Implementation of Movable Helmholtz Coils on the Remote Glow Discharge Experiment (RGDX)

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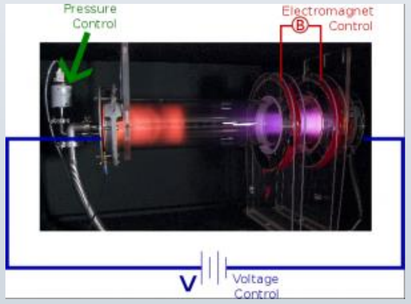
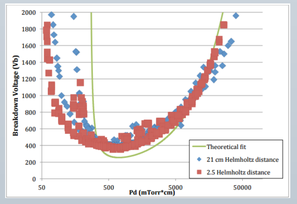
Intro to RGDX

- RGDX is an internet accessible DC glow discharge tube with Helmholtz coils designed to create plasma at low temperatures.
- Possesses capability to control distance between electrodes, pressure, voltage, and magnetic field intensity.

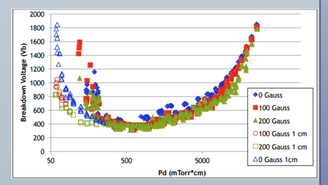


Motivation



Alex Millet, past PPPL intern, collected data suggesting a link between magnetic field location/strength and the Paschen curve. [3]

This data justified the continuation of this project (proposed by Sosa et al) in order to further investigate this effect.[1]



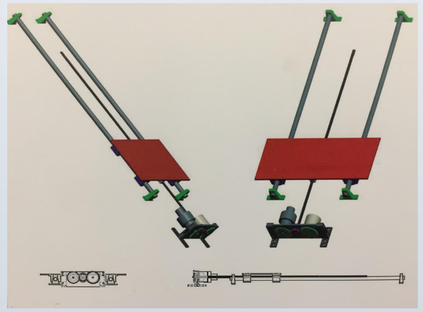
Goals

- The principal objective of this project was to improve the RGDX by adding the movable Helmholtz coil system to investigate the effects of the magnetic field.
- Students should gain skills in 3D Design, 3D Printing, mechanical assembly, electronics, Arduino programming, and LabVIEW.

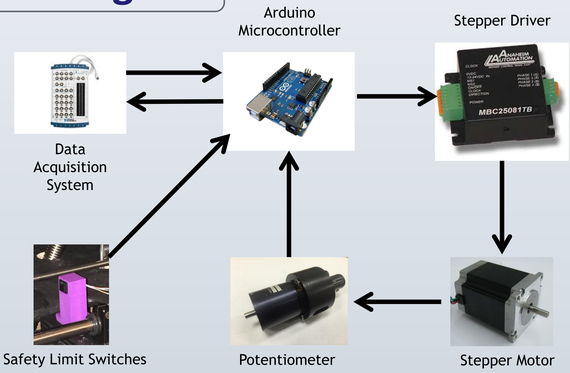
Primary Challenges

- Mechanical – Alignment of components to ensure smooth movements (gears, threaded rod)
- Electronics Assembly – Clean wiring, soldering, troubleshooting faulty components
- Software – Eliminate voltage noise in input signals (DAQ, potentiometer)
- LABVIEW – Adapting the software to the new hardware in a web interface

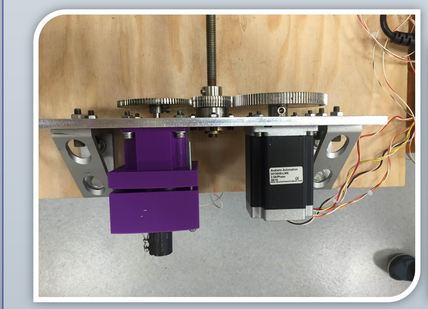
Project Design



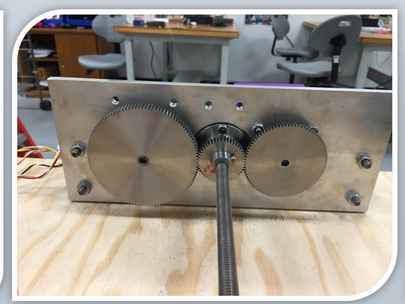
Designed by Michael McNulty & Carl Sosa-Rivera



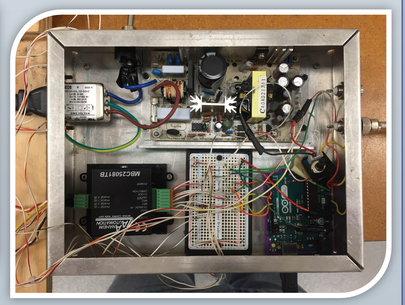
Main Upgrade Components



Potentiometer & Motor



Gears & Threaded Rod

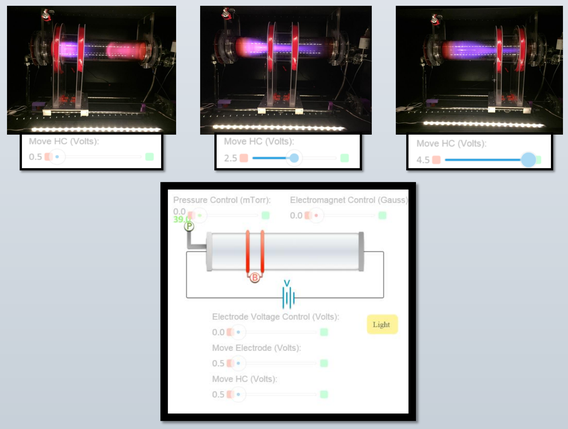


Electronics Box

Final Product

Conclusions

- Movable Helmholtz Coils system was developed.
- The use of two wheels on 3D printed holders to distribute the weight of the coils was indispensable.
- Mechanical alignment allowed the system to work smoothly.
- Using an Arduino Uno microcontroller and a potentiometer, precise position control was achieved.
- New functionalities were added to the online interface to study the effects of a movable external magnetic field on the Paschen curve.



Future Work

- Experimentation for the study of the effect of the location of a magnetic field on RGDX-created plasmas.
- Implement the option of photodiode alert to detect the glow of very tenuous plasma independently of what the webcam shows
- Improvement of remote-control capabilities on RGDX website.
- Maintenance and further study of the effectiveness of the Movable Coil Upgrade system.

References

- [1]C. Sosa-Rivera, M. McNulty, A. Dominguez, A. Zwicker - Movable Electrode and Electromagnet Setup for RGDX. August 2014.
- [2]F. Paschen, Wied. Ann. 37 (1889).
- [3]A. Millet-Ayala – Implementation of a Movable Electrode on the Remote Glow Discharge Experiment. May 2015.
- [4]"Arduino - Reference." *Arduino - Reference*. Arduino, n.d. Web. <https://www.arduino.cc/en/Reference/HomePage>.

Acknowledgements

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