# E- Truck Thermal Management

PACCAR

## Background

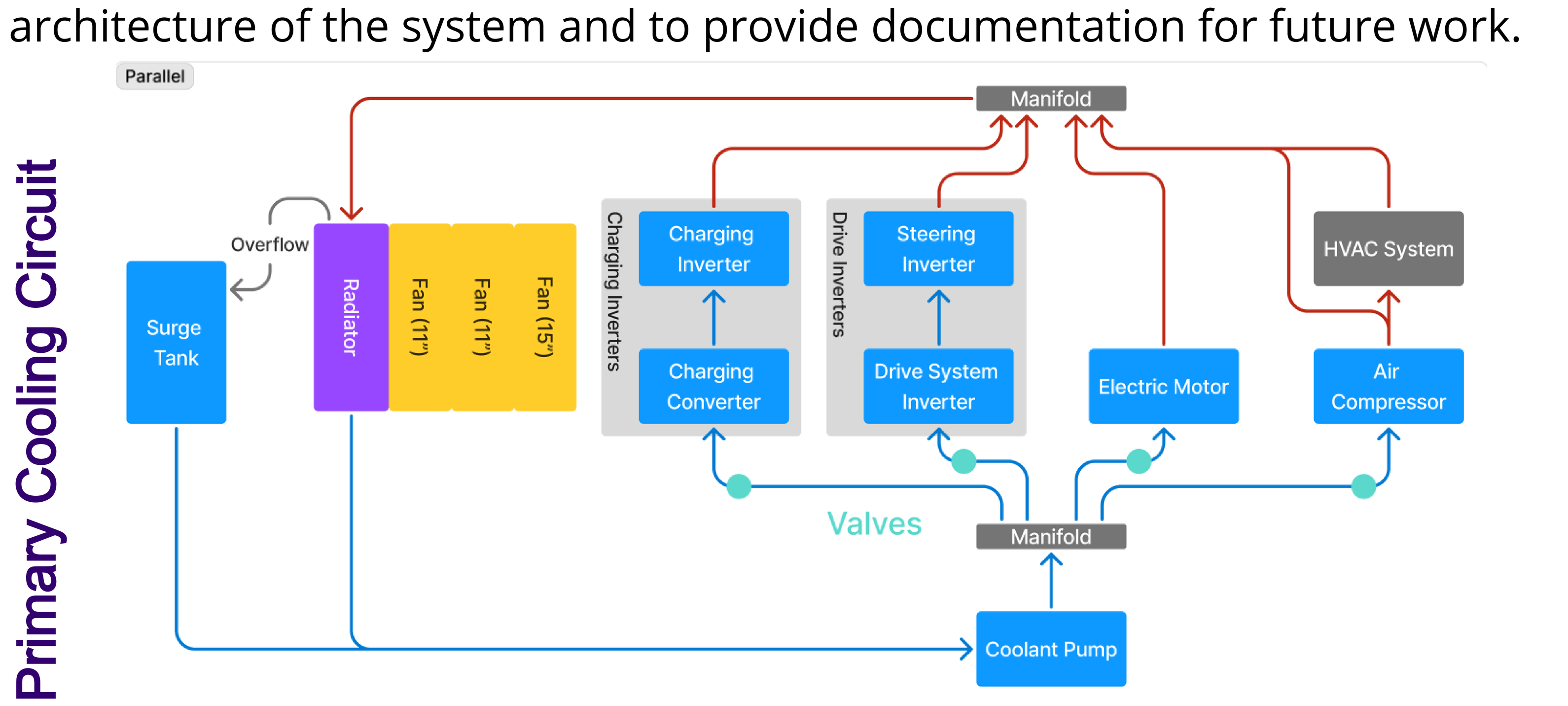
This is the second year of the E-Truck RSO's 4-year project of converting a medium-duty Peterbilt 337 truck to use a fully electric powertrain. This year the project involved 6 capstone teams across the ME, ECE, HCDE, and MSE departments.

