Enhancement of Strange and Multi-Strange Baryons in Central Pb-Pb Interactions at 158 GeV/c per Nucleon

Presented by David Evans for the WA97 Collaboration

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Strange and multi-strange baryon production is expected to be enhanced in heavy ion interactions if a phase transition from hadronic matter to a Quark-Gluon Plasma takes place. The production yields and transverse mass spectra of strange and multi-strange baryons and anti-baryons are presented for lead-lead interactions at 158 GeV/c per nucleon. Yields and transverse mass spectra from proton-lead and proton-beryllium interactions, where no phase transition is expected, are also presented and compared to those from lead-lead interactions.

1. INTRODUCTION

QCD predicts that, under extreme conditions of temperature and density, hadronic matter may undergo a phase transition into a deconfined plasma of quarks and gluons known as a Quark-Gluon Plasma (QGP). It is believed that the high energy densities produced in ultra-relativistic heavy ion collisions may be high enough for such a phase transition to take place. The enhancement of strange particle production in such collisions is considered to be one of the most promising signatures for QGP formation to date [1]. In particular, it is expected that the enhancement of multi-strange particles would be more pronounced than that for singly strange particles [2].

The WA97 experiment was designed to study strange and multi-strange baryon production in Pb-Pb interactions and compare the strangeness yields to those from proton induced reactions. The experimental set-up and details of the trigger and data analysis have been described in detail elsewhere [3–5].

2. EXPERIMENTAL RESULTS

2.1. Transverse Mass & Rapidity Distributions

The distributions of particle yields have been fitted to the expression

$$\frac{\mathrm{d}^2N}{\mathrm{d}m_{\mathrm{T}}\mathrm{d}y} = f(y)m_{\mathrm{T}}\mathrm{exp}\left(-\frac{m_{\mathrm{T}}}{T}\right) \tag{1}$$

where m_{T} is the transverse mass and y is the rapidity. The fit was performed using the method of maximum likelihood. The analysis assumed the rapidity distributions to be flat in the region $|y - y_{cm}| < 0.5$ *i.e.* $f(y)$ = constant. Figure 1 shows the rapidity distributions for K^0s, Λs, and $\overline{\Lambda}$s in the central unit of rapidity in Pb-Pb interactions. The closed symbols represent the data and the open symbols are their reflection about

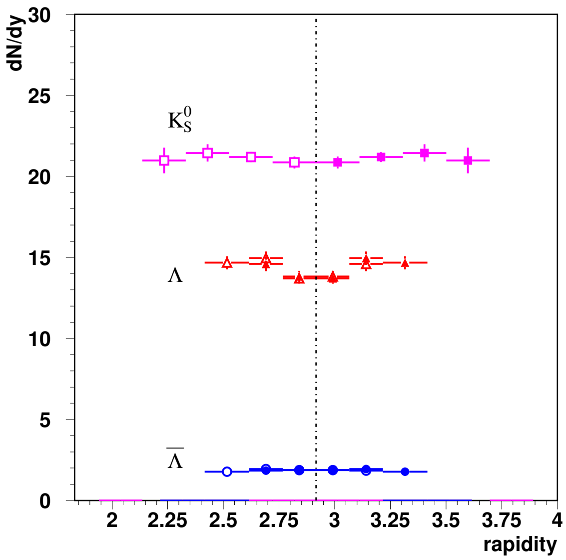

Figure 1. Rapidity distributions for different particle species.

midrapidity. As can be seen from figure 1 these particles are consistent with having a flat rapidity distribution in this range.

