LAPP-EXP-89-15
November 1989

THE PRODUCTION OF ϕ IN 200 GEV/NUCLEON S-U AND O-U INTERACTIONS

NA38 COLLABORATION

Annecy[1], CERN[2], Clermont-Ferrand[3], Ecole Polytechnique[4], Lisbon[5], Lyon[6], Orsay[7], Strasbourg[8], Valencia[9]

M.C. Abreu[5], M. Alimi[6†], C. Baglin[1], A. Baldisseri[1] , A. Baldit[3], M. Bedjidian[6], P. Bordalo[5], A. Bussière[1], P. Busson[4], R. Cases[9], J. Castor[3], C. Charlot[4], B. Chaurand[4], D. Contardo[6], E. Descroix[6], A. Devaux[3], O. Drapier[6], J. Fargeix[3], X. Felgeyrolles[3], R. Ferreira[5], P. Force[3], L. Fredj[3], J.M. Gago[5], C. Gerschel[7], Ph. Gorodetzky[8], P. Gras[9], B. Grosdidier[8], J.Y. Grossiord[6], A. Guichard[6], J.P. Guillaud[1], R. Haroutunian[6], D. Jouan[7], L. Kluberg[4], R. Kossakowski[1], G. Landaud[3], P. Liaud[1], C. Lourenço[5], S. Papillon[7], L. Peralta[5], M. Pimenta[5], J.R. Pizzi[6], C. Racca[8], S. Ramos[5], A. Romana[4], R. Salmeron[4], S. Silva[5], A. Sinquin[7], P. Sonderegger[2], F. Staley[1], X. Tarrago[7],J. Varela[5], F. Vazeille[3]

Abstract

Preliminary results on the low mass resonances region (ρ,ω and ϕ) from NA38 experiment are presented. The ratio ϕ/ω is studied (for high p_T dimuons) in correlation with the transverse neutral energy E_T of the collision. This ratio increases with increasing E_T, for both S-U and O-U interactions.

Presented at the International Europhysics Conference on High Energy Physics
Madrid, september 6-13, 1989
by
A. BALDISSERI , LAPP, Annecy-le-Vieux, France.

[redacted]

[1] LAPP, CNRS-IN2P3, Annecy-le-Vieux, France.
[2] CERN, Gereva, Switzerland.
[3] LPC, Univ. de Clermont-Ferrand and CNRS-IN2P3, France.
[4] LPNHE, Ecole Polytechnique and CNRS-IN2P3, Palaiseau, France.
[5] LIP, Lisbon, Portugal.
[6] IPN, Univ. de Lyon and CNRS-IN2P3, Villeurbanne, France.
[7] IPN, Univ. de Paris-Sud and CNRS-IN2P3, Orsay, France.
[8] CRN, Univ. Louis Pasteur and CNRS-IN2P3, Strasbourg, France.
[9] IFIC, Burjasot, Valencia, Spain.
† accidentally deceased

1. INTRODUCTION

The phase transition between ordinary hadronic matter and quark gluon plasma (QGP) has been predicted by many authors[1] for an energy density ≈ 3 GeV.fm^{-3} and/or temperature ≈ 200 MeV. These conditions are reached in S+U and O+U collisions at 200 GeV/nucleon . In order to identify this new state, several signals have been proposed, in particular the enhancement of the ratio ϕ/ω production rate if the QGP is formed[2]. This report presents a preliminary analysis of this ratio from NA38 experiment.

2. THE EXPERIMENT

Mass and p_T spectra of dimuons produced in 200 GeV/nucleon heavy ions interactions have been measured in correlation with the neutral transverse energy E_T of the collision. The monitored beam of Protons, Oxygen or Sulfur ions of high intensity (up to 5.10^7 ions/burst) impinges the active target (20% interaction length) composed of 10 Uranium subtargets ($\approx$1mm thick). The detector consists of a dimuon spectrometer (rapidity range $2.8 < y_{lab} < 4$) and a Pb-scintillating fiber electromagnetic calorimeter (pseudo-rapidity range $1.7 < \eta_{lab} < 4.1$). The detailed description of the apparatus and of the event-by-event data processing has already been published[3]. For the ϕ, the mass resolution is 115 MeV/c^2 and the acceptance is 2.8% ($x_F > 0$).

