Status of the NA57 experiment at CERN PS

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Abstract
The NA57 experiment aims to investigate the production of strange and multi-strange particles in nucleus–nucleus collisions at CERN SPS. NA57 has been specifically designed to extend the study of Λ, Ξ and Ω as well as the K^o_s (and

their antiparticles) production pattern in ultra-relativistic nuclear collisions, as a function of the centre-of-mass energy and in a wider centrality range than its predecessor WA97. In this paper we recall the main features of the NA57 set-up and we report on the status of the processing and analysis of data samples collected in 1998 with a lead beam at 158 A GeV c^{-1} and in 1999 with lead and proton beams at 40 A GeV c^{-1}.

(Some figures in this article are in colour only in the electronic version; see www.iop.org)

1. Introduction

The WA97 experiment [1] has shown that the multi-strange baryon and antibaryon yields per wounded nucleon at central rapidity are enhanced when going from p–Be to Pb–Pb collisions. The enhancement increases with the strange content of the produced particles. Such an effect has been predicted [2] as a characteristic signature of the phase transition to a quark–gluon plasma, and has so far not been reproduced by microscopic hadronic collision models. The NA57 experiment has been designed to study the strange and multi-strange particle production in nucleus–nucleus collisions as a function of the centre-of-mass energy and collision centrality [3]. Its main physics goal is to search for the onset of the observed strangeness enhancement by:

- extending the centrality range of WA97 for Pb–Pb collisions at 158 A GeV c^{-1}
- measuring the pattern of multi-strange hyperon production in Pb–Pb collisions at lower values of the energy density.

2. The NA57 set-up

The NA57 set-up is designed to measure the decays of strange baryons and antibaryons in the high-multiplicity environment of the Pb–Pb collisions at the SPS. The full apparatus is shown schematically in figure 1: a detailed description can be found elsewhere [4].

We recall here that the heart of the apparatus is a telescope tracker made of silicon pixel detectors, placed inside a 1.4 T magnetic field. Strange and multi-strange particles are identified by reconstructing their weak decays into final states containing only charged particles. The telescope is inclined with respect to the beam line and points back to the target: the inclination angle can be changed to select different laboratory rapidity settings. The full acceptance coverage corresponds to about one unit of rapidity at medium transverse momentum and it is the same for particles and antiparticles.

The centrality trigger for Pb–Pb collisions, based on a scintillator petal system placed 10 cm downstream of the target, selects the most central 60% of the total inelastic cross section (to be compared with 40% in WA97). The centrality of the collision is measured via the charged particle multiplicity, sampled at central rapidity by two multiplicity strip detector (MSD) stations, as in WA97.

3. Data samples

After a commissioning proton run in 1997, the following samples of data for physics analysis have been collected by NA57 in 1998 and 1999:

