Λp Elastic Scattering with CLAS

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Outline

- Motivation
- Data skim
- Event ID
- Plans

HadLab Undergrads

Original Motivation

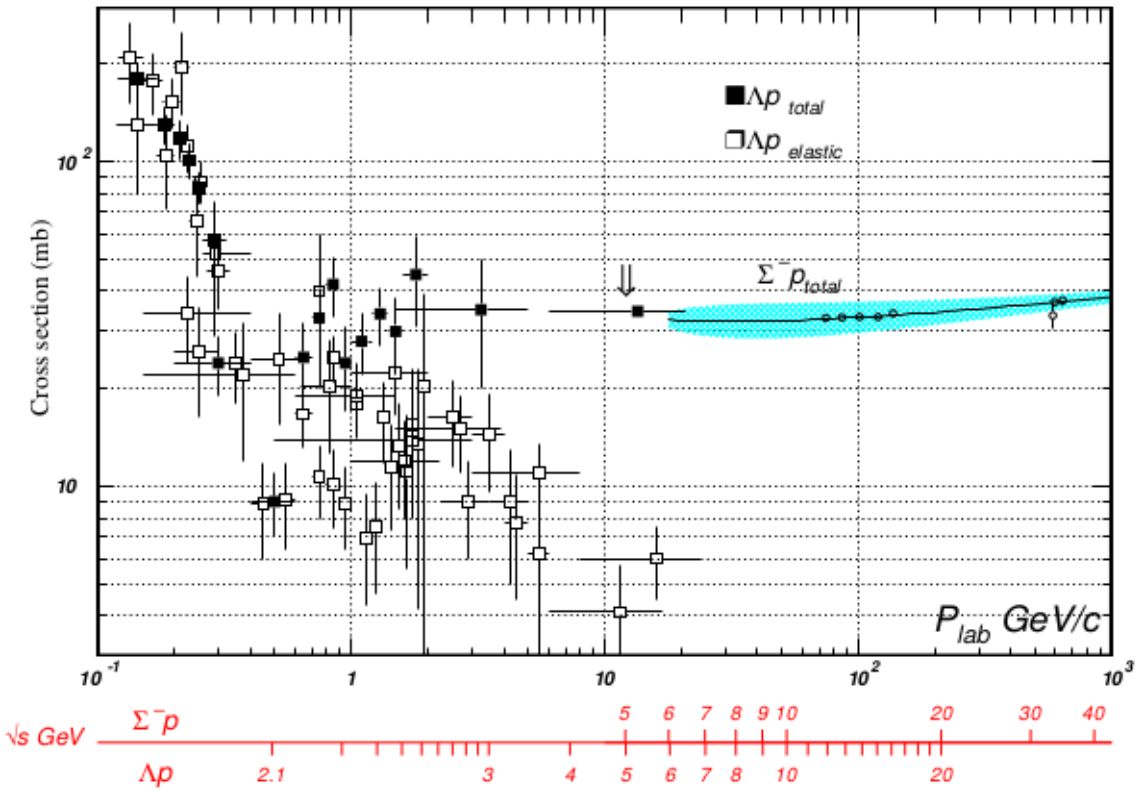
- Search for Ξp scattering
  - Possible to directly measure $\Pi(\Xi^-)$
- Not enough events
  - Expected to see roughly 4 in *g12*
- Need to wait for CLAS12
- Meanwhile, we should check to see whether this is a crazy idea...

New Motivation

- Instead, look for Λp scattering
  - Test for eventual Ξp search
  - Astrophysical interest
- Benefits compared to Ξp
  - Higher Λ production rate
  - Higher acceptance (fewer final-state particles)
  - Expect to see (optimistically) about 4700 in *g12*

Previous data

- Not much; all bubble chamber data
  - Taken from 1959 to 1975
  - About 1200 events total
  - ~50% error bars
- We can do better, right?
- RIGHT?

