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Pulsed Power Diagnostics for Fusion Propulsion Experiments

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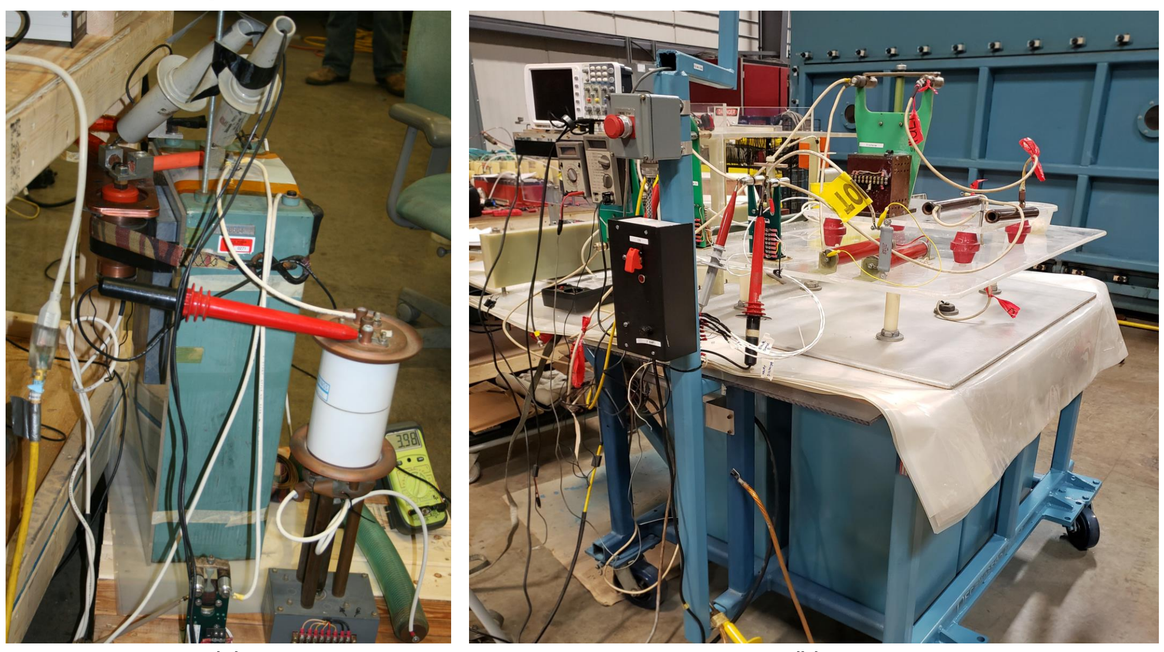
Introduction

One of the major obstacles of interplanetary exploration is mission duration. Ongoing research at the University of Alabama in Huntsville supports the development of advanced propulsion methods necessary for these missions to become routine.



(a) (b)

- The 'Can Crusher' (a) is a 3kJ machine used for testing pulsed power diagnostics.
- 'Sparky' (b) is a 60kJ, 1MA pulser currently under development.

Diagnostics

Magnetic field ($\dot{B}$) probes were constructed for the diagnostics of our pulsed power systems. $\dot{B}$ probes measure the induced voltage from a time-varying magnetic field directly related to the current of the circuit. A Helmholtz coil was used to obtain a calibration factor for the probes.

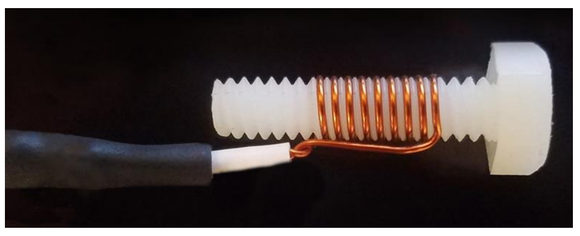
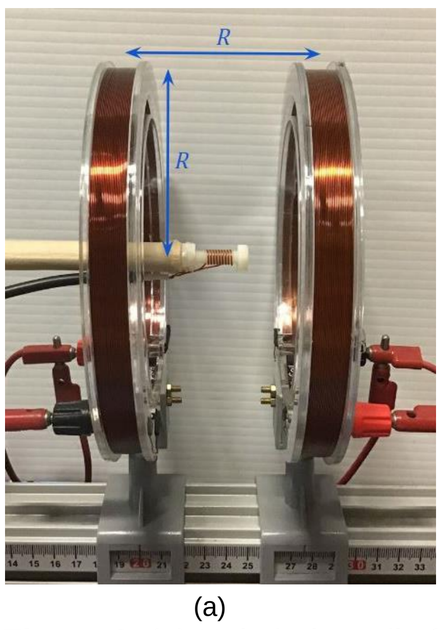
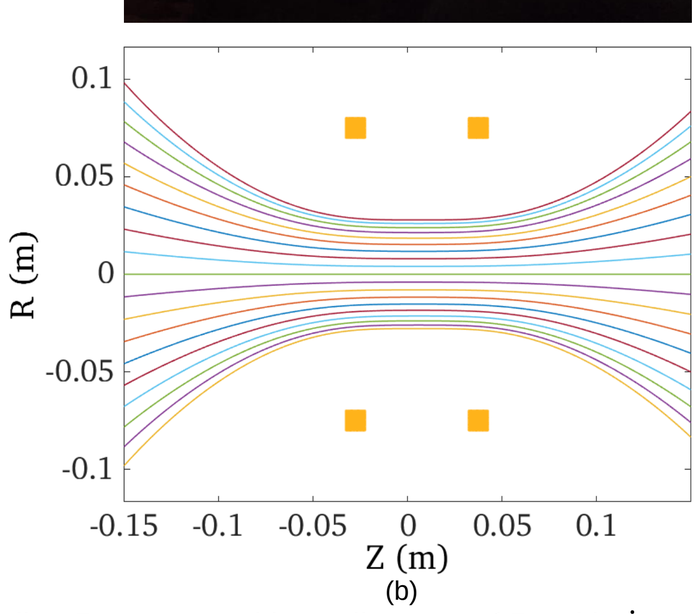


