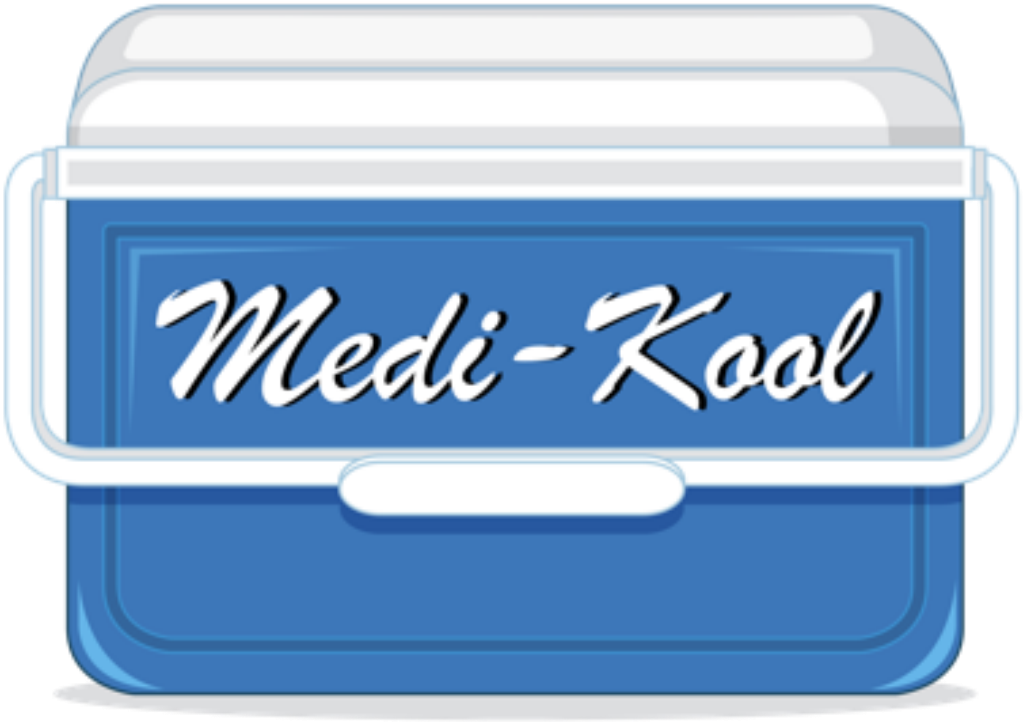

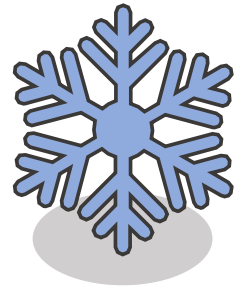

Temperature Sensitive Medication Storage During Natural Disaster

Team Introductions

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Systems Integration Engineer

Travis Amaral
Project Manager & Research Engineer

Nick Georgevich
Design Engineer

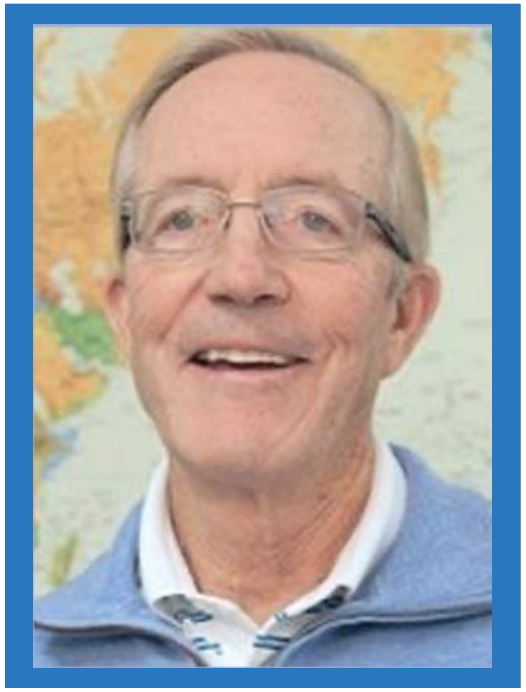
Keon Glass
Entrepreneurial Leader & Research Engineer

Diego Mendoza
Electrical Engineer

Andrew Sayers
Quality Control Engineer

Advisors & Sponsor

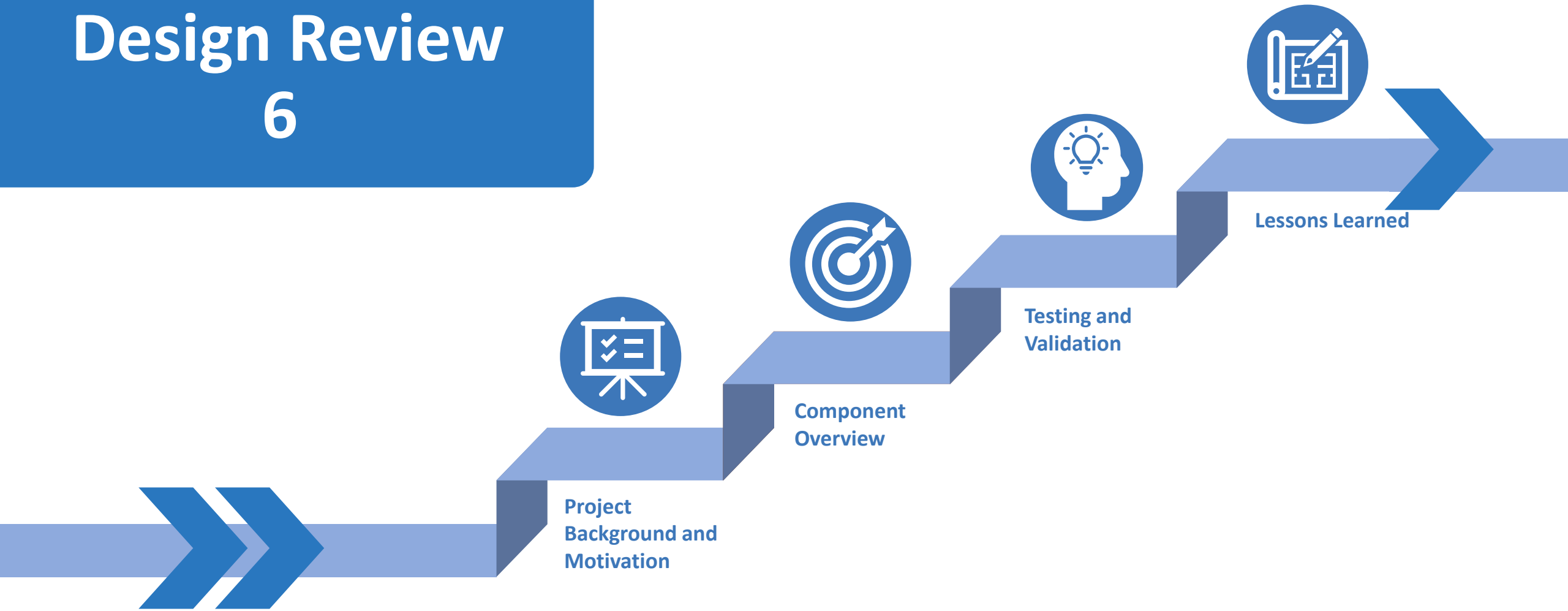
Dr. Shayne McConomy



Dr. Michael Devine

FAMU-FSU College of Engineering

Design Review 6

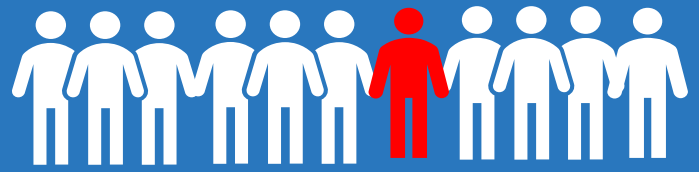


Objective

Our objective is to develop a device that stores and maintains the quality of temperature sensitive medication in the event of a long-term power outage

