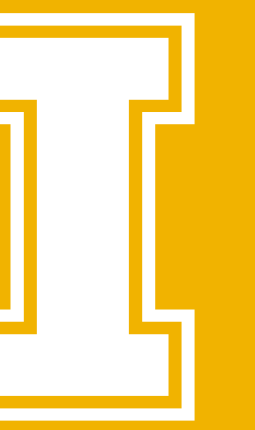


EXPO REUSABLE MOLD FOR NUCLEAR FUEL CASTING



engineering ▲ design

VALUE PROPOSITION

The current process for producing cast nuclear fuel rods is inefficient because molds must be destroyed for each production. To address this issue, a process that uses reusable molds is being designed. FLOW-3D Cast software demonstrates the processes advantages. Simulations will be validated with a quarter-scale design, using safe materials.

OBJECTIVE

Design a reusable mold capable of casting 20kgs of Uranium-10wt%Zirconium (U-10Zr)

REQUIREMENTS

- Mold must be reusable with minimal maintenance
- 5-6mm diameter rods
- 250-300mm length
- Simulation capable of casting 20kg of U-10Zr
- Create physical prototype capable of casting 5kg equivalent of U-10Zr

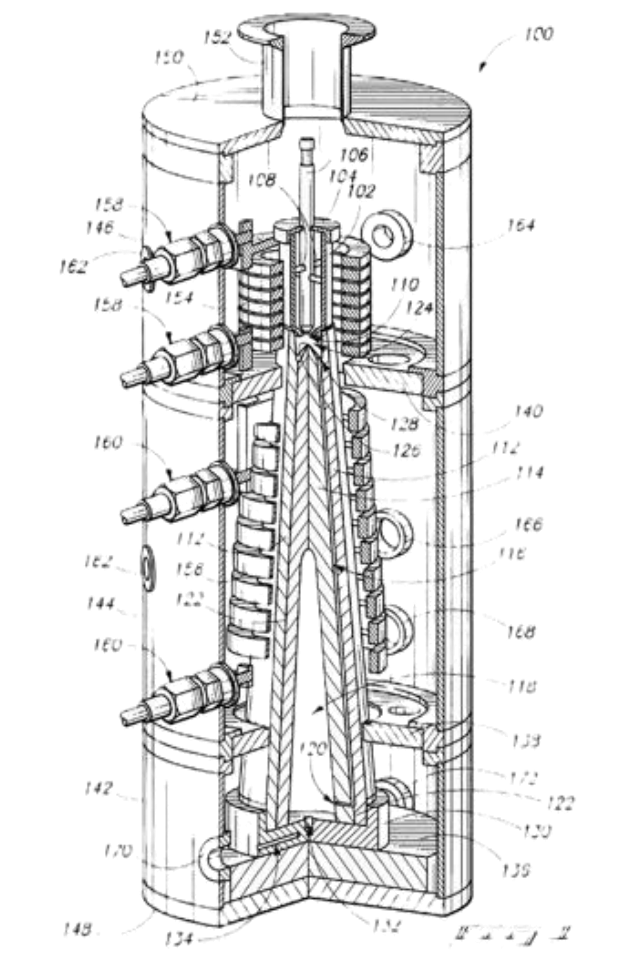
Acknowledgements

Dr. Michael Maughan, Levi Bailey, Brain Petty, Randall Fielding

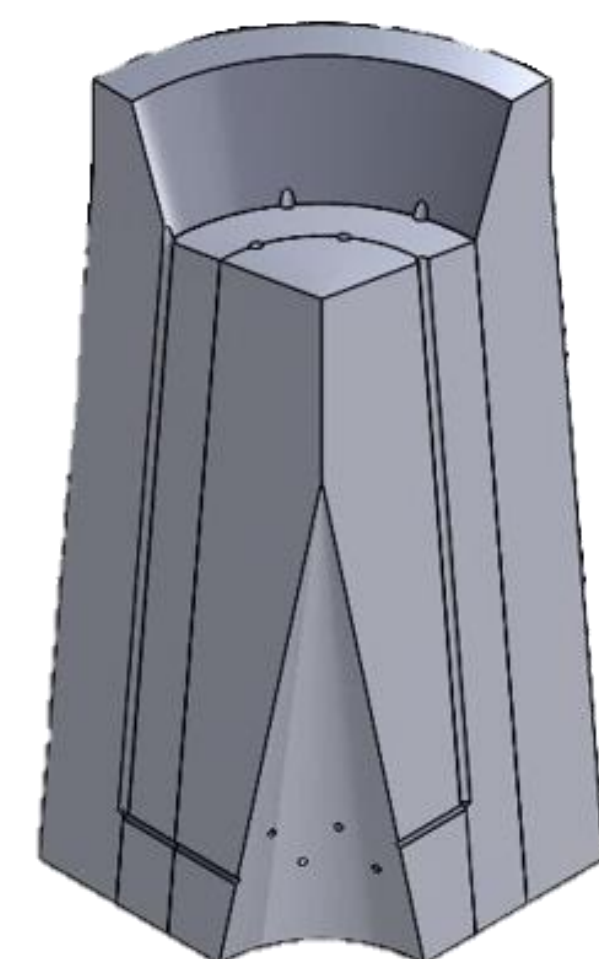


CONCEPT DEVELOPMENT

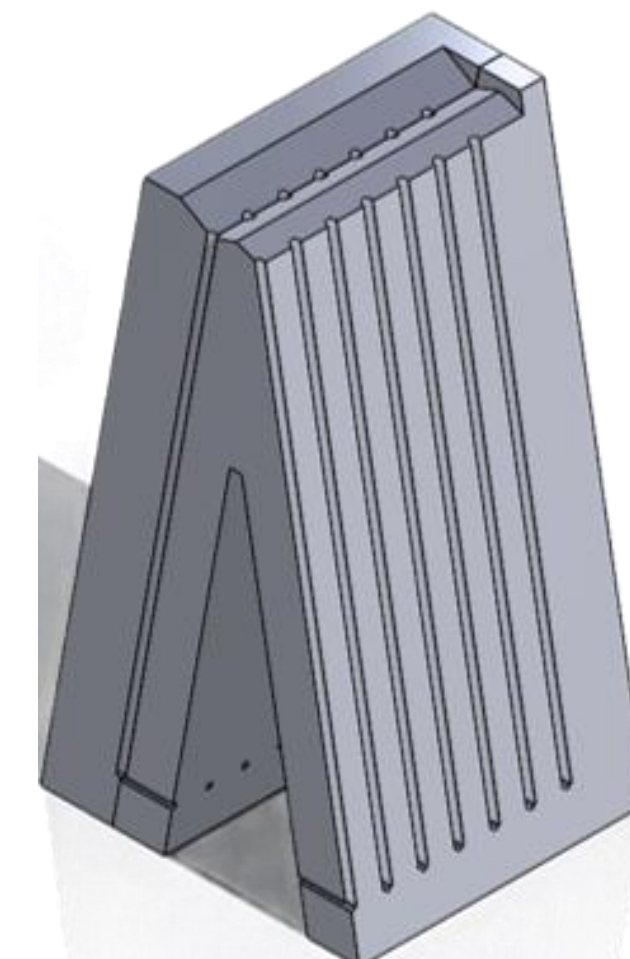
- INL Patent led to a Cylindrical Design
- For easy of manufacturing chose a linear plate
- On test pour switched from top fill to bottom runner



