“Study of $^{nat}Mg(d,d_0)$ reaction at detector angles between 90° and 170°, for the energy range $E_{d,lab}$=1660-1990 keV”

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Contents

Introduction

- Magnesium is one of the most frequently used metals.

Used in the industry: production of several high-volume parts and for fabrication of numerous electronic devises.

Used for research of superconductive materials and applications.

- IBA: one of the most important non-destructive analytical technique.

Can facilitate the composition and the elemental depth profile in the near surface layer of solids.

Motivation

- EBS: one of IBA techniques where light beam particles (protons, deuterons) with energy of a few MeV can be used to solve the problem of Mg depth profiling.
- Due to low Z value Mg usually forms complex compounds with other light elements

Motivation

- d-NRA (d,p_x) data from V. Paneta et al.

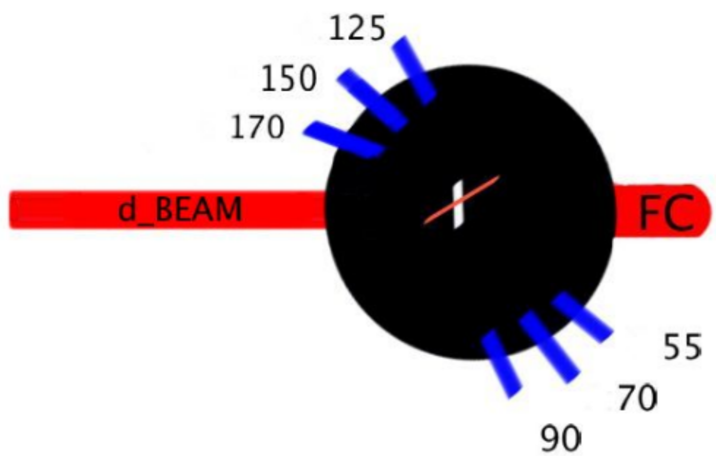
- It should be noted that there is a lack of elastic scattering experimental data suitable for EBS in the literature.

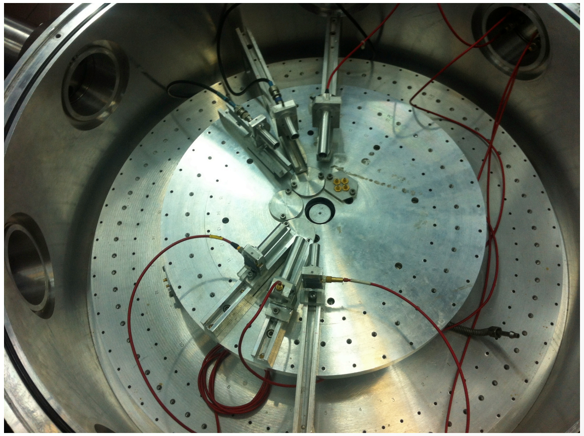
- The knowledge of the non-Rutherford $^{nat}Mg(d,d_0)$ reaction cross section is of prime importance for the simultaneous depth profiling analysis by d-NRA and EBS

Experimental setup

NCSR "Demokritos" , Athens, Greece

- Target from evaporation : MgO,MgCl, Au
- Cylindrical scattering chamber R≈40cm
- Target was placed at a distance of 15-25cm from the detectors and tilted to the beam by 45°.
- The detection system consisted of 6 Silicon surface barrier detectors.

