AstroBox – a new type of low energy proton detector

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We have recently started collaboration with CEA Saclay and IKP Koln on a new detector for very low energy protons from beta-delayed proton decays. This 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]. In an effort to lower the beta 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 [2].

The first test was done in March 2011 with a beam of ^{23}Al. A detailed description of the experiment and the detector is given in the corresponding report [3]. We obtained a significant reduction of the beta background. The low energy proton peaks detected were well separated and had good resolution (**Error! Reference source not found.**).

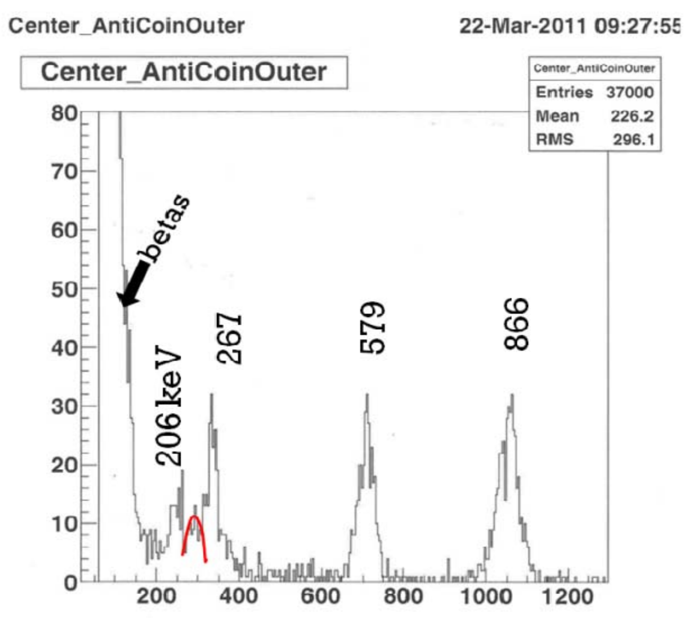

FIG. 1. Proton spectrum obtained in the first test experiment.

We have continued to work on improving the design and have conducted a second test in October 2011. For consistency, we used the same nuclide, ^{23}Al, under similar beam conditions. The AstroBox detector was used in a slightly different setup. We changed the gas medium from P10 (90% Argon, 10% Methane) to P5, keeping the same pressure and flow rate. We also chose to have 3 output signals, instead of 2. In the first test, we had only one signal from the 4 outer pads. In this experiment we split them in 2, one signal from the two upstream pads and one signal from the two downstream pads, giving us, with the center, 3 regions of detection. The electronics setup was changed correspondingly.

We then followed the same experimental procedure. First, we implanted the ^{23}Al nuclei in the active region of the detector. We used 2-dimensional histograms showing the central signal versus the outer signals to determine when the implantation was done correctly (**Error! Reference source not**

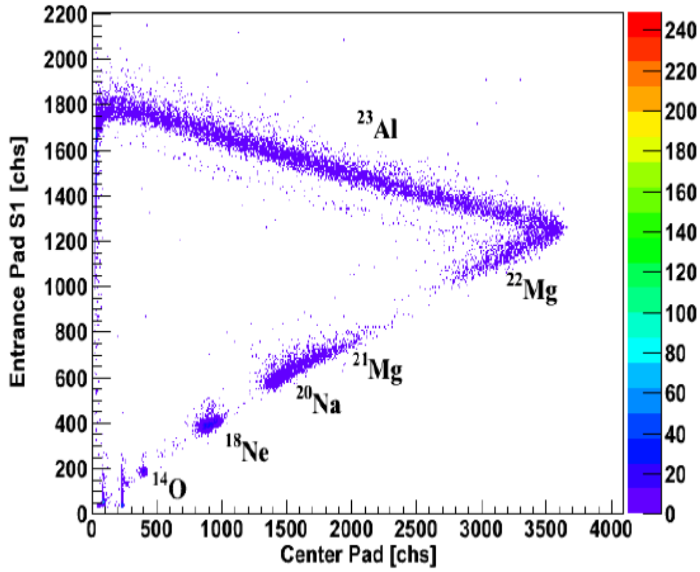

FIG. 2. Histogram showing the implantation spectrum at the right position (middle of the active region).

found.).

Second, we measured the decay of the implanted nuclei with the AstroBox. We used a pulsed beam to alternate between implantation (beam on, detector off) and measurement (beam off, detector on). Several sets of electronic settings were tested. **Error! Reference source not found.** shows an example of

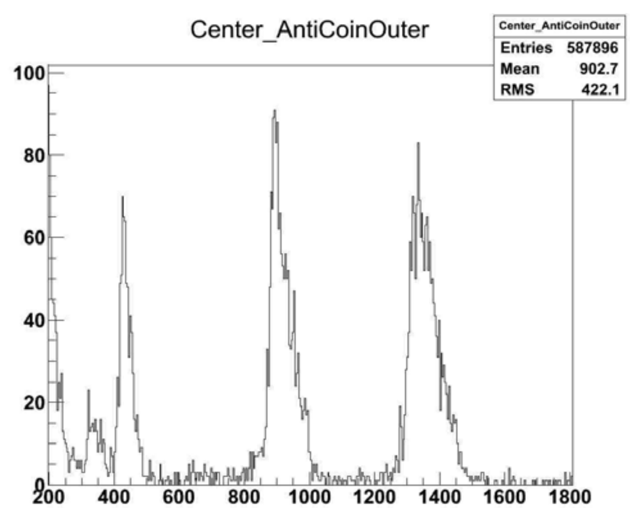

FIG. 3. Raw proton spectrum from the decay of ^{23}Al obtained in the second test experiment.

the raw proton spectra obtained.

The results confirmed the beta background reduction and improved resolution obtained in the first test. We also made further discoveries on the behavior of the detector and determined changes needed for a better design. The implementation of these observations is already in the works and we are hoping to test the upgraded version, AstroBox 2, in the following year.

[1] A. Saastamoinen, L. Trache, A. Banu *et al.*, Phys. Rev. C **83**, 045808 (2011).

[2] Y. Giomataris *et al.*, Nucl. Instrum. Methods Phys. Res. **A376** 29 (1996).

[3] E. Simmons *et al.*, in *Progress in Research*, Cyclotron Institute, Texas A&M University (2010- 2011), p.V-31.