Elastic Compton Scattering from Carbon

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Motivation

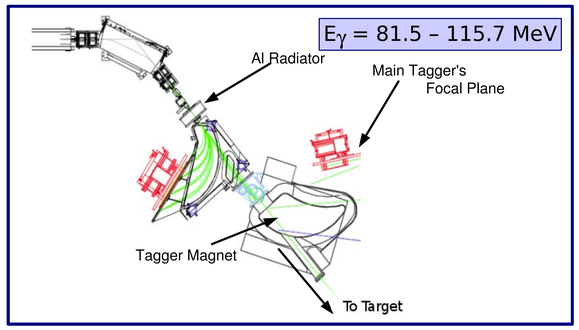
This Compton scattering experiment was conducted at MAX-lab in Lund, Sweden by a collaboration including the George Washington University, University of Illinois, University of Kentucky and Lund University.

The goals of this experiment are:

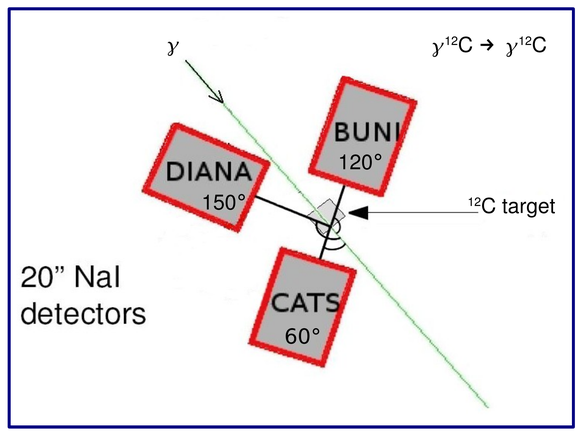
• to demonstrate the soundness of this methodology for other Compton scattering experiments (deuteron).

• to cross-check previously published measurements on carbon.

Experiment



Data were collected from photons with tagged initial energies (above) after they were scattered elastically off a ^{12}C target (below).



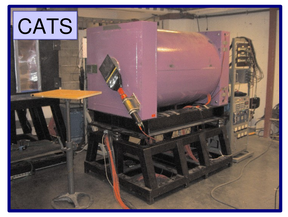
Above: experimental detector geometry with respect to the ^{12}C target and the photon beam.

Photon Detectors

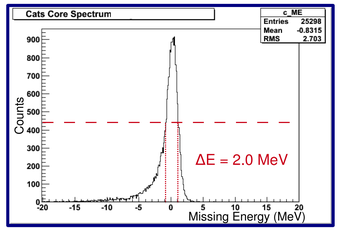
BUNI:
• Solid NaI(Tl) core, 26.7 cm diameter
• 4 NaI(Tl) quadrants, 11.4 cm thick

DIANA:
• Solid NaI(Tl) core, 48.3 cm diameter
• NaI(Tl) annulus, 5.9 cm thick

CATS:
• Solid NaI(Tl) core, 26.7 cm diameter
• 6 NaI(Tl) segments, 10.8 cm thick



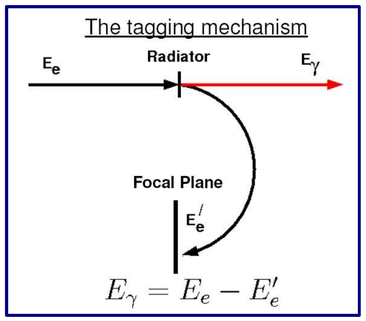
Right: NaI core spectrum from in-beam run.
All tagged energies have been included.



Photon Tagging

After interacting with the aluminum radiator and creating bremsstrahlung, electrons were deflected from their path by the tagger magnet. Depending on the electron's remaining energy, the radius of its arc brought it to one of 62 plastic scintillator detectors located on the focal plane.

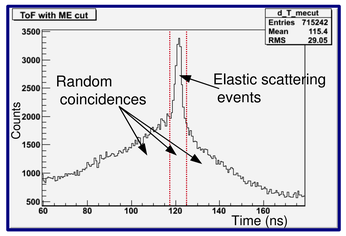
A timing coincidence between the tagger detectors and the NaI detectors allowed for a particular photon's energy to be tagged, as depicted below.



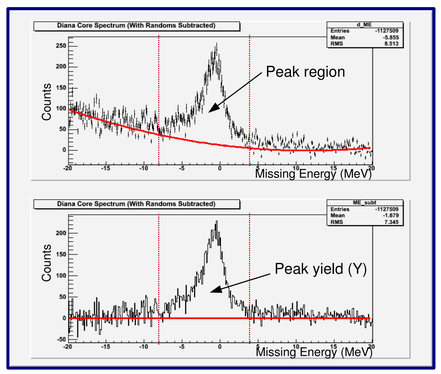
Data Analysis

The analysis of the raw data collected in the Fall of 2008 has been performed for each detector in two stages:

• the timing coincidence region for elastic scattering events was identified in the TDC, allowing the elastic peak to be identified in the energy spectrum after subtracting the contribution of random timing coincidences.



• the remaining background was fit using a second-order polynomial and then subtracted, leaving only the peak and providing the yield used in calculating the differential cross section.



Cross Section Extraction

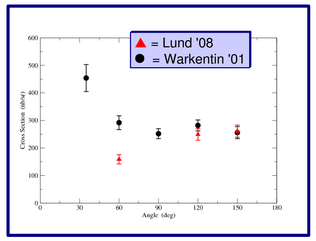
Calculation of rough differential cross section:

$$\frac{d\sigma}{d\Omega} = \frac{Y}{f \cdot \varepsilon_{tag} \cdot N_e \cdot d\Omega \cdot t}$$

where, Y = integrated peak yield
ε_{tag} = tagger efficiency
N_e = number of electrons detected in the focal plane
dΩ = NaI detector solid angle
t = carbon target thickness

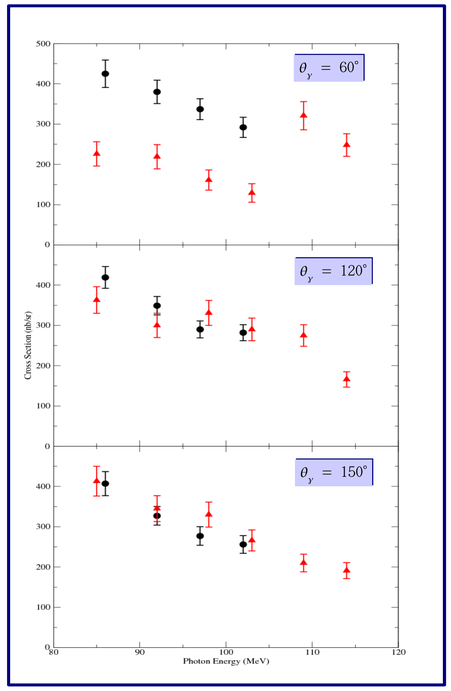
Note: the term (f) shown in the denominator represents the detector efficiency and target absorption factors, which are not included in this preliminary analysis.

Preliminary Results



Left: Warkentin '01 at 102 MeV, Lund '08 at 99.5 MeV.

Both statistical (3-9%) and systematic (7%) errors have been approximated.



Continuing Analysis

• more precise errors must be determined by propagating the errors in the analysis code
  ➔ this will improve the background fit

• residual cosmics must be subtracted

• GEANT4 simulations will be run
  ➔ this will help determine the missing term f, which relates to the detector efficiency and photon absorption in the target
  ➔ this will take into account finite geometry factors which relate to dΩ and t

• closely examine analysis of all detectors

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