Analysis Update
Cross Section of the $\Xi^{-}(1320)$ Baryon in Electroproduction off of a Proton Target

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Outline

- Introduction & Motivation
- Experimental Equipment
- Methodology and Analysis
- Summary & Outlook

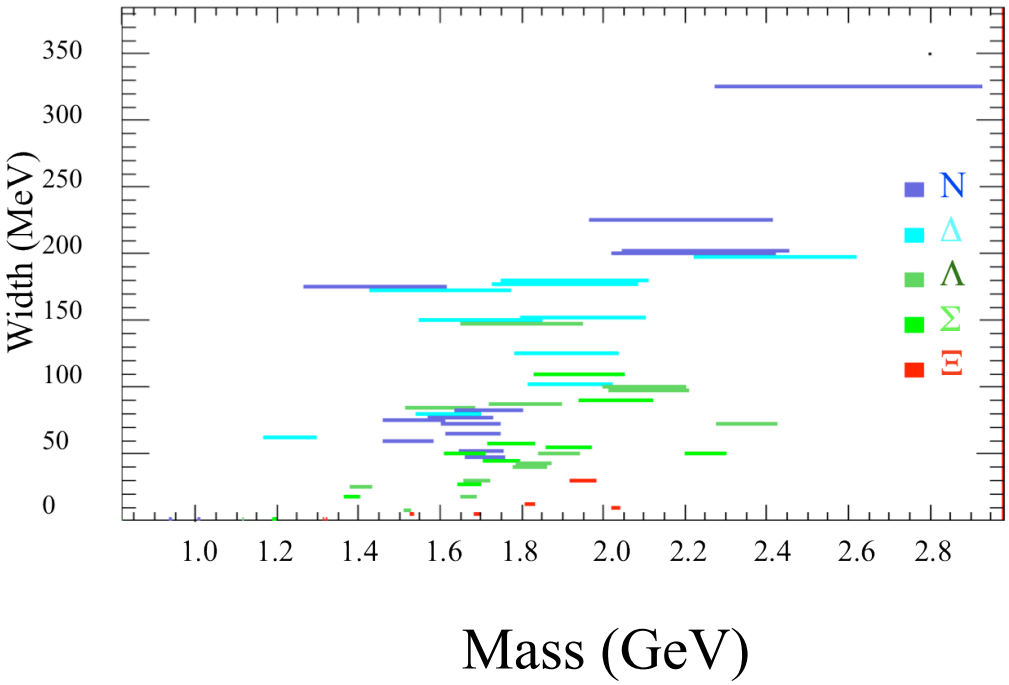
Motivation

- S. Capstick and N. Isgur, Phys. Rec. D 34, 2809 (1986) predicted 44 states
- Validate SU(3) flavor symmetry (there should be a Ξ^* for every N^* and Δ^*)
- Probe production mechanism
  - Starting from 0 strange quarks, producing Ξ^- which contains 2 strange quarks
  - Low cross section
- Stimulate future theoretical developments
  - Ξ's have been around ~50 years
  - Lack of theory

Motivation

The Book

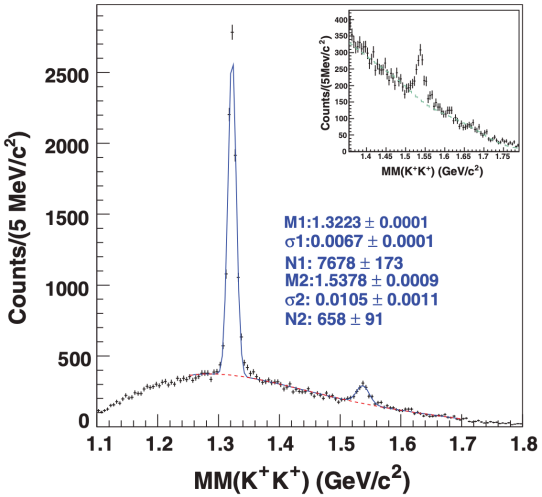
Particle	J^P	Overall status
$\Xi(1320)$	$\frac{1}{2}^+$	****
$\Xi(1530)$	$\frac{3}{2}^+$	****
$\Xi(1620)$		*
$\Xi(1690)$		***
$\Xi(1820)$	$\frac{3}{2}^-$	***
$\Xi(1950)$		***
$\Xi(2030)$	$\frac{5}{2}^?$	***
$\Xi(2120)$		*
$\Xi(2250)$		**
$\Xi(2370)$		**
$\Xi(2500)$		*

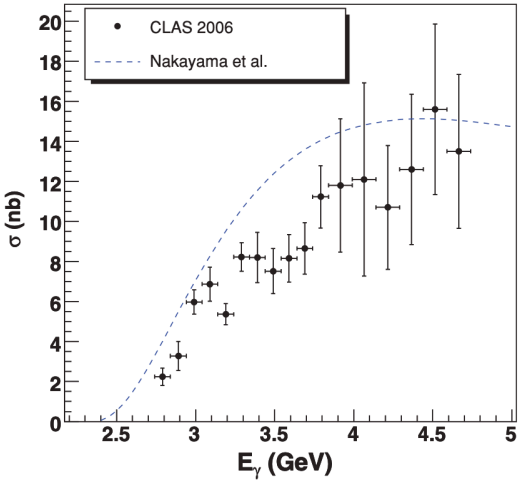


Plot from Dr. Lei Guo, Reimei 2016

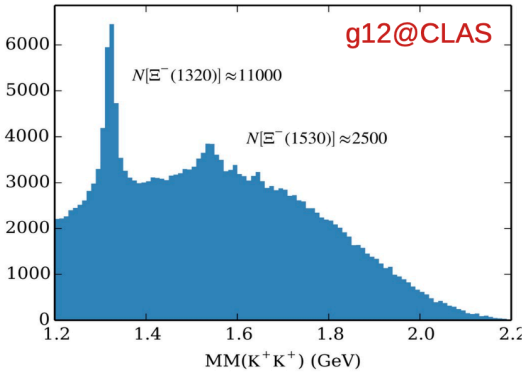
Previous Work on Ξ's

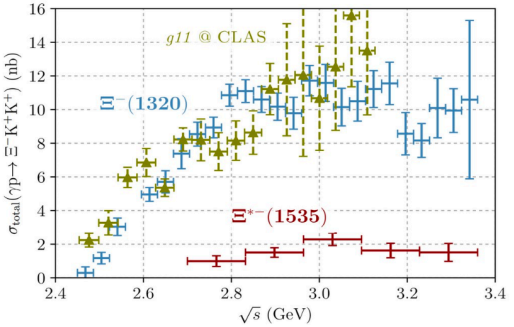
Ξ^- cross section in photoproduction





Guo et al, Phys.Rev.C76:025208 (2007)





