Robledo Station Report

EVN TOG Meeting, March 2013
MPIfR, Bonn

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)- does not use the Field System 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) on a Mark5C recorder with SDK 9.2

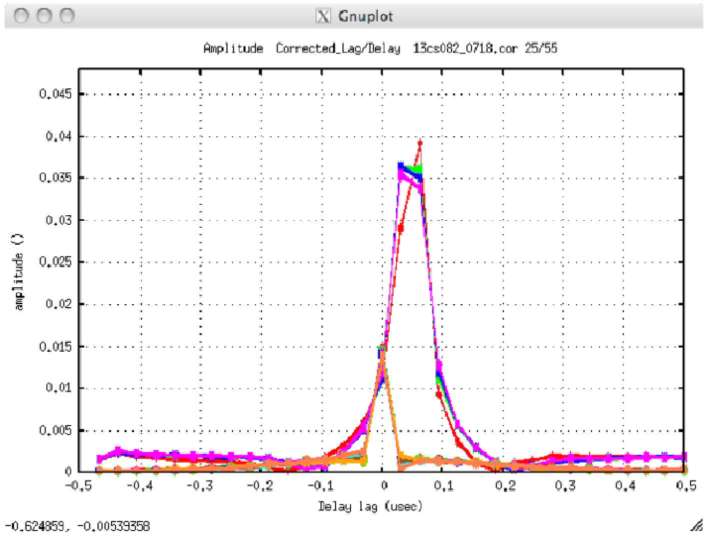
2. Hardware status.

2.1 DSN digital backend.

The DSN is replacing 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, 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.

A DVP prototype has been installed at Goldstone and at Robledo and are currently being tested recording in piggyback mode during certain VLBI observations. Following is the plot of the first successful X/Ka bands 2 Gbps interferometric fringes detection using the DVP during a JPL

Reference Frame Calibration Catalog X/Ka VLBI observation performed with DSS-55 (Ro) and DSS-25 (Go) antennas (34m beam waveguide antennas):



First 2 Gbps fringes using DVP and Mark5C recorder at X/Ka bands (8/32 GHz).

The DVP was been also tested for EVN observations configuration and recorded in piggyback mode during EVN observation ET026. It was found a problem on how the DVP schedule generator handles Mark5 continuous recording, recording a scan for every individual source instead. GAP and MINPAUSE parameters that control the continuous recording mode are currently being considered. Additionally the IF signal was not properly configured by the DVP script (X-RCP signal was incorrectly fed to the odd channels).

Whenever convenient a sample of DVP VDIF data will be sent to JIVE and Bonn correlators for its inspection and analysis.

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

As a result of a power plant failure several components of the DSS-63 70m antenna K-band receiver failed back in 2010. The ambient load is still at JPL being debugged. The K-LCP downconverter (MMS1) LO unit was replaced (Sep. 2012) and HPIB control was recovered, but the IF unit needs to be replaced but no spares are available in the DSN network. The K-RCP downconverter (MMS2) fan failed (at unit HP70004A) last Dec. 2012 and was replaced to avoid excessive heating of the unit.

2.3 DSS-63 (70m) L-band receiver upgrade.

DSN 70m antennas L-band receivers (with the exception of Ti) have been upgraded during the summer 2012 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.

2.4 DSS-54 (34m) Q-band receiver upgrade.

The Q-band receiver cryogenic system has not been replaced by a DSN standard package as was the original plan. Instead additional drive units will be available for maintenance tasks. During DSS-54 downtime a service platform was installed under the receiver package to ease the maintenance tasks. In preparation for the DSS-54 return to service in April a cool down of the Q-band receiver was performed by RF staff. The downconverter rack and the Host Country spectrometer have been placed closer to the receiver to avoid as much as possible undesired attenuation in the signal cables carrying K-band RF.

