

Photoproduction and Decay of Light Meson in CLAS

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On behalf of the CLAS Collaboration

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Outline

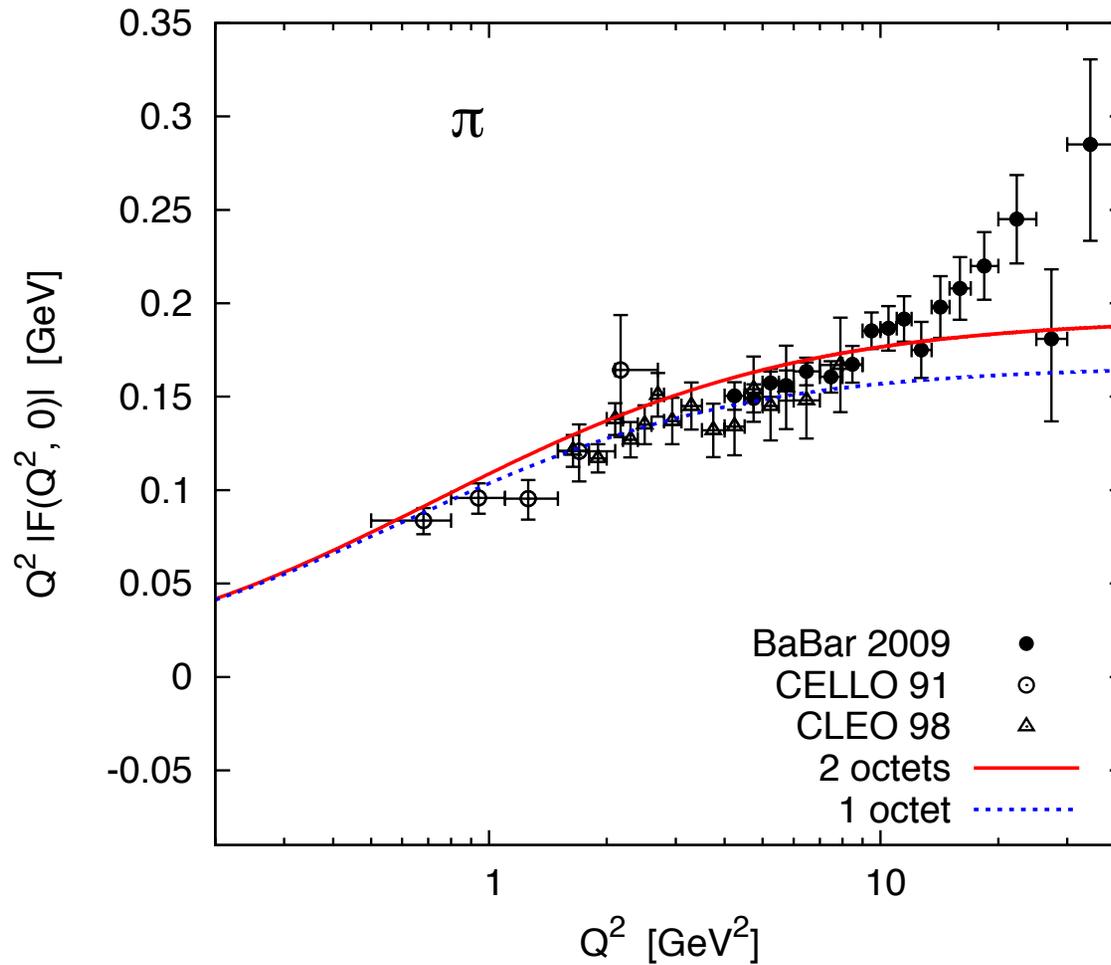
Pseudoscalar, Vector, Axial Vector Mesons

1. Dalitz Decays
2. Radiative Decays
3. Hadronic Decays

Light Mesons in CLAS

| | | | | | |
|-----------|----------------|--------------------|-------------------|------------------|--|
| π^0 | $e^+e^-\gamma$ | | | | |
| η | $e^+e^-\gamma$ | $\pi^+\pi^-\gamma$ | $\pi^+\pi^-\pi^0$ | | |
| η' | $e^+e^-\gamma$ | $\pi^+\pi^-\gamma$ | $\pi^+\pi^-\pi^0$ | $\pi^+\pi^-\eta$ | |
| ρ | | $\pi^+\pi^-\gamma$ | | | |
| ω | $e^+e^-\pi^0$ | $\pi^+\pi^-\gamma$ | $\pi^+\pi^-\pi^0$ | | |
| φ | | | $\pi^+\pi^-\pi^0$ | $\pi^+\pi^-\eta$ | |
| f1(1285) | | | | $\pi^+\pi^-\eta$ | |
| | | | | | |

Space-Like Form Factor $e^+e^- \rightarrow \pi^0$



$$F(Q^2) \sim 1 + a_\pi Q^2$$

$$a_\pi = 0.0309 \pm 0.0008 \pm 0.0009 \text{ (CLEO)}$$

$$Q^2 > 0.5 \text{ GeV}^2$$

Time-Like Form Factor $\pi^0 \rightarrow e+e-\gamma$

Slope is measured with very large errors:

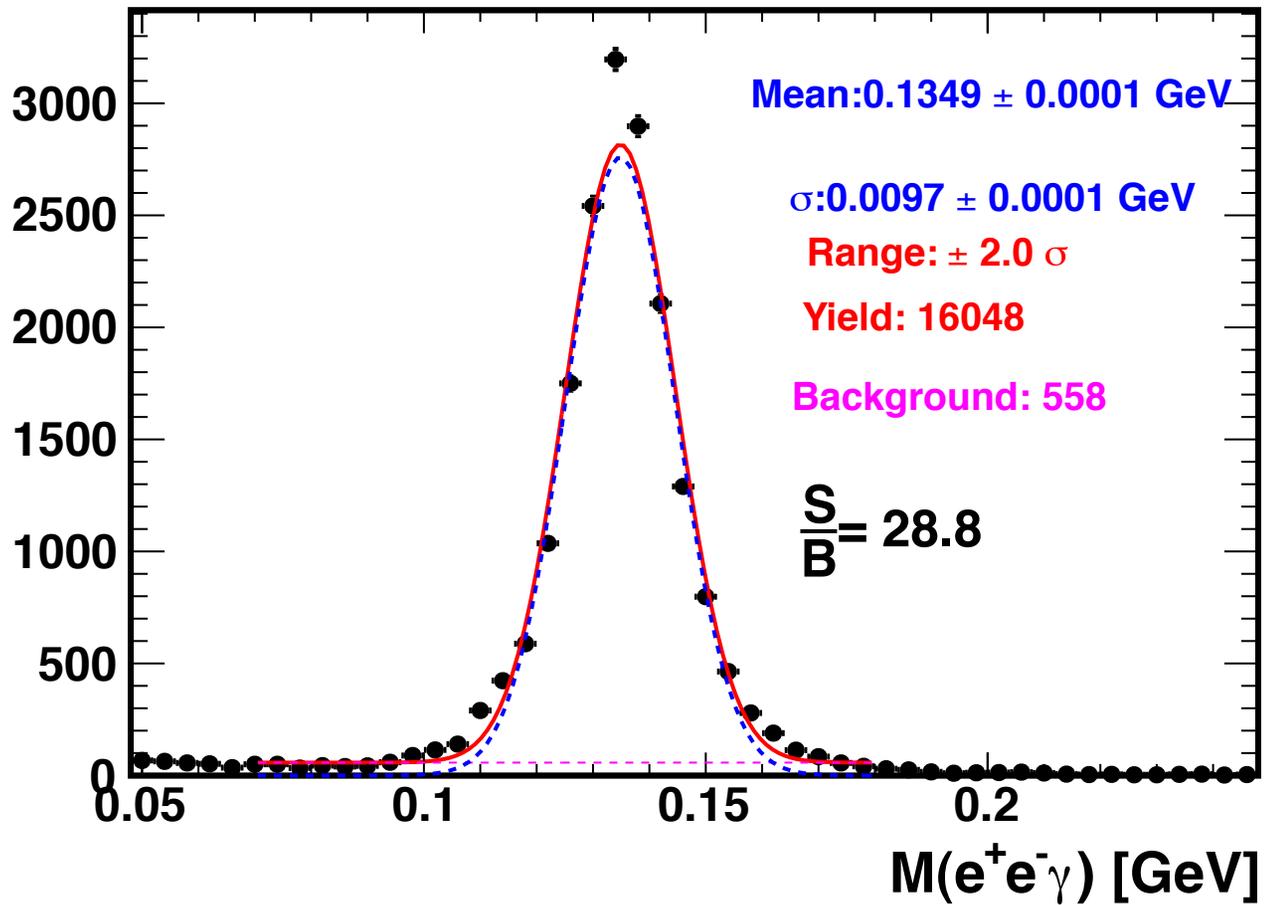
$$a_\pi = -0.11 \pm 0.03 \pm 0.08 \quad [2]$$

$$a_\pi = +0.026 \pm 0.024 \pm 0.0048 \quad [3]$$

$$a_\pi = +0.025 \pm 0.014 \pm 0.026 \quad [4]$$

- [2] H. Fonvieille, N. Bensayah, J. Berthot, P. Bertin, M. Crouau, et al., Phys.Lett. **B233**, 65 (1989).
- [3] F. Farzanpay, P. Gumplinger, A. Stetz, J. Poutissou, I. Blevis, et al., Phys.Lett. **B278**, 413 (1992).
- [4] R. Meijer Drees et al. (SINDRUM-I Collaboration), Phys.Rev. **D45**, 1439 (1992).