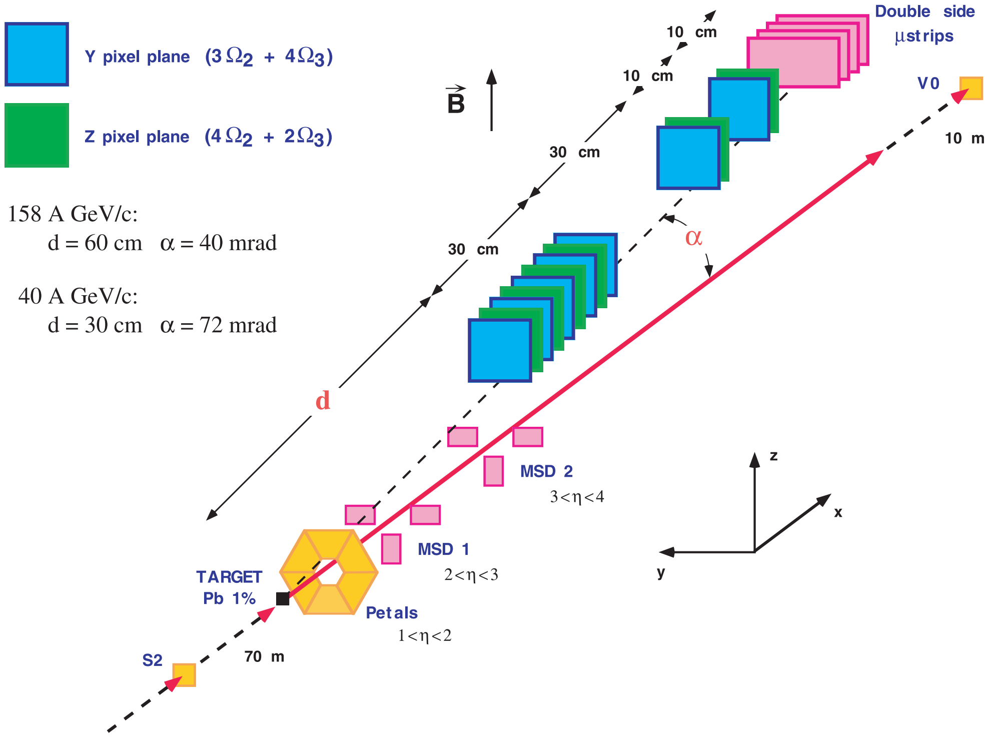

Figure 1. A schematic view of the NA57 layout (not to scale).

- 230×10^6 Pb–Pb triggers at 158 A GeV c^{-1} (1998)
- 60×10^6 p–Be triggers at 40 GeV c^{-1} (1999)
- 260×10^6 Pb–Pb triggers at 40 A GeV c^{-1} (1999).

For the 1998 Pb–Pb data the event reconstruction process has already been completed and the acceptance and efficiency corrections are in progress. The reconstruction of the events collected in 1999 has already been completed for proton data and it is in progress for the Pb–Pb data.

In the year 2000 Pb–Pb data taking at 158 A GeV c^{-1} beam momentum will take place in order to increase the Ξ and Ω statistics, especially for the more peripheral collisions. An additional request for the proton beam is planned for the year 2001 with the main aim being to complete the p–Be data sample.

4. Event reconstruction and physics analysis

The main changes of the NA57 experimental apparatus with respect to WA97 are:

- a new telescope layout, fully based on silicon pixel detectors
- a new magnet (GOLIATH), due to the decommissioning of the OMEGA magnet used by WA97, which provides a slightly weaker, less uniform field than in WA97
- a new data acquisition (DAQ) system, based on the ALICE oriented development of DATE [5].

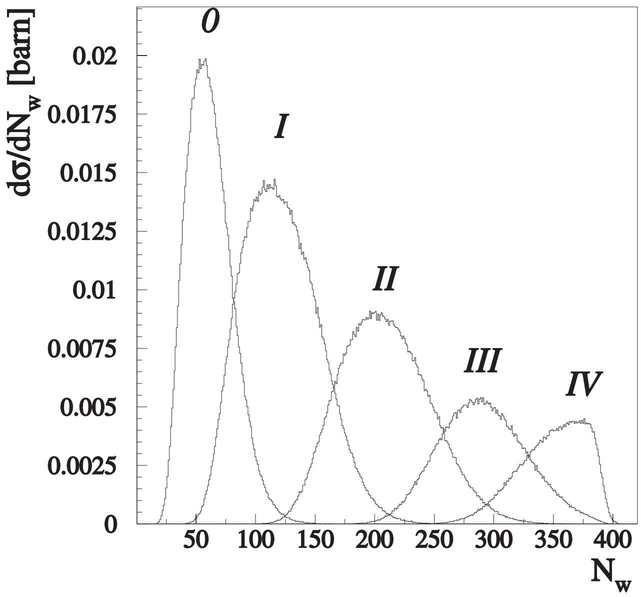

Figure 2. Wounded nucleon distributions for the five NA57 multiplicity classes.

