A Study of Λ-N Scattering using g12 at Jefferson Lab

Joey Rowley, Ken Hicks (Ohio University)
John Price (Cal State Univ Dominguez Hills)

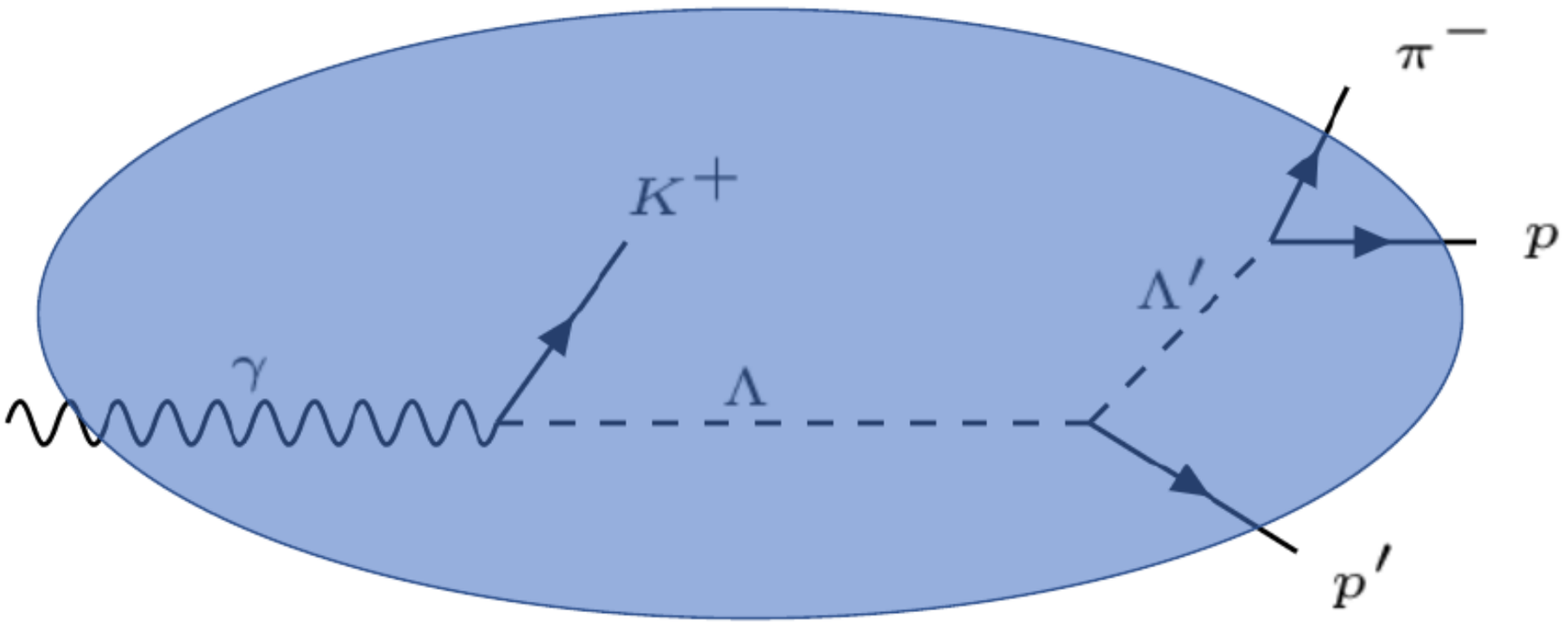
Department of physics + astronomy

OHIO UNIVERSITY 1804

clas

CEBAF Large Acceptance Spectrometer

Reaction

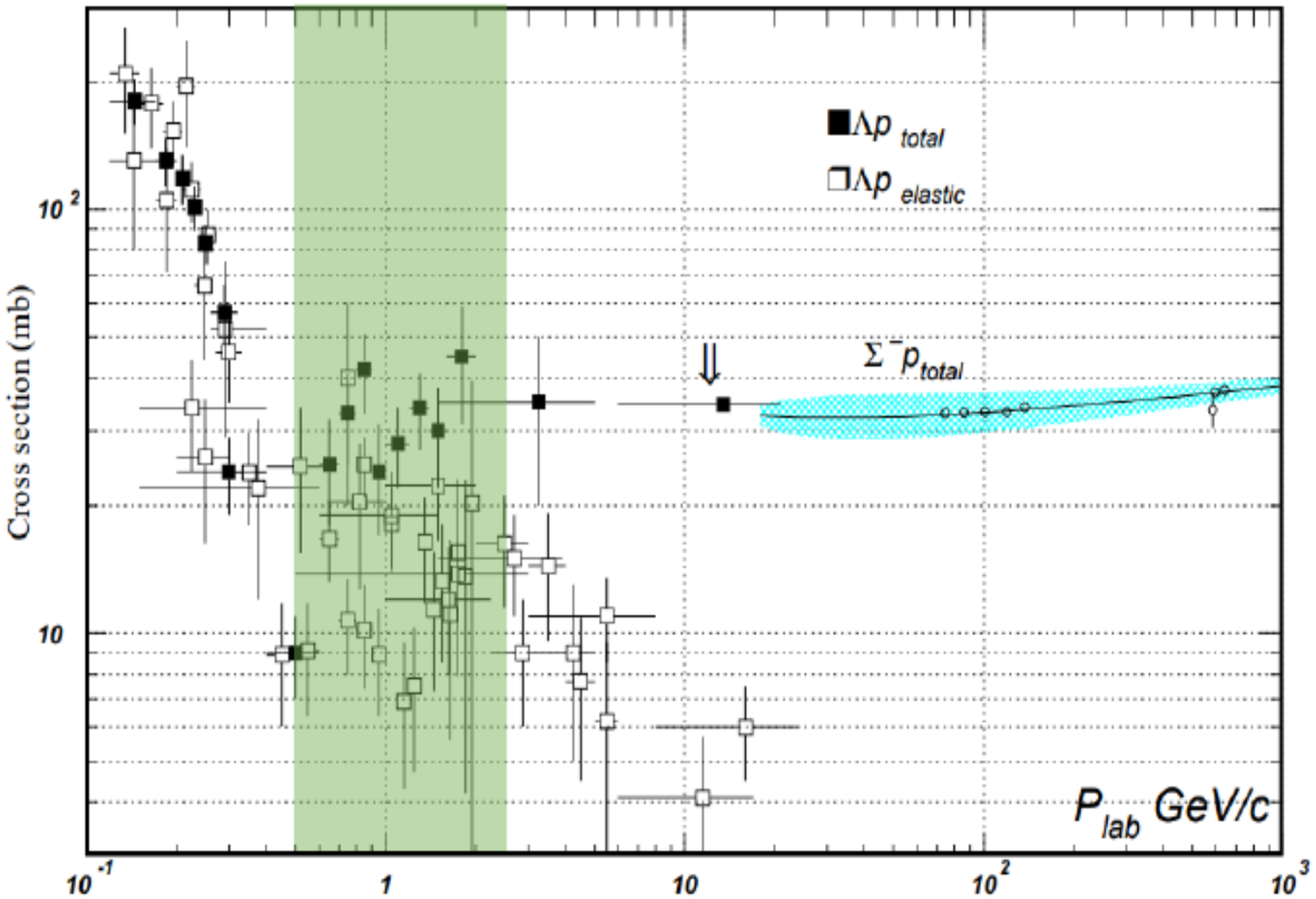


- Liquid Hydrogen Target
- p, p’, π^- detected
- Λp scatter elastically

Motivation

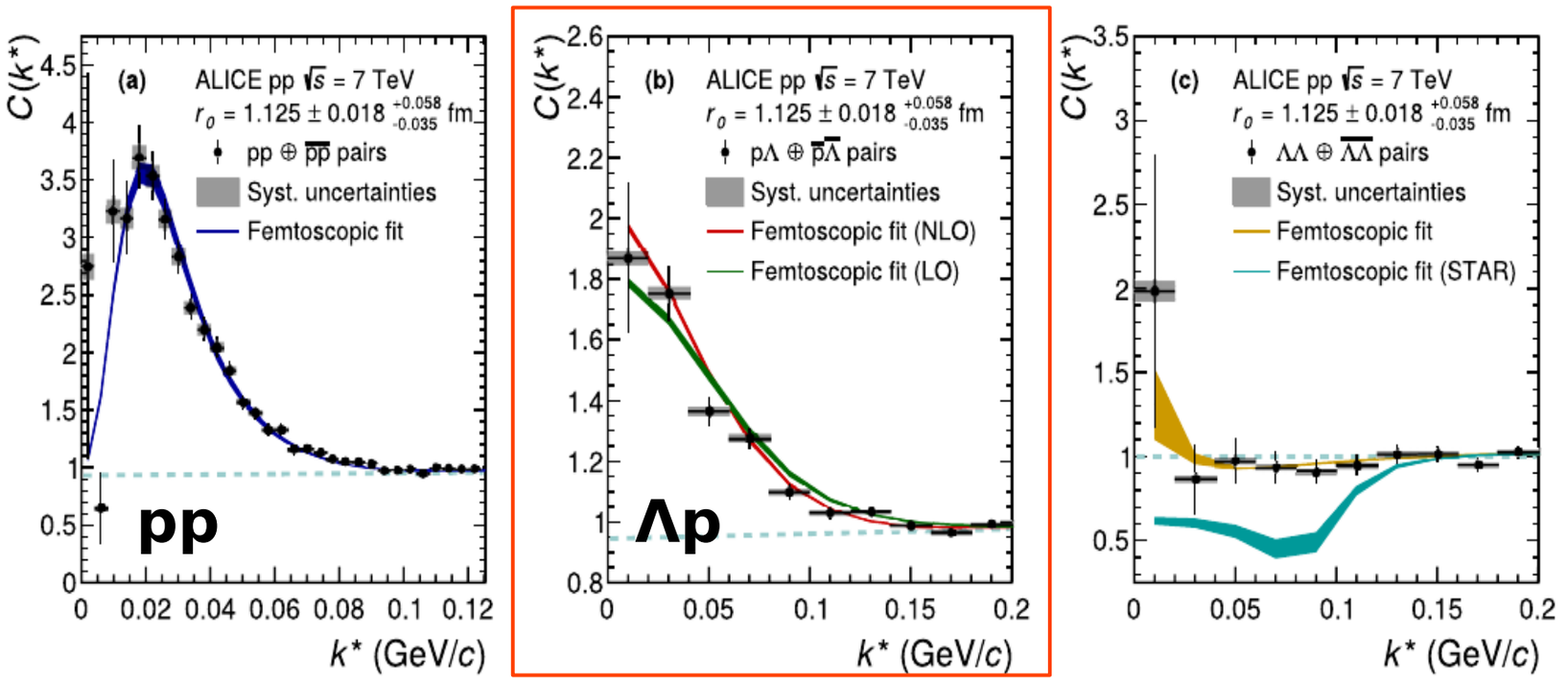
- Currently very little data for ΛN scattering compared to other elastic scattering processes (NN, KN or πN).

