Goddard Geophysical and Astronomical Observatory

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Abstract

This report summarizes the technical parameters and the technical staff of the VLBI system at the fundamental station GGAO. It also gives an overview about the VLBI activities during the report year. The outlook lists the outstanding tasks to improve the performance of GGAO.

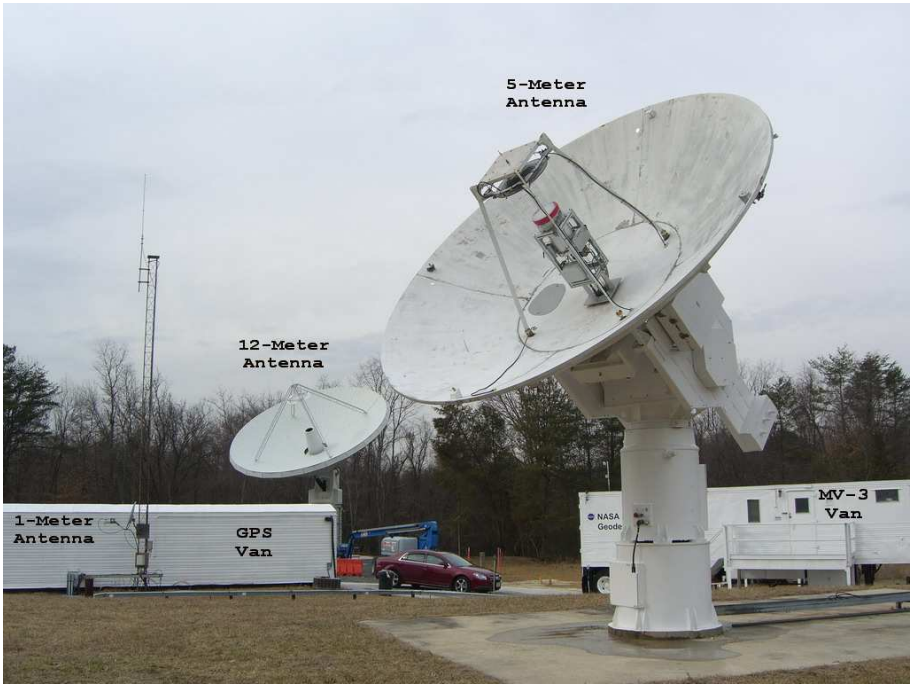

Figure 1. Goddard Geophysical and Astronomical Observatory.

1. GGAO at Goddard

The Goddard Geophysical and Astronomical Observatory (GGAO) consists of a 5-meter radio telescope for VLBI, a new 12-meter radio telescope for VLBI2010 development, a 1-meter reference antenna for microwave holography development, an SLR site that includes MOBLAS-7, the NGSLR development system, and a 48″ telescope for developmental two-color Satellite Laser Ranging, a GPS timing and development lab, a DORIS system, meteorological sensors, and a hydrogen maser. In addition, we are a fiducial IGS site with several IGS/IGSX receivers.

GGAO is located on the east coast of the United States in Maryland. It is approximately 15 miles NNE of Washington, D.C. in Greenbelt, Maryland (Table 1).

Table 1. Location and addresses of GGAO at Goddard.

Longitude	76.4935° W
Latitude	39.0118° N
MV3 Code 299.0 Goddard Space Flight Center (GSFC) Greenbelt, Maryland 20771	
`http://cddisa.gsfc.nasa.gov/ggao/vlbi.html`	

2. Technical Parameters of the VLBI Radio Telescopes at GGAO

The 5-meter radio telescope for VLBI at GGAO (MV3) was originally built as a mobile or transportable station; however, it was moved to GGAO in 1991 and has been used as a fixed station since that time. In the winter of 2002 the antenna was taken off its trailer and permanently installed at GGAO.

In October of 2010, construction of the new 12-meter VLBI2010 developmental antenna was completed. This antenna features all electric drives and a Cassegrain feed system. Integration of the broadband receiver and the associated sub-systems is underway as a joint effort between HTSI and the MIT Haystack Observatory.

The technical parameters of the radio telescopes are summarized in Table 2.

Table 2. Technical parameters of the radio telescopes at GGAO.

Parameter	5-meter	12-meter
Owner and operating agency	NASA	NASA
Year of construction	1982	2010
Diameter of main reflector d	$5m$	$12m$
Azimuth range	$+/-270°$	$+/-270°$
Azimuth velocity	$3°/s$	$5°/s$
Azimuth acceleration	$1°/s^2$	$1°/s^2$
Elevation range	$+/-90°$	$5-88°$
Elevation velocity	$3°/s$	$1.25°/s(Avg.)$
Elevation acceleration	$1°/s^2$	$1°/s^2$
Receiver System		
Focus	Cassegrain	Cassegrain
Receive Frequency	$2-14GHz$	$2-14GHz$
T_{sys}	$100\,K$	$50\,K(Theoretical)$
Bandwidth	$512MHz$, 4 bands	$512MHz$, 4 bands
G/T	$26\,dB/K$	$43\,dB/K$
VLBI terminal type	VLBI2010	VLBI2010
Recording media	Mark 5B	Mark 5B
Field System version	9.10.3	9.10.3

3. Technical Staff of the VLBI Facility at GGAO

GGAO is a NASA R&D and data collection facility, operated under contract by Honeywell Technology Solutions Incorporated (HTSI). Table 3 lists the HTSI staff that are involved in VLBI operations and development at GGAO.

