EML 4551-2

Team 510: Climatic Camera

Design Review IV

Nash Bonaventura
Diego Gonzalez
Bryce Shumaker

Team Introductions

Diego Gonzalez
Design Engineer

Nash Bonaventura
Simulation Engineer

Bryce Shumaker
Project Manager

Stakeholders

Engineering Mentor
Kourosh Shoele, Ph.D.
Assistant Professor
FAMU-FSU College of Engineering

Sponsor
Vinayak Hegde,
Reliability Engineering Manager
Danfoss Turbocor Compressors, Inc.

Objective

The objective of the project is to design a product that will maintain operation of a recording device at extreme temperatures (-40 to 160 °C)

(-40 to 320 °F)

Diego Gonzalez

Background

- Air compressor manufacturer
- All components are tested by reliability engineering department
- Components are tested using cyclic temperature tests
- Tests go full duration or until visible LED failure
- Test Temperature range (-40 to 160 °C)
- Cameras operates between 0 and 45 °C

Diego Gonzalez

Current Problems

- Physical presence is necessary to monitor
- Window gets foggy and obstructs view
- Reflection from window
- Poor visibility
  - Frost Accumulation
  - Fixed viewing distance
  - Short reach

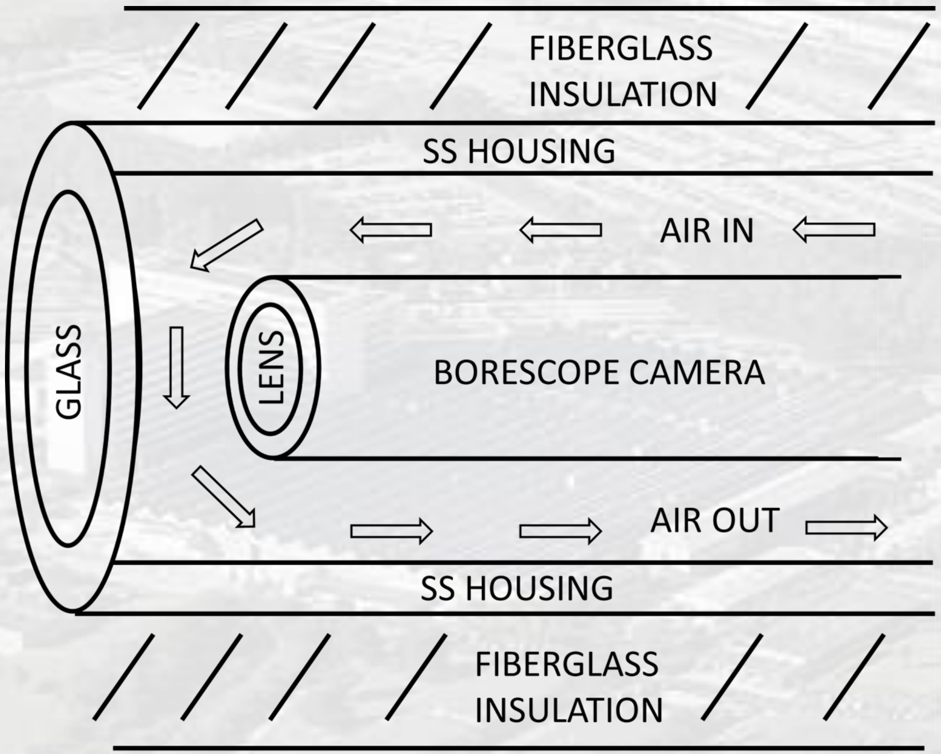
Diego Gonzalez

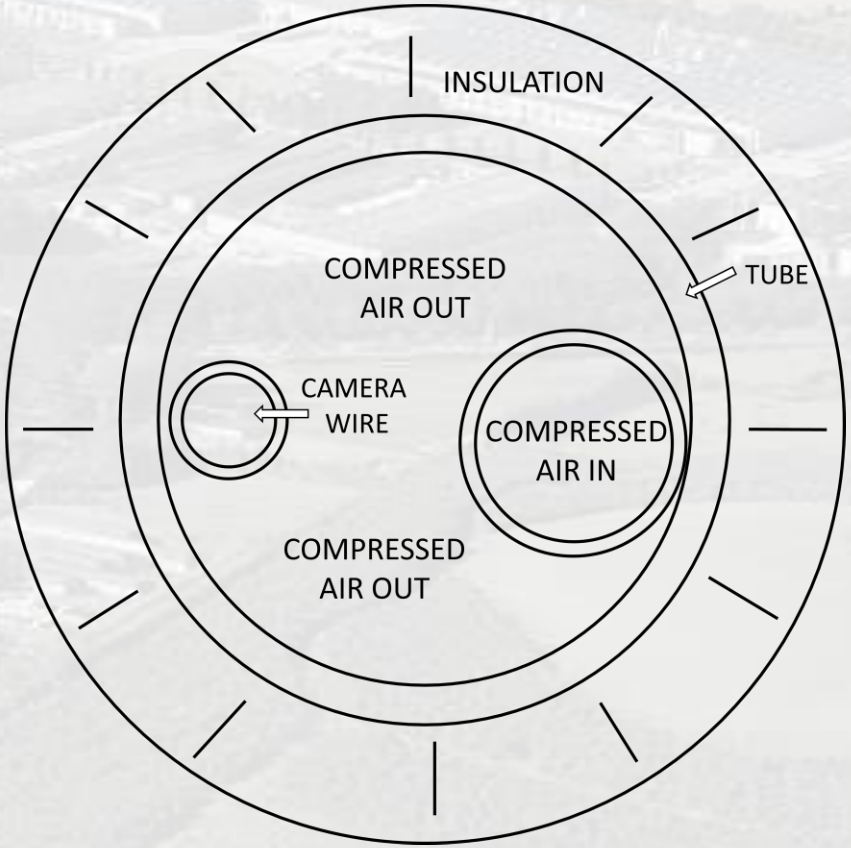
Available Resources

- Compressed Air – temperature regulation
- Laptop – power supply, software interface, data storage
- Chamber Port – connection with auxiliary systems
- Racks – mounting
- Machine Shop

