

## Present state of cosmic ray stations of the Institute of solar-terrestrial physics of Siberian branch of the Russian Academy of sciences (ISTP SB RAS)

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**Abstract.** The paper describes means for improving the operation of cosmic ray (CR) stations of the Institute of Solar-Terrestrial Physics of Siberian Branch of Russian Academy of Sciences (ISTP SB RAS) in 2012–2014.

We consider changes taken place in functioning CR stations of ISTP SB RAS in 2012–2014. Instrumental measures for improving real time data presentation of the CR stations (IRKUTSK, IRKUTSK2, IRKUTSK3 and NORILSK) are presented. There are some problems for each CR station. We show ways for solving these problems to provide data without failures and omissions. Introduction

There are four CR stations at our Institute. They are IRKUTSK, IRKUTSK2, IRKUTSK3 and NORILSK (Table 1).

All stations are equipped with a recording device including one 8-ch Counter/Timer PCI Card (PCI-1780) and Russian barometers BRS-1M. PCI-1780 records data of the CR neutron component. PCI-1780 is a general-purpose multi-channel counter/timer card for the PCI bus. It uses the AM 9513 Counter Chip and provides eight 16-bit counter channels, 8 digital outputs and 8 digital inputs; the time base is up to 20 MHz. The data is recorded onto the hard disc minutely.

To record atmospheric pressure, the recording computers are equipped with barometers BRS-1M. The measuring range of BRS-1M is 600–1100 hPa; the absolute accuracy is  $\pm 33$  (20 for BRS-1M-2) Pa; the data is displayed on the screen and recorded onto the hard disc using RS-232 interface unit.

The data are transmitted from the NM stations to the server in Irkutsk by a satellite link every 3–5 min (1-min values) and every hour (hourly values).

There the data are processed and transmitted in real-time to the World Data Center (WDC) and to the Neutron Monitor Data Base (NMDB).

Primary data checking is carried out by the Super Editor in registering computers at each station.

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**Table 1.** Characteristics of the cosmic ray stations IRKUTSK, IRKUTSK 2, IRKUTSK 3 and NORILSK

Name	Altitude, m	Geographic latitude/ longitude	Number counters, CNM-15 [1]	Barometric coefficient, %/mb	Standard atmospheric pressure $P_0$ , mb	Effective vertical cutoff rigidity $R_c$ , GV
<b>IRKT</b>	475	52.47N, 104.03E	18	-0.713	960	3.56
<b>IRK2</b>	2000	51.37N, 100.55E	12	-0.713	800	3.56
<b>IRK3</b>	3000	51.37N, 100.55E	6	-0.72	715	3.56
<b>NRLK</b>	0	69.26N, 88.05E	18	-0.7	1000	0.56

For operative measures and correction of eventual errors which cannot be corrected automatically, Irkutsk server should have not only preprocessing files but also the information from each recording channel separately.

The local databases at each CR station as well as the server at the institute in Irkutsk are continuously synchronized.

All databases are functioning on the basis of the Oracle Data Manager [2].

Creation of a database of CR stations of ISTP SB RAS has been determined by the necessity of collecting data from CR stations IRKUTSK, IRKUTSK2, IRKUTSK3 and NORILSK at the shared center in order to perform on-line control of data quality, fault diagnosis and program failures [3].

The free version of Oracle Express Edition is used at CR stations of ISTP SB RAS. This edition has the following constraints: its hardware requirements are 1 GB RAM and a single operating CPU, and the maximum database size of Oracle Database XE is 12 GB. This includes the space of 0.5–0.9 GB for the data dictionary, internal schemas, and temporary space, which leaves just 11.0 GB for user's data.

Afterward the data can be corrected manually.

## 1. Irkutsk

The detector housing is not well isolated and the roof of the building is flat. The temperature inside varies from +5 to +25 °C in winter and from +20 to +27 °C in summer.

In winter, there is often snow on the roof, and it must to be cleaned.

At IRKUTSK CR station, there is a special handwritten registry with the indication of the date and time (accuracy is  $\pm 10$  min) when the snow is removed from the roof. We do not correct CR intensity data of IRKUTSK station for the snow effect because the roof is cleaned every morning when snowing.

