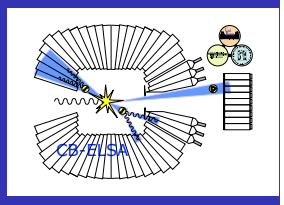
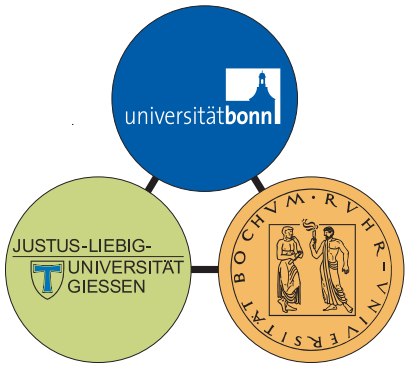


Double Polarization Measurements with the Crystal Barrel-Experiment @ ELSA

Jan Hartmann

HISKP, University of Bonn

supported by Bonn-Cologne Graduate School of Physics and Astronomy



funded by DFG with SFB/TR16

06/20/2008

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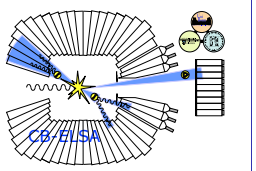
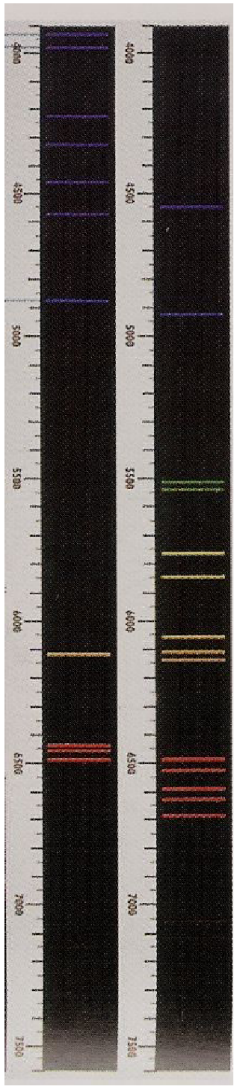
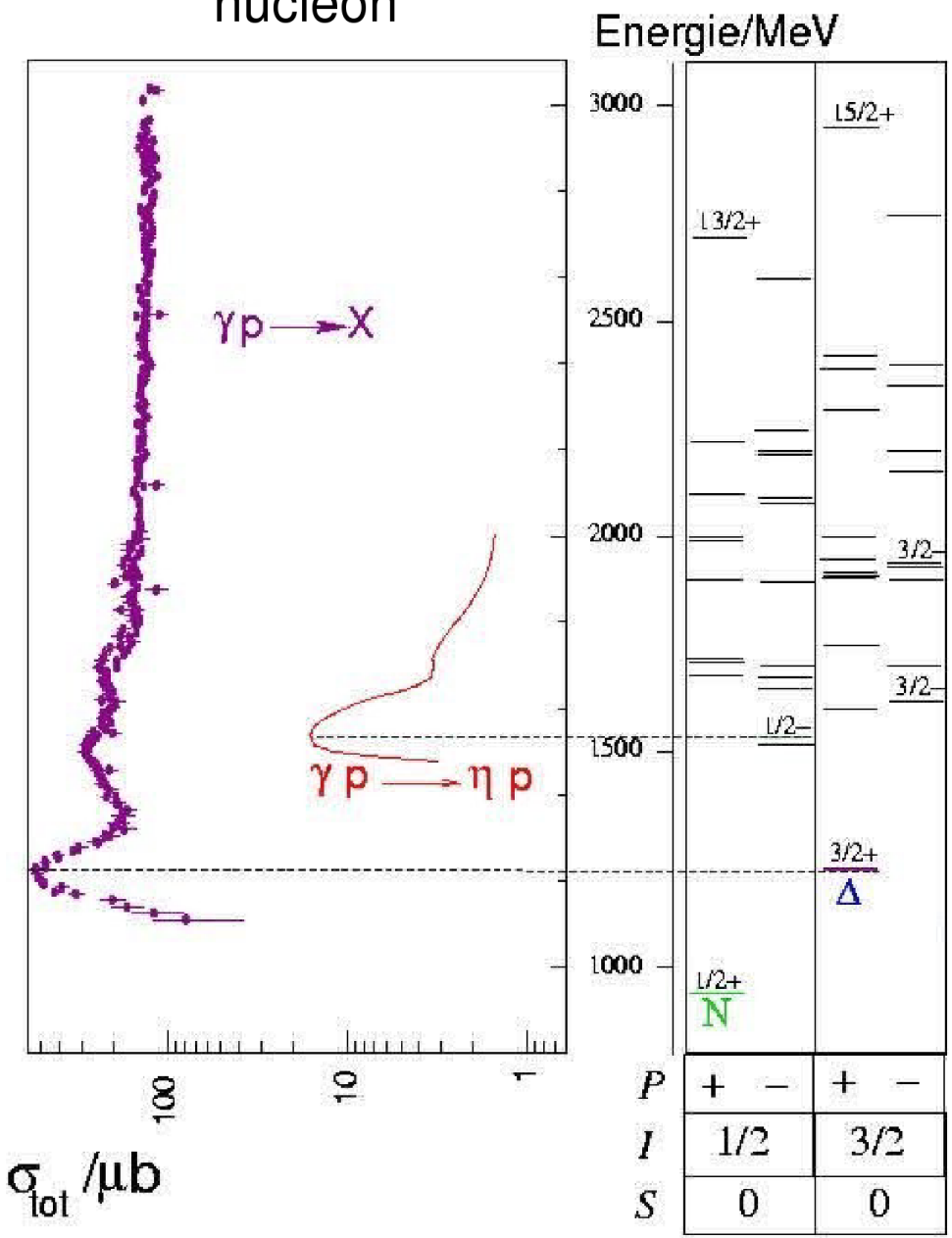
Double Polarization Measurements with the Crystal Barrel-Experiment @ ELSA



