Virtual Prototyping of Liquid Lithium Divertor Concepts

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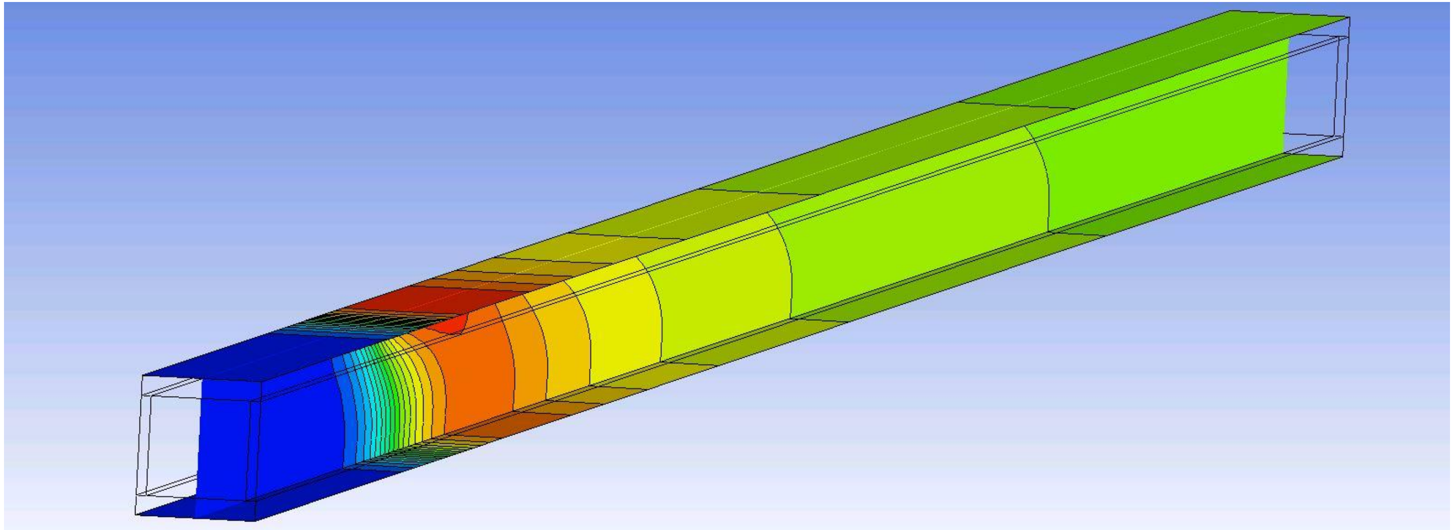
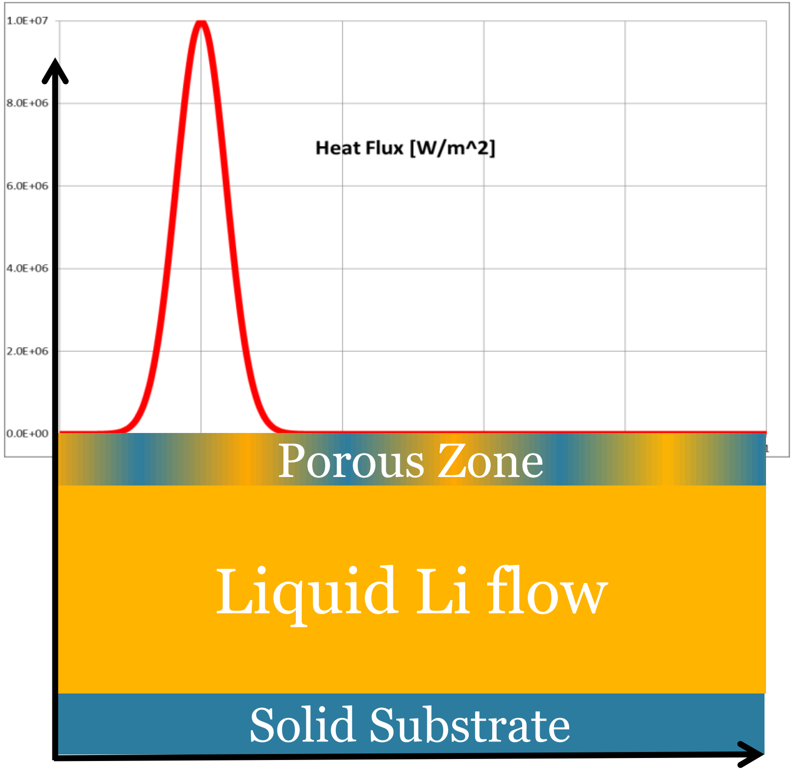


