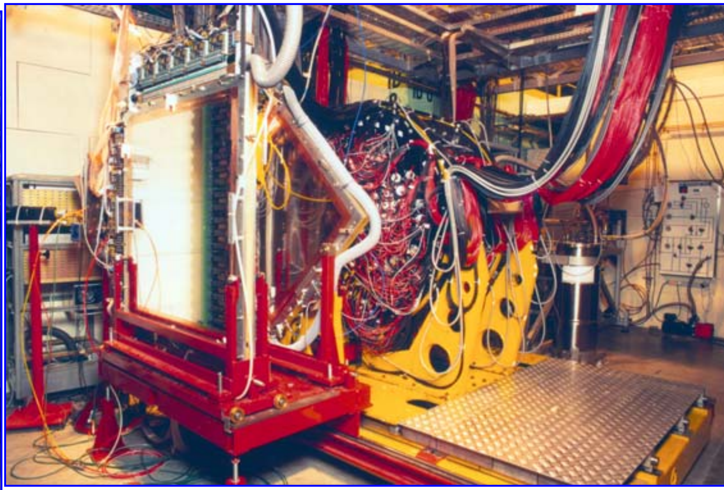
Search for N*(1685) in Real Compton Scattering: First Results



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Why Compton Scattering?

Recent observation of N*(1685) resonance in eta photoproduction off the neutron dictates a need to search for its signal in other reactions. The decay of this resonance to a pion final state is predicted to be suppressed (R. A. Arndt, Ya. Azimov, M.v.Polyakov, I. Strakovsky, and R. Workman, Phys. Rev. C69 035208 (2004); arXiv: nucl-th/0312126, M.Polyakov, A.Rathke, hep-ph/0303138)

,.

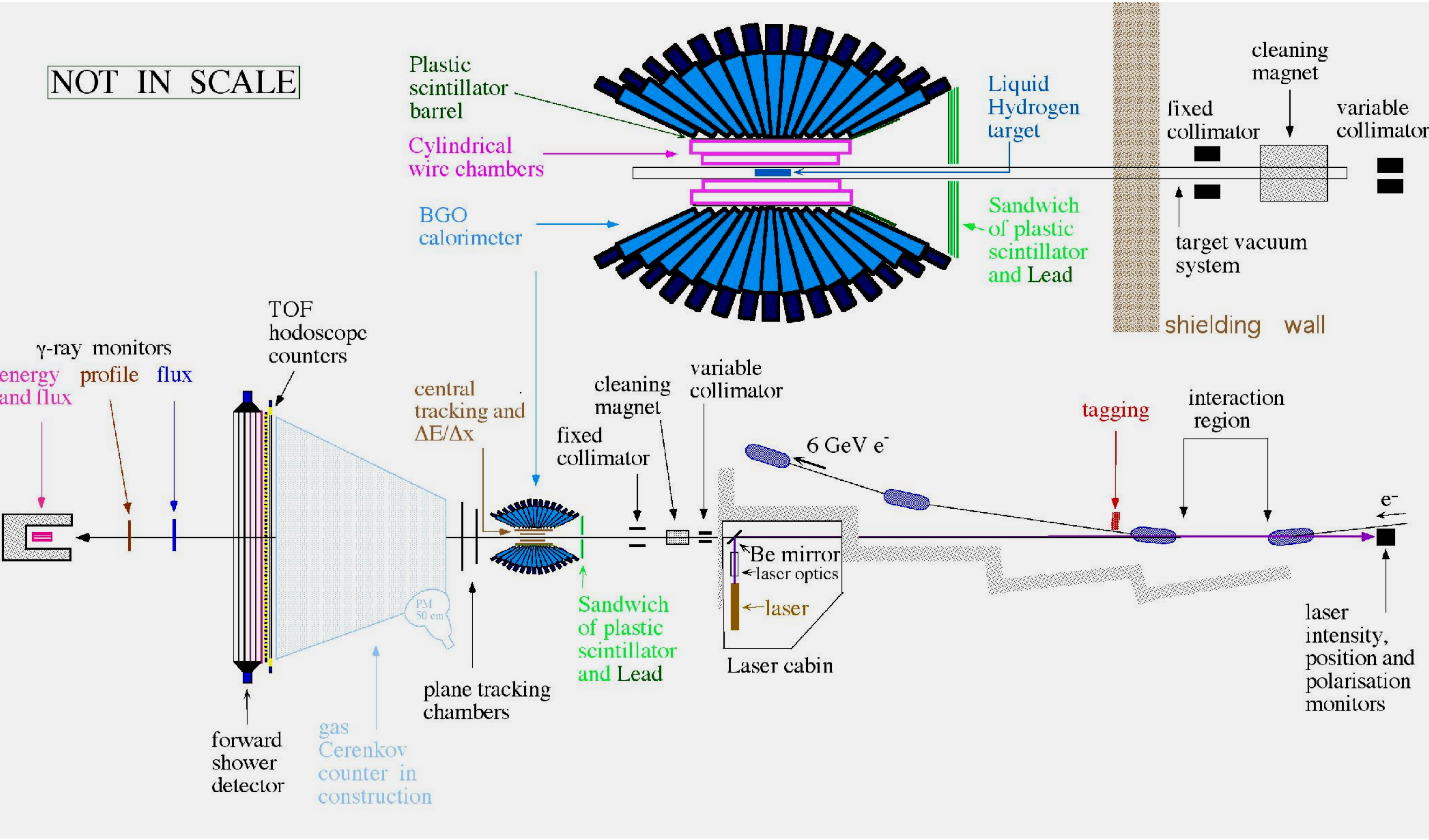
There two other reactions to search for N*(1685)

$\gamma n \rightarrow K^0 \Lambda$

The threshold is ~1.62 GeV. Problems are near-threshold effects overlapping with Fermi motion smearing, FSI, background reactions $\gamma N \rightarrow \pi\pi N$, $\gamma N \rightarrow \pi\pi\pi N$, $\gamma N \rightarrow \omega N$,$\gamma N \rightarrow \rho N$ all having peculiarities near 1.72 GeV, plus low efficiency of the GRAAL detector for this final state .

