Dynamical modeling of particle production and baryon distribution in heavy-ion collisions from GeV to TeV

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C. Shen and B. Schenke, arXiv:2203.04685 [nucl-th]

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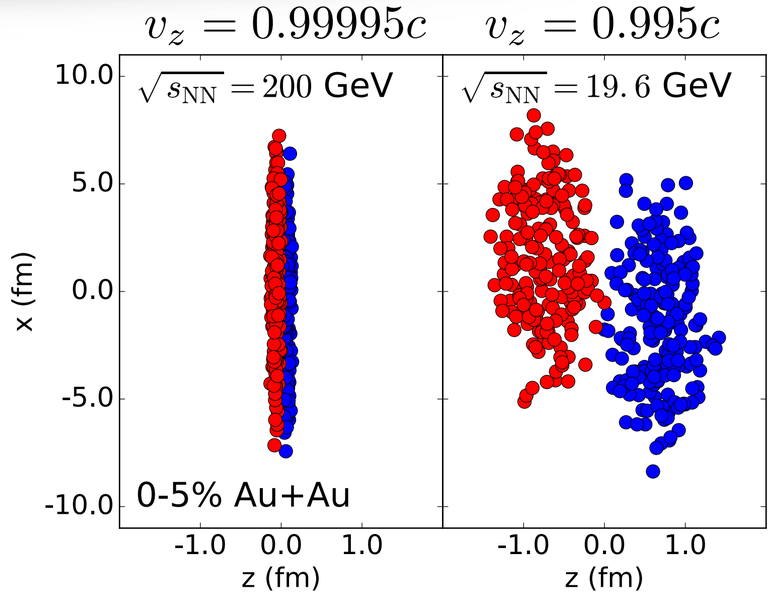
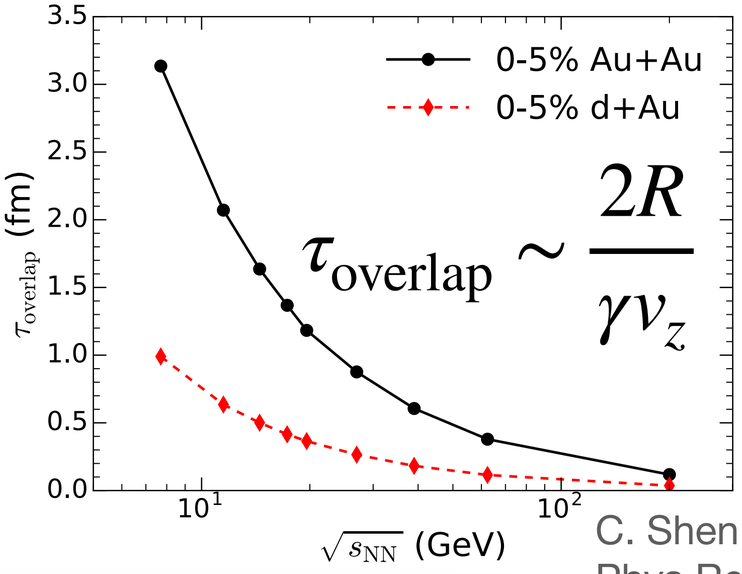
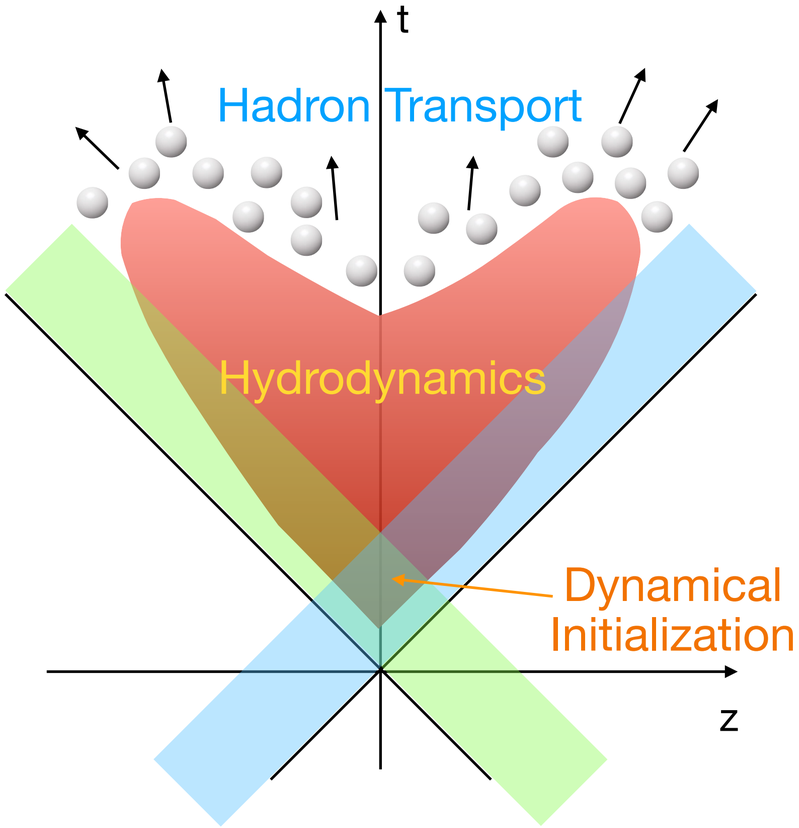
(3+1)D modeling of relativistic nuclear collisions