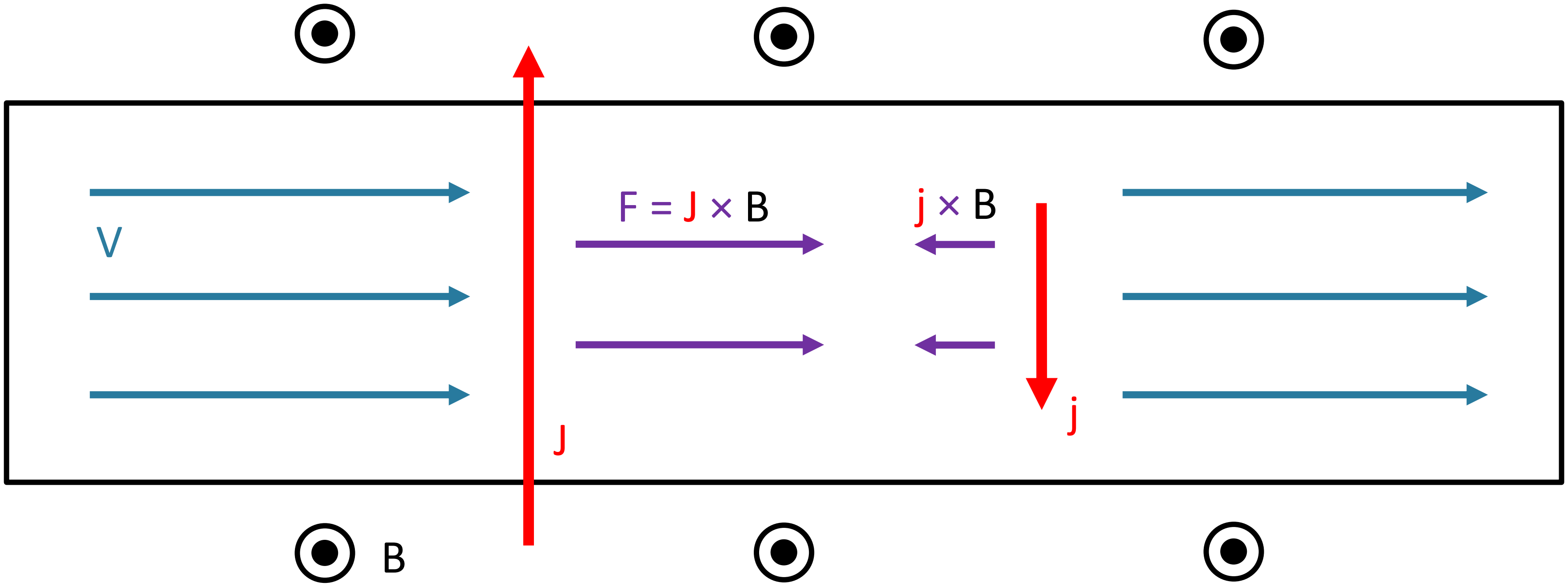
Background

- We're interested in heat transfer in liquid lithium flows under strong magnetic fields
- We want to maximize the amount of heat the lithium can carry away
- Porous delivery system gives some of the benefits of solid and liquid PFCs