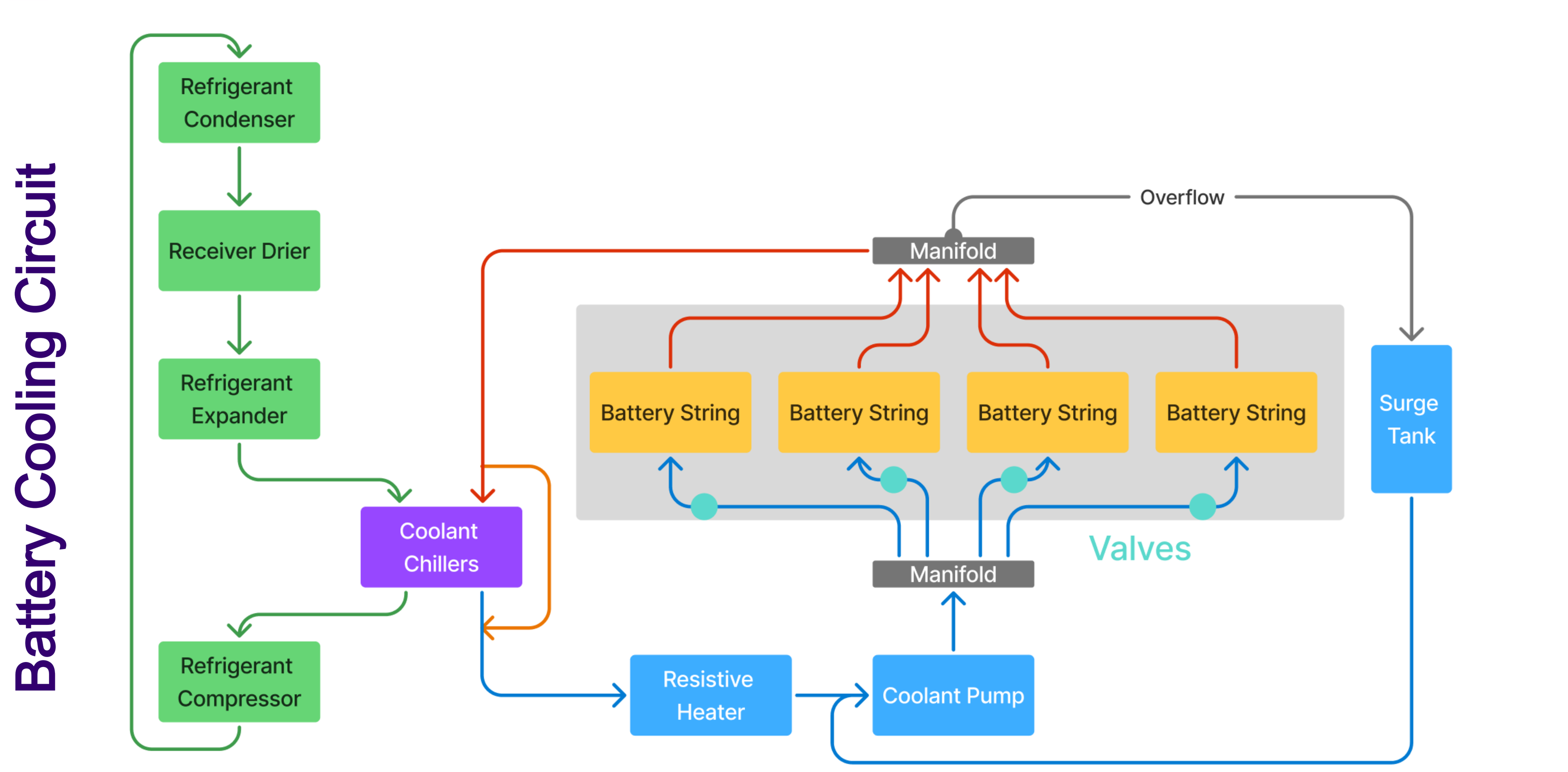
## Problem Statement

We are responsible for designing a thermal management system for the E-truck that keeps the batteries, E-axle, and other components at their ideal operating temperatures. The truck will use NMC Li-ion batteries, so it's critical for our system to be able to prevent a thermal runaway event. We will use thermal simulations, CAD models, hardware testing, and the selection of components that are commonly used in similar trucks to achieve this.

## System Design

To start off our project, we designed system diagrams to figure out the overall architecture of the system and to provide documentation for future work.



