Differential Cross-section Measurements for Deuteron Elastic Scattering on $^{11}_{5}B$

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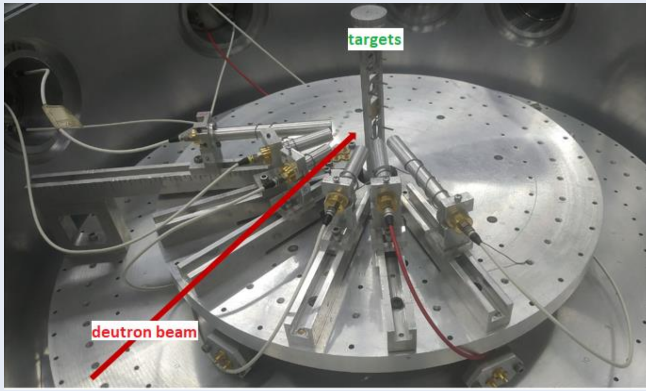
Motivation

Implementation of Boron in the p-type semiconductor industry calls for the accurate quantitative determination of its depth profile concentrations in near surface layers of various matrices. The cross section values of the $^{11}B(d,d_0)^{11}B$ elastic scattering were determined in the energy range $E_{d,lab}$ = 1300 – 1860 keV via relative measurements for the backscattering angles of 150°, 160°, 170°, allowing a potential combination of d-EBS & d-NRA.

Experimental Setup

- Van de Graff Tandem 5.5 MV Accelerator
  N.C.S.R. "Demokritos", Athens, Greece
- **Final beam Energy** determined via **NMR**
- **Estimated ripple 3 keV**
- High precision goniometer (~0.1°), N.C.S.R. "Demokritos"
- **6 Silicon Surface Barrier detectors**
  ϑ: 120°- 170° (step: *10°*)



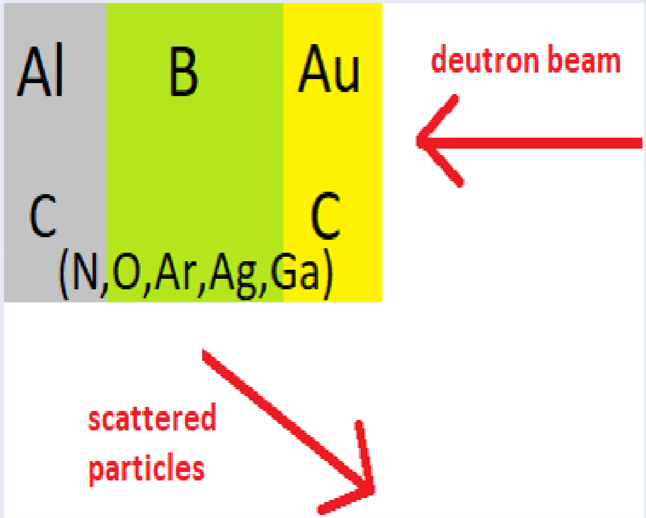
The Target

Constructed at *Ruđer Bošković Institute*.

^{nat}**B** consists of: ^{10}**B** (19.9%), ^{11}**B** (80,1%).