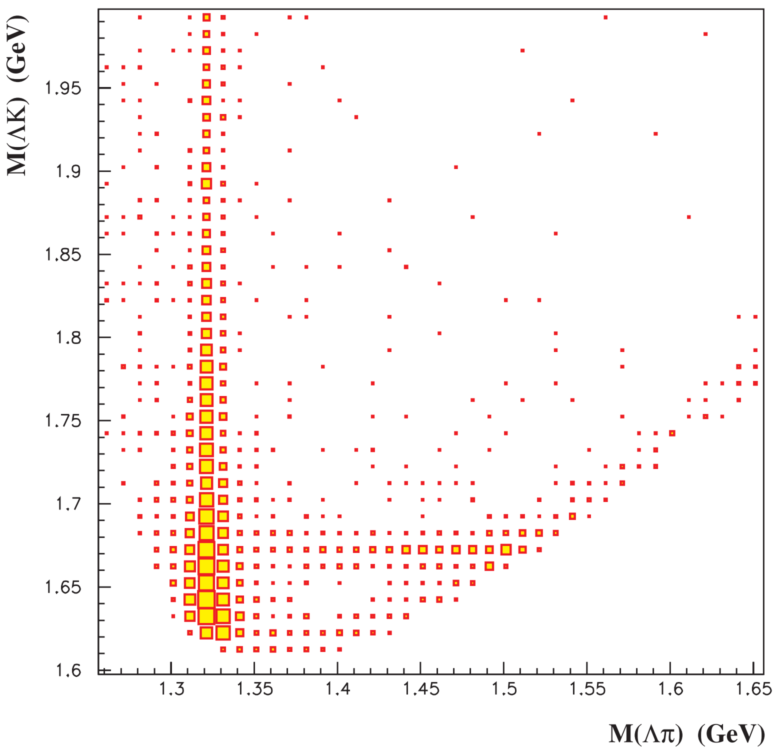

Figure 3. Scatter plot of ΛK versus $\Lambda\pi$ invariant mass.

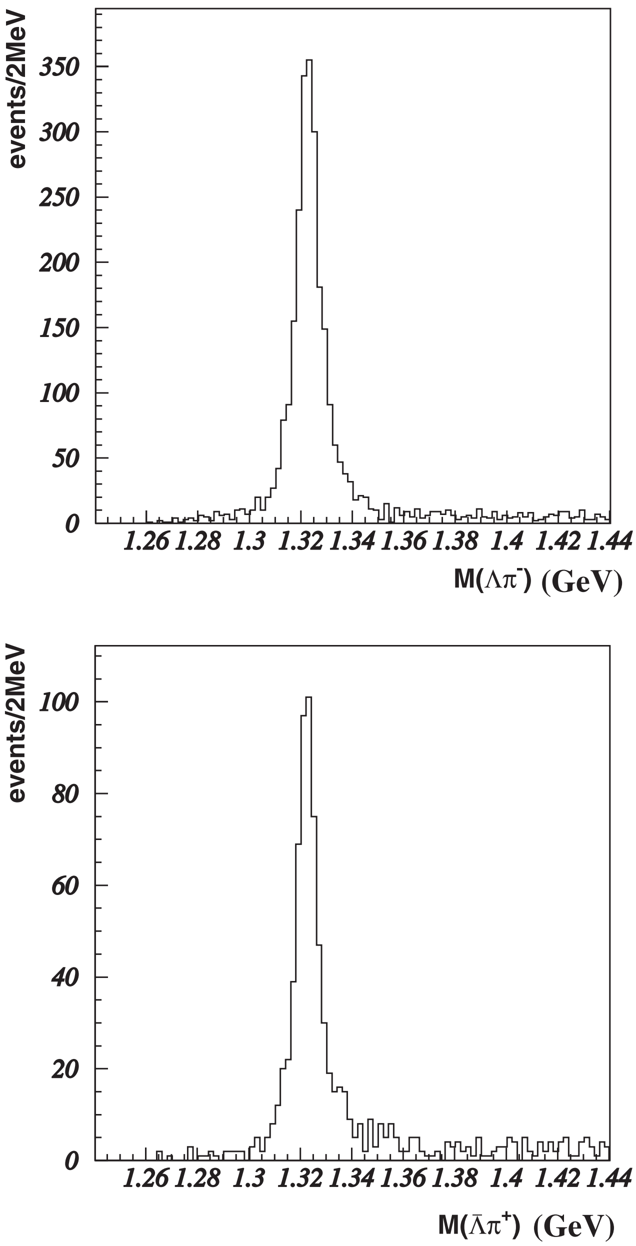

Figure 4. $\Lambda\pi^-$ and $\overline{\Lambda}\pi^+$ invariant mass distributions.

