# Search for Missing Resonances in $\gamma p \rightarrow K\Lambda$ Using Circularly Polarized Photons on Longitudinally Polarized Target

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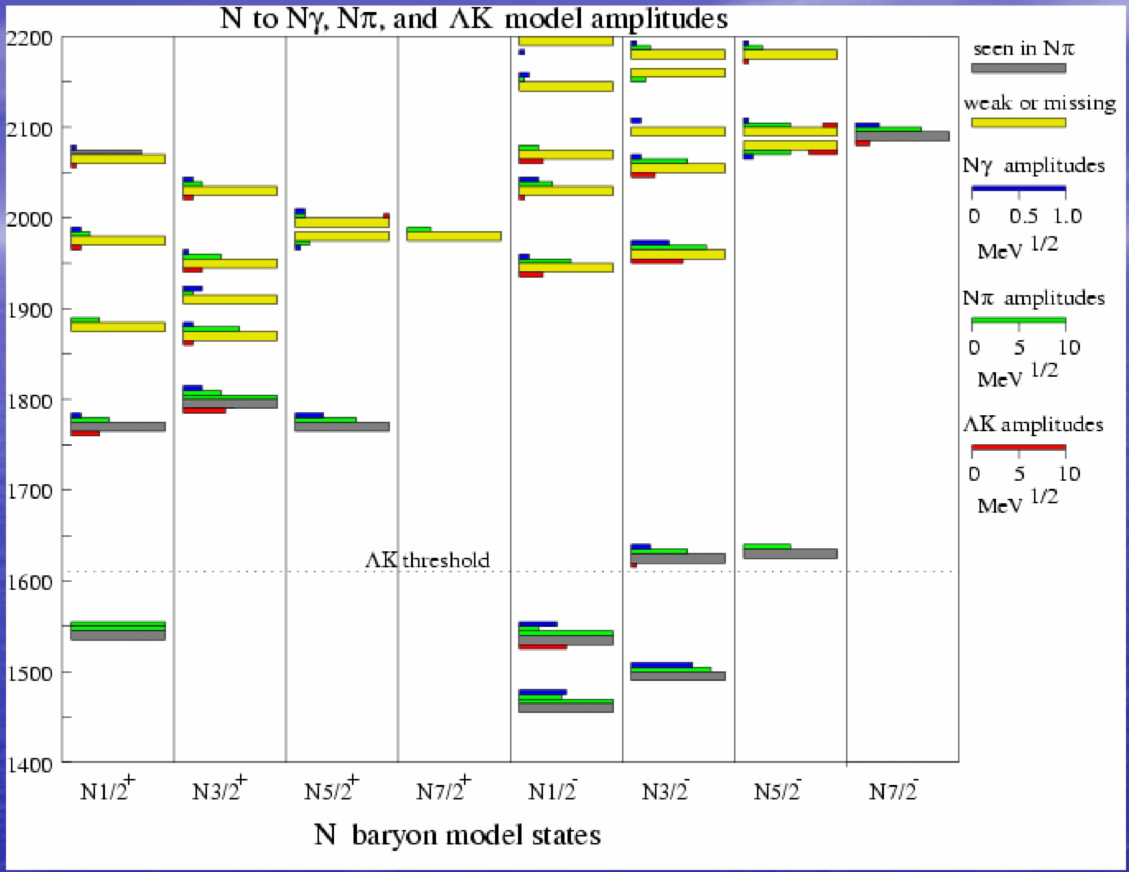
# Motivation – Missing Resonances

- Resonances predicted by constituent quark models not found in πN data.

- Supermultiplets filled consistent with diquark models

- Resonances may couple strongly to strange decay channels: KΛ KΣ.




- D13(1960) question expected to be solved in this analysis.

- KΛ can only involve isospin ½ states and so is expected to couple to few resonances.

- Finding the resonance in the KΛ channel should be relatively simple.

# Introduction – Polarization Observables

| Photon beam | | Target | | | Recoil | | | Target + Recoil | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $x'$ | $y'$ | $z'$ | $x'$ | $x'$ | $y'$ | $z'$ |
| | | $x$ | $y$ | $z$ | | | | $x$ | $z$ | $x$ | $z$ |
| unpolarized $\gamma$ | $\sigma_0$ | | $T$ | | | $P$ | | $T_{x'}$ | $-L_{x'}$ | $T_{z'}$ | $L_{z'}$ |
| linearly $P_\gamma$ | $\Sigma$ | $H$ | $(-P)$ | $-G$ | $O_{x'}$ | $(-T)$ | $O_{z'}$ | $(-L_{z'})$ | $(T_{z'})$ | $(-L_{x'})$ | $(-T_{x'})$ |
| circular $P_\gamma$ | | $F$ | | $-E$ | $-C_{x'}$ | | $C_{z'}$ | | | | |

