Pixel Inner System Cooling

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US-ATLAS ITk Pixel Inner System Meeting

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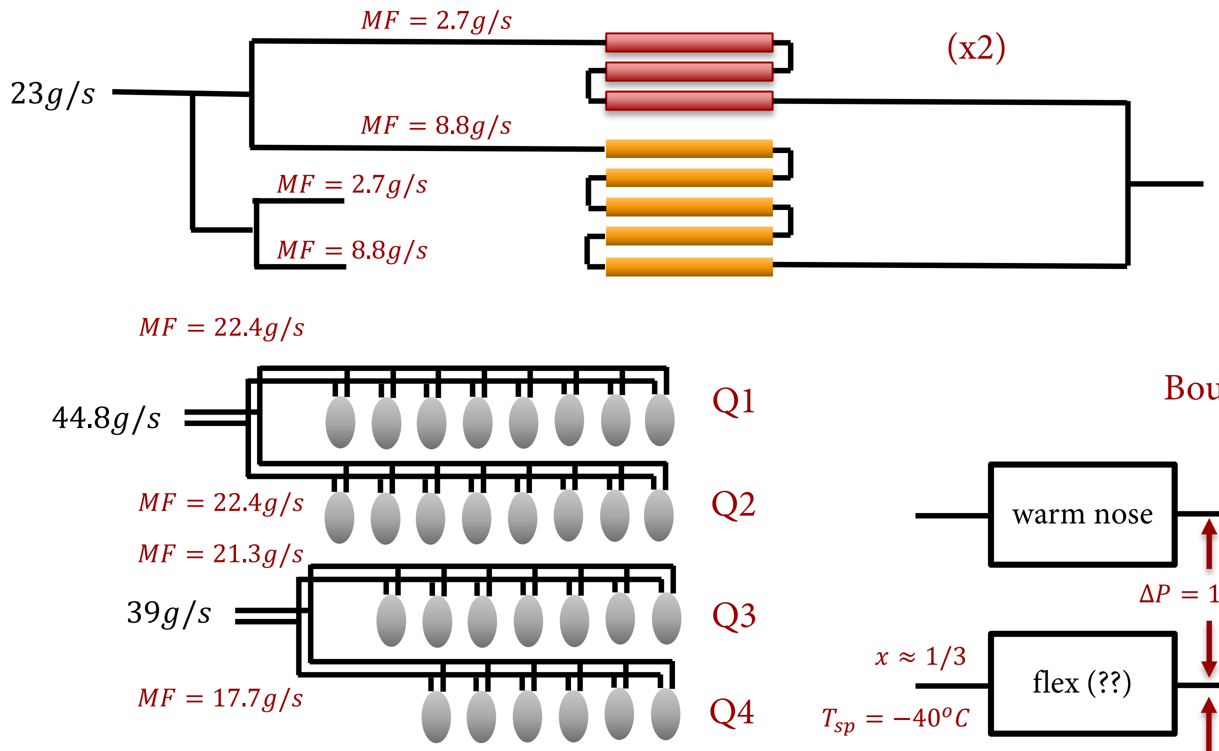
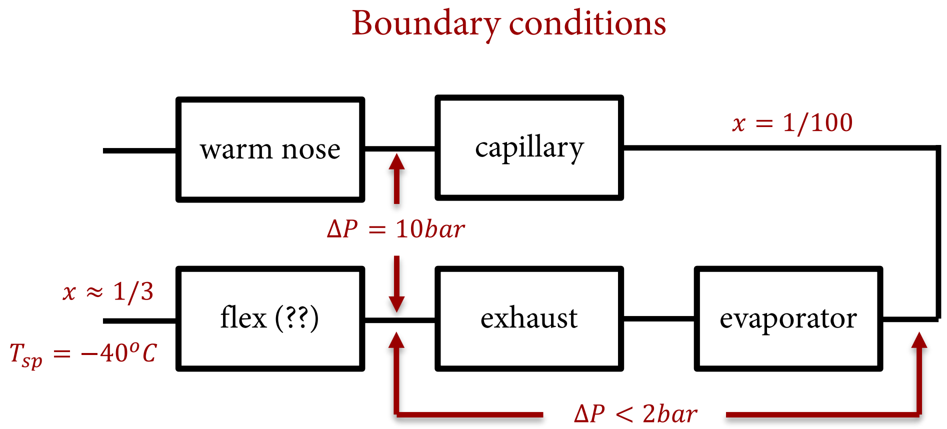
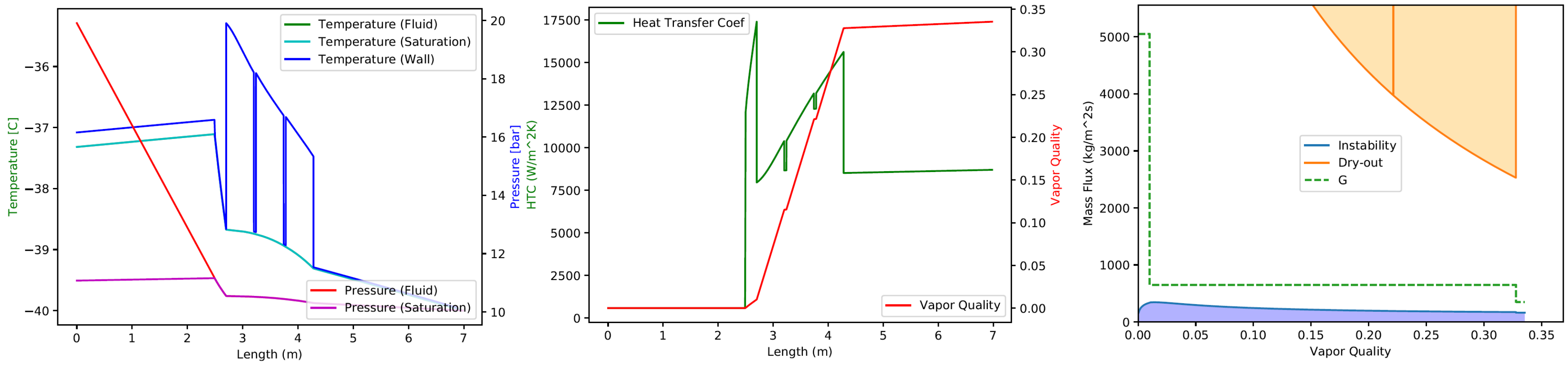
Summary of cooling strategy





