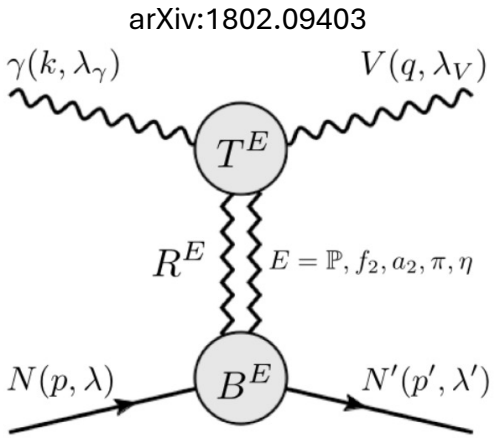
Studies for 2pi quasi-real photoproduction at MesonEX

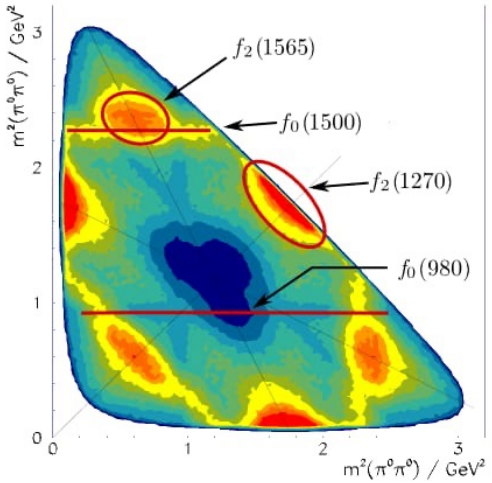
Marco Filippini
University of Messina & INFN Catania

Hadron Spectroscopy

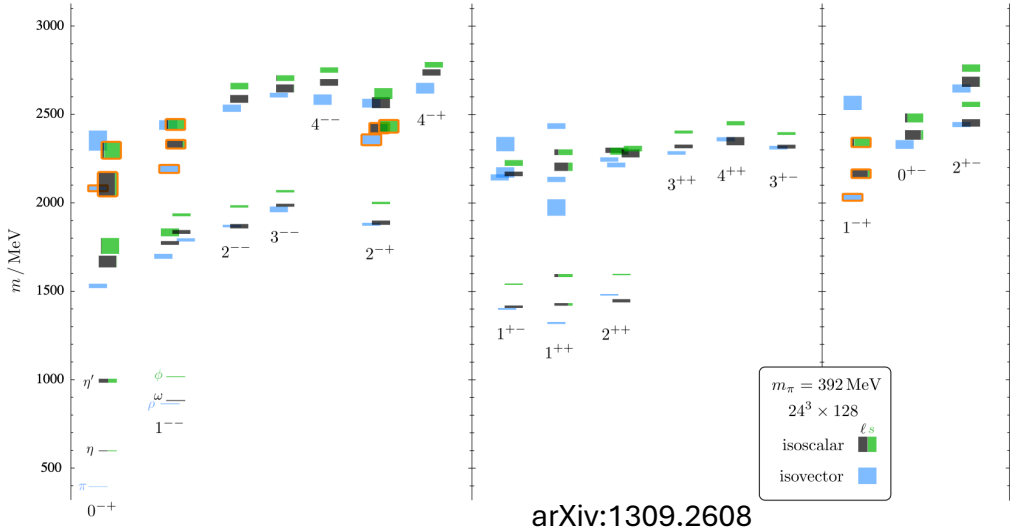
Necessary for understanding:

- QCD
- Quark confinement
- Looking for new particles (exotics)
- Nature of mass





Electromagnetic interactions gives access to hadron radii and matrix elements

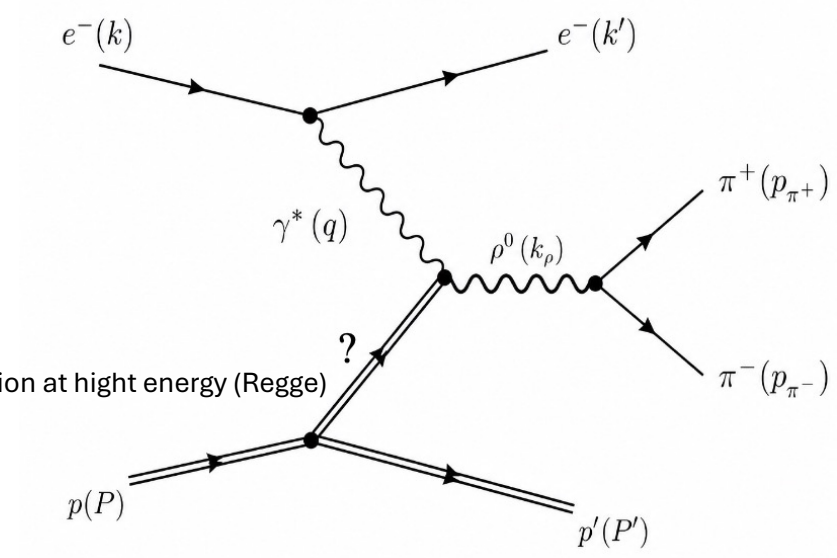


Meson Spectroscopy

Why focus on meson production:

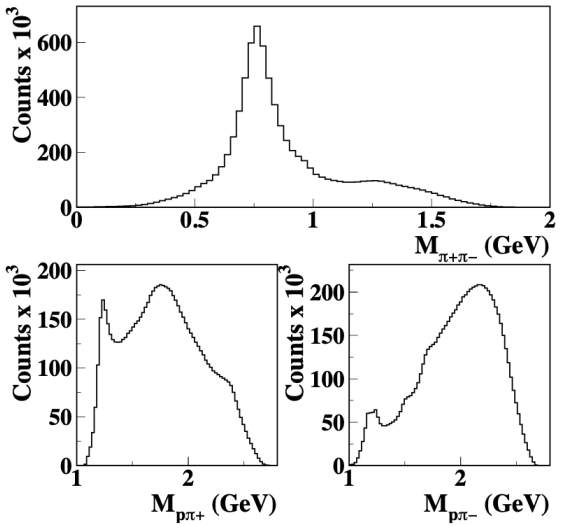
- Look for known ordinary resonances
- Analysis of channel $\gamma^*p \rightarrow p\,\pi^+\,\pi^-$
- Determine production mechanism
  - old results from CLAS g11 for 3-3.8 GeV

Possible goal is extracting production cross section and SDMEs for f_2

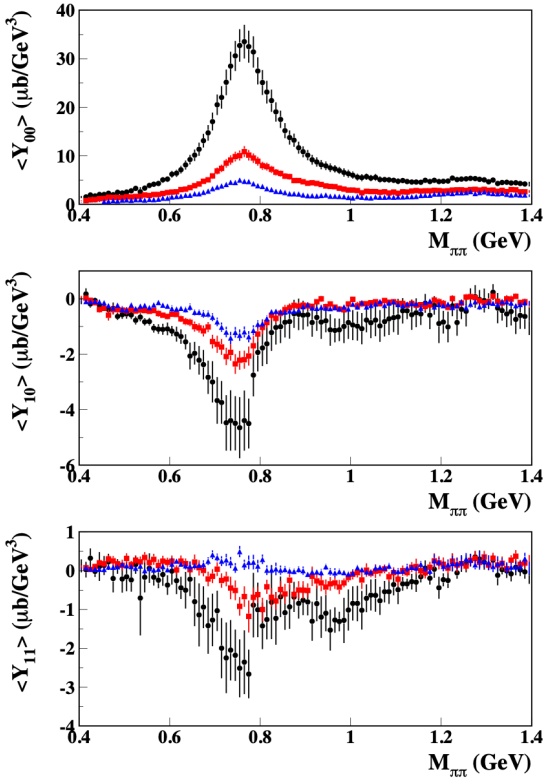


Dominant production at hight energy (Regge)

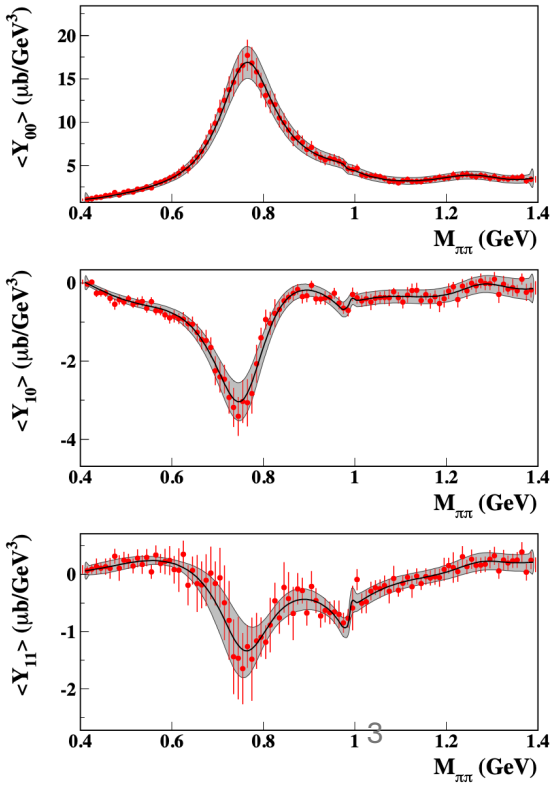
arXiv:0907.1021 CLAS g11



arXiv:0907.1021 CLAS g11



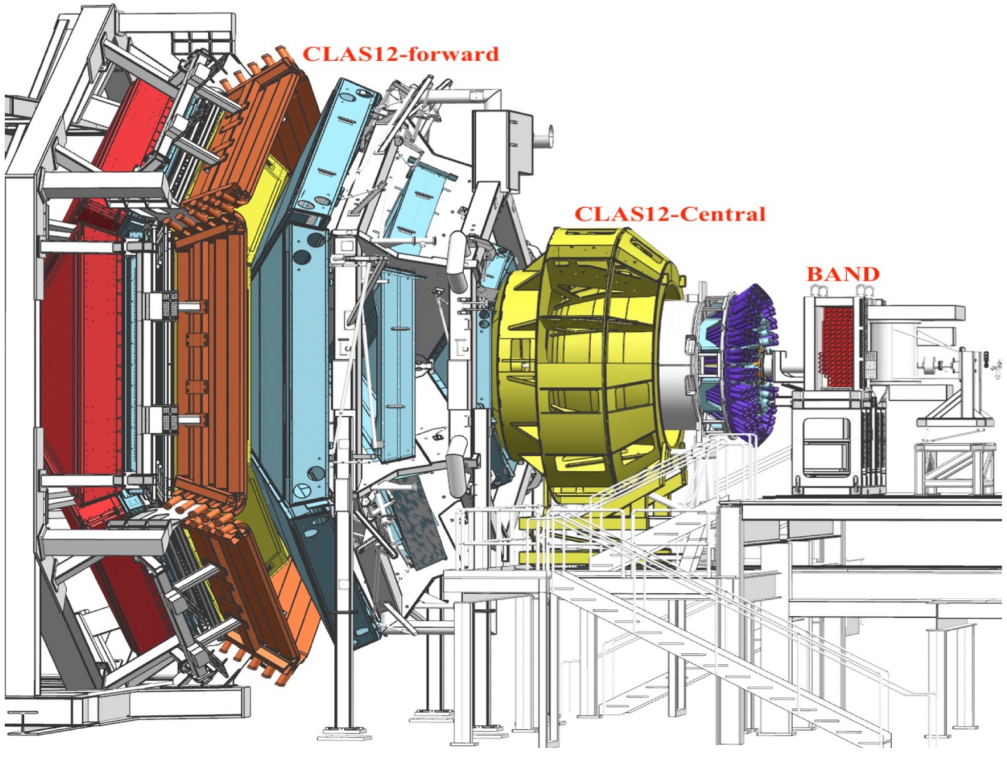
arXiv:0907.1021 CLAS g11

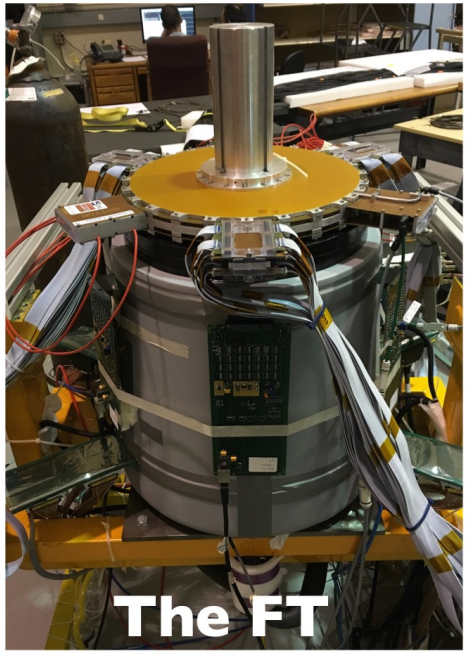


CLAS12 Particles Detection

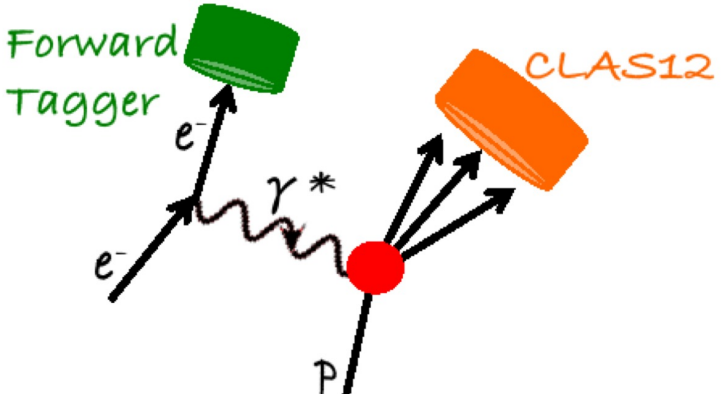
Trigger requirement →

- Electron up to 5 GeV in the FT (low Q^2)
- Two tracks (no specifics ID particles) in at least two sectors of the FD





