Analysis of reaction $\gamma + p \rightarrow a_2^- \Delta^{++}$

From GlueX Data

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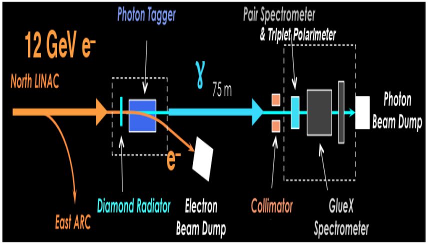
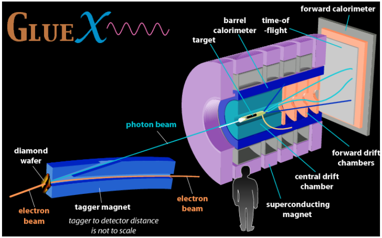
(Jefferson Lab) GlueX Hall D Detector





- Diamond Radiator
- Brems·strah·lung electrons
- Photon Tagger
- Electron Beam Dump
- Collimator
- Pair Spectrometer

- GlueX Spectrometer
- Liquid Hydrogen Target
- Central/Forward Drift Chamber
- Barrel/Forward Calorimeter

Previous Experiments

Previous Experiments have shown angular distributions and cross-sections of a_2^- which decays to...

- $K^- K_s$ through pion proton reaction

$$\pi^- p \rightarrow K^- K_s \, p$$

- 3 pions $\pi^\pm$ through gamma proton reaction

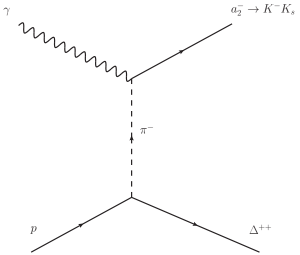
$$\gamma p \rightarrow a_2^- \Delta^{++} \rightarrow \Delta^{++} \pi^+ \pi^- \pi^-$$

But never has $a_2^- \Delta^{++}$ been identified as $K^- K_s \Delta^{++}$ through gamma proton reaction

Reaction

$$\gamma + p \rightarrow \quad a_2^- \ \Delta^{++} \rightarrow \quad K^- \ K_s \, \pi^+ \ p$$

- Decay
  - $\Delta^{++}(1232) \rightarrow \pi^+ \ p$
  - $a_2^-(1320) \rightarrow K^- \ K_s$
  - $K_s \rightarrow \pi^+ \ \pi^-$
- **Branching Fraction**
  - **99.4%**
  - **5%**
  - **69.2%**



Method

a_2^- was not directly measured from the experiment. Instead it's identification comes from it's decay $K^- K_s$

Where, **$\mathbf{K_s}$ had to be reconstructed** and identified by it's own decay $\pi^+\pi^-$

Parts of data received from the detectors are modified or removed to single out specific areas of interest (to find/identify). Because of this we need to solve many questions...

- What are we trying to find?
- What needs to be modified/removed from our data and how do we go about doing it?
- What procedures can we take in order to ensure we are modifying/removing only whats necessary?
- How do we strengthen our findings and reduce the possibility of miss identification of particles

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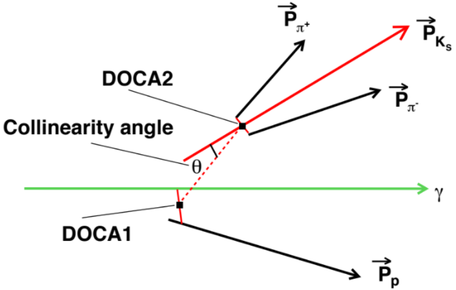
Vertex and Collinearity Angle For K_s Reconstruction

CODE - Jorn Langheinrich: DAnalysisUtilities::Calc_DOCA



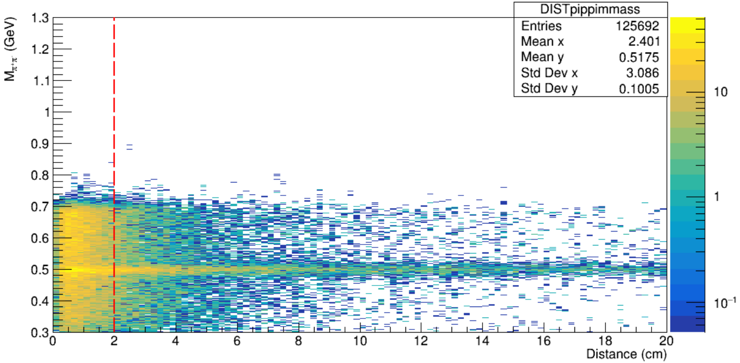
Primary Vertex / Decay Vertex / Collinearity Angle

