Status and Developments at TIGO Concepción

Cristian Herrera, Felipe Pedreros, Octavio Zapata, Hayo Hase

Abstract

The main activities at the TIGO VLBI station during 2011 have been the successful observation of 121 VLBI sessions enabling post-earthquake monitoring, the development of a VLBI control software for smartphones, encoder replacement, and beamsize analysis measurements.

1. General Information

The operation of TIGO is based on an agreement between the Republic of Chile and the Federal Republic of Germany. The following three institutions are responsible for the actual activities: Universidad de Concepción (UdeC, Chile), Instituto Geográfico Militar (Chile), and Bundesamt für Kartographie und Geodäsie (BKG, Germany). TIGO is located on a tract of land of UdeC (73.025°W, 36.843°S) in Concepción, Chile. Due to financial problems of UdeC, the TIGO project was threatened with termination by the end of 2011. A temporary financial aid from BKG allows for the continued operation in 2012.

2. Component Description

The IVS Network Station TIGOCONC constitutes the VLBI part of the Geodetic Observatory TIGO, which was designed as a fundamental station for geodesy. Hence, the VLBI radio telescope is co-located with an SLR telescope (ILRS site), a GPS/Glonass receiver (IGS site), and other instruments such as a seismometer, a superconducting gravimeter, and an absolute gravity meter. The atomic clock ensemble of TIGO consists of three hydrogen masers, three cesium clocks, and four GPS time receivers realizing the Chilean contribution to the Universal Time scale (Circular T, BIPM). The technical parameters of the TIGO radio telescope published in [1] have not changed.

3. Staff

The 2011 VLBI staff consisted of four persons (see Table 1). At the beginning of 2011, three

Table 1. TIGO VLBI staff in 2011. Email addresses are `firstname.lastname@tigo.cl` for individuals and `vlbistaff@tigo.cl` for all VLBI operators.

Staff	Function
Hayo Hase	Head
Cristian Herrera	Informatic Engineer
Felipe Pedreros	Telecommunications Engineer
Octavio Zapata	Telecommunications Engineer

(from left) Herrera, Zapata, Pedreros, and Hase.

former staff members (Sergio Sobarzo, Eric Oñate, and Pedro Zaror) left; their positions could not be refilled due to financial problems at UdeC.

4. Current Status and Activities

During 2011 TIGO was scheduled to participate in 124 regular IVS sessions plus 15 additional sessions of the CONT11 campaign. Twelve 24-hour experiments were carried out within the TANAMI project [2]. Table 2 gives an overview of the participation of TIGOCONC in 2011. Out of the 136 requested observation days, 121 could be observed successfully, reaching an efficiency of 89%. The main reason for the experiment failures was a technical problem in the vacuum system of the dewar in April 2011. The replacement of the waveguide window and the vacuum valve became necessary. The lack of these spare parts at TIGO and the delay for delivery caused the loss of several experiments.

Table 2. TIGO's IVS observation statistics for 2011.

Name	R1xxx	R4xxx	OHIGxx	T2	RD	TANAMI	CONT11	Total IVS
# of Exp.	48	48	5	2	6	12	15	**136**
Success	42	40	5	2	5	12	15	**121**
Failure	6	8	0	0	1	0	0	**15**

4.1. Post-earthquake Monitoring

Two years after the M8.8 earthquake, the TIGOCONC coordinates still show post-seismic activity. Figure 1 depicts the coordinate time series for TIGOCONC (relative to the first session) for the period 2002–2012; the insets display the post-earthquake coordinate behavior. The post-seismic velocity vector points to the West, while the pre-seismic velocity vector pointed to the North-East.

