EiC ToF Mechanics and Cooling Updates

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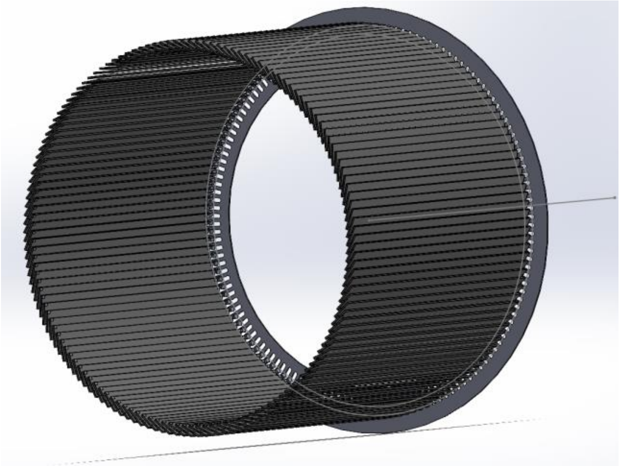
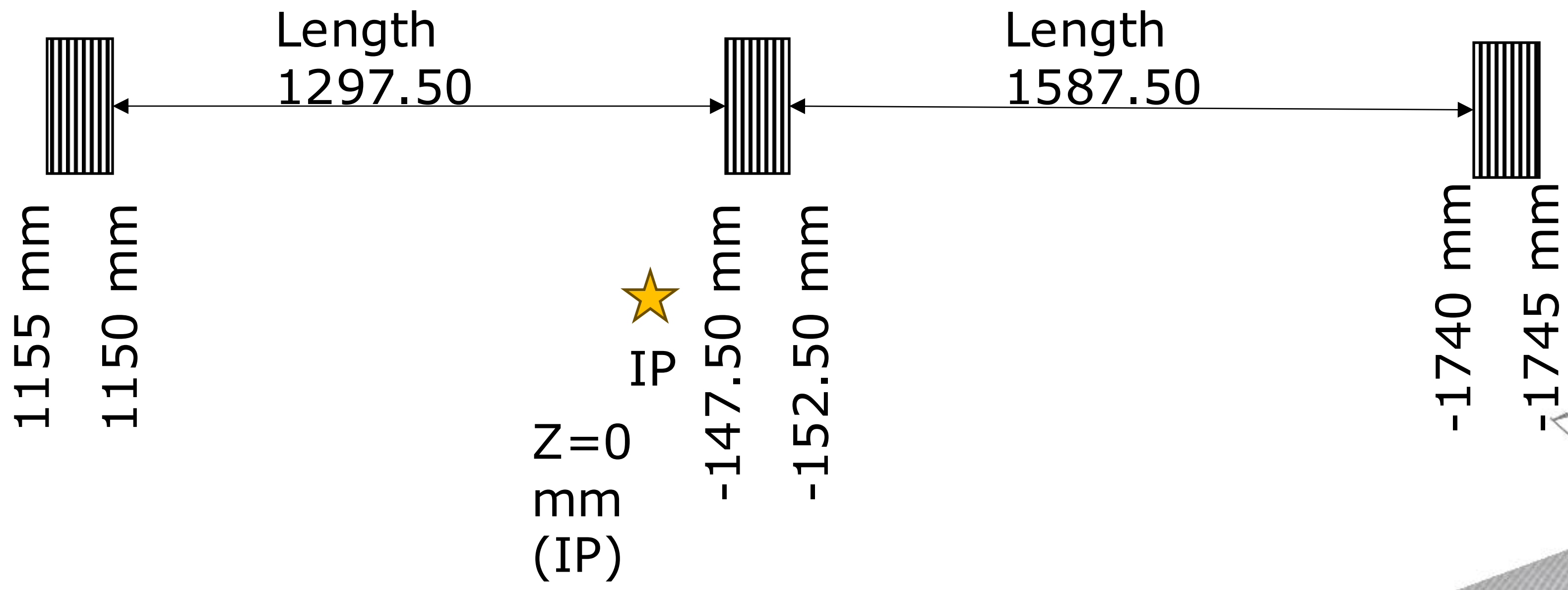
25 Sept 2024

Barrel TOF stave cut outs

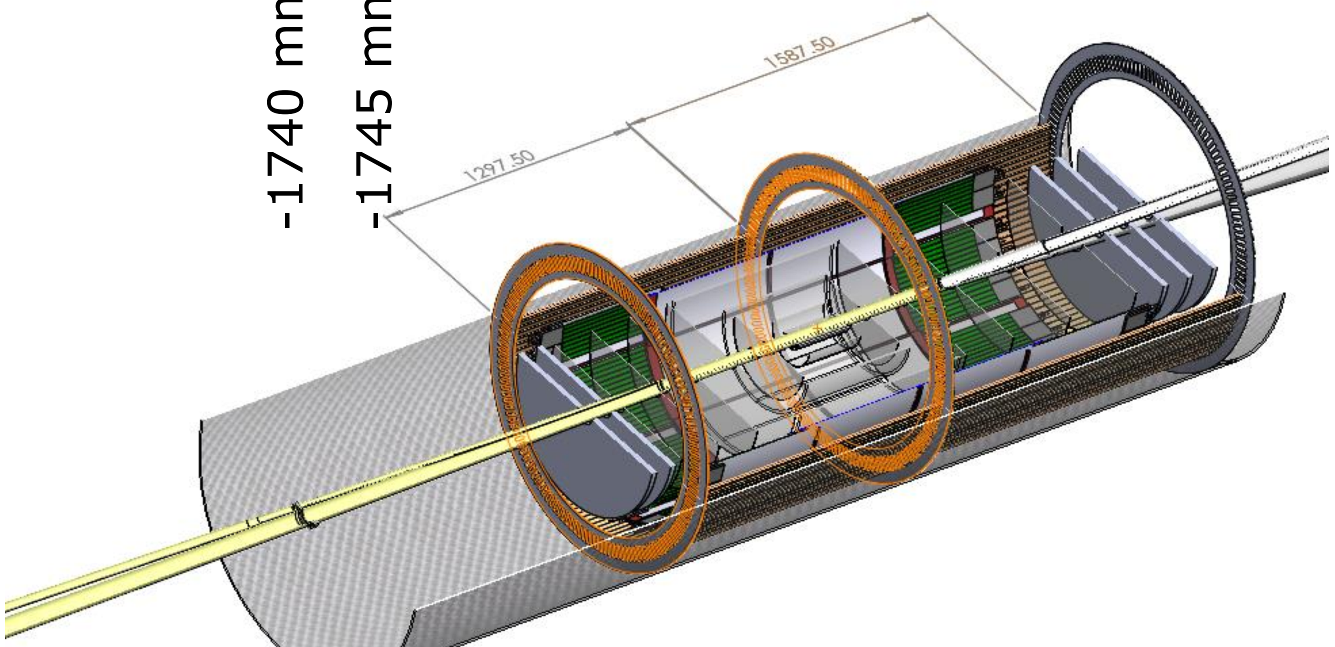
Two lengths of staves planned. There will be acceptance loss at the center engagement ring.

The ring thickness is currently designed to be 5 mm.



