Puzzles of spin and strangeness in hadronic hyperon production

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Λ polarization: a reminder

Ω production by Σ^-: new data

A search for Ω^- resonances

hyperon beam:

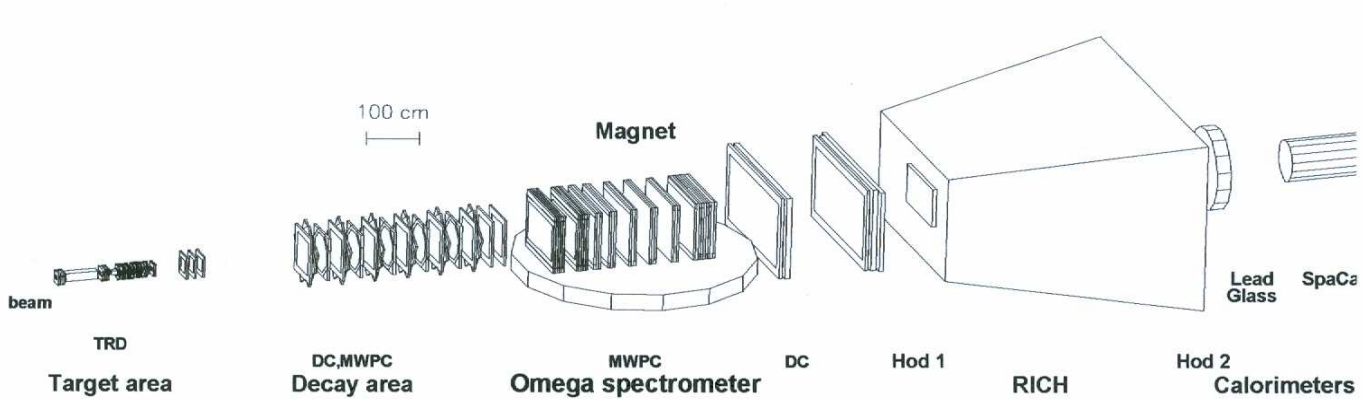
negative secondaries with mean momentum 340 GeV/c produced by SPS-protons of 450 GeV/c in Be target

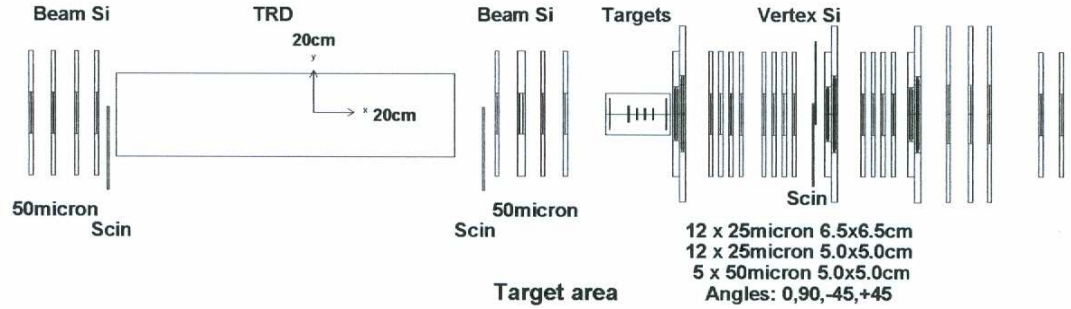
expt. target 16m downstream of proton target,
at the target $\Sigma^-/\pi^-/K^-/\Xi^- = 1/2.3/0.025/0.08$
π^- suppressed in trigger by TRAD counters

10m field-free decay region downstream of target

Omega magnet: 1.8T, field region 4m diam., 1.8m height

RICH: acceptance cutoff at $\approx$12 GeV/c
K^- threshold at 19.5 GeV/c


100 cm
Magnet
beam
TRD
Target area
DC,MWPC
Decay area
MWPC
DC
Omega spectrometer
Hod 1
RICH
Lead Glass
SpaCa
Hod 2
Calorimeters

