

Barrel Outer Tracker / MPGD (μ RWELL)

Triple I Engineering Meeting Update (09/21/2026)

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Electron-Ion Collider

Update - Facility

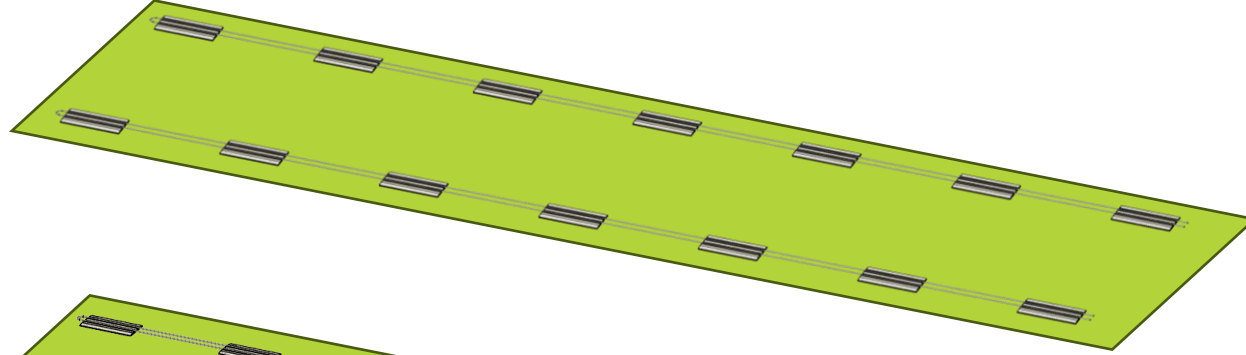
- Jlab MPGD Facility is moving foreword.
- Major progress
 - Ultrasonic water bath – Transformer (220V) Installed, no water yet (working on DI water system).
 - Sanding station for detector frame – Installed, protocol (dust control) accepted by ES&H.
 - Fume hood for vacuum gluing – Installed, outside vent fan must be verified by 3rd party.
 - Nitrogen box for GEM foil test – Assembled.
 - Deliver N₂ gas into Cleanroom – N₂ bottle space outside, delivered into clean room.
 - GEM stretcher - Installed. preparing mockup test. 3D printed mockup frame.
 - Ultrasonic bath water – Bulk DI water ordered (200 Gallon)
 - Still waiting for final approval from ES&H for equipment/process

Update – Thermal study

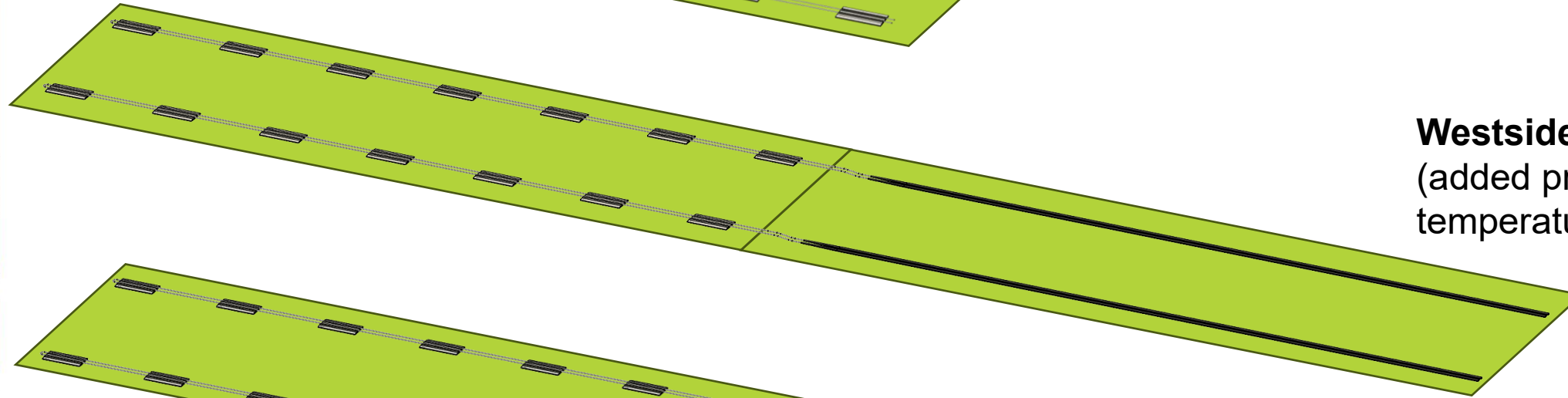
- We will stop thermal simulation at this point.
- We will continue to update when FEB components are made/updated.
- There was an update on SALSA power estimation and power supply scheme.
- Power consumption from 15.5 W to 18.5 W per FEB (20% increase)
- Overall cooling scheme has not been changed.
- Thermal simulation will be done with new numbers.

- Working on the module on West side
- Working on combined cooling scheme (14 FEBs instead of 7 FEBs).

