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Molten Salt Reactor
PROGRAM

Tritium Transport

Update on the Molten Salt Tritium Transport Experiment

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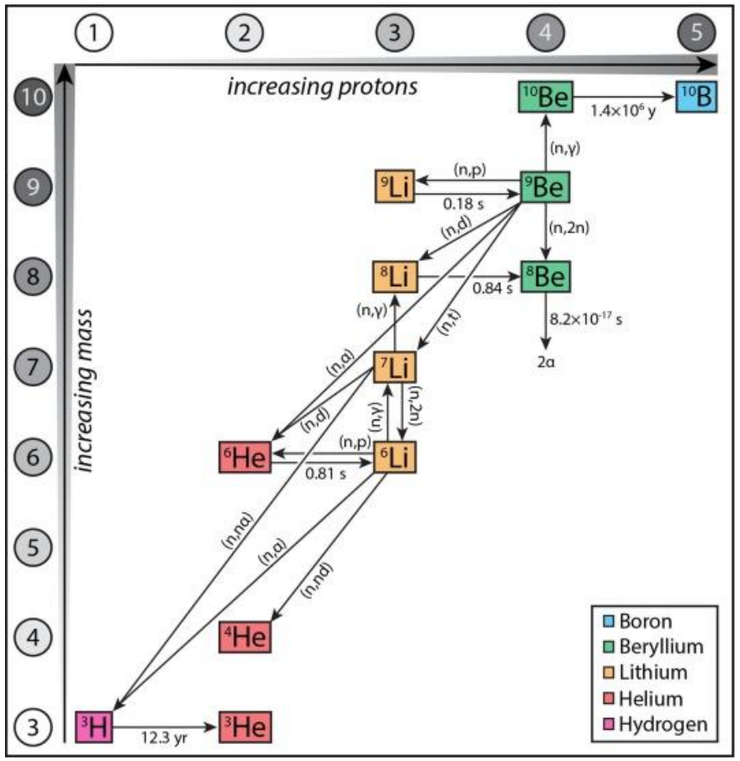
Outline

- Tritium Transport Background
  - Generation in MSRs
  - Transport in MSRs
- **M**olten **S**alt **T**ritium **T**ransport **E**xperiment (MSTTE)
  - Overview
  - Status Update

Tritium Generation in MSRs

Tritium generated by neutron reactions with Li, Be, and F.

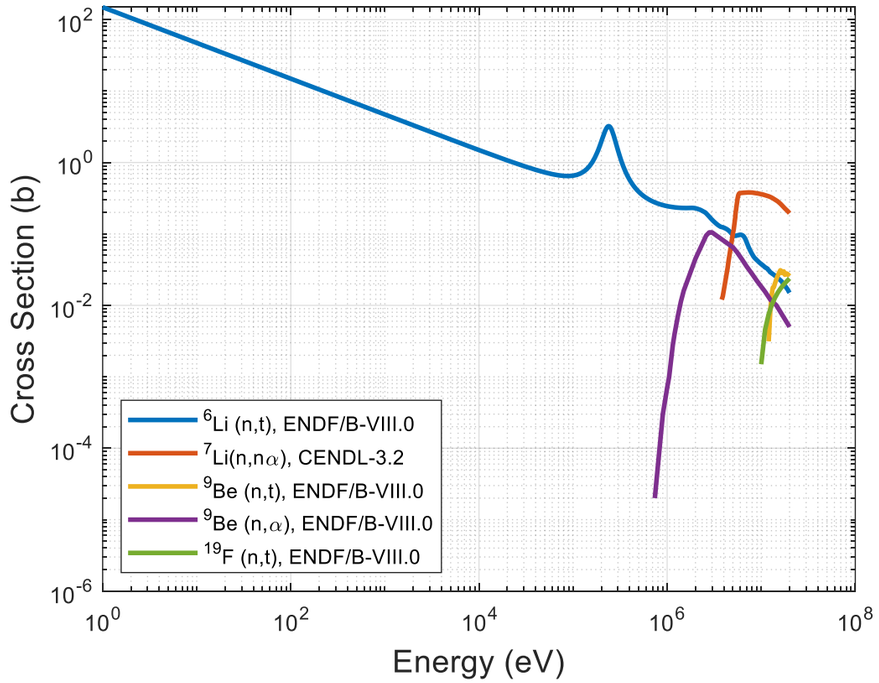


Andrews, Hunter B., et al. "Review of molten salt reactor off-gas management considerations." Nucl. Eng. Des. 385 (2021): 111529.

^{6}Li (7.5%) large thermal cross-section.

^{7}Li (92.5%) moderate cross-section in fast-spectrum.

^{9}Be and ^{19}F in fast-spectrum.



Tritium generation rates in *fluoride* salt reactors are similar to CANDU reactors.

CANDUs produce world's commercial supply of tritium.

Tritium is a valuable byproduct of MSRs.

