Target Chamber Design for Autonomous Target Retrieval

D. Thomas[1], Y. S. Park[3], J. A. Nolen[2]

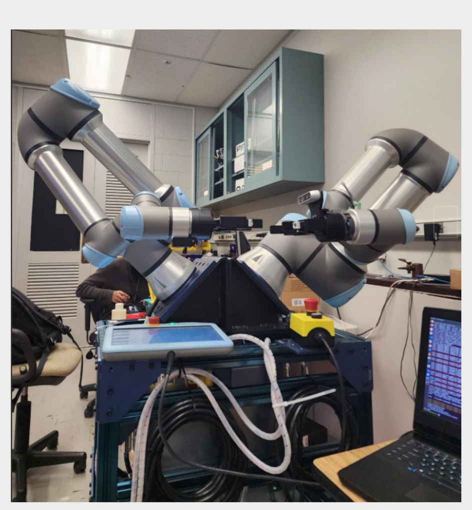
[1] Cyclotron Institute, Texas A&M, College Station, Texas
[2] Department of Physics, Argonne National Lab., Illinois
[3] Applied Materials Division, Argonne National Lab., Illinois

Introduction

- Delays in the transportation of radioisotopes cause unnecessary exposure of personnel and loss in yield
- Automation of this process addresses both issues
- Proper mechanical and thermodynamic design allows for the implementation of an autonomous retrieval process using a robotic arm.

