Study of nuclear medium effects on Λ hyperon polarization in quasi-real photoproduction at 27.3 GeV positron beam

(HERMES draft 83)

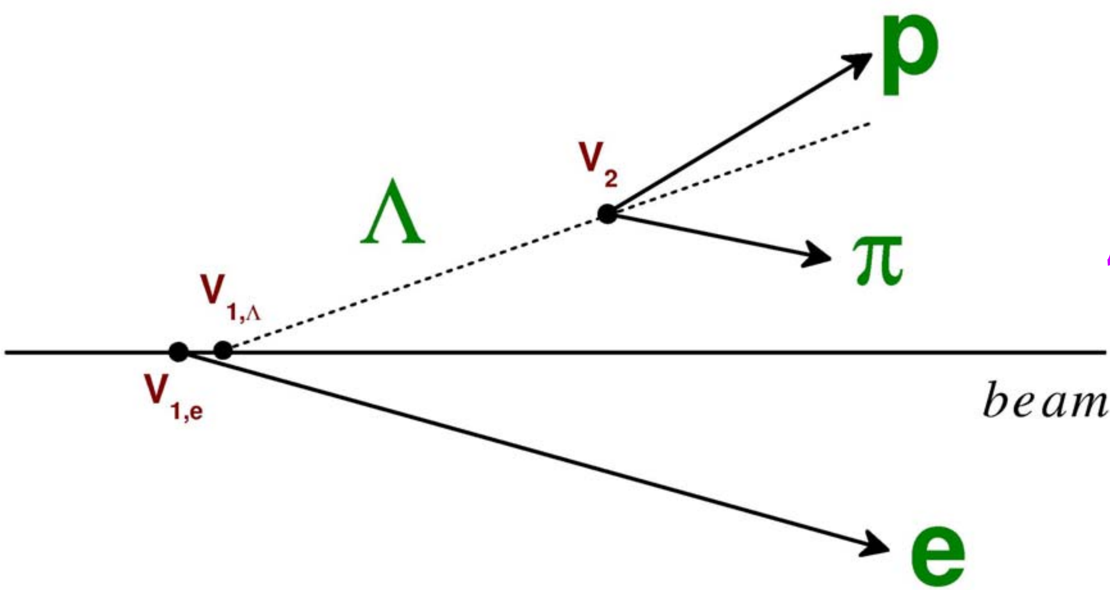
Λ event topology, detection and kinematical variables

