Nuclear medium dependence of transverse Λ polarisation in quasi-real photoproduction

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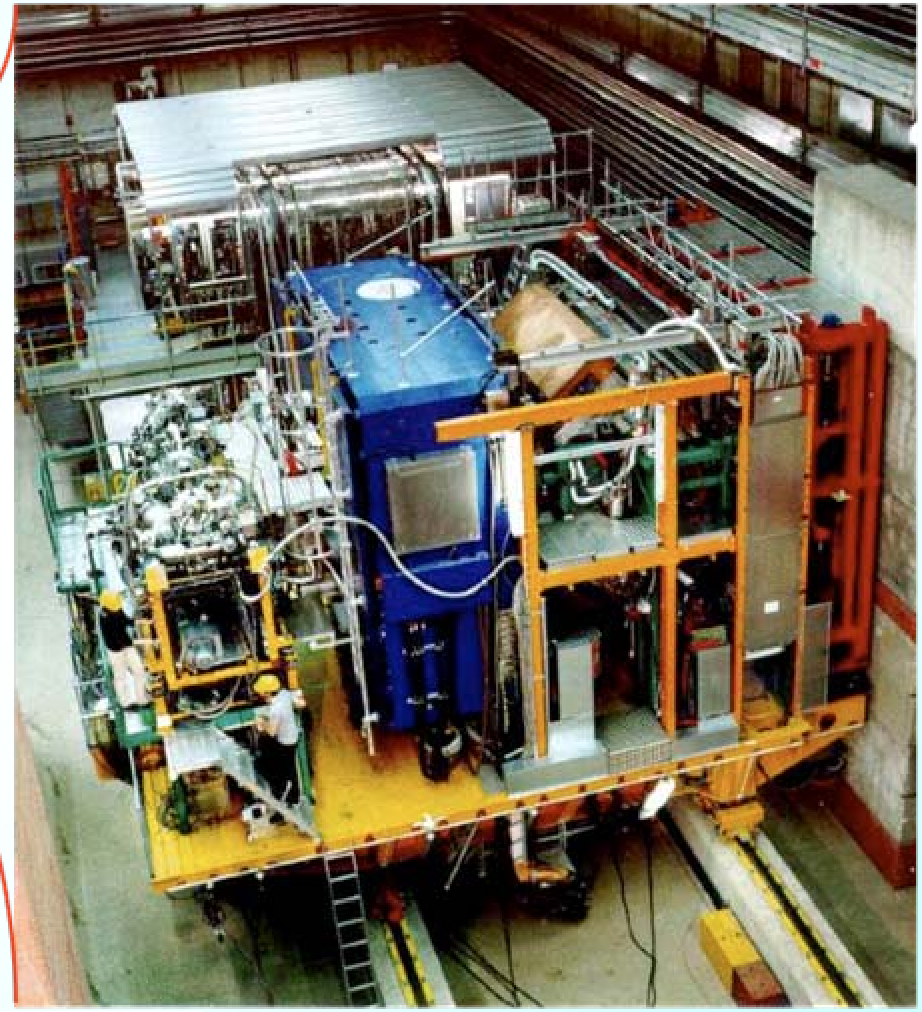
On behalf of the hermes collaboration

