ISBN: 978-3-95450-240-0 ISSN: 2673-5539 doi:10.18429/JACoW-RuPAC2021-MOPSA17

# AUTOMATED SYSTEM FOR HEATING ULTRA-HIGH VACUUM ELEMENTS OF SUPERCONDUCTING SYNCHROTRONS OF THE NICA COMPLEX

A.Sergeev, A.Butenko, A.Svidetelev, JINR, Dubna

*Abstract*

The Nuclotron-based Ion Collider fAcility that is under construction and commissioning in the Veksler - Baldin Laboratory for High Energy Physics of JINR contains three superconducting synchrotrons, three detectors and several beam transfer lines. All these installations and devices are equipment of high and ultra-high vacuum that requires standard procedure of preparation: preliminarily degassing the "warm" sections of the vacuum systems of the synchrotrons by prolonged heating to remove water vapor from the inner surface of the walls of the beam chamber. The heating system for the "warm" sections of the beam chambers allows one to heat up individual sections of the accelerators with minimal time spent and maximum efficiency. Due to the fact that the Booster and Collider are experimental facilities of original design, they consist of many "warm" areas. Each such element is an experimental, which has an peculiar exterior form and is made of specific composition of materials.

## INTRODUCTION

The system being created allows heating elements with an unknown heat capacity and thermal conductivity, which is a very urgent task, since some of the installations are delivered without their own heating system and heating is carried out by the specialists of VBLHEP JINR directly at the place where installation is mounted.

A new method has been developed for correcting the parameters of the power supplied to the heating elements, depending on the temperature of the surface of the heated element. Since in such systems (installations) it is impossible to use high-speed proportional-integral-differentiating controllers (hereinafter PID) due to possible overheating and, consequently, destruction of installation elements due to different coefficients of thermal expansion of different interconnected elements, the algorithm is additionally used correction, which prevents overheating of individual components of the system.

## FEATURES OF THE DEVELOPED SYSTEM

- Temperature control of critical elements of the heated system.
- Control of the heating process by introducing feedbacks from temperature sensors, which allows automatically, according to the set parameters of the heating process, to control the speed and intensity of heating of accelerator elements.
- The temperature control of the installation is carried out along the heated surface, which allows evenly heating parts of various shapes and lengths.
- Optimization of the heating process due to the implementation of the connection between the cabinets of different devices, which allows combining several cabinets into a single system that heats up one complex installation as a whole.
- Flexibility of controllability of system parameters, directly in the process of work (warm-up).
- The ability to exclude individual elements from the heating zones, which allows you to concentrate power on certain areas of the heated equipment.
- Automated operational control of a non-staff set of heaters or other equipment (vacuum pumps, gates, etc.).
- Automatic processing of the progress of the heating process and its results, which makes it possible to generate the final product heating certificate.

Within the framework of the NICA project, the following elements of the Booster were heated: numerous high-vacuum posts, RF stations, beam pipe, Septum.