Strangeness Production on the Neutron via the Reaction

$$\gamma\, n\,(p) \rightarrow K^+\, \Sigma^-\, (p)$$

- motivation
- experiment
- K+ identification, kinematic corrections
- inclusive/exclusive analysis
- background studies
- acceptance/efficiency
- unfolding the Σ^- cross section

Jörn Langheinrich

NSTAR 2005

Strangeness Photoproduction

Isospin Channels:

$\gamma p \rightarrow K^+ \Lambda$

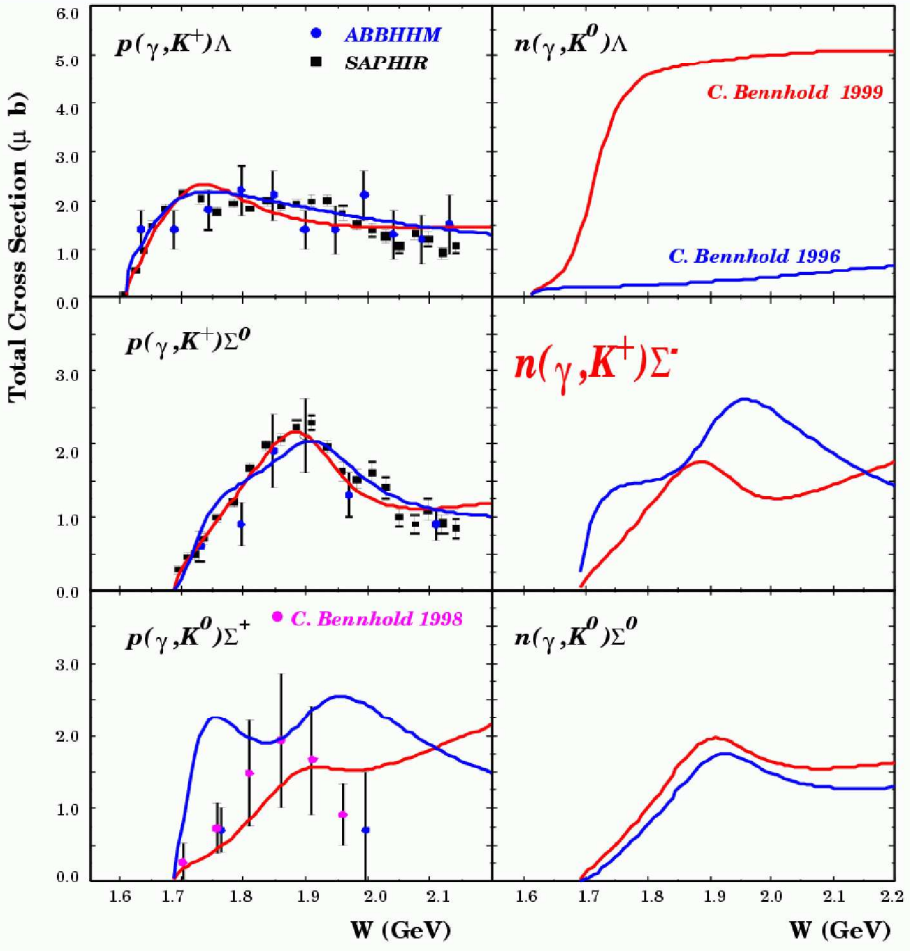
$\gamma p \rightarrow K^+ \Sigma^o$

$\gamma n \rightarrow K^+ \Sigma^-$

$\gamma n \rightarrow K^o \Lambda$

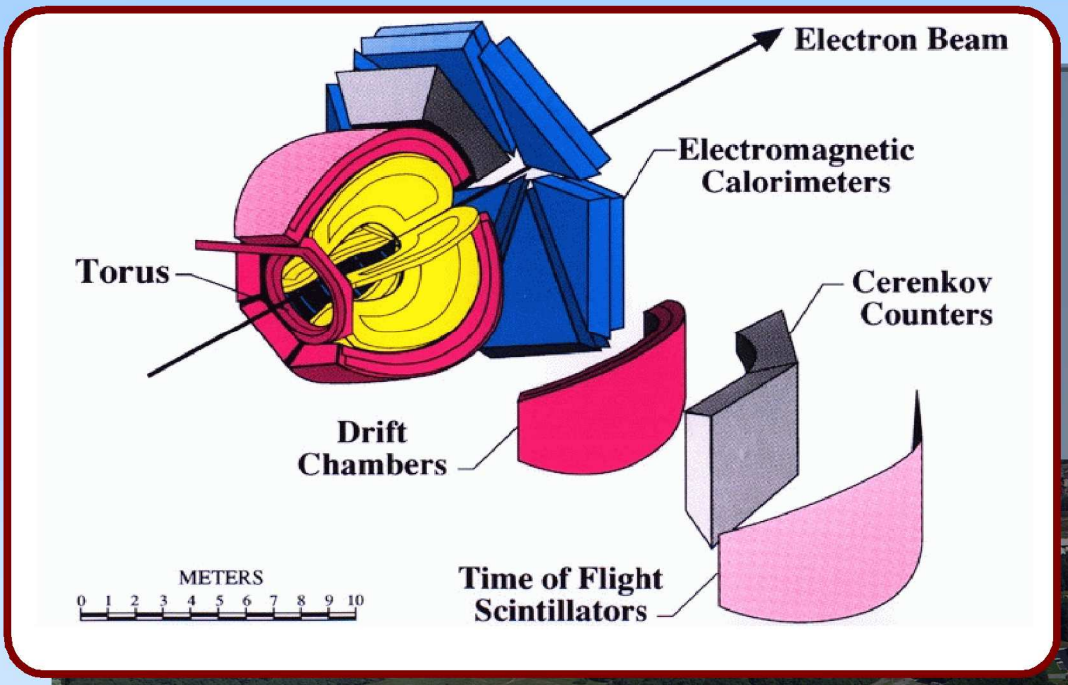
$\gamma n \rightarrow K^o \Sigma^o$

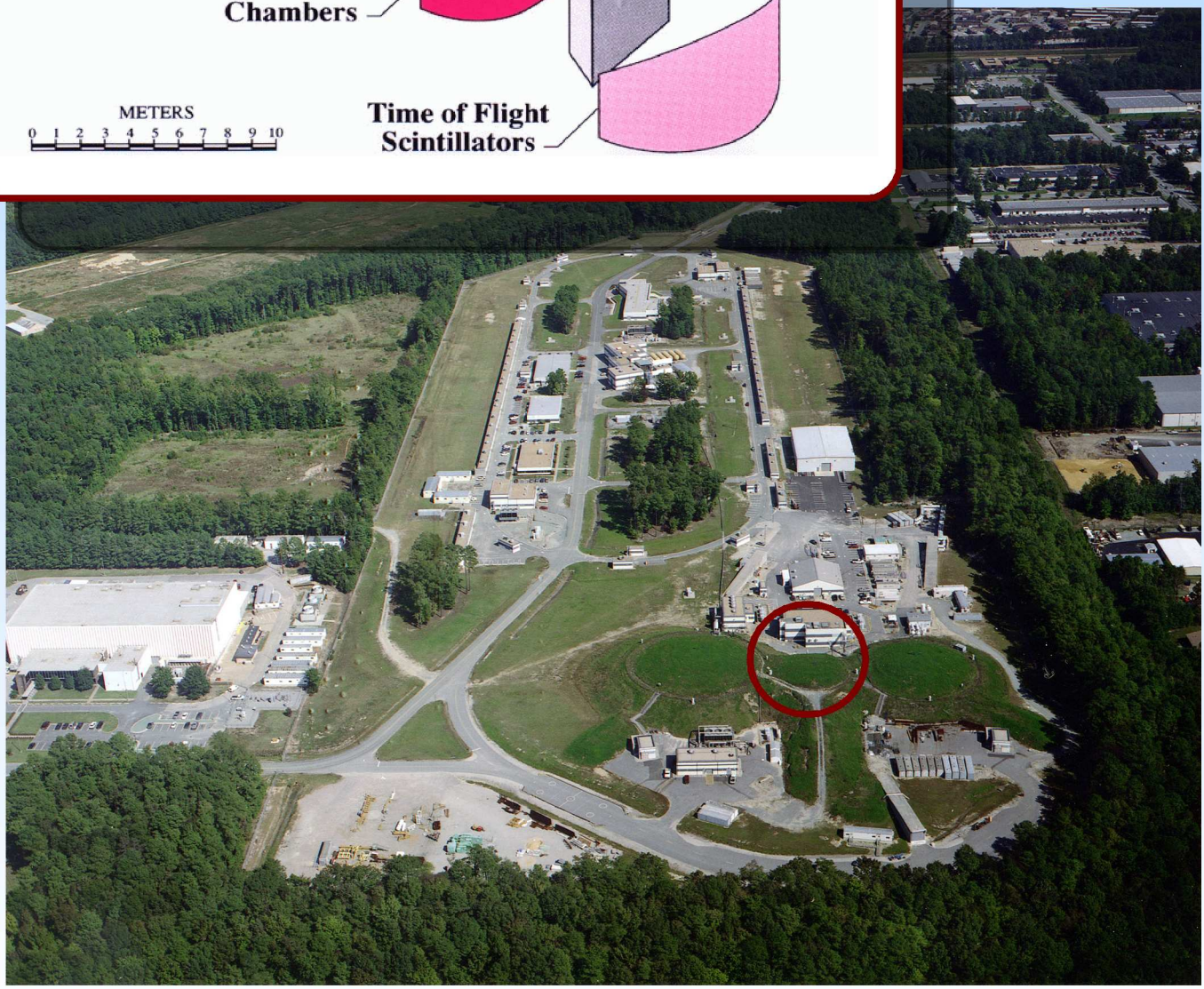
$\gamma p \rightarrow K^o \Sigma^+$



F.X. Lee, T. Mart, C. Bennhold, L.E. Wright
nucl-th/9907119 1999

CEBAF Large Acceptance Spectrometer





g2a experiment

Beam energy E_0: 2.5 GeV

Photon energy: 20% - 95% of E_0 (tagged region)

Trigger: tagger + 1 charged (or 2 neutral)

Torus current: 87 % pos. outbending

Beam current: 10-13 nA 10^{-4} radiator

Events recorded: over $2 * 10^9$

This Analysis:

Ana Lima GWU
Jörn Langheinrich USC

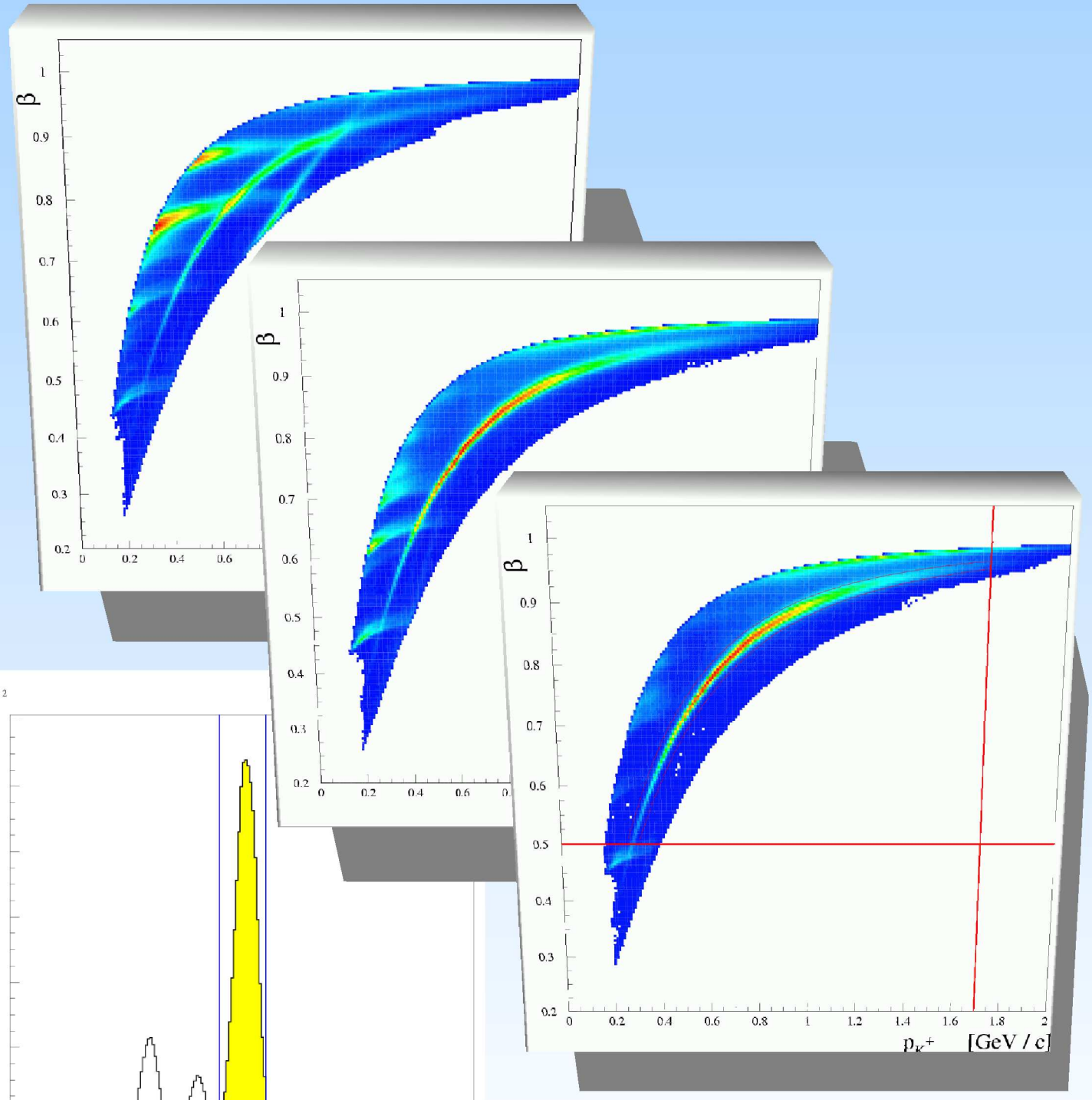
Sponsor:

