Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT of ENERGY | Office of Science

Outer MPGD Detector Cooling

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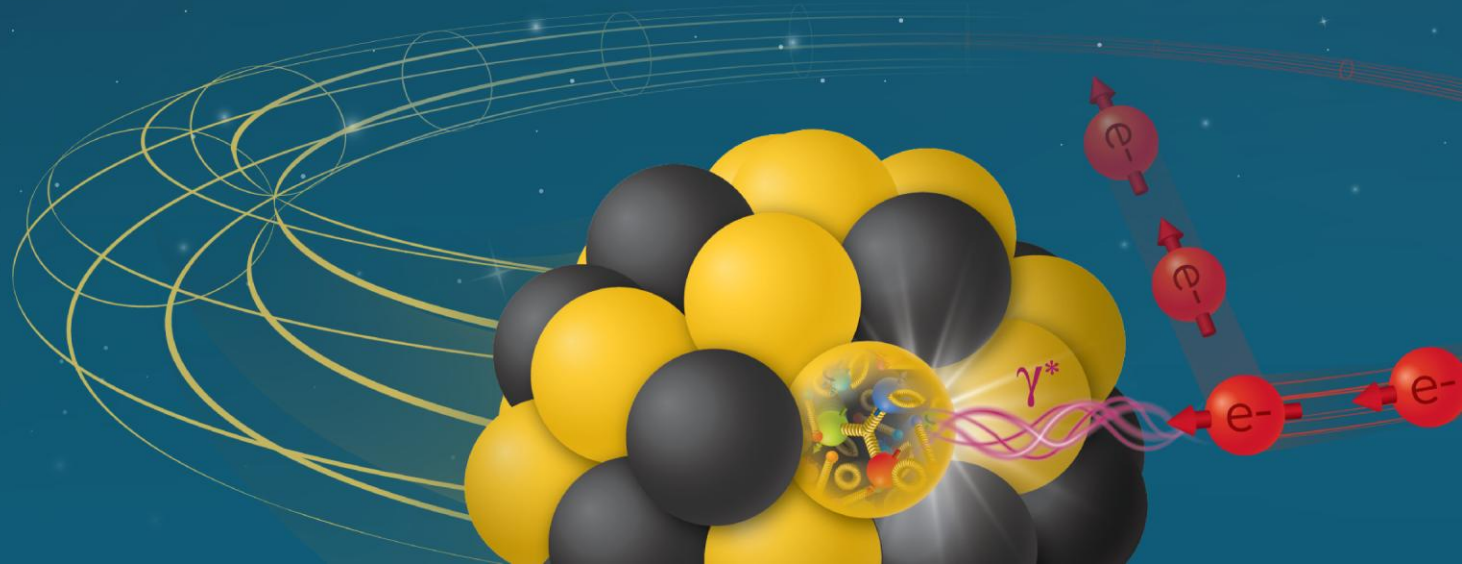
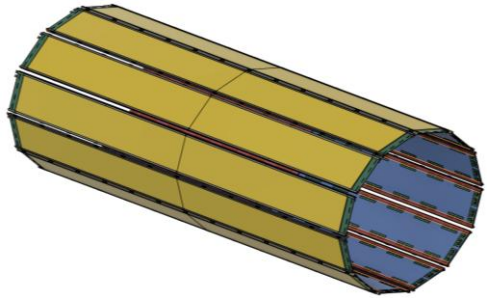
BOT Engineer