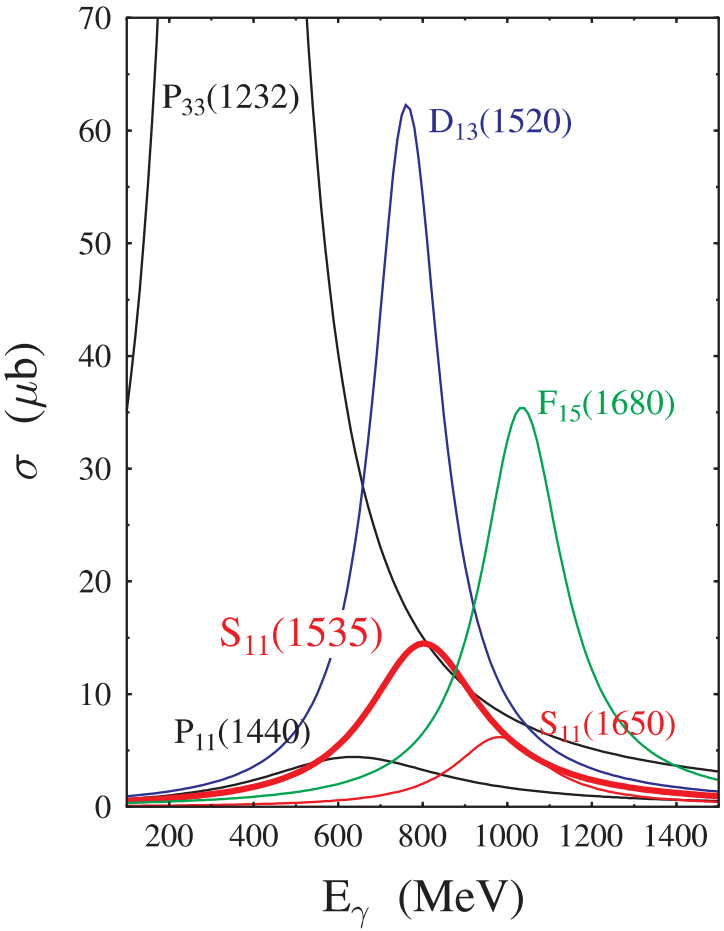
Why spectroscopy?



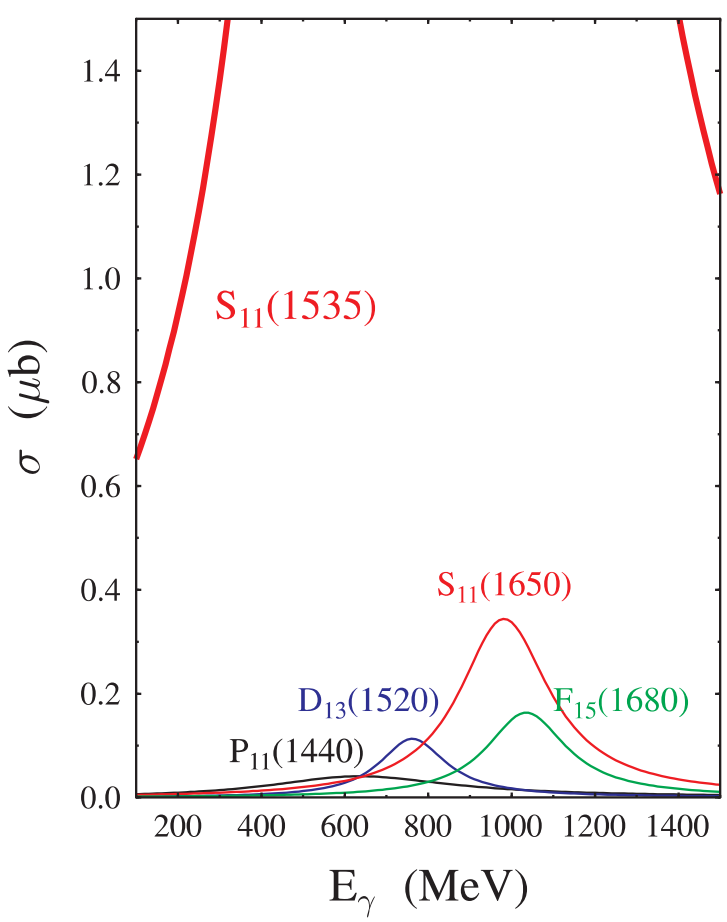


Nucleon Resonances

$\gamma + p \rightarrow N^*, \Delta^* \rightarrow N + \pi$

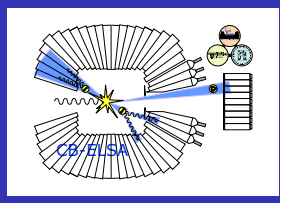


$\gamma + p \rightarrow N^* \rightarrow N + \eta$



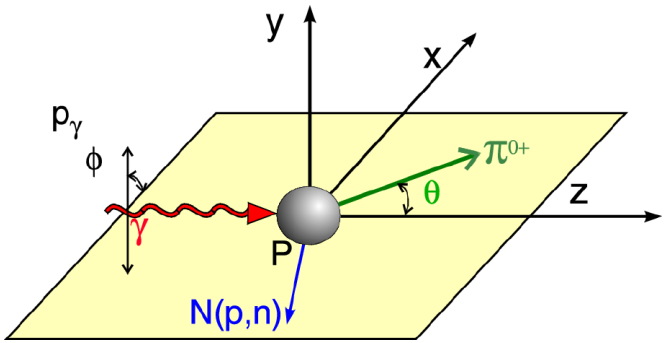
Strongly overlapping resonances with different intensities

- Different decay channels
- Polarization observables



Polarization Observables

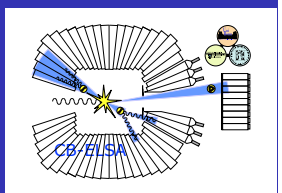
- Partial wave analysis required to extract the contributing amplitudes.
- Polarization observables needed!

