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VENTSPILS RADIOTELESCOPES: HISTORY, PARAMETERS, POSSIBILITIES

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Abstract. After the withdrawal of the Russian army from Latvia, two fully steerable parabolic antennae of 32 m and 16 m in diameter were left near Ventspils, a port town on the shore of the Baltic sea. They have high surface accuracy and work in the centimeter and millimeter ranges. Their main mechanical and radiotechnical parameters, for example, a sensitivity of about 3–35 mJy in a wavelength range of 1–10 cm, allow their use as powerful middle class radiotelescopes for investigations of various cosmic radio sources. The antennae are open to international cooperation.

Key words: instrumentation – radiotelescopes

1. HISTORY

In the summer of 1993, before the withdrawal of the Russian army from Latvia, Latvian scientists got information about a high precision 32 m fully steerable antenna in a very secret Russian military object – space communication center "Zvyozdochka" of the Russian Ministry of Defence, located in Ance village near Ventspils. Knowing the potential possibilities of such antennae for solution of many important scientific and practical problems, the staff of the Radioastrophysical Observatory of the Latvian Academy of Sciences, supported by the Academy President J. Lielpeteris, have started a campaign for the scientific use of this antenna. This initiative was supported by the President of the Russian Academy of Sciences Y. Osipov and later on by many international organizations and scientific institutions: URSI (Union Radio-Scientifique Internationale), JIVE (Joint Institute for VLBI in Europe), Onsala Cosmic Observatory of the Chalmers University of Technology (Sweden), Max Planck Institute for Radioastronomy (Germany), the Lithuanian Astronomical Council and the Astronomical Society of Russia.

Due to these joint and sometimes quite dramatic efforts, with an effective support of the Russian scientific community, this military object was given over to Latvia on July 22, 1994, including the whole campus with a well-developed infrastructure, and – the most important – with two parabolic fully steerable antennae, 32 m and 16 m in diameter. This complex of instruments and buildings was transferred to management of the Latvian Academy of Sciences, and the Latvian Government decided to organize there the Ventspils International Radio Astronomy Center (VIRAC).

Since this moment, a guard of the object has been organized, followed by efforts to make the antennae usable. The problem was that no technical documentation concerning the antennae was left by the Russian army. Negotiations on this issue were fruitless: no documents were received. Consequently, it was necessary to investigate the electric and mechanical systems of guidance of the antennae, including the cable lines, electric and hydraulic drives, etc. This hard task has been solved successfully. Now the investigation of the 32 m antenna is completed. The antenna rotates again both around the vertical and horizontal axes, i.e. in azimuth and altitude.

2. PARAMETERS

The choice of scientific problems, especially if they are related with experimental research, depends on technical capabilities of the instrumentation. So, discussing the use of the Ventspils radiotelescopes for various scientific purposes, their technical parameters must be evaluated first, at least approximately.

Some information was received from the Russian military specialists and some has been obtained in the process of investigation (up to now it mostly concerns the 32 m antenna). Now some technical parameters of these antennae are known and some can be foreseen. The complete investigation will be possible when the reflector feeds, receivers, guidance systems, etc., will be installed (now missing).

Both the antennae for the future radiotelescopes RT-32 and RT-16 are fully steerable, Cassegrain system rotational paraboloids with diameters D of 32 m and 16 m. Their geometric areas of apertures

Fig. 1. The Ventspils 32 m radiotelescope.

are 804 m^2 and 201 m^2, respectively. The diameters of the secondary mirrors are about 0.1 D (more precisely, for the 32 m antenna it is 2.4 m).

Fig. 2. The Ventspils 16 m radiotelescope.

According to information received from the Russian military specialists, the standard deviation of the surface from a rotational paraboloid is about $\sigma = 0.04$ cm for both antennae. The two parameters, D (or geometric area) and σ, allow us to evaluate approximately the scientific capabilities of RT-32 and RT-16 (regarding astrophysical observations and applied research), which are defined actually by the angular resolution $\Delta\phi$ and the sensitivity ΔF of the instruments (Christiansen & Hogbom 1985). The latter parameter shows how weak fluxes of the cosmic radio radiation can be registered and which objects are observable with the instrument. In the following

Table 1. Characteristics of the Ventspils radiotelescopes.

