Institute of Applied Astronomy Technology Development Center

Alexander Ipatov, Nikolay Koltsov, Andrey Mikhailov, Sergey Smolentsev

Abstract

The domain of IAA TDC includes the development of software and hardware for Russian VLBI network QUASAR. This report describes IAA activities in this direction.

1. General

Technology Development Center is responsible for all parts of the Russian VLBI network and consists of separate laboratories developing hardware and software for this project. Now the 32 m radio telescope in Svetloe is participating in international VLBI network observations and in domestic radioastronomical and VLBI observations. Radio telescope in Zelenchukskaya is participating in domestic radioastronomical and VLBI observations. At the Badary radio telescope the construction work is finished, the installation of the hardware and putting the telescope into operation will be done.

2. Technical/Scientific

2.1. Timekeeping and Frequency

The creation of the new phase calibrator "antenna unit" was finished in 2003. This devise has two pulses out for S and X bands receivers. Step-recovery diode is used for producing short pulses.

Pulse performance: Duration ≈ 50 ps, Amplitude $= 1.2$ V.

Demultiplexer is similar to the original version documented in Mark III manual, but special HYBRID was used here.

Electronic module of the phase calibrator is installed into 54°C thermostat. The complex testing of the phase calibrator will be fulfilled in 2004.

2.2. VLBI Data Acquisition System

In 2003 the IAA Technology Development Center finished construction of the data acquisition system (DAS) for the S2-RT recording terminal.

This DAS includes main module and up to 3 added modules. Each of modules contains distributor for 2 input IF signals (100–1000 MHz), 2 base band converters (BBCs), control unit and power-supply unit. So DAS may include from 2 up to 8 BBC's, each of them contains video channels for upper and lower side bands and output 2-bit samplers. The digital signals levels meter controls levels of input IF signals and video signals. There are filters for selection of the harmonic phase calibration signals. DAS contains the 32 MHz clock and 1 PPS synchronizer for S2-RT. Computer with RS-232 interface controls DAS.

Parameters of this DAS are showed in table 1.

First module of new DAS produced in 2002 was tested in the Svetloe and Zelenchukskaya observatories. In 2003 DAS of 4 modules (8 BBCs) for the S2-RT recording terminal was produced

Table 1. Parameters of the new DAS

Intermediate frequency range	100–1000 MHz
Number of IF inputs	2
Number of modules	from 1 up to 4
Number of base band converters	from 2 up to 8
Connection of base band converters to IF inputs	electronic switch
Sidebands	upper and lower
Image rejection	more then 26 dB
Bandwidths	0.25; 2; 8 and 16 MHz
Number of digitizer bits	2
IF attenuator's range on distributor inputs	0–18 dB
IF attenuator's range on base band converter's input	0–15 dB
Attenuation step	1 dB
Error of signal level measure	0.1%
Phase noise of local oscillator	less then 1.2 degree rms
Clock Frequency for signal's record	32 MHz
Number of two-bits output streams	up to 16
Max Total Output Data Rate	1 Gbit/s
Module Dimension	$300 \times 445 \times 465$ mm

(Fig. 1). Now it is being tuned and tested by IAA TDC. We are planning to install new DAS at the Badary observatory in summer or in autumn 2004.