Consequently, the detector alignment procedure and the track finding and event reconstruction software packages had to be significantly changed to match the NA57 specific new features.

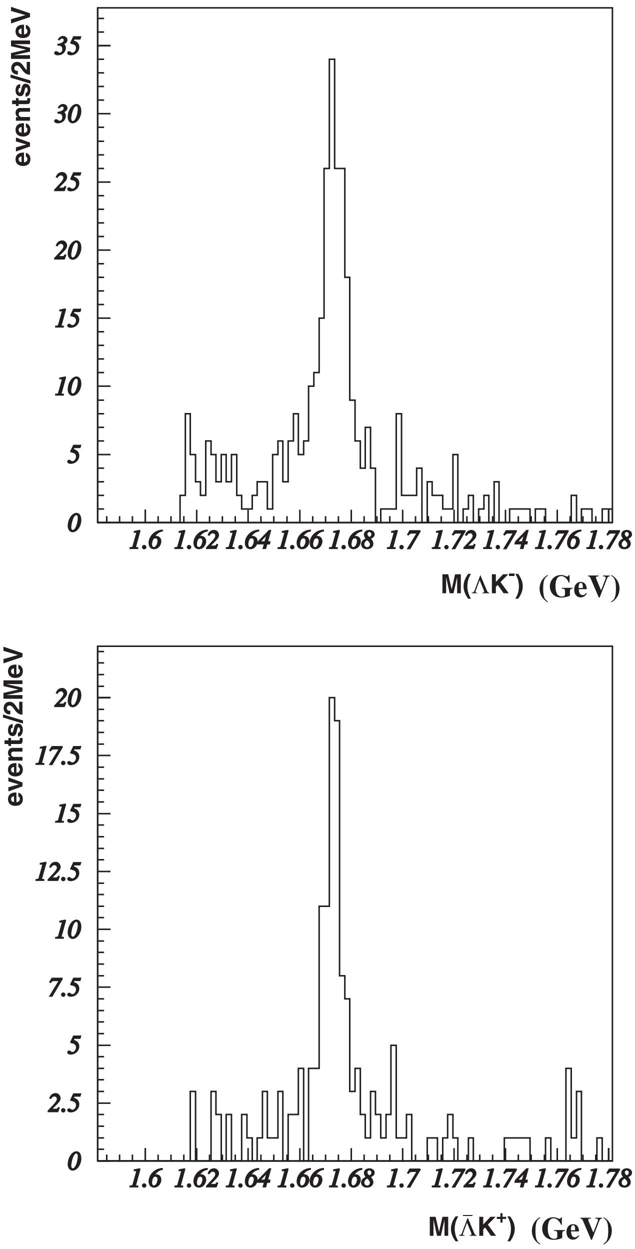

Figure 5. ΛK^- and $\overline{\Lambda} K^+$ invariant mass distributions.

5. Signals from the 1998 data sample

5.1. Centrality range

The study of the collision centrality has been improved with respect to the WA97 data [6]. In the NA57 experiment a precise measurement of the trigger cross section allowed us to estimate