INL Patent Design



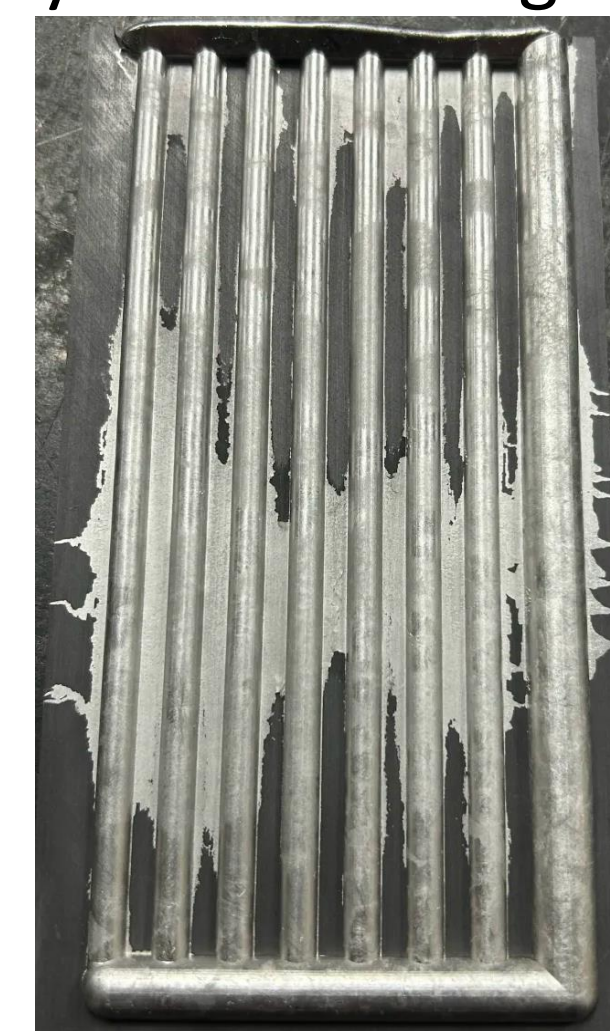
Cylindrical Design



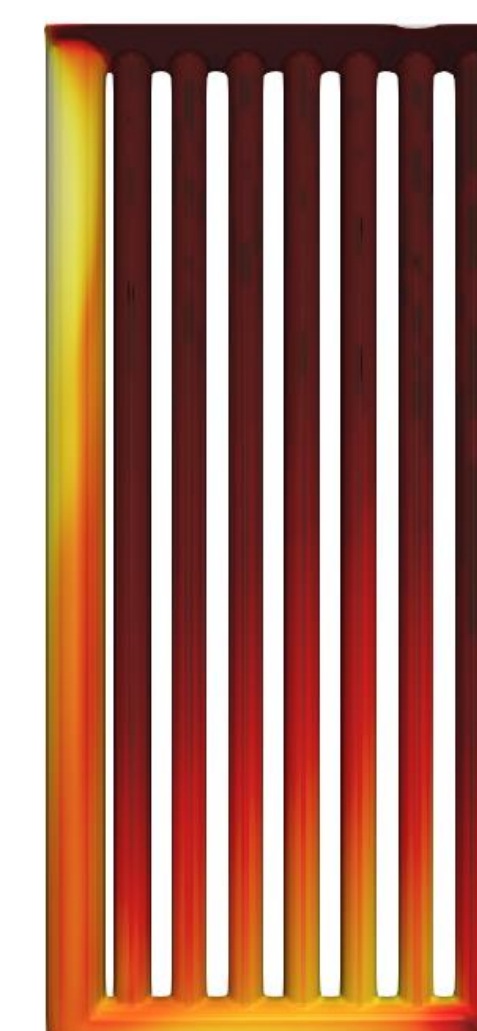
Linear Plate Design



Top Fill Experiment



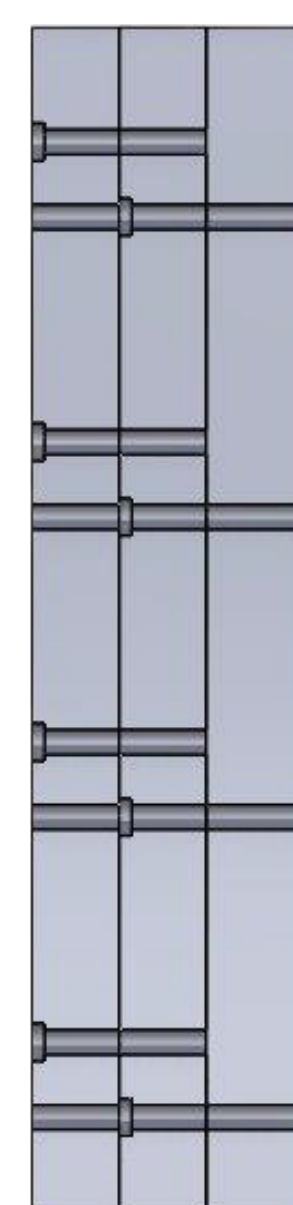
Bottom Fill Experiment



Experimental Validation

GRAPHITE TAP TESTING AND MACHINING

- Thread strength of graphite was tested
 - 800 lbf for ¼" and 1300 lbf for ½"
- Machining was completed dry, with a vacuum



