Θ^+ *Search in CLAS*

$\gamma d \rightarrow p K^0 K^- (p)$

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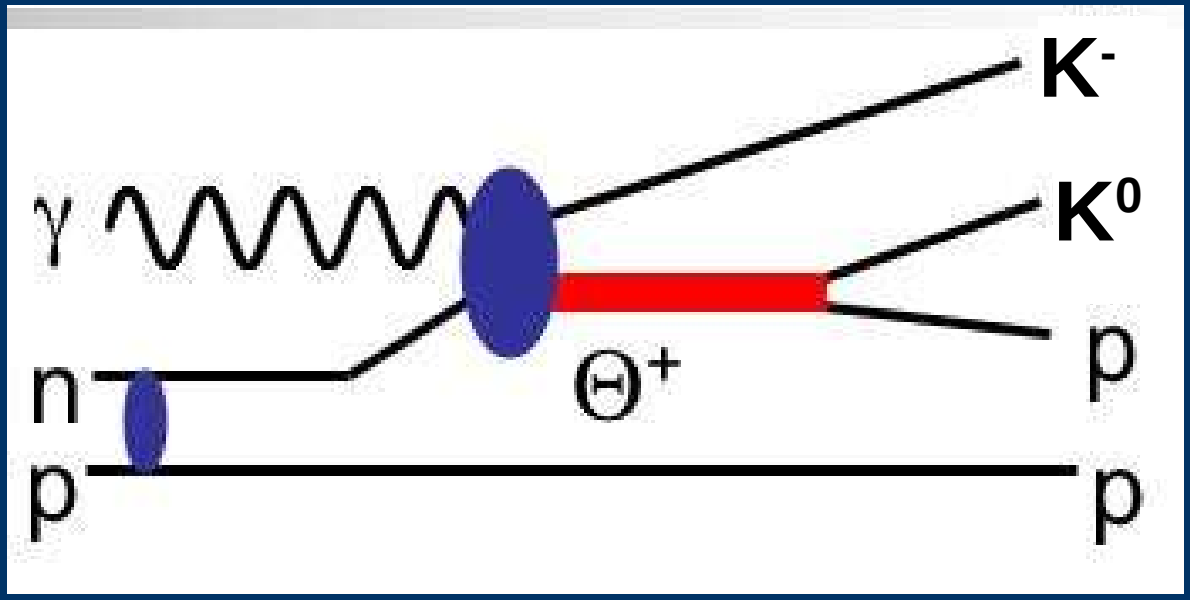
for the CLAS Collaboration

Outline

- Motivation
- The Experiment
- Analysis
- Simulation of Backgrounds

Motivation: $\gamma d \rightarrow \Theta^+ K^- (p) \rightarrow p K^0 K^- (p)$

- A search for Θ^+ photoproduction on the neutron.
- An exclusive measurement with no FSI required.
- pK^0 strangeness is well defined, $S = {}^+1$.
- Should agree with the $\Theta^+ \rightarrow nK^+$ analysis of the same data.



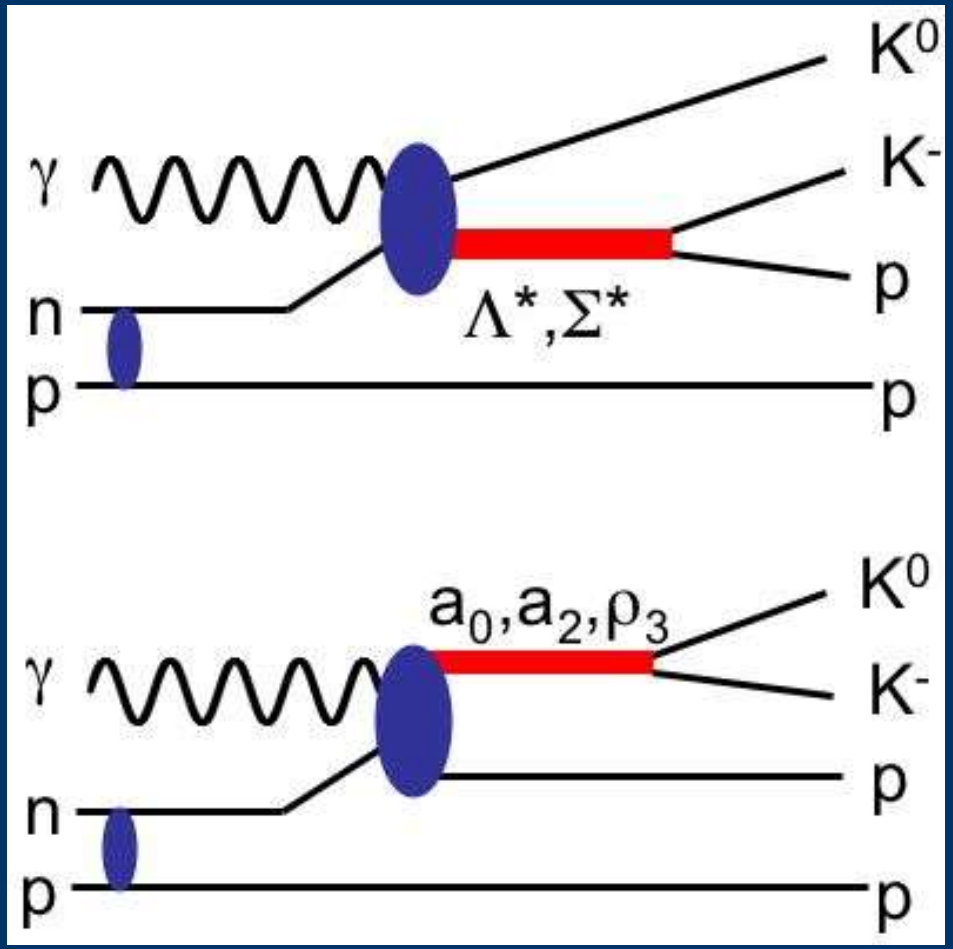
$\gamma d \rightarrow p K^0 K^- (p)$ Background Processes

- Hyperon Resonances:

  $\gamma n \rightarrow Y^* K^0$

- Meson Resonances:

  $\gamma n \rightarrow M p$



- Both exist in our data, and it is important to understand the background in this analysis.

The Experiment

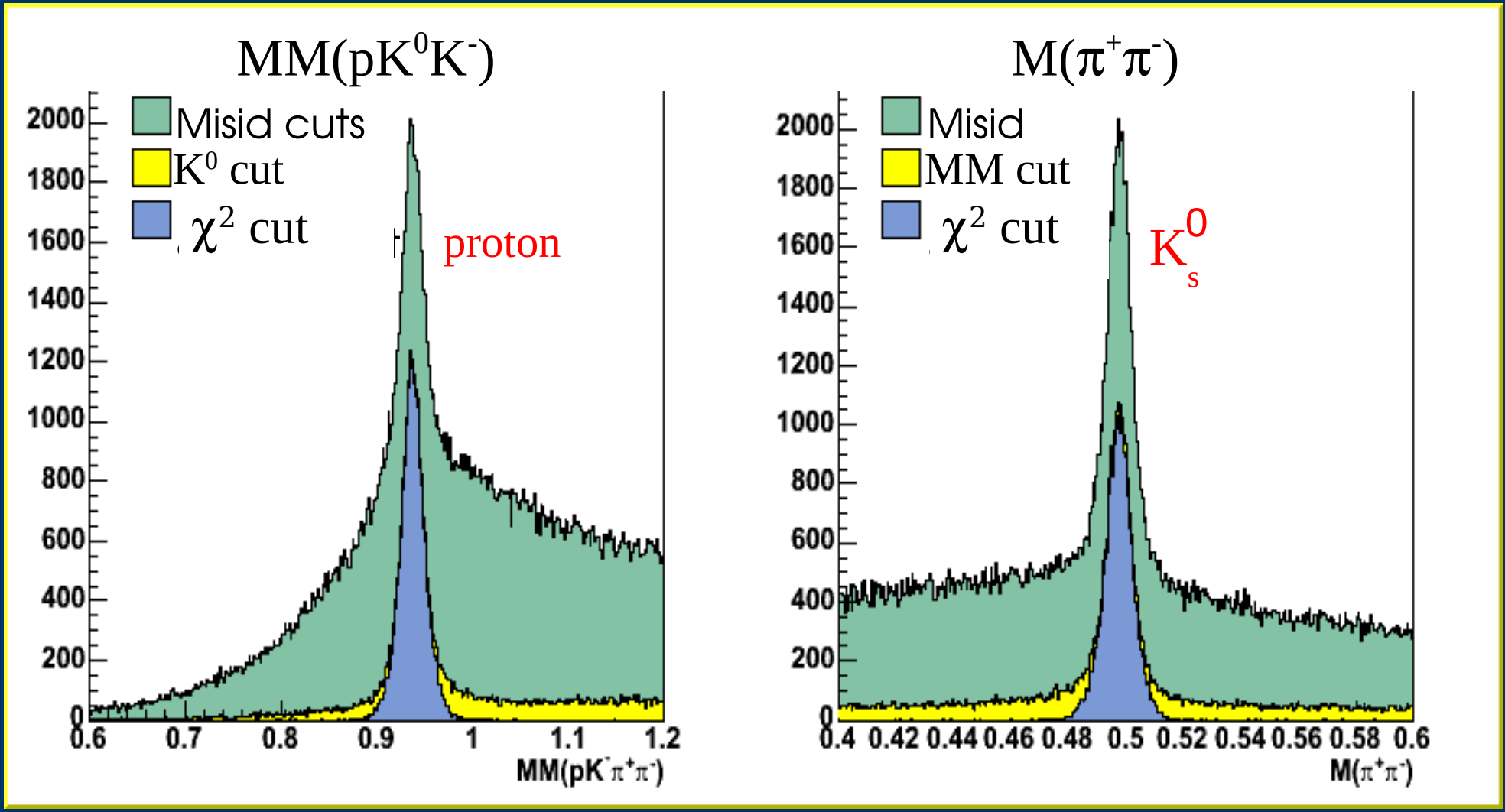
- Data acquired Spring 2004 in Hall B at TJNAF.
- Tagged Bremsstrahlung photon beam.
  - 3.6 GeV endpoint.
- 24 cm liquid deuterium target; 0.163 g/cm^3.
- CLAS large acceptance spectrometer.
- 50 pb^{-1} luminosity; 9.7 trillion triggers.

