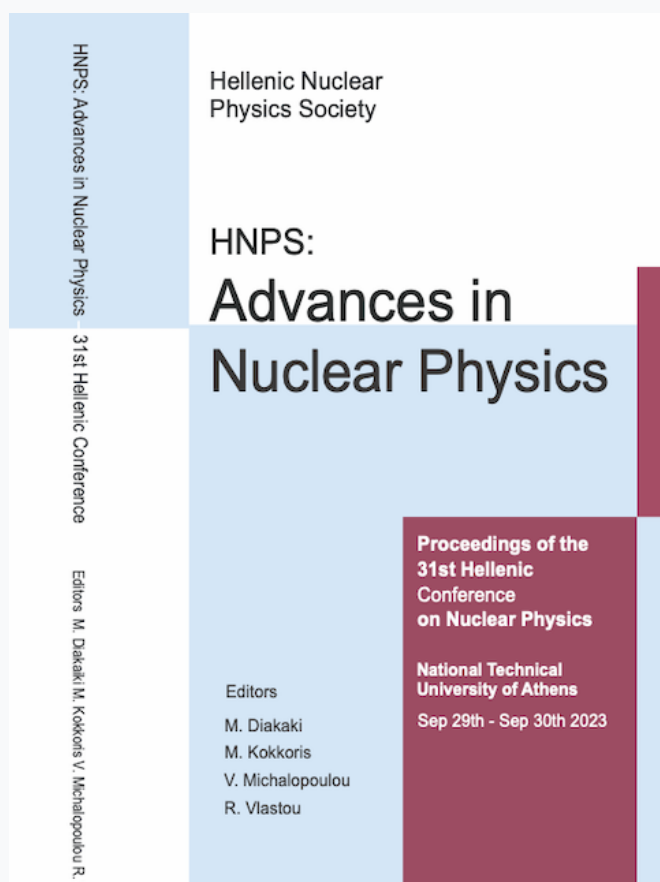


Annual Symposium of the Hellenic Nuclear Physics Society

Τόμ. 30 (2024)

HNPS2023



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MARIA KAGIOGLOU, Rosa Vlastou, Maria Diakaki, Michail Kokkoris, Sotirios Chasapoglou, Zoi Bari, Michail Axiotis, Anastasios Lagogiannis

doi: [10.12681/hnpsanp.6355](https://doi.org/10.12681/hnpsanp.6355)

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Βιβλιογραφική αναφορά:

KAGIOGLOU, M., Vlastou, R., Diakaki, M., Kokkoris, M., Chasapoglou, S., Bari, Z., Axiotis, M., & Lagogiannis, A. (2024). Neutron Induced Reactions on ^{203}Tl at 15.7MeV, 16.0MeV and 18.0MeV. *Annual Symposium of the Hellenic Nuclear Physics Society*, 30, 203–206. <https://doi.org/10.12681/hnpsanp.6355>

Neutron Induced Reactions on ^{203}Tl at 15.7 MeV, 16.0 MeV and 18.0 MeV

M. Kagioglou^{1,*}, R. Vlastou¹, M. Diakaki¹, M. Kokkoris¹, S. Chasapoglou¹, Z. Bari¹,
M. Axiotis² and A. Lagoyannis²

¹ Department of Physics, National Technical University of Athens, Zografou campus, 15780 Athens, Greece

² Tandem Accelerator Laboratory, Institute of Nuclear Physics, NCSR «Demokritos», Agia Paraskevi, 15310 Athens, Greece

Abstract The aim of the present work is to study the potential channels that result from the interaction of ^{203}Tl with neutrons by bombarding natural TlCl pellet targets with neutron beams at 15.7, 16.0 and 18.0 MeV. The monoenergetic neutron beams were produced at the 5.5 MV Tandem Van de Graff accelerator laboratory of NCSR "Demokritos" by means of the $^3\text{H}(\text{d},\text{n})^4\text{He}$ reaction. The cross section measurements were based on the activation technique and deduced with respect to the $^{197}\text{Au}(\text{n},2\text{n})^{196}\text{Au}$ and $^{27}\text{Al}(\text{n},\alpha)^{24}\text{Na}$ reference reactions. After the end of the irradiations, the induced activity in the target and reference foils was measured by γ -ray spectroscopy, using High Purity Germanium detectors (HPGe).

