NA49 RESULTS FROM Pb+Pb COLLISIONS AT THE CERN SPS*

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Recent results of experiment NA49 from Pb+Pb collisions at the CERN SPS are shown on light nuclei production, on the Balance Function and on the energy dependence of multiplicity and mean transverse momentum fluctuations.

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1. Introduction

The main purpose of the NA49 experiment [1] at the CERN SPS is the search for evidence of quark–gluon deconfinement in the early stage of Pb+Pb collisions. Measurements of particle yields and m_{T} distributions suggest that deconfinement indeed starts in the lower SPS energy range [2–4]. The search for evidence of a first order phase transition and of the predicted critical point of hadronic matter [5] in fluctuations is the subject of intensive current and future [6] investigations.

2. Production of light nuclei in central Pb+Pb collisions

Production of light nuclei has traditionally been interpreted in terms of coalescence models [7]. The production rates depend on the nucleon density, temperature, and collective flow. Thus they provide information on the properties of the produced fireball.

New results on ^{3}He production in central Pb+Pb collisions at $20A$–$80A$ GeV are shown in Fig. 1. The left panel demonstrates the clean iden-

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tification from dE/dx and M^2 (computed from momentum and and time-of-flight). The center panel displays the $m_{\rm T}$ distributions at midrapidity. Rapidity distributions, summarised in the right panel, were obtained by integration of the $m_{\rm T}$–distribution in narrow bins of rapidity. Since the coverage in rapidity is large, total yields have been estimated by fitting and integrating a parabolic parameterisation (the shape predicted by the RQMD model) up to beam rapidity.

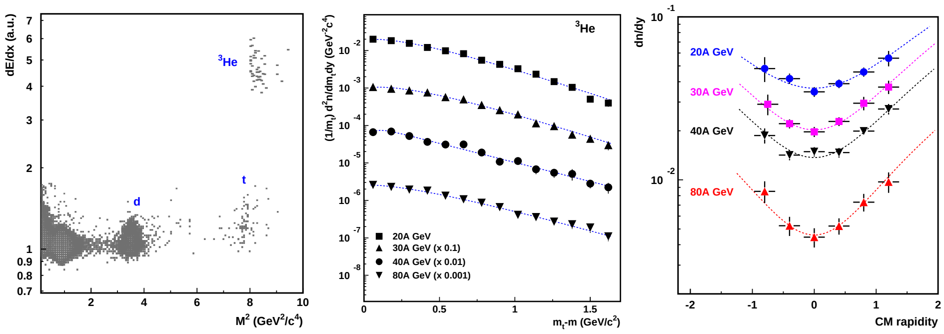

Fig. 1. ^{3}He production in central Pb+Pb collisions (NA49 preliminary). Left: energy loss dE/dx *versus* M^2 from momentum and time-of-flight at 40A GeV. Center: transverse mass $m_{\rm T}$ dependence of invariant yields at midrapidity. Right: rapidity dependence of yields; a parabolic fit (curves) was used to estimate total yields.

The energy dependence of the coalescence parameter B_A for deuteron and ^{3}He production at $p_{\rm T} = 0$ measured by NA49 is compared to results from lower and higher energies in Fig. 2, left. One observes a gradual decrease which indicates an increasing effective coalescence volume in the coalescence

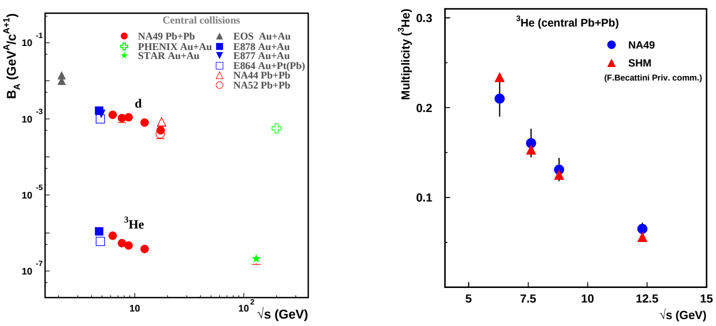

Fig. 2. ^{3}He production in central Pb+Pb collisions (NA49 preliminary). Left: energy dependence of coalescence parameter B_A at $p_{\rm T} = 0$ for d and ^{3}He. Right: total ^{3}He yields (dots) compared to predictions of the statistical hadron gas model [8] (triangles).

model scenario. Remarkably, one finds for total ^{3}He yields (see Fig. 2, right) surprising agreement with the predictions of the statistical hadron gas model [8] using parameters fitted to meson and baryon yields.

3. Energy and rapidity dependence of the Balance Function

The Balance Function measures the range in rapidity of correlations of oppositely charged particles [9]. A narrowing of its width was predicted as a signature of a first order phase transition due to the long expected lifetime of the mixed phase. At midrapidity such a narrowing was observed first at RHIC for central Au+Au collisions and subsequently also found in central Pb+Pb collisions at the SPS [10] (see Fig. 3, center and right). However, the narrowing does not occur at forward rapidity (see Fig. 3, left). The narrowing can possibly be explained by local charge conservation and strong radial flow. Nevertheless, it is interesting that current microscopic models of nucleus-nucleus collisions do not reproduce the effect, except for AMPT which includes a phase transition (see Fig. 3, right).

