

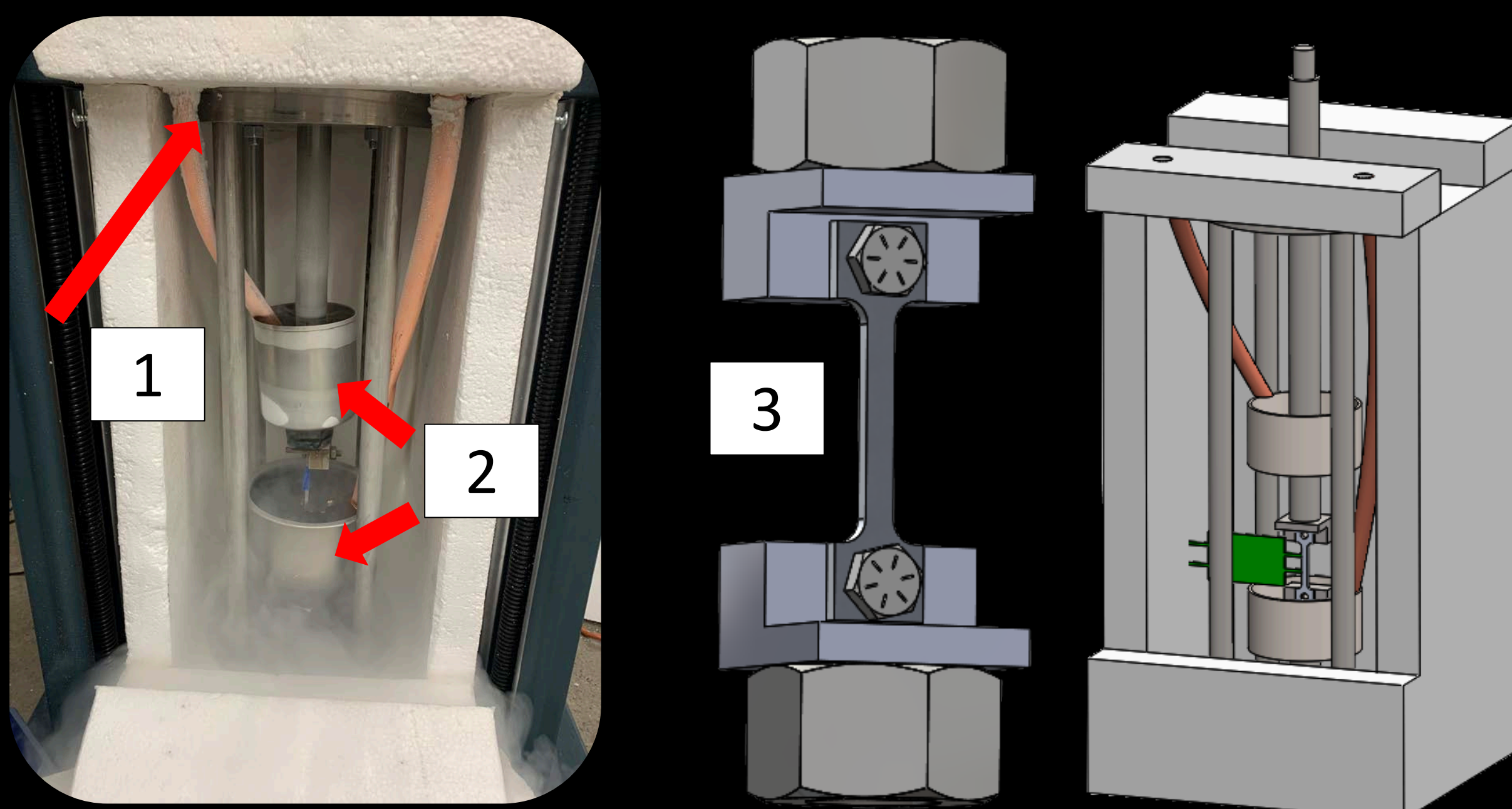
Introduction

Material properties change at low temperatures, and tensile testers that can achieve these temperatures are large and expensive. Our goal is to create a cryogenic tensile tester that is low-scale and low-cost.

