# VERA AND EAST ASIAN VLBI NETWORK

H.Kobayashi(NAOJ) 19、April,2012 Resolving The Sky - Radio Interferometry

### VERA

http://veraserver.mtk.nao.ac.jp/index.html

Antenna Diameter 20m  $(250 \,\mu \,\mathrm{m})$ Observing band 2,8,22,43GHz Maximum baseline 2273km Minimum baseline 1000km 2 beam phase referencing -> Inst. Path error <0.1 mm

Construction: 2000-2004 Operation: 2005-







#### Phase-referenced VLBI



# First phase variations between 2 beams

Honma, et

#### al, 2003 PASJ <u>55</u>

#### Fringe phase of W49N,OH4



#### Allan variance of them



# Scientific goal

- Astrometry with 10µarcsec. accuracy between background object and galactic object within 2.2 degree separation
  - Proper motion and parallax measurements
    - 3D map and velocity field of the Galaxy
    - Detailed 3D velocity structure of molecular gas around evolved stars and star forming regions

# VERA scientific goal

- Measurements of distance and proper motions of galactic maser objects (H<sub>2</sub>O,SiO)
- Dynamics of the Galaxy Maser object: Iuminous point-like
  - objects
  - -> triangulation point of the Galaxy !



# Current status of astrometry with VERA



#### $Ro = 8.35 \pm 0.44$ kpc

## Rotation Curve of Galaxy





# Displacement of Mizusawa



~3m displacement of the station

# Japanese VLBI Network (JVN)

#### Collaboration

- NAOJ (VERA)
- Hokkaido, Ibaraki, Tsukuba, Gifu, Osaka-Pref, Yamaguchi, Kagoshima university
- JAXA, NICT, GSI
- 13 telescopes (11m ~ 64m)

#### Purpose

- A new, characteristic VLBI array
- A Base of East-Asian VLBI

#### Progress

- Started in 2004
- Steady Observation in 2005
- First Paper published in 2006
  - Observing time ~200 hr/yr
- EAVN test observation



## KDDI(telecom) passed on Intelsat stations to NAOJ





Yamaguchi 32m

Ibaraki 32mx2

Cooled C&X band and K band RXs are equipped.

#### C band Methannol maser observations by using JVN +CVN(Shanghai)





Constructions of three stations were completed on Dec. 2008 !

Simultaneous Multi-Frequency Obs. -Phase Compensation, mm-VLBI

#### Receiver





Prototype 43 GHz Receiver

| Freq. Band              | S Band        | X Band    | K Band         | Q Band      |
|-------------------------|---------------|-----------|----------------|-------------|
| Freq. Range             | 2.2 ~ 2.8 GHz | 8 ~ 9 GHz | 21.5 ~23.5 GHz | 42 ~ 44 GHz |
| Rx Noise                | < 25 K        | < 25 K    | < 30 K         | < 50 K      |
| 1 <sup>st</sup> IF / BW | 2.5G/600MHz   | 8.5G/1GHz | 8.5G/2GHz      | 8.5G/2GHz   |
| IF Power                | -20 dBm       | -20 dBm   | -20 dBm        | -20 dBm     |
| Polarization            | LCP/RCP       | LCP/RCP   | LCP/RCP        | LCP/RCP     |

#### \* 86, 129 GHz Receivers will be installed.





# Current working VLBI stations in Eastern Asia is 20 !

#### Japan(13)

- VERA(4), Kashima, Tsukuba, Yamaguchi, Nobeyama, Usuda, Tomakomai, Gifu, Uchinoura, Takahagi, Hitachi
- Solution Korea(3)
  - KVN (3) Yonsei, Ulsan, Tamna
- Ochina(4)
  - Shanghai, Urumqi, Beijin, Kumming
  - Shanghai 65m under construction



# UV-coverage by EAVN



Declination +30 deg. 0 deg. -30 deg.

### Seoul VLBI correlator center



#### 8Gbps x 16 station Largest VLBI correlator

# Opened on May 13<sup>th</sup>, 2010





# OCTAVE (8Gbps Disc recorder)



### EAVN observtaions

 KVN/VERA : Some scientific verification observations are on going.

- 22GHz/43GHz mapping
- H<sub>2</sub>O(22)/SiO(43,86)/CH<sub>3</sub>OH(44)
- Geodesy
- 43GHz SgrA\* etc.
- CVN(Shanghai)/JVN
  VN
  CVN(Shanghai)/JVN
  CVN(Sha
  - CH<sub>3</sub>OH(6) observations
  - X band mapping test

# Test observation result



# Schedule

#### 2010-2011

- Test Observations with VERA+KVN, JVN+CVN
- 2011-2012
  - Start of science observations with Japan (VERA,JVN) +Korea (KVN), and Japan(JVN)+China(CVN).

#### 2013

 Start of science observations with Japan, Korea and China

# Conclusion

- East Asian VLBI Network is organizing with Japan, Korea and China.
- Sector Sector
- From 2012, science array observation with Japan, Korea, and China is expected.
- VERA has carried out astrometry observations with precise phase referencing VLBI.

# EAVN and SKA as future



# UV-coverage comparison with/without SKA

