

Introduction to the East Asian VLBI Network (EAVN) and Activities in mm-VLBI in East Asia

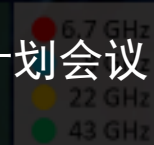
Contents

Introduction to EAVN and Its Open-Use Program
EAVN AGN Campaign
Compact Triple-Band Receiver
Summary

WAJIMA, Kiyooki (輪島 清昭; KASI)

2019年5月20日 东亚天文台亚毫米波未来的计划会议

(Image Credit: Reto Stöckli, NASA Earth Observatory)





The East Asian VLBI Network

(Image Credit: Reto Stöckli, NASA Earth Observatory)

- 6.7 GHz
- 8 GHz
- 22 GHz
- 43 GHz

EAVN: Specifications (as of 2019 May 20)

- **Number of (potential) telescopes:** 20 (17 telescopes have participated in previous EAVN observations one or more times)
 - Korea: 4, China: 5, Japan: 11
- (Possible) **frequency coverage:**
 - 6.7 GHz (11 stations), 8 GHz (15), 22 GHz (16), 43 GHz (12)
- (Expected) **angular resolution:**
 - 2.4 mas (6.7 GHz; Ogasawara – Kunming)
 - 1.5 mas (8 GHz; Ogasawara – Nanshan)
 - 0.6 mas (22 GHz; Ogasawara – Nanshan)
 - 0.3 mas (43 GHz; Ogasawara – Nanshan)
- **Sensitivity for 7- σ fringe detection** ($\tau = 60$ s, $B = 256$ MHz):
 - 1.6 mJy (8 GHz; Tianma – KVN)
 - 9.5 mJy (22 GHz; Tianma – KVN)
- (Expected) **recording rate:** ≥ 1 Gbps (= 512 MHz BW)
- (Currently-used) **correlator:**
 - KASI (Korea): Daejeon Hardware Correlator (DHC) and DiFX
 - SHAO (China): DiFX

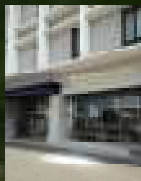
The East Asian VLBI Network

(Image Credit: Reto Stöckli, NASA Earth Observatory)





Tamna 21 m



KASI/DHC



Yonsei 21 m



Ulsan 21 m



Mizusawa 20 m



Nanshan 26 m



Tianma 65 m



Ishigakijima 20 m



Iriki 20 m



Nobeyama 45 m



Ogasawara 20 m

KVN 21 m x 3 (Korea)
 VERA 20 m x 4 (Japan)
Nobeyama 45 m (Nagano, Japan)
Tianma 65 m (Shanghai, China)
Nanshan 26 m (Urumqi, China)
 Daejeon Hardware Correlator (Daejeon, Korea)

Status of EAVN Open Use

- EAVN started the **open-use program** from 2018B semester
 - Frequency: 22, 43 GHz
 - Observation time: 100 h/semester (~ 4.5 months)
 - Correlator: Daejeon Hardware Correlator at KASI

Semester	Maximum observation time	Oversubscription Rate (# of accepted/ submitted proposals)	Telescope
2018B	100 h	1.08 (5/6)	KaVA, Nobeyama, Tianma (9)
2019A	100 h	2.35 (8/16)	KaVA, Nobeyama, Tianma, Nanshan (10)
2019B	100 h		KaVA, Nobeyama, Tianma, Nanshan (10)

Proposal submission deadline for EAVN 2019B semester:

