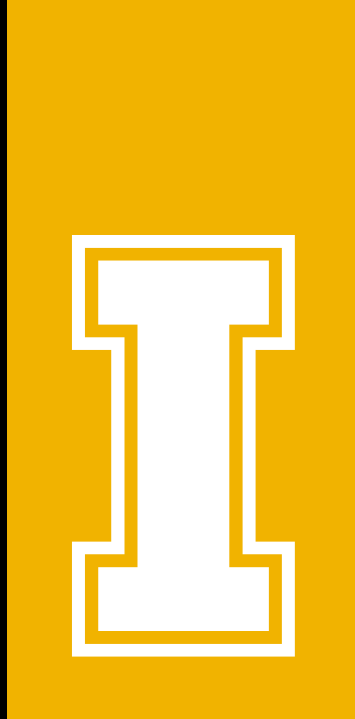




SMALL-SCALE CONTINUOUS CASTING DEMO



THE TEAM: KADE FORBES, TRISTAN DENNING, TIM STEVENS, WYATT KNICKERBOCKER, BRENNEN COULSON

OBJECTIVE

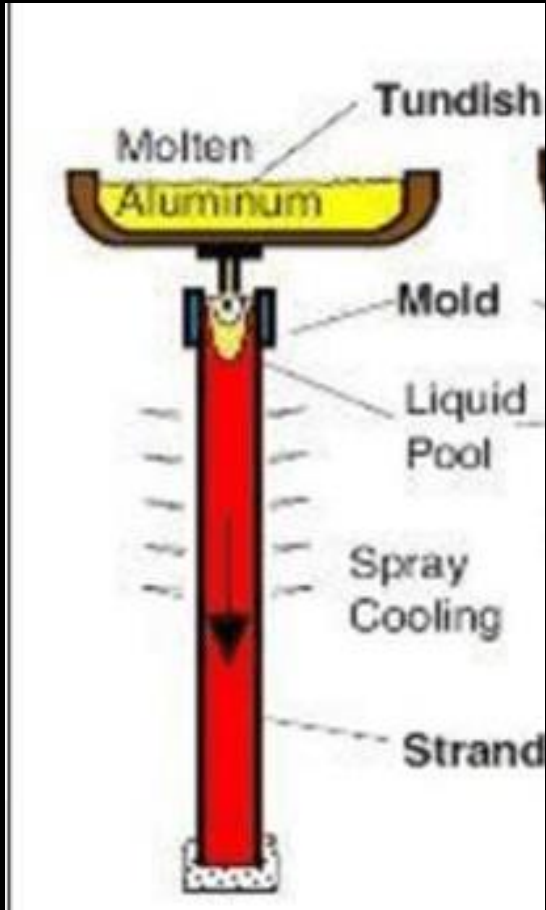
Demonstrate the feasibility of using continuous casting as a manufacturing technique for production of nuclear reactor fuel pins.

BACKGROUND

Current production method relies on single use molds. Roughly 840 kg/year of quartz is used to cast enough fuel pins to keep one small reactor running. The irradiated quartz is nuclear waste that must be dealt with accordingly (sealed and buried).

CONTINUOUS CASTING

CC is an efficient production method of long strands of metal from a melt. Molten metal is poured into a mold where it solidifies and is drawn out the bottom (right). It is used in large scale aluminum and steel production.



VALUE PROPOSITION

Continuous casting would eliminate the need for single use quartz molds and drastically reduce waste and recycle streams in the production of nuclear fuel pins. This would make nuclear power a cleaner and more efficient energy source.

