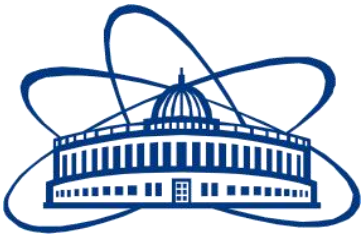

JOINT INSTITUTE FOR NUCLEAR RESEARCH

Veksler and Baldin laboratory of High Energy Physics

FINAL REPORT ON THE SUMMER STUDENT PROGRAM

Software development for measurement of heat releases by calorimetric method

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Abstract

NICA is a new accelerator collider complex under construction in JINR, Dubna. More than 390 SC-magnets are needed for the NICA booster and collider [1]. One of the parameters measured during the cold testing of superconducting magnets for the NICA project is the heat releases. The software for automation of heat releases measurement in the SC-magnets by calorific method that is implemented at the facility for testing of superconducting magnets at JINR is described.

Introduction

The measurements of heat releases are performing by two methods: electrical [2] and calorimetrical [3]. Electrical method measures only dynamic heat releases (heat due the flowing of current through a SC-magnet).

Calorimetric method measures static heat releases (the heat from the cryostat) as well as dynamic heat releases. The matching of values, that obtained by these methods, confirms by results.

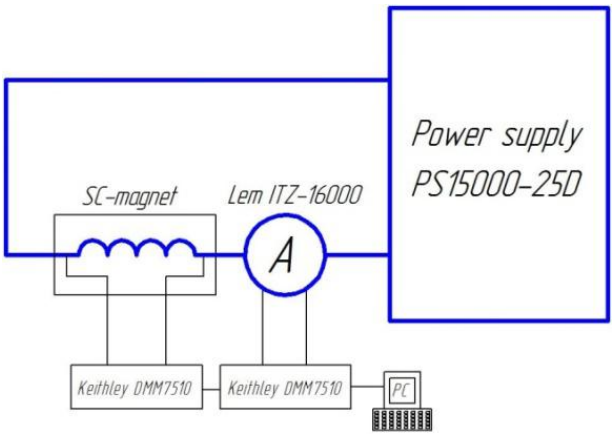

Fig 1. Scheme of the heat releases measurement by electrical method

The system for measurement of dynamic heat releases by electrical method is shown at the Fig.1. It consists of two multimeters, that measures the values of current and voltage simultaneously.

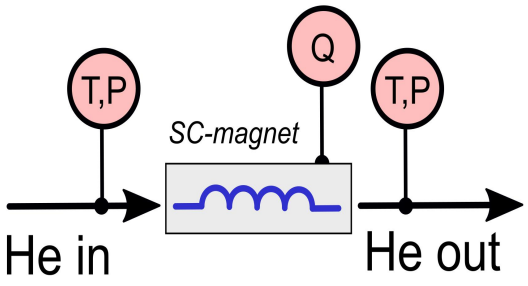

Fig 2. Scheme of the heat releases measurement by calorimetrical method

The system for measurement of calorimetric heat releases is shown at the Fig2. In process of calorimetric measurements helium is fed into the inlet of SC-magnet cryogenic system in the form of a liquid.

The necessary parameters of the helium flow determine by the condition, that whole helium flow has to transform to the gas form at the outlet.Helium

transforms into the gas state due to the absorption of energy released by the SC-magnet and the heat flow from the cryostat. Parameters that needs for determinating of heat releases are inlet pressure and temperature, outlet pressure and temperature and flowrate.

Software development

This software was developed by LabView IDE. Program in real-time mode acquires data from the required sensors. Some of data is transmitting via the RS-485 communication protocol, and the rest of data receiving by connecting to the internal server via Ethernet protocol. The obtained data transform to the required form, after which the heat release value is calculated. The fragment of code of the program is presented at the Fig.3:

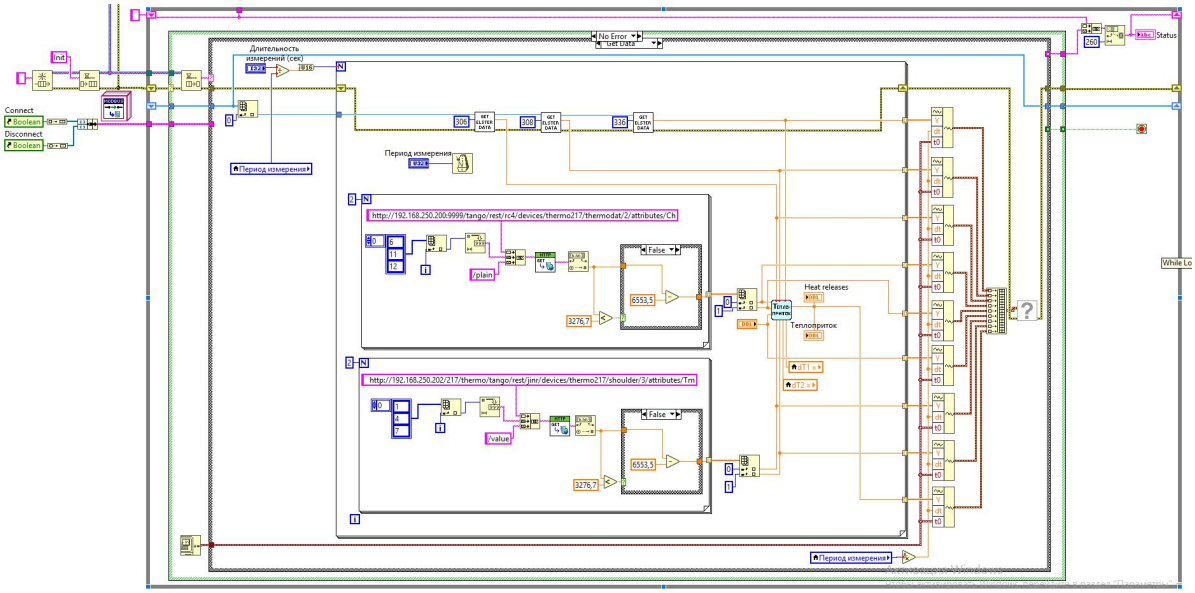

Fig 3. The fragment of the LabView program code

Interface of the program (Fig. 4) includes a box for the graph of heat release versus time dependence. There are also settings of the connection to sensors, some settings for obtaining data, and the possibility of calibrating the temperature sensors. All received data and calculated values are saving to a file.

