JÜLICH
FORSCHUNGSZENTRUM

measurements of meson decays and meson transition form factors with CLAS

Susan Schadmand, IKP
for the CLAS collaboration
PhiPsi17, June 2017

List of Meson Decays

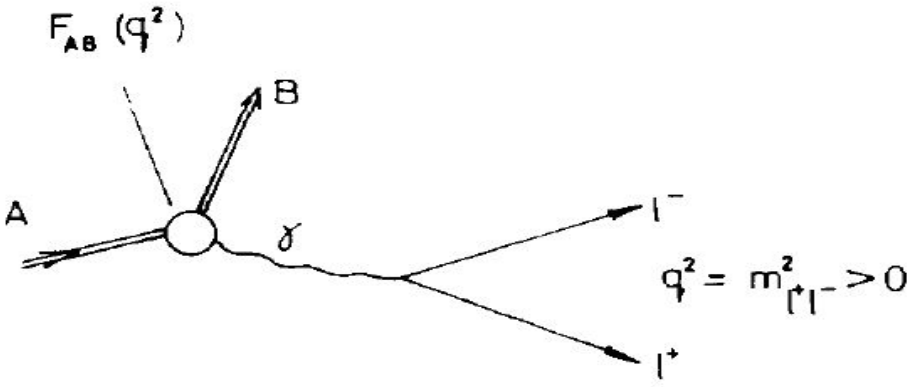
CLAS approved analysis CAA-LMD

From Lmdwiki

meson decay	physics	people	data	status	publication
$\pi \to \gamma e^+e^-$	transition form factor, Me+e- (dark photon)	Michael Kunkel (Jülich)	g12	PhD 2014, ODU	pi0 cross section in preparation
$\eta' \to \gamma e^+e^-$	transition form factor	Michaela Schever	g12	Master 2015, RWTH Aachen ----→ proposed for CLAS12	
$\eta \to \gamma e^+e^-$	transition form factor				
$\omega \to \pi^0 e^+e^-$	transition form factor	Susan Schadmand (Jülich)	g12	this talk	
$\eta \to \pi^0 e^+e^-$	C violation				
$\eta' \to \pi^+\pi^-\gamma$	box anomaly upper limit branching ratio	Georgie Mbianda Njencheu	g11	PhD 2017, ODU analysis report in preparation	
		Daniel Lersch (Jülich)	g12		
$\eta \to \pi^+\pi^-\gamma$	box anomaly	Torri Roark (ODU)	g11		
		Daniel Lersch (Jülich)	g12		
$\varrho \to \pi^+\pi^-\gamma$		Tyler Viducic (ODU)	g11 ?		
$\eta, \omega, \phi \to \pi^0\pi^+\pi^-$ η ω ϕ	Dalitz plot analysis	(JPAC and CLAS) Daniel Lersch, (Diane Schott) Carlos Salgado + , Chris Pederson	g11/g12		
$\eta' \to \pi^+\pi^-\eta$	Dalitz plot analysis pi+ pi- correlation	Sudeep Ghosh (Indore)	g12, (g11)	analysis report in preparation	

Moskov Amaryan (ODU)
Ankhi Roy (IIT Indore)

transition form factor



$$\frac{d\Gamma(A \to B\, l^+l^-)}{dq^2 \cdot \Gamma(A \to B\gamma)} = \left|F_{A\to B}(q^2)\right|^2 \cdot |\mathrm{QED}|$$

form factor: divide experimental q^2 distribution by QED

$$F_{AB}(q^2) = [1 - q^2/\Lambda^2]^{-1}$$ (single) pole approximation

$$F_{AB}(q^2) \simeq 1 + q^2[\mathrm{d}F_{AB}/\mathrm{d}q^2]|_{q^2\simeq 0} = 1 + q^2 b_{AB} = 1 + \tfrac{1}{6}q^2\langle r^2_{AB}\rangle$$

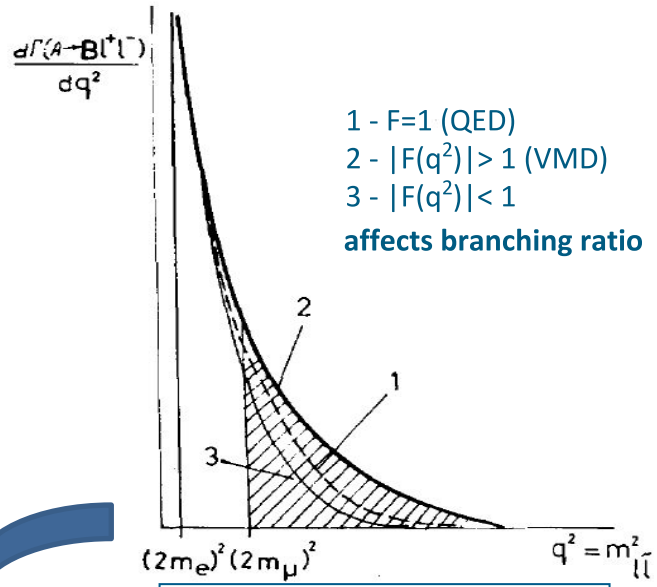
$$\Lambda \simeq m_\rho \ (\Lambda^{-2} = b_{AB})$$

