## SIMEIZ RADIO TELESCOPE: IVS NETWORK STATION, SINGLE DISH S/X BAND OBSERVATIONS

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### 1. INTRODUCTION

The Laboratory of Radioastronomy of the Crimean Astrophysical Observatory (CrAO) operates with 22-m radio telescope (RT-22) located on the Black Sea coast of the Crimean peninsula in 60 meters from sea. Table 1 shows the RT-22 antenna parameters.

Table 1: The RT-22 antenna parameters

| | |
|---|---|
| Diameter D, m | 22 |
| Surface tolerance, mm (root mean square) | 0.25 |
| Wavelength limit, mm | 2 |
| Feed System | Cassegrain system or primary focus |
| Focal length F, m | 9.525 |
| Focal ratio F/D | 0.43 |
| Effective focal length for Cassegrain system, m | 134.5 |
| Mounting | Azimuth-Elevation |
| Pointing accuracy, arc sec. | 10 |
| Maximum slewing rate, degree/sec | 1.5 |
| Maximum tracking rate, arcsec/sec | 150 |
| Working range: in azimuth, degrees (0 to South) | –270 – +270 |
| in elevation, degrees | 0 – 85 |

The RT-22 operation is supported by control system, consisting of two encoders with accuracy of about 3 arcsec (rms), personal computer, CAMAC, quartz time standard, electric engines and other needed equipment and software. The fast RT-22 movement is supported by 2 engines each with 20 kW power, which are used for rapid change of pointing or for movement of the RT-22 from one source to another. 2 kW engines are used for tracking of sources.

The telescope was constructed in 1966 and the VLBI Simeiz station at the RT-22 started operation in cooperation with some American stations in 1969 using Mark-I system and rubidium standard (Broderick *et al.*, 1970).

Later the RT-22 was included into the global VLBI network for study of astrophysical objects. The Simeiz station was equipped with Mark-II system and hydrogen maser frequency standard with stability $10^{-14}$. The CrAO and the Institute of Space Research carried out the observations at 1.35, 2.8, 6, 18, 49 and 92 cm wavelengths.

In June 1994 the Simeiz station was equipped with Mark-IIIA terminal provided by NASA GSFC and low noise receivers of S/X bands supplied by the Institute of Applied Astronomy (Clark *et al.*, 1995).

Since this time the RT-22 was included into international geodetic VLBI network under the “Crimea” name. Low noise cooled receivers of S/X bands with dual frequency feed have been installed in the prime focus of the antenna. Dual feed is capable to receive both LCP and RCP. The feed is connected to receivers by straight waveguide in X band and by the short coaxial cable in S band.

S and X band receivers have been constructed for superheterodin scheme with FET amplifiers. Fronted directional coupler and FET amplifiers are cooled by microcryogenical system to obtain low noise temperatures. Table 2 shows the parameters of radio telescope – radiometer system.

Focusing both for S band and for X band (more precisely) was made. The power pattern of antenna has been measured using the radio sources: Taurus-A, Virgo-A, Cas-A and Cygnus-A. System equivalent flux densities

Table 2: The radio telescope – radiometer parameters

| Band | Input frequencies | LO | Tsys | System equivalent flux density |
|---|---|---|---|---|
| S | 2.15–2.5 GHz | 2.02 GHz | 75 K | 1100 Jy |
| X | 8.18–8.68 GHz | 8.08 GHz | 50 K | 780 Jy |

(SEFD) was measured using radio sources with known flux density. The increasing of Tsys for angles lower then 30 degrees is caused by rise of atmosphere optical depth. Characteristics obtained correspond to the standards of VLBI low noise system.

Geodynamical VLBI observations are conducted in 24 hours sessions scheduled 6-15 times per year. Observational programs are a part of common efforts for maintenance of terrestrial reference frame, celestial reference frame and monitoring Earth orientation parameters carried out by international community under the auspices of International VLBI Service (IVS) (Vandenberg, 1999). Data are recorded on magnetic tapes, which are shipped to correlator centers for further correlation and fringing. Fringed data are freely available via Internet for scientific analysis for everybody after 1–2 months after observations.

## 2. OBSERVATIONS AND DATA ANALYSIS

### 2.1 IVS

All available dual-band geodetic MARK-III VLBI observations for 20 years: 1979.59–1999.82, 2 931 sessions, 2 708 795 observations including 34 successful sessions with participation of the Simeiz station for 4.5 years: 1994.48–1998.96 with 17 655 good measurements of group delays were used in an analysis.

The Simeiz station moves with respect to the Eurasian tectonic plate considered as a rigid with rate $2.1 \pm 0.9$ mm/yr in a north-east direction. Thorough investigation of possible systematic effects has been done and the reliability of the estimate of the uncertainty has been evaluated. Performance of the receivers and H-maser were examined. The stability of the station with respect to local marks was investigated and an inclination of the azimuthal axis (Pisa effect) of the telescope with velocity $2''\!.6$ per year was disclosed.