C. Shen and B. Schenke, Phys.Rev. C97 (2018) 024907

C. Shen and L. Yan, Nucl. Sci. Tech. 31, no.12, 122



- Heavy-ion collisions with various collision energy probe nuclear matter properties in a wide (T, μ_B) region
- Heavy-ion collisions with $\sqrt{s} \sim \mathcal{O}(10)$ GeV have significant nucleus overlapping time $\tau_{\rm overlap}$
- 3D Dynamical initialization of hydrodynamic evolution plays an important role in modeling the dynamics of relativistic nuclear collisions

3D MC-Glauber model with string deceleration

- Transverse collision geometry is determined by MC-Glauber model
- 3 valence quarks are sampled from PDF with

$$\sum_i x_i \leq 1$$

- Incoming quarks are decelerated with a string tension σ,

$$dp^z/dt = -\sigma$$

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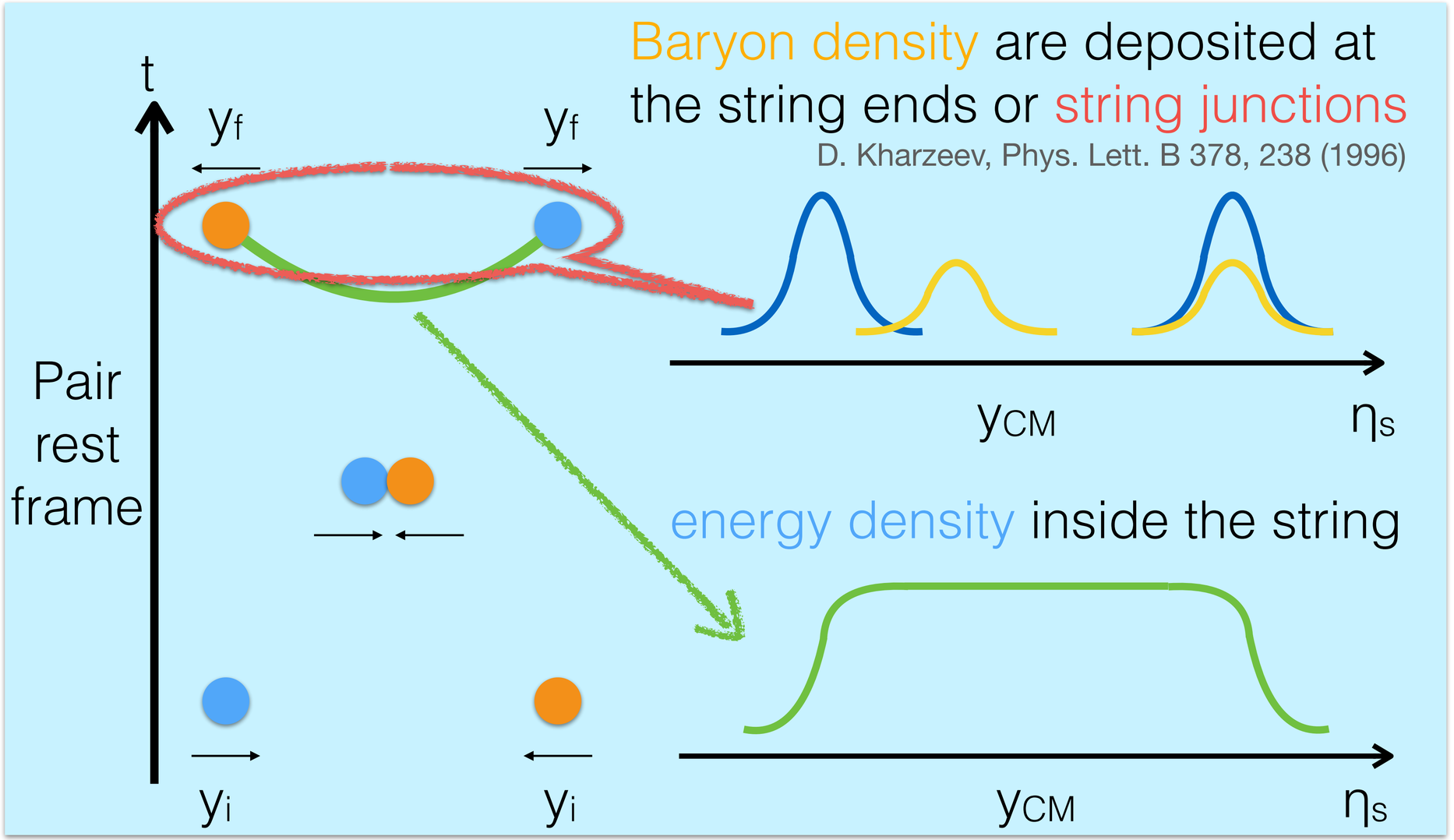