- ΛN scattering is important to understand the interior of neutron stars. (Haidenbauer and Meissner, PRC 72, 044005 (2005).)



C. Patrignani *et al.* (Particle Data Group), Chin. Phys. C, **40**, 100001 (2016) and 2017 update.

Motivation: RHIC Data



$$C(\mathbf{p}_1, \mathbf{p}_2) \equiv \frac{P(\mathbf{p}_1, \mathbf{p}_2)}{P(\mathbf{p}_1) \cdot P(\mathbf{p}_2)}$$

k* : relative momentum of pair

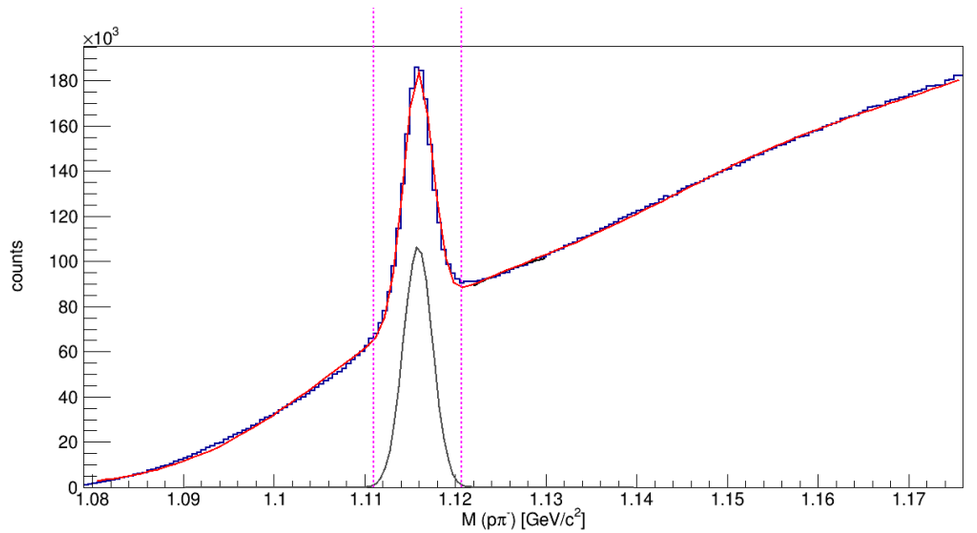
- Correlation function relies on the cross section of Λp
- Our analysis will help improve these results

