



**University of Idaho**

College of Engineering

# **FITS LIKE A GLOVE**

**IDAHO NATIONAL LABS:**

**GLOVEBOX TENSILE TESTING**

**SYSTEM**

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Logan Matti

Sponsor: Randall Fielding, Idaho National Laboratory

Instructor: Dr. Michael Maughan

Mentor: Anas Nawafleh

# OBJECTIVE STATEMENT



- Design a tensile testing system that will fit through an 8-inch access port inside a glovebox and can perform tensile tests at temperatures reaching 700 °C.



# VALUE PROPOSITION

Currently, existing small-scale tensile testing systems are extremely expensive, and do not meet Idaho National Lab's functional requirements. INL requires tensile testing system that can be installed in an existing glovebox and can perform tests at up to 700 degrees Celsius. A glove box is required to protect people from potentially harmful conditions that could arise from testing certain alloy such as INL's current project using U-Pu-Zr alloys, so they have asked us to design a small-scale tensile testing system. The goal is to create an easy to assemble and use small-scale tensile testing system for an existing glovebox. Our tensile testing system aims to be able to fit through an 8-inch hole and be easily .

# BACKGROUND

- U-Pu-Zr alloys are being proposed as candidate fuels for advanced reactor applications.
- In the scientific community there is very little mechanical data on these alloys.
- Due to hazards with handling Pu alloys all testing will be done in a shielded glovebox.
- Currently there is no Tensile Testing System (TTS) that meets the requirements needed by INL.



Traditional Glovebox



Traditional TTS w/Heating System

# PRODUCT REQUIREMENTS



- Must be able to complete tests remotely
- Must be small as possible
- Must be able to test a 1.5" specimen
- Must be electronically sparse as possible
- Must fit through 8" hole and be assembled in glove box.
- Must withstand temperatures up to 700°C

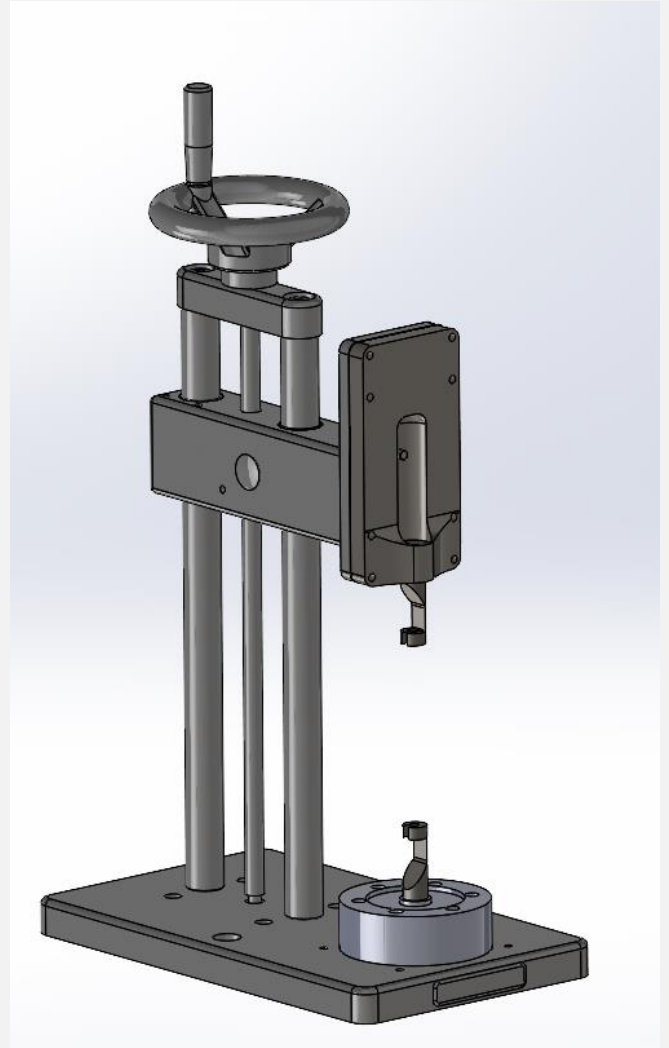
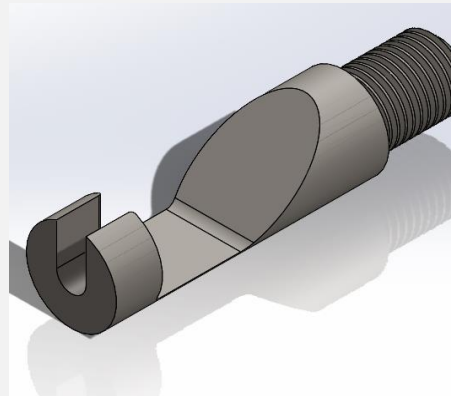
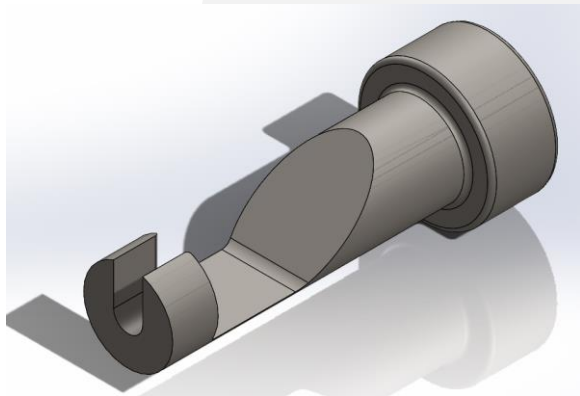
# CURRENT DESIGN CONCEPTS

