LUNAR ELECTROMOTIVE LAUNCH

WILLIAM E. BOEING
DEPARTMENT OF AERONAUTICS & ASTRONAUTICS
UNIVERSITY of WASHINGTON

LOCKHEED MARTIN

YAFFET BEDRU, JUSTIN DANH, ETHAN DUER, SYDNEY JACKSON, KYLE KLEM, HAILI KUESTER, PHUONG LE, DANIEL LORD, KEVIN MAJOR, KATELYNN MOEN, JULIUS NAEHRIG, EMI PETERSON, AND CESAR TIRADO

ABSTRACT

The Lockheed Martin Capstone team is designing a conceptual electromagnetic launcher capable of launching a payload of lunar materials from the Moon's surface into orbit. The team has decided to design a large, multi-stage coilgun to accelerate a one-ton payload using electric and magnetic forces. To demonstrate the capabilities of the coilgun, the team has built a subscale coilgun with four stages to launch **100-gram** projectiles at exit velocities between **50-100 meters per second.**

INTRODUCTION

Lockheed Martin's Goals:

Human and robotic exploration, weather and Earth science, commercial communications

Lunar Electromotive Launch:

- Launch propellants and feedstocks made from lunar in-situ resources from the Moon's surface to orbit
- Cheap export of lunar surface resources to cislunar space
- Fuel space exploration

CONCEPT OF OPERATIONS

- Deliver materials to Moon and assemble launcher
- Load lunar materials into a capsule
- Begin charging capacitors
- Load the capsule into the launcher
- Turn on the power supply
- Launch capsule into orbit
- Complete insertion burn
- Intercept with catcher/ferry system
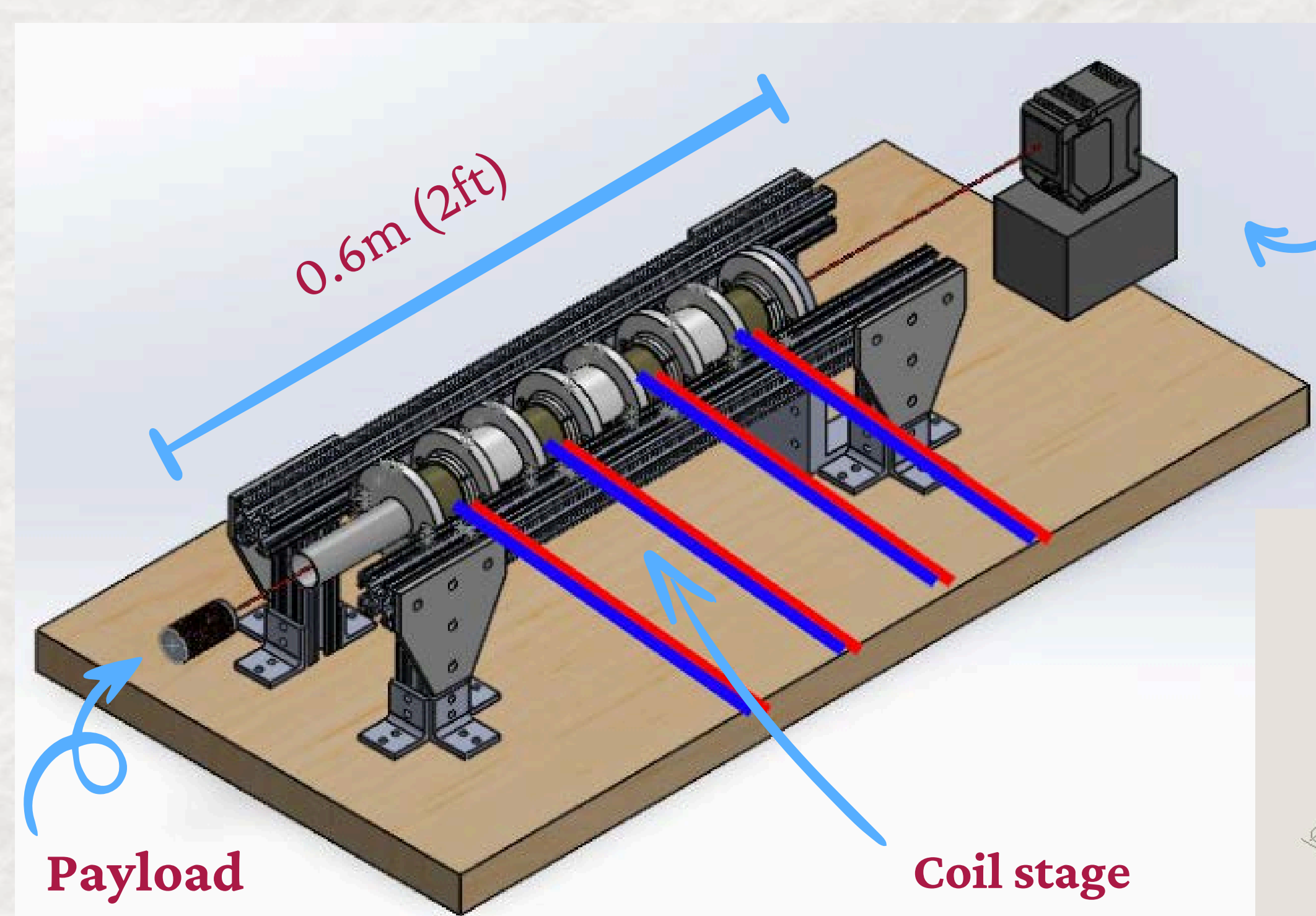- Catcher/ferry system delivers payload to Gateway

