

Medical Grade Tubing Ovality Removal

Isaiah Curtis | Kyle McDonnell | Nick Brahill | Yiwen Shen | Bradley Kittrell | Alex Seymour

Background

- Terumo BCT required the removal of ovality from blood tubing within a fully automated manufacturing process.
- Unacceptable tubing ovality has prevented increased production rates and rendered a large portion of the tubing unusable.

Objective

Ovality Removal

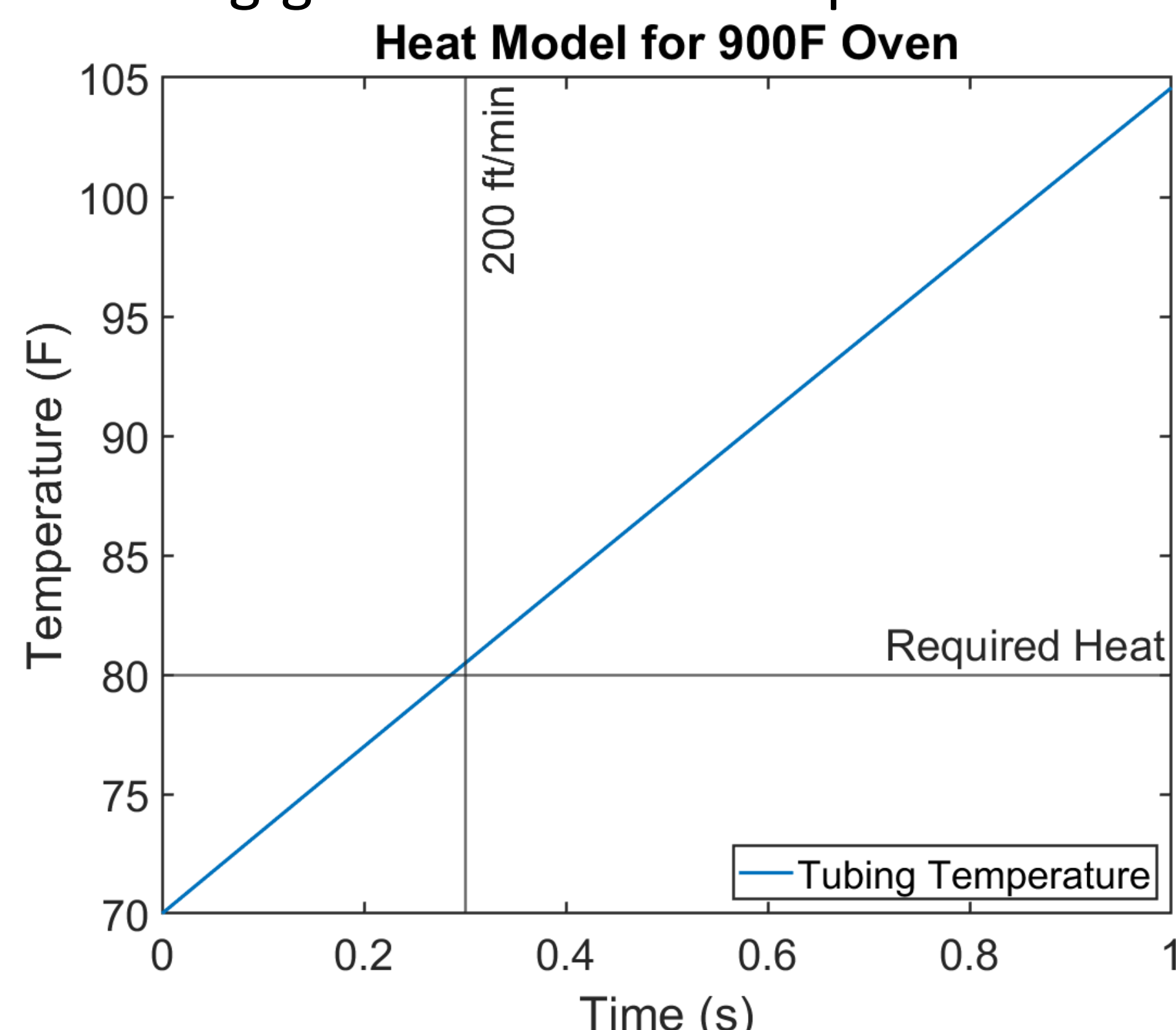
- Ensure the maximum and average ovality in any section of tubing does not exceed 0.0400" and 0.0200" respectively.
- Tubing is heated to 80F, allowing for permanent reshaping with mechanical manipulation.

