



한국우주전파관측망  
KOREAN VLBI NETWORK · KASI



# Recent Status of KJCC for KaVA and EAVN

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and NAOJ Corr. Team



# Contents



- ❖ **KJCC correlation status**
- ❖ **KJCC Development status**

# Korea-Japan Correlation Center(KJCC)



Executive Board



Daejeon HW Correlator



DiFX SW Correlator on HPC

# Correlation Mode



Corr. mode	Band width [MHz]	Output streams	#bits	Output data rate [Mbps]	Clock rate [MHz]
<sup>a</sup> 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
<sup>b</sup> W1	512 x 4band	4	2	8192	64
W2	512 x 4band	1IF <sup>c</sup> x2P <sup>d</sup> 2IFx1P	2	8192	64
W3	512 x 4band	2IFx2P	2	8192	64

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



# Correlation Status



Radio Home [KVN](#) | [KaVA](#) | [EAVN](#) | [KJCC](#) | [TRAO](#)

<http://radio.kasi.re.kr>

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## Radio Astronomy Division

[Radio Home](#)

[Notice](#)

[Colloquium](#)

### Call for Proposal

The 2nd Generation of KVN Key Science Program Call for Proposal [2020B Season](#)

### About Radio Astronomy Division in KASI

Since the establishment of 13.7m telescope in Taeduk Radio Astronomy Observatory (TRAO), Radio Astronomy is one of the active research fields in KASI and of Korea Astronomical Society. Its research activity has been enforced and deepened with installing and operating the Korean VLBI Network (KVN) in KASI since 2008.



Currently KVN is in correlated operation with VLBI Exploration of Radio Astronomy (VERA) in National Observatory of Japan (NAOJ) and researchers in Korea-Japan VLBI Correlator Center work for the joint operations for this KVN-VERA program.

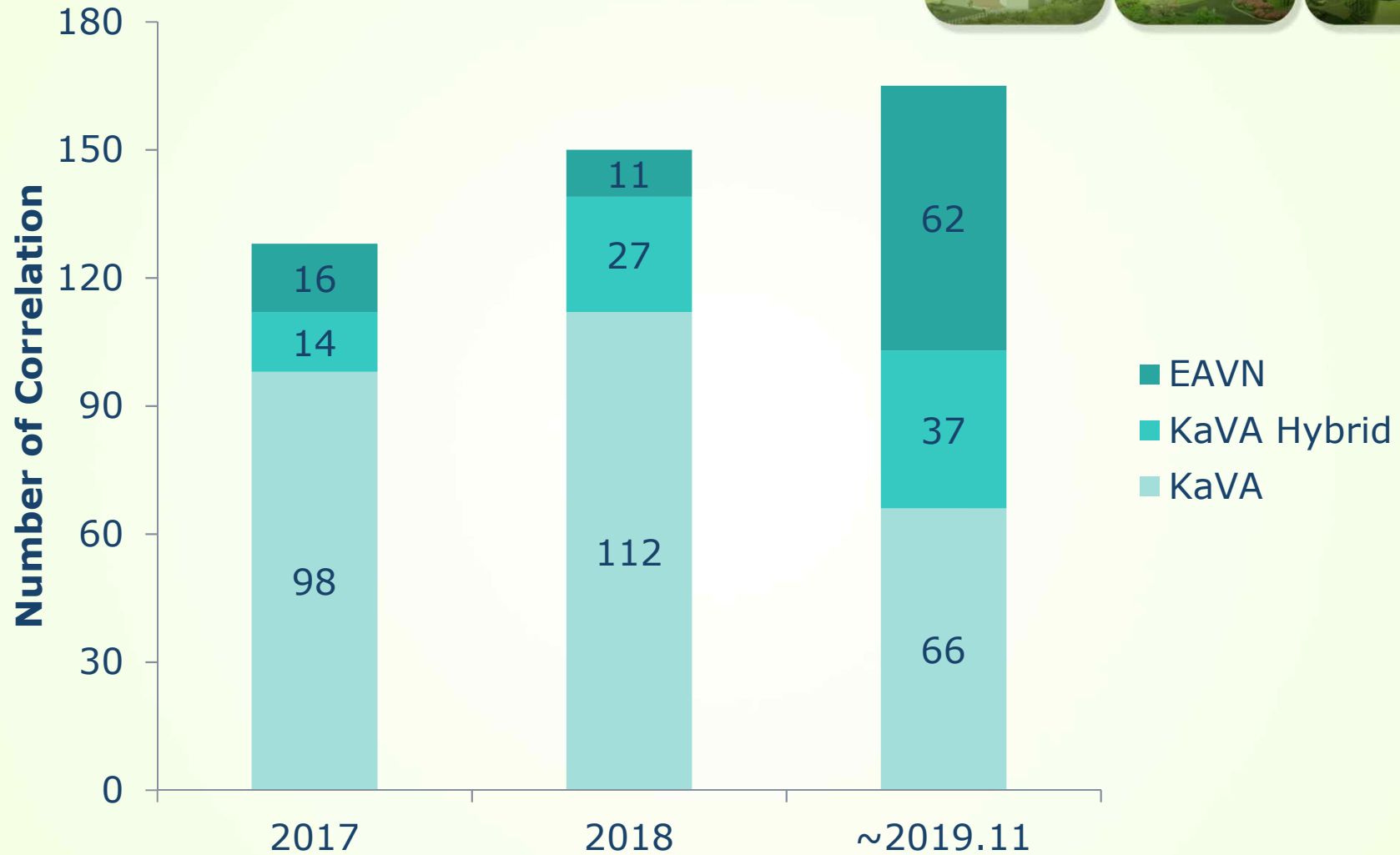
Radio Technology Development Group (RTDG) in KASI has focused on the new millimeter wave receiver system with input optics that simultaneous observations in four bands of 22, 43, 86, and 129 GHz to facilitate calibrating tropospheric phase fluctuations for millimeter-wave VLBI observations. RTDG also focusing on the development of prototype 230 GHz band SIS mixer for THz applications and other technology for the radio observation instruments.