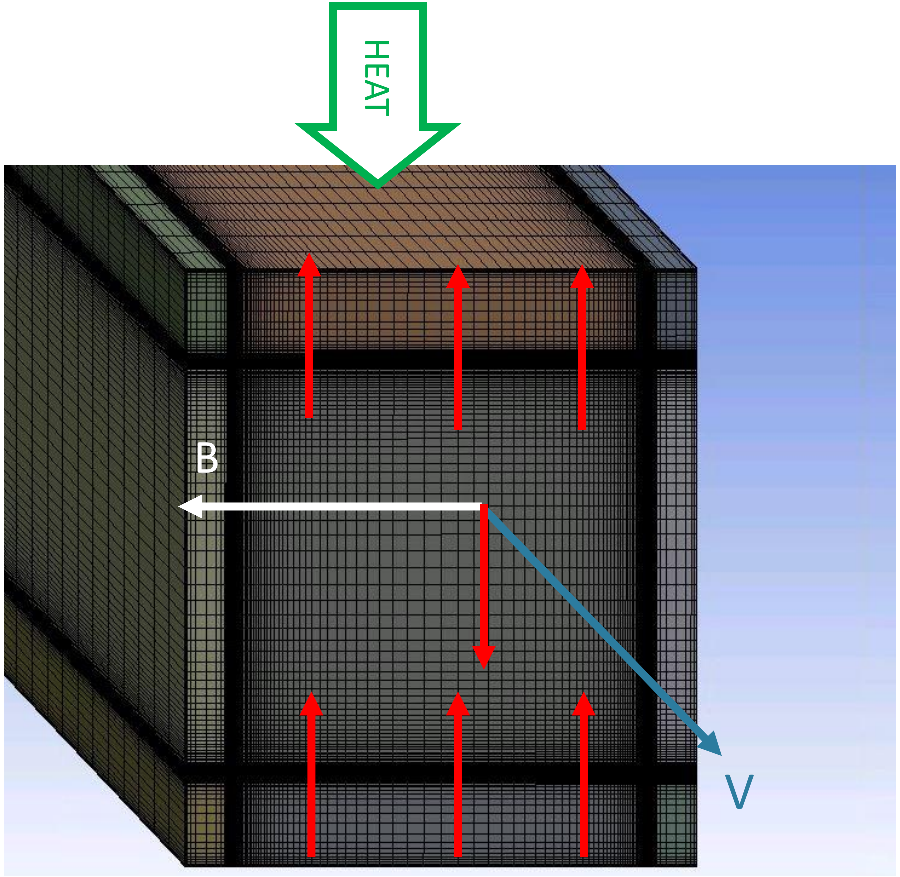


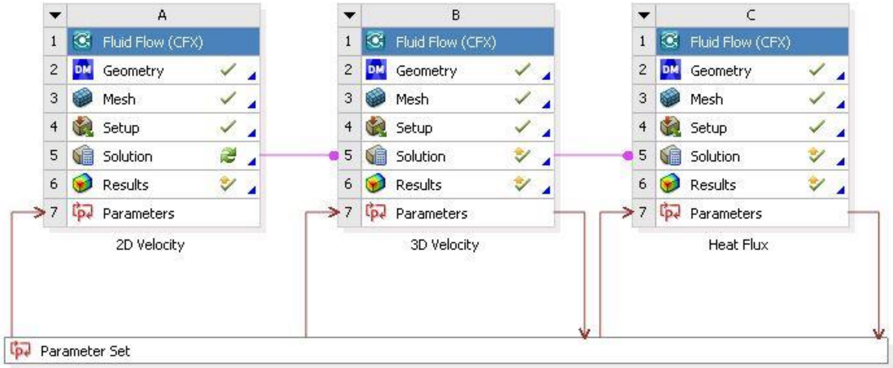
Questions

- Applied current can overcome MHD drag
- Can an MHD pumped LM channel flow handle the load on a divertor?
- How can we maximize heat removal?