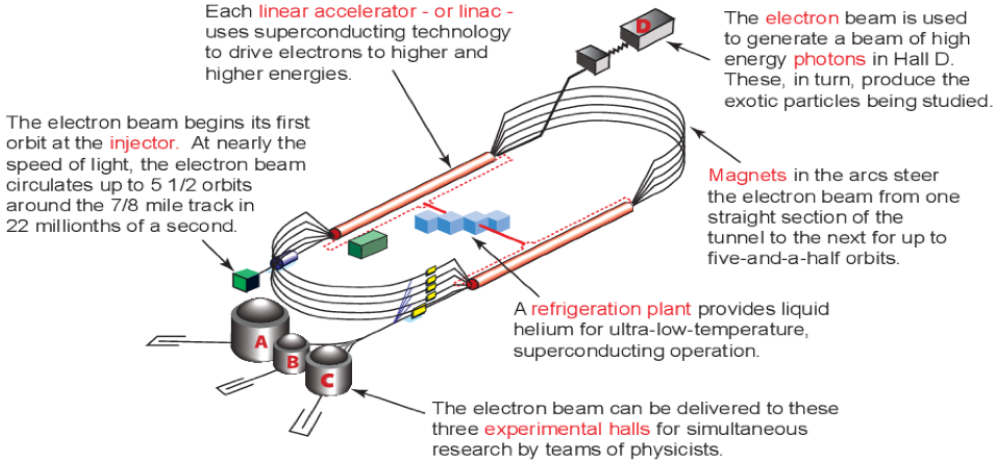
J. T. Goetz et al. Phys. Rev. C 98, 062201 (2018)

Jefferson Lab

How CEBAF Works

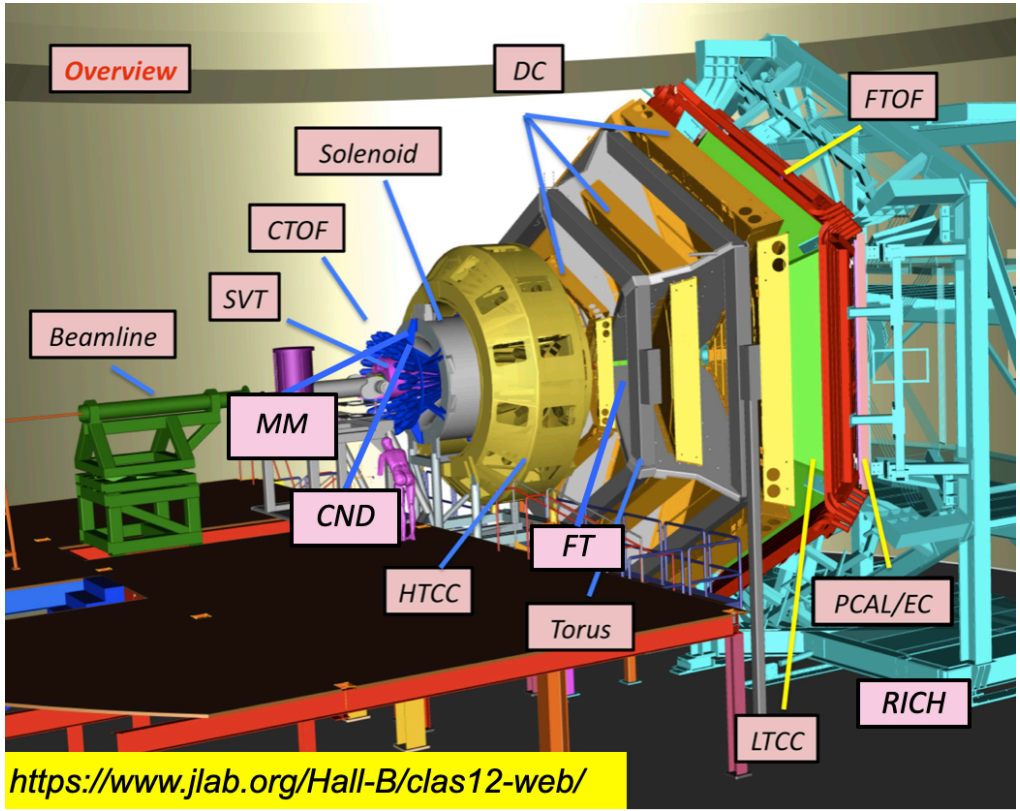
The Continuous Electron Beam Accelerator Facility

Jefferson Lab
Find out more at www.jlab.org

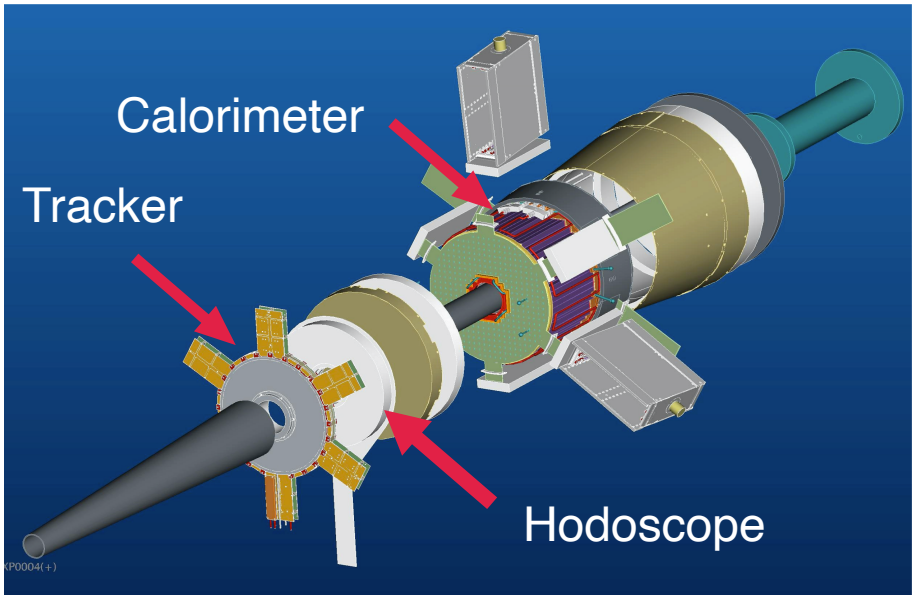


CLAS12 Detector in Hall B

- Forward Detector
  - HT Cherenkov Counter
  - Drift Chambers
  - Torus Magnet
  - LT Cherenkov Counter
  - Ring_imaging Cherenkov
  - Time of Flight Detector
  - EM calorimeters
- Central Detector
  - Silicon Vertex tracker
  - Time of flight
  - Muon Vertex tracker
  - Central Neutron Detector
  - Solenoid Magnet
- Forward Tagger



