Simeiz VLBI Station - H-maser and Mark 5B+ Upgrade

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Abstract

We summarize briefly the status of the 22-m radio telescope as an IVS Network Station. In 2008 RT-22 was equipped with a modern Mark 5B+ VLBI recording system and a new H-maser. That gives the possibility to continue astrophysical and fundamental geodetic VLBI observations.

1. General Information

Figure 1. The Simeiz VLBI station.

The Simeiz VLBI Station (also known as CRIMEA in the geodetic community), operated by Radio Astronomy Laboratory of Crimean Astrophysical Observatory of the Ministry of Education

and Sciences of Ukraine, is situated on the coast of the Black Sea near the village Simeiz 20 km west of the city Yalta in Ukraine.

Radio telescope RT-22 has a steerable parabolic mirror with a diameter of 22 m and a focal length of 9,525 mm. The surface has a root mean square accuracy of 0.25 mm and an effective area of 210 m^2 which is independent of elevation angle. The antenna is an azimuth-elevation mount with axis offset -1.8 ± 0.2 mm. The maximal slewing rate is $1\overset{\circ}{.}5$/sec. A control system of the telescope provides pointing accuracy of $10''$.

The foundation of the telescope is 9 meters deep consisting of 3 meters of crushed stones and then 6 meters of concrete. The height of the elevation axis above the foundation is 14.998 meters. The telescope is located at 80 meters from the edge of the Black Sea. Parameters of the 22 meter radio telescope are presented in Table 1.

Table 1. The antenna parameters of the Simeiz station.

Diameter D	22 m
Surface tolerance (root mean square)	0.25 mm
Wavelength limit	2 mm
Feed System	Cassegrain system or primary focus
Focal length F	9.525 m
Focal ratio F/D	0.43
Effective focal length for Cassegrain system	134.5 m
Mounting	Azimuth-Elevation
Pointing accuracy	10 arcsec
Maximum rotation rate	1.5°/sec
Maximum tracking rate	$150''$/sec
Working range in Azimuth (0 to South)	$-270^\circ \pm 270^\circ$
in Elevation	0° - 85°

The control system of the radio telescope provides the possibility to point the antenna and to track the observed source in two regimes: autonomous and automatic. All modes of the radio telescope operation (antenna motion, radiometer readings, and data recording) are given from a special host computer in automatic regime. The 2 GHz and 8 GHz receivers, as well as the phase and amplitude calibration units, have been installed in the primary focus of the antenna.

Table 2 shows the 2 and 8 GHz receivers' parameters.

Table 2. Receiver performance of the Simeiz antenna (temperatures in K).

Band	Frequency	Tsys	Treceiver	Tfeed	Tmainlobe	Tsidelobes
S	2.1 - 2.5 GHz	100	40	25	7	28
X	8.18 - 8.68 GHz	80	50	5	10	15

2. Current Status and Activities

In 2008, RT-22 was equipped with a modern Mark 5B+ VLBI recording system and a new H-maser. This allows the continuation of astrophysical and fundamental geodetic VLBI observations.

The Hydrogen Frequency and Time Standard provides the highest frequency-stable 5 MHz, 100 MHz, and 1 Hz (time scale) output signals with the following characteristics (Table 3).

Table 3. H-maser characteristics.

Frequency accuracy (factory calibration)	$\pm 5 \cdot 10^{-13}$
Frequency corrector:	
resolution	$1 \cdot 10^{-14}$
range	$1 \cdot 10^{-10}$
Frequency stability (Allan variance at 25° C, environmental effects are excluded):	
1 s	$< 3 \cdot 10^{-13}$
10 s	$< 3 \cdot 10^{-14}$
100 s	$< 8 \cdot 10^{-15}$
1000 s	$< 3 \cdot 10^{-15}$
1 day	$< 3 \cdot 10^{-15}$
Phase noise (dB/Hz) (at the 5 MHz output):	
10 Hz	< -125
100 Hz	< -140
1000 Hz	< -150

The H-maser was put into operation at the 22-m radio telescope, and the first session was carried out on December 16, 2008 (IVS-T2059).