$$E_z^2 + F_x^2 + G_z^2 + H_x^2 = 1 + P^2 - \Sigma^2 - T^2 \ ,$$

$$F_x G_z - E_z H_x = P - \Sigma T \ ,$$

$$C_x^2 + C_z^2 + O_x^2 + O_z^2 = 1 + T^2 - P^2 - \Sigma^2$$

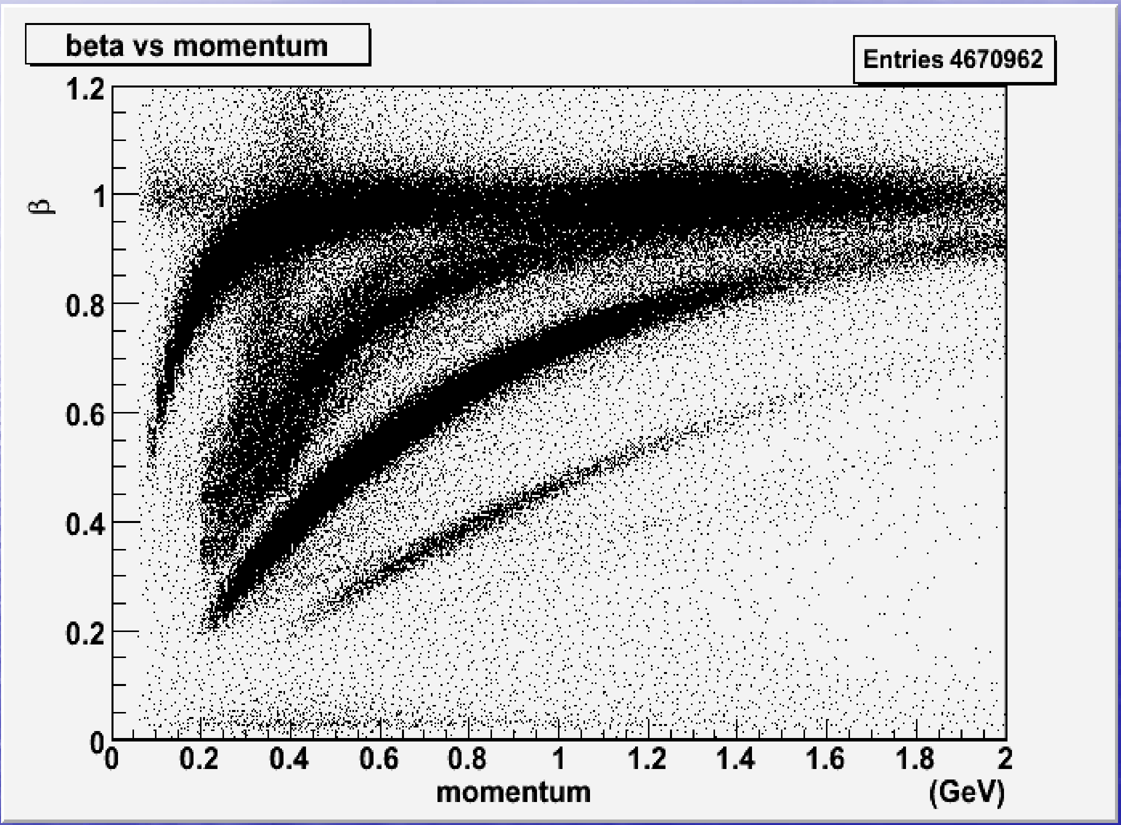
$$C_z O_x - C_x O_z = T - P\Sigma \ ,$$

$$T_x^2 + T_z^2 + L_x^2 + L_z^2 = 1 + \Sigma^2 - P^2 - T^2 \ ,$$

$$T_x L_z - T_z L_x = \Sigma - PT \ .$$

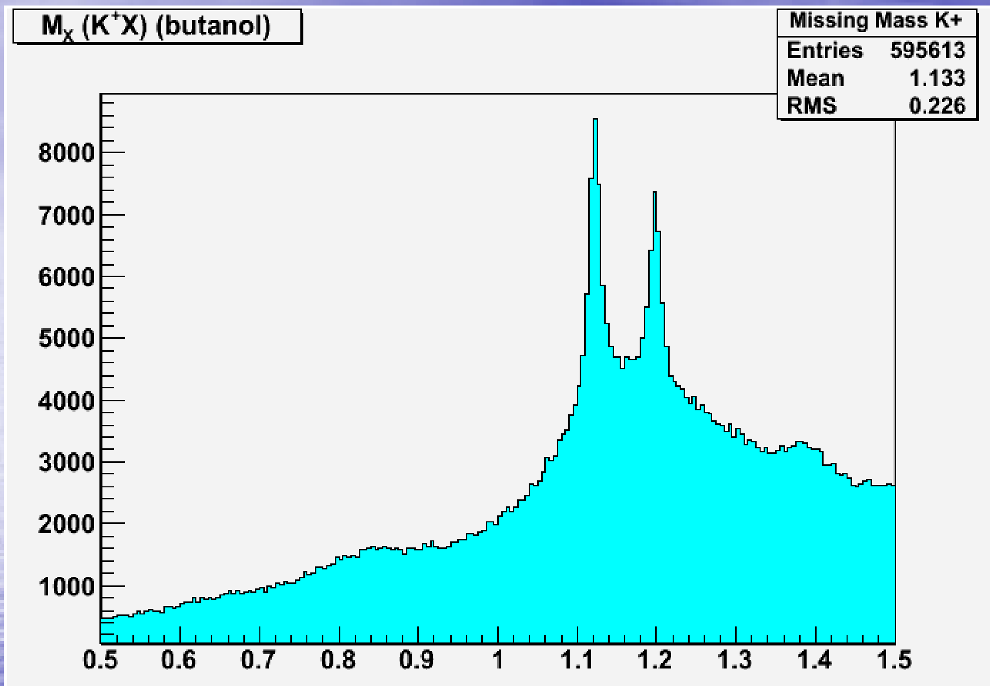
- Frost uses long. and trans. polarized target with circular and linearly polarized photons to obtain 16 polarization observables.
- 8 observables needed to determine 4 complex CGLN amplitudes.
- Overdetermined experiment allows for consistency checks.