$$\Lambda \to p + \pi^- \qquad \vec{\Lambda} = ud\vec{s}$$

$$\bar{\Lambda} \to \bar{p} + \pi^+$$

Under study

e + p(d,A) → e' + Λ(Λ)+X



always detected by HERMES spectrometer

detected ⇨ *DIS regime:*

$Q^2 > 0.8\, GeV^2 \quad x, y, z, x_F$

not detected ⇨ *Quasi-real photoproduction regime:*

$Q^2 \approx 0$

Under measurements

Spin transfer from beam/target,

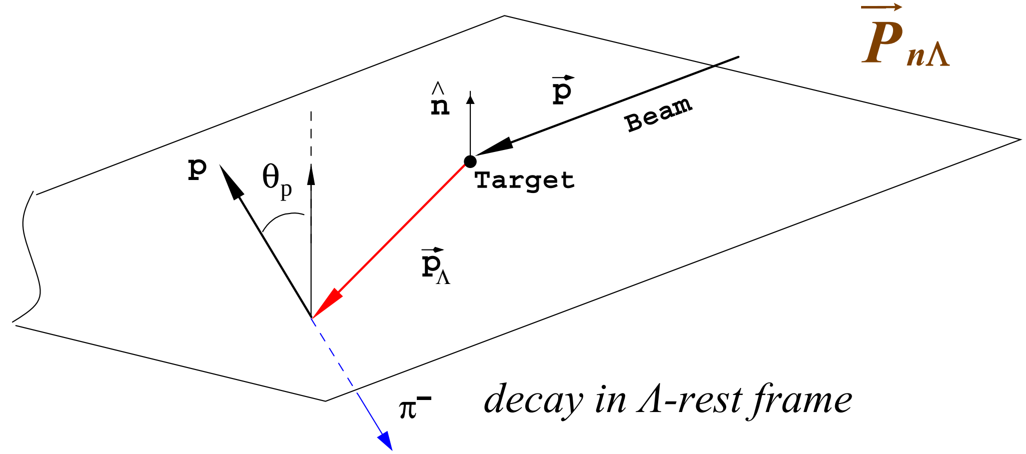
Spontaneous Λ polarization

Transverse (spontaneous) polarization

neither beam not target polarized
only possible direction of Λ (Λ)
polarization

$$\vec{n} = \frac{\vec{p}_e \times \vec{p}_\Lambda}{\left|\vec{p}_e \times \vec{p}_\Lambda\right|} \qquad \vec{P}_{n\Lambda} = P_{n\Lambda} \cdot \vec{n}$$

$\vec{P}_{n\Lambda}$

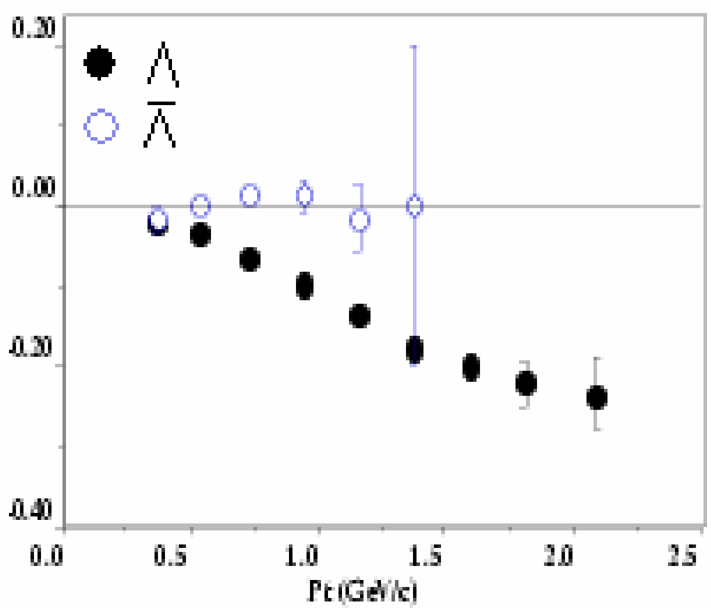


decay in Λ-rest frame

---

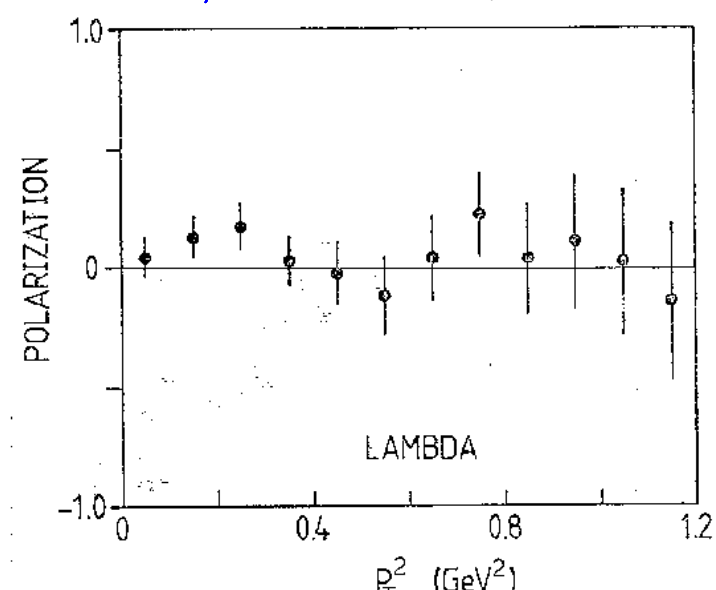
hadron beams $p + Be \rightarrow \Lambda(\bar{\Lambda}) + X$