$\gamma n \rightarrow \gamma n$

GRAAL Setup

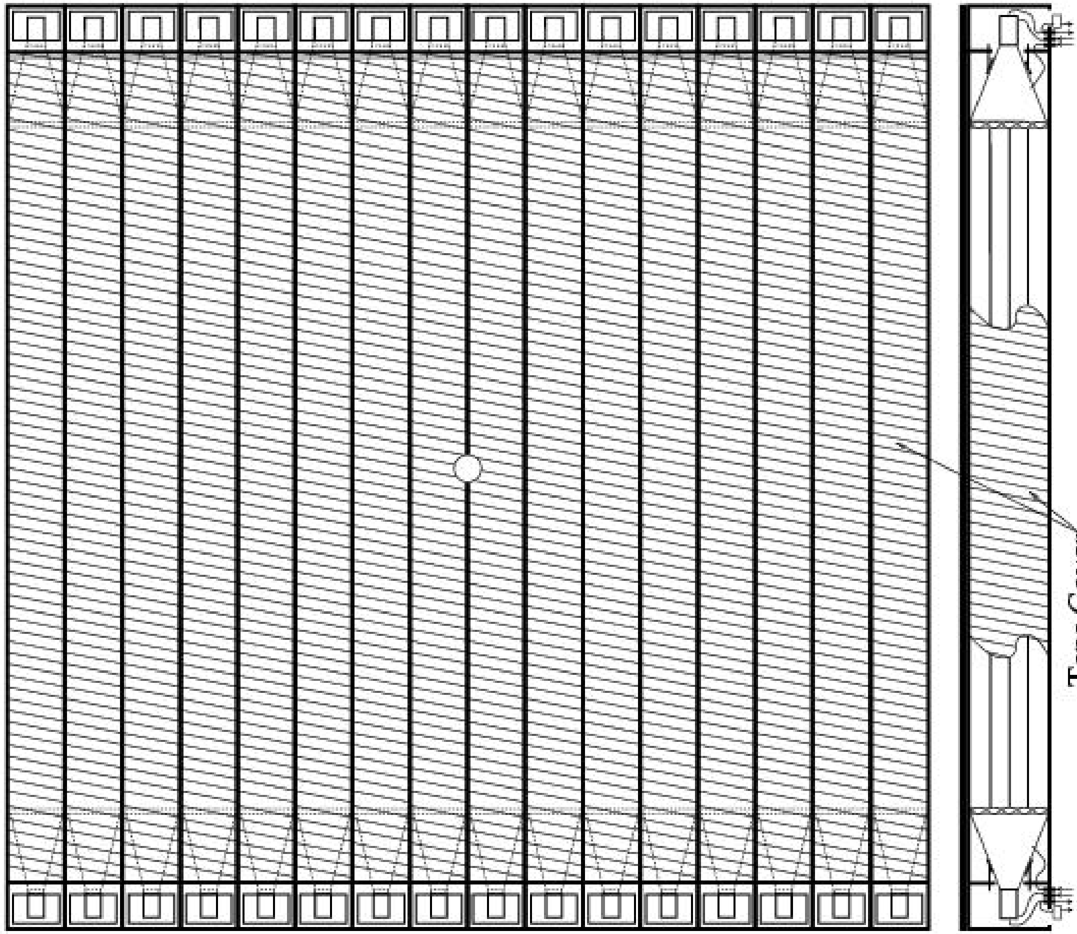


NOT IN SCALE
Plastic scintillator barrel
Cylindrical wire chambers
BGO calorimeter
Liquid Hydrogen target
Sandwich of plastic scintillator and Lead
fixed collimator
cleaning magnet
variable collimator
target vacuum system
shielding wall
γ-ray monitors
energy and flux
profile
flux
TOF hodoscope counters
central tracking and ΔE/Δx
cleaning magnet
fixed collimator
variable collimator
tagging
interaction region
6 GeV e-
e-
Be mirror
laser optics
laser
Laser cabin
Sandwich of plastic scintillator and Lead
plane tracking chambers
forward shower detector
gas Cerenkov counter in construction
laser intensity, position and polarisation monitors

GRAAL forward lead-scintillator wall (``Russian Wall")

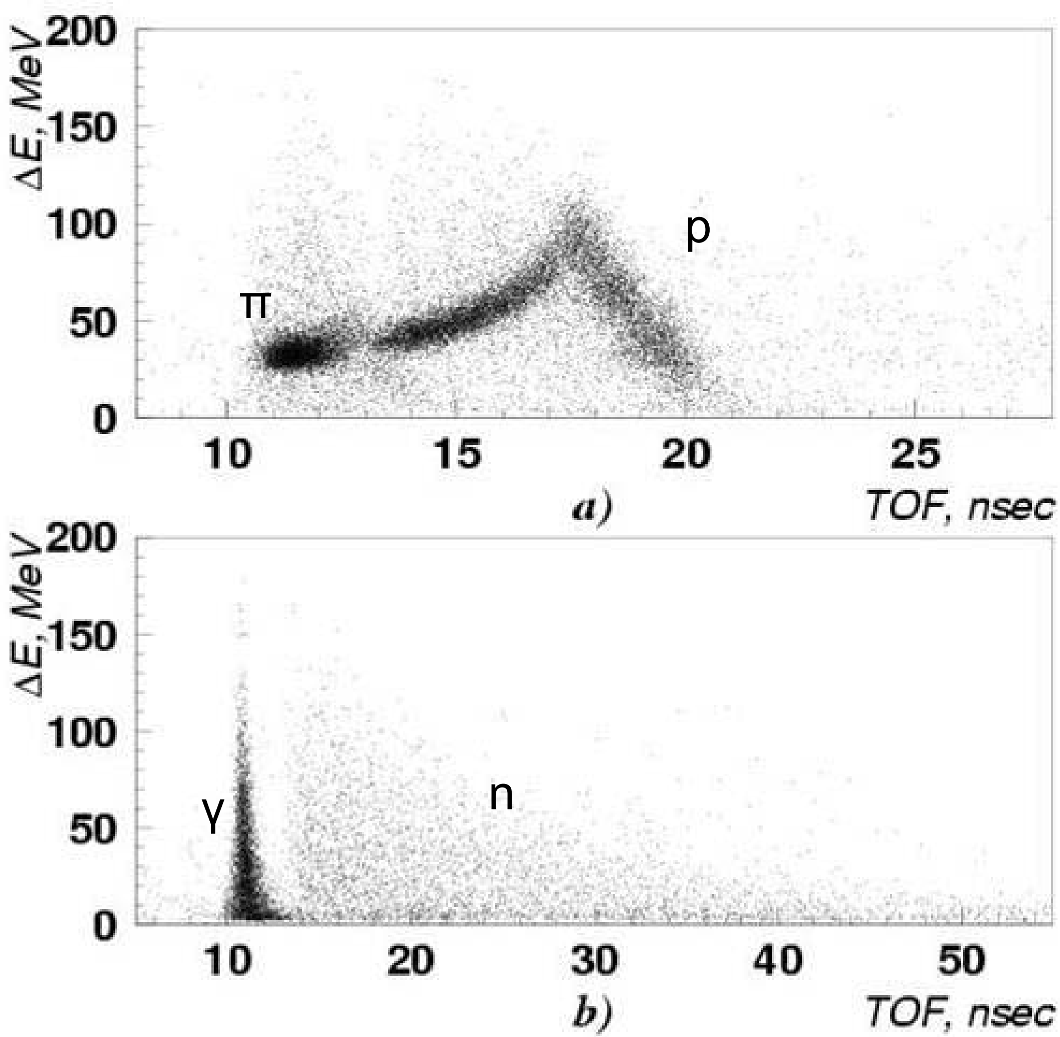
V.Kouznetsov et al., NIM A **487** (2002) 396.