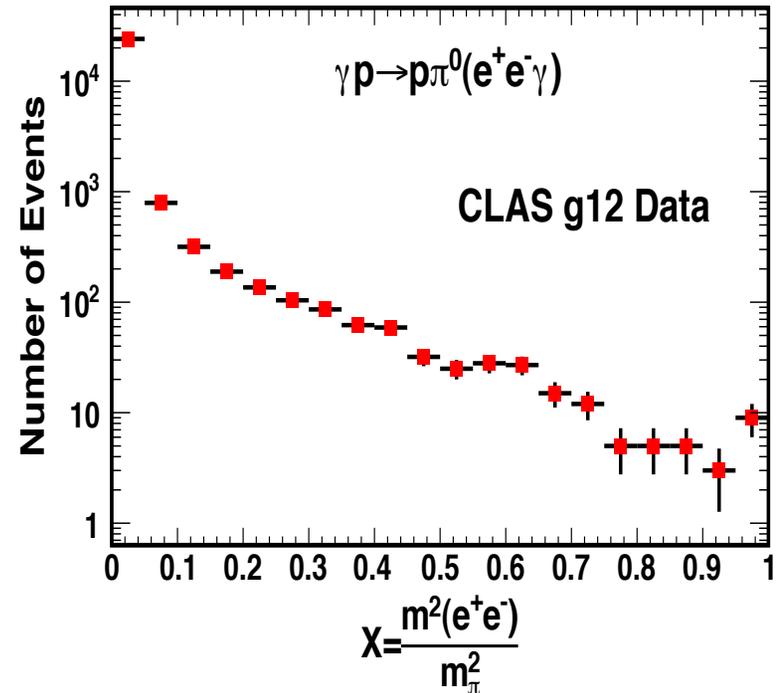
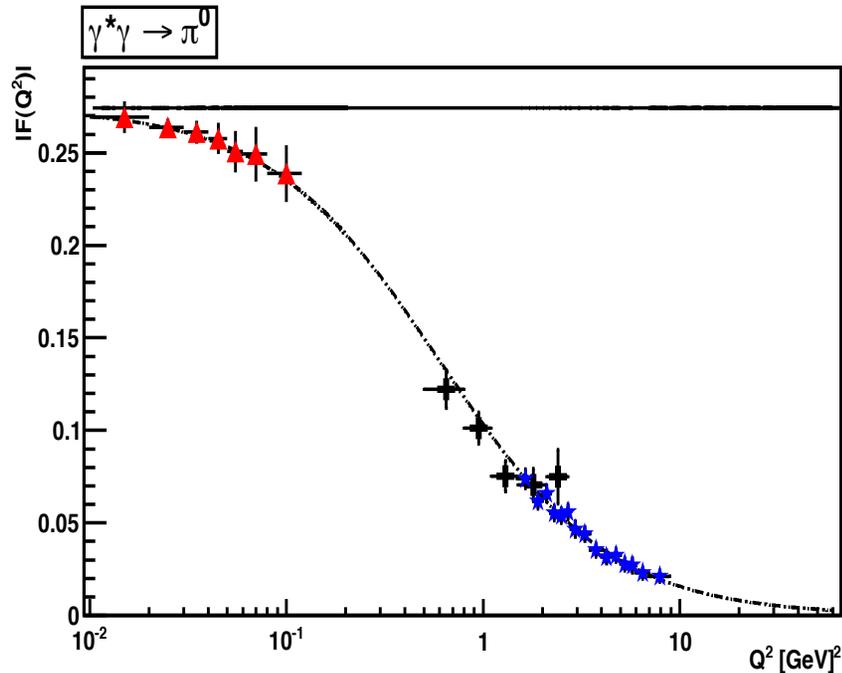
CLAS g12 Data



Transition Form Factor

KLOE-2 Proposal

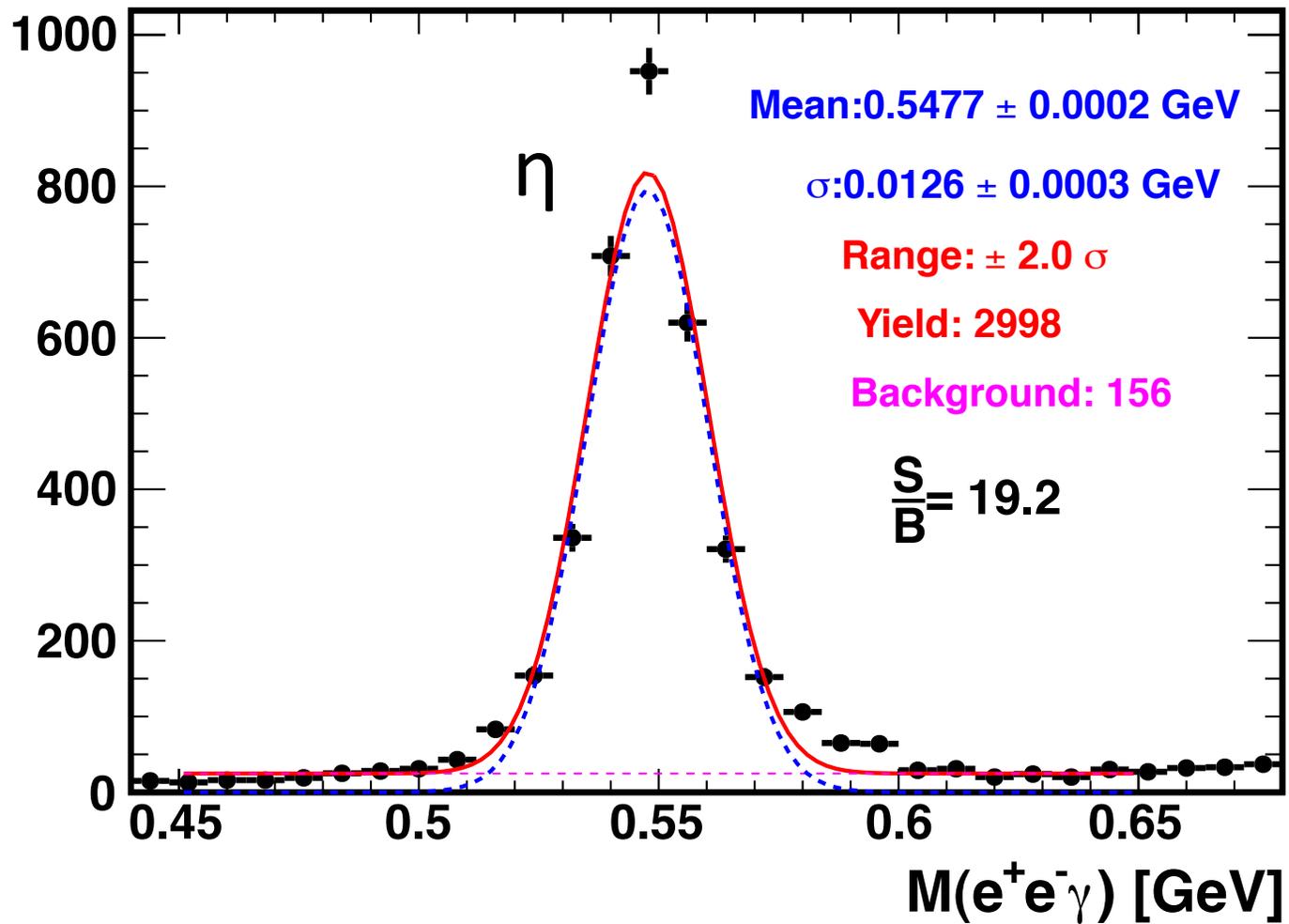
CLAS g12 Data



CLAS provides unprecedented statistics for precision measurement of the TFF slope!

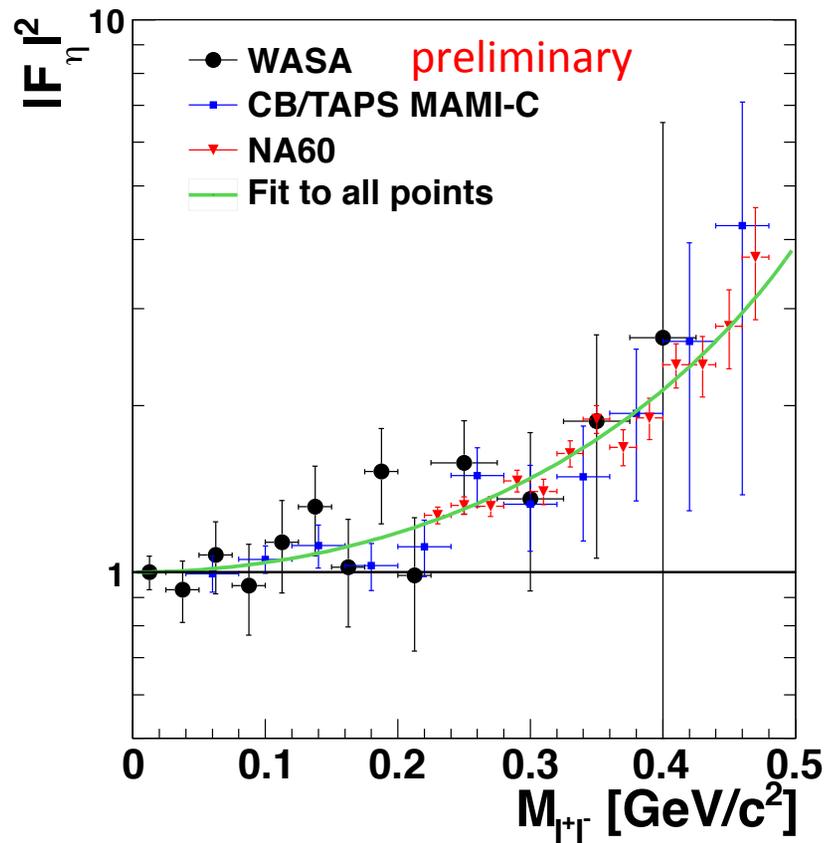
Also Important for LbyL radiative corrections to g-2

