Technology Development Center at NICT

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Abstract

The National Institute of Information and Communications Technology (NICT) leads the development of the VLBI technique and is highly active in both observations and technical developments. This report gives a review of the Technology Development Center (TDC) at NICT and summarizes recent activities.

1. TDC at NICT

NICT's IVS Technology Development Center publishes the newsletter "IVS NICT-TDC News (former IVS CRL-TDC News)" at least once a year in order to inform about the development of VLBI related technology . The newsletter is available through the Internet from the following URL **http://www2.nict.go.jp/w/w114/stsi/ivstdc/news-index.html**.

2. Staff Members of NICT TDC

Table 1 lists the staff members of NICT who are involved in the VLBI Technology Development Center.

Table 1. Staff Members of NICT TDC as of January 2011 (alphabetical).

Name	Works
AMAGAI, Jun	QZSS[1], GPS analysis, TWSTFT[2]
HASEGAWA, Shingo	K5/VSSP32, K5/VSI
HOBIGER, Thomas	QZSS[1], e-VLBI, GPS, GNSS analysis
ICHIKAWA, Ryuichi	MARBLE[3] system, VLBI analysis
ISHII, Atsutoshi	MARBLE[3] system
KAWAI, Eiji	34-m and 11-m antenna system
KIMURA, Moritaka	Giga-bit system, K5/VSI, Software correlator, e-VLBI
KONDO, Tetsuro	K5/VSSP32, Software correlator, e-VLBI
KOYAMA, Yasuhiro	e-VLBI, Group reader
MIYAUCHI, Yuka	Software correlator
SEKIDO, Mamoru	e-VLBI, Delta-VLBI, VLBI analysis
TAKEFUJI, Kazuhiro	ADS3000+ system
TAKIGUCHI, Hiroshi	VLBI analysis, e-VLBI, GPS analysis
TSUTSUMI, Masanori	K5 system, ADS3000+ system

[1] QZSS: Quasi-Zenith Satellite System
[2] TWSTFT: Two-Way Satellite Time and Frequency Transfer
[3] MARBLE: Multiple Antenna Radio-interferometry of Baseline Length Evaluation

3. Current Status and Activities

3.1. RF Direct Sampling

We have successfully carried out a test VLBI experiment with the so-called “RF direct sampling” technique. In a conventional VLBI system, RF signals are converted to IF band and thereafter converted further to baseband using an analog baseband converter. Finally the signals are sampled and converted to digital signals. With recent technology it became possible to sample IF signals directly due to the performance improvement of sampling devices, which led to the development of our digital baseband converter, named ADS3000. Recently a few sampling devices support a wide frequency bandwidth of up to or more than 10 GHz. If RF signals such as those in the 8 GHz band signals can be sampled directly, an IF converter becomes obsolete within the receiving system. This will reduce the costs of the system and increase the reliability of the system. ADX-830 developed by the ELECS INDUSTRY CO. LTD., is a sampler that has an input bandwidth of 30 GHz. We have carried out a test VLBI observation between the 34-m and 11-m antennas at Kashima by using the ADX-830 to evaluate the feasibility of RF direct sampling. Figure 1 shows the corresponding system block diagram. RF direct sampling with sampling modes of 2bit-1024Msps, 1bit-2048Msps, and 1bit-4096Msps were performed at the Kashima 11-m antenna. At the Kashima 34-m antenna, IF signals were sampled by using the ADS-1000 system with a sampling mode of 2bit-1024Msps. We could successfully get fringes except for the 1bit-4096Msps mode (Figure 2).

