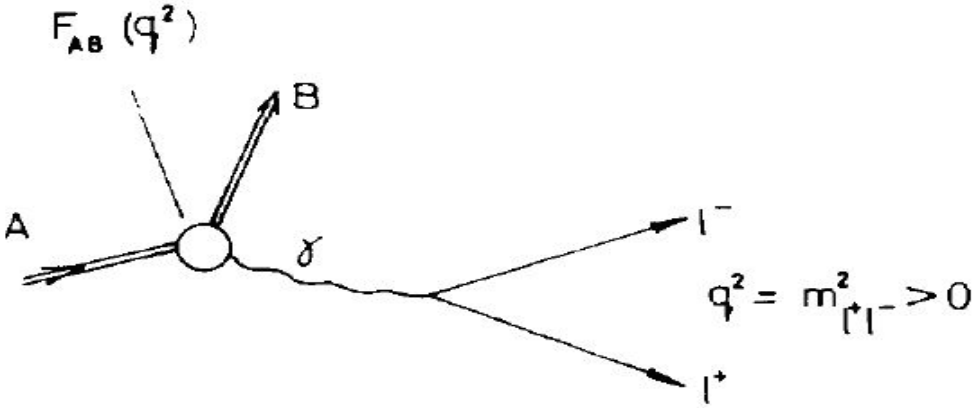
update on the $\omega \to \pi^0 e^+ e^-$ analysis

Susan Schadmand, IKP
hadron spectroscopy session
CLAS collaboration meeting
June, 2016, Jefferson Lab

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

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

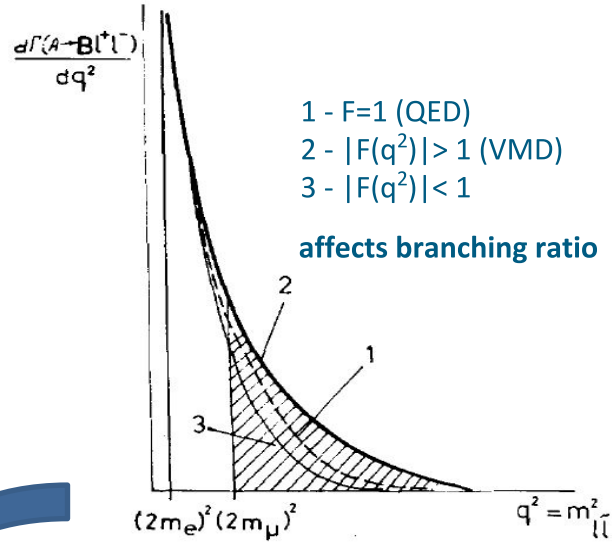
$$\Lambda \simeq m_\rho \ (\Lambda^{-2} = b_{AB})$$

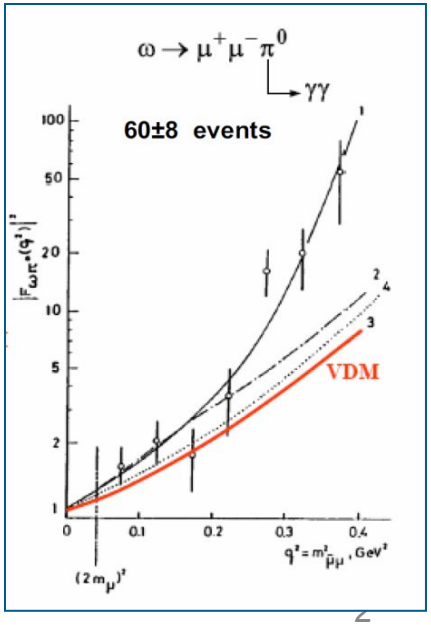
'standard' VMD

slope parameter

size (transition region)

L.G. Landsberg, Electromagnetic decays of light mesons





2015 Review of Particle Physics.
Please use this CITATION: K.A. Olive *et al.*(Particle Data Group), Chin. Phys. C, **38**, 090001 (2014) and 2015 update.

