

VLBI Activities in East Asia and First-Year Achievements of Open Use Program with the East Asian VLBI Network (EAVN)

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(Image Credit (ground photograph): Reto Stöckli, NASA Earth Observatory)

● 6.7 GHz
● 8 GHz
● 22 GHz
● 43 GHz



The East Asian VLBI Network

(Image Credit (ground photograph): Reto Stöckli, NASA Earth Observatory)

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

EAVN: Specifications (as of 2019 Sep 24)

- **Number of (potential) telescopes:** 19 (16 telescopes have participated in previous EAVN observations one or more times)
 - Korea: 4, China: 5, Japan: 10
- (Possible) **frequency coverage:**
 - 6.7 GHz (11 stations), 8 GHz (14), 22 GHz (15), 43 GHz (11)
- (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 (= 256 MHz BW)
- (Currently-used) **correlator:**
 - KASI (Korea): Daejeon Hardware Correlator (DHC) and DiFX
 - SHAO (China): DiFX

The East Asian VLBI Network

(Image Credit (ground photograph): Reto Stöckli, NASA Earth Observatory)



Recent Updates (since the last EAVW)

- Shutdown of Kashima 34 m telescope
- **Approval of the E-KVN project** (2020 – 2027) (Taehyun-san's talk on Sep 24)
 - New 21-m telescope at northeast of Korea
 - High-accuracy antenna surface up to 230 GHz
- Receiver upgrade
 - Installation of new wideband receivers at Q-band (35 – 50 GHz) and W-band (85 – 116 GHz) at KVN Yonsei (2019 Sep)
 - **Installation of K/Q simultaneous reception system at all VERA stations** (test observations in 2019 Sep)
 - **Development of K/Q/W simultaneous reception system at Nobeyama** (Imai-san's talk on Sep 26)
- **EAVN-hi experiments** (Matsushita-san's talk on Sep 24)
 - VLBI fringe tests at 230 GHz using EA telescopes
- **Activities in Southeast Asian countries**
 - Malaysia, Thailand, Indonesia (Zamri-san, Phrudth-san, and Taufiq-san's talks on Sep 25)

Launch of EAVN Open-Use Program

- EAVN open-use program has been launched from the 2018B semester on the basis of MoA between 4 institutes (KASI, NAOJ, SHAO, and XAO)



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	250 h	1.54 (17/24)	KaVA, Nobeyama, Tianma, Nanshan (10)
2020A	500 h		KaVA, Nobeyama, Tianma, Nanshan, Takahagi (11)

Summary of KaVA/EAVN Observations

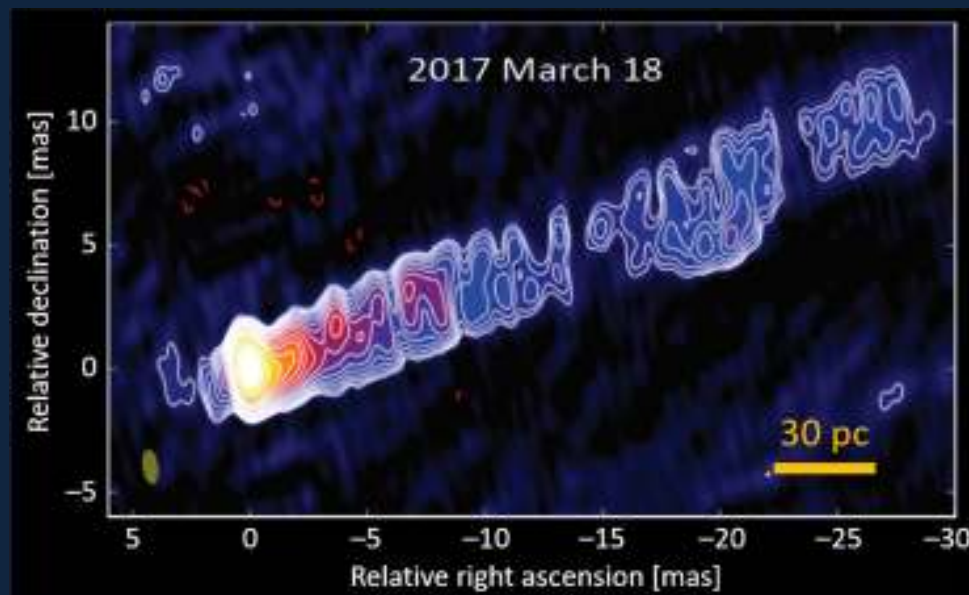
Semester	Category	Total observing time (# of observing epochs)			
		KaVA	Tianma	Nanshan	Nobeyama
2018B	KaVA Open Use	152.5 (23)	–	–	–
	EAVN Open Use	92.0 (14)	92.0 (13)		38.0 (5)
	LP (AGN)	46.0 (7)		14.0 (2)	
	LP (SFR)	96.0 (12)			
	LP (Evolved stars)	43.0 (14)	12.0 (4)	12.5 (5)	
	Performance test	32.0 (2)	–	–	–
	Total	461.5 (71)	104.0 (17)	26.5 (7)	38.0 (5)
2019A	KaVA Open Use	48.0 (9)	–	–	–
	EAVN Open Use	79.5 (13)	76.0 (13)	61.5 (8)	46.0 (8)
	LP (AGN)	180.0 (22)	161.0 (19)	47.0 (6)	
	LP (SFR)	72.0 (9)			
	LP (Evolved stars)	48.0 (12)			
	KaVA/EAVN DDT	116.0 (16)	21.5 (4)	6.0 (1)	
	Performance test	75.0 (7)	51.0 (6)	15.0 (3)	
	Total	618.5 (88)	309.5 (42)	129.5 (18)	46.0 (8)