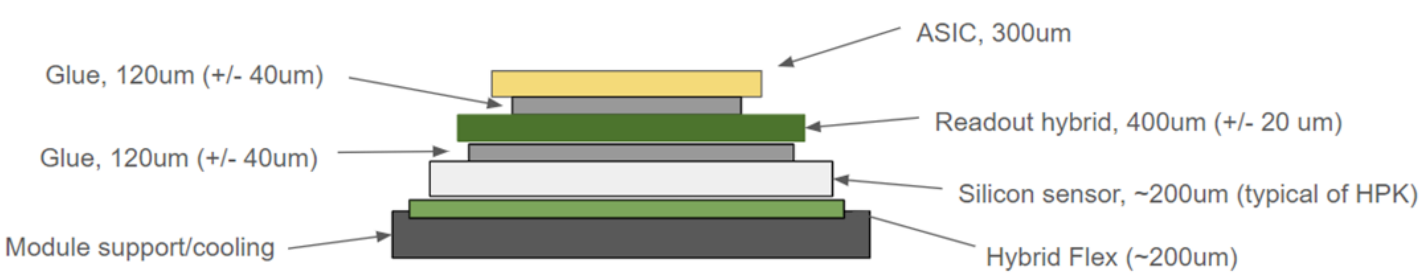


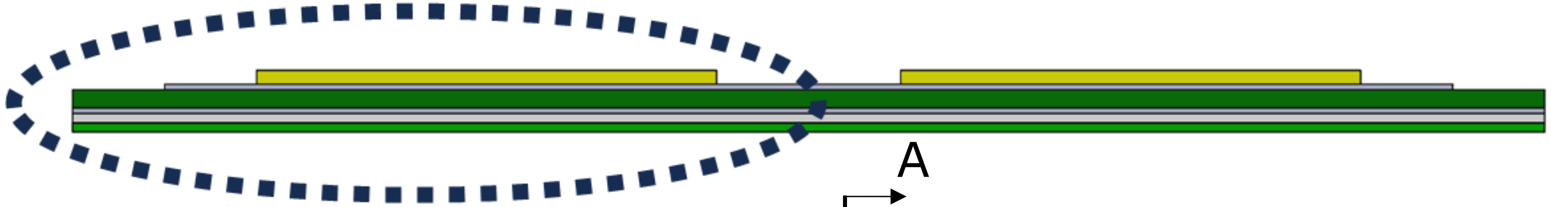
Z coordinates for Engagement Ring

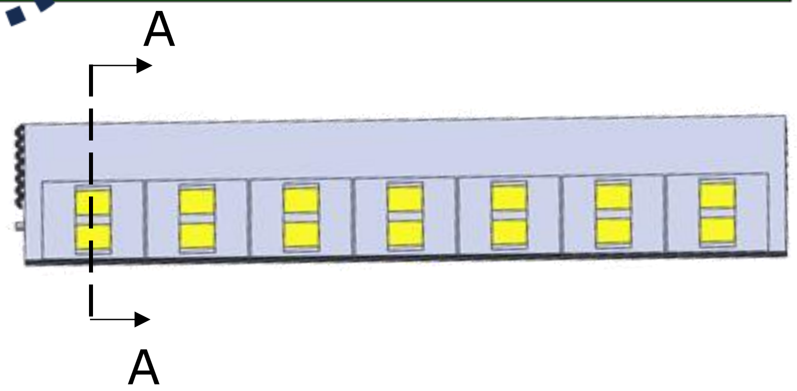


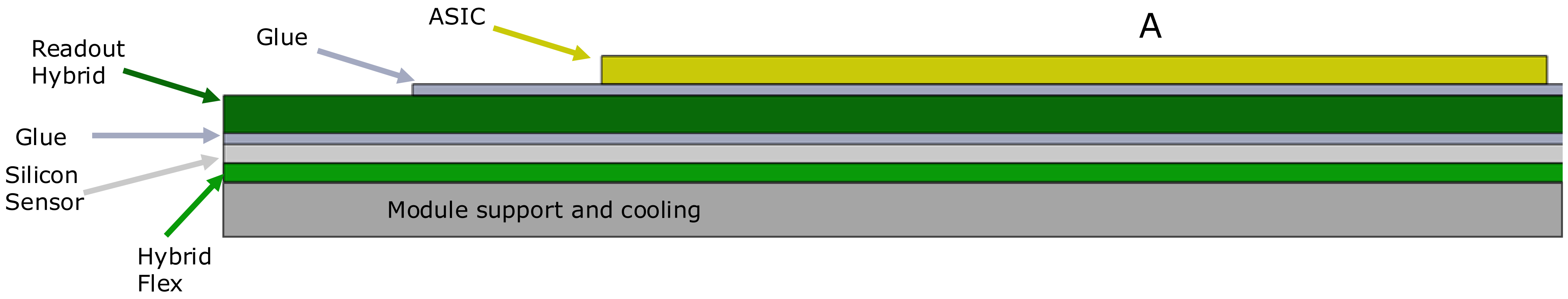
Single Sided Sensor cross-section set up – Ansys HT

Part Name	Thermal Conductivity (W/mK)	Thickness (µm)
ROC and ASIC (PCB/Kapton properties)	0.97	400 and 300
Silicon Module	148	200
Carbon Face Sheet	Kxx - 180 Kyy - 150 Kzz - 1.36	200
Carbon Foam	25	6420
Loctite Epoxy (Glue)	1.28	120
Stainless Steel Pipe	16	716





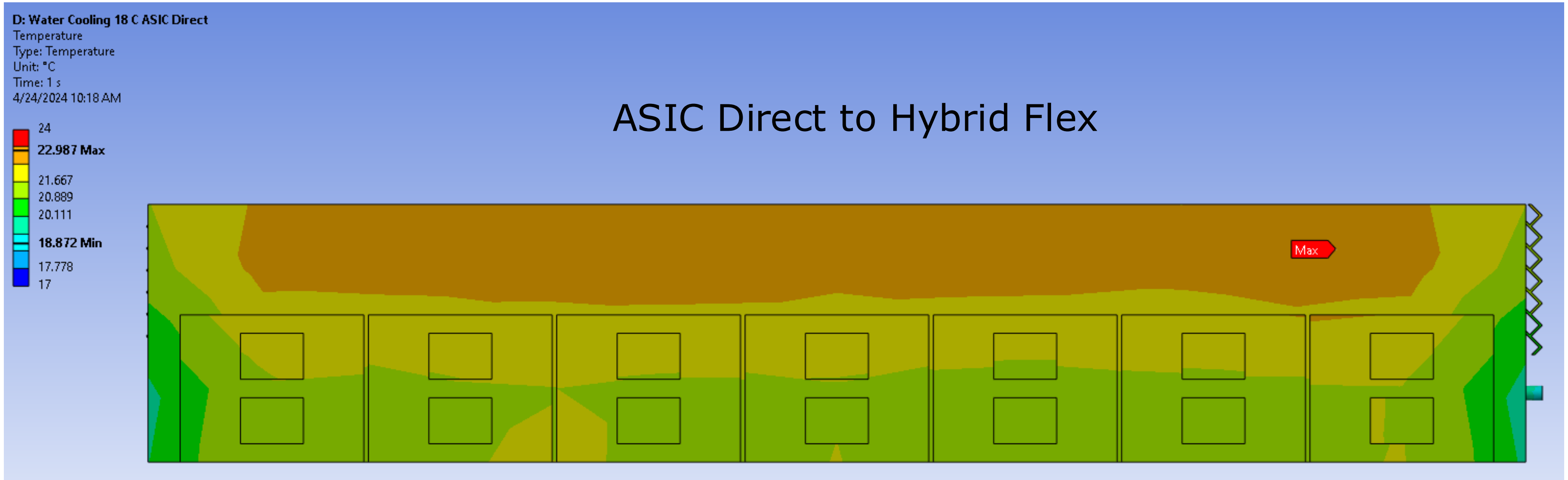


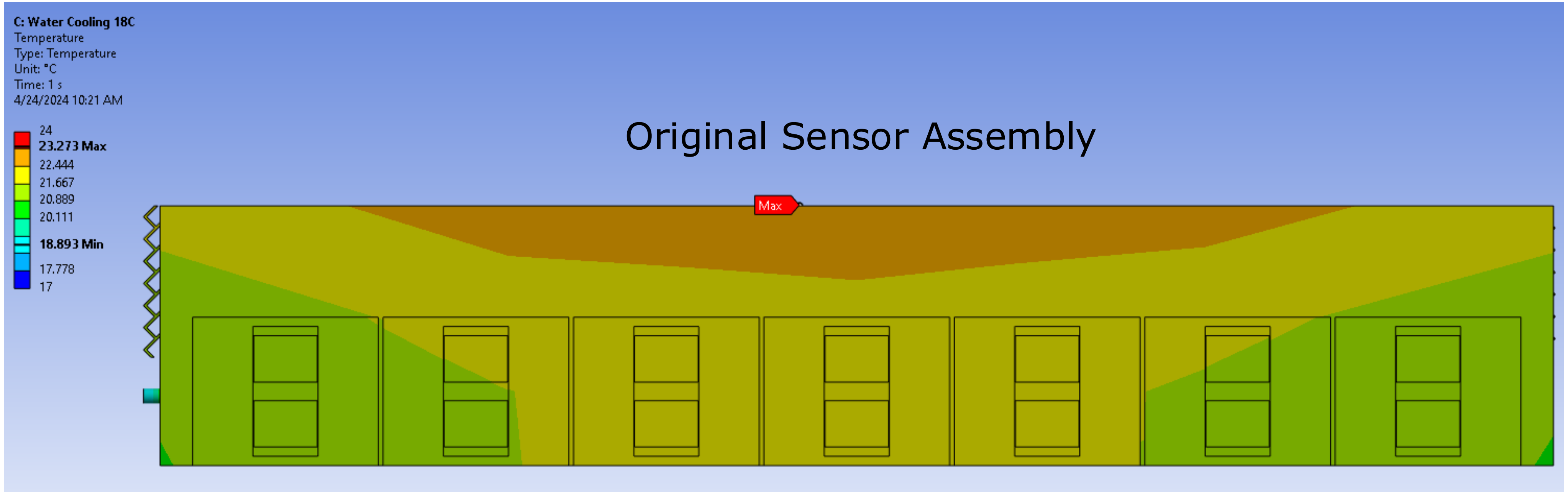


ASIC Direct – miniSTAVE (300 mm long stave results) (18 C Water)