Figure 2 shows the inverse slope, T, from expression (1) for different particle species as a function of the number of participants. The squares represent data from p-Be interactions, the triangles represent data from p-Pb interactions, and the circles represent data from Pb-Pb interactions split into four centrality bins. As can be seen from figure 2, the inverse

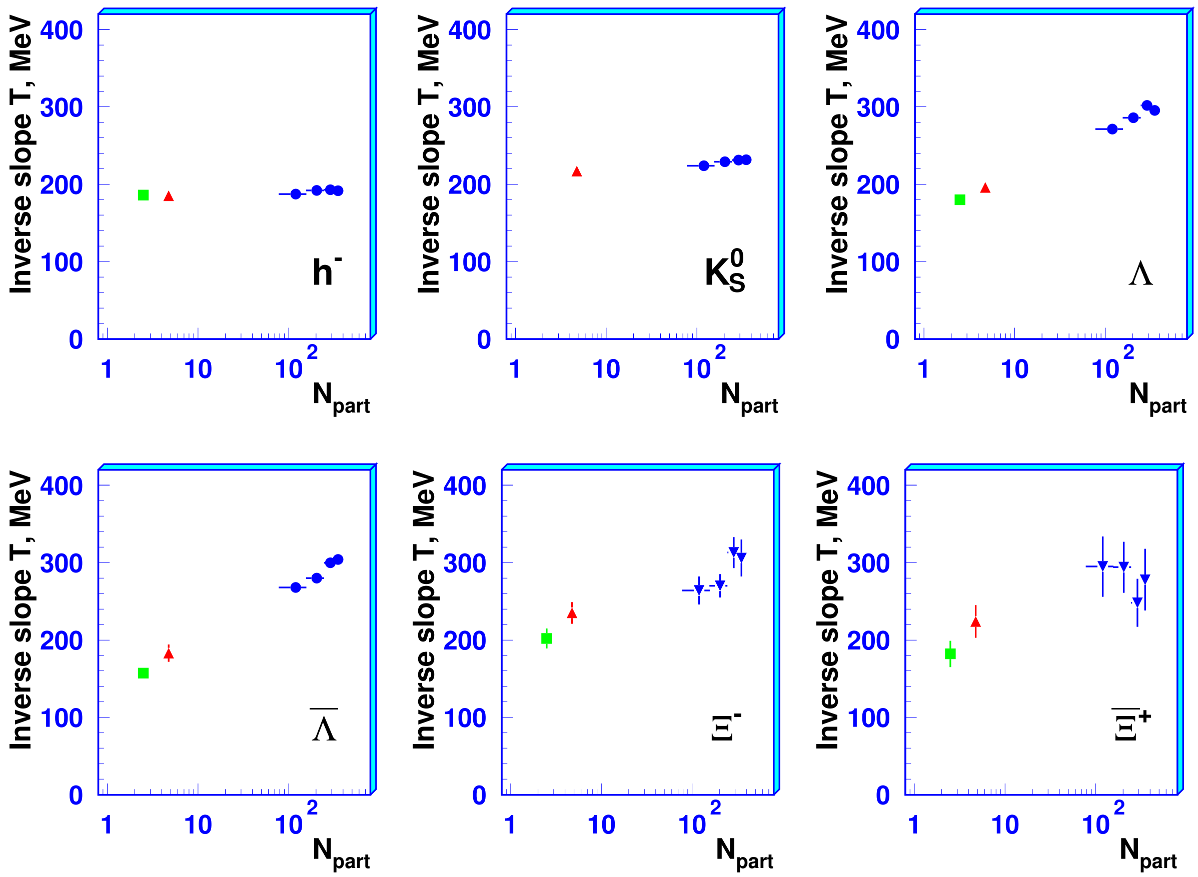

Figure 2. Inverse mt slopes for different particles in different interactions.

slope as a function of centrality is flat for negative particles and almost flat for K^0s while it increases with centrality for Λs and $\overline{\Lambda}$s . There is also an indication that (T) increases with centrality for Ξ^- and $\overline{\Xi}^+$ hyperons although the statistics are lower.

