

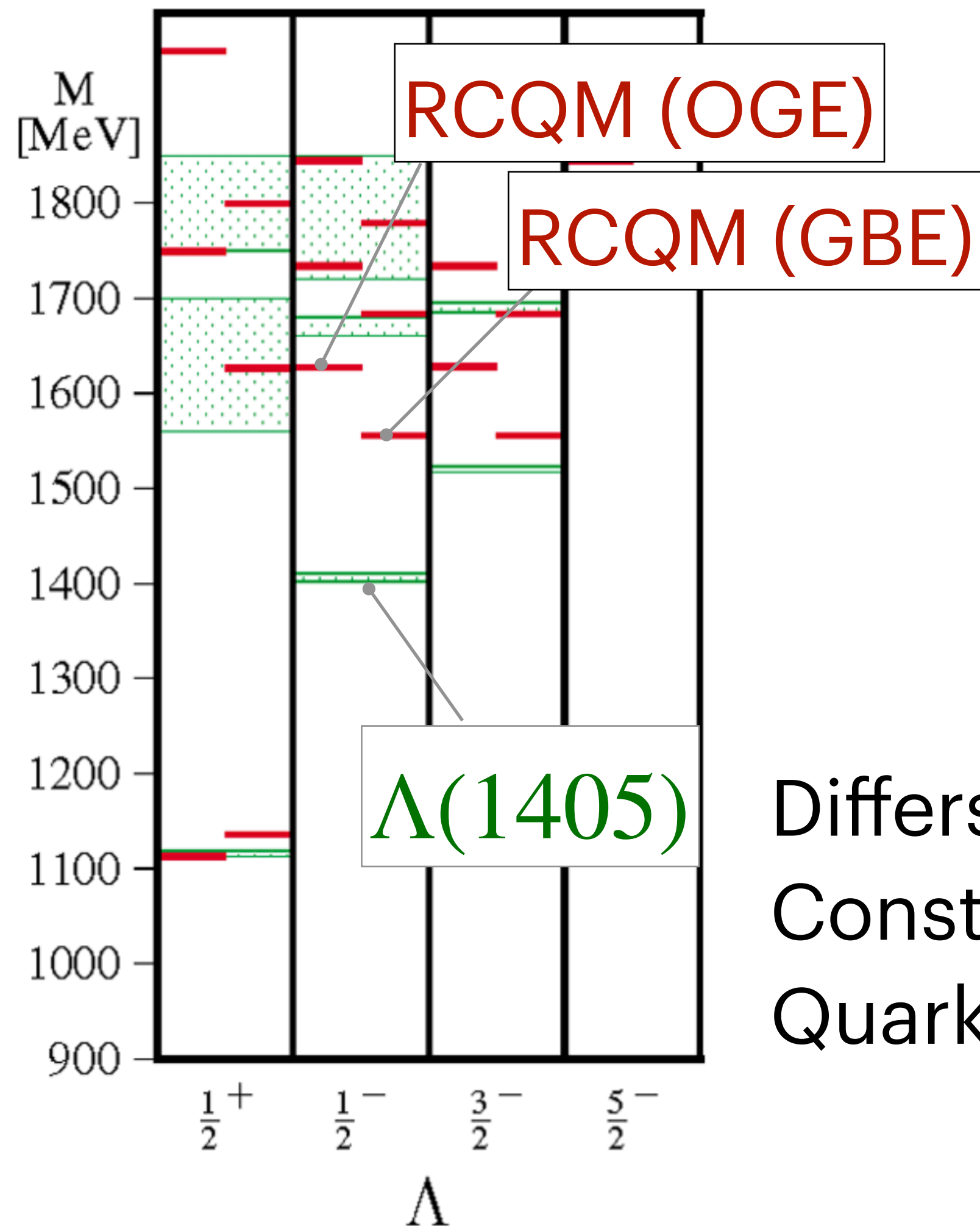
Electroproduction of $\Lambda(1405)$

CLAS collaboration meeting
Tatsuhiko Ishige (Tohoku University)

