THE COAL BASED RTDs CALLIBRATION SYSTEM

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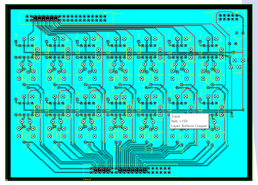
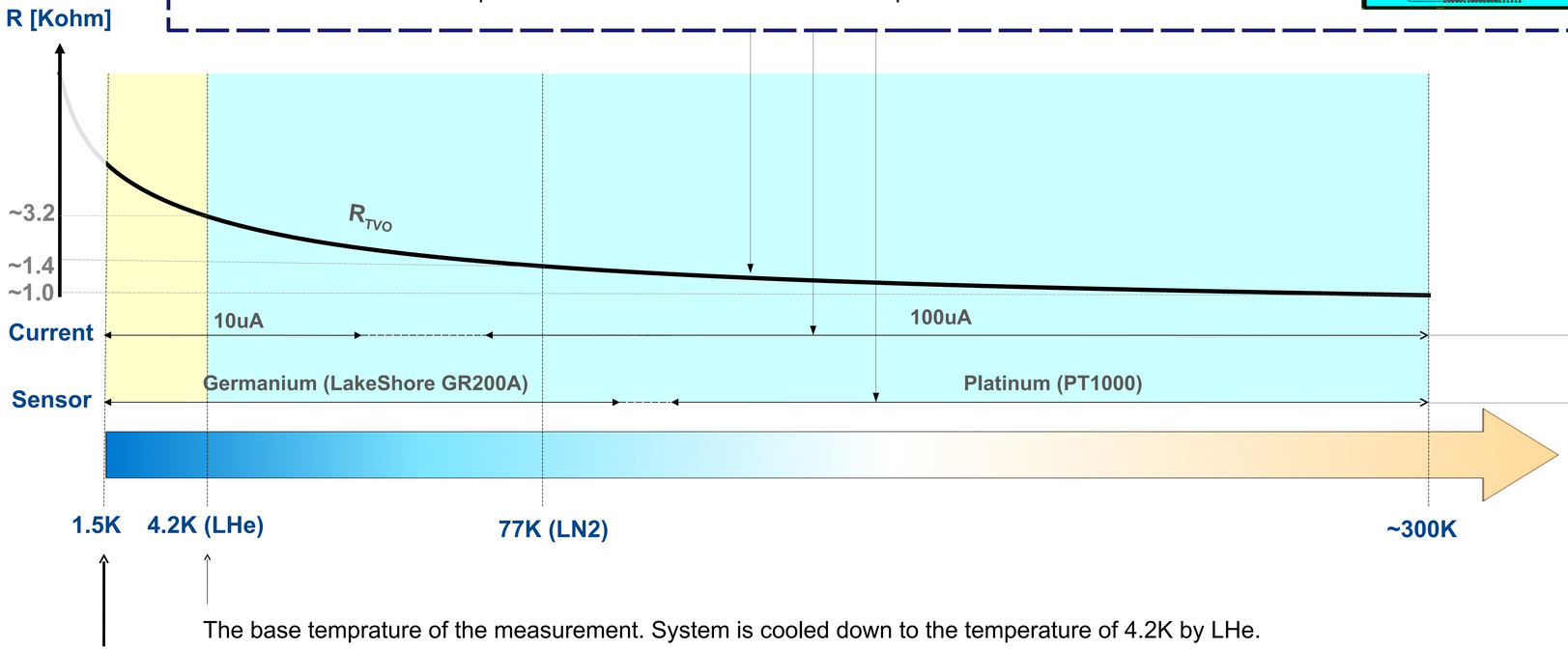
Abstract

Proper operating, particle accelerators based on superconductive magnets requires a precise temperature monitoring. A calibration system for resistance temperature detectors (RTD) designed for this purpose, together with the details on the calibration process which it implies is presented. The calibration routine, originally prepared for the nuclotron monitoring system only, was optimized for high accuracy of sensors in cryogenic temperatures. The system was rebuilt and is currently based on an 18-bit ADC with an internal MUX and 35 input channels for calibrated resistors and referential sources. The reconstruction was long overdue, since the NICA project, currently underway, clearly demands a higher efficiency.

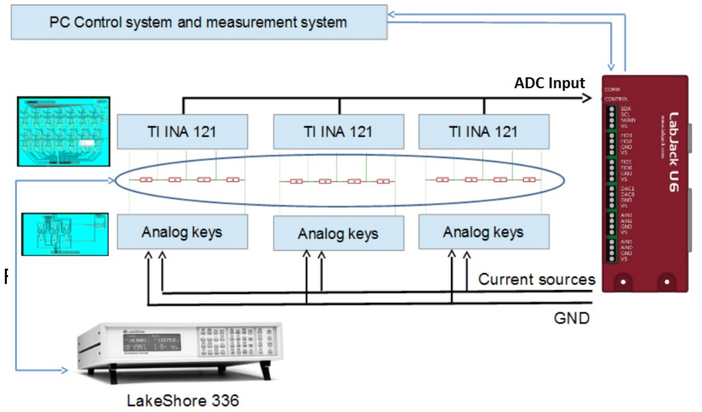
A PCB based on TI INA 121 instrumental amplifiers were designed for signal conditioning. They are responsible for processing the input from all the reference sources and the calibrated TVOs
The amplification is programmed by a resistance. For better stability of the amplification the second channel of the LakeShore 336 temperature controller was used for the temperature stabilization o all the electronics.





The base temprature of the measurement. System is cooled down to the temperature of 4.2K by LHe.

If needed, the temperature can be lowered from 4.2K by reducing the cryostat prasure with vacuum pomps. The minimal temperature used is 1.5K



The Measurement system was based on a LabJack U6 pro ADC system and a Lakeshore 336 temperature controller.
Signal conditionning and measurement circuit modifications (polarization switch and current adjustment) are made by PCBs designed especially for this purpose.

Measurement current is being adjusted to the temperature in the cryostat due to the low specific heat of materials in the low temperatures.

For precise temperature reference two reference RTDs have been used. A platinum – based sensor with a positive R/T characteristics and a germanium based with a negative R/T characteristics.

Solutions

Carbon RTDs and its characteristic

In the nuclotron monitoring system coal-based RTDs were used. The specific of the carbon resistors is allowing to get the highest measurement resolution for the temperature that is present in the nuclotron installation during the experiment (approximately 4.2 K).
During the callibration process carbon resistors are exposed to thirty different temperatures in order to obtain a precise resistance-temperature characteristic with a sufficient accuracy.

Seebeck effect reduction

The temperature difference between measurement system elements is up to 300 K. In this conditions an electromotive force present as a result of the Seebeck effect may significantly influence the final measurement data.
To prevent that, a dual polarization measurement is applied by the addition of the DG 303 analog keys to the circuit.