WA97 results on strangeness production in lead-lead collisions at 158 A GeV/c

Presented by H. Helstrup, Bergen, Norway *

The WA97 Collaboration

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Preliminary results from WA97 measurements on Λ, Ξ and Ω production in lead-lead and proton-lead collisions are presented, along with a comparison of WA97 proton-lead data with previous WA85 proton-tungsten results. The ratio Ω/Ξ seems to be enhanced in lead initiated reactions compared to proton initiated reactions.

1. INTRODUCTION

An enhanced production of strange particles has long been suggested as a tool to identify the establishment of a flavour equilibrated system in particle reactions [1,2]. The equilibration times are expected to be much shorter in a Quark Gluon Plasma than in a hadron gas [3,4]. In particular, multistrange (anti-) baryons have been suggested as a useful probe of the early phases of the collision [5], since hadronic production of such particles is strongly suppressed due to high mass thresholds.

An enhanced production of multistrange (anti-)baryons has already been observed in sulphur initiated reactions by the WA85 and WA94 collaborations [6,7].

2. EXPERIMENTAL SETUP

The experimental setup is discussed in detail in ref. [8].

Tracks are identified in a silicon telescope placed 90 cm from a lead target, both placed inside the homogeneous region of the magnetic field of the CERN Omega spectrometer. The central part of the telescope consists of 7 silicon microstrip detectors with a 50 μm pitch, and 3 silicon pixel planes with a pixel size of 75×500 μm^2. An additional station containing a pixel plane and a microstrip plane is placed 150 cm from the target. Lever arm measurements are made by three MWPCs with pad cathode readout, located just outside the magnetic field at a distance of 4 m from the target.

The telescope is configured as to give acceptance in the region of central rapidity and medium transverse momentum. The geometric acceptance is the same for particles and antiparticles, since our apparatus is symmetric in the magnetic bend direction.

Multiplicity detectors located close to the target provide a centrality trigger of about 30% of the cross section. Additional silicon microstrip multiplicity detectors allow for more detailed offline analysis of centrality dependences. Furthermore, a zero degree calorimeter is placed about 26 m from the target.

The results presented here are based on analysis of 9 M lead-lead events and 60 M proton-lead events, corresponding to about 3% and 60 % of the collected statistics respectively.

