

The Total-Temperature Measurements and Interlock System at the VEPP-4M Collider

V. Kaplin, S. Karnev, A. Krashnin, O. Plotnikova, S. Vasichev
BINP SB RAS, Novosibirsk, 630090, Russia

INTRODUCTION

The high-energy physics experiments performed at the VEPP-4M collider require a high-precision beam energy measurement. Beam energy is proportional to the dipole magnetic field integral. On-line monitoring of the magnetic field with 10^{-4} accuracy is realized by nuclear magnetic resonance (NMR) method.

But the beam energy also depends on thermal changing of the magnets and tunnel dimensions. For accurate estimation of the beam energy between resonance depolarization calibrations it is necessary to measure precisely temperature in a lot of locations of the VEPP-4M facility. The control of the temperature of the RF cavities is required also. The RF cavities have undesirable modes of oscillations, which excite coherent oscillations of the beams particles during the experiment.

The new system of temperature monitoring was developed in order to provide total precise permanent interlock with the second function of the system is interlock function.

SYSTEM REALIZATION

The temperature measurement system comprises 25 controllers and almost 500 sensors.

- The system is used for two purposes:
- temperature measurements for the beam energy estimation during the experiments with colliding beams;
 - temperature measurements for the prevention of the magnets overheating.

For the first purpose the air and the tunnel walls temperatures are measured in several points. Also the temperature of each magnet is measured in two points: cooling water and down part of yoke. For these measurements sensors are used for these measurements.

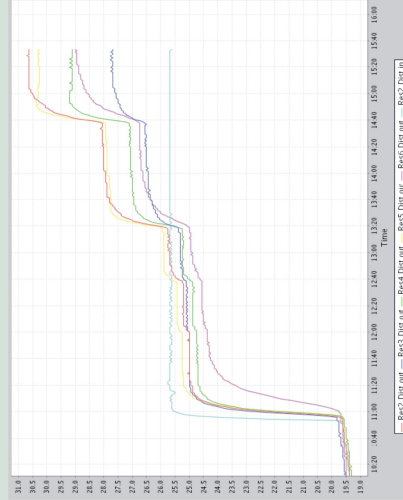
For the second purpose the temperatures of magnetic coils and the temperatures of magnet commutations are measured. Number of sensors the interlock sensor the range of working temperatures is set in memory of the controller. The each sensor has two blocking levels: warning level and power supply switching off level.

SOFTWARE

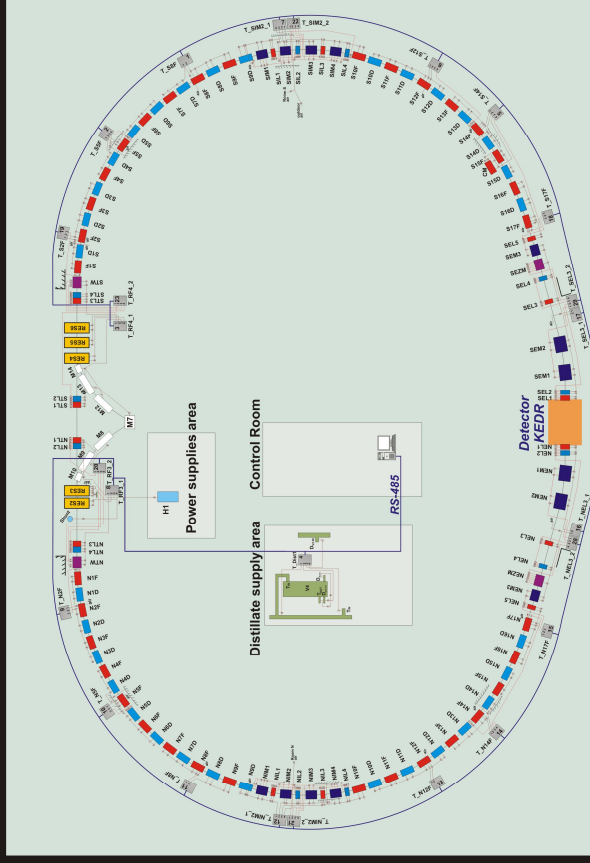
The full description of the controllers and sensors configuration is contained in the VEPP-4 database. The resident program works with controllers and periodically reads the configuration data from the database for the case of renewing of the temperature measurement canals configuration. The program reads the data from the all controllers and writes measurements to database once per minute.

