universitätbonn

# Measurement of polarization observables in ω-photoproduction

Holger Eberhardt
CBELSA/TAPS Collaboration

NSTAR 2011
Parallel session III-C
May 19, 2011

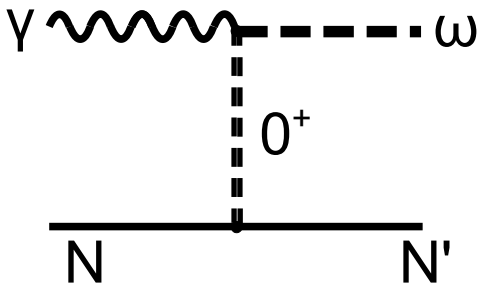
Physikalisches Institut
Nußallee 12, 53115 Bonn

SFB/TR16

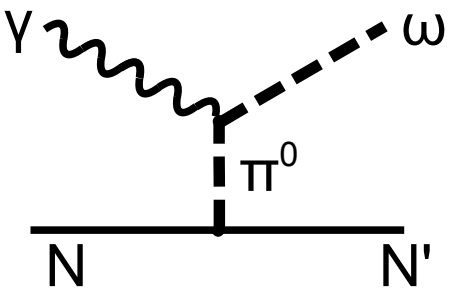
supported by the DFG

# ω production mechanism

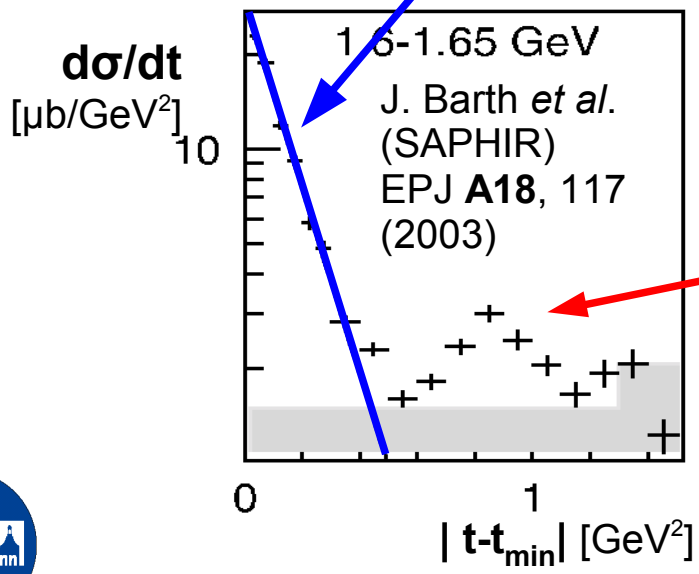
pomeron-exchange

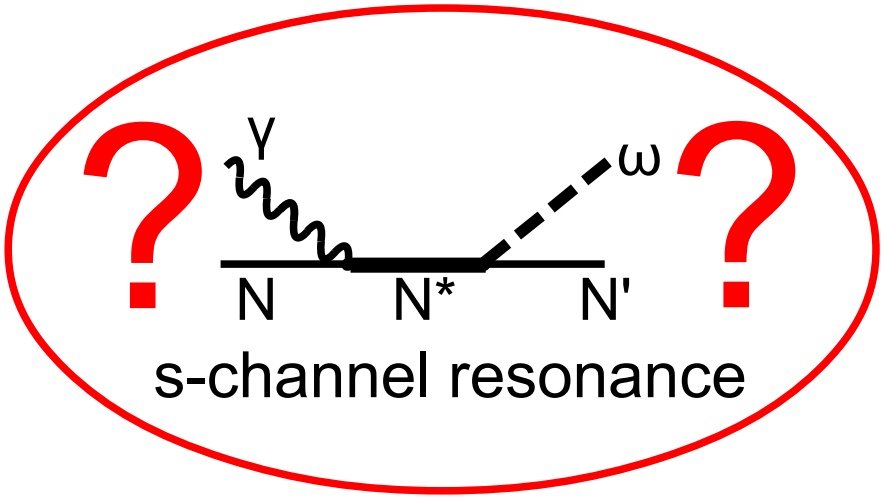



pion-exchange




t-channel



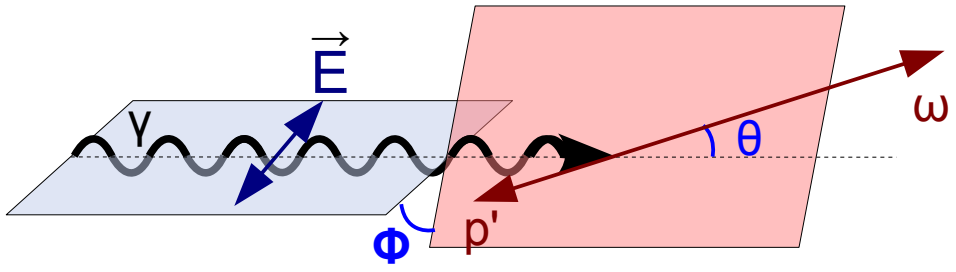




→ A. V. Sarantsev et al., Eur. Phys. J. A 39, 61-70 (2009)

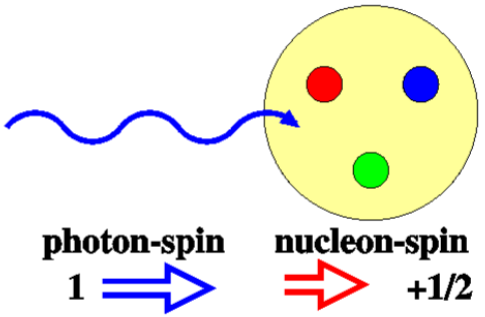
# polarization observables

$$\frac{d\sigma}{d\Omega} = \frac{d\sigma_0}{d\Omega}\left(1 - P_{\gamma,l}\,\Sigma_{(\pi)}\cos(2\Phi_{(\pi)}) + P_{z,t}\,P_{\gamma,l}\,G_{(\pi)}\sin(2\Phi_{(\pi)})\right)$$

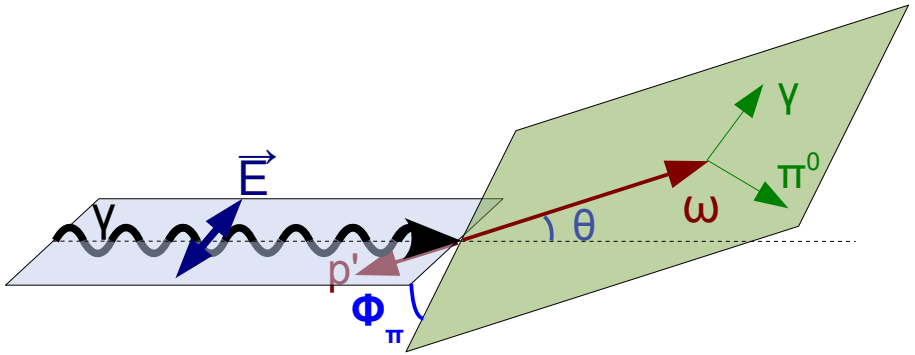
$$\frac{d\sigma}{d\Omega} = \frac{d\sigma_0}{d\Omega}\left(1 - P_{z,t}\,P_{\gamma,\circ}\,E\right)$$