When ASIC is directly on the hybrid flex there is better heat dispersion

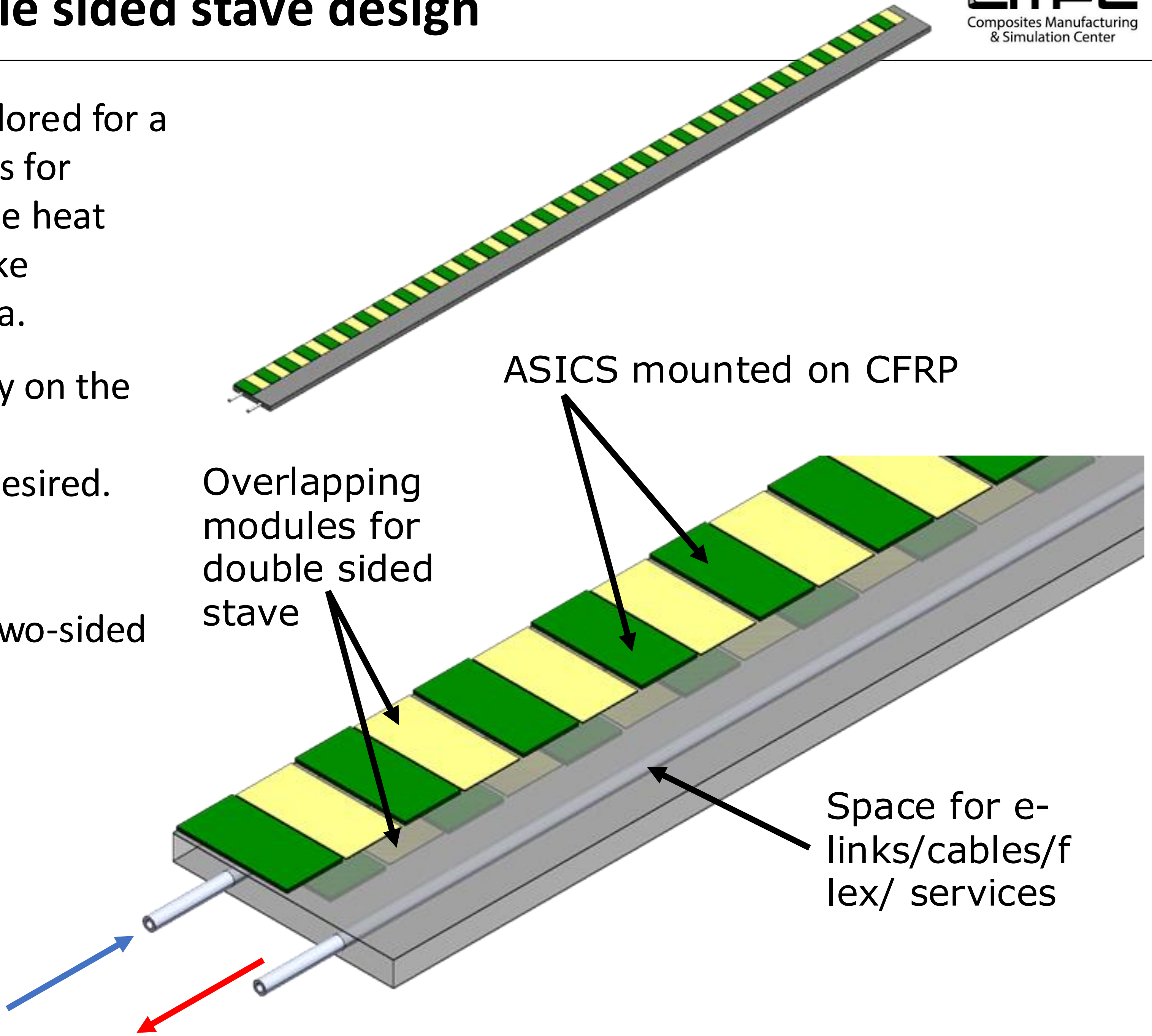
This led to a design with separating out ASICS and Silicon Modules to a two sided active area stave.



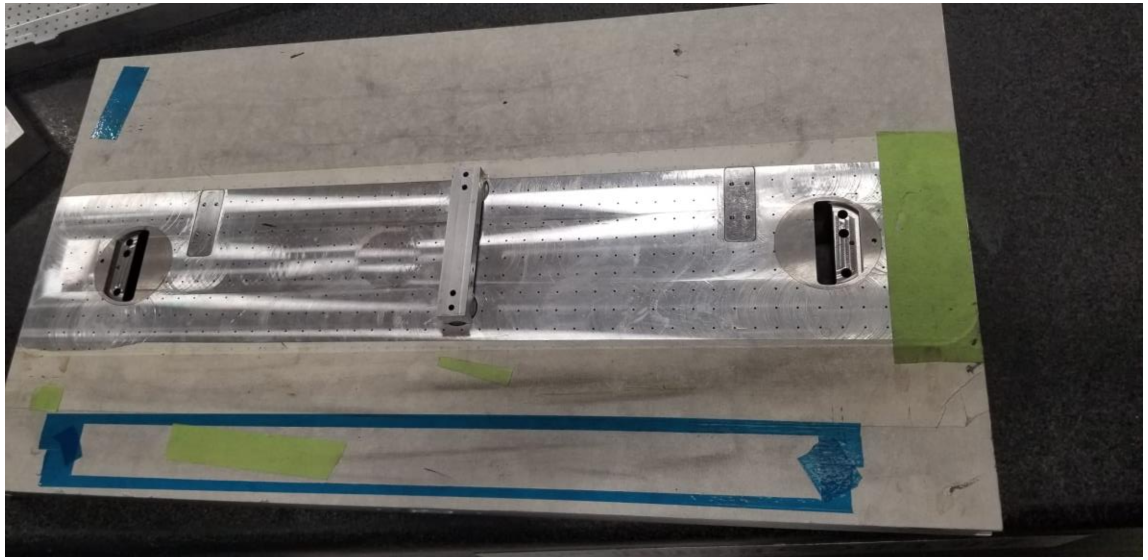


Double sided stave design

- Barrel TOF stave design is being explored for a double-sided active area. This allows for spreading out of the services and the heat loads from single sided design to take advantage of larger heat spread area.
- The HT simulations for ASICS directly on the CFRP laminate show a smeared-out temperature gradient response as desired.
- Heat transfer simulations with the two-sided stave design is on-going.

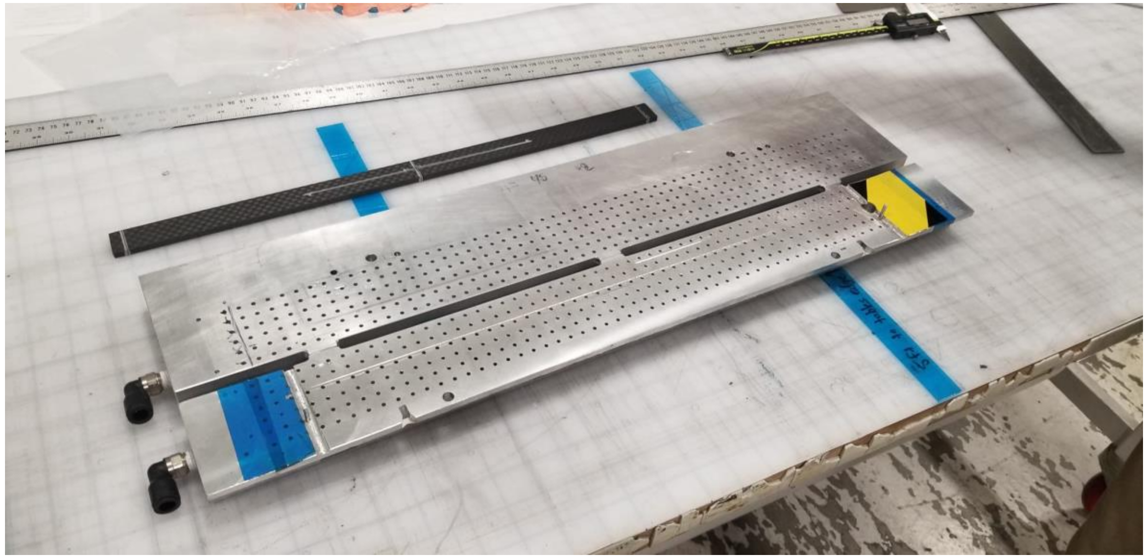


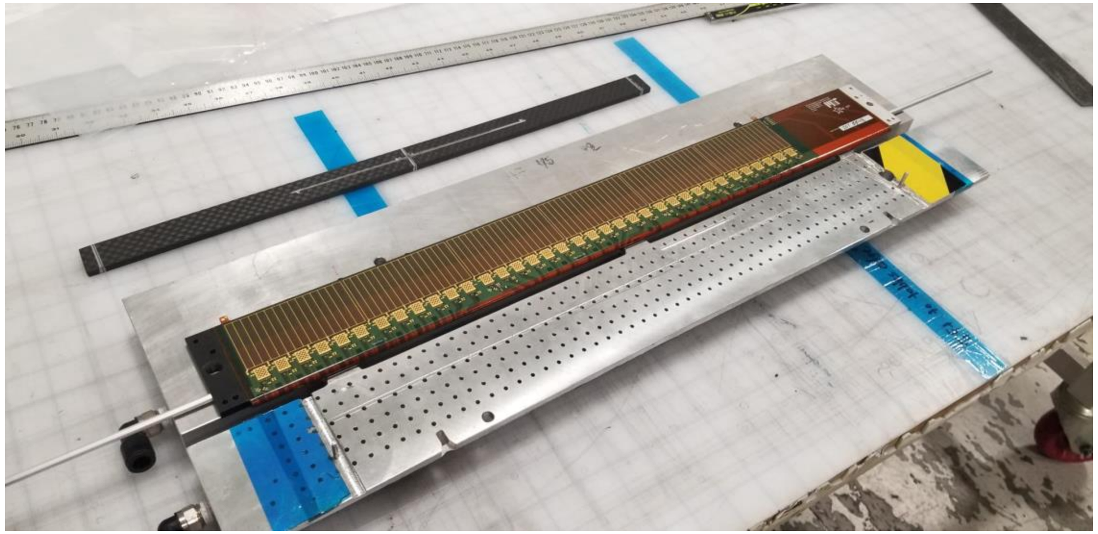
Concept for manufacturing and co-curing hybrid flex circuits and ROCs on staves – double sided iteration possible



