New measurement of the $^{10}$B(n,$\alpha$)$^{7}$Li through the Trojan Horse Method

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Abstract. $^{10}$B(n,$\alpha$)$^{7}$Li reaction cross section has been measured using the Trojan Horse method, with the specific aim to separate the $\alpha_1$ contribution (coming from the first $^{7}$Li excited level) by the $\alpha_0$ (related to the $^{7}$Li ground state), using a very thin target. Preliminary results are shown of the three-body $^{10}$B(d,$\alpha$)$^{7}$LiH cross section.

1. Introduction
Studying the $^{10}$B(n,$\alpha$)$^{7}$Li cross section has become always more important in these last years, because of the importance of its knowledge for applied physics (it is considered to be a standard in neutron induced cross section [1]). Applications regard nuclear energy production in actual and future plants (it is widely used to monitor the neutron flux through ionization chambers filled with $^{10}$B) [2] and medical cure. Indeed, it is used for the cure of melanomas and rheumatoid arthritis, with a treatment called Boron Neutron Capture Therapy (BNCT) [3] [4]; moreover, this reaction is helpful to study negative effects of the $\alpha$ particles doses on the human body [5].

This reaction has already been measured using Trojan Horse Method [6], but now a new measurement has been performed in order to separate the the two main contribution to this cross section, coming from the ground state and from the first excited state (energy 0.477 MeV) of the $^{7}$Li.

2. Experimental apparatus
The experimental run has been performed in 2014 in Laboratori Nazionali del Sud (LNS, Catania), using a 28 MeV $^{10}$B beam impinging on a CD$_2$ target, to measure the $^{10}$B(d,$\alpha$)$^{7}$LiH cross section. Outcoming particles of interest ($\alpha$ and $^{7}$Li) have been detected by four PSD detectors, symmetrically placed inside the chamber, shown in fig. 1. Details are reported in [7]. To get the two $\alpha$ contributions separated, it has been used a very this target (56 $\mu$g/cm$^2$), because it helped in minimizing the energy straggling and loss.

3. Three-body reaction selection
Once $\alpha$ and $^{7}$Li produced have been discerned via their energy loss in isobutane inside the ionization chambers, the Q-value spectrum, reported in [7], clearly shows two separated peaks related to the two channels desired. From now on, it will be referred to $\alpha_0$ and $\alpha_1$ data meaning data under the two peaks in these Q-value spectra. The corresponding kinematical loci are in very nice agreement with the Monte Carlo simulations (fig. 2).
4. Quasi-free mechanism selection
As common procedure for Trojan Horse Experiment, the spectator (a proton, in this case) momentum distribution must be considered to select the quasi-free mechanism. In fig. 3 it is evident that data, for both the channels, show a Hultn function shape, that is the momentum distribution function of the proton inside the deuteron for the l=0 wave, peaked at $p_s = 0 \text{ MeV/c}$. This intends that proton acts as a spectator to the two body process, selecting data under this function, whose full width half maximum is in agreement with what expected experimentally, considering the transferred momentum \[8]. This confirms the presence of the quasi-free mechanism, leading the analysis to the following step, the cross section extraction.

5. Preliminary results
The preliminary three body cross section, considering only data with $p_s < |40| \text{ MeV/c}$, is shown in fig. 4, for both channels. In conclusion, the separation of the two $\alpha$ contributions (the primary aim of this measurement) has been reached, propelling the further analysis to the final result of the two body reaction cross section.
Figure 3. Spectator momentum distribution (black points) following the Hultn function, indicating the quasi-free mechanism presence.

Figure 4. Three body reaction cross section for α₀ and α₁ channel.

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