Coherent ω-Meson Photoproduction off Deuterium from CLAS

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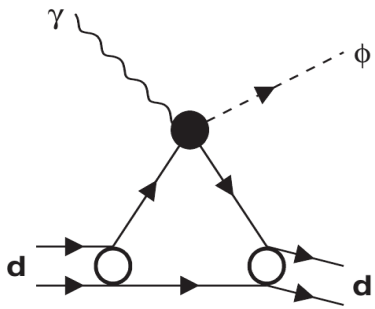
Outline

- **Motivation**
- **CLAS Detector**
- **Particle Identification**
- **Yield Extraction**
- **Preliminary Results**
- **Summary**

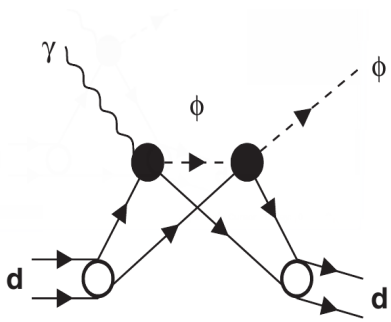
Motivation

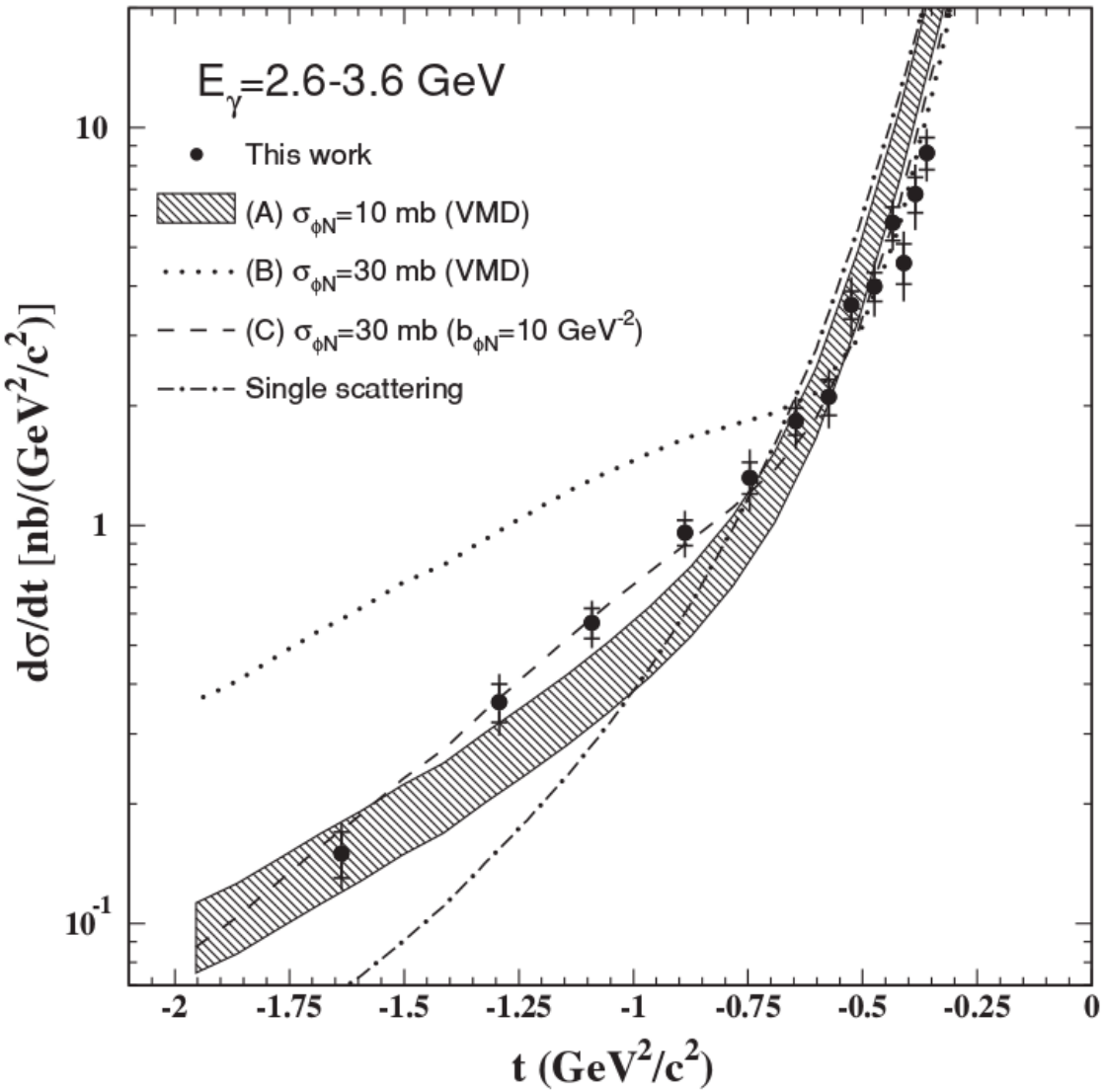
$\gamma d \rightarrow \varphi d$

Single scattering



Double scattering





Mandelstam *t* :

$$t = (P_\gamma - P_\varphi)^2 = (P_{d_i} - P_{d_o})^2$$

T. Mibe *et al.* PHYSICAL REVIEW C 76, 052202(R) (2007)

Motivation

Reaction of interest

$$\gamma d \rightarrow \omega d \rightarrow \pi^+ \pi^- \pi^0 d \quad (88.8\%)$$

Limited World Data

- Photoproduction of omega mesons off Deuteron: limited studies → limited world data.