WHAT IS IT?

A coil gun is a type of **electromagnetic launch system** that operates on the principle of electromagnetism to accelerate a capsule along a set of coils or a "barrel" before releasing it at high speeds. This launch system utilized a sequence of coils and its precise timing system to create an electromagnetic force that sends the capsule through the barrel at a high velocity.
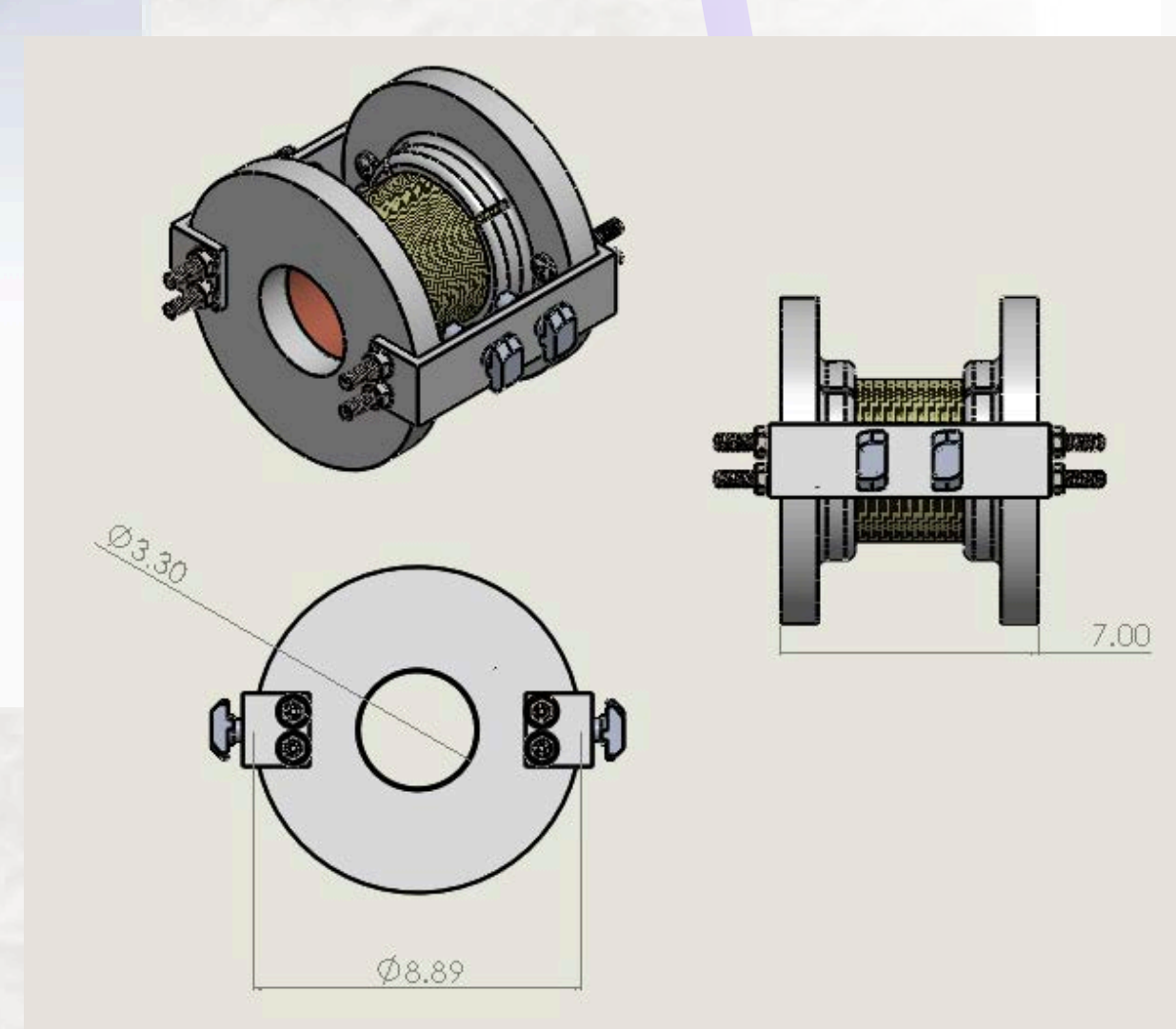
"Coilgun." Wikipedia, Wikimedia Foundation, 