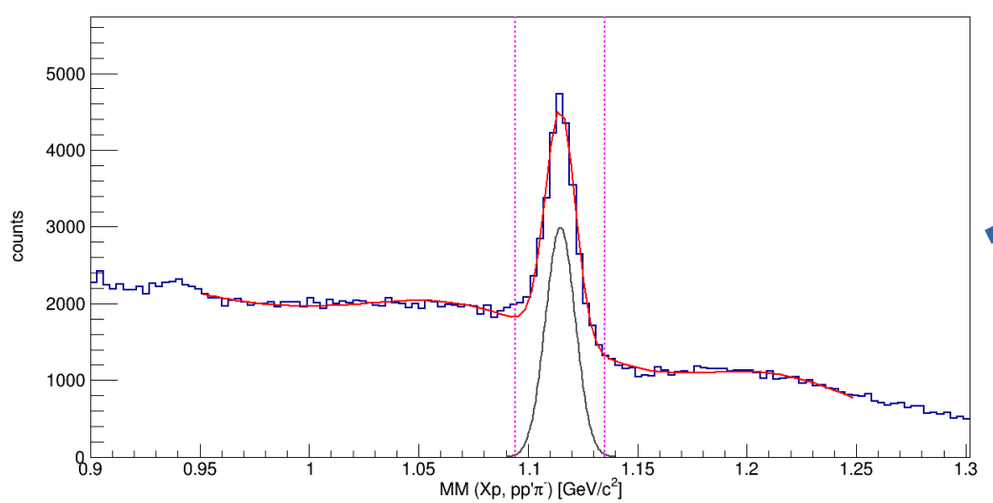
Procedure Analysis

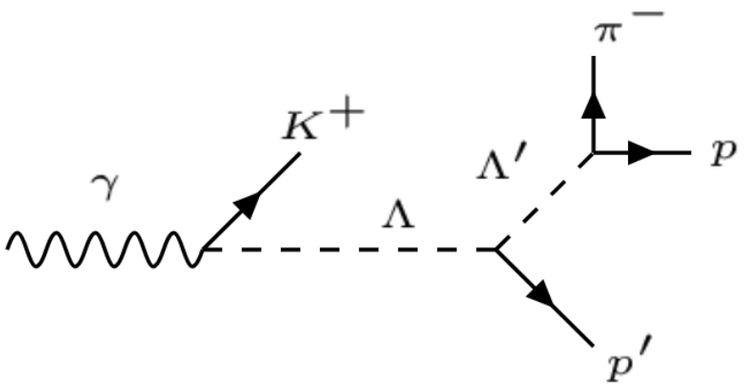
$$\gamma p \rightarrow K^{+}\Lambda \longrightarrow \Lambda \mathrm{p} \rightarrow \Lambda' p' \rightarrow p' p \pi^{-}$$

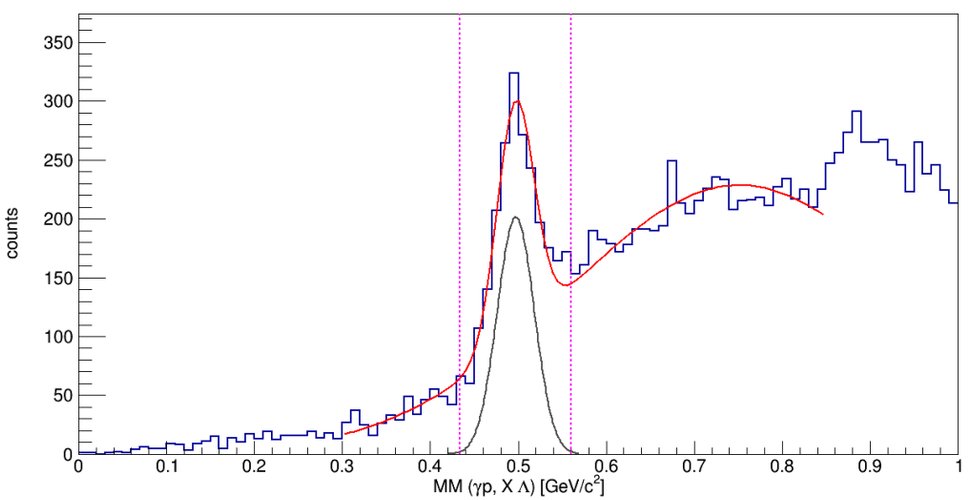
- Data from g12
- Reconstruct the Λ’ mass: M(Λ’) = M(pπ-)
- Reconstruct incident Λ
- Identify K+ by missing mass

Data

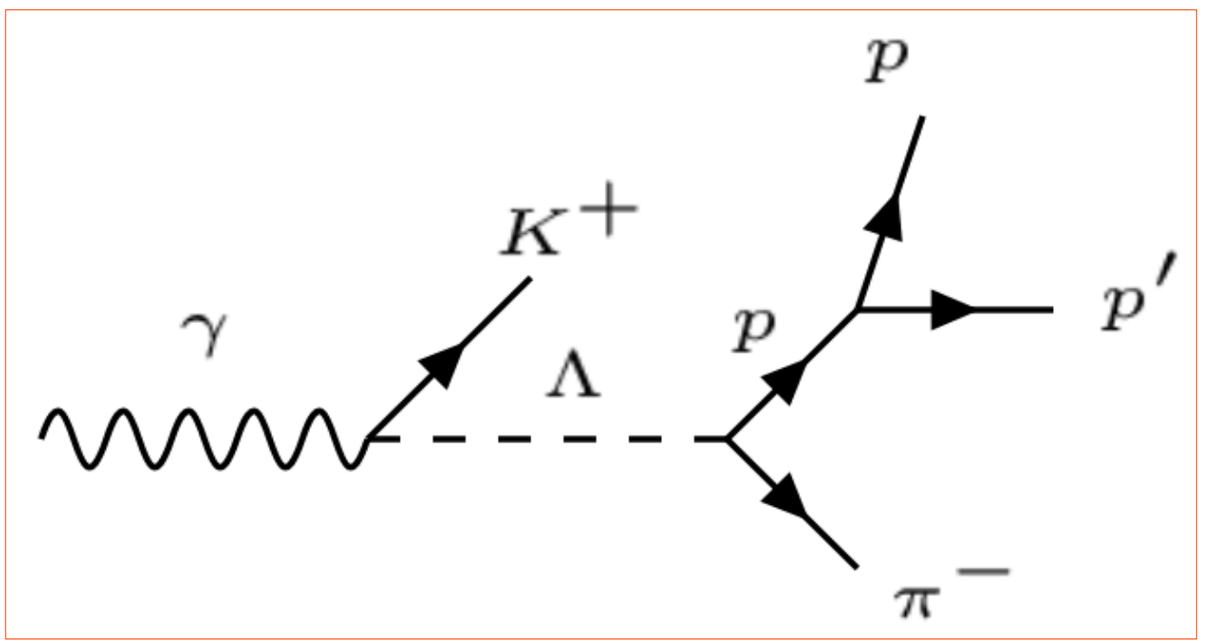

×10^3
counts
M (pπ⁻) [GeV/c²]

