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Towards an activation cross section measurement of the $^{17}O(p,\gamma)^{18}F$ reaction in a wide energy range

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Introduction

- The **CNO cycles** are fusion processes in stars that converts hydrogen to helium. These **hydrogen burning processes** occurs in several sites and stages of stellar evolution, such as **red giants**, asymptotic giant branch **(AGB) stars**, **massive stars**, and **classical novae**.

- One of the important reactions in the **CNO-III** and **CNO-IV** cycles is the ^{17}**O(p,γ)**^{18}**F** [1]. The only available total cross section measurement in a wide energy range for this reactions dates back to several decades ago [2] which makes the theoretical extrapolation to astrophysical energies more difficult and introduces uncertainty.

- The aim of the present work is to provide precise total cross section data in the energy range between about 500 keV and the 2 MeV using the **activation method**. The experimental campaign at the new tandetron accelerator of Atomki is in progress.

Experiment

- The present experiment is the first scientific project on the new accelerator (Fig. 1-2), the beam energy calibration was carried out using resonances in the ^{27}Al(p, γ) reaction.

- The Ta_2O_5 targets were produced by anodic oxidation of tantalum backings in isotopically enriched water [3]. The target thicknesses were measured with **RBS** technique. In Fig. 3 the typical spectrum can be seen, clearly showing the Ta_2O_5 layer on the Ta backing.

- Target stability is monitored with ^{17}O(p,γ) and ^{18}O(p,γ) resonances scans detecting the prompt gamma radiations, as shown in Fig. 4.

- The targets were irradiated by the proton beam with an intensity of **several μA** for a few hours, after which they were transported to an offline detector for the measurement of the ^{18}F decay (see Fig. 5).

Fig. 1 – Tandetron accelerator at Atomki.

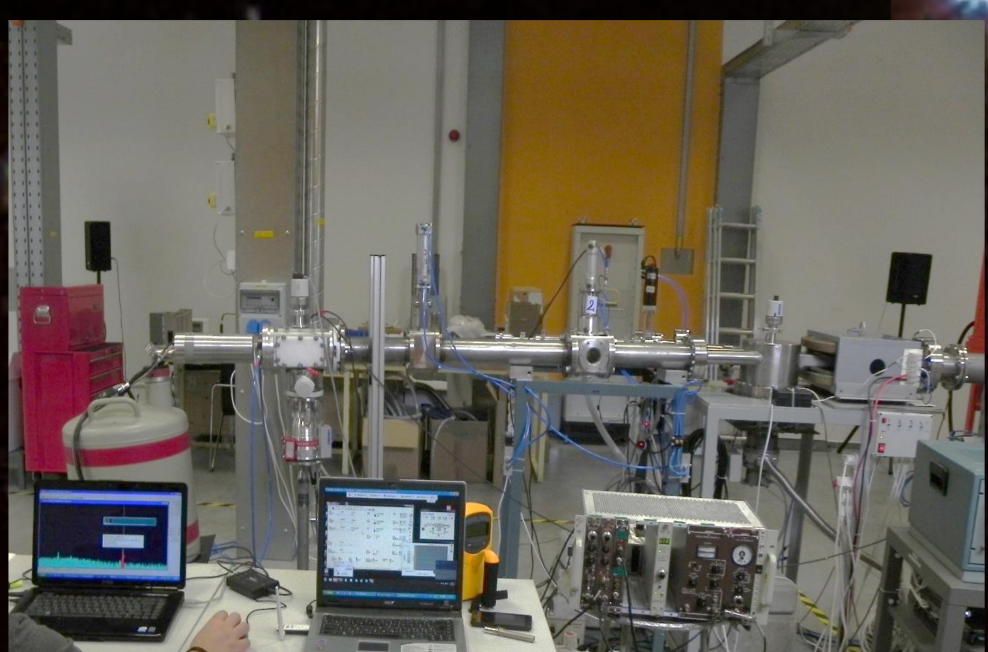

Fig. 2 – Closer up of setup.