15 Apr. 2024, en.wikipedia.org/wiki/Coilgun#:~:text=Coilguns%20generally%20consist%20of%20one,the%20barrel%20via%20magnetic%20forces.
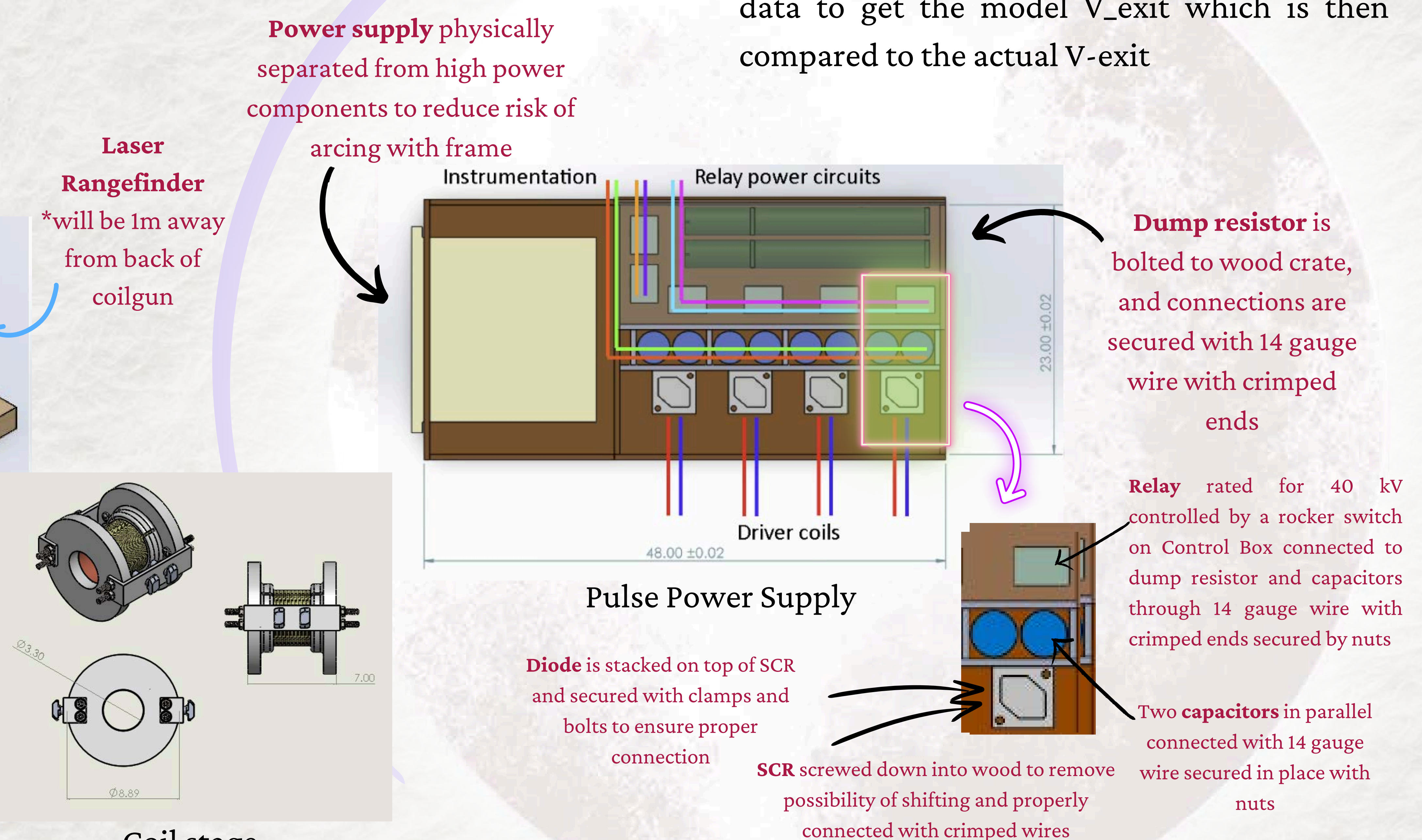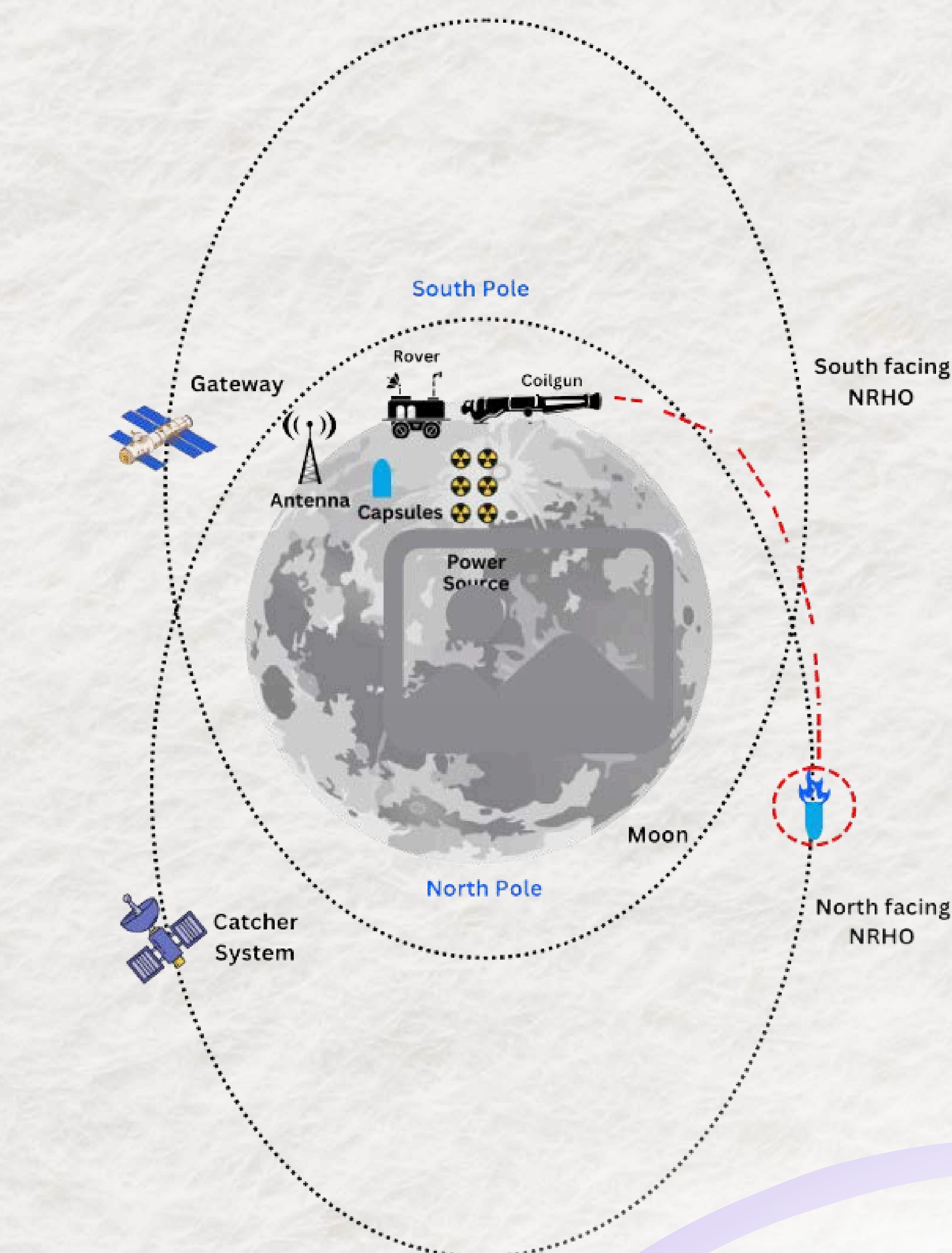
SUBSCALE MODEL

