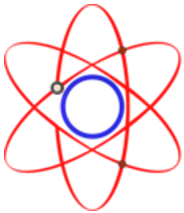

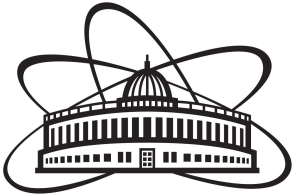

Supported in part by

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Nuclear modification factor of inclusive charged particles in Au+Au collisions at $\sqrt{s_{NN}} = 27$ GeV with the STAR experiment.

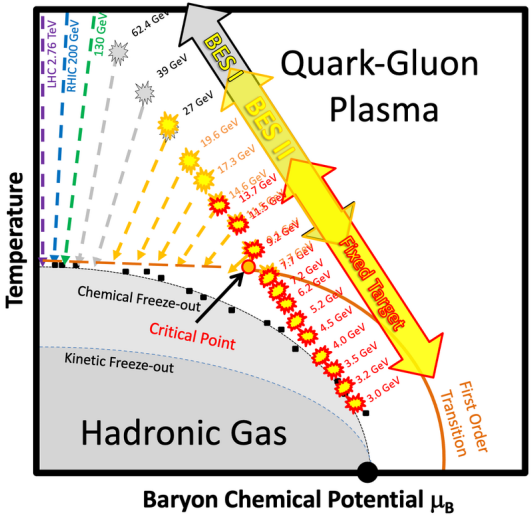
Alisher Aitbayev[1,2] (for the STAR collaboration)

[1]Joint Institute for Nuclear Research, Dubna - Russia,

[2]The Institute of Nuclear Physics, Almaty - Kazakhstan

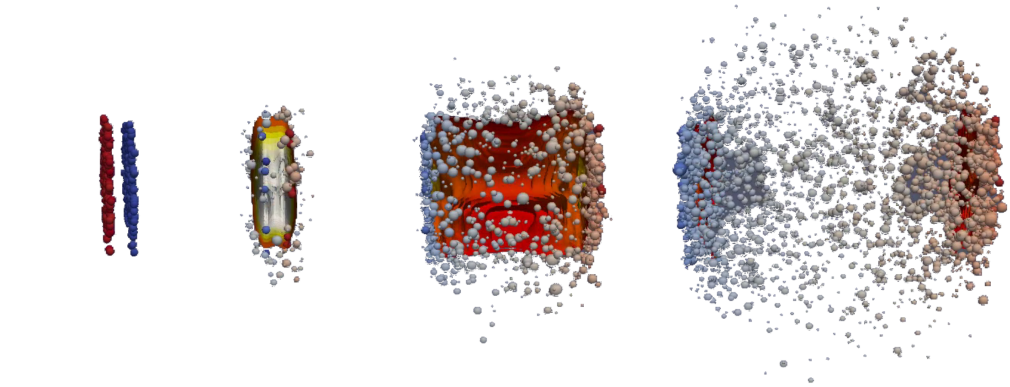
June 7, 2025

Phases of QCD Matter



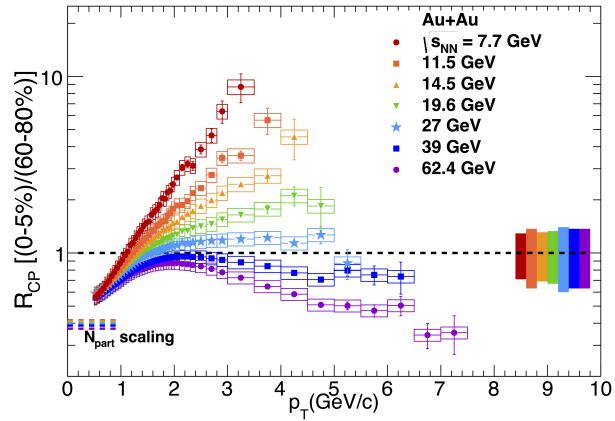
- **QCD Phase Diagram**
  - Cross-over transition expected at low baryon chemical potential (μ_β)
  - First-order transition expected at high μ_B
  - Critical point is the end point of the first order phase transition
- **Beam Energy Scan (BES)**
  - Explore the QCD matter by colliding gold ions at different energies - and search for the potential QCD critical point
  - Seeking to map onset of deconfinement, and the predicted QCD critical point