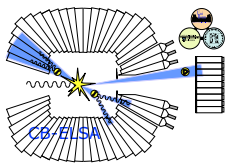


Photon Pol.		Target Pol. Axis		
		x	y	z
unpolarized	σ		T	
linear	$-\Sigma$	H	$-P$	$-G$
circular		F		$-E$

$$\frac{d\sigma}{d\Omega}(\theta,\phi) = \frac{d\sigma}{d\Omega}(\theta) \cdot \Big[1 - P_\gamma^{\text{lin}}\,\Sigma(\theta)\cos(2\phi) + P_x \cdot \left(-P_\gamma^{\text{lin}}\,H(\theta)\,\sin(2\phi) + P_\gamma^{\text{circ}}\,F(\theta)\right) + P_y \cdot \left(+P_\gamma^{\text{lin}}\,P(\theta)\,\cos(2\phi) - T(\theta)\right) - P_z \cdot \left(-P_\gamma^{\text{lin}}\,G(\theta)\,\sin(2\phi) + P_\gamma^{\text{circ}}\,E(\theta)\right)\Big]$$

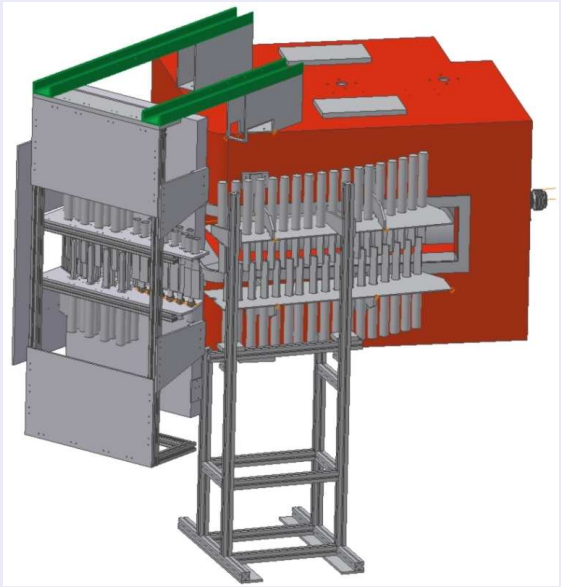
I. S. Barker, A. Donnachie, J. K. Storrow, Nucl. Phys. B95, 347 (1975)



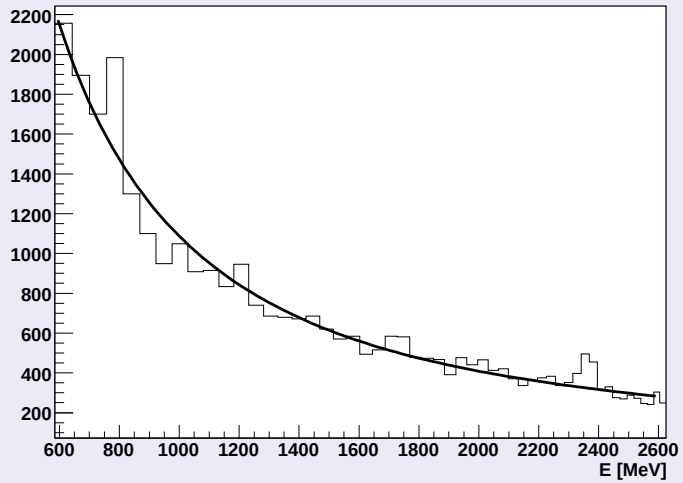


Detector components

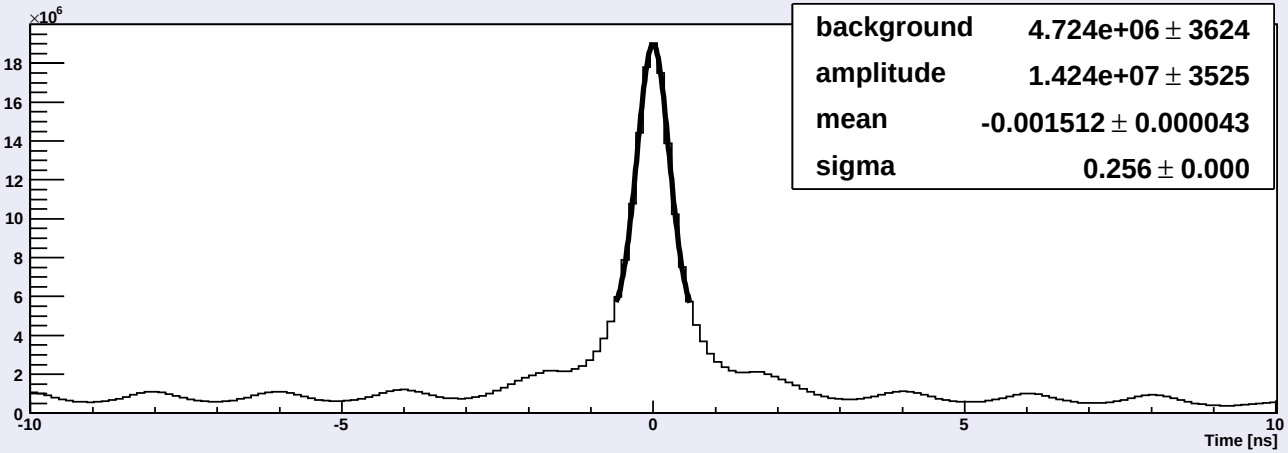
Tagging System

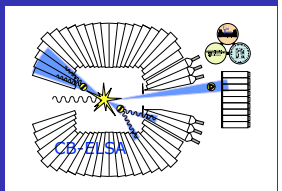


energy spectrum:



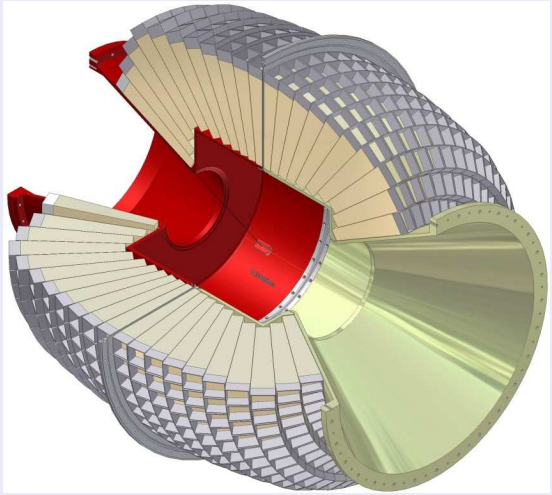
time resolution:

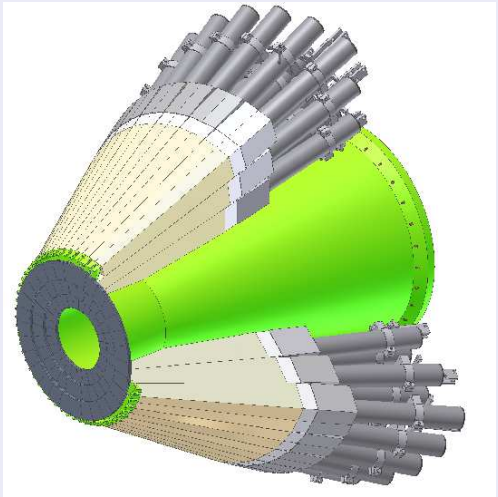


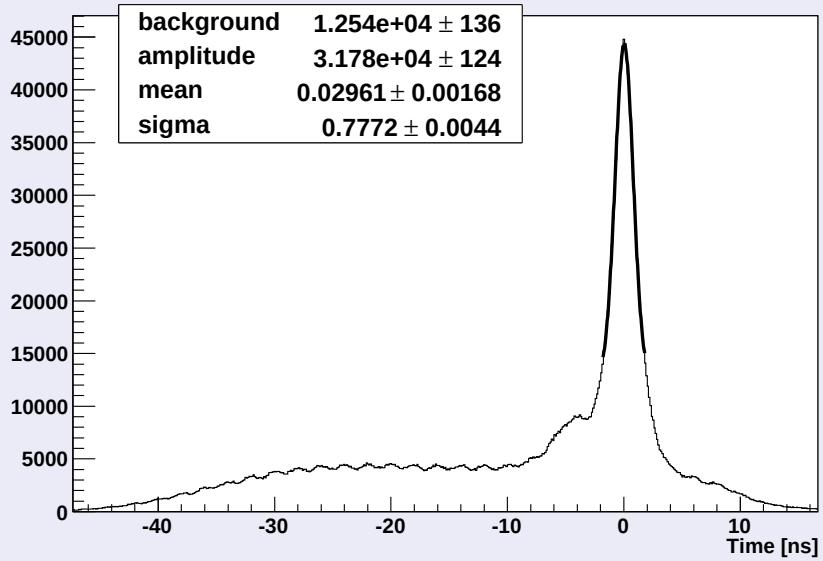


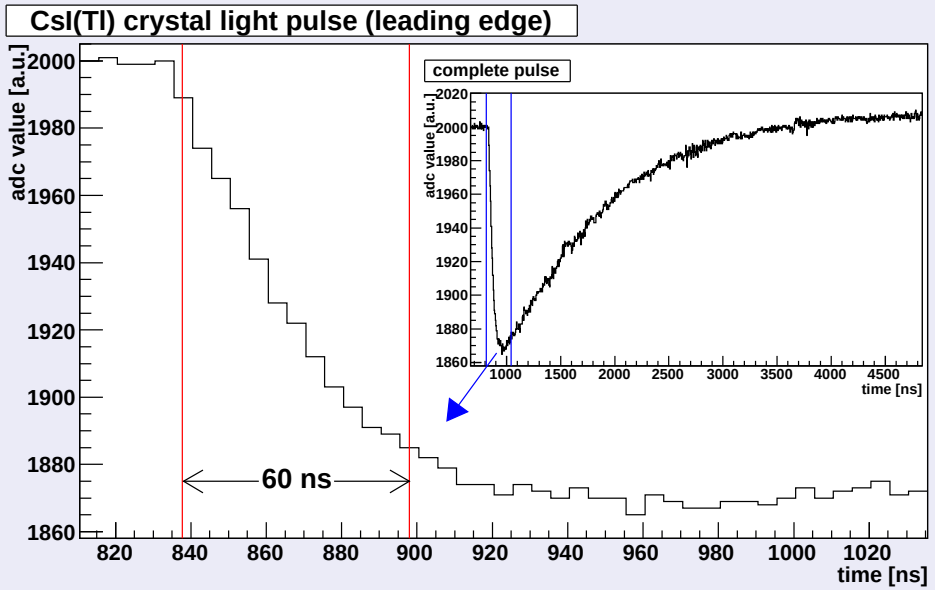
Detector components

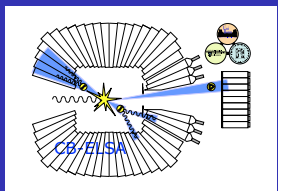
Crystal Barrel with Forward Plug





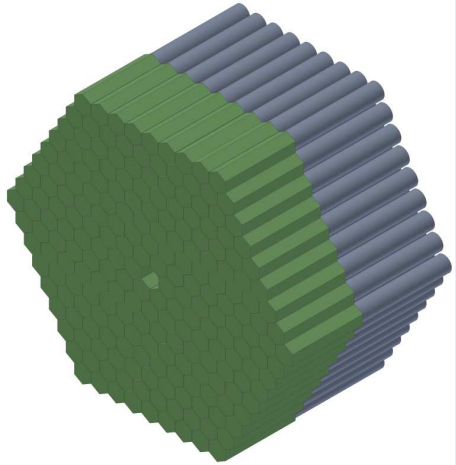


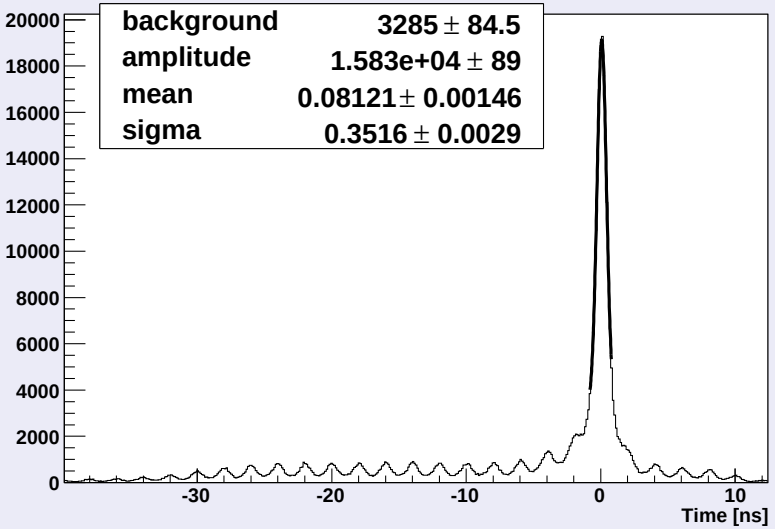