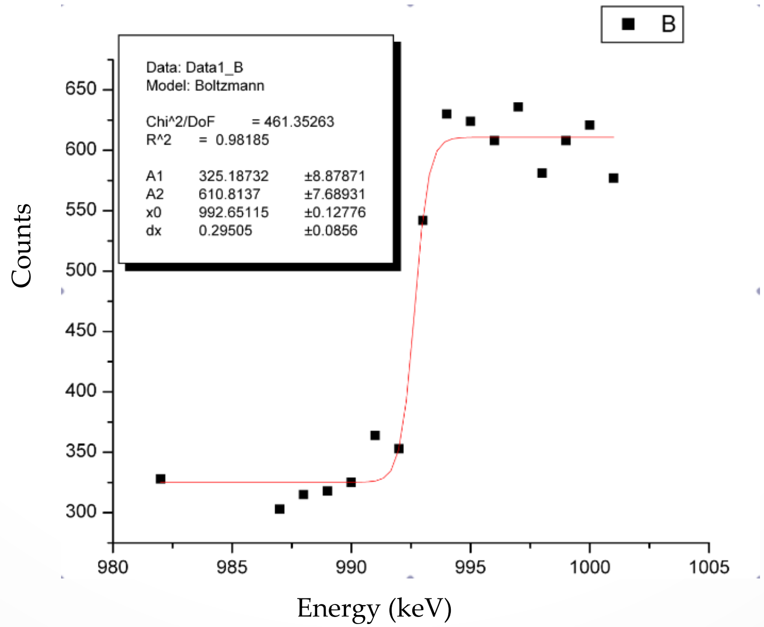




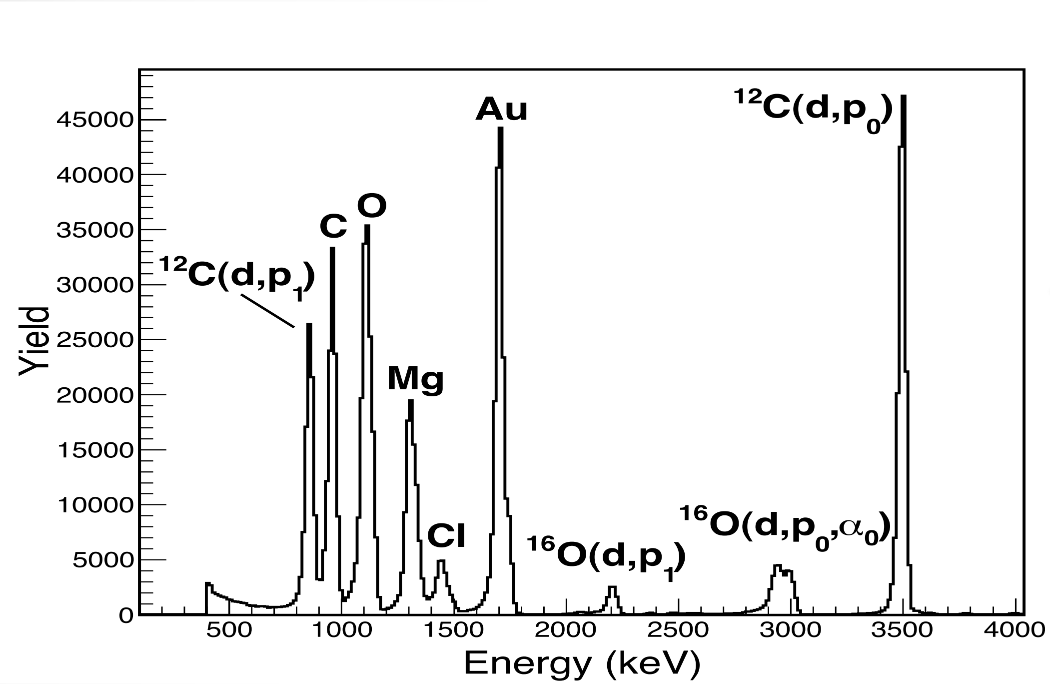
Procedure

- Energy range $E_{d,lab}$=1660-1990 keV, in steps 5keV and for detector angles between 90-170 deg.
- Beam energy calibration.