Group	E_γ [GeV]	t [GeV/c^2]	Comments
Gupta *et. al.* [SLAC] Phys. Rev. D 14, 42 (1976)	5.5	-	Low statistics. No mass fit was possible
Morris *et. al.* [NINA] Nuclear Physics B119 (1977)	3.9	-	*Total Cross-section measured: 1.4 ± 0.5 μb *Coupling constant ratio (rho/omega) measured

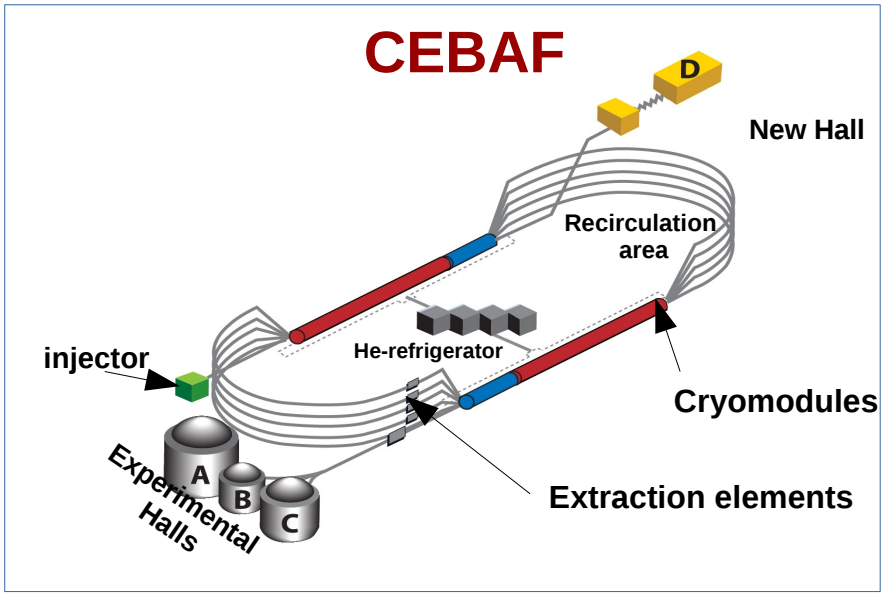
Photon Coupling ratio of the vector mesons:

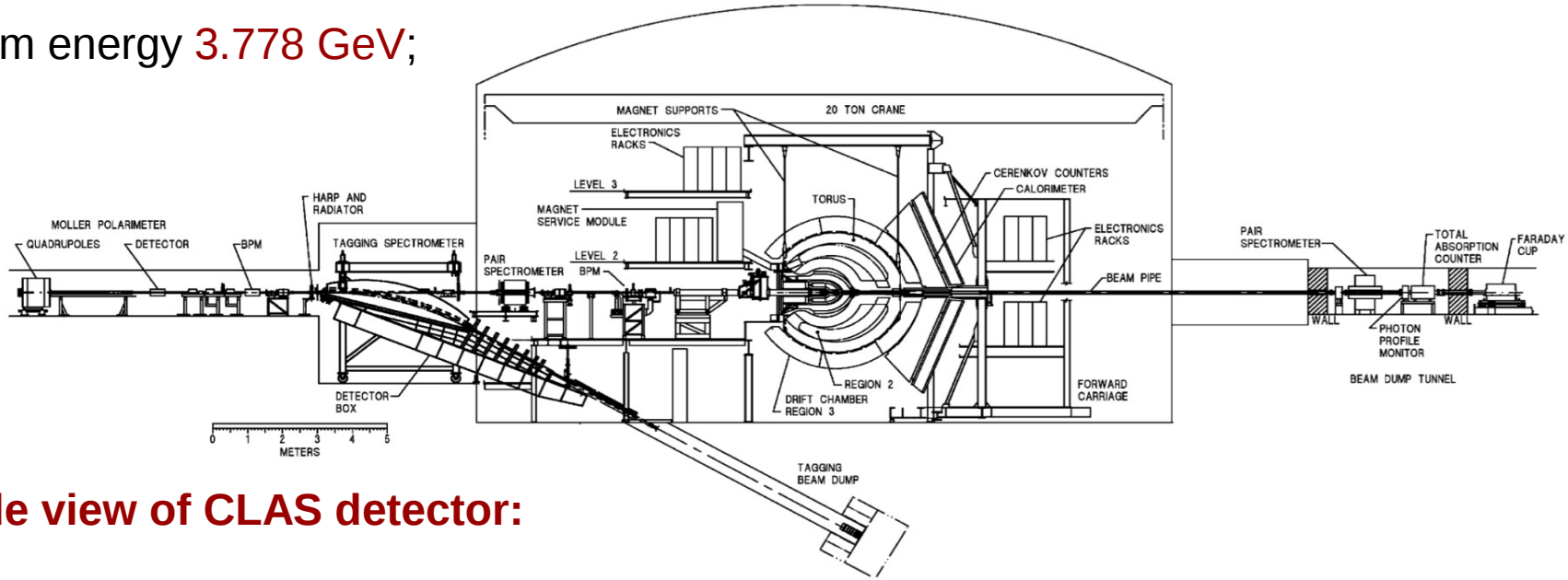
$$\gamma_\rho : \gamma_\omega : \gamma_\varphi = 1 : 3 : -3/\sqrt{2}$$

- Assuming SU(3) and SU(6) symmetry.
- The Coupling constants provide understanding for EM form factors of pseudo-scalar mesons and nucleons, EM meson decays, etc.
- Better understanding of the Current-field identity.

CLAS Detector

- JLAB: Newport News, VA;
- CEBAF: accelerated electrons up to 6 GeV;
- Experimental Halls: A, **B**, C and D;
- Hall B: electron or photon beam;
- Data from *g*10 run period (Spring, 2004);
- Target: 24 cm long liquid deuterium at Z = -25 cm;
- Electron beam energy 3.778 GeV;



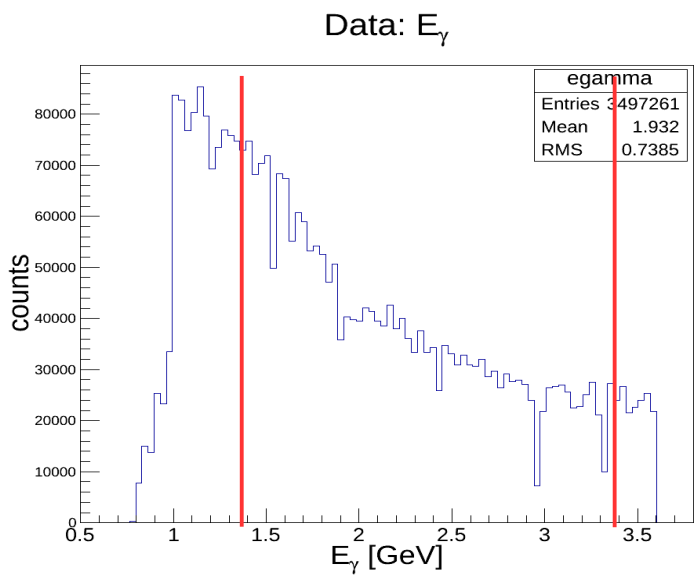


Side view of CLAS detector:

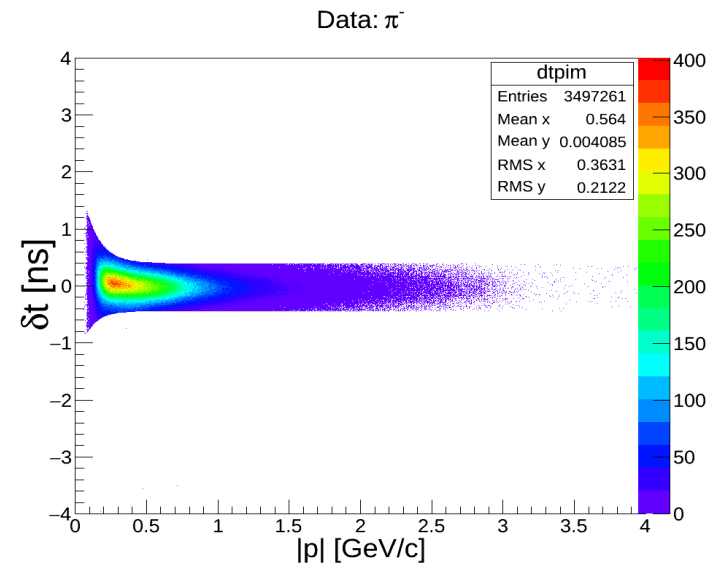
B. A. Mecking *et al.*, NIM in PhysicsResearch A, 3:513–533, 2003