2.5 DSS-63 tracking problems.

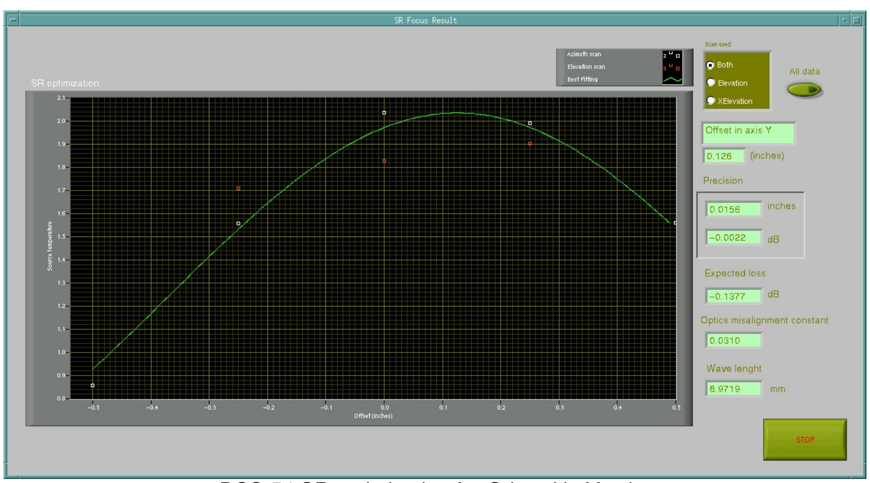
DSS-63 antenna controller is exhibiting excessive tracking errors during sidereal tracking. This problem mostly affects to K-band observations. Problem is currently under investigation.

3. Calibration.

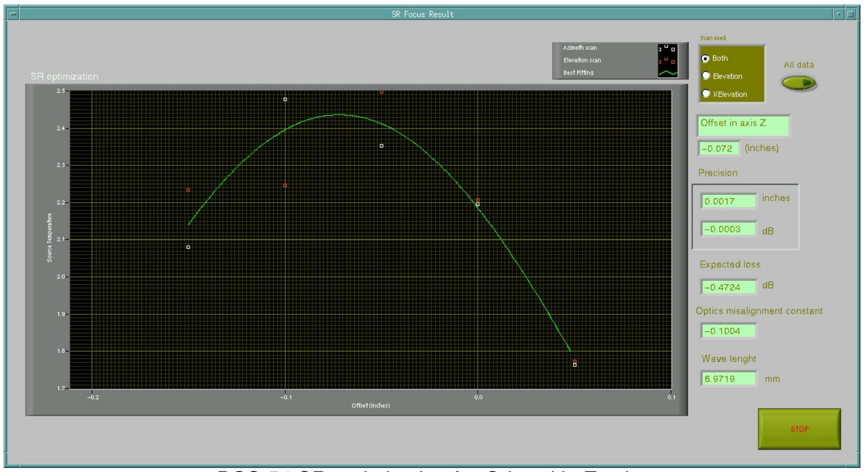
a. **DSS-63 K-band calibration.** Currently there is no ambient load available so calibrations are performed using the noise diode. Noise diode calibration was checked using the ground.

b. **DSS-63 K-band pointing.** K-band pointing model performance (for autocollimator AC2) was checked before our participation in the EVN observing session #3 2012.

c. **DSS-54 subreflector position optimization for Q-band.** After AZ track and wheels replacement at DSS-54 the subreflector position for Q-band reception has been optimized. New values are: Z=-70” (previous Z=-51”) and Y=120” (previous Y=0”). Following in the result from an optimization session in both axes.



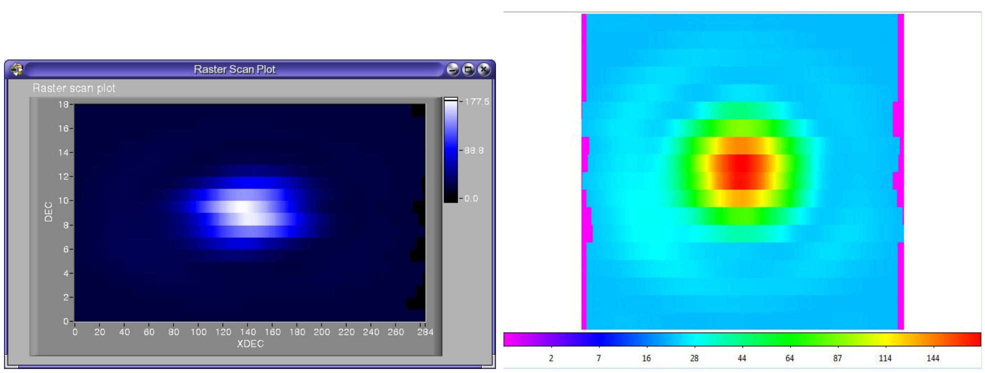
DSS-54 SR optimization for Q-band in Y axis.