KEY REQUIREMENTS

- Cast rods 6mm in diameter and ~30cm long
- Use non-toxic, low melting point alloy
- Minimize human interaction within the casting process

Acknowledgements:

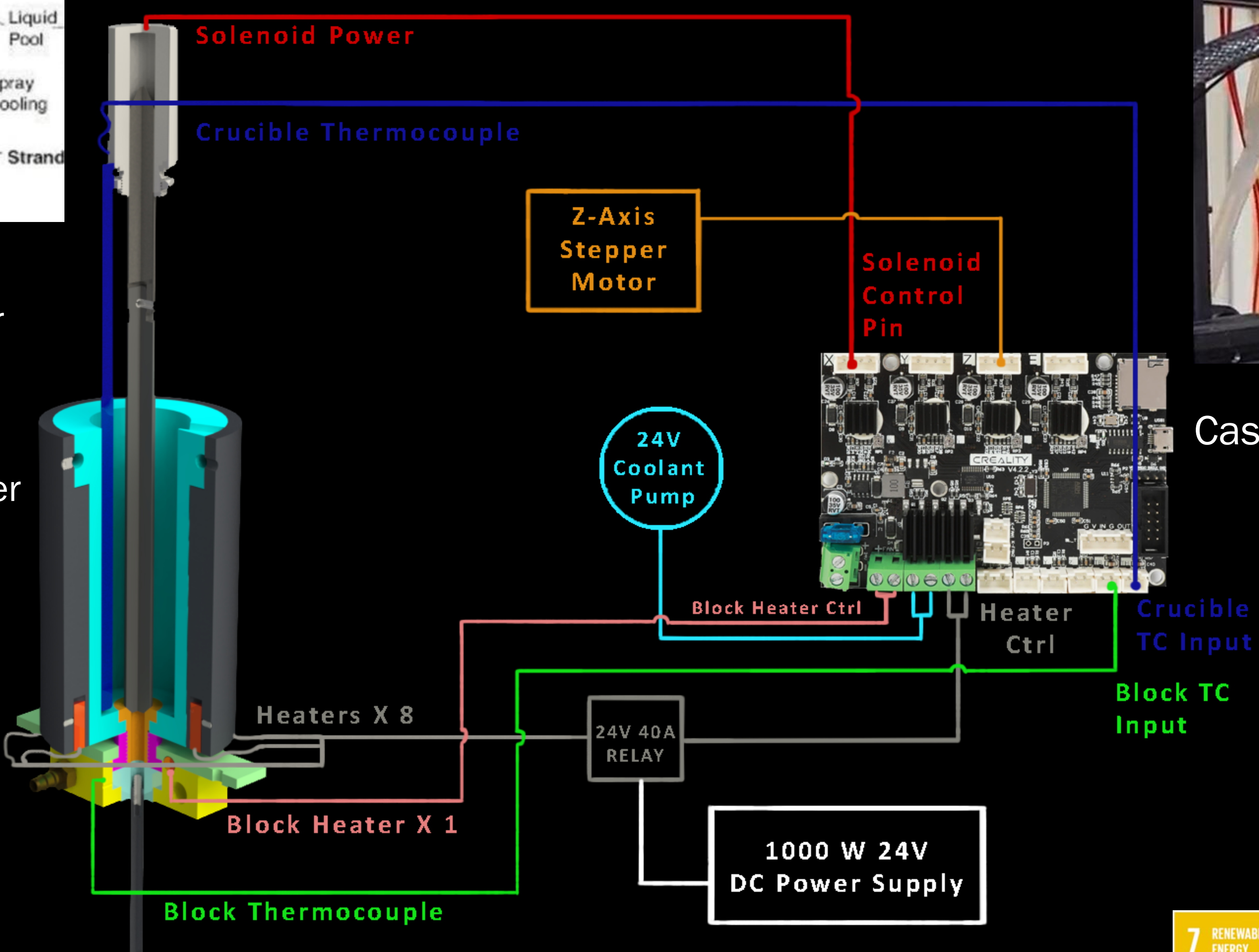
Client: Randall Fielding | Instructor: Dr. Michael Maughan | Grad Mentor: Dan Revard | Shop Mentors: Brian Petty, Charles Cornwall

FINAL DESIGN



- Solenoid Actuated Plug and Crucible Thermocouple
- Crucible Surrounded by Insulation
- Mold and Casting Temp Control Block
- Dummy Block
- Modified Ender 3 Pro 3D Printer
- Catch Pan

