

Proposal to the PAC

Mesurement of the Σ beam asymmetry in

$$\gamma + p \rightarrow \eta' + p$$

The BGO-OD Collaboration

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Dal proposal di fisica al PAC ($\gamma p \mapsto \eta' p$)

G. Mandaglio

26 Giugno 2013 – Roma Tor Vergata – GM MAMBO

Brevemente...

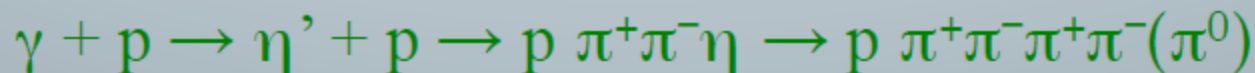
- **Ciò che è stato presentato al PAC**
(G. Mandaglio e P. Levi Sandri)
- **Ciò che è stato fatto in seguito**
(G. Mandaglio , P. Levi Sandri, F. Curciarello, V. De Leo)
- **Ripercussioni dei nuovi studi sulla fattibilità della misura a BGO-OD**

Recent η' data off the proton

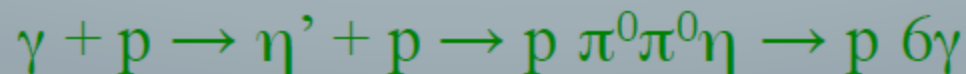
the threshold energy for $\gamma + p \rightarrow \eta' + p$ is $E_\gamma = 1.447$ GeV