Heavy Ion Collisions



Different stages of relativistic heavy ion collision. From left to right: (1) two Lorentz contracted nuclei right before the collision, (2) formation of dense, hydro dynamically expanding matter at around 1-2 fm/c after the collision, (3) hydrodynamic expansion of the dense core, surrounded by hadronic corona (the particles on the plot represent individual hadrons), (4) final state hadronic interactions and decoupling of the fireball. (Image from an animation by MADAI)

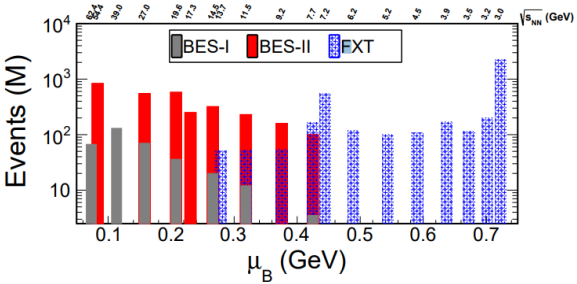
Motivation



Dependence of the nuclear modification factor on the transverse momentum of produced particles (BES-I)

J.Adams (STAR Collaboration), Phys. Rev. Lett., 121 (2018) n.3, 032301

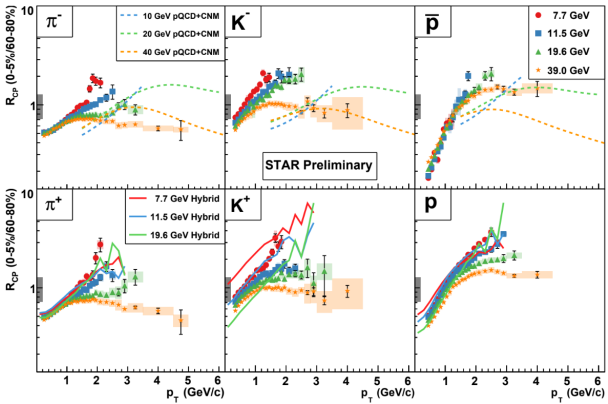
Comparison of statistics between *BES-I* (2010-2017) and *BES-II* (2019-2021)



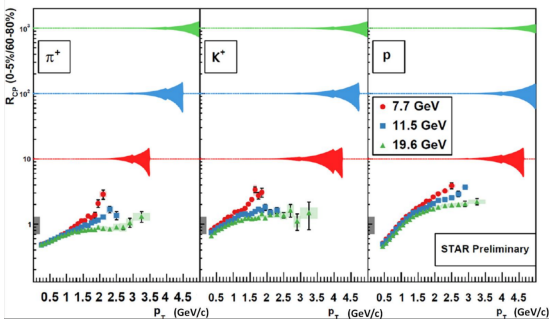
- Nuclear modification factor:

$$R_{CP} = \frac{\langle N_{coll} \rangle_{Peripheral}}{\langle N_{coll} \rangle_{Central}} \frac{\left(\frac{d^2N}{dp_T d\eta} \right)_{Central}}{\left(\frac{d^2N}{dp_T d\eta} \right)_{Peripheral}}$$