Particle Identification

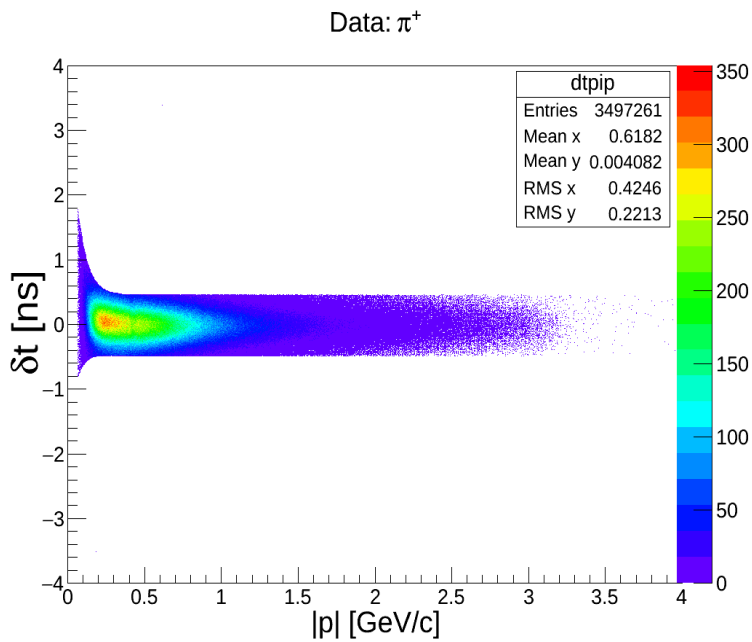
E_γ



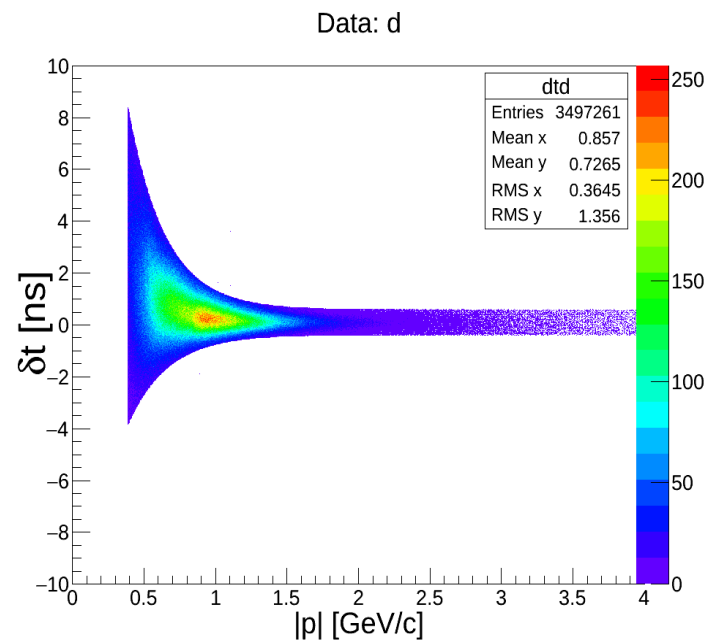
π^-



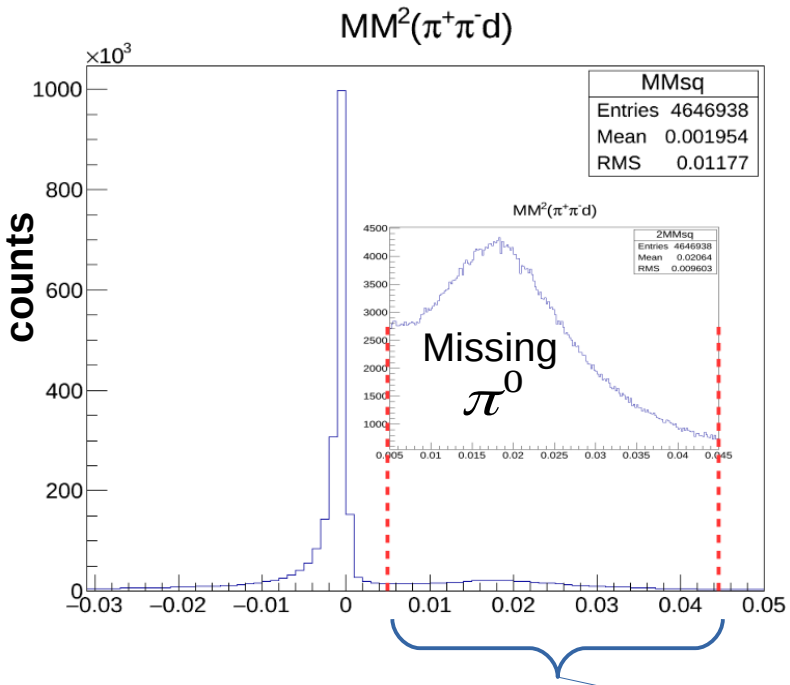
π^+

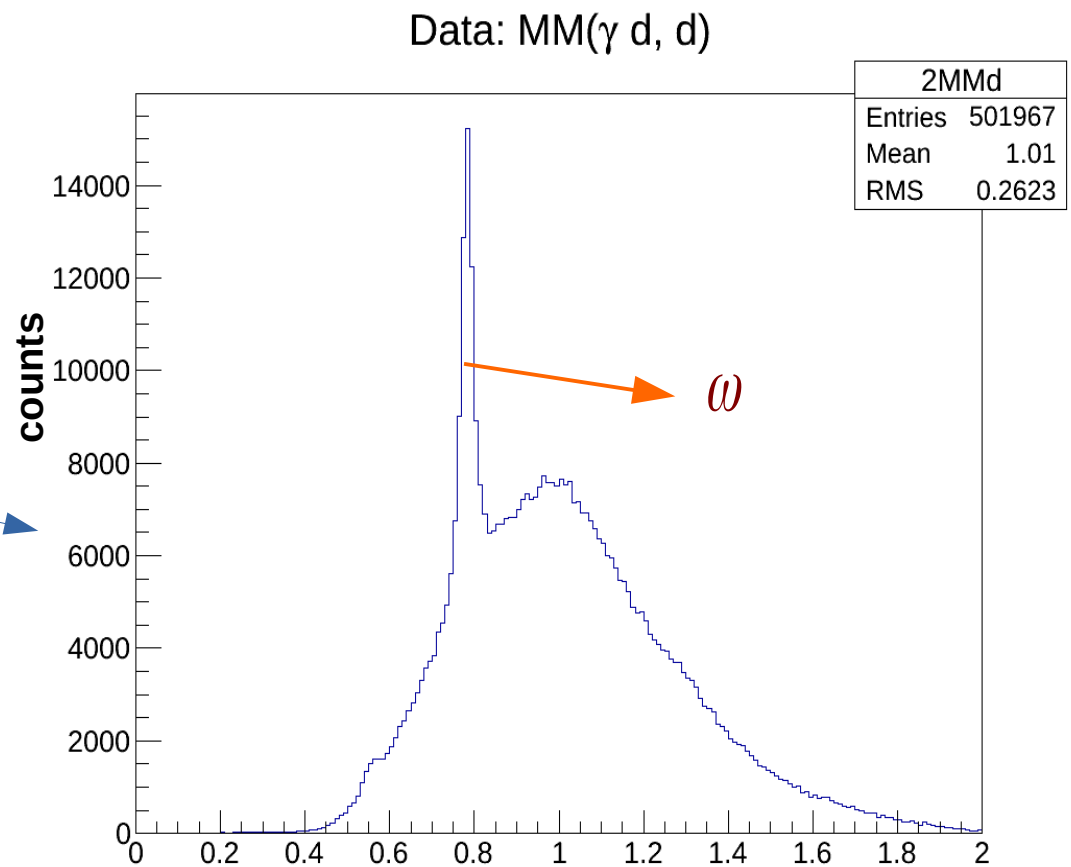


d



Global Spectrum



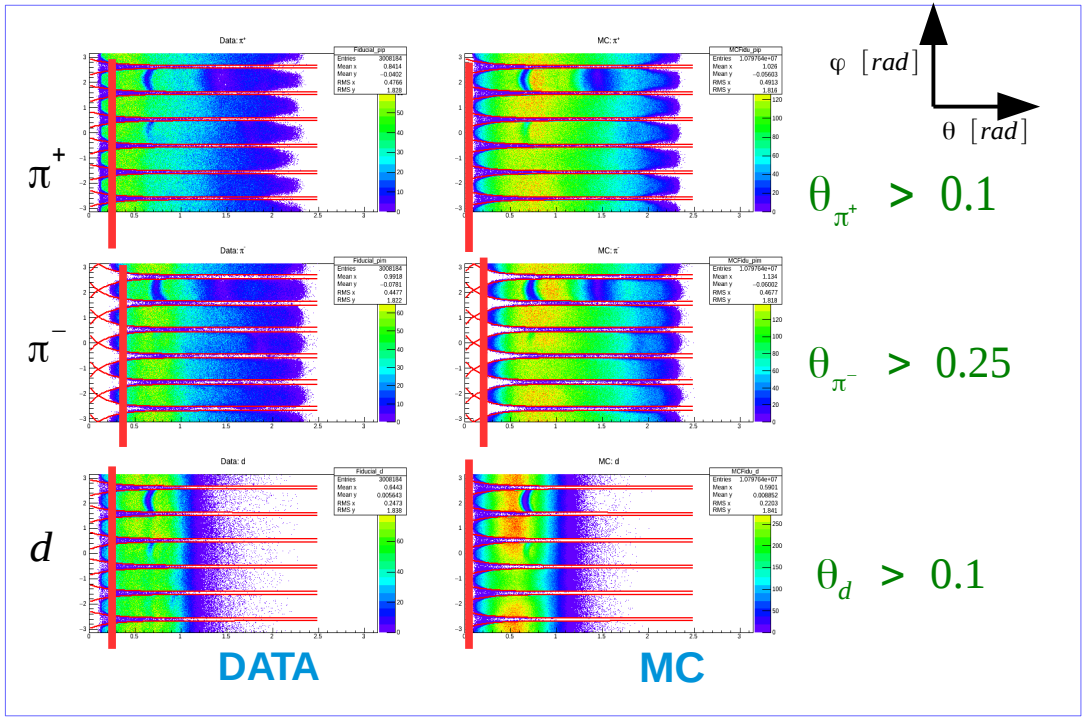


$$\gamma d \rightarrow \omega d$$

$$\omega \rightarrow \pi^+ \pi^- \pi^0 \ (88.8\%)$$

Cuts Applied

- Timing cuts made using momentum-dependent analysis
- $-40\,cm < z_{vertex} < -10\,cm$
- $-0.01 < MM^2 < 0.005 \quad [GeV^2/c^4]$
- Theta cut applied
- Fiducial cuts applied $\varphi = a e^{b\theta} + c$
- Paddle Cuts

