Resonant elastic scattering of ^{14}O on α particles studied with the TexAT active target

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The reaction ^{14}O + alpha was studied at Cyclotron Institute of Texas A&M University as part of the commissioning experiments for the TexAT active target [1]. The ^{14}O beam was produced using Magnetic Achromat Recoil Separator (MARS) with the reaction $^{14}N(p,n)^{14}O$. The ^{14}N primary beam with energy of 11 MeV/nucleon was delivered by the K500 Cyclotron. The energy of the ^{14}O beam was 61.8 MeV and the intensity was about 10^4pps.

The data analysis is still in process. The Energy calibration of the TexAT Silicon detectors has been performed using alpha sources. During the run with the beam, some of the signals were saturated. In order to recover the energy of these signals, an average signal of unitary amplitude has been produced by averaging at least 10000 non-saturated waveforms normalized to amplitude one. The real amplitude of the saturated signals has been obtained overlapping the saturated signal with the average signal, normalized to match the tails of the saturated signal. After this procedure ΔE-E plots were produced using the energy deposited in the last few centimeters of the Micromegas as ΔE and the energy deposited in the Silicon detector as E. Fig. 1 shows that the alpha particles can be easily separated from the protons. Alpha particles were identified with a two-dimensional gate around the alpha particle ridge.

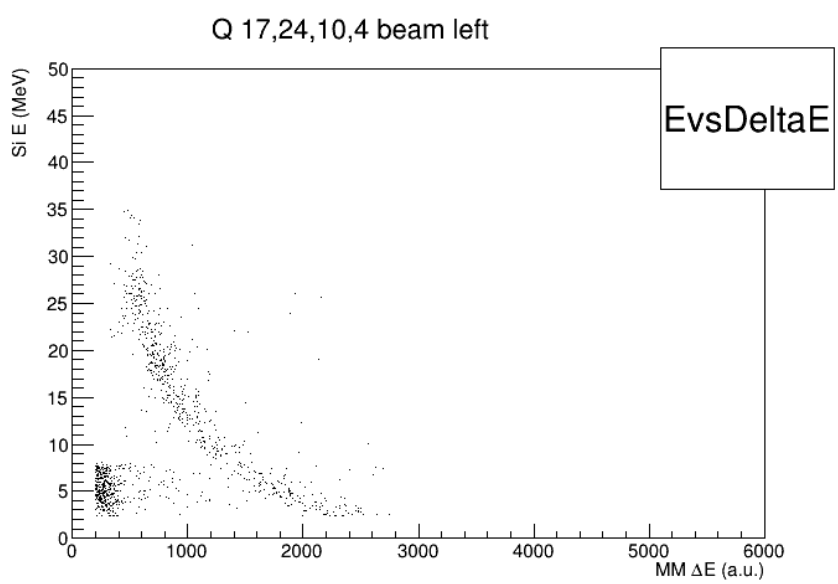

FIG. 1. E vs. ΔE plot.

For each waveform, the timing has been picked up at the 15% of the waveform amplitude as shown in Fig. 2. The tracks of the alpha particles detected in each silicon detector were reconstructed.

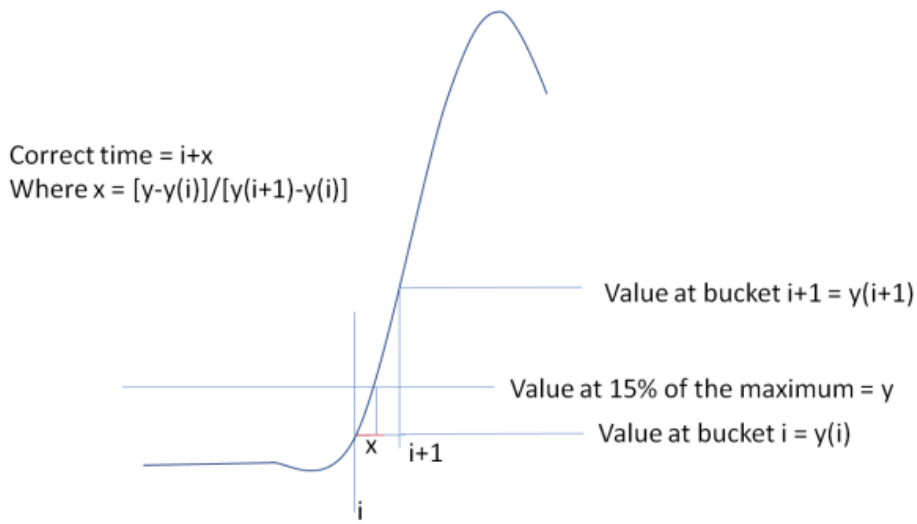

FIG. 2. For each waveform the time is determined at the 15% of the waveform maximum.

