NICT Technology Development Center 2013 Annual Report

Kazuhiro Takefuji, Hideki Ujihara

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 (formerly 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) requirements. Distinguishing features of Gala-V are a direct sampler called Galas and a broadband feed horn called Iguana. Here we will report the current activities. First, we evaluated a jitter and frequency response of Galas. Secondly, a prototype of Iguana feed was deployed to the Kashima 34-meter antenna at the end of December 2013. We could detect simultaneously methanol maser lines of 6.7 GHz and 12.2 GHz from the star forming region W3OH.

Kashima Space Technology Center, National Institute of Information and Communications Technology

NICT Technology Development Center

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3 Evaluation of Direct Sampler Galas

The broadband signal from 1 GHz to 18 GHz transfers without frequency conversion via a high sensitivity optical transmitter and receiver from the antenna to the sampler Galas. For this reason, Gala-V has a 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 by digital signal technique inside Galas. Figure 1 shows the design of Galas. It has four analog inputs and four 10 GbE outputs. Galas will sample an input signal at 16 GHz speed and 3-bit quantization and will perform digital frequency conversion. At first, we evaluated jitter performance and a frequency response. We input the sinusoidal signal from a signal synthesizer to Galas at each frequency, then calculated the phase noise as a jitter from the digitized signal. The jitter is shown in Figure 2, where we obtain a result of 0.191 picoseconds. We expect good sampler performance even at the frequency of 20 GHz based on the obtained jitter values. Figure 3 shows the frequency response of Galas from comparing the amplitude from quantized bit distribution between reference signal and target signal.

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

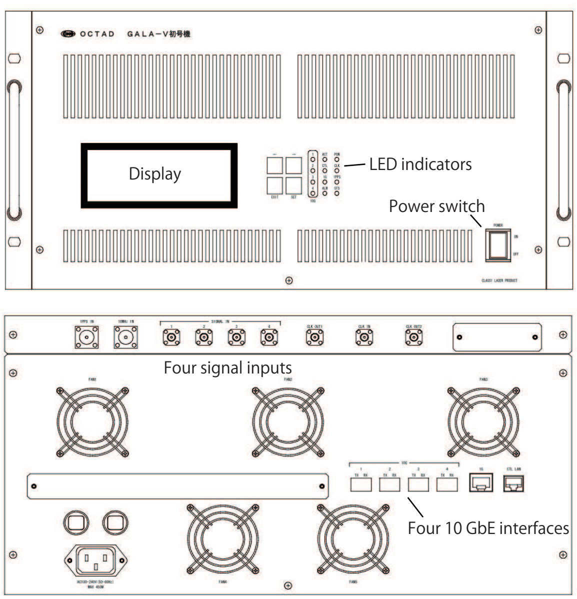

Fig. 1 The design of the direct sampler Galas.

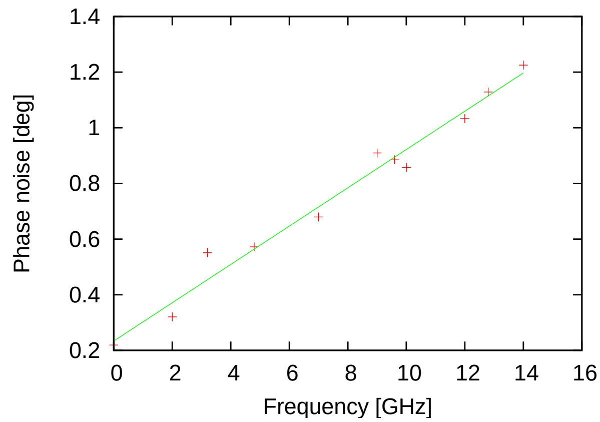

Fig. 2 The jitter performance of the direct sampler Galas.

