New HERMES Results on Baryon Production

The photoproduction cross sections of $\bar{\Lambda}(1520)$ and $\Lambda(1520)$

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On behalf of the HERMES collaboration

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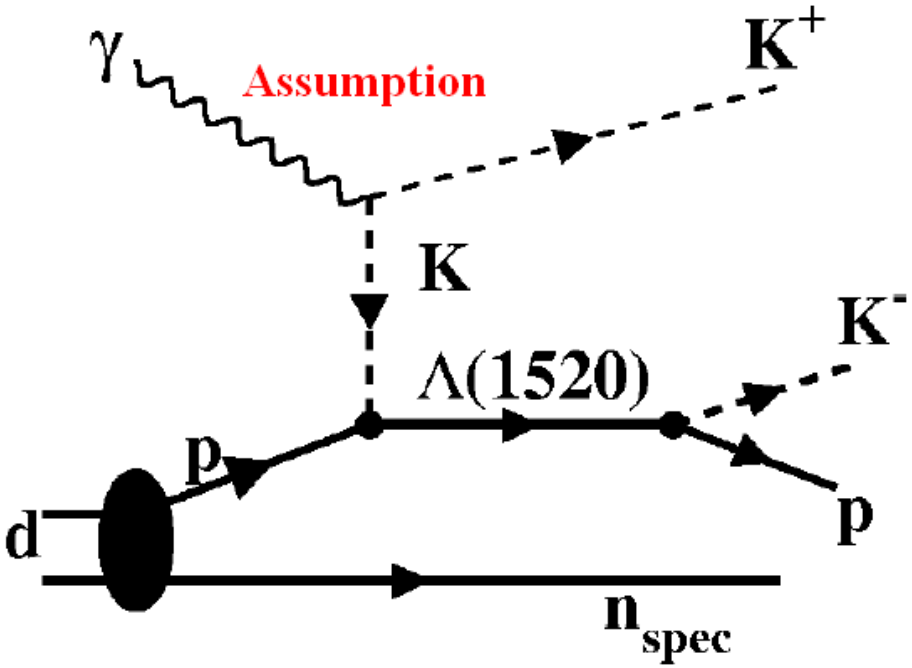
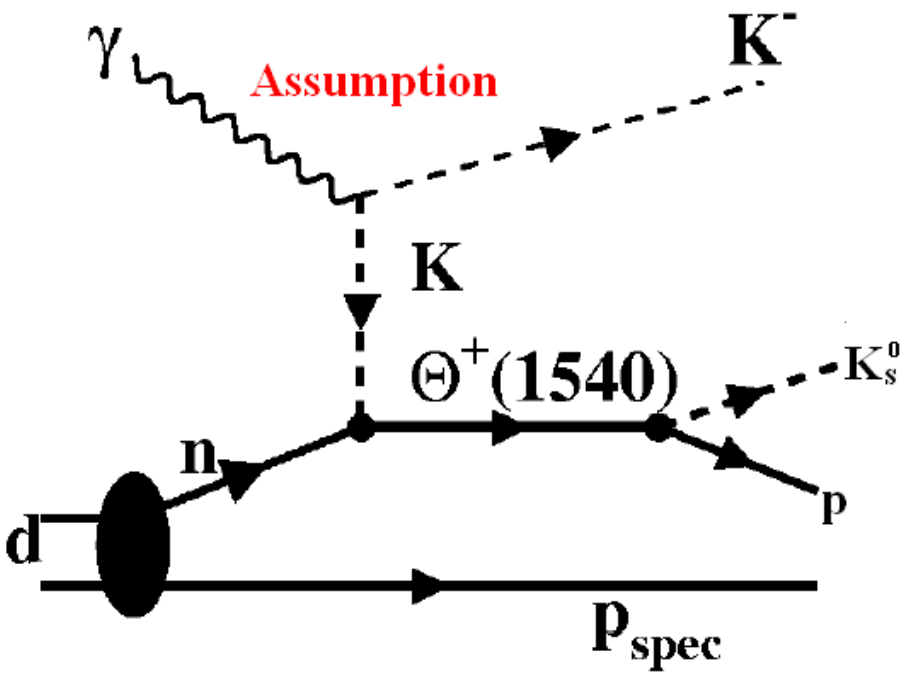
Outline

For Penta-quark Searching

Assumption: Same production mechanism for $\Lambda(1520)$ and Θ^+

- HERMES: evidence Θ^+ seen, $\bar{\Theta}^-$ not (Numbers: $59 \pm 16/3 \pm 6$)
- Also saw $\Lambda(1520)$, how about the $\bar{\Lambda}(1520)$?
  $\sigma_{\Theta^+} = 100 \sim 220$ nb, $\sigma_{\bar{\Lambda}(1520)} = ?$ $\sigma_{\Lambda(1520)} = ?$