FNAL *E*440



lepton beams $\gamma + p \rightarrow \Lambda + X$

$E_\gamma = 25 - 70\ GeV$ *CERN*

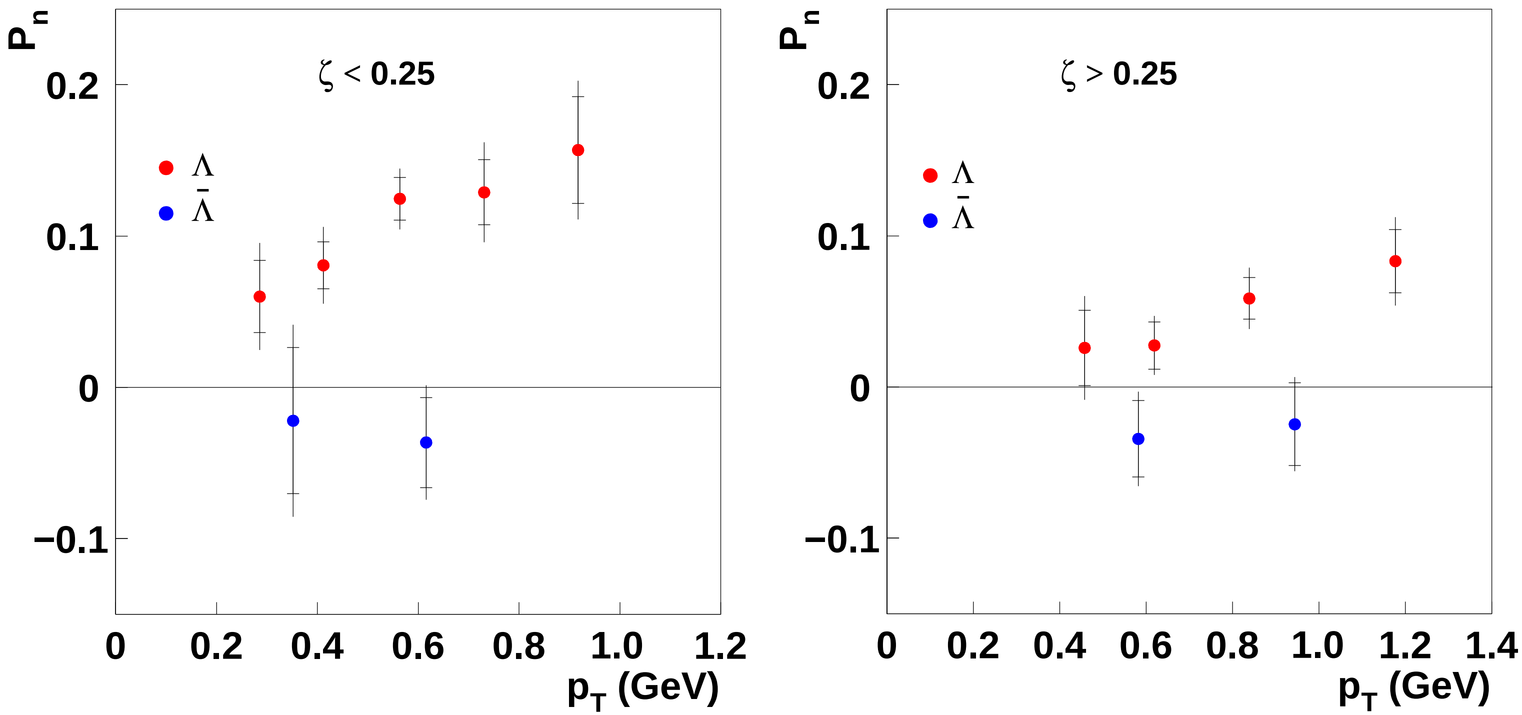


Phys Rev. D 2007
(RUN I)

