IAA Correlator Center

Igor Surkis, Voitsekh Ken, Alexey Melnikov, Vladimir Mishin, Nadezda Sokolova, Violet Shantyr, Vladimir Zimovsky

Abstract

The activities of the six-station IAA RAS correlator include regular processing of national geodetic VLBI programs Ru-E, Ru-U, and Ru-F. The Ru-U sessions have been transferred in e-VLBI mode and correlated in the IAA Correlator Center automatically since 2011.

The DiFX software correlator is used at the IAA in some astrophysical experiments.

1. Introduction

The IAA Correlator Center is located at and staffed by the Institute of Applied Astronomy in St. Petersburg, Russia.

The IAA Correlator Center is devoted to processing geodetic, astrometric, and astrophysical observations made with the Russian national VLBI network Quasar.

Figure 1. View of the six-station ARC correlator, showing four racks containing (left to right) signal distribution and synchronization system (SDSS) and three Mark 5B playback units, two correlator crates and KVM, three correlator crates, and one more cabinet with SDSS and three Mark 5B playback units.

2. Component Description

The ARC (Astrometric Radiointerferometric Correlator) (Figure 1) was the main data processing device in the IAA Correlator Center in 2012. The ARC was designed and built in the IAA RAS in 2007 - 2009. The correlator has an XF design and is based on FPGA technology.

The ARC is a six-station, 15-baseline correlator. It is able to process up to 16 frequency channels on each baseline, for a total of 240 channels. The correlator accesses two-bit VLBI signals with 32 MHz maximal clock frequency. The maximal data range from each station is 1 Gbit per second. The correlator requires VSI-H input VLBI signals, and it is equipped with Mark 5B playback terminals.

Since 2011 the DiFX software correlator has been used in some astrophysical experiments. The DiFX is installed at the IAA on a Sun Fire X4450 Server as a virtual machine under the VMware.

3. Staff

- Voitsekh Ken — GPU software developer;
- Alexey Melnikov — software developer, DiFX processing, scheduler of the Ru-sessions;
- Vladimir Mishin — software developer, data processing;
- Nadezda Sokolova — software developer;
- Violet Shantyr — software developer, post processing;
- Igor Surkis — leading investigator, software developer;
- Vladimir Zimovsky — leading data processing;
- Ekaterina Medvedeva — data processing;
- Alexander Salnikov — leading e-VLBI data transfer;
- Ilya Bezrukov — e-VLBI data transfer;

4. Current Status and Activities

The ARC correlator was used for processing all of the national geodetic VLBI observations in the IAA Correlator Center in 2012. The RUE and RUU geodetic VLBI sessions were observed in IAA RAS.

The three-station 24-hour RUE sessions for EOP determination were observed one time per week, as in 2011.

The two-station one-hour sessions for UT1-UTC determination in e-VLBI mode were carried out one time per week up to June 2012 and one time per day starting in July 2012. The RUU sessions were executed on cold station receivers, with a frequency channel bandwidth of 8 MHz and a total bitrate of 256 Mbps, and on warm receivers, with a frequency channel bandwidth of 16 MHz and a total bitrate of 512 Mbps. The data transfer speed from station to correlator was improved in 2012, and near to realtime correlation processing with a data bitrate of 256 Mbps was achieved.

In 2012, the DiFX software correlator became the main tool for a spectral radio source observation processing routine. We have started regular observing program Ru-P in 1.35 cm band and

18 cm band. Target sources are Orion KL, W49N, W3OH, and W75, and the experiment bitrate is 32 Mbps. The processing time for one second of real data is about eight seconds with DiFX using current facilities on a Sun Fire X4450 Server and its virtual machines under the VMware. The output data has a resolution from 1024 to 4096 spectral channels. Several experiments were observed with station Simeiz: RU0069, RU0083, RU0084, RU0087, and RU0088. These were 1.35 cm band sessions. Data from the Simeiz station were transferred via Internet directly to IAA's server, then processed with DiFX. We also used DiFX in test experiments of a new wideband DAS: a single IF channel of 512 MHz width with 2 Gbps total bitrate was successfully processed using DiFX.

5. Future Plans

The design of a new FX software correlator intended for the new small antenna VLBI network in comformance with VLBI2010 was started in 2012 at IAA RAS. The correlator design is supposed to process up to 16 Gb/s data stream from each of up to six observatories. VLBI data are recorded from four frequency bands with bandwidth up to 1024 MHz in one circular polarization or up to 512 MHz in two linear polarizations using 2-bit sampling. The input data format is VDIF. The correlator computes cross-spectra with a resolution up to 4096 spectral channels, and it extracts up to 16 phase calibration tones in each frequency band of each station. The correlator's hardware is based on hybrid blade server technology. Blade server contains two Intel CPU and two Nvidia Tesla GPUs. All critical computing such as Fourier transform, spectra multiplication and addition, and phase cal extraction will be perfomed using GPU; other tasks (data stream synchronization and distribution) will be provided by CPU. By a preliminary estimate, the hardware will contain up to 20 blade servers.