2019 June 3, 08:00 UT

Online submission: <http://eavn.kasi.re.kr/>

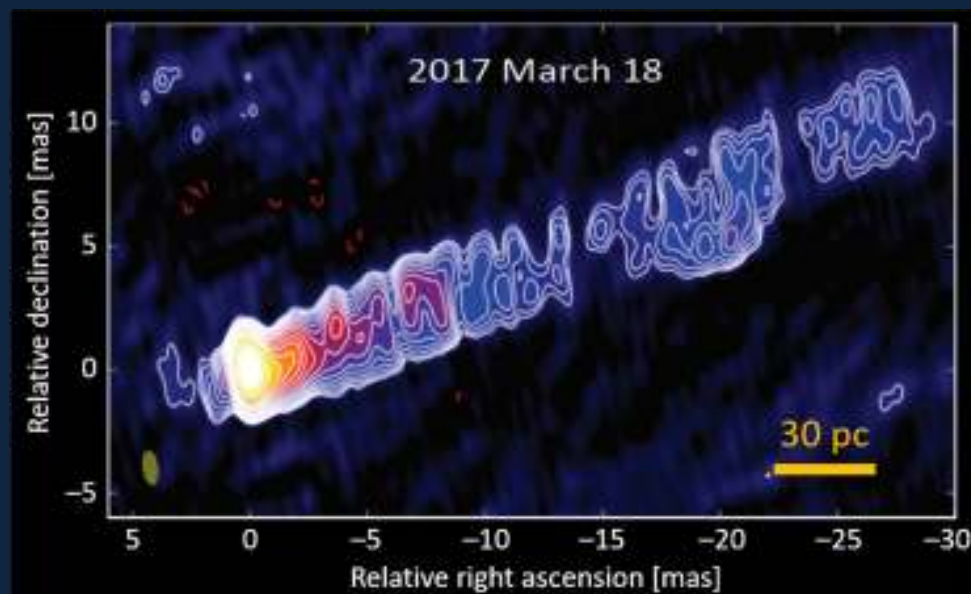
EAVN AGN Campaign

- Dense VLBI monitoring (every ~ 10 days) quasi-simultaneously with the EHT campaign
- Term: From March to May every year
- Target: **Sgr A*** and **M87**

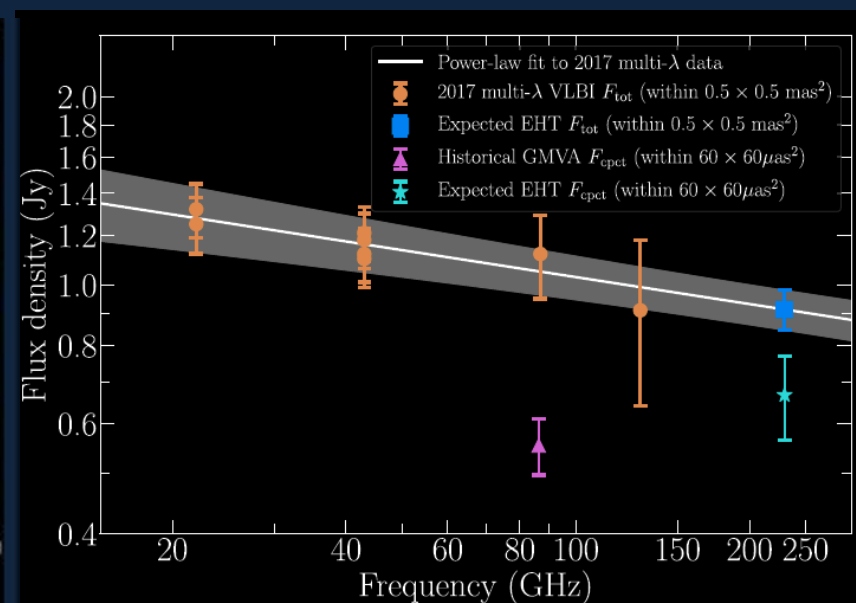
Year	Total Duration (# of epochs)			# of antennas				
	Total	22 GHz	43 GHz	Total	CN	KR	JP	IT
2017	140 h (17)	40 h (5)	100 h (12)	15	2	4	7	2
2018	186 h (18)	83 h (9)	103 h (12)	14	2	3	7	2
2019	174 h (21)	78 h (9)	96 h (12)	13	2	3	5	3

EAVN AGN Campaign

- Tracing trajectory of each jet component in M87 precisely
- Relation between the physical state of the supermassive black hole and jet launch/acceleration mechanisms