Requirements:

- Operate at temperatures ranging from 100K to 300K (-280 °F to 80 °F)
- Build a testing fixture to withstand 10,000 lbs of force
- Perform, monitor and collect tensile test data, including force, strain, displacement and temperature
- Accommodate for 3 inches of travel of elongation of sample
- Total budget of \$6581

Cooling System



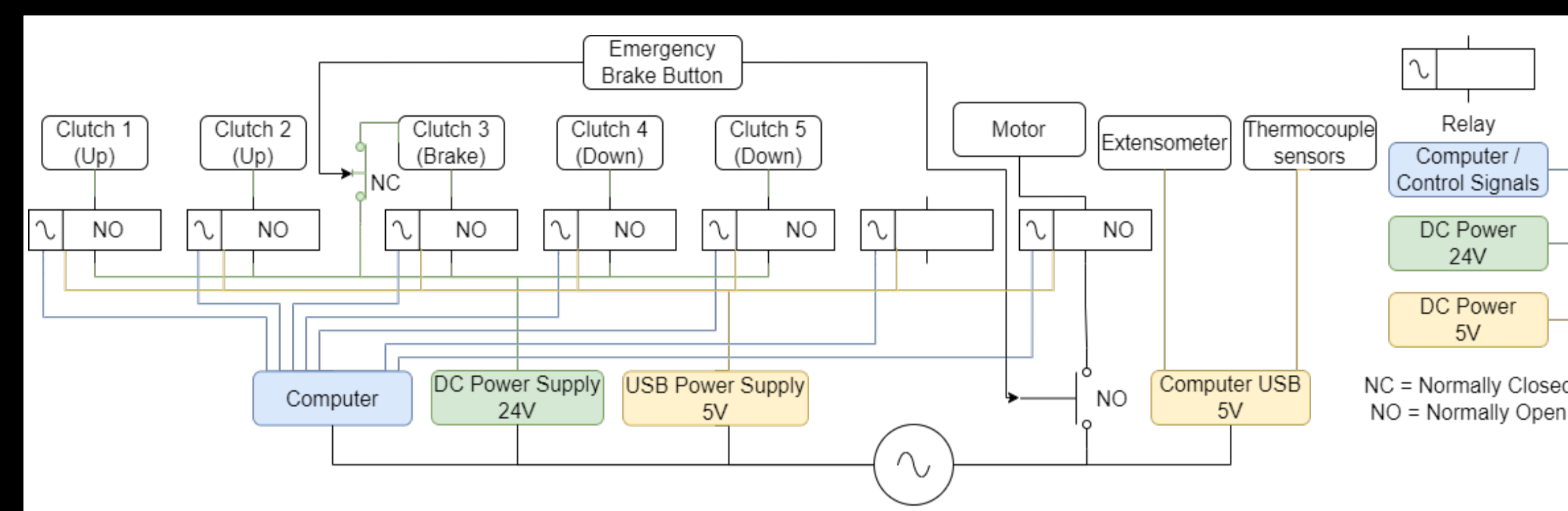
- 1) Liquid nitrogen is poured into copper tubes through inlets at top of cooling chamber.
- 2) Liquid nitrogen flows into two metal cups, one above the test specimen and one below.
- 3) Test specimen is then cooled through conduction to desired temperature.

System Overview and Background

Subsystems:

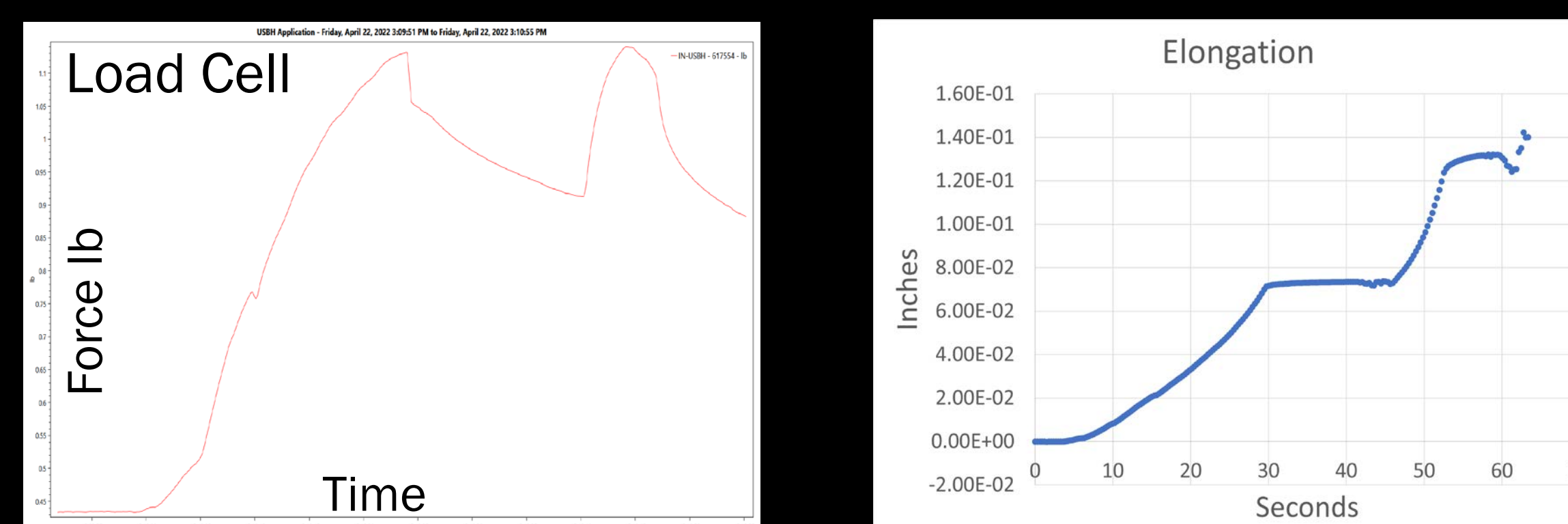
- **Mechanical Frame** – Refurbished 1970's Instron Tensile Tester, includes motor and gearbox.
- **Cooling System** – Includes liquid nitrogen delivery and conduction-cooling system, and foam chamber for insulation.
- **Sensors and System Control** - Includes an extensometer, load cell, rotary encoder and a K-type thermocouple.

Control Diagram



- Relays are used to control the clutches and the motor.
- Clutch 3 acts as an emergency brake.
- Emergency stop button will de-energize the motor and engage clutch 3 after the button is pressed down and until it is reset.

