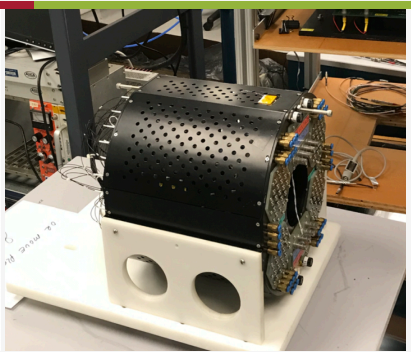




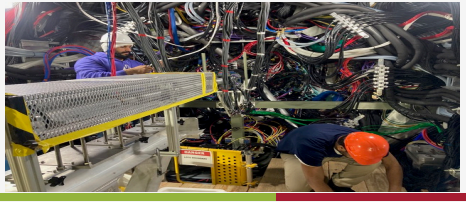
- **MBD:** Minimum Bias Detector; centrality and event plane measurement
- **sEPD:** sPHENIX Event Plane Detector; event plane and centrality measurement
- **ZDC:** Zero Degree Calorimeter; centrality measurement
- **SMD:** Shower Max Detector; Ψ_1 measurement

sPHENIX MINIMUM BIAS DETECTOR



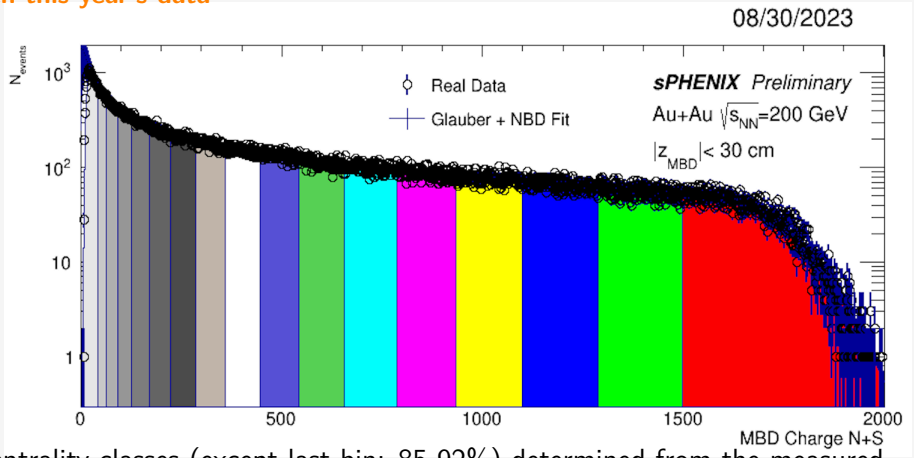


- 2 arms of 64 channels
- 3 cm thick quartz radiator on mesh dynode PMT
- Covers $3.51 < |\eta| < 4.61$



CENTRALITY MEASUREMENT WITH THE MBD

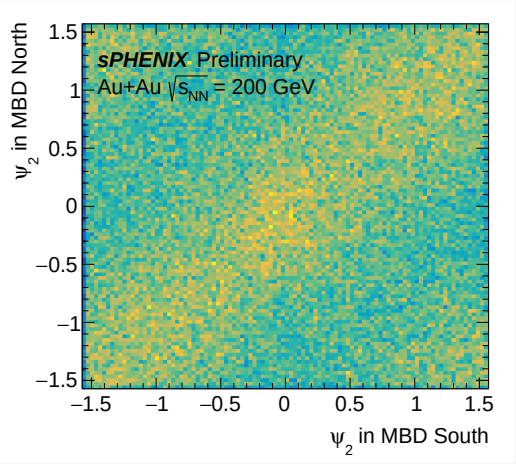
★ with this year's data



5% centrality classes (except last bin: 85-92%) determined from the measured MBD total charge distribution and Glauber + NBD fit