Barry Berman

Contributions:

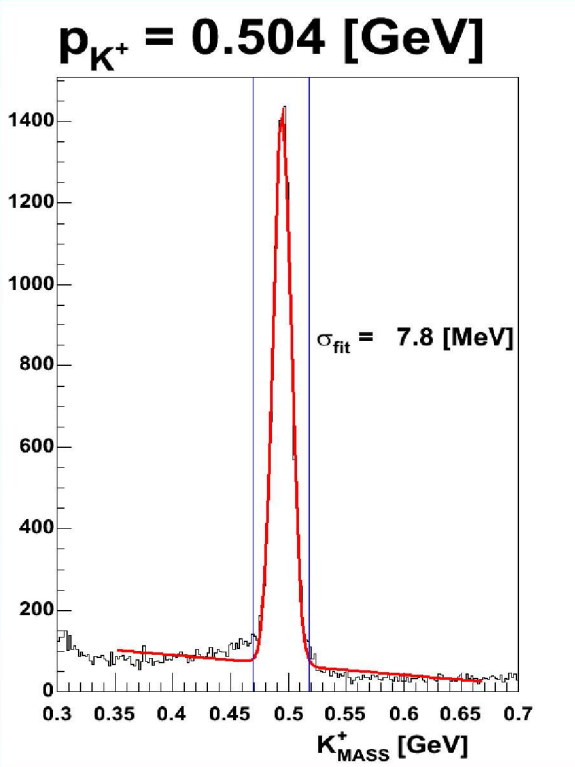
Bernhard Mecking
Henry Juengst
Ioana Niculescu
Ulrike Thoma
All nice people doing g2 cooking, calibration, and shifts

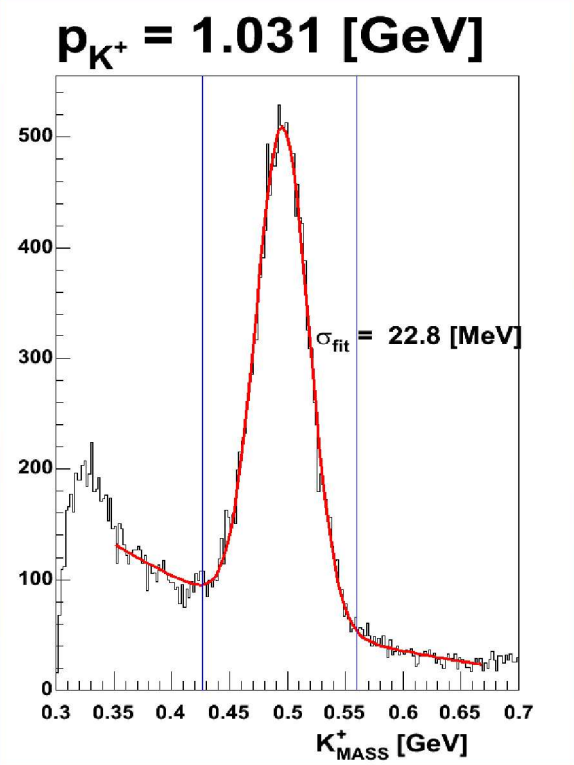
K^+ cuts

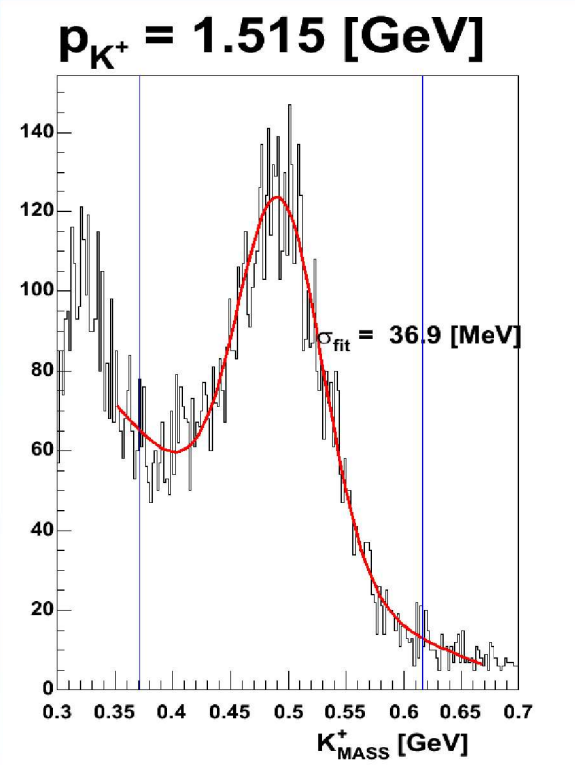

β
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
p_{K^+} [GeV / c]

x 10 2
counts
7000
6000
5000
4000
3000
2000
1000
0
-10
-8
-6
-4
-2
0
2
4
6
8
10
$t_{SC} - t_{ST}$ [ns]