- Purchase an **existing TTS** that will be modified.
- Stepper Motor
- Building a **heating system** to reach desired temperature.
- **Instrumentation**: Mainly controlled by a laptop or PC
  - ⑩ Develop a way to read the **output** values through an extensometer, PID controller, and heating rope.
  - ⑩ Use Arduino or LabView to give specific **inputs** to the system.

# TENSILE TESTING SYSTEM FRAME

## MARC-10 ES20 LOAD FRAME

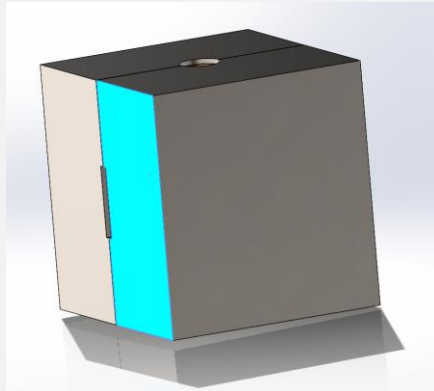
- Purchased Load Frame
- Modified to accept holding plate and load cell
- Each end of the system has a grip machined to match the attachment type



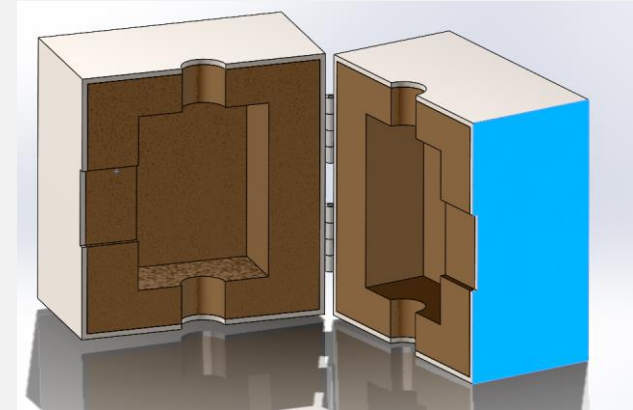
# HEATING SYSTEM

## HEATING ROPE AND INSULATED ENCLOSURE

The Heater enclosure will be rectangular to simplify manufacturing and assembly.



The cavity will exist to allow easy installation and removal of the test specimen.