Integration

- Tubing is driven with 2 high-powered DC motors rated to meet a 200 ft/min feed rate.
- Double tripod base allows for height and angle adjustments.
- Prototype is ISO 8 Class A clean room compliant and operates off 120V AC power.

Material Quality

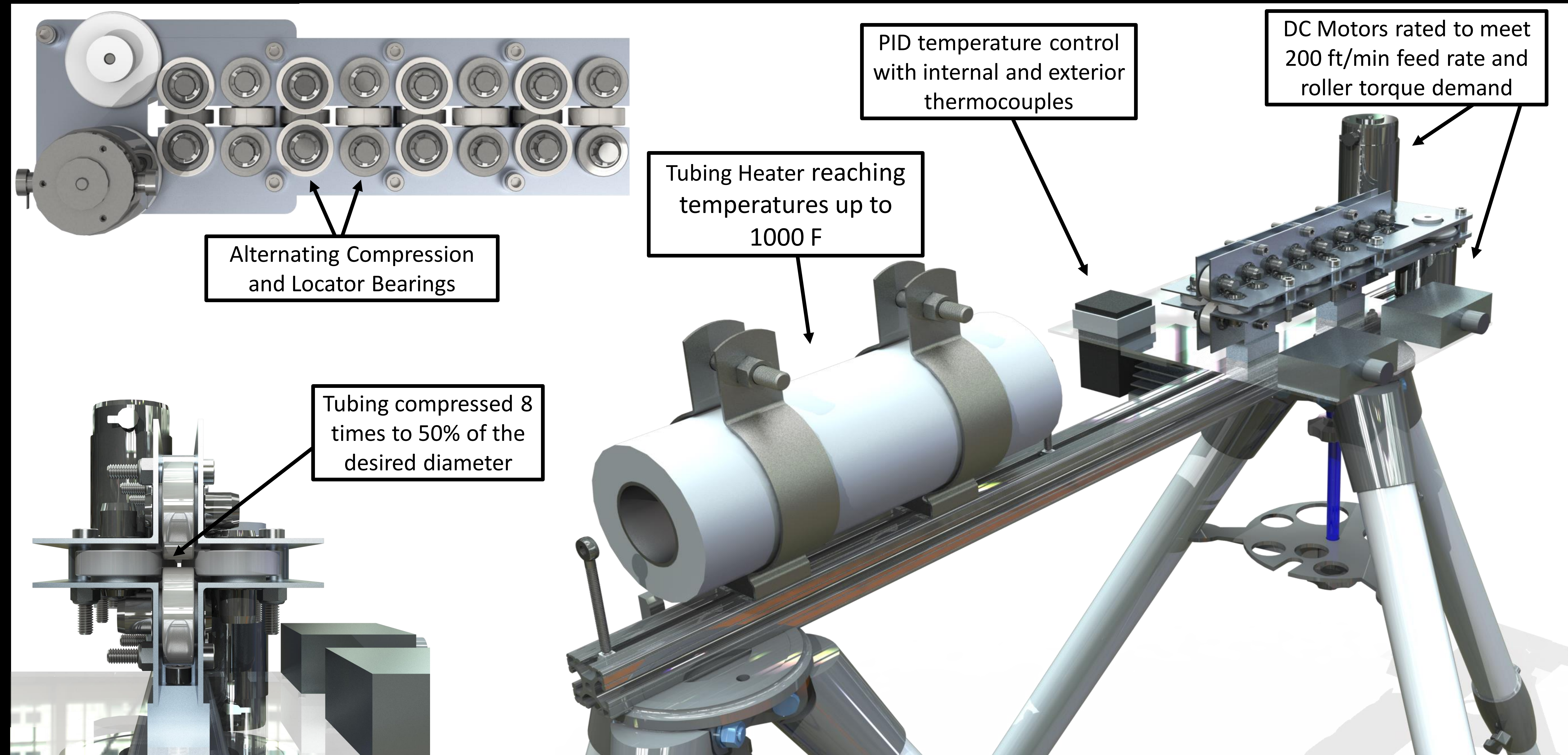
- Continual tensile testing is required to control for tubing elasticity.
- Smooth compression bearings were selected to ensure surface roughness was not altered.
- Heat model prevents tubing from reaching glass transition temperature.



