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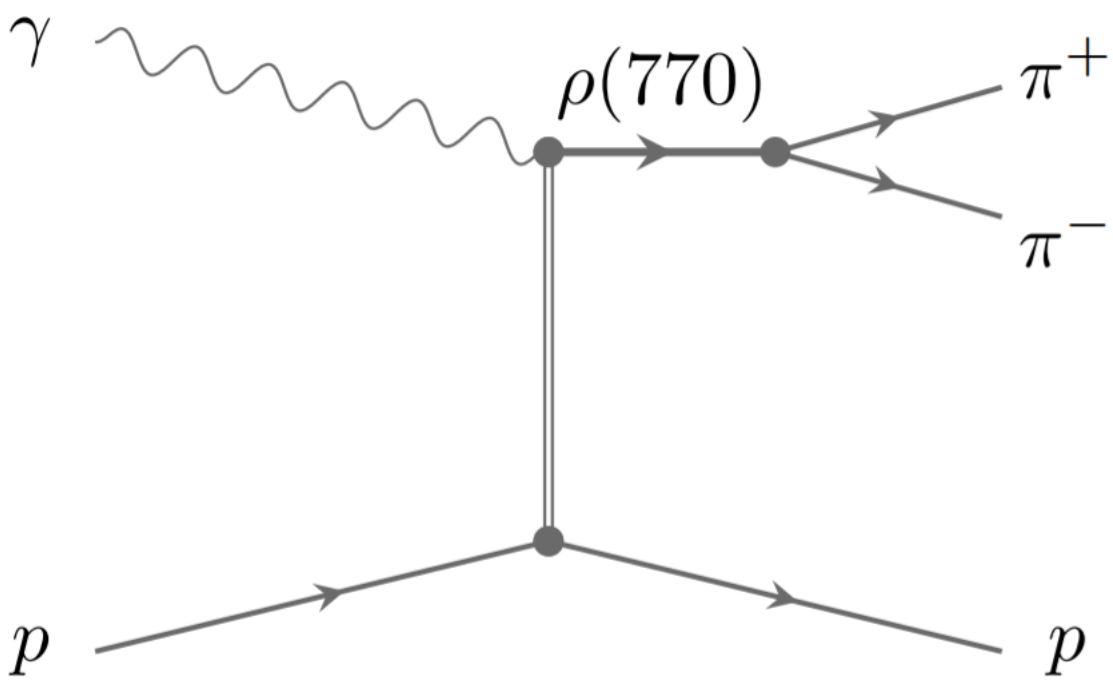
SDMEs in Unpolarised ρ(770) Photoproduction

Jamie Fitches

Motivation

- Nine linearly independent vector meson SDMEs accessible with GlueX (6 polarised + 3 unpolarised)
- Polarised SDMEs can only be measured over the coherent peak
- Three polarisation independent SDMEs can be extracted over the full beam energy range (3 to 11.6 GeV)
- This measurement will probe the relative strengths of different exchange process as a function of E_γ



SDME Extraction

Intensity function:

$$W^0(cos\Theta,\phi) = \frac{3}{4\pi}\left(\frac{1}{2}(1-\rho^0_{00}) + \frac{1}{2}(3\rho^0_{00}-1)cos^2\Theta - \sqrt{2}Re\rho^0_{10}sin2\Theta cos\phi - \rho^0_{1-1}sin^2\Theta cos2\phi\right)$$

$$W^1(cos\Theta,\phi) = \frac{3}{4\pi}\left(\rho^1_{11}sin^2\Theta + \rho^1_{00}cos^2\Theta - \sqrt{2}Re\rho^1_{10}sin2\Theta cos\phi - \rho^1_{1-1}sin^2\Theta cos2\phi\right)$$

$$W^2(cos\Theta,\phi) = \frac{3}{4\pi}\left(\sqrt{2}\mathrm{Im}\ \rho^2_{10}sin2\Theta\ sin\phi + Im\rho^2_{1-1}sin^2\Theta sin2\phi\right)$$

$$W(cos\Theta,\phi) = W^0(cos\Theta,\phi) - P_\gamma cos2\Phi\ W^1(cos\Theta,\phi) - P_\gamma sin2\Phi W^2(cos\Theta,\phi)$$

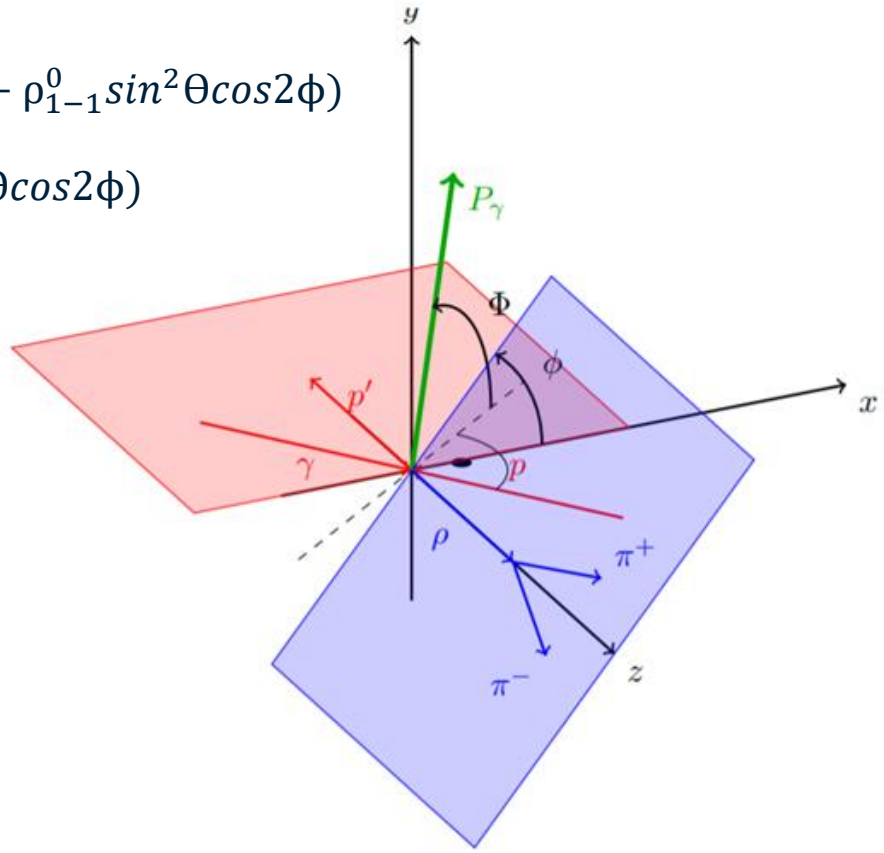
MCMC parameter estimation:

$Measured\ Intensity\ \mathrm{I}(\Omega) \propto W(cos\Theta,\phi)$

$lnL = observed\ events\ (weighted) - normalisation\ integral$

$= \sum_{i=1}^{N} w_i lnI(\Omega_i) - \int d\Omega I(\Omega)\eta(\Omega),$

where $w_i = 1$ (prompt) or -1/8 (background)