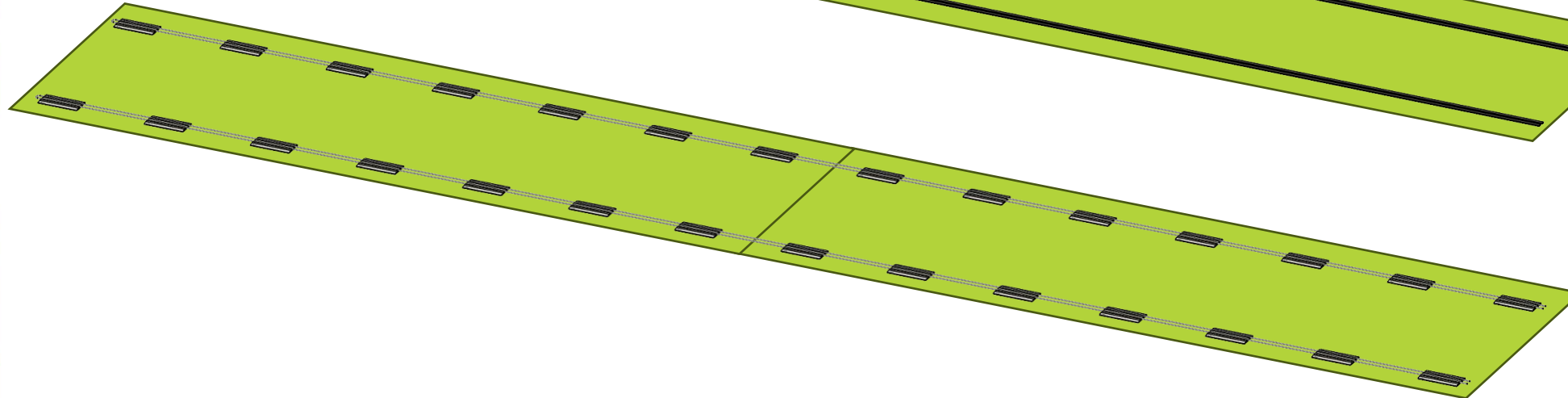
Update – Thermal study



Base model 7 FEB (done)



Westside model
(added pressure drop +
temperature rise)

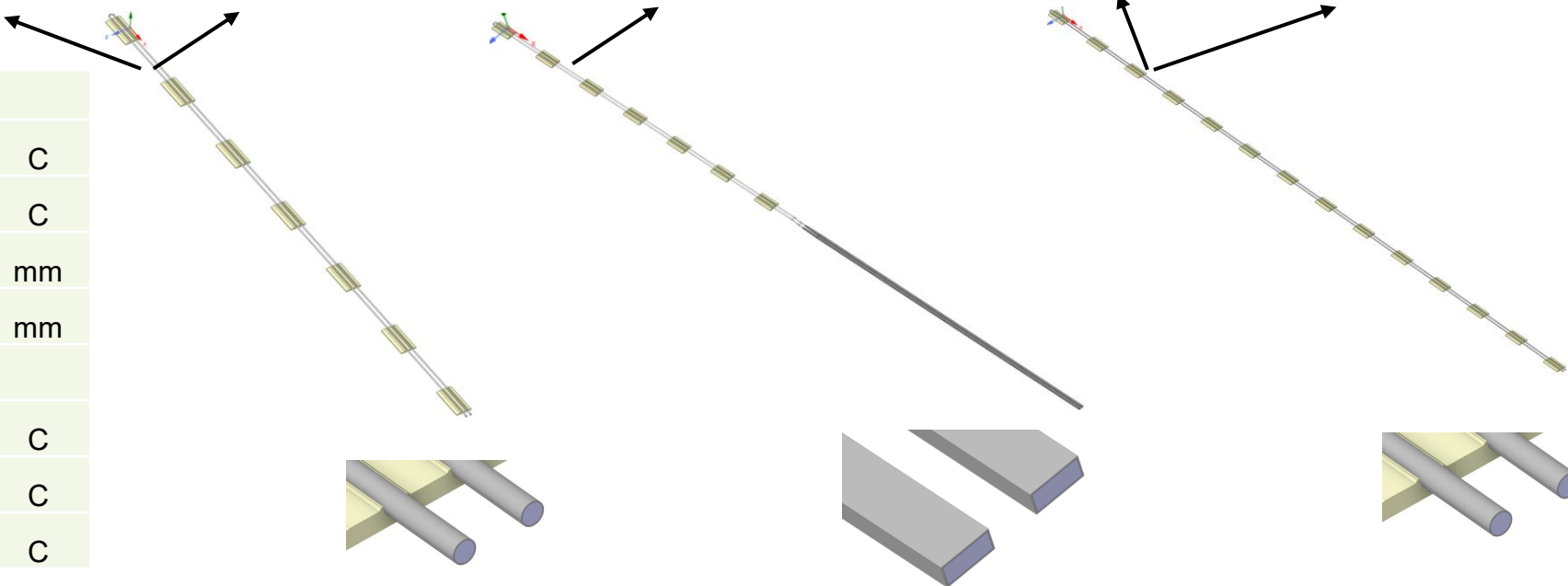


14 FEB model
 $\frac{1}{2}$ cooling line
FEB temp. variation
increase

ePIC Detector – Outer MPGD Comparison

Component	Cooling loop1 half module	Cooling loop1 half module	Cooling loop2 half module	Combined - Full module	Combined - Full module
Number of FEBs	7	7	7	14	14
Single FEB Heat (W)	15.206	15.206	15.206	15.206	15.206
Total FEB Heat (W)	106.442	106.442	106.442	212.884	212.884
Temperature Rise (C)	2	2	2	2	4
Flow (lpm)	0.76	0.54	0.76	1.52	0.76
Reynolds Number	3765 (Transition Flow)	2662 (Transition Flow)	2535 (Transition Flow)	7531(Turbulent Flow)	3765 (Transition Flow)
Pressure drop (bar)	0.083	0.055	0.15	0.78	0.167

