Kashima 34-m Radio Telescope

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Abstract

National Institute of Information and Communications Technology (NICT) operates Kashima 34-m radio telescope continuously as a facility of the Kashima Space Research Center in Japan. This is the network station report mainly focused on the telescope facilities.

1. Introduction

The Kashima 34-m telescope (Figure 1) was constructed by National Institute of Information and Communications Technology (NICT) in 1988. The telescope is located about 100 km east of Tokyo, Japan. During 18 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 Space-Time Applications Project (formerly the Radio Astronomy Applications Group) of the Space-Time Standards Group of Kashima Space Research Center (KSRC), NICT.

Figure 1. The Kashima 34-m radio telescope.

2. Telescope Status

2.1. Receiver Systems

The receivers currently available at the Kashima 34-m telescope can observe L, C, K, Ka, Q, S, and X-bands. The measured performance of the receivers are summarized in Table 2. If the polarization of the receiver is switchable to both RHCP and LHCP polarizations, it is indicated as

Table 1. Main specifications 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 AZ/EL intersection above sea level	43.6 m
Height of azimuth rail above sea level	26.3 m
Antenna design	Modified Cassegrain
Mount type	AZ-EL mount
Drive range azimuth	North ±270°
Drive range elevation	7°-90°
Maximum speed azimuth	0.8°/sec
Maximum speed elevation	0.64°/sec
Maximum operation wind speed	13 m/s
Panel surface accuracy r.m.s.	0.17 mm

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

Band	frequency (MHz)	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	8180-9080∗	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

∗: X-band receiving frequency is a result of preliminary expansion of the receiving frequency range. See section 2.2 in this report for details.

R/L. If the polarization cannot be switched, but it is still possible to change the polarization by changing the wave guide configuration, it is indicated as R(L) or L(R). Ka-band efficiency in Table 2 is a provisional value. All receivers, except for the C-band receiver, are using cooled HEMT LNA which are kept around 12 K physical temperature. The C-band LNA is using an ambient FET LNA. The low noise amplifiers of the Ka and K-band receivers are placed inside a dual-band dewar. The low noise amplifiers of S and X-band receivers are also placed inside a cooled dewar. Only L and Q-band LNAs are placed in a dedicated cooled dewar for each band.

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 [1]. A coaxial bandpass filter with 11 sections was employed for 1350-1450 MHz in the L-band to avoid the influence of RFI.

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 frequency range of 5-7 GHz as the IF signals. IF signals are then converted to base band signals or other IF signals in the observation room.

Table 3. X-band nominal receiving frequency range of Kashima 34-m antenna before and after the preliminary expansion.

Receiver	Frequency Coverage (MHz)		
	Before Sept. 2005	From Sept. 2005 to May 2006	After May 2006
X-n	8180-8600	—(∗)	8180-8600
X-wL	7860-8360	8580-9080	8580-9080
X-wH	8180-8600	8180-8600	8180-8600

∗: To use local oscillator signal for X-wL subsystem, X-n subsystem was temporally unavailable.

2.2. On the Change of the X-band Receiver Configuration

The original nominal frequency coverage of the X-band receiver of the Kashima 34-m antenna was from 7860 MHz to 8600 MHz. This frequency coverage was chosen to cover a wide frequency range to improve the time delay measurements in domestic geodetic VLBI experiments. However, after the 34-m antenna was constructed, international wide band geodetic VLBI experiments began to be performed by expanding the X-band receiving frequency to the upper frequencies up to 9080 MHz. Therefore, we decided to try to expand the frequency range of the X-band receiver of the 34-m antenna up to 9080 MHz so that it can participate in the international wide band geodetic VLBI experiments. At first, we replaced the RF bandpass filter of the X-wL subsystem from its original filter (7860-8360 MHz) to the new filter (8580-9080 MHz) as shown in Table 3 in August 2005 during annual maintenance. To convert the new frequency range of the X-wL subsystem, the local frequency signal (8080 MHz) for the X-n subsystem was temporally removed and connected to the mixer of the X-wL subsystem. Detailed measurements are described in Ref. [2], [3].

After May 2006, the X-n subsystem became available for observations (Table 3). Then simultaneous dual polarization (RHCP/LHCP) observation became possible for frequency range 8180 - 8600 MHz. Figure 2 shows the block diagram of the S/X-band receiver system after change in May 2006.

2.3. Mechanical System

In September and October 2006, the backup structure of the main reflector was repaired by removing the rust and by welding reinforcement plates. In 2007 we plan to have a large-scale repair of the backup structure of the main reflector from August until mid-October 2007.

