Hartebeesthoek Radio Astronomy Observatory (HartRAO)

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Abstract

This report summarises the current technical parameters of the HartRAO VLBI station. It also gives an overview of our geodetic VLBI activities during the period March 1999 to the end of 2000. A brief description of our involvement with other space geodesy techniques is given. Surface upgrading of the 26 m antenna which should improve the performance of HartRAO as a VLBI station is discussed.

1. Geodetic VLBI at HartRAO

HartRAO is located north of Johannesburg, South Africa, in a valley of the foothills of the Witwaters mountain range (see Table 1). 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.

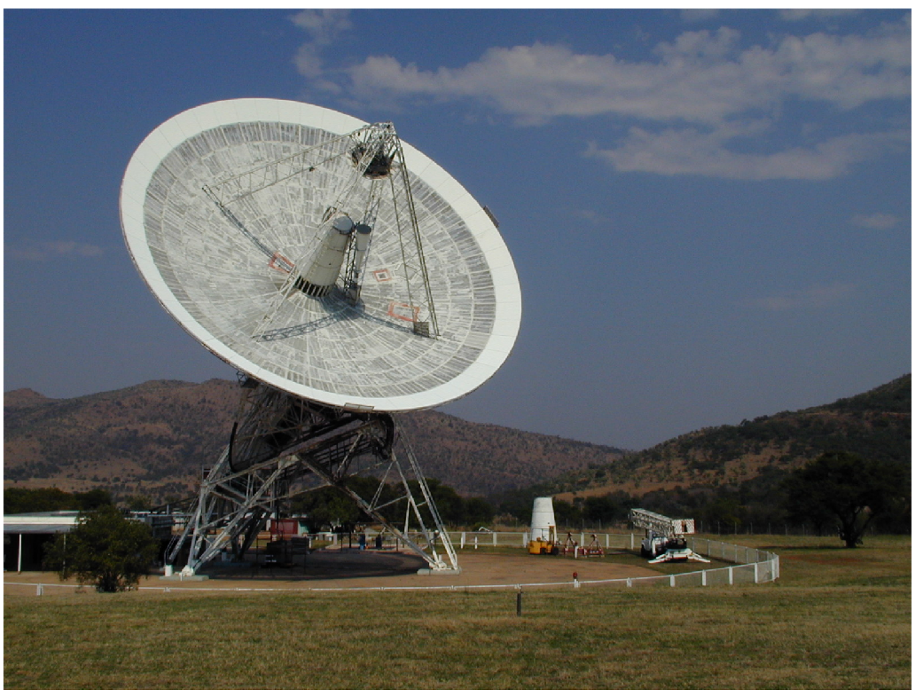

Figure 1. The 26 metre radio telescope. Solid panels have been fitted on the outer ring as part of the surface upgrade. All panels will eventually be replaced with non-perforated, higher tolerance panels. Typical rms accuracy of these panels is 170 microns.

2. HartRAO Radio Telescope Surface Upgrade

The upgrade of the radio telescope is well underway with the outer ring completed. It is expected that total rms surface accuracy after completion will be less than 0.5 mm. Improvement

Table 1. Location and addresses of HartRAO.

Latitude	25.889° S
Longitude	27.686° E
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http://www.hartrao.ac.za/geodesy/geodesy_index.html	

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

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	$25.914m$
focal length f	$10.886m$
f/d	0.424
surface contour of reflector	$\pm 2.0mm$
wavelength limit	2.5 cm
pointing resolution	0.001°
pointing repeatability	0.004°
X-band (standard $\nu = 8.580GHz, \lambda = 0.0349m$)	$8.180 - 8.980\,GHz$
T_{sys}	$65\,K$
S_{SEFD}	$1500\,Jy$
Point source	$17.1\,Jy/K$
3 dB beamwidth	0.092°
S-band (standard $\nu = 2.280GHz, \lambda = 0.1316$)	$2.210 - 2.344GHz$
T_{sys}	$40\,K$
S_{SEFD}	$1500\,Jy$
Point source	$9.7\,Jy/K$
3 dB beamwidth	0.332°
VLBI terminal type	MKIV
recording media	thin-tape only
Field System version	9.4.18
attended VLBI observations	24h, mode C

at X band will be approximately 60%. The new panels are being manufactured on site. The manufacturing technique includes the use of a 'bed of bolts' which can be adjusted very accurately. High precision measurements are made of each panel to monitor quality and shape of the panels. Holography will be used to ascertain the parameters of the shape of the resurfaced dish for adjustment and efficiency calculation purposes.

