

# Hall B - Run Group K

## Color Confinement and Strong QCD

### Exclusive Channels Analysis Update

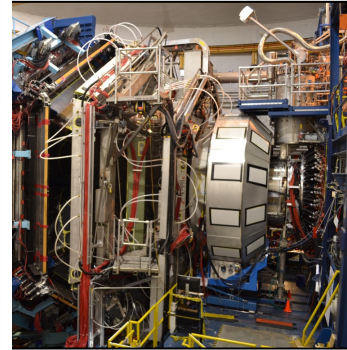
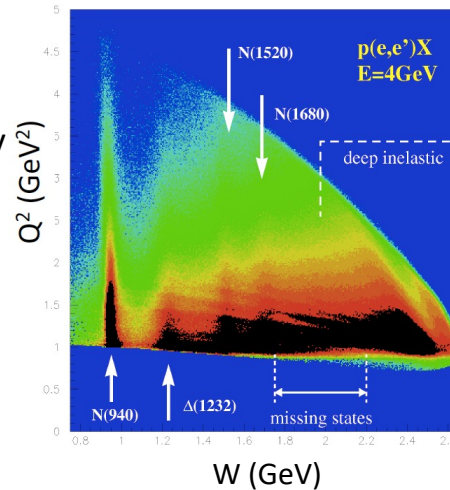
#### Search for Hybrid Baryons

Annalisa D'Angelo

University of Rome Tor Vergata & INFN Rome Tor Vergata Rome – Italy

#### Outline:

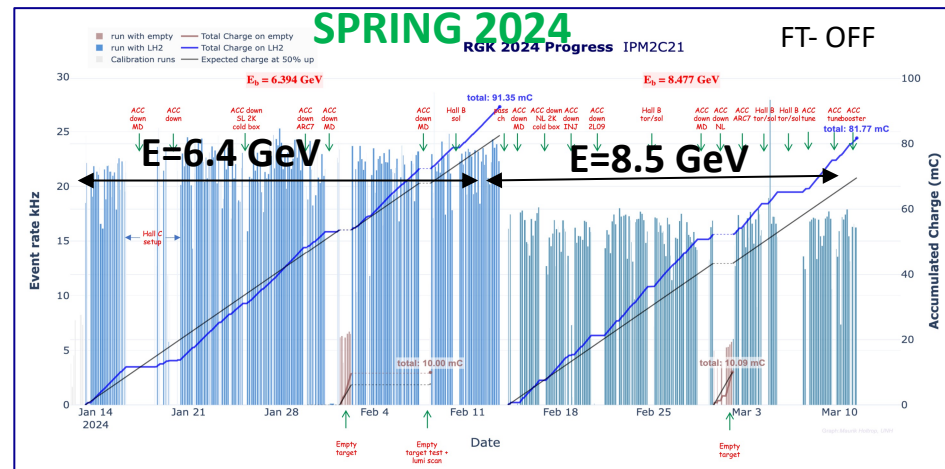
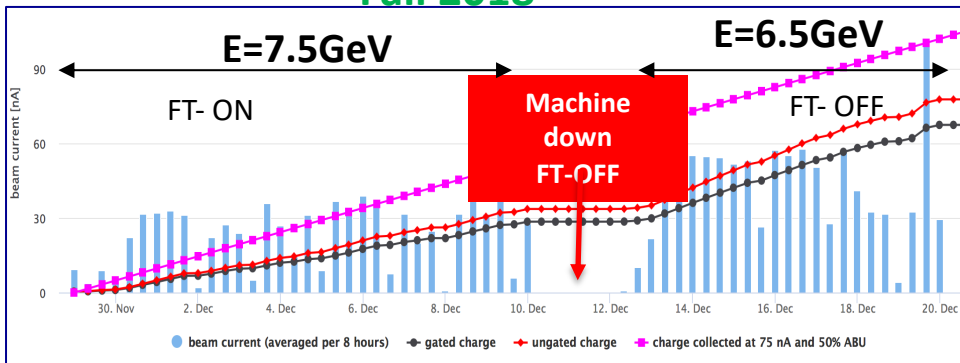
- RG-K data
- Assigned 2025 PAC days



# Run Group K Production



Fall 2018



45mC of accumulated charge

193mC of accumulated charge

Fall 2018		
Beam Energy	Beam Current	Collected Events
7.5 GeV	35 nA	3.5 G
7.5 GeV	45 nA	4.3 G
6.5 GeV	60 nA	7.8 G