CLAS g12 Data

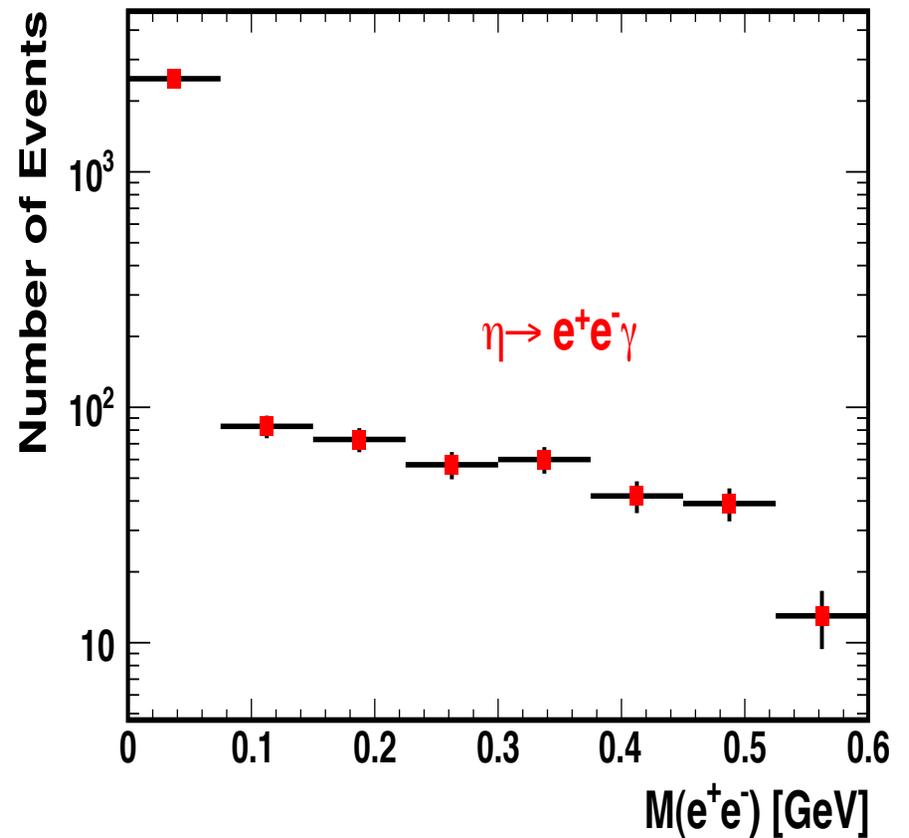


Time-Like Form Factor of η

World Data

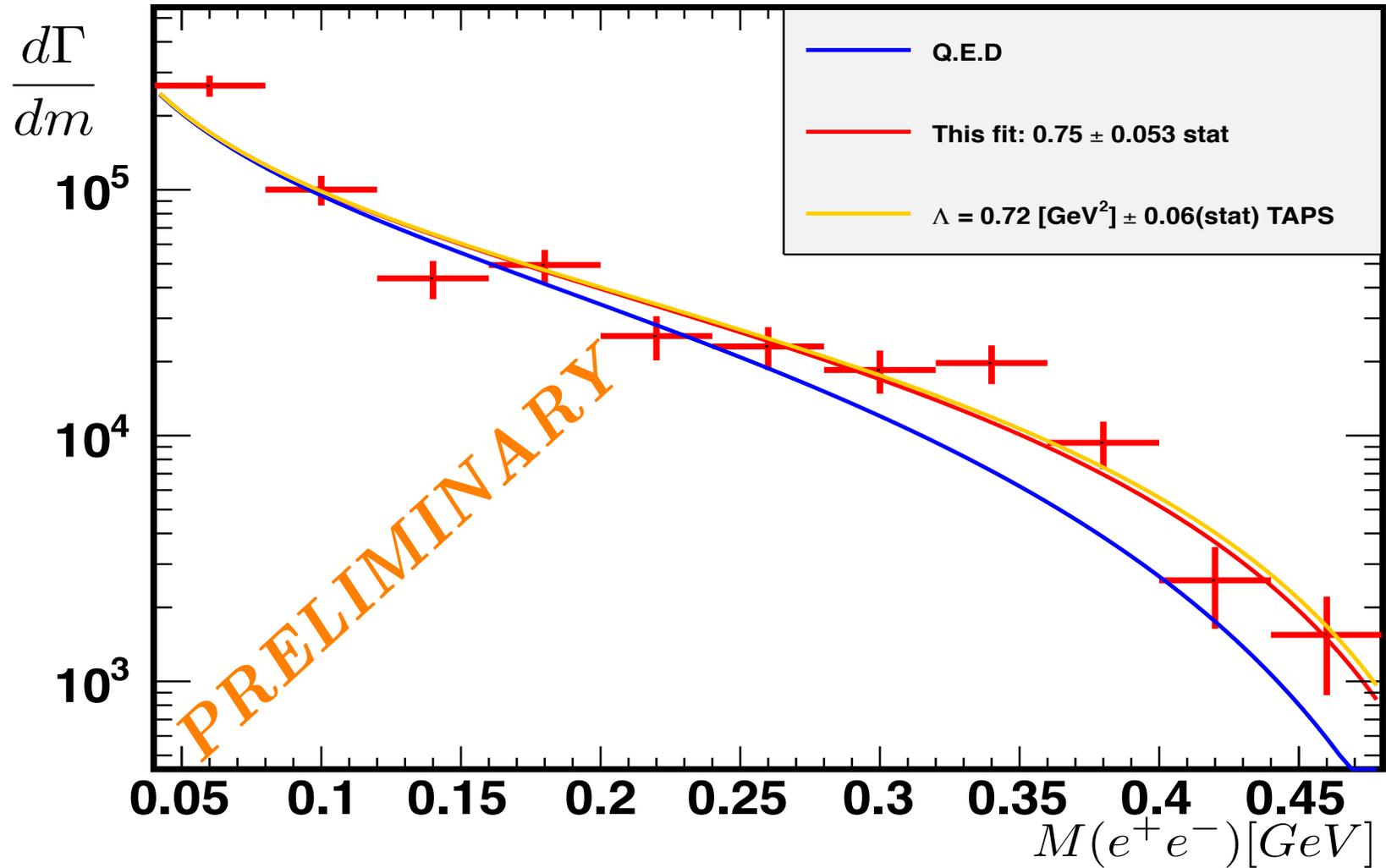


CLAS g12 Data

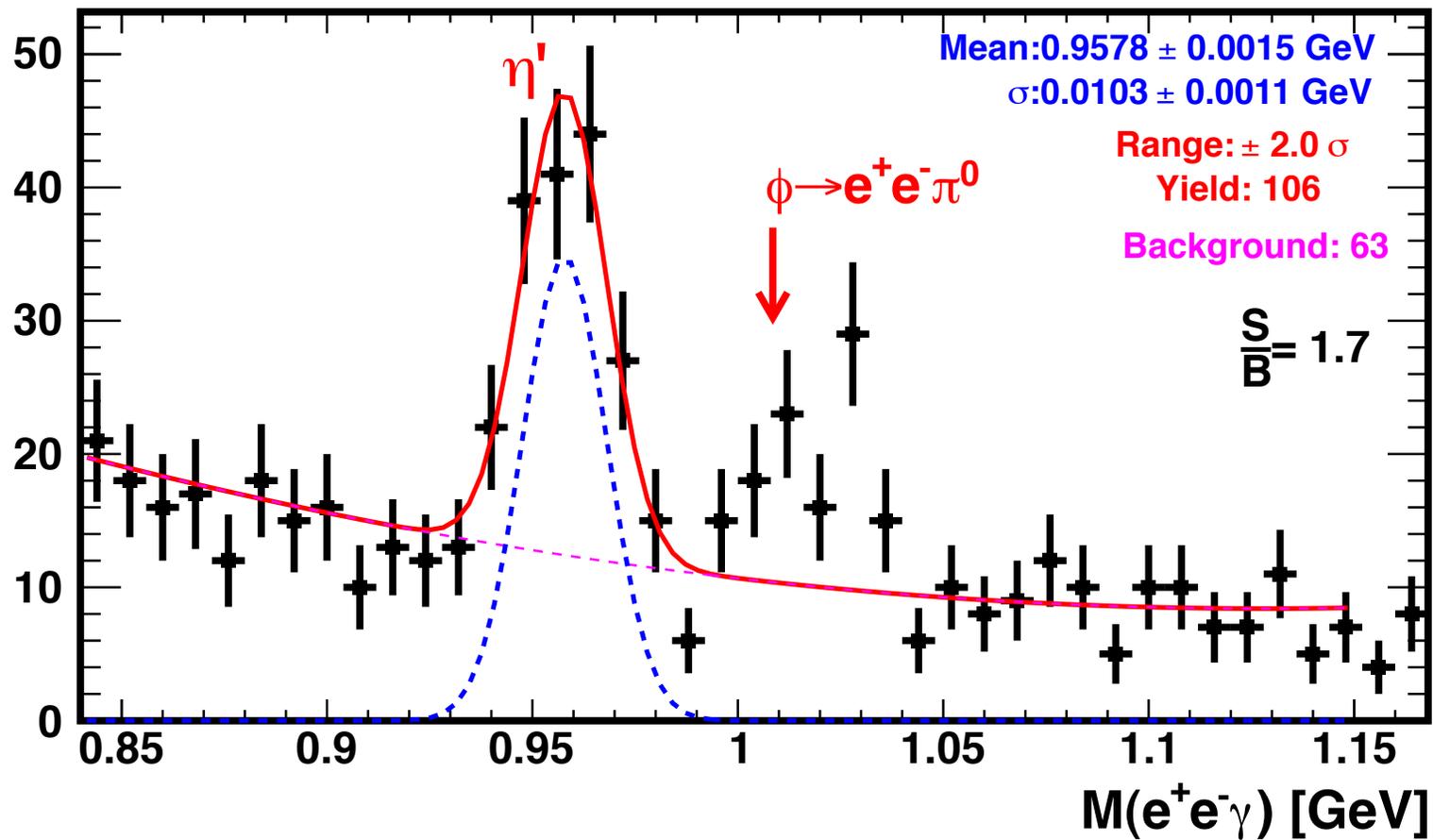


CLAS Preliminary

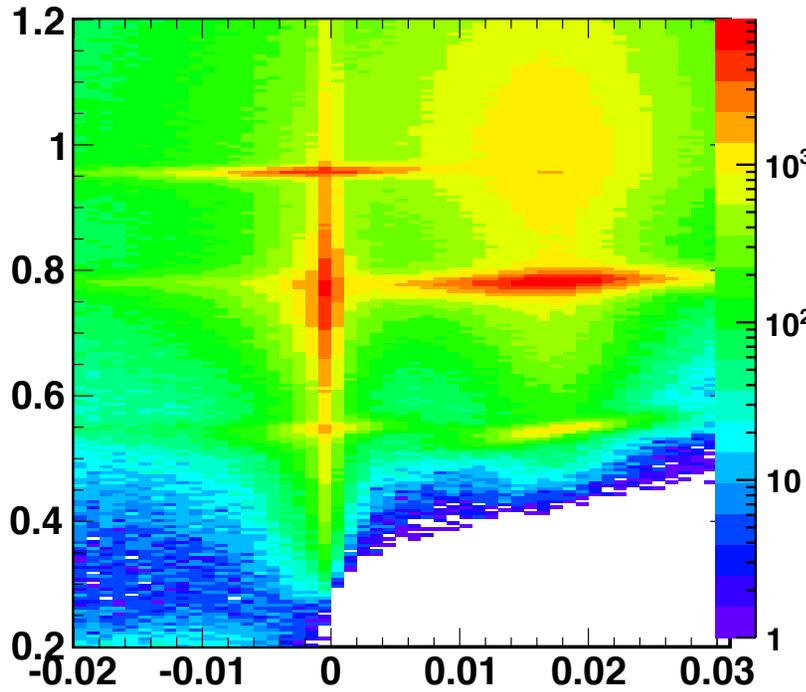
Accepted Correct Spectrum



First measurement of Dalitz Decay of eta' from CLAS



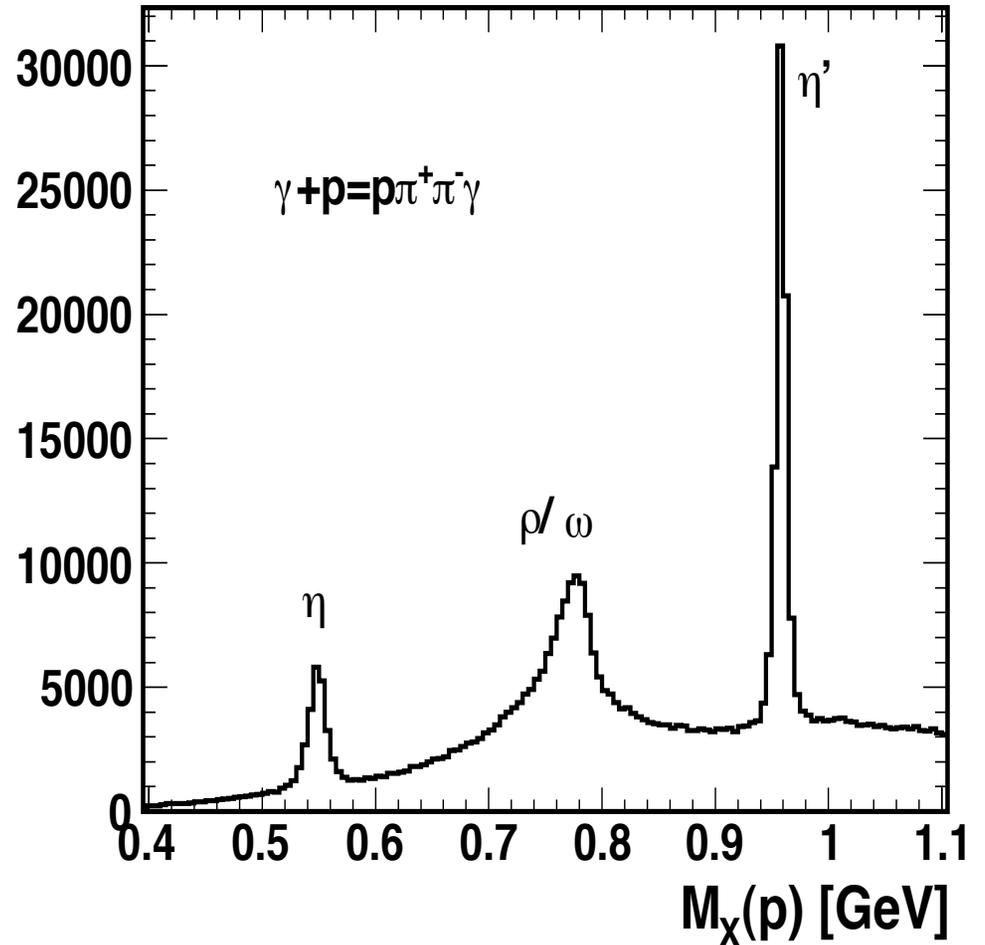
