Badary Radio Astronomical Observatory 2015–2016 Report

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Abstract The current status as well as activities in 2015 and 2016 of the Badary Radio Astronomical Observatory are considered.

1 General Information

The "Quasar" VLBI Network is a unique Russian astronomical instrument created in the Institute of Applied Astronomy of the Russian Academy of Sciences (IAA RAS). The Network consists of three observatories including Svetloe in the Leningrad Region, Badary in Eastern Siberia, and Zelenchukskaya in the Northern Caucasus, and the Data Processing Center in St. Petersburg. Svetloe Observatory was the first to be put into operation in 1999, the next was Zelenchukskaya in 2002, and finally Badary in 2005 (Figure 1). Each observatory is equipped with at least three co-located instruments of different techniques: VLBI, SLR, combined GNSS receivers, and the DORIS system [1]. The main instrument in each of three observatories is a 32-m radio telescope (RT-32), which provides a completely automatic process of observing radio sources and satellites in a radiometric or a radio interferometric mode. The main technical characteristics of the antennas are presented in Table 1. The RT-32 radio telescopes equipped with highly sensitive receivers provide signal amplification in 1.35 cm, 3.5 cm, 6 cm, 13 cm, and from 18 cm to 21 cm frequency bands in both circular polarizations. The baselines of the radio interferometer vary from 2,000 to 4,400 km. All observatories are linked by optical fiber lines and are equipped with identical hydrogen Time Standards, Water Vapor Radiometers, and meteorological stations, which are used by all types of observations.

Fig. 1 Badary Observatory.

2 Activities during the Past Two Years

Upgrading of the "Quasar" VLBI Network started in 2012. The aim of the upgrade was to create a Radio Interferometer of the new generation for improving the accuracy, reliability, and efficiency of providing the Earth rotation parameters to consumers in Russia and abroad. The Radio Interferometer of the new generation is designed to operate as part of the "Quasar" and international VLBI Networks. Currently, this new Radio Interferometer operates successfully and consists of two multi-band fast rotating Antenna Systems with

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IVS 2015+2016 Biennial Report

Table 1 Specifications of RT-32.

Mount	alt-azimuth
Configuration	Cassegrain
Subreflector scheme	asymmetrical
Main mirror diameter	32 m
Subreflector diameter	4 m
Focal length	11.4 m
Azimuth speed	1.0°/sec
Elevation speed	0.5°/sec
Limits by Az	±265°
Limits by El	0° – 85°
Axis offset	0.9 ± 1.0 mm
Tracking accuracy	±10 arcsec
Surface accuracy (RMS)	0.5 mm
Frequency range	1.4 – 22 GHz
Polarization	LCP + RCP

a mirror diameter of 13.2-m (RT-13), which were installed at the Zelenchukskaya and Badary (Figure 2) observatories in 2015 [2]. Table 2 presents some specifications of the RT-13 Antenna System, which meet all requirements of the VGOS program.

Fig. 2 The RT-13 Antenna at the Badary observatory.

During 2015—2016 RT-32 and the RT-13 radio telescopes at the Badary observatory participated in both IVS and domestic (Ru-E, Ru-I, and R) VLBI observations. Activities of the observatory are presented in Table 3 and Table 4. e-VLBI data transfer is used at Badary for the domestic sessions. Since 2015, the RT-13 radio telescope participates in the following geodetic sessions:

Table 2 Specifications of the RT-13.

Mount	alt-azimuth
Configuration	Cassegrain
Subreflector scheme	ringfocus
Main mirror diameter	13.2 m
Subreflector diameter	1.48 m
Focal length	3.7 m
Azimuth speed	12.0°/sec
Elevation speed	6.0°/sec
Limits by Az	±245°
Limits by El	6° – 109°
Axis offset	−0.3 ± 0.5 mm
Operation	24 h/7 d
Tracking accuracy	±15 arcsec
Surface accuracy (RMS)	0.3 – 0.1 mm
Frequency range	2–40 GHz
The surface efficiency	> 0.7
Polarization	LCP + RCP

- The 0.5–one-hour geodetic program in S/X bands for UT1 determination (“R”, on the baseline ZELRT13V–BADRT13V).
- The test geodetic program in X/Ka and S/X/Ka bands (“Ru-TEST”, on the baseline ZELRT13V–BADRT13V).
- The 23-hour geodetic program in S/X bands for improving the position data of the RT-13 antennas (“Ru-TEST”, all “Quasar” antennas).
- Miscellaneous test sessions, including international cooperation (“Ru-TEST”).

Table 3 VLBI observations of RT-32 at Badary Observatory.

Sessions	2015	2016
IVS-R4	25	19
IVS-T2	2	5
EUROPE	2	5
R&D	4	4
Ru-E	37	35
Ru-I	356	370

Table 4 VLBI observations of the RT-13 of Badary Observatory.

Sessions	2015	2016
R	137	1378

3 Future Plans

In the next two years, the Badary Observatory will continue to participate in IVS and domestic VLBI observations, upgrade the existing equipment, and replace the obsolete equipment.

References

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