

VLBI Status of the Bear Lakes Radio Astronomy Station

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Abstract

The Bear Lakes Radio Astronomy Station (BLRAS) based on a 64-m dish antenna near Moscow was organized by Pulkovo Astronomy Observatory and Special Research Bureau in the end of 2002. The joint efforts of few institutions under INTAS IA-01-02 project allowed refurbishing the RT-64 construction and scientific infrastructure: modernizing the pointing system, adjusting two H-masers, upgrading GPS time service, repairing the building and rooms, painting the antenna. The apparatus rooms were connected to Internet by optical cable with possibility to transfer up to 500 Mb/s. Currently RT-64 has receivers at three frequency bands: 0.327 GHz, 1.665 GHz and 5 GHz. Three new receivers (0.61 GHz, 2.3 GHz and 8.4 GHz) are in production. The VLBI complex includes a BBC of 8 MHz bandwidth, sampler, S2 system and Mark II terminal. The elaboration of the 128 MHz 8-channel BBC was interrupted due to stopping the INTAS IA-01-02 financing. This circumstance also cancelled our plans about purchasing the FS computer and Mark 5 terminal.

The INTAS-01-0669 support allowed installing new VLBR terminal designed in Noto. This terminal records the VLBI data on PC-discs and then translates them in Internet for e-VLBI processing. BLRAS participated in two sessions of the Low Frequency VLBI Network (LFVN): at 1.665 GHz with S2 terminal for the investigations of the AGN, stars, OH-masers and solar wind; and at 5 GHz with both Mark II and VLBR terminals for the accurate radiolocation of Mars, 2000 PH 5 asteroid and high-orbit space debris. In the next year, we would like to obtain the large bandwidth BBC to participate in S2 geodetic VLBI and to support the LFVN activities. The works were partially supported also by RFBR 02-02-17568 and RFBR-02-02-39023 grants.

1. Bear Lakes VLBI Station Background and Programs

The unique fully steerable 64-m dish radio telescope was constructed at Bear Lakes near Moscow, Russia in 1979 and put into operation in 1983. This was the first large antenna of the former Soviet Union and it was fruitfully used for goals astronomy, deep space communication, space navigation and education of students of Moscow Power Engineering Institute over a very long time period.

The 64-m antenna was constructed by the Special Research Bureau of the Moscow Power Engineering Institute. It has a quasi-parabolic axially symmetric Gregory mirror system with subreflector of 6-m diameter and multi-band feedhorn system. The dish is equipped with a system for the phase compensation of gravitational deformation by means of a programmed subreflector movement. Rotation angles: + 220 degrees in azimuth, 1-89 degrees in elevation; guidance velocities: from 1.5 arcsec/s to 0.75 arcmin/s along two coordinates and object tracking accuracy about

15 arcsec. Effective area was about 2000 square meters at wavelength 18 cm with the possibility in principle for the main mirror to operate up to 1.35 cm.

It was a part of the Russian Deep Space Tracking Network which controlled all Russian deep space missions of Martian and Venusian programs and received the telemetry information from these spacecraft (i.e. it received the signals with Venusian surface panorama), participated in differential VLBI measurements of the Venus Atmosphere Dynamics Balloons in VEGA Project. Some part of antenna's time was spent for radio astronomy research under activity of few NIS scientific institutes. As part of radio interferometer "Orion", Bear Lakes participated in differential VLBI measurements of deep space and high-apogee mission spacecraft trajectories, fulfilled a series of VLBI experiments with USA DSN antennas, participated in a series of geodetic NIS VLBI observations and had episodic collaboration with European and Global VLBI Network with Mark II recording terminal. In fact, Bear Lakes RT-64 was the informal center of collective use for many scientific institutes of the NIS. But lack of modern radio astronomy equipment due to absence of specialized financing for this goal was limiting this activity. Nevertheless, Bear Lakes always demonstrated excellent and stable performances in the time of VLBI experiments (best of all other NIS antennas).



Figure 1. Bear Lakes RT-64.

The observations were carried out at 18 cm wavelength mostly. In 1996, Bear Lakes RT-64 joined the project of Low Frequency VLBI Network (LFVN) that has the purpose to arrange international VLBI cooperation with participation of former Soviet Union antennas.

The trial observations with Canadian S2 recording system (up to 128 Mbit/sec) were arranged between Bear Lakes and Tidbinbilla in June 1996 with a S2 baseline of 11538 km. But the RT-64

was equipped with S2 terminal on permanent basis in 1998 only. The base band converter (single channel of 2, 4 or 8 MHz) and sampler (S2 interface) were produced. The Bear Lakes RT-64 participated in five S2 observation sessions under LFVN project and a few VSOP experiments at 18-cm wavelength in 1998-2000.

In 2000, the 6-cm cooled receiver was installed at Bear Lakes RT-64 under LFVN program of VLBI radar searching for the near Earth asteroids, the Earth group planets and space debris. RT-64 participated in four VLBR sessions in 2001-2003.

In 2002, September 26, the agreement between Special Research Bureau of Moscow Power Engineering Institute and Central Astronomical Observatory at Pulkovo (CAO) of Russian Academy of Sciences was signed to establish the Bear Lakes Radio Astronomy Station (BLRAS) as a branch of CAO.



Figure 2. Recording terminals, base band converter, sampler, synthesizers, rubidium frequency standard, oscilloscopes, gauge of frequency, gauge of time intervals, spectrum analyzer, power supplies, paper recorder.

Since this time, all radio astronomical works at Bear Lakes RT-64 are carried out under BLRAS activities. During 2003 the program of the Bear Lakes VLBI site modernization was started:

- both H-masers were repaired and adjusted in GNIPI, N. Novgorod;
- “Thunderbolt GPS Disciplined Clock” with time precision down to 20 ns was purchased and incorporated in time and frequency service of antenna site;
- Internet access was organized by optical cable connection to the antenna building. The maximum possible speed is 500 Mbit/s (current 100 Mbit/s due to interface card);
- near real time VLBI terminal (NRTVT) was installed and tested in trial e-VLBI experiment on baseline with Noto in July 2003;
- the production of 49 cm, 13/3.6 cm receivers and two-channel radiometer will be finished in February 2004;
- repairing the antenna building and rooms was arranged during 2003;
- painting the antenna constructions and main mirror was started in summer;

- the works on the verification and rehabilitation of antenna constructions and mechanisms have been carried out.

The observations at 1.665 GHz that were carried out in January 2003, after long interruption (previous 18-cm experiment was in December of 2000), fixed the strong increasing of interferences in this frequency band that may be explained by close erecting of tower for mobile telephone connection “Combelga”. There are no serious interferences at 5 GHz band. The investigations of S/X bands will be arranged in April after installation of the S/X band receivers.

The next e-VLBI experiment using NRTVT on baseline with Noto is scheduled for April 2004 (it is planned to test also NRTV terminals of Evpatoria RT-70 and Simeiz RT-22). The next VLBR session is scheduled for July 23-29, 2004 (the program includes asteroid 2000PH5, Mars, Venus and space debris). An astrophysical VLBI experiment (6-cm, 13-cm) is planned in November 2004.