Forward Tagger



FT Technical Design

$E_{e'}$	$0.5 - 4.5$ GeV
$\theta_{e'}$	$2.5° - 4.5°$
$\phi_{e'}$	$0° - 360°$
E_γ	$6.5 - 10.5$ GeV
P_γ	$70 - 10$ %
Q^2	$0.01 - 0.3$ GeV^2 ($< Q^2 > 0.1 GeV^2$)
W	$3.6 - 4.5$ GeV

- FT_Cal: Homogeneous Lead Tungstate ($PbWO_4$) crystals that measure the electromagnetic shower and provide a fast trigger signal
- FT-Hodo: Scintillator counter that provides e/γ separation
- FT-trck : Micromegas detector measure the scattering angle

Data and Status

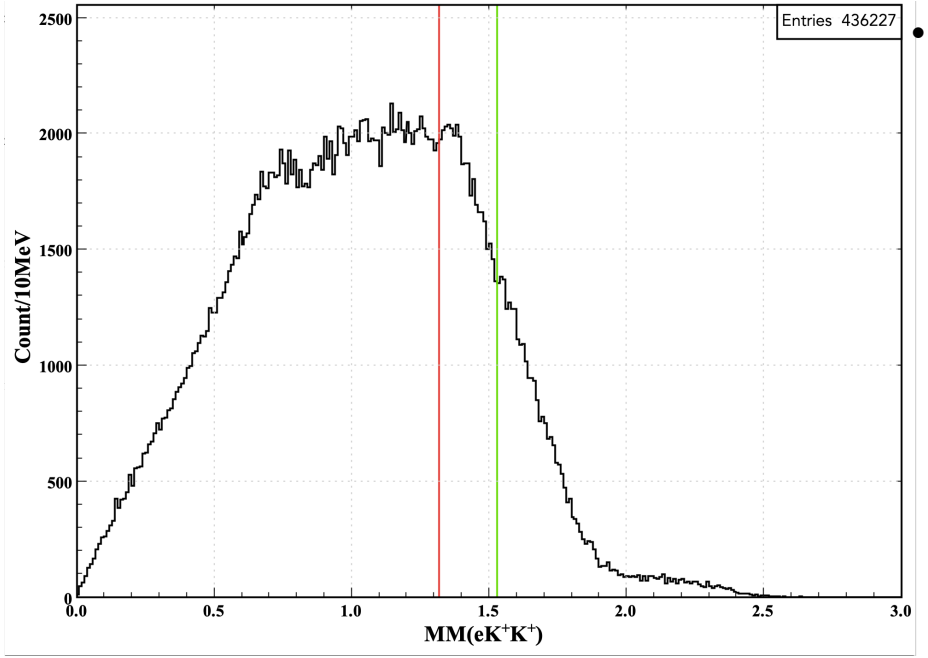
- Run Groups:
  - RGA
    - Ran from Spring 2018 - Spring 2019 (energy 10.2 / 10.6 GeV)
    - Both inbending and outbending Torus polarity
  - RGK (12% data collected)
    - Fall 2018 (energy 6.535 GeV / 7.546 GeV)
    - Outbending only

Status : Event Selection

- RGK with FT on (7546 MeV)
  - Require e^- in FT, and 2 K^+ in FD.
- RGK with FT off (6535 MeV)
  - Require e^- in FD, and 2 K^+ in FD.

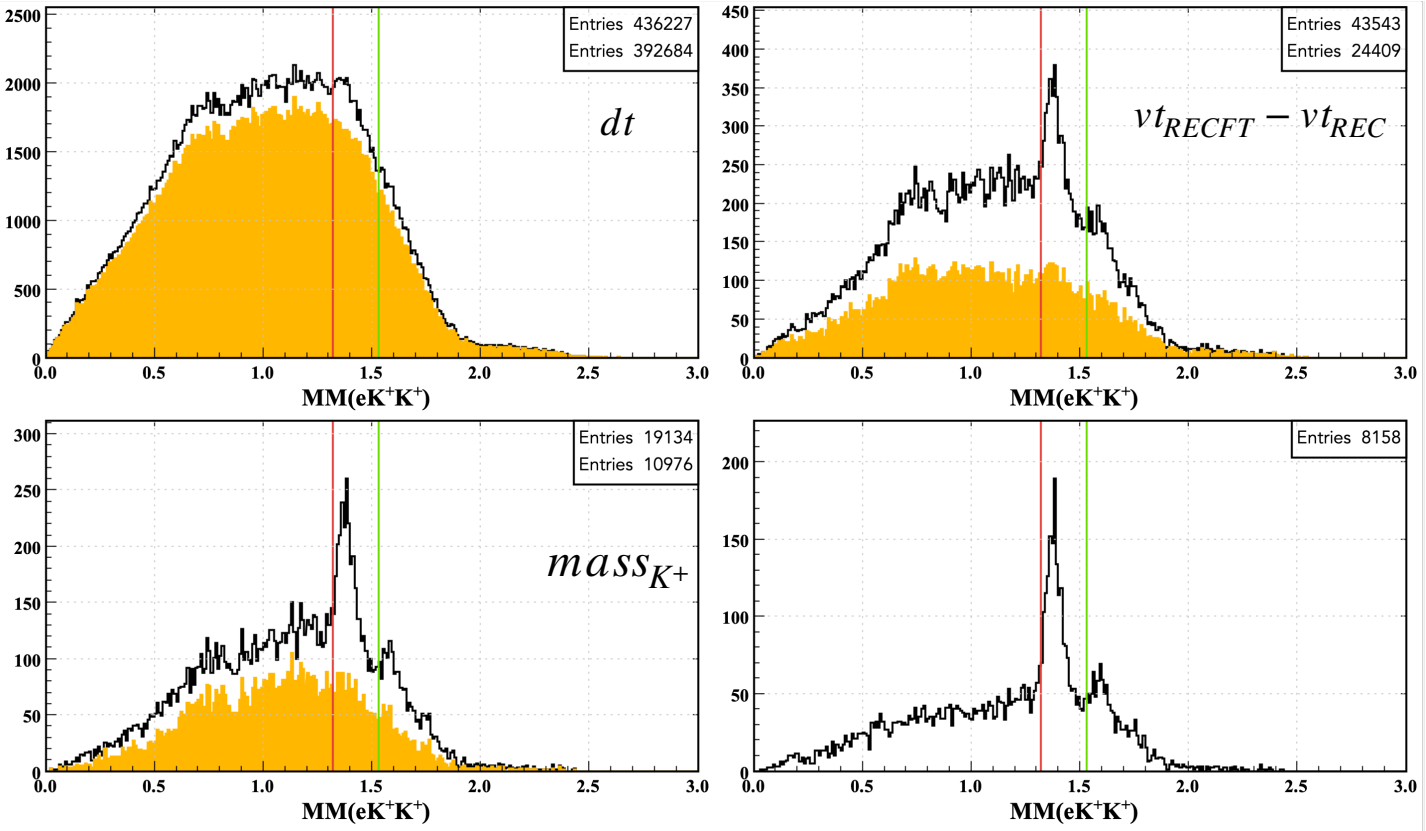
- $MM(e'K^+K^+)$: Missing mass in the $ep \rightarrow eK^+K^+X$ reaction
  - Looking for Ξ^- s (ground and excited states)