built in Genoa



electrons in FT

pions mostly in FD

protons mostly in CD

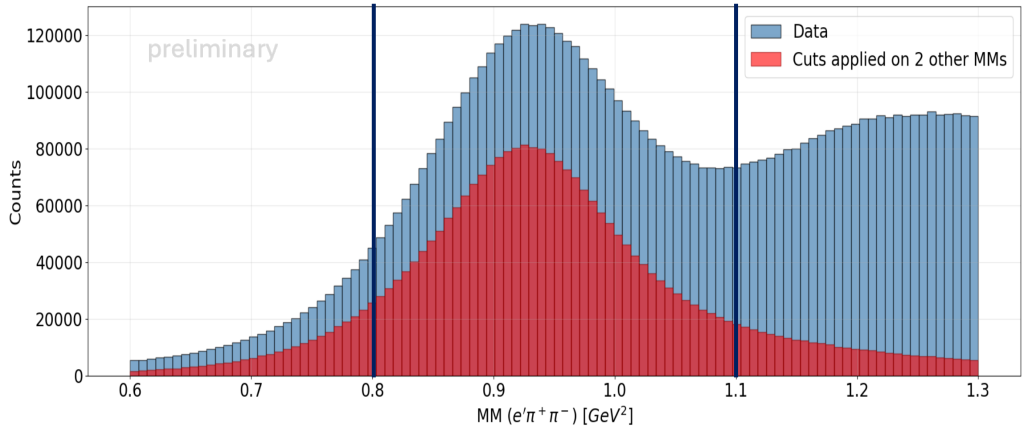
Data Analysis

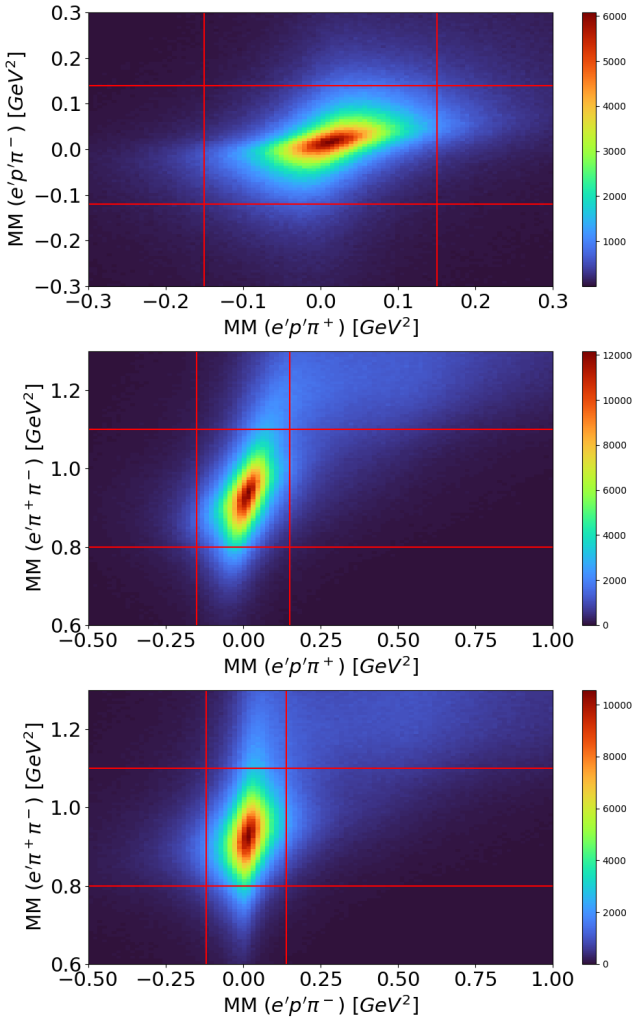
Dataset:

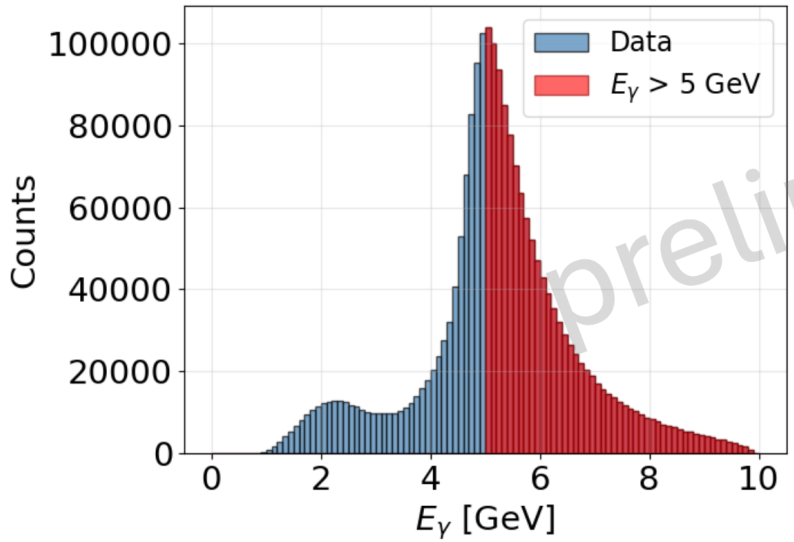
- RG-A pass2
- Spring 2019

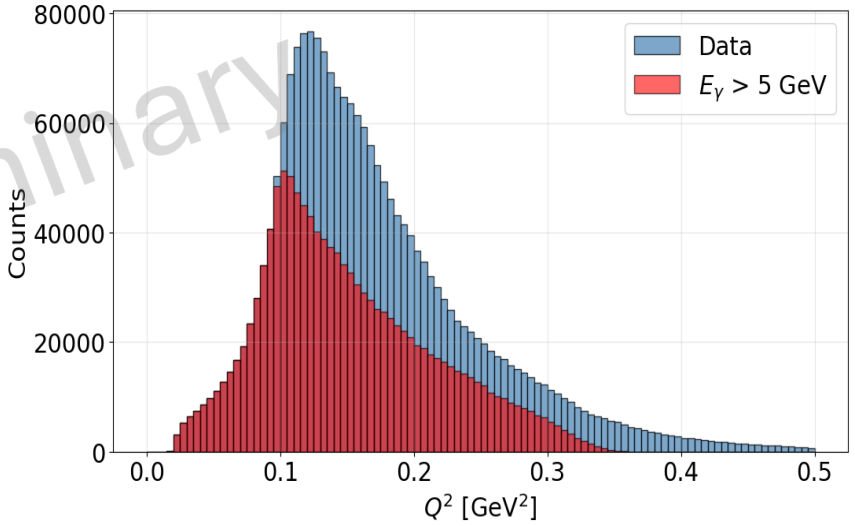
Analysis selection:

- 0.8 < MM (e' pi+ pi-)< 1.1 GeV^2
- -0.15 < MM (e' p' pi+)< 0.15 GeV^2
- -0.12 < MM (e' p' pi-)< 0.14GeV^2
- E_γ > 5 GeV





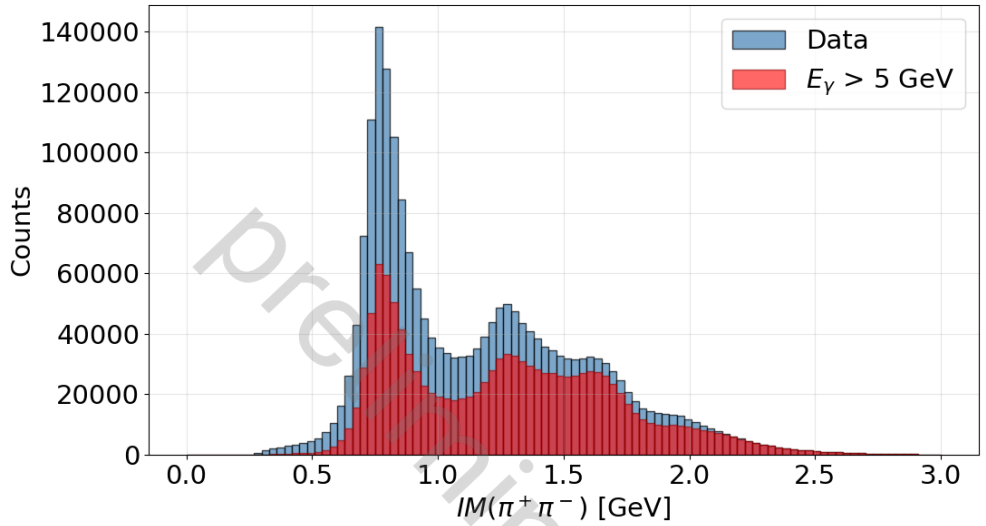


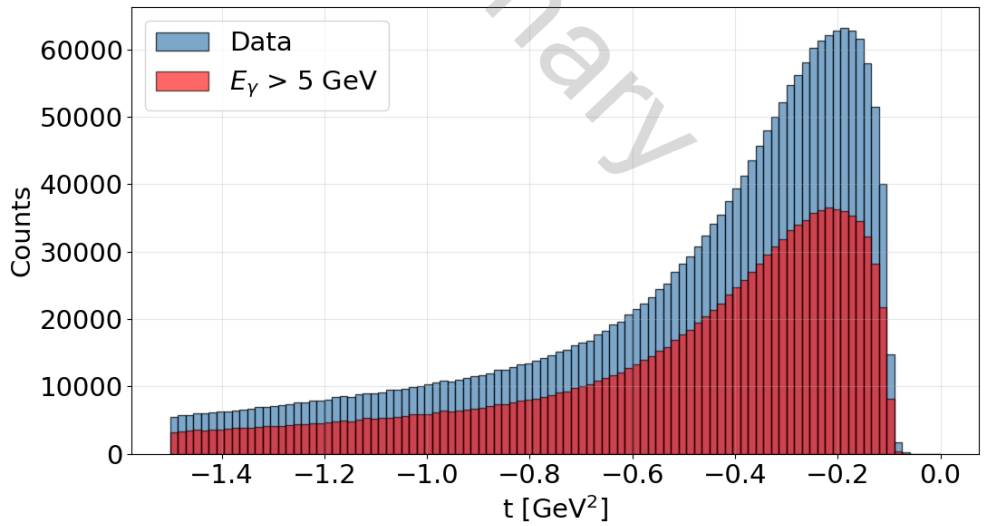


preliminary

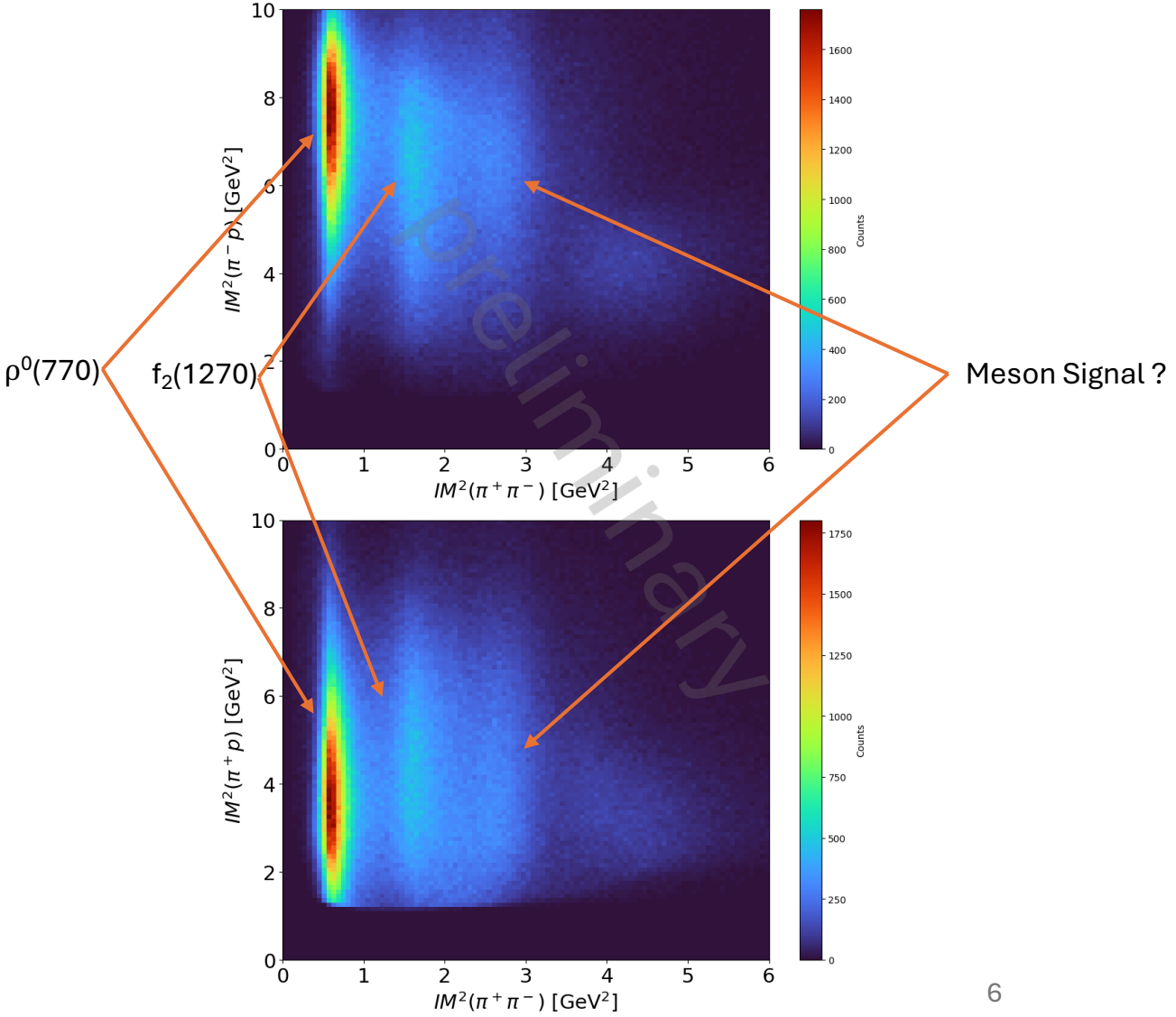
Data Analysis

Looking for resonances





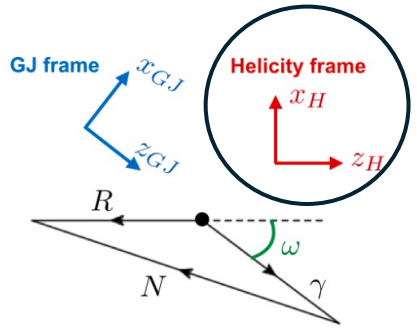
Dalitz Plots

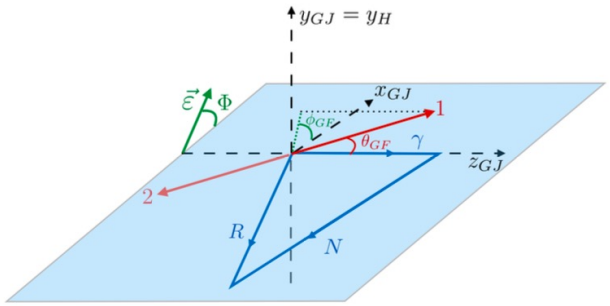


Fitting Moments

Necessary step for Partial Waves extraction

Extracting moments by fitting HEL angles using a PhaseSpace MC for ACCEPTANCE





arXiv:1909.09473

$$H^0(LM) = \frac{1}{2\pi}\int_0^{2\pi}\int_0^{2\pi}\int_{-1}^{1} I(\Omega,\Phi)\, d^L_{M0}(\theta)\cos M\phi \; \mathrm{d}(\cos\theta)\mathrm{d}\phi\mathrm{d}\Phi,$$

$$H^1(LM) = \frac{1}{P_\gamma \pi}\int_0^{2\pi}\int_0^{2\pi}\int_{-1}^{1} I(\Omega,\Phi)\, d^L_{M0}(\theta)\cos M\phi \cos 2\Phi \; \mathrm{d}(\cos\theta)\mathrm{d}\phi\mathrm{d}\Phi,$$

