Kashima 34-m Radio Telescope

Eiji Kawai, Hiroshi Takeuchi, Hiromitsu Kuboki

Abstract

Communications Research Laboratory (CRL) was reorganized into National Institute of Information and Communications Technology (NICT) in April, 2004. NICT will operate Kashima 34-m radio telescope continuously as a facility of the Kashima Space Research Center. This is the network station report mainly focused on the telescope facilities.

1. Introduction

The Kashima 34-m telescope was constructed by National Institute of Information and Communications Technology (NICT), formerly Communications Research Laboratory (CRL) in 1988. The telescope is located about 100 km east of Tokyo. During 16 years of operation, the telescope has been kept in a fairly good condition and the antenna has participated in various VLBI and single-dish observations. The 34-m telescope is operated by the Radio Astronomy Applications Group of Kashima Space Research Center (KSRC).

Figure 1. The Kashima 34-m radio telescope.

2. Highlights

The S-band receiving frequency was expanded to receive 2040 MHz signal for observations of the Huygens probe to precisely measure the position of the probe by means of VLBI during its descent to Saturn's moon, Titan. System equivalent flux density was measured as 5400 Jy and system noise temperature was measured as 260 K at 2040 MHz. These values are not very good compared with the S-band receiver performance for the Kashima 34-m antenna, but the frequency of 2040 MHz is outside of the original receiver pass band and it seems there is a large signal loss due to the wave guide of the front-end system.

Table 1. Main specification of the 34-m Radio Telescope.

Main reflector aperture	34.073 m
Latitude	N 35° 57' 50.76"
Longitude	E 140° 39' 36.16"
Height of antenna center above sea level	43.6 m
Height of antenna position above sea level	26.3 m
Antenna shape	Modified Cassegrain
Mount shape	AZ-EL mount
Drive range azimuth (deg)	North ±270
Drive range elevation (deg)	7-90
Maximum speed azimuth (deg/sec)	0.8
Maximum speed elevation (deg/sec)	0.64
Operation wind speed (m/s)	13
Panel surface accuracy r.m.s. (mm)	0.17

In April 2004, NICT started the operation of the high speed research network test bed JGN II and KSRC became one of the access points of the network. 10 Gbps backbone connecting Kashima and Koganei Headquarter of NICT became available. Two GbE interfaces were installed at the access point at Kashima and we started to use the network for e-VLBI research and developments. Currently a data server is connected to the network and is used to store the K5 observation data from IVS sessions. The data are transferred and converted to Mark 5 format files for correlation processing by Haystack Observatory.

A new meteorological observation system was installed on December 5, 2003 replacing the old system. The old meteorological sensors were moved to the top of the observation building of the Kashima 34-m antenna. The new system is a WINS system of Meisei Corporation. Originally the system was capable of recording temperature, humidity, air pressure, wind speed, wind direction, and rain fall every 10 minutes. But the system was modified to record these data every minute. We started to use the new system in January, 2004.

3. Telescope Status

3.1. Receiver Systems

The receivers currently available at the Kashima 34-m telescope can observe on L,C,K,Ka,Q and S/X-band. The Ka and K-band receivers are integrated into a dual-band dewar. The receiver performances are summarized in Table 1. The polarization of the receiver is switchable to both RHCP and LHCP polarizations; the current setting is indicated by R or L. With the polarization fixed, it is still possible to change the polarization by changing the wave guide; this is indicated by R(L) or L(R). Ka-band efficiency in Table 1 is a provisional value. All receivers, except for the C-band receiver, are using cooled HEMT LNA which is kept around 12K physical temperature. The C-band LNA is using an ambient FET LNA.

To mitigate Radio Frequency Interference (RFI), additional filters were installed in the L and S-band receivers. For the S-band receiver, a High Temperature Superconductor (HTS) filter is used (see next section). Coaxial 11 sections usually employ a 1350-1450MHz bandpass filter for the L-band.

The IF (intermediate frequency) signals of the receivers are transmitted from the telescope to the observation room via optical fibers. Higher frequency band receivers (K, Ka, and Q) use an IF signal of 5-7 GHz. IF signal are converted to base band signal or other IF signal in the observation room.

