η photoproduction on Nuclei

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For the CBELSA/TAPS Collaboration

Outline :

Motivation

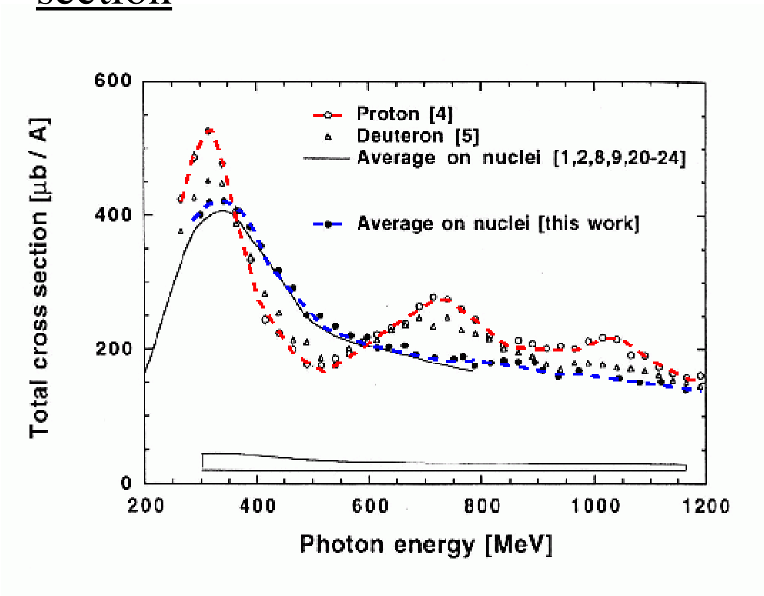
Experimental Setup

Preliminary Results

Outlook

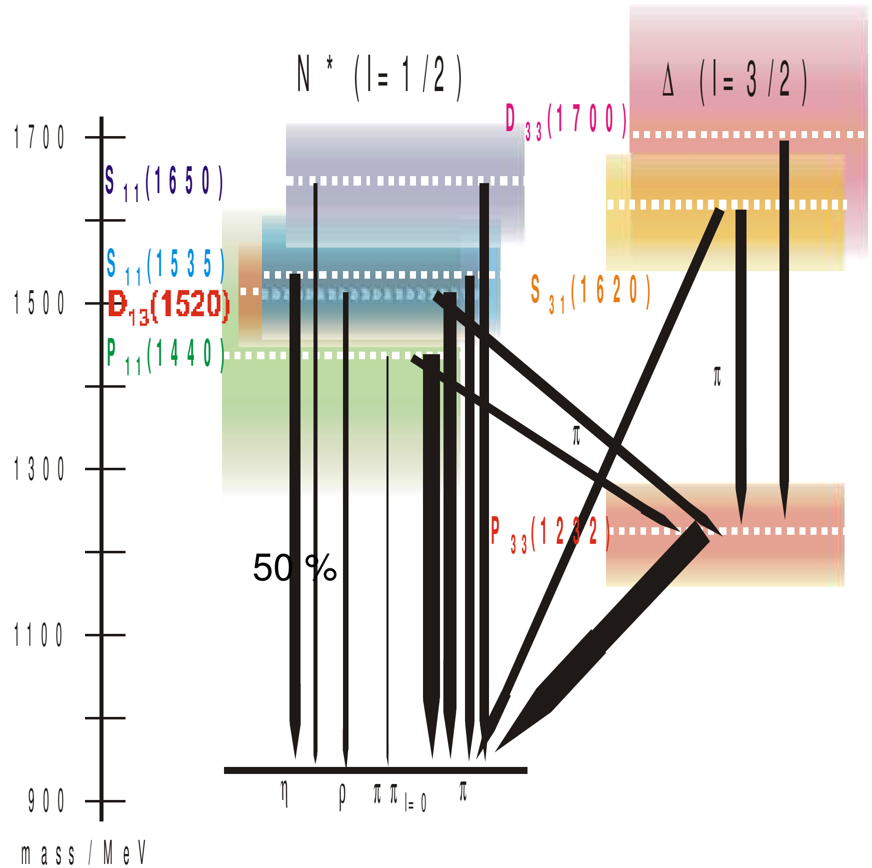
Where are the resonances gone ?

Total photoabsorption cross section



N. Bianchi et al. (Phys. Lett. B 325)

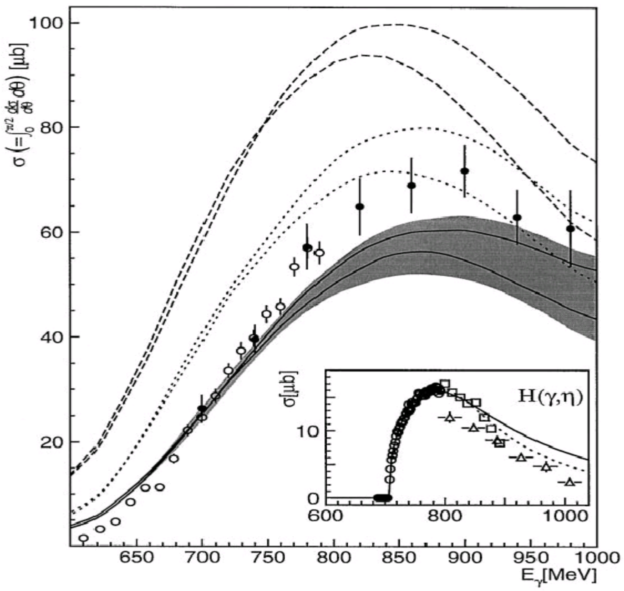
Resonance decay



Fermi motion, Pauli blocking
Collision Broadening
Final State Interation
In-medium effect on resonance widths ?