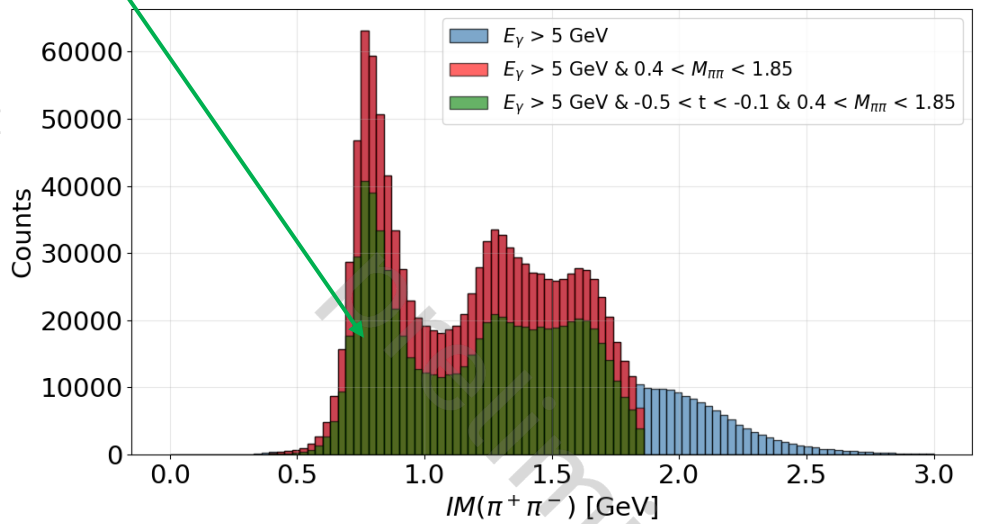
$$\mathrm{Im}H^2(LM) = \frac{-1}{P_\gamma \pi}\int_0^{2\pi}\int_0^{2\pi}\int_{-1}^{1} I(\Omega,\Phi)\, d^L_{M0}(\theta)\sin M\phi \sin 2\Phi \; \mathrm{d}(\cos\theta)\mathrm{d}\phi\mathrm{d}\Phi.$$

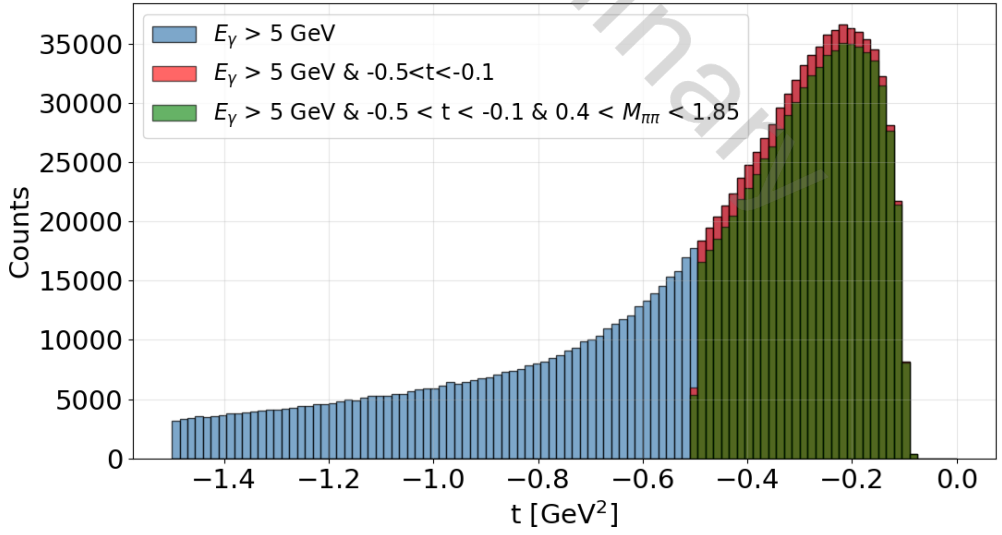
In practice we have to use this acceptance term

$$\frac{dN}{d\Omega} = \sum_{LM} H^0_{LM}(m_{\pi^+\pi^-}, t) d^L_{M0}(\theta)\cos M\phi \times \alpha(m_{\pi^+\pi^-}, t, \theta, \phi)$$

Spherical Harmonics

40 bins

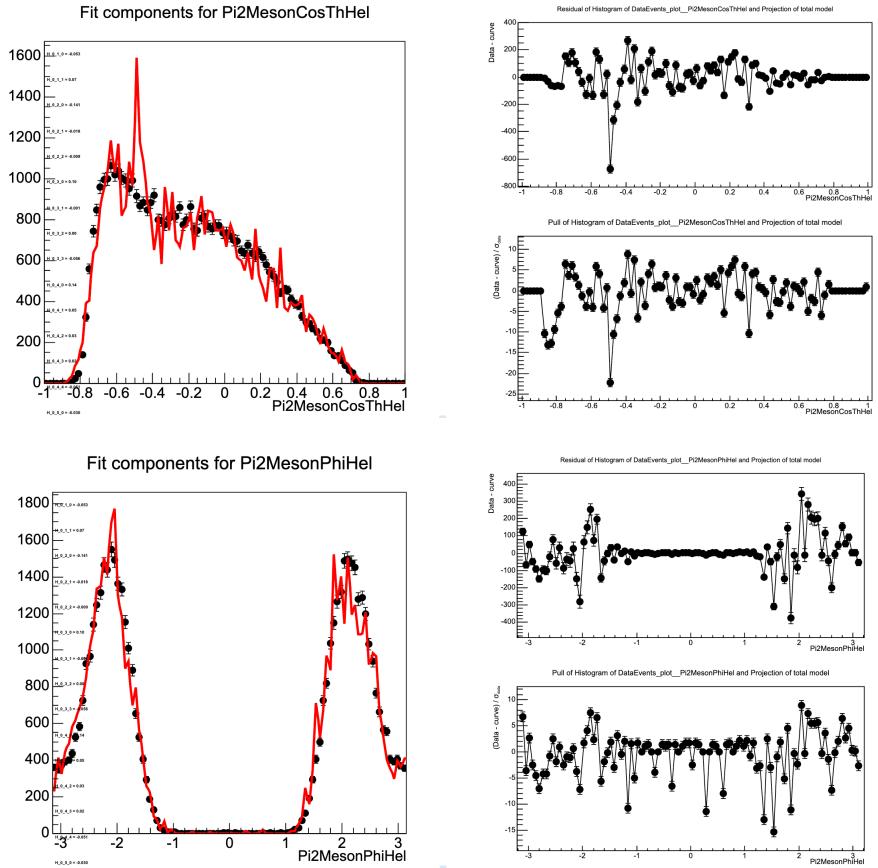




Preliminary

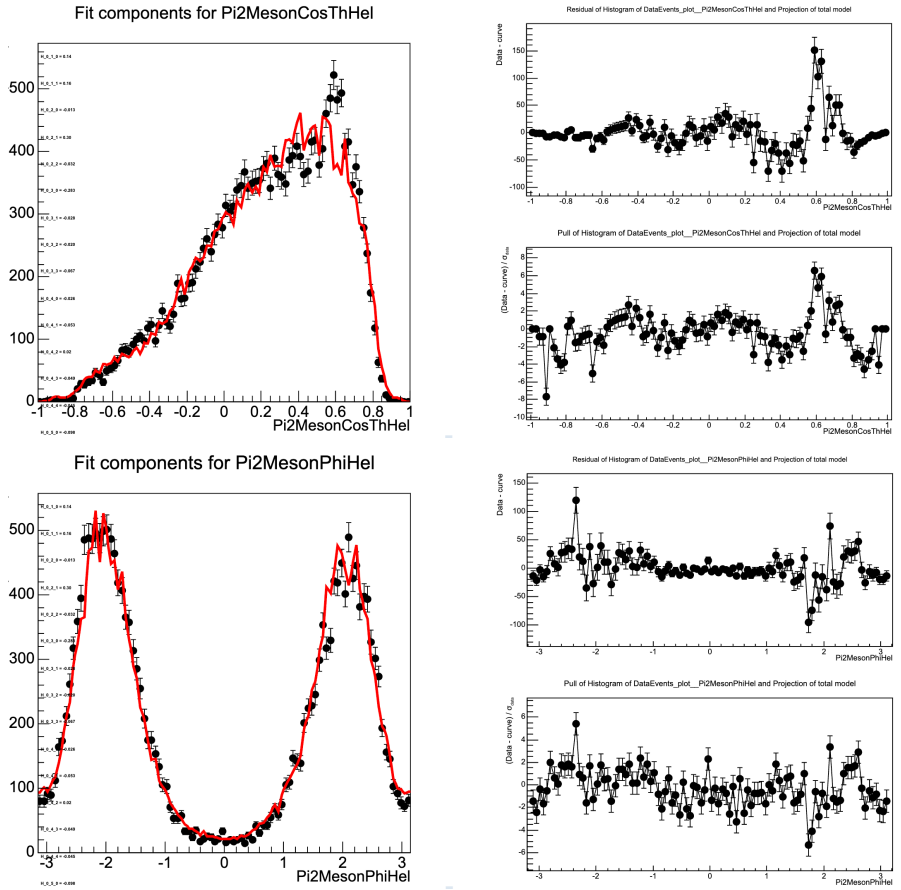
Fitting Moments

$M_{\pi\pi}$ region of the ρ^0 resonance ($0.75 < M_{\pi\pi} < 0.81$ GeV)



Low acceptance

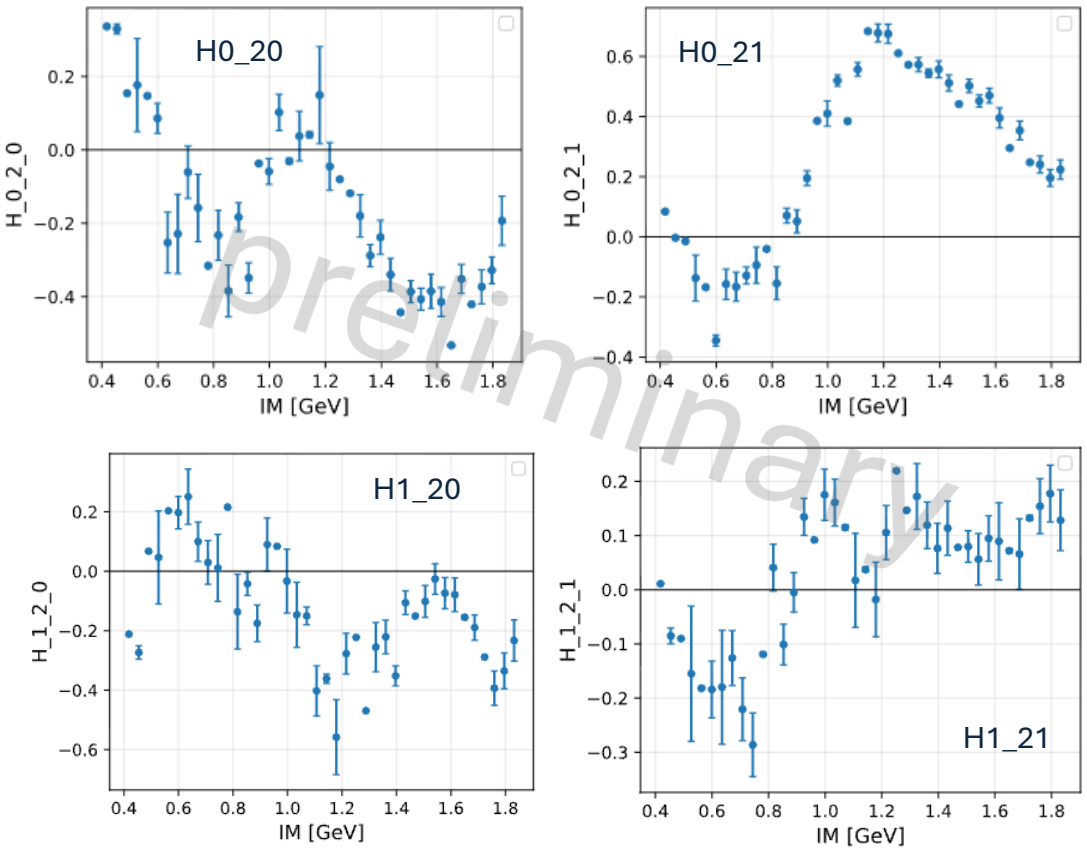
$M_{\pi\pi}$ region of the f_2 resonance ($1.18 < M_{\pi\pi} < 1.25$ GeV)