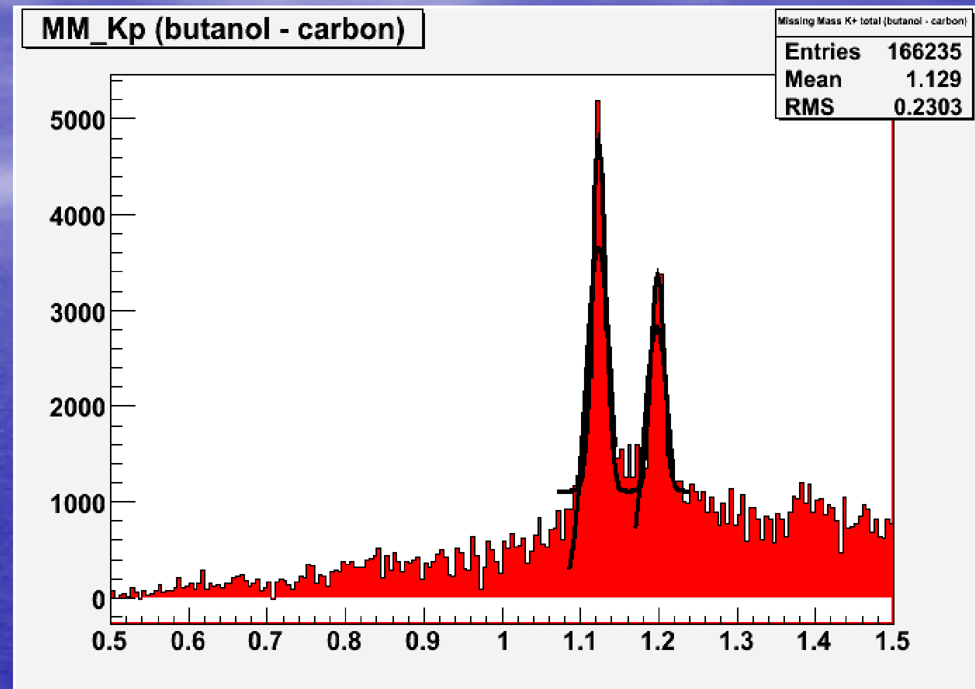
# Particle Identification




- Protons, pions, and kaons are identified by beta and momentum cuts.
- Kaon region may overlap with misidentified protons and pions.
- Bad timing information may also give false kaon identification at low momentum.

# Missing Mass Plots: Finding Λ



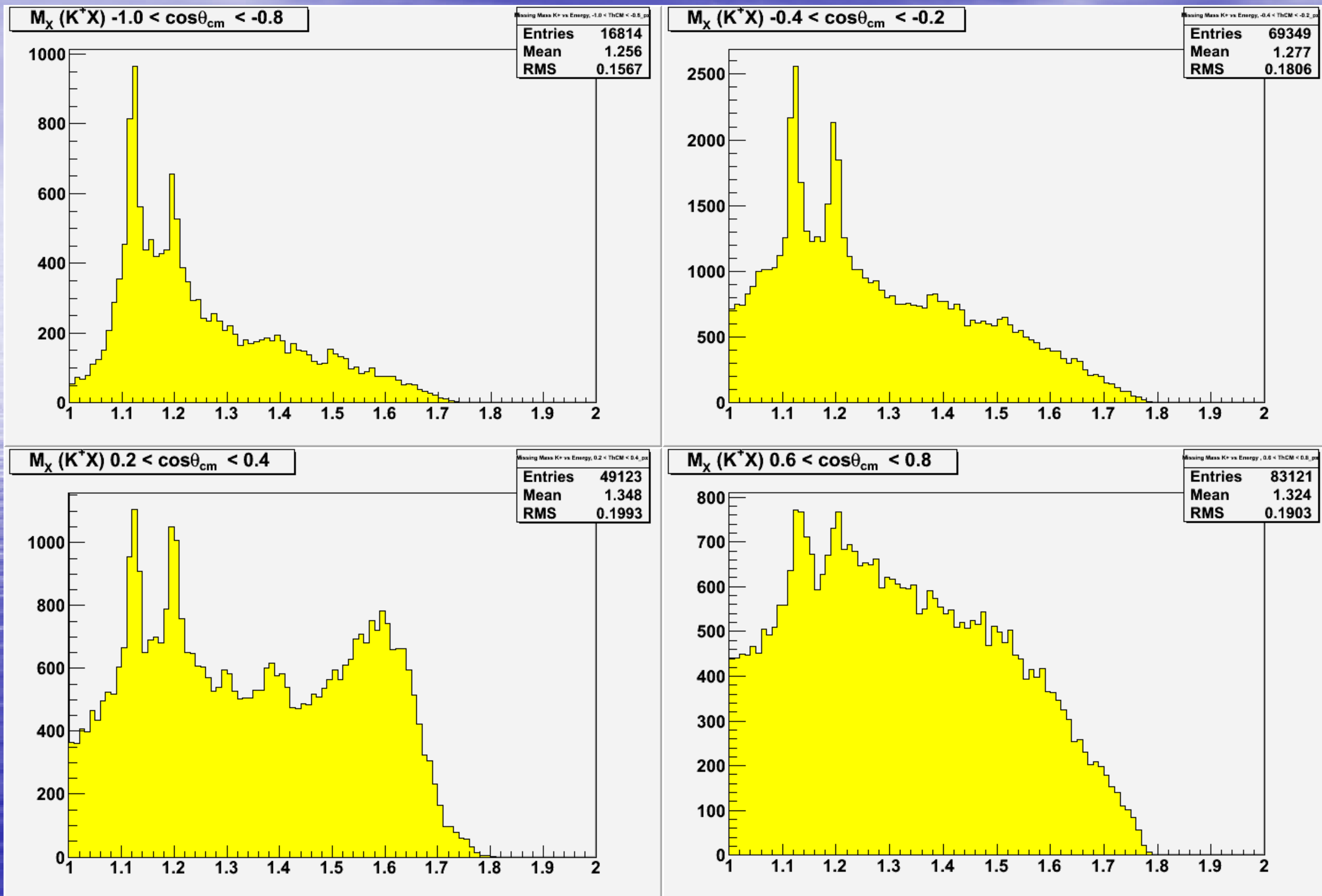

Λ and Σ are identified by missing mass.