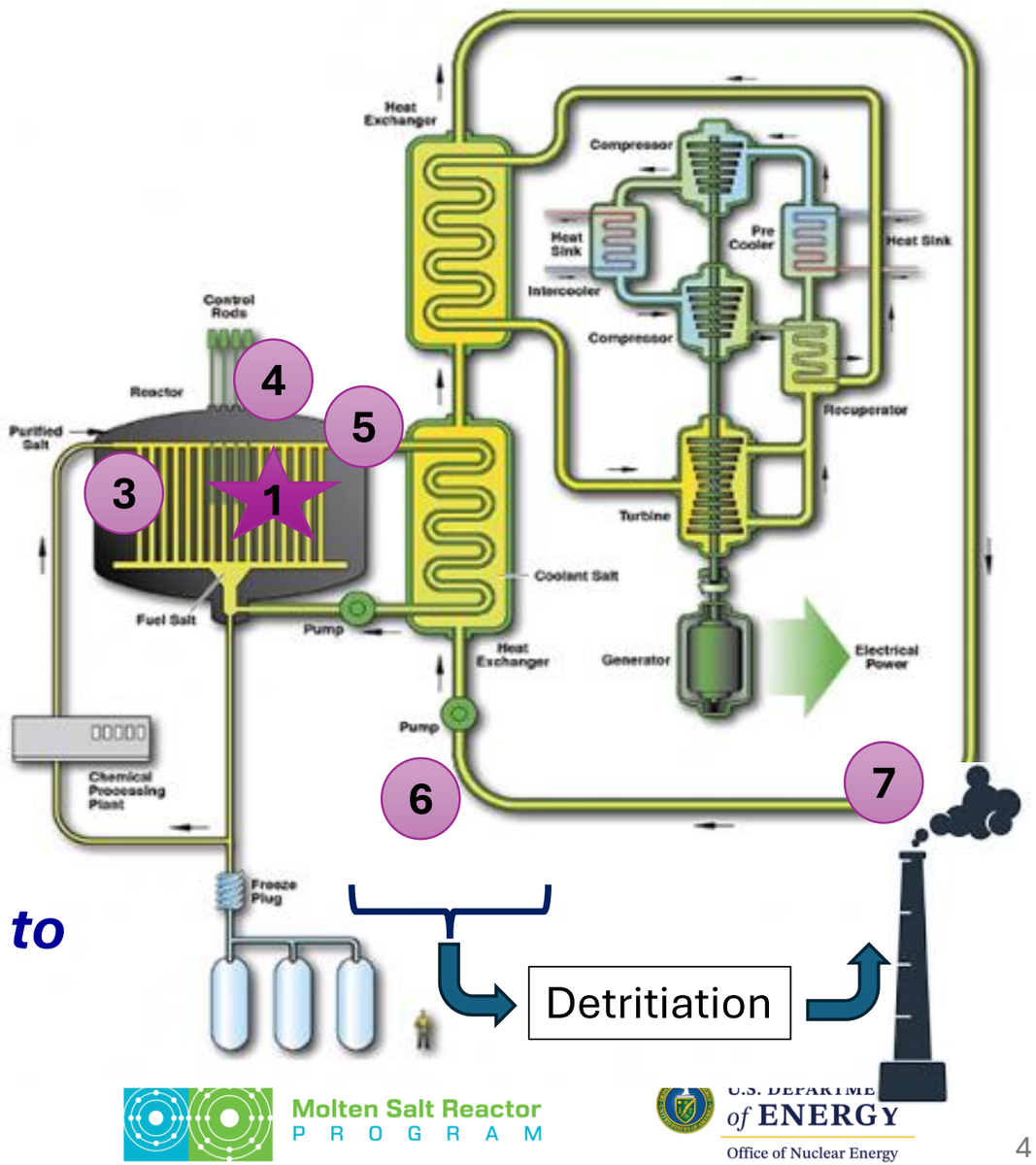
Reactor Type	Tritium Formation Rate 1000 MWe (Ci/day) [1]
MSR	2400*
CANDU	2700
HTGR	50
PWR	2

*MSBR enriched in ^{7}Li (99.992%).

Tritium Transport in MSRs

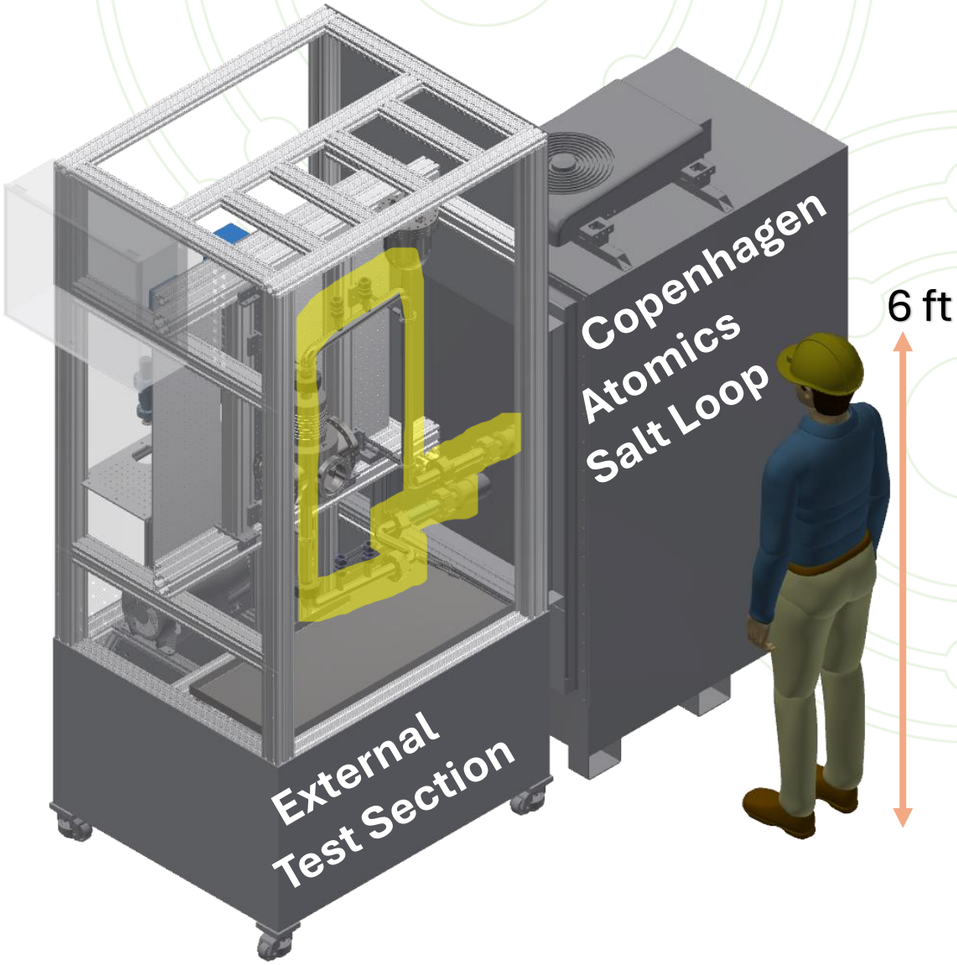
1. Production (neutrons + Li, Be, F)
2. *Speciation (TF vs. T_2)*
3. *Graphite*
4. Evolution into off-gas system
5. *Diffusion through materials*
6. Secondary system off-gas system
7. Onwards to detritiation/stack

