Final Design and Safety Review of the INTT Ladder and Barrels

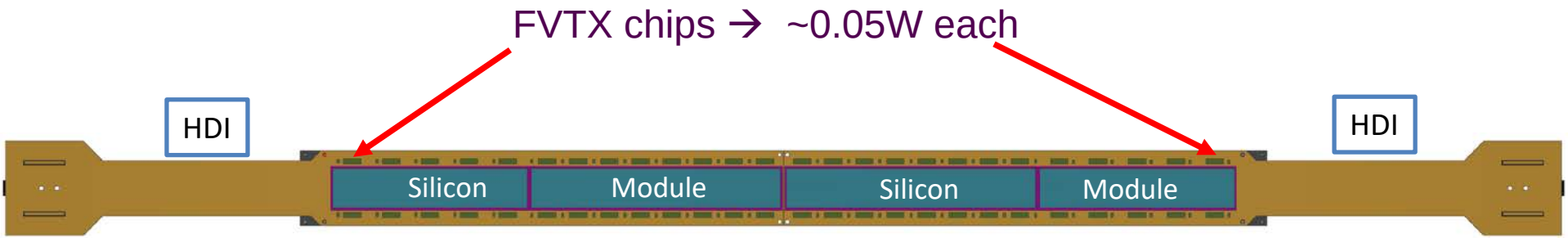
INTT Cooling System

WBS: 3.0X

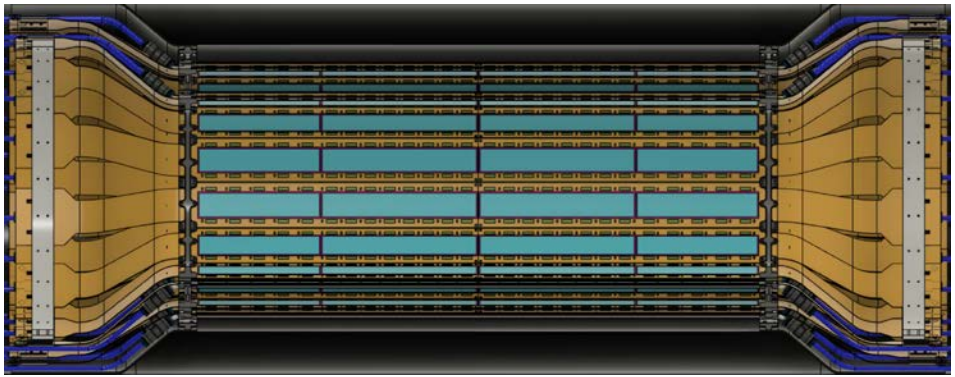
Rob Pisani, BNL

June 1th, 2020

Ladder – Stave with Two HDIs



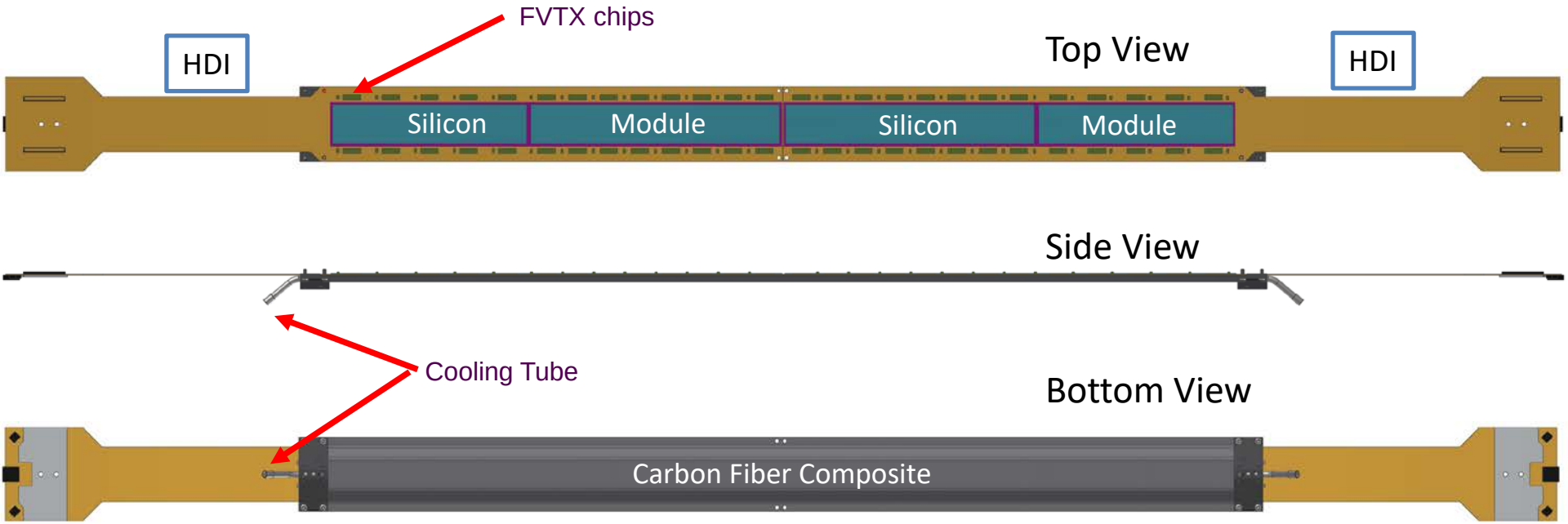
52 Chips + HDI components → 2.6 Watts



Rounding up to 3Watts per ladder

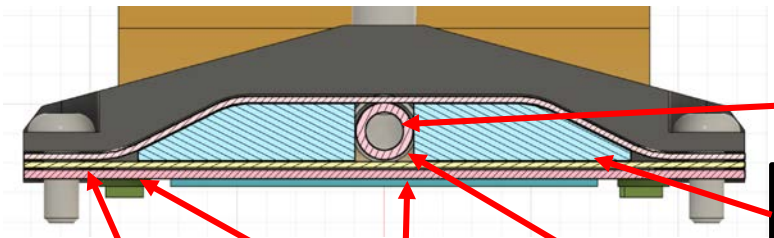
