PROCEEDINGS OF SCIENCE

Data Compatibility for Radioastron Mission

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Within the scopes of the preparation of the Radioastron mission on February 4, 2010 the ground based VLBI experiment has been done. The VLBI session included a Russian 22-m antenna in Puschino (near Moscow) and three radiotelescopes of the EVN-network (Effelsberg, Medicina and Noto). The EVN telescopes used Mark5A recording systems. The telescope in Puschino used a RDR1 unit developed at ASC LPI (the recorder data format is RDF – Radioastron Data Format). Data processing was executed by a software FX correlator of ASC LPI (ASL Correlator), supporting RDF, Mark5A, Mark5B, VLBA, VDIF formats. Some extra converters have been developed to provide a reliable data exchange with other data processor outside Russia. The converters can provide transformations of an international standard formats (Mark5A, Mark5B, VLBA, VDIF, RDF) into RDF and VDIF (the last one has a trend to become an international standard for existing and future VLBI networks). The EF-MC-NT-PU experiment included totally 100 minutes observations of 2200+420 and 0316+413 sources at 6-cm during 100 minutes of observing time. The results demonstrate good functioning of RDR1 recorders and ASL software Correlator. Examples of cross-correlation functions for given experiment are presented. Also the correlation function is presented for an archive 3.6 cm experiment between Crimea and Wettzell (June 24, 2009). where we have used Mark5B recorder at the Crimea telescope. Parameters and efficiency of new ASC LPI cluster processor are demonstrated in this poster.

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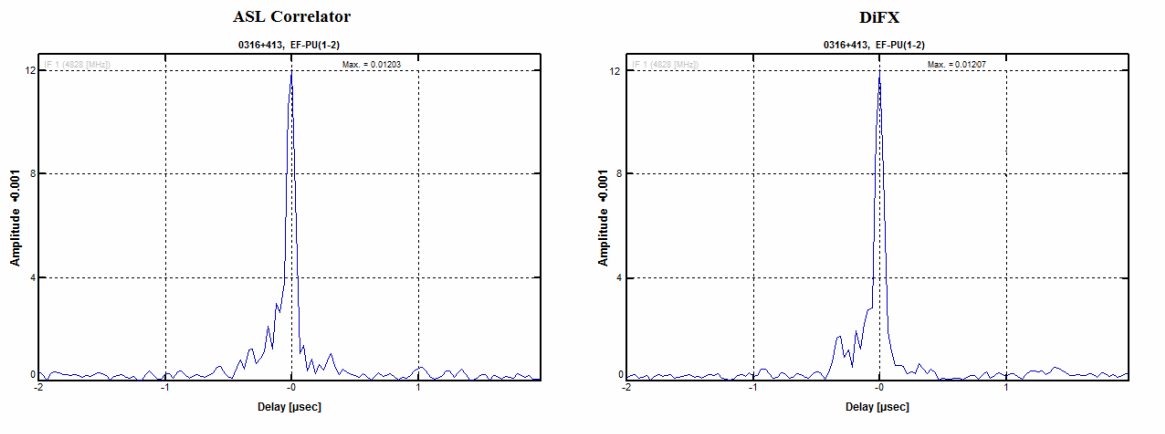
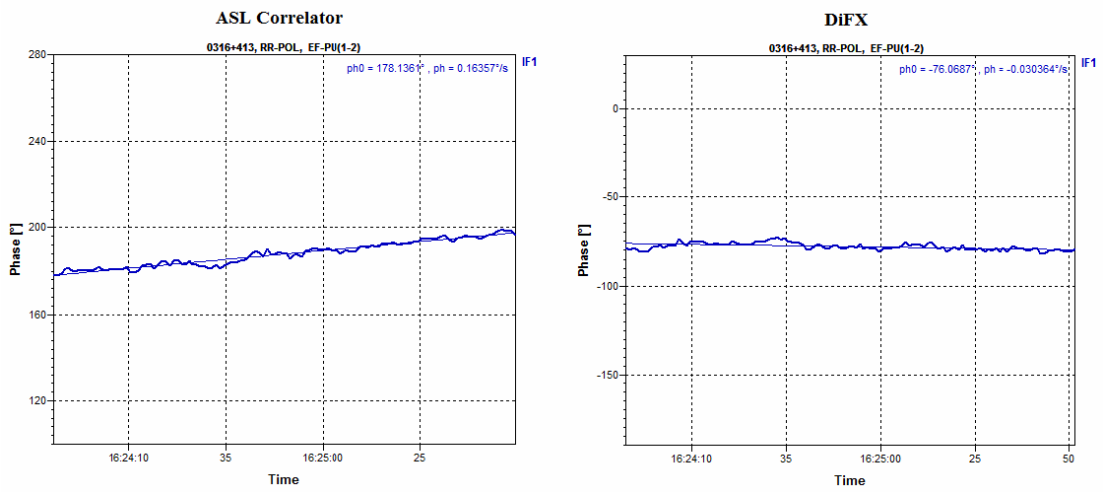
1. Introduction