Radiative Decay $\eta, \eta' \rightarrow \pi^+ \pi^- \gamma$



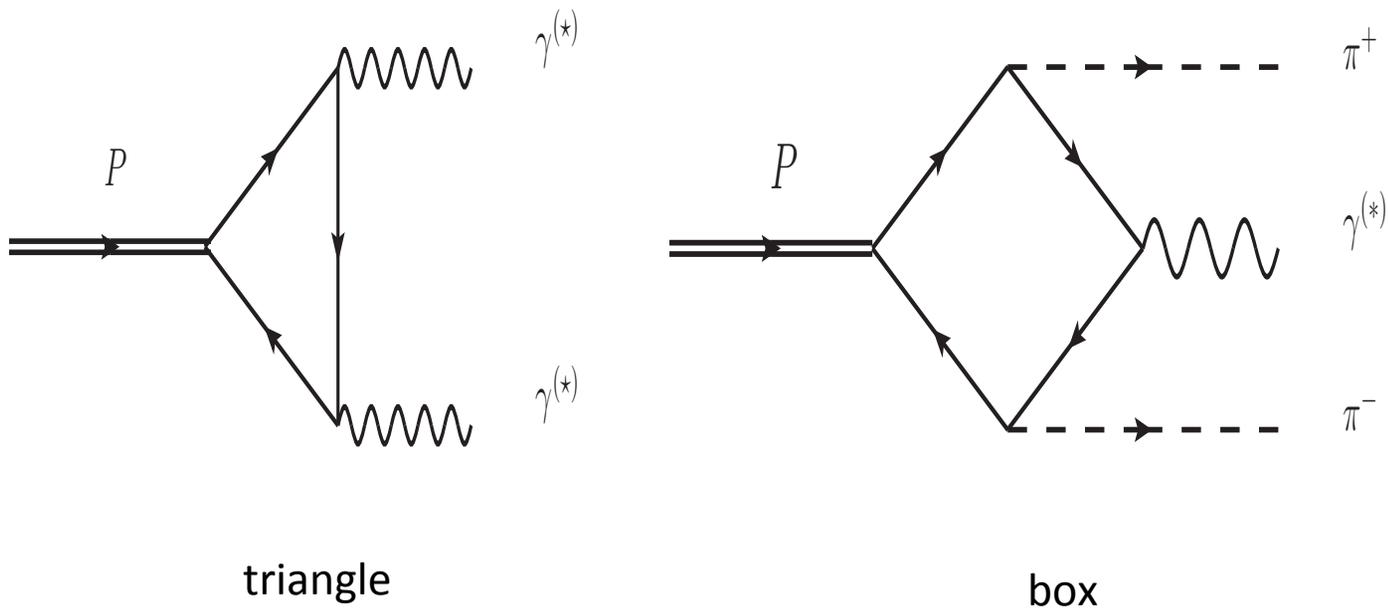
$M_X^2(p)$ versus $M_X^2(p\pi^+\pi^-)$

$ME > 0.01 \text{ GeV}$

$ME - E_\gamma < 0.03 \text{ GeV}$

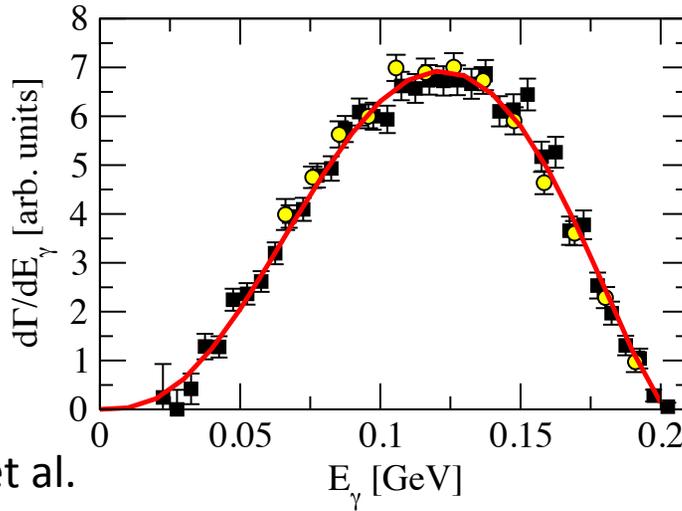


Why is radiative decay interesting?

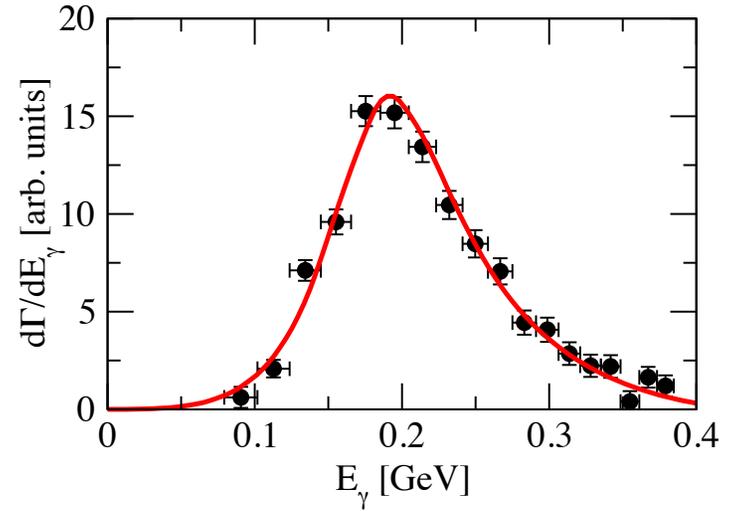


It gives an access to the box anomaly term of Wess-Zumino-Witten Lagrangian !