[Notice](#)



한국천문연구원  
Space Science Institute

# Number of correlations



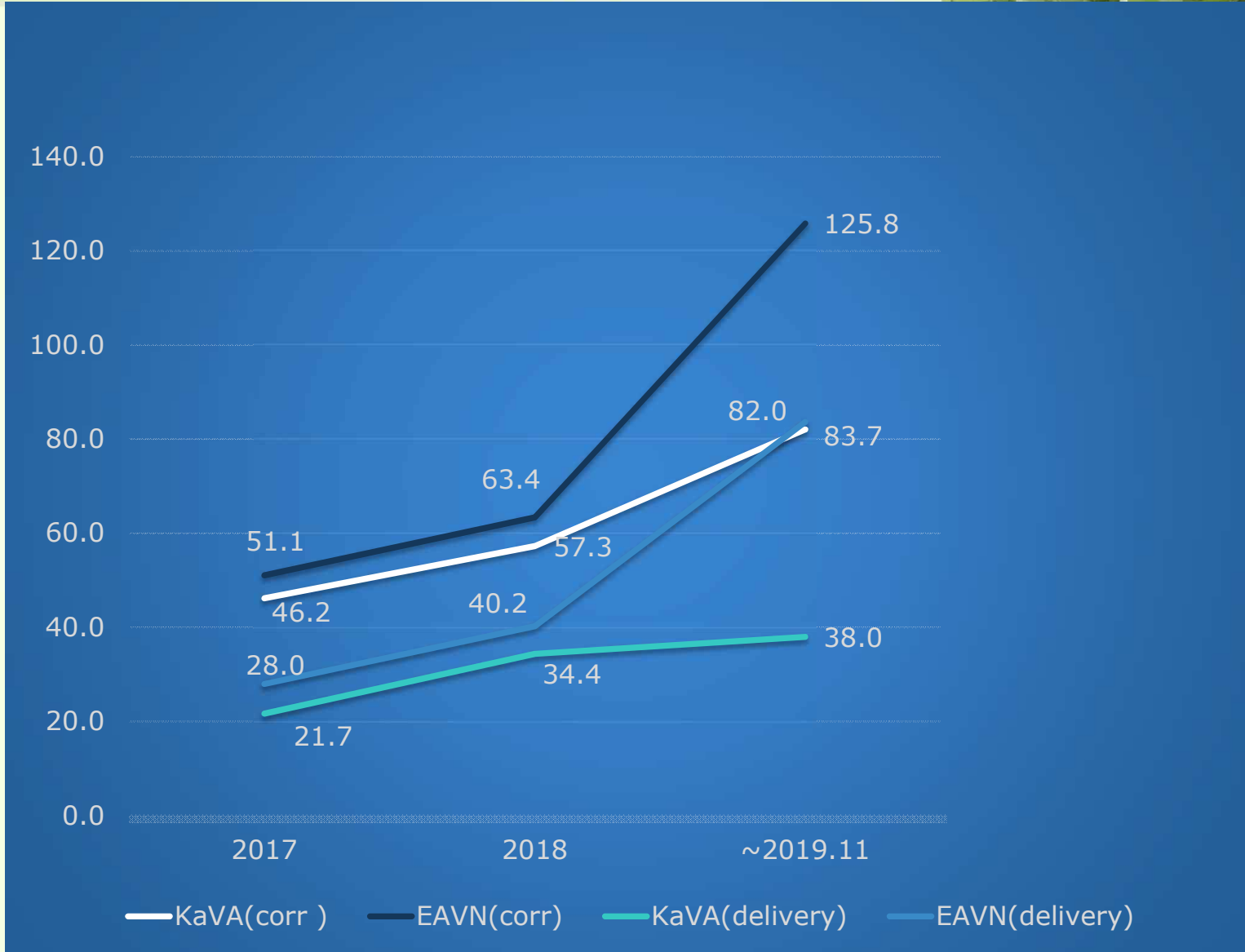
KaVA Hybrid : VERA 2 Beam + KVN Multi Band or KVN Dual Pol. Observation

