Technology Development Center at NICT

Kazuhiro Takefuji, Hideki Ujihara, Hobiger Tomas

Abstract

National Institute of Information and Communications Technology (NICT) has been developing VLBI techniques and has been keeping high activities in both observations and technical developments. This report gives a review of the Technology Development Center (TDC) at NICT and summarizes recent activities.

1. NICT as IVS-TDC and Staff Members

National Institute of Information and Communications Technology (NICT) has published a newsletter "IVS NICT-TDC News (former IVS CRL-TDC News)" at least once a year in order to inform a development of VLBI related technology as an IVS technology development center. The newsletter is available at a following URL **http://www2.nict.go.jp/w/w114/stmg/ivstdc/news-index.html**. Table 1 lists the staff members at NICT who are involved in the VLBI technology development center at NICT.

Table 1. Staff Members of NICT TDC as of January, 2013 (alphabetical).

HASEGAWA, Shingo	HOBIGER, Thomas	ICHIKAWA, Ryuichi	KAWAI, Eiji
KONDO, Tetsuro	KOYAMA, Yasuhiro	MIYAUCHI, Yuka	SEKIDO, Mamoru
TAKEFUJI, Kazuhiro	TSUTSUMI, Masanori	Ujihara, Hideki	—

2. Current Status and Activities

We will report progresses of development related to the VLBI techniques hereafter.

2.1. Development of Gala-V: brand new VLBI system

In order to realize the Time and Frequency transfer with compact and portable VLBI system, NICT has been developing an 1.5 meter class VLBI system. An SEFD of compact antenna are quite large due to small size antenna and ambient temperature receiver. Thus, We has been developing a broad band VLBI system to improve a signal to noise ratio, it also meets the requirement of the VLBI2010. The compact antenna needs co-observation with a large size antenna to detect fringes, our 34 meter antenna also will upgrade to broad band system. Before we started to make a development, we measured the RFI surrounding our region, in paticular Kashima in Ibaraki and Koganei in Tokyo. Figure.1 to 3 shows the results of RFI mesurements from 2GHz to 18GHz. The RFI are seriously strong on the roof our NICT head quarter in tokyo, but there are still some quite frequency bands. and we chose the bandwidth.

We will perform a bandwidth synthesis to make a sharp delay function with picking up the bands from the quiet. Finally we decided the four fixed channels of 3.2-4.8GHz, 4.8-6.4GHz, 9.6GHz-11.2GHz and 12.8GHz-14.4GHz in the manner of the VLBI2010, hereafter we will call

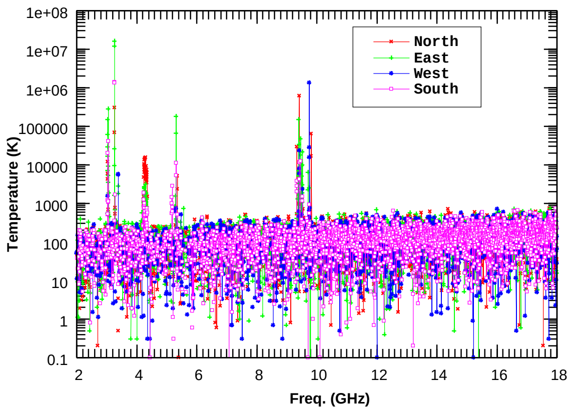

Figure 1. RFI survey in Kashima.

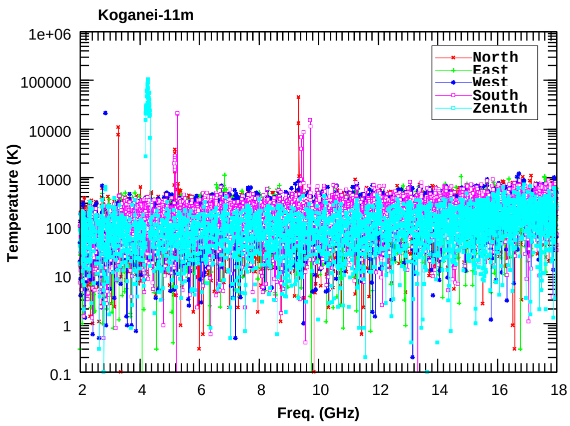

Figure 2. RFI survey near the 11 meter antenna in Koganei in Tokyo

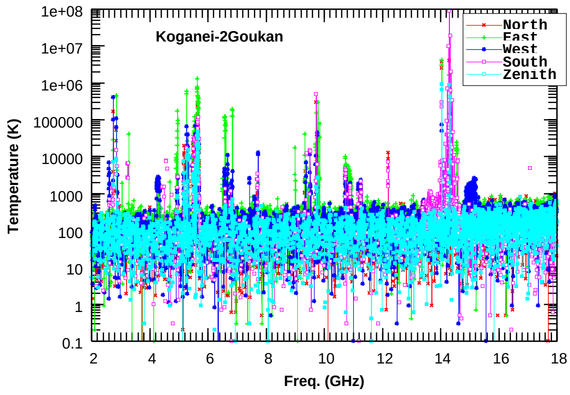

Figure 3. RFI survey on the roof of head quarter of NICT in Koganei in Tokyo

these band, A frequency variance of the Gala-V bands becomes 4.4GHz. Based on the Gala-V bands, we started to developing receivers, feeds, and samplers. The Gala-V bands have a great advantage in sampling. In case of the 12.8GHz sampling, They line up in order without any analogue frequency conversion but with high-order sampling. Now we have developing new digital A/D sampler, whose sampling speed are 16GHz. The sampler has two channel inputs, it means the single sampler will sample the two polarization of four 1GHz to 1.6GHz bandwidth at a time.