HERMES Experiment

27.5 GeV e^+/e^- beam of HERA



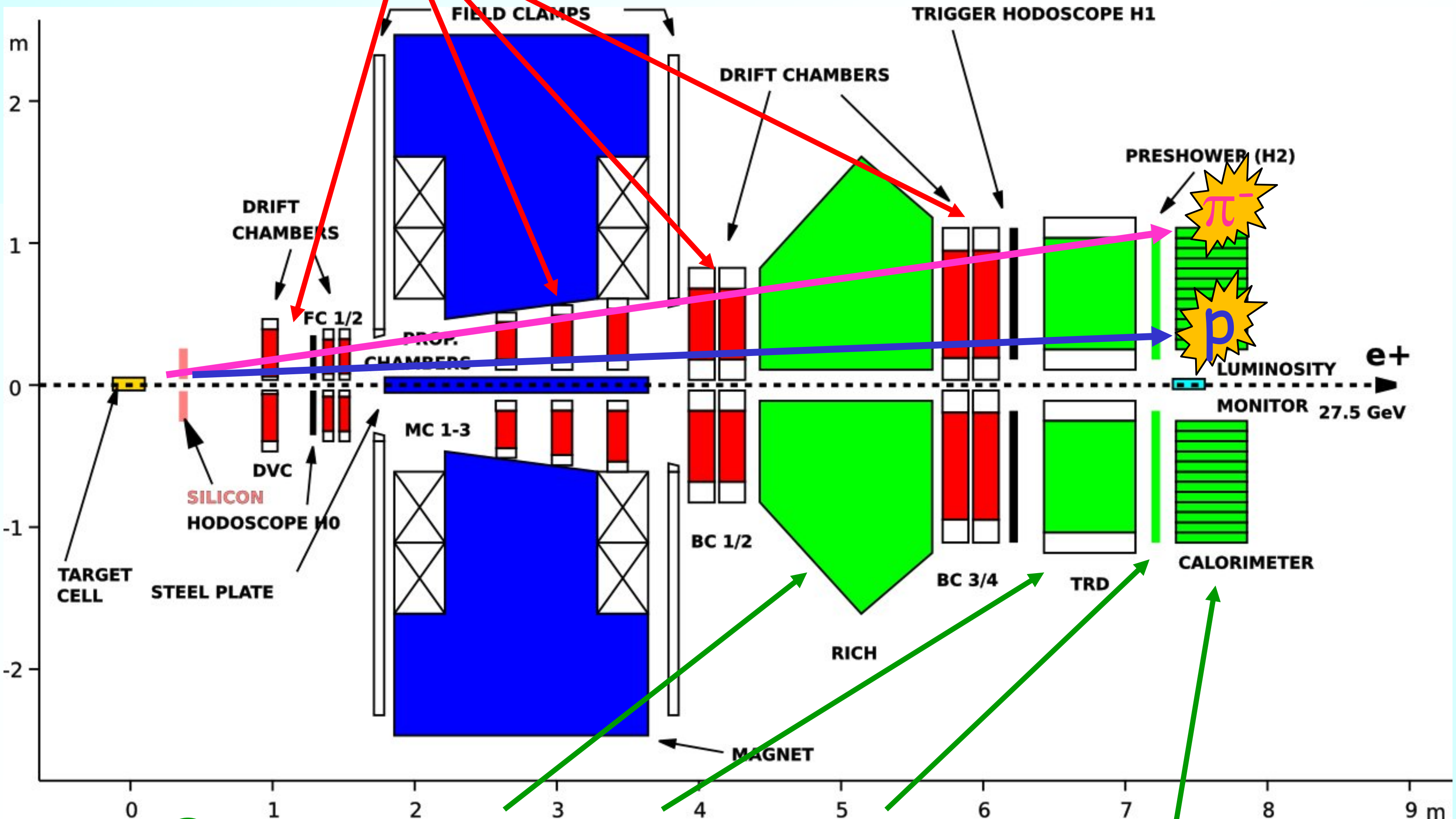
Internal gas targets

polarized : $^1\vec{H}$, $^1H^{\uparrow}$, $^2\vec{H}$, $^3\vec{He}$

unpolarized: ^1H, ^2H, ^3He, ^4He, ^{14}N, ^{20}Ne, ^{84}Kr, ^{131}Xe

HERMES Spectrometer

- tracking: δp/p~2%, δΘ<0.6 mrad, 40-220 mrad



- PID: RICH, TRD, Preshower, Calorimeter
  lepton-hadron separation > 98%

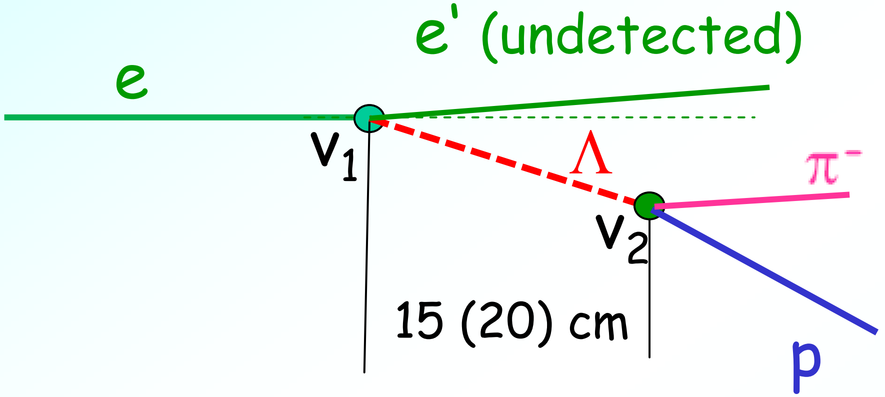
Reconstruction of Λ events

$eN \to \Lambda^{\uparrow} X$

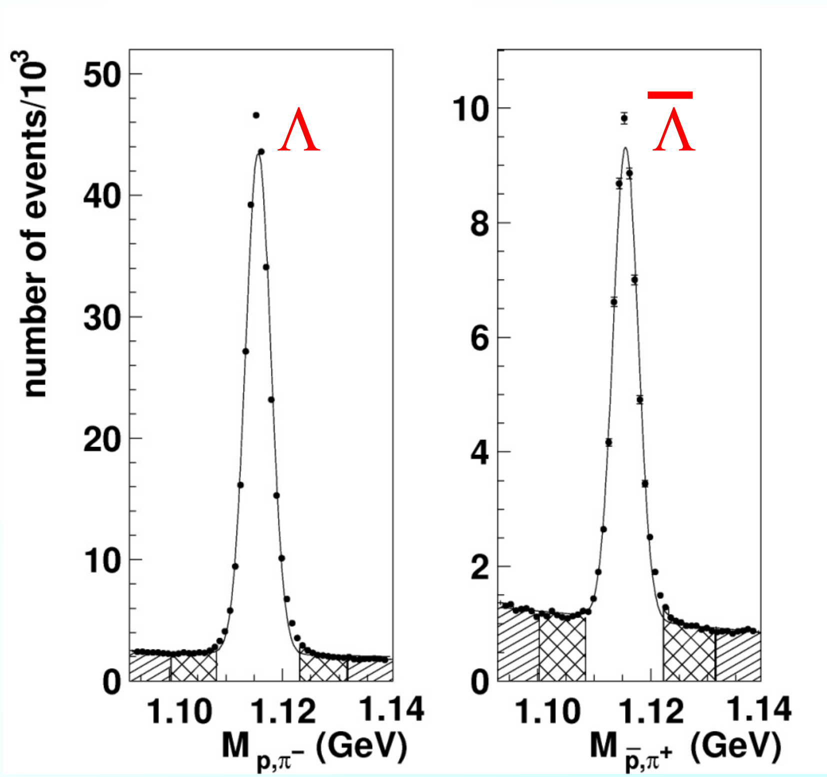
