

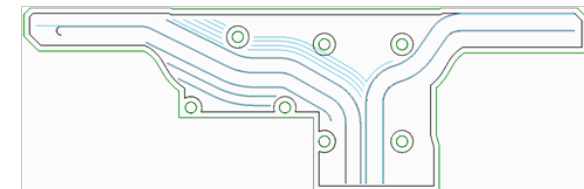
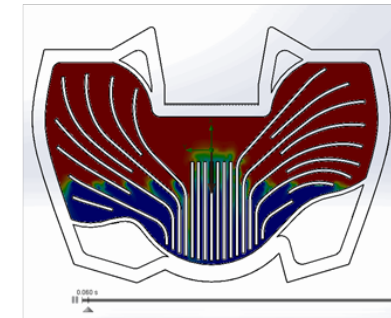
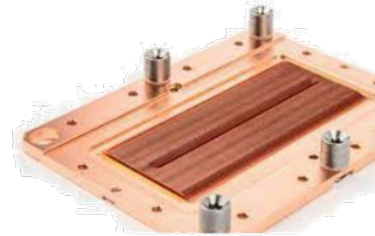
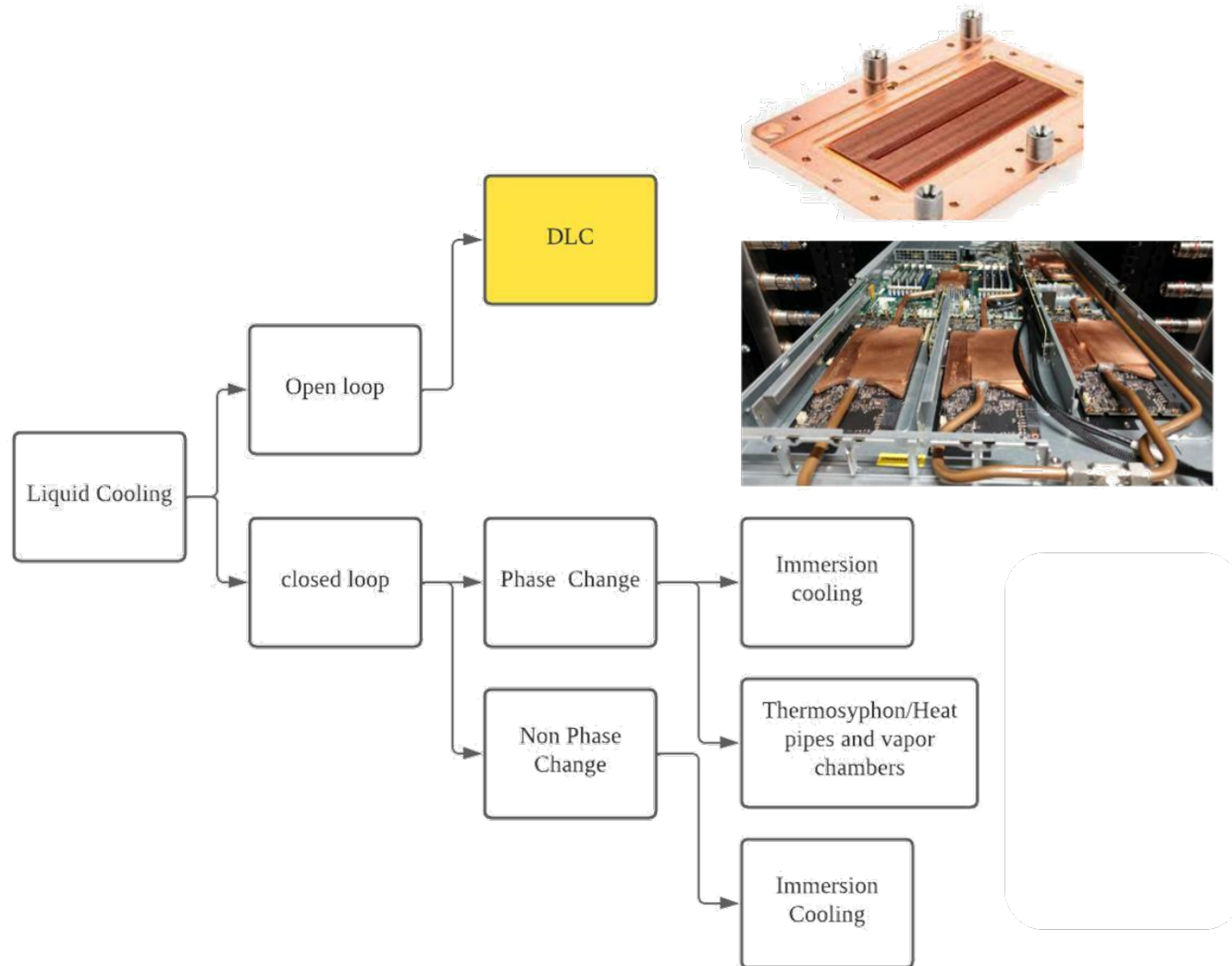