$\eta \rightarrow \pi^+ \pi^- \gamma$



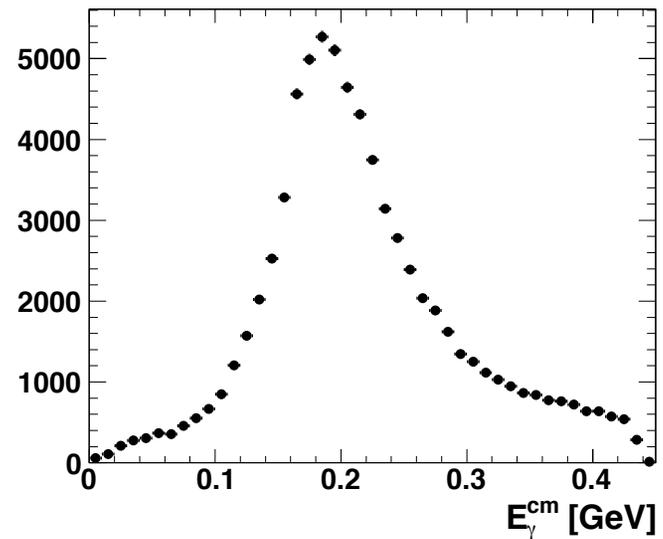
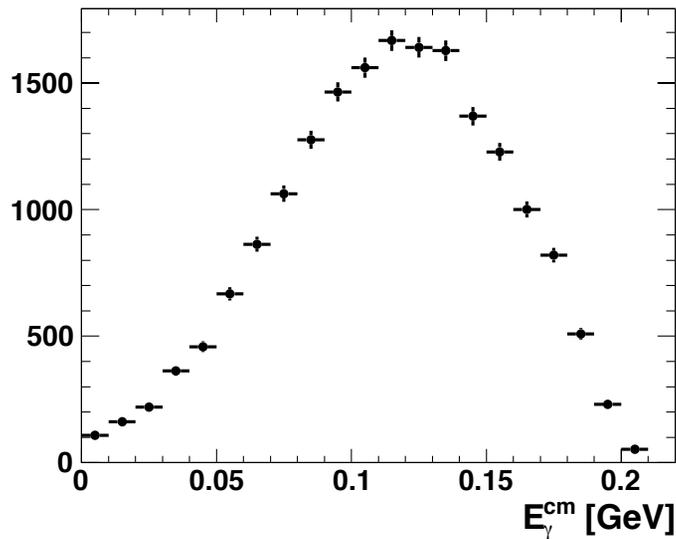
$\eta' \rightarrow \pi^+ \pi^- \gamma$



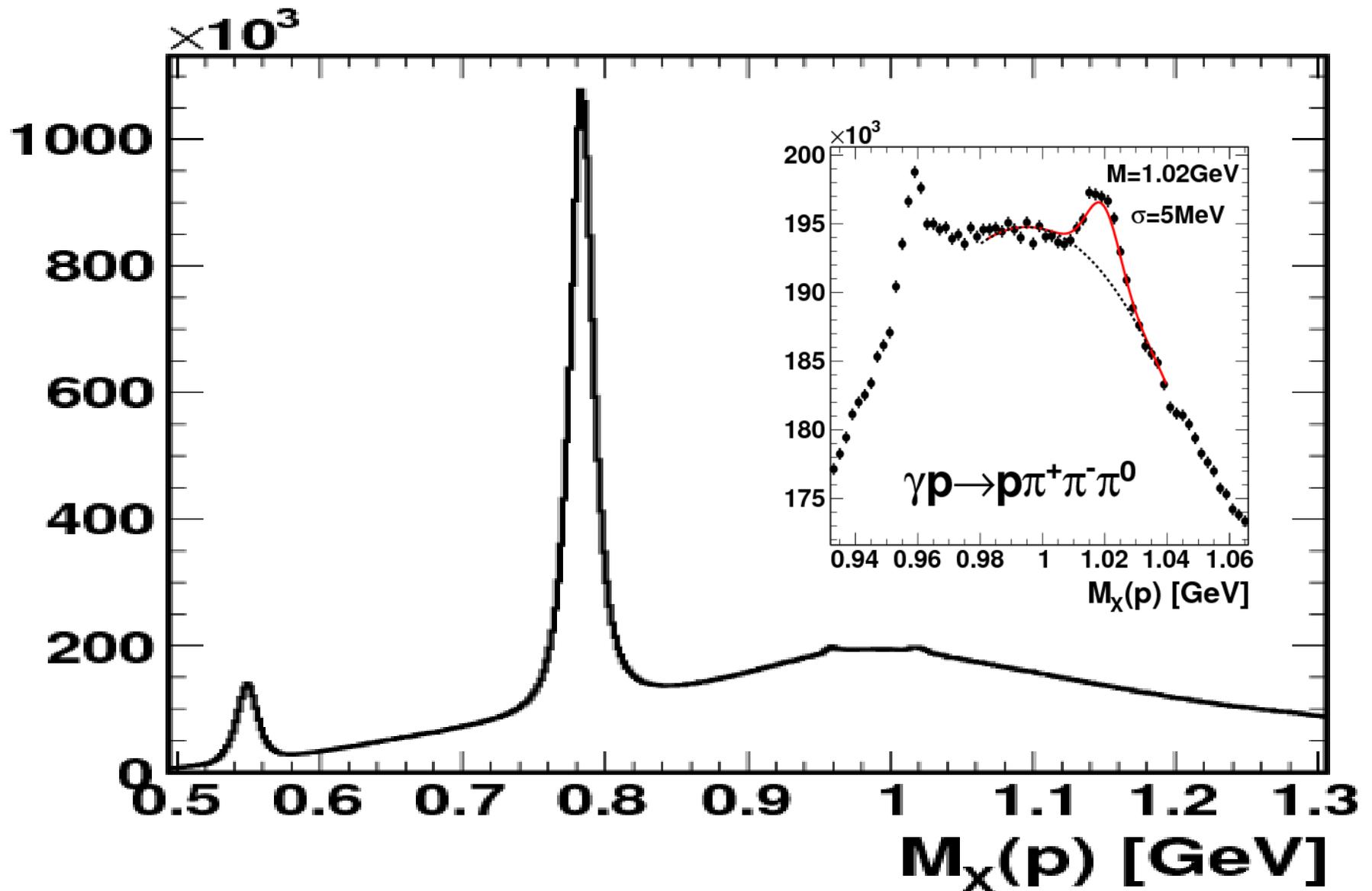
World data

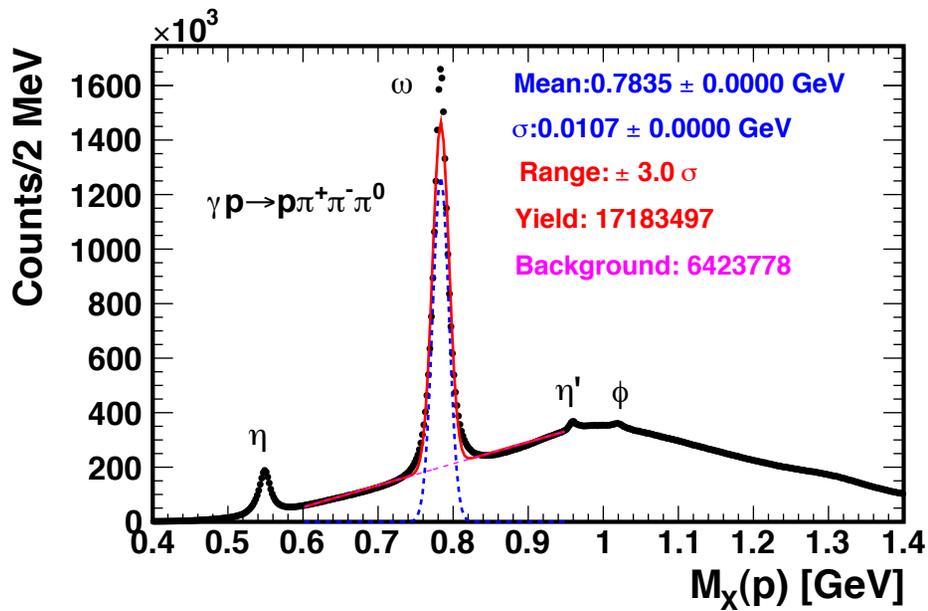
Theory:
E.Stollenwerk et al.
PL B707, 184, 2012

