Λ and $\bar{\Lambda}$ hyperons production by polarised muons at COMPASS.

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Λ and $\bar{\Lambda}$ production in deep-inelastic scattering of 160 GeV/c polarised muons on a polarised ^{6}LiD target is under study in the COMPASS experiment. Preliminary results from data collected during 2002 beam period are presented.

Measurements of Λ polarisation in target fragmentation region provide important information on the fundamental properties of the nucleon such as the role of the $\bar{s}s$ pairs in the proton wave function [1]. The polarised nucleon intrinsic strangeness model [2, 3] predicts negative longitudinal polarisation of Λ hyperons produced in target fragmentation region. The measurement of the Λ polarisation in the current fragmentation region allows to investigate another phenomenon, namely the spin transfer from polarised quark to a polarised baryon. Recent theoretical models of Λ polarisation in DIS can be found in [4]-[8]. The experimental situation of Λ production in DIS is summarised in Table 1. One can see that in target fragmentation region the Λ polarisation is negative, the spin transfer for current fragmentation region seems small, however the experimental data are quite scarce.

COMPASS studies Λ and $\bar{\Lambda}$ production by polarised muons of 160 GeV/c on a polarised ^{6}LiD target of the COMPASS spectrometer constructing in framework of CERN experiment NA58 (for description, see talk of C. Marchand at this conference).

The total amount of collected data during the run in 2002 is about 260 TB, with typical event size of 35 kB. This analysis uses about 10^7 DIS events, which correspond to is approximately 1/6 of the total 2002 statistics. A similar set of data is being collected in the 2003 run.

The polarised ^{6}LiD target consists of two oppositively polarised 60 cm long cells. The data presented here are averaged on target polarization.

Reaction Exp.	$< E_b >$ (GeV)	x_F	N_Λ	P_Λ	$N_{\bar{\Lambda}}$	$P_{\bar{\Lambda}}$
$\bar{\nu_\mu} Ne$	40	$x_F < 0$	403	-0.63 ± 0.13		
WA59[11]		$x_F > 0$	66	-0.11 ± 0.45		
μN	470	$0 < x_F < 0.3$	750	1.2 ± 0.5	650	-0.26 ± 0.6
E665 [12]		$x_F > 0.3$		0.32 ± 0.7		-1.1 ± 0.8
$\nu_\mu N$	43.8	$x_F < 0$	5608	-0.21 ± 0.04	248	0.23 ± 0.20
NOMAD [13]		$x_F > 0$	2479	-0.09 ± 0.06	401	-0.23 ± 0.15
eN	27.5	$x_F > 0$	$\approx 10^4$	$\frac{P_\Lambda}{P_B D} =$		
HERMES [14]				0.06 ± 0.09		

Table 1: Summary of experimental measurements of Λ hyperon polarisation in DIS. Sign of polarisation is given with respect to virtual photon momentum.

Selection criteria of Λ, $\bar{\Lambda}$ and K^0_s (V^0) are the following. The primary vertex should be inside target cells whereas the decay vertex of V^0 must be outside of the target. The angle between vector of V^0 momentum and vector between primary and V^0 vertices should be $\theta_{col} < 0.01$ rad. Cut on transverse momentum of the decay products with respect to the direction of V^0 particle $p_t > 23$ MeV/c was applied to reject e^+e^- pairs from the γ conversion.

The standard DIS cut $Q^2 > 1$ (GeV/c)^2 and $0.2 < y < 0.9$ have been used. After background subtraction the experimental sample containes about 3600 Λ and 2000 $\bar{\Lambda}$.

The kinematical characteristics of produced Λ, $\bar{\Lambda}$ and K^0_s are shown in Fig.1 and Fig.2. The x_F and Q^2 experimental distributions are compared to Monte-Carlo ones in Fig. 1. COMPASS is able to access mostly current fragmentation region. The momenta of V^0 particles and their decay products are shown on Fig.2; the mean Λ momentum is 12 GeV/c, while decay pion momentum is 2 GeV/c. Both figures shows reasonable agreement between data and Monte-Carlo. In the simulation , the DIS events are produced by LEPTO 6.5.1 generator [9] and the apparatus is described by a full GEANT 3.21 [10] model.

Λ ($\bar{\Lambda}$) hyperon polarisation can be measured via the angular asymmetry of positive particle in $\Lambda \to p\pi^-$ ($\bar{\Lambda} \to \bar{p}\pi^+$) decays. Angular distribution of the

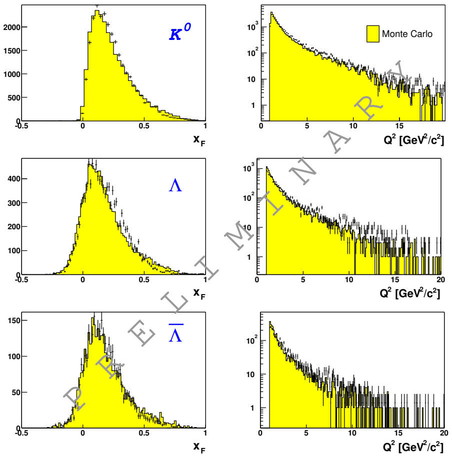

Figure 1: x_F (left column) and Q^2 (right column) distributions for K_s^0 (upper row), Λ (middle row) and $\bar{\Lambda}$ (lower row). The experimental data points are shown together with Monte-Carlo data.

