

## Spectroscopy of $^{12}\text{Be}$ using TexAT

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This project aims to develop the capacity to use the TEXas Active Target (TexAT) [KOS20] for transfer reaction studies in inverse kinematics. We plan to demonstrate this capacity by extracting spectroscopic factors to low-lying states in  $^{12}\text{Be}$  with the  $^{13}\text{B}(d,^3\text{He})^{12}\text{Be}$  reaction. The structure of these states, in particular the p-wave versus intruder  $(sd)^2$  contributions to their wavefunctions, remains an open question [ALB78, FOR94, KAN10, JOH13].

Specifically, this experiment will also help to establish the validity of using an Active Target Time Projection Chamber (AT-TPC) for  $(d,^3\text{He})$  transfer reaction studies – with the eventual goal of coupling TexAT to the forthcoming TexNEUT p-Terphenyl neutron detector to study neutron-unbound states.

We took data in September of 2022 at the TAMU Cyclotron Institute using the K500 cyclotron and MARS line. A primary beam of  $^{15}\text{N}$  at 30 MeV/u was impinging on a 1 mm  $^9\text{Be}$  target to produce  $10^4$  pps of  $^{13}\text{B}$  at the TexAT window. The total purity was approximately 80% with near equal (10%) contamination from  $^{10}\text{Be}$  and  $^8\text{Li}$ . TexAT's active volume was filled with 100 Torr of Deuterated Methane ( $\text{CD}_4$ ).

As shown in Fig. 1, the active region is surrounded by an array of silicon-cesium iodide

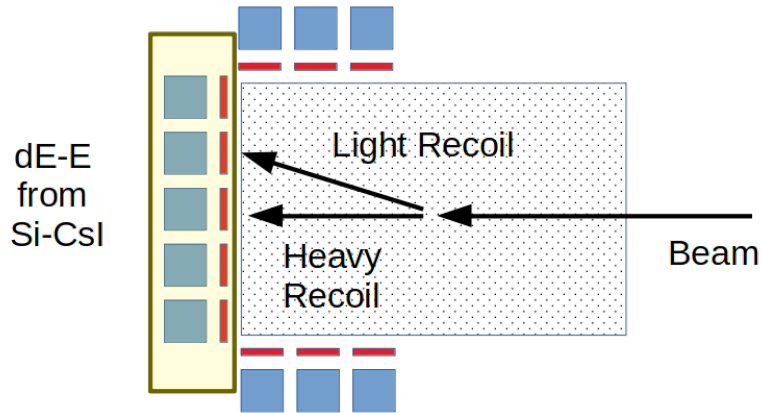


FIG. 1. Cartoon of the TexAT set-up from a top-down perspective showing the Si-CsI telescopes arranged around the micromegas.

telescopes (Si-CsI). These are used to identify the heavy recoil and elastically scattered deuterons with the differential-energy loss (dE-E) method. dE-E plots for heavy- and light-recoil identification are shown in Fig. 2. The isotopic selectivity of the light-recoil identification is not found to be present in the events of interest due to a signal quality problem emerging from the large capacitance of the pads in TexAT's multiplexed side regions. The next iteration of TexAT, the TEXas Birmingham Active-Target (TeBAT)

will not feature multiplexing so we are confident this problem will not reemerge in future studies performed by our collaboration.

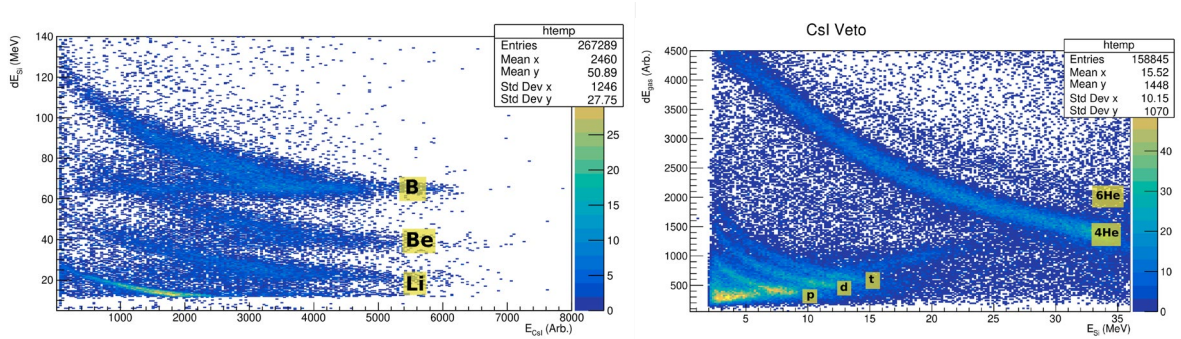


FIG. 2. dE-E plots for heavy-recoil (Left) and light-recoil (Right) identification.

Track reconstruction and missing mass analysis have given the excitation spectrum shown in Fig. 3. The signal quality issues mentioned earlier made upwards of 90% of the data unusable leaving only 9 counts in the region of interest ( $E_x(^{12}\text{Be}) = 0\text{-}5$  MeV). Data taken with  $\text{CH}_4$  was passed through an identical analysis process and produced no counts in the region of interest. Though promising, there were insufficient counts in the  $\text{CD}_4$  data to register signal-over-background in the region of interest above a 68% confidence interval.

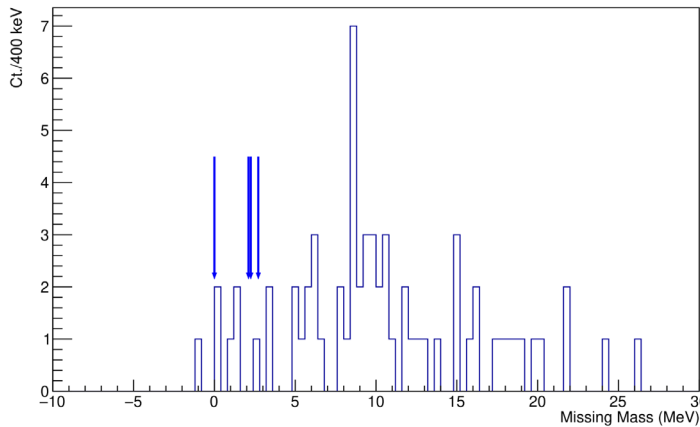


FIG. 3. Excitation spectrum of  $^{12}\text{Be}$  with states of interest indicated with arrows.

Analysis of this data has been concluded. Although it is not possible to claim observation ( $d, ^3\text{He}$ ) from the data taken, we are confident that the insights provided by this study have paved the way for future efforts to make transfer reaction measurements using TexAT-like systems. Specifically, the changed read-out topology TeBAT guarantees that the signal distortion problems seen in this experiment

will not reemerge. When coupled with the isotopic selectivity shown in Fig 2. (Right), (d,<sup>3</sup>He) spectroscopy in active targets should be well within technical possibility.

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