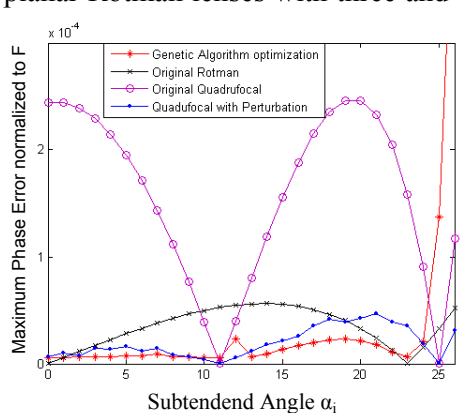
**Non-Focal Minimum-Phase-Error Planar Rotman Lens**

Junwei Dong*†, Amir I. Zaghloul†, and Ruth Rotman††
†Virginia Polytechnic Institute and State University, Virginia, USA
††IAI Elta Electronics Industries, Ashdod, Israel

The conventional Rotman Lens phase error could be reduced by adapting a non focal design strategy. The proposed method in this paper allows designing a Rotman Lens phase center contour without passing any ideal foci. The original Rotman lens (Rotman and Turner, IEEE AP Trans., 11, 623-632, 1963) was designed to have 3 ideal focal points, which yields a deterministic inner receiving contour that gives zero path length error for the beams emitted from these 3 focal points. However, in the realistic design, more beam elements are expected to occupy the beam contour, which leads to phase errors for the non-focal beams. The lens can be designed to achieve minimum average phase errors for all the elements rather than achieving best matches for only selected beams. Starting from this requirement, we choose the general phase error as the objective function and regard all the phase centers on the beam and inner receiving contour as variables to form a global minimization problem. This objective function is given as:

$$f(x_i,\cdots x_j,\cdots w_j) = \sum_{i=1}^{N}\sum_{j=1}^{M} \left| \sqrt{(x_i - x_j)^2 + (x_i \tan\alpha_i - y_j)^2} + w_j + y_j \sin(b_i\alpha_i) - \sqrt{x_i^2 + (x_i \tan\alpha_i)^2} \right|$$

where $x_i$ is the $x$ coordinate of the beam port with subtended angle at the receiving array center of $\alpha_i$, $(x_j,y_j)$ is the receiving element port position, $w_j$ is the transmission line length between the receiving element and the lens output port, and $b_i$ is the ratio of the scan angle and $\alpha_i$. The optimization results show that a lens contour without any focal point has the potential to achieve minimum phase errors.

In this paper we address the design of a non-focal Rotman lens that minimizes the phase error over the array aperture and over the scanning range. The phase error minimization is achieved using a genetic algorithm optimization. The results, shown below, are compared with planar Rotman lenses with three and four focal configurations (Rotman and Turner, IEEE AP Trans., 11, 623-632, 1963; Rappaport and Zaghloul, IEEE AP Trans., 33, 1227-1236, 1985). It should be added that designing the non-focal lens is also achievable by applying more sophisticated high dimensional numerical global optimization techniques.