TECHNOLOGY AND CONSTRUCTION OF THE SUPERCONDUCTING SYSTEMS. PRELIMINARY TEMPERATURE MONITORING SYSTEM FOR THE EXPERIMENT ON THE ELECTRON COOLING SYSTEM OF NICA*

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One of the main parameters of the project of technology and construction in the superconducting systems being the part of the experiment on the electron cooling system of Nuclotron-based Ion Collider fAcility (NICA) project is monitoring the temperature, the liquid helium level in the cryostat and magnetic field. In this paper, temperature monitoring system has been discussed. The temperature monitoring system is controlled to protect against adverse heat supply. Therefore, the construction of temperature monitoring system should distinguish itself in terms of a large number of sensitive sensors and high accuracy of the sensor calibration. The following paper presents the preliminary prototype of the temperature monitoring system for NICA project.

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1. Introduction

During the realization of the project, which is the part of the Slow Control System, we focused on the influence of the open superconducting shield on magnetic field in an electromagnet. The purpose of these measurements was obtaining homogeneous lines of magnetic field. The value should be in the range of 10^{-4} to 10^{-5} T. Figure 1 (top) shows an example of how electromagnet behaves with and without a shield. Additionally, Fig. 1 (bottom) presents the scheme of the cryostat [1].

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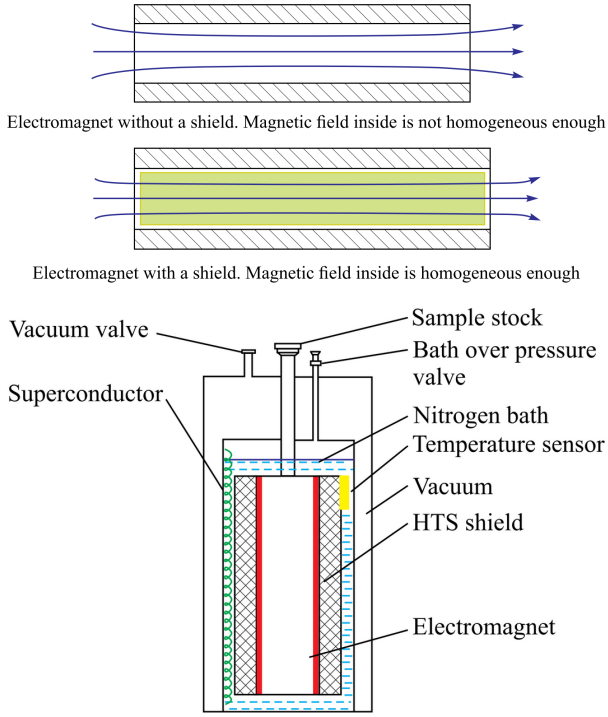

Fig. 1. The electromagnet with/without a shield (top); Cryostat [2] (bottom).

2. Preliminary design of the temperature monitoring system

A relevant issue was determining parameters for the temperature monitoring system to which belong:

— scope of the current source from 10 to 500 μA;

— the accuracy of the calibration should be 5×10^{-4} K;

— assembly of the heat exchanger;

— a large number of sensors;

— calibration of the temperature changes from 4.2 to 300 K.

Operating temperature of the magnet is about 4.5 K — it gives a safety margin of 1 V, whereby accuracy of the calibration should be 5×10^{-4} K. Moreover, a large amount of sensors improve measurement accuracy. The calibration procedure is based on the pre-selection in several well-known temperatures from 4.2 to 300 K [1].

2.1. Prototype of the temperature monitoring system

The draft of the temperature monitoring software was created in LabVIEW. The layout of the prototype is shown in Fig. 2.

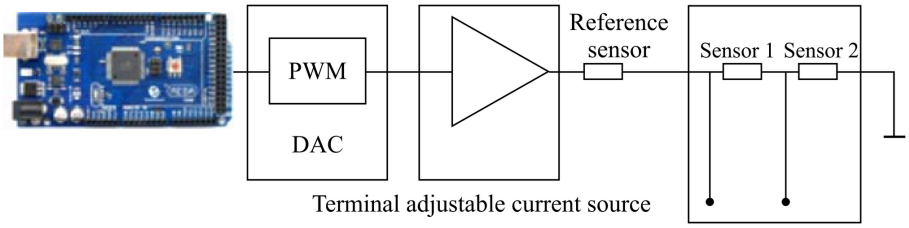

Fig. 2. Prototype of the temperature monitoring system.

The presented project has used the following items:

— integrated circuit Arduino Mega 2560;

— the PWM (Pulse-Width Modulation), where the voltage signal with constant amplitude and frequency is adjustable;

— current source;

— reference sensor;

— sensors placed in the cryostat.

The block diagram of the temperature monitoring system is shown in Fig. 3.

The first subVI shows the voltage drop on the reference sensor, for the next sensors, the same effect is observed [3].

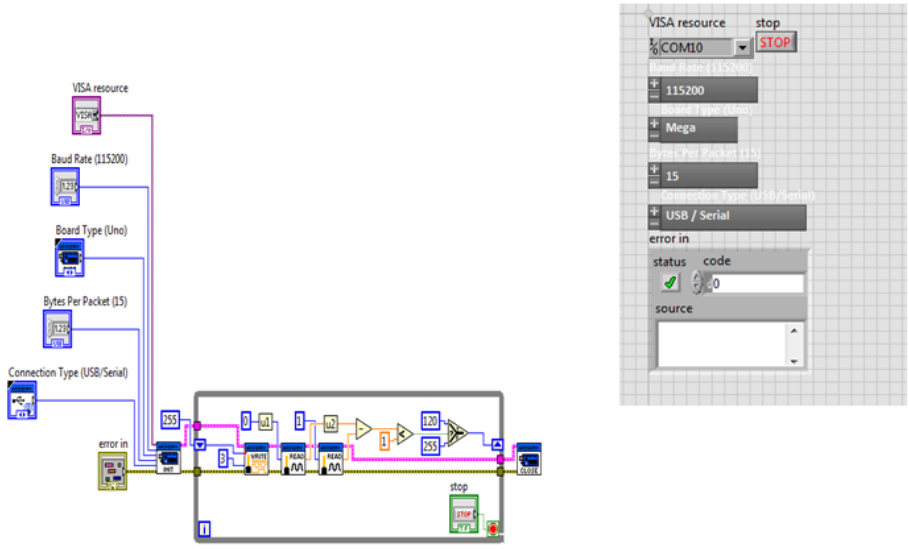

Fig. 3. Block diagram for prototype of temperature monitoring system.

3. Conclusions

In a general summary of the principle of operation of the temperature monitoring prototype for the Nuclotron-based Ion Collider fAcility (NICA) [4] project, we apply the voltage limits. The program replaces the current value by the half which is associated with the prevention of heat supply to the monitoring system.

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