Strangeness production in pBe, pPb and PbPb interactions

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Abstract

Strange particle production in proton-beryllium, proton-lead and lead-lead interactions as measured by the WA97 experiment is presented. Particle yields are presented, as well as inverse slope systematics.

1. Introduction

An enhanced production of strange particles has been put forward as one of the promising signals for the identification of a phase transition from hadronic matter to quark gluon plasma (QGP) [1, 2].

Production ratios of strange and multistrange baryons in heavy ion reactions compared to similar ratios measured in proton induced reactions are a particularly suitable signal to quantify this strangeness enhancement.

The WA97 experiment has measured such ratios in lead-lead, proton-lead and proton-beryllium interactions.

† Deceased.

2. Experimental setup

The WA97 setup, outlined in figure 1, has been presented elsewhere [3, 4]. Tracks are identified using a silicon telescope containing 7 pixel planes with 75×500 μm^2 pixel size, and 10 microstrip planes with a 50 μm pitch. Further tracking detectors were used to improve the momentum resolution.

Fast scintillators were used to provide a centrality trigger corresponding approximately to the 40% most central events. Detailed multiplicity measurements were made by two arrays of silicon microstrips.

Hyperons were selected by their decay patterns, requiring all decays to take place before the first plane of the telescope, located 60-90 cm from the target.

In the proton runs, a special trigger was used to select only events with tracks passing through the telescope.

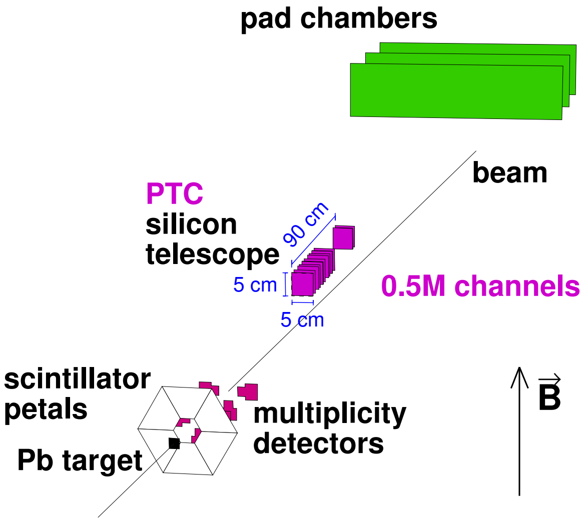

Figure 1. WA97 experimental setup

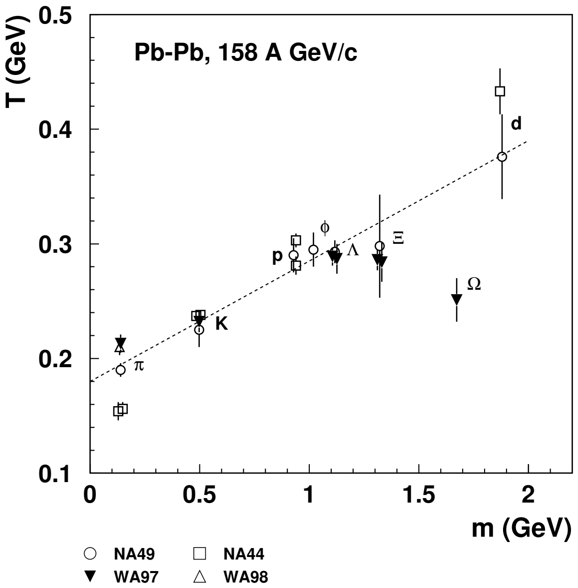

Figure 2. Dependence of the m_{T} spectra inverse slopes T on the particle mass m.

Further details on the reconstruction procedure are discussed in refs [4, 5].

3. Transverse mass spectra

The transverse mass spectra have been fitted by the formula

$$\frac{1}{\mathrm{m_T}}\frac{\mathrm{dN}}{\mathrm{dm_T}} \propto \mathrm{m_T}\exp\left(-\frac{\mathrm{m_T}}{T}\right) \qquad (1)$$

.

A compilation of inverse slope parameters measured by WA97, WA98, NA44 and NA49 (see ref. [6] and references therein) is shown in figure 2.

A general trend is observed that the inverse slope increase linearly with particle mass. The Ω, and possibly the Ξ, slopes form a notable exception from this trend. This may indicate that the multistrange particles decouple earlier than other particles, as discussed in ref. [7].

