Westford Antenna 2017–2018 Biennial Report

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Abstract Technical information is provided about the antenna and the VLBI equipment at the Westford site of the MIT Haystack Observatory and about changes to the systems since the IVS 2015—2016 Biennial Report.

1 Westford Antenna at Haystack Observatory

Since 1981, the Westford antenna has been one of the primary geodetic VLBI sites in the world. Located 70 km northwest of Boston, Massachusetts, the antenna is part of the MIT Haystack Observatory complex.

The Westford antenna was constructed in 1961 as part of the Lincoln Laboratory Project West Ford that demonstrated the feasibility of long-distance communication by bouncing radio signals off a spacecraft- deployed belt of copper dipoles at an altitude of 3,600 km. In 1981, the antenna was converted to geodetic use as one of the first two VLBI stations of the National Geodetic Survey Project POLARIS. Westford has continued to perform geodetic VLBI observations on a regular basis since 1981.

In recent years Westford has been focused on the next generation VLBI VGOS technology development and operational integration. As the first prototype VGOS station, Westford provides this valuable knowledge base to all of the new VGOS operational stations as they come on line around the world.

MIT Haystack Observatory

Westford Antenna

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Fig. 1 Aerial view of the radome and facilities of the Westford antenna. (For scale the diameter of the radome is 28 m.)

Table 1 Location and addresses of the Westford antenna.

Longitude	71.49° W
Latitude	42.61° N
Height above m.s.l.	116 m
MIT Haystack Observatory 99 Millstone Rd Westford, MA 01886-1299 U.S.A.	
`http://www.haystack.mit.edu`	

2 Technical Parameters of the Westford Antenna and Equipment

The antenna is enclosed in a 28-meter air-inflated radome constructed of a 1.2 mm thick teflon fabric (Raydel R-60) (see Figure 1). The major components of the VLBI data acquisition system at Westford include a VGOS broadband cryogenically-cooled receiver, RF-over-Fiber (RFoF) Transmission links,

an RF power distributor, four Up/Down converters, four RDBEs, and a Mark 6 recorder with expansion chassis, which are all controlled by a PCFS running version 9.12.11. We also use the MCI system, which monitors and logs parameters for key components in the system. The primary frequency standard on site is the NR-4 Hydrogen maser.

Fig. 2 View of the Westford antenna inside the radome. The VLBI VGOS receiver is located at the prime focus.

Westford continues to host the WES2 GPS site of the IGS network. A Dorne-Margolin chokering antenna is located on top of a tower about 60 meters from the VLBI antenna. A Septentrio PolaRx5 Reference Station receiver completes the WES2 GPS site.

3 Westford Staff

The personnel associated with the geodetic VLBI program at Westford, and their primary responsibilities, are:

Table 2 Technical parameters of the Westford antenna for geodetic VLBI.

Parameter	*Westford*
primary reflector shape	symmetric paraboloid
primary reflector diameter	18.3 meters
primary reflector material	aluminum honeycomb
feed location	primary focus
focal length	5.5 meters
antenna mount	elevation over azimuth
antenna drives	electric (DC) motors
azimuth range	$90^\circ - 470^\circ$
elevation range	$4^\circ - 87^\circ$
azimuth slew speed	3° s^{-1}
elevation slew speed	2° s^{-1}
	Frequency range 2-14 GHz
T_{sys} at zenith	*40-70 K*
aperture efficiency	0.25-0.60
SEFD at zenith	1800-4500 Jy

- Alex Burns: Technician, Observer
- Chet Ruszczyk: VGOS Technical Manager
- Pedro Elosegui: Principal Investigator
- Colin Lonsdale: Site Director
- Glenn Millson: Observer
- Arthur Niell: VLBI Science Support
- Michael Poirier: Site Manager
- Ganesh Rajagopalan: Lead RF Engineer

4 Standard Operations

From January 1, 2017 through December 31, 2018, Westford participated in 55 VGOS sessions, including 48 VT, two Mini-CONT, and five CONT sessions. Westford also supported many short fringe tests with other worldwide stations assisting in their VGOS system configuration and operational checkout.

Use of the Westford antenna was shared with the Terrestrial Air Link (TAL) Program, but this was ended in 2017.

5 Research and Development

Presently we are running bi-weekly 24-hour sessions supporting the core VGOS stations. These sessions covered a wide range of focus from engineering testing

to the standardizing of operational configuration formats supporting the expanding VGOS network.

6 Outlook

Westford expects to continue to support the VGOS operational series of 24-hour sessions, along with supporting new development, testing, and integration of VGOS operational systems around the world.

We soon will be installing four new V2.1 UDCs and four R2DBEs into our operational VGOS system. These upgrades will make Westford a fully VGOS compliant station in terms of operating frequency and 1 GHz bandwidth coverage. We expect over the next two years we will continue to upgrade our operational systems to help Westford in breaking new ground in VLBI technical development along with running stable and consistent operations.

Acknowledgements

We would like to thank Pedro Elosegui, Arthur Niell, Ganesh Rajagopalan, and Chet Ruszczyk for their contributions to this report. Funding for geodetic VLBI at Westford is provided by the NASA Space Geodesy Program.