MEASUREMENT SYSTEM OF ENVIRONMENTAL QUANTITIES FOR THE SPRING-8 STORAGE RING

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Abstract

We have built a measurement system of environmental quantities for the SPring-8 storage ring to study the correlation between beam stability and variation of environmental quantities. Temperatures of the ground, a base rock, magnets, girders, air in the storage ring tunnel and a power supply room, cooling water and ground water are measured by thermocouples and resistance thermometers. Ground water level and humidity are also monitored. These data are stored in the database.

1 INTRODUCTION

Orbit stability is one of the most important characteristics for synchrotron radiation sources. There are many causes for orbit instability. In addition to the direct causes such as power supply current ripple for magnets, change of environmental quantities affect the orbit stability[1]-[6]. Therefore it is important to measure these quantities and study the correlation of them with orbit instability.

As the quantities to be measured, we chose ground temperature, height of water level in the ground, atmospheric temperature and humidity of the outdoor, temperature in the tunnel where the accelerator is placed, magnet and girder temperature, cooling water temperature and temperature in the power supply room. To measure these quantities, we dug holes and set the sensors. In this paper, we describe the details of the environment measurement system.

2 ENVIRONMENT MEASUREMENT SYSTEM

Our system consists of four main parts. First is the ground temperature measurement system. This system also consists of two subsystems. One is the temperature measurement just under the storage ring. For this purpose, we made four holes under the beamline of the storage ring and set thermometers. The other is the temperature of a base rock on which the SPring-8 storage ring is built. We dug a 10 m long hole in the base rock and set thermometers. Second is the measurement of underground water level. The SPring-8 storage ring surrounds the small mountain Mihara Kuriyama. If it rains, almost all the rainwater that falls in inner area of the ring circle is stored in the mountain. The change of the weight of the underground water may move the storage ring tunnel and affect the beam stability. Therefore we made a 10 m well in depth to monitor the underground water level. Third is the temperature measurement of magnet and girder. Temperature change of magnet and girder may affect the beam orbit directly. Fourth is the measurement of cooling water temperature that has also high possibility of affecting beam stability.

The signals of the sensors are measured for every ten second or one minute and stored in the SPring-8 data base via Ethernet as shown in Fig. 1.

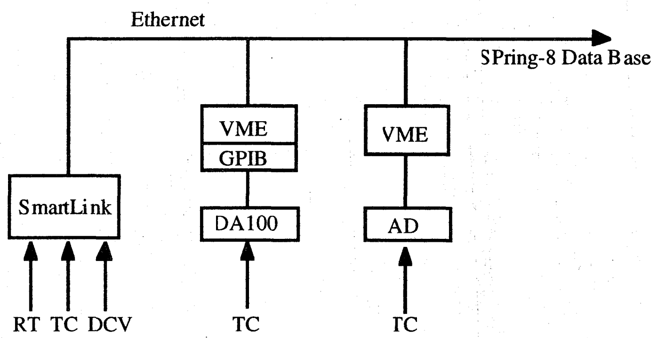

Fig. 1 Data acquisition system.

3 UNDERGROUND TEMPERATURE

3.1 Ground just under the Storage Ring

The SPring-8 Storage Ring is divided into four zones and there is an underground room for RF wave guide at each zone just under the storage ring beam line. We dug the holes in the rooms and set a thermometer at each room. Figure 2 shows the thermometer set in the underground.

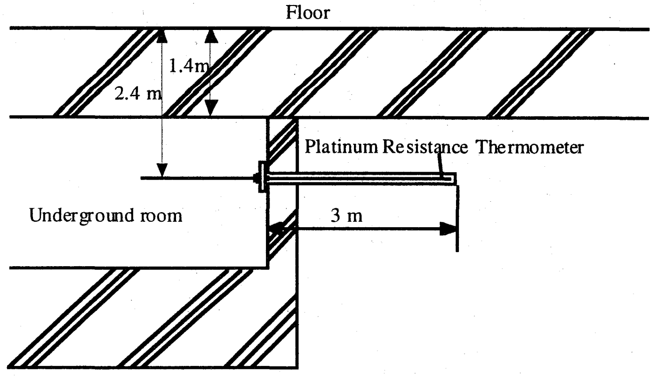

Fig. 2 Temperature measurement of ground just under the beamline of the storage ring.

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The platinum resistance thermometer was set at the depth of 2.4 m from the floor and 3 m from the room. After setting the thermometer, the hole was filled with mortar. The temperature of the underground room is also measured by a platinum resistance thermometer. The signals from the thermometer are measured by measurement module SmartLink (KEITHLEY). SmartLink is connected to the Ethernet and measured data are stored in the database. Example of the measured results at each zone is shown in Fig. 3.