Quasi-real photoproduction

$Q^2 < 0.05\ GeV^2$ for 80% of events

$< \nu > = 15.6\, GeV$



1995-2000 data
(all targets except Xe)



Background suppression:
Cherenkov information + vertex cuts

$N_{\Lambda} \approx 250k$ $\quad N_{\bar{\Lambda}} \approx 50k$

Transverse Λ polarisation

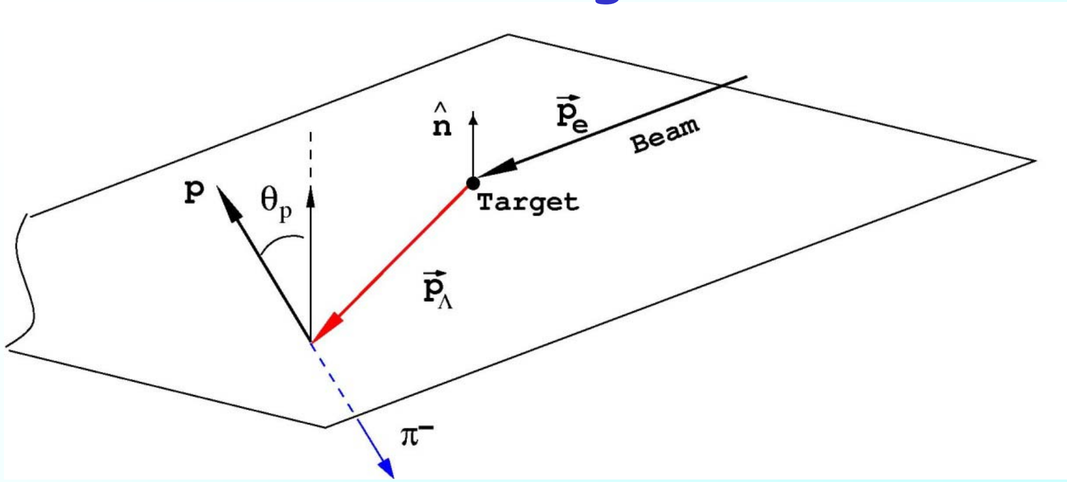
- Parity violating decay $\Lambda \rightarrow \pi^- p$:
  p preferentially emitted along Λ spin

$$\frac{dN}{d\Omega_p} = \frac{dN_0}{d\Omega_p}(1+\alpha P_\Lambda \cos\theta_p) \qquad \text{(in } \Lambda \text{ CMS)}$$