Liquid Cooling & Cold Plate Manufacturing ver. 2.0

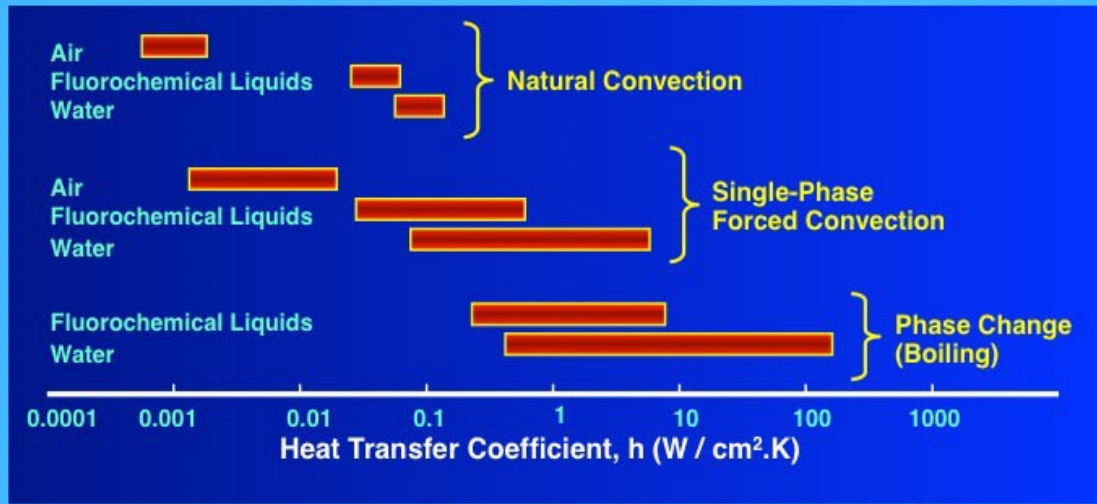
- Classification of Liquid Cooling
- Cooling scheme and selection
- Analysis flow
- Project sharing
- Practical samples and manufacturing feasibility
- Quality check and flow



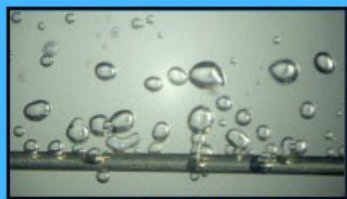
Liquid Cooling Category



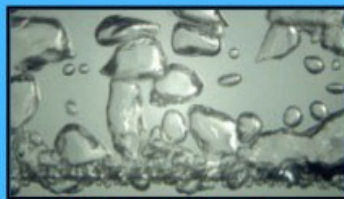
Cooling Tactics



Heat Transfer Coefficients associated with different Cooling Configurations and Different Coolants



Nucleate Boiling

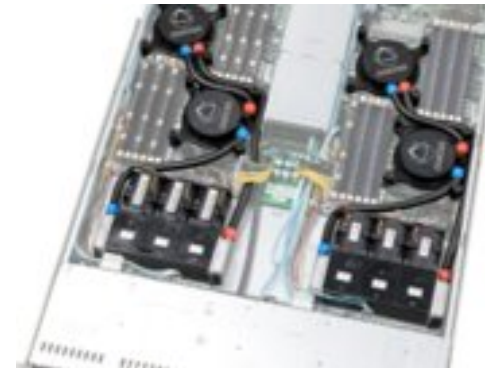
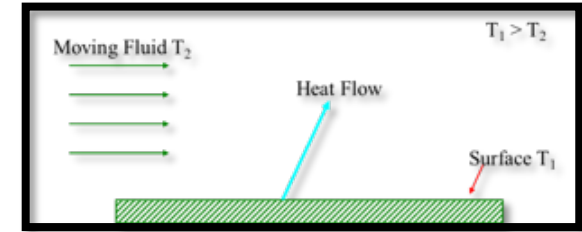