Can we predict tritium transport in order to develop required control technology?



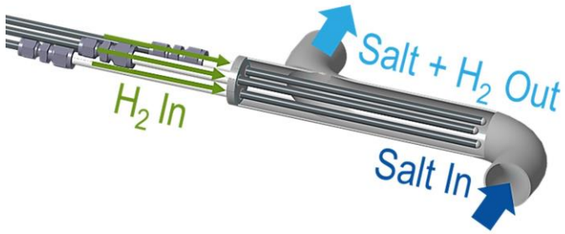
Molten Salt Tritium Transport Experiment

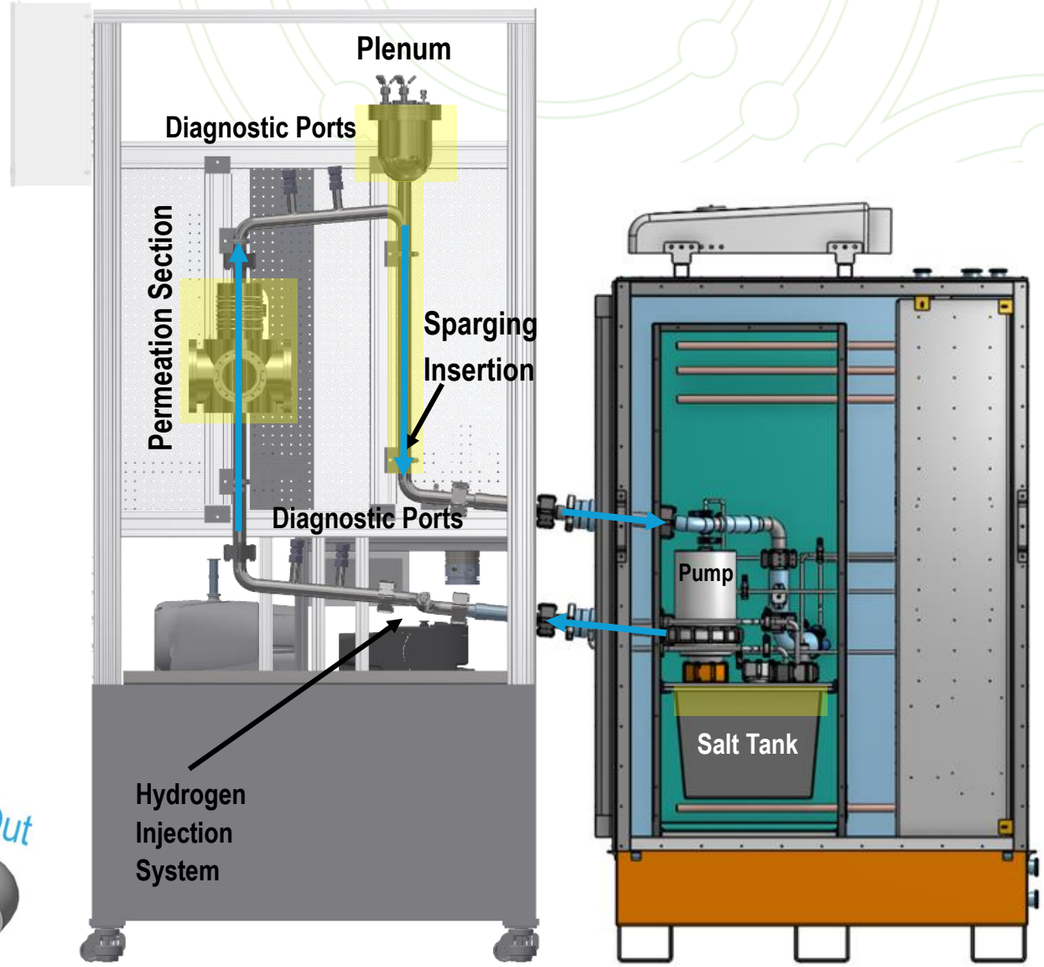
- *MSTTE is a semi-integral tritium transport experiment for flowing fluoride salt systems.*
- Location: Safety and Tritium Applied Research facility at Idaho National Laboratory
- **Objectives:**
  - **(1) Safety code validation data.**
  - **(2) Test stand for tritium control technology.**
- *Major Equipment:*
  - **Copenhagen Atomics Salt Loop**: salt tank, pump, flow meter, instrumentation and control
  - **External Test Section:** hydrogen injection, permeation, plenum, salt diagnostics, gas systems, controls, salt exchange tank, and *versatile*



