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Lucas Cell Simulation using Geant4

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Receiving low levels of background and measuring trace amounts of remaining radioactivity is very important for particle astrophysics experiments looking for neutrinos or dark matter. The original SNO collaboration developed and has been using Lucas Cells since 1992. They are instrumental to measure the radon concentration in its surrounding water shield as well as its nitrogen cover gas system. Lucas cells are still used by the SNO+ experiment and SNOLAB at large to perform radon emanation measurements for many materials and continue radon assays. These scintillation counters are primarily sensitive to alpha particles, notably those emitted from radon and its progeny. Photomultiplier tubes (PMTs) are then able to detect the light emitted by the silver doped zinc sulfide scintillator, originating from the individual alpha decays. The counting efficiency of these cells measured with alternate means doesn't match the radon board's efficiency, which indicates the need for further investigation. To assess, I constructed a Lucas Cell model in a Monte-Carlo based physics simulation toolkit, Geant4. The Lucas Cell geometry was formulated using the Geometry Description Markup Language (GDML) and FreeCAD. A radioisotope decay timing model was devised for radon's relevant alpha emitting progeny. Additionally, the silver doped zinc sulfide scintillator's optical response was characterized and the Lucas Cell counting efficiency was calculated. The developed simulation framework will help guide further Lucas Cell based radon assay research and enhance the accuracy of current radon measurements. The status and initial results of this project will be presented.

Keyword-1

Radon Measurement

Keyword-2

Scintillation Counters

Keyword-3

Geant4 Simulation

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