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## VLBI Technology Development at SHAO

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### Abstract

VLBI technology development made significant progress at SHAO in the last few years. The development status of the Chinese DBBC, the software and FPGA-based correlators, and the new VLBI antenna, as well as VLBI applications are summarized in this paper.

### 1. Introduction

In 1972 Shanghai Astronomical Observatory (SHAO) prepared and started to develop a VLBI system in China. The project was proposed in 1975, and it was approved in 1978. Three years later, the first successful VLBI experiment was observed between a 6-m antenna at SHAO and the 100-m antenna at Effelsberg at L-band. After that, SHAO started to build a 25-meter telescope. The telescope was put into full operation in 1987. With the strong support of the Chinese Lunar Project, four VLBI stations and one data processing center were built in 2006. They form the Chinese VLBI Network (CVN). The Shanghai Astronomical Observatory is an organizer and technical supporter of CVN.

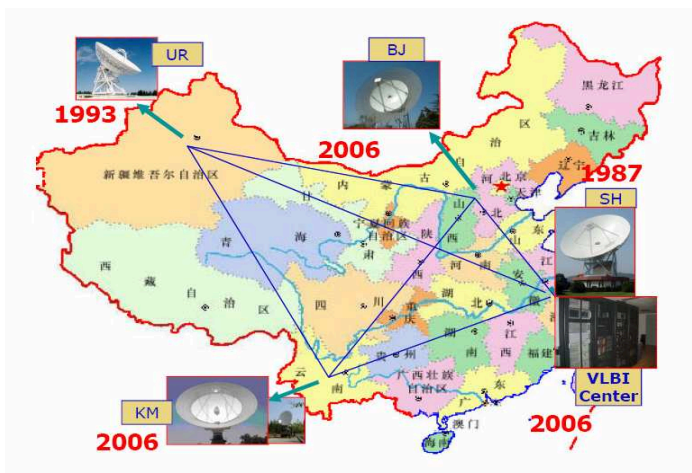


Figure 1. The location of the CVN stations.

## 2. The CVN

There are four VLBI stations in China. They are named Sheshan (Sh), Nanshan (Ur), Kunming (Km), and Miyun (Bj). The longest baseline of the CVN is 3249 km (Sh to Ur). There are fiber connections between the VLBI stations and the data processing center. The data rate is about one Gbps for Sheshan and 100 Mbps for the other three stations. Figure 1 shows a map with the locations of the CVN stations.

## 3. The Digital Backend System

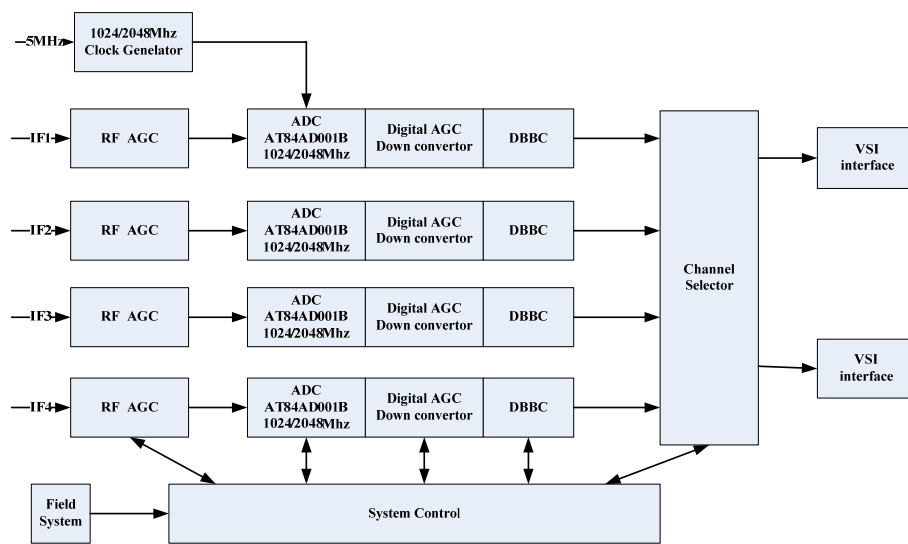


Figure 2. Diagram of the Chinese Data Acquisition System CDAS.



Figure 3. Collage of photos showing the CDAS at the four CVN stations.



