Recent Status of KJCC and Development toward Wideband

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VERA-UM 2017 @ Miz, 11. 3~4, 2017

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- Development status for wideband
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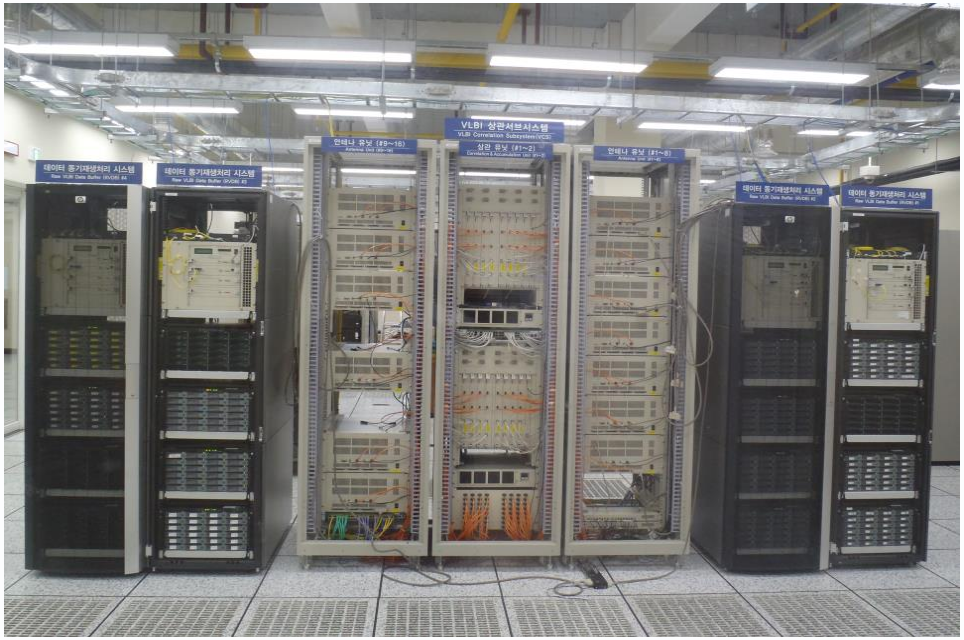
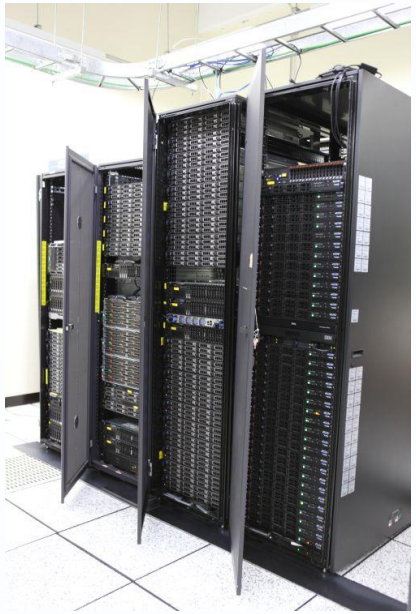
Korea-Japan Correlation Center(KJCC)

Executive Board



Daejeon Correlator



DiFX Correlator on HPC

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Correlation Status
(2016B, Nov~2017A)

KVN only (216) by DiFX		
Type	Obs time (Hours)	HDD (TB)
1Gbps	1,817.5	2,730.3
2~8Gbps	391.2	3,803.3
Total	**2,208.7**	**6,533.6**

KaVA (86) by Daejeon Corr.		
Type	Obs time (Hours)	HDD (TB)
KaVA	570.9	2027.2
KVN (@KaVA)	111.8	237.5
Total	**682.7**	**2,264.7**

EAVN (16) by Daejeon Corr.		
Type	Obs time (Hours)	HDD (TB)
EAVN	119.2	494.1
Total	**119.2**	**494.1**

- FITS delivery for KVN only is currently delivered to PI within 2-weeks.
- In case of KaVA/EAVN, FITS file is distributed to PI within 1.5 month after arriving the media at KJCC, which depends on the diskpack delivery or data copy, transmission.
- In 2017A, average FITS deliver period
  - AGN : 25days (mostly)
  - ES : 22days
  - SFR : 58days (wide field)