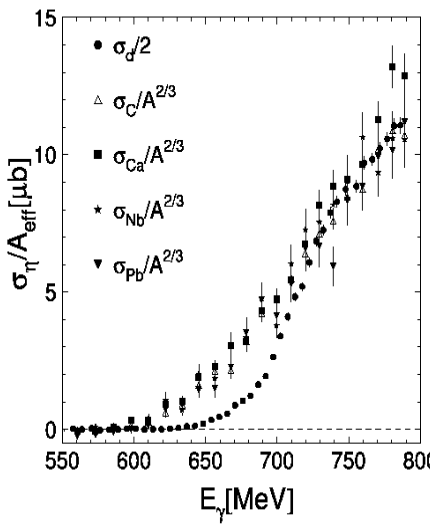
Modification of the S_{11}(1535) in-medium ?

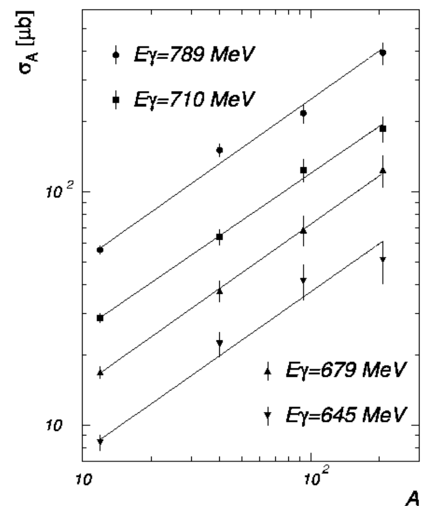
Investigation with η – photoproduction



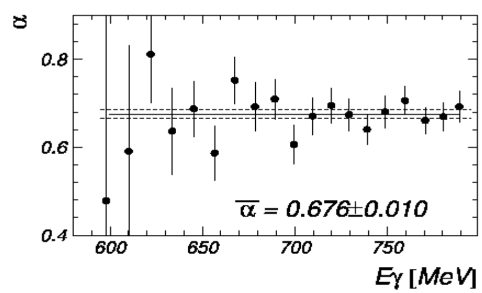
Carbon : Yorita et al. Phys. Lett. B476
Proton : D. Rebreyend et al. Nucl Phys A663
B. Krusche et al. Phys. Rev Lett. 74(1995)
Nuclei : Mathis Roebig Landau PhD Thesis

Dependence of the η cross section on the Target mass.





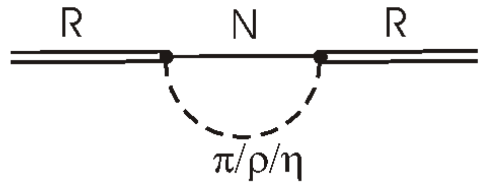
Fit: σ(A) ~ A^{α}



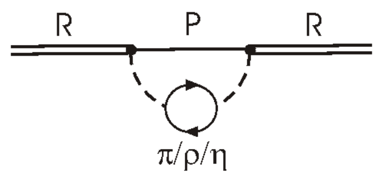
α=1 (Volume)
α =2/3 (Surface)

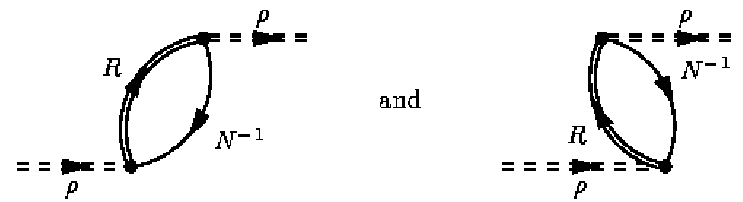
Spectral Function of the S_{11}(1535)

In vacuum



In-medium

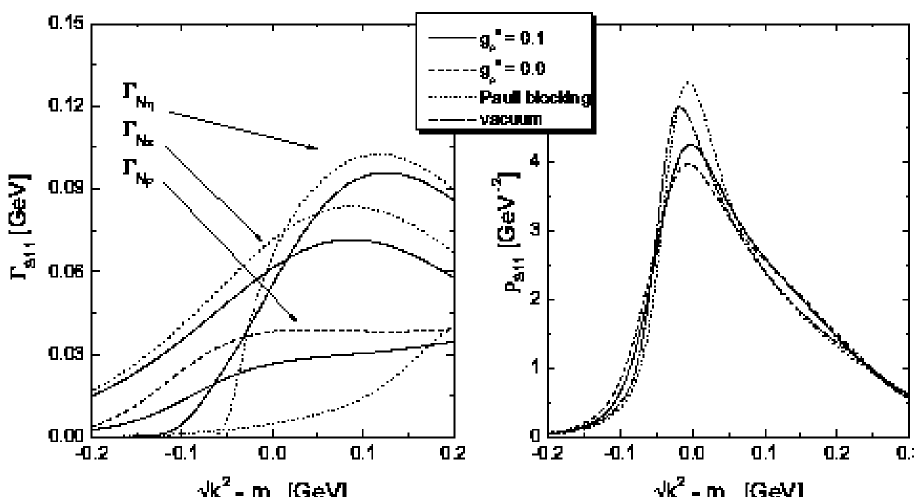




$$\mathcal{A}_M^{med}(q) = -\frac{1}{\pi}\mathcal{I}m\frac{1}{q^2-m_M^2-\Pi_{vac}(q)-\Pi_M(q)}$$

$$\rho^{med}(k) = -\frac{1}{\pi}\mathcal{I}m\frac{1}{k^2-m_R^2-\sigma_{med}(k)}$$