the reaction was measured

at CLAS (2006 and 2009) from thr. up to 2.84 GeV by looking at



at CB-ELSA(2009) from thr. up to 2.55 GeV by looking at



all have measured $d\sigma/d\Omega$ but no polarization observables

Theory - 3

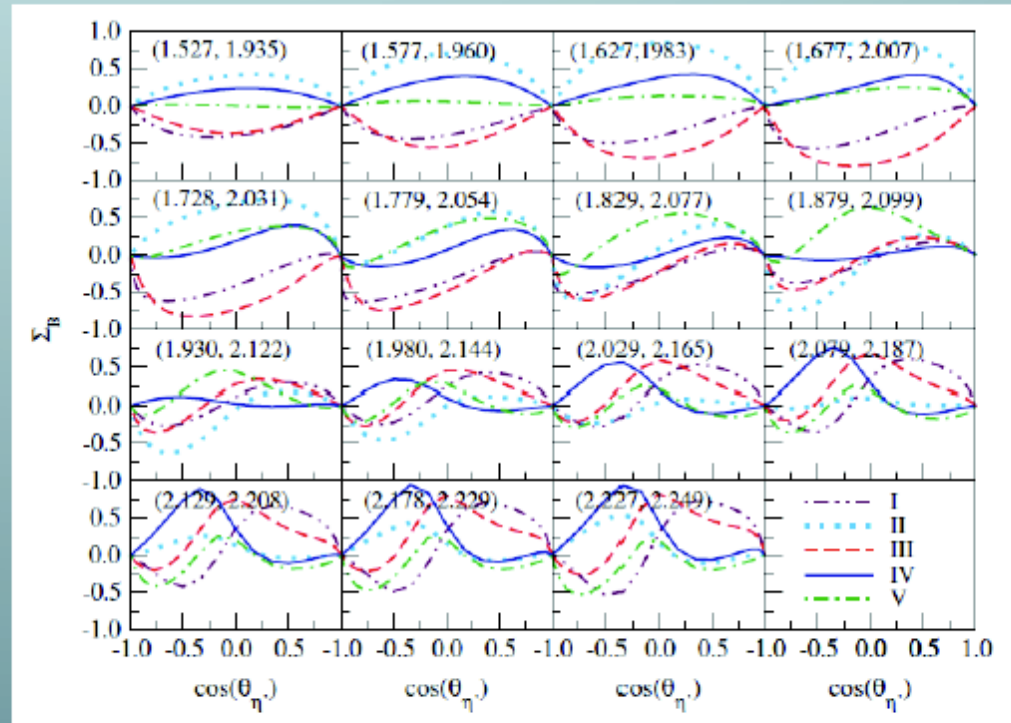
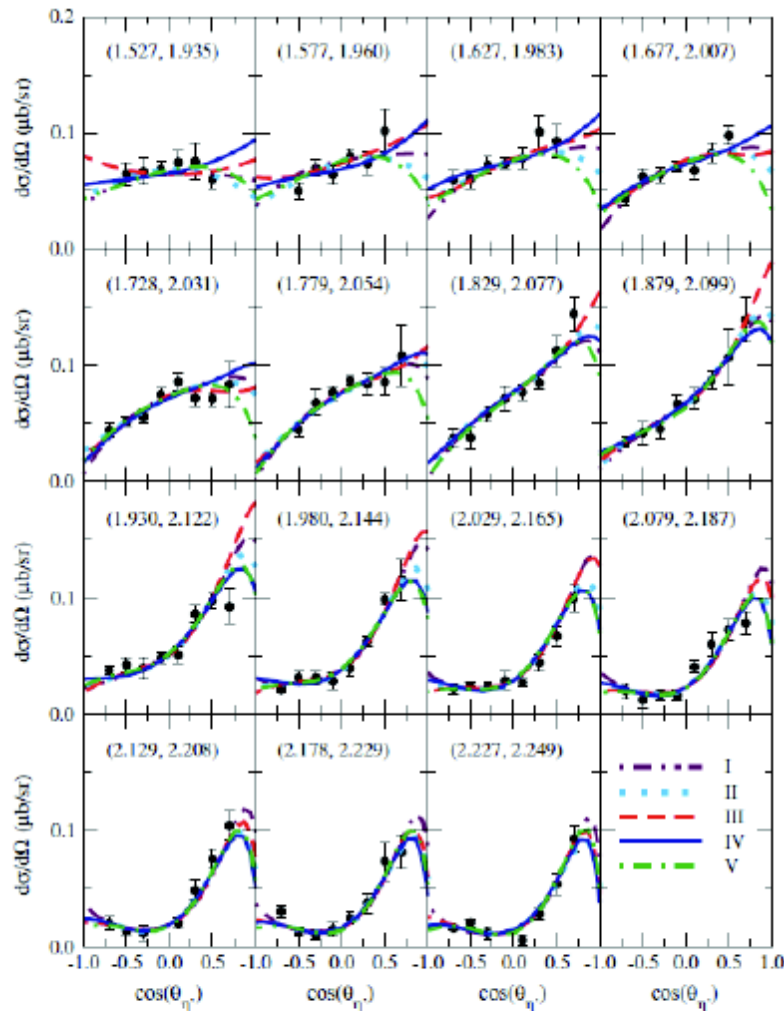
pseudo-scalar meson photoproduction is described by 4 complex helicity amplitudes

$$d\sigma/d\Omega \sim H_1^2 + H_2^2 + H_3^2 + H_4^2$$

$$\Sigma \sim \text{Re}(H_1 H_4^* - H_2 H_3^*)$$

$$T \sim \text{Im}(H_1 H_2^* - H_3 H_4^*)$$

$$P \sim \text{Re}(H_1 H_3^* - H_2 H_4^*)$$



count rates

$$n_{\eta'} = N_0 \rho x / A \cdot N_{\gamma} \cdot d\sigma/d\omega \cdot \Delta\Omega \cdot \Gamma \cdot \varepsilon$$

$$\begin{array}{ccc} \downarrow & \downarrow & \downarrow \\ 2.5 \cdot 10^{23} & 2.5 \cdot 10^6 & 6.3 \cdot 10^{-2} \text{ (}\mu\text{b/sr)} \end{array}$$