Diego Gonzalez

Selected Design





Bryce Shumaker

Selected Design

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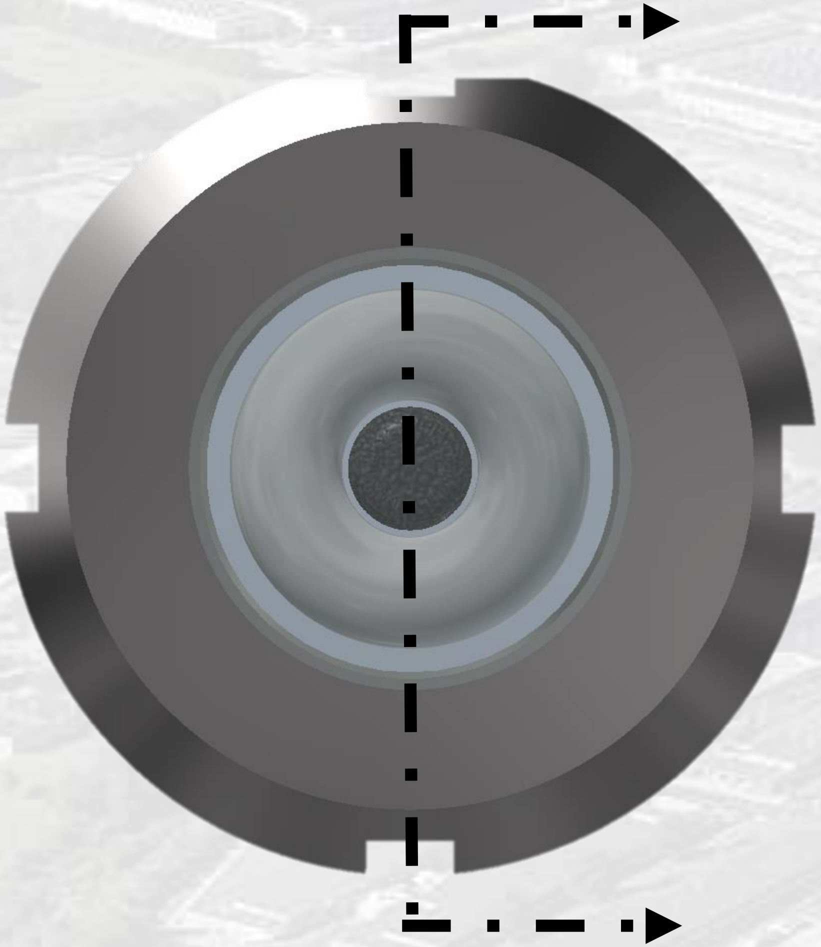
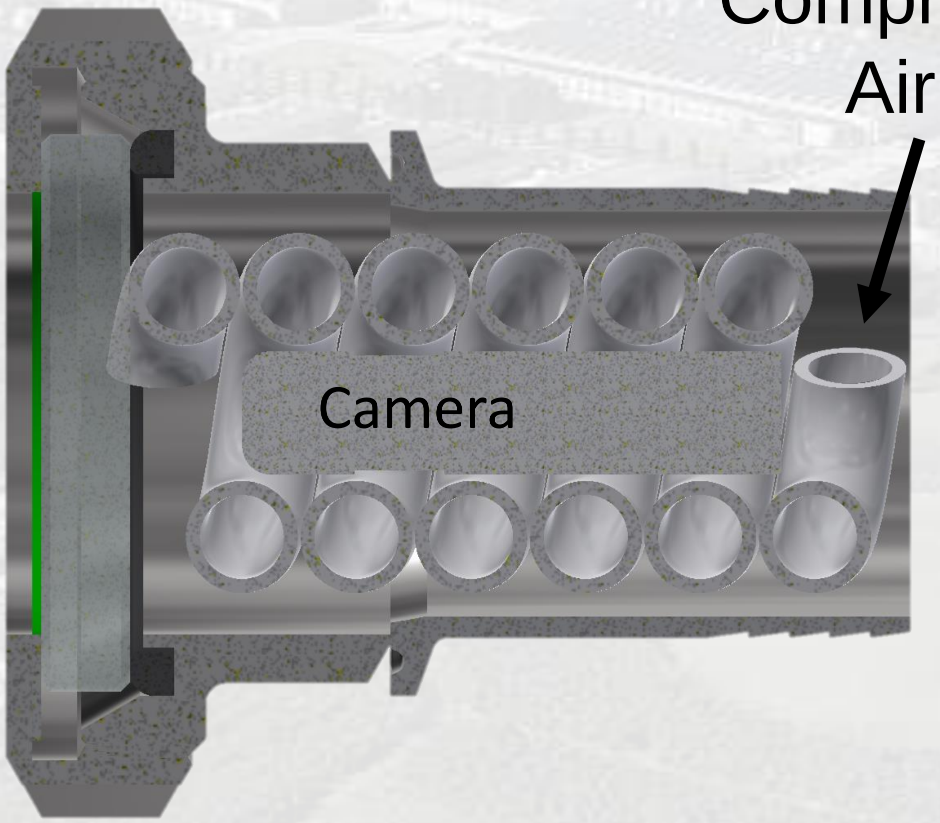
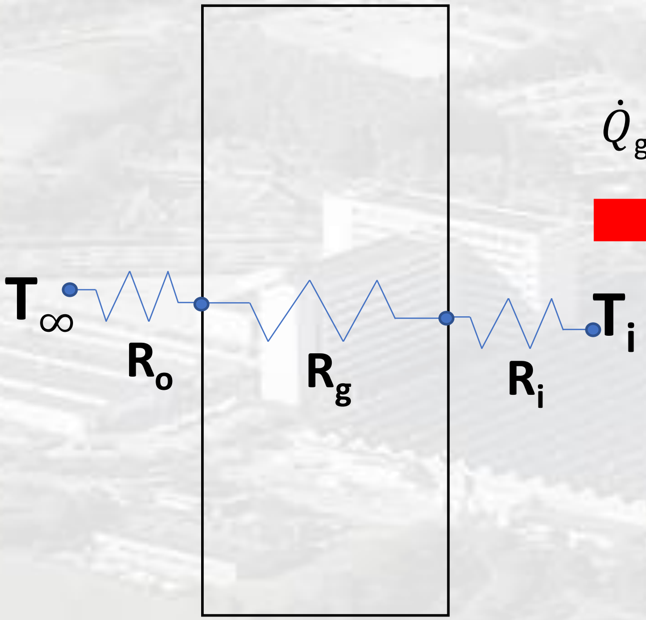


