

# Tsukuba VLBI Correlator

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## Abstract

This is a report of activities at the Tsukuba VLBI Correlator in 2003.

## 1. General Information

The Tsukuba VLBI Correlator is located at Geographical Survey Institute(GSI) in Tsukuba, Ibaraki, Japan. The facility holds the K-4 (KSP) correlation system for processing geodetic VLBI experiments. It consists of three correlator units, three tape drive units housed in auto tape changers and a HP workstation to control the system and run Interactive CALC/SOLVE (NASA/GSFC). The workstation also provides a working area for executing correlation software, Oxtail Version 2.0, which was updated in March 2003 as described in the previous Annual Report.

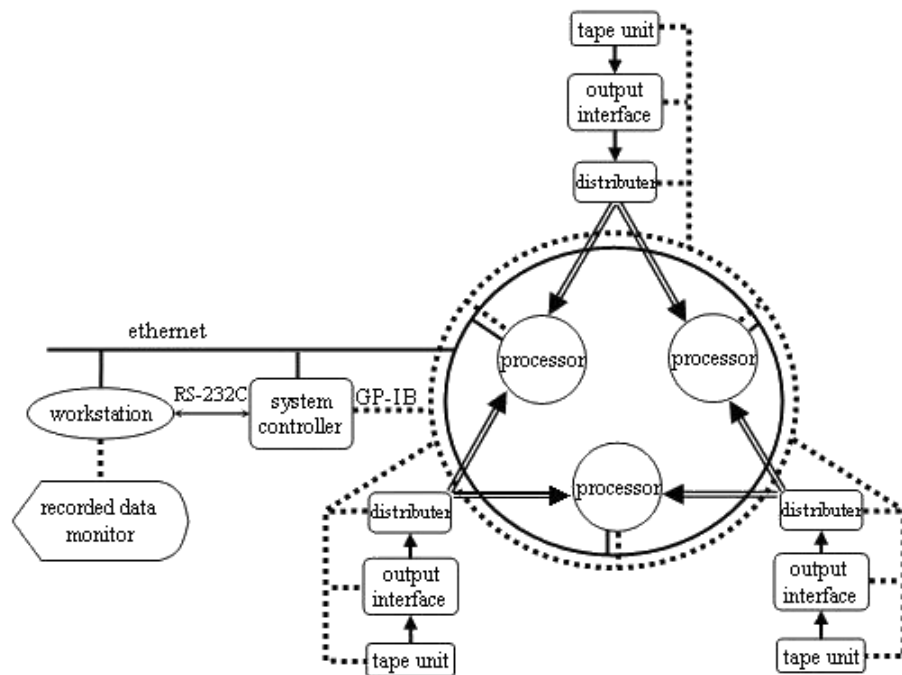


Figure 1. Diagram of K-4 (KSP) correlation system at the Tsukuba VLBI Correlator.

## 2. Correlation Processing

We extended the operational time due to the increased demand for geodetic correlation. During 2003, 11 domestic experiments, 28 intensive sessions and some fringe tests have been processed at the Tsukuba VLBI Correlator. The JADE (Japanese Dynamic Earth observation by VLBI) series are set monthly by GSI for monitoring plate motions and maintaining the International

Terrestrial Reference Frame in Japan. GSI's original VLBI network (GARNET or GSI Advanced Radiotelescope Network) stations regularly take part in the JADE experiments, and other stations with K-4 recording system can join JADE to determine their antenna positions. Due to that the capacity is not enough to process the data from all participating stations at once, we correlated only the data from the GARNET stations and the Mizusawa station at the Tsukuba VLBI Correlator, and the data from other participating stations were correlated by Gifu University or CRL at the KSP-VLBI Correlation Center of Kashima Space Research Center under an agreement between CRL and GSI. In 2003, it took several months to get all data put together into Mark III databases with several non-GARNET stations joined in JADE, and we handled as follows. As preliminary stage, we processed the GARNET and Mizusawa station's data and made databases to check the quality of the results. After these databases were submitted to IVS, we re-processed all baselines by adding the data of the other stations that were sent later from the KSP-VLBI Correlator at Kashima. We resubmitted it informing the re-processing to IVS analysts, because correlators normally submit databases to IVS only once.

Intensive sessions for determining UT1 were observed by the single baseline between TSUKUB32 and WETTZELL nearly weekly from April through December, 2003. At each session, we took 5-7 days to receive the data from WETTZELL and 1 day to complete the correlation processing and the primary solution. After the database was submitted to IVS, the final analysis were done at University of Bonn. We were confident that UT1 was determined with consistency by comparing our results to the WETTZELL-KOKEE baseline. The WETTZELL-KOKEE baseline is orthogonal to TSUKUB32-WETTZELL baseline and the intensive sessions of the WETTZELL-KOKEE single baseline is being carried out 4 times a week with Mark 5 recording systems. The results of these two baselines generally agreed each other in each experiment even though two different recording systems were used.

In the JADE experiments, no fringe had been detected on the baselines to SINTOTU3 in the GSI VLBI network since August, 2002. We tried to get to the reason for it in various ways and found that there was about -5 msec of gross time deviation on the local time system, which was caused by unlocking 1 pps signal in the GPS timing receiver. We tried to do fringe test with setting the stations's clock offset -5.165 msec and finally succeed in fringe detection. Some of previous JADE experiments such as JADE-0206 were re-processed with the offset and new databases were re-submitted to IVS.

In the intensive sessions, because of equipment failures, we lost the data of several sessions, which were not taken into account of 28 sessions.