$\vec{P}_{n\Lambda}$ results

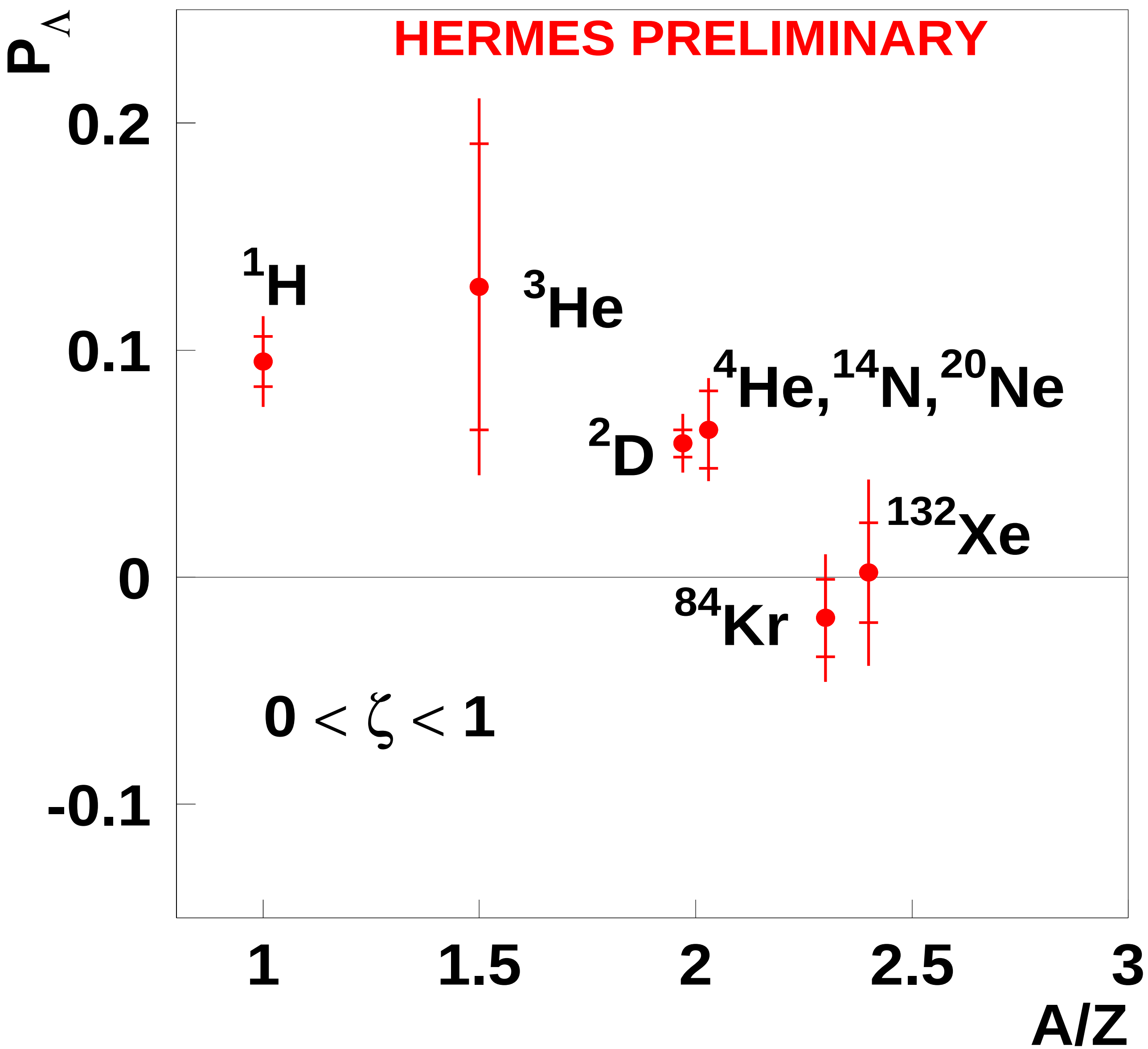
$$e + p \rightarrow \Lambda \uparrow + X \;\; at \; \langle E_\gamma \rangle = 15.6 \; GeV$$

