JARE Syowa Station 11-m Antenna, Antarctica

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Abstract

Syowa Station is located at 69.0 deg S and 39.6 deg E on East Ongul Island, Antarctica. The Japanese Antarctic Research Expedition (JARE), which is coordinated by the National Institute of Polar Research (NIPR), operates the 11-m S/X band paraboloid antenna for VLBI, and for receiving data from the EXOS-D and the ERS-2 satellites. Brief reports on current status and on-going project of VLBI observations are presented.

1. Introduction

The National Institute of Polar Research (NIPR) constructed an S/X band 11-m paraboloid antenna at Syowa Staton, Antarctica in 1989 [1]. Although its main purpose was to receive data from the EXOS-D "AKEBONO" satellite and the MOS-1 "MOMO" satellite, it was designed to be capable of making geodetic VLBI observations. At an initial stage, there was no dedicated back-end system nor stable frequency standards, but a test VLBI observation was made between Syowa, Tidbinbilla and Kashima in 1990 by JARE-30, using a temporary receiver system and a Cesium frequency standard, in close collaboration with the Communications Research Laboratory (CRL). This experiment resulted in a successful baseline determination with Syowa Station [2]. After a long pause of eight years, integration of the permanent receiver/back-end system and hydrogen maser system was made by JARE-39 at the end of December 1997. For the three expeditions from JARE-39 through JARE-41, regular (quasi-seasonal) geodetic VLBI observations were made/planned among the University of Tasmania 26 m antenna at Hobart and the Hartebeesthoek Radio Astronomy Observatory (HartRAO) 26 m antenna, and the first regular experiment (named SYW981 experiment) was made in February 1998. Because JARE members change every year after one-year wintering, the 11-m telescope (Figure 1) was operated and maintained by the staff who participated in JARE from the National Astronomical Observatory (NAO; JARE-39) and from the Geographical Survey Institute (GSI; JARE-40).

2. Antenna Specifications

2.1. Mechanical System

The Syowa 11-m telescope has an ability of the maximum slew rate of 10 degree per second in azimuth within the range from -270 degree to 270 degree, but we operate it under 6 degree per second speed to prevent mechanical wear. The maximum slew rate in elevation is 6 degree per second within the range from 0 degree to 180 degree. As the telescope is covered with a 17 m radius radome, it can endure 60 m/s blizzards, and weathering/corrosion of the antenna panels was found to be insignificant by the inspection made in 1997. Although rare, some part of radome is likely to be covered with snow (especially in September), which decreases the signal strength. The mechanical performance and related parameters of the telescope are summarized in Table 1. Regular inspections of the driving motors and preparations of spare units by the JARE winter-over member from the manufacturer (NEC Corporation) substantially reduce unexpected troubles,

Figure 1. Syowa Station and the antenna radome.

but accidental power failure of the facility caused several damages to the electrical units/boards previously.

Table 1. Specification of the Syowa 11-m antenna.

Maximum Speed in Azimuth	10 °/sec.
Maximum Speed in Elevation	6 °/sec.
Drive Range in Azimuth	±270°
Drive Range in Elevation	0-180°
Pointing Accuracy	within 0.02 ° rms.
Verticality of Azimuth axis	within 0.004 °
Endurance Wind Speed	60 m/sec.
Panel Surface Accuracy	applicable to 22GHz experiment
Latitude	$-69°00.4'$
Longitude	$39°35.2'$

2.2. Receiver System

Currently available receivers are S and X bands. The LNAs are not cooled; the system noise temperature for X-band is estimated as around 186 K for the average of 7700-8600 MHz, while that for S-band is estimated as around 91 K for the average of 2100-2500 MHz. According to the source on/off test of ORI-A, aperture efficiency of X-band is obtained as 48%, while that of S-band is obtained as at worst 50%. Thus SEFDs are 11230 and 5300 for the X and S bands, respectively. The receiver characteristics are summarized in Table 2.

Table 2. Receiver performance of the Syowa 11-m antenna.