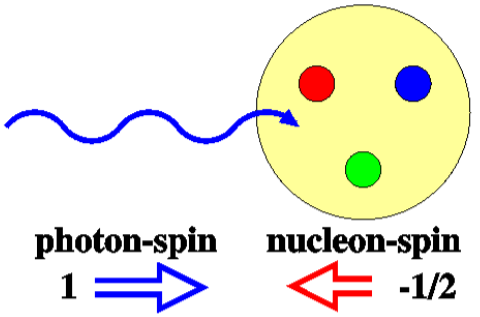

polarization plane reaction plane




$\sigma_{3/2}$




polarization plane decay plane

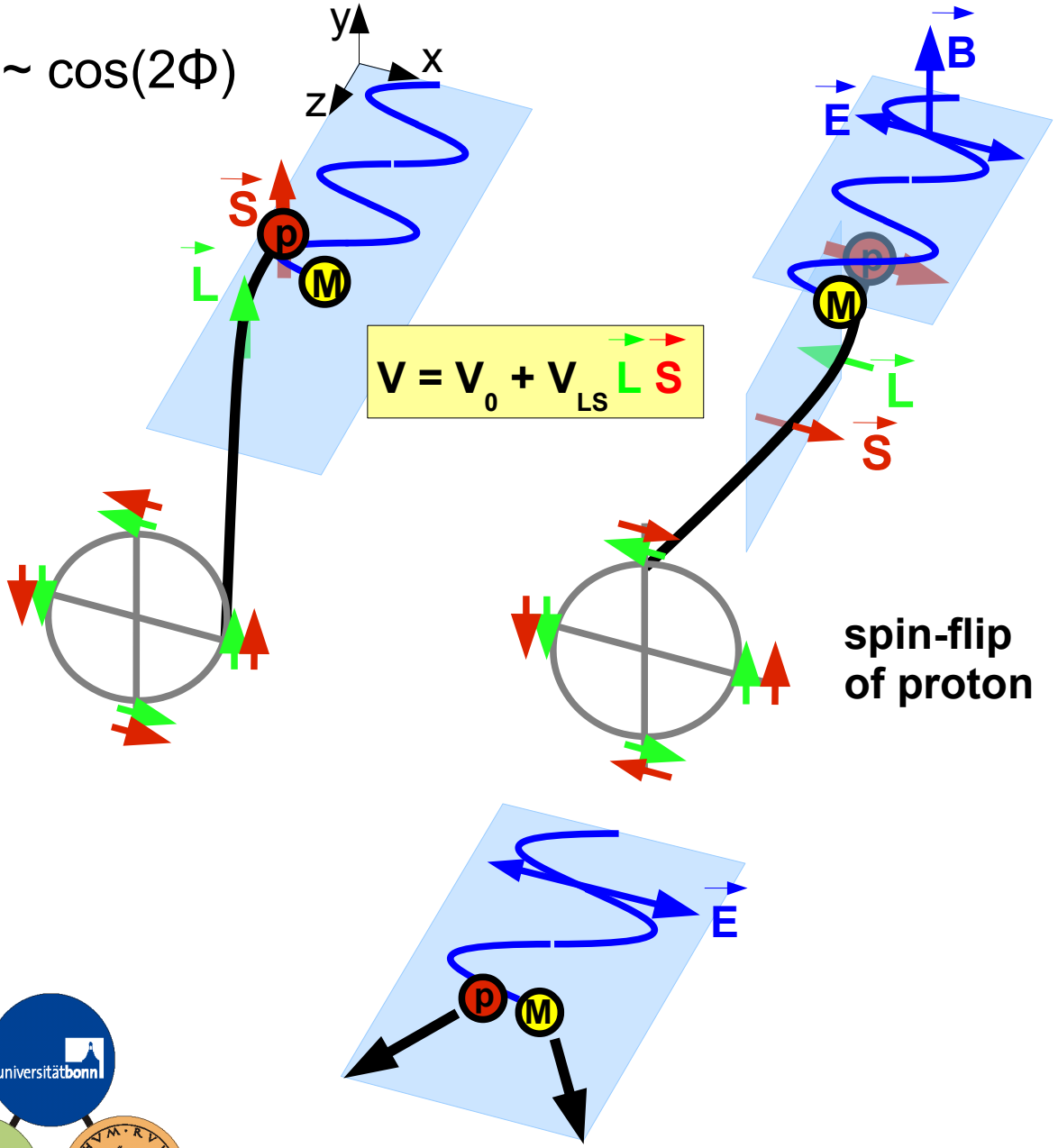


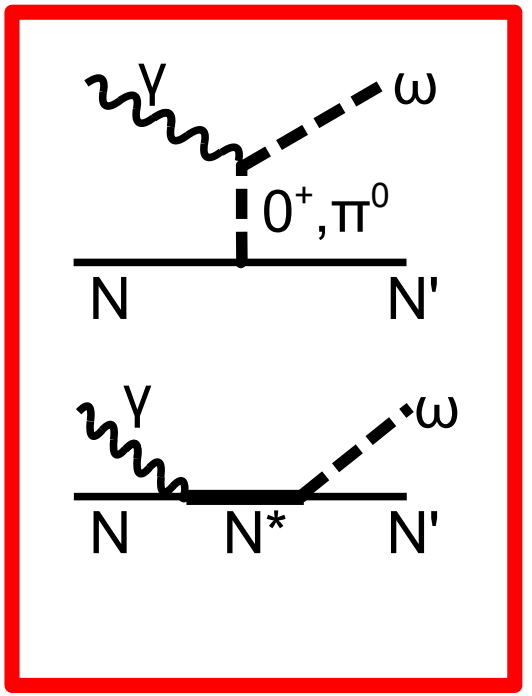

$\sigma_{1/2}$

possible measurement of cross section and 5 polarization observables

# polarization observables

$\Sigma \sim \cos(2\Phi)$

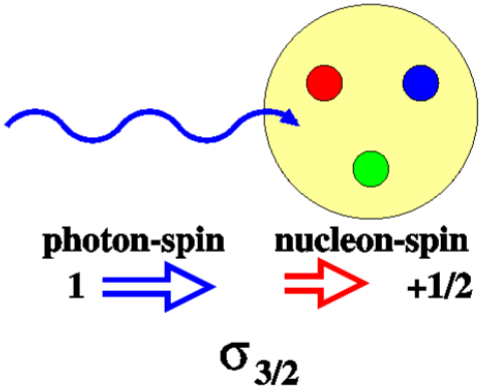



H. Schmieden, Ch. Phys. J. C 33, 1146-1152 (2009)

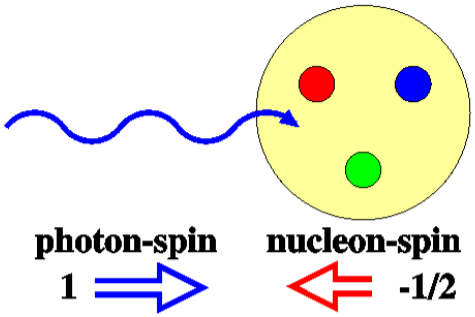
# polarization observables

$$\frac{\sigma_{\frac{1}{2}} - \sigma_{\frac{3}{2}}}{\sigma_{\frac{3}{2}} + \sigma_{\frac{1}{2}}} \propto E$$



