KVN+VERA Test Observations and Evaluation Studies

SAWADA-SATOH Satoko
(NAOJ, Mizusawa VLBI Observatory)

1 The KVN+VERA Combined Array

VERA (VLBI Exploration of Radio Astrometry), led by NAOJ in cooperation with several Japanese universities, is a VLBI array to aim for obtaining 3-dimensional map of the Milky Way galaxy. It consists of four 20-m antennas located at Mizusawa, Iriki, Ogasawara and Ishigaki in Japan, to achieve baselines longer than 1000 km up to 2300 km.

KVN (Korean VLBI Network), promoted by KASI, is the first dedicated mm-wavelength VLBI array, which consists of three 21-m antennas located at Yonsei (Seoul), Ulsan and Tamna (Jeju island). The baseline length ranges between 300 and 500 km.

On the basis of the VLBI collaboration agreement between KASI and NAOJ, we have started the joint observation with the KVN+VERA array. The KVN+VERA array complements baseline length range up to 2300 km fully, and can achieve a good imaging quality. The early phase observations have been carried out using the K4/VSOP terminal at 128 Mbps sampling, alternatively. The experiments history for the early phase test observations with the KVN+VERA array is listed in Table 1.

Table 1: The experiments history

Date	Bands	Antennas	Notes
2008 nov	22	KVN-Yonsei, VERA	The fringe detection test.
2009 mar	43	KVN-Yonsei, VERA	The fringe detection test.
2009 oct	22, 43	All of the KVN+VERA	The fringe detection test.
2010 apr	22, 43	All of the KVN+VERA	The first imaging test.

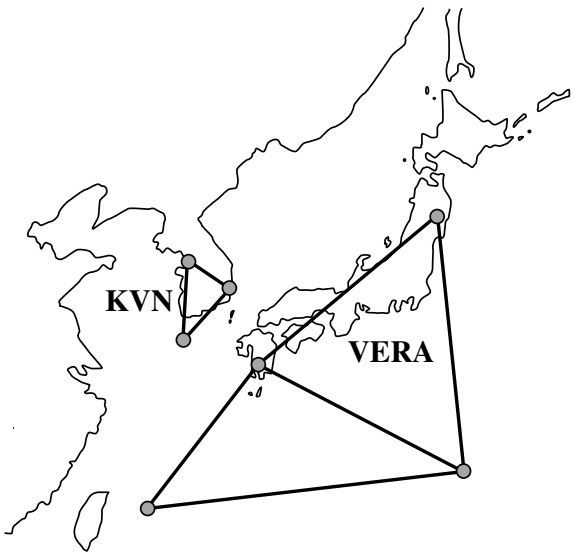

Figure 1: The location of the KVN and the VERA antennas.

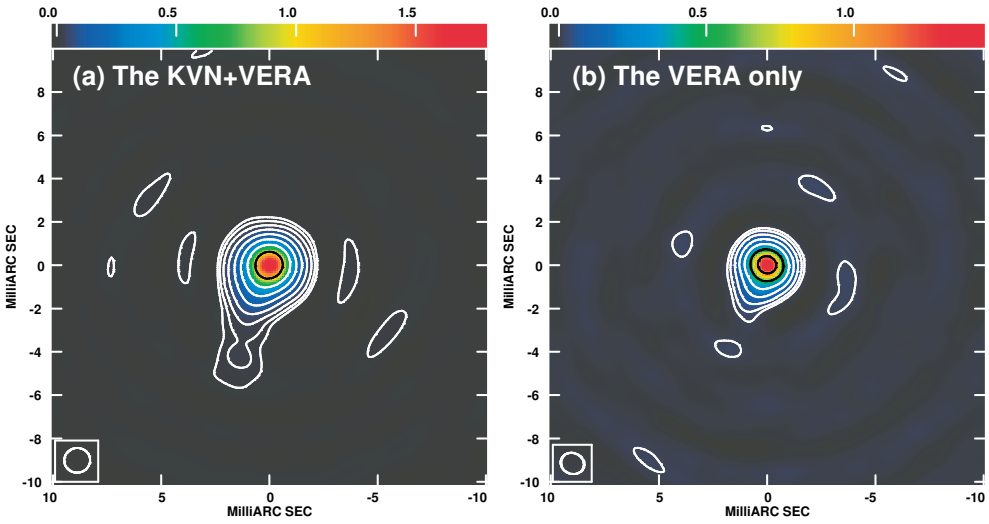

Figure 2: Two VLBI images of 1928+738 obtained by (a) the KVN+VERA and (b) the VERA only. Achieved image rms level is (a) 2.67 mJy beam^{-1} and (b) 5.34 mJy beam^{-1}, respectively.

