Contribution ID: **1100** Type: **Contributed Oral Presentation**

C1Or2A-01: High Level Gamma Radiation Effects on Platinum and Silicon Diode Cryogenic Temperature Sensors

Monday, July 22, 2019 4:00 PM (15 minutes)

High energy physics research facilities require a vast cryogenic infrastructure to cool superconducting magnets, superconducting RF cavities, and other components to their necessary operational temperatures. The temperature sensors used to monitor this infrastructure are invariably exposed to leakage radiation in varying doses depending upon their location. Compared to many other cryogenic temperature sensors, platinum resistance thermometers (PRTs) and silicon diode thermometers (SiDTs) have the advantages of adhering to standard curves and requiring a single fixed current for operation. This work examines the gamma radiation-induced calibration offsets on two PRT models, the ceramic encapsulated PT-103 and the glass encapsulated PT-111, and a SiDT model DT-670-SD, all manufactured by Lake Shore Cryotronics. Subgroups of each model were subjected to a gamma radiation dose ranging from 10 kGy to 5 MGy with temperature calibrations performed pre- and post-irradiation over their respective operating ranges. Data were analyzed in terms of the temperature-equivalent change in the measured parameter. The PRTs behaved very well in radiation with the PT-103 and PT-111 subgroup average offsets for all tested irradiation levels being less than ±25 mK and ±35 mK respectively over the 20 K to 325 K temperature range. The SiDT model DT-670-SD behavior was more complicated with a clear change in behavior at 30 K. Below 30 K, the offsets consistently increased from slightly positive to roughly -5 K as the radiation dose increased. Above 30 K, the induced offset had saturated at 10 kGy ranging from about 0 K at 30 K to +30 K at 300 K, and exhibiting that same behavior and offset for all higher radiation doses. Equivalent temperature offset data over the sensors'operating temperature ranges are presented by sensor model and total gamma dose.

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Session Classification: C1Or2A - Applications: Safety and Instrumentation