The 6 m VLBI Telescope at Kagoshima, Japan

Toshihiro OMODAKA[1], Masaki MORIMOTO[1], Noriyuki KAWAGUCHI[2], Takeshi MIYAJI[2], Shigeru YASUDA[3], Tomonari SUZUYAMA[3], Takahiro KITAGAWA[3], Tomoyuki MIYAZAKI[3], Ley FURUYA[4], Takaaki JIKE[4], Keisuke MIYAZAWA[2], Hiroshi MIKOSHIBA[2], Seisuke KUJI[5], Osamu KAMEYA[5], and Kagoshima VLBI Group

[1]*College of Liberal Arts, Kagoshima University, Japan*
[2]*Nobeyama Radio Observatory, National Astronomical Observatory, Japan*
[3]*Faculty of Engineering, Kagoshima University, Japan*
[4]*Faculty of Science, Kagoshima University, Japan*
[5]*Mizusawa Astrogeodynamics Observatory,*
National Astronomical Observatory, Japan

Abstract. The 6 m telescope was moved from Nobeyama Radio Observatory to Kagoshima, southern tip of Japanese Islands, and a new VLBI station was constructed. The telescope is usable up to 100 GHz. At the present time, the telescope is equipped with a cooled HEMT amplifier in a frequency range between 20 and 28 GHz. Kagoshima-Nobeyama-Mizusawa interferometer VLBI experiments began in June 1993 with collaboration from the Nobeyama Radio Observatory, and Mizusawa Observatory.

The first fringe at 22 GHz were detected in H_2O maser sources toward Orion KL and W49N. The present paper discusses the status of the 6 m telescope.

1. Introduction

In Japan, two mm-VLBI telescopes have been performing. One is 45 m telescope at Nobeyama (NRO), and the other is 34 m telescope at Kashima (CRL). Recently, a new mm-VLBI telescope was constructed at Mizusawa (Mizusawa Astrogeodynamics Observatory). However, these telescopes are situated in the northern part of Japan. Our project is to construct a new mm-VLBI station in the southern part of Japan. The 6 m telescope at Nobeyama Radio Observatory was moved to Kagoshima (see Fig. 1) last December, mainly for the purpose of millimeter VLBI observations. The telescope is usable in a frequency range between 20 and 100 GHz. We have finished the construction of the antenna in this March including driving test and have installed a 22 GHz cooled receiver in April. The full width between the half maximum of the main beam is 9.5′ at 22 GHz.

The telescope is equipped with an acousto-optical spectrometer with band width of 40 MHz and frequency resolution of 37 kHz.

The observing site is located at Kinkohwan park in Kagoshima city at the

Fig. 1. Locations of Japanese mm-VLBI network telescope.

geographic coordinates 31°27′ 51.212″ and 130°30′ 25.723″ and an altitude of 87 m above sea level. Zenith optical depths have been measured and estimated to be less than 0.9 at 22 GHz in most cases. The first spectrum of H_2O maser toward the Orion KL was obtained in this June. VLBI experiments began in June 1993. In the present paper, we describe the present status of performance of the telescope and the first results of the 22 GHz VLBI experiment are reported.

2. Observing System

Figure 2 shows a system block diagram of the telescope. The front end of the receiver is 15 K cooled HEMT amplifier followed by a 5–7 GHz mixer. The first intermediate frequency (IF) is centered at 6 GHz with an instantaneous band width of 2 GHz. The system noise temperature including antenna noise temperature was measured to be about 200 K in the frequency range from 20 to 24 GHz. For wide band VLBI observations (B.W. ~2 GHz), we used the optical fiber cables, that is, the down converted IF signals are transformed into optical signal and transmitted through the wideband optical fiber cables to the backend systems in the observing room. The transmitted signals are transformed into video signals and the data are recorded with the K-4 system. Owing to the smallness of this antenna mm-VLBI observations require substantial technical efforts: The system has two distinctive characteristics as compared with current VLBI practice in order to improve the sensitivity. One is the capability of a burst mode operation (KAWAGUCHI, 1991) with a high speed sampler and a large capacity memory (32 Gbits). The other is a new bandwidth synthesizer mode operation using both high speed sampler and filters instead of video converters (SUZUYAMA *et al.*, 1994, in preparation). By introducing these new equipments, a marked increase of sensitivity will be expected. Optical fiber cables are used for transmission of wide IF band (2 GHz) for these new methods (SATO *et al.*, 1992).

