Recent status of VLBI activities in Japan and east Asia

Yoshiaki Hagiwara (NAOJ)

Invited talk in the VLBI Consortium meeting , 29 October 2014, Tsukuba, GSI

Astronomical VLBI in Japan

1. VERA (VLBI Exploration of Radio Astrometry)

   H. Kobayashi's talk in this meeting

2. Japanese VLBI Network (JVN) ,

   K. Fujisawa's talk in this meeting

3. EAVN (East Asia VLBI Network)

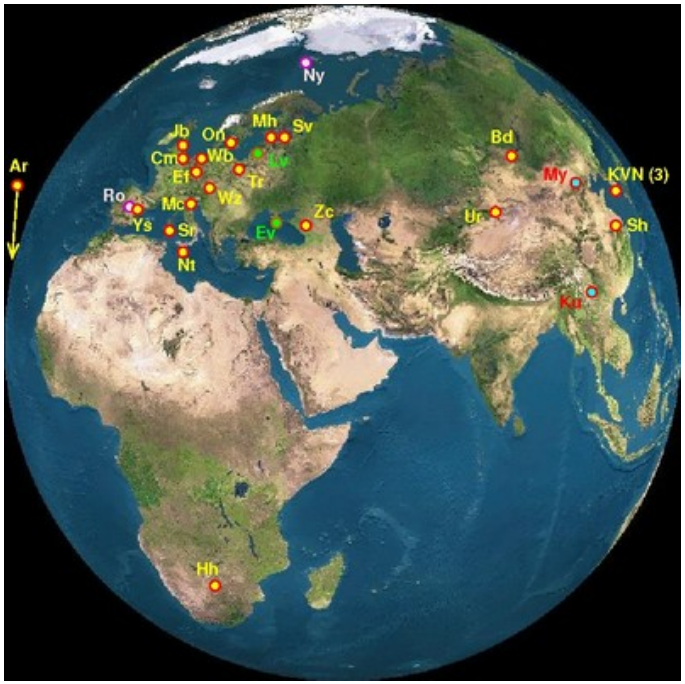
   - KaVA (*K*orean VLBI Network *a*nd *V*ERA *A*rray)
   - EAVN status
   - Other International collaboration

   = > This talk

Astronomical VLBI in the world

- Two Major networks: EVN, VLBA
- Some others: VERA/JVN (Japan), KVN (Korea), CVN (China), LBA (Australia)