02/19/2026

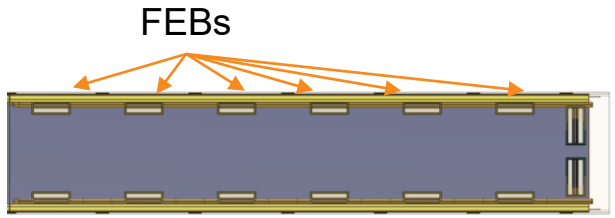
Electron-Ion Collider

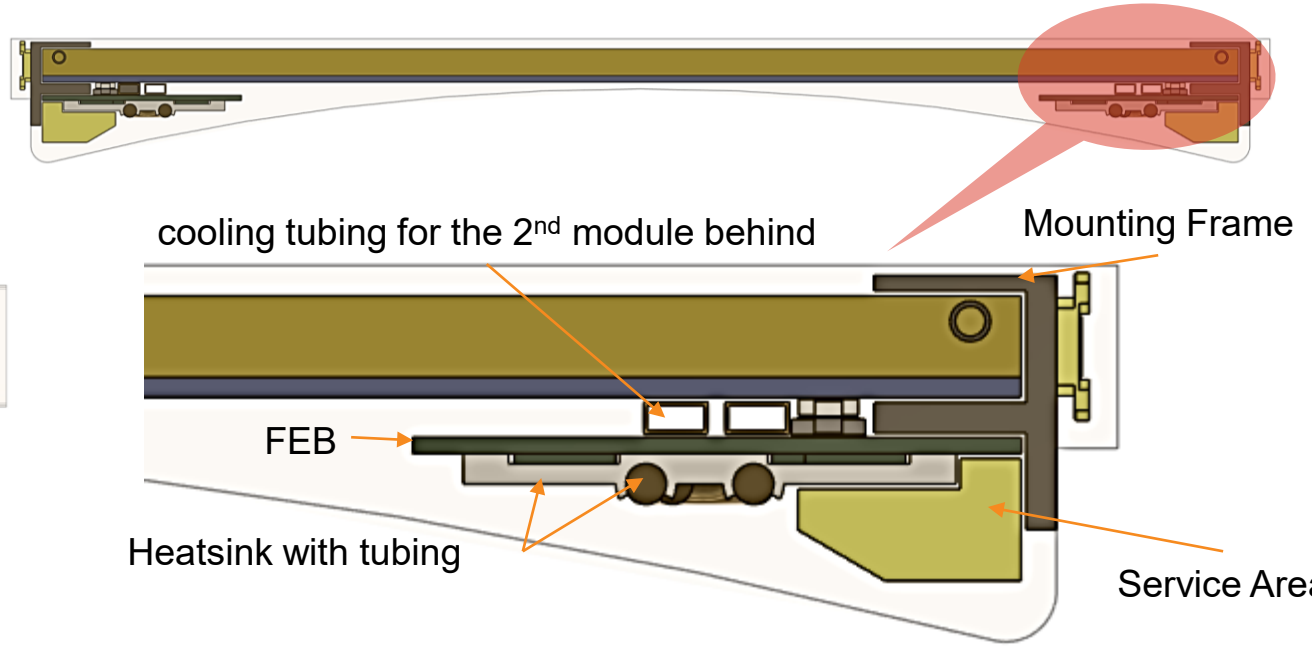


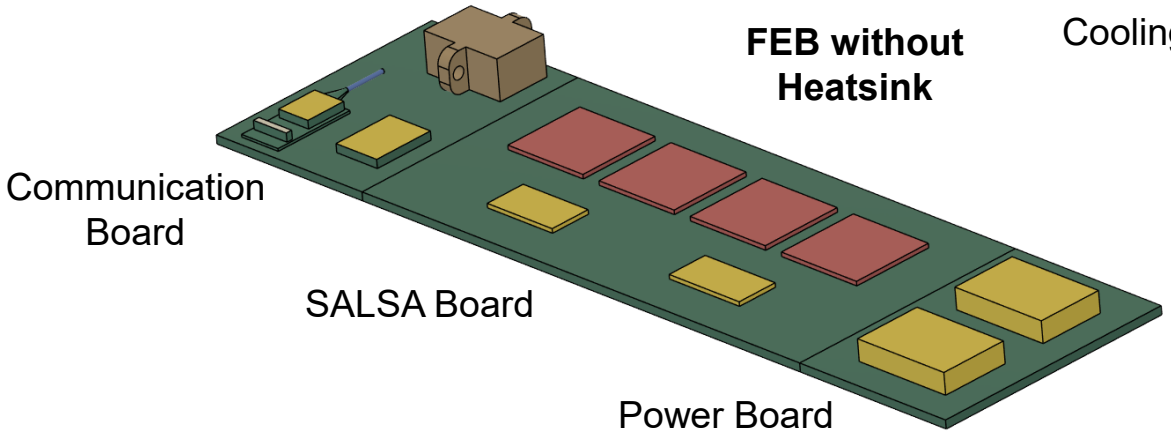
MPGD-BOT module: FEB with cooling

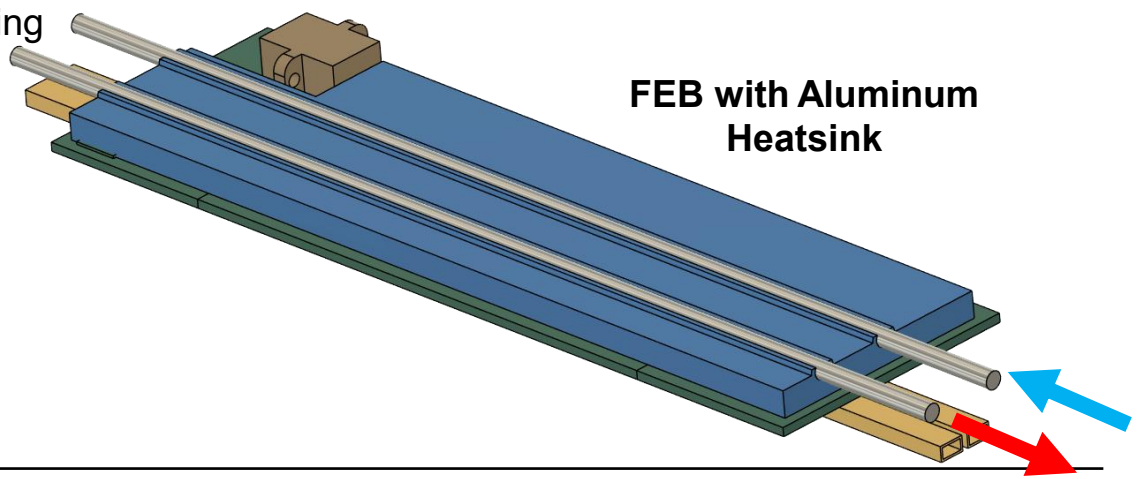


MPGD Barrel Outer Tracker (MPGD-BOT)