$\alpha = 0.642 \pm 0.013$

- Unpolarised beam and target ($P_B P_T = 0.0000 \pm 0.0005$):
  Spontaneous polarisation is directed along $\hat{n}$

$$\vec{P}_\Lambda = P_\Lambda \cdot \hat{n}, \quad \hat{n} = \frac{\vec{p}_e \times \vec{p}_\Lambda}{|\vec{p}_e \times \vec{p}_\Lambda|}$$



Extraction of Λ polarisation

Formalism is based on
up/down mirror (geometrical) symmetry of the detector

$$< \cos\theta >_0^{up} = - < \cos\theta >_0^{down}$$

$$P_\Lambda = \frac{<\cos\theta_p>}{\alpha <\cos^2\theta_p>} = \frac{\frac{1}{N_\Lambda}\sum_{i=1}^{N_\Lambda}\cos\theta_p}{\alpha\frac{1}{N_\Lambda}\sum_{i=1}^{N_\Lambda}\cos^2\theta_p}$$

Kinematical dependences of P_Λ

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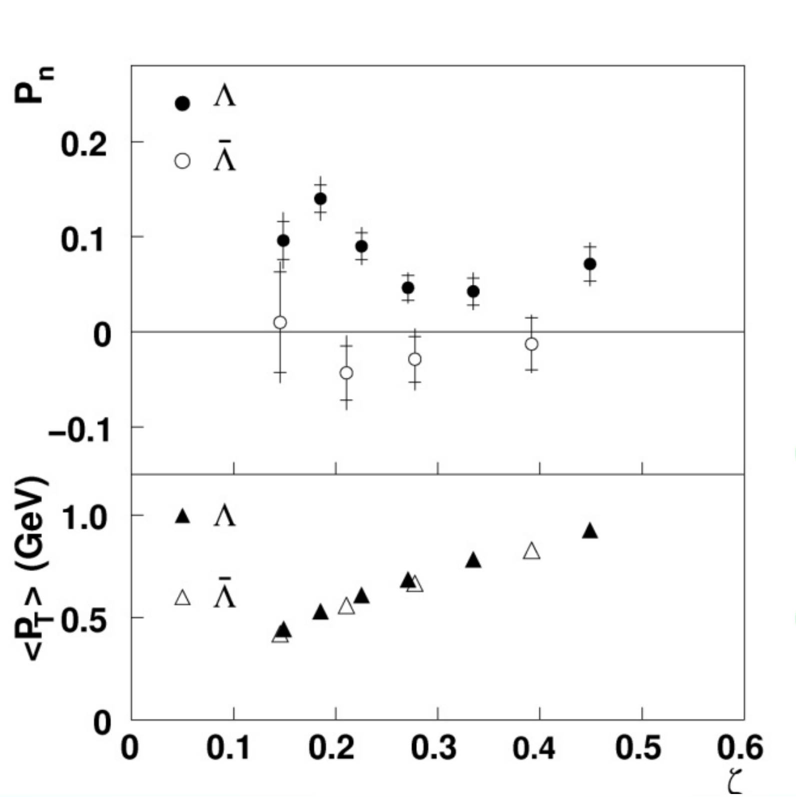
1995-2000 data (all targets except Xe)



$\zeta = (E_\Lambda + p_{z\Lambda}) / (E_e + p_e)$

ζ and x_F are correlated
$\zeta > 0.25 \leftrightarrow x_F > 0$

Λ: $P_n = 0.078 \pm 0.006_{stat.} \pm 0.012_{syst.}$

$\bar{\Lambda}$: $P_n = -0.025 \pm 0.015_{stat.} \pm 0.018_{syst.}$

- $P_n(\Lambda)$ is positive
- Opposite sign compared to pion and proton beams
- Same sign as for K^- ($\bar{u}s$) and Σ^- (dds) beams
- Origin: s-quark content of γ ?

Kinematical dependences of P_Λ

1995-2000 data (all targets except Xe)