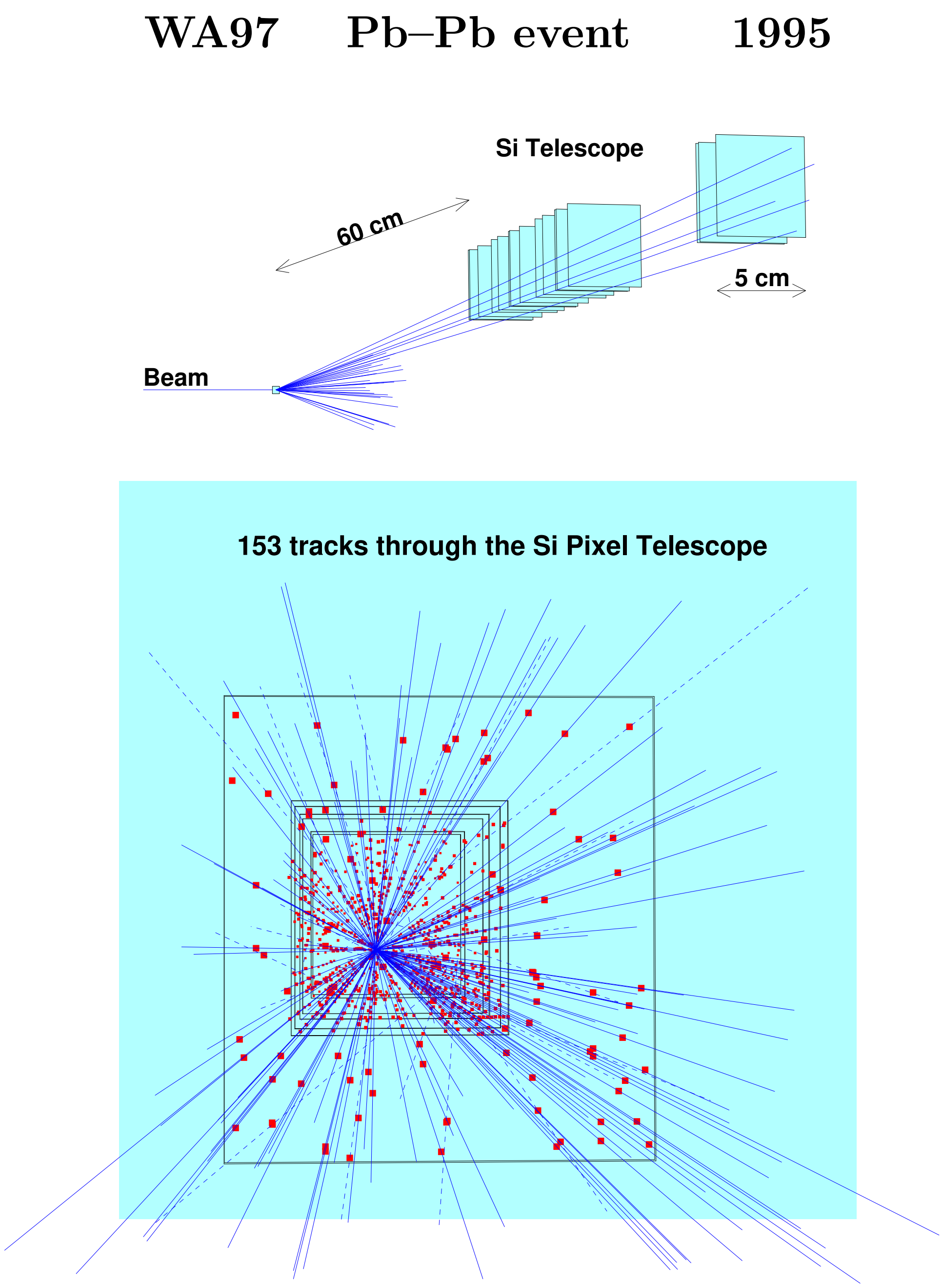

Figure 1. Reconstructed tracks in the WA97 pixel telescope in a no-field event.

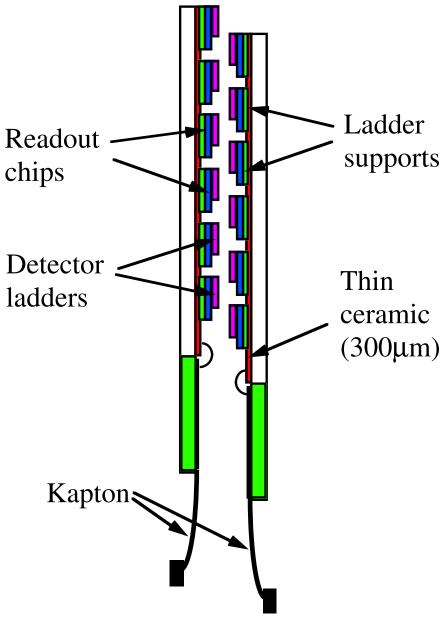

Figure 2. Layout of a silicon pixel plane consisting of two arrays containing six ladders each.

3. SILICON PIXEL DETECTORS

The silicon pixel detectors, recently developed in collaboration with the CERN RD19 group [9], form a crucial part of the WA97 telescope. Figure 1 shows an event from the 1995 lead run, where the telescope is placed 60 cm from the target. This no-field event contains 153 reconstructed tracks, corresponding to an occupancy of about 0.2 % of the 72K channels provided by each pixel plane.

The pixel planes are built from 12 ladders, each providing 96×63 sensitive pixels with a pixel size of 500×75 μm^2. Six read-out chips are bump-bonded directly to the sensitive area of each ladder. To cover a 5×5 cm^2 region, two arrays consisting of six ladders each are mounted in a staggered fashion as outlined in figure 2. The two arrays are mounted some mm apart, but due to a small overlap at the edges of each ladder, the whole 5×5 cm^2 region is covered by sensitive material.

An overall detector efficiency above 95% have been obtained for all planes during the

1994 lead run.

4. ANALYSIS AND SELECTION CRITERIA

Strange particles are identified by reconstructing their decay tracks in the silicon telescope. All decays are required to take place in a decay region, starting at 50 cm from the target and ending just before the first plane of the telescope. All decay tracks are required to pass all the planes in the compact part of the telescope (30 cm).

Pairs of oppositely charged tracks are considered V^0 candidates if the distance of closest approach between the two tracks is < 0.05 cm, and this point falls within the decay region. The V^0 candidate should point back to the reconstructed target position within 0.3 cm in the bend plane of the magnetic field, and 0.15 cm in the other direction.