1- $\eta' \rightarrow \pi^+\pi^-\eta \rightarrow \pi^+\pi^-\gamma\gamma$	$\Delta\Omega = 10 \text{ sr}$ $\varepsilon \approx 0.054$	$n_{\eta'} = 36.1 \cdot 10^{-4} \text{ s}^{-1}$
2- $\eta' \rightarrow \pi^0\pi^0\eta \rightarrow 6\gamma$	$\Delta\Omega = 6.7 \text{ sr}$ $\varepsilon \approx 0.044$	$n_{\eta'} = 9.70 \cdot 10^{-4} \text{ s}^{-1}$
3- $\eta' \rightarrow 2\gamma$	$\Delta\Omega = 10 \text{ sr}$ $\varepsilon \approx 0.25$	$n_{\eta'} = 22.0 \cdot 10^{-4} \text{ s}^{-1}$

$$n_{\eta'}^{\text{d}} = 67.8 \cdot 10^{-4} \text{ s}^{-1} \Rightarrow 586 \text{ d}^{-1}$$

and applying a global efficiency of 50% (macroscopic duty factor, daq lifetime, safety margin)

$$n_{\eta'}^{\text{d}} = \underline{293 \text{ d}^{-1}}$$

beam time request

$$T(\Delta\Sigma) = \frac{N_{\eta'}^T}{n_{\eta'}^d} = \frac{N_{\eta'}^P}{P \cdot n_{\eta'}^d} = \frac{nbin \cdot n_{\eta'}^P}{P \cdot n_{\eta'}^d} = \frac{nbin}{P \cdot n_{\eta'}^d \cdot \Delta\Sigma^2} [days]$$

$$nbin = 15$$

$$P = 0.3$$

with

$$n_{\eta'}^d = 293$$

we obtain

$$T = 68 \text{ days (1600h) for } \Delta\Sigma = 5\%$$

$$T = 35 \text{ days (840 h) for } \Delta\Sigma = 7\%$$

$$T = 17 \text{ days (408 h) for } \Delta\Sigma = 10\%$$

Giudizio del PAC

ELSA/06-2012-BGO: **B (Resonances)**

A choice should be made between this proposal and ELSA/02-2012-CB.

