Westford Antenna 2014 Annual Report

Mike Poirier

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 2013 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.

The Westford antenna was constructed in 1961 as part of the Lincoln Laboratory Project WestFord 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 of 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 testbed in the development of new equipment and techniques now employed in geodetic VLBI worldwide.

MIT Haystack Observatory

Fig. 1 Aerial view of the radome and facilities of the Westford antenna. (For scale the diameter of the radome is 28 m.)

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`

2 Technical Parameters of the Westford Antenna and Equipment

The antenna is enclosed in a 28-meter diameter air-inflated radome made of 1.2 mm thick Teflon-coated fiberglass (see Figure 1). System temperatures are 10—20 degrees higher at X-band when the radome is wet than when it is dry. The effect is smaller at S-band. The major components of the VLBI data acquisition system

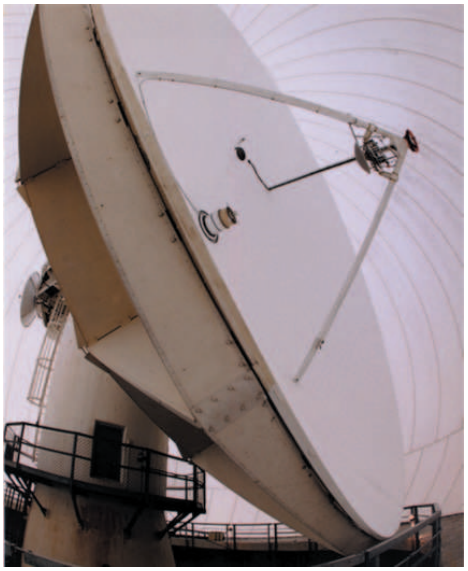

Fig. 2 Wide-angle view of the Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

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

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 a 1 pps reference clock to which the maser 1 pps is compared.

Westford also hosts the WES2 GPS site of the IGS network. A Dorne-Margolin chokering antenna is located on top of a tower at about 60 meters from the VLBI antenna. A LEICA GRX1200 Reference Station receiver completes the WES2 GPS site.

3 Westford Staff

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

- Chris Beaudoin: broadband development
- Alex Burns: technician, observer
- Joe Carter: antenna servo support
- Brian Corey: VLBI technical support
- Kevin Dudevoir: pointing system software
- Dave Fields: technician, observer
- Colin Lonsdale: site director
- Glenn Millson: observer
- Arthur Niell: principal investigator
- Michael Poirier: site manager

4 Standard Operations

From January 1, 2014 through December 31, 2014, Westford participated in 24 standard 24-hour sessions along with a 15-day continuous CONT14 session.

Westford reduced its regularly scheduled 54 sessions to support developmental and operational testing of the VGOS system.

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 communication signals at 20 GHz.

5 Research and Development

The Westford antenna, in its role as a testbed for VLBI development, has been fitted with the VGOS broadband frontend and backend, MCI, and Mark 6 recorder systems. Presently, we are running bi-weekly 1-hour operational tests between Westford and the GGAO 12-m antenna, exercising the equipment and test procedures while providing quality VLBI geodetic observations.

6 Outlook

Westford is expected to participate in 54 24-hour sessions starting in March 2015. These sessions will include R1, R&D, and several VGOS sessions, along with the occasional fringe test and support of special VGOS broadband development testing.

Westford has purchased a replacement PC Field System (PCFS), and it is presently being configured by NVI, Inc. The pointing system upgrade will be implemented early in 2015 with the new PCFS, which will improve the compatibility with the new VGOS system and more easily support the Lincoln Laboratory (LL) program at Westford.

The Westford broadband system continues to be operated successfully at Westford. Operational testing continues, and we expect to become fully operational supporting all of our NASA sessions during 2015.

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