Westford Antenna

Mike Poirier

Abstract

Technical information is provided about the antenna and VLBI equipment at the Westford site of Haystack Observatory, and about changes to the systems since the 2005 IVS 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.

Figure 1. The radome of the Westford antenna.

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 in 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. Primary funding for geodetic VLBI at Westford is provided by the NASA Space Geodesy Program.

Table 1. Location and addresses of 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.

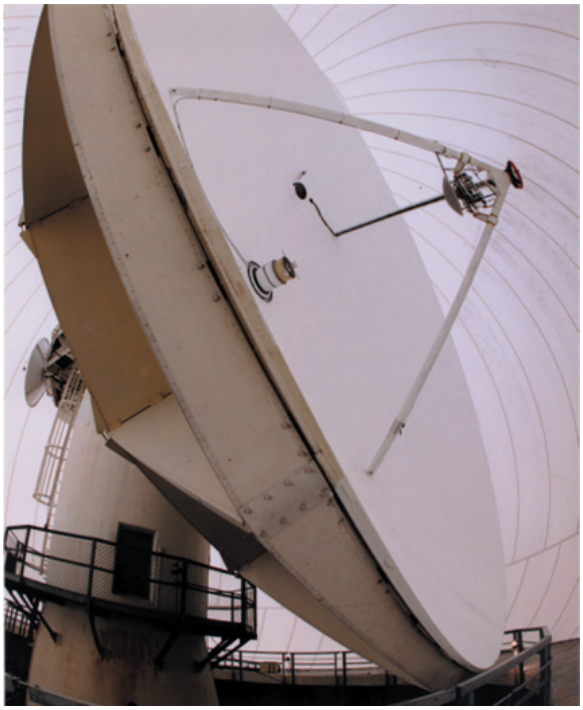

Figure 2. Wide-angle view of Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

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

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° s^{-1}	
elevation slew speed	2° 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

10–20 K at X-band and by a smaller amount at S-band. The major components of the VLBI data acquisition system are a Mark IV electronics rack, a Mark 5A recording system, and a Pentium-class PC running PC Field System version 9.9.2. The primary frequency and time standard is the NR-4 hydrogen maser. A CNS Clock GPS receiver system provides independent timing information and comparisons between GPS and the maser. 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 Turbo Rogue receiver acquires the GPS data. A meteorology package provided by the NOAA Forecast Systems Laboratory continually logs meteorological data, which are downloaded daily and are available from the IGS and cignet archives.

3. Westford Staff

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

Joe Carter	antenna controls
Brian Corey	VLBI technical support
Kevin Dudevoir	pointing system software
Dave Fields	technician, observer
Glenn Millson	observer
Michael Poirier	site manager
Alan Whitney	site director

4. Status of the Westford Antenna

During the period 2006 January 1 through 2006 December 31, Westford participated in 62 24-hour geodetic sessions. Westford regularly participated in the IVS-R1, IVS-R&D and RD-VLBA series of geodetic sessions as well as various fringe tests and e-VLBI experiments.

Some minor losses of data were caused by equipment failures compounded by our normal mode of unattended operations. A major loss of data occurred in December, when multiple components in the antenna servo control system failed, and Westford was unable to observe the six sessions scheduled for that month. The component failures along with the unavailability of replacement parts forced us to upgrade and re-engineer the antenna servo control system. The Westford team replaced the digital servo, main servo amplifiers, and main motor generator and control circuitry in both the azimuth and elevation axes. These systems were replaced with a new digital servo and with solid-state motor controllers in both axes. These upgrades and the associated software work were completed in just over one month after the failure.

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. E-VLBI Development at Westford

Westford continues to play a key role in the development of e-VLBI. In 2006, Westford served as a test bed for:

- continued high-speed e-VLBI development over both a dedicated 10 Gbps link to Haystack Observatory and a 2.5 Gbps (OC48) link to the rest of the world, and
- integration and testing of the e-VLBI technology with the new Mark 5B system.

As an additional, operational test of the Mark 5B system, the Westford data from four IVS-R&D sessions in the second half of 2006 were recorded on a Mark 5B system, in parallel with the Mark 5A.

6. Outlook

At Westford we anticipate being able to participate in 68 24-hour geodetic sessions in 2007 and to support occasional e-VLBI experiments and fringe tests.