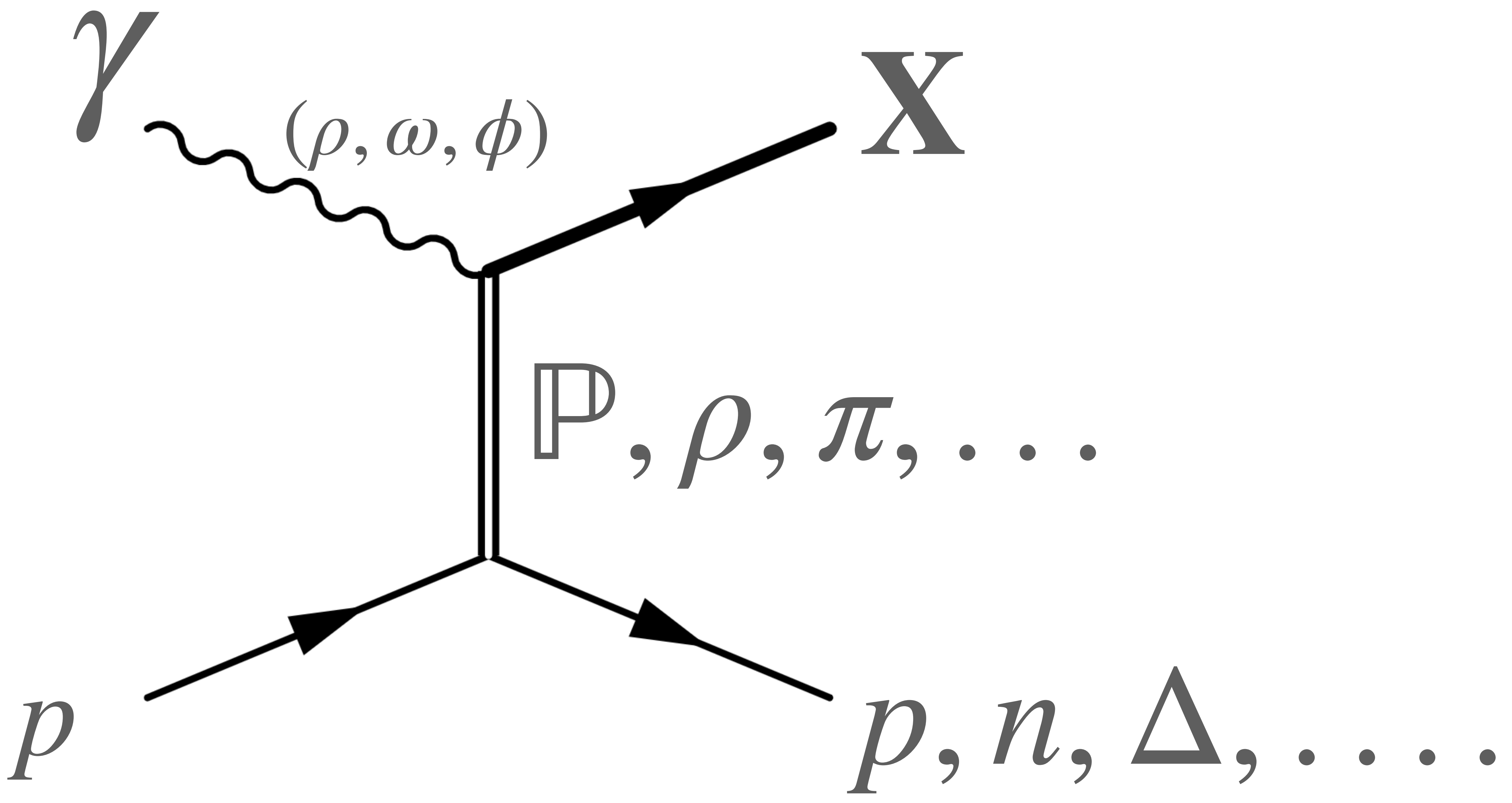
$a_2^- \rightarrow KsK^-$

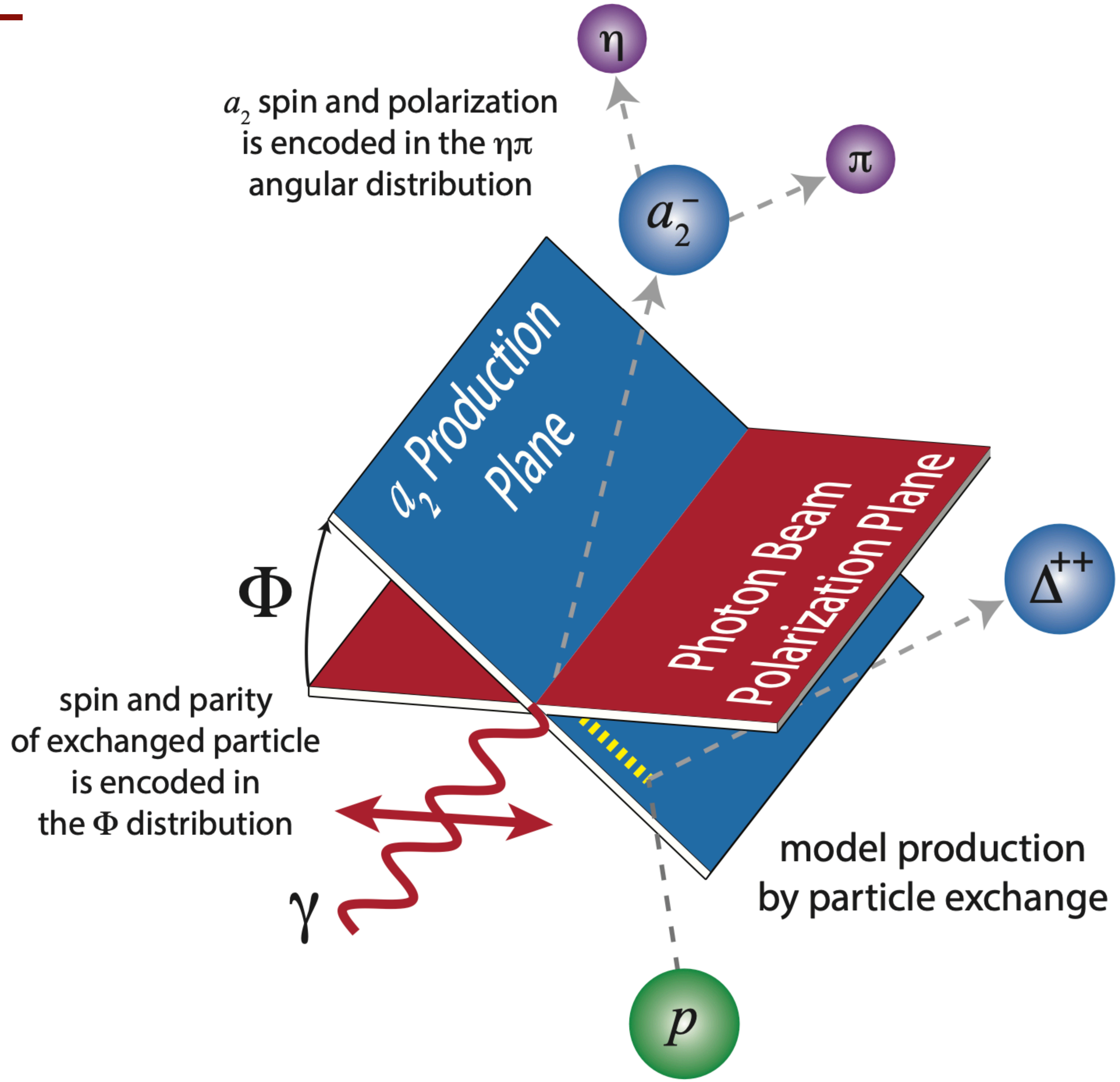
Kevin Saldaña

Dr. Matthew Shepherd

Photoproduction

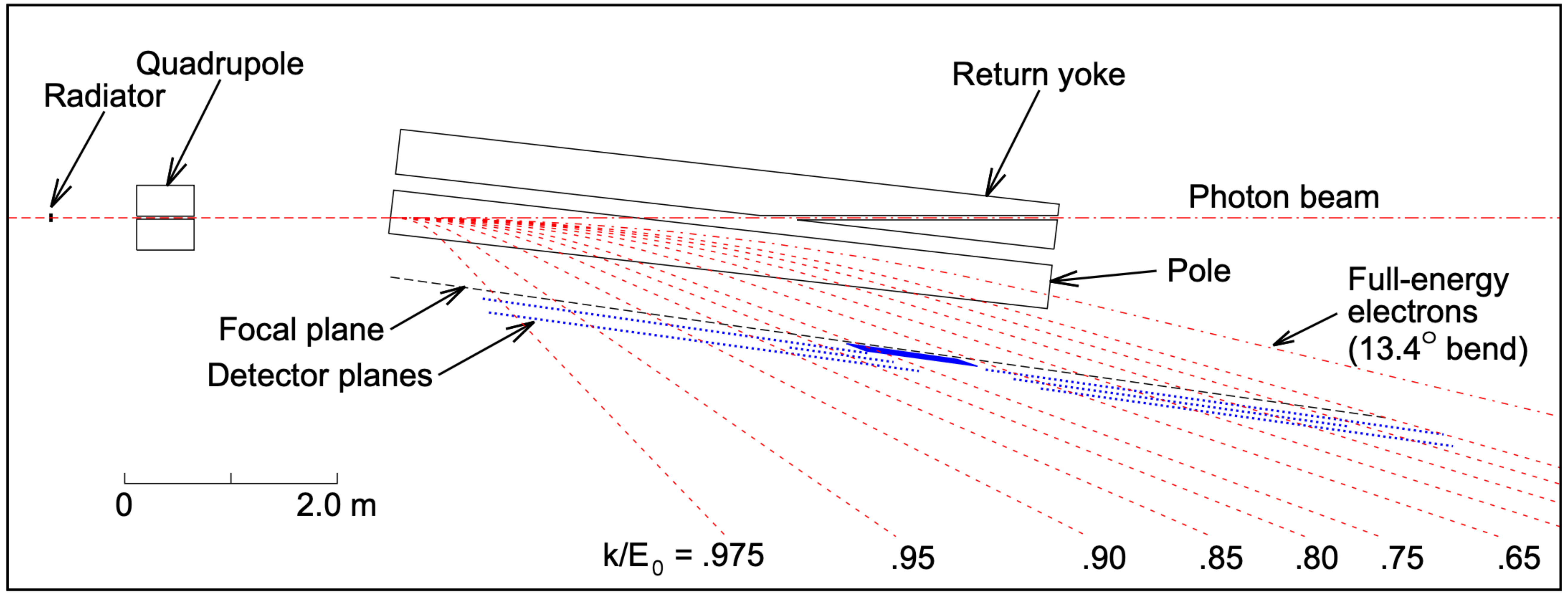


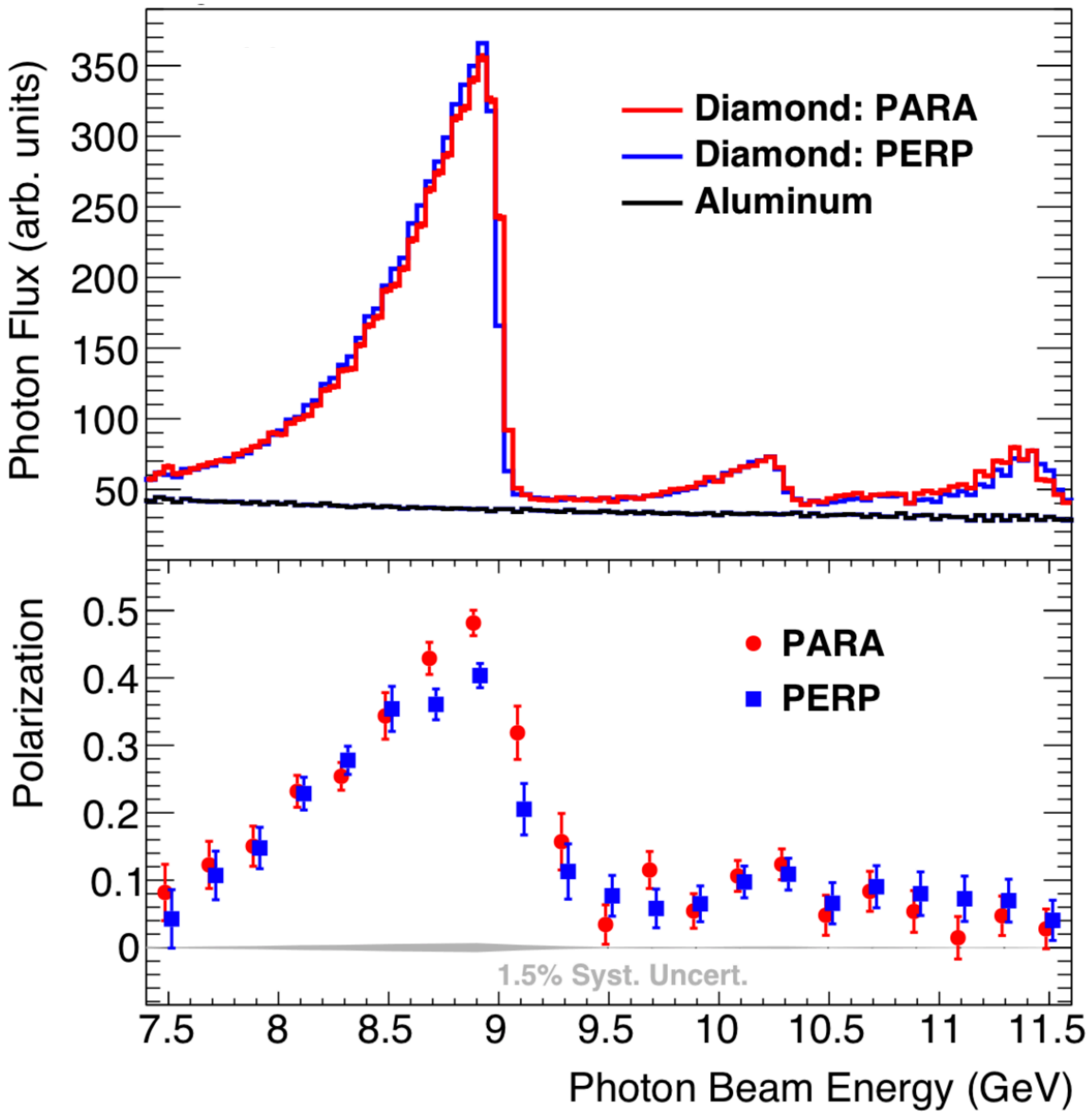
- **Linearly polarized photon beam**
- **Freedom to select "naturality" of exchange particle**



Polarized Photon Beam

- 50 μm diamond radiator, 4 polarization plane orientations
- Energy measurement
  - Tagger microscope (TAGM)
  - Tagger hodoscope (TAGH)
- Polarization and flux measurement
  - Triplet polarimeter (TPOL)
  - Pair spectrometer (TS)





GlueX Detector

Tracking:

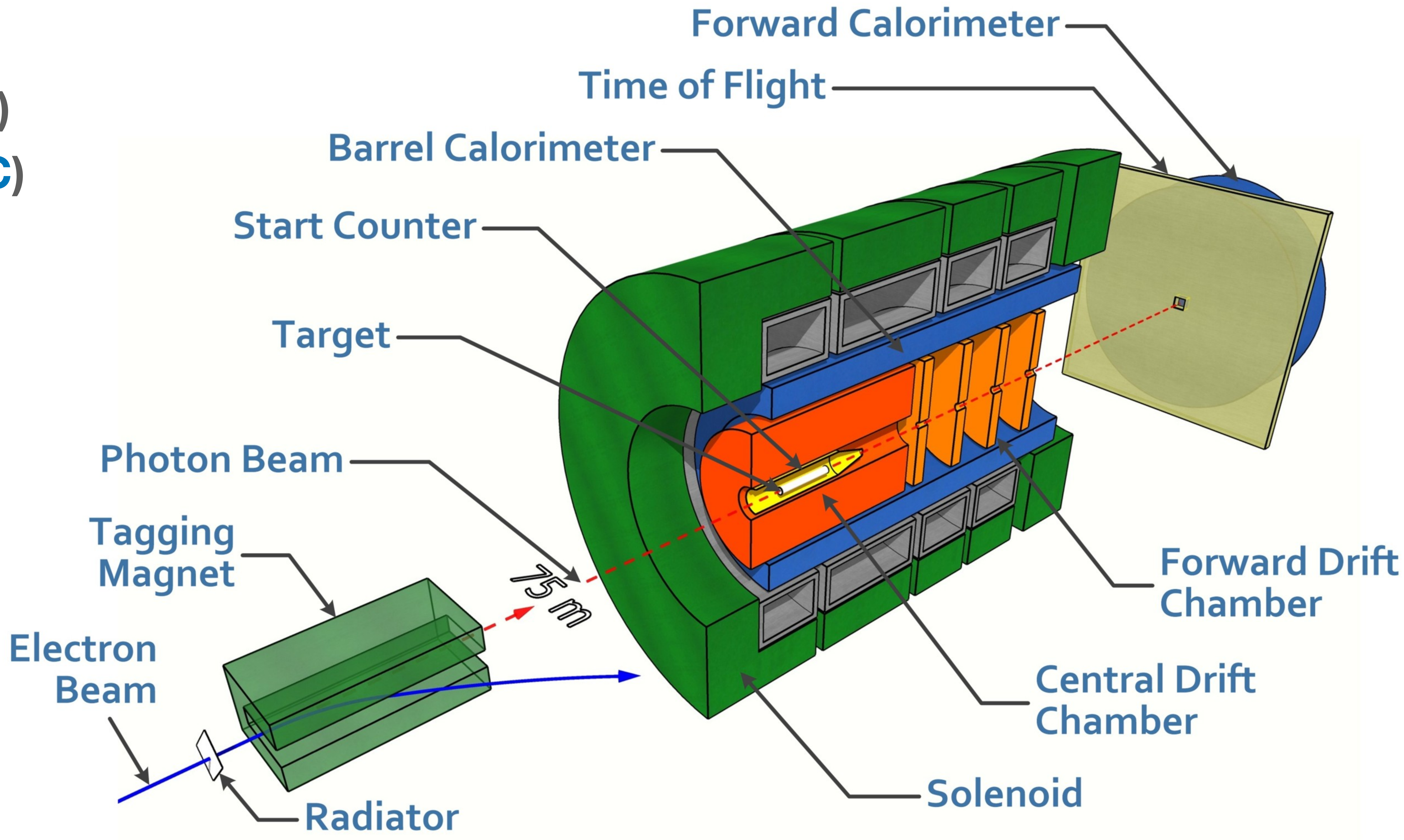
- Central Drift Chamber (CDC)
- Forward Drift Chamber (FDC)
- Momentum resolution 1-3%

Calorimetry:

