Light Nuclei Production in Au+Au Collisions at Fixed Target $\sqrt{s_{NN}}$ = 3 GeV from STAR

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Abstract

Light nuclei, such as deuteron and triton, are loosely bound objects. Their yields are expected to be sensitive to the baryon density fluctuations and can be used to probe the signature of the first order phase transition and/or a critical point in heavy-ion collisions. In this poster, we present the first measurements of particles(p, d, t, ^3He, ^4He) production in Au + Au collisions at $\sqrt{s_{NN}}$ = 3 GeV by the STAR experiment. Compared with STAR Beam Energy Scan I, we find the kinematic dynamics at 3 GeV is completely different with that in high energy collisions, indicating a different medium equation of state.

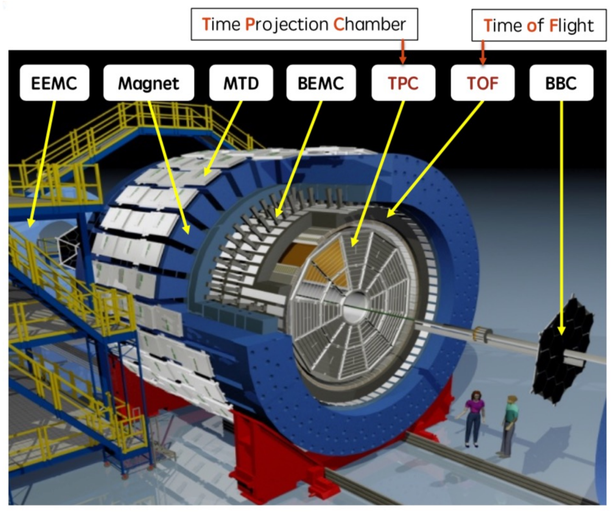
Introduction

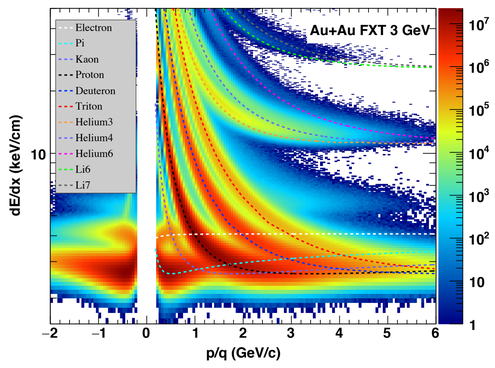
- Phase Transition
  - High Temperature: QGP properties
  - High Baryon Density: Critical Point and 1st order phase boundary
- Light nuclei, such as deuteron and triton, are loosely bounded objects with small binding energies (d with 2.2 MeV and t with 8.4 MeV). Those are formed via coalescence of nucleons[1][2]

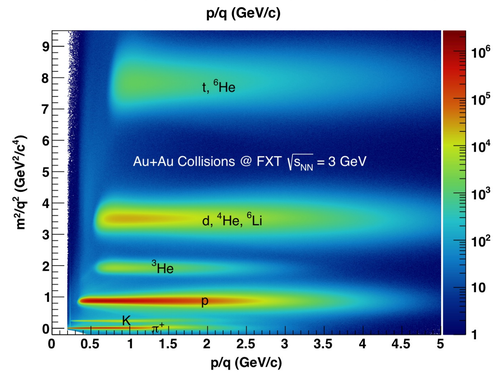
$$E_A \frac{d^3N_A}{d^3p_A} = B_A\left(E_p \frac{d^3N_p}{d^3p_p}\right)^Z \left(E_n \frac{d^3N_n}{d^3p_n}\right)^{A-Z} \approx B_A\left(E_{p,n} \frac{d^3N_{p,n}}{d^3p_{p,n}}\right)^A \Big|_{\vec{p}_p=\vec{p}_n=\frac{\vec{p}_A}{A}}$$

- Collective motion leads to predictable behavior of the shape of the momentum spectra as a function of particle mass[3]