The first step of the track reconstruction is done by matching strips and chains in the side regions of the micromegas. This is done for each event using the timing information. For each strip signal, the corresponding chain should have a signal at the same time. After this matching, the Hough transform is used to further clean the tracks from spurious hits produced by random pads firing in coincidence with the track. This procedure is commonly used to optimize the tracking on Time Projection Chambers (see for example Ref. [2]). Event by event, the position of the interaction point in the active target is obtained

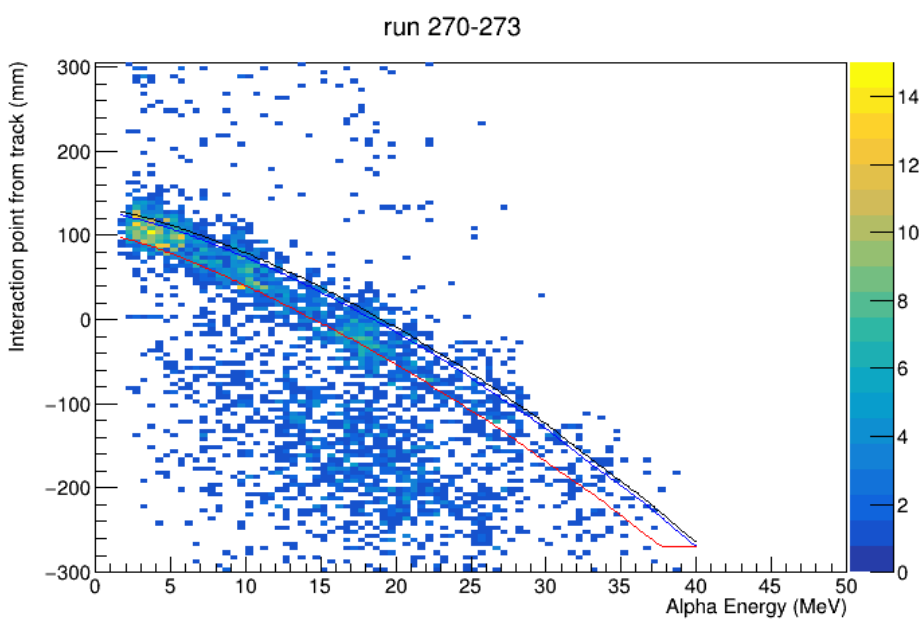

FIG. 3. Interaction point reconstructed from the tracks as a function of the alpha particle energy detected in the silicon detectors. The lines show the interaction point calculated for elastic scattering at 0 degrees (black), 5 degrees (blue), 15 degrees (red).

by intersecting the track corresponding to the detected alpha particle with the track of the beam, if the interaction point is in the region covered by the Micromegas or with the ideal beam line if the interaction point was before the beginning of the Micromegas. Fig. 3 shows the position of the reconstructed interaction point as a function of the alpha particle energy. The interaction point for elastic scattering, calculated from the reaction kinematics at 0, 5 and 15 degrees is also shown in the picture.The events corresponding to elastic scattering of ^{14}O on ^{4}He form a ridge inside the lines from the calculation. Events corresponding to inelastic scattering are located below this region. The determination of the interaction point in the central region requires a different procedure and is still in process.

The elastic scattering events are selected with a 2 dimensional gate around the elastic ridge in Fig. 3. The excitation function of ^{18}Ne at different angles then obtained using these events. Fig. 4 shows as example the excitation function measured at 5 degrees compared with previous data for the same reaction, measured with a thick passive target. The data analysis is still in progress, the full statistics of data needs to be processed and further R-matrix analysis needs to be performed on the measured excitation function.

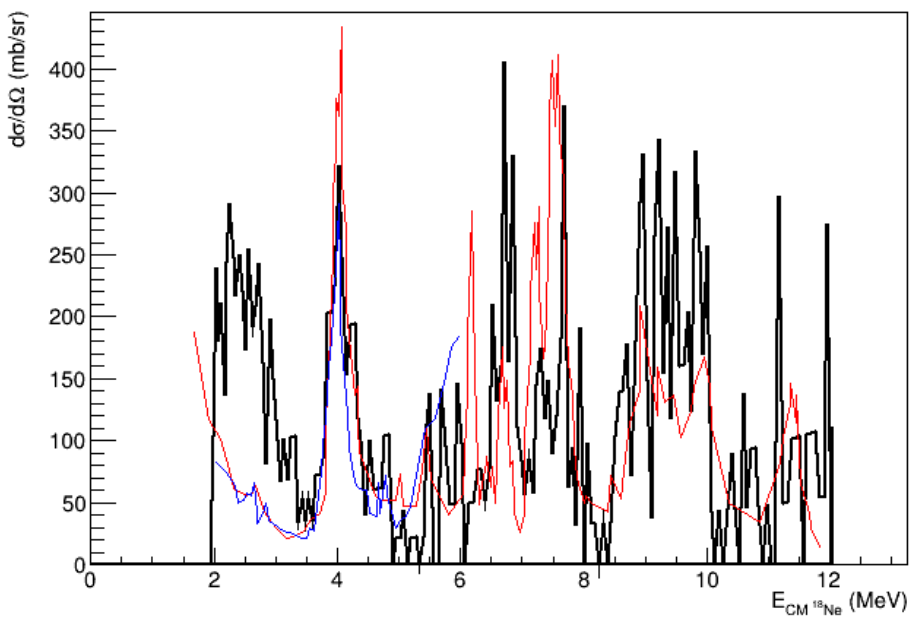

FIG. 4. Preliminary excitation function of ^{18}Ne measured at 4° from the entrance window (black line), compared with the data in Ref.[3] measured with a passive thick target at 4° (blue line) and 0° (red line).

[1] E. Koshchiy *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2016-2017), p. IV-56.

[2] C. Santamaria *et al.*, Nuclear Instrum. Methods Phys. **A905**, 138 (2018).

[3] C.B. Fu *et al.*, Phys. Rev. C **77**, 064314 (2008).