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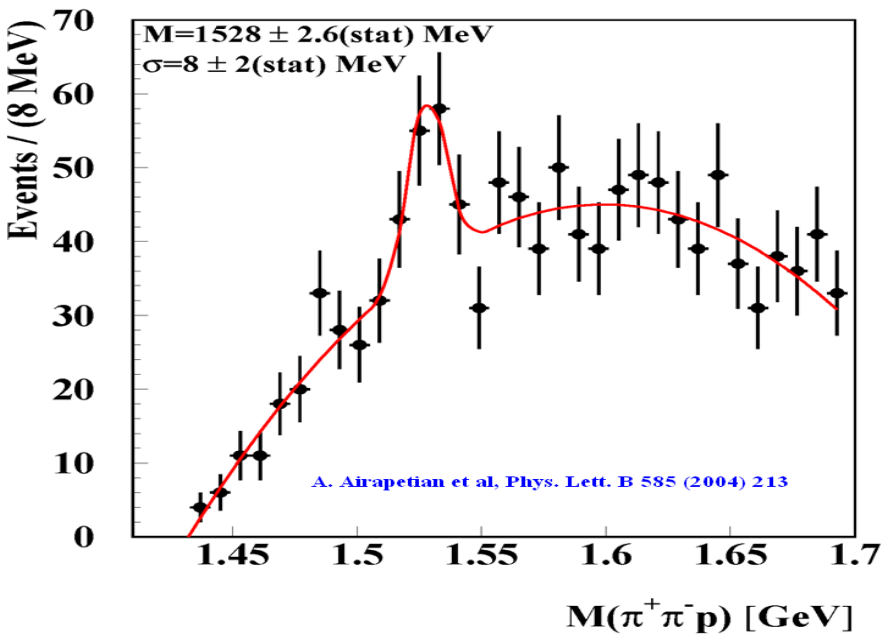
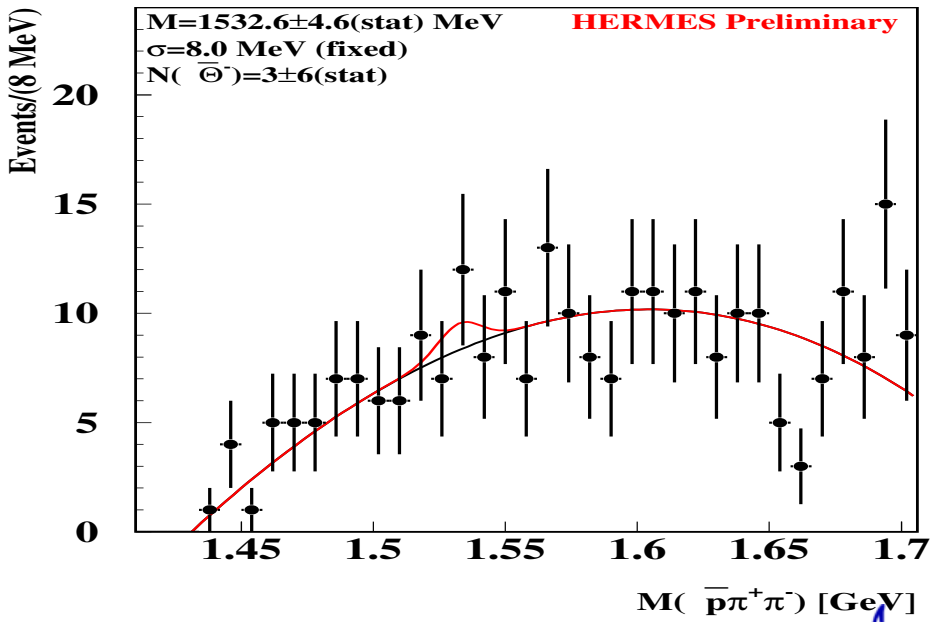


