Differential cross section measurements of the ^{7}Li (p,p'γ_{1-0}) ^{7}Li reaction suitable for PIGE applications

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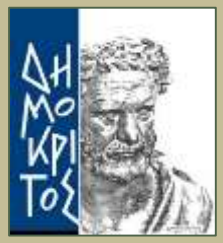
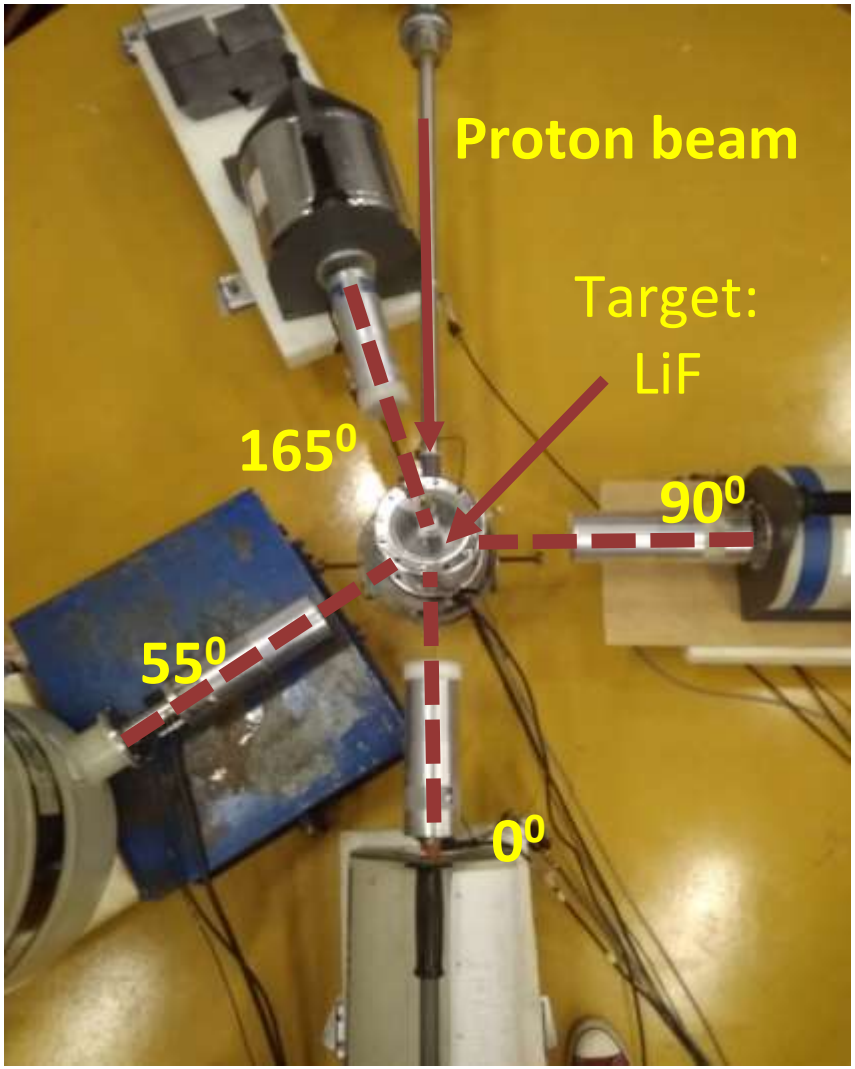


Motivation

- Lithium is one of the abundant light elements in nature and its study via the PIGE technique is widely applied in many disciplines.
- ^{7}Li is the most abundant isotope (92.5%) of natural lithium, so the accurate calculation of the differential cross sections of the reaction ^{7}Li (p,p'$\gamma_{1\text{-}0}$) ^{7}Li is of great importance for analytical purposes.
- However, due to discrepancies between older experimental datasets and the considerable lack of results corresponding to different angles, a further study of the reaction is carried out in the present work.

