Tsukuba VLBI Correlator

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Abstract

At Tsukuba VLBI Correlator, we make, at first step, correlation process for VLBI domestic experiment in Japan with K-4 (KSP) correlator to obtain station positions, baseline length, etc. This report presents general information, correlation process and the related topics in 2001.

1. General Information of Tsukuba VLBI Correlator

In this section, we will explain the general information about Tsukuba VLBI Correlator. Tsukuba VLBI Correlator is located in Tsukuba VLBI Center in Geographical Survey Institute, Japan. At Tsukuba VLBI Correlator, we have K-4 (KSP) correlator developed by CRL and we can make correlation process for 3 stations, 3 baselines at once. With this correlator, it takes about 2 weeks to process the data of one domestic experiment in which 5 domestic stations participated. In Figure 1, we show the photo of K-4 (KSP) correlation devices at Tsukuba VLBI Correlator.

Figure 1. K-4 (KSP) correlation devices at Tsukuba VLBI center. The three boxes on the left are automatic tape changers. In each, a playback recorder is installed. There are two racks at the center. The three correlators, system controller and other devices are stored in the racks. On the right, there are workstation and disk array to run correlation software and SOLVE.

2. Correlation Processing

In 2001, we processed the following experiments at Tsukuba VLBI Correlator.

- 4 GSI regular domestic experiments carried out in 2001
- 3 GSI remote-controlled domestic experiments in 2001

- 5 Syowa experiments carried out in 1999 and 2000
- Short baseline experiment between TSUKUB32 and TSUKU3 (Aug. 2001)

The first two experiments are called JADE as session code. You can obtain the various information about the experiments, correlation and analysis on the GSI VLBI Web page or the NASA GSFC Web page. We have obtained the variation of baseline length or the displacement of each station as well as station positions and baseline length from these experiments.

In 2001, an accident happened to the SINTOTU3 antenna. The main reflector of SINTOTU3 antenna broke down due to the load of deep snow (Figure 2, left). In this area, snow had lain deeper than is usual in the winter. The broken reflector was replaced with the reflector of the TSUKU3 mobile antenna in summer and its function was quickly recovered. After the repair, SINTOTU3 took part in the domestic experiment starting with JADE-0105 in Oct. 2001 and we obtained results as before. Considering the heavy snowfall of last year, the SINTOTU3 antenna is now covered with a tent in winter (Figure 2, right) and we plan to cover it every winter. We can't, however, use SINTOTU3 antenna in winter as before. Now there remains only the foundation and basement of the mobile antenna after removing the reflector at TSUKU3.

Figure 2. Left photo: Broken main reflector of SINTOTU3. Right photo: Antenna cover of SINTOTU3 for protecting the reflector from snowfall (Dec. 2001).

As for the regular domestic experiments, GIFU3 which belongs to Gifu University also participated in the experiments and the processing was done at Tsukuba VLBI center. Moreover MIZNAO10 supported by National Astronomical Observatory of Japan took part in our JADE experiments which were carried out in Feb. and Nov. 2001. Remote-controlled experiment was in development; therefore fringes were not detected as much as with regular experiments because of troubles with ACU, formatter or the misoperation of automatic tape changer during the experiments. Short baseline experiment between TSUKUB32 and TSUKU3 was carried out for analysis with phase delay. However, fringes for the source (NRAO150, S-band) were not detected because the flux density was overestimated in the catalog by the scheduling program (sked).

3. Related Topics

In 2001, bugs in the programs for system controller, which calculates parameters to correct fringe phase, etc. and controls each device intensively, and bandwidth synthesis were fixed and ROMs installed in automatic tape changer and the protocol converter between the system controller and the automatic tape changer was replaced. We will make the detailed explanation for each topic.

3.1. Revised Program for System Controller (CRC-9511-CNT1)

Two major bugs were found in the program for system controller (CRC-9511-CNT1), and they were fixed. One was miscalculation of a priori value of rate. The other was that the system controller ordered the correlation devices to process with incorrect process time.

As for the former bug, a priori rate was calculated incorrectly, so fringes of some particular source or baseline were not detected. There was a problem in the algorithm for calculating a priori values. A priori delay and rate values used for correlation were calculated from the interpolation of 4th order polynomial. This polynomial was calculated from theoretical 5 delay values, at the PRT (processing reference time), the start time, the end time, the middle of the PRT and the start time, the middle of the PRT and the end time of an observation with Jacobi matrix. PRT was defined as the middle of start time and longest observation duration time for each scan. Assuming that the observation duration time of some baseline was half of the longest observation duration time of all baselines, there was no difference between PRT and the end time of the observation of the baseline. Therefore the order of Jacobi matrix was degenerate, and a priori values were not calculated correctly. This is the reason why a priori rate was calculated incorrectly. Now we define PRT as the middle of start time and shortest observation duration time for each scan. This problem was solved in Feb. 2001.

Regarding the latter bug, we have already reported in IVS 2000 Annual Report [2]. This bug, however, had not been completely fixed, and we didn't notice this bug for a while. The developer of this software fixed the bug in Mar. 2001.

3.2. Debug for Bandwidth Synthesis Program

The bug in the program for calculating ambiguity was found by Dr. Sekido at CRL. The greatest common divisor of frequency intervals among channels was occasionally not calculated correctly in case that some channels were not synthesized with bandwidth. This bug was fixed by Dr. Kondo at CRL in Apr. 2001.

3.3. ROM Update

There had been a lot of occasions forcing the suspension of the correlation process due to the hang up of the protocol converter. The program for controlling automatic tape changer and protocol converter was updated by Dr. Kiuchi at CRL. The updated ROMs were installed in each device of Tsukuba VLBI Correlator in Oct. 2001.

4. Staff

Staff of Tsukuba VLBI Correlator is as follows. The other staff of GSI VLBI is listed in the table on Tsukuba 32-m VLBI station in network section.

- Kohei Miyagawa : correlation chief, correlator operator
- Kyoko Kobayashi : correlator operator

Ms. Kobayashi will leave GSI on Feb. 28, 2002.

5. Plan for 2002

It is planed that the amount of correlation processing will increase. The reason is that the total number of experiments with K-4 system will increase. As one of GSI experiment plans, we plan to carry out remote-controlled domestic experiments regularly (7 times from May 2002 to Mar. 2003) in addition to regular domestic experiments. Either experiment is scheduled once a month. As a result of these intensive experiments, we are expecting to be able to monitor the variation of baseline length and the displacement of each station with higher temporal resolution. In addition to these domestic experiments, experiments between TSUKUB32 and WETTZELL are intensively scheduled 20 times to inspect UT1 variation in different baseline.

6. Acknowledgements

We'd like to express our gratitude to staff members of CRL VLBI for their support to our correlator such as bug fixes, program updates, etc.

References

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[2] Miyagawa, K., Tsukuba VLBI Center, In: International VLBI Service for Geodesy and Astrometry 2000 Annual Report, NASA/TP–2001-209979, N. R. Vandenberg and K. D. Baver (eds.), 176–177, 2001.