Westford Antenna 2015–2016 Biennial Report

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Abstract Technical information is provided about the antenna and VLBI equipment at the Westford site of the MIT Haystack Observatory, and about changes to the systems since the IVS 2014 Annual 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 WestFord 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. Westford has also served as a testbed in the development of new equipment and techniques now employed in geodetic VLBI worldwide.

MIT Haystack Observatory

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 front end, fiber optic RF downlinks, optical-to-RF

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

distributor, four Up/Down converters, four RDBEs and a Mark 6 recorder with expansion chassis, all controlled by a new PC running PCFS version 9.11.18. We are also running with our newly operational pointing interface, which allowed us to upgrade our new PCFS systems. We also have 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.

Westford also hosts the WES2 GPS site of the IGS network. A Dorne-Margolin chokering antenna is located on top of a tower at about 60 meters from the VLBI antenna. A LEICA GRX1200 Reference Station receiver completes the WES2 GPS site. ("The GPS receiver will soon be upgraded to a Septentrio unit by NOAA.")

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

3 Westford Staff

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

- Alex Burns: Technician, Observer
- Brian Corey: VLBI Technical Support
- Kevin Dudevoir: Pointing System Software
- Pedro Elosegui: Principal Investigator
- Colin Lonsdale: Site Director
- Glenn Millson: Observer
- Arthur Niell: VLBI Science Support
- Michael Poirier: Site Manager
- Ganesh Rajagopalan: RF Engineer

4 Standard Operations

From January 1, 2015, through December 31, 2016, Westford participated in 46 VGOS sessions. Westford also supported many short fringe tests with many worldwide stations in assisting their VGOS system configuration checkout.

Use of the Westford antenna is shared with the Terrestrial Air Link (TAL) Program operated by the MIT Lincoln Laboratory. In this project, Westford serves as the receiving end on a 42-km terrestrial air link de-

signed to study atmospheric effects on the propagation of wideband communication signals at 20 GHz.

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 systems around the world.

I expect over the next year we will install the last piece of the pointing system upgrade, which will give us better redundancy, and increased reliability for consistent operations.

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