'standard' VMD, b~1.69/GeV^2

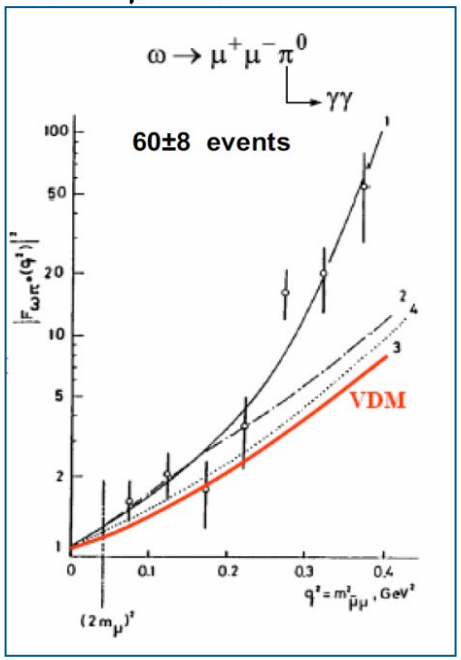
slope parameter

size (transition region)

L.G. Landsberg, Electromagnetic decays of light mesons



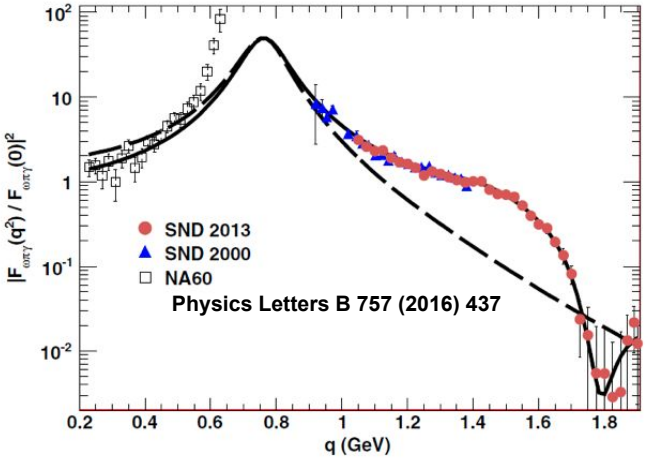
1 - F=1 (QED)
2 - $|F(q^2)| > 1$ (VMD)
3 - $|F(q^2)| < 1$
affects branching ratio



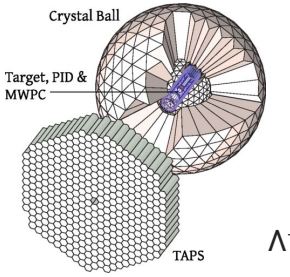
status of the ω-π transition form factor

Phys.Rev. D88 (2013) 054013

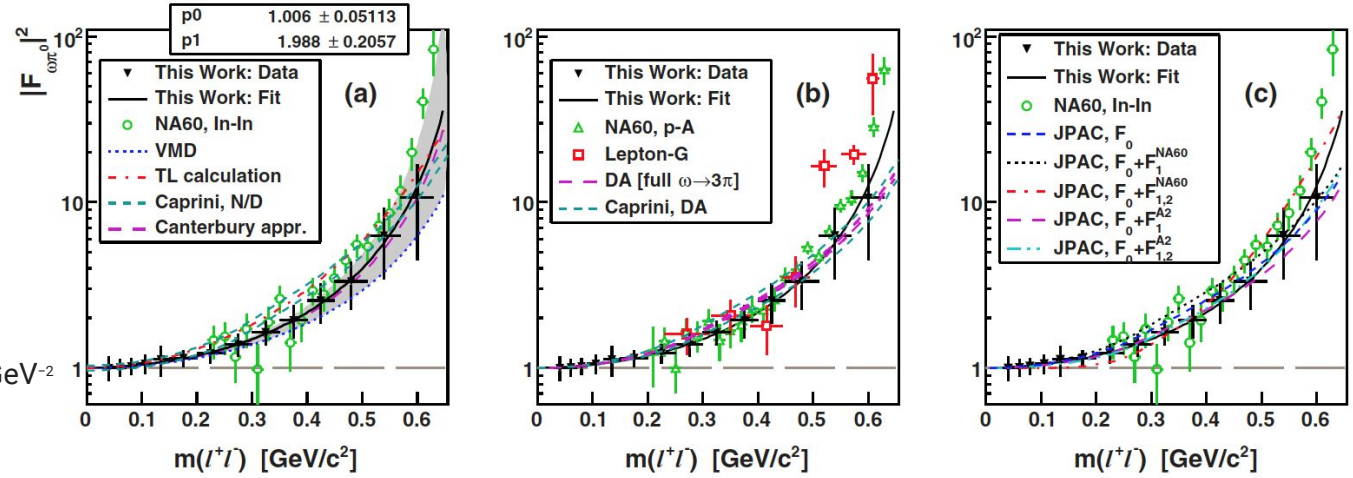
Study of $e^+e^- \to \omega\pi^0 \to \pi^0\pi^0\gamma$ in the energy range 1.05–2.00 GeV with SND