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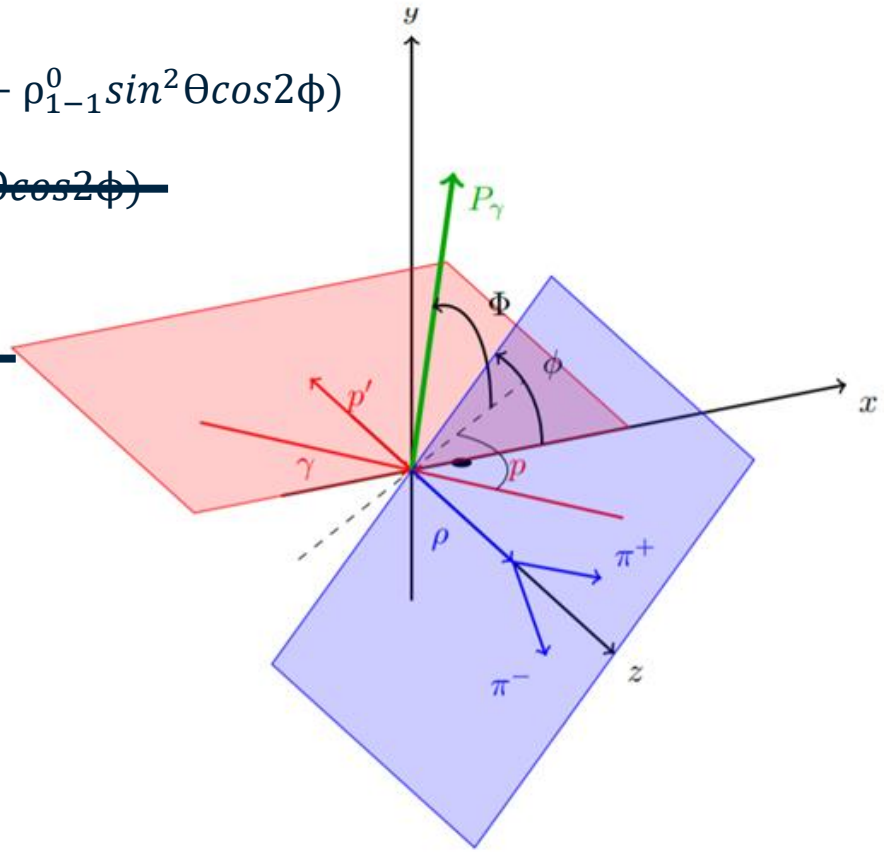
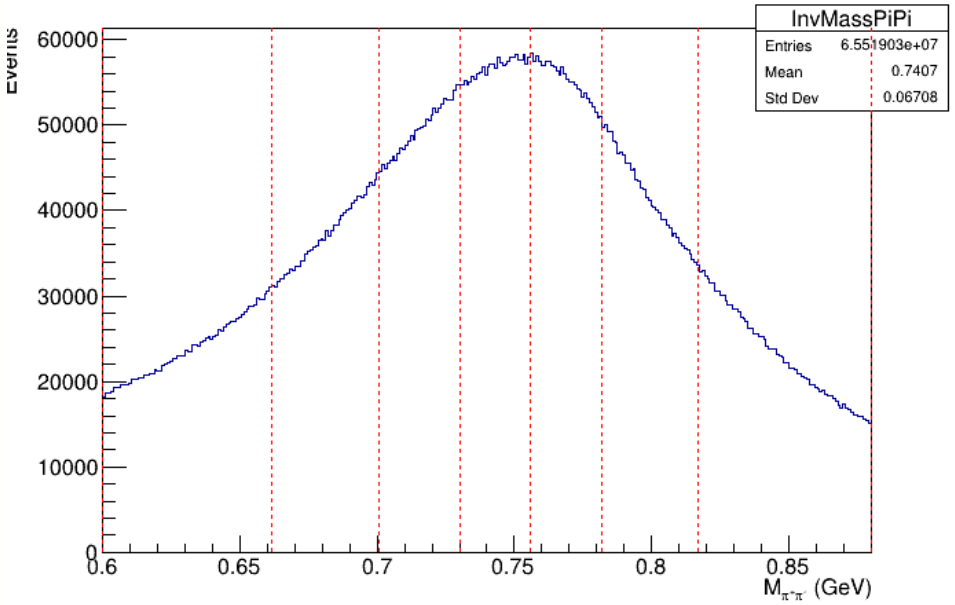
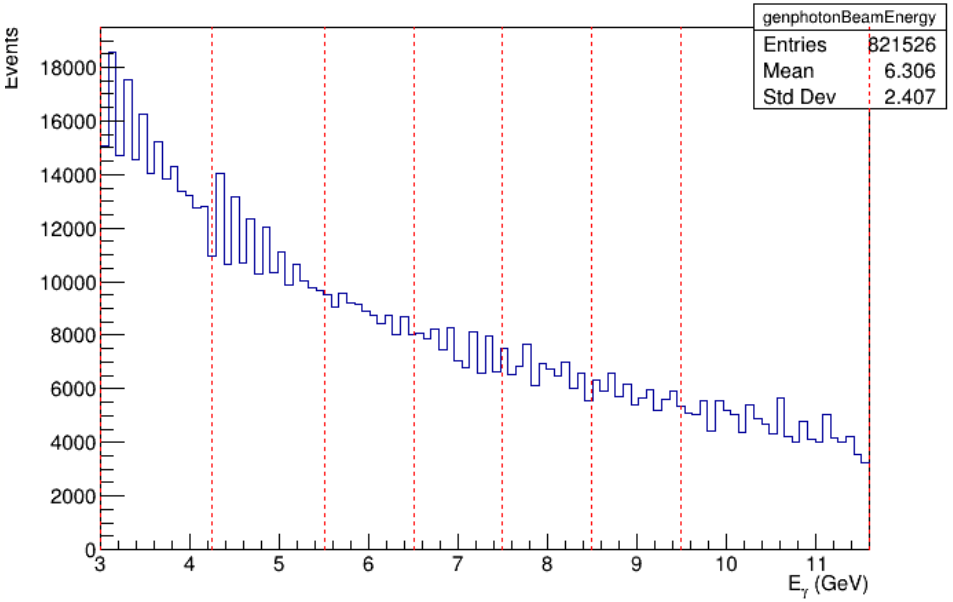