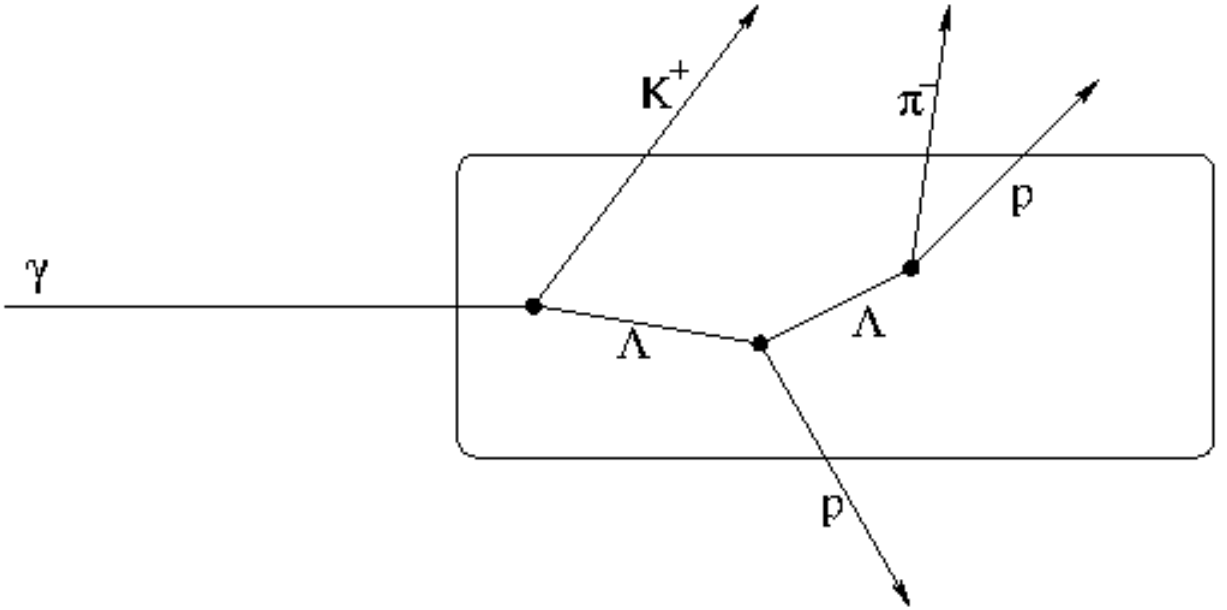


g12 skim

- Full process:
  - $\gamma p \rightarrow K^{+}\Lambda;\ \Lambda p \rightarrow \Lambda p\ (\Lambda \rightarrow \pi^{-} p)$
  - Final state: $K^{+}\pi^{-}pp$
- Skim for events with pp in final state
  - Apparent baryon # violation = rescattering signal
  - Reduces size of dataset from 126 TB (raw) to 17 GB (cooked)
  - HadLab cluster takes ~12 minutes to analyze

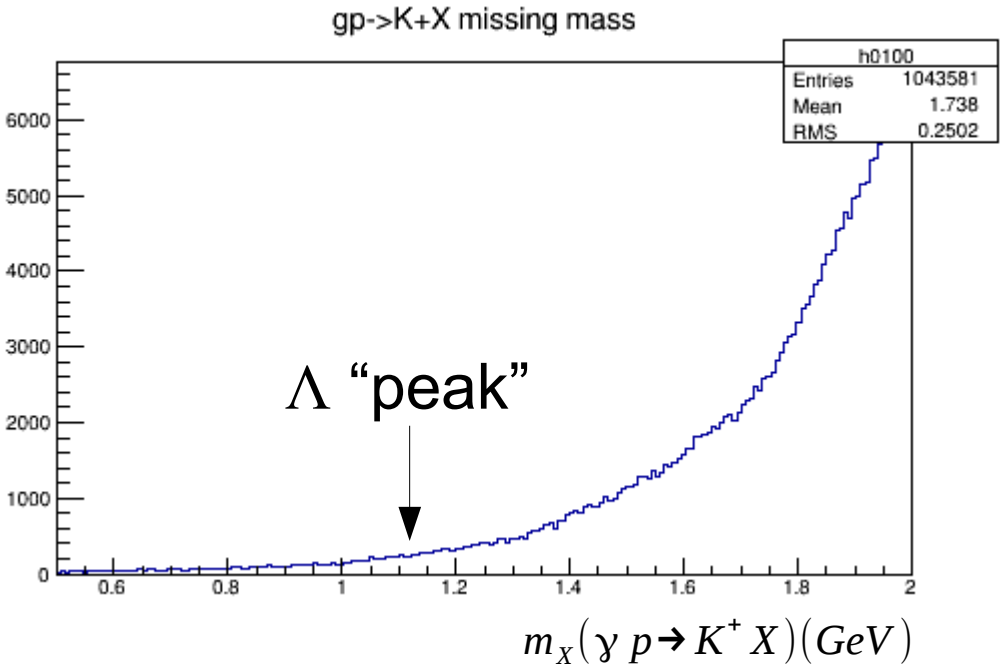
Event topology

- Expected event:
- Plan:
  - Look for $K^+\Lambda$
  - Find scattered p
  - Look for scattered Λ in missing mass