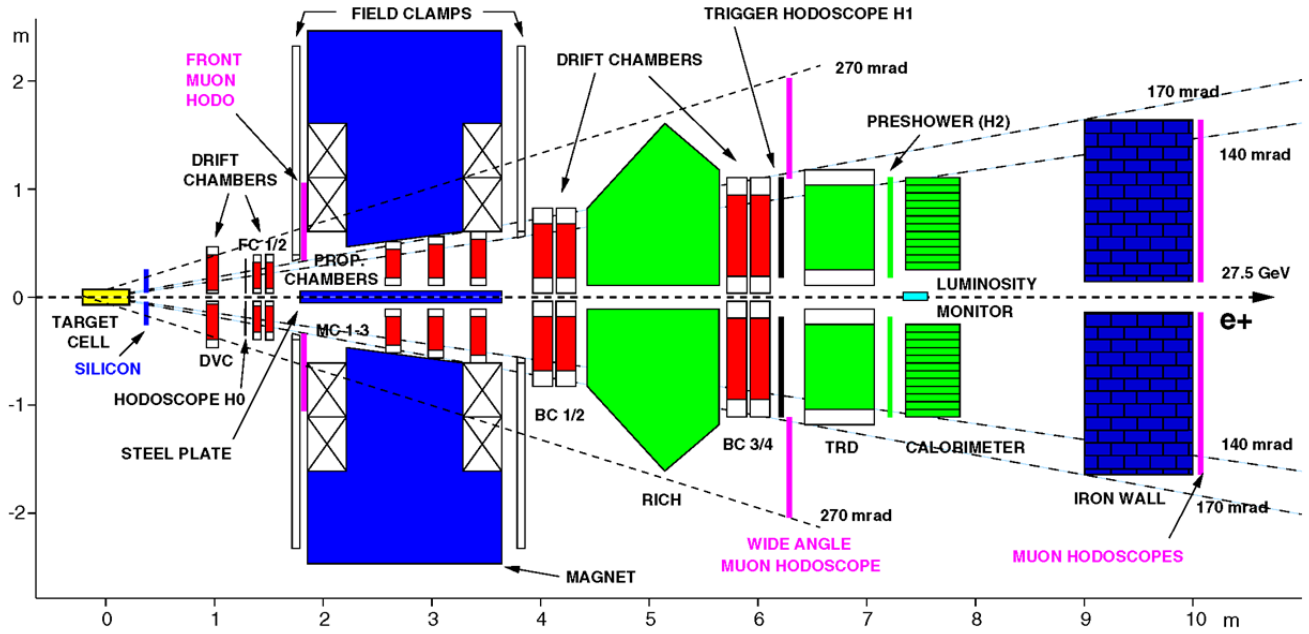


Location of HERMES

HERMES in beautiful Hamburg,Germany:

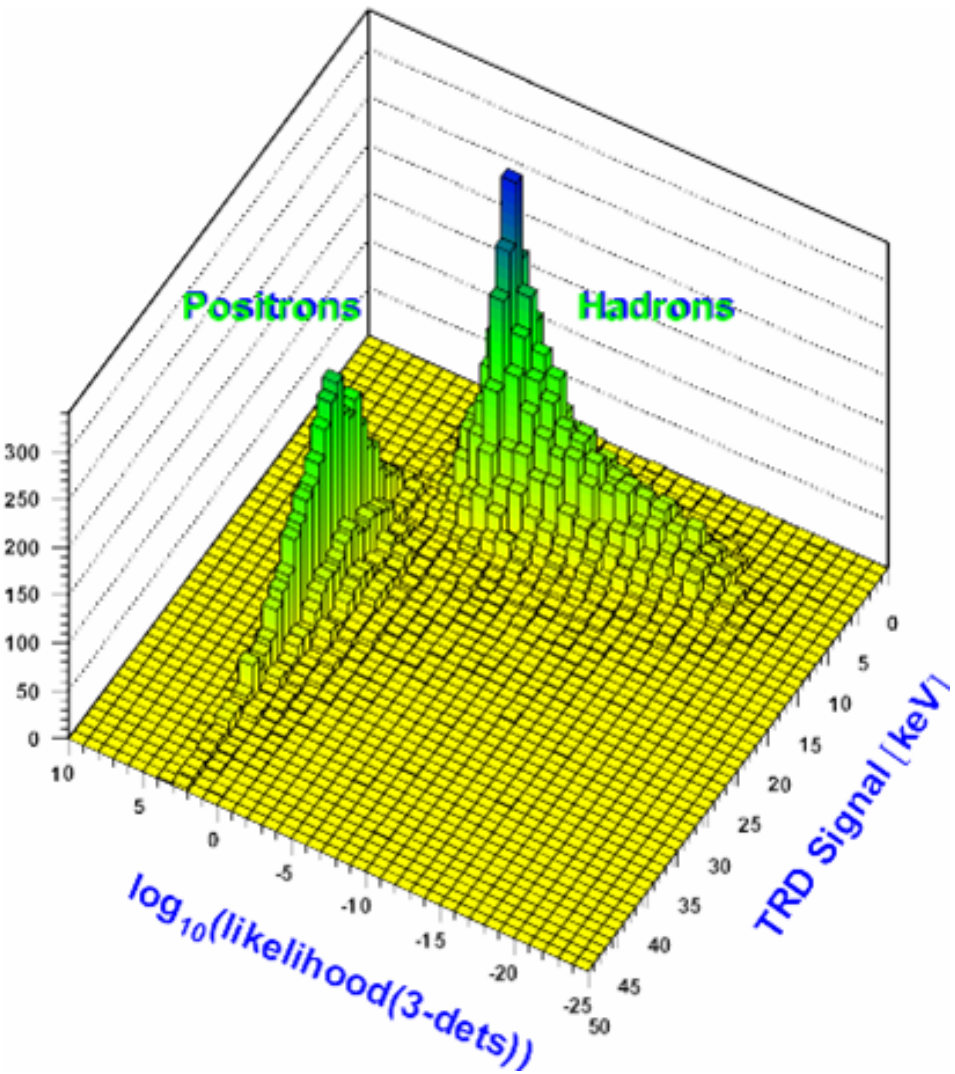
- Investigating: the quark-gluon structure of matter
- Seeking: how overall nucleon spin of 1/2 is constructed by its constituents!