3 W x 56 ladders = 168 W

Ladder – Stave with Two HDIs



Stave Design and Thermal Load

What we care about for Cooling



3M Thermal Epoxy TC2810

Loctite 2902 (Silver Epoxy)

Graphite Epoxy (EP75-1)

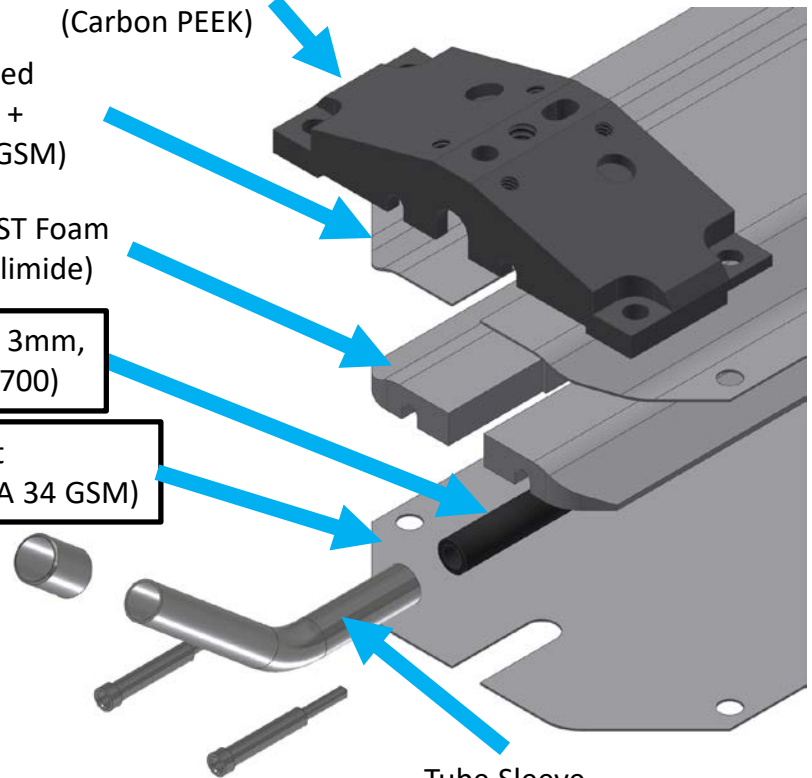
CFC Tube (OD: 3mm, ID: 2mm) (T700)

CFC Flat (K13C2U + 20301A 34 GSM)

Rohacell 110 RIST Foam (polymethacrylimide)

CFC Formed (K13C2U + 20301A 34 GSM)