4. Centrality measurement

The centrality measurements are based on the charged particle multiplicity measured by the multiplicity microstrips. The lead-lead data sample is divided into four multiplicity classes. The average number of wounded nucleons (participants) in each multiplicity class is determined by a Wounded Nucleon Model [8] fit. The fit procedure is described in detail in ref. [9]. The number of wounded nucleons in proton-induced reactions have been determined as an average value for inelastic collisions in the framework of the Glauber model [10]

5. Particle yields

The particle yields per unit of rapidity at central rapidity are plotted for negatives, K^0_S, Λ, Ξ, Ω and their antiparticles in figure 3. The horizontal error bars correspond to the FWHM of the N_{part} distribution obtained from the Wounded Nucleon Model fit in each multiplicity class. The particles are divided into two groups. Those particles with at least one valence quark in common with the nucleon are plotted on the left together with K^0_S, and those with no common quarks are plotted on the right.

In figure 4, the yields are normalised to the value measured in proton-beryllium interactions. The full line shown in this figure corresponds to scaling the proton-beryllium result by the number of participants. A strong enhancement of strange particle production can be observed, surpassing a factor 10 for $(\Omega^- + \overline{\Omega}^+)$. Within each group of particles, the enhancement factor depends on the strangeness content of the particle, e.g. particles with |S|=3 (Ω) are more enhanced than |S|=2 particles (Ξ) which again are more enhanced than particles with |S|=1 (Λ).

The observed yields are proportional with the number of participants within the sample measured in lead-lead interactions. Furthermore,

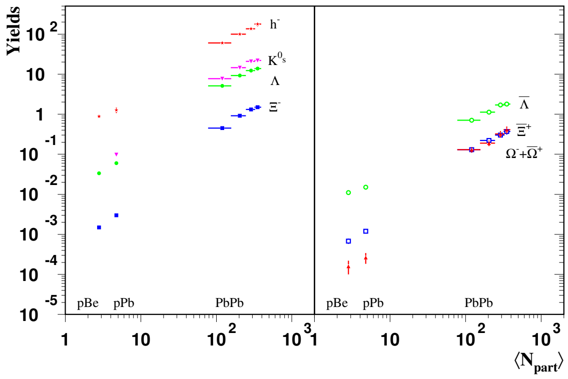

Figure 3. Yields per unit of rapidity at central rapidity as a function of number of wounded nucleons.

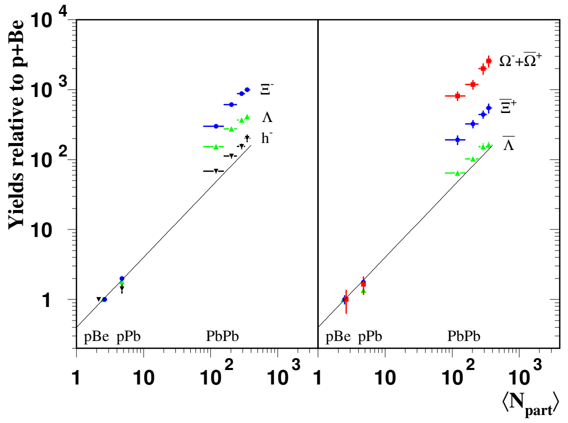

Figure 4. Yields per unit of rapidity relative to proton-beryllium yields.

proton-beryllium and proton-lead yields are also proportional to the number of participants, but the yields per participant measured in lead-lead interactions are significantly higher than those measured in proton-induced reactions. These results call for a closer investigation of the intermediate centrality region, to search for a possible transition behaviour.

6. Outlook

The experimental programme of the WA97 collaboration has been taken over by the NA57 experiment. The aim of this experiment is to extend the centrality range by extending measurements to more peripheral lead-lead collisions, and to run both at 160 GeV per nucleon and at 40 GeV per nucleon beam energy.

7. Conclusions

The WA97 experiment has measured particle spectra for negatives (mainly pions), strange and multistrange baryons.

The transverse slope parameters, extracted by several experiments, generally show a linear increase with particle mass. Multistrange hadrons do not follow this trend, suggesting that these particles decouple early from the hadronic phase.

Strangeness enhancement is observed when comparing yields from central lead-lead interactions to the yields observed in proton-beryllium interactions. The enhancement gets more pronounced for particles of higher strangeness content, surpassing a factor 10 for $(\Omega^- + \overline{\Omega}^+)$. Within the centrality window of the WA97 experiment, corresponding to the 40% most central interactions, the strange particle yields are proportional to the number of participants in the reaction.

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