Spring 2024		
Beam Energy	Beam Current	Collected Events
6.4 GeV	65 nA	38.3 G
8.5 GeV	75 nA	21.7 G

EVENTS  
15.6 G

EVENTS  
60 G

Fall 2018 →  
X4 more statistics: 50% of total assigned

SPRING 2024

# Run Group K Assigned Data Taking



SPRING 2025

March 18 – May 19

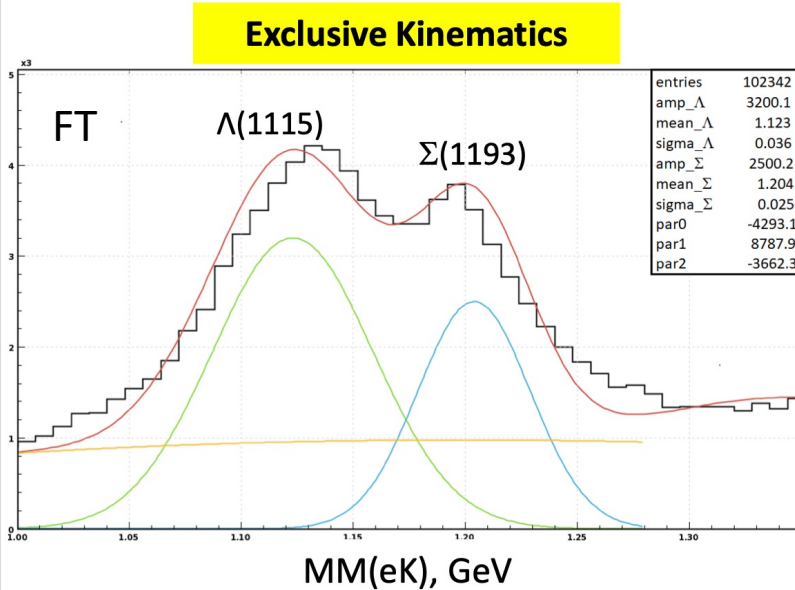
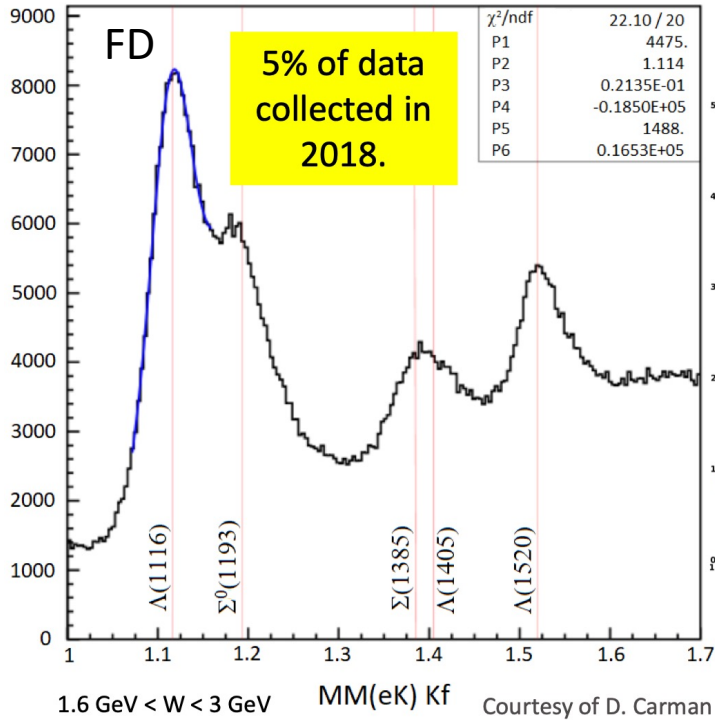
May be delayed

