Contribution ID: **150** Type: **Contributed Oral Presentation**

Effects of High Level Gamma Radiation Doses on Cernox(TM) Cryogenic Temperature Sensors

Tuesday, 11 July 2017 15:00 (15 minutes)

Cryogenic temperature sensors are used in high energy particle colliders to monitor the temperatures of superconducting magnets, superconducting RF cavities, and cryogen infrastructure. While not intentional, these components are irradiated by leakage radiation during operation of the collider. A common type of cryogenic thermometer used in these applications is the CernoxTM resistance thermometer (CxRT) manufactured by Lake Shore Cryotronics, Inc. This work examines the radiation-induced calibration offsets on CxRT models CX-1050-SD-HT and CX-1080-SD-HT resulting from exposure to very high levels of gamma radiation. Samples from two different wafers of each of these two models tested were subjected to a gamma radiation dose ranging from 10 kGy to 5,000 kGy. The data was analyzed in terms of the temperature-equivalent resistance change between pre- and post-irradiation calibrations. The data shows that the resistance of these devices decreased following irradiation resulting in positive temperature offsets across the 1.4 K to 330 K temperature range. Variations in response were observed between wafers of the same CxRT model. Overall, the offsets increased with increasing temperature and increasing gamma radiation dose. At 1.4 K the average offsets ranged from 0 mK to +15 mK in going from a 10 kGy to a 5,000 kGy exposure. At 300 K the average offsets ranged from +175 mK to +2,500 mK in going from a 10 kGy to a 5,000 kGy exposure. Equivalent temperature offset data are presented over the 1.4 K to 330 K temperature range by CxRT model, wafer, and total gamma dose.

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Session Classification: C2OrE - Instrumentation, Visualization, and Controls II - sponsored by Scientific Instruments Inc.