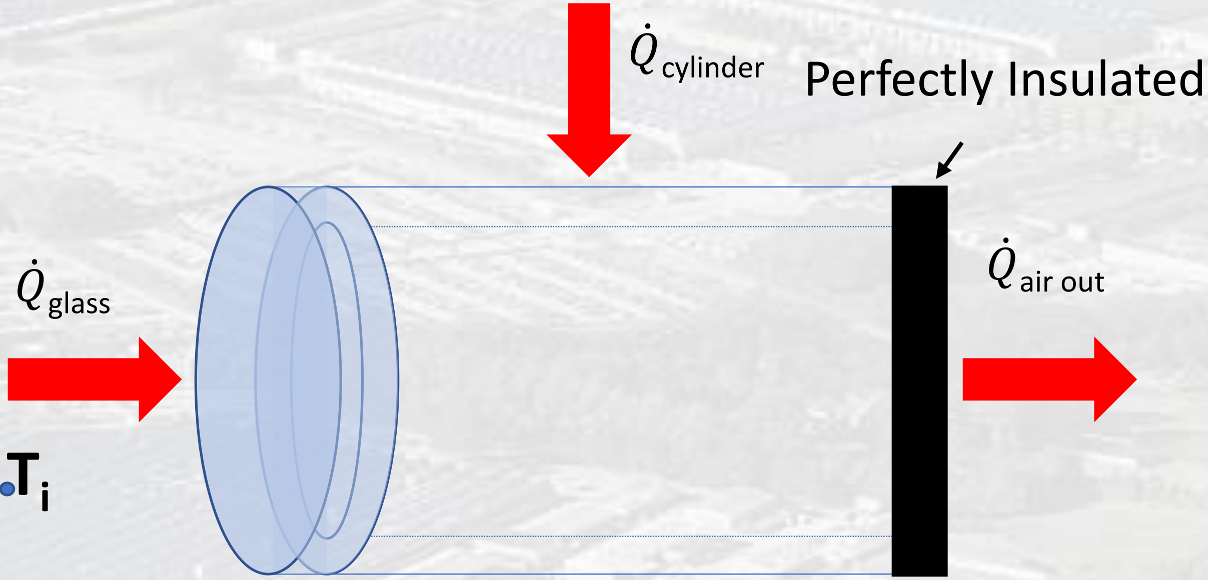


Bryce Shumaker

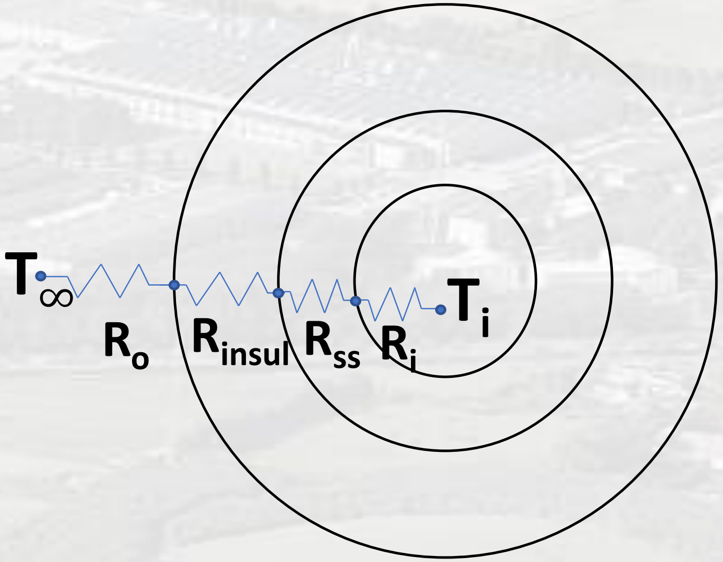
Selected Design

Thermal Resistance of Glass





Thermal Resistance of Cylindrical Shell



$$\dot{Q}_{cylinder} = \frac{T_\infty - Ti}{R_o + Rinsul + Rss + Ri}$$

$$\dot{Q}_{glass} + \dot{Q}_{cylinder} = \dot{Q}_{air\ out}$$

$$\dot{Q}_{glass} = \frac{T_\infty - Ti}{R_o + Rg + Ri}$$

$$\dot{Q}_{air\ out} = \dot{m}c_p(T_{air\ in} - T_{air\ out})$$

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Simulation

Boundary Conditions input to COMSOL model

- Steady state
- Natural convection occurs on the exterior surfaces exposed to the chamber
- Heat generation of the camera is negligible
- Compressed air enters the device with a mass flow rate of 1 gram per second at ambient temperature

