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C2Po1E-03: Cernox® Cryogenic Temperature Sensor Performance after High Level Neutron Irradiation

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The need for superconducting magnets in high energy physics investigations currently drives much of the research and development in cryogenics. With collider energies and fusion reactors continuing to reach new levels, it's necessary to constantly push the operating limits of supporting technologies. A crucial component in these experiments is the cryogenic temperature sensor used to monitor both superconducting magnet temperatures and their accompanying cryogen support infrastructure. Gamma radiation and neutron radiation are often used as a predictor of both the survival and accuracy of sensors in the actual radiation environments. In this research, three models of cryogenic temperature sensors commercially available from Lake Shore Cryotronics, Inc. were neutron irradiated at the Ohio State University Nuclear Reactor Laboratory pool reactor. The tested devices consisted of Cernox® models CX-1010-SDs, CX-1050-SDs, and CX-1080-SDs. Separate test groups comprised of samples of each model were irradiated at room temperature to total fluences of 1E+12 n/cm2, 1E+13 n/cm2, 1E+14 n/cm2, 1E+15 n/cm2, 1E+16 n/cm2, 1E+17 n/cm2. and 1E+18 n/cm2. Temperature calibrations over each sensor's respective operating temperature range were performed both before and after irradiation, with the neutron-induced shifts presented in terms of equivalent temperature. The Cernox® temperature sensors continued to operate with temperature offsets increasing with both increasing fluence and increasing temperature. This work details the resulting survivability and performance of each tested model as a function of temperature and total neutron fluence. A fit of the equivalent average temperature offset as a function of total neutron fluence and temperature is presented.

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