

Photoproduction and Decay of Light Meson in CLAS

Moskov Amaryan

Old Dominion University
Norfolk, Virginia, USA

On behalf of the CLAS Collaboration

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Outline

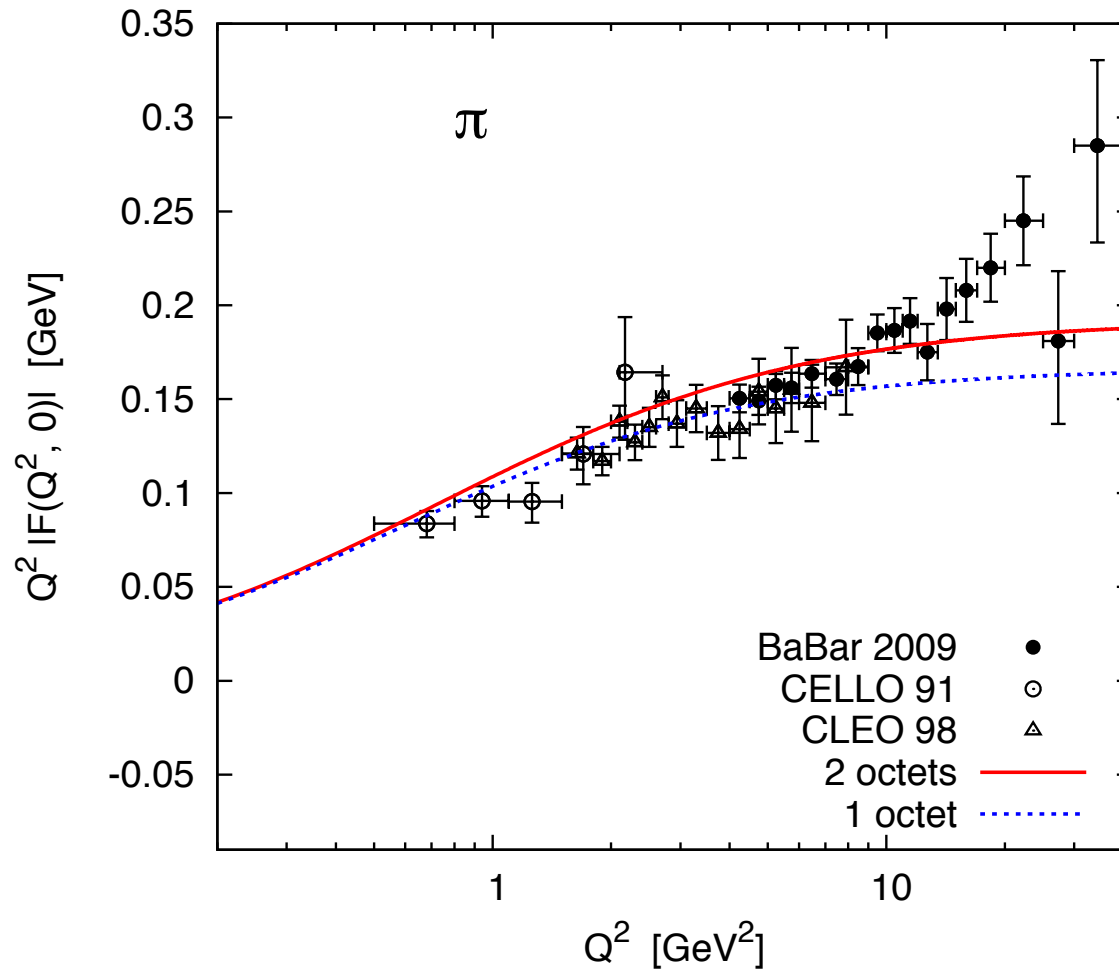
Pseudoscalar, Vector, Axial Vector Mesons

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:

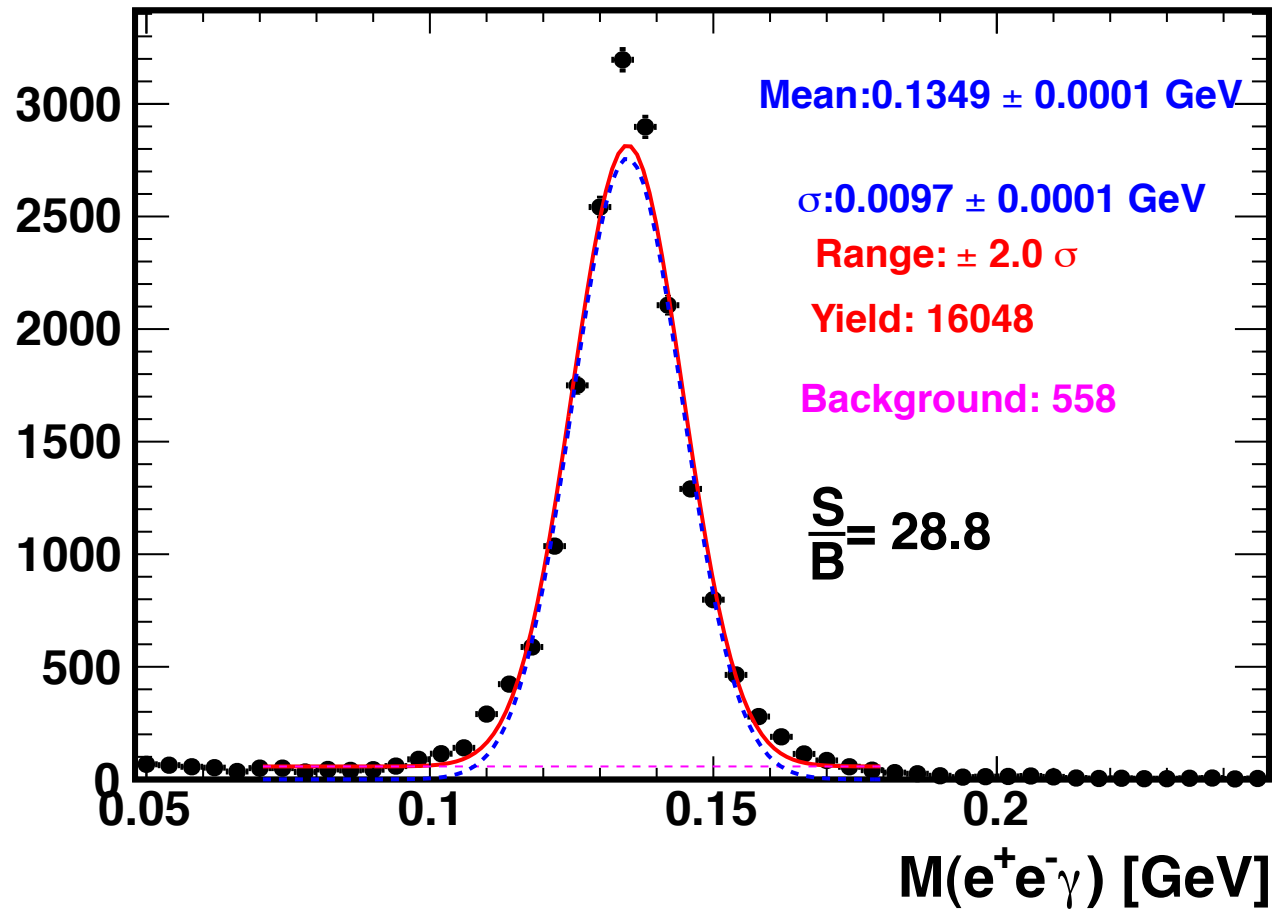
$$a_\pi = -0.11 \pm 0.03 \pm 0.08 \quad [2]$$

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

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

- [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).

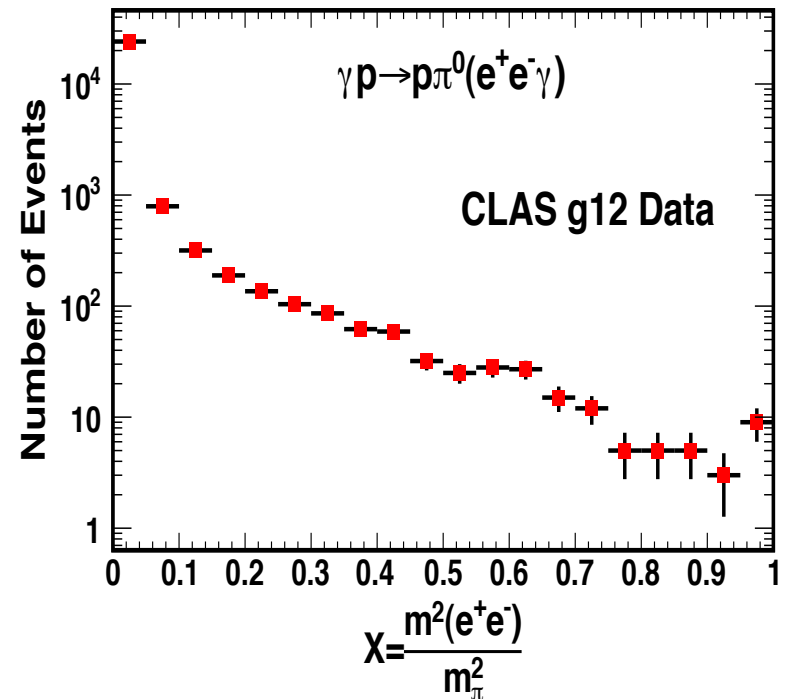
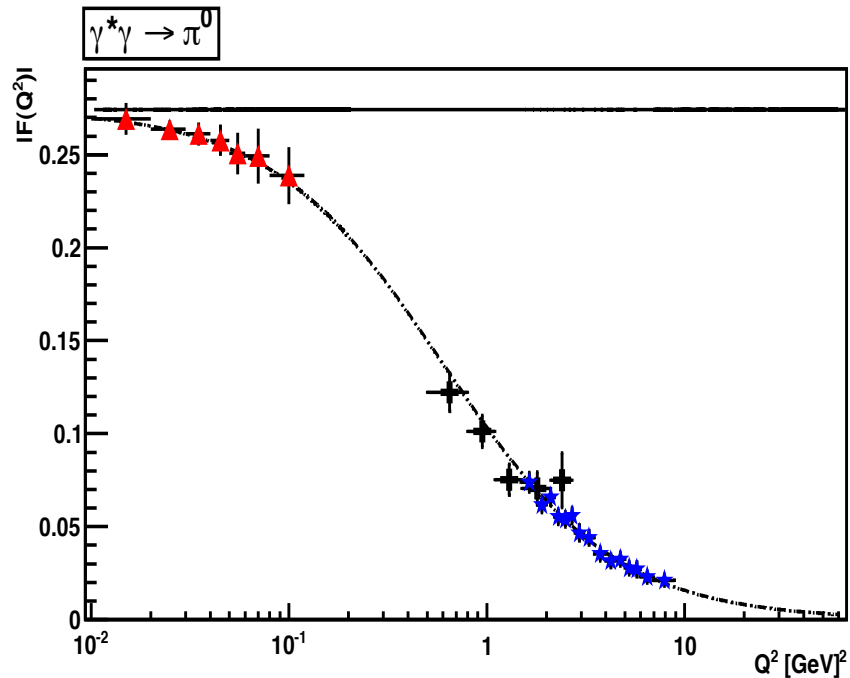
CLAS g12 Data