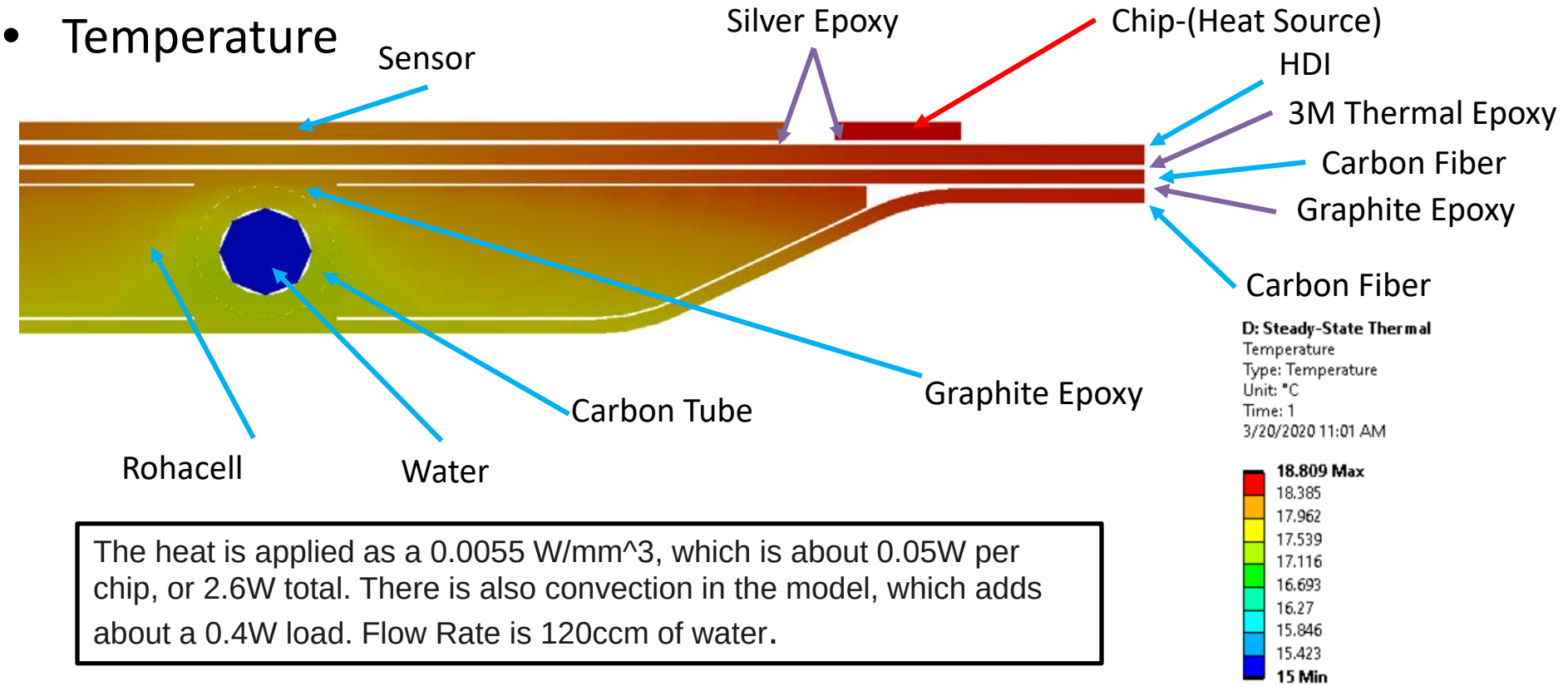
Endcap (Carbon PEEK)



Tube Sleeve (316 Stainless)