- Ground design will be used to validate conceptual Python model of coil gun performance.
- The ground model is expected to launch a capsule with a mass of 100 g at an exit velocity of 50-100 m/s

0.6m (2ft)

Payload

Coil stage

Primary Coilgun Structure (4 stages)

South Pole

Gateway

Rover

Coilgun

South facing NRHO

Antenna

Capsules

Power Source

Moon

North Pole

Catcher System

North facing NRHO

Coil stage

TESTING

- The coilgun is activated or controlled via a control box that manages capacitor voltage and relay operations.
- The positioning laser sensor emits a laser beam that reflects off the target to a sensor that measures the reflection time and distance.
- High-speed camera and backdrop are used to record the launch and calculate the exit velocity of capsule
- Using the measurements recorded during the test, run the Python model with the measured data to get the model V_exit which is then compared to the actual V-exit

Power supply physically separated from high power components to reduce risk of arcing with frame

Laser Rangefinder *will be 1m away from back of coilgun

Instrumentation

Relay power circuits

23.00 ±0.02

Driver coils

48.00 ±0.02

Pulse Power Supply

Dump resistor is bolted to wood crate, and connections are secured with 14 gauge wire with crimped ends

Relay rated for 40 kV controlled by a rocker switch on Control Box connected to dump resistor and capacitors through 14 gauge wire with crimped ends secured by nuts

Diode is stacked on top of SCR and secured with clamps and bolts to ensure proper connection

SCR screwed down into wood to remove possibility of shifting and properly connected with crimped wires

Two **capacitors** in parallel connected with 14 gauge wire secured in place with nuts