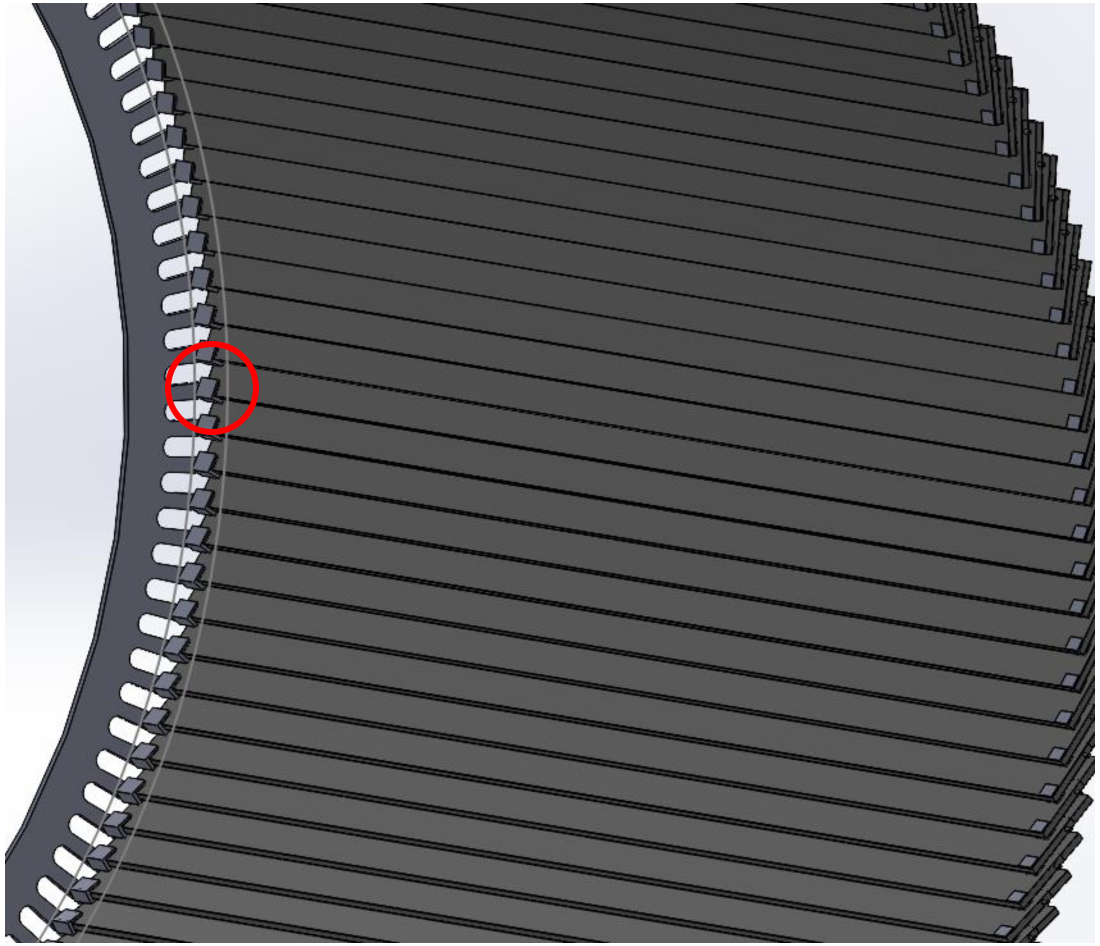
Assembly jig from ATLAS stave from Eric A. from LBL

Vacuum chuck assembly for foam + facesheet + Kapton co-bonding



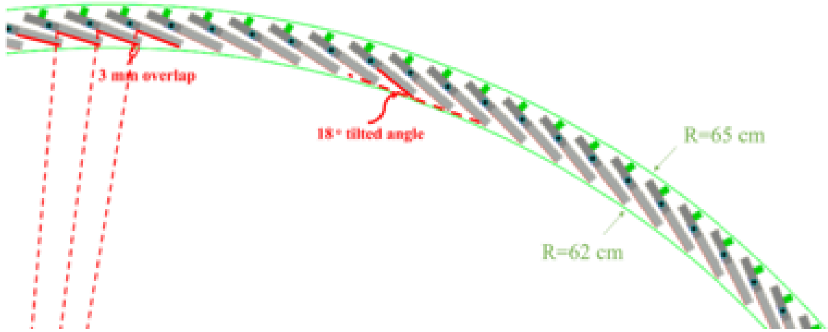


Concept for stave mounting mechanism on engagement rings

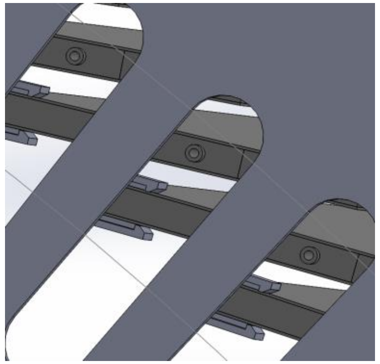


- Constraints:

- the clips can only be mounted inside this region
- Staves must be removable individually for maintenance
- Each stave must be at 18 degrees



- For now, staves have pipe on both sides, so both end rings have holes



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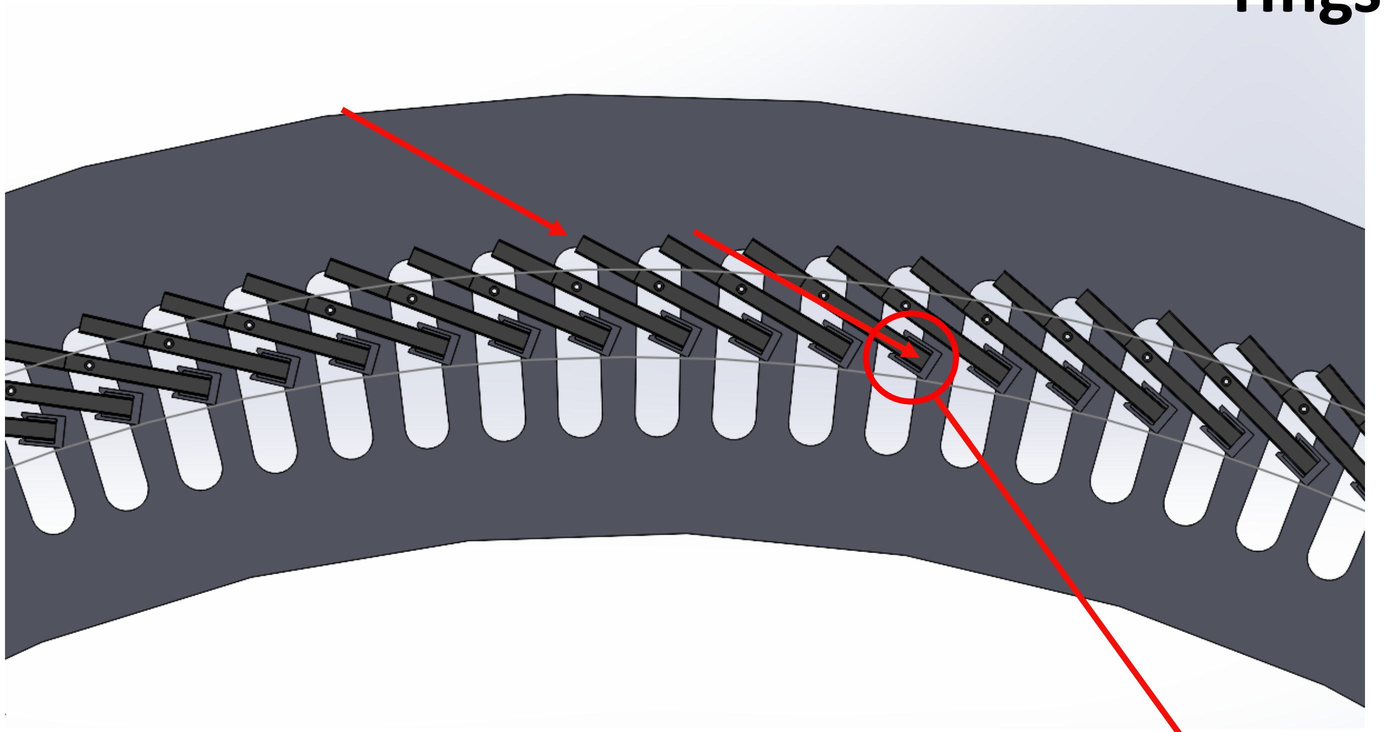
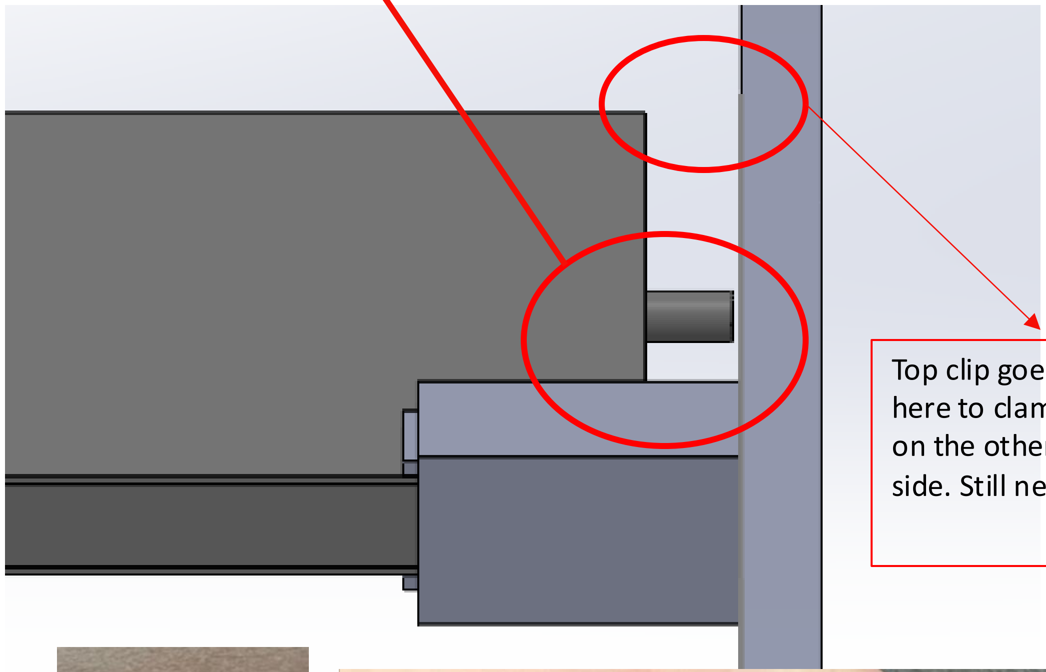
Concept for stave mounting mechanism on engagement rings