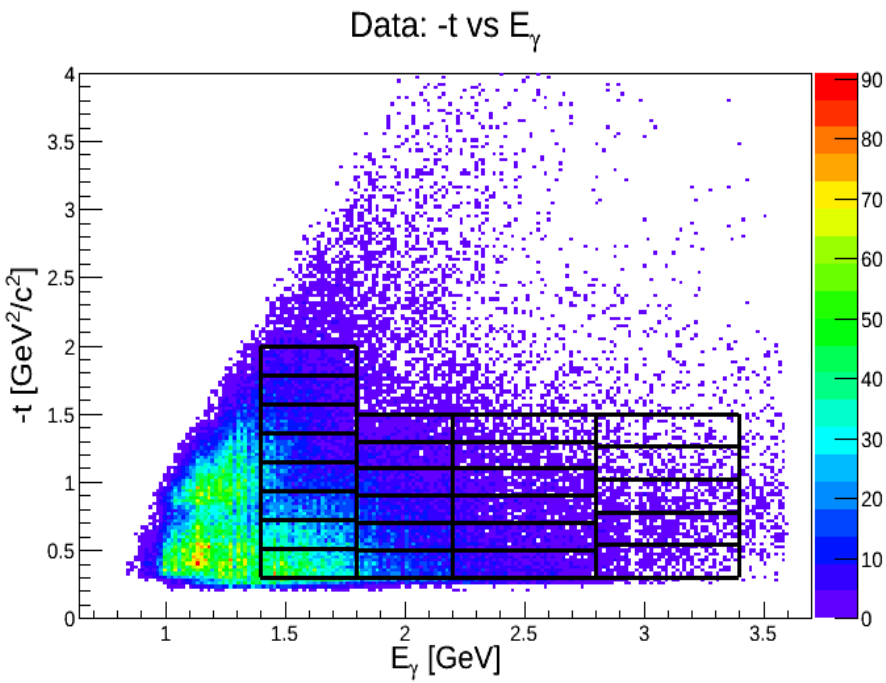


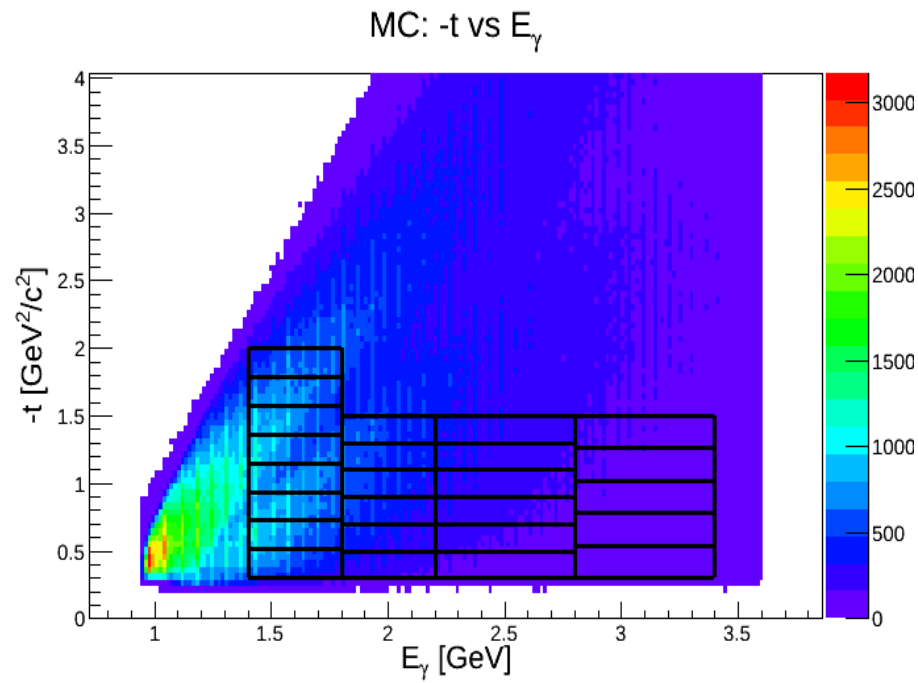
Particle	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6
π^+	23, 27 ≥ 43	≥ 45	11, 23, 31 ≥ 40	23, 33, 35 ≥ 46	23, 29 ≥ 46	23 ≥ 45
π^-	23, 27 ≥ 41	≥ 41	11, 15, 16, 23, 34-36 ≥ 41	23, 27, 35 ≥ 43	20, 23, 29 ≥ 43	23 ≥ 42
d	23, 27 ≥ 35	23 ≥ 35	11, 22, 23 ≥ 35	23 ≥ 35	23 ≥ 35	23 ≥ 35

