Antenna Range Imaging

Vaughn P. Cable
California Institute of Technology
Jet Propulsion Laboratory

Introduction

The quality of antenna measurements is important to the success of JPL missions. Most antenna ranges experience some form of multipath as a source of error and uncertainty in the measured data. At JPL, data from these measurements, including measurement uncertainties, are used in spacecraft link budget and sensor performance estimates to help determine optimal mission profiles. The best estimate of this uncertainty is obtained from field probe measurements of amplitude and phase across the quiet zone. These samples provide an accurate map of amplitude and phase ripple and taper and formulas exist [*Standard Test Procedures for Antennas*, IEEE, 1979] that compute the measurement uncertainty for that particular set of data.

These field probe measurements can also be used to locate many of the sources of multipath on the range [e.g., Moghaddar & Walton, AMTA, 1990]. For example, 2D planar field probe data can be mathematically transformed into a map (or image) of the up–range sources illuminating the quiet zone. This includes primary as well as secondary (unwanted) sources. This paper describes a field probe technique and the post processing currently being implemented at JPL to image and locate (and reduce) these secondary sources and, thereby, to improve the quality of JPL antenna measurements.

Background

The Jet Propulsion Laboratory antenna measurement facility currently uses 9 antenna ranges, including 6 outdoor free space ranges and 3 indoor chambers, for development and testing of spacecraft communications and remote sensing antennas over a wide range of frequencies (VHF through W band). Depending on the wavelength and the range being used, the data from these measurements usually includes some form of multipath, either from ground bounce, surrounding foliage scattering, support tower scattering and scattering from nearby buildings or chamber walls. Some sources of multipath on an antenna range are intuitive (i.e., tower scattering and ground bounce) and placement of absorber is obvious. But others are not so intuitive. For example, measuring low sidelobes in the presence of multibounce, indoors or outdoors.

Imaging Sources of Multipath

This paper describes a Fourier approach to transforming 2D planar amplitude and phase field probe data into wavenumber and angle space. Windowing functions are used to limit the processing sidelobes and results from simulated as well as measured quiet zone data are presented to demonstrate the usefulness of this technique for imaging and locating range multipath.