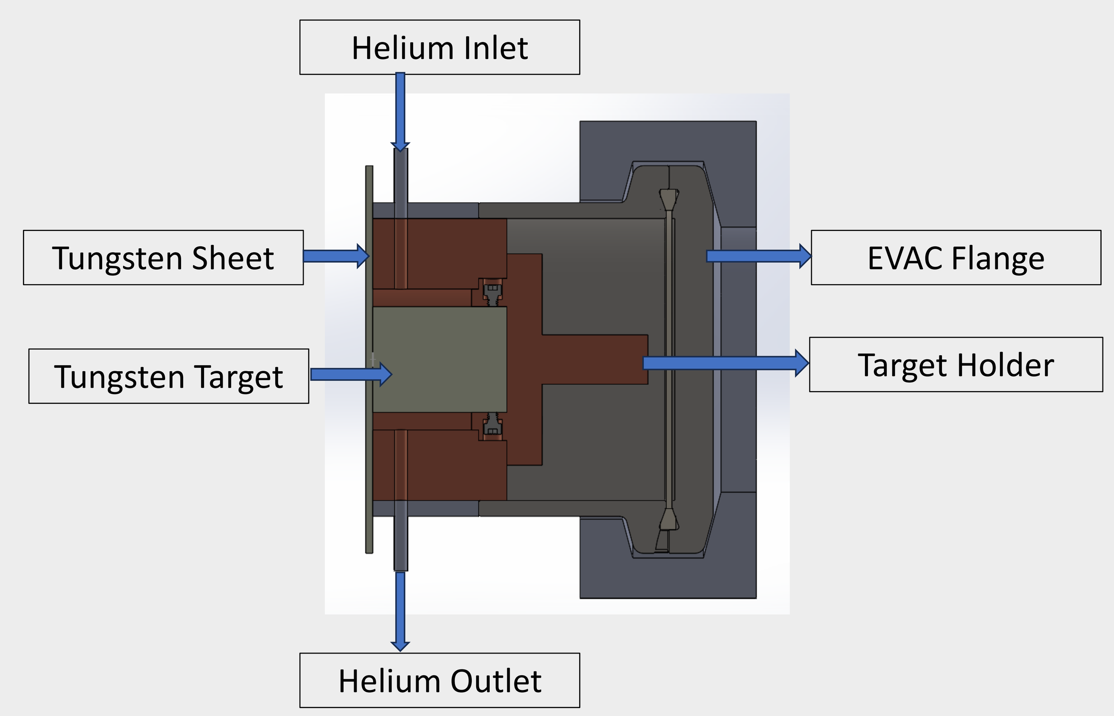
Methods

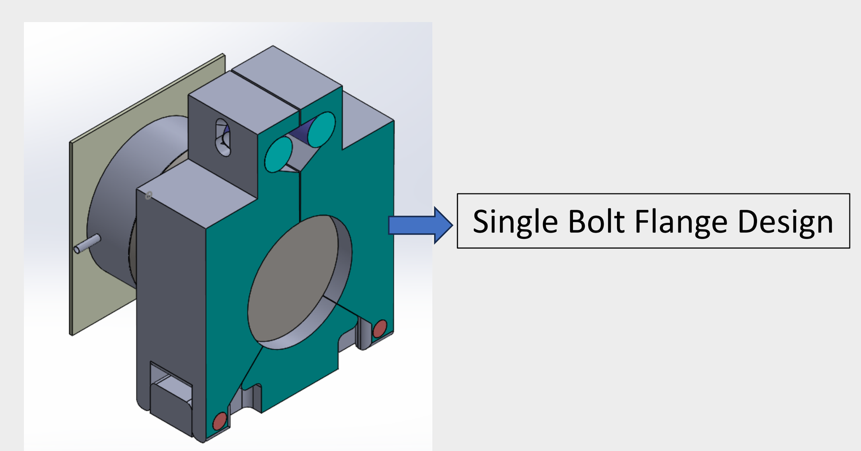
- The design of the target chamber is created in SolidWorks
- The convective coefficient was then calculated manually with respect to the design geometry
- The convective coefficient was then used in the FEMM 4.2 simulations
- The nature of the flow of helium was analyzed to determined the flow velocity using ANSYS CFX. This was used to update the convective coefficient calculations
- The design was then optimized for robotic retrieval
- An easily operatable flange for the robotic arm was designed and implemented into the target chamber design