Thermal – Midplane Cross Section

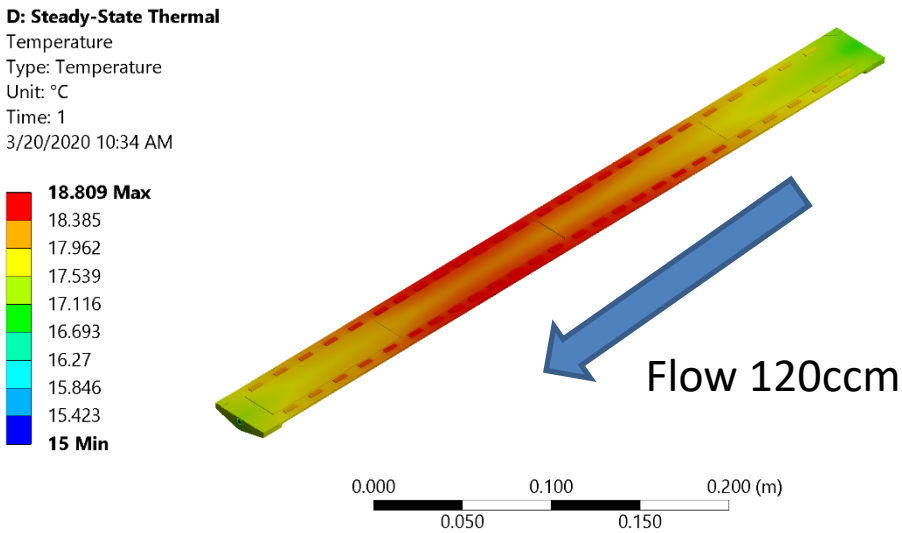
- Temperature



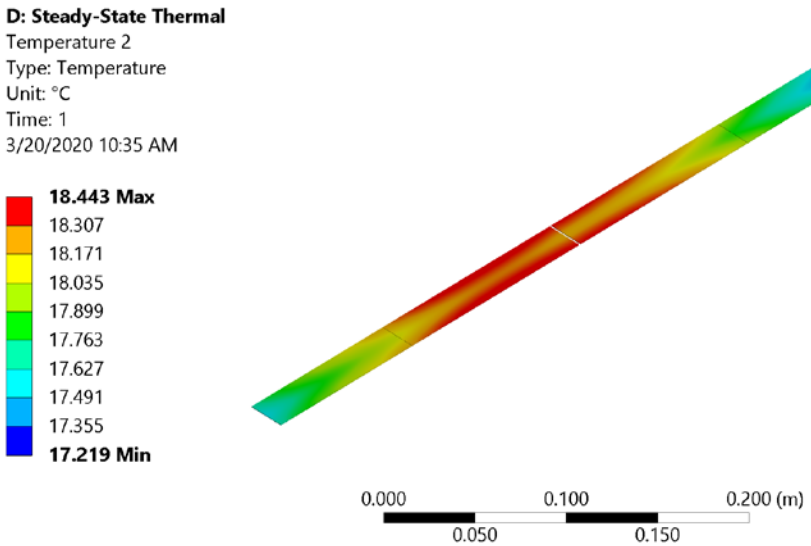
The heat is applied as a 0.0055 W/mm^3, which is about 0.05W per chip, or 2.6W total. There is also convection in the model, which adds about a 0.4W load. Flow Rate is 120ccm of water.

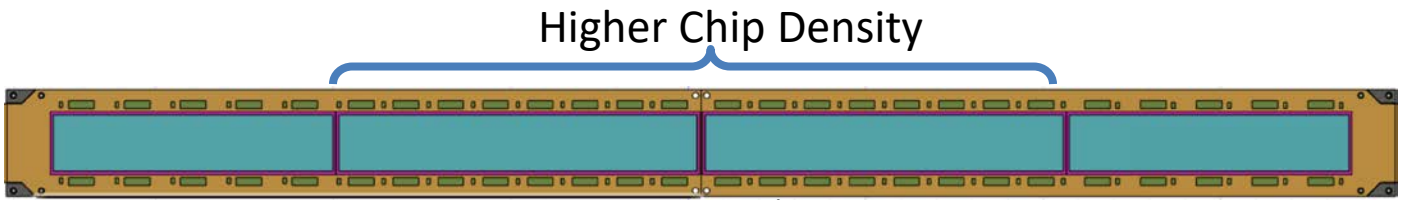
Thermal – Temperatures

Stave ΔT – 3.8 ° C (6.8 ° F)

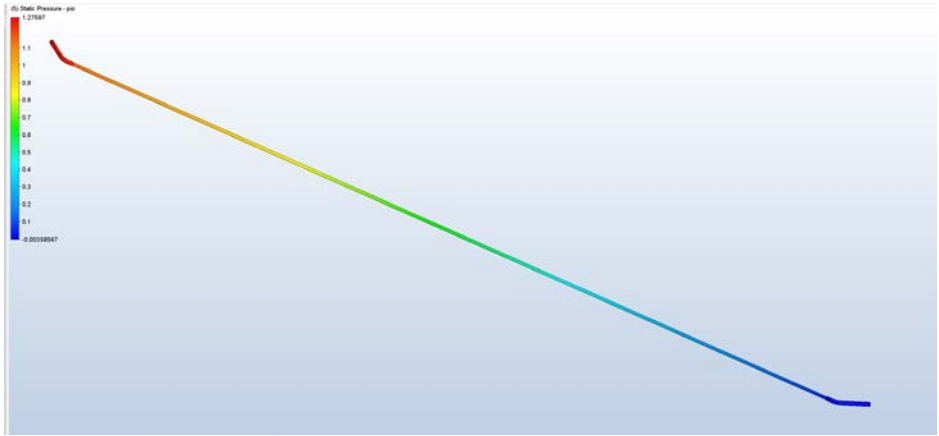


Sensors ΔT – 1.2 ° C (2.2 ° F)