Data with no cuts (RGK e’ in FT)



- Find Cuts that improve signal to background ratio:
  - -10 < vz < 1 (cm)
  - -1.0 < dt < 1.0 (ns)
  - -1.0 < dt_vt < 1.0 (ns)
  - -1.0 < RECFT_vt - REC_vt < 1.0 (ns)
  - 0.45 < m < 0.53 (GeV)
  - Fiducial Cuts

Results of Cuts on data



Energy Correction for the electron in FT

FT ad-hoc energy correction

- Simple reaction with the scattered electron in FT
  - $ep \rightarrow e'p\pi^+\pi^-$
- Treat the scattered electron as a missed particle I.e.
- Using the four-momentum of the missing particle to calibrate the detected electron

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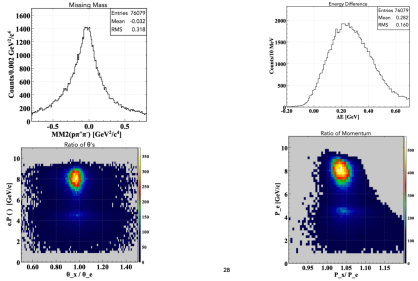
Event Selection and Methodology



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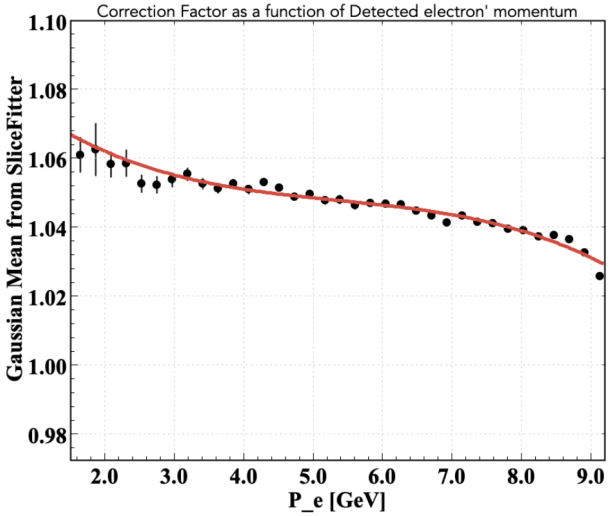
Correction Factors



- Fit (any) empirical Function
  - Constant
  - Linear
  - Higher Order Polynomials
  - Rational
  - Etc

$$CF = 1.0888 - 0.0189 * P_e + 0.0031 * P_e^2 - 0.0002 * P_e^3$$

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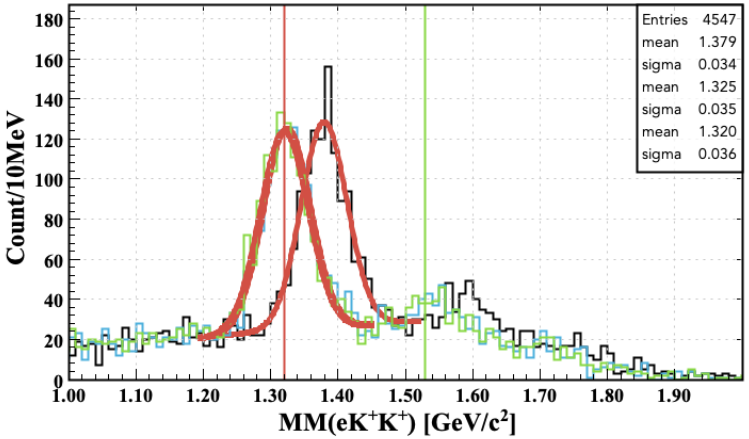
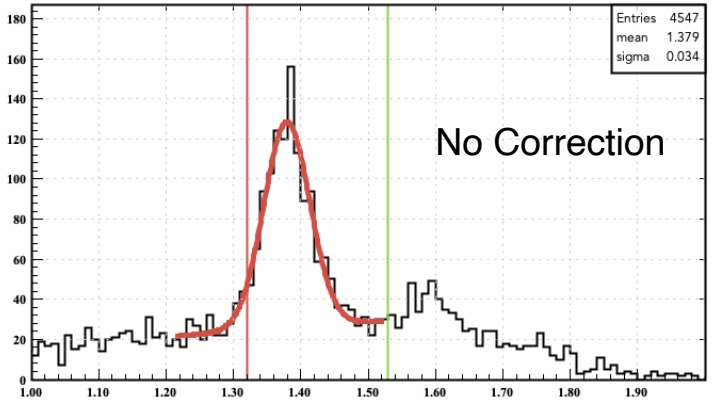
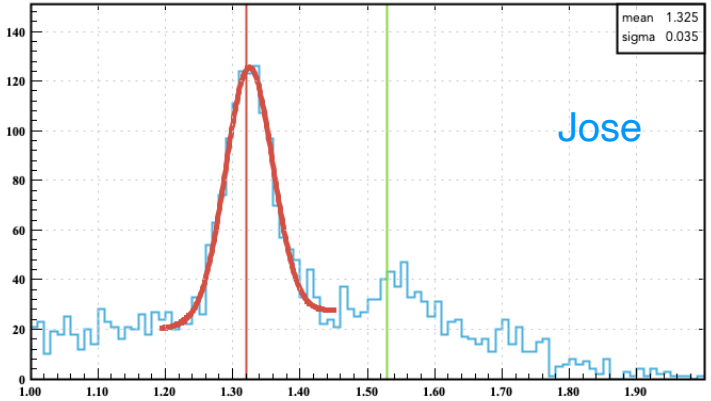
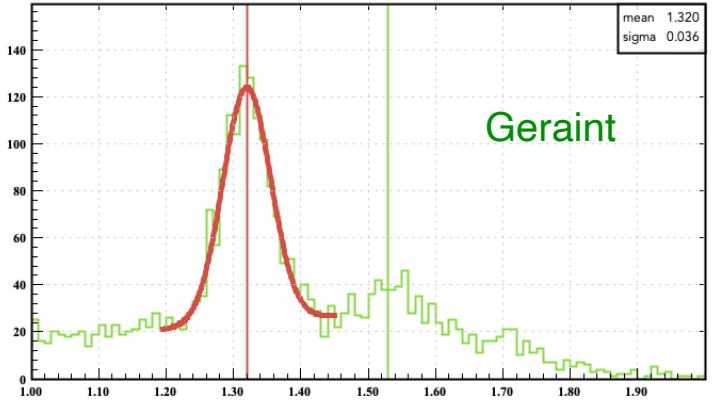
Energy Correction for the electron in FT