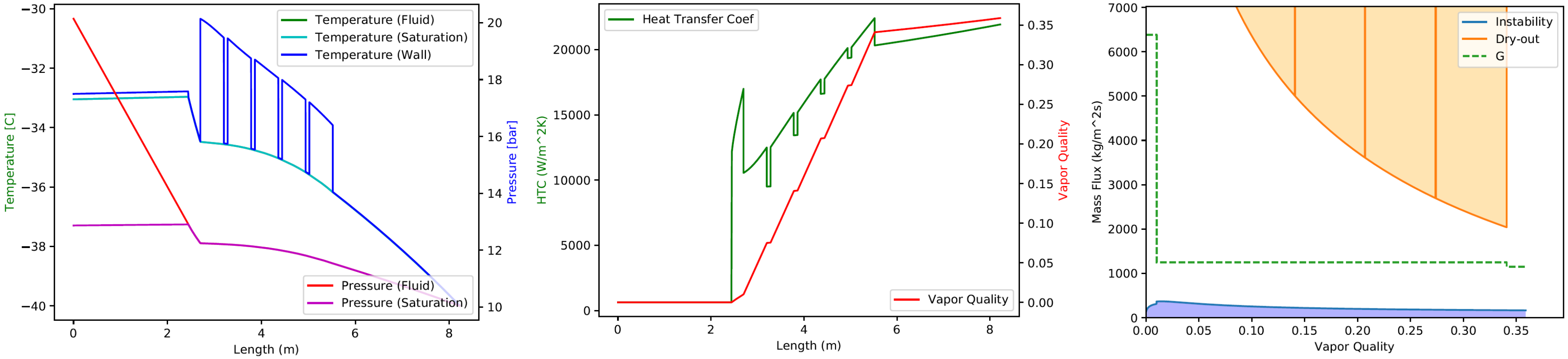
Barrel L0

- Using and exhaust tube with ID = 3mm. Evaporator with ID = 2.3mm. Capillary with 2.7m
- Should fit well in the tray.
- Heat dissipation to most recent recommendations [FE (0.8)+ sensor (0.041)+ services (0.092)]
- Result: capillary ID = 0.820mm