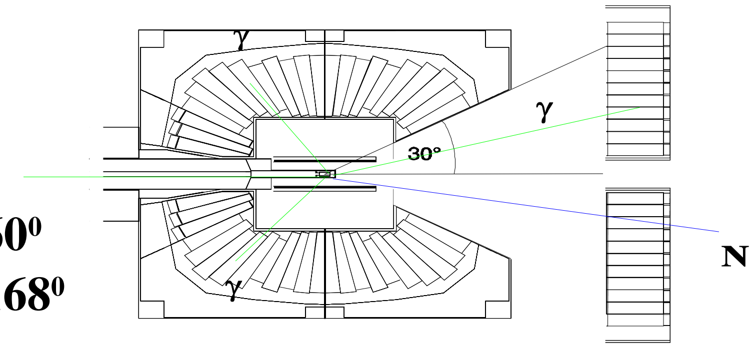
Prediction : broadening of the S_11(1535) width of almost ~35 MeV explained by Pauli-Blocking and the coupling of the D_13(1520) to the Nρ



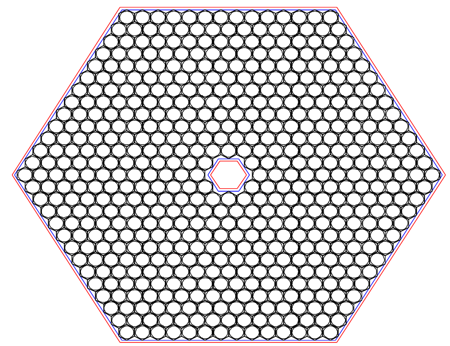
Combined 4π detector system

Crystall Barrel
Side view
1290 CsI

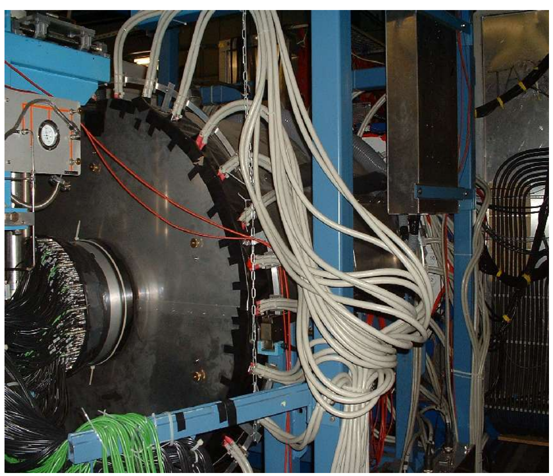
Taps
Front view
528 BaF2

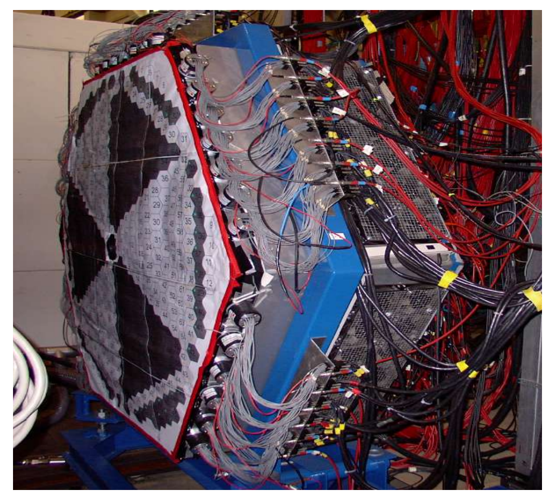


$\Phi = 0^0$ to 360^0
$\Theta = 30^0$ to 168^0

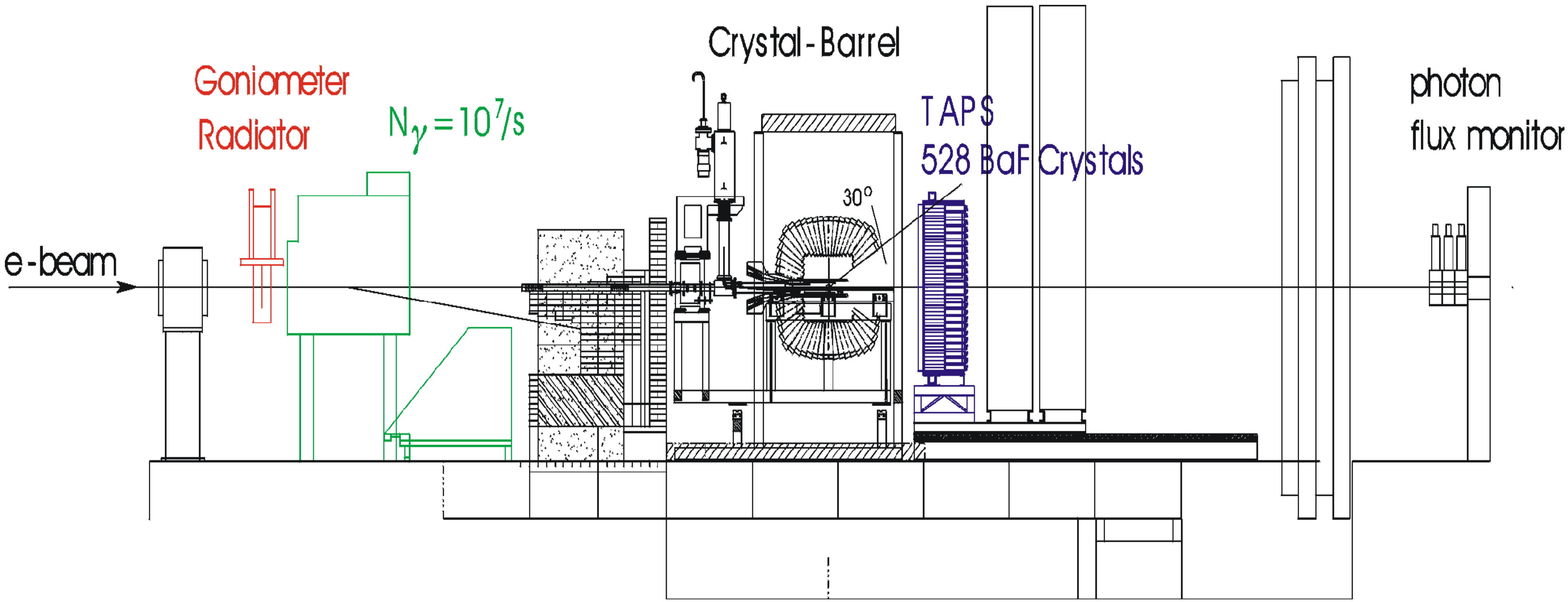


$\Phi = 0^0$ to 360^0
$\Theta = 5^0$ to 30^0





