NICT Technology Development Center 2013 Annual Report

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Abstract The National Institute of Information and Communications Technology (NICT) is developing and testing VLBI technologies and conducts observations with this new equipment. This report gives an overview of the Technology Development Center (TDC) at NICT and summarizes recent activities.

1 NICT as IVS-TDC and Staff Members

The National Institute of Information and Communications Technology (NICT) 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 as an IVS technology development center. The newsletter is available at a following URL **http://www2.nict.go.jp/aeri/sts/stmg/ivstdc/news-index.html**. Table 1 lists the staff members at NICT who are contributing to the technology development center.

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 General Information

We have been developing a new VLBI system called Gala-V, which has the VGOS (VLBI2010 Global Observing System) requirments. Distinguishing features of Gala-V are direct sampler called Galas and broad band feed horn called Iguana. Here we will report the current activities. Firstly, We evaluated a jitter and frequency response of Galas. Secondly a prototype of Iguana feed has deployed to the Kashima 34 meter antenna in end of December 2013. We could detect simultaneously methanol maser lines of 6.7 GHz and 12.2 GHz from star forming region W3OH.

3 Evaluation of Direct sampler Galas

The broad band signal from 1GHz to 18GHz transfers without frequency-conversion with high sensitivity optical transmitter and receiver from antenna to the sampler Galas. With this reason, Gala-V has quite simple system. Actually, our system has no analog frequency conversion, but we realized the down-conversion with high order sampling and digital baseband conversion of digital signal techniche inside Galas. A figure 1 shows the design of Galas. It has four analog inputs and four 10GbE outputs. Galas will sample an input signal at 16GHz speed and 3 bits quantization and will perform digital frequency conversion. At first, we evaluated jitter performance and a frequency response. We input

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the sinusoidal signal from signal synthesizer to Galas at each frequencies, then calculated the phase noise as a jitter from digitized signal. The jitter is shown in figure 3, where we obtain the 0.191 pico second. We expect good sampler even at frequency of 20 GHz from the obtained jitter value. The figure 3 shows the frequency response of Galas from comparing amplitude from quantized bit distribution between reference signal and targed signal.

In 2013, we conducted VLBI experiments between the direct sampler Galas and the existing wideband sampler ADS3000+ of 1GHz bandwidth. And we had successfully obtained a consistent geodetical result. We have more plan of broad band VLBI after Iguana feed installation.

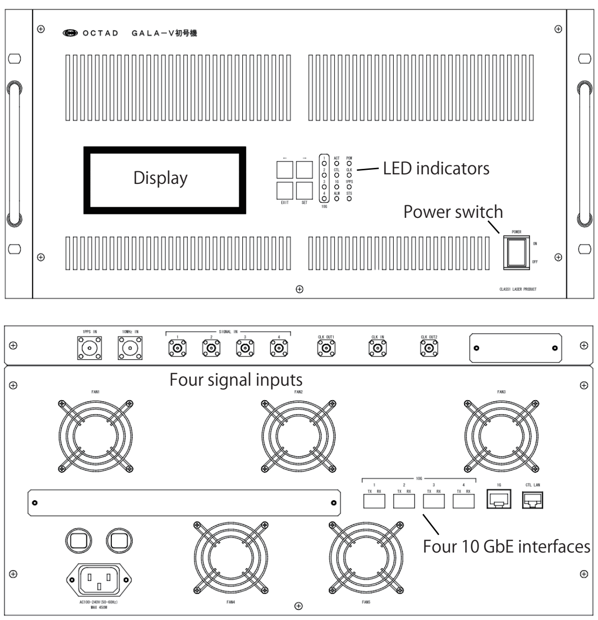

Fig. 1 The design of the direct sampler Galas.

4 Developing the broad band feed Iguana

Prototype of Iguana feeds were multimode horns, which were designed for 6.4-15GHz. Their beam patterns were measured at Microwave Energy Transmission Laboratory (METLAB) in Kyoto University. The first prototype of 133mm aperture diameter was set on Kashima 34 meter for testing our wideband