Measurement of the Σ beam asymmetry in $\gamma p \rightarrow \eta' p$

Efficienza per i canali + puliti

Efficienza di analisi ε

36.8 % η' in $\pi^+\pi^-\eta(\gamma\gamma)$

57% η' in $\gamma\gamma$

37% η' in 6γ

Non si raggiungiamo le performace di CB di

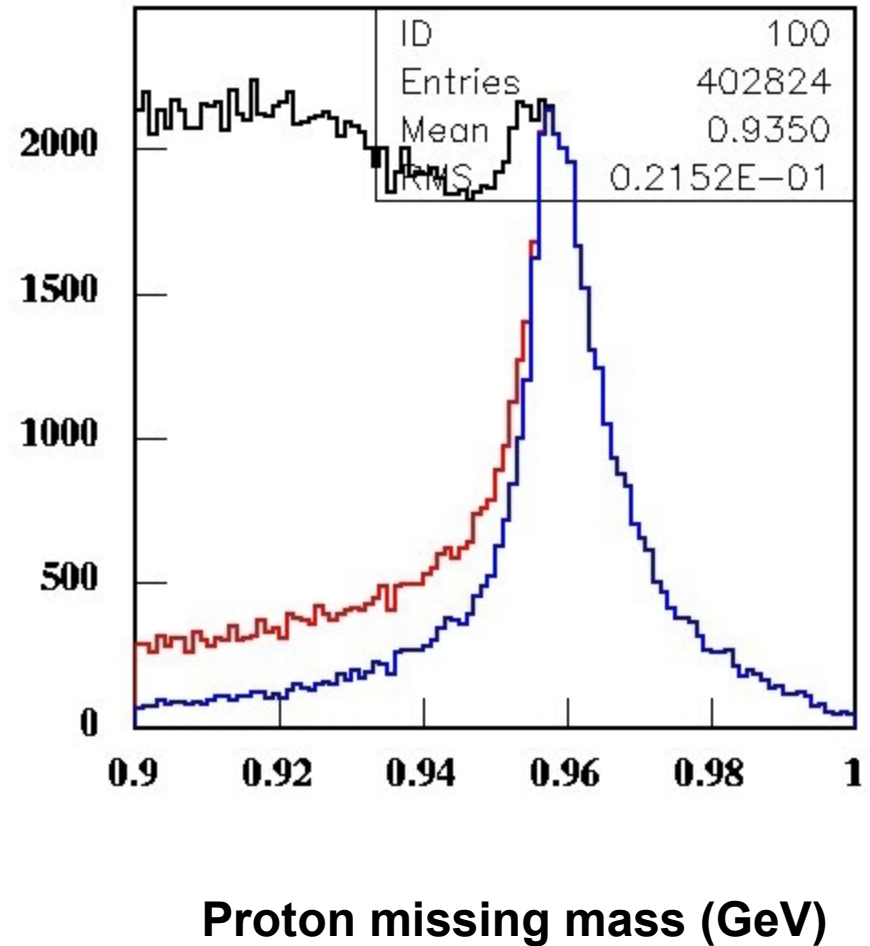
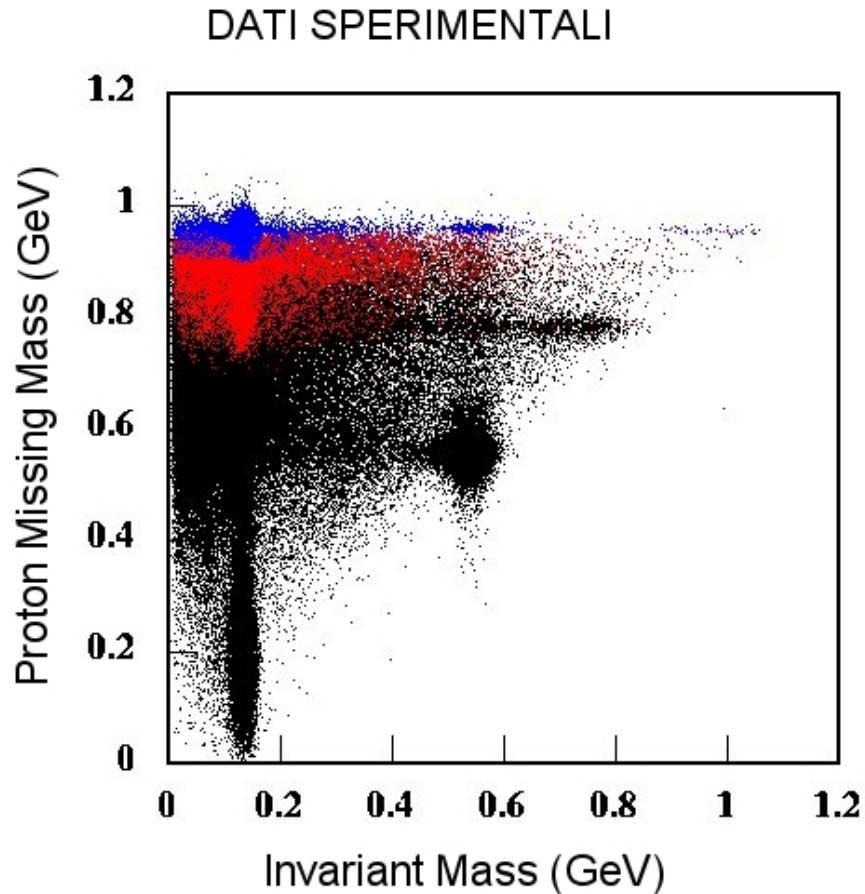
300 η' all'ora