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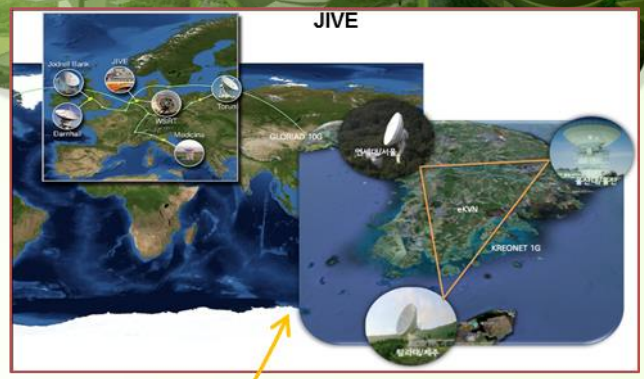
KVN KREONET Status



Yonsei Astronomy Observatory

Correlation Center in Daejeon

10G

100G

KREONET

KRLight

10G

GLORIAD

AARNet (Australia)

JAPAN

KREONet2

Seoul

Daejeon

10G

Jeju

Ulsan

10G

Tamna Astronomy Observatory

To Be: Virtual Dedicate Networks on KREONET-S

Ulsan Astronomy Observatory

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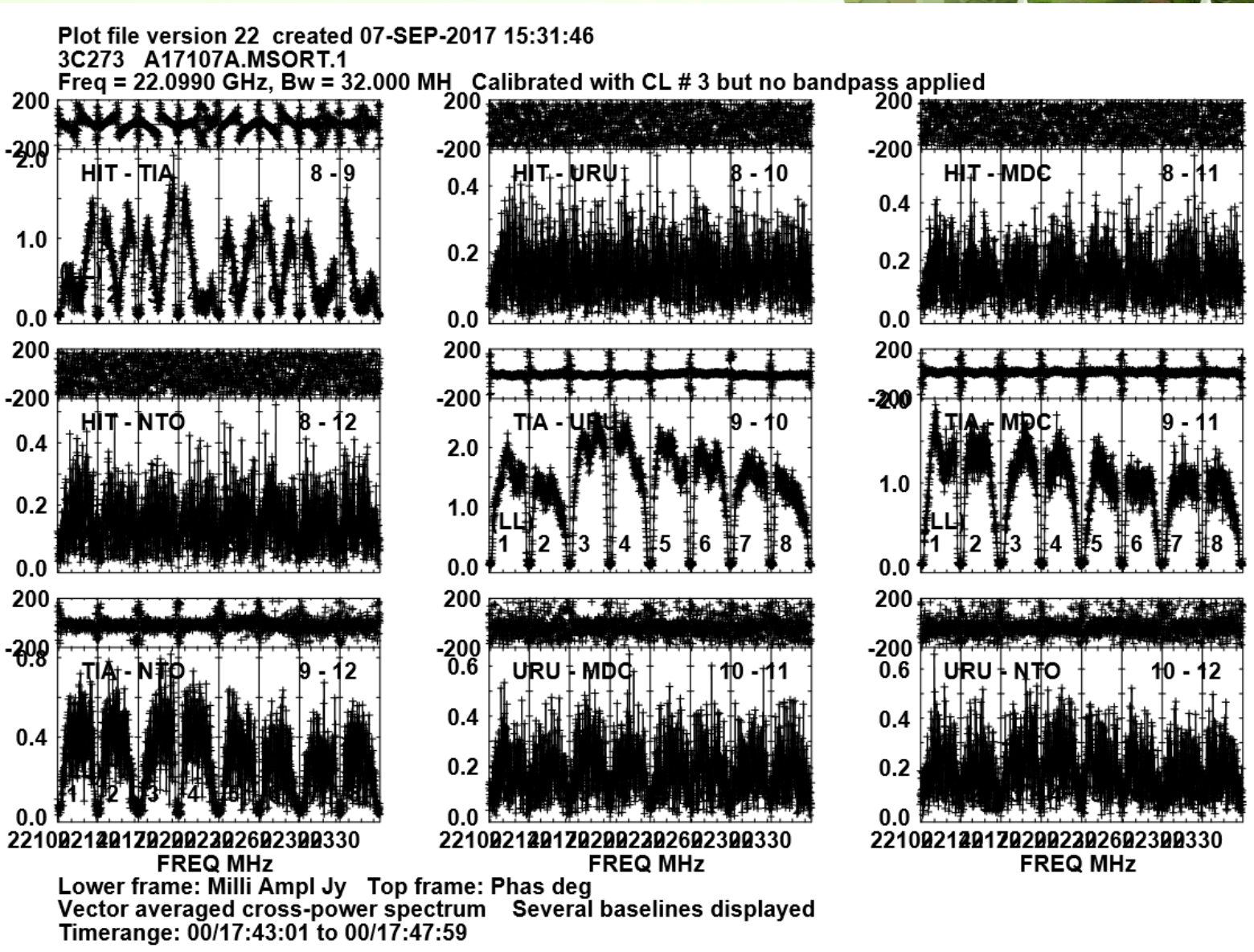
EAVN(a17107a) EHT campaign
➔ EATING VLBI (Italy)