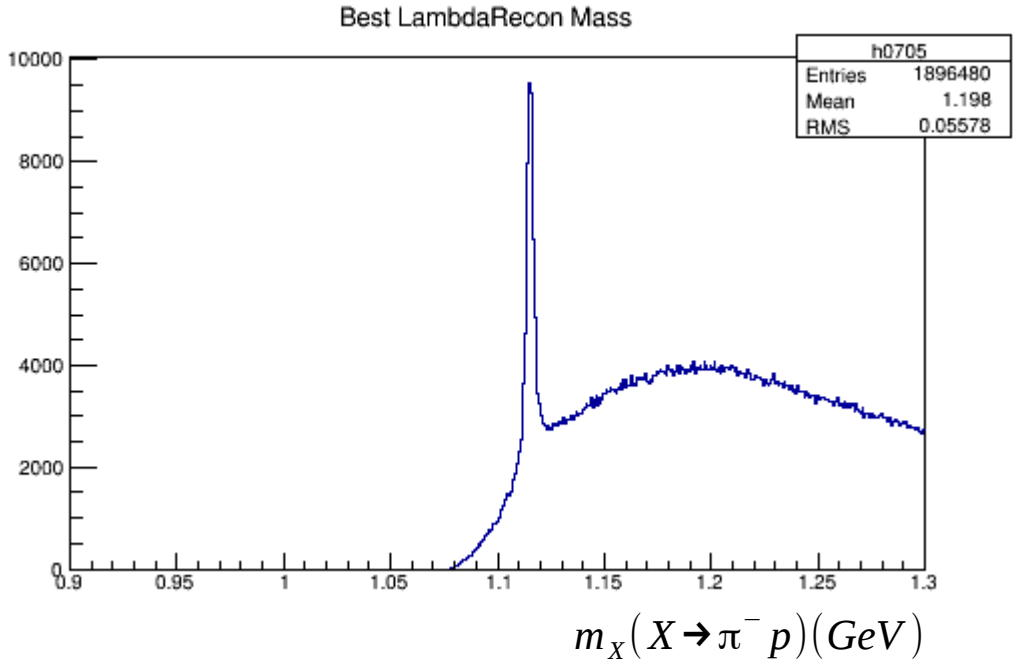


Looking for Lambdas...

- Look for $K^{+}\Lambda$
- Really, really unimpressive
  - "impressively unimpressive"
- Spent ~2 years looking for stupid mistakes
- As it turns out, *that* was the stupid mistake