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

Band	frequency (Hz)	Trx (K)	Tsys (K)	Efficiency	SEFD (Jy)	Polarization
L	1350-1750	18	43	0.68	190	R/L
S	2193-2350	19	83	0.65	390	R/L
C	4600-5100	100	127	0.70	550	L(R)
X	7860-8680	41	52	0.68	230	R/L
K	21800-23800	75	160	0.5	970	L(R)
Ka	31700-33700	85	150	0.4	1100	R(L)
Q	42300-44900	180	300	0.3	3000	L

3.2. RFI Mitigation

Severe RFI at S-band due to third-generation mobile phone systems (IMT-2000) began to influence the Kashima 34-m antenna station in 2002 [1]. To mitigate the interference, we have developed a cooled HTS filter [2]. The sharp cutoff filter edge of -10 dB/MHz enables the reception of lower S-band adjacent to the IMT-2000 allocation. The filter is integrated into a maintenance free cryogenics cooler and is now continuously operating between LNA and the down-converter.

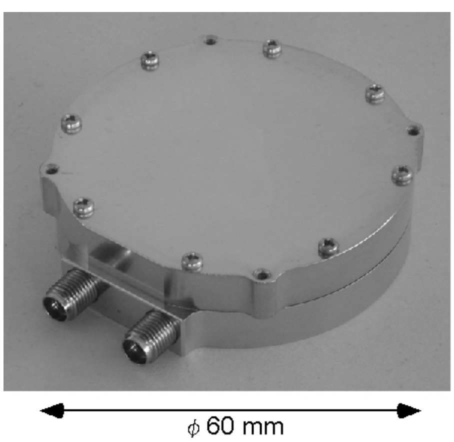

Figure 2. HTS filter

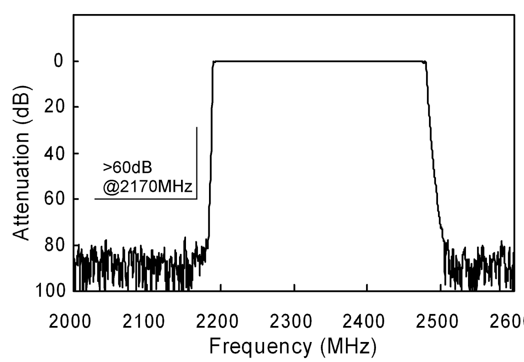

Figure 3. HTS filter specification

3.3. Mechanical System

The ACU had some failures due to its aging recently. For example, we have experienced EL axis hunting, servo mode exchange failure, and so on. To prevent observation failure, we prepared new ACU and it will be installed in January 2005. As the main reflector backup structure was corroded, repair painting and welding was performed in August and September, 2004. Additional repair work is planned for the month of February, 2005. Since a lot of repair work had to be done, repair time was used up after only two months. Replacement of the nut-plate, which fixes a main reflector to the backup structure, was also performed.

4. Technical Staff of the Kashima 34-m Radio Telescope

Engineering and technical staff of the Kashima 34-m telescope are Eiji Kawai (leader of all operations and maintenance), Yasuhiro Koyama (scientist and engineer of software and hardware), Mamoru Sekido (scientist and engineer of software and reference signal), Hiroshi Takeuchi (scientist and engineer of software and hardware), Kuboki Hiromitsu (technician of mechanical and RF related parts), and Tetsuro Kondo is the supervisor of the overall project.

References

[1] Eiji Kawai, Hiroshi Ohkubo, Junichi Nakajima, and Jun Amagai, S-band RFI problems at Kashima 34-m antenna and a passive filter for mitigation, IVS CRL TDC News, No.21, pp. 9-11, Nov. 2002.

[2] Eiji Kawai, Junichi Nakajima, Hiroshi Takeuchi, Hiromitsu Kuboki, and Tetsuro Kondo: Wide-band high-temperature superconductor filter on 2.2 GHz RFI mitigation. IVS CRL TDC News, No.22, pp. 2-4, Jun. 2003.