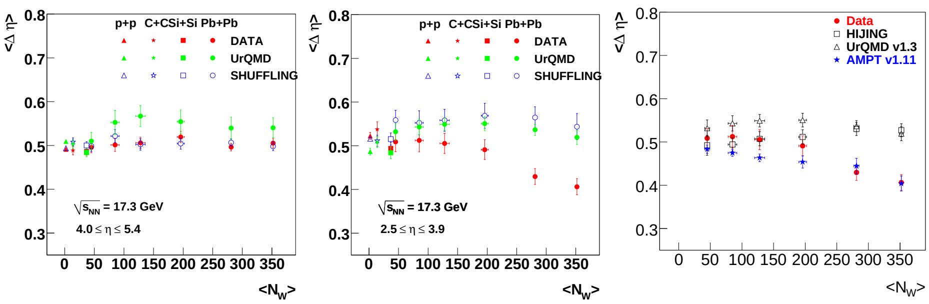

Fig. 3. Width $\langle \Delta\eta \rangle$ of the Balance Function for oppositely charged hadrons at 158*A* GeV beam energy. Experimental results are shown by full dots, shuffled event reference by open circles and model predictions by other symbols. Left: forward pseudo-rapidity (4.0< η <5.4); center, right: central pseudo-rapidity (2.5< η <3.9).

4. Energy dependence of multiplicity and $\langle p_T \rangle$ fluctuations

Significant non-statistical event-by event fluctuations may occur for the multiplicity and $\langle p_T \rangle$ of particles if they are produced near a first order phase transition or a critical point of hadron matter [11]. Since a deconfined state appears to be reached in central Pb+Pb collisions in the low SPS energy range, a search for such fluctuations has been the subject of intense investigation.

No structure is observed in the energy dependence of multiplicity fluctuations in the SPS energy range. Fig. 4 shows that the scaled variance ω of the multiplicity distribution is near unity (Poisson distribution). This holds also for the low p_{T} range (Fig. 4, right), which is expected to be most sensitive to effects of the critical point (0.1 units increase of ω [11]). The energy dependence of the $\langle p_{\mathrm{T}} \rangle$ fluctuation measure $\Phi_{p_{\mathrm{T}}}$ is plotted in Fig. 5. Again there is no indication of the expected increase of about 8 MeV/c [11].

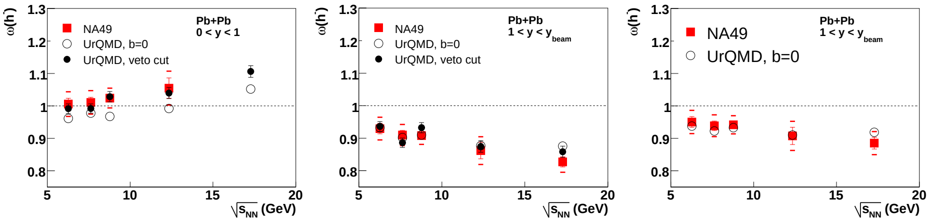

Fig. 4. Energy dependence of the scaled variance ω of the multiplicity distribution of negative hadrons in the 1% most central Pb+Pb collisions. Data are shown by squares, UrQMD model predictions by dots; c.m.s. rapidity interval 0<y<1 (left); $1 < y < y_{\mathrm{beam}}$ (center); $1 < y < y_{\mathrm{beam}}$ and $p_{\mathrm{T}} < 0.5$ GeV/c (right), (NA49 prelimin.).

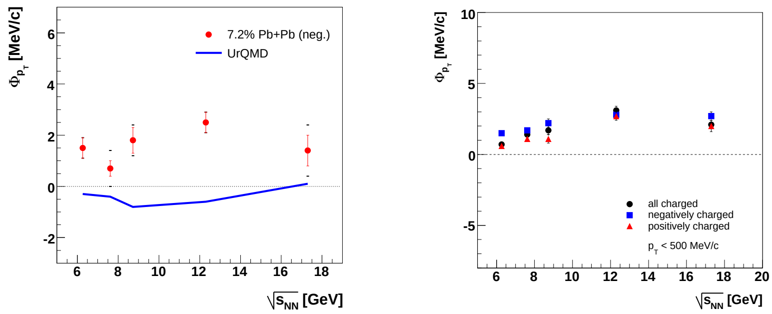

Fig. 5. Energy dependence of the $\langle p_{\mathrm{T}} \rangle$ fluctuation measure $\Phi_{p_{\mathrm{T}}}$ in the rapidity region $1.1 < y_{\pi} < 2.6$ in the 7.2% most central Pb+Pb collisions. Left: data points and UrQMD model prediction (curve) for all p_{T}. Right: for $p_{\mathrm{T}} < 0.5$ GeV/c, (NA49 preliminary).

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