Figure 4. Two CDAS systems integrated into one box.

The data acquisition system is the key equipment at a VLBI station. The traditional DAS systems with analog base band converters are used at most VLBI stations in the world. Unfortunately, this type of data acquisition system is no longer manufactured. The new type of data acquisition system with digital base band converters is coming slowly into the market. After a long discussion, SHAO started the development of a data acquisition system with digital base band converters at the beginning of 2007. The system will be integrated and operated at the four Chinese VLBI stations. The name of this digital base band converter is “Chinese VLBI Data Acquisition System”, abbreviated to CDAS. It is compatible with the traditional data acquisition system, which currently operates at the VLBI stations. But the total bandwidth of the CDAS is 2 GHz. There are two VSI data output interfaces in CDAS. With a different IP core, the CDAS could be compatible with the DBBC and DBE, which are being developed by the EVN and at Haystack Observatory respectively. CDAS has the following characteristics:

- use of 5 MHz as standard frequency signal input
- use of 1 pps as a time signal input
- four channel IFs input (the bandwidth of each IF may be 512MHz/1024MHz)
- two VSI interfaces to Mark 5B Disk Array
- fully compatible FS interface of traditional DAS (hardware and software)
- PCAL and total power output
- any two channels auto and cross spectrum monitor
- PCI interface for control

Figure 2 shows the diagram of CDAS. CDAS consists of three parts: RF AGC, Digital Part, and Output Module.

Figure 3 shows photos of CDAS which are integrated at the CVN stations now. Figure 4 shows the new CDAS version, which is configured with two CDAS in one box. Both CDAS have an individual power supply and input/output signal interface. For more details of CDAS characteristics, see [5].

### 4. The Correlator

The CVN data processing center has two correlators. One is a software correlator which is described by Dr. Zheng [6]. The other is an FPGA-based correlator. This is a 5-station FX-type correlator. It was specifically designed for the first Chinese Lunar satellite (CE-1) mission. The data rate of this correlator is 256 Mbps. Some functions of this correlator have been improved for the second Chinese Lunar satellite (CE-2). The VSI and network interface have been integrated into the modified correlator. Figure 5 shows a diagram of the FPGA-based correlator. A more

