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Precision Measurement of Nuclear Electron Capture Decay DAVID KOLTICK, SHIH-CHIEH LIU, HAOYU WANG, Purdue University, JORDAN HEIM, JONATHAN NISTOR, Techsource Inc. — The method of accurately measuring the radioactive decay constant of a isotope by measuring the decay rate as a function of time requires that both the detector and environment be stable over time periods comparable to the life-time of the isotope. In addition statistical accuracy requires initial counting rates be high but limited by the dead time capability of the data collection system and the detectors double-event resolving time. A High Purity Germanium (HPGe) spectrometer, sensitive to radiation from 3-KeV to over 3-MeV, has been built to measure radioactive decay constants to a level of 10^{-5} ~10^{-6} at a location only 6 meters from the core of the High Flux Isotope Reactor located at Oak Ridge National Laboratory. Such accuracy requires understanding of, background, signal-processing algorithms, and both the double and triple event pile-up in the observed spectrum. The approach taken is to fit the collected energy spectrum with invariant shapes, independent of event rate. By fixing the source-detector geometry and environmental conditions, the invariant shapes are (1) ideal energy spectrum without pile-up and background, (2) the ideal double event pile-up spectrum, (3) the ideal triple event pile-up spectrum, and (4) the stable background spectrum. A method is presented that finds these ideal shapes using the collected data in situ. Taking this approach the HPGe detector photopeak shape in the absence of background and pile-up is presented showing associated structure over a range of 7 orders of magnitude.

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