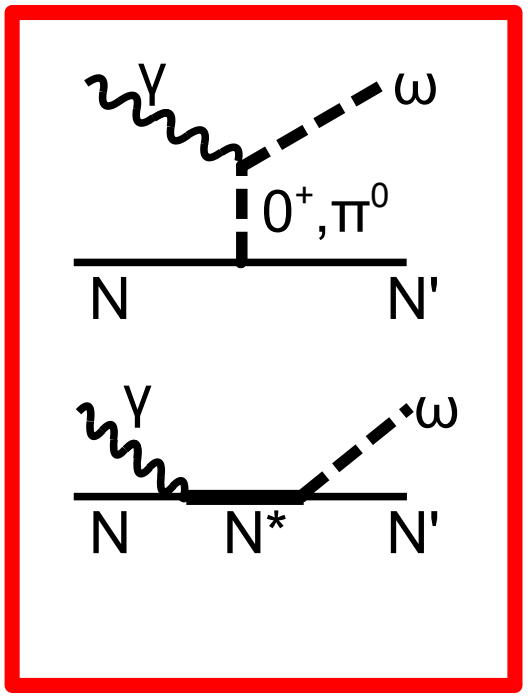

$\sigma_{3/2}$

$$\sigma_{\frac{3}{2}} \sim \sin^2\theta$$




$\sigma_{1/2}$

$$\sigma_{\frac{1}{2}} \sim \cos\theta$$



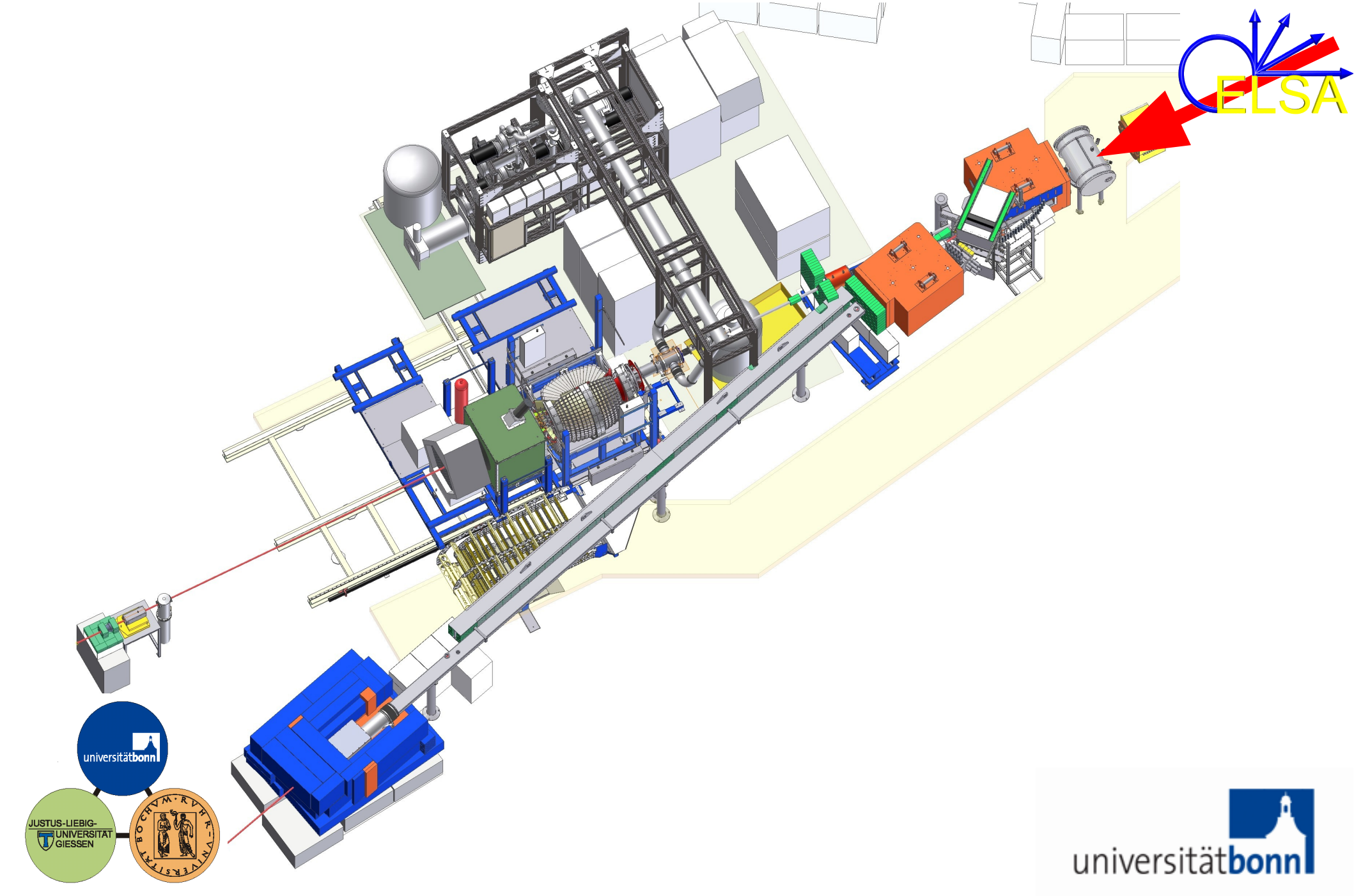

universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

RUHR-UNIVERSITÄT BOCHUM

universitätbonn

# Crystal-Barrel/TAPS experiment




universitätbonn

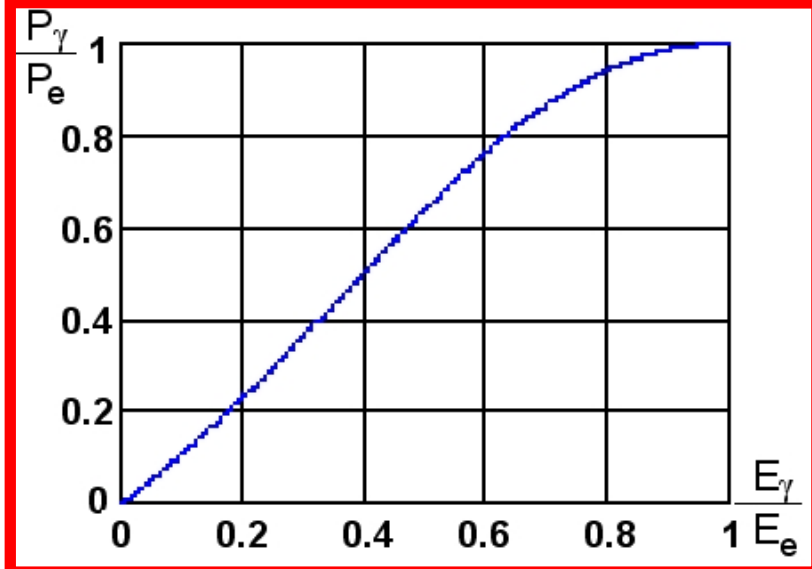
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

RUHR-UNIVERSITÄT BOCHUM

universitätbonn

# Crystal-Barrel/TAPS experiment

**circular polarization (helicity transfer)**







**linear polarization (coherent bremsstrahlung)**




universitätbonn

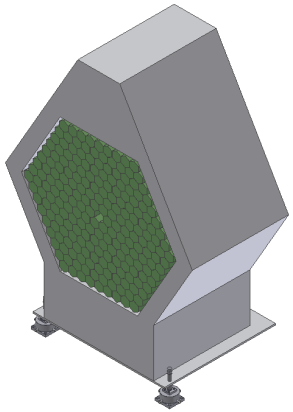
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

