VLBI Correlators in Kashima

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Abstract

Correlators at Kashima were used for processing of experimental VLBI observations. Software correlators are being developed for specific purposes. Activities of NICT's group related with correlators are reported.

1. General Information

Kashima Space Research Center of National Institute of Information and Communications Technology (NICT: former Communications Research Laboratory) has been contributing to VLBI community by development of VLBI technologies. Environment of VLBI technology is changing owing to rapid growth of technologies in three points: computational power of personal computer (PC), miniaturization and boosting in recording capacity on hard disk drive (HDD), and availability of high speed network. It is making differences in some view points: data transportation, turn around time, flexibility of processing technique, and spreading VLBI education to universities.

Software correlators, using clusters of general purpose PCs, have the potential to reach and to overcome the performance of hardware correlators. The VLBI group at NICT is working for development of software correlator and for their application to geodesy and spacecraft observation as an engineering application. Figure 1 shows a view of observation room of the 34m station. The cluster of PCs, which are used for VLBI data acquisition, are also used for correlation processing. Data observed at other stations are transfered through the Internet or by usual mail and stored on HDD of other PCs. The distributed correlation processing is performed by sharing these data via Local Area Network.

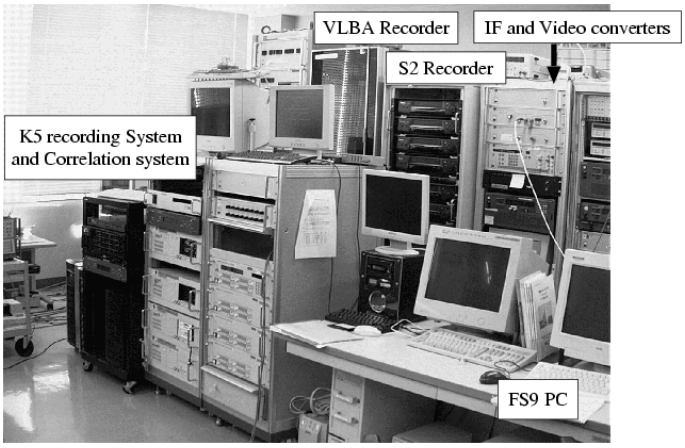

Figure 1. A K5 system located in observation room of 34m station. Since the K5 system is composed of a cluster of PCs, these PCs are used for both observation and correlation processing.

2. Component Description

2.1. Data Processing for Geodesy

Continuous VLBI campaign 2005 was organized in September 2005. Kashima 34m station did not officially participate in the observation, although VLBI observations were performed with the same schedule during a part of the campaign period. The data was recorded with 16Msps-1bit-16ch mode. Observed data at Tsukuba 32m station, which fully participated in the campaign, was transfered to Kashima and correlation processing was performed for Kashima-Tsukuba one baseline with software correlator.

GEX-13 (Giga-bit series VLBI experiment) was performed between Kashima 11m and Koganei 11m baseline with ADS-2000 in 32Msps-2bit-16ch mode [1]. The observation data were stored on HDD of PC through VSI-interface card. The data were converted to K5 format data files, then they were processed via software correlator.

2.2. Data Processing of Spacecraft Observation

A series of VLBI experiments for spacecraft HAYABUSA were organized with domestic VLBI stations in Japan. HAYABUSA, launched by Japanese space agency (JAXA/ISAS), is an exploration mission of asteroid (ITOKAWA). Basic observation strategy is measuring geometrical delay for spacecraft with differential VLBI technique by observing nearby quasars. Delay data of quasar have been derived by bandwidth-synthesis technique in the same way as with geodetic VLBI. Regarding the delay measurement for the spacecraft, two sorts of delay observables—group delay and phase delay—are under investigation. Since the bandwidth of the spacecraft's signal is not so wide as quasar, the precision of group delay observable is not always enough depending on the signal types. Thus phase delay is thought as alternative choice to get higher delay resolution, even the ambiguity of phase is an issue to be solved. Data reduction of group delay is performed with software correlator *fx_cor* as the same with geodetic VLBI. Phase delay observables are extracted with a special correlation software for the signal of spectral line. The flexibility in this kind of special data processing is an advantage of software correlator.

2.3. Data Processing of Wide-band and Real Time VLBI

Two sorts of VLBI experiments with wide bandwidth in single channel were performed with Kashima 34m and Kashima 11m antennas. One experiment is performed in 4 Gbps (2Gsps-2bit) data rate. Observed signal was sampled with ADS-3000 [2] and recorded with 2 set of PCs through VSI-interface cards at each station. Software correlator developed by Takeuchi was used for processing. The result of first fringe with the ADS-3000 is reported in IVS-GM 2006[2].

Another VLBI experiment was real-time VLBI with ADS-1000 sampler [3]. Observation data rate was 1 Gbps (512Msps-2bit), although a quarter of the data rate was taken for real-time correlation processing and other part of data was discarded. Then real-time correlation processing in the data rate 256 Mbps (128Msps-2bit) was achieved via a software correlator, which is developed by M. Kimura. This processing was performed with Optiron Dual core 1.6GHz CPU. The reason for discarding three quarters of data rate was the limited hardware resources at that time. Real-time Giga-bit rate processing should be available with some more PC resources with high performance CPUs. Further information on the technology development will be found in NICT Technology

Development Center report in this issue [4].

2.4. KSP Correlation System

KSP correlation system[5, 6] was operational (Figure 2), although data processing with hardware correlator was not performed in this year. Geodetic VLBI experiments of Antarctica, which are organized by National Institute of Polar Research (NIPR), have been recorded with K4 and S2 system so far. Now K5 VLBI system is installed and used for VLBI observation in Syowa station in Antarctica; still some VLBI data recorded in S2 and K4 system are not completely processed yet. Thus the use of our KSP correlation system for the data processing of those VLBI experiments is being consulted now.

Figure 2. KSP Correlator room. The KSP hardware-correlation system, which has capability of 4 stations and 6 baselines of tape-based VLBI data processing.

3. Staff

- Tetsuro Kondo is working for development of software correlators, which is mainly used for geodetic VLBI.
- Yasuhiro Koyama is in charge of overall activity in our group. He is intensively working on e-VLBI on intercontinental baseline.
- Mamoru Sekido is in charge of KSP correlation system and is working on VLBI applications for spacecraft navigation.
- Moritaka Kimura is working on the development of a high speed Giga bit software correlator. He is in charge of development of next generation software correlators for VERA project of National Astronomical Observatory in Japan.
- Hiroshi Takeuchi is working on the next generation high speed sampler (ADS-3000), which has programmable data processing (digital BBC) capability, and software correlator for it.

References

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