We obtained the following position of the Simeiz station at the epoch 1997.0 and its rate of change in the ITRF97 system:

$$
\begin{aligned}
X &= 3785231.073 \pm 0.004 \ \text{m} & \dot{X} &= 5.5^{-10} \pm 0.2^{-10} \ \text{m/sec} \\
Y &= 2551207.417 \pm 0.003 \ \text{m} & \dot{Y} &= 4.9^{-10} \pm 0.1^{-10} \ \text{m/sec} \\
Z &= 4439796.362 \pm 0.006 \ \text{m} & \dot{Z} &= 2.3^{-10} \pm 0.2^{-10} \ \text{m/sec}
\end{aligned}
$$

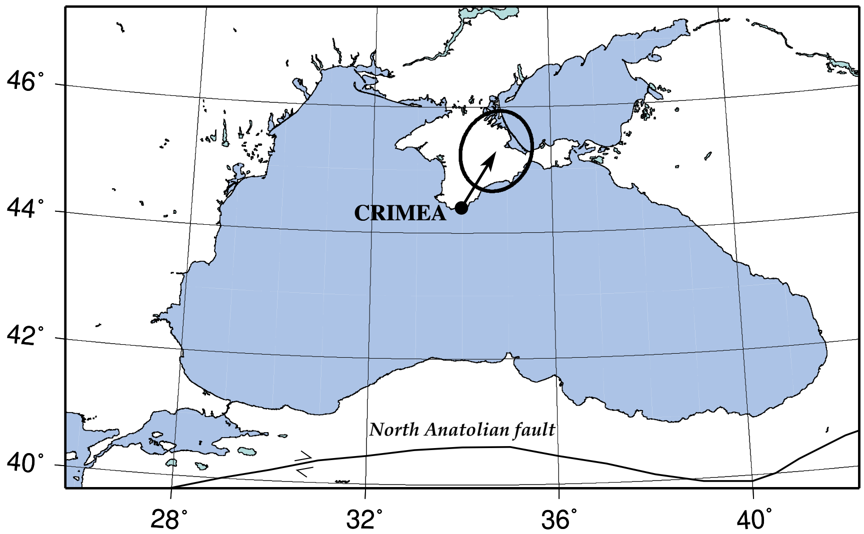


Figure 1: Motion of the station Simeiz

The details of the scientific analysis are given in Petrov *et al.*, 2000.

### 2.2 SINGLE DISH

The antenna temperatures from sources were measured by the standard ON–OFF method. Before measuring the intensity, we determined source position by scanning. The radio telescope was then pointed alternately at source and at the distance of 5 beamwidths off source. The antenna temperature from a source was defined as a difference between radiometer responses averaged over 10 s at two different antenna positions. Depending on the intensity of emission from sources, we made a series of 20–60 measurements and then calculated the mean signal intensity and estimated the rms error of the mean. The fluxes from the objects under study were calibrated using measurements of the calibration sources Cyg-A, Cas-A, Tau-A, Vir-A, whose flux densities or brightness temperatures are given in Mark-IV Field System Documentation (1993). Converting antenna temperatures to flux densities, we took into account the dependence of effective antenna area $A_{\text{eff}}$ on elevation.

Table 3 shows measured flux densities of source at 8 GHz in which Column (1) is IAU source designation; Column (2) and Column (3) is date and time observations, respectively; Column (4) is flux densities; Column (5) is the rms errors of the measured flux densities.

Table 3: Single dish 8 GHz measured flux densities

| SOURCE | DAT(YY.MM) | TM(DD.UT) | FLUX(Jy) | SIGM(Jy) |
|---|---|---|---|---|
| 0316+413 | 97.09 | 4.931 | 22.4 | 1.1 |
| | 97.12 | 10.668 | 20.9 | 1.4 |
| 0528+134 | 97.09 | 5.149 | 3.3 | 0.7 |
| | 98.02 | 1.685 | 3.1 | 0.9 |
| 0552+398 | 97.09 | 4.999 | 5.2 | 0.5 |
| 0642+449 | 97.09 | 30.294 | 1.9 | 0.3 |
| | 98.02 | 1.622 | 3.3 | 0.9 |
| | 98.04 | 20.303 | 2.7 | 0.8 |
| | 98.06 | 23.458 | 1.8 | 0.4 |
| | 98.06 | 23.478 | 2.7 | 0.7 |
| | 98.06 | 23.487 | 3.0 | 0.5 |
| 1226+023 | 97.08 | 29.651 | 30.5 | 3.7 |
| 1253-055 | 97.08 | 29.668 | 22.3 | 1.4 |
| 2037+421 | 97.09 | 4.898 | 19.2 | 1.6 |
| | 97.12 | 10.661 | 21.2 | 0.7 |
| | 98.02 | 2.344 | 20.9 | 1.0 |
| 2145+067 | 98.02 | 2.355 | 6.2 | 1.3 |
| 2200+420 | 98.02 | 3.406 | 3.8 | 1.3 |
| 2251+158 | 98.02 | 3.417 | 11.2 | 1.7 |

## 3. DISCUSSION OF RESULTS AND CONCLUSIONS

The 4.5 years of geodetic VLBI observations at the CRIMEA station allow to conclude that the Simeiz station moves with respect to the Eurasian tectonic plate considered as a rigid with rate $2.1 \pm 0.9$ mm/yr in a north-east direction.

The results of single dish S/X observations of sources used for geodesy investigations can be then reviewed after experiment to check the consistency of data from each source.

## REFERENCES


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