Composites Manufacturing & Simulation Center

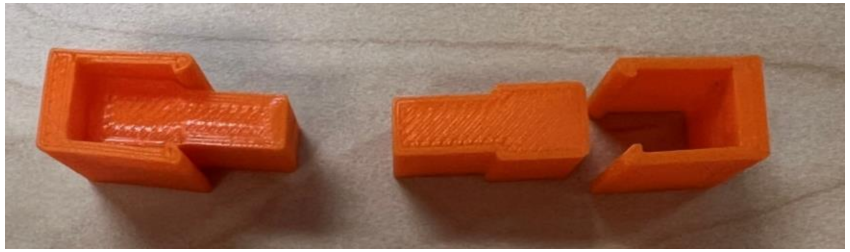


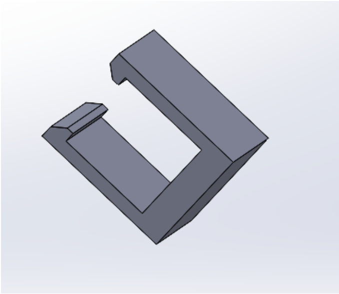
- The side of the stave cannot be directly on the ring because the pipe needs to also fit when sliding staves in.



Top clip goes here to clamp on the other side. Still need a

- Staves slide into the clip in the direction showed above, and then the top clips provides clamping force to secure (at the bottom the clip holds less force and the clamp more because of gravity. This happens at both rings.





Summary and Notes

- Clip design needs to be improved to enable single stave mounting and removal without affecting neighbouring staves
- Second iteration of mounting mechanisms on-going with stave clips embedded in the stave ends instead of using the space on the surface of the staves
- The staves will be asymmetric in length and the inlet and outlet of the pipe will be on the same side. Checked with Roland and in process to design manifolds in the TOF volume to reduce the number of pipes going out of GST
- Detailed heat transfer simulations with the new detector stave design on-going

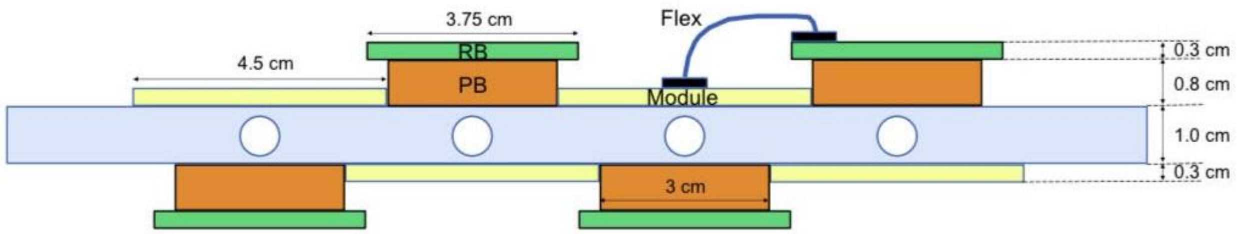
fTOF DISC Thermal Simulations

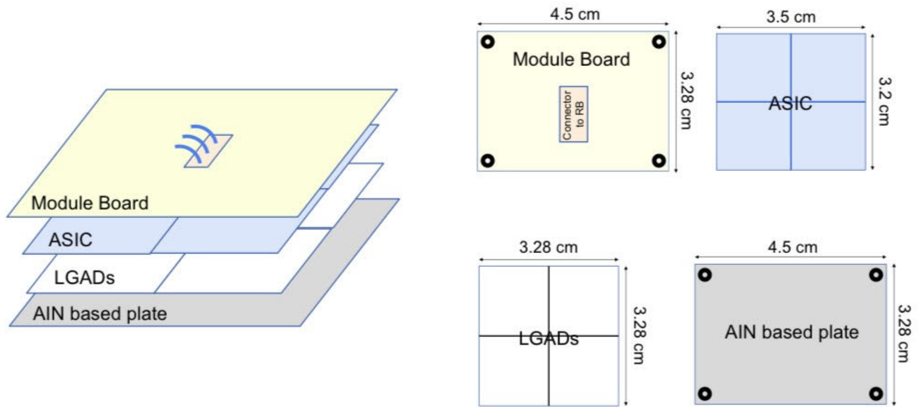
First attempt to understand the thermal gradient on the fTOF disk and the needed piping layout and overlap scheme for fTOF discs

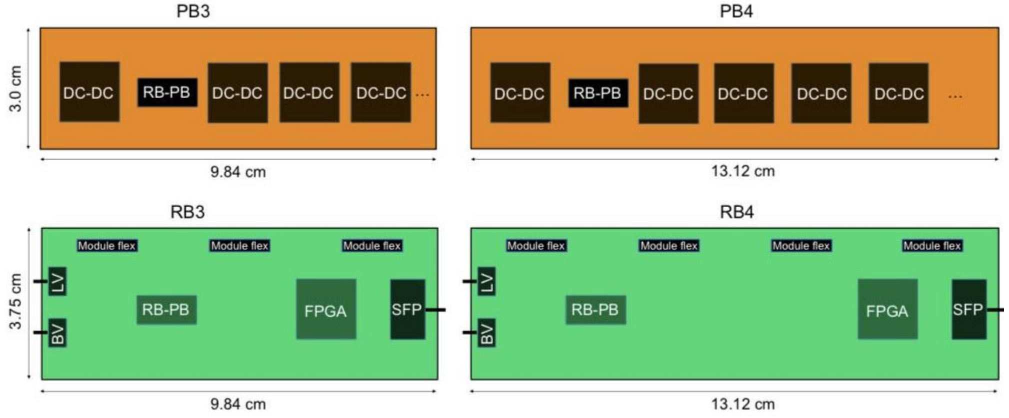
Heat Transfer Simulation Inputs

Part Name	Thermal Conductivity (W/mK)	Thickness (mm)
ASIC	0.97	0.75
LGAD	0.97	0.75
AlN	160	0.75
Silicon Module	148	0.75
Carbon Face Sheet	Kxx - 200 Kyy - 200 Kzz - 2	0.5
Carbon Foam	17	5
Stainless Steel Pipe	15	0.1