S. Prakhov (A2 Collaboration at MAMI)
Phys. Rev. C 95, 035208



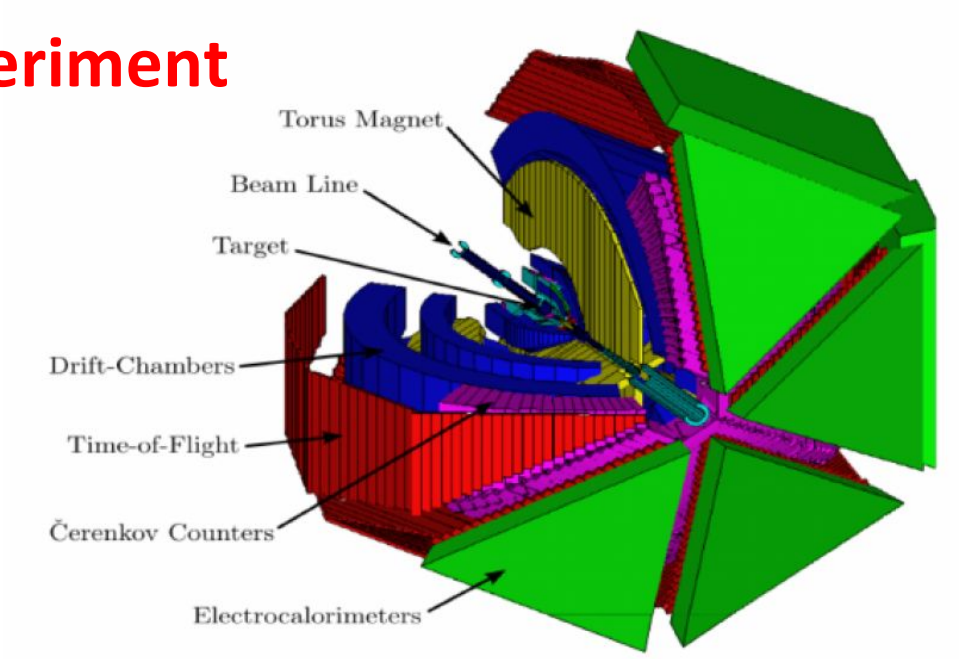
$\Lambda^{-2}=(1.99\pm0.21_{tot})\text{GeV}^{-2}$



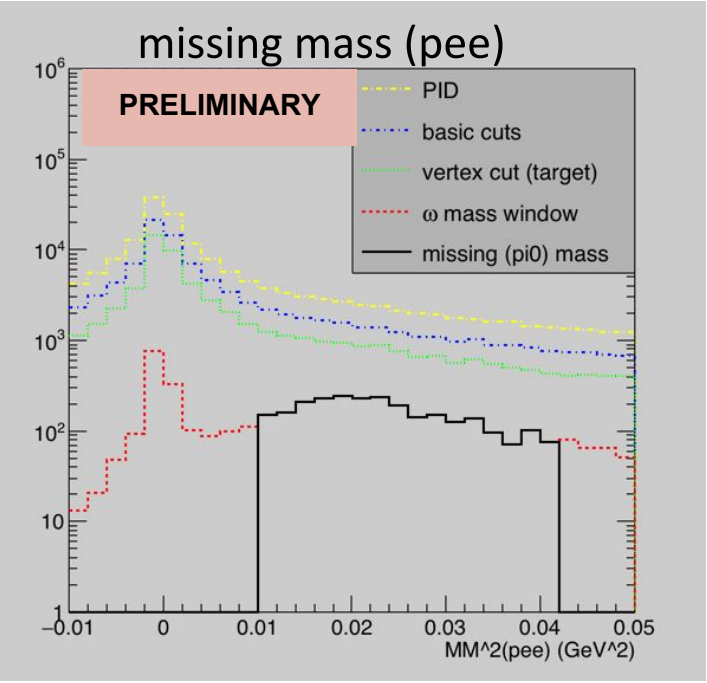
conclusion:

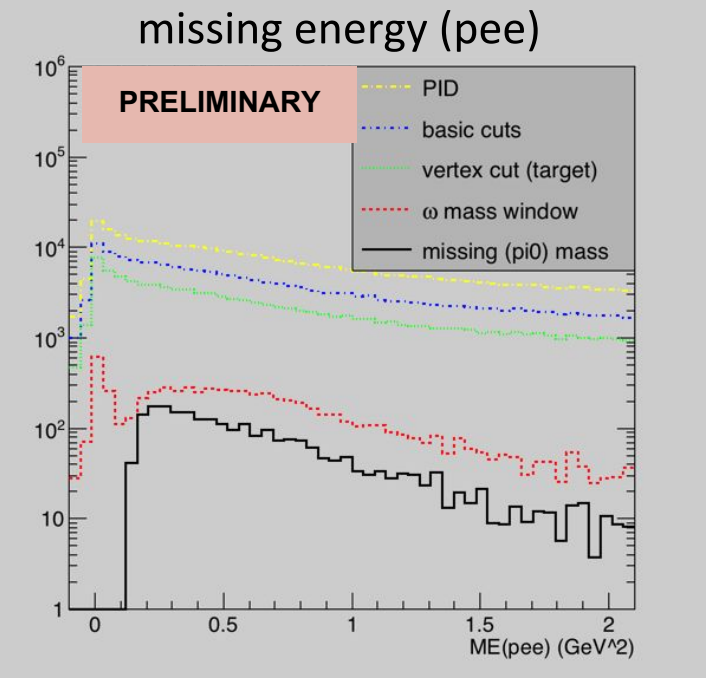
- A2 results are in better agreement with theoretical calculations, compared to earlier experiments
- statistical accuracy of the present data points at large m (ee) masses does not allow a final conclusion