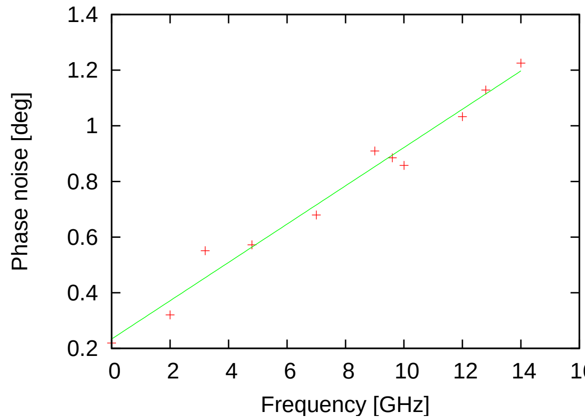

Fig. 2 The jitter performance of Galas

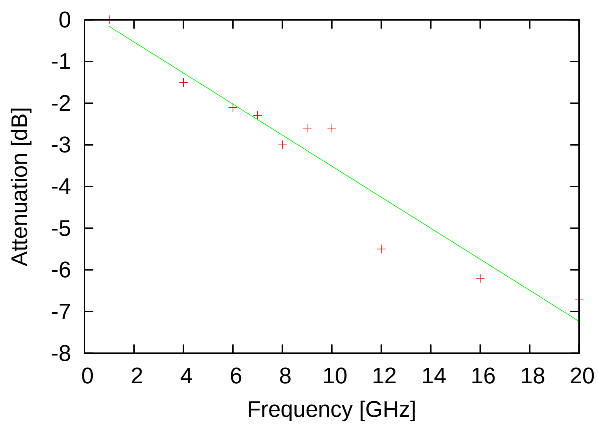

Fig. 3 The frequency response of Galas

frontend system. The aperture size of the second feed is 120mm.

They can be replaced to select best efficient frequency for various observations. Also, waveguide high-pass filters are ready for $f_{cut} = 6.4GHz, 8.0GHz, and 9.6GHz$ cut-off frequencies to suppress RFI, following WRD580 waveguide and SMA adapter output.

Our configuration is for one linear polarization now.

5 First light of Gala-V, deployed to the Kashima 34 meter antenna

We have deployed the prototype feed to the Kashima 34 meter antenna. The feed after deployed is shown in figure 4. Kashima 34 meter antenna has four pedestals involving feed and receiver. We can choose one pedestal from four pedestals moving exclusively. Figure 5 shows two methanol lines at 6.7GHz and 12.2GHz from star forming region W3OH detecting by Gala-V system. It was a memorable first light(s). The system temperature of the prototype system is shown in figure 6. We are currently using ambient temperature LNA, thus the system temperature are plausible. The aperture efficiency of the prototype feed are also shown in figure 7. Until 12GHz, the effieciency is about 40 %. then the effiency begins to decreases, 20 % at 15 GHz with first prototype feed.