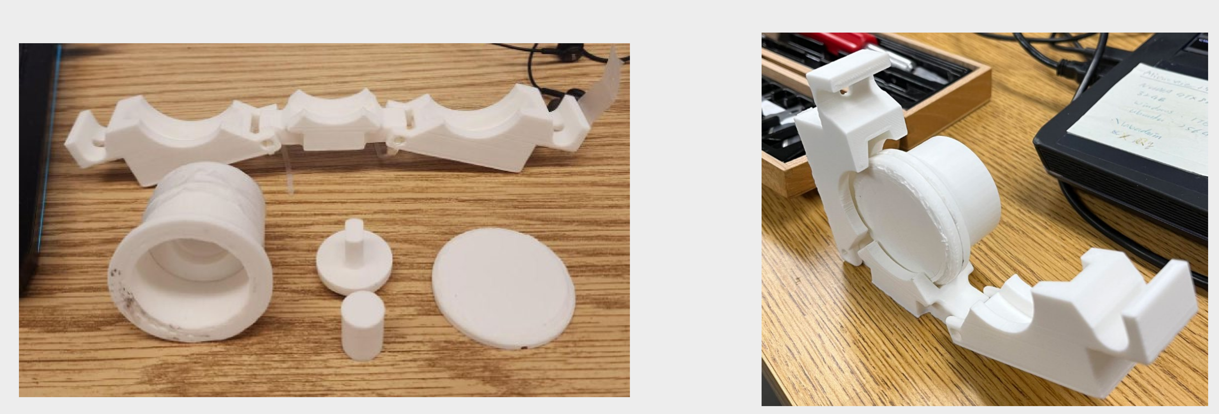
Robotiq 2F-85 Gripper Arm

Design and Experimental Setup



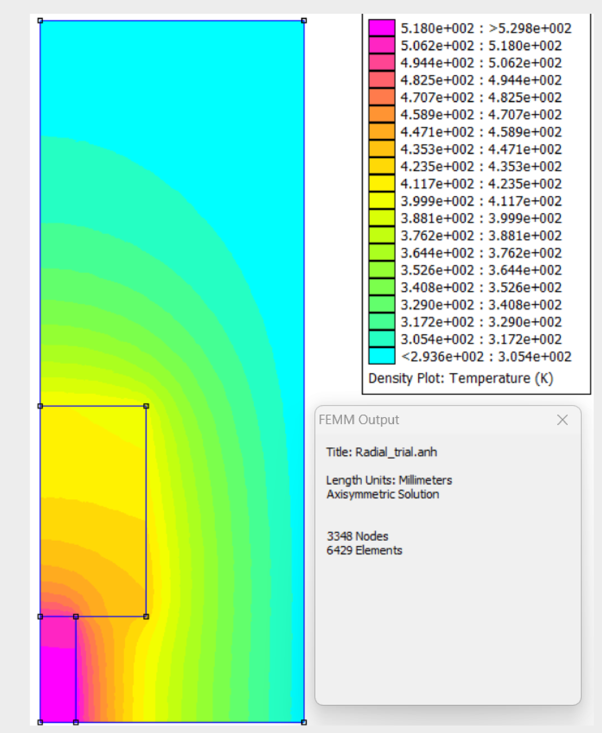


- The target is placed inside a heat exchanger.
- The flange design allows for easy removal and installation using a robotic arm.
- The design also allows for a helium line for adequate cooling.