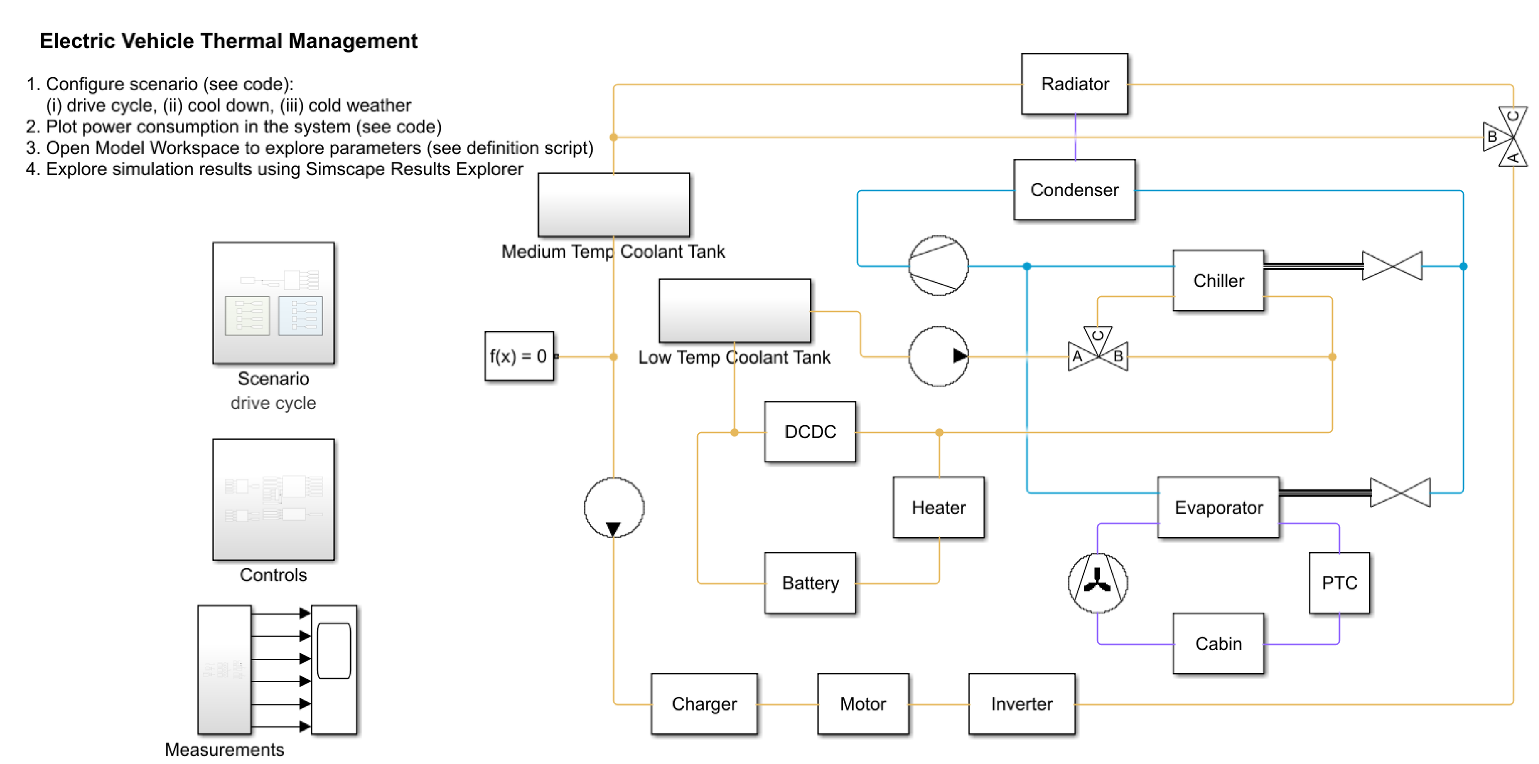

| Design Choice | Reasoning |
|---|---|
| Primary circuit components in parallel | Having the components in parallel rather than in series allows the system to focus the cooling on the components that need it most by throttling the flow to the other components via the valves. |
| Refrigerant circuit for batteries | The battery circuit needs a refrigerant loop because the coolant going to the batteries must be 15°C, so refrigerant is needed to cool it below ambient temperature. |

