

# Antenna Characterization for the Wideband Instrument for Snow Measurements (WISM)

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**Abstract** — Experimental characterization of the antenna for the Wideband Instrument for Snow Measurement (WISM) under development for the NASA Earth Science Technology Office (ESTO) Instrument Incubator Program (IIP), is discussed. A current sheet antenna, consisting of a small, 6x6 element, dual-linear polarized array with integrated beamformer, feeds an offset parabolic reflector, enabling WISM operation over an 8 to 40 GHz frequency band. An overview of the test program implemented for both the feed and the reflector antenna is given along with select results for specific frequencies utilized by the radar and radiometric sensors of the WISM.

horizontal), in three different pattern planes (E-Plane, H-Plane, and an intercardinal plane), and at 25 MHz intervals within the specific WISM frequency ranges of operation. Four different range configurations were required to cover the full 8-40 GHz frequency range. Feed gain was evaluated by using the gain substitution method in conjunction with broadband horns as gain references. Feed impedance was measured over the full 8-40 GHz frequency range using a network analyzer. The antenna remained mounted in the range for the impedance test.

## I. INTRODUCTION

The NASA Snow and Cold Land Processes (SCLP) Earth science mission is a future mission defined to provide satellite-based capability to perform spatial and temporal snow information at a higher fidelity than that available today. Specifically, the SCLP concept calls for a combination of synthetic aperture radar and radiometry over a broad band of frequencies between the X- and Ka-Bands. An enabling technology that supports the capability sought for this mission is a wideband, single aperture, dual-polarized antenna that operates from 8-40 GHz [1]–[2]. This antenna, when used as a feed in a reflector system, allows for demonstration and evaluation of an instrument that is designed to be capable of achieving the science objectives. The WISM sensor system is expected to serve as the facility instrument to investigate combined active/passive measurement of snow accumulation from space.

In this paper, an overview of the characterization tests performed on the antennas at the NASA Glenn Research Center (GRC) is provided along with select results. Impedance, radiation pattern, and gain measurements were performed on the feed in a far-field range. Laser radar instrumentation was used to characterize the reflector surface, find an equivalent paraboloid and align the feed relative to the reflector. Lastly, near-field measurement techniques were used to produce far-field radiation patterns and estimated gains for the reflector antenna.

## II. WISM FEED CHARACTERIZATION

Characterization tests of two WISM feed prototypes and two final design feeds were performed in the NASA GRC Far-Field Range. A picture of a final design array, mounted in the range, is shown in Fig 1. Co-polarized and cross-polarized radiation patterns were taken for each polarization (vertical and

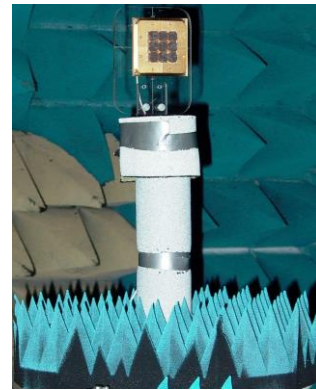


Fig. 1. WISM Feed mounted in the NASA GRC Far-Field Range.

Principal plane co-polarized and cross-polarized patterns at 36.5 GHz are shown in Fig. 2 for one of the final build feeds. Measured gain for the antenna is shown in Fig. 3.

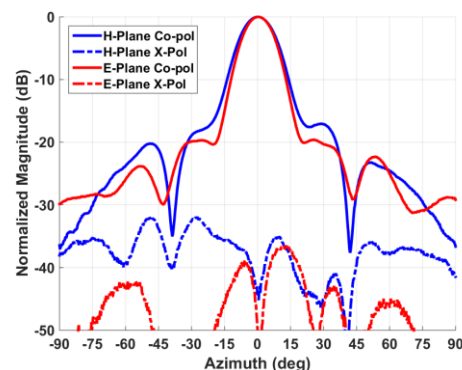


Fig. 2. WISM Feed principal plane patterns at 36.5 GHz.

## III. FEED ALIGNMENT IN THE REFLECTOR SYSTEM

Surface mapping of the offset parabolic reflector was done using a Leica Geosystems, LR200 Laser Radar. The mapping and subsequent processing provided an equivalent paraboloid

and hence a focal point at which to place the feed. The feed phase center, which was known by design and feed far-field measurement, was placed at this focal point and the feed secured. Fig. 4 shows an image of the feed seen on the surface of the reflector with the LR-200 visible light laser illuminating a corner of the feed ground plane.

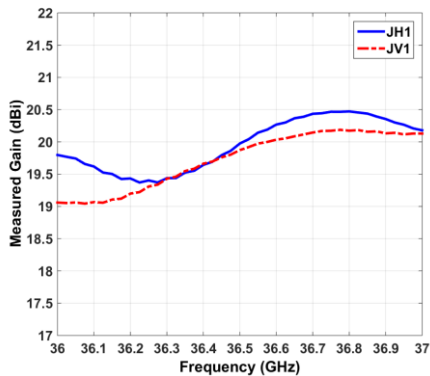


Fig. 3. Measured Ka-Band gain for WISM Feed.

