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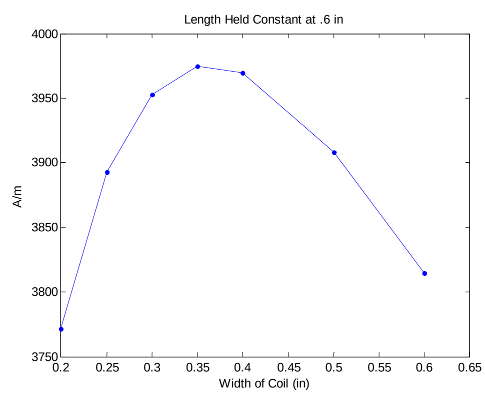
ModCon EDS
Partner: Mary Germino

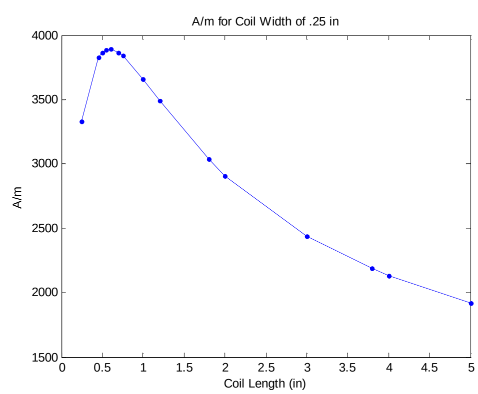
Coil Gun Lab

Width (in) / Length (in)

Length (in) \ Width (in)	0.2	0.25	0.3	0.35	0.4	0.5	0.6
0.25		3332					
0.45		3825					
0.5		3867		3914			
0.55		3890					
0.6	3772	3893	3953	3975			
0.7		3867		3983			
0.75		3843		3973			
0.8				3955	3970	3908	3815
1		3660					
1.2		3492					
1.8		3039					
2		2910					
3		2442					
3.8		2187					
4		2135					
5		1918					

In an effort to optimize the coil, we knew we needed to optimize the z component of the field produced by the coil. The radial component of the field is what exerts the force on the magnet and the z component inside the coil is approximately equal to the radial component outside the coil. Using ComSol we found various measures for the z-component of the field. Typically, one would sum up the component of the field along the 1 in magnet. We decided to make the assumption that the maximum of the field would lend accurate-enough results and that the difference would be minimal especially considering the amount of variability in the construction of the coil.





When each dimension of the coil is held constant, we can find the areas where there is a possible maximum. Once we narrowed our search to the areas surrounding the maximums of each dimension found when the other dimension was held constant.

We found that a coil with length of 0.7 in and a diameter of 0.35 in was at least a local maximum.

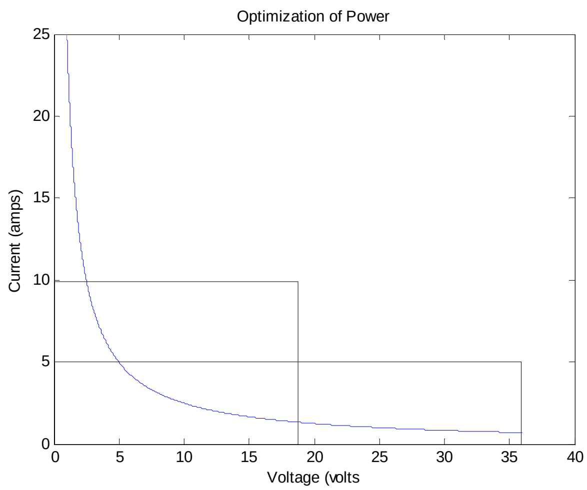
The next step in the process was to determine which type of wire to use.

We has 25 watts of power and given the resistance of the wire we found the necessary voltage and currents necessary for use in the various thicknesses of wire.

Gauge	diameter of wire (in)	wire resistance (ohm/Mft)	length wire (Mft)	voltage used	current (amps)
10	0.1019	0.9989	0.007	0.418099	59.794
18	0.0403	6.385	0.0335	2.31245	10.81103
20	**0.032**	**10.15**	**0.05**	**3.561951**	**7.0186**
22	0.0253	16.14	0.0792	5.652	4.42252
24	0.0201	25.67	0.1276	9.049	2.726

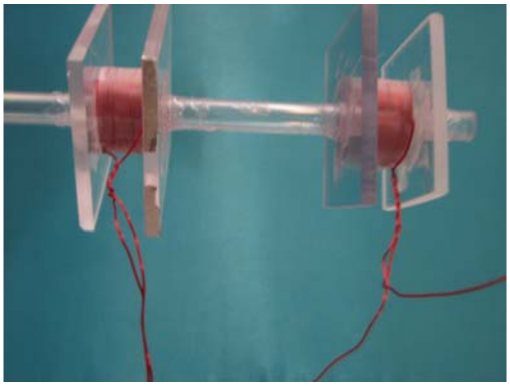
We also checked this against the physical limitations of the power output.

We needed to use the 20, 22, or 24 gauge wire. We also knew we wanted to use a medium gauge wire so for ease of manufacturing so we decided to use the 20 gauge wire.



As an additional challenge, we wanted to use 2 coils to add an extra boost to the performance of the coil gun. Since friction is such a large part of determining the power of the coil gun, we decided that the best way to time the coils was through trial and error.

To try and assist in the manufacturing process, we created end caps of Plexiglas to guide the production of the coils. We used Lawn and Garden sealant to fix them in place, .7 in. apart and started coiling. Mary did most of the manufacturing while I was in class and the coils came out beautifully. The next step was to strip the ends and test while adjusting the timing.



The timing circuit wasn't yet working (ahh, professors) but we tested each coil individually and came in towards the lower end. We also has the smallest coils and the most neatly wound in the class. It seems we found a local and not an absolute maximum. We were held in suspense until the next evening to determine how both coils together would do. However, the day was not a total waste. Because we tested the coils individually, we can find the muzzle velocity to be 2.94 m/s. This measurement gives us a general idea regarding the timing of the coil which should speed the timing calibration process.

By Friday, the timing circuit was working and we were able to get our coil tested. It did rather well. It went 1.05 m with both coils. It was the 3rd best double coil gun in the class. I am pretty happy with the results.

Overall, I would say it was a successful optimization.