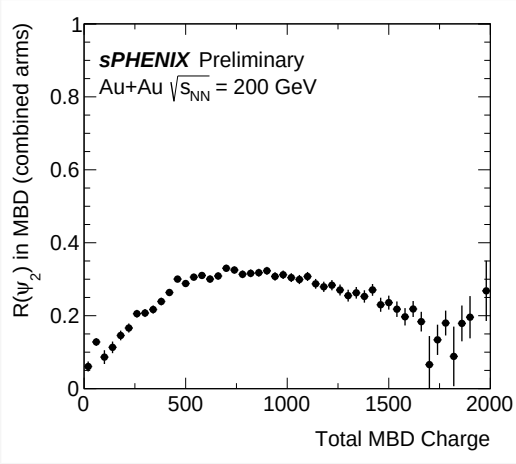
EVENT PLANE MEASUREMENT WITH THE MBD

★ New data



MBD N-S Ψ_2 correlation

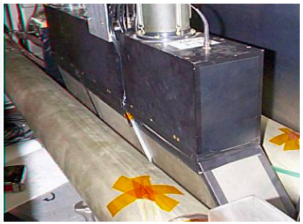
★ New data

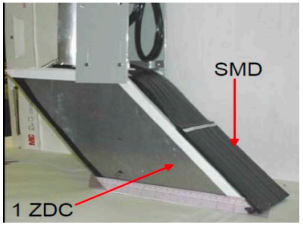


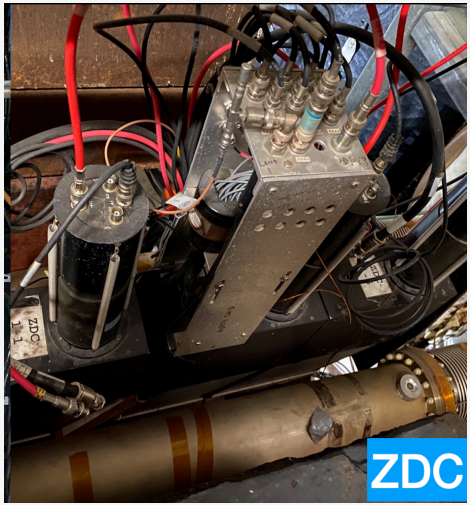
MBD Ψ_2 resolution

sPHENIX ZDC AND SMD

- **ZDC:** 2 arms with 3 tungsten-fiber modules, 1 PMT per module; measures spectator neutrons. 18m from interaction point
- **SMD:** 2 layers of plastic scintillator strips. Provides (x,y) position for where the neutrons hit