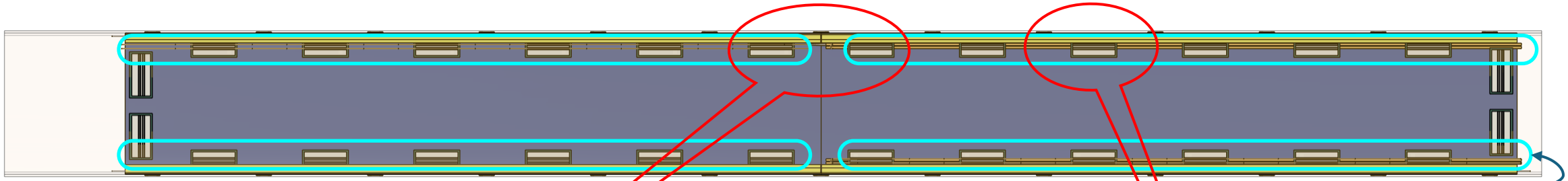






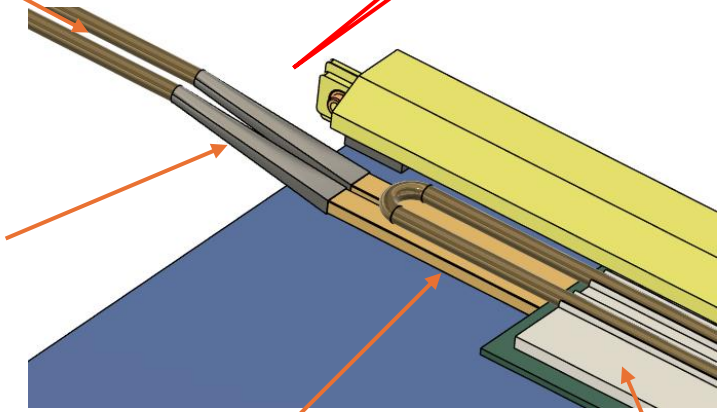


MPGD-BOT module: FEB cooling design



Service Area for
4 ×cooling loop

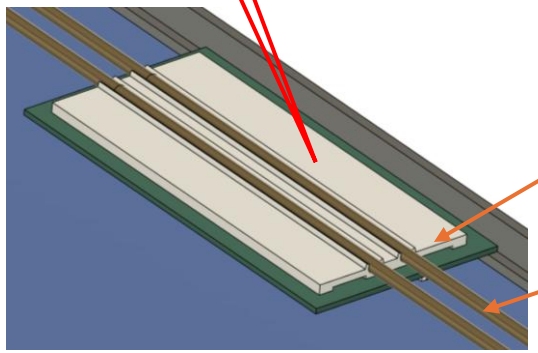
Cooling line
(left module)



Custom
adapter

Rectangular Tubing
under FEB (low profile)

Cooling line
(right module)



Aluminum
Heat Sink

Cooling Pipe

Expected Cooling Parameters

Total power: 112W = 16W × 7 FEB

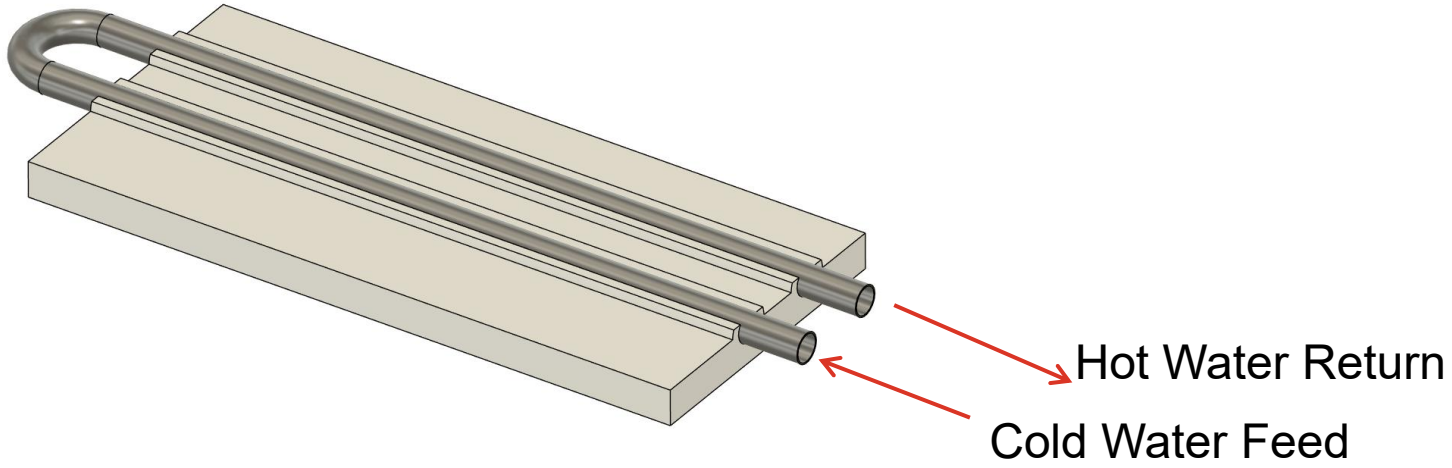
Flow rate: 1.6 L/min

Flow speed: ~ 1.5 m/s (OK for 5 mm ID pipe)