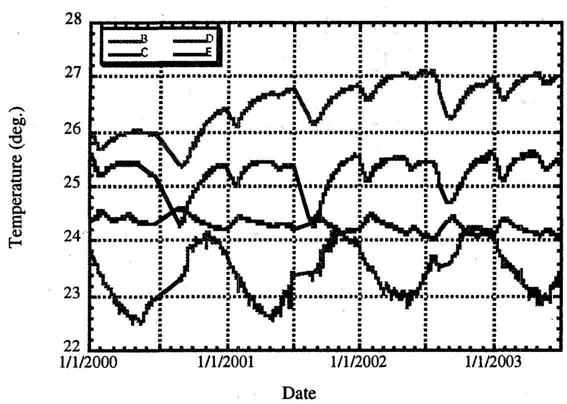

Fig. 3 Temperature variation of the underground just under the beamline of the storage ring.

3.2 Base Rock

The SPring-8 storage ring is on a huge base rock and the temperature change of the base rock affects the storage ring. We determined to measure the temperature of the base rock. For this purpose we dug a hole 10 m in depth, which is located at the inner area of the building for the storage ring and apart from 11 m from the storage ring. Platinum resistance thermometers were set in the hole at the depth of 0.5 m, 3 m, 5 m, and 10 m. After setting the thermometers, the hole was filled with mortar. The signals are measured

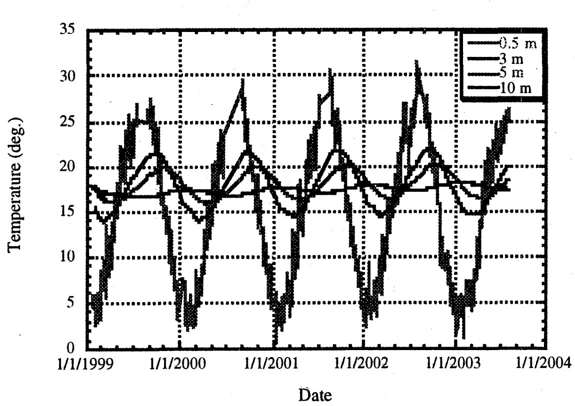

Fig. 4 Temperature variation of the vase rock, on which the SPring-8 storage ring is built.

by the SmartLink and sent to the database. Figure 4 shows the temperature variation of the base rock.

4 WATER LEVEL

A well was dug at the inner area of the circular storage ring and a stainless steel pipe was installed to measure the ground water level as shown in Fig. 5. Diameters of the well and the stainless steel pipe are 110 mm and 89 mm, respectively. The pipe is 10 m in length and has many holes of 10 mm diameter. A water level meter (Tokyo Sokki Kenkyujo) and a platinum resistance thermometer were installed in the pipe. In an instrument screen, a hygrometer and a platinum resistance thermometer were set. In a ground at 1 m depth, a platinum resistance thermometer was also set to measure the ground temperature. The signals from these sensors were connected to the SmartLink and sent to the database via Ethernet. We can get the variation data of water levels as shown Fig. 6. In the figure, zero shows the sensor position.

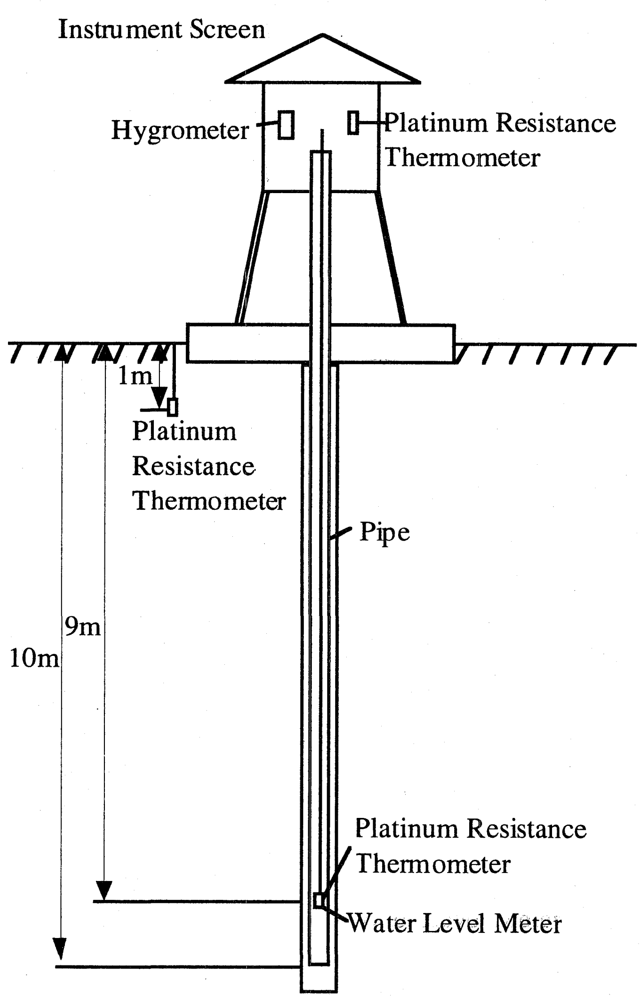

Fig. 5 A well for ground water level measurement. Temperature and humidity are also measured.