Screws are offset to separate plates



Graphite piece used for thread test

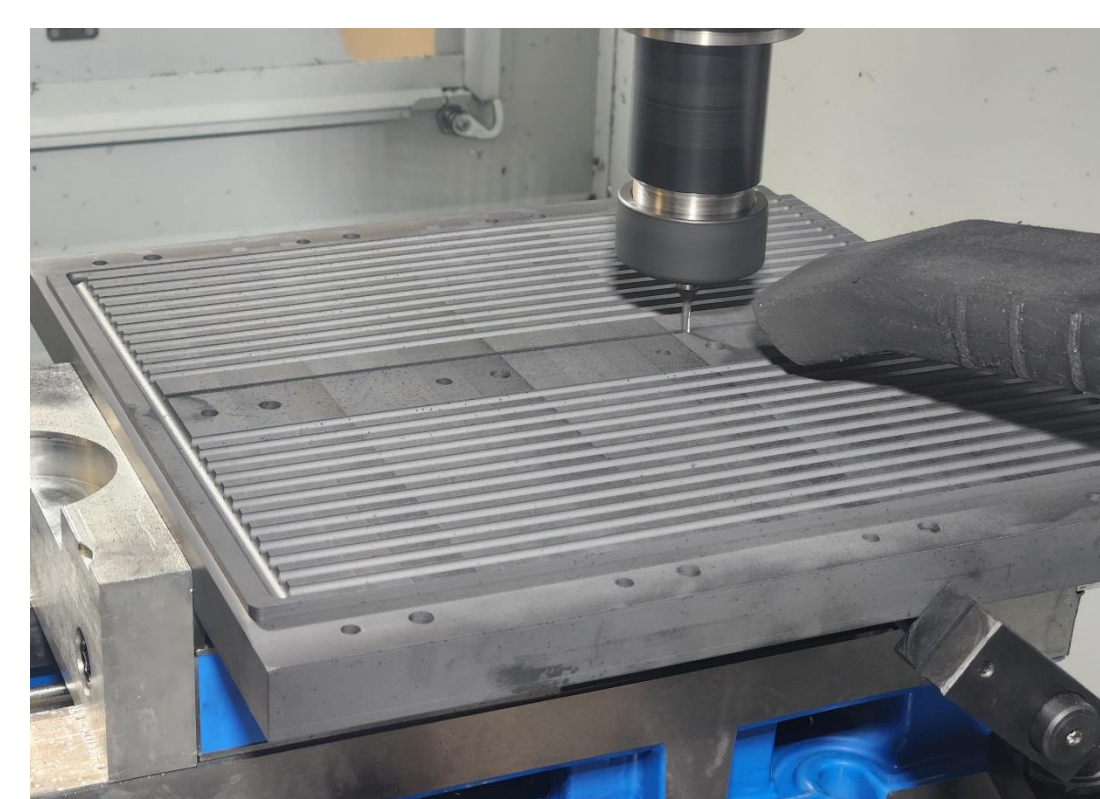