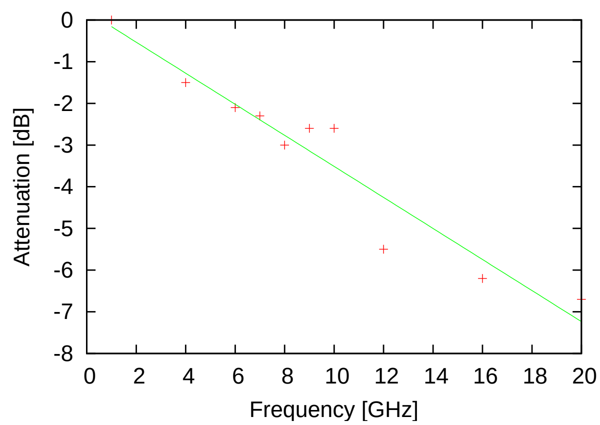

Fig. 3 The frequency response of the direct sampler Galas.

4 Developing the Broad Band Feed Iguana

The prototype Iguana feeds were multimode horns, which were designed for 6.4-15 GHz. Their beam patterns were measured at Microwave Energy Transmission Laboratory (METLAB) in Kyoto University. The first prototype of 133 mm aperture diameter was set on the Kashima 34 meter for testing our wideband frontend system. The aperture size of the second feed is 120 mm.

They can be replaced to select the most efficient frequency for various observations. Also, waveguide high-pass filters are ready for f_{cut}=6.4 GHz, 8.0 GHz, and 9.6 GHz 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 deployment is shown in Figure 4. The Kashima 34-meter antenna has four pedestals for the feed and receiver. We can choose one pedestal from four pedestals moving exclusively. Figure 5 shows two methanol lines at 6.7 GHz and 12.2 GHz from the star forming region W3OH detected by the Gala-V system. It was a memorable first light. The system temperature of the prototype system is shown in Figure 6. We are currently using ambient temperature LNA; thus the system temperatures are plausible. The aperture efficiency of the prototype feed is also shown in Figure 7. Until 12 GHz, the effieciency is about 40%. Then the effiency begins to decrease, to 20% at 15 GHz with the first prototype feed.

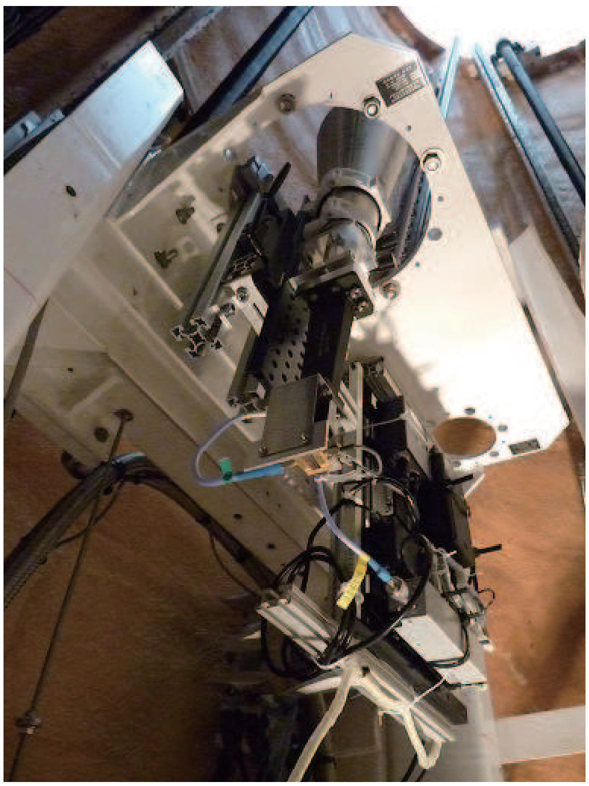

Fig. 4 The prototype Iguana feed was deployed to the Kashima 34-meter antenna

6 Future Plans

The upgrade to the Kashima 34-m antenna for wider bandwidths such as 2.2-18 GHz is on-going. The Iguana and broadband receiver will be fully installed by this spring, and we will install a new dual polarization feed by next winter.

