Badary Radio Astronomical Observatory

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Abstract

This report provides information about Badary network station: general information, facilities, staff, present status and outlook.

1. General Information

The Badary Radio Astronomical Observatory (BdRAO) was founded by the Institute of Applied Astronomy (IAA) as one of three stations of the Russian VLBI network QUASAR [1]. The sponsoring organization of the project is the Russian Academy of Sciences (RAS). The Badary Radio Astronomical Observatory is situated in the Burytia Republic (East Siberia) about 130 km east of Baikal Lake (see Table 1). The geographic location of the observatory is shown on the IAA RAS [3] Web site. The basic instruments of the observatory are a 32-m radio telescope and technical systems for doing VLBI observations.

Figure 1. Badary Observatory.

Table 1. Badary Observatory location and address.

Longitude	102°14′
Latitude	51°46′
Badary Observatory Republic Burytia 671021, Russia sergeev@ipa.nw.ru	

2. Technical and Scientific Information

The Badary station equipment includes the following main components: a 32-m radio telescope equipped with low noise receivers, a frequency and time keeping system with H-masers, a local geodetic network, a GPS receiver (geodetic) and a GPS/GLONASS K161 receiver (synchronization of time keeping system), a data acquisition system R1001 [2], Mark 5B and S2 recording terminals, control computers, a local computer network and technical service systems. An automatic meteorological station WXT510 (Vaisala) has been installed at Badary. The local geodetic network 2 is adjusted with accuracy 2–3 mm. Characteristics of the radio telescope and other main components of the station are presented in Tables 2, 3, and 4.

The time and frequency system is composed of two hydrogen maser standards CH1-80 as well as GPS/GLONASS receivers for preliminary time synchronization with an accuracy of not more than 100 ns. The frequency stability of the H-masers is presented in Table 4. Local VHF oscillators are locked by a reference signal of 5 MHz and provide 10–20 mW power output signals at frequencies 1.26, 2.02, 8.08, 4.5, and 22.12 GHz. A pulse calibration system includes a pulse generator with a pulse duration of about 50 ps. The Badary Observatory was connected with main line optical fiber glass in December 2007.

Table 2. Technical parameters of the radio telescope.

Year of construction	2000
Mount	AZEL
Azimuth range	±270 (from south)
Elevation range	from -5° to 95°
Maximum azimuth - velocity - tracking velocity - acceleration	 1.5°/s $1.5'$/s $0.2^\circ/s^2$
Maximum elevation - velocity - tracking velocity - acceleration	 0.8°/s $1.0'$/s $0.2^\circ/s^2$
Pointing accuracy	better than $10''$
Configuration	Cassegrain (with asymmetrical sub-reflector)
Main reflector diameter	32-m
Sub-reflector diameter	4 m
Focal length	11.4 m
Main reflector shape	quasi-paraboloid
Sub-reflector shape	quasi-hyperboloid
Surface tolerance of main reflector	±0.5 mm
Frequency capability	1.4–22 GHz
Axis offset	−11.5 mm

Table 3. Parameters of receivers.

Wave band	Frequency range	Input noise temperature
13 cm	2.15–2.5 GHz	12 K
3.5 cm	8.2–8.9 GHz	15 K

Table 4. Frequency stability of the CH1-80 H-maser.

Sample time interval	(Allan variance)$^{1/2}$
1 second	$3 \cdot 10^{-13}$
10 seconds	$3 \cdot 10^{-14}$
100 seconds	$1 \cdot 10^{-14}$
1000 seconds	$3 - 5 \cdot 10^{-15}$

3. Technical Staff

Roman Sergeev — Observatory chief,
Nicolay Mitovin — FS, pointing system controls,
Alexander Seryx — front end and receiver support.

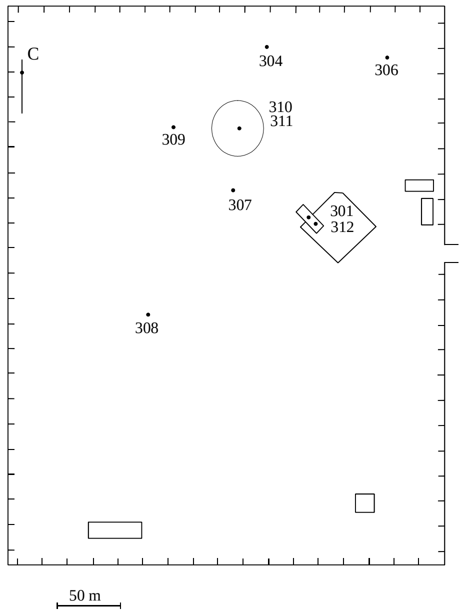
4. Co-location with GPS

A permanent GPS receiver Leica SR520 was installed at Badary during April 2005 (Fig. 2, Fig. 3).

Figure 2. GPS marker.

Figure 3. GPS receiver.

The accuracy of the local geodetic network (LGN) is about 2 mm. However, we still cannot provide an accurate survey of the VLBI radio antenna. In September 2006 a leveling session was carried out to check the LGN marker stability.



The LGN includes ten reference points. 304 and 306–309 are ground markers. 301 and 312 are located on the roof of the laboratory building and are intended for the installation of GPS/GLONASS and DORIS antennas. 310 is the intersection of the radio telescope axes, and 311 is an intermediate marker on the azimuthal platform of the radio telescope.

Figure 4. Local geodetic network at Badary Observatory.

5. Participation in IVS Observing Programs

In 2007 the Badary station started participating in IVS programs. During 2007 the Badary IVS station participated in 13 IVS sessions: 10 IVS-R4, 2 EUROPE, and 1 IVS-T2.

6. Outlook

Our plans for the coming year are the following:

- Final adjustment of all radio telescope systems to satisfy VLBI requirements.
- Participation in 56 IVS observing sessions: IVS-R1, IVS-R4, IVS-T2, and EURO.
- Participation in domestic observational programs for obtaining Earth orientation parameters.
- Surveying the local geodetic network.

References

[1] Finkelstein A., Ipatov A., Smolentsev S. Radio Astronomy Observatories Svetloe, Zelenchukskaya and Badary of VLBI Network QUASAR. In: IVS 2004 General Meeting Proceedings, eds. N. R. Vandenberg, K. D. Baver, NASA/CP-2004-212255, 2004. pp. 161–165.

[2] Fedotov L., Ivanov D., Ipatov A., Ipatova I., Lavrov A., Kosobokov M., Mikhailov A. Institute of Applied Astronomy Technology Development Center. In: IVS 2006 Annual Report, eds. D. Behrend, K. D. Baver, NASA/TP-2007-214151, 2007. pp. 255–258.

[3] http://www.ipa.nw.ru/PAGE/koi8-r/DEPOBSERV/rus.