**Efficiency of an Air-Core Induction Linear Accelerator**

**Abstract:**

The purpose of this paper is to compare the input energy of an Air-Core Induction Linear Accelerator (commonly known as a Coil-gun or Gauss Cannon) to the output energy of the projectile. The input energy is supplied from a voltage discharge from a capacitor which is calculated from the equation E = ½ C\*V2, where C is the capacitance and V is the voltage across the capacitor. Output energy is calculated from the velocity and the mass of the projectile (E = ½ m\*v2). This paper presents a “photo-gate” apparatus which consists of an infrared diode and a photodiode with infrared sensitivity used to determine the muzzle velocity of the accelerator.

**Introduction:**

An Air-Core Induction Linear Accelerator (which from this point forward will be referred to as a Gauss Cannon or Coil-gun) uses the magnetic field produced by current running though an inductor to accelerate a projectile made of ferromagnetic materials.

Data collection for this experiment was conducted using a programming environment developed by National Instruments called LabVIEW. This application is a “highly productive development environment” which allows users to “rapidly design and deploy measurement and control systems.”[[1]](#endnote-1) In this research, a LabVIEW program was used to control the input voltage across the infrared diode of the photo-gate as well as to monitor the output voltage across the photodiode. The program took as an input the number of samples to be taken, the desired sampling rate, the length of the projectile, the voltage to be placed across the infrared diode, and a voltage threshold which would be used to determine when there was an object in the gate. The program gave the time in the gate, the muzzle velocity, as well as a graph of the voltage measured across the photodiode as a function of time. This graph was used to determine an appropriate voltage threshold level as well as provide the user with a visual representation of the run.

The muzzle velocity is found from detecting the amount of time the projectile spends in the photo-gate and by measuring the length of the projectile that will be crossing through the gate. During data collection, a voltage is applied across the infrared diode in the photo-gate and the voltage across the voltage diode is measured with a sampling rate of 500 kHz. When an object passes through the photo-gate and blocks the infrared radiation produced by the diode from reaching the detector, the voltage level across the photodiode in the gate drops. For every sample that the voltage across the photodiode is below the voltage threshold inputted by the researcher, a variable representing the number of samples the projectile is in the gate is incremented. At the end of the run the number of samples is divided by the sampling rate which results in the time that the projectile spent in the gate. The length of the projectile can be divided by the time spend in the gate to give the velocity. From here, the measured mass can be combined with this velocity to determine the output energy of the Coil-gun.

**Experimental Set-up:**

**Methods:**

**Data:**

**Analysis:**

**Conclusions:**

1. http://www.ni.com/labview/whatis/ [↑](#endnote-ref-1)