Date	Day	Time	Subject	Status	Notes
3/18/25	Tuesday	2.2	Physics	TBD	Reconfigure
3/19/25	Wednesday	2.2	Physics	TBD	RG-K
3/20/25	Thursday	2.2	Physics	TBD	RG-K
3/21/25	Friday	2.2	Physics	TBD	RG-K
3/22/25	Saturday	2.2	Physics	TBD	RG-K
3/23/25	Sunday	2.2	Physics	TBD	RG-K
3/24/25	Monday	2.2	Physics	TBD	RG-K
3/25/25	Tuesday	2.2	Physics	TBD	RG-K
3/26/25	Wednesday	2.2	Physics	TBD	RG-K
3/27/25	Thursday	2.2	Physics	TBD	RG-K
3/28/25	Friday	2.2	Physics	TBD	RG-K
3/29/25	Saturday	2.2	Physics	TBD	RG-K
3/30/25	Sunday	2.2	Physics	TBD	RG-K
3/31/25	Monday	2.2	Physics	TBD	RG-K
4/1/25	Tuesday	2.2	Physics	TBD	RG-K
4/2/25	Wednesday	2.2	Physics	TBD	RG-K
4/3/25	Thursday	2.2	Physics	TBD	RG-K
4/4/25	Friday	2.2	Physics	TBD	RG-K
4/5/25	Saturday	2.2	Physics	TBD	RG-K
4/6/25	Sunday	2.2	Physics	TBD	RG-K
4/7/25	Monday	2.2	Physics	TBD	RG-K
4/8/25	Tuesday	2.2	Physics	TBD	RG-K
4/9/25	Wednesday	2.2	Physics	TBD	RG-K
4/10/25	Thursday	2.2	Physics	TBD	RG-K
4/11/25	Friday	2.2	Physics	TBD	RG-K
4/12/25	Saturday	2.2	Physics	TBD	RG-K
4/13/25	Sunday	2.2	Physics	TBD	RG-K
4/14/25	Monday	2.2	Physics	TBD	RG-K
4/15/25	Tuesday	2.2	Physics	TBD	RG-K
4/16/25	Wednesday	2.2	Physics	TBD	RG-K
4/17/25	Thursday	2.2	Physics	TBD	RG-K
4/18/25	Friday	2.2	Physics	TBD	RG-K
4/19/25	Saturday	2.2	Physics	TBD	RG-K
4/20/25	Sunday	2.2	Physics	TBD	RG-K
4/21/25	Monday	2.2	Physics	TBD	RG-K
4/22/25	Tuesday	2.2	Physics	TBD	RG-K
4/23/25	Wednesday	2.2	Physics	TBD	RG-K
4/24/25	Thursday	2.2	Physics	TBD	RG-K
4/25/25	Friday	2.2	Physics	TBD	RG-K
4/26/25	Saturday	2.2	Physics	TBD	RG-K
4/27/25	Sunday	2.2	Physics	TBD	RG-K
4/28/25	Monday	2.2	Physics	TBD	RG-K
4/29/25	Tuesday	2.2	Physics	TBD	RG-K
4/30/25	Wednesday	2.2	Physics	TBD	RG-K
5/1/25	Thursday	2.2	Physics	TBD	RG-K
5/2/25	Friday	2.2	Physics	TBD	RG-K
5/3/25	Saturday	2.2	Physics	TBD	RG-K
5/4/25	Sunday	2.2	Physics	TBD	RG-K
5/5/25	Monday	2.2	Physics	TBD	RG-K
5/6/25	Tuesday	2.2	Physics	TBD	RG-K
5/7/25	Wednesday	2.2	Physics	TBD	RG-K
5/8/25	Thursday	2.2	Physics	TBD	RG-K
5/9/25	Friday	2.2	Physics	TBD	RG-K
5/10/25	Saturday	2.2	Physics	TBD	RG-K
5/11/25	Sunday	2.2	Physics	TBD	RG-K
5/12/25	Monday	2.2	Physics	TBD	RG-K
5/13/25	Tuesday	2.2	Physics	TBD	RG-K
5/14/25	Wednesday	2.2	Physics	TBD	RG-K
5/15/25	Thursday	2.2	Physics	TBD	RG-K
5/16/25	Friday	2.2	Physics	TBD	RG-K
5/17/25	Saturday	2.2	Physics	TBD	RG-K
5/18/25	Sunday	2.2	Physics	TBD	RG-K
5/19/25	Monday	2.2	Physics	TBD	RG-K

