Transverse Circular polarized Bessel beam launchers for near-field applications, by using a RLSA with an inward Hankel aperture distributions

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In many antenna applications, such as near-field probing and imaging, focusing or collimating energy in the near-field or Fresnel zone of an antenna is required. Nevertheless, the spreading of the transverse profile of a propagating wave is an all-present phenomenon known as diffraction, which should be limited for performance enhancement. The possibility of limiting diffraction spreading over a limited region has been an interesting area of research since the introduction of the so-called non-diffractive Bessel beams. Bessel beams are solutions to the scalar wave equation carrying infinite power, thus being nonphysical. However, a properly defined truncated radiating aperture is able to realize Bessel-like beams over a well-defined zone in front of the aperture, called "non-diffractive range". In particular, the Bessel radiation is obtained by the combination of two cylindrical waves traveling in opposite directions over the aperture. Few works have been devoted to the focusing capabilities of the Hankel waves generating Bessel beams. Recently, a full analytic approach has been developed for infinite apertures to get physical insights over the generation of Bessel beams by inward Hankel aperture distributions (M. Albani, S.C. Pavone, M. Casaletti and M. Ettorre, "Generation of non-diffractive Bessel beams by inward cylindrical traveling wave aperture distributions", Opt. Expr., April 2014). The theory was validated by numerical results for a Bessel beam launcher made by a radial waveguide loaded with annular slots whose normal component of the electric field took on a zero-th order Bessel function.

In this paper, a different solution is proposed for generating a Bessel beam with a transverse profile in circular polarization. The launcher is made by a Radial Line Slot Array (RLSA) antenna synthetizing an inward Hankel aperture distribution with a circular polarization. The RLSA antenna consists of a radial parallel-plate waveguide, loaded on the top plate with thousands of circularly polarized radiators made by couple of slots $\lambda/4$ apart, at ± 45 degrees with respect to the radial direction. An optimization procedure recently proposed for RLSA antennas has been used for the design (M. Albani, A. Mazzinghi, A. Freni, "Automatic design of CP-RLSA antennas," IEEE Trans. Ant. and Propag. 60, 5538–5547, 2012). The proposed antenna is able to create a circular polarized Bessel beams in a defined region close to the aperture axis of symmetry in a large band of operation.
The design procedure will be detailed at the conference with numerical results and if available at the time of the conference, measurement results will be presented based on the current development of one prototype.