Projected to the magnetic bend plane, two V^0 topologies are possible, depending on the direction of the initial momenta of the decay particles. If the magnetic force bend the two decay tracks towards each other, they will cross again downstreams of the decay point. This is referred to as the *cowboy* topology. In the opposite case, the *sailor* topology, a (non-physical) second crossing can be reconstructed upstreams of the decay point.

The WA97 telescope acceptance favour the *cowboy* topology, as the tracks from this decay topology keep closer together in space. Pairs of tracks coming from the target may also simulate a *sailor* vertex inside the decay region, thus producing extra background. Only *cowboy* candidates are accepted for further analysis. This corresponds to 70% of the

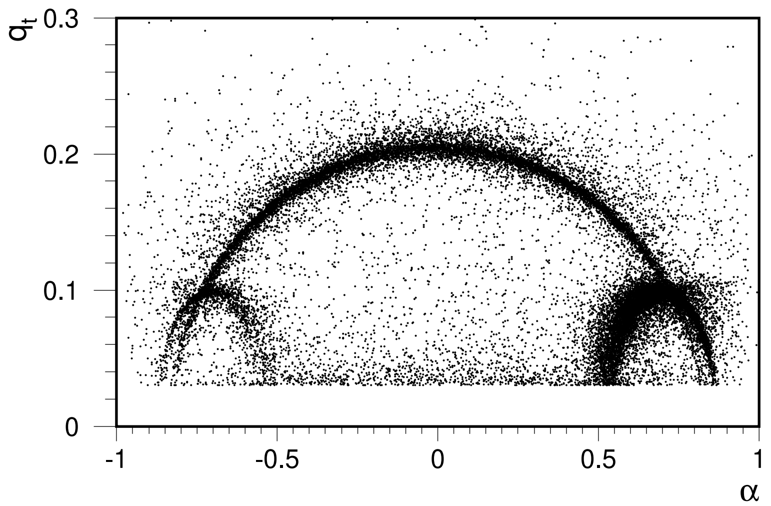

Figure 3. Podolanski-Armenteros plot for the lead data sample. V^0 candidates with low q_t ($q_t < 0.03$ GeV/c) have been removed to reduce background from electron pairs.

total sample of V^0 candidates.

Λ and $\overline{\Lambda}$ candidates are selected using the Podolanski-Armenteros variables α and q_t, $|\alpha| > 0.45$ and $0.03 < q_t < 0.40$ GeV/c. Additionally, to avoid ambiguities, a V^0 is rejected as a Λ candidate if the reconstructed K^0 mass is within 25 MeV of the table value. The Podolanski-Armenteros plot obtained from the lead data sample is shown in figure 3. Clear accumulations of points can be found around the ellipses corresponding to the Λ and K^0 masses.

Cascade candidates ($\Xi \rightarrow \Lambda\pi$, $\Omega \rightarrow \Lambda K$) are selected by combining an already reconstructed V^0 with a third track. The Ω candidates are required to be unambigous with respect to Ξs, by rejecting Ω candidates if their reconstructed Ξ mass is less than 1.38 GeV (Ξ table value 1.321 GeV).

5. COMPARISON TO WA85 PROTON DATA

The WA97 proton data have been compared to previous proton-tungsten data from WA85 [10]. The preliminary WA97 data are corrected for geometrical acceptance, but not for reconstruction efficiency and feed-down from cascade decays. The WA85 proton-tungsten data are fully corrected.

The inverse slopes, τ, for lambdas and antilambdas, fitted by the expression

$$\left(\frac{1}{m_t}\right)^{\frac{3}{2}} \frac{\mathrm{d}N}{\mathrm{d}m_t} \propto e^{\frac{-m_t}{\tau}} \tag{1}$$

in the m_t range > 1.5 GeV/c, are shown in the upper part of table 1. The errors quoted for the WA97 data are statistical only. The uncorrected $\overline{\Lambda}/\Lambda$ ratio is compared to WA85 values in the lower part of table 1. Altogether, there is a good agreement between the two experiments.