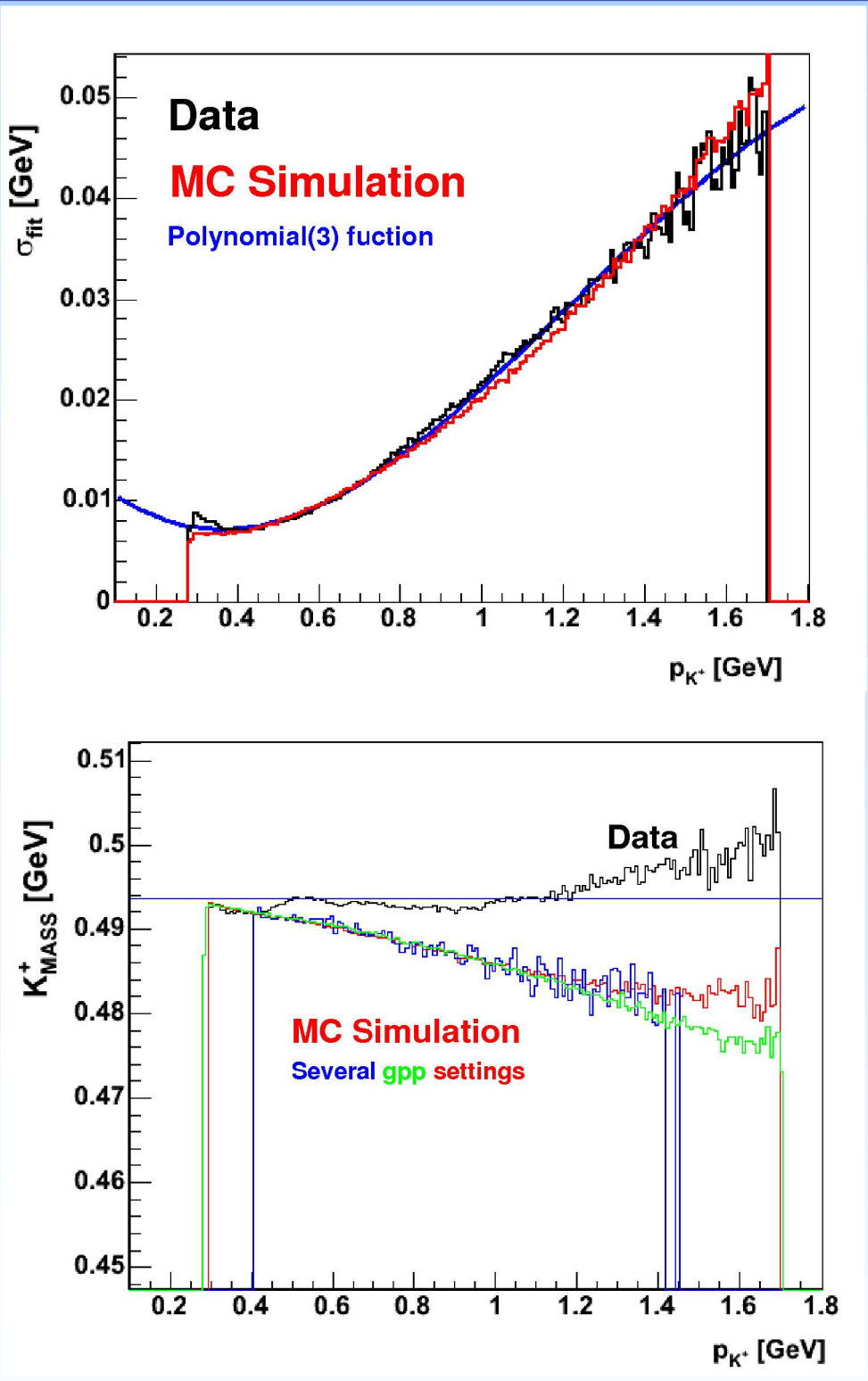
K^+ Mass Resolution





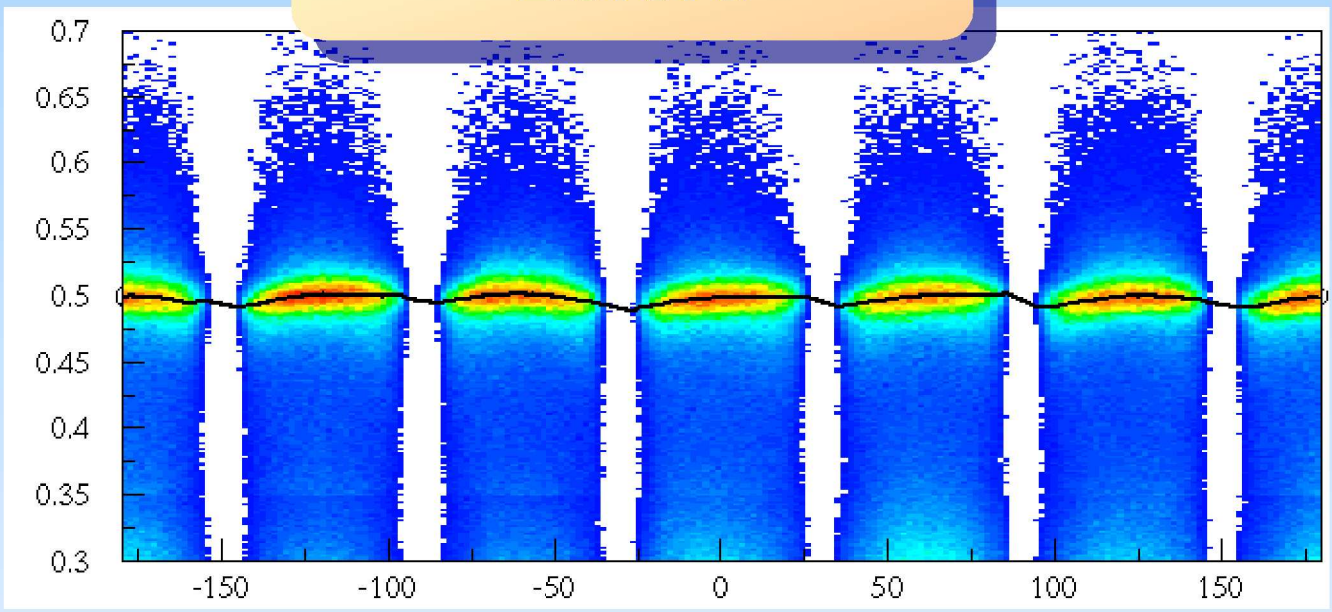


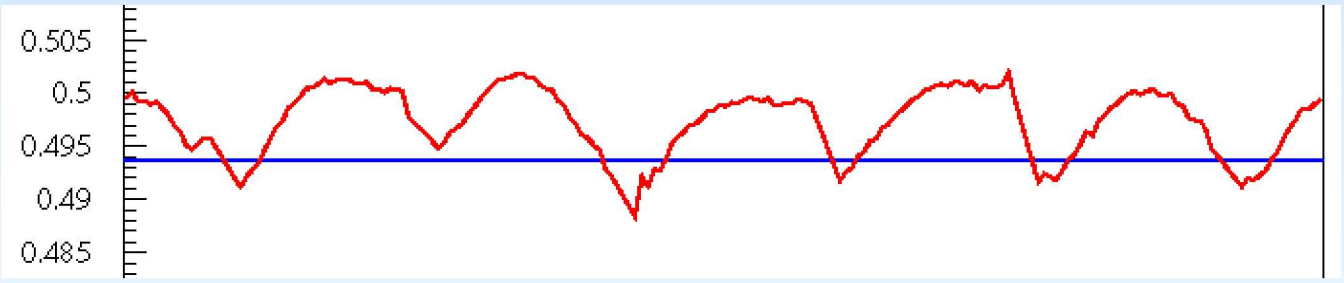
K^+ Mass Peak / Resolution



K^+ Time-of-Flight Correction

Before



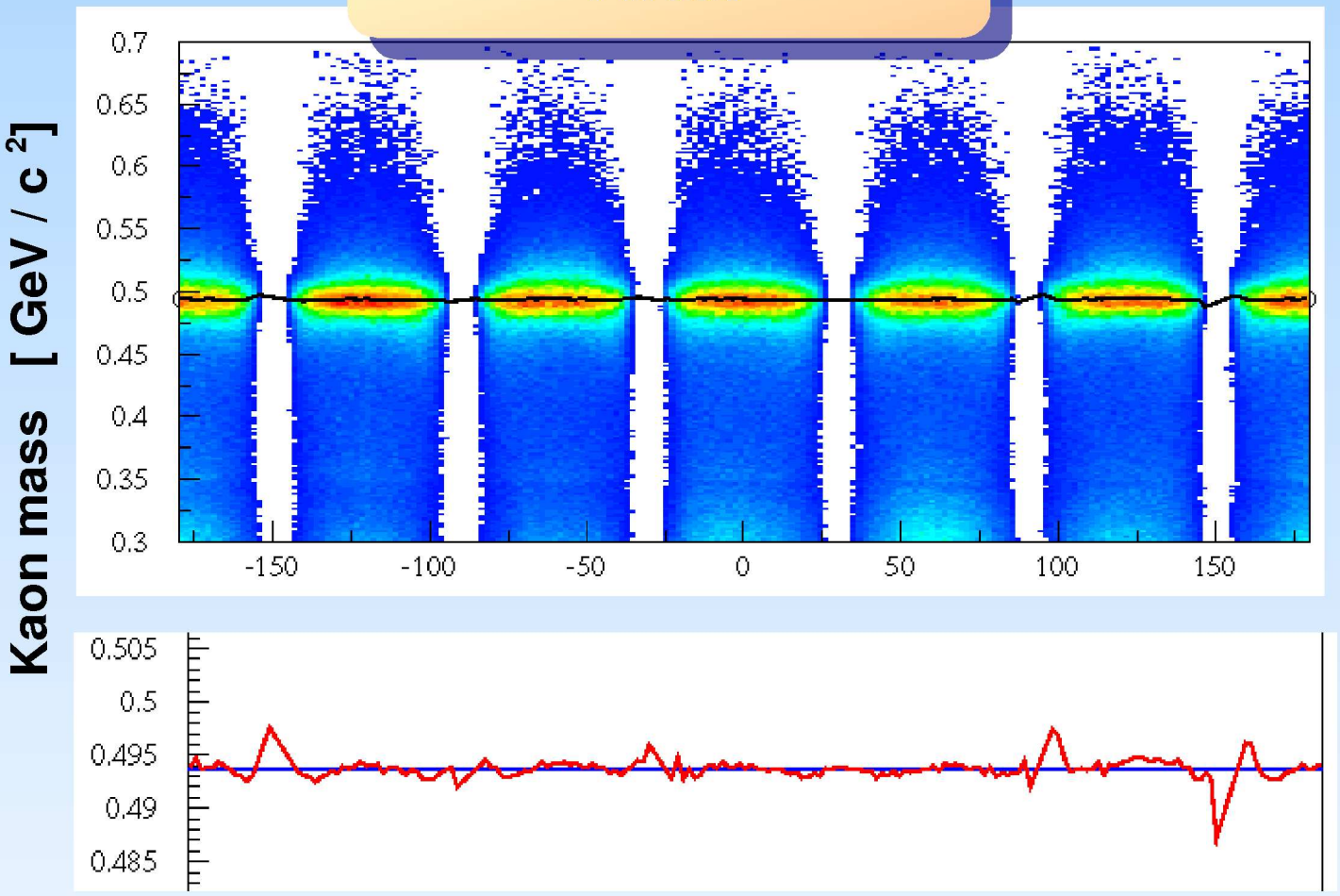


Kaon mass [GeV / c^2]

Φ [deg]

K^+ Time-of-Flight Correction

After



... consider fiducial cuts

Inclusive or Exclusive analysis?

Σ^- missing mass

- **High Acceptance**
  - Flat Acceptance
  - High θ, E_γ coverage
  - Model independent simulation
  - Background easy to understand

$\Sigma^- \rightarrow \pi n$

- **Separation of Σ^-**
  - Stand alone analysis
  - High mass resolution
  - Fermi motion correction
  - Low background

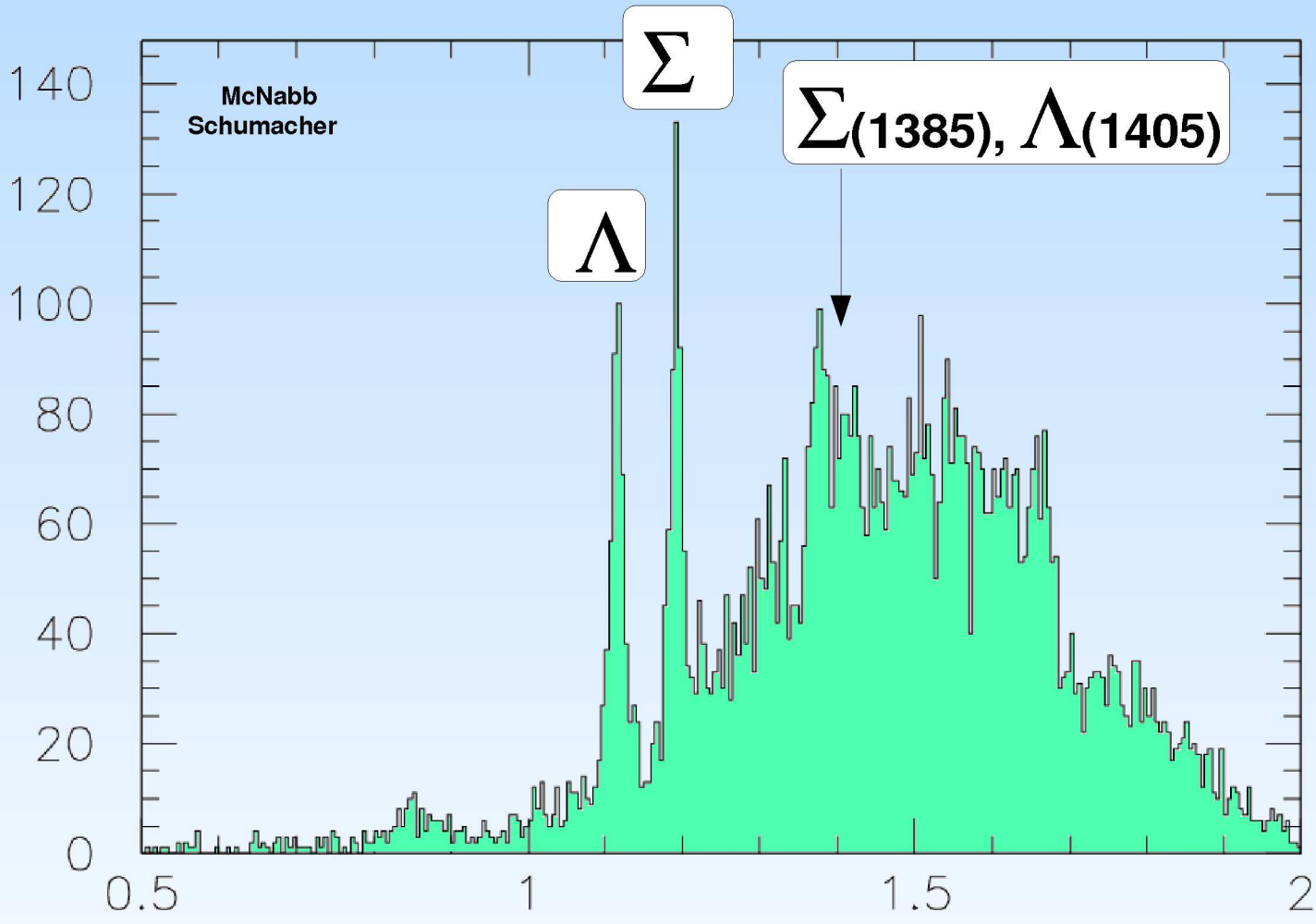
Let's do both!

Ana Lima
Jörn Langheinrich

Ioana Niculescu
Gabriel Niculescu

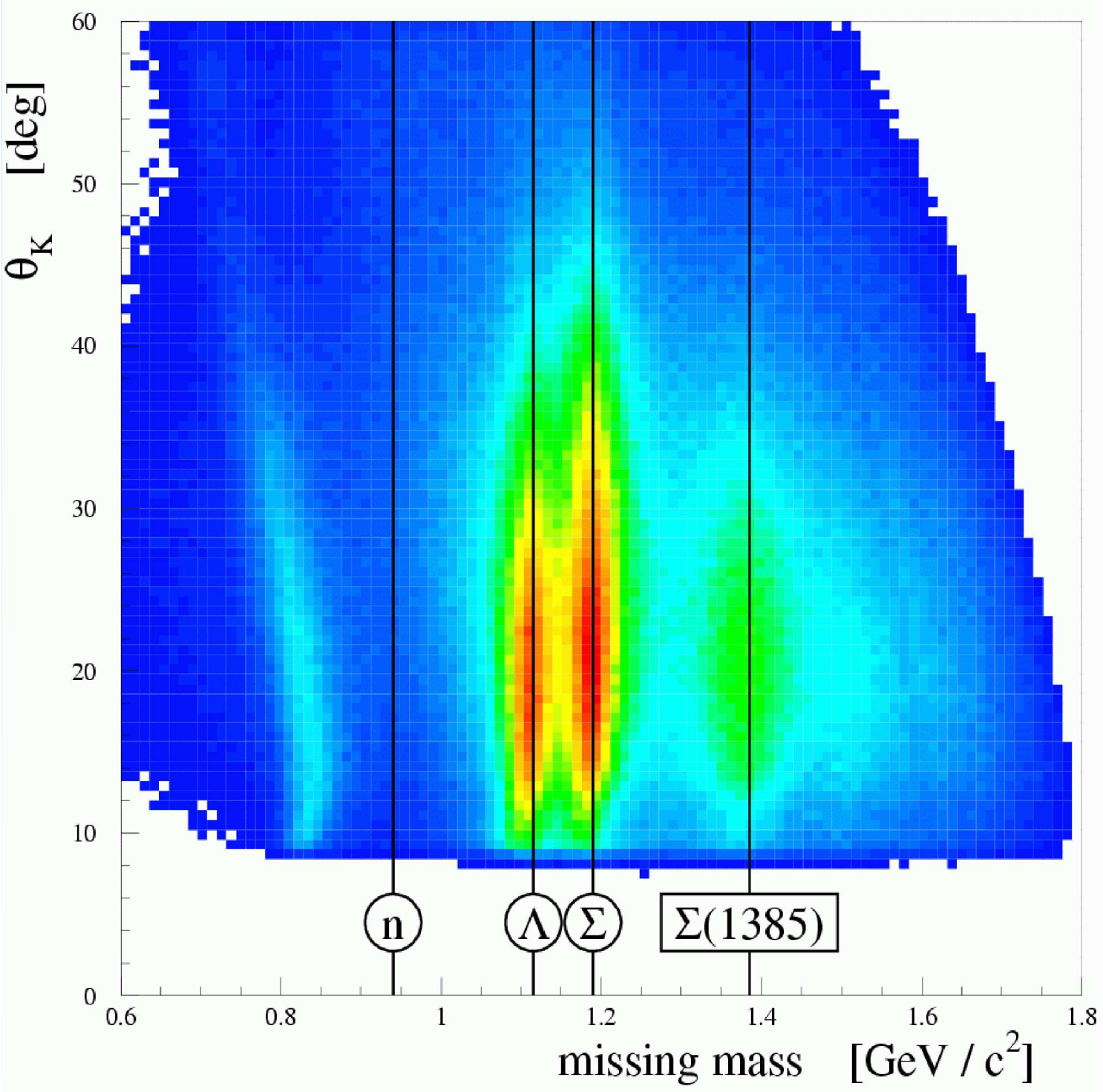
Missing Mass Calculation

$$M_X = \sqrt{M_N^2 + M_K^2 - 2M_N E_K + 2E_\gamma (M_N - E_K + p_K \cos\theta)}$$