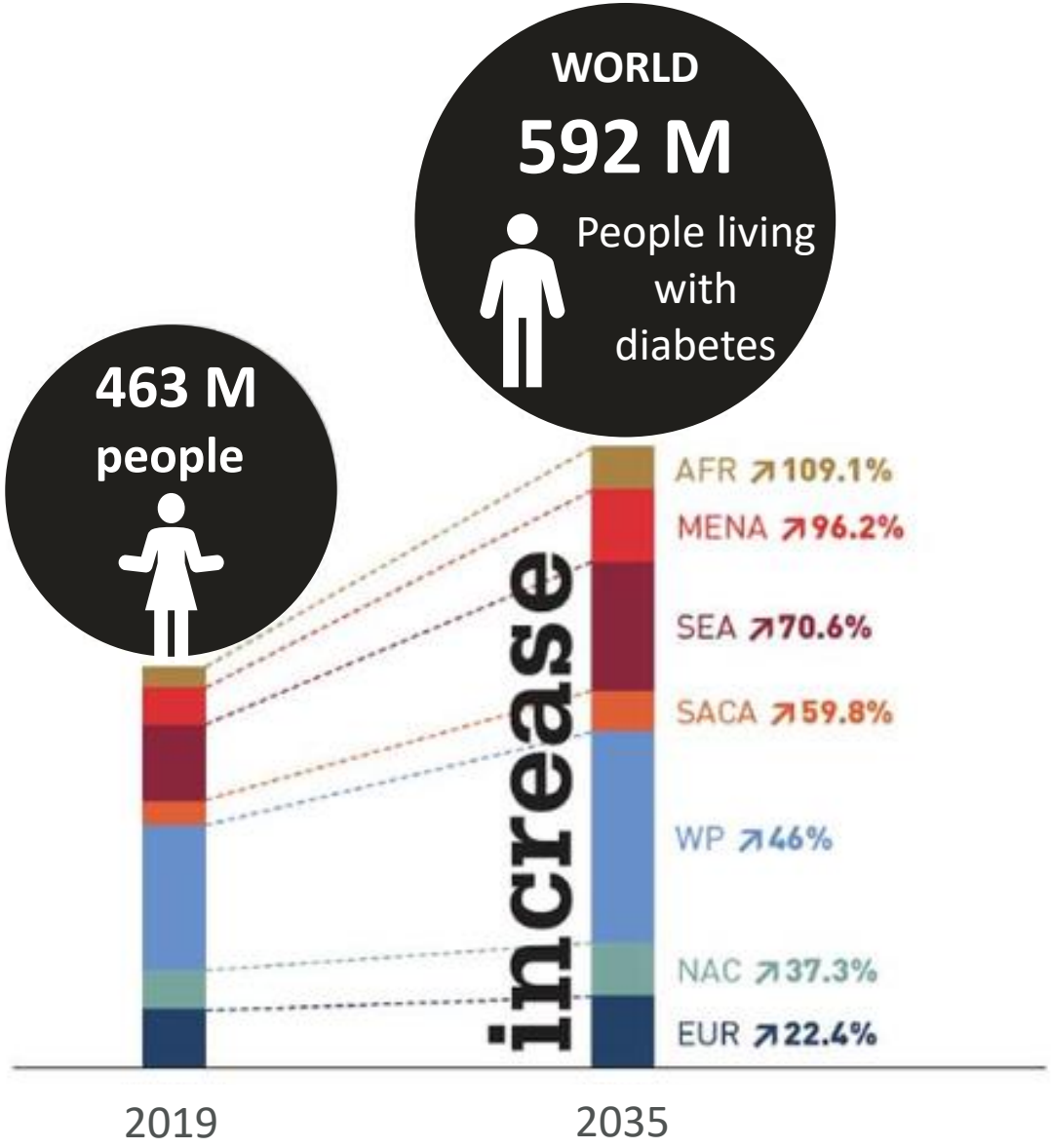

Before

Motivation

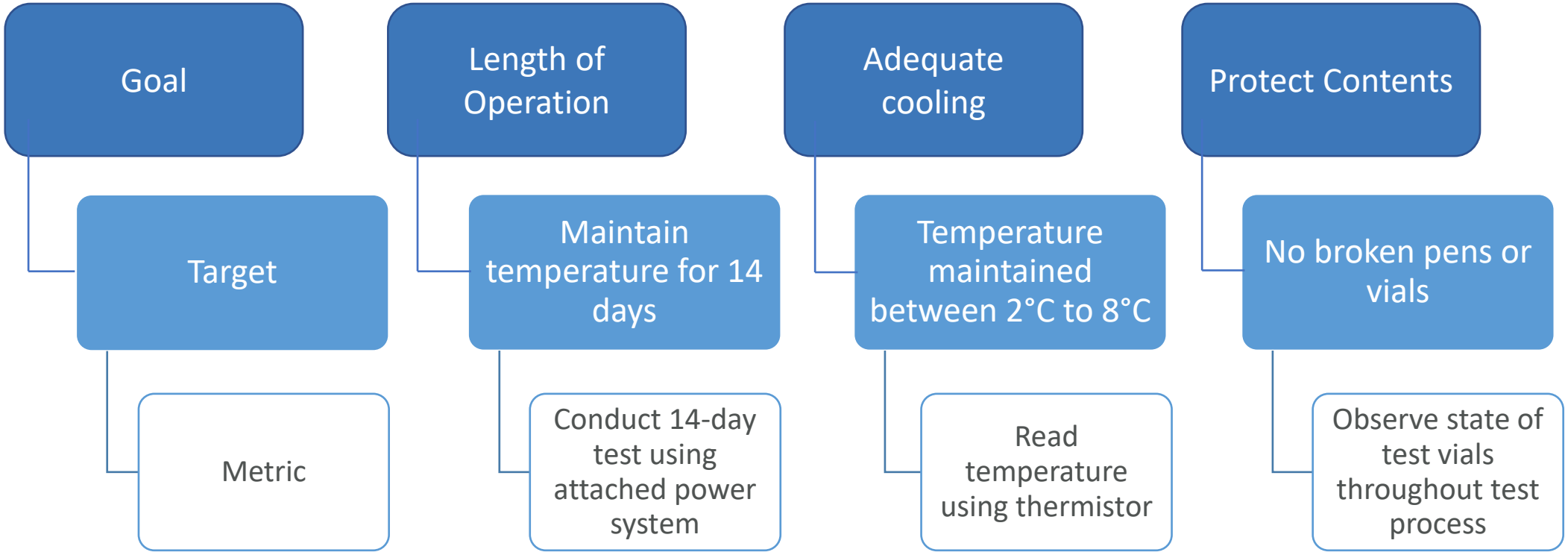


1 in 11 adults require insulin

One study found that hurricanes increase diabetes related deaths by **40%**



Targets & Metrics



Concept Generation

Housing

- Soft Bodied Cooler
- Hard Bodied Cooler

Power System

- Solar Panel Battery Combo
- Portable Power Station

Thermal System

- Thermoelectric Peltier Plate
- Convective Peltier System
- Liquid Heat Exchanger

