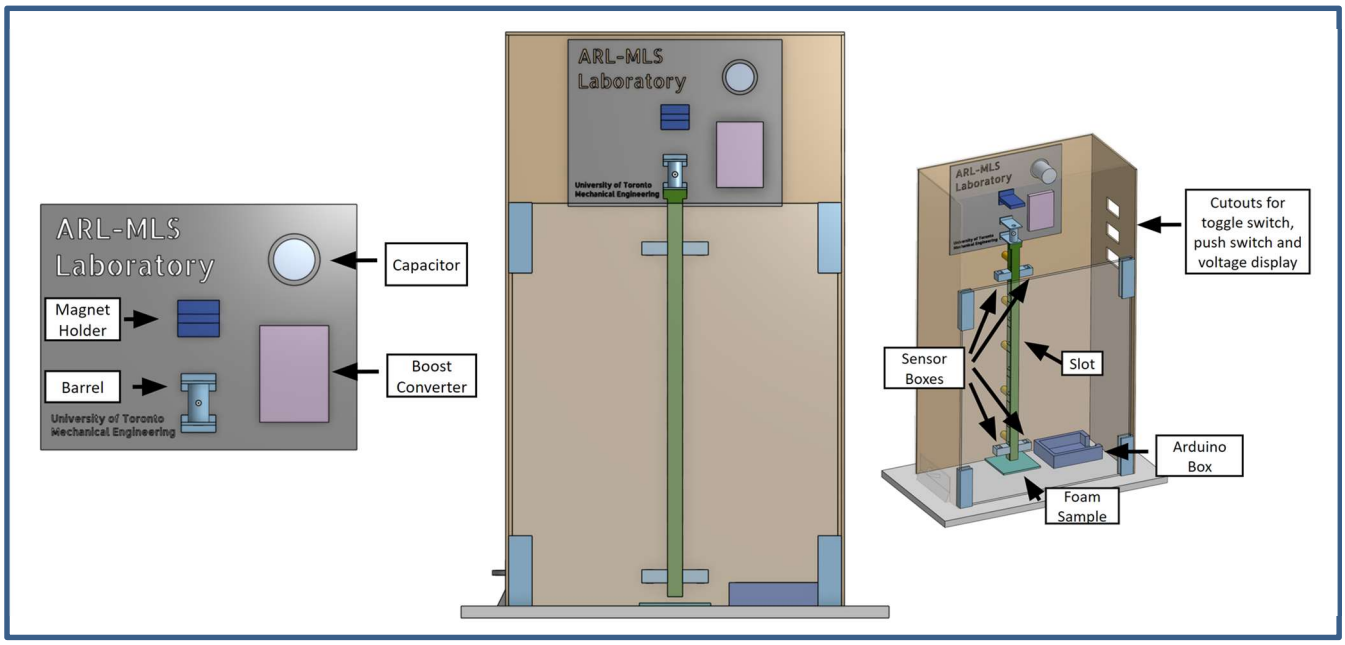

From Magnetic to Mechanical: Electromagnetically Powered Impact System

Client: ARL-MLS Laboratory

Team Members: Nathalie Cristofaro, Yu-Tung (Jasmine) Chen, Kevon Seechan, & Victoria Velikonja

Supervisor: Professor Kamran Behdinan

A scalable impact system capable of testing ceramic samples from low to high velocities

The ARL-MLS lab at UofT requires an impact testing method for lightweight ceramic armour systems. Ceramic armour systems demonstrate desirable properties for ballistic protection, as they are lightweight yet hard and strong; however, they need to be properly tested to ensure their safety. Typically, impact testing is done at high velocities to replicate the high impact forces armours must withstand, thus a tall vertical space or a linear actuator is required to achieve such velocities. Due to vertical lab space constraints, a linear actuator is the most feasible option, and the prototype will begin operating at low velocities but will be scalable to higher velocities to ensure user safety. A projectile impact system would allow for safe, repeatable, and scalable testing for the ARL-MLS lab to further their ceramic armour research. Furthermore, this system could be used for a variety of material testing methods in the laboratory, as it can be scaled down to lower velocities.

Small machine, high velocity

In order to provide a scalable impact system, this design uses magnetic coils as a linear actuator. Once the projectile enters the coil it will accelerate and follow a downwards path to the sample. The amount of acceleration in the coil is determined by the number of coil layers and the amount of current sent to the coil. This makes the impact system easily scalable and controllable, as the velocity can be easily controlled by the amount of current sent. The magnetic coil is charged via a power supply, and the current is controlled via capacitors and switches to ensure safe release of the projectile when the researcher is ready. Two infrared (IR) sensors measure the final velocity of the projectile by capturing time stamps of the productile within a set distance. The sensors are controlled via an Arduino so all data can be displayed on the researcher's computer. The final prototype has demonstrated consistent test results at low velocities, scalability, user-friendliness, and meets safety regulations thus achieving the objectives of the client and providing the lab with a safe and reliable method for ceramic armour testing.