Effect of Magnetic Field Distribution on MDO Operation

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***Abstract*— A high efficiency relativistic magnetron with diffraction output (MDO) was designed at the University of New Mexico (UNM) and its experimental verification is underway. In this paper we explore the effect of magnetic field variation along the interaction space on MDO [1] operation. Two magnetic field distribution scenarios were studied in MAGIC [2]: 1) nearly 100% uniformity and 2) 90% uniformity. These results will be presented. Furthermore, the recently-constructed pulsed discharge circuit used for energizing the electromagnets will also be described.**

Keywords-relativistic magnetron; MDO

I. Introduction

It was necessary to adapt a previously-existing Helmholtz coil pair to provide the magnetic field necessary for the MDO operation [1]. However due to the physical size of the existing coils and the constraints it presented, the spacing between the coils needed to be reduced. As such, it was necessary to explore the effects of magnetic field non-uniformity on the operation of the MDO. This was accomplished by performing MAGIC [2] simulations with a variety of magnetic field configurations, some with as much as 10% variation in the field distribution, in the hopes of maintaining the high performance of the device. MAGIC is a 3-dimensional fully relativistic, fully electromagnetic particle-in-cell code. An electromagnetic discharge circuit was built to generate this field.

II. Simulation Setup

The simulations in MAGIC were performed by modifying the magnetic field profile, both by adjusting the spacing between the coils to either 13.2 cm or 8.34 cm, and by varying the peak magnitude of the magnetic field between 0.37 T to 0.47 T in 0.02 T increments. These variations were used to cause a non-uniformity of roughly 10% along the interaction space of the device. The results of these simulations can be seen in Fig.1. Output microwave power, total current, and total efficiency were measured. The operating mode of interest is the 4π/3 mode, although some results might fall outside of this for completion.

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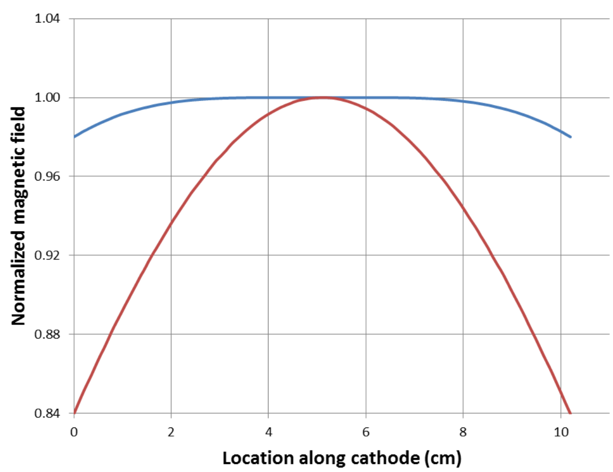

Figure 1. Normalized magnetic field distribution for a Helmholtz coil pair (blue) and a modified Helmholtz coil pair configuration (red) along the interaction space of the cathode.

III. Electromagnet Circuit

The electromagnetic discharge circuit was designed to provide a maximum 0.69 T magnetic field. This circuit consists of a 1.6 mF capacitor bank with maximum charging voltage of 3 KV. The capacitors are discharged into the coils by means of an optically-triggered thyristor switch.

IV. Conclusion

For the narrow range of magnetic fields studied, the results of the simulations with a magnetic field variation of up to 10% shows that there are only minor effects on the operation of the MDO. Thus we can conclude that the MDO is a robust system, with good tolerance to variations in the insulating magnetic field. However further research into the effects of larger variations in the insulating magnetic field will be presented.

References

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