Beam off at 7am

# Run Group K Physics Results

# KY Events selection: electron in the FD(CLAS)/FT



Preliminary results obtained with data collected in 2018

$p(e, e'K^+)X$

$E_{beam} = 7.546 \text{ GeV}$

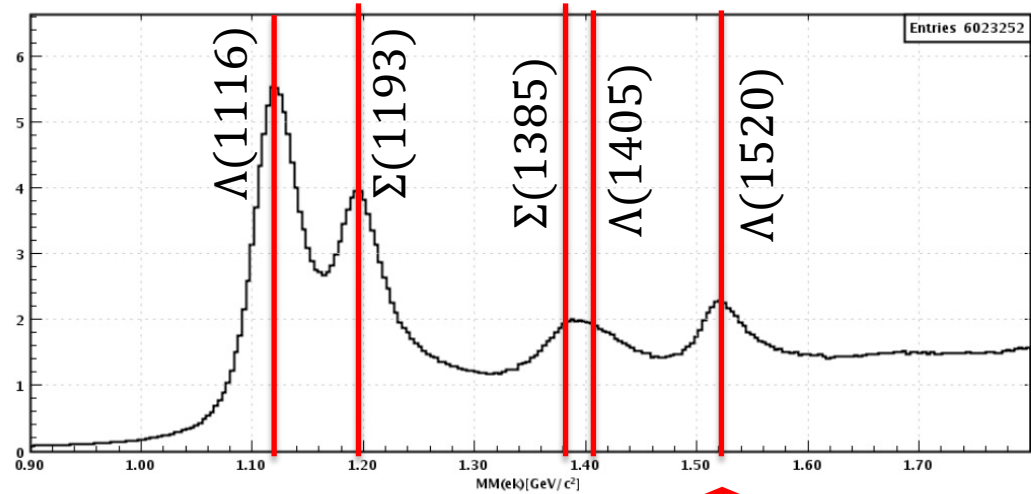
# $\Lambda(1520)$

kFWD pFWD

Other channels could be exploited as final states for possible new resonances..

$$ep \rightarrow eK^+\Lambda(1520) \rightarrow eK^+ K^- p$$

The existence of several non-strange  $N^*$  resonances with significant ( $\sim 5\%$ ) branching ratios into the  $K^+\Lambda(1520)$  decay channel has been predicted



$\Lambda(1520)$  arises as a separate structure

- S. Barrow et al., CLAS Coll., Phys.Rev.C64:044601,2001
- Simon Chapstick and W. Roberts, Phys. Rev. D **58** 074011

# KY Polarization Formalism



By Dan Carman

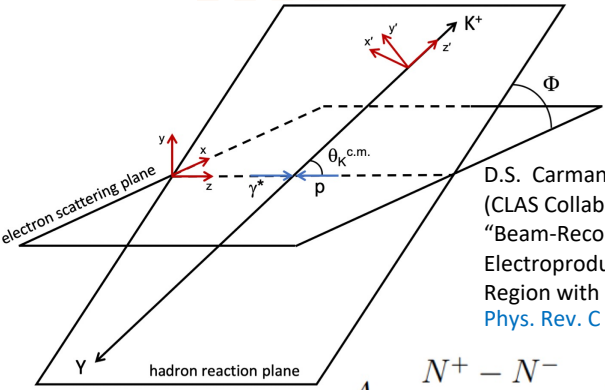
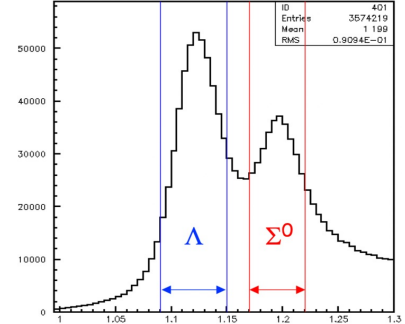
RG-K Fall 2018 pass1 data

$\mathcal{P}^0$  = recoil polarization

$\mathcal{P}'$  = transferred polarization

$ep \rightarrow e'K^+\gamma$

$(x',y',z')$		$\phi$ -integrated		$(x,y,z)$	
$\mathcal{P}_{x'}^0$	0	$\mathcal{P}_x^0$	0		
$\mathcal{P}_{y'}^0$	$K_I(R_T^{y'0} + \epsilon R_L^{y'0})$	$\mathcal{P}_y^0$	$\frac{1}{2}\sqrt{\epsilon(1+\epsilon)}K_I(R_{LT}^{x'0} \cos \theta_K^{c.m.} + R_{LT}^{y'0} + R_{LT}^{z'0} \sin \theta_K^{c.m.})$		
$\mathcal{P}_{z'}^0$	0	$\mathcal{P}_z^0$	0		
$\mathcal{P}_{x'}^{\prime}$	$K_I\sqrt{1-\epsilon^2}R_{TT}^{x'0}$	$\mathcal{P}_x^{\prime}$	$\frac{1}{2}\sqrt{\epsilon(1-\epsilon)}K_I(R_{LT}^{x'0} \cos \theta_K^{c.m.} - R_{LT}^{y'0} + R_{LT}^{z'0} \sin \theta_K^{c.m.})$		
$\mathcal{P}_{y'}^{\prime}$	0	$\mathcal{P}_y^{\prime}$	0		
$\mathcal{P}_{z'}^{\prime}$	$K_I\sqrt{1-\epsilon^2}R_{TT}^{z'0}$	$\mathcal{P}_z^{\prime}$	$\sqrt{1-\epsilon^2}K_I(-R_{TT}^{x'0} \sin \theta_K^{c.m.} + R_{TT}^{z'0} \cos \theta_K^{c.m.})$		