- Forward Calorimetry (FCAL)
- Barrel Calorimetry (BCAL)
- Energy resolution ~6%

Particle Identification

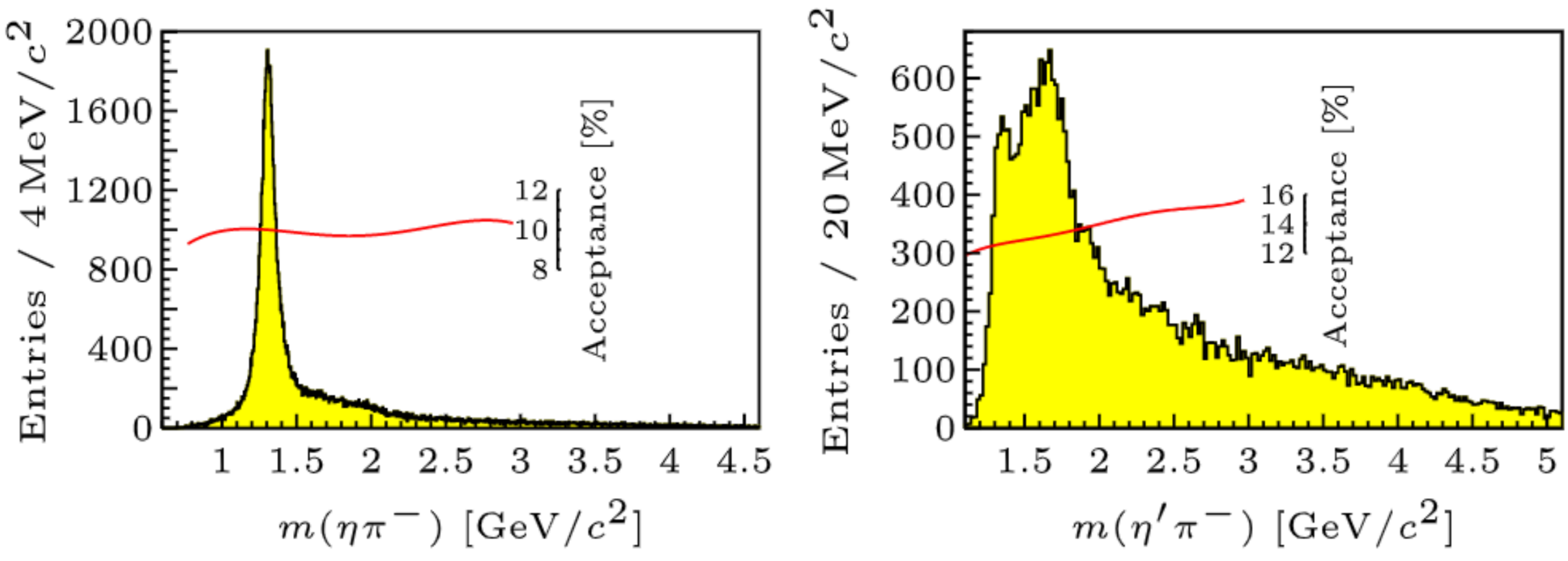
- Time of Flight (TOF)
- BCAL timing
- Tracking chambers dE/dx

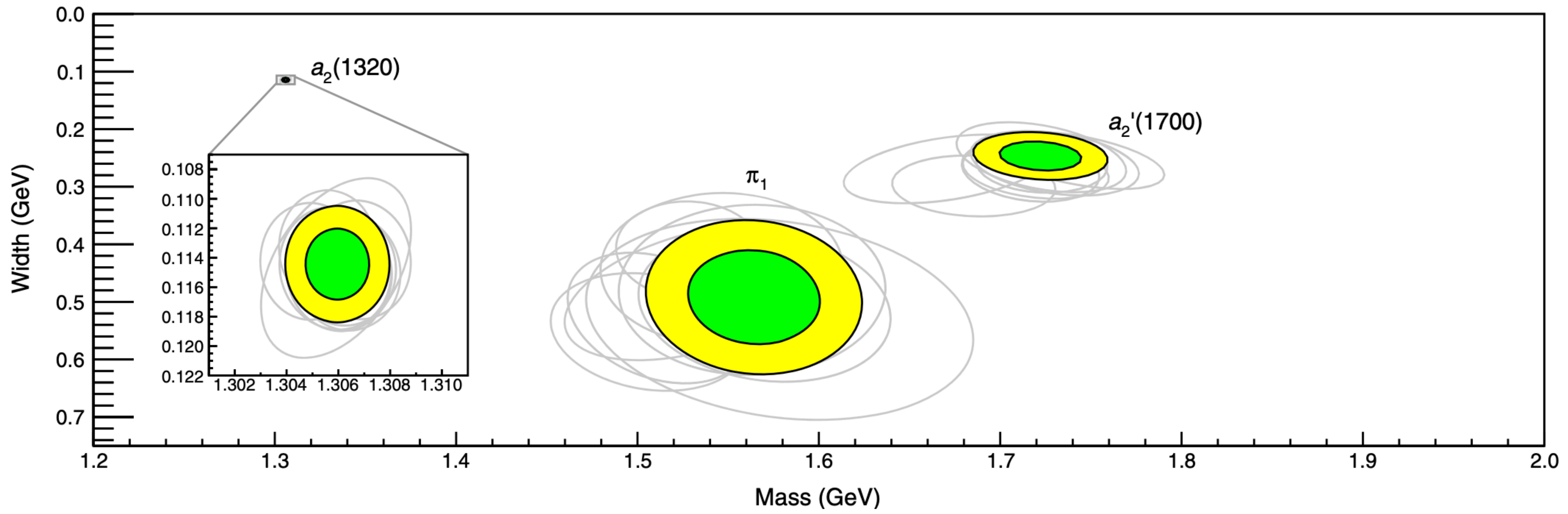


Exotic search

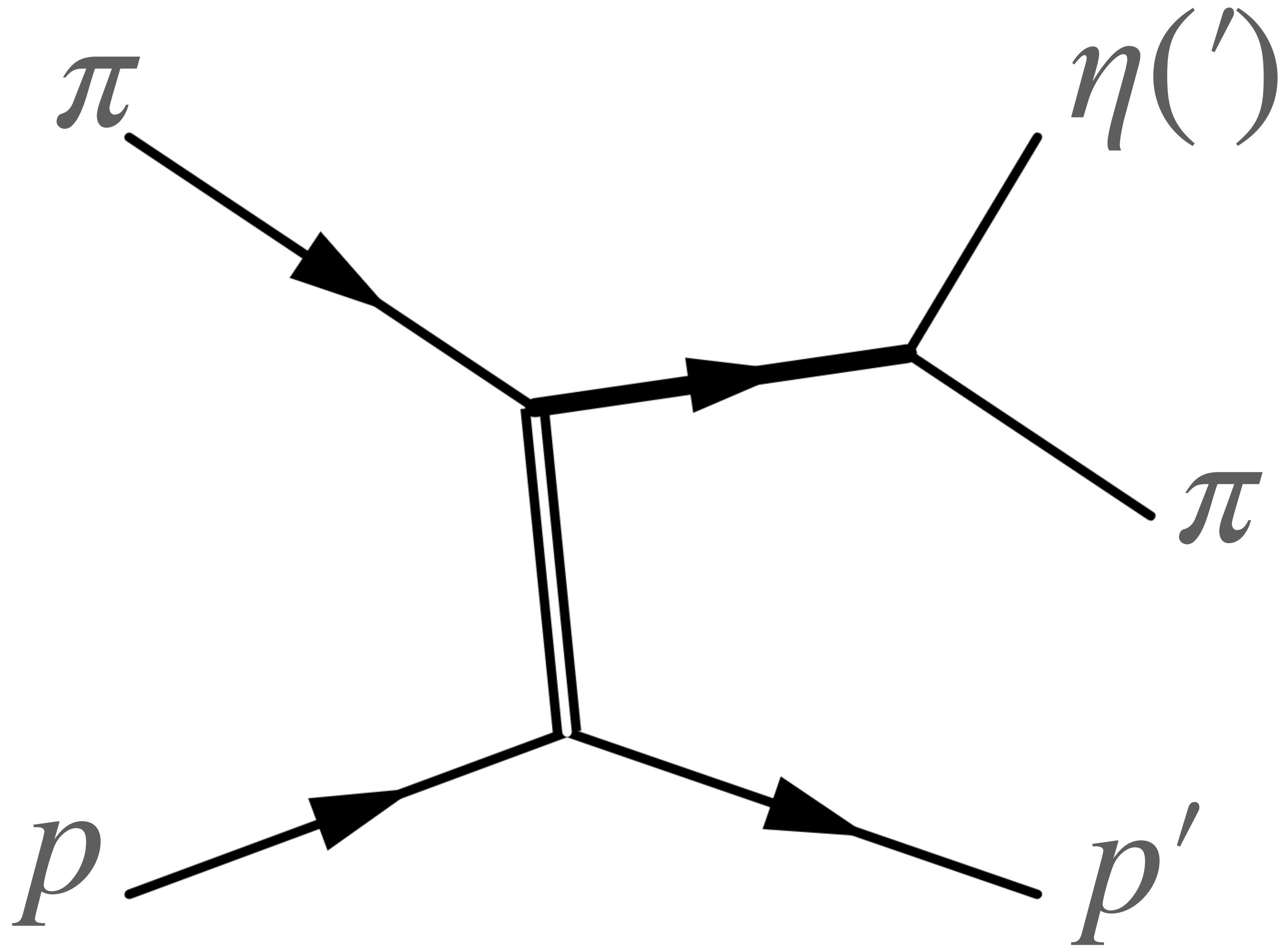
- **COMPASS and JPAC partial- wave analysis (PWA) for pion-production**
- $\pi p \to \eta' \pi p$
- $\pi p \to \eta \pi p$
- **Single π_1 resonance couples to $\eta^{(\prime)}\pi$**

COMPASS Collaboration / Physics Letters B 740 (2015) 303–311



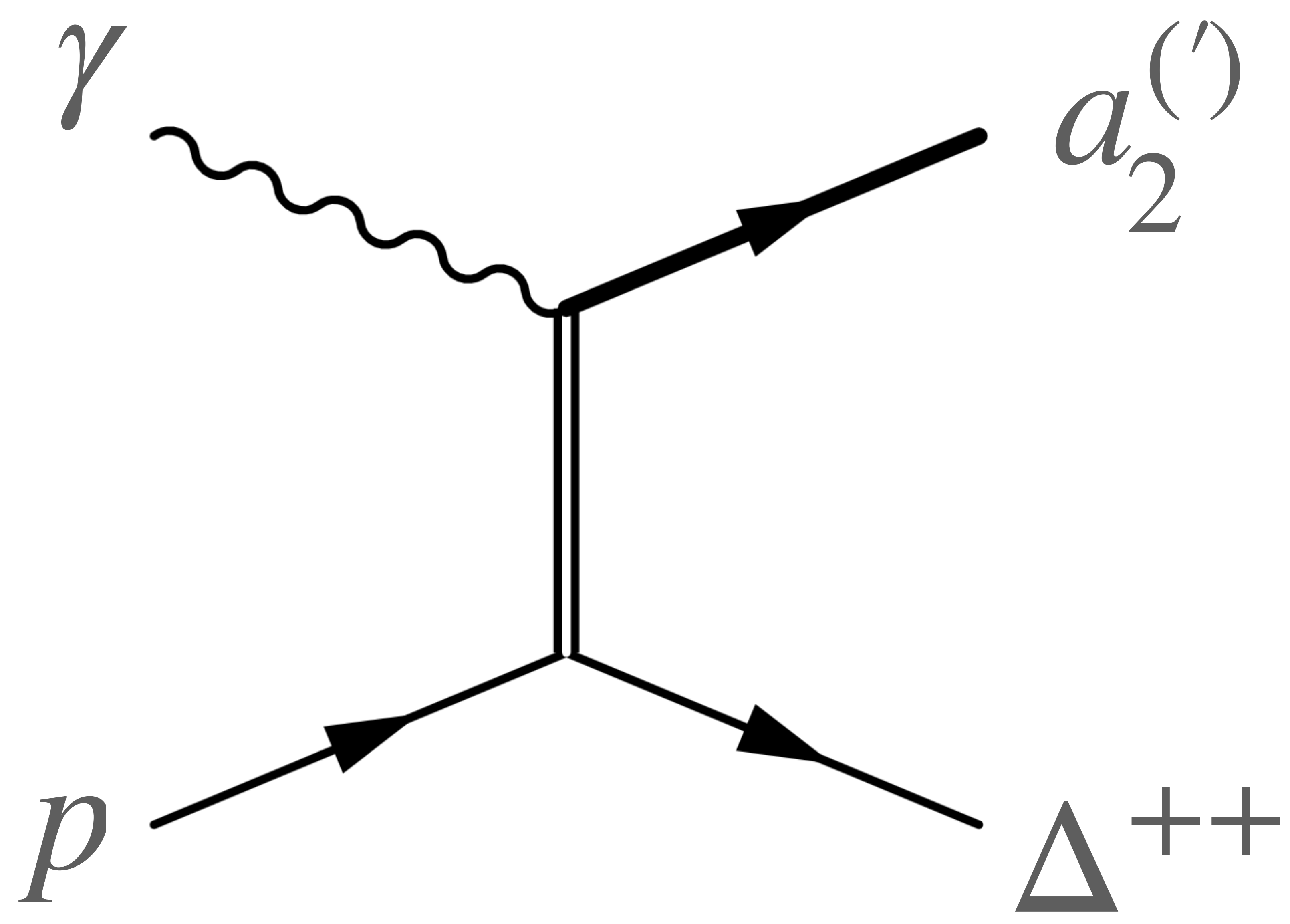


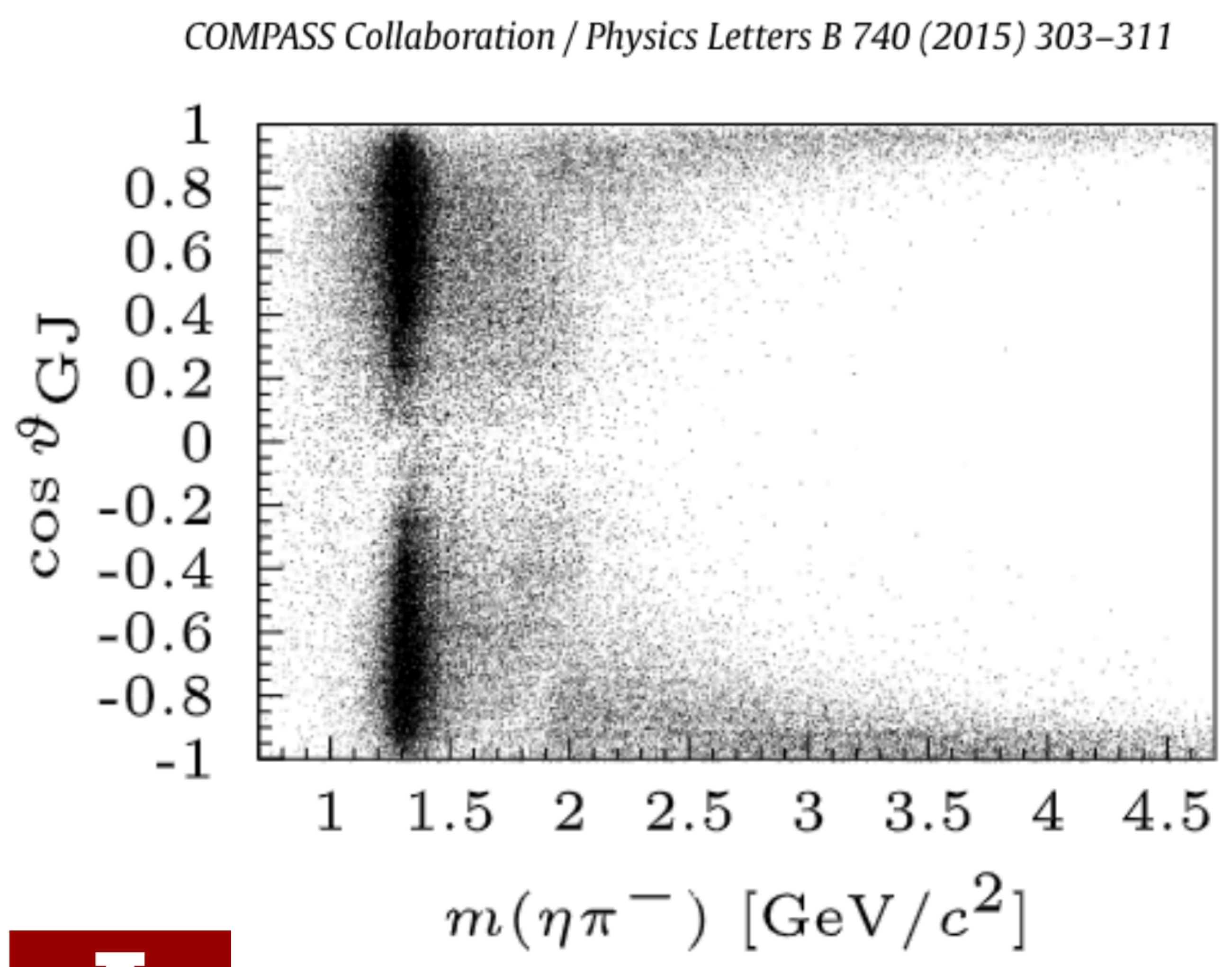
JPAC. Phys. Rev. Lett. **122**, 042002 (2019)

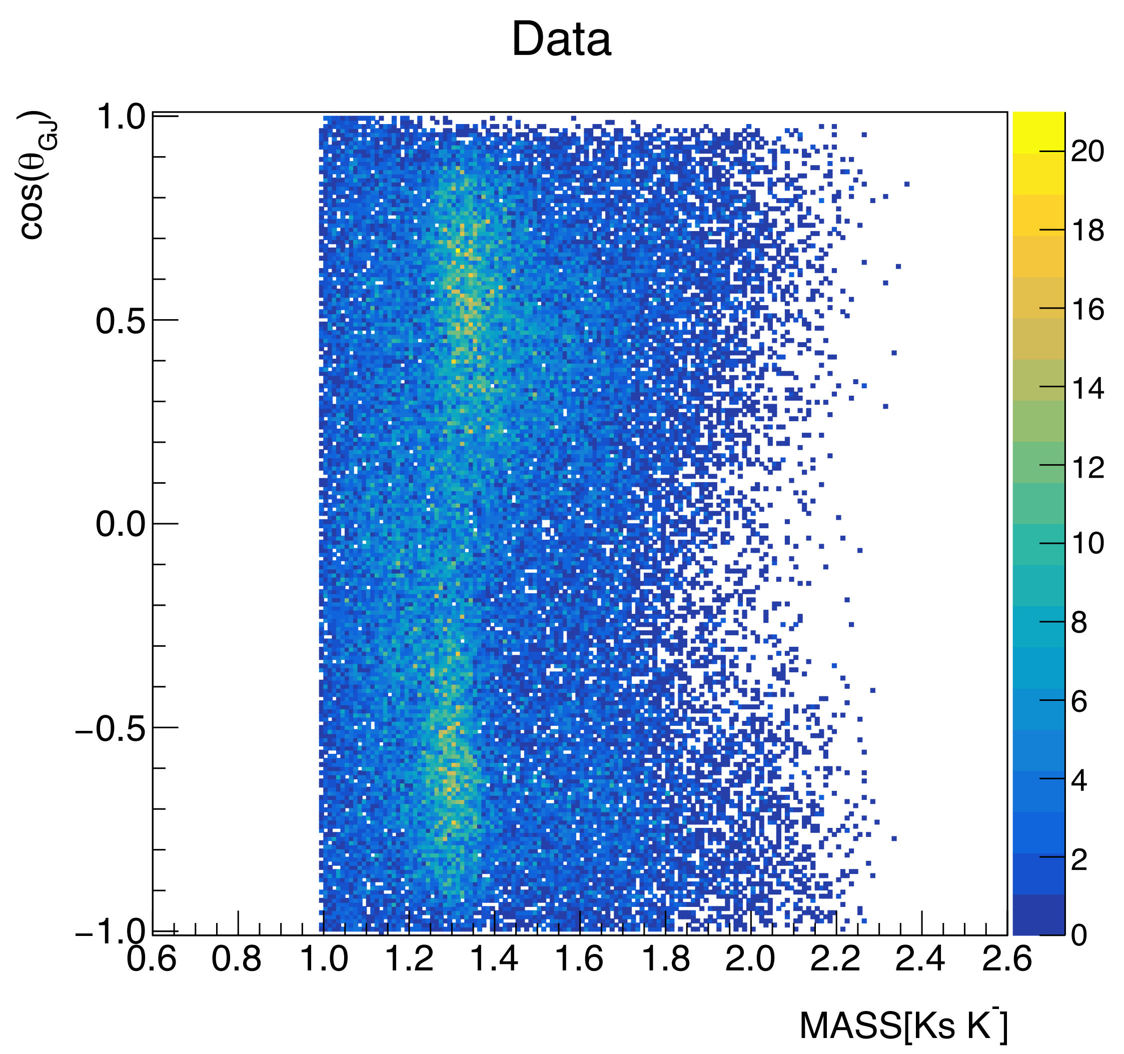


$a_2^{(\prime)}$ Analysis

- Look at exclusive reaction $\gamma p \rightarrow KsK^{-}\pi^{+}p$
- Priority of $\eta^{(\prime)}\pi$ in GlueX, strongest evidence for exotics
- Study production, t dependent cross section **without PWA**