Pressures and flow analysis

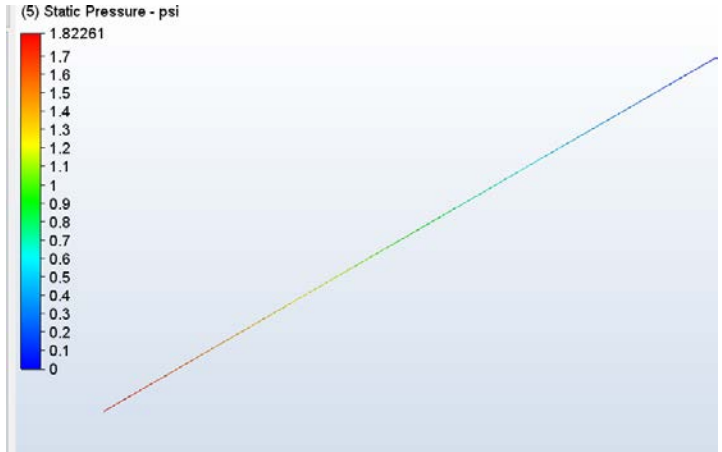


1.3psi to obtain a flow of 120ccm through the ladder.

Additional 1.8psi for the 2.8m I.D. 3mmID Poly Tubing

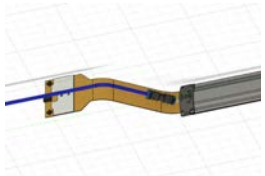
Coupling with 3mm bore

3mm ID 4mm OD
2.8m Polyethylene
Tubing

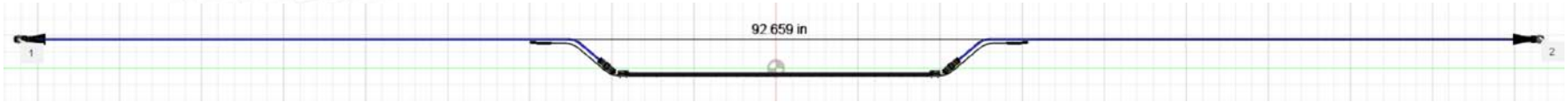


INTT FDS Cooling

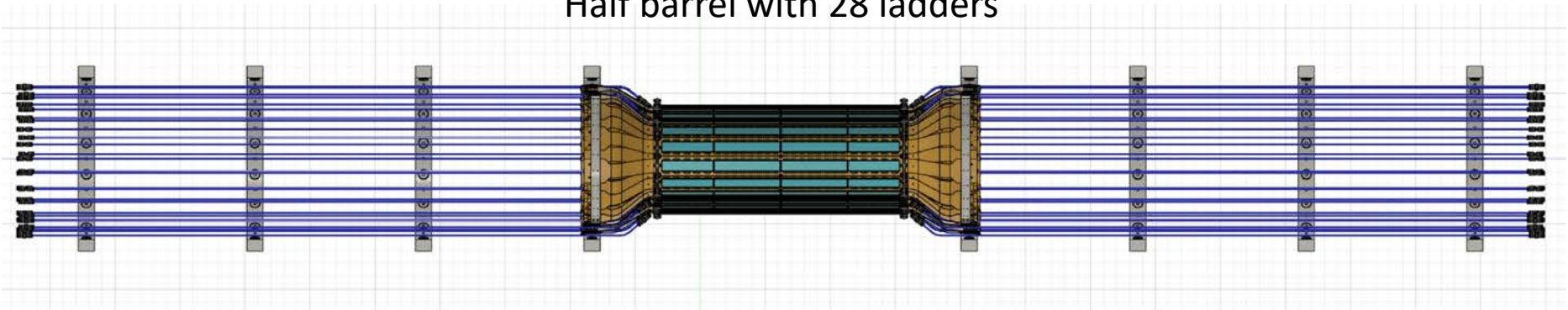
Pressures and flows



We will need 3.4 psi to obtain a flow of 120ccm per ladder through the barrel.