Ma con i tre canali ne produciamo

Circa 137 all'ora

3278 al giorno

Asimmetrie di fascio $\gamma p \rightarrow \eta' p$



η' decay particles

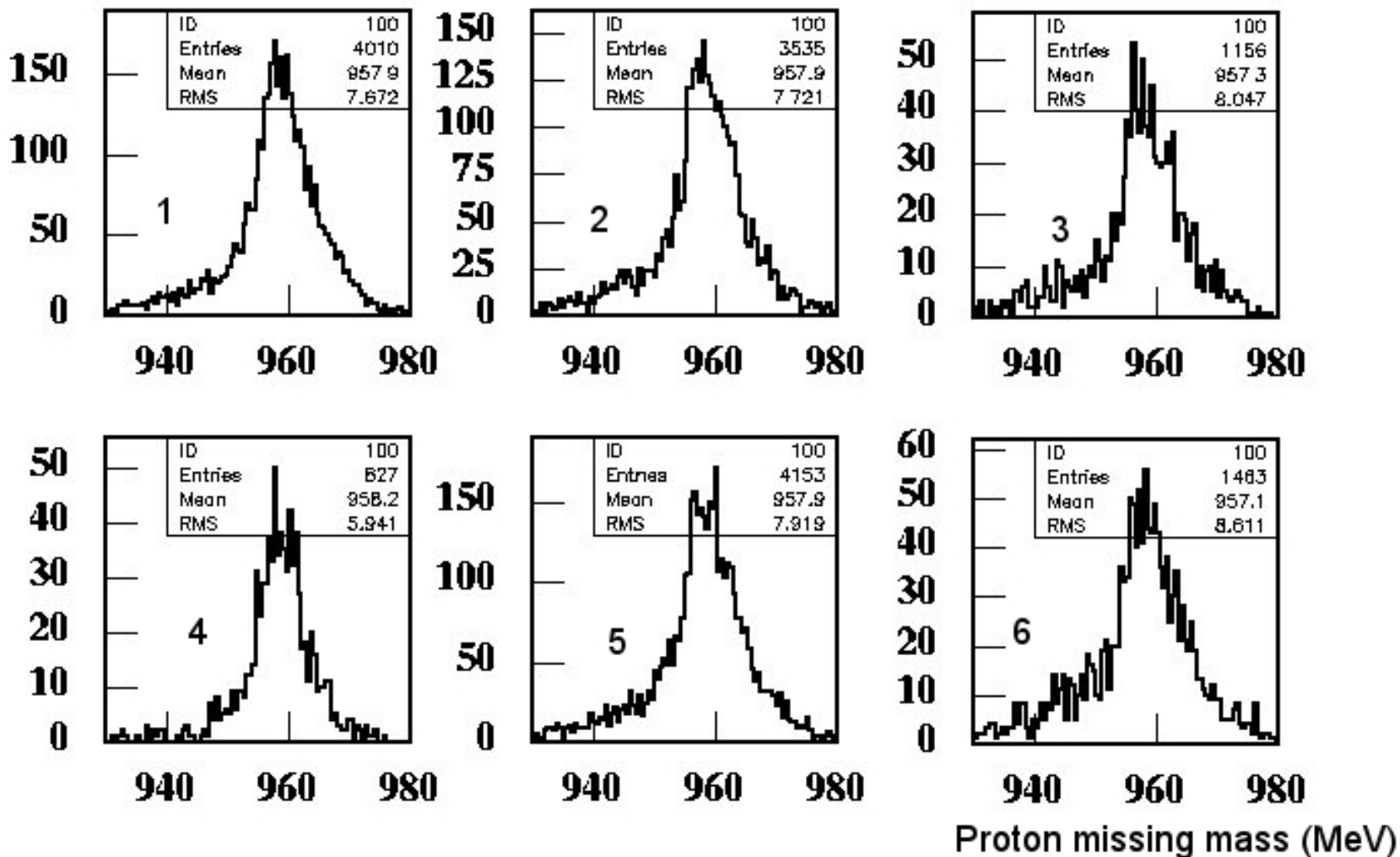
(Casi studiati) $E_\gamma < 1.5$ MeV

- 1) $\pi^+\pi^-(\eta \rightarrow \gamma\gamma)$
- 2) $\gamma\gamma$
- 3) $\gamma(\gamma)$
- 4) $\pi^+\pi^-(\eta \rightarrow 6\gamma)$
- 5) $\pi^0\pi^0\eta \rightarrow 6\gamma$
- 6) $\pi^+\pi^-\gamma\gamma$

Lo studio sui dati di Graal dimostrano: grande varietà di casi che possono essere studiati grazie alla combinazione alta risoluzione nella misura del protone in avanti + Rivelatori al centro. CASO GRAAL L'alta risoluzione per il protone è dovuta al fatto che la misura è in soglia e il protone è lento.