Dimensions and Boundary Conditions

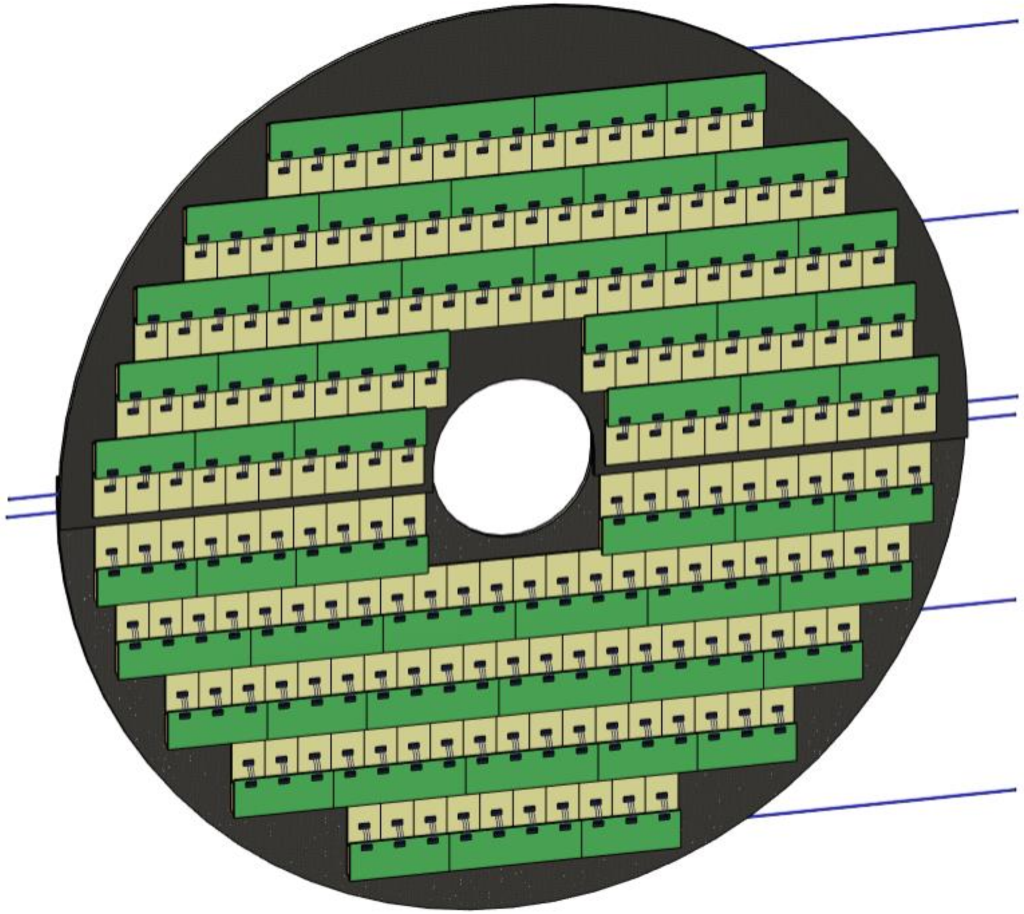


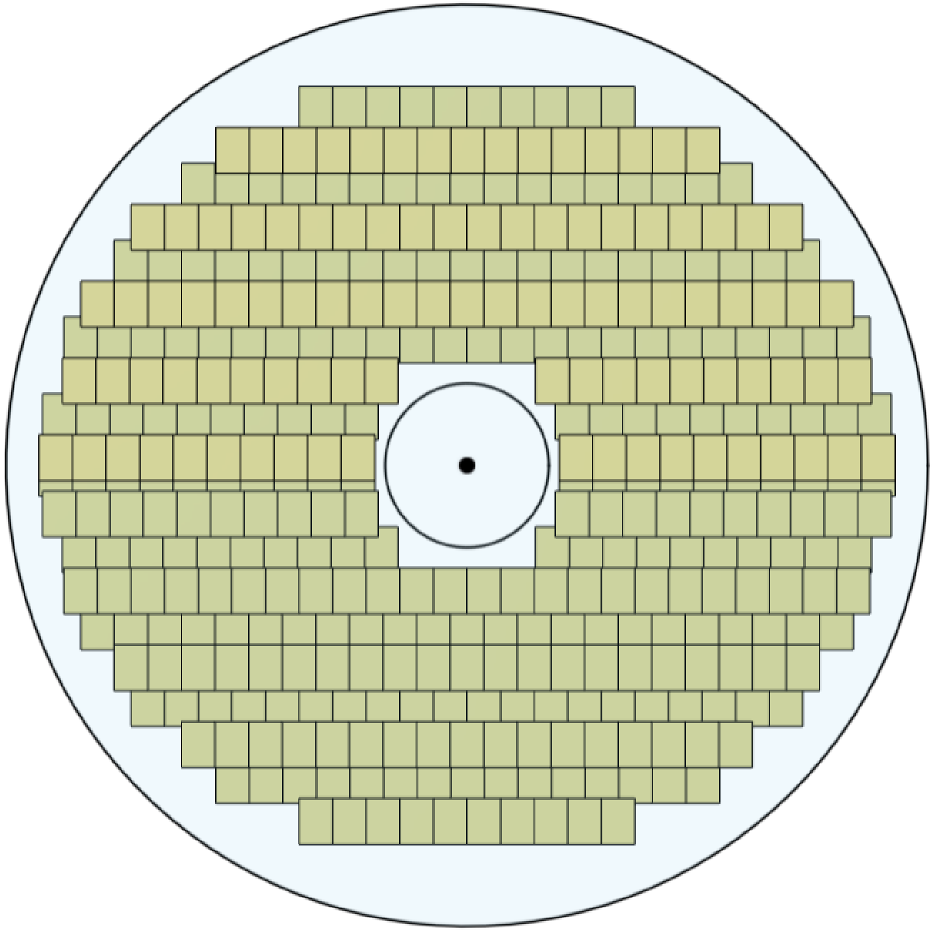




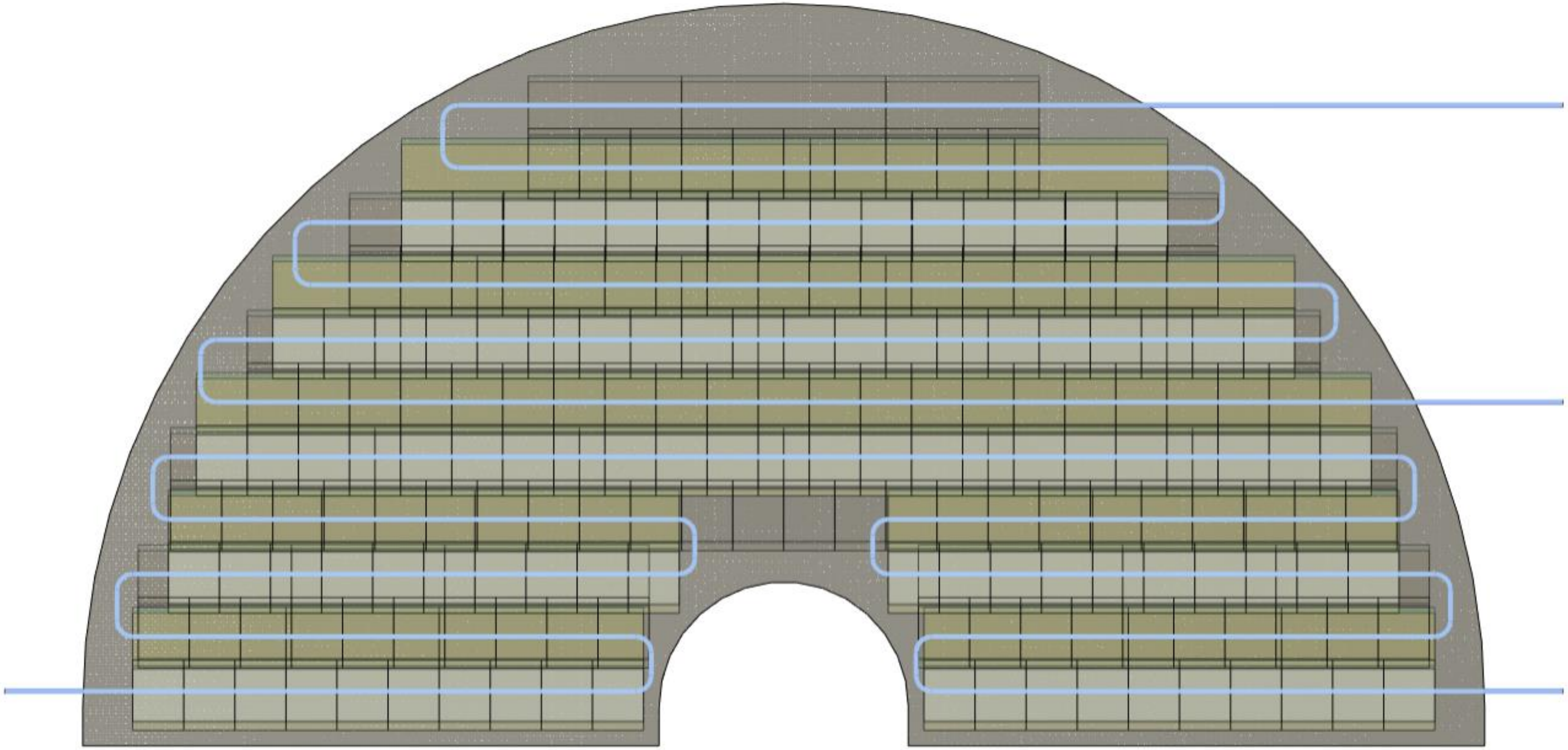
- 1.4 W/cm^2 on ASIC surface
- 5 C pipe cooling – water glycol 70/30
- 22 C ambient air with 5 W/m^2 Film Coefficient
- 30 C impinging air from R500-R600 with 10 W/m^2 Film Coefficient