Analysis: Identifying $\gamma d \rightarrow p K_s K^- (p)$

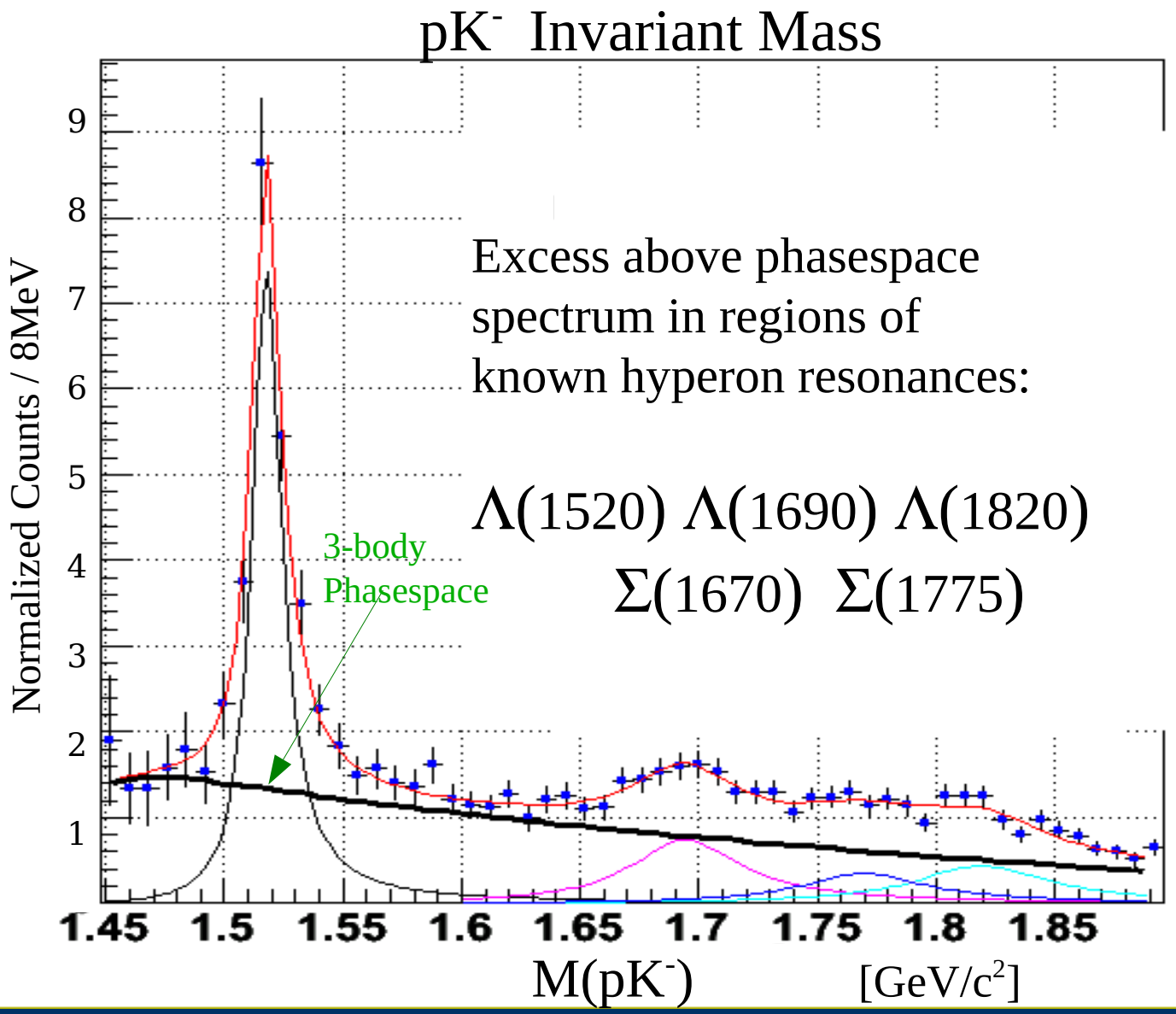
- Measure $p\pi^+\pi^-K^-$ 4-vectors in CLAS, γ in tagger.
- Kinematic Fitting:
  - 1C – Reject $K-\pi$ misidentification.
  - 2C – Identify $K_s \rightarrow \pi^+\pi^-$ and missing Proton.
- "Spectator nucleon": missing momentum < 100 MeV/c.
- $\Lambda(1520)$ can be cut from the pK^- invariant mass spectrum.

