π^0 **Primakoff Reaction on the Proton**

Why the proton?

• Coherence can be satisfied by a missing mass cut

• The "nuclear coherent" amplitude for the proton is on a firm theoretical foundation[+]

Provides simultaneous description of:

$$\gamma p \rightarrow n\pi^+$$
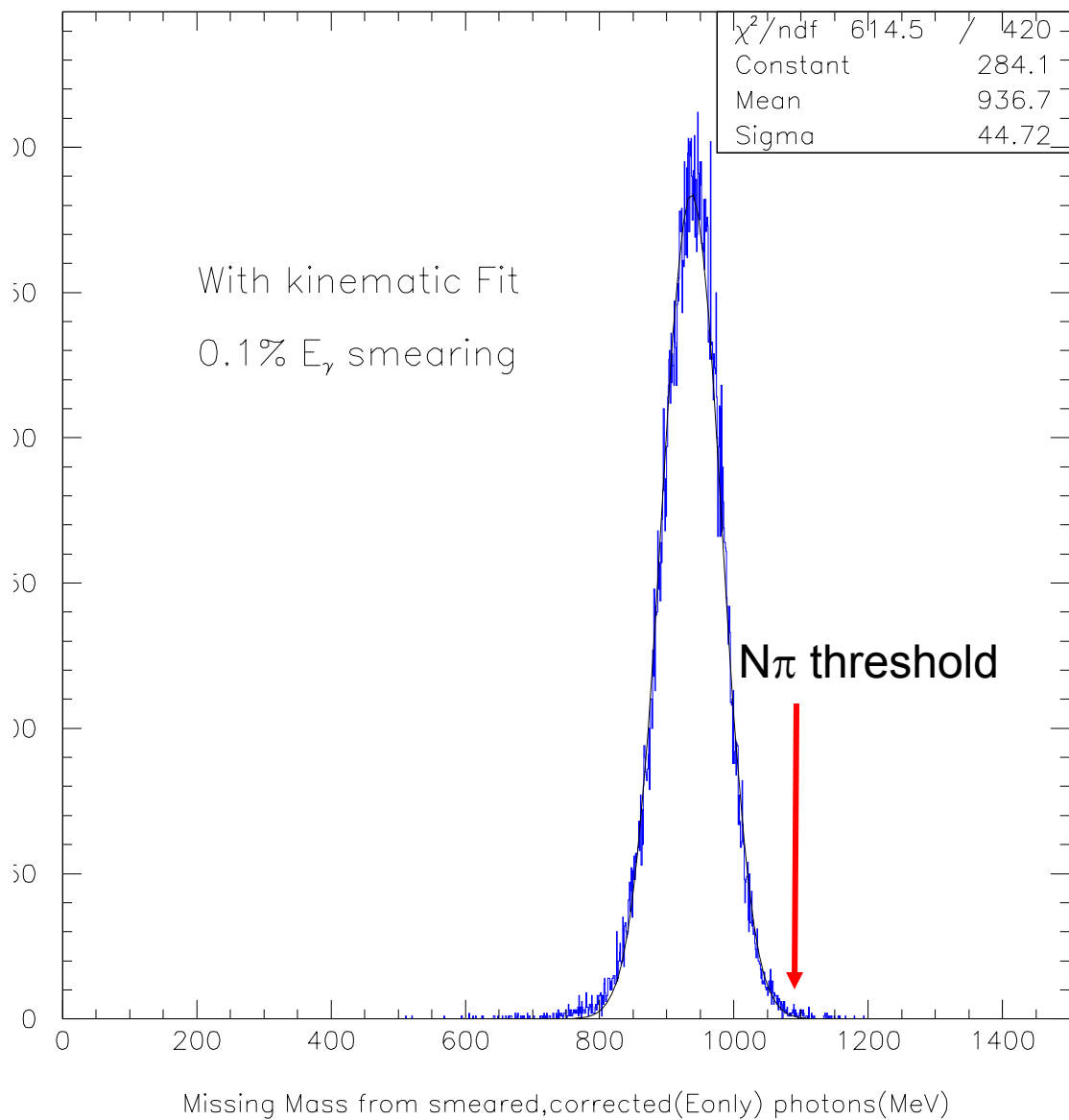$$\gamma p \rightarrow p\pi^0$$
$$\gamma n \rightarrow p\pi^-$$
$$\gamma n \rightarrow n\pi^0$$

