ANTENNA SYSTEM SPACE STATION EXPERIMENT (ASSET)

Y. RAHMAT-SAMII
Department of Electrical Engineering
University of California Los Angeles
Los Angeles, CA 90024

I. INTRODUCTION Large spacecraft antennas are the major component in many of the currently planned advanced communications, and scientific missions. For example, NASA's mobile satellite communications program (MSAT) and the emerging personal access communications system (PASS) concept are based on the application of large antennas to achieve high performance capability by providing multiple beams and high gain. Such large antennas are also needed for many scientific applications such as Earth observation (higher resolution radiometers) and Earth- orbiting VLBI (QUASAT).

Large antennas with dimensions exceeding 15 meters have been the focus of much investigation during the last decade. Various concepts have evolved as a consequence of user needs. Among these, one can refer to mesh deployable antennas such as the wrap-rib, hoop-column, and box-truss types, and others. There are also new concepts such as inflatable reflectors, reflectors assembled from rigid panels, and others [1].

Due to the stringent operational requirements imposed upon these antenna systems (for example, low side lobes), any distortions resulting from dynamic or quasi-static thermal or mechanical disturbances will have significant effect on their performance. Technology maturation of these antenna concepts requires characterization of these effects on the antenna performance. There have been many proposed concepts for the measurement of these large antennas [2]. However, a space-station-based experiment has tremendous potential for accommodating the validation of analytical models and ground-test methodologies. Furthermore, the demonstration of the ability to achieve pre-specified performance levels on orbit will result in significantly increased reliability and decreased technology risk to large antenna system users.

II. CONCEPT STUDY OBJECTIVES The concept study encompasses all the challenging steps required to demonstrate the feasibility of future space-station-based large antenna experiments. These experiments fall into the broad categories of radio frequency (RF) pattern measurement and electronic surface compensation demonstration [3], deployment of large flexible structures, structural dynamic and thermal/mechanical characterization of antenna structure, and reflector shape, pointing, and vibration control. In this paper, the RF experiment is discussed.

The core of the RF experiment will be to establish near- and/or far-field test ranges aboard the Space Station. The block diagram shown in Fig. 1 summarizes available options which will be studied for the optimum selection. It is anticipated that a novel scheme based on the combination of a plane-polar and cylindrical near-field probing configuration will be used. The overall dimension of the setup depends on the physical size of the antenna being tested. Different probe motion mechanisms are considered including a string-driven concept, a fixed-modulated scattering concept, a bi-polar configuration, and others. Fig. 2 depicts the proposed geometrical configuration for the combined plane-polar/cylindrical geometry. In the bi-polar configuration the probe location with respect to the arm is fixed and both the antenna and the arm rotate to provide the needed scan plane coverage. It will be determined which scheme has the most efficient data gathering capabilities and least impact on the space-station resources. Additionally, a utilization of the microwave holographic surface reconstruction technique will be assessed for the diagnostic purposes [2]. Attention will be focused on developing a scheme which may not require the phase measurement.

The applicability of direct far-field measurement is also investigated. In this case the orbital maneuvering vehicle (OMV) will be used to support an antenna illuminator for far-field measurements. The position of the OMV will be controlled by a laser target ranging mechanism. Figure 1 shows a schematic of this versatile near- and far-field measurement facility. In particular attention is focused on the application of the nonuniform sampling technique for gathering the far-field data [5]. This scheme has previously been proposed for a shuttle attached experiment. Many simulations and measurement have been performed to demonstrate the utility of the nonuniform sampling technique. In Fig. 3, the results of such an evaluation are demonstrated.

ACKNOWLEDGEMENTS The research described in this paper were carried in part at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration. The Author would like to thank his colleagues at JPL for their helpful discussions during the preparation of this manuscript.

[1] Roederer A. G. and Y. Rahmat-Samii, "Unfurlable Satellite Antennas: A Review", JINA conference, pp. 121-134, Nice, France, Nov. 8-10, 1988.

[2] Rahmat-Samii Y., "Large Antenna Measurement and Compensation Techniques", 11th ESTEC Antenna Workshop on Antenna Measurements, pp. 57-68, Gothenburg, Sweden, June 20-22, 1988.

[3] Rahmat-Samii Y., "Reflector Antenna Distortion Compensation by Array Feeds: An Experimental Verification," Electronics Letters, vol. 24, pp. 1188-1190, September 1988.

[4] Rahmat-Samii, Y. and R. Cheung, "Nonuniform Sampling Techniques for Antenna Applications," IEEE Trans. Antennas and Propagation, vol. AP-35, pp. 268-279, March 1987.