Background is reduced by subtracting data from the carbon target times a scaling factor.

Fitting with a double gaussian gives us a range (+/- 2σ) for accepted Λ events.

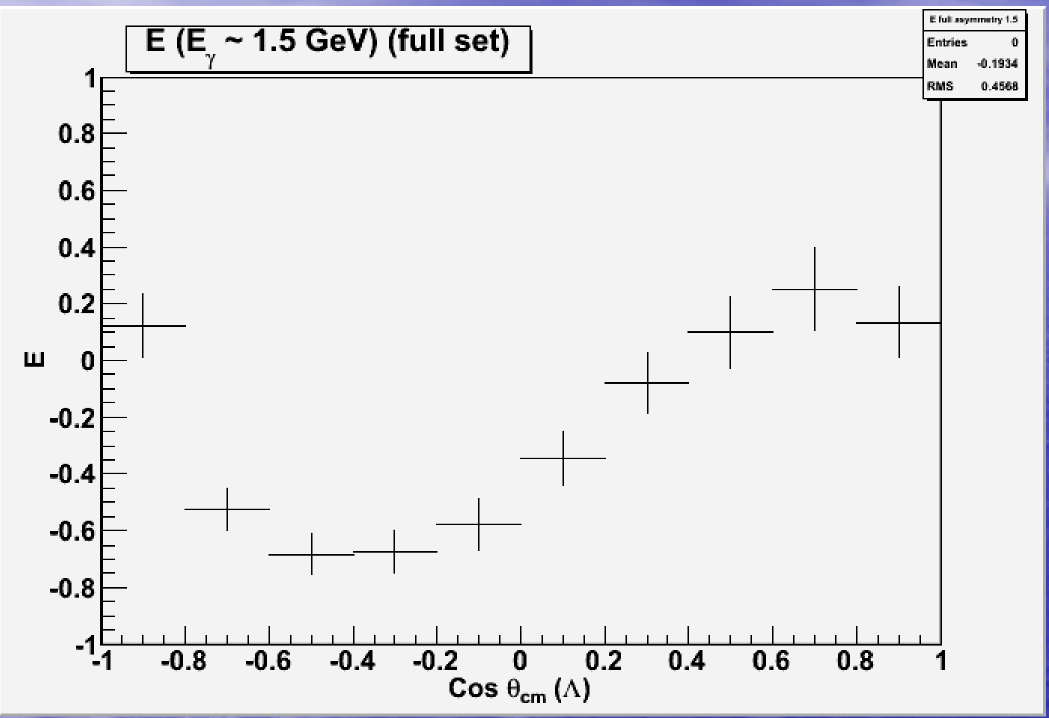
$D_{eff}$ is the ratio of butanol events to carbon events times scaling factor in the region

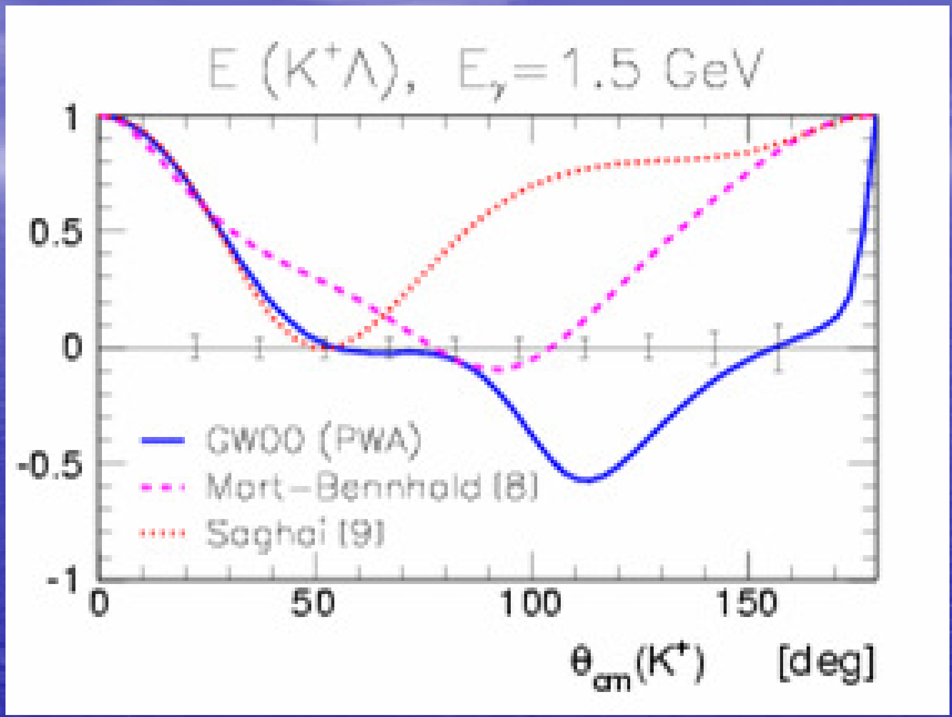
# Missing Mass Plots: Finding Λ (cont)