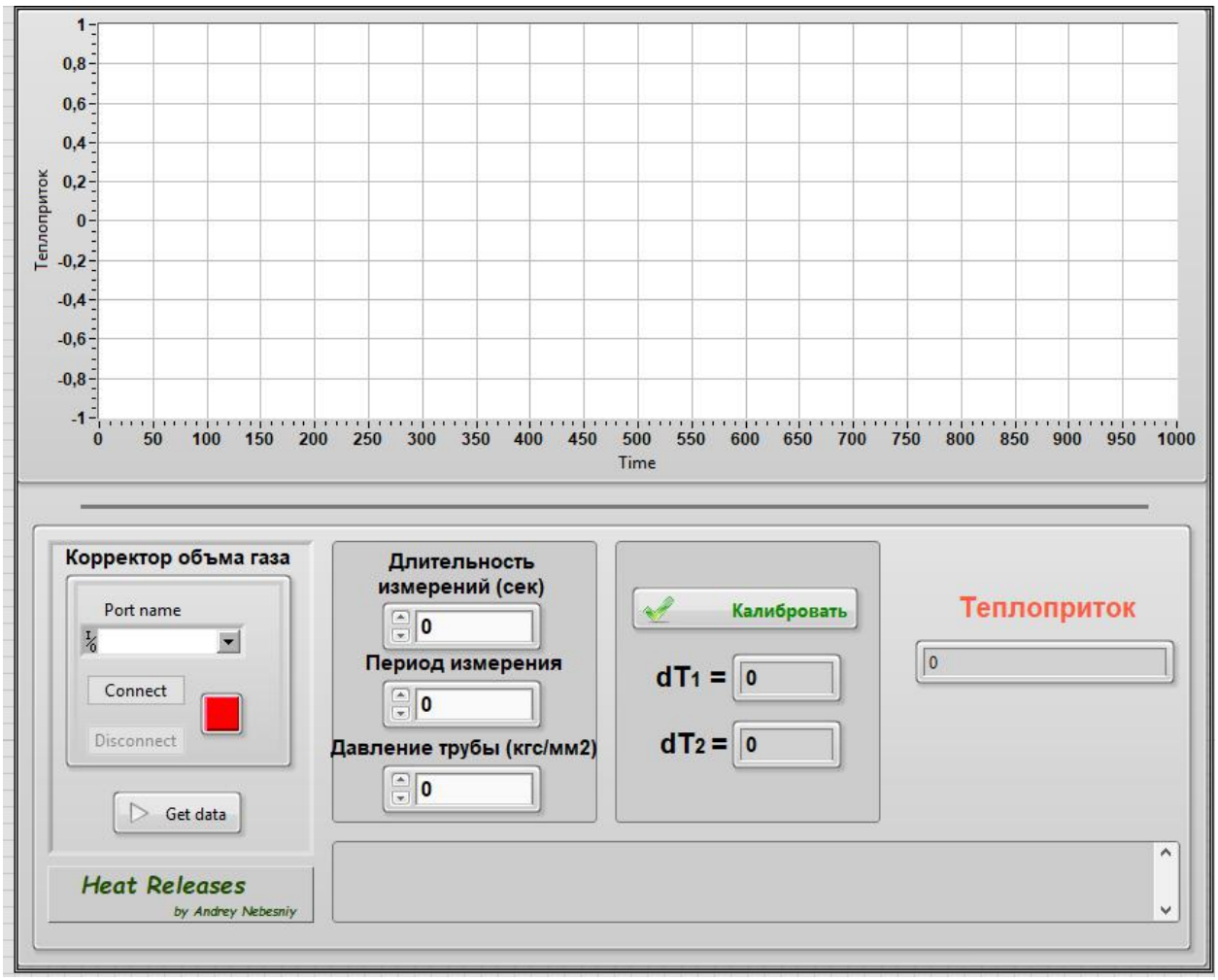

Fig 4. The program interface

One more project

Also during the practice I started to implement thermotester device. This device based on the STM32 microcontroller. It is required for measuring and testing the SC-magnet thermoresistors inside a cryostat

Fig 5. The components of the thermotester

The main purpose of the device is the determination of broken cable place in the thermoresistors circuit.

The device connects sensors, switching them one by one by high-speed analog multiplexers (MP). The selected sensor is supplying by current from current source and measuring the value of voltage droping on it. Knowing the value of current and of voltage it is became possible calculating the resistance of sensor using Ohm's law R=U/I. Four-contact measurement method is used for ignore resistance of connecting cables.

The scheme of device is shown at the Fig 6:

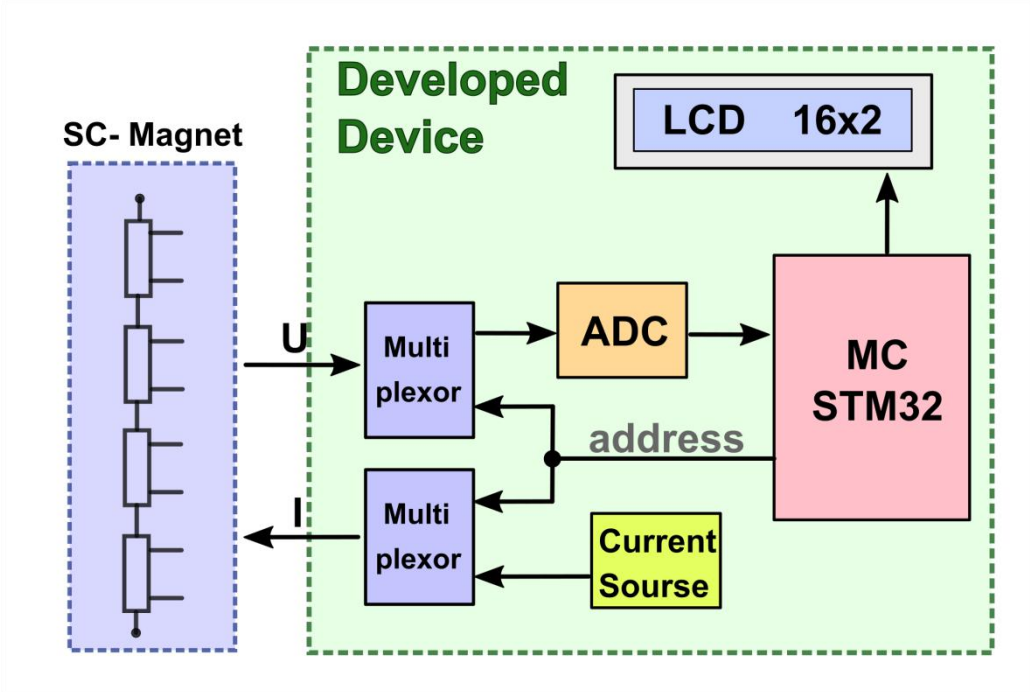

Fig 6. The scheme of the thermotester

The device has screen to display the measured and calculated values. If any of connections of the sensor was broken, device would indicate it by the screen. There was used 16-bit ADC AD7705.

References

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2. **D. Nikiforov et al**., *Serial cryogenic tests of SC-magnets for NICA project*, 14th CRYOGENICS 2017, Dresden, Germany

3. **Б. Кондратьев и др.,** *Измерение динамических теплопритоков дипольных магнитов бустера* NICA, 12th International scientific workshop in memory of V.P. Sarantsev, 2017, Alushta