Microwave multi-beam generation using an anisotropic metasurface

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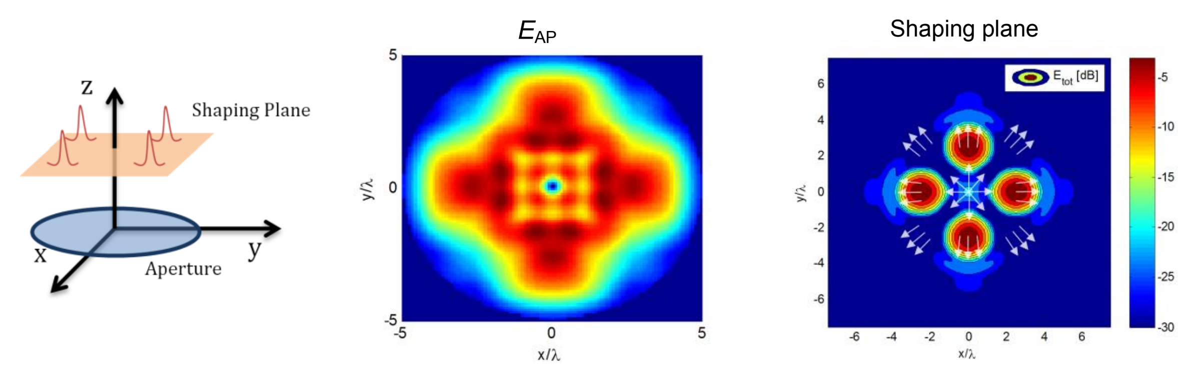
This paper describes the generation of four focused beams originating from a single antenna aperture, practically implemented by an anisotropic metasurface. The apparatus is fed using a single coaxial cable and is capable of generating four focused beams at a distance equal to the radius of the structure. Specifically, the radius of the structure is 5λ and the shaping plane is located at a vertical distance of z=5λ (Fig. 1a). The frequency of operation is 20 GHz.

The procedure for the generation of the multiple beams is as follows. The theoretical derivation of the aperture field (E_{AP}) is accomplished using a near-field shaping technique based on a back-propagation optimization scheme (M. Ettorre et al., TAP, 62, 4, 1991-1999, 2014). This technique has been extended in order to handle the intensity of the field and not only a single component (scalar). In order to achieve that, a four-beam mask, which enforces a radial polarization (along ρ) to the field on the shaping plane has been elaborated. The imposed polarization means that two of the beams are quasi x-polarized (beams along x axis) and the other two are quasi y-polarized (beams along y axis). Fig. 1b shows the aperture distribution, resulting from the optimization. The four beams at the shaping plane are illustrated in Fig. 1c.

The metasurface, etched on top of a thin substrate, acts as a tensorial surface impedance boundary and is based on circular patches of different diameters. In order to achieve the necessary anisotropy, a varying sector of the patches is removed. The patches are then rotated accordingly. Possible applications include sensing and high-speed near-field communications. A prototype and measurements are expected by the time of the conference.



(a) (b) (c)

Figure 1. (a) Problem set-up, (b) theoretical aperture distribution of the multiple beam generation and (c) the four beams at the shaping plane (the field direction is shown with white arrows).