T_{in} = 22 °C, dT < 1 °C

Requires more dedicated thermal simulation

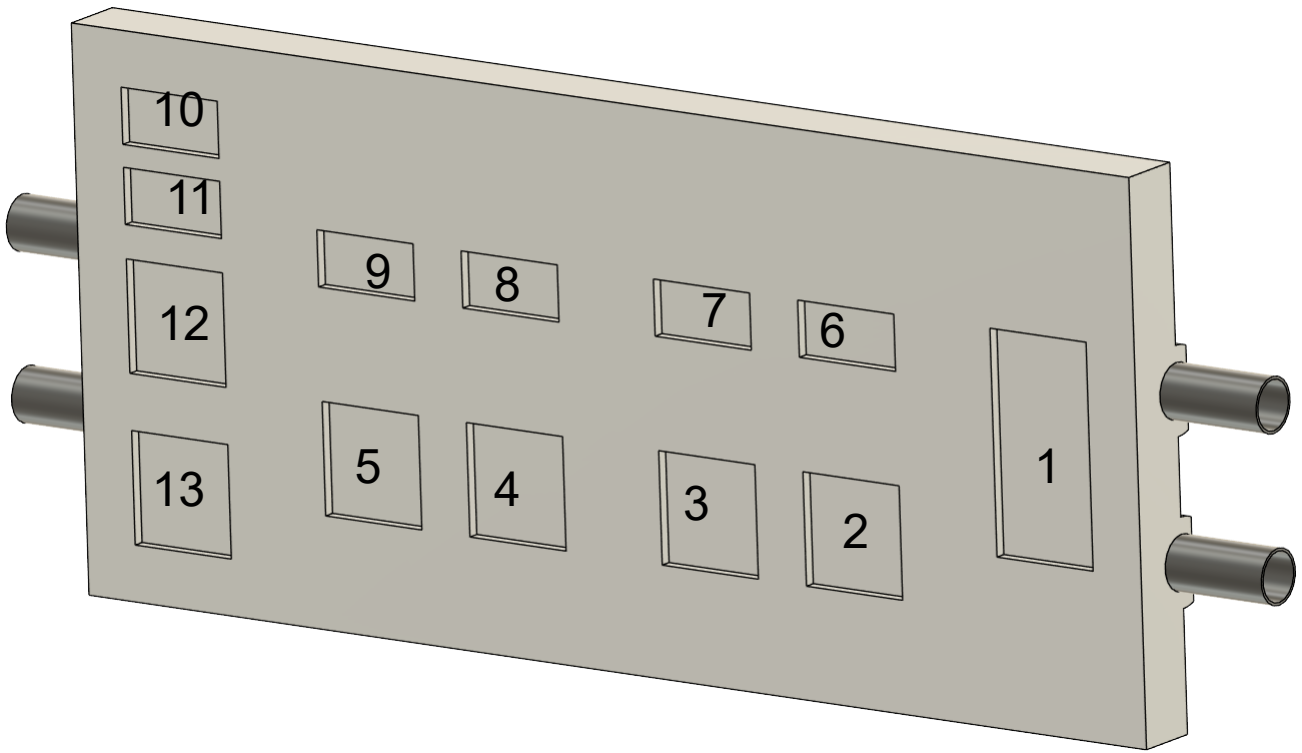
Heatsink Model for Simulation



- Stainless Steel (304) Pipe embedded Aluminum Heatsink. (5 mm OD)
- 304 Stainless steel (~16.5 W/mK)
- 6063 Aluminum (200 W/mk)

- Why Stainless steel? – 0.25 mm wall thickness. (0.5 mm for copper for similar sized pipe)
- If SS conductivity has issue, copper or brass can be an option.