High acceptance

Extracting Moments

From moments we can study the partial waves contributions of resonances



Normalized by H00

$$H_{00}^{0} \sim |S|^2 + |P|^2 + |D|^2$$

$$H_{20}^{0,1} \sim |P|^2 + |D|^2 + \mathrm{Re}(SD^*)$$

$$H_{21}^{0,1} \sim \mathrm{Re}(SD^*) + \mathrm{Re}(PP^*) + \mathrm{Re}(DD^*)$$

arXiv:1909.09473

preliminary

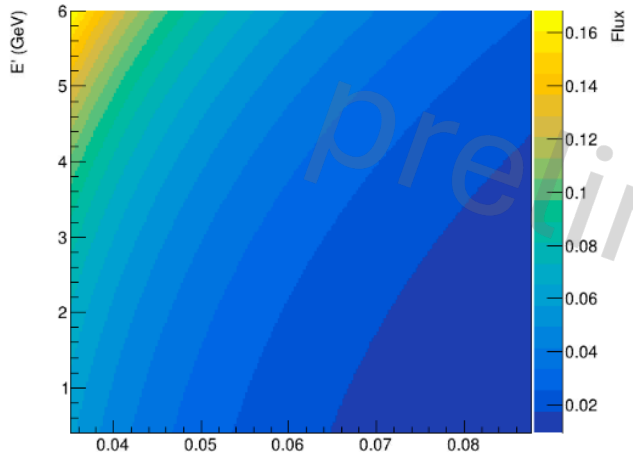
Photon Flux Calculation

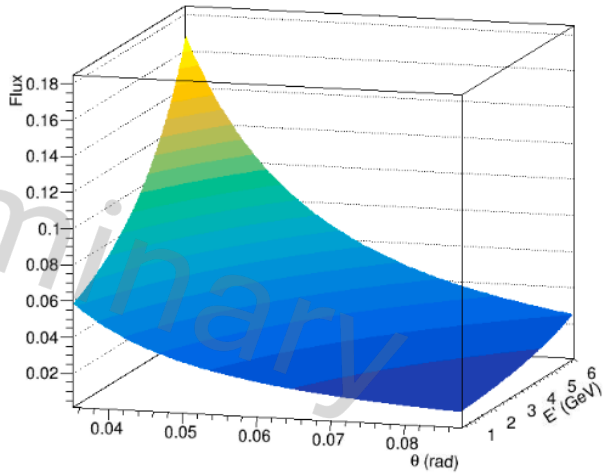
$$\frac{d^2\sigma}{dE'd\Omega} = \frac{1}{2\pi}\frac{d^2\sigma}{dE'd\cos\theta} = \boxed{\frac{\alpha}{2\pi^2}\cdot\frac{K\cdot L}{E}\cdot\frac{1}{E-E'}\cdot\frac{1}{1-\cos\theta}}\cdot\sigma_{\gamma p}$$

$$0.4 < E' < 6.0 \text{ GeV}$$
$$2^\circ < \theta < 5^\circ$$

Integrated over FT acceptance

From Electroproduction to Photoproduction





preliminary

$$K = \nu - \frac{Q^2}{2M} > 0,$$

$$\nu = E - E',$$

$$Q^2 = 2EE'(1-\cos\theta),$$

$$L \simeq \frac{y}{1-\epsilon},$$

$$y = \frac{E-E'}{E},$$

$$\epsilon = \frac{1}{1+2\left(1+\nu^2/Q^2\right)\tan^2(\theta/2)},$$

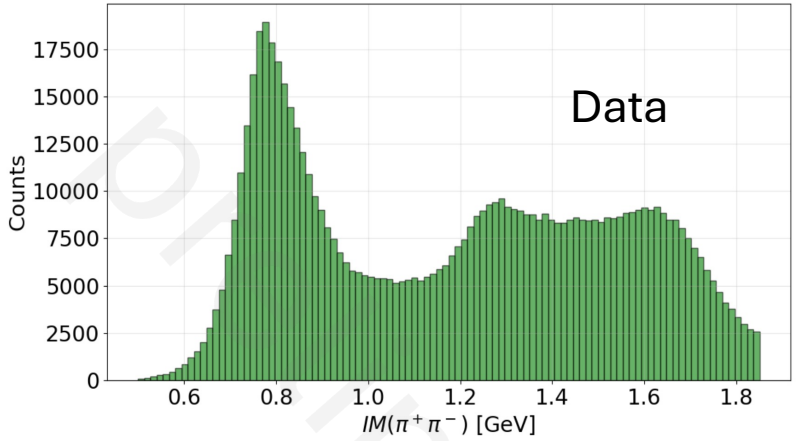
The photon flux is the product of the photon flux factor and the electron flux.

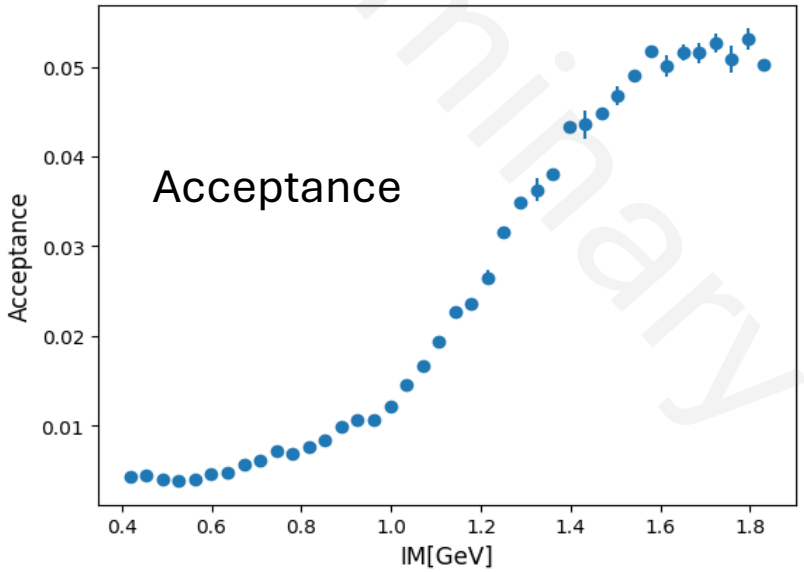
Run period	Photon flux factor	Accumulated charge (mC)	Electron flux	Photon flux
Fall 18 inbending	0.0112442	8.0466	5.029125×10^{16}	$5.65484873 \times 10^{14}$
Fall 18 outbending	0.0112442	6.9937	4.3710625×10^{16}	4.9149101×10^{14}
Spring 19 inbending	0.0120835	10.281	6.425625×10^{16}	$7.76440397 \times 10^{14}$

Credits to:
Charlie Velasquez

Acceptance Correction

We calculate acceptance using MC



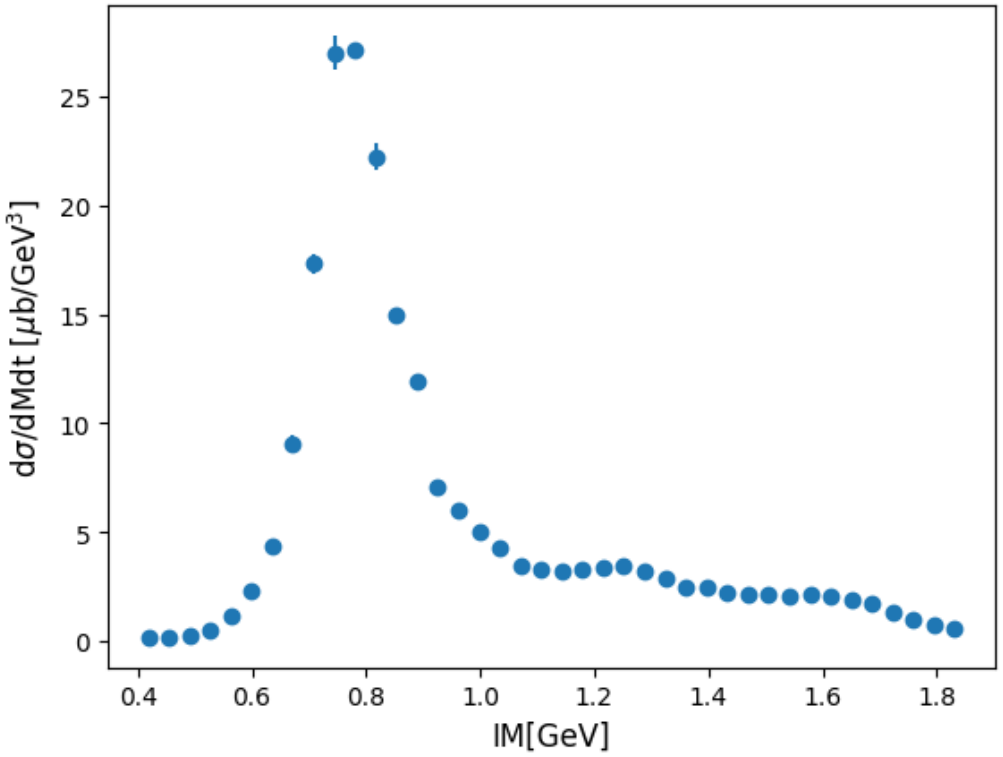


$$\frac{d^2\sigma}{dM\,dt} = \frac{N_{\text{yield}}}{\alpha\, F_\gamma\, n_{\text{target}}\, \Delta M\, \Delta t}$$

acceptance

photon flux

$$n_{\text{target}} = \rho L$$

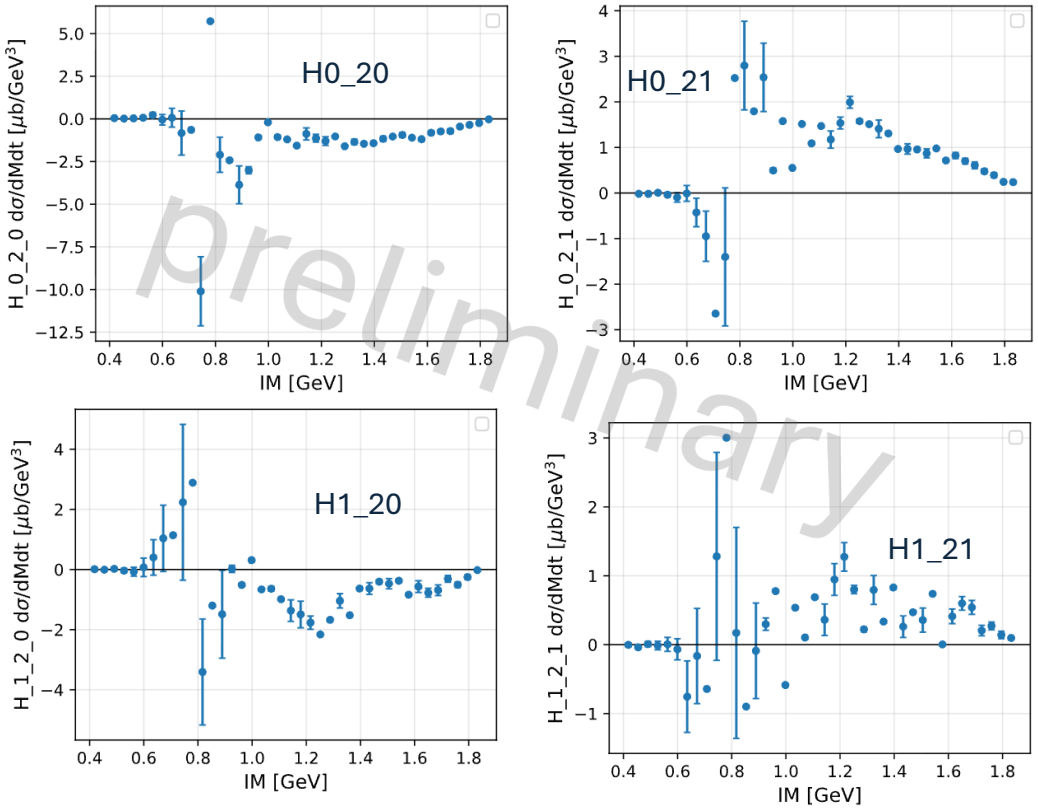


MC t distribution must be improved (Small corrections expected)

