Astrophysical Phenomena Revealed by Space VLBI
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1 Gbit VLBI System and Recent Observations

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Abstract

Since the aperture size of satellite radio-telescopes is limited, wide-band acquisition is the most effective approach to increase the sensitivity of space VLBI. The Communications Research Laboratory and National Astronomical Observatory have completed a 1-Gbit VLBI system and started astronomical and geodetic VLBI observations. This system is already working at the full 1024 Mbps (1 giga-bit/sec) rate. We introduce the Giga-bit VLBI system and describe recent observations.

1 Introduction

In order to improve angular resolution, we need long baselines. But, if we don't let improve sensitivity, there are only few sources which can be observed. The detection sensitivity in VLBI depends on the antenna diameter, integration time, and recording bandwidth. We think that improvement in bandwidth is the most important for next generation VLBI observing. A Giga-bit VLBI system has been jointly development by the Communication Research Laboratory and National Astronomical Observatory. We detected first fringes on 1998 July 10 and various observations are now being carried out.

2 Giga-Bit VLBI System

The Giga-bit VLBI system is shown in Figure 1 and the functions of the units making up the system are listed in Table 1.

The TDS-784/580 sampler was developed by Sony Tektronix. It is originally an oscilloscope, and we remodeled it as an A/D sampler for VLBI. This sampler has 4-channel 1024 M-sps A/D units with 8 bit resolution. We use only one-channel 1-bit data (1 G-sps) for our Giga-bit VLBI system.

Table 1: Function of the Giga-bit VLBI Unit.

Unit Name	Function
TDS-784/580	4ch 8bit A/D Sampler
DRA1000	Time control unit
	Data converter (VLBI data $\Longleftrightarrow$ HD-TV data)
GBR-1000	Data recording and playback
DRA2000	Global delay tracking
GICO	1 Gbps VLBI correlator

The DRA1000 was developed by Toshiba and Yamashita Engineering Manufacturing. This unit controls the Giga-bit VLBI system time. It converts the VLBI bit stream data into digital high-definition TV (HD-TV) image data for recording time and converts the HD-TV image data into a VLBI bit stream data for correlation.

The GBR-1000 was developed by Toshiba. It is designed for HD-TV recorders. It can record HD-TV digital image data without any compression. It is first recorder in the world to have a 1024 Mbps recording rate. This recorder uses metal-particle tape in a cassette and the recording time of each tape is one hour. This recorder unit is compatible with commercial recorders, so we can expect Toshiba technical support all around the world as well as TV broadcasting stations.

The GICO was developed by Oki Electric. This correlator's chip was developed by the National Astronomical Observatory. This chip was designed for the Nobeyama Millimeter Interferometer. It has only 4k bit memory for delay buffer and it can not remove large delay such as those encountered in global VLBI observations. To remove large delays, the DRA2000 was developed. This unit was developed by Yamashita Engineering Manufacturing. It has a 1024 Mbit buffer memory for delay tracking. Direct download from buffer memory allows data analysis on a personal computer. This was a very useful function during the development of our VLBI system.

3 Recent Observations

On 1999 December 25, we started high-z QSO ($z > 3.5$) survey observations at 22 GHz with the Nobeyama 45 m and Kashima 34 m telescopes.

Figure 1: Giga Bit VLBI system

These observations are very sensitive and we have detected many faint sources. During these observations, we tried a real-time fringe check system. Figure 2 shows the block diagram of our real-time fringe check system. Using the DRA2000's function, a software correlator and Internet data transfer,

We could find fringes very quickly without transportation of tapes. Figure 3 shows the first fringes with software correlation of data from observation of 3C 279. Our personal computer performed this correlation in several minutes. The real-time fringe check system is very useful for our Giga-bit VLBI system. It is thought that success rate of VLBI observations will improves greatly.

Currently, the Giga-bit VLBI system has been installed in Gifu, Nobeyama, and Kashima radio observatories. We are continuing the high-z QSO survey and have started geodetic VLBI observations.

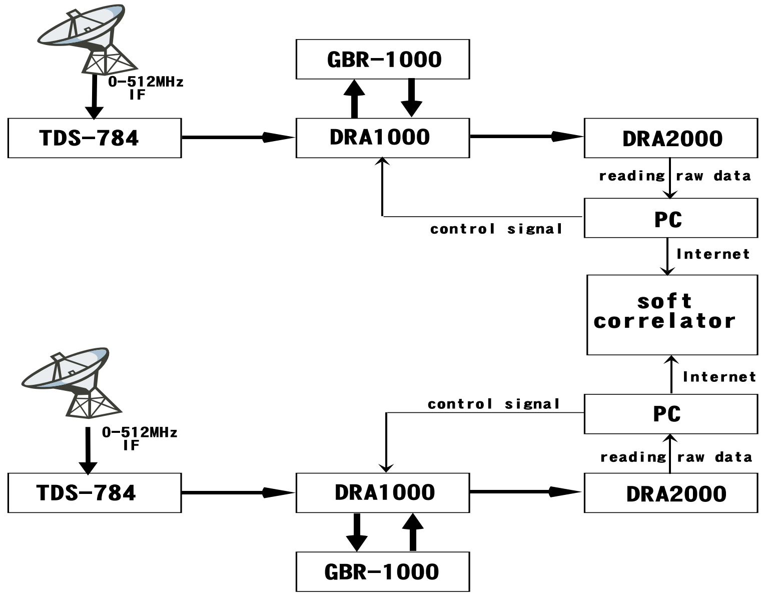

Figure 2: Real time fringe check system diagram

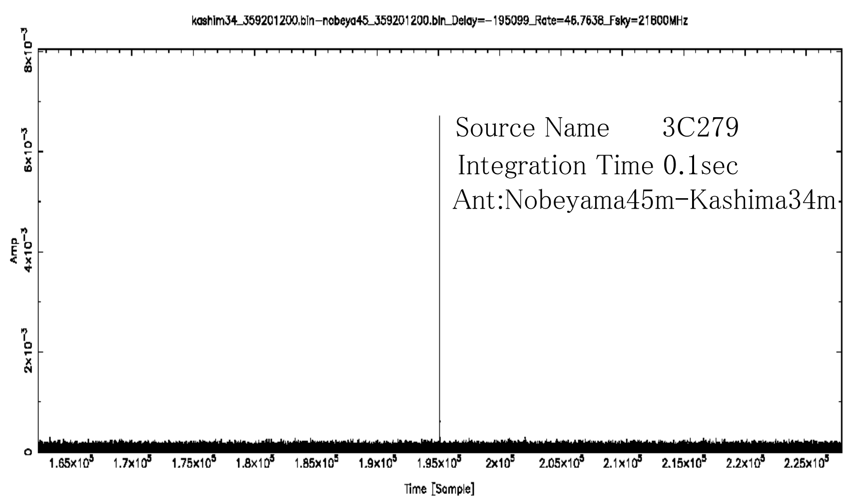

Figure 3: Result of software correlation