CLAS6 experiment



CLAS g12 experiment	
fixed target experiment with energy-tagged Bremsstrahlung photon beam from 6GeV CEBAF	
LH_2 target	main source for *external γ conversion*
magnetic field	charged particle tracking momenta and *charge state*
Cerenkov Counters	excellent *electron-positron identification*
EM calorimeter	particle identification (limited acceptance photon detection)





analysis strategy

e+e- detection
and missing particle

missing pion:
- missing mass is pion mass
- missing energy finite

ω→πee

missing photon:
- missing mass zero
- missing energy finite

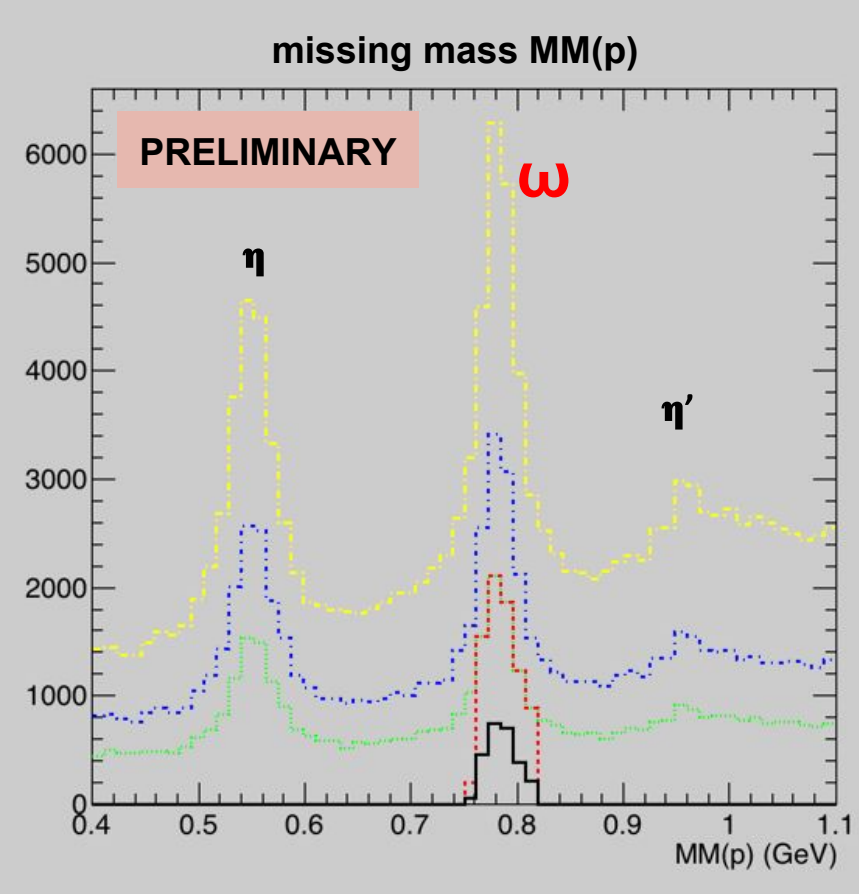
η(′)→γee

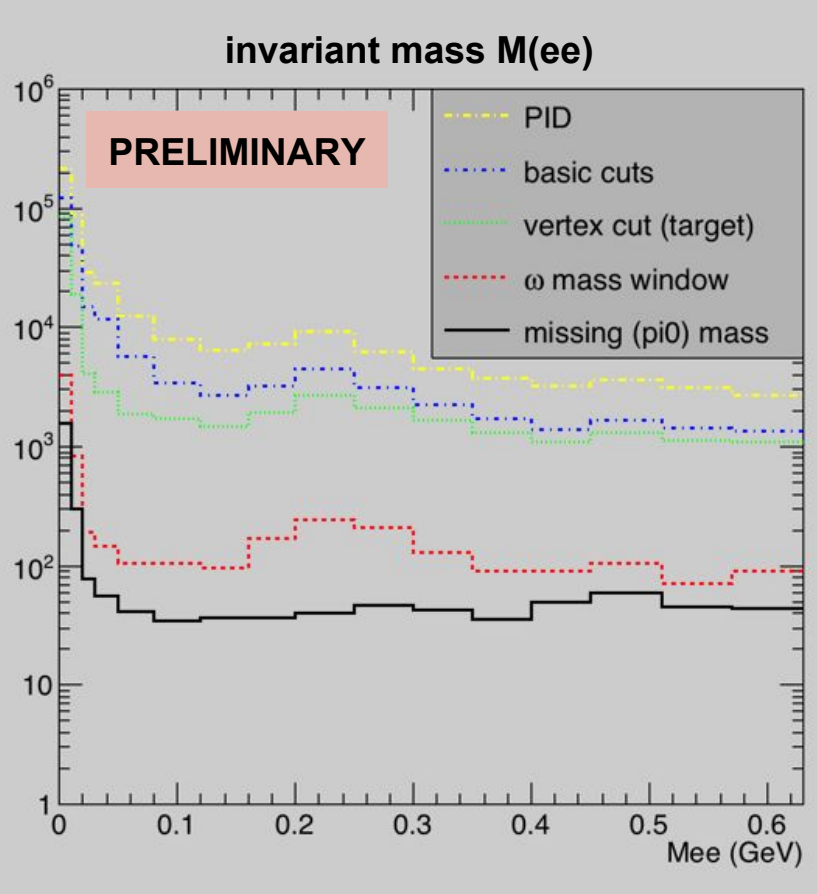
missing nothing:
- missing mass zero
  missing energy zero