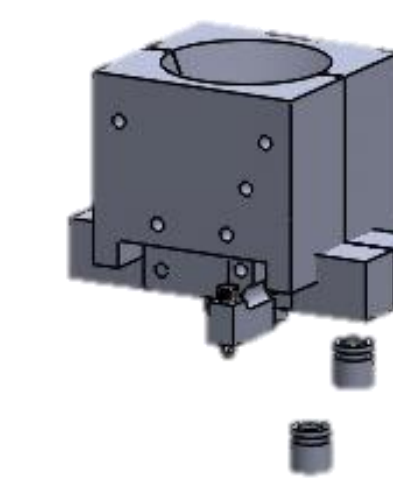
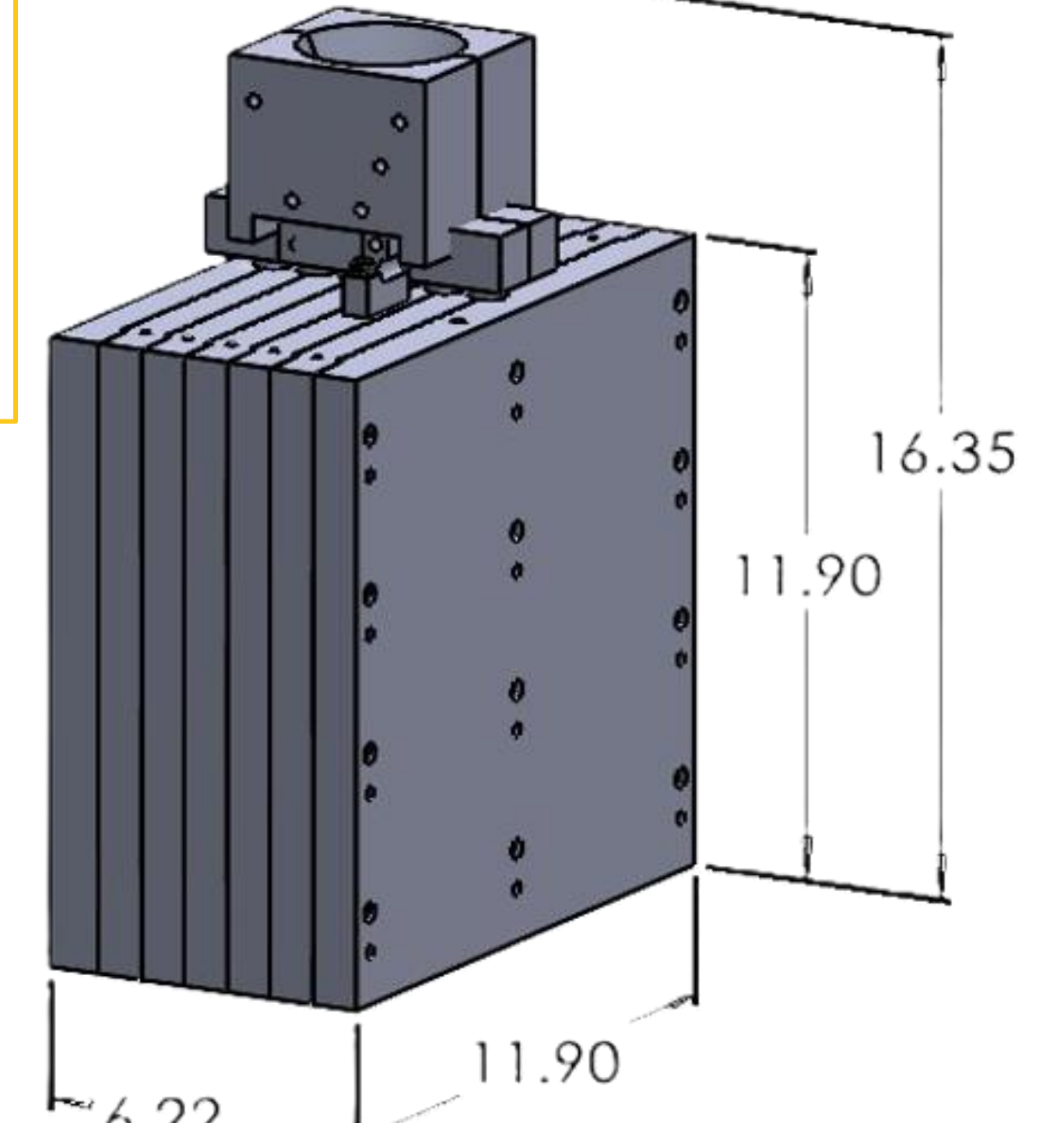
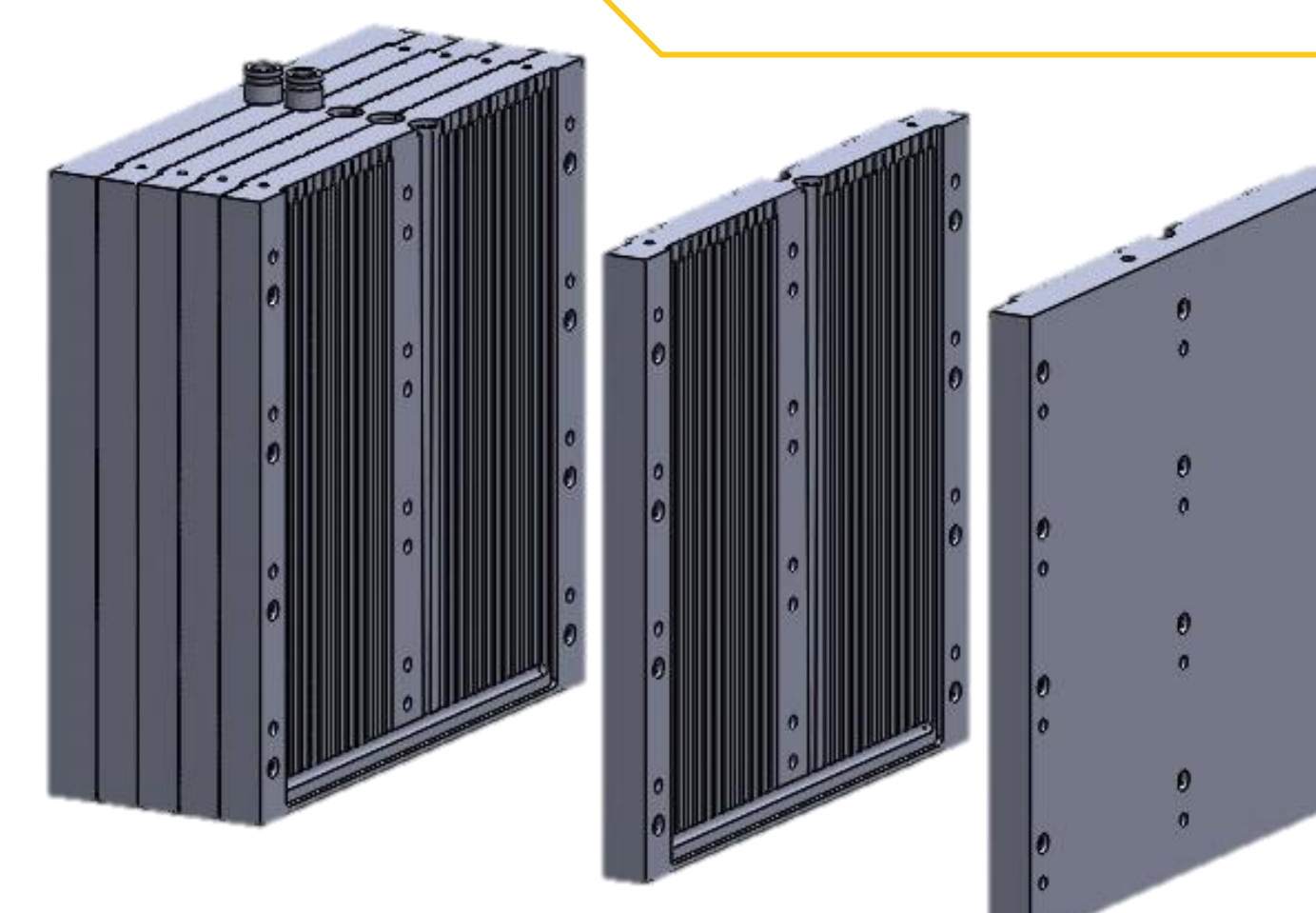


