Thermal dielectron production in Au+Au collisions at $\sqrt{s_{NN}}$ = 17.3 GeV at STAR

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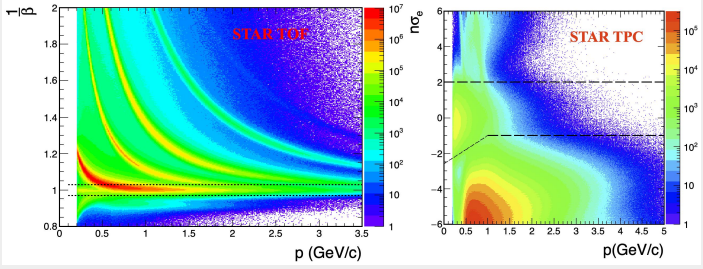
Abstract

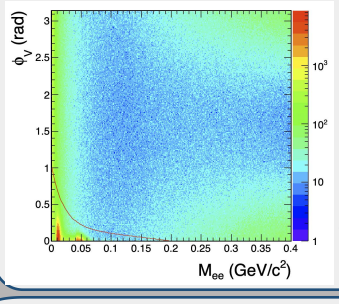
Dielectrons are an ideal probe for understanding the properties of the QGP and its evolution. By measuring the invariant mass distribution of thermal dielectrons, it is possible to extract the average temperature of the hot QCD medium at different stages of the evolution. We present new measurements of the dielectron raw mass spectra in Au+Au collisions at $\sqrt{s_{NN}}$ = 17.3 GeV with the STAR experiment.

Introduction

- EM probes: Produced throughout system evolution, are not coupled to strong interaction.
- Dileptons carry stage-specific information across mass ranges:
  - Intermediate Mass Range (IMR: 1 < M_{ee} < 3 GeV/c^2):
    - ✓ QGP thermal radiation: $q\bar{q} \rightarrow e^+e^-$
    - ✓ Semi-leptonic decay of charm and bottom hadrons
  - Low Mass Range (LMR: M_{ee} < 1 GeV/c^2):
    - ✓ In-medium decay of vector mesons
    - ✓ Dalitz decay of long-lived hadrons
- Thermometer: extract temperature from mass spectra (in-medium ρ and QGP thermal radiation). [1-2]
- Chronometer: estimate lifetime from integrated yield.
- The Beam Energy Scan program provides an opportunity to study energy dependence.

Electron Identification



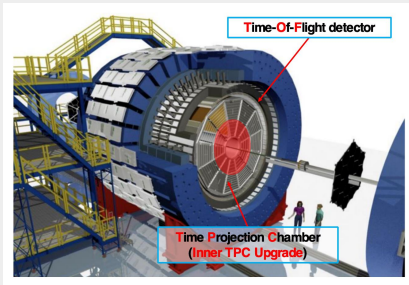


Combine TPC and TOF to identify electrons

- $|1 - 1/\beta| < 0.03$
- $\begin{cases} n\sigma_e < 2 \\ n\sigma_e > -2.6 + 1.6 \times p, p < 1 \\ n\sigma_e > -1, p \geq 1 \end{cases}$
- $n\sigma_e = \frac{1}{R} ln \frac{\langle dE/dx \rangle^{measured}}{\langle dE/dx \rangle_e^{Bichsel}}$

Photon conversion electrons are tagged and removed using the ϕ_v cut method. [3]

STAR detector and Dataset



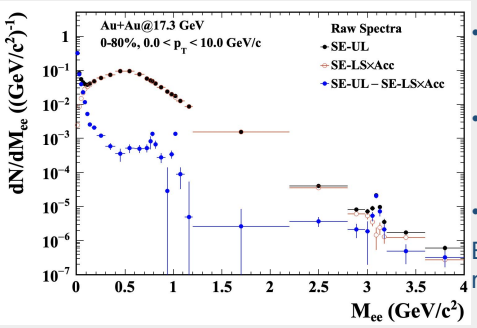
2021 Au+Au collisions
$\sqrt{s_{NN}}$ = 17.3 GeV
Minimum-bias trigger

TPC:
momentum, pathlength, dE/dx.

TOF:
time of flight (time resolution ~ 75 ps).

Inner TPC Upgrade (2019+):
Enhances momentum resolution and dE/dx measurement.

Raw mass spectra



- SE-UL: e^+e^- pairs from same event.
- SE-LS: e^+e^+ or e^-e^- pairs from same event.
- $Acc = \frac{B_{+-}}{2\sqrt{B_{++}B_{--}}}$, B is the pairs from mixed-event

- Like-sign technique: Accounts for combinatorial and correlated backgrounds.
- Mixed-event technique: Estimates the acceptance correction for like-sign pairs.

Summary and Outlook

- Raw mass spectra are reconstructed in Au+Au collisions at 17.3 GeV at STAR.
- Physical background (cocktail) analysis is ongoing to extract interested signals.

Reference

[1] R. Rapp, Nat. Phys. 15, 990–991 (2019)
[2] HADES, Nat. Phys. 15, 1040–1045 (2019)
[3] PHENIX, Phys. Rev. C 81, 034911 (2010).

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