Band	Frequency (MHz)	Tsys (K)	Efficiency	SEFD (Jy)
S	2200-2320	91	0.50	5300
X	7860-8600	186	0.48	11230

2.3. Hydrogen Maser Systems and Time Comparison

Two hydrogen maser systems (Anritsu RH401A) were installed at the site and one of them is used for the frequency reference. Cable length between the hydrogen maser and the receiver unit is 150-160 m. The frequency standard system is also equipped with a Cesium frequency standard (HP8508A), and is synchronized to UTC by using a GPS time receiver.

2.4. VLBI Back-end System

The VLBI back-end system basically adopted at Syowa Station is called K4-TCU (Timing Control Unit) system. Three PCs are used, where the first one is used for VLBI field system (FS9 compatible), the second one is used for pointing control and the third is used for delay calibrations. At present, there are no on-line meteorological sensors, and editing of the log-file from the information by the JARE meteorological observatory is necessary. As a back-up field system, Syowa has a Mark III type field system (called GAOS by GSI). The sampling/recording specification is summarized in Table 3.

Table 3. Sampling/recording specification of the Syowa 11-m VLBI antenna.

Bandwidth	2 MHz or 4 MHz
Sampling rate	4 Mbits/s or 8 Mbits/s
Sampling bit	1 bit
Channels	16
Recording rate	64 Mbits/s or 128 Mbits/s
X band	6 ch, 2217 - 2302 MHz
S band	8 ch, 8210 - 8570 MHz

3. On-going Project

As part of JARE Earth science program titled "Study of dynamical process of the Earth by geodesy and solid-earth geophysics", NIPR made an agreement with the Australian VLBI group and HartRAO to do 48-hour geodetic VLBI observations four times a year for the three expeditions (JARE-39 through -41). Four observations (SYW981, SYW982, SYW983, SYW984) were made in 1998. As the correlator processing of the Syowa data basically depends on the Mitaka VSOP correlator of NAO, and as the hybrid correlation of the S2-K4 data is still in a development stage, baseline solutions for the above experiments are not obtained yet [3]. However, the SYW984 experiment showed clear fringes for any combination of the station pairs, and configuration of the Syowa VLBI system was proved to be adequate for the intercontinental geodetic VLBI observations. JARE is rather flexible concerning programs on station geophysics, and participation in the other international VLBI programs (CRF07 and COHIG-6) was realized in February 1999. The D1 tape recorded data were tried to be copied on a Mark III tape, but time stamps were found to have many bit errors, and copying is not completed yet.

4. Staffs for the JARE Syowa Station 11-m antenna

- Kazuo Shibuya, Project coordinator at NIPR.
- Koichiro Doi, Liaison officer at NIPR.
- Seiji Manabe, Project coordinator at NAO Mizusawa.
- Takaaki Jike (from NAO Mizusawa), Chief operator of JARE-39 (Feb. 1998 - Jan. 1999).
- Teruhito Tanaka, Antenna maintenance staff of JARE-39.
- Yoshihiro Fukuzaki (from GSI), Chief operator of JARE-40 (Feb. 1999 - Jan. 2000).
- Takeshi Ino, Antenna maintenance staff of JARE-40.
- Koichiro Doi (tbd), Chief operator of JARE-41 (Feb. 2000 - Jan. 2001).
- Seiji Takao (tbd), Antenna maintenance staff of JARE-41.

As there are few staffs at NIPR, Antarctic VLBI is accomplished by a consortium with NAO, GSI, CRL and NIPR staffs; the principal scientists are listed as authors of [3].

5. Concluding Remark

Syowa Station is located on a firm bedrock area without sedimentary layer and is situated in a geographically important position for global geodynamics. Colocation observations using DORIS, GPS, PRARE, STS-1 seismometer and pressure- sensor sea-level meter are continuing, e.g. [4]. We have a proposal to continue VLBI for the coming five-year JARE project (JARE-42 through JARE-46).

References

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