### 3. Global Solution

The set of coordinates of GSI VLBI stations is to be a basis for defining the framework in the geodetic datum of Japan. However, the GSI VLBI stations except TSUKUB32 are not members in the major IVS network stations that the positions and velocities have been determined on a worldwide scale with global solutions using the CALC/SOLVE etc. The JADE experiments that these GSI VLBI local stations take an active role do not have the advantage of estimating EOP, because the baselines are not intercontinental. Consequently, the weights of these stations are set too low on the conventional global solutions on a regular basis such as for EOP. In this circumstances, we have approached to determine these local station position/velocity with few mm precision in our research activities in 2003. Preliminary results (Table 1) can be reviewed on the

web (<http://vldb.gsi.go.jp/sokuchi/vlbi/solutions/>).

Table 1. Station position with global solution by GSI

station	X [m]/sigma	Y [m]/sigma	Z [m]/sigma	session
TSUKUB32	-3957408.777	3310229.389	3737494.810	159
	0.001	0.001	0.001	
SINTOTU3	-3642142.083	2861496.672	4370361.833	25
	0.004	0.003	0.004	
AIRA	-3530219.321	4118797.578	3344015.867	30
	0.003	0.003	0.003	
CHICHI10	-4490618.487	3483908.175	2884899.137	32
	0.003	0.003	0.003	
TOMAKO11	-3680586.461	2917515.862	4300987.820	4
	0.012	0.012	0.011	
KASHIM11	-3997505.669	3276878.395	3724240.692	9
	0.001	0.001	0.001	
MIZNAO10	-3857236.104	3108803.215	4003883.080	15
	0.004	0.003	0.004	
VERAMZSW	-3857241.871	3108784.809	4003900.612	4
	0.007	0.005	0.007	
GIFU11	-3787123.441	3564181.761	3680275.133	9
	0.032	0.029	0.031	
GIFU3	-3787518.273	3564247.177	3679797.254	5
	0.022	0.020	0.021	

#### 4. Related Topics

In the process of correlation and primary solution, we often found our station's problems affected the quality of results such as clock breaks and unstable thermal environments. To improve the quality of data obtained from the stations, we checked the data each time after experiments and fed back the information to the stations each time when a defect occurred (Figure 2).

We upgraded the management system of D1 tape, which was introduced in July 2002, with a handy barcode reader to reduce tape librarian's burden.

The geodetic department of GSI will be reorganized from April 2004. The GSI VLBI group will belong to a newly established space geodetic division.

#### 5. Staff

- K. Takashima : Operation manager (GSI).
- M. Machida : technical staff (GSI).
- M. Ishimoto : technical staff, intensive setups (GSI).

- S. Kurihara : technical staff, global solution analyst (GSI).
- K. Sakamoto : operator in charge of routine correlation processing (Space Engineering Development Co., Ltd).
- T. Nishino : operator in charge of routine correlation processing (Space Engineering Development Co., Ltd).

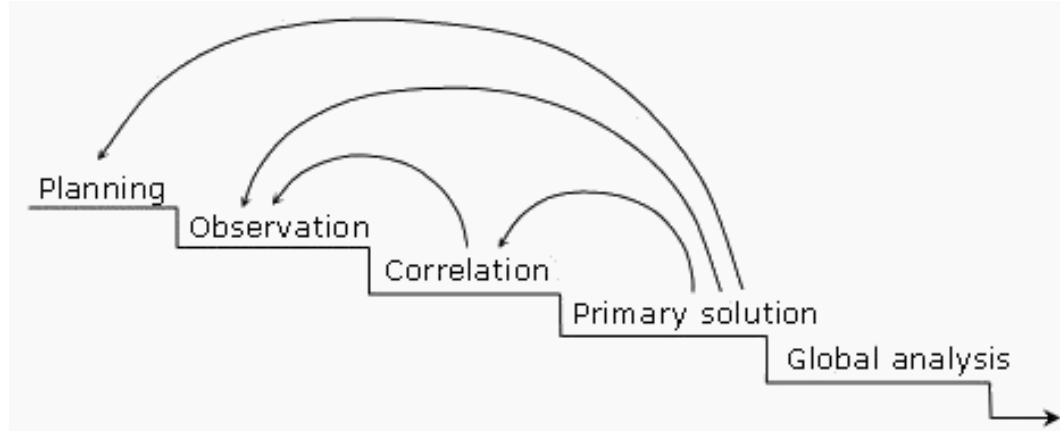


Figure 2. Water-fall model for VLBI operations at GSI

## 6. Plan for 2004

From April 2004 to March 2005, GSI is planning 12 JADE experiments. Because GSI is shifting the recording system of GSI network stations toward the disk-based K-5 recording system in early 2004, we will need a K-5 compatible correlation system to deal with the K-5 data at Tsukuba. We are considering to increase the number of UT1 intensive sessions in 2004. The sessions on Saturday will be observed with the K-4 recording system as usual. The weekday's sessions are expected to be run by Mark 5/K-5. It seems that introducing the K-5 system to the Tsukuba VLBI Correlator would be useful in land surveying as well as in navigations with on-line data transfers. The current tape based correlator has the ability to process 3 baselines for 3 stations simultaneously. It could be still usable for JADE experiments to confirm the data by the K-5 system. We are planning to expand it to process 6 baselines for 4 stations simultaneously for more efficient correlating processing.

## References

- [1] S. Kurihara, K. Takashima, T. Tanabe, H. Kawawa, K. Miyagawa: IVS Intensive VLBI Experiments for UT1 determination between Tsukuba and Wettzell, Journal of the Geographical Survey Institute 2003 Vol. 102, 3-10, 2003.(in Japanese)