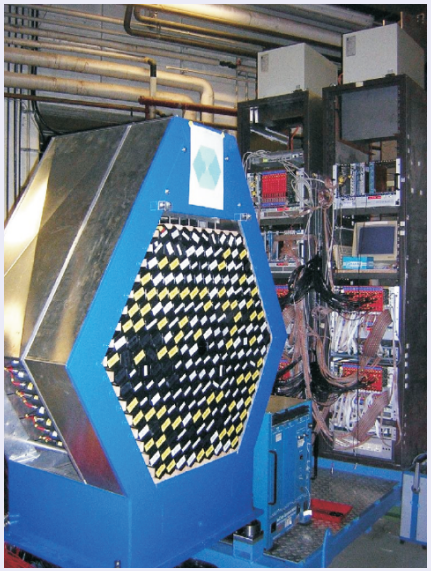


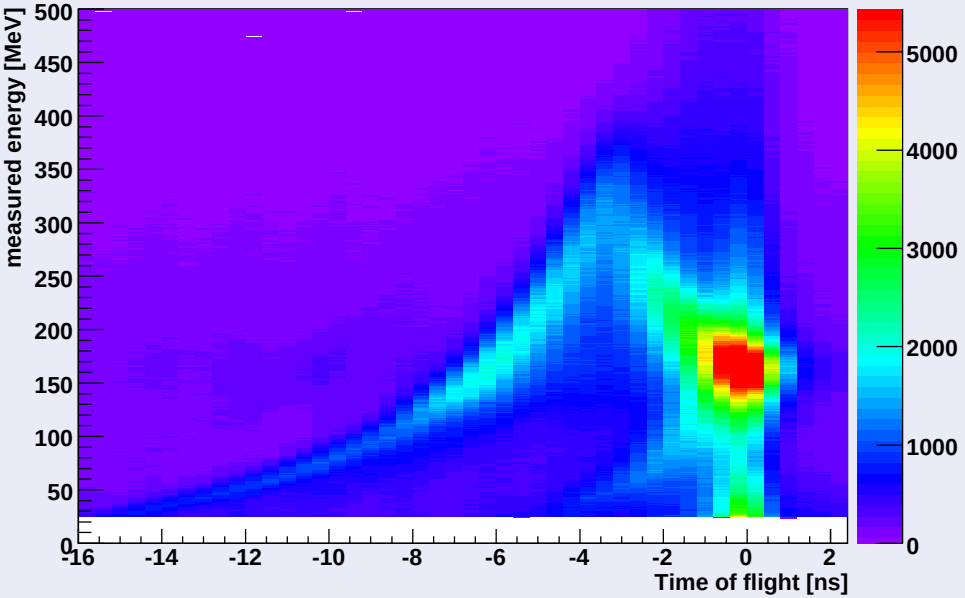
Detector components

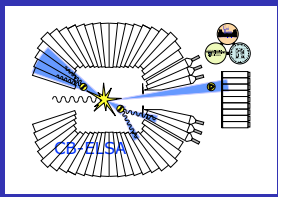
MiniTAPS

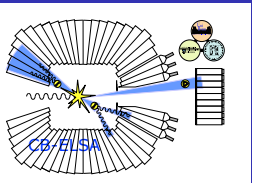








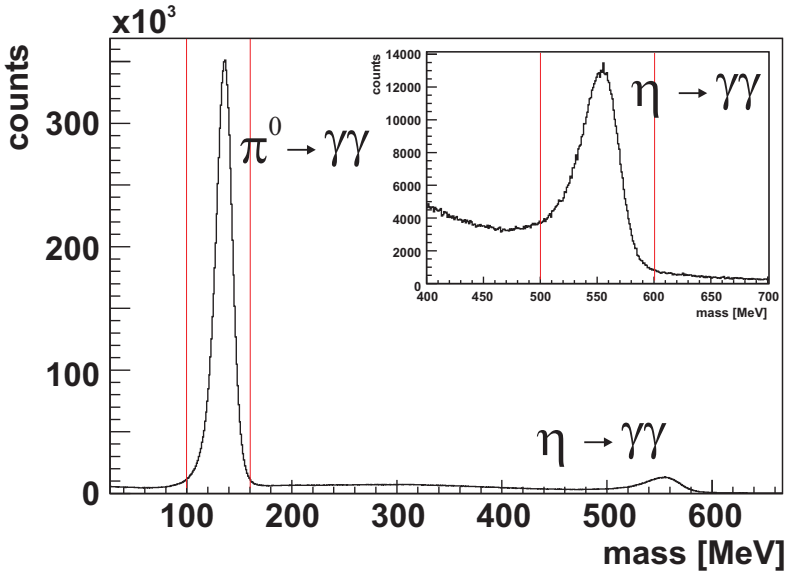


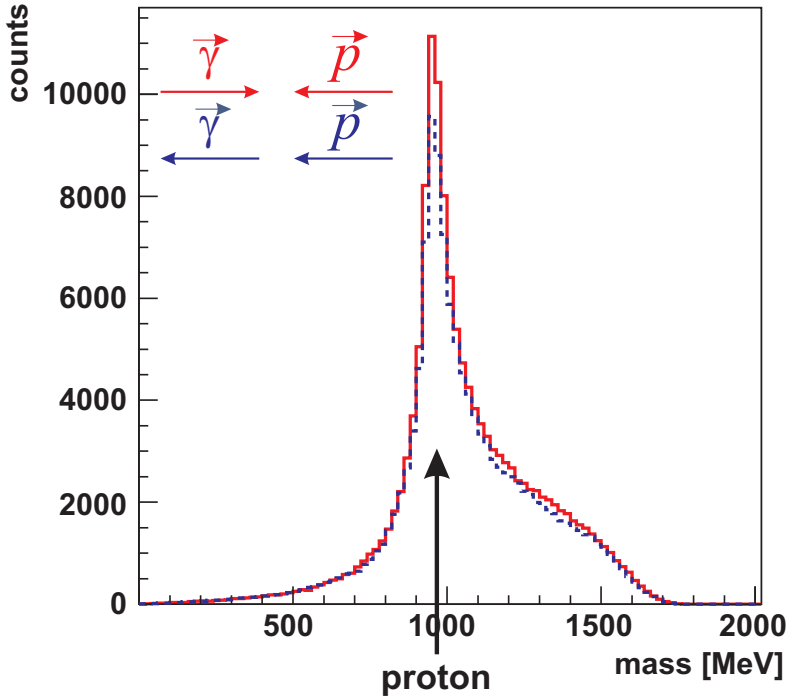


Online spectrum: $\gamma\gamma$ invariant mass