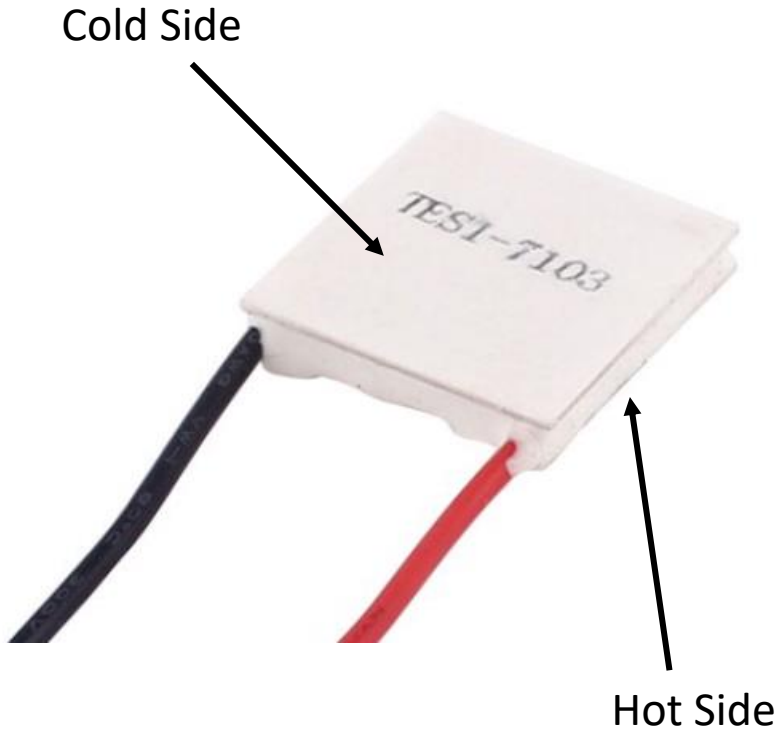
How it works

Power is applied and current runs through the conductors

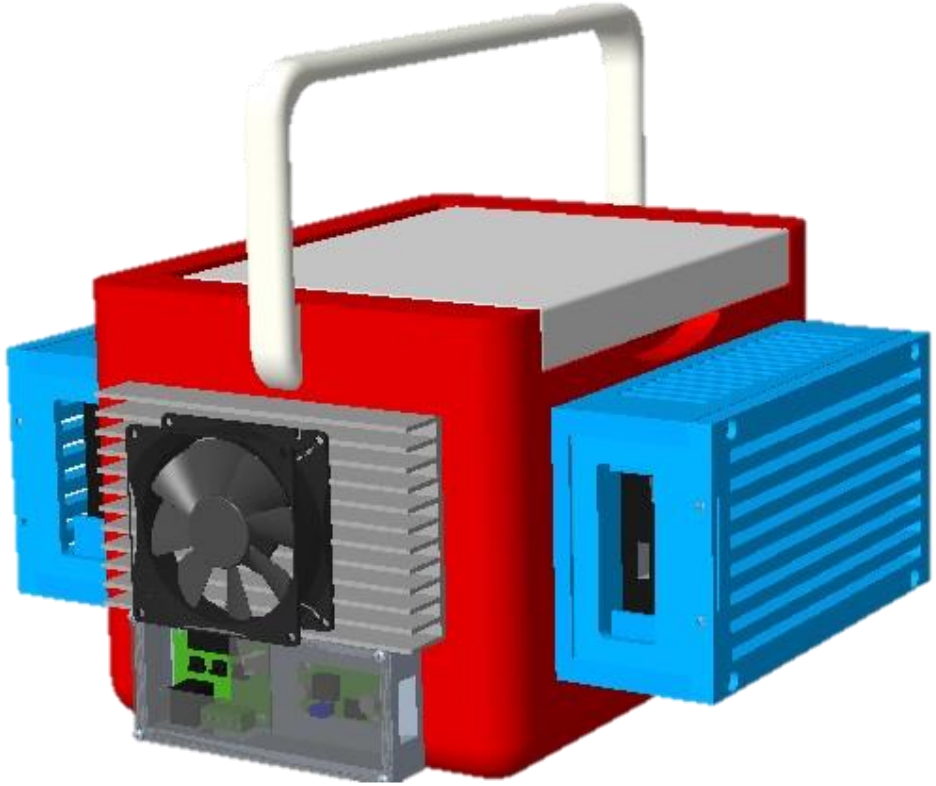
Bottom side of the plate gets hot

Top side of the plate gets cold

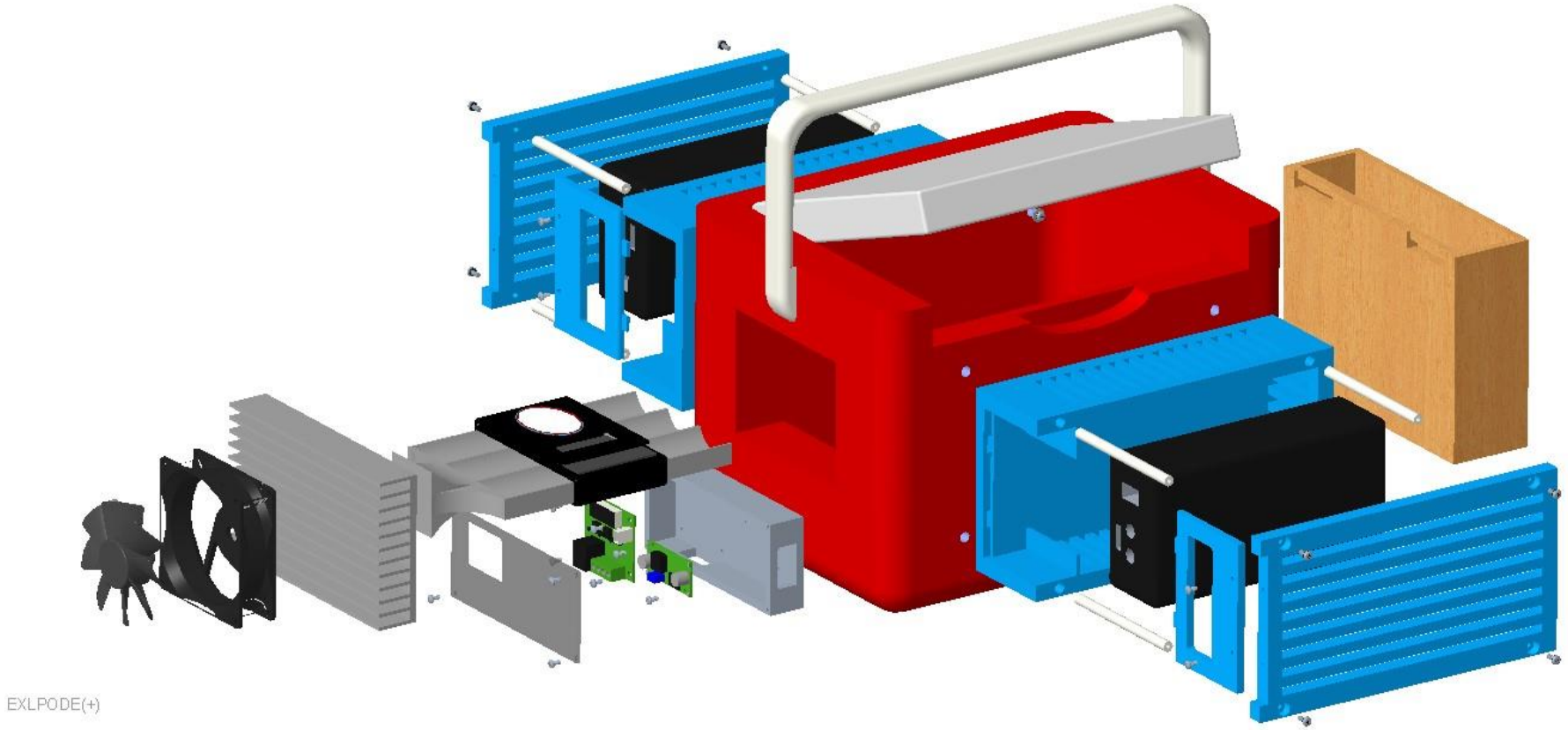
Use the cold side to cool the system



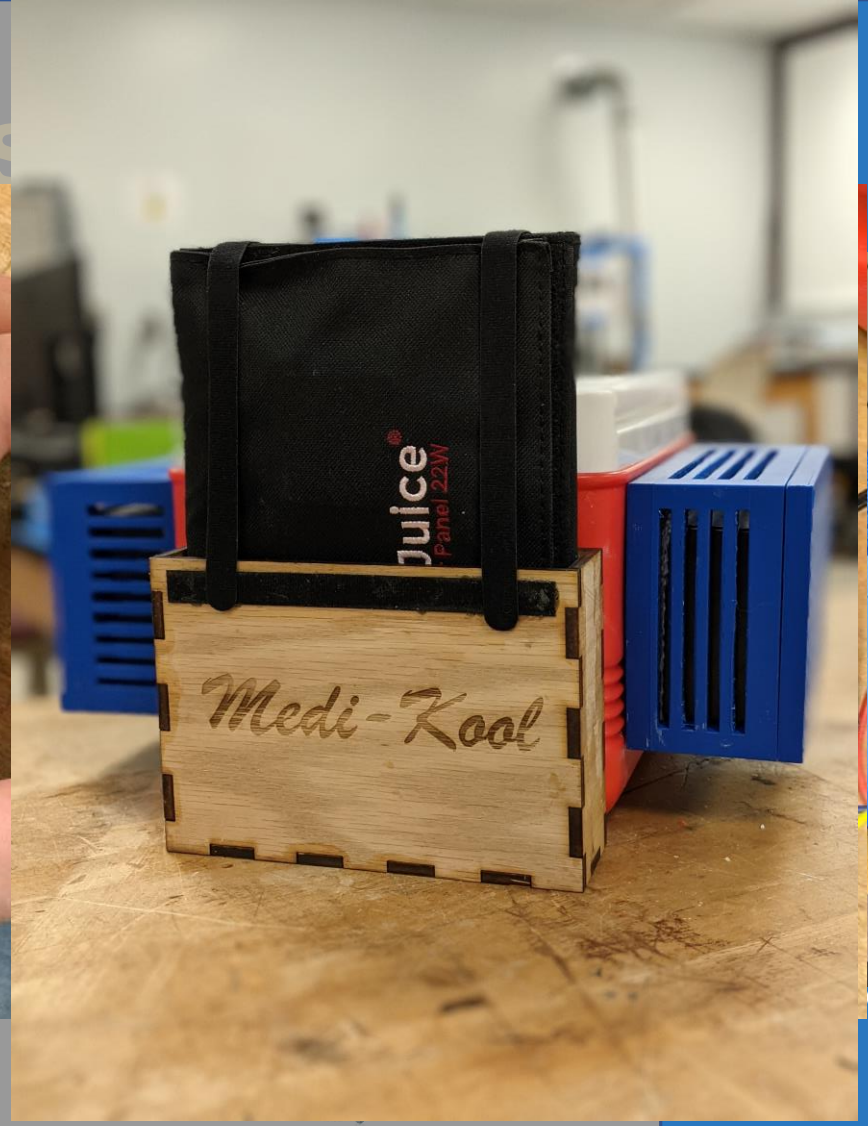
Final Concept Selected

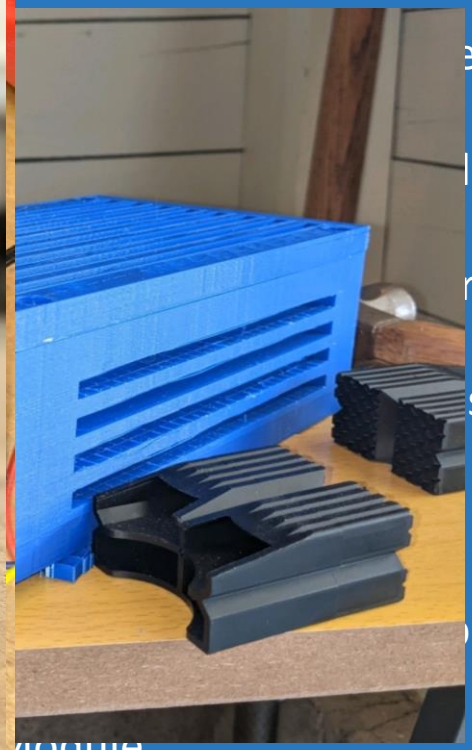


Final Concept Selected



Cooler Hous





er

l sides

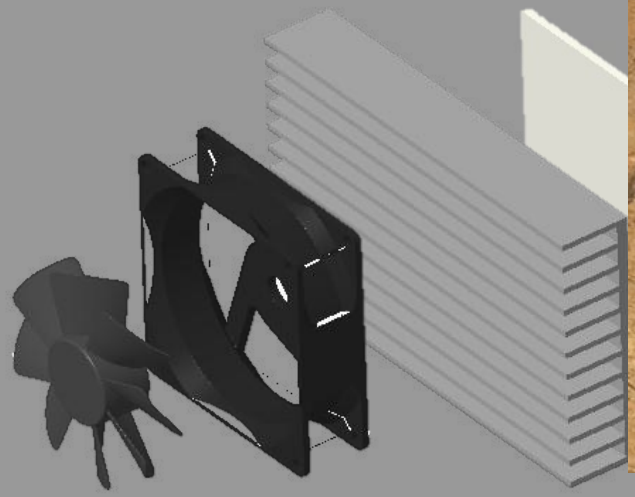
ront and Back

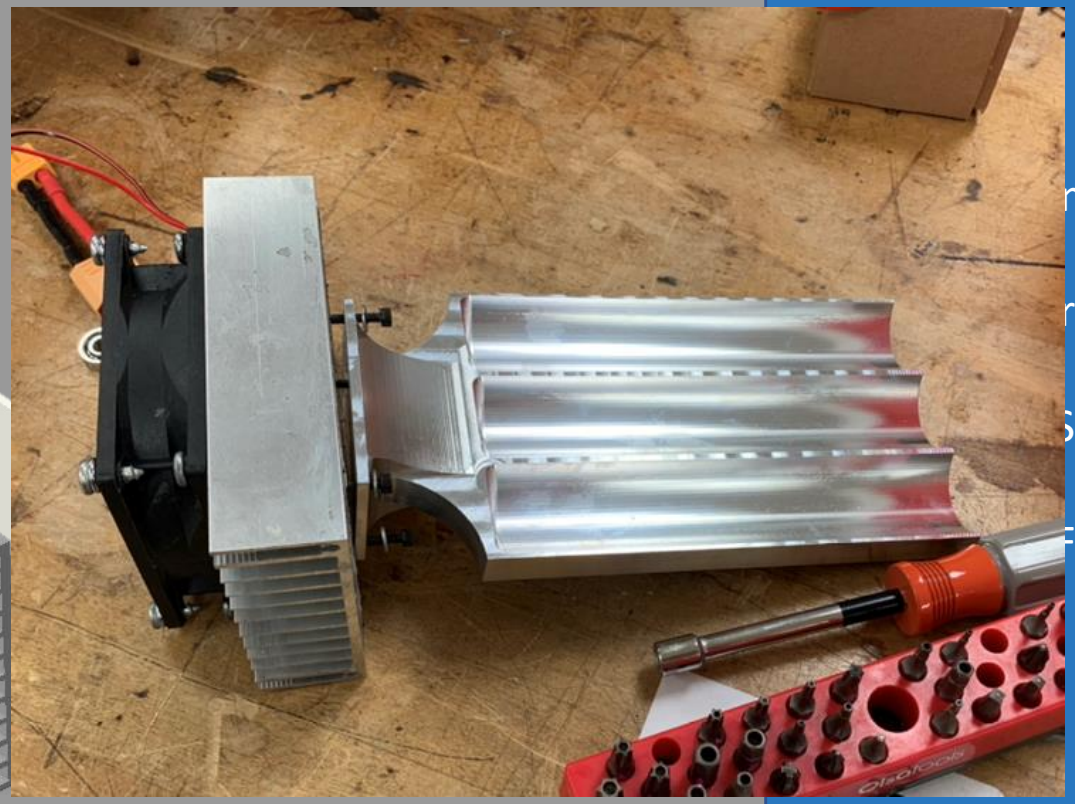
