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 2001 and progress of related projects.

1. Introduction

Communications Research Laboratory (CRL) constructed the Kashima 34-m telescope in 1988. Throughout the 13 years operation the telescope has been kept in good condition and joined various VLBI observations. The Kashima Space Research Center of CRL was founded in 1964 near the Pacific ocean and is located 100 km east of Tokyo. The 34-m telescope shown in the figure is currently operated by the Radio Astronomy Applications Group. Here we report revised network station report mainly focused on newly updated aspects of the Kashima 34m telescope.

Figure 1. The Kashima 34m radio telescope.

2. Telescope Status

2.1. Receiver Systems

By a newly added Q-band receiver, the available receivers are increased to L,C,K,Q and S/X band. Their performance is summarized in Table 1. Performance of the K-band receiver is drastically improved in 2001. In the 34m telescope, a computer controls the feed groups in the cassegrain secondary focus. In the case of off axis mounted receiver, additional sub-reflector control is needed because of the feed position. All receivers except C-band are cooled HEMT around 12K physical temperature. The C-band LNA is now cooled to 100K using a closed cycle compact refrigerator. We need approximately 15 minutes to switch a receiver to the other band. The IF (intermediate frequency from receiver) is transmitted from telescope to observation room via optical fibers. The IF below X-band (8 GHz) are the commonly used 100-600MHz IF band. On the other hand, the higher band receivers employ IF of 5-7GHz. The whole IF bandwidth is transmitted with fibers. Then they are converted to baseband or other IF frequency in the observation room.

Table 1. 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	150	200	0.57
Q	42300-44900	180	300	0.3

2.2. Standard Signals

Three K-4 type (Anritsu) hydrogen masers are used for frequency standard. We have another Russian maser for reference and backup. For H-1PPS comparison to the GPS-UTC, the Totally Accurate Clock-2 is in operation. TAC-2 promotion to domestic institutes and TAC-2 technical support is done by the CRL Kashima group.

2.3. VLBI Back-end System

As of January 2001, VSI-Gigabit, K-4, K3-A (Mark-IIIA compatible), VLBA, VSOP, and S-2 VLBI systems are available. The VSI-based Gbps VLBI system is used in regular observations. K4, VLBA and S2 are controlled by the Field System (FS-9) together with 34m telescope. Now the K4 and S2 are adapted to VSI and mutual conversion is examined in the back-end room. K4 and VSOP observations use an automatic tape change robot during observations. A digital spectrometer with auto-correlation and total power recording by DAT are also possible.

2.4. AOS Spectro-meter 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 removals to obtain accurate timing were carried out. The other one is a multi purpose AOS spectrometer developed under collaboration with Kagoshima University. The latter enables long integration of faint objects and molecular line observations were started in 2001.

2.5. RFI (Interference)

We have been experiencing strong RFI interferences in L-band. These are from artificial satellites and mobile phone base stations. A satellite phone service has 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. A pre-LNA HPF filter will be needed to protect us from the RFI. Power Line Communication (PLC) is another kind of interference seriously affecting base-band instruments and generating interference. We are negotiating with the appropriate Ministry to settle these issues. These activities are done together with collaborating institutes, National Astronomical Observatory and the radio astronomy frequency committee in Japan. As for the S/X VLBI, the S-band has no legal protection in radio astronomy, and we will need other mitigation to overcome the problems.

2.6. Mechanical System

In 2001, the antenna is operated under parameters shown in Table 2. Although the telescope has higher performance, the slew rate is reduced to prevent wear of the track. Every summer, an annual inspection of the electric system and drive motors are carried out. Two AZ motors and an EL motor are available in case of troubles. Spares for all other important electronic boards are available for replacement. By these support units, there has been no observation failure due to troubles. Half of back up structures inspection was finished. Several damaged support parts of the main reflector were replaced in 2001.

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 2001

Following are the several major VLBI observation projects which are currently related to the Kashima 34 m radio telescope.

Optical-linked 1Gbps VLBI (GALAXY) After the successful first-ever 1-Gbps optical linked VLBI fringes in July 2001, four observation sessions were done to detect astronomical objects. In the system, 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. Further improvement of the system up to 2.4 Gbps is planned in 2002.

2-Giga-bit VLBI Also the first-ever 2-Gbps tape based VLBI fringe was detected on 22 Dec. 2001 by CRL group. Besides Gbps observations, 2-Gbps test observations are planned with the 34m telescope.

IP-VLBI Expecting linked VLBI networks in the near future, an IP-based VLBI system has a much higher possibility for connection both in multi-national science and opportunity in their connection. Along with ATM-based optical linked VLBI system, CRL has developed IP-VLBI which will cover the existing tape-based 256 Mbps system. Initial geodetic observation using the IP-VLBI system is planned in 2002.

NOZOMI observation Experimental observations for inter-planetary spacecraft "NOZOMI" are in preparation. The spacecraft needs position measurement for the Earth swing-by in 2003.

HOKT (HOKkaido University Telescope) An 11m telescope of CRL (the former KSP Miura station) was moved to Hokkaido University. The 11m radio telescope is the first radio tele-

scope on Hokkaido Island. We have performed initial observations and geodetic analysis is under progress.

Pulsar VLBI Astrometric pulsar VLBI observations have been performed under collaboration with Lebedev Physical Institute of Russia. Proper motions of PSR0329+54 and five other pulsars were measured.

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 the astronomical side, most of the JNET observation are of K-band water masers. Gbps systems are installed at the stations and hi-z QSOs were detected using the Gbps sensitivity.

VSOP (VLBI Space Observatory Program) In collaboration with ISAS (Institute of Space Astronaut 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 with the ISAS 64m.

4. Technical Staff of the Kashima 34m Radio Telescope

Engineering and Technical staff of the Kashima 34m telescope are Eiji Kawai (technician responsible for overall operations and maintenance), Hiroshi Okubo (engineer of mechanical and RF maintenance), Hiroo Osaki (software engineering and mechanical maintenance) and Satoru Morisaki (student at Kagoshima University contributing to telescope improvement) this year.

5. Outlook

Sub reflector control unit replacement by popular PC control is being examined. Receiver physical temperature read out is under experiment too. Integrated K/Ka band cooled receiver for future research will be installed during 2002.