Event Selection

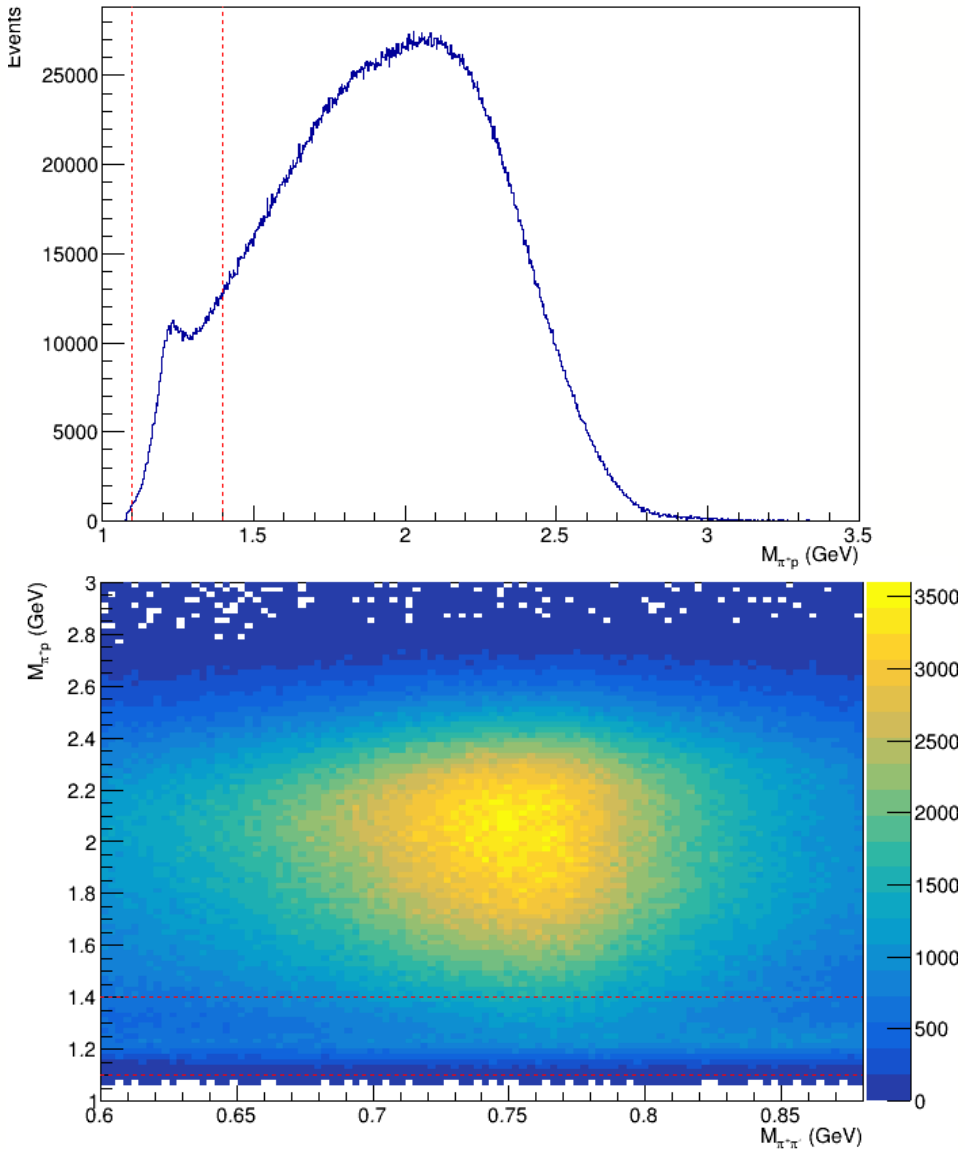
- Data set:
  - tree_pippim__B4, ver46 (2017-01), amorphous
  - Kinematic fit: Vertex and 4-momentum
  - 4 beam bunches on either side of prompt peak
- Simulation:
  - Generator: gen_amp
  - Flat angular distribution
- Dselector cuts:
  - Default proton dE/dx in CDC
  - |Missing mass squared| < 0.02 GeV^2
  - Cut 1.1 < $M_{\pi^+ p}$ < 1.4 GeV region for E_γ < 5.5 GeV
  - 55cm < Z_{vertex} < 75cm
  - Bin SDME fits in E_γ and $M_{\pi^+\pi^-}$





Low E_γ Δ^{++} Background

- Non-negligible contribution from $\gamma p \rightarrow \Delta^{++}\pi^- \rightarrow p\pi^+\pi^-$ at low E_γ (< 5.5 GeV)
- Toy study to determine most effective anti-delta cut:
  - Weight flat MC sample with JPAC SDMEs
  - Add 2% Δ^{++} contribution (generated with TGenPhaseSpace)
  - Extract SDMEs with both cuts and compare with input model
  - Van Hove and $M_{p\pi^+}$ cuts both seen to be effective



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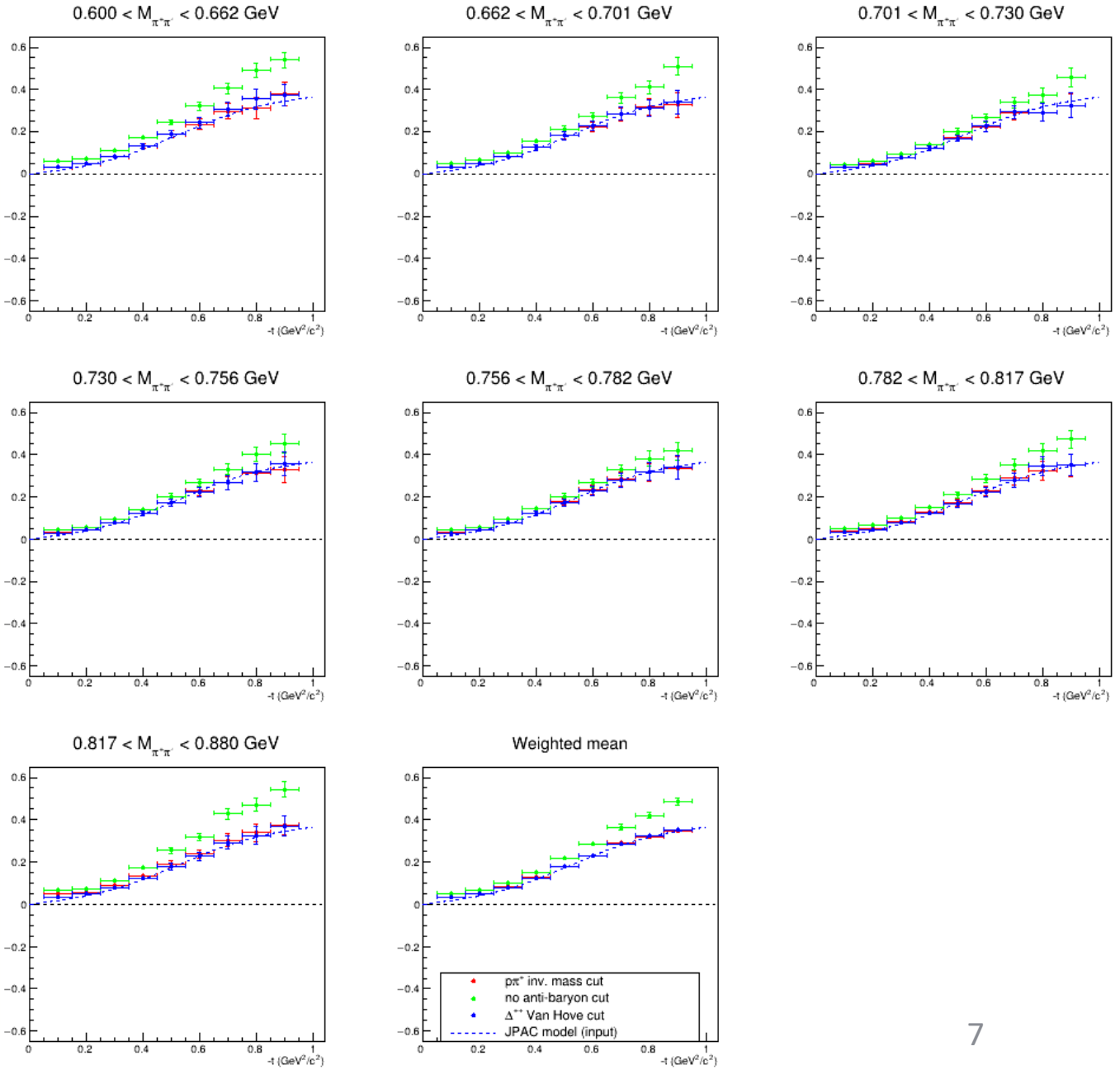