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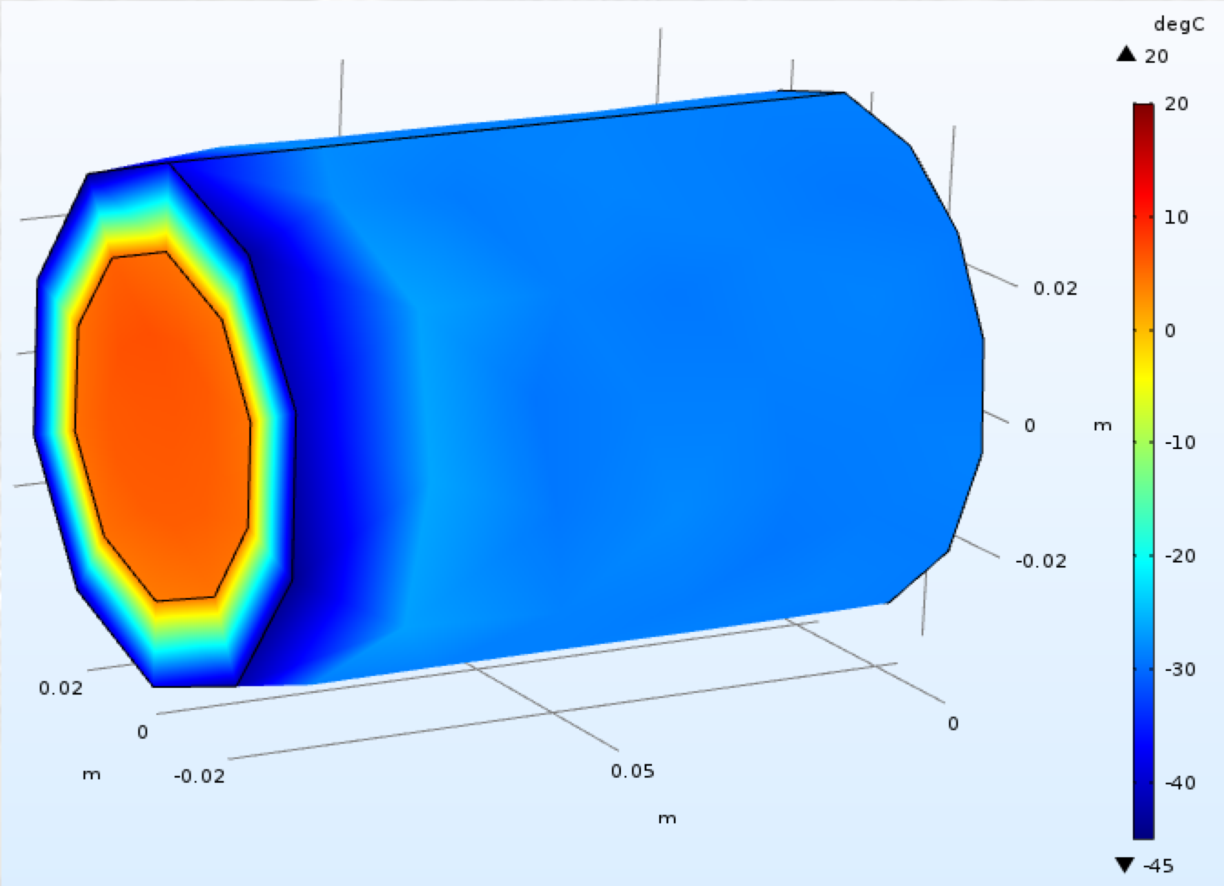
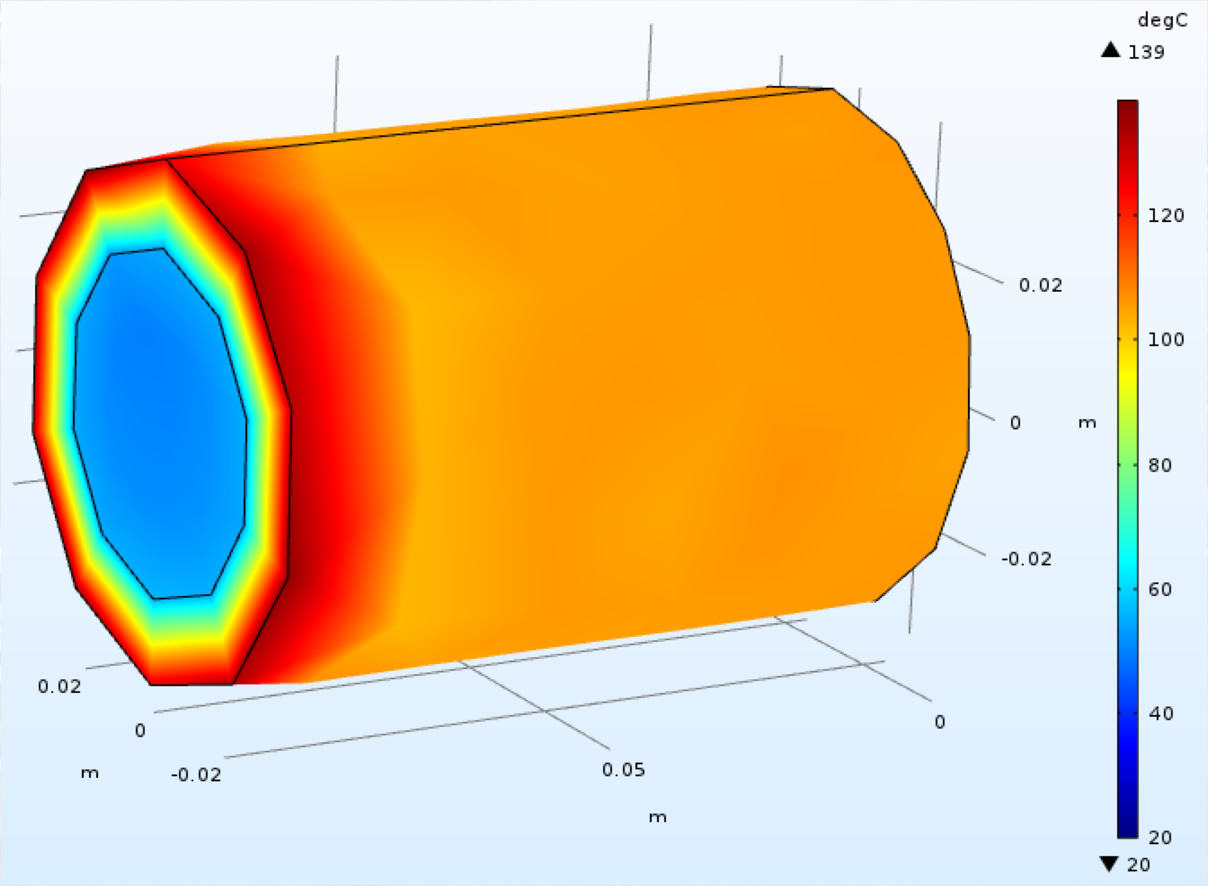
Simulation