Nowadays, VLBI data formats are great in number and sometimes difficult to manage due to their origins in data storage on tape. Many versions have emerged during their long evolution, not always well documented. For compatibility with the telescopes planned for involvement in the Radioastron program, support of the most important formats has been realized in the ASL correlator (Mark5A, Mark5B, VLBA, VDIF, RDF). Converters from Mark5A, Mark5B, VLBA, VDIF, RDF formats into VDIF and RDF formats also have been written based on the *mark5access* library code (part of the DiFX software correlator).

2. Converters

Converters operate under MS Windows OS and are available for downloading from ASC LPI web site. Note that it is not always possible to convert from one format into another directly. This is because in some data formats, for example in Mark5A, the recorder is regularly writes the frame headers over the small fragments of the data, replacing them. Hence, to convert any format with data loss, for example, Mark5A to RDF or VDIF, it is necessary to restore removed data fragments, which can be accomplished in different ways. The converter replaces headers with sequences of pseudo-random numbers. The correlator does not have this problem, as it is capable of replacing headers with zeros and packing the decoded data into a bit stream (not classical quantization, which cannot contain zero values). However, in practice this difference is not critical, because headers replace only about 1% of data. To check converters we have compared the results of cross-correlation by ASC correlator for two experiments after data conversion into a native RDF format and by DiFX software correlator [1] which reads the data in Mark5A and Mark5B formats, native to DiFX. Identical parameters are assumed. The plots show that both correlators give similar values of the correlation peak amplitudes and corresponding phases. The small difference can be explained by difference between the delay models applied.





3. RDR Registrator

The VLBI data recording units, using the ASC Radioastron format, are part of the ground facilities of the Radioastron mission. They will be put to work as the data acquisition system for space and ground based antennas and data processing centers. The recorders implement the following tasks:

- Writing/reading radio-astronomical data from ground based radio telescopes, ground decoders of Radioastron data.
- The build-in analyzer of the recorder statistical characteristics for test purposes.
- The generation of the autocorrelation function and power spectrum of a signal.
- Independent checking of the recorder signal path.
- Maintenance of time/frequency mapping of registered data using a precise time/frequency standard.
- Providing control functions which are not dependent on a given terminal but can be accessed remotely using the local network and/or RS-232 channel.

3.1 The RDR basic technical characteristics:

- Up to 16 input channels, 32 MHz data rate.
- Overall rate not less than 512 Mbit/s
- Error rate not more than 10^{-5}
- Time mapping 1 Hz, 32 MHz
- Record time not less than 6.4 hours.

- 2011 – VSI-compatible
- Compatibility with Mark-5A/B/C
- Total recorded data volume 2x720 Gbit
- Life time not less than 5000 hours

4. ASL Correlator

The ASL Correlator (product of ASC LPI) is running on the HPC Cluster. The HPC Cluster includes 5 servers, each with two four-nuclei processors. The servers are joint by 10 Gbit/sec Ethernet links and running under HPC server 2008 OS. The cluster productivity is 400 Gflops/sec.

The Radioastron project processing falicities include:

- Control server
- Processing servers (ASL Correlator, http and ftp servers)
- Data transmission networks
- Data mass storage
- Data backup device
- Uninterruptible Power Supply
- Data backup storage in Pushino (PRAO)
- Air-conditioning facilities

Antennas	Time	Ratio
2	4.76	0.24
5	11.56	0.58
7	18.59	0.93
10	26.56	1.33

Table 1. Correlation job duration for 20 sec 128 Mbs VLBI real time data.

5. Conclusions

- The ASL Correlator can directly read VLBI stations data in different formats (Mark5A, Mark5B, VLBA, VDIF, RDF) and supply correlated data in UVX format.
- The UVX format, developed at ASC LPI, looks like simple FITS format.
- Convertors from UVX to UVF FITS can be found at the ASC LPI web site.
- Converters from Mark5A, Mark5B, VLBA, VDIF, RDF formats into VDIF and RDF formats also have been written.
- Converters from Mark5A, Mark5B, VLBA, VDIF, RDF formats into VDIF and RDF formats are free to download from ASC LPI web site.
- Converters are being used effectively at ASC LPI for routine processing of the VLBI data.

References

[1] Deller A. T. , Tingay S. J. , Bailes M. & West C., DiFX: A Software Correlator for Very Long Baseline Interferometry Using Multiprocessor Environments, 2007, PASP, 119, 318