2024.November.14

$\Lambda(1405)$

Constituent quark model
vs Measured

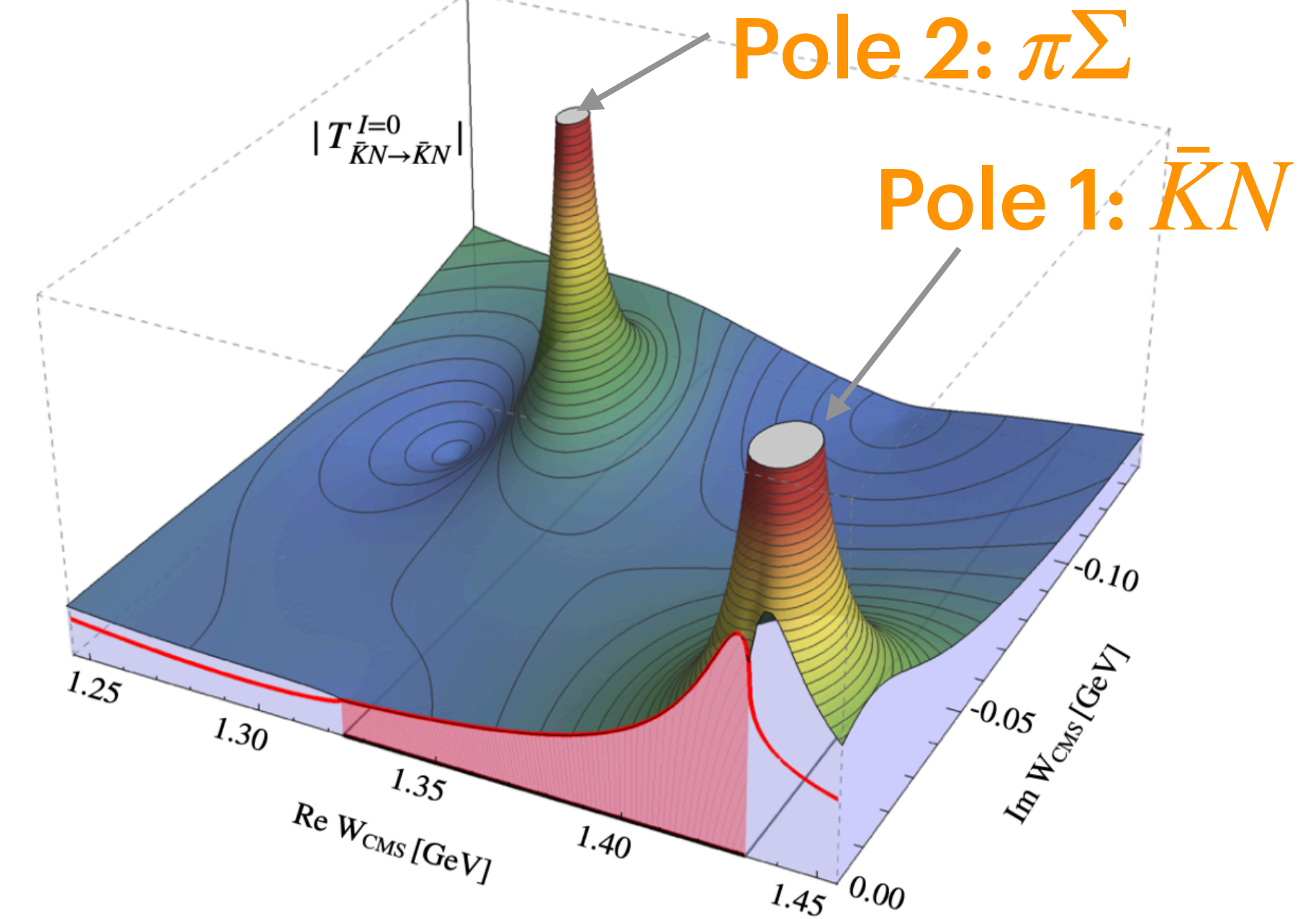


One of approaches to reproduce the mass



Differs from
Constituent
Quark Model

Analytic continuation of the $\bar{K}N$
scattering amplitude



[2] M. Mai, Eur. Phys. J. Spec. Top. (2021) 230:1593-1607

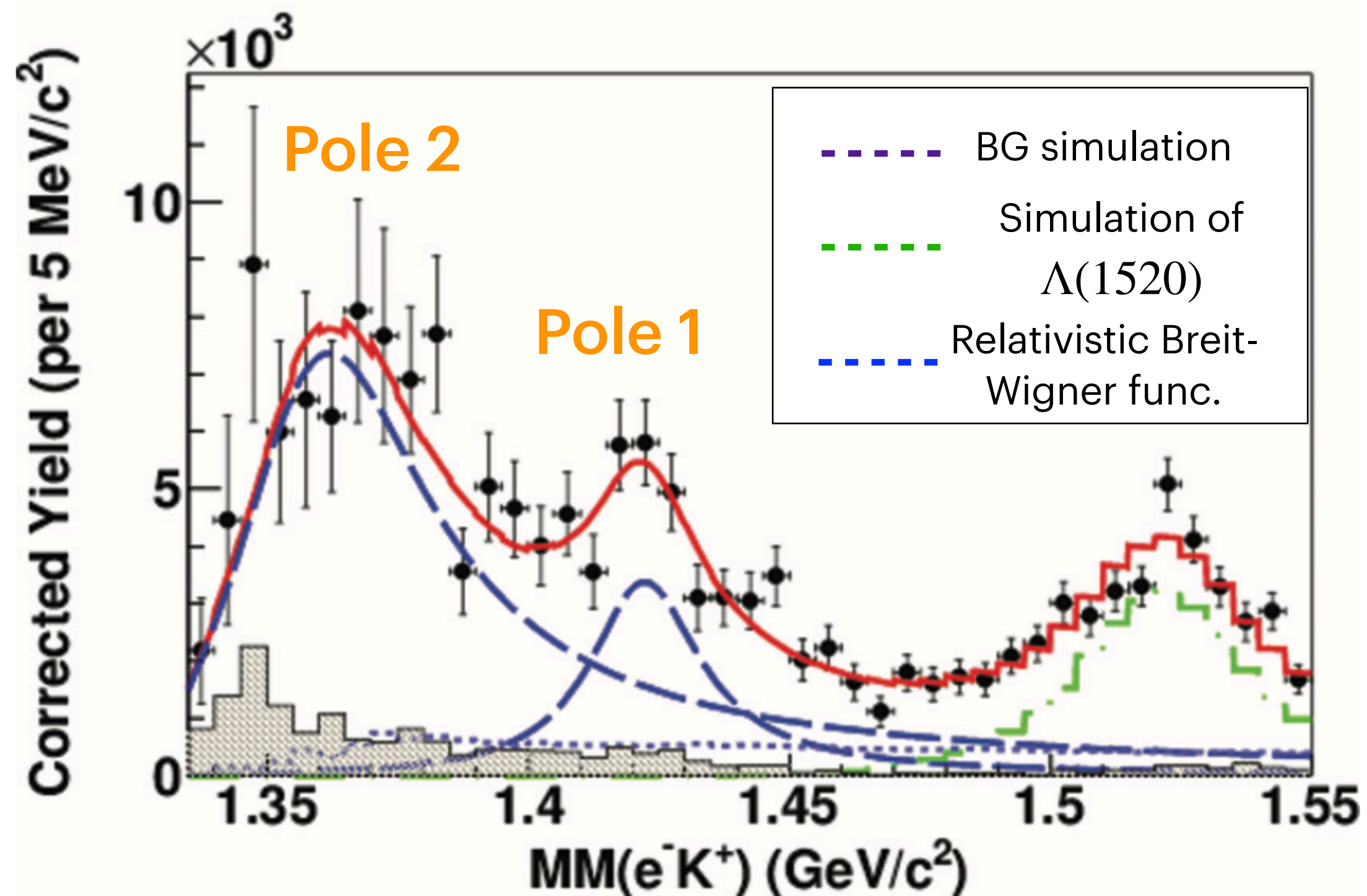
- Pole positions vary by theoretical models
- Important to determine poles by experiment data \rightarrow Key to understanding $\Lambda(1405)$ dynamics

[1] T. Melde et al., Phys. Rev. D 77, 114002 (2008)

Previous experimental research

- ✓ Photoproduction using CLAS data [3,4]
- ✓ Electroproduction using CLAS data [5]

$MM(ep \rightarrow e'K^+X)$ under $\{e', K^+, p, \pi^0, \pi^-\}$ event[5]



- Achievement (despite limited statistics)
 - ◆ Extracted mass values of two poles
 - ◆ Due to limited statistics, Q^2 was integrated
- Unstudied physics for understanding $\Lambda(1405)$ dynamics
 - ◆ Q^2 dependence of cross section
 - ◆ Q^2 dependence of line shape of $\pi\Sigma$ invariant mass
 - ◆ → I will use the high-statistics CLAS12 data for analysis

[3] K. Moriya et al., Phys. Rev. C 88, 045201 (2013)

[4] K. Moriya et al., Phys. Rev. C 87, 035206 (2013)

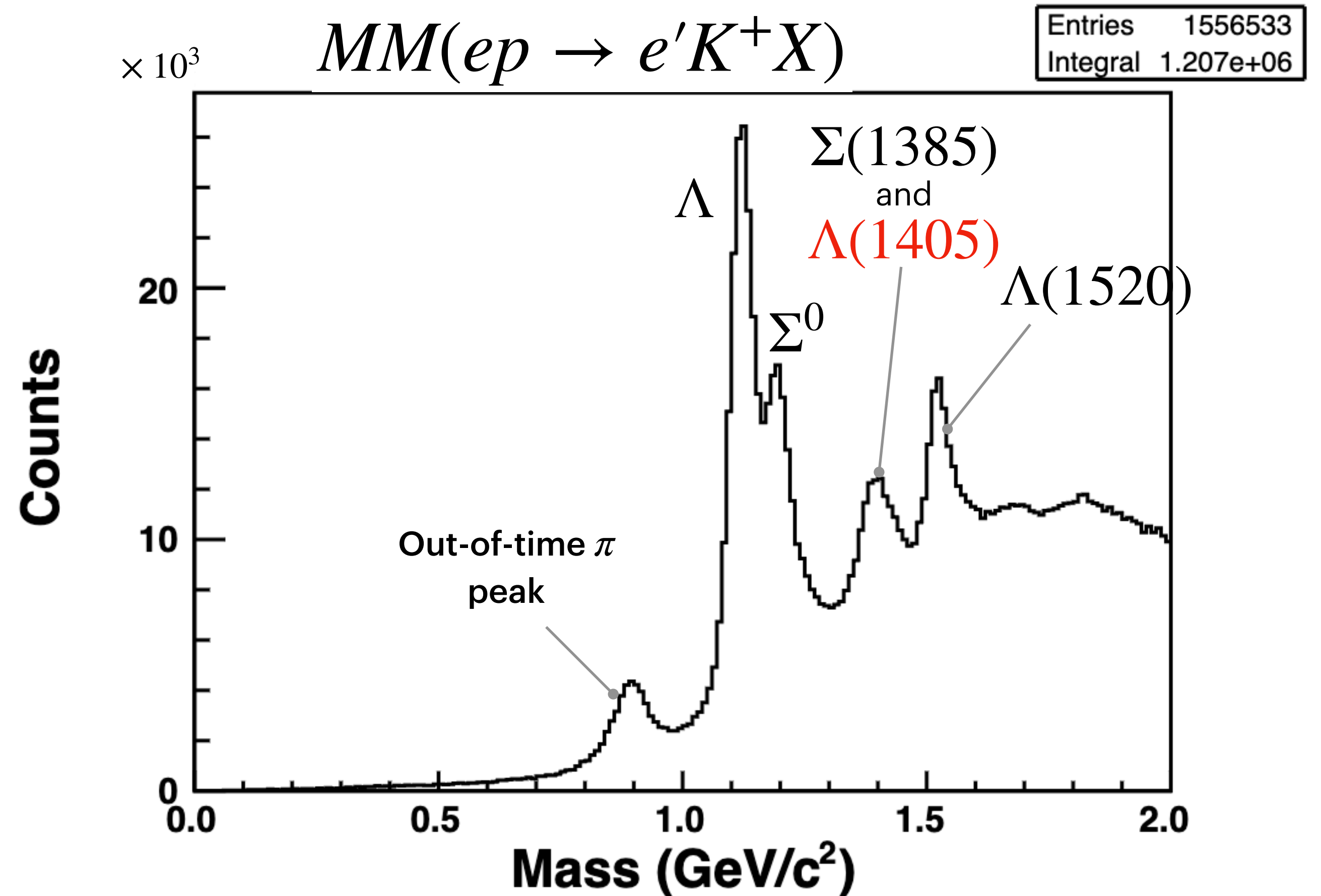
[5] H. Lu et al., Phys. Rev. C 88, 045202 (2013)