# Correlation Processing Time after Obs.



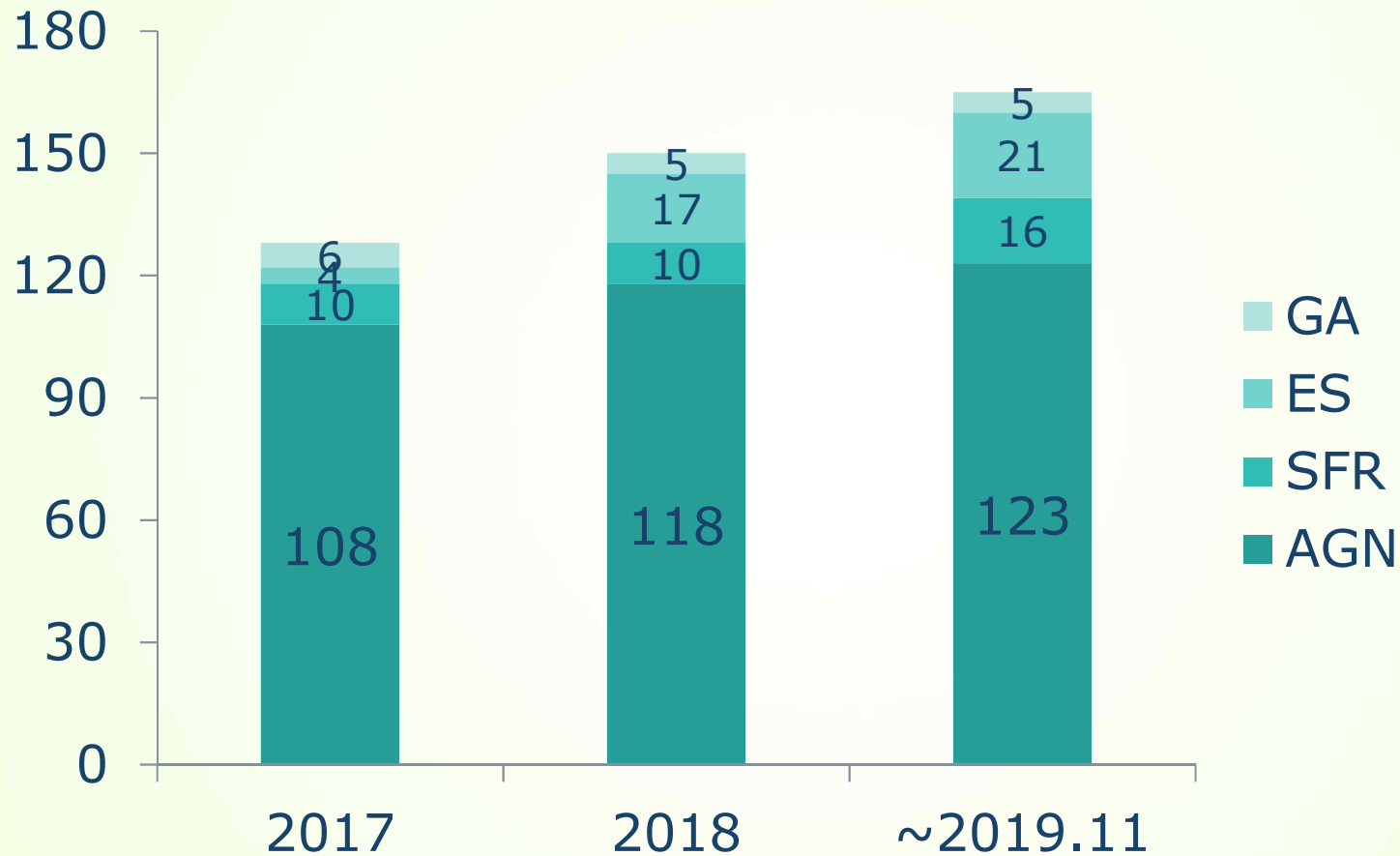
KaVA Hybrid : VERA 2 Beam + KVN Multi Band or KVN Dual Pol. Observation

# Average Corr. and Media Delivery Period



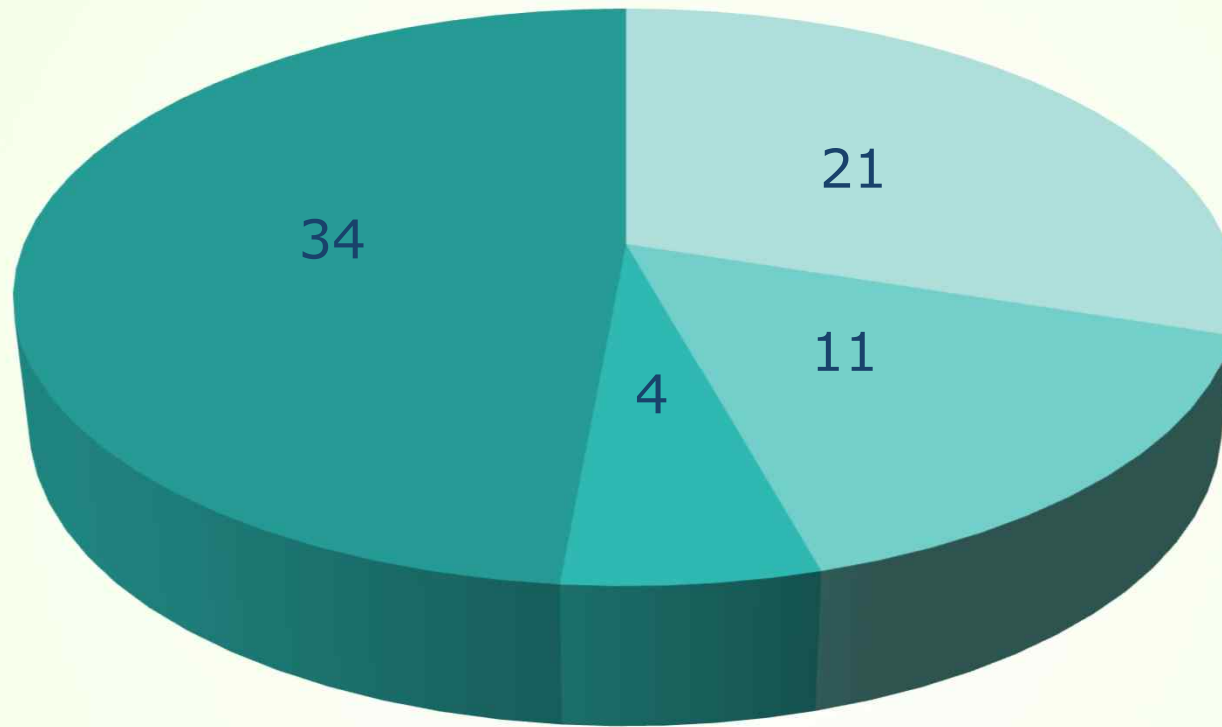


# Number of Science Working Group



GA: Galactic Astrometry, ES: Evolve Star, SFR: Star Formation Region, AGN: Active Galactic Nuclei

