Kashima 34m Radio Telescope

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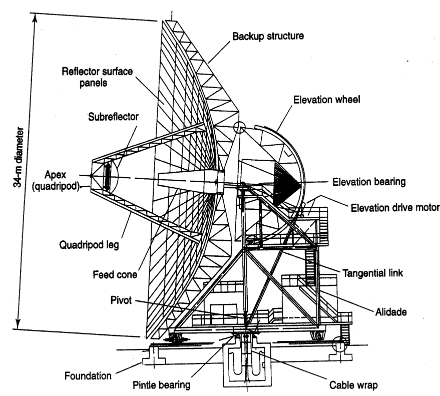
Abstract

Kashima 34m radio telescope is a facility of the Kashima Space Research Center, Communications Research Laboratory. The telescope is mainly used for geodetic VLBI and other astronomical observations. Here we present its status as of year 2000 and progress of related project.

1. Introduction

Communications Research Laboratory (CRL) constructed the Kashima 34m telescope in 1988. Since the operation started, 12 years have passed. The telescope is kept in a good condition and joined various VLBI observations continuously. The Kashima Space Research Center of CRL was founded in 1964 near the Pacific ocean and is located 100 km east of Tokyo. The 34m telescope shown in the figure is currently operated by Radio Astronomy Applications Group. The telescope structure below the alidade section is almost identical to NASA DSN 34m stations, but the equipped frequency range, feed and electronics are different.

a.Image of 34m



b.Structure

Figure 1. The Kashima 34m radio telescope

2. Antenna Specifications

2.1. Mechanical system

Although the Kashima 34m telescope has a maximum slew rate of 1 degree per second in azimuth, we reduced its speed to prevent wear. Telescope mechanical performance is shown in Table 1. Annual inspection of the electric motors and preparation of spare motors reduced unexpected troubles. In recent years, there has been no observation failure due to mechanical trouble. Last year major modifications to AZ and EL encoder system were carried out. Through the modifications we replaced an old encoder interface with a new one and the telescope system increased its reliability. Sub-reflector FRP surface was cleaned and re-painted from metal paint layer. One third of backup structure inspection and main reflector panel supports replacement were finished in 2000. The rest of the telescope will be maintained in 2001.

Table 1. Mechanical Specification of the 34m Radio Telescope.

Maximum Speed Azimuth(deg/sec)	0.8
Maximum Speed Elevation(deg/sec)	0.64
Drive Range Azimuth(deg)	+-270
Drive Range Elevation(deg)	7-90
Operation Wind Speed (m/s)	13
Panel Surface Accuracy r.m.s.(mm)	0.17

2.2. Receiver system

Available receivers are L, C, K and S/X band and they are summarized in Table 2. A computer controls the feed groups in the cassegrain secondary focus. In our telescope feed groups are mounted on elevator units named “trolley”. With the trolley, the selected feed and receiver are moved to the secondary focus. The other receivers are retracted to lower positions. In the case of the C-band receiver additional sub-reflector adjustment is needed because of its feed position offset. All receivers except C-band are cooled HEMTs around 12K physical temperature. The C-band LNA, formerly in an ambient environment, is now cooled around 100K using closed cycle refrigerator. We need approximately 15 minutes to 1 hour to switch the receivers to another band. The IF (intermediate frequency from receiver) is transmitted from the telescope to the observation room via optical fibers. The IF except K-band are in the range of commonly used 100-600 MHz band. Additional up converters in the observation room can up convert the 100-500 MHz to 600-1000 MHz. On the other hand the K-band receiver IF is 5-7 GHz. Whole IF bandwidth is also transmitted with fibers, wide-band E/O and O/E. Then they are converted to baseband or other IF frequency. Recently we have strong RFI interference in L-band. These are from artificial satellites and mobile phone base station. With the satellite phone service, we negotiated to prohibit terminal transmission near the telescope to prevent receiver saturation.

Table 2. Receiver Specification of the 34m Radio Telescope.

Band	frequency(Hz)	Trx(K)	Tsys(K)	Efficiency
L	1350-1750	18	43	0.68
S	2150-2350	19	83	0.65
C	4600-5100	25	108	0.70
X	7860-8680	41	52	0.68
K	21900-23900	300	330	0.57

2.3. Standard signals

Two K-4 type (Anritsu) hydrogen masers are used for frequency standard. The same masers are also used for KSP Kashima 11m station. We have another Russian maser for reference and backup.