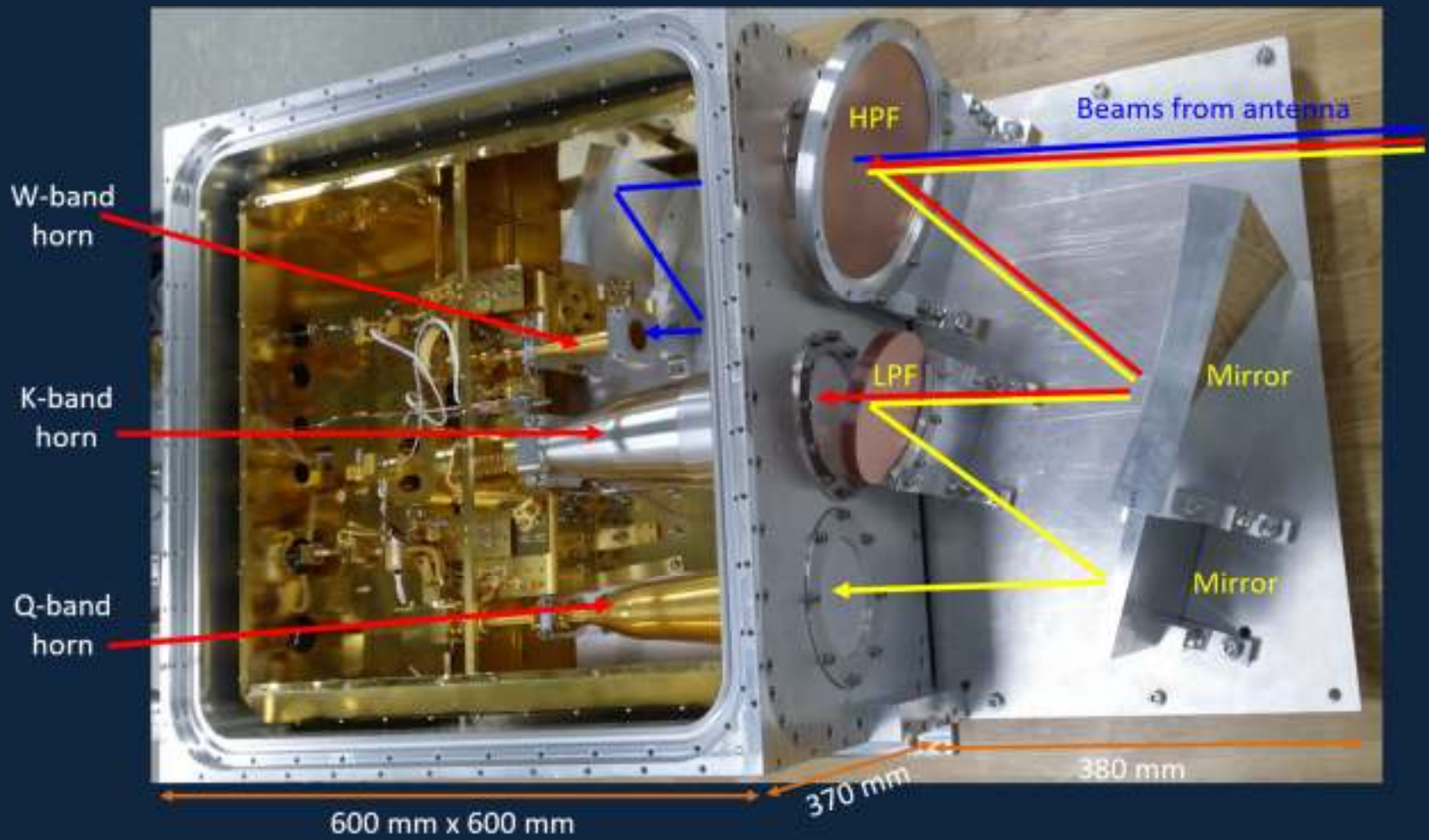
(EAVN Collaboration, in prep.)



