CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)

James (Jiajun) Luo

Project Number

S0814

Project Title

Circuit Dynamics and Modeling of the Gauss Accelerator

Abstract

Objectives/Goals

The Gauss Accelerator, commonly known as the Gauss or Coil Gun, demonstrates potential for future use in military and space applications. However, efficiency is miniscule due to a lack of understanding of factors that affect the performance of the Gauss Gun. Since the Gauss Gun functions as part of a time-dependent circuit, the circuit itself should play an immense role in the efficiency of the accelerator. Thus, setting parameters for a theoretical, ideal circuitry and design of the Gauss Gun was attempted through the use of Fourier Transforms and Magnetic Field equations.

Methods/Materials

Three methods were used to elucidate the factors involved in Gauss Gun operation. Method one involved magnetic field equations and experimentation to understand magnetic field in terms of increasing length and increasing radius. Method two involved energy calculations using the Biot-Savart Law to determine factors that affected muzzle velocity, with experimental evidence. Method three involved the use of Fourier transforms and the Quality factor to understand energy efficiency in the Gauss Accelerator.

Results

The field model predicts that radial expansion of the Gauss Gun optimizes muzzle velocity and flux density, and energy calculations predict that on some level, higher circuit resistance is beneficial to the system. Experimental results show that between 0-10 amperes of current, 10 Amperes was least effective and 4 or 5 amperes were most effective for projectile distance for the specific accelerator tested. A successful manipulation of the Fourier transform and Quality factor also yielded a possibly important tool for future Gauss Gun designs and optimization.

Conclusions/Discussion

Large-scale implementation of the Gauss Accelerator is only efficient if there is an increase in radius and a calculated increase in length. The muzzle velocity is also dependent on the resistance of the circuit. Fourier transformations prove to be valuable tools for future optimization of time-dependent circuitry and dynamics of the Gauss Accelerator by frequency adjustments in AC, allowing for computer programs that could generate efficient Gauss Gun systems.

Summary Statement

This study uses a combination of electrical theory and experimentation to improve Gauss Gun implementation and also suggest future directions of optimization.

Help Received

Used lab equipment at California State Unviersity Los Angeles under the supervision of Professor Oscar Bernal; Seung Jung helped test experimental data.