Table 1
Inverse slopes and particle ratios measured by WA85 and WA97

	Inverse slope (MeV)	
Particle	WA85 (p-W)	WA97 (p-Pb)
Λ	197 ± 2	212 ± 7
$\overline{\Lambda}$	185 ± 5	179 ± 10
	$2.3 < y_{lab} < 2.8$	$2.9 < y_{lab} < 3.1$
Ratio	$m_t > 1.9$ GeV	$m_t > 1.8$ GeV
$\overline{\Lambda}/\Lambda$	0.19 ± 0.02	0.20 ± 0.03

6. LEAD BEAM RESULTS

6.1. Lambda results

The lambda and antilambda mass spectra extracted from the 1994 lead data in the rapidity range $2.5 < y_{lab} < 3.4$, are shown in figure 4.

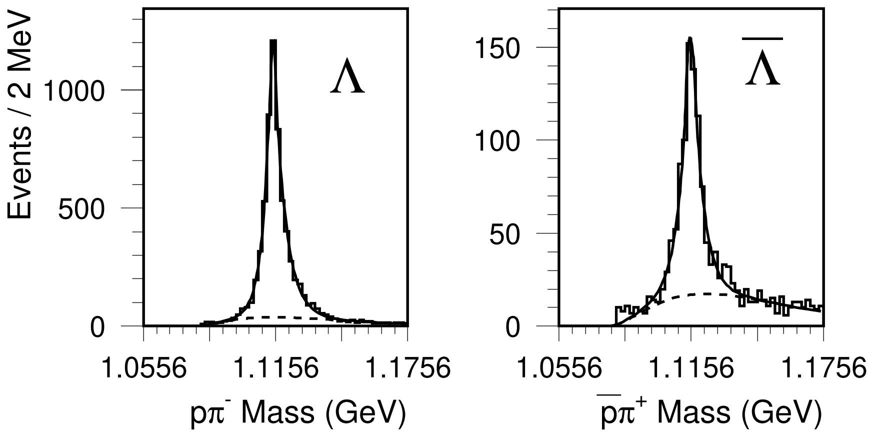

Figure 4. Lambda and antilambda mass spectra in 2 MeV bins. Full line shows fitted function, dashed line shows background component only.

Preliminary $\overline{\Lambda}/\Lambda$ ratios are calculated after background subtraction, but not corrected for geometrical acceptance or reconstruction efficiency. However, to a first approximation these corrections should cancel, due to the symmetry of the $\Lambda/\overline{\Lambda}$ system. The ratios are not corrected for feed-down from cascade decays, but the effect of this correction is expected to fall within the quoted errors.

Table 2
Antilambda/lambda ratio in different p_t bins

	WA97 $2.9 < y_{lab} < 3.1$		WA94 $2.5 < y_{lab} < 3.0$	WA85 $2.3 < y_{lab} < 3.0$
p_t	p-Pb	Pb-Pb	S-S	S-W
0.6-0.9	0.27 ± 0.03	0.14 ± 0.02		
0.9-1.2	0.26 ± 0.03	0.13 ± 0.02		
1.2-2.0	0.23 ± 0.03	0.13 ± 0.02		
1.2-3.0			0.23 ± 0.01	0.20 ± 0.01

Table 2 presents the $\overline{\Lambda}/\Lambda$ ratio in three different bins of transverse momentum, both for WA97 proton and lead data. For comparison, WA85 and WA94 values, taken from refs. [6,7], are also presented. Note that the rapidity and transverse momentum ranges for these data points are somewhat different from the ones presented for the WA97 data.

The $\overline{\Lambda}/\Lambda$ ratio presented in section 5 is calculated with the cut $m_t > 1.8$ GeV. This correspond to a p_t cut around 1.4 GeV/c, and is thus consistent with the values presented in table 2.

6.2. Cascade results

Multistrange hyperons are identified by their cascade decays ($\Xi \rightarrow \Lambda\pi$, $\Omega \rightarrow \Lambda K$). The total sample of Ωs reconstructed by WA97 so far (in proton-lead and lead-lead data) is shown in figure 5. This mass spectrum shows a clear peak at the Ω mass, well above background.

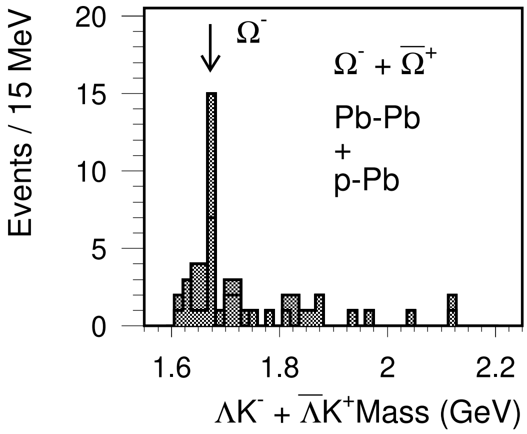

Figure 5. Total sample of Ωs reconstructed by WA97

In the proton run a trigger was applied to select events with tracks in the telescope. Figure 6 shows the raw mass peaks for ($\Xi^- + \overline{\Xi}^+$) and ($\Omega^- + \overline{\Omega}^+$) in p-Pb and Pb-Pb collisions.