Taps/Crystall Barrel @ ELSA



tagging spectrometer :

tagging range : 30 % - 94 % of E_{beam}

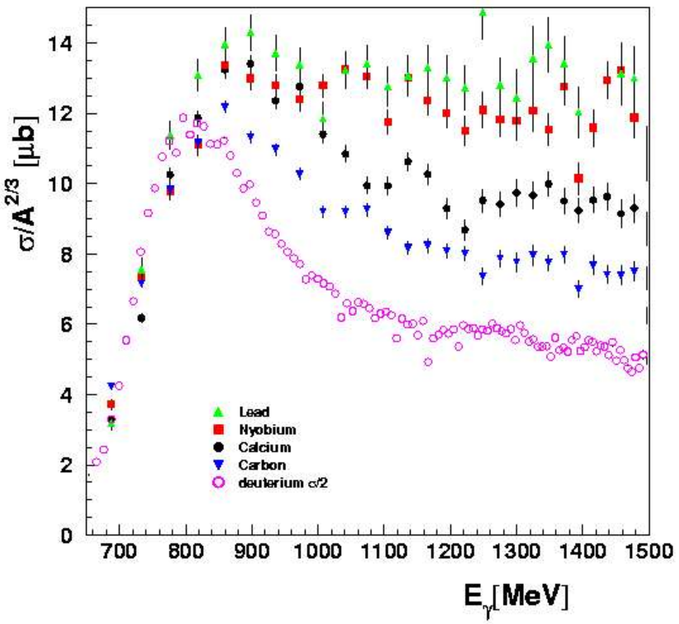
$E\gamma = E_{beam} - E_e$

Preliminary Results: Inclusive η cross section

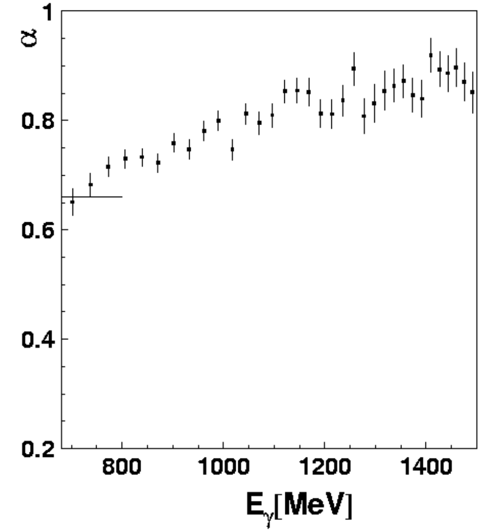
$\gamma + A \to \eta + X$

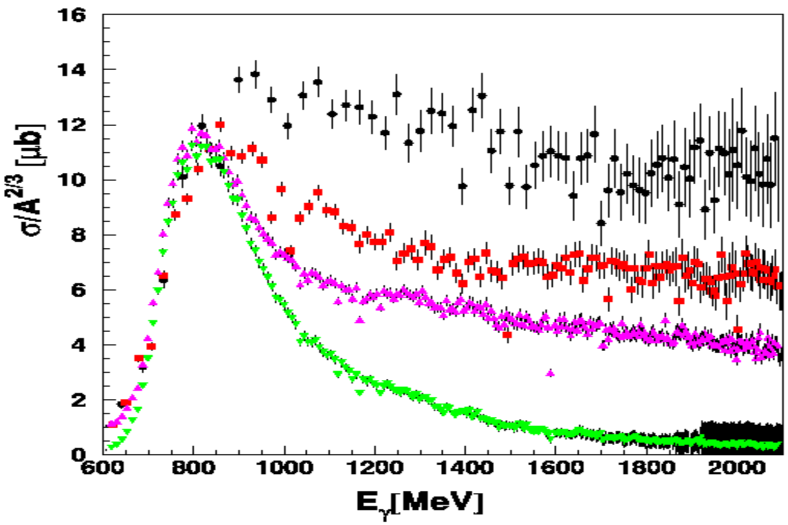
$\eta \to 3\pi^0 \to 6\gamma$

(deuterium
from Igal Jaeglé)



Fit : $\sigma(A, E_\gamma) \approx A^{\alpha(E\gamma)}$





Evolution of the scale factor with the incident photon beam energy

Background type ?

