# KSP-VLBI Correlation Center Report

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**Abstract**

Communications Research Laboratory has been regularly operating Key Stone Project (KSP) VLBI experiments to monitor crustal deformation around the Tokyo metropolitan area. The KSP system detected crustal deformation in the south part of the Kanto region due to volcanic activities at Izu islands in 2000. Daily 23.5-hour VLBI experiments were performed to monitor the crustal motion. Such frequent experiments could not be performed without a real-time VLBI system. At beginning of 2001, Miura station was closed and the other three stations will continue monitoring of crustal movement. Optically linked real-time VLBI experiment with Usuda 64m antenna and Kashima 34m antenna was also performed several times.

## 1. Introduction

Communications Research Laboratory (CRL) has been doing regular geodetic VLBI experiments to monitor crustal deformation around the Tokyo metropolitan area. The name of the project is Key Stone Project (KSP) [1]. The KSP VLBI has two types of correlation processing systems. One is a tape-based VLBI correlation system [2][3] and the other is a real-time VLBI correlation system [4][5][6] (Figure 1). Both systems are operated at a data rate of 256 Mbps. KSP VLBI with four stations started in tape-based mode from fourth quarter of 1996 and 256 Mbps real-time VLBI observation started third quarter of 1997 by using Asynchronous Transfer Mode (ATM) network under collaboration with NTT (Nippon Telephone and Telegraph Corporation). Tape-based and real-time VLBI correlation processing is performed with 6 units of single baseline correlators, correlation controller and operation software with GUI interface designed for easy operation [7].

## 2. Correlation Center History of Routine KSP Operation

Real time VLBI experiments had been operated every other day with three stations (Kashima, Koganei, and Tateyama) for 23.5 hours, since optical fiber link of Miura station was closed in May 1999. The reason for the observation interval is to reduce abrasion of antenna system. Four-station tape-based VLBI observation had been performed once every 6 days. The reason for the low frequency of observation with the four-station tape-based system was that correlation processing of tape-based data took much time. Tape-based observations every other day is hard for both operator, tape recorder, and tape changer machine. Mechanical motion is the most frequent cause of the troubles in routine operation. From this point of view, real time VLBI was indispensable for daily VLBI observation as described in a later section.

In July 2000, shortening of the Kashima-Tateyama baseline was detected and the observation schedule was changed from every other day to every day with three stations and tape-based four-station VLBI observation every 6 days. The crustal deformation was found to be caused by volcanic activities in the Izu islands located about 100km south west of Tateyama. The daily VLBI observation continued to 11 November 2000, then the observation mode was changed to the same as before July, since rapid changing of the baseline length was finished and the change rate returned to the same state as before July. Miura station was closed after tape-based four-station

Figure 1. The KSP tape-based VLBI correlation system (left) and the KSP real-time VLBI correlation system (right) at Koganei, In the left figure, four racks at the left are automatic tape changer (DMS-24). The right three racks contain correlators, output interfaces, and correlation controller. All of these tape-based equipment will be transported to Kashima Space Research Center in near future.

VLBI observation on 4th January, because it had been planned before. After that date, routine KSP VLBI observations have been carried out by real-time VLBI with three stations.

Except for the routine KSP VLBI observation, domestic VLBI observation campaign has been performed for connection of KSP stations and Japanese geographical reference frame to international reference frame. The name of the campaign is JPNTI. The JPNTI VLBI experiments using KSP 4 stations, Kashima 34m antenna, Kashima 26m antenna, and Tsukuba 32m antenna were conducted in March, June, September, October, and November in 2000. The next JPNTI experiment is planned in February 2001. Most of these experiments were processed with the KSP correlation system.

KSP VLBI Kashima-Koganei baseline was also used for Giga-bit VLBI system performance check experiments, which were named GEX series. GEX-8 in May and GEX-9 in June 2000 were organized for delay measurement accuracy comparison between KSP and Giga-bit VLBI system.

## 3. Optically Connected VLBI Experiments

Optically linked VLBI experiments with large diameter antennas named GALAXY were performed several times under mutual collaboration among CRL, NTT, National Astronomical Observatory (NAO), and Institute of Space and Astronautical Science (ISAS). Kashima 34m antenna (CRL), Usuda 64m antenna (ISAS), KSP 11m antennas, and rarely Nobeyama 45m antenna (NAO) joined the observations. Currently the only established real-time VLBI correlation system is the KSP correlator in Japan. Thus all the real-time VLBI experiments are processed at Koganei Correlation center at present. Also distributed multi-baseline correlation processing was demonstrated with the KSP correlator by sending observed data via ATM network at NTT R&D Forum 2000. NAO's Mitaka FX correlator is under preparation for adapting to real time processing.

## 4. Technical Staff for the KSP VLBI Correlation Center

Technical staff members who are contributing to the KSP correlation center are listed below.

- Tetsuro Kondo, Responsible for overall operations and performance.
- Taizoh Yoshino, Leader of the Key Stone Project team in CRL.
- Hitoshi Kiuchi, Developments of correlation system and real-time VLBI interfaces.
- Jun Amagai, Responsible for management of correlation center.
- Mamoru Sekido, Development of correlation processing software.
- Naoki Goto and Muneo Takeda, Hiroyuki Shibata, Operator at the correlation center, Space Engineering Development Co., Ltd.

## 5. Current Status and Future Plans

After tape-based data processing including JPNTI experiments have finished, tape-based correlation system (Figure 1) will be transported to Kashima Space Research Center for data processing of experimental VLBI observation.

## References

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