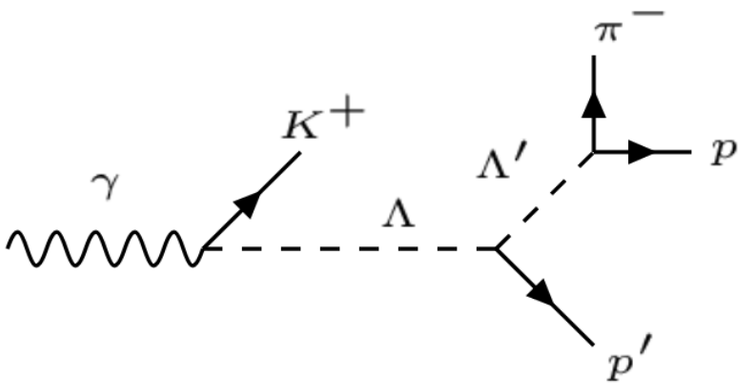

counts
MM (Xp, pp'π⁻) [GeV/c²]


γ
K+
Λ
Λ′
π⁻
p
p′


counts
MM (γp, X Λ) [GeV/c²]

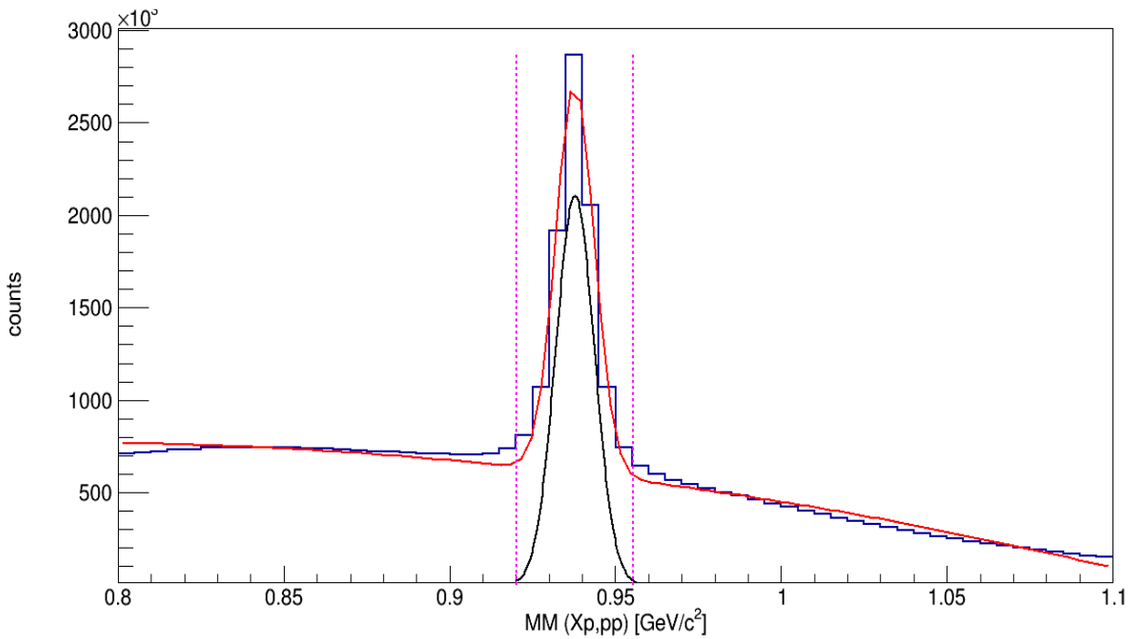
pp → pp events

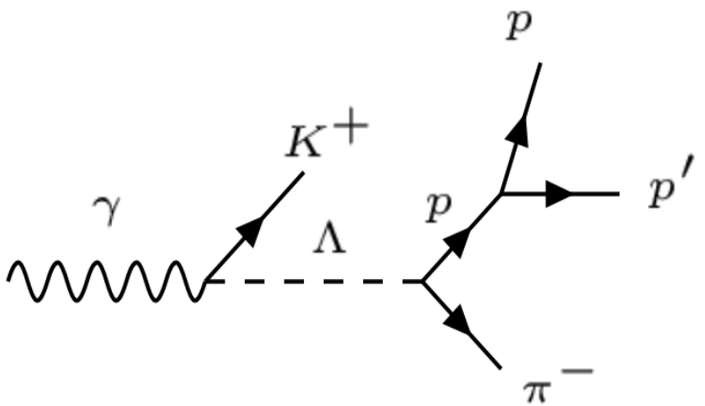




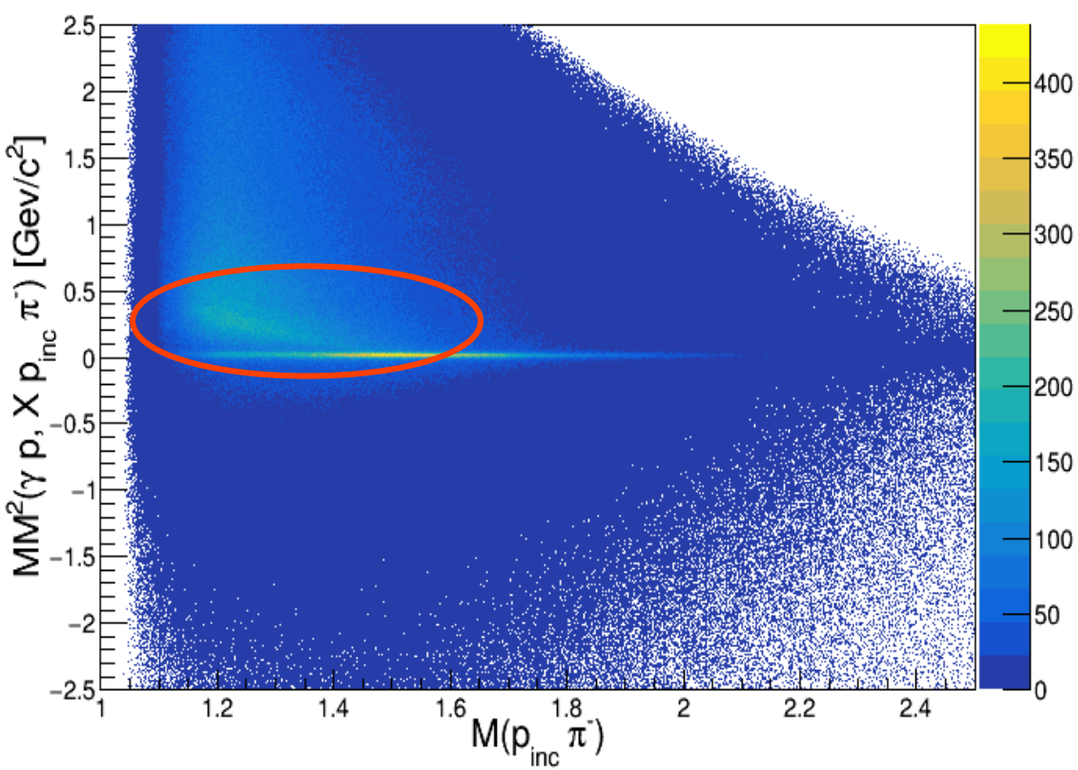
- pp → pp events can also result in the same final state.