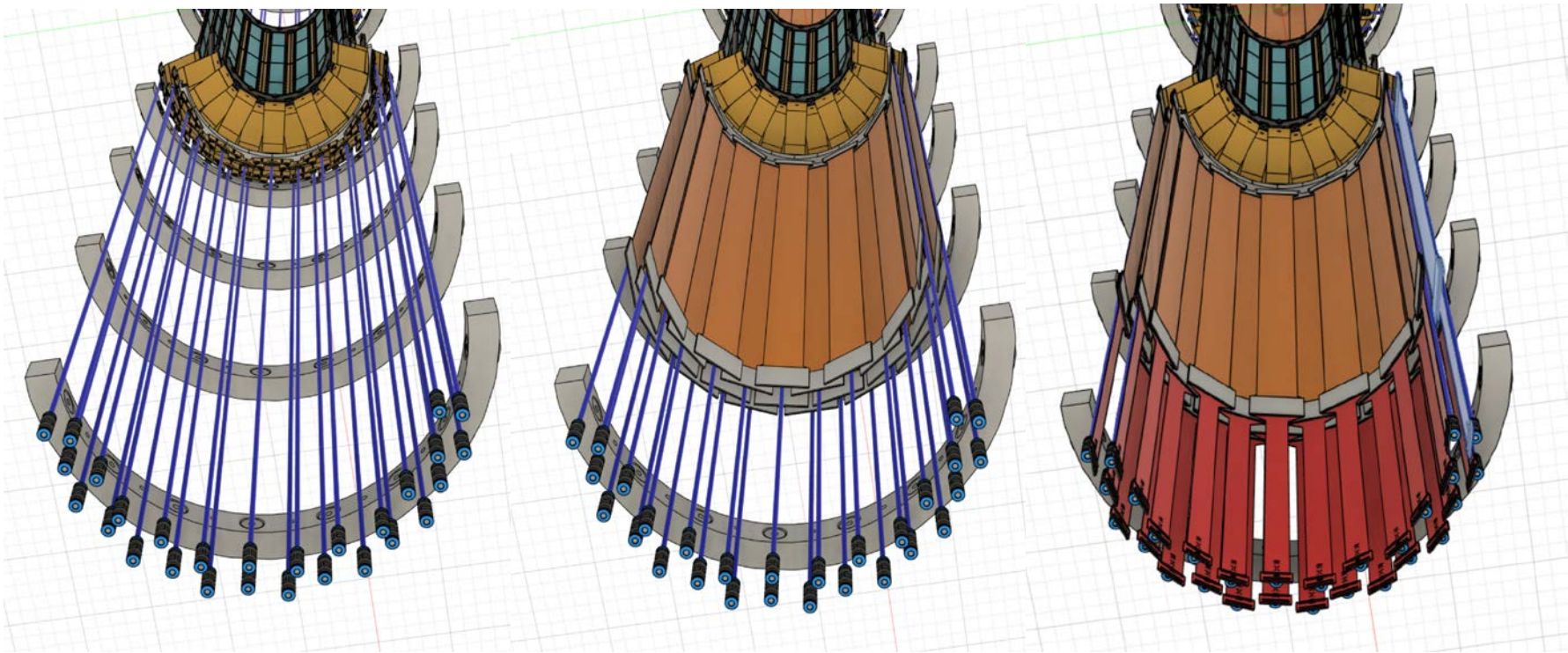


Half barrel with 28 ladders

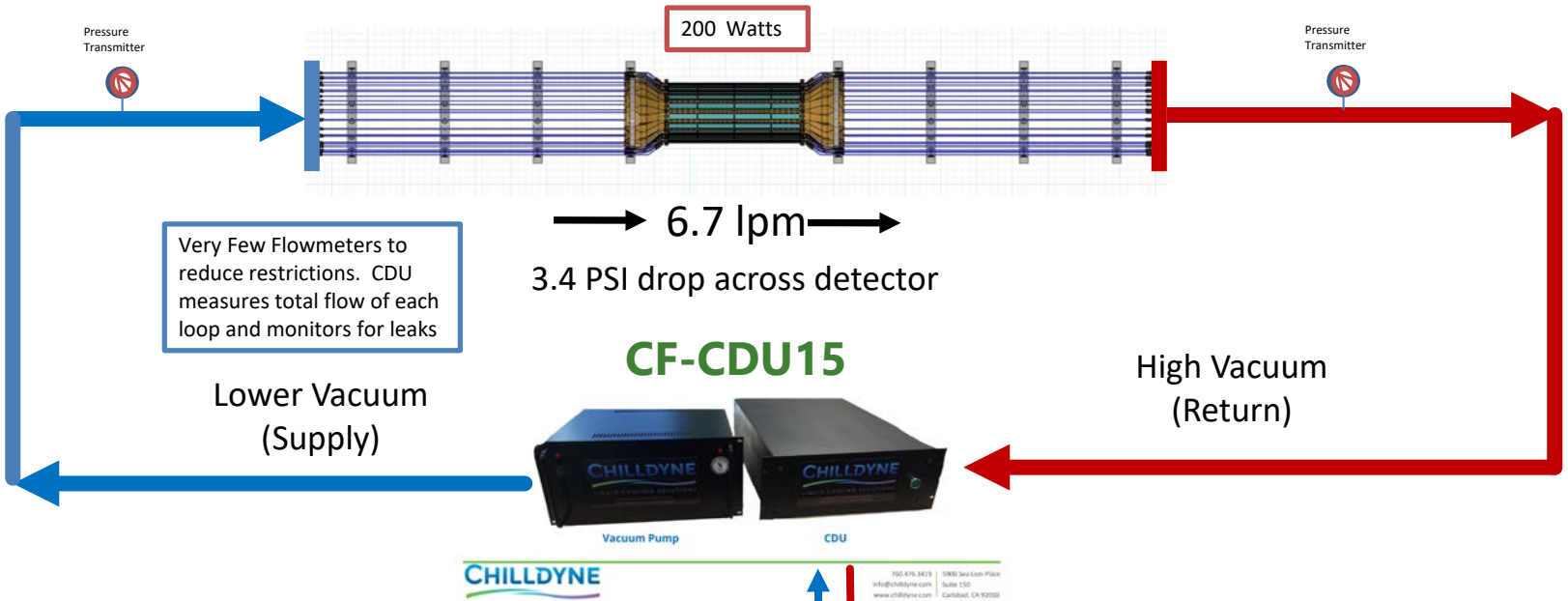


All Ladders will be plumbed in parallel. Manifold will be external to detector to allow for modifications post installation.

The INTT



Sub-Atmospheric Cooling System



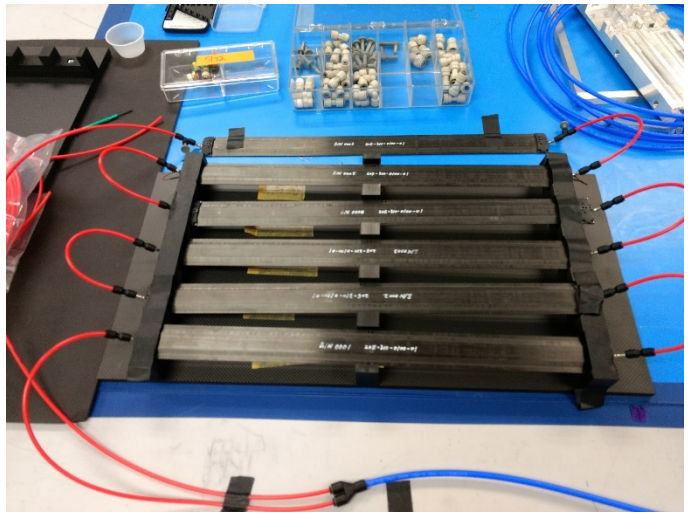
- Monitors water temperature flow rate and heat transfer, fills, drains and test for leaks
- 9 lpm at ½ atmosphere
- Failure tolerant, negative pressure system
- Data logging of key performance parameters
- Web based software: control and monitor from anywhere.
- Automatic drain and fill under remote control.
- Leak-Proof-uses negative pressure on both supply and return so if a leak occurs anywhere air will flow into the system instead of coolant leaking out.

