Ionization chamber development for super heavy elements search

S. K. Wuenschel, E. J. Kim, M. Barbui, J. B. Natowitz, H. Zheng, N. Blando, and K. Hagel

We reported previously an experimental search for super heavy elements (SHE) [1]. During the experiment and in subsequent analysis, we found that it would be necessary to solve a number of problems encountered during that previous experiment. Neutrons were responsible for generating false signals in the silicon detectors. In order to counteract that effect, small area thin silicon detectors were then inserted both in order to conclusively identify alpha particles as well as to lower the probability of false signals from n-Si reactions in the silicon detector. With these modifications in the previous run, we observed a number of alpha particles emanating from the catcher foil. The geometry was, however, very low.

In order to increase the geometry we have designed and constructed a set of ionization chambers that have a much larger area than the silicon ΔE-E telescopes inserted in the previous experiment. Gas in the IC is also effectively very thin, indeed much thinner than a 50 μm silicon detector, so the possibility of a reaction with the neutrons is expected to be significantly reduced.

The ICs that we designed and built are of the traditional design in that they consist of a cathode at ground, a grid mounted on a frame separated from the anode by a few millimeters. A depiction of the detectors is shown in Fig. 1. In the figure, we show the chamber with the two plates and grid as well as a planned PPAC in the front and two silicon detectors in the back in order to achieve particle identification with the ΔE-E technique. The backmost silicon detector is a 300 μm Micron 7 strip detector. The silicon detector just in front of that is expected to be a 50μm Micron 16x16 strip detector.

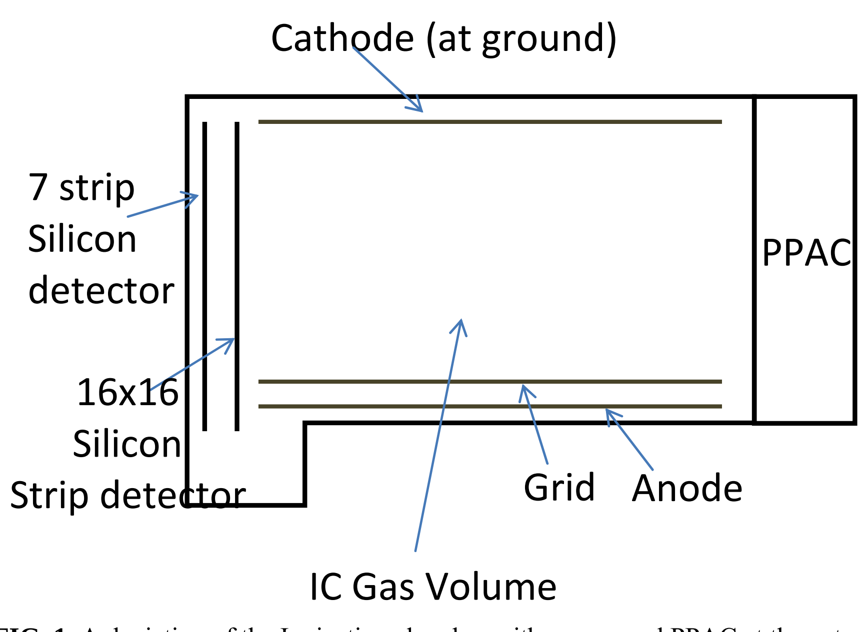

FIG. 1. A depiction of the Ionization chamber with a proposed PPAC at the entrance as well as the silicon detectors in back.

We performed tests on the ICs with a ^{228}Th source. Fig. 2 shows a ΔE-E plot of energy lost in the IC vs. residual energy in the silicon detector (one detector was used in these tests. We see that the different lines of the alphas from the ^{228}Th source follow the expected ΔE-E trend.

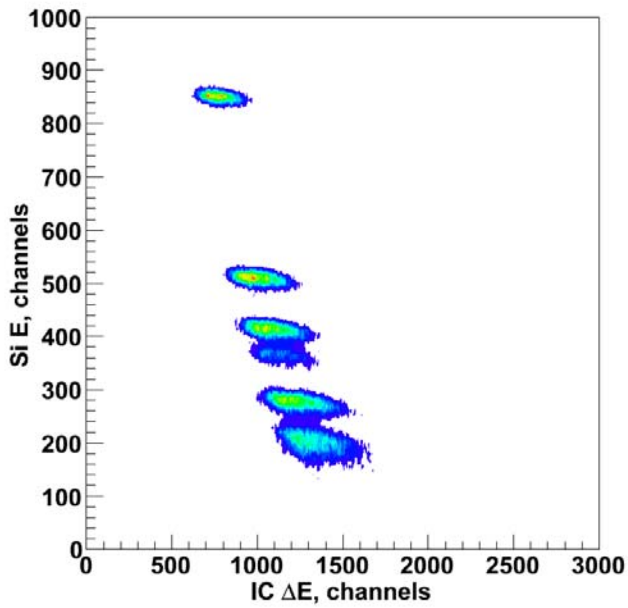

FIG. 2. ΔE-E plot of Ic vs silicon detector using a ^{228}Th source.

The line trends show that the IC can be used to identify alpha particles. The resolution in the IC, however, requires improvement in order to be able to have adequate resolution in the total energy in order to estimate the mass of the possible heavy elements should they be produced in the experiment. We are currently working to increase the high voltage that can be applied before sparking occurs. This should improve the resolution.

The PPAC that is depicted at the entrance to the IC in Fig. 1 is in the planning stages. Once this PPAC is built and implemented, we will have the ability, by inserting, in addition, the 16x16 strip detector, to track the origin of detected alpha particles to the active catcher that is currently being built by our collaborators in Krakow, Poland.

[1] M. Barbui *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2011-2012), p. II-1.