Analysis: Identifying $\gamma d \rightarrow p K_s K^- (p)$

Yield ≃22,000



$\gamma n \rightarrow Y^* K^0$ $\Lambda(1520)$ Yield $\simeq$ 2,000

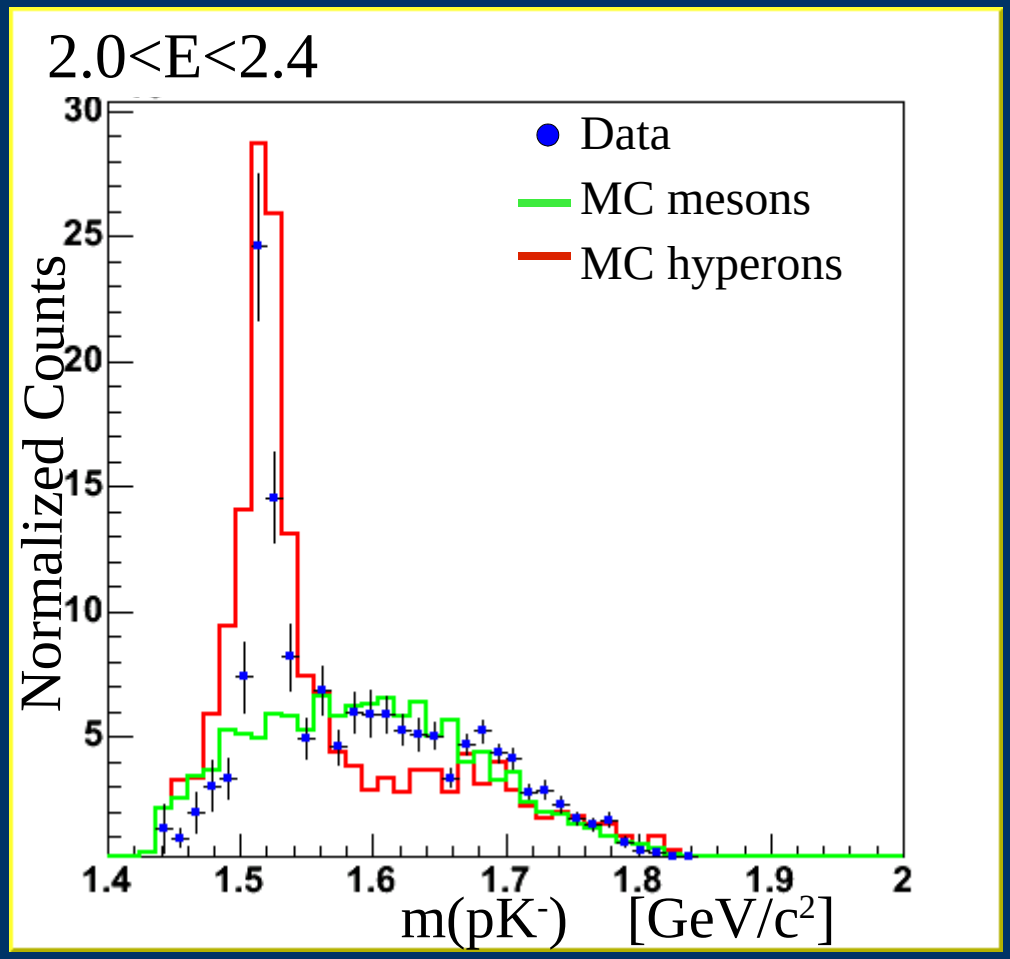


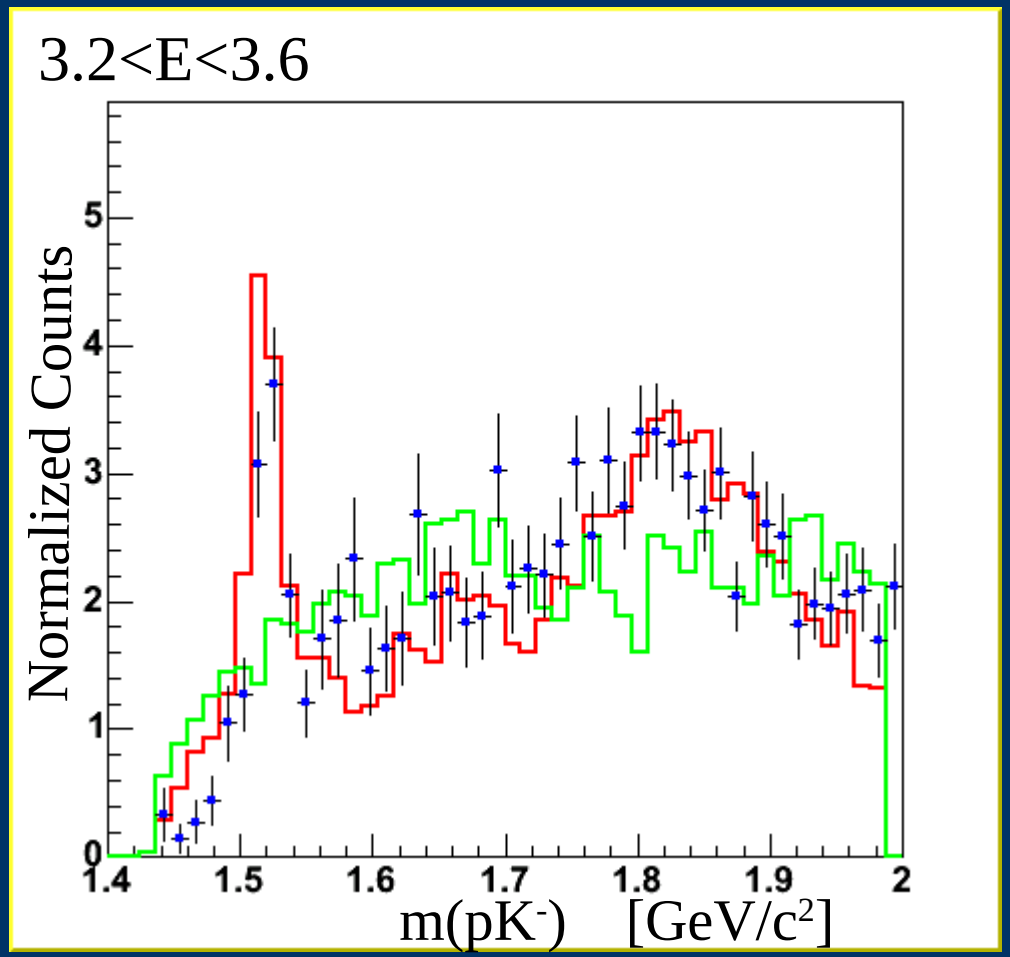
Simulation with Resonances

- 3-body phasespace + Fermi smearing for spectator.
- Adding the relativistic, complex Breit-Wigner amplitudes:
  - $\gamma n \rightarrow Y^{*} K^{0}$ hyperons
    - $\Lambda(1520)$, $\Lambda(1690)$, $\Lambda(1820)$, $\Sigma(1775)$, $\Sigma(1670)$.
  - $\gamma n \rightarrow Mp$ mesons
    - $a_0(980)$, $a_2(1320)$, $\rho_3(1690)$
- Comparing our data with these simulated resonances in various kinematic distributions helps to understand our data.

pK^- Invariant Mass Spectra

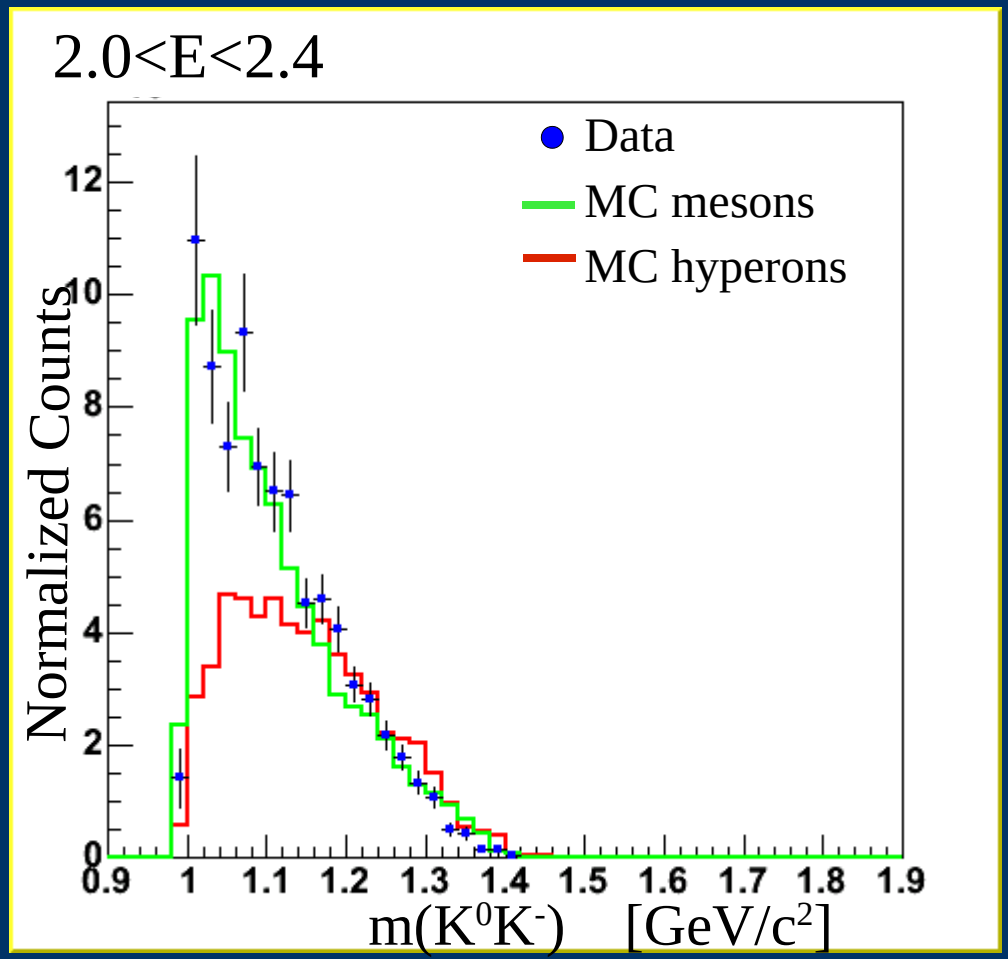
Λ(1520) and higher mass hyperons.