Correlation Mode

Corr. mode	Band width [MHz]	Output streams	#bits	Output data rate [Mbps]	Clock rate [MHz]
[a]C1	256	1	2	1024	32
C2	128	2	2	1024	32
C3	64	4	2	1024	32
C4	32	8	2	1024	32
C5	16	16	2	1024	32
[b]W1	512 x 4band	4	2	8192	64
W2	512 x 4band	1IF[c]x2P[d] 2IFx1P	2	8192	64
W3	512 x 4band	2IFx2P	2	8192	64

a, Narrow band, b. Wideband, c. IF, d. Polarization

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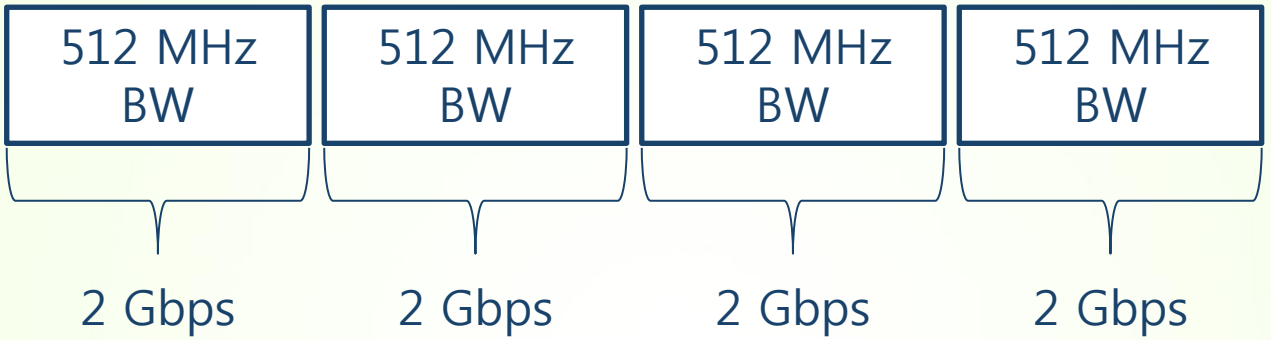
Support wideband of 8Gbps

❖ 8Gbps concept(Total 2048MHz BW)



❖ Obs Combination(w/ polarization)

- **4 bands (4Fx1P, 2Fx2P,1Fx2P+2Fx1P)**

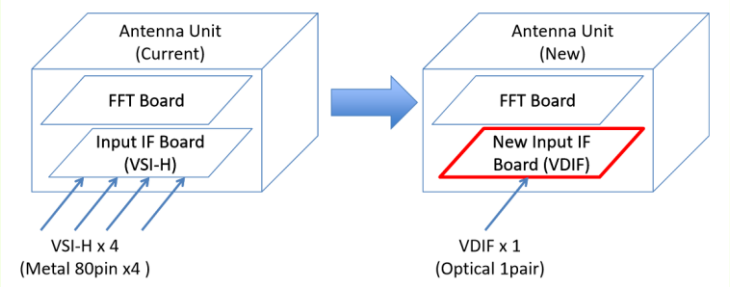
Array	Concept			
KVN	22L/R	43L/R	86L/R	129L/R
KaVA	22L	22R	43L	43R
KVN/NRO45/CVN	22L	22R	86L	86R
	43L	43R	86L	86R
	22L	22R	43L	86L
	22L	43L	86L	86R

KaVA 8Gbps correlation

- Max. 8Gbps/7 or 8 stations
  - If 8Gbps will be correlated by Daejeon correlator for 7 or 8stations, 3 or 4 RVDBs should be needed.
  - If we support 8Gbps correlation for KaVA in future, the following items should be considered.
    - More RVDBs are needed
    - VSI to VDIF change for VCS antenna unit
    - Or slow correlation by ½ speed, ¼ speed, which means that data is divided for each channel(not full 2048MHz BW, using only each 512MHz BW(2Gbps or 4Gbps etc)