2 Imaging ability

2.1 Continuum source : 1928+738

The imaging test observations at 22 GHz toward a continuum radio source 1928+738 were carried out on 26 January 2011 with the KVN+VERA array. This source is known to exhibit an extended jet structure along the north-south direction [1]. The KVN+VERA image succeeds to detect the extended jet structure toward south, although the VERA image at 22 GHz does not show the structure clearly. (Figure 2).

2.2 SiO maser v=2 in Orion KL

The Orion KL region contains strong SiO maser emissions, which have been imaged with VLBI techniques. Those images show that the 43 GHz SiO masers are distributed in four regions that make X shape [2][3][4]. Distribution and velocity field of SiO v=2 maser spots in the image obtained by the KVN+VERA array are consistent with the image in 2008 with the VERA [4]. The number of detected maser spots ($> 10\sigma$) are around 250, and it is twice more than the VERA image in spite of shorter observation time.

3 KJJVC and observing modes

KASI and NAOJ have been developing compatible data acquisition system and a common correlator, KJJVC (Korea-Japan Joint VLBI Correlator). KJJVC is able to process 16 stations, at the maximum sampling rate of 8 Gbps/station. KJJVC can accept data from several different VLBI playback systems such as Mark 5b, VERA2000 and K-5, and correlate Gbps sampling data between the KVN Mark 5b and the VERA2000 backend terminals [5]. Possible observational modes for the KVN+VERA array are shown in Table 2.

4 Current and future works

The KVN+VERA array adopts a priori amplitude calibration. Each KVN and VERA antenna has the chopper wheel of the hot load and the system noise temperature is obtained by R-Sky method. VERA antennas measure the sky power even during scans, which allow frequent system temperature measurements. The similar frequent measurement system will be installed to the KVN.

The elevation dependence of the aperture efficiency of the KVN and VERA antennas was measured by observing bright H_2O and SiO maser sources at 22 and 43GHz. For both of KVN and VERA, the aperture efficiencies are flat at elevation of $> 20°$. The aperture efficiency in low elevation of 20° decreases slightly, but this decrease is less than about 10% [6][7].

Table 2: The observational modes for the KVN+VERA

Mode	IF Num.	Bandwidth (MHz)	Bits	Max data rate (Mbps)	Compatible VERA modes
1	1	256	2	1024	–
2	1,2	128	2	1024	VERA1
3	1,2,3,4	64	2	1024	VERA2
4	1,2,3,4	32	2	1024	VERA4
5	1,2,3,4	16	2	1024	VERA7, VERA9 GEO1, GEO2
6	1,2,3,4	8	2	512	GEO3, GEO4
7	1,2,3	64/128	2	1024	VERA3
8	1,2,3,4	32/64/128	2	1024	VERA5
9	1,2,3,4	32/128	2	1024	VERA6
10	1,2,3,4	16/32/128	2	1024	VERA8

Currently, several test observations have been scheduled for the KVN+VERA array. First, geodetic VLBI observation will be carried out to obtain accurate KVN antenna locations. After that, we have several plans for observations in multi-frequency mode. The KVN has introduced a simultaneous multifrequency receiver system that performs simultaneous observations at four frequencies of 22, 43, 86, and 129 GHz [8]. The system allows to calibrate the atmospheric fluctuations at 43, 86, or 129 GHz from the visibility phase at 22 GHz [9]. Korea-Japan joint science WG has started to discuss about the early science observations with the KVN+VERA array, and the observations will be scheduled end of 2011.

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References

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