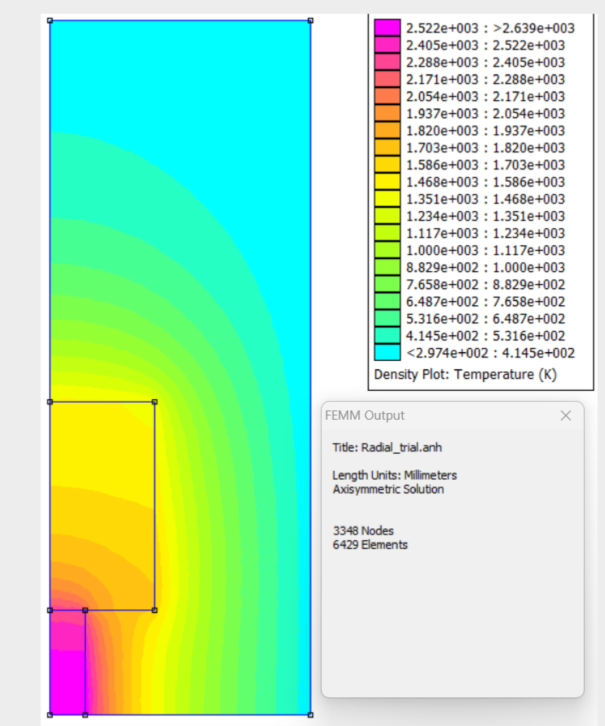


3D Printed Target Chamber Design along with the Single Bolt Flange Design

Results



Heat Generation – 10 W



Heat Generation – 100 W

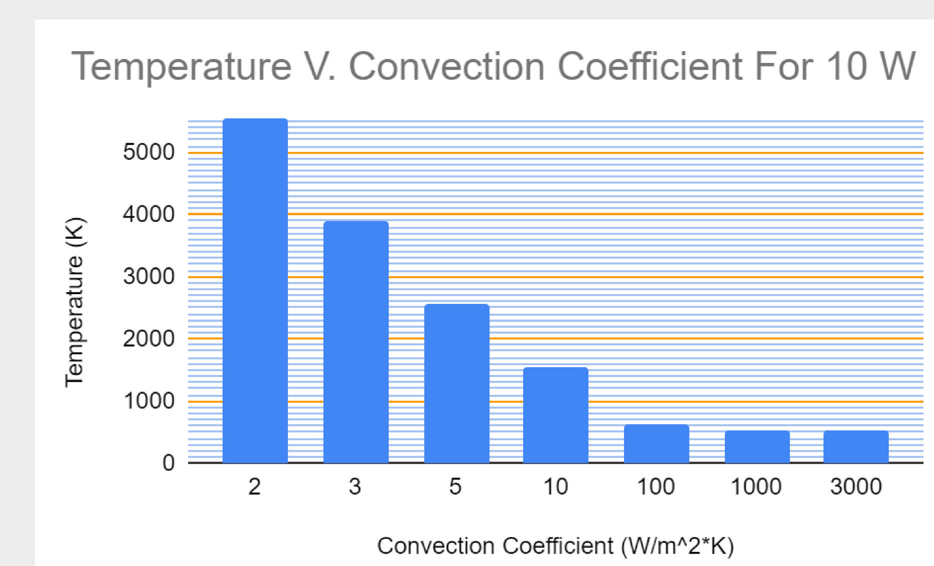
FEMM 4.2 Simulation using known beam conditions

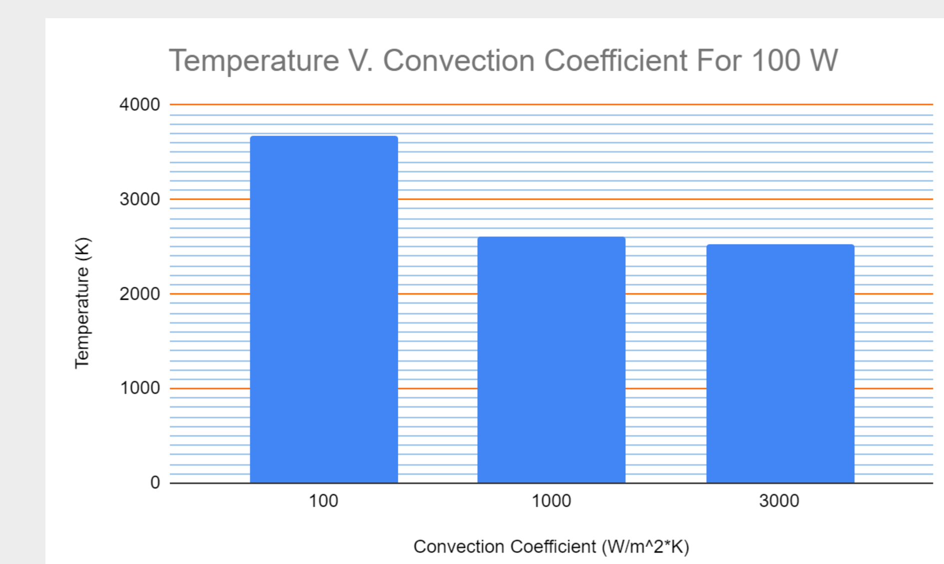
Convection Coefficient – 3kW/m^2*K

The target simulation shows the temperature gradient in the target

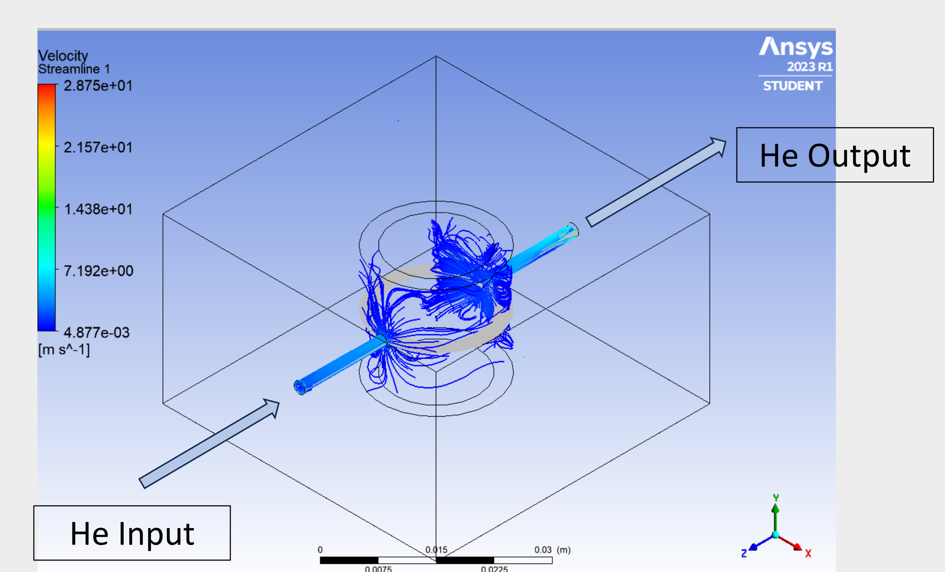
Melting point of the outer target material (Tungsten) is 3,695 K

