THE PRECISE TEMPERATURE MEASUREMENT SYSTEM OF THE VEPP-4M ELECTRON-POSITRON COLLIDER

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Abstract

The temperature of the magnets is an important factor determining the average energy of the particles in the circulating bunches in colliders

The work describes the VEPP-4M temperature measurement system based on 32-channel Temperature Controllers using High-Precision Digital Thermometers DS1631 with the resolution 0.0625º C. Temperature values are renewed for the all of 32 channels of each controller every second automatically. The controllers are connected to PC via serial interface RS232/RS485.

The program running in PC reads the data from the all controllers and writes the data to PostgreSQL database every minute. The graphic interface provides browsing of the temperature diagrams of the selected sensors for any period of time. The programs run under Linux and use Motif library.

INTRODUCTION

The most important factor determining the average energy of particles in circulating bunches in the VEPP-4M collider is the temperature of the dipole magnets [1].

The integral value of the magnetic field in the beam orbit area depends on the magnet dimensions, which depend on a temperature. Thus, for the estimation of the average energy of bunches, it is necessary to measure the temperature of the magnetic elements precisely and to provide thermal stability of the all magnets.

The control of the temperature of the RF cavities is required also. The RF cavities dimensions variation results in excitation of undesirable modes of oscillations, which excite coherent oscillations of the beams particles.

The new measurement system was developed on the VEPP-4M collider in order to provide the precise and continuous temperature measurements.

THE COMPONENTS OF THE TERMOCONTROL SYSTEM

The VEPP-4M temperature measurement system bases on BINP developed 32 channel temperature controllers using High-Precision Digital Thermometers DS1631 with the resolution 0.0625º C [2].

High-Precision Digital Thermometers DS1631

DS1631 is produced by MAXIM/DALLAS Company. Sensor's principal features are:

- DS1631 provides ±0.5° C accuracy within 0° C up to +70° C range;
- operating temperature range: –55°C to +125° C;
- temperature measurements require no external components;
- output resolution is user-selectable to 9, 10, 11 or 12 bits (12 bits resolution corresponds 0.0625° C);
- wide power supply range (2.7V to 5.5V);
- converts temperature to digital word in 750 ms (max);
- data is read/written through 2–wire serial interface.

32- channel Temperature Controller

32-channel Temperature Controller was developed in BINP. Controller's functions are:

- data is read from the temperature sensors every second and is written to the memory of the controller;
- automatic check of the temperature value of each sensor to be inside the specified temperature range;
- switching on the relay interlock if the temperature is out of the specified range.

Figure 1: The temperature controller; 1 - sensor board; 2 – sensor inside the protection case.

Controller is connected with sensors through four-wire multi-drop serial lines. It is possible to connect up to eight sensors in one line of 20 meters length. Temperature values are renewed for the all sensors of each controller and stored to the memory every second automatically.

If some of the temperature values exceed specified temperature limits, then specified relay contact is closed automatically. Relay interlock is proposed to be used to prevent the VEPP-4M magnetic elements overheating. There are up to 12 solid-state relays in one controller. PC program reads from and writes to controller the specifications for relay contact closure. Controller closes relay contacts automatically but can't opens its. PC-program may close and open relay in accordance the