Cooling media	Water	
Inlet Temperature	22	C
Ambient Temperature	23	C
Tube inner diameter	4.5	mm
Tube outer diameter	5	mm
Tube material	Stainless Steel	
Min Temperature of Detector	25	C
Max Temperature of Detector	35	C
Temperature stability	± 3	C

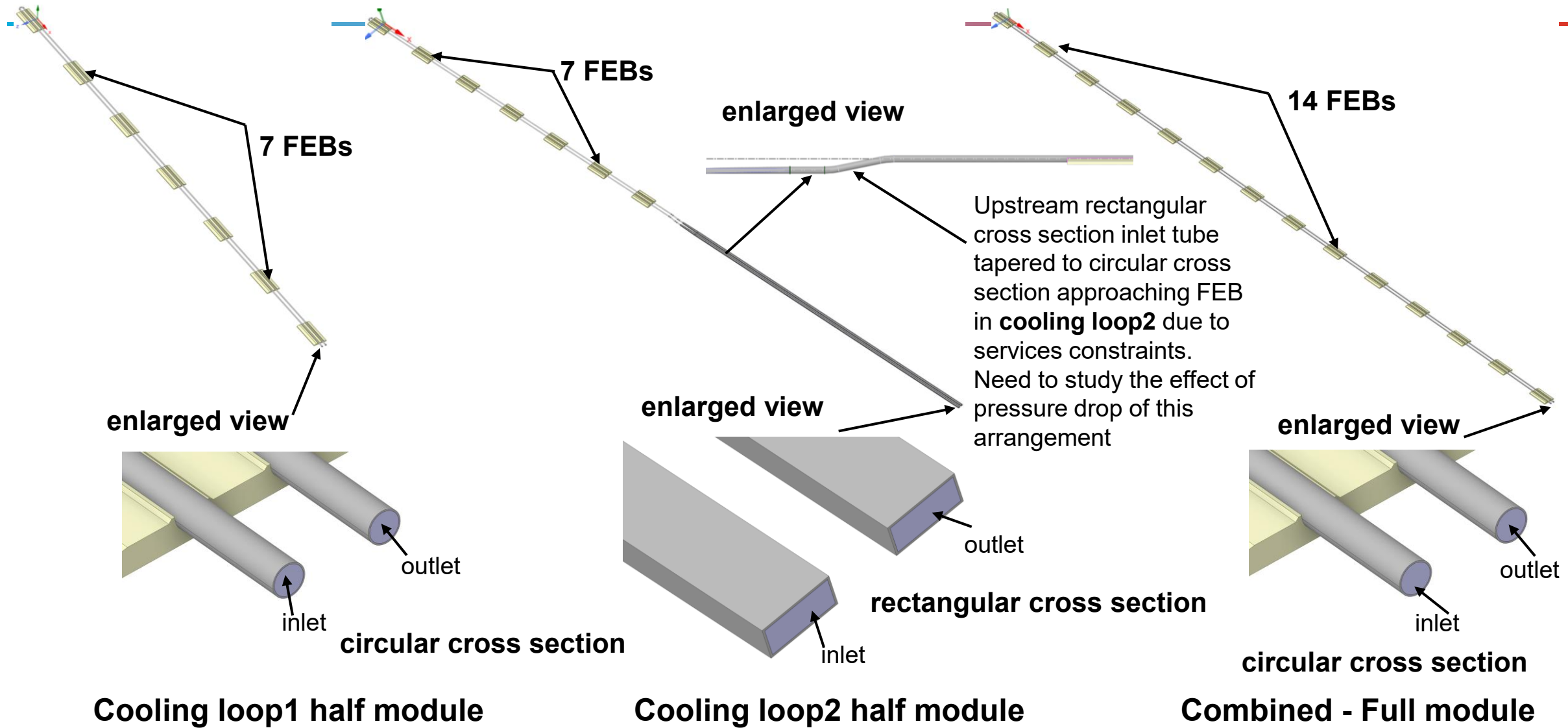


Pressure drop issue

- Pressure drop for Detector module is set to 0.2 bar (requires confirmation)
- One $\frac{1}{2}$ module (each side) has 7 FEBs = 126W
- $dT = 2\text{ }^{\circ}\text{C}$: 54 Liter or 0.9 L/min
- 4.5 mm ID is marginal for East side but not good for West side or Combined Model
- ID 5 ~ 6 mm will be used for the cooling model.
- Update on thermal simulation will be done.

