Westford Antenna 2013 Annual Report

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Abstract Technical information is provided about the antenna and VLBI equipment at the Westford site of the Haystack Observatory and about changes to the systems since the IVS 2012 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 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 3600 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 test bed in the development of new equipment and techniques now employed in geodetic VLBI worldwide. Funding for geodetic VLBI at Westford is provided by the NASA Space Geodesy Program.

MIT Haystack Observatory

Westford Antenna

IVS 2013 Annual Report

Fig. 1 The radome of the Westford antenna.

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 Off Route 40 Westford, MA 01886-1299 U.S.A.	
http://www.haystack.mit.edu	

2 Technical Parameters of the Westford Antenna and Equipment

The technical parameters of the Westford antenna, which is shown in Figure 2, are summarized in Table 2.

The antenna is enclosed in a 28-meter diameter air-inflated radome made of 1.2 mm thick Teflon-coated fiberglass—see Figure 1. When the radome is wet, system temperatures increase by 10–20 K at X-band and by a smaller amount at S-band. The major components

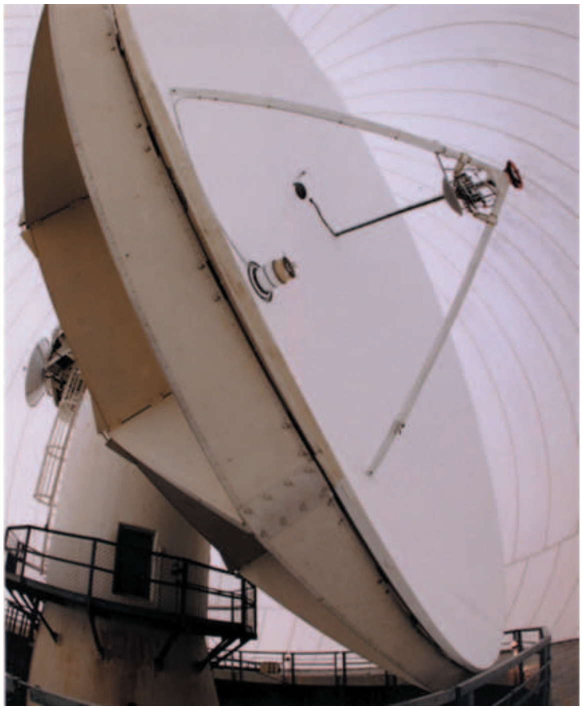

Fig. 2 Wide-angle view of the Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

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	
S/X 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	$3^\circ\ s^{-1}$	
elevation slew speed	$2^\circ\ s^{-1}$	
	X-band system	*S-band system*
frequency range	8180-8980 MHz	2210-2450 MHz
T_{sys} at zenith	50–55 K	70–75 K
aperture efficiency	0.40	0.55
SEFD at zenith	1400 Jy	1400 Jy

of the VLBI data acquisition system are a Mark IV electronics rack, a Mark 5B recording system, and a Pentium-class PC running PC Field System version 9.10.2. The primary frequency and time standard is the NR-4 hydrogen maser. A CNS Clock GPS receiver system provides a 1 pps reference clock to which the maser 1 pps is compared.

Westford also hosts the WES2 GPS site of the IGS network. A Dorne-Margolin chokering antenna is located on top of a tower ∼60 meters from the VLBI antenna, and a LEICA GRX1200 Reference Station receiver acquires the GPS data.

3 Westford Staff

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

Chris Beaudoin	broadband development
Joe Carter	antenna servo support
Brian Corey	VLBI technical support
Kevin Dudevoir	pointing system software
Dave Fields	technician, observer
Alex Burns	technician, observer
Glenn Millson	observer
Arthur Niell	principal investigator
Michael Poirier	site manager
Colin Lonsdale	site director

4 Standard Operations

From January 1, 2013, through December 31, 2013, Westford participated in 52 standard 24-hour sessions. Westford regularly participated in IVS-R1, IVS-R&D, IVS-T2, and RD-VLBA observations.

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 long terrestrial air link designed to study atmospheric effects on the propagation of wideband communications signals at 20 GHz.

5 Research and Development

In its role as a test bed for VLBI developments the Westford antenna was implemented several times during the year with the VGOS broadband feed assembly and used successfully as the second element of the interferometer with the GGAO 12-m VGOS system.

The first VGOS geodetic observations were scheduled and observed in October 2012. Two six-hour sessions were run on successive days. The initial results agree at the few millimeter level, consistent with the expected performance of the two systems. In May 2013 the first 24-hour session was observed. When broken into four six-hour sections, the session showed geodetic repeatability among the segments of better than 2 mm. An important goal of that session was to demonstrate unattended operation following setup, and the antenna functioned as expected.

The antenna was also equipped with the Mark 6 prototype data recorder for a demonstration of 16 Gbps recording capability. The equipment has been left in place for additional Mark 6 testing and development.

6 Outlook

Westford is expected to participate in 87 24-hour sessions in 2014. These will include the 15-day CONT14 campaign and several VGOS sessions, along with the occasional fringe test and support of the VGOS broadband development program.

Westford is planning to upgrade the PC Field System and complete the pointing system upgrade, which will facilitate compatibility with the VGOS/MCI system to be installed on the Westford antenna.

The Westford broadband system will see several upgrades in 2014, including improvements to the Dewar, implementation of noise diode calibration, and separation of the RF signal path into two bands to reduce senstivity to S-band RFI.

Acknowledgements

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