



Motivation

In the γ -process of heavy element nucleosynthesis (α, γ) reactions play an important role. Reaction-network calculations require the alpha-nucleus optical model potential (AOMP) as an input, so their reliability depends on the applied AOMP. Among the available potentials, ATOMKI-V2 is a promising candidate for γ -process calculations. AOMPs can be tested by comparing experimental cross sections with TALYS calculations. The TALYS code is a computer code which can be used to calculate nuclear reaction cross sections. Near the reaction threshold, (α, n) cross sections are determined mainly by the AOMP and are therefore well suited to such studies. This poster presents activation cross-section measurements of the $^{89}\text{Y}(\alpha, n)^{92\text{m}}\text{Nb}$ and the $^{107,109}\text{Ag}(\alpha, n)^{110,112}\text{In}$ reactions. As the experimental work is still in progress, only preliminary results are presented.

Target preparation

Yttrium targets

The targets were prepared by thermal vacuum evaporation of 99.9% pure yttrium onto 10 μm Al foils of 99.99% purity. However, the targets were contaminated with oxygen during or after evaporation. The number of target nuclei, essential for cross-section measurements, was determined by Rutherford backscattering spectrometry (RBS). A typical RBS spectrum is shown in Figure 1, and the results are listed in Table 1.

Table 1. The results of the RBS measurements. The average uncertainty of the Y nuclei number values is 3%.

Target number	Layer thickness (10^{18}atom/cm^2)	Y:O ratio	Y nuclei number (10^{18}atom/cm^2)
19	1.90	0.67	0.76
20	1.95	0.40	0.55
21	1.95	0.41	0.65
22	3.00	0.42	0.88
23	1.99	0.60	0.75
24	2.60	0.46	0.80

Silver targets

Ag_2S was used as the source material for thermal vacuum evaporation of the silver targets. The $^{32}\text{S}(p, \gamma)^{33}\text{Cl}$ reaction has a narrow resonance at $E_p = 589 \pm 1$ keV, enabling the number of Ag nuclei in the target layer to be determined by the nuclear resonance method. These measurements are planned but could not be performed before publication of this poster.

