

First Phase Development of Korea-Japan Joint VLBI Correlator (KJJVC) and its Current Progress

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Abstract

The first phase of the Korea-Japan Joint VLBI Correlator (KJJVC) development has been completed and installed to correlate the observed data from KVN (Korean VLBI Network) and VERA (VLBI Exploration of Radio Astrometry) in October 2009. KJJVC is able to process 16 stations, a maximum of 8 Gbps/station, and 8,192 output channels for VLBI data. The system configuration, the experimental results, and future plan would be introduced in this paper.

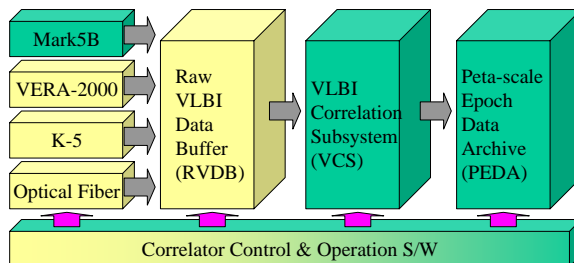
VLBI Facility in Asia

KVN, VERA, CVN, VSOP-2

- **Dedicated VLBI networks**
 - ✓ VERA (Since 2002), KVN (From 2008), CVN, VSOP-2 (~2015)
- **Other Radio Telescopes**
 - ✓ Nobeyama 45m, TRAO 14m, Delingha 14m
 - ✓ Others in many Universities and Institutes



Korea-Japan Joint VLBI Correlator (KJJVC)



Next Generation Correlator in East Asia

- Joint Correlator Project between Korea and Japan VLBI Facility in Asia

- **MOU between KASI & NAOJ (2005. 7. 7.)**
 - Development of Korea-Japan Joint VLBI Correlator
 - Common facility of correlation & data center
- **Joint Development Project was initiated respectively.**
 - Japan : 5 years from April 2005
 - Korea : renewed succession project, 5 years from Jan. 2006
- The overall system of KJJVC is under way of integration in close cooperation between Korea-Japan and manufacturer until end of 2009.
- KJJVC would fill the role of heart for East Asian VLBI Network and the Space VLBI with VSOP-2. (East Asia VLBI Consortium Committee, organized at the EAMA6 meeting on Oct. 2004)
- We expect that this project becomes a representative East Asian cooperation in astronomy field. (East Asian Core Observatories Association, organized at Tokyo on Sep. 21, 2005)

Main specifications of VCS

| | |
|-----------------------------------|--|
| # of stations | 16 |
| # of Inputs / station | Max. 4 inputs |
| Max. # of Correlations / Input | 120 Cross + 16 Auto |
| Subarray constitution | 2 case (12 + 4, 8 + 8) |
| Observation Frequency | (VSOP-2) 45 GHz, 130/86/43/22 GHz |
| Largest Baseline Length | ±36,000 km (± 0.12sec) |
| Max. Data Output Rate | 1.4 GBytes/sec |
| Digitization for each Input | 1 Gbps by 2bits/sample |
| Quantization Levels | 4 levels as 00<01<10<11 |
| Interface | VS I-H(32 parallels, 1PPS, VALID, PDATA) |
| Input Data Rate | 2 Gbps/1 Gbps |
| Architecture | FX type, with FPGA and DSP chips |
| FFT points | 256k/128k/64k/32k/16k/8k Adjustable |
| Word length in FFT | 16+16 bits fixed point for real & imag. |
| Integration period | 25.6msec-10.24sec |
| Frequency Binning | 1-256 channels bin(2's powers) |
| Correlation Output Data Interface | 10 Gbits Ethernet x 4ea |

VLBI Correlation Subsystem (VCS)



- **Mark5B** : which is widely used in VLBI and KVN participated in developing Mark5B as int'l consortium member. This is VSI compatible with 1Gbps and consists of 2(two) 8-pack HDD.
- **VERA2000** : DIR2000 is in use extensively at VERA. VERA 2000, which is modified by DIR1000, will be used for VERA with 1Gbps.
- **K5** : which is one another HDD based system for other institutes and university from NICT, Japan.
- **Optical Fiber** : Capable of dealing with the full data rate of 8 Gbps.

•RVDB (Raw VLBI Data Buffer)

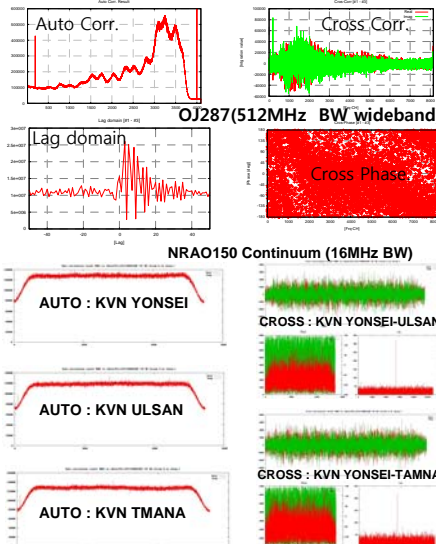
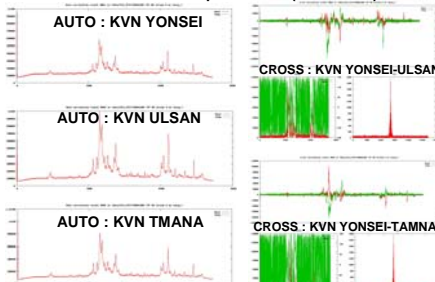
- Data format adjustment : # of bits per sample, and so on
- Easy synchronization while playback (heterogeneous recorder models)
- Buffering between recorder speed(1 Gbps) and correlation speed(8 Gbps)
- Handy switching over to next session
- 4 sets RVDB system development were completed and basic experiments were successfully performed. And RVDB system are already used in Mitaka Real Time Correlator, Japan.

•PEDA (Peta-scale Epoch Data Archive)

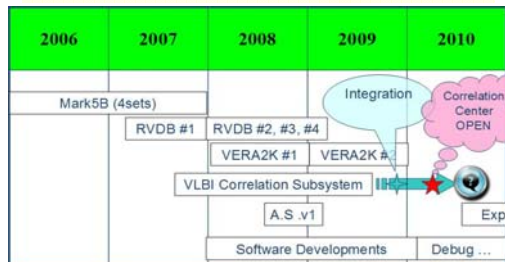
- It is able to process Max. data rate of 1.4GB/sec from VCS
- Basic system Architecture : Infiniband
- Max. Capacity : 1~3 PB for 1 year (EAVN, VSOP-2), now we prepared 110TB.
- This system will adopt CODA file system, which is a modified version of Mitaka FX correlator's file system.

Experimental Results

W49N Spectral Line(16MHz BW)



KJJVC Schedule



*Joint Correlation Center will be opened in close cooperation with NAOJ and East Asian VLBI Network in May 2010.

- To verify the performance of VCS, we just conducted correlation experiments using KVN data in KVN-VERA and JVN data of Japan, which is a spectral line source named as W49N (narrowband) and continuum source named as OJ287(wideband), NRAO150(narrow band).
- The above results were just performed the correlation, the fringe-fitting SW will be completed the end of April 2010.