Condition & First look

- Condition

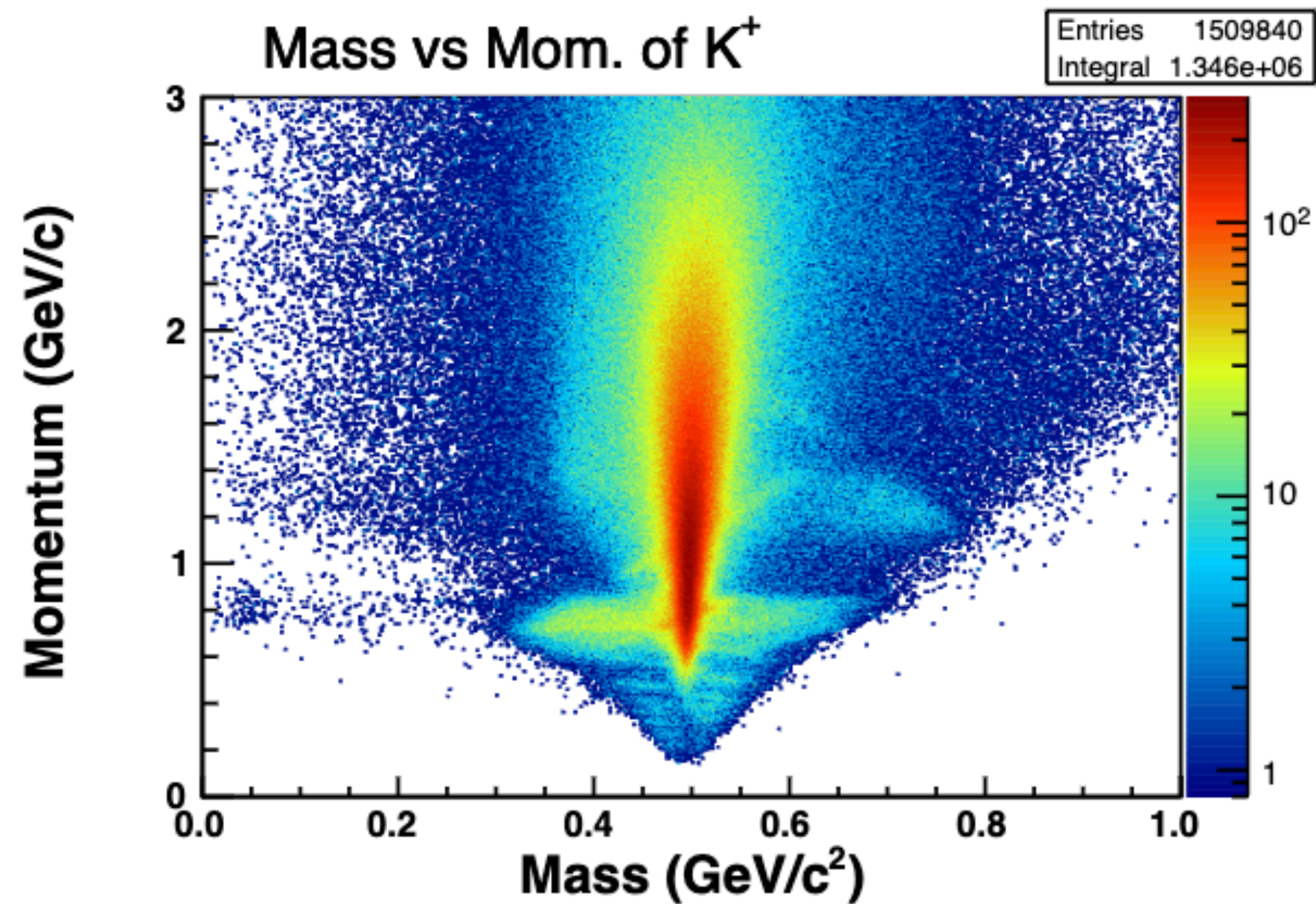
- ◆ Run Group K data
- ◆ Targets: LH2, 5cm long target cell at -3cm
- ◆ Beam: 7.5 GeV
- ◆ Torus field: outbending
- ◆ Skim21 ($e'K^+$ selection)
- ◆ 21files/145files
- ◆ Require e' and K^+ of FD

Path: /mss/clas12/rg-k/production/recon/fall2018/
torus+1/7546MeV/pass1/v0/dst/train/skim21



Clear peak of $\Lambda(1405)$ is found ($> 10^3$ events)

