THE COOLING, THE REGULATION AND THE TEMPERATURE STABILIZATION SYSTEM FOR MPD DETECTOR AT JINR ACCELERATOR COMPLEX NICA*

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The cooling, the regulation and the temperature stabilisation system is very important for every kind of electronics. Devices, which are not cooled, can be destroyed and burned. This publication presents simulation of different cooling systems for MPD detector as an example of TOF detector.

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1. Introduction

Collisions of relativistic hadrons and heavy ions are a very important source of information on material's structure and elementary particles' properties. According to theoretical predictions for high-energies collisions, there can arise a new state of matter, called QGP (Quark–Gluon Plasma) [1]. These conditions mean that quarks are not confined in hadrons but they behave as quasi-free particles (Fig. 1).

Specialized detectors use advanced electronics, which emit energy in the form of heat. Semiconductor, silicon chips without heat sinks or coolers can work incorrectly, destroy or fuse. Because of that, the cooling system is required.

The main reason for studying relativistic collisions is to understand the properties of matter under high baryonic density and high temperature. According to QCD (Quantum Chromodynamics) predictions, under these

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conditions, there should exist a phase transition from hadronic matter into quark matter [2]. After that, quarks and gluons will not be confined inside hadrons but there will exist new degrees of freedom. If matter is in thermodynamic equilibrium, this new state will arise (QGP).