The database graphic observation program provides browsing of the temperature diagrams of the selected sensors for any period of time in any scale. Also, the graphic interface allows temperature monitoring. The diagrams of input and output cooling water temperatures of input and output circulating distillate temperature is shown in the picture.

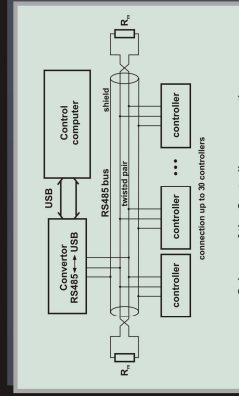
The resident program runs under Linux. The observation program can run in any Control Room computer.



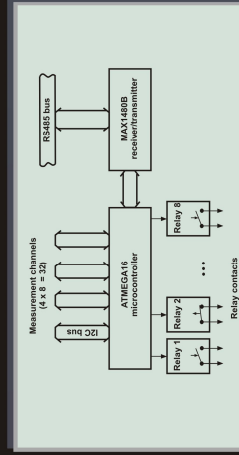
Changing of the VEPP-4 RF cavities temperatures during the test operations



Scheme of the temperature measurement system



Scheme of the controllers connection



Scheme of the Temperature Controller

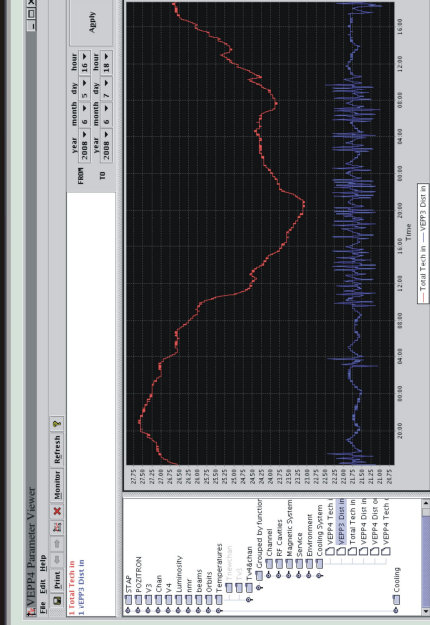


1 - sensor board; 2 - sensor inside the protection case



- 1 - temperature controller
- 2 - sensor for the air temperature measuring
- 3 - sensor fixed on the upper part of the magnet

The controller placed at the VEPP-4M ring



One day observation of the VEPP-3 cooling water temperatures

High-Precision Digital Thermometers DS1631 (produced by MAXIM corporation)

Sensor's principal features are:

- DS1631 provides $\pm 0.5^\circ\text{C}$ accuracy within 0°C up to $+70^\circ\text{C}$ range
- operating temperature range: 55°C to $+125^\circ\text{C}$
- 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 two-wire serial interface

32-channel Temperature Controller

- 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

Controller is connected with sensors through RS485 bus. It is possible to connect up to eight sensors in a 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 8 solid-state relays in one controller. Program reads the relay status to the controller. The interlock for the contacts changing. Controller closes relay contacts automatically but can't open its PC program may close and open the relay in accordance the operation logic.

The controllers are connected to PC via industrial RS485 bus. This line can be attached to PC via USB or COM port using protocol converter "RS485-USB" or "RS485-COM". Thirty controllers can be connected to one RS485 bus. The length of bus can be up to 1200 meters.

NEAREST PLANS

Improvement of test utilities for checking of the system components (controllers, sensors).

Development of graphical diagnostic panel for visualization of the measured temperatures. The graphical panel updates once per second. The server program reads the data from the controllers and processes graphical diagnostic panel for storing the data to the database) read temperature values from the server program.

Implementation of the system at the VEPP-3 storage ring and at the new transport channel from the new injector complex to VEPP-3.

CONCLUSION

The temperature measurement system started its work in 2006/2007 operating season. Installation of sensors and controllers in the tunnel and on the magnets was completed. In 2007-2008 the measurement system has been showing very good reliability. Precise measurements were used for the permanent beam energy reconstruction, for the diagnostic of state of the cooling and magnetic systems of the VEPP-4M collider. Precise measurements will be used for protection of the magnets against overheating.