Transition Form Factor

KLOE-2 Proposal

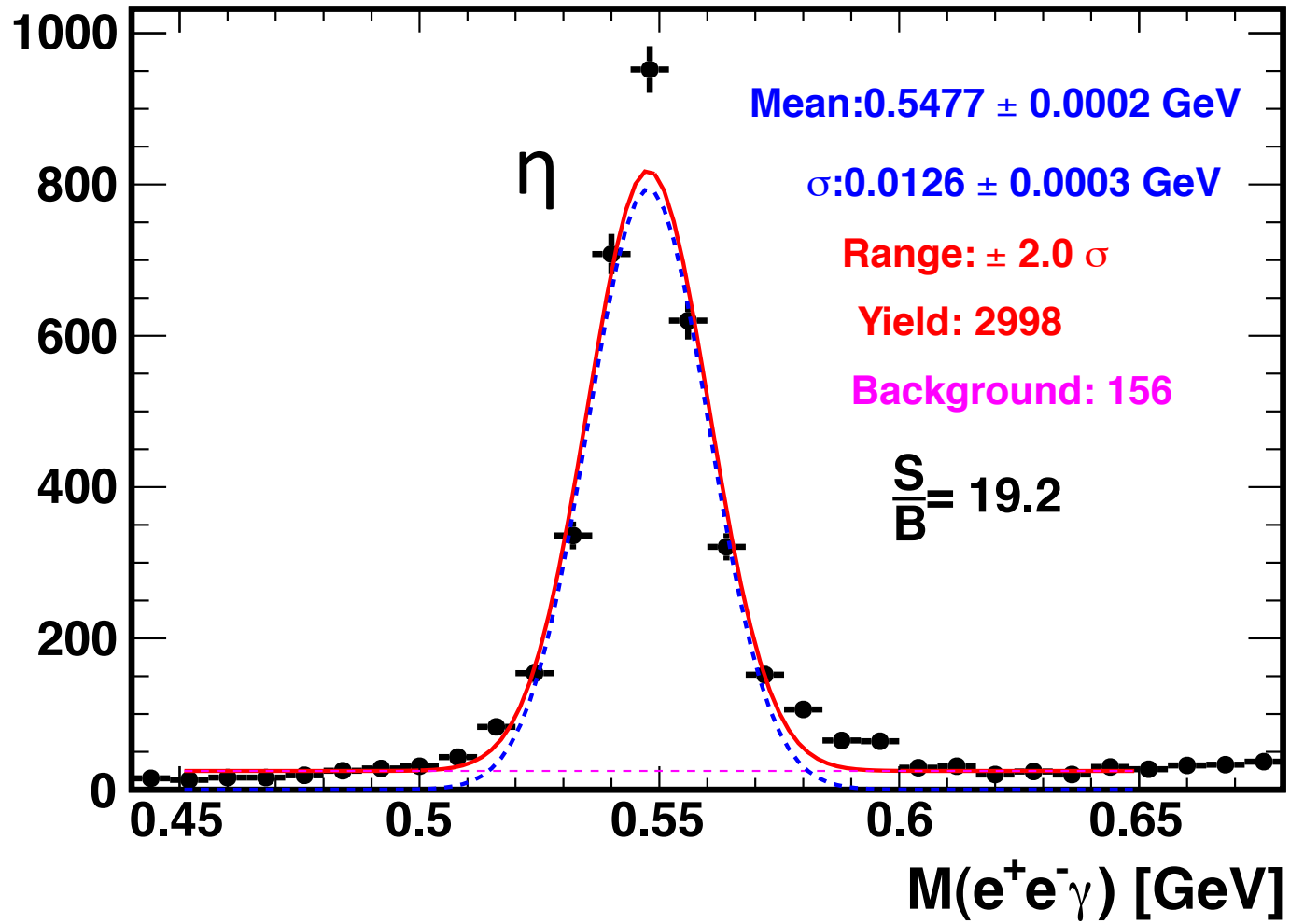
CLAS g12 Data



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

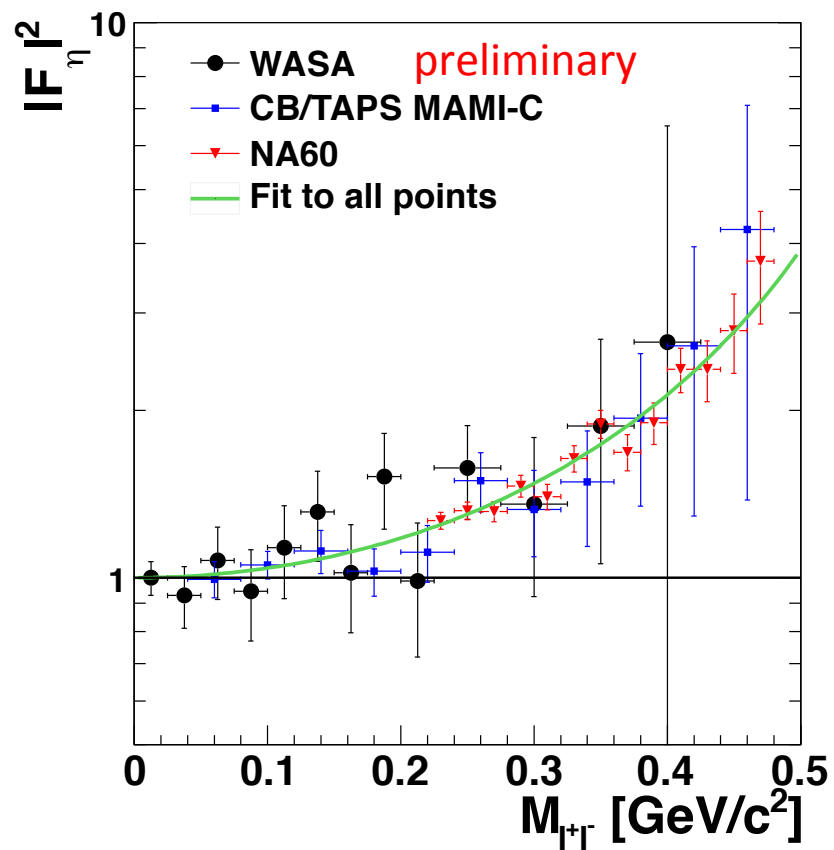
Also Important for LbyL radiative corrections to g-2