3. Technical Staffs of the Kashima 34-m Radio Telescope

Engineering and technical staffs of the Kashima 34-m telescope are Eiji Kawai (responsible for operations and maintenance), Mamoru Sekido (software and reference signals), Hiroshi Takeuchi (software and hardware) until February 2006, Hiromitsu Kuboki (mechanical and RF related parts), Yasuhiro Koyama (international e-VLBI), and Tetsuro Kondo (software correlator developments and e-VLBI).

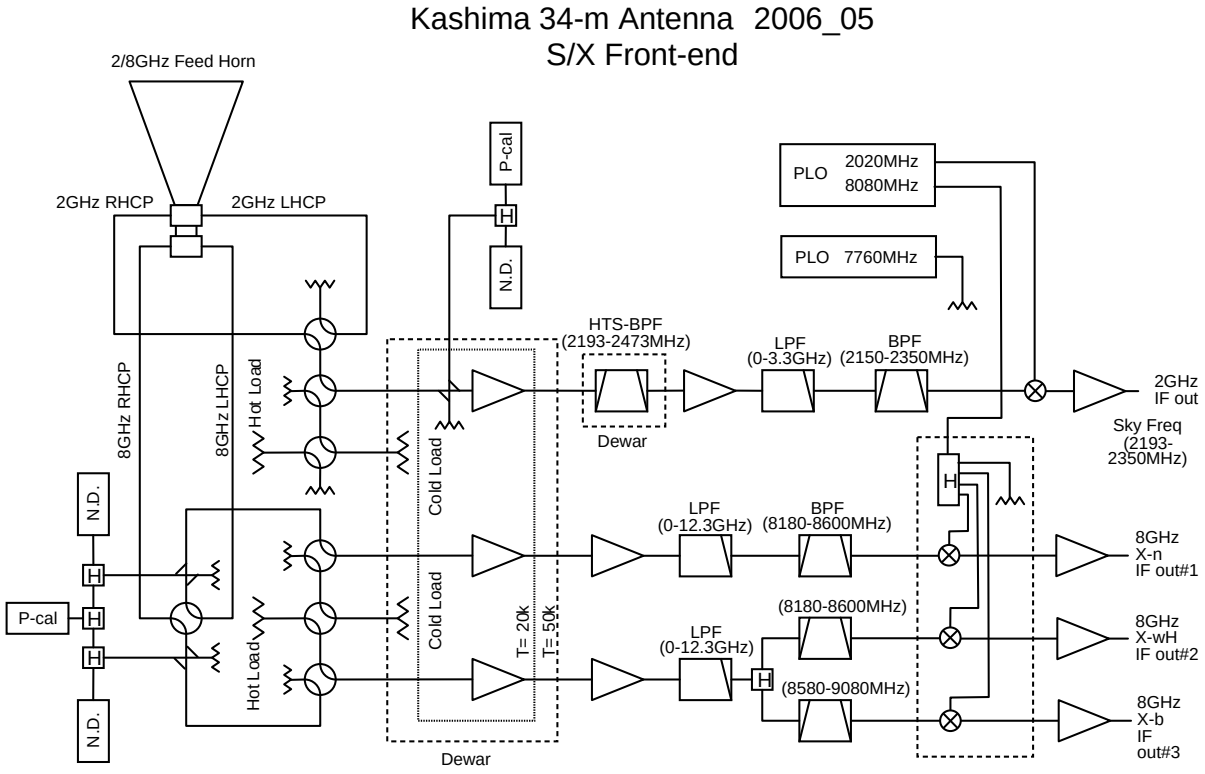

Figure 2. Block diagram of the Kashima 34-m antenna S/X receiver after May 2006.

References

[1] Eiji Kawai, Hiroshi Takeuchi, and Hiromitsu Kuboki, Kashima 34-m Radio Telescope, IVS 2004 Annual Report, NASA/TP-2005-212772, pp. 64-67, Feb. 2005.

[2] Eiji Kawai, Hiroshi Takeuchi, and Hiromitsu Kuboki, Kashima 34-m Radio Telescope, IVS 2005 Annual Report, NASA/TP-2006-214136, pp. 83-86, Apr. 2006.

[3] Eiji Kawai, Hiromitsu Kuboki, Yasuhiro Koyama, and Tetsuro Kondo: On the expansion of the frequency coverage of an X-band of Kashima 34-m antenna, IVS NICT TDC News, No.26, pp. 23-25, Sept. 2005.