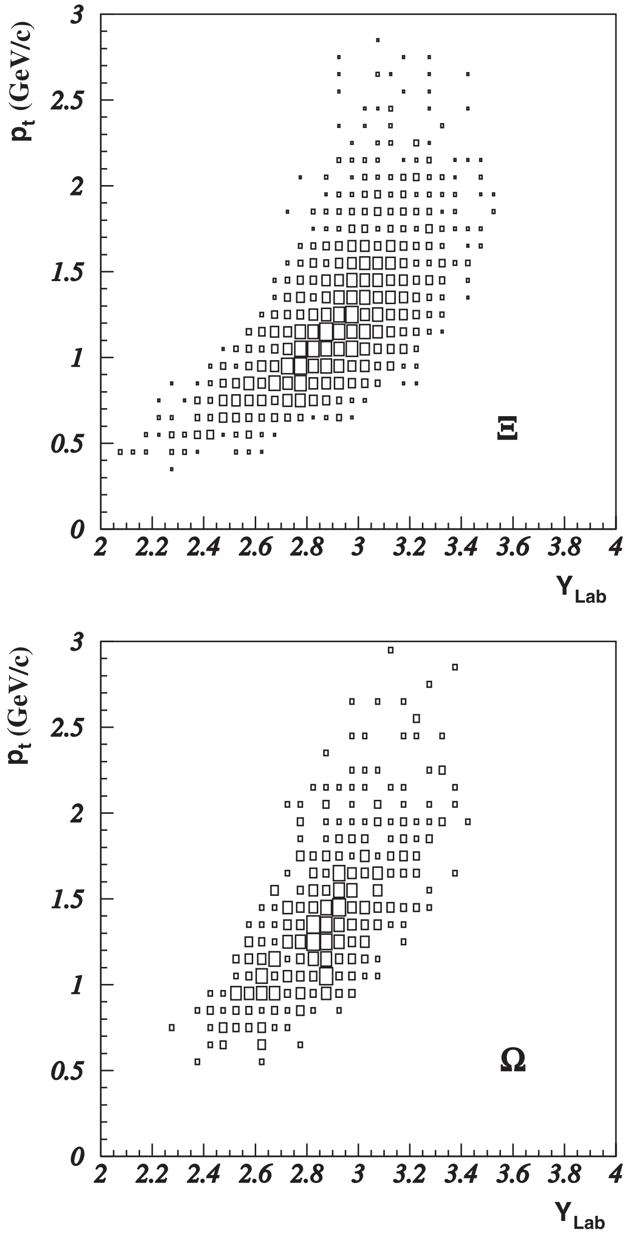

Figure 6. Acceptance windows for Ξ and Ω.

the number of wounded nucleons without assumptions on its scaling with the measured charged particle multiplicity.

The NA57 sample of events has been divided into five multiplicity classes: the corresponding distributions of the number of wounded nucleons are shown in figure 2.

The most peripheral events in the class 0 correspond to the new region to be investigated with respect to the WA97 studies.

5.2. Mass spectra

Figure 3 shows the correlation of the $\Lambda\pi$ and ΛK invariant masses, after preliminary analysis cuts have been applied: clear signals from $\Xi \rightarrow \Lambda\pi$ and $\Omega \rightarrow \Lambda K$ particle decays are visible.

Figures 4 and 5 show the mass spectra in 2 MeV bins for $\Lambda\pi^-$ and ΛK^- and charge-conjugate channels separately. For the Ω^- and $\overline{\Omega}^+$ signals an additional cut is applied to reject the background due to Ξ decays kinematically ambiguous with Ω decays.

The distributions peak at the nominal Ξ and Ω masses, with FWHM of about 10 and 12 MeV, respectively.

The y_{Lab}–p_T distributions for the selected Ξs and Ωs are shown in figure 6. A weighting procedure, based on a Monte Carlo simulation of the full apparatus, will then be applied to each selected particle to account for losses due to geometrical acceptance, detection and reconstruction efficiencies.

6. Summary and future plans

The status of the NA57 analysis has been reported. First results are shown for the centrality analysis, together with the first Ξ and Ω signals from the 1998 Pb–Pb run at 158 A GeV c^{-1}. Low-energy p–Be and Pb–Pb data from 1999 runs at 40 A GeV c^{-1} beam momentum are being processed.

The year 2000 run should provide a substantial increase of the statistics for the Pb–Pb data at 158 GeV c^{-1}. In the year 2001 we plan a 40 A GeV c^{-1} proton run in order to increase the present p–Be statistics.

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