circularly polarized photons and longitudinally polarized target

reaction: $\vec{\gamma}\vec{p} \rightarrow p\gamma\gamma$



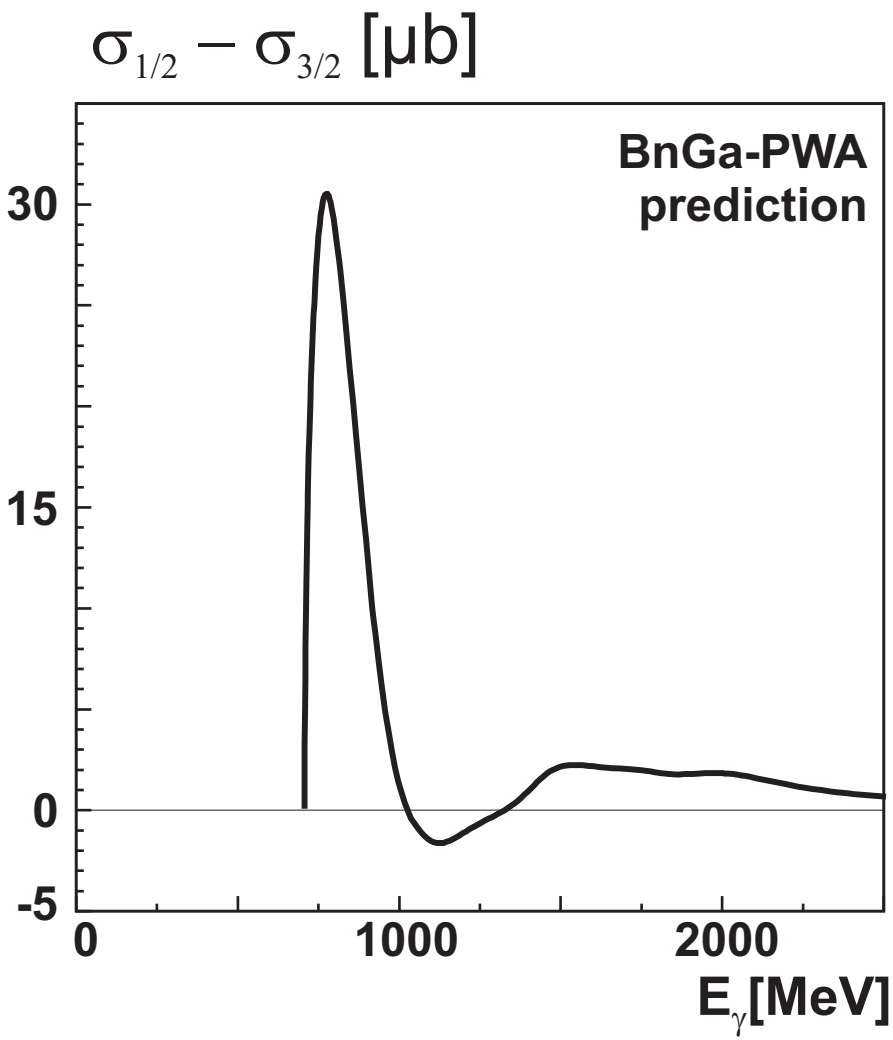


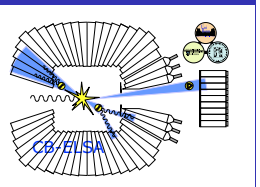
Reminder:

$$\frac{d\sigma}{d\Omega}(\theta,\phi) = \frac{d\sigma}{d\Omega}(\theta) \cdot \left[1 - P_z \cdot P_\gamma^{\text{circ}}\, E(\theta)\right]$$

