# Kashima 34-m Radio Telescope

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**Abstract**

National Institute of Information and Communications Technology (NICT) formerly CRL (Communications Research Laboratory) is operating 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 constructd 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 in Japan. During 17 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 has been operated by the Radio Astronomy Applications Group of Kashima Space Research Center (KSRC), NICT.

Figure 1. The Kashima 34-m radio telescope.

## 2. Highlights

Since the original configuration of the X-band receiver system of Kashima 34-m antenna did not cover upper frequency range above 8600 MHz which is required by some IVS sessions, we started to try to expand the X-band receiver frequency coverage up to 9080 MHz. The expansion was preliminary realized by replacing the RF bandpass filter. Although the performance of the expanded frequency is not satisfactory especially near the upper edge of the band, we have suc-

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 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 |

ceeded to detect fringes from all X-band channels allocated for the CONT05 sessions by using the KASHI34-TSUKUB32 baseline. Details will be described in section 3.2.

The International Academy of Astronautics (IAA) awarded its Laurels for Team Achievement Award for 2005 to the VLBI (Very Long Baseline Interferometry) Space Observatory Programme (VSOP) Team. The award was presented at the 56th International Astronautical Congress in Fukuoka, Japan, on October 16th 2005. The award is a tribute to the efforts of entire VSOP team, including Kashima 34-m antenna and many observatories, who made it possible to realize a radio telescope bigger than the earth.

## 3. Telescope Status

### 3.1. 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 R/L. If the polarization can not 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-bnad 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 [2]. 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

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 3.2 in this report for details.

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.

### 3.2. On the expansion of the frequency coverage of an X-band

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 determined to cover 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. 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 to the mixer of the X-wL subsystem. As the result, the X-n subsystem is currently unavailable for observations. After these changes, SEFD of the X-band receiver was measured on September 6, 2005. As shown in the Figure 2, the average SEFD of lower band (8180-8600 MHz) was 232 Jy whereas the average SEFD of the upper band (8600-8850 MHz) was 237 Jy. On the other hand, the SEFD increases to 250 Jy at 8900 MHz and 430 Jy at 9890 MHz. The reason of the poor performance of the upper edge of the receiver is considered as an inadequate down converter configuration. In the near future, we will try to figure out the cause of this poor performance and improve the SEFD in the upper frequency edge up to 9080 MHz. To evaluate the expanded X-band receiver performance, we performed observations during the c0505 session on September 16, 2005 and only the TSUKUB32-KASHIM34 baseline was correlated. As the results, we have succeeded to detect fringes from all channels observed in the c0505 session and basic performance of the expanded X-band receiver was confirmed.

### 3.3. Mechanical System

The occurrence of the failures of the Antenna Control Unit (ACU) is increasing recently because of its aging. Most typical failures are occasional emergency brakes during observations and tracking

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

| Receiver | Frequency Coverage (MHz) | |
|---|---|---|
| | Before | After |
| X-n | 8180-8600 | —(*) |
| X-wL | 7860-8360 | 8580-9080 |
| X-wH | 8180-8600 | 8180-8600 |

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

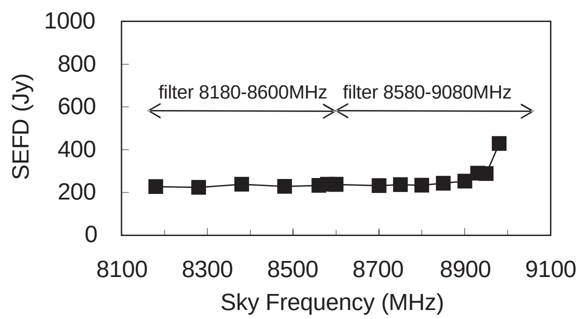


Figure 2. SEFD of the expanded X-band receiver of the 34-m antenna

mode change failures. To prevent observation to fail, we replaced the ACU with a new unit in January, 2005. In February, 2005, the remaining part the backup structure of the main reflector which has never been repaired was repaired by removing the rust and by welding reinforcement plates. The corroded nut-plates which are used to fix the main reflector plates to the backup structure were also replaced.

## 4. 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), Hiromitsu Kuboki (mechanical and RF related parts), Junichi Nakajima (research and developments for observing system), Yasuhiro Koyama (international e-VLBI), and Tetsuro Kondo (software correlator developments and e-VLBI).

## References

[1] 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.

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