VCS upgrade
Advantage/Disadvantage

	Advantage	Disadvantage
Change VSI to VDIF on VCS	• Recent VDIF standard adopting • Maybe over 8Gbps corr possible by modifying FPGA	• High cost • Change the main board step by step, half change then remained half change
Buying RVDB2(OCTAVIA2, OCTADISK2)	• Low cost • No change, just continuously and stable operating possible	• VSI port remained • Over 8Gbps corr will be difficult



4set RVDB
+
4 set
{OCTAVIA2,
OCTADISK2}

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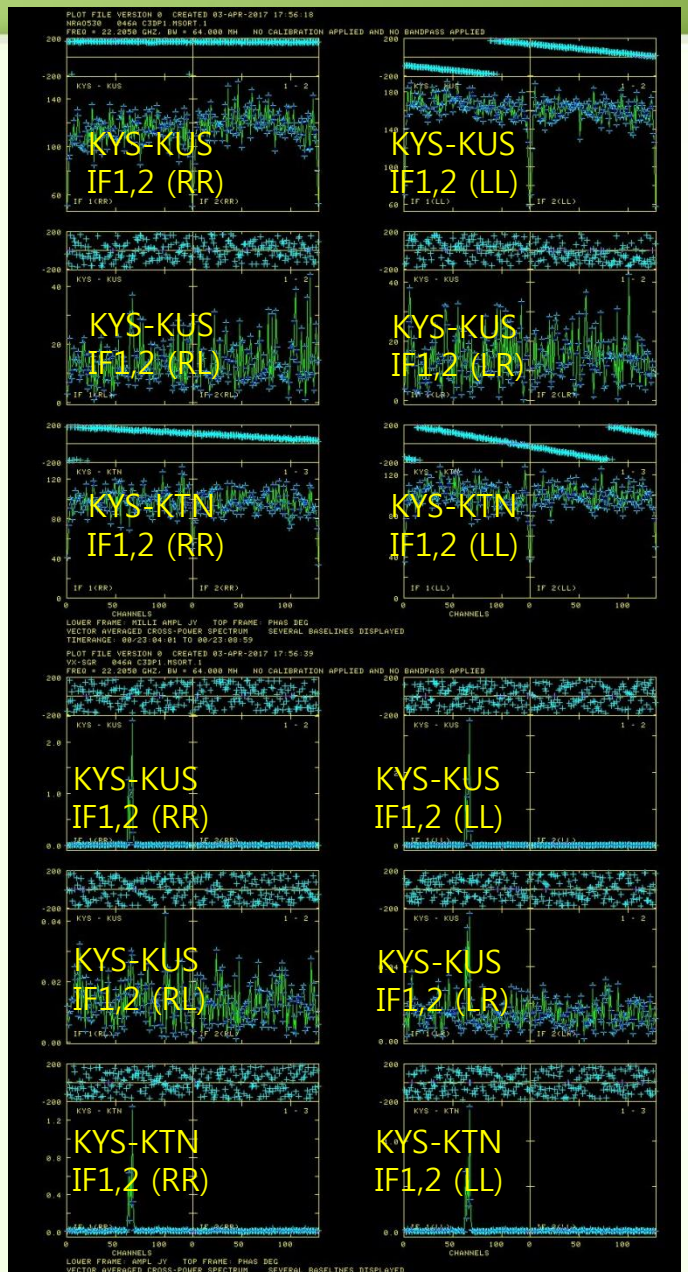
Data conversion SW development