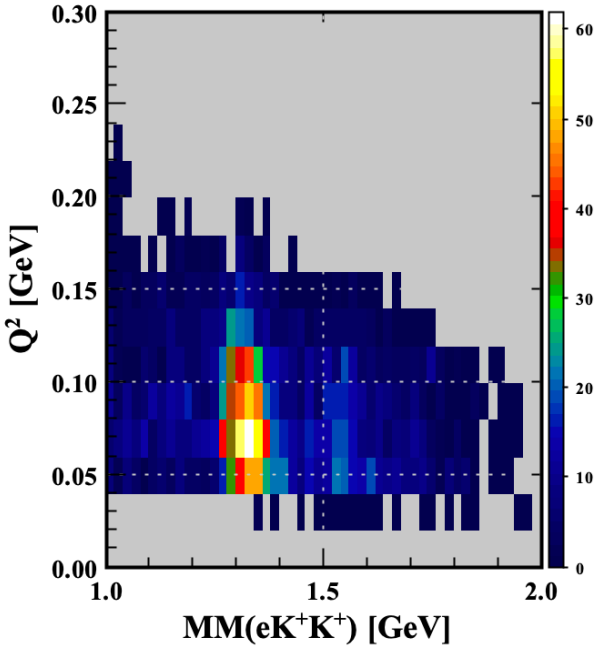


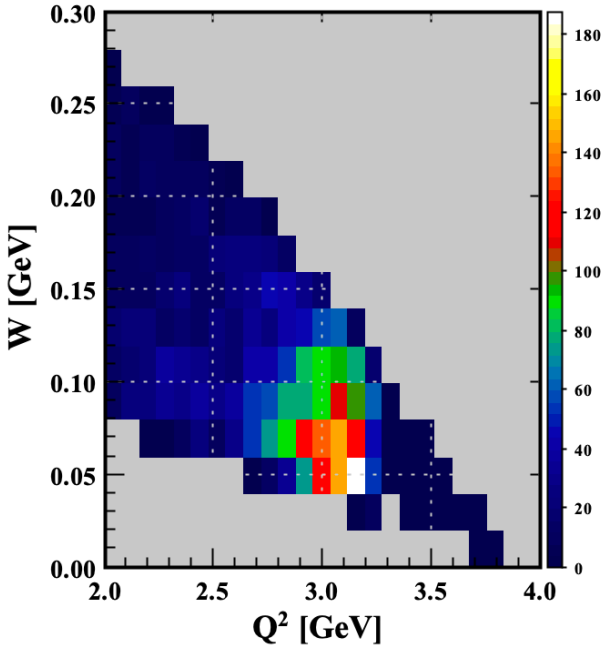


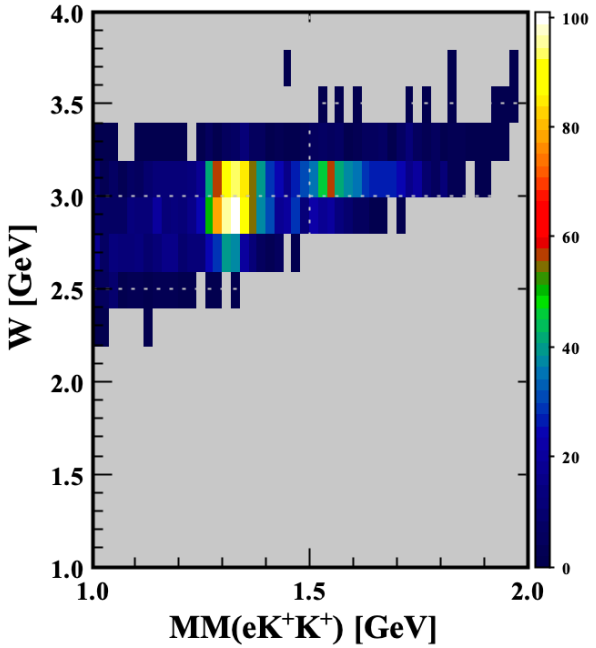




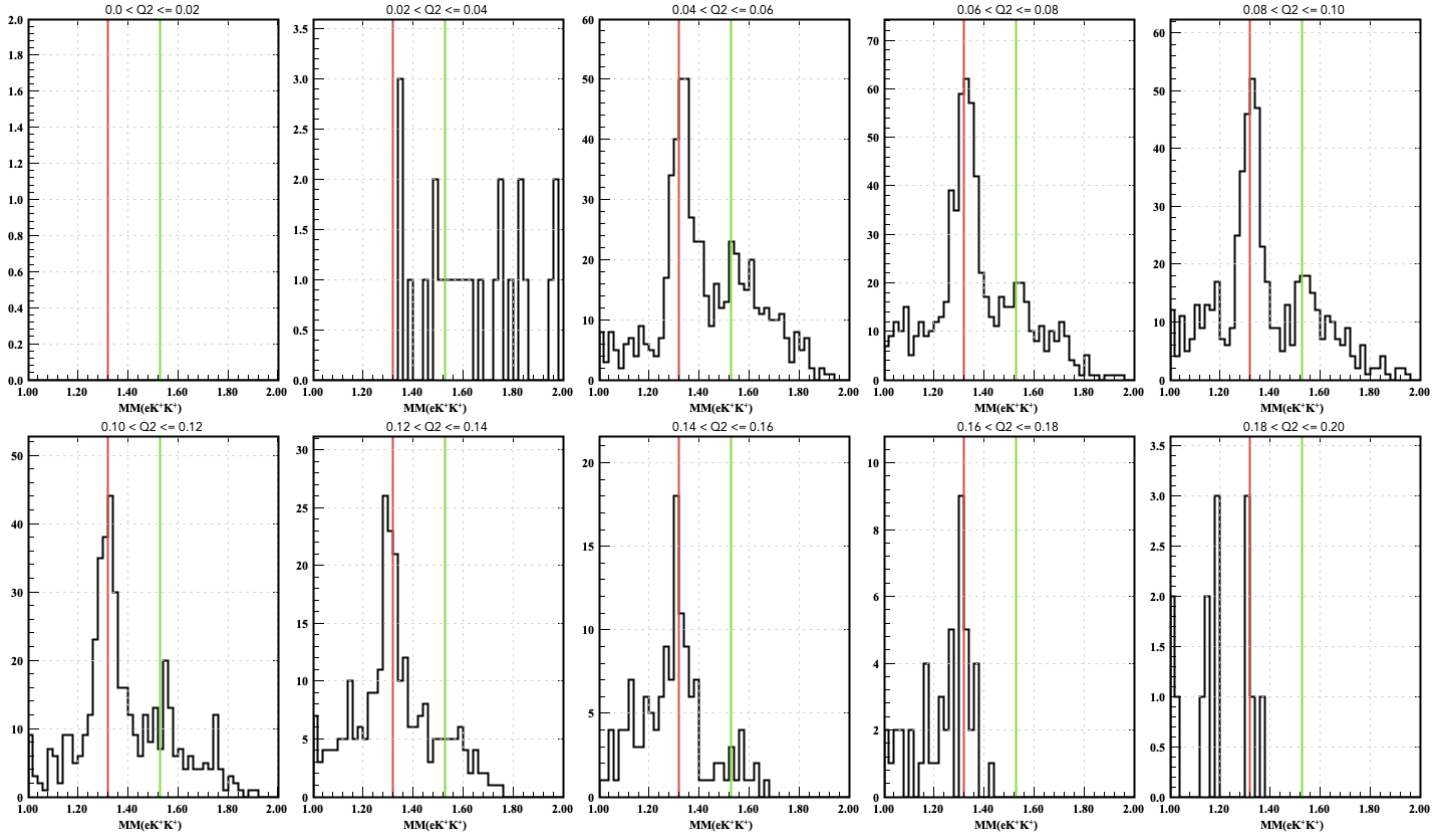
FT electron


0.30
0.25
0.20
0.15
0.10
0.05
0.00
Q^2 [GeV]
1.0
1.5
2.0
$MM(eK^+K^+)$ [GeV]
60
50
40
30
20
10