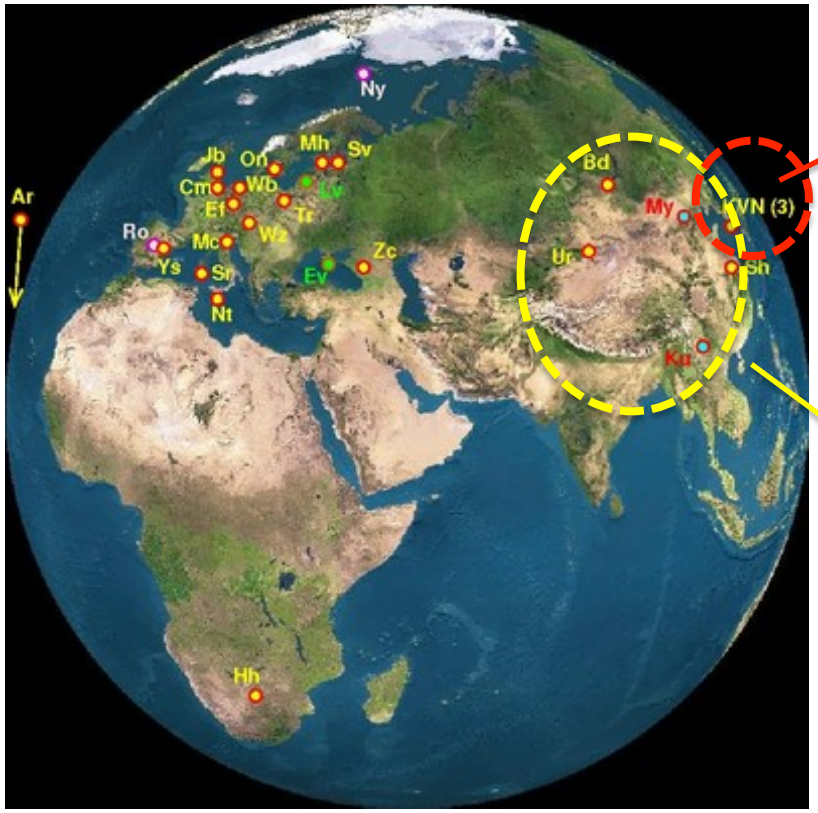
EVN = European VLBI Network



VLBA= Very Long Baseline Array

Long Baseline Array

European VLBI Network Map

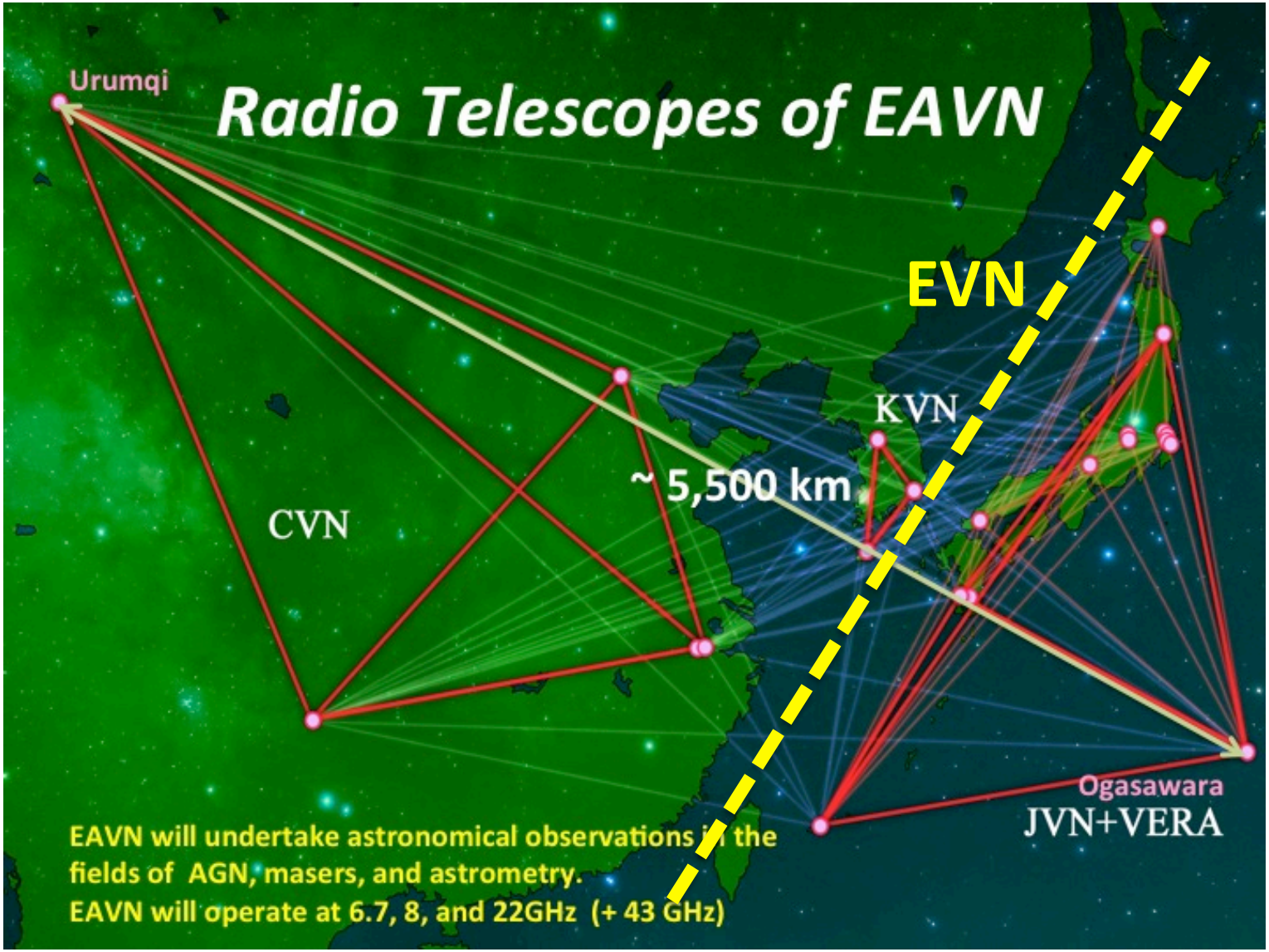


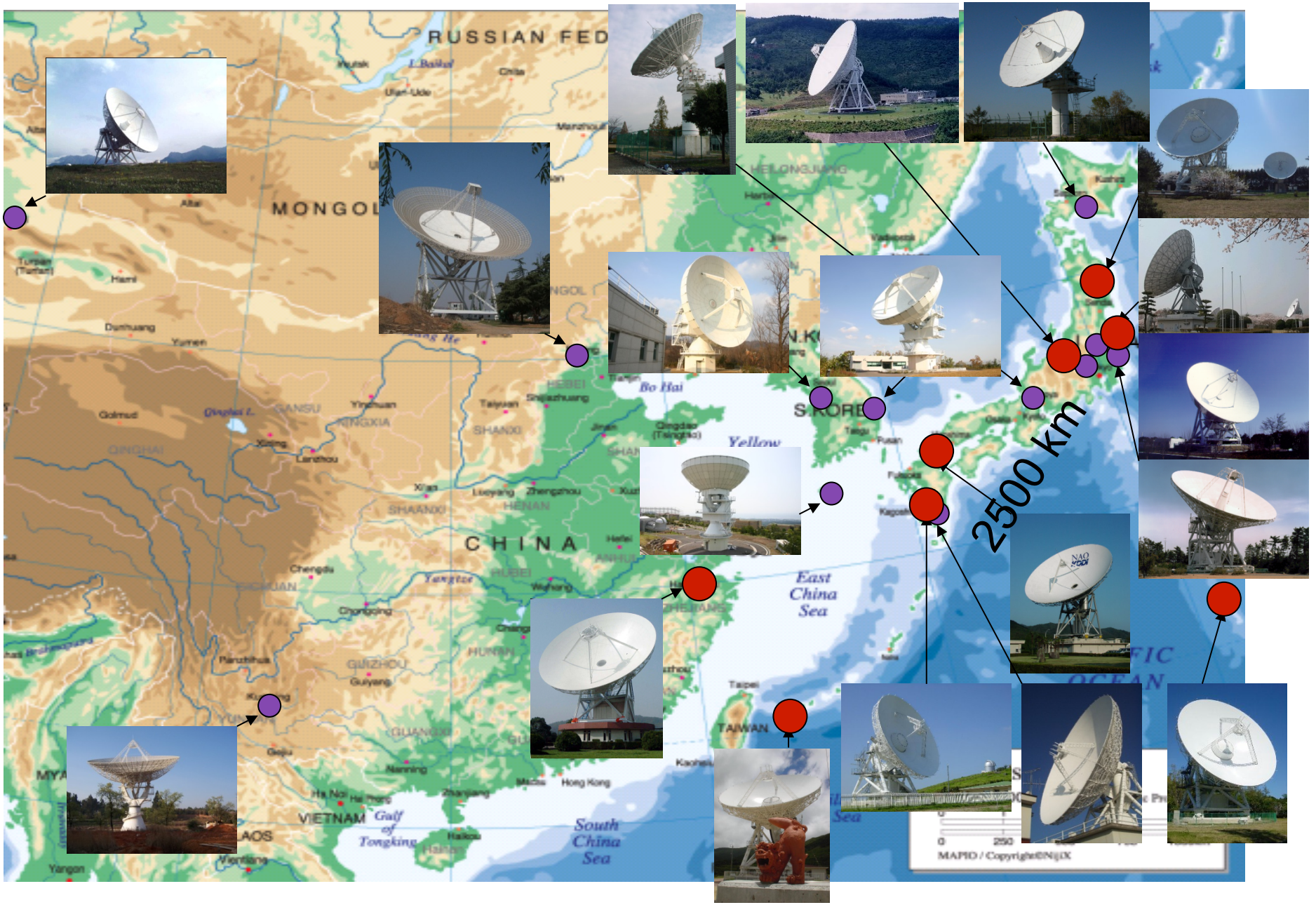
KVN (Korea)

CVN (China)

Adopted from EVN Homepage

EAVN (East Asia VLBI Network) map




RUSSIAN FED
MONGOL
CHINA
Yellow
East
China
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South
China
Sea
Bo Hai
TAIWAN
VIETNAM
Gulf
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2500 km
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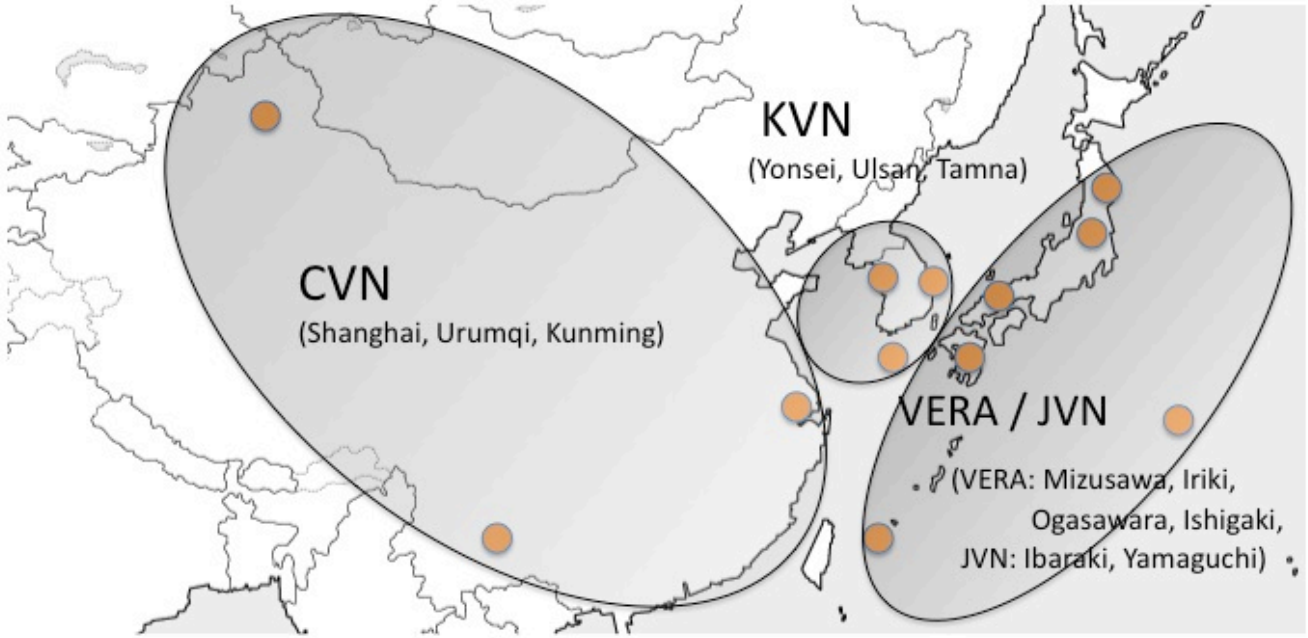
VLBI Arrays in east Asia

KVN and VERA Array (KaVA)

East Asia VLBI Network (EAVN)

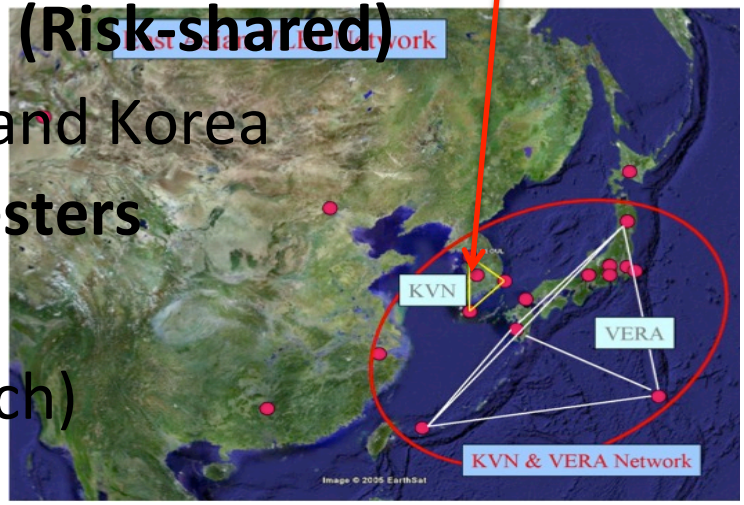


Japan-Korea Collaboration (KaVA: KVN and VERA Array)

- **KaVA status**

  - 7 telescopes: VERA 4x20m, KVN 3x21m
  - Hardware correlator (**KJJVC**) locates at Daejong (Software DiFX correlates KVN data only)