Backups

ePIC Detector – Outer MPGD

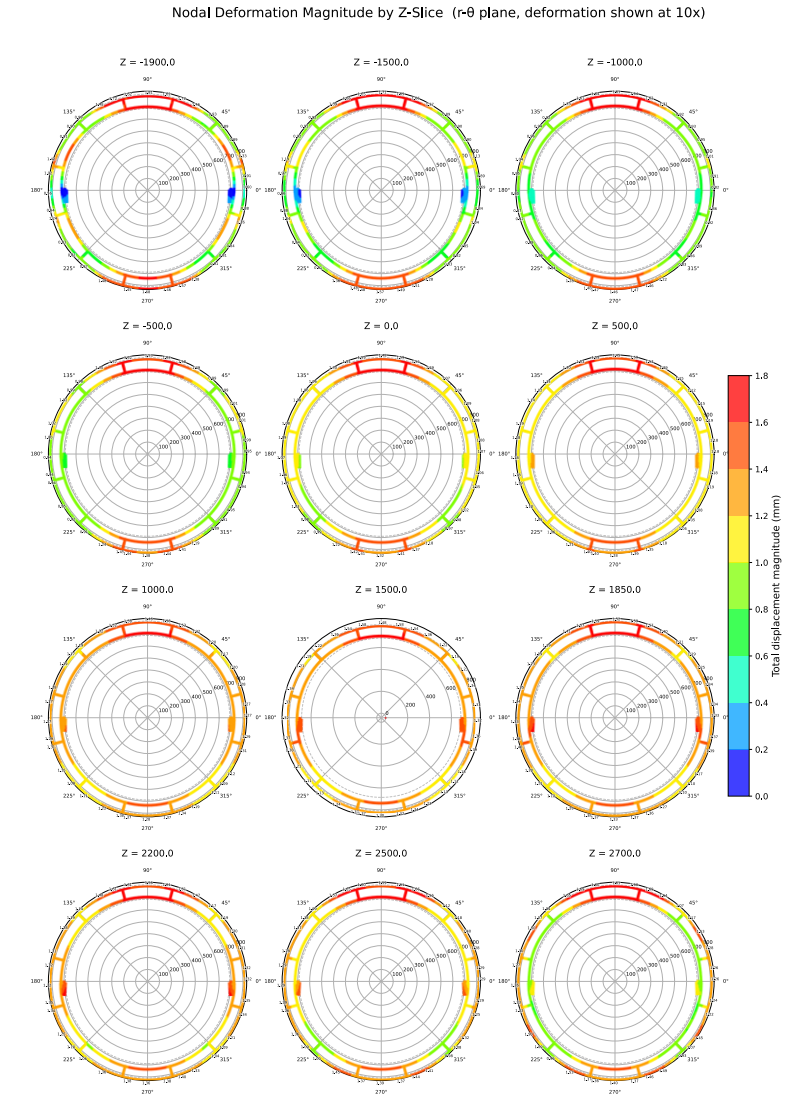


ePIC Detector – Outer MPGD Comparison

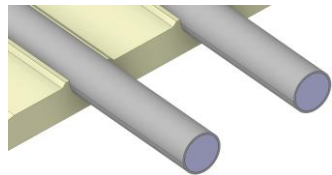
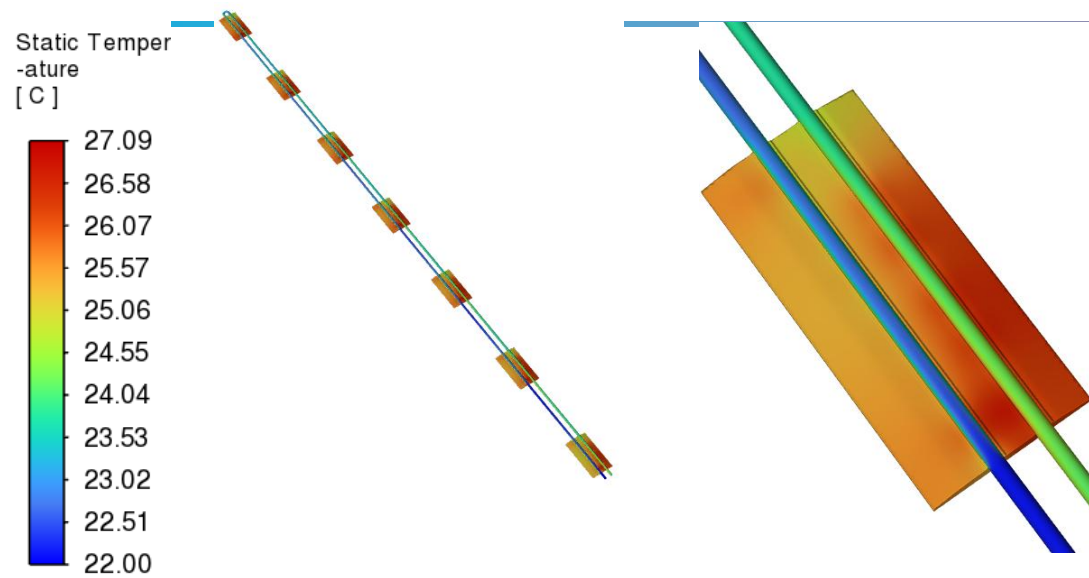
- Pressure drop is significant for the module at west side or single looping.
- For the optimized design, hard limit for pressure drop is required (i.e. 0.25 bar).
- Further thermal/fluidic simulation is required.
- Still preliminary until SALSA/FEB design is finalized.
- Current cooling design at service line (from Chiller to Detector) unknown.

