

# Westford Antenna 2019–2020 Biennial Report

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**Abstract** Technical information is provided about the VLBI antenna and equipment located at the Westford site of the Haystack Observatory, the off-campus location of the Massachusetts Institute of Technology (MIT) in Westford, Massachusetts. Updated information is also provided about changes to the VLBI systems since the last IVS Biennial 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 approximately 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 West Ford Project by Lincoln Laboratory that demonstrated the feasibility of long-distance communication by bouncing radio signals off a spacecraft-deployed belt of copper dipoles flying at an altitude of approximately 3,600 km above the Earth’s surface. The antenna was converted to geodetic use in 1981, becoming one of the first two VLBI stations of the POLARIS Project by the National Geodetic Survey. Westford has continued to perform geodetic VLBI observations on a regular basis since 1981.

In recent years, Westford has focused on and supported the technology development and operational in-

tegration of the next-generation VLBI Global Observing System (also known as VGOS; e.g., Niell et al., 2018; Merkwowitz et al., 2019). As the first “prototype” VGOS station, Westford continues to provide this valuable knowledge base to all of the new VGOS operational stations as they come on line around the world.



**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 99 Millstone Rd Westford, MA 01886-1299 U.S.A. <a href="https://www.haystack.mit.edu">https://www.haystack.mit.edu</a>	

MIT Haystack Observatory

Westford Antenna

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## 2 Technical Parameters and Equipment of the Westford Antenna

The Westford antenna is enclosed in a 28-meter air-inflated radome constructed of a 1.2-mm-thick teflon fabric (Raydel R-60) (see Figure 1). The major components of the VLBI data acquisition system at Westford include a VGOS broadband cryogenically-cooled receiver, RF-over-Fiber (RFoF) Transmission links, an RF power distributor, four Up/Down converters (v2.1), four R2DBEs, and a Mark 6 recorder with expansion chassis which are all controlled by the personal computer field system (PCFS) running version 9.12.11. Westford is also equipped with an MCI system, which monitors and logs parameters for key components in the system. The primary frequency standard on site is the NR-4 Hydrogen maser.



**Fig. 2** View of the Westford antenna VGOS feed which is located at prime focus on the antenna.

Westford also continues to host WES2, the permanent Global Navigation Satellite System (GNSS) site of the International GNSS Service (IGS) network. The WES2 system currently consists of a Dorne-Margolin choking antenna and a Septentrio PolaRx5 Reference Station receiver. The antenna is located on top of a tower approximately 60 meters from the VLBI antenna, and the receiver is housed within the Westford premises. These specific equipment brands and models were damaged from a severe high-voltage event in 2020 and are being replaced.

**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
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	$3^\circ \text{ s}^{-1}$
elevation slew speed	$2^\circ \text{ s}^{-1}$
Frequency range 2–14 GHz	
$T_{\text{sys}}$ at zenith	40–70 K
aperture efficiency	0.25–0.60
SEFD at zenith	1800–4500 Jy

## 3 Westford Staff

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

- Alex Burns: Technician, Observer
- Pedro Elosegui: Principal Investigator
- Colin Lonsdale: Site Director
- Glenn Millson: Observer
- Arthur Niell: VLBI Science Support
- Michael Poirier: Site Manager
- Ganesh Rajagopalan: RF Engineer
- Chet Ruszczyk: VGOS Technical Manager

## 4 Standard Operations

From January 1, 2019, through December 31, 2020, Westford participated in 54 VGOS sessions, including 27 VGOS Tests (VT), 24 VGOS operational sessions (VO), and three S/X legacy-VGOS R&D-type 24-hr sessions. Westford also supported 18 so-called VGOS Intensive sessions (VI and/or V2), along with many short fringe tests with other worldwide stations, thus assisting in their VGOS system configuration and operational checkout.

## 5 Research and Development

Presently, we are running bi-weekly 24-hr sessions supporting the core VGOS network. These sessions covered a wide range of focus from engineering testing to the standardizing of operational configuration formats supporting the expanding VGOS network.

## 6 Outlook

Westford presently expects to continue to support the VGOS operational series of 24-hr sessions, along with supporting new development, testing, and integration of VGOS operational systems around the world.

We are in the process of replacing the GNSS hardware at WES2 with a Trimble Alloy receiver, a new Dorne-Margolin choking antenna with dome, and a new LMR-600 cable with lightning suppressors to bring it back to continuous operations. We expect that over the next two years we will continue to upgrade our operational systems to help Westford in breaking new ground in VLBI technical development and support for the operational network of stations, along with locally running stable and consistent operations.

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## References

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