MSTTE Transport Phenomena

- Permeation through structural materials: *permeation test section:*
  - **316 SS – 1 ½ in OD – 0.120 in WT – ASTM A269**
    - 15,000 < **Re**$_{FLiNaK}$ < 90,000
    - 7,000 < **Re**$_{FLiBe}$ < 40,000
- Evolution to off-gas: *plenum* and *salt tank*
  - Argon Cover Gas
- ***Sparging in downward salt flow leg***
  - ***0.5 in OD Tube Port***





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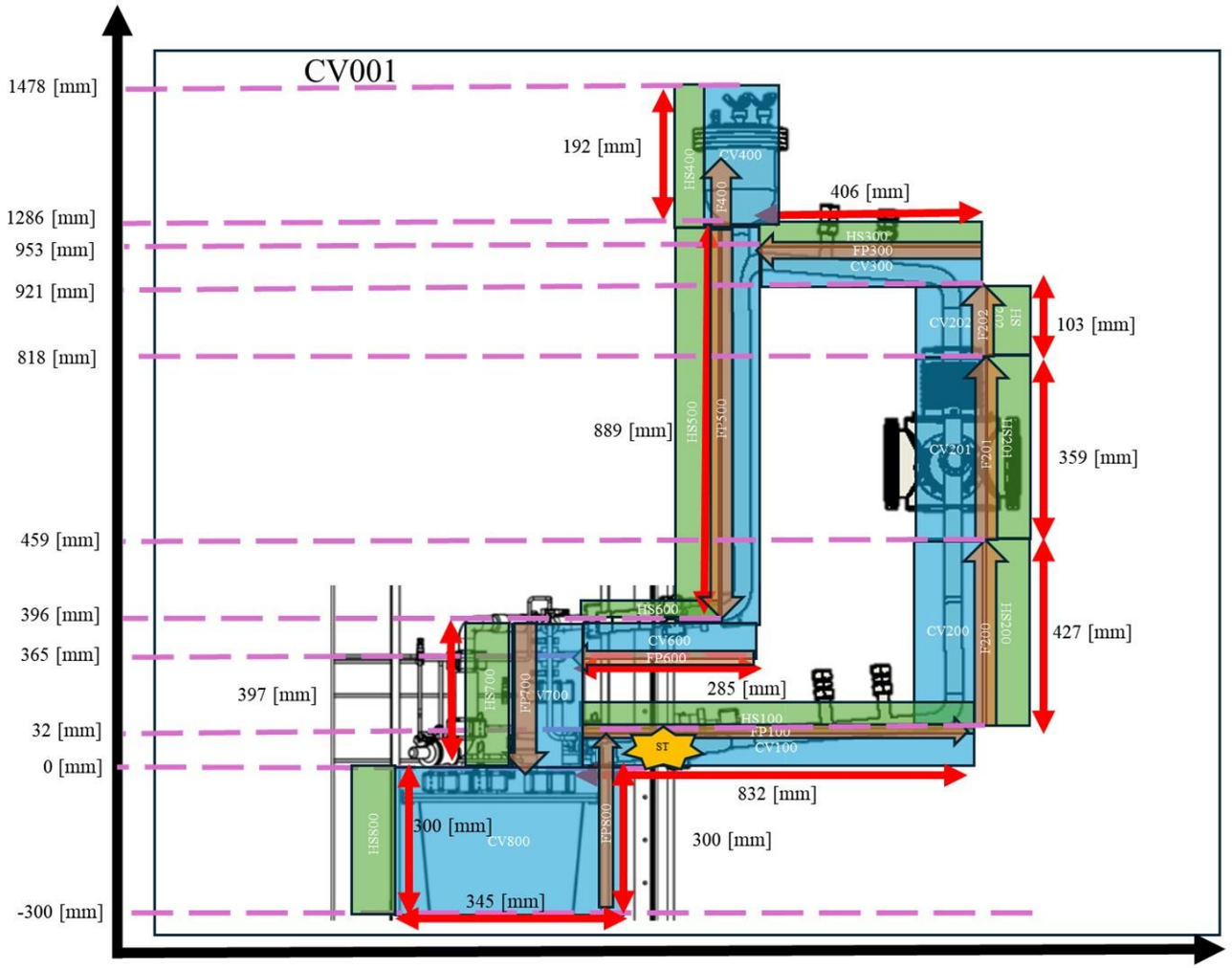
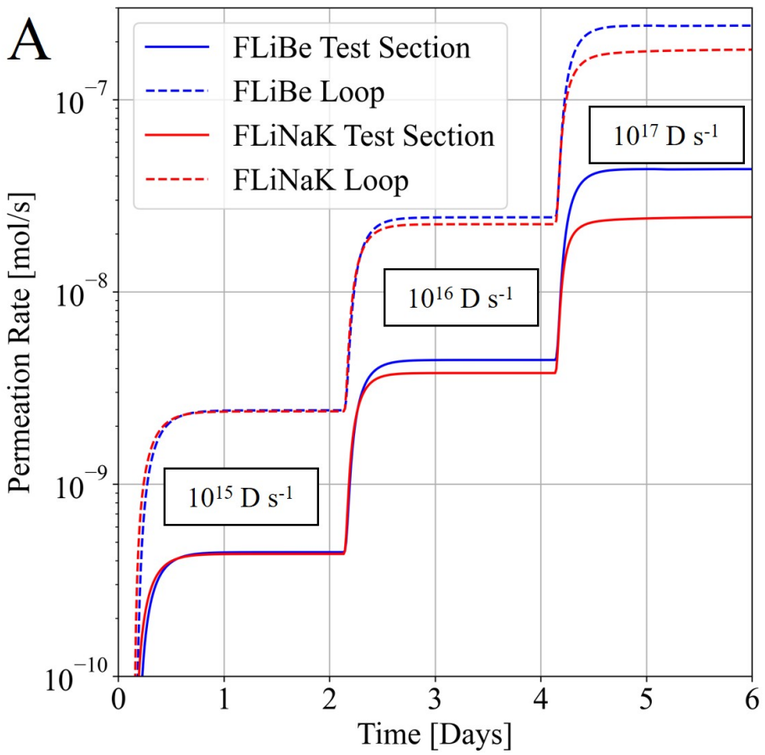
Permeation and Analysis - Model