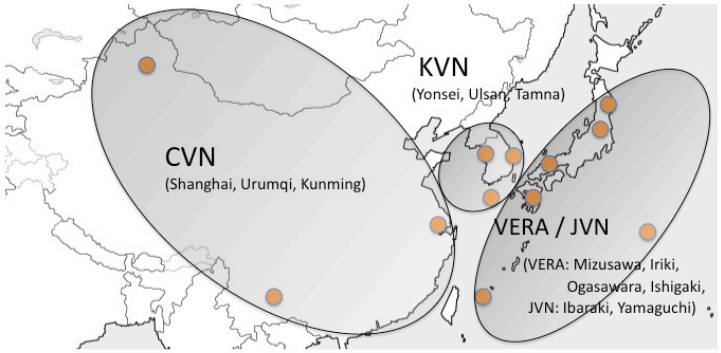
  - **Proposal-based observations started (Risk-shared)**
    - AO: twice a year , limited to Japan and Korea
    - **280 hr allocated in two 2013 Semesters**
  - Bands: 22 GHz and 43 GHz
  - Recording mode: 1Gbps (16MHz x 16ch)



KaVA status

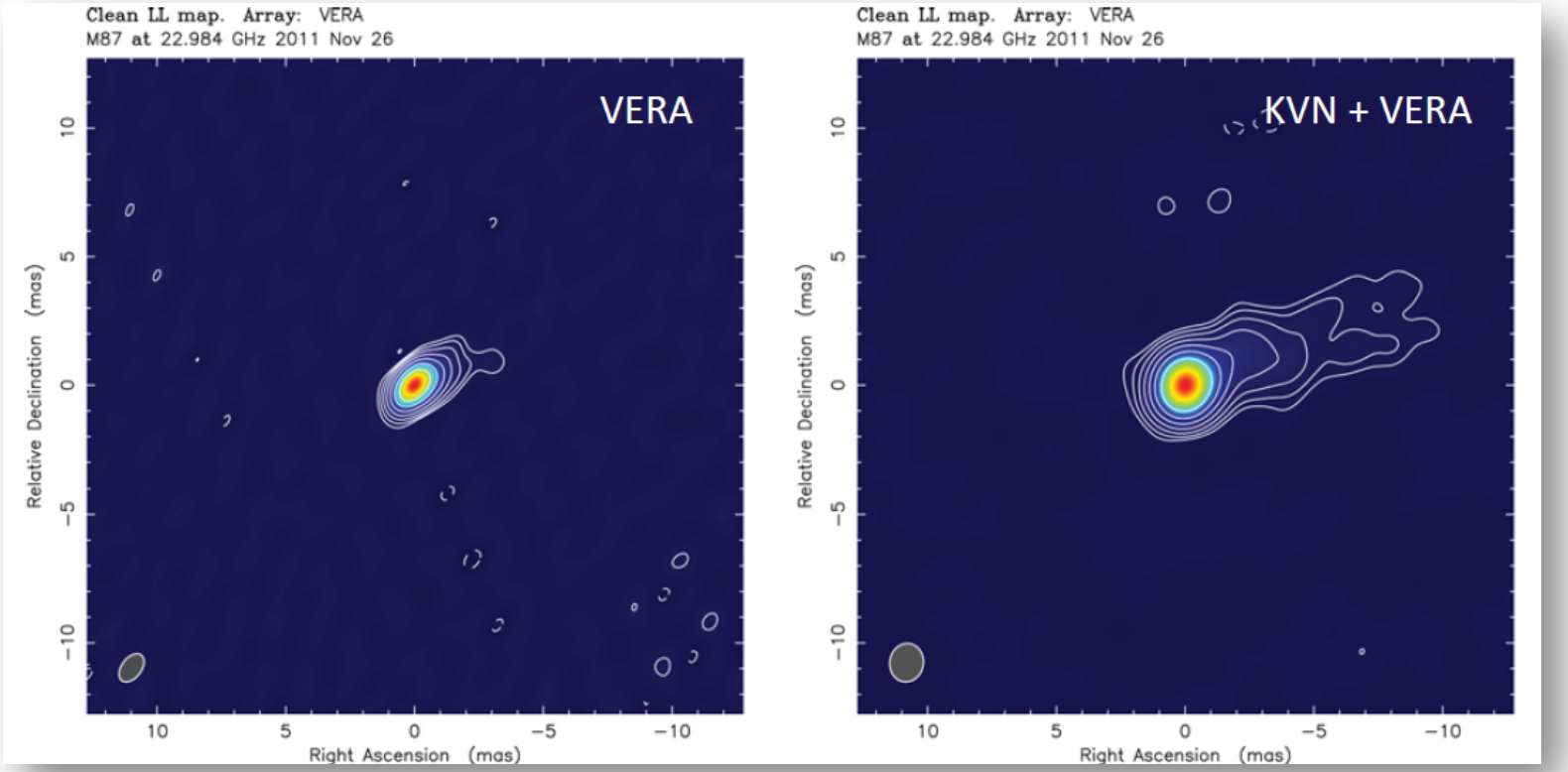
- From 2014 Semester, <u>proposal opportunity opened to researchers in China and Taiwan</u>

- KVN plans to have two more telescopes to extend its baseline length in e.g., North Korea/ Chiang Mai in Thailand/Qingdao in China



KaVA Imaging performance test

- M87, nearby radio galaxy
- 22 GHz, at 128 Mbps rec. rate

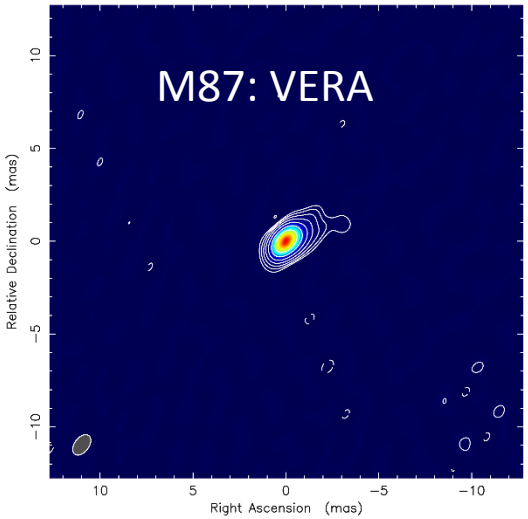


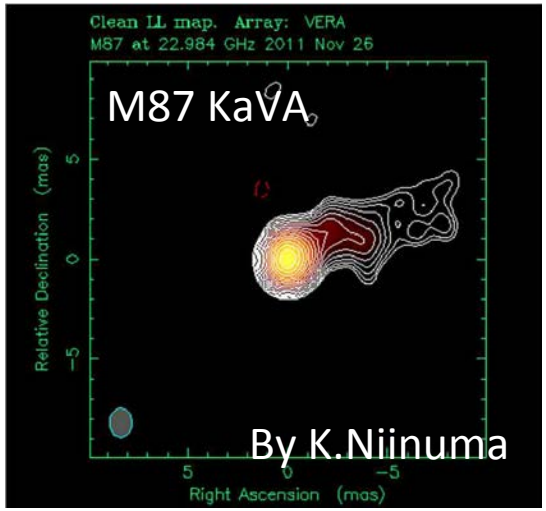
K. Niinuma, PASJ, in press

KaVA Science activities

- **Science activities**

  - AGN, Astrometry, SFR, Evolved Stars WGs meet F2F twice a year
  - Key Science Program discussion on-going
  - Publications : Niinuma+, in press (AGN mapping,)
    Matsumoto+ 2014 (44GHz Methanol maser)
    Zhao+ (Monitoring SgrA* at 22/43 GHz)