Range of temperatures for suitable materials:
-45°C to 139°C

Outer Surface



Cold Extreme



Hot Extreme

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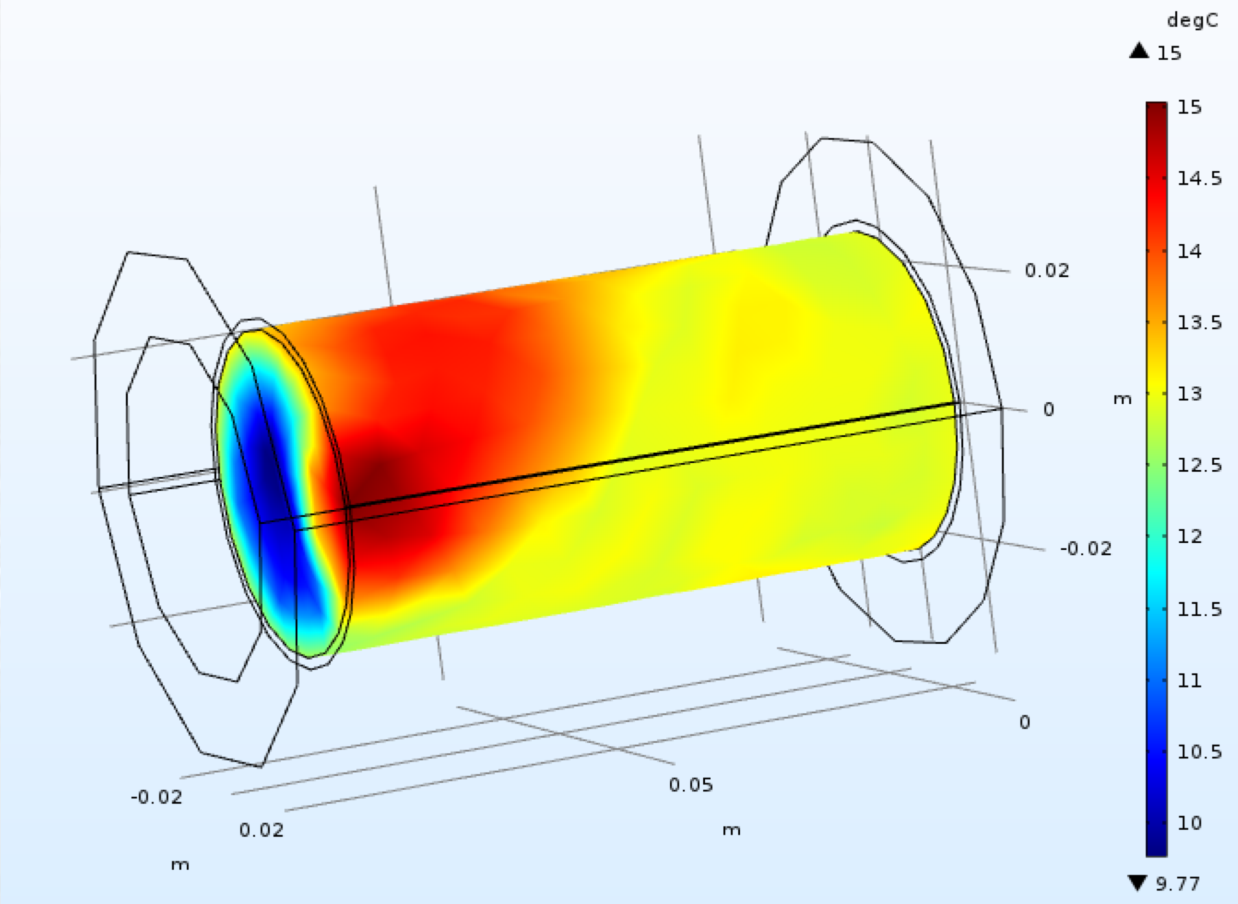
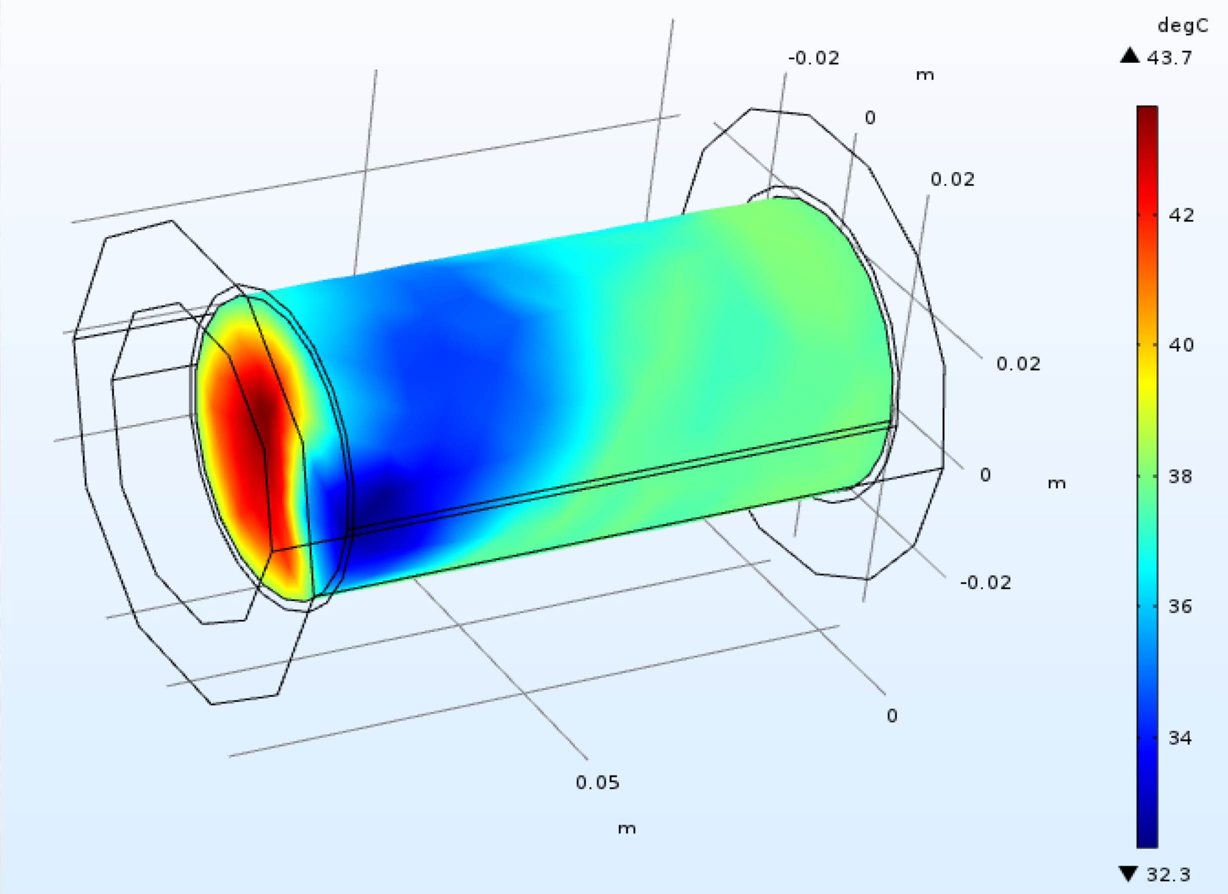
Simulation

