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 previous year. The outlook lists the outstanding tasks to improve the performance of GGAO.

1. GGAO at Goddard

The Goddard Geophysical and Astronomical Observatory (GGAO) consists of a radio telescope for VLBI, an SLR site to include MOBLAS-7, SLR-2000 (development system), a 48" telescope for developmental two color Satellite Ranging, a GPS timing and development lab, meteorological sensors, and an H-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 about 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://www.gsfc.nasa.gov`	

2. Technical Parameters of the VLBI Antenna at GGAO

The radio telescope for VLBI at GGAO (MV3) was originally built as a mobile or transportable station. It was previously known as Orion and was part of the original CDP. It is now being used as a fixed site, having been moved to Goddard and semi-permanently installed here in the spring of 1991. In the winter of 2002, the antenna was taken off its trailer and permanently installed at GGAO. The design criteria were:

- Transportability on two tractor trailers, utilizing a 5 meter dish size to maximize reception and mobility considerations,
- Setup of the radio telescope within eight hours (although it has been used as a fixed site since the spring of 1991)

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

Table 2. Technical parameters of the radio telescope of GGAO for geodetic VLBI.

Parameter	GGAO-VLBI
Owner and operating agency	NASA
Year of construction	1982
Diameter of main reflector d	$5m$
Azimuth range	$0 \ldots 540°$
Azimuth velocity	$3°/s$
Azimuth acceleration	$1°/s^2$
Elevation range	$0 \ldots 90°$
Elevation velocity	$3°/s$
Elevation acceleration	$1°/s^2$
X-band	$8.18 - 8.98\,GHz$
Receiving feed	Cassegrain focus
T_{sys}	$24\,K$
Bandwidth	$800MHz, -2dB$
G/T	$32.1\,dB/K$
S-band	$2.21 - 2.45GHz$
Receiving feed	Primary focus
T_{sys}	$19\,K$
Bandwidth	$240MHz, -2dB$
G/T	$21.2\,dB/K$
VLBI terminal type	Mark IV
Recording media	Mark 5B
Field System version	9.10.2

3. Technical Staff of the VLBI Facility at GGAO

The GGAO VLBI facility gains from the experience of the Research and Development VLBI support staff. GGAO is a NASA R&D and data collection facility, operated under contract by Honeywell Technology Solutions Incorporated (HTSI). Table 3 lists the GGAO station staff that are involved in VLBI operations.

Table 3. Staff working at the MV3 VLBI station at GGAO.

Name	Background	Dedication	Agency
Jay Redmond	Engineering technician	100%	HTSI
Skip Gordon	Engineering technician	20%	HTSI

4. Status of MV3 at GGAO

Having ceased VLBI operations in May of 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 Haystack Observatory, MV3 has played a critical role in the advancement of the VLBI2010 project.

The Haystack-constructed front end dewar (see Figure 1), containing the broadband Lindgren feed, two low noise amplifiers, and cryogenic refrigerator, has been upgraded to include directional couplers for phase cal injection and high-pass (> 3.1 GHz) filters to reduce the effect of out-of-band RFI. The RF signal path from the antenna to the electronics van consists of two broadband fiber optic links that interface with an Optical Receiver/Splitter/Amplifier (ORCA) for distribution.

The MV3 electronics van is now equipped with a full complement of Haystack-developed VLBI2010 prototype backend equipment, including four Up/Down Converters (UDC), two Digital Back Ends (DBE), and four Mark 5B+ data recorders. This equipment can be controlled remotely via the internet. Additional MV3 modifications include expanded 5 MHz, 1 pulse per second, and Ethernet distribution. The Mark IV recorder was removed in order to accommodate the VLBI2010 equipment.

As a result of both single station tests at MV3 and dual station tests with an identical system at Westford, significant progress has been made in understanding the advantages and limitations of the broadband concept. Several notable results during 2008 include:

- First fringes with broadband systems on both antennas (8.5 - 9 GHz).
- First fringes from 3.4 to 7 GHz.
- Software control of UDCs implemented for easy frequency selection.
- Demonstrating the usefulness of satellite signals for focus and pointing settings.

5. Outlook

GGAO will continue to support VLBI2010, e-VLBI, and other developmental activities during the upcoming year. Tentative plans for 2009 include:

- Characterization of the Lindgren feed.
- Installation and testing of the new phase calibrator for the VLBI2010 system.
- Installation of a new 5 MHz distribution system in the MV3 electronics van.
- Installation of a new Field System computer.
- Continued investigation and characterization of the performance of the 5-meter MV3 antenna.
- Installation of a new 12-meter VLBI2010 antenna.

Figure 1. Close-up of the VLBI2010 wide band prototype dewar at GGAO.