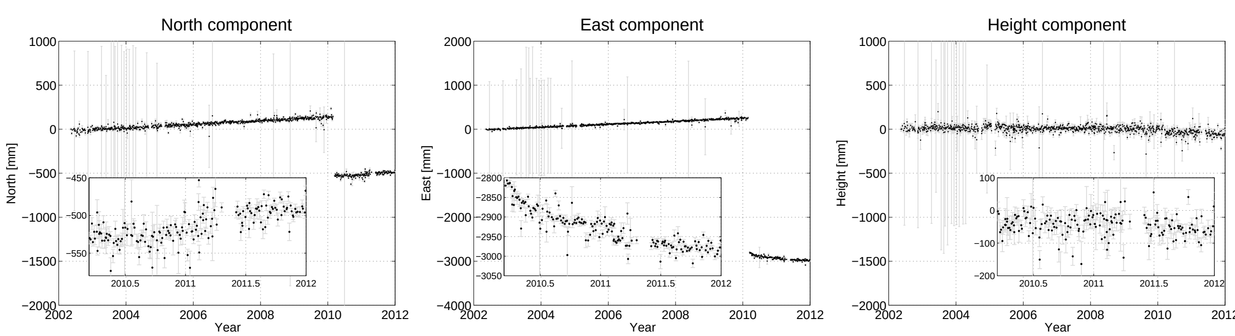

Figure 1. TIGOCONC coordinate time series showing pre- and post-earthquake displacements in the North, East and Up components. The biggest change is still active in the East component. (Time series courtesy of Gerald Engelhardt, BKG.)

4.2. Elevation Encoder Replacement

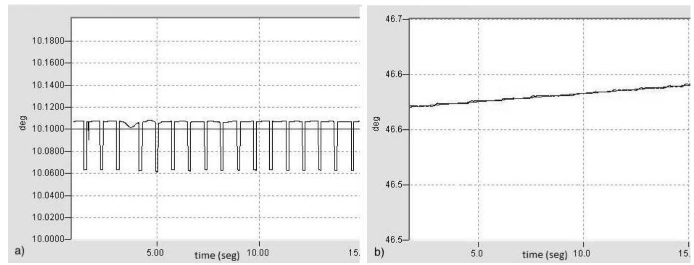

Figure 2. Screen shots from the diagnosis computer of the elevation encoder signal during tracking before (left) and after (right) the encoder replacement.

During 2011 the elevation servo control showed small jumps in the elevation axis of the telescope without causing an emergency stop. Several warning messages about this behavior appeared in the log files. Since the amplitude of these periodical jumps were only on the order of 0.01 degrees, the observations were not affected by significant pointing errors. After ruling out many potential error sources through tests, the problem was identified as missing bits in the elevation encoder. Consequently, the encoder was replaced by a spare which resolved the problem. Figure 2 presents screen shots from the diagnosis computer showing the elevation encoder signal during tracking before and after the exchange of the encoder.

4.3. Beam Pattern and Sidelobe Detection Measurements

In collaboration with undergraduate students of UdeC, work was done to characterize the beam pattern of the 6-m telescope [3]. For the first part of the investigation two RF sources (2.3 GHz

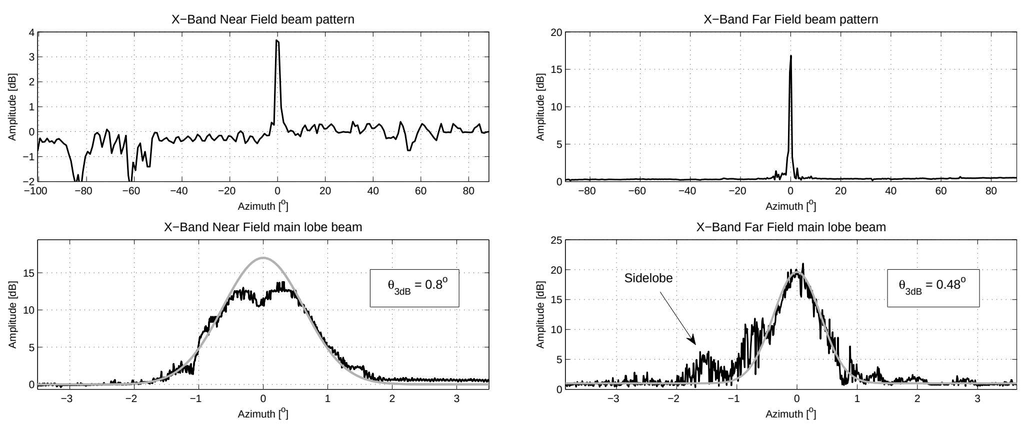

Figure 3. Beam patterns in the near field (left) and far field (right) measured at 8.4 GHz.