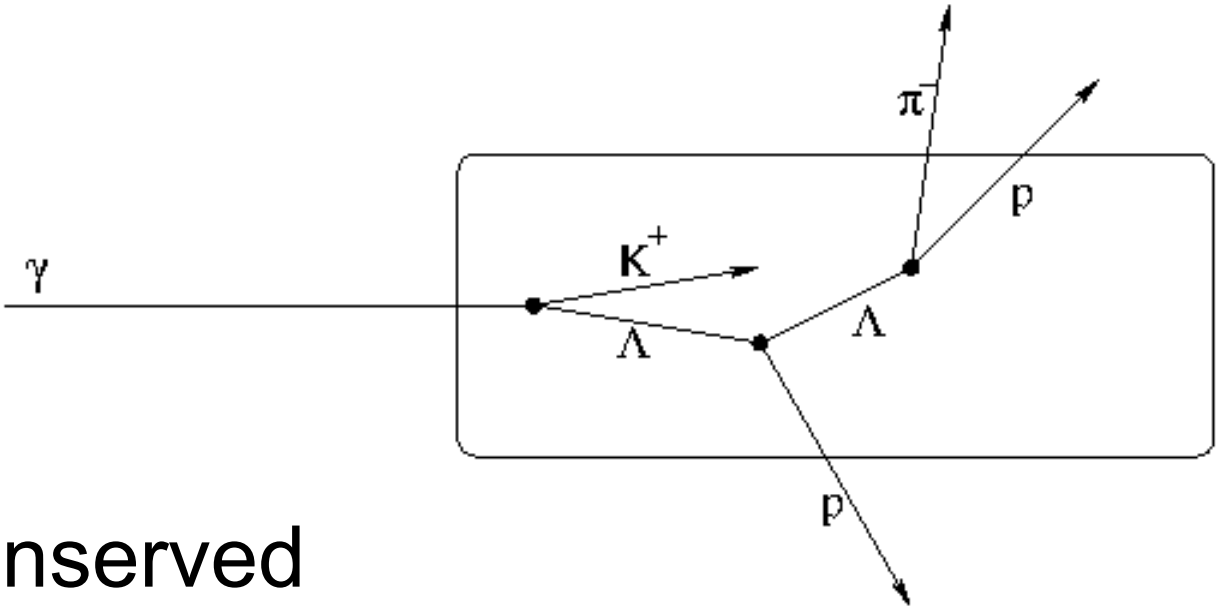
Still looking for Lambdas...



- We know they're there
- Why can't we find them the way everyone else does...?
- We're not doing what everyone else does!
  - We have two protons in our event
    - The Λ is going down the target to rescatter on a second proton

Why we're not finding them

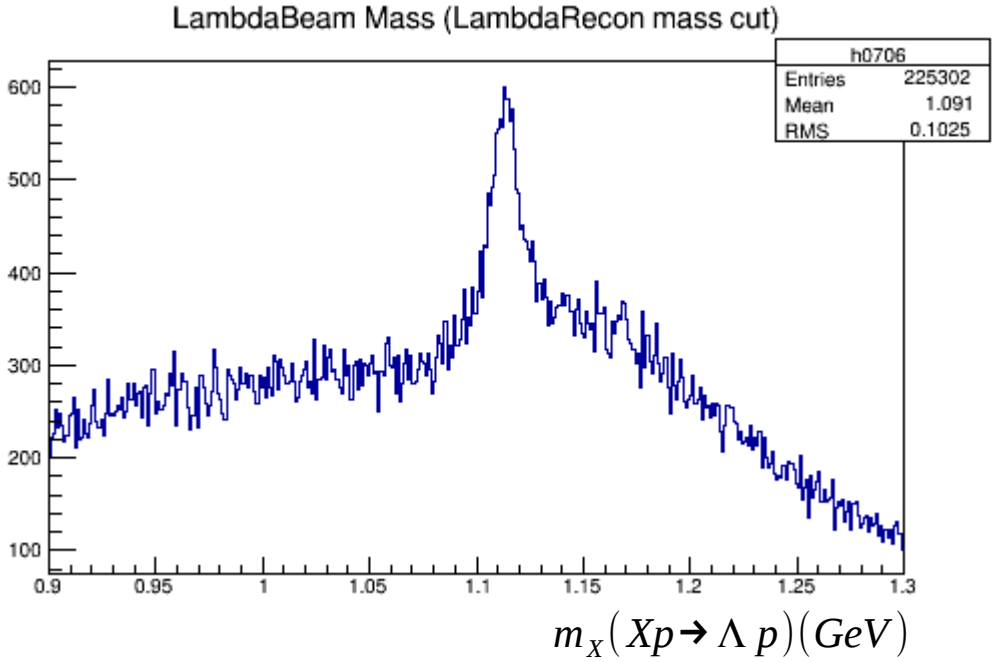
- If the Λ is going straight down the target, *so is the kaon!*



- Momentum is conserved
  - Remember freshman mechanics...?
- We shouldn't see completely reconstructed events in *g12*
  - Let's stop trying...

On the right track...