PARAMETER Λ IN $\omega \to \pi^0\mu^+\mu^-$ DECAY

INSPIRE search

In the pole approximation the electromagnetic transition form factor for a resonance of mass M is given by the expression: $|F|^2 = (1 - M^2/\Lambda^2)^{-2}$, where for the parameter Λ vector dominance predicts $\Lambda = M_\rho \approx$ 0.770 GeV. The ARNALDI 2009 measurement is in obvious conflict with this expectation. Note that for $\eta \to \mu^+\mu^-\gamma$ decay ARNALDI 2009 and DZHELYADIN 1980 obtain the value of Λ consistent with vector dominance.

Value (GeV)	EVTS	Document ID		TECN	Comment
$0.668 \pm 0.009 \pm 0.003$	3k	ARNALDI	2009	NA60	158A In−In collisions
*** We do not use the following data for averages, fits, limits, etc ***					
0.65 ± 0.03		DZHELYADIN	1981B	CNTR	25−33 π^- $p \to \omega n$

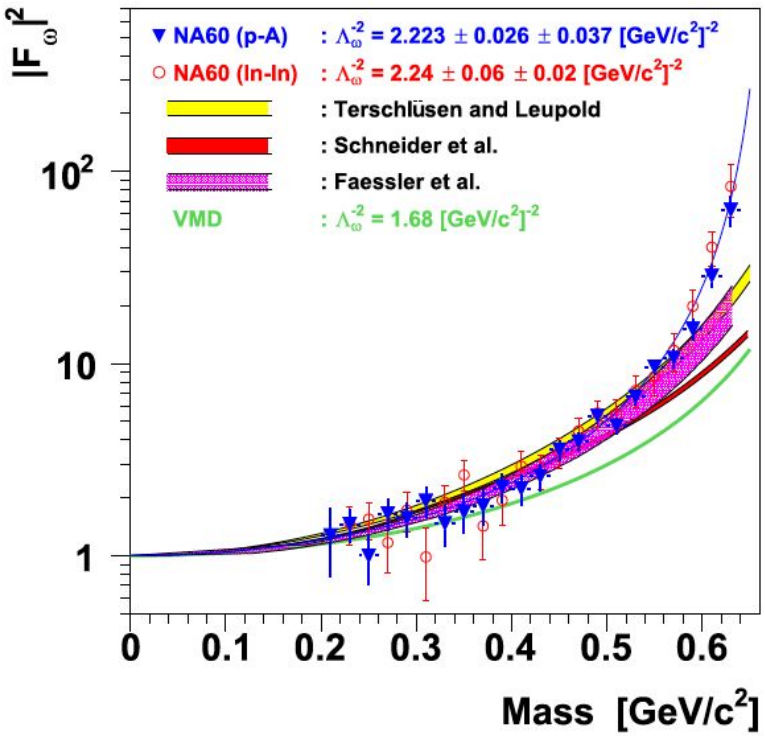
References

ARNALDI	2009	PL B677 260	Study of the Electromagnetic Transition Form-Factors in $\eta \to \mu^+\mu^-\gamma$ and $\omega \to \mu^+\mu^-\pi^0$ Decays with NA60
DZHELYADIN	1981B	PL 102B 296	Study of the Electromagnetic Transition Formfactor in $\omega \to \pi^0\mu^+\mu^-$ Decay

