

Hartebeesthoek Radio Astronomy Observatory (HartRAO)

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Abstract

HartRAO, the only fiducial geodetic site in Africa, participates in VLBI, GNSS, and SLR global networks, among others. This report provides an overview of our geodetic VLBI activities during 2008. On the 3rd of October 2008, a critical failure of the 26-m radio telescope put a halt to VLBI observations.

1. Geodetic VLBI at HartRAO

Hartebeesthoek is located 65 kilometers northwest of Johannesburg within the World Heritage Site known as the Cradle of Humankind, just inside the provincial boundary of Gauteng, South Africa. The nearest town, Krugersdorp, is 32 km distant. The telescope is situated in an isolated valley which affords protection from terrestrial interference. HartRAO uses a 26-metre equatorially mounted Cassegrain radio telescope built by Blaw Knox in 1961. The telescope was part of the NASA deep space tracking network until 1975 when the facility was converted to an astronomical observatory. The telescope is co-located with an SLR station (MOBLAS-6) and an IGS GNSS station (HRAO). HartRAO joined the EVN as an associate member during 2001. Geodetic VLBI has been allocated 18% of the available telescope time. The allocation for geodetic VLBI was increased from 58 24-hour experiments in 2007 to 65 in 2008 to include the CONT08 campaign.



Figure 1. Veld fire in our valley two days after the CONT08 came to an end and about a month before the 26-m (in the foreground) lost its bearing. (Credit: M. Gaylard)



Figure 2. The 26-m telescope breaks down. The gap between the bearing housing and static ring confirms suspicion of a south polar bearing collapse.

2. Technical Parameters of the VLBI Telescope of HartRAO

The feed horns used for 13 cm and 3.5 cm are dual circularly polarized conical feeds. The RF amplifiers are cryogenically cooled HEMTs. Tables 1 and 2 contain the technical parameters of the HartRAO radio telescope and its receivers. The data acquisition system consists of a Mark IV terminal and a Mark 5A recorder.

Table 1. Antenna parameters.

Parameter	HartRAO-VLBI
Owner and operating agency	HartRAO
Year of construction	1961
Radio telescope mount	Offset equatorial
Receiving feed	Cassegrain
Diameter of main reflector d	25.914 m
Focal length f	10.886 m
Focal ratio f/d	0.424
Surface error of reflector	0.5 mm
Wavelength limit	< 1.3 cm
Pointing resolution	0.001°
Pointing repeatability	0.004°
Slew rate on each axis	0.5° s^{-1}

Table 2. Receiver parameters with dichroic reflector (DR), used for simultaneous S-X VLBI, off or on.

Parameter	X-band	S-band
T_{sys} (DR off) (K)	60	44
T_{sys} (DR on) (K)	70	50
S_{SEFD} (DR off) (Jy)	684	422
S_{SEFD} (DR on) (Jy)	1330	1350
Point source sensitivity (DR off) (Jy/K)	11.4	9.6
Point source sensitivity (DR on) (Jy/K)	19	27
3 dB beamwidth (°)	0.092	0.332

3. Staff Members Involved in VLBI

Table 3 lists the HartRAO station staff who are involved in geodetic VLBI. Jonathan Quick (VLBI friend) provides technical support for the Field System as well as for hardware problems.

Table 3. Staff supporting geodetic VLBI at HartRAO.

Name	Function	Programme
Ludwig Combrinck	Programme Leader	Geodesy
Jonathan Quick	Hardware/Software	Astronomy
Roelf Botha	Operator	Geodesy
Jacques Grobler	Operator	Technical
Lerato Masongwa	Operator	Technical
Marisa Nickola	Logistics/Operations	Geodesy
Pieter Stronkhorst	Operator	Technical

4. Current Status

On the 3rd of October 2008 the 26-m telescope's cries of distress were heard as a series of loud cracking noises. On investigation, it was discovered that a **critical failure** of the south polar bearing had occurred. To assess the damage properly and replace the bearing will entail lifting the 200 tonnes of structure above the drive shaft. This will be a difficult, risky and costly task, but the void left by the 26-m in the worldwide geodetic VLBI network (especially for ICRF southern sky observations) makes it an essential undertaking. Furthermore, from a geodetic perspective the 26-m telescope acts as a reference point for the co-location of the SLR and GNSS stations on site as well as the reference datum for our country's surveying system.

During 2008 HartRAO participated in 55 experiments (table 4). Due to the mechanical failure of the 26-m telescope, telescope time allocated to geodetic VLBI was not utilized to its fullest extent. When operations came to an unexpected halt on the 3rd of October, ten geodetic sessions still appeared on the 26-m telescope's to-do list for 2008. The Deep South experiment, CRDS49, on the 16th of September, in which we were partnered by Hobart, proved to be the 26-m's swan song for 2008.

Table 4. Geodetic VLBI experiments HartRAO participated in during 2008.

Experiment	Number of Sessions
R1	20
C08	15
CRDS	8
CRF	3
OHIG	3
R&D	2
RDV	2
CRFS	1
T2	1
Total	55

HartRAO was one of only two Southern Hemisphere stations that participated in the **CONT08** campaign. A two month media shipment delay by Customs did not augur well for impending



Figure 3. The polar shaft, ready for installation as a 16-ton pre-assembled unit back in 1961.



Figure 4. The new GPS reference station at the Matjiesfontein site.

CONT08 media shipments. Data had to be e-shipped for the month of July, with the Bonn correlator assisting with downloading data from the JHB TENET mirror server, as well as with recording the data to disk pack and with shipping it to other correlators. Customs released the CONT08 media barely a week before the campaign kicked off. The only maintenance that had to be performed during the entire campaign was necessitated by a massive helium leak causing receivers to warm up. But the CONT08 campaign was not kind to a telescope nearing its half-century. Mechanical stress on the 26-m during 15 days of continuous observation took its toll, and the bearing failure occurred a month later.

With the installation of high-speed connectivity at HartRAO came the prospect of not having to ship data on disk any longer. On 5 May 2008, HartRAO participated in its first EVN **e-VLBI** session together with telescopes from Poland, Sweden, Italy, the UK, and Puerto Rico, and on 22 May 2008, HartRAO participated in the first real-time EVN e-VLBI session using telescopes located in Africa (HartRAO), Europe (Effelsberg, Medicina, Onsala, and Westerbork), North America (Arecibo), and South America (TIGO).

5. Future Plans

Determining costs for repairing or replacing the 26-m telescope tops the list for 2009.

Planning for the fundamental space geodetic observatory for South Africa, the HartRAO Matjiesfontein Outstation project, continued during 2008, and the first piece of equipment, a GPS reference station, was installed during December 2008 as part of the IGS network. Communication issues need to be resolved in 2009. There is also the prospect of a gravimeter and a DORIS station occupying the site before the end of 2009.

The Space Geodesy Programme is an integrated programme, combining VLBI, SLR, and GNSS, and is active in several collaborative projects with GSFC, JPL, and GFZ (Potsdam) as well as numerous local institutes. Collaboration also includes CNES/GRGS/OCA and the ILRS community in a Lunar Laser Ranger (LLR) project with local support from the University of Pretoria and the National Laser Centre (CSIR), amongst numerous others. General information as well as news and progress on Geodesy and related activities can be found on <http://geodesy.hartrao.ac.za/>.