sing Adjacent

posite TEC

Module

Cooling System





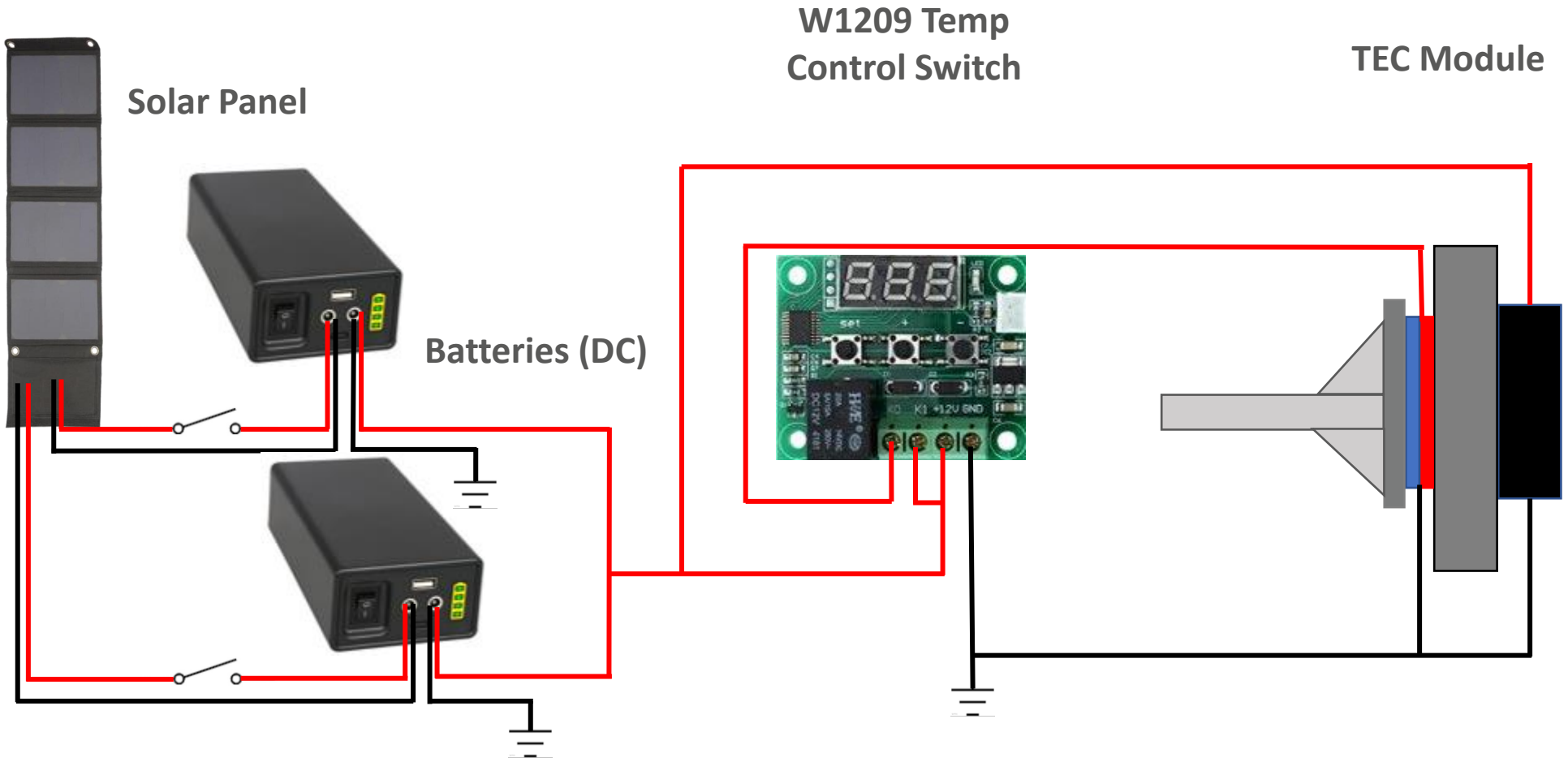
m Aluminum Cold Plate

r Plate

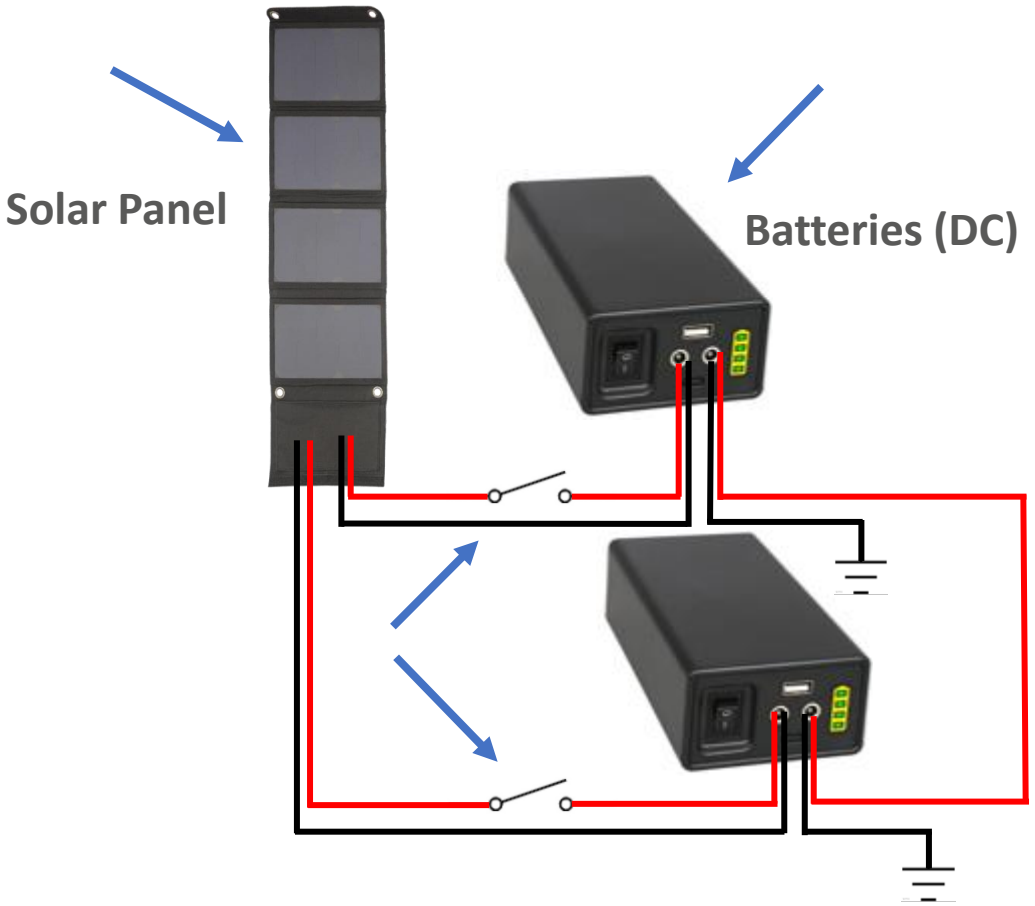
Sink

Fan

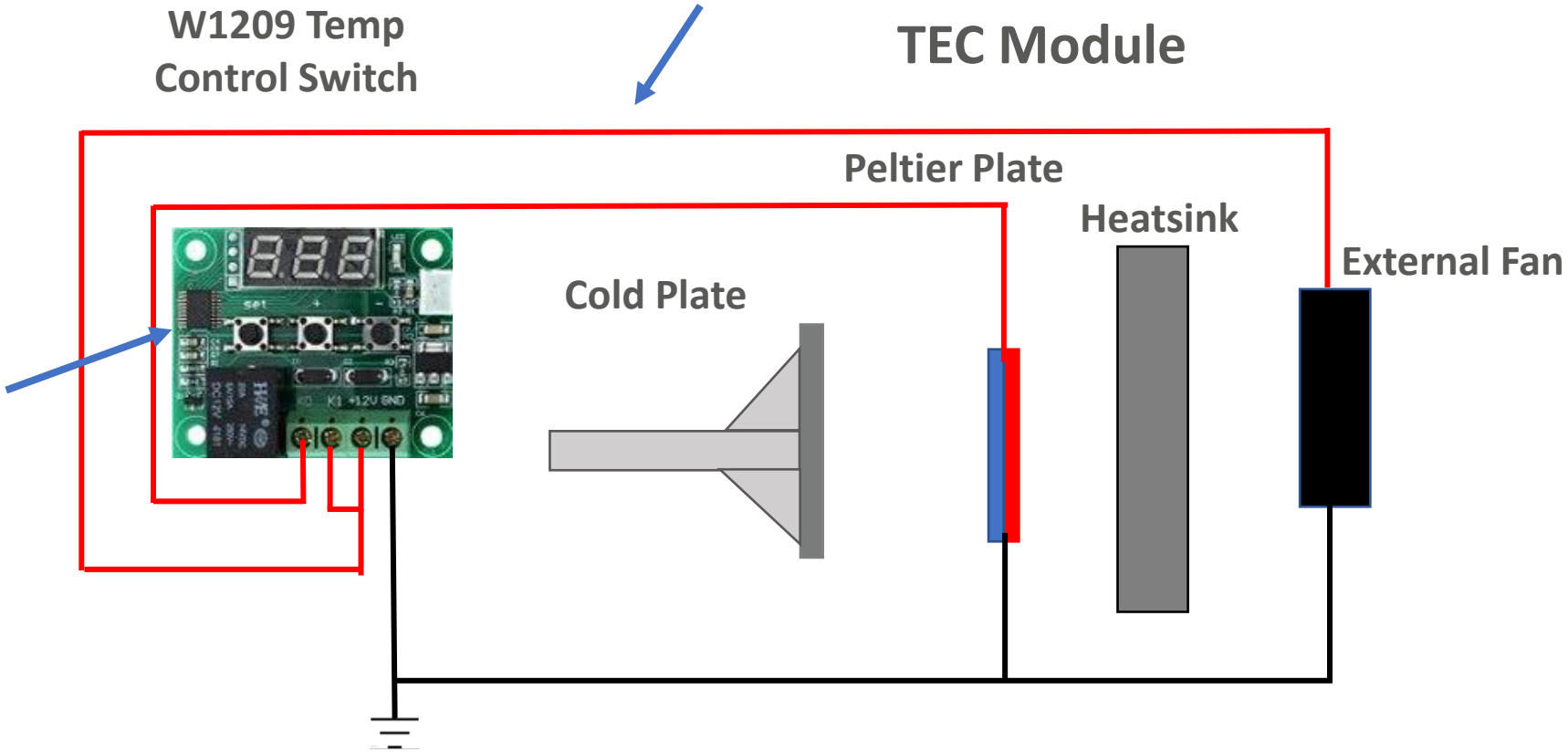
Electrical System Schematic



Power System Schematic



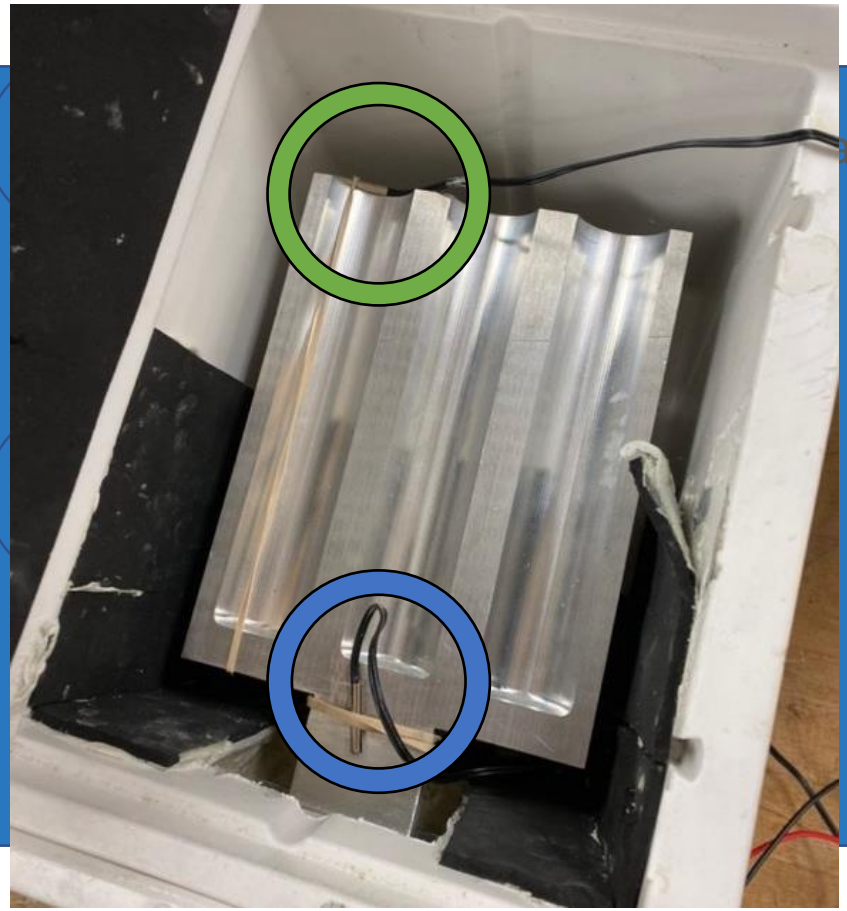
Control System Schematic



Steps to Concept Validation

1. Reaching our temperature target
2. Ensuring the entire cold plate is within range
3. Observe long term power & temperature
4. Keeping temperature within range for 14 days