Modeling and Assumptions

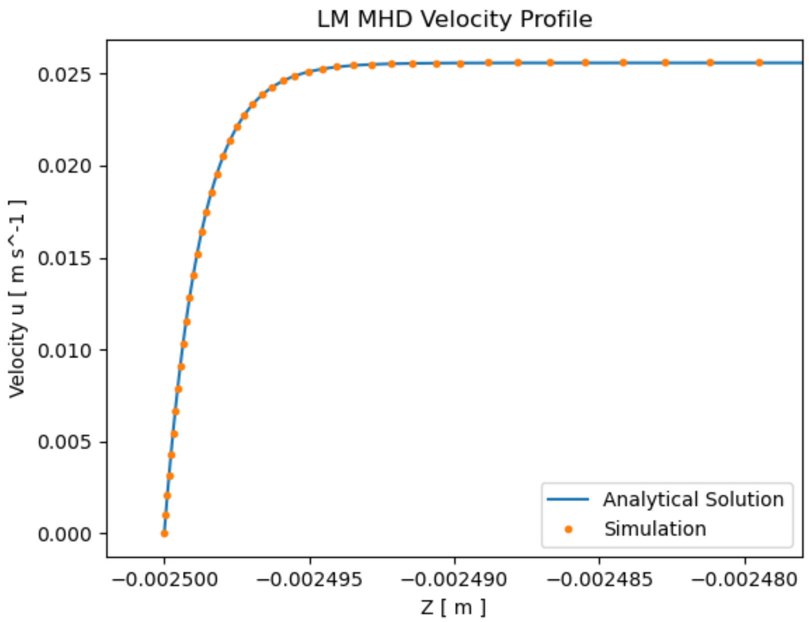


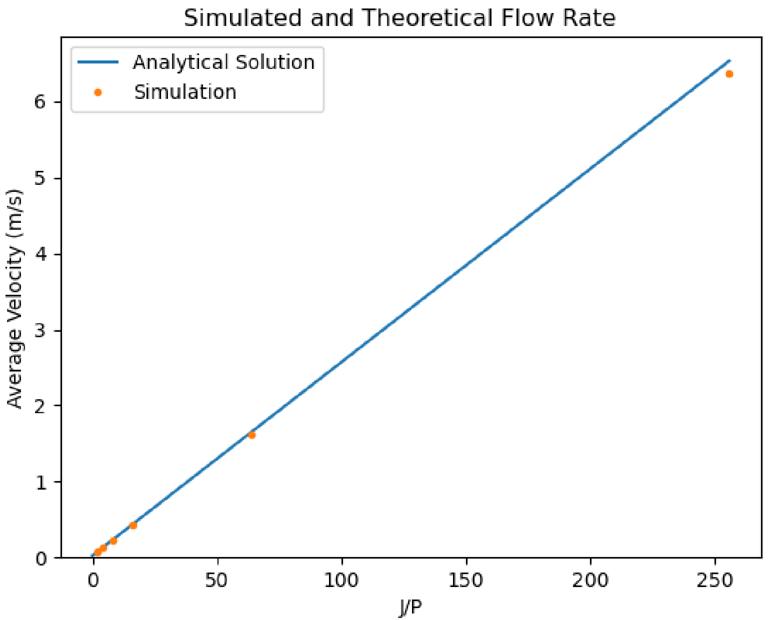


1. Solve MHD equations over a 2d slice of the channel
2. Interpolate over the 3d channel
3. Solve heat transport equations on frozen velocity field