RUHR-UNIVERSITÄT BOCHUM

universitätbonn

# Crystal-Barrel/TAPS experiment

**Mini TAPS**



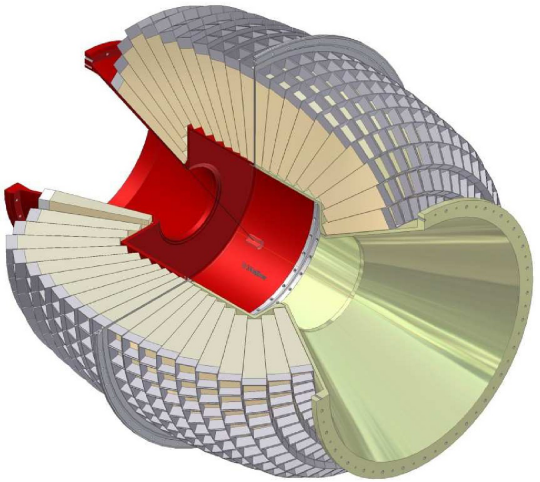
216 $BaF_2$-crystals

**polarized target**

$\overline{P} \approx 70\%$, $\tau \approx 500$ h

ELSA

**Crystal-Barrel**



1320 CsI(Tl)-crystals

universitätbonn

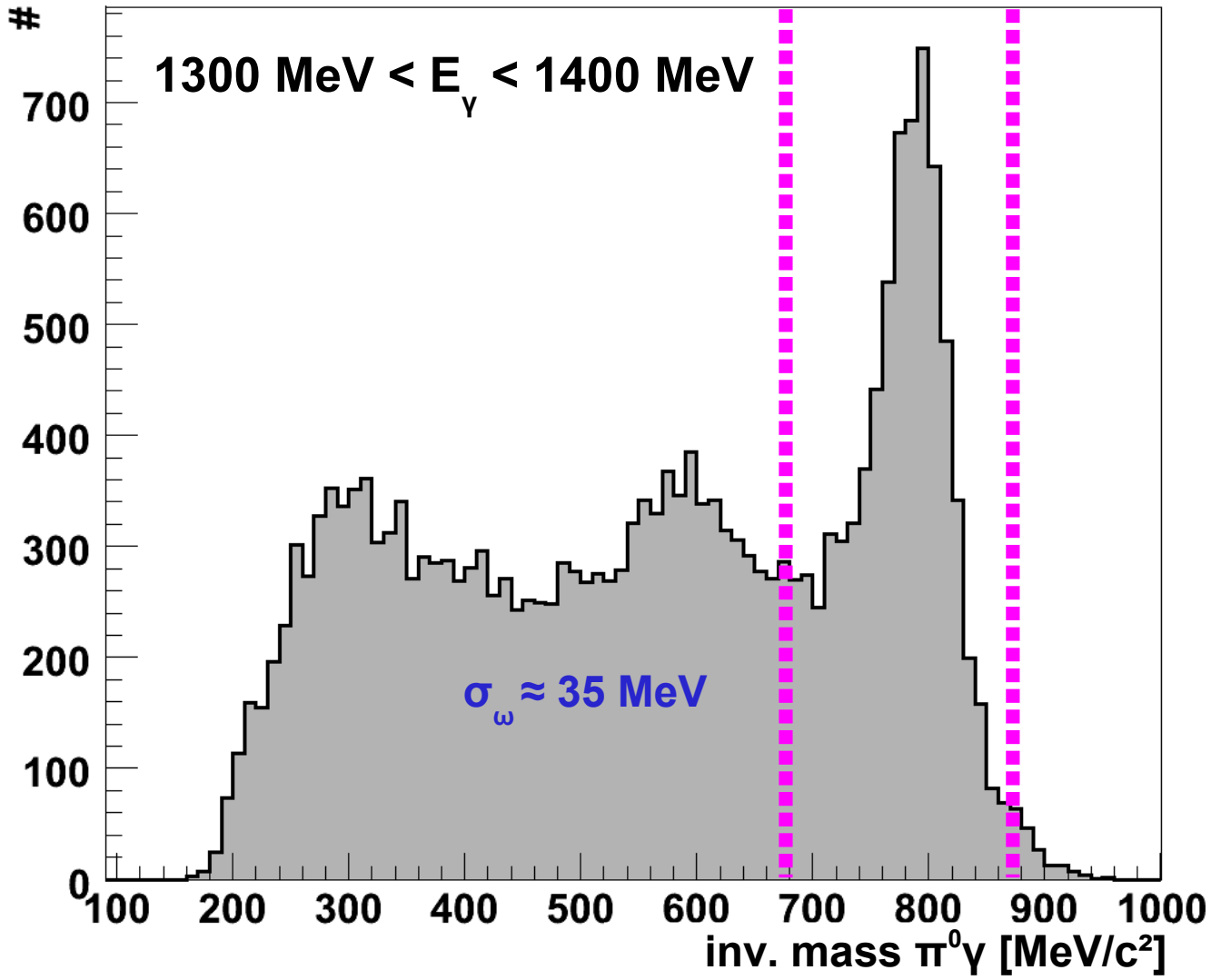
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

RUHR-UNIVERSITÄT BOCHUM

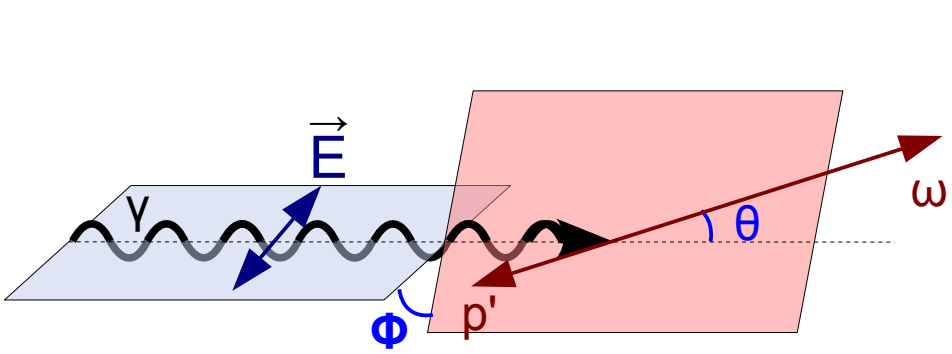
universitätbonn

# $\gamma p \rightarrow p\omega$

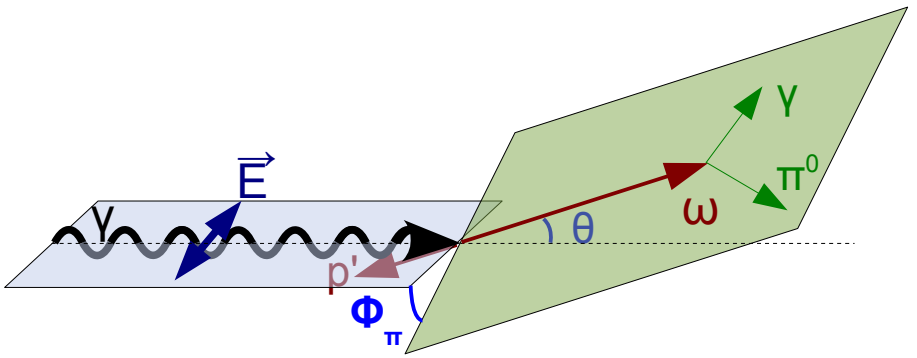
8.9% $\rightarrow \pi^0\gamma \rightarrow \gamma\gamma\gamma$



# beam- and pion-asymmetry ($\Sigma$, $\Sigma_\pi$)

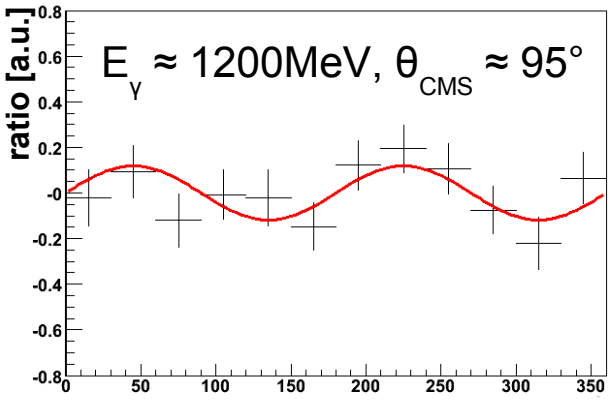



polarization plane reaction plane

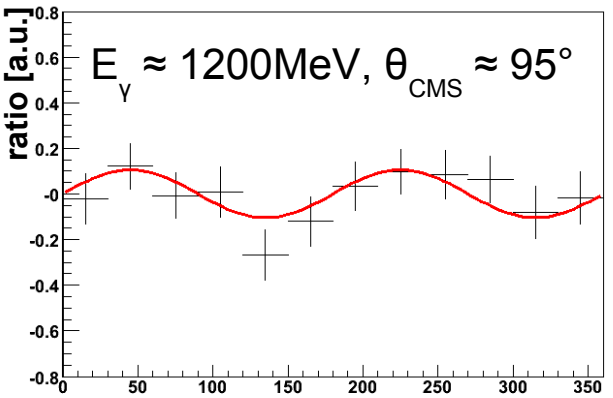



polarization plane decay plane

$$\frac{N_{P_\gamma=45°}(\Phi_{(\pi)}) - N_{P_\gamma=-45°}(\Phi_{(\pi)})}{N_{P_\gamma=45°}(\Phi_{(\pi)}) + N_{P_\gamma=-45°}(\Phi_{(\pi)})} = P_\gamma \Sigma_{(\pi)} \cos(2\Phi_{(\pi)})$$




