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Developing a Nuclear Orientation Thermometer for the UCT Dilution Refrigerator

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A significant challenge in low temperature thermometry is the accurate measurement of temperatures below 1 k. Nuclear Orientation (NO) is a non-electronic technique to measure ultra-low temperature accurately as opposed to traditional resistive thermometers. The NO method relies on the measurement of the alignment of the nuclear spin in a radioactive nucleus, where the temperature can be derived from the Boltzmann distribution.
The aim is to develop a NO thermometry system using the recently procured gamma-ray anisotropy thermometer (60CoCo(hcp)) source for use in the University of Cape Town Department of Physics dilution refrigerator. The UCT dilution refrigerator is able to achieve these ultra-low temperatures (down to 8 mK) by taking advantage of the properties of both 3He and 4He gas.

The 60CoCo(hcp) radiation source, irradiated using the SAFARI-1 research reactor at NECSA, is incorporated into the dilution fridge by thermally mounting it onto the plate in which the mixing chamber is positioned. The data acquisition system, a Sodium Iodide (NaI) scintillation detector, is placed in line with the source allowing it to detect the radiation as accurately as possible. The ratio of the detected radiation at various temperatures provides the measurement of nuclear spin alignment and thus the absolute temperature of the system. The preliminary measurements are promising, but more work needs to be done in order to develop a fully-functioning NO temperature measurement system.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

Primary author: Mr NTOLOSI, Yanga (NMISA & University of Pretoria)

Co-authors: Prof. PETERSON, Steve (Department of Physics ,University of Cape Town); Prof. BLUMENTHAL, Mark (2. Department of Physics, University of Cape Town); Dr GOUVEIA, Dominique (2. Department of Physics, University of Cape Town)

Presenter: Mr NTOLOSI, Yanga (NMISA & University of Pretoria)

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