SYSTEMS AND WIRING



CASTING ALLOY

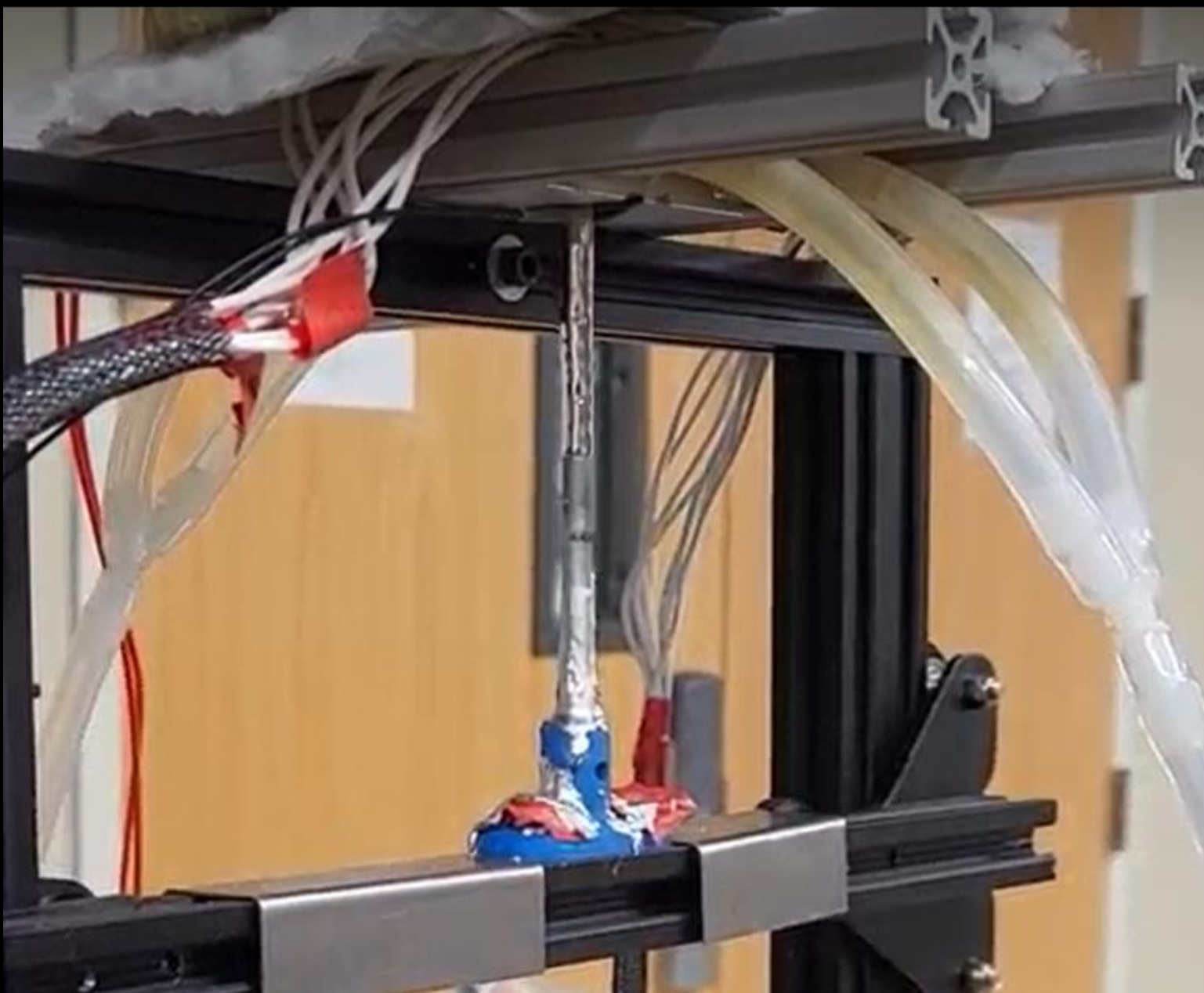
- 60/40 Bismuth Tin Alloy
- Melting Range: 138-170°C



AUTOMATION

Utilizing Marlin firmware, we allow the operator to control the casting process either through a user interface or run a casting sequence automatically via the industry-standard CNC programming language "G-Code"

RESULTS



Casting in Action



Casting Sample

FUTURE WORK

- All parts alloy contacts should be made of Graphite
- More precise thermal control of system
- Annular mold design



2023 Capstone Project