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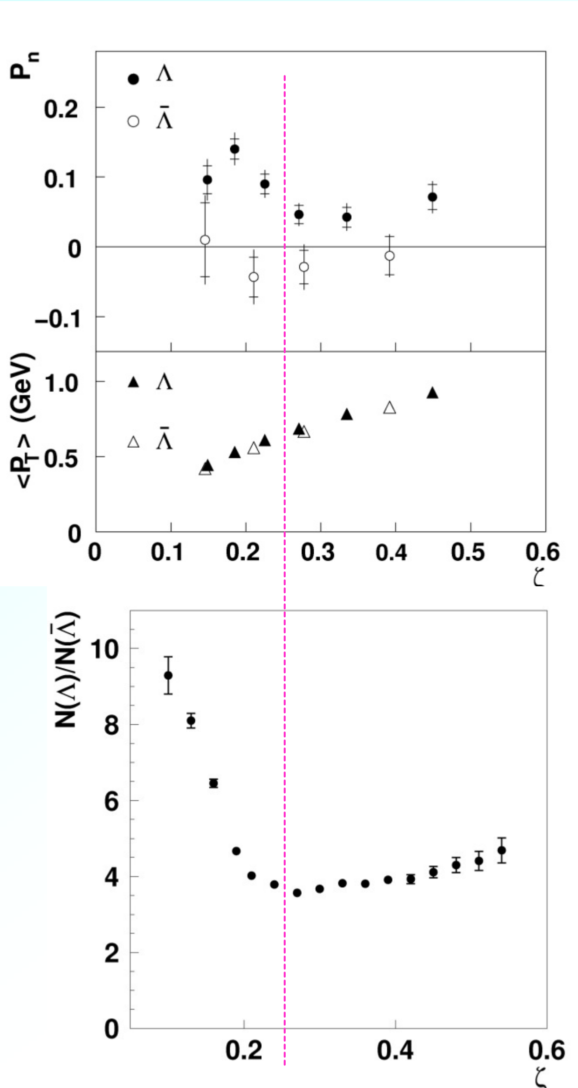
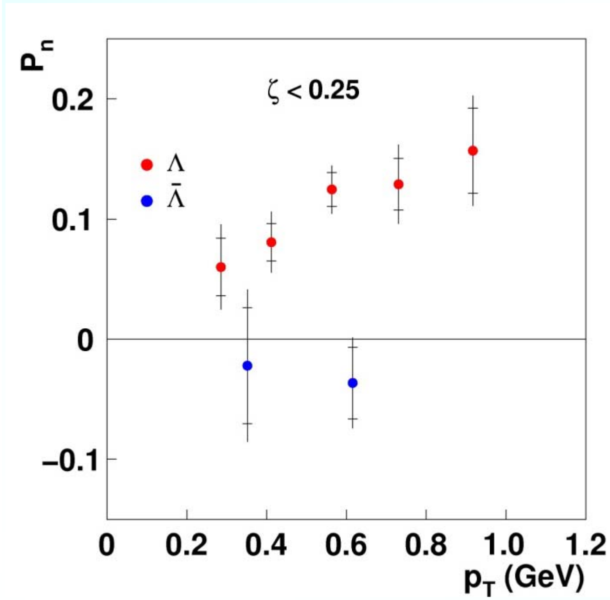
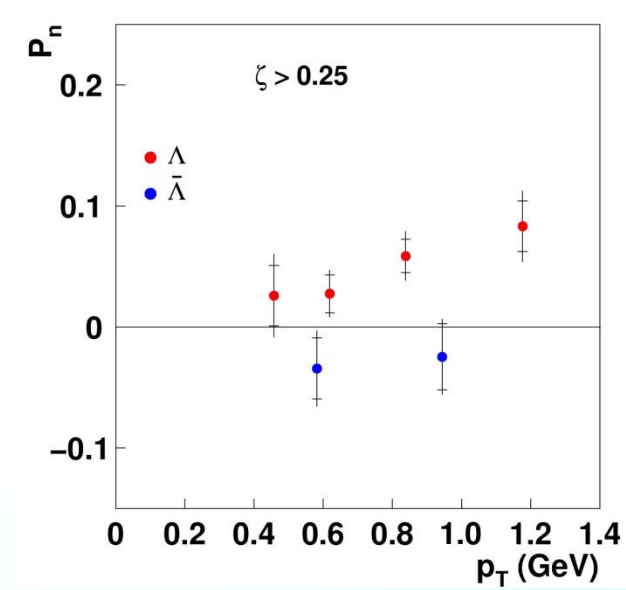