CLAS g12 Data

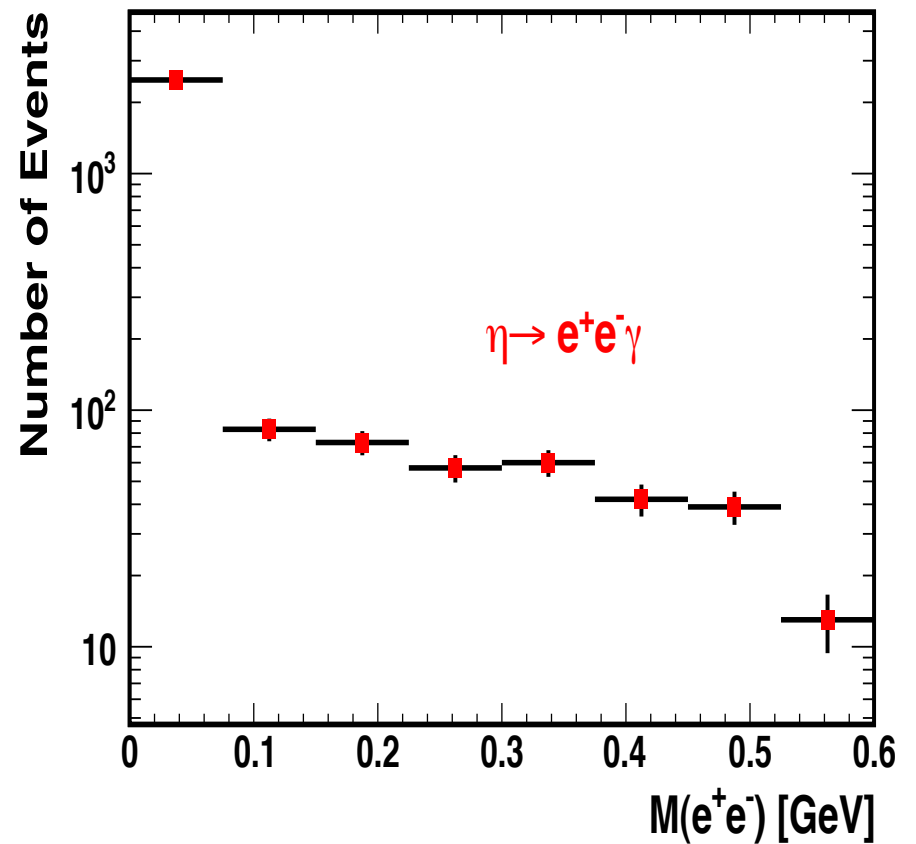


Time-Like Form Factor of η

World Data

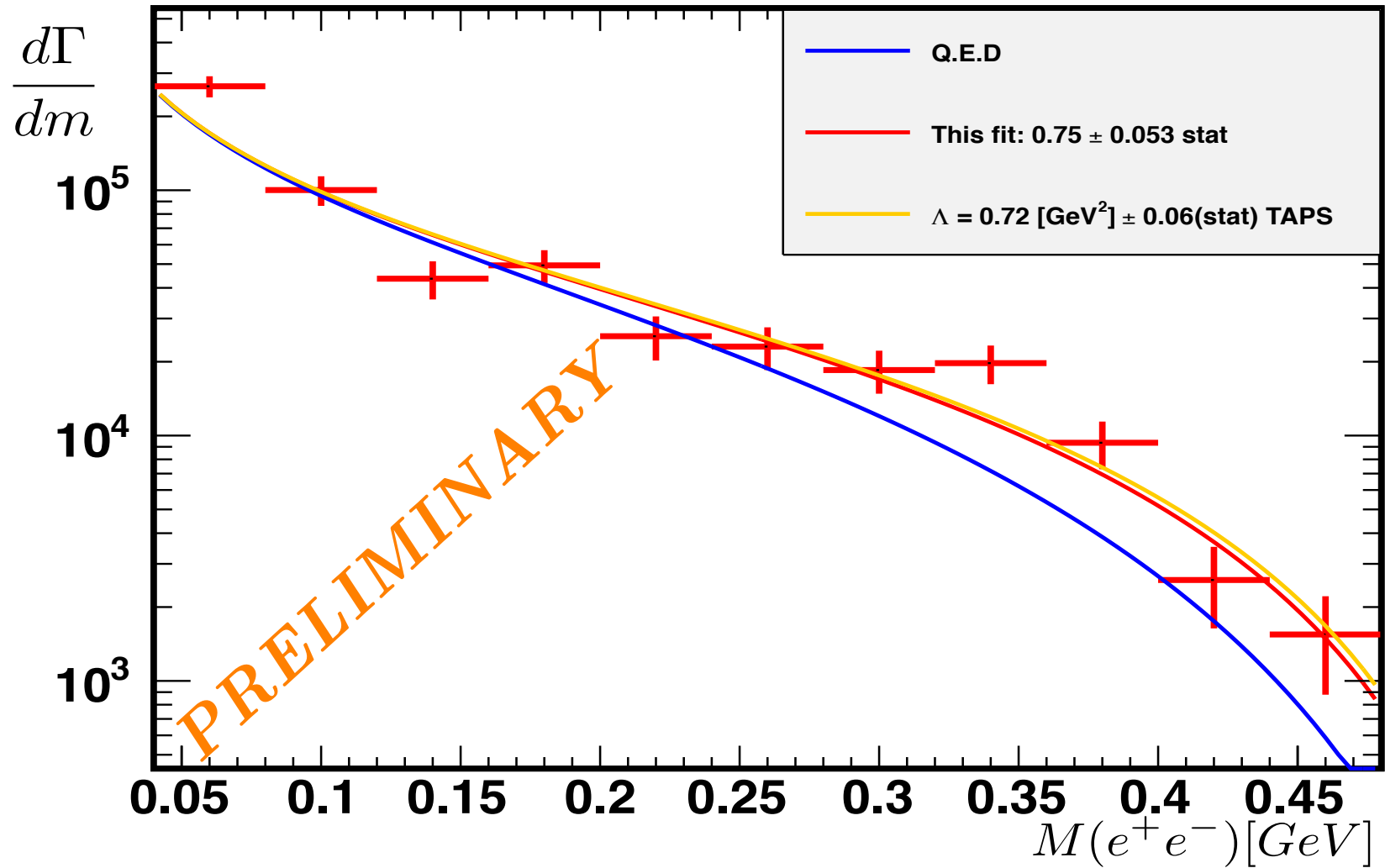


CLAS g12 Data

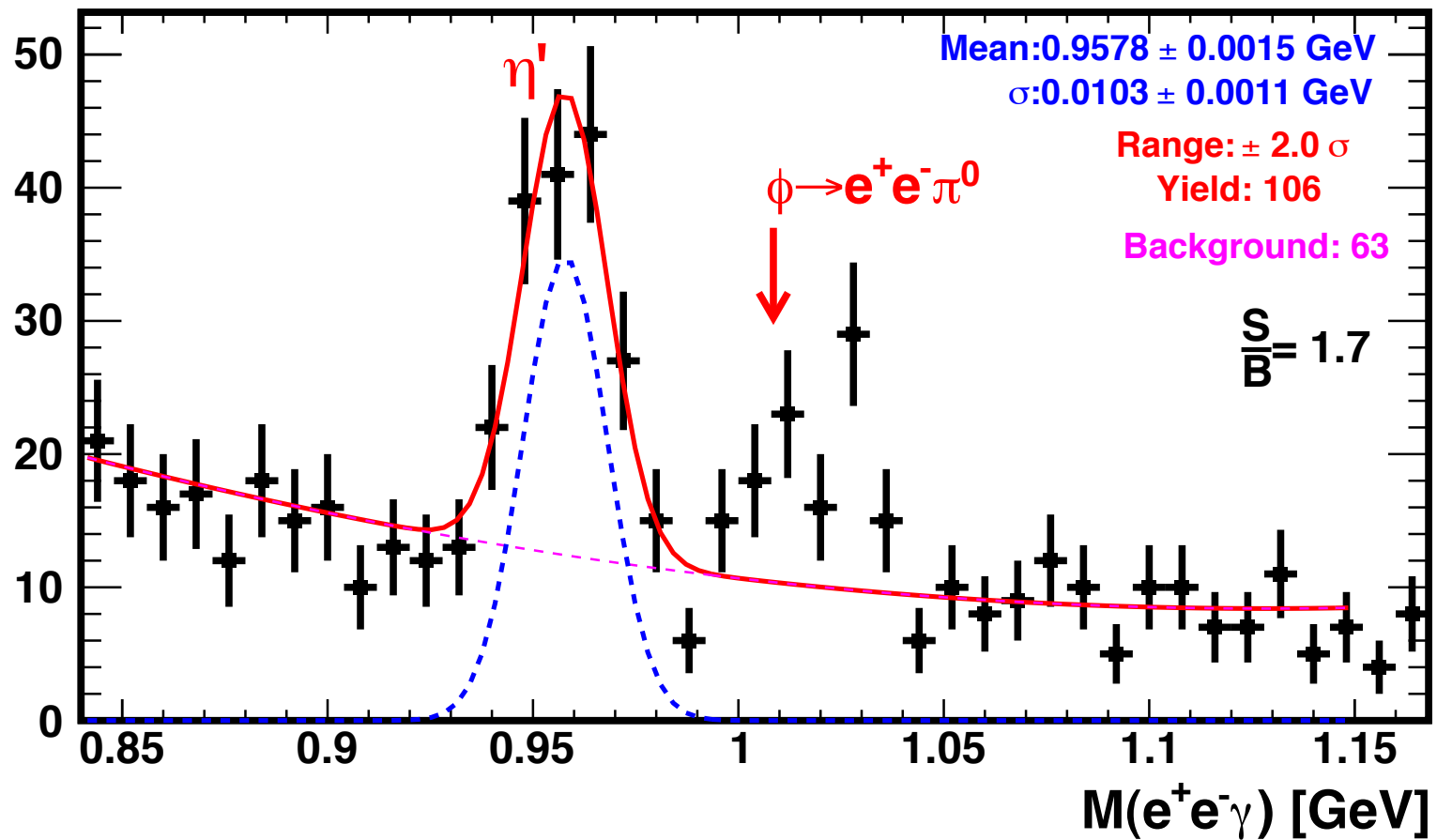


CLAS Preliminary

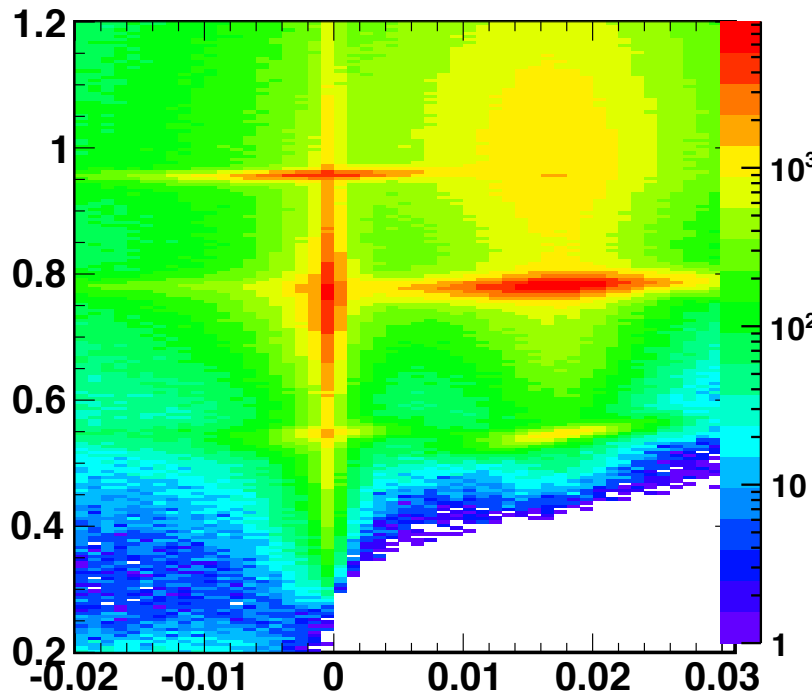
Accepted Correct Spectrum



First measurement of Dalitz Decay of eta' from CLAS



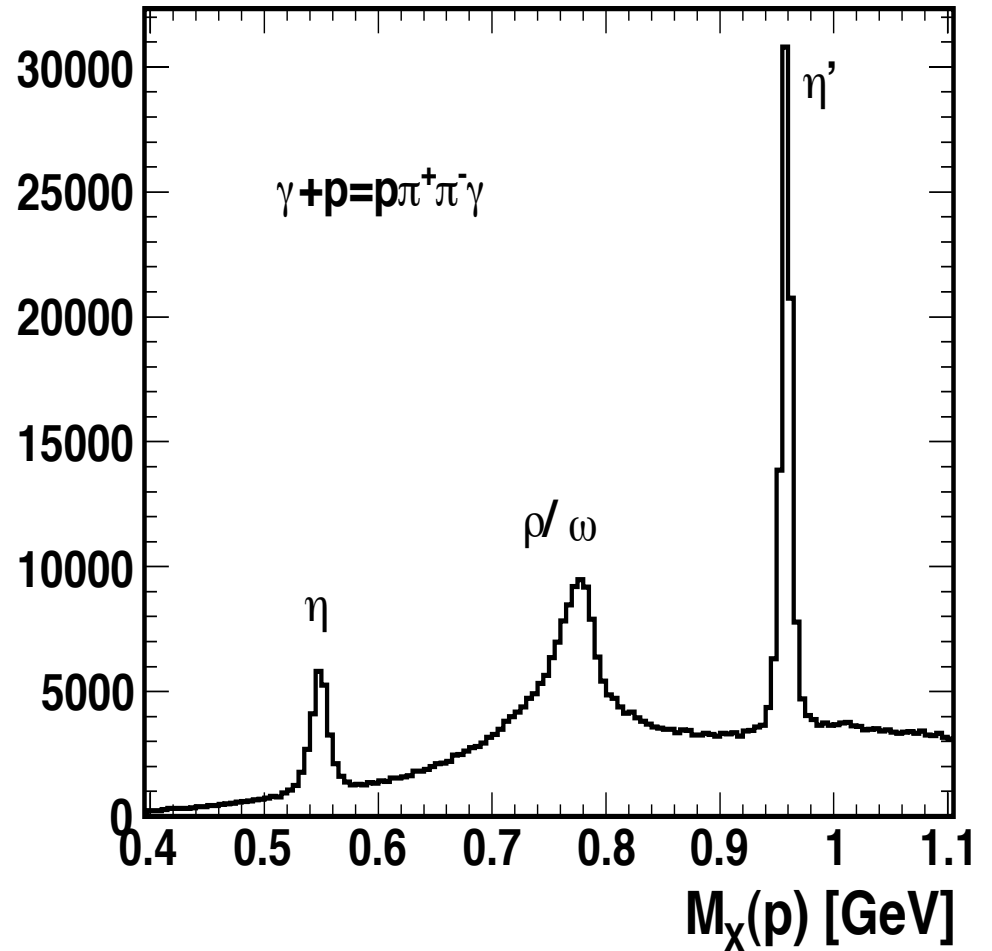
