Thermal dielectron measurement in Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7 GeV with the STAR experiment

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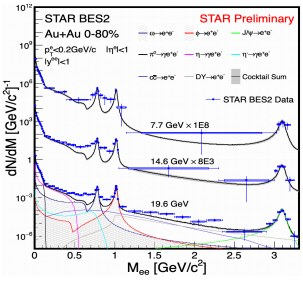
Abstract

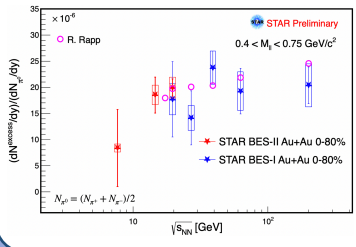
Due to the minimal interactions with the hot and dense QCD matter created in relativistic heavy-ion collisions, thermal dileptons emitted throughout the medium evolution are suggested as an excellent probe to study the medium properties. In the dilepton invariant mass range from 400 to 800 MeV/c², the mass distribution is proportional to the in-medium ρ propagator, which is sensitive to medium's properties including total baryon density and temperature. The systematic measurement of in-medium ρ propagators at different collision environments can be used to study the vector meson interactions with the hot and dense QCD medium.

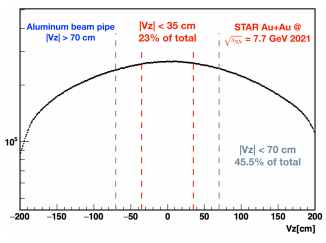
During the Beam Energy Scan Phase-II (BES-II) program, the STAR experiment recorded large datasets in Au+Au collisions at low center-of-mass energies from 3 to 19.6 GeV with detector upgrades. In this poster, we will report the first measurement of the thermal dielectron invariant mass distribution at $\sqrt{s_{NN}}$ = 7.7 GeV. Machine learning techniques are used for suppressing background and increasing signal significance, which is critical for such measurements at low energies.

STAR BES-II Dielectron Measurement

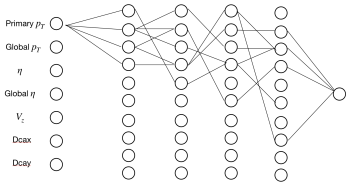


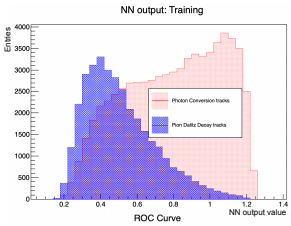
- **First measurement** of dielectron thermal radiation at $\sqrt{s_{NN}}$ = 7.7 GeV.
- Need to **increase statistics** for more robust physics conclusions.
- **Expanding event |Vz| range** as the primary approach.



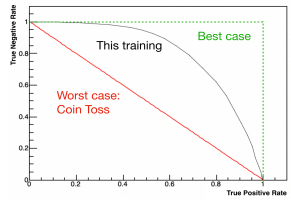


Neural Network



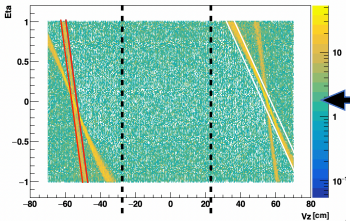


- **Neural Network Structure**:
  - 10×10×10×10 hidden layers.
- **Activation function**: Sigmoid.
- **Loss function**: Mean square error.
- **Input**: training (validation)
  - 68k (10k) photonic $e^{\pm}$ tracks.
  - 34k (10k) pion Dalitz decay $e^{\pm}$ tracks.
- **ROC AUC**: **0.802**.

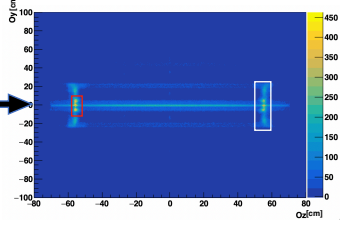


Photonic Electron

Photon conversion simulation in STAR environment



Real data dielectron pair reconstruction

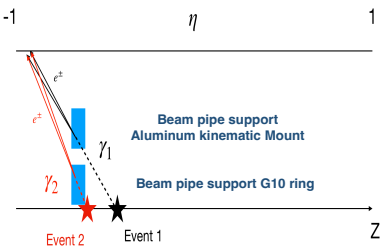


✦ Photonic electron

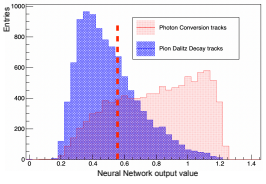
- Why |V_z| < 35cm? *R*educing $e^{\pm}$ from **photon conversion**.
- **Neural network** approach for discriminating photonic electron.

✦ Simulation

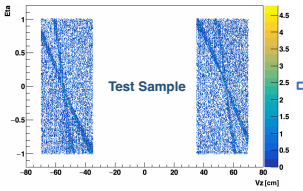
- Major photon conversion source in STAR environment:
  - Beam pipe support **G10 ring (red box)**.
  - Beam pipe support **Aluminium kinematic Mount (white box)**.

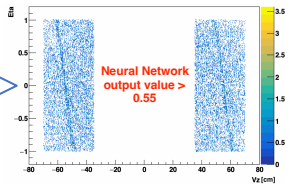


Results and Outlook



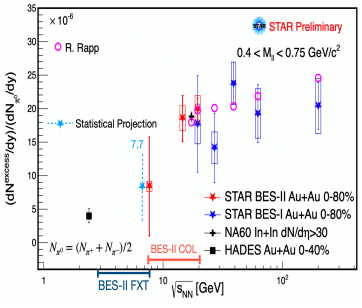
- Photonic $e^{\pm}$ from **Aluminium kinematic Mount** can be efficiently removed.
- Developing neural network approach to discriminate photonic $e^{\pm}$ from **G10** ring efficiently.





✦ Outlook

- Enhanced training performance will be attained with **large statistics** simulation sample.
- Statistical uncertainty of excess yield in thermal dielectron measurements will be reduced > **30%** by expanding |Vz| range to 70cm.
- Utilization of the neural network approach will be crucial to future BES-II **low energy** and **fixed-target** measurement.



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The STAR Collaboration
https://drupal.star.bnl.gov/STAR/presentations