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 2004 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.

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.

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`	

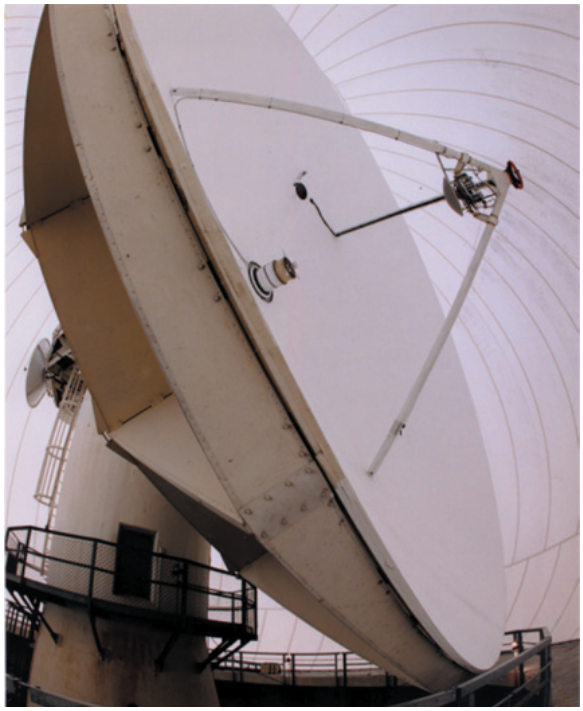

Figure 2. Wide-angle view of Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

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 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, a Mark 5A recording system, and a Pentium-class PC running PC Field System version 9.7.7. 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

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

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:

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

4. Status of the Westford Antenna

During the period 2005 January 1 - 2005 December 31, Westford participated in 57 24-hour geodetic sessions along with the 15-day CONT05 campaign in September. Westford regularly participated in the IVS-R1, IVS-R&D, and the RD-VLBA series of geodetic sessions, as well as two IVS-T2 sessions and various fringe tests and e-VLBI experiments.

During the last quarter of 2005, Westford did not participate in the IVS-R1 sessions due to

budgetary constraints. During the second half of 2005, we did however revamp and augment several of our operational systems, in order to improve reliability and reduce costs. These changes include:

- The antenna pointing software was modified to improve its robustness in the event of occasional communications problems that previously required manual intervention to restore proper pointing.
- The S/X receiver was mounted in a new frame that will allow improved access for maintenance and repairs. A new power supply package that uses fewer, and more robust, power supplies was also installed in the receiver.
- The unattended operational capability was enhanced through the addition of remote monitoring software and cameras, which together enable personnel to view the status of the equipment and the overall operation.

With these upgrades in place, Westford will be able to rejoin the IVS-R1 network, starting in January 2006.

The Mark 5A is our primary recording system on site. All geodetic sessions are now recorded on the Mark 5A. The Mark IV tape drive has been taken offline.

The only failures in the Westford antenna or VLBI systems this year were: a servo amplifier within the antenna control system, a power supply and a D/A chip within the cavity controller of the maser, and two receiver crossheads.

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 2005, Westford's participation included:

- Testbed for continued high-speed e-VLBI development over both a dedicated 10Gbps link to Haystack Observatory and a 2.5 Gbps link to the rest of the world.
- A real-time e-VLBI demonstration experiment was conducted at the SuperComputing 2005 conference in Seattle where Westford, GGAO and Onsala observatories all transmitted data to the Haystack Mark IV correlator in real-time at 512 Mbps. The correlation results were relayed in real-time for display on the showroom floor in Seattle.
- Westford continues to act as an e-VLBI testbed for the Mark 5B system, which is due for general release in Spring 2006.

6. Outlook

We anticipate Westford will be able to participate in the 68 24-hour geodetic sessions along with many e-VLBI experiments.