Goal:

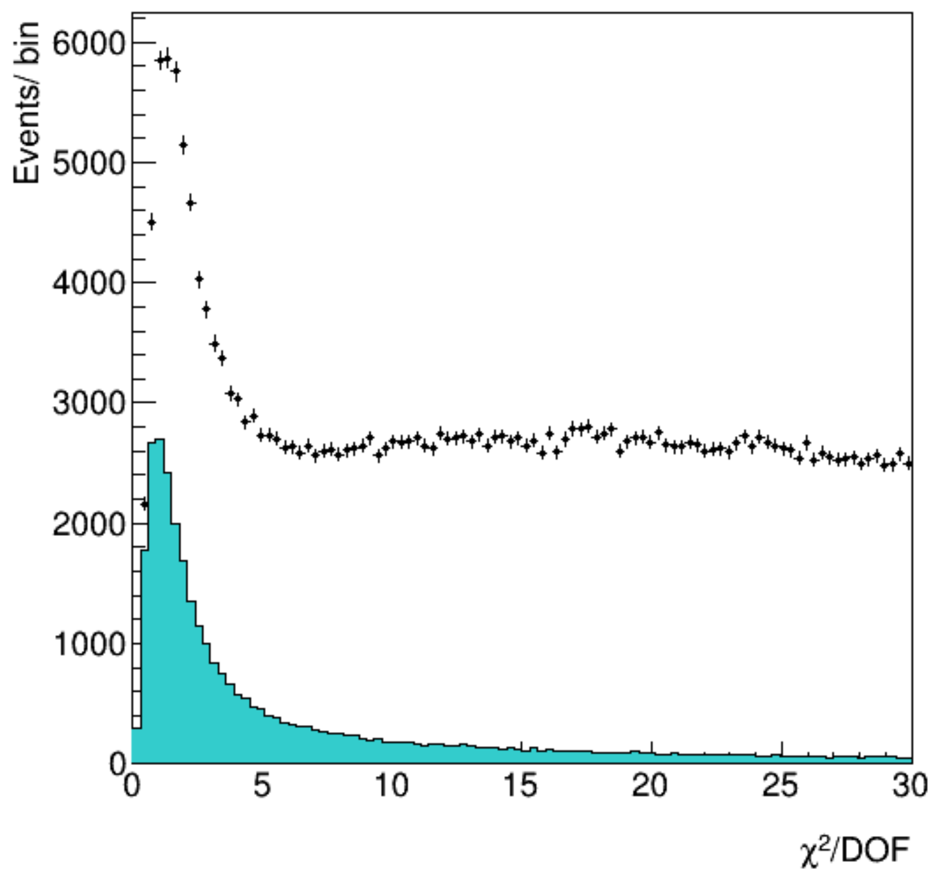
- Measure $\dfrac{\Gamma(a_2(1320) \rightarrow K\bar{K})}{\Gamma(a_2(1320) \rightarrow \eta\pi)}$
- Measure possible $a_2(1700)$

$a_2^{(\prime)}$ Analysis

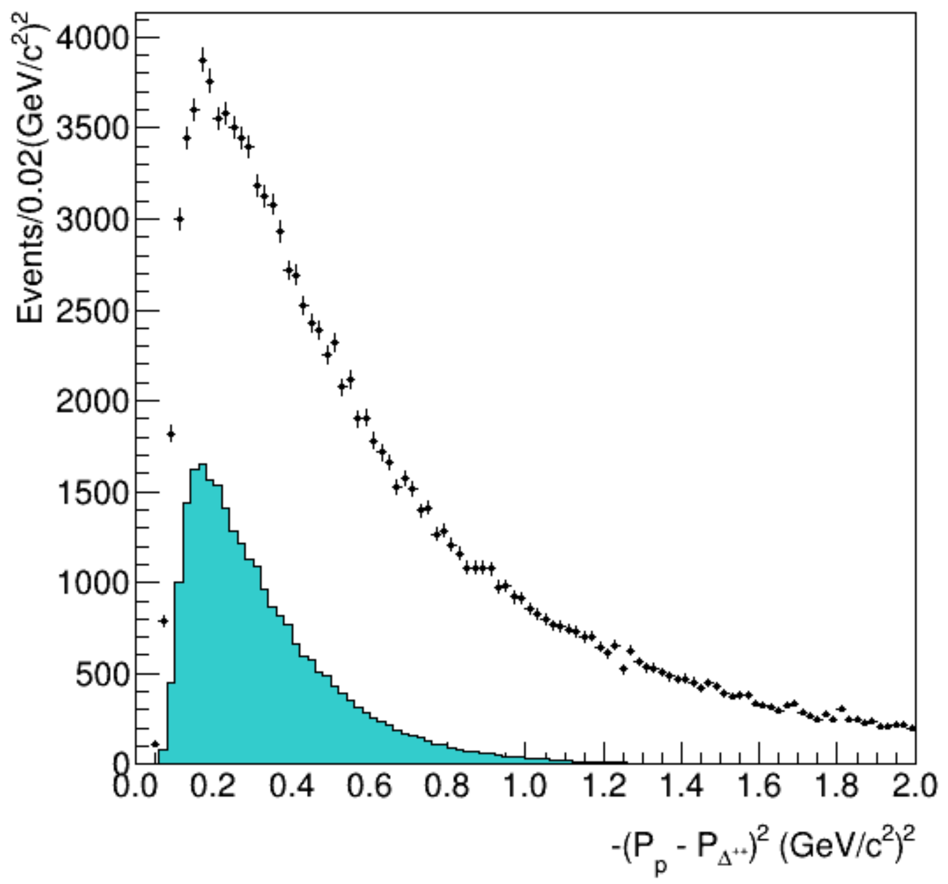
- Using Fall 2018 data

CUTS:

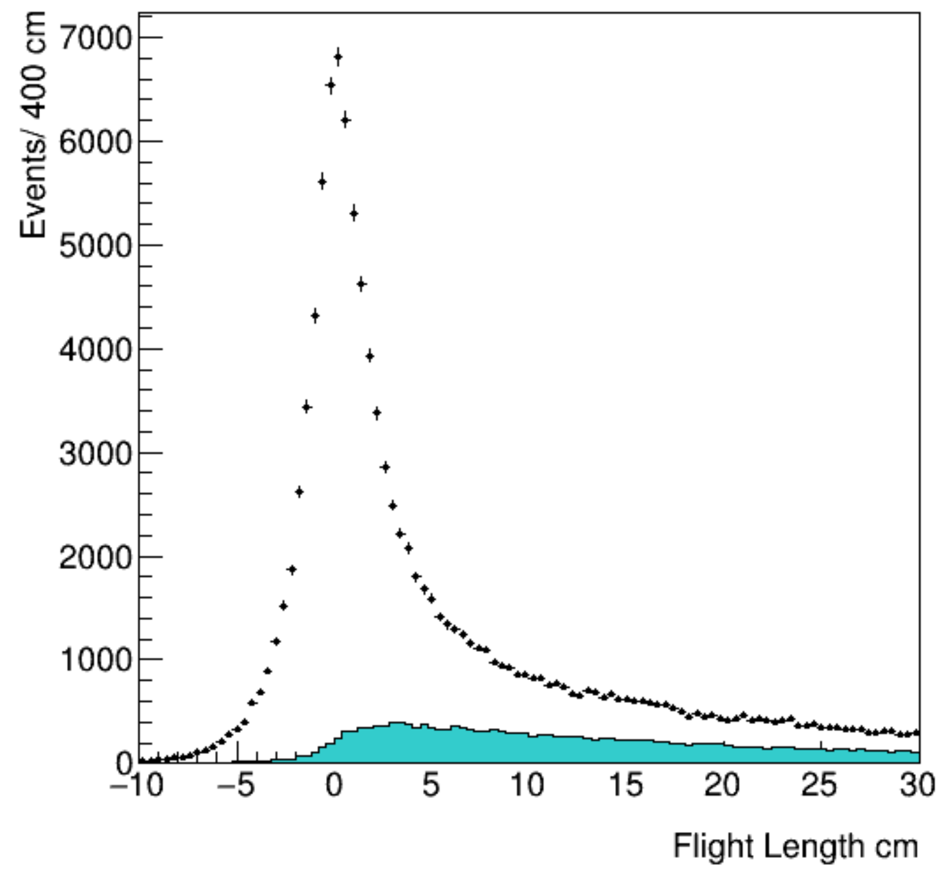
$\chi^2/DOF < 5$

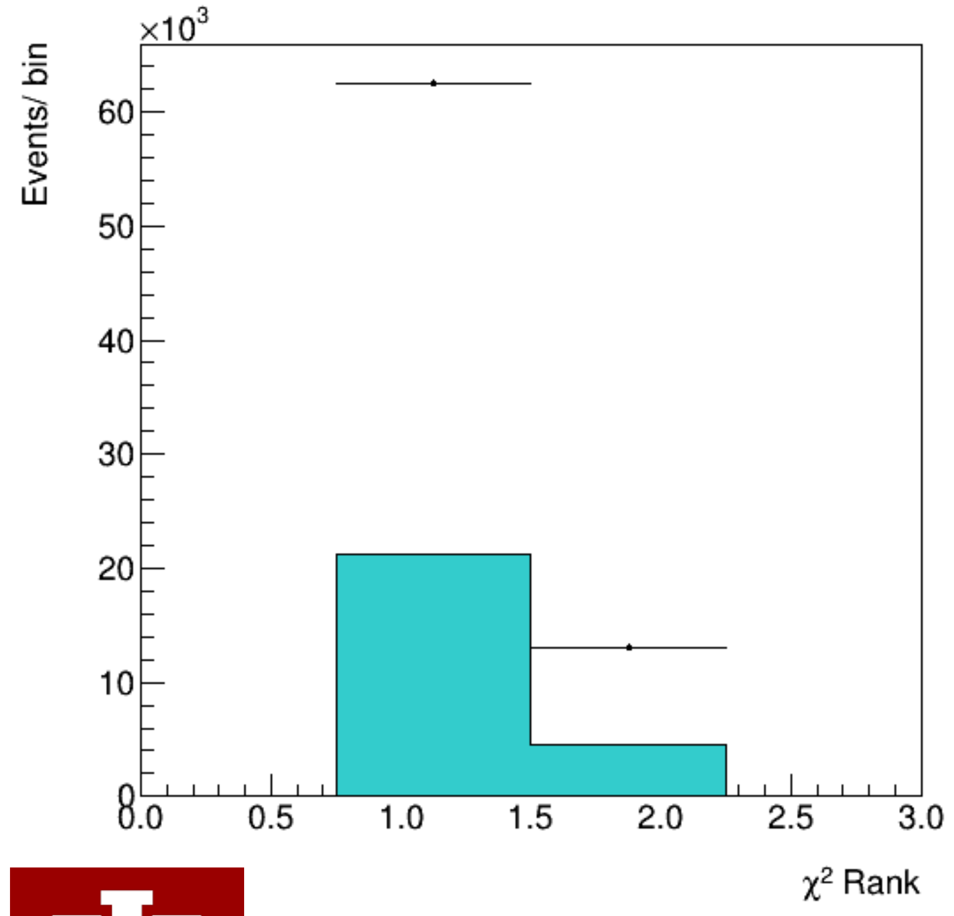


0.1 $GeV^2 <$ -t $<$ 0.5 GeV^2

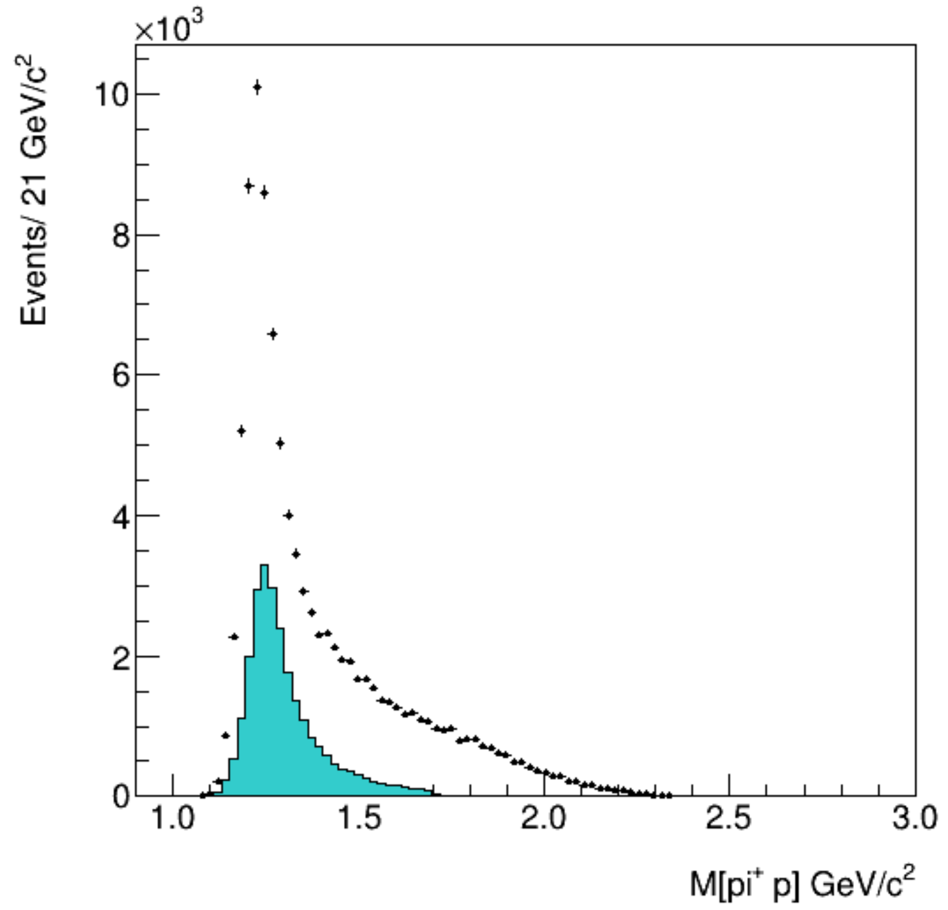


Ks Flight Length > 3 cm





1.1 $GeV < M[\pi^+ p] <$ **1.4** GeV



Signal MC scaled using:

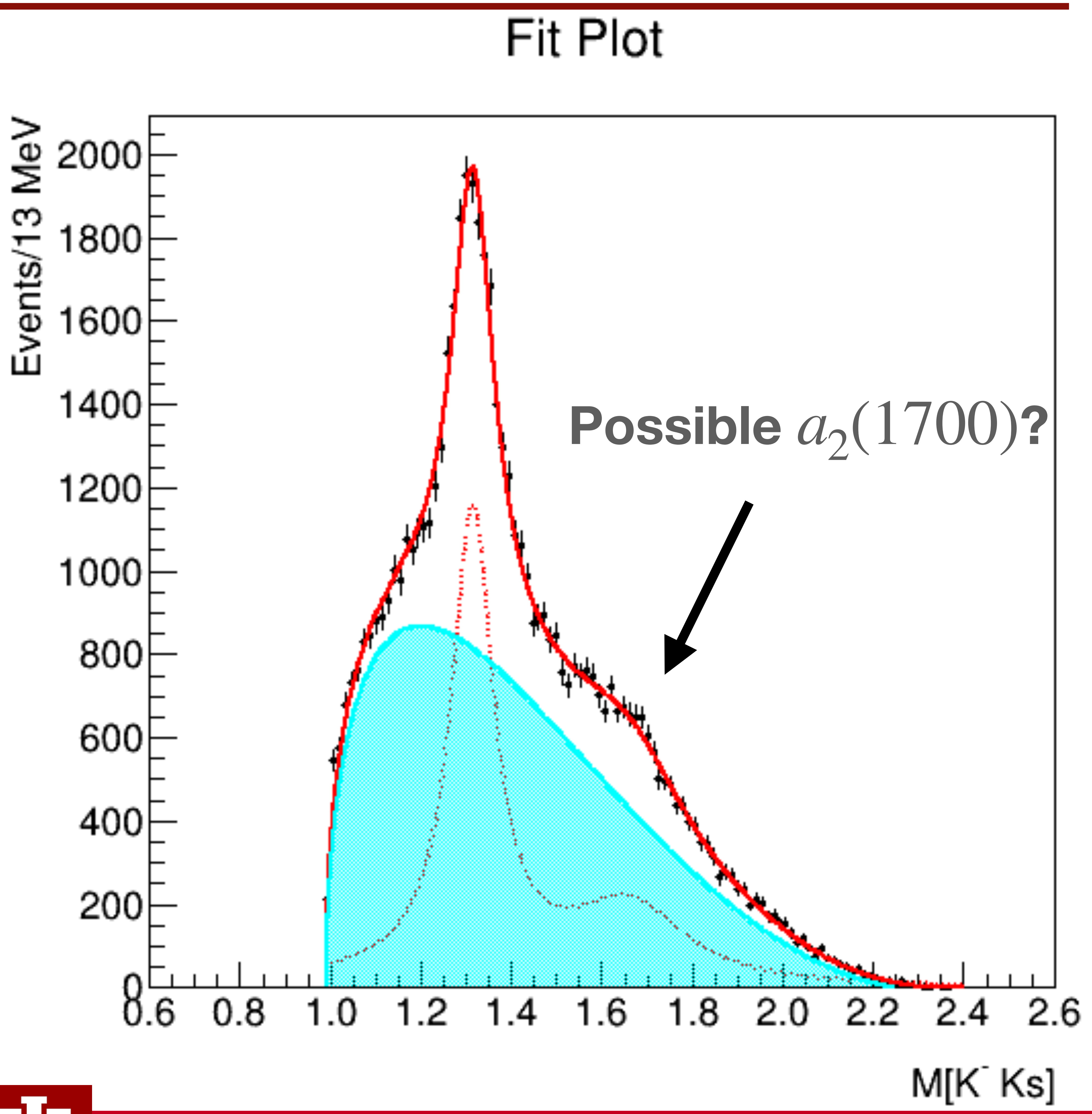
$$N^{data} = \left[\frac{L\sigma B}{N^{MC,gen}}\right] N^{MC,acc}$$

Data

Signal MC

$a_2^- \Delta^{++} \rightarrow (KsK^-)(\pi^+ p)$

$a_2^{(\prime)}$ Analysis



$$\left| \frac{a}{M_{INV}^2 - M_{a_2}^2 + iM_{a_2}\Gamma_{a_2}} + \frac{be^{i\delta}}{M_{INV}^2 - M_{a_2'}^2 + iM_{a_2'}\Gamma_{a_2'}} \right|^2$$

$$\sigma = \frac{N^{DATA}}{LB((a_2 \rightarrow K\bar{K})(Ks \rightarrow \pi^+\pi^-))\ \epsilon} = 461 \pm 13_{stat.}\ nb$$