$^{27}Al(p,\gamma)$ {resonance 991,89 KeV}



Data analysis

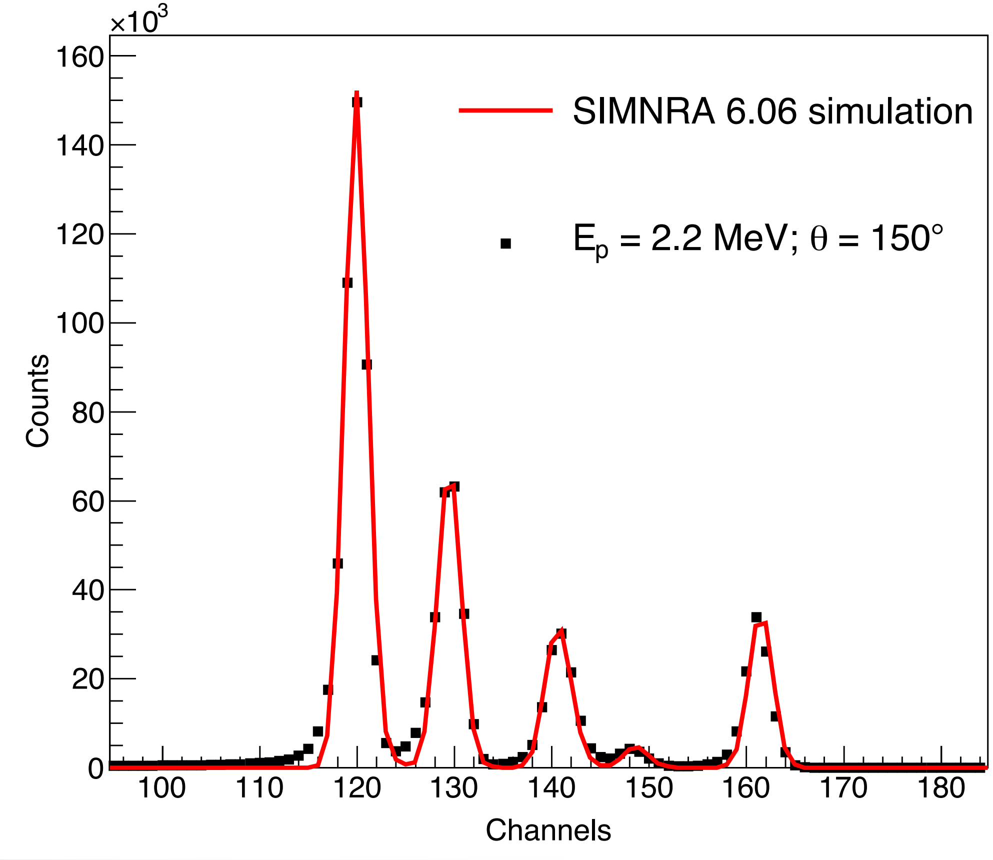


- N_{Au}/N_{Mg}
- Y_{Mg}/Y_{Au}
- $(d\sigma/d\Omega)_{\theta,R}{}^{Au}$

$$\left(\frac{d\sigma}{d\Omega}\right)_{\theta}^{Mg} = \frac{\left(\frac{d\sigma}{d\Omega}\right)_{\theta,Ruth}^{Au} \times Y_{Mg} \times N_{Au}}{Y_{Au} \times N_{Mg}}$$

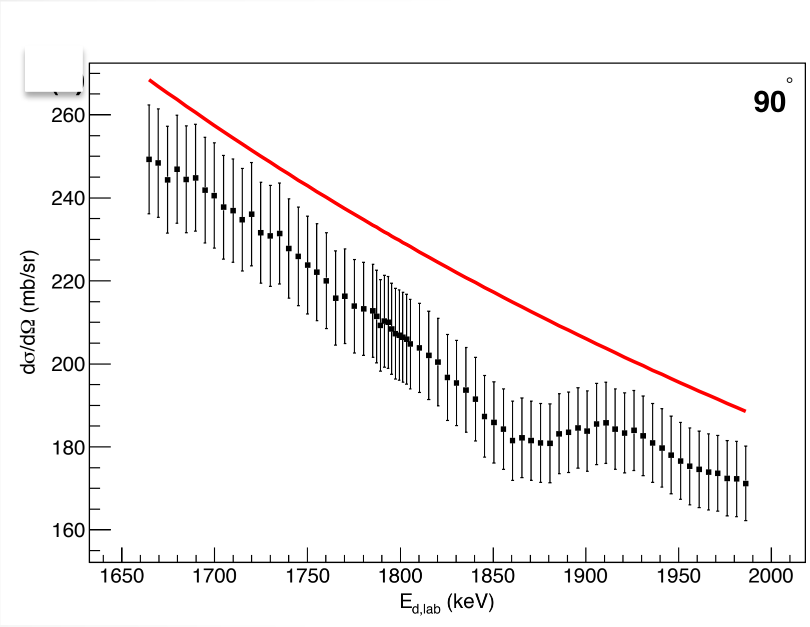
Data analysis

Typical experimental spectra with the simulated one:

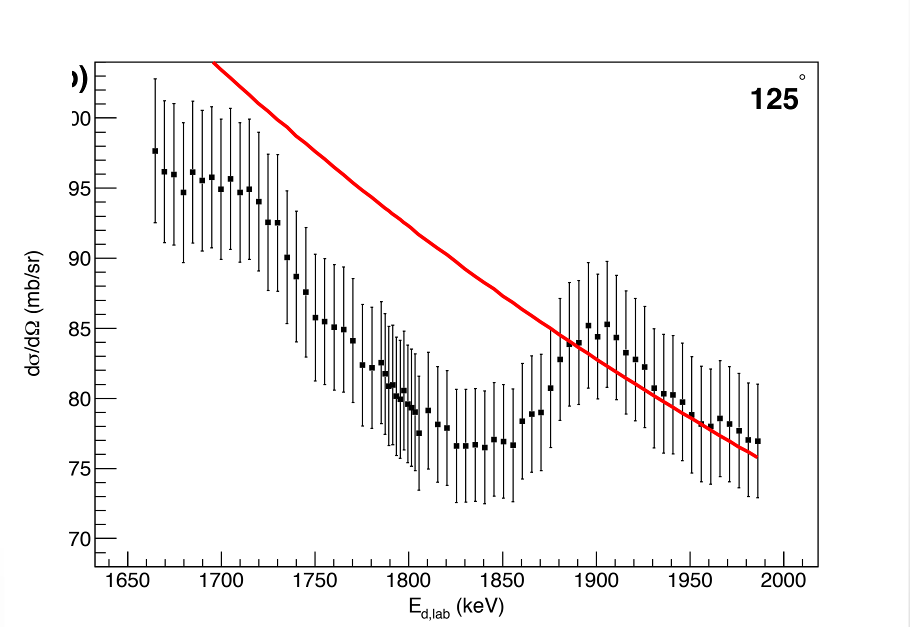


- *In these calculations the N_{au}/N_{Mg} was used as a free parameter and the cross section were taken from IBANDL,R-matrix calculator Sigma Calc.*
- *Using the backward detection angles 150 and 170 deg due to their superior resolution.*

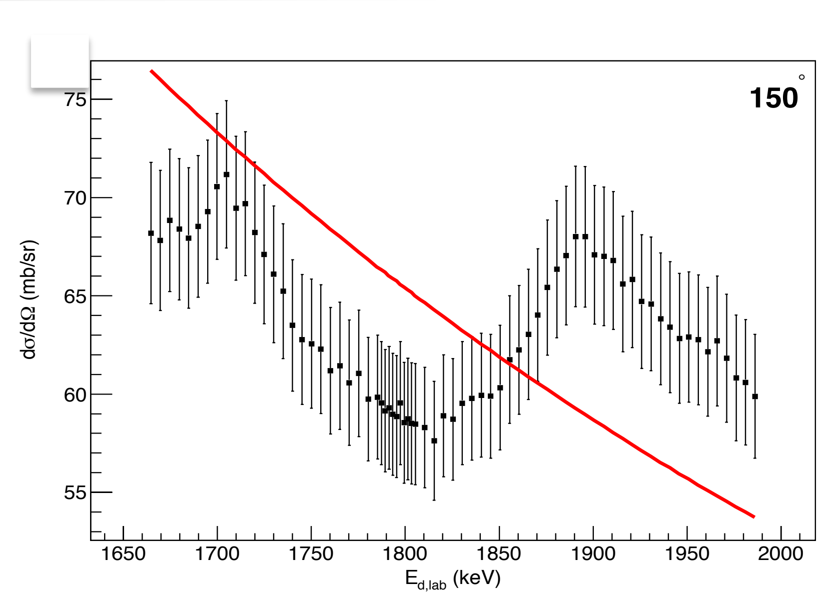
Results



Elastic scattering excitation functions were recorded in steps of 5keV, while a 2keV Step was adopted in the energy region around 1800keV.