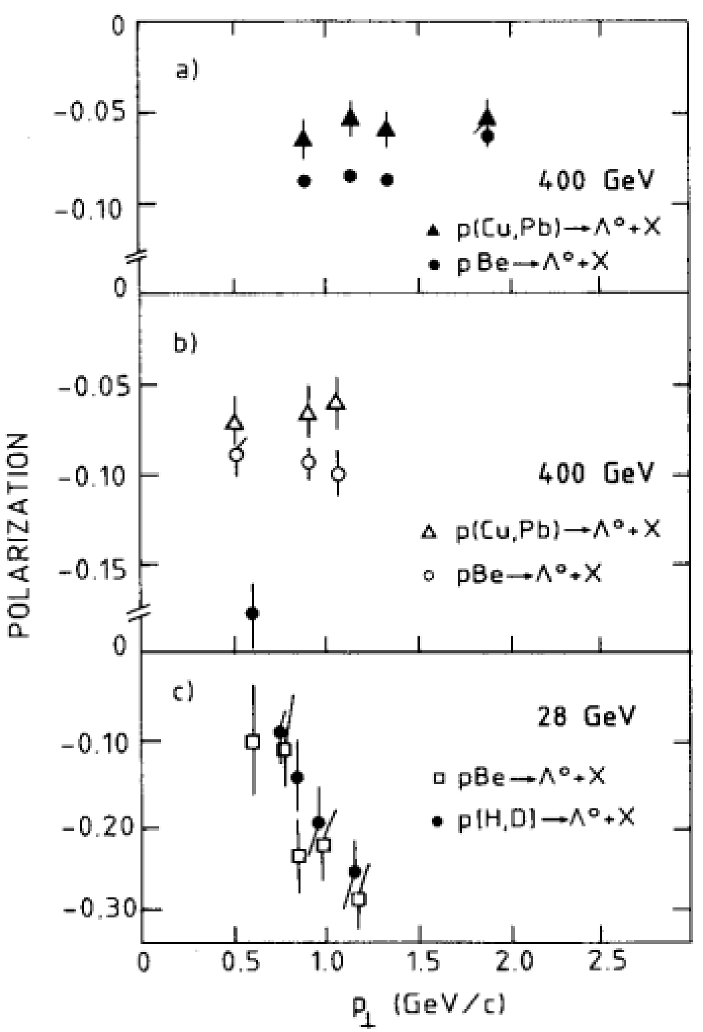


$\zeta = (E_\Lambda + p_{z\Lambda}) / (E_e + p_e)$

$P_n(\Lambda)$ increases with increasing p_T

$P_n(\Lambda)$ is larger for low ξ (target fragm.) than for high ξ (current fragmentation)

A dependence in pA collisions

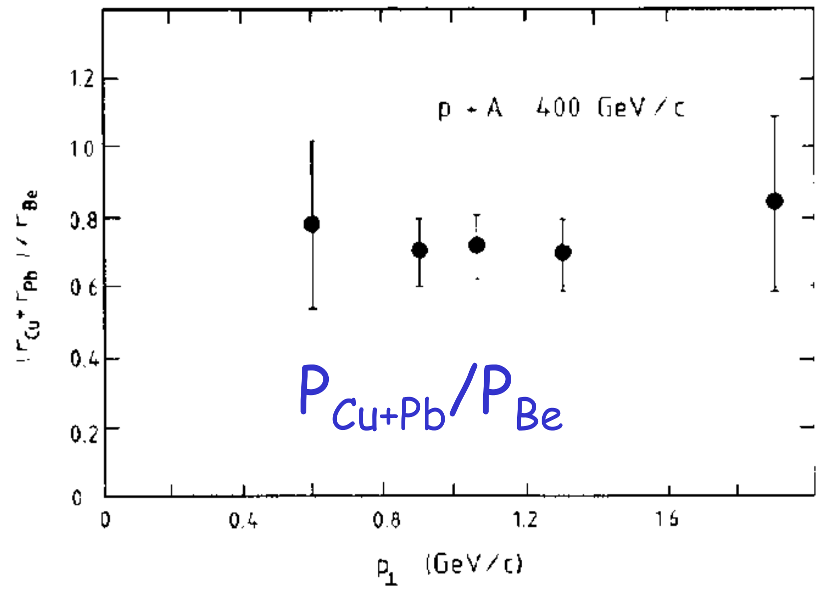


Experiment @ FNAL

$p\ A \rightarrow \Lambda\ X$

(targets Cu, Pb, Be)