(EHT Collaboration 2019, ApJL, 875, L4)

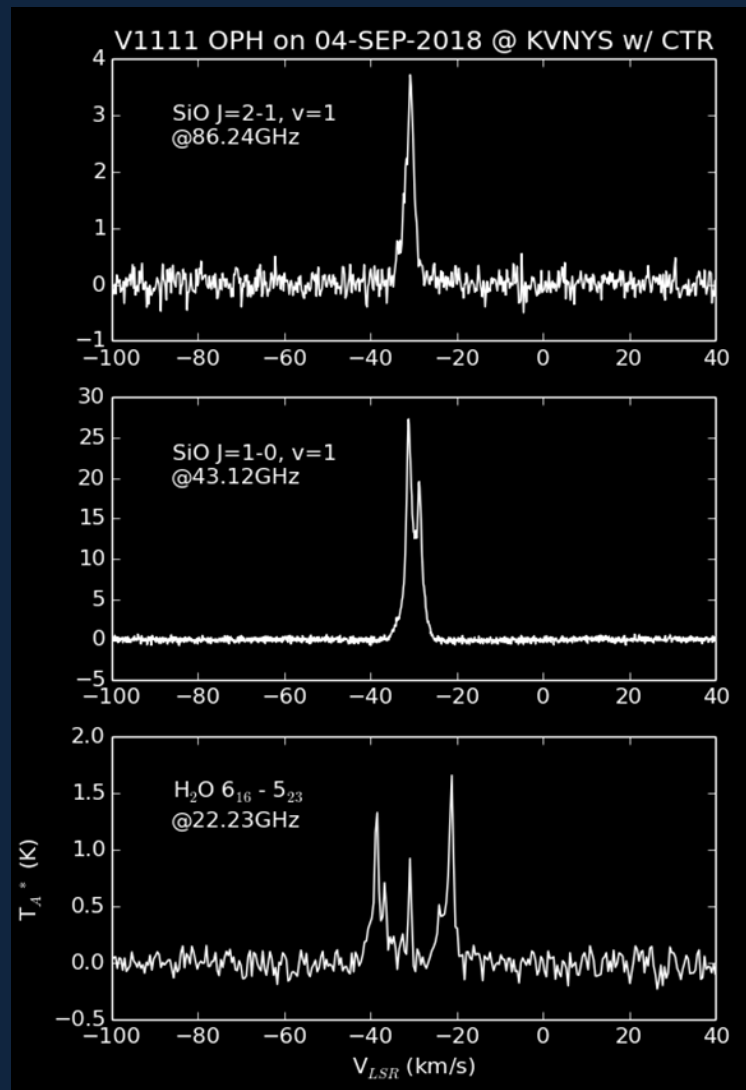
Compact Triple-Band Receiver

- Simultaneous reception system at three frequencies (22/43/86 GHz)



Compact Triple-Band Receiver

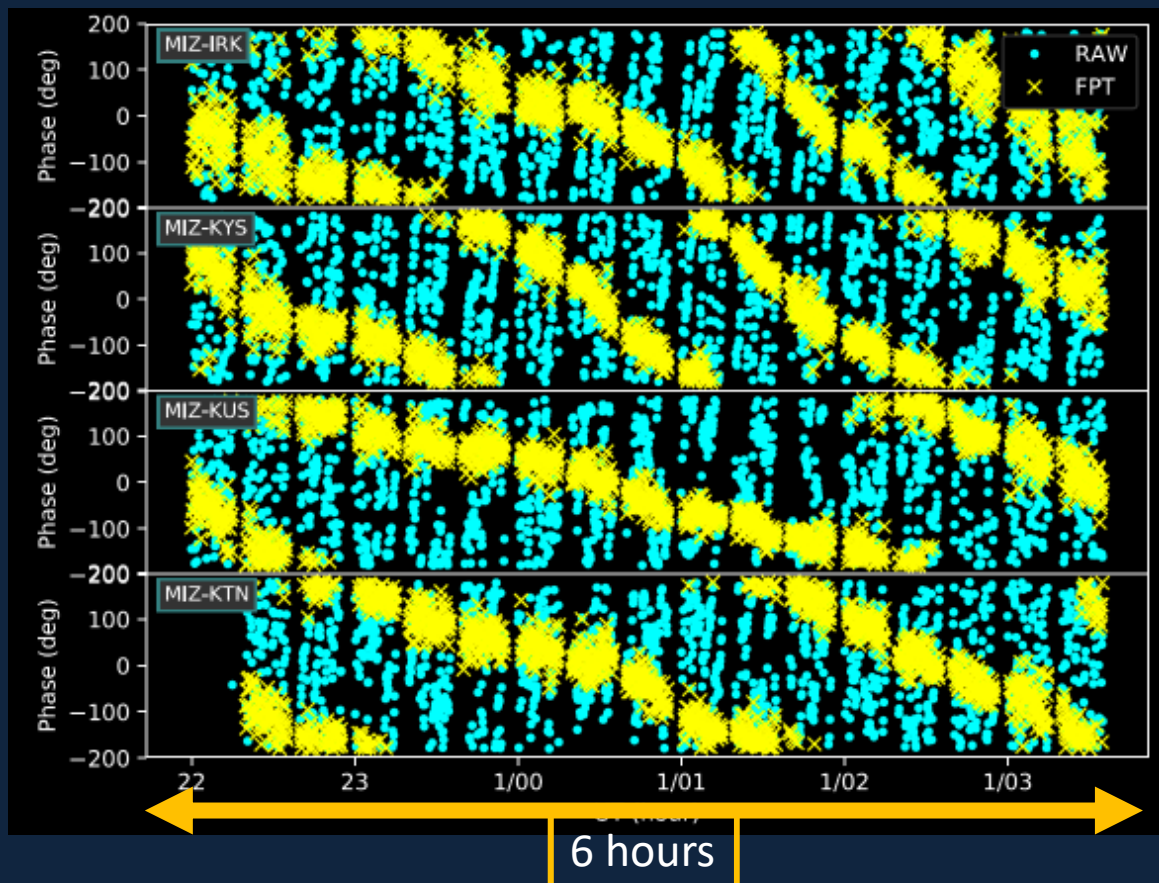
- Simultaneous reception system at three frequencies (22/43/86 GHz)
- Simultaneous detection of H₂O/SiO maser emission from a Mira variable V1111 Oph on 2018 Sep 4