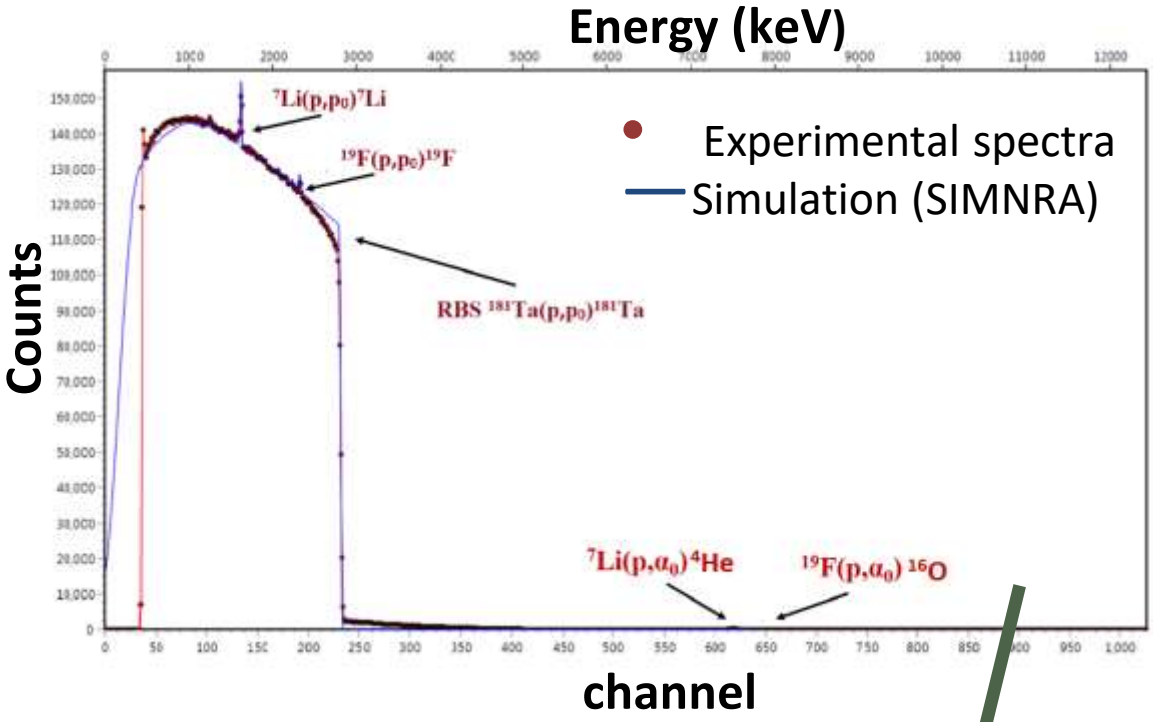
Experimental setup

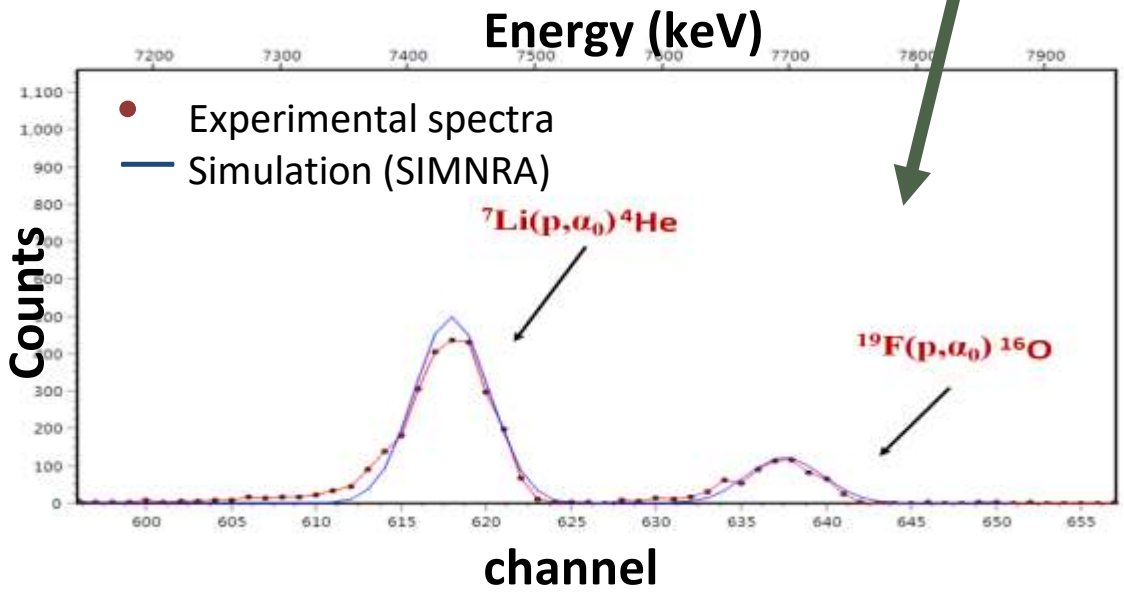
Proton beam delivered by the 5.5 MV Tandem Van de Graaff Accelerator of NCSR "Demokritos"