GST FEA study

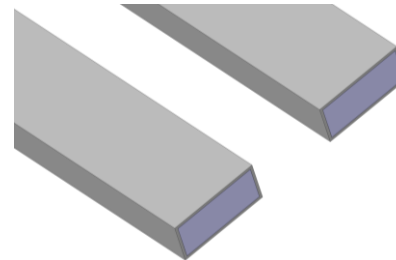
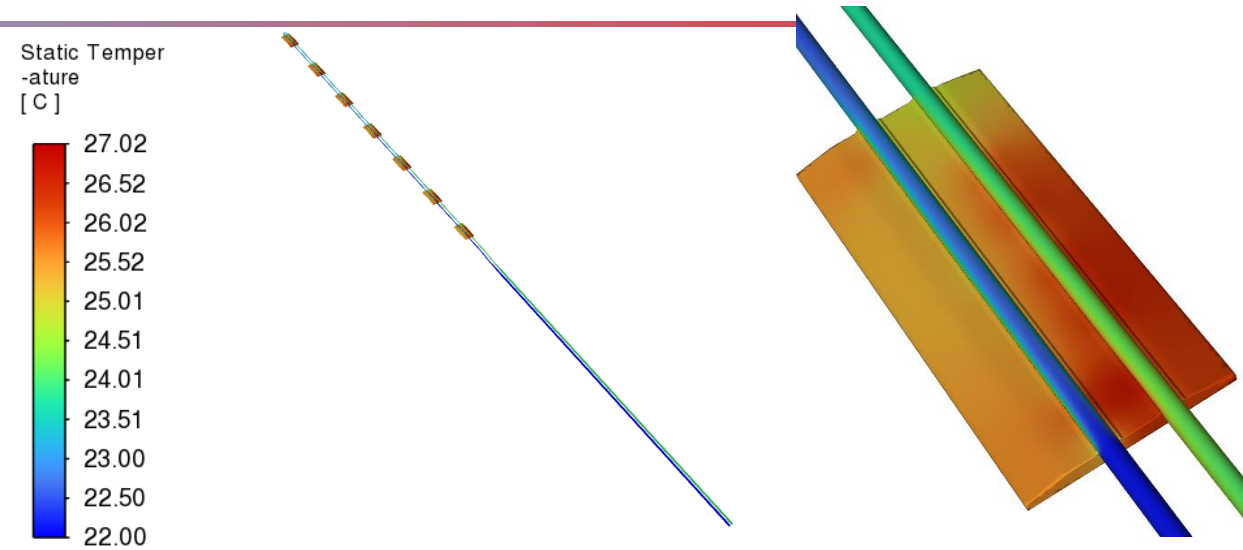
- There was discussion for deformation of GST related to hp-DIRC and BOT
- BOT tolerance < 50 $\mu\text{m}/\text{ft.}$, while GST deformation is about 2 mm max.
- Due to the detector design (stretched GEM foil, HV to thin gaps) small deformation will damage the whole detector or make the detector non-functional.
- Decoupling of GST is ideal.
- Waiting for further simulation of GST to identify level of deformation for design of decoupling mount.