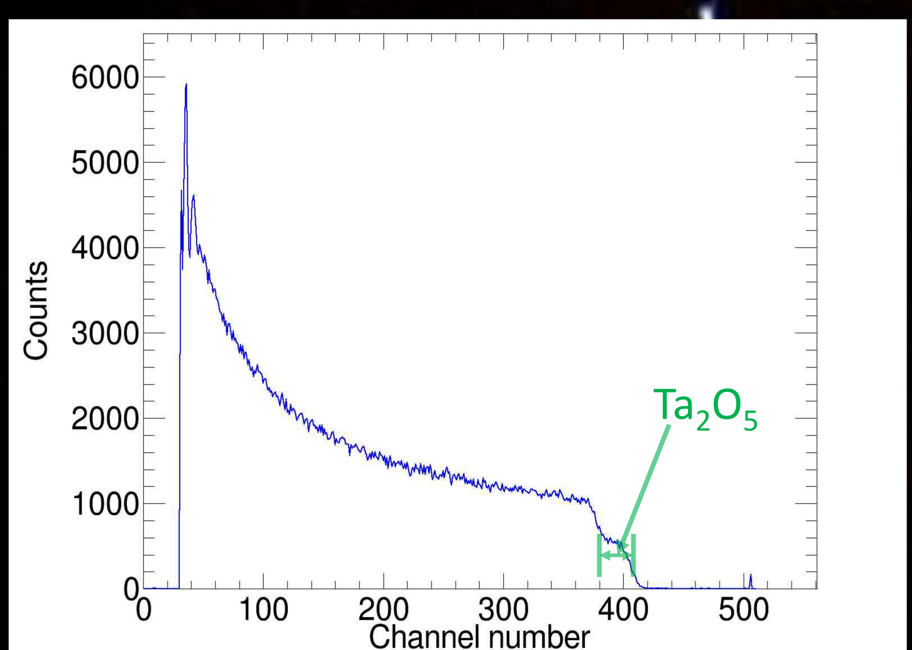

Fig. 3 – RBS spectrum of a Ta_2O_5 target, measured at 1.6 MeV, with detector at 135°.

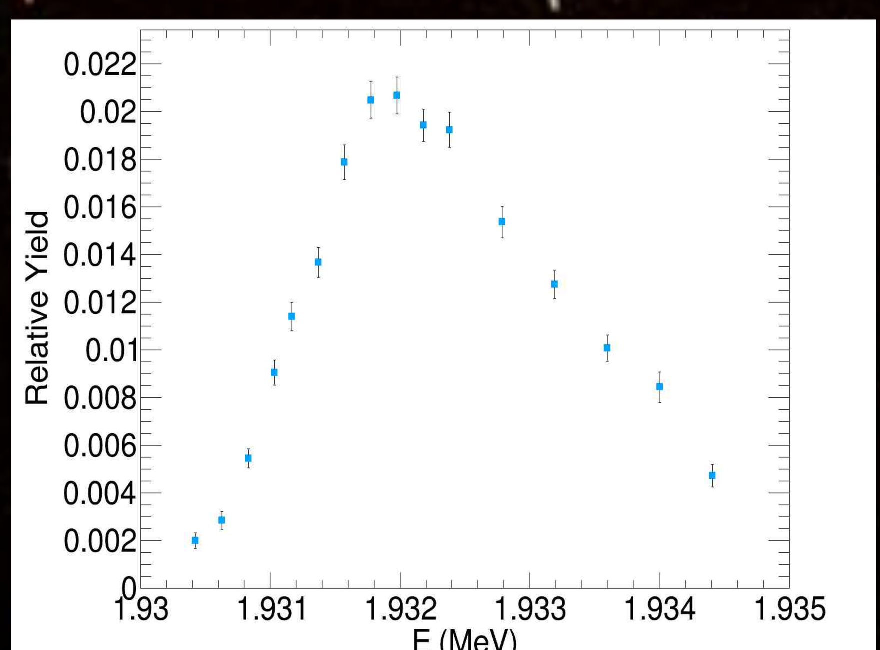

Fig. 4 – ^{18}O(p,γ) resonance.