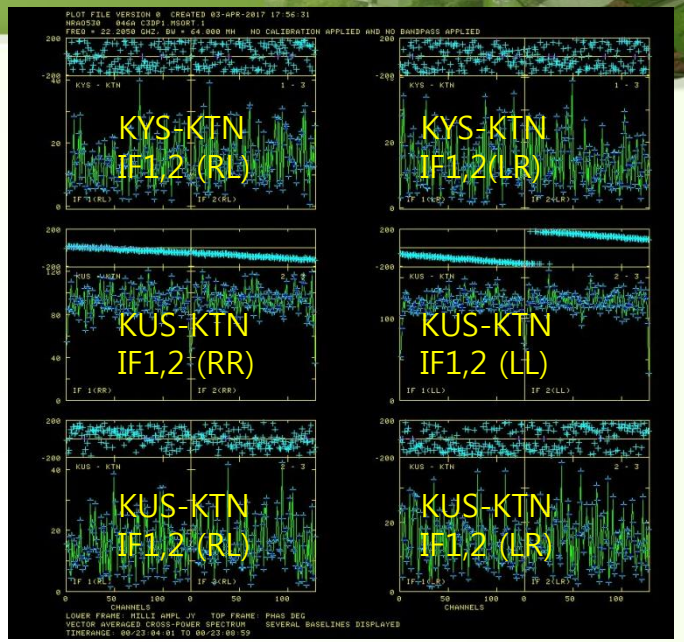
#	SW	Function
1	Mark5BtoVDIF	Convert Mark5B format to VDIF format
2	VDIFtoMark5B	Convert VDIF format to Mark5B format
3	VDIFtoVDIF	Convert General VDIF format to OCTA-VDIF format
4	Cut_Mark5B	Extract Data from Mark5B format file
5	Cut_VDIF	Extract Data from VDIF format file

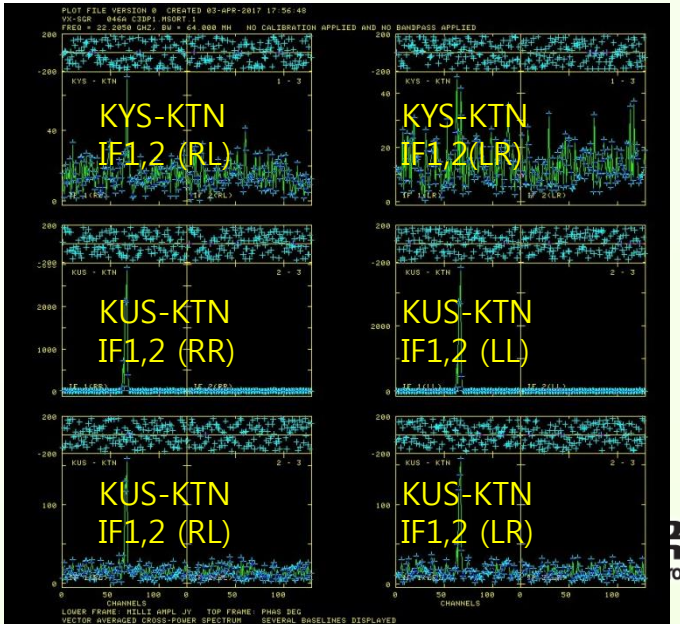
CODA/FITS development

- **Multi-frequency Multi-polarization (wideband mode, ex: 8Gbps)**
  - CODA is currently possible to support
  - If selection rule of frequency part will be adopted, CODA/FITS for each IF will be generated
- **Dual-polarization mode support**
  - CODAgen SW development was completed.
  - Test obs data was used (s17so01a(k17046a), C2~C5 mode)

C3(64MHzBW x 4ch) mode(LLRR)