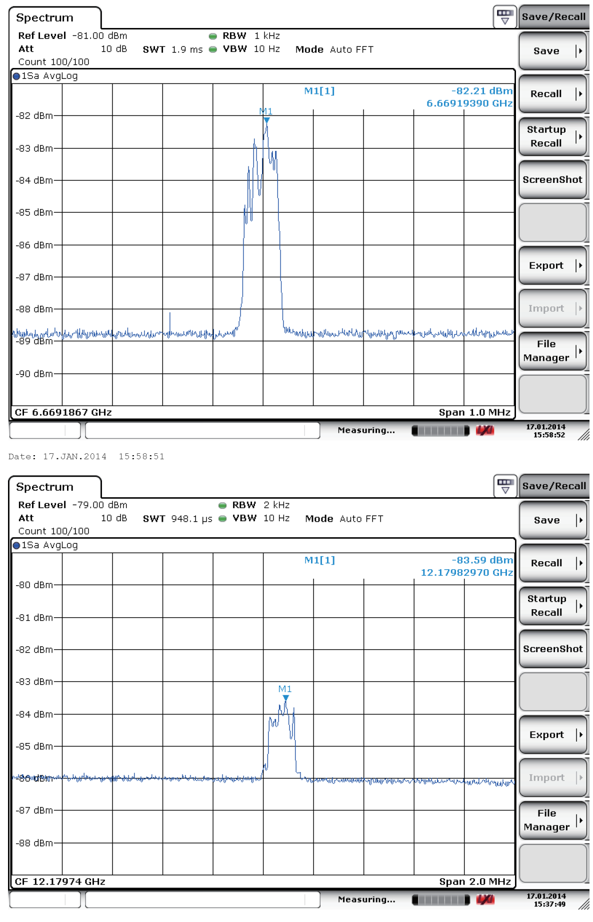

Fig. 5 The first light of methanol maser of W3OH. The methanol lines of 6.7 GHz and 12.2 GHz were simultaneously obtained.

Acknowledgements

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

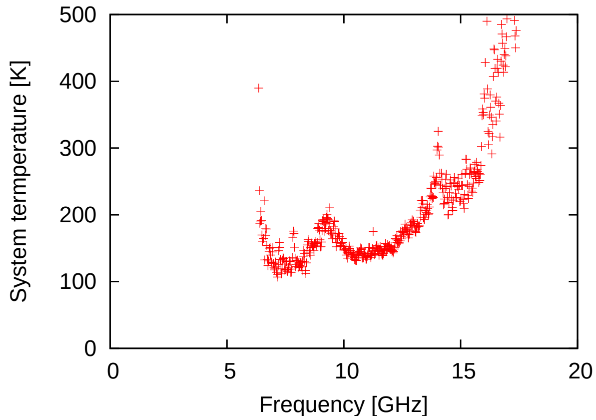

Fig. 6 Gala-V system temperature with the prototype Iguana feed.

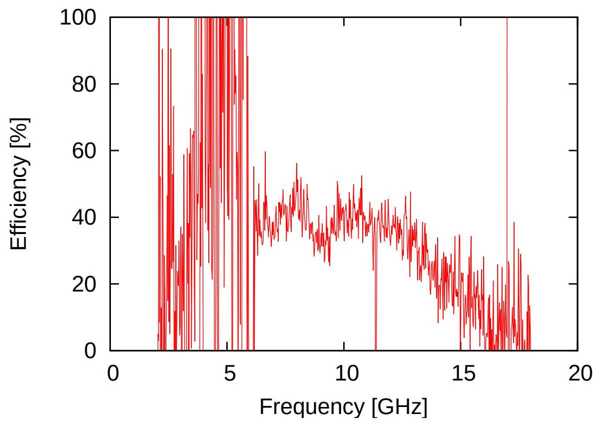

Fig. 7 Gala-V aperture efficiency with the prototype Iguana feed.