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Construction of the Korean VLBI Network (KVN)

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Abstract

Korea's new VLBI project has been started at 2001 as a 5 year project. We plan to build three new radio telescopes of 20-m diameters in three places in Korea, Yonsei University at Seoul, Ulsan University at Ulsan, and Tamna University at Jeju island. This KVN is the first VLBI facility in Korea and these telescopes will be used for VLBI observations exclusively. We plan to focus on the 100 and 150 GHz millimeter-wave VLBI observations, but the 2/8, 22, and 43 GHz HEMT receivers will be installed first for astronomical, geodetic, and earth science researches. The new hard-disk type recorder Mk 5 will be KVN's main recorder and the KVN correlator will also be developed.

The KVN research center is also planned to be built at Seoul, which will be a center for exchanges of manpower, research activites, and technical developments. It must be essential to collaborate with the leading institutes in VLBI activities in the world for the success of this project. After the completion of our project, we will be actively involved in the international VLBI activities.

1. Background

The first radio astronomical project of Korea Astronomy Observatory (KAO) was the construction of the radome enclosed 14-m millimeter wave radio telescope, which was completed about 15 years ago. This radio telescope is the main observing facility of Taeduk Radio Astronomy Observatory (TRAO) of KAO. After this 14-m radio telescope project, KAO has concentrated its power mainly to the construction of several optical telescopes, including a 1.8-m reflector of Bohyunsan Optical Astronomy Observatory of KAO, for last 10 years. By the completion of the optical telescope constructions, the KVN project was submitted to our government a few years ago and finally this project has been accepted. We will be carrying forward this project as a national facility in the basic science field.

At present the 14-m radio telescope has the dual channel SiS receivers, working at the frequencies of 100 and 150 GHz. An autocorelator and filter banks are being used as spectrometers. This telescope has been used mostly for interstellar molecular line observations, such as the transitions from CO, CS, HCN, HCO^+, etc. Our research activities using this radio telescope have been concentrated mainly to the studies of Galactic molecular clouds and their structures and chemistry.

To improve the mapping efficiency of our 14-m radio telescope, we plan to install a multi-beam receiver, QUARRY, made by Five College Radio Astronomy Observatory at Massachusetts, USA. This focal plane array receiver has 15 Schottky mixers working at 100 GHz band, and, as the backend, the 15 auto-correlators are planned to be ready this year. This focal plane array and our present dual-channel receiver will be the two main receivers for the common use of the 14-m telescope from the fall of 2003.

From the year 2001, we are carrying out VLBI experiments with the Nobeyama VLBI group at Japan and detected fringes successfully at 86 GHz of the SiO maser line toward several well known

maser sources, such as Orion KL, VY CMa, etc., in the last two observing sessions. We used Japan's VSOP terminal and the data from our 14-m telescope at Taeduk and 45-m telescope at Nobeyama have been successfully correlated at Mitaka, Japan. We are making the 43 GHz HEMT receiver for more frequent VLBI test experiments and for KVN receiver constructions. Our radio group's main power will be concentrated to the construction of the KVN system for next 5 years at least.

2. Outline of the Project

Our KVN project is to build three new radio telescopes of 20-m diameters and latest VLBI systems inside Korea. These antenna's main dish will be made of carbon-fiber coated with alluminium and we expect high efficiency observations even at 300 GHz. Our main target will be 100 and/or 150 GHz millimeter-wave VLBI observations, but we plan to install HEMT receivers of the 2/8 GHz for geodesic observations, and the 22 and 43 GHz for interstellar maser line observations first. And as a recorder we plan to use the new hard-disk type Mk 5 and participated in the consortium to develop the final version of Mk 5 being developed at Haystack. But we are still discussing with many VLBI researchers in the world to decide the details of our system configurations to have the best and lastest systems available. We also plan to develop the KVN correlator.

In constructing the KVN we are not configuring a special system to unveil *unknown* or

Figure 1. The three sites in south Korea to build KVN antennas: Seoul, Ulsan, and Jeju locations are indicated. The other three antennas (shaded) are the plan for future.

totally unexplored cosmic phenomena, or to overcome the present limits in technologies. This KVN is the first VLBI facility in Korea and will be used for all VLBI activities in Korea in the fields of Astronomy, Geodesy, Earth Science, etc. So, generally speaking, KVN will be a *conventional* VLBI system, but we will make the KVN as one of the most efficient and productive VLBI networks in the world.

Last year we chose the three places in Korea as our KVN observatory sites. Many candidate places have been reviewed and judged depending on the scientific merits, accessibilty, convenience facillities, etc. and finally three universities have been chosen: Yonsei University at Seoul, Ulsan University at Ulsan, and Tamna University at Jeju island. The rough position of the sites are shown in Fig. 1. The actual construction of the site will be started at the end of 2002. When this KVN project goes alright for next couple of years as the 3-site project, we plan to submit the second expansion project to put 2-3 antennas more in north and south Korea in the places shown in Fig. 1, and will make the KVN as a 6-antenna network.