R_{CP} of identified hadrons up to $p_T = 5 GeV/c$

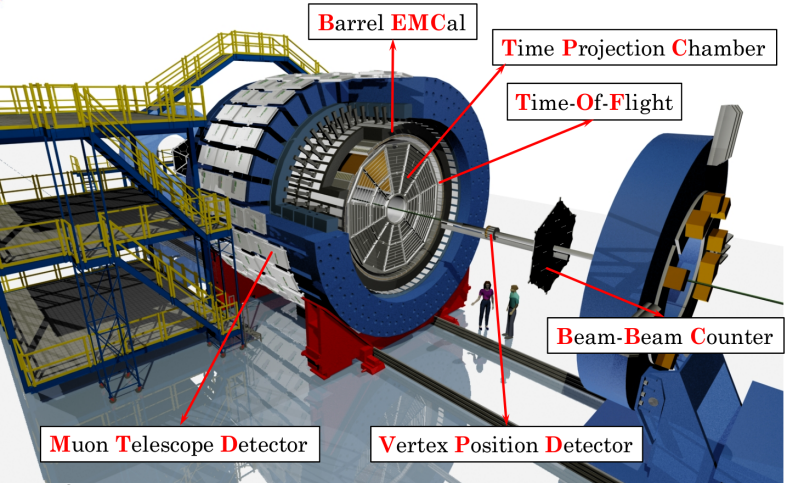


Studying $R_{CP}(p_T)$ shape quantifies jet-quenching evolution at lower beam energies.



Although the BES-I RCP results hint at the disappearance of the QGP signature, their certainty remains limited due to the constraints of 3-4 GeV/c for inclusive hadrons and 2-3 GeV/c for identified hadrons. The anticipated extension of pT capabilities in BES-II holds paramount importance in establishing unequivocal determinations regarding QGP formation at distinct collision energies.

Solenoidal Tracker at RHIC (STAR)



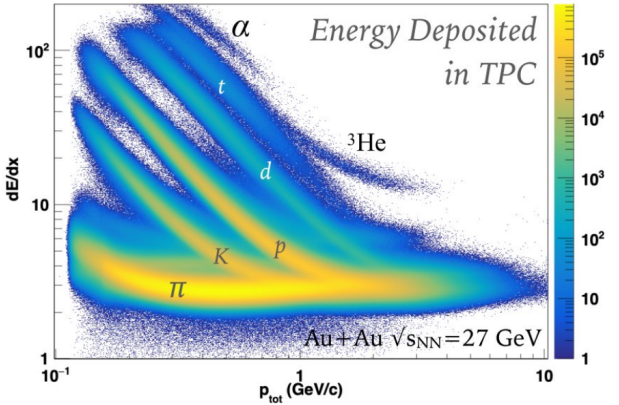
STAR detector and its various detector subsystems

- **Time Projection Chamber (TPC)**
  Measures charged particle momentum with track curvature under B-field.
  Identifies particle with energy loss per unit length (dE/dx).
  TPC: $|\eta| < 1$
- **Time of Flight (TOF)**
  Extends momentum range for particle identification.
  Pile-up rejection.
  TOF: $|\eta| < 1$
- **Detector Modernization (2018+)**
  EPD: $2.1 < |\eta| < 5.1$
  iTPC: $|\eta| < 1.5$
  eTOF (2019+): $-1.6 < \eta < -1$

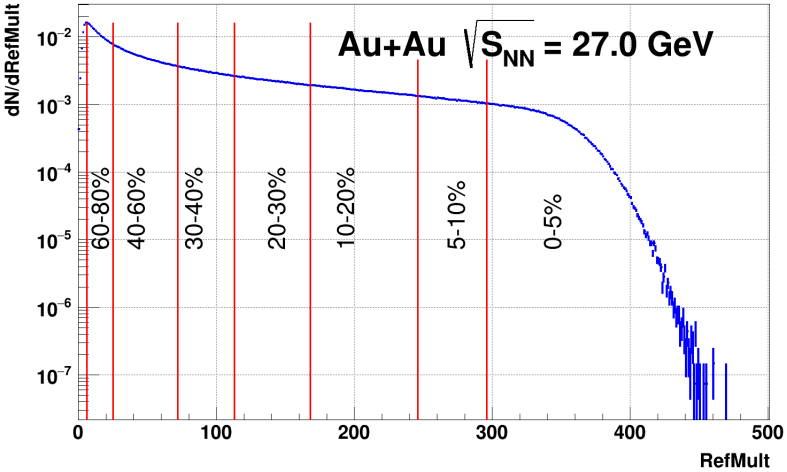
Data sets for 27 GeV

Data set:

- System: Au + Au @ 27GeV (BES-II)
- Data were collected in 2018

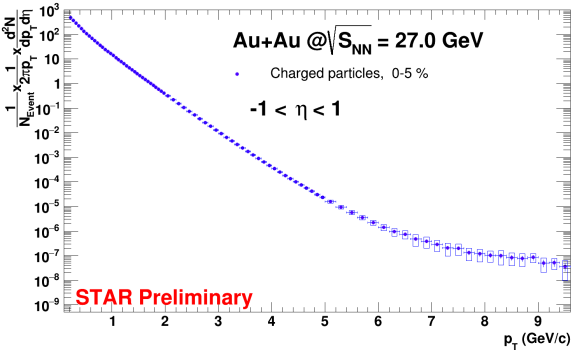


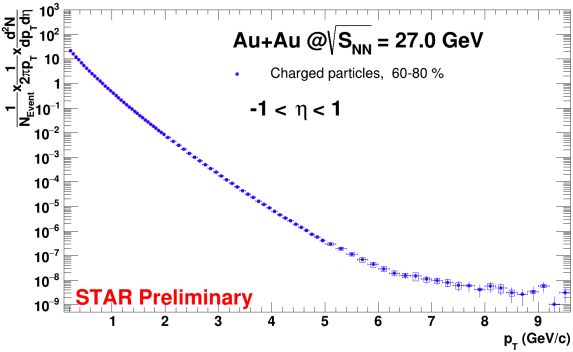
Centrality definition



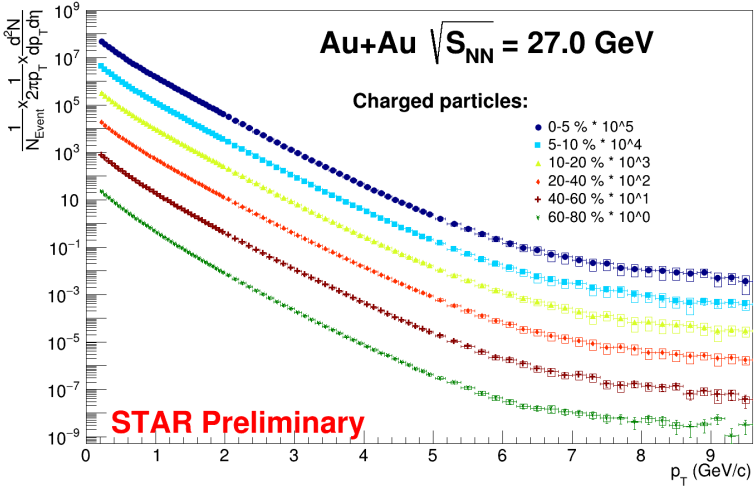
- exclude Bad Run
- define centrality
- define weight