Phase Calibration Technique by the Frequency Phase Transfer (FPT)

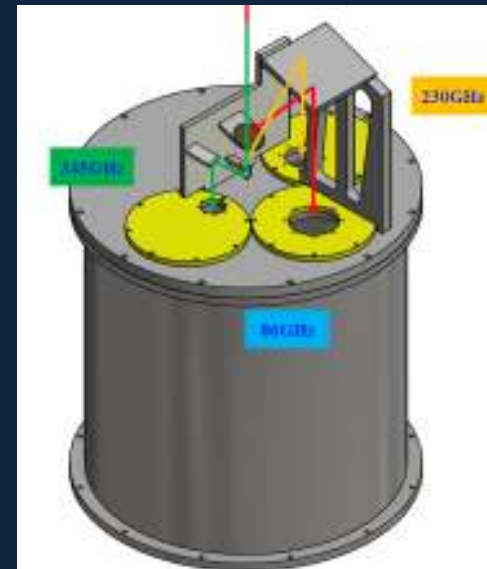
- FPTed phases at 43 GHz (**yellow**) by applying phase solutions for 22 GHz to the raw visibilities at 43 GHz (**blue**) for a quasar 4C 39.25 (Zhao et al. 2019, JKAS, 52, 23)

Solution interval of
> 10 min for fringe
detection can be
applied at 129 GHz.



Simultaneous Data Reception (SDR) System

- One of key technologies for future (sub-)mm VLBI
 - Completion of installation of SDR system in VERA (at 22/43 GHz; Japan) and Yebes (at 22/43 GHz; Spain)
 - SDR system development ongoing for three Italian telescopes (Sardinia, Noto, and Medicina at 22/43/86 GHz; 2019 – 2022)
 - Discussion on the possibility of installation of CTR in GLT (86/230/345 GHz)
- VLBI fringe test at 230 GHz in EA
 - Refer to presentations by Matsushita-san and Imai-san



Summary

- Introduction to the East Asian VLBI Network (EAVN) and results obtained by EAVN AGN campaign
- Introduction to sub-mm VLBI-related activities in East Asia, including development of simultaneous data reception system

- Proposal submission deadline for EAVN 2019B semester: 2019 June 3, 08:00 UT (online submission)
 - Refer to EAVN website: <http://eavn.kasi.re.kr/>
- 12th East Asian VLBI Workshop
 - 2019 September 24 – 26, Ibaraki University (Japan)