Westford Antenna

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Abstract

Technical information is provided about the antenna and VLBI equipment at the Westford site of Haystack Observatory.

1. Westford Antenna at Haystack Observatory

Since 1981 the Westford antenna has been one of the primary geodetic VLBI sites in the world. Located ∼45 miles northwest of Boston, Massachusetts, the antenna is part of the MIT Haystack Observatory complex.

Figure 1. Aerial view of Westford site. The VLBI antenna is inside the radome. The WES2 GPS antenna is on top of the tower in the upper left corner of the photograph.

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 3. 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 of the VLBI data acquisition system are a Mark IV electronics rack, a Mark IV tape drive, which is used for recording thin tapes only, and a Pentium-class PC running PC Field System version 9.3.25. The primary frequency and time standard is the NR-3 hydrogen

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 GHz	2210-2450 GHz
T_{sys} at zenith	50–55 K	70–75 K
aperture efficiency	0.40	0.55
SEFD at zenith	1400 Jy	1400 Jy

Figure 3. Westford site at night, with radome illuminated from inside.

maser. A TAC GPS receiver provides independent timing information.

Westford also hosts the WES2 GPS site of the IGS network. A Dorne-Margolin GPS antenna is located on top of a tower ~60 meters from the VLBI antenna, and a TurgoRogue 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:

John Ball	pointing system software
Joe Carter	antenna controls
Brian Corey	VLBI technical support
Ellen Lautenschlager	observer
Glenn Millson	observer
Michael Poirier	site manager; chief observer
Alan Whitney	site director

4. Status of the Westford Antenna

Westford participates regularly in the CORE-A, CORE-B, IRIS-S and RD-VLBA series of geodetic experiments, as well as in occasional NEOS experiments, fringe tests, and various ad hoc experiments. In the year ending 1999 March 1, Westford participated in a total of fifty-one 24-hour geodetic experiments.

Upgrades to the antenna and VLBI systems over the last two years include:

- replacement of the original antenna controls with a system based on programmable logic controllers
- replacement of the 1970s-vintage analog servo with a digital servo system
- conversion of the Mark IIIA electronics rack and recorder to Mark IV
- replacement of the HP-1000 E-series computer used to point the antenna with a Pentium-class PC that also runs the PC Field System.

The only significant equipment failure during the past year occurred in the cryogenic helium compressor; AlliedSignal shipped a replacement quickly. Roughly twice a year the receiver LNA warms up due to contamination in the cold head, which must then be purged.

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. Outlook

With the advent of the Mark IV correlators and more intensive observing in the CORE program, we anticipate being able to increase by a modest amount the number of geodetic experiments observed annually at Westford.

Two more upgrades to the antenna systems are planned for the coming year: (1) addition of a second drive motor with clutch assembly to each axis, to improve fine movement control, and (2) replacement of the 17-bit position encoder on each axis by a 19-bit, LED-based encoder, to provide improved pointing accuracy and to reduce maintenance costs.