Critical Heat Flux

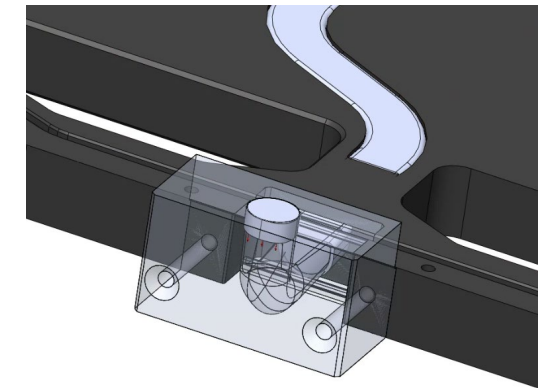
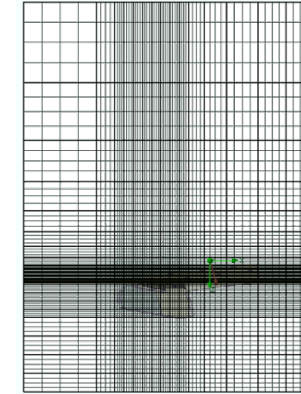
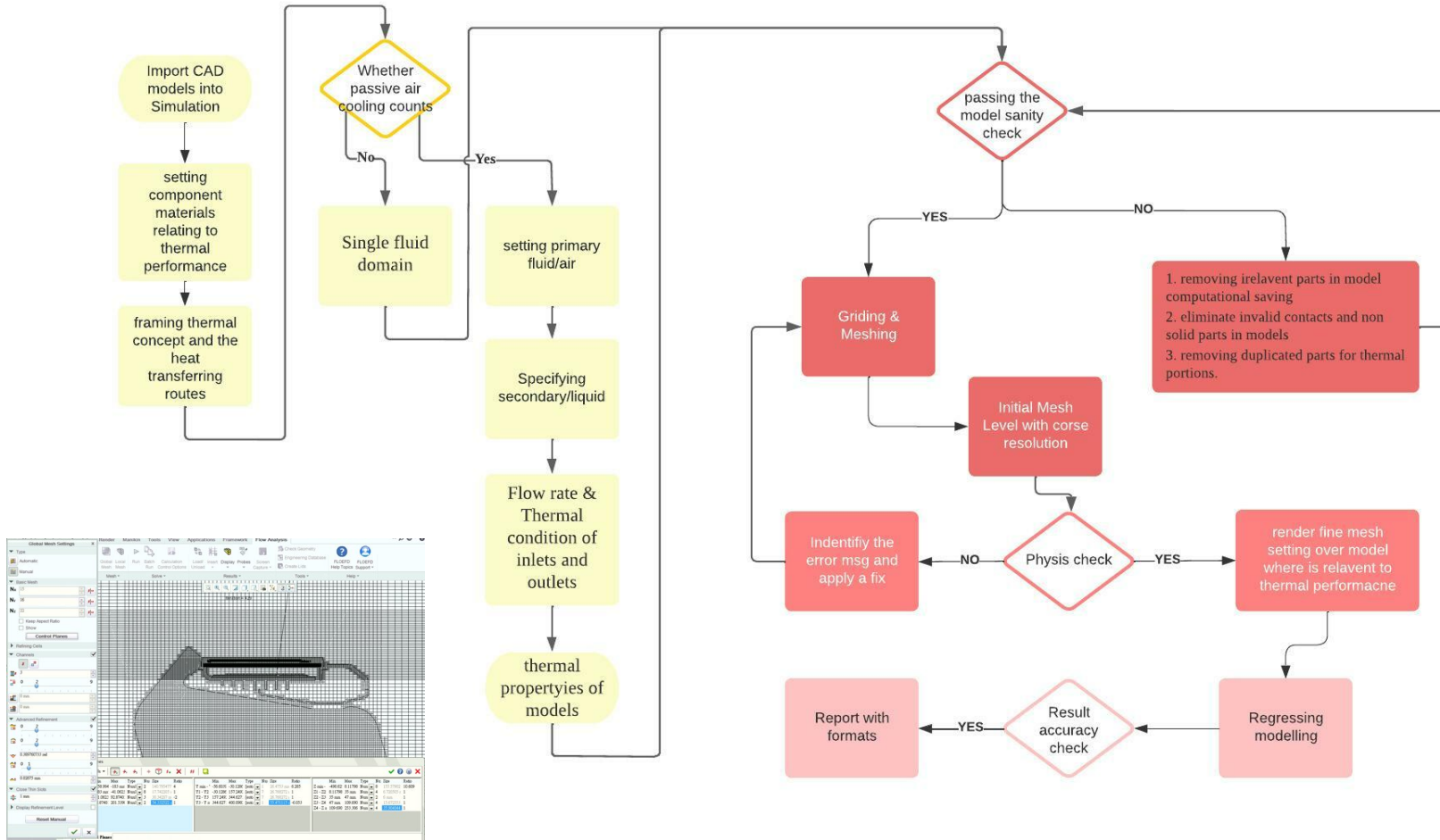