- Energy range: $1.4 < E_\gamma < 3.4 \quad [GeV]$

Binning

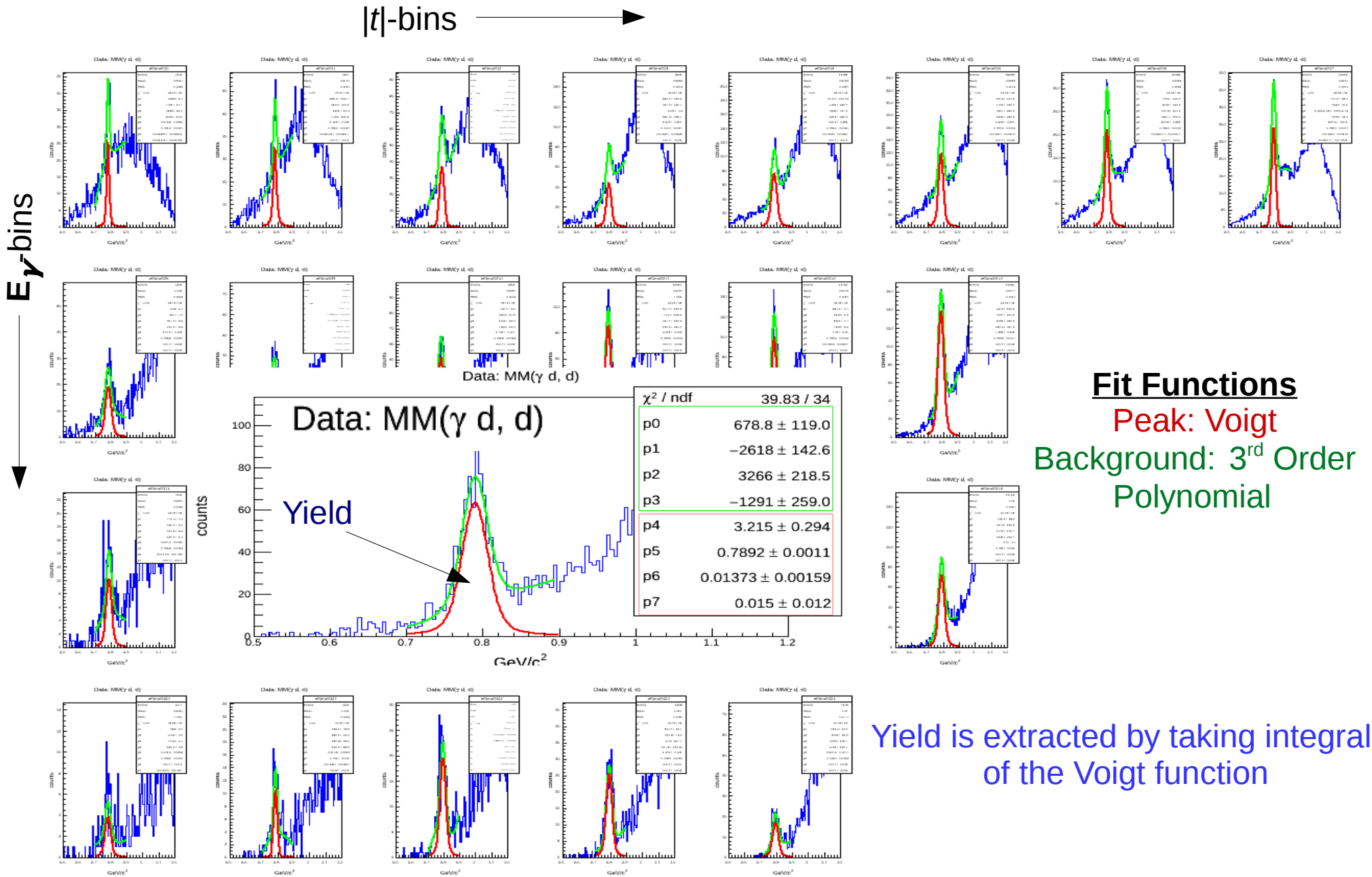
$$0.069 < MM(\gamma d, d') < 0.91 \quad [GeV/c^2]$$





E_{photon} [GeV]	*t*-bins	$-t_{min}$ [GeV^2]	$-t_{max}$ [GeV^2]
1.4-1.8	8	2.0	0.3
1.8-2.2	6	1.5	0.3
2.2-2.8	6	1.5	0.3
2.8-3.4	5	1.5	0.3

Yield Extraction



Fit Functions

Peak: Voigt

Background: 3rd Order Polynomial

Yield is extracted by taking integral of the Voigt function

Differential Cross-section

PRELIMINARY

Differential cross-section,

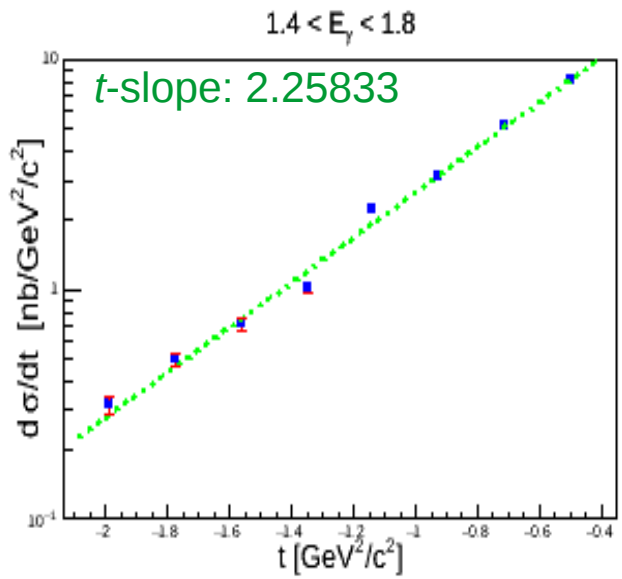
$$\frac{d\sigma}{dt} = \frac{Yield}{(\delta t)\epsilon L(E_\gamma)}$$

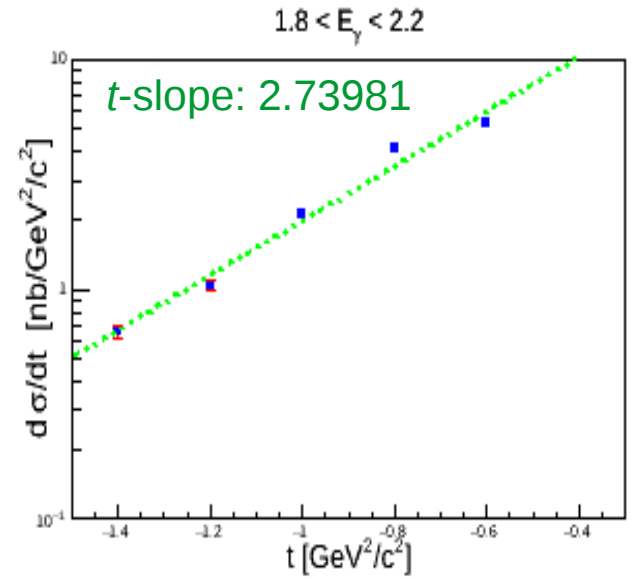
$\epsilon \equiv Detector\ Acceptance$
~ 0.17