Sensor Tiling CAD

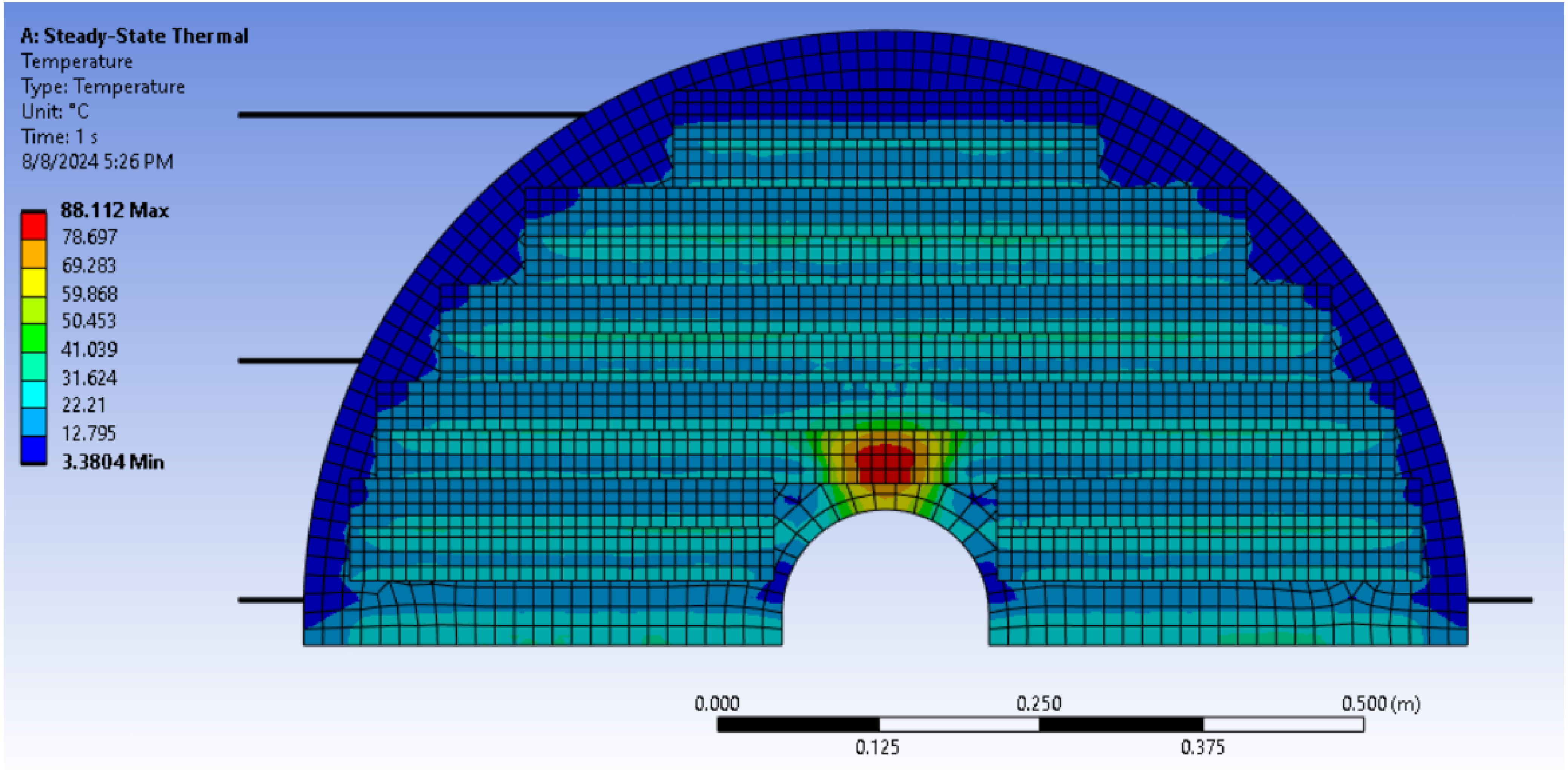




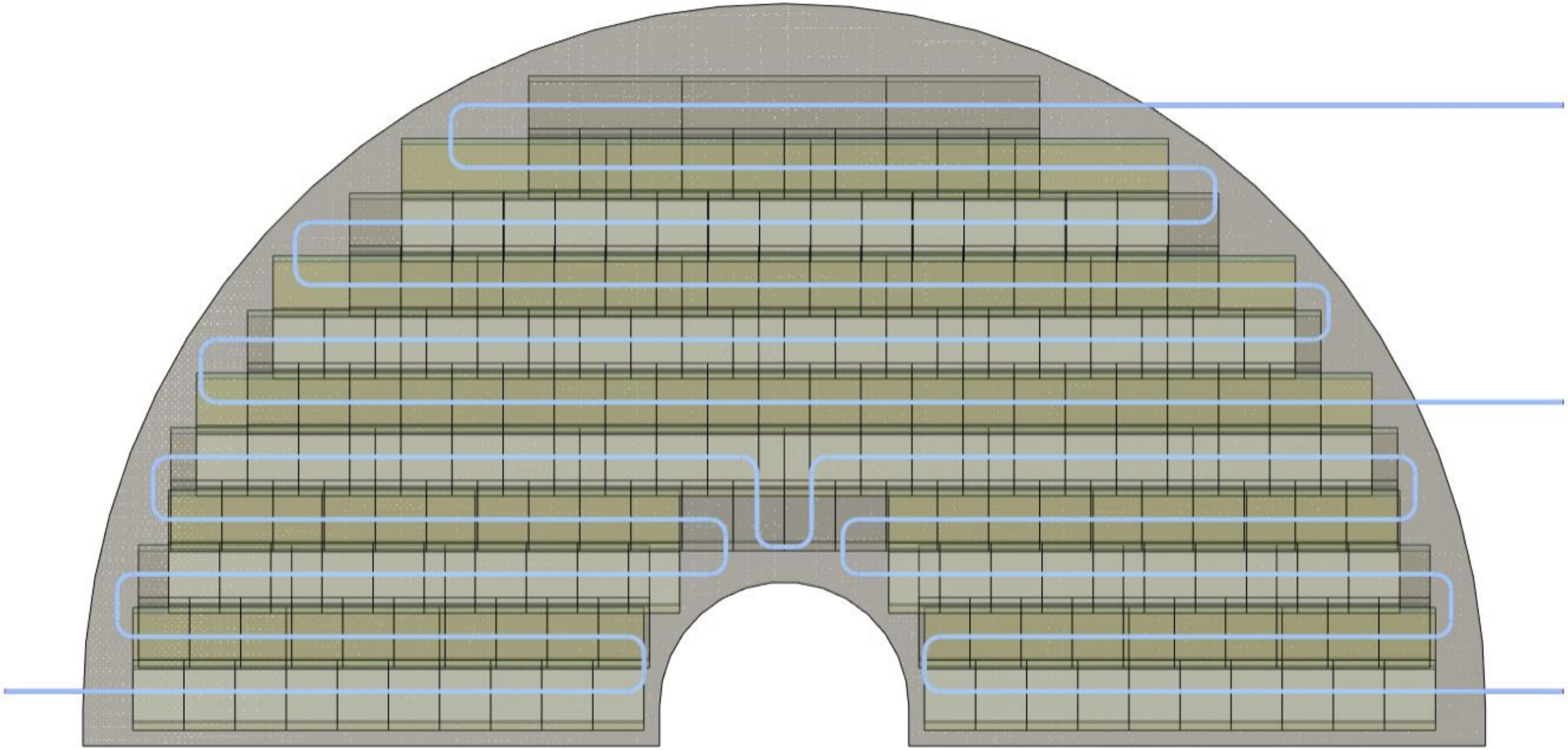
Pipe Routing



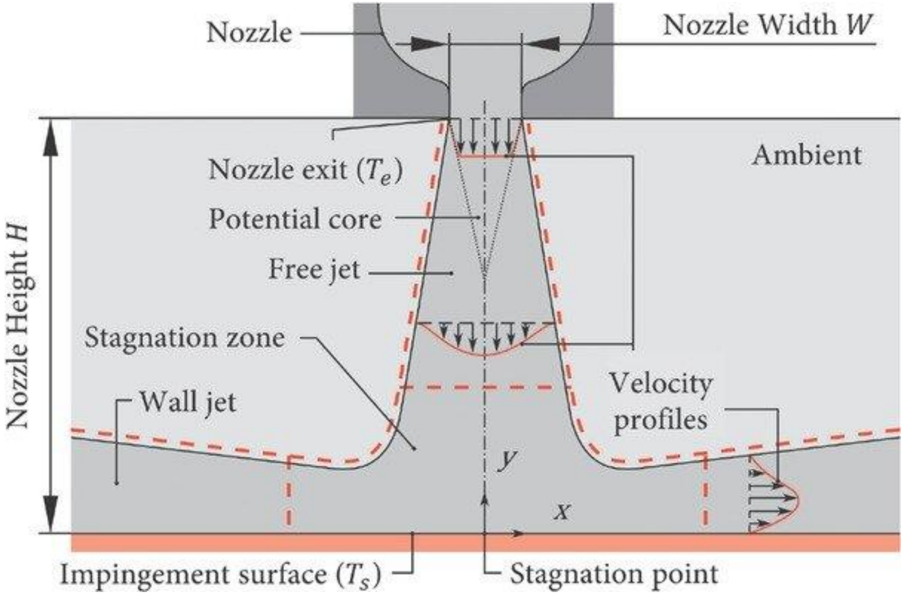
First Heat Transfer Results

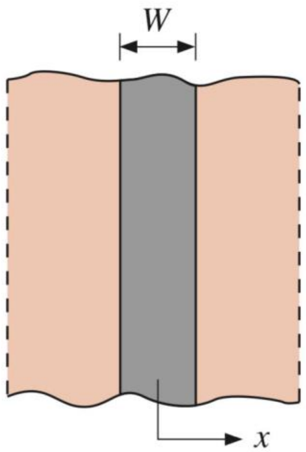


Pipe Re-routing



Heat Transfer Coefficient Calculation for Impinging Air





$A_r = W/2x$
(d)

Slot Nozzles For a *single slot nozzle* ($A_r = W/2x$), the recommended correlation is

$$\frac{\overline{Nu}}{Pr^{0.42}} = \frac{3.06}{0.5/A_r + H/W + 2.78} Re^m \qquad (7.75)$$

where

$$m = 0.695 - \left[\left(\frac{1}{4A_r}\right) + \left(\frac{H}{2W}\right)^{1.33} + 3.06\right]^{-1} \qquad (7.76)$$