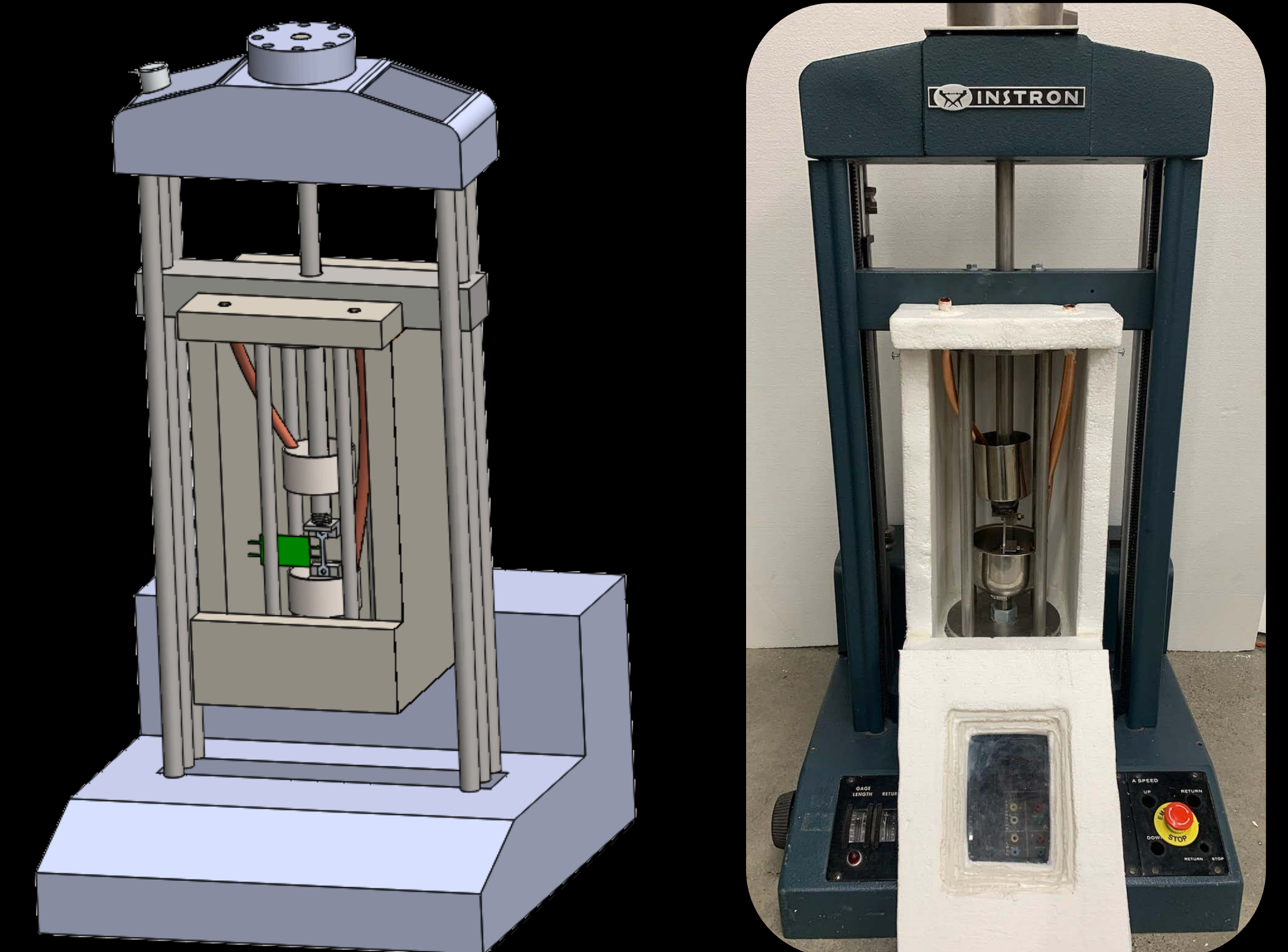
Data Collection



- Load cell force still needs to be properly scaled
- The test was paused in the middle which caused the dip in force and constant elongation section

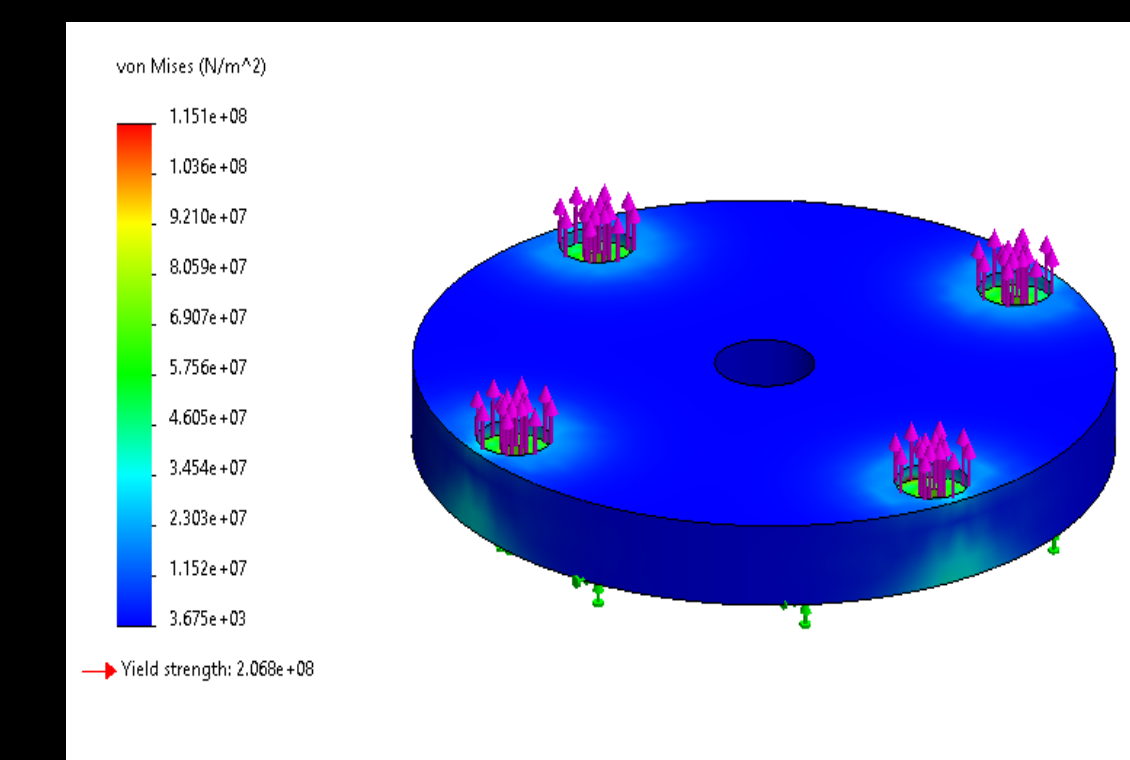
We would like to acknowledge Dr. Michael Maughan, Dr. Matthew Swenson, NASA Idaho Space Grant Consortium, Bill Magnie, Jared Gray and Abdallah Smadi for their contributions to this project.