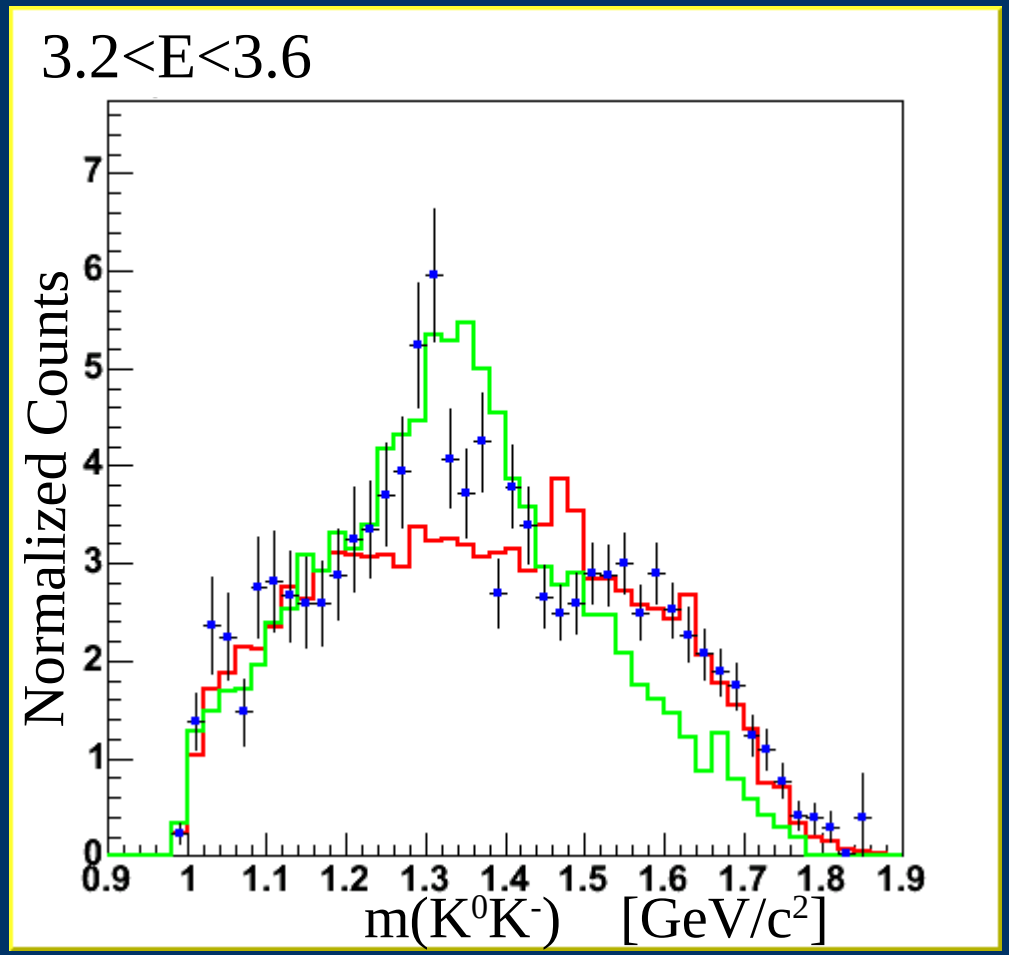




K^0K^- Invariant Mass Spectra

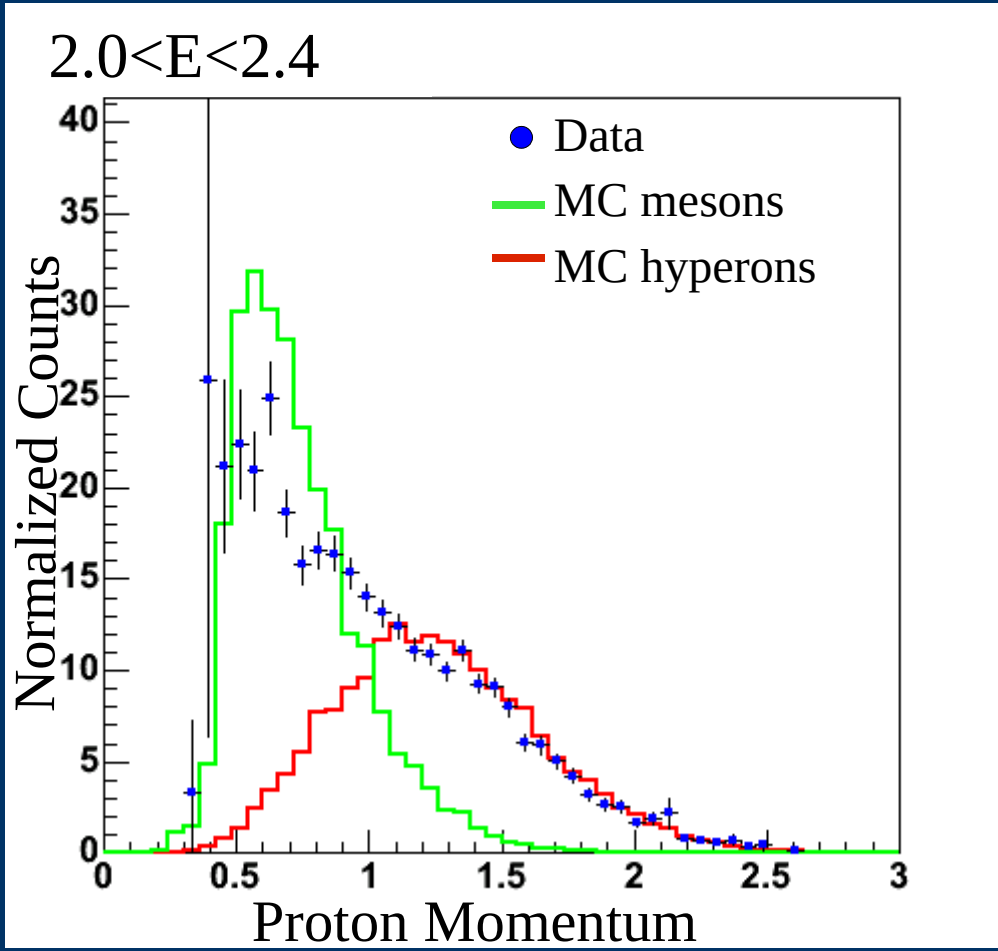
Contributions from $a_0(980)$ and $a_2(1320)$.