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

3. Staff Members Involved in VLBI

The Geodesy Programme has undergone some changes in its staff complement. With the addition of the MOBLAS-6 SLR unit, several new staff members were recruited as part of the SLR project. We have incorporated several of these staff members into the VLBI operations and envisage that they will improve and enhance our geodetic VLBI activities, after adequate training. The staff members listed have direct VLBI responsibilities, but other staff are sometimes involved in supporting and maintenance roles.

Table 3 lists the HartRAO station staff who are involved in geodetic VLBI.

Table 3. Staff supporting geodetic VLBI at HartRAO.

Name	Background	Dedication	Function	Programme
Ludwig Combrinck	Geodesy	30%	Programme Manager	Geodesy
Jonathan Quick	Astronomy	5%	Hardware/Software	Astronomy
William Moralo	Technical	30%	Shift Operator	Geodesy
Johan Bernhardt	Technical	10%	Shift Operator	SLR
Marisa Nickola	Logistics	10%	Shift Operator	SLR

4. Status of the HartRAO Geodetic VLBI Component

During the period of this report (March 1, 1999 - December 2000) HartRAO participated in the IRIS-S, CORE-A, RDV, COHG and SYOWA VLBI projects. We have been participating in VLBI experiments on a regular basis since 1986. Currently about 15 percent of available telescope time is allocated for geodetic VLBI. Upgrades to our VLBI equipment during 2000 includes:

1. 3.5cm Dual Polarisation receiver upgrade.
2. New Mark IV decoder installed.
3. Headstack replaced after repair – long-standing reproduce problem now fixed.
4. S2 recorder transports underwent service replacement.

5. Future Plans

In order to bring geodesy closer to home and the African continent, the Geodesy Programme is in the process of establishing a Geodetic Institute for Africa. The purpose of this Institute at HartRAO will be to take Africa into the future by developing and nurturing country specific projects in space geodesy. These projects will be tied in a unifying structure which will advance and support Africa's role in geodesy. It will support and promote the activities of the IVS, ILRS and IGS.

We are continuing our footprint survey, which has as its main purpose the determination of eccentricities between the GPS, VLBI and SLR reference points as well as the maintenance of a control network to enable stability monitoring of the site on a local scale. The current eccentricities between VLBI and SLR (Table 4) were determined using GPS (Combrinck & Merry 1997) and the SLR to GPS eccentricities values are from 1998 footprint results. We are processing HRAO in a 17 station regional (IGS) network and envisage processing the SLR (MOBLAS 6) data for eccentricity determinations. This will strengthen collocation and with accurate eccentricities should tie the independent ITRF (Table 5) coordinates to a high degree of accuracy. HartRAO has several upgrades in progress which will affect VLBI and general radio telescope performance. The main projects for 2001 are:

1. Upgrade of radio telescope surface.
2. Automation of dichroic.
3. Improvement of pointing map; especially the far south and north can do with improvement.

Table 4. Table of eccentricities, VLBI telescope to SLR and GPS (HRAO) reference points.

Reference	Coordinate	Δ	σ (mm)
SLR	X	41.680	15.8
SLR	Y	-66.564	7.5
SLR	Z	-8.131	3.9
HRAO	X	90.236	15.8
HRAO	Y	-132.190	7.5
HRAO	Z	-34.704	3.9

Table 5. Table of Geodetic reference points, ITRF96 Epoch 1997, VLBI, SLR and GPS (HRAO).

Reference	Coordinate	Cartesian (m)	σ (m)	Velocity (m)	σ (kxm)
VLBI	X	5085442.780	0.006	0.0007	0.0009
VLBI	Y	2668263.483	0.005	0.0192	0.00101
VLBI	Z	-2768697.034	0.005	0.0164	0.0007
GPS	X	5085352.500	0.009	0.0007	0.0009
GPS	Y	2668395.681	0.007	0.0192	0.00101
GPS	Z	-2768731.692	0.006	0.0164	0.0007
SLR	X	5085401.135	0.101	0.0007	0.0009
SLR	Y	2668330.108	0.063	0.0192	0.00101
SLR	Z	-2768688.865	0.071	0.0164	0.0007

References

[1] Combrinck W.L. and Merry, C.L. *Very long baseline interferometry antenna axis offset and intersection determination using GPS.* JGR, Vol.102, NO.B11, pages 24,741-24,743, 1997.