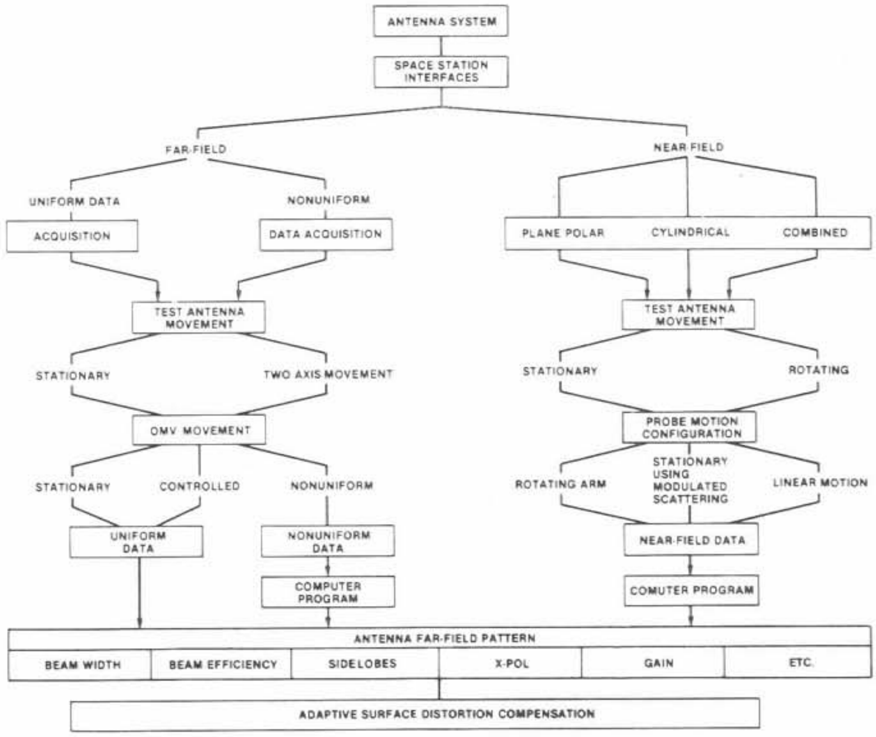

Fig. 1. RF Experiment Configuration Options.

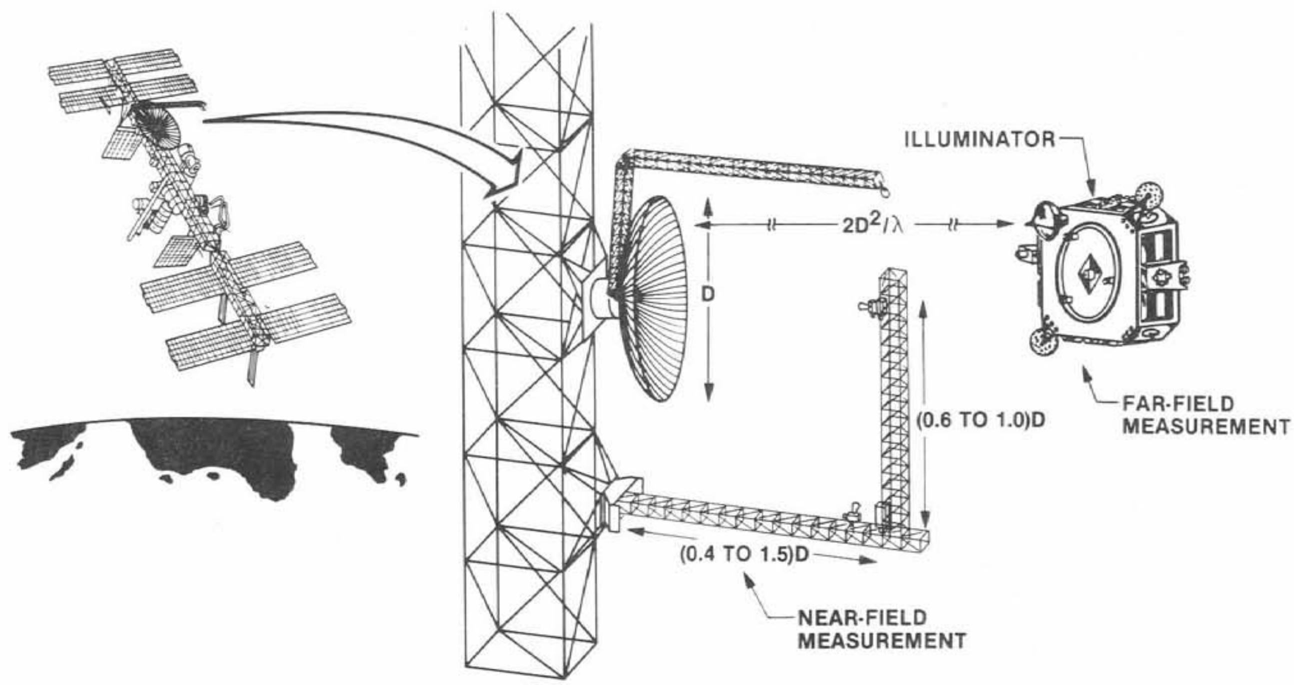

Fig. 2. Schematic of the Near-Field and Far-Field RF Measurement System Aboard the Space Station.