Radiative Decay $\eta, \eta' \rightarrow \pi^+ \pi^- \gamma$



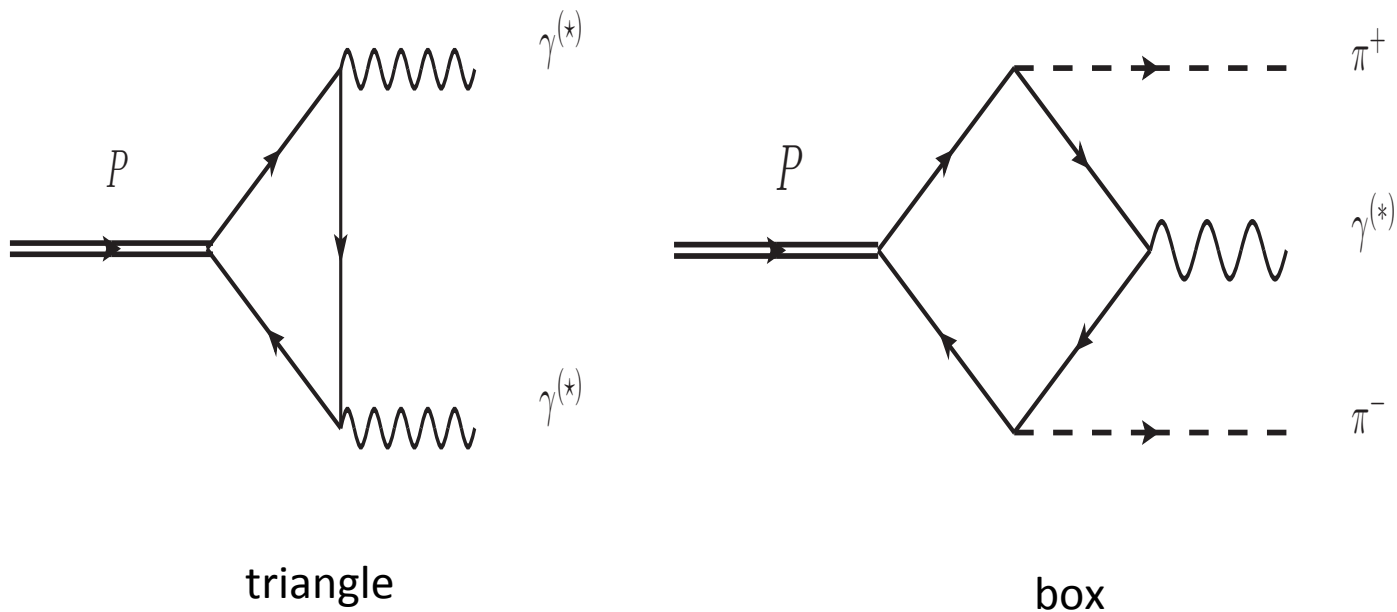
$M_X^2(p)$ versus $M_X^2(p\pi^+\pi^-)$

$ME > 0.01 \text{ GeV}$

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

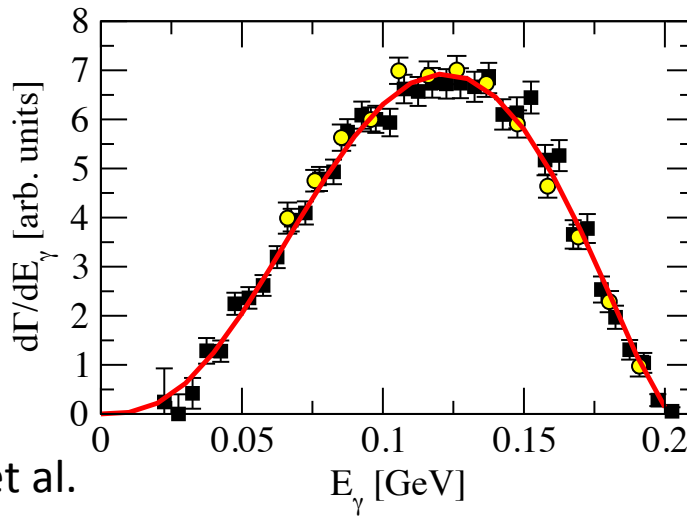


Why is radiative decay interesting?

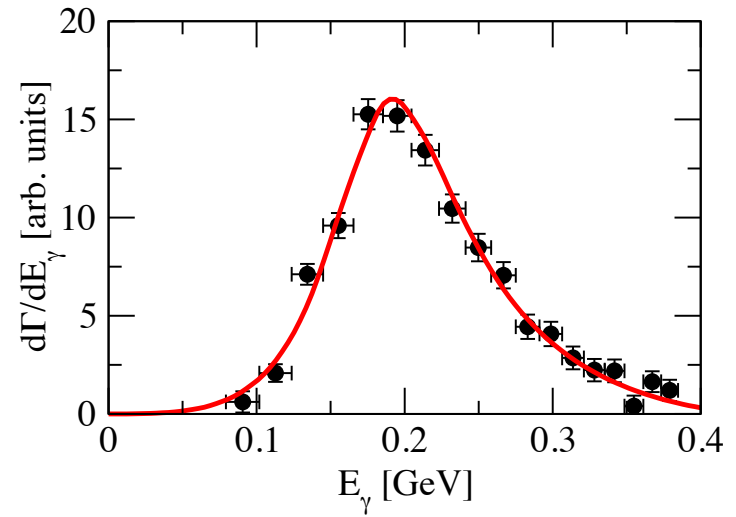


It gives an access to the box anomaly term of Wess-Zumino-Witten Lagrangian !