Steps to Concept Validation



arget

Test Setup

Two thermistors

- 1 Furthest from TEC
- 1 Closest to TEC

30-minute run time

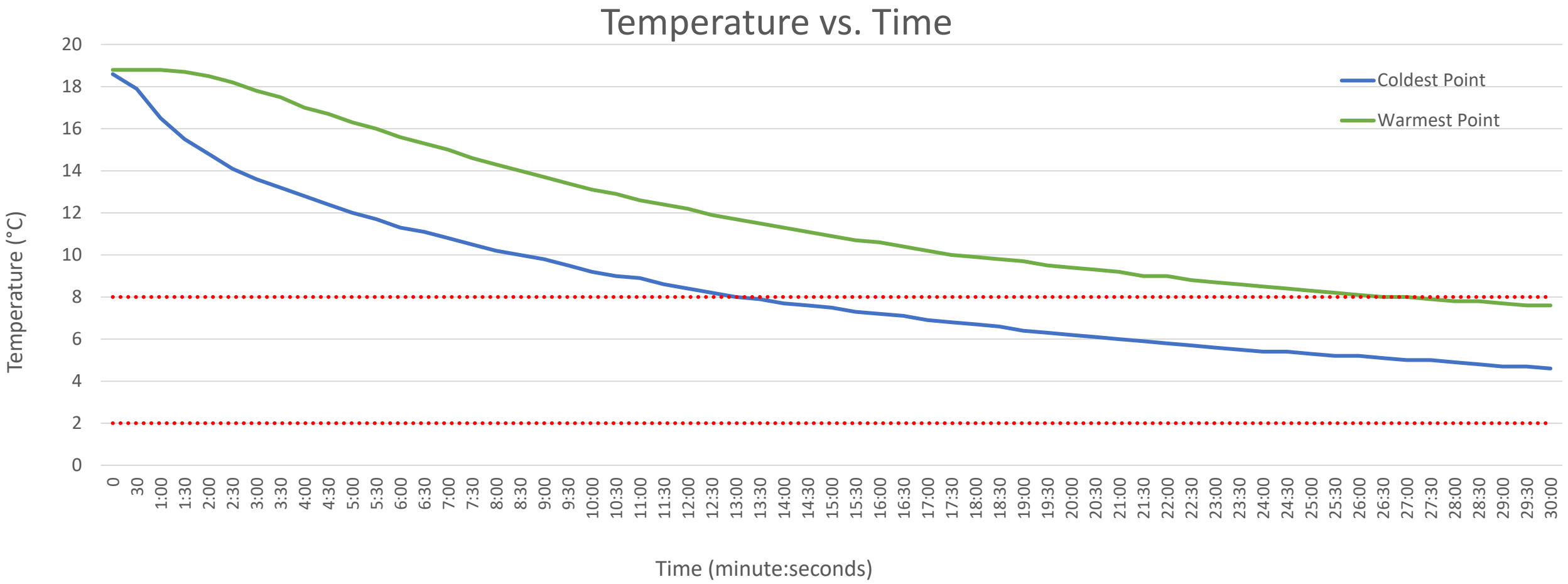
Test Objectives

- Observe temperature gradient
- Observe cool down rate

2 Ensuring the entire cold plate is within range

4 Keeping temperature within range for 14 days

Test Results

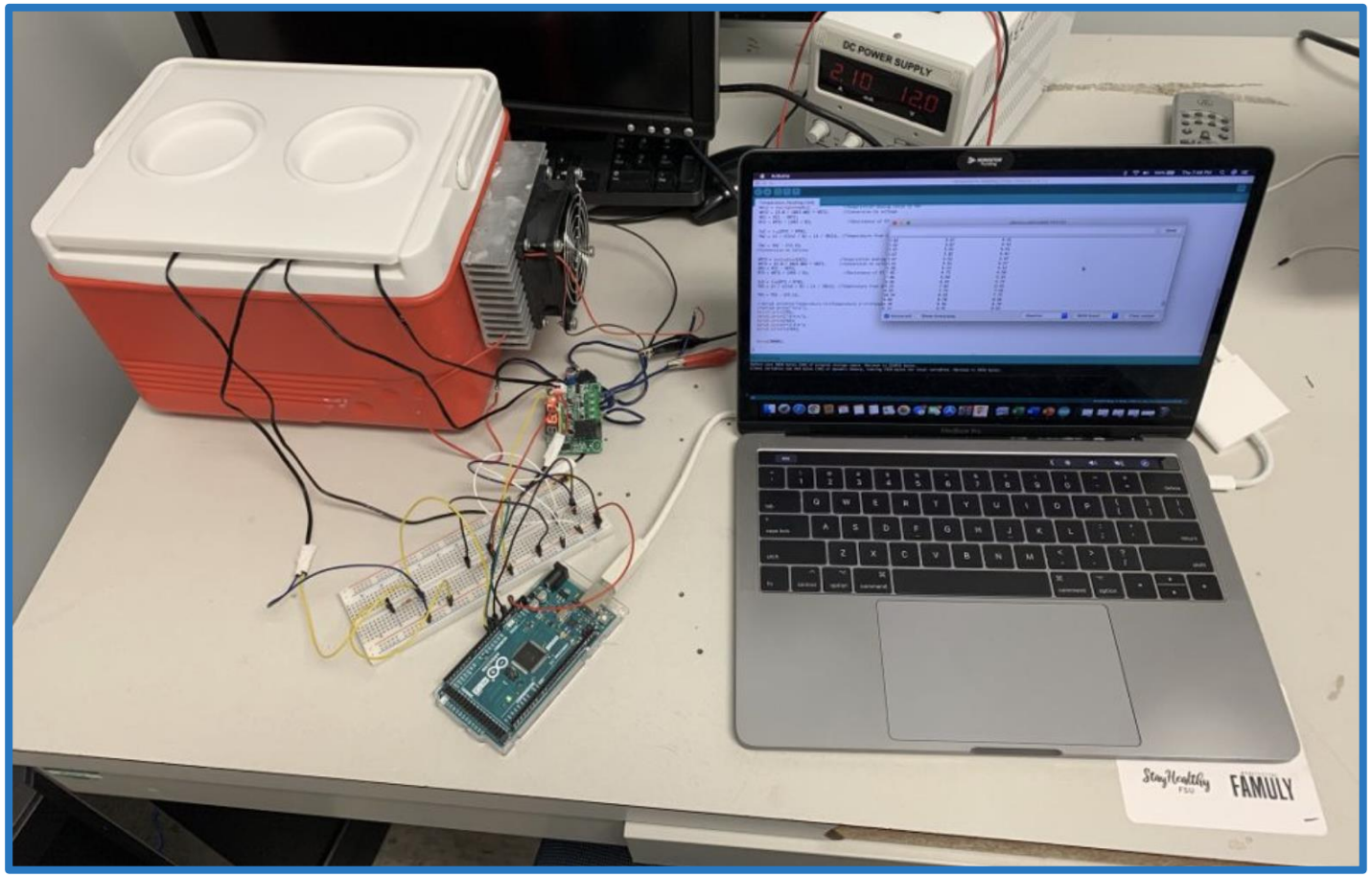


Test Summary

- Temperature difference was 4°C at its worst and 3°C at its best without insulation
- Temperature difference is acceptable to keep medicine within 2°C and 8°C
- Additional TEC will not be needed
- Cold plate was fully in range after about 27 minutes

3

Observe long term power & temperature

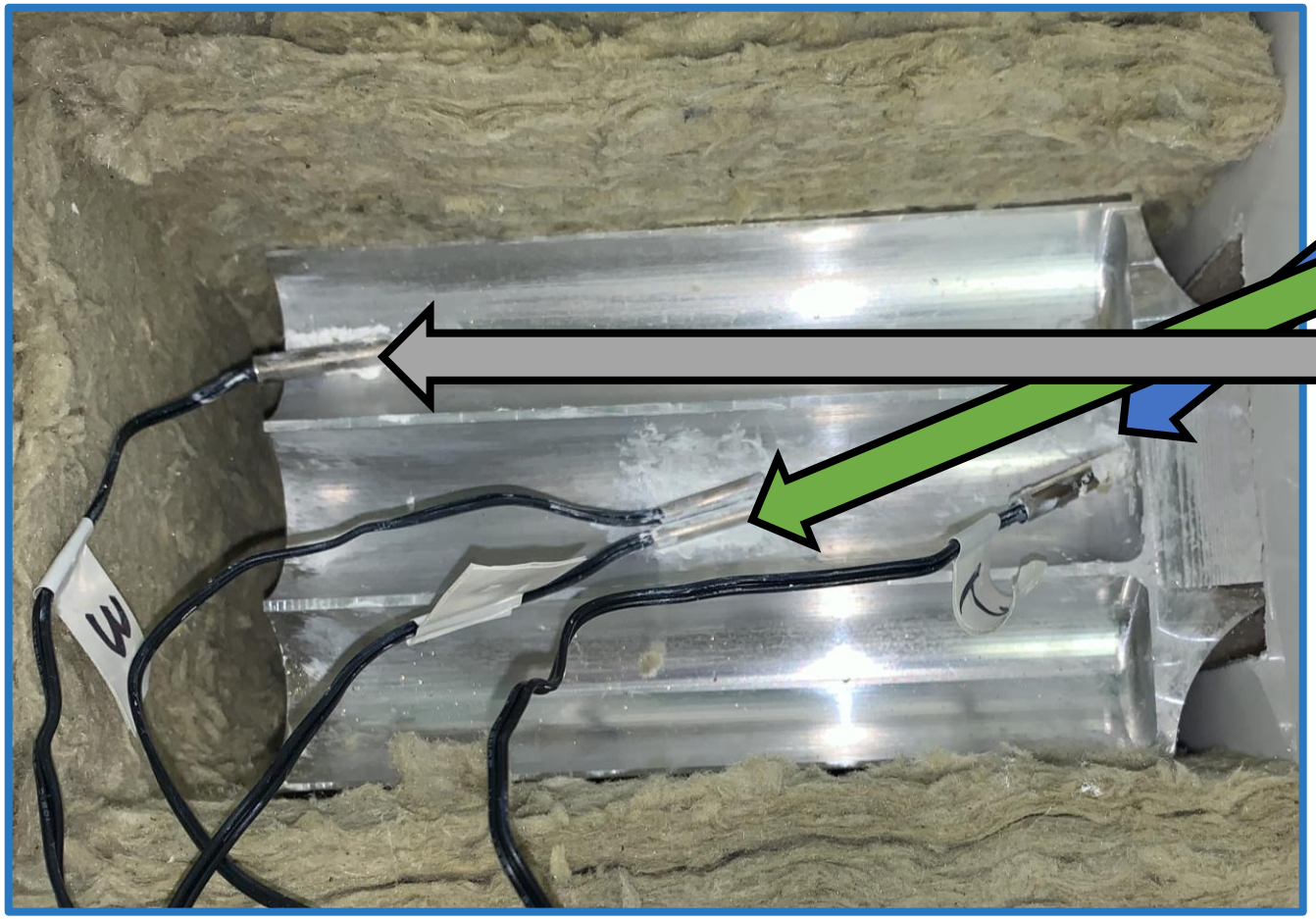


Test Objectives

- Observe long-term temperature fluctuations
- Take temperature from 3 spots every 30 seconds
- Extrapolate long term power requirements
- Confirm cold plate gradient is acceptable