2.2. Strangeness Enhancement

Average particle yields per event have been calculated for different particles in p-Be, p-Pb and Pb-Pb interactions. Figure 3 shows the particle yield per participant, $(Y)/(\mathrm{N}_{part})$, as a function of the number of participants, (N_{part}), relative to that for p-Be interactions (*i.e.* the yields per participant have been rescaled so that the value for the p-Be data is set to one). The number of participants are calculated as described in Ref. [4]. If the particle yields increase linearly with the number of participants then all the data points should lie on the same line as the p-Be data. As can be seen from figure 3 all particle yields increase with centrality from p-Pb to Pb-Pb faster than linearly with the number of participants. Within our experimental centrality range for Pb-Pb, however, we observe that all particle yields do increase linearly with the number of participants. In other words, there is an enhancement of strange and multi-strange baryons going from proton induced to central

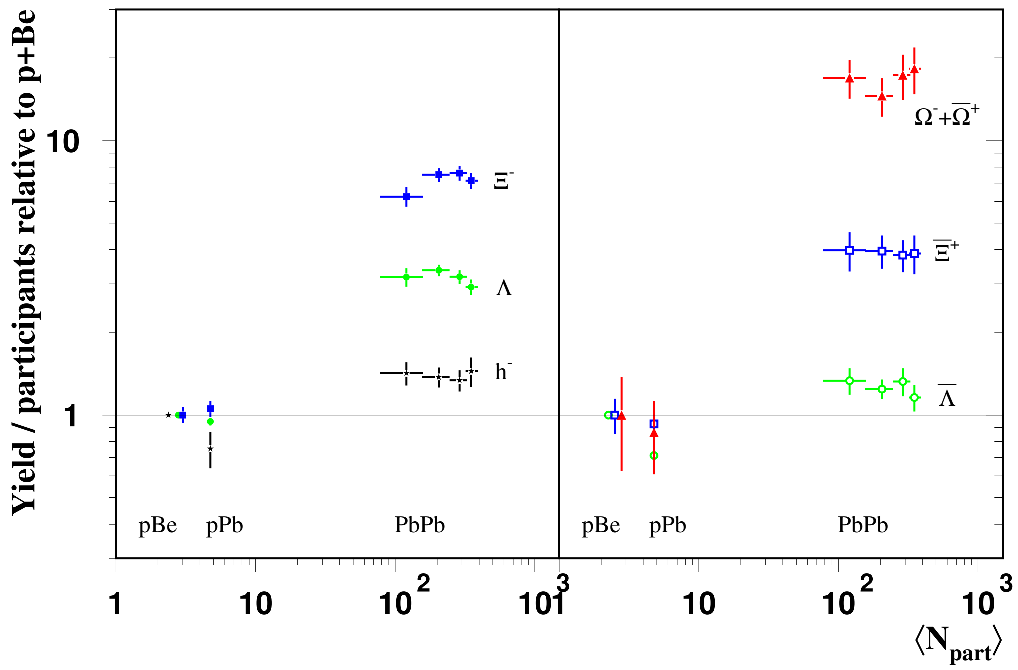

Figure 3. Yield per participant as a function of the number of participants for different particles.

Pb-Pb interactions although there is no further increase after $N_{parts} > 100$. As can be seen from figure 3, the baryon enhancements increase with strangeness content with the Ω being enhanced by over an order of magnitude.

3. SUMMARY & CONCLUSIONS

In conclusion, we find that our rapidity distributions of K^0s, Λs and $\overline{\Lambda}$s are consistent with being flat in the central unit of rapidity in Pb-Pb interactions. The inverse m_T slopes, T, in Pb-Pb interactions do not increase with centrality for h^- but do increase with centrality for Λs and $\overline{\Lambda}$s . There is no increase in strangeness yields per participant from p-Be to p-Pb interactions but there is a significant increase in strangeness from p-Pb to Pb-Pb interactions. The enhancement increases with strangeness content as predicted in QGP models and exceeds one order of magnitude in the case of the Ω particle.

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