ρ/ω→ee

missing mass cut is crucial

analysis ω→πee candidates





- smooth background ← fit and subtract
- in-peak background (competing decays) ← simulations
- photon conversion from π→γγ ← simulations, small ee masses

simulation ω decays

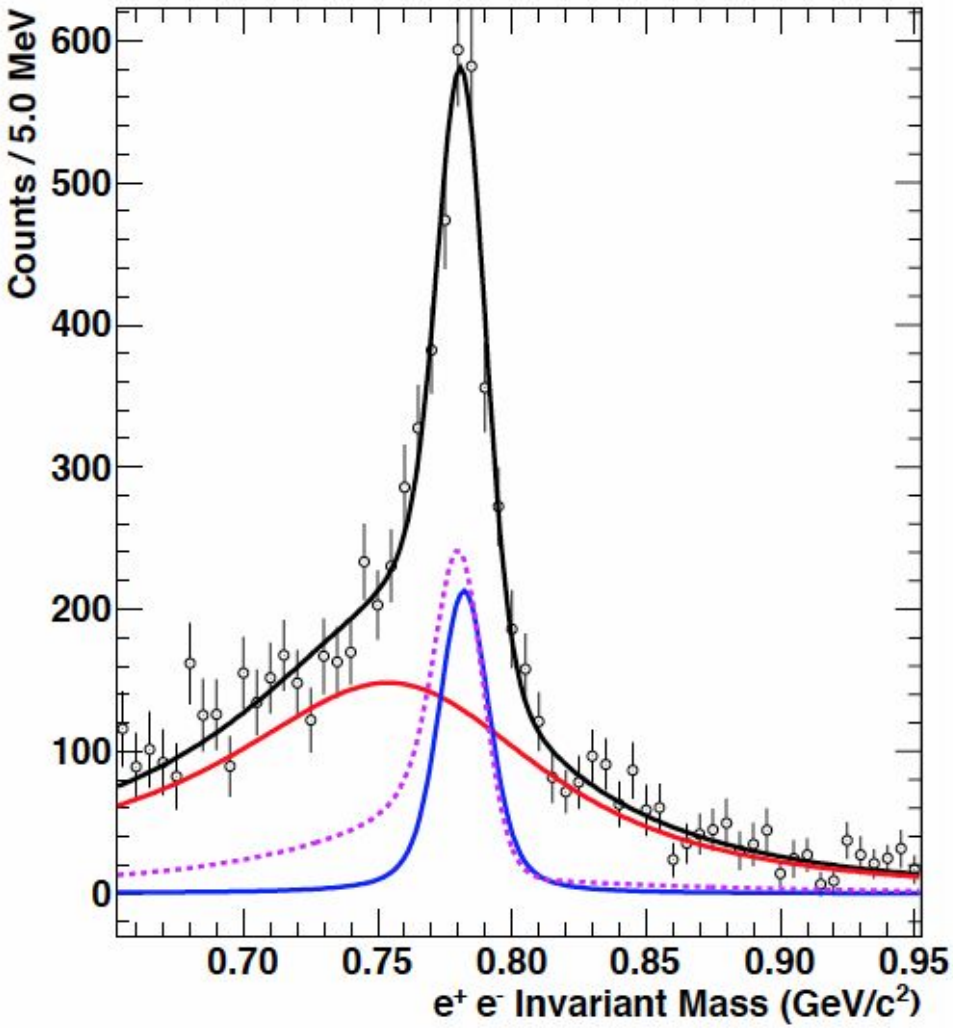
PLUTO event generator
incl. Bremsstrahlung beam profile and ω angular distribution

Citation: K.A. Olive *et al.* (Particle Data Group), Chin. Phys. C, **38**, 090001 (2014) and 2015 update

ω(782) DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi^+\pi^-\pi^0$		(89.2 $\pm$0.7) %		327
$\pi^0\gamma$		(8.28$\pm$0.28) %	S=2.1	380
$\pi^+\pi^-$		($1.53^{+0.11}_{-0.13}$) %	S=1.2	366
neutrals (excluding $\pi^0\gamma$)		(8^{+8}_{-5}) $\times 10^{-3}$	S=1.1	–
$\eta\gamma$		(4.6 $\pm$0.4) $\times 10^{-4}$	S=1.1	200
$\pi^0 e^+ e^-$		(7.7 $\pm$0.6) $\times 10^{-4}$		380
$\pi^0\mu^+\mu^-$		(1.3 $\pm$0.4) $\times 10^{-4}$	S=2.1	349
e^+e^-		(7.28$\pm$0.14) $\times 10^{-5}$	S=1.3	391
$\pi^+\pi^-\pi^0\pi^0$		$<$ 2 $\times 10^{-4}$	CL=90%	262
$\pi^+\pi^-\gamma$		$<$ 3.6 $\times 10^{-3}$	CL=95%	366
$\pi^+\pi^-\pi^+\pi^-$		$<$ 1 $\times 10^{-3}$	CL=90%	256
$\pi^0\pi^0\gamma$		(6.6 $\pm$1.1) $\times 10^{-5}$		367
$\eta\pi^0\gamma$		$<$ 3.3 $\times 10^{-5}$	CL=90%	162
$\mu^+\mu^-$		(9.0 $\pm$3.1) $\times 10^{-5}$		377
3γ		$<$ 1.9 $\times 10^{-4}$	CL=95%	391
Charge conjugation (C) violating modes				
$\eta\pi^0$	C	$<$ 2.1 $\times 10^{-4}$	CL=90%	162
$2\pi^0$	C	$<$ 2.1 $\times 10^{-4}$	CL=90%	367
$3\pi^0$	C	$<$ 2.3 $\times 10^{-4}$	CL=90%	330