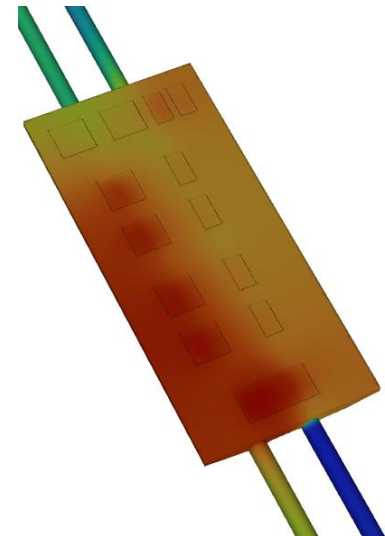
ePIC Detector – Outer MPGD - Results



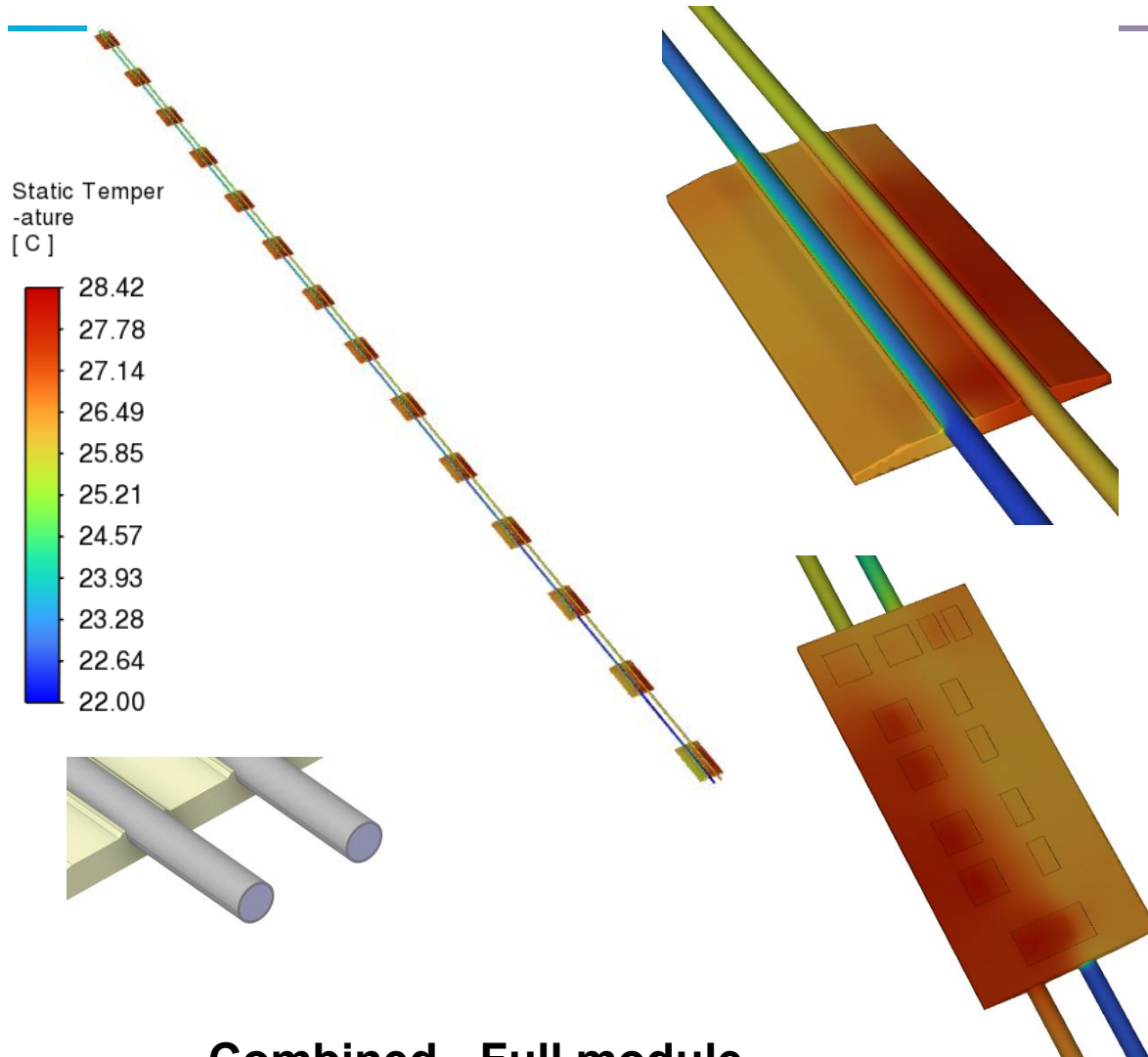
Cooling loop1 half module



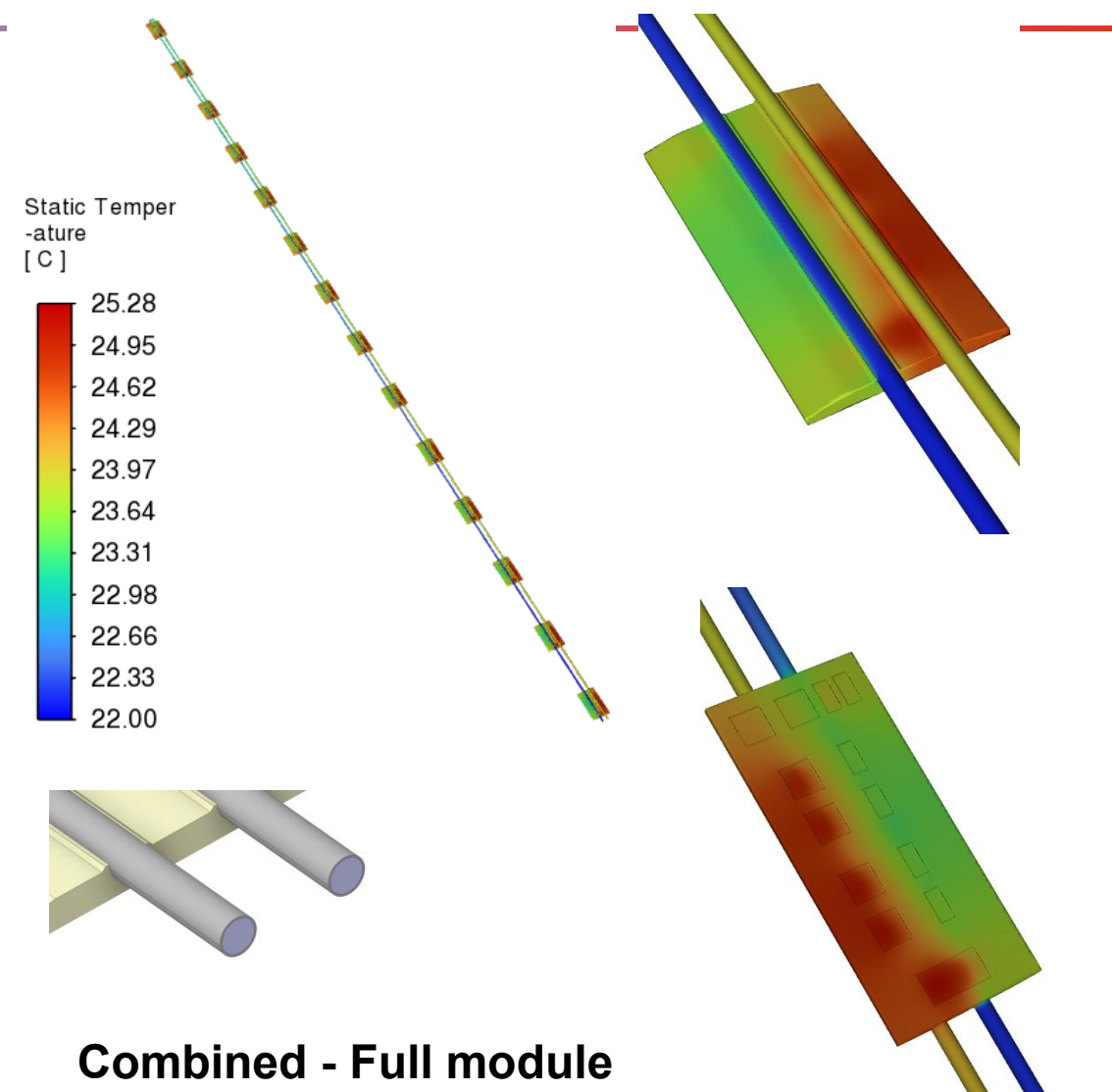
Cooling loop2 half module



ePIC Detector – Outer MPGD - Results

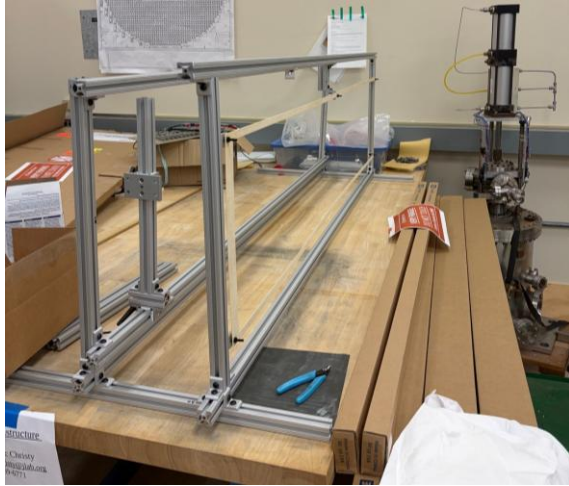


Combined - Full module
Flow – 0.76 lpm, dT – 4C



