Transportable Integrated Geodetic Observatory

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Abstract

This report summarises the technical parameters and the technical staff of the VLBI module of the transportable fundamental station TIGO. It also gives an overview about the VLBI activities during its test period at Wettzell. The outlook lists the outstanding tasks to improve the performance before TIGO will be used at a remote site abroad.

1. TIGO at Wettzell

The Transportable Integrated Geodetic Observatory consists of a radio telescope for VLBI, an optical telescope for SLR, a GPS array of four GPS permanent receivers, a super-conducting gravimeter, a broad spectrum seismometer, meteorological sensors and an ensemble of atomic clocks. TIGO is still located at the site of the Fundamentalstation Wettzell, since arrangements have to be setup for hosting the entire system and some technical problems need to be fixed before its first operation abroad.

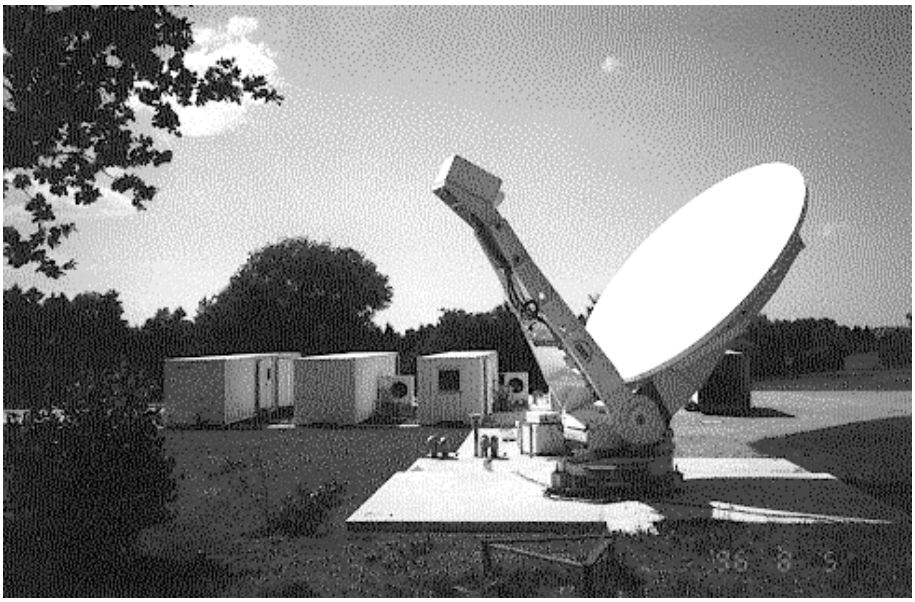

Figure 1. TIGO VLBI module at Wettzell. The 6m-offset radio telescope can be setup within a week by two persons. The operations room is in the air-conditioned container in the background.

Wettzell is located in the Bavarian Forest in the south-east of Germany.

2. Technical Parameters of the VLBI module of TIGO

The largest instrument of TIGO is the radio telescope for VLBI. The design criteria were

Table 1. Location and addresses of TIGO at Wettzell.

Longitude	12.88° E
Latitude	49.14° N
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`http://www.wettzell.ifag.de`	

- transportability in 12.20-m standard containers and maximisation of the dish size,
- setup of the radio telescope with muscle power within three days,
- optimisation for the constance of signal-path length under various elevations.

The technical parameters of the radio telescope are summarised in Table 2.

3. Technical Staff of the VLBI Module of TIGO

The TIGO VLBI module gains from the experiences of the staff from the 20-m radio telescope. For the use of TIGO at a remote site additional operators and engineers for the maintenance will be necessary.

Table 3 lists the TIGO station staff which are involved in the VLBI module.

4. Status of the TIGO VLBI Module

TIGO participated in several VLBI experiments which are listed in Table 4. Initially a linear polarisation in S-band reduced the SNR to about 50% of the expected one. After the discovery of two broken connectors no fringes indicated a wrong polarisation as delivered by the feed company. Since May 1998 the S-band polarisation is right-hand circular. The performance in X-band is better than specified, in S-band the specifications have not been reached yet. Some improvements are on the agenda for 1999.

TIGO owns the world's first VLBA4 terminal. However the Mark IV formatter is a prototype and the Mark IV decoder is still under development. Both components are expected to be replaced by the final one during 1999.

TIGO was used in several experiments with an offset reference frequency of the H-maser. Usually the reference frequency is 5 MHz. The offset at TIGO was -0.1 Hz to the 5 MHz. This enabled the short baseline determinations between the Wettzell and TIGO radio telescopes. The analysis was done by Leonid Petrov, GIUB, who checked his phase-delay routines with it [1]. The very high accuracy of the phase-delay solution was about ± 0.2 mm which cannot be increased due to mechanical limits of the radio telescope (surface, bearings).