Λ favored in backwards direction in CM frame

# Polarization Observable E: Comparison to Model Predictions (full circ. pol. set)

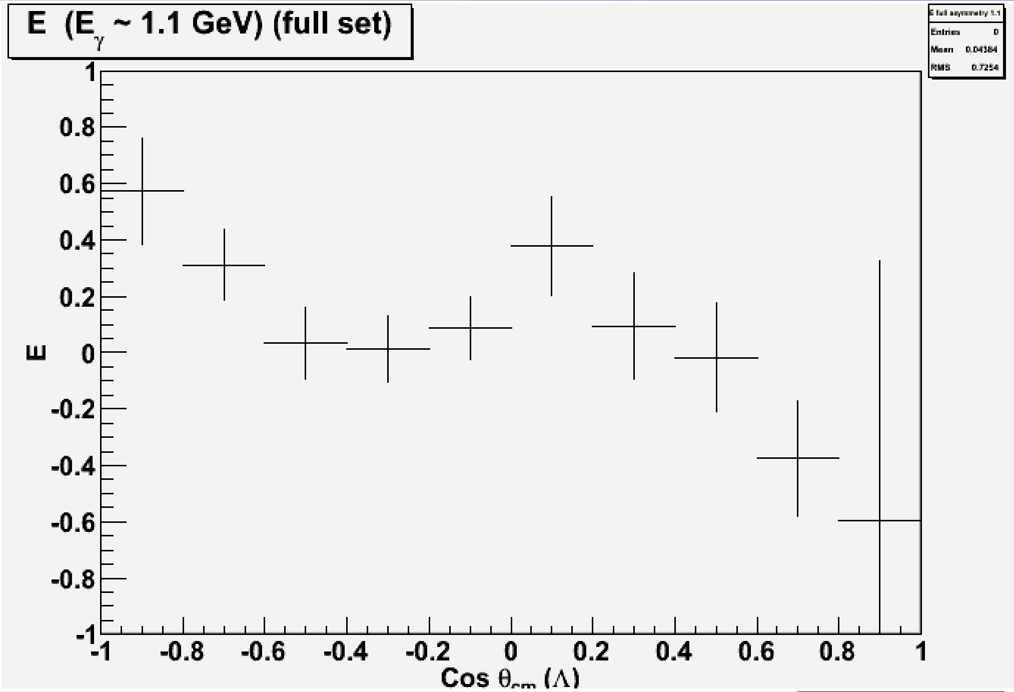


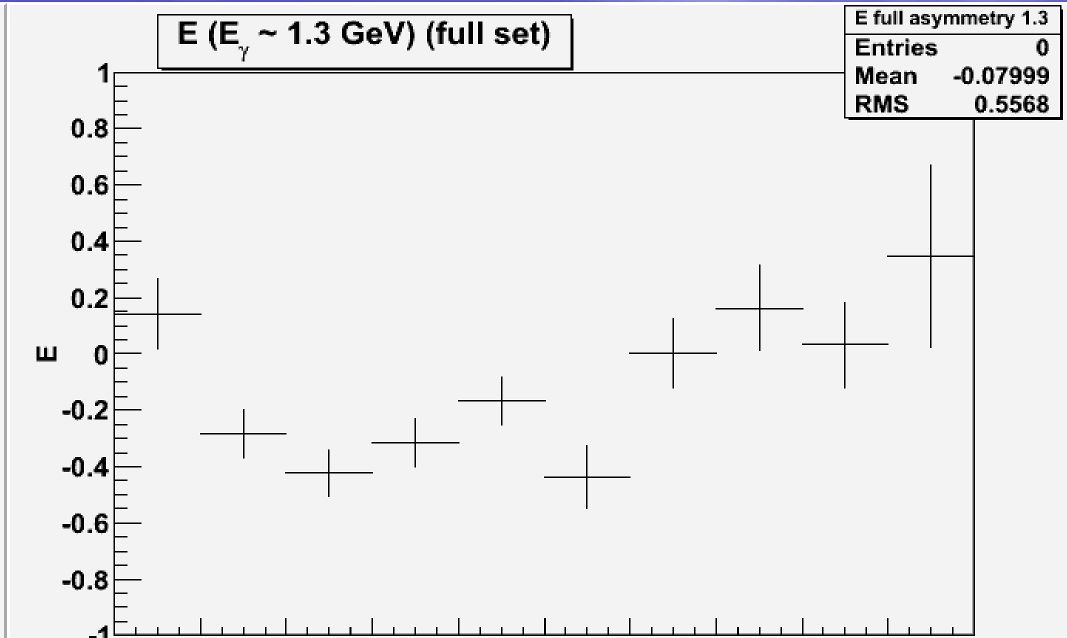



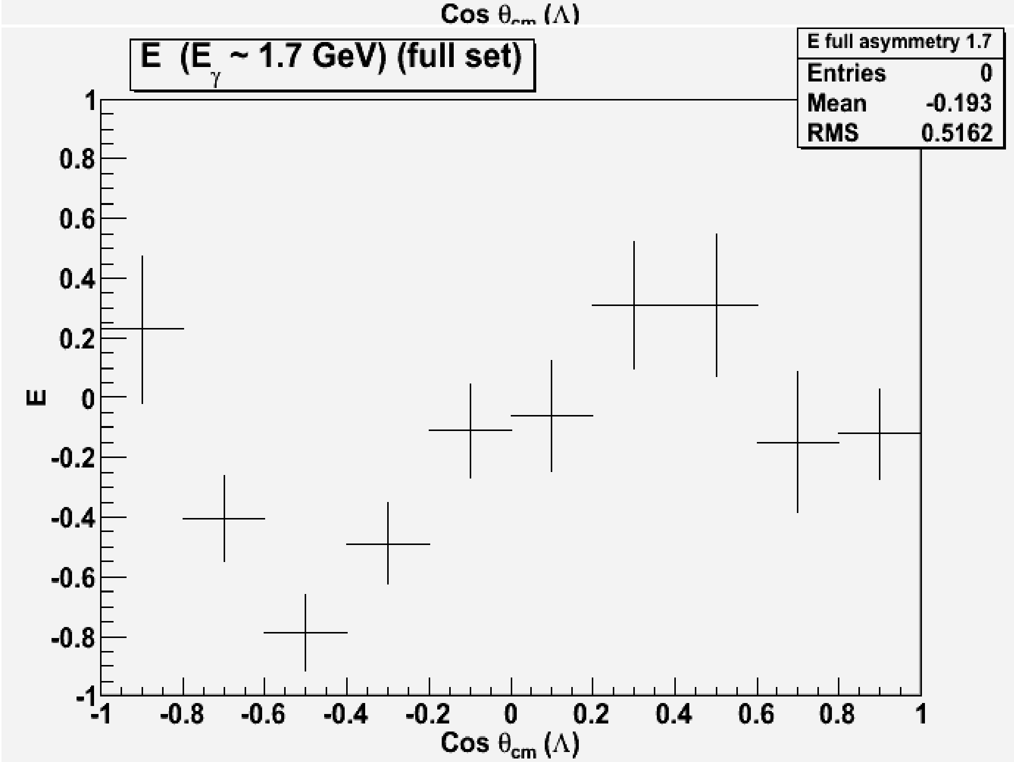

$$E = \frac{D_{eff}}{P_\lambda P_z} \frac{N_{par} - N_{anti}}{N_{par} + N_{anti}}$$