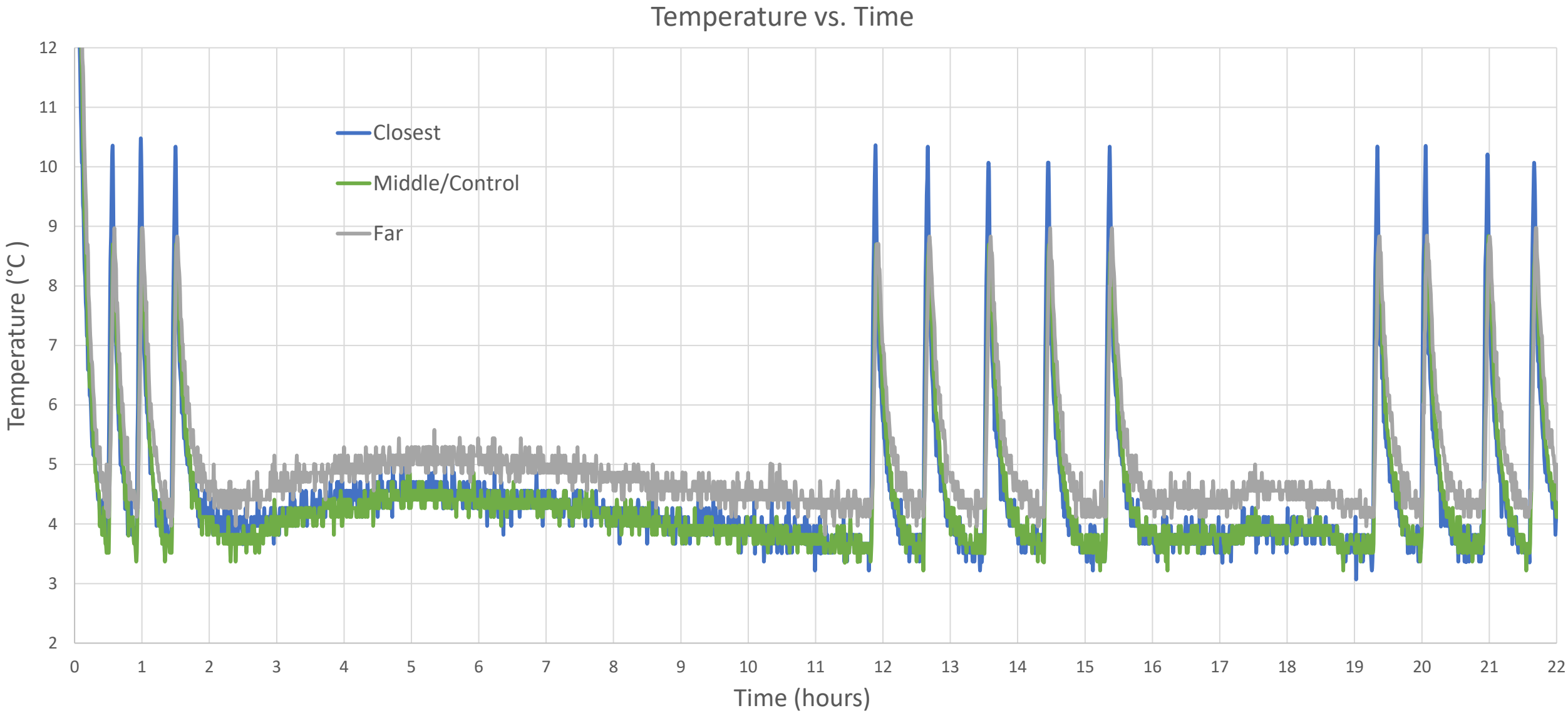
3

Observe long term power & temperature



Test Setup

- Closest to TEC
- Middle
  - Thermistor for Temp Control Switch
- Furthest from TEC
  - Hooked up to Arduino to record temperatures
  - Turn OFF at 3.5°C
  - Turn back ON at 8°C

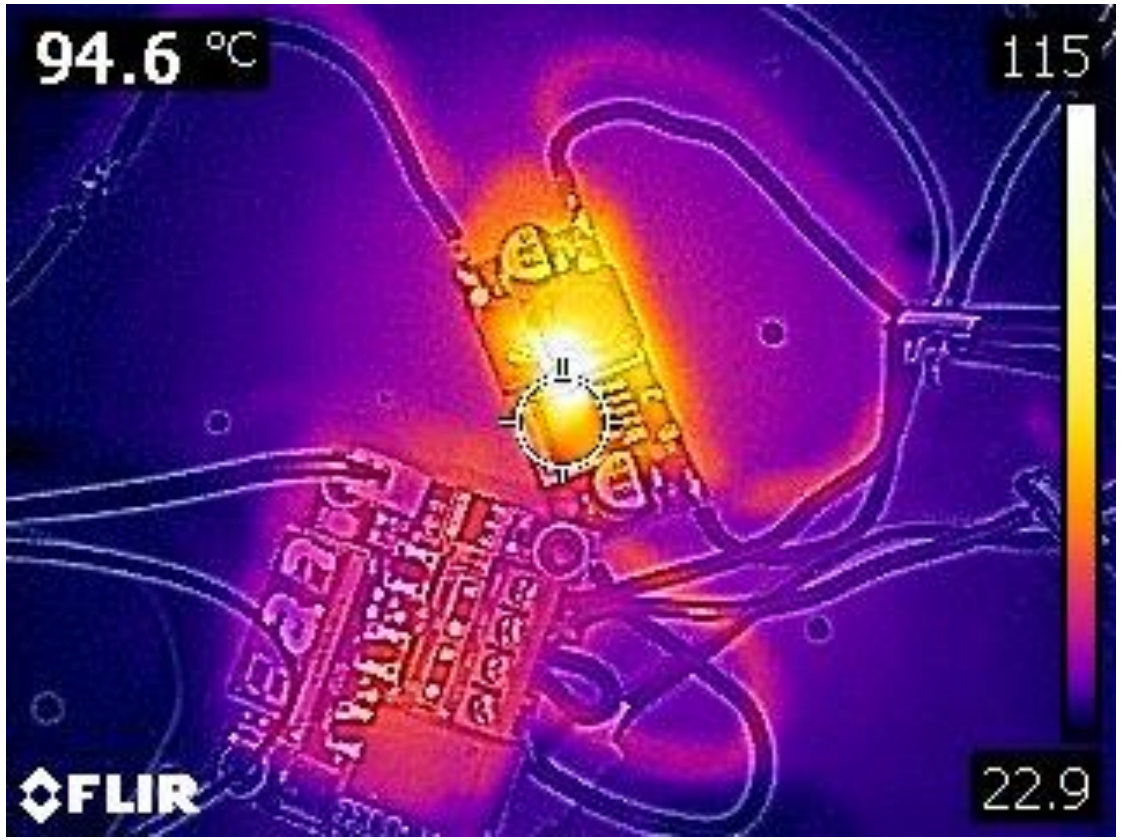

Temperature vs. Time
Closest
Middle/Control
Far
Temperature (°C)
Time (hours)
12
11
10
9
8
7
6
5
4
3
2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

Test Summary

- Power only turned off 12 times in 22 hours
- Cool down time was 12.5 min
- System was off for 7.5 min at a time in power saving mode
- Maximum temperature at 10.5°C
- Lots of condensation in cooler after test

3

Observe long term power & temperature

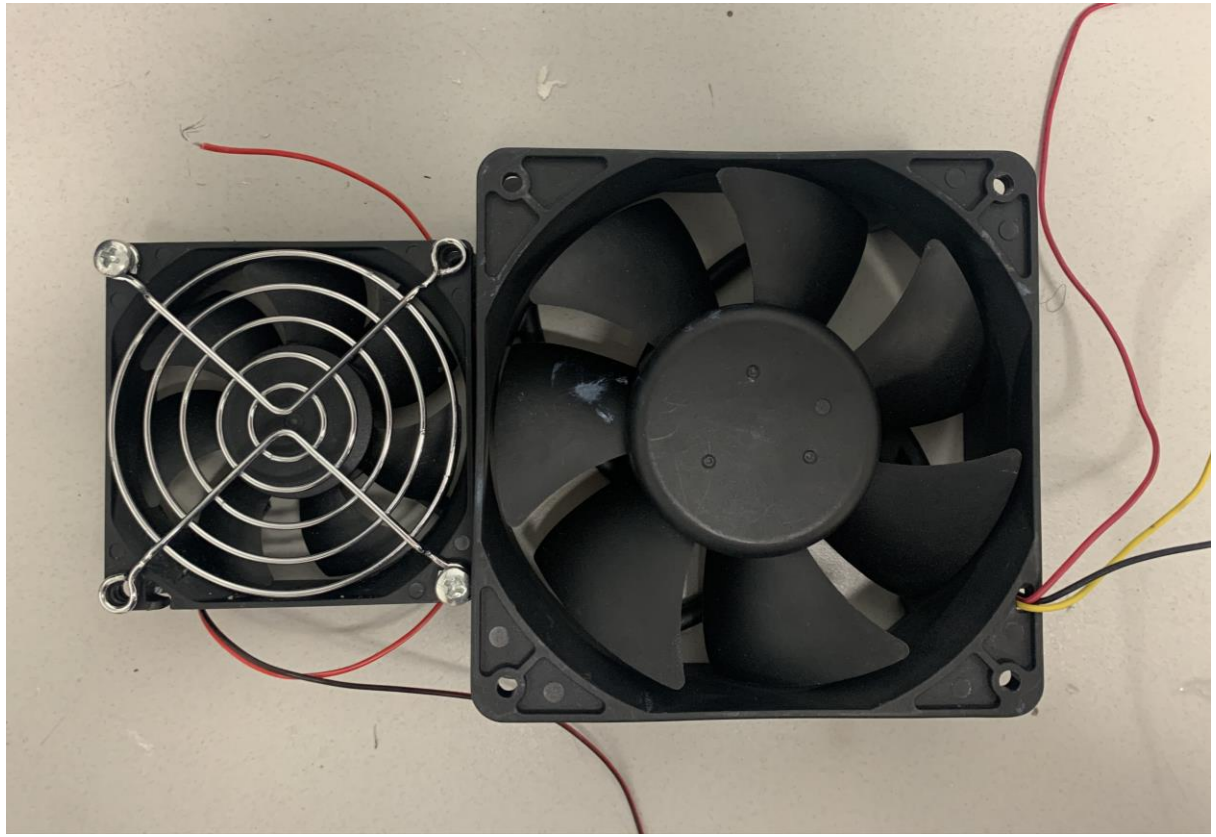


Buck Converter

- Dissipated more heat than expected
- Overheated entire system when attached to cooler
- Additional cooling needed

