SPHERICAL REFLECTOR ANTENNAS WITH COMPENSATING ARRAY FEED FOR EXTREMELY LARGE NUMBER OF SCANNED BEAMS

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Abstract Submission Form

2006 National Radio Science Meeting

Abstract: bahadori14280

Date Received: September 20, 2005

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2. J - Radio Astronomy

3. (a) S-J/B2

4. I - Invited Paper, Program chair: Yahya Rahmat-Samii

5. This paper is submitted for special session (S-J/B2)

Radar remote sensing of the atmosphere and sever storms from geostationary orbit is highly desirable due to the radar ability to simultaneously provide vertical rainfall profiles, large spatial converge, and frequent observation. With the rapid advances in radar technology, the feasibility of developing such an instrument has greatly improved. Under NASAs Earth Science Technology Program, a novel instrument concept and the associated antenna technologies are currently evaluated for 35 GHz Doppler radar for detailed monitoring of hurricanes and severe storms from a geostationary orbit. One of the main challenges is the very large distance between radar in the geostationary orbit and cloud levels. This requires a very large antenna (28 meter) for both sensitivity and surface clutter considerations. To minimize surface clutter a horizontal resolution of 12 km or better is required. In addition, it is required to scan the beam of the antenna to cover an angular range of 4 degree which translates into an unconventionally large number of 200 beamwidths. The operational frequency band has been chosen as the Ka-band in order to compromise between antenna size and atmospheric attenuation.

Considering the required size of antenna aperture, using electronically scanned array antenna seems to be formidable and almost impractical for this application. The first feasible candidate that comes to mind is a single or multiple parabolic reflector antennas. As it is known, parabolic reflector antennas suffer from severe limitation when the beam is scanned a large number of beamwidths. Implementing a focal plane array to compensate for off-axis performance of parabolic reflectors could also become an expensive proposition because it necessitates the usage of an array which must be capable of adaptively varying its excitation coefficients for different beam look angles. Another candidate for this design is a spherical reflector antenna which is inherently capable of scanning its beam to any desired direction without degradation the quality of the radiation performance. However, a spherical reflector antenna with a single feed typically suffers from a significant amount of spherical aberration.

To overcome the performance degradation induced by this aberration, the utility of using planar array feeds for correcting spherical phase aberrations is investigated in this paper. Two different methodologies are developed for the array excitation coefficients determination based on phase conjugate matching and the results are compared. Using the compensating feed array, the radiation characteristics of the compensated spherical reflector are simulated for no scan and large scan cases and the results are compared with the uncompensated case to show performance improvement. To demonstrate the technological readiness of the concept, a 1.5 m breadboard model is also designed to be built for experimental measurements. In order to evaluate the effects of manufacturing errors on the reflector performance, several scenarios of errors in feed positioning and complex excitation coefficients of the compensating array feed are also modeled and their effects are simulated.