π, ρ, ω, and b_1 exchange parameterized by Regge trajectories

Essentially no free parameters in the calculation

[+] M. Guidal, J.-M. Laget, M. Vanderhaeghen, Nucl. Phys. A 627 (1997) 645.
M. Guidal, J.-M. Laget, M. Vanderhaeghen, Phys. Lett. B 400 (1997) 6.
M. Vanderhaeghen, M. Guidal, J.-M. Laget, Phys. Rev. C 57, 1454 (1998).

γ p → π° X

χ²/ndf	614.5 / 420
Constant	284.1
Mean	936.7
Sigma	44.72

With kinematic Fit

0.1% E_γ smearing

Nπ threshold

Missing Mass from smeared,corrected(Eonly) photons(MeV)

Using the proton as a Primakoff target: Proof of principle
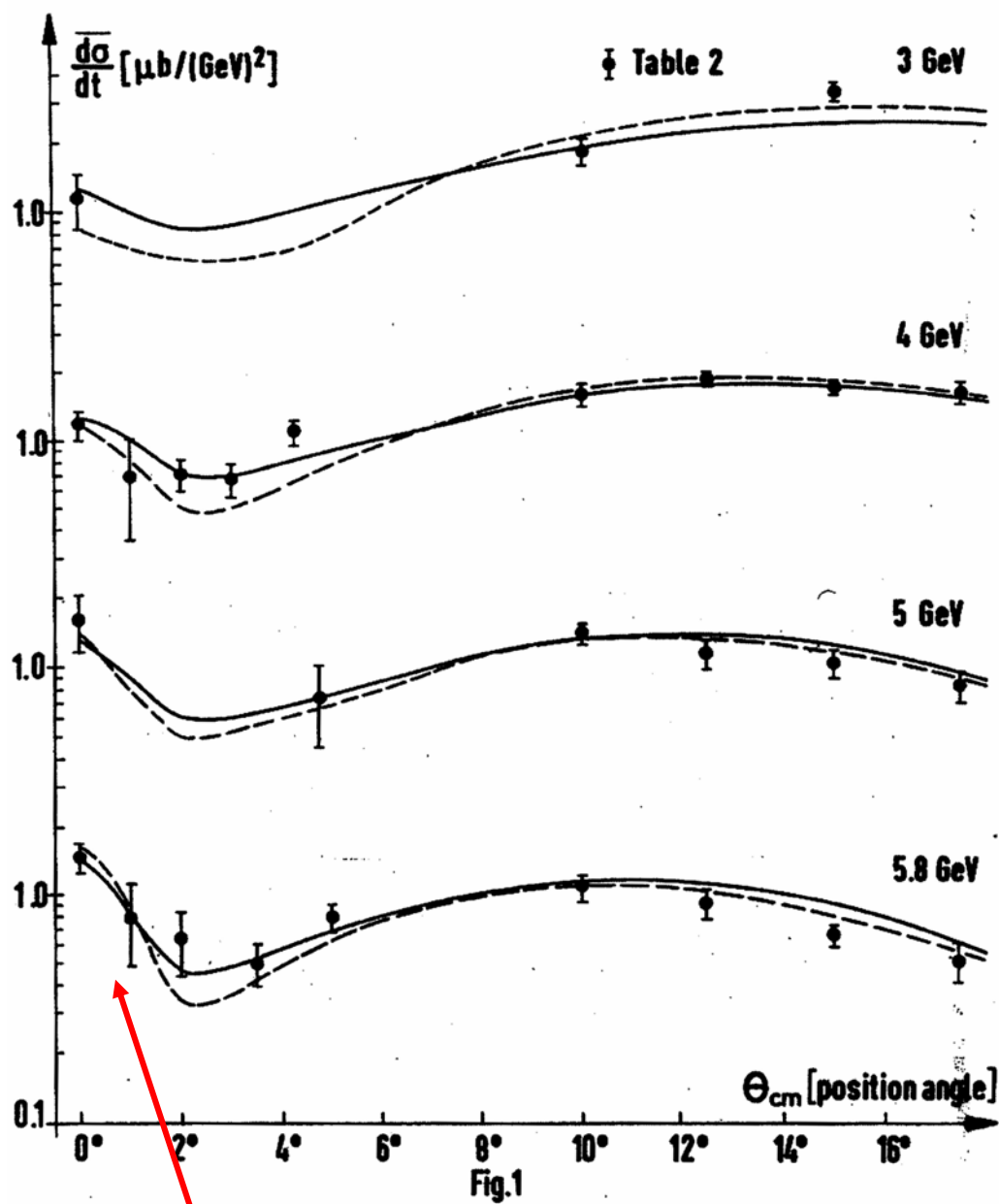
In the late 60's a DESY group measured forward π^0 photoproduction from a hydrogen target[+]