External Chiller required to control temp below 20C. Merlin M75, +/- 0.1C control -15C to 75C, 2kW

Status

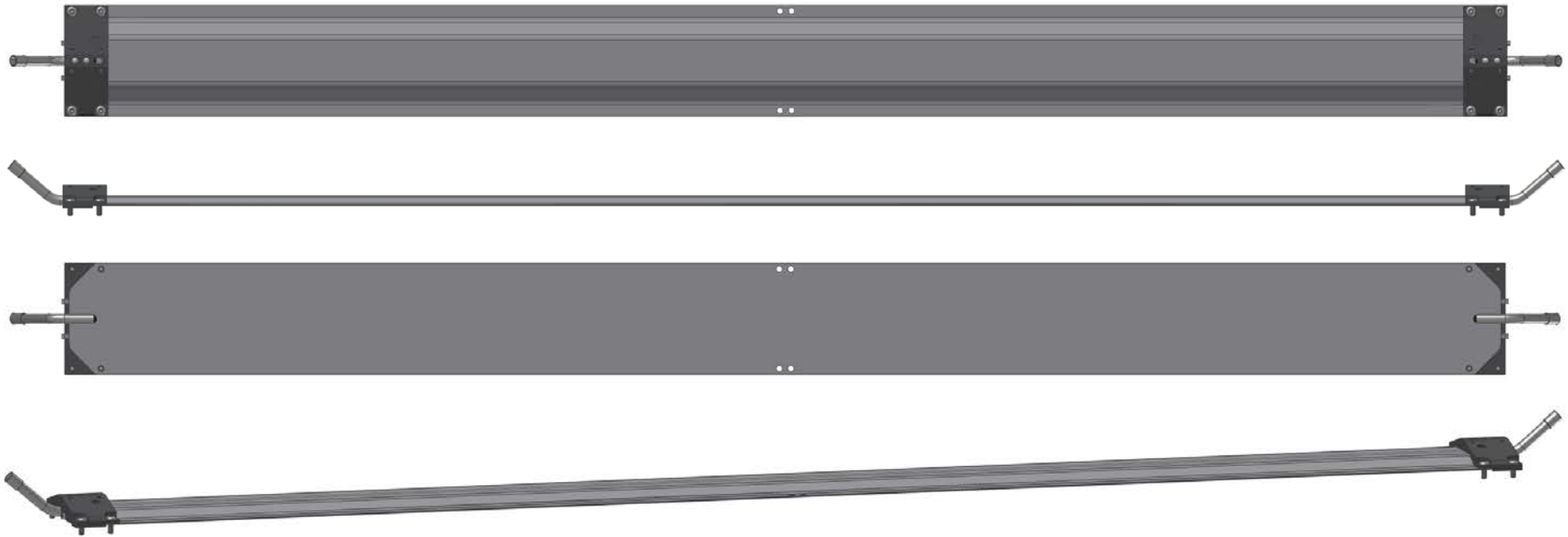
- CF-CDU15 Purchased and received March 2019
- Testing Flows and load capacities
- Have not finished testing because of lab closure

- First Articles received March 2019
- Pressure drop and Flow testing was in progress
- Stopped because of Lab Closure



Back Up notes
Will not post at review

Stave Design



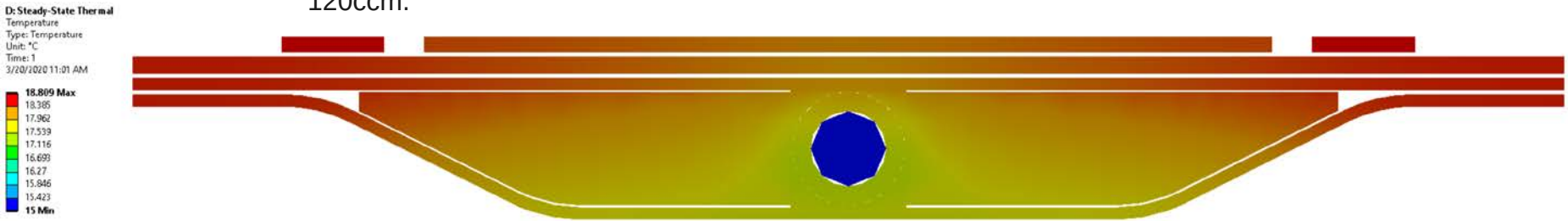
Thickness: 0.76 mm
Height: 3.76 mm
Width: 38.00 mm
Length: 497 mm

Material: Carbon Fiber, Polymethacrylimide (PMI), Stainless Steel and Epoxy (radiation length = 0.40%)

Thermal – Midplane Cross Section

Temperature

The heat is applied as a 0.0055 W/mm^3, which is about 0.06W per chip, or 3W total. There is also convection in the model, which adds about a 0.4W load. The flow rate is 0.002kg/s or 120ccm.



Heat Flux