# Study of $\alpha$-cluster transfer reaction with $^{7}$Be

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## Introduction

The $\alpha$-cluster transfer reaction studies involving loosely bound stable and unstable nuclei have a profound impact on astrophysics. In particular, the reactions with $^{6,7}$Li have been widely used to get spectroscopic factors and reduced $\alpha$-widths. These quantities in turn have been successfully utilized in the understanding of stellar nucleosynthesis [1,2]. In the present work, we have studied $\alpha$-transfer reaction with the radioactive nucleus $^{7}$Be on $^{12}$C at 5 MeV/A.

## Experimental setup

We have carried out an experiment at HIE-ISOLDE, CERN with $^{7}$Be beam of intensity $\sim 5\times10^{5}$ pps. We used deuterated polyethylene ($CD_2$) target of thickness 15 $\mu$m. The detector setup consisted of a 1000 $\mu$m annular silicon detector (S3) covering angles 8° - 25°. Five 16 × 16 double-sided silicon strip detectors (DSSD) backed by 1500 $\mu$m thick unsegmented Si detectors in a $\Delta$E - E telescope configuration cover angles 40° - 80° in a pentagon geometry. At the back angles, two 32 × 32 DSSDs of thickness 60 $\mu$m and 140 $\mu$m backed by 1500 $\mu$m unsegmented silicon pad detectors cover 120° - 140°. This setup covers 29% of the total solid angle $4\pi$ [3].

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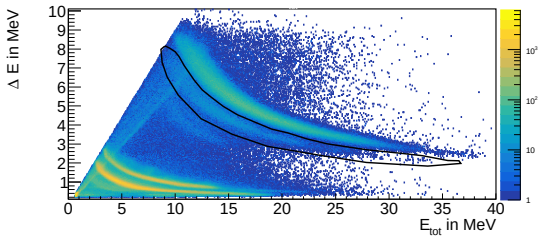


FIG. 1: $\Delta$E - $E_{tot}$ plot and a banana gate selecting $^{3}$He

## Analysis

The transfer reaction, $^{12}$C($^{7}$Be,$^{3}$He)$^{16}$O has been studied and compared to similar reaction from the mirror counterpart $^{7}$Li. A typical $\Delta$E - $E_{tot}$ plot with angular correction and the front-back matching of energy within the tolerance 500 keV is shown in Fig. 1. The banana gate drawn on this plot selects the particle of interest, $^{3}$He. Subsequently, those events give the energy spectrum showing the excitation states of $^{16}$O (Fig. 2).

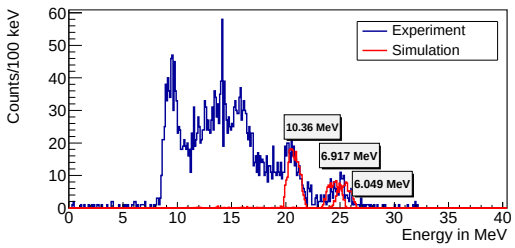


FIG. 2: Energy spectra of $^{3}$He at $\theta_{lab} = 44°$ showing the $^{16}$O excited states

In Fig. 2, the energy spectrum of $^{3}$He at $\theta_{lab}$ = 44° shows the $^{16}$O excited states at 6.049, 6.917 and 10.36 MeV. In the figure, we also show the relevant simulation using NPTool [4], a package built on GEANT4 and ROOT.

## Conclusions and outlook

The spectra show higher level excitations of $^{16}$O upto 25 MeV. Our angular coverage will allow us to arrive at improved angular distribution as compared to earlier data [5]. Since $^{7}$Be has a prominent $\alpha$-cluster structure, its breakup channel is also being investigated as compared to the above transfer reaction. Data analysis is underway.

## Acknowledgment

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