Φ[°]

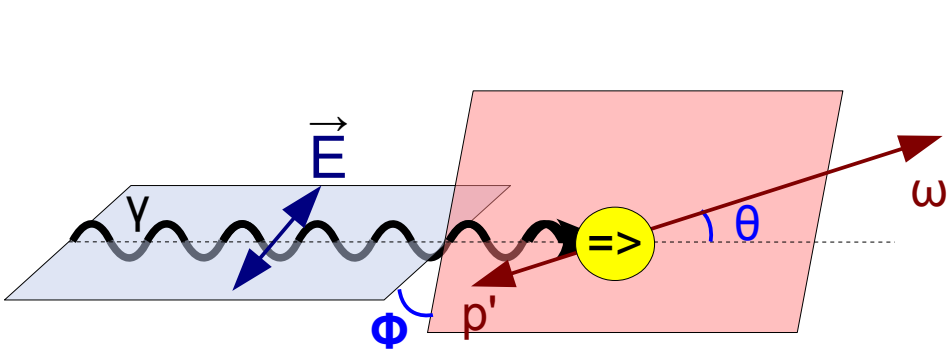



$\Phi_\pi$[°]

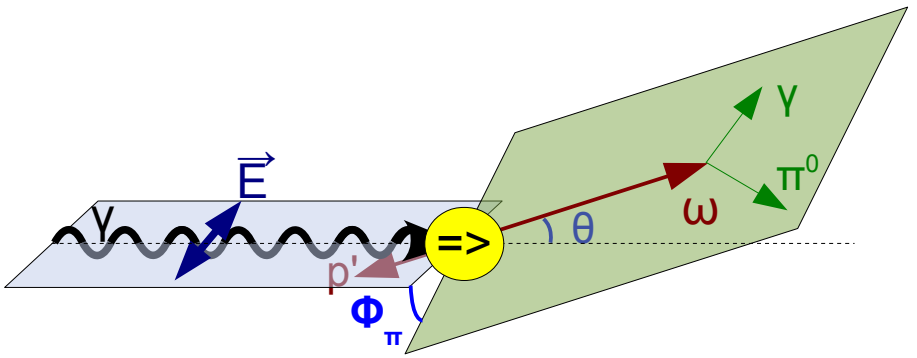
universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

# polarization observables G and $G_{\pi}$

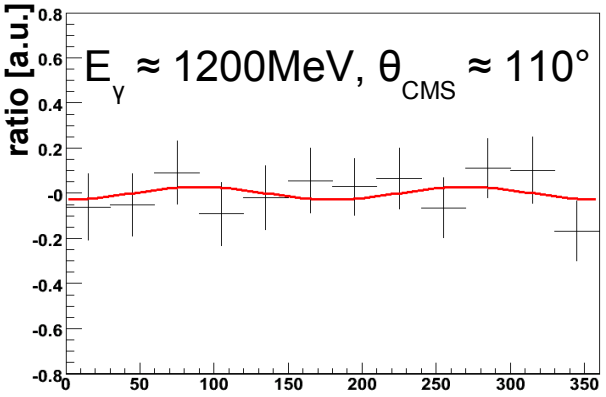



polarization plane reaction plane

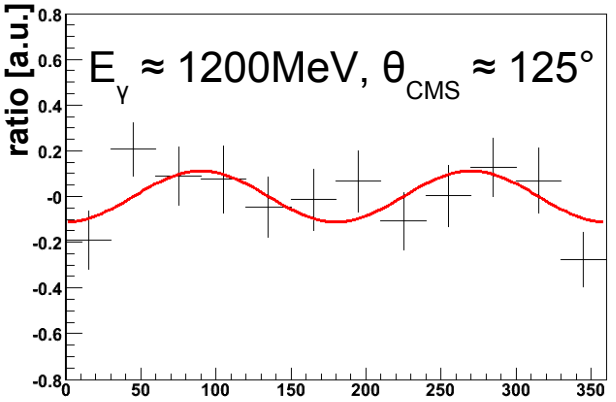



polarization plane decay plane

$$\frac{\left(N^{P_T=+}_{P_\gamma=45^\circ}(\Phi_{(\pi)})+N^{P_T=-}_{P_\gamma=-45^\circ}(\Phi_{(\pi)})\right)-\left(N^{P_T=-}_{P_\gamma=45^\circ}(\Phi_{(\pi)})+N^{P_T=+}_{P_\gamma=-45^\circ}(\Phi_{(\pi)})\right)}{N^{P_T=+}_{P_\gamma=45^\circ}(\Phi_{(\pi)})+N^{P_T=-}_{P_\gamma=-45^\circ}(\Phi_{(\pi)})+N^{P_T=-}_{P_\gamma=45^\circ}(\Phi_{(\pi)})+N^{P_T=+}_{P_\gamma=-45^\circ}(\Phi_{(\pi)})} = P_\gamma P_T G_{(\pi)} \sin(2\Phi_{(\pi)})$$




Φ[°]




$\Phi_{\pi}$[°]

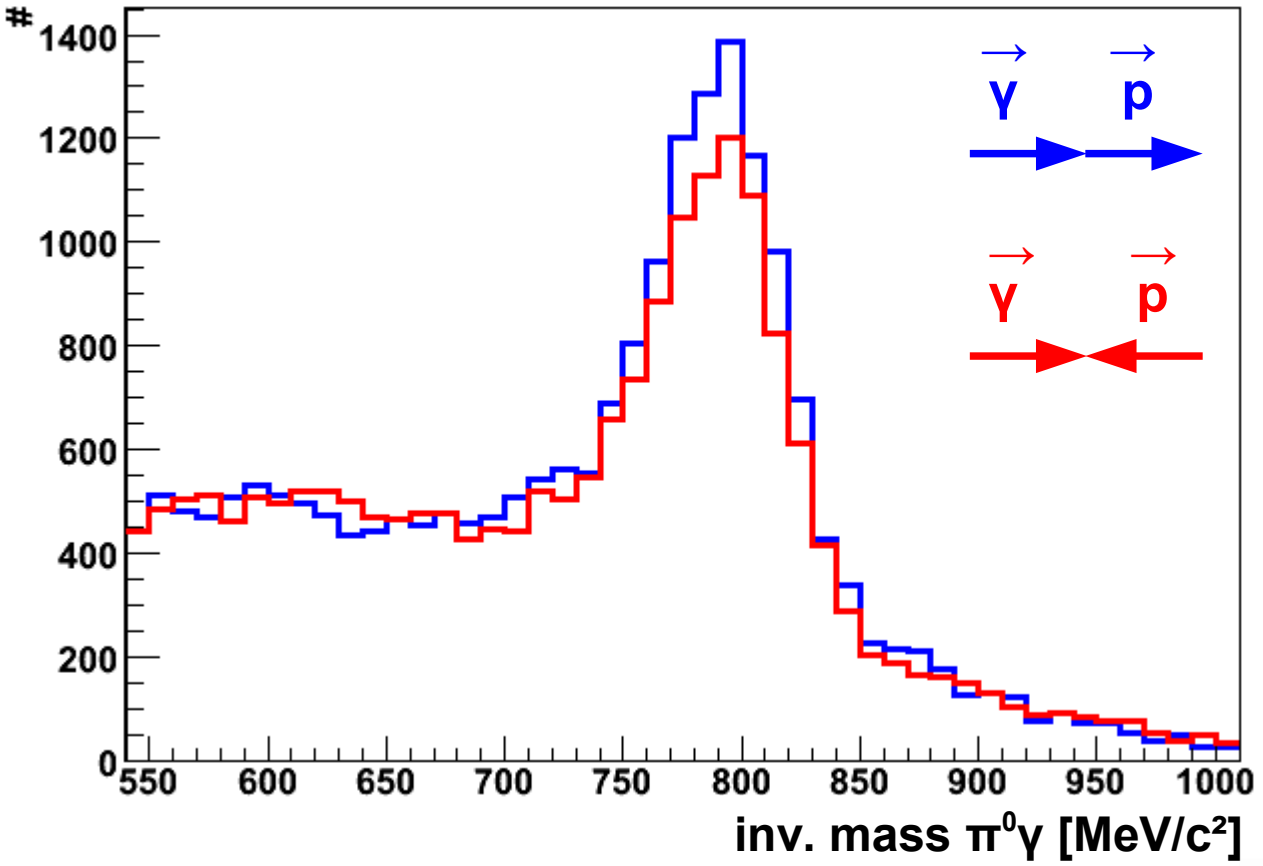
universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