$M_{a_2} = 1.315 \pm 0.002\ GeV$

$\Gamma_{a_2} = 0.114 \pm 0.003\ GeV$

$M_{a_2'} = 1.660 \pm 0.010\ GeV$

$\Gamma_{a_2'} = 0.322 \pm 0.021\ GeV$

DATA

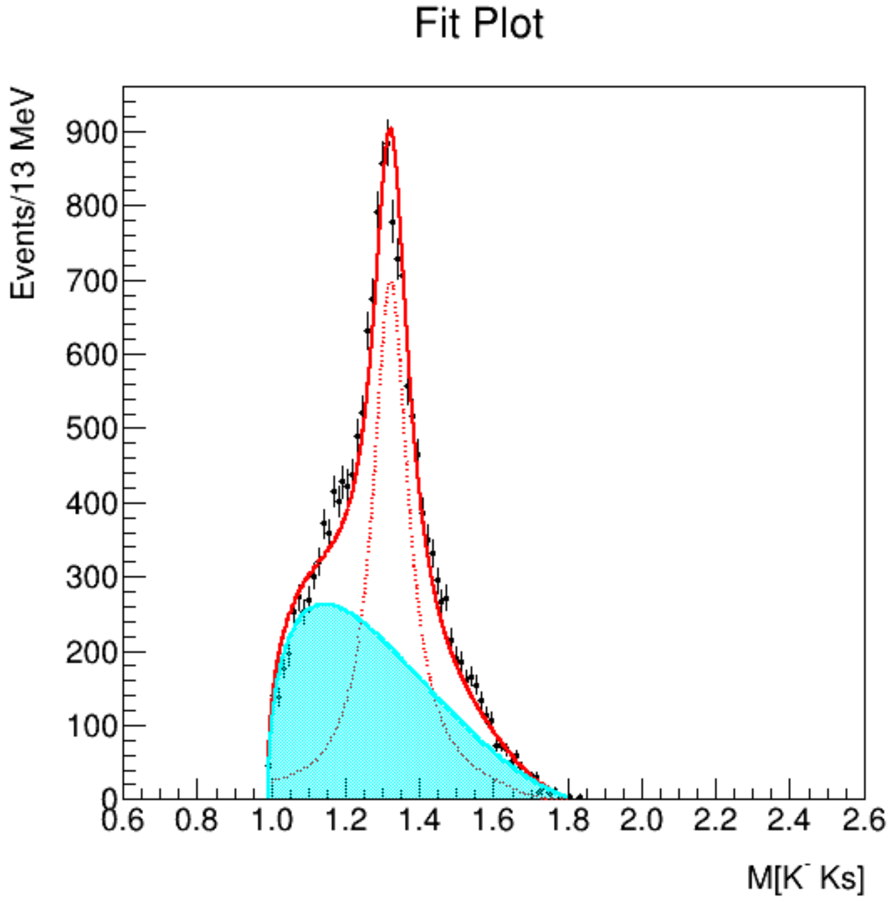
Breit_Wigner

Phase Space x 2nd order poly

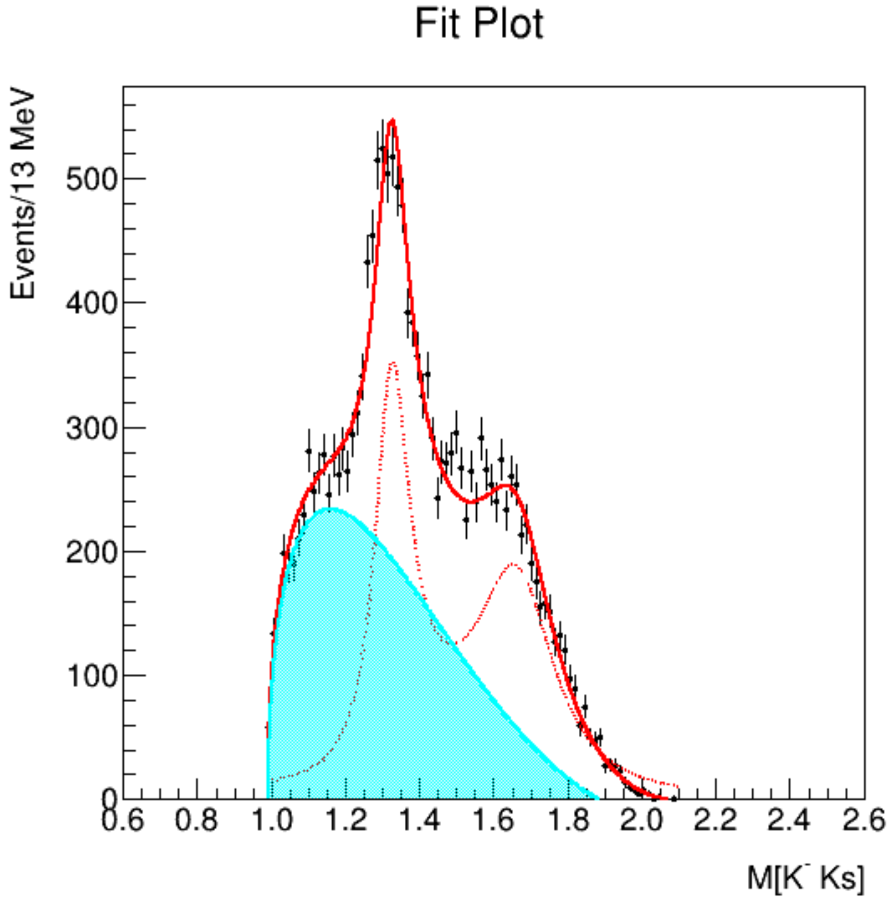
t-dependent cross section

- Calculate cross section in bins of t

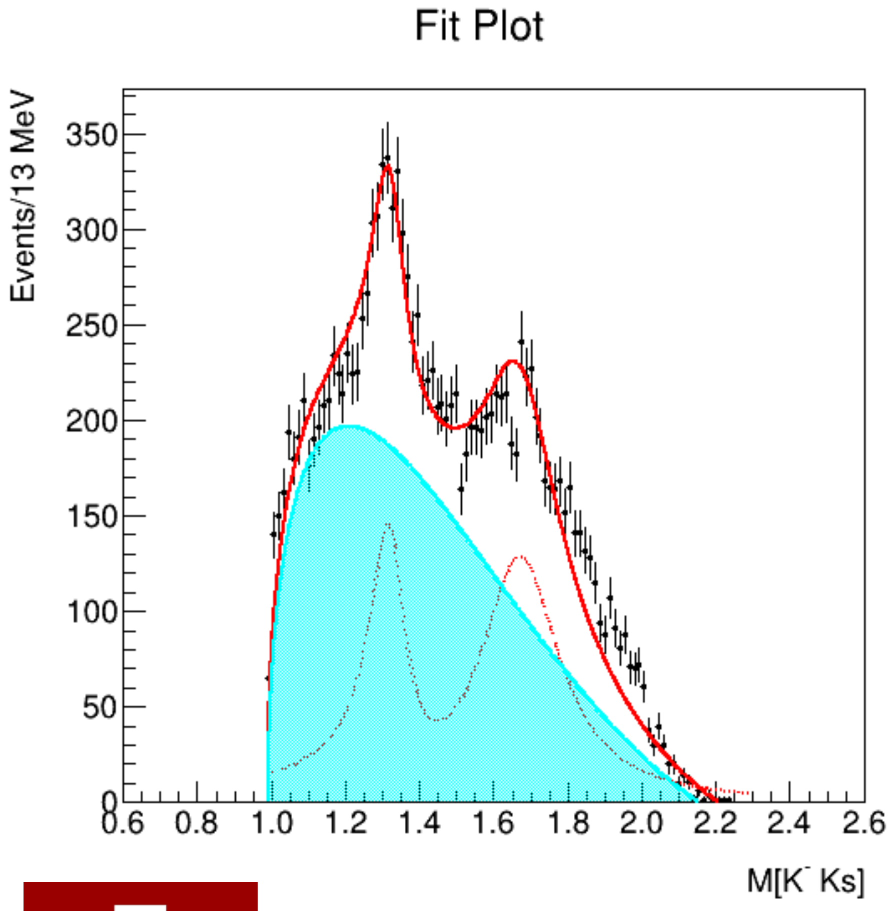
0.1 < -t < 0.2



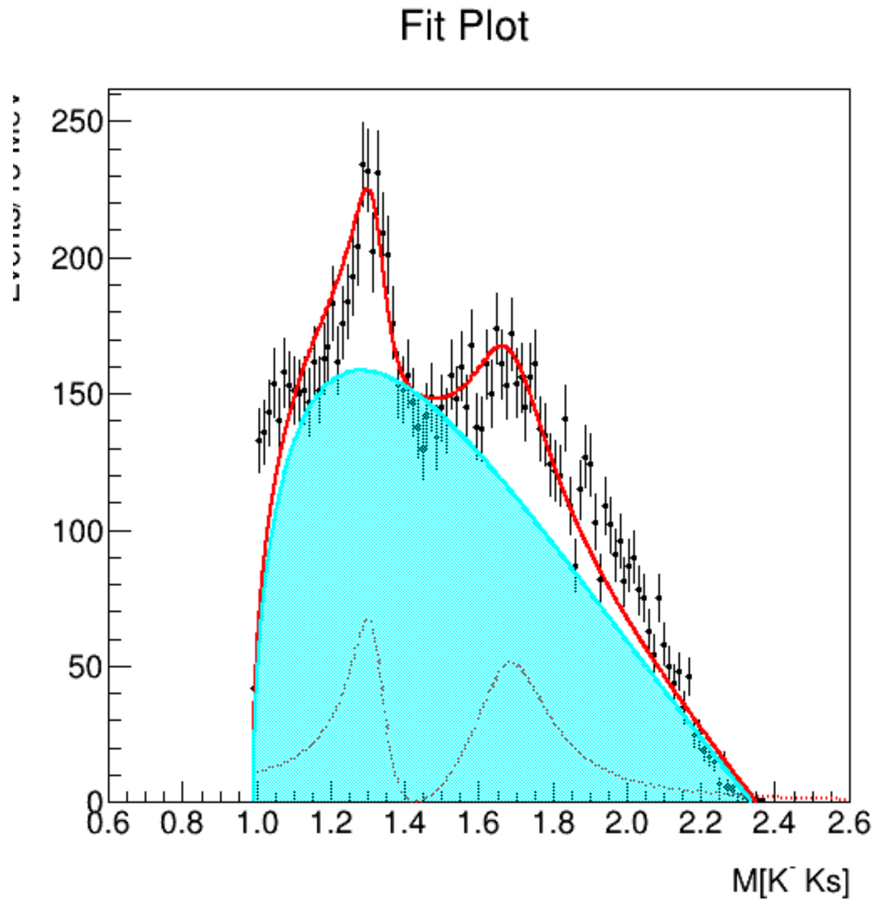
0.2 < -t < 0.3



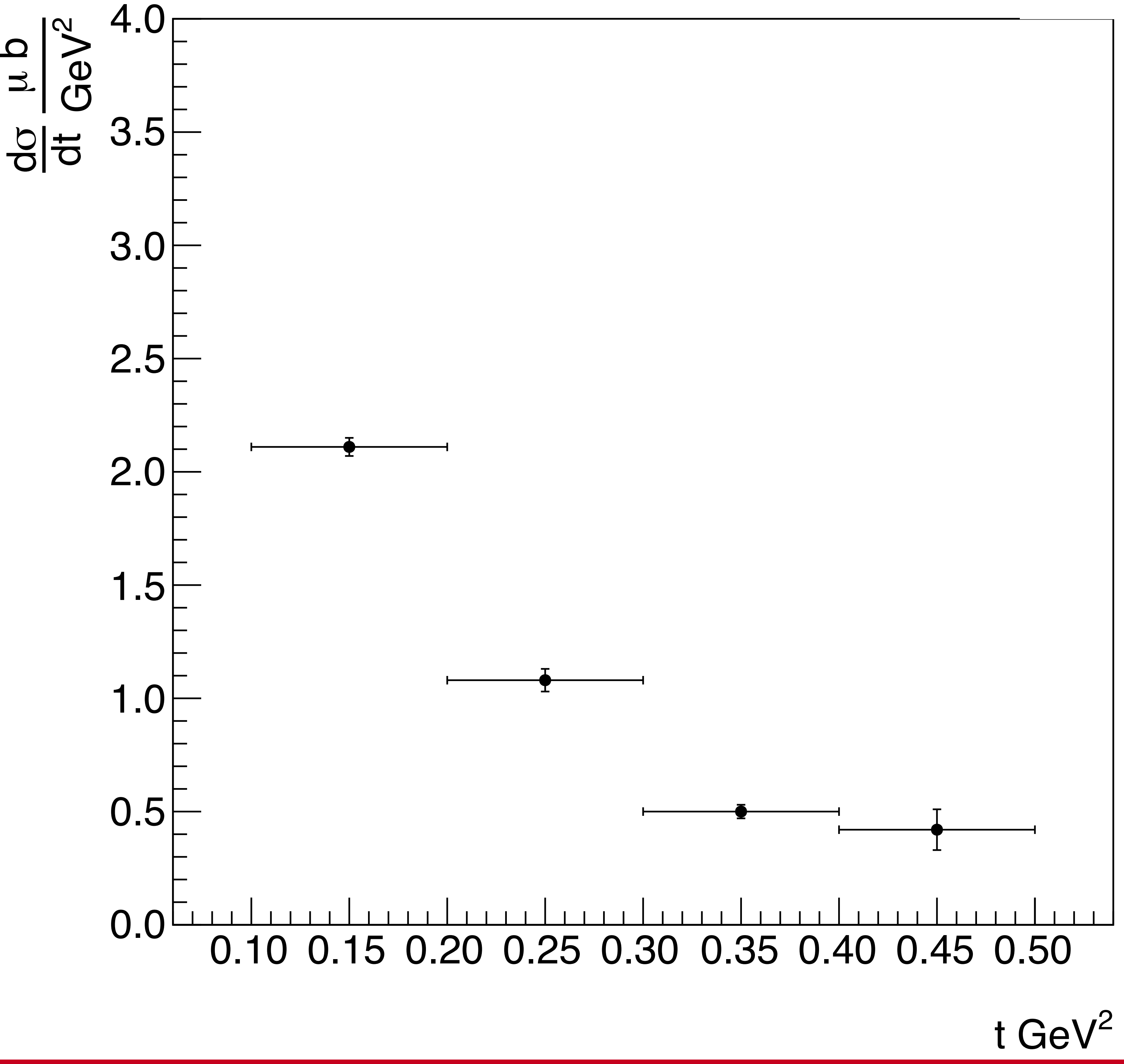
0.3 < -t < 0.4

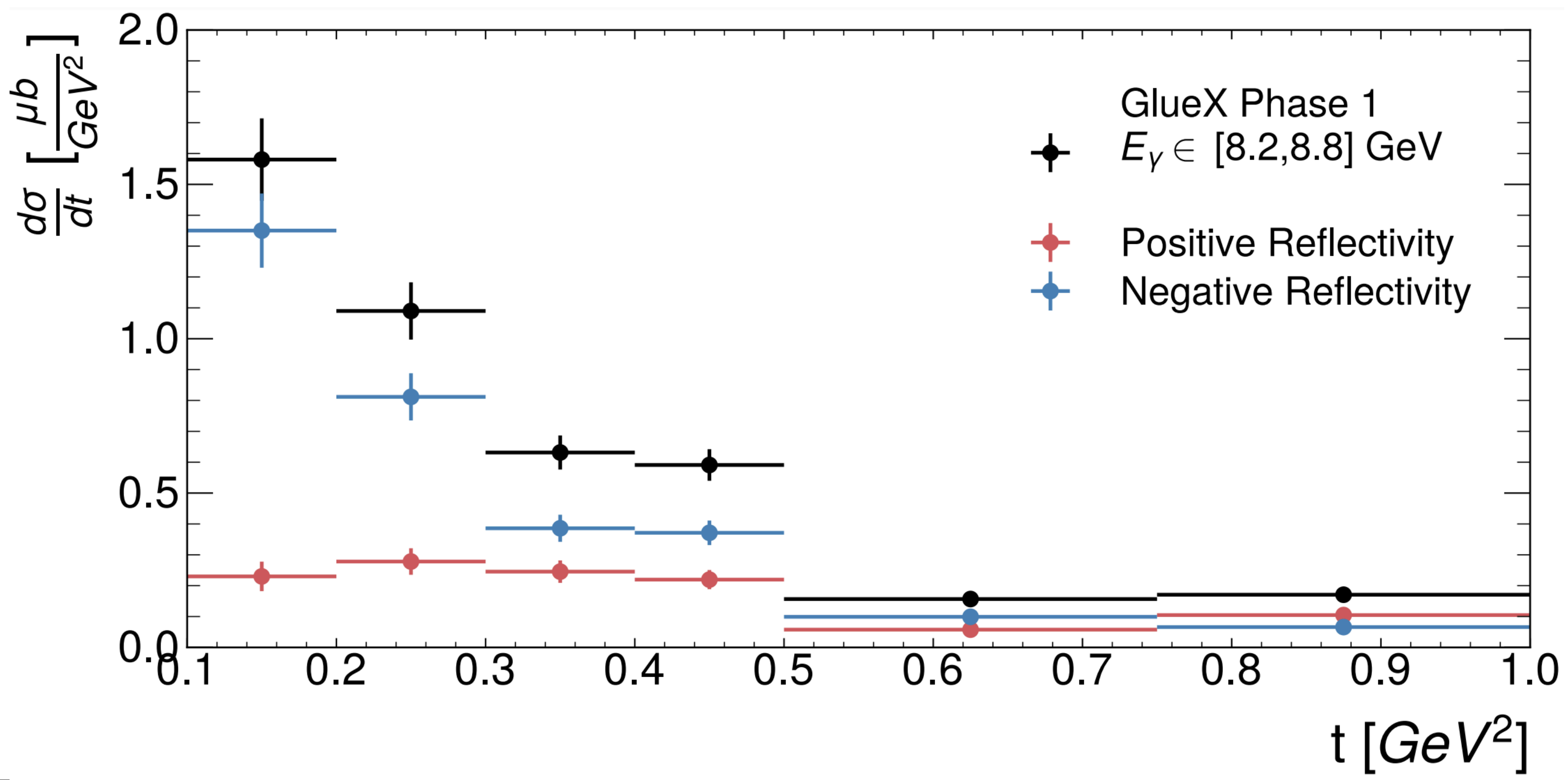


0.4 < -t < 0.5



- Understand **background** under signal
  - Contributions?
  - Can eliminate?



