“Quasar” VLBI Network Stations 2021–2022 Report

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Abstract The current status and activities in 2021 and 2022 of the “Quasar” VLBI network stations are presented.

1 General Information

The “Quasar” VLBI network is a unique Russian astronomical instrument created at the Institute of Applied Astronomy of the Russian Academy of Sciences (IAA RAS) [1].

The “Quasar” VLBI network includes three observatories located on the territory of the Russian Federation: Svetloe observatory in the Leningrad region, Badary observatory in Eastern Siberia, and Zelenchukskaya observatory in the North Caucasus (Figure 1). All observatories are equipped by radio telescopes RT-32 and RT-13 with mirror diameter of 32 and 13 meters, as well as GNSS receivers, satellite laser ranging systems, water vapor radiometers, and a weather station.

At present, a fourth observatory is included at the IAA RAS. The new observatory is located in the Far East, near the city of Ussuriysk. We plan to build a VGOS radio telescope at this observatory to carry out geodetic VLBI observations. The parameters of the future radio telescope are assumed to be identical to the parameters of the existing RT-13 radio telescopes. In a new configuration, the “Quasar” VLBI network will carry out VLBI observations with a cadence of 100–120 per hour with baseline lengths varying from 2,000 to 6,000 km. During 2021–2022, significant efforts were directed to improve the characteristics of the observatory equipment and increase its reliability.

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Fig. 1 Zelenchukskaya observatory.

2 Staff

The staff of the “Quasar” VLBI observatories has not changed compared to that given in the report 2019–2020 [2].

3 Current Status and Activities

During 2021–2022, the RT-32 and the RT-13 radio telescopes of the “Quasar” VLBI network participated in both IVS and domestic VLBI observations. Activities of the observatories are presented in Tables 1 and 2.

Table 1 VLBI observations with the RT-32 radio telescopes.

	Sv		Zc		Bd	
Sessions	2021	2022	2021	2022	2021	2022
IVS-R1	11	10	19	11	12	13
IVS-R4	15	13	17	20	24	15
IVS-T2/IVS-T2P	2	2	2	2	2	2
CRF				3	3	3
IVS-Intensive	13	10				
RI	36	38	347	339	347	353

Table 2 VLBI observations with the RT-13 radio telescopes.

	Sw		Zv		Bv	
Sessions	2021	2022	2021	2022	2021	2022
R	1377	1627	1380	1641	1379	1648
RI-RT13			347		347	
24-h		4		4		4
X (S/X/Ka)	349	337	352	342	333	337

In 2021–2022 we performed some significant repair and upgrade works at the RT-32 telescopes. At the Zelenchukskaya observatory, the running wheel and the central bearing of the RT-32 radio telescope were replaced. At the Svetloe observatory, work has been done to replace cables in RT-32 cable loops. In all observatories, regular monitoring of radio interference was carried out and measures of state control were taken to limit the growth of RFI sources.

3.1 Absolute Gravimeter

A new gravimetric station was created at the Svetloe observatory in 2021. In the gravimetric pavilion, a decoupled foundation was built, on which the absolute ballistic gravimeter "LIAG-4" was installed (Figure 2). In ten series of 100 measurements, the LIAG-4 gravimeter shows measurements with an accuracy (rms) of no more than 4 μGal ($4*10^{-8}$ m/s^2).

Fig. 2 Absolute ballistic gravimeter "LIAG-4" (bottom right corner) at Svetloe observatory.

3.2 Water Vapor Radiometer

The "Quasar" VLBI network observatories are equipped with water vapor radiometers that operate continuously in automatic mode. Data processing is carried out in real time.

3.3 Multifunctional Digital Backend

The Multifunctional Digital Backend (MDBE) has been succesfully operating on the RT-13 at Svetloe observatory since the end of 2020 [2]. For use on the RT-32, the MDBE was supplemented with intermediate frequency distribution modules and firmware with VLBI modes with narrow bands, and wideband radiometric and spectral selective radiometer modes (see more details in the IAA Technology Development Center Report for 2021–2022).

The first modified MDBE sample was installed at Svetoloe observatory in the autumn of 2022. The system is located in the moving part of the radio telescope. To transmit the 100-MHz reference frequency signal to the moving part, a fiber-optic communication line is used. The MDBE works in parallel with the standard signal conversion system R1002M, which allows it to be tested and debugged. Twice a week, regular VLBI sessions are held for the operational determination of time using this system.

Next year we plan to install these systems on the RT-32 radio telescopes at the Zelenchukskaya and Badary observatories.

4 Future Plans

In the next two years all stations of the “Quasar” VLBI network plan to continue to participate in IVS and domestic VLBI observations. Further support of station equipment will continue in order to upgrade and replace obsolete equipment.

References

1. N. Shuygina, D. Ivanov, A. Ipatov et al., “Russian VLBI network “Quasar”: Current status and outlook”, in: Geodesy and Geodynamics 10 (2019), DOI: 10.1016/j.geog.2018.09.00, pp. 150–156
2. D. Marshalov, E. Nosov, G. Ilin, E. Khvostov, V. Bykov, A. Isaenko, V. Stempkovskiy, A. Shishikin “IAA Technology Development Center Report for 2019–2020”, in: International VLBI Service for Geodesy and Astrometry 2019+2020 Biennial Report, edited by D. Behrend, K. L. Armstrong, and K. D. Baver, NASA/TP-20210021389, pp. 279–282, 2021.