0

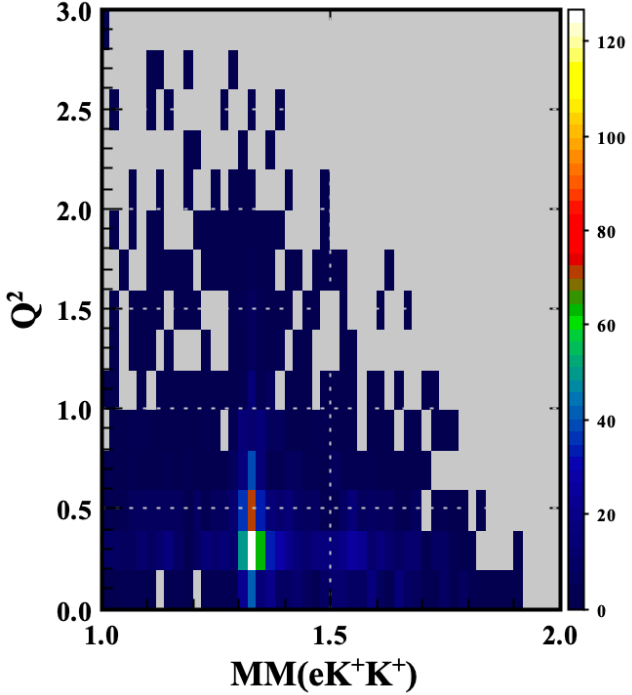

0.30
0.25
0.20
0.15
0.10
0.05
0.00
W [GeV]
2.0
2.5
3.0
3.5
4.0
Q^2 [GeV]
180
160
140
120
100
80
60
40
20
0

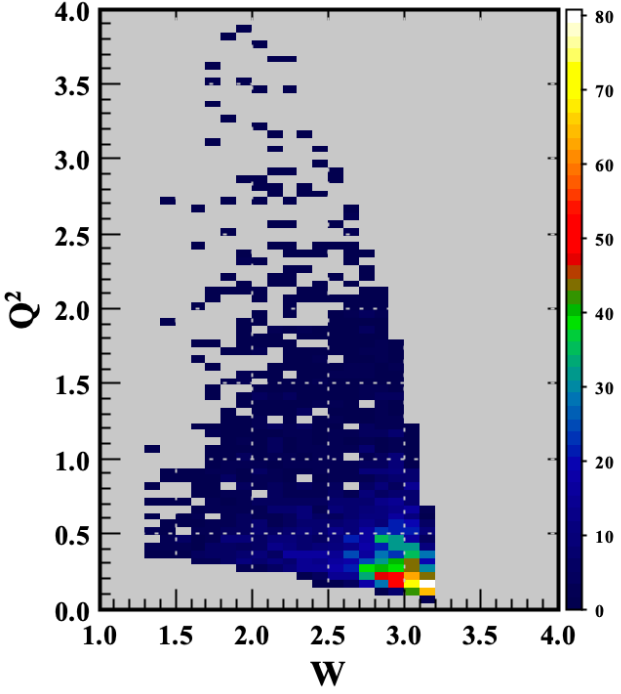

4.0
3.5
3.0
2.5
2.0
1.5
1.0
W [GeV]
1.0
1.5
2.0
$MM(eK^+K^+)$ [GeV]
100
80
60
40
20
0