D.S. Carman, A. D'Angelo, L. Lanza V. Moiseev (CLAS Collaboration)  
 "Beam-Recoil Transferred Polarization in K+Y Electroproduction in the Nucleon Resonance Region with CLAS12"  
 Phys. Rev. C 105, 065201 (2022)

$$A = \frac{N^+ - N^-}{N^+ + N^-} = \nu_Y \alpha_\Lambda P_b \mathcal{P}'_Y \cos \theta_p^{RF}$$



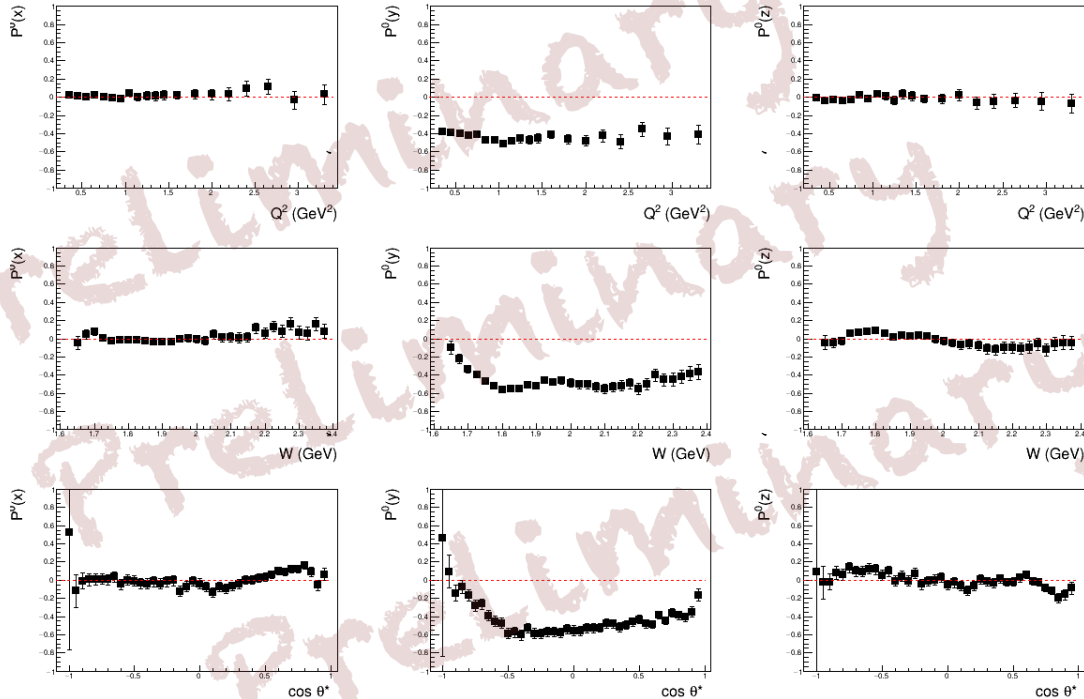
CLAS12 @ 6.5 GeV

MM(e'K+) (GeV)

# K<sup>+</sup>Y Induced Polarization CLAS12



$$\frac{N^+ - N^-}{N^+ + N^-} = \frac{\nu_Y \alpha P_Y}{2}, \nu_Y = 1 \text{ or } \nu_Y = -0.256, \alpha = 0.732$$



