Recent Progress of Korean VLBI Network (KVN) Project

2006. 10.

Se-Hyung Cho
Korea Astronomy and Space Science Institute
Contents

• Characteristics of Korean VLBI Network
• KVN Expectation Schedule
• View of Each Observatory
• Receiver system & DAS
• Quasi Optics Mounting on Receiver Plate and Test
• K-J Correlator
• KVN Science
Characteristics of Korean VLBI Network

- National Facility dedicated to exclusive mm-VLBI (KVN 21 m x 3+TRAO 14 m)

- Simultaneous multi-frequency observation from 22GHz up to 129GHz

- Multi-frequency phase-referencing and fast-switching phase-referencing capabilities → Faint sources, weak lines at mm wavelengths

- Compact network with a few hundred km baselines
Expanded to KVN+VERA and
East Asian VLBI Network
KVN Expectation Schedule

■ Observatory Building
  ● Ulsan and Yonsei obs. building was completed
  ● Tamna obs. building will be completed within this autumn

■ Antenna Installation
  ● First antenna at Ulsan observatory
    - Started on Sept. 18 and will be finished until about end of 2006
    - Test observation and acceptance as a single dish: within March 2007
  ● Second antenna at Yonsei observatory
    - Installation and acceptance will be finished within Sept. 2007
  ● Third antenna at Tamna observatory
    - Installation and acceptance will be finished within end of 2007
■ Receiver Development and Installation

● Three sets of 22, 43 GHz band receivers at 1st stage will be developed and installed within 2008
● At least, one set of 2/8 GHz receivers will be developed within 2008
● 86, 129 GHz band receivers at 2nd stage
  - Design work will be started in 2007 (Development budget was approved by government this year)
  - Development and installation will be completed until 2010

■ Correlator Development and Installation

● Completion of specifications, Korea-Japan working group, and review committee
● Assemble whole correlator system in 2008 and start of experimental operation in 2009
● Practical use for KVN and K-J joint VLBI network in 2010
KVN Ulsan Observatory

KVN at VERA User’s Meeting
KVN Tamna Observatory

Observatory building will be completed within this autumn

KVN at VERA User’s Meeting
Receiver system & DAS

<table>
<thead>
<tr>
<th>Freq. Band</th>
<th>S Band</th>
<th>X Band</th>
<th>K Band</th>
<th>Q Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq. Range</td>
<td>2.2 ~ 2.8 GHz</td>
<td>8 ~ 9 GHz</td>
<td>21.5 ~ 23.5 GHz</td>
<td>42 ~ 44 GHz</td>
</tr>
<tr>
<td>Rx Noise</td>
<td>&lt; 25 K</td>
<td>&lt; 25 K</td>
<td>&lt; 30 K</td>
<td>&lt; 50 K</td>
</tr>
<tr>
<td>1st IF / BW</td>
<td>2.5G/600MHz</td>
<td>8.5G/1GHz</td>
<td>8.5G/2GHz</td>
<td>8.5G/2GHz</td>
</tr>
<tr>
<td>IF Power</td>
<td>-20 dBm</td>
<td>-20 dBm</td>
<td>-20 dBm</td>
<td>-20 dBm</td>
</tr>
<tr>
<td>Polarization</td>
<td>LCP/RCP</td>
<td>LCP/RCP</td>
<td>LCP/RCP</td>
<td>LCP/RCP</td>
</tr>
</tbody>
</table>

* 86, 129 GHz Receivers will be installed within 2010.

KVN at VERA User’s Meeting
Proto-type of KVN 43GHz HEMT receiver

Developed: June 2003

KVN at VERA User's Meeting
Proto-type of KVN 86GHz HEMT receiver

Developed: June 2004

KVN at VERA User’s Meeting
Quasi Optics Mounting on Receiver Plate and Test

RX Group (S. T. Han, M. H. Jung & D. H. Je)
Dicroic Low-pass filter

Low-pass filters: Meter-mesh (Thomas Keating)

- 22GHz/43GHz channel
- 22 and 43GHz/86 and 129GHz channel
- 86GHz/129GHz channel

KVN at VERA User's Meeting

KVN at EAVN
K band Ortho-Mode-Transducer test

C. Kim & Je

A.R. vs frequency

GHz

KVN at VERA User’s Meeting
# Time Schedule of K-J Correlator

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
</table>
| 2005 | Requirements, Specification  
Start of Technical Design |
| 2006 | Completion of Technical Design and Contract  
Start of Manufacturing (each parts) |
| 2007 | Manufacturing (each parts)  
Development of Control & Operation Software |
| 2008 | Assemble into Whole Correlator System  
Test and Debug the Correlator System (HW & SW) |
| 2009 | Start of Experimental Operation  
Completion of Archive System |
| 2010 | Practical Use for Korea-Japan Joint VLBI Network  
Establish the K-J Joint Correlation (Data) Center |