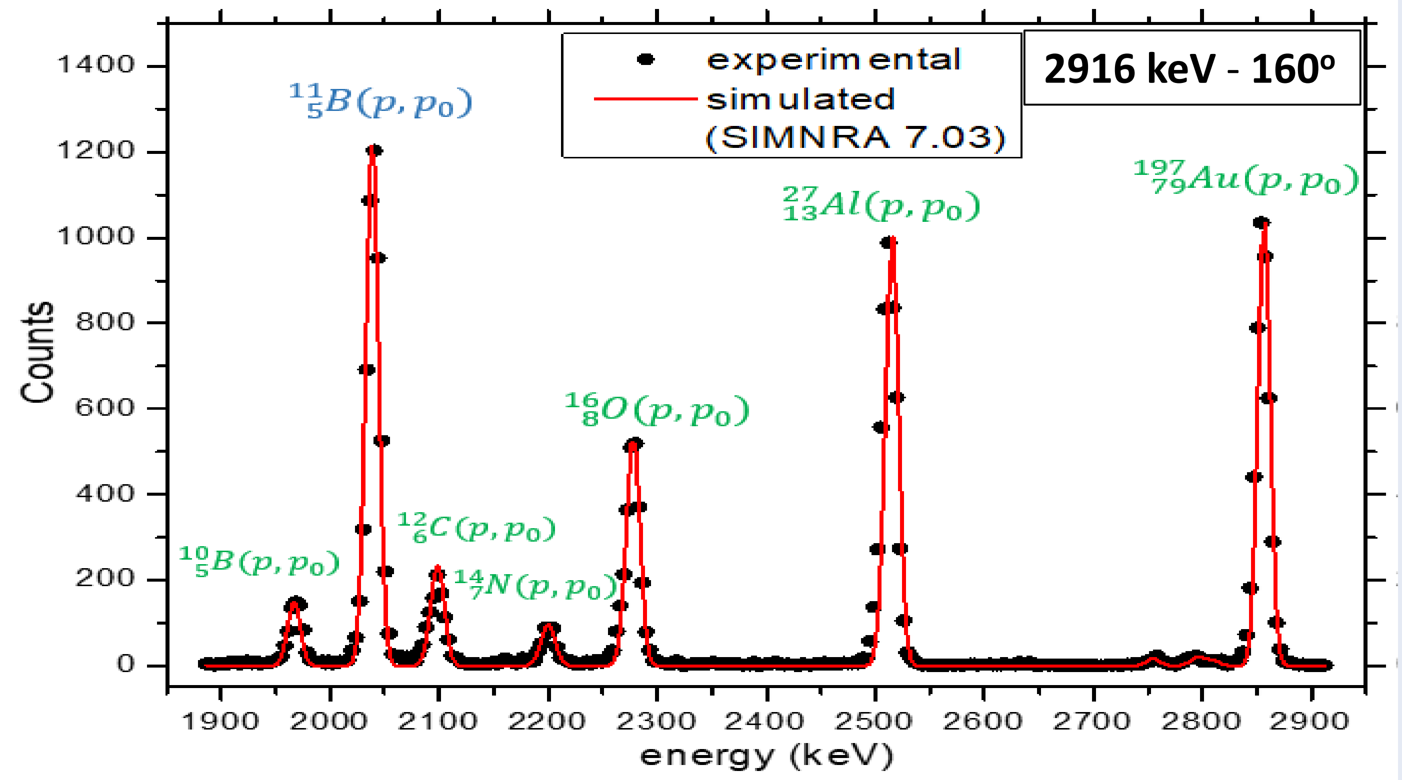
Self supporting thin foil consisting of 3 layers:

- **Al** foil (backing of the target)
- ^{nat}**B** sputtered on top of the Al
- ^{197}**Au** evaporated on the surface
  (for normalization purposes)



Target Stoichiometry

- Complementary measurements: $\mathbf{E_{p,lab} = 2750, 2920}$ **keV** $\boldsymbol{\vartheta} = \mathbf{140^o}$, $\mathbf{160^o}$
- Use of the **SIMNRA code** [1] version 7.03
- Datasets [2],[3] used for $^{11}B(p,p_0)$ cross section.



[1] M. Mayer, Improved Physics in SIMNRA 7, Nucl. Instrum. Methods B332 (2014) 176-180

[2] M. Chiari et al. Nucl. Instr. Meth. B 184 (2001) 309

[3] M. Kokkoris+(2010), Jour. Nucl. Instrum. Methods in Physics Res., Sect.B, Vol.268, p.3539