# # of Fringe Detection Failures by Cause



■ FS ■ BS ■ WC ■ Unknown

FS: Field System, BS: Backend System, WC: Weather Condition  
Unknown: miss operation? and/or unreported problems?

# # of Fringe Detection Failures by Station



Ky: Yonsei, Ku: Ulsan, Kt: Tamna, Vm: Mizusawa, Vr: Iriki, Vo: Ogasawara, Vs: Ishigakijima  
 Ny: Nobeyama, T6: Tianma, Ur: Urumqi

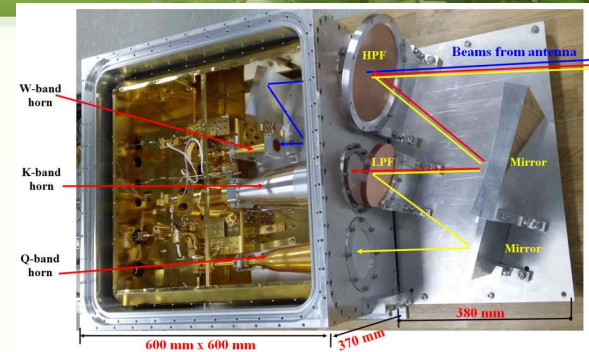
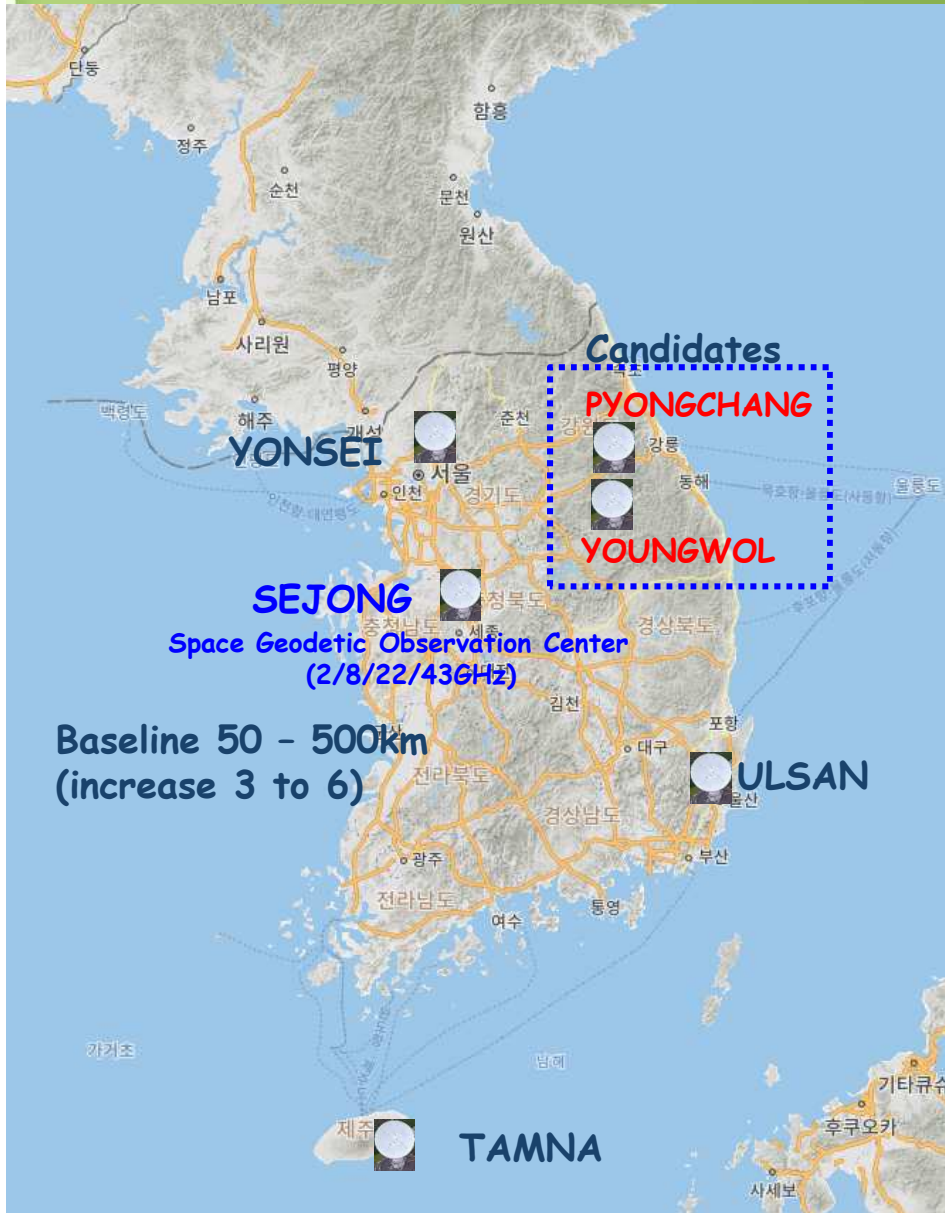
## Problems during Corr.