status of the ω-π transition form factor

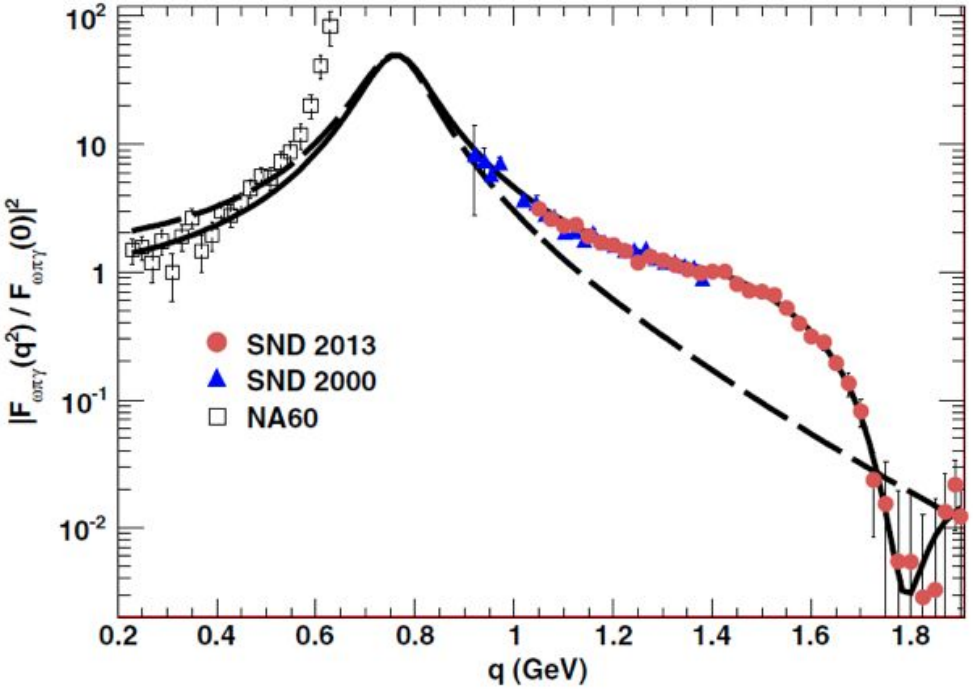
Physics Letters B 757 (2016) 437–444

Precision study of the $\eta \to \mu^+\mu^-\gamma$ and $\omega \to \mu^+\mu^-\pi^0$ electromagnetic transition form-factors and of the $\rho \to \mu^+\mu^-$ line shape in NA60