Imposed conservation for energy, momentum, and net baryon density

Particle production in pp collisions

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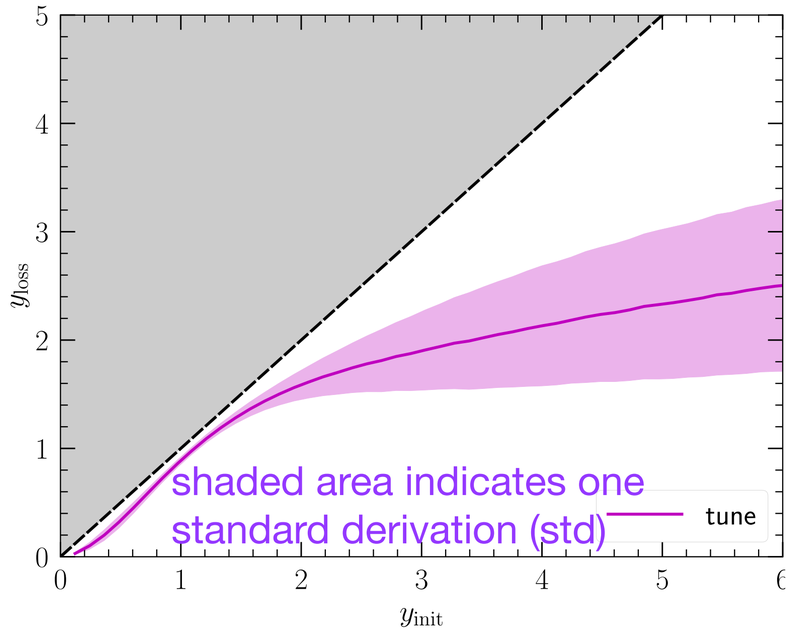
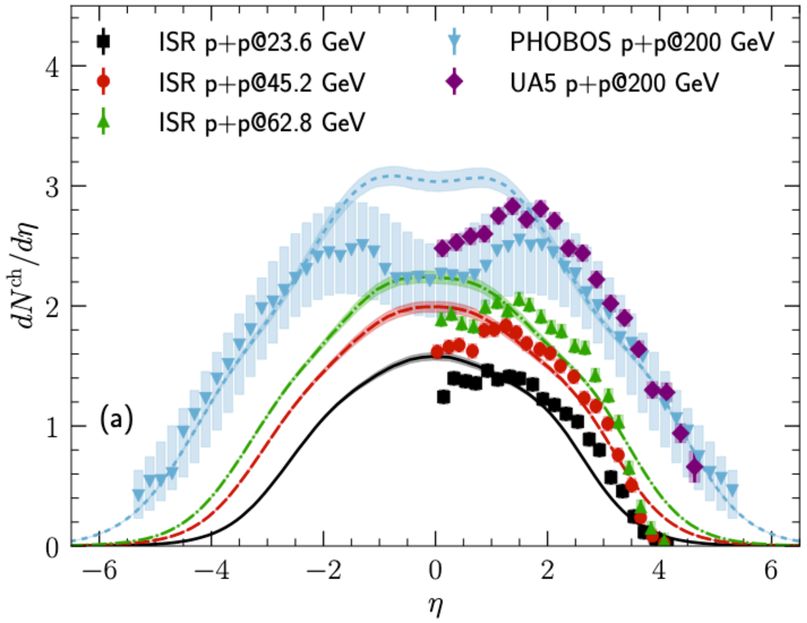