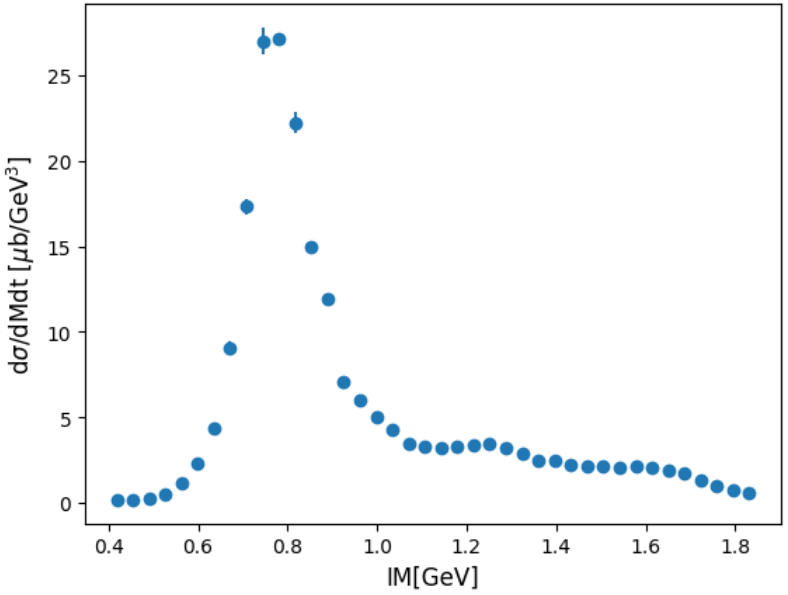
preliminary

Extracting Moments

From moments we can study the partial waves contributions of resonances



preliminary



$$H_{00}^{0} \sim |S|^2 + |P|^2 + |D|^2$$

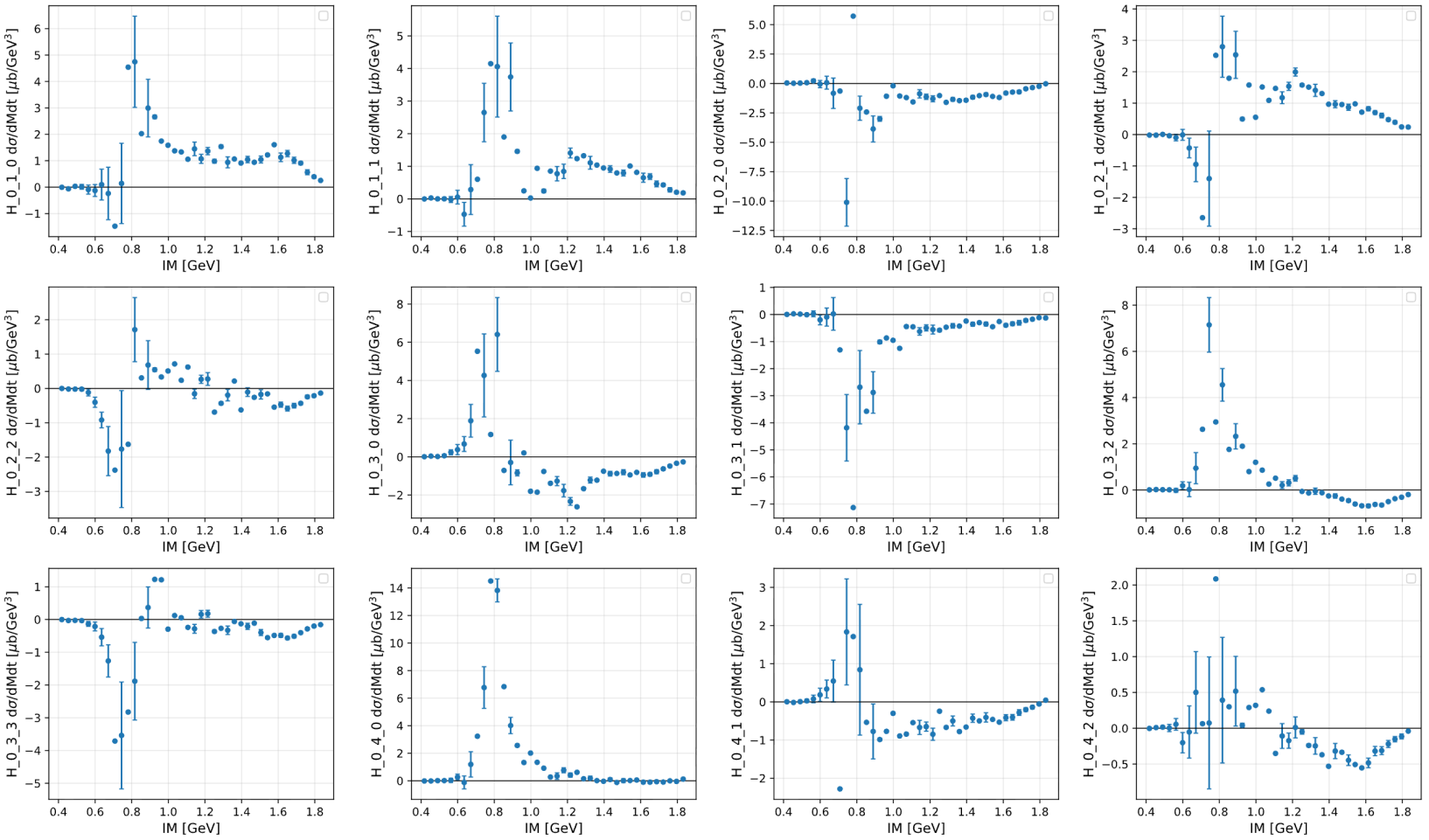
$$H_{20}^{0,1} \sim |P|^2 + |D|^2 + \mathrm{Re}(SD^*)$$