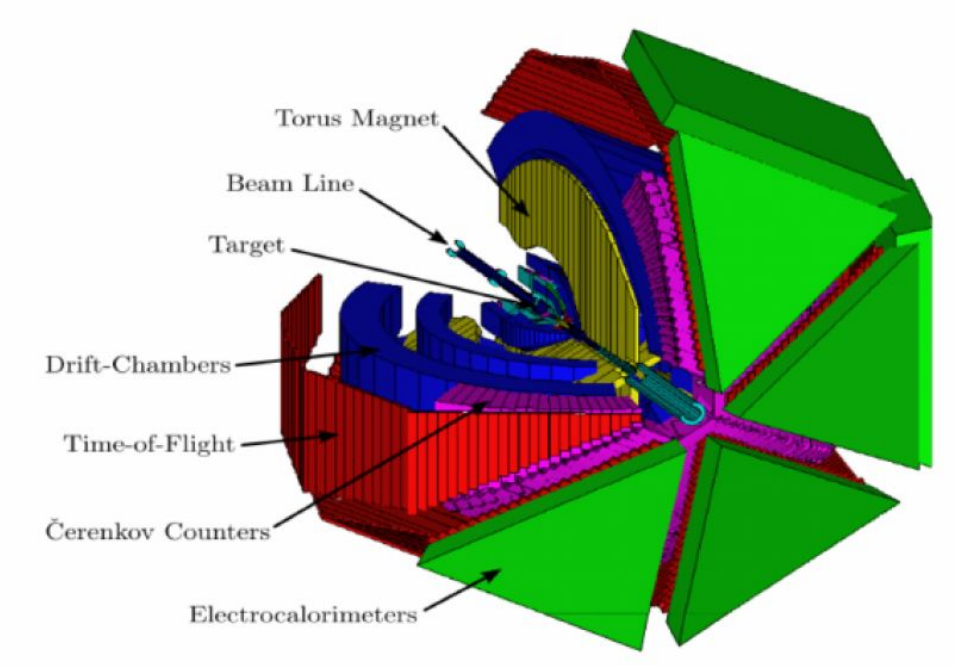
Phys.Rev. D88 (2013) 054013

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



→ study ω decay with CLAS g12

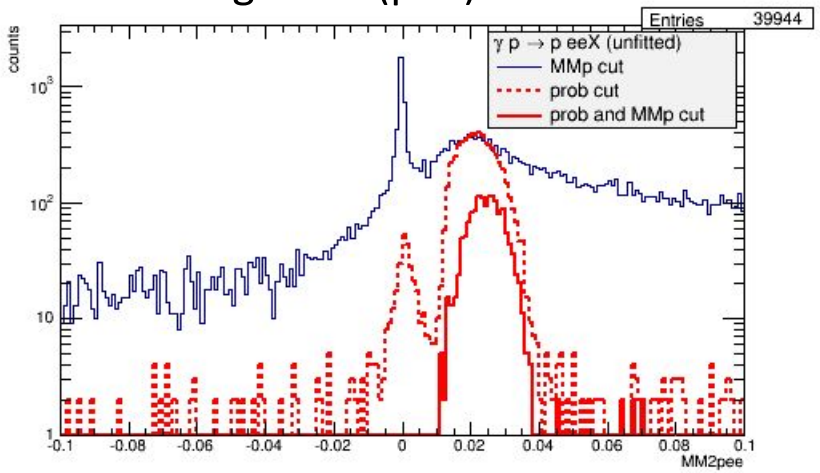
CLAS g12 experiment



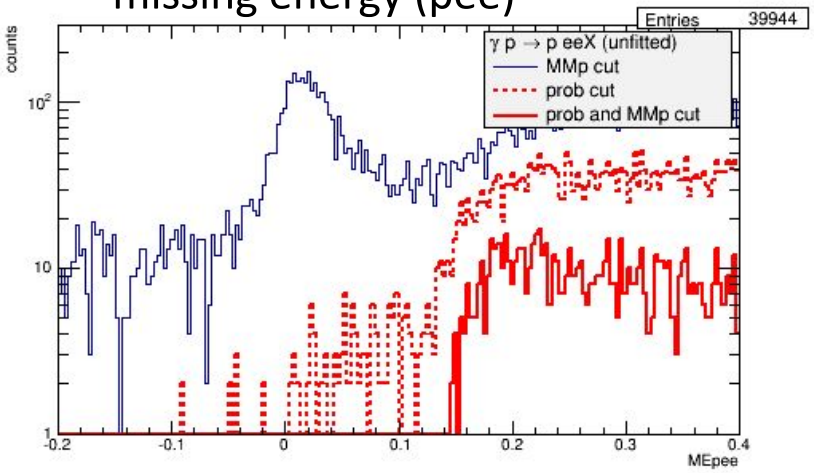
CLAS g12 setup	
LH_2 target	main source for *external γ conversion*
Cerenkov Counters	excellent *dilepton identification*
EM calorimeter	particle identifcation photon detection

towards the ω-π transition form factor

missing mass (pee)



missing energy (pee)