Spectrometer

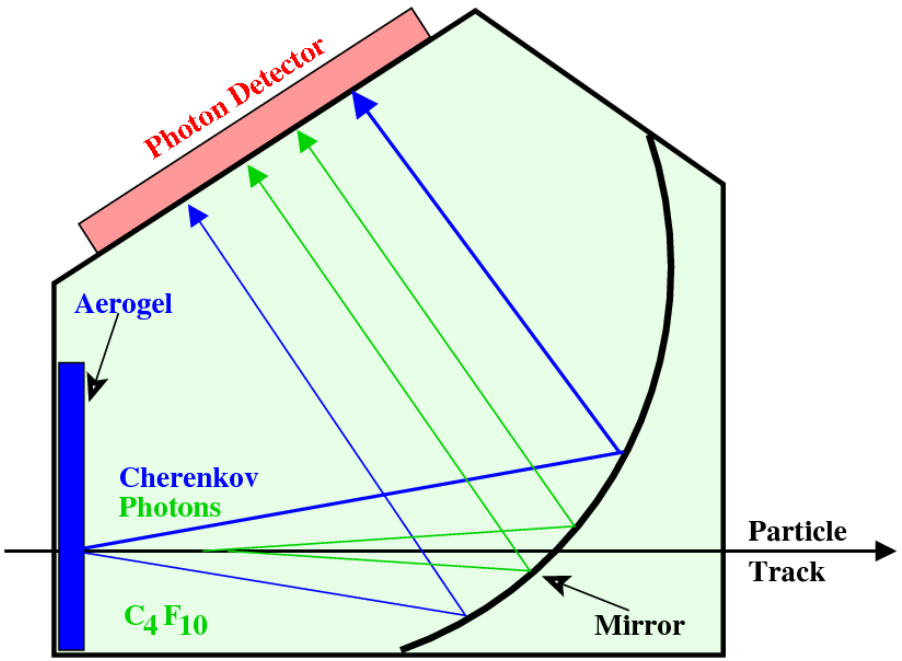


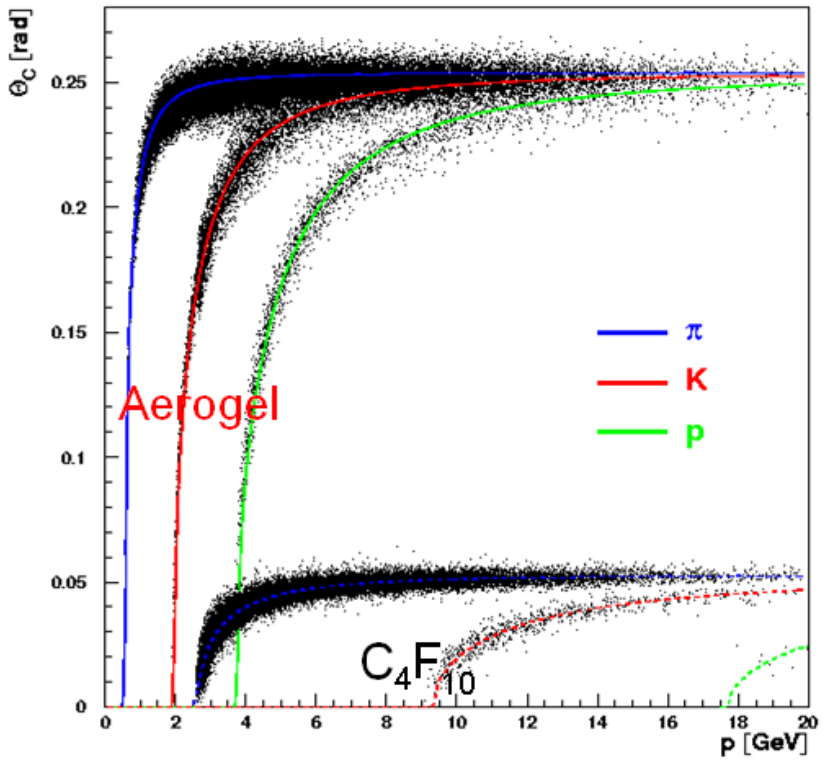
- Beam: 27.5 GeV e^+/e^-
- Target: D target, Luminosity $209 pb^{-1}$
- Forward spectrometer: $\theta_x \leq 175 mrad$, $40 mrad \leq \theta_y \leq 140 mrad$
- Reconstruction: $\Delta p/p$: $1.0 \sim 2.0\%$ and $\Delta\theta \leq 0.6 mrad$
- Particle ID:
  - **RICH, TRD, Preshower, Calorimeter** (hadron/lepton)
  - Dual radiator **RICH** (π, K, p)

Leptons $\rightleftharpoons$ Hadrons Separation:



Hadrons⇛ $\pi/K/p$ (RICH)





Dual Radiator RICH:

- Silica Aerogel: $n = 1.0304$
- C_4F_{10} : $n = 1.0014$

Particle Identification:

- Cherenkov angle: $\cos\theta_C = \frac{1}{\beta n}$
- $P = \frac{m\beta c}{\sqrt{1-\beta^2}}$

