Dimuon Production in Au+Au $\sqrt{s_{NN}}$ = 200 GeV Collisions at STAR

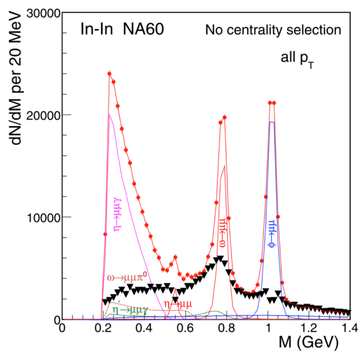
Kefeng Xin (for the STAR Collaboration)

Abstract

Dimuon production, which is sensitive to the early stage of heavy-ion collisions, provides a unique tool to study the Quark-Gluon Plasma. At low invariant mass, the dimuon mass spectrum has the contributions from many mesons, such as η, ω, η′. At the same time, the background from γ conversion is largely suppressed compared to the background from dielectron measurement. With the Time Projection Chamber and the Time of Flight detector together, the STAR experiment at RHIC has good muon identification at low momentum (<0.26 GeV/c) with full azimuthal coverage at mid-rapidity which allows us to study the dimuon as an electromagnetic probe. We present the preliminary results of the low-mass dimuon (<0.6 GeV/c^2) distribution at mid-rapidity |y|<1 and compare to hadronic cocktails in Au+Au $\sqrt{s_{NN}}$= 200 GeV.

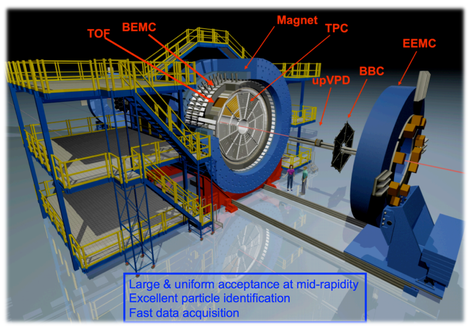
NA60 Measurement

NA60 experiment has measured the invariant mass spectra of muon pairs.[1] A strong excess of pairs above the known sources is observed in the whole mass region 0.2<$M_{\mu\mu}$<2.6 GeV/c^2. The mass spectrum for M<1 GeV/c^2 is consistent with a dominant contribution from $\pi^+\pi^- \rightarrow \rho \rightarrow \mu^+\mu^-$ annihilation. The associated ρ spectral function shows a strong broadening.



STAR Detector

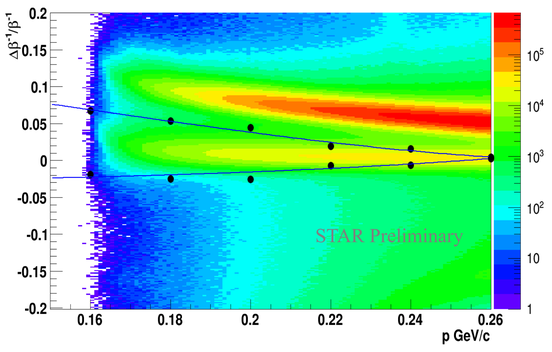
The two main detectors for this analysis are the **Time-Projection Chamber** (TPC) and the **Time-Of-Flight Detector** (TOF). The TPC measures the dE/dx for particle identification, as well as kinetic information for pair construction. The TOF measures traveling time to further improve particle identification. 518 million events collected by STAR in 2011 are analyzed.



Particle Identification

Low transverse momentum muons are identified by first applying a tight TPC cut, $-3<n\sigma_{dE/dx(\mu)}<-0.5$, and then applying the TOF cut based on 98% purity requirement.

$$\left.\frac{\Delta\beta^{-1}}{\beta^{-1}}\right|_{\mu} \equiv \frac{\beta^{-1}_{mea}-\beta^{-1}_{\exp}}{\beta^{-1}_{mea}} = 1-\beta_{mea}\sqrt{m_{\mu}^2/p^2+1}$$