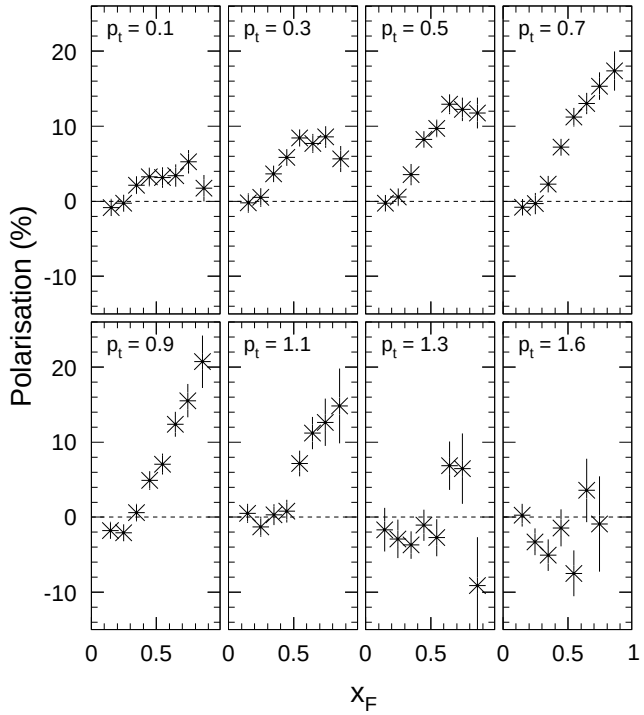

Beam Si
TRD
20cm
y
x
20cm
50micron
Scin
Beam Si
50micron
Scin
Target area
Targets
Vertex Si
Scin
12 x 25micron 6.5x6.5cm
12 x 25micron 5.0x5.0cm
5 x 50micron 5.0x5.0cm
Angles: 0,90,-45,+45

As reported in the previous workshop here, the polarization of Λ produced by Σ^- of 340 GeV/c momentum has *positive* sign:

WA89 (CERN), Σ^--beam (340 GeV/c), Λ and Ξ^- polarization
Eur. Phys. J. C32,221 and C36,315 (2004)

SELEX (Fermilab), Σ^- (610 GeV/c) and proton (525 GeV/c) beams, Λ (and $\overline{\Lambda}$) polarization arXiv:0706.3660v1

Λ polarizations from expt. WA89, as a function of x_F for fixed bins in p_t, in units of %



Two surprises:

P is mainly positive !!

in disagreement with predictions from recombination model:

Y. Yamamoto, K. Kubo and H. Toki, Prog. Theor. Phys. **98** (1997) 95

L. Zuo-tang and C. Boros, Phys. Rev. Lett. **79** (1997) 3608

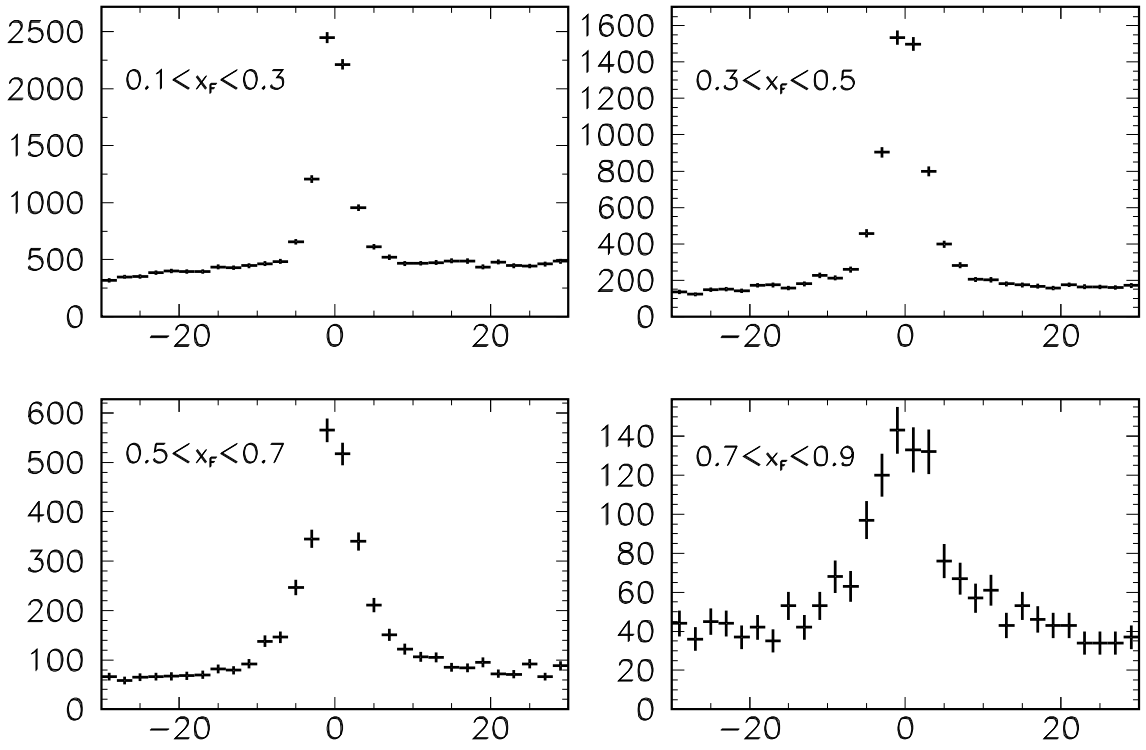
P breaks down above $p_t \approx$ 1.2 GeV/c !