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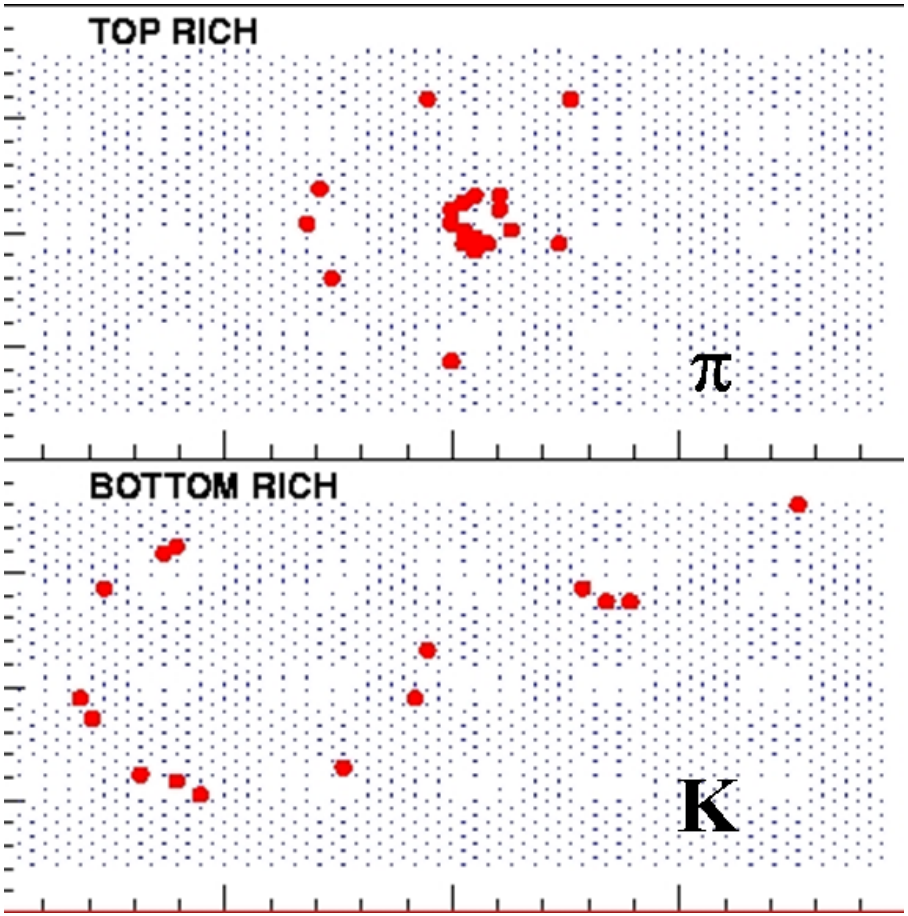
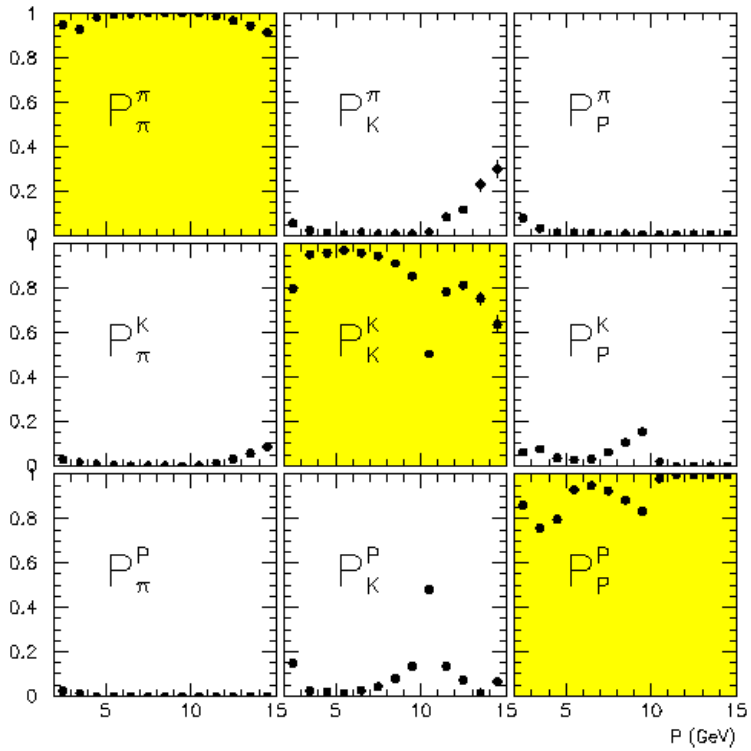