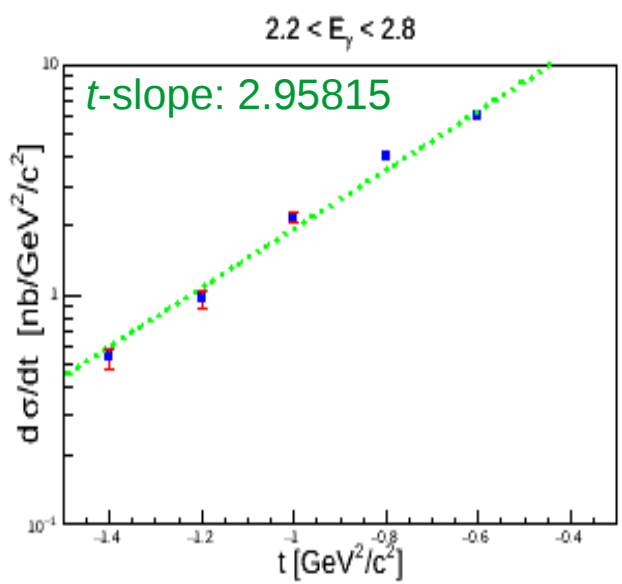
Luminosity,

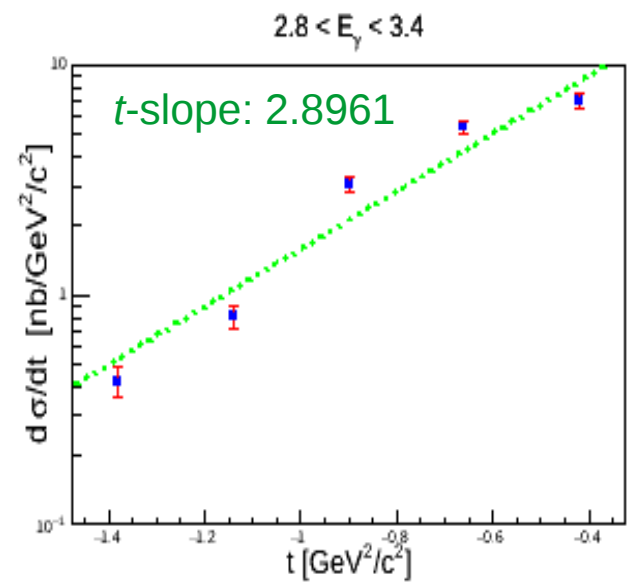
$$L(E_\gamma) = \frac{\rho_d N_A l_d}{M_d} N_\gamma(E_\gamma)$$

$\rho_d = 0.169\ gcm^{-3}$
$l_d = 24\ cm$
$M_d = 2.014\ g\,mole^{-1}$
$N_\gamma =$ Photon Flux









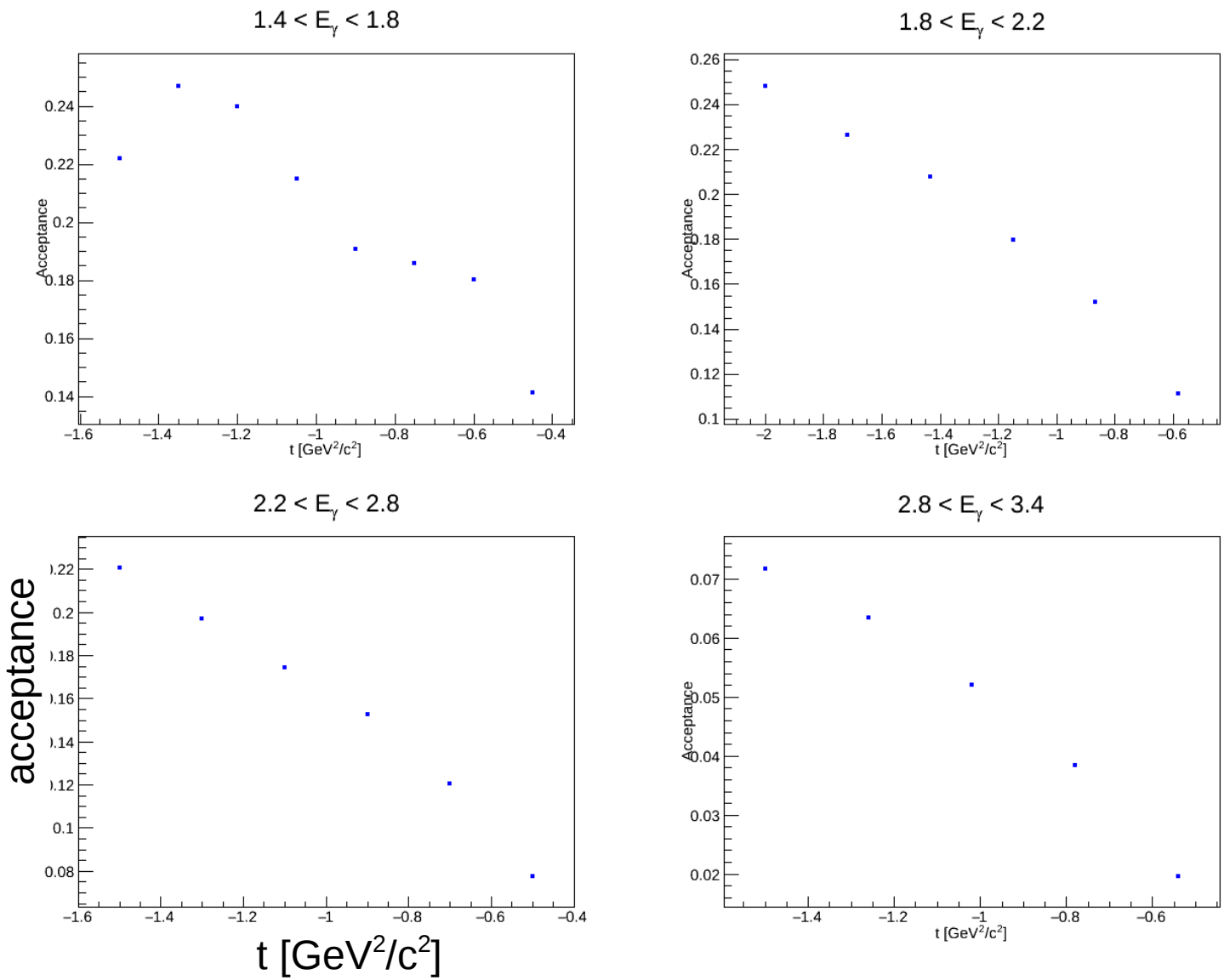
PRELIMINARY

Summary

- The cross-section data provides sensitivity to the nucleon-scattering data in the energy and momentum transfer range mentioned.
- First high statistics world data for the reaction: $\gamma d \rightarrow \omega d$
- Double scattering contribution.
- Next steps would include:
  - Study of systematic uncertainties.
  - Calculate the ratio of photon-vector meson coupling constant.
  - Comparison with a theoretical model.