ρ →

ρ-ω interference



PoS Hadron2013 (2013) 176
JLAB-PHY-13-1839

based on same data
CLAS g12 experiment

targeted channel
γ + p → p + ee (in the ρ regime**)**

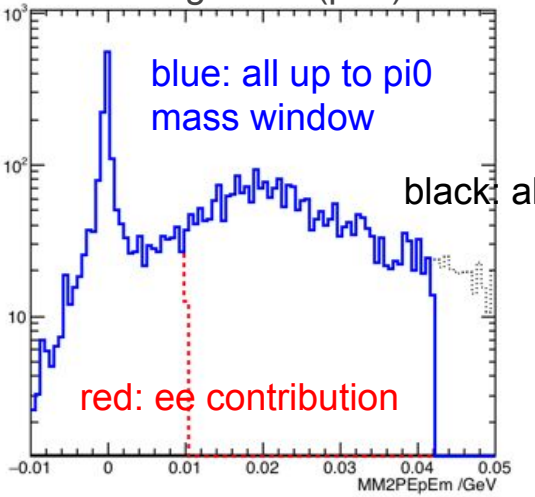
event selection via

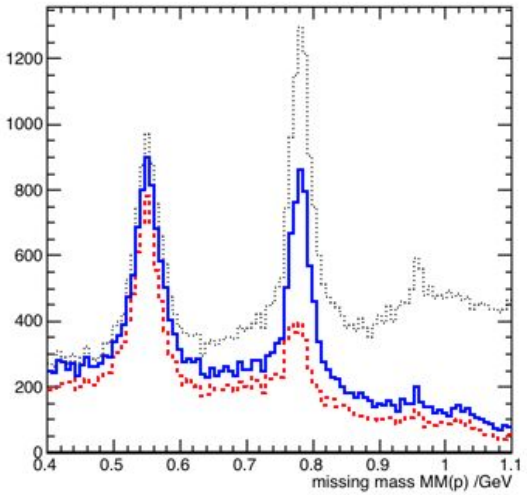
- PID dilepton
- missing mass MM(ee)=M(p)

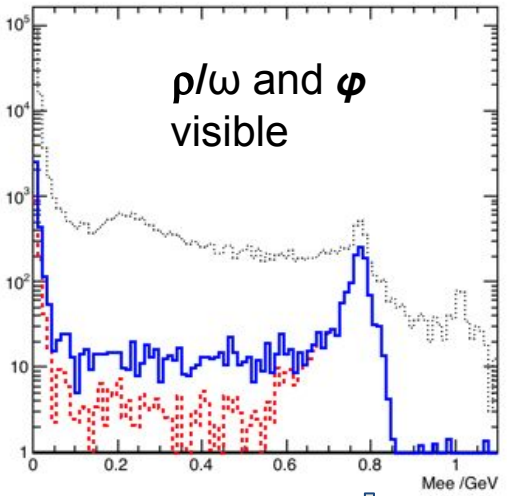
interference
causes low-mass tail

suppression of ee contribution

missing mass (pee)