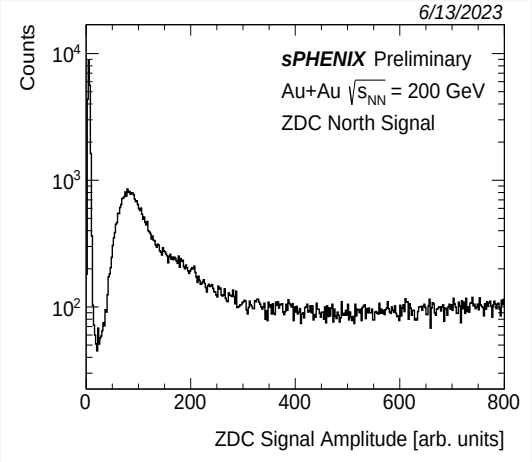






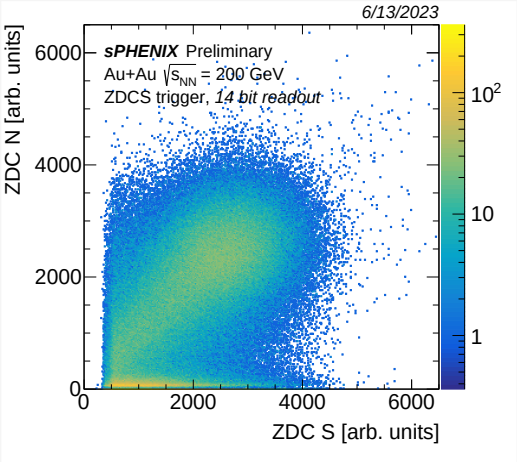
MEASUREMENTS WITH THE ZDC

★ New data



ZDC single neutron peak

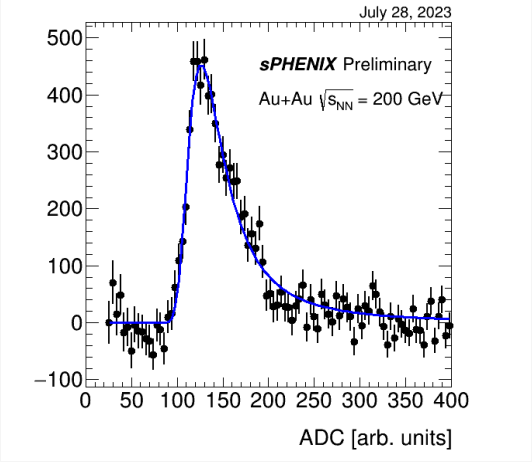
★ New data



ZDC north-south signal correlation

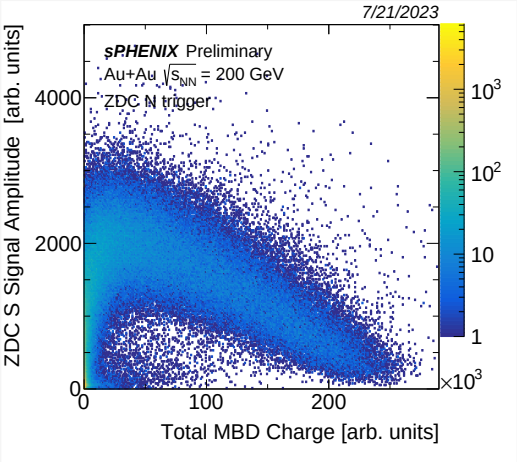
MEASUREMENTS WITH THE ZDC AND MBD

★ New data



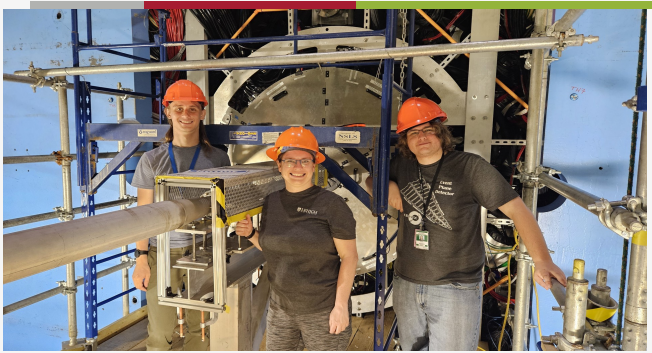
MBD single channel MIP with Landau fit

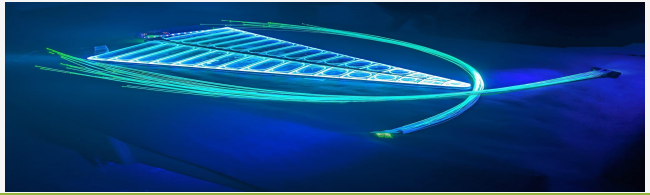
★ New data

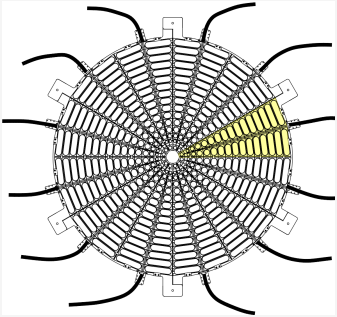


ZDC-MBD correlation

sPHENIX EVENT PLANE DETECTOR



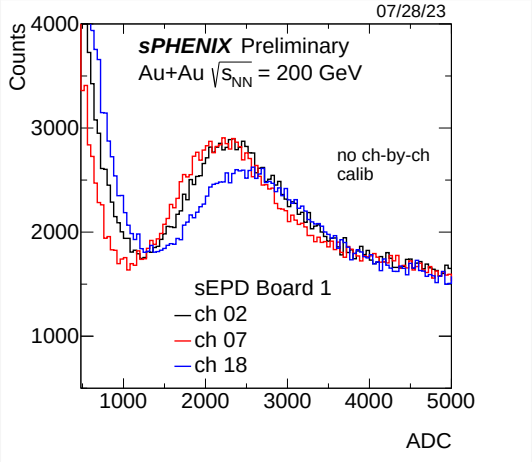




- 2 wheels of 12 sectors, 744 channels
- 1.2cm thick plastic scintillators with embedded WLS fibers
- Covers $2.0 < |\eta| < 4.9$

