RESULTS ON CASCADE PRODUCTION IN LEAD-LEAD INTERACTIONS FROM THE NA57 EXPERIMENT

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The NA57 experiment has been designed to study the production of strange and multi-strange particles in Pb-Pb and p-Be collisions at the CERN SPS.
The predecessor experiment WA97 has measured an enhanced abundance of strange particles in Pb-Pb collisions relative to p-A reactions at 160 GeV/c per nucleon beam momentum. NA57 has extended the WA97 measurements to investigate the evolution of the strangeness enhancement pattern as a function of the beam energy and over a wider centrality range. In this paper, we report results on Ξ^- and $\overline{\Xi}^+$ hyperon production for about the 60% most central Pb-Pb collisions at 160 GeV/c per nucleon.

1 Introduction

The WA97 experiment has measured an enhancement in the production of strange and multi-strange baryons and anti-baryons when going from p-Be to central Pb-Pb collisions [1]. The observed effect increases with the strangeness content of the particles. Such a behaviour has been predicted [2] as a consequence of the QCD phase transition to a Quark Gluon Plasma (QGP) and is not reproduced by microscopic hadronic collision models.
The main goal of NA57 is to study the dependence of the enhancement on the interaction volume and on the collision energy per incoming nucleon [3]. To this purpose, the experiment has extended the centrality range down to a lower limit of about 50 wounded nucleons (the corresponding limit for WA97 was about 100) and has collected data using both 160 and 40 A GeV/c beams at the CERN SPS.

2 Experimental apparatus and data sets

The NA57 experiment detects strange and multi-strange hyperons by reconstructing their weak decays into final states with charged particles only (e.g. $\Xi^- \to \Lambda\pi^-$, with $\Lambda \to \pi^- p$). Tracks are measured in the silicon telescope, an array of 13 pixel detector planes with 5×5 cm^2 cross section and 30 cm length, placed 60 cm downstream of the target and inclined with respect to the beam line to match the central rapidity region. Similarly to WA97, the full acceptance coverage corresponds to about one unit of rapidity at medium transverse momentum. The centrality trigger for Pb-Pb interactions, based on a scintillator petal system placed 10 cm downstream of the target, selects the most central 60% of the inelastic cross section. The centrality of the collision is determined from the charged particle multiplicity sampled at central rapidity by two silicon strip detector stations (MSD). A detailed description of the full apparatus can be found elsewhere [4].
A summary of the NA57 data samples is reported in Table 1. The experiment has collected data on Pb-Pb collisions at both 160 and 40 A GeV/c beam momentum. A small reference data sample of p-Be interactions at 40 GeV/c was collected in 1999. The collection of p-Be reference data will continue in the summer 2001.

Table 1: Data sets and status of reconstruction.

System	Beam mom.	Sample size	Data taking	Reconstruction
Pb Pb	160 A GeV/c	230 M events	November 1998	February 2000
p Be	40 GeV/c	60 M events	July 1999	July 2000
Pb Pb	40 A GeV/c	290 M events	November 1999	January 2001
Pb Pb	160 A GeV/c	230 M events	October 2000	October 2001 (exp)
p Be	40 GeV/c	150 M events (exp)	August 2001	December 2001 (exp)

Reference data on p-Be and p-Pb at 160 GeV/c are available from the WA97 measurements. The results on Ξ^- and $\overline{\Xi}^+$ particles reported in this paper have been obtained analyzing the 1998 Pb-Pb data sample at 160 A GeV/c.

3 Data analysis and results

The collision centrality has been evaluated by measuring the charged particle multiplicity in the interval $2 < \eta < 4$ by the MSD. The multiplicity spectrum, divided into five bins, is shown in the left hand plot on Fig.1: the drop at low multiplicities is due to the centrality trigger condition. The measured cross section corresponding to each class is also indicated. The distributions of the number of wounded nucleons, obtained in the framework of the Glauber Model, are shown on the right hand plot [5]. Classes I to IV correspond to the four centrality bins of WA97.