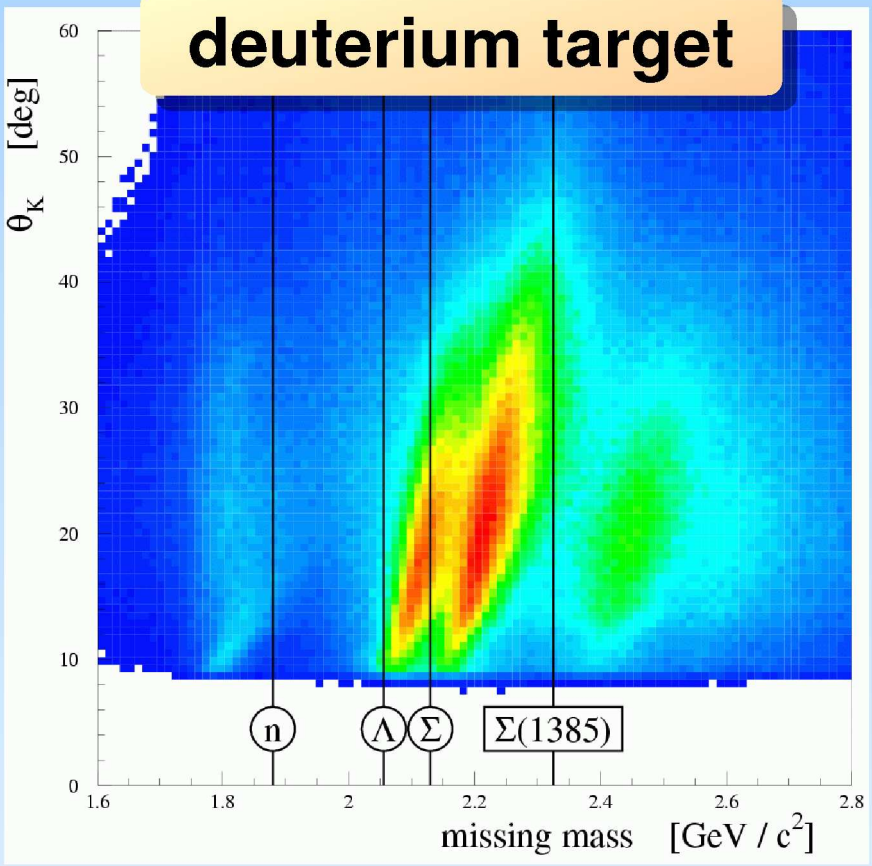
Mx from ($\gamma p \rightarrow K^+ + X$) all E, Run 20941

Assuming Nucleon Target

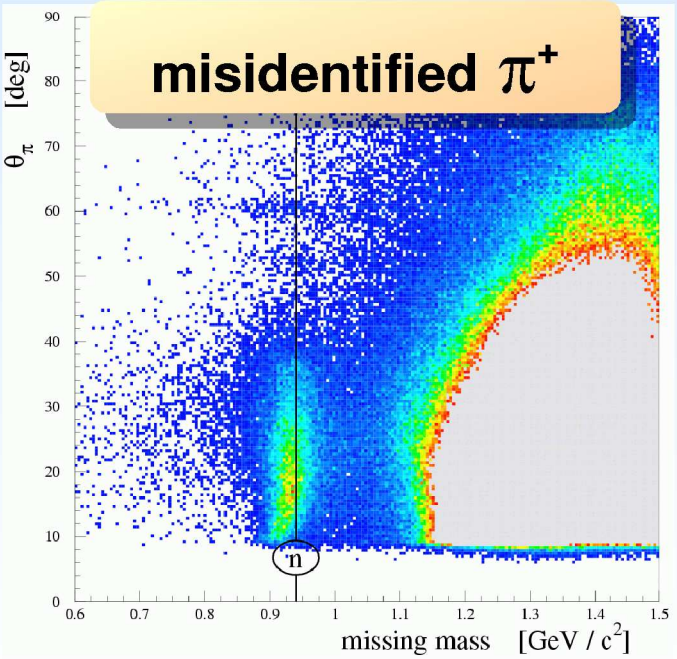


Other Assumptions

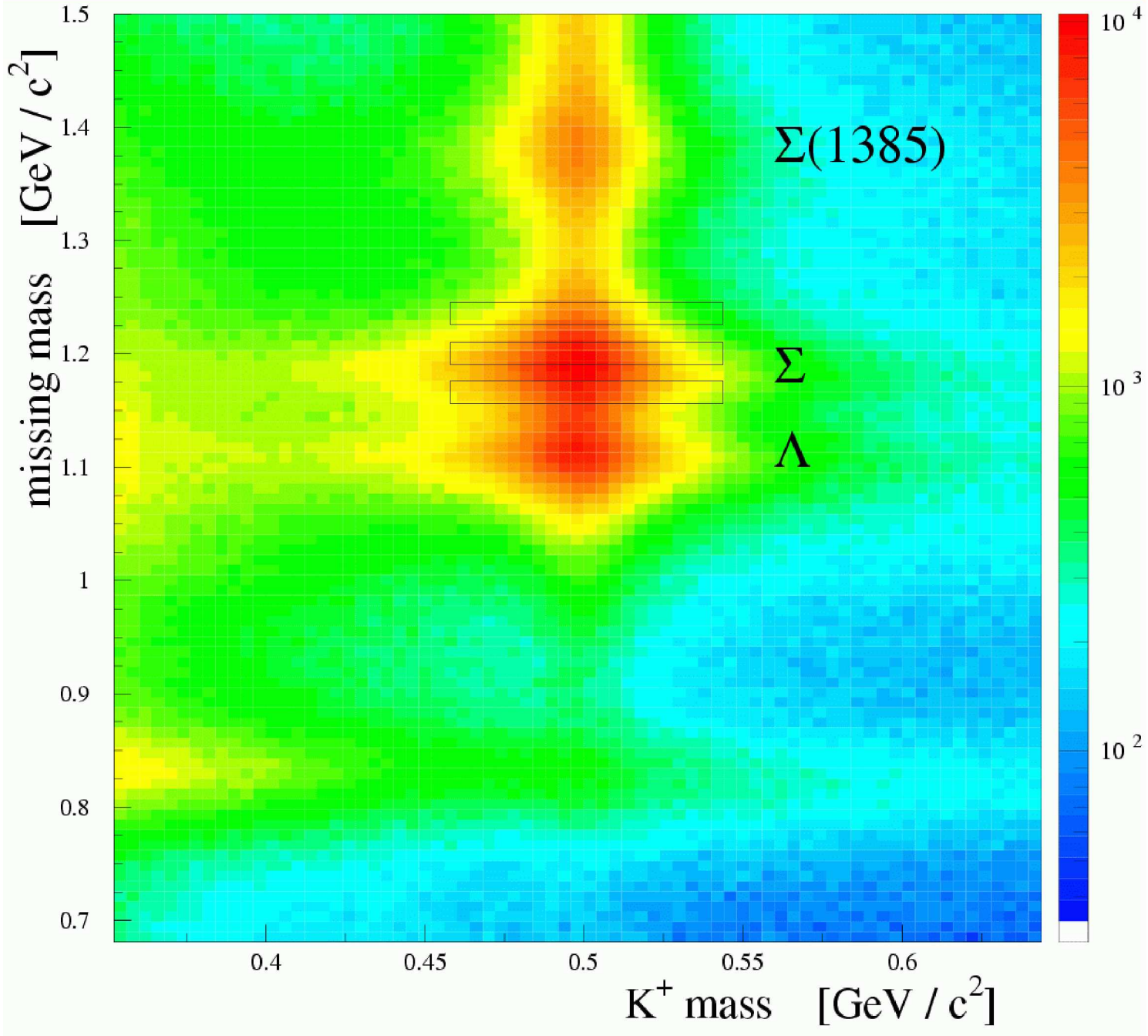
deuterium target



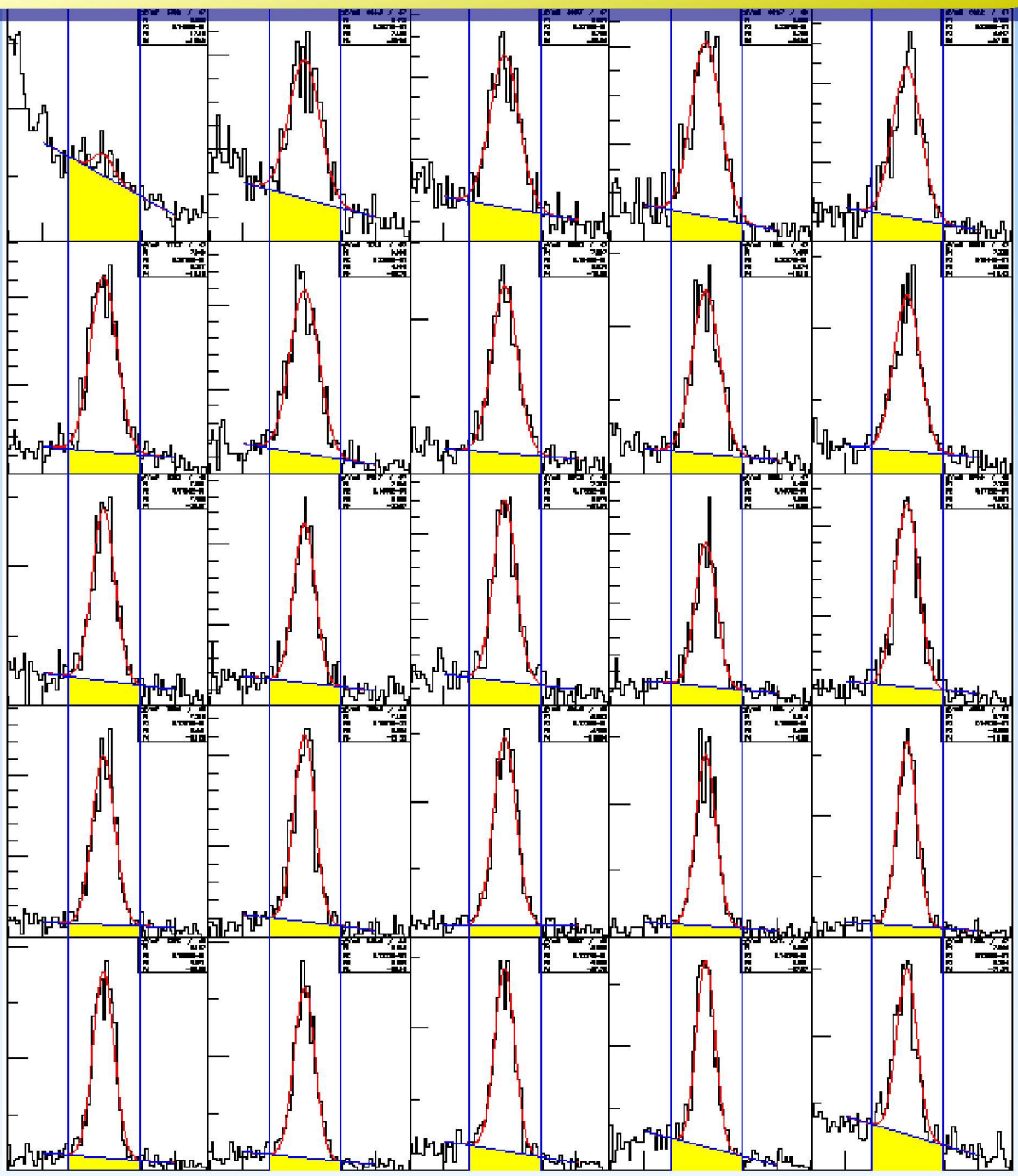
misidentified π^+

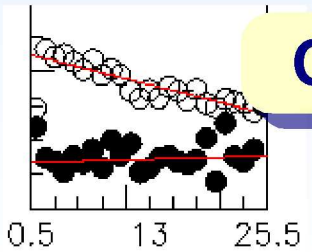


Missing mass vs Kaon mass



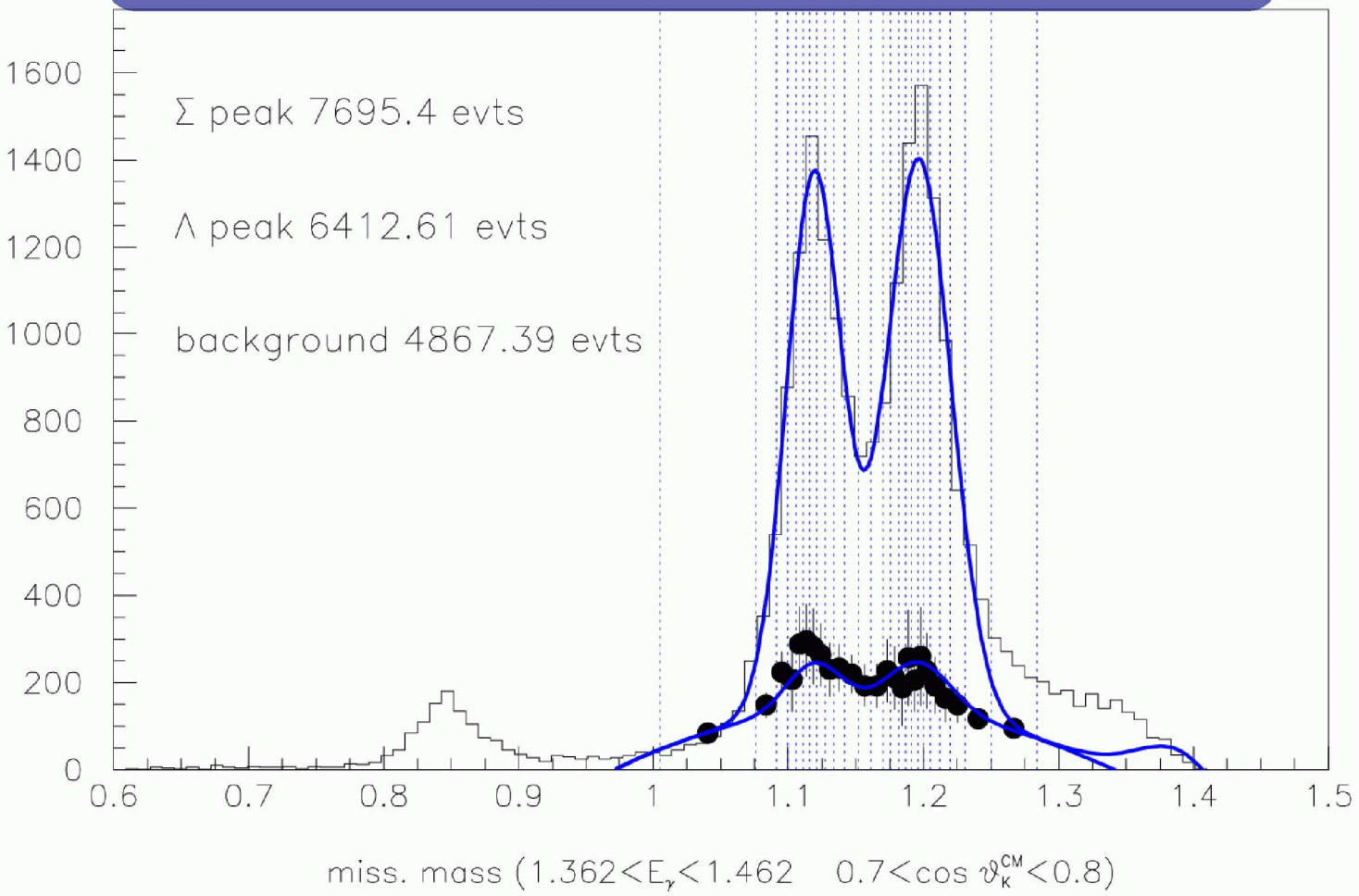
Divide missing mass distribution into bins
Fit K+ mass distribution in each bin