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



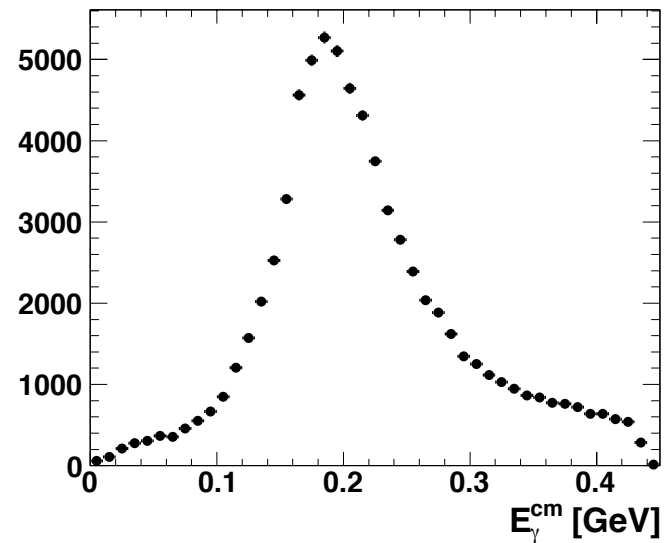
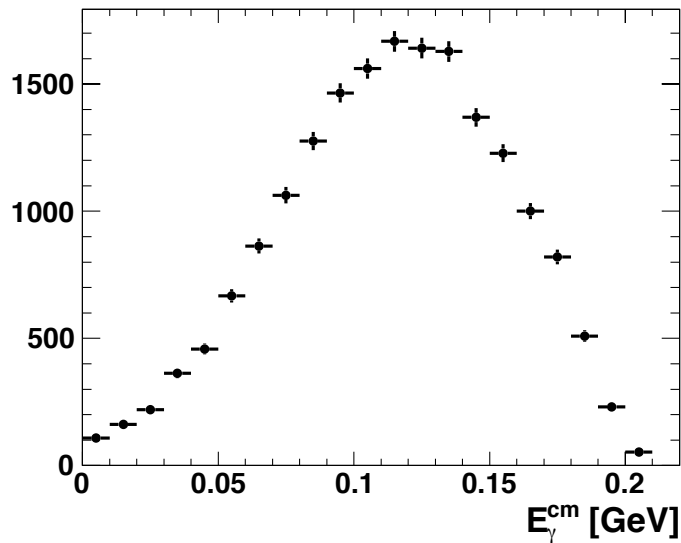
$\eta' \rightarrow \pi^+ \pi^- \gamma$



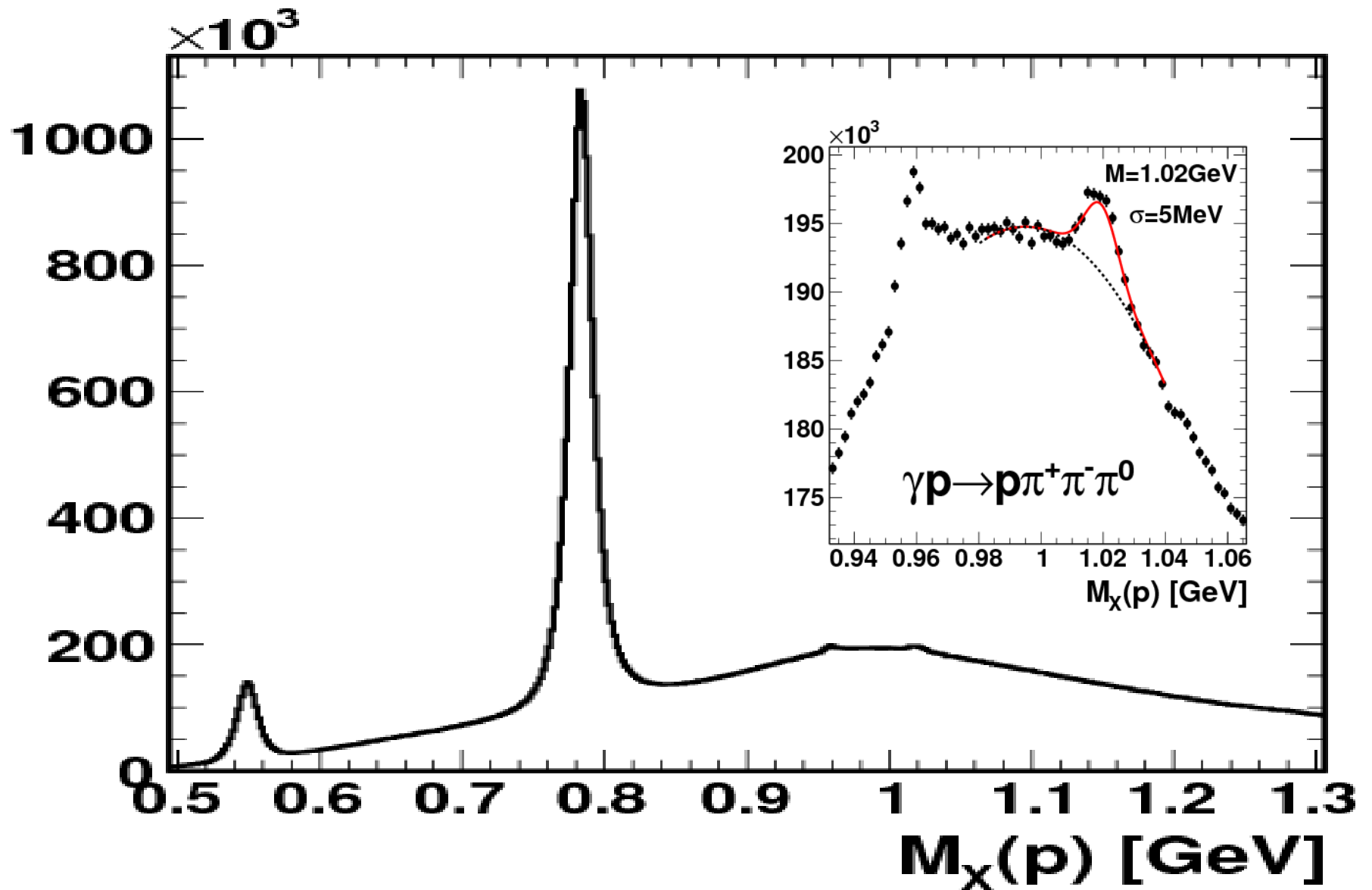
World data

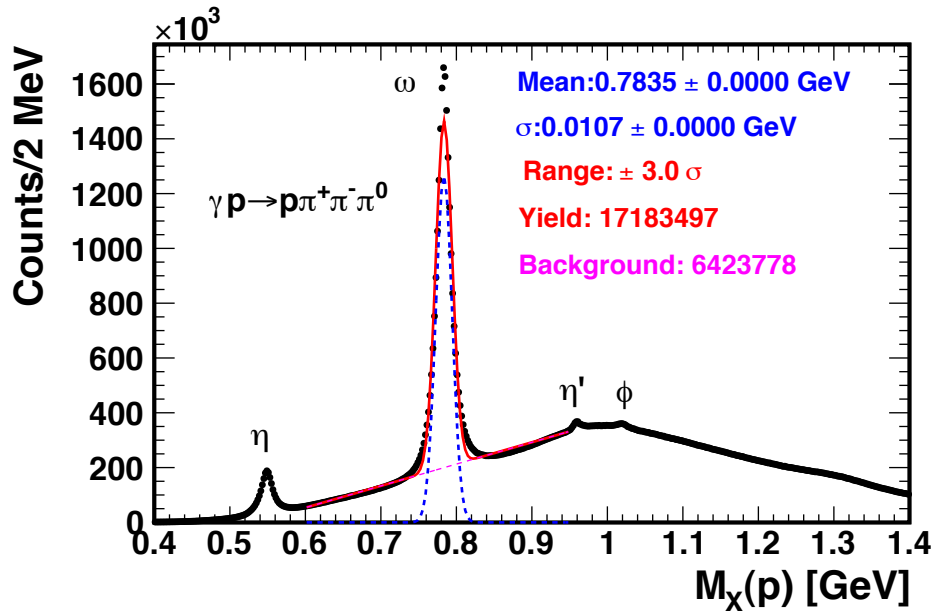
Theory:
E.Stollenwerk et al.
PL B707, 184, 2012