Keywords thallium, cross section, neutron activation analysis

INTRODUCTION

In many facets of daily life, including electronic equipment, nuclear medicine, infrared detectors, and fiber optics, thallium is widely employed. However, in the literature, there is little information about neutron-induced reactions on Thallium isotopes, and there seem to be significant discrepancies in the existing data of the most studied reaction, $^{203}\text{Tl}(\text{n},2\text{n})^{202}\text{Tl}$, especially in the energy range of 12 MeV and above [1], as illustrated in Fig. 1. This work constitutes a continuation of a previous work of our group with measurements at 16.4, 18.9 and 19.3 MeV, in order to cover the high energy range of neutron beams that can be produced at NCSR "Demokritos" [2,3].

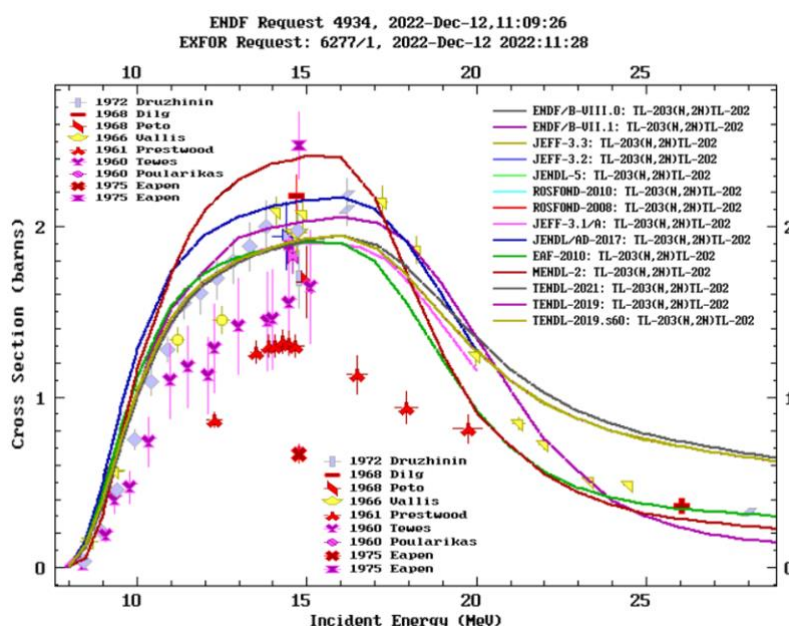


Figure 1. Existing experimental data and ENDF evaluations of the $^{203}\text{Tl}(\text{n},2\text{n})^{202}\text{Tl}$ reaction

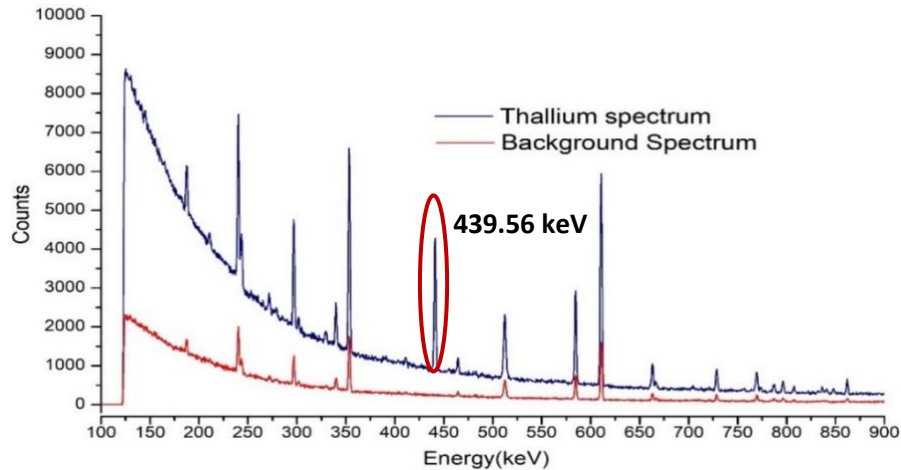
* Corresponding author: mariakagiogloy@gmail.com

Figure 3. *CuTiT* target

Table 1. *Characteristics of the irradiations*

Neutron Energy (MeV)	Irradiation time (h)	Measurement time (h)	Deuteron Energy (MeV)
15.7	~5	~22 ~2	2.145
16.0	~8	~19	2.153
18.0	~7	~22	2.916

The resulting Thallium gamma-ray spectrum compared to the background spectrum is shown in Fig. 4.