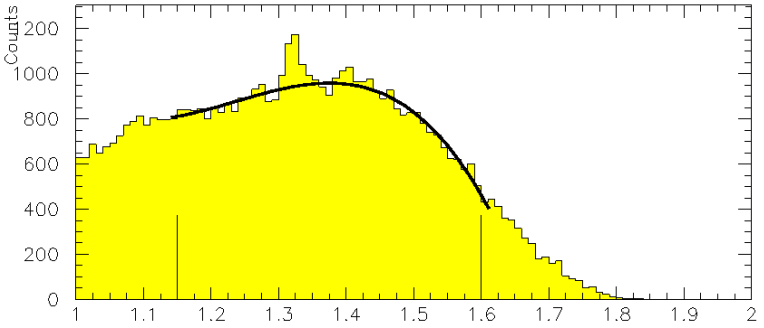
- Instead of looking for the Λ in $\gamma p \rightarrow K^{+} X$, look for it in $Xp \rightarrow \Lambda p$
- Now, it's almost “easy”
- Haven't done much with this yet, but we have more than 2000 events

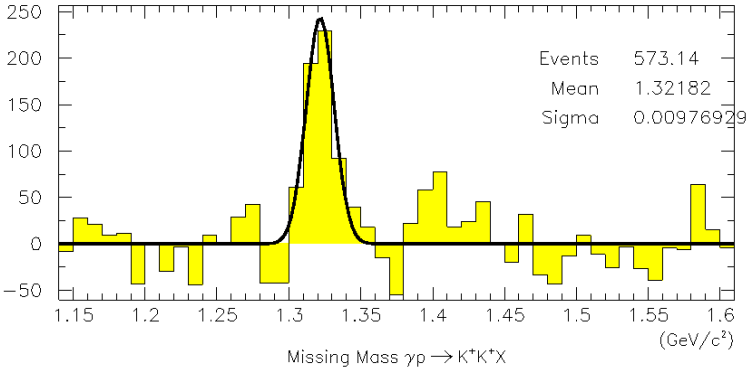


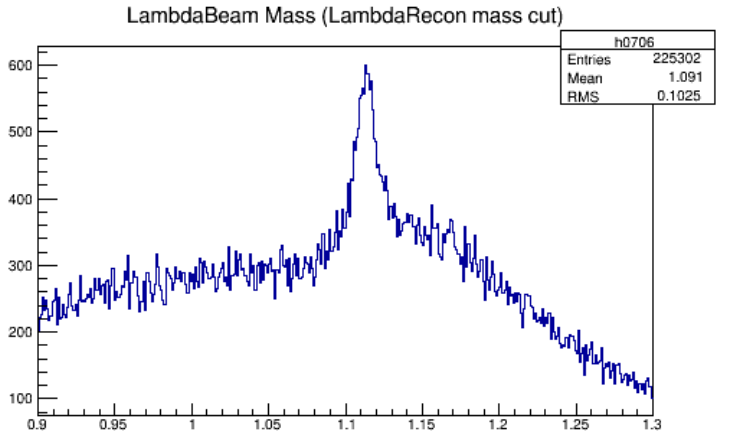
- Almost nothing has been done to clean up this plot
  - Background should get significantly smaller

Why *I* think this is so cool...

- Let's recall the last crazy thing I did here
- 1999: $\gamma\, p \rightarrow K^+ K^+ \Xi^-$
  - We all knew it was impossible
  - Many of you told me so several times in 1998
  - Yet, there it is...
- The signal for $\Lambda\, p \rightarrow \Lambda\, p$ is significantly larger compared to the background