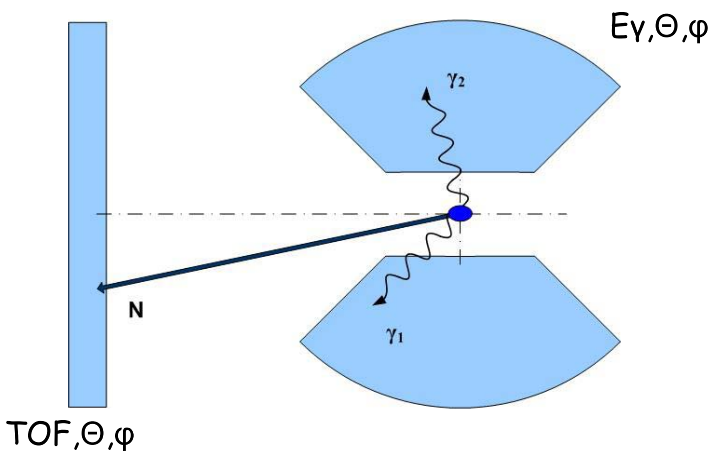
An assembly of 16 modules. Each module is a sandwich of four 3000x40 mm2 bars with 3 mm thick lead plates between them. A 25 mm thick steel plate at the front of the module acts as a main converter and as a module support.



Particle identification and performance

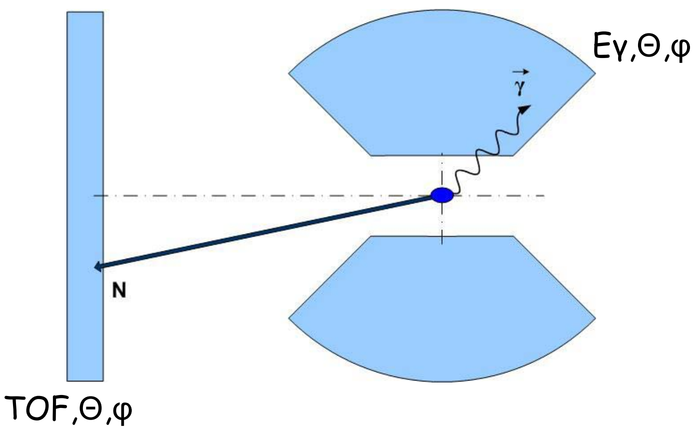
- Performance of the Russian Wall at GRAAL:
- TOF resolution – 0.6 ns(FWHM)
- Angular resolution – 2-3 deg(FWHM)
- Photon efficiency – 95%
- Neutron efficiency – 22%





The GRAAL detector makes it possible the simultaneous study

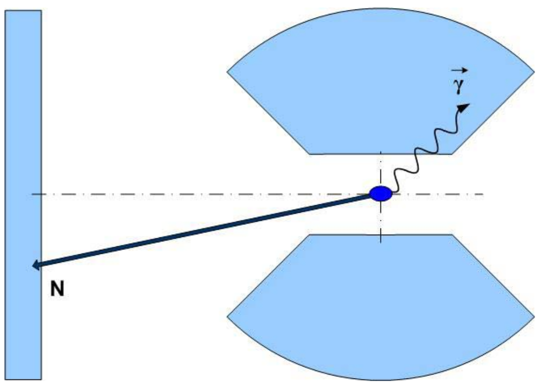
γp→ηp	γn→ηn
γp→π^0p	γn→π^0n
γp→γp	γn→γn



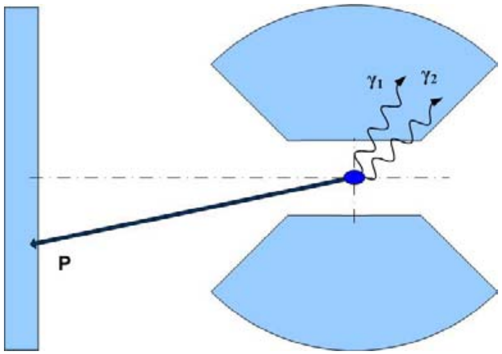
on the quasi-free proton and quasi-free neutron in the same experimental run.

The main problem of Compton scattering measurements is the π^0 background.

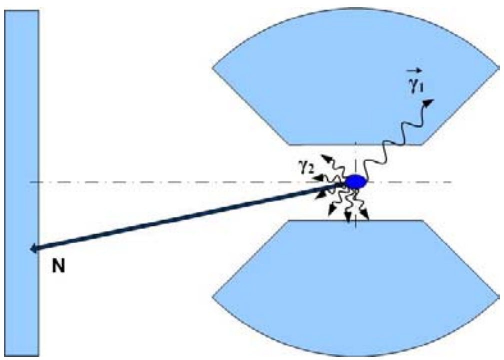
Compton scattering



π^0 background



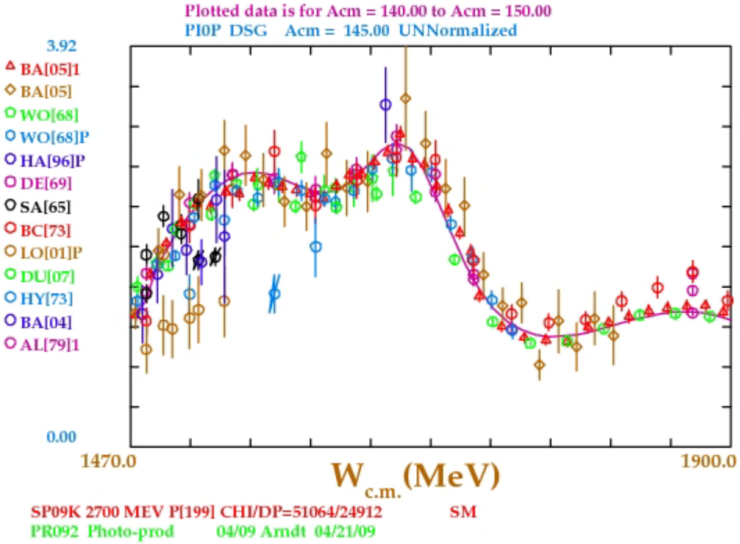
Symmetric π0 decay, two photon hits are mixed in one BGO cluster.