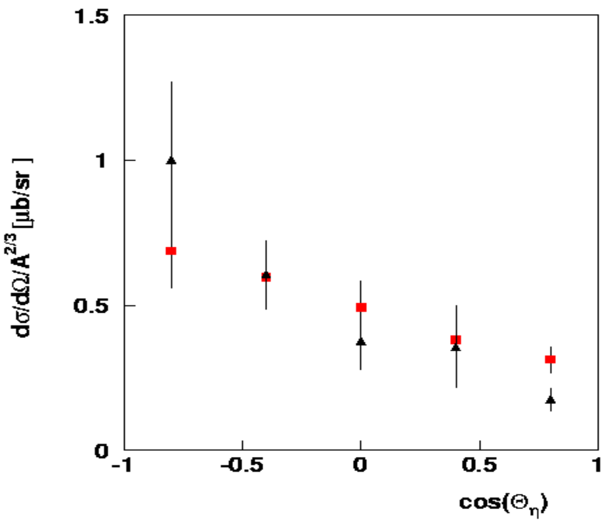
Deuterium : primary ηπ seen on purple curve, cut by missing mass on green.

Carbon : Red

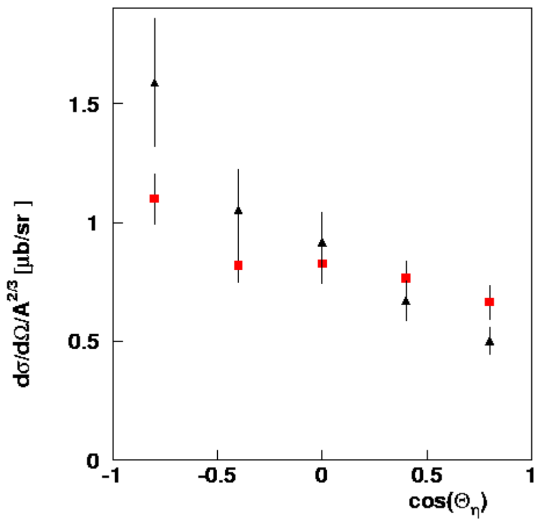
Lead : Black

(additionnal background type volumic dependent)