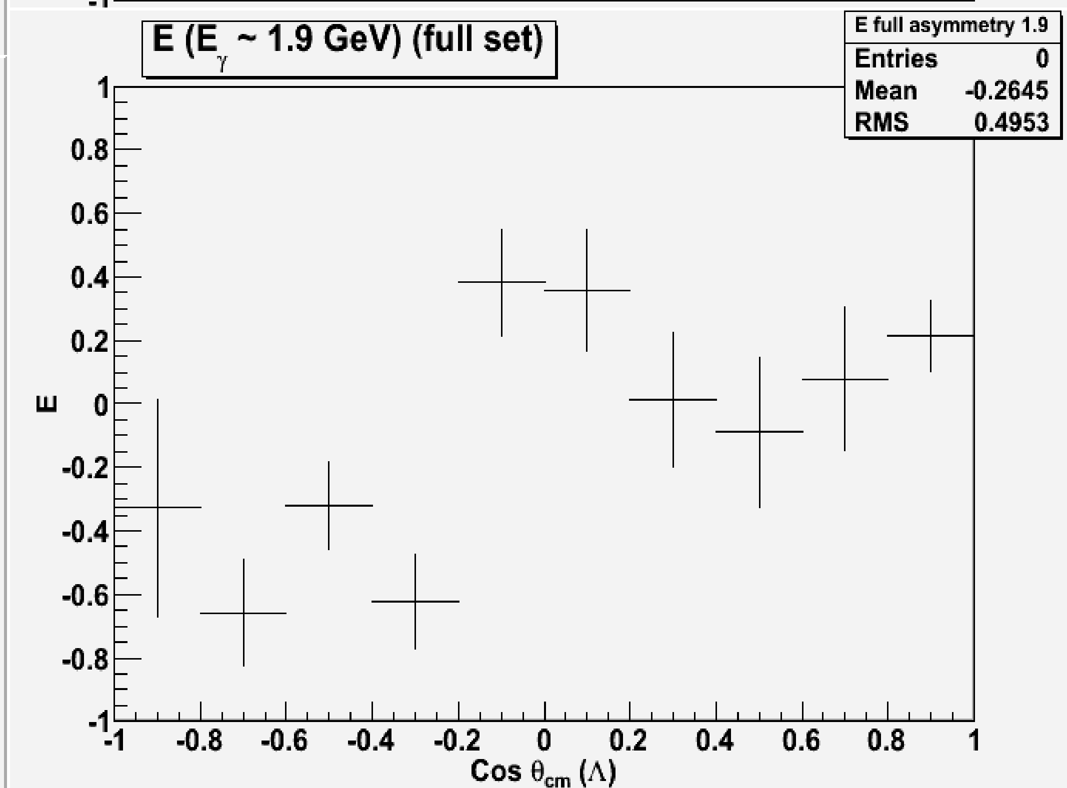
- Doesn't appear to follow model predictions. However, the values at the end points are also far from the required value. Possibly steep decline at both ends like SAID PWA near π.
- Higher cos θ bins are more suspect due to high background contamination.
- For full asymmetry, $P_\lambda$ ~ 0.8, $P_{el}$ ~ 0.85 are taken as averages.