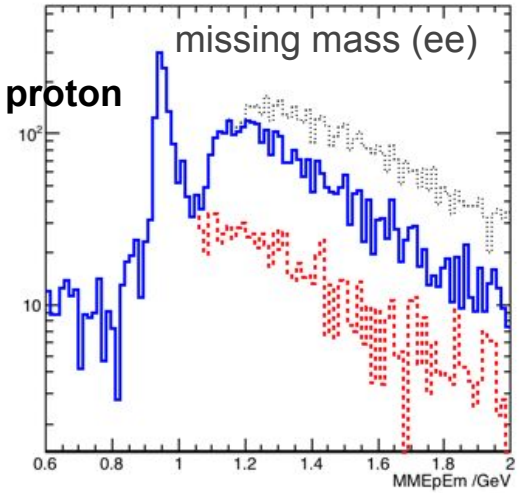


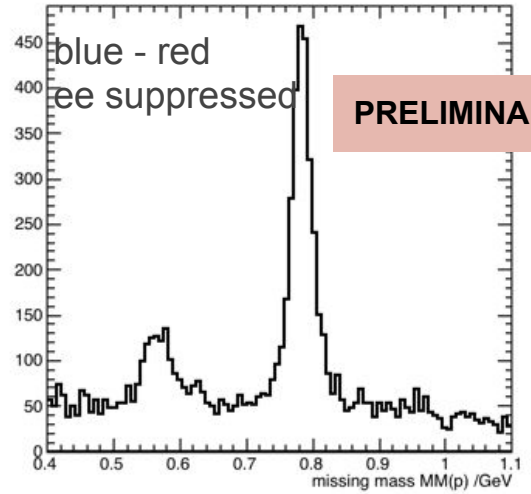


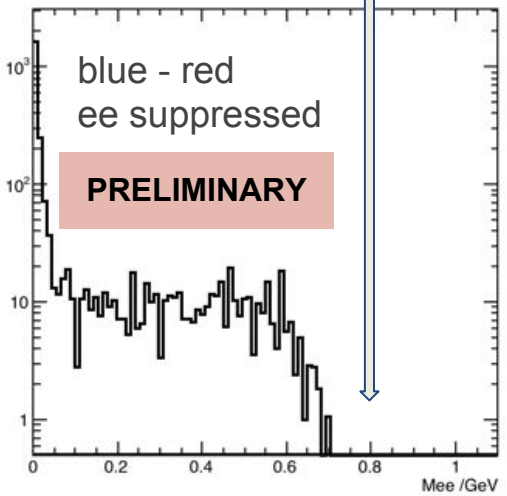


missing mass (p)

mass (ee)