REFERENCES

- [1] V. Kaplin, S. Karnev, A. Krashnin, O. Plotnikova, S. Vasichev, "The total-temperature measurement system of the VEPP-4M electron-positron collider", Proc. of RUPAC 2006, Novosibirsk, 2006.
- [2] <http://www.jacow.org>
- [3] <http://www.jacow.org>
- [4] <http://www.jacow.org>
- [5] <http://www.jacow.org>
- [6] <http://www.jacow.org>
- [7] <http://www.jacow.org>
- [8] <http://www.jacow.org>
- [9] <http://www.jacow.org>
- [10] <http://www.jacow.org>
- [11] <http://www.jacow.org>
- [12] <http://www.jacow.org>
- [13] <http://www.jacow.org>
- [14] <http://www.jacow.org>
- [15] <http://www.jacow.org>
- [16] <http://www.jacow.org>
- [17] <http://www.jacow.org>
- [18] <http://www.jacow.org>
- [19] <http://www.jacow.org>
- [20] <http://www.jacow.org>
- [21] <http://www.jacow.org>
- [22] <http://www.jacow.org>
- [23] <http://www.jacow.org>
- [24] <http://www.jacow.org>
- [25] <http://www.jacow.org>
- [26] <http://www.jacow.org>
- [27] <http://www.jacow.org>
- [28] <http://www.jacow.org>
- [29] <http://www.jacow.org>
- [30] <http://www.jacow.org>
- [31] <http://www.jacow.org>
- [32] <http://www.jacow.org>
- [33] <http://www.jacow.org>
- [34] <http://www.jacow.org>
- [35] <http://www.jacow.org>
- [36] <http://www.jacow.org>
- [37] <http://www.jacow.org>
- [38] <http://www.jacow.org>
- [39] <http://www.jacow.org>
- [40] <http://www.jacow.org>
- [41] <http://www.jacow.org>
- [42] <http://www.jacow.org>
- [43] <http://www.jacow.org>
- [44] <http://www.jacow.org>
- [45] <http://www.jacow.org>
- [46] <http://www.jacow.org>
- [47] <http://www.jacow.org>
- [48] <http://www.jacow.org>
- [49] <http://www.jacow.org>
- [50] <http://www.jacow.org>
- [51] <http://www.jacow.org>
- [52] <http://www.jacow.org>
- [53] <http://www.jacow.org>
- [54] <http://www.jacow.org>
- [55] <http://www.jacow.org>
- [56] <http://www.jacow.org>
- [57] <http://www.jacow.org>
- [58] <http://www.jacow.org>
- [59] <http://www.jacow.org>
- [60] <http://www.jacow.org>
- [61] <http://www.jacow.org>
- [62] <http://www.jacow.org>
- [63] <http://www.jacow.org>
- [64] <http://www.jacow.org>
- [65] <http://www.jacow.org>
- [66] <http://www.jacow.org>
- [67] <http://www.jacow.org>
- [68] <http://www.jacow.org>
- [69] <http://www.jacow.org>
- [70] <http://www.jacow.org>
- [71] <http://www.jacow.org>
- [72] <http://www.jacow.org>
- [73] <http://www.jacow.org>
- [74] <http://www.jacow.org>
- [75] <http://www.jacow.org>
- [76] <http://www.jacow.org>
- [77] <http://www.jacow.org>
- [78] <http://www.jacow.org>
- [79] <http://www.jacow.org>
- [80] <http://www.jacow.org>
- [81] <http://www.jacow.org>
- [82] <http://www.jacow.org>
- [83] <http://www.jacow.org>
- [84] <http://www.jacow.org>
- [85] <http://www.jacow.org>
- [86] <http://www.jacow.org>
- [87] <http://www.jacow.org>
- [88] <http://www.jacow.org>
- [89] <http://www.jacow.org>
- [90] <http://www.jacow.org>
- [91] <http://www.jacow.org>
- [92] <http://www.jacow.org>
- [93] <http://www.jacow.org>
- [94] <http://www.jacow.org>
- [95] <http://www.jacow.org>
- [96] <http://www.jacow.org>
- [97] <http://www.jacow.org>
- [98] <http://www.jacow.org>
- [99] <http://www.jacow.org>
- [100] <http://www.jacow.org>