pp → pp events





Events need to be removed for incident p events but not for incident π^-



Cross Section

$$\frac{d\sigma}{dcos(\theta)}(E) = \frac{Y}{A * \mathcal{L} * \text{b. r.} * \Delta \cos(\theta)}$$

Y: Yield

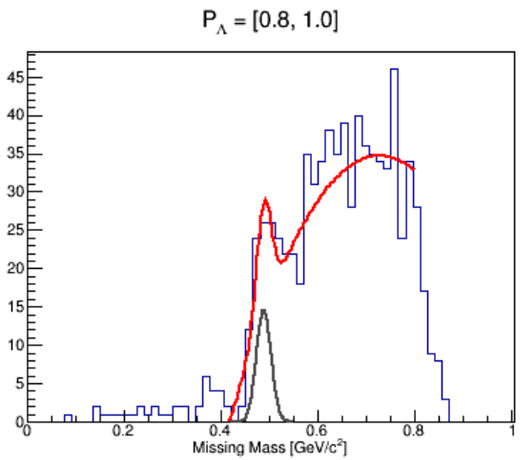
A: Acceptance

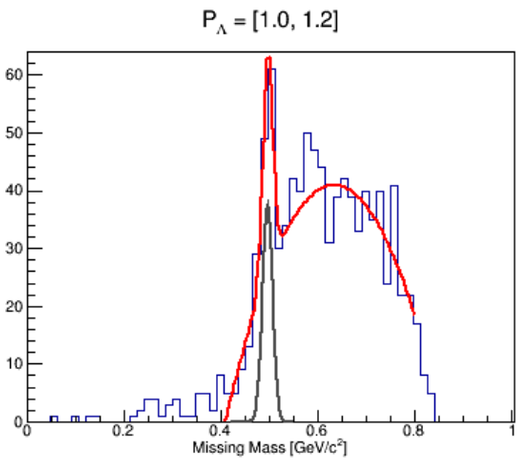
$\mathcal{L}$: Luminosity

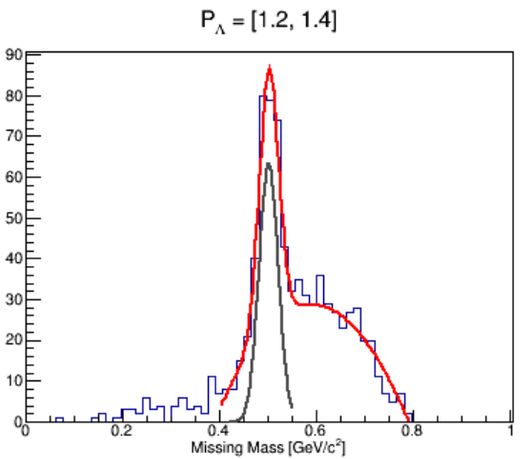
b.r: Branching ratio (for $p\pi^-$)

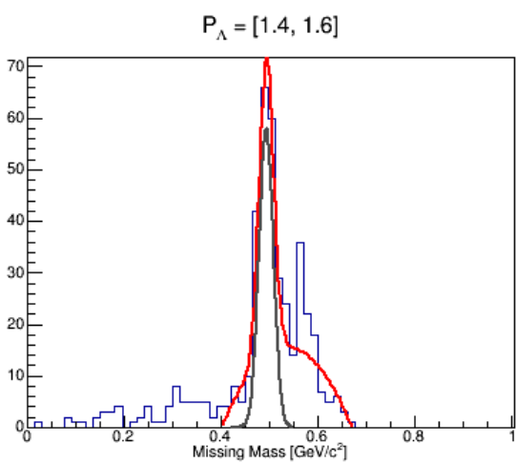
$\frac{d\sigma}{dcos(\theta)}(E)$: Energy dependent cross section