Combined - Full module
Flow – 1.52 lpm, dT – 2C

Photos



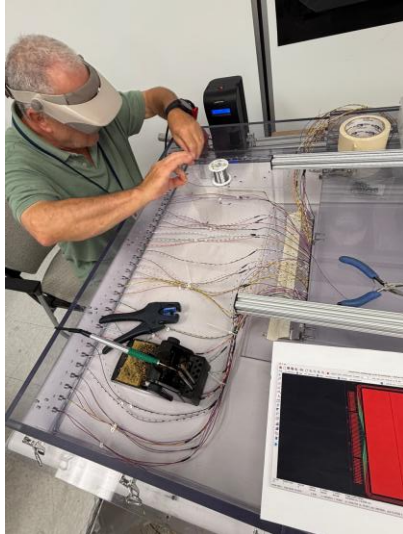
Sanding station



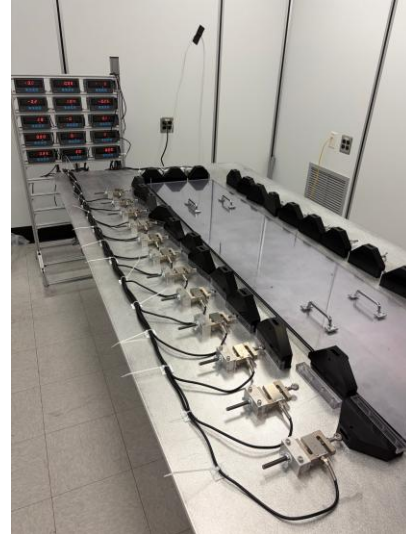
Ultrasonic Bath



Fume hood for Vacuum gluing



N₂ box for GEM foil test



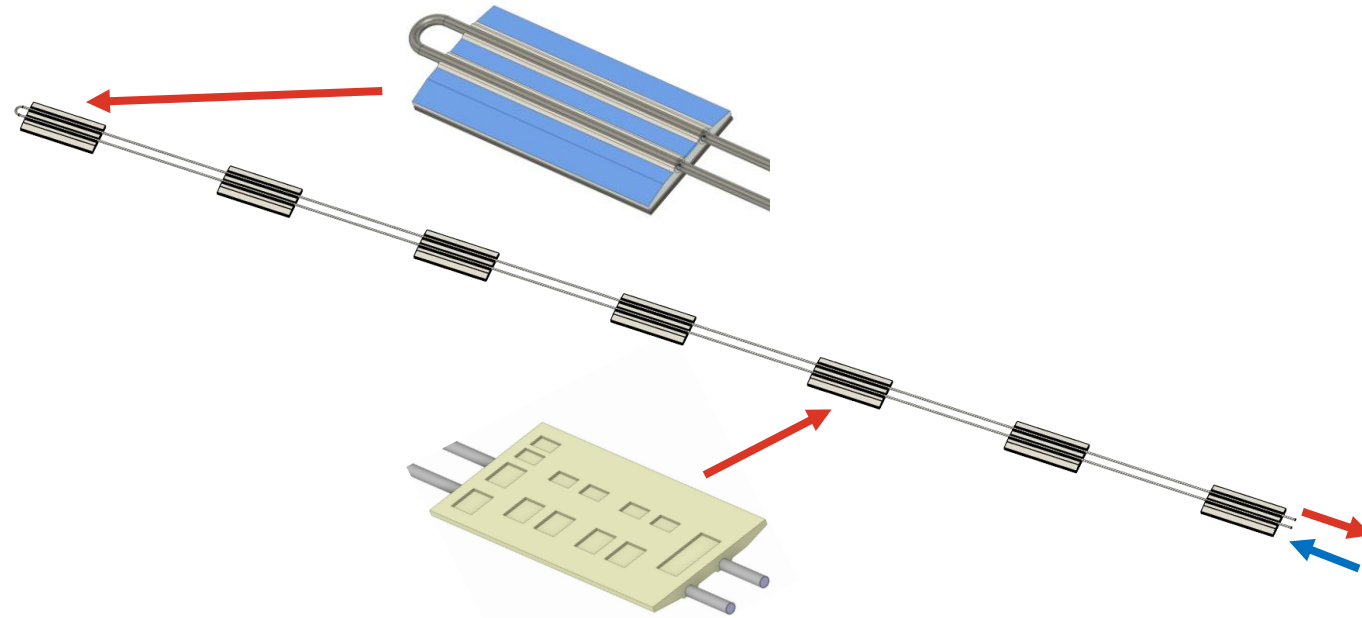
GEM stretcher



URWELL assembly station (in progress)

