Prospects of Split Ring Resonators for the Generation of High Power Microwaves

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Abstract— **In this work we explore several configurations of split ring resonator (SRR) interaction structures for the generation of high power microwave (HPM) radiation. The 3-dimensional code MAGIC was used to initiate the design and optimization process of this novel device. An electron beam was propagated along the axis of the SRR periodical arrangement. The response of the structure was evaluated by measuring the output power and frequency. The preliminary results are presented.**

Keywords-split ring resonator; HPM; Metamaterials

I. INTRODUCTION

Recently, there has been interest in exploring metamaterials for HPM generation. Split ring resonators are commonly used as periodic arrays to serve as building blocks for bulk metamaterial structures that exhibit non-conventional properties like negative permeability and negative permittivity.

We used the 3-dimensional fully relativistic, fully electromagnetic particle-in-cell code MAGIC [1] for studying the effect of the SRR's when an annular electron beam concentric to it is allowed to propagate through. The SRR configuration used for this study is similar to the Broadside-Coupled SRR geometry. The rings are arranged in a longitudinal manner and the cuts in the consecutive rings are 180^{o} out of phase.

Two geometrical variations were studied. The main difference between the two approaches lies in the way the SRR's were suspended in the cylindrical waveguide. From the results obtained thus far one design shows less mode competition and the excitation of a low order TE_{21} mode but outputs very low power which is attributed to the mode being evanescent in the waveguide. While the other design exhibits higher output power, higher mode competition and a higher order radiated mode. It was also seen in simulations that the former design was very prone to instabilities when the beam current exceeded 2 kA.

II. SIMULATION SETUP

Two SRR configurations are explored for HPM generation. Figure 1 (a) and (b) show the SRR design variations.

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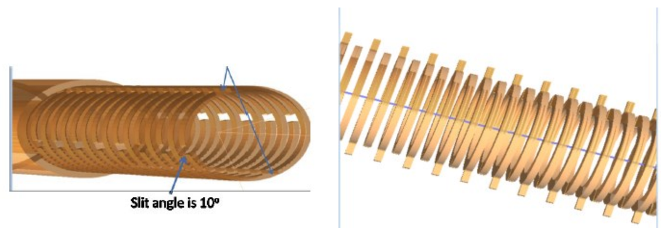

Figure 1. Schematic of the SRR design 1 (left) and design 2 (right).

In the first design the SRR's are electrically connected by means of a rod that is then connected to a cylindrical waveguide. In the second design the SRR's are connected directly to the cylindrical waveguide by means of alternating conducting tabs. For both cases the radius of the cylindrical waveguide was set to 2.5 cm.

Figure 2 shows the mode pattern measured at the waveguide output port for the two designs and their corresponding fast Fourier transforms (FFT).

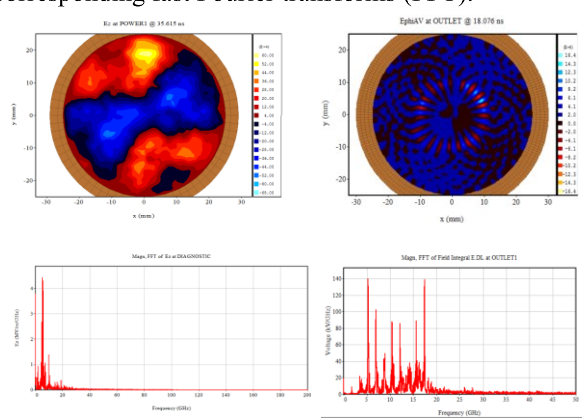

Figure 2. Mode pattern and it's corresponding FFT detected at the output port for design 1 (left) and design 2 (right).

III. CONCLUSION

We present the preliminary results on the prospects of using SRR's for HPM generation. Understanding and analysis of these results will lead towards the design of a more robust system.

REFERENCES

[1] MAGIC ATK Mission Research, Newington, VA [Online]. Available: http://www.mrcwdc.com/Magic/.