At this preliminary stage of the analysis, the relative normalization between the p-Pb and Pb-Pb samples has not yet been determined. Therefore, we shall only compare the observed Ω/Ξ ratio from p-Pb with the corresponding one from Pb-Pb. In such a comparison, geometrical acceptances are taken into account, and we assume the same reconstruction efficiency for Ωs and Ξs for each of the two samples, as both these particles are identified by reconstructing three tracks in the spectrometer. These correction factors can then be assumed to cancel when ratios are calculated. Assuming the same Ω/Ξ production ratio in p-Pb as in Pb-Pb, we would expect an Ω signal about five times stronger in the p-Pb data than the one shown in figure 6. The Ω/Ξ ratio appears therefore to be strongly enhanced comparing Pb-Pb collisions to p-Pb collisions.

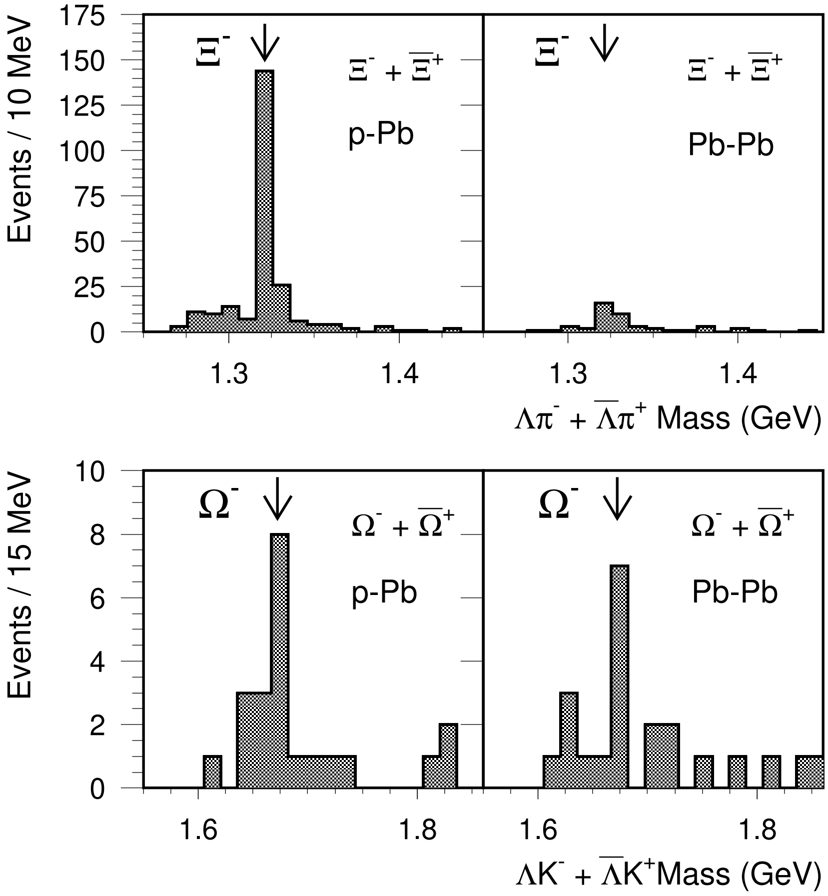

Figure 6. Uncorrected Ξ and Ω mass spectra from WA97

7. CONCLUSIONS

First results from WA97 lead-lead and proton-lead data are presented. WA97 proton-lead data are in good agreement with previous WA85 proton-tungsten data.

Uncorrected values for the $\overline{\Lambda}/\Lambda$ ratio are presented in different bins of transverse momentum. The values obtained from the lead data are significantly lower than the values obtained from the proton data and from previous sulphur data [6,7].

Comparisons of raw mass spectra of Ξs and Ωs suggest that the Ω production is enhanced with respect to Ξ production in lead initiated reaction with respect to proton initiated reactions.

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