Ω^- production by Σ^-:

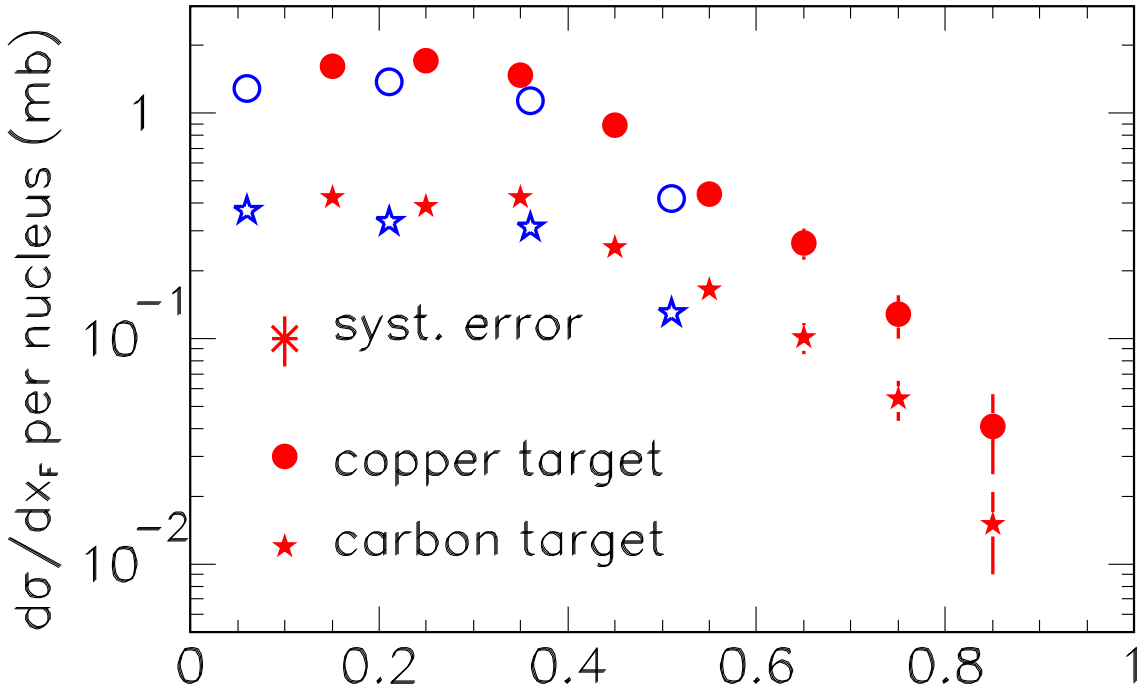
$\Omega \longrightarrow \Lambda K^-$ decays identified by cascade geometry and decay kinematics
reject candidates with $m(\Lambda\pi^-) \approx m(\Xi^-)$
K^- selected by rejecting π^- identified clearly by the RICH counter

13,000 identified decays from interactions in copper and carbon target

production cross section analyzed as function of x_F
the dependence on p_t is very similar for all combinations of beam particle and produced hyperon and depends only slightly (if at all) on x_F.

