Dimuon enhancement in nucleus-nucleus ultrarelativistic interactions

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Abstract

The study of muon pairs in the mass region $1.5 < M_{\mu\mu} < 2.5$ GeV/c^2 in 450 GeV/c p-A, 200 GeV/nucleon S-U and 158 GeV/nucleon Pb-Pb collisions is presented. In p-A interactions, the dimuon signal mass spectra are well described by a superposition of Drell-Yan and charmed meson semi-leptonic decay contributions, in agreement with previous experiments when considering a linear A dependence. In nucleus-nucleus reactions, taking only into account these two physical ingredients, a dimuon enhancement both with increasing A·B and centrality is observed.

1. Introduction

The NA38/NA50 experiment studies muon pair production in proton-nucleus and ion induced collisions at high energies. Its aim is the search for quark gluon plasma formation. The most striking result obtained concerns the anomalous J/ψ suppression [1]. In the dimuon mass spectrum we also observe the ϕ enhancement, reported to this conference [2], and the continuum enhancement between the ϕ and the J/ψ, in the so-called intermediate mass region (IMR: 1.5< $M_{\mu\mu}$ <2.5 GeV/c^2), which is the subject of the present report. Thermal dimuons in the IMR are predicted to be emitted from the plasma phase [3]. Indeed, earlier results of NA38/NA50 and NA34 Collaborations [4,5] have shown an excess in this mass region. Technical details can be found in previous publications [6,7].

2. Analysis and results

Fig. 1 shows the mass distribution for Pb-Pb interactions at 158 GeV/nucleon.

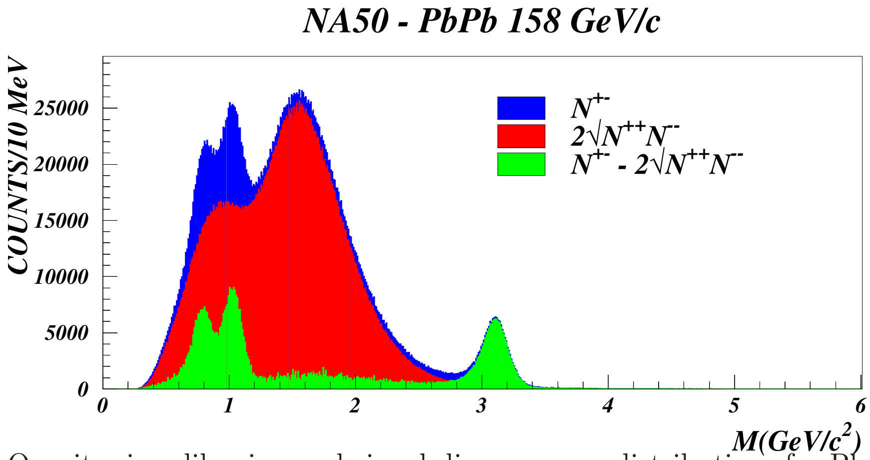

Figure 1: Oposite-sign, like-sign and signal dimuon mass distributions for Pb-Pb interactions at 158 GeV/nucleon.

The important background originating from π and K decays in this region, which amounts to 80% in p-A and 95% in Pb-Pb, has been subtracted with special care. It is estimated from combinations of single muons from measured like-sign pairs [8] according to: $\frac{dN^{bkg}}{dM} = 2R\sqrt{\frac{dN^{++}}{dM}\frac{dN^{--}}{dM}}$. The normalization R, which could be slightly greater than 1, depending on charge correlations, is given by the VENUS simulation and checked with real data collected with two different setup configurations. The used R values are presented in fig. 2 as a function of the impact parameter for S-U and Pb-Pb collisions.

The mass distribution fits shown in fig. 3 are performed using the known contributions, namely Drell-Yan pairs (DY), open charm semileptonic decays ($D\bar{D}$) and ψ and ψ' resonances. DY and $D\bar{D}$ are calculated in the LLA with the PYTHIA simulator using the MRS A parton distribution functions with m_c=1.5 GeV/c^2 and σ_{K_T}=0.8 GeV/c . The

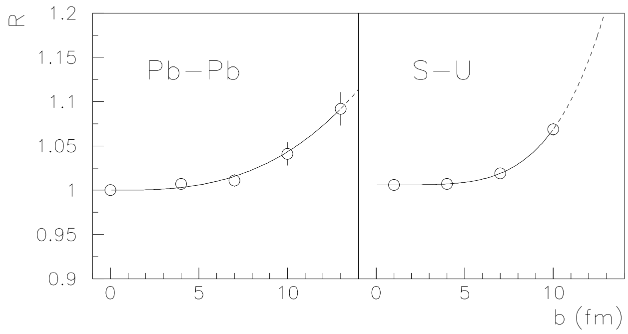

Figure 2: Background normalization R as a function of the impact parameter for S-U at 200 GeV/nucleon and Pb-Pb at 158 GeV/nucleon collisions.

generated events and particle decays into muons go through a simulation program of the detector and are reconstructed as real data in order to introduce smearing and acceptance effects.
The DY contribution, with its well known shape and linear A·B dependence (from p-p to Pb-Pb collisions [9]), is normalized from the high mass region of the spectrum ($M_{\mu\mu}$ > 4.5 GeV/c^2).
As the open charm production also exhibits a linear A-dependence in p-A collisions, for Pb-Pb data we fix the $D\bar{D}$ normalization to the DY contribution as given by our proton data, which agree with previous measurements.