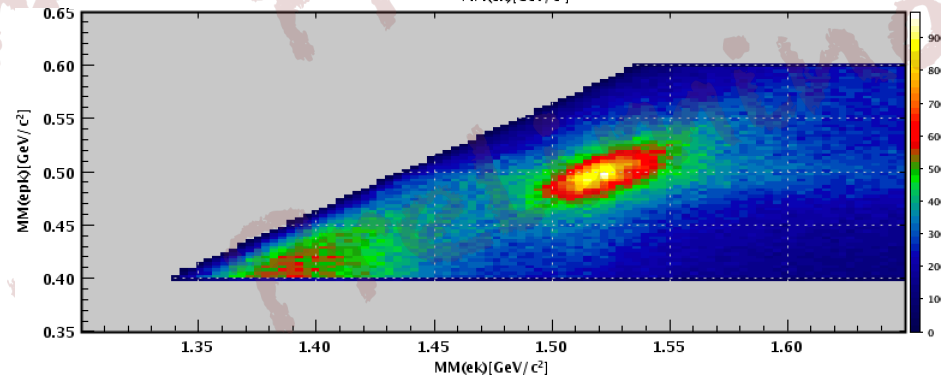
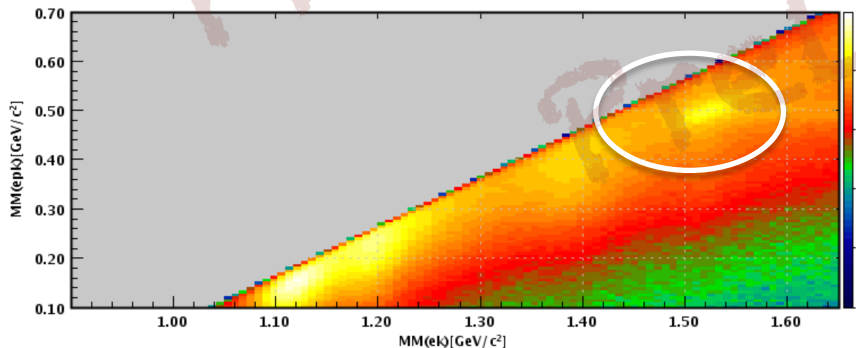
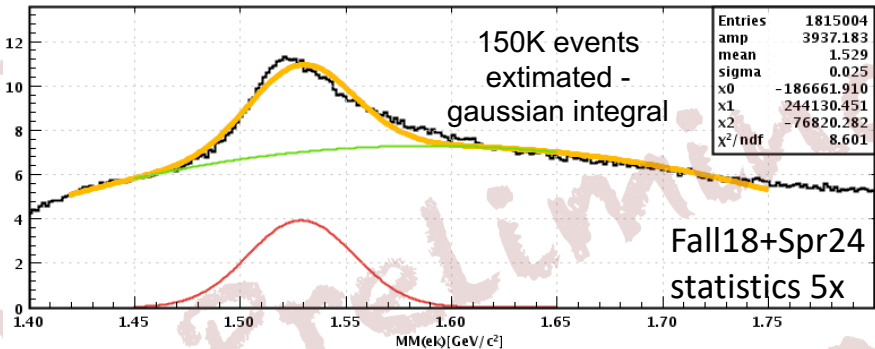
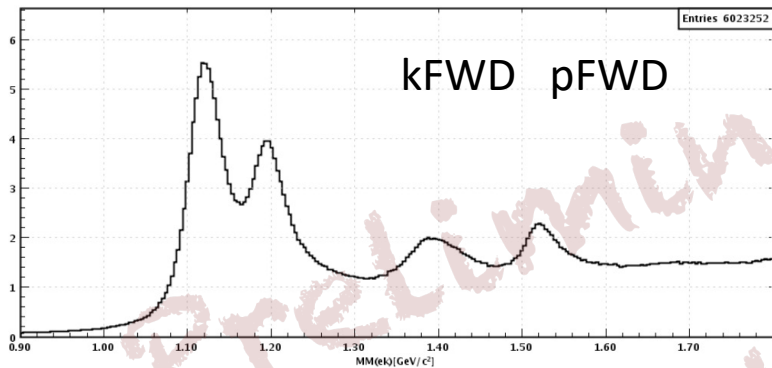
x and z components still not fully compatible with 0 as expected from theory

The analysis will be improved once the **Spring 2024** data will be available for analysis

