Highly-segmented HPGe Detector at Oroville Low Background Counting Facility

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The Majorana experiment[1] is a proposed 120 kg enriched, segmented, HPGe detector array that will primarily search for neutrinoless double-beta ($0\nu\beta\beta$) decay. It will rely on pulse-shape discrimination and segmentation to suppress remnant radioactive backgrounds following careful materials selection. The projected sensitivity of Majorana to $00\nu\beta$ decay is a half-life of 4×10^{27} years.

The Majorana HPGe detectors will be segmented detectors that have to operate at a remote, low-background facility for several years with minimal maintenance. We have fielded a highly segmented HPGe detector at the Oroville Dam low-background counting facility to study the behavior of such a detector under realistic conditions. The HPGe detector was custom-built by Canberra with 8 longitudinal and 5 azimuthal segments, as shown in figure 1. The detector has been operated continuously now for about a year and collected several TB of data. The custom-built DAQ electronics (fig. 2) capture the full waveform of the energy deposits in the segments. This additional data will also allow us to evaluate the efficiency of the segmentation and pulse-shape analysis for rejecting natural radioactive background events.

Figure 3 shows the low-energy part of the spectrum from our initial analysis. One clearly sees the lines from primordial ^{238}U, as well as K-Shell X-rays from the surrounding lead shield that are induced by higher energy gamma rays interacting in the shield.

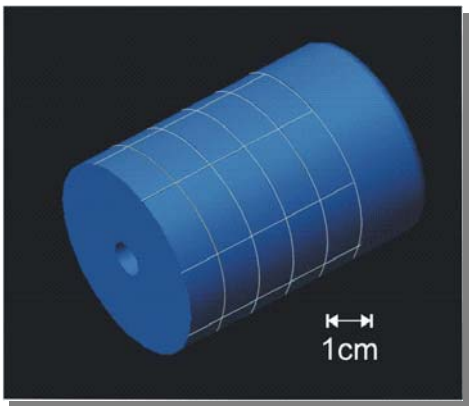

Figure 1: Rendering of the 8x5 segmented HPGe Crystal

Figure 2: The detector in its cryostat and with its DAQ electronics

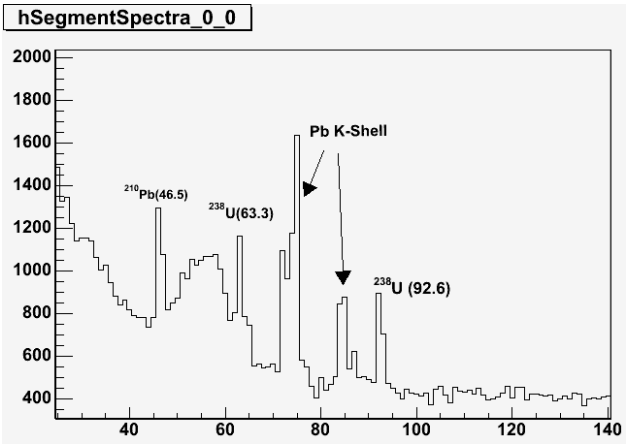

Figure 3: Low energy part of background spectrum at Oroville. Shown are lines from the surrounding lead shield and primordial ^{238}U

REFERENCES

[1] The Majorana Zero-Neutrino Double-Beta Decay Experiment White Paper. nucl-ex/0311013.