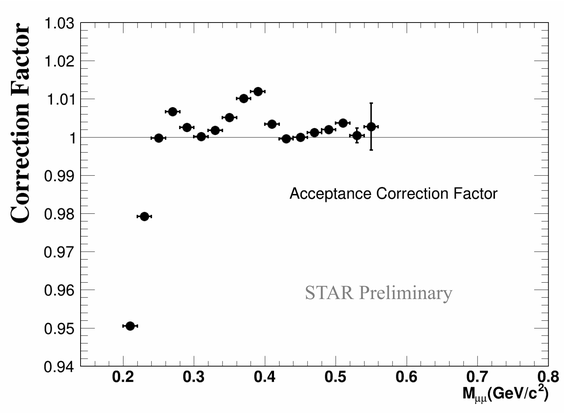


Background Subtraction

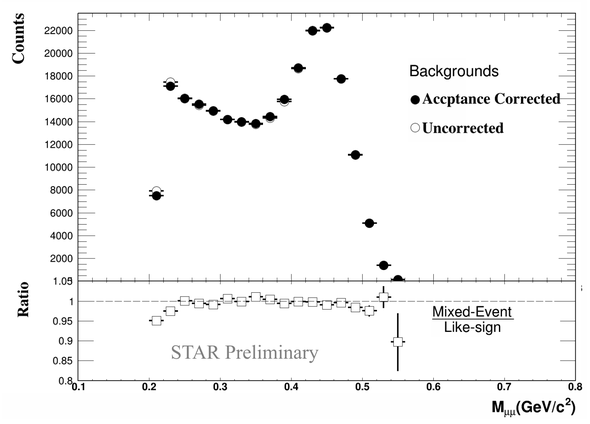
Invariant mass background is studied with like-sign (LS) background methods, in which every muon is paired with another muon in a same event, if they have the same charge. The background is then corrected for acceptance difference between like-sign and unlike-sign pairs. Mixed-event (ME) background is constructed by mixing muons from different events with similar characteristics.

Acceptance correction factor:
The acceptance difference between like-sign pairs and unlike-sign pairs are studied by comparing like-sign and unlike-sign in mixed events. The ratio of them is used to correct the like-sign background:

$$LS_{corrected} = \sqrt{LS_{++}LS_{--}}\frac{ME_{unlike-sign}}{\sqrt{ME_{++}ME_{--}}}$$

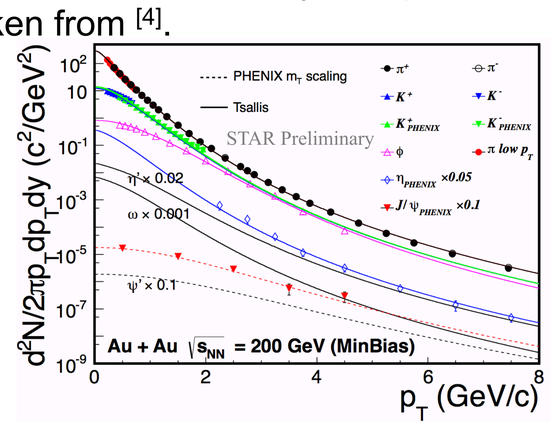


Background after acceptance correction:
Unlike-sign mixed-event background lacks contributions from jet correlations. It is thus lower than like-sign background at very low mass.



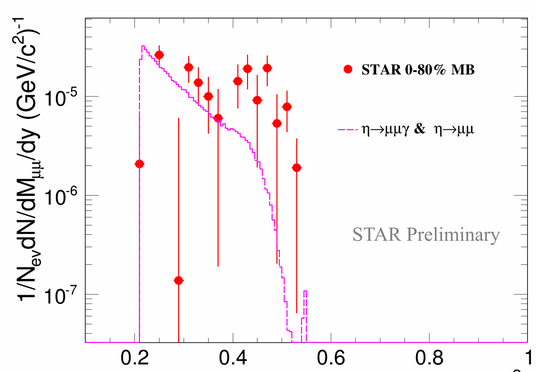
Cocktail Simulation

The muon pairs observed from known hardron sources are simulated with similar process as in [2]. The input spectra for the cocktail simulations were from simultaneous fitting with Tsallis Blast-Wave model[3]. dN/dy of η′ meson was taken from [4].



Invariant Mass Spectrum

The raw dimuon mass spectrum after background subtraction is shown below. The major contribution from η has been simulated (line). Other contributions in the cocktail are works in progress. The data and cocktail will be compared to find the possible ρ contribution.



Summary and Outlook

- The STAR detector has the ability to identify low momentum muons.
- Preliminary low mass dimuon spectra in Au+Au collisions at 200 GeV from the STAR experiment are shown.
- Other components in the cocktail will be simulated and compared with data.
- ~50% more data from year 2010 will be analyzed.

[1] NA60 Collaboration, Eur. Phys. J. C (2009) 61: 711–720;
[2] STAR Collaboration, Phys. Rev. C 86, 024906 (2012);
[3] Z. Tang et al., Phys. Rev. C 79, 051901 (2009);
[4] PHENIX Collaboration, Phys. Rev. C 81, 034911 (2010).

* This work is supported by the US Department of Energy under grant DE-FG02-10ER41666

XXIV QUARK MATTER DARMSTADT 2014

BROOKHAVEN NATIONAL LABORATORY