GRAAL Data (proton target)

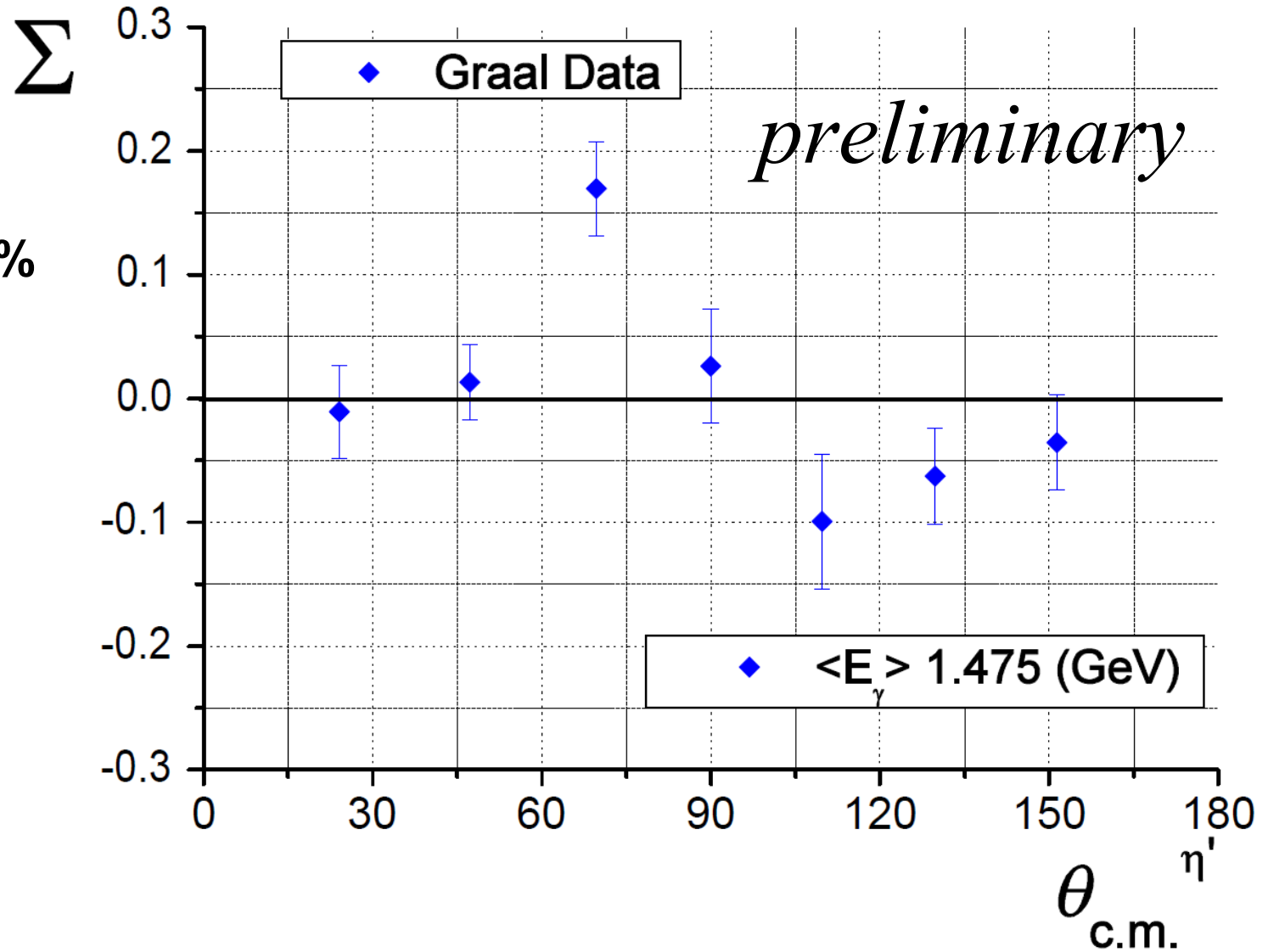
Counts