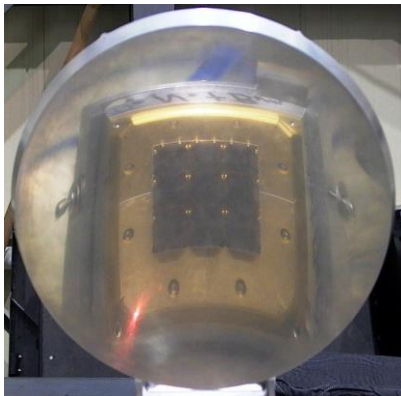


Fig. 4. Laser radar used to ensure proper feed alignment.

#### IV. WISM REFLECTOR SYSTEM CHARACTERIZATION

The reflector antenna measurements were performed in the NASA GRC Planar Near-Field Facility. Pictures of the antenna and as mounted in the range are shown in Fig. 5.

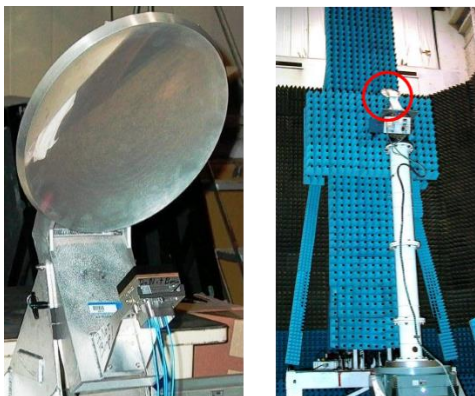


Fig. 5. WISM Reflector Antenna (left); WISM Reflector Antenna mounted for measurements in the GRC Planar Near-Field Range (right).

A total of ten near-field tests of the antenna were performed to produce far-field patterns of interest at the currently envisioned WISM frequency bands and other bands that are planned in future applications. The scan plane was of sufficient size to allow for a maximum far-field angle of 50° or 60° at the lower bands and 35° at Ka-Band. Two orthogonal polarizations of the near-field probe were used to enable computation of co- and cross-polarized far-field patterns. Directivity was obtained from the far-field processing of the near-field data and additional measurements were made to estimate gain via the method described in [3]. An example of a far-field pattern obtained from near-field data is shown in Fig. 6. Measured Ka-Band directivity and gain are shown in Fig. 7.

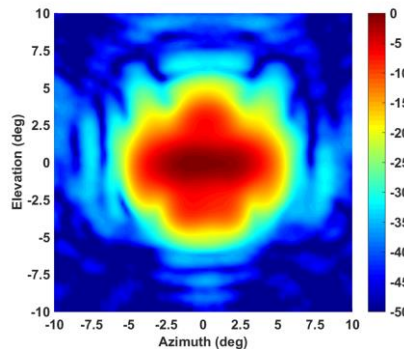


Fig. 6. Far-Field Pattern of the WISM Reflector Antenna at 36.5 GHz.

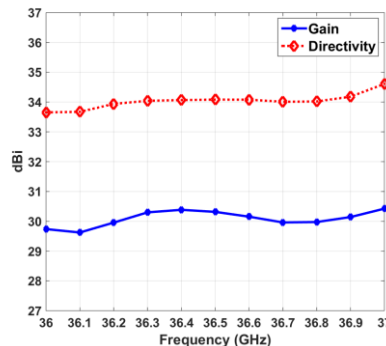


Fig. 7. Ka-Band directivity and gain of the WISM Reflector Antenna.

#### V. CONCLUSION

Testing of the feed and reflector antenna for the WISM demonstration has provided necessary system information and shown their suitability for the proposed purpose.

#### REFERENCES

- [1] T. Durham, H. P. Marshall, L. Tsang, P. Racette, Q. Bonds, F. Miranda and K. Vanhille, "Wideband Sensor Technologies for Measuring Surface Snow," Earthzine, 02 Dec. 2013. [Online]. Available: <http://www.earthzine.org/2013/12/02/wideband-sensor-technologies-for-measuring-surface-snow/>. [Accessed 09-Jan-2015]
- [2] K. Vanhille, T. Durham, W. Stacy, D. Karasiewicz, A. Cable, C. Trent, K. Lambert, and F. Miranda, "A Microfabricated 8-40 GHz Dual-Polarized Reflector Feed", 2014 Antenna Applications Symposium, Monticello, IL, September 23-25, 2014.
- [3] A.C. Newell, R.D. Ward, E.J. McFarlane, "Gain and Power Parameter Measurements Using Planar Near-Field Techniques," *IEEE Transactions on Antennas and Propagation*, pp. 792-803, Volume 36, No. 6, June 1988.