By Lucilla Lanza



# $\Lambda(1520)$



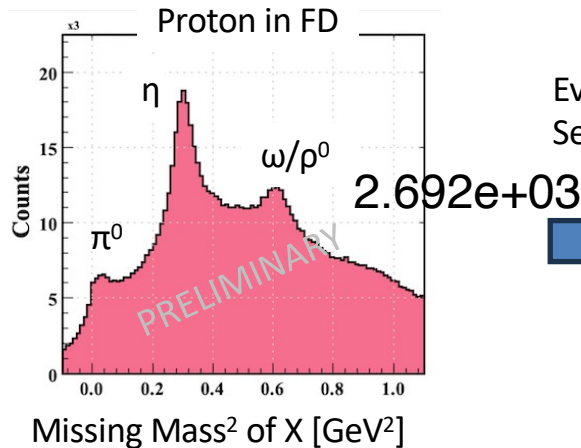
Five structures:  $\Lambda(1116)$ ,  $\Sigma^0(1193)$ ,  $\Sigma(1385)$ ,  $\Lambda(1405)$ ,  $\Lambda(1520)$

By Lucilla Lanza

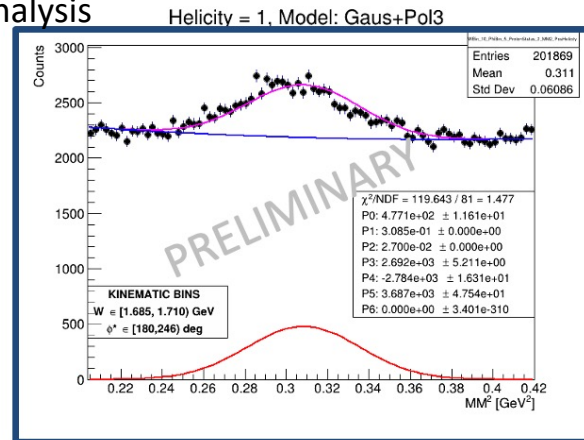
$ep \rightarrow eK^+ \Lambda(1520) \rightarrow eK^+ K^- p$

# Event Selection and $\eta$ Identification

- **Key Idea:**  $\eta$  mesons are identified using the missing mass technique in the  $ep \rightarrow e'p'X$  reaction (e and p in the FD)
- Reconstruct the missing mass squared ( $MM^2$ ) of the undetected particle X
- $\eta$  signal appears as a peak around  $MM^2 = 0.3 \text{ GeV}^2$
- Apply analysis cuts:
  - $W < 2 \text{ GeV}$  (nucleon resonance region)
  - $0.15 \text{ GeV}^2 < MM^2 < 0.45 \text{ GeV}^2$  ( $\eta$  peak region)
- Implement standard RGK fiducial cuts and cuts developed for analysis



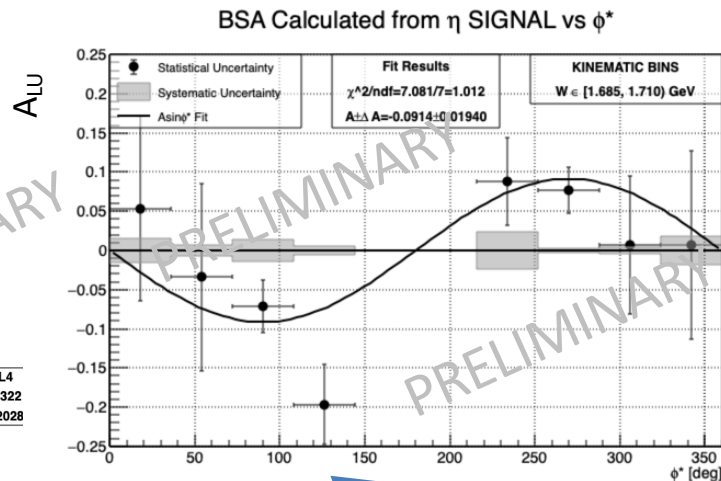
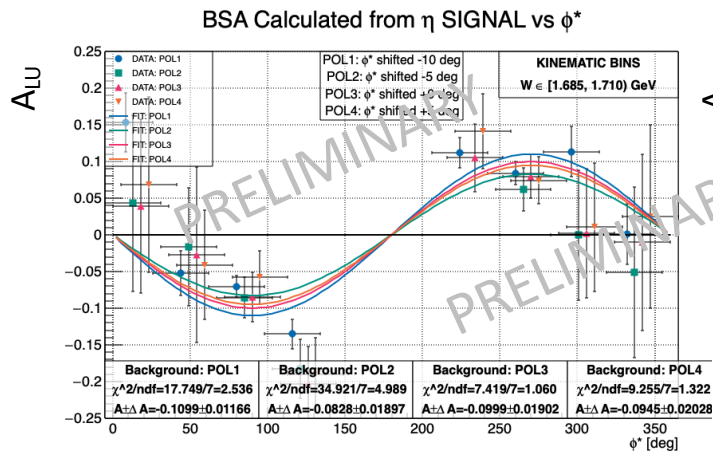
Event Selection