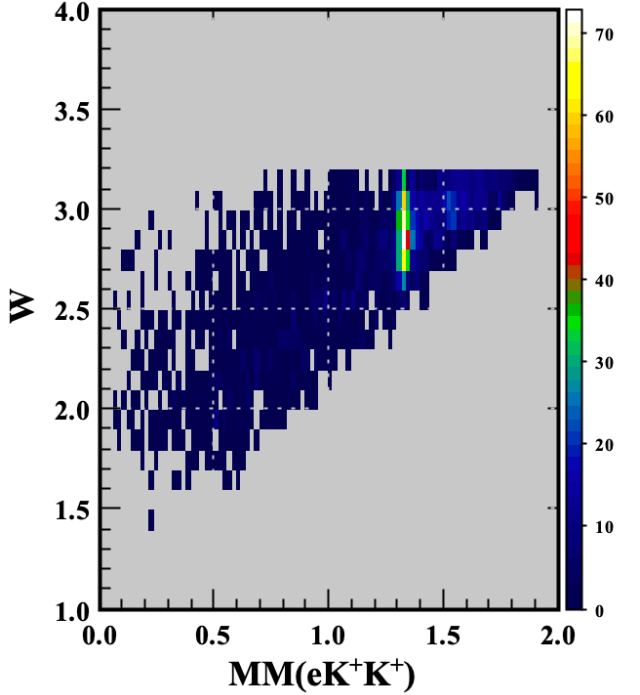
Q^2 plots


0.0 < Q2 <= 0.02
0.02 < Q2 <= 0.04
0.04 < Q2 <= 0.06
0.06 < Q2 <= 0.08
0.08 < Q2 <= 0.10
0.10 < Q2 <= 0.12
0.12 < Q2 <= 0.14
0.14 < Q2 <= 0.16
0.16 < Q2 <= 0.18
0.18 < Q2 <= 0.20
MM(eK⁺K⁺)
Counts/ 10 MeV

FD electron

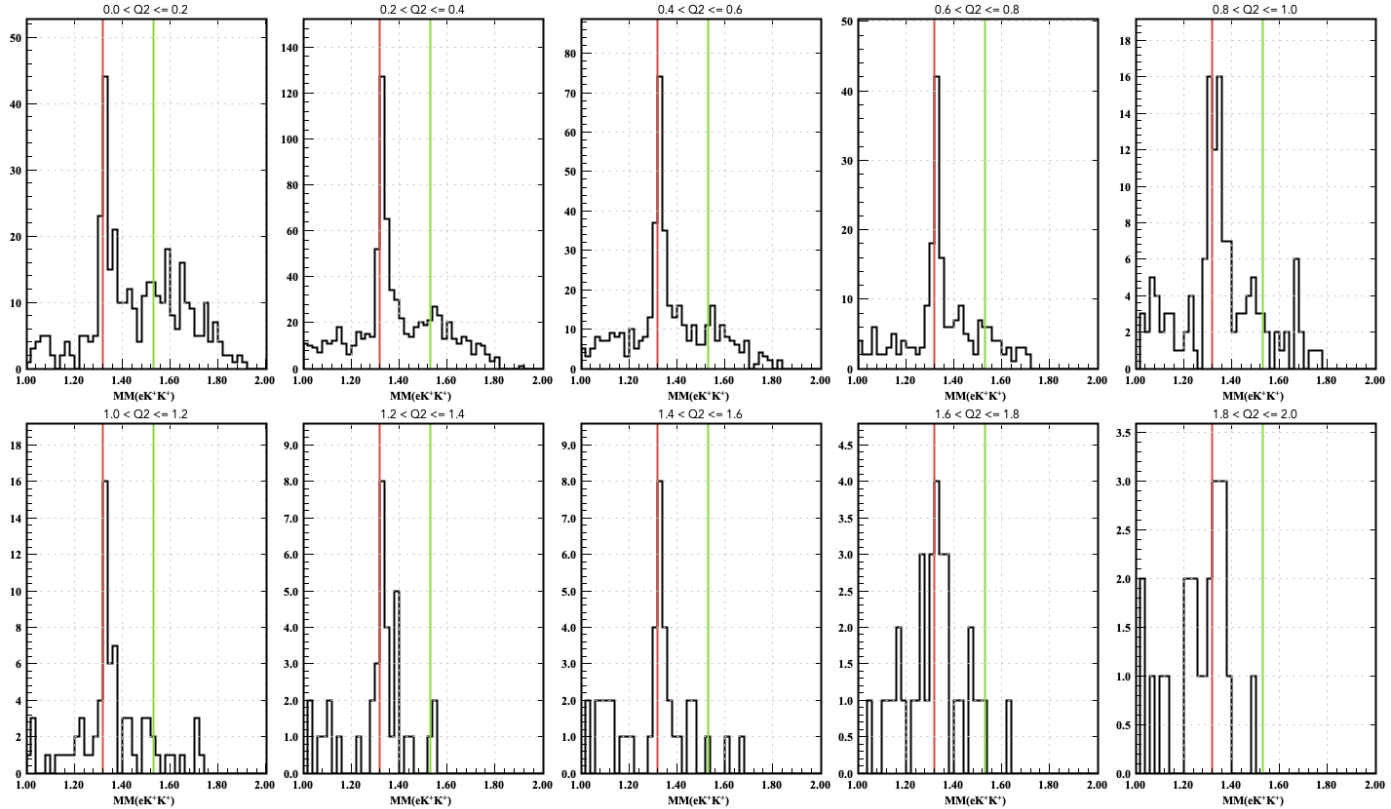

3.0
2.5
2.0
1.5
1.0
0.5
0.0
Q^2
1.0
1.5
2.0
MM(eK⁺K⁺)
120
100
80
60
40
20
0


4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Q^2
1.0
1.5
2.0
2.5
3.0
3.5
4.0
W
80
70
60
50
40
30
20
10
0


4.0
3.5
3.0
2.5
2.0
1.5
1.0
W
0.0
0.5
1.0
1.5
2.0
MM(eK⁺K⁺)
70
60
50
40
30
20
10
0

Q^2 plots

Counts/ 10 MeV



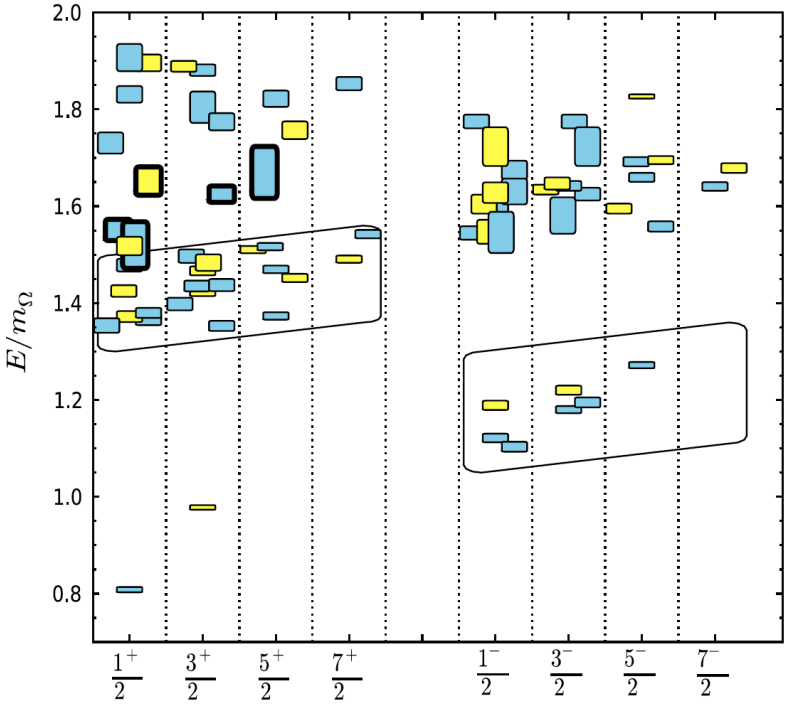
Outlook

- Generate (more) Monte Carlo Data
- Study Detector response and efficiency
- Extract Corrected Yield
- Extract Cross Sections as a function of Q2
- Error Analysis