In Table 1 and 2 we summerize the positions and baseline lengths of our three selected sites. These three sites are located in the big cities and their altitudes are not high and the baseline lengths between them are less than 500 km. Since the sites are located in big cities, the radio interference by comercial telecommunications appers to be serious in 2 GHz band. We think that the proper selection of the frequency band and using protecting filters may be necessary at 2 GHz band. In Fig. 2 we show a sample UV coverage and the synthesized beam shape for these three sites combined with the 14-m telescope at Taeduk.

3. Domestic and International Collaborations

Since this KVN is the first VLBI system in Korea, we plan to make a consortium consisting of several VLBI-related institutes in Korea, and to construct KVN as a national facility for the basic science research. The construction and operation of KVN are being discussed by the nationwide KVN steering committee. After the completion of this project we will participate actively in various international VLBI research programs. We hope that VLBI research activities and international

Table 1. Location of the KVN Observatories

	Site	Longitude	Latitude	Altitude
1	Yonsei U. (Seoul)	126° 56′ 35″ E	37 33 44 N	260 m
2	Ulsan U. (Ulsan)	129 15 04 E	35 32 33 N	120 m
3	Tamna U. (Jeju)	126 27 43 E	33 17 18 N	320 m
4	TRAO (Taeduk)	127 22 19 E	36 23 53 N	110 m

Table 2. Baseline Lengths between KVN Sites

	Site	Seoul	Ulsan	Jeju	TRAO
1	Yonsei U. (Seoul)	–	305.2 km	477.7 km	135.1 km
2	Ulsan U. (Ulsan)	305.2 km	–	358.5 km	194.2 km
3	Tamna U. (Jeju)	477.7 km	358.5 km	–	356.0 km
4	TRAO (Taeduk)	135.1 km	194.2 km	356.0 km	–

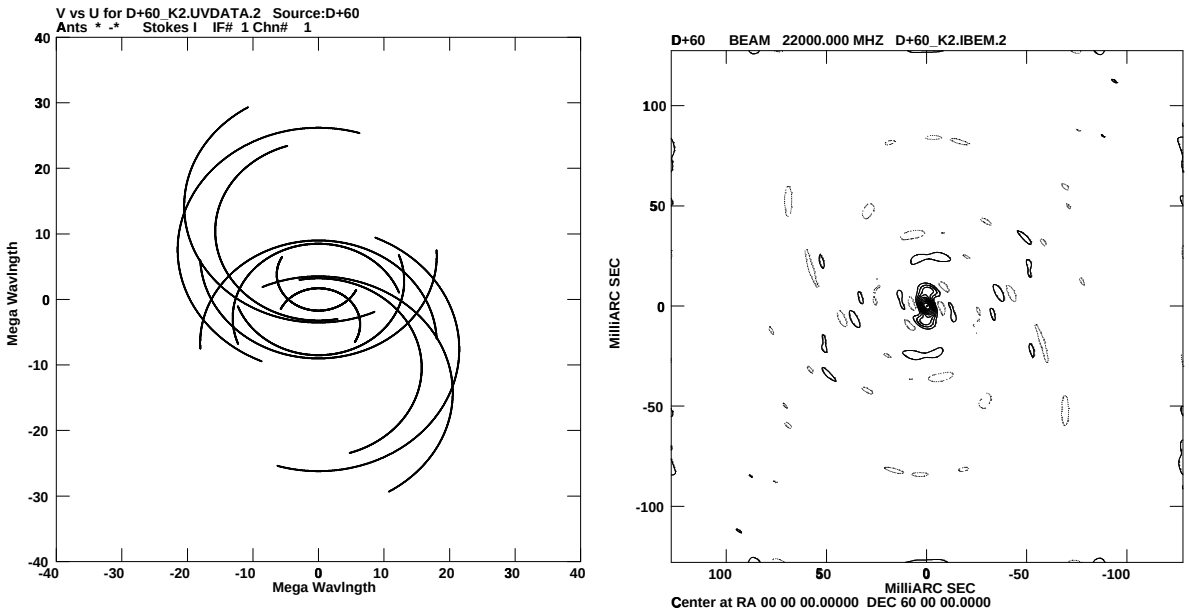

Figure 2. The UV coverage($left$) and the synthesized beam shape ($right$) for the Seoul-Ulsan-Jeju-Taeduk baselines for the source of $\delta = 60°$.

collaborations by Korean researchers can be greatly promoted through KVN. Various support programs to stimulate the VLBI activities in Korea will be prepared with the construction of KVN.

We think that we will face many difficulties in constructing the KVN because of our lack of VLBI experience and manpower. Therefore, for the success of this project, it must be essential for us to collaborate with and get many suggestions and consultations from the leading institutes in VLBI in the world. We are having discussion on Mk 5 and the development of the correlator with Haystack, and on antenna systems with German institutes. Especially the Japan-Korea collaboration in VLBI has been started in very good shape. At present the possible collaborations between VERA of Japan and our KVN have also been discussed very positively in both sides. The compatibility between two systems could be very exciting in future VLBI measurements. It is very fortunate that the international VLBI society is very open and cooperative. We are already having many productive discussion with many VLBI research institutes in the world, which will lead to the success of our KVN.