3. THE ANALYSIS

Up to now, the NA38 data analysis was focalized on the J/Ψ and dimuon continuum production in the high $\mu\mu$ mass region. The principal difficulty of the data analysis in the low mass region is due to the very unfavourable signal to background ratio. As a matter of fact, the mass distributions of the reconstructed opposite-sign (OS) and like-sign (LS) $\mu\mu$ pairs (Fig. 1a) show a very high background level in the ρ,ω and ϕ mass region ($0.6 < M_{\mu\mu} < 1.2$ GeV/c^2). The situation is particularly difficult in the low p_T domain. However in the high p_T region the ρ,ω and ϕ resonances can be observed over the relatively low background. One way to select the high p_T $\mu\mu$ pairs is to introduce a *cut* on the individual muons kinematical variables. The transverse and longitudinal momentum of individual muons in the laboratory frame are required to satisfy $p_T \geq 0.7$ GeV/c and $p_L \geq 13$ GeV/c (corresponding to $p_{T\mu\mu} \geq 1.3$ for dimuons). Fig. 1b shows the OS and LS spectra after these cuts.

The signal to background ratio is considerably improved as seen by comparing Fig. 1a and Fig. 1b. Two maxima corresponding to $\rho+\omega$ and ϕ are clearly seen in fig. 1b. Another advantage of using the cut on individual muons parameters is the improvement of the mass resolution (the low momentum muons are highly affected by multiple scattering in the absorber).

The dimuon mass spectrum (for $M < 2.5$ GeV/c^2) has been fitted to a superposition of 3 gaussians for ρ,ω and ϕ resonances and a smooth continuum :

$$dN/dM = A_\phi \exp[(M-M_\phi)^2 /2\sigma_\phi{}^2] + A_\omega \exp[(M-M_\omega)^2 /2\sigma_\omega{}^2] + A_\rho \exp[(M-M_\rho)^2 /2\sigma_\rho{}^2]$$
$$+ A_c (M-0.3) \exp(-M/1.5)$$

where masses and resonances widths (M_ϕ, σ_ϕ, M_ω, σ_ω, M_ρ, and σ_ρ) are fixed parameters, provided by preliminary Monte-Carlo simulation. The relative amount of ρ and ω (A_ρ/A_ω) is fixed assuming the same production cross section for ρ and ω. Finally the three degrees of freedom for the fit are : A_ϕ, A_ω and A_c. Fig. 2 shows the low mass signal spectrum for S+U interactions, superimposed with the fitted contributions of ρ,ω,ϕ resonances and continuum.

4. E_T DEPENDENCE OF ϕ/ω RATIO

The whole data was separated into four neutral transverse energy bins of approximatively equivalent statistics for O-U and S-U interactions. Fig. 3 shows the mass spectrum for the two extreme E_T bins in S-U interactions. The enhancement of the ϕ/ω ratio appears very clearly for high E_T. Fig. 4 shows the ϕ/ω ratio for O-U and S-U interactions normalized to the p-U data as a function of $E_T A^{-2/3}$ ($\approx$Bjorken energy density[4])

5. CONCLUSION

This preliminary work shows that low mass high p_T dimuon spectra collected in the NA38 experiment present a satisfactory signal to background ratio for a quantitative analysis. The ϕ/ω ratio increases with E_T by a factor greater than 1.5 in S-U and O-U collisions. This ratio also increases between p-U and ion-U collisions (up to factor 3 at the highest E_T value). These preliminary results are in agreement with the predictions of A. Shor[2] based on QGP production. Work is in progress for a more detailed analysis.

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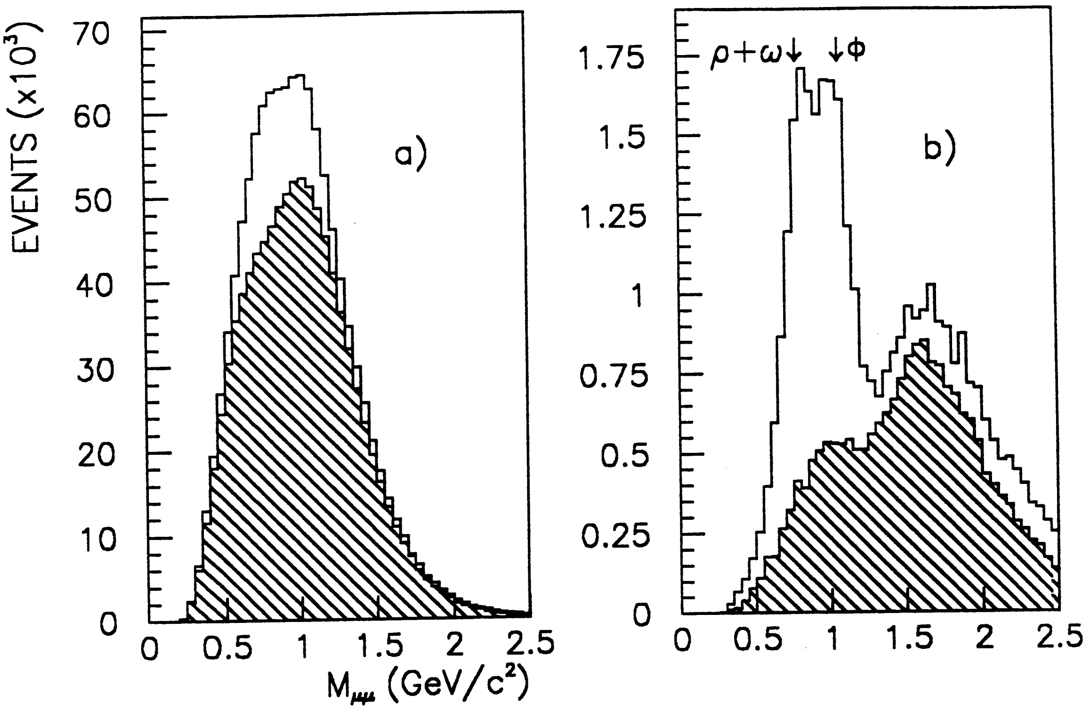

