Westford Antenna

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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 IVS 2007 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.

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`

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 3,600 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.

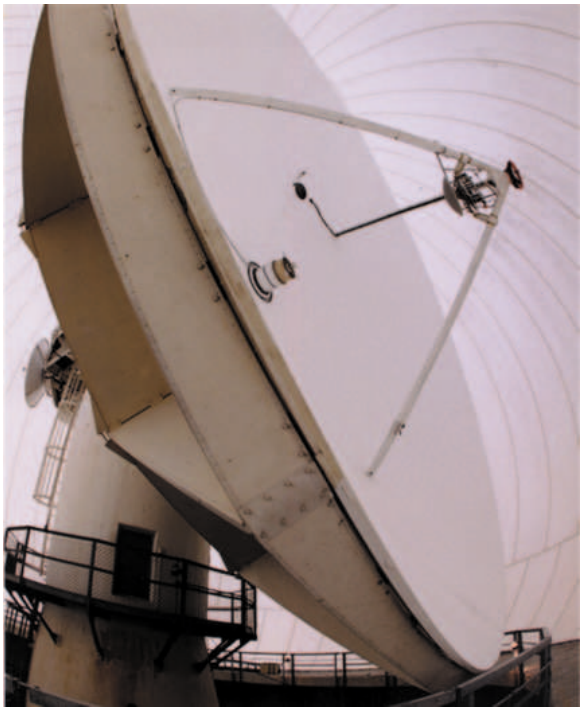

Figure 2. Wide-angle view of Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

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 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 independent timing information and comparisons between GPS and the maser. Westford also hosts the WES2 GPS site of the IGS network. A Dorne-Margolin choke ring antenna is located on top of a tower ∼60 meters from the VLBI antenna, and an Ashtech Model-Z Reference Station receiver acquires the GPS data.

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

3. Westford Staff

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

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

4. Status of the Westford Antenna

From 2008 January 1 through 2008 December 31 Westford participated in 60 standard 24-hour geodetic sessions along with the 15-day continuous CONT08 session. Westford regularly participated in the IVS-R1, IVS-R&D, and the RD-VLBA sessions along with fringe tests, e-VLBI experiments, and VLBI2010 broadband development testing.

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. During 2008, Westford served as a test bed for continued high-speed e-VLBI development in testing the application for the new Mark 5B+ system to achieve real-time playback. Unfortunately, there was a reduction in Westford's available data rate to the outside world to 1 Gbps over a shared network due to the end of support of the NSF DRAGON project at MAX and the loss of the BOSSNET connection to Internet2 in Maryland. The impact on e-VLBI was that real-time experiments with other correlators, though attempted, were unsuccessful. The outlook for Westford in 2009 is that it will continue to play a crucial role in e-VLBI development for VLBI2010 and the broadband development effort as the Mark 5C and DBEv2 programs release equipment.

6. VLBI2010

During 2008 we constructed a broadband feed system for the Westford Antenna. The dewar design is a duplicate of the system on the MV-3 antenna except that the mount design is specific to the Westford prime focus location. We now have a full complement of broadband equipment that includes four Mark 5b+s, four Up/Down Converters, four DBEs, and one ORCA box, all dedicated to this development effort. We have recently been making single dish measurements using satellite signals to improve the focusing and pointing. VLBI observations have been successful with fringes detected at various times in bands spanning 3.5 - 9 GHz. We will continue testing and expect fringes over the whole currently available range 3.1 - 11.5 GHz which will enable us to better understand this broadband development.

7. Outlook

Westford is expected to participate in 68 24-hour geodetic sessions in 2009. We also plan to have the flexibility to support the occasional fringe test and e-VLBI experiments while continuing the VLBI2010 broadband development testing.