Summary of KaVA/EAVN Observations

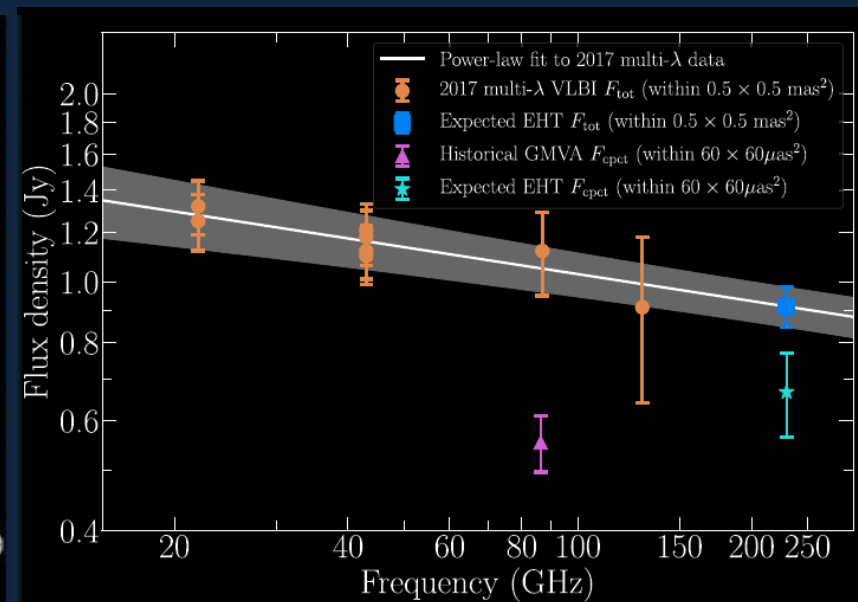
- Total **observing time** (and # of **observing epochs**) for KaVA/EAVN sessions in the 2018B and 2019A semesters
 - KaVA: **1080.0 h** (**159**) (incl. GOT **372.0 h** / LP **485.0 h**)
 - Tianma: **413.5 h** (**59**) (incl. GOT **168.0 h** / LP **173.0 h**)
 - Nanshan: **156.0 h** (**25**) (incl. GOT **61.5 h** / LP **73.5 h**)
 - Nobeyama: **96.0 h** / **84.0 h** (**13**)
 - Hitachi (JP): **12.0 h** (**2**) (EAVN TT)
 - Yamaguchi (JP): **12.0 h** (**2**) (EAVN TT)
 - Medicina (IT): **28.5 h** (**9**) (GOT 13.0 h / LP 15.5 h)
 - Noto (IT): **30.0 h** (**9**) (GOT 13.0 h / LP 17.0 h)
 - Sardinia (IT): **29.0 h** (**10**) (GOT 6.0 h / LP 23.0 h)
 - Badary (RU): **6.0 h** (**1**) (GOT)

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)



Tamna 21 m



KASI/DHC



Yonsei 21 m



Ulsan 21 m



Mizusawa 20 m



Nantna 26 m



Tianma 65 m



Takahashi 33 m



Ishigakiyama 20 m



InRI 20 m



Nobeyama 45 m



Dossener 20 m



Short-Term Agenda

- **Open-use program at 6.7 GHz** from the 2020B semester
 - 8 telescopes (VERA, KVN-Ulsan, Tianma, Hitachi, Yamaguchi)
- Open-use program with dual-polarization mode (2020B or 2021A)
- **Launch of the new EAVN Large Program** from the 2020B semester

Mid-Term Agenda

Year	2017	2018	2019	2020	2021
Actions	<ul style="list-style-type: none"> • Performance evaluation and science commissioning at 6.7/22/43 GHz • Practice of the array operation (scheduling, telescope operation, data handling, etc.) 	<ul style="list-style-type: none"> • (Late 2018) Risk-shared open use at 22/43 GHz • Performance evaluation at 6.7 GHz • Performance evaluation of 2 Gbps mode 	<ul style="list-style-type: none"> • (Late 2018) Risk-shared open use at 22/43 GHz • Performance evaluation for extending observation modes (2-pol., 2 Gbps, etc.) 	<ul style="list-style-type: none"> • (Late 2020) Risk-shared open use at 6.7 GHz • (Late 2020) Risk-shared open use of dual-polarization mode • Test observation at low frequencies (< 5 GHz) 	<ul style="list-style-type: none"> • (Early 2020) Risk-shared open use of 2 Gbps mode
Freq.	6.7/22/43 GHz	6.7/22/43 GHz	6.7/22/43 GHz	(1.6/2/5/)/6.7/22/43 GHz	(1.6/2/5/)/6.7/22/43 GHz
Purposes	<ul style="list-style-type: none"> • Initial scientific outputs from EAVN • Confirmation of performance at all frequencies 	<ul style="list-style-type: none"> • Launch of regular operation of EAVN • Confirmation of performance for wideband observation 	<ul style="list-style-type: none"> • Launch of regular operation of EAVN • Confirmation of performance for various observation modes 	<ul style="list-style-type: none"> • Stable operation of EAVN • Investigation of low-frequency VLBI with FAST and/or other telescopes 	<ul style="list-style-type: none"> • Regular operation with various observation modes

Summary

- Introduction to the East Asian VLBI Network (EAVN) and **one-year achievements of the EAVN open-use program**
 - Total observing time of 1,080 hours (159 epochs) by EAVN
 - Introduction to recent progresses and updates of VLBI-related activities in (South)East Asian countries
- Proposal submission deadline for EAVN 2020A semester: **2019 November 15, 08:00 UT** (online submission)
 - Refer to EAVN website: <http://eavn.kasi.re.kr/>