2.2. Development of Wide Band Feeds

Wide Band feeds has been developing in NICT, NAOJ and universities in japan for VLBI2010, SKA. In this fiscal year, a novel wide band feed has developed for Kashima 34m, which was designed for our VLBI aimed for Time and Frequency transfer project, however it will be a first step in Japan to develope wide band feed and receiver system for VLBI2010 or SKA.

Our project was named Gala-V, which was shortened Galapagos VLBI, because we Japanese often sympathize Galapagos Islands which was isolated and unique species like Japan. The feed named IGUANA Feed also has unique specification and structure. Operational frequency bands of the feed are carefully selected to avoid RFI and satisfy 0 redundancy condition on delay measurement, and also feasibility condition of nested feed[fig:4]. Thus our Gala-V band are set on 3.2-4.8GHz, 4.8-6.4GHz, 9.6GHz-11.2GHz and 12.8GHz-14.4GHz which are all aligned on 1.6GHz x N to make easier direct sampling. Lower 2 bands are received outer IGUANA Mom feed, which is a corrugated horn used as a C-band feed at Kashima 34m to reduce development cost and time, higher 2 bands are received inner Daughter feed which is a multi mode horn derived from designs for ASTRO/VSOP-2 satellite and VERA project. The feed is now under manufacturing after half year development with numerical simulation[fig:5] and will hear first radio noise from the universe in this spring.

At last of this section, the Author would like to emphasize that IGUANA feed is novel, but, please do not call it in shortly Ig-Noble feed.

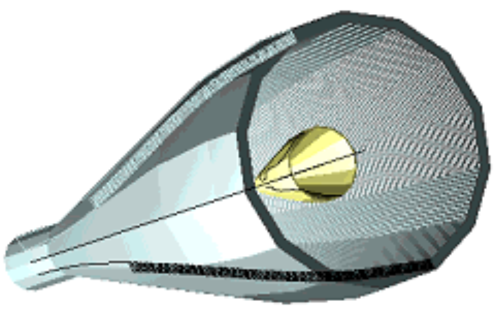

Figure 4. Conceptual model of IGUANA feed

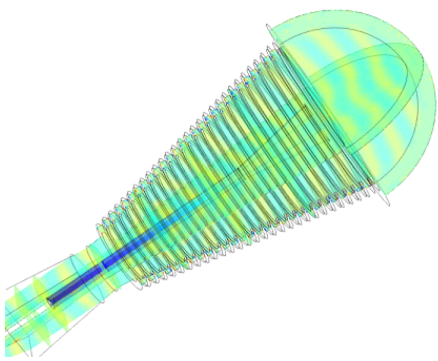

Figure 5. Expetimental result of Ey field in Mom feed at 4.8GHz with COMSOL.

2.3. Kashima Flexible Correlator (KFC)

In order to process the growing amount of data that comes along with the implementation of the VLBI2010 technology, NICT has started to develop the "Kashima Flexible Correlator (KFC)". This software correlator is expected to operate similar to other existing correlators by making use of the Message Passing Interface (MPI) for distribution of the workload across several computing nodes. KFC will consist of three components (see figure 6), i.e. one master control, several data streamers and a certain number of correlators. The master control oversees the correlation process and manages all other components. Data streamers extract PCAL signals, decode the sampling data depending on bit resolution and the number of channels and send the data to the packetized correlators where auto- and cross-correlation are computed. The initial development will only rely on CPU nodes, but the flexible software design supports heterogeneous CPU-GPU(or other multi-processor) platforms in the future as well.

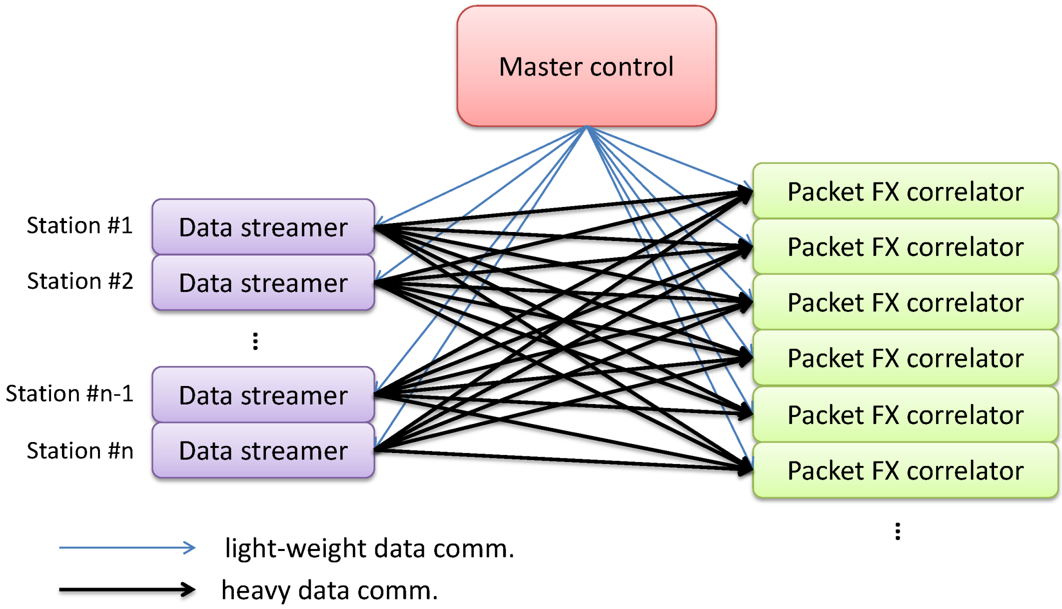

Figure 6.