Energy Dependence of Exclusive ρ^0 Production in Ultra-Peripheral Collisions

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Coherent ρ^0 production in ultra-peripheral relativistic heavy-ion collisions (UPC) were observed at STAR at $\sqrt{s_{NN}} = 130$ and $\sqrt{s_{NN}} = 200$ GeV/nucleon. Two trigger configurations where used in this analysis. The coincident detection of neutrons from nuclear break up in the zero degree calorimeters (ZDC), i.e. the usual minimum bias trigger, is sensitive to ρ^0 production accompanied by mutual nuclear excitation, $AuAu \to Au^\star Au^\star \rho^0$. A low-multiplicity topology trigger, which does not require a ZDC signal, allows the detection of ρ^0 production with both nuclei remaining in their ground state, $AuAu \to AuAu\rho^0$.

Spectra of p_T^ρ, $M_{inv}(\pi\pi)$, y^ρ, and t, as well as results on the production cross sections have been recently published for the $\sqrt{s_{NN}} = 130$ GeV data [1]. Here we show the corresponding spectra for the $\sqrt{s_{NN}} = 200$ GeV data.

Figure 1a) shows the transverse momentum spectrum of oppositely charged pion–pairs (points). A clear peak, the signature for coherent coupling, can be observed at $p_T < 150$ MeV. A background model from like-sign combination pairs (shaded histogram), which is normalized to the signal at $p_T > 250$ MeV, does not show such a peak. The open histogram is a Monte Carlo simulation [3] for coherent ρ^0 production accompanied by nuclear break-up superimposed onto the background. The rapidity distribution in Fig. 1b) is well described by the reconstructed events from the Monte Carlo simulation. The generated rapidity distribution is also shown. The acceptance for exclusive ρ^0 is about 40% at $|y_\rho| < 1$. At $|y_\rho| > 1$, the acceptance is small and this region is excluded from the analysis; the cross sections are extrapolated to the full 4π acceptance with the Monte Carlo simulation. Using the energy deposits in the ZDCs, Fig. 1c), we select events with at least one neutron (xn,xn), exactly one neutron (1n,1n), or no neutrons (0n,0n) in each ZDC; the latter occurs only in the topology trigger. Figure 1d) shows the $d\sigma/dM_{\pi\pi}$ spectrum for events with pair-$p_T < 150$ MeV/c (points). The fit (solid) is the sum of a relativistic Breit-Wigner for ρ^0 production and a Söding interference term for direct $\pi^+\pi^-$ production (both dashed). A second order polynomial (dash-dotted) describes the combinatorial background (shaded histogram).

Figure 2 compares our published results on cross sections for coherent ρ^0 production at $\sqrt{s_{NN}} = 130$ GeV[1] and preliminary results for $\sqrt{s_{NN}} = 200$ GeV to the calculations of Ref. [3]. The cross sections are obtained from the integral of the Breit-Wigner fit, extrapolated to full rapidity. The cross sections at $\sqrt{s_{NN}} = 130$ and 200 GeV are in agreement with theoretical calculations, which treat ρ^0 production and nuclear excitation as independent processes.

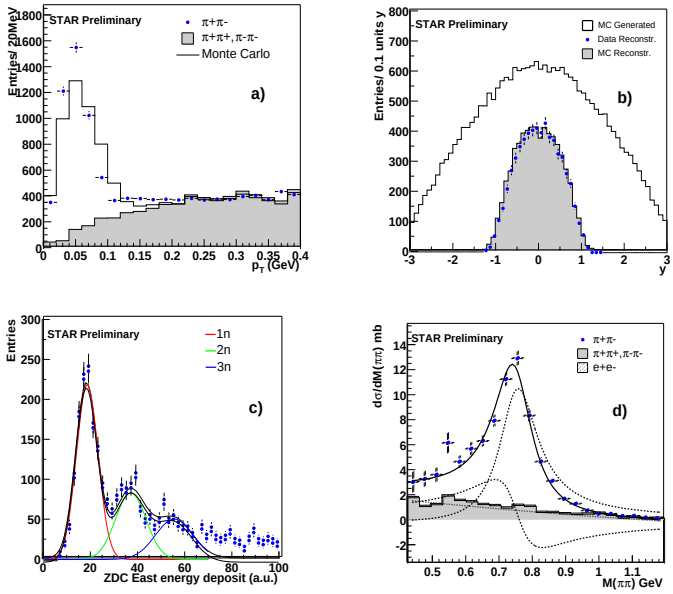

FIG. 1: The (a) ρ^0 transverse momentum and (b) rapidity distribution, the (c) ZDC response, and (d) the $d\sigma/dM_{\pi\pi}$ invariant mass distribution for 2-track (xn,xn) events in the $\sqrt{s_{NN}} = 200$ GeV minimum bias data.

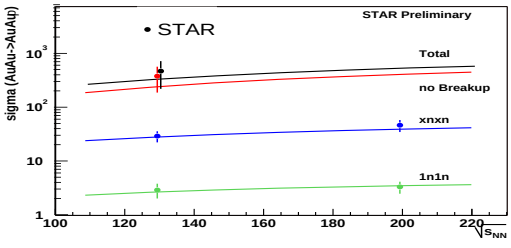

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FIG. 2: Comparison to predictions from Ref. [3].

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[2] F. Meissner, *Proceedings Quark Matter 2002*, Nantes, France (2002).
[3] S. R. Klein and J. Nystrand, Phys. Rev. C **60**, 014903 (1999); J. Nystrand, A. J. Baltz and S. R. Klein, Phys. Rev. Lett. **89** 012301 (2002).