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.

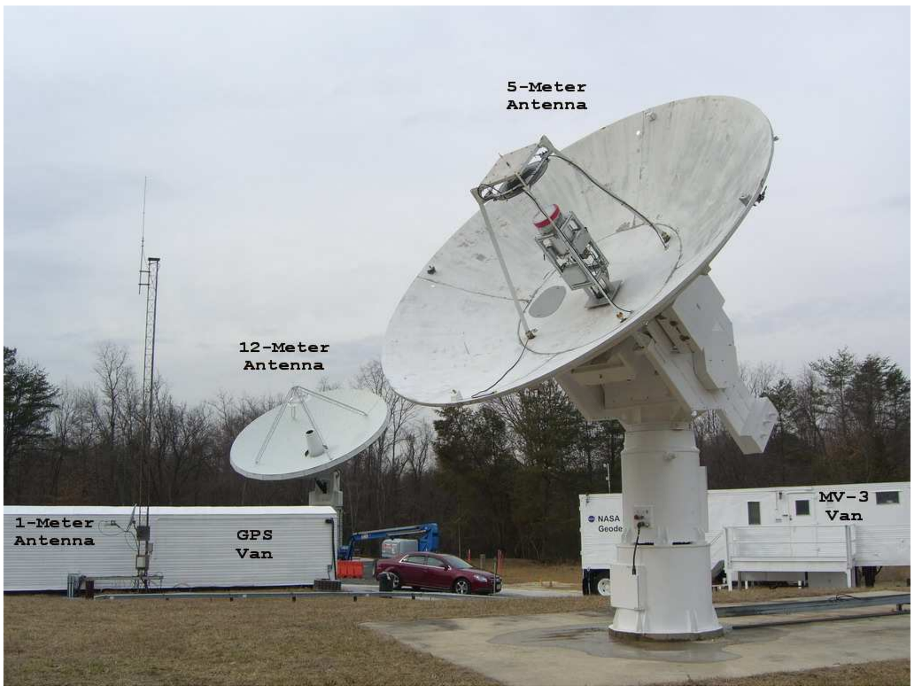

Figure 1. Goddard Geophysical and Astronomical Observatory.

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

In October 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 ITT Exelis 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	5m	12m
Owner and operating agency	NASA	NASA
Year of construction	1982	2010
Diameter of main reflector d	$5m$	$12m$
Azimuth range	$\pm 270°$	$\pm 270°$
Azimuth velocity	$3°/s$	$5°/s$
Azimuth acceleration	$1°/s^2$	$1°/s^2$
Elevation range	$\pm 90°$	$5 - 88°$
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 5C	Mark 5C

3. Technical Staff of the VLBI Facility at GGAO

GGAO is a NASA R&D and data collection facility. On April 9, 2011 the NENS contract transitioned to the SCNS contract operated by ITT Exelis Information Systems. Wendy Avelar conducts VLBI operations and maintenance at GGAO with the support of Ricardo Figueroa, Katie Pazamickas, and Charles Kodak.

4. Status of MV3 at GGAO

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. MV3 is configured with the prototype VLBI2010 broadband receiver originally installed in 2009. The 5-m antenna is primarily used to support the holography effort.

Much of the 2011 activities at GGAO have been focused on the performance testing of the VLBI2010 antenna. There were some other activities worth noting:

- Wideband system testing and characterization of the 5-m antenna.
- Procurement of new test equipment for characterization of the wideband RF hardware.
- Broadband Phase Cal unit was installed and under test on the 12-m antenna.
- Testing of three different feed designs for future Broadband use.
- Elevation creep monitoring and prevention.
- Use of Mark 6 recorders to demonstrate 16 Gigabit per second with Westford.
- QRFH feed installed.
- Antenna efficiency significantly improved by adjustment of subreflector and feed positions.
- System temperature, efficiency, and SEFD exceeded nominal values.
- Proof of concept/value of high frequency optical fiber link.
- Refinement of maintenance procedures/schedules for the antenna system.

The holographic imaging capability, which is being developed by the MIT Haystack Observatory with support from ITT Exelis, was suspended during 2011. Activity will begin early in 2012 in order to understand antenna deformations that could potentially dilute the accuracy of the VLBI2010 system. Initially holographic data collections were performed using the 5-m dish as the antenna to be tested and a 1-m satellite receiving dish as the phase reference. Preliminary results from 2010 data collection 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 Water Vapor Radiometer (WVR) cover, and the subreflector in the center of the primary as shown in Figure 2.

5. Outlook

GGAO will continue to support VLBI2010, e-VLBI, and other developmental activities during the upcoming year. Tentative plans for 2012 include:

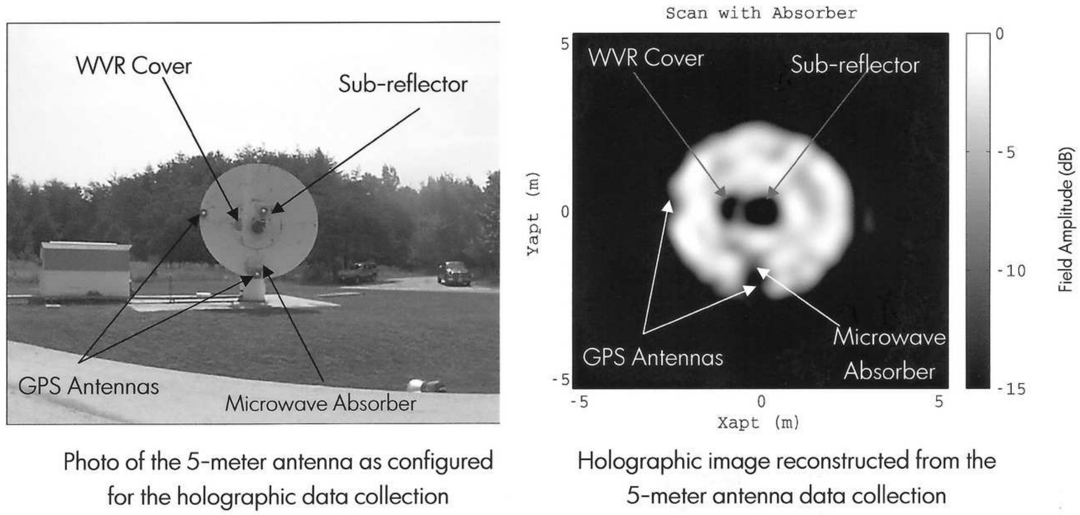

Figure 2. Holographic imaging of the 5-m antenna.

- Install the new VLBI2010 broadband receiver system onto the 12-m antenna.
- Short baseline ties between the 5-m and 12-m antennas.
- Continue testing of the new broadband phase calibrator for the VLBI2010 system.
- Continue holographic imaging of the 5-m and 12-m antennas.
- Continue broadband observations and testing of the VLBI2010 system.
- Continue integration of the RDBEs and Mark 5Cs to replace DBE1s and Mark 5B+s.
- Install newly designed positioner for Dewar and Post-Dewar electronics.
- Test new capabilities of the RDBE digital back end: noise diode switches control and synchronous power measurements for system temperature; use of sign-bit for phase cal monitoring and system diagnosis.
- Implement and use new Mark 6 recorder.
- Use holography to check the position and alignment of the 12-m subreflector.
- Measure the baseline between the 5-m and the 12-m antennas for position tie for the reference frame.
- Continue to monitor elevation creep and evaluate solutions.
- Investigate/resolve problems encountered with cold weather related performance of the 5-m and 12-m elevation axis controller.