At the highest incident photon energies a peaking of the cross section was observed at 0°.

The Primakoff reaction.

[+] M. Braunschweig, et. al., Phys. Lett. 26B (1968) 405, and DESY preprint 70/1 (1970).
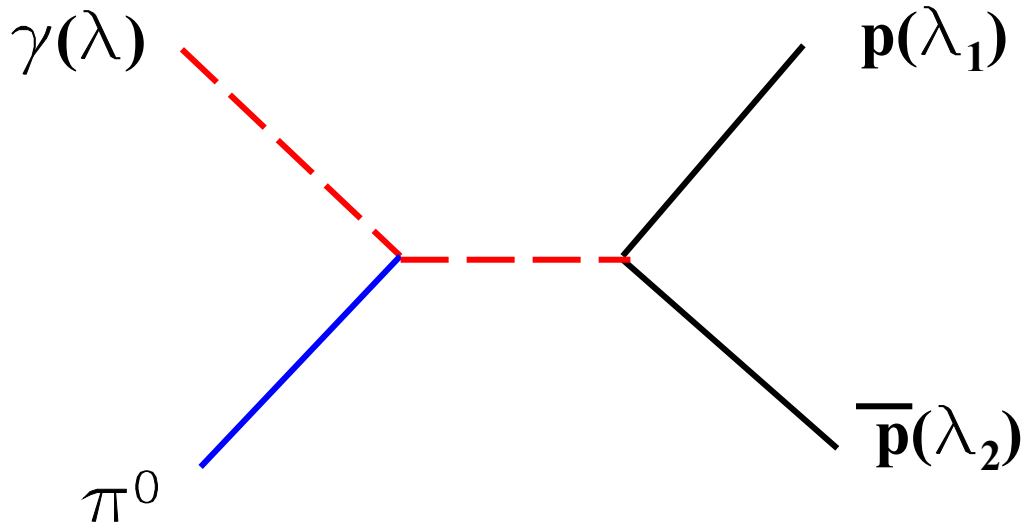
$$\frac{\overline{d\sigma}}{dt} \; [\mu b/(GeV)^2]$$

Table 2

3 GeV

4 GeV

5 GeV

5.8 GeV

1.0

1.0

1.0

1.0

0.1

0° 2° 4° 6° 8° 10° 12° 14° 16°

Θ_{cm} [position angle]

Fig.1

$\Gamma_{\pi 0 \to \gamma\gamma} = 8.44 \pm 0.93$ eV

Primakoff cross sections in the t-channel helicity frame

(see Braunschweig, et. al.)

