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 activities at Westford during 2002.

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.

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.

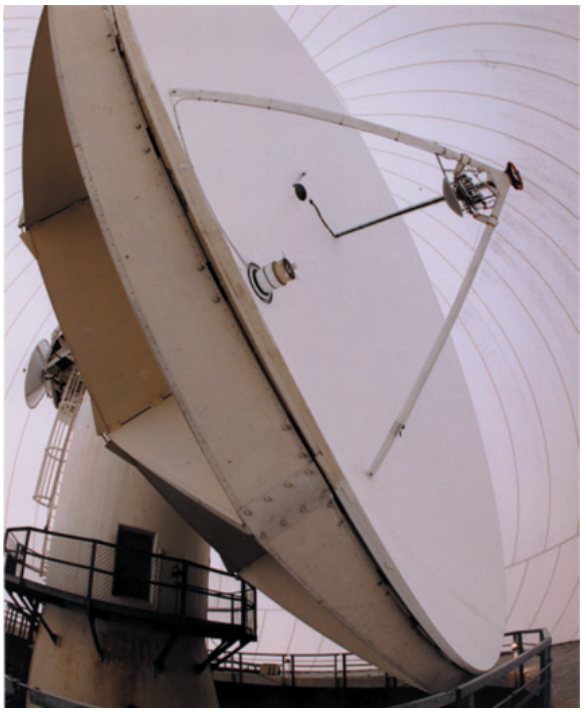

Figure 2. Wide-angle view of Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

The antenna is enclosed in a 28-meter-diameter, air-inflated radome made of 1.2-mm-thick, Teflon-coated fiberglass – see Figure 1. The major components of the VLBI data acquisition system are a Mark 4 electronics rack, a Mark 4 tape drive, which is used for recording thin tapes only, a Mark 5 recording system, and a Pentium-class PC running PC Field System version 9.5.13. The primary frequency and time standard is the NR-4 hydrogen maser. A CNS Clock

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 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

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 GPS antenna is located on top of a tower ∼60 meters from the VLBI antenna, and 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
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

During 2002, Westford participated in a total of 84 24-hour geodetic experiments. Westford participated regularly in the IVS-R1, IVS-R&D, GRAV, and RD-VLBA series of geodetic experiments. Westford also observed the full 15 days of the CONT02 experiment in October 2002, as

well as three IVS-T2 sessions, numerous fringe tests, and several e-VLBI experiments (see Section 5). There were no significant equipment failures during this operational period.

Upgrade of the azimuth motor generator on the antenna to a new solid-state unit was begun in 2002. We are hoping to upgrade elevation in the near future. This will increase the reliability of the system by removing components that are obsolete.

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 2002, Westford participated in the following experiments as part of the continuing e-VLBI effort:

1. On 4 October 2002, the Westford and GGAO antennas were used to do the first Gbps e-VLBI experiment in the U.S. Data were collected on magnetic disks using the Mark 5 system both at Westford and GGAO. The data were then transmitted at a rate of ∼780 Mbps to disks at MIT Haystack Observatory, where they were subsequently correlated on the Mark 4 correlator. Normal fringes were obtained.
2. On 24 October 2002, the Westford and GGAO antennas were again used to do another e-VLBI experiment, but this time the data were transmitted in real-time at 288 Mbps from the antennas to Haystack Observatory, where they were recorded on magnetic disks. Subsequent correlation was done on the Mark 4 correlator at Haystack.
3. On October 15 2002, the first intercontinental fringes were obtained using e-VLBI between Westford and Kashima, Japan. Data were recorded on the Mark 5 system at Westford and the K5 disk-based recorder at Kashima. Data were interchanged via network exchange and subsequently correlated at both Haystack and Kashima, though the average transfer rate was quite slow at ∼1.5 Mbps. The results were nominal.

6. Outlook

We anticipate Westford will be able to participate in the 72 24-hour geodetic experiments that are scheduled for Westford in 2003. More e-VLBI experiments are also planned for 2003.