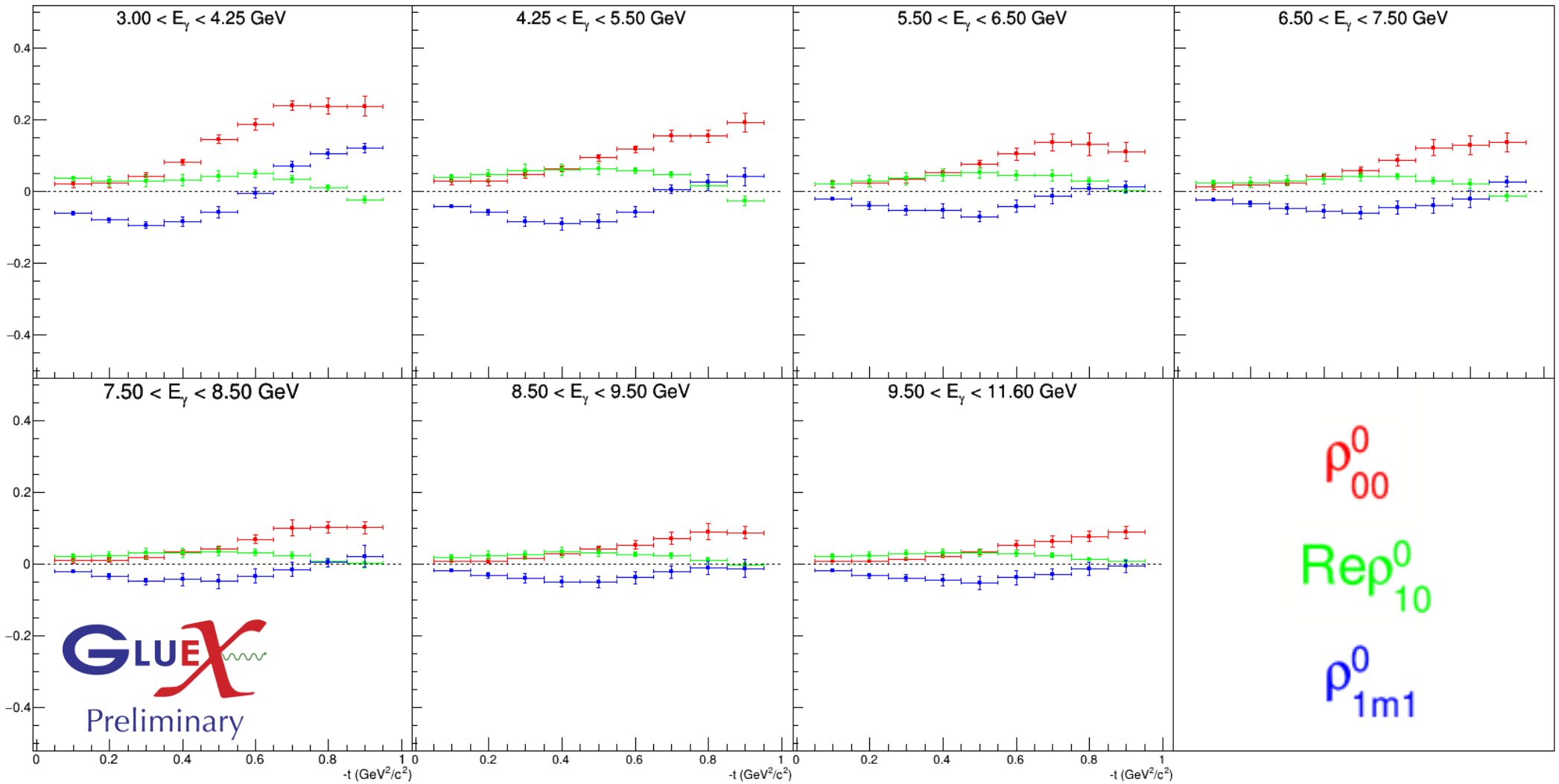
3.00 < E$_\gamma$ < 4.25 GeV
4.25 < E$_\gamma$ < 5.50 GeV
5.50 < E$_\gamma$ < 6.50 GeV
6.50 < E$_\gamma$ < 7.50 GeV
7.50 < E$_\gamma$ < 8.50 GeV
8.50 < E$_\gamma$ < 9.50 GeV
9.50 < E$_\gamma$ < 11.60 GeV
0.4
0.2
0
−0.2
−0.4
0
0.2
0.4
0.6
0.8
1
-t (GeV^2/c^2)
ρ^0_{00}
Reρ^0_{10}
ρ^0_{1m1}
GLUEX
Preliminary

