Westford Antenna

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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 2008 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 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`	

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. 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.

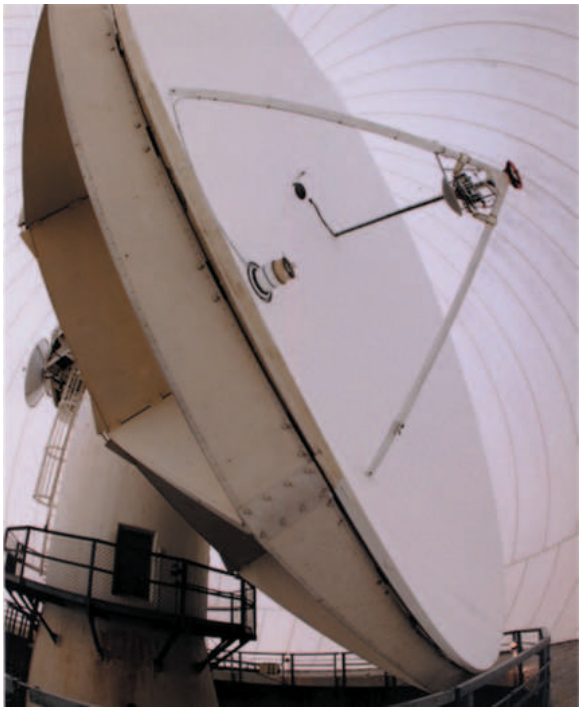

Figure 2. Wide-angle view of the Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

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 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.

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 January 1, 2009 through December 31, 2009, Westford participated in 40 standard 24-hour geodetic sessions. Westford regularly participated in the IVS-R1, IVS-R&D, and the RD-VLBA sessions along with fringe tests, e-VLBI experiments, and extensive 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 continued to play a key role in e-VLBI by participating in the kickoff of the IYA e-VLBI 24-hour demonstration in January 2009. The outlook for 2010 is that e-VLBI development will increase substantially with the expected technology advances and availability of the RDBE and the Mark 5C, specifically by using the new 10 Gbps Ethernet interface and by implementing the new VLBI Data Interchange Format (VDIF) standard. These efforts are important for the VLBI2010 broadband development program.

6. VLBI2010

In 2009, Westford played a critical role in the VLBI2010 effort as one of the two stations (GGAO being the other) composing the only functional broadband geodetic VLBI baseline. This year in broadband development saw the detection of fringes from 3.4 - 11.5 GHz, thereby demonstrating the wideband capability of the system. Later in the year, after mitigating various RFI sources, a leakage problem with the Westford phase calibration generator was discovered. This leakage was a major factor limiting the precision to which phase delay ambiguities could be resolved. This discovery prompted the development of a new phase calibration generator enclosure being designed by Honeywell-TSI specifically for broadband operation; the new generator is expected to be installed at both sites in early 2010. Other enhancements to the broadband hardware expected in 2010 include the installation of the RDBE and Mark 5C which will enable data recording at 4 Gbps.

7. Outlook

Westford is expected to participate in 61 24-hour geodetic sessions in 2010. We also plan to have the flexibility to support the occasional fringe test and e-VLBI experiments while continuing the VLBI2010 broadband development testing.