Kashima 34-m Radio Telescope

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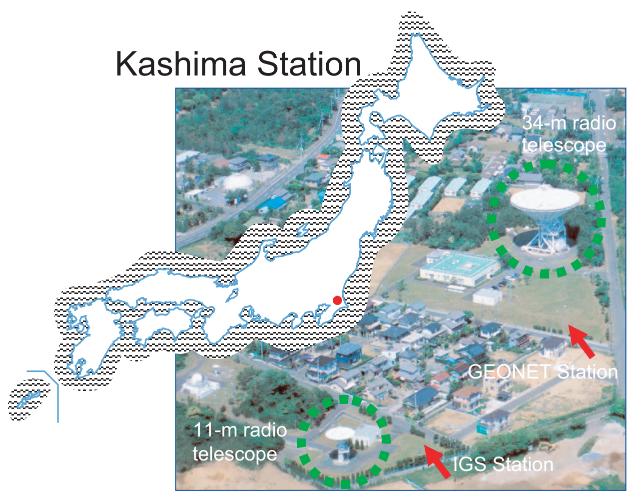
Abstract

The Kashima 34-m radio telescope has been continuously operated and maintained by the National Institute of Information and Communications Technology (NICT) as a facility of the Kashima Space Research Center (KSRC) in Japan. This brief report summarizes the status of this telescope, the staff, and activities during 2011. In particular, we describe antenna damage due to the M_w 9.0 megaquake which occurred on March 11th, 2011.

1. General Information

The Kashima 34-m radio telescope (Figure 1, left) was constructed as a main station of the "Western Pacific VLBI Network Project" in 1988. After that project's termination, the telescope has been used not only for geodetic experiments but also for astronomy and other purposes [1]. The station is located about 100 km east of Tokyo, Japan and is co-located with the 11-m radio telescope and the International GNSS Service station (KSMV) (Figure 1, right). The station is maintained within the Space-Time Measurement Project of the Space-Time Standards Group, NICT.

The Kashima 34-m radio telescope with new logo design of NICT.



Facilities at Kashima.

Figure 1. The Kashima Station.

2. Component Description

The receiver equipment of the Kashima 34-m radio telescope is summarized in Table 1 and Table 2. In particular the high-temperature superconductor (HTS) band-pass filter is equipped at the S-band receiver for RFI mitigation [3]. We also installed a band-pass filter on July 15, 2008 to cut out signals between 1405 MHz and 1435 MHz for L-band RFI mitigation.

Table 1. Main specifications of the 34-m radio telescope.

Main reflector aperture	34.073 m
Latitude	N 35° 57’ 21.78”
Longitude	E 140° 39’ 36.32”
Height of AZ/EL intersection above sea level	43.4 m
Height of azimuth rail above sea level	26.6 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. The receiver specifications of the 34-m radio telescope.

Band	frequency (MHz)	Trx (K)	Tsys (K)	Efficiency	SEFD (Jy)	Polarization
L	1350-1750⋆	18	45	0.68	200	L/R
S	2193-2350	19	72	0.65	340	L/R
C	4600-5100	100	127	0.70	550	L(R)
X-n	8180-9080∗	41	48	0.68	210	L/R
X-wL	8180-9080#	41	67	0.68	300	L/R
X-wH	7860-8360#	-	67	0.68	300	L/R
K	22000-24000	105	141	0.5	850	L(R)
Ka	31700-33700	85	150	0.4	1100	R(L)
Q	42300-44900	180	350	0.3	3500	L(R)

∗ : 8 GHz LNA narrow band use. # : 8 GHz LNA wide band use.
⋆ : Narrow bandwidth filter, 1405 – 1435 MHz, is used generally to mitigate RFI.

3. Staff

The engineering and technical staff of the Kashima 34-m radio telescope are listed in Table 3. Dr. Sekido returned to KSRC in March 2011, and he is now continuing the development of the K5 system.

4. Current Status and Activities

The M_w 9.0 megaquake hit the 34-m antenna on March 11th, 2011. We suffered from strong ground motion, and a 5.2-m high tsunami attacked the Kashima port as shown in Figure 2. In addition, we were facing serious restrictions due to the Fukushima nuclear accident. Fortunately, we have no staff casualties in KSRC/NICT. Coseismic crustal deformations measured by our GPS station near the 34-m antenna showed movements of up to 749 mm in the horizontal (eastward) and

Table 3. The engineering and technical staff of the Kashima 34-m radio telescope.

Name	Main Responsibilities
KAWAI Eiji	responsible for operations and maintenance
SEKIDO Mamoru	technical development for time and frequency (T&F) transfer
TAKEFUJI Kazuhiro	T&F experiments using VLBI facilities
HASEGAWA Shingo	K5 operation and data transfer
ICHIKAWA Ryuichi	responsible for the project
KONDO Tetsuro	software correlator development and e-VLBI

-245 mm in the vertical. Moreover, post-seismic deformations following the main shock reached values of over 270 mm in the horizontal and about 100 mm in the vertical component as recorded until the end of July.

We carried out an operational repair of the antenna (i.e., repainting of the main dish and rust-proofing of the antenna structure) starting on the first of January, 2011. The repair was supposed to be finished by the end of March. However, the repair was stopped due to the earthquake. The repair was restarted in April, and it was finished at the end of June. After the repair, we investigated earthquake damage carefully. Unfortunately, the gear reducers, the power and helium plumbing, the azimuth track wear strips, and one azimuth wheel were damaged by the strong motion which exceeded 650 gal as recorded around the Kashima region. In 2011, the operation time of our 34-m antenna was only 364 hours in total. About 60% of the operation time was used for earthquake damage investigation. The other facilities at KSRC/NICT (e.g., the main building, the guest room building, and the outreach building) are also partly damaged. Thus, these buildings are currently under repair.

5. Future Plans

First, we have to fix damage of the 34-m radio telescope due to the earthquake as soon as possible. Though the damage is severe, we are going to repair them by the end of the next fiscal year. In addition, we have a plan to install new AZ/EL driving units into the antenna in this fiscal year.

References

[1] Kawai, E., M. Sekido, R. Ichikawa, Kashima 34-m Radio Telescope, International VLBI Service for Geodesy and Astrometry 2008 Annual Report, NASA/TP–2009-214183, D. Behrend and K. D. Baver (eds.), pp. 114–117, 2008.

[2] "Koho Kashima (Kashima public relations, `http://city.kashima.ibaraki.jp/20kouhou/data/20110401/0401_all_ver2.eps (in Japanese)`)", No. 393, April 1st, 2011.

[3] Kawai, E., J. Nakajima, H. Takeuchi, H. Kuboki, T. Kondo, M. Suzuki, K. Saito, RFI mitigation at a 2 GHz band by using a wide-band high-temperature superconductor filter, J. Geod. Soc. Jpn., Vol. 54, No. 1, pp. 31–37, 2008.

Figure 2. Earthquake damage in Kashima city. (a) A tsunami struck the Kashima port and surrounding area [2], (b) train rail bent by powerful ground motion, (c) cargo containers thrown around by the tsunami in Kashima, (d) Kashima port hit by the tsunami, (e) ripple mark of 34-m antenna azimuth rail caused by strong motion, (f) broken road in front of the KSRC/NICT main building (photos (b) and (f) were taken by Dr. Kondo).