Figure 4. *Thallium spectrum at 15.7 MeV in comparison with the background spectrum*

CROSS SECTION MEASUREMENT

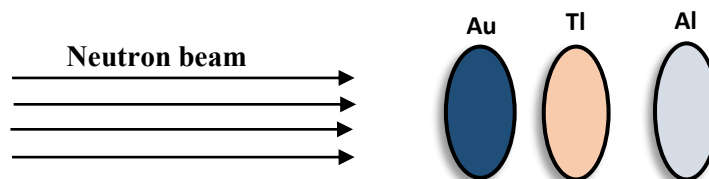
The measurement of the cross section (σ) was based on the Neutron Activation Analysis (NAA) and was calculated using the following expression:

$$\sigma = \frac{N_p}{N_t} \cdot \frac{1}{\Phi}$$

Where:

- N_p : the number of unstable nuclei produced by the neutron irradiation.
- N_t : the number of irradiated target nuclei.
- Φ : neutron flux calculated with Monte Carlo simulations via the MCNP code [4] and compared with experimental fluxes from the reference reactions.

For the determination of the neutron flux (Φ) of the reaction $^{203}\text{Tl}(n,2n)^{202}\text{Tl}$, the reference reactions $^{197}\text{Au}(n,2n)^{196}\text{Au}$ and $^{27}\text{Al}(n,\alpha)^{24}\text{Na}$ were used, along with MCNP simulations using the geometry of the irradiation setup, shown in Fig. 5.


Figure 5. *Schematic representation of the irradiated target and reference foils*

RESULTS AND DISCUSSION

The preliminary results of the experimental cross section (σ) at energies 15.7 MeV, 16.0 MeV and 18.0 MeV are presented in Table 2 as well as in Fig. 6 shown in blue, along with the previous measurements from our group at 16.4, 18.9 and 19.3 MeV shown in green [2,3] and existing data in literature.

Table 2. *Experimental Cross-section preliminary results*

	$\sigma \pm \delta\sigma$ (barn)
Neutron Energy (MeV)	$^{203}\text{Tl}(n,2n)^{202}\text{Tl}$
15.7	1.96 ± 0.09
16.0	1.91 ± 0.10
18.0	1.67 ± 0.11

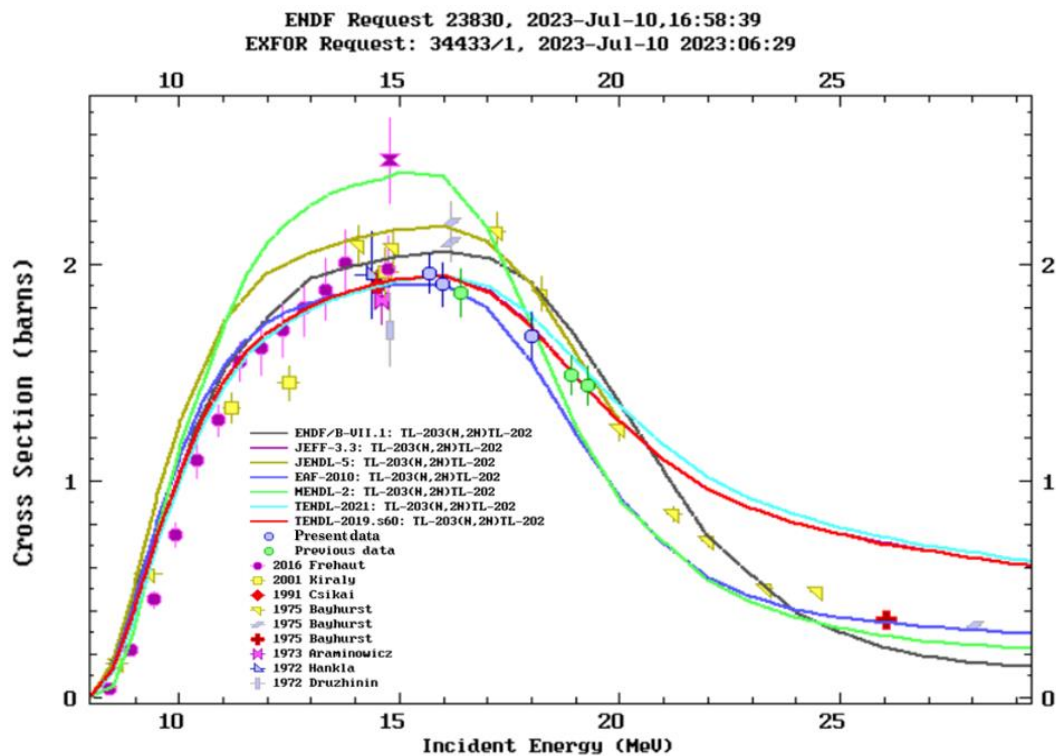


Figure 6. Existing and present experimental data along with evaluations [4]

References

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