CLAS Preliminary uncorrected



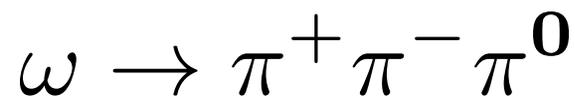
CLAS Hadronic decays: g11 Data



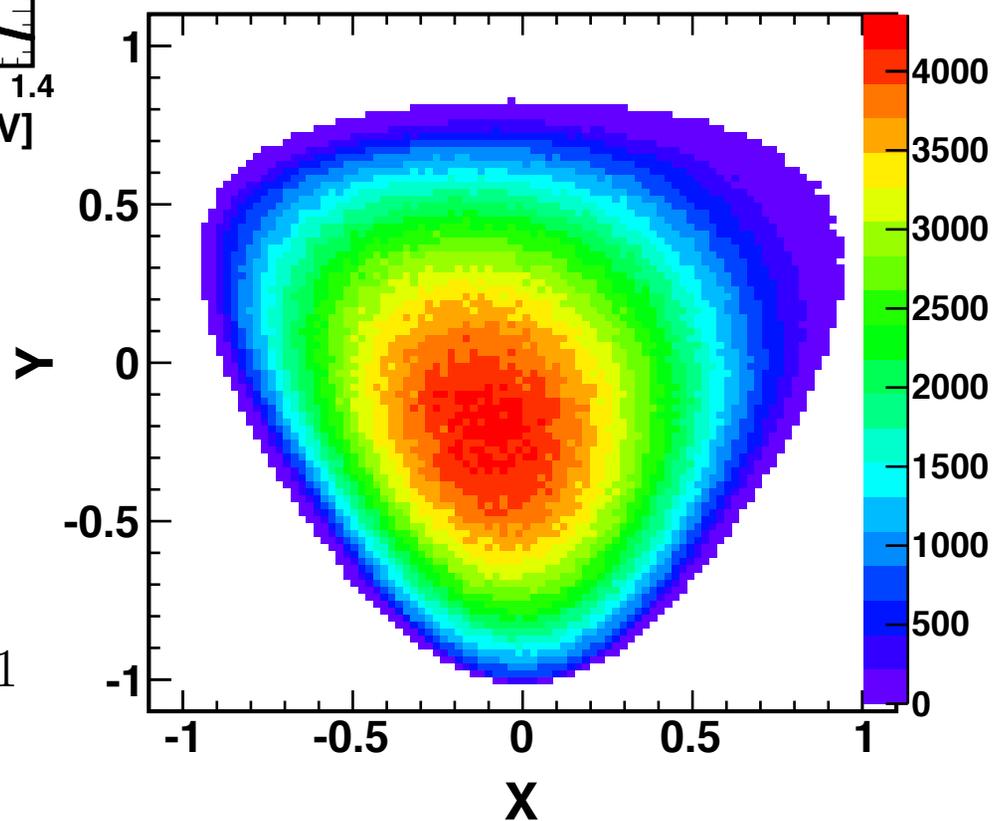


About 17M ω 's

CLAS

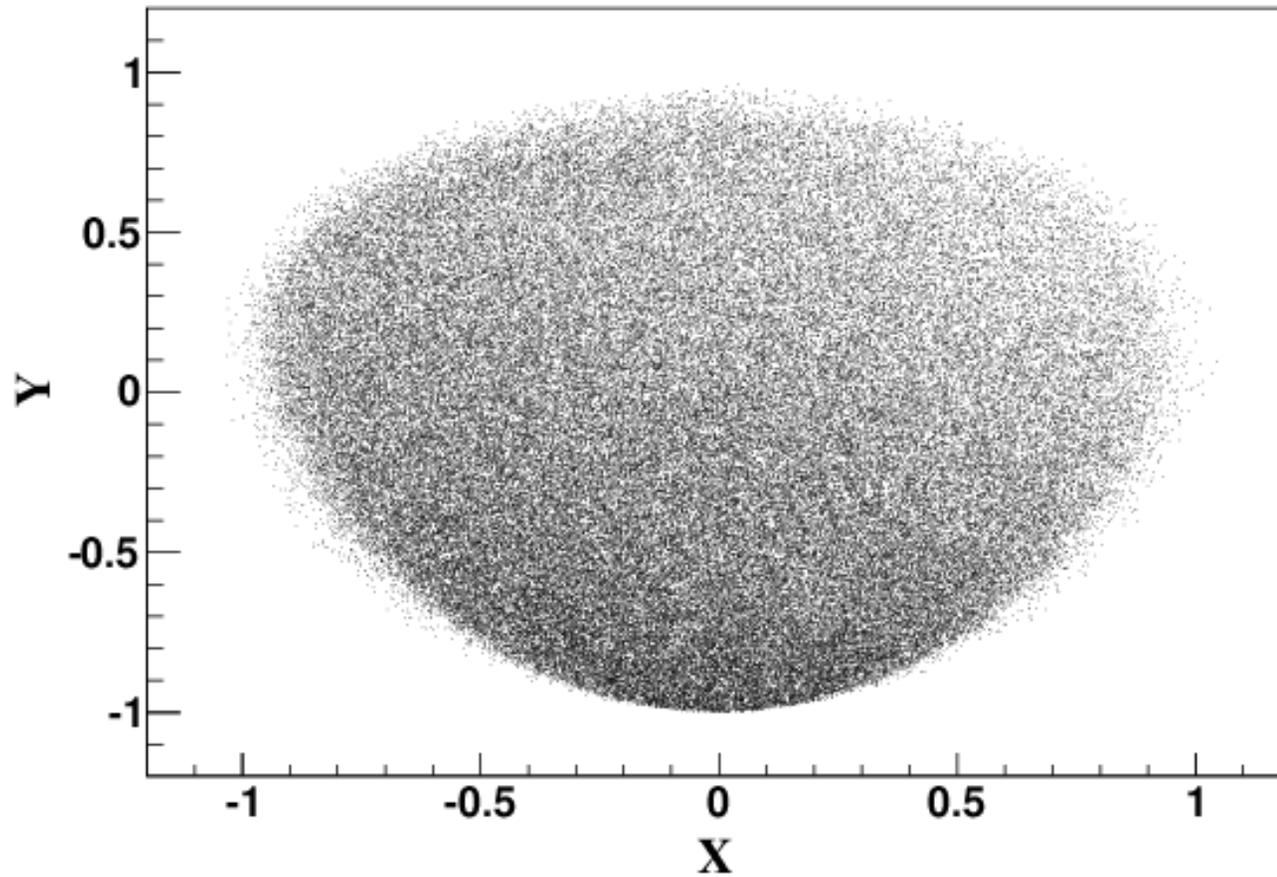


Not corrected for acceptance



$$X = \frac{\sqrt{3}}{Q} (T_{\pi^+} - T_{\pi^-}), \quad Y = \frac{3T_{\pi^0}}{Q} - 1$$

CLAS $\eta \rightarrow \pi^+ \pi^- \pi^0$



$$X = \frac{\sqrt{3}}{Q}(T_{\pi^+} - T_{\pi^-}), \quad Y = \frac{3T_{\pi^0}}{Q} - 1$$

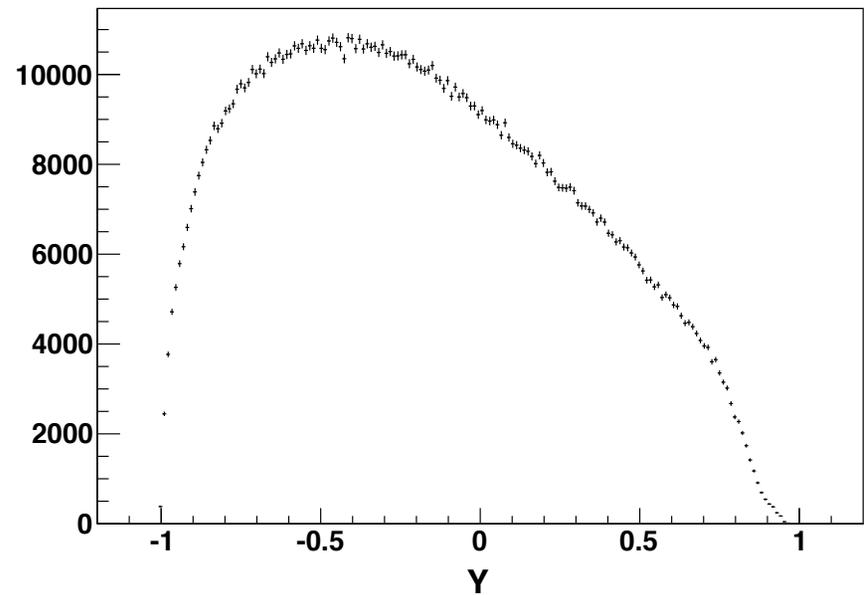
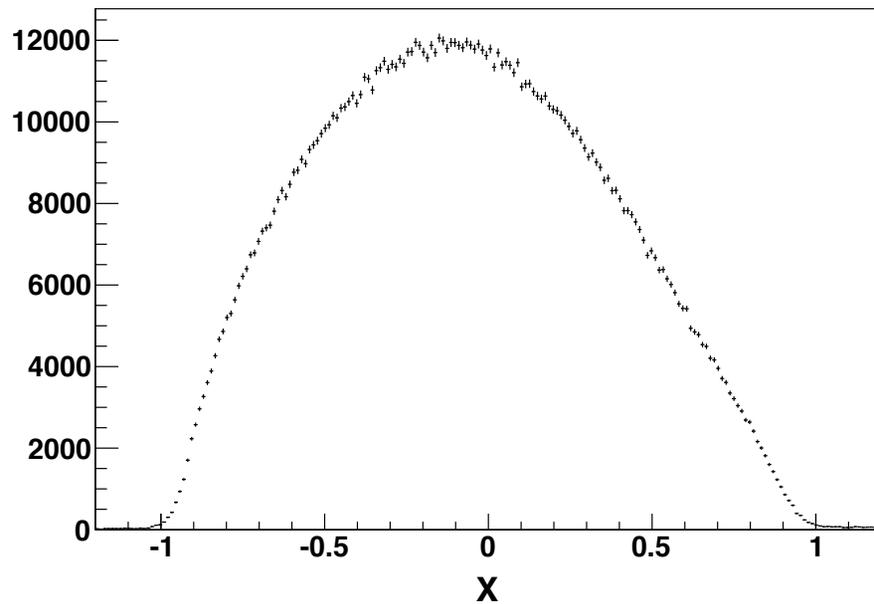
~2M events

Dalitz plot projections $\eta \rightarrow \pi^+ \pi^- \pi^0$

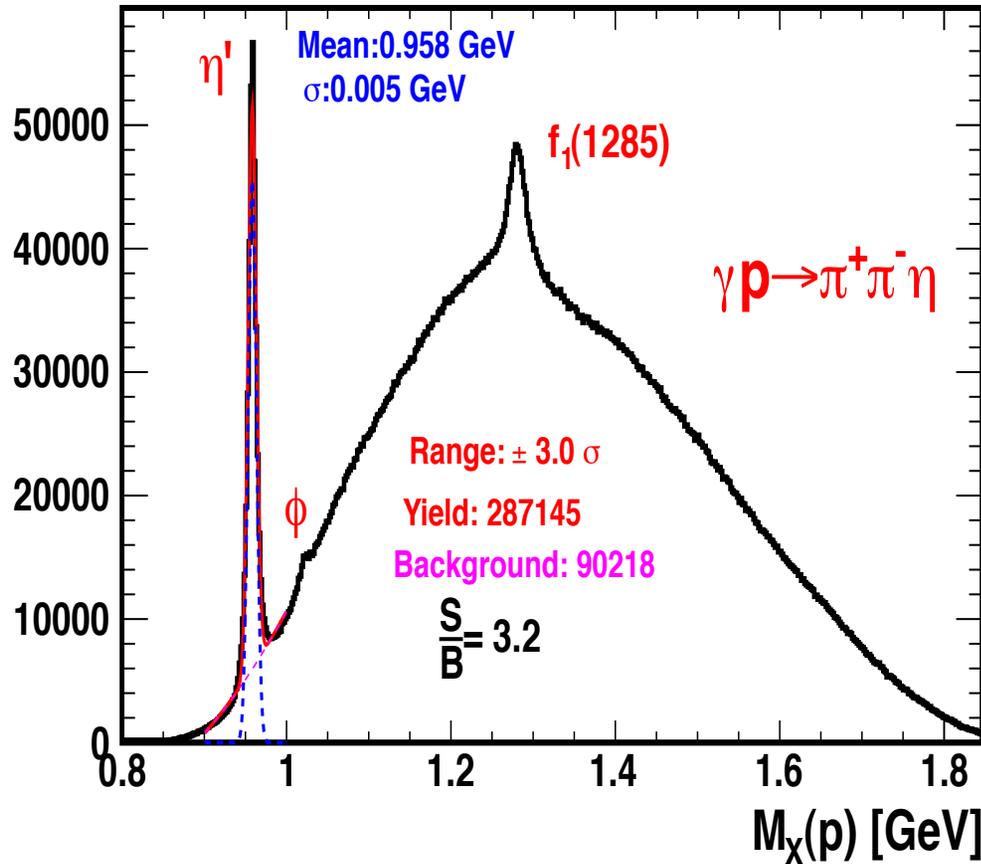
$$M^2 = A(1 + aY + bY^2 + cX + dX^2)$$

(Decay Matrix element expansion)