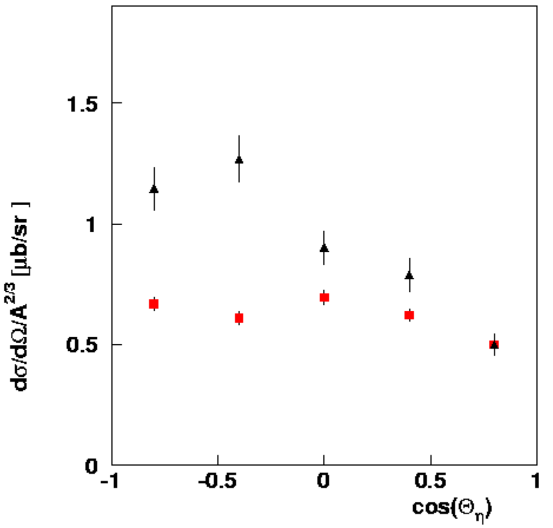
Angular differential cross section



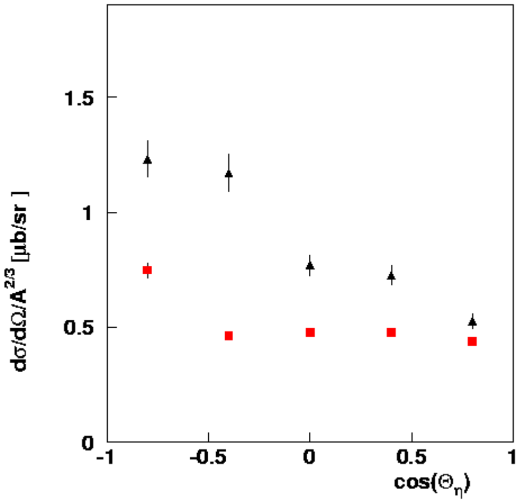
E_γ = (660, 800) MeV



E_γ = (800, 1000) MeV



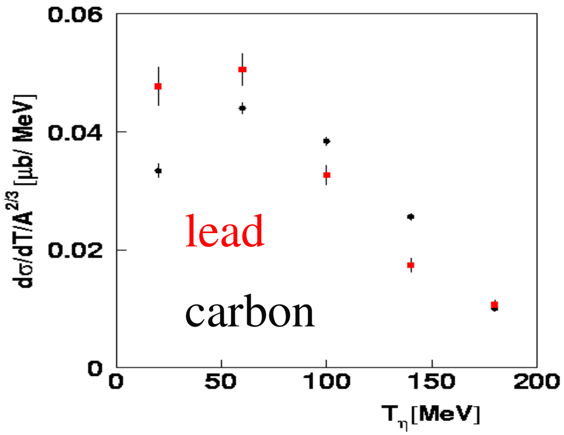
E_γ = (1000, 1300) MeV



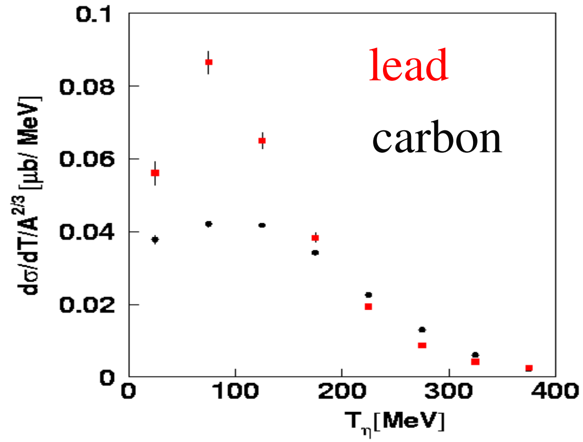
E_γ = (1300, 1500) MeV

Dependence of the cross section with the η kinetic energy

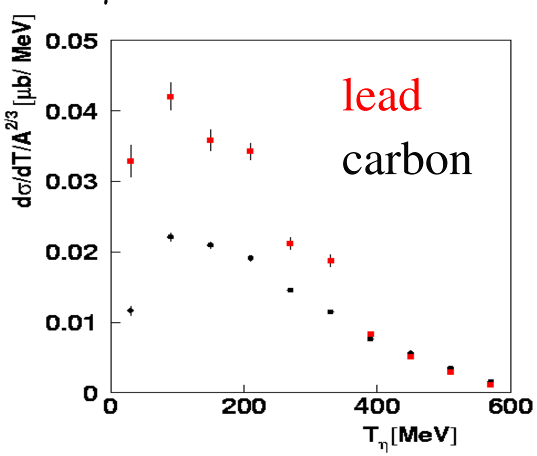
E_γ = (660, 800) MeV



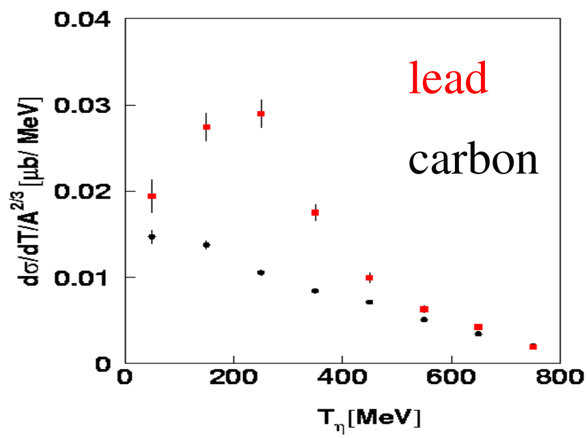
E_γ = (800, 1000) MeV



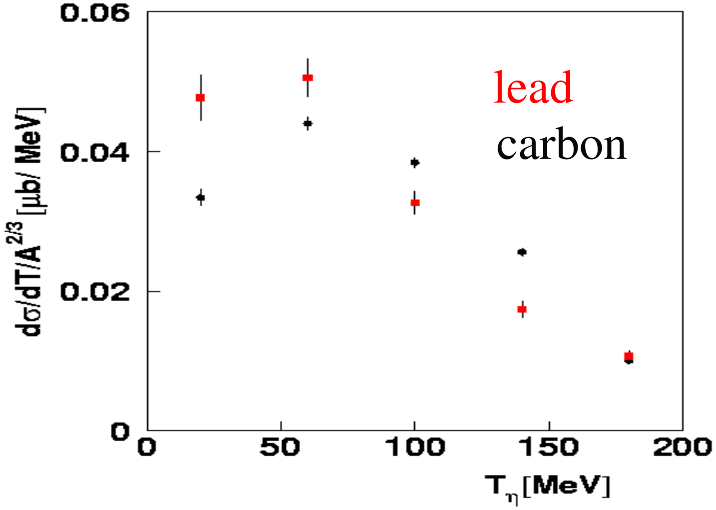
E_γ = (1000, 1300) MeV

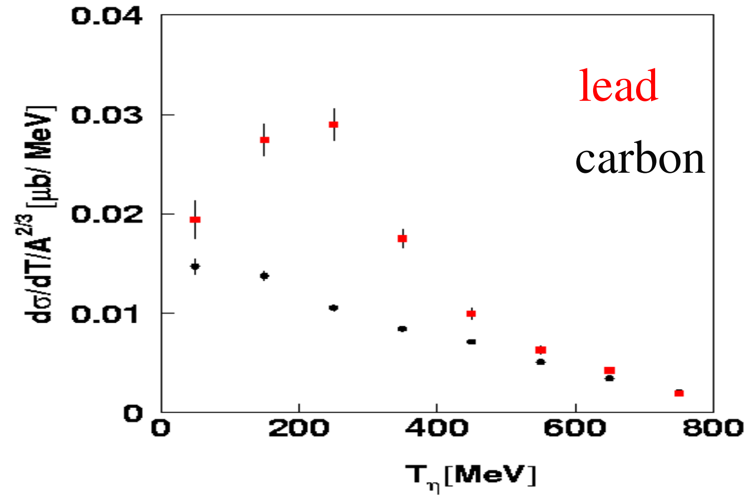


E_γ = (1300, 1500) MeV



Search for η FSI





E_γ = (660, 800) MeV

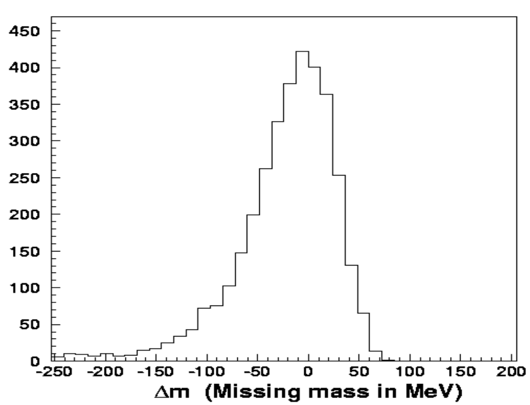
E_γ = (1300, 1500) MeV

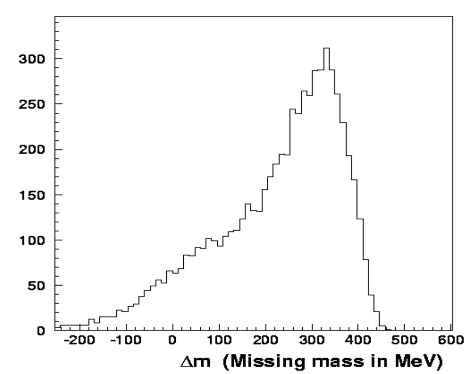
$$m_X = \sqrt{(E_{beam} + m_p - E_\eta)^2 - (\vec{P}_{beam} - \vec{P}_\eta)^2}$$

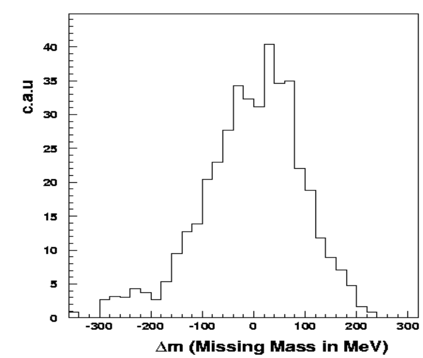
$$\Delta M = m_X - m_N$$

All kinetic range !