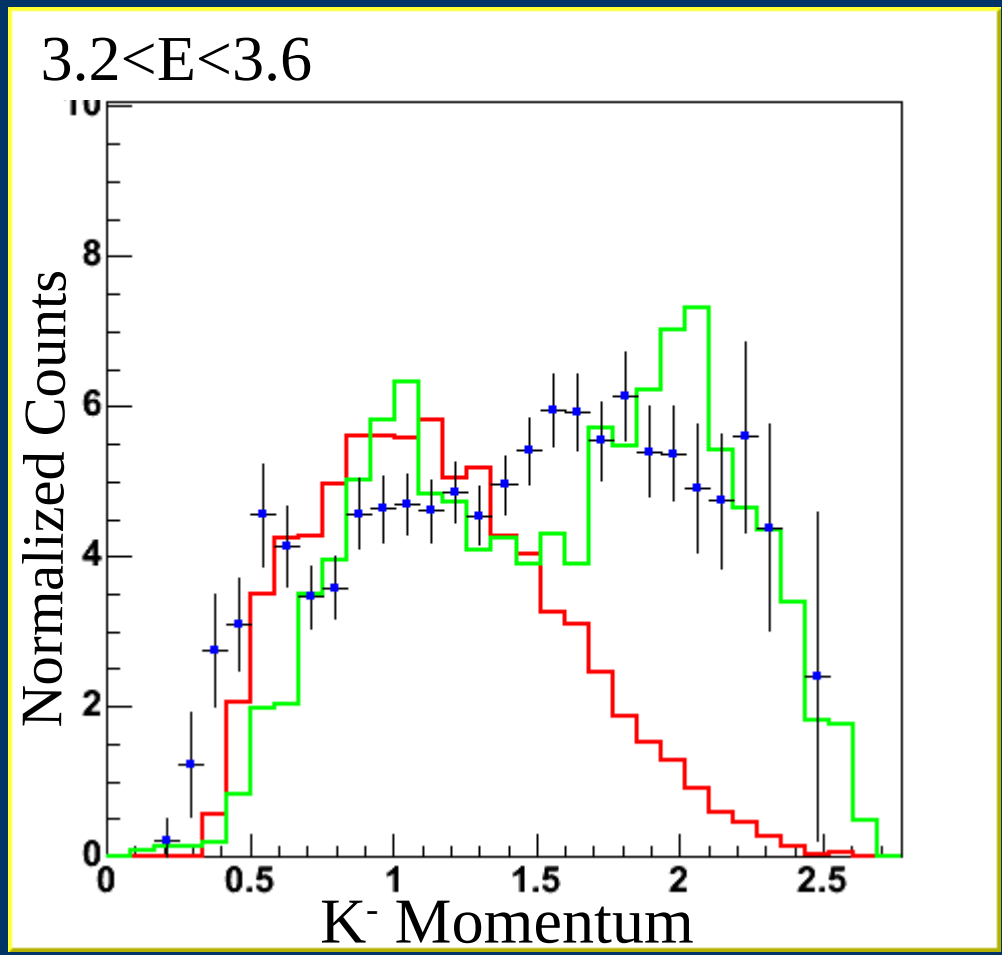




Particle Momenta

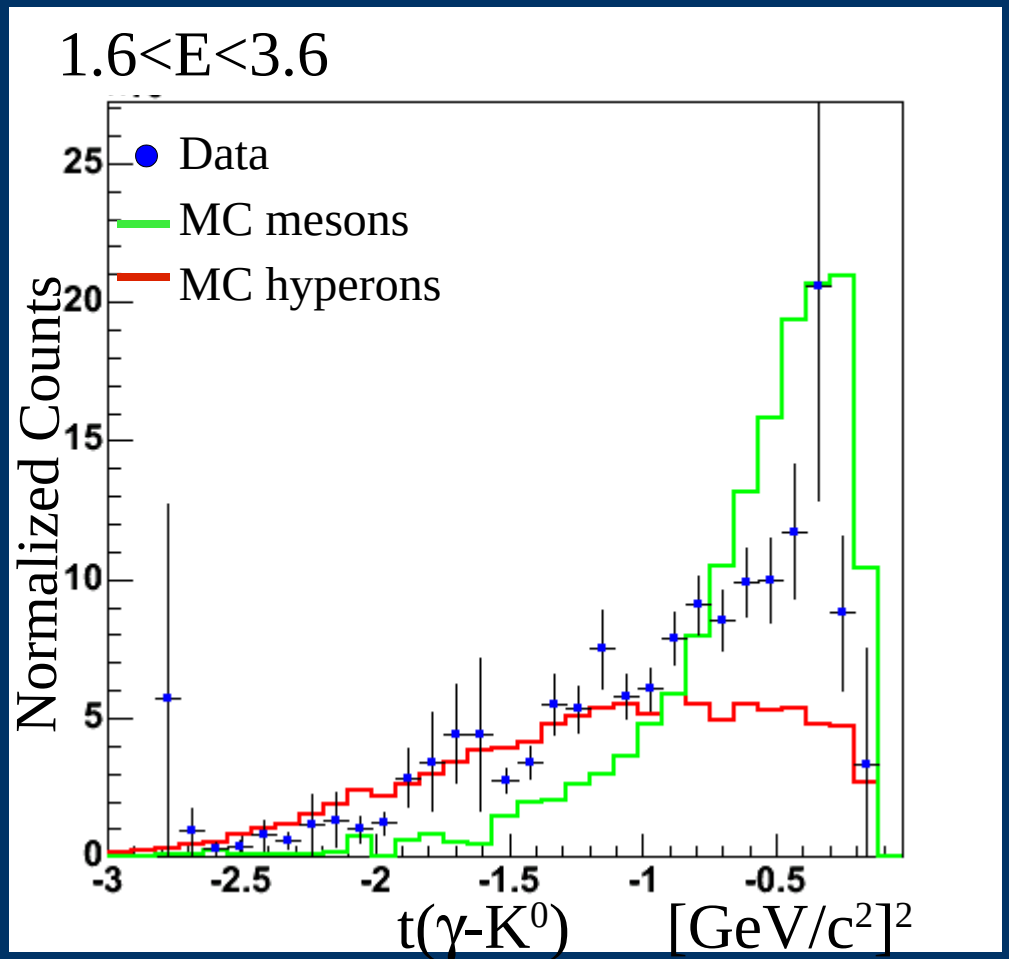
Proton and K^- momenta distributions have characteristics of meson and hyperon production.