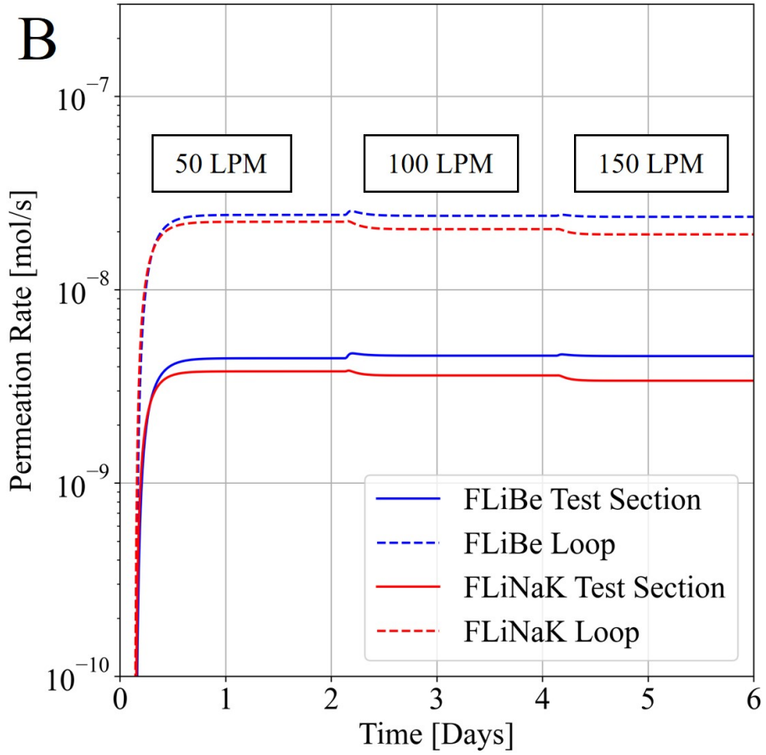
Permeation Analysis – Results

MELCOR-TMAP

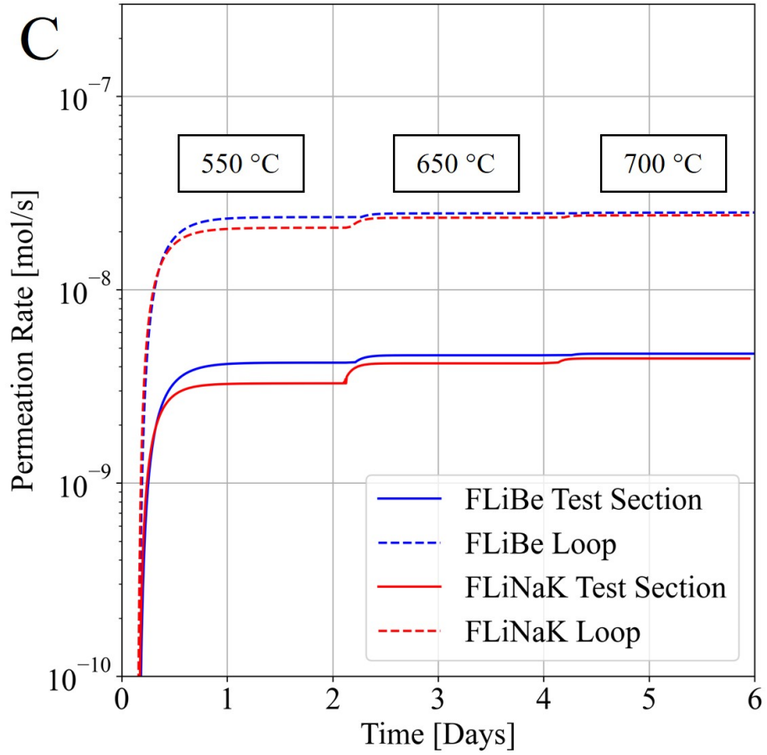
H Injection Rate



Salt Flow Rate

