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. Here we report recent status as of year 2002 and progress of the telescope related project. The telescope is mainly used for geodetic VLBI, astrometry VLBI and other astronomical observations.

1. Introduction

Communications Research Laboratory (CRL) constructed the Kashima 34m telescope in 1988. Through the 14 years operation. The telescope are kept in a good condition and joined various VLBI observations. The Kashima Space Research Center of CRL which was founded in 1964 near the Pacific ocean and is located 100km east of Tokyo. The 34m telescope shown in the figure is currently operated by Radio Astronomy Applications Group. Here we report revised network station report mainly focused on newly updated aspects of Kashima 34m telescope.

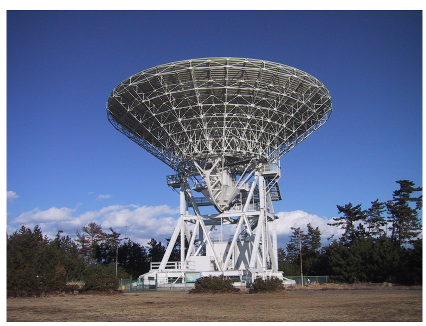

Figure 1. The Kashima 34m radio telescope.

2. Telescope Status

2.1. Receiver Systems

A new Ka-band receiver was successfully installed in December 2002. Now the available receivers at Kashima 34m telescope are L,C,K,Ka,Q and S/X band. The Ka and K receivers are integrated into a dual-band dewar. These receiver performances are summarized in Table 1. Ka band efficiency is being measured. Switchable polarization is written as R/L. Fixed polarization that can be changed is written as R(L) or L(R). In the 34m telescope, a computer controls the feed groups at the cassegrain secondary focus. In the case of off-axis mounted receivers, additional sub-reflector control is needed because of its feed focus position. A PC controls the sub-reflector position by numerical inputs. All receivers except C-band are cooled HEMT around 12K physical temperature. The C-band LNA is now cooled to 100K using closed cycle compact refrigerator. We need approximately 15 minutes to switch receivers to a different band. The IF (intermediate frequency from receiver) is transmitted from telescope to observation room via optical fibers. The IF below X-band (8-GHz) uses 100-600 MHz IF. On the other hand, the higher band receivers employ IF of 5-7 GHz. The entire IF channels are transmitted through fibers. Then they are converted to baseband or other IF frequency in observation room.

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

Band	frequency(Hz)	Trx(K)	Tsys(K)	Efficiency	Polarization
L	1350-1750	18	43	0.68	R/L
S	2210-2350	19	83	0.65	R/L
C	4600-5100	25	108	0.70	L(R)
X	7860-8680	41	52	0.68	R/L
K	21800-23800	75	160	0.5	L(R)
Ka	31700-33700	85	150	—	R(L)
Q	42300-44900	180	300	0.3	L

2.2. Standard Signals

Two K-4 type (Anritsu) hydrogen masers are used for frequency standard. We have another Russian maser for reference and backup. TAC-2 (Totally Accurate Clock-2) is used for the H-1pps comparison to the GPS-UTC.

2.3. VLBI Back-end and Field System

As of January 2003, VSI-Gigabit (1/2 Gbps), VSI-PC (1 Gbps), K-5 (VSSP, Internet VLBI, 256 Mbps), K-4 (256 Mbps), K3-A (Mark-IIIA compatible), VSOP, and S-2 VLBI systems are available. K4, VLBA and S2 are controlled by the Field System (FS-9) together with 34m telescope. The FS-9 functional enhancement was made to get in touch with a standby operator using mobile phone for operator-less observation. VSI Gigabits instruments are controlled by another portable software named 'GS-cont'. The GS-cont enables ftp-fringe test by the Field System itself. Gbit, K4 and VSOP observations use automatic tape change robots during the observations.

2.4. AOS Spectrometer System

Besides VLBI, two AOS systems are installed at Kashima 34m telescope. One is the Pulsar AOS timing measurement system. Wide-band pulsar observation and dispersion removal to obtain accurate timing had been carried out. The another one is multi purpose AOS spectrometer developed under collaboration with Kagoshima University. The latter AOS enables long integration of faint object and molecular line observations. A digital spectrometer by auto-correlation and total power recording by DAT are also possible.