Film Boiling

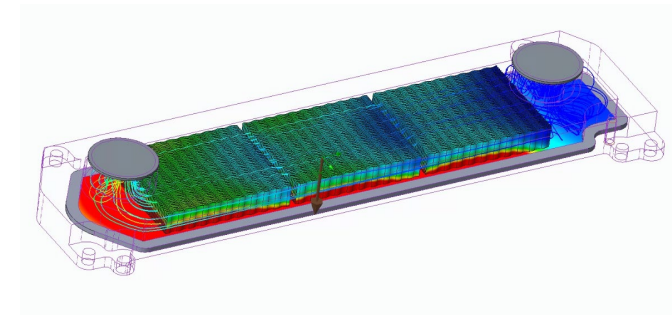
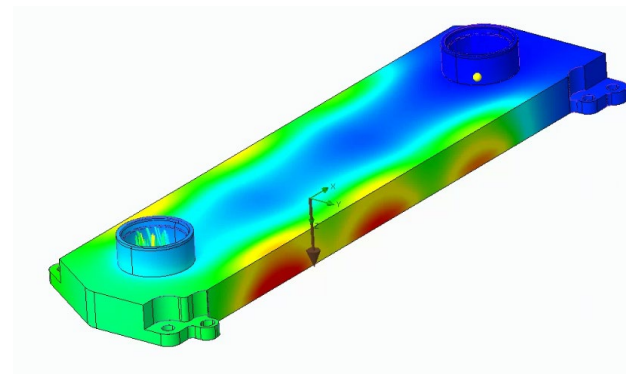
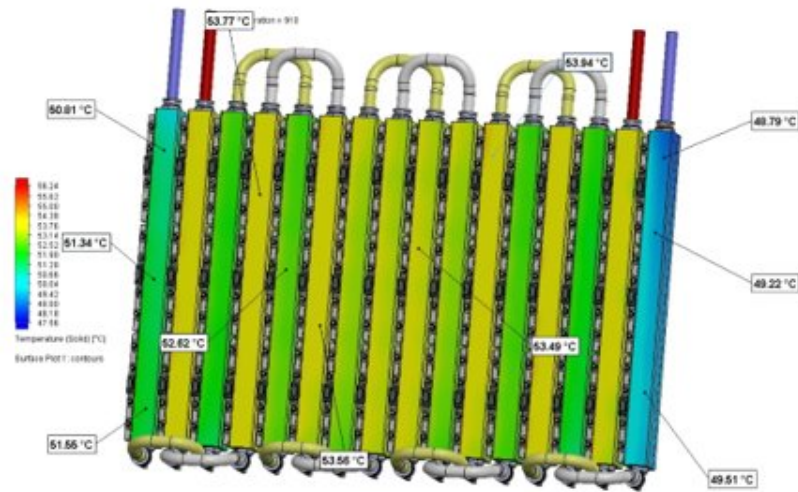
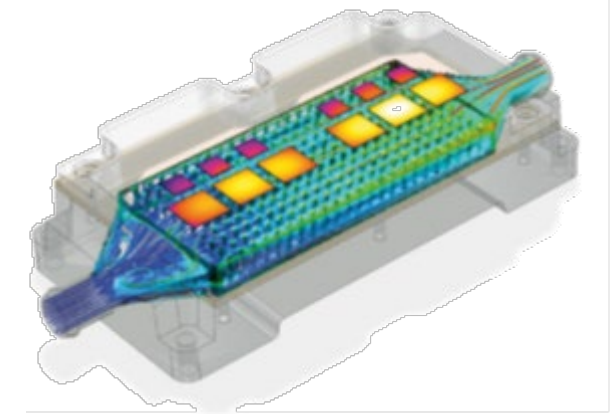
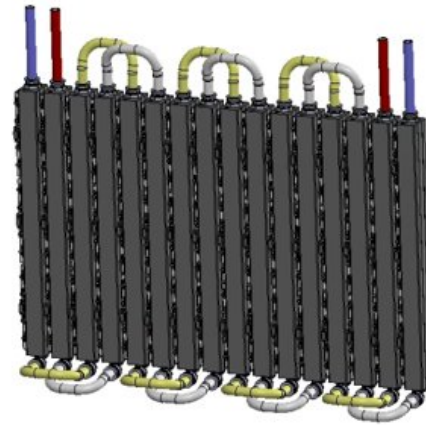
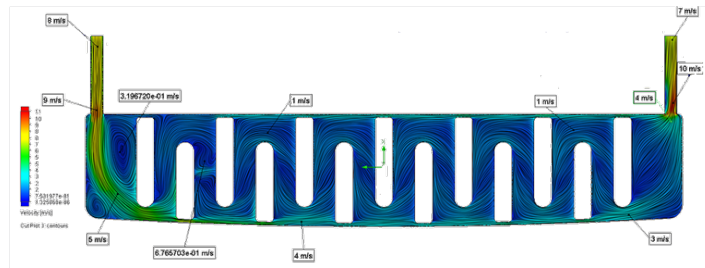
Pool Boiling Regimes