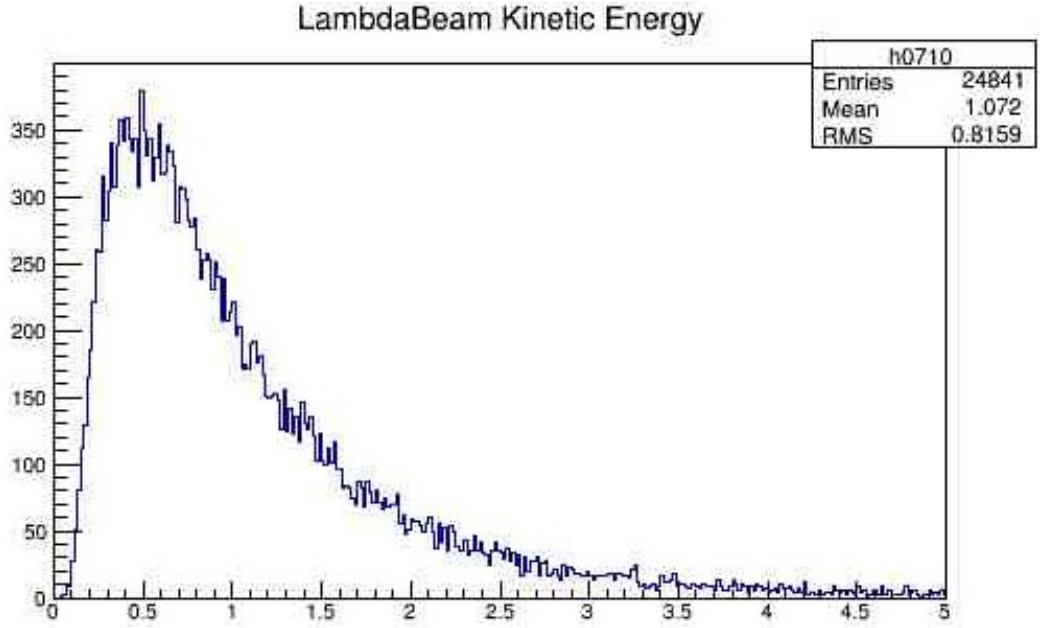


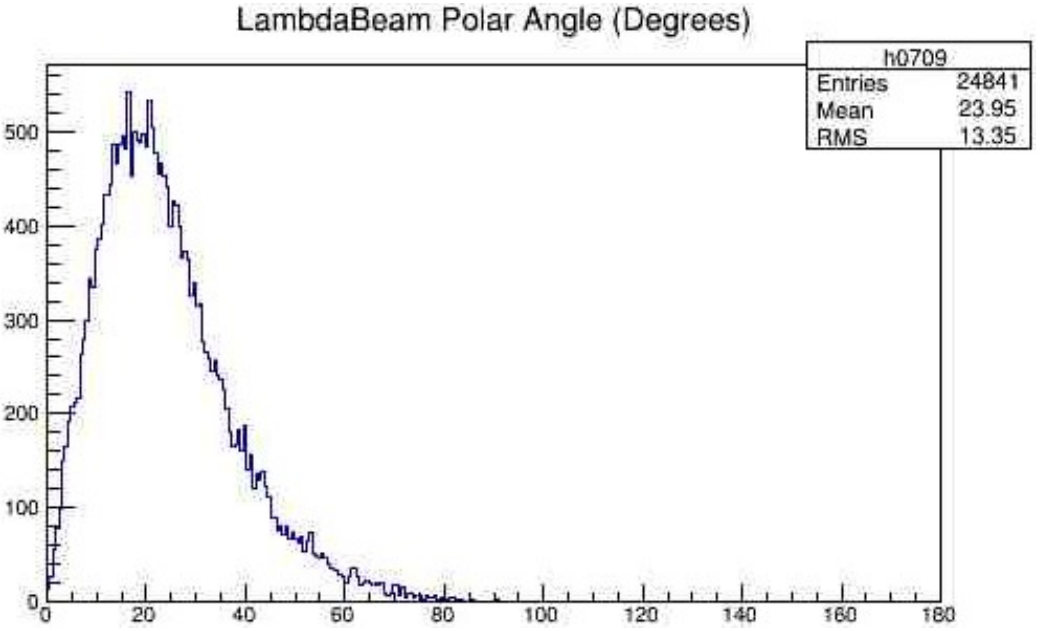


$m_X(Xp \rightarrow \Lambda\, p)(GeV)$

Λ properties

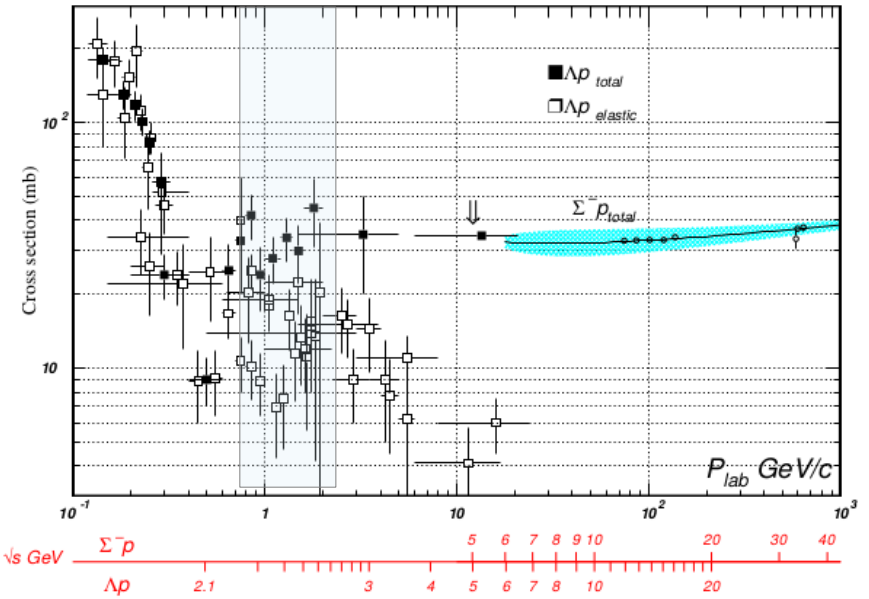
- Get KE, θ of the Λ
  - Background unsubtracted
- Use to understand whole process
- Perhaps we “should” see the K^+...
- Maybe we're looking at the wrong photon?
- Still under study





Comparison to old data

- Our data runs from about 750 MeV/*c* to about 2.5 GeV/*c*
- Remember, this is a data mining measurement



- With a dedicated experiment, we should be able to improve in both directions

Calculating a cross section

- Remember basic formula: $\sigma = \frac{N_e}{N_b N_t A}$

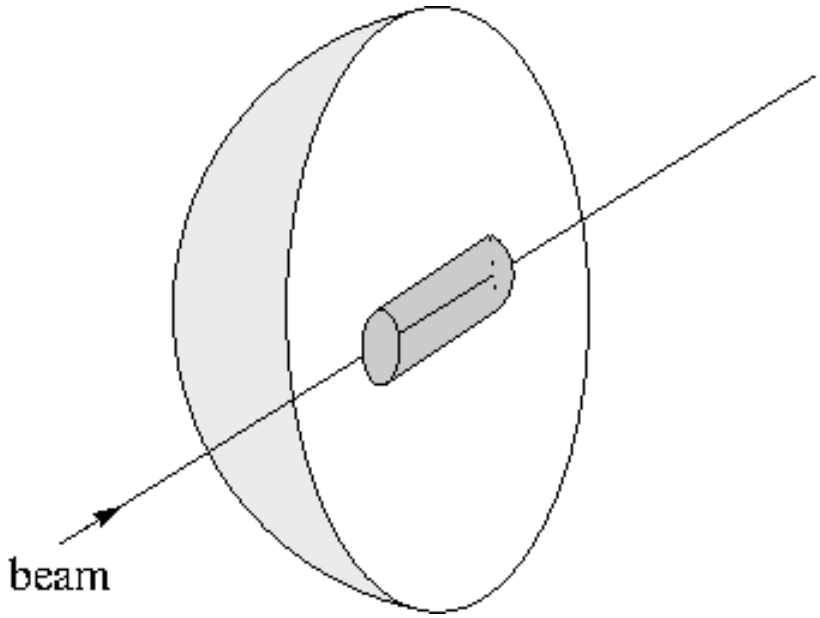
- N_e comes from analysis
- N_b comes from $\gamma\, p \rightarrow K^+ \Lambda$ cross section
  - Subtlety: need data in terms of Λ momentum, angle
- N_t, A come from simulation
- Should be doable “soon”...

Further down the line

- This represents a Λ “beam” in CLAS
- Lots of potential spectroscopy work
- Planning PAC proposal
  - Dedicated experiment to optimize flux, acceptance
  - Need special geometry for target
  - Collaborators welcome

New target concept

- Need a new target
  - "primary" LH_2 target
  - "secondary" other target
  - Maximize acceptance by making secondary target a "shell" around the primary



  - "Easy" for solid targets; not so much for LH_2/LD_2
  - Need engineering design in any case

Summary

- What I *don't know*
  - Λ flux (and therefore cross section)
  - Can use $K^+\Lambda$ cross section to estimate
- What I "think"
  - We have observed Λp elastic scattering
    - I could still be fooling myself...suggestions?
  - Statistics greater than twice the world sample
  - We can do it better with a dedicated experiment
  - This is kind of a Big Deal
- What I "know"
  - This looks like the coolest thing I've ever done...