CLAS Preliminary uncorrected



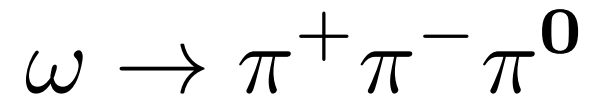
CLAS Hadronic decays: g11 Data



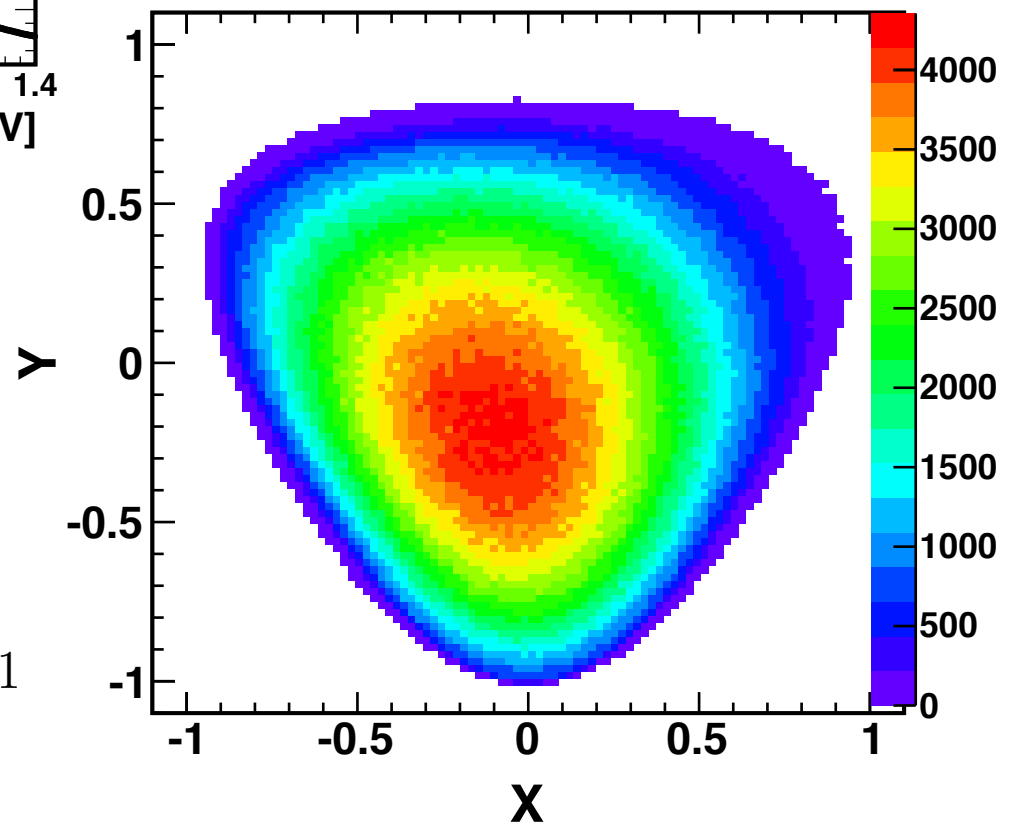


About 17M ω 's

CLAS

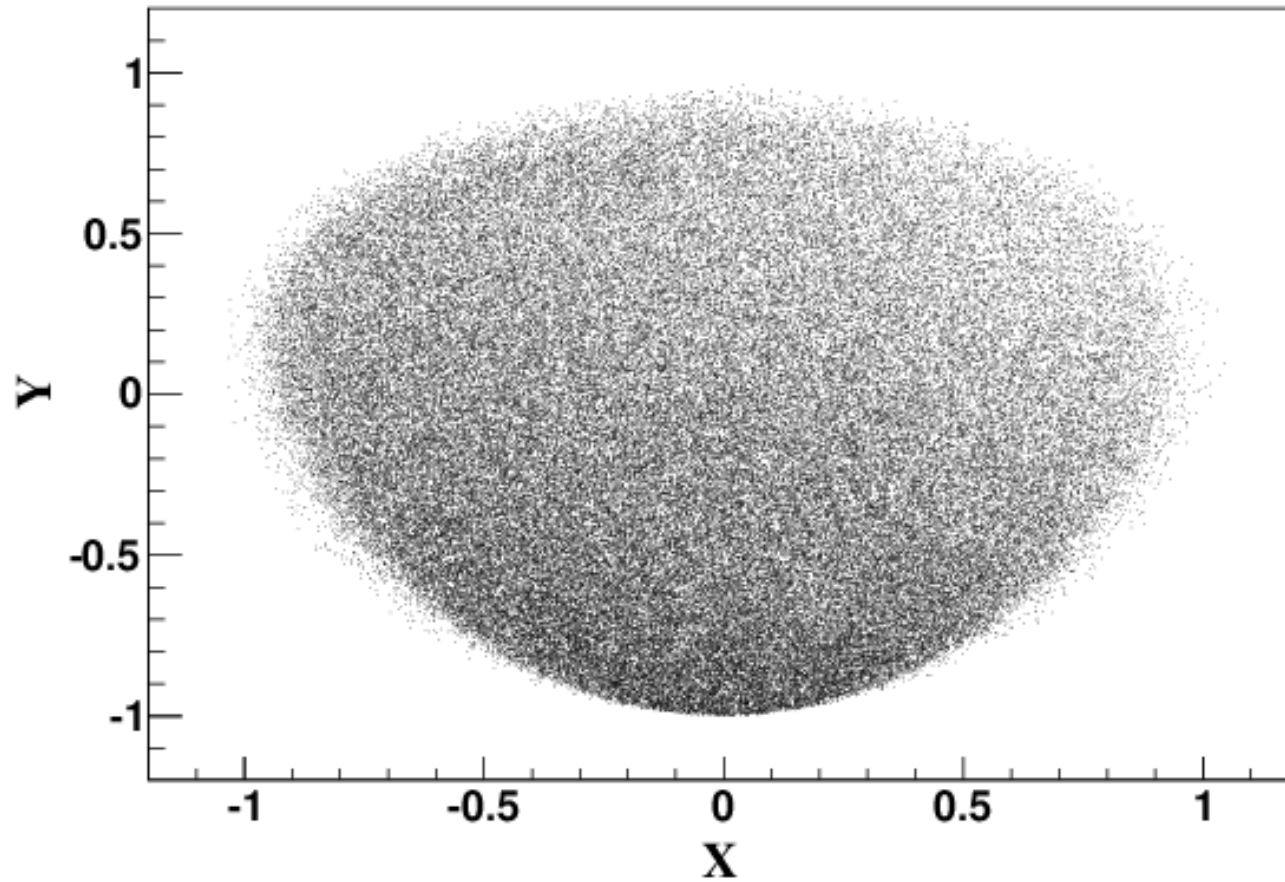


Not corrected for acceptance



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

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



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

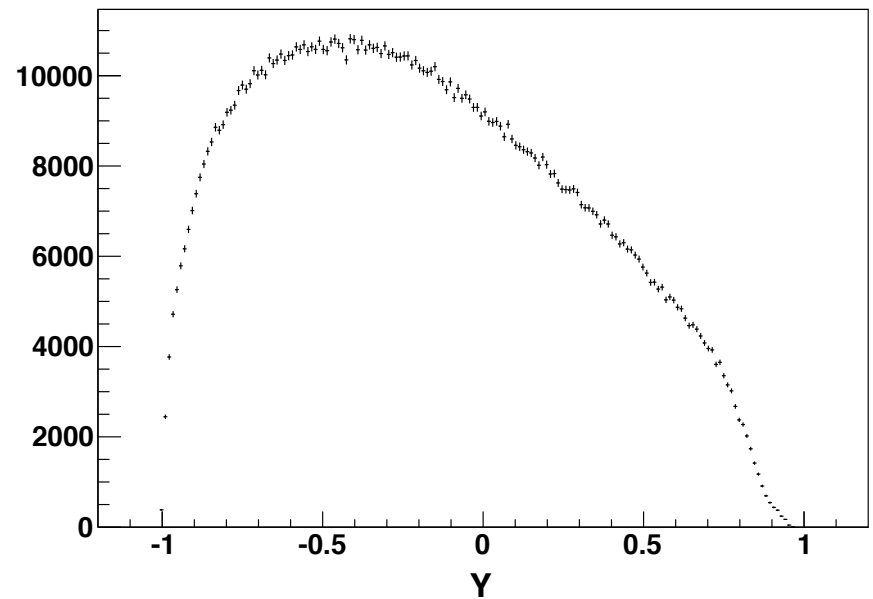
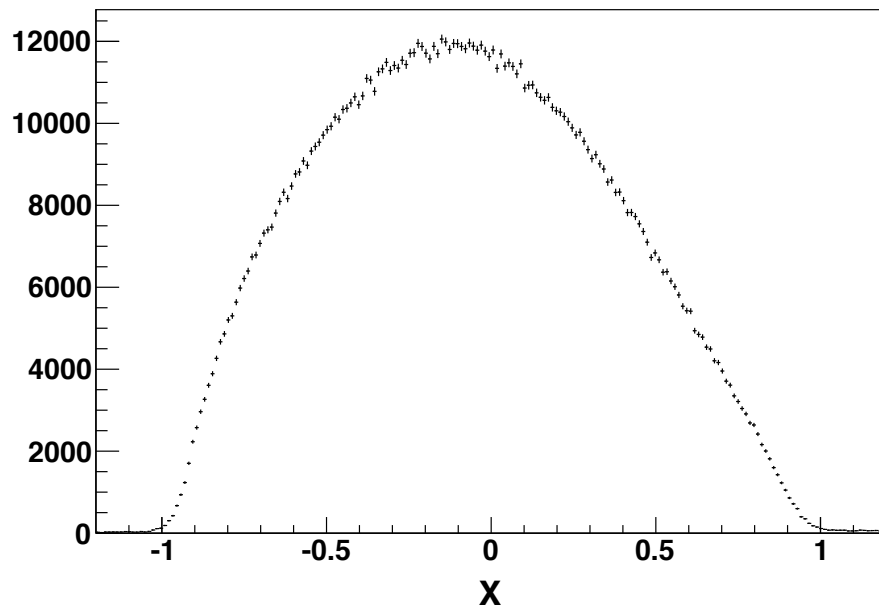
~2M events

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

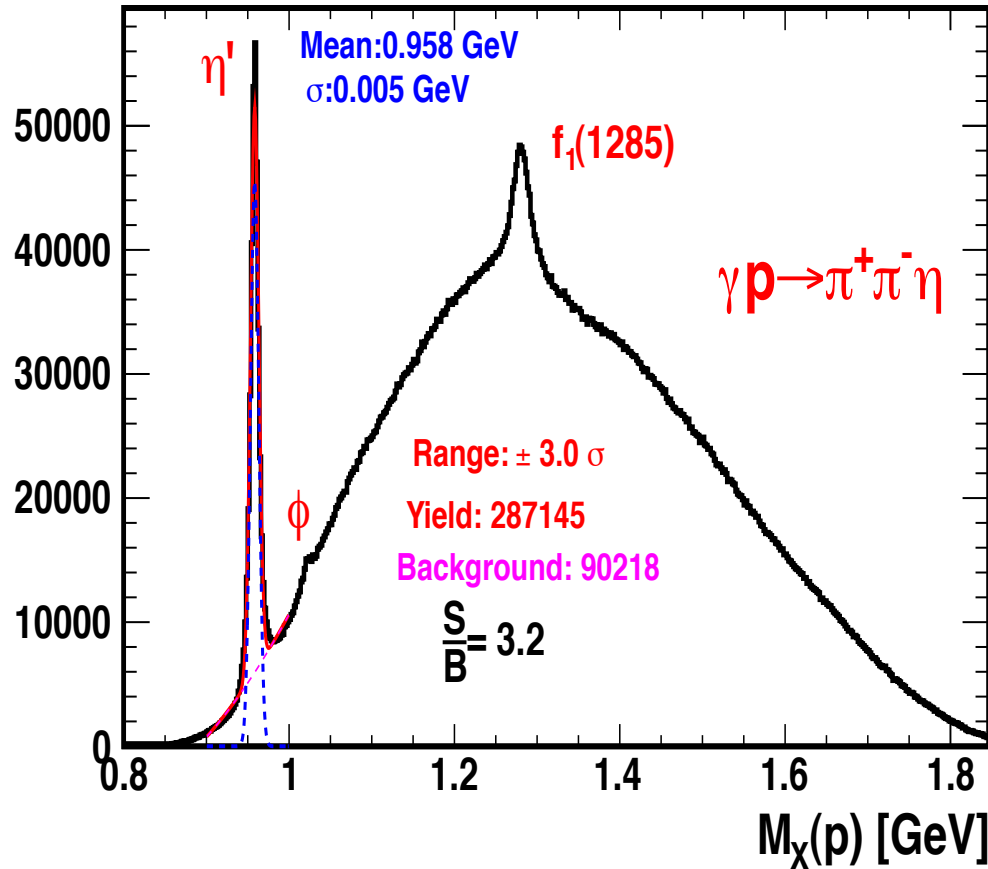
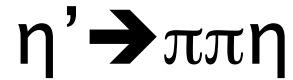
$$M^2 = A(1 + aY + bY^2 + cX + dX^2)$$

