Geodetic Study at the Simeiz IVS Station

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Abstract

This report gives an overview about the geodetic VLBI activities during 7 years at the Simeiz station. The positions of the points in the fundamental geodynamics area "Simeiz-Katsively" have been determined by special Second GPS survey campaign in October 2001. The report also summarizes the technical parameters and upgrades done to improve the reliability of the receivers.

1. The Fundamental Geodynamics Area "Simeiz-Katsively"

The fundamental geodynamics area "Simeiz-Katsively" is situated on the coast of the Black Sea near the village Simeiz 20 km west of the city Yalta in Ukraine. It consists of two satellite laser ranging stations, a permanent GPS receiver, a sea level gauge and the radiotelescope RT-22. All these components are located within 3 km (Figure 1).

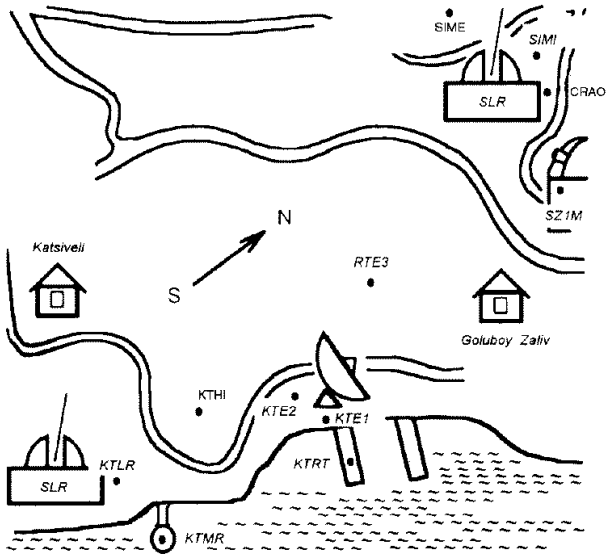

Figure 1. The geodynamics area "Simeiz-Katsively".

The radiotelescope RT-22 has a steering parabolic mirror with diameter 22 m and focal length 9 525 mm. The surface has a root mean square accuracy 0.25 mm and effective area 210 m^2 which does not depend on elevation angle at geodetic frequencies 2.3 and 8.4 GHz. The antenna has an azimuth-elevation mounting with axis offset -1.8 ± 0.2 mm. The working range in azimuth is $[-210°,210°]$ (zero is to the south) and in elevation $[-1°, 85°]$. The maximum slewing rate is 1.5°/sec. The control system of the telescope provides accuracy of pointing at the level of $10''$.

The foundation pit of the telescope is 9 meters deep and it has 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 80 meters from the edge of the Black sea.

The reference point of the radiotelescope has IERS name: "CRIMEA", ITRF name: "Simeis", IERS dome number 12337S008, CDP number 7332.

The reference point of the antenna is the point of projection of the azimuthal axis on the elevation axis. The coordinates of this point are determined in analysis of the observations. However, this point may move with respect to the local area where the radiotelescope is located.

Positions of both horizontal and azimuthal axis were also carefully measured with precision of 2″ during a special First GPS survey campaign in 1995 (Bolotin et al., 1995). One of the conclusions of the surveying campaign was that *"a more detailed study of the complete dataset gives us grounds to believe that the azimuthal axis draws a cone in space and has smooth random wobbles when the antenna moves on azimuth. Nevertheless, the total effect does not exceed* ±1 *mm".*

The time series of the deviation of the azimuthal axis with respect to the local plumb line as a function of time is presented in paper of Petrov et al., 2001. The inclination angle is increasing with a rate 2.6″ per year in the direction of azimuth 296° and we believe that the antenna is leaning like the Pisa tower.

The positions of the points in the geodynamics test area "Simeiz-Katsively" have been determined by special Second GPS survey campaign by Main Astronomical Observatory in October 2001. Results are presented in Table 1.

Table 1. Final solution for coordinates of points in the area "Simeiz-Katsively".

Station	X, m	RMS, m	Y, m	RMS, m	Z, m	RMS, m
KTHI	3785378.6041	0.0004	2551165.3915	0.0003	4439717.4172	0.0004
KTLR	3785923.9017	0.0005	2550781.8054	0.0003	4439471.6117	0.0004
KTRT	3785160.8761	0.0004	2551262.2573	0.0002	4439789.8357	0.0004
SIME	3783746.4067	0.0000	2551362.7445	0.0000	4441445.1801	0.0000
CRAO	3783897.2187	0.0006	2551404.3953	0.0004	4441264.2859	0.0006
SIMI	3783887.4552	0.0004	2551403.5454	0.0003	4441266.8603	0.0005
KTE2	3785236.0690	0.0477	2551188.5462	0.0308	4439784.2244	0.0531
KTE1	3785206.0519	0.0345	2551216.1368	0.0240	4439790.8836	0.0426

2. Observations and Data Analysis

In 2001 the Simeiz station continued the regular VLBI observations of extragalactic sources under the International VLBI Service for Geodesy and Astrometry programs.

All available dual-band geodetic MARK III VLBI observations for 21 years, from 1979.59 till 2000.72 were used in the analysis: 3 058 sessions, **3 005 651** observations including 36 successful sessions with participation of the station Simeiz for 6 years: 1994.48–2000.36 with **19 631** good measurements of group delays.

Estimates of the horizontal velocity of the station Simeiz were calculated using VLBI observations carried out under geodynamics programs during the years 1994-2000. The complete set of 3 million VLBI observations has been analyzed and it was found that the station moves with respect to the Eurasian tectonic plate considered as rigid with a rate 2.8±0.9 mm/yr in a North-North-East direction.