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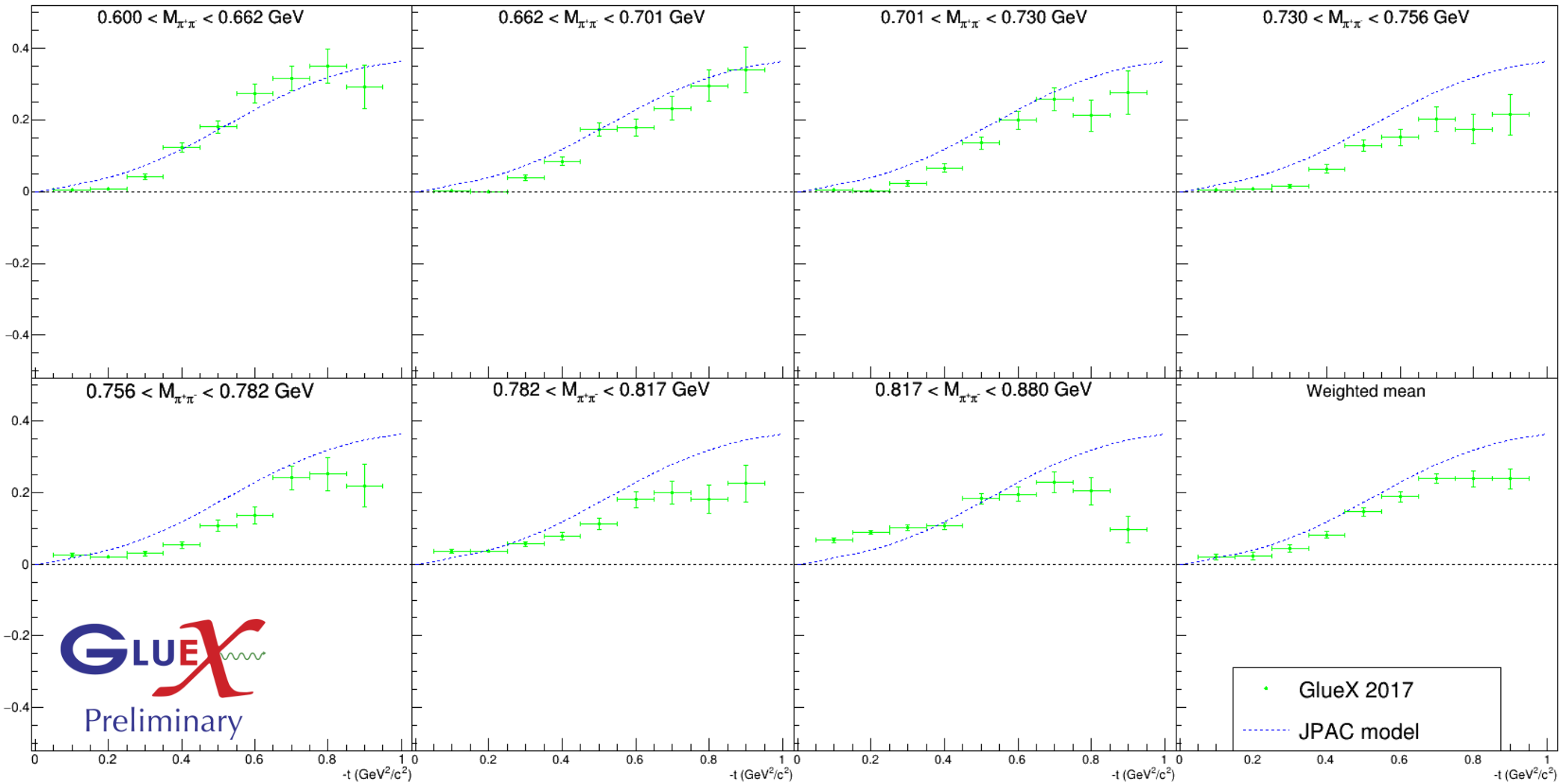
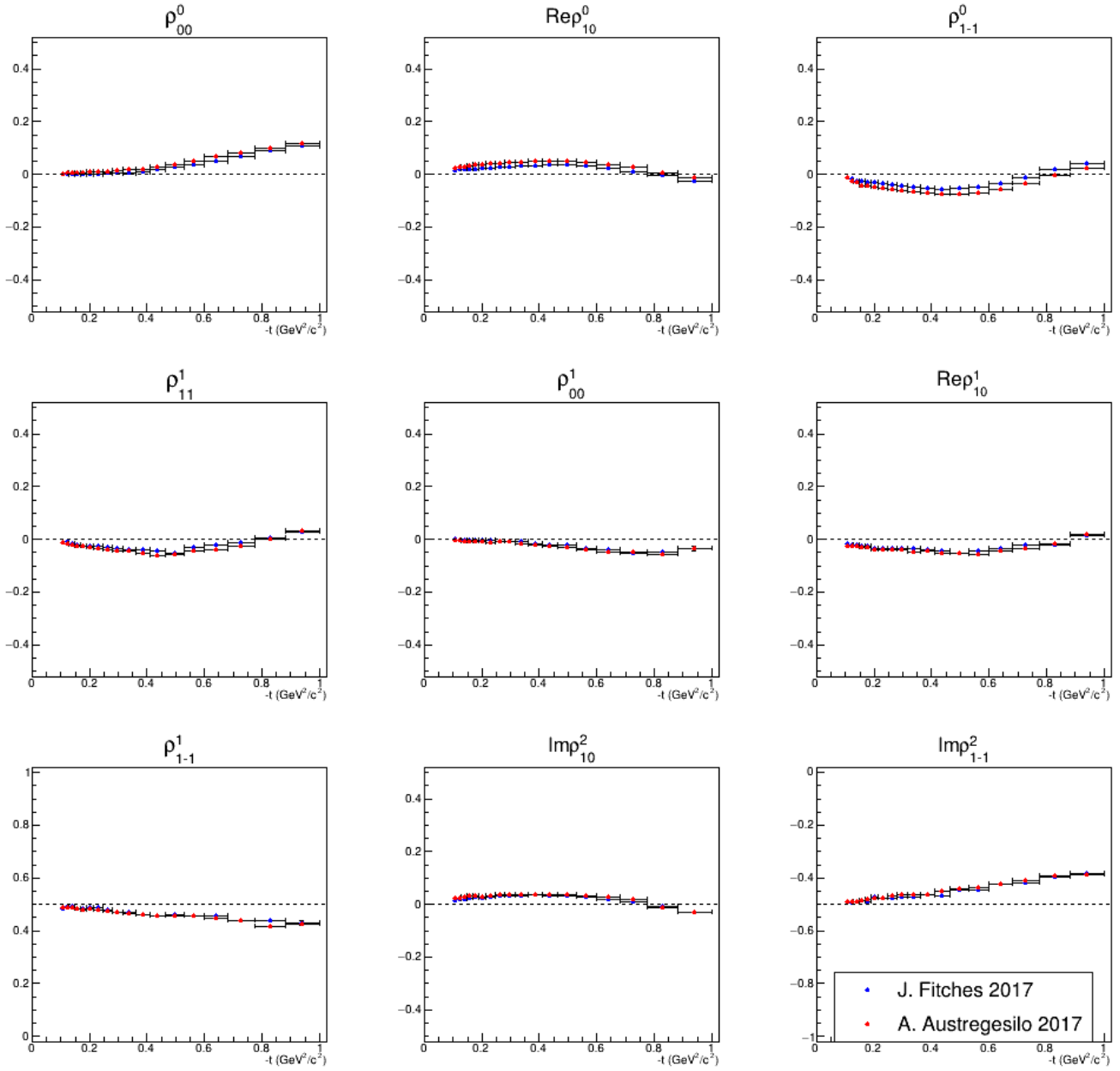
ρ_{00}^{0} (3 < E_γ < 4.25 GeV)