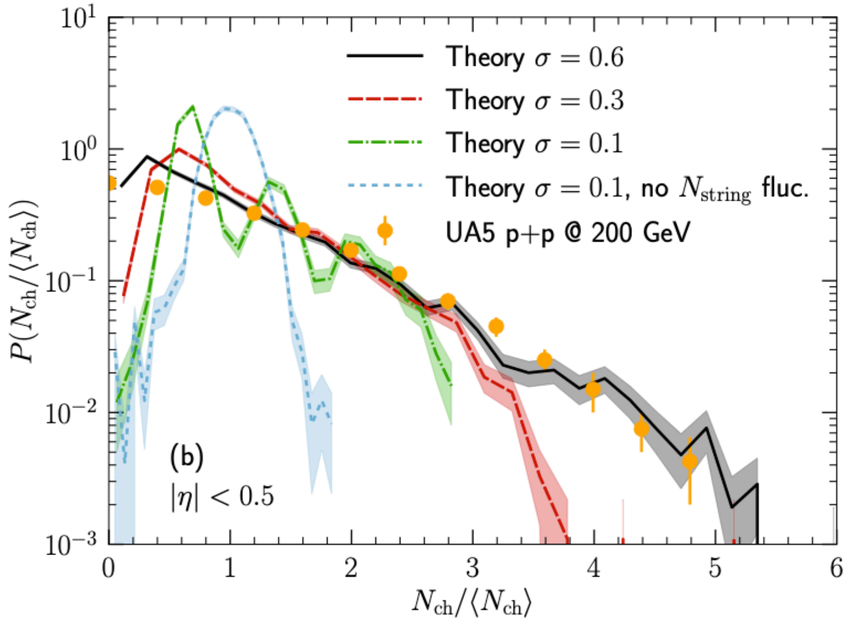






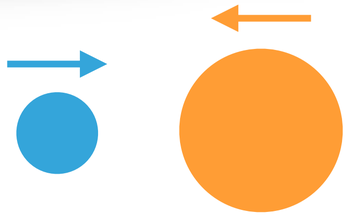
Rapidity loss parameterization

$$\langle y_{\rm loss}\rangle = A y_{\rm init}^{\alpha_2}[\tanh(y_{\rm init})]^{\alpha_1-\alpha_2}$$