Distance Between Midpoints of DOCA1 and DOCA2

Cos θ as the Collinearity angle

$M_{\pi^+ \pi^-}$ vs Distance

Graphically representing vertex distance to remove background

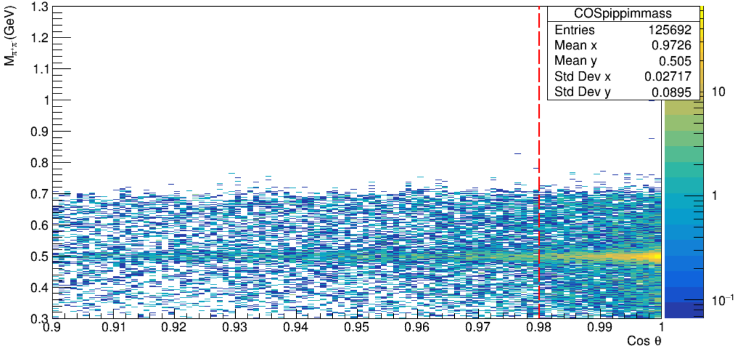


Distance > 2 cm

Between midpoints of DOCA1 & DOCA2

$M_{\pi^+\pi^-}$ vs Cos θ

Graphically representing collinearity angle to remove background

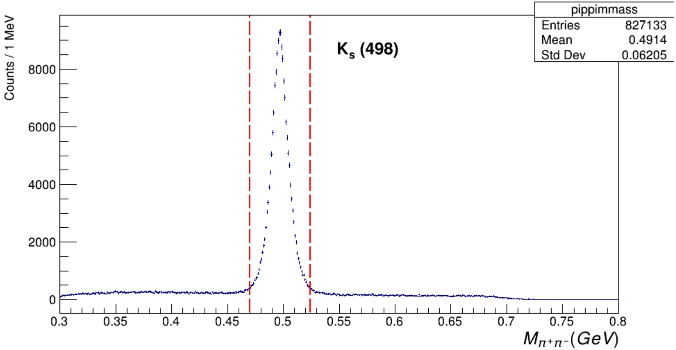


Cos $\theta > 0.98$

Collinearity Angle

Invariant Mass of $\pi^+\pi^-$

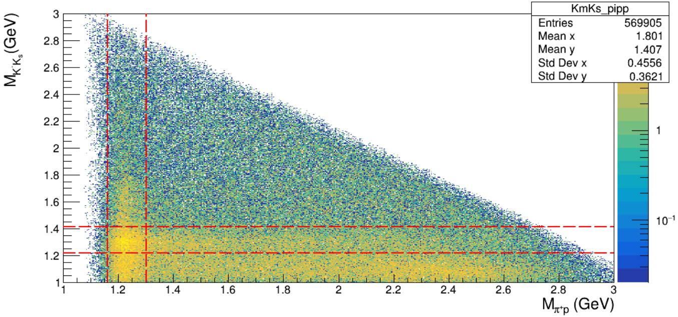
By limiting our decay vertex we are able to identify K_s (known value 498 MeV)



- $0.470 < \quad M_{\pi^+\,\pi^-} \quad < 0.524$ GeV $\qquad$ **497** $\pm 27\ MeV$

$M_{K^-K_s}$ vs M_{π^+p}

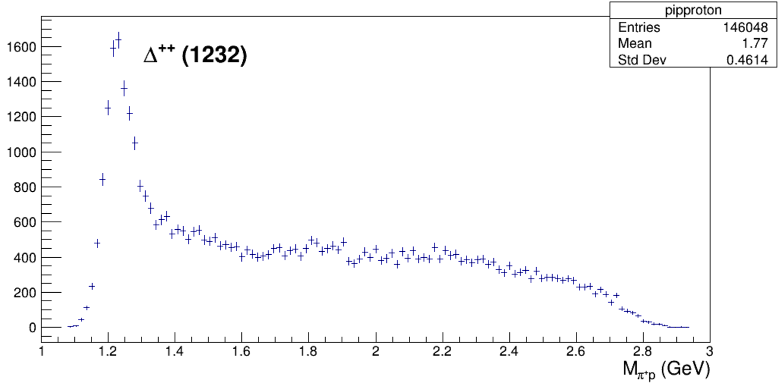
In order to correctly identify a_2^- and Δ^{++} we must single out K^-K_s (expected to be a_2^-) and π^+p (expected to be Δ^{++}) and deem the surrounding areas as unwanted background



- $1.220 < M_{K^-K_s} < 1.420$ GeV
- $1.162 < M_{\pi^+p} < 1.302$ GeV

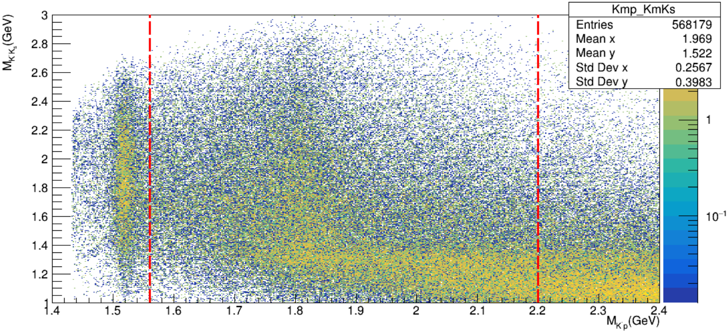
Invariant Mass of $\pi^+ p$

We are then able to identify Δ^{++} (known value 1232 MeV)



- Clear peak at 1230 MeV

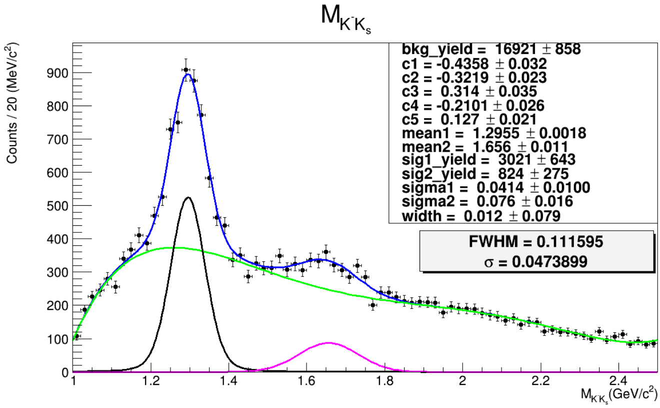
$M_{K_s K^-}$ vs $M_{K^- p}$



- $1.56 < M_{K^- p} < 2.2$ GeV

Λ (1520) contributes to background

a_2^- Voigtian Fit



- Results for Full beam energy range
- Clean peak for a_2^- (1320)
- Possible peak around 1700 MeV

Outlook

First observation of $a_2^- \rightarrow K^- K_s$ in photoproduction

Test natural and unnatural parity contribution