Results are presented in Table 2. (Azimuth is measured from North.)

The details of the analysis are stated in the paper of Petrov et al., 2001.

Table 2. Residual velocities with respect to the Eurasian plate.

Station	Up (mm/yr)	East (mm/yr)	North (mm/yr)	Corr E-N	Hor. Rate (mm/yr)	Azimuth (Deg)	D
DSS65	2.1 ± 1.5	-0.1 ± 0.2	0.0 ± 0.1	0.86	0.1 ± 0.2	271°± 51°	h
EFLSBERG	-0.5 ± 0.8	0.5 ± 0.3	-0.4 ± 0.2	0.03	0.7 ± 0.2	132°± 22°	h
MATERA	1.1 ± 0.9	0.9 ± 0.4	4.9 ± 0.4	0.30	5.0 ± 0.5	11°± 5°	f
MEDICINA	-3.1 ± 0.8	1.7 ± 0.4	2.0 ± 0.4	0.11	2.6 ± 0.4	40°± 8°	f
NOTO	0.6 ± 1.0	-1.0 ± 0.5	5.0 ± 0.4	0.30	5.1 ± 0.4	349°± 6°	f
NYALES20	5.8 ± 1.5	0.0 ± 0.0	0.0 ± 0.0	-0.92	0.0 ± 0.0	350°± 65°	h
ONSALA60	3.3 ± 0.6	-1.0 ± 0.4	-0.8 ± 0.4	-0.11	1.3 ± 0.3	229°± 17°	f
WETTZELL	-0.0 ± 0.1	-0.3 ± 0.2	0.4 ± 0.2	-0.04	0.5 ± 0.2	322°± 25°	hv
SIMEIZ	**2.7 ± 3.0**	**1.3 ± 0.7**	**2.5 ± 0.9**	**0.07**	**2.8 ± 0.9**	**27°±15°**	f

The last column contains status of the station: free (f), defining for horizontal motion (h), defining for both horizontal and vertical motion (hv).

3. A New S/X Receiver

The 8 GHz VLBI radiometer was introduced into operation on Simeiz station in 2001. The LNA is not cooled. The feed illuminates the main dish of the antenna over the angle 140° at the level -10 db. The receiver characteristics are summarized in Table 3.

Table 3. Receiver performance of the Simeiz antenna.

Band	Frequency, GHz	Tsys, K	Treceiver, K	Tfeed, K	Tmainlobe, K	Tsidelobes, K
X	8.18 - 8.68	80	50	5	10	15

System equivalent flux density (SEFD) was measured as 1100 Jy in zenith that practically does not differ from its values with former cooled amplifier. Measured SEFD of the new receiver is plotted at Figure 2.

Focusing of the system and measurements of SEFD were made by measuring the power pattern of the antenna from observations of the strongest radio sources Taurus-A, Virgo-A, Cas-A and Cygnus-A.

The weight on the legs carrying the primary focus cabin is reduced from 100 to 1 kg. The process of mounting equipment is significantly lightened.

The antenna pointing calibration was made with the new receiver.

We plan in the near future to upgrade the 2 GHz receiver also.

References

[1] Bolotin, S., Gaiovitch, I., Khoda, O., Samoilenko, A., Yatskiv, Ya. // Kosmichna Nauka i Technologija, dodatok do zhurnalu, 1995, vol. 1, p. 3.

[2] L. Petrov, A. Volvach, N. Nesterov // Kinematics and Physics of Celestial Bodies. 2001, Vol.17, N5, P. 424-436.

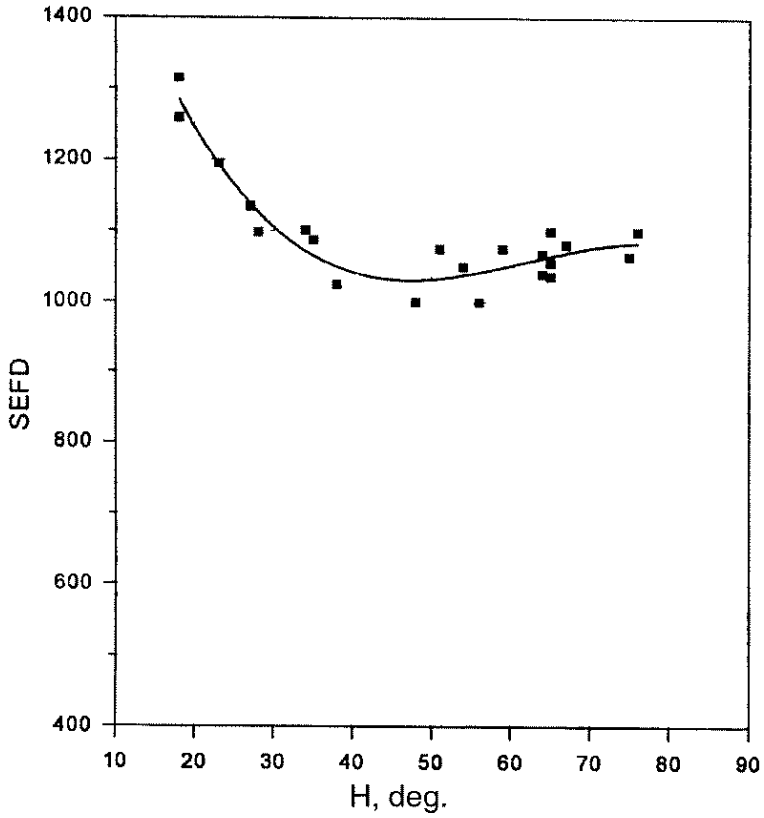

Figure 2. X-band SEFD of the new receiver.