- 1. Increased correlation period due to delayed data shipment**
- 2. Difficulties in detecting fringes for unknown reasons**
- 3. Setting mismatches(frequency, polarization, etc...)**
- 4. Data storage**
- 5. Log and antab files**



# What is Extended KVN?



S-T, Han

**Compact Triple-band Receiver(CTR) 22/43/86 GHz**  
 + 150 GHz (D-band)  
 + 230 GHz for EHT  
 + 8 GHz (X-band, 7.8GHz)

KVN Receiver	Freq. (old)	Freq. (new)	Trx (new)	Installation
K-band	21.24 - 23.25	18 - 26	< 40	Completed in '18 (all KVN stations)
Q-band	42.11 - 44.11	35 - 50	< 50	KYS ('19 Sep) KUS ('20) KTN ('20 or '21)
W-band	85 - 95	84 - 116	< 80	KYS ('19 Sep) KUS (done, '18) KTN ('20)
D-band	125 - 142	125 - 174	< 60	~ '22 Sep

# E-KVN DAS

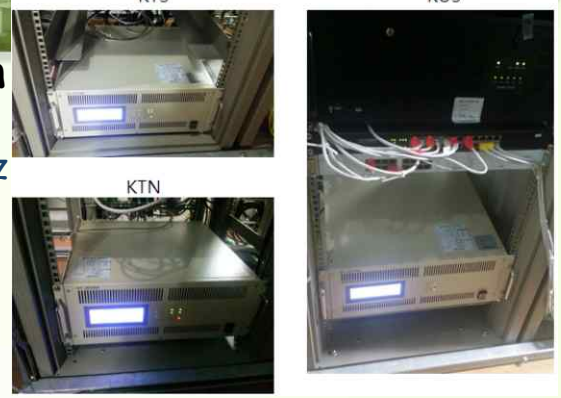


KVN observe full polarization with 4 frequencies  
 22 R/L, 43 R/L, 86 R/L, 129 R/L

- Sampler & Digital Filter (DBBC)
  - OCTAD x 2Set
- Recorder (and playback, 64Gbps)
  - Mark6, FlexBuff, or Peta Data Recorder

## OCTAD Specification

- 4 ADC (4 x 16Gsps)
- Input Freq. 8 - 16GHz
- Digital Down Converter
- Digital Filter
- 4 x 10GbE Output
- VDIF Format



Bandwidth (MHz)	Max Num of Channels	Max Data Rate (Gbps)
8192	1	32
4096	2	32
2048	4	32
1024	8	32
512	16	32
256	16	16
128	16	8
64	16	4
32	16	2
16	16	1

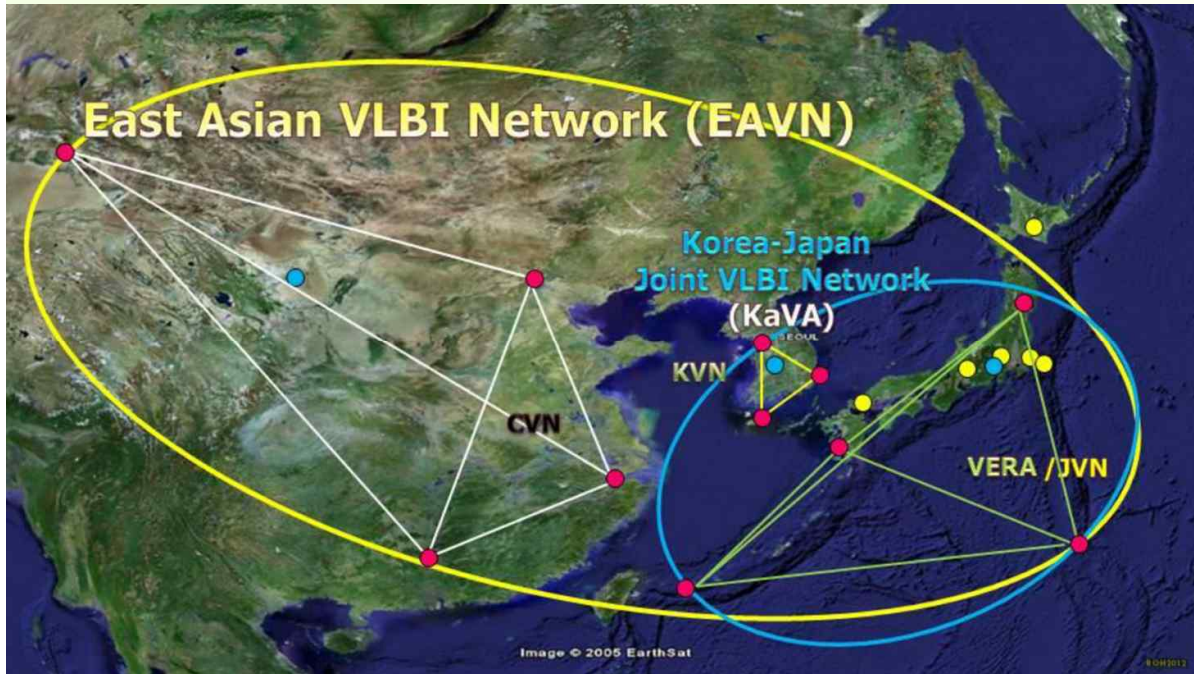


# Correlator now in KASI



**Daejeon Correlator**  
- Hardware Correlator  
- KaVA, EAVN  
- 16 Stations, 8Gbps

**DiFX Correlator**  
- Software Correlator  
- KVN 3 Stations only



- Both correlators are not able to use in E-KVN
  - cannot process higher than 8Gbps data
- Need a new correlator able to correlate 64Gbps data with full polarization