inclusively detected



Lower ς (lower t) ⇒ higher Λ polarization

HERMES experimental results



Discussion

Unlike hadron collision experiments, HERMES observed strong nuclear medium effect on transverse Λ *polarization , thus for the targets as heavy as Kr and Xe* $P_{n\Lambda}$ *drops down to zero. This might be due to essential distinction in the hyperon production mechanism . In the photoproduction case* $\gamma \to ss^{bar}$ *with* s-*quark slowing down to couple to a valence di-quark from the target, which results in the positive* $P_{n\Lambda}$.

Another distinction. Because of very strong absorption of hadrons in nuclear matter, in the case of proton (hadron) beam Λ *production is a surface (peripheral) effect,*

$$\sigma \approx \sigma_H A^{1/3}.$$

In the photoproduction case, Λ *can be produced deep inside the nucleus, therefore nuclear medium effect is expected to be much stronger. Yet* Λ *produced in nuclear medium is absorbed , such that*

$$\sigma \approx \sigma_H A^p \quad p \neq 1.$$

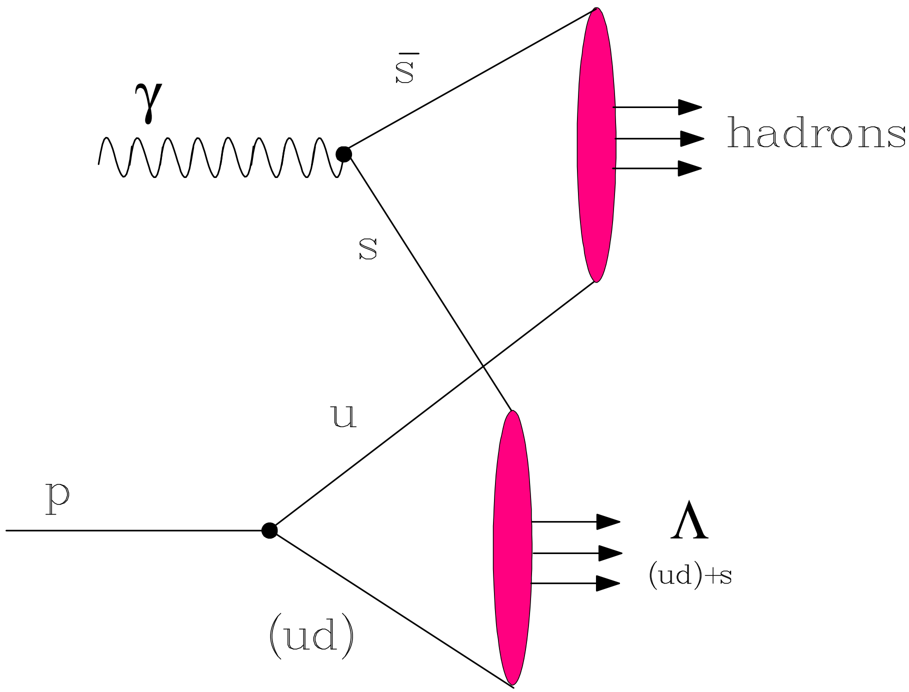
p=?? is still to be found in the analysis