Range of temperatures for suitable materials:
9.77°C to 43.7°C

Inner Wall



Cold Extreme



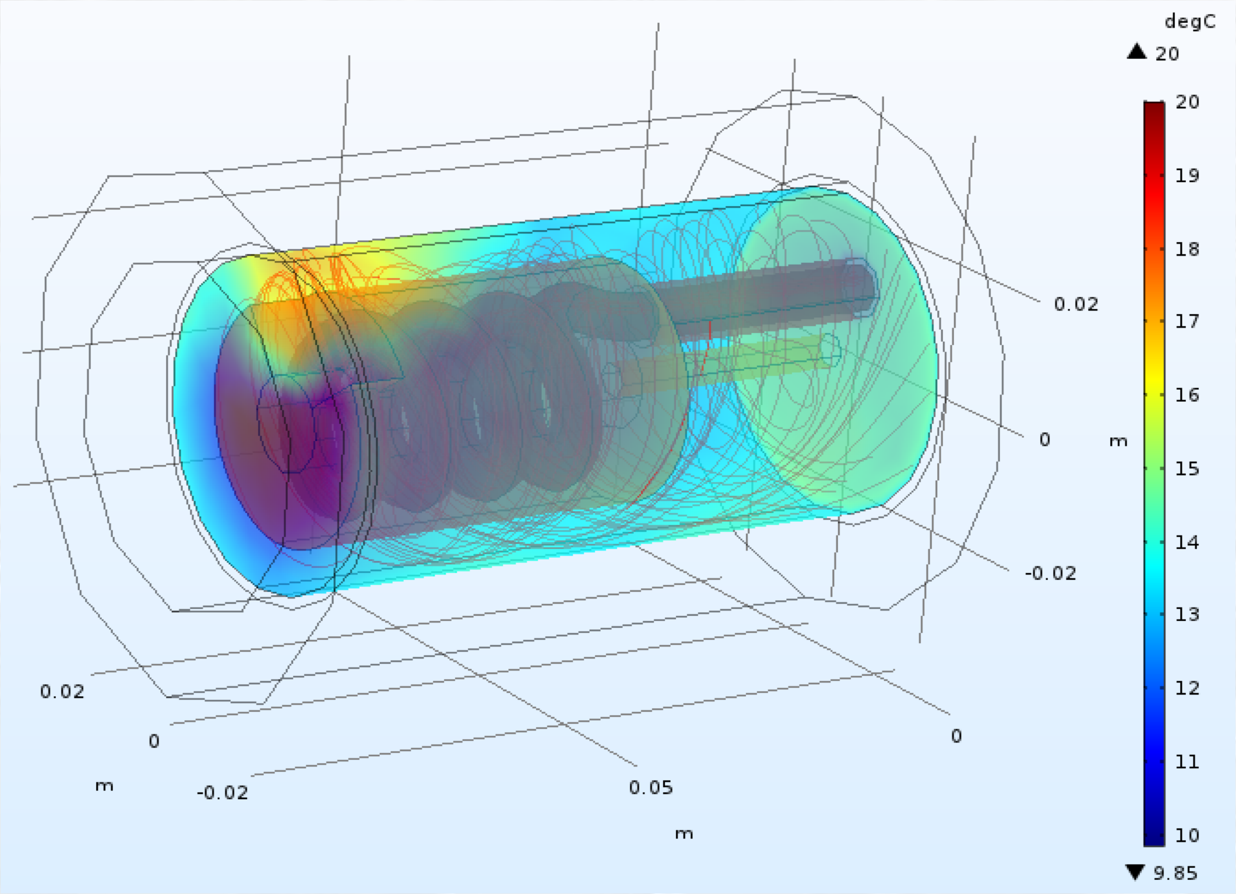
Hot Extreme

Nash Bonaventura

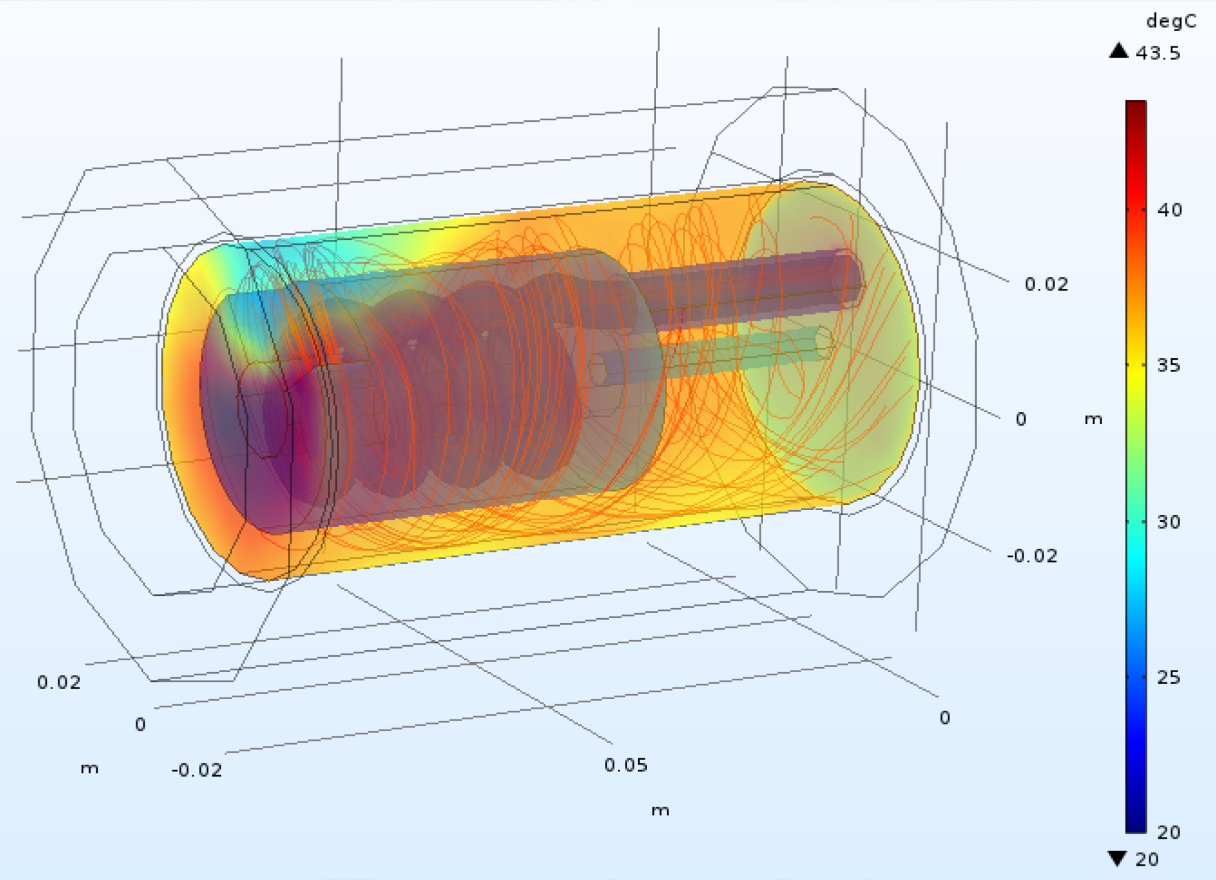
Simulation