- A: the slope
- At small y: $\langle y_{\rm loss}\rangle \propto y_{\rm init}^{\alpha_1}$
- At large y: $\langle y_{\rm loss}\rangle \propto y_{\rm init}^{\alpha_2}$
- Std of $y_{\rm loss}$ fluctuations: σ_y ($y_{\rm loss} \in [0, y_{\rm init}]$)

- Calibrate parton's rapidity loss with charged particle pseudo-rapidity distribution in minimum bias p+p collisions [1-3]
- Rapidity loss fluctuations are essential to reproduce the p+p multiplicity distribution [4]

Extend the 3D description to asymmetric systems



- Our model reasonably predicts the asymmetric charged hadron rapidity distributions in light-heavy nuclear collisions measured by the PHENIX Collaboration [5]
- Centrality dependence of the shapes of $dN^{\mathrm{ch}}/d\eta$ are captured
- Particle productions in central p+Al and ^{3}He+Au are overestimated by 15%

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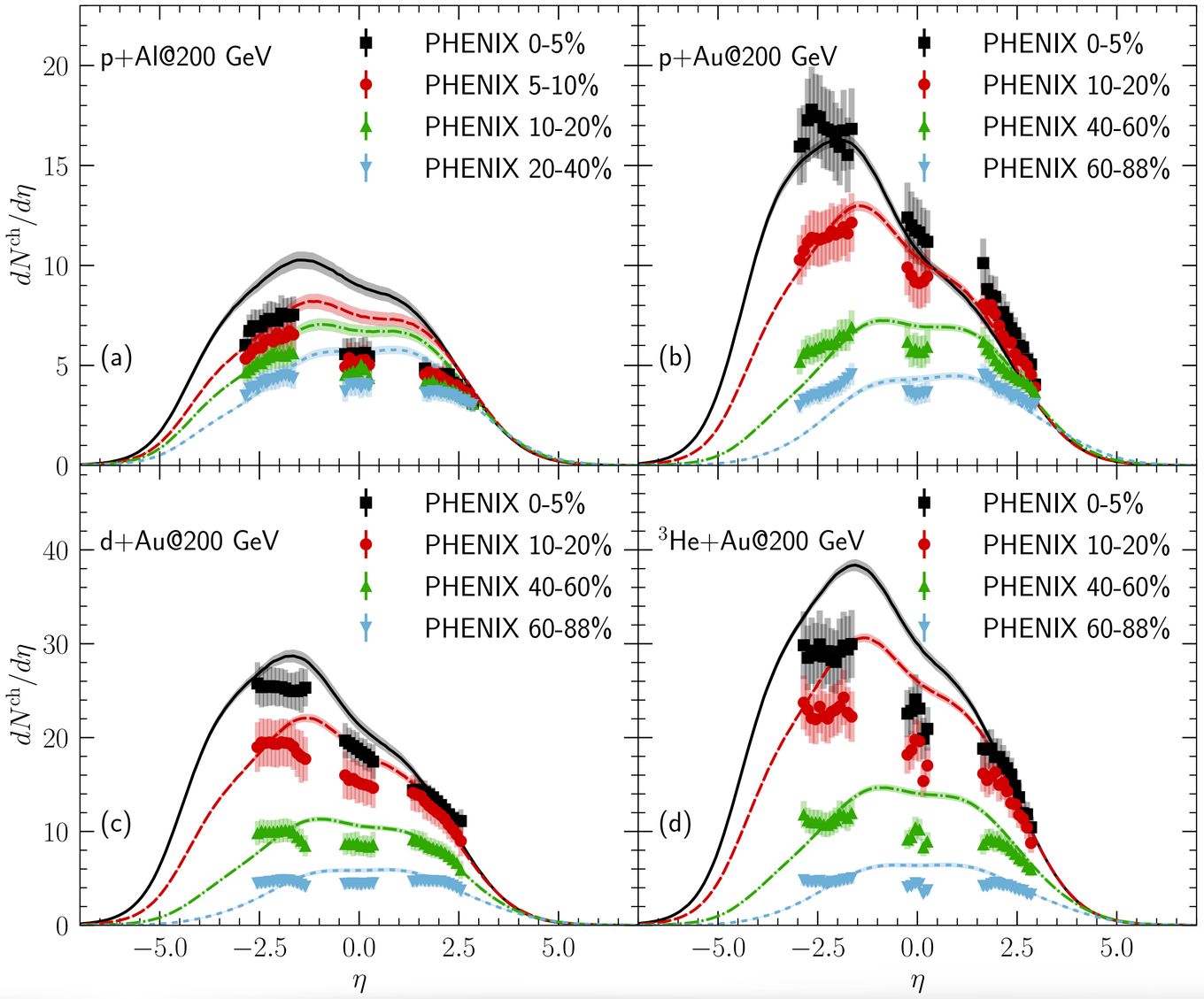