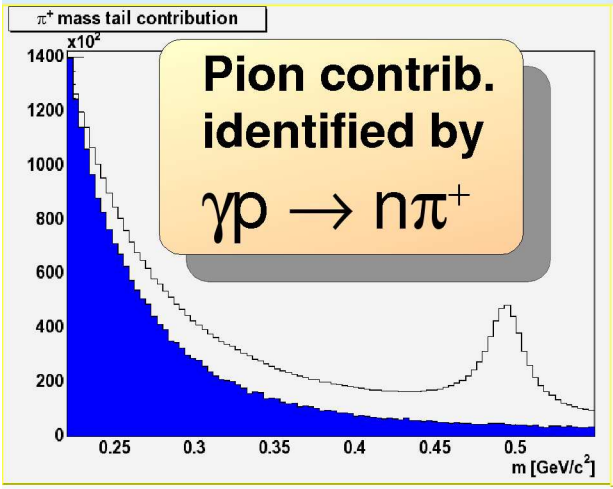




Check fit quality!

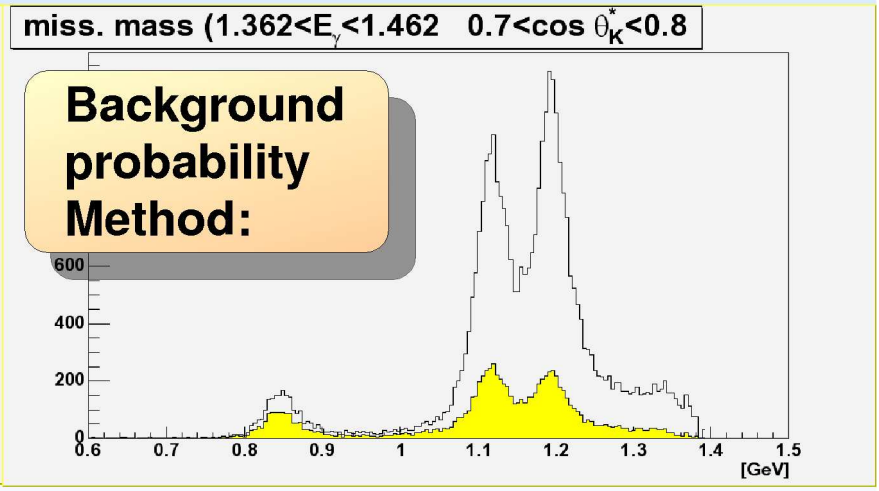
Hyperon structure in background





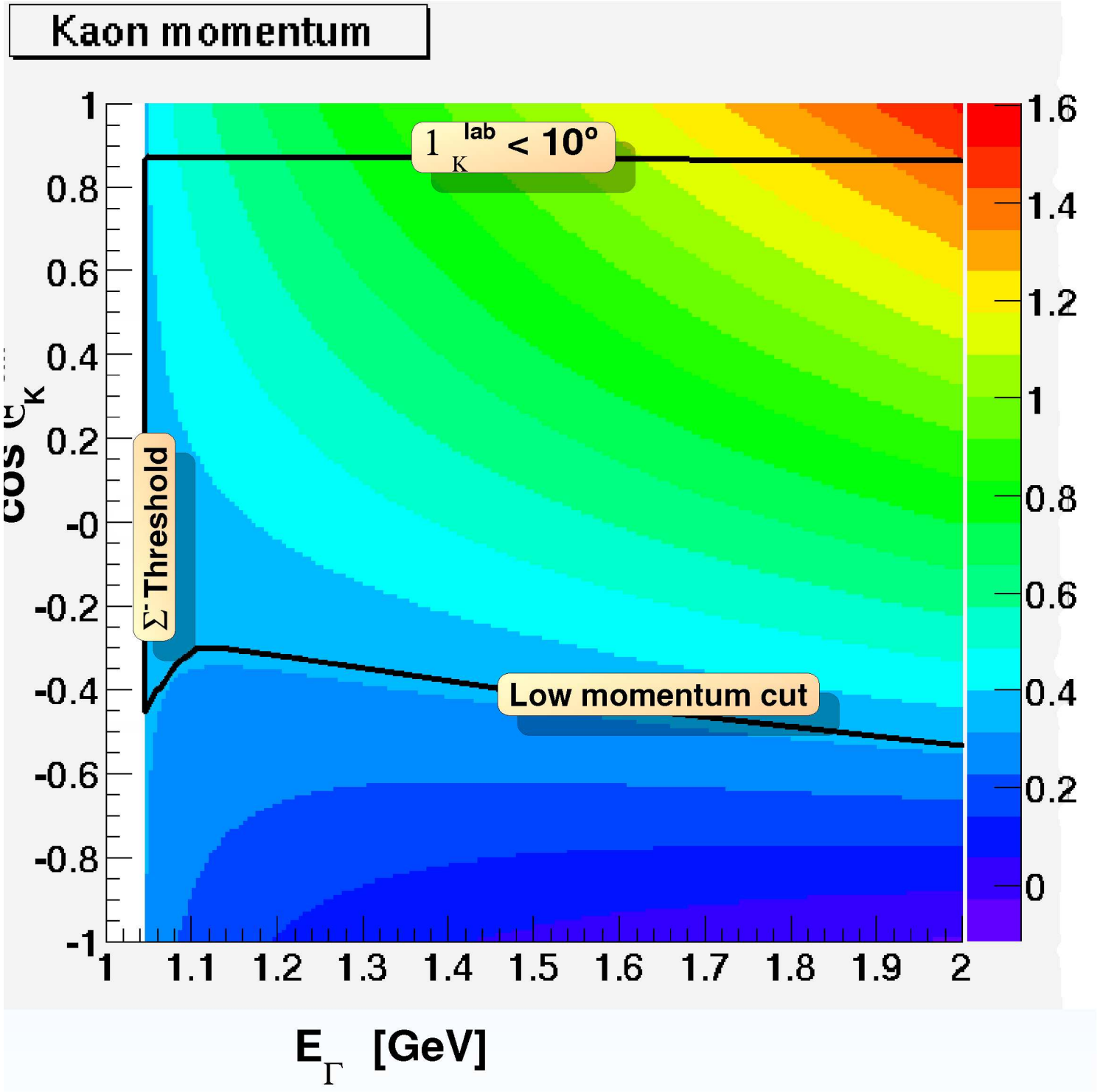
Pion contrib. identified by

$\gamma p \rightarrow n\pi^+$



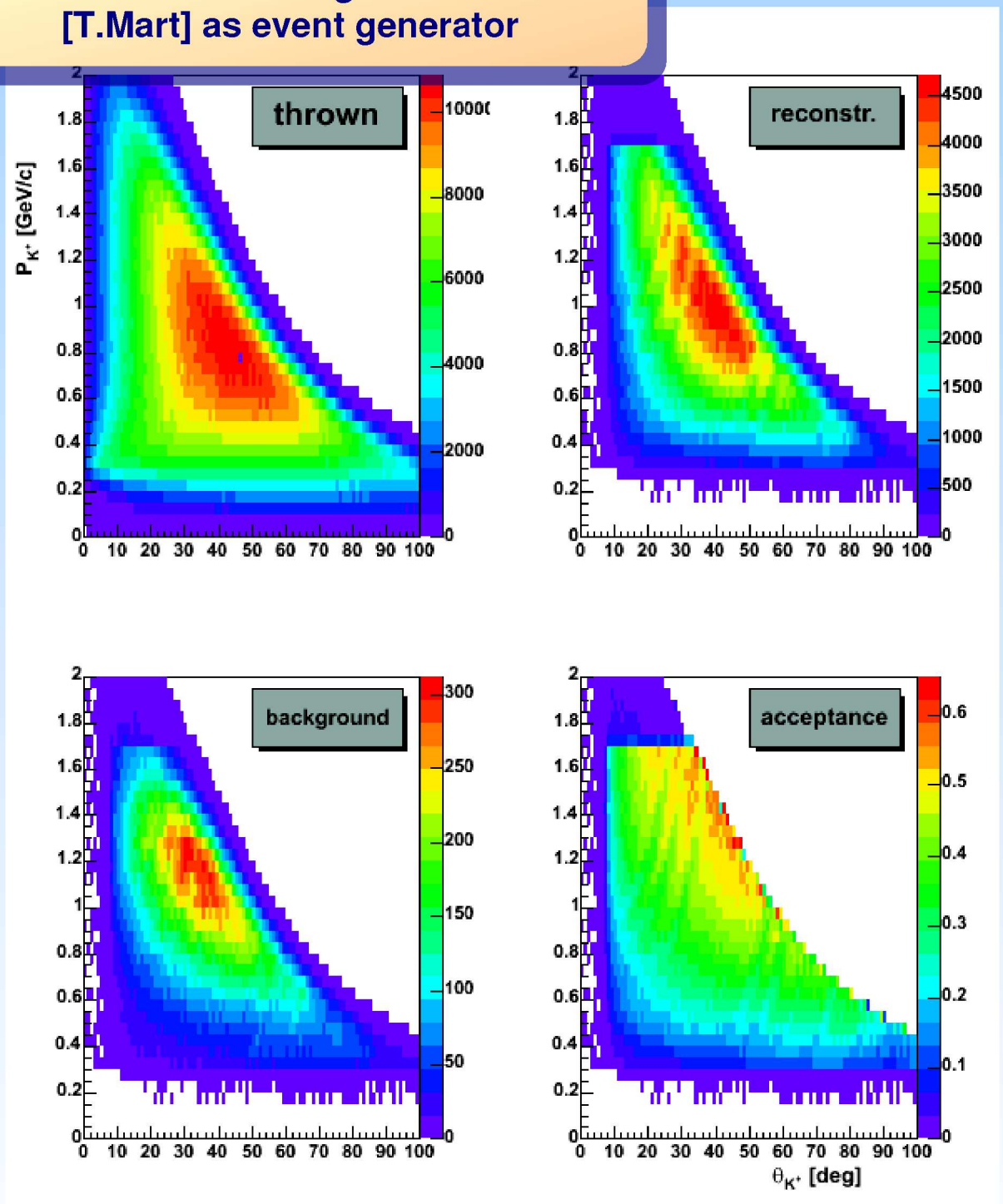
Background probability Method:

K^+ Acceptance / CM System



K^+ Efficiency / Lab System

MC-simulation using isobar model [T.Mart] as event generator



Strategy: unfolding Σ^0 / Σ^-

Smear Λ, Σ^0 photoproduction cross section measured off proton target [McNabb, Schumacher] by Fermi motion.