Polarised ρ(770) photoproduction SDMEs

- Event selection:
  - Default proton dE/dx in CDC
  - 8.2 GeV < E_γ < 8.8 GeV
  - 0.60 GeV < $M_{\pi^+\pi^-}$ < 0.88 GeV
  - $\frac{\chi^2_{kinfit}}{NDF} < 5$
  - 55cm < Z_{vertex} < 75cm
  - r_{vertex} < 1 cm
  - |Missing energy| < 0.5 GeV
  - |Missing mass squared| < 0.02 GeV^2
  - Accidental background subtracted with combo/timing weights + scaling factor



Outlook

- Understand discrepancies seen in SDMEs for polarised ρ(770) photoproduction compared with Alex's measurements
- Understand mass dependence of unpolarised SDMEs and deviations from s-channel helicity conservation at low t
- SDME results validation studies

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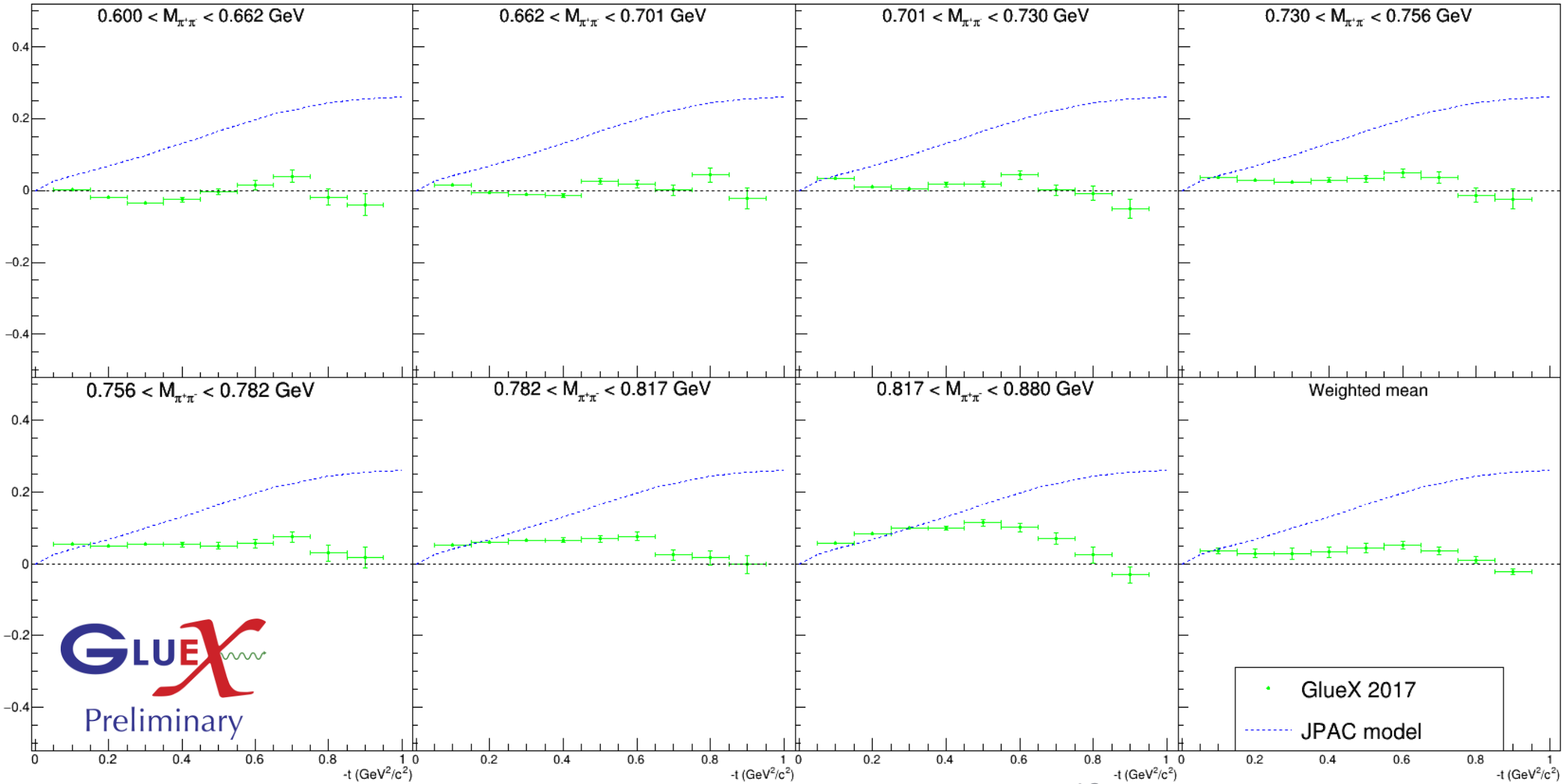
$Re\rho_{10}^{0}$ (3 < E_γ< 4.25 GeV)



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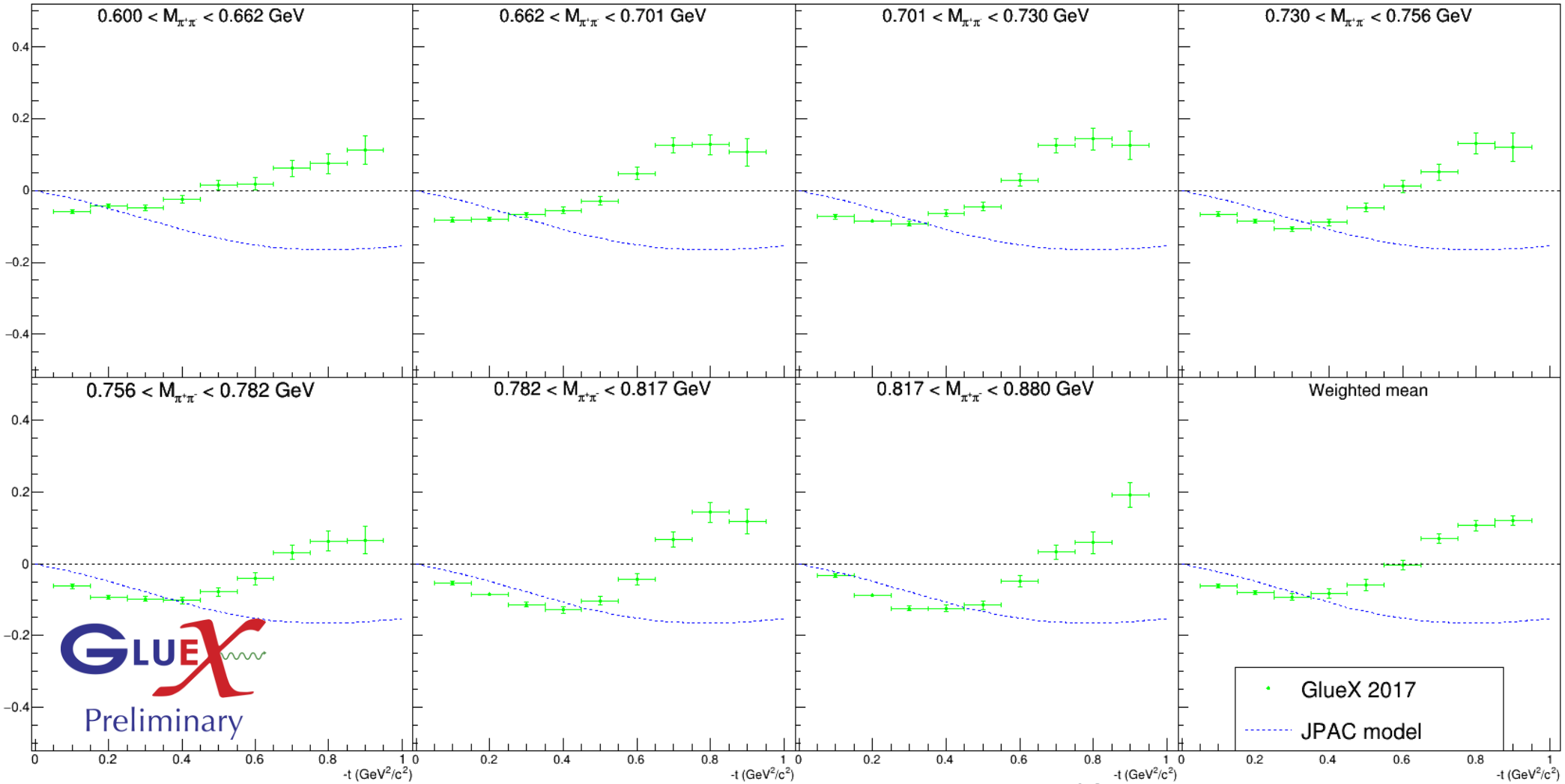
ρ^0_{1-1} (3 < E_γ < 4.25 GeV)