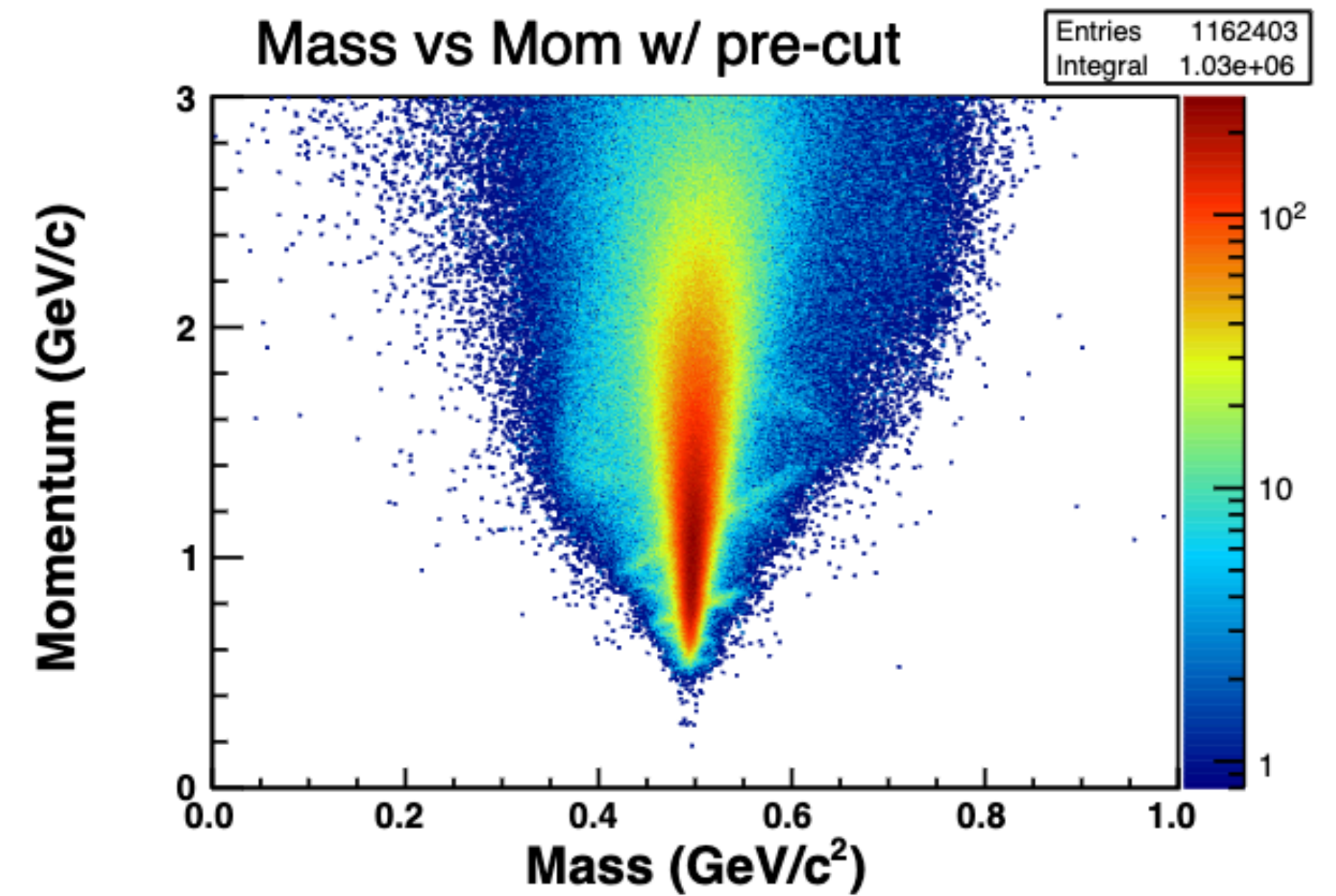
Present status of KaonID



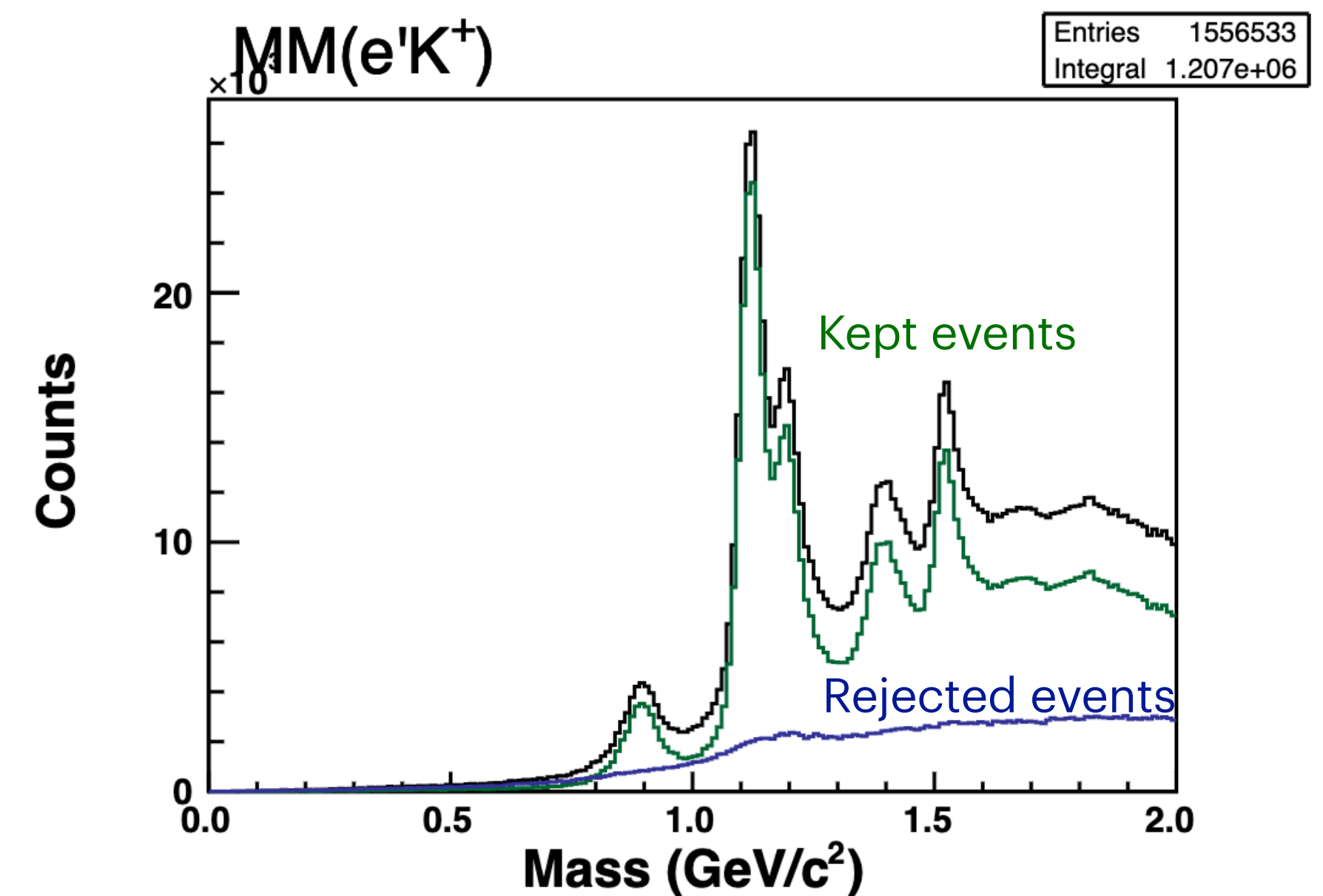
▶

Vertex cuts

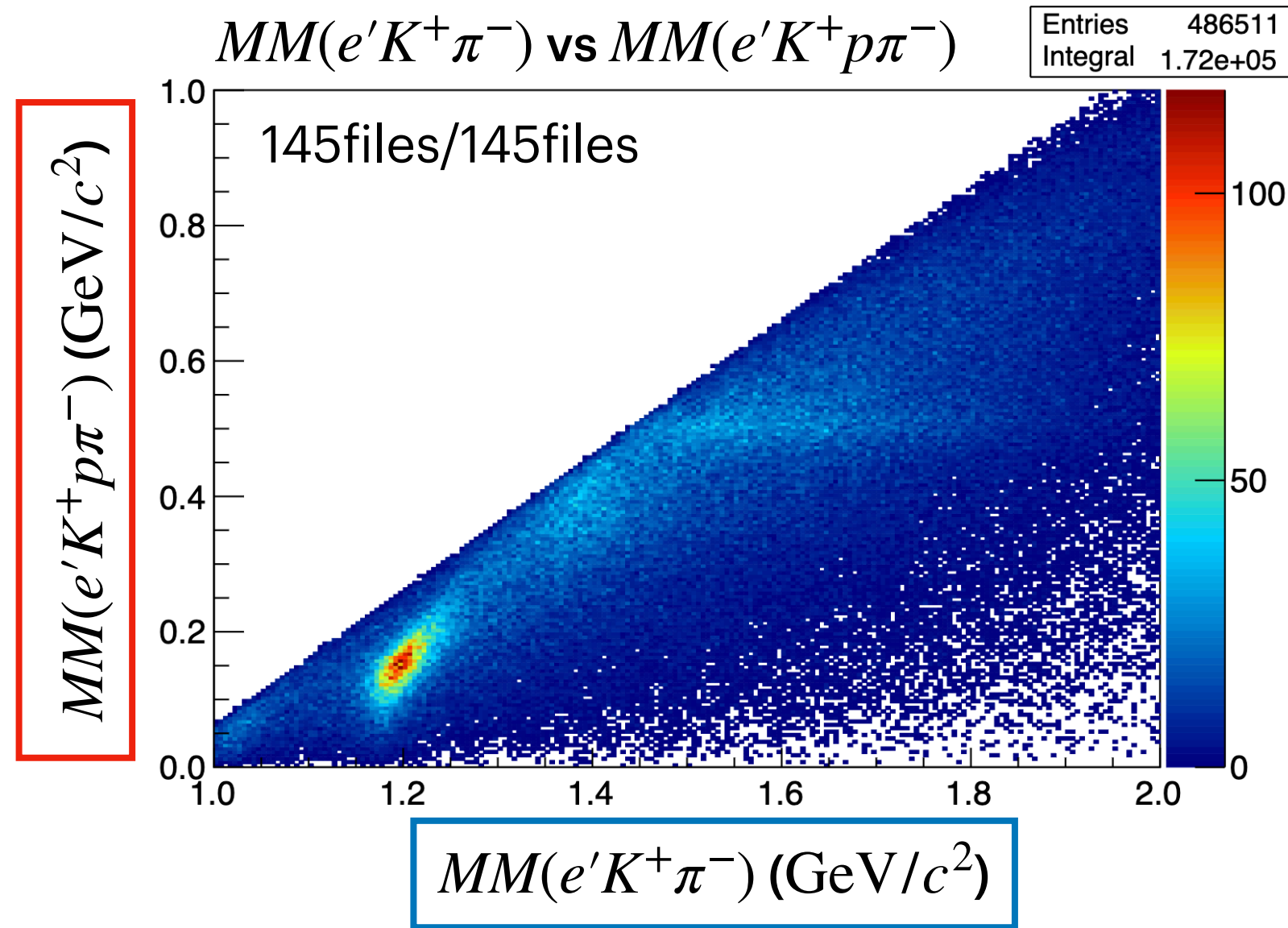
- $-10 \text{ cm} < z_{vertex,e'} < 2 \text{ cm}$
- $-10 \text{ cm} < z_{vertex,K^+} < 2 \text{ cm}$
- $|z_{vertex,e'} - z_{vertex,K^+}| < 3\sigma$
- $|t_{vertex,e'} - t_{vertex,K^+}| < 2 \text{ ns}$



- Crossing band as background on the 2D plot of m vs p
- Background reduced well by the vertex cuts