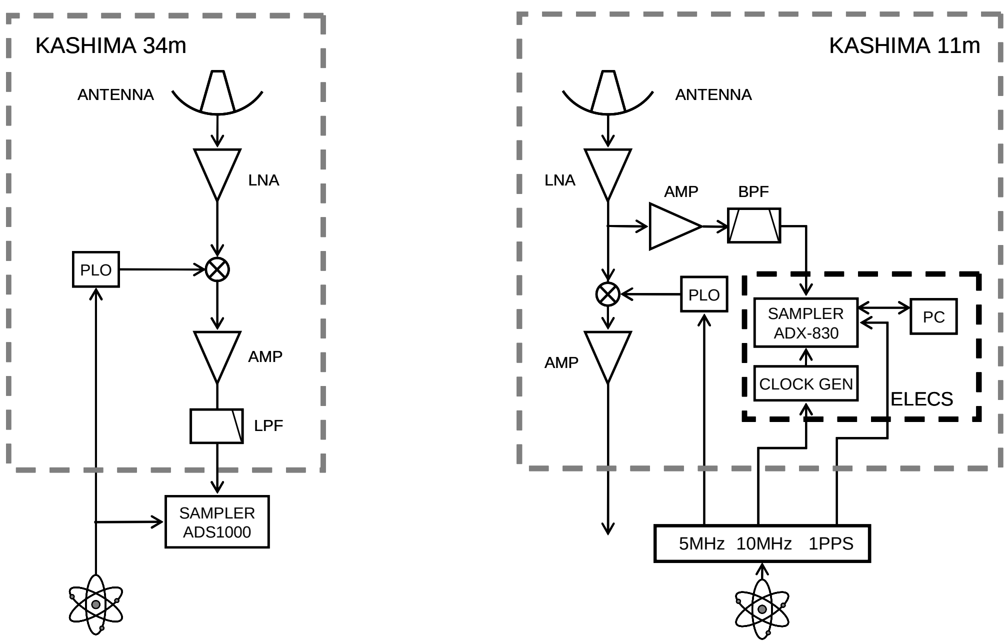

Figure 1. System block diagram for RF direct sampling at the Kashima 11-m antenna.

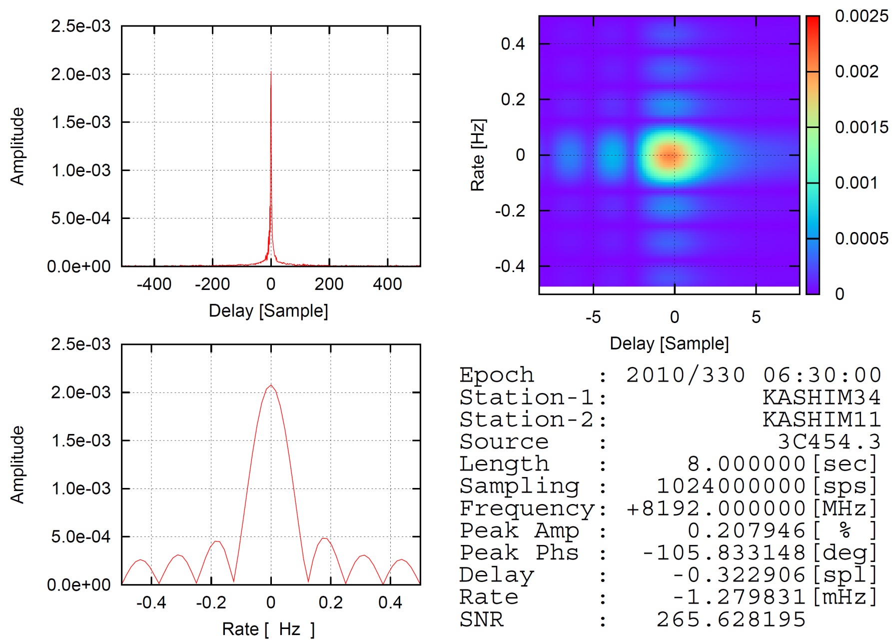

Figure 2. First fringe from RF direct sampling using a 2bit-1024Msps sampling mode of the ADX-830. See the on-line Annual Report for a colored version of the upper right figure.

3.2. Geodetic VLBI using the K5/VSI System

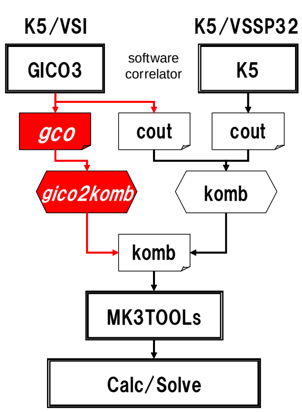

Figure 3. Data flow from the K5 sampling system to the baseline analysis program.