# HEATING SYSTEM (CONT)

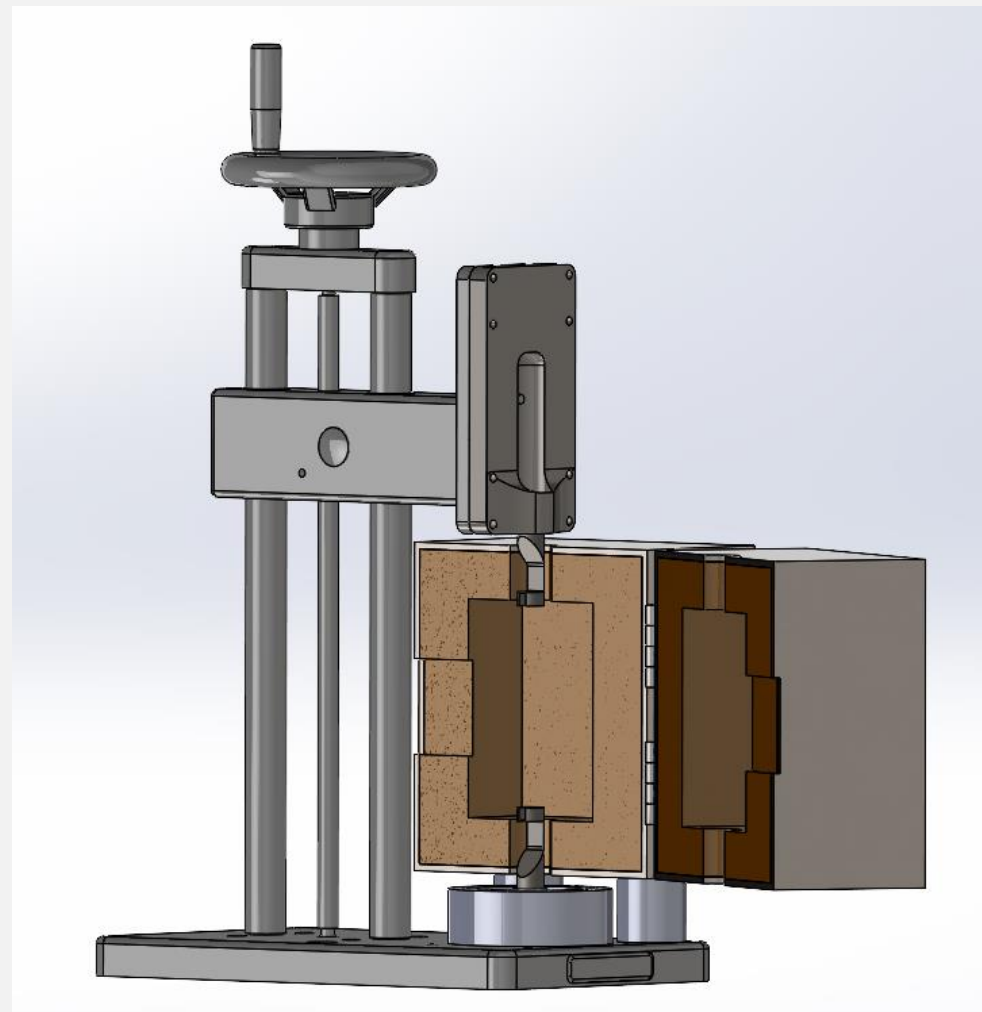
## HEATING ROPE



- Omega brand heating tape operates at 120V and 312 W with a maximum temperature of 1400° F (760° C)
- PID controller will be used in conjunction with a thermocouple for temperature control