In 2008 the positions of the points in the Simeiz-Katsively geodynamics test area were determined in a special GPS Survey Campaign of the Main Astronomical Observatory. It consisted of two satellite laser ranging stations, a permanent GPS receiver, a sea level gauge, and the radio telescope RT-22. All these components are located within 3 km (Figure 2).

The local geodetic ties between the VLBI, SLR, and GPS reference points of the station Simeiz-Katsively were analysed [1].

A number of relatively small regions of the Earth have been found where the annual periodicity of seismic activity is most prominent; namely the Balkans and Turkey, an isthmus between North and South America, Alaska and the Aleutians, and some others. In both hemispheres, these regions are associated with subduction zones or intensely faulted segments of the continental crust [2].

The annual period of seismic activity of the earth was determined for the time span 1964-2007. The catalog of the National Earthquake Information Center (1928-2007) was used for Fourier analysis of planetary earthquakes in 1964-2007 (403,849 earthquakes with $M \geq 3.0$ and depth of hypocenter $H \geq 1$km) separately for the Northern Hemisphere (248,056 events) and for the Southern Hemisphere (152,928 events). The annual periodicity in the occurrence of weak earthquakes ($M < 5.0$) is revealed with high significance level. All of the peculiar properties of this period (dependence on geographic altitude and depth of hypocenters, north-south asymmetry), which were discovered for 1964-1990, remain the same for 1964-2007 [3].

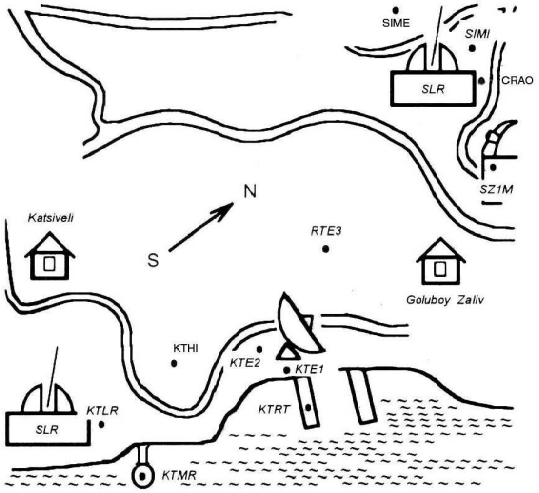

Figure 2. The geodynamics area "Simeiz-Katsively".

An interdepartmental center for the collective use of the radio telescope RT-22 was created on the basis of the Scientific-Research Institute "Crimean Astrophysical Observatory" of the Ministry of Education and Sciences of Ukraine.

During last year Simeiz station regularly participated in various radio astronomy programs including VLBI and single-dish observations of quasars and planets.

Table 4. The current projects.

Very Long Baseline Interferometry	Astrophysics, geodesy, astrometry and radar projects with the international networks.
Monitoring of AGN	The regular monitoring at frequencies 22.2 and 36.8 GHz.
Molecular lines observations at mm wavelength	Observations in molecular lines of maser sources, star forming regions, and other objects have been intensively carried out since 1978 in the range from 1.6 GHz up to 115 GHz.

3. Future Plans

Our plans for the coming year are the following: to operationally observe with the Mark 5B+ VLBI recording system and to install a VLBI Data Acquisition System DBBC.

References

[1] Bolotina, O.V., et al. // Kinematics and Physics of Celestial Bodies. 2008. V.24. N.5, P.388.

[2] Volvach A.E., Gorkavyi N.N., Dmytrotsa A.I., Levitsky L.S. // Bulletin of CrAO. 2008. V.104, P.145.

[3] Volvach A.E., Gorkavyi N.N., Dmytrotsa A.I., Levitsky L.S. // Bulletin of CrAO. 2009. in press.