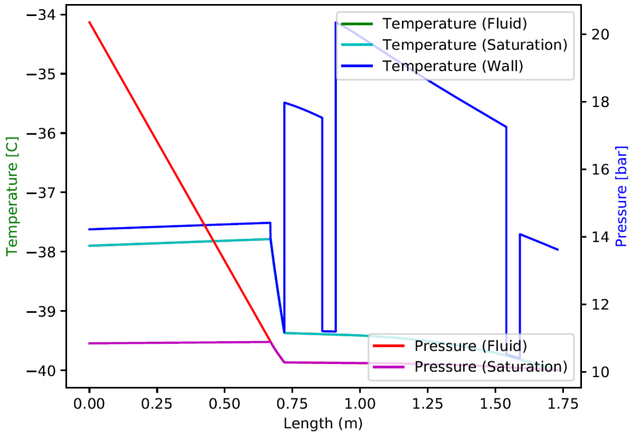
Barrel L1

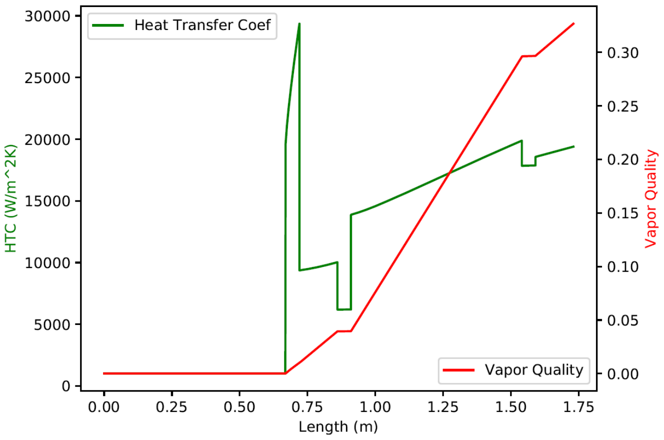
- Using and exhaust tube with ID = 3mm. Evaporator with ID = 3mm. Capillary with 2.7m
- Heat dissipation to most recent recommendations [FE (0.8) + sensor (0.013) + services (0.077)]
- Result: capillary ID = 1.325mm

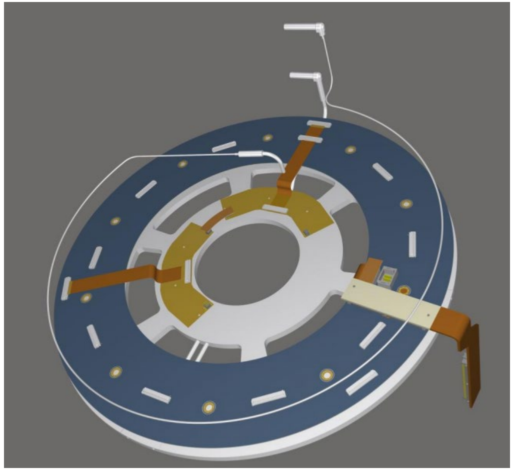


Endcap R0/1

- Design fixes the length of capillary (currently 72cm). This may be problematic, since $d(\Delta P)/d(ID)$ is very large and it may be difficult, in practice, to reach the design 10 bar.
- Evaporator ID=2.3mm
- Capillary ID=0.685mm