kinematic fit for CLAS g12 dileptons

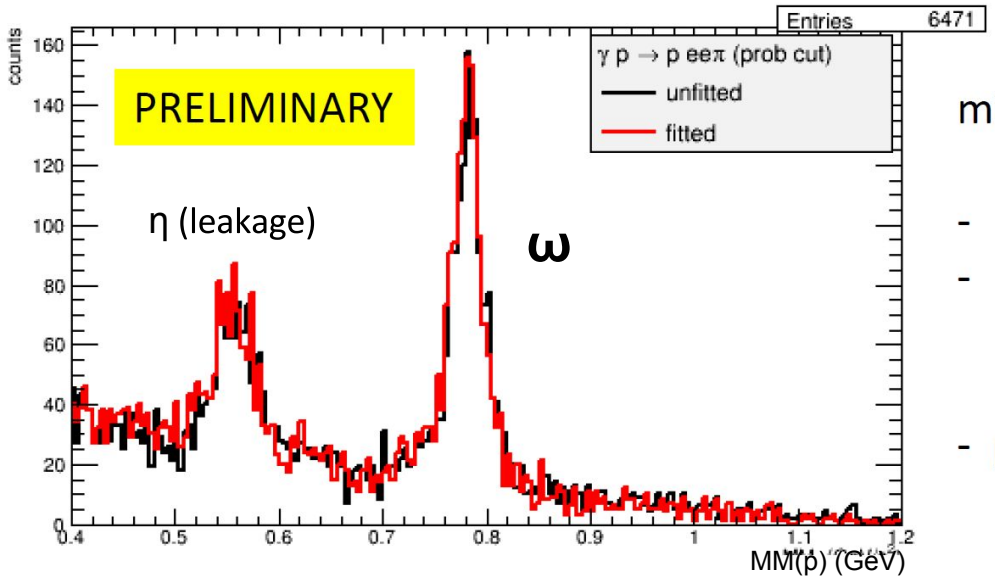
analysis strategy:
e+e- detection
and missing particle

missing pion: **ω→πee**
- missing mass is pion mass
- missing energy

missing photon: **η(´)→γee**
- missing mass zero
- missing energy

missing nothing: **ρ/ω→ee**
- missing mass and nergy zero

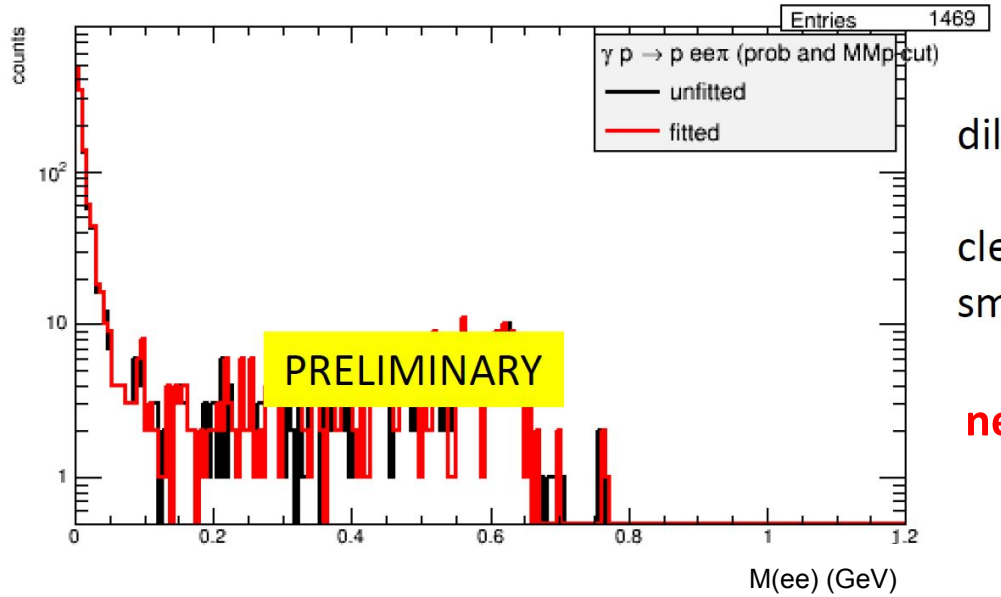
towards the ω-π transition form factor



missing mass (p)

- smooth background
- in-peak background:
  competing decays
  photon external conversion
- peaking background?