NICT is currently developing two types of sampling systems named K5/VSSP32 and K5/VSI (ADS1000 and ADS3000+). Also, we are developing software correlators corresponding to each system. The K5 software correlator handles data from K5/VSSP32 and is mainly used for geodetic VLBI experiments of Japanese stations as well as for international experiments conducted by GSI. The K5/VSI and GICO3 software correlator forms the other suite of tools, which are mainly used for astronomical purposes. In 2010, we developed new data conversion programs (Figure 3) which enable us to use the K5/VSI system for geodetic VLBI experiments. In order to evaluate the results based on data which was sampled by the K5/VSI system, we carried out a comparison experiment between K5/VSSP32 and K5/VSI system on the Kashima11m—Koganei11m baseline. Table 2 shows the baseline length calculated from the two types of K5 system. Results from two experiments show good agreement. Thus it is concluded that the K5/VSI and GICO3 software correlator can be used for geodetic VLBI experiments without loss of precision.

Table 2. The baseline length calculated from the data which was sampled either with K5/VSSP32 or K5/VSI.

Exp. date	System	Baseline Length	1σ
2010/08/04	K5/VSSP32	109099639.00 mm	0.53 mm
2010/08/04	K5/VSI	109099639.00 mm	0.57 mm
2010/10/01	K5/VSSP32	109099635.43 mm	0.58 mm
2010/10/01	K5/VSI	109099635.58 mm	0.66 mm

3.3. ADS3000+ — First DBBC Fringe Detected

NICT has developed a next-generation ADC called ADS3000+ which supports up to 4-GHz sampling and which is equipped with FPGA chips to realize a digital baseband converter (DBBC) and real-time RFI(CW) suppression.

There are 16ch DBBCs inside the ADS3000+ [1]. The specifications of the DBBC are shown in Table 3. Analog baseband spectra (band character) which are frequency-converted by an image-rejection mixer have a downside shape. The overall band-character of the DBBC shows a flat and symmetric shape. The flat band-character of DBBC is anticipated to increase the SNR. A first DBBC VLBI experiment was carried out in June 2010. The K5/VSSP32 system was deployed at the Koganei 11-m antenna, and ADS3000+ (DBBC) was installed in the Kashima 11-m antenna leading to a baseline of about 140 km. After correlation of the recorded data, first DBBC fringes could be successfully detected. The results are shown in Figure 4.

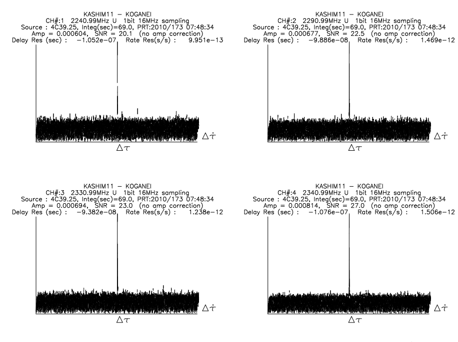

Figure 4. First DBBC fringes between the Kashima 11-m antenna and the Koganei 11-m antenna.

Table 3. Specification of ADS3000+ DBBC mode. One VSI-H outputs 16ch x 2bit or 8ch x 4bit of DBBC, and the VSI clock speed is adjustable. 1024Msps x 4ch is supported by the DBBC for broadband purposes.

Sample speed	Quantization	VSI clock
8Msps	4bit	Fix: 64MHz, Variable 8MHz
16Msps	4bit	Fix: 64MHz, Variable 16MHz
32Msps	4bit	Fix: 64MHz, Variable 32MHz
64Msps	4bit	Fix: 64MHz, Variable 64MHz
1024Msps	2bit	Fix: 64MHz

References

[1] Takefuji K., Tsutsumi M., Takeuchi H., and Koyama Y., Current Status of Next-Generation A/D Sampler ADS3000+, IVS TDC News, No. 31, pp.6-9, 2010.