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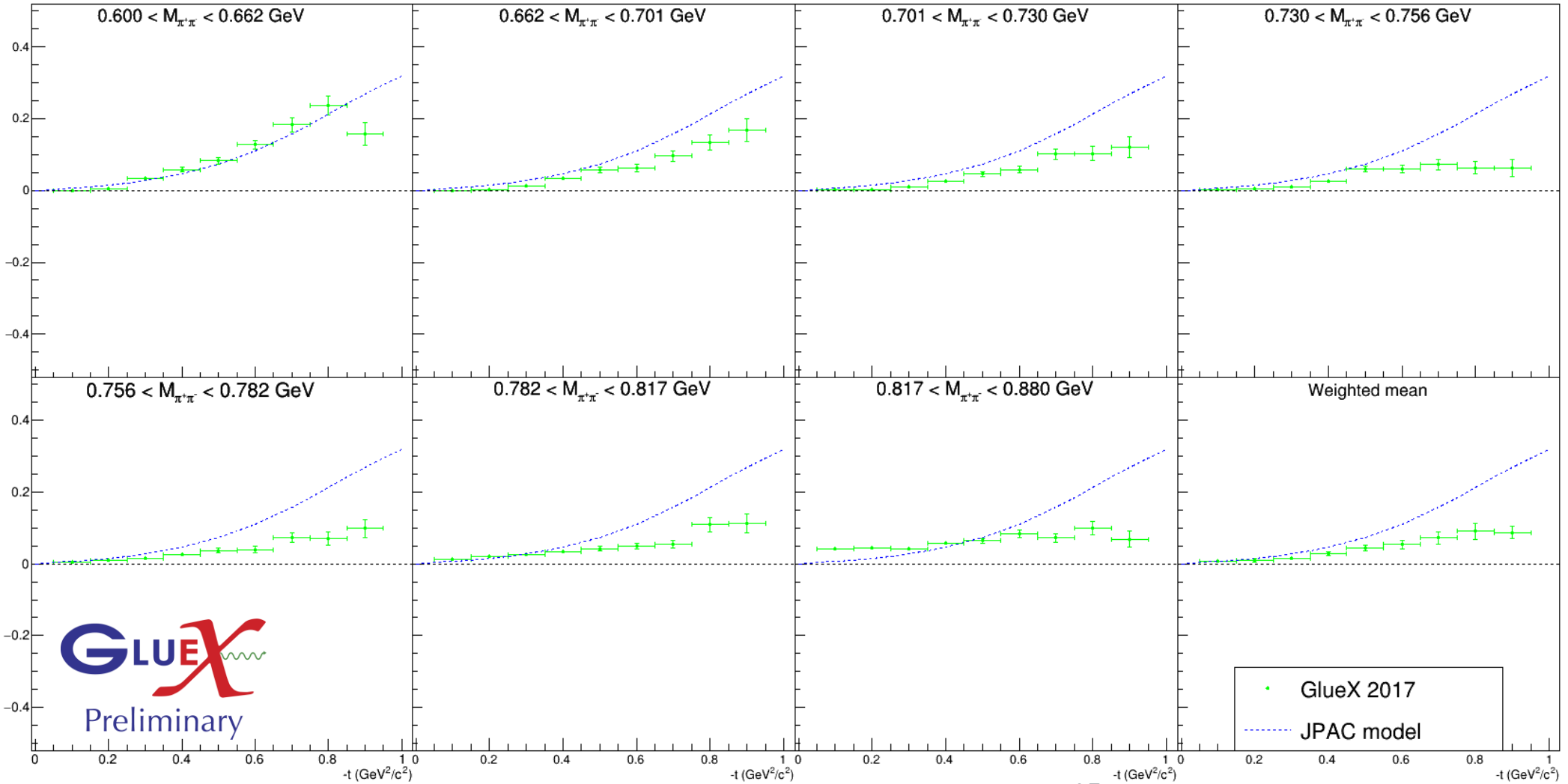
ρ_{00}^{0} (8.5 < E_γ < 9.5 GeV)