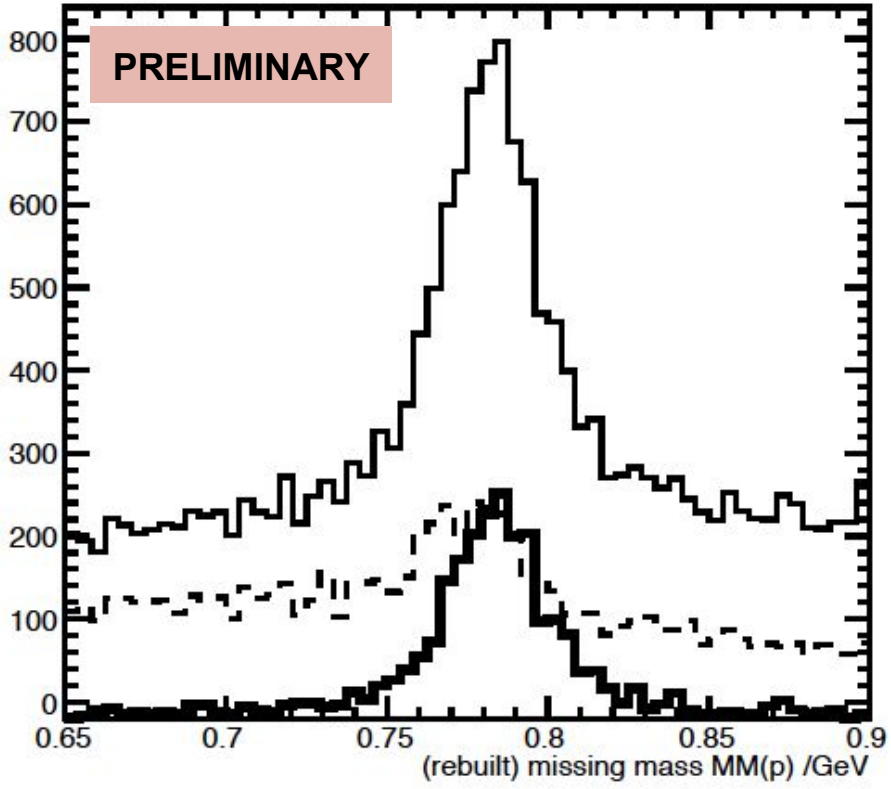


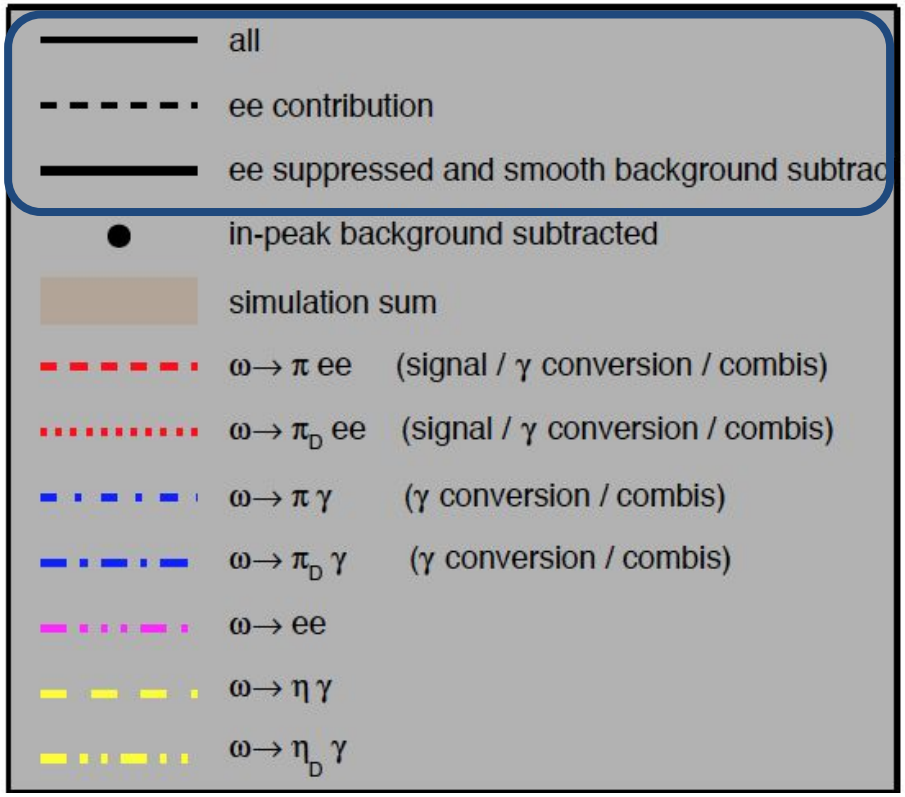


contribution from ρ/ω→ee could cause excess yield

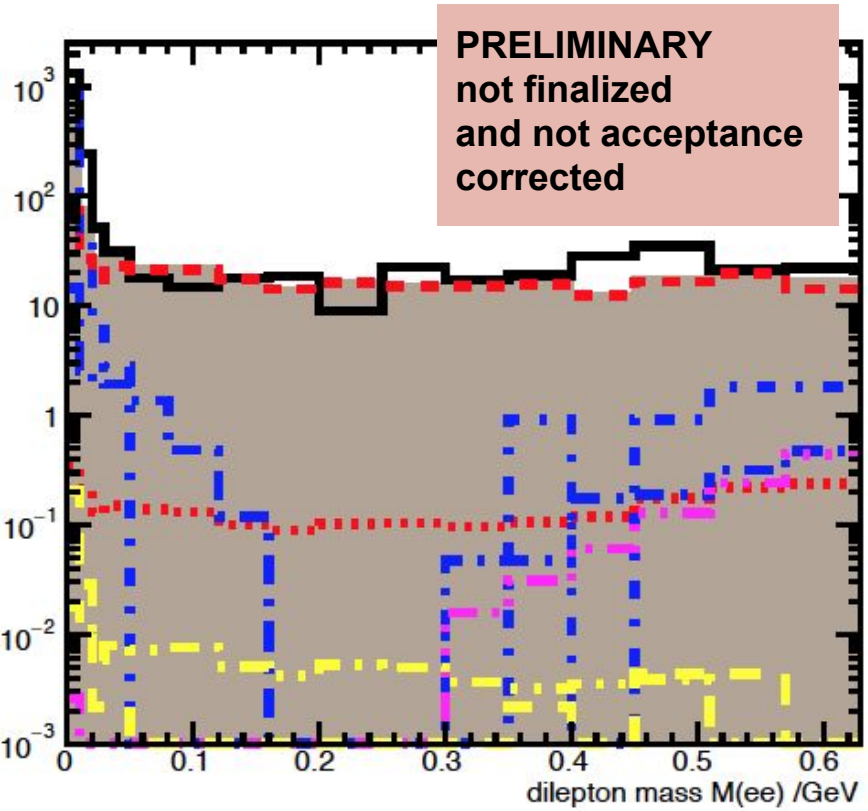
ω→πee candidates

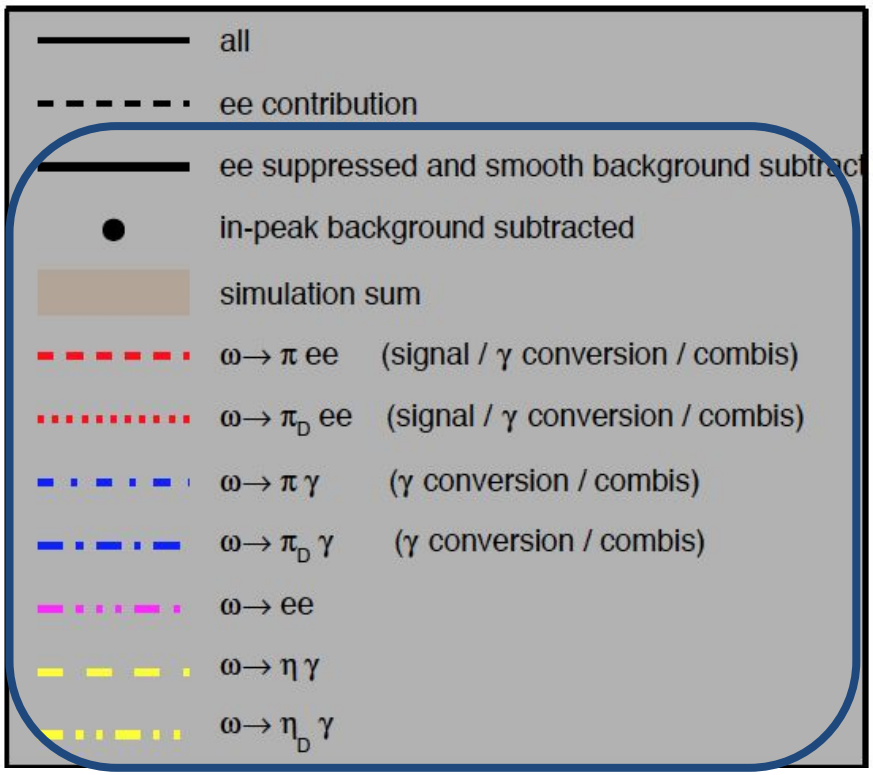
bin-wise subtraction of smooth background (in bins of Mee)





ω→πee candidates





- **preliminary**
  - cut-based and exploratory analysis
  - in-peak background strongly reduced
- **statistics**
  - external conversion dominates the branching ratio
  - limited in ROI----------→ thinking about proposal for CLAS12
- **combinatorics**
  - tendency for combinatorics seen

preliminary conclusion

trend: no excess yield at large masses