Analysis

- The main decay path of the ^{18}F is by β^+ emission (96.7%) with half-life of 109.77 minutes. To track this β^+ decay curve, several 10 minutes gamma-spectra where taken to measure the 511 keV annihilation radiation, allowing the calculation of the activity after the activation of the Ta_2O_5 target.

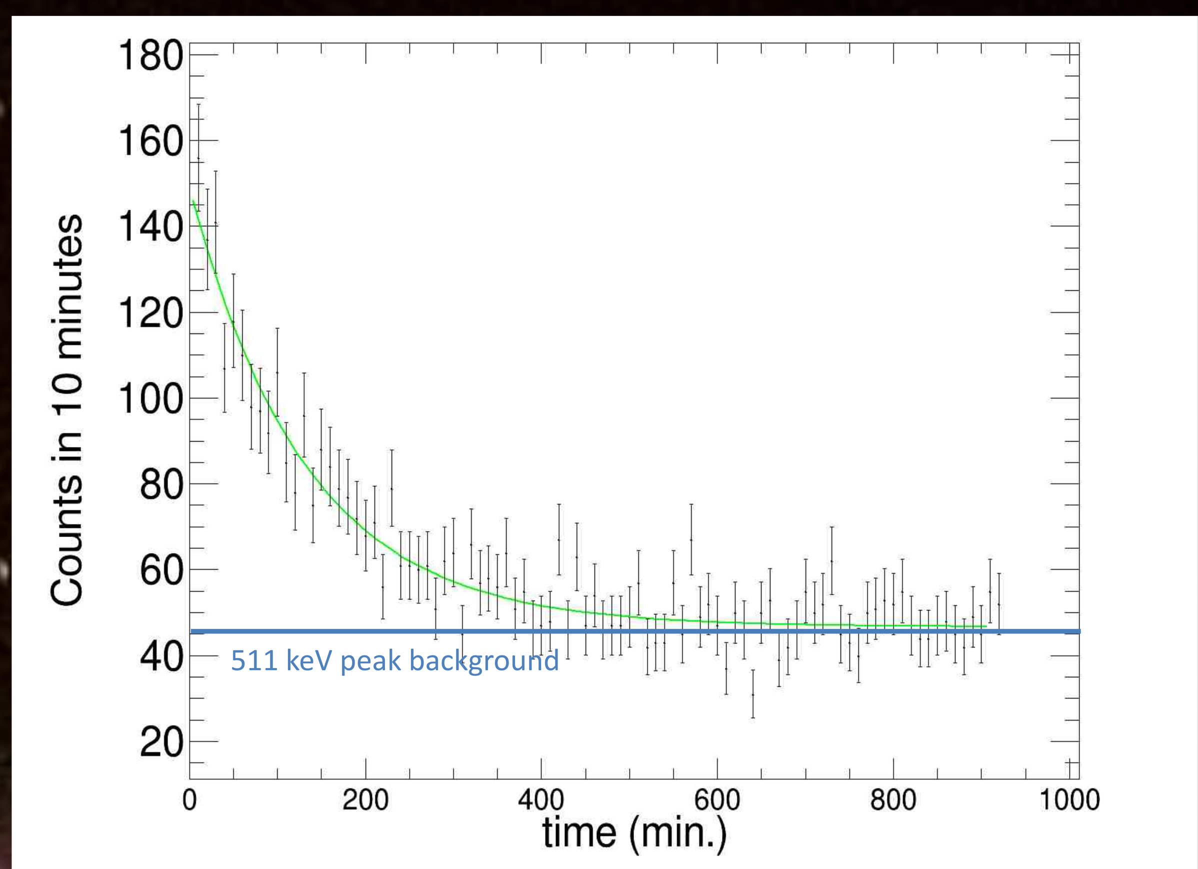

Fig. 5 – β^+ decay curve of ^{18}F after activation with 1 MeV protons.

Preliminary Results and Outlook

- A few test irradiations were carried out between 580 and 1500 keV in order to study the feasibility of the measurement. A preliminary total cross section calculated from the 1 MeV measurement is shown in Fig. 6. compared to the data of [2].

- The results are still preliminary and the experimental campaign is ongoing.