KVN at VERA User’s Meeting
Framework of K-J Joint Correlator

Mark5B

DIR-2000

K-5

Optical Fiber

Raw VLBI Data Buffer

Correlation Subsystem

Data Archive

Correlator Control & Operation

Responsible to KASI

Responsible to NAOJ
## Observation Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>#IF</th>
<th>Bandwidth [MHz]</th>
<th>Max. #Chan</th>
<th>#Bits</th>
<th>Max. Data Rate [Mbps]</th>
<th>Recorder</th>
<th>VERA Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>256</td>
<td>1</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VLBI1</td>
</tr>
<tr>
<td>2</td>
<td>1,2</td>
<td>128</td>
<td>2</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA1, VLBI2</td>
</tr>
<tr>
<td>3</td>
<td>1,2,3,4</td>
<td>64</td>
<td>4</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA2, VLBI3</td>
</tr>
<tr>
<td>4</td>
<td>1,2,3,4</td>
<td>32</td>
<td>8</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA4, VSOP1</td>
</tr>
<tr>
<td>5</td>
<td>1,2,3,4</td>
<td>16</td>
<td>16</td>
<td>2</td>
<td>1,024</td>
<td>Mark5B</td>
<td>VERA7, VERA9, Geo1, Geo2, VSOP2</td>
</tr>
<tr>
<td>6</td>
<td>1,2,3,4</td>
<td>8</td>
<td>16</td>
<td>2</td>
<td>512</td>
<td>DIR2000</td>
<td>Geo3, Geo4, K4-1</td>
</tr>
<tr>
<td>7</td>
<td>1,2,3</td>
<td>64/128</td>
<td>2/1</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA3</td>
</tr>
<tr>
<td>8</td>
<td>1,2,3,4</td>
<td>32/64/128</td>
<td>2/1/1</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA5</td>
</tr>
<tr>
<td>9</td>
<td>1,2,3,4</td>
<td>32/128</td>
<td>4/1</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA6</td>
</tr>
<tr>
<td>10</td>
<td>1,2,3,4</td>
<td>16/32/128</td>
<td>2/3/1</td>
<td>2</td>
<td>1,024</td>
<td></td>
<td>VERA8</td>
</tr>
<tr>
<td>W4</td>
<td>1,2,3,4</td>
<td>512</td>
<td>4</td>
<td>2</td>
<td>4x2,048</td>
<td>Mark5B+ Fiber</td>
<td></td>
</tr>
</tbody>
</table>

**KVN at VERA User’s Meeting**
# Summary of Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Antennas</td>
<td>16</td>
</tr>
<tr>
<td># of Inputs / Antenna</td>
<td>4 bands (4Fx1P, 2Fx2P, 1Fx2P+2Fx1P)</td>
</tr>
<tr>
<td>Max. # of Correlations / Input</td>
<td>120 Cross + 16 Auto</td>
</tr>
<tr>
<td>Subarray</td>
<td>2 case (12 + 4, 8 + 8)</td>
</tr>
<tr>
<td>Bandwidth for each Input</td>
<td>512 MHz</td>
</tr>
<tr>
<td>Digitization for each Input</td>
<td>1 Gsps by 2bits/sample</td>
</tr>
<tr>
<td>Clock for Input data</td>
<td>128 MHz</td>
</tr>
<tr>
<td>Max. Delay compensation</td>
<td>32,000 km</td>
</tr>
<tr>
<td>Max. Fringe Tracking</td>
<td>860 kHz</td>
</tr>
<tr>
<td>FFT points</td>
<td>1,048,576, w.r.t. multi-channel stream</td>
</tr>
<tr>
<td>Word length in FFT</td>
<td>16+16 bits fixed point for real &amp; imag. Re-quantization to 4+4 bits fixed point</td>
</tr>
<tr>
<td>Integration</td>
<td>&lt; 25 msec</td>
</tr>
<tr>
<td>Data compression (Flexible Binning)</td>
<td>8,192 channels</td>
</tr>
</tbody>
</table>
K-J Correlatorator in 2006

- Establishment of K-J WG and K-J correlator review committee
  - First review committee meeting in June, Seoul
  - Reviewing correlator manufacturing plan and specification etc.
- Contraction of correlator design work with Elecs company in Aug.
- Submit a public tender in Oct. for the contraction of correlator manufacture based on design work
- Second review committee meeting in Nov., Ulsan (KVN Ulsan Observatory) during K-J regular VLBI meeting
KVN Science

- Multi-frequency and multi-epoch observational study for

  Star forming region, late-type stars, Galactic center, AGN, detection of core shift, variability of microquasars, gravitational lens objects

- Maser mini workshop: July 2006 at KASI
- AGN mini workshop: Aug. 2006 at KASI by KVN Science WG

- KVN Science Advisory Committee
  - Reviewing KVN Key Science
  - KVN Science meeting in 2008/2009
Basic Research for KVN SiO Maser Study

- SiO J=2-1 & J=3-2 Observations towards Late-Type Stars with TRAO 14m Telescope
  - First detection of the SiO v=3, J=2-1 maser emission from χ Cyg → Cho et al. 2006 ApJ

- SiO J=2-1 & J=3-2 Observations toward Orion KL with TRAO 14m Telescope → Cho et al. 1999 AJ
  - Connection to KVN Science in SiO Maser Study