TIGO's cable wrap showed some problems in the azimuth part. The limited space due to its transportability did not leave enough room for about 30 cables. This problem should be solved by introducing four hybrid cables, which have been made specially for TIGO. The installation is planned for spring 1999.

Table 2. Technical parameters of the radio telescope of TIGO for geodetic VLBI.

Parameter	TIGO-VLBI
owner and operating agency	BKG
year of construction	1995
radio telescope system	offset
receiving feed	primary focus
diameter of main reflector d	$6m$
focal length f	$2.18m$
f/d	0.3629
surface contour of reflector	$\pm 0.2mm$
azimuth range	$0 \ldots 540^\circ$
azimuth velocity	$6^\circ/s$
azimuth acceleration	$1^\circ/s^2$
elevation range	$0 \ldots 90^\circ$
elevation velocity	$3^\circ/s$
elevation acceleration	$1^\circ/s^2$
X-band	$8.1 - 8.9\,GHz$
(reference $\nu = 8.4GHz, \lambda = 0.0357m$)	
T_{sys}	$65\,K$
$S_{SEFD}(CASA)$	$7700\,Jy$
G/T	$35.5\,dB/K$
η	0.824
S-band	$2.2 - 2.4GHz$
(reference $\nu = 2.3GHz, \lambda = 0.1304m$)	
T_{sys}	$85\,K$
$S_{SEFD}(CASA)$	$12000\,Jy$
G/T	$22.3\,dB/K$
η	0.692
VLBI terminal type	VLBA4
recording media	thin tape only
Field System version	9.3.207
unattended VLBI observations	24h, mode C

Table 3. Staff working at the TIGO VLBI module at Wettzell.

Name	Background	Dedication	Agency
Hayo Hase	geodesy	100%	BKG
Olaf Lang	electrical engineering	30%	BKG
Armin Böer	electrical engineering	10%	BKG

5. Outlook

It is envisaged that TIGO has reached a status for its abroad mission to define new fundamental points in the southern hemisphere.

Table 4. Participation of TIGO in VLBI Experiments from the beginning until March 1, 1999.

Date	Experiment	Remarks
1997-11-12	fringe test (Tg-Eb-On)	successful, but weak S-band
1997-12-08	EUROPE-40	first 24h experiment
1998-02-03	EUROPE-41	reference frequency offset
1998-02-10	NA254	reference frequency offset
1998-03-17	NA255	
1998-03-24	NA256	
1998-03-31	NA257	fixing linear polarisation in S-band
1998-04-07	NA258	no fringes
1998-04-14	NA259	
1998-04-21	NA260	
1998-04-28	NA261	
1998-05-05	NA262	S-band RHC polarisation correct
1998-05-19	NA264	
1998-06-22	EUROPE-43	
1998-07-20	SBI98A	reference frequency offset
1998-08-17	EUROPE-44	reference frequency offset
1998-10-12	EUROPE-45	lost due to GPS-time offset in Turbo-Rogue
1998-12-14	EUROPE-46	reference frequency offset
1999-02-01	EUROPE-47	reference frequency offset
1999-02-04	WZTIE-1	reference frequency offset
1999-02-23	NA304	
1999-02-25	WZ4TS	reference frequency offset

An *Announcement of Opportunity* for possible hosting countries will introduce TIGO to foreign institutions. A decision on the first destination should be reached within 1999. Outside Germany TIGO should be used regularly within the CORE project at a new site in the ITRF.

Several tasks must be done at Wettzell beforehand. The agenda for 1999 consists of:

1. Test PC-FS version 9.3.207 based on the Linux kernel 2.0.
2. Test the Mark IV decoder prototype.
3. Replace cables in the TIGO azimuth cable wrap.
4. Improve S-band performance.
   - Make and install a low-loss cable in front of the receiver input.
   - Investigate spillover of 6-m reflector.
   - Replace S-band LNA.
   - Replace dewar.
5. Integration of the Totally Accurate Clock into the VLBA4 system.
6. Install databases for meteorological data.

References

[1] Hase, H., Petrov, L.: The First Campaign of Observations with the VLBI-Module of TIGO, In: Proceedings of the 13th Working Meeting on European VLBI for Geodesy and Astrometry, held at Viechtach, February 12-13, 1999, edited by W. Schlüter and H. Hase, Bundesamt für Kartographie und Geodäsie, Wettzell, 1999