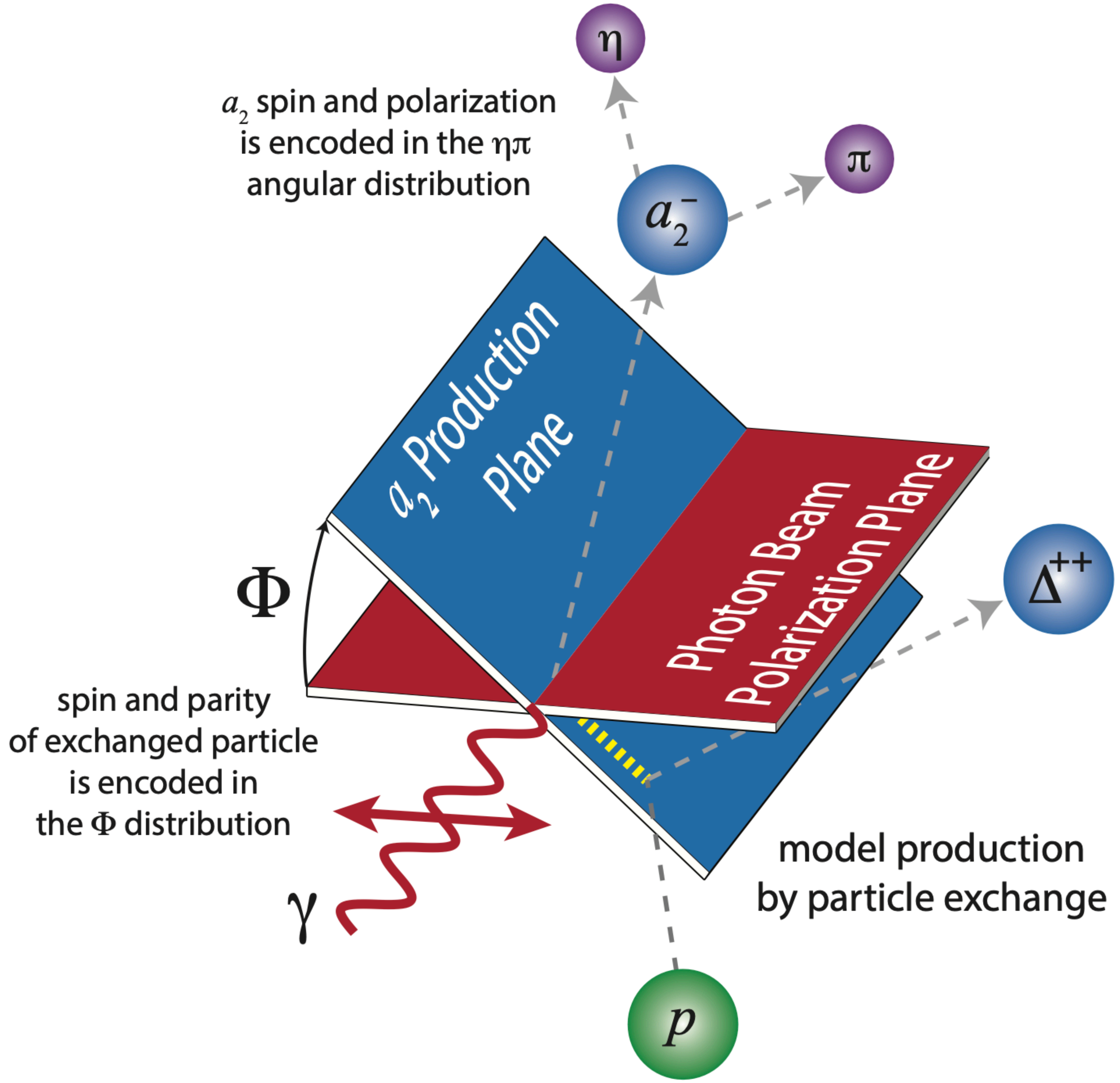


Angular Moments

- **Angular distributions give indication of parent particles**
- **Weight bins of mass by angular distributions show contribution of S,P,D waves**

$$H^0(LM) = \frac{1}{2\pi} \int_o I(\Omega, \Phi)\ d^L_{M0}(\theta)\ cosM\phi$$

$$H^1(LM) = \frac{1}{\pi P_\gamma} \int_o I(\Omega, \Phi)\ d^L_{M0}(\theta)\ cosM\phi\ cos(2\Phi)$$

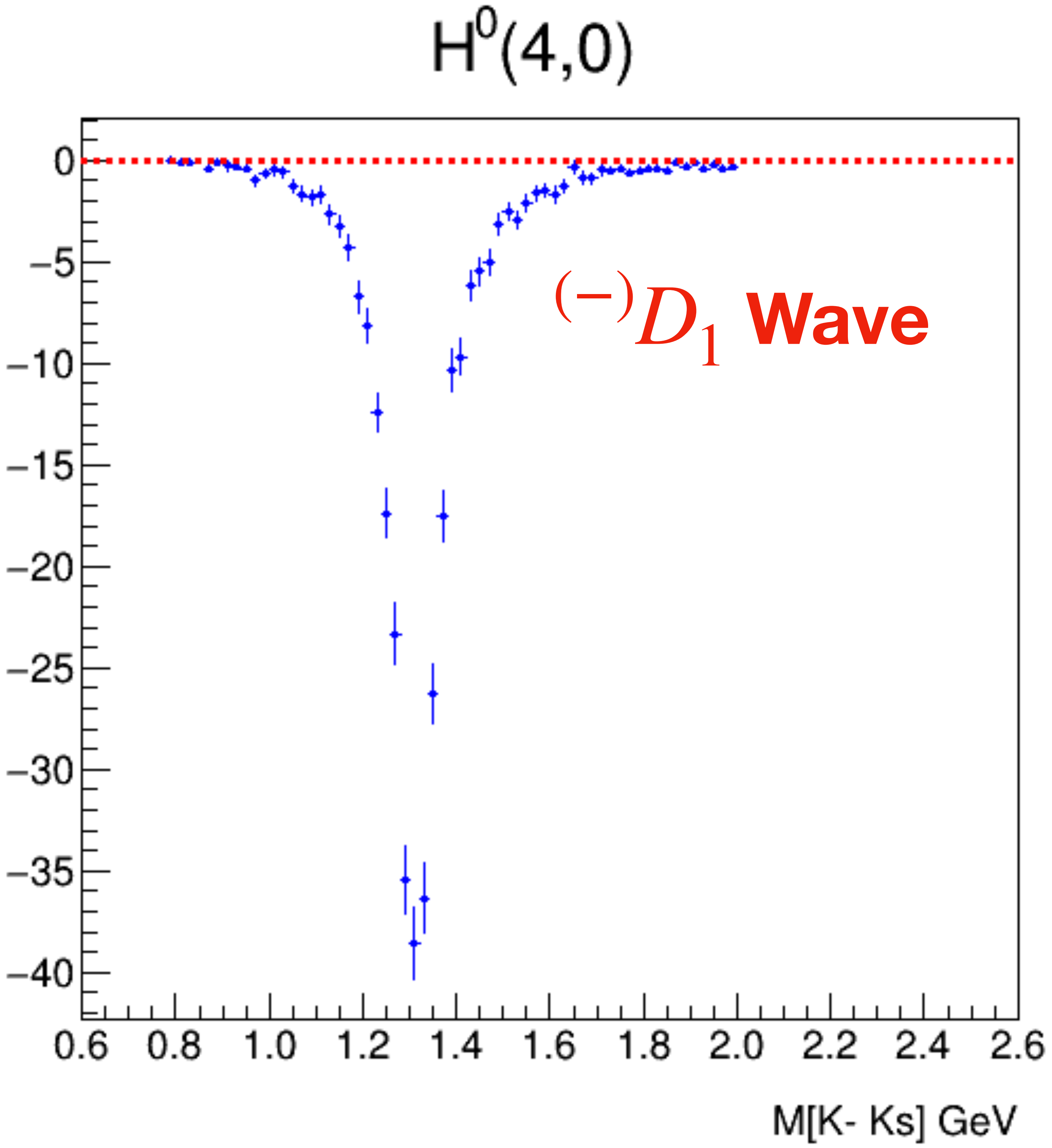


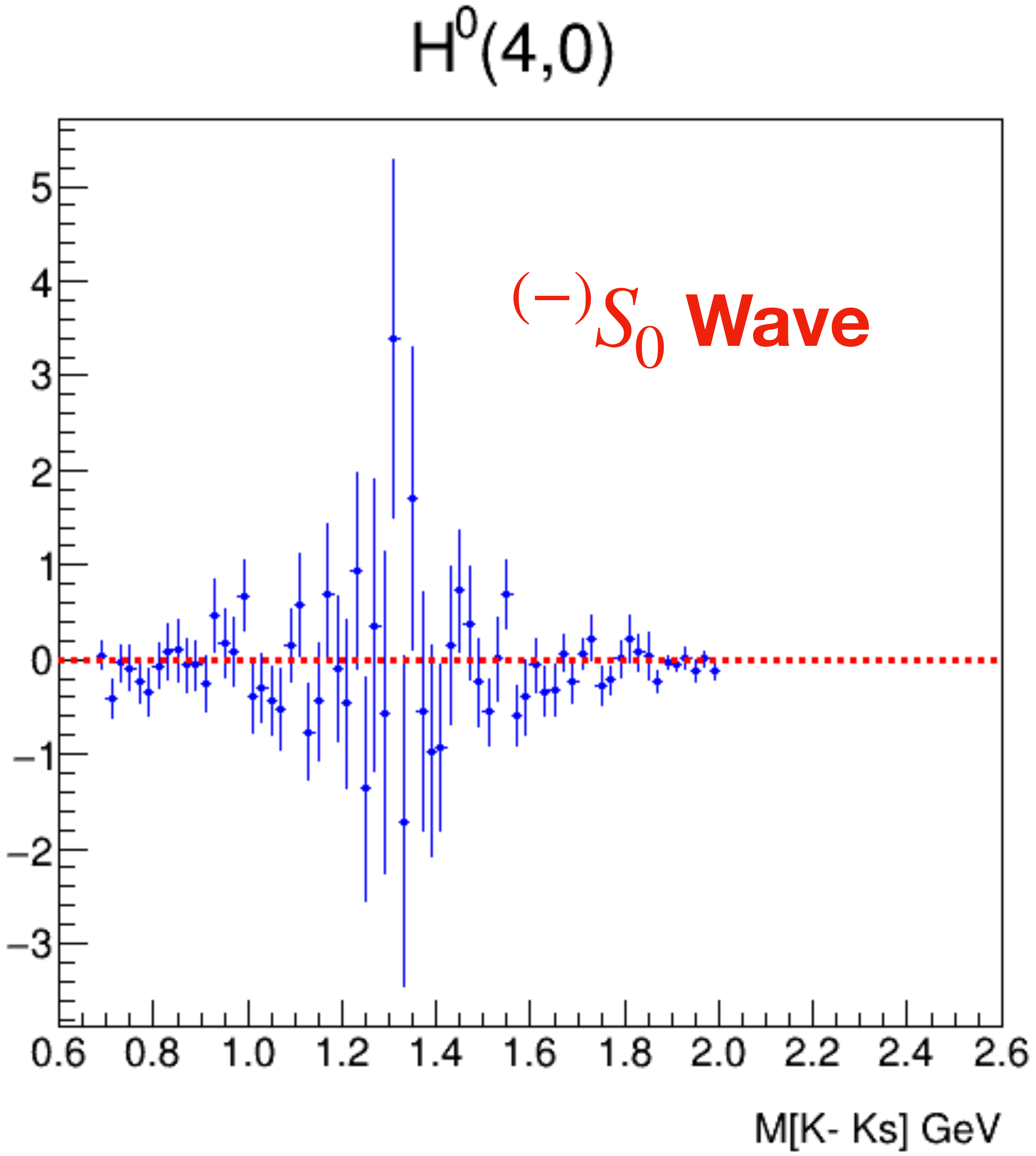
Angular Moments (Cont.)

$$^{(-)}H^{(0)}(4,0) = \frac{2}{21}\left[6\,|D_0^{(-)}|^2 - 4\left(|D_1^{(-)}|^2 + |D_{-1}^{(-)}|^2\right) + |D_2^{(-)}|^2 + |D_{-2}^{(-)}|^2\right]$$

Polarization Angle = 45°

Gen-amp

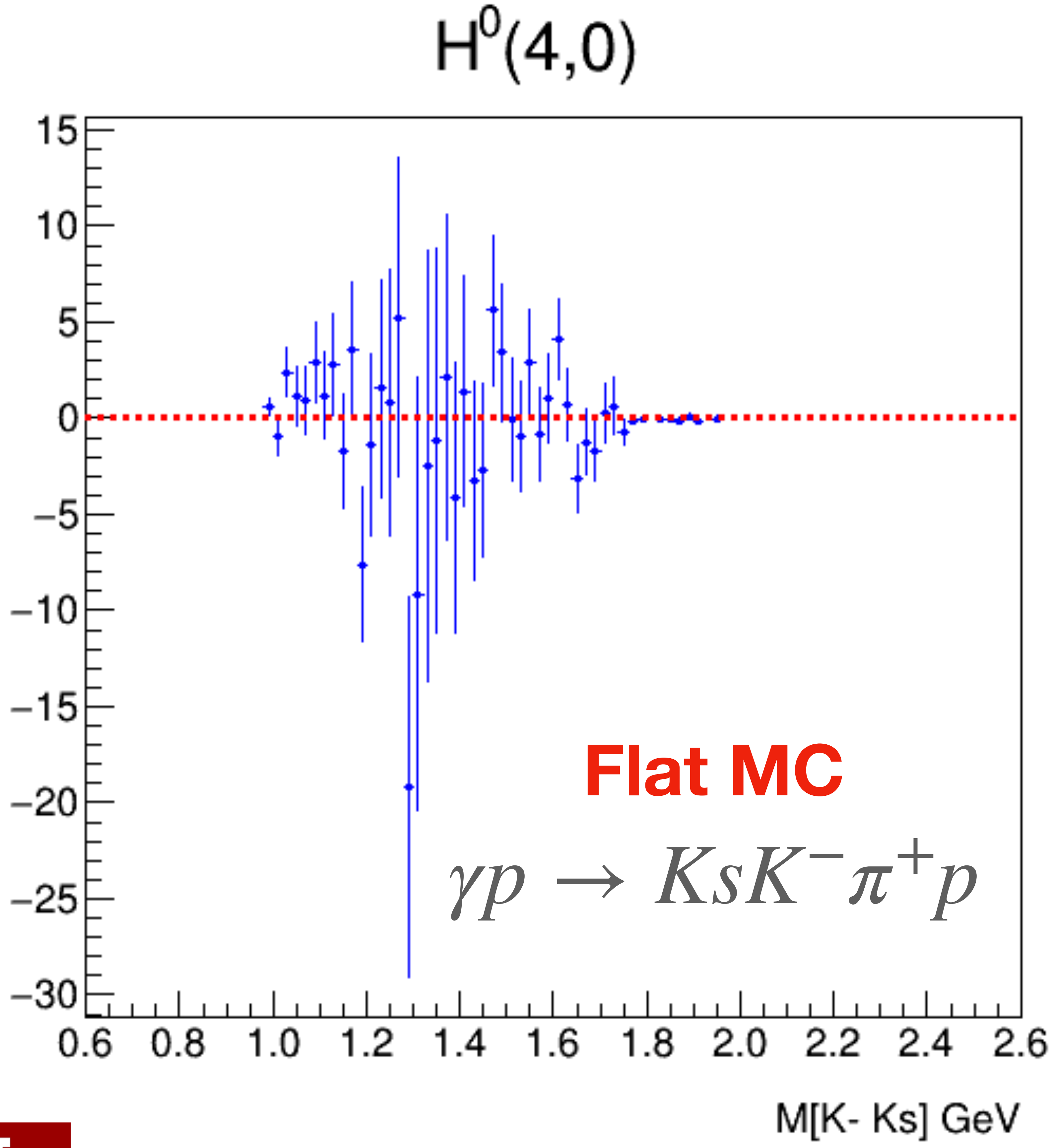


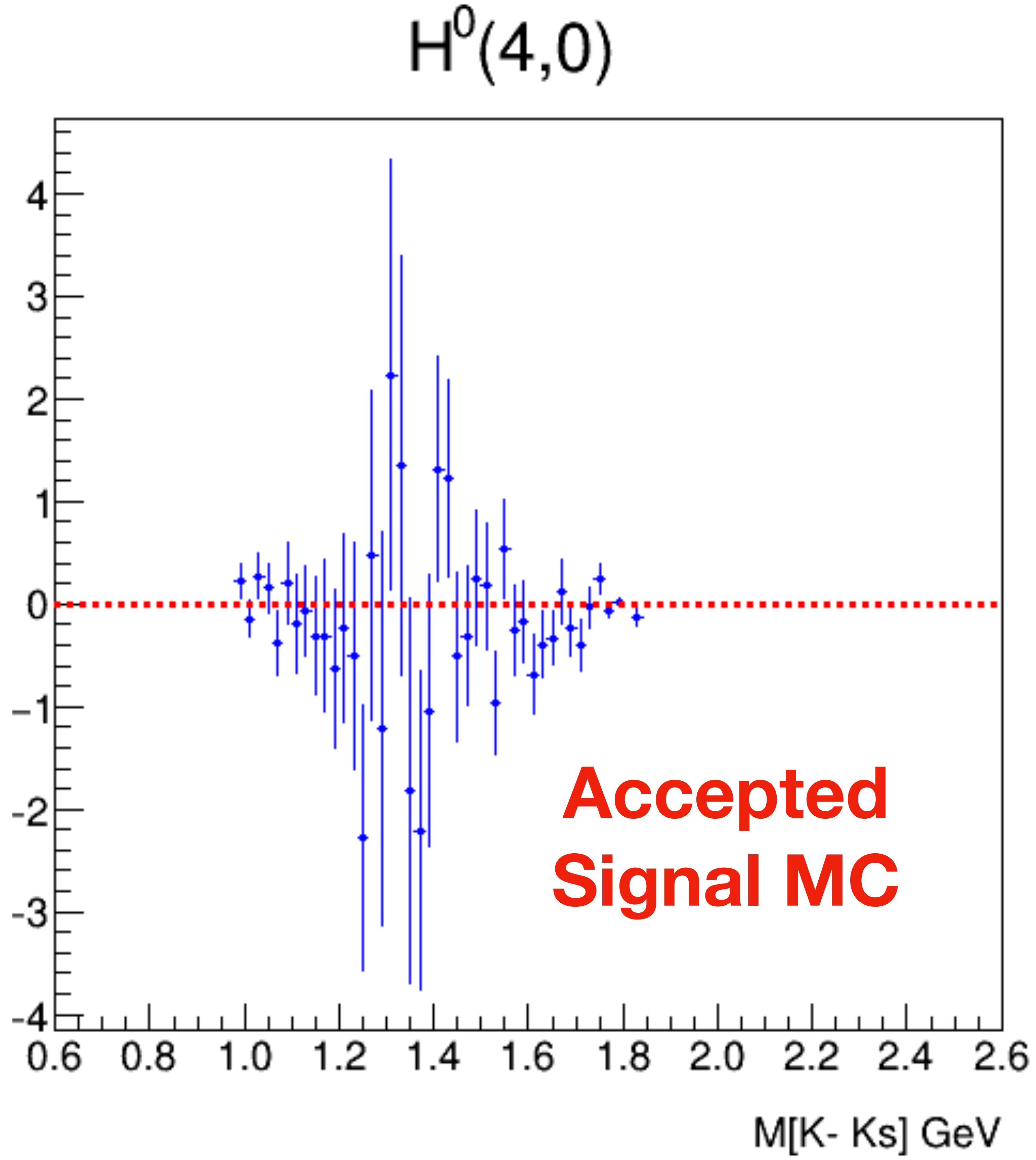


Angular Moments (Cont.)

$$^{(-)}H^{(0)}(4,0) = \frac{2}{21}\left[6\,|D_0^{(-)}|^2 - 4\left(|D_1^{(-)}|^2 + |D_{-1}^{(-)}|^2\right) + |D_2^{(-)}|^2 + |D_{-2}^{(-)}|^2\right]$$