MECHANICAL ENGINEERING
UNIVERSITY of WASHINGTON

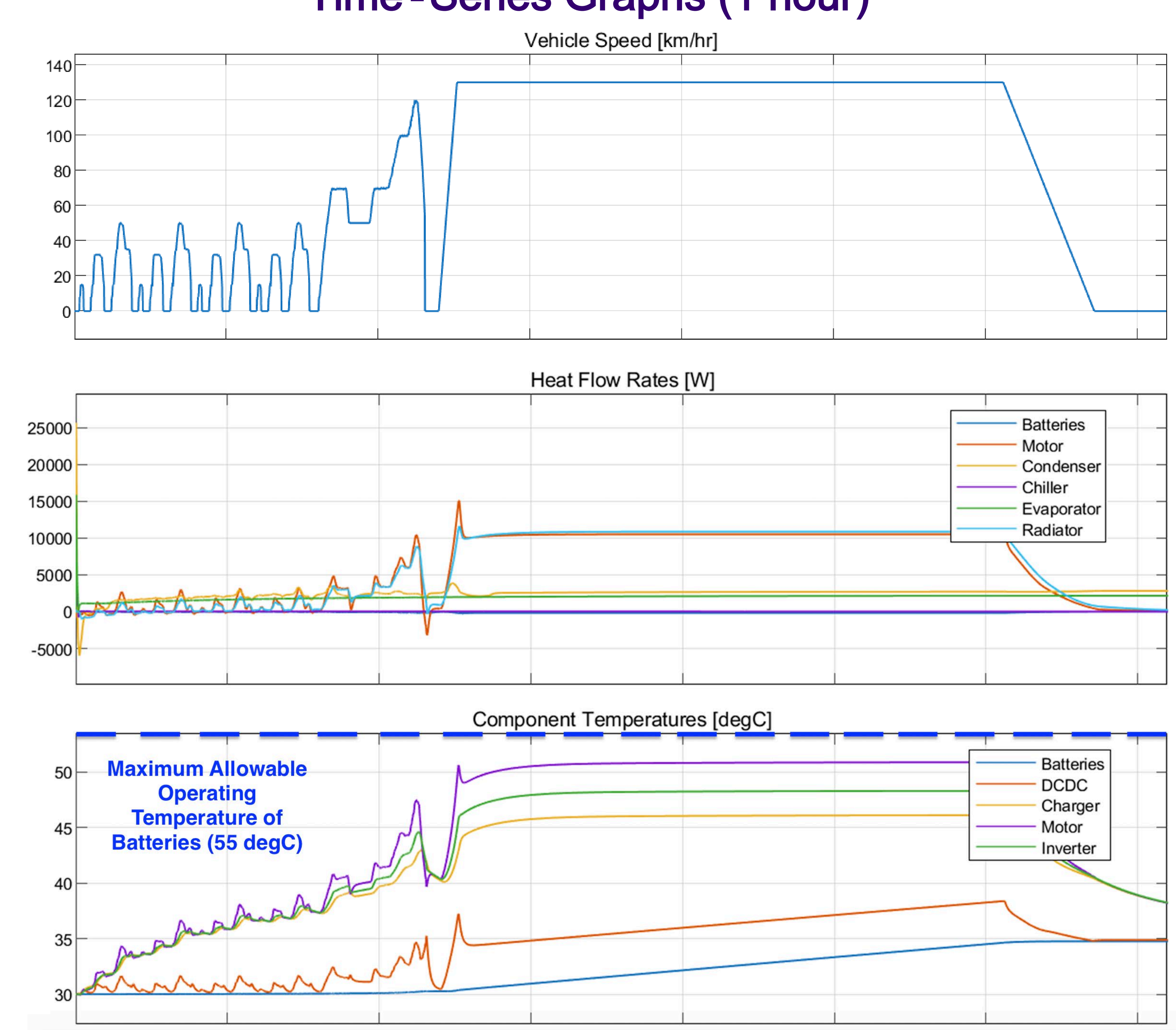
E-TRUCK EST. 2023

## Simulation Results

We created a Simscape model in MATLAB to simulate whether our thermal management system can reject all the heat generated by the truck and maintain critical powertrain components within safe temperature limits for a given drive cycle. Our simulations predict that all of the components cooled by the thermal management system will be maintained below 55° C, which is the maximum allowable operating temperature of our NMC batteries (the most stringent temperature requirement).