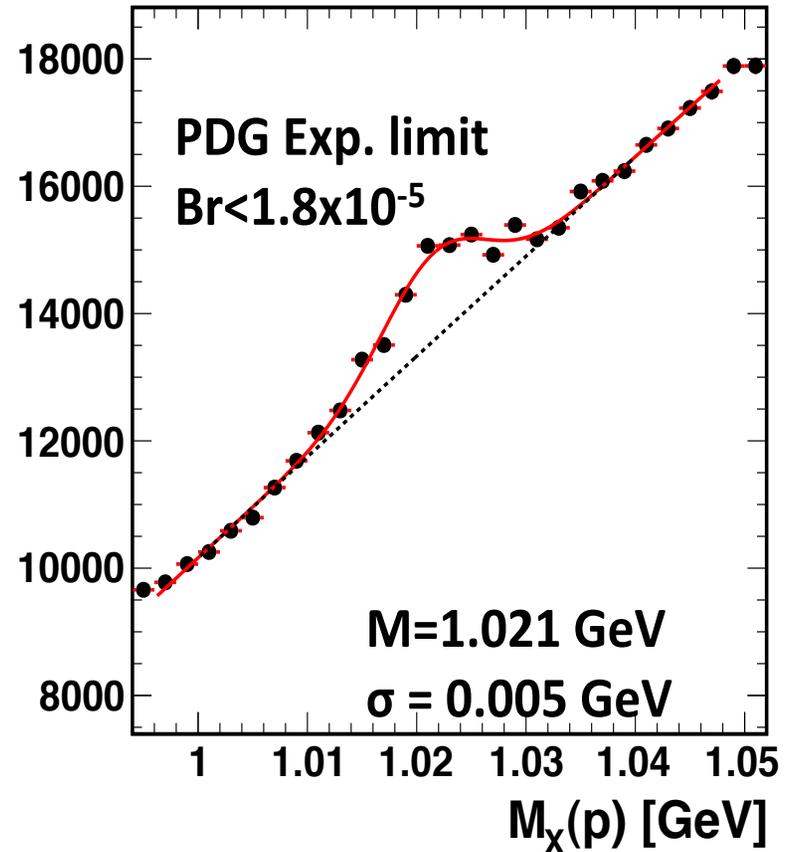
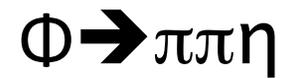
g11 Data



Hadronic decay



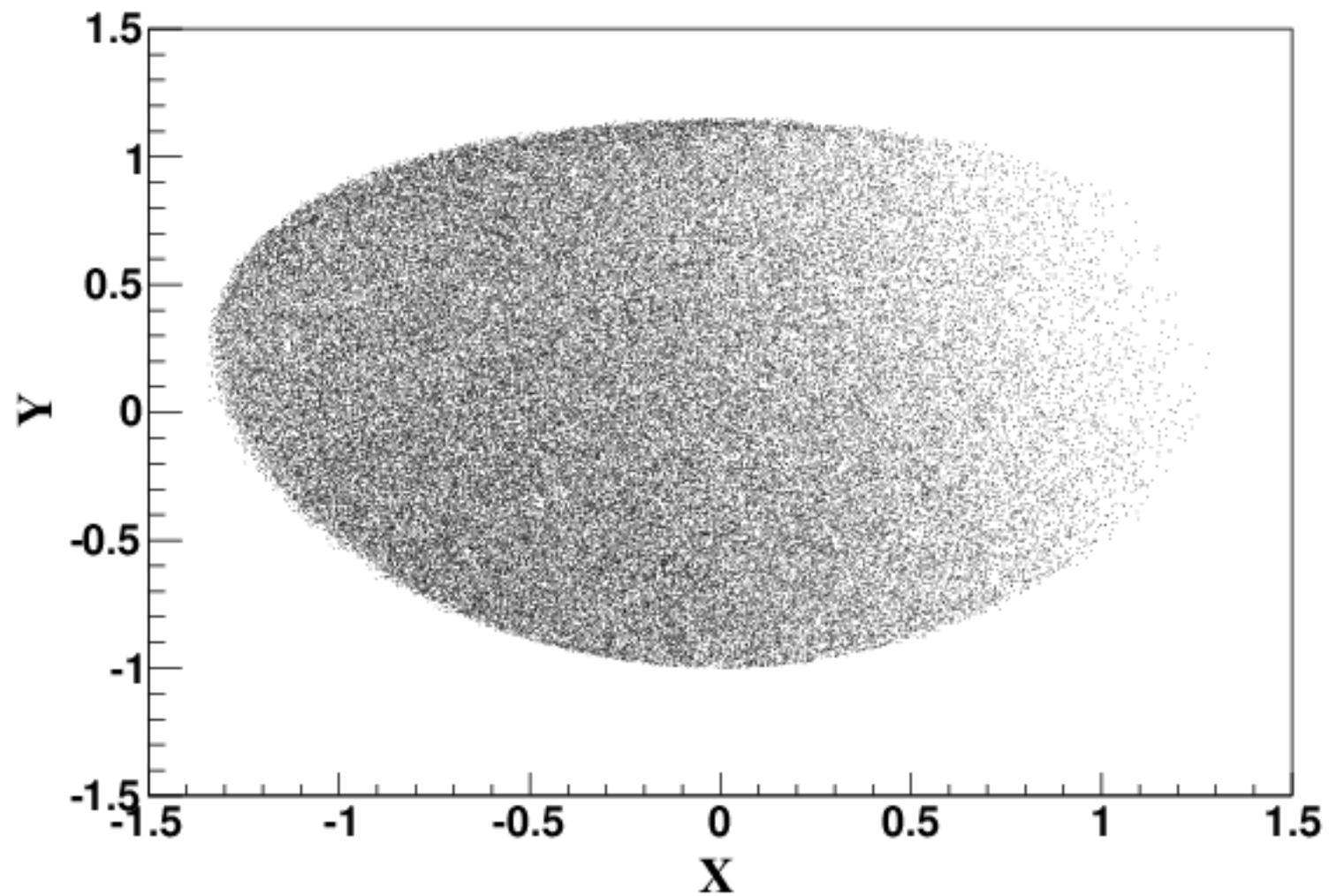
G-Parity violation



CLAS g11 Data (7 times more η' than in BESIII)

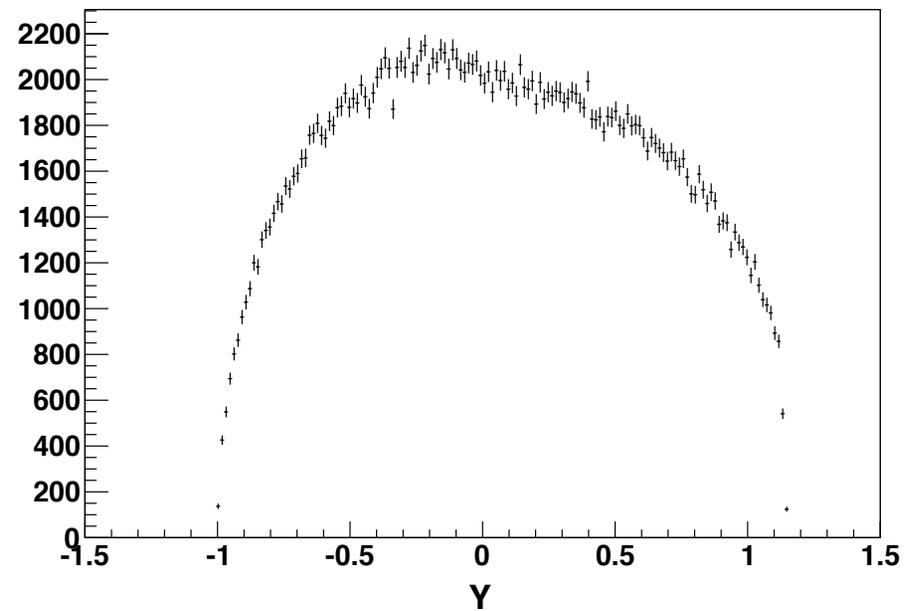
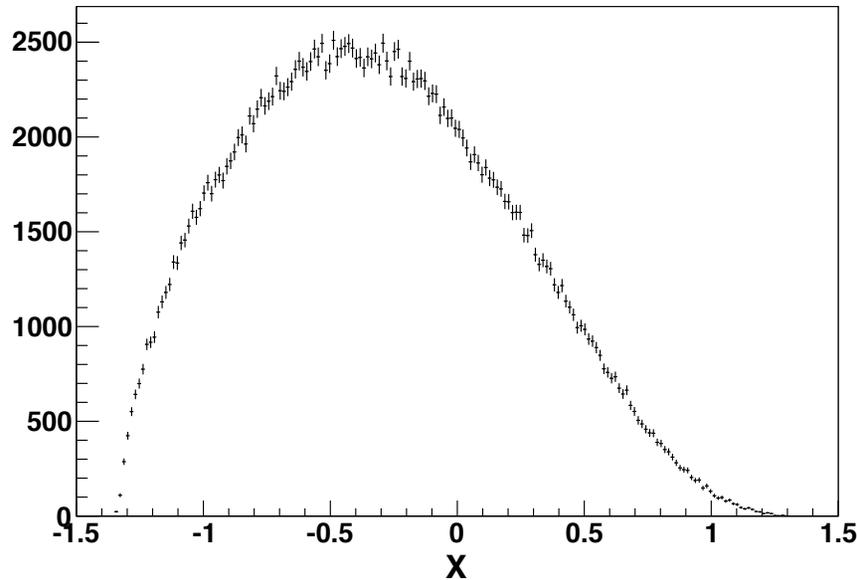
3 times more on tape