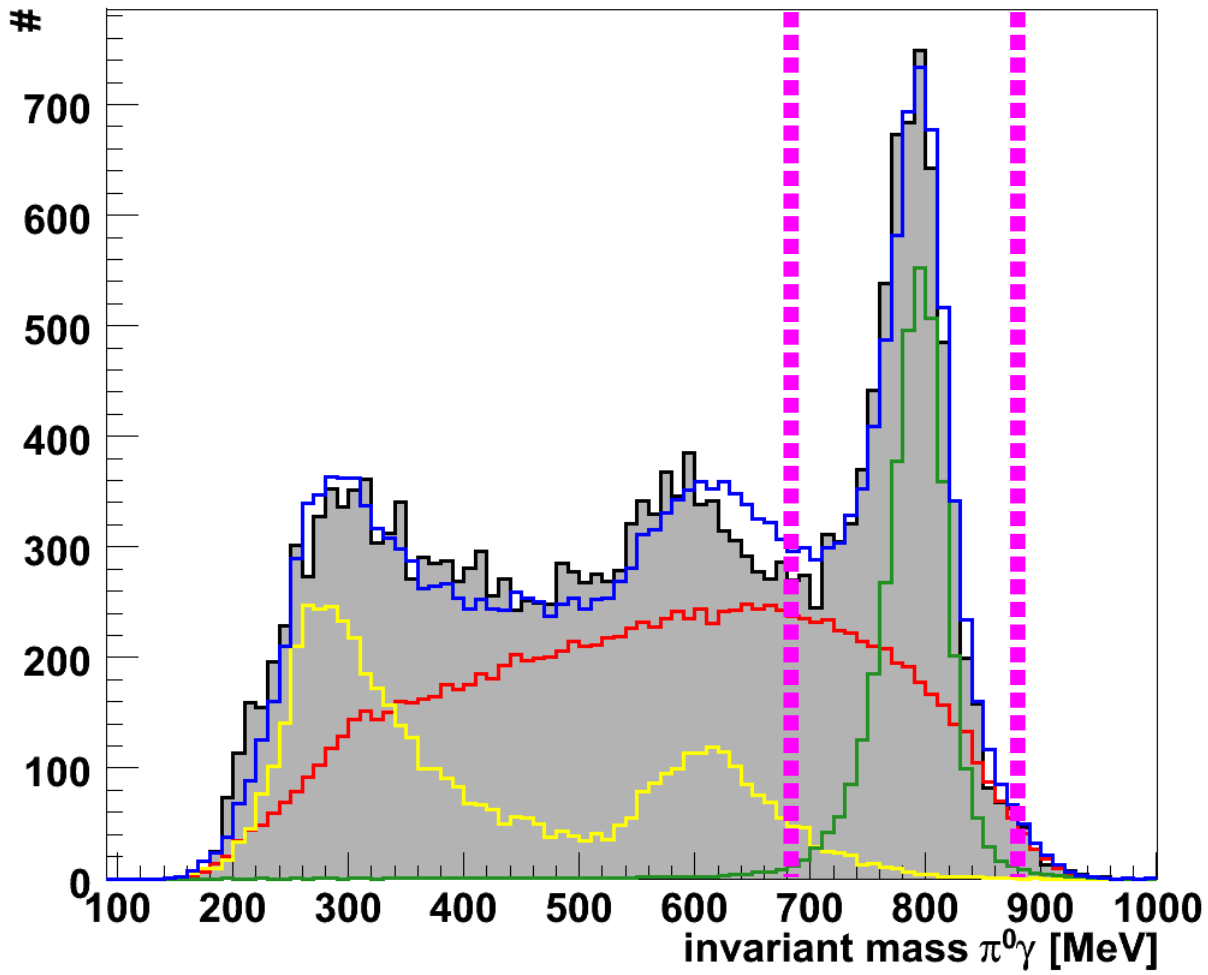
RUHR-UNIVERSITÄT BOCHUM

# polarization observable E

$$\frac{N_{P_{\gamma,o}\uparrow\downarrow P_T} - N_{P_{\gamma,o}\uparrow\uparrow P_T}}{N_{P_{\gamma,o}\uparrow\uparrow P_T} + N_{P_{\gamma,o}\uparrow\downarrow P_T}} = P_{\gamma,o} P_T E$$