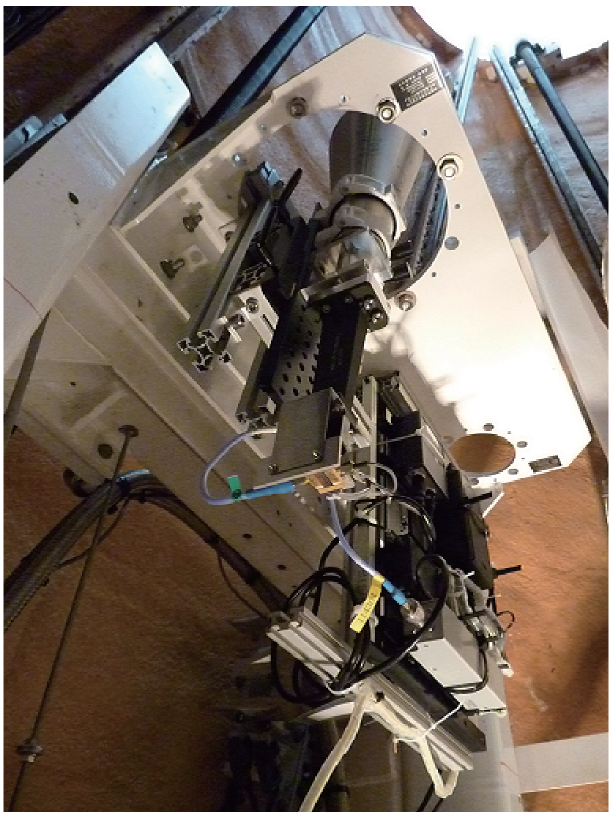

Fig. 4 The prototype Iguana feed was deployed to the Kashima 34 meter antenna

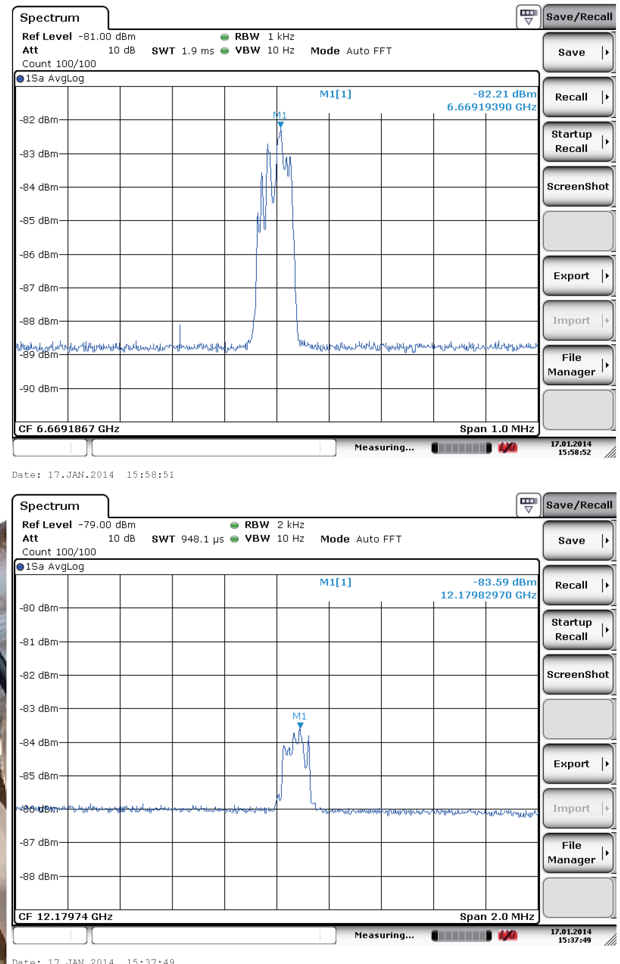

Fig. 5 The first light of methanol masar of W3OH, The methanol lines of 6.7GHz and 12.2GHz were simultanously obtained.

6 Future Plans

The upgrade is on going to the Kashima 34m antenna for wider bandwidth such as 2.2-18GHz. The Iguana and broad band receiver will be fully installed by this spring, and two polarization will be available by next winter.

7 Acknowledgement

The development of Gala-V is supported by a jointed development of National Astronomical Observatory Japan (NAOJ). It is entitled “Development of ultra broadband system for Kashima 34 meter antenna”.

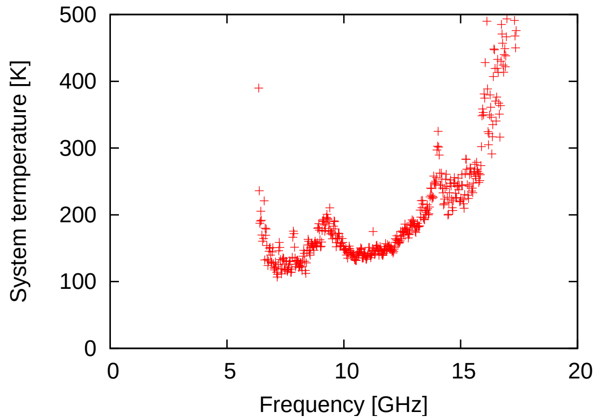

Fig. 6 Gala-V system temperature with the prototype Iguana feed.

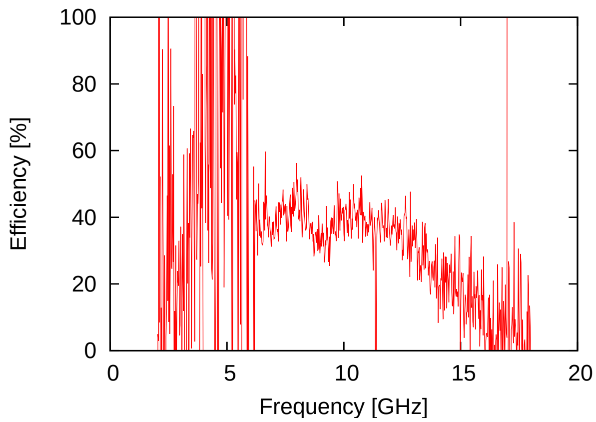

Fig. 7 Gala-V aperture efficiency with the prototype Iguana feed.