Noto Station Status Report

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Abstract

Noto station was not operational for a large part of 2010 due to a structural damage in the radio telescope. An expensive maintenance is needed, and INAF found the resources to repair the structure at the end of the year. The activity at the station is reported.

1. Antenna Status, Receivers, Networks

Noto antenna suffered from very serious damage to the axis of a driving azimuth wheel (see Figures 1 and 2). This event necessitated stopping all operations and placing the antenna in a safe state. As the azimuth track grout needs to be remade, new wheels and a new track have been planned. The entire repair operation has been financed (about 850,000 Euro) by INAF (Istituto Nazionale di Astrofisica). In the first months of 2011 the selection of the company able to renew the structure will be made, and then a period of around six months is planned for fully recovering the antenna functionality. The whole work (wheel replacement, grout and track removal, new track installation and its anchorage with innovative techniques and telescope alignment) should be completed by the end of summer 2011.

The maintenance of the receivers (C,Q,K) is currently underway. The SXL receiver developed in the last years will be renewed in order to reduce its weight, allowing its placement in the primary focus in a safe way. All the bands will also be converted in a digital implementation to be transfered with 10G Ethernet optical network technology to the control station and the DBBC environment.

A fiber optics link for e-VLBI activities has been financed by GARR (Italian Academic and Research Network) and is in the commissioning phase. It is planned to start with the installation in June 2011.

2. DBBC Backend

The DBBC backend is now regularly used at some stations after a gradual introduction in the station activities. Here, in summary, we list the main news.

Two operational modes are possible at present—the Digital Down Converter configuration and the Multichannel Equispaced configuration.

The Digital Down Converter configuration generates 16 x 1-16 MHz wide tunable bands. The implementation emulates an analog VLBI down-converter system, with independent channels in bandwidth and tuning base. Each Core2 board is able to produce four BBCs.

The Multichannel Equispaced configuration generates 16 x 32 MHz wide bands. The implementation is realized adopting the intrinsic capability of a highly efficient DFT processor to down-convert in base band contiguous slices of band. As the single DFT operation shows poor frequency rejection between adjacent channels, a preliminary filter is adopted to greatly improve the separation performance.

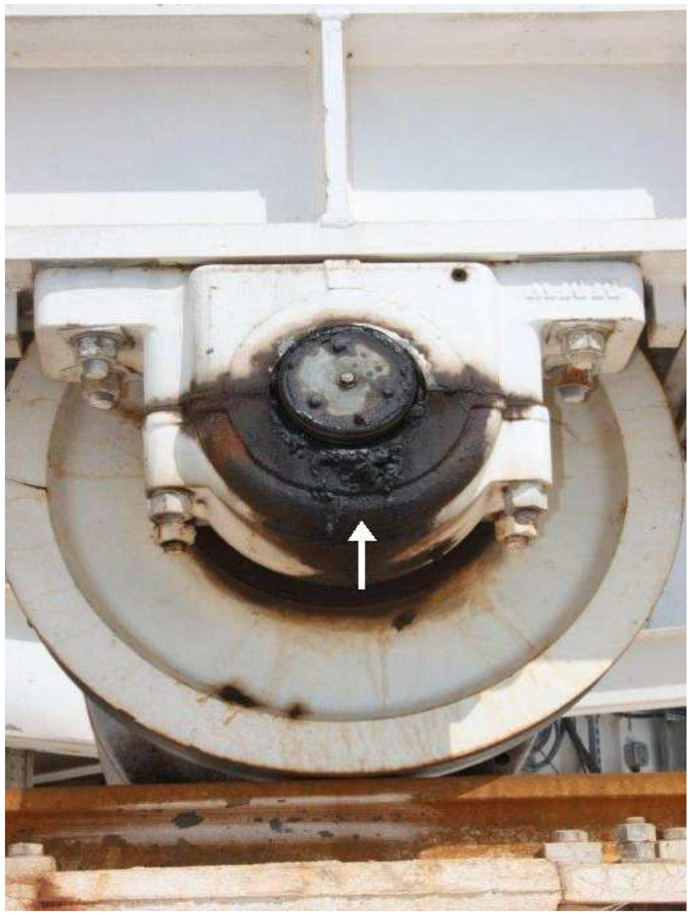

Figure 1. The damaged Noto azimuth wheel. The arrow points towards the damaged area.

Figure 2. The damaged axis in detail; the wheel is off-axis.

2.1. Hardware

In the VLBI backend implementation two observing types are mainly required: tunable configuration and fixed contiguous bands. The first is adopted to emulate the present Mark IV terminal and is required for both geodetic and astronomical observing modes. The second is devoted to astronomical millimeter observations and the coming VLBI2010 geodetic modes. Both modes are required in the same terminal to be used depending on the observation to be performed; so some efforts have been made to accomplish these modes in a unique hardware architecture.

