

## Germanium ionization detector in a cryo mode at liquid helium temperature

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The high-purity germanium (HPGe) detectors are well known for operating at liquid nitrogen temperature and cryogenic temperature at mK. Very little is known about Ge detector operating at liquid helium temperature. It is expected that operating Ge detectors at liquid helium temperature reduces thermal noise and hence allows the detectors to have better energy resolution in comparing to operating at liquid nitrogen temperature. We characterized Ge ionization detectors operated at liquid helium temperature at the University of South Dakota (USD) using the home-grown crystals. We measured the impurity freeze-out temperature in Ge. Using alphas from an Am-241 source, the charge collection efficiency (CCE) as a function of bias voltage was measured for three detectors with different impurity levels. Subsequently, we studied the impact of the impurity levels on the time-dependent CCE of the Ge detectors. The implication of the CCE at low temperature is discussed for Ge detectors with a-Ge contacts in searching for rare-event physics.

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