Differential Equation Governing Tubing Temperature

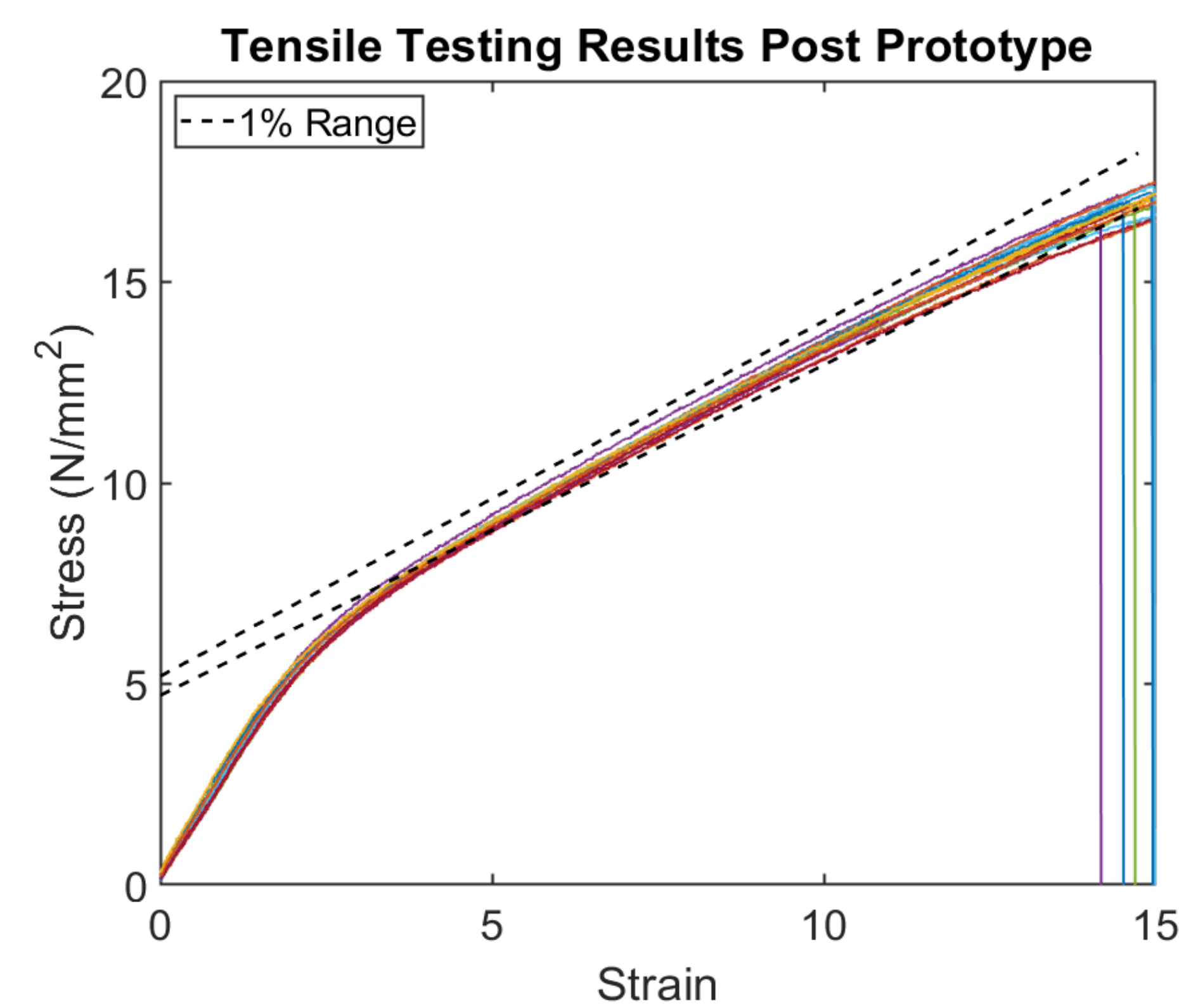
$$\frac{\sigma dC_p}{4} \left(\frac{dT}{dt} \right) = h(T_\infty - T(t)) + \sigma \epsilon_{tubing} (T_s^4 - T(t)^4)$$