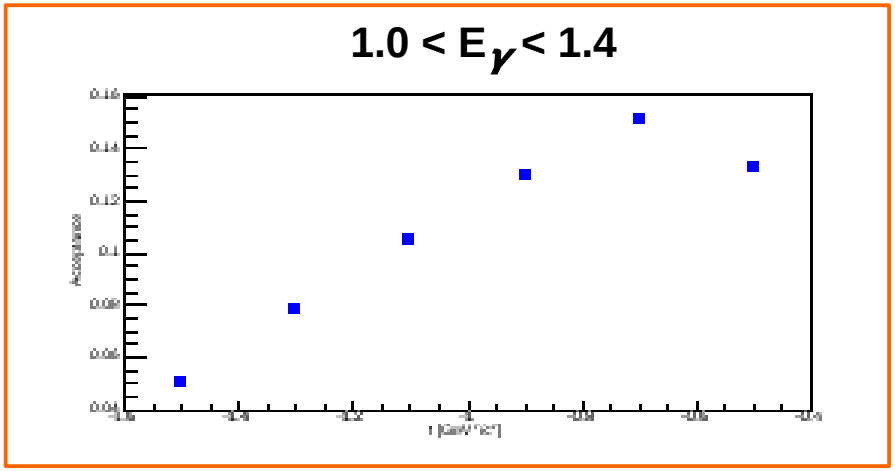
Acceptance

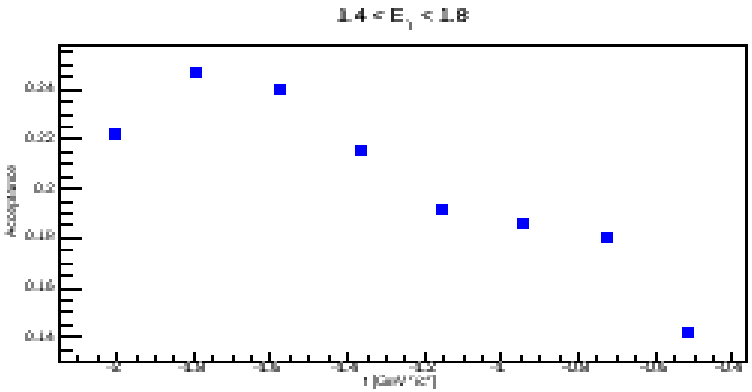
Back-up

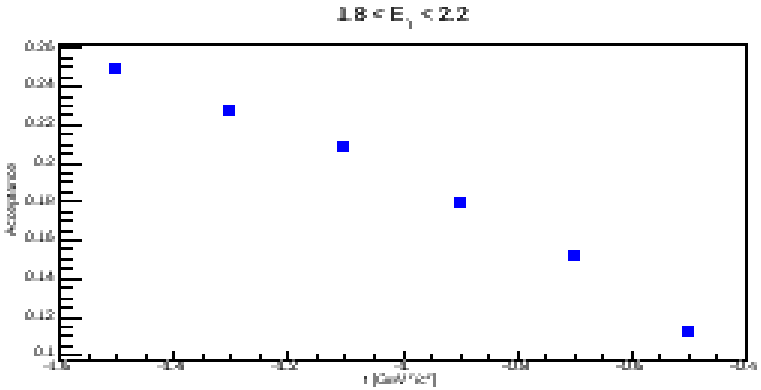


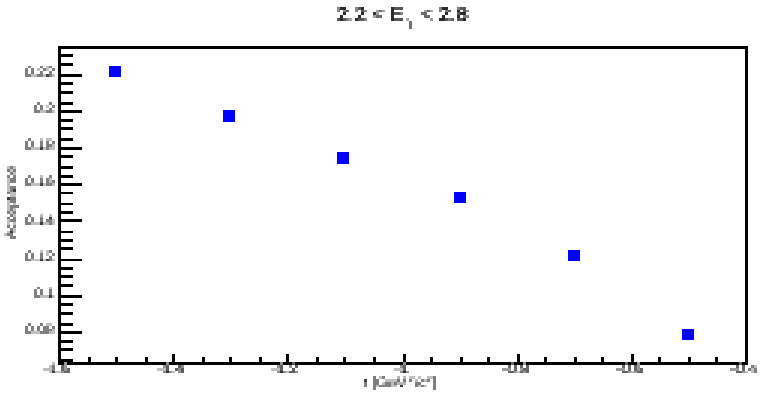
Acceptance

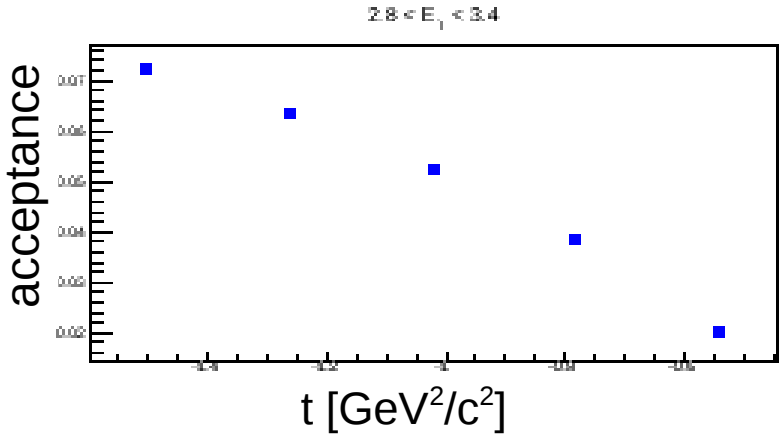
Back-up











1.0 < E$_\gamma$ < 1.4 excluded.

Need to investigate the unusual acceptance.

Previous Studies

Back-up

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