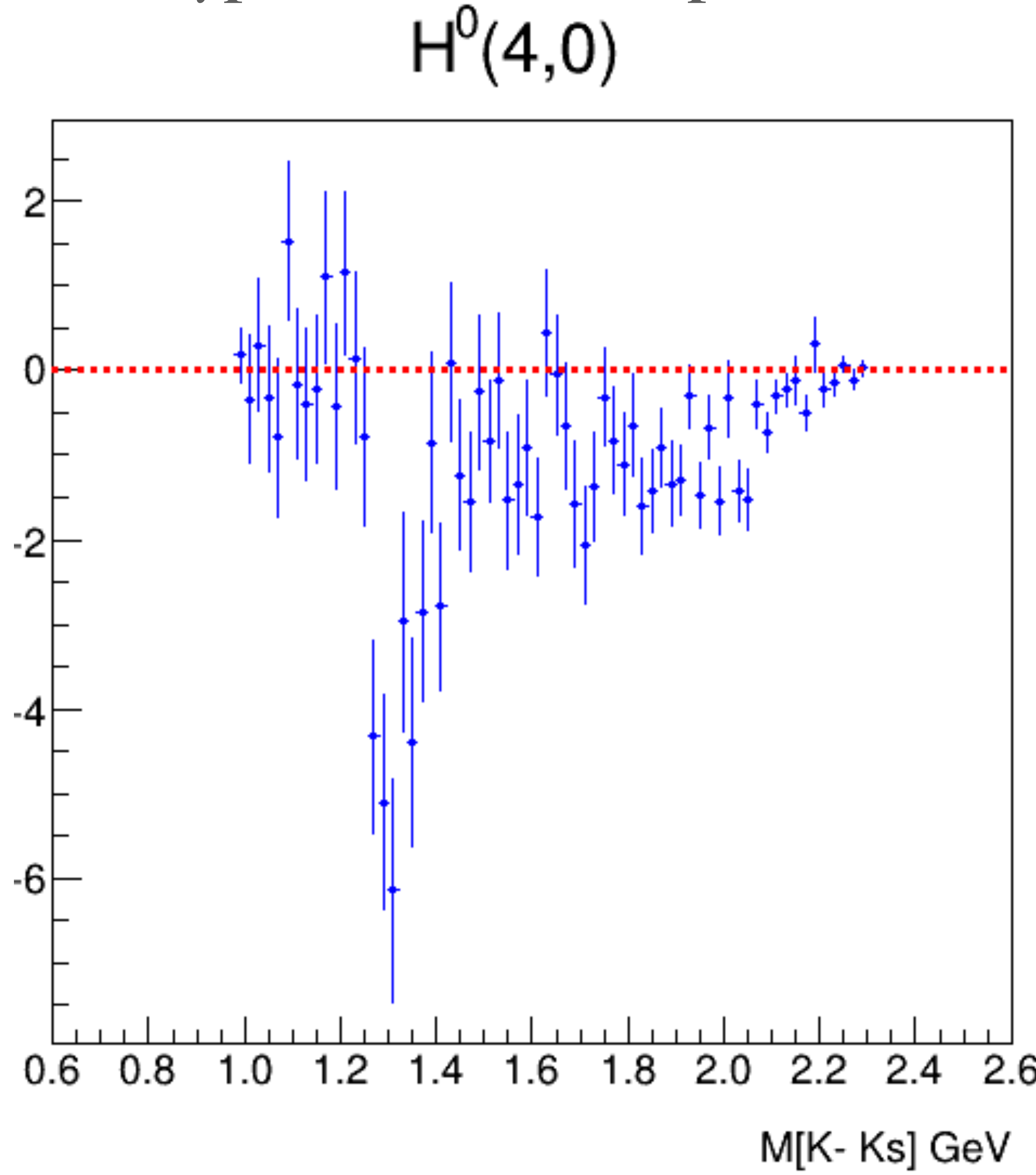
Polarization Angle = 45°





Data

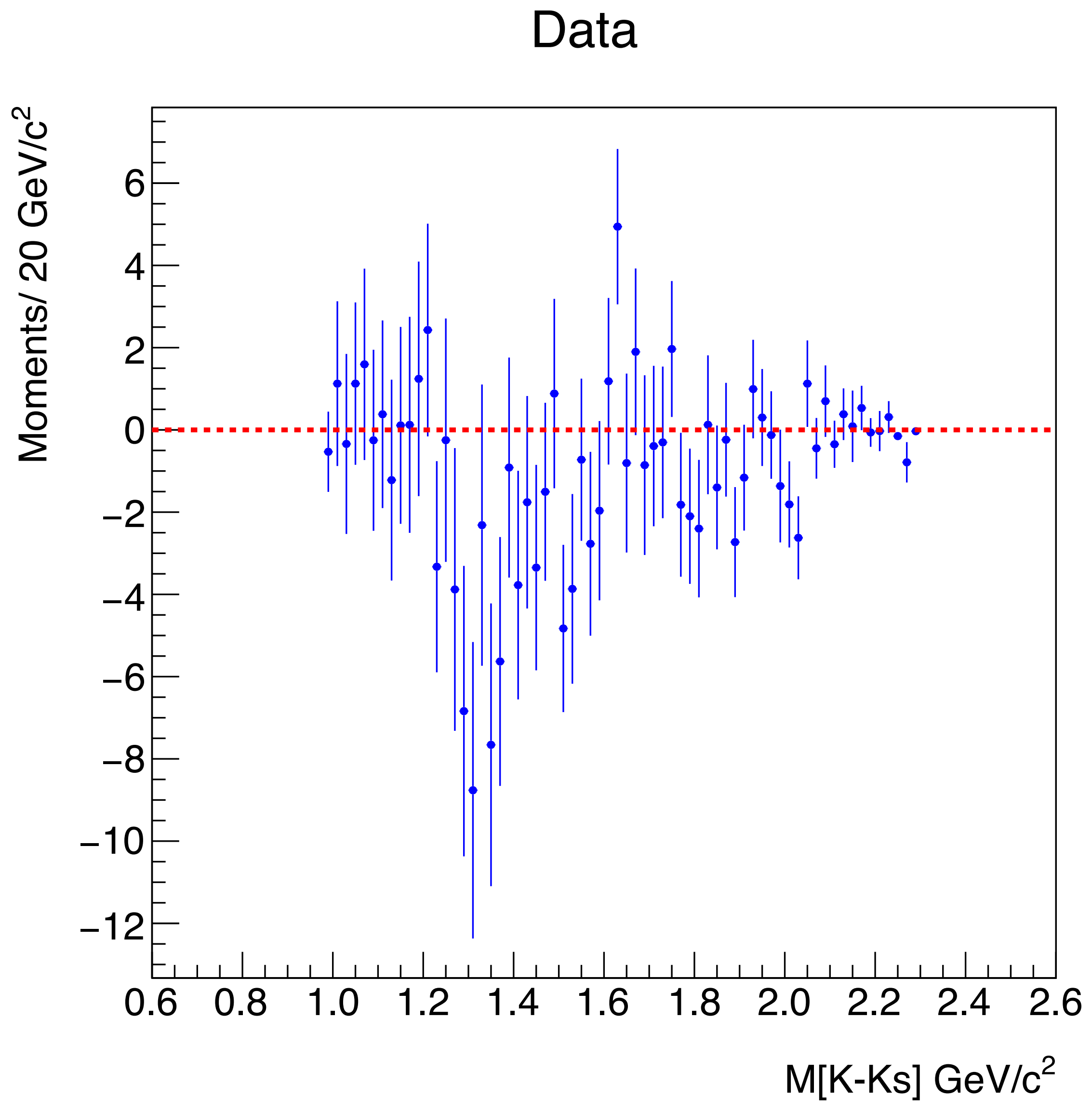
$\gamma p \rightarrow KsK^{-}\pi^{+}p$

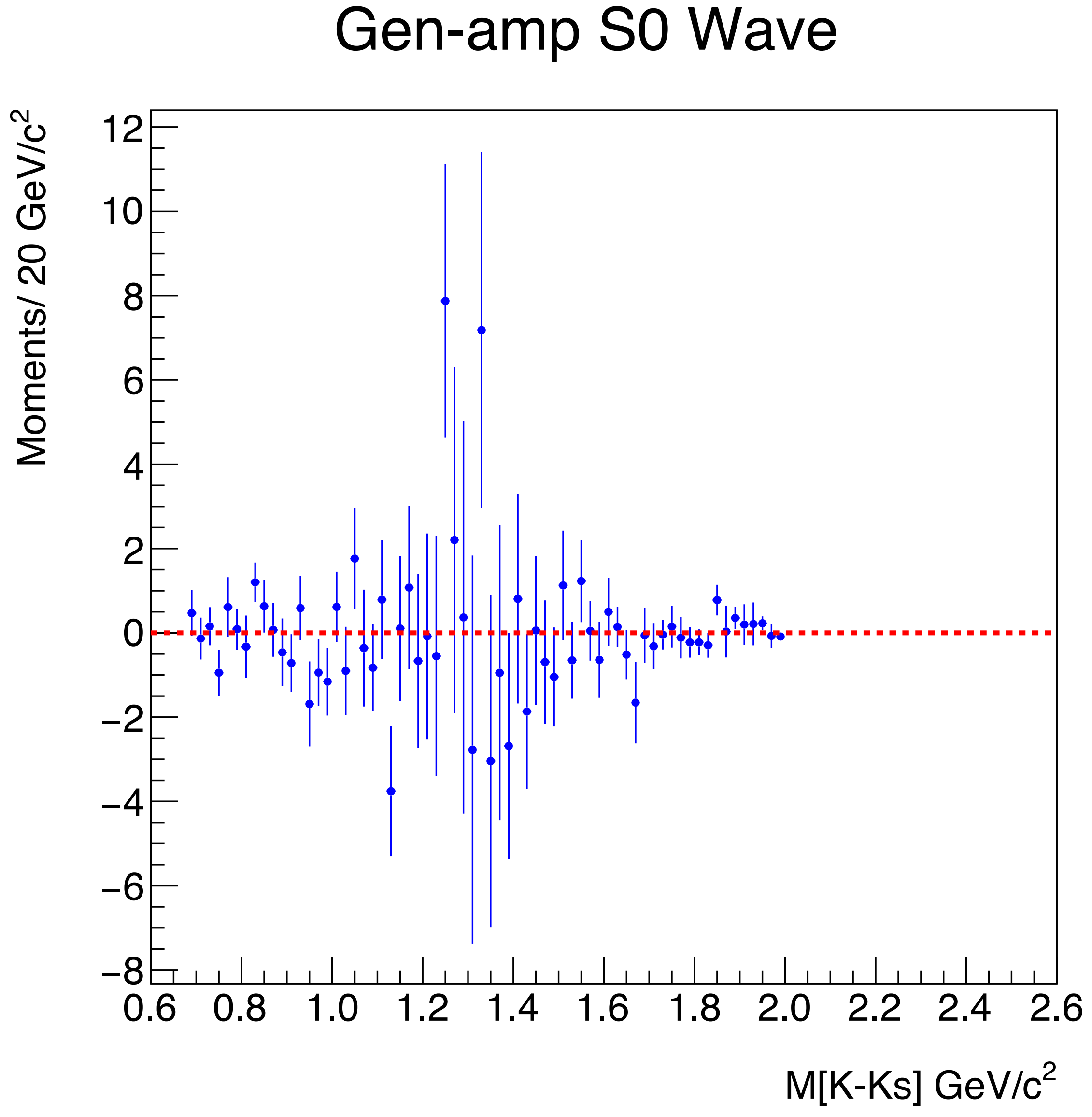


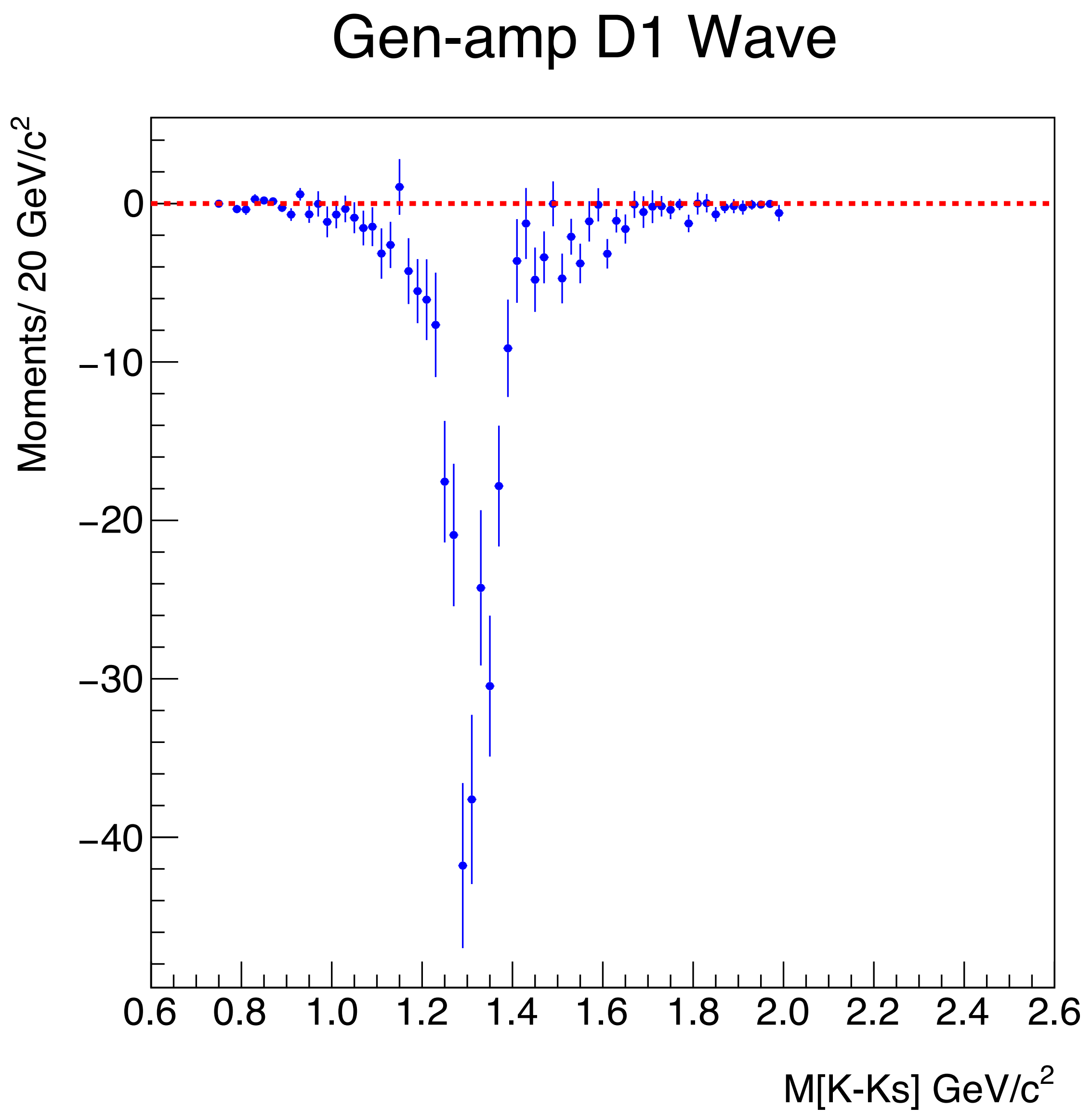
Angular Moments (Cont.)

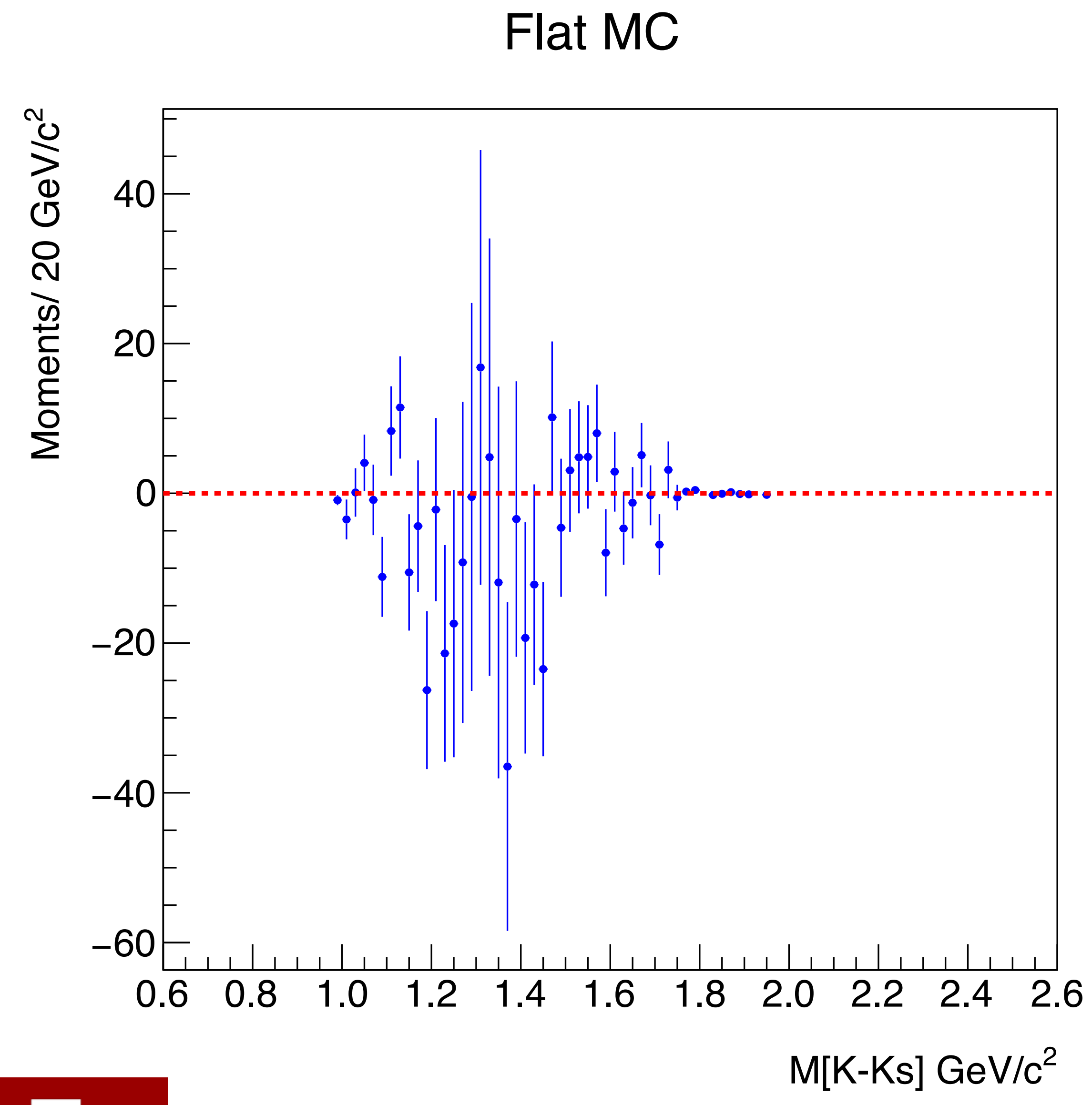
$$^{(-)}H^0(4,2) - ^{(-)}H^1(4,2) = -\frac{2\sqrt{10}}{21}\left|D_1^{(-)}\right|^2$$