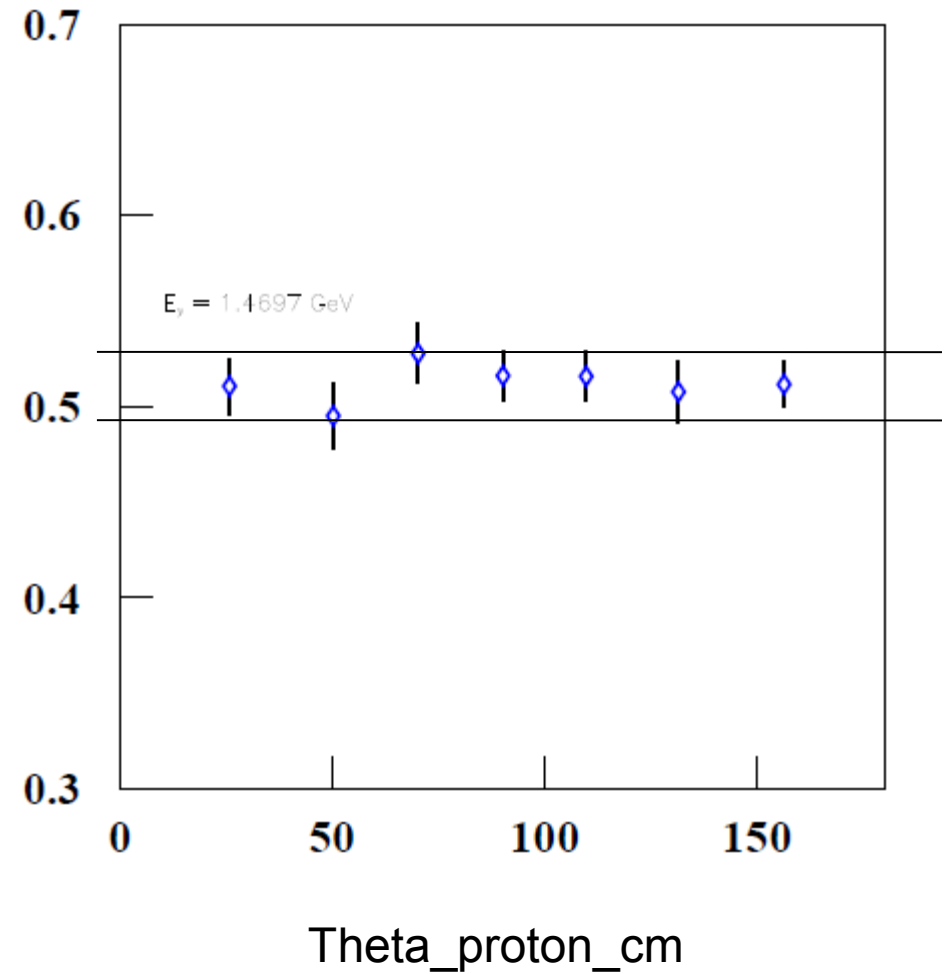
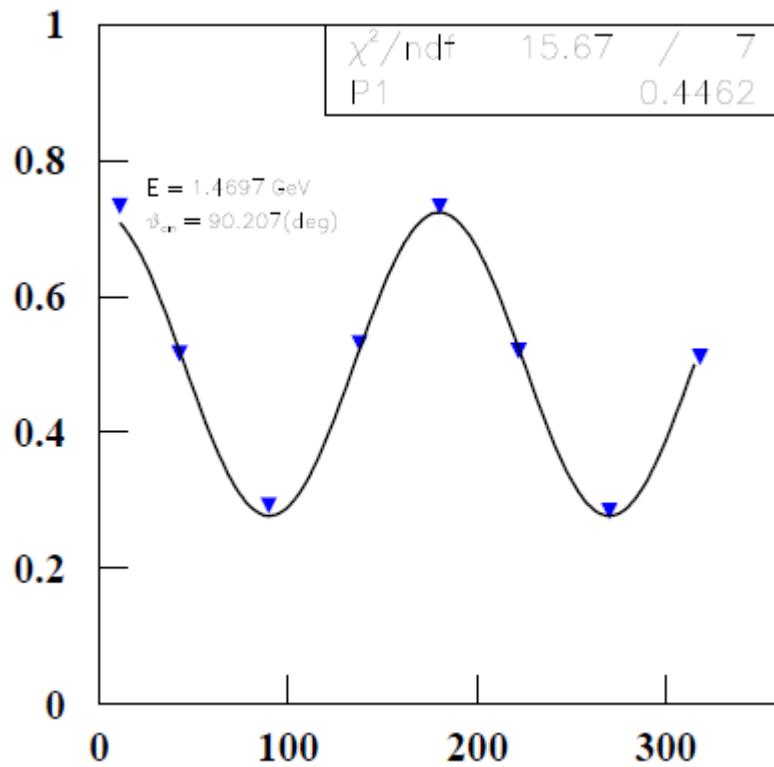
Proton missing mass (MeV)