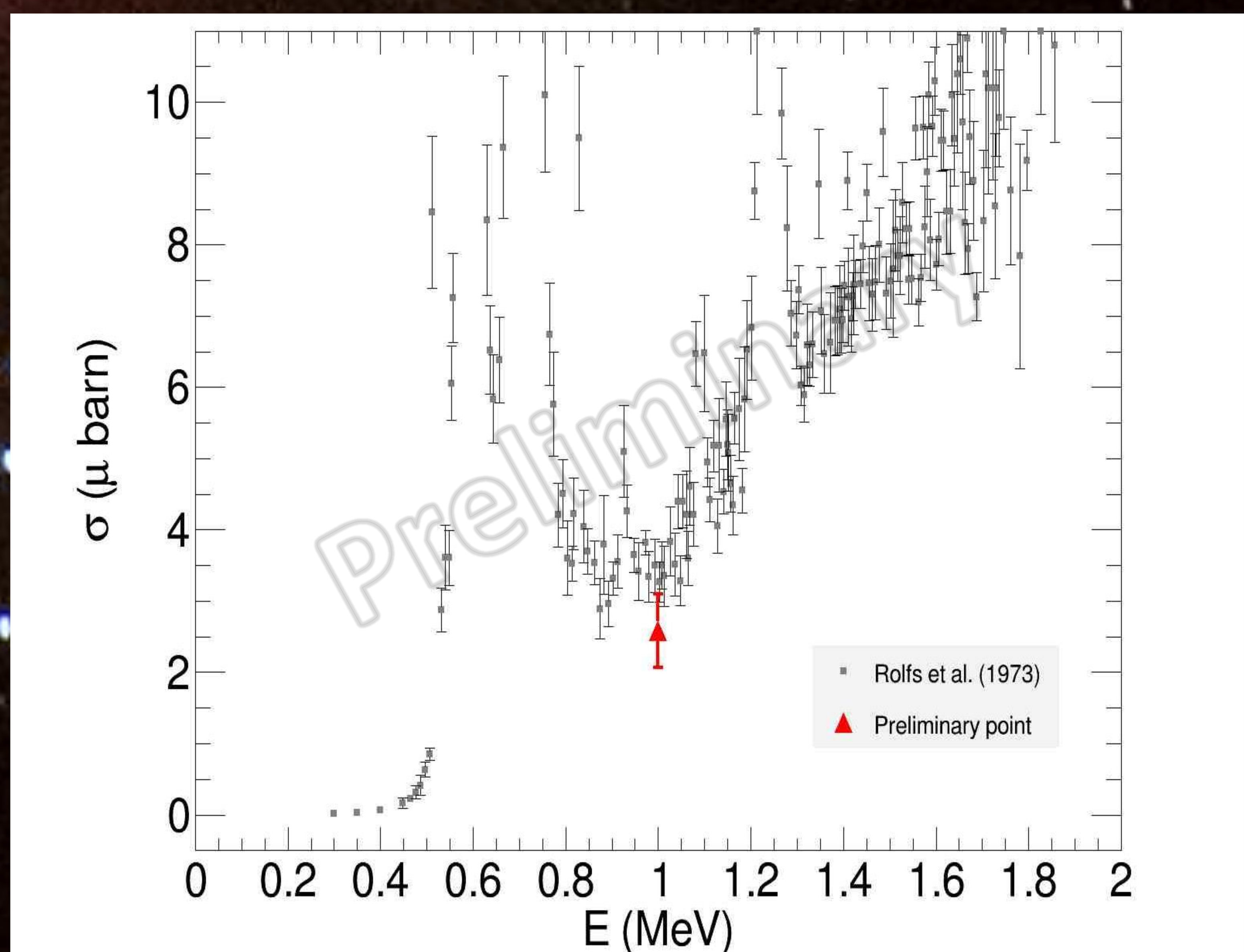

Fig. 6 – Total cross section of the $^{17}O(p,\gamma)^{18}F$ reaction.

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References

[1] J. Jose, Rep. Prog. Phys. **74**, 096901 (2011).
[2] C. Rolfs, Nucl. Phys. A **217**, 29 (1973).
[3] A. Caciolli et al., Eur. Phys. J. A. **48**, 144 (2012)