Plate in CNC mill

FINAL DESIGN



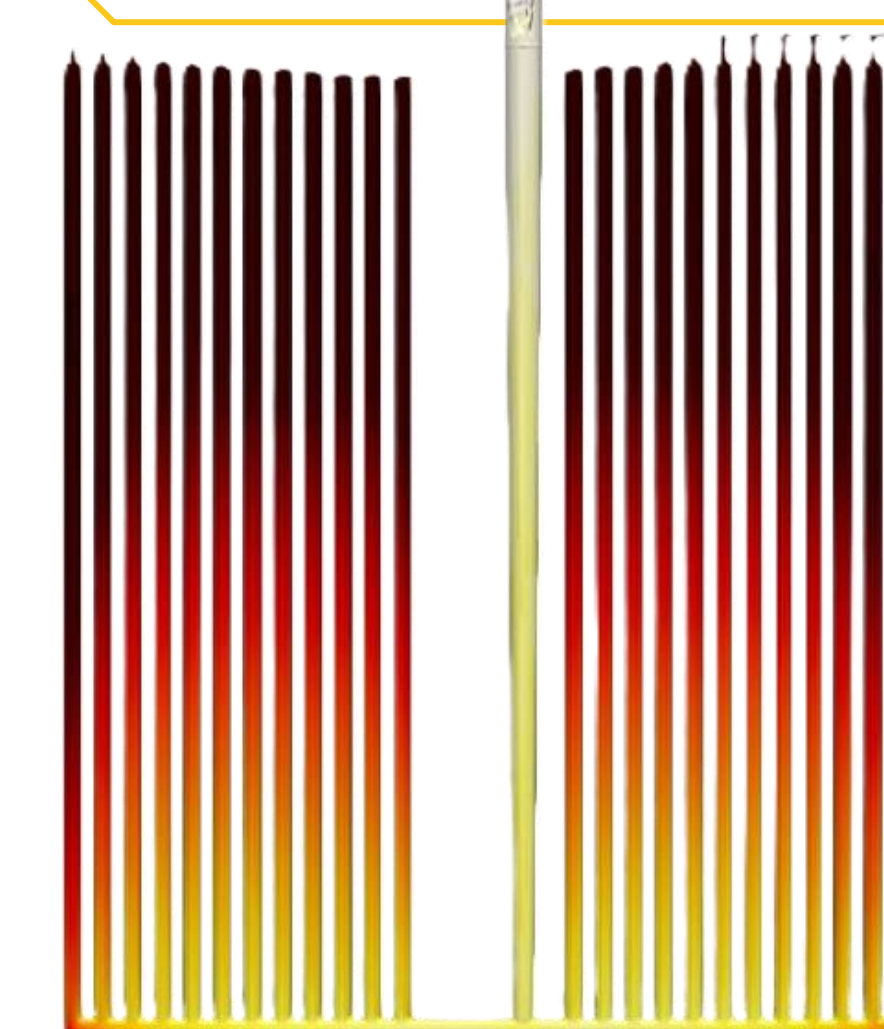
Full Scale mold, modular design allows additional graphite plates.