The ADB1 board operates with a 1024 MHz sampling clock, for converting an input signal in the range 10—2200 MHz, while the ADB2 is operated at 2048 MHz with an input signal of up to 3500 MHz. The ADB2 is able to operate in ADB1 mode and moreover can adopt as piggy-back a FILA10G board, to transfer pure sampled data using optical fibers with a 10G Ethernet connection. The ADB2 board was widely tested and is available to be inserted in the standard DBBC2 stack.

The processing unit Core2 board is also fully operative and represents the element adopted to generate the down-converted channels in both modes: tunable and fixed tuning. The board is compatible with ADB1 and ADB2 and supports a minimal equivalent of four Core1 functionality. One Core2 board is able to emulate the complete functionality of four analog BBCs, or to generate a fixed tuning version of fifteen 32-MHz-wide baseband channels, covering an input receiver band of 512 MHz.

The new CaT2 board (Clock and Timing) is able to generate a highly flexible number of synthesized sampling clock (e.g., 2048 MHz, 1024 MHz) values, phase locked with an external 10 MHz. Low phase-noise and very small sensitivity to temperature are the main features. The board is also producing 1PPS synchronization signals for all the ADB boards and the entire digital chain. Frequency selection is performed with the use of the DBBC2 internal PC Set.

The FiLa10G can be used as piggy-back board with any ADB2 sampler, giving the possibility to transmit and receive at the same time a high data rate of 20 Gbps + 20 Gbps. The bi-directional functionality could be required, for instance, when an RFI mitigation is needed to be realized in a remote location with respect to the sampling and processing site. With the typical sampling frequency of 2.048 MHz and the full 10-bit data representation, a double optical fiber set meets the full data handling requirement. The Fila10G is the interface between the DBBC and Mark 5C recorder.

2.2. Firmware

The DBBC2 VHDL firmware was completely rewritten in a platform-independent fashion. This was accomplished with a great simplification that produced a very compact and efficient code. Performance improvement guarantees a bit-by-bit identical output from a set of BBCs belonging to the same Core2 board, having of course the same tuning settings and input data. Some debugging is still underway to check the entire new code.

The fixed tuned (PFB) configuration firmware is also available; it produces a set of 16 (15 usable) contiguous 32 MHz bands from a 512 MHz input range, in any of the Nyquist zones available from the ADB1/2 boards. This configuration is available for the VLBI2010 mode or for the millimeter VLBI network.

Firmware under development is covering the following tasks: a) fully tunable 1 GHz input bandwidth, b) 1 GHz PFB with 31 channels 32 MHz bandwidth, c) 65K points spectrometer.

2.3. New Hardware Development

New hardware parts to be integrated in the system are under development. This covers the interfacing, input bandwidth, and processing capability.

The FILA10G board is the interface between the system and the Mark 5C recorder or the network. Main connections are two optical fibers operating each at a maximum rate of 10 Gbps. In VLBI standard this is limited by 8.192 Gbps/fiber, and for the present recording capability the limitation is 4 Gbps. The data rate is fully bi-directional and compliant with the standard Ethernet networks, under UDP protocol. At present the development status sees the hardware defined and available with some prototypes, and the firmware development completed for Mark 5B mode while VDIF modes are underway.

The 10G network FILA10G board is adopting optical fibers. In order to be connected with one or two Mark 5C recorders, that adopt the copper CX4 standard, it needs to be interfaced with a commercial 10G switch having both types of ports. As an alternative, a bi-directional interface that can be used for this purpose was developed. It is named GLAPPER to recall its functionality to be a transition between GLAss and coPPER.

A kit to expand the backend functionalities to the VLBI2010 has been defined as upgrade element for a standard DBBC terminal. In such an implementation eight IFs are implemented.

2.4. HAT-Lab

HAT-Lab is a spin-off company supported by INAF for the DBBC production. The company has agreements with IRA-Noto, where laboratories are placed for a part of the production, and MPI in Bonn where other phases of the production are realized. A certain number of operations are realized by external specialized companies to simplify and optimize the production of the complex boards. Assembly and testing is fully realized at HAT-Lab, IRA, and MPI.

At present eight systems have been deployed by IRA, and in 2010 HAT-Lab has delivered eight additional systems. Production time is today close to six months while the first batch of production took a longer time, around nine months, due to the initial settings of the production lines.

2.5. Fringe Test

Regular observations are underway in the geodetic network. More fringe test observations have also been performed with the down-converter configuration. A reduction in the fringe amplitude has initially been seen, around 80%. This has been found due to an additional noise in the timing communication between ADB1 and Core2 boards. An extensive laboratory testing has been realized, and the best conditions have been determined making use of a phase calibration.

3. Geodetic Observations in 2010

During 2010, the Noto station participated in three geodetic experiments: EUR103, EUR104, and T2062.