BACKUP SLIDES

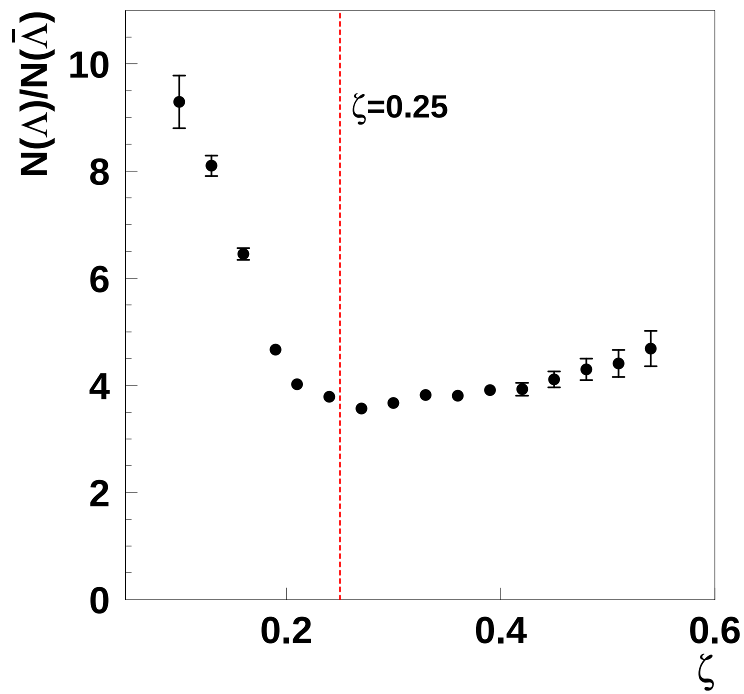
Λ photoproduction mechanism by PYTHIA

$$\langle E_\gamma \rangle = \langle E_e - E_{e'} \rangle \simeq 15.6\ GeV$$

$$\gamma \to q\bar{q} \quad (s\bar{s})$$

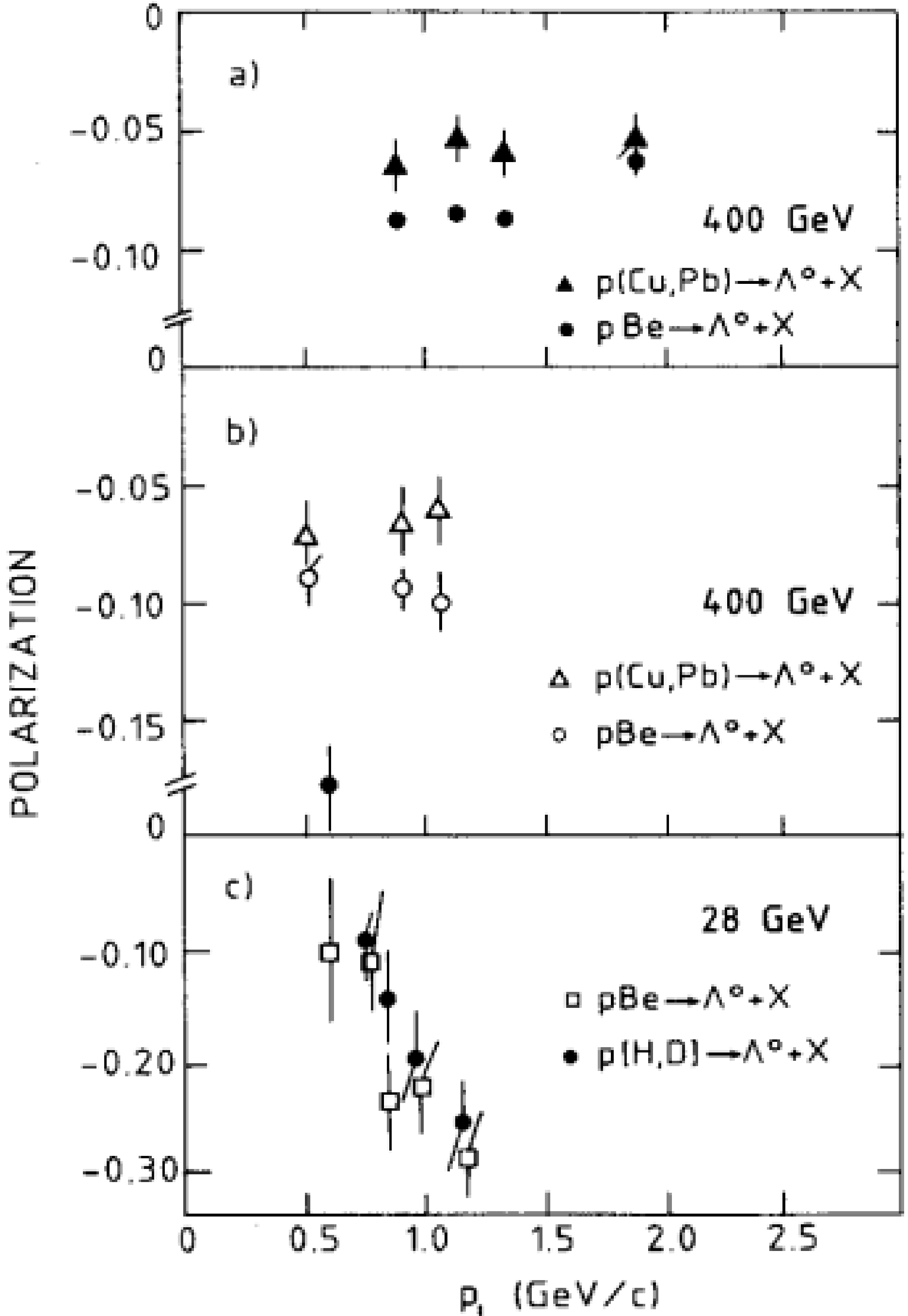


Λ to Λ yield ratio



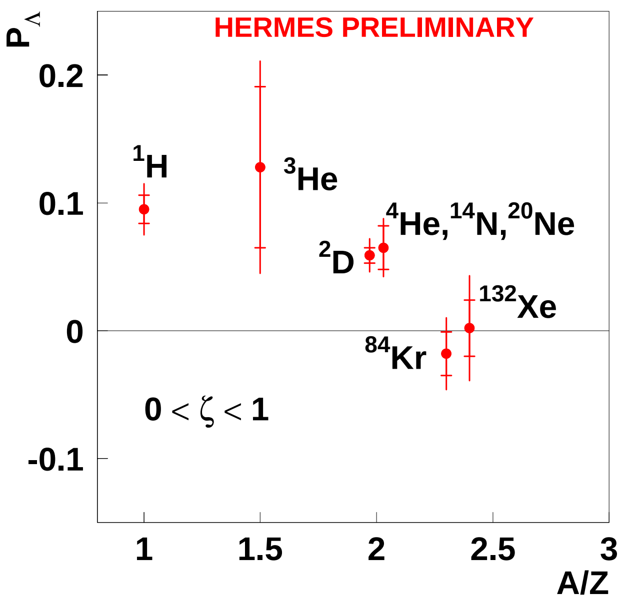
$$\zeta^\Lambda \simeq \frac{E^\Lambda}{E_e} < 0.25 \quad \sqrt{t} = 3.31\, GeV$$

target (ud) mechanism



POLARIZATION
a)
400 GeV
▲ p(Cu,Pb)→Λ°+X
● pBe→Λ°+X
b)
400 GeV
△ p(Cu,Pb)→Λ°+X
○ pBe→Λ°+X
c)
28 GeV
□ pBe→Λ°+X
● p(H,D)→Λ°+X
0
-0.05
-0.10
-0.15
-0.20
-0.30
0.5
1.0
1.5
2.0
2.5
p⊥ (GeV/c)

HERMES experimental results



	H	D	^{3}He	^{4}He	N	Ne	Kr	Xe
P_Λ	0.095 ± 0.011 (stat.) ± 0.009 (syst.)	0.059 ± 0.006 ± 0.007	0.128 ± 0.063 ± 0.023	0.052 ± 0.048 ± 0.015	0.119 ± 0.025 ± 0.017	0.001 ± 0.028 ± 0.009	-0.018 ± 0.016 ± 0.011	0.002 ± 0.022 ± 0.019
N_Λ	73914	232223	2304	3606	14507	11290	29386	16995
A	1	2	3	4	14	20	84	132
$\langle \zeta \rangle$	0.246	0.246	0.250	0.274	0.231	0.272	0.241	0.242
$\langle p_T \rangle$	0.621	0.625	0.621	0.682	0.601	0.682	0.636	0.634