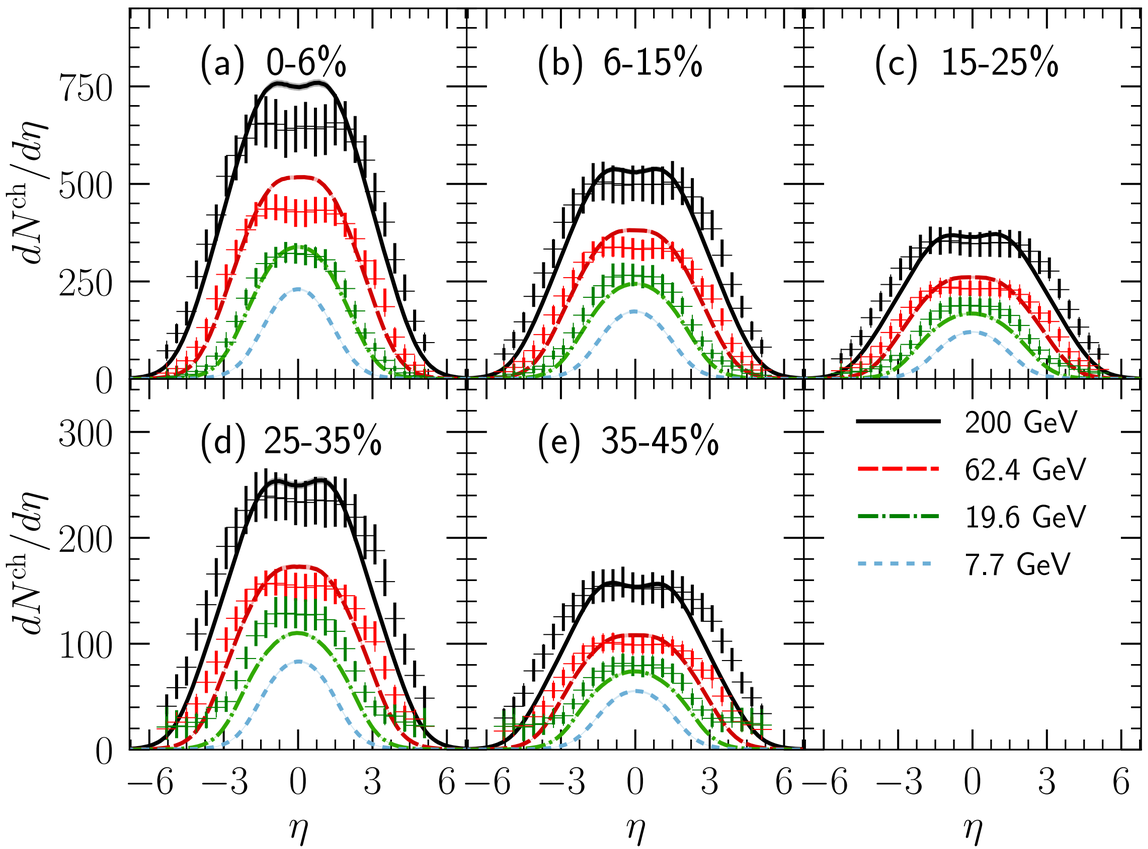
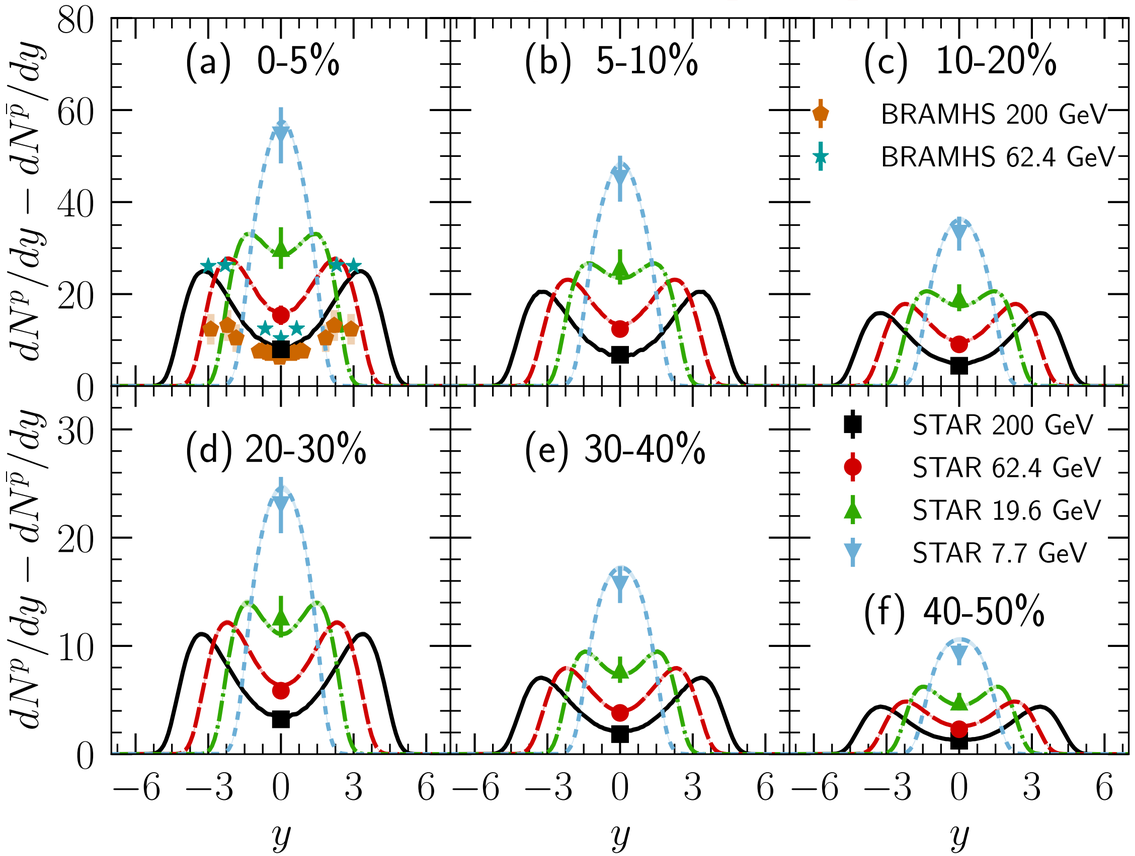


Particle production at RHIC BES

Charged hadrons [6]



Net protons [7-10]



- Model predictions for Au+Au collisions show good descriptions of charged hadron and net proton rapidity distributions vs. data at the RHIC BES energies
- Our model is a unified framework to study the full (3+1)D dynamics of pp, γ^*A, pA, and AA collisions from GeV to TeV

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