The heat generation is concentrated in the first three millimeters of the target

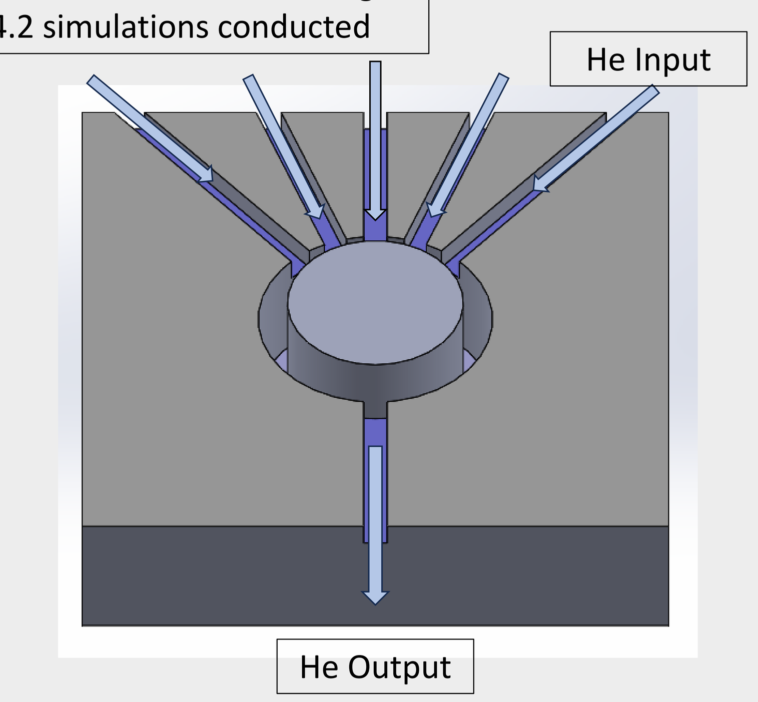




Temperature V. Convection Coefficient data shows the cooling limitations according to the FEMM 4.2 simulations conducted



ANSYS CFX Simulations shows the flow of Helium through the Target Chamber



SolidWorks Example for a possible helium flow

Future Directions

- Weldability of Tungsten
- Building and testing of vacuum seal
- Trial of helium cooling system
- Trial of robotic insertion and retrieval of target

Acknowledgements

This work is supported in part by the Horizon-broadening Isotope Production Pipeline Opportunities (HIPPO) program, under Grant DE-SC0022550 from the Department of Energy's Isotope R&D and Production Program, and also, in part, by funding from the Argonne Laboratory Directed Research and Development Program. Supported by the Argonne LDRD program.

References

- J. Bailey, R. Gromov, T. Petersen, S. Chemerisov, Thermal Test of 29mm and 12mm Targets, Experimental Operations and Facilities Division, Argonne National Laboratory, 2019
- C.P.C. Wong, C. Baxi, R. Bourque, C. Dahms, S. Inamati, R. Ryder, G. Sager, R. Schleicher, Helium cooling of fusion reactors, Fusion Engineering and Design, Volume 25, Issues 1–3, 1994