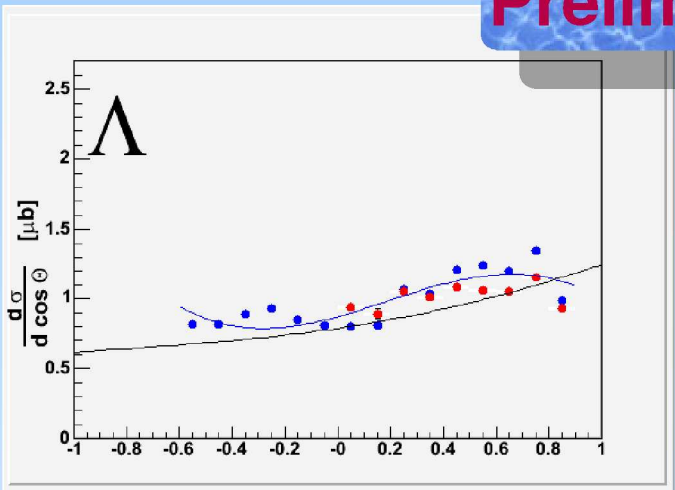
Apply phenomenological fit (Legendre Polynom) to get Σ^0 / Λ ratio

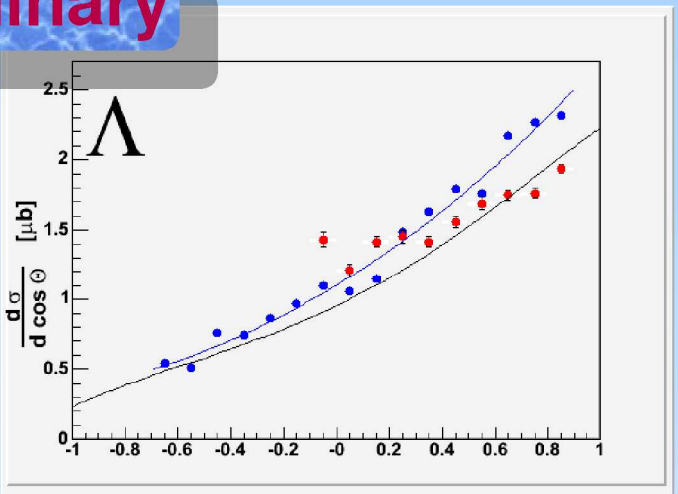
Use this ratio and our measured Λ cross section off deuteron target to calculate Σ^0 cross section

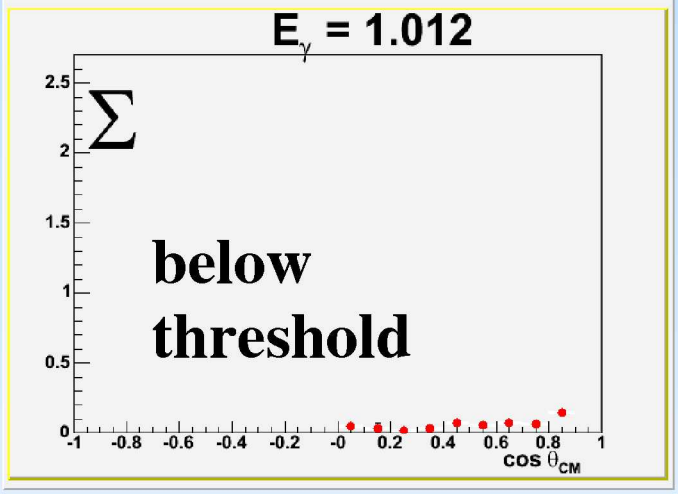
Subtract calculated Σ^0 cross section from our measured Σ_{TOTAL}

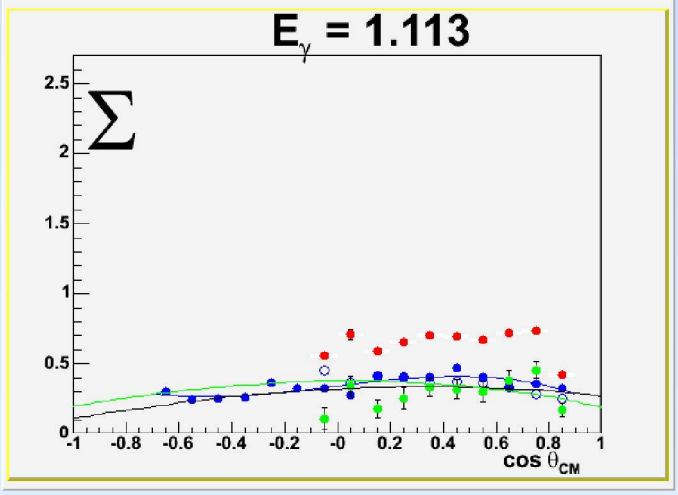
Differential Cross Section

Preliminary









Differential Cross Section

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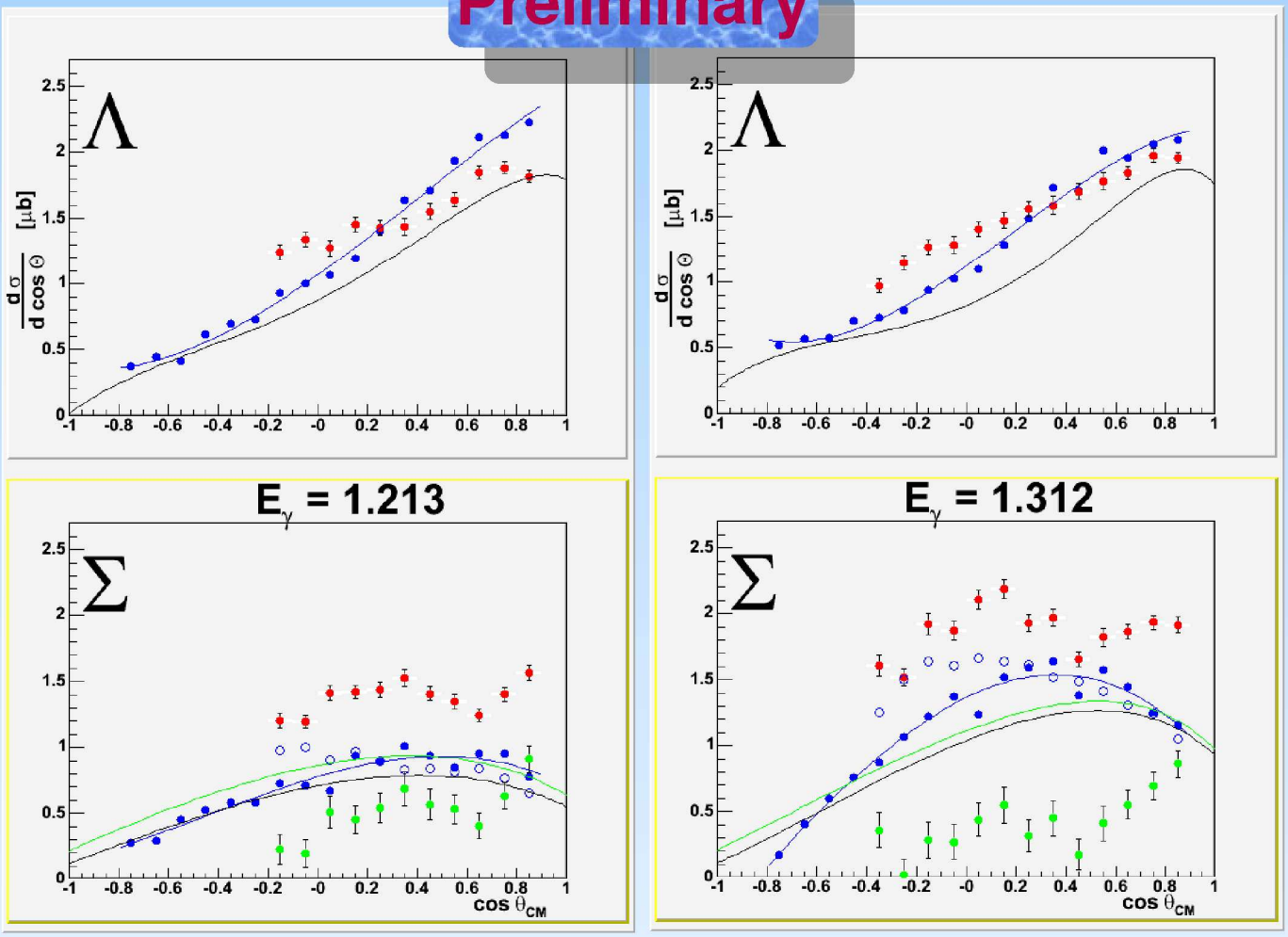


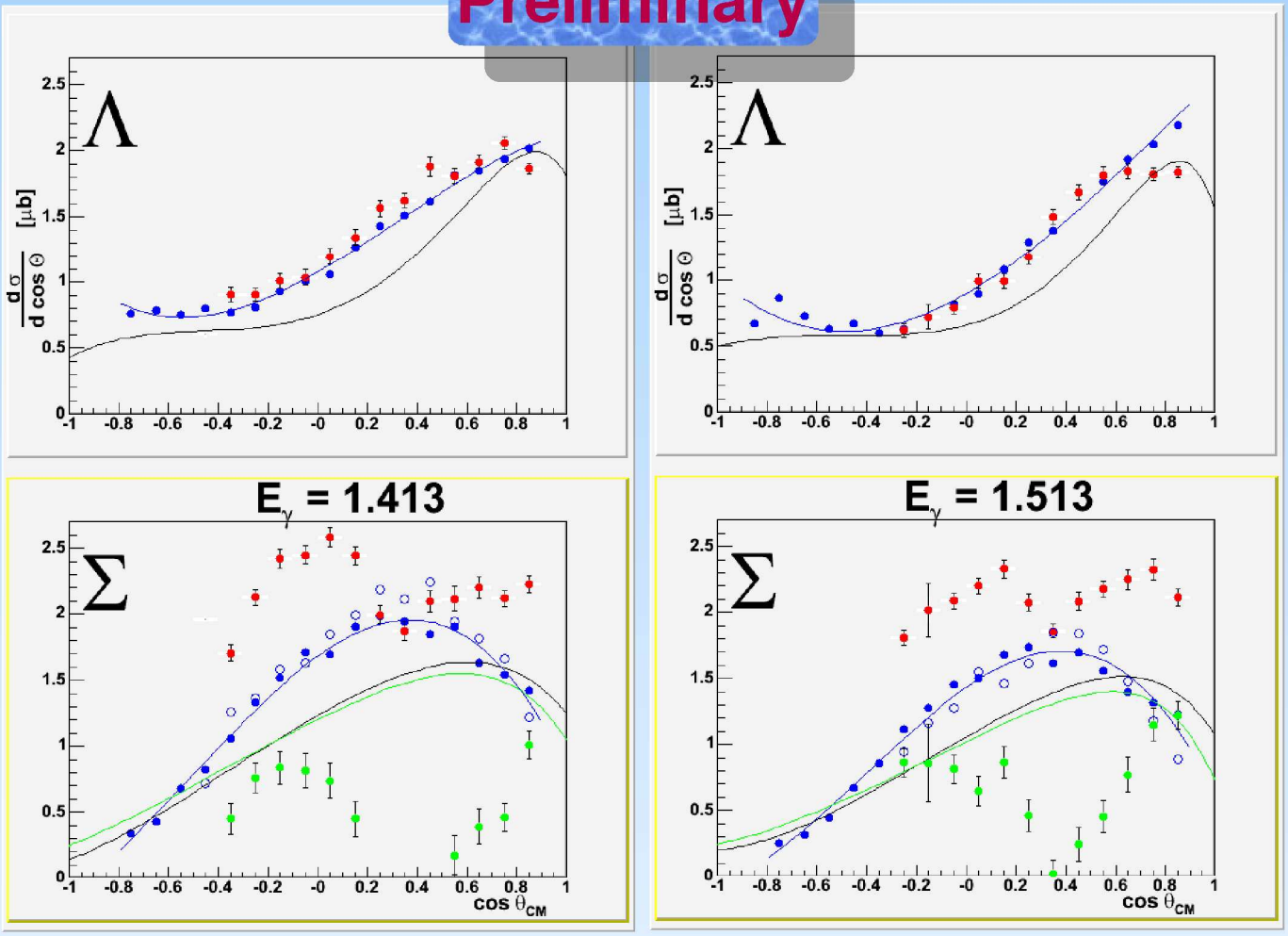
Our Analysis

Cross Section off Proton [McNabb, Schumacher]