Assembly



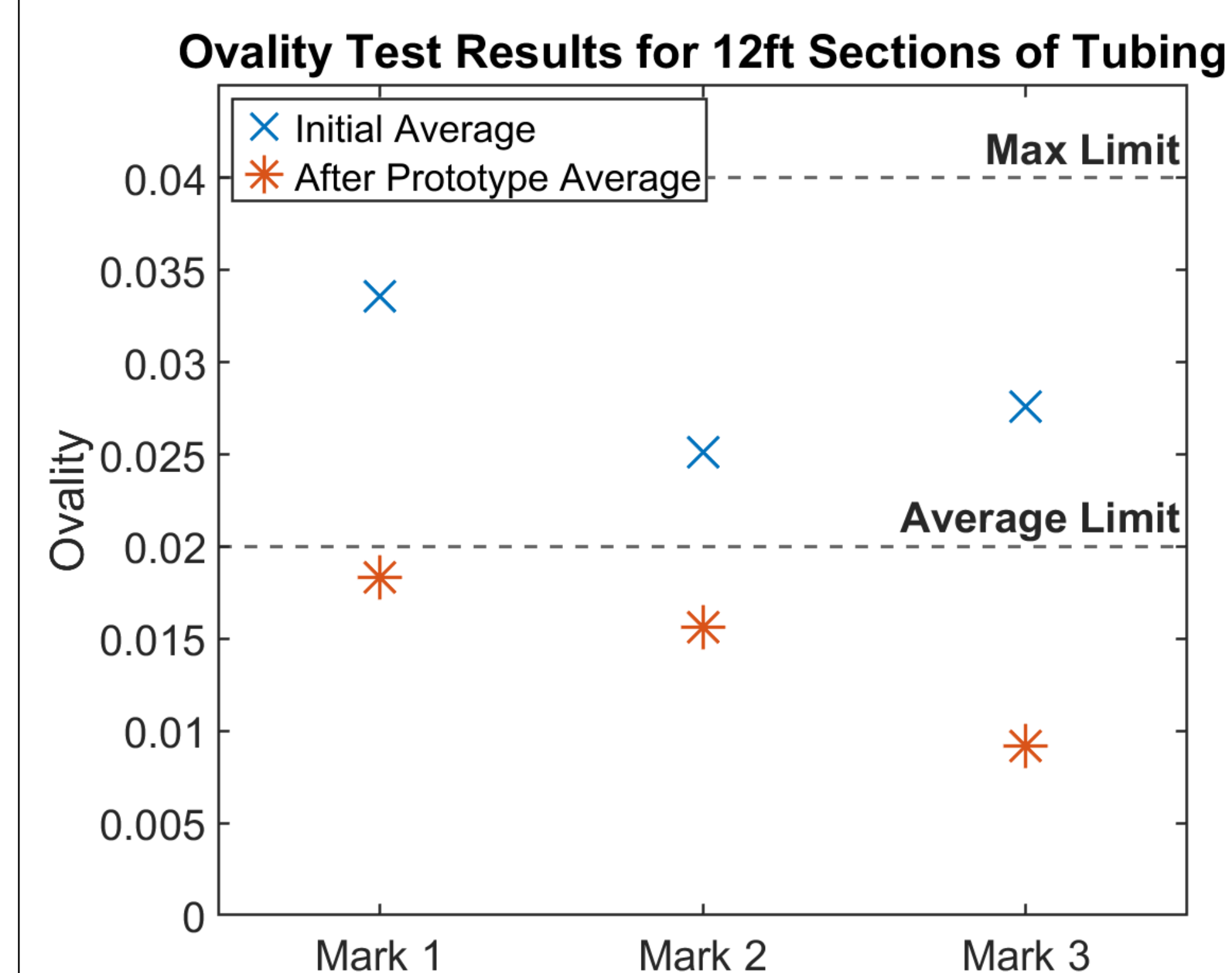
Tensile Testing

- To ensure the tensile strength of the tubing is not changed, the elastic moduli is used as a control variable.
- Baseline measurements of elastic moduli are used to ensure the reformed tubing stays within 1% of its original elasticity.



Ovality Testing

$$Ovality = Max\ OD - Min\ OD$$



- After heating and reforming the tubing, we observed significant improvement in ovality, rendering more of the tubing within spec.

Future Work

- Improve drive system
- Closing heater off to meet ISO 8 Class A clean room.
- Efficient method to access heater and roller system to initially load tubing.
- Optimize the roller system by increasing/decreasing the number of rollers to meet ovality requirements.