Figure 1. $\dot{B}$ probe soldered to a coaxial cable incased in heat shrink tubing.



(a)

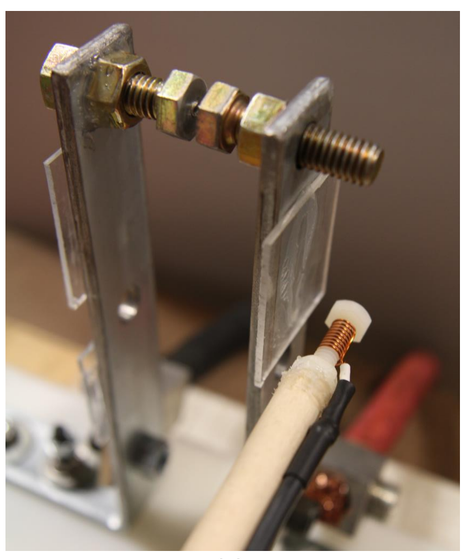


(b)

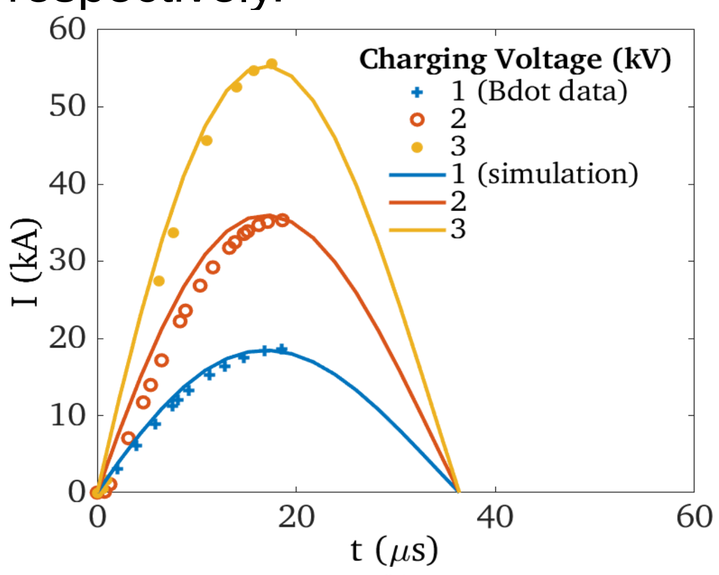
Figure 2. (a) Helmholtz coil of radius R, separated by a distance of R, with $\dot{B}$ probe alignment (b) simulation of the magnetic field produced by Helmholtz coil.

Results

The Can Crusher was operated at initial charging voltages of 1, 2, and 3kV. The $\dot{B}$ probe was placed on the outside of the transmission line as shown below. Calculations were performed and the probe data was scaled in order to closely match simulated values. The peak currents were found to be 18, 36, and 55kA respectively.



(a)



(b)

Figure 4. (a) Transmission line with $\dot{B}$ probe placement and (b) comparison of scaled $\dot{B}$ probe data and RLC simulated data.

Figure 5. Sequence of screenshots from a video of the Can Crusher experiment and $\dot{B}$ probe trace on an oscilloscope.

Conclusion & Future Research

- This project consisted of designing magnetic field probes to measure the current and magnetic field of pulsed power machines.
- The $\dot{B}$ probes will be scaled and paired with a Rogowski coil to provide diagnostics of larger experiments.
- With these adjustments, we hope to generate more accurate measurements so that simulations are not relied upon in our future research.

Acknowledgements

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