# background correction




ω Monte Carlo

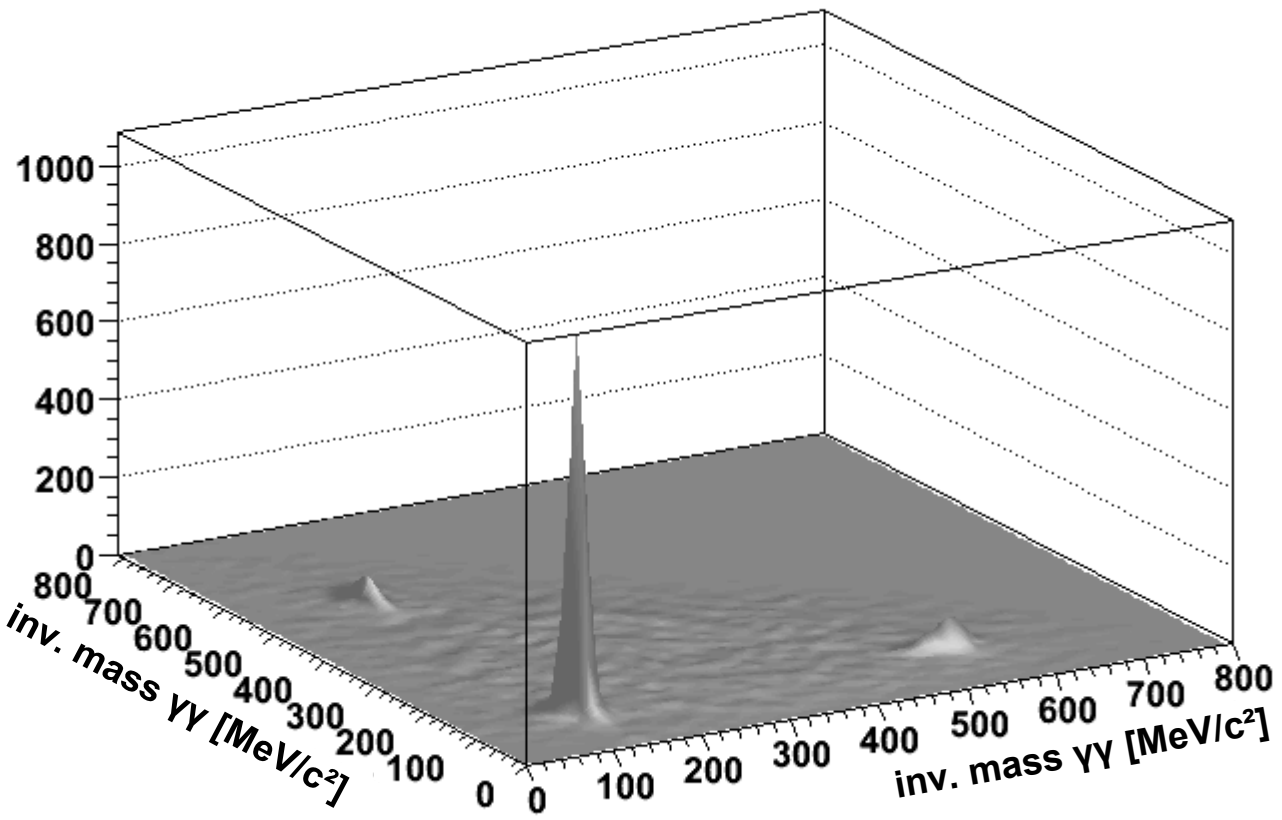
$2\pi^0$ Monte Carlo

$\pi^0$ Monte Carlo

sum

$$O_{measured} = w \cdot O_{\omega} + (1-w) \cdot O_{\pi\pi\pi}$$

# background correction




- $2\pi^0$ analysis with same kinematic cuts as for ω analysis
- restriction of the $2\pi^0$ invariant mass region to
  ω invariant mass region +20 MeV (energy loss due to thresholds)

universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

RUHR-UNIVERSITÄT BOCHUM

universitätbonn

# dilution factor f

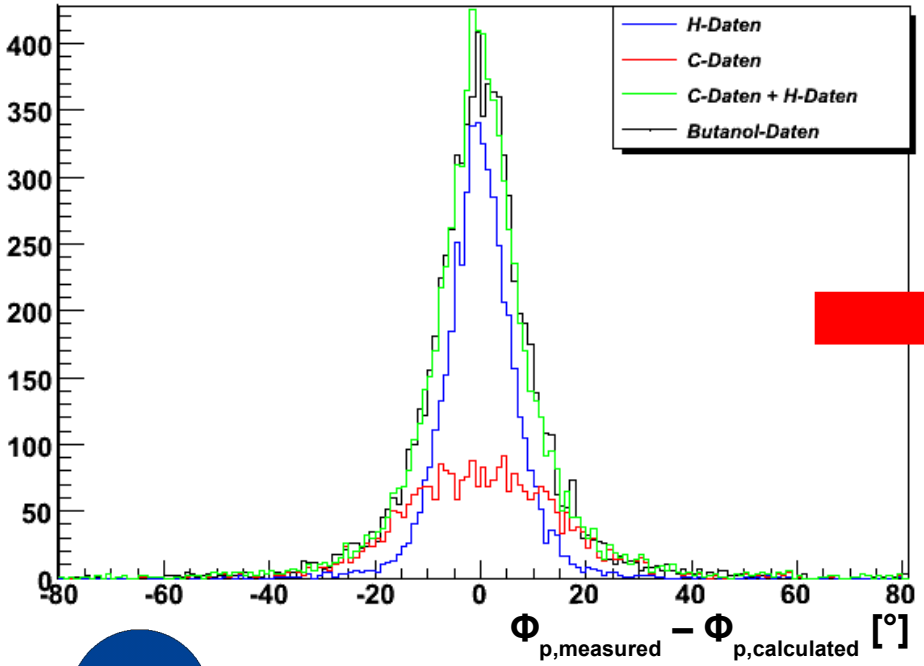
polarized target: Butanol = $C_4\mathbf{H_{10}}O$