not background subtracted
not acceptance corrected



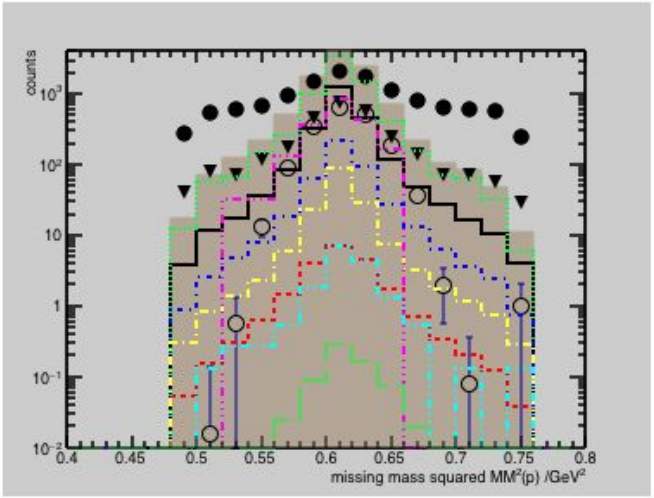
dilepton mass

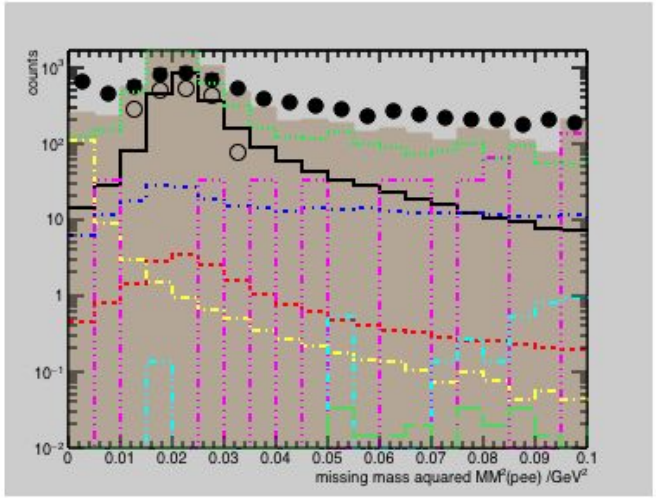
clearly dominated by background
small masses: external conversion