3

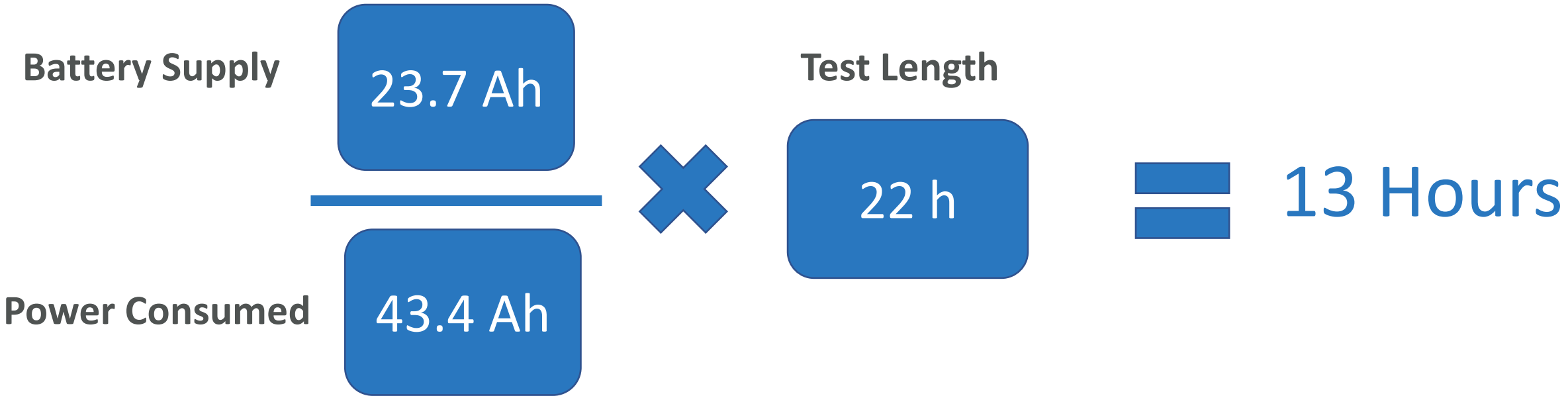
Observe long term power & temperature



Larger Fan Test

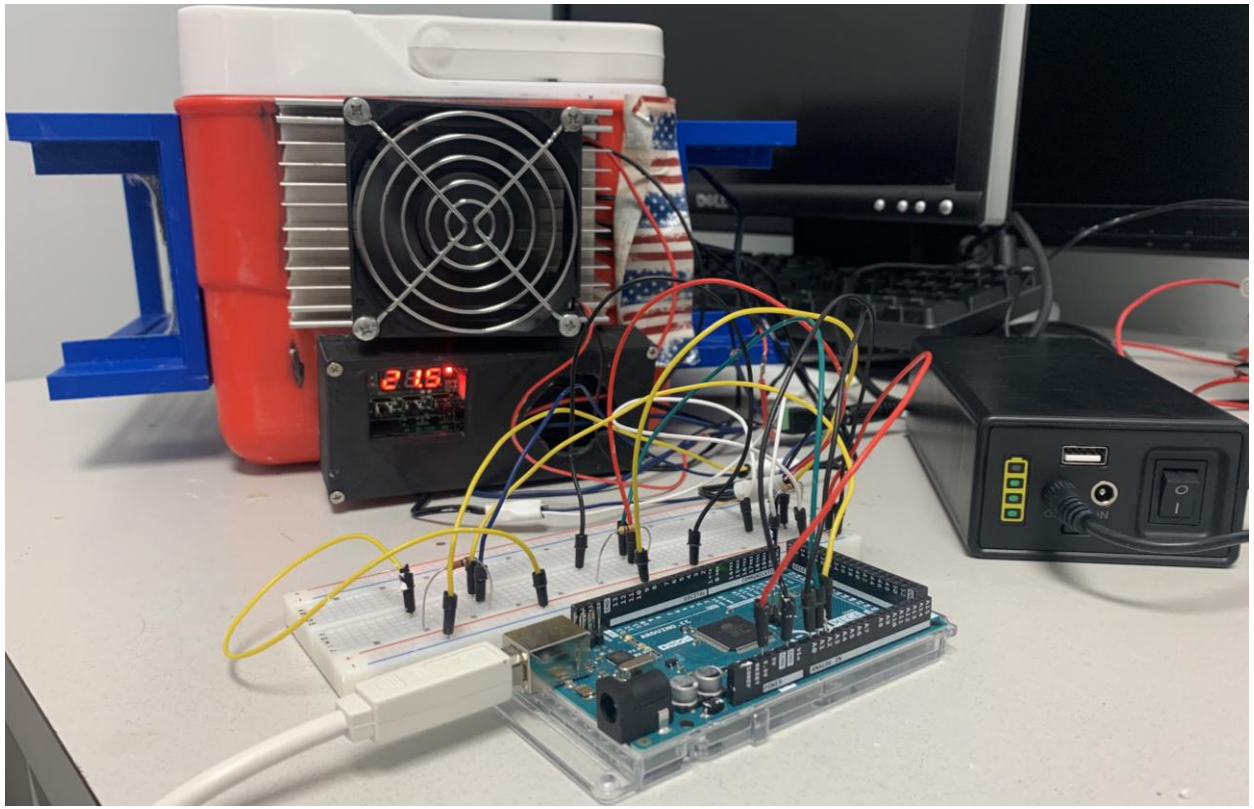
- Attached larger fan to heat sink
- Secured buck converter behind fan for cooling
- Sealed off holes
- Larger fan ended up using too much power

3 Observe long term power & temperature



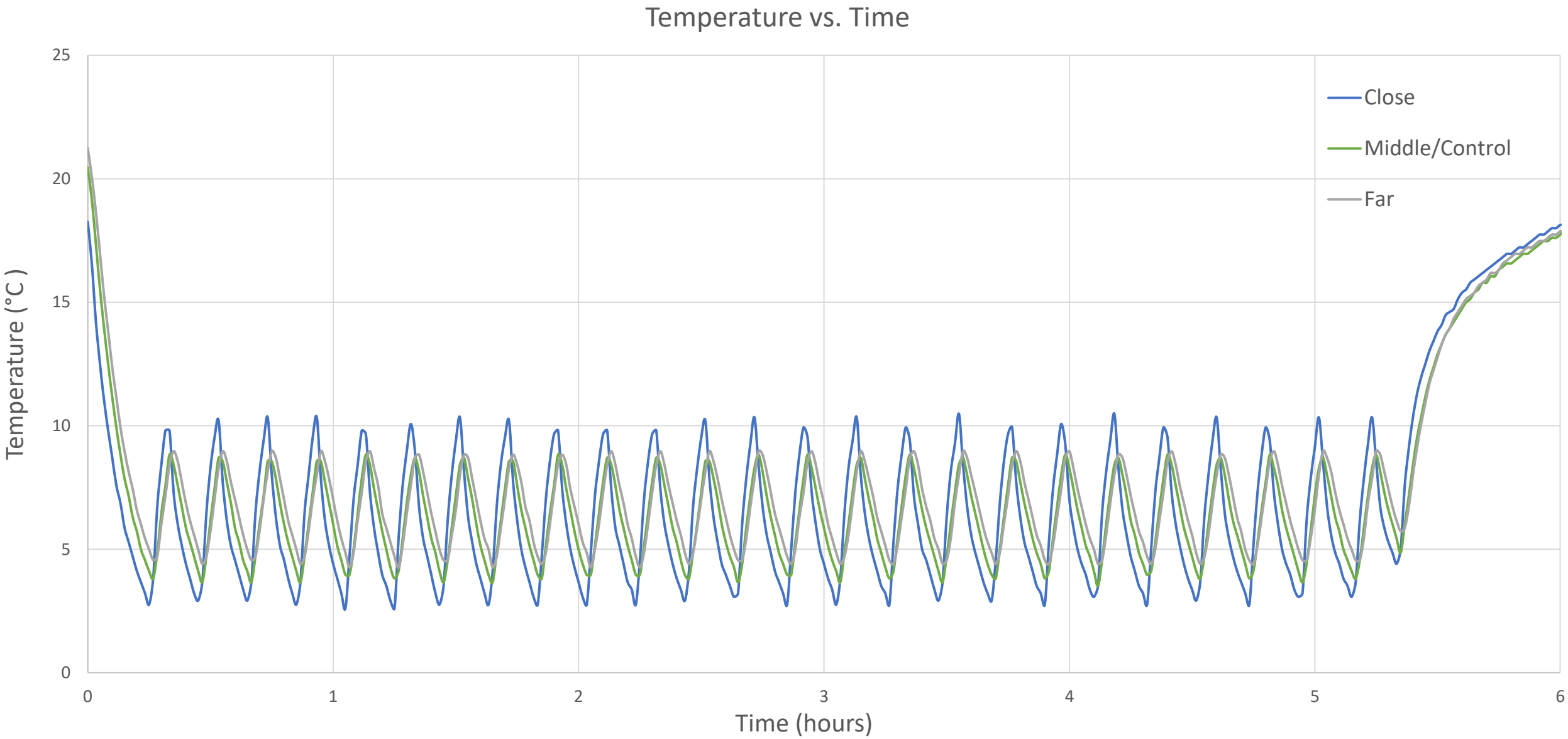
3

Observe long term power & temperature



Battery Test

- Reattached smaller fan and got rid of buck converter
- Powered circuit with one lithium battery
- Observed temperatures in 3 spots
- Observe how long it runs


Temperature vs. Time
Close
Middle/Control
Far
Temperature (°C)
Time (hours)
0
5
10
15
20
25
0
1
2
3
4
5
6

Test Summary

- System preforms better without buck converter and large fan
- Cool down time was 10 min
- Operational for 5 hours and 20 minutes
- Proper control system performance was achieved