and the ranges of validity are

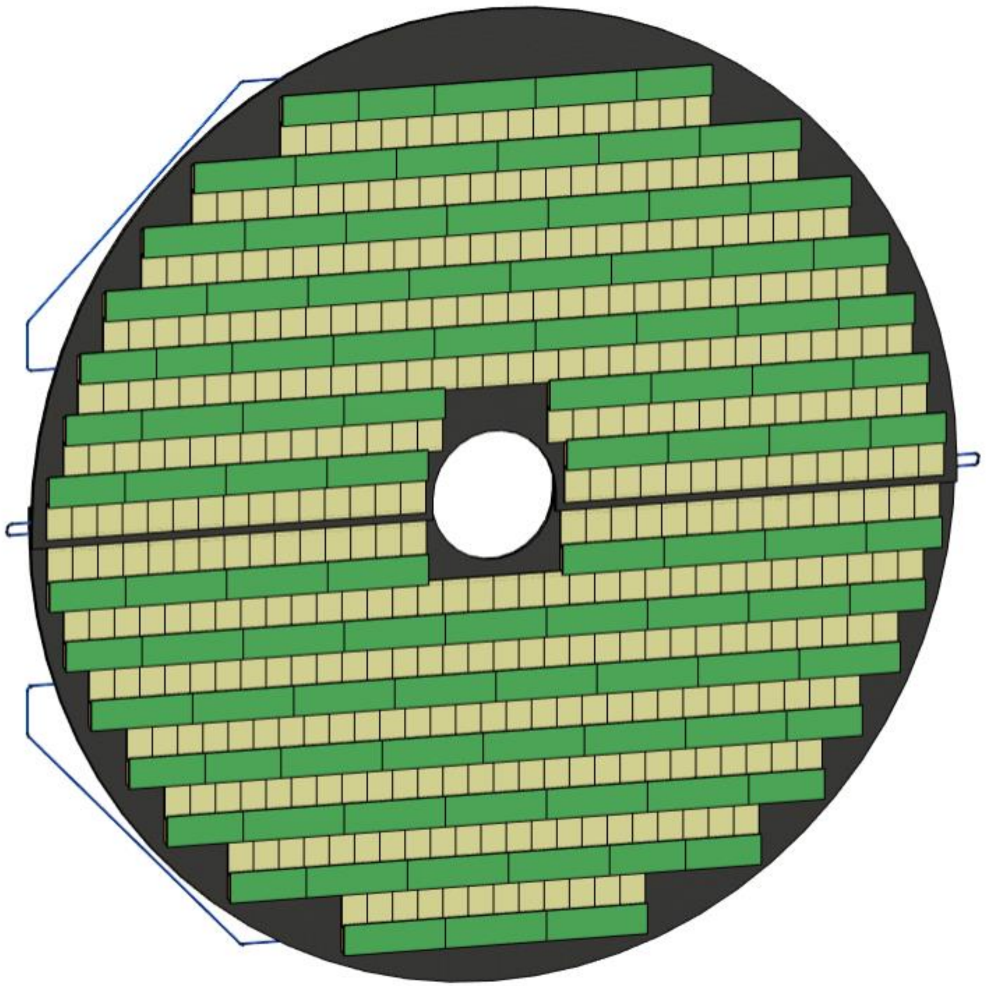
$$\begin{bmatrix} 3000 \lesssim Re \lesssim 90{,}000 \\ 2 \lesssim H/W \lesssim 10 \\ 0.025 \lesssim A_r \lesssim 0.125 \end{bmatrix}$$

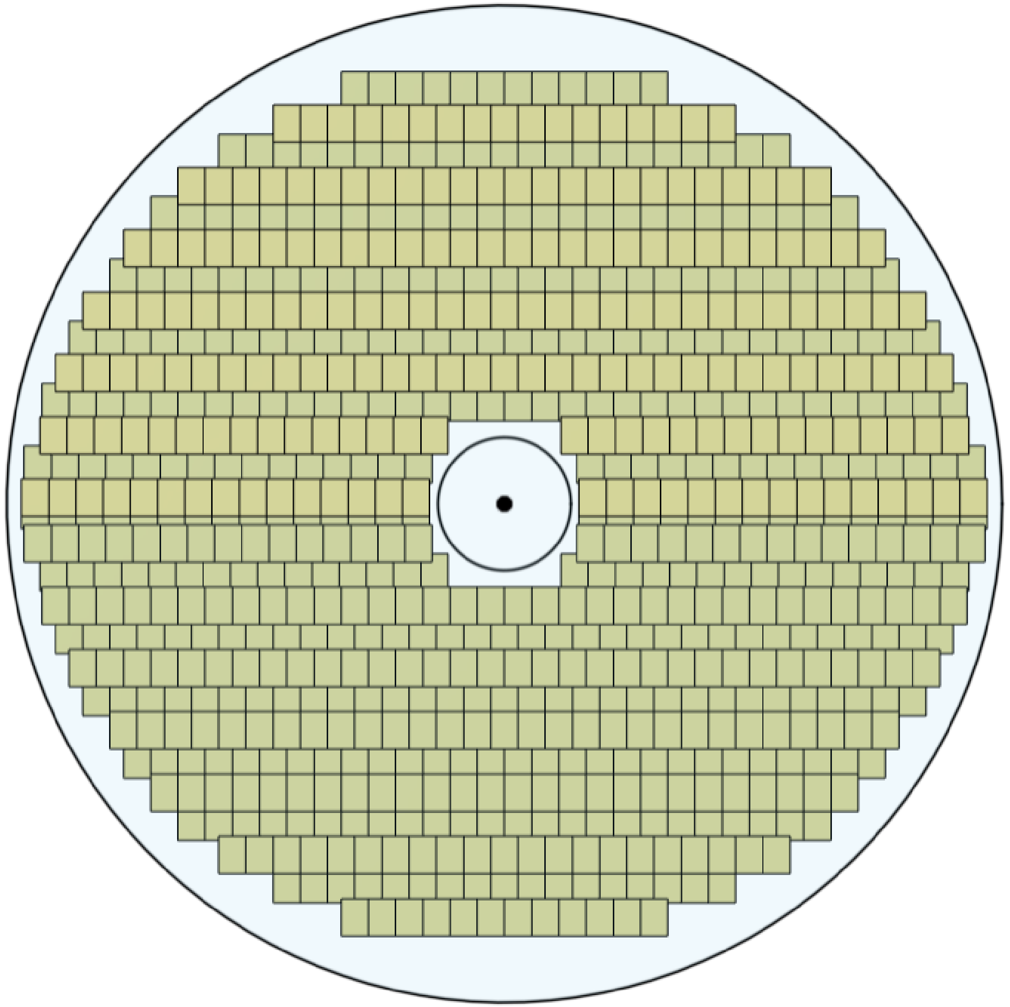
As a *rst approximation* , Equation 7.75 may be used for $A_r \gtrsim 0.125$, yielding predictions for the stagnation point ($x = 0$, $A_r \to \infty$) that are within 40% of measured values.

- H = 370 mm, W = 100 mm
- 100 cfm -> 0.268 m/s
- h = ~7.5 W/m^2

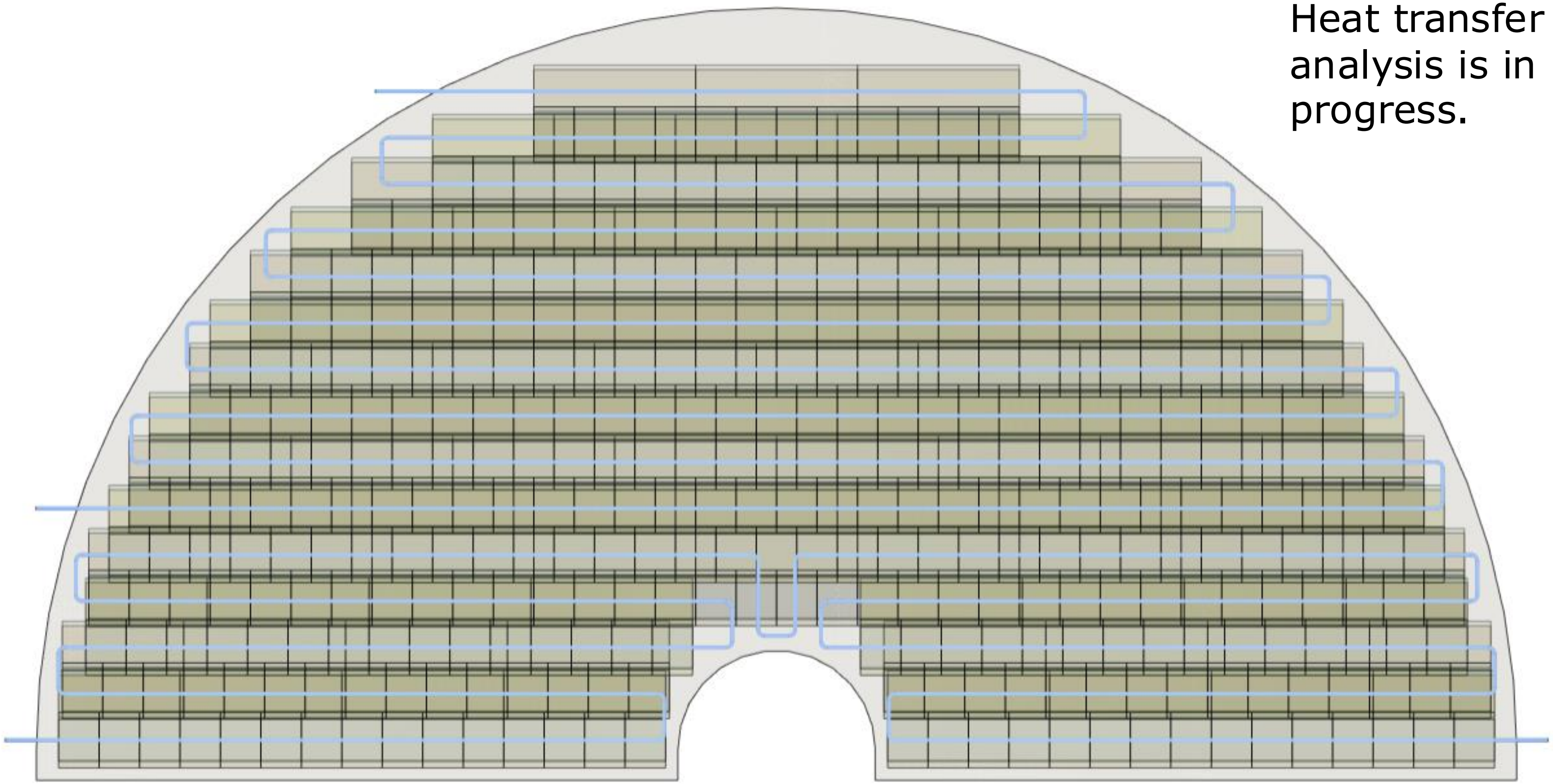
This is to take into account air cooling for SVT if they choose to go this route. The heat transfer from their system to fTOF is assumed for cooling calculations for the fTOF disc

Updated Sensor Tiling CAD – 9/20/2024





Updated Pipe Routing – 9/20/2024



Heat transfer analysis is in progress.