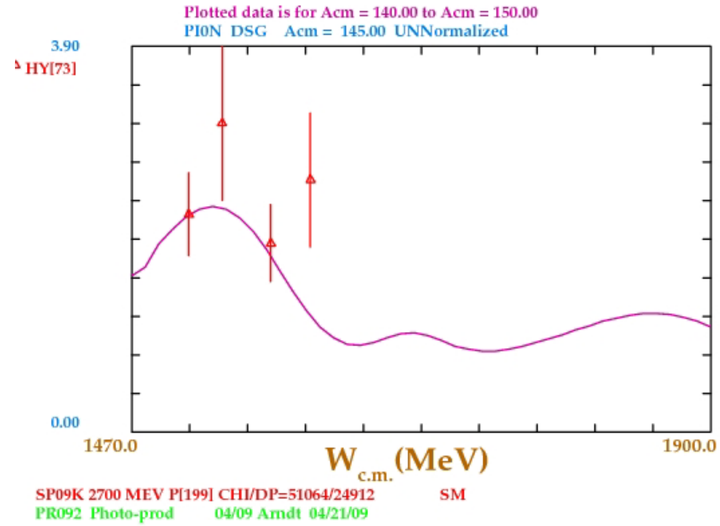


Asymmetric π0 decays, the second low-energy photon may not be detected.

First Step: Study of π^0 background

SAID Data Base





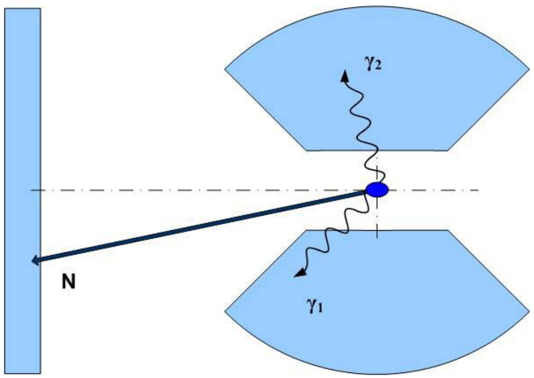
$\gamma p \rightarrow \pi^0 p$: Bump structure near W=1.65-1.7 GeV

: Almost no data

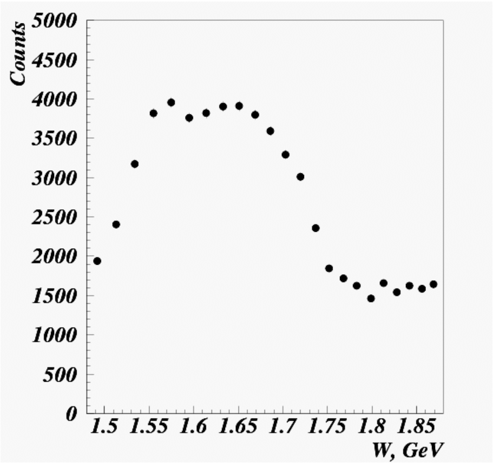
There is a need to study $\gamma n \rightarrow \pi^0 n$

π^0 Data analysis

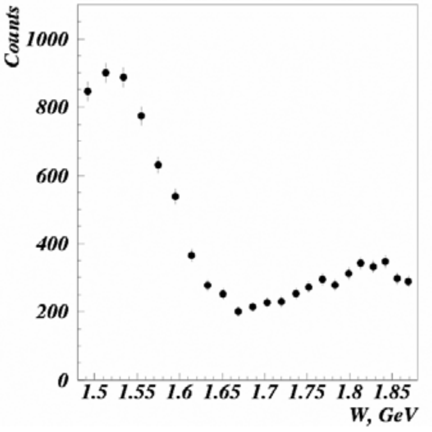
- Detection of two photons in the BGO ball and the recoil proton/neutron in the forward detectors;
- Cut on the neutron/proton missing mass;
- Cut on the 2γ invariant mass;
- Cut on the square of the pion missing mass;
- Complanarity;



Reaction yields



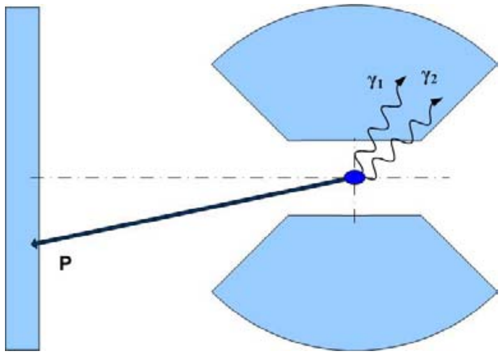
$\gamma p \rightarrow \pi^0 p$: Bump structure at W~1.7 GeV



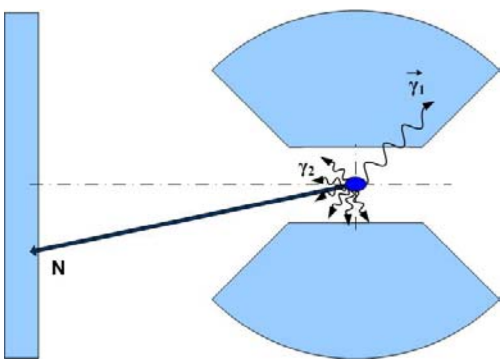
$\gamma n \rightarrow \pi^0 n$: No bump structure

See also Talk of Bernd Krusche by Monday.

Rejection of π0 background



Symmetric decays are rejected by the analysis of cluster shapes in the BGO Ball. Efficiency of this rejection is ~99%. If the pion is emitted at backward angles, its energy is low. Such events are suppressed.



Asymmetric decays: If the first photon is emitted at **the backward angles,** the low-energy second photon can be detected in the Russian Wall or the BGO Ball.