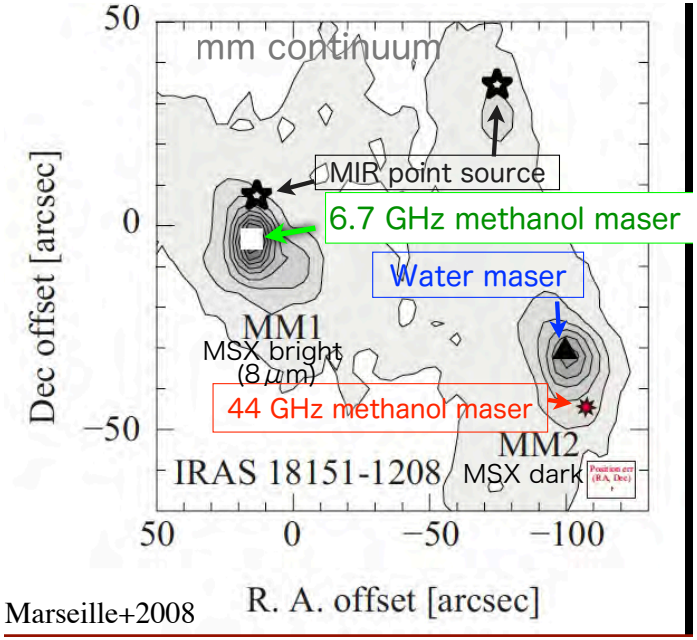




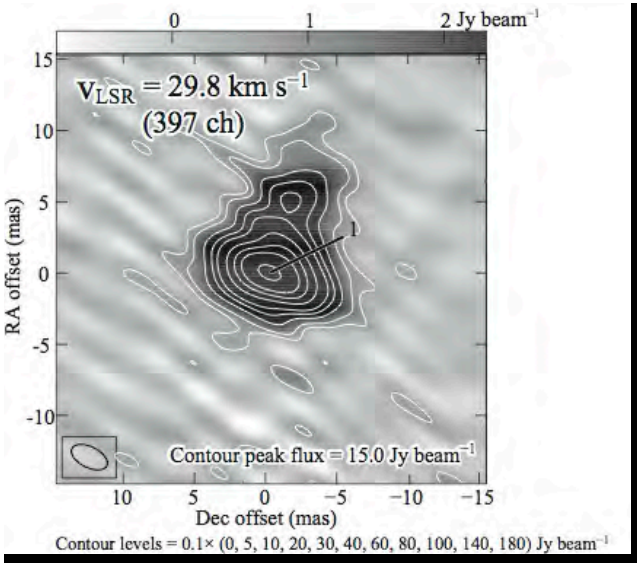
KaVA Science high lights

(Matsumoto et al. , ApJL, 2014)

- 44 GHz CH_3OH maser in the massive star-forming region, G18.34+1.78 SW, imaged by KaVA in 2012-2013.
- Three maser spots associate with G18.34+1.78 SW (left)
  - spot size ~ 3 mas (8AU@2.7kpc), brightness temp. ~ 9 10^9 K
- One of the velocity features resolved (right).



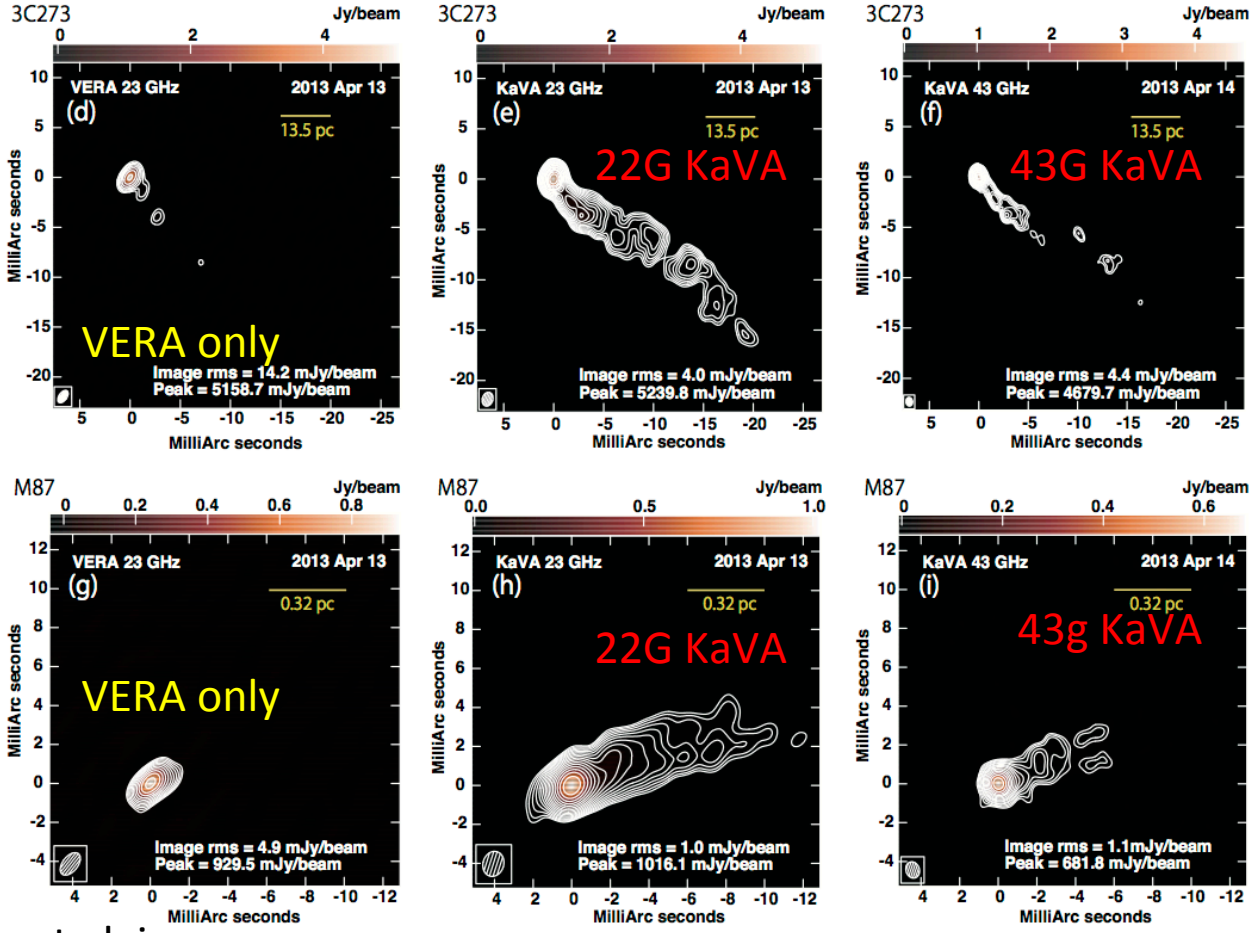
Marseille+2008



KaVA Science high lights

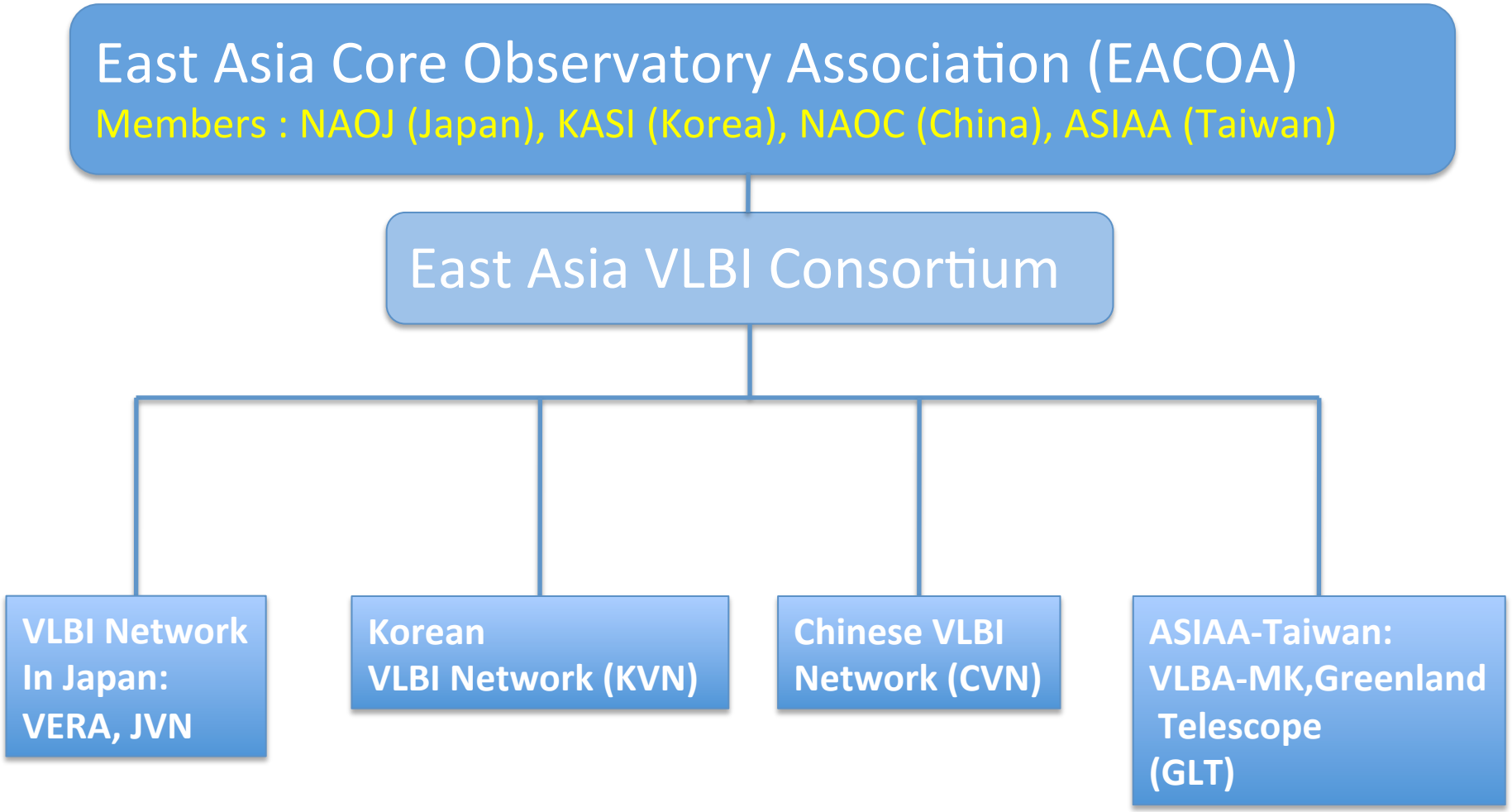
(Niinuma et al. PASJ, in press)