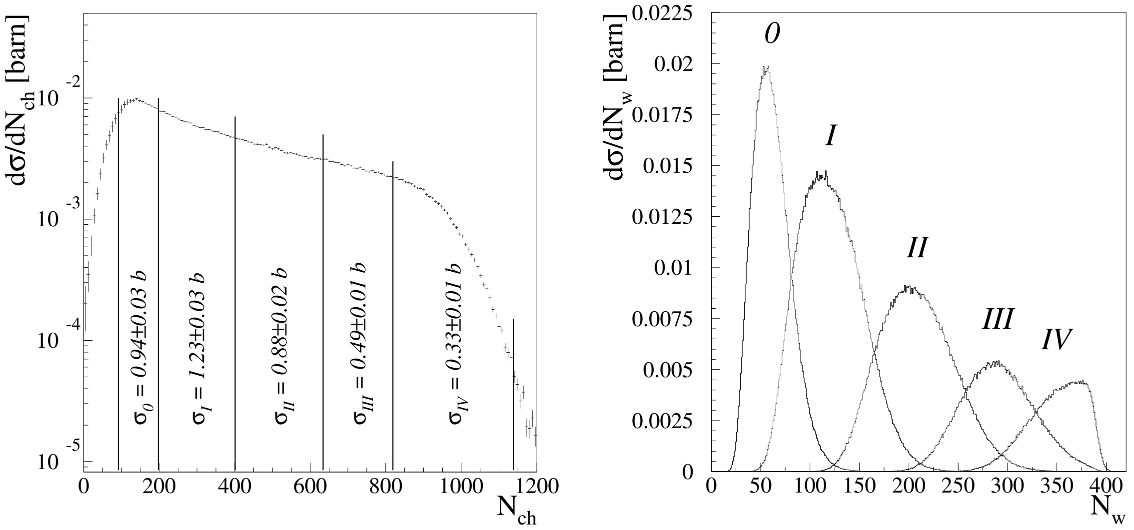

Figure 1: Multiplicity distribution (left) and distributions of wounded nucleons in each multiplicity class (right).

Fig.2 shows the $\Lambda\pi$ invariant mass distributions after all the selection cuts and the corresponding kinematic window (enclosed area) selected in the y-p_T distribution of the reconstructed Ξ^- and $\overline{\Xi}^+$ particles.

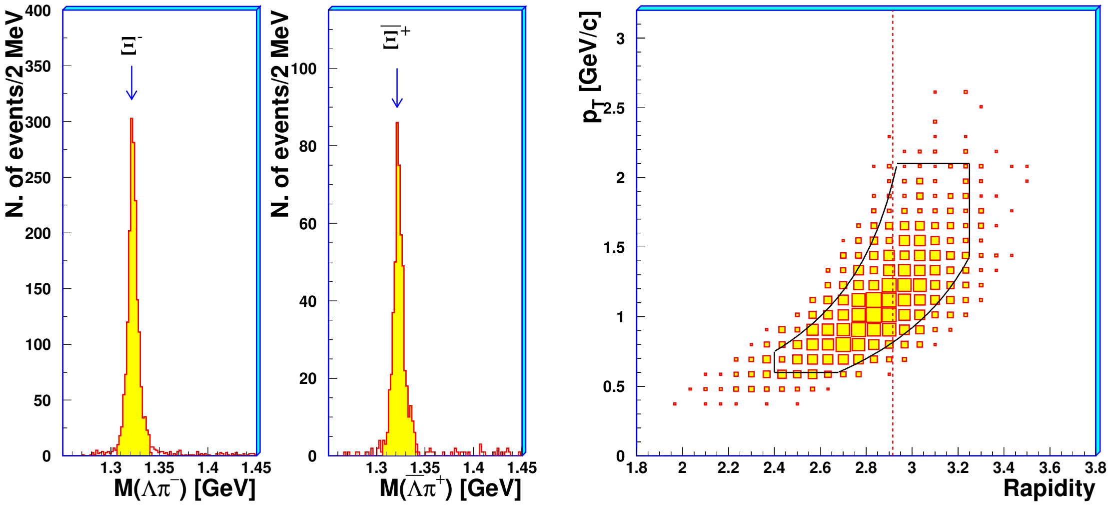

Figure 2: $\Lambda\pi$ invariant mass distributions (left) and corresponding p_T versus rapidity distribution (right).