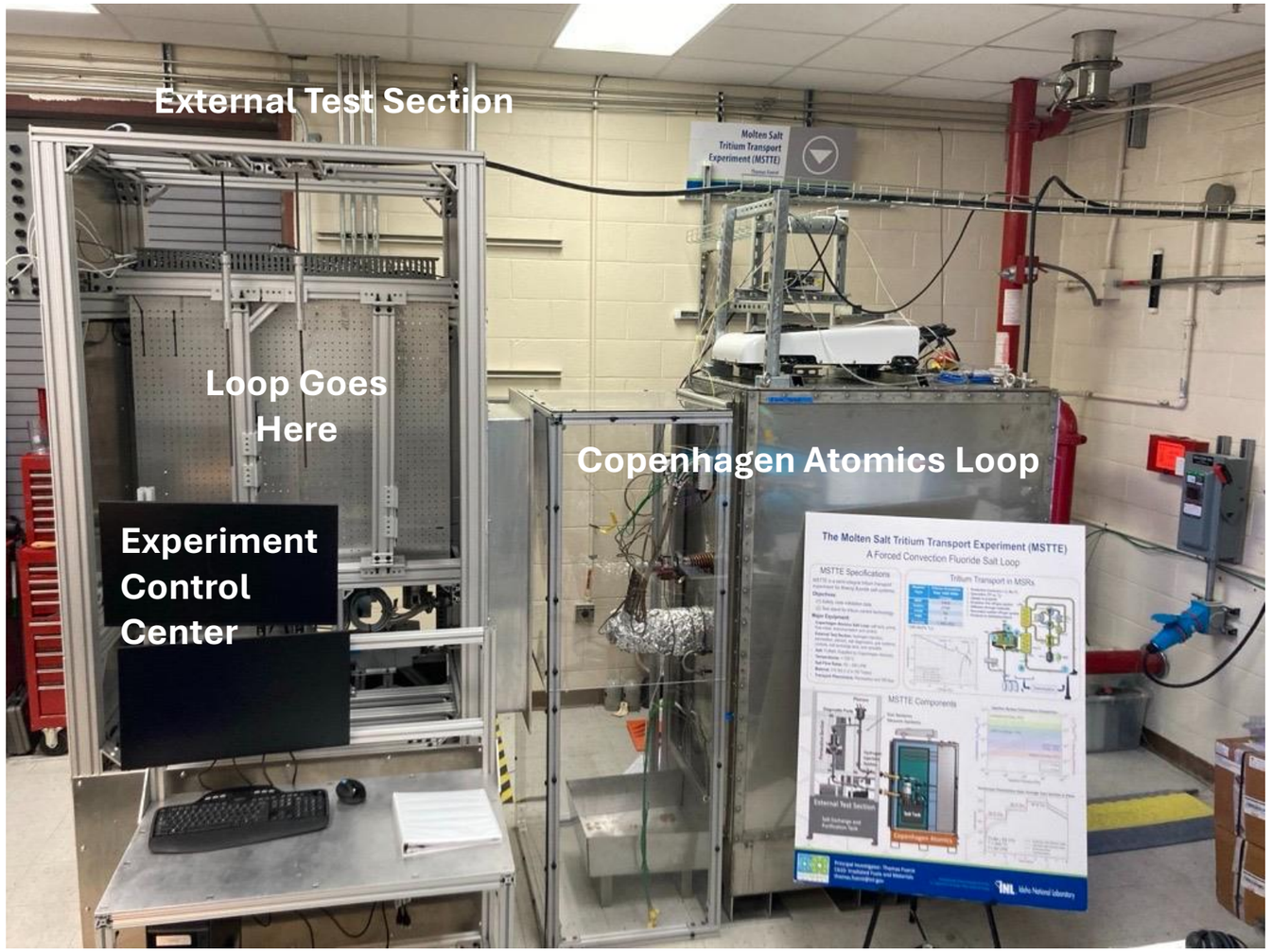


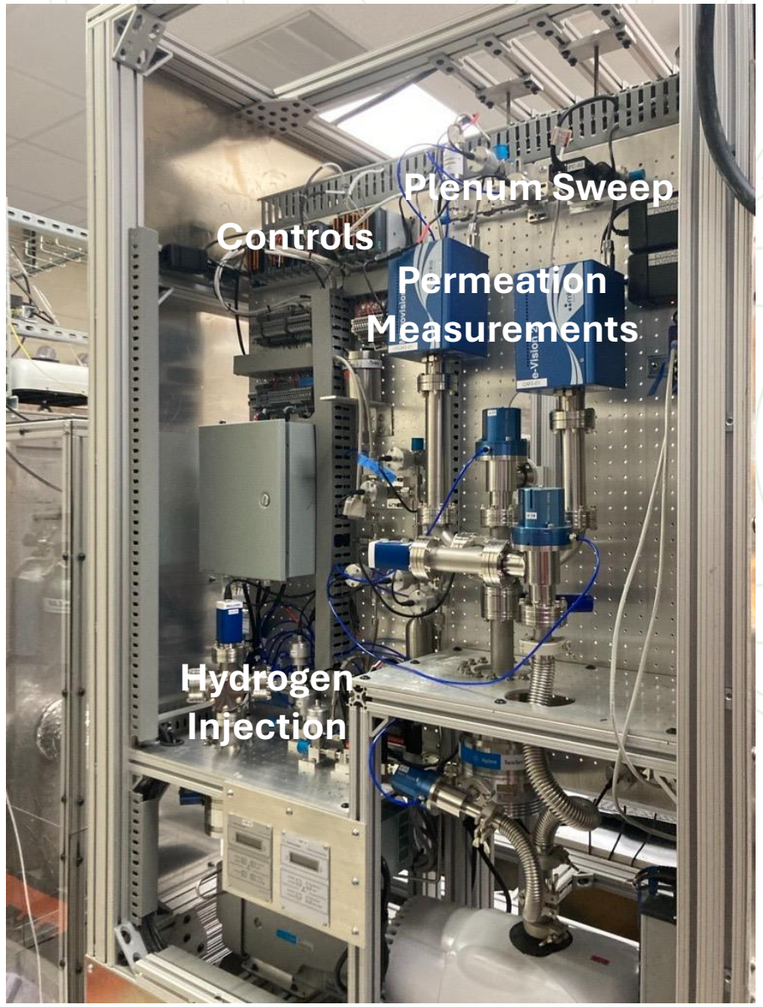
Salt Temperature



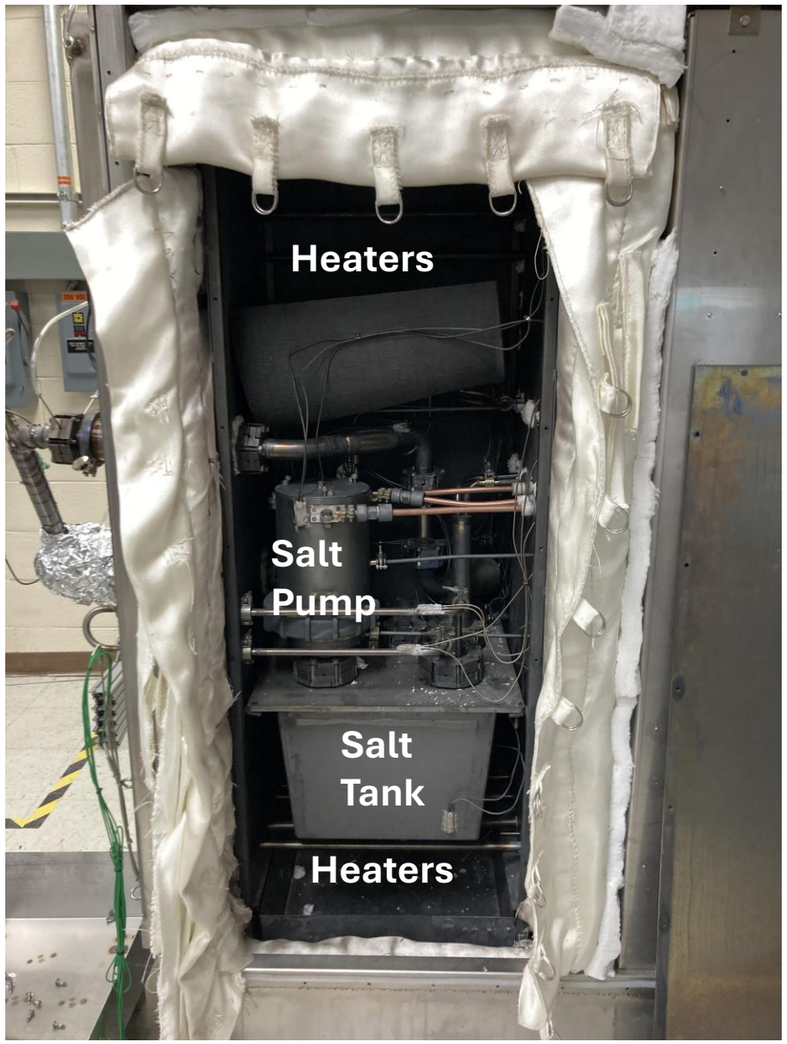
Base Conditions: 600° C, 10^{16} D s^{-1}, 50 LPM