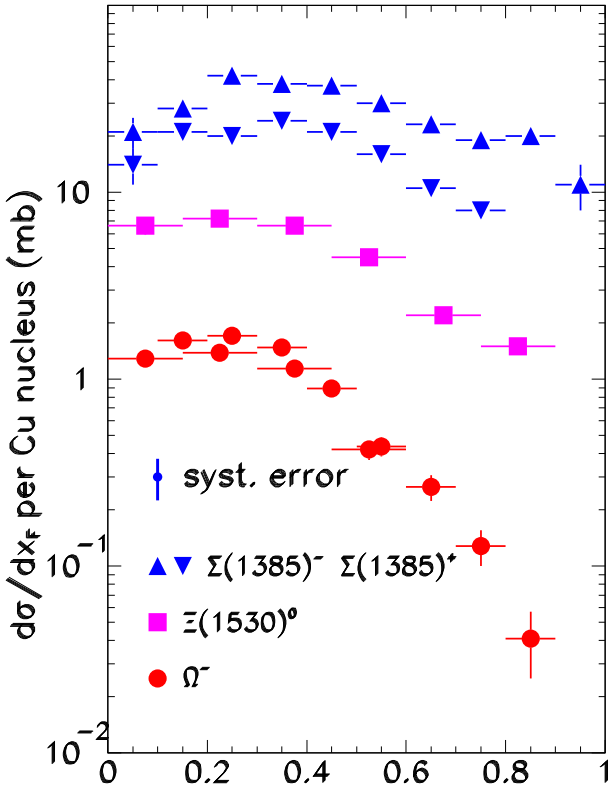


ΛK^- mass for different x_F intervals (2 MeV per bin)



Earlier measurement (open symbols) was based on 1/4 of total statistics and RICH was not used EPJ 26,357 (2003)

$\longrightarrow$ range now extended to large x_F.



Decuplet hyperon production by Σ^-, expt. WA89

One more contribution to the existing large set of hyperon and antihyperon production cross sections by $\pi^{\pm}$, K^{-}, p, n, Σ^{-} and Ξ^{-} beams

Nobody so far has managed (tried ??) to provide a model or at least a coherent phenomenological descriptio of these data
80 % of course would already be a good success rate, given experimental uncertainties

If people use strangeness as a tag for interesting processes at LHC, keep this in mind ....

Ω^- resonances:

poorly known ! PDG has 14 Λ^*, 15 Σ^*, 8 Ξ^*, 3 Ω^*

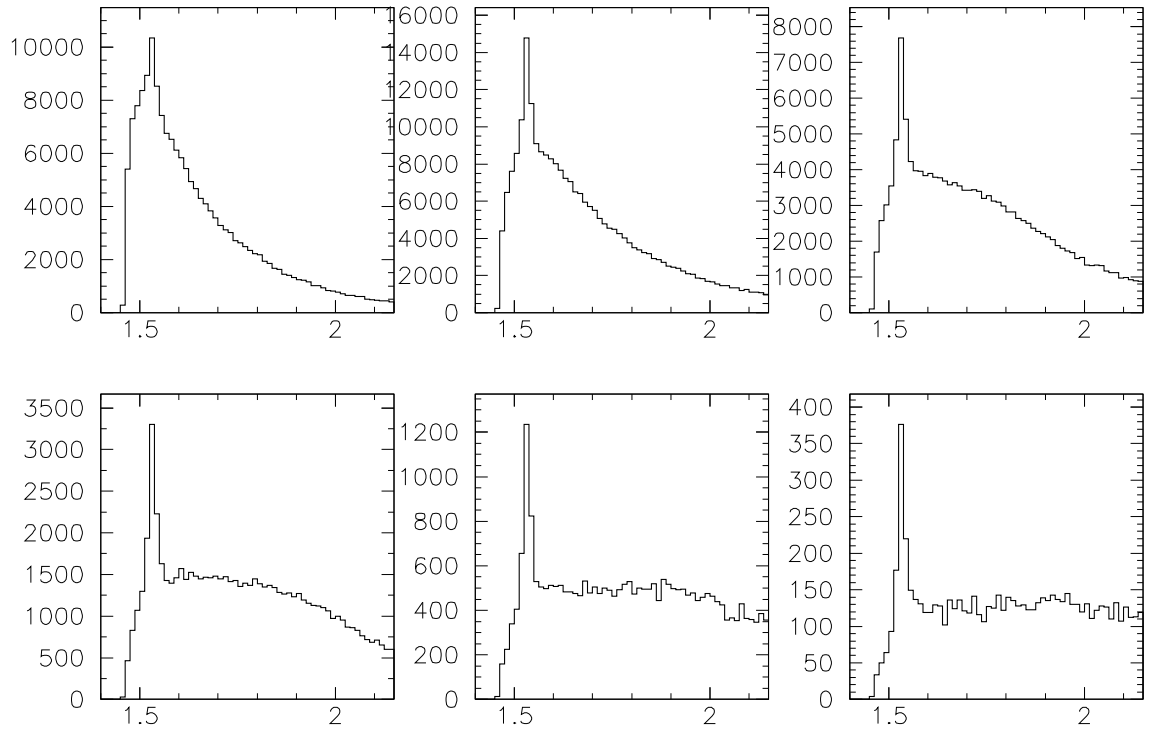
mass [MeV]	width [MeV]	decay channel	BR	N_{obs}	beam [GeV/c]
2251 ± 12	48 ± 28	$\Xi^0(1530)K^-$	0.7±0.2	78	Ξ^-, 102[a]
2253 ± 13	81 ± 38		≈1	44	K^-, 11[b]
2384 ± 12	26 ± 23	$\Xi^0(1530)K^-$	< 0.45	45	Ξ^-, 102[a]
		$\Xi^-\overline{K^0}$	0.5±0.3		
2474 ± 12	72 ± 33	$\Omega^-\pi^+\pi^-$		59	K^-, 11[b]

Observations of Ω resonances. BR is relative to $\Xi^-\pi^+K^-$.

[a]: Biagi et. al., ZPHY C31, 33 (1986), [b]: Aston et al., PLB 194, 579 (1987)

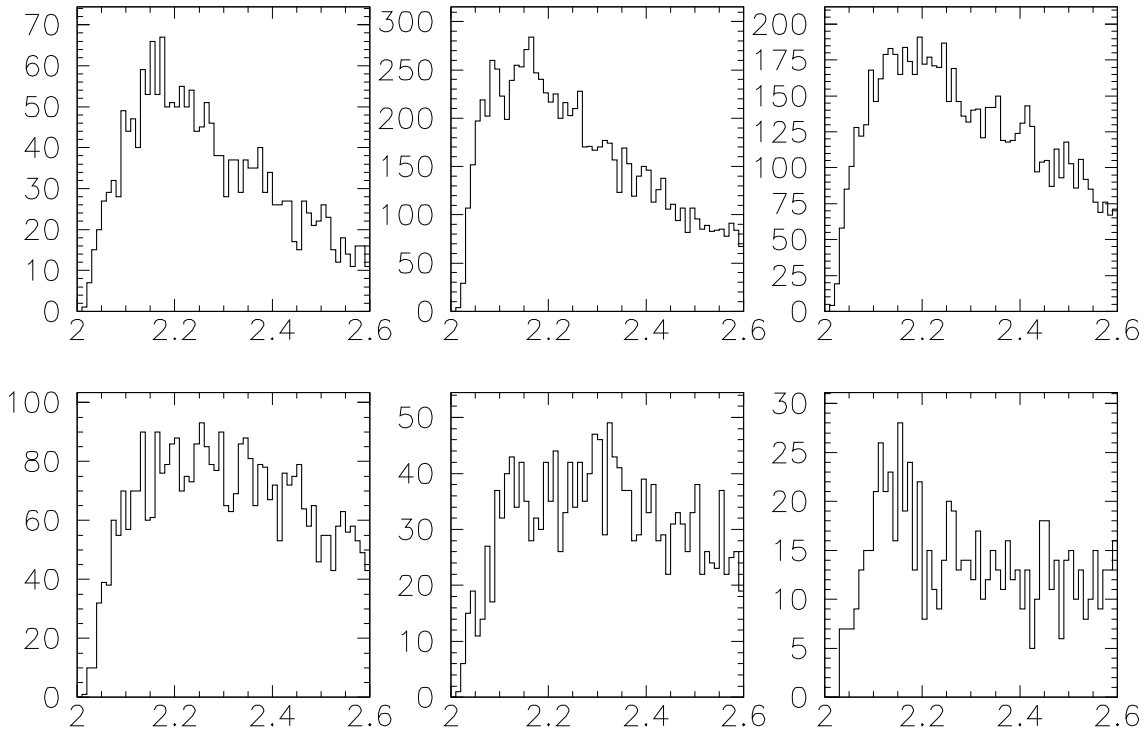
$\longrightarrow$ Most promising is a search for $\Omega^-(2250) \longrightarrow \Xi^0(1530)K^-$:
$\Xi^0(1530)$ identified by cascade geometry and kinematics, K^- by RICH