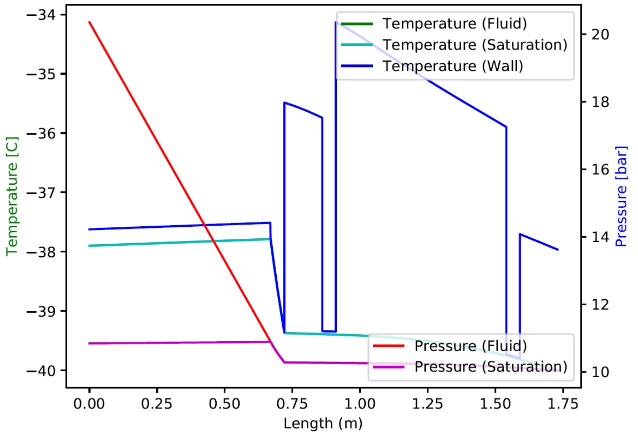


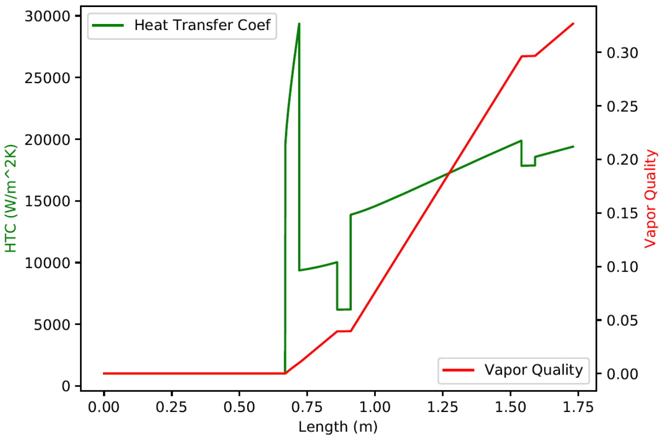


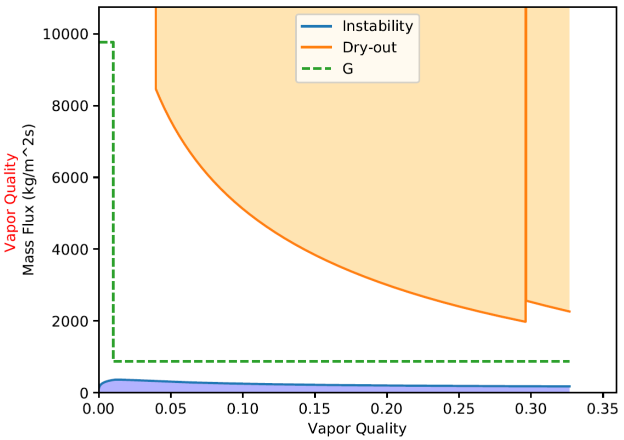


Endcap R0/1

- Design fixes the length of capillary (currently 72cm). This may be problematic, since $d(\Delta P)/d(ID)$ is very large and it may be difficult, in practice, to reach the design 10 bar.
- Evaporator ID=2.3mm
- Capillary ID=0.685mm