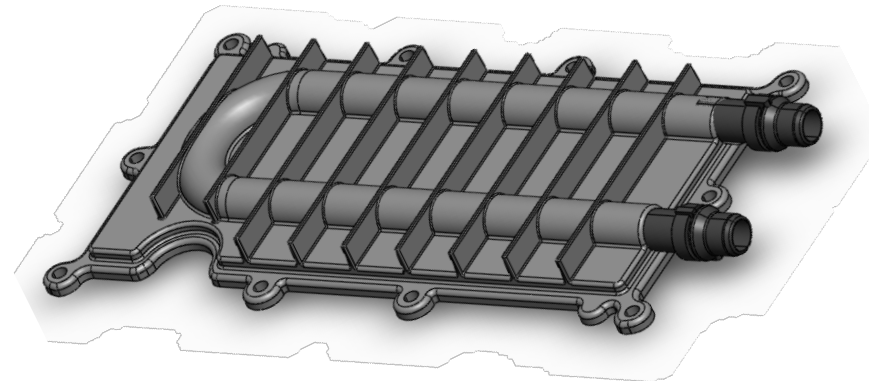
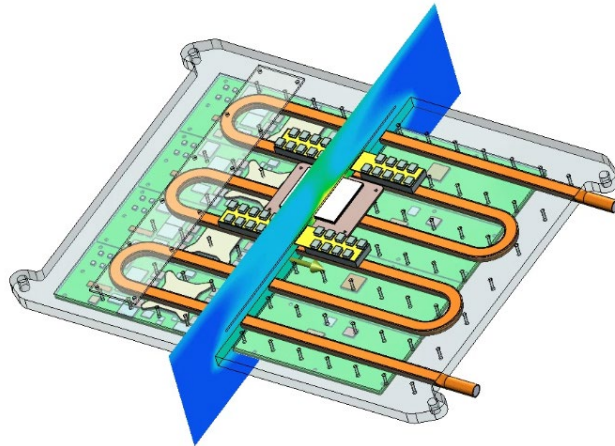
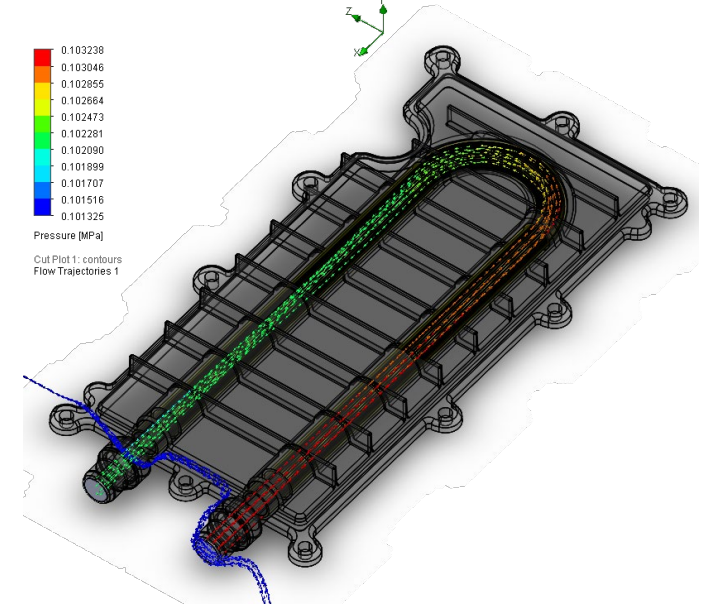