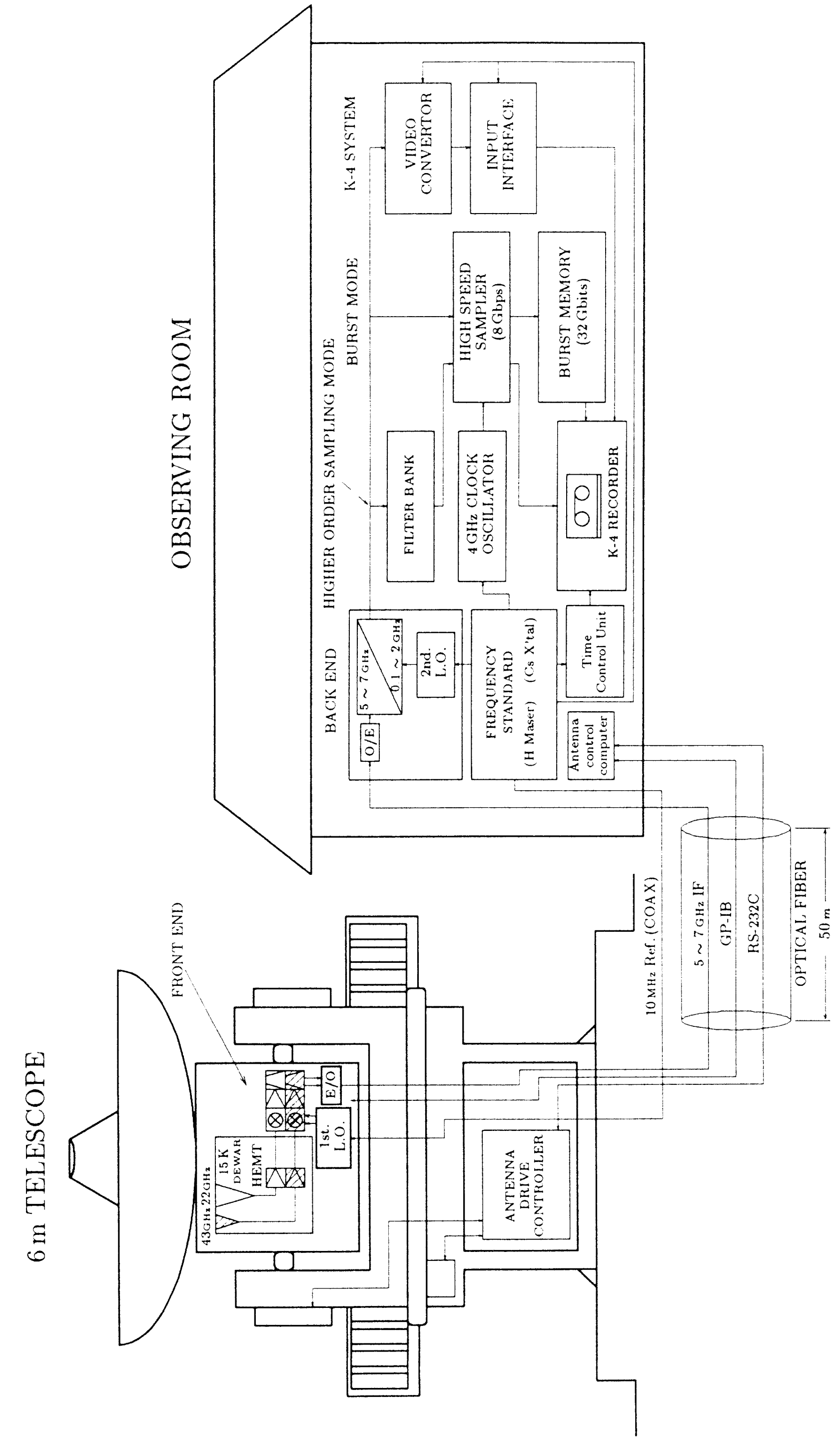

Fig. 2. Block diagram of Kagoshima station.