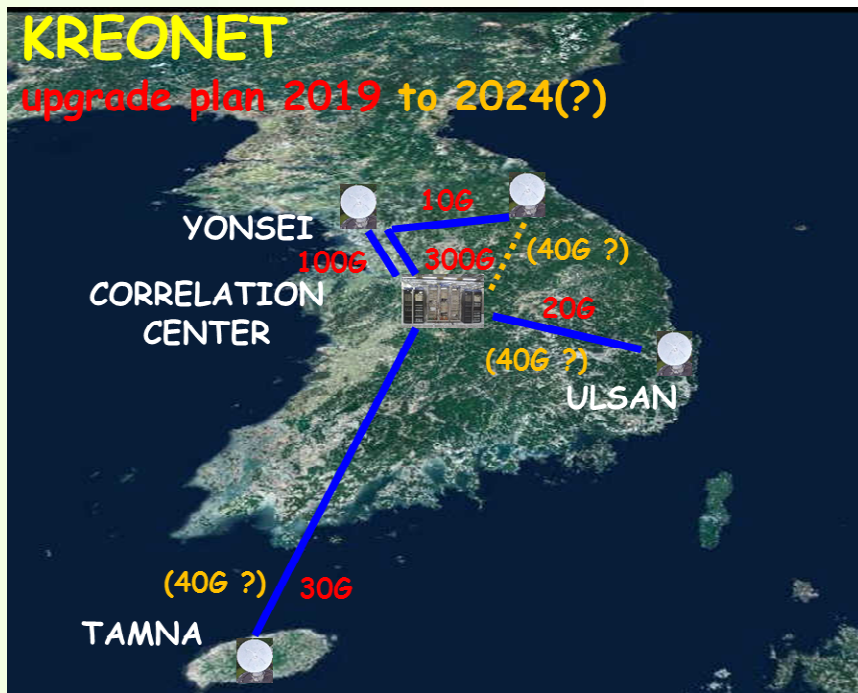
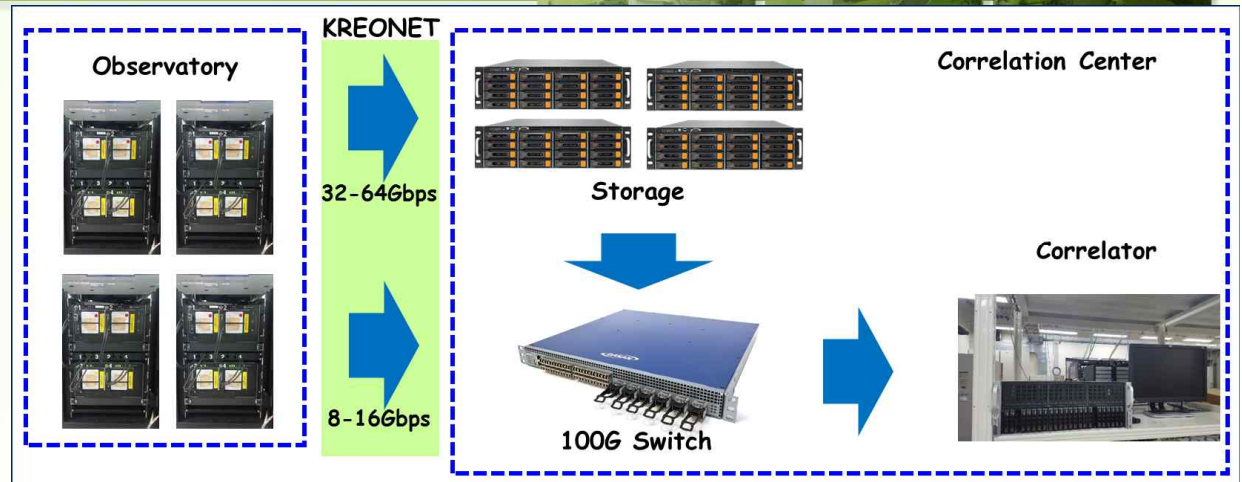
# New Correlator's Goal



- ❖ **32Gbps R/L in real time mode**
- ❖ **64Gbps R/L in run time mode within 2 - 3 times for observation time**
- ❖ **Maximum 5 stations**  
(Yonsei, Ulsan, Tamna, Sejong, and another site)
- ❖ **GPU and network based, e-transfer using KREONET**  
(Korea Research Environment Open NETwork)
- ❖ **until 2024**



# How transfer data to correlation center



- Elementary concept is to use the KREONET
- Request 40Gbps speed rate until 2024
- Recorded data 8, 16Gbps, 32Gbps(?) correlate simultaneously with e-transfer (seems like e-VLBI)
- 32, 64Gbps data, stored to local storage on correlation center, and then correlate

# Lab Test



- **Supermicro 4029GP TRT**
  - CPU Intel XEON Gold 6154 x 2ea
  - RAM 384GByte DDR4
  - SAS RAID Card x 2ea
  - 10Gb Ethernet NIC SFP+ x 2ea
  - 100GbE Mellanox NIC
  - Nvidia Titan V GPU



- **Storage**
  - Stardom RAID Box x 2ea
  - 24TByte(3TB x 8), 64TByte(8TB x 8)
  - Support SAS 12Gb