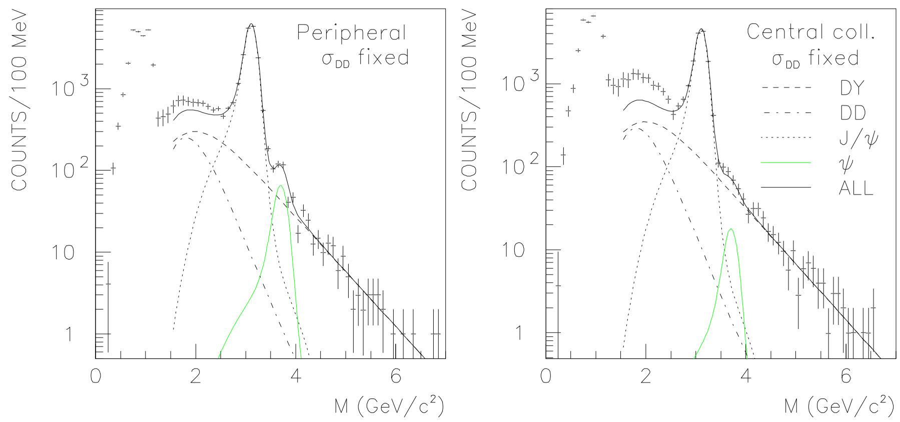

Figure 3: Signal mass distribution fits with the known sources for peripheral and central Pb-Pb collisions at 158 GeV/nucleon.

The fit results are displayed in fig. 3 for peripheral and central collisions. One clearly sees that an excess is present in the IMR, with respect to what is expected from p-A extrapolations and that it is more pronounced for central collisions. In fact, the ratio of the measured IMR yield with respect to the known sources increases as a function of the number of participants (N$_{part}$), as shown in fig. 4, where the values are normalized to the same quantity obtained in p-A collisions.

3. Discussion and conclusion

The excess is slightly increased by 20% when we impose the combinatorial background normalization R=1 . Nevertheless, the IMR excess mass shape is incompatible with background and agrees with the charm distribution, as shown in fig. 5 . In fact, the mass distribution fit gives a low χ^2 value if the $D\bar{D}$ contribution is used with free normalization. The excess is not explained either by $D\bar{D}$ rescattering. A simple generator based on Lin and Wang hypothesis of strong rescattering [10], accounts for only 20% of the excess when

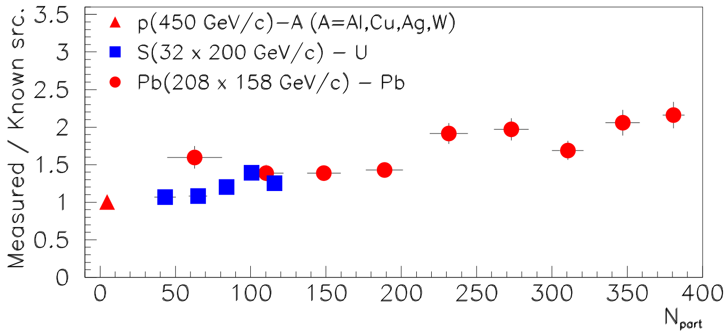

Figure 4: Signal measured over known sources as function of the number of participants divided by the same quantity obtained in p-A.

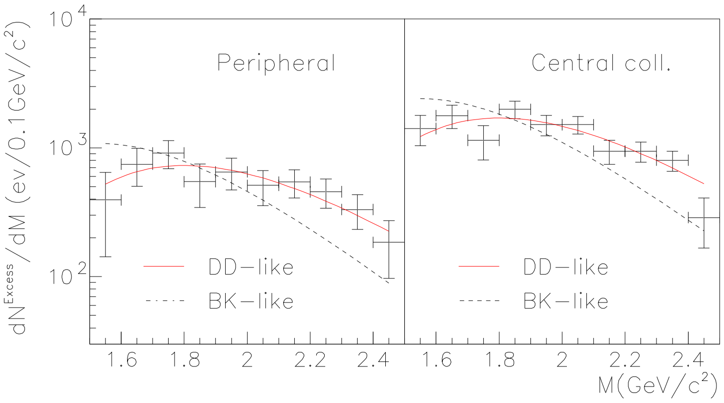

Figure 5: Excess mass distribution (data - known sources) compared with the shapes of combinatorial backgound (BK) and open charm production (DD) for peripheral and central Pb-Pb collisions.

considering P_T distributions and for about 30% when dealing with cos θ shapes. Anyway, a more complete study is needed.
For the moment, a thermal dimuon generator is not yet taken into account.

This work was partially supported by Fundação para a Ciência e a Tecnologia and by INTAS grant 96-231. One of the authors (LC) acknowledges financial support from EC (TMR program) under contract number ERBFMBICT961204.

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