The transverse mass distributions have been parametrized according to:

$$\frac{d^2N}{dm_T dy} = A\, m_T \exp\left(-\frac{m_T}{T}\right) \tag{1}$$

and the inverse slopes T have been extracted using a maximum likelihood fit. The values are found [6] to be compatible with the WA97 ones. No significant variation with the collision centrality is observed within the present statistics.
The particle yields have been computed by integrating Eq.1 over one unit of rapidity and extrapolating to $p_T = 0$. In Fig.3 the NA57 yields for Ξ^- and $\overline{\Xi}^+$ relative to the p-Be yields are shown in the five classes, as a function of the centrality of the collision.

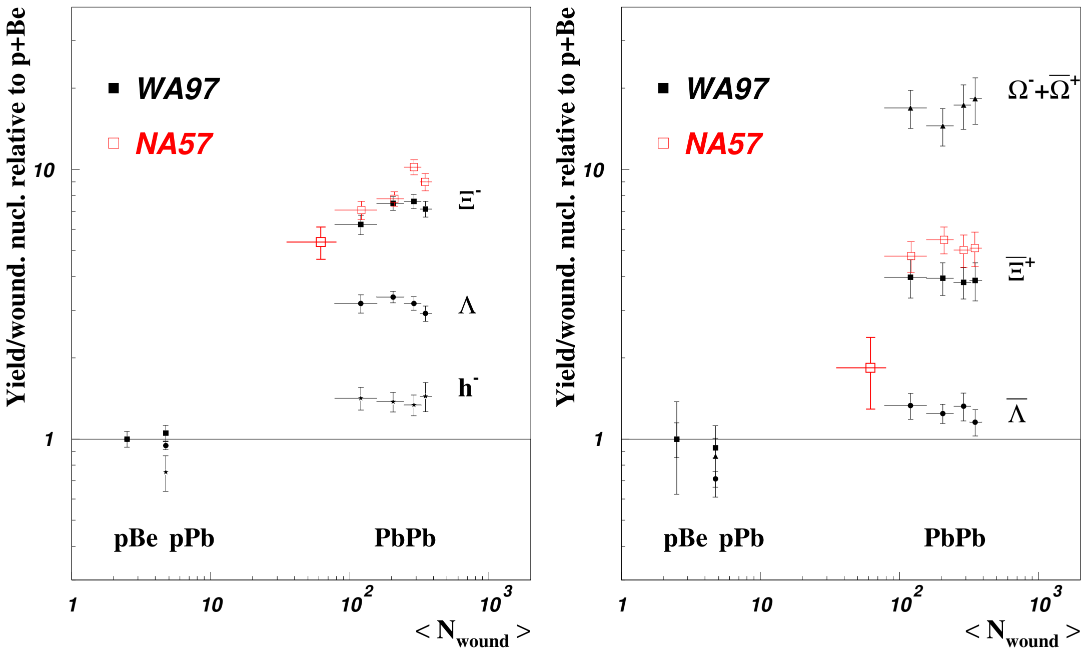

Figure 3: Yields per wounded nucleons relative to p-Be from WA97 for all measured particles (closed symbols) and from NA57 for Ξ^- and $\overline{\Xi}^+$ (open symbols).

All the WA97 yields in the four most central classes are also reported. In the common centrality region the NA57 yields are about 20% larger than the WA97 ones: this systematic difference is under investigation. In the new low-centrality bin the $\overline{\Xi}^+$ (Ξ^-) yields, as measured by NA57, drop by a factor 2.6 (1.3) corresponding to a 3.5 (1.8) sigma effect. Such a sudden reduction of the yields as a function of centrality cannot be an artifact of our acceptance correction procedure since a similar drop is already present in the uncorrected data [6].

4 Summary and outlook

Results from NA57 on cascade production in Pb-Pb collisions at 160 A GeV/c have been reported. The Ξ^- and $\overline{\Xi}^+$ yields per participant in the most peripheral bin are lower than the corresponding values in more central collisions. The sudden drop for $\overline{\Xi}^+$, in particular, warrants further investigation since it could signal the point of the QGP phase transition.

The study of Λ and $\overline{\Lambda}$ on the same sample is under way. A doubling of the statisitcs with year 2000 data will allow later this year to perform the analysis of the triply-strange Ω hyperons and to reduce the error bars on the Ξ yields.

The analysis of the 40 A GeV/c Pb-Pb data is also under way; the collection of the p-Be reference sample, needed to compute the enhancements, will be completed in the next summer.

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