and 8.4 GHz) were placed at a distance of 115 m from the telescope. Using a raster scan technique, the variation of the received power was measured at the square law detectors in the two baseband converters. Then the background noise was measured (with the RF sources off) and subtracted from the data. Figure 3 (left) shows the main beam and a wide scan beam pattern, looking for sidelobes in X band. However, the results obtained are not a true representation of the beam, since the distance between the source and the receiver is in the near field of the telescope and very likely affected by ground reflections. In the second part of the investigation, the RF source was located beyond the Rayleigh distance for X band (∼2 km). The geography allowed placement of the RF source at an elevated height (20 m above the observatory level) at a distance of 2.84 km. The direct line of sight crossed a valley therefore reducing ground reflections. The same previous scanning and acquisition strategy was used. Figure 3 (right) shows the far field main beam and the wide beam pattern for X band. The main beam was fitted with a Gaussian function. Results show that the measured 3dB beamwidth $\theta_{3dB} = 0.48°$ is larger than the theoretical value for an X-band 6-m aperture antenna (0.36°). In addition a sidelobe near 1.5° from the center has been detected at a level of ∼15dB below the maximum.

4.4. Smartphone Monitor Application

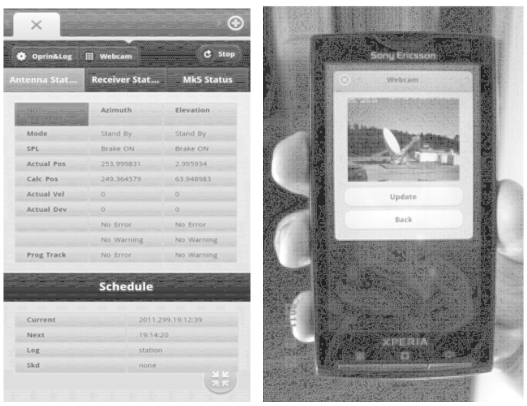

Figure 4. (left) A screen shot of the smartphone software with Antenna Control Unit and the current schedule. (right) Webcam of the radio telescope in the interface of the smartphone software for VLBI experiments.

Due to a shortage of operators it was necessary to control the running of VLBI sessions from elsewhere. For the remote control and monitoring of VLBI operations a software optimized for smartphones was developed by Cristian Herrera. This is a new tool based on a client-server architecture with a Web interface optimized for smartphone screens and cellphone networks. The server uses variables of the Field System and its station specific parameters stored in shared memory. The client running on the smartphone by a Web interface analyzes and visualizes the current status of the radio telescope, receiver, schedule, and recorder. In addition, it allows the sending of commands remotely to the Field System computer and displays the log entries. The software also integrates a webcam interface. It was tested successfully in many sessions during 2011, and it can be adapted to other VLBI stations.

5. Future Plans

The VLBI activities in 2012 will focus on the execution of the IVS observation program, upgrading from the Mark 5A recorder to Mark 5B+, and tests of e-VLBI transfer.

References

[1] Vandenberg, N. R.: International VLBI Service for Geodesy and Astrometry 2000 Annual Report, NASA/TP–1999-209243, 1999.

[2] M. Kadler, R. Ojha, S. Tingay and J. Lovell, *The TANAMI Program: Southern-Hemisphere VLBI Monitoring of Relativistic Jets in Active Galaxies*, American Astronomical Society, AAS Meeting #211, #04.13; Bulletin of the American Astronomical Society, Vol. 39, p. 732.

[3] F. Pedreros, H. Pacheco, H. Hase, *Beam pattern characterization of the 6 m TIGO telescope*, Poster presented at the 7th IVS General Meeting, Madrid, Spain, 2012.