→ **Discrimination of Compton scattering from π^0 events is possible at backward angles.**

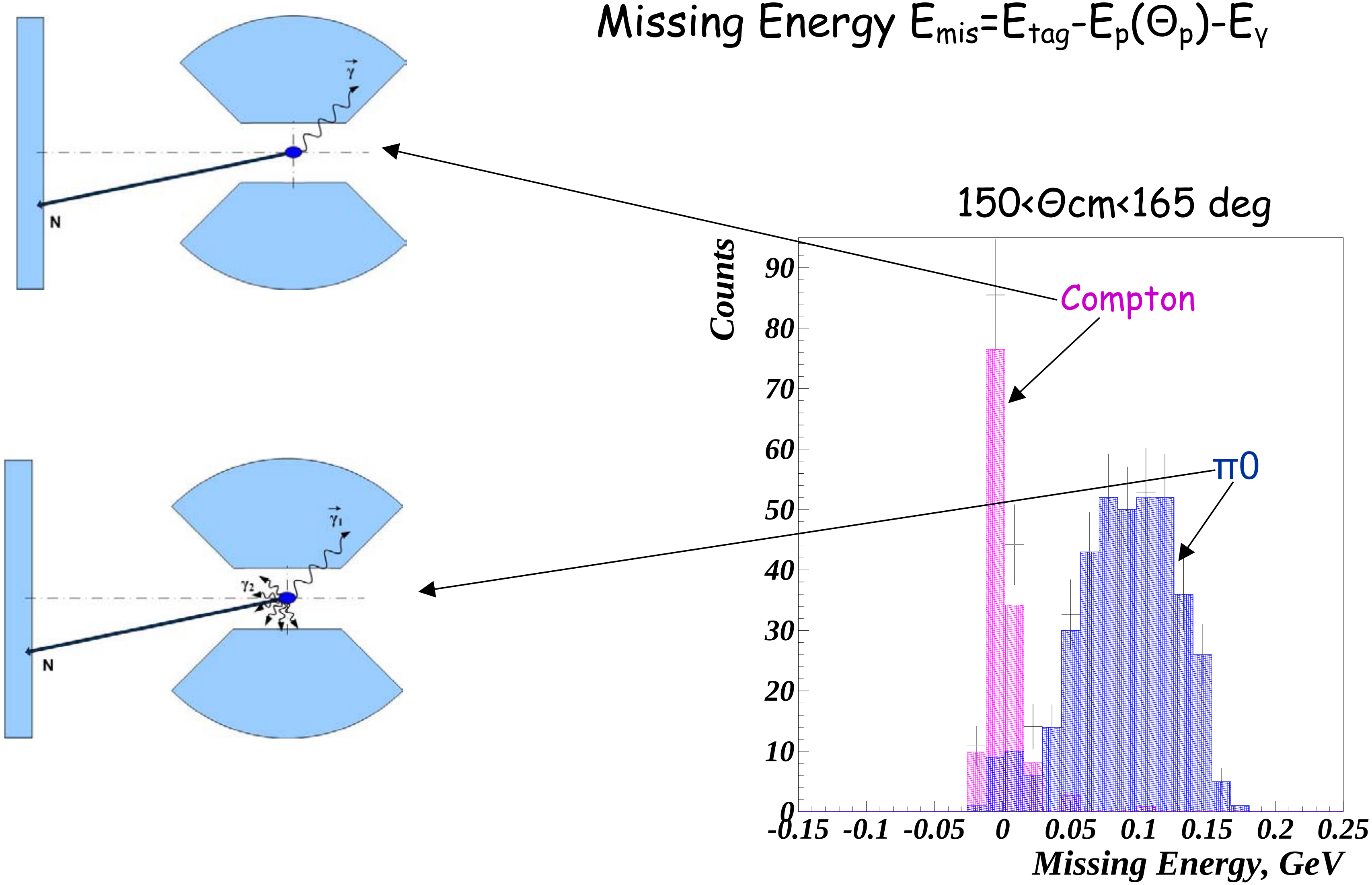
Data analysis

- Detection of only one photon in the BGO Ball and the recoil proton/neutron in the Russian Wall;
- Complanarity;
- Cut in the neutron/proton TOF and angle;
- Cut on the proton/neutron missing mass;
- Cut on the squared photon missing mass;
- Cluster-shape analysis.

After that Only Compton and π^0 events (asymmetric decays) are selected.

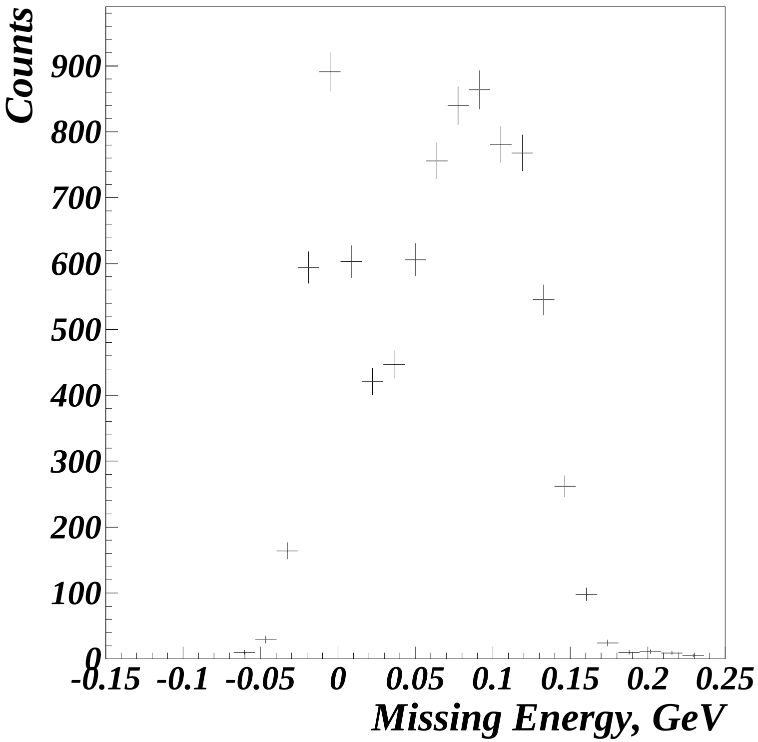
$\gamma p \rightarrow \gamma p$ Simulations