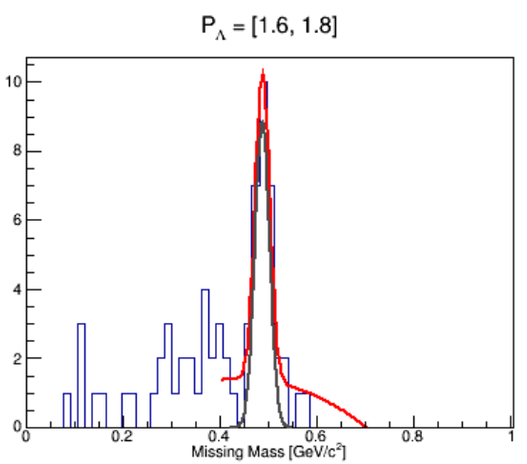
Yields







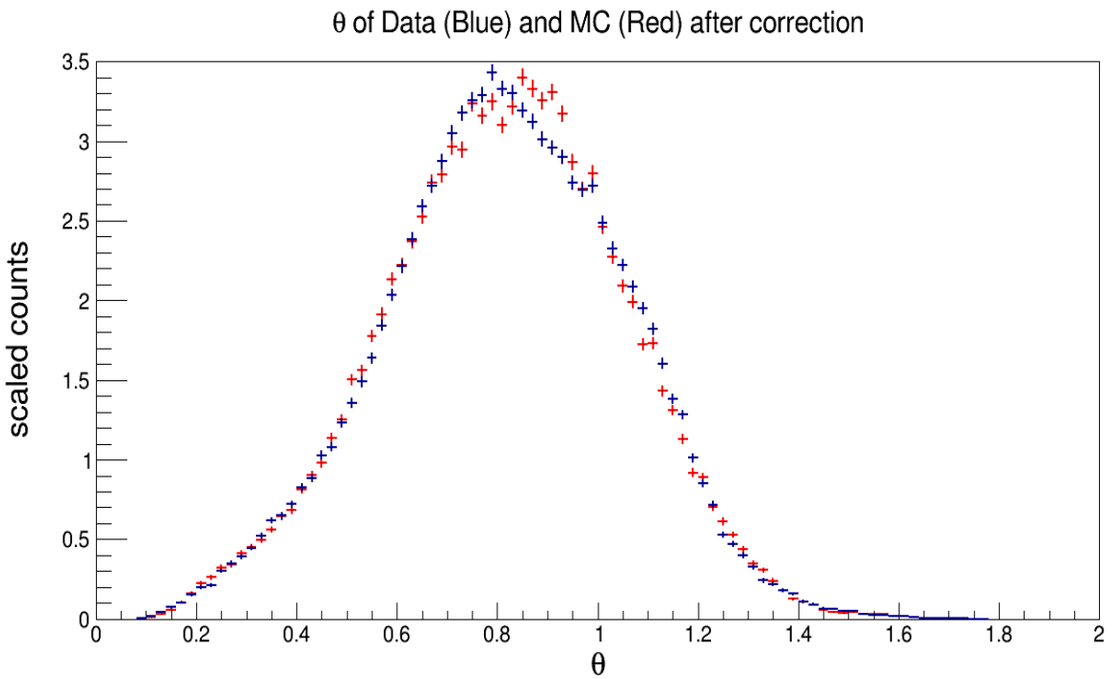


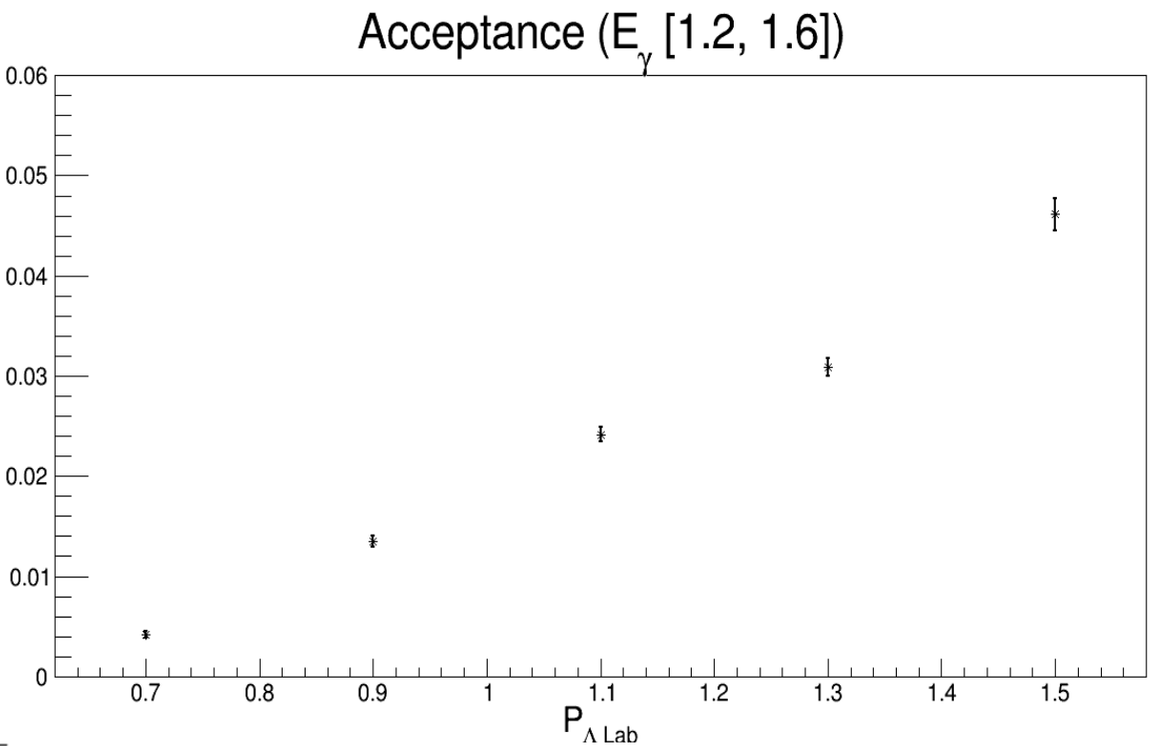


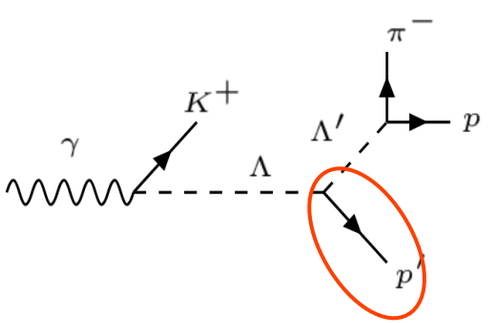
- Yield is taken from Missing Mass (K+ peak)
- Binned in Λ Momentum

Acceptance

Acceptance = Accepted Events/ Generated Events







Luminosity

$$L_\Lambda(E_\Lambda) = \frac{\rho_T * N_A * l}{M} * N_\Lambda(E_\Lambda)$$

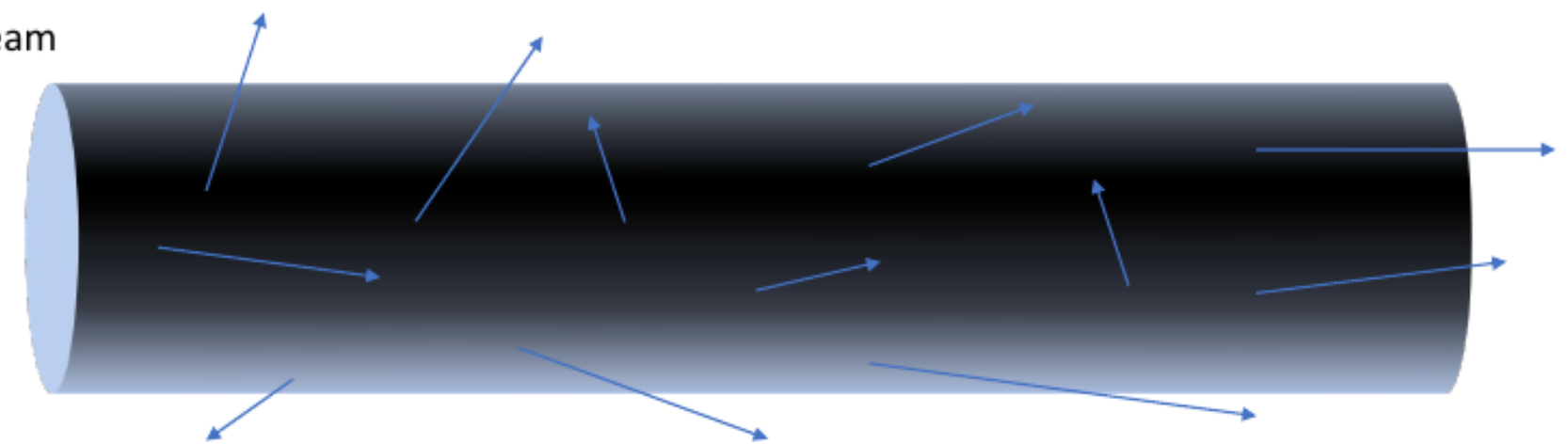
- ρ_T: density of the target
- N_A: Avogadro's number
- M: molar mass of Hydrogen
- l: travel distance of Λ
- $N_\Lambda(E_\Lambda)$: yield in a certain energy range

Problem: How do we find l and $N_\Lambda(E_\Lambda)$?