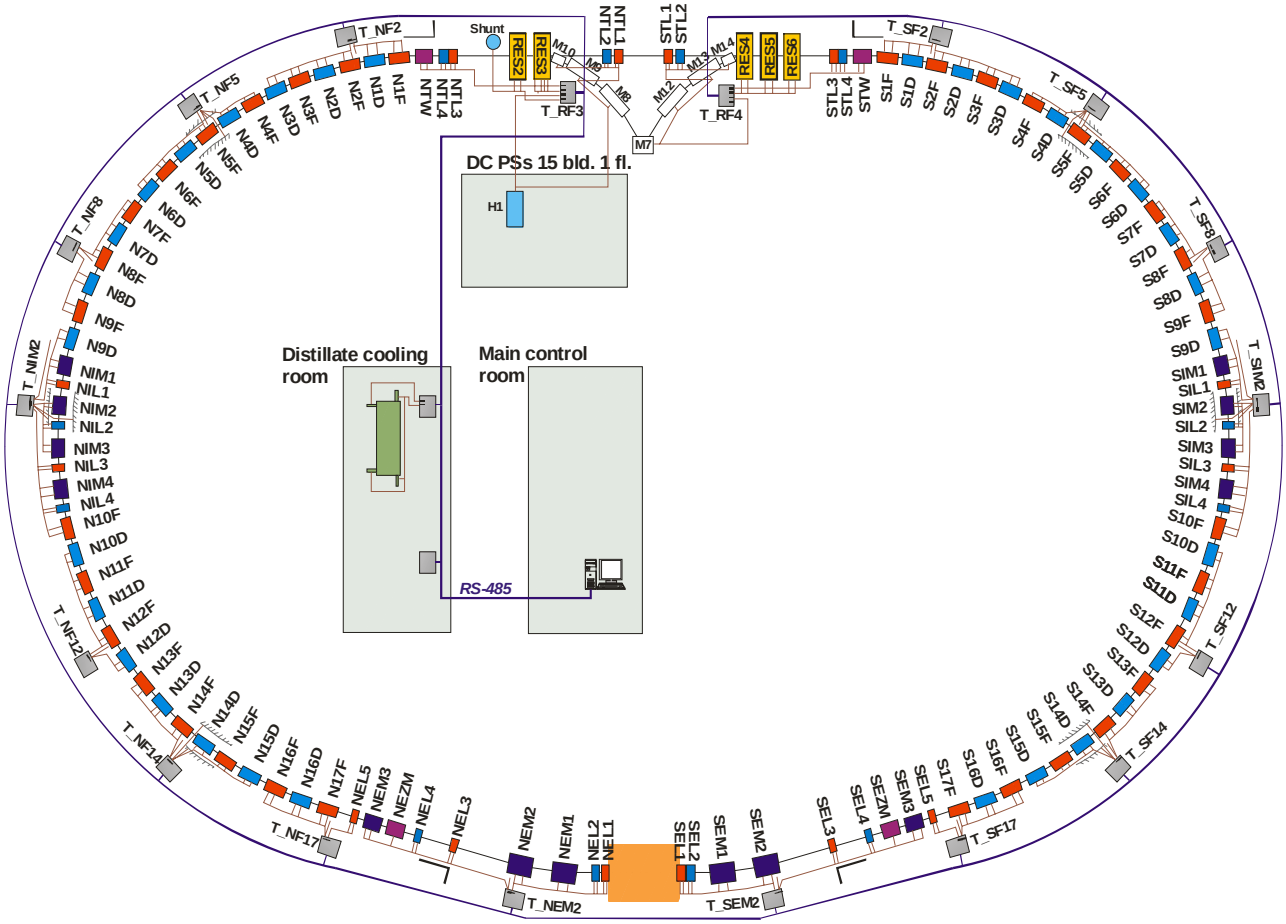

Figure 2: Scheme of the VEPP-4M temperature system.

operation logic.

It may be connected up to 30 controllers in parallel to one link via serial port in PC. The distance from PC to the last controller is up to 1200 meters. Fig. 2 illustrates the sensors and controllers distribution at the VEPP-4M ring.

Figure 3: The controller placed at the VEPP-4M ring: 1 - temperature controller, 2 - sensor for the air temperature, 3 - sensor on the upper part of the magnet.

RS-485/RS-232 interface and specially developed protocol are used for the connection between the temperature controller and the PC.

The air and tunnel walls temperatures are measured in several points in order to provide the estimation of the ring geometry. Each magnet is measured in two points: on upper and down parts of the yoke (see Fig. 3).

THE TEMPERATURE SYSTEM SOFTWARE

The program running in PC reads the data from the all controllers and writes the data to PostgreSQL database once per minute. The graphic interface provides browsing of the temperature diagrams of the selected sensors over any period of time. The typical temperature diagrams are presented in Fig. 4 and Fig. 5. The configuration of the controllers and sensors are stored into PostgreSQL database too. The monitoring program reads the configuration data from the database for renewing periodically. It provides permanent measurement and storing of the temperature data if the measurement system is modified. All the programs run under Linux and use Motif's library.