As for H-1PPS comparison to the GPS-UTC, the AOA receiver and the Totally Accurate Clock-2 are in operation. Expensive GPS receivers will be replaced by the TAC-2. TAC-2 encouragement to domestic institute and their TAC-2 kit assembly support is done by the CRL Kashima group.

2.4. VLBI back-end system

As of January 2000, K3-A (Mark-IIIA compatible), VLBA, K4, VSOP, S-2 and Giga-bit VLBI systems are available. The newly installed S-2 system and Gbit system are fully in operation. K4, VLBA and S2 are controlled by the Field System (FS-9) as well as the telescope. Other equipment are still controlled from their original field system. K4 and VSOP observations can use automatic tape change robot during their observations. A digital spectrometer with auto-correlation and total power recording by DAT are also possible.

3. On-going Projects and Major Result of 2000

Following are the major VLBI observation projects which are currently running at Kashima 34m radio telescope.

K4-TIE experiment In collaboration with the Geological Survey Institute and others, Intensive K-4 TIE experiment to tie the KSP VLBI network to a global terrestrial reference frame (ITRF) was carried out. Final session is planned in February 2000.

Pulsar VLBI (Asia Pacific Telescope) Since 1997 regular observations were carried out between the Kryazin 64m telescope in Russia and Kashima 34m. A K4 system is installed on the Russian side. Periodic observations revealed the intrinsic motion of pulsars in high resolution after data analysis. Pulsar timing observations were carried out too.

VSOP (VLBI Space Observatory Program) In collaboration with ISAS (Institute of Space Astronautical Sciences), Kashima 34m joined the project as a ground telescope. Mainly C-band and L-band receivers are used. The Kashima 34m role is complementary work with ISAS 64m.

J-NET (Japanese domestic astronomical VLBI network) With three other stations in Japan (Nobeyama 45m, Mizusawa 10m and Kagoshima 6m), proposal based observations were made. Focused on astronomical side, most of the JNET observations are tuned in K-band water maser. A number of sources were found under intensive observations of the VERA Survey in 2000. We found reference continuum sources near water maser sources concentrated at low Galactic latitudes.

GALAXY (Giga-bit Astronomical Large Array with cross connect) Utilizing optical networks, three large telescopes in Japan are optically connected via ATMs. Kashima 34m and Usuda 64m were connected in September 1998. Kashima 34m and Nobeyama 45m were also connected on 7th June 1999. Koganei KSP correlator is now used for regular GALAXY experiments. In 2000, we have tried to start Mitaka-FX as the second real-time correlator. A 2.4 Gbps optical transmitter was successfully developed at NAO. Real-time Giga-bit observation using the network is planned in 2001.

GIFT (Gifu University Telescope) A 3m telescope of CRL was moved to Gifu university. We have performed initial observations and geodetic analysis to start up the university site. A

Gbps system was also introduced and the small telescope was spot lighted again.

Giga-bit VLBI Experimental Giga-bit observations were carried out both in geodesy and astronomy. High sensitivity Gbps observations for radio astronomy are starting now. The 1024 Mbps recorders work with JNET 256 Mbps simultaneously and double its sensitivity.

4. Technical Staff for the Kashima 34m Radio Telescope

Engineering and Technical staff members who are contributing to observations and operations of the Kashima 34m are listed below.

- Eiji Kawai, Technical responsibility for overall operations and maintenance.
- Junichi Nakajima, Engineering leader of the 34m.
- Yasuhiro Koyama, Field system developments and monitoring software.
- Mamoru Seido, Hydrogen maser and standard signal distribution.
- Hiroshi Okubo, Technician for mechanical and RF maintenance
- Hiroo Osaki, Technician for software and mechanical maintenance.
- Yuki Watababe, Engineer from Rikei Corporation. Rikei is the contract agency of Vertex corporation TIW division.

5. Outlook

The subreflector control unit will be replaced for high reliability. Receiver physical temperature read out will be replaced too. A new HEMT 43 GHz receiver will be installed by Kagoshima University and NAO. Publication of a special issue of CRL journal which summarizes related recent results is planned in April 2001.