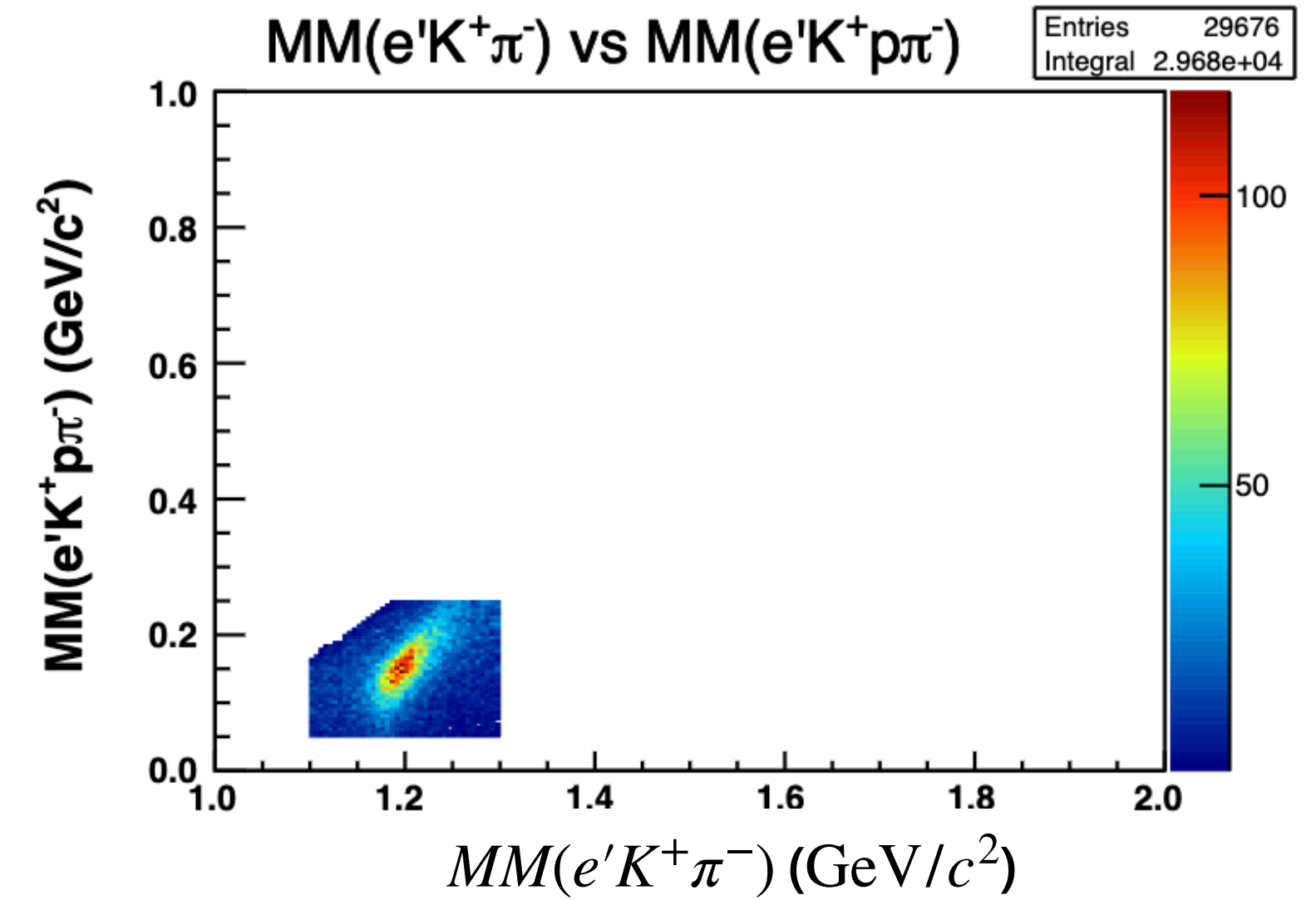


Decay mode selection

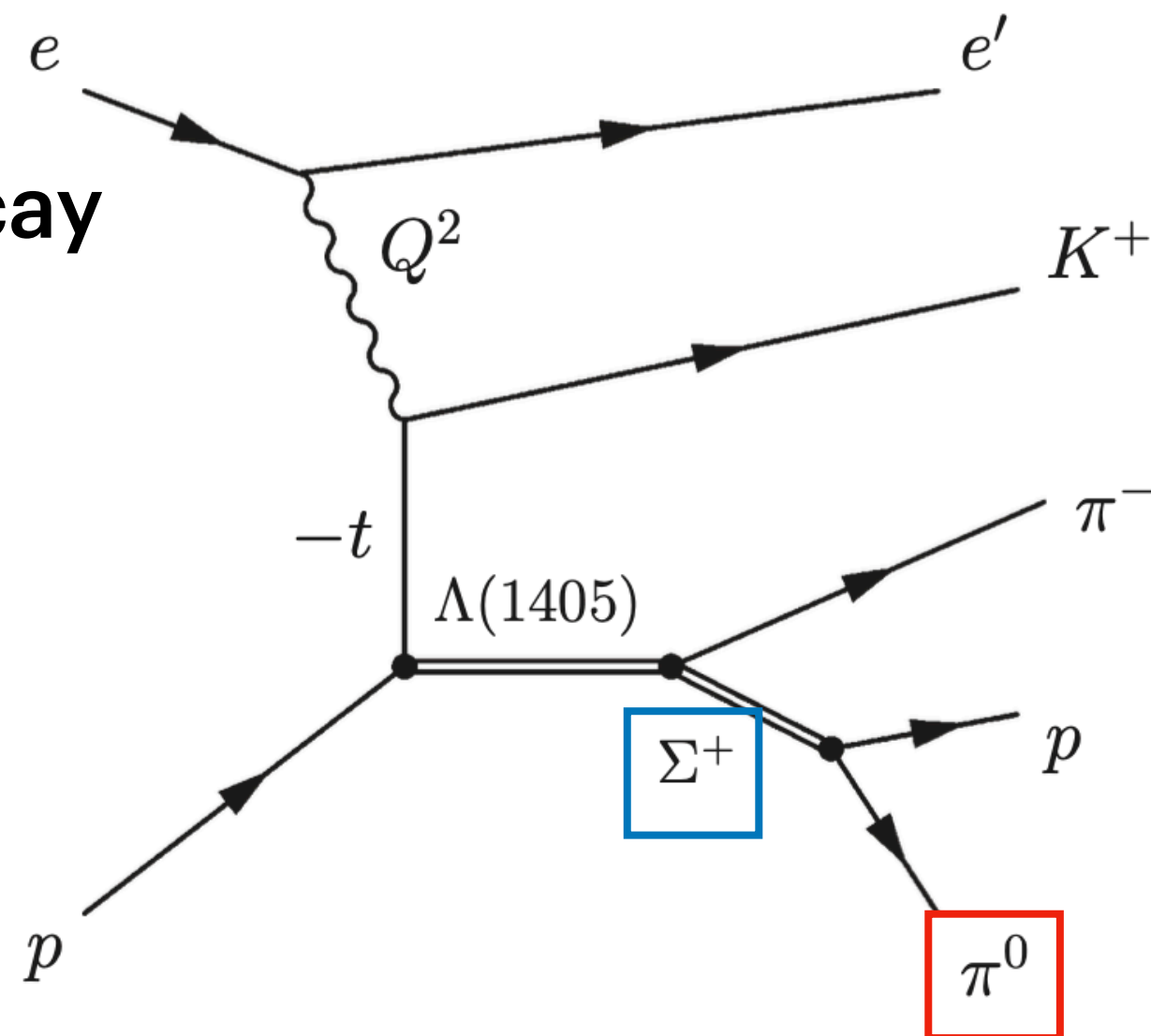


$$0.05 < MM(e'K^+p\pi^-)/(GeV/c^2) < 0.25$$

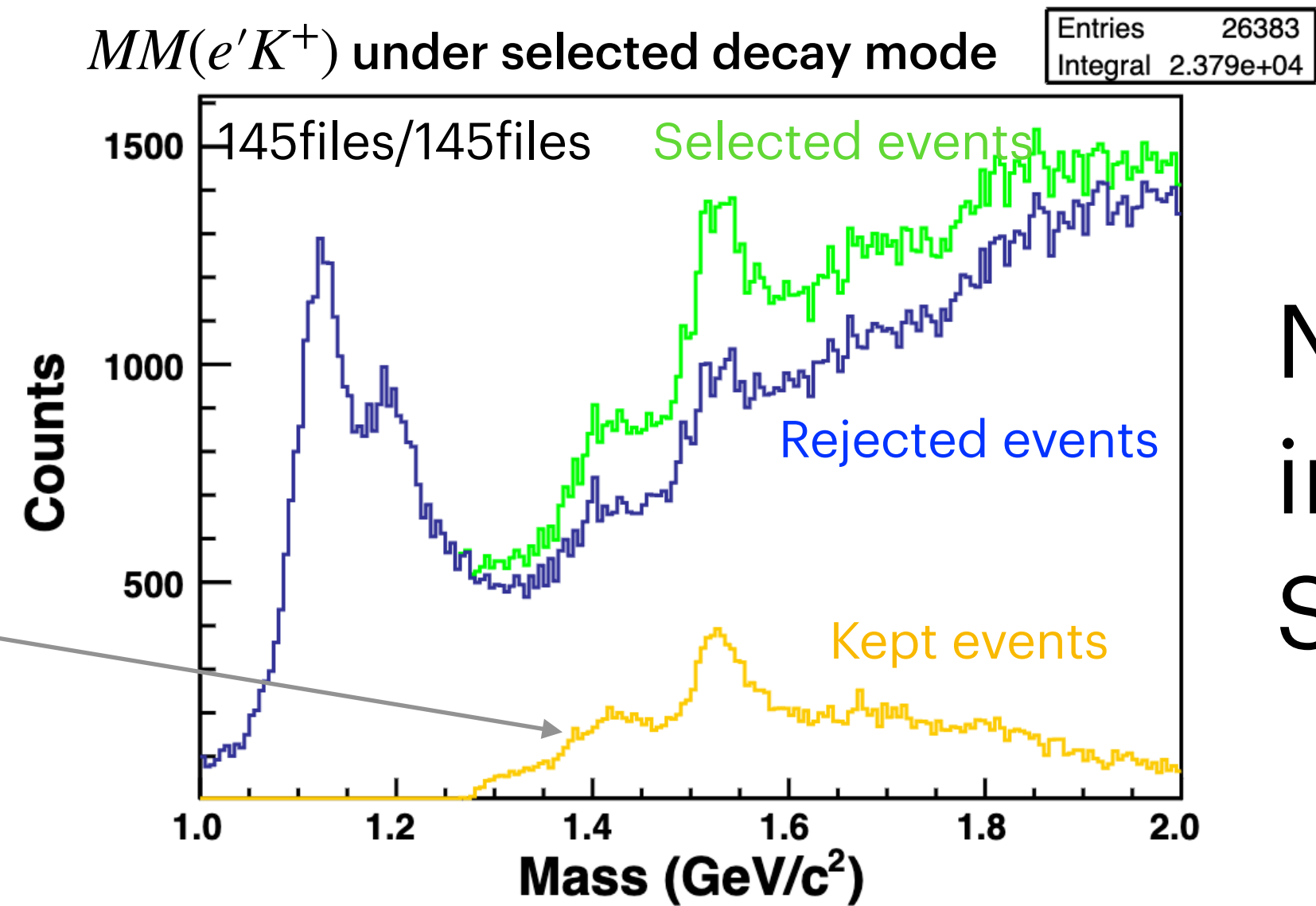
$$1.1 < MM(e'K^+\pi^-)/(GeV/c^2) < 1.3$$



Selected decay mode



$\Lambda(1405)$ under the decay mode



Need to improve SN ratio

Summary

- Study of $\Lambda(1405)$ electroproduction at CLAS12
 - ◆ Final goal: Understand $\Lambda(1405)$ dynamics through the peaks of the two poles
 - ◆ Analysis: Analyze Q^2 evolution of cross section and “line shape”