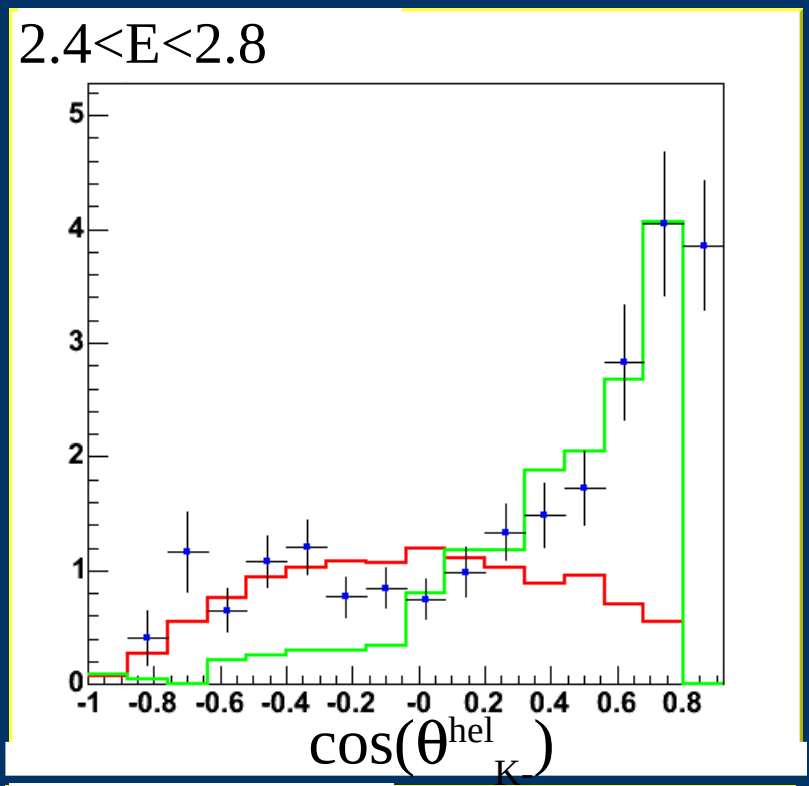


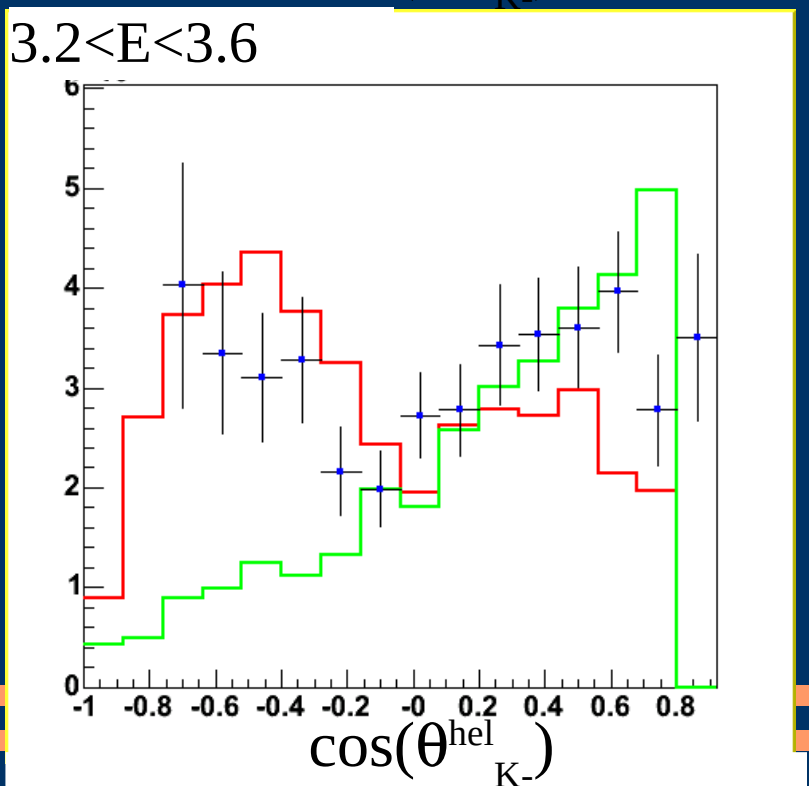


Angular Distributions of (1520) Events

$m(pK^-) < 1.56\ GeV/c^2$





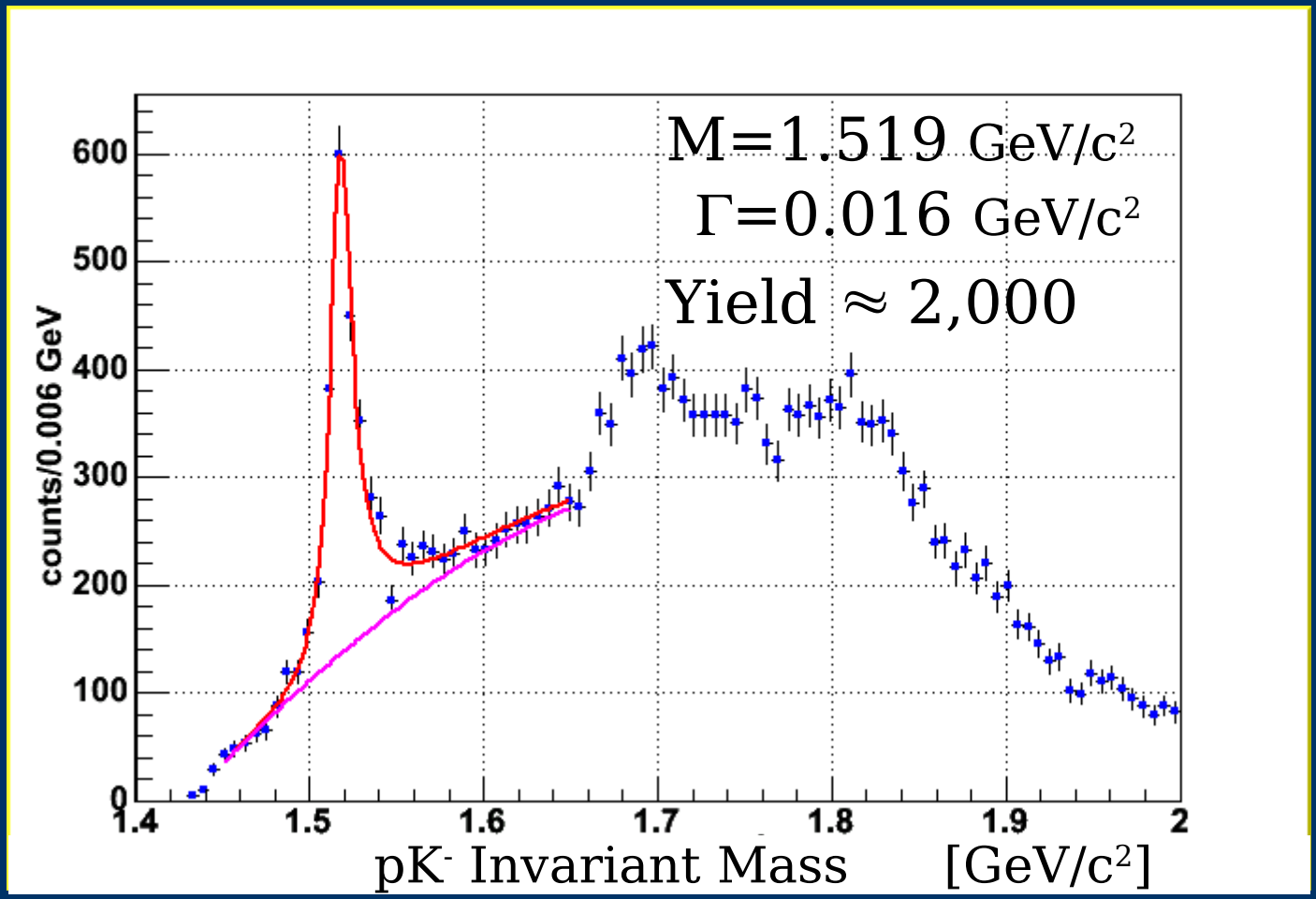


Summary

- Before drawing conclusions and releasing results in this pentaquark search, it is important to understand the background.
- MC model – resonant mesons and hyperons fits the data well.
- In future: unbinned log-likelihood fit of the resonant amplitudes.
- Possibility to measure $\gamma n \rightarrow {}^{0}\Lambda(1520)$ cross section.