Missing Energy $E_{mis}=E_{tag}-E_p(\Theta_p)-E_\gamma$

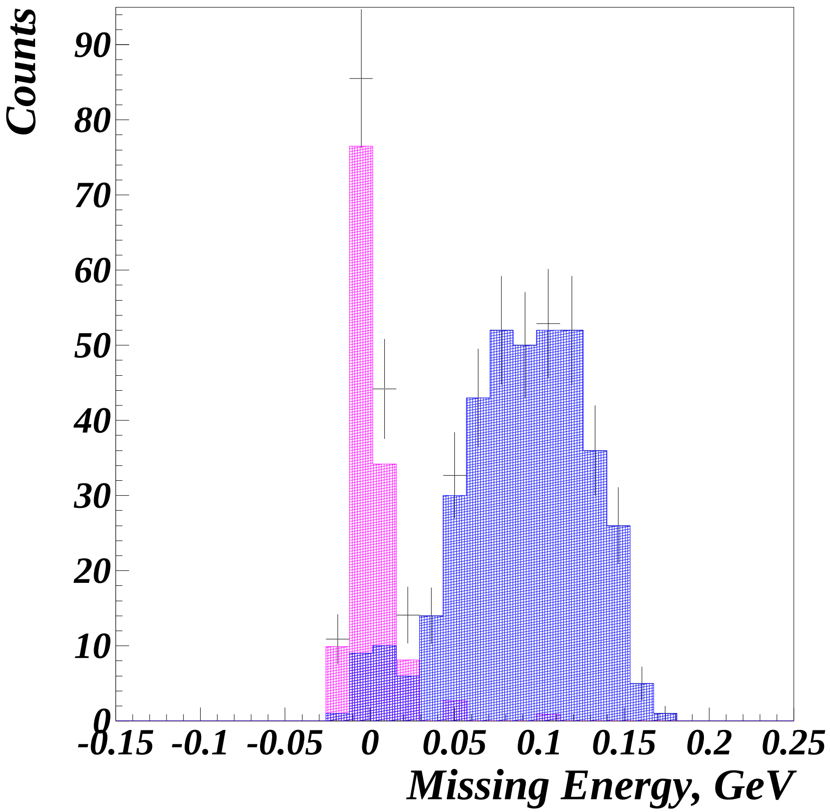


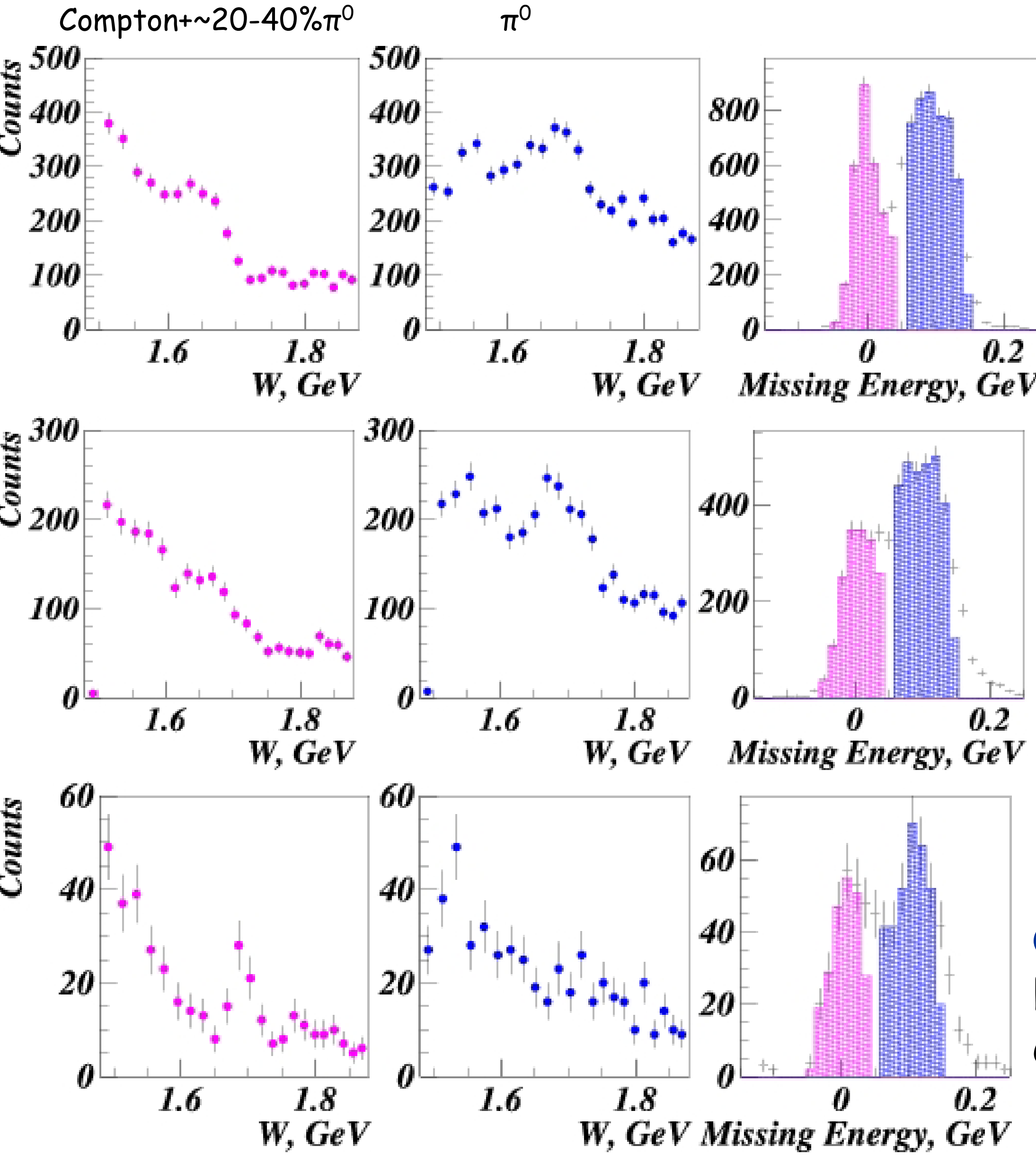
γp→γp on the free proton at 150<Θcm<165 deg

Data



Simulations

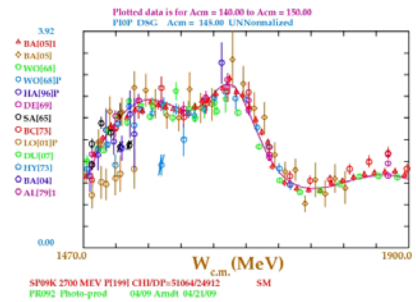




$150 < \Theta_{cm} < 165$ deg

Free proton

Bump structure at W~1.7 GeV in π^0 background similar to that seen in $\gamma p \to \pi^0 p$ data.