Update – Thermal study

- Baseline thermal study is done.
- Cooling plan
 - 7 FEBs per one cooling loop
 - 2 cooling loops per detector module
 - 4 cooling loops per section (out of 12)
 - all cooling service from east side
 - 16W per FEB, 112W per cooling loop
 - $T_{in} = 22\text{ }^{\circ}\text{C}$, $T_{out} = 23.9\text{ }^{\circ}\text{C}$
 - Pipe ID = 3.5 mm, OD = 4 mm SS.
 - Flow rate = 13.4 ml/s, Speed = 1.4 m/s
 - Pressure drop = 1.5 psi/m
 - 6.3 W heat to the ambient air

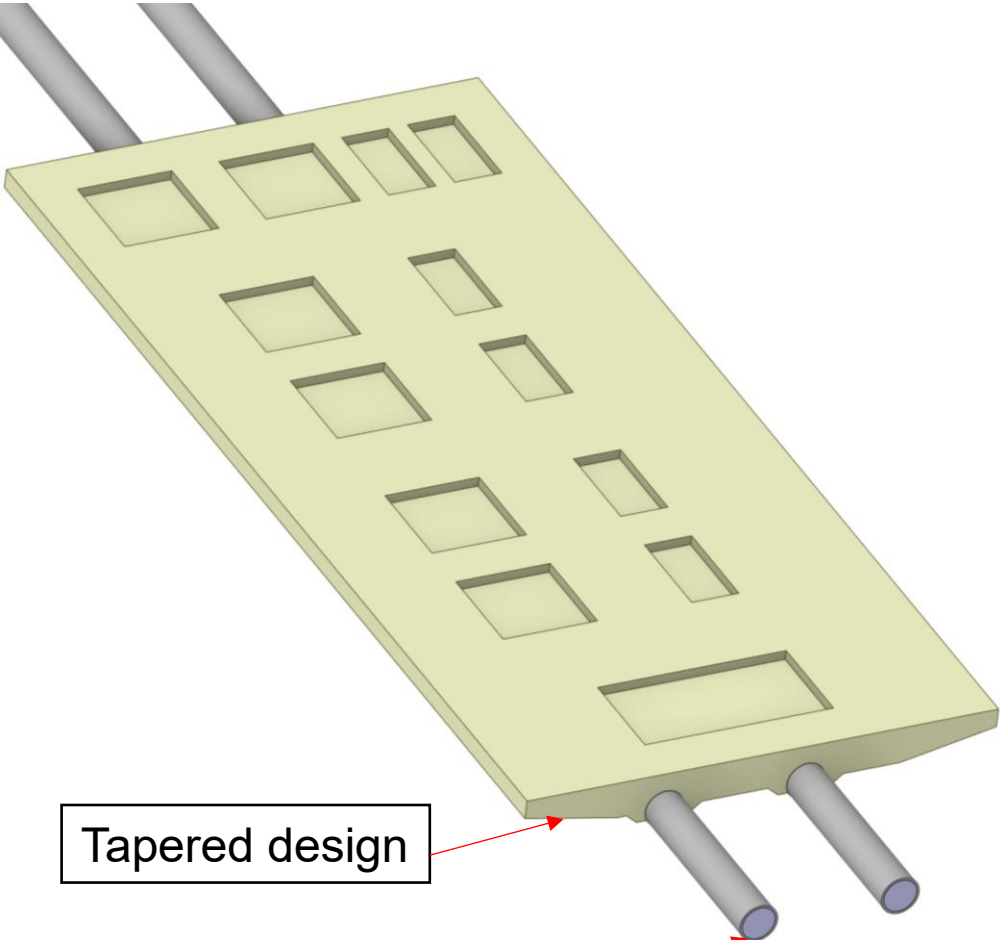


Heat Load

Analytical calculation	112	W
CFD calculation	105.7	W
Difference	6.3	W

7 FEB Heat Load – modified design – without insulation

Temperature rise 2 C



Tapered design

Tube ID changed from 4.5 mm to 3.5 mm
OD changed from 5 mm to 4 mm

Analytical calculation

Number of FEB	7	
Single FEB	15.5	W
with margin	16	W
Total FEB	112	W
dT	2	C
Cp	4181	J/kg C
m	0.01339	kg/s
m	0.01339	l/s
m	13.39	ml/s
Velocity	1.392	m/s
Re	5145	Turbulent

CFD calculation

m	0.013285	kg/s
Cp	4181	J/kg C
inlet	22	C
outlet	23.903	C
dT	1.903	C
Total FEB heat load	105.7	W

Heat Load

Analytical calculation	112	W
CFD calculation	105.7	W
Difference	6.3	W

Inlet water Temperature	22	C
Ambient Temperature	23.3	C