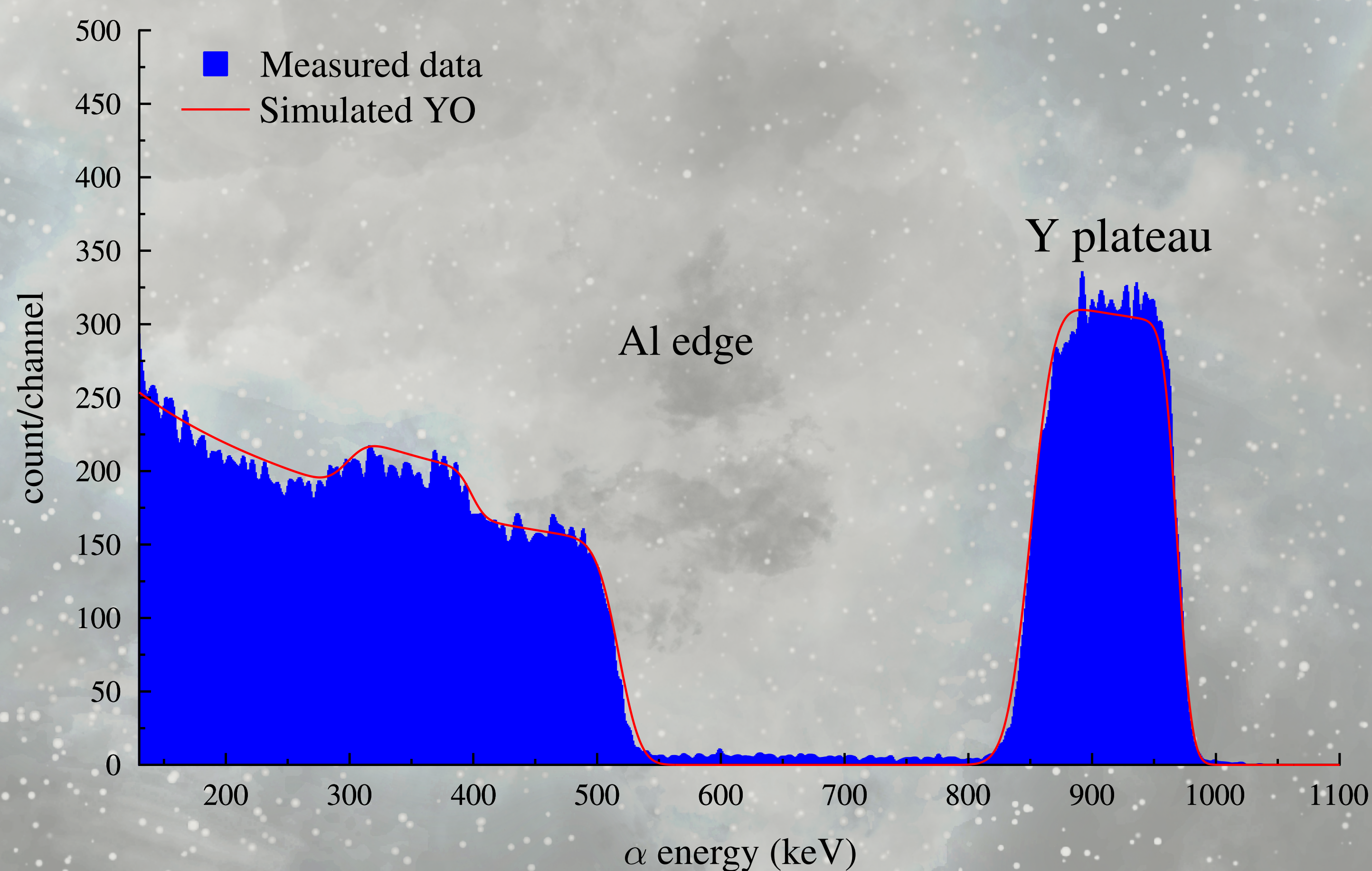


Figure 1. A typical RBS spectrum of the prepared yttrium targets (target T20 in particular). The blue histogram represents the measured data. The red line shows a SIMNRA simulation. The simulation was performed assuming that oxygen can be found in the target layer. The simulated spectrum and measured data are in good agreement.

Activation measurements and experimental cross sections

Since the produced nuclei ($^{92\text{m}}\text{Nb}$, and $^{110,112}\text{In}$) are radioactive, the (α, n) cross sections can be determined by activation. The α beam was provided by the HUN-REN ATOMKI cyclotron at $I_\alpha = 0.5 - 1$ μA . Irradiation times were in the range of $t_{\text{irr}} = 0.25 - 14.5$ hours. Because $^{92\text{m}}\text{Nb}$ has a half-life of $t_{1/2} = 243.6$ h, the irradiated target can be transported to a detector room with better background conditions. The shorter half-lives of $^{110,112}\text{In}$ prevent such transport, so the detector must be placed next to the activation chamber. In all cases, radioactive decay is followed by γ -ray emission. $^{92\text{m}}\text{Nb}$ emits a $E_\gamma = 934.44$ keV γ -ray while $^{110,112}\text{In}$ emit several γ -rays with high relative intensities. These were detected with HPGe detectors. The efficiency of the detector used for $^{92\text{m}}\text{Nb}$ counting was determined with calibration sources, as shown in Figure 2.