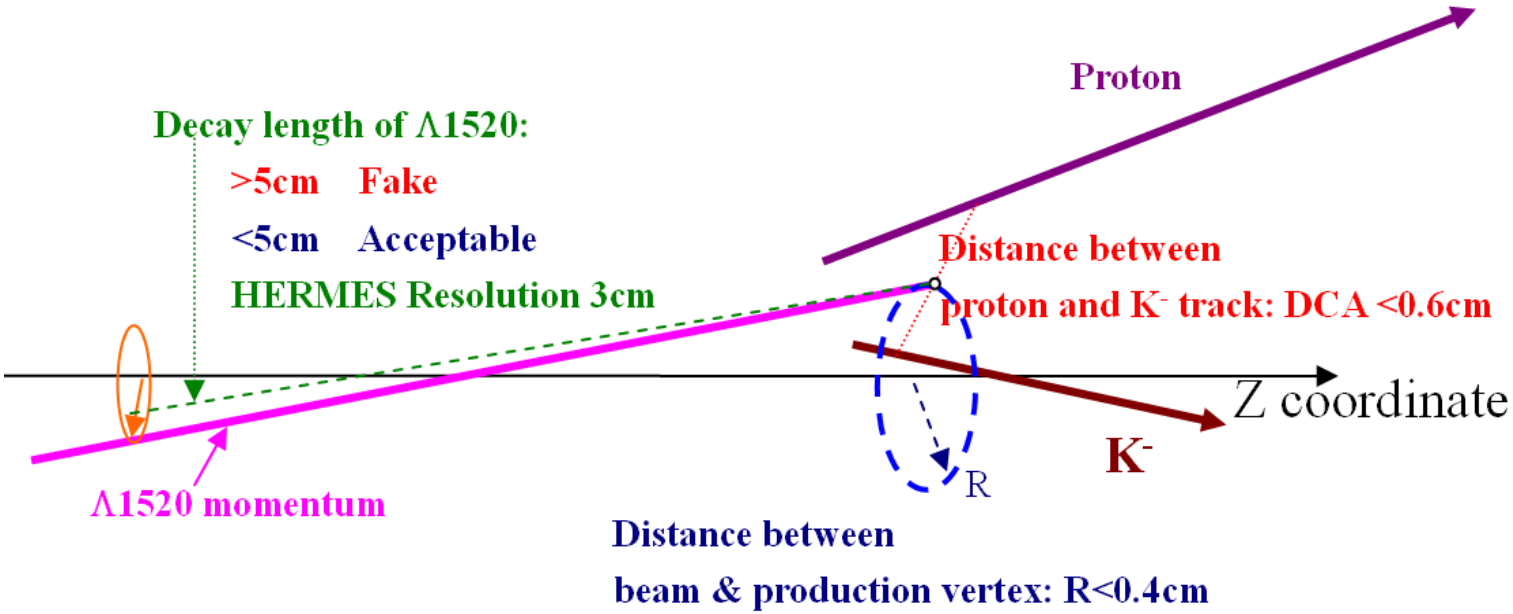
Detection Efficiencies:

- Diagonal: Identified
- Off-Diagonal: Mis-Identified

Reconstruction of $\Lambda(1520)$ and $\bar{\Lambda}(1520)$

$e + D \rightarrow \Lambda(1520) + X \rightarrow pK^- + X$

$e + D \rightarrow \bar{\Lambda}(1520) + X \rightarrow \bar{p}K^+ + X$



Topology of $\Lambda(1520)$ ($c\tau \approx 12.6fm$)

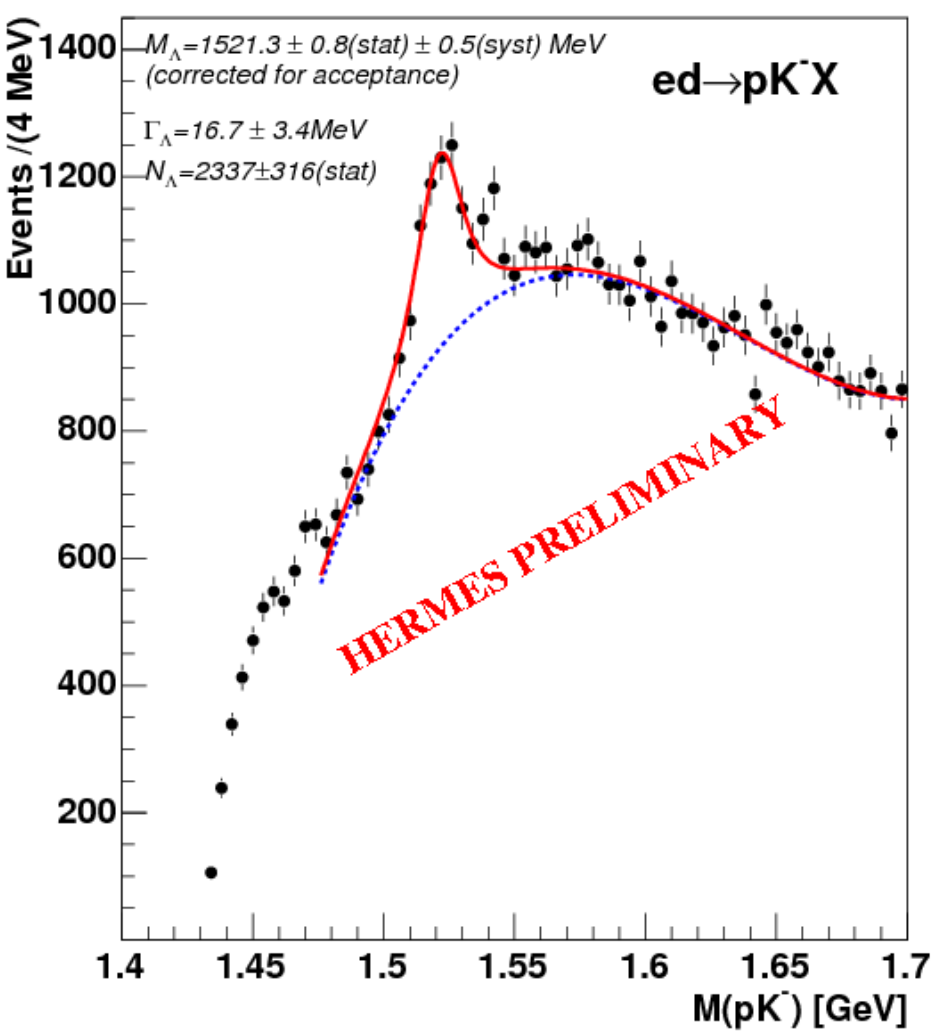
- p and K from one vertex $DCA < 0.6$ cm
- $\Lambda(1520)$ decayed from Beam $R < 0.4$ cm
- Decayed inside target cell $|Z < 18cm|$
- $\Lambda(1520)$ decay Length < 5 cm(Resolution along z: 3cm)