(Decay Matrix element expansion)

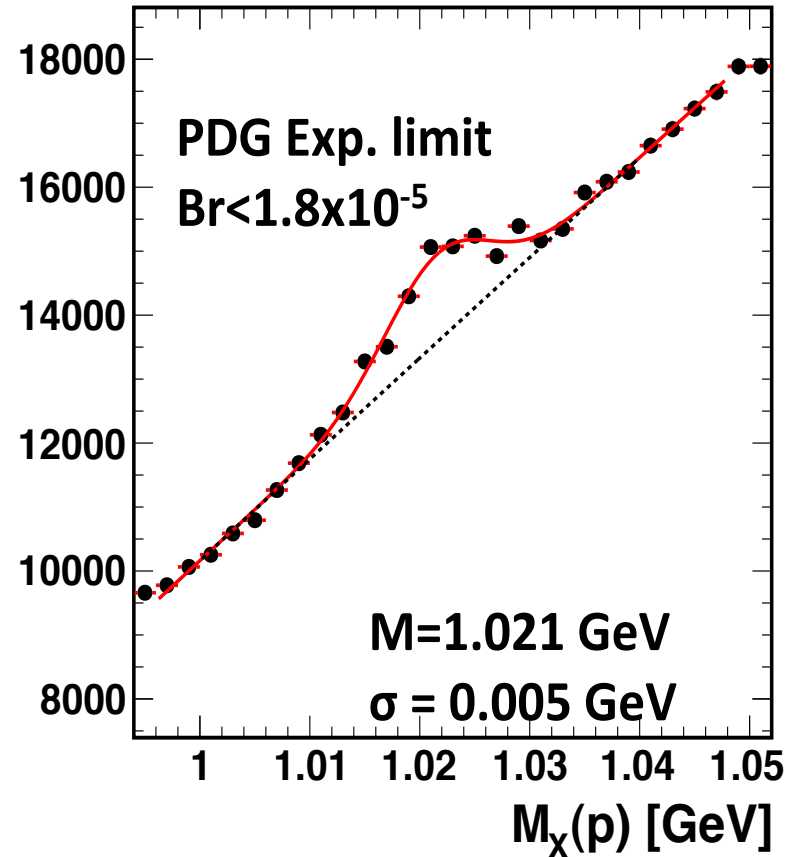
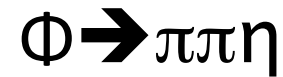
g11 Data



Hadronic decay



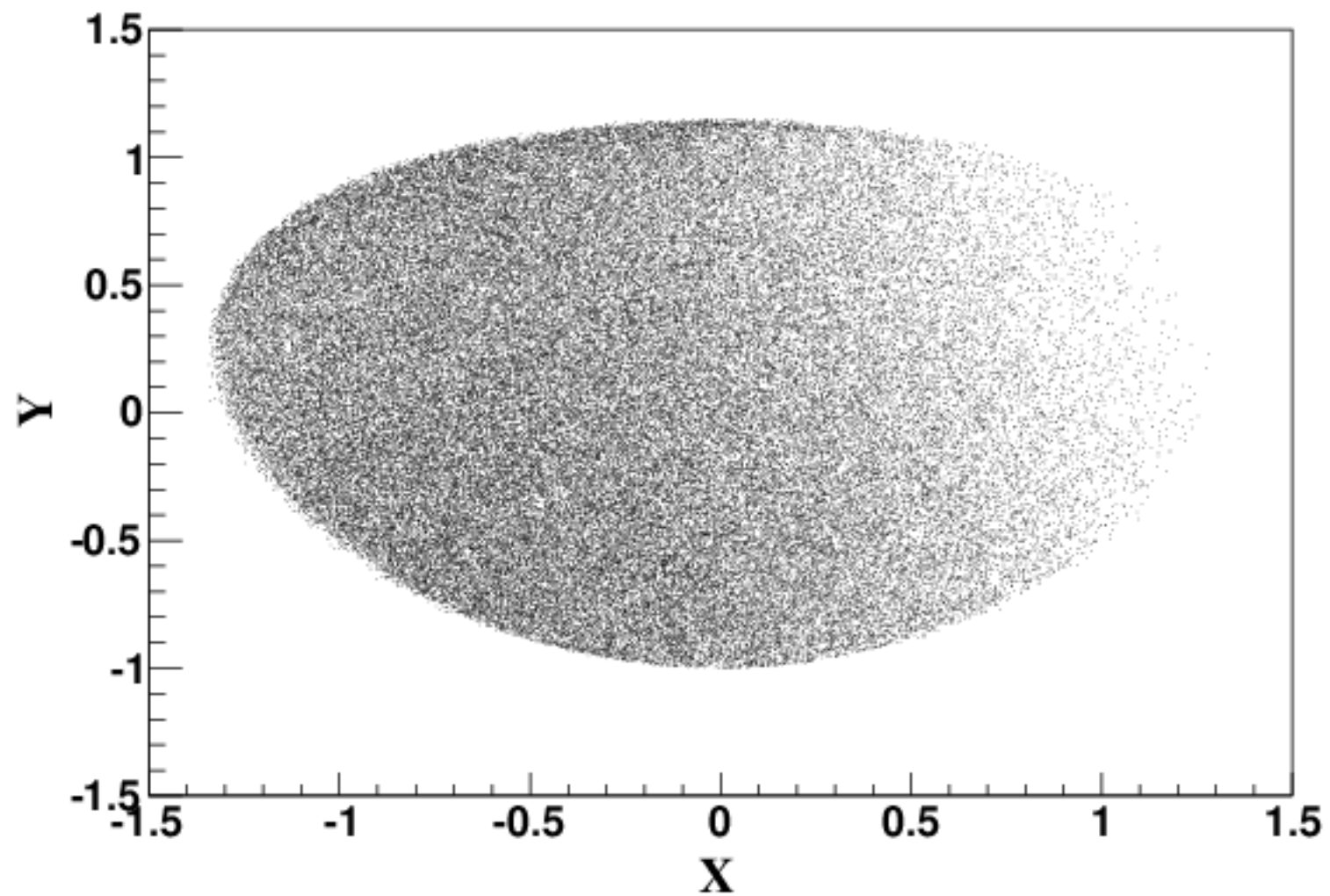
G-Parity violation



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

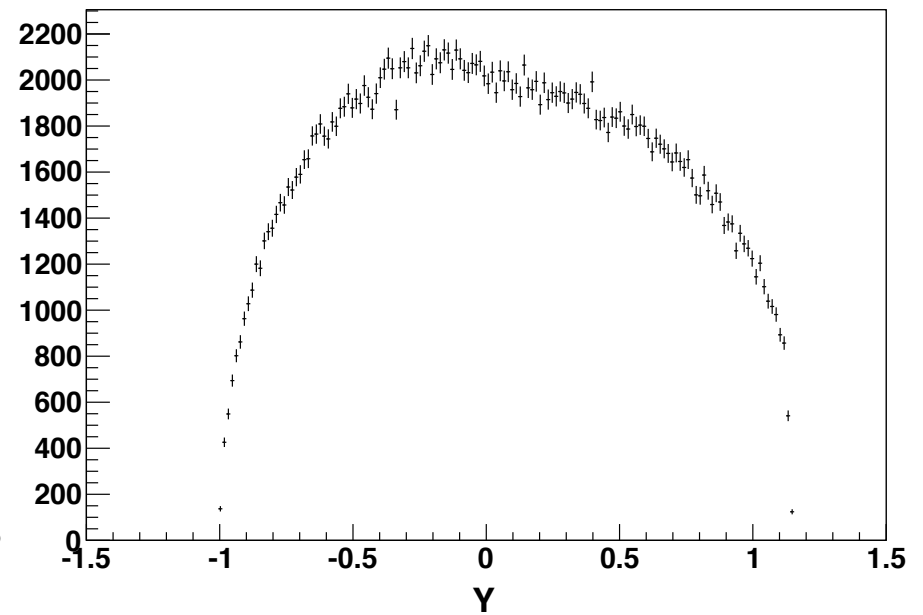
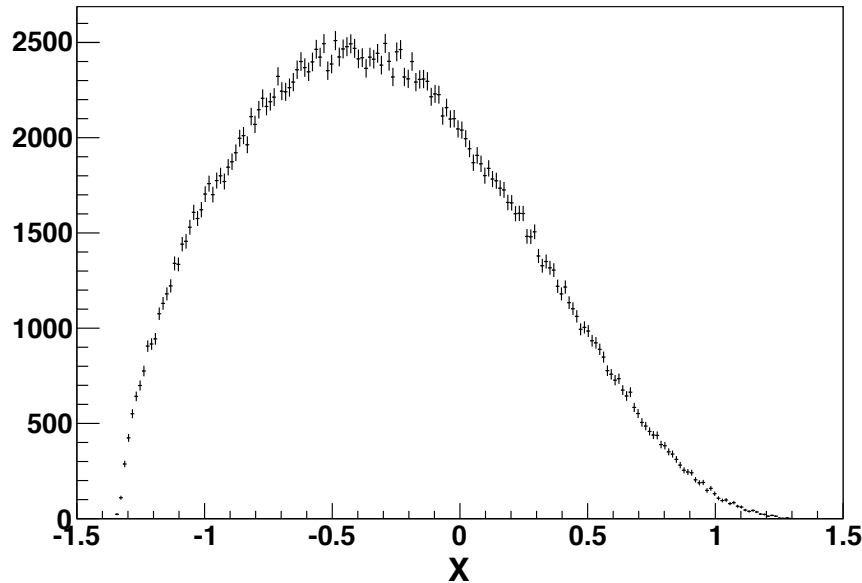
3 times more on tape