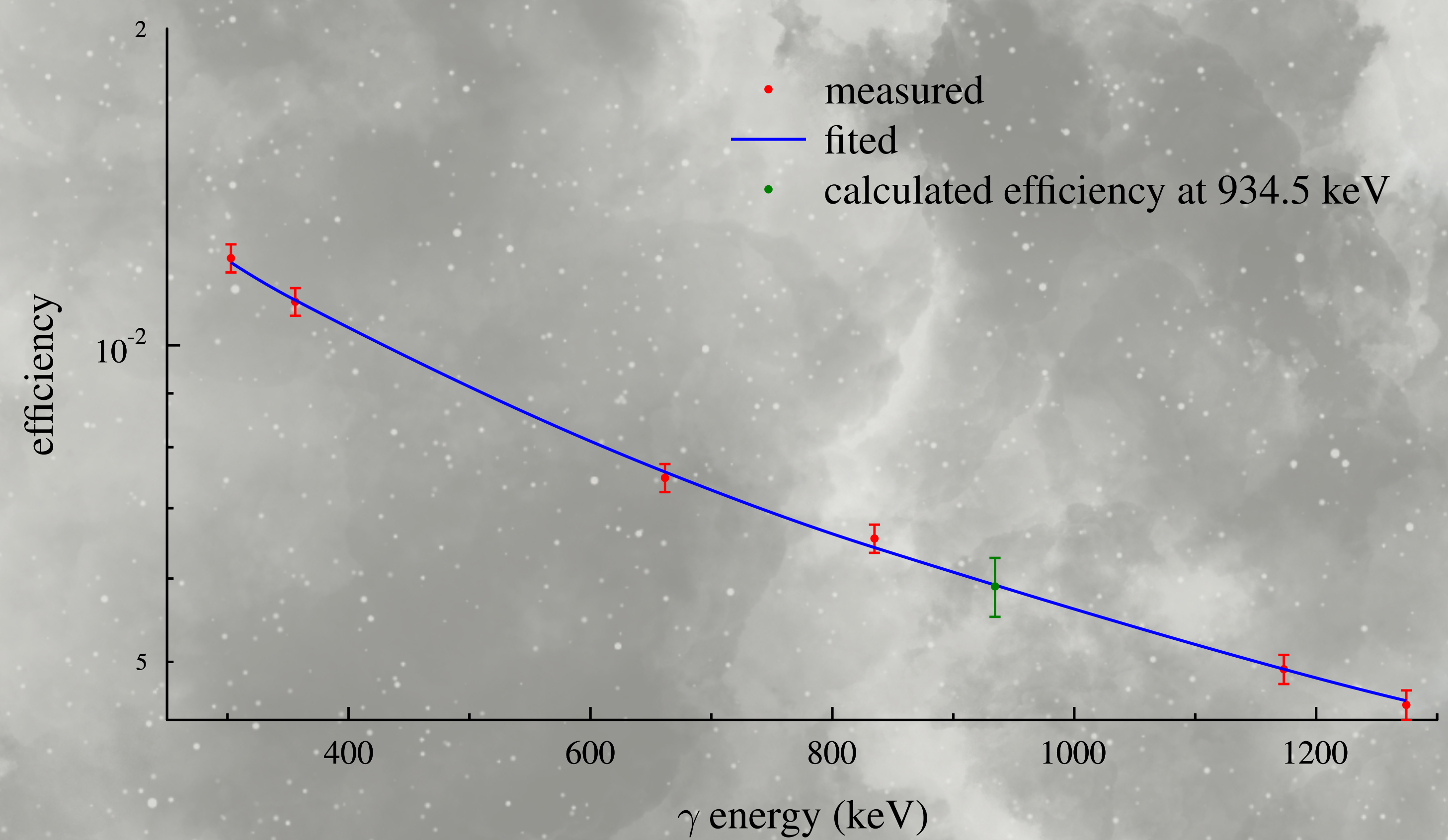


Figure 2. The result of the efficiency calibration. The measured points are shown by red dots, the fitted polynomial function with the blue line, and the calculated efficiency is labelled with the green dot. The error bars contain both statistical and systematic errors.

The cross section can be calculated from the number of target nuclei, detector efficiency, and γ -ray peak area the cross section can be calculated. Preliminary results for the $^{89}\text{Y}(\alpha, n)^{92\text{m}}\text{Nb}$ reaction are compared with a TALYS calculation.