Status Update

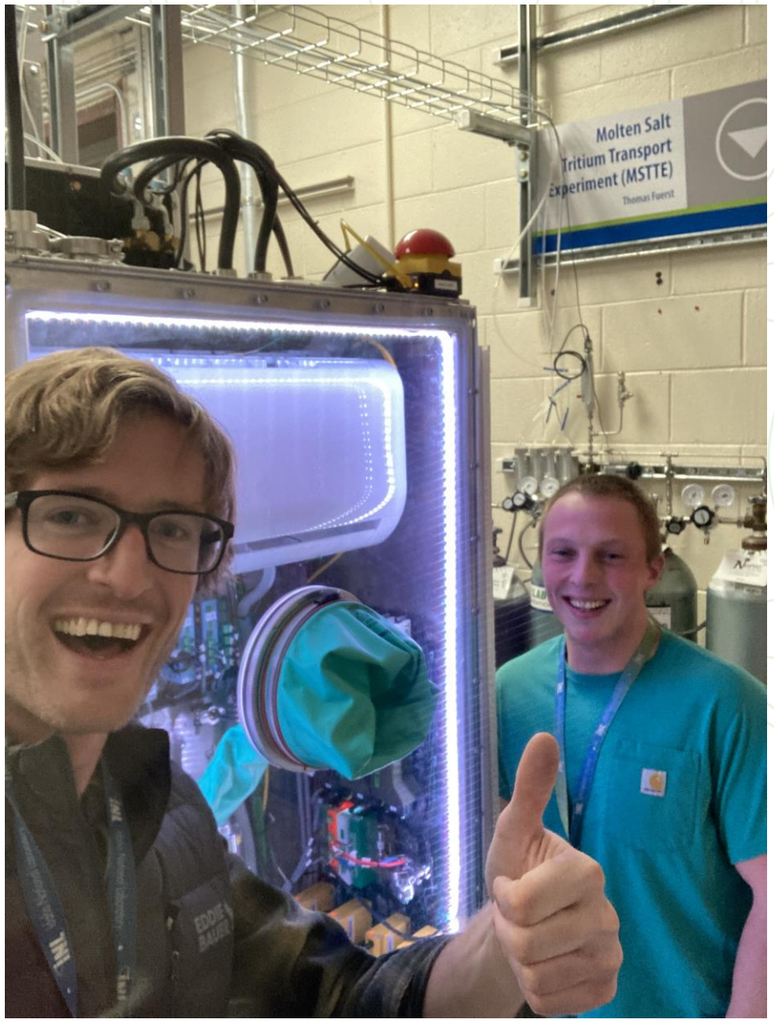




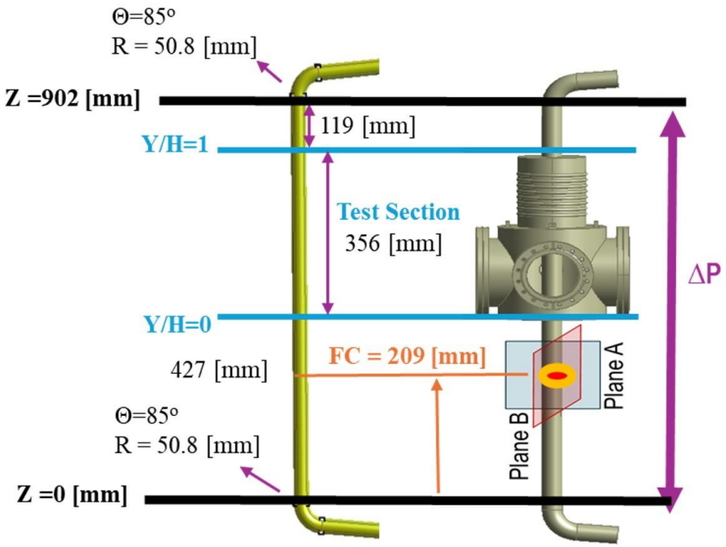
Copenhagen Atomics Loop

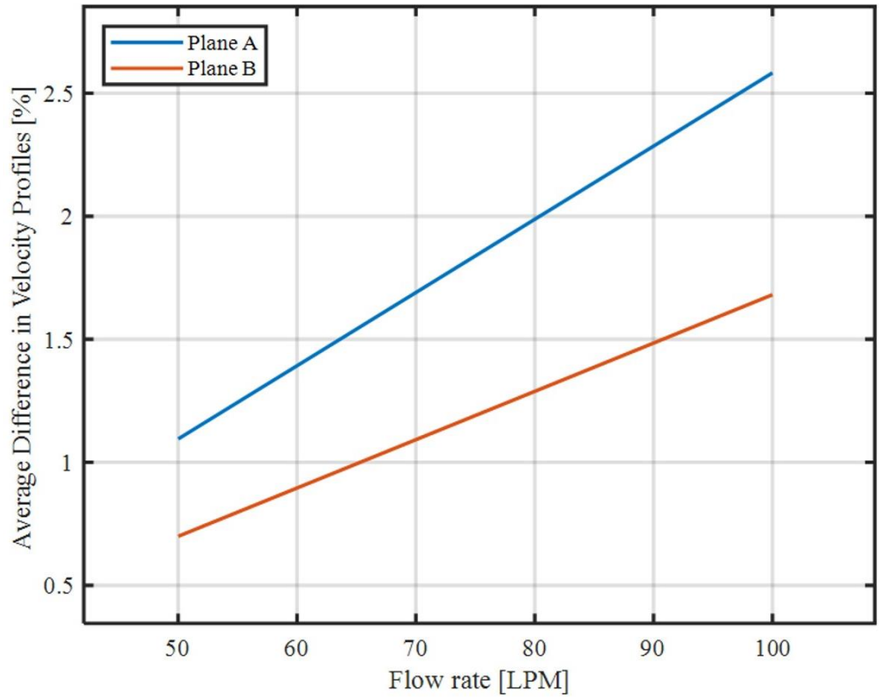


Loop Powered!



External Test Section

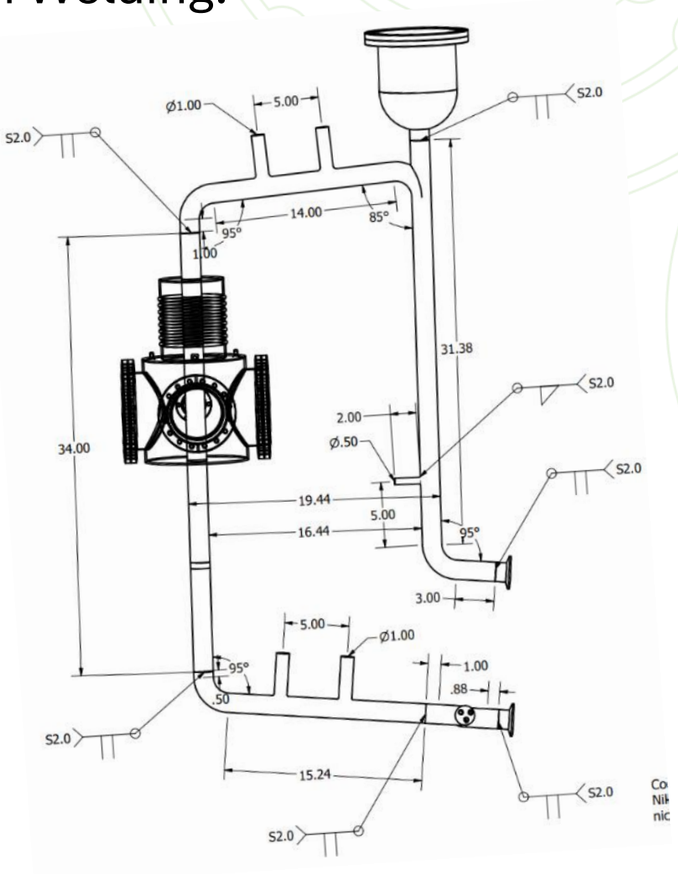




Symmetric flow achieved with flow conditioner!

External Test Section Fabrication

All Components Received!
Waiting on Welding.



Summary

- Molten Salt Tritium Transport Experiment is versatile capability designed to provide tritium transport data and test control technology related to Molten Salt Reactors

- Sensors and Diagnostics
- Modeling and Simulation

Connect with me!

Contributions/Collaborations

Safety and Tritium Applied Research Facility

- ***Joseph Redmond (MSU)***
- ***Tucker Warden (CSM)***
- Chase Taylor
- Nikki France
- Masashi Shimada
- Shayne Loftus
- Bob Pawelko
- Taylor Hill
- Casey White
- Travis Neuman
- Rowdie Shepherd
- Randel Paulsen
- Megan Laing

Modeling and Simulation

- Ad Riet
- Matt Eklund
- Sam Walker

Argonne NATIONAL LABORATORY

- Travis Mui
- Rui Hu
- ***Yifan Mao***

UMASS LOWELL

- ***Anthony Bowers***
- Prof. Subash Sharma

***Student Interns**

Thank you

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