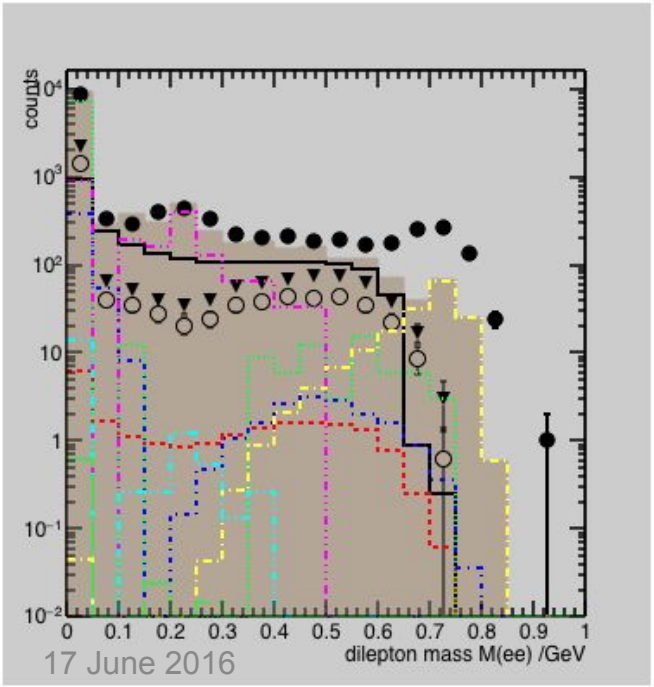
next step: background study

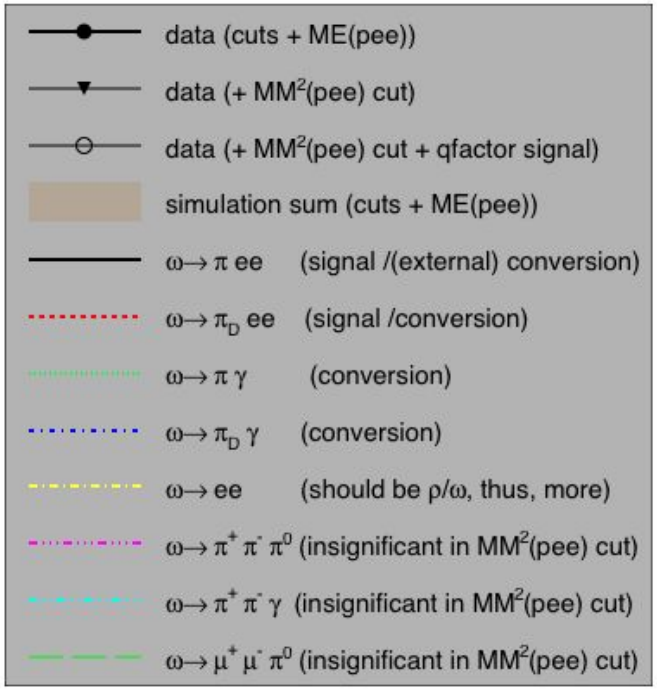
snapshot background study

CLAS g12 PRELIMINARY I $\omega \to \pi^0 e^+e^-$ I cut-based analysis: background study









- dilepton skim
- cut based (w/o kin. fit)
- cuts:
  - LepG7
  - beta leptons
  - vertex
  - MM(p) window

simulations,
PLUTO event generator

so far, 'only' omega decays

issues:

- conversion
- combinatorics
- MM(pee) cut

PRELIMINARY:
this is not done yet
(need more simulations,
no corrections,
analysis not finalized,
...)