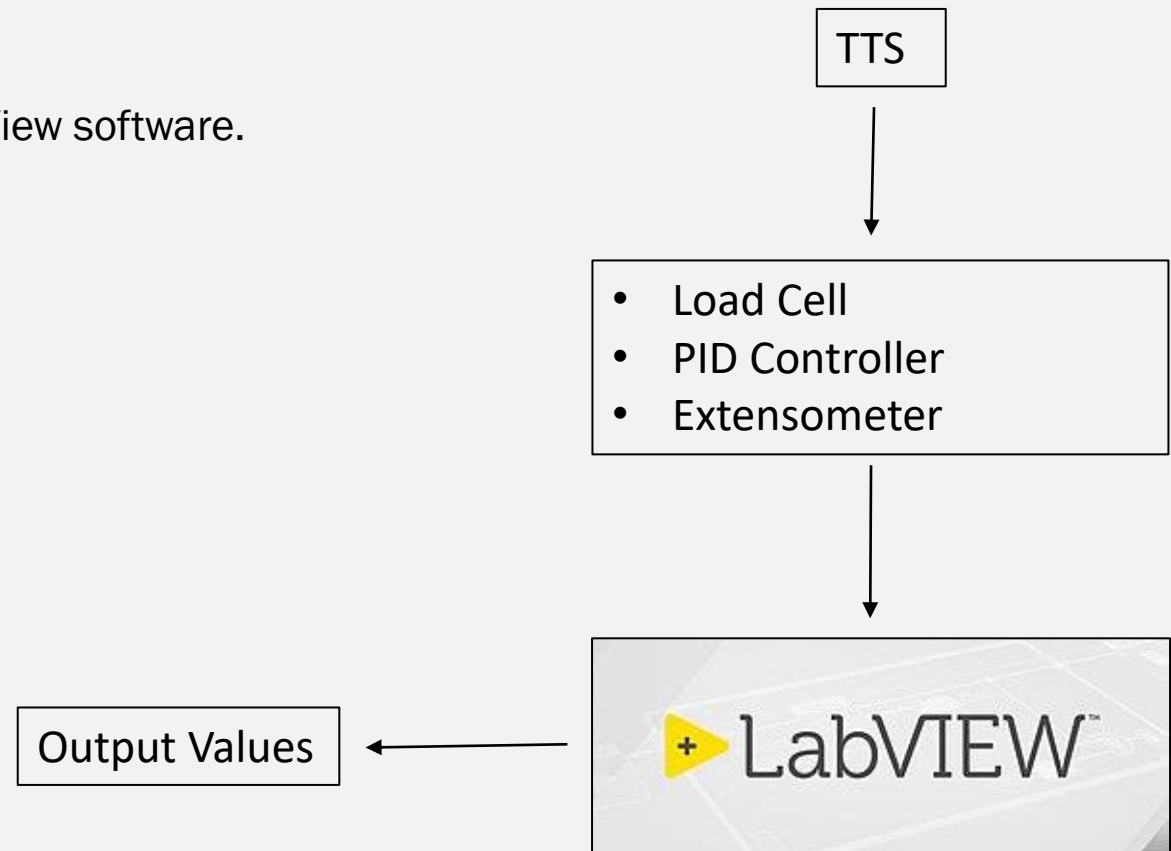


# TOTAL TTS SUBASSEMBLY



# INSTRUMENTATION

- Tests and Data Collection will be carried out with LabView software.
- Extensometer.
- Data collection will be sent to a side station laptop.
- Data Collected:
  - Force being applied.
  - Temperature of specimen.
  - Displacement.



# POTENTIAL RISKS

- Heating Systems becoming too hot on the outside.
- Instrumentation influenced by heat.
- Ease of assembly and disassembly.
- Purchased TTS failing.

# MOVING FORWARD

- Purchase existing TTS, Load Cell, and Stepper Motor.
- Develop and physically change the overall TTS frame mechanical system.
- ⑩ Test prototype
  - Build/test heating unit.
  - Purchase remaining supplies/parts.
  - Test the ease of assembly and disassembly
  - Test instrumentation to give inputs and get specific outputs backed by calculations.



# SUMMARY OF VALIDATION APPROACH

1. Ensure prototype can be easily assembled/disassembled.
2. Test TTS capabilities.
3. Test that heating system can reach up to 700 C.
4. Test and confirm instrumentation.
5. Perform a dFMEA analysis on all components.
6. Test motor functionality.
7. Rough life cycle calculations.





Task Description	Duration	Assigned	Sept					Oct					Nov					Dec					
			9/3	9/10	9/15	9/17	9/24	10/1	10/6	10/8	10/13	10/15	10/22	10/29	11/5	11/12	11/13	11/20	11/27	12/4	12/11	12/18	12/25
Product Requirements Document	1 Weeks	Team																					
Research Operational Parameters	5 Weeks	Team																					
Rough Draft Bill of Materials	1 Weeks	LM, JB																					
Design Solution to Challenges/Problem	7 Weeks	Team																					
Preliminary CAD Modeling	12 Weeks	LM, JB																					
Concept Design Review	2 Weeks	Team																					
Preliminary Coding Skeleton	7 Weeks	JG,MU																					
First Round Prototyping (POC) (ABS)	2 Weeks	JG,MU																					
Review and Revise CAD	6 Weeks	Team																					
Review and Revise Coding	6 Weeks	Team																					
Second Round Prototyping (ABS)	2 Weeks	Team																					
Second Round Coding Review	1 Weeks	LM, JB																					
Prototype Testing	1.5 Weeks	Team																					
Final CAD Review	3 Weeks	Team																					
Final Coding Review	2 Weeks	Team																					
Purchase TTS Parts from BOM	3 Weeks	LM																					
Machine Custom Parts from BOM	3 Weeks	Team																					
Choose Final Testing Materials	1 Weeks	Team																					
Final Assembly of Parts	3 Weeks	Team																					
Final Product Review	1 Weeks	Team																					
Final Budget Finished	2 Weeks	LM																					
Testing Final Product	2 Weeks	Team																					

# PROJECT SCHEDULE FALL SEMESTER





		2021																							
		Jan					Feb					Mar					Apr				May				
Task Description		1/1	1/8	1/15	1/22	1/26	1/29	2/5	2/12	2/19	2/26	3/5	3/9	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28
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Final Product Review																									
Final Budget Finished																									
Testing Final Product																									
Product Validation																									
Deliver/Report Final Project to Client																									

# PROJECT SCHEDULE SPRING SEMESTER



**THANK YOU!**

QUESTIONS?