- Imaging performance test was performed on AGN
- Improved rms sensitivities on images, by factor of ~ 4,
- Dynamic range achieved to ~ 1,000



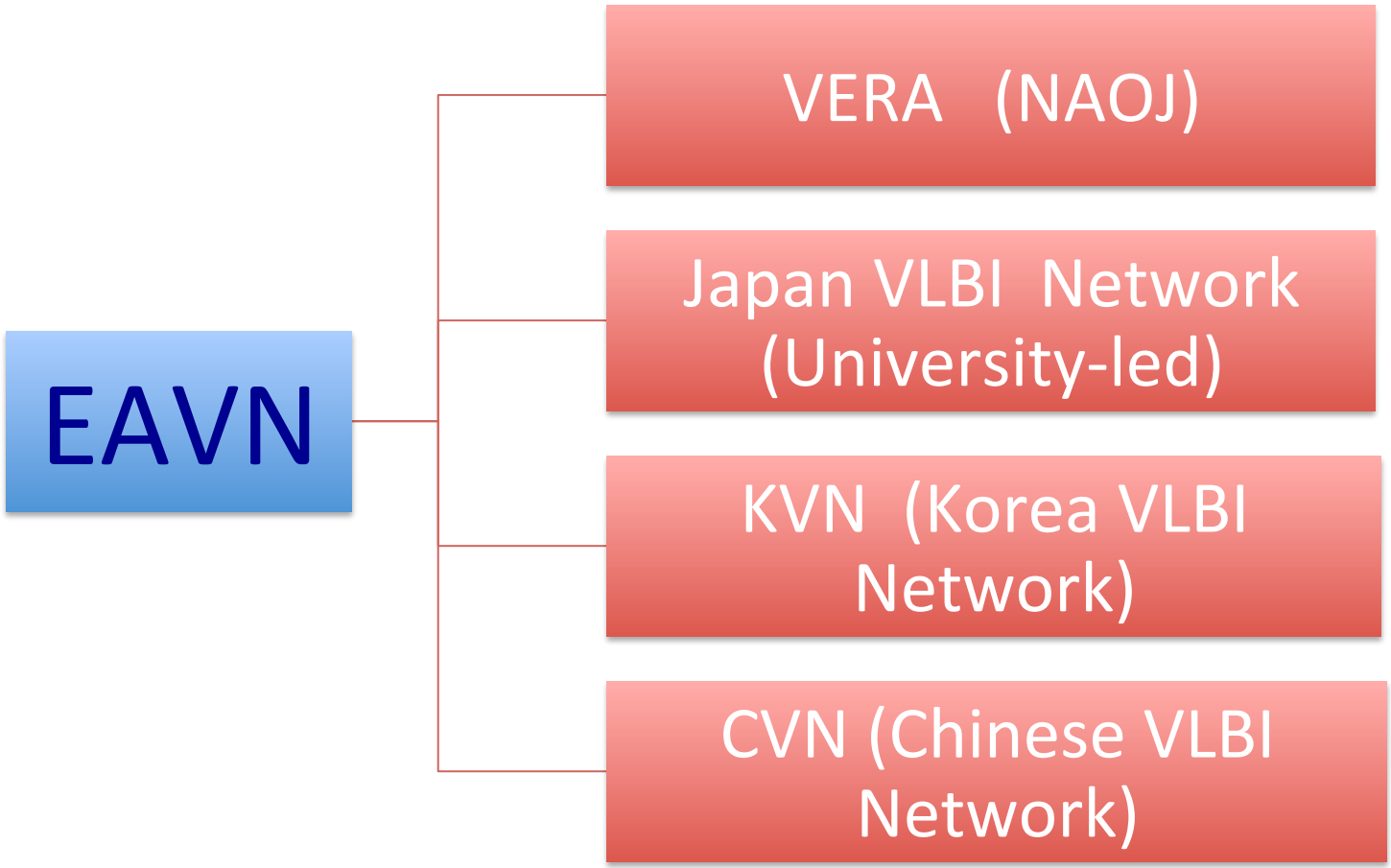
Niinuma et al. in press

VLBI collaboration in East Asia



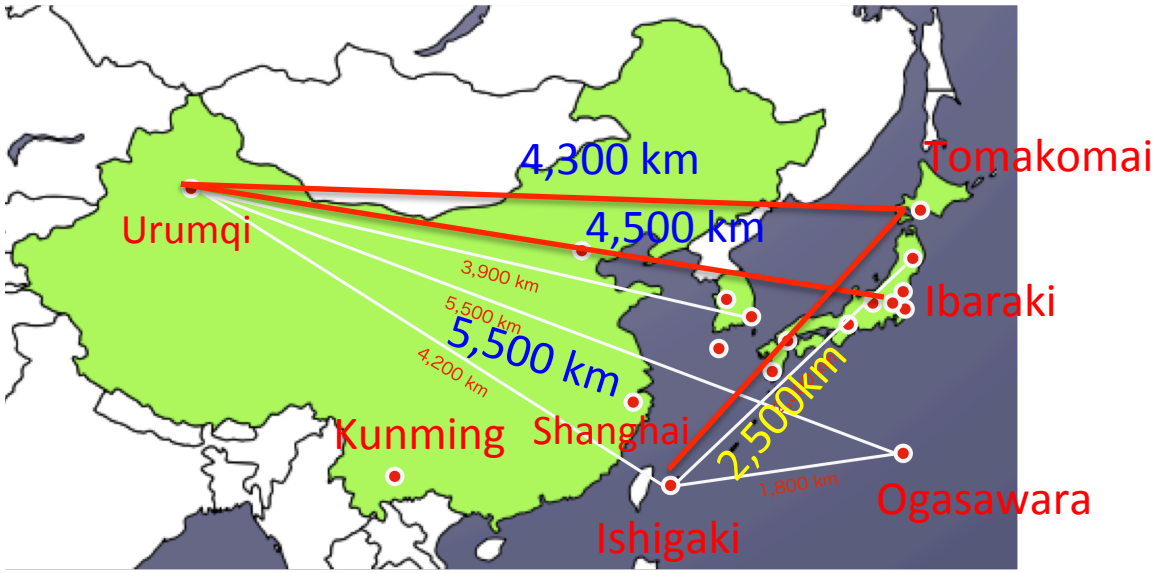
East Asia VLBI Network (EAVN)

- **East Asia VLBI Network: EAVN**



What is EAVN?

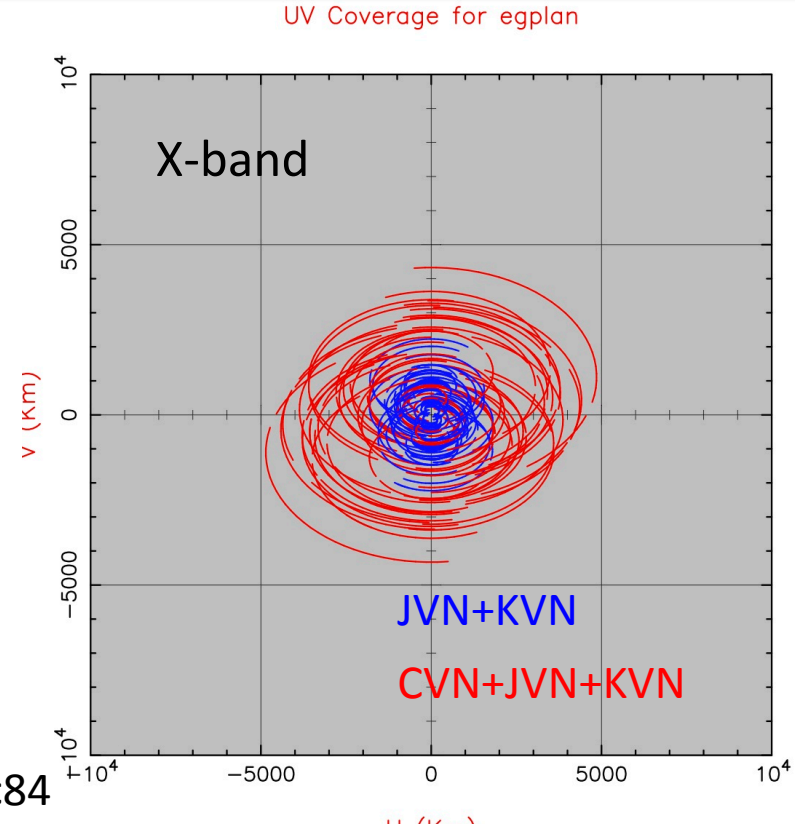
1. Local VLBI Network in East Asia, constituting of > 10 telescopes
2. The longest baseline is ~ 5,500 km between Urumqi and VERA-Ogasawara, in stead of 2,500 km within Japan and Korea
3. Observing bands are 2/8, 6.7, 22, 43 GHz
4. Some telescopes with a big aperture participate (Tm65m, Km40m)