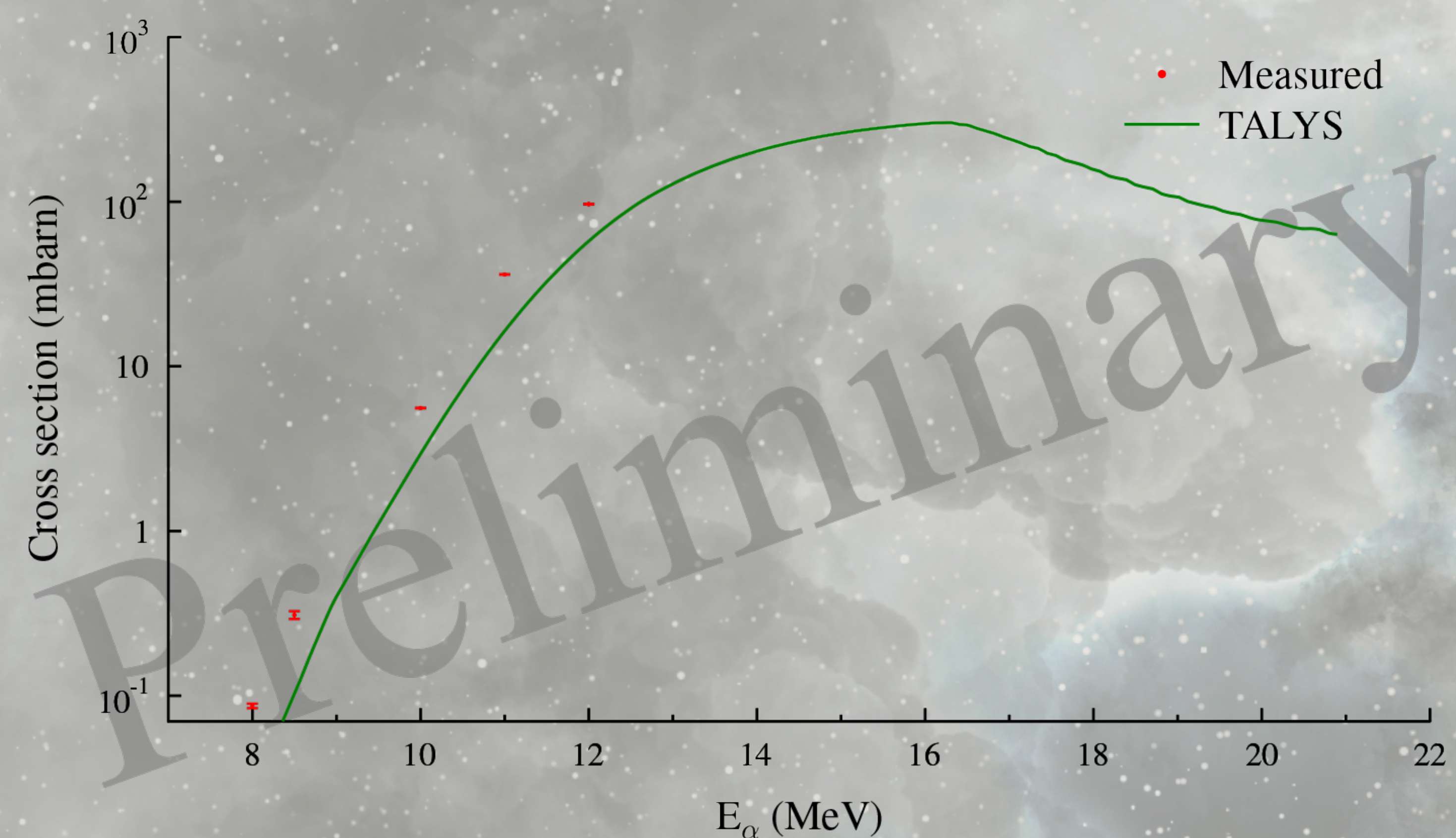


Figure 3. Preliminary experimental results of the $^{89}\text{Y}(\alpha, n)^{92\text{m}}\text{Nb}$ reaction cross section. The red dots represent the measured cross-section values and the error bars represent only the statistical errors. For the TALYS calculation the default input parameters are used.

Outlook

Next, the $^{89}\text{Y}(\alpha, n)^{92\text{m}}\text{Nb}$ data will be compared with TALYS calculations using various AOMPs, including ATOMKI-V2. For the $^{107,109}\text{Ag}(\alpha, n)^{110,112}\text{In}$ reactions, the targets will be characterized by the nuclear resonance method and the cross sections will be measured.