# Polarization Observable E: More Energy ranges

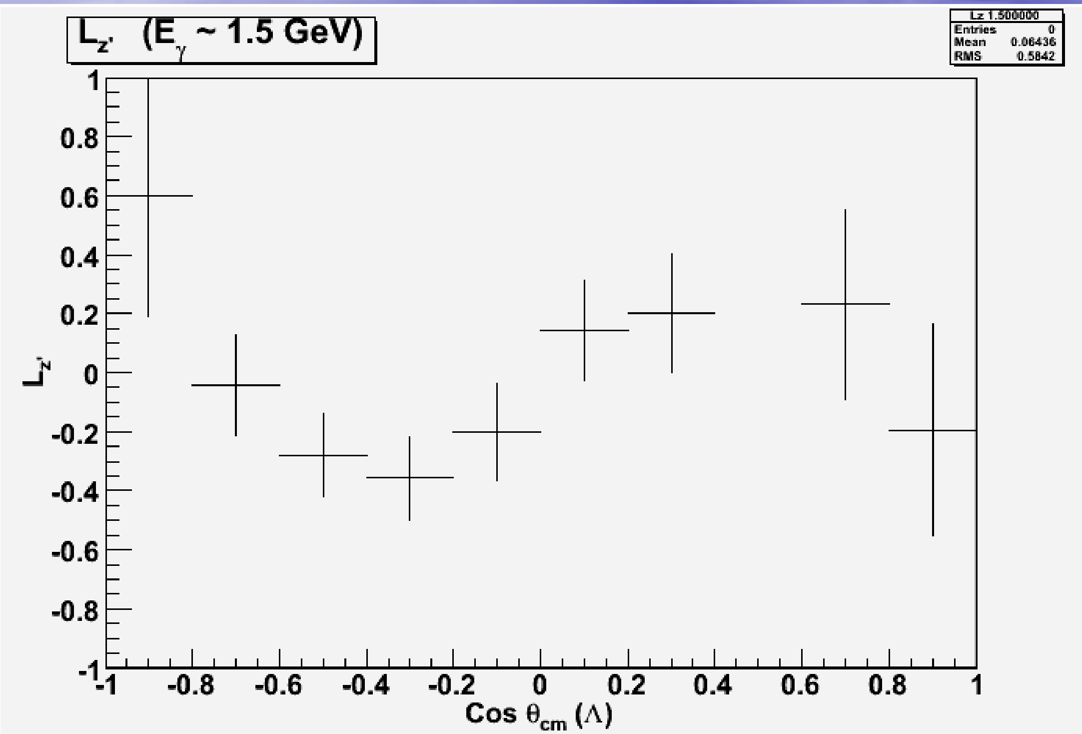


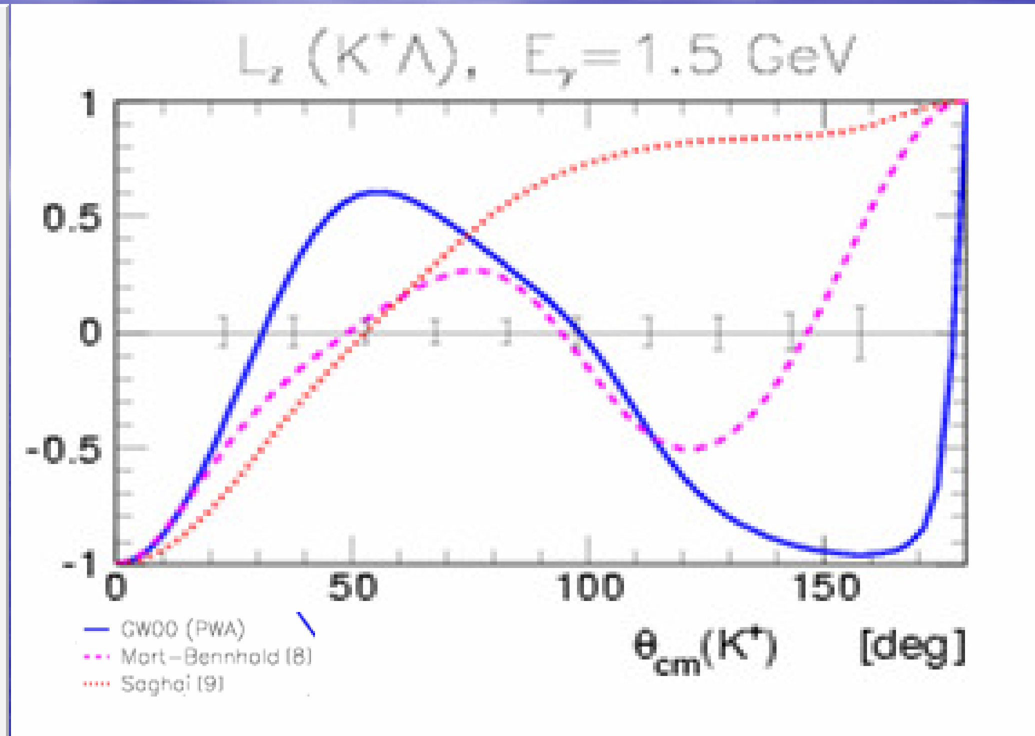



# Polarization Observable $L_{z'}$: Comparison to Model Predictions (1.645 GeV Beam)



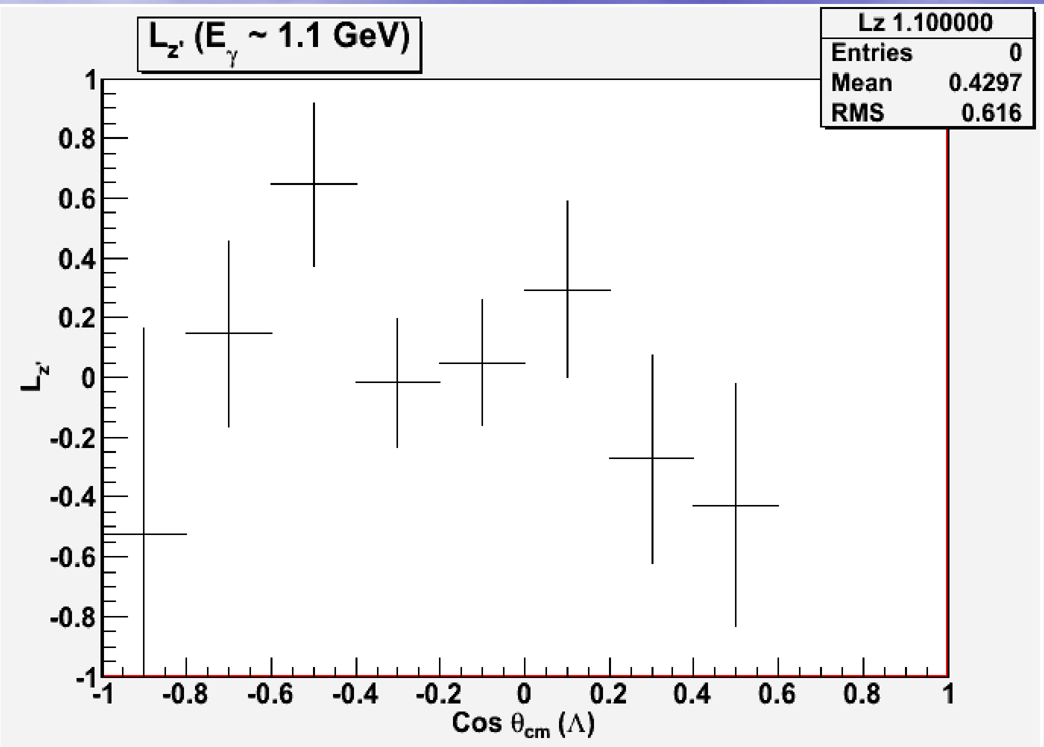

$$L_{z'} = \frac{D_{eff}}{P_z} \frac{N_> - N_<}{N_> + N_<}$$

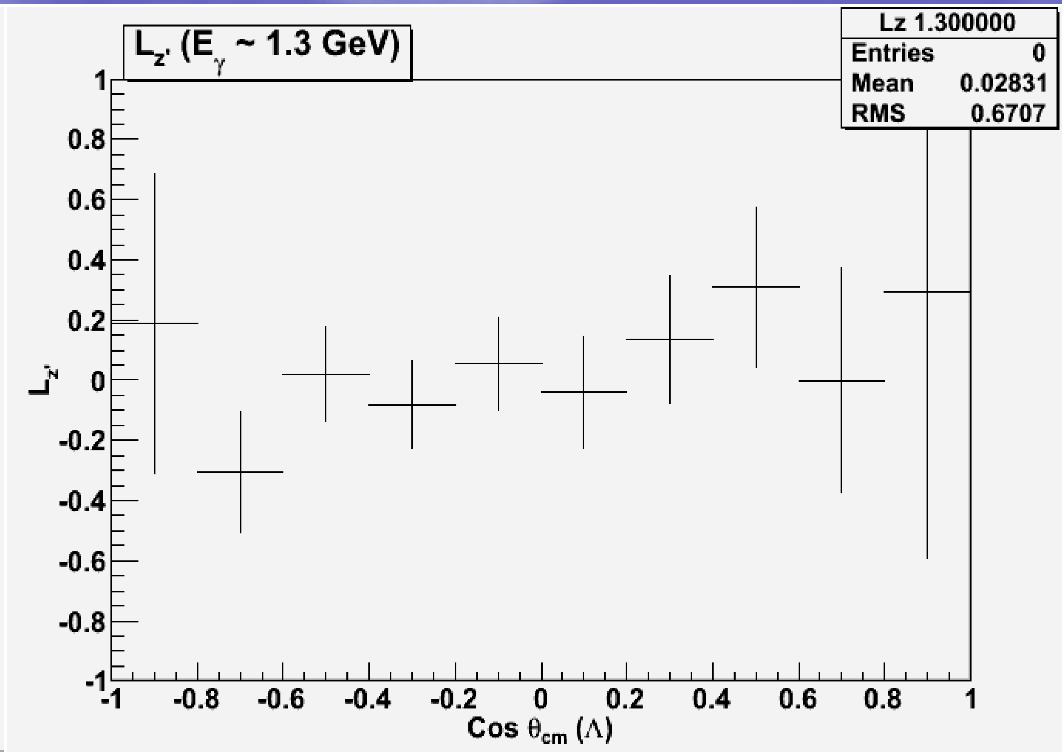
Lz′ is found by comparing the angle of the decay proton with that of lambda.

$N_>$ is the number of decay protons with greater $\theta$ than $\Lambda$ in the CM frame for positive target polarization and the opposite for negative target polarization.

Possible inversion of Mart-Bennhold and SAID structure.

# Polarization Observable $L_{z'}$: More Energy Ranges (1.645 GeV Beam)



# Conclusions and Further Work

- Results are still preliminary, but first measurements of E suggest a departure from model predictions.
- Issues at extreme angles in the measurement of E need to be investigated. Available statistics may prove to be an obstacle.
- $L_{z'}$ shows some agreement with SAID PWA at 1.5 GeV, if opposite sign convention is being used.
- Measurements for the other polarization observables that can be obtained using circularly polarizes photons on longitudinally polarized target will be completed.