Only events with E_{kin} > 600 MeV

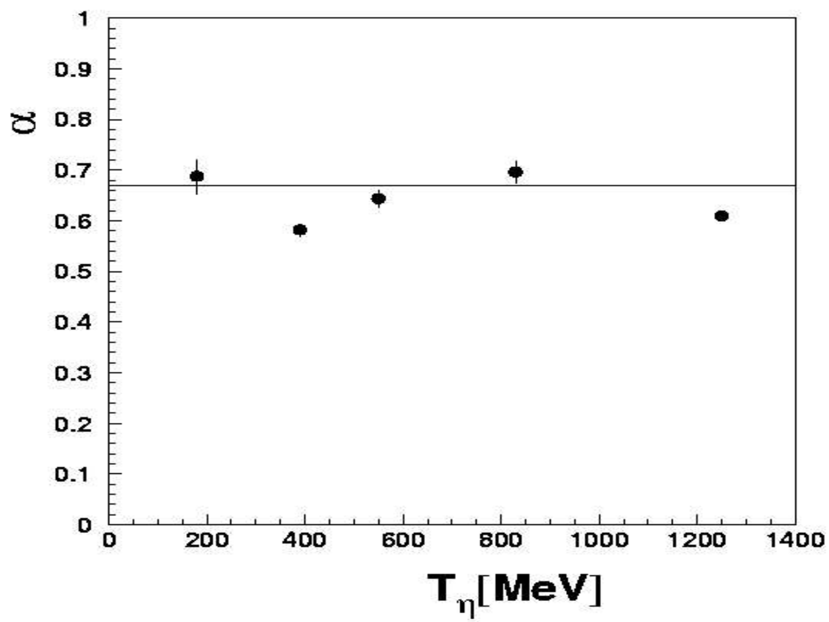






Clear quasifree signal at the highest kinetic energy !

Estimation of the η mean free path with Glauber approximation



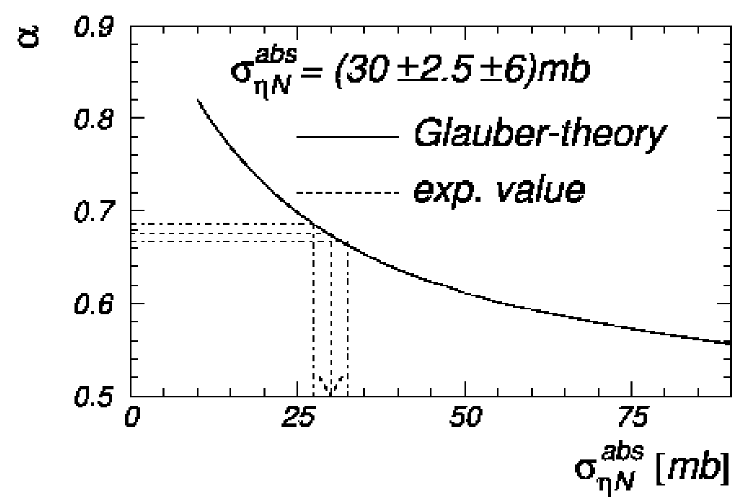
-Determination of the scale factor α for different range of incident photon beam energy assuming we keep events with at least 70% of highest kinetic energy.

-the nucleus is seen as "black" by the η meson for all the available kinetic energy range.

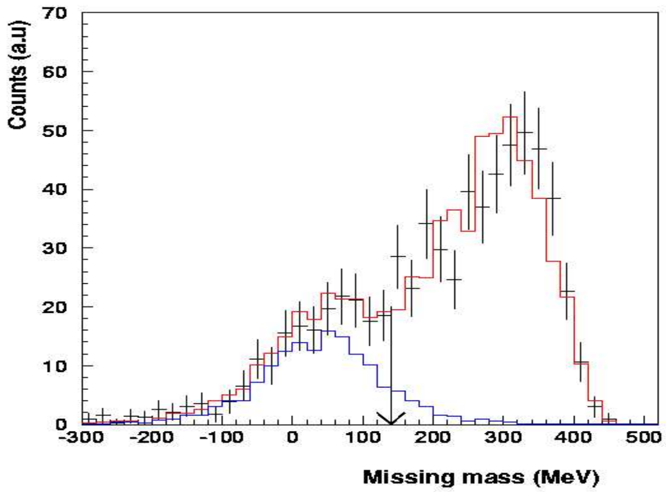
-Deduction of the η mean free path in the frame work of the glauber-theory.