Luminosity

Photon Beam

Λ Beam



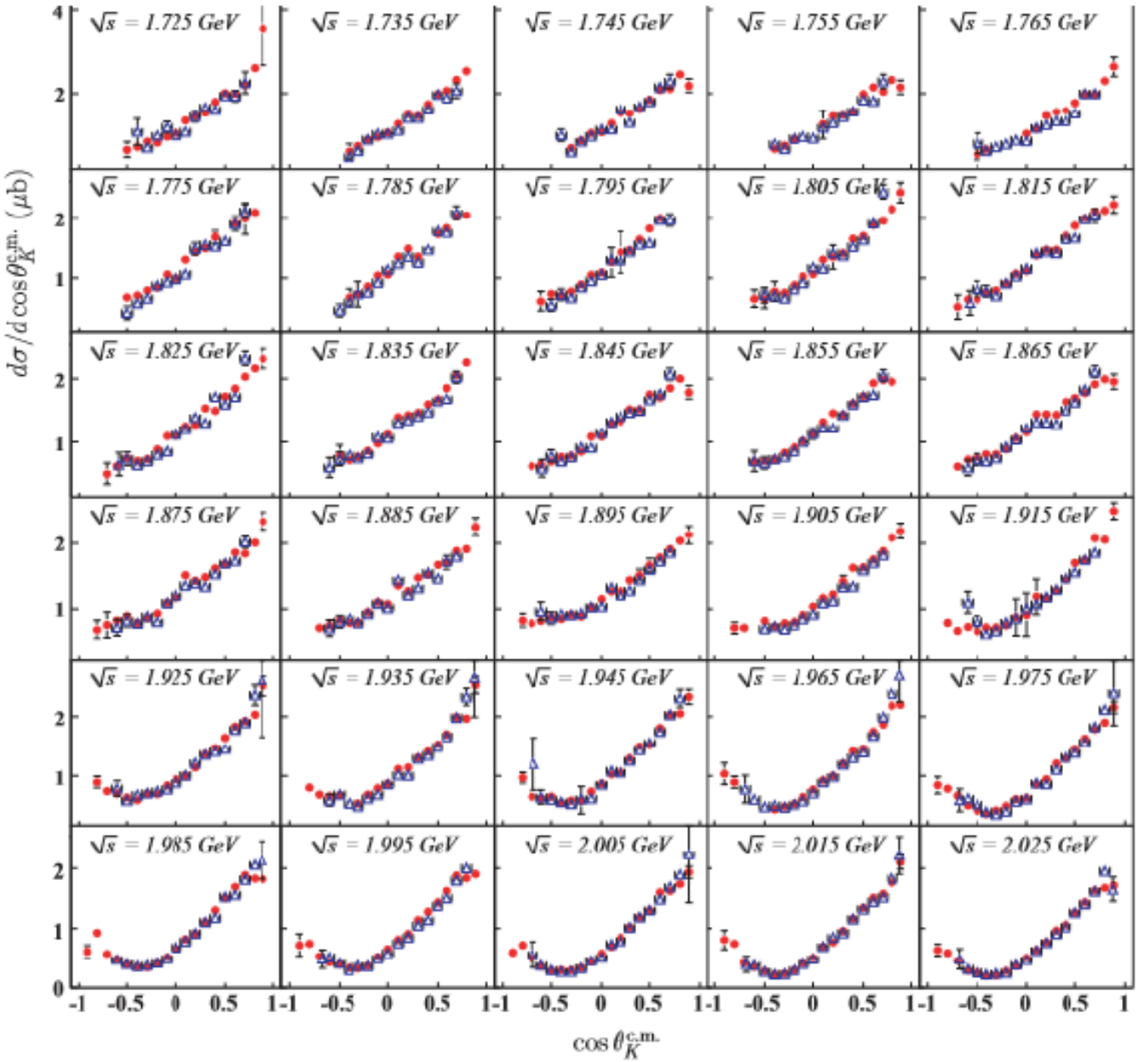
Λ Decay Length (l)

$$P(z) = e^{-(\frac{M}{p})(\frac{z-z0}{c\tau})}$$

- P(z): probability of Λ decay
- M: mass of Λ (1.115 GeV/c^2)
- p: momentum of Λ
- z0: starting position
- $c\tau$: mean proper life (7.89cm)