Components



Number	Name	Power (mW)
1	DC/DC	4400
2	SALSA1	1800
3	SALSA2	1800
4	SALSA3	1800
5	SALSA4	1800
6	LDO_S1	450
7	LDO_S2	450
8	LDO_S3	450
9	LDO_S4	450
10	LDO_lpgbt	156
11	LDO_VTRX	875
12	lpGBT	600
13	VTRX	175
	TOTAL	15,206

Detector – Heat Load

Temperature rise 0.5 C

FEB	15.5	W
with margin	16	W
dT	0.5	C
Cp	4181	J/kg C
m	0.00741	kg/s
m	0.00741	l/s
m	7.41	ml/s

Velocity	0.467	m/s
Re	2198	Laminar

Temperature rise 2 C

FEB	15.5	W
with margin	16	W
dT	2	C
Cp	4181	J/kg C
m	0.00185	kg/s
m	0.00185	l/s
m	1.853	ml/s

Velocity	0.1168	m/s
Re	549.53	Laminar

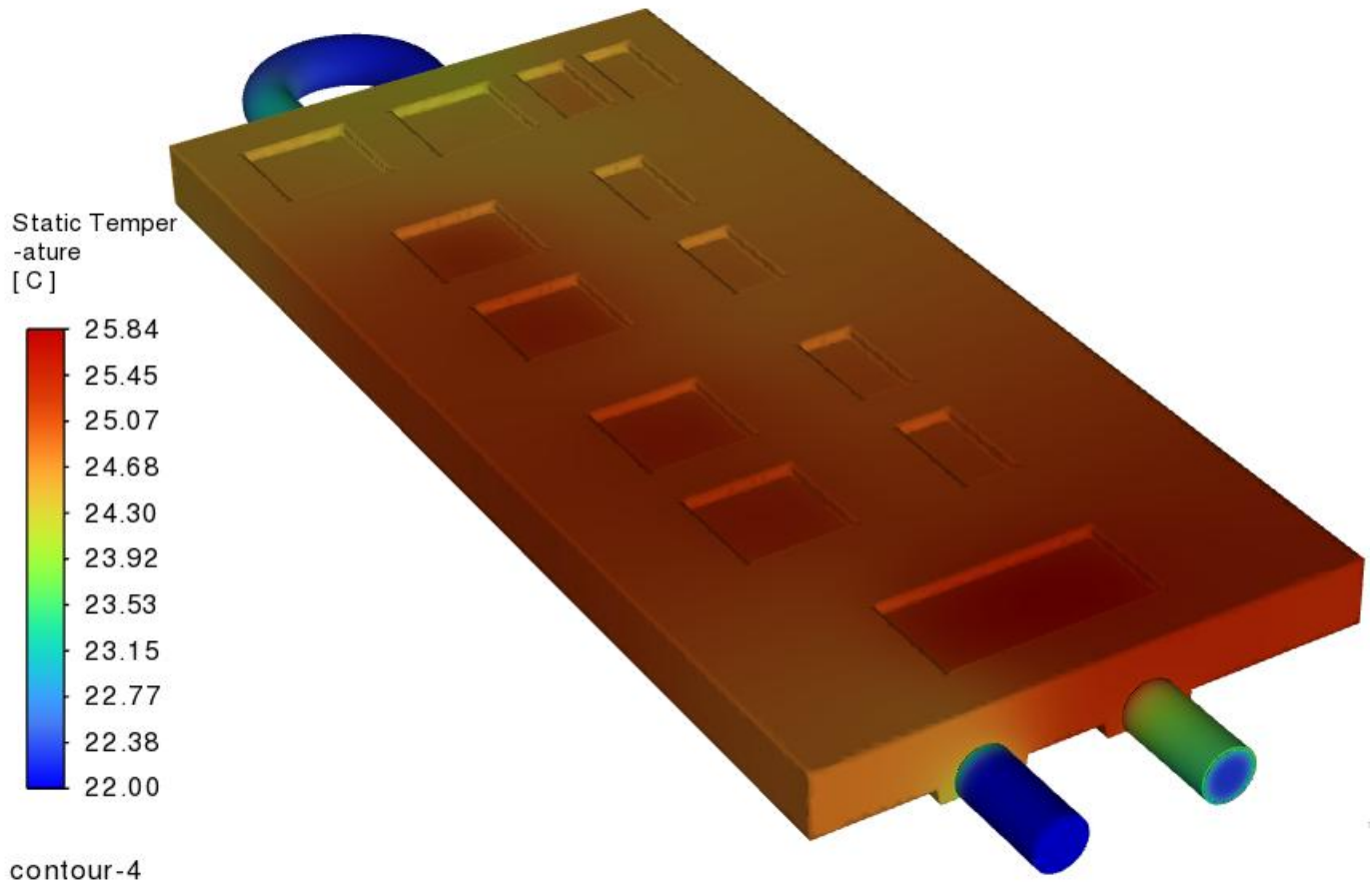
Inlet water Temperature	22	C
Ambient Temperature	23.3	C

