Design of High Precision Lens or Reflector Antenna Systems for CubeSat MMW/ SMMW radiometers

Lavanya Periasamy*(1), and Albin J. Gasiewski(1)
(1) Department of Electrical, Computer & Energy Engineering, University of Colorado, Boulder, CO.

The fidelity of brightness temperature data obtained from radiometers is largely dependent on the accurate prediction of its lens/ reflector antenna system pattern. It is hence crucial to know, with high precision the antenna system's spillover, main beam and ohmic efficiencies as well as the feed's phase center. Although the Gaussian (paraxial) beam mode analysis is a reasonable first order approximation for such an analysis, its accuracy is limited off-axis for millimeter and sub-millimeter wavelength diffraction fields. The purpose of this study is the rigorous analysis of the complex diffraction field due to a feed at the lens aperture, within the dielectric lens and at the far field. This analysis leads to the determination of an optimal lens profile such that the main beam efficiency of the system is maximized. An optimized matching function at the planar surface of the lens is also obtained that minimizes reflection losses. These techniques can also be applied to reflector antenna systems.

Assuming exact knowledge of the feed-horn geometry and aperture field, the complex diffraction field at the lens aperture is exactly determined by the Fourier Transform analysis technique. Considering fields along the lens aperture to be locally planar, transport equations for fields within the lens are evaluated by treating it as a linear, homogenous but lossy medium using the Eikonal approximation. A lens profile is found such that the fields in the far zone are planar with maximum main beam efficiency. By treating the impinging fields at either lens-vacuum boundary as locally planar, losses due to multiple surface reflections are included in the analysis. By determining the reflection coefficient functions at these boundaries, the planar surface of the lens can be modified to minimize intensity of the reflected fields and hence their contributions to the antenna system's total spill over loss.