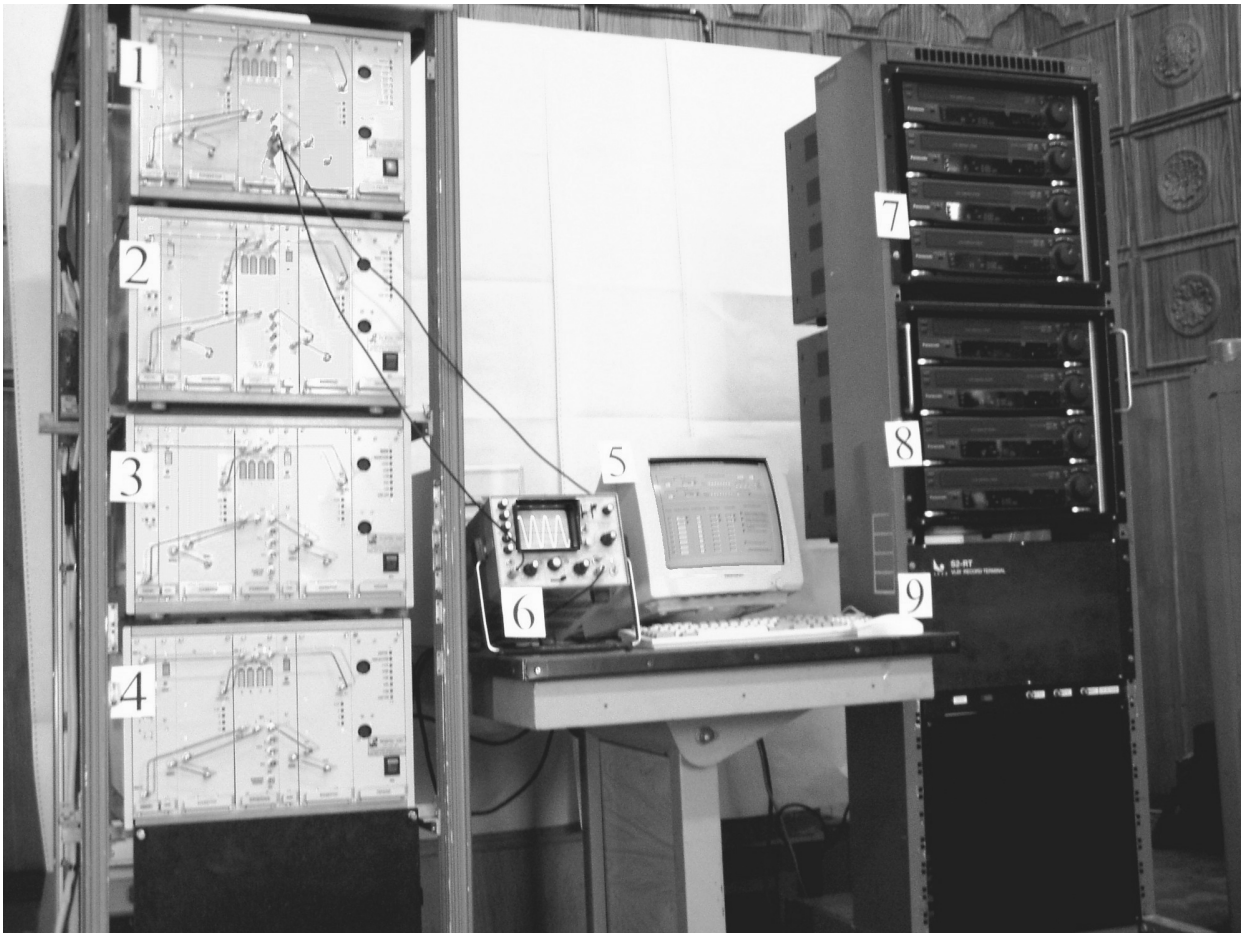
2.3. The Software

The investigations were made to improve the pointing accuracy of the antenna in Svetloe. The periodic nonlinearity errors of antenna position encoders were found previously during antenna calibration procedures. The amplitude of these errors is about 20–25 arcseconds, i.e. approximately 10% of half power beam width on X-band. It may affect the results of observations on X-band and certainly prevents the quality observations on the shorter antenna wavelength 1.35 cm. After testing of encoders we came to conclusion that this problem is the result of a deficiency in the encoder's design and elimination of nonlinearity is impossible.

The special method of measurement of such errors was developed to solve the problem. The method doesn't use any other equipment except the encoder itself and the antenna control system. The nonlinearity errors of encoders were measured in full range of antenna position angles. These results are used in antenna control software for correction of the errors.

The software was updated for this purpose. The testing of antenna pointing with the correction of nonlinearity errors indicates that the accuracy became significantly better and is within few arcseconds.

The important result of the pointing accuracy improvement is better antenna performance on the 1.35 cm band. First session of automatic pointing measurement was successfully carried out in this band using Field System software.



1, 2, 3, 4 — DAS modules; **5** — control PC; **6** — oscilloscope for phase calibration signal monitorng; **7, 8, 9** — S2-RT modules.

Figure 1. 8-channel DAS with S2-RT recording terminal

3. Technical Staff

For all the IAA address (8, Zhdanovskaya st., St. Petersburg, 197110, Institute of Applied Astronomy (IAA) RAS, Russia, Director Andrey Finkelstein, FAX +7-812-230-7413) is valid.

Table 2. Technical Staff

Prof. Alexander Stotsky	Main Scientific Researcher	Radio Physics Radio holography	+7-812-235-3216	stotskii@ipa.rssi.ru
Prof. Nikolay Koltsov	Chief the Laboratory Signals Conversion Registration	VLBI and radiometric registration system	+7-812-235-3316	nec@ipa.rssi.ru
Dr. Sergey Smolentsev	Vice Director	Time keeping Frequency standard	+7-812-275-4415	smolen@ipa.rssi.ru
Dr. Alexander Salnikov	Chief the Laboratory Communication and Computer Systems	Network Communication Computers	+7-812-230-8361	ais@ipa.rssi.ru
Dr. Edward Korkin	Main Scientific Researcher	Dish metal constructions	+7-812-230-7415	korkin@ipa.rssi.ru
Dr. Irina Ipatova	Senior Scientific Researcher	Receivers Antenna performance	+7-812-230-6496	ipatova@ipa.rssi.ru
Dr. Vyacheslav Mardyshkin	Chief the Receivers Laboratory	Receivers Refrigerators Antenna performance	+7-812-230-6496	vvm@iaa.nw.ru
Mr. Andrey Mikhailov	Scientific Researcher	FS software Radio telescope control system	+7-812-230-6496	agm@ipa.nw.ru
Dr. Dmitry Ivanov	Chief the Laboratory Time and Frequency	Time keeping Frequency standart	+7-812-230-7416	labtf@ipa.rssi.ru
Dr. Leonid Fedotov	Senior Scientific Researcher	BBC channels	+7-812-235-3316	fedotov@ipa.rssi.ru

4. Outlook

In the new IVS year we are planning:

- to include the VLBI site Svetloe into routine geodetic VLBI observations using Mark 5 facilities,
- to include the VLBI site Zelenchukskaya into routine geodetic VLBI observations using VLBA4 — Mark 5 facilities.