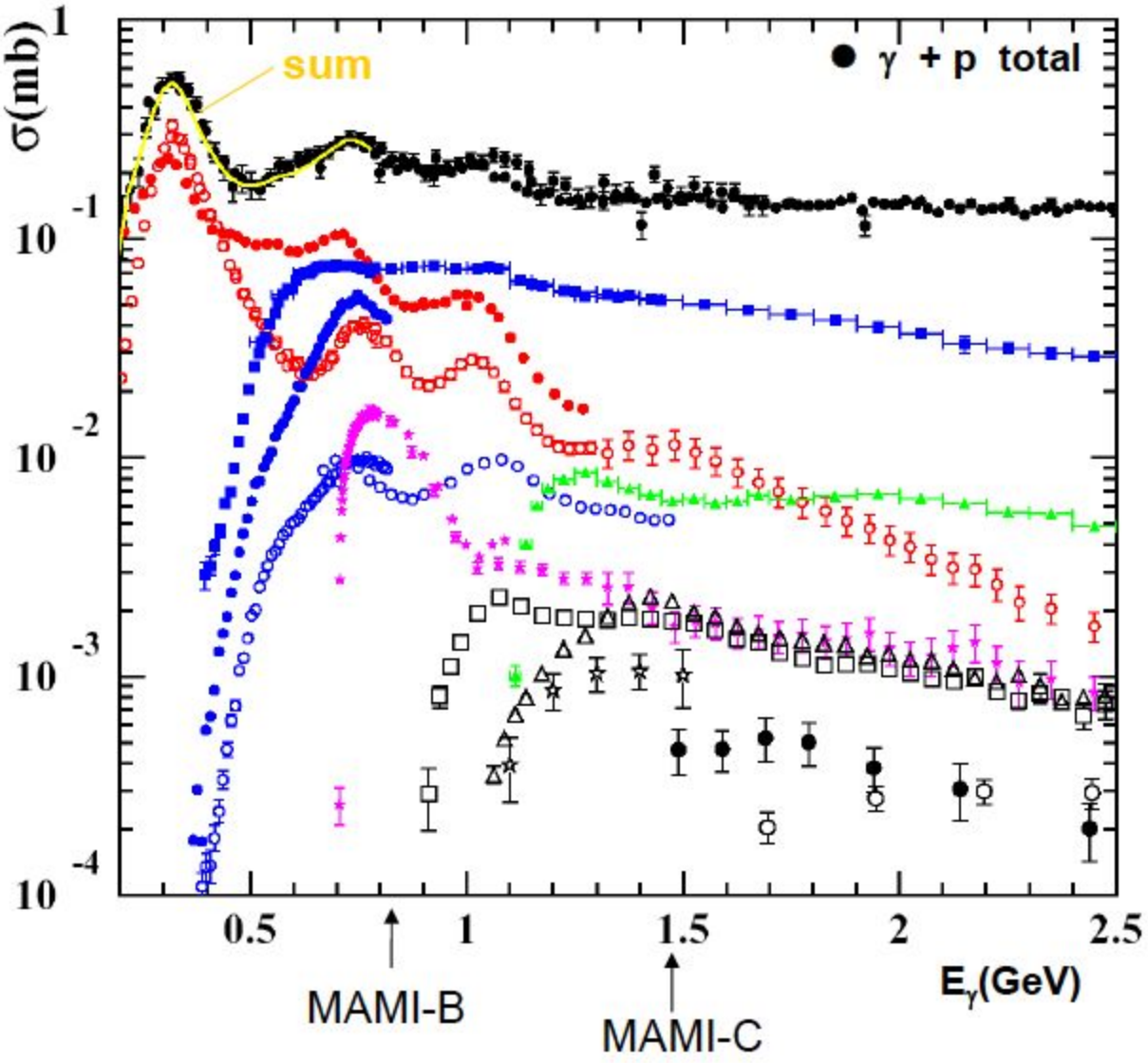
next steps

- more simulations (background not from ω decays)
- different methods:
  - cut based analysis
  - kinematic fit
  - qfactor background subtraction
- compare/combine methods (⇨ systematic errors)
- acceptance correction
- extract transition form factor

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)
1	$\pi^+\pi^-\pi^0$	(89.2 ±0.7) %		327
2	$\pi^0\gamma$	(8.28±0.28) %	S=2.1	380
3	$\pi^+\pi^-$	($1.53^{+0.11}_{-0.13}$) %	S=1.2	366
4	neutrals (excluding $\pi^0\gamma$)	(8^{+8}_{-5}) × 10^{-3}	S=1.1	–
5	$\eta\gamma$	(4.6 ±0.4) × 10^{-4}	S=1.1	200
6	$\pi^0 e^+ e^-$	(7.7 ±0.6) × 10^{-4}		380
7	$\pi^0\mu^+\mu^-$	(1.3 ±0.4) × 10^{-4}	S=2.1	349
8	e^+e^-	(7.28±0.14) × 10^{-5}	S=1.3	391
9	$\pi^+\pi^-\pi^0\pi^0$	< 2 × 10^{-4}	CL=90%	262
10	$\pi^+\pi^-\gamma$	< 3.6 × 10^{-3}	CL=95%	366
	$\pi^+\pi^-\pi^+\pi^-$	< 1 × 10^{-3}	CL=90%	256
	$\pi^0\pi^0\gamma$	(6.6 ±1.1) × 10^{-5}		367
	$\eta\pi^0\gamma$	< 3.3 × 10^{-5}	CL=90%	162
	$\mu^+\mu^-$	(9.0 ±3.1) × 10^{-5}		377
	3γ	< 1.9 × 10^{-4}	CL=95%	391
	Charge conjugation (C) violating modes			
	$\eta\pi^0$	C < 2.1 × 10^{-4}	CL=90%	162
	$2\pi^0$	C < 2.1 × 10^{-4}	CL=90%	367
	$3\pi^0$	C < 2.3 × 10^{-4}	CL=90%	330

Photoproduction from the Proton



SAPHIR (Bonn)
CBELSA (Bonn)
DAPHNE, TAPS (Mainz)
GRAAL (Grenoble)
CBELSA/TAPS (Bonn)

● π+
○ π°

■ π+ π-
● π+ π°
○ π° π°

★ η
▲ ω

□ K+ Λ
△ K+ Σ°
✡ K° Σ

● η'
○ φ

S. Schadmand *(ca 2004)*