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PRELIMINARY TEMPERATURE MONITORING SYSTEM FOR THE EXPERIMENT ON THE ELECTRON COOLING SYSTEM OF **NICA**

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Дырч П. и др. E13-2017-85
Прототип системы контроля температуры для проекта NICA

Одна из основных задач проекта по технологии и строительству сверхпроводящих систем, являющегося частью эксперимента по созданию электронной системы охлаждения для проекта NICA (Nuclotron-based Ion Collider fAcility), — мониторинг температуры, уровня жидкого гелия в криостате и магнитного поля. В данной статье обсуждается система контроля температуры, предназначенная для защиты оборудования от перегрева. Особенностью такой системы является большое количество чувствительных датчиков, обладающих высокой точностью калибровки. Представлен прототип системы контроля температуры для проекта NICA.

Работа выполнена в Лаборатории физики высоких энергий им. В. И. Векслера и А. М. Балдина ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна, 2017

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Preliminary Temperature Monitoring System for the Experiment on the Electron Cooling System of NICA

One of the main points 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 of the temperature, the liquid helium level in the cryostat, and magnetic field. In this paper, temperature monitoring system has been discussed. It is controled 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, high accuracy of the sensor calibration. The following paper presents a prototype of the temperature monitoring system for the NICA project.

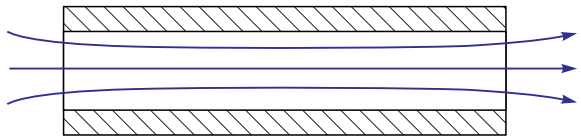
The investigation has been performed at the Veksler and Baldin Laboratory of High Energy Physics, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna, 2017

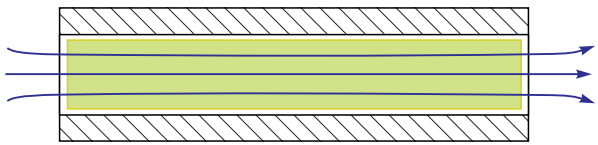
INTRODUCTION

During the implementation of the project, which is a 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 [1]. Figure 1, *a* shows an example of how electromagnet behaves with and without a shield. Additionally, Fig. 1, *b* presents the scheme of the cryostat [2].

a



Electromagnet without a shield. Magnetic field inside is not homogeneous enough



Electromagnet with a shield. Magnetic field inside is homogeneous enough

b

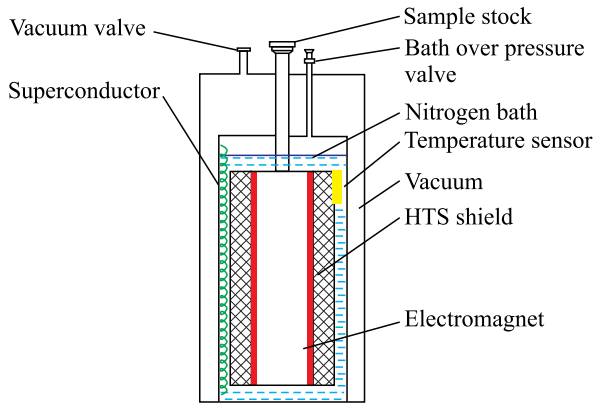


Fig. 1. *a*) The electromagnet with/without a shield; *b*) cryostat [3]

1. PRELIMINARY DESIGN OF THE TEMPERATURE MONITORING SYSTEM

Relevant issue was determining the parameters for the temperature monitoring system to which they belong:

- scope of the current source from 10 to 500 μA;
- the accuracy of the calibration should be $5 \cdot 10^{-4}$ 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 $5 \cdot 10^{-4}$ K. Moreover, a large amount of sensors improve measurement accuracy too. The calibration procedure is based on the pre-selection in several well-known temperatures from 4.2 to 300 K [2].

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

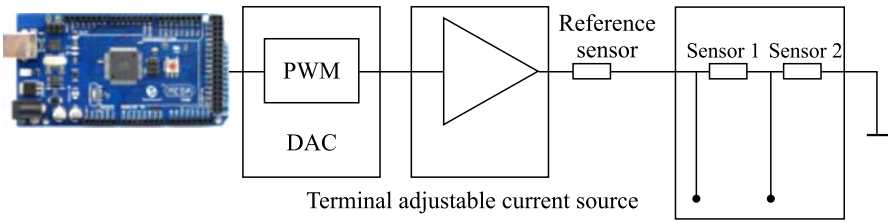


Fig. 2. Prototype of the temperature monitoring system

The presented project has used the following items:

- integrated circuit Arduino Mega 2560;
- the PWM (Pulse-Width Modulation), where the voltage signal is adjustable with constant amplitude and frequency;
- 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 [4].

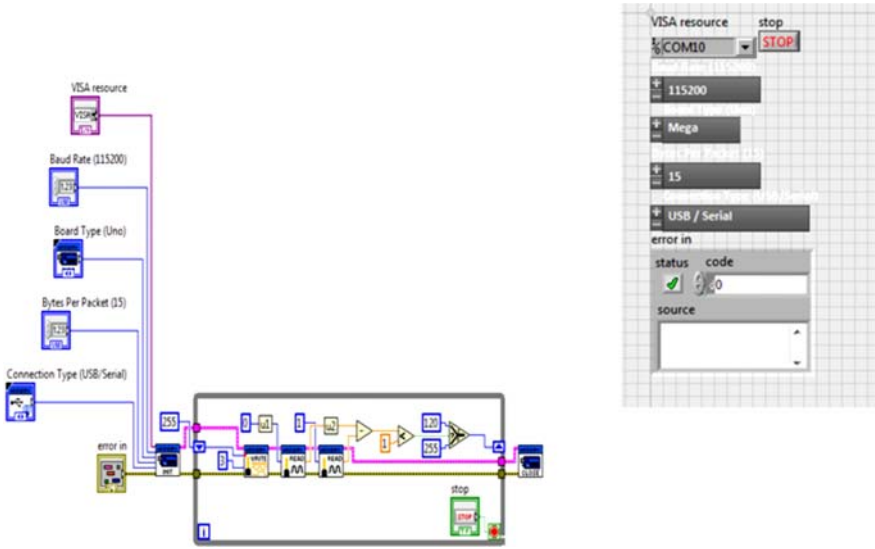


Fig. 3. Block diagram for the prototype of temperature monitoring system

CONCLUSIONS

In a general summary of the principle of operation of the temperature monitoring prototype for the Nuclotron-based Ion Collider fAcility (NICA) 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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