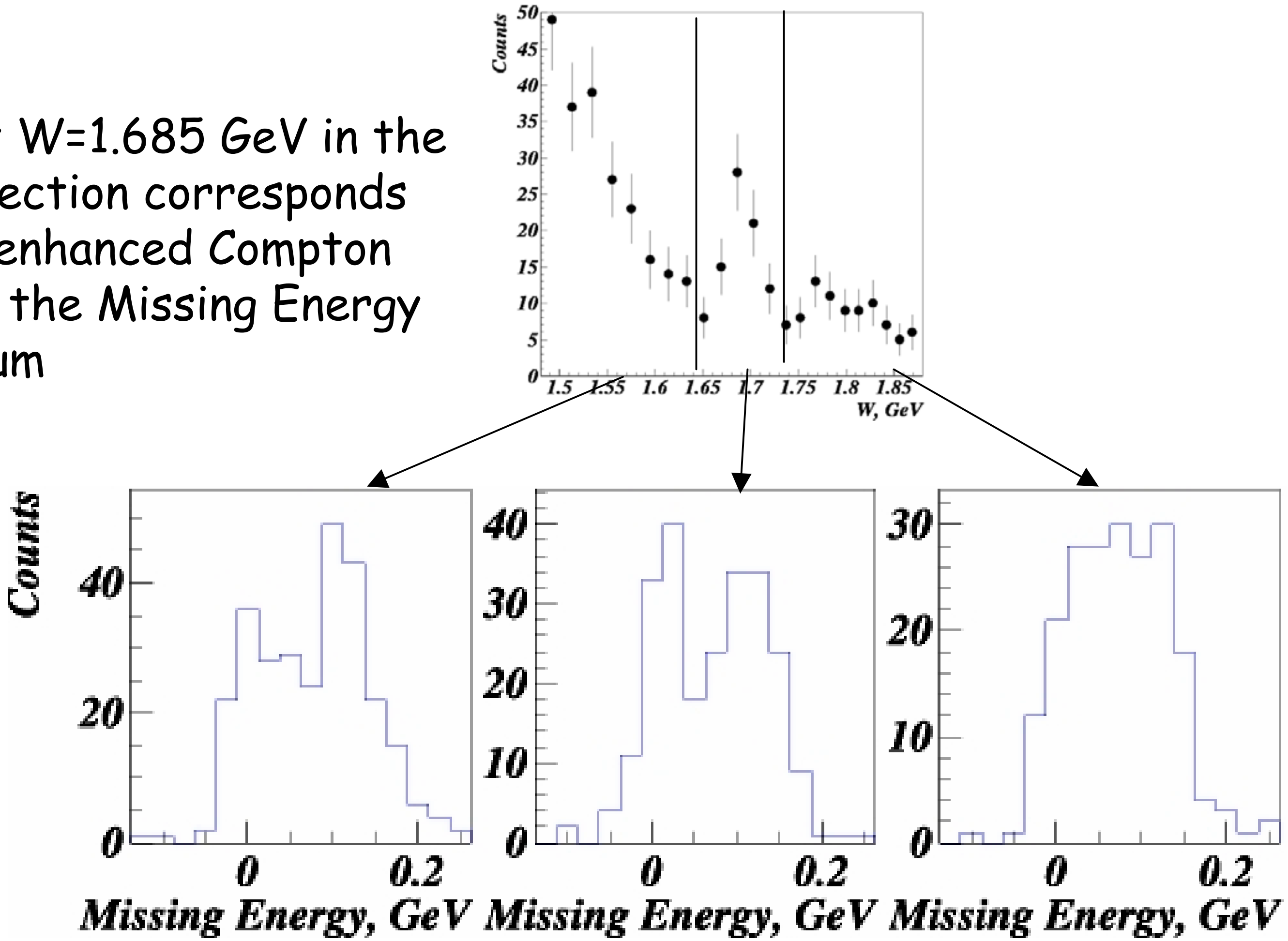


Quasi-free proton

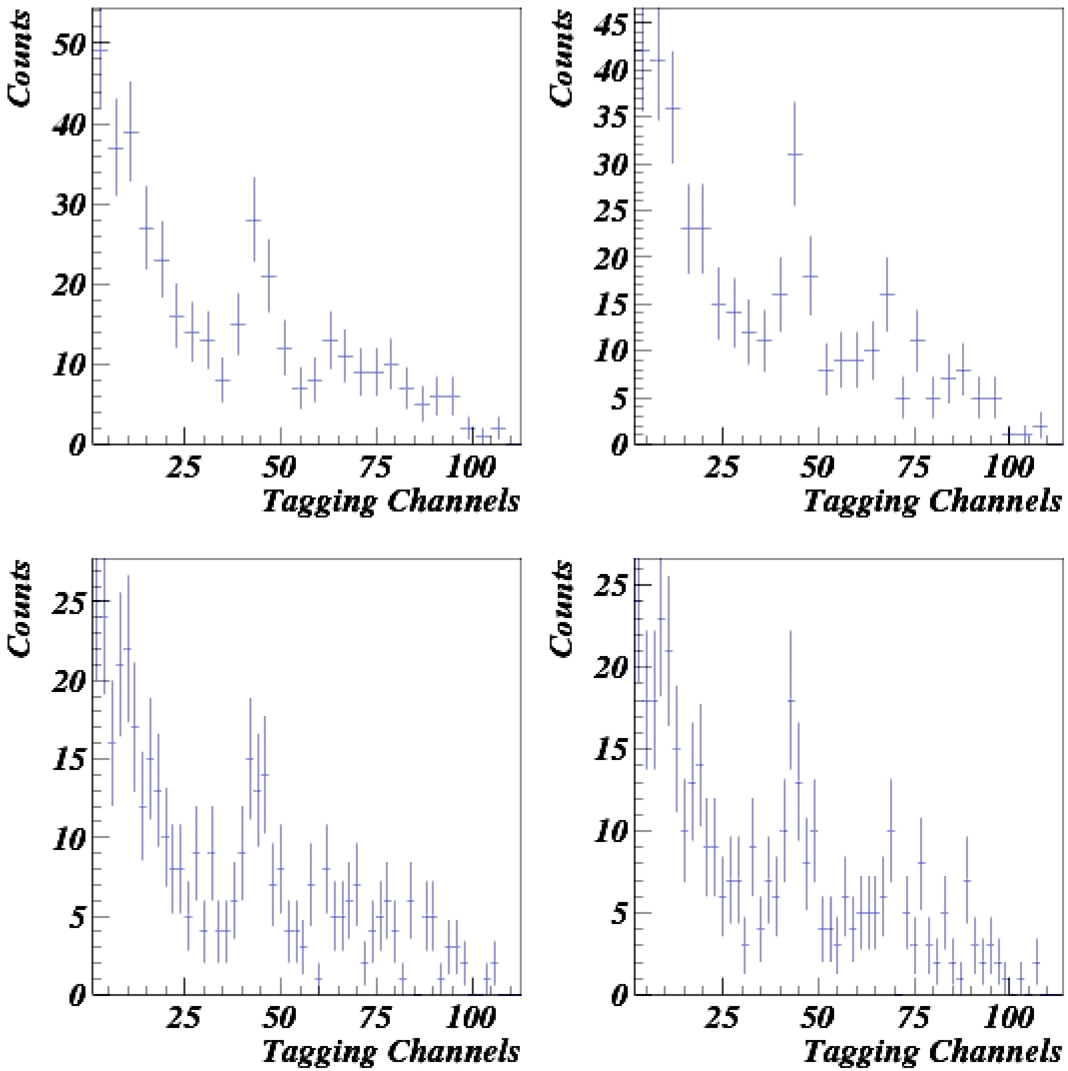
Quasi-free neutron: narrow bump at W=1.685 GeV in Compton, flat π^0 background