After Sigma0 Subtraction

Differential Cross Section

Preliminary



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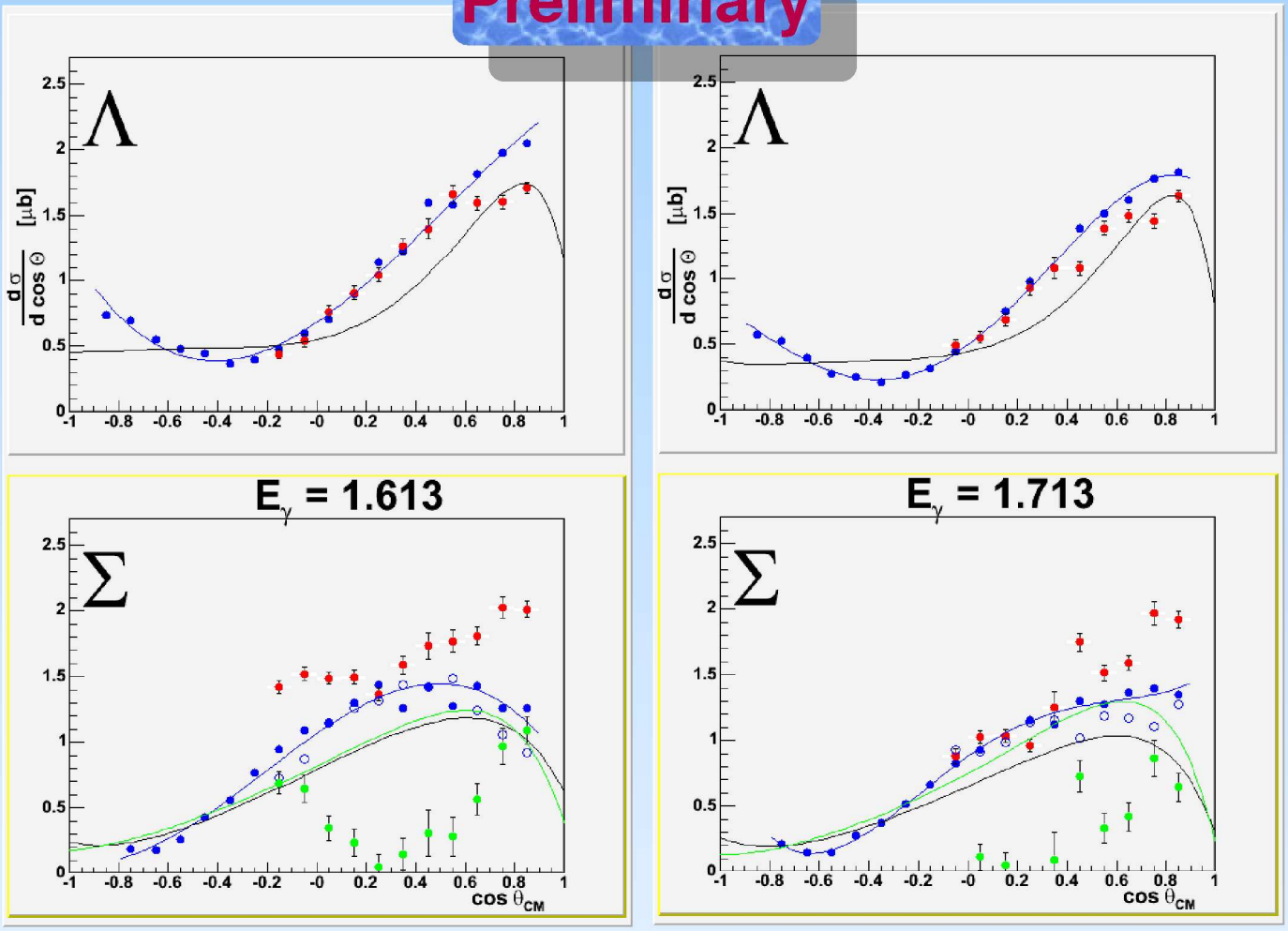

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Differential Cross Section

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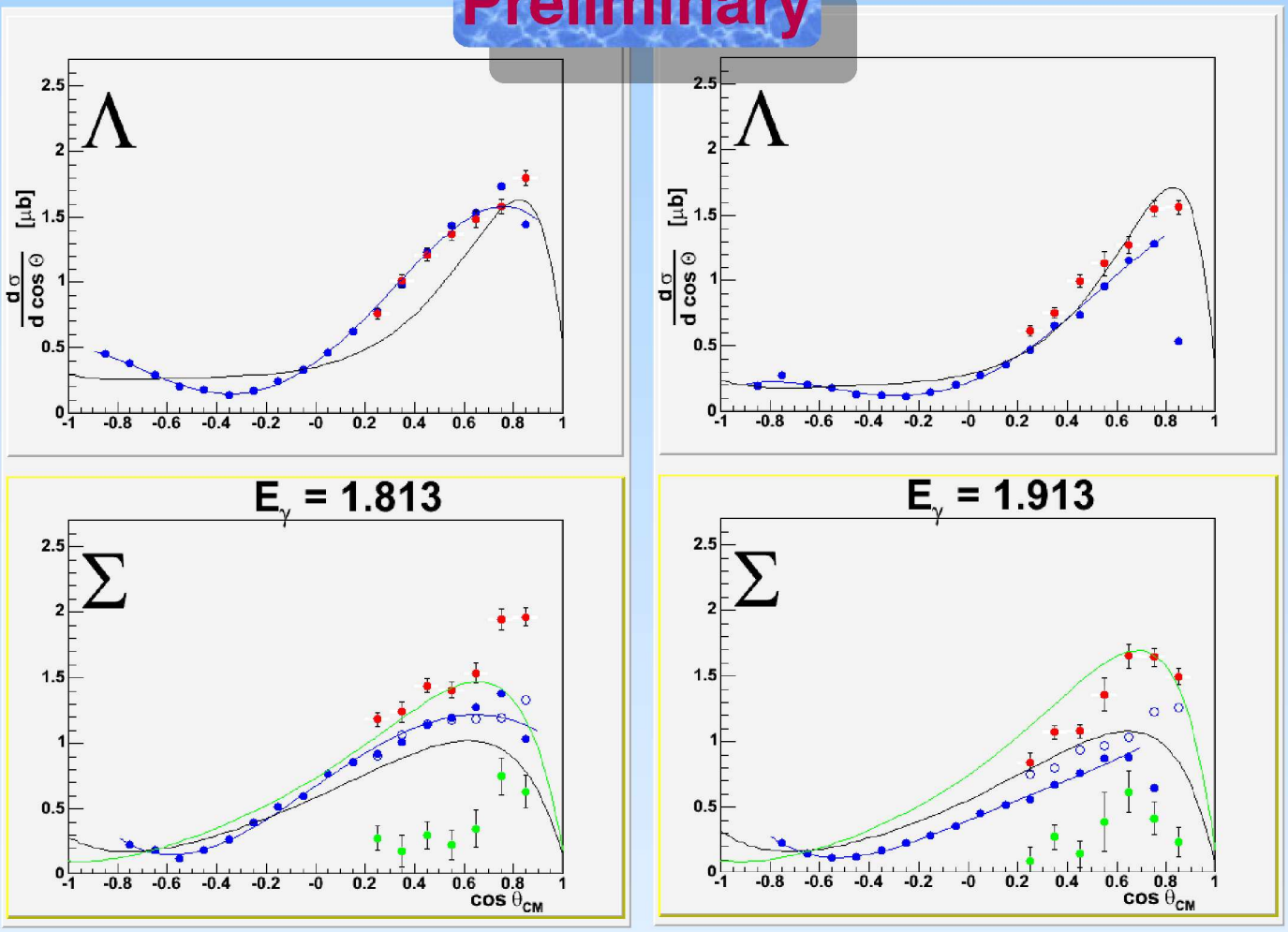

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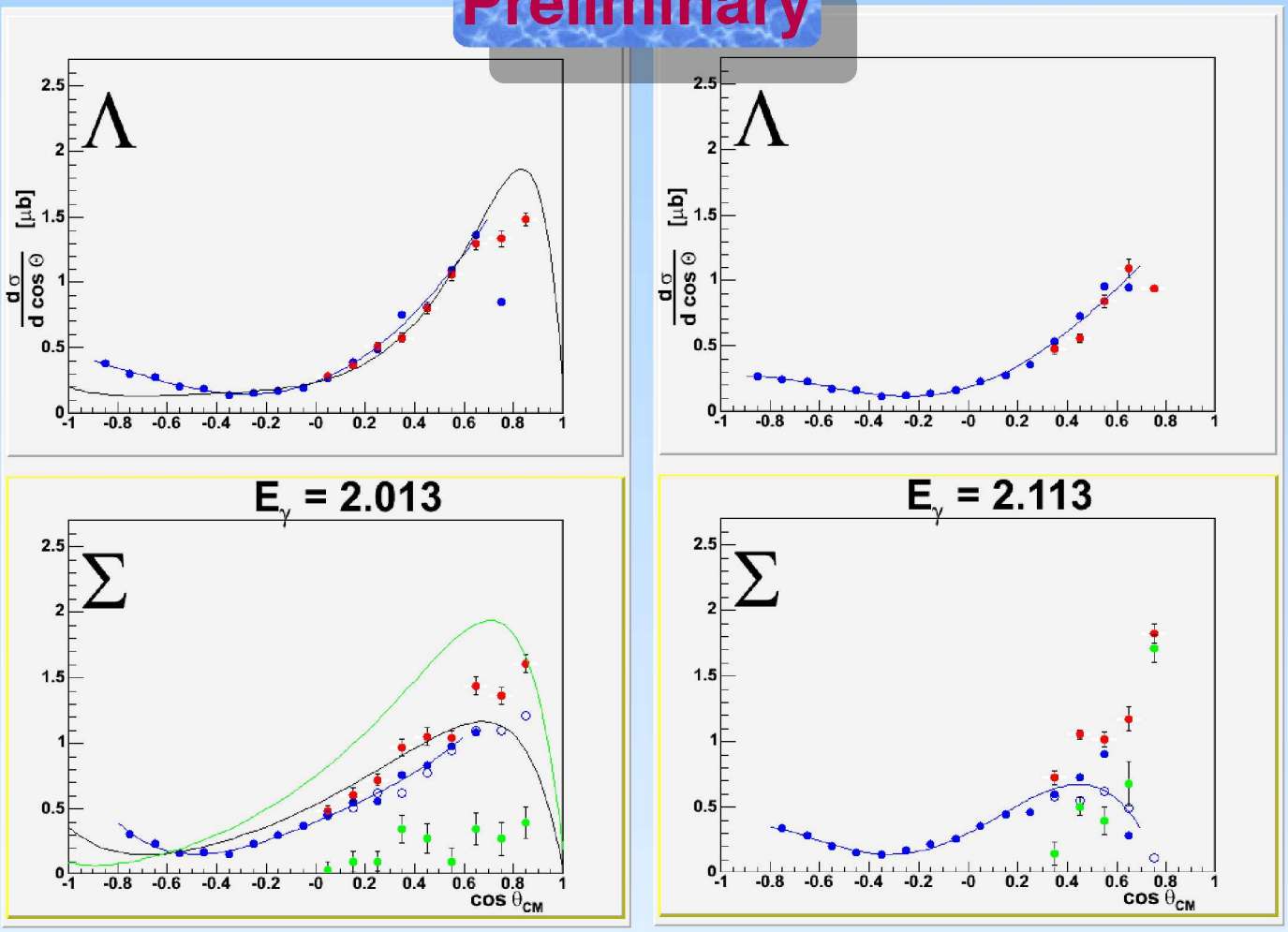
After Sigma0 Subtraction

Differential Cross Section

Preliminary



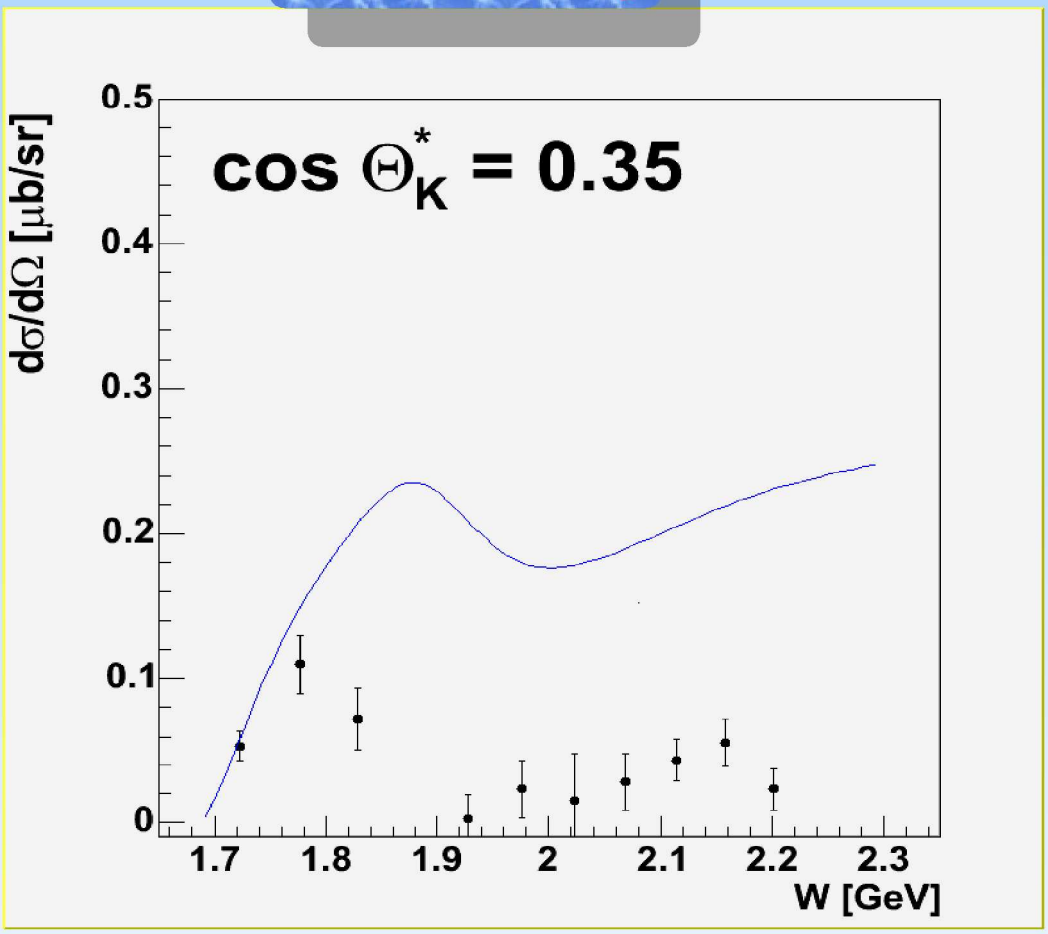
Our Analysis

Cross Section off Proton [McNabb, Schumacher]