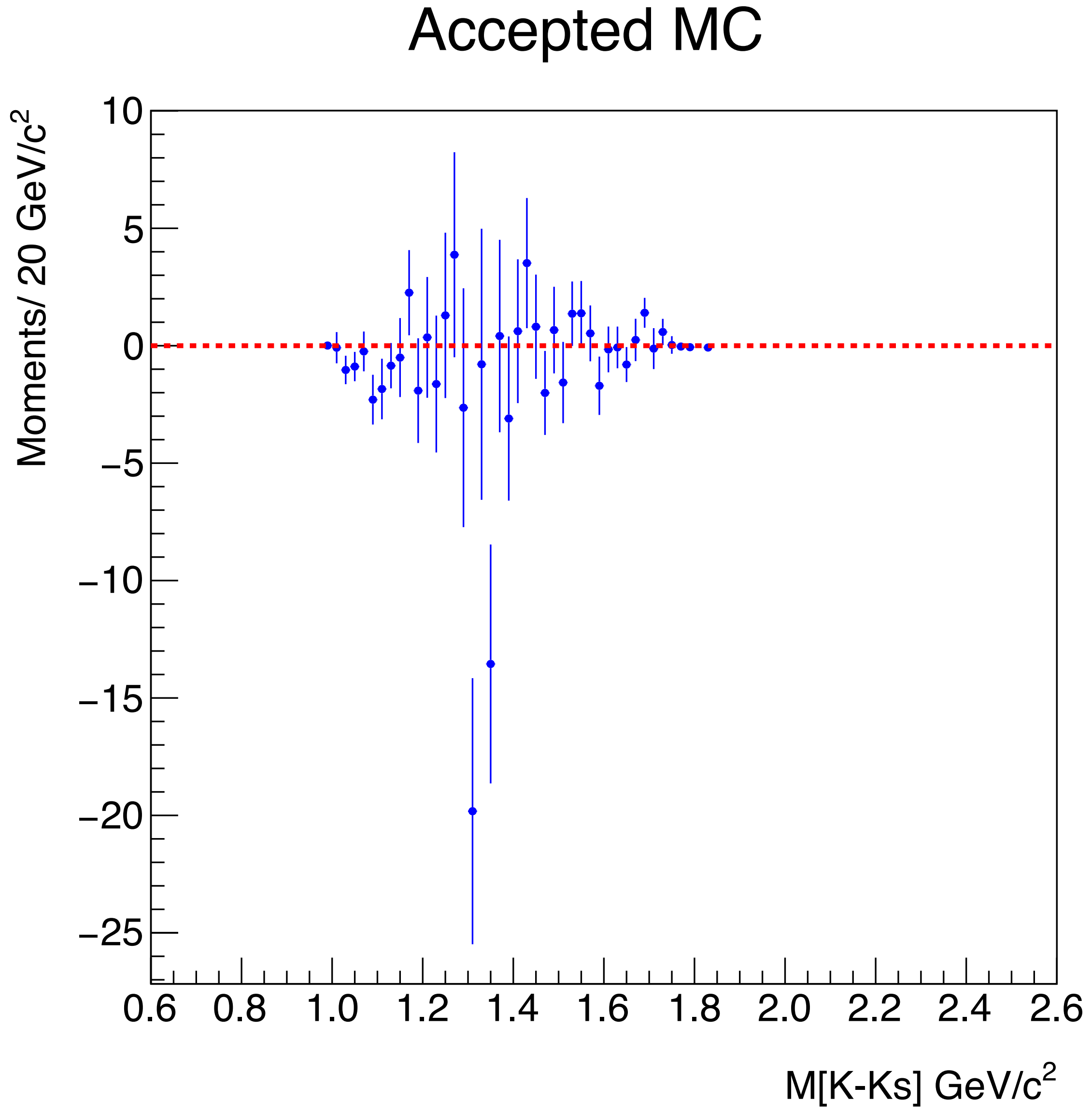
Polarization Angle = 45°











Summary

- Study $a_2^{(\prime)}$ within GlueX, production and t-dependent cross sections
- Further analysis on background
- Investigate angular moments

Extra Slides

$$N^{DATA} = \mathscr{L} \cdot B \cdot \sigma \cdot \epsilon$$

$$B = (a_2 \rightarrow K\bar{K}) \cdot (K\bar{K} \rightarrow K_s K^-) \cdot (K_s \rightarrow \pi^+\pi^-)$$

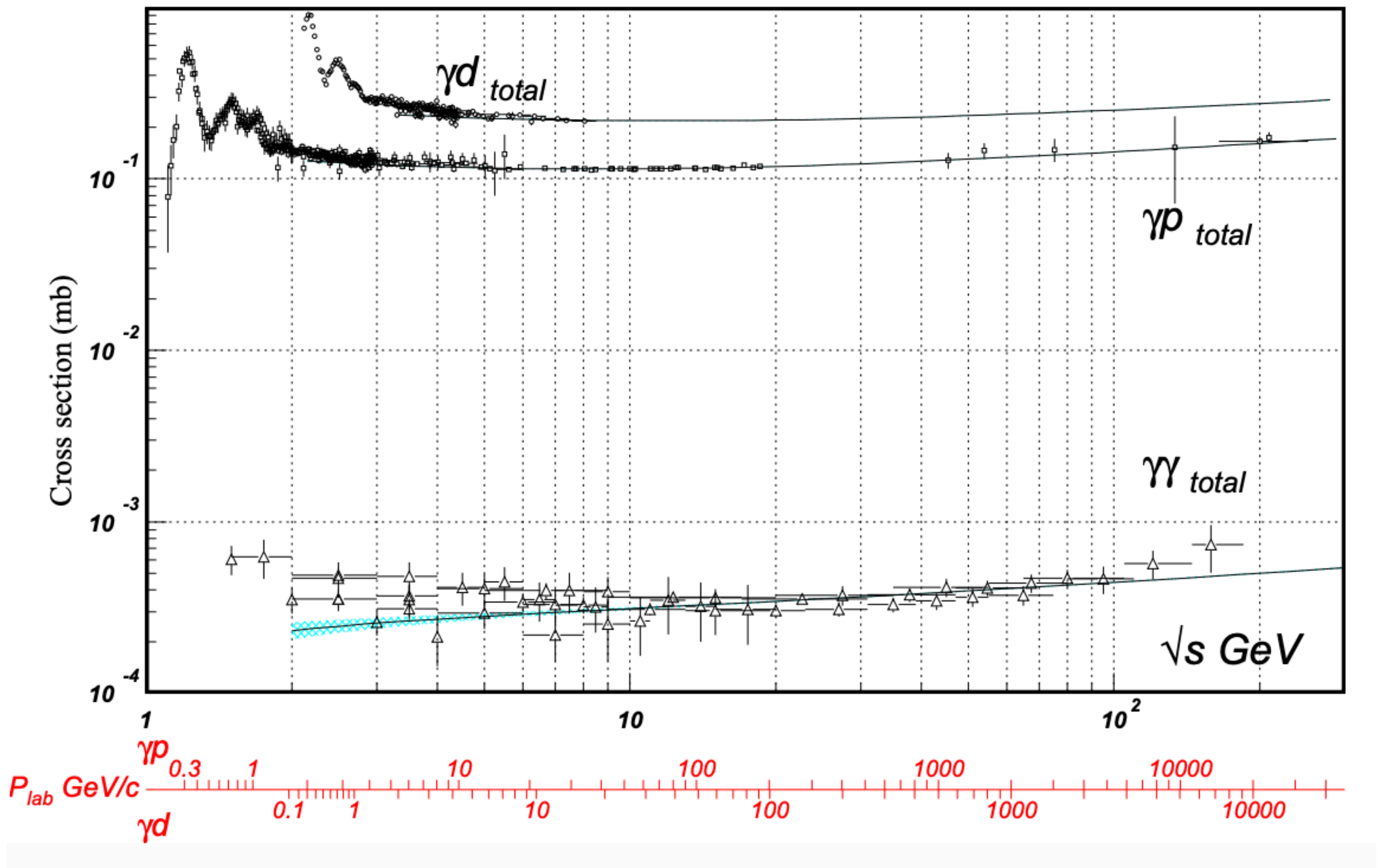
$$B = (0.049)*(0.5)*(.692)$$

$$\mathscr{L} = 142.379\ (pb)^{-1}$$

$$\mathscr{L}^{Coherent\ Peak} = 39.2602\ (pb)^{-1}$$

$$\sigma = 400 \text{ nb}$$

$$\epsilon = 0.0529$$

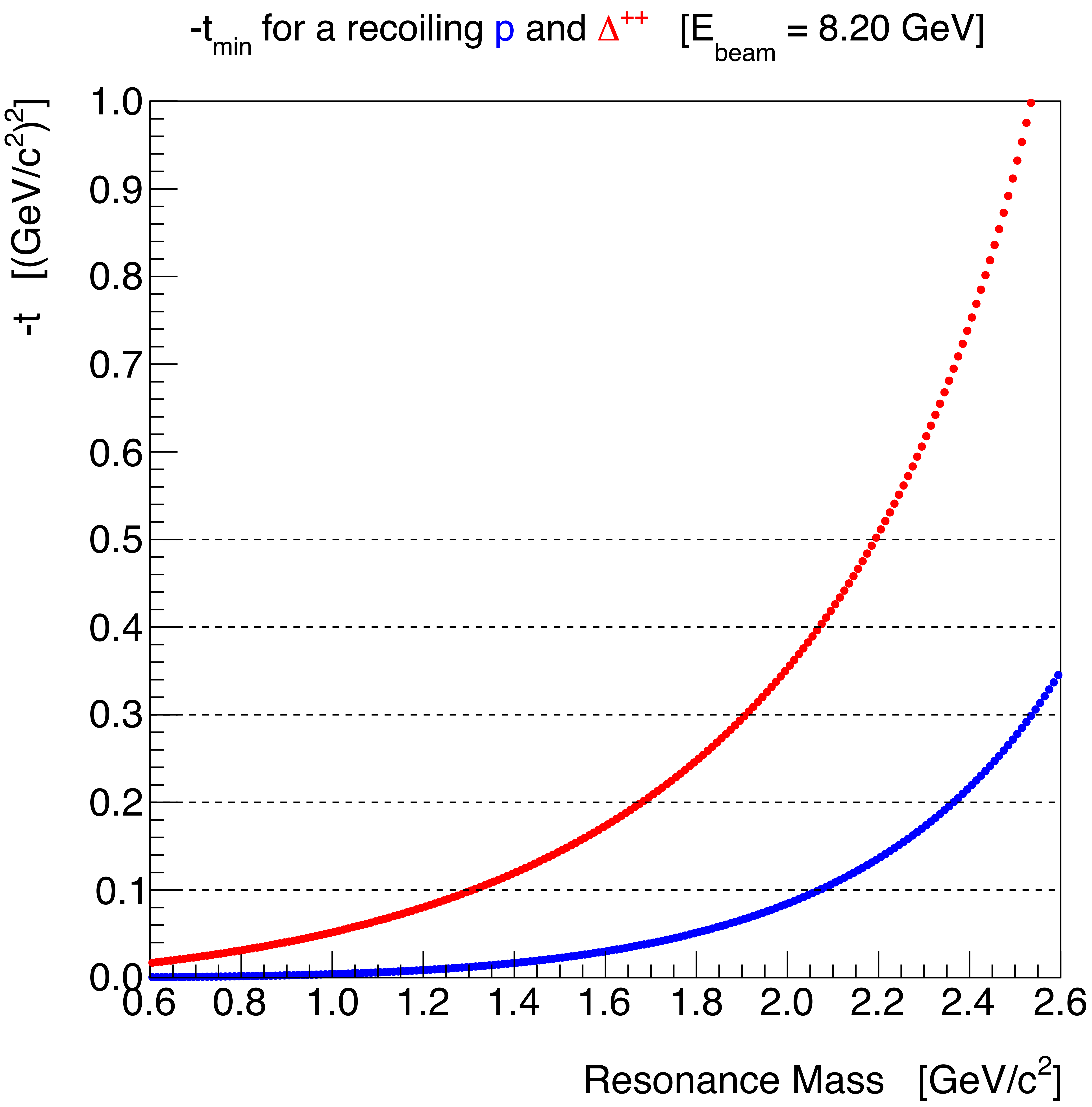


$$N^{GEN}_{BGGEN} = 2.052e08$$

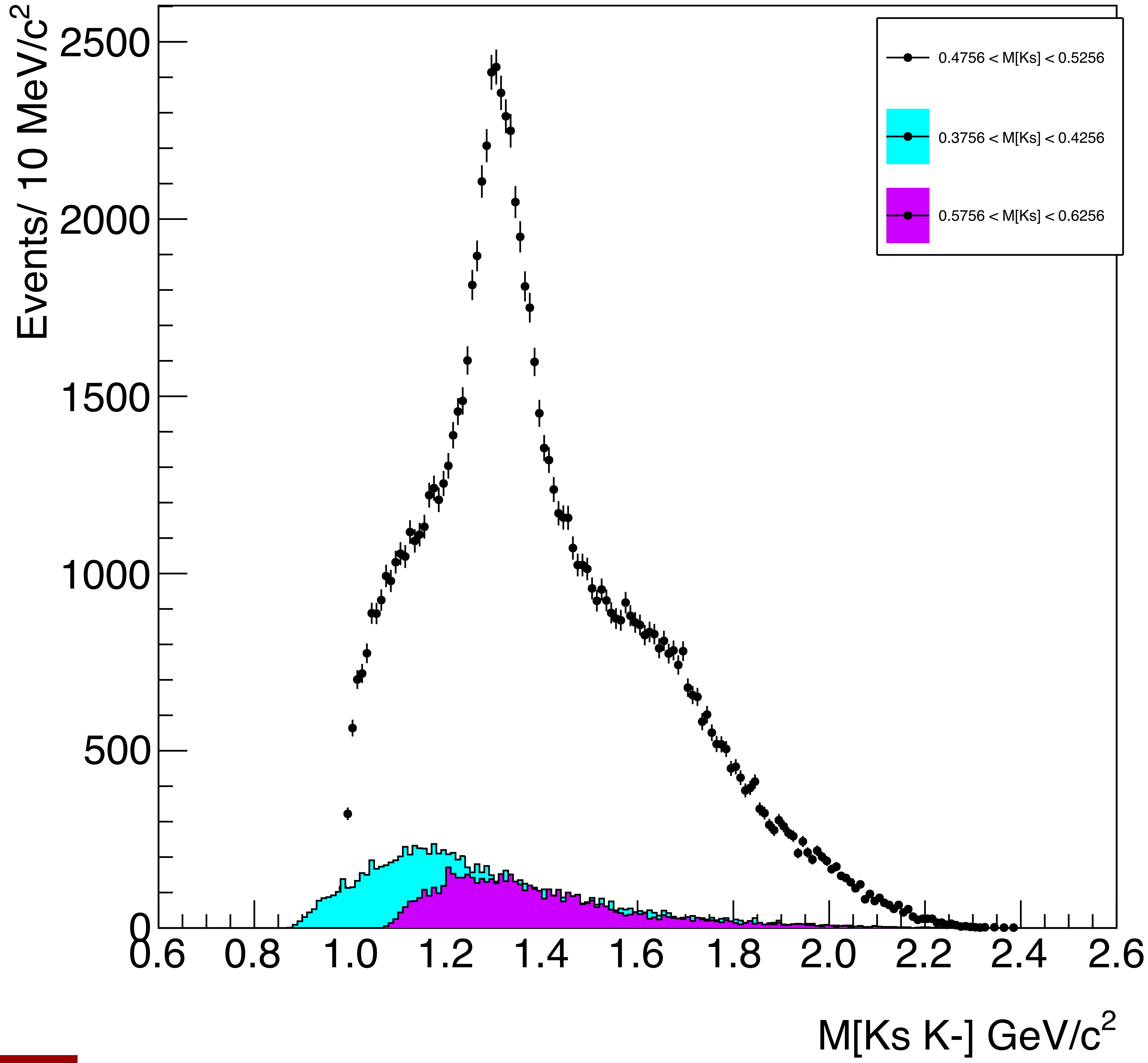
$$\mathscr{L}_{BGGEN} = 2.0317(pb^{-1})$$

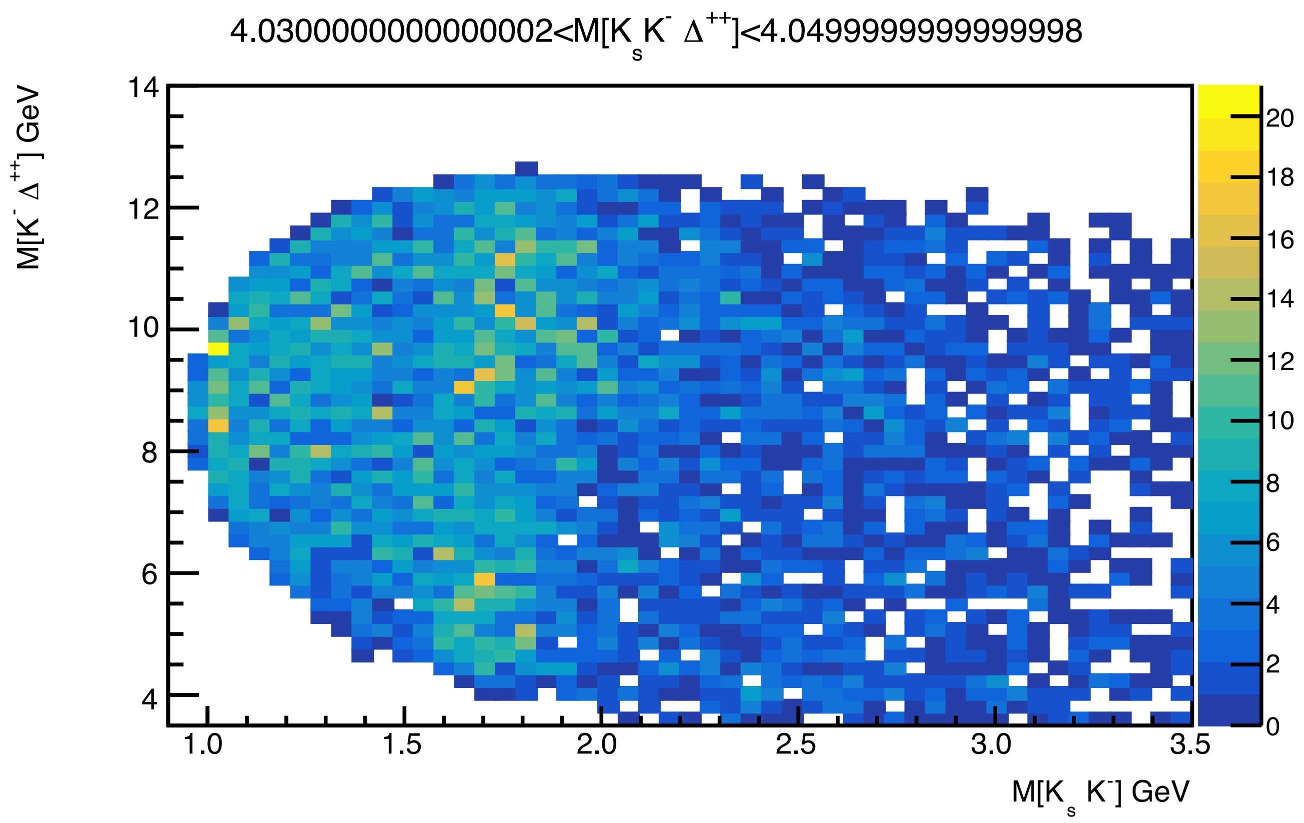
$$mN^{Gen}_{BGGEN} = \mathscr{L}^{DATA}\sigma_{Hadronic}$$