- This assumes that temperature doesn't affect the flow

Model Validation

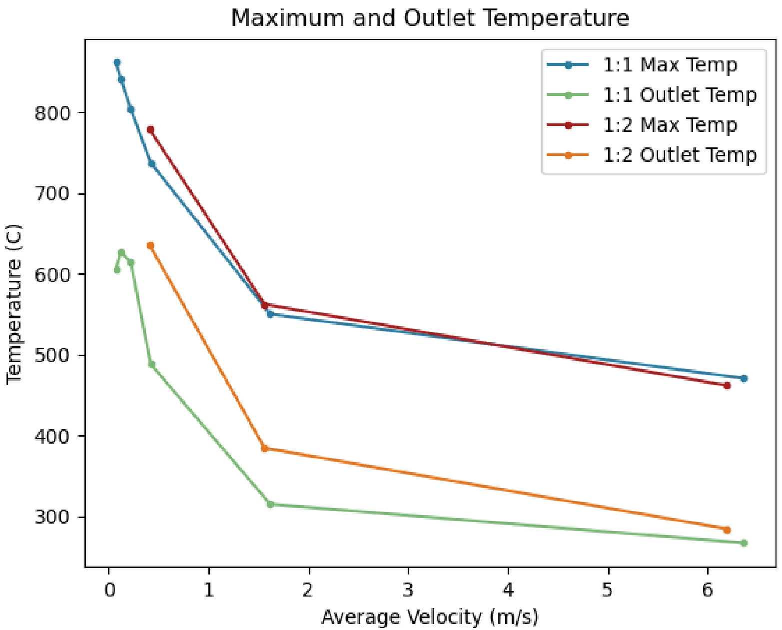


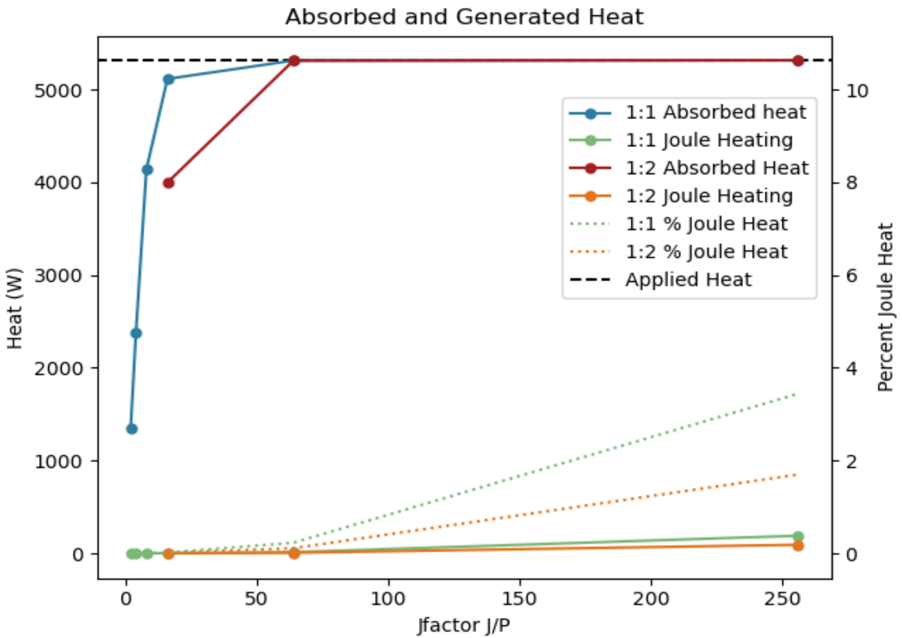


- Simulated velocities match predictions
- Thin boundary layer and uniform core flow

- Velocity dependence on current also matches predictions
- Discrepancy at large currents due to electrode resistance

Preliminary Results



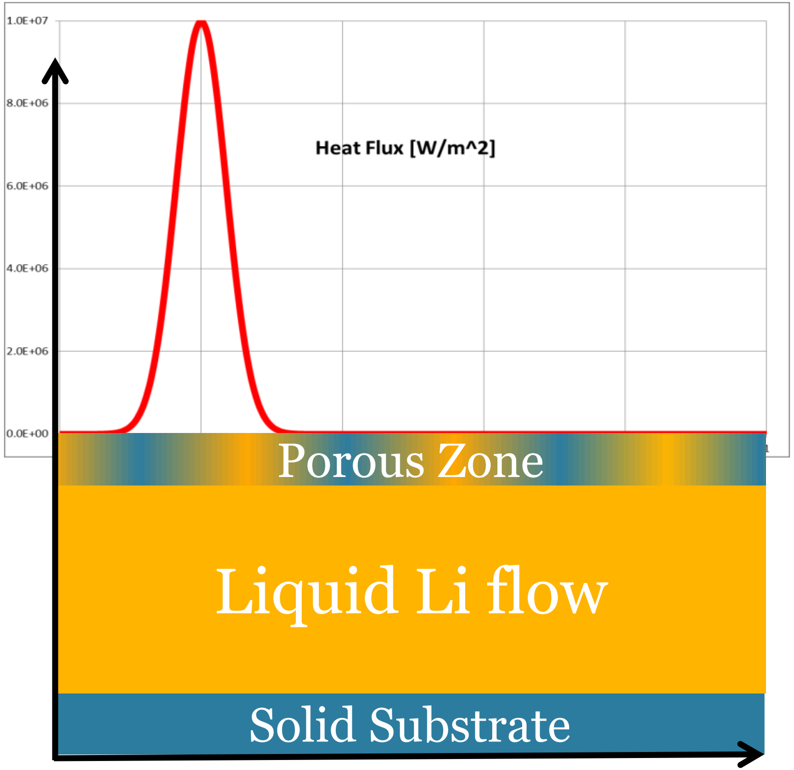


- Temperature is decreased by increasing current and velocity
- Smaller Channel can't remove as much heat at low currents

- Heat is only lost to evaporation at very low velocities
- Smaller channel is more efficient — generates less Joule heat

Future/Ongoing work

- Studying impact of different channel geometries
- Larger currents
- Creating porous wall



References

Donald Chiang and Thomas Lundren, "Magnetohydrodynamic Flow in a Rectangular Duct with Perfectly Conducting Electrodes," *Journal of Applied Mathematics and Physics (ZAMP)* 18, 92–106 (1967).

J. A. Shercliff, "Steady motion of conducting fluids in pipes under transverse magnetic fields," *Mathematical Proceedings of the Cambridge Philosophical Society, 49*(1), 136-144 (1953).

Acknowledgement

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