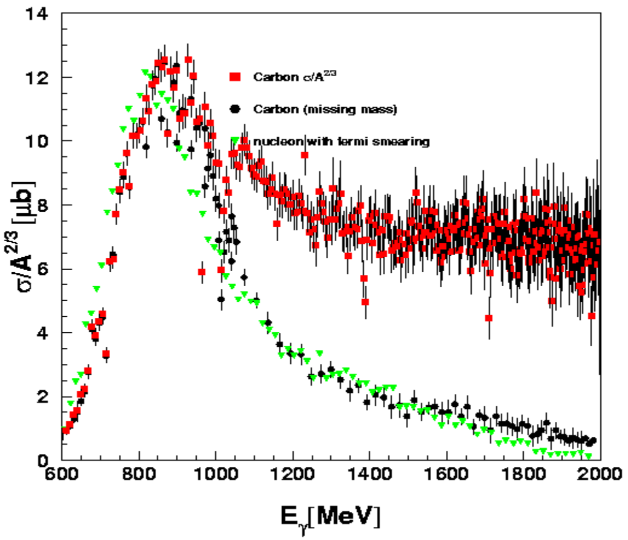
-One can link the $\sigma_{abs}(\eta N)$ and the η mean free path (λ) with $\lambda_\eta = 1/(\rho_0 \sigma_{abs})$

λ_η ~ 2 fermi in nuclear matter at any η kinetic energy ?

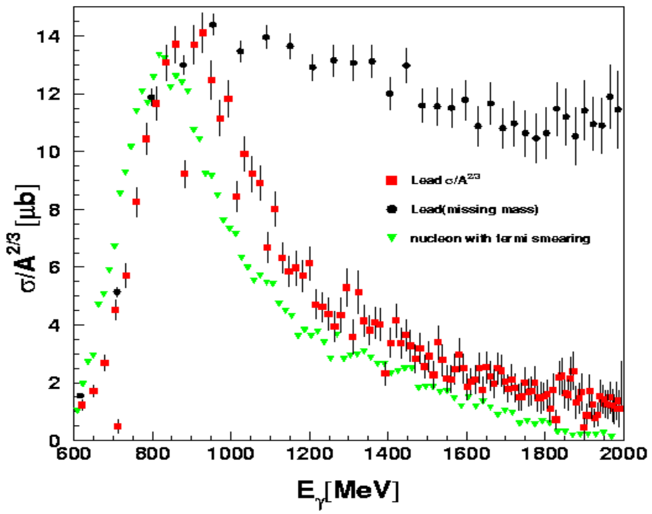


Properties of the $S_{11}(1535)$ resonance in-medium : Strategy 1





E_{γ} = (1300, 1500) MeV



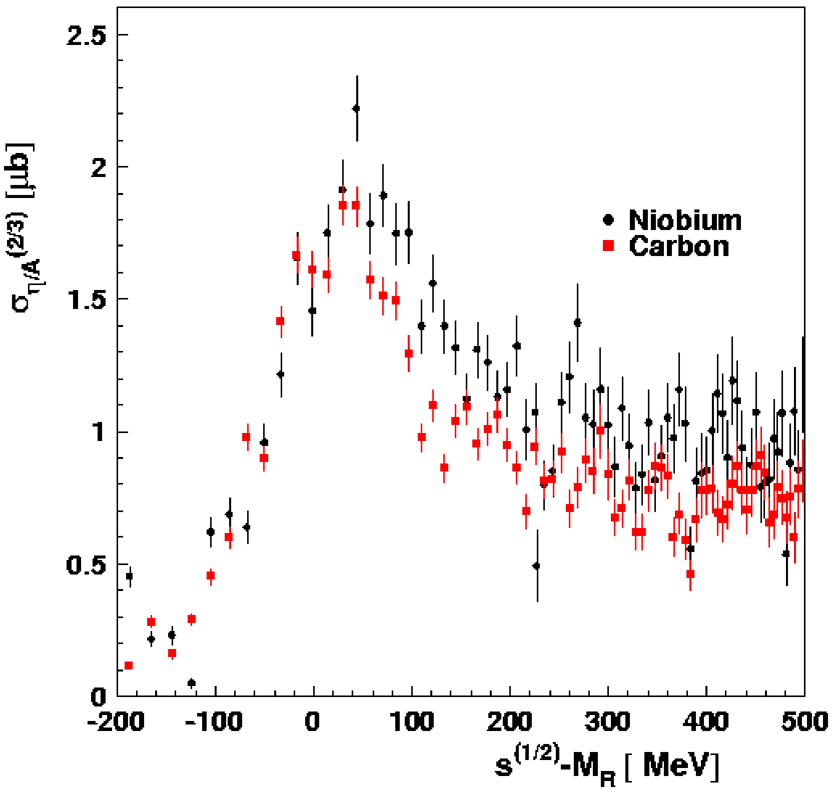
Data on Lead are compared with BUU Simulation, Pascal Muehlich (private communication)

Apply cut on missing mass < 140 MeV
Maximum width increase of 100 MeV for lead ?
Real in-medium effect or background ?

Strategy 2 :

Considering η events with kinetic energy at least greater than 70% of the maximum available Kinetic energy for the corresponding photon beam energy.
Remove most of the background (primary ηπ and secondary η are strongly suppressed by this cut only remain quasifree ηN events in a 2 body decay).
Disadvantage: leak of statistic

Width of the S_11(1535) seems to be larger in the niobium case than on Carbon. ~ 50 MeV consistent with prediction.



Outlook

Preliminary results have been shown concerning inclusive η cross section

Better understanding of the background source to the η meson

Contribution of $\eta\pi$ as final states particles produced in primary vertex.
Secondary η via primary produced π, sensitive to the target volume
Evidence of this effect seen from differential cross section

Assumptions have been done concerning the η mean free path in relation with
Its kinetic energy. $\lambda \sim 2$ fm through the available kinetic energy range

Search for quasifree reaction in progress, with a maximum increase of 100 MeV
For the S11 resonance width in-medium (Lead target)
With kinetic energy cut : width increase of ~ 50 MeV on niobium