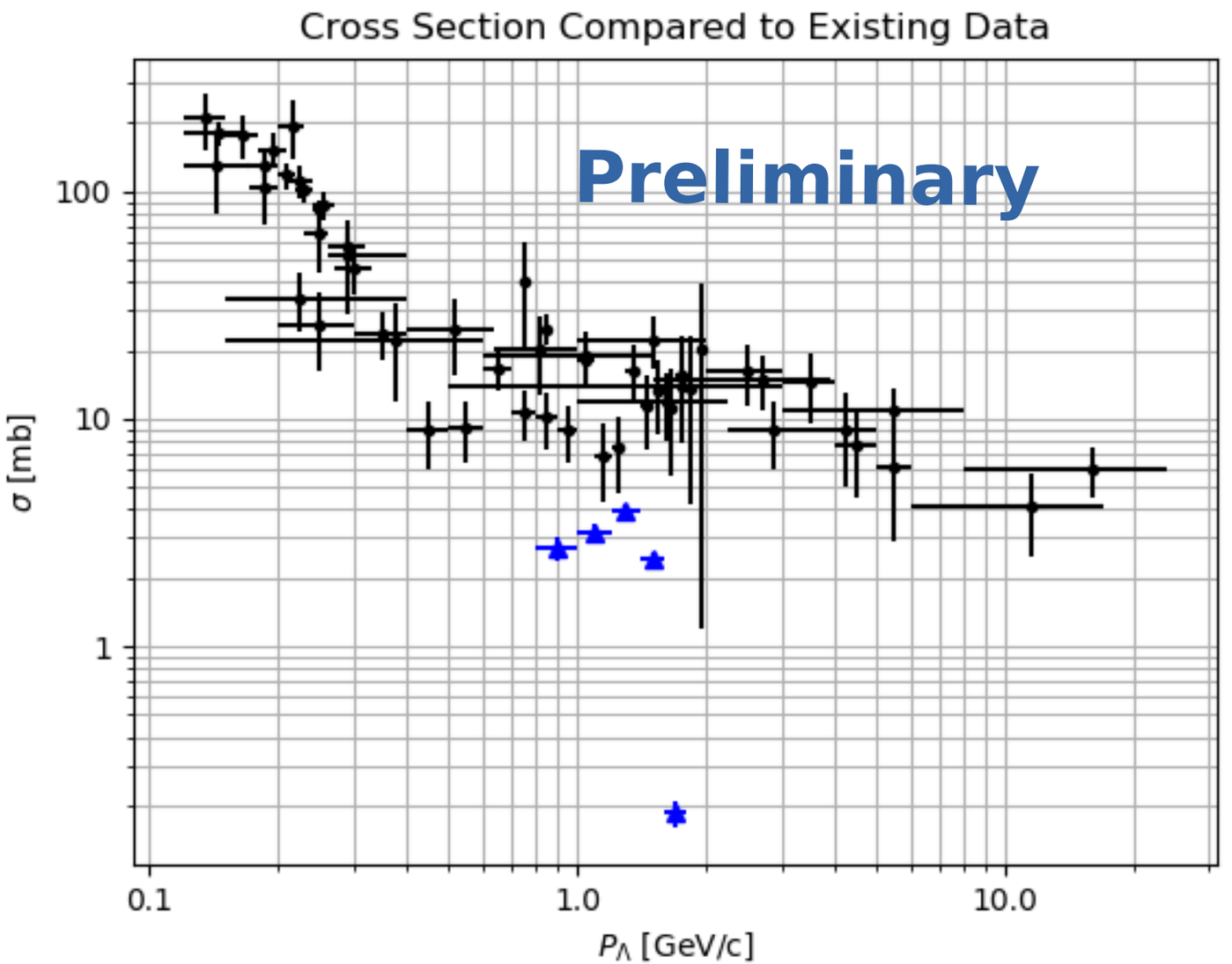
$$N_\Lambda(E_\Lambda)$$

$$\frac{d\sigma}{d\Omega} = \frac{N_\Lambda}{2\pi * L_\gamma * \Delta\cos(\theta)}$$



M. E. McCracken *et al.* PHYSICAL REVIEW C 81, 025201 (2010)

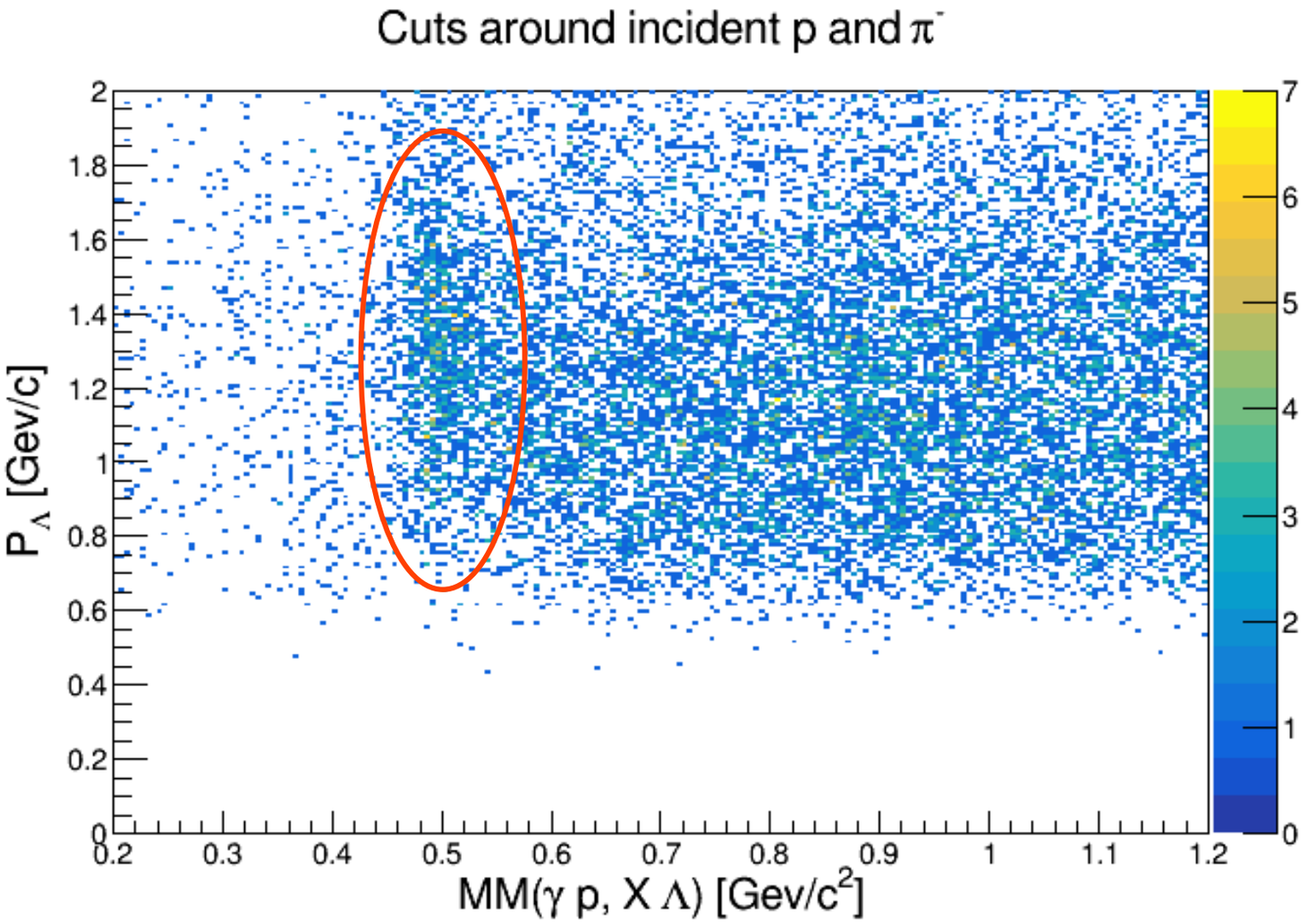
Preliminary Results



- Black: Existing world data
- Blue: Measurements from this study

Questions?

Extra



~2622 events

Extra (proton identification)