p_{beam} = 400 GeV



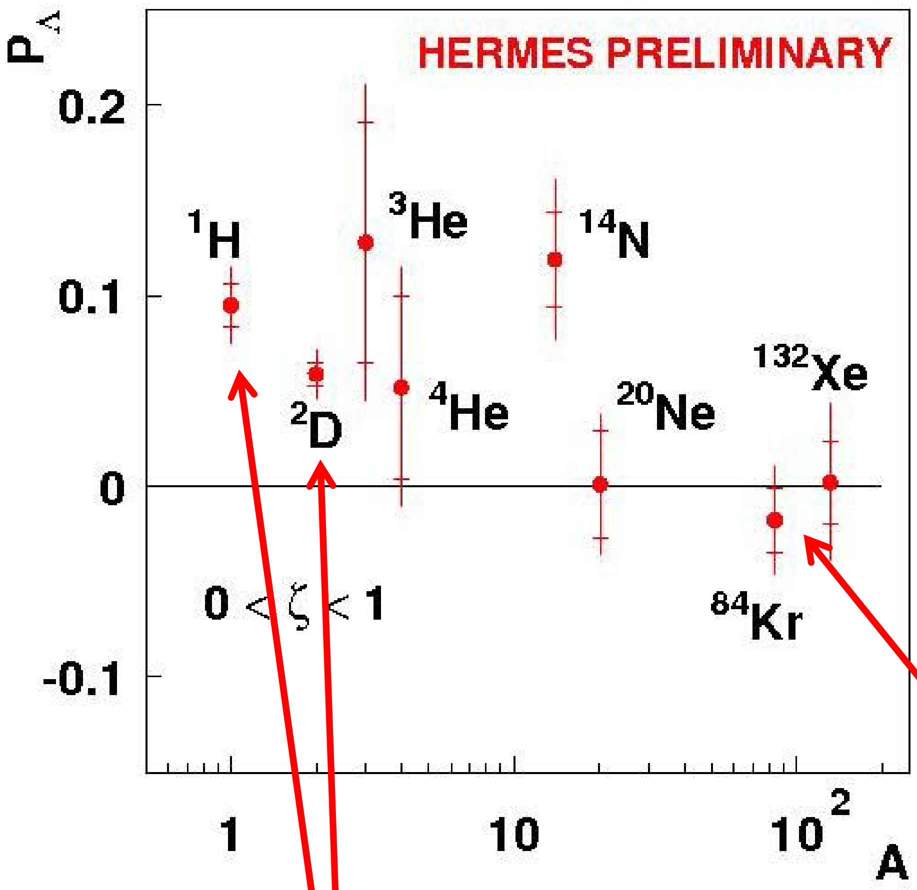
Experiment @ BNL

$p\ A \rightarrow \Lambda\ X$

(targets H, D, Be)

p_{beam} = 28 GeV

A dependence of Λ polarisation



1995-2005 data; $N_\Lambda \approx 385$k

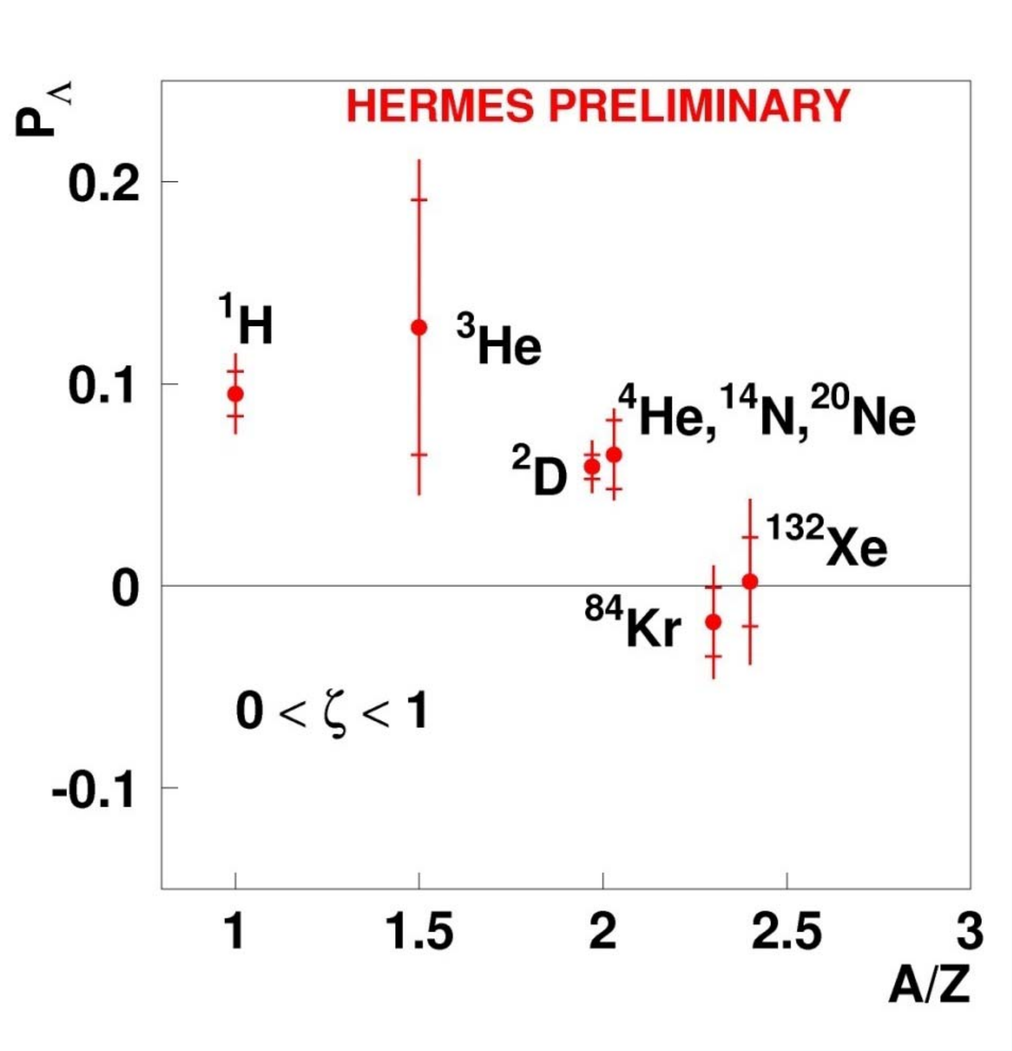
(50 % more D + 25k Kr, 17k Xe)