- **Proton energy range:** 1010 – 4000 keV in steps of 10-20 keV
- **Beam energy:** Via Nuclear Magnetic resonance (NMR). The offset value was 2.0 keV and was calculated using the $^{27}Al(p,\gamma)^{28}Si$ reaction's resonance at 991.89 ± 0.1 keV. The total energy ripple was ~4.7 keV
- **Target:** Evaporated LiF powder on a ^{nat}Ta thick layer
- **Detectors:** 3 High Purity Germanium detectors of 16-20% relative efficiency, mounted on a table at the angles of 0º, 55º, 90º, 165º distance from the target: ~20 cm, angular acceptance: ~11º

Target Characterization





Thickness of ^{7}Li:
$(1850\pm130)\times10^{15}$ atoms/cm^2 using the EBS - NRA technique via the ^{7}Li (p,a$_0$) ^{4}He reaction for the proton beam energy E_p = 2899 keV (detection angle 170^o).

The analysis was carried out using the SIMNRA 7.02 code.

Cross section data for (p,a$_0$) reactions: V.Paneta et al.

Data Analysis

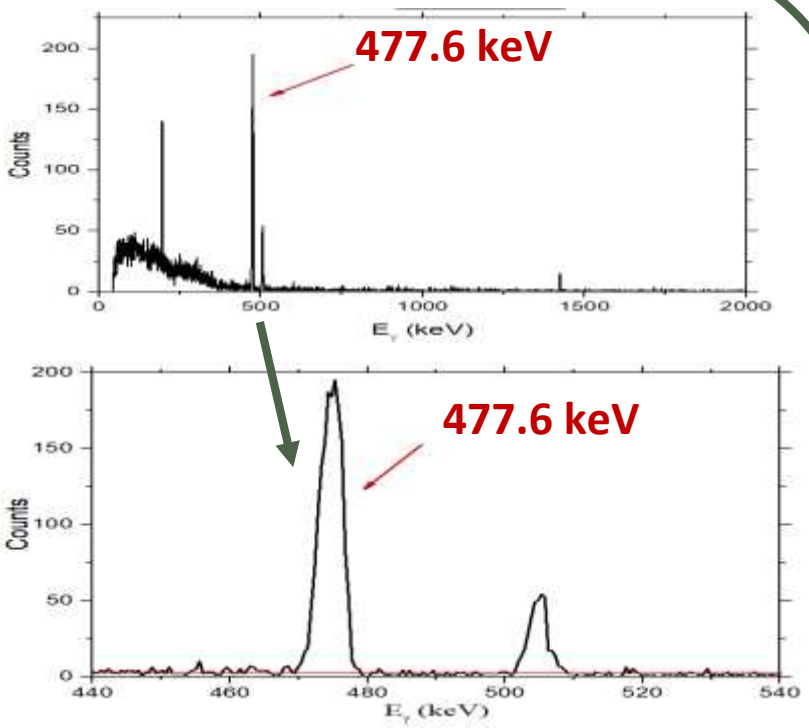
Absolute measurement

$$\frac{d\sigma(E,\theta)}{d\Omega} = \frac{Y(E,\theta)}{N_p \cdot N_t \cdot 4\pi \cdot \varepsilon_{abs}}$$

where

- **Y(E,θ):** experimental yield, determined by integrating the peak of interest at each spectrum
- **N_p:** number of incident protons
- **N_t:** target thickness (atoms/cm^2)
- **ε_{abs}:** detector absolute efficiency

Spectrum

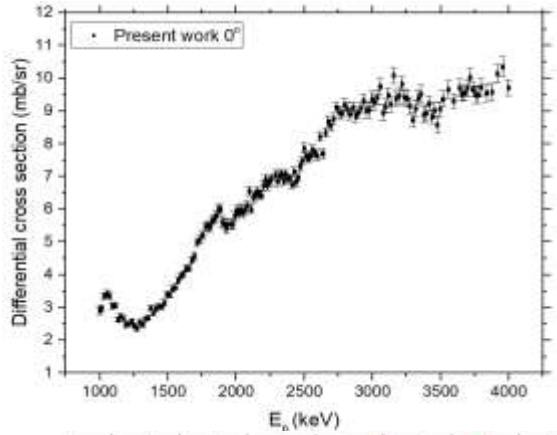


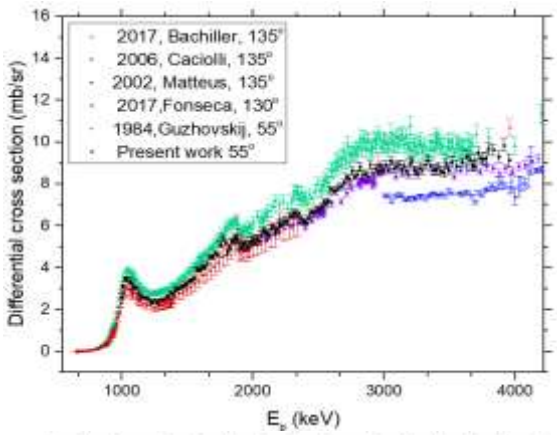
The integration of each peak was carried out using SPECTRW.