Dalitz plot $\eta' \rightarrow \pi\pi\eta$



Dalitz plot projections $\eta' \rightarrow \pi\pi\eta$

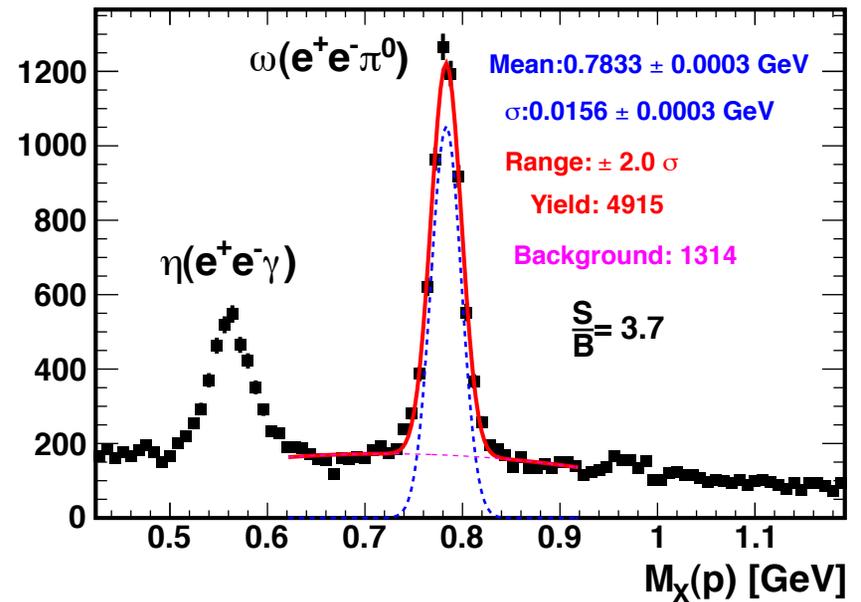
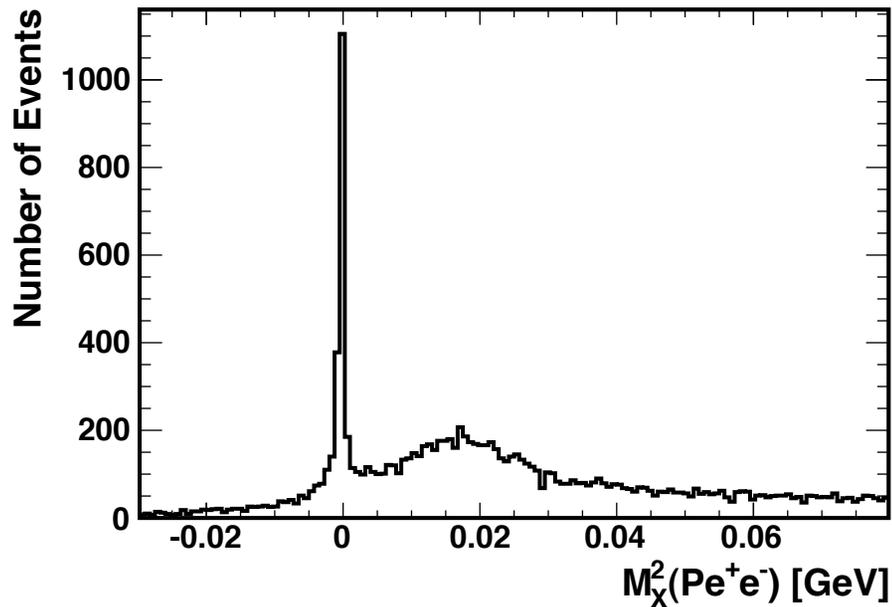
CLAS Preliminary uncorrected



| Par. | VES | Theory | BES | Stat err. In BES | Stat. err. In CLAS |
|------|--------------|--------------|--------------|---------------------|-----------------------|
| a | -0.127±0.018 | -0.116±0.011 | -0.047±0.012 | +0.011 | +0.004 |
| b | -0.106±0.032 | -0.042±0.034 | -0.069±0.021 | +0.019 | +0.006 |
| c | +0.015±0.018 | ----- | +0.019±0.012 | +0.011 | +0.004 |
| d | -0.082±0.019 | +0.010±0.019 | -0.073±0.013 | +0.012 | +0.004 |

Dalitz decay $\omega \rightarrow e^+e^-\pi^0$

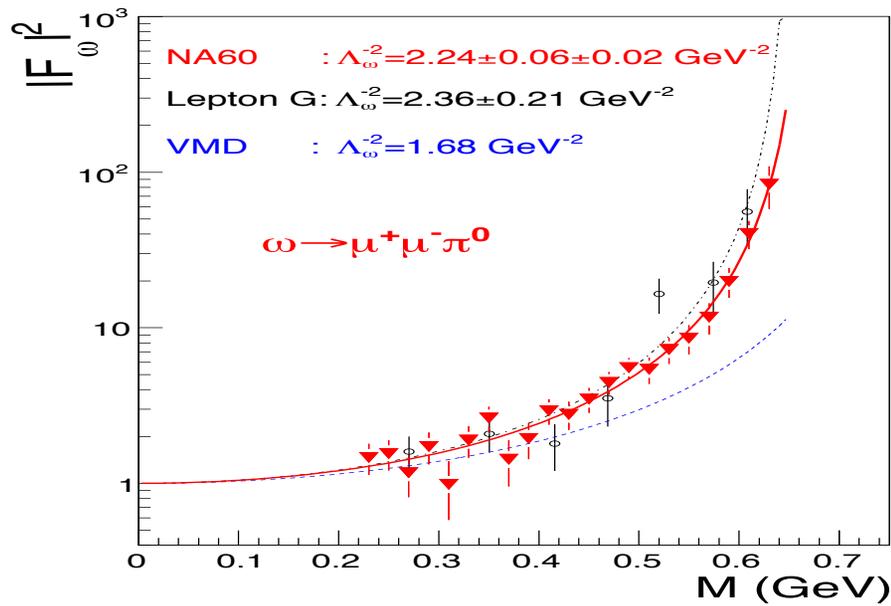
CLAS g12 Data



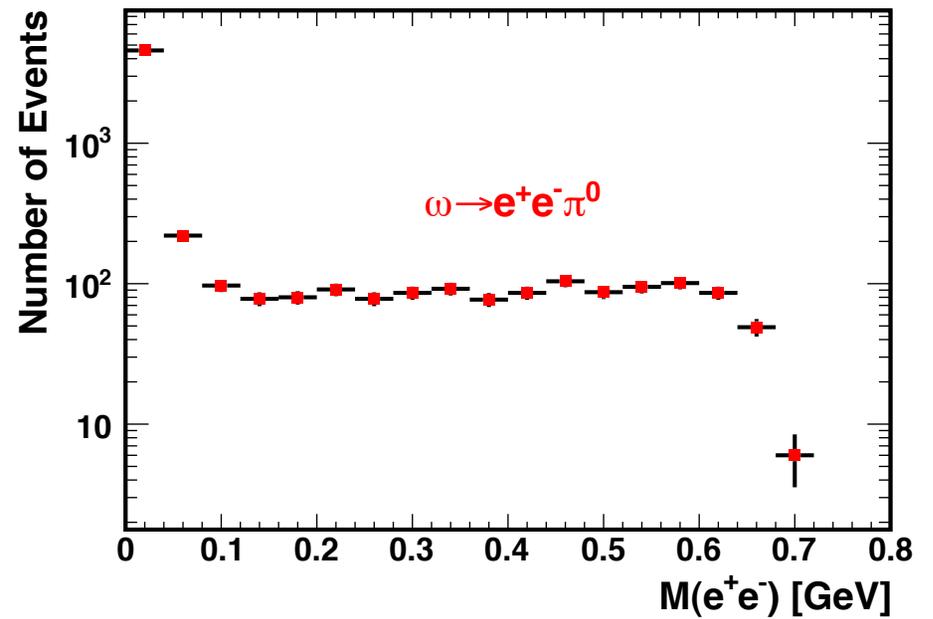
Transition Form Factor

$$\omega \rightarrow e^+e^-\pi^0$$

World data



CLAS g12 Data



Summary

We expect to release at least the following results:

1. Transition form factor of π^0 in the time-like region from Dalitz decay $e^+e^-\gamma$ with unprecedented accuracy
2. Transition form factor of η in the time-like region from Dalitz decay $e^+e^-\gamma$ with unprecedented accuracy
3. Branching ratio $\eta' \rightarrow e^+e^-\gamma$ for the first time
4. Measurement of E_γ distribution in radiative decay $\eta \rightarrow \pi^+\pi^-\gamma$ with highest statistical accuracy achieved so far
5. Measurement of E_γ distribution in radiative decay $\eta' \rightarrow \pi^+\pi^-\gamma$ with highest statistical accuracy achieved so far
6. Transition form factor of ω in time-like region from Dalitz decay $\omega \rightarrow e^+e^-\pi^0$ with the highest statistical accuracy up to date
7. Dalitz plot analysis of hadronic decay $\eta \rightarrow \pi^+\pi^-\pi^0$ with statistical precision comparable to that obtained at other facilities
8. Dalitz plot analysis of hadronic decay $\eta' \rightarrow \pi^+\pi^-\eta$ with almost an order of magnitude improvement in statistics compared to the best measurement achieved at BES
9. First observation of G-parity violating decay $\phi \rightarrow \pi^+\pi^-\eta$
10. Search of heavy η 's with partial wave analysis in photoproduction reaction $\gamma + p \rightarrow p\pi^+\pi^-\eta$

Photoproduction and Decay of Light Mesons in CLAS

CLAS Analysis Proposal

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You are welcome to join!