- $P_\Lambda(^1H) \gg P_\Lambda(^2H)$

  ⇒ $P_\Lambda(n) \ll P_\Lambda(p)$?

- P_Λ compatible with zero for large A

A/Z dependence of Λ polarisation



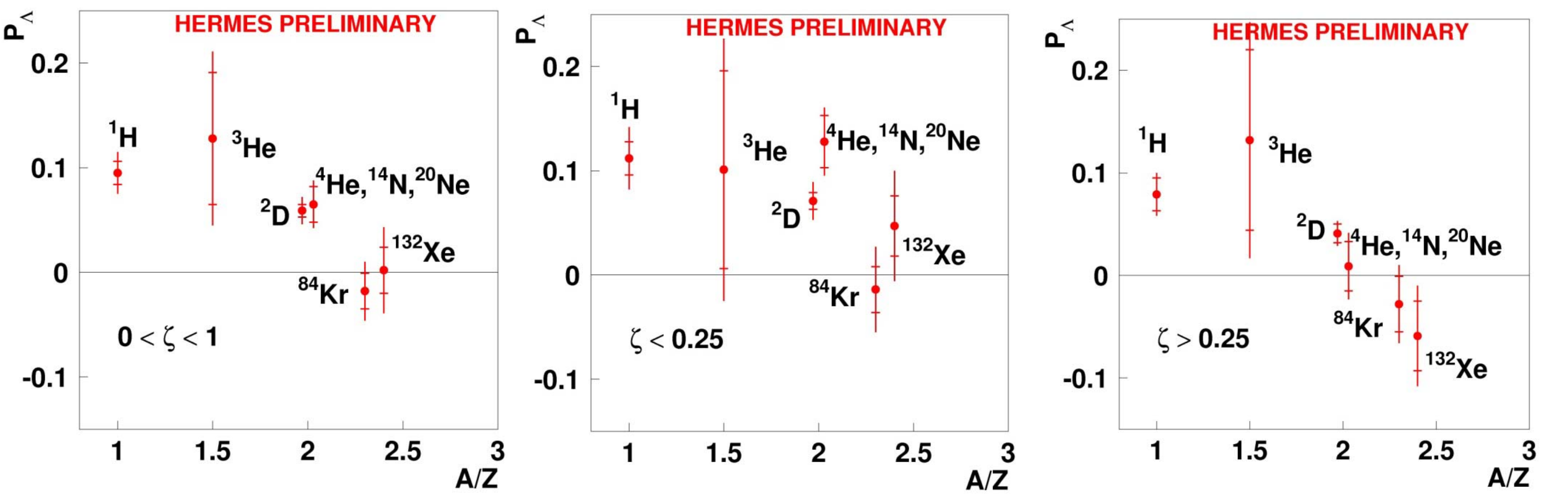
$P_\Lambda(n) \ll P_\Lambda(p)$ not sufficient to explain vanishing P_Λ for large *A*

Additional nuclear medium effects required for explanation,
P_Λ destroyed by FSI ?

Conclusion

- Transverse Λ polarisation observed in quasi-real photoproduction
- $P_n(\Lambda)$ is positive. Same sign as for K^- (us) and Σ^- (dds) beams. Origin: s -quark content of γ ?
- $P_\Lambda(^1H) \gg P_\Lambda(^2H)$ $\Rightarrow$ $P_n(\Lambda)$ for neutrons substantially smaller than for protons ?
- Nuclear medium effects:
  $P_n(\Lambda)$ appears to vanish for large A (A/Z)

A/Z dependence of Λ polarisation



A dependence of Λ polarisation