Count rate difference $\vec{\gamma}\vec{p} \rightarrow p\eta$

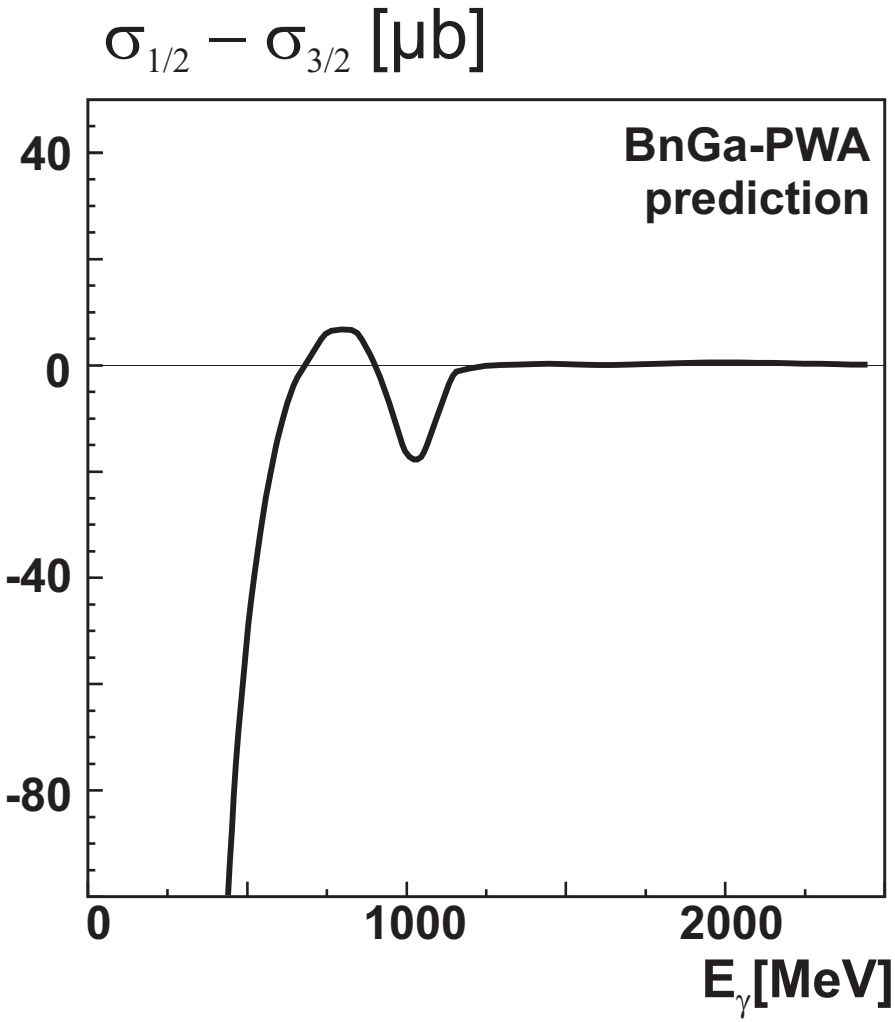
circularly polarized photons and longitudinally polarized target

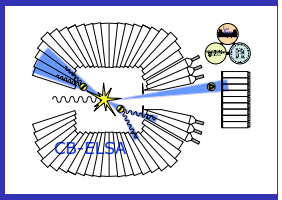




Count rate difference $\vec{\gamma}\vec{p} \rightarrow p\pi^0$

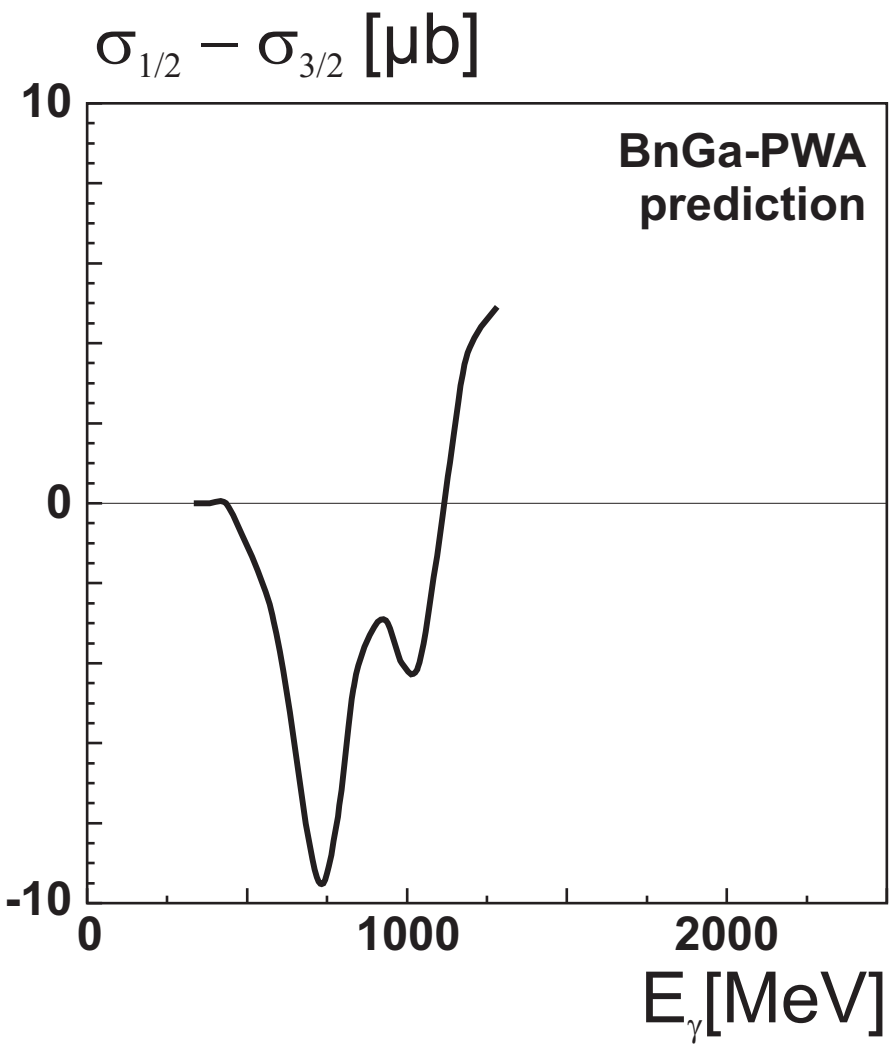
circularly polarized photons and longitudinally polarized target