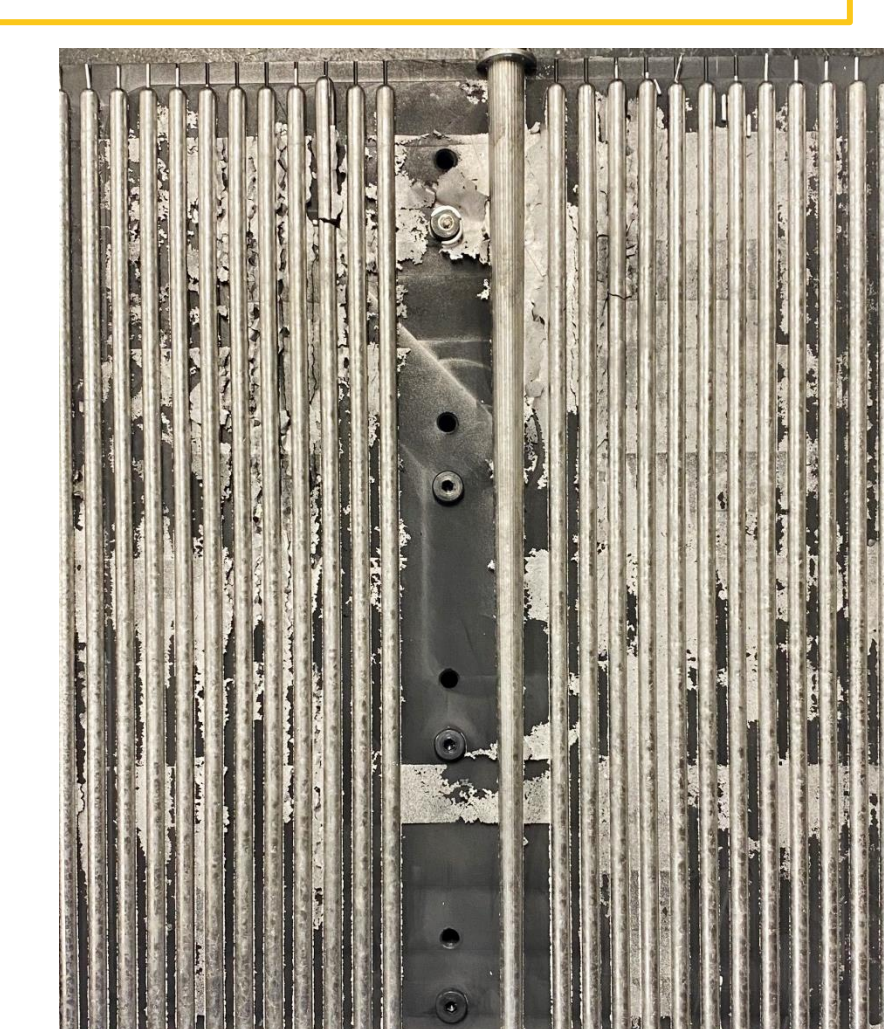
VALIDATION

- Used Flow 3D to sim small scale
- Validated simulations by performing experiments

- Mold Temp: 275 °F
- Melt Temp: 350 °F



Flow 3D simulation of small scale



Experimental Cast



Cleaned Rod Measurement

RESULTS

- Mold was able to produce rods that meet design requirements
 - 5.5 mm diameter
 - 280 mm Length
- On average, flash exceeded 0.005in on 2 of 24 rods
- Experiments required super heat on melt and molds, relative to melting point in K.



2025 Capstone Project