STAR Detector & Particle Identification

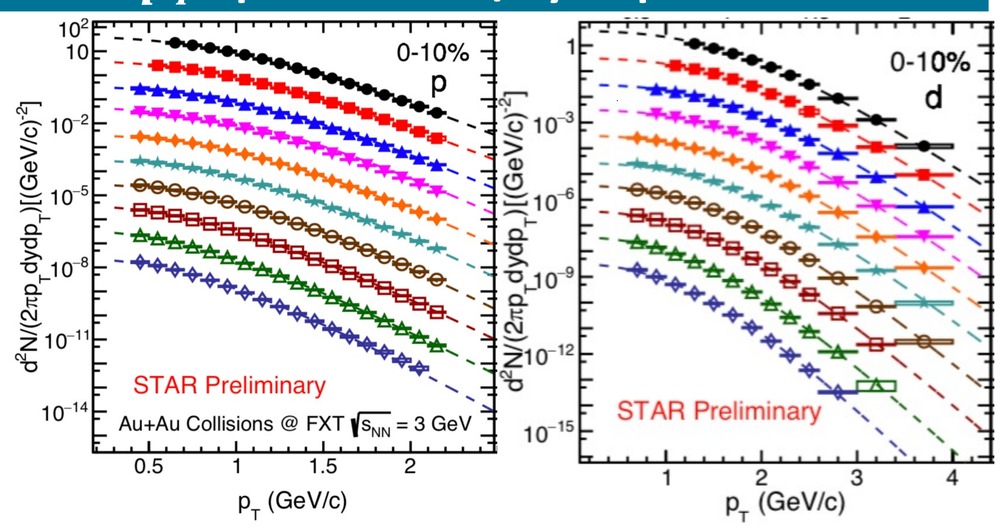


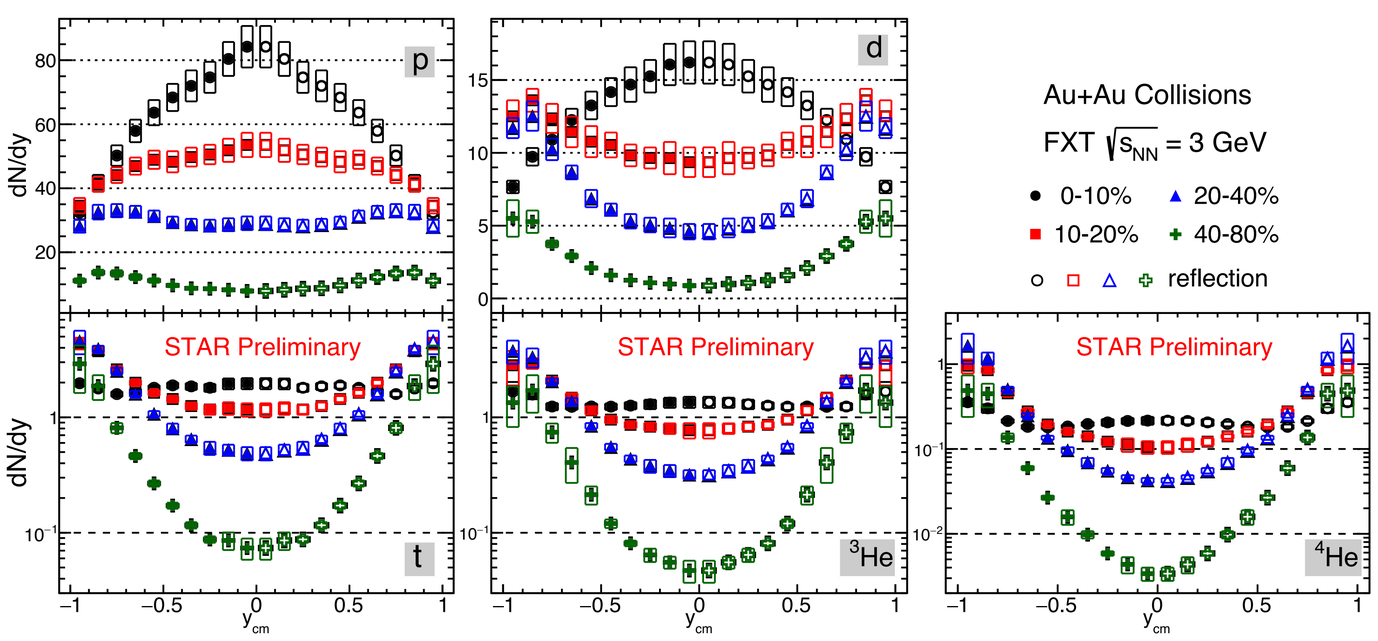




- TPC: Ionization energy loss dE/dx of charged particles
- ToF: m^2 of charged particles