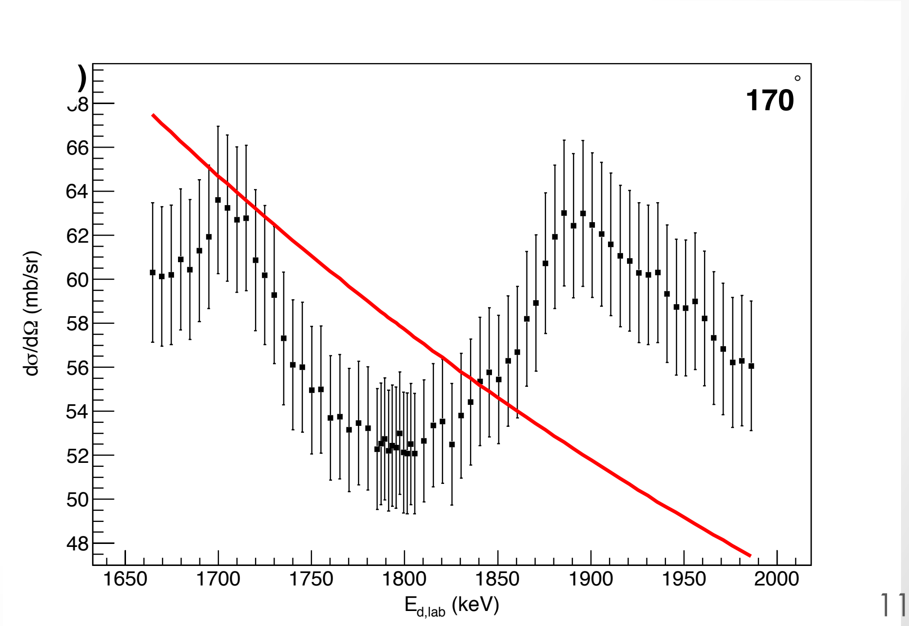


Results

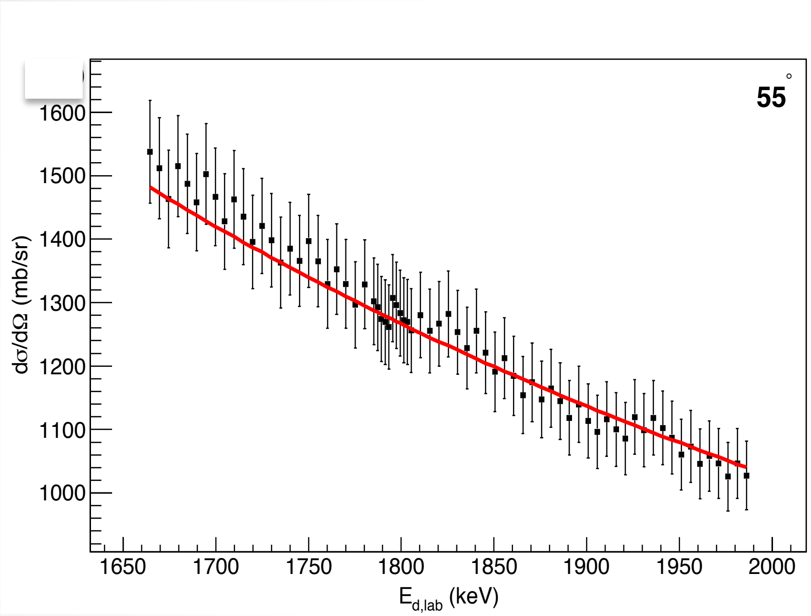


The main source of ≈5% uncertainty of the elastic scattering cross section, originates from the target characterization.

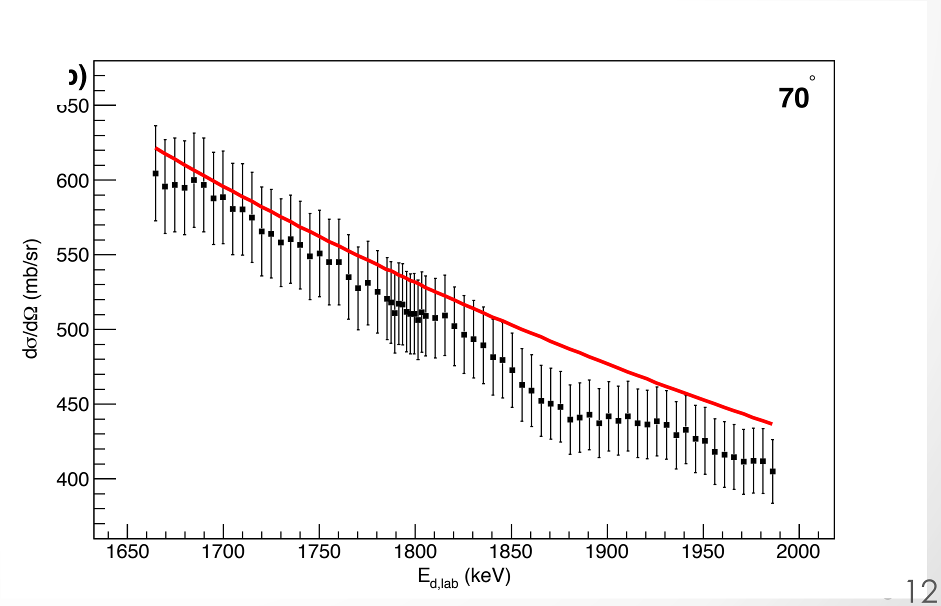
The statistical uncertainty from the yield ratio (Y_{Mg}/Y_{Au}) was much less than≈1%, therefore it was neglected.



Results



Forward angles 55º and 70º presented as byproduct of the same campaign designed for R-matrix reaction analysis of the system d+^{24}Mg, aimed to level characterization of the compound nucleus ^{26}Al.



Conclusions

- Elastic scattering cross section data $^{nat}Mg(d,d_0)$ were obtained for the first time in the energy range at backward angles relative to EBS depth profiling studies.
- In this way EBS and d-NRA methods can be used to define the depth profiling of magnesium.
- The same experimental data will be used to obtain spectroscopic information for the ^{26}Al compound nucleus.

Collaboration

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THANK YOU FOR YOUR ATTENTION

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