positive particle in Λ ($\bar{\Lambda}$) rest frame is

$$\frac{dN}{d\cos\theta_i} = \frac{N}{2}\left(1 + (-)\alpha P_i \cos\theta_i\right)$$

where i = x,y,z, coordinate system for each Λ ($\bar{\Lambda}$) hyperon, polarisation vector $\mathbf{P} = (P_x, P_y, P_z)$, $\cos\theta_i = \mathbf{n}_i \cdot \mathbf{k}$, $\mathbf{k}$ is the unit vector of the direction of the positive decay particle and α is hyperon decay parameter.

An convenient coordinate system can be built using directions of virtual photon ($\mathbf{e}_\gamma$) and target nucleon ($\mathbf{e}_T$), all vectors are taken in the Λ rest frame:
$\mathbf{n}_x = \mathbf{e}_\gamma$
$\mathbf{n}_y = \mathbf{e}_\gamma \times \mathbf{e}_T / |\mathbf{e}_\gamma \times \mathbf{e}_T|$
$\mathbf{n}_z = \mathbf{n}_x \times \mathbf{n}_y$

The analysis was performed slicing each angular distribution in 10 bins and fitting the invariant mass distribution of V^0 peak to obtain the number of events in the bin. Fig. 3 shows ratios of measured $\cos\theta_i$ distributions to Monte-Carlo ones for K_s^0, Λ and $\bar{\Lambda}$. It is expected that such distributions should be flat

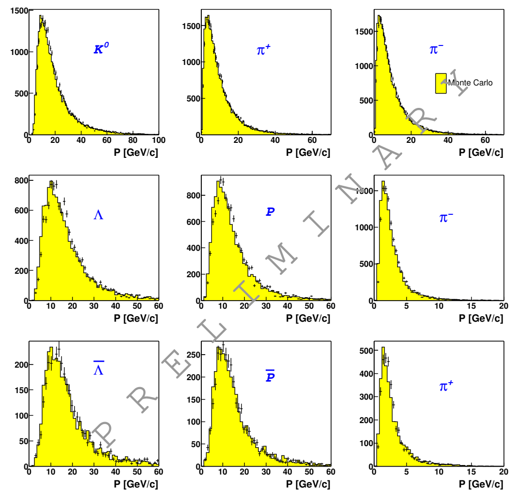

Figure 2: The momentum spectra for strange particles and their decay products are shown: K_s^0, π^+ and π^- in upper row; Λ, proton and π^- in middle row; and $\bar{\Lambda}$, $\bar{p}$ and π^+ in lower row. The experimental data points are shown together with Monte-Carlo data.

for K_s^0 since it is spinless particle, might show some polarisation in $\cos\theta_x$ and $\cos\theta_y$ for Λ and $\bar{\Lambda}$ hyperons, but $\cos\theta_z$ distribution should be also flat for them. One can see that indeed no artificial polarisation is produced by the apapratus and by the analysis procedure. There is indication that Λ and $\bar{\Lambda}$ polarisations are small.

The complete analysis of the 2002 data will significantly increase the statistics on Λ and $\bar{\Lambda}$ hyperons (only 1/6 of 2002 data statistics were processed till now) and perform measurement of their longitudinal polarisation.

COMPASS 2002 data show good potential for Λ and $\bar{\Lambda}$ hyperons polarisation measurement.

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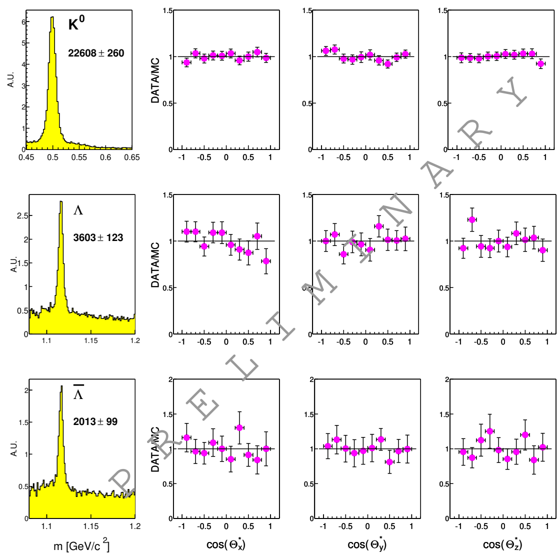

Figure 3: The ratios of measured over MC $\cos\theta_x$ (second column) $\cos\theta_y$ (third column) and $\cos\theta_z$ (forth column) distributions for K_s^0 (upper row), Λ (middle row) and $\bar{\Lambda}$ (lower row). The first column shows invariant mass distributions for K_s^0, Λ and $\bar{\Lambda}$, respectively.

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