$$H_{21}^{0,1} \sim \mathrm{Re}(SD^*) + \mathrm{Re}(PP^*) + \mathrm{Re}(DD^*)$$

Rescaling moments with cross sec

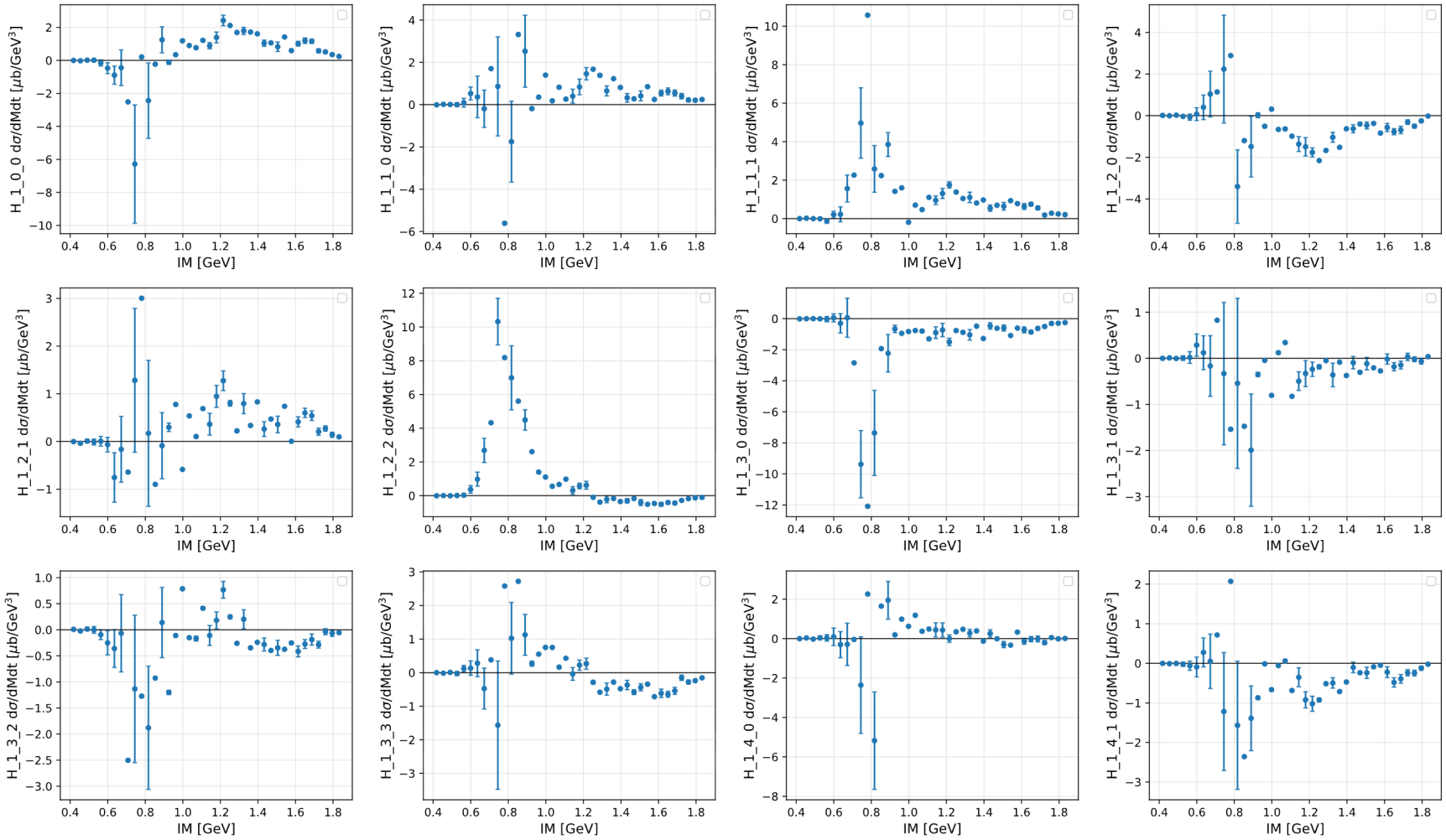
Extracting Moments

Some H0_LM



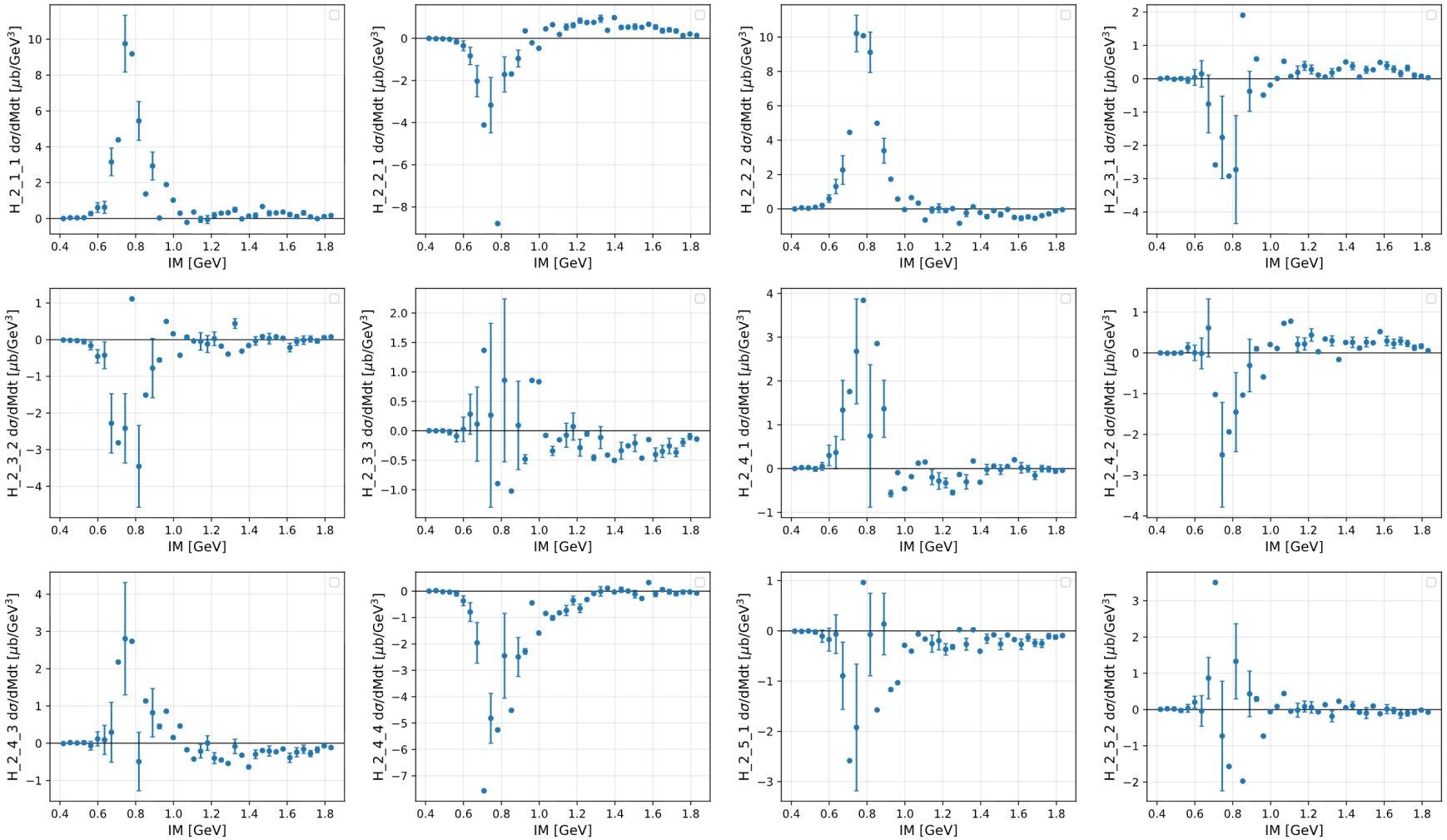
Extracting Moments

Some H1_LM



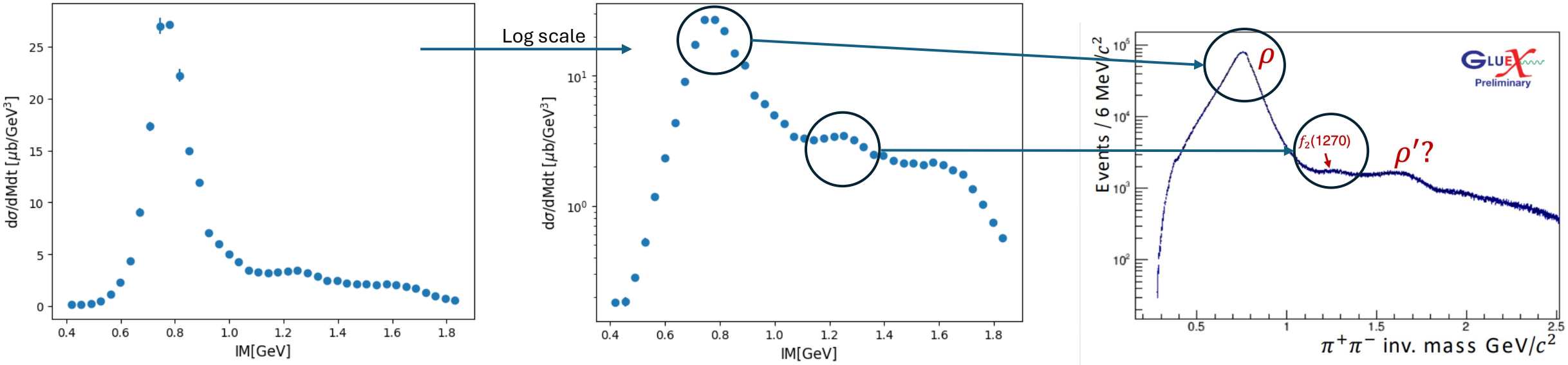
Extracting Moments

Some H2_LM



Comparison GlueX

Coss section calculation and comparison with Gluex Ylds

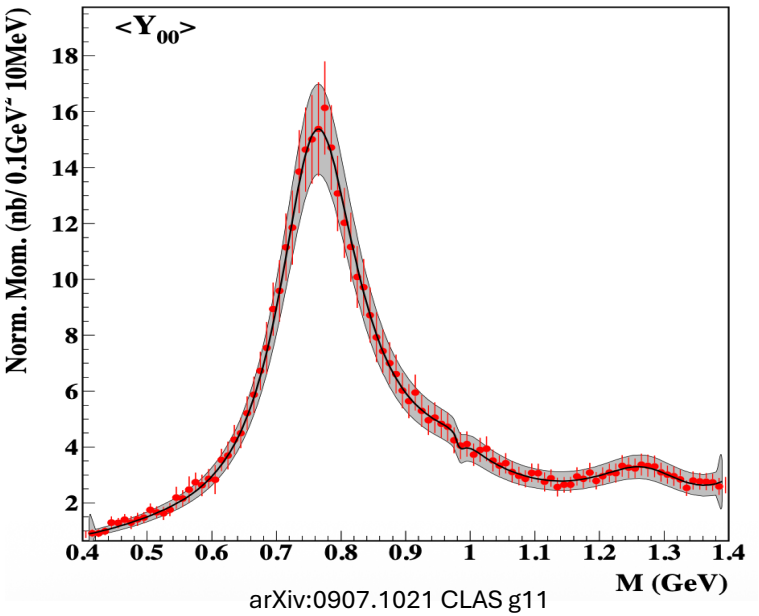


DOI: 10.1142/S2010194518600297

Good agreement with previous results

Comparison Clas g11

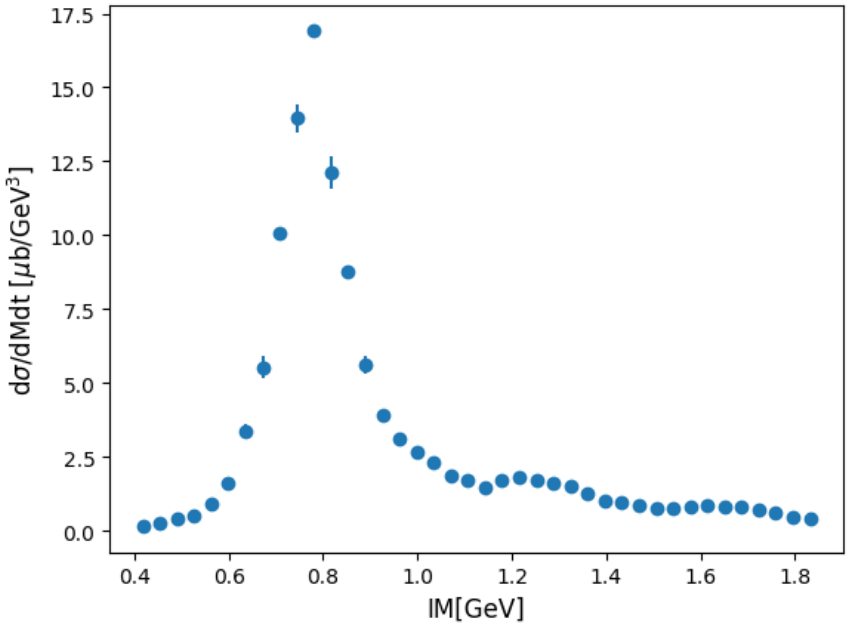
Clas g11



arXiv:0907.1021 CLAS g11

3.2 GeV < Eγ < 3.4 GeV
0.5<-t<0.6

CLAS12

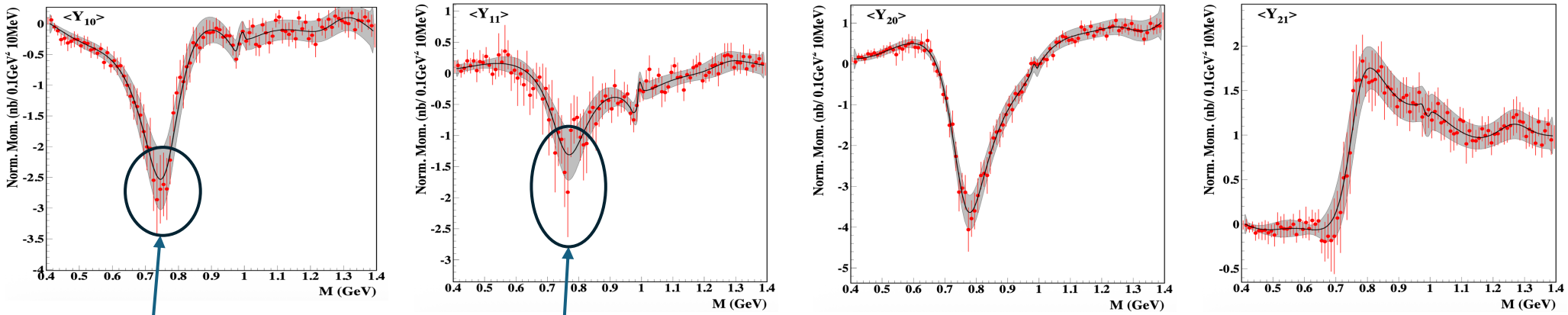


Eγ > 5 GeV
0.5<-t<0.6

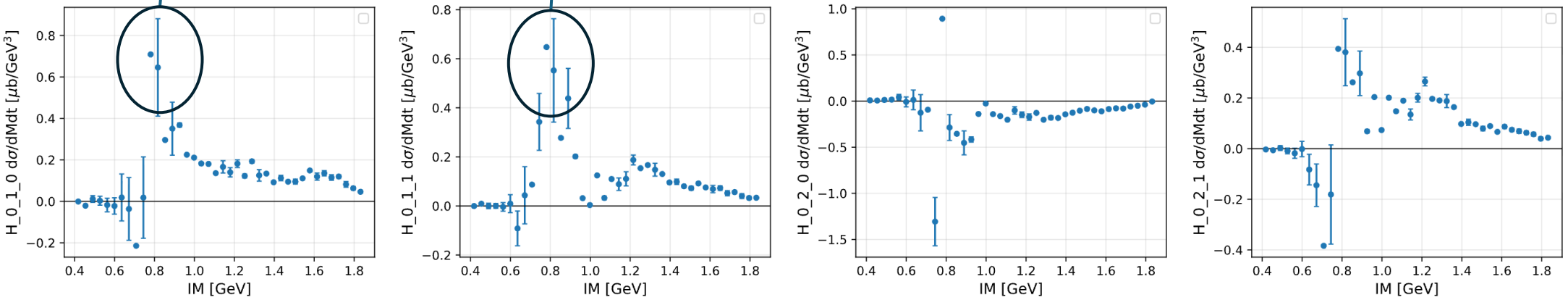
Good agreement with previous results

Comparison with clasg11

clasg11



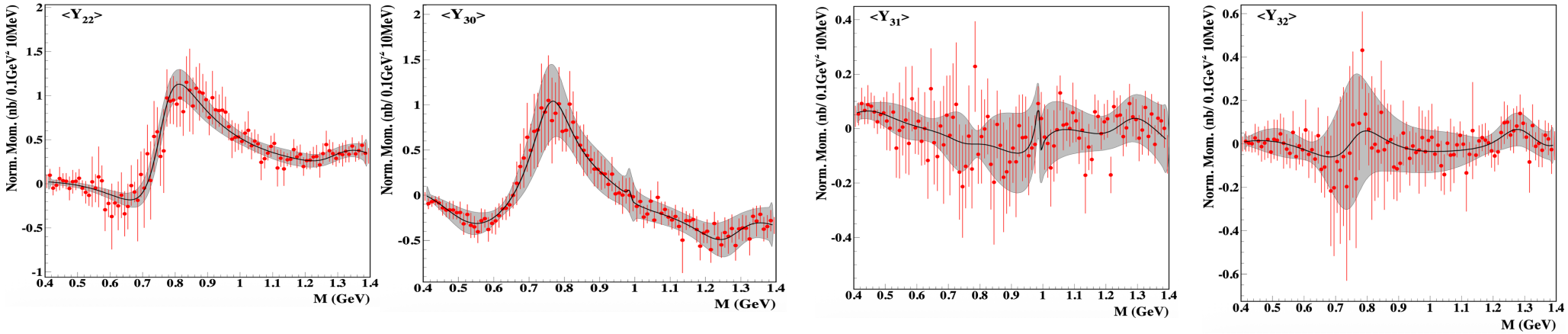
CLAS12



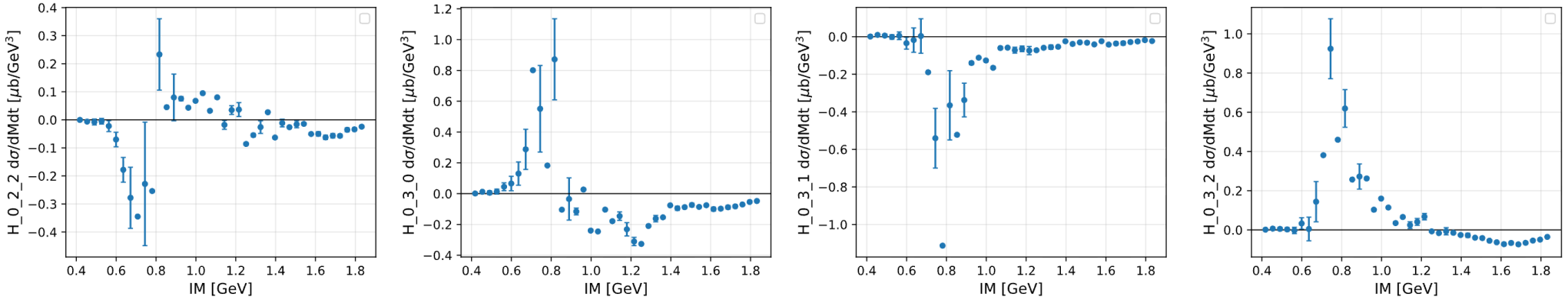
Error bars from MCMC need to be improved

Comparison with clasg11

clasg11



CLAS12



Error bars from MCMC need to be improved

Summary

Next Steps:

- Analysing other run periods (fall2018)
- Studying better the comparison with clasg11
- Analysing different topologies
    - Estimate acceptance systematics and efficiency
    - Improving efficiency corrections (using simulated triggers and measure particle efficiency)
- Fitting mass dependent Partial wave functions to moments