Table 3. Staff working at the VLBI station at GGAO.

Name	Background	Dedication	Agency
Jay Redmond	Engineering technician	100%	HTSI
Irv Diegel	Electrical Engineer	50%	HTSI
Skip Gordon	Engineering technician	20%	HTSI
Paul Christopoulos	Engineering technician	20%	HTSI

4. Status of MV3 at GGAO

Having ceased VLBI operations in May 2007, MV3 continues on a full time basis to be a major component in the program to demonstrate the feasibility of the VLBI2010 broadband delay concept. Working under the guidance of the MIT Haystack Observatory, MV3 has played a critical role in the advancement of the VLBI2010 project.

Although MV3 is still outfitted with the prototype VLBI2010 equipment installed in 2009, most of the activities at GGAO have been focused on the construction of the new VLBI2010 12-meter antenna. However, there were some other activities worth noting:

- Continuation of wideband system testing and characterization of the 5-meter antenna.
- Upgrade of the ethernet infrastructure at MV3.
- Installation of a new Field System computer.
- Installation of a thermal shutdown system to protect the backend equipment from HVAC failure.
- Procurement of new test equipment for characterization of the wideband RF hardware.
- Re-packaging of the Broadband Phase Cal unit into a temperature-controlled RF-tight enclosure with additional monitor and control capabilities.
- Support for a Small Business Innovation Research (SBIR) project to investigate and develop the use of GPS to measure large radio telescope properties. This was an effort led by NVI, Inc. with support from HTSI.
- Support for the development and implementation of a holographic imaging capability based on the VLBI2010 receiving hardware.

The holographic imaging capability is being developed by the MIT Haystack Observatory, with support from HTSI, in order to understand antenna deformations that could potentially dilute the accuracy of the VLBI2010 system. Initial holographic data collections were performed using the 5-meter dish as the antenna to be tested and a 1-meter satellite reeiving dish as the phase reference.

Preliminary results show that the imaging technique was able to faithfully reconstruct deformations in the aperture of the primary reflector. These deformations included GPS antennas mounted on the rim of the dish, an RF absorbing block, the offset feed cover, and the subreflector in the center of the primary as shown in Figure 2.

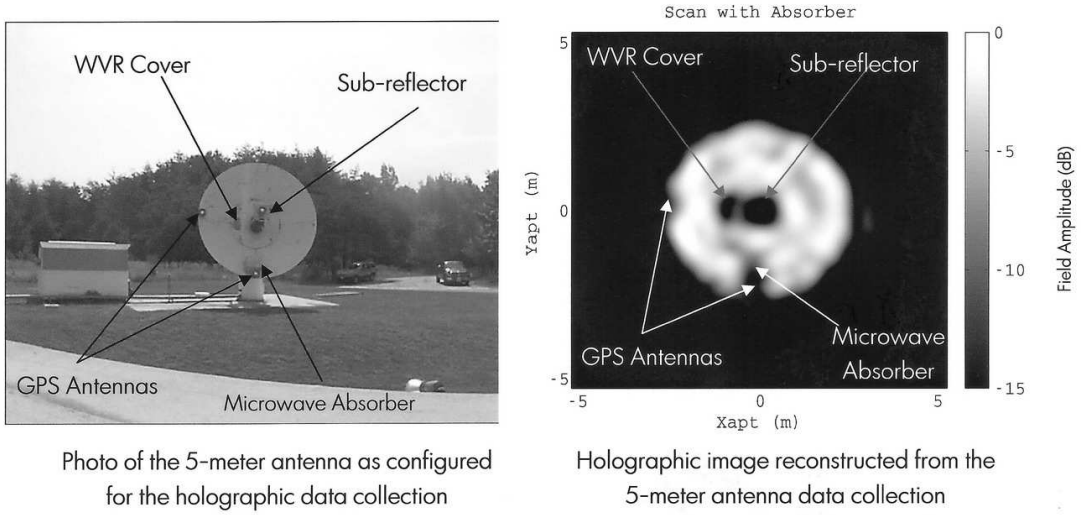

Figure 2. Holographic imaging of the 5-m antenna.

5. Outlook

GGAO will continue to support VLBI2010, e-VLBI, and other developmental activities during the upcoming year. Tentative plans for 2011 include:

- Installation of the new VLBI2010 broadband receiver system onto the 12-meter antenna.
- Short baseline ties between the 5 and 12-meter antennas.
- Continued testing of the new broadband phase calibrator for the VLBI2010 system.
- Installation of the new RDBE and Mark 5C, enabling data recording at 4 Gbps.
- Installation of a new Sigma Tau maser in the MV3 trailer.
- Continue holographic imaging of the 5 and 12-meter antennas.
- Continue broadband observations and testing of the VLBI2010 system.