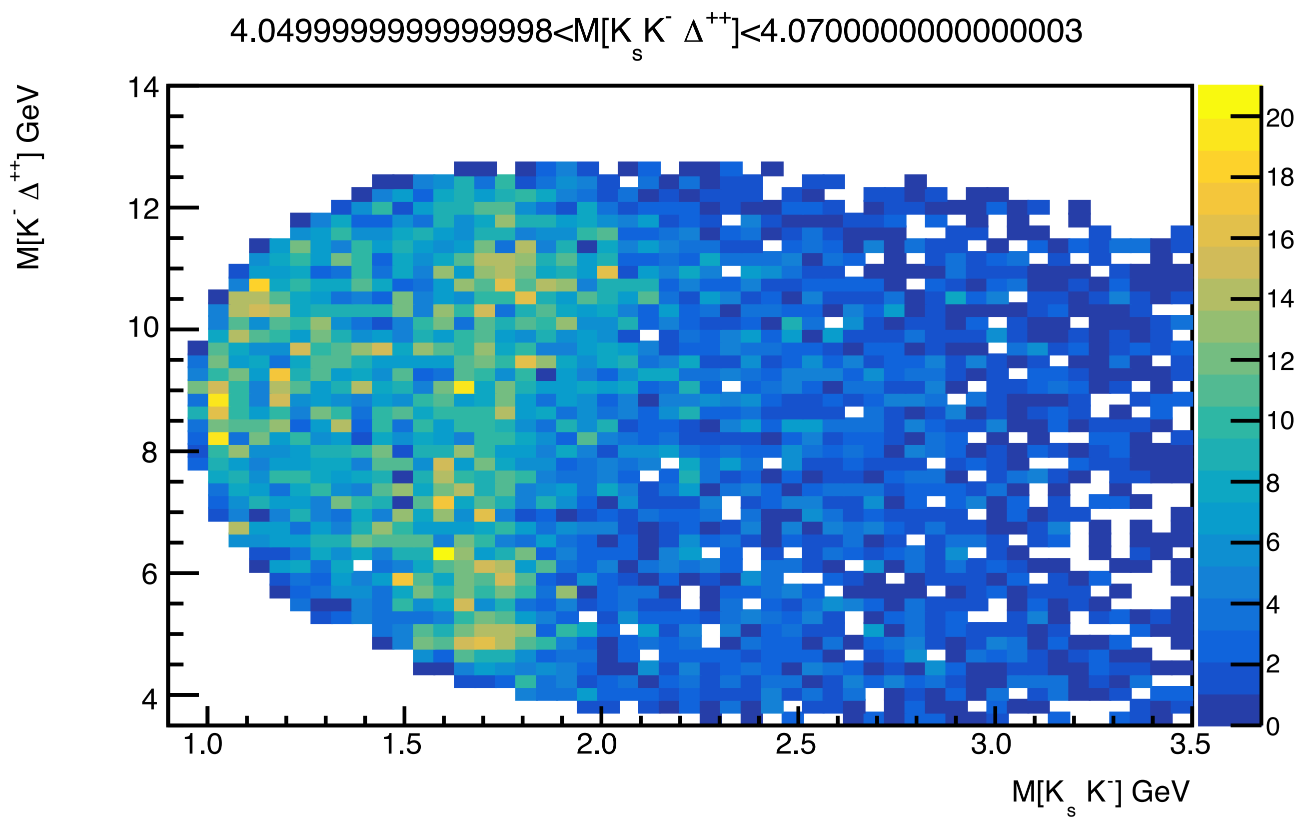
$$N^{DATA}_{peak} = 1.42 \times 10^4 \qquad N^{Bggen}_{Background} = 9.5 \times 10^3$$

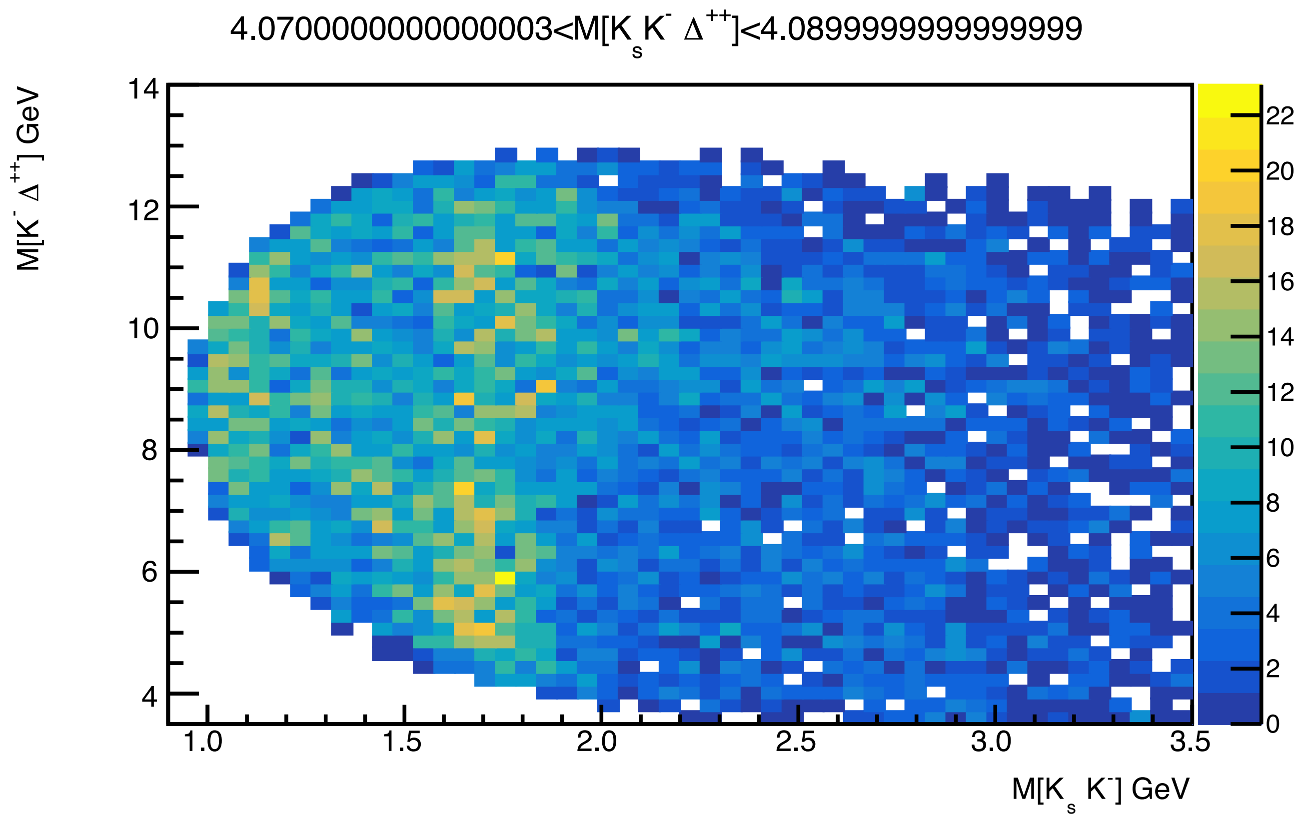

-t_min for a recoiling p and Δ++ [E_beam = 8.20 GeV]
-t [(GeV/c²)²]
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
Resonance Mass [GeV/c²]

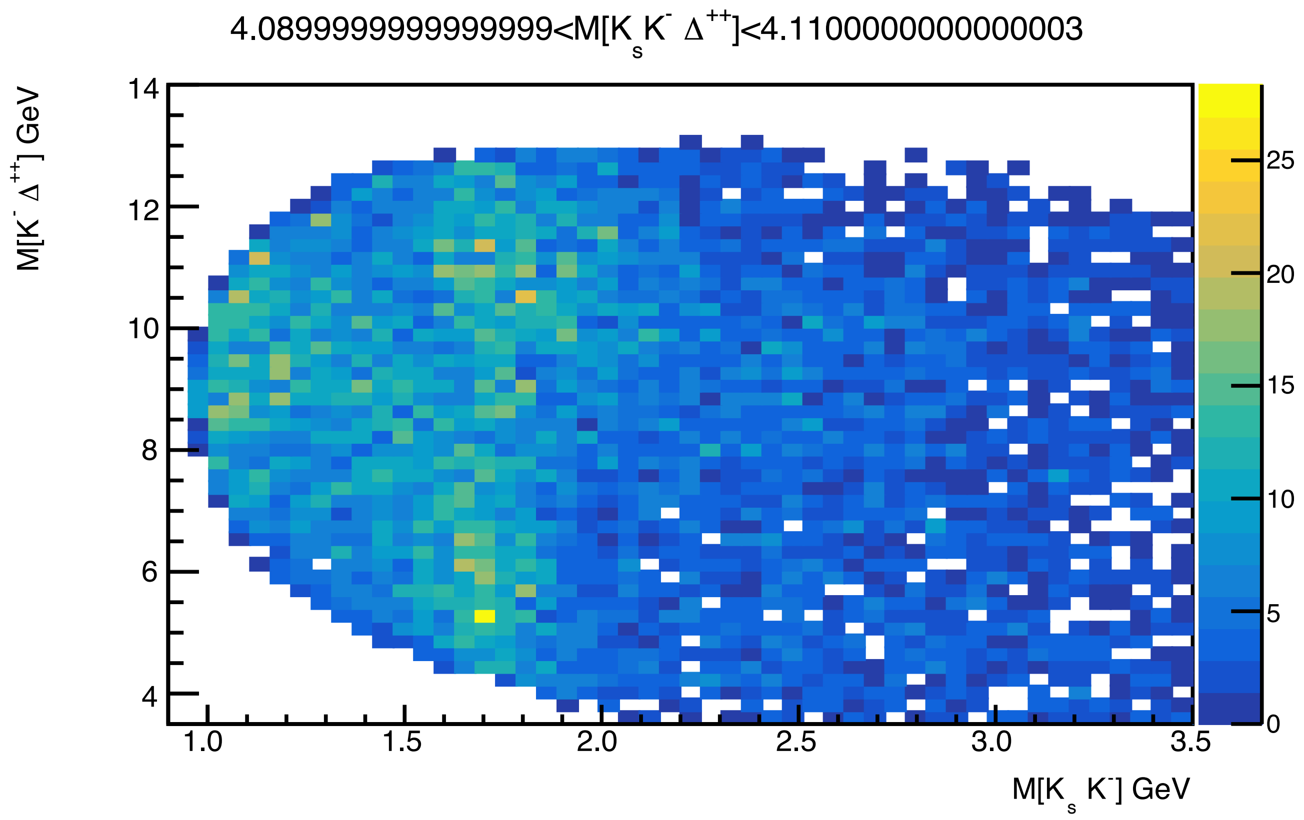
Ks sidebands

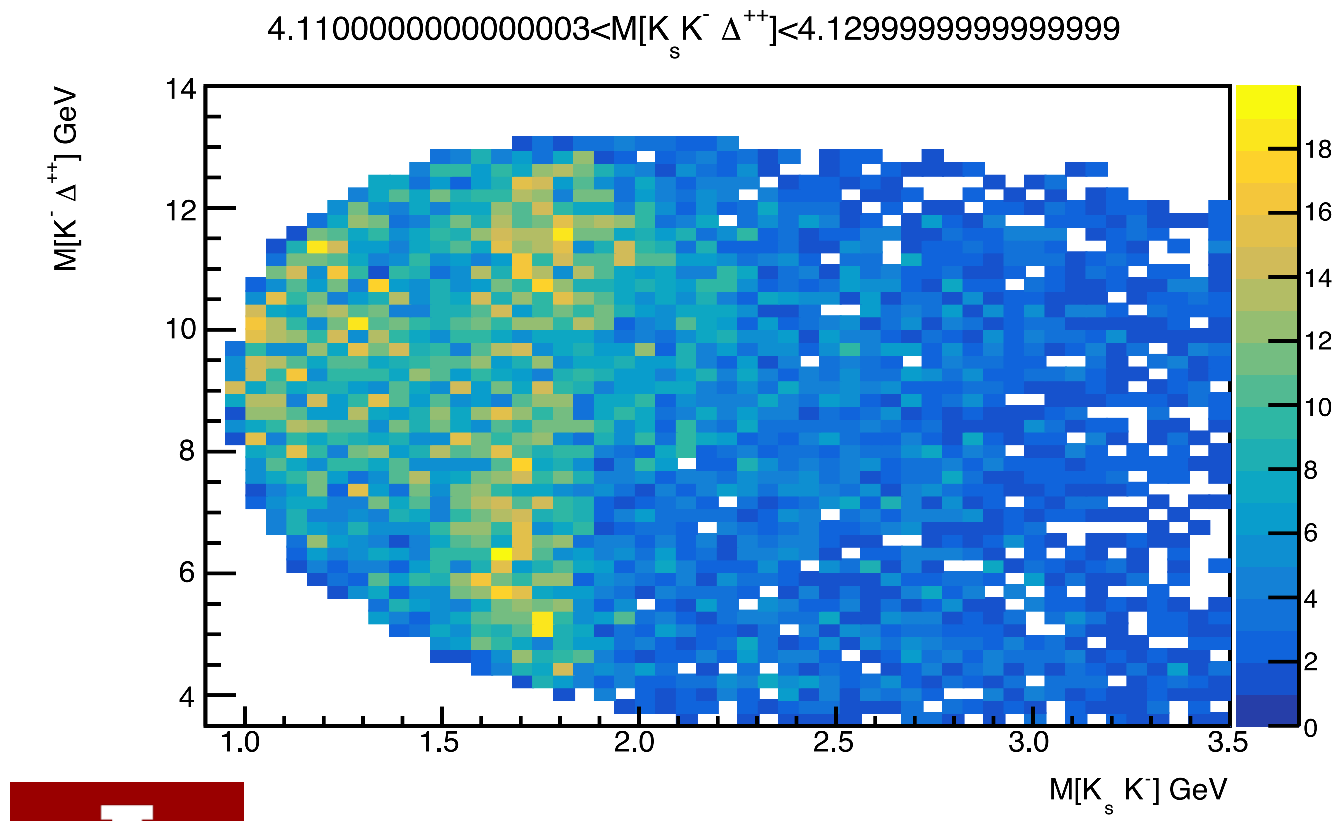


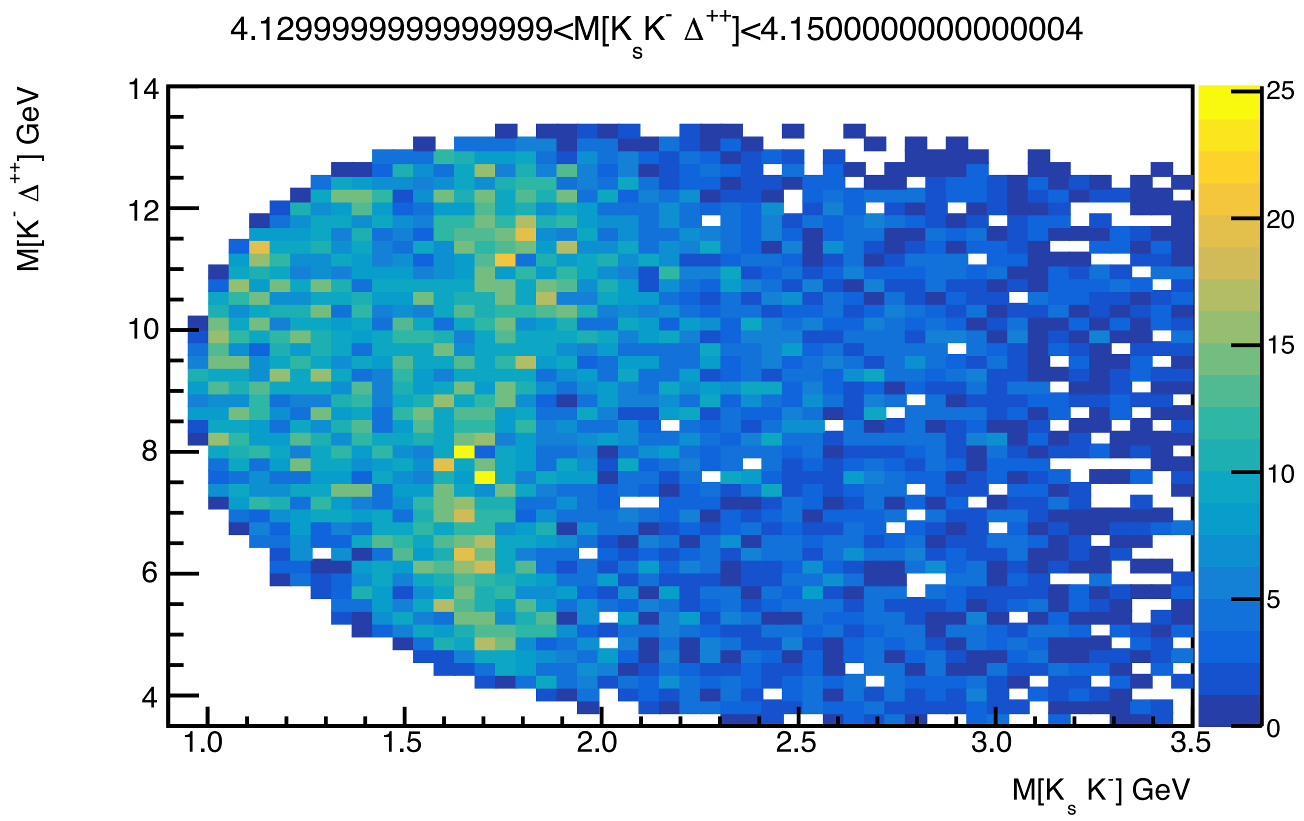












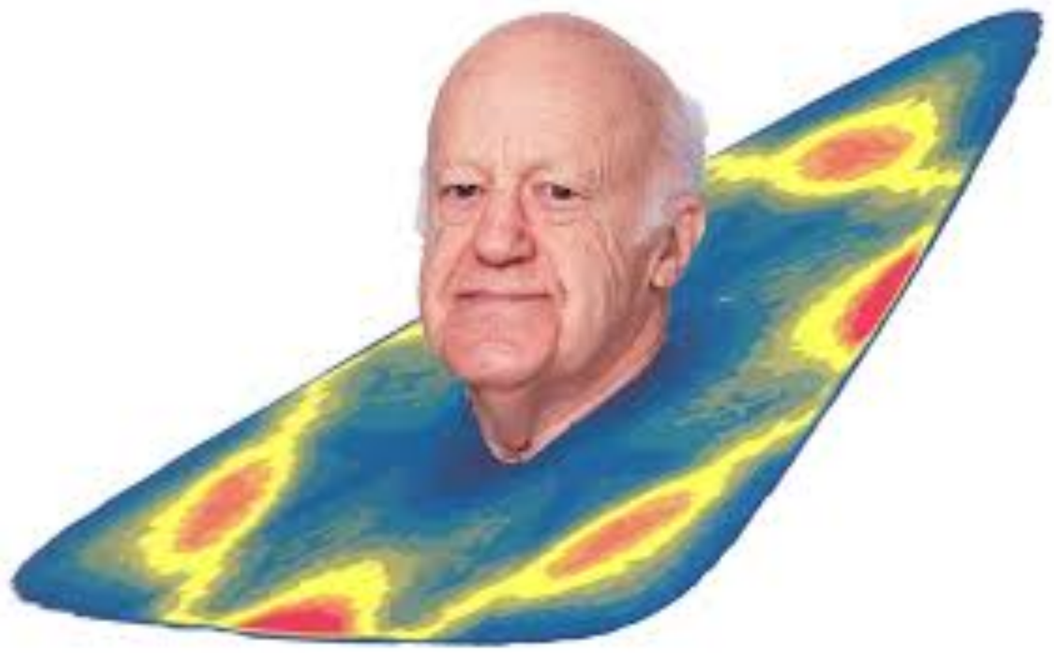


Image credit: Mike Pennington