$$\frac{d\sigma}{dt} = \frac{1}{4\pi s k_s^2} \underset{\lambda_1 \lambda_2}{\Sigma} \left| f_{\lambda_1 \lambda_2 \lambda} \right|^2$$
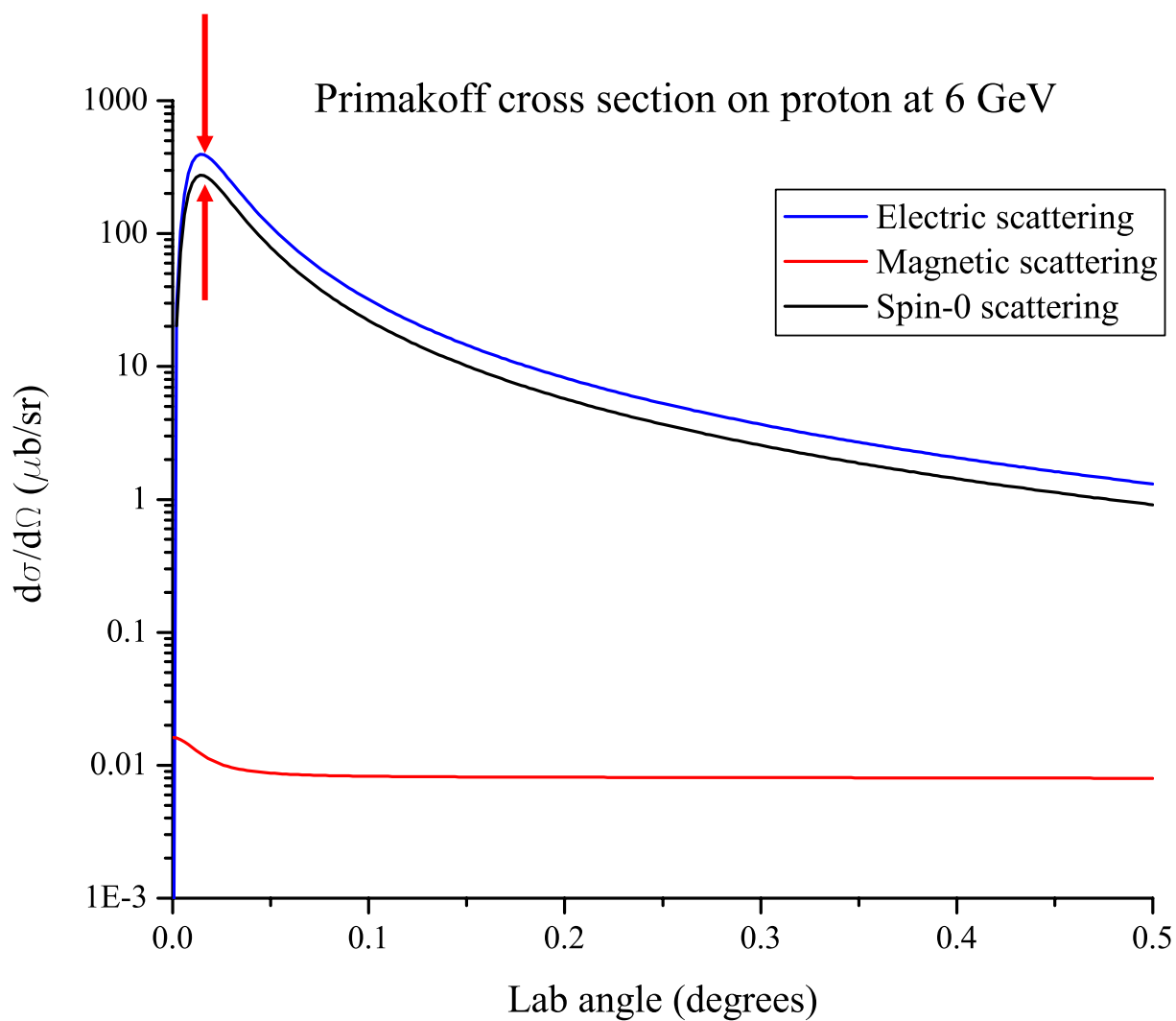

Non-spin-flip $\quad f_{\lambda \lambda 1} \propto G_E$

Spin-flip $\quad f_{\lambda - \lambda 1} \propto G_M$

50%

Primakoff cross section on proton at 6 GeV

- Electric scattering
- Magnetic scattering
- Spin-0 scattering

$d\sigma/d\Omega$ (μb/sr)

Lab angle (degrees)

Comparison of DESY data with proton calculation averaged over the angular resolution of the detector

E_γ	Data $d\sigma/dt$ @ 0°	Calc. ($\Gamma_{\gamma\gamma}$=7.7 eV)
5.0	1.62 ± 0.44	1.2
5.8	1.48 ± 0.22	1.5

Conclusions:

Good agreement and consistency between data and the resolution averaged calculation.

The calculated cross sections are 50% higher than the standard spin-0, no recoil Primakoff equation.

The next step is to include the nuclear coherent amplitude.