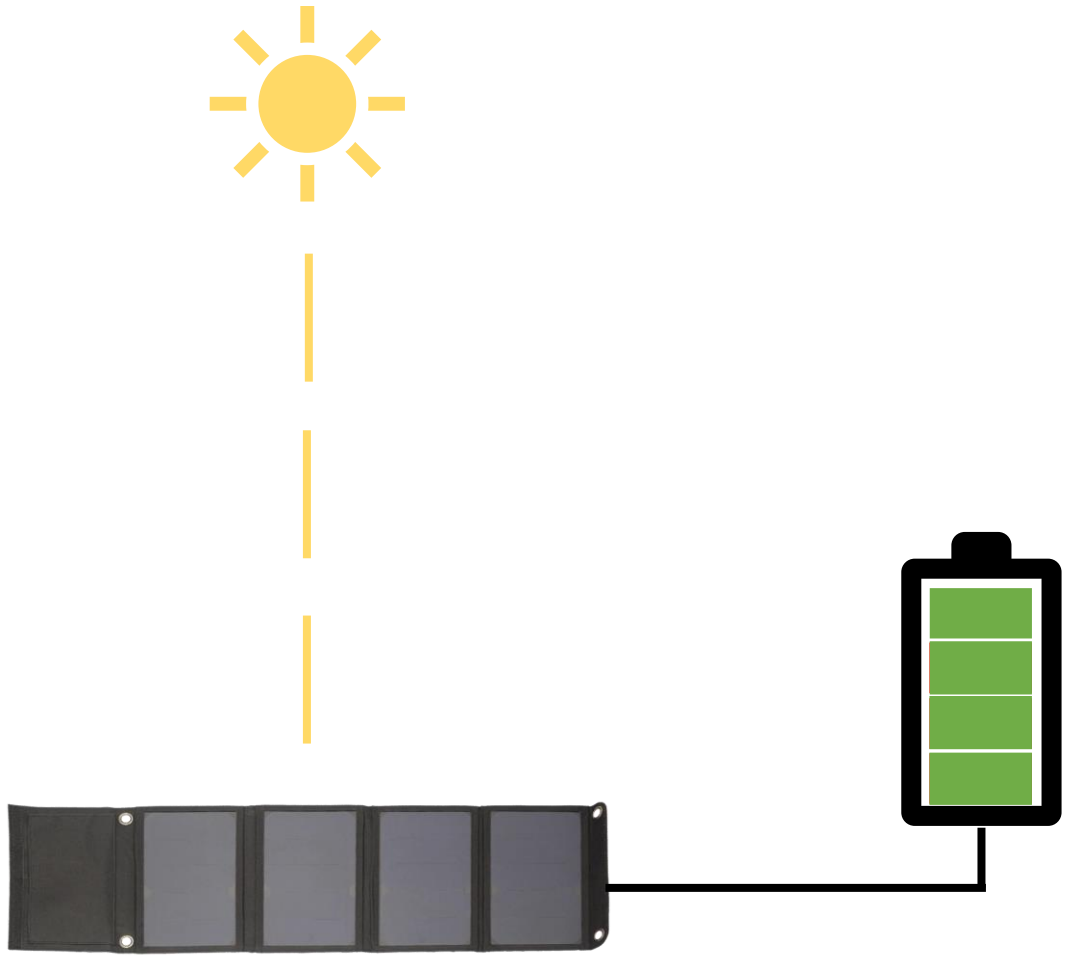
4

Keeping temperature within range for 14 days

Assuming Ideal Conditions

1 Battery Requires 8 Hours of Sunlight for a Full Charge

1 Battery Supplies 5 Hours of Power



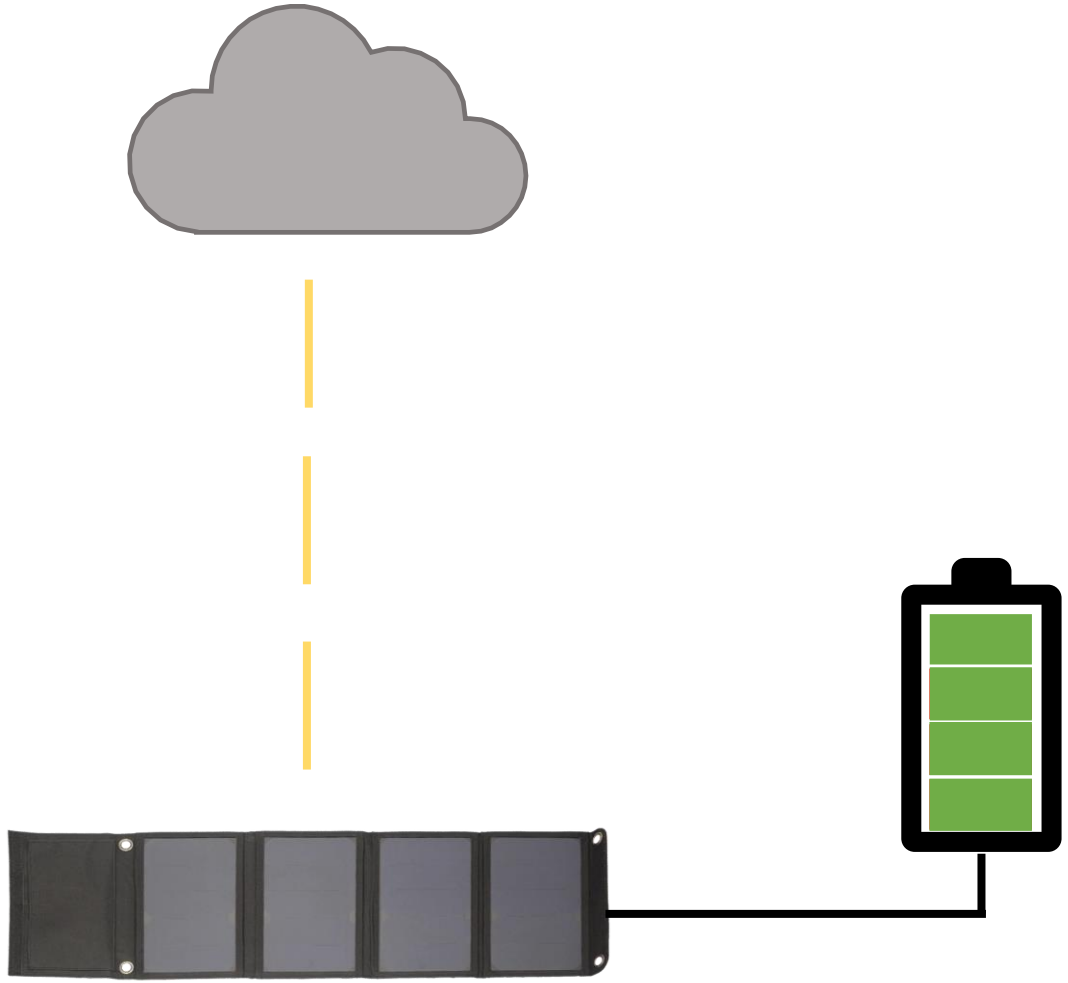
4

Keeping temperature within range for 14 days

Additional Factors

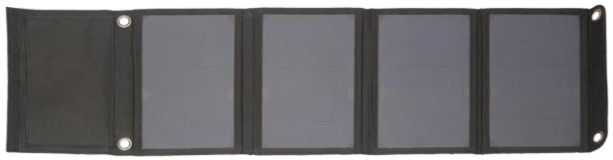
Lack of Direct Sunlight

Outdoor Climate



4

Keeping temperature within range for 14 days



Double Battery Supply:

- Double battery operation time
- Increase opportunity for solar charging
- Only add 3 pounds to total design weight

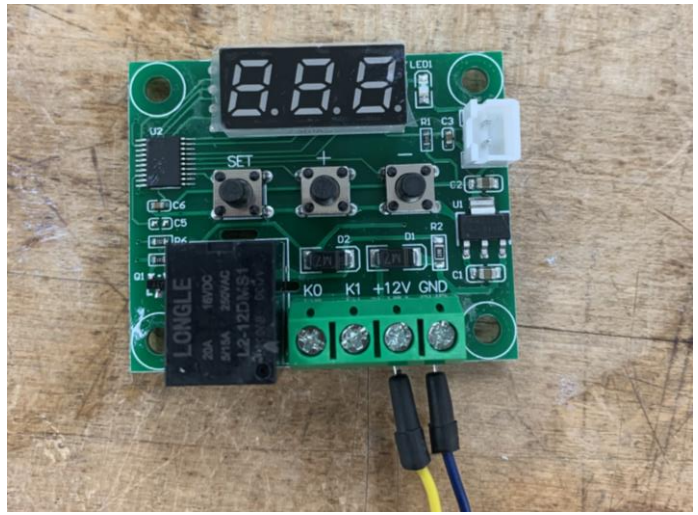
Increase Solar Supply:

- Significant increase in generated power
- Reduce necessary charge time

Lessons Learned

- Condensation formed during long-term test
- Spray-foam used to seal; more testing needed
- Wool insulation easily fell apart
- Not sterile or appropriate for medicine storage

Lessons Learned



Temperature Control Switch

Buck Converter

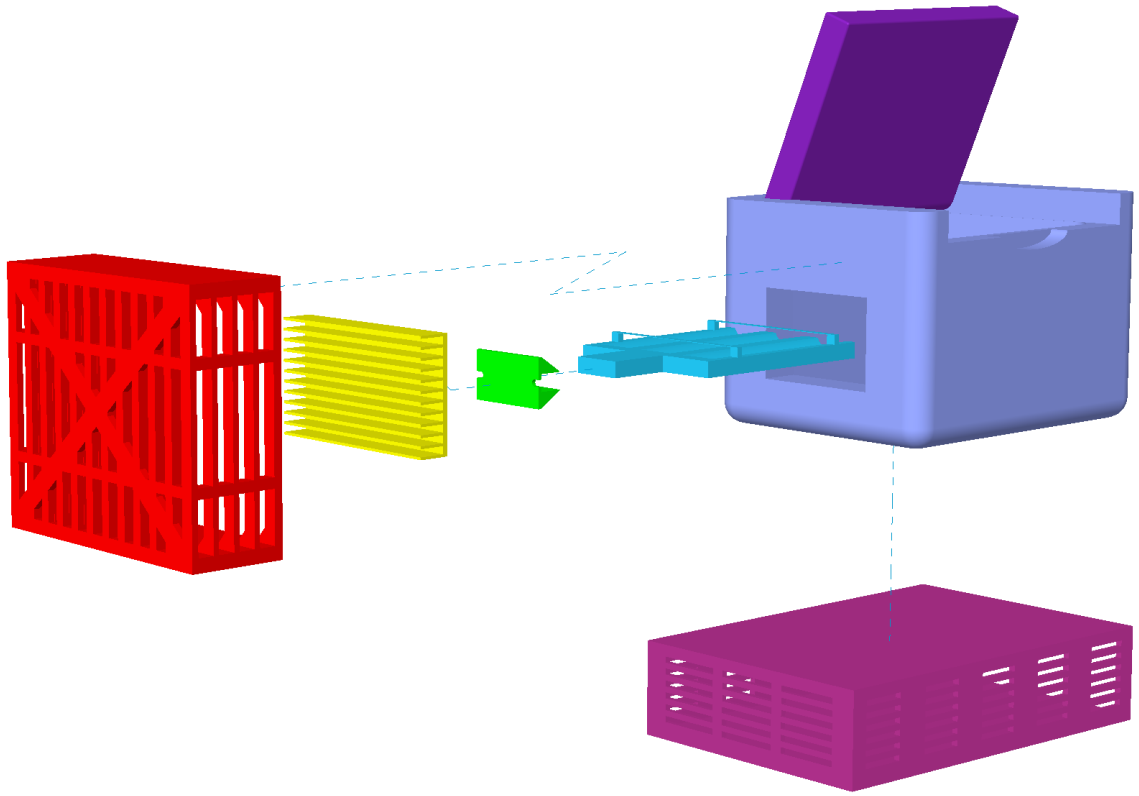
Temperature Control Switch

- Would break easily and often
- Sometimes temperature readings differed by 1°C - 2 °C

Buck Converter

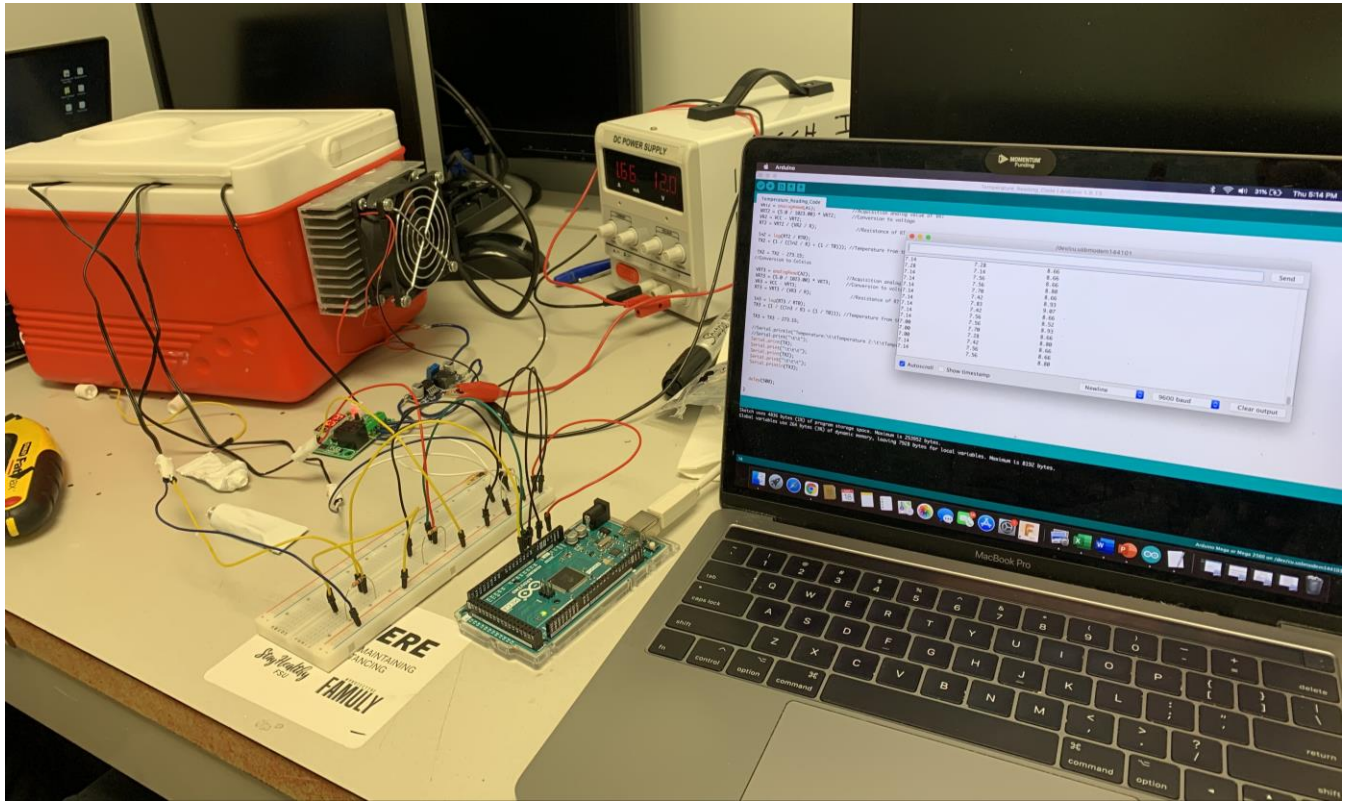
- Overheats during long-term test
- Didn't improve system performance

Lessons Learned



- Prototyping should have begun a lot earlier
- Original CAD needed more detail
- Didn’t originally CAD extra components and wiring

Lessons Learned



- Needed a better method to collect data
- Data was lost multiple times during long term test

Project Summary

Completed Work

- Getting device to target temperature range
- Portability of the device

Continued Work

- Complete a 14-day test
- Electrical equipment
- Power Consumption vs. Generation

Entrepreneurship

Medi-Kool

MEDI-KOOL
FLORIDA STATE UNIVERSITY

ACC
INVENTURE PRIZE

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