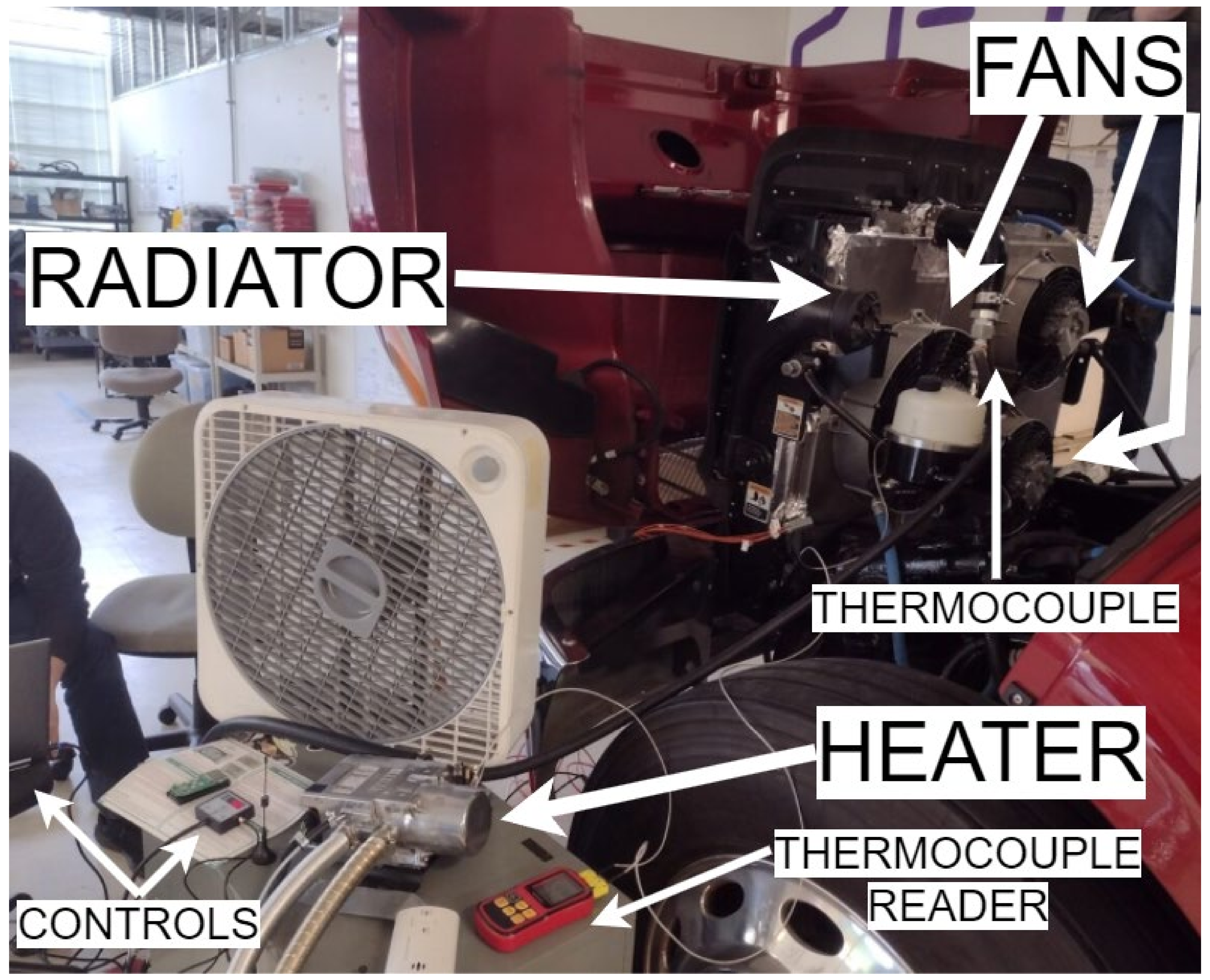


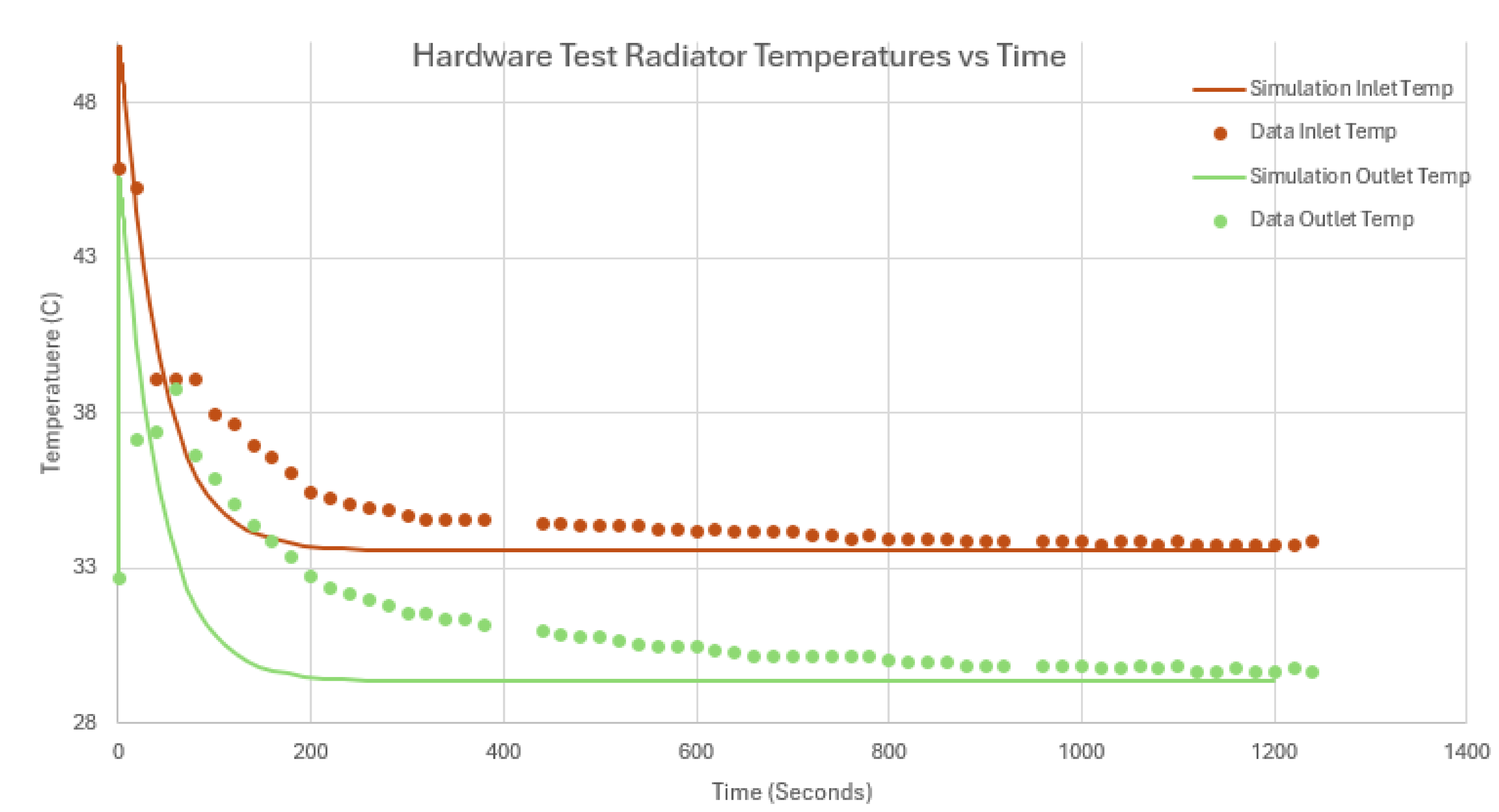

### Time-Series Graphs (1 hour)




## Hardware Test Comparison

A hardware test was built to measure radiator and fan performance in the primary circuit. A water pump was used to circulate coolant through the radiator and a 5-kW diesel heater to model worst case temperatures (75° C) in the primary circuit. For a constant coolant flow rate of 17.1 lpm and one 15" fan turned on to 4350 rpm, the inlet and outlet coolant temperature data was monitored until it reached a steady state. These results were then compared to a digital twin of the hardware test in Simscape to validate our simulation.





## Acknowledgements

Industry Mentor: Andrew McBride
Faculty Mentor: Eli Patten
MechE Shop Masters: Vee, Pranav, Eamon


creo Figma SOLIDWORKS