Status of AstroBox and analysis of ^{23}Al β-delayed proton decay data

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AstroBox is a new detector for measuring very low energy protons from beta-delayed proton decays. The development of this detector was motivated by results obtained in an ongoing study of such decays relevant for nuclear astrophysics. Previously, the study was done with a setup of Si detectors [1,2]. In an effort to lower the β-background in the 100-400 keV region and increase the energy resolution we designed the AstroBox, a detector based on a gas medium and Micromegas [3]. This new detector was commissioned at the Cyclotron Institute in measurements that were conducted in March 2011 and October 2011. Summaries of these measurements were given in previous annual reports in 2011 [4] and 2012 [5].

During 2012, the analysis of the ^{23}Al β-delayed proton decay data measured with the AstroBox detector in 2011 was continued. A spectrum of the protons from this analysis is shown in Figure 1. The spectrum agrees very well with earlier measurements of the ^{23}Al decay measured with silicon detectors here at TAMU [1], and elsewhere [6]. However, the advantage of the new measurement with AstroBox is that the spectrum in Figure 1 was obtained without the subtraction of β^+ background in the 100-400 keV that was needed in previous analyses.

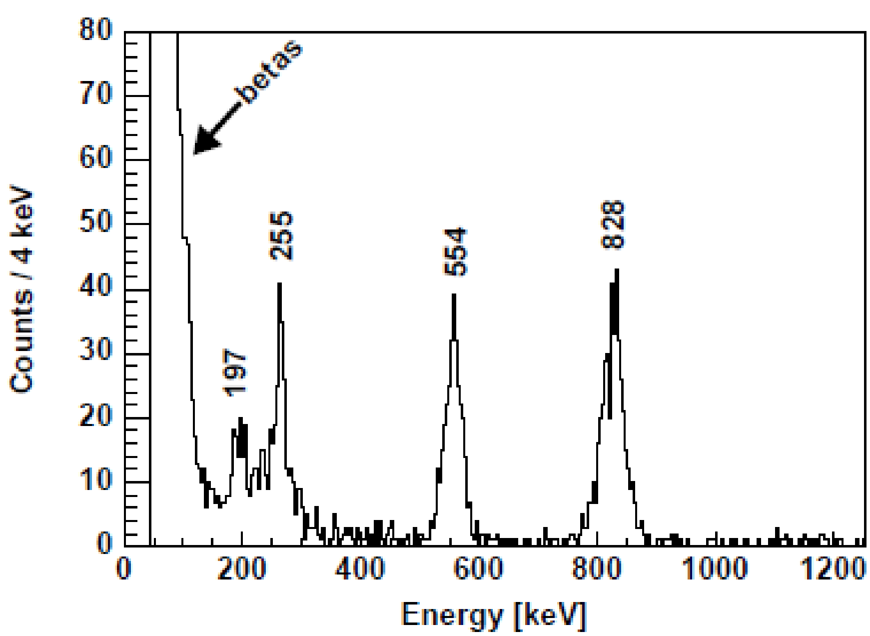

FIG. 1. ^{23}Al β-delayed proton decay spectrum. The energies of the protons are taken from Ref. [6].

The spectrum shown in Fig. 1 was compared with Monte-Carlo simulations of the ^{23}Al decay in AstroBox using the GEANT4 toolkit [7]. The simulation included details about the design of the detector, and data from the ^{23}Al β-delayed proton decay given in previous measurements. The results of these simulations are shown in Fig. 2. The blue line in the figure reproduces the low-energy part of the spectrum, which arises from the energy deposits of the β^+ particles from the ^{23}Al. The blue line also reproduces the proton decay spectrum if the energies of the protons from the previous publications [6] are assumed in the simulations.

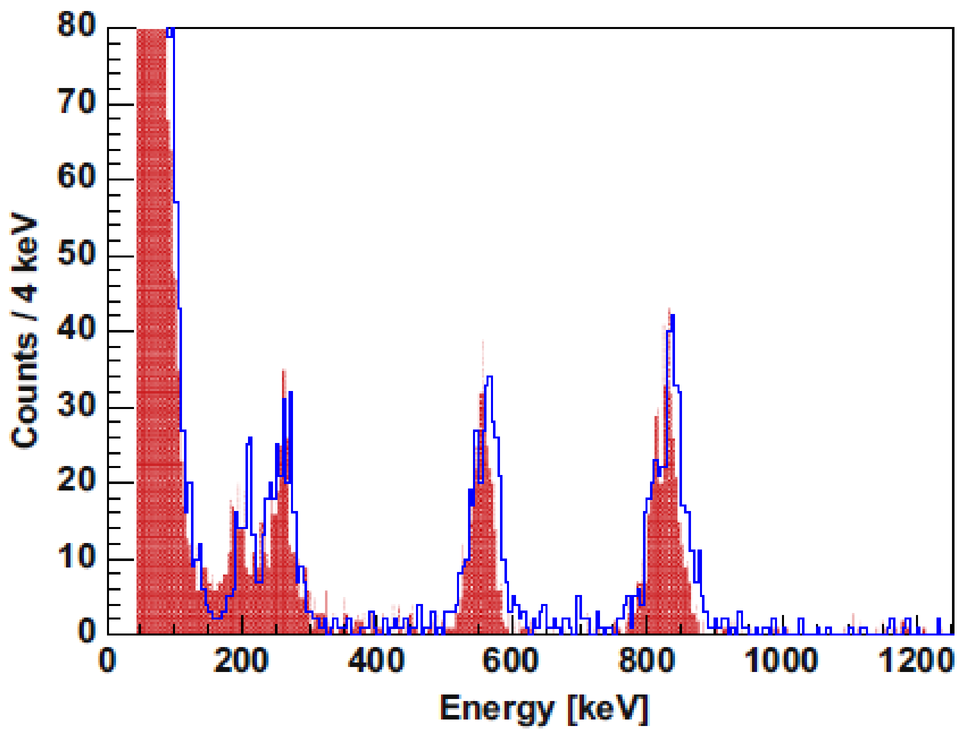

FIG. 2. GEANT4 simulation of the ^{23}Al β-delayed proton decay in AstroBox compared with the data given in Figure 1. The red shading represents the data and the blue line represents the simulation. See text for discussion.

In conclusion, AstroBox, a new detector using micromegas, has been commissioned and used in experiments. To date, three measurements have been conducted, two measurements of ^{23}Al decay and one measurement of ^{27}P decay, which is mentioned in a separate report [8]. The detector has been shown to reduce the background from β^+ particles in the region of 100-300 keV by a factor of about 100 versus previous measurements with implantation in silicon detectors [1]. Further measurements with this detector are planned in the coming year. Finally, an article detailing the design of the detector and the results of the test measurements has been recently submitted to Nuclear Instruments and Methods A [9].

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