By Izzy Illari

# Representative Fit to Beam Spin Asymmetry

- **Key Idea:** The BSA is extracted by fitting the asymmetry as a function of  $\phi^*$  with a sine function.
- Data are binned over  $W$  and  $\phi^*$ , integrated over  $Q^2$  and  $\cos\theta^*$



$$A_{LU} = \frac{1}{P_b} \frac{N^+ - N^-}{N^+ + N^-}$$

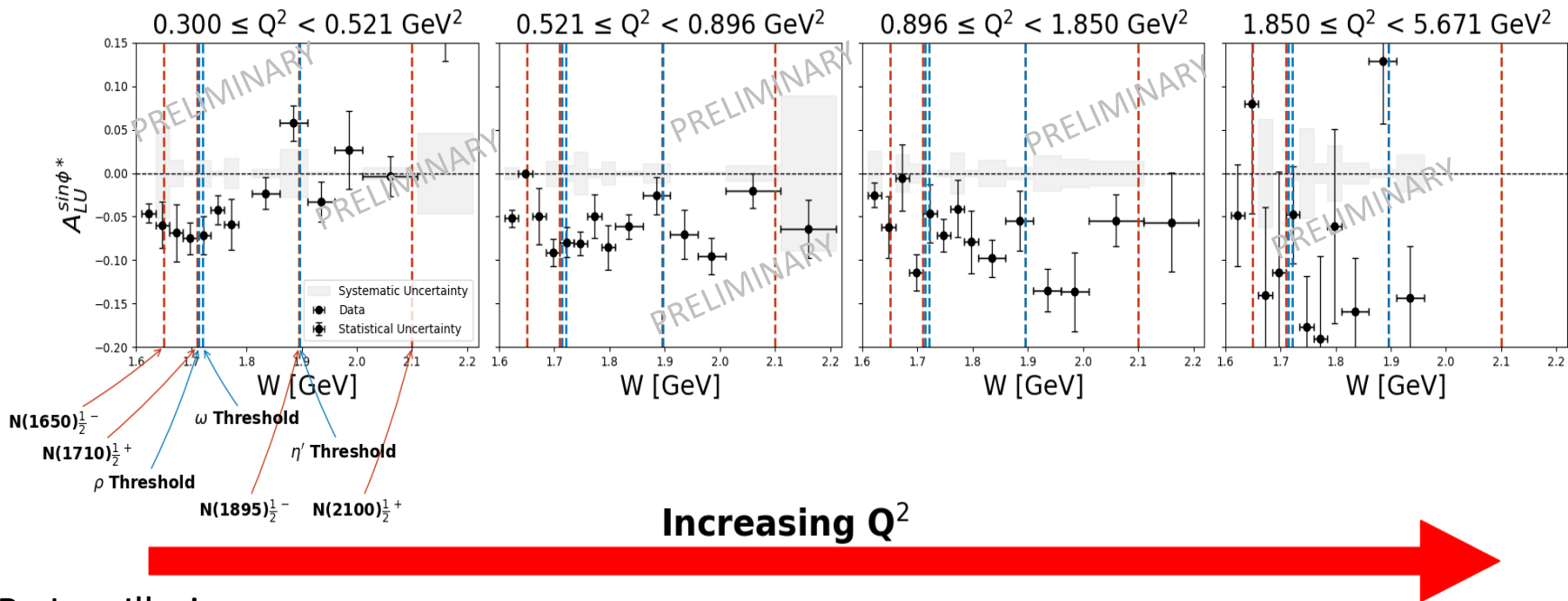
$$A_{LU} \cdot \approx A_{LU}^{\sin \phi^*} \sin \phi^*$$

By Izzy Illari

# $Q^2$ Dependence of the Sine Moment ( $A_{LU}^{\sin\phi^*}$ )

- Key Idea:** Binning the data over  $Q^2$  allows for investigating the dependence of  $A_{LU}^{\sin\phi^*}$  on the four-momentum transfer squared.

Binned over  $W$ ,  $Q^2$  and  $\phi^*$ , Integrated over  $\cos\theta^*$



By Izzy Illari