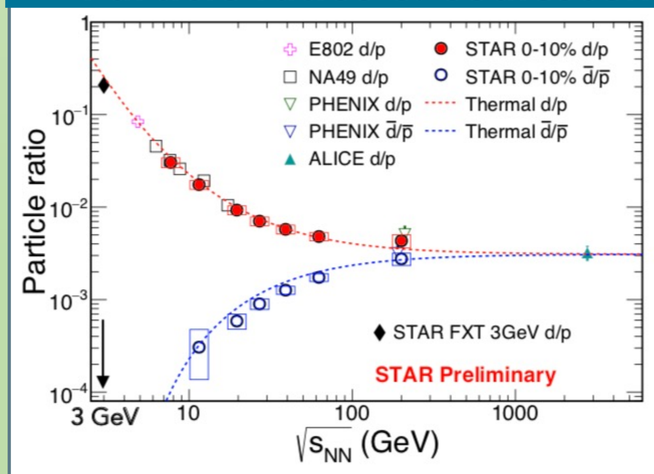
p_T Spectra & dN/dy of particles

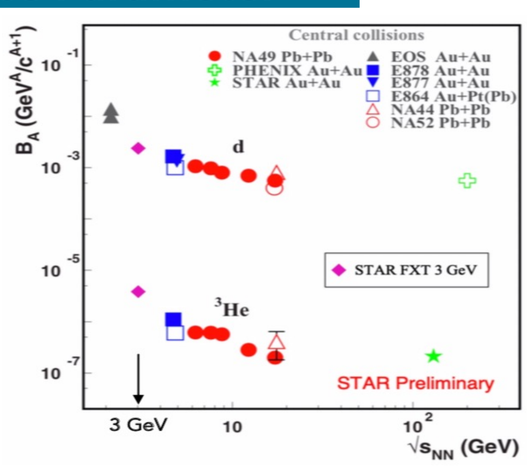




- Particle(p, d) spectra at different rapidity windows are scaled by different factors
- dN/dy of particles as a function of rapidity; Measurements are plotted by solid symbols and open points show reflections of measurements around midrapidity; shows strong rapidity and centrality dependence

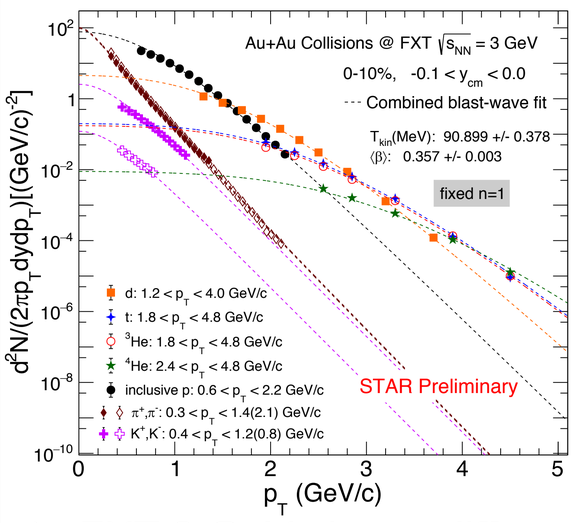
Particle ratios & Coalescence Parameter

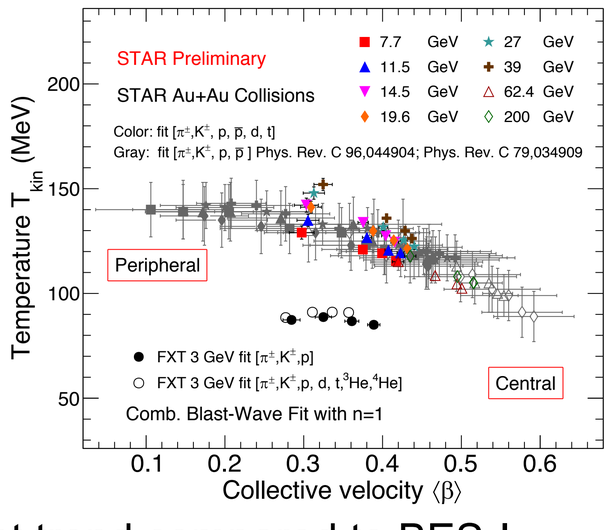




- d/p ratio follows the energy dependence and can be described by statistical thermal model
- Coalescence Parameters ($B_2$of deuteron and $B_3$of ^3He) follows the world trend, and shows energy dependence

Combined Blast-Wave fit and Collective Motion





- FXT 3 GeV shows different trend compared to BES-I Au+Au collisions, indicating a different medium equation of state (EoS) at 3 GeV

Summary & References

- We report the first measurement of light nuclei (d, t, ^3He and ^4He) production in Au + Au collisions at FXT $\sqrt{s_{NN}}$ = 3 GeV from the STAR experiment
- The kinematic dynamics at FXT 3 GeV is completely different with that in high energy collisions, indicating a different medium equation of state (EoS) at 3 GeV

[1] LászlóP. Csernai, et al, 1986 Phys. Reps. 131, 223
[2] J. Adam et al. [STAR Collaboration], 2019 Phys. Rev. C 99, 064905
[3] J. Adams et al. [STAR Collaboration], Nucl. Phys. A 757 (2005) 102-183

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The STAR Collaboration
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