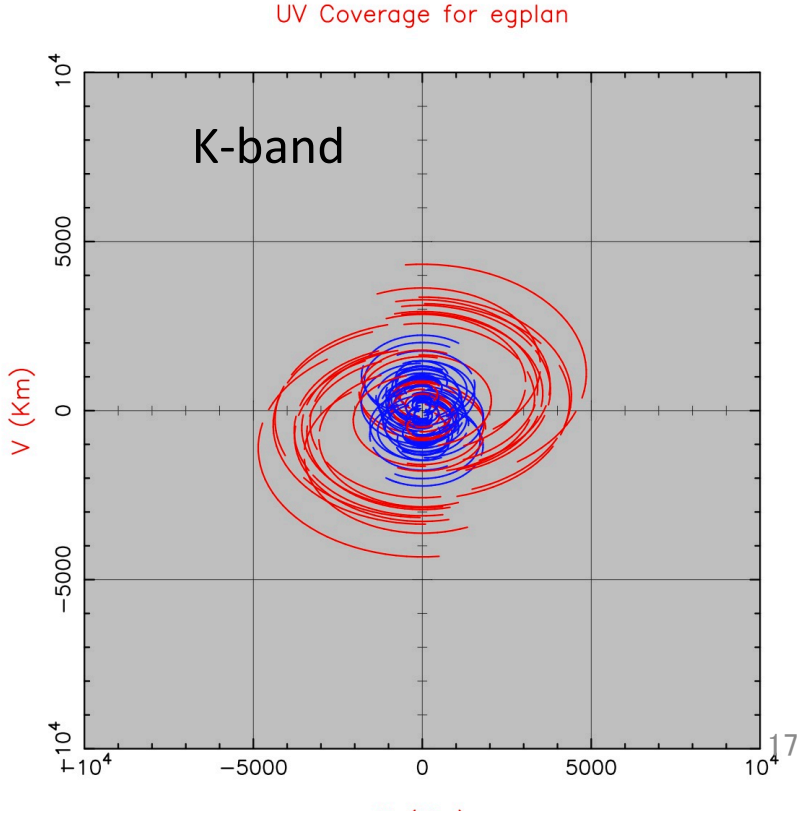


Tentative (u,v) coverage

CVN : Sh25m,Tm65m(X), Ur25m(X/K), Km 40m(X)
KVN: 3 sta.
VERA: 3 sta.
JVN: Yamaguchi(X)、Takahagi(K), Hitachi (X)

X-band: 11 sta.
K-band: 9 sta.





3c84

	EAVN (2013) (+Kas34,UD64,Tsukuba32)	VLBA (+GBT100m)	EVN
#Telescope	13 (16)	10 +1 (GBT)	22
Eff. Aperture [m^2]	8 GHz: 4,800 (7,280) 22 GHz: 1,800 (5,200)	8 GHz: 3,400 (8,970) 22 GHz: 3,040 (8,380)	8 GHz: ~ 8,000 22 GHz: 8,350
Max. Baseline [km]	5,500 km	8,600 km	10,000 km (+CVN) 2,500 km (EU)
Bands [GHz]	2.2, 6.7, 8, 22, (43)	1.4-1.6, 5, 6.7, 8,15,22,43, 86	2.2, 6.7, 8, 22, 43 GHz
Polarimetry	△ (not VERA)	○	△
Rec. Rate	1 Gb/s (2-8 Gb/s)	2 Gb/s	1 Gb/s

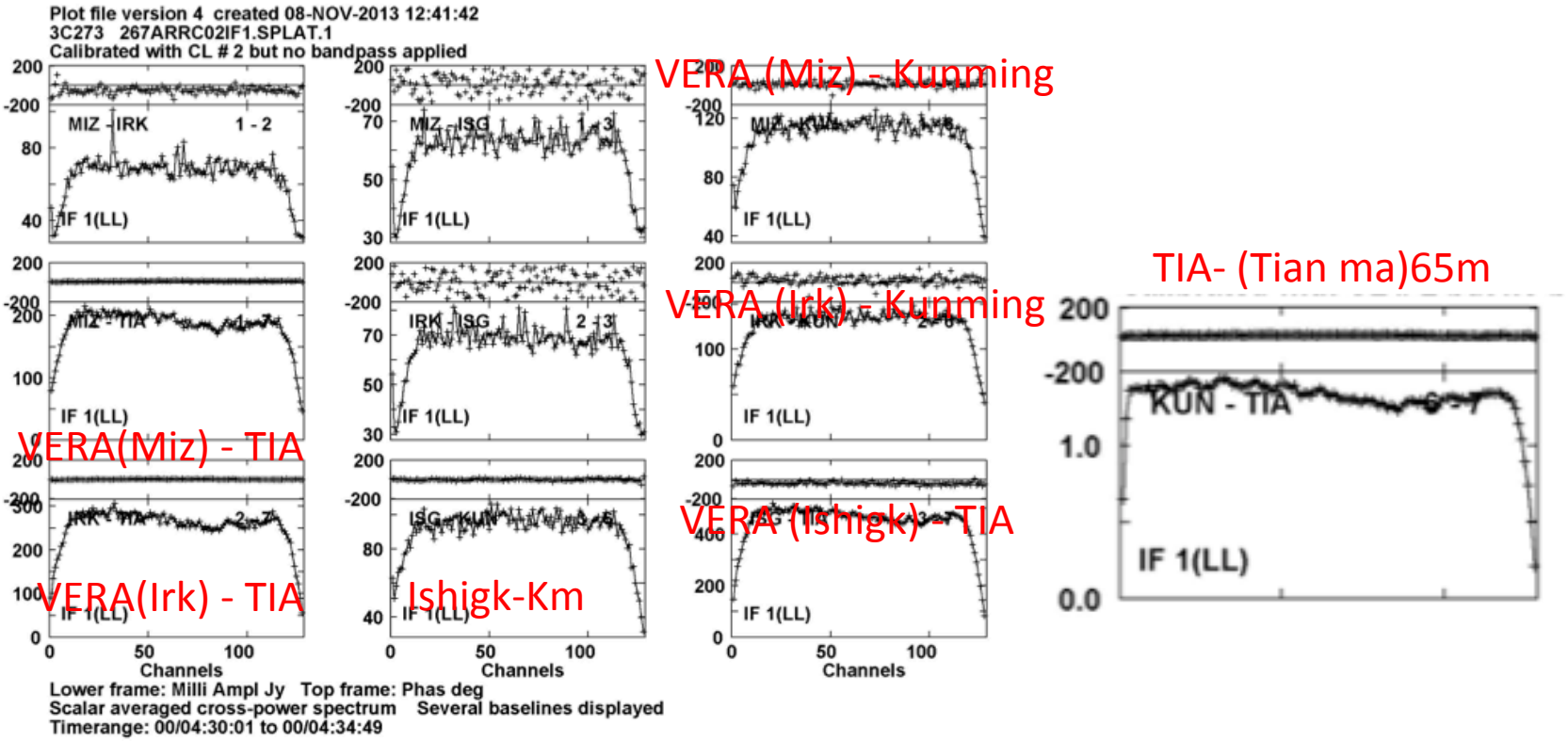
EAVN experiments

- Task force organized to conducting VLBI test experiments (Chair: Y.Hagiwara)
- Aim to start-up the initial phase of EAVN
- Members selected from CVN, KVN , VERA, JVN (June 2013)
- Fringe experiments undergoing to detect fringes among all the EAVN telescopes
- Regular telecon meeting twice/months