Fig.1 Mass distribution for OS (solid line) and LS (hacthed) for S-U interactions, a) before cut , b) after cut.

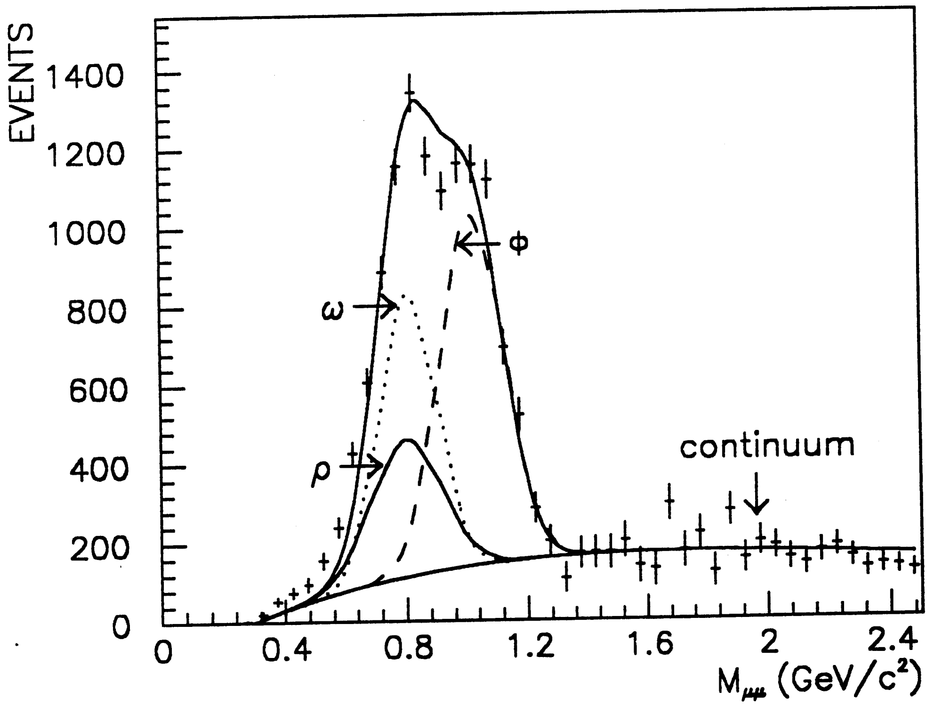

Fig. 2 Signal mass distribution for S-U interactions. The fitted contribution of ρ,ω,φ and continuum are shown separately.