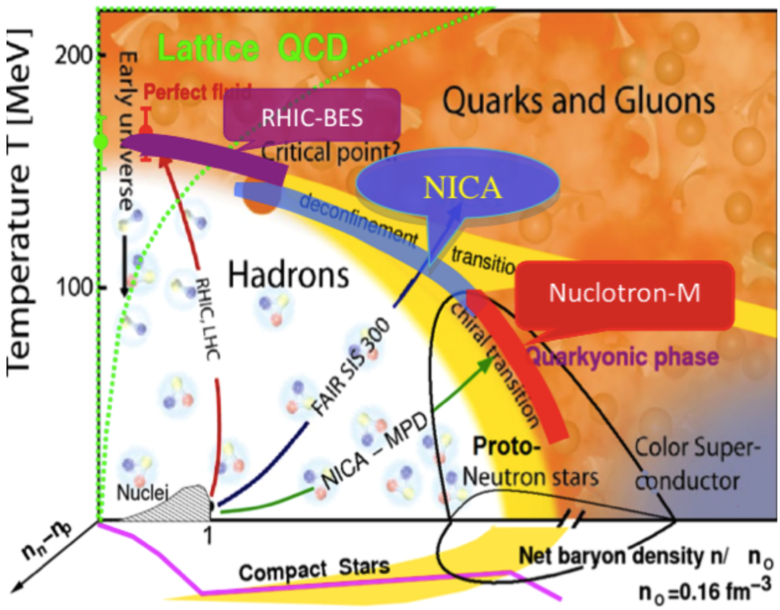


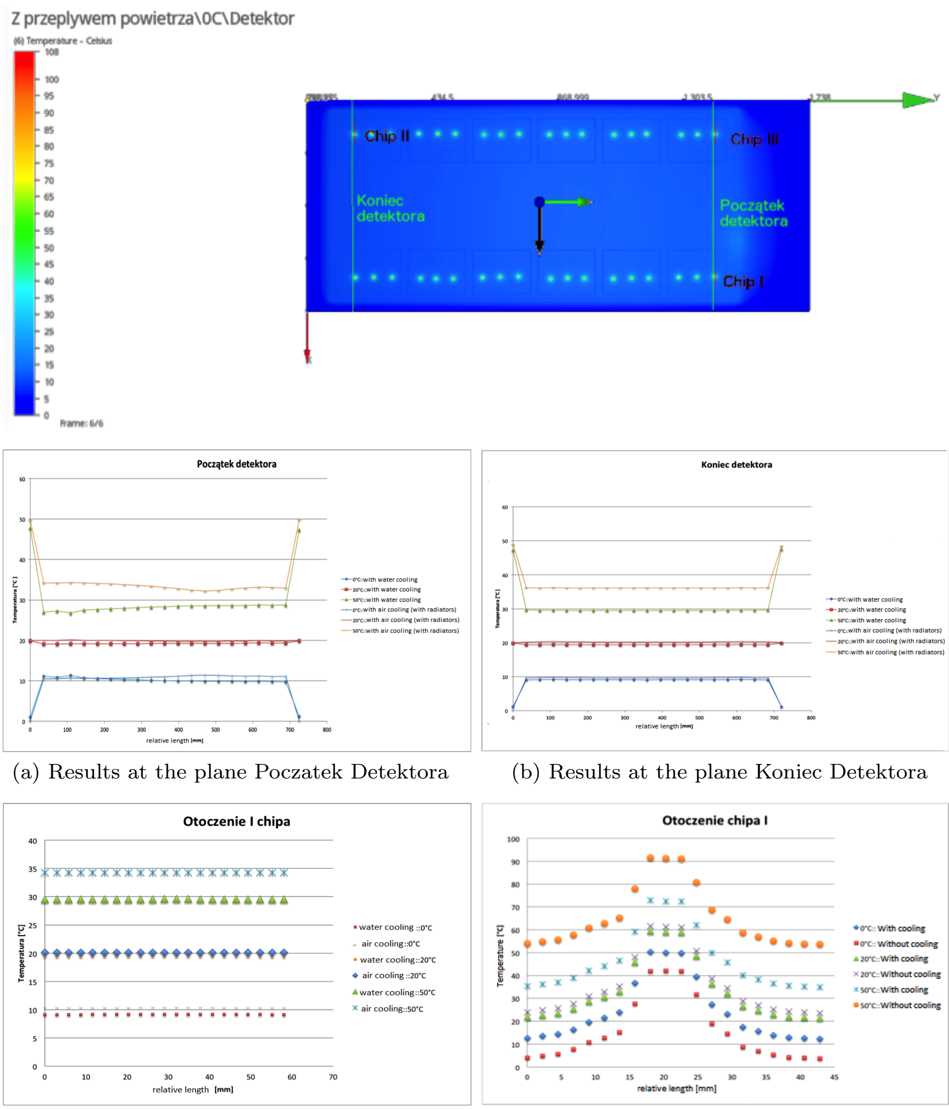
Fig. 1. Phase diagram [3].

The phase transition into QGP is possible for both low- and high-baryonic densities but its nature is different [2]: For low-baryonic density and high temperatures, the phase transition is called cross-over. It means that there are not rapid changes of materials properties. This situation is similar to first moments of the existence of Universe — few seconds after the Bing Bang. For hig-baryonic density and low temperatures, the material's states are similar to electrons in metals capable of superconducting [4]. This can be the case of neutron's stars. Between these two different phase transitions, there is a very interesting region where the two classes of phase transition can meet: the cross-over and the first order. It follows that there should be a critical point. The temperature and baryonic density for this critical point are so far unknown [5].

2. Results

Simulations allow for measuring the temperature in the TOF (Time of Flight) detector. This detector is a part of MPD (Multi Purpose Detector), which is still under construction in Dubna.

The temperature value measured on three NINO-board integrated systems and on two surfaces of the TOF detector was obtained as the simulation result (Fig. 2).



(a) Results at the plane Poczatek Detektora

(b) Results at the plane Koniec Detektora

(c) Results at the point Chip I

(d) Results at the point Chip I without using radiators

Fig. 2. Measuring points.

These charts show that the best cooling and stabilization system is a system based on liquid. Additionally, this solution is pretty quiet and clean. It is a close loop so it means that it does not absorb impurities.

For preparing this cooling system is needed:

— 36 radiators,
— 3 m of cooper pipe,
— introducing water hoses,
— 20 l reservoir,
— pump,
— 36 thermometers.

3. Conclusions

There was prepared a heat transfer simulation in geometry, which was made in Autdesk Inventor. The simulation shows that the maximal temperature of NINO chips is close to the maximum allowable temperature for silicon. The cooling system is required. Proposed three types of cooling systems are:

— method based on air flow without radiators,
— method based on air flow with radiators,
— method based on liquid flow.

The first type of system causes the reductions of the temperature inside the detector but the temperature on NINO chips is still too high. It cannot be used for cooling and stabilization system. In this case, attaching heat sinks have a huge impact on the temperature of NINOs. The best solution is the third method, which allows not only to cool down the temperature, but also its stability.

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