# Correlation Control GUI(Graphical User Interface)



MAIN #ANT1 #ANT2 #ANT3

Setting from VEX : k17kh03b.vex

#ANT : 3 Bit Rate [Mbps] : 2048 Bit/Sample : 2

#Streams : 1 #FFT chanel : 2048 Integration Time [sec] : 1.048576

Fractional Bit Correction :

Frequency [GHz] (Band Edge):

S01 : 43.134	S02 : 22.227	S03 : 22.227	S04 : 22.227
S05 : 22.227	S06 : 22.227	S07 : 22.227	S08 : 22.227
S09 : 22.227	S10 : 22.227	S11 : 22.227	S12 : 22.227
S13 : 22.227	S14 : 22.227	S15 : 22.227	S16 : 22.227

Store to Directory : (None)

----- Make Schedule -----

47    2017y290d02h13m00s    VERA45    1219+044    420 sec    2146.14	<input type="checkbox"/>	eVLBI
48    2017y290d02h23m00s    VERA45    M87    840 sec    2199.993896 G	<input type="checkbox"/>	
49    2017y290d02h38m00s    VERA45    M84    180 sec    2307.687012 G	<input type="checkbox"/>	
50    2017y290d02h42m00s    VERA45_CS    3C273    180 sec    2330.762	<input type="checkbox"/>	
51    2017y290d02h46m00s    VERA45    1219+044    420 sec    2353.84	<input type="checkbox"/>	
52    2017y290d02h54m00s    VERA45    M87    780 sec    2407.686035 G	<input type="checkbox"/>	
53    2017y290d03h08m00s    VERA45    M84    120 sec    2507.686035 G	<input type="checkbox"/>	
54    2017y290d03h11m00s    VERA45    RT-VIR    120 sec    2523.071045	<input type="checkbox"/>	
55    2017y290d03h14m00s    VERA45_CS    3C273    240 sec    2538.455	<input type="checkbox"/>	
56    2017y290d03h19m00s    VERA45    1219+044    420 sec    2569.22	<input type="checkbox"/>	
57    2017y290d03h27m00s    VERA45    M87    840 sec    2623.070068 G	<input type="checkbox"/>	
58    2017y290d03h42m00s    VERA45    M84    180 sec    2730.761963 G	<input type="checkbox"/>	
59    2017y290d03h46m00s    VERA45_CS    3C273    180 sec    2753.839	<input type="checkbox"/>	
60    2017y290d03h50m00s    VERA45    1219+044    420 sec    2776.91	<input type="checkbox"/>	

Start Stop

----- View Cross Power Spectrum -----

ANT:1	2	3	4	5	6	7	8	9	10
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Progress : Run Time :

MAIN #ANT1 #ANT2 #ANT3

Input Directory : (\*.lst; \*.delay) YS

----- Bit Weight Table -----

00: -1.0 01: -0.125 10: 0.125 11: 1.0

Clock Offset [usec] : 0.0

Data Format :  VIDF - Standard

VDIF - VSRACK

VDIF - OCTA

Mark5

RAW - Data only

Bit Assignment (each bit):

00: 0 01: 1 02: 2 03: 3 04: 4 05: 5 06: 6 07: 7

08: 8 09: 9 10: 10 11: 11 12: 12 13: 13 14: 14 15: 15

16: 16 17: 17 18: 18 19: 19 20: 20 21: 21 22: 22 23: 23

24: 24 25: 25 26: 26 27: 27 28: 28 29: 29 30: 30 31: 31

Setting Parameter : Set



## For this lab test



### Test data

- Experiment Code: k17kh03b (r17289c)
- Observation Date: 2017y290d02h43m25s
- Data Rate: 2.048Gbps (1.024Gsps), 2bit
- Site: KVN 3 stations (Yonsei, Ulsan, Tamna)
- 3 cross power + 3 auto power spectrum
- 4,096 FFT channels
- Observation duration 103 seconds
- GPU correlation processing time 98 - 101 seconds (97%)  
using 1 Titan V GPU card only
- Now, lab testing time split correlation using 2 GPU cards
- Complete in this year