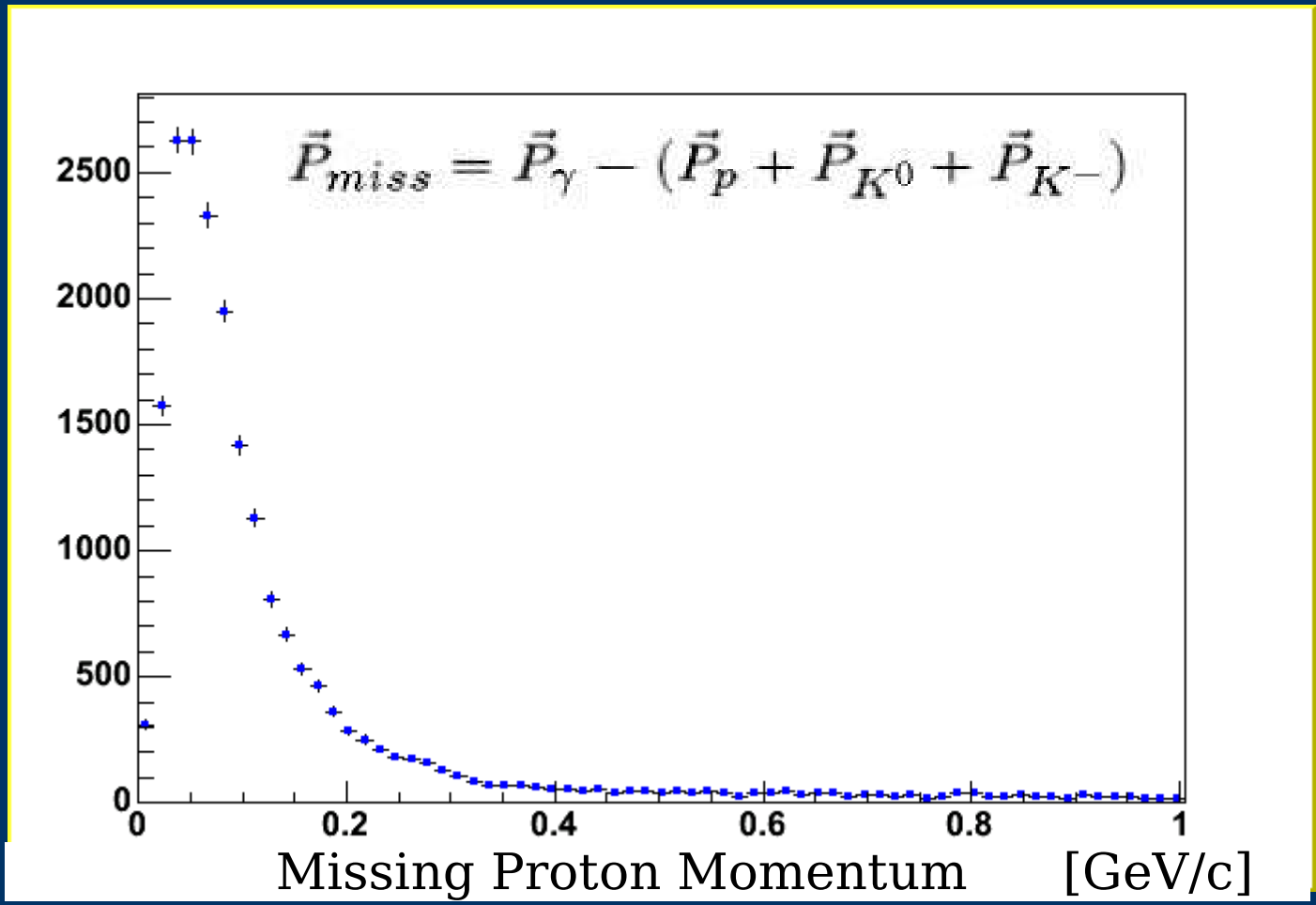
Extra Slides

$\gamma n \rightarrow K^0 \Lambda(1520)$



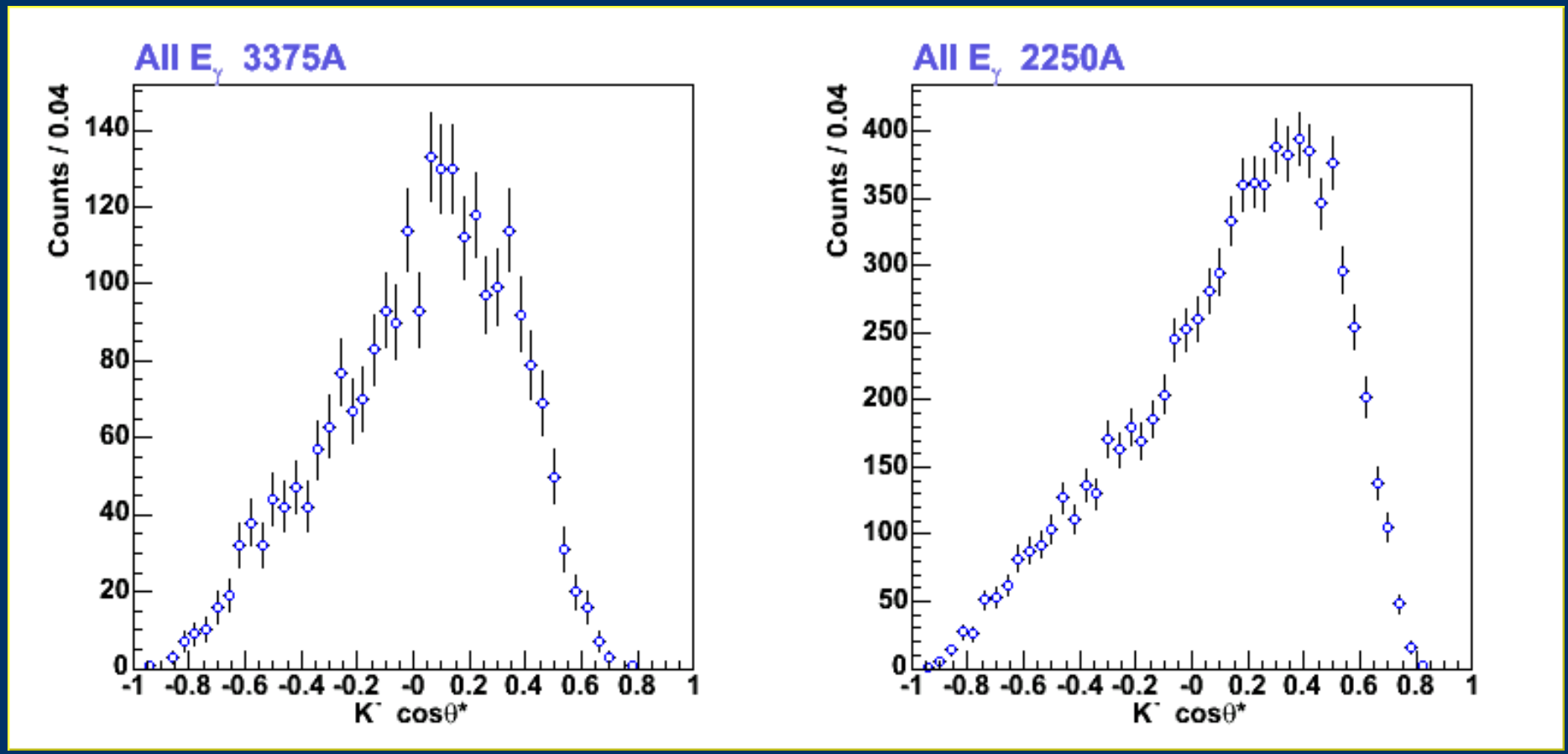
Missing Proton Momentum

$\gamma d \rightarrow p K^0 K^- (p)$



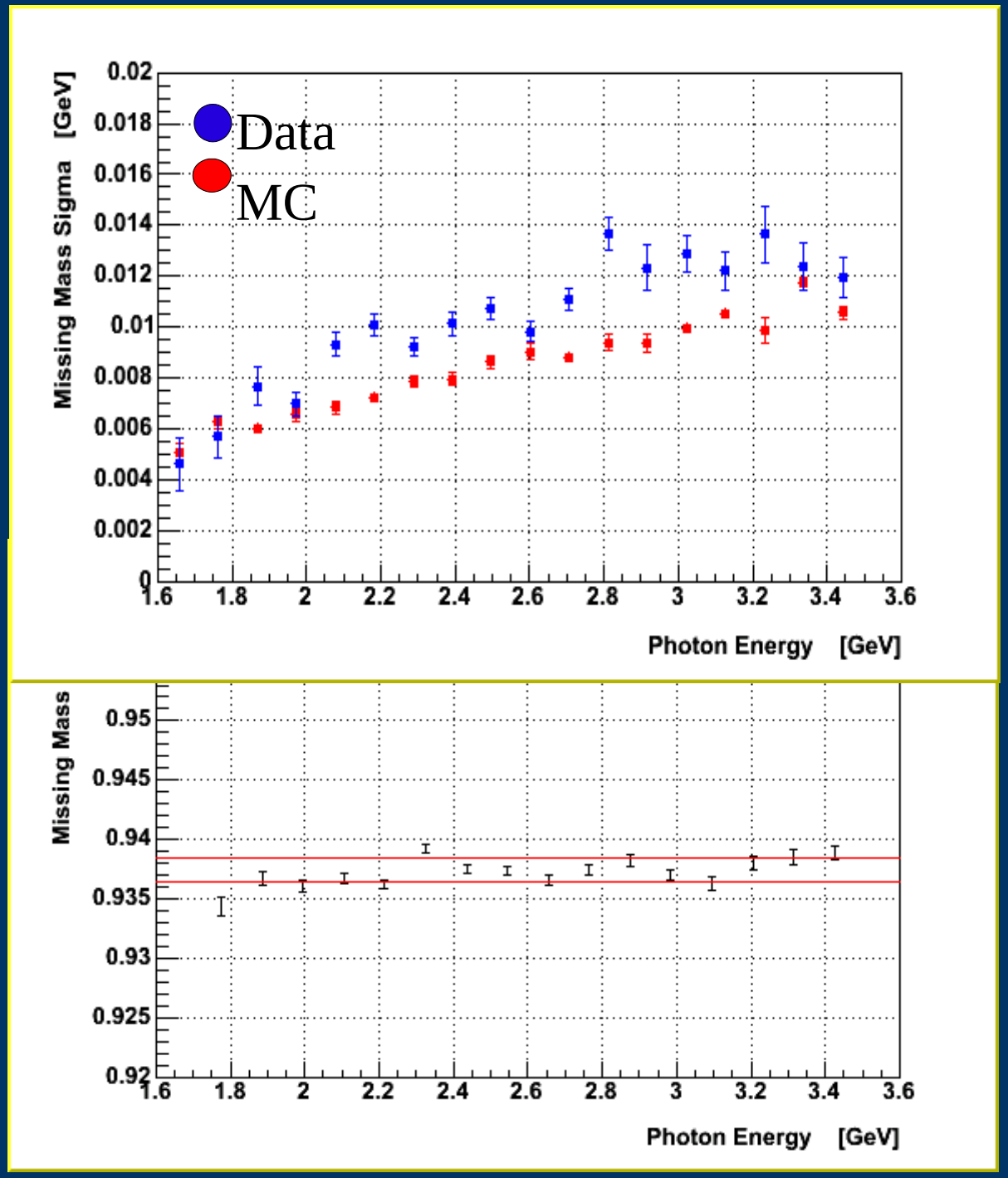
K^- Angular Coverage

2 torus field settings

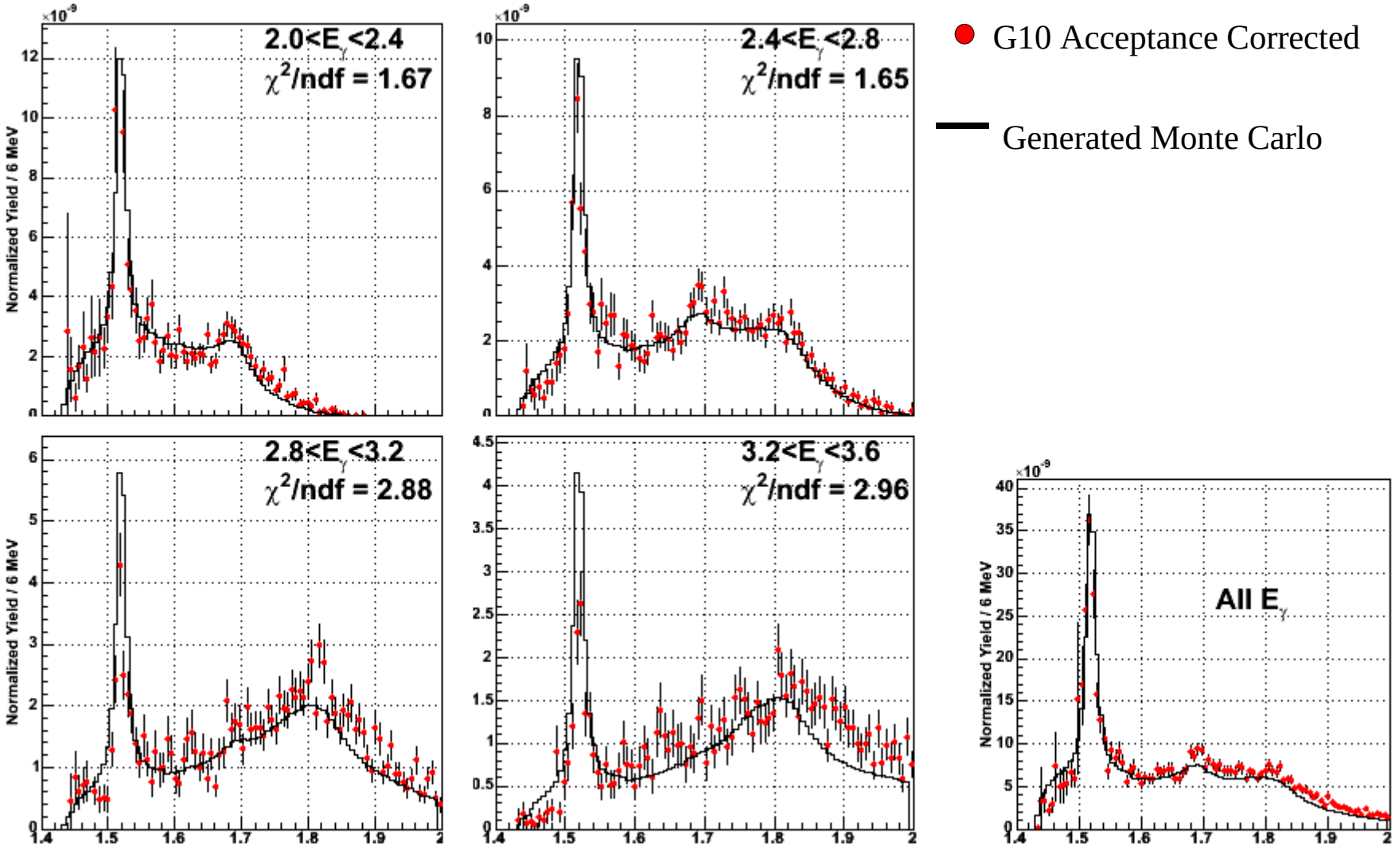


Reconstructed Mass Resolution

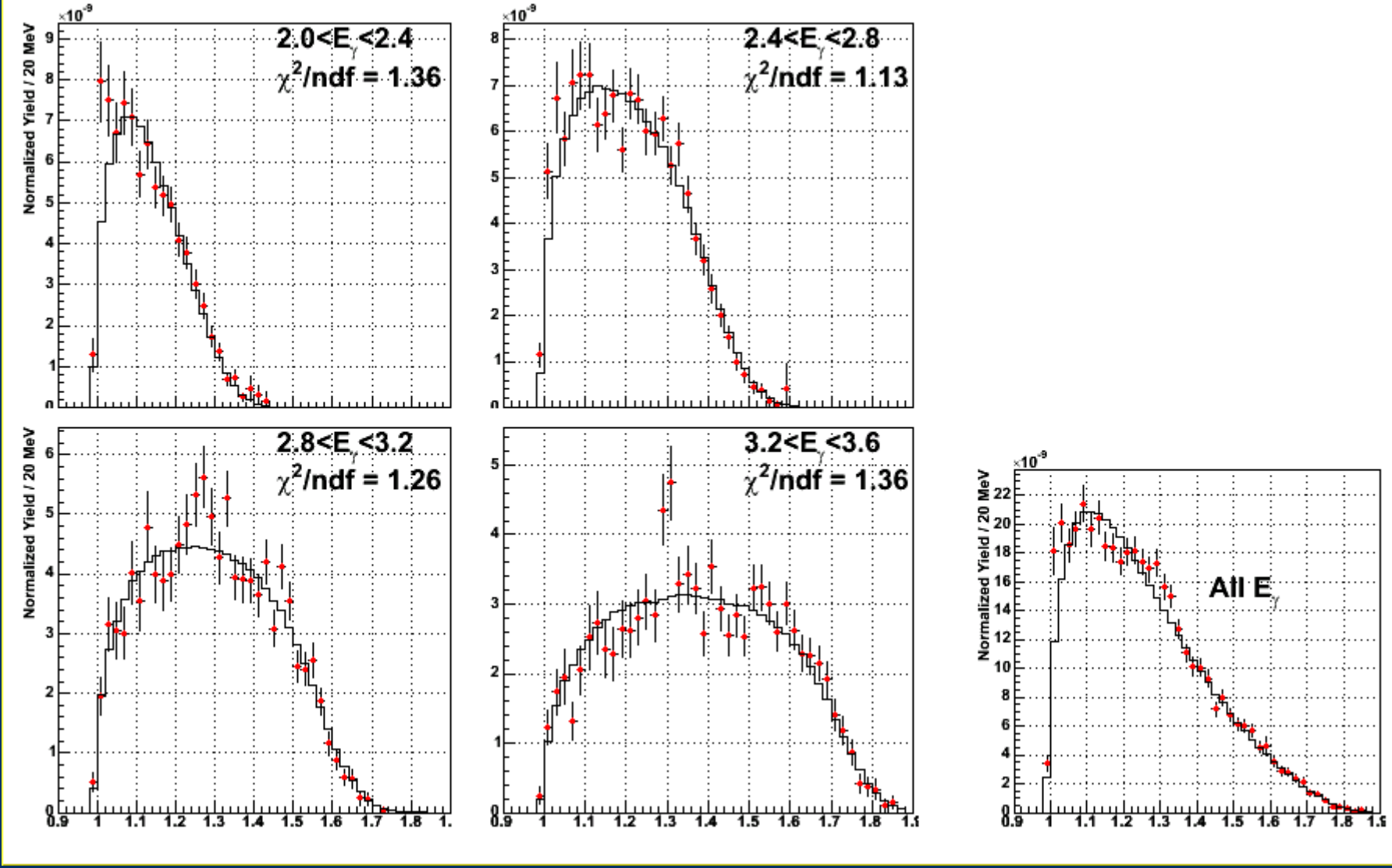
- : Data / Simulation
  - Proton: 9.0 / 7.5 MeV/c^2
  - K^0: 4.0 / 3.5 MeV/c^2



pK^- Invariant Mass $\gamma n \rightarrow Y^* K^0$



K^0K^- Invariant Mass