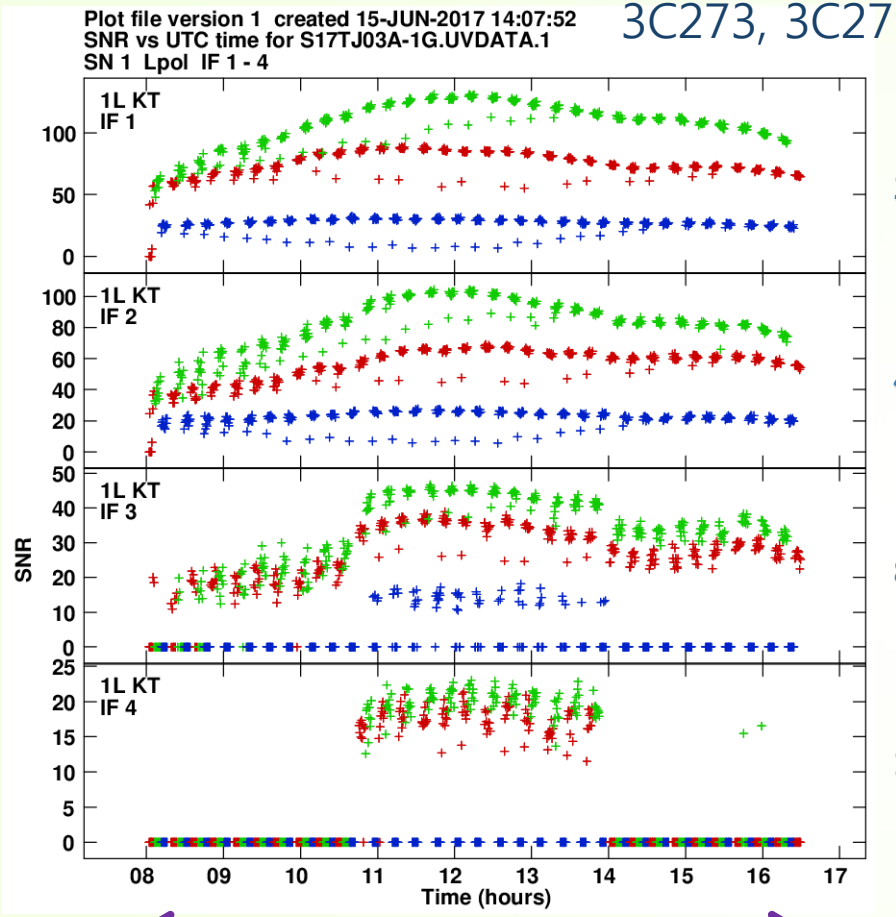


KVN Halcyon recorder (Specification)

- Target processor : Intel Xeon
- Target board
  - Asrock X99 extreme11
  - DDR4 RAM 32GBytes
  - Broadcom BCM57711 NIC 10GbE PCIe
- Operating System : FirmOS(like DOS)
  - include scheduler
  - support multi-core
  - no filesystem
  - DRAM/NIC/SATA control directly (without device driver)
- Build environment: gcc, nasm(boot code)
- **can make full resources and performance**
  - recording speed 8.224Gbps(VDIF UDP)
  - recordable capacity 90% of SATA HDD
- very cheap(Mainboard/CPU/RAM/NIC/Chassis)
  - around $5,000 without HDDs

KYS-KTN baseline

1Gbps SNR (MK5)



3C273, 3C279, M87

22GHz

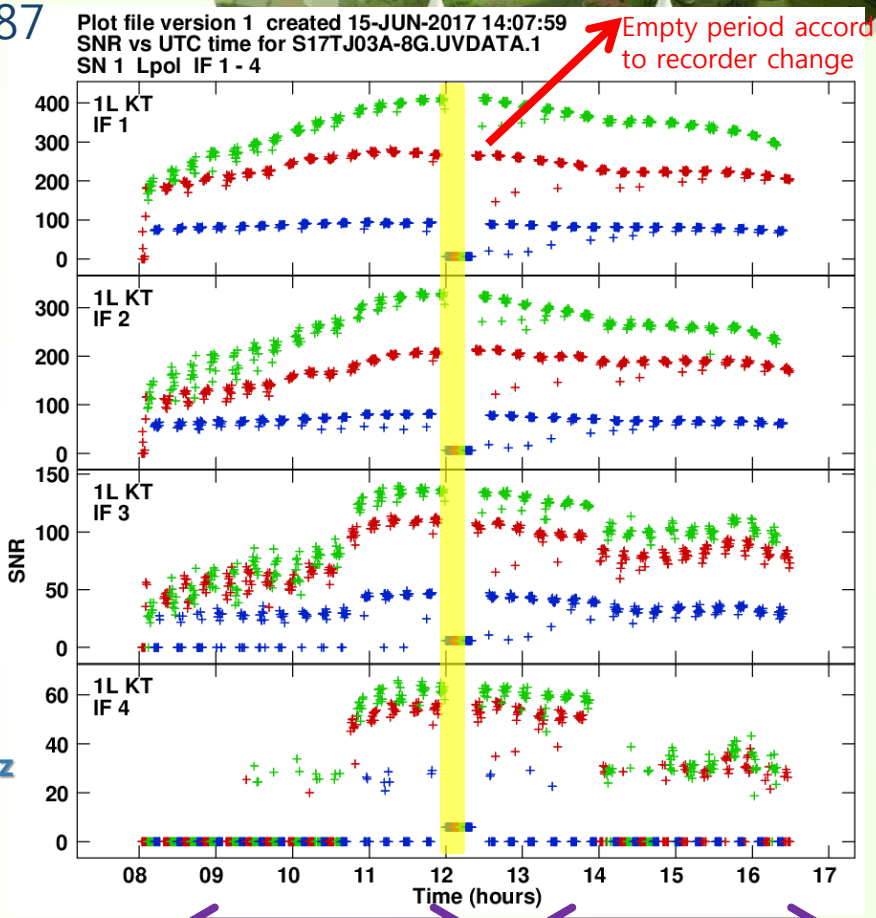
43GHz

86GHz

129GHz

MK5 recorder

8Gbps SNR (Halcyon + MK6)