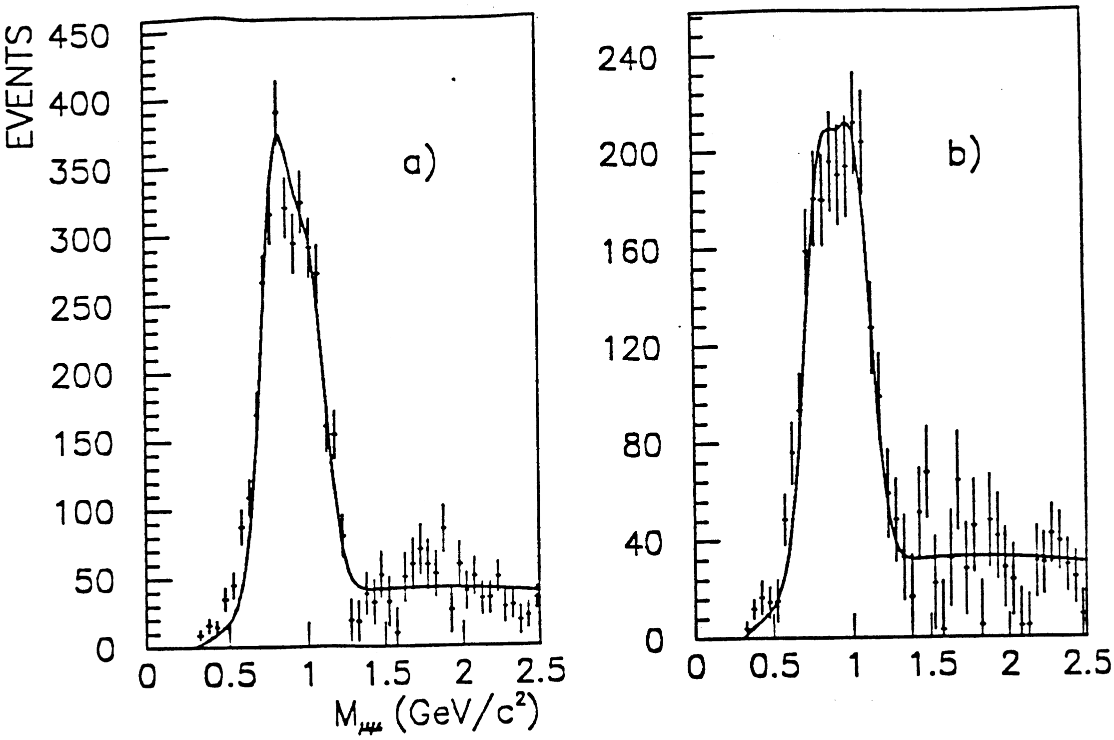

Fig.3 Signal mass spectra for the two extreme E_T bins for S-U interactions, a) low E_T (E_T<42 GeV), b) high E_T (E_T> 76 GeV).

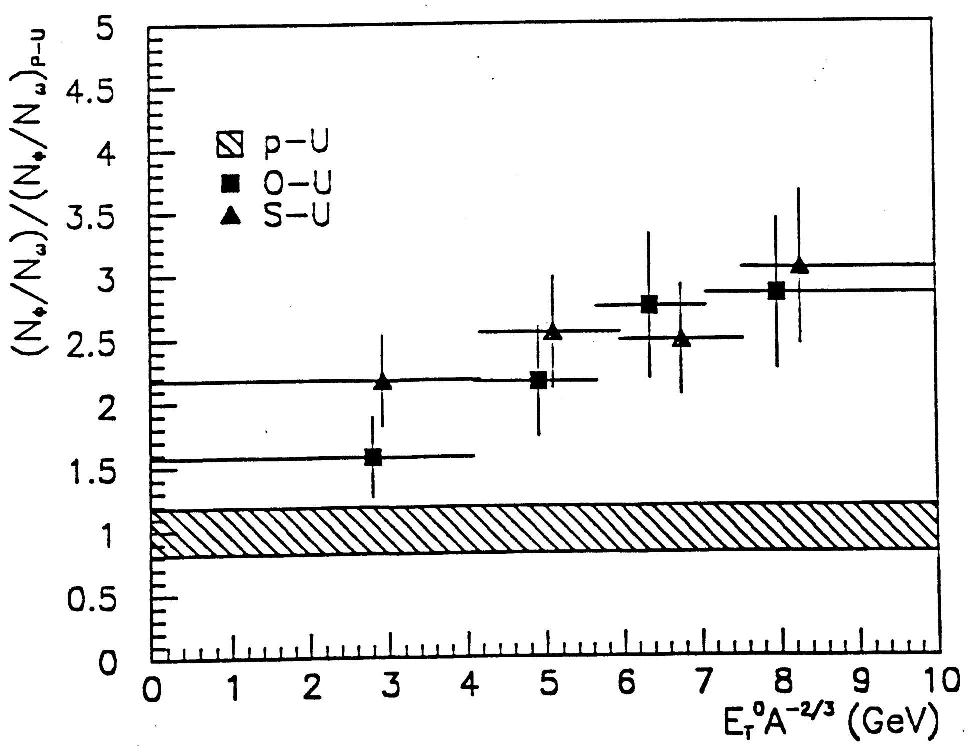

Fig.4 The ϕ/ω ratio normalized to the ϕ/ω ratio for p-U interactions as a function of $E_TA^{-2/3}$.