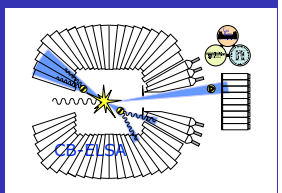




Count rate difference $\vec{\gamma}\vec{p} \rightarrow p\pi^0\pi^0$

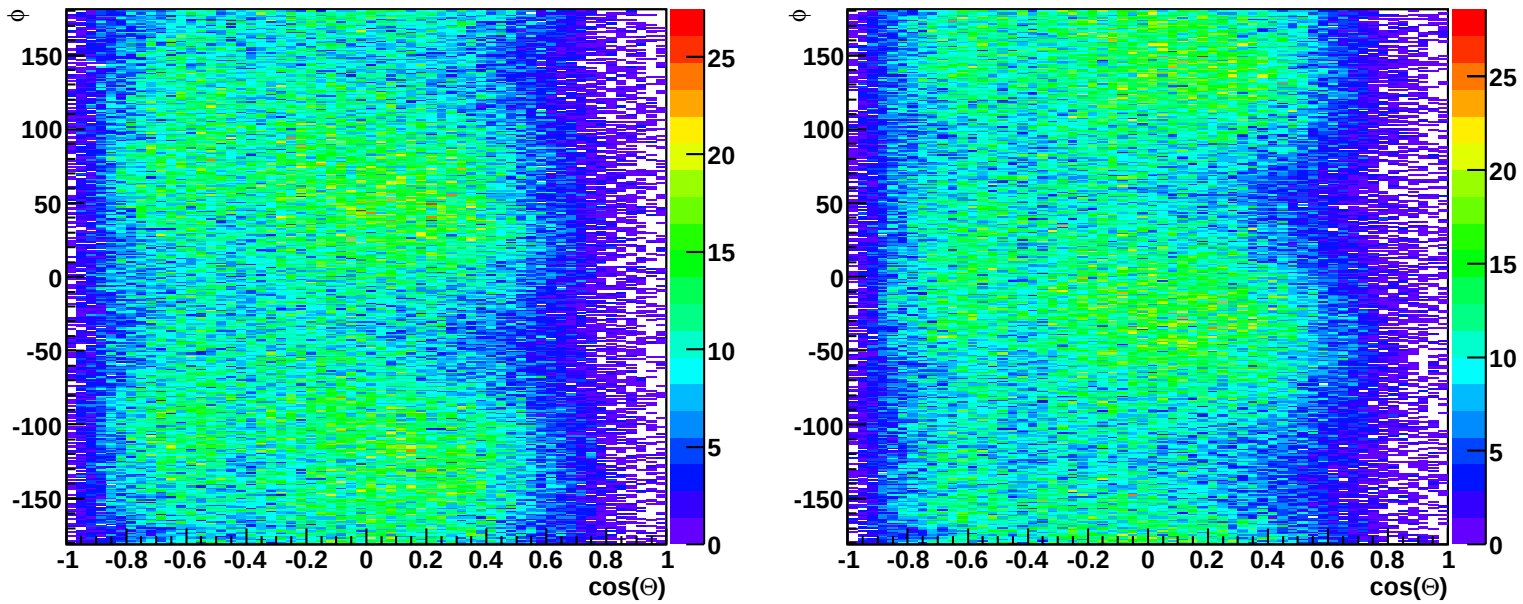
circularly polarized photons and longitudinally polarized target





π^0 angular distribution in $\vec{\gamma}\vec{p} \longrightarrow p\pi^0$

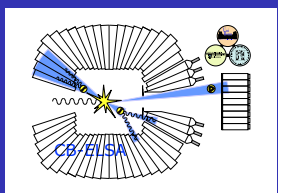
linearly polarized photons and longitudinally polarized target online spectrum:



$+45°$ beam polarization axis $-45°$

Reminder:

$$\frac{d\sigma}{d\Omega}(\theta,\phi) = \frac{d\sigma}{d\Omega}(\theta) \cdot \left[1 - P_\gamma^{lin} \cdot (\Sigma(\theta)\cos(2\phi) - P_z\, G(\theta)\, \sin(2\phi))\right]$$



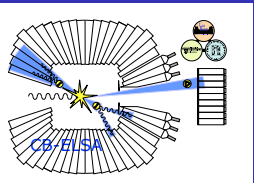
ϕ distribution of π^0 in $\vec{\gamma}\vec{p} \rightarrow p\pi^0$

linearly polarized photons and longitudinally polarized target online spectrum:

Target pol. pos. / neg.

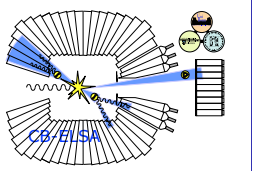
sum of both pol. $+45^\circ$ beam polarization axis -45°

$$\frac{d\sigma}{d\Omega}(\theta,\phi) = \frac{d\sigma}{d\Omega}(\theta) \cdot \left[1 - P_\gamma^{lin} \cdot (\Sigma(\theta)\cos(2\phi) - P_z\, G(\theta)\, \sin(2\phi))\right]$$



Summary and Outlook

- New Crystal Barrel/TAPS setup at ELSA allows measurement of polarization observables.
- Polarization observables needed for unambigous and model independent determination of partial wave amplitudes.
- First data seems to indicate important differences to the PWA-predictions.
- Currently more double polarization data is taken for better statistics, analysis in progress.



Polarization Observables

Photon Pol.		Target Pol. Axis			Recoil Pol.		
		x	y	z	x'	y'	z'
unpolarized	σ		T			P	
linear	$-\Sigma$	H	$-P$	$-G$	$O_{x'}$	$-T$	$O_{z'}$
circular		F		$-E$	$-C_{x'}$		$-C_{z'}$

Photon Pol.	Target and Recoil Pol.			
	x'	x'	z'	z'
	x	z	x	z
unpolarized	$T_{x'}$	$-L_{x'}$	$T_{z'}$	$L_{z'}$
linear	$-L_{z'}$	$T_{z'}$	$L_{x'}$	$-T_{x'}$
circular				

see also: W.T. Chiang, F. Tabakin, Phys. Rev. C 55, 2054 - 2066 (1997)