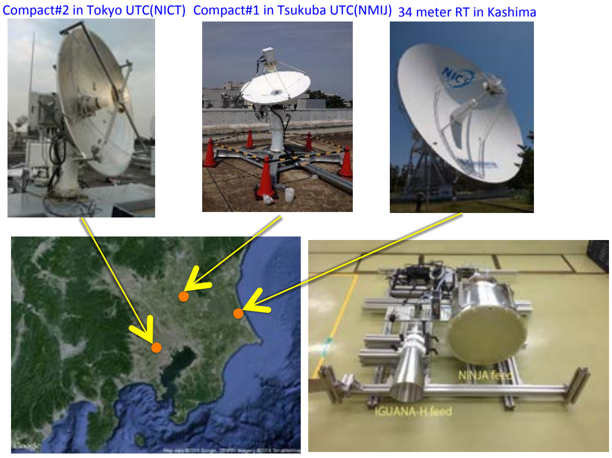
Broadband System at Kashima Space Technology Center
Kazuhiro Takefuji , on behalf of the NICT/Kashima VLBI group
National Institute of Informations and Communication Technology
893-1 Hirai,Kashima, Ibaraki 314-8501, Japan takefuji@nict.go.jp



Introduction

To measure a precise frequency difference by VLBI, we have installed two compact antennas in time-keeping institute in Japan. One is installed in NICT, keeping **UTC(NICT)** in Tokyo and another is installed in AIST, keeping **UTC(NMIJ)** in Tsukuba.

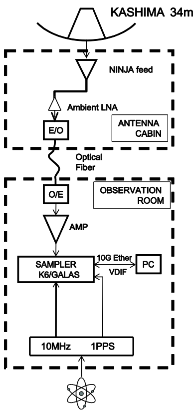
Since the compact antennas are small (**1.6m** and **2.4m** diameter), Large dish like Kashima 34m should be connected to get fringes. Then the difference between UTC(NICT) and UTC(NMIJ) is measured by subtracting two baseline results. However it needs to achieve broadband system to obtain better fringes. Thus, we have been developing broad-band system for Kashima 34 meter radio telescope with cassegrain optics and two compact antennas.

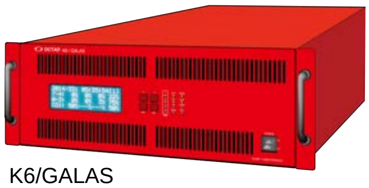
We have carried out sessions in 2 or 3 times in month. Normally we sample 4 * 1GHz bandwidth per each station. Then wide bandwidth synthesis will be applied after correlation process.

Developments

The three stations have broadband feed and a 16GHz sampling direct sampler K6/GALAS. Currently we have installed two type of broadband feed for Kashima 34m. Firstly **IGUANA-H** for 6.5 GHz to 15 GHz since December 2013 and secondary **NINJA**, 3.2 GHz to 14.4 GHz (SEFD~ 1500Jy) since July 2015. The modified NINJA feed 3-15GHz has been installed to Compact #2 (SEFD ~0.5MJy) in early 2016. Compact #1 is currently used QRHA of ETS lindgren, but soon its feed and main dish will be replaced modified NINJA feed.

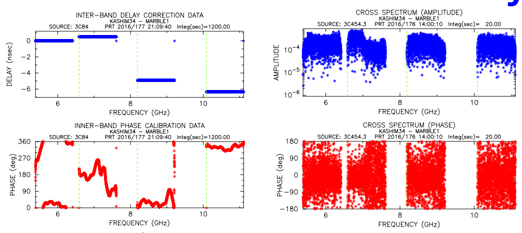
The direct sampler **K6/GALAS** has 1GHz bandwidth DBBC inside. Since deploying the K6/GALAS, the front-end system has become quite simple(see right figures). Currently K6/Galas has 2 ADCs, First IF inputs lower 8GHz range and second IF inputs upper 8GHz range. Since there are no analog frequency converters, the bandwidth synthesis also become reliable





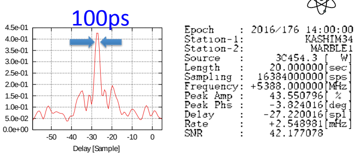
K6/GALAS
*Direct sampling system
*Selectable 16.384GHz or 12.8GHz sampling speed
*Sensitivity ~ 20GHz
*10GbE output on VDIF format
*Available 1GHz band DBBC
*Operation by telnet
*Selectable color

24h VLBI and bandwidth synthesis

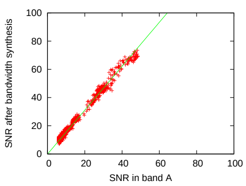


Template for WBWS Scan applied by WBWS

First we determine a template data from strong sources scan for wide bandwidth synthesis (WBWS) [T. Kondo & K.T 2016]. Upper left figures as template show the delay difference among bands and phase variation in each band.
Cross spectrum of each band is connected by using the template data. Then residual delay and delay rate are estimated by calculating a search function. Finally differential TEC will be estimated.



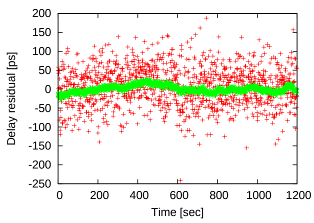
Fringe after synthesized four bands.



SNR after WBWS improved 1.55 times better than the single band.

Name	Time [sec]	Scans	Band-A	Band-B	Band-C	Band-D	WBWS
0059+581	20	479	38	16	5	1	454
0212+735	20	474	1				396
2145+067	40	166	73	17			163
3C454.3	20	121	121	121	121	121	121
3C84	20	90	90	90	90	90	90
0552+398	20	72	26	4	1		68
2134+00	20	62	61	61	57	39	61
1308+326	60	65					
3C345	20	71	68	46	12	3	70
4C39.25	20	55	55	54	54	51	55
NRAO530	20	57	2				48
1921-293	20	38	34	34	22	5	38
3C279	20	31	28	28	28	28	28
0727-115	20	20	20	20	20	13	20
1334-127	20	14	2		1		12
3C446	20	13					1
0420-014	20	13					
3C273B	20	9	9	9	9	8	9

Count of the fringe detection on Kas34-compact#1 baseline. The fringe after WBWS increased the number of detection.



Delay error in tracking 3C84 in 20min. Red points shows delay in 1s integration for the single band and green point shows the delay for synthesized bands.
The error estimated 70 ps for single band and 5 ps for synthesized band.

GV16176	Kas34 - #1	Kas34 - #2	#1 - #2
Residual	35.1ps	34.4ps	36.4ps Clock delay could be measured between compact antennas!
Clock+Rsd Solve Output