Completed Tensile Test Fixture

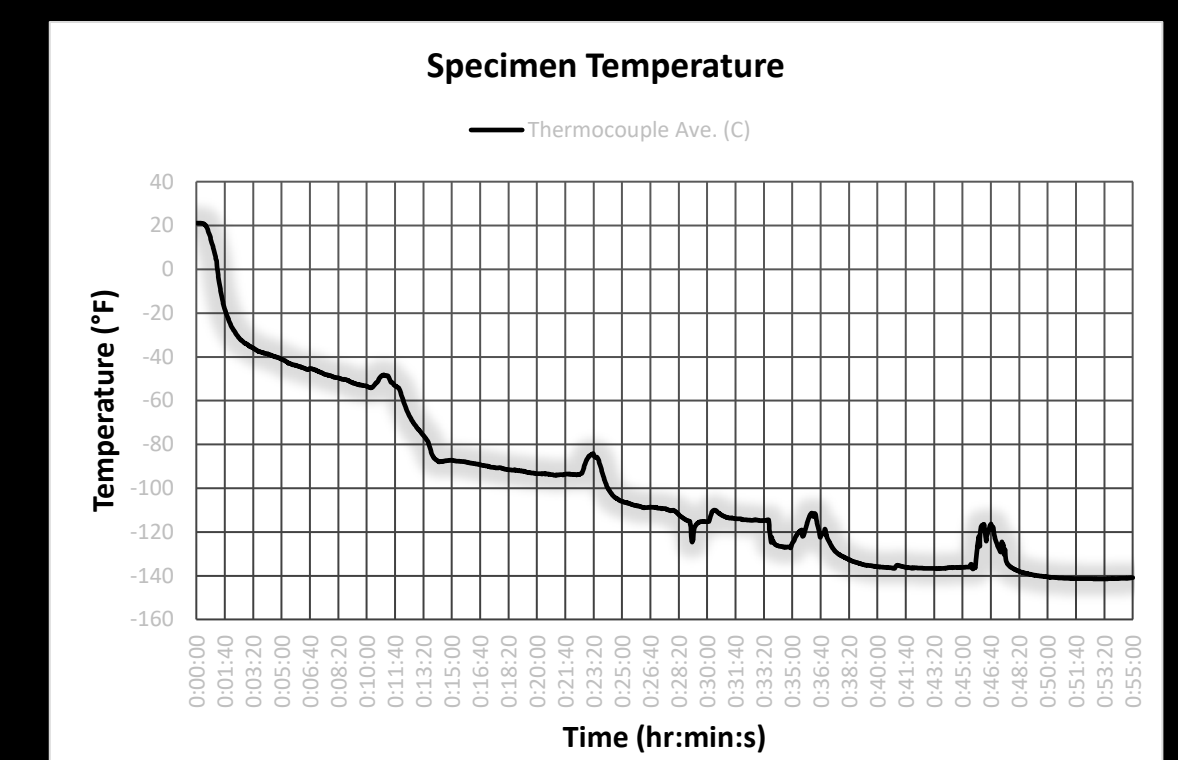


Design Validation

Finite Element Analysis



Liquid Nitrogen Testing



The chamber was simulated in SolidWorks to provide a factor of safety of >3.

Liquid nitrogen testing cooled the specimen down to -141 °F (~129 K).

Future Work

- Integrate more speed options into the machine using a variable frequency drive
- Improve Cooling System to achieve more consistent low temperatures



The Ice Breakers