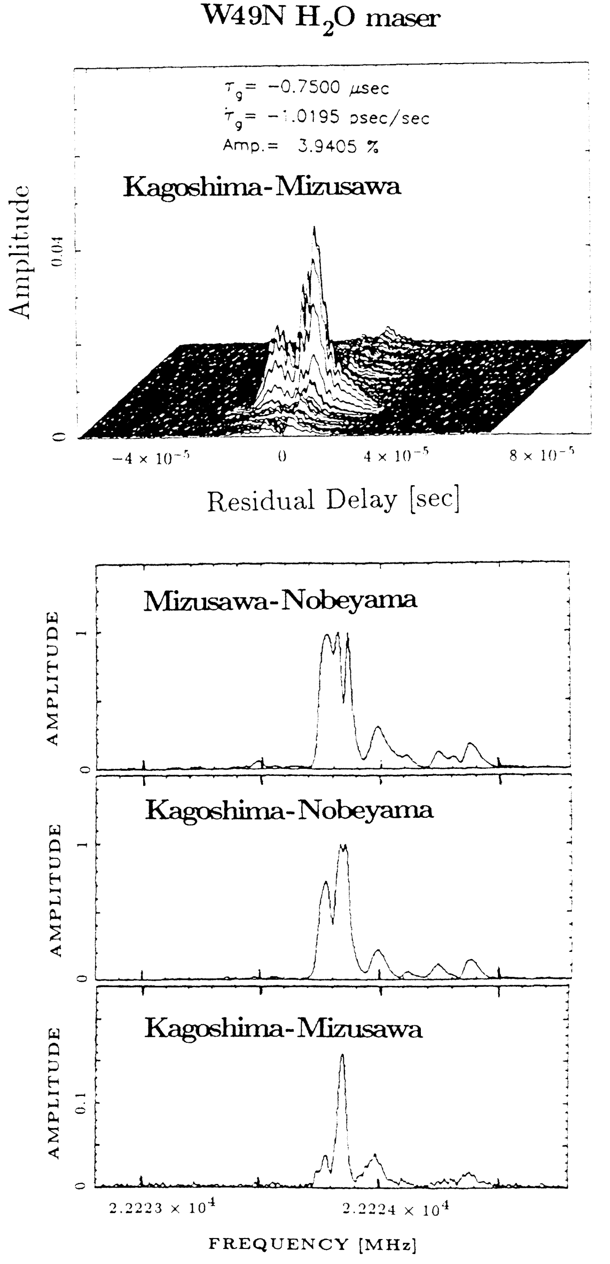

Fig. 3. Fringe amplitude as a function of residual delay and frequency.

Table 1. Parameters of telescopes.

Stations	Diameter (m)	Receiver	T_{sys} (K)	Frequency Standard	VLBI Terminal
Kagoshima	6	HEMT	200	H maser/CS	K4
Nobeyama	45	HEMT	150	H maser	K4
Mizusawa	10	HEMT	800	H maser	K4

3. VLBI Observations

We started the observations of H_2O maser sources in May and the first spectrum toward the H_2O maser sources in the Orion KL was obtained in June. On June 28, the first VLBI observations were conducted between Kagoshima 6 m and NRO 45 m telescope. Also, the second VLBI observations were done on October 27 between Kagoshima 6 m, NRO 45 m, and Mizusawa 10 m telescopes. We used the K-4 recording terminal with bandwidth of 2 MHz × 16 channels. As a frequency standard at Kagoshima station, we used a crystal quartz phase-locked to a Cs frequency standard for the first VLBI experiment and a hydrogen maser frequency standard for the second one. The observational parameters at the stations are given in Table 1. The correlation processing was carried out with the National Astronomical Observatory COrrelator (NAOCO). Figure 3 shows the obtained fringes toward the W49N H_2O maser sources for three baselines between Kagoshima 6 m, NRO 45 m, and Mizusawa 10 m (the longest baseline length is 1300 km). As is clear from the figures, the fringe for the longest baseline between Kagoshima and Mizusawa shows that the sources are clearly resolved compared with other baselines. We are now making maps by fitting, for each velocity channel, the relative phase with respect to the reference feature.

The 6 m telescope will join the Japanese millimeter VLBI network. The longest baseline of this network is 1300 km which provides a fringe separation of 1 mas at 43 GHz. This VLBI network will observe H_2O masers (in 22 GHz band), SiO masers (in 43 GHz band) sources and compact continuum sources.

REFERENCES

KAWAGUCHI, N., 1991, in *Proc. of Frontiers of VLBI*, 269–276.

SATO, K., HARA, T., FUJISHITA, M., KUJI, S., TAMURA, Y., SASAO, T., SATO, K., and MANABE, S., 1992, *IEEE Trans. on Instrumentation and Measurement*, **41**, 385–389.