Physical Optics Modeling of a Pillbox as a Beam Forming Network for a Large Imaging System in Satellite Communications

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Communications systems in Ka-band are an expanding research field for satellite applications due to the increasing demand of high data-rate links. The coverture of the certain Earth region by smaller spot sizes is a fundamental issue, based on efficient multiple-beam antenna designs. These antennas are composed by a beam forming network driving several sources illuminating a focusing system of large reflectors. In this work, we propose a Ka band satellite system whose radiating part is an imaging system consisting of two confocal parabolas. The beam forming network is composed of two arrays of parabolic pillboxes (Ettorre *et al.*, IEEE Trans. Antennas Propag., 1093-1100, 2011), realized in parallel-plate technology, in order to scan the beam direction along two orthogonal axes.

The expected radiated beams are used to derive, based on a reciprocal approach, the Conjugate Matching (CM) field at the focusing plane of the imaging systems. These field distributions are synthetized in phase and amplitude by the pillbox beam forming network to generate the required beam. In particular, once the phase and amplitude distributions on the focusing plane of the imaging system are known, a second reciprocal analysis, this time on the pillbox beam former, is performed in order to define the source type and location in the focusing plane of the pillbox systems generating the required distribution. This is accomplished by means of an in-house physical optics tool, capable of modeling the pillbox with negligible computational effort. Several kinds of excitations and reflectors can be easily included in the analysis. The reciprocal analysis is performed according to the following guidelines: A reciprocal current source is placed at the pillbox output, with the phase and amplitude tapering of the CM field. The field radiated by this reciprocal source illuminates the pillbox reflector system and focuses in a certain region, where the real pillbox source is placed. Once its position is determined, the orientation and directivity of the real source is chosen through a direct analysis: The real source illuminates the pillbox reflector in order to match the CM field at the pillbox output. Very good results in terms of achieved radiated beams have been obtained for a required scanning range of ±2° around broadside.

The proposed design technique (i.e., the co-design of the pillbox and the reflectors) is particularly attractive for reducing phase aberrations occurring for extreme pointing directions. More details will be provided at the conference.