Questions

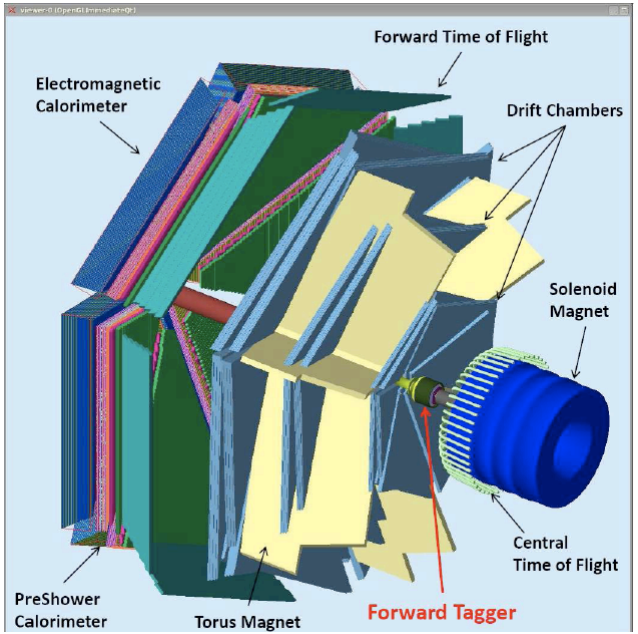
Backup Slides

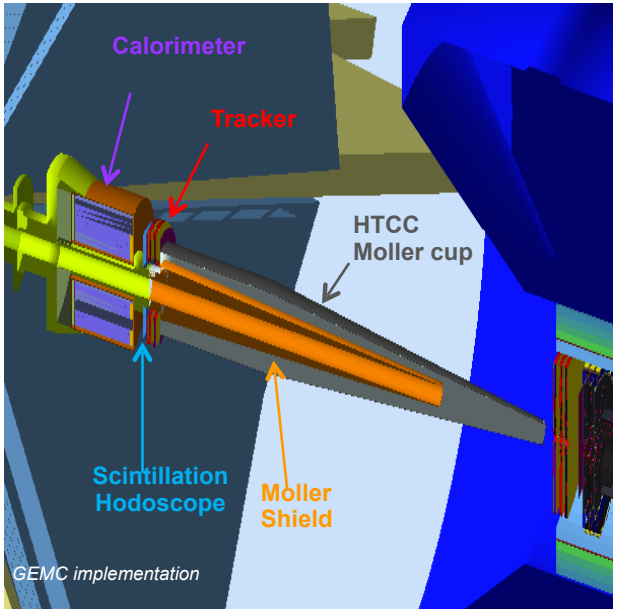
LQCD calculation for the Ξ and Ω spectra



R. Edwards *et al.* "Flavor structure of the excited baryon spectra from lattice QCD",PRD 87, 054506(2013)

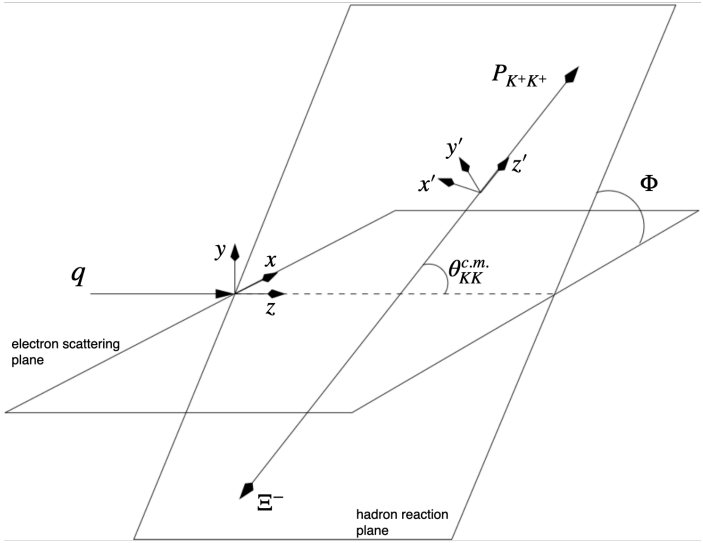
CLAS12 E12-11-005A with Forward Tagger



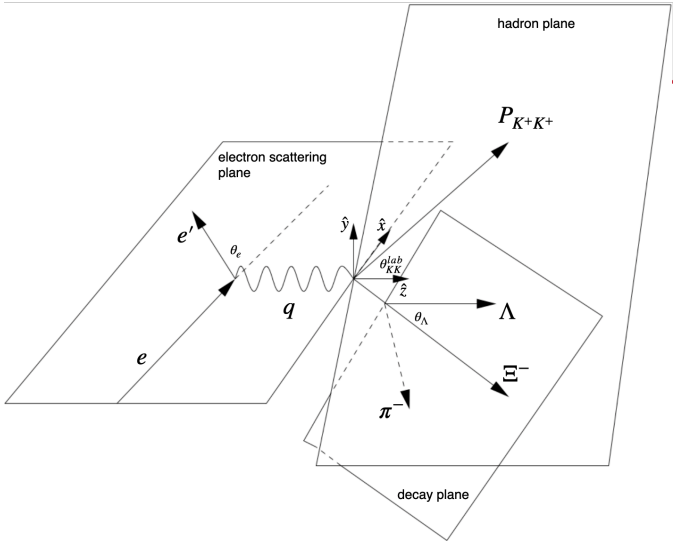


From Dr. Lei Guo (Reimei 2016)

Reference Frames



Hadron reaction plane in C.M.



Lab frame for hadron reaction and decay planes

$P_{K^+K^+}$ is defined as the 4-momentum vector sum of both kaons.