Spectra for central and peripheral centrality classes

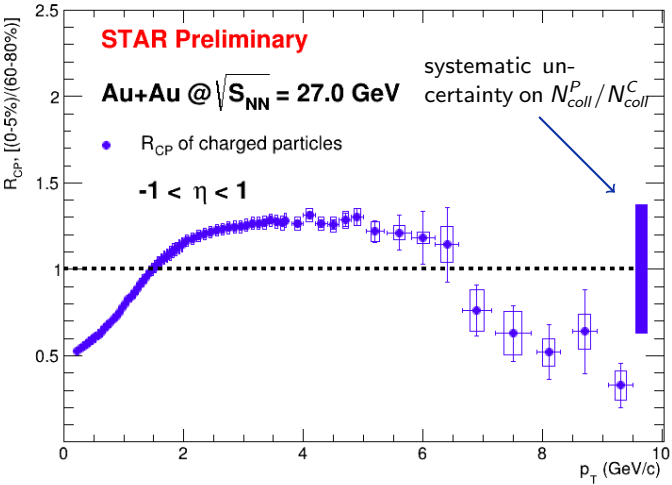




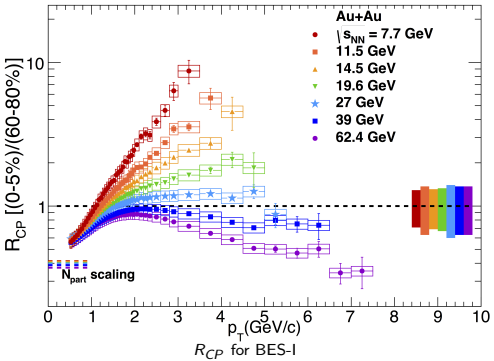
Spectra for centrality classes



Nuclear modification factor for 27 GeV

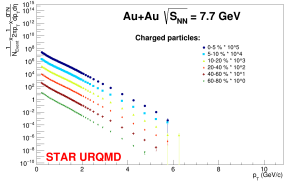


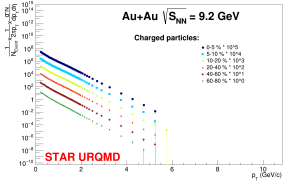
$$R_{CP} = \frac{\langle N_{coll} \rangle_{Peripheral}}{\langle N_{coll} \rangle_{Central}} \frac{Spectra_{0-5\%}}{Spectra_{60-80\%}}$$

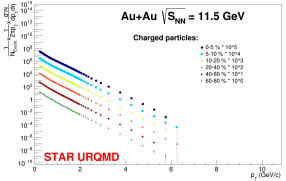


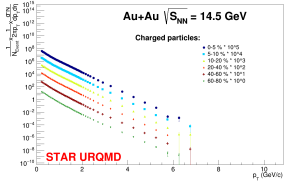
R_{CP} for BES-I

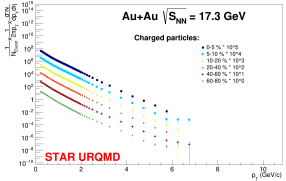
Spectra in URQMD model

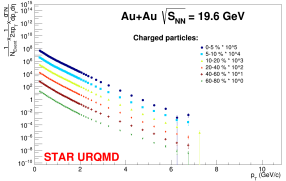




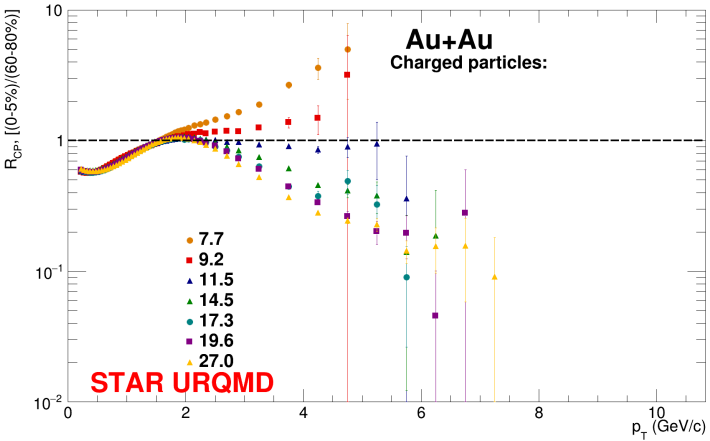


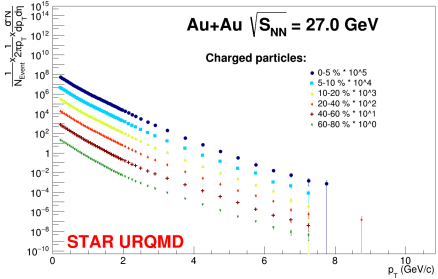






Nuclear modification factor in URQMD model





Conclusion

- Calculated nuclear modification factor at $\sqrt{S_{NN}} = 27 GeV$ under Beam Energy Scan II.
- Compared to results from the BES-I program, significant extension to the high p_T is achieved. This advancement facilitated a more precise depiction of the behavior of the nuclear modification factor.
- Notably, an increase in transverse momentum corresponds to the suppression of particles.

Thank you!