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



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

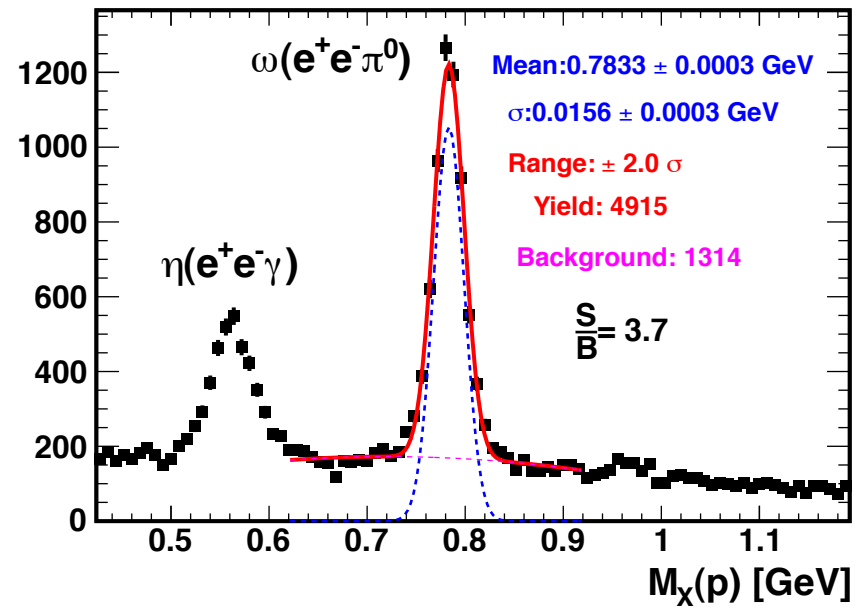
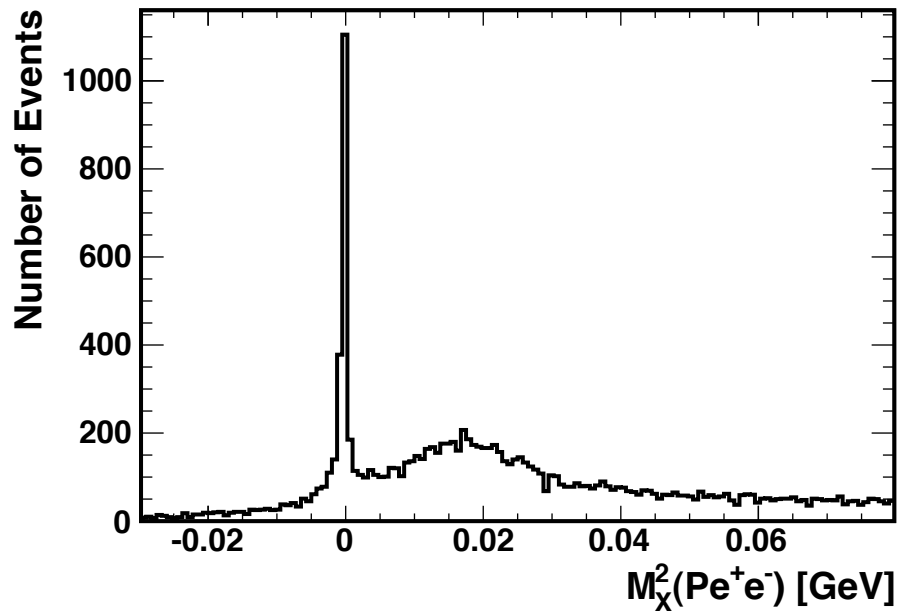
CLAS Preliminary uncorrected



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

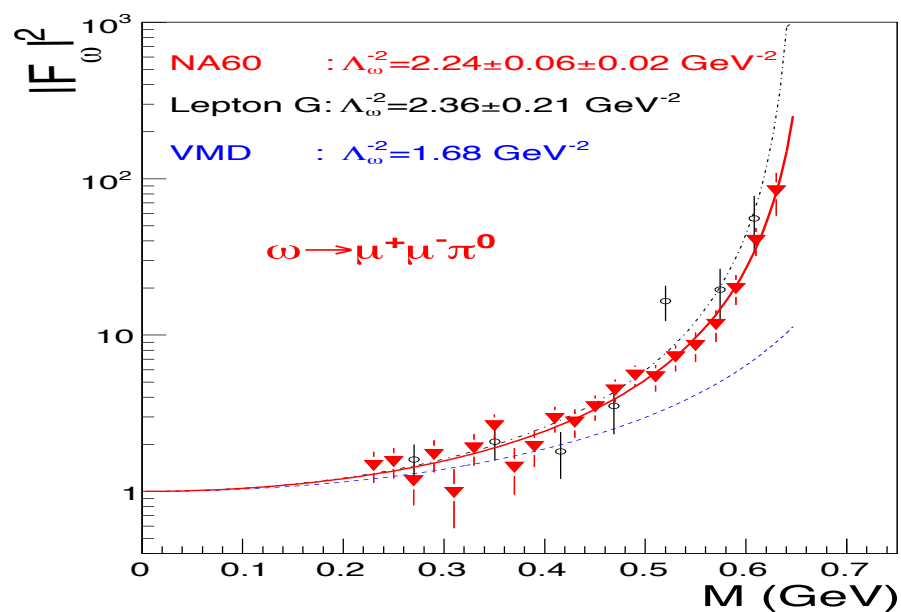
CLAS g12 Data



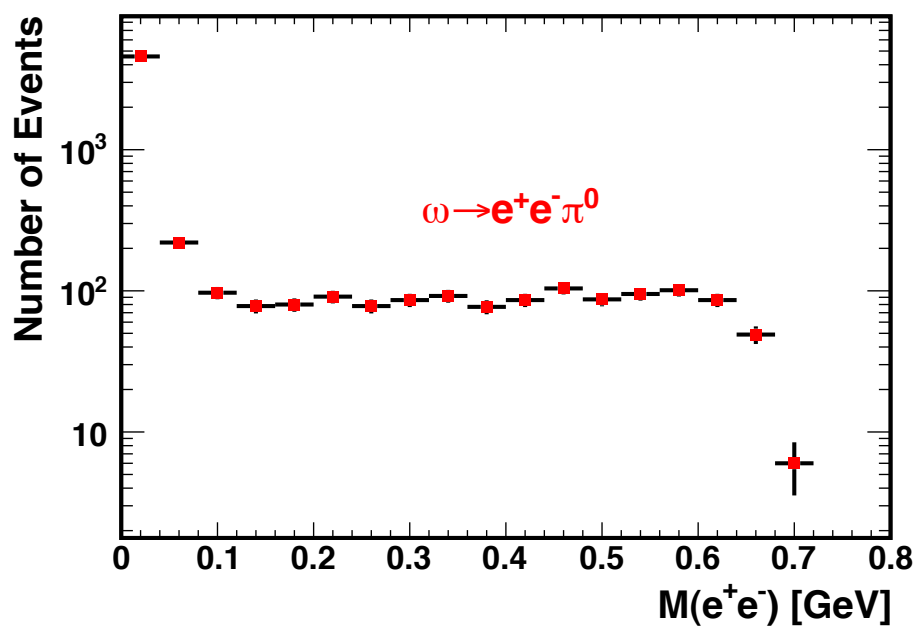
Transition Form Factor

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

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

M.J. Amaryan (spokesperson),^{1,*} Ya. Azimov,² M. Battaglieri,³ W.J. Briscoe,⁴ V. Crede,⁵
R. De Vita,³ C. Djalali,⁶ M. Dugger,⁷ G. Gavalian,¹ L. Guo,^{8,9} H. Habertzettl,⁴ C.E. Hyde,¹
D.G. Ireland,¹⁰ F. Klein,¹¹ A. Kubarovsky,^{12,13} V. Kubarovsky,⁹ M.C. Kunkel,¹ K. Nakayama,¹⁴
C. Nepali (spokesperson),¹ E. Pasyuk,⁹ M.V. Polyakov,^{15,2} B.G. Ritchie,⁷ J. Ritman,^{16,17,18} C. Salgado,¹⁹
S. Schadmand (spokesperson),^{16,17} I. Strakovsky,⁴ D. Weygand,⁹ U. Wiedner,¹⁸ and A. Wirzba^{16,17,20}

¹Old Dominion University, Norfolk, Virginia 23529

²Petersburg Nuclear Physics Institute, Gatchina, St. Petersburg 188300, Russia

³INFN, Sezione di Genova, 16146 Genova, Italy

⁴The George Washington University, Washington, DC 20052

⁵Florida State University, Tallahassee, Florida 32306

⁶University of South Carolina, Columbia, South Carolina 29208

⁷Arizona State University, Tempe, Arizona 85287-1504

⁸Florida International University, Miami, Florida 33199

⁹Thomas Jefferson National Accelerator Facility, Newport News, Virginia 23606

¹⁰University of Glasgow, Glasgow G12 8QQ, United Kingdom

¹¹Catholic University of America, Washington, DC 20064

¹²Rensselaer Polytechnic Institute, Troy, New York 12180-3590

¹³Skobeltsyn Nuclear Physics Institute, 119899 Moscow, Russia

¹⁴Department of Physics and Astronomy, University of Georgia, Athens, GA 30602, USA

¹⁵Institut für Theoretische Physik II, Ruhr-Universität Bochum, D-44780 Bochum, Germany

¹⁶Institut für Kernphysik, Forschungszentrum, Jülich, Germany

¹⁷Jülich Center for Hadron Physics, Forschungszentrum Jülich, 52425 Jülich, Germany

¹⁸Institut für Experimentalphysik I, Ruhr Universität Bochum, 44780 Bochum, Germany

¹⁹Norfolk State University, Norfolk, VA 23504, USA

²⁰Institute for Advanced Simulation, Forschungszentrum Jülich, 52425 Jülich, Germany

You are welcome to join!