	λ (cm)	η	S_{eff} (m^2)	$\Delta\varphi$ $'$ $''$	$\Delta\varphi_0$ $'$ $''$	ΔT (10^{-3} K)	ΔF mJy
	1	0.56	450	1 18	2 02	1.0	3.0
RT-32	5	0.71	571	6 30	10 09	2.3	5.6
	10	0.72	579	13 00	20 19	3.3	7.9
	1	0.50	101	2 36	4 04	1.0	14.1
RT-16	5	0.63	126	13 00	20 19	2.3	25.3
	10	0.64	129	26 00	40 38	3.3	35.3

table the results of such approximate evaluation for both antennae are given at three different wavelengths (1, 5 and 10 cm); 1 cm is considered as a minimum wavelength for which the aperture efficiency of both radiotelescopes is sufficient, assuming an overall noise temperature (for both antennae and radiometer) to be about 40 K (see Table 1).

Here η is the aperture efficiency, S_{eff} is the effective area, $\Delta\phi$ is the angular resolution (Rayleigh angle), $\Delta\phi_0$ is the beamwidth of the main lobe of the antenna pattern at 3 dB level for a Cassegrain system, ΔT are temperature fluctuations, assuming the time constant to be $\tau = 1$ s and the bandwidth to be $0.1f$, where f is the frequency.

The amplitude of the motions of the antennae (mostly regarding the 32 m antenna) is $\pm 330°$ in azimuth and $15° - 105°$ in height (Bervalds 1995). The focal length is 10 m, the highest point of the structure above ground level is 50 m. The maximum velocity around the axes of altitude and azimuth (two direct-current 60 kW motors) is $1'$/s – $2°$/s and the minimum velocity around the axes of altitude and azimuth (two direct-current 5.5 kW motors) is $2''$/s – $5'$/s. The antennae are supplied with an automatic backlash prevention system. The pointing accuracy, according to information obtained from the Russian specialists, is $\sim 5''$. Observations may take place if the wind does not exceed 15 m/s. The survival wind speed is 40 m/s.

3. POSSIBILITIES

In the case of the Ventspils antennae, there is a quite uncommon situation with the sequence of events. Usually the scientific project is stated first, and then the instrument or equipment is constructed for its appropriate realization. In our case, there are instruments which are almost ready, and the research projects must now be chosen. Fortunately, as is seen from Table 1, the capabilities of these instruments, including the most important parameter, a sensitivity (3 – 50 mJy), are quite remarkable. Thus, we possess two powerful radiotelescopes of a middle class which may be used for investigation of a variety of cosmic objects. A 32 m radiotelescope can successfully register radiation from the majority of quasars, pulsars, radio galaxies, cosmic maser sources, etc.

One of the most promising directions in the application of the RT-32 antenna could be VLBI research through an international collaboration. In this case, there are many attractive research programs, for example, the measurements of precise coordinates of quasars for the needs of fundamental astrometry. A collaboration with other observatories is most important at the beginning stage, when the scientific team of VIRAC is to be formed.

Astronomers of the Radioastrophysical Observatory of the Latvian Academy of Sciences have experience in decimeter and centimeter wavelength observations of the Sun. In the decimeter wavelengths, the so-called quasiperiodic fluctuations of radiation and their connection with magnetic fields and other phenomena of solar activity, especially with proton flares, have been investigated. The aim was to improve the methods of prognosis of such flares from the analysis of long period ($P > 20$ min) pulsations of radiation. In centimeter wavelengths, the intensity of the integral flux was measured, and its correlation with the activity features in other domains of Sun's electromagnetic radiation, as well as with the corpuscular emission, has been investigated (Averyanikhina et al. 1993). We intend to renew this type of work. We also plan to investigate the microbursts of solar radio emission with high time resolution in the dm wavelength range (Balklavs 1992 and Balklavs & Shmeld 1993) using the 16 m antenna. However, both antennae are open for proposals of other research programs.

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