**Temperature influence of the TOF detector and cooling systems (aquatic and aerial) on the accuracy of particle detection in the detector**

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## 1. Motivation

Collisions of relativistic hadrons and heavy ions are an important source of information about the structure of matter and the properties of elementary particles. According to the theoretical predictions, with a sufficiently high collision energy, a state of matter called quark-gluon plasma can be formed. In such a state, quarks are not bound in hadrons, but behave as quasi-free particles. Mostly those nuclei that have a large atomic number, such as gold or lead, are collided in specially prepared accelerators. The most effective devices for collision of heavy ions are colliders, which are devices designed to accelerate two opposing beams at speeds close to the speed of light.

The collisions occur in a strictly defined place, so that, with the help of detectors, it is possible to obtain as much information as possible about the course of the collision and the matter that arises after collision. The quark-gluon plasma state is very short, which makes it impossible to investigate such a state directly. One way to obtain information about collision-generated matter is to analyze the properties manifested in the investigated particle processes. In the process of detection, a combination of several, or even a dozen, technologically advanced detectors are used.

Specialized detectors use advanced electronics that produces heat during operation. Semiconductors, silicon integrated circuits, without heat dissipation, may work incorrectly, or even may burn at too high temperatures. It is necessary to create a system that allows the heat to be removed from the inside of the detector. In addition, variable ambient conditions affect the accuracy of particle detection.

The MPD (Multi-Purpose Detector) is the main element of the experimental complex utilizing rotating heavy ions in the collider. Multitasking imposes very high demands on the detector's recording capacity. On the one hand, the detector should make it possible to use the luminosity of the accelerator system, recording interesting events with sufficiently high frequencies, and on the other hand, it should be able to select very rare and most interesting events, for example, recording particles containing very heavy quarks. Likewise, femtoscopic correlation studies require very good resolution in the area of small relative momentum, whereas measurement of the correlation of particles emitted in different areas of the phase space requires very high acceptance of the detection system. Some tasks require precise registration of short-lived particles, other – of photons or muons. Some of them are geared for the reconstruction of strange particles, etc. There is an obvious prerequisite for the cost of the whole system. The design of the detector must, therefore, be a compromise between the requirements that are often mutually contradictory, thus preventing their simultaneous fulfillment.

One of the major detectors used for particle identification is the TOF (time-of-flight) detector. The primary purpose of time-of-flight systems is to identify charged hadrons within a momentum between 0.1 and 2 GeV/c. In the low-momentum area, information from the TOF is supplemented by the measurement results from the TPC detector (energy loss - dE / dx) and from the IT detector.

For identifying charged particles (knowledge of mass), in addition to the knowledge of particle momentum, it is necessary to measure the length of the particle trajectory and the time it takes to travel. For a particular type of a detector to be used in the MPD experiment, the influence of temperature on the parameters, such as:

- Time resolution,
- Particle speed during the drift through the detector,
- Time of particle flight.

should be studied.

Investigating the effect of the detector temperature changes on the particle identification accuracy is very important from the experimental point of view. The TOF detector cooling system was the subject of our master thesis. Based on computer simulations, it is known that such a system is essential for the correct operation of electronics, but its effect on the detection capability is unknown.

## 2. Tasks

Students will work with the LabVIEW and myRIO device. The main tasks are:

1. arrangement of the system in an assembly block and connection to the network of measurement systems,

2. development of the software,
3. development of the Data Acquisition System,
4. test measurements and preparation of documentation.

**4. Requirements**

1. Computer with Windows operating system,
2. Programming skills in LabView,
3. Basic English skills.

**5. Recommended literature**

1. a) www.jinr.ru – JINR's website,
2. b) http://nica.jinr.ru – NICA's website,
3. c) http://labview.pl – LabView website,
4. d) http://nica.fizyka.pw.edu.pl/ - Twiki of SCS group.

**6. The maximum number of project participants:** 2