2.5. RFI (Interference)

We had been experiencing strong RFI interference in L-band. These are from artificial satellites and mobile phone base stations. With a satellite phone service, we have agreed to prohibit their terminal transmission nearby the telescope to prevent receiver saturation. S-band also suffered from emerging RFI from next generation IMT-2000 mobile phone service systems. Bandpass filter and band-rejection filters in ambient temperature are installed to secure the S-band reception. Observers should note the frequency allocation at lower end of S-band (See Table.1). Cooled super-conductivity filters are being designed to recover S-band bandwidth. The filter system will have much tolerance to severe RFI which is expected in future. Power Line Communication (PLC) in HF (2-30MHz) is another possible emerging interference source which will seriously affect the base-band VLBI instruments. Prudently Japanese government decided that they will not approve the PLC in July 2002. On the other hand, the S-band reception has no legal protection as radio astronomy service, thus we have to prepare other frequency combination for geodetic VLBI.

2.6. Mechanical System

The Kashima 34m telescope had disasters in 2002. In August, extraordinary thunder storm passed the area. The lightning struck an encoder electrical unit and computers. Telescopes were recovered by using spare units. Since there is no remaining units, we have ordered new electrical unit. In October, a huge typhoon once in 50 years attacked Japanese main-land and the telescope was exposed to survival wind-speed of 50 m/s. Though several local towers of power line were collapsed, the 34m telescope was not damaged. Due to increasing operation hours in recent years, wear of motors are remarkable. We had prepared additional AZ and EL motor parts. Structure inspection, regular maintenance and rust removal are scheduled during July-September as usual.

Table 2. 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

3. On-going Projects and Major Results of 2002

Following are major VLBI observation projects. Besides conventional VLBI, new Internet observations and e-VLBI related experiments are increasing.

eVLBI(PC-VSSP,IP-VLBI) For the purpose to replace the VLBI system below 256 Mbps with conventional PCs, PC-VSSP system which is well known as IP-VLBI was developed. Domestic experiments between Koganei and Kashima were successful with the VSSP units. Final integration of the K-5 system as a counterpart of the Mark 5 is nearly completed. The first step experiment, Haystack-Kashima reciprocal eVLBI experiment was carried out on 5th October 2002. Primitive correlation results were obtained on both sides. The PC-VSSP also was practically used in spacecraft observations of Nozomi and Geotail. The PC-VSSP is the only system that can process observed data from spacecraft when they need non-regular VLBI correlation at finite distance.

NOZOMI observation Targeting VLBI positioning during unavailable period of original satellite ranging, a joint collaboration of CRL and ISAS is in progress. Number of observations are intensively allocated before and during orbit control period. Fringes of nearby reference quasars and a satellite were obtained. Simultaneously, analysis package is improving.

PC-VSI To prove mutual compatibility of VSI (VLBI Standard Interface), wide-band single channel Gbps VLBI through Internet has started between Finland and Japan. We used K-band (22GHz) as the common frequency between Metsahovi, Helsinki University of Technology and CRL. PC-VSI system record the Gbps data in Japan. In Finland, multiple VSIB boards acquired the Gbps data. By the TVG test signal, instantly we had confirmed the compatibility between the systems. On October 16th, the first fringe from the object water maser source W3OH were found. In this observation software correlator of CRL was used.

Optical-linked 1-Gbps VLBI (GALAXY) 2.4G ATM-link between Usuda-64m telescopes is used for sensitive astronomical observations. Seyfert galaxies are observed and real-time correlator GICO processes the data. The observation time is limited by 64-m telescope time mainly tracking satellites in deep space.

Giga-bit VLBI As the sub-set of 2-Gbps VLBI system, 1-Gbps systems were temporarily installed at VERA telescope sites in 2002. They did a continuum survey for VERA reference object. Unfortunately, the observing conditions were unsatisfactory during multiple trials.

CUTE (CRL and University Telescopes) Two 11m telescopes of CRL (the former KSP stations) were moved to Hokkaido University and Gifu Universities. To determine the precise location of the telescopes, a series of geodetic VLBI were carried out together with GSI telescopes. In the observations Usuda-64m telescope position was also determined precisely. In 2003, the Hokkaido University telescope will be modified to K-band. The Gifu university telescope will join geodetic VLBI experiments.

IVS-T and CRF series Kashima 34m joined sessions of IVS-T series and the IVS-CRF series. The number of joined session was once in each series. We will join the IVS observation as needed.

Pulsar, J-Net, VSOP and other international observation Regular observation of pulsars, Japanese domestic astronomical VLBI observation including Nobeyama 45m and VSOP (VLBI Space Observatory Program) are continuing with conventional VLBI system. The J-Net of National Astronomical Observatory will utilize four VERA stations when they are completed. VSOP observation is increasing as the complementary work with Usuda-64m. The Kashima 34m telescope join the other international VLBI observation on its importance and when the observation is beneficial to both the proposed institute and CRL.

Figure 2. Authors of this report. Kawai, Okubo, Osaki and Nakajima are site telescope consultation staff.