Asimmetrie di fascio $\gamma p \rightarrow \eta' p$ (GRAAL)

Background < 2%
Software Sys. ~ 1 %



Cross check



Conclusioni per ora

- > Pubblicazione risultati di Graal
- > Preparazione di un nuovo proposal per il PAC

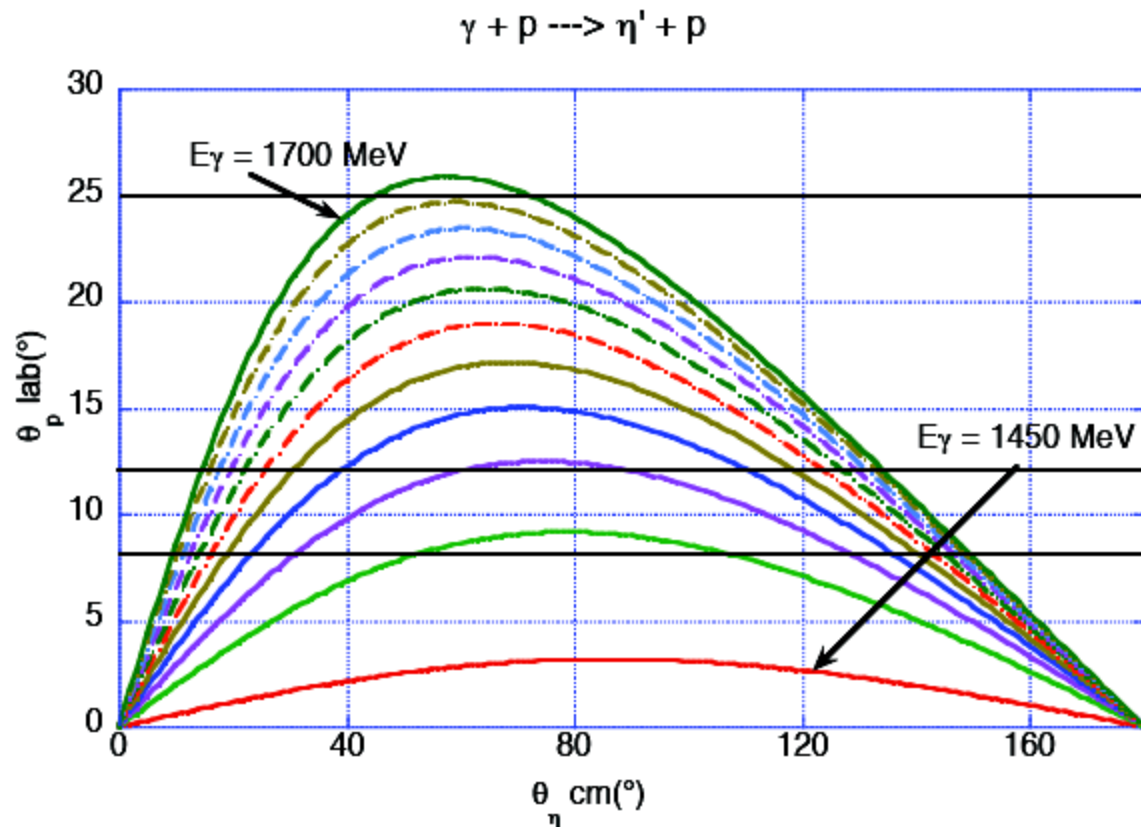


Figure 6 Kinematics of the reaction $\gamma + p \rightarrow \eta' + p$. The curves show (25 MeV steps for the incident photon energy E_{γ}) the behavior of the proton laboratory angle θ_p as a function of the η' center-of-mass angle $\theta_{\eta'}$. The horizontal lines show the geometrical dipole aperture limits (vertical direction 8° , horizontal direction 12° and the BGO calorimeter lower limit (25°)).