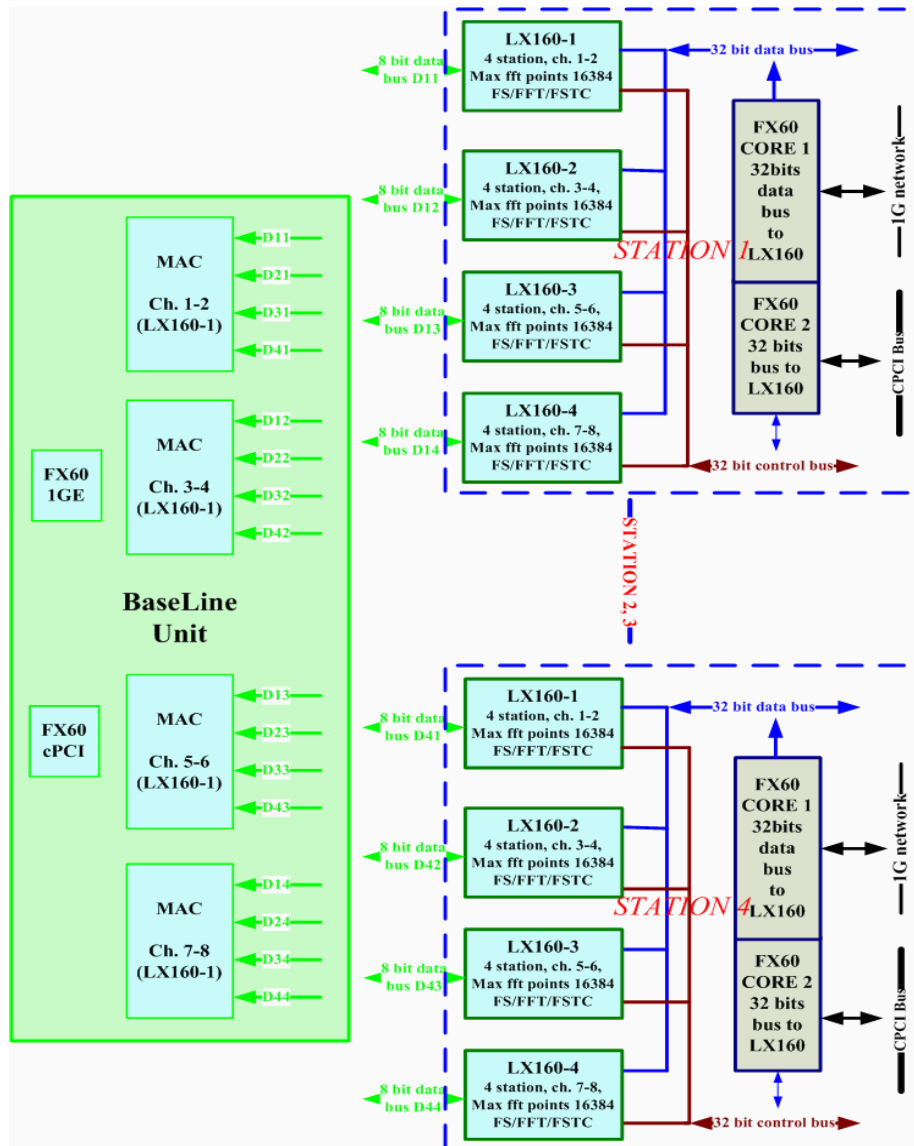


Figure 5. Diagram of the new FPGA-based correlator for the CE-2 project.

detailed description can be found in [7]. SHAO has become an official member of RadioNet. We recently joined the Uniboard project and plan to use the Uniboard to build a new FPGA-based e-VLBI correlator for astrophysics, astrometry, and geodesy applications.

## 5. New Telescope

The CVN showed excellent efficiency in the first Chinese Lunar Project. The people realized the advantage of VLBI technology for spacecraft tracking. With the support of the local government of Shanghai, the Chinese Academy of Sciences, and the Chinese Lunar Project, SHAO has an opportunity to build a new 65-meter telescope. The frequency of the Shanghai 65-meter telescope will cover L, S, C, X, Ku, K, Ka, and Q bands. In 2012, the 65-meter telescope will be observing in L, S/X, and C bands. The full facility of this telescope will be finished in 2015. Figure 6 shows the structure of the Shanghai 65-meter telescope. More information can be found on the Web at <http://202.127.24.8/eng.aspx>.

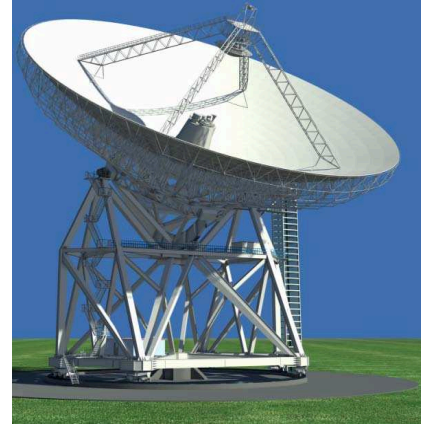


Figure 6. Artist's rendition of the structure of the Shanghai 65-meter antenna.

## 6. Conclusion

The CVN accomplished very successfully the CE-1 tracking task. CVN will continue to work on astrophysics, astrometry, and geodesy applications. With new VLBI equipment, the CVN plans to join international and domestic observations more actively.

## References

- [1] XZ Zhang, et al., CVN Correlator and its Future, *New Technologies in VLBI*, Astronomical Society of the Pacific Conference Series Volumes, Vol. 306, 287–300, 2003.
- [2] Zhijun Xu, et al., Real Time Correlator in FPGA, *IVS 2006 General Meeting Proceedings*, p. 89–92.
- [3] Gino Tuccari, et al., DBBC - A Flexible Platform for VLBI Data Processing, *IVS 2006 General Meeting Proceedings*, p. 185–189
- [4] Alan R. Whitney et al., A Wide-Band VLBI Digital Backend System, *IVS 2006 General Meeting Proceedings*, p. 72–76.
- [5] Renjie Zhu, et al., this volume.
- [6] Weimin Zheng, et al., CVN Software Correlator Applications in Deep-Space Exploration, *Proceedings of SPIE*, Vol. 6795, 2007.
- [7] Weimin Zheng, et al., this volume.