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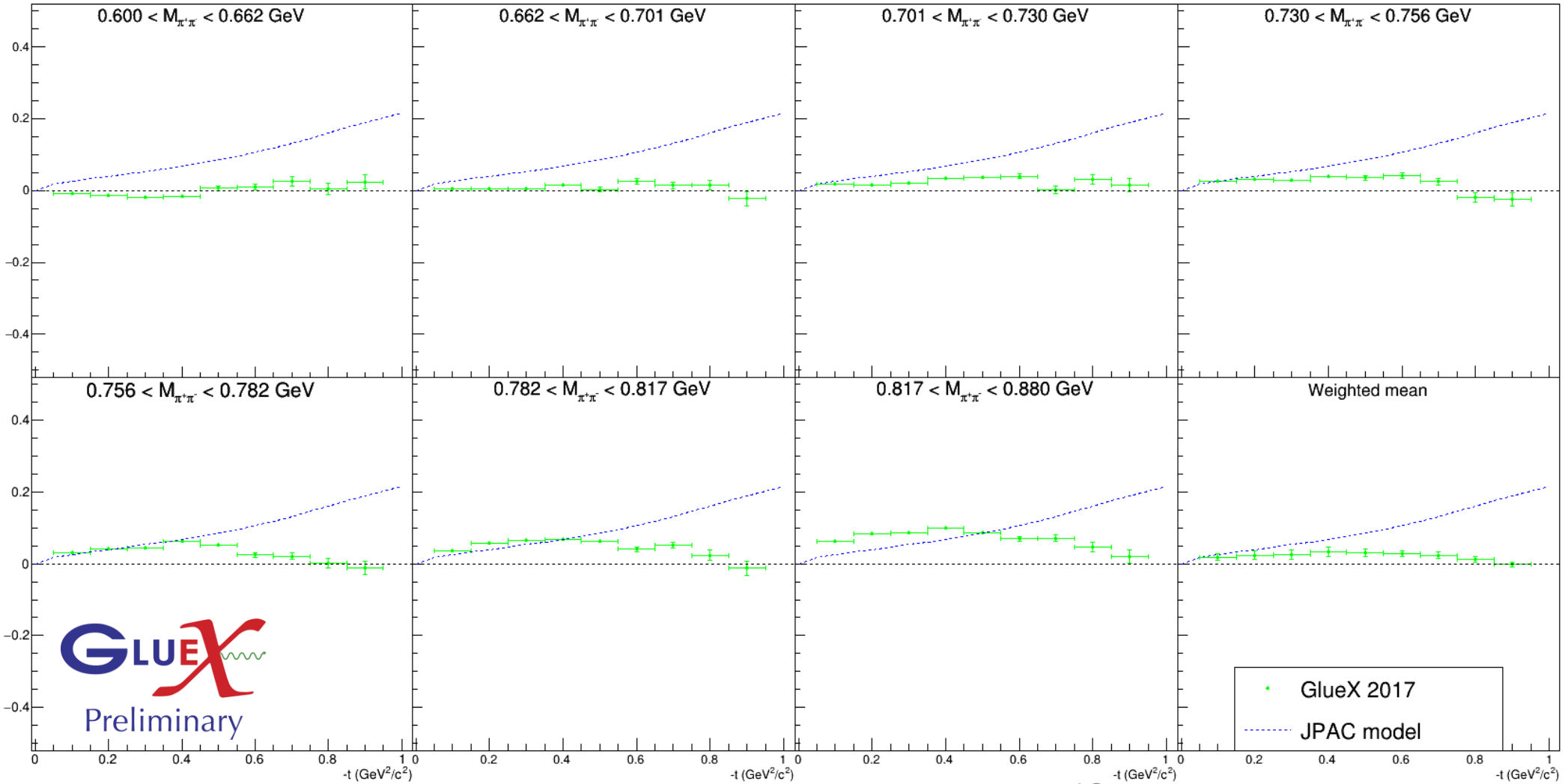
$Re\rho_{10}^{0}$ (8.5 < E_γ< 9.5 GeV)



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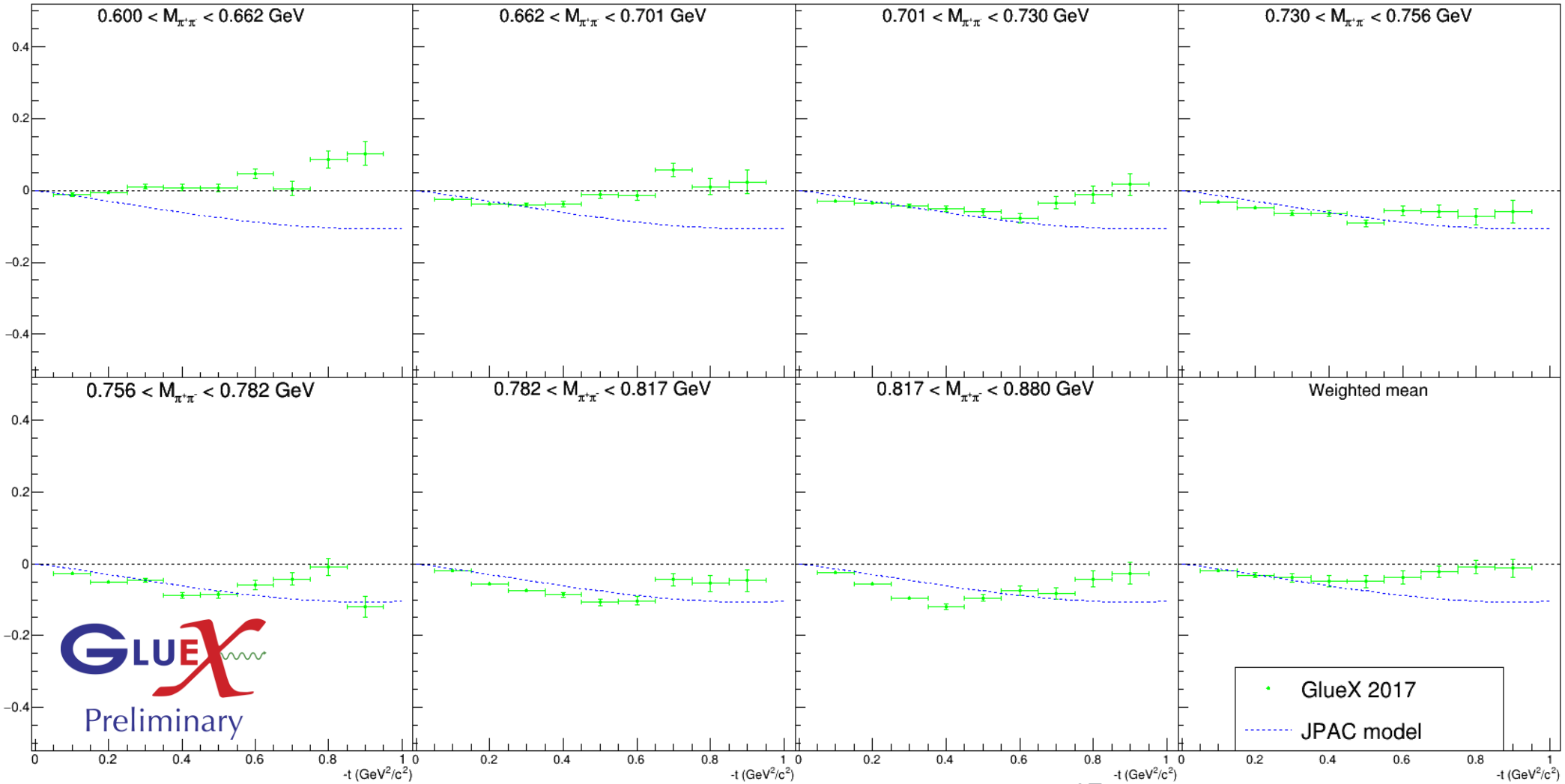
ρ^0_{1-1} (8.5 < E_γ < 9.5 GeV)