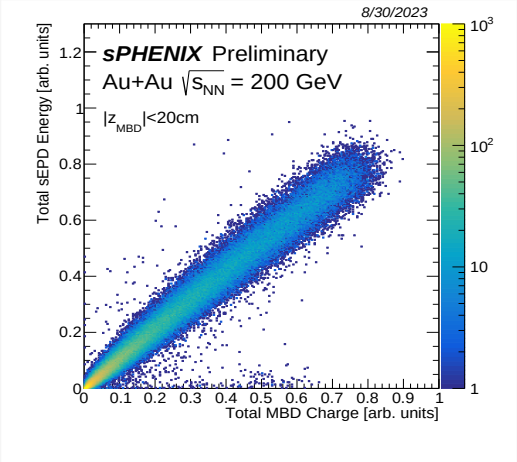
MEASUREMENTS WITH THE sEPD

★ New data



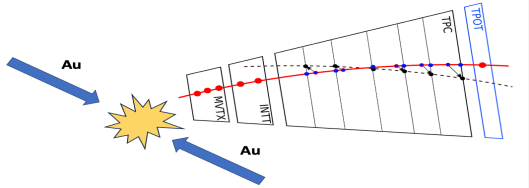
sEPD MIP distribution in 3 channels

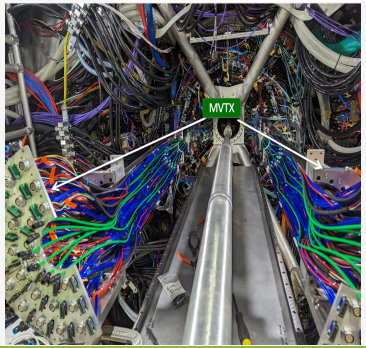
★ New data

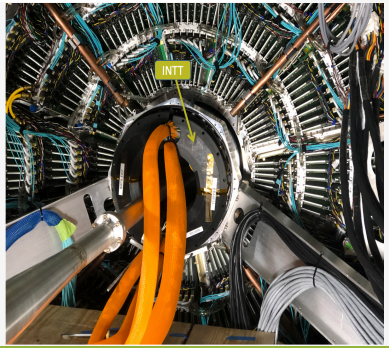


sEPD-MBD correlation

sPHENIX TRACKING DETECTORS

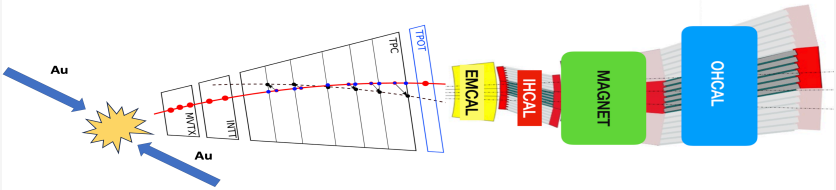




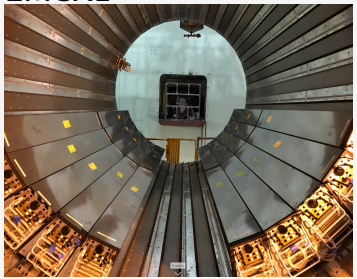


- **MVTX:** 3 layers of Monolithic Active Pixel sensors based on ALICE ITS-II. Spatial resolution of 5 μm
  - **Provides vertexing**; essential for heavy flavor flow: D^0 v_1, D^0 v_2, $b$jet v_2
- **INTT:** Intermediate silicon strip tracker surrounding the MVTX. Associates fully reconstructed tracks with the event that produced them
  - **Provides timing** (100ns resolution); measurement for: $dN_{ch}/d\eta$

sPHENIX CALORIMETERS



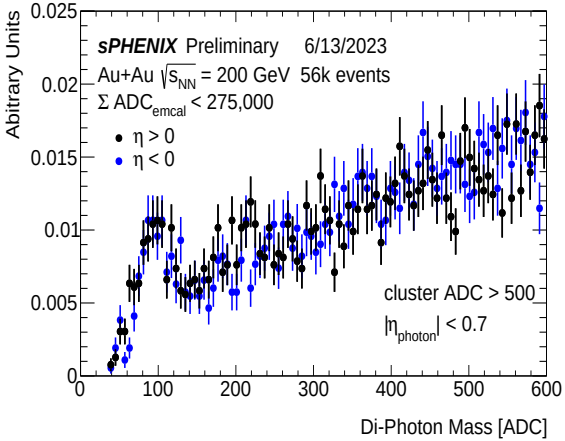
EMCAL



- **EMCAL**: scintillating fibers in tungsten and epoxy. Tower seg.: $\Delta\phi \times \Delta\eta \approx 0.025 \times 0.025$
- **Hadronic calorimeters**: plastic scintillating tiles plus tilted steel (oHCAL) / Al (iHCAL) plates with embedded WLS fibers. Seg.: $\Delta\phi \times \Delta\eta \approx 0.1 \times 0.1$
- **bulk measurements:** $dE_T/d\eta$, π^0 v_2, jet v_n

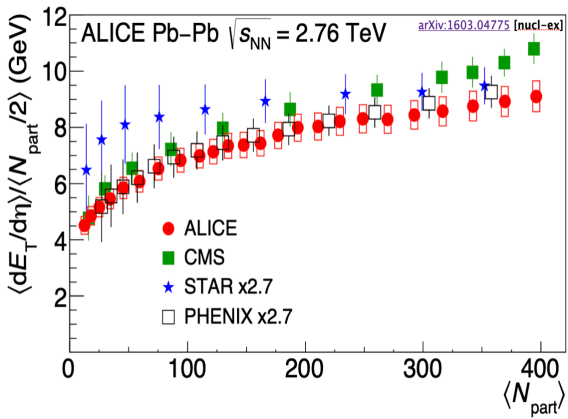
MEASUREMENTS WITH THE CALORIMETERS

★ New data



di-photon mass distribution; visible π^0 peak!