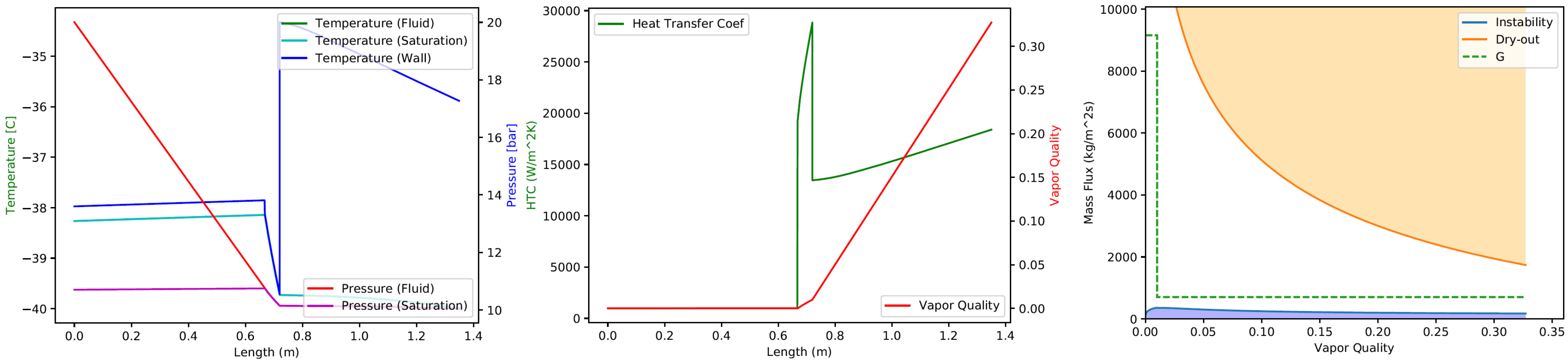






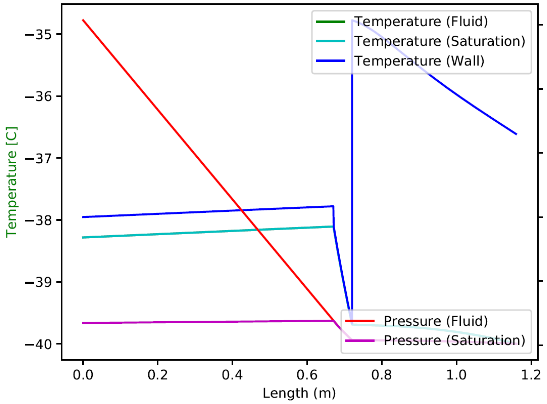
Endcap R1

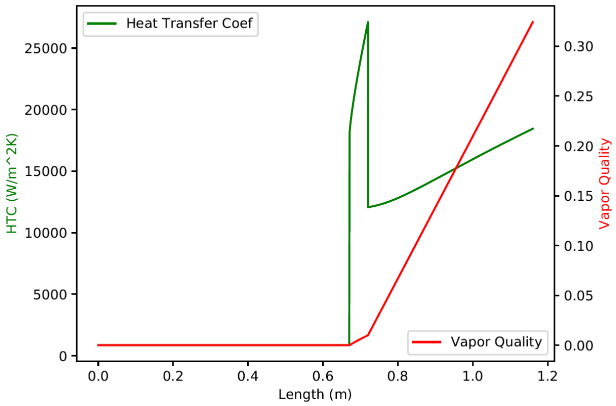
- Design fixes the length of capillary (currently 72cm). This may be problematic, since $d(\Delta P)/d(ID)$ is very large and it may be difficult, in practice, to reach the design $10\ bar$.
- Evaporator ID=2.3mm
- Capillary ID=0.635mm

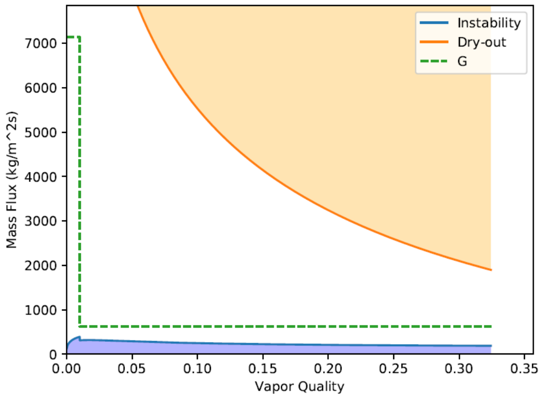


Endcap R0.5

- Again, length of capillary fixed by design (72cm). It would be good to have some room for design.
- The coolant mass flow is very different. For instance 1.1g/s here against 3.6g/s in the R0/1. This is also not ideal for manifolding.
- Evaporator of ID=2.3mm does not work. Too big, creates unstable flow. Here we use evaporator ID=1.5mm and calculate a capillary with ID=0.443mm