Range of temperatures for suitable materials:
9.85°C to 43.5°C

Inner Wall



Cold Extreme



Hot Extreme

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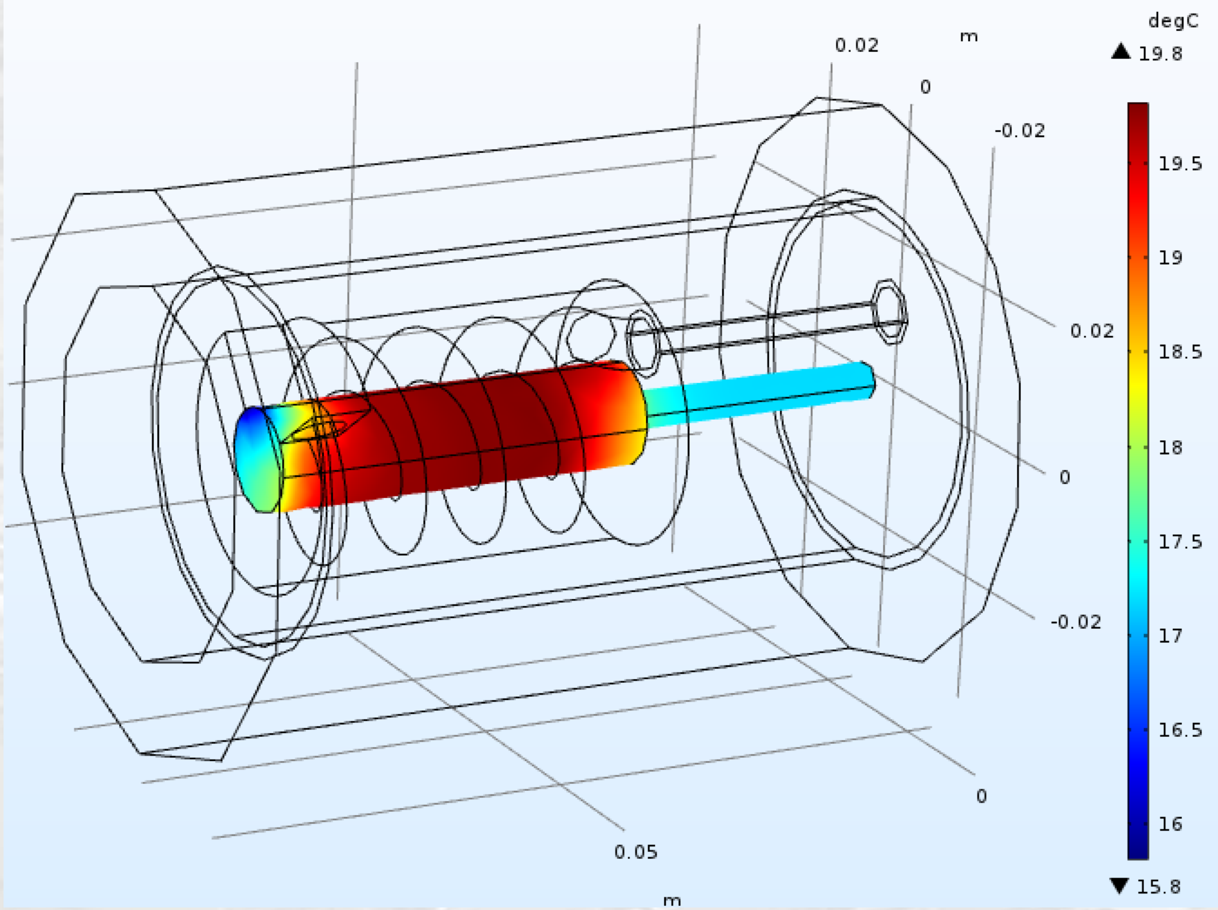
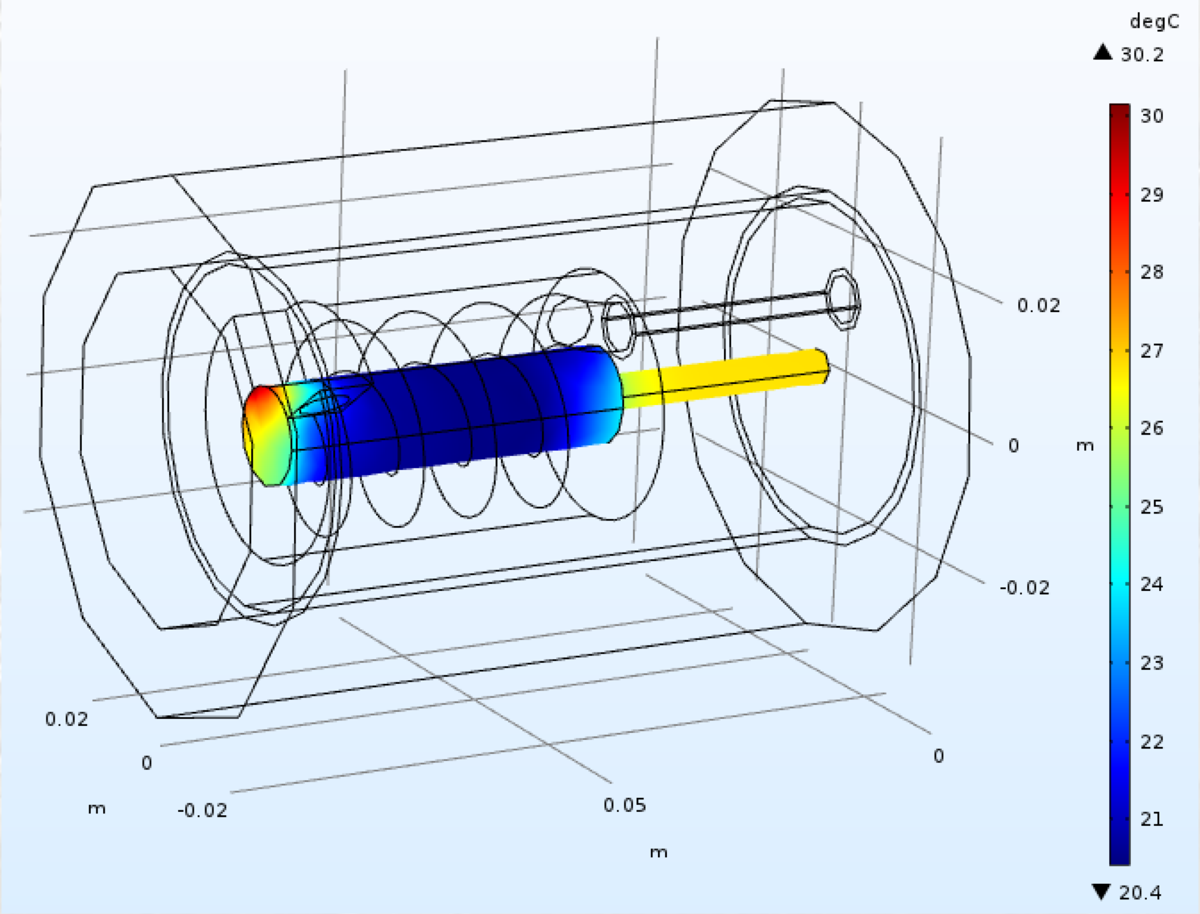
Simulation