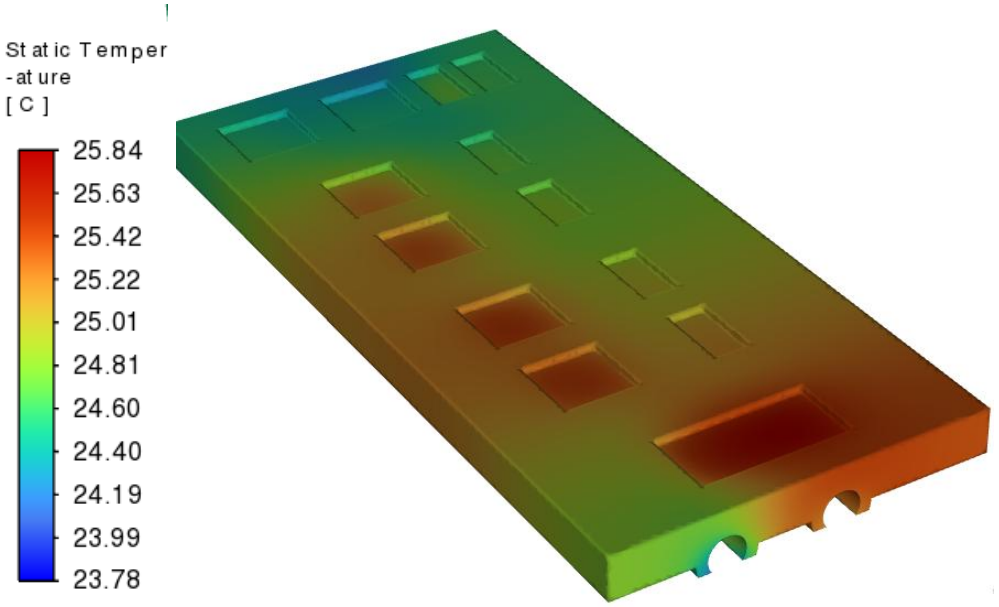
Detector – Heat Load

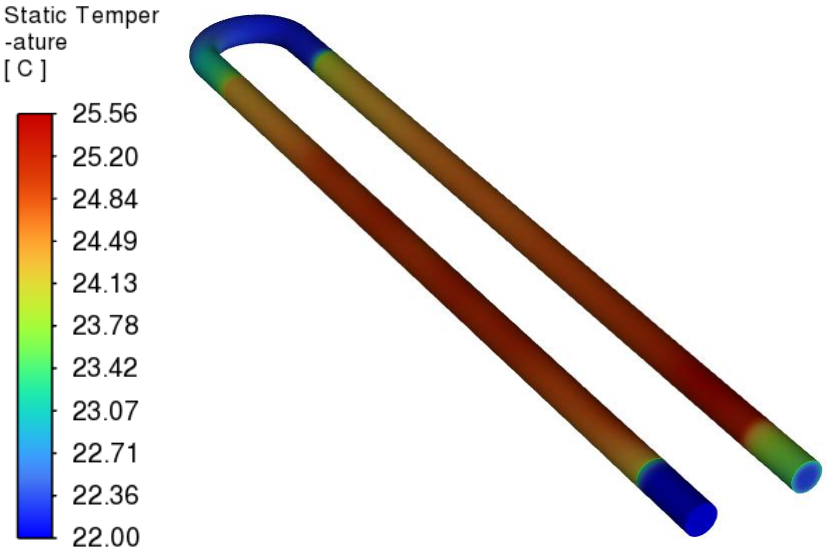
Component	Power	Power	Area	Area	Heat Flux
	mW	W	mm^2	m^2	W/m^2
DC/DC	4,400	4.4	200	0.0002	22,000
SALSA	1,800	1.8	100	0.0001	18,000
SALSA	1,800	1.8	100	0.0001	18,000
SALSA	1,800	1.8	100	0.0001	18,000
SALSA	1,800	1.8	100	0.0001	18,000
LDO	450	0.45	50	0.00005	9,000
LDO	450	0.45	50	0.00005	9,000
LDO	450	0.45	50	0.00005	9,000
LDO	450	0.45	50	0.00005	9,000
LDO lpGBT	156	0.156	50	0.00005	3,120
LDO VTRX	875	0.875	50	0.00005	17,500
lpGBT	600	0.6	100	0.0001	6,000
VTRX	175	0.175	100	0.0001	1,750
	15206	15.206			

Components Heat load data

Results – 0.5C temperature rise (Girish, BNL)