Planned measurement with year 1 data

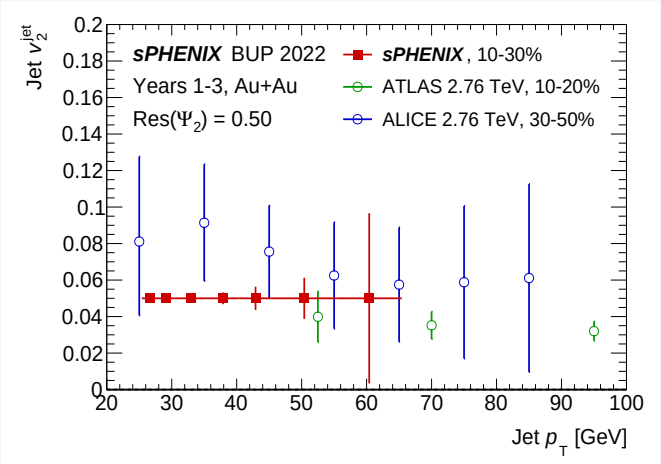


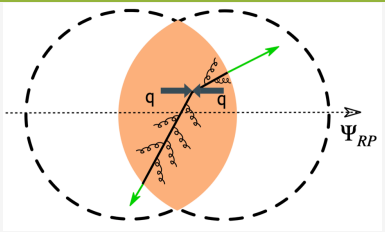
sPHENIX measurement of $dE_T/d\eta$ will resolve the tension in the STAR measurement

A FEW PROJECTIONS FOR SPHENIX BULK PHYSICS MEASUREMENTS

PATH-LENGTH DEPENDENT ENERGY LOSS

Projections for sPHENIX jet v_2

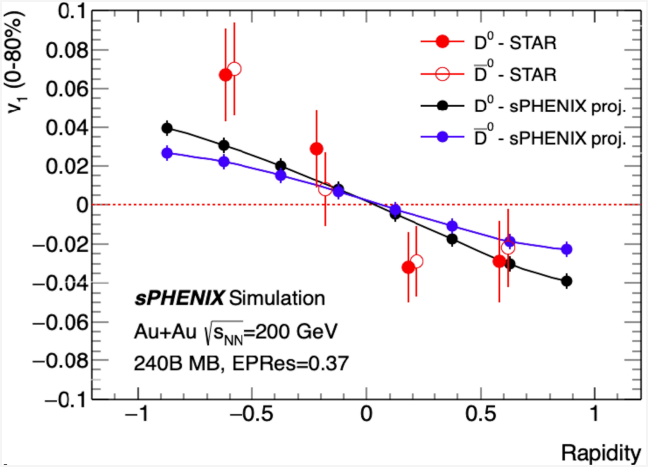




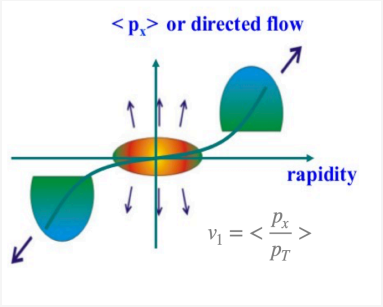
- jet v_n: the angular distributions of jets with respect to the event plane is measured
- directly sensitive to the shape of the QGP
- high precision measurement in sPHENIX enabled by high data-taking rate and high resolution of the sEPD Ψ_2

OPEN CHARM DIRECTED FLOW

Projections for sPHENIX D^0 v_1



PRL 123 (2019) 162310



- initial transient EM field can induce opposite v_1 for c and $\bar{c}$ quarks. Larger effect for charm quarks than light hadrons
- enabled by sPHENIX MVTX (vertexing) and SMD Ψ_1

SUMMARY AND OUTLOOK

- All detectors fully commissioned with collision data except sEPD, SMD, TPC, and MVTX due to the premature end of the run on August 1, 2023
- Plans for new physics run as early as January 2024
- Active analysis of collected commissioning data ongoing
- Looking forward to sPHENIX first bulk physics measurements!

Thank you!