College of Integrative Sciences and Arts
Arizona State University

Student Showcase

Measuring the Photoproduction of K^{+*} K^+ Ξ^- States from a Proton Target

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GlueX Jefferson Lab

Introduction and Objectives

The GlueX experiment in Hall D of Jefferson National Lab was created to further investigate the strong interaction within hadronic matter, which is matter that contains quarks. In the Standard Model, the strong interaction is mediated by gluons, the study of which is known as Quantum Chromodynamics, or QCD.

One of the aims of the GlueX experiment is to explore QCD-inspired models of hadrons. Most models predict many more cascade states than have been observed. Additionally, cross sections of some production modes of the ground state cascades have yet to be published.

One such unpublished reaction is $\gamma\, p \rightarrow \mathrm{K}^{+*}\, \mathrm{K}^{+}\Xi^{-}$.

Methods

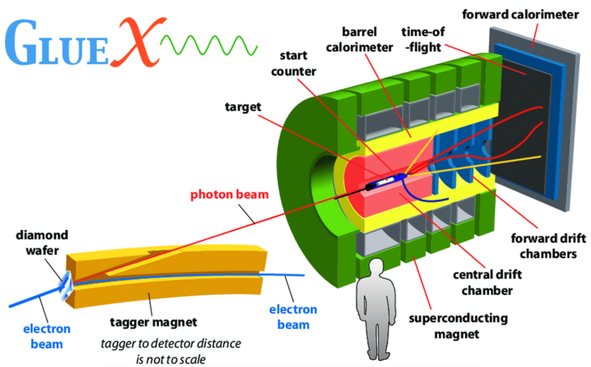

Fig 1. Hall D's detector apparatus.

Hall D utilizes a 12 GeV electron beam to facilitate photoproduction. The energy levels of the produced photons and hadrons are then measured and stored in a data tree with over 31 million events.

Using CERN's ROOT framework, the data tree was then analyzed and categorized into various histograms for each decay reaction. Using a C++ script, these end products were then reconstructed into the intermediate products:

$$\gamma\, p \rightarrow \mathrm{K}^{+*}\, \mathrm{K}^{+}\Xi^{-}$$
$$\Xi^{-} \rightarrow \pi^{-}\Lambda$$
$$K^{+*} \rightarrow \mathrm{K}^{+}\, \pi^{0}$$

Results

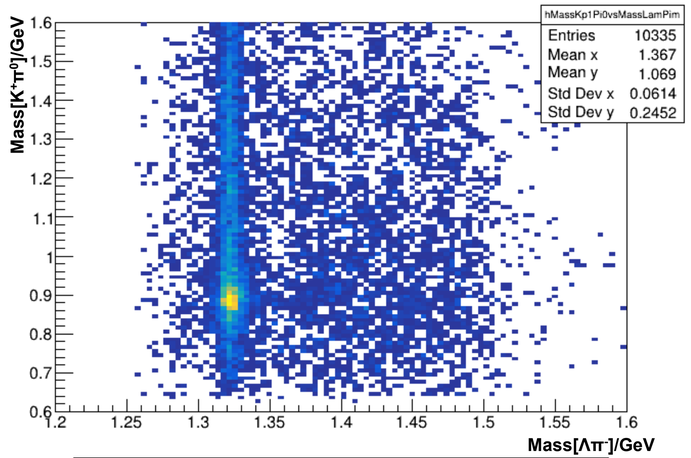

Fig 2. Comparison of $K^{+}{}_{a}\pi^{0}$ states to $\Lambda\, \pi^{-}$ states.

Examination of each Kaon (K_a and K_b) showed that no momentum difference existed between the two. Projecting the histogram onto the y-axis and creating polynomial and gaussian fits of the background and spike, respectively, yields:

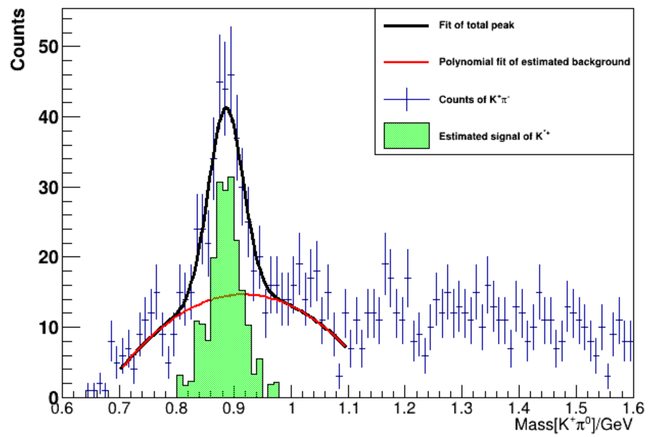

Fig 3. K^{+*} histogram corresponding to a bin center of 1322 MeV for the mass of the Ξ^{-}.

Results contd.

Compiling the K^{+*} signals from each of these bins and comparing to the mass of the corresponding Ξ^{-} particle:

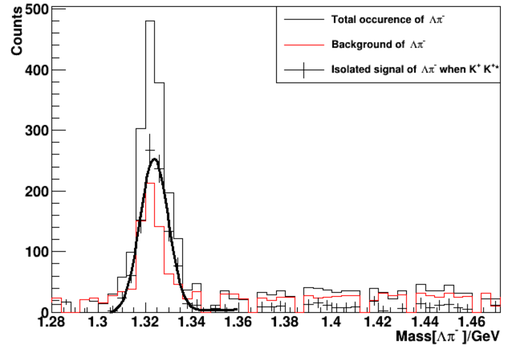

Fig 4. Comparison of K^{+*} counts to corresponding Ξ^{-} mass for K_a

This corresponds to a mean Ξ^{-} invariant mass of 1324 ± 0.4 MeV and a sigma of 5.648±0.4 MeV (PDG value [1] is 1321.71±0.07). Repeating the same process for the other K^{+} particle, however, yields:

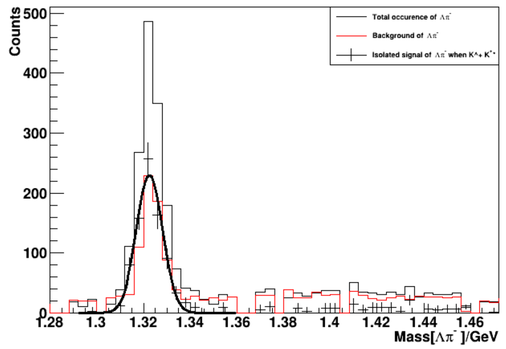

Fig 5. Comparison of K^{+*} counts to corresponding Ξ^{-} mass for K_b

Which corresponds to a mean of 1322 ±0.4 Mev and a sigma of 5.573 ±0.5 MeV.

Literature Cited

[1] S. Navas *et al*. (Particle Data Group), Phys. Rev. D 110, 030001 (2024)