Halcyon recorder

MK6 recorder

※ SNR comparison: 1Gbps(64 MHz BW/4IF) and 8Gbps(512MHz BW/4IF)
Expected value of theoretical sensitivity increment (about 3 times) is well followed according to the bandwidth increase (8 times).
The results of Halcyon are almost same as those of KYS Mark6

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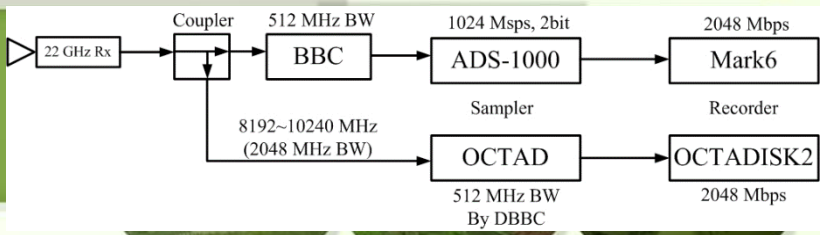
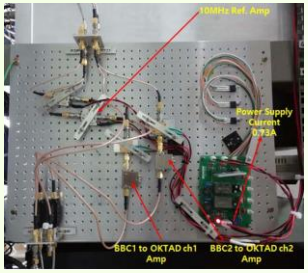
HDD checking system

- HDD with huge capacity is used to record high rates of obs data.
- In recording at Obs., the data was correctly recorded, but the diskpack was not recognized at Correlator center during playingback
- In order to overcome this issue, HDD checking system was developed using FirmOS same as OS of KVN Halcyon recorder.