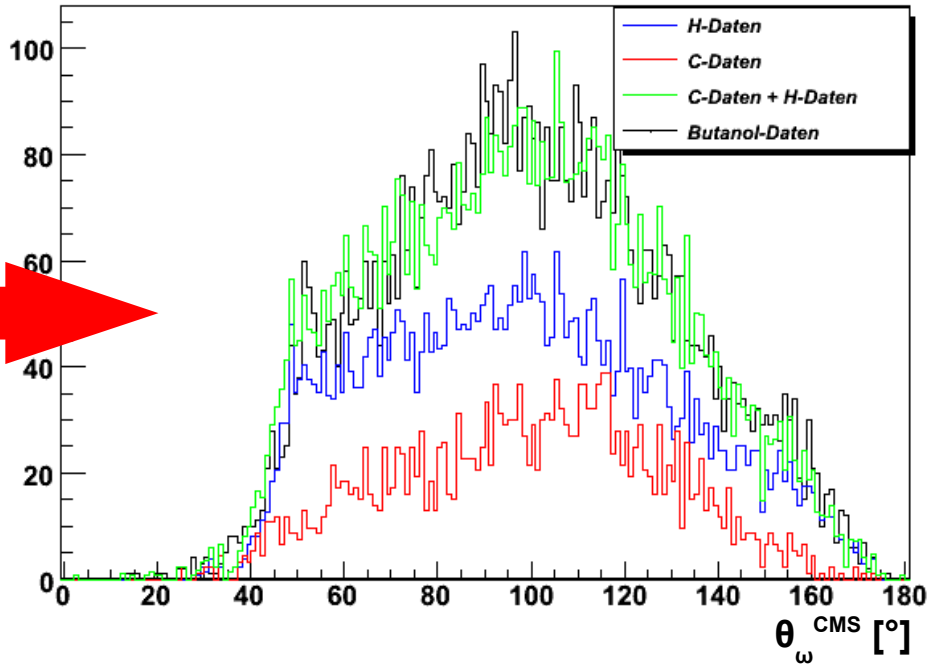
↓

target polarization: $P_T \hat{=} \mathbf{f} \cdot \tilde{P_T}$

↓

determination via H- and C-data



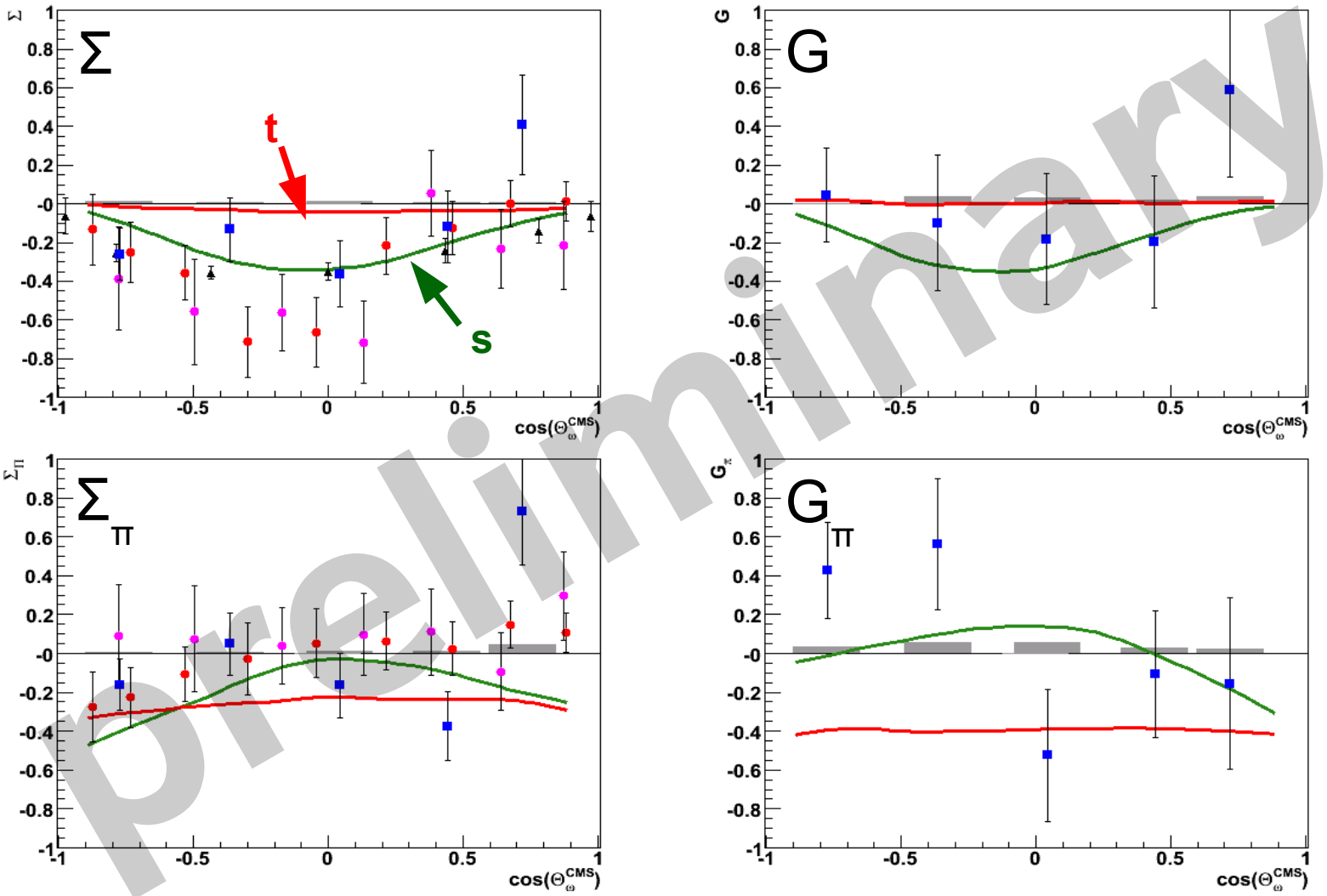

universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

RUHR-UNIVERSITÄT BOCHUM

universitätbonn

# results $\Sigma,\Sigma_\pi,G,G_\pi$(1108-1300MeV)





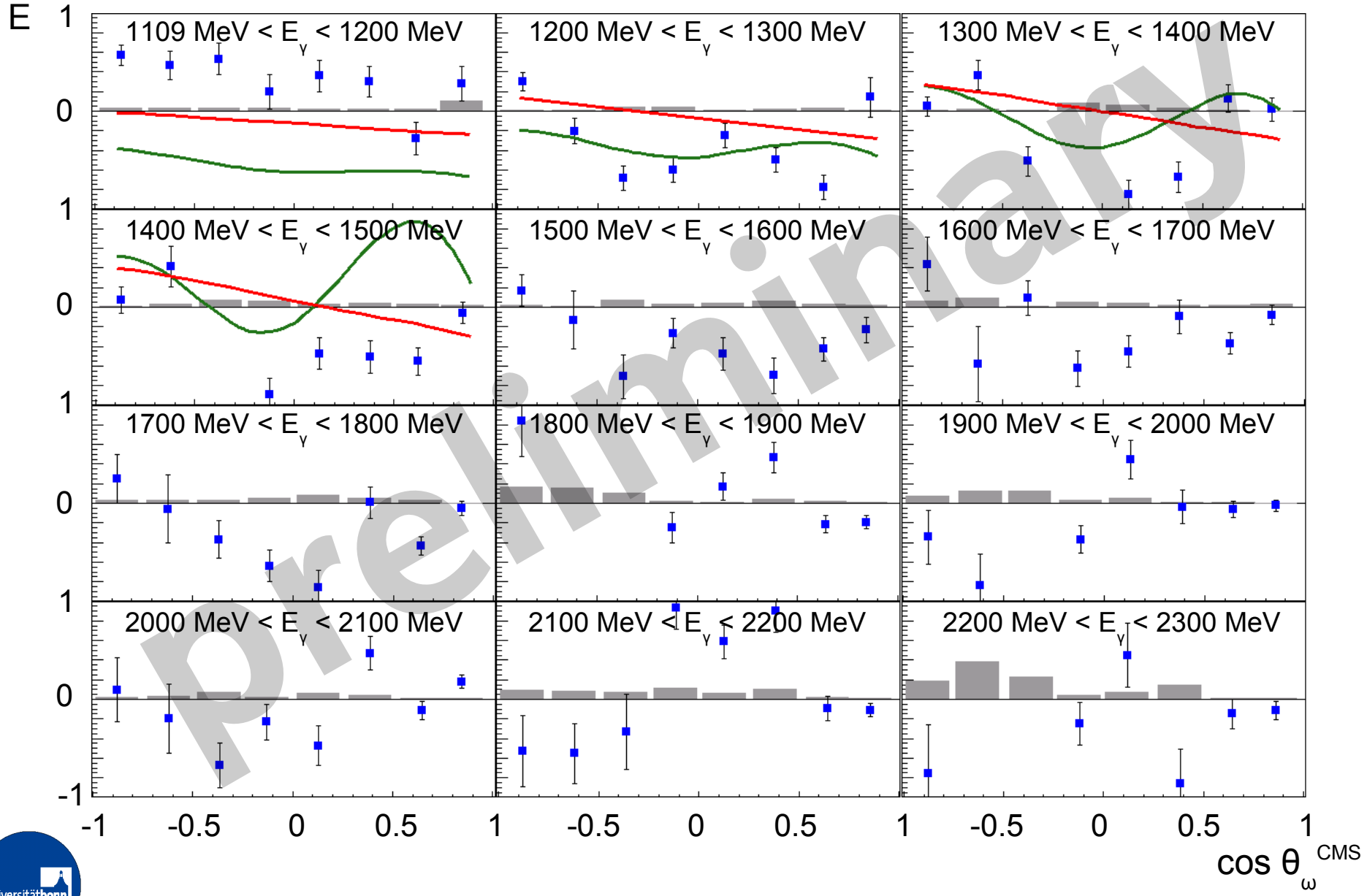

- this work
- Frank Klein et al., Phys. Rev. D 78 (1108MeV – 1200MeV)
- Frank Klein et al., Phys. Rev. D 78 (1200MeV – 1300MeV)
- ▲ Ajaka et al., PRL 96 (1108MeV - 1218MeV)
- A.V. Sarantsev et al., Eur. Phys. J. A 39 (t-channel)
- A.V. Sarantsev et al., Eur. Phys. J. A 39 (incl. s-channel)

universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

universitätbonn

# results E






- this work
- A.V. Sarantsev et al., Eur. Phys. J. A 39 (t-channel)
- A.V. Sarantsev et al., Eur. Phys. J. A 39 (incl. s-channel)

universitätbonn

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

universitätbonn

# summary

- status of my analysis of the reaction γp→pω
  - extraction of:
    - single polarization observables **Σ, $\Sigma_\pi$** (linear)
    - double polarization observables **G, $G_\pi$** (linear)
    - double polarization observable **E** (circular)
- clear evidence for s-channel contributions in Σ und E
- extension of statistics in particular for G and $G_\pi$ necessary

**SFB/TR16**

**supported by the DFG**

universitätbonn