Robledo Station Report

EVN TOG Meeting, October 2014
Cagliari, Italy

1. Software status.

The DSN supports VLBI observations using the Field System version FS-9.9.0 and the Mark5A recorders. Our current Mark5 s/w version is the following (SDK 6):

```
DTS_id? 0 : Mark5A : 2005y147d17h : 1 : Mark560a : 1 : 1 : 2.7x : 0xb8 : 0x19 ;
mk5/!OS_rev1? 0 : "Linux version 2.4.20-8 (bhcompile@porky.devel.redhat.com) (gc" ;
mk5/!OS_rev2? 0 : " version 3.2.2 20030222 (Red Hat Linux 3.2.2-5)) #1 Thu Mar 13 17:54:28 EST 2003" ;
mk5/!SS_rev1? 0 : "BoardType PCI-816VXF2, SerialNum 8270, ApiVersion 5.21, ApiDateCode Apr  7 2005" ;
mk5/!SS_rev2? 0 : "FirmwareVersion 10.84, FirmDateCode Apr 06 2005, MonitorVersion 6.02, XbarVersion
3.18, AtaVersion 1.05, UAtaVersion 0.00, DriverVersion 623" ;
form/m,16,1:2,off,,3,pass,41,0x44,okay
```

The new DSN VLBI digital backend -DSN VLBI Processor (DVP)- has passed the acceptance test and has been declared operational on April 2014. The MarkIV DAT has not been decommissioned yet until DVP support for external users has been properly verified.

The DVP does not use the NASA Field System application to configure the terminal and carry out the observations. A schedule processor has been developed to translate the VEX schedules into DVP scripts. Currently it records VDIF format (multi-channels data threads, 16 bytes legacy headers) on a Mark5C recorder with SDK 9.2

The DVP schedule processor (script builder) does not support yet Mark5 continuous recording. DVP recording script needs to be manually edited for continuous recording.

2. Hardware status.

1.1. DSN digital backend.

The DSN has replaced the aging MarkIV Data Acquisition Terminal (DAT) with a digital backend, the DSN VLBI Processor (DVP). It is based on the Wideband VLBI Science Receiver (WVSR), a custom made open-loop digital receiver developed at JPL that is successfully supporting differential-VLBI for spacecraft navigation (DDOR) and other radio astronomy applications, e.g. Earth orientation, astrometry, and spectroscopy observations.
The new acquisition terminal has inherited from the WVSR the Intermediate Frequency (IF) digitizer module, the firmware architecture and monitor and control software. Among the new features, the DVP improves considerably the recording rate providing at least 2 Gbps with the goal of achieving 4 Gbps (3 Gbps were achieved in the lab), uses a CASPER ROACH board for real-time Digital Signal Processing and channelization and streams the data (VDIF format using multi-channels data threads) into a Mark5C recorder. The DVP is compatible with similar digital developments (e.g. RDBE, DBBC). As the new backend will not use the standard Field System environment to perform the VLBI observations, efforts are under way to make it compatible with

non-JPL correlators, providing monitor and calibration data in the appropriate format. Lately an important effort has been made in the DSN towards automation of VLBI data acquisition using the Automation Language for Managing DSN Operations (ALMO). The automation process will be adapted for the new DAT.

The DVP is successfully supporting JPL VLBI projects since October 2013 using the JPL software correlator. Efforts are under way to test it within international VLBI networks. Fringes have been already demonstrated within the EVN for several observations using the EVN software correlator (SFXC) at JIVE (Fig. 1). Fringes have been obtained as well with the VERA japanese network and Canberra DSN antennas. Certain issues related with the DSN VDIF format need to addressed to make it compatible with the DiFX software correlator extensively used by several networks (IVS, VLBA, etc).

Robledo has supported the EVN observations performed during 2014 with the DVP as prime backend.

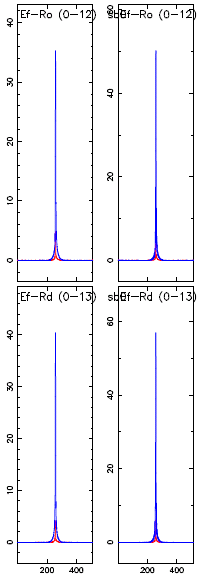


Figure. 1. First successful interferometric DVP fringes found with the EVN Network. The plot shows lag-based fringes between Effelsberg and Robledo MarkIV DAT (Ro) and Robledo DVP (Rd) for the first 2 channels (16 MHz BW, 2 bits, blue is LL, red cross-pol). Note that fringes are stronger with the DVP than with the MarkIV DAT.

1.2. DSS-63 (70m) K-band receiver status.

Only K-LCP polarization operational. K-RCP polarization system temperature is very high. It is suspected the K-RCP path at the Post-amp & Calibration assembly unit. Lately it has been noticed a considerable drop in the signal level at both polarizations. Further troubleshooting is required.

1.3. DSS-63 (70m) L-band receiver status.

Operational. All DSN 70m antennas L-band receivers have been upgraded from 90 MHz bandwidth (1625-1715MHz sky frequency) to 500 MHz (1400-1900MHz sky frequency). The upgrade took place at just one of the LNAs, replacing the refrigerated RF filter installed before the LNA. The spare LNA has not been modified yet.

1.4. DSS-54 (34m) Q-band receiver status.

Operational. Host Country group is extensively using it to perform single dish spectroscopy observations.