## 2. Irkutsk2

The problem at IRKUTSK2 is a dirty electrical power supply, i.e. the alternating voltage is not a pure sinus wave, and there are frequent power-offs.

There is a diesel generator at the observatory but the diesel motor must be started manually that is not always possible as the station is not continuously operated by technicians.

The WLAN devices DWL-2700 and DWL-2000 need a reboot after sticking. DWL-2000AP+ is a multi-purpose wireless access point. It provides a stable connection with 802.11g wireless devices at a rate of up to 54 Mbit/s. The transmitter power is 100 mW.

Outdoor wireless access point D-Link AirPremier DWL-2700AP that conforms to IEEE 802.11b/g standards covers a large operating distance providing wireless Internet access at transfer speeds of up to 54 Mb/s. DWL-2700AP is an ideal instrument for adverse climatic conditions due to its solid, watertight housing and built-in heater with a temperature sensor, so this AP is environment-proof. Power supply over Ethernet cable enables an access point to be installed at places with no AC power sockets available.

### 3. Irkutsk3

Under strong wind, the measured atmospheric pressure values can vary abruptly up to 1 hPa within one minute (e.g., 31.03.2014, 17:00 LT, IRKUTSK3, IRKUTSK2).

The reason is that at this altitude, the building construction is not solid and wind can easily penetrate. The building walls at IRKUTSK3 station are made of 100×18×18 cm wooden pieces connected with metal staples. Under strong wind, the walls shake hard. This is not typical for IRKUTSK2 station (the altitude is 2000 m) built in a similar way.

There are many problems with IRKUTSK3 CR station. In winter the temperature inside the detector housing is cold. We use the central power supply for electric heating. There are frequent failures. We can do nothing against this fact.

The low temperature in the detector housing affects the counting rate of the neutron monitor. At present, we examine the dependence of IRKUTSK, IRKUTSK2, IRKUTSK3 and NORILSK data on the temperature inside the buildings.

Conductor sag, lightning protection failures and insulator breaking at 10 kV power lines feeding CR IRKUTSK3 station can occur during thunderstorms, strong winds and snow. So, the replacement of the step-down transformer is required. The ascent to the IRKUTSK3 CR station every week is very difficult because we use horses at any weather.

### 4. Norilsk

The problems at the station NORILSK are similar to those at the other stations. Power-offs are frequent and long because of old line accidents. In the autumn of 2014, it was planned to replace the burned-out substation. In winter, Norilsk CR station did not operate because of  $-45^{\circ}\text{C}$  outside temperature and strong wind. Besides, the inside temperature was  $0^{\circ}\text{C}$ . There was also a failure of the barometer that is installed inside the building of the CR station. For the barometer BRS-1M, the operating temperature is  $+(15-35)^{\circ}\text{C}$ . In the summer of 2014, windows at the CR station were sealed. After a power-off, there can be sticking of the transmitting equipment (router or access point). There is the ground connection between the CR station building and the administrative building. The distance between buildings is 800 meters. Besides, induced electromagnetic fields can occur.

Yearly, the Norilsk station is supported by the engineer. In winter, the buildings are not easy of access because of snowdrifts up to 2.5 m. Skis and a snowmobile are needed to reach the cosmic ray station and the doors of the station must be cleaned from the snow.

### Acknowledgments

A technician mounts to the stations IRKUTSK2 (2000 m) and IRKUTSK3 (3000 m) stations once a week if necessary to check the equipment, uninterrupted power supply and data recording and after

power-offs. Remote CR stations need to enlarge the Internet satellite channel to increase the data transfer rate [3].

Power lines and the electric power supply systems at IRKUTSK2, IRKUTSK3 and NORILSK CR stations also need to be reconstructed. The main reason is that because of power-offs great information content can be lost.

## References

- [1] <http://www.nmdb.eu/?q=node/142>
- [2] <http://www.oracle.com/technetwork/database/database-technologies/express-edition/overview/index.html>
- [3] Lukovnikova A et al. J. Phys.: Conf. Ser. 409 (2013)
- [4] Aleshkov V, Dvornikov V, Lukovnikova A, Sdobnov V International Symposium: fundamental Science and Applied Aspect (Athens, Greece, 2007) 396 (2007).