# NPTool simulations for $^{7}$Be + d experiment at CERN−ISOLDE

Sk M. Ali[1],* D. Gupta[1],† K. Kundalia[1], and Swapan K. Saha[1]
[1]*Department of Physics, Bose Institute, Kolkata 700009, India*

## Introduction

We carried out an experiment involving a 5 MeV/A $^{7}$Be beam on a $CD_2$ target to study resonance excitations, at the HIE−ISOLDE facility of CERN, Geneva [1]. In this work, we present the simulations of the $^{7}$Be + d experiment with NPTool (Nuclear Physics Tool). NPTool [2] is an open source, freely distributed package for Monte Carlo simulation and data analysis of nuclear physics experiments. It offers a unified framework for designing, preparing and analyzing complex experiments employing multiple detectors using GEANT4 [3] and CERN ROOT [4] toolkits. It has been successfully used in accelerator based experiments worldwide with both stable and radioactive beams.

## Monte Carlo simulations

Detailed Monte Carlo simulations are essential to successfully carry out a nuclear physics experiment. It helps in determining the required thickness of detectors and their positions for an efficient study of the nuclear reactions. The details of the experimental setup is given in [1]. Fig. 1 shows the NPTool simulations of the experimental setup incorporating actual measurements. In the simulation we used an isotropic source to determine the solid angles ($\Delta\Omega$) corresponding to each detector and the geometrical efficiency ($\epsilon$) of the setup. The total number of simulated events distributed uniformly over $4\pi$ is taken as $10^7$. For the $^{7}$Be + d reaction, a uniform cross section over the whole angular range with $10^7$ incident $^{7}$Be ions were used in the simulations. The experimental values of the beam energy, target thickness are provided as input to the simulations.

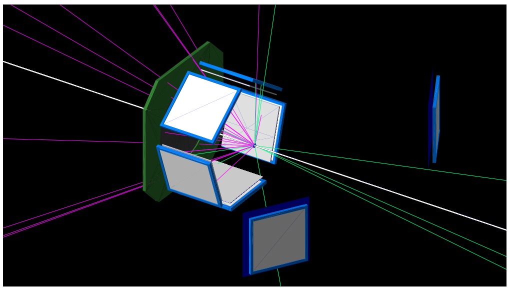

FIG. 1: NPTool simulations of the experimental setup.

## Results and discussions

Fig. 2 shows the geometric efficiency of the setup and Fig. 3 shows the solid angle of the detectors as a function of the lab scattering angles ($\theta$). In Fig. 3, DSSD1−5 curves represent the 16×16 strip detectors corresponding to the pentagon geometry, S3 represents the annular strip detector covering the front angles $8° - 25°$ in lab and the BB7 corresponds to the 32×32 strip detectors covering the back angles from $120° - 140°$. The total solid angle coverage of the setup is about 29% of $4\pi$.

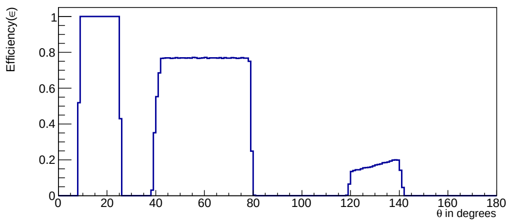


FIG. 2: Efficiency of the detector setup.

*Electronic address: mustak@jcbose.ac.in
†Electronic address: dhruba@jcbose.ac.in

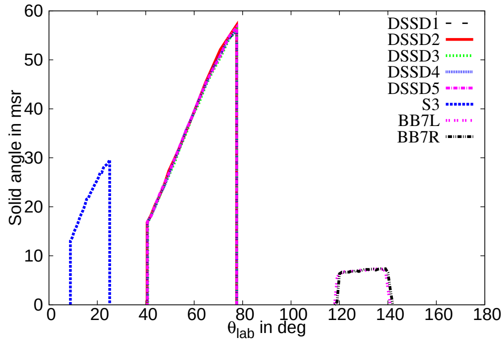


FIG. 3: Variation of solid angle with lab scattering angle.

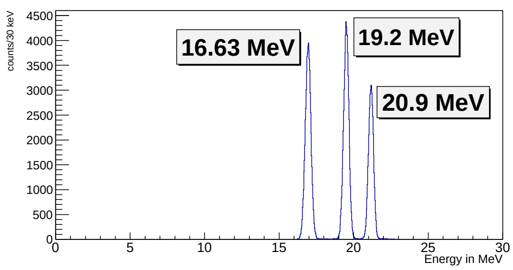


FIG. 4: Simulated excitation energy spectrum of $^{8}$Be$^{*}$.

In Fig. 4 the simulated excitation energy spectrum of $^{8}$Be from the $^{7}$Be + d reaction at 5 MeV/A is shown. The prominent excited states of 16.63 MeV, 19.2 MeV and 20.9 MeV are shown corresponding to those found in the experiment [1]. The NPTool simulations have played a vital role in planning and successfully carrying out the experiment at ISOLDE. Data analysis is in progress.

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## References

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