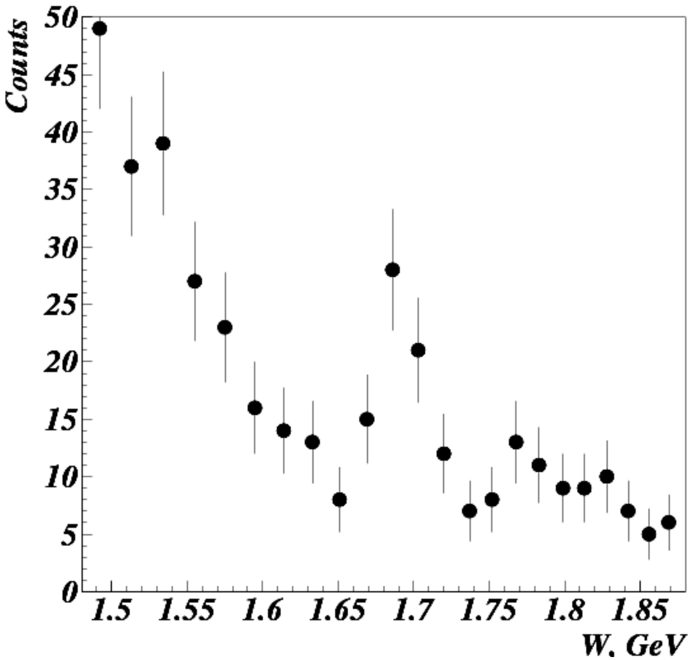
Cross Check

Peak at W=1.685 GeV in the cross section corresponds to the enhanced Compton peak in the Missing Energy spectrum

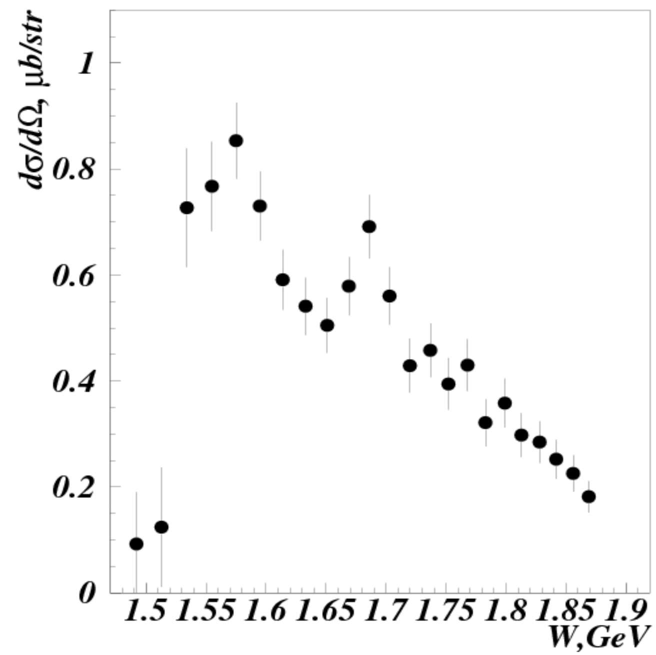


Different Binning




Counts
50
45
40
35
30
25
20
15
10
5
0
1.5 1.55 1.6 1.65 1.7 1.75 1.8 1.85
W, GeV

γn→γn


dσ/dΩ, μb/str
1
0.8
0.6
0.4
0.2
0
1.5 1.55 1.6 1.65 1.7 1.75 1.8 1.85 1.9
W,GeV

γn→ηn

Summary

First results on Compton scattering on the neutron reveal the peak at $W \approx 1.685$ GeV which is not seen in Compton scattering on the proton. Being considered in conjunction with the results on eta photoproduction, this observation supports the existence of N*(1685).

Thanks for your attention!

π^0 Data analysis

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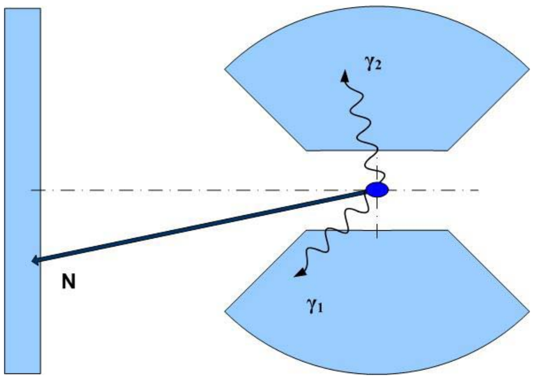

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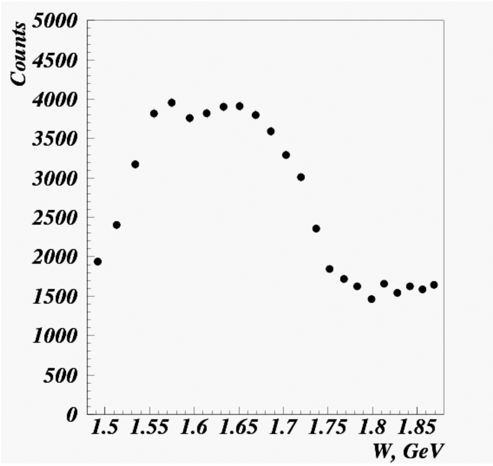
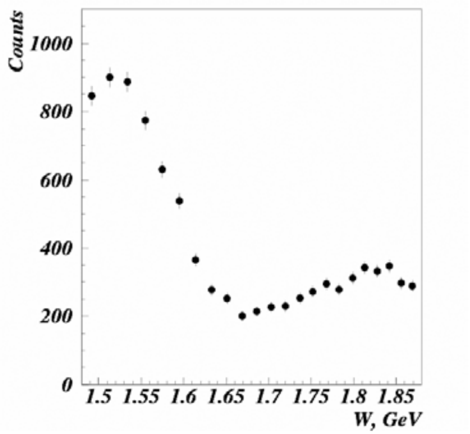


$\gamma p \rightarrow \pi^0 p$: Bump structure at W~1.7 GeV



$\gamma n \rightarrow \pi^0 n$: No bump structure

See also Talk of Bernd Krusche by Monday.