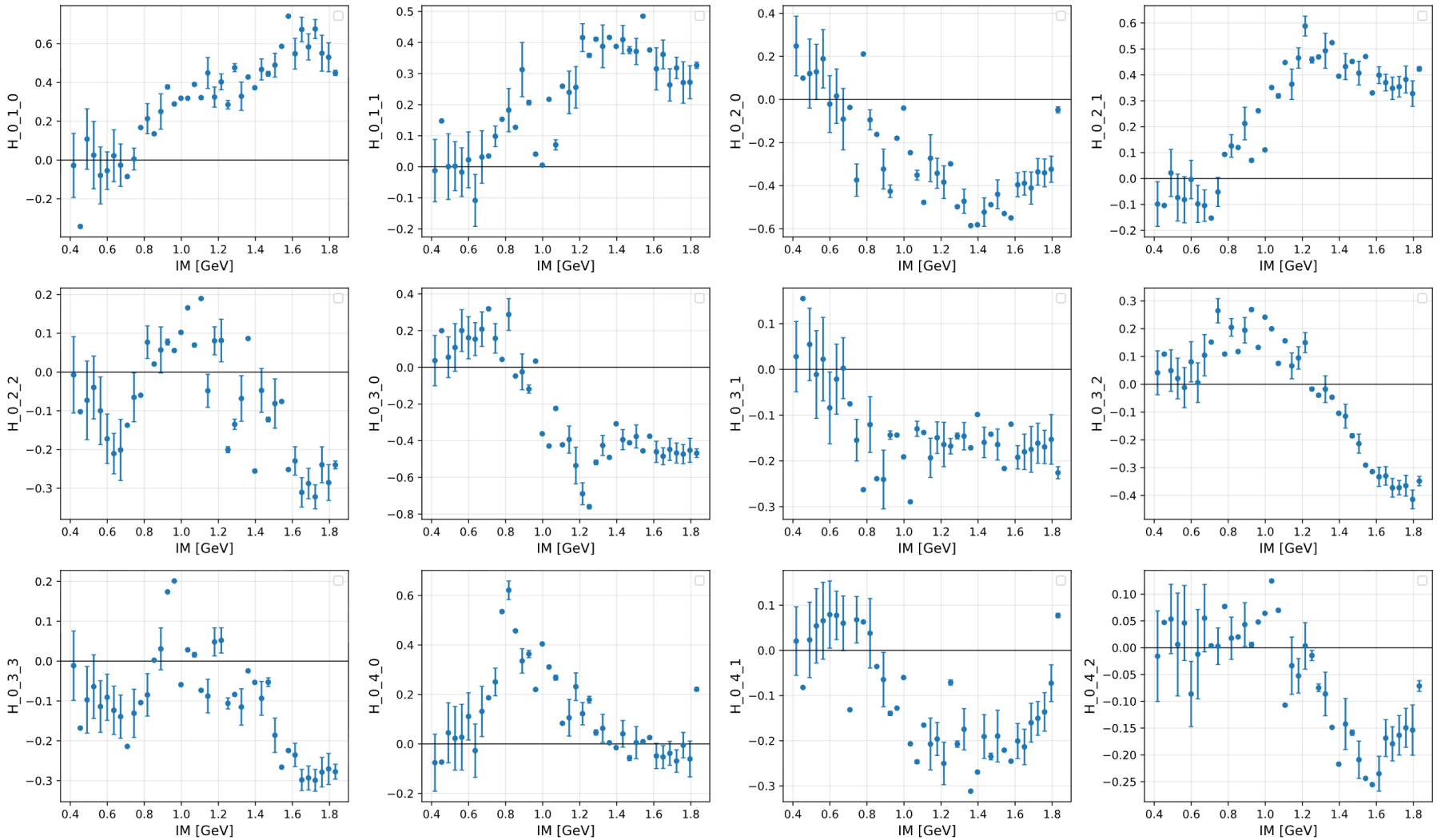




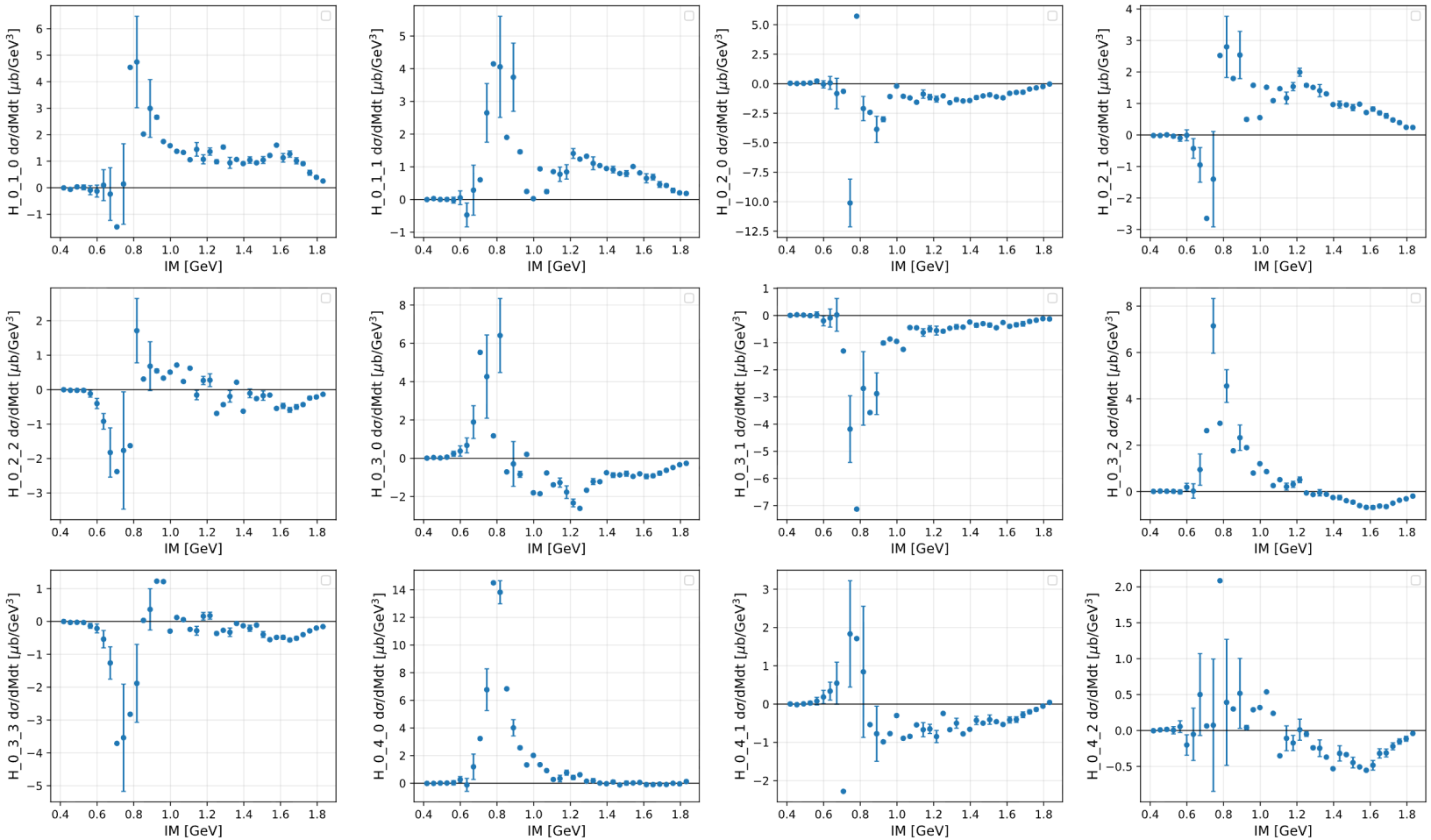
THANKS FOR YOUR ATTENTION

BACKUP

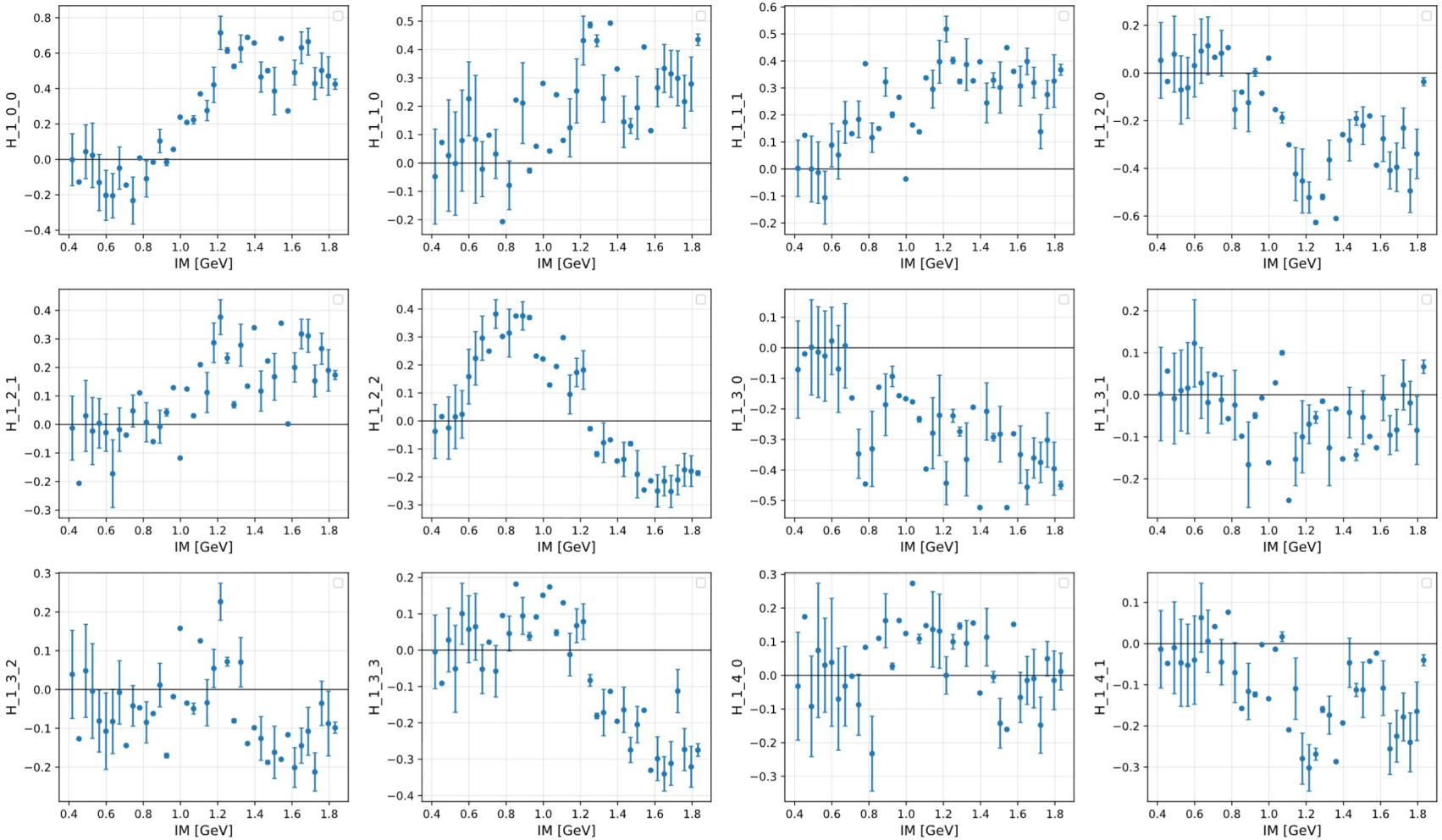
H0_LM
normalized



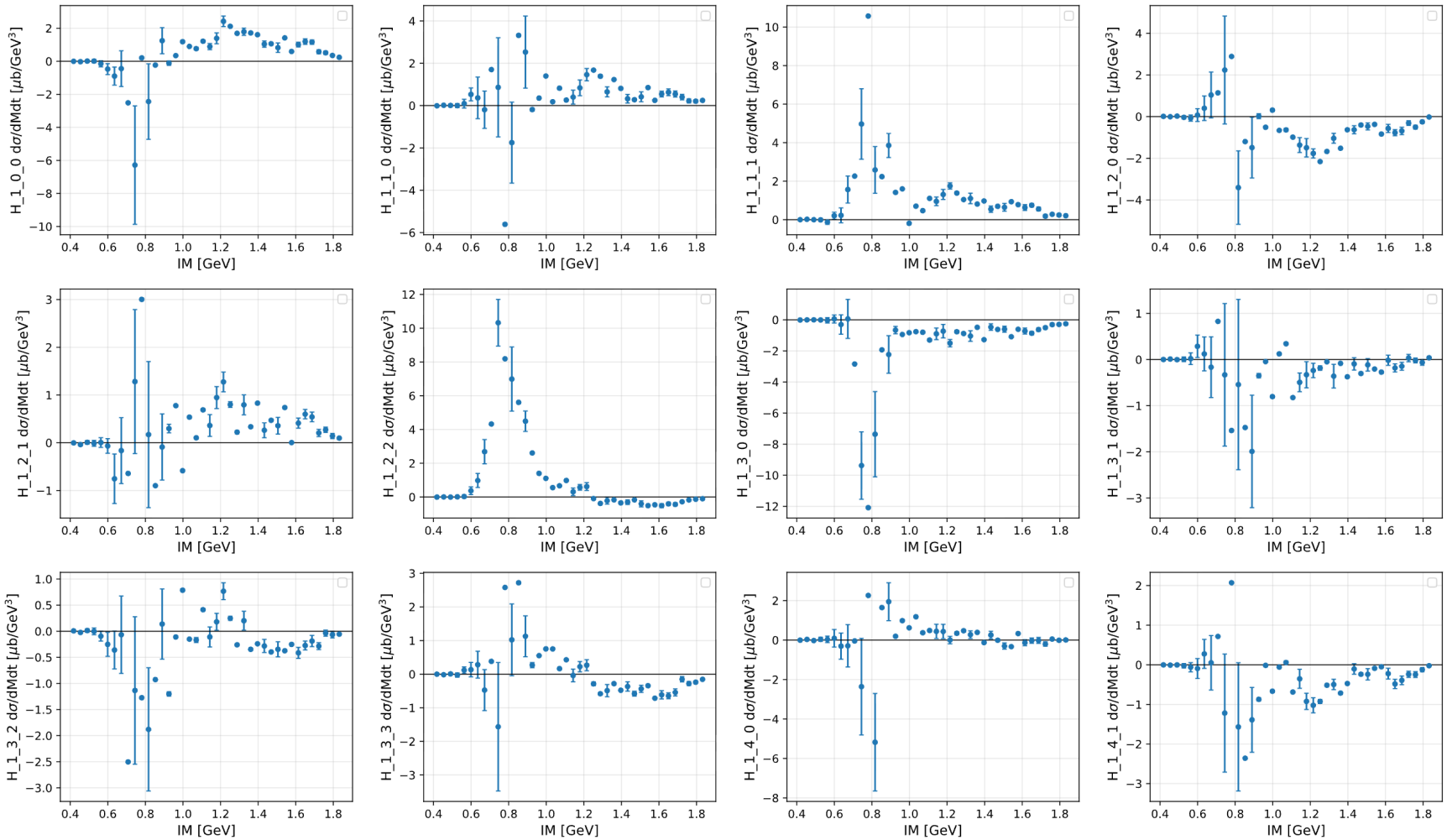
H0_LM Rescaled with Cross Sec



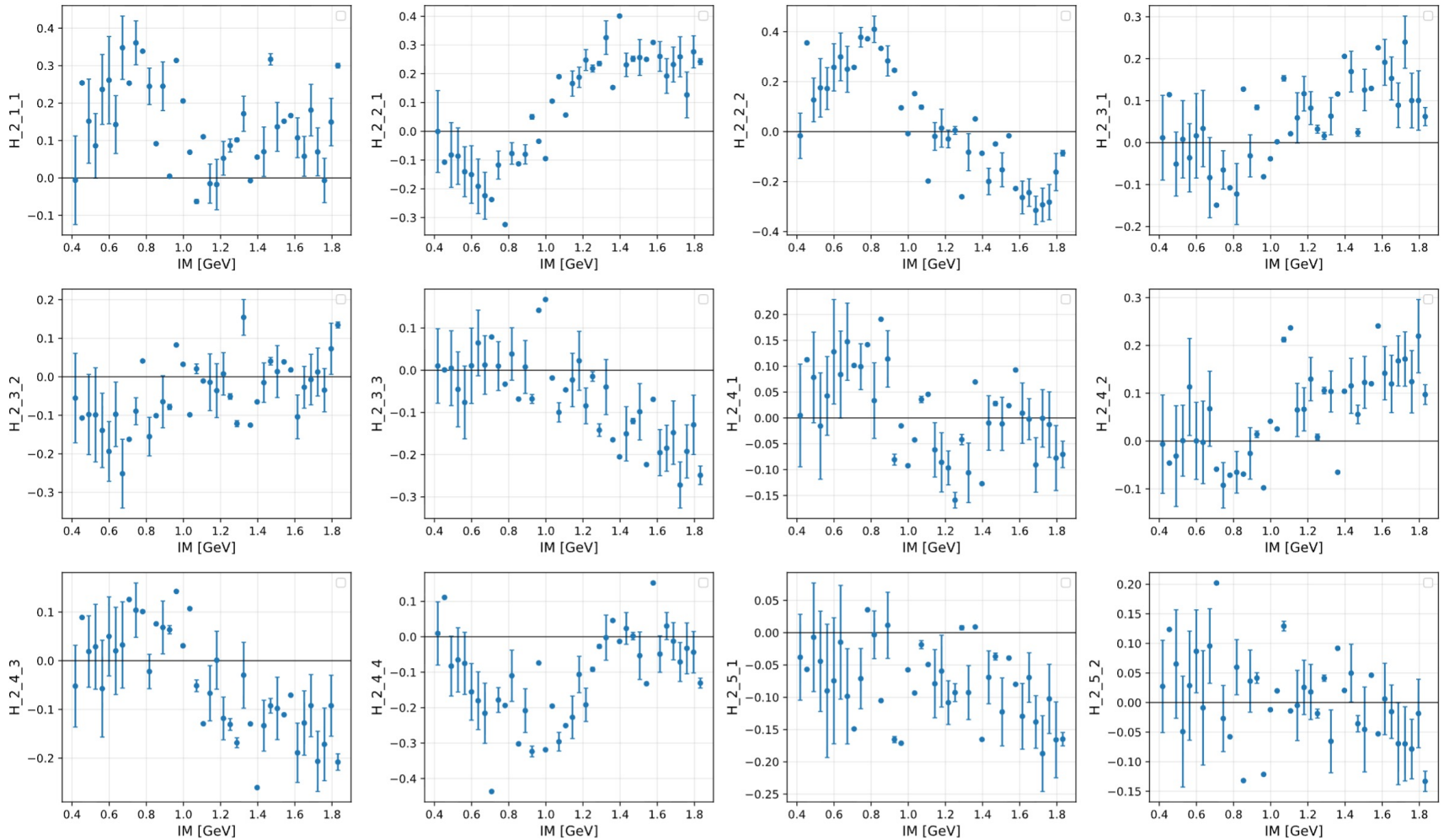