  A face-to-face meeting held at SHAO in July 2014

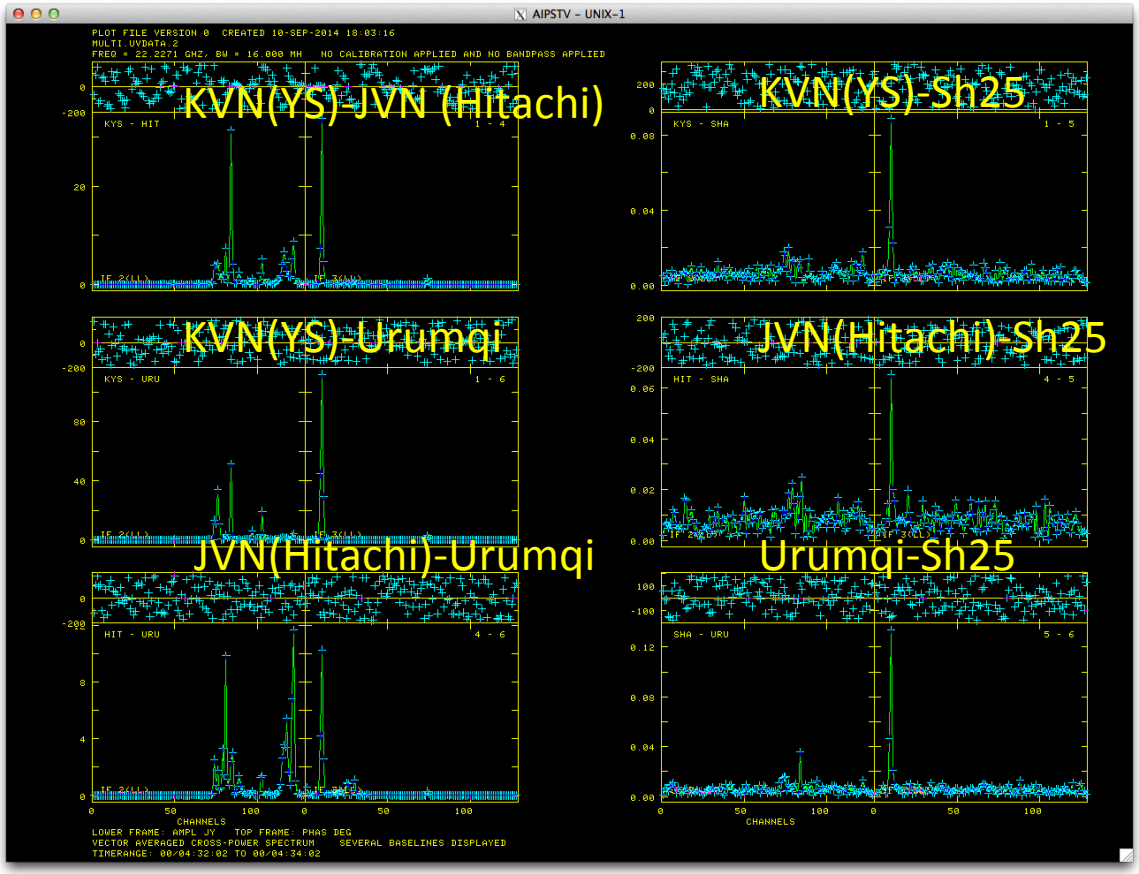
1st Fringe test

- Results of the 1st fringe test in September 2013
- 3C273, 8 GHz(partly succeeded), 22 GHz (failed)



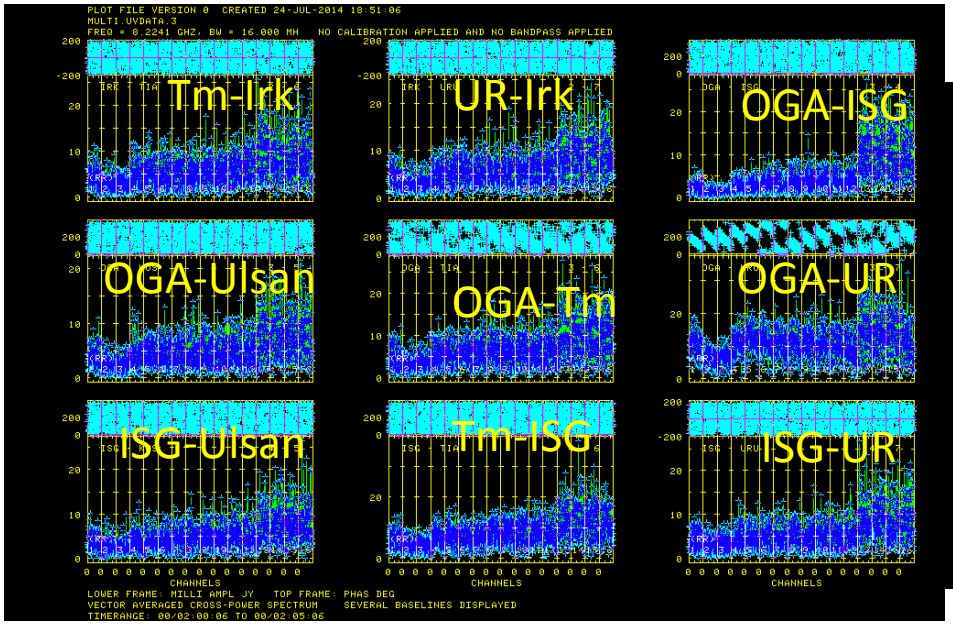
The 3rd FT

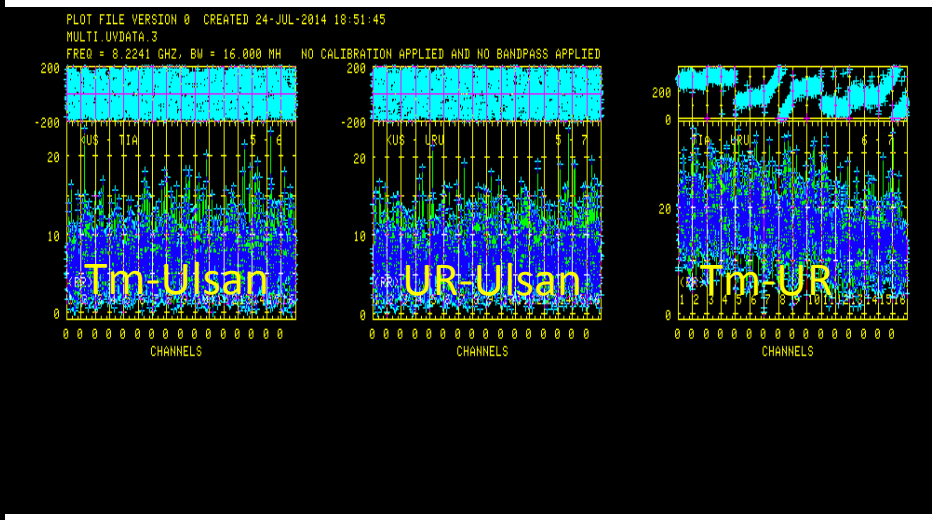
- Results of the 3rd fringe test, January 2014
- W49N (H_2O maser), 22 GHz, VERA failed in recording