Data Analysis

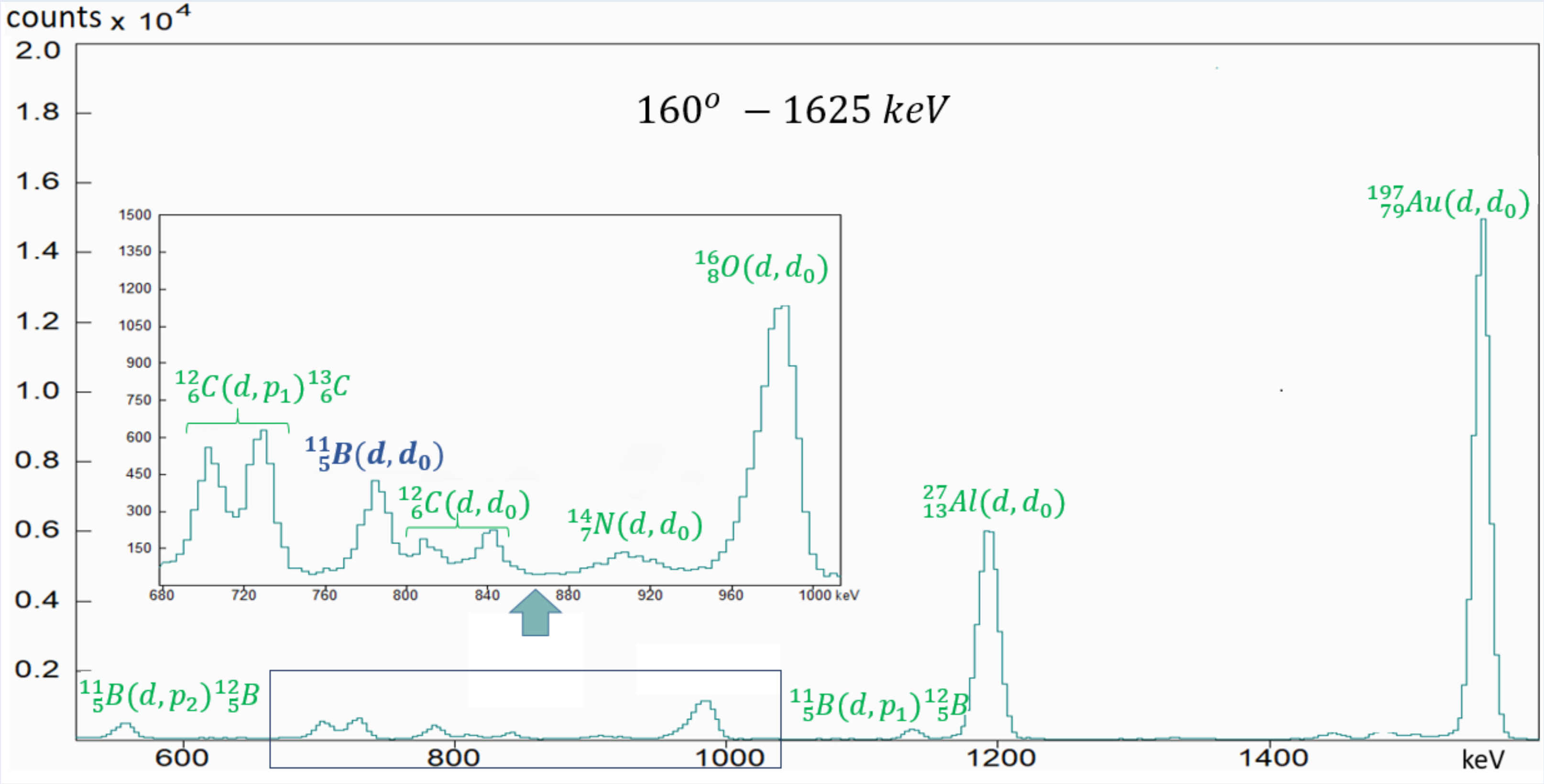
Cross section results obtained via the relative technique:

$$\left(\frac{d\sigma}{d\Omega}\right)^{E,\theta}_{{}^{11}_{5}B(d,d_0)} = \left(\frac{d\sigma}{d\Omega}\right)^{E',\theta}_{Au(d,d_0)} \frac{Y_{{}^{11}_{5}B(d,d_0)}}{Y_{Au(d,d_0)}} \frac{N_{t,Au}}{N_{t,{}^{11}B}}$$

- $\left(\frac{d\sigma}{d\Omega}\right)^{E,\theta}_{{}^{11}_{5}B(d,d_0)}$: Diff. cross section of $^{11}B(d,d_0)$ scattering, detection angle ***ϑ***, energy at the half of the target thickness ***E*** (accelerator energy calibration taken into account).
- $\left(\frac{d\sigma}{d\Omega}\right)^{E',\theta}_{Au(d,d_0)}$: **Screened Rutherford** diff. cross section of $^{197}Au(d,d_0)$ scattering for the final ion beam energy ***E'***.
- $N_{t,x}$: Total number of x nuclei present in the target (determined via the SIMNRA code).
- **Y_x** : The integrated yield of the experimental elastic peak *x*

Derived Spectra

- Extremely rich spectra with several peaks of interest
- Peaks integrated using the SpectrW code [4].
- Carbon in 2 separate target layers creates double peaks.



[4] Kalfas C.A. et al., SPECTRW: A software package for nuclear and atomic spectroscopy, Nucl. Instr. Methods A830 (2016) 265-274.

Results & Conclusions

- Extreme peak overlap from the parasitic carbon in target backside, information could not be extracted for backscattering angles *ϑ: 120º, 130º, 140º*
- The $^{11}B(d,d_0)$ differential cross sections values were determined for the energy range: $E_{d,lab}$=1300-1860 keV, θ= 150º, 160º& 170º.
- Values below the $^{11}B(d,d_0)$ Rutherford ones
- Overlapping resonances observed in the energy range of interest
- No noticeable angle distribution in the differential cross sections