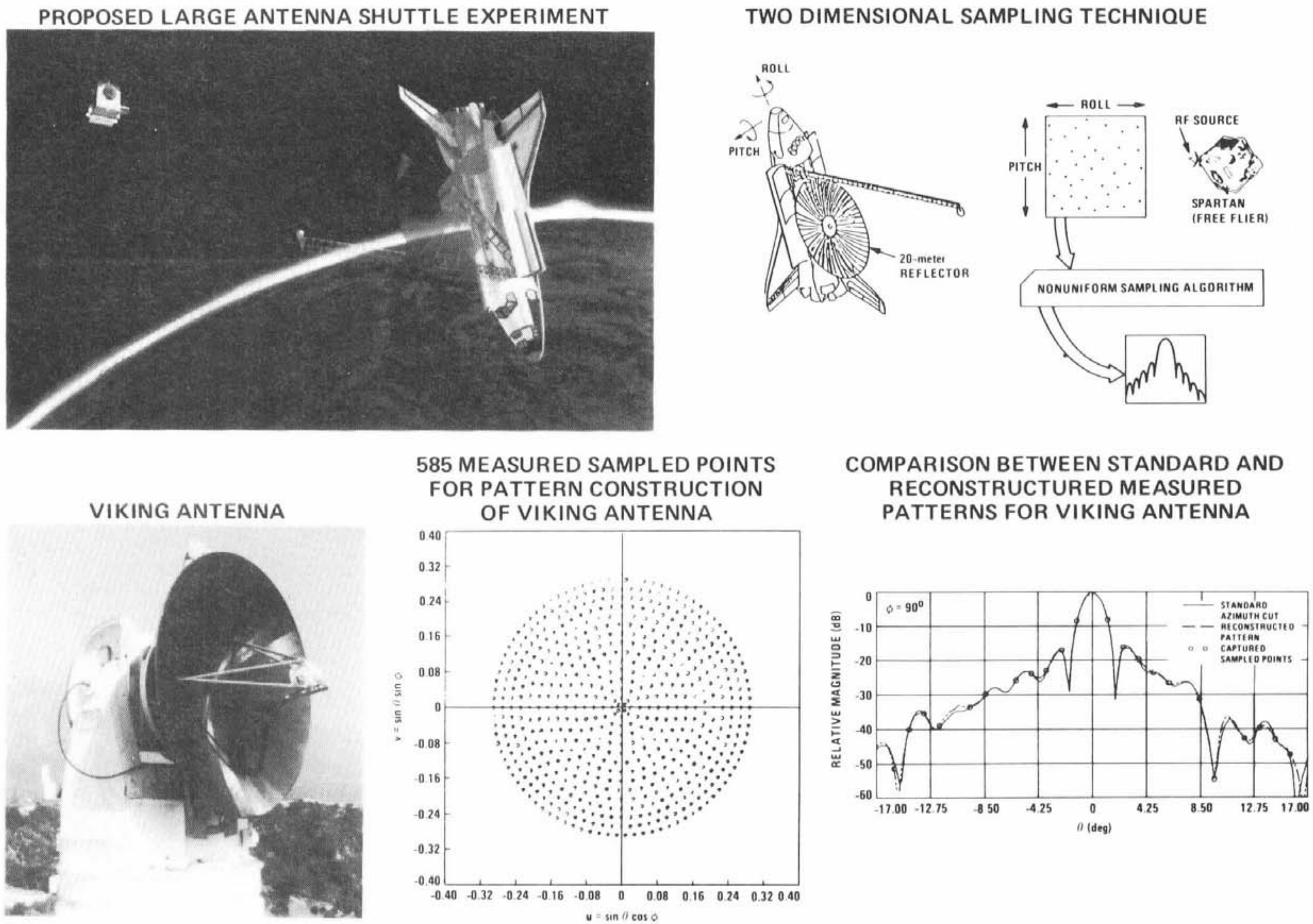

Fig. 3. Antenna Pattern Measurement Using Nonuniform Sampling Technique.