After Sigma0 Subtraction

W dependence of results

Preliminary



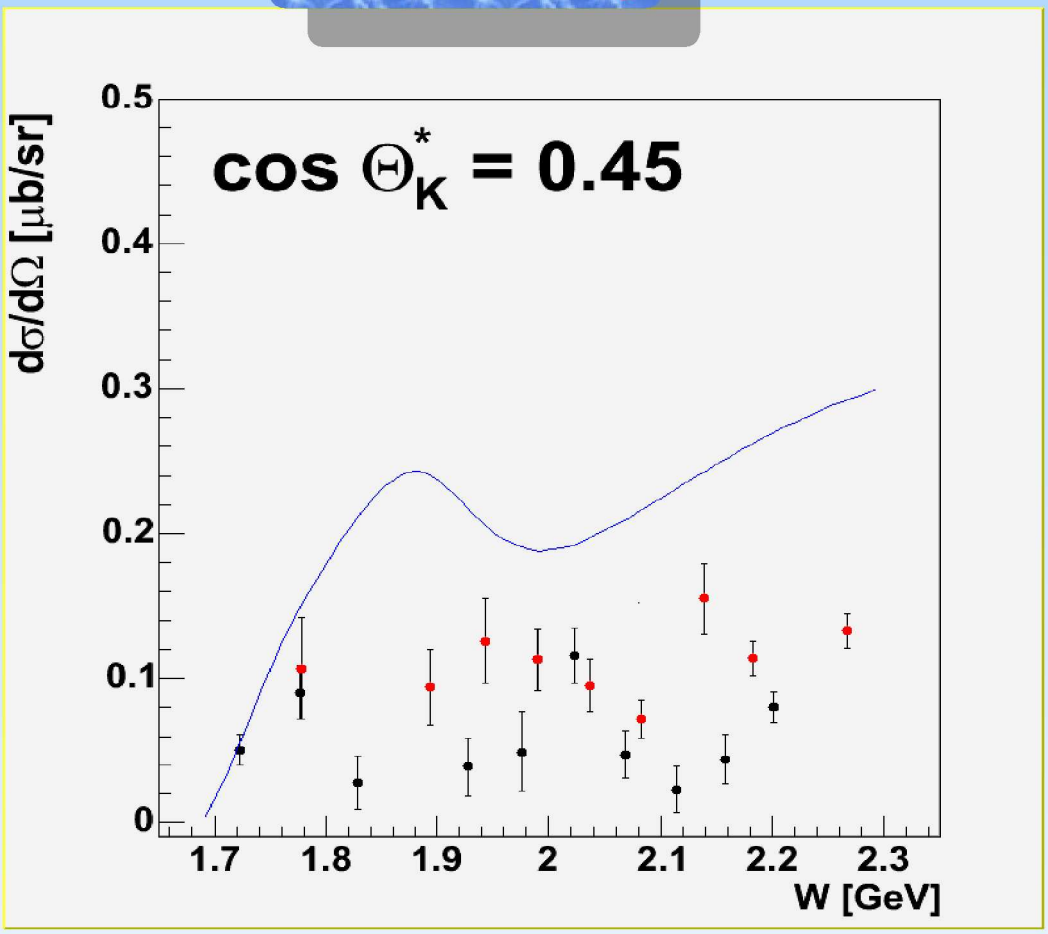
Σ^- after Σ^o subtraction

Results from exclusive analysis

Kaon MAID

W dependence of results

Preliminary



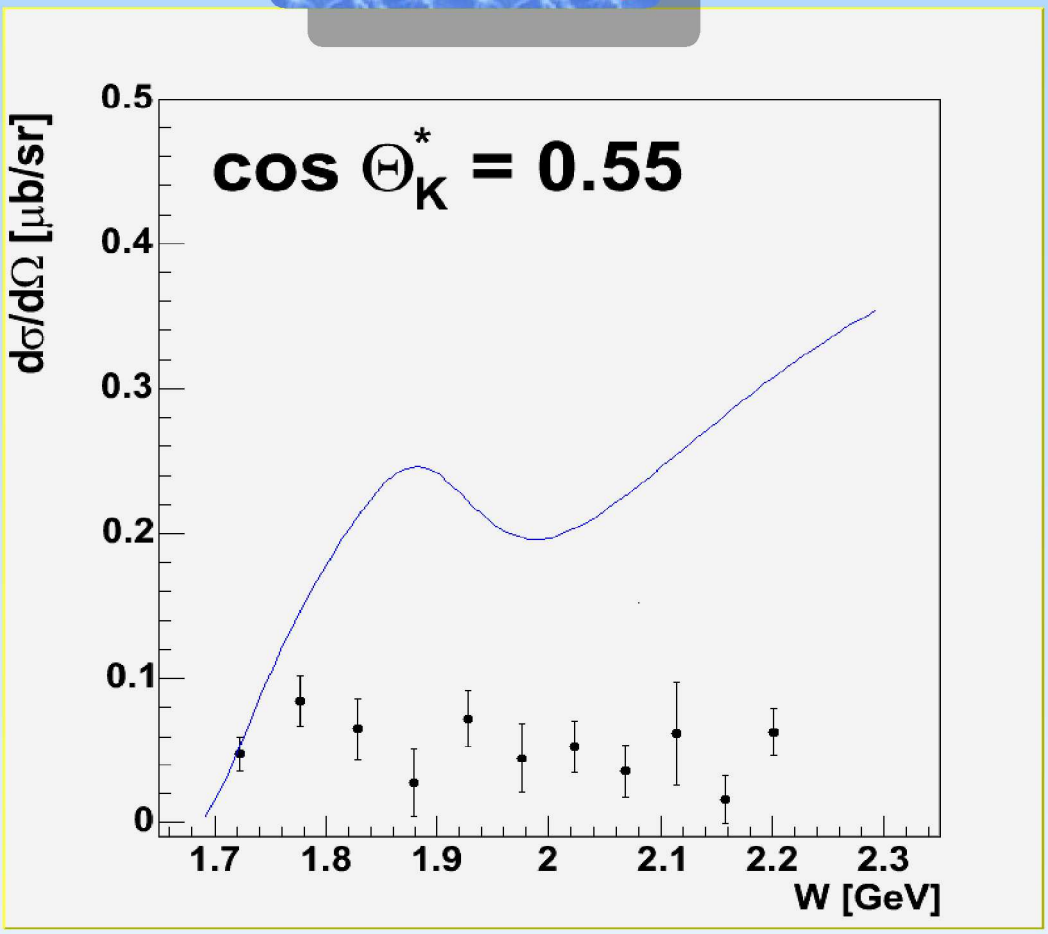
Σ^- after Σ^0 subtraction

Results from exclusive analysis

Kaon MAID

W dependence of results

Preliminary



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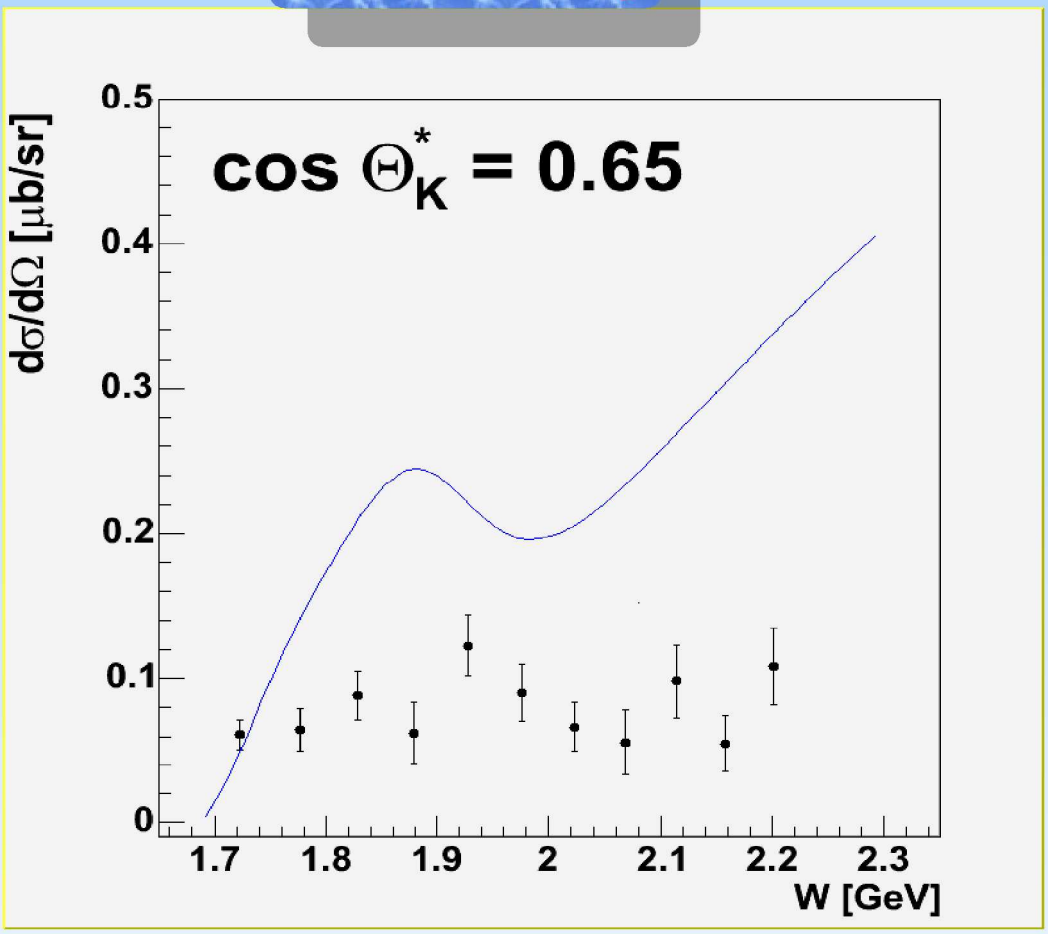
Kaon MAID

W dependence of results

Preliminary



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Results from exclusive analysis

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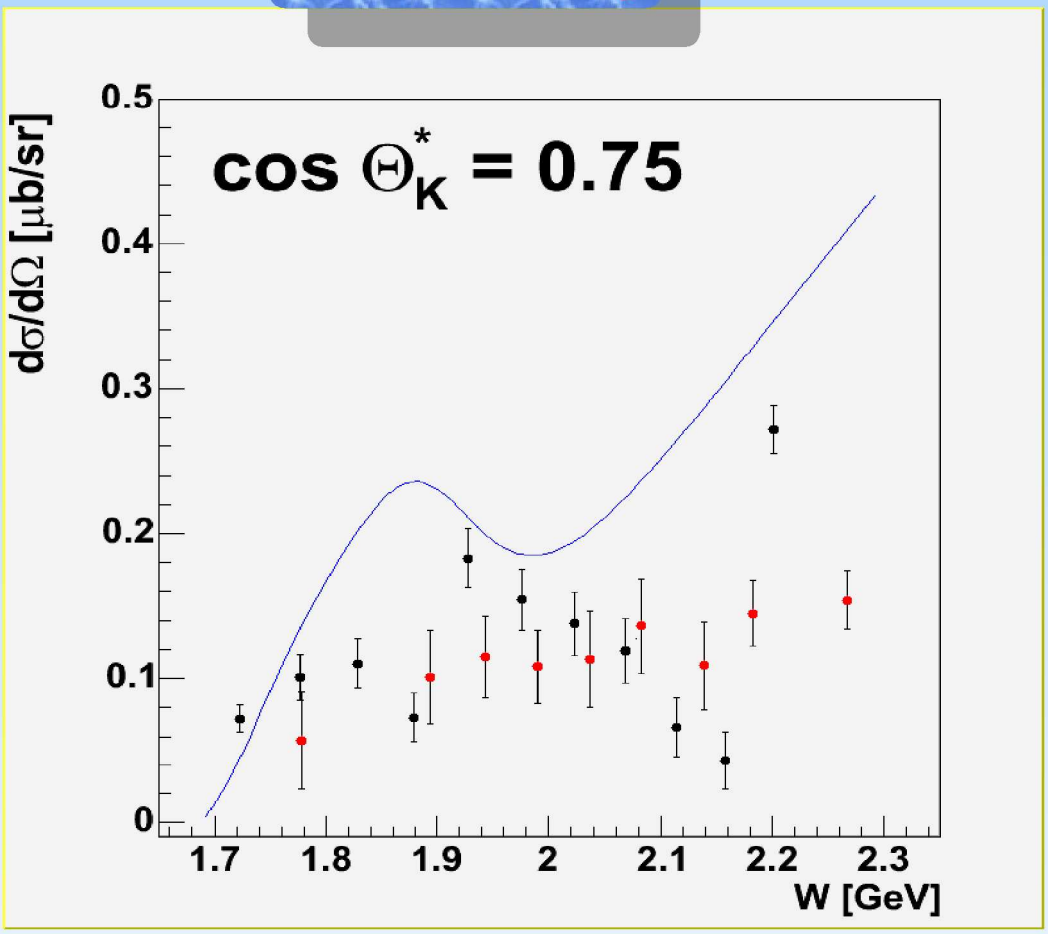
W dependence of results

Preliminary



Σ^- after Σ^0 subtraction

Results from exclusive analysis

Kaon MAID

Summary

Accomplished:

Robust, model independent analysis
Good/fair reproduction of Λ cross section
Surprising result for Σ^- cross section
- Σ^- cross section lower than expected
- cos Θ structure: minimum at 0.45

To do:

Compare exclusive and inclusive
Discuss systematic errors

Your suggestion goes here

Analysis review process