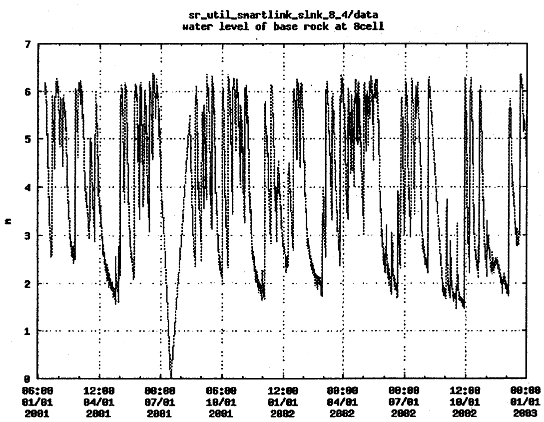

Fig. 6 Variation of ground water level with time.

5 MAGNET AND GIRDER TEMPERATURE

The SPring-8 storage ring consists of 44 Chasman-Green cells. T type thermocouples were set for magnets and girders of one cell to monitor the temperature: Thermocouples were set for ten quadrupole magnets, two bending magnets and three girders. For quadrupole magnets, thermocouples were attached to the return yokes. For four magnets out of ten, they were also attached to the magnet poles to measure the magnet shape change. For two bending magnets, we set thermocouples inside and outside of the return yokes to measure the temperature difference of near and far points from the magnet coil. Fourteen thermocouples were set for girder temperature measurement: For the first girder in the cell, two thermocouples were attached to the top and bottom of the girder. For the second and third girder, six thermocouples were set, respectively: Three were on the top and residual three were on the bottom of the girder. These thermocouples were connected to the data logger DA100 and then VME. The data from the VME were stored in a computer via Ethernet. Examples of the measurement results were shown in Fig. 7. We can see that more than 24 hours were required to reach the stable condition of magnets.

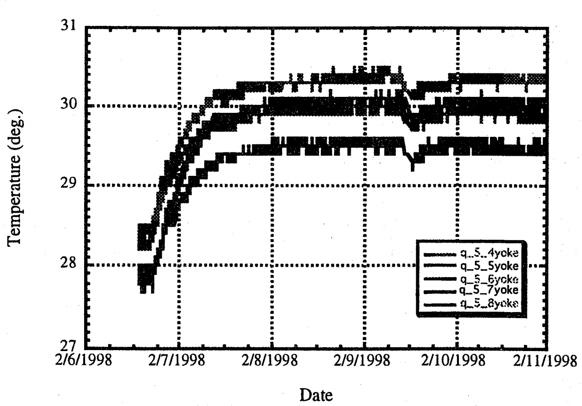

Fig. 7 Temperature variation of quadrupole magnets.

6. COOLING WATER AND POWER SUPPLY ROOM TEMPERATURE

6.1 Cooling Water

Temperature change of cooling water of magnet affects the beam orbit seriously, which made us to monitor the cooling water temperature. The cooling water system of the SPring-8 storage ring is divided to four zones. Temperature measurement system of cooling water at each zone was constructed. Temperature of cooling water before and after passing through the magnets is measured by T type thermocouples. In addition to this primary cooling water system, temperature of the secondary cooling water system is also measured for some points. Because the change of the secondary cooling water temperature affects the primary cooling water temperature. The thermocouples are connected to the SmartLink and the measured data are stored in the data base via Ethernet.

6.2 Power Supply Room

Power supplies for main magnets are placed in a power supply room. Temperature of the room once reached more than 40 degrees and power supply was failed due to this high temperature. Then we decided to monitor the temperature of the power supply room. We monitor the temperature at three points: a main magnet power supply room, a steering magnet power supply room and just outside of the power supply room. T type thermocouples are connected to the VME with DA and measured temperature data are sent to the data base via Ethernet.

7. SUMMARY

We have established the measurement system of environmental quantities. The temperature of base rock, ground just under the beamline, magnets, girders, storage ring tunnel, magnet cooling water, power supply room and water in the ground are monitored. Measured data are stored in the data base. The water level in the ground, air temperature and humidity are also monitored and stored in the data base. From these measurement data, we can study the relation between beam stability and environmental quantities.

REFERENCES

[1] Photon Factory Activity Report 1988, R-12.
[2] ibid., 1989, R-18.
[3] ibid., 1990, R-15.
[4] ibid., 1991, R-18.
[5] ibid., 1992, R-14.
[6] T. Katsura et al., EPAC'92, Berlin, March 1992, p. 1631.