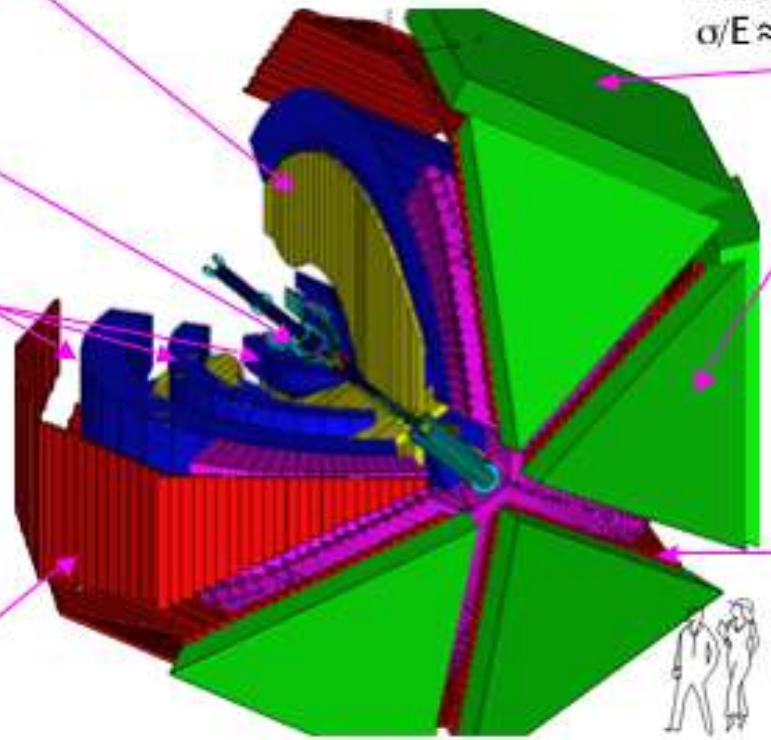
CEBAF Large Acceptance Spectrometer

Torus magnet
6 superconducting coils
$\int B \cdot dl \approx 1.7\ Tm$

Liquid D_2 (H_2)target +
γ start counter; e minitorus

Drift chambers
argon/CO_2 gas, 35,000 cells
$\sigma \approx 300 \mu m$

Time-of-flight counters
plastic scintillators, 684 photomultipliers
$\sigma \approx 145 ps$



Electromagnetic calorimeters
Lead/scintillator, 1296 photomultipliers
$\sigma/E \approx 10\%/E^{1/2}$

Gas Cherenkov counters
e/p separation, 256 PMTs
99.5% efficient over 55 m^2 area

Mecking et al., Nucl. Inst. Meth., A 503 (2003) 513.