DSS-54 SR optimization for Q-band in Z axis.

d. DSS-54 Q-band pointing model. After the subreflector optimization for Q-band reception a new pointing model has been derived with MRE 2mdeg. Still pending to measure the gain curve and estimate the efficiency across the bandpass (39-49 GHz).

e. 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 have been 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.



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 July 15th- August 9th 2013 for *depot level* maintenance tasks, including regrouting of the AZ track. Overall K-band receiver performance will be checked, including subreflector optimization, measurement of gain curve and efficiency and derivation of pointing models for both autocollimators if grouting tasks permit. Additionally antenna tracking problems will be investigated.

DSS-54 Robledo 34m antenna downtime that started in September 9th 2012 and was planned to finish in November 28th 2012 for AZ track and wheels replacement has been extended until April 12th 2013. Once the antenna is operational we will resume Q-band single dish spectroscopy observations.

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: the 300 Mbps connection from Robledo to the Spanish Research and Educational Network (RedIRIS) was successfully tested to JIVE using iperf application. Connection to 1Gbps will happen as soon as appropriate Gbps communication hardware is installed and configured.

5. Robledo support to EVN observations.

During EVN session#3 2012 Robledo participated in following 11 observations:

GM070 (L-LCP band; DSS-63 70m antenna): successful 512 Mbps Mark5 recording; LCP polarization calibrated using the noise diode.

EG067A (L-LCP band; DSS-63 70m antenna): successful 256 Mbps Mark5 recording; LCP polarization calibrated using the noise diode.

EG067B (L-LCP band; DSS-63 70m antenna): successful 256 Mbps Mark5 recording; LCP polarization calibrated using the noise diode.

EY015D (L-LCP band; DSS-63 70m antenna): successful 1024 Mbps Mark5 recording; LCP polarization calibrated using the noise diode.

EP076C (L-LCP band; DSS-63 70m antenna): successful 1024 Mbps Mark5 recording; LCP polarization calibrated using the noise diode.

GK045B (K-dual band; DSS-63 70m antenna): successful 256 Mbps Mark5 recording; both polarizations calibrated using the noise diodes.

EE009C (X-dual band; DSS-63 70m antenna): successful 512 Mbps Mark5 recording; only RCP polarization calibrated using the noise diode, the other polarization noise diode took too long to respond for preob calculations; subreflector could not move during the support to focus for each elevation, expect degraded efficiency.

ER030 (X-dual band; DSS-63 70m antenna): successful 1024 Mbps Mark5 recording; only RCP polarization calibrated using the noise diode, the other polarization diode took too long to respond; subreflector could not move during the support to focus for each elevation, expect degraded efficiency.

RO004B (K-dual band; DSS-63 70m antenna): not performed, subreflector could not rotate to K-band position.

EE009D (K-dual band; DSS-63 70m antenna): not performed, subreflector could not rotate to K-band position.

ET016B (K-dual band; DSS-63 70m antenna): not performed, subreflector could not rotate to K-band position.

During EVN session#1 2013 Robledo participated in following 2 observations:

EZ024 (K-dual band; DSS-63 70m antenna): 1024 Mbps recording, experienced problems with EVN module JOD-0055, sources from 21:24:58-21:36:39UT and from 23:37:28 till the end not recorded; both polarizations were calibrated using the noise diode; antenna controller was not able to clear tracking errors soon enough, expect impact on pointing; VC01 and VC02 did not had proper signal level because their frequencies lay outside the K-band downconverter bandwidth; Tsys high at the beginning of the observation due to bad weather.

ET026 (X-dual band; DSS-63 70m antenna): 1024 Mbps recording, experienced problems with EVN module JOD-0055 at the beginning of the observation (first 5 sources were not recorded), used a JPL module during the rest of the observation (JPL-0044/4000/1024) without further problems; antenna controller was not able to clear tracking errors soon enough, expect impact on pointing; both polarizations were calibrated using the noise diodes.

For EVN observations JPL is not providing the experiment files (Field System files) and have to be locally developed at Robledo from the provided 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. Feedback report is sent to http://www.evlbi.org/session/feedback.html.

Best regards,

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