OCTAD installation



S.D



KYS

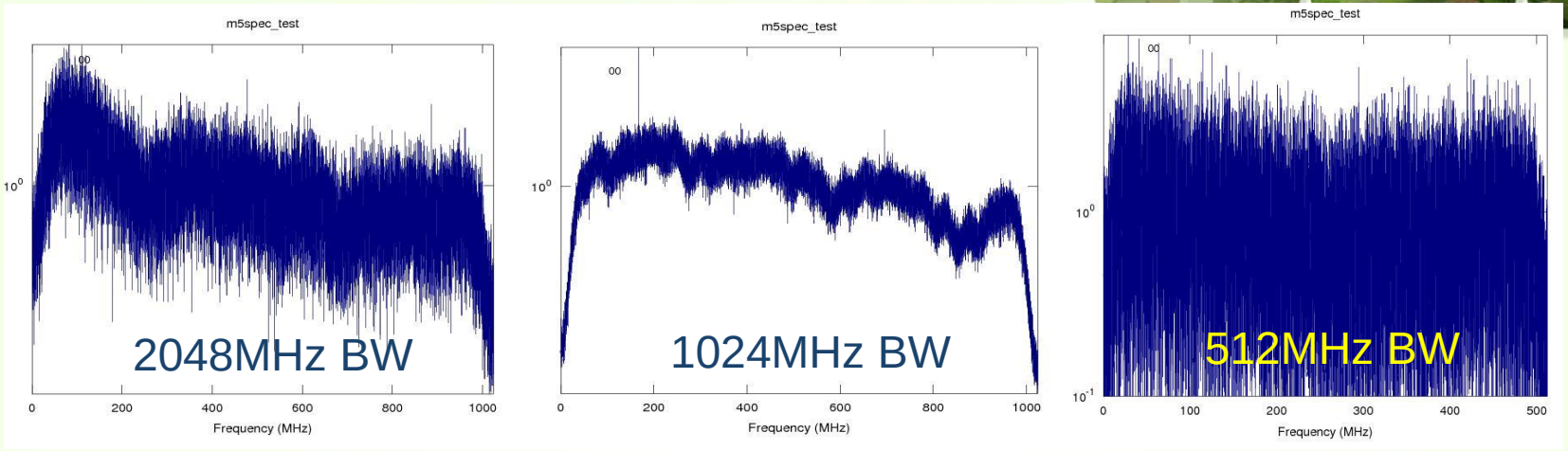
KUS

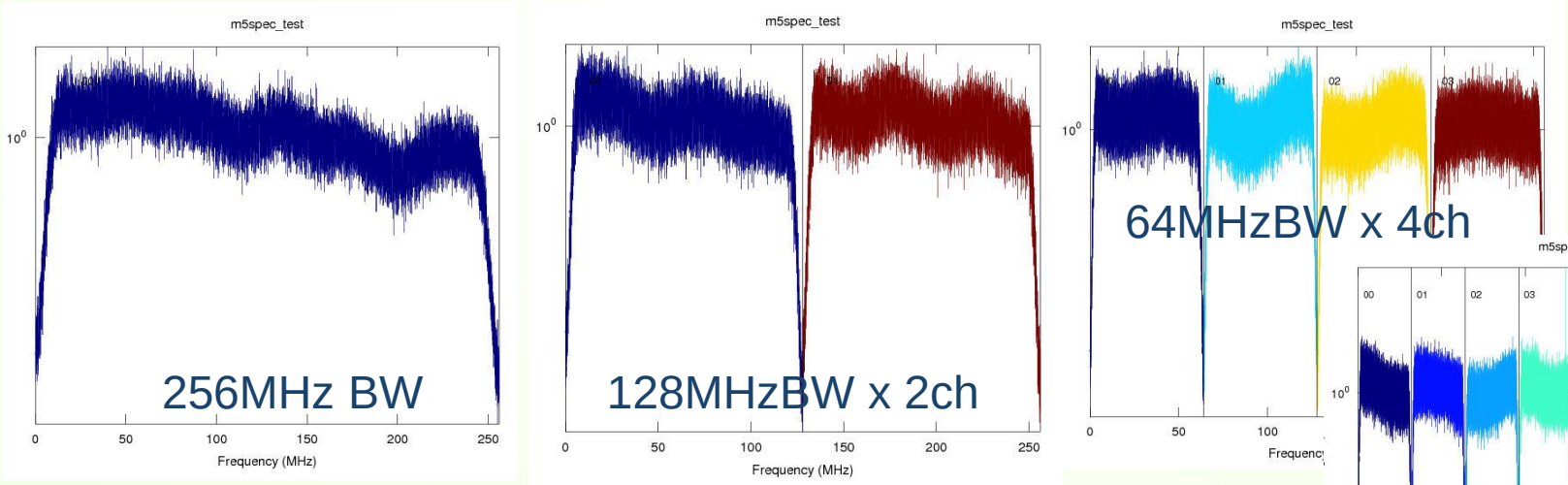
KTN

- 2017.08 : installed at KVN 3 stations
- Preliminary Test item

	Mode name	Obs mode structure	Recording speed
Wideband		2048 MHz BW x 1ch	8 Gbps
		1024 MHz BW x 1ch	4 Gbps
	W1	512 MHz BW x 1ch	2 Gbps
Narrowband	C1	256 MHz BW x 1ch	1 Gbps
	C2	128 MHz BW x 2ch	1 Gbps
	C3	64 MHz BW x 4ch	1 Gbps
	C4	32 MHz BW x 8ch	1 Gbps

OCTAD preliminary result [Q-band @ KYS]





Future works

- **Data format alignment**
  - VERA : VDIF(octa)
  - KVN : VSI, VDIF(general)
  - KJCC : current all support ➔ general VDIF
- **Direct FITSgen SW**
  - Reduce FITS generation time
    - No CODA FS exist, which is just for request base
    - The SW development will be conducted with Leonid from next month
- **Support binning-factor for CODA/FITSgen**
  - Reduce FITS file size for spectral-line
- **SW Digital Filter Development**
  - Support EAVN, and Speed up
  - GPU server will be introduced

Near Future : Data Transmission

- **Data transmission from each Obs.**
  - 4set STARDOM(RAIDBOX) server were prepared
  - 2set STARDOM server will be introduced next year.
    - 3 set for KVN, 2 set for VERA/EAVN, 1set for test
  - Mark5B/Mark6 data for KaVA will be transferred mid of next year

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