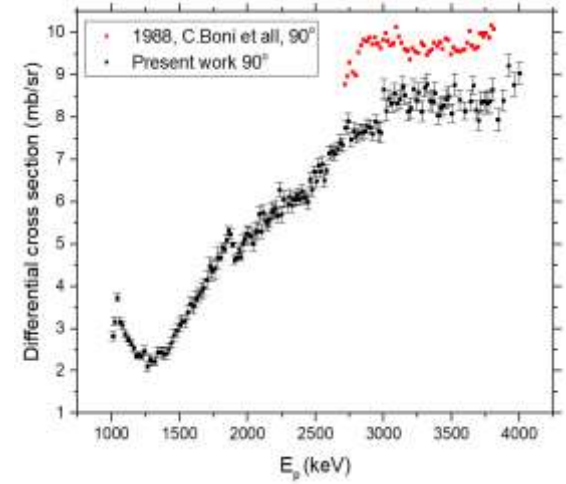
Statistical uncertainty: < 4% in all cases

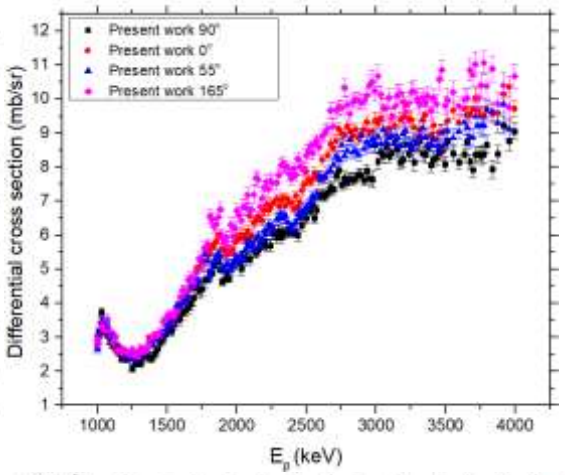
Total systematic uncertainty: ~ 8% due to target thickness, current integration and detector efficiency

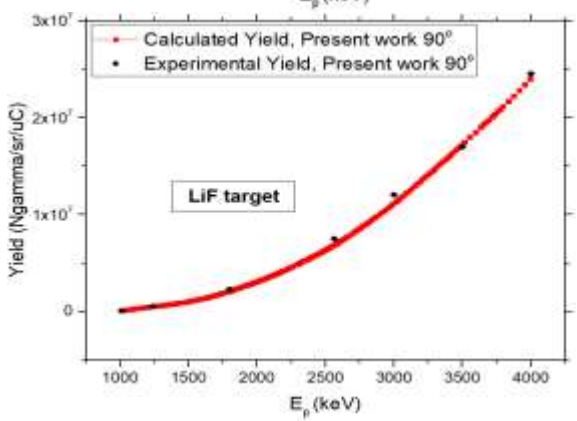
Results and Conclusions

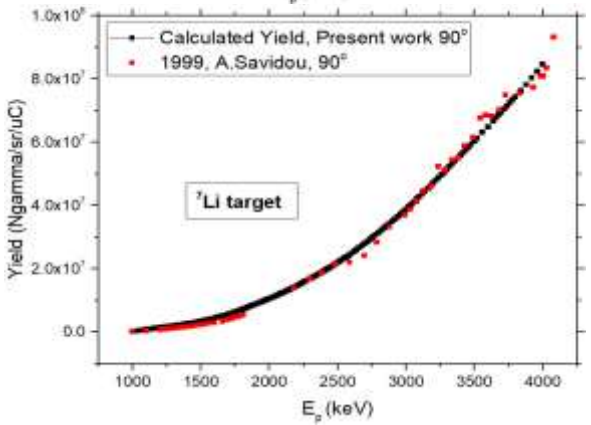












- Results follow the trend of older experimental datasets.
- There is a satisfactory agreement between the results obtained in the present work at 55° and the datasets measured at 135° and 130° by Matteus and Fonseca respectively.
- Experimental Yields are in a good agreement with the calculated results obtained using measured differential cross sections at 90°.
- Results from the present work and from A.Savidou's exhibit discrepancies less than 7%.