Normalized
H1_LM



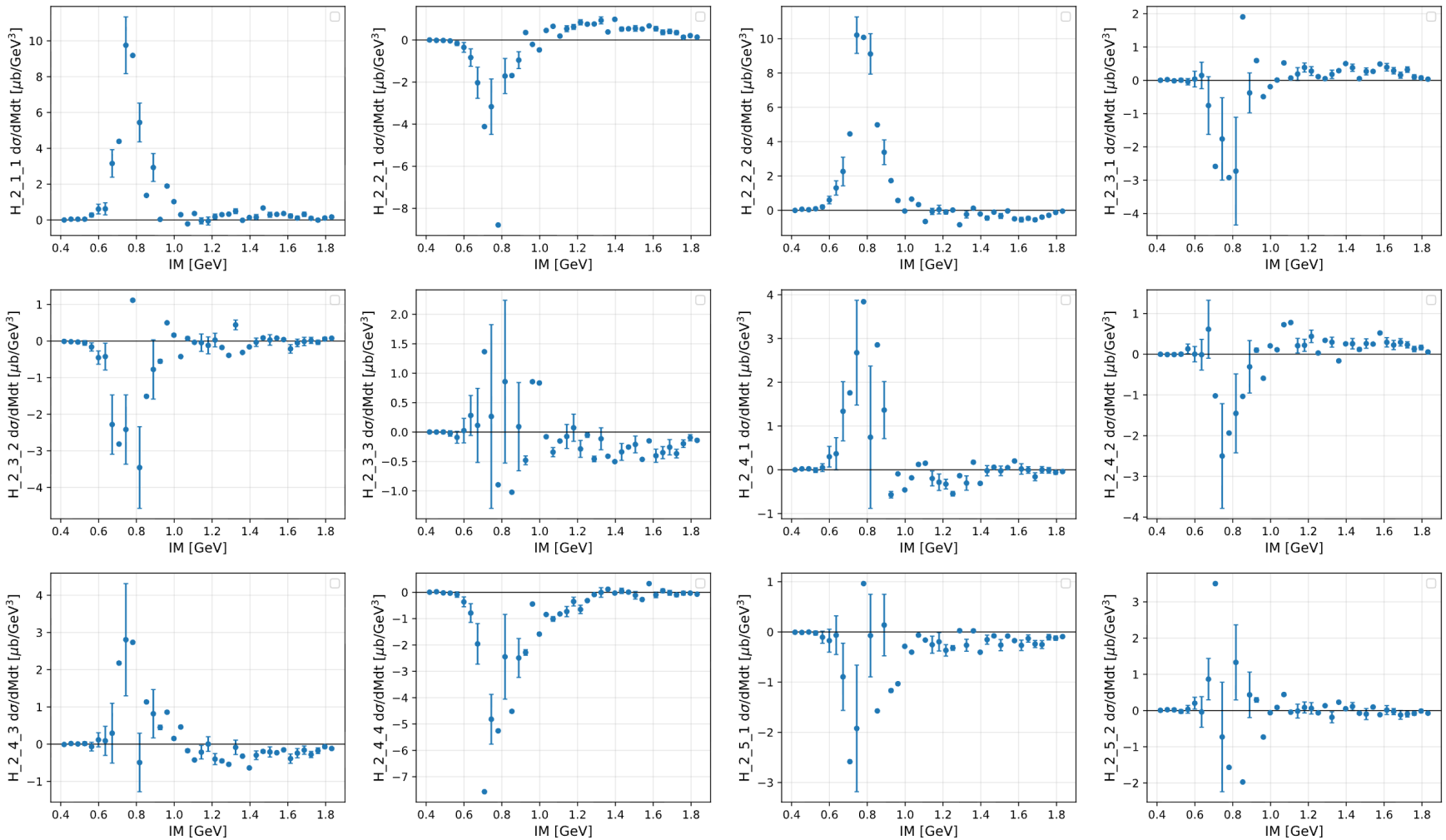
H1_LM Rescaled with Cross Sec



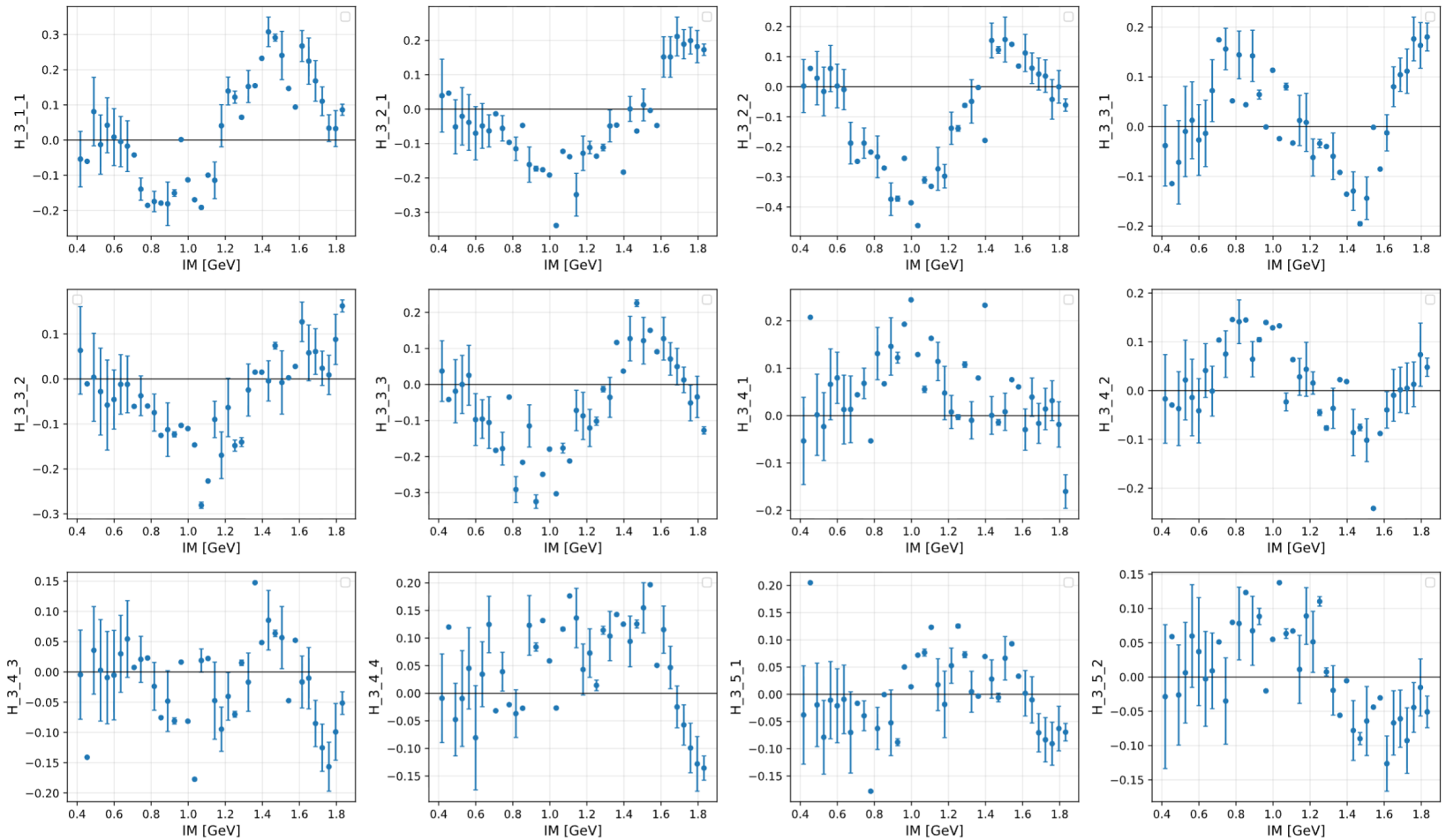
Normalized
H2_LM



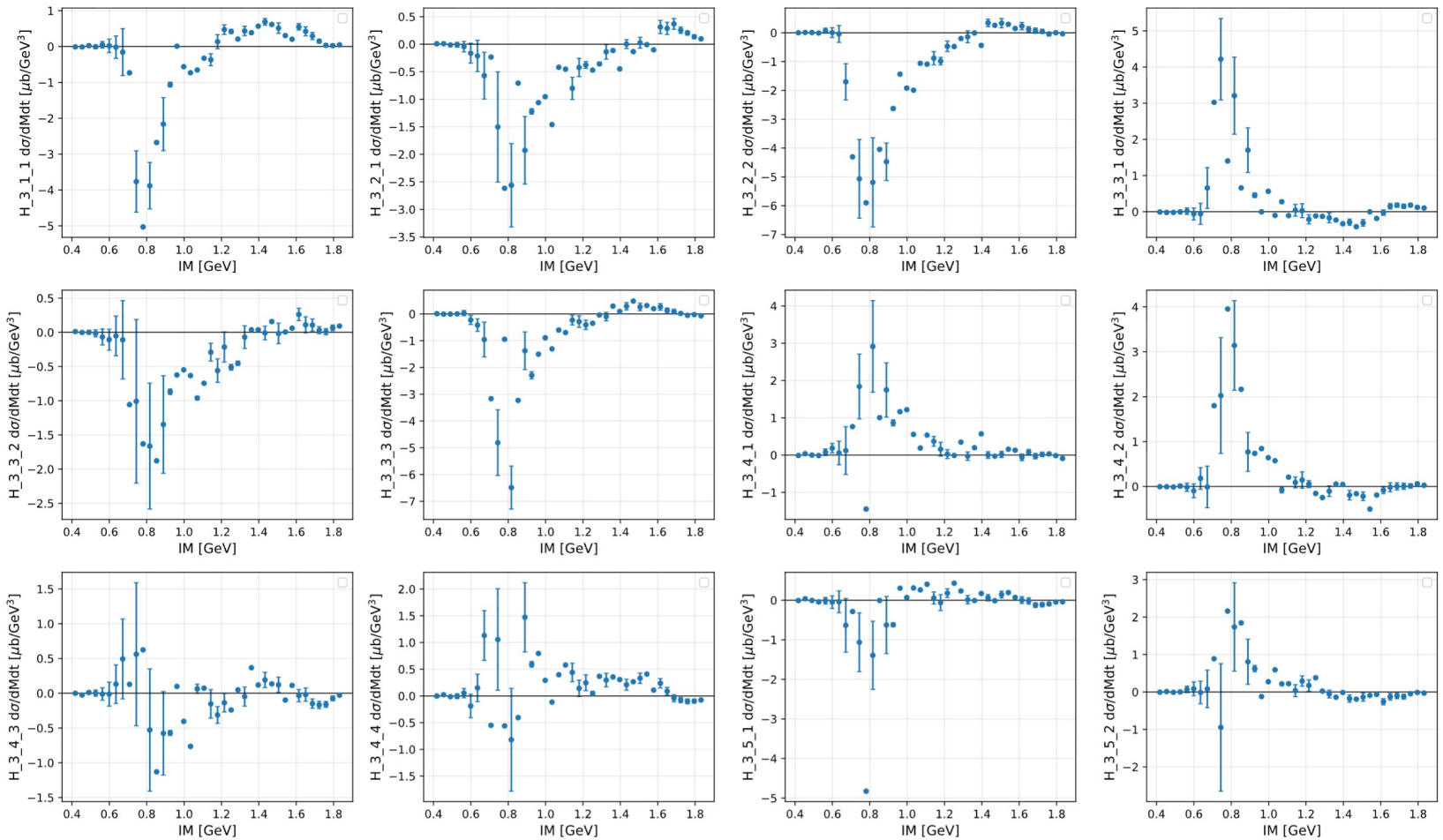
H2_LM Rescaled with Cross Sec



Normalized
H3_LM



H3_LM Rescaled with Cross Sec



Timelines