- Present analysis situation
 - ◆ Vertex cut applied → Reduced background in $MM(e'K^+)$
- Future plan
 - ◆ Develop analysis methods for $\Lambda(1405)$ study
 - ◆ Collect events from recent data using the newly developed methods

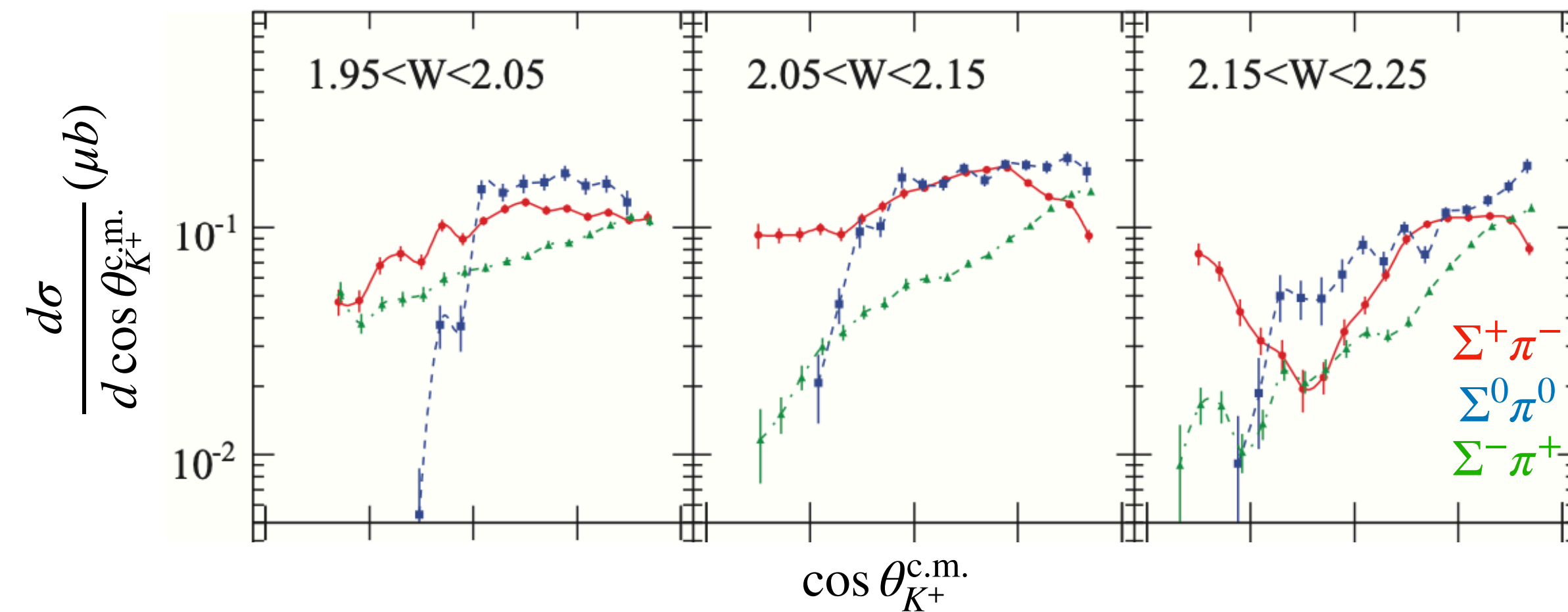
Backup

Previous experimental research

✓ Photoproduction using CLAS data [3,4]

✓ Electroproduction using CLAS data [5]

Cross section



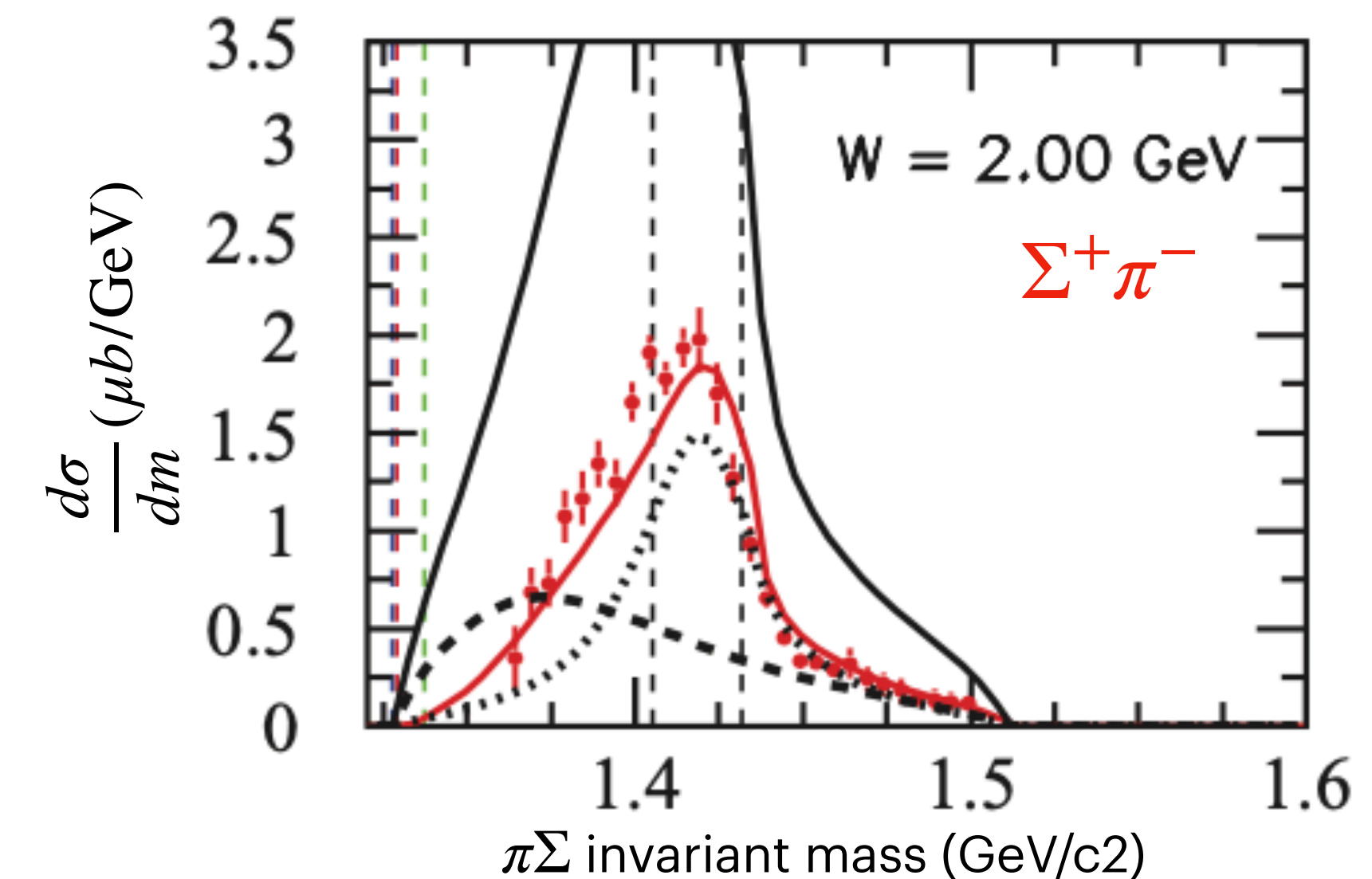
- At lower W , there is an additional dynamics depending on isospin