Range of temperatures camera experiences:
15.8°C to 30.2°C

Camera Surface



Cold Extreme



Hot Extreme

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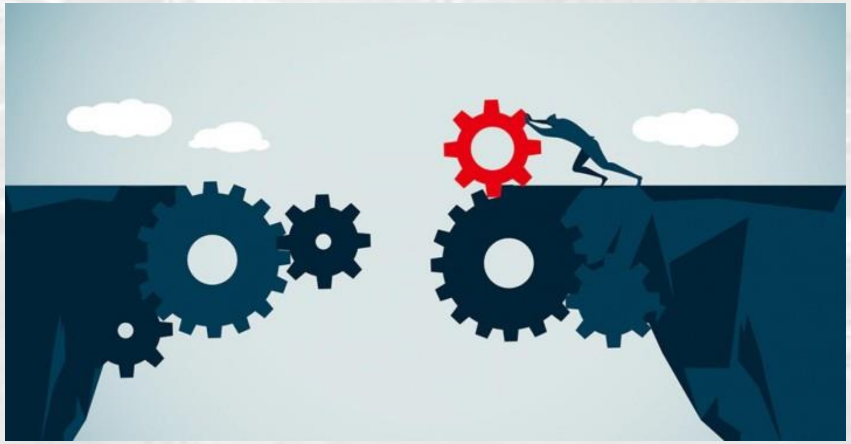
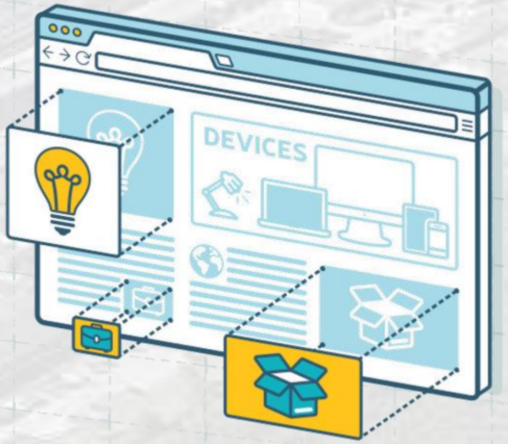
Current Work

- Material Research
- Simulation
- Receive ordered materials from Danfoss
- Website





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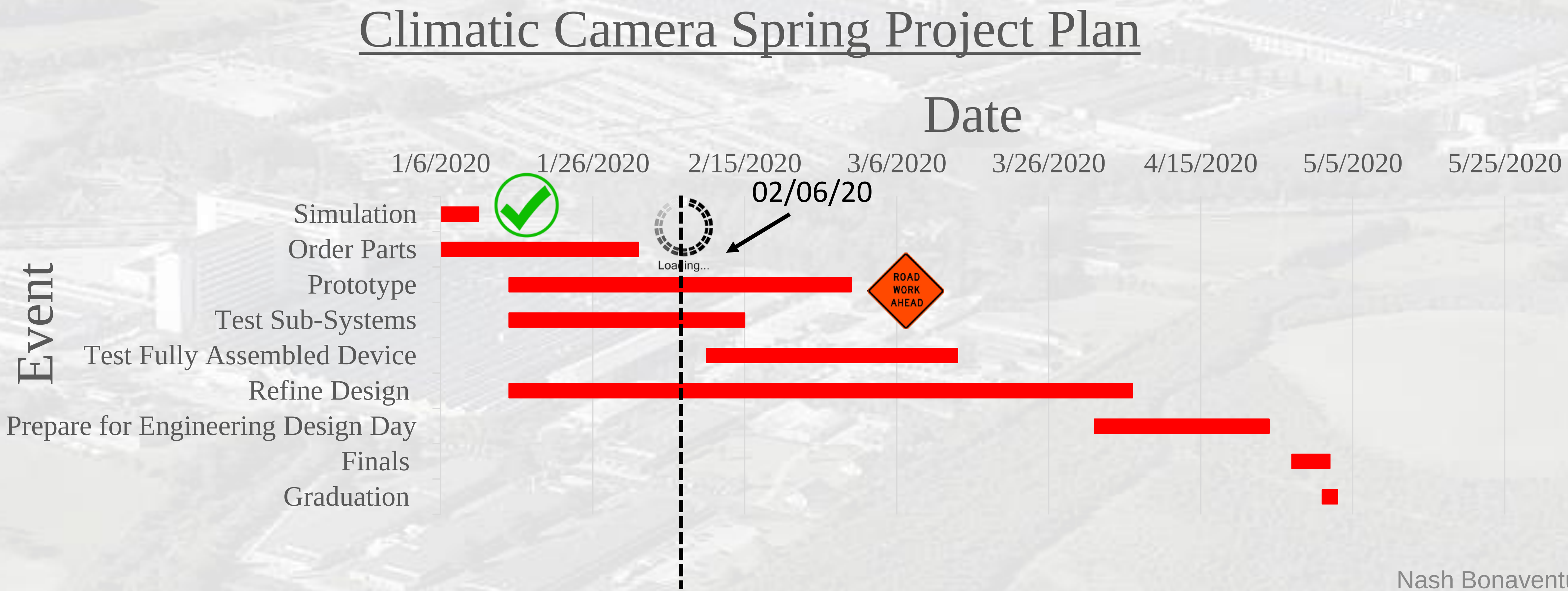
Spring Project Plan Standing



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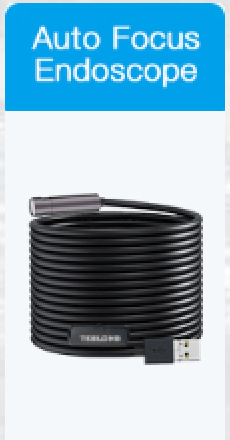
Purchased Items

- Housing
- Housing lens
- Borescope camera



Auto Focus Endoscope

Resolution	2594x1944 pixels
Diameter and Length of Cable	14mm dia-5m
Focal Length	0.01m~100m
Waterproof Level of Cable	IP67
LED Lights	✓
Accessory	✓

Nash Bonaventura

Moving Forward

- Validate design through ordered parts
- Order remaining parts
- Monitor heat distribution with IR camera
- Update simulation
- Building prototype
- Testing
- Refine

Nash Bonaventura

References

McConomy, S. (2019, February 2). Engineering Characteristics, Functions, Targets, and Metrics. FAMU-FSU College of Engineering.’

Industrial, C. S. Z. (2010). Z-Plus Temperature & Humidity Chambers. Retrieved October 1, 2019, from https://www.cszindustrial.com/Products/Temperature-Humidity-Chambers/Z-Plus.aspx.

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“It’s not a problem it’s an opportunity”

This is the end of the Presentation

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