^{6}HeCRES beta monitor design

D. McClain, M. Holloway, V. Iacob, D. Melconian, and B.M. Vargas-Calderon

The ^{6}HeCRES experiment utilizes the cyclotron radiation emission spectroscopy (CRES) technique to measure the β spectrum of ^{6}He and ^{19}Ne. Due to a fixed detector frequency bandwidth, we measure the cyclotron radiation, which is emits when a charged particle precesses in a magnetic field, at different magnetic fields to scan the whole spectrum. The cyclotron frequency, f, of an electron is dependent on the kinetic energy E_e of the electron in a magnetic field B according to

$$f = \frac{1}{2\pi}\frac{eB}{m_e + E_e}$$

Where e is the electron charge and m_e is the rest mass of the electron. The change in magnetic field shifts the energies detectable within our frequency bandwidth and we take slices of the beta spectrum as seen in Fig. 1.

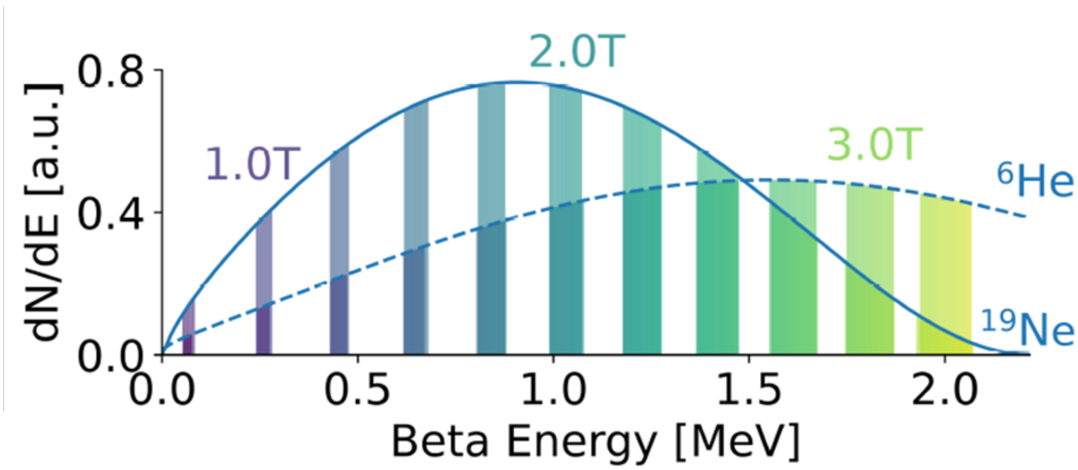

FIG.1. Beta spectrum of ^{6}He and ^{19}Ne within the 18-19 GHz frequency bandwidth for various magnetic fields.

The reconstruction of the beta spectrum requires the normalization of these slices by the number of decays that occurred during their measurement. To fufill this need we utilize an external beta monitor to measure the rate of decays over the length of the run. The rate represents the activity of the gaseous isotopes being pumped to the decay cell, as the monitor lies along the path of the gas to the decay volume. Thus we can normalize our experimental results to the monitor's rate. Previously, three designs of the beta monitor were used, a three detector veto design used to normalize the rate to a known radioactive source, an E-ΔE telescope that is able to reject gammas, and a small scintillator attached to four silicon photomultipliers (SiPMs) that is expected to achieve a greater efficiency, but must be shielded to reject external triggers. Since the beta monitor resides near the experiments large magnet, fringe fields cause uncertainties to the efficiency at the 10^{-3} level, comparable to the precision required in the search for new physics, that can be limited by reducing distance from source to detector. Because of this, Texas

A&M and the University of Washington have each designed new monitors to replace the issues of the old. Because the monitor exists outside of vacuum, limiting the distance from the vacuum seal window is the primary issue to overcome.

The Texas A&M beta monitor is an E-ΔE telescope that is designed to reside in a bucket that mounts directly to the beamline and holds the detector at the window to minimize this distance. The bucket design, shown in Fig. 2., allows for tunable position of the two scintillators, and has a cutout of the top to hold the photomultiplier tube (PMT) such that the ΔE scintillator lies in contact with the

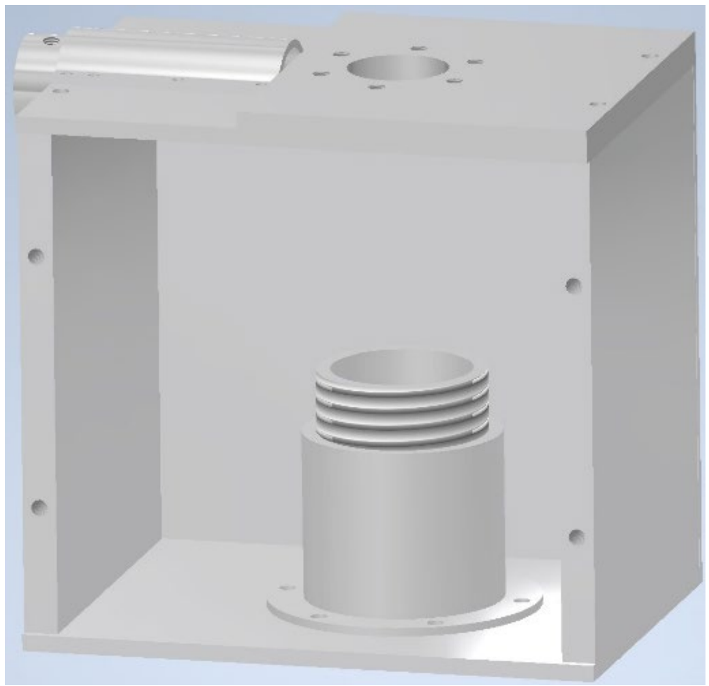

FIG.2. CAD design of the PMT Bucket that will house the beta monitor.

vacuum port. The beta monitor will also employ a temperature stabilizer circuit to prevent variations in gain, and thus detector efficiency across the duration of the experiment. The new design, along with the new detector from the University of Washington will be utilized to confirm the source stability, and the more successful model will be used during future gaseous CRES experiments.