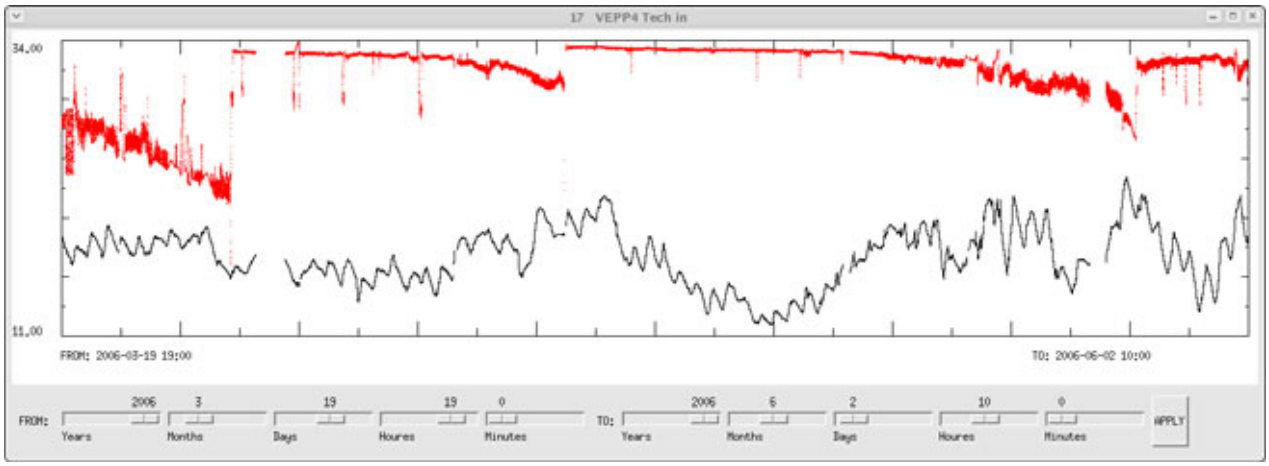

Figure 4: The out circuit cooling water temperatures during two and half months (red – out-stream temperature, black – in-stream temperature).

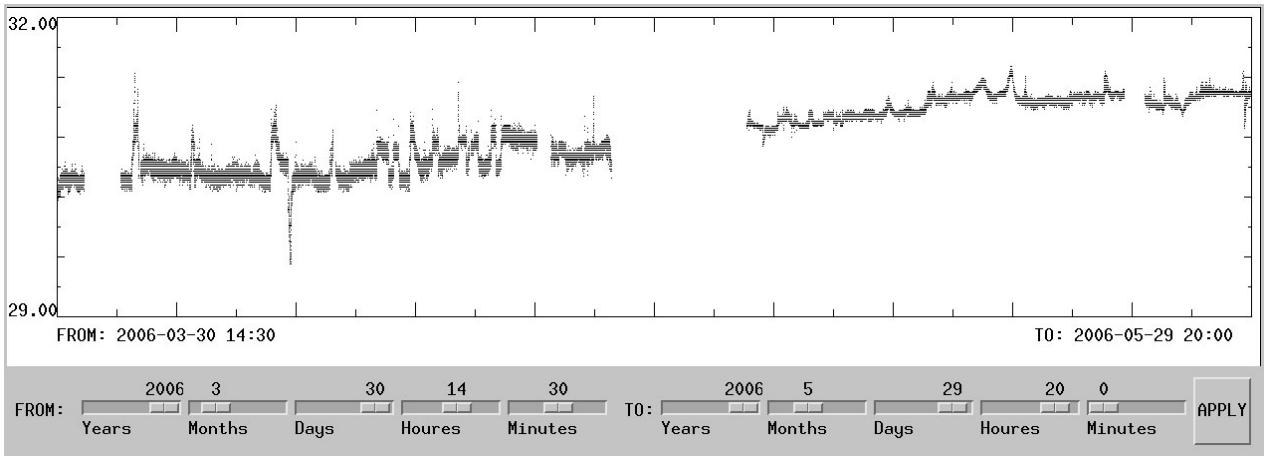

Figure 5: The temperature of N5F magnet during two months.

CONCLUSION

The controllers and sensors were tested during the 2005/2006 operating season. They provided a high reliability of the measurement system during several months (see Fig. 4, 5). Now the system is in preparation for the next season. The measured temperatures will be used for the permanent beams energy estimation in the experiments on high precision Ψ-meson and τ-lepton masses measurements.

REFERENCES

[1] V.Blinov, et al. “Status of VEPP-4M collider: current activity and plans”, Proceedings of the XIX International Workshop on Charged Particle Accelerators, September13-18, 2005, Alushta, Crimea.

[2] http://www.maxim-ic.com/parts.cfm/p/DS1631