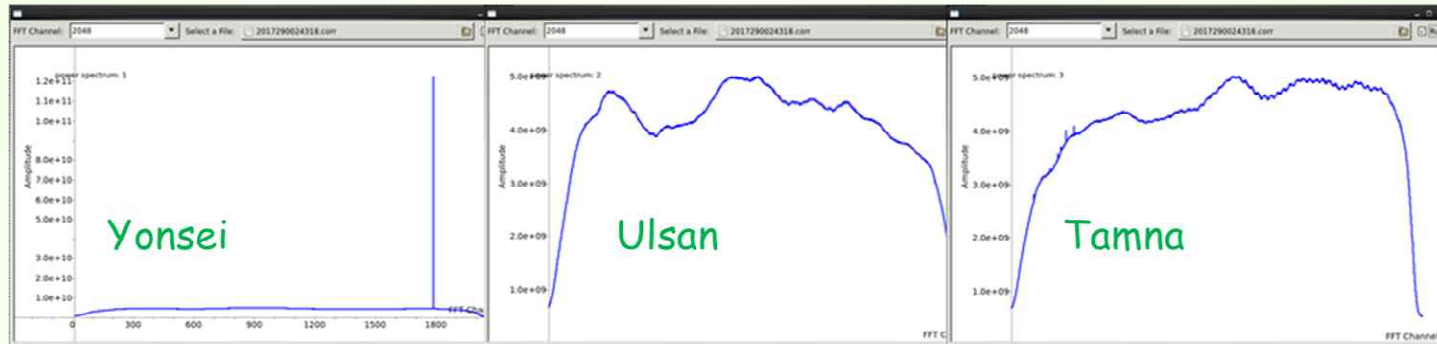


# Test Result

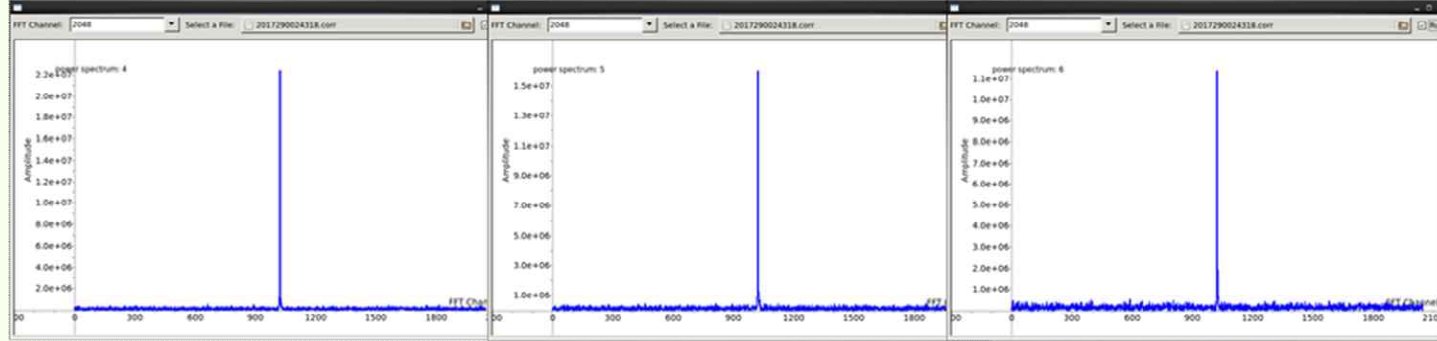


Plot

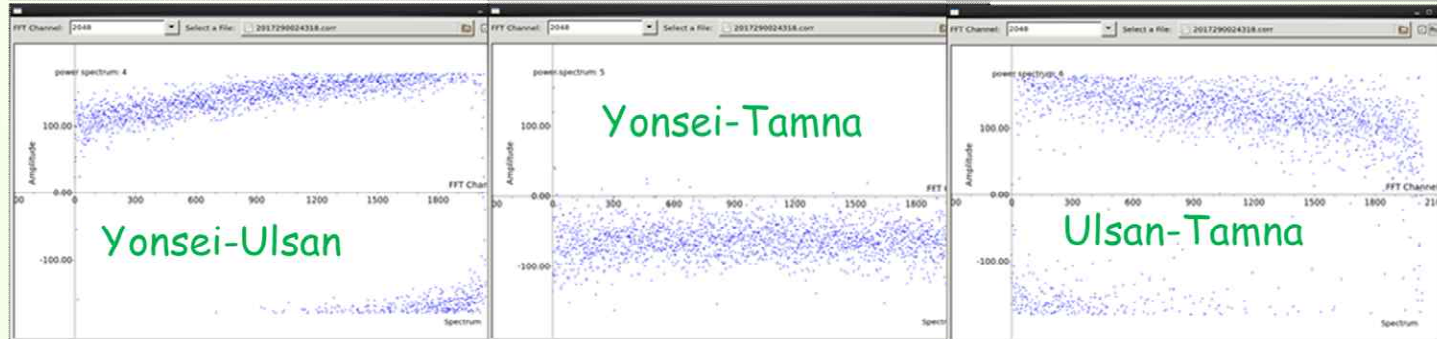
Auto-Power  
Spectrum



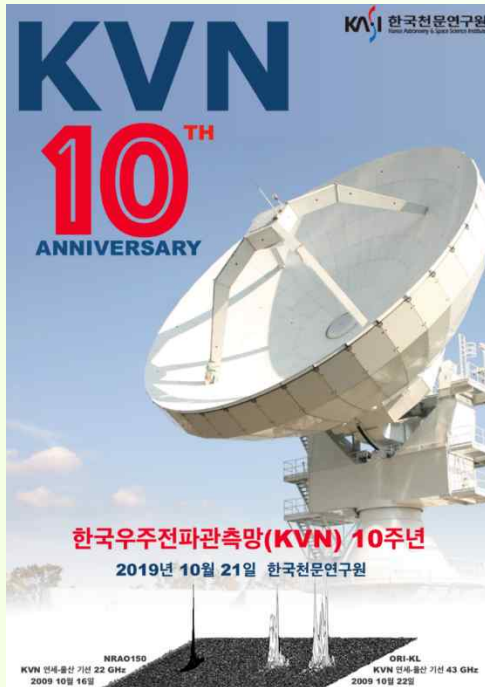
Fringe



Phase



# Correlation Center Peoples



D- G, Roh

Leader



S- J, Oh

Correlator  
Manager



H- R, Kim

DiFX  
Correlator



J- H, Yeom

Maintenance  
& Develop  
Engineer

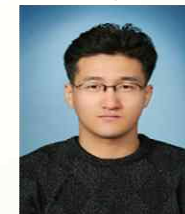


C- S, Oh



J- S, Kim

Data Quality Analyzer



J- Y, Hwang

Correlator Operation



D- G, Jung

Daejeon  
Correlator



D- G, Jung