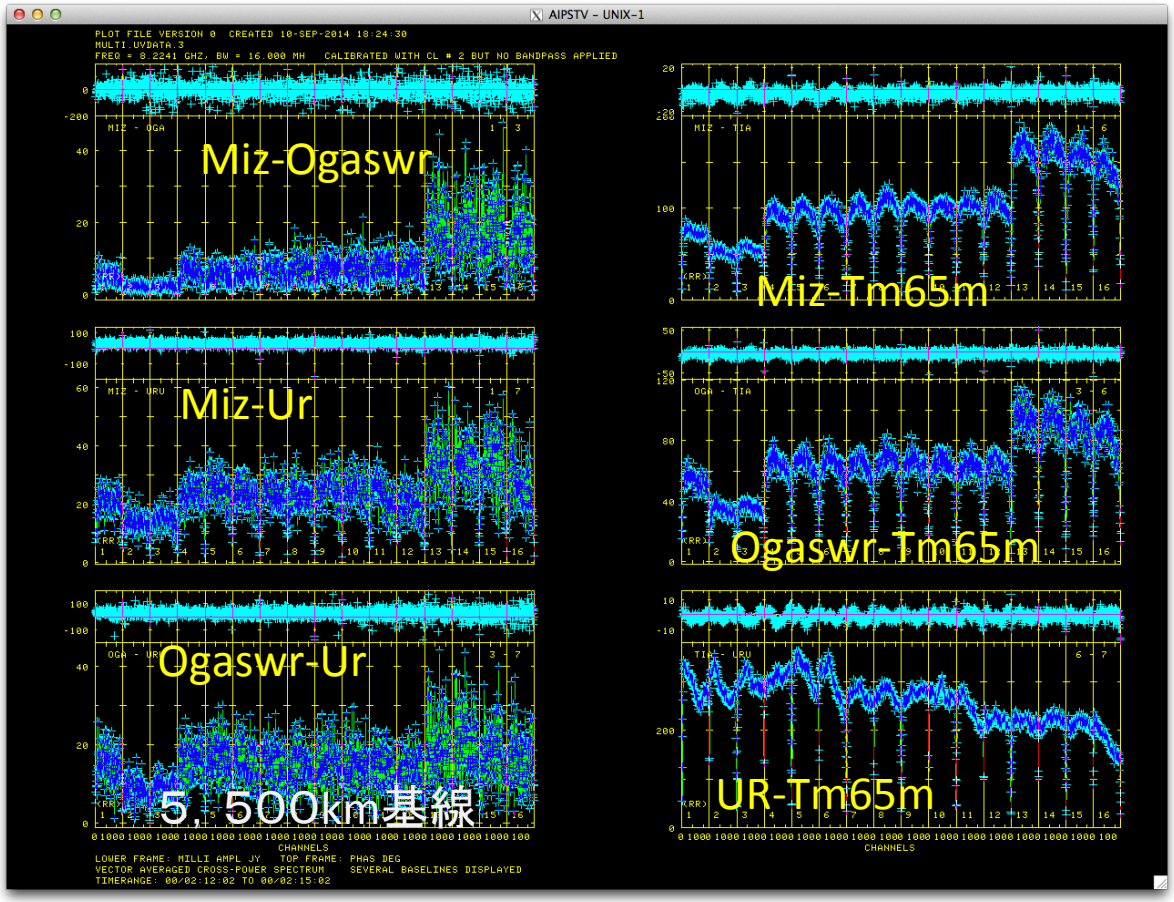
The 3rd FT

- Continuum data: 3C345, 8 GHz, no data of JVN
- Raw data

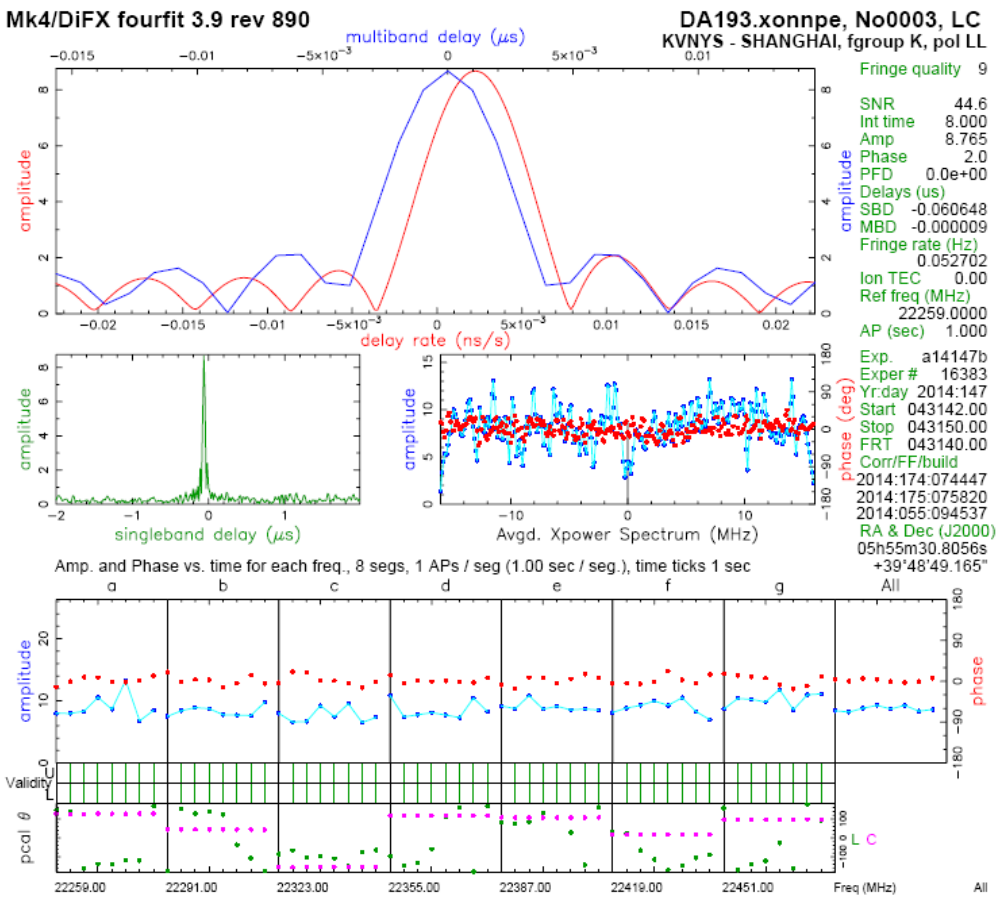




- After fringe-fitting – only 6 baselines detected fringes, at 1Gbps: 16 MHz x 16IFs



Fringe test by ftp data-transfer (Shanghai 25m – KVN)



By Jiang Wu @ Shanghai Observatory

- **Date: 27 May 2014**
- **Band: X-band**
- **Data (8 sec.) transferred via ftp after the observations**

- **Correlation by DiFX Software at SHAO**

-<u>Fringes detected between Shanghai 25m – KVN 21m</u>

Lots issues to be solved

- Scheduling file format of VERA differs from CVN/KVN
- Polarization, different frequency assignment
- Processing the Inhomogeneous log files automatically
- Preparing a web interface to upload logs, Tsys files, operator reports
- Media shipping time takes long (1-2 month)
- JVN has no dBBC (recorded with BW=512 MHz then go through DFU at NAOJ)
- Fringes from Chinese station-related baselines are not always seen when recorded with CDAS (Chinese digital BBC)

Time line of EAVN

Fiscal Year	2013	2014	2015
Actions	Three fringe experiments done	Further fringe experiments Ftp-based data-transfer on-going	Imaging test
Bands	8、22 GHz	(6.7)、8、22 GHz	6.7、8、22 GHz
Purposes	Fringe detection from all the EAVN stations. (not yet)	Fringe detection Increasing # telescopes	Evaluate array performance Science commissioning

Urumqi 25m telescope renovation

- Ur25 built in 1997 – 15 year passed
- New specification

- feed 2m=>3m
- Dish 25m => 26m
- More accurate surface

Enables 43GHz reception

- Movable 2nd reflector

- S/X VLBI ready

(31 August 2014)

- Starting date: 2014.03.20
- Scheduled ending date: 2014.10.01

Dismantling stage on 20 April

By Ming Zhang@XAO

Shanghai Observatory – New 65m telescope

- Tian Ma 65m built in 2012
- Test observations started in 2013
- Installation of high freq. bands began

Bands: L, S/X, K, Ka, Ku, Q
Backend: dBBC2, CDAS DIBAS
Terminal: Mk 5B, 5C
Fiber: 1 Gbps
Active surface (for Q-band)

Prof. Kawaguchi works at Tm65 since April 2014

Tian Ma 65m

By Tao An@SHAO

Radio astronomy in Thailand

- NARIT (National Astronomical Research Institute of Thailand) plans to establish Thai National Observatory (TNO) and build a radio telescope.

- The new telescope
  - Dedicated for astronomy (single-dish, VLBI)
  - Diameter of > 20m
  - Site : Chiang Mai (plan)
  - Cost cap (current): 10 M Euro

- Budget request to government being prepared towards the deadline of February 2015.

- KASI(KVN) are interested in collaboration

Italy-Japan VLBI collaboration
(Details are in Orienti's talk)

- We are preparing VLBI experiments by linking **3 telescopes in Italy** with **VERA**.

- Including the **KVN**, we can construct "EATING-VLBI (**East Asia To Italy: Nearly Global VLBI)** ".

Beyond the EAVN, toward the global VLBI

EAVN should be able to collaborate with other VLBI networks, and oraganize the most powerful VLBI array in the world

- **New science areas to be explored, adding new capabilities to current VLBI**

- **Global connectivity**

  - **Common front/back-end system to be considered**
  - **Linking EAVN with EVN+VLBA realizes "True" global VLBI**

Summary

VLBI astronomy is active in east-Asia

- Each array produces science result continuously
- Regional collaboration ongoing

- The VLBI in east Asia is going to be more developed.
- It is time to think of “true” global VLBI
  - Only one VLBI in the world but most powerful VLBI network would be necessary