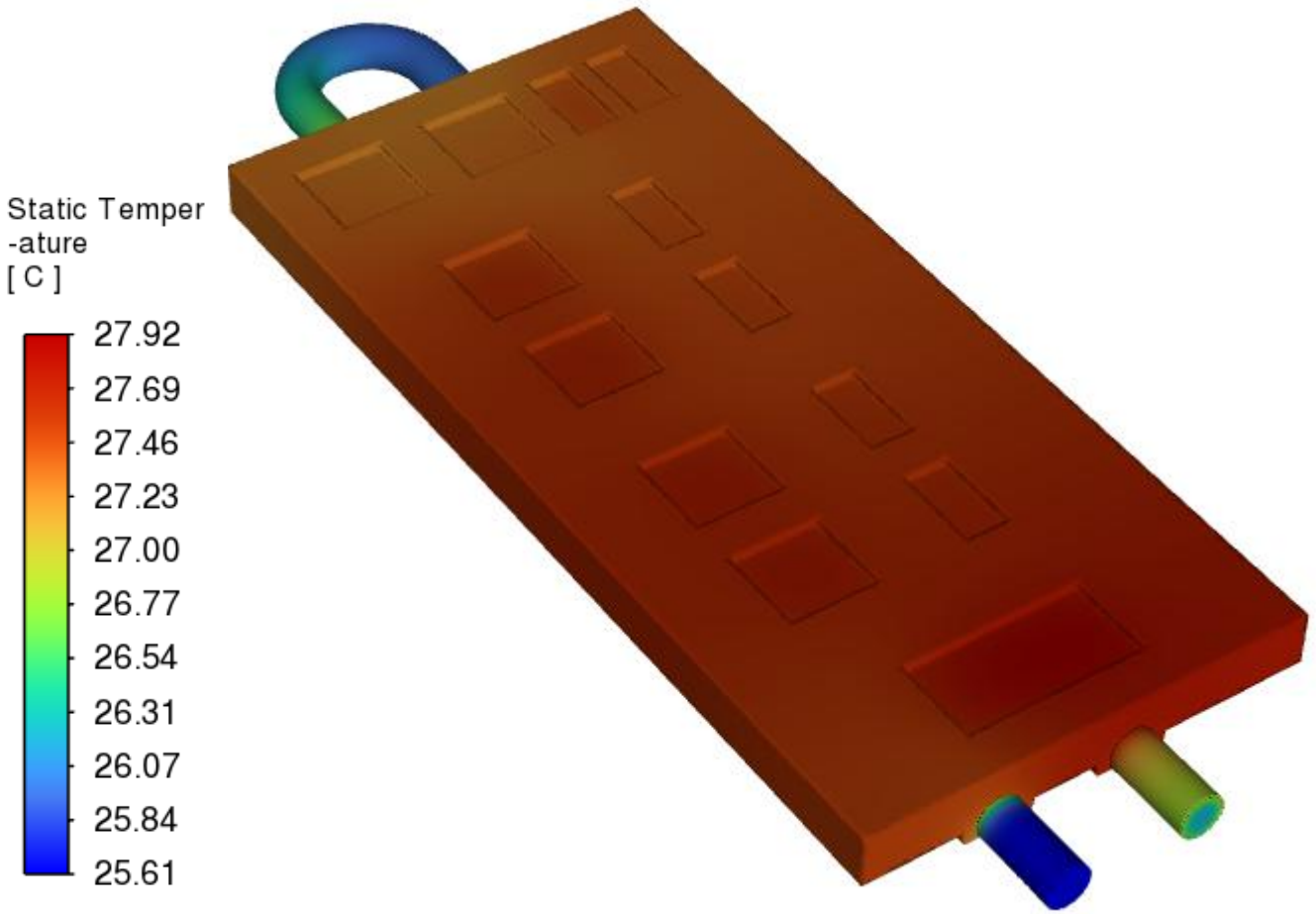


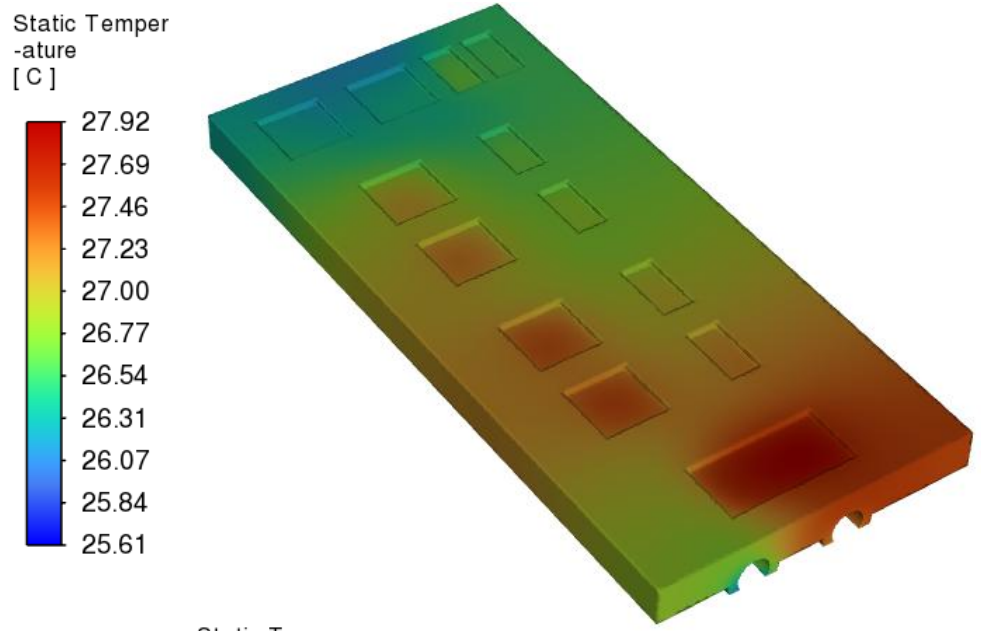


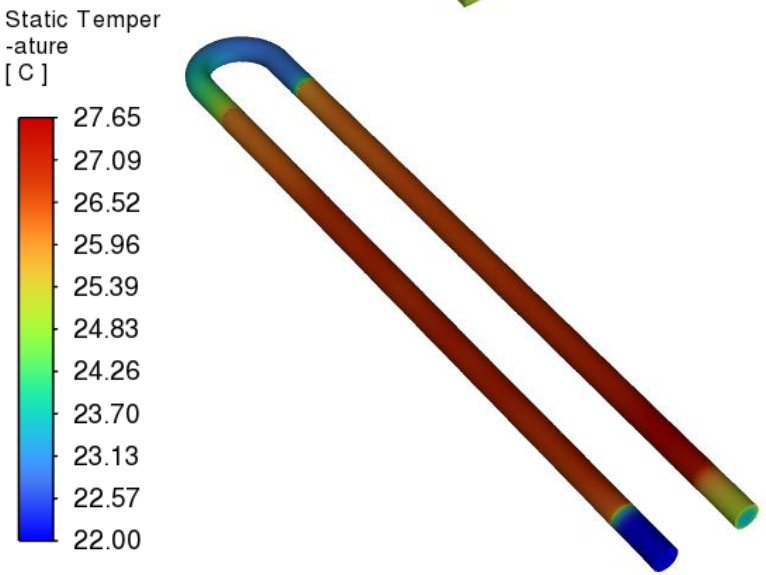


Temperature distribution

Results – 2C temperature rise (Girish, BNL)







Temperature distribution

Future Plan

- Working with Girish (BNL) for simulation of various scenarios

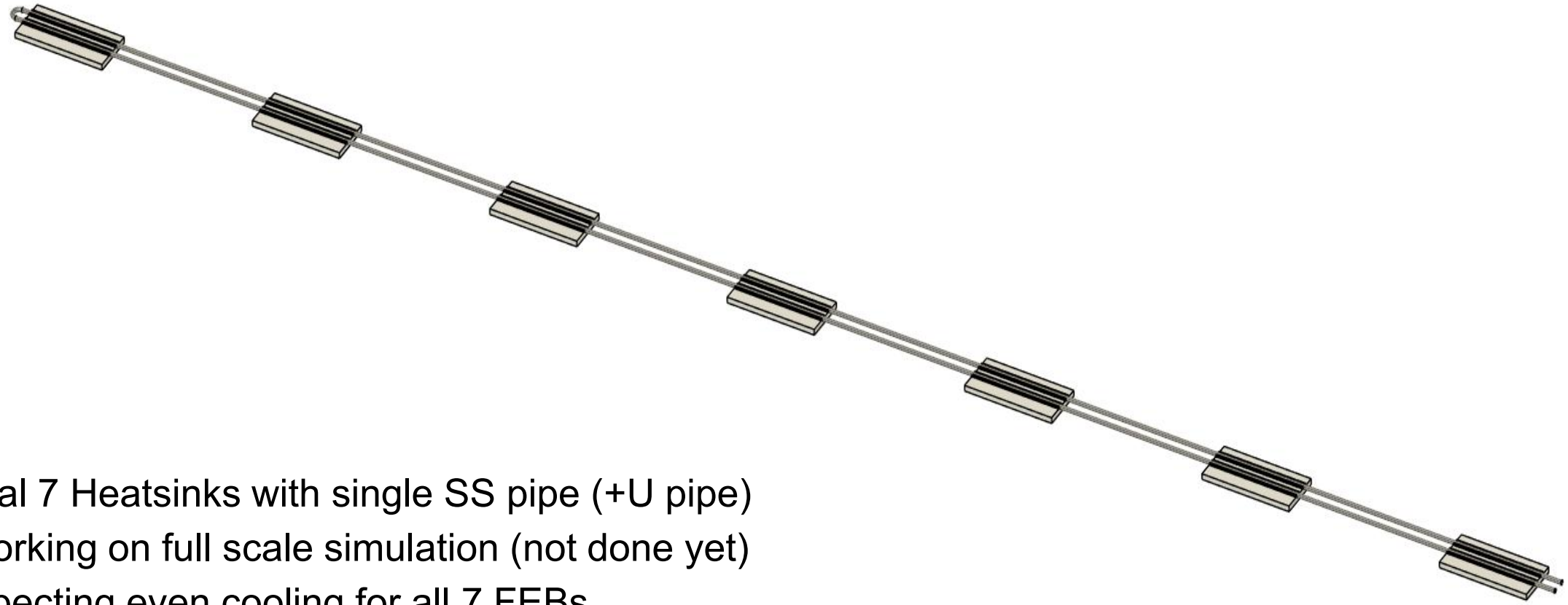
- Including other materials (thermal pad, thermal epoxy)
- Material (Stainless steel, Copper, Brass)
- Heatsink Insulation (prevent ambient heating)
- Flow rate
- Turbulator (in case we need)

- Build a baseline simulation package

=> quickly adapt realistic parameter/requirement from SALSA development

- Key parameter for simulation: SALSA power consumption + SALSA operation temperature

Full Setup



- Total 7 Heatsinks with single SS pipe (+U pipe)
- Working on full scale simulation (not done yet)
- Expecting even cooling for all 7 FEBs