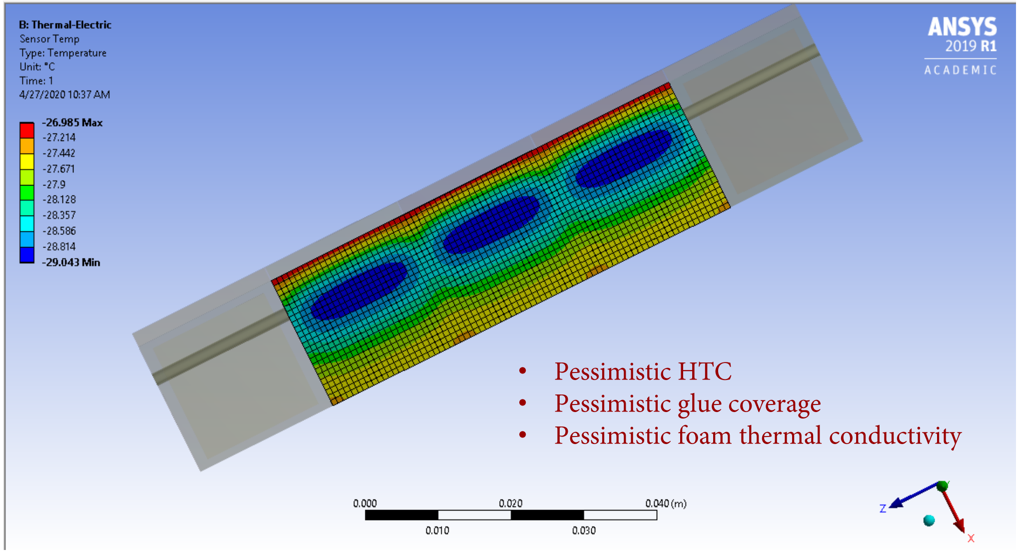






L0 simulation at smaller radius

- Quick check of L0 condition at smaller radius (R=34mm)
- Updated bias voltage and heat dissipation for 3D sensor at fluence of 1e16 neq/cm2 (design fluence is 1.86e16 neq/cm2, so this is slightly “optimistic” compared to end-of-life)



- Pessimistic HTC
- Pessimistic glue coverage
- Pessimistic foam thermal conductivity

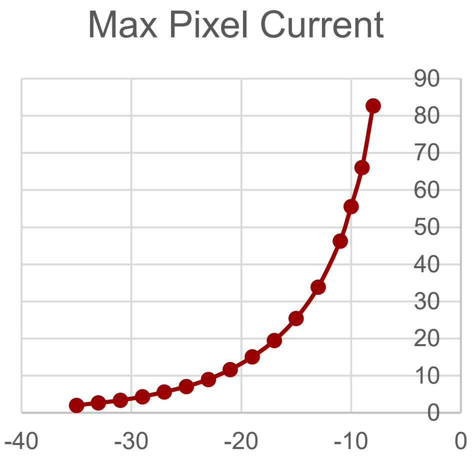
This is very preliminary. A complete re-run of the FEA is being performed. But I was asked to provide some partial feedback.

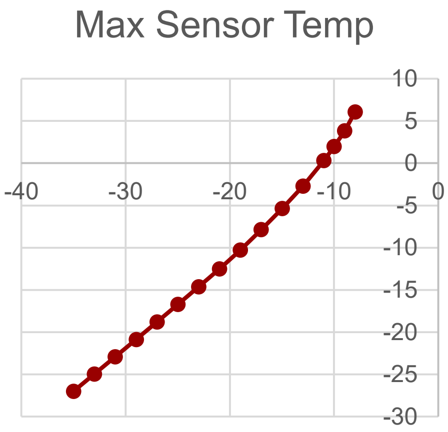
$$TFM = \frac{-26.99 + 35}{power\ density} = 8.02\ {}^{0}C/(\frac{W}{cm^2})$$

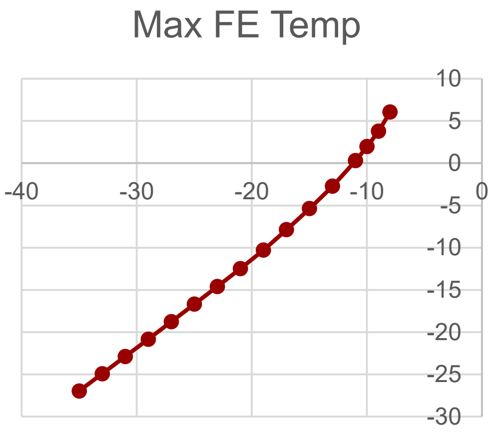
L0 Thermal Specifications		
	TFM_{Design} [°C·cm²·W⁻¹]	TFM_{Total} [°C·cm²·W⁻¹]
~~Old Specs~~	~~20.5~~	~~28.5~~
New Specs	13.8	18.4

Some quick plots

- Again, I change HTC but do not iterate with thermo-fluidic simulation (yet)
- L0 stave, as before, is very far away from runaway.
- If (max) current has to be kept below 10nA, we need T < -23oC
- For FE temp below -10oC, we need T < -19oC.







It looks ok...

- But this is very preliminary, take with grain of salt.
- A complete study will be ready soon.