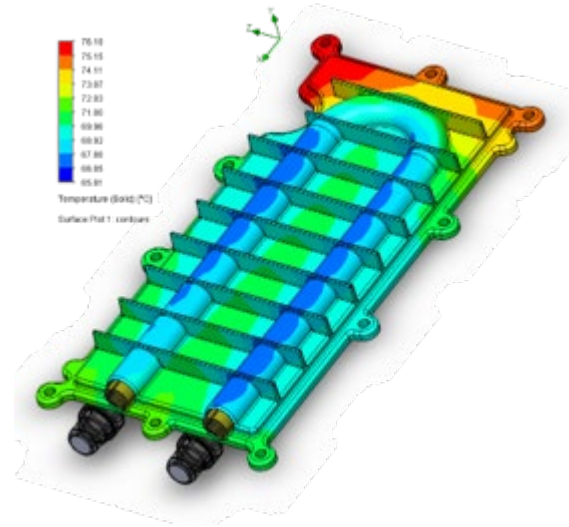
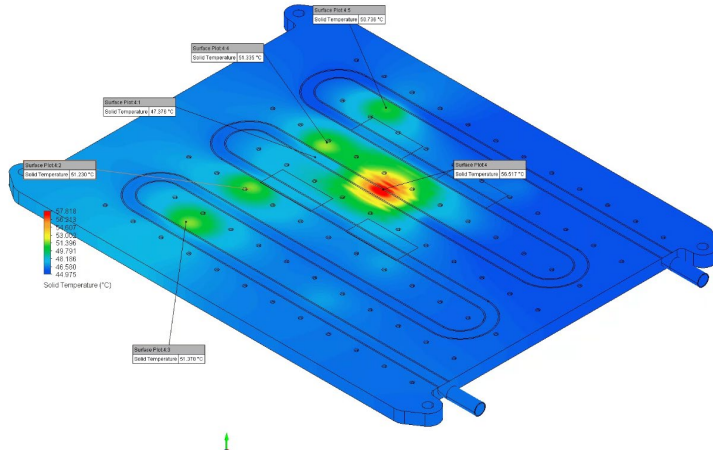


Design Flow(Liquid Cooling)

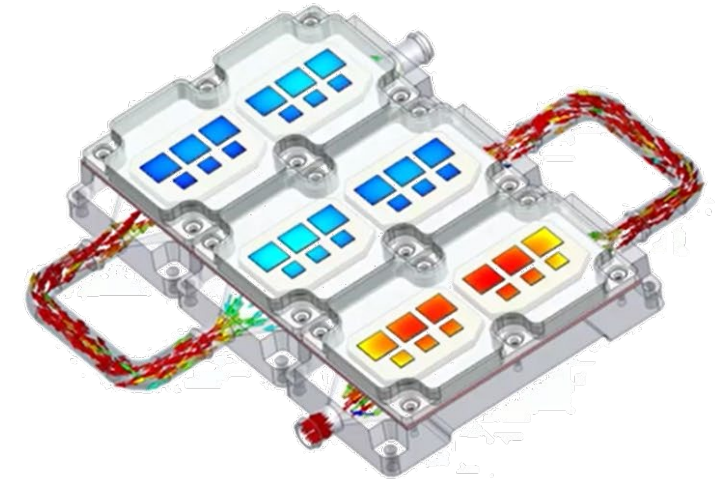