[3] K. Moriya et al., Phys. Rev. C 88, 045201 (2013)

[4] K. Moriya et al., Phys. Rev. C 87, 035206 (2013)

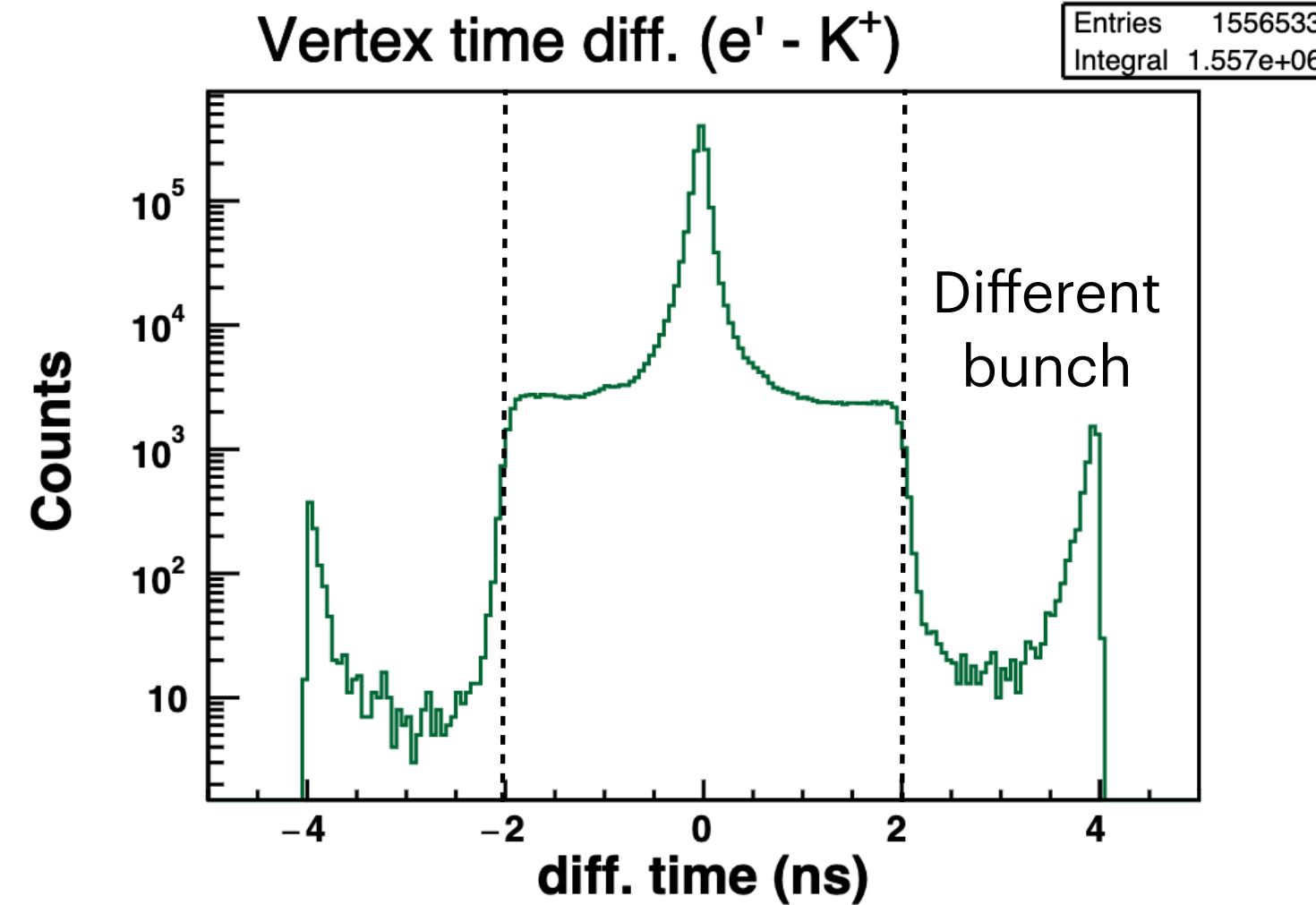
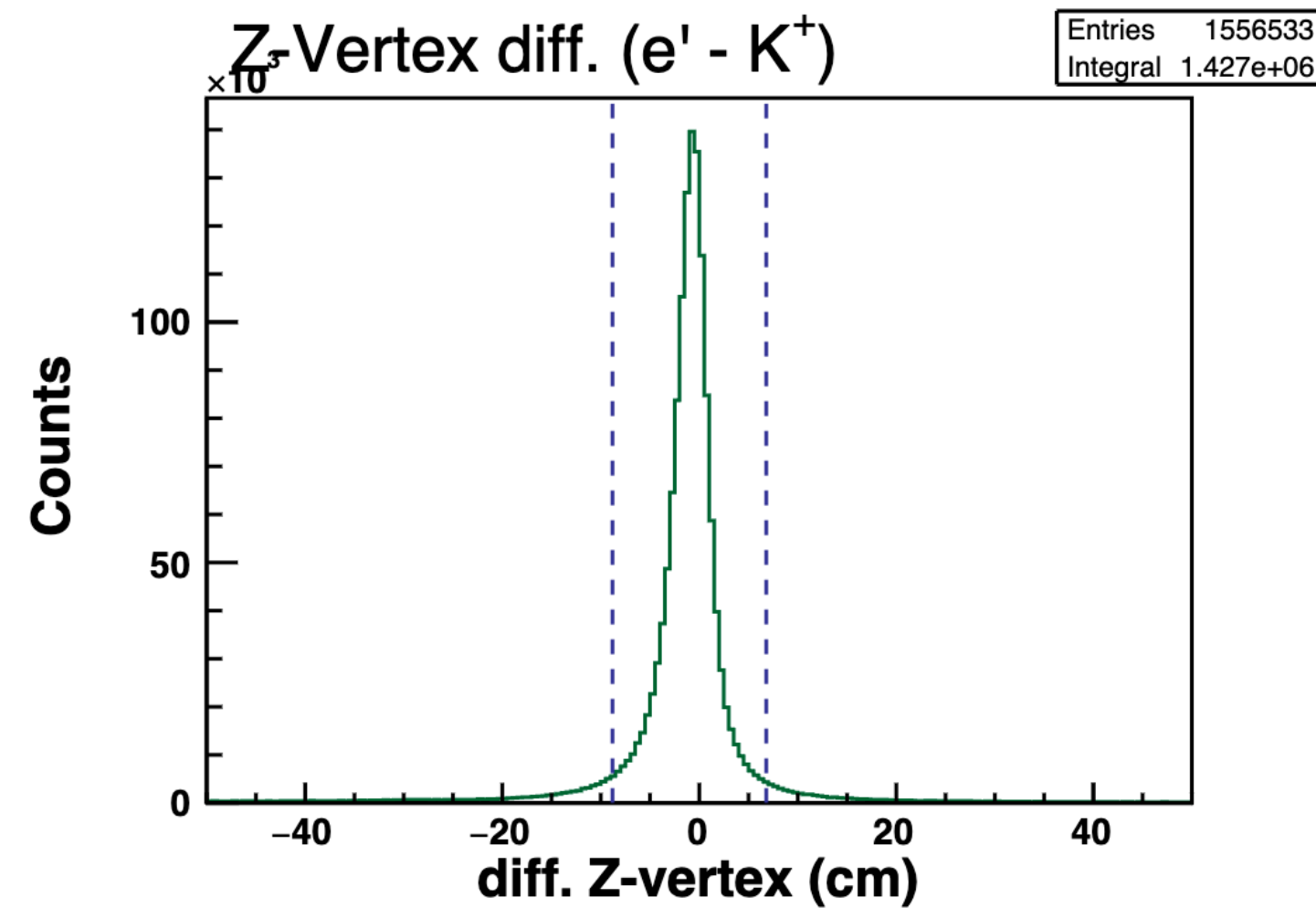
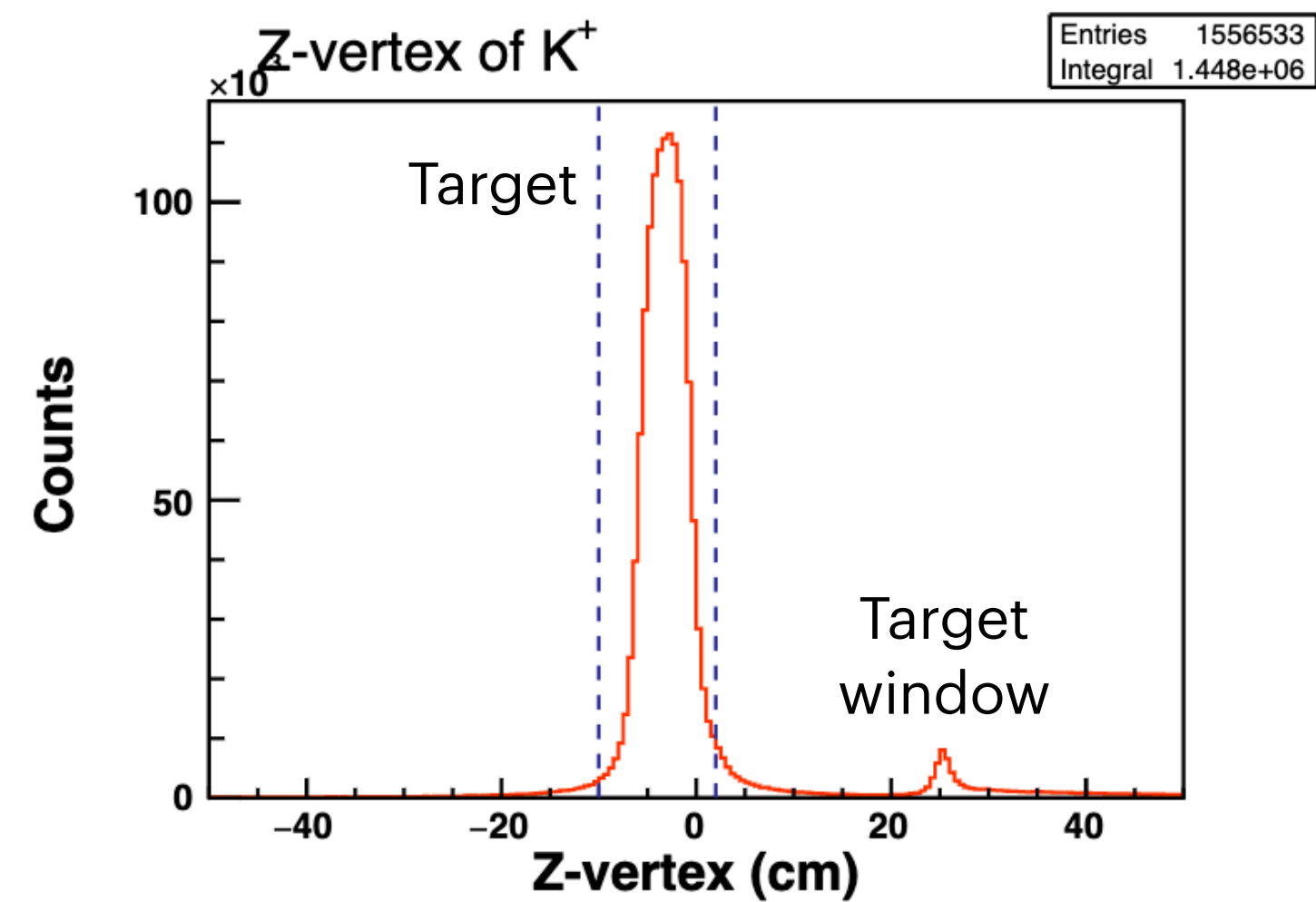
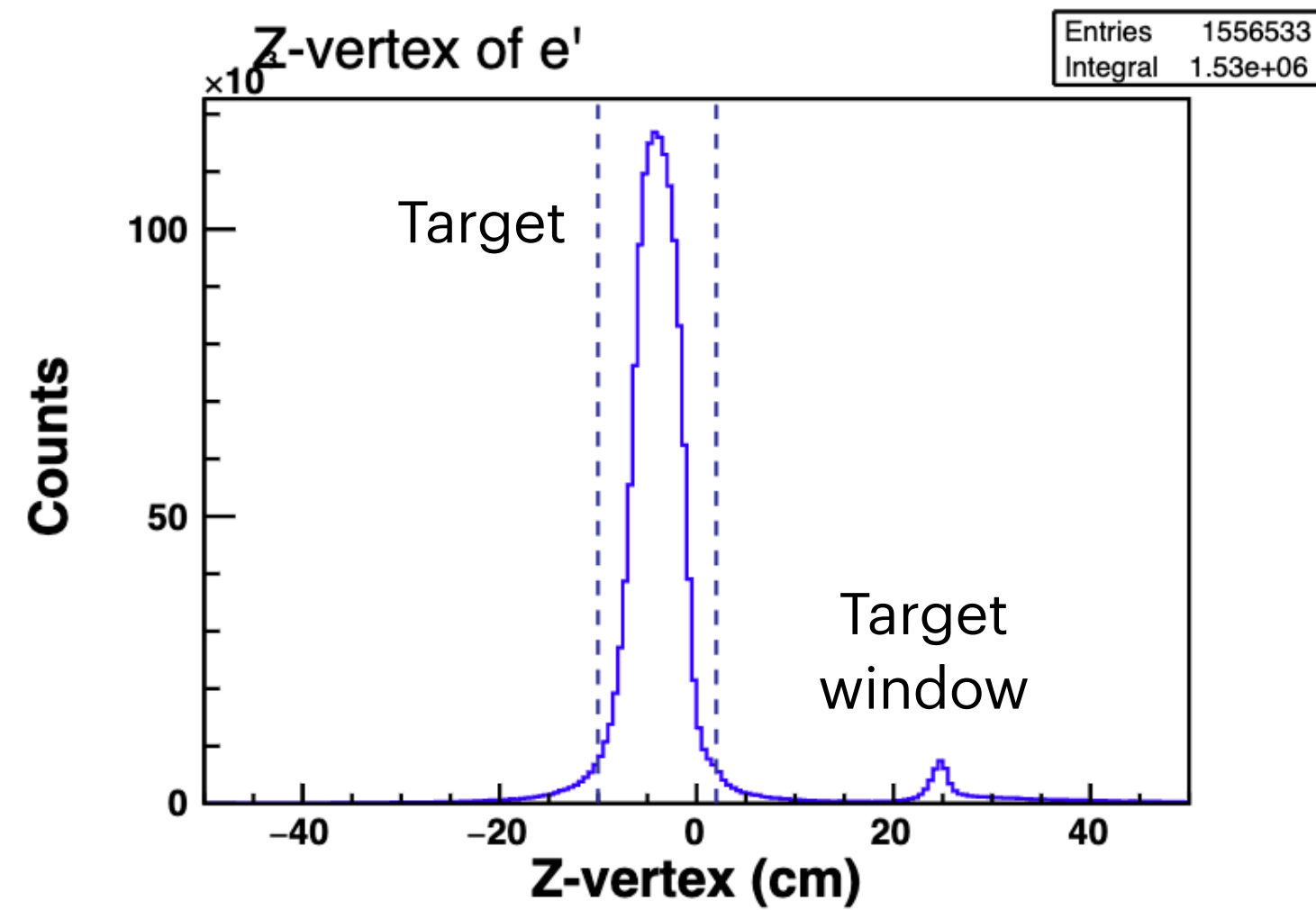
[5] H. Lu et al., Phys. Rev. C 88, 045202 (2013)

“Line shape” of invariant mass



- Line shapes are not relativistic Breit-Wigner functions
- There are effects on both $I = 0, 1$ of $\pi\Sigma$

Vertex cut for electron and K+



- Z-vertex cut
 - ◆ For each particle
 - [-10cm, 2cm]
 - ◆ Difference
 - Gaussian fitting
 - Mean $\pm 3\sigma$
- Vertex time cut
 - ◆ Difference
 - [-2 ns, 2 ns]