An Array of Metamatieral-Inspired Antennas for High Power Applications

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***Abstract*—Metamaterial-inspired antennas leverage techniques that can make an electrically small antenna (ESA), that would typically be an inefficient radiator, achieve radiation efficiencies of greater than 90%. Using an array of such antennas, to distribute the input field over many elements, can be an effective method to create a very low profile antenna array for HPM applications. In this paper we specifically explore using an array of magnetic EZ antennas to act as a mode converter and efficiently radiate energy produced by a 12-cavity relativistic magnetron operating in the TE_{61} mode.**

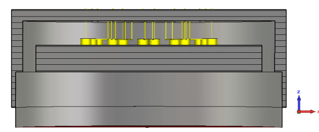
***Index Terms*—array, metamaterial, magnetron, high efficiency antenna, electrically small antenna.**

I. Introduction and Background

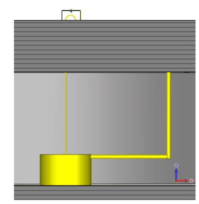
The EZ antenna is an electrically small, magnetic dipole antenna. The EZ antenna consists of a small semi-loop antenna over a ground plane. This driven element is then surrounded by a capacitively loaded loop (CLL) element that is located in the near-field of the semi-loop antenna [1], [2].

To couple the guided TE_{61} mode of the circular waveguide, which is produced by a relativistic magnetron, to the coaxial input of the EZ antenna we modified a design for a high power cavity feed presented in [3] that was designed for GW levels of power. Our waveguide removes the bottom section of the outer conductor and the structure is fed with a circular waveguide, the same as the output of the magnetron. A cross section of the model used in CST simulations of the array is shown in Fig. 1a and a zoomed in section of the probe is shown in Fig. 1b. This probe is used to extract the energy from the cavity and couple it a coaxial output that leads to an antenna. The power handling abilities of the cavity with the probes will be discussed further in the presentation. In Fig. 1b the EZ antenna that is used to radiate the energy extracted from the cavity is seen at top of the outer conductor of the cavity.

The probe used to extract the energy from the cavity modify the fields in the cavity and lead to potential breakdown, and will in turn limit the power handling capabilities of the system.



(a)



(b)

Figure 1: (a) Cross section of the waveguide used to couple the TE_{61} mode from a circular waveguide to an array of EZ antennas and (b) a zoomed in section of the output probe that extracts energy from the cavity and couples it to the coaxial output

II. Simulation Results

The waveguide and the EZ antenna were separately tuned via CST simulations to have a resonant frequency near $2.52\,GHz$, which corresponds to one of the frequencies at which the magnetron source we are using to drive the system operates. The two structures were tuned such that the $|S_{11}|$ value at the resonant frequency was minimized. Then the structures were combined using CST's Design Studio software package to simulate the total structures performance. The resulting $|S_{11}|$ values for the combined system are shown in Fig. 2.

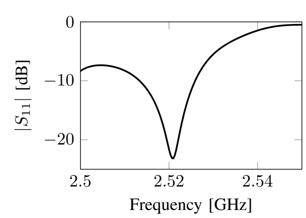


Figure 2: $|S_{11}|$ parameter versus frequency for the total array system

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