1.5. DSS-63 tracking problems.

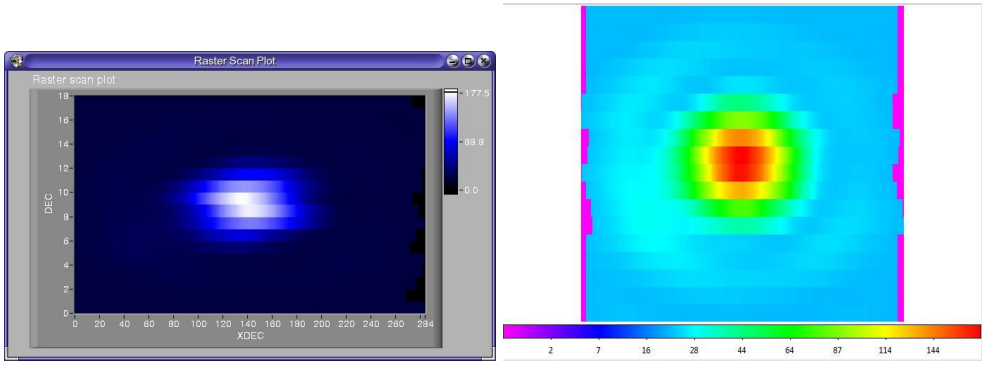
It has been found that DSS-63 antenna controller excessive tracking errors random problem is solved after resetting the Antenna Monitor and Control subsystem (AMC version 2).

3. Calibration.

a. DSS-63 K-band calibration. Currently there is no ambient load available so calibrations are performed using the noise diode. Noise diode calibration was checked using the ground.

b. DSS-63 K-band pointing. K-band pointing models have been recently improved.

c. DSS-63 L-band beam-shape measurement. EVN has requested to provide DSS-63 beam-shapes at L-band and low antenna elevations for calibrating off-axis detections in wide field observations. Several preliminary raster scans were performed in DEC/XDEC using different sources and antenna elevations. It has been found that it is necessary to post-process the scans to remove antenna tracking errors during the execution of the raster scan to align the individual XDEC scans. Following is an example using 3C274. Once the post-processing routine is stable we will provide raster scans results for point-like sources at low elevations with improved resolution in DEC. Lack of available antenna time has avoided to continue this task.



L-band DEC/XDEC raster scan over 3C274 performed at 50deg elevation: raw (left) and corrected (right).

4. Immediate and Future Plans.

DSS-63 Robledo 70m antenna downtime in October 27th - November 30th 2014 for additional regrouting of the AZ track. This downtime will impact Robledo participation in EVN observing session #3.

The old DSN K-band broadband receiver (18-26.5GHz, with only 70MHz baseband bandwidth per polarization) is currently being upgraded from three to four IF channels with a goal of 10 GHz instantaneous usable bandwidth at each polarization (17-27GHz), and beam switching capability for single dish spectroscopy. The actual downconverter (MMS) will be replaced by a design from the EE Department at Caltech that will down convert the IF channels into 1GHz wide USB and

LSB (or into 2 GHz wide in-phase/quadrature-phase) analog data channels. It will also allow selecting linear or circular polarization. Phase I of the receiver (only 21-23GHz and 23-25GHz frequency ranges) has been installed in Canberra 70 m antenna (DSS-43) and is currently in commissioning phase. Goldstone and Madrid receivers will be upgraded depending on available budget.

DSN L-band receiver upgrade to 1.4-1.9 GHz bandwidth: the original L-band feed is band-limited and does not allow the usage of the whole available bandwidth. The design of a replacement corrugated feed is already complete and ready to be implemented. The development of an orthomode/turnstile junction (that will provide L-band dual polarization) and the bandwidth upgrade of the spare LNA will be deferred. The lower edge of the band is hard-limited by the actual waveguide cut-off so participation in 21cm observations will be limited. On the other hand the DSN is considering the upgrade to broader L-band bandwidths, using feeds similar to the wide-band Eleven feed (Chalmers) or the Circular Quadruple-ridge flared horn (Caltech).

Robledo e-VLBI activities: 300 Mbps connection from Robledo to the Spanish Research and Educational Network (RedIRIS) has not yet being upgraded to 1 Gbps.

5. Robledo support to EVN observations.

Robledo has supported the EVN observations performed during 2014 with the DVP as prime backend.

During EVN session#1 2014 Robledo participated in following observation:

DOY	START	BOT	EOT	END	FACILITY	USER	ACTIVITY
051	1600	1730	0000	0030	DSS-63	EGS	EVN-EM111 (L-band)

EM111 (L-dual band; DSS-63 70m antenna): 1024 Mbps recording, Robledo only recorded L-LCP. Recorded with DVP as prime terminal, MarkIV DAT in piggyback mode.

During EVN session#2 2014 Robledo participated in following observation:

DOY	START	BOT	EOT	END	FACILITY	USER	ACTIVITY
154	2310	0040	0355	0425	DSS-63	EGS	EVN EH031 (L-band)

EH031 (L-dual band; DSS-63 70m antenna): 1024 Mbps recording, Robledo only recorded L-LCP. Recorded with DVP terminal only.

Out of session EVN observations: Robledo participated in following RadioAstron co – observations in L and K bands:

DOY	START	BOT	EOT	END	FACILITY	USER	ACTIVITY
001	1940	2110	2345	0015	DSS-63	EGS	EVN-A140101 (L-band)
010	1455	1625	2320	2350	DSS-63	EGS	EVN-A140110 (K-band)

For EVN observations JPL is not providing the experiment files (Field System files and DVP

script) and have to be locally generated at Robledo from the VEX file. Additionally for calibration purposes the antabfs file is derived locally for each observation using the antabfs.pl application and sent to the EVN archive with the observing log including flagr information and the uvflag file. Calibration data is not yet provided for the DVP. Feedback report is sent to http://www.evlbi.org/session/feedback.html .

Best regards,

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