PROCEEDINGS OF SCIENCE

Towards the Italian VLBI network: first tests and perspectives

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Since the installation of the DiFX software correlator and storage facilities in IRA headquarters in Bologna there has been a series of both national and international enquires and tests to prove the effectiveness of an Italian interferometer involving the antennas of Medicina, Noto and SRT. A series of test cases regarding in particular the placement in operation of the dBBC and Fila 10G hardware will be presented to discuss the strengths and downsides of handling equipment that could improve correlation processes and advance the way data is recorded and stored. Data transfers, formats and correlation issues will be discussed in detail to shed a light on the perspectives of a more efficient process management that would eventually lead to effective science results.

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1. VLBI-IT - The Italian VLBI network and correlator

The Italian antennas located in Medicina, Noto and Sardinia are part of the Italian network that allows to perform VLBI observations at 1.6, 5, 9, 13 and 23 GHz with a resolution up to 0.002 arc sec. The geodetic antenna in Matera (property of the Italian Space Agency) has also participated in some experimental geodetic VLBI observations with the antennas of Medicina and Noto correlated in Bologna. The DiFX [1] (Distributed FX - Fourier transform (F) of cross multiplied spectra(X)) software correlator was successfully installed and placed in operation in the Bologna headquarters in 2012 and it consists of 3 servers. These machines provide up to 50 TB each of storage space for the raw astronomical data coming from the antennas. They are connected to a 10 Gbit optical fiber line to the GARR and GEANT networks. In addition a 40 Gbit Infiniband connection is in place to allow fast MPI (Message Passing Interface) correlation processes for the data residing on disks which are set up in RAID (Redundant Array of Independent Disks) arrays thus allowing up to a 1 GB/sec of throughput. Thanks to this configuration the servers are capable of acting as recorders for a direct network stream of data from the antennas that are connected through optical fiber (at the moment Medicina and Noto are connected at 10 Gbit) and could be used both as storage space for postponed correlation and as raw data retrieval place for international VLBI observations like EVN or RadioAstron. A management software developed in-house (VSM - Vlbi Storage Manager) allows a quick overlook of the machines storage status and it is also used as space reservation for experiments scheduling. An example of correlation processing time with DiFX [1] software correlator is of the order of 720 GB/hr per antenna when data recorded at 1 Gbit/s from the 3 antennas is correlated, that is approximately 2/3 of an average experiment time. At present correlation tests are carried out including the new astronomical data standard VDIF (VLBI Data Interchange Format).

2. VLBI-IT data

The Italian VLBI Network comprises baselines that range between 500 to 900 km. An eventual addition of Matera antenna could add two baselines of respectively 400 up to 700 km, though only when observing in Geodesy bands S and X at present. This would mean a better uv plane coverage.

Baselines Km	
Medicina/Noto	878
Medicina/SRT	580
Noto/SRT	562

Table 1: Baselines

Resolutive Power (arcseconds)				
GHz	Medicina	Noto	SRT	VLBI
1.6	1474	1474	731	0.02
5	472	472	234	0.007
22	103	103	51	0.002

Table 2: Resolutive Power

Baseline Sensitivity (mJy)				
GHz	Medicina - Noto	Noto - SRT	Medicina - SRT	VLBI
1.6	1.954	0.397	0.367	0.267
6	0.542	0.227	0.184	0.138
22	1.930	0.812	0.760	0.533
43	-	0.766	-	-

Table 3: Sensitivity - EVN Calculator (http://www.evlbi.org/cgi-bin/EVNcalc) - 10 min @ 1024 Mbit/s

The estimated Resolutive Power and Sensitivity grow quite dramatically in case of VLBI observations.

3. Results

Even though first tests had a success ratio of ~50% which included some or all baselines, we have had first fringes on Medicina - Noto baseline on April 15th 2013 and on Medicina - SRT baseline on January 27th 2014. The low success ratio may be due to a series of environmental factors, the most relevant of them being the introduction of the new digital Base Band Converter and its new formatter board Fila10G, which are still undergoing testing and development enhancements to fulfill future requirements such as observing at more than 2 Gbit sampling and introducing new VDIF data format.

The advantages of using new backends has proved effective when recording directly at the correlation facility in Bologna using a software recording system developed at JIVE by Harro Verkouter which is capable of recording valid data stream on disks up to 4 Gbit/s, thus enabling the possibility to correlate data within a short time.

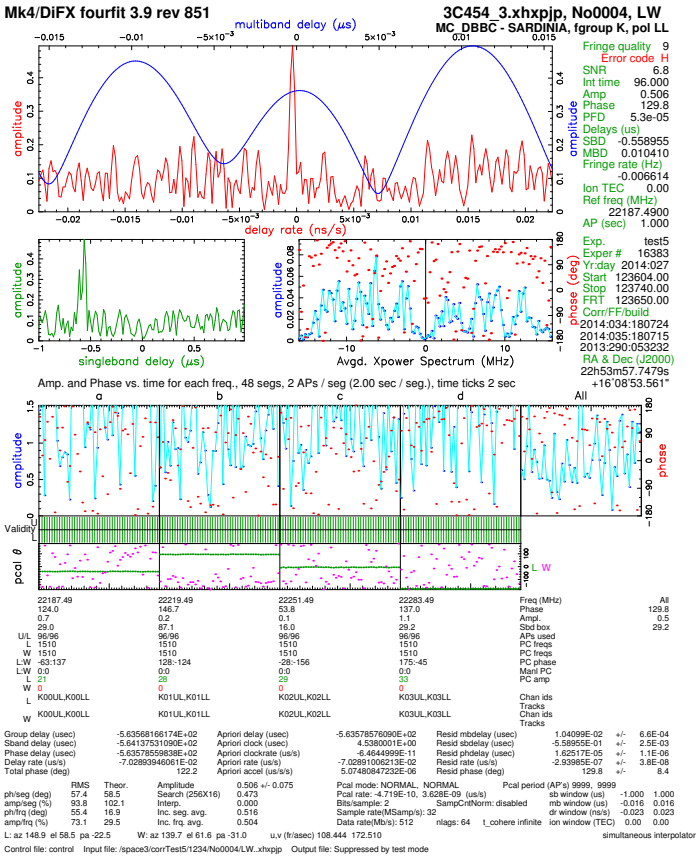

Figure 1: SRT first fringe

References

[1] Deller, A. T. and Brisken, W. F. and Phillips, C. J. and Morgan, J. and Alef, W. and Cappallo, R. and Middelberg, E. and Romney, J. and Rottmann, H. and Tingay, S. J. and Wayth, R. *DiFX-2: A More Flexible, Efficient, Robust, and Powerful Software Correlator*, Publications of the Astronomical Society of the Pacific, 2011