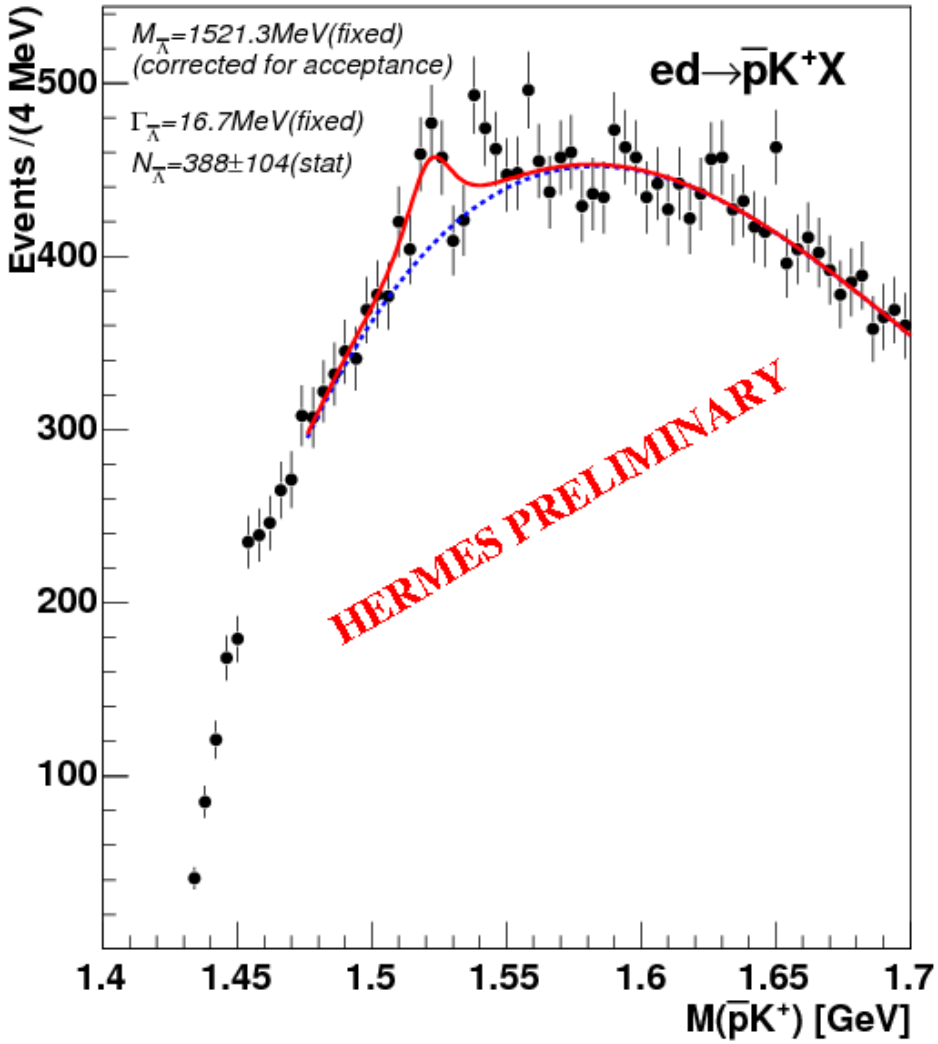
to Fit:

Unbinned Maximum Likelihood Fit

- With $\frac{1}{(x-M)^2+\frac{1}{4}\Gamma^2} \otimes \exp\left(-\frac{x^2}{2\sigma^2}\right) + \left(a_0 + a_1 x + a_2 x^2 + a_3 x^3\right)$
  - Breit-Wigner Function: Γ for intrinsic width
  - Gaussian Function: $\sigma = 4MeV$ for HERMES resolution(MC)
  - Polynomial function for baseline
- Steps to get $N_{\Lambda(1520)}$ and $N_{\bar{\Lambda}(1520)}$:
  1. With Fix $\sigma = 4MeV$ fit M(pK^-) spectrum and get M, Γ and $N_\Lambda(1520)$
  2. Fix $\sigma = 4MeV$, take the M and Γ from $\Lambda(1520)$ to get $N_{\bar{\Lambda}(1520)}$ on $\bar{p}K^+$ spectrum

$\Lambda(1520)$ and $\bar{\Lambda}(1520)$ Spectra





Partial Cross Section($P_z > 6$ GeV)

Calculated with the acceptance of HERMES spectrometer(MC) and integrated luminosity, partial cross sections are:

Partial cross section of $\Lambda(1520)$ and $\bar{\Lambda}(1520)$

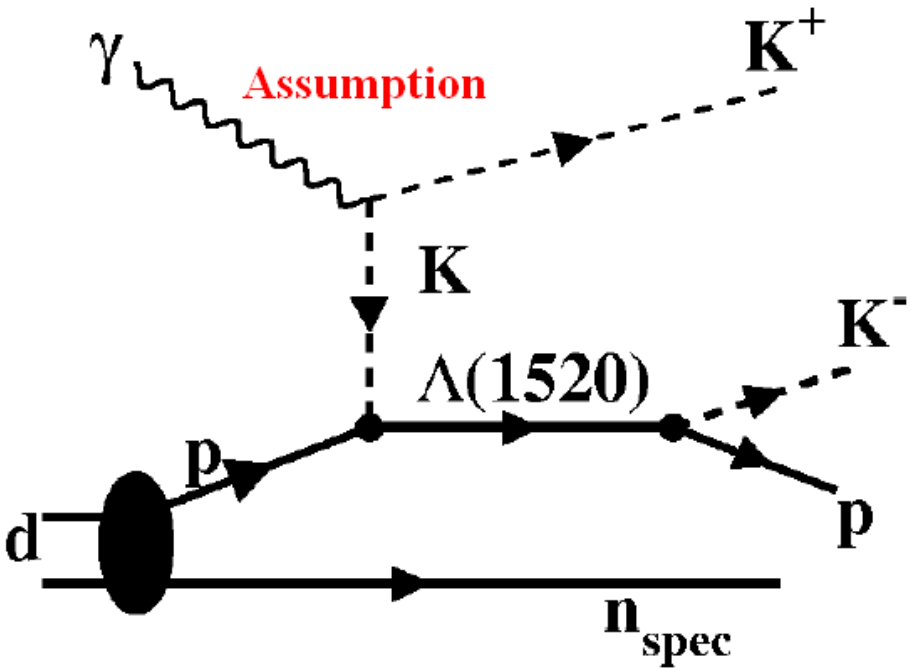
$\sigma_{\bar{\Lambda}(1520)}$ $9.8 \pm 2.6(stat) \pm 0.9(syst)$ nb

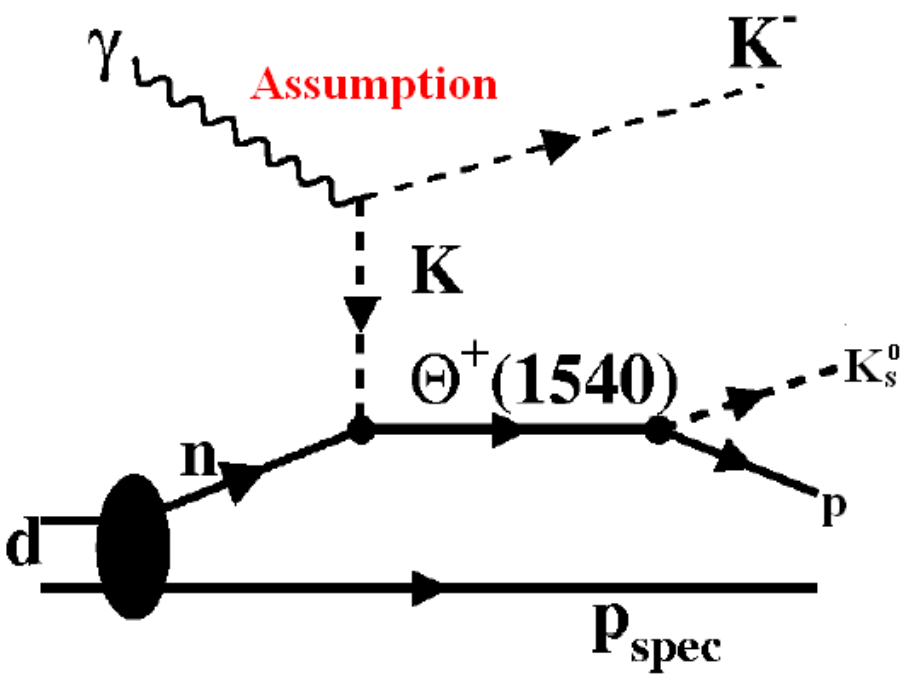
$\sigma_{\Lambda(1520)}$ $65.3 \pm 8.8(stat) \pm 6.9(syst)$ nb

Systematic Errors:

- Effect on acceptance from difference of the initial momentum distributions

Estimate of $N_{\bar{\Theta}^+}$ in HERMES





Base on the assumption of same production mechanism for $\Lambda(1520)$ and Θ^+, and also assumption of $\frac{N_{\bar{\Theta}^+}}{N_{\Theta^+}} = \frac{N_{\bar{\Lambda}}}{N_{\Lambda}}$, $N_{\bar{\Theta}^+}$ estimated as

1. $N_{\bar{\Theta}^+} = \frac{N_{\bar{\Lambda}}}{N_{\Lambda}} N_{\Theta^+} \approx 10 \pm 4$ should be seen
2. $N_{\bar{\Theta}^+} = 3 \pm 6$ has been seen

Summary

1. The cross sections of the $\Lambda(1520)$ and $\bar{\Lambda}(1520)$ were presented
2. The number of $\bar{\Theta}^{+}$ candidates that HERMES should see was given according to the assumption of similar ratio of $\bar{\Lambda}(1520)/\Lambda(1520)$ and number of Θ^{+} candidates seen at HERMES
3. Nucleons like the universe: at HERMES energy, it can easily produce $\Lambda(1520)$ but not easily create a $\bar{\Lambda}(1520)$ from the sea. It will be interesting to see how the ratios of particle and antiparticle for hyperons change with invariant mass.