Loading cavities with electrical small antenna feeds to accomplish power combining in HPEM applications

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In recent years, we have explored the use of the magnetic EZ-antenna as a potential radiating element for use in high power electromagnetic (HPEM) applications. This electrically small antenna (typical size $< \lambda/12$ over a ground plane) has been demonstrated to be usefol for mesoband applications with power levels of up to 20 MW (70 kV into a 100-Ω load).

However, for true HPEM applications, significantly greater power handling is required. In addition, the EZ-antenna system tends to have relatively narrow bandwidth for an HPEM radiator ($< 3\%$), whereas many HPEM sources have bandwidths on the order of 10% due to the nature of their operation. In this paper we present a flexible arraying strategy that uses a coaxial feed as the basis of a linear array of EZ-antennas. The individual resonances of the antennas can be tuned to increase the bandwidth, and the locations of the antennas can be altered along the feed section to affect the radiation properties. Numerical results and experimental measurements are used to demonstrate the concept.

While the single-antenna system we have presented earlier (Ramon, *et al.*, *IEEE Antennas and Wireless Propagation Letters*, vol. 15 p. 642 (2016)) demonstrates impressive results, it is not truly an HPEM system, as the power that can be pushed through the single element is only 28 MW peak. Most HPEM sources have much higher power capabilities. In the past, we have considered cavity-fed arrays of EZ-antennas as potential power combining tools that allow multiple individual elements to share the power output by a single source (Ramon, *et al*, *2014 IEEE AP-S International Symposium*, p. 1805). In this paper, we describe various strategies using different waveguide systems such as loaded waveguides, coaxial cavities, and radial waveguides fed by over-moded waveguides.

The systems have been modeled using CST Microwave Studio in order to understand the design parameters and how to optimize it for various parameters such as polarizaiton, radiation pattern, directivity, and power handling. Test fixtures have been built for some of the designs that allow the concepts to be experimentally evaluated.