$\Xi^0(1530)$ selection:



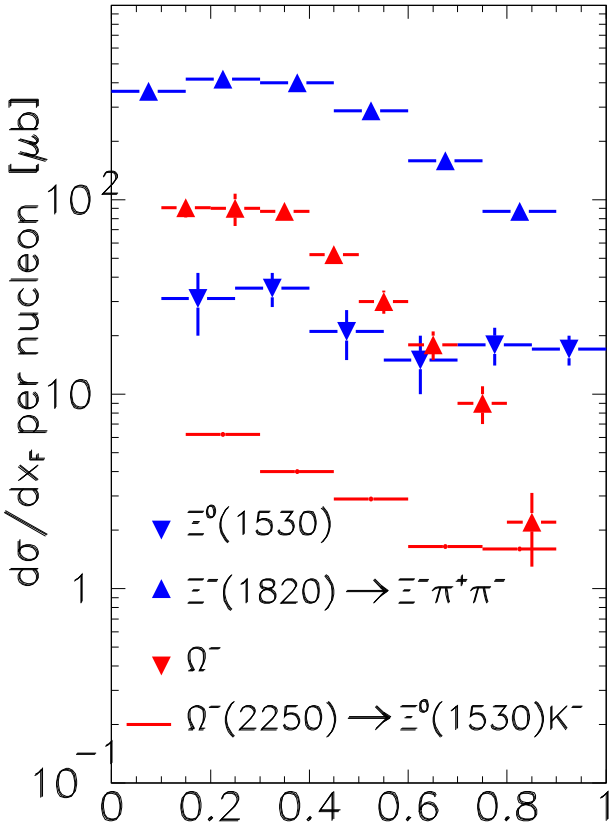
$\Xi^-\pi^+$ mass distribution in 6 bins of x_F, top left: 0-0.15, bottom right: 0.75-0.9.

K^- selection: reject π^-, e^- with RICH $\longrightarrow$ independent of K^- threshold !



$\Xi^0(1530)K^-$ mass distribution in 6 bins of x_F, copper and carbon target.

we extract limits on $BR \cdot d\Sigma/\mathrm{dx}_F$ at 95% CL,
at 2250 MeV, for $\Gamma = 50$ MeV



Production cross sections per nucleon (WA89)

Limits for decay to $\Xi^-\pi^+K^-$ are higher by factor ≈ 2.5

We also looked in the Ξ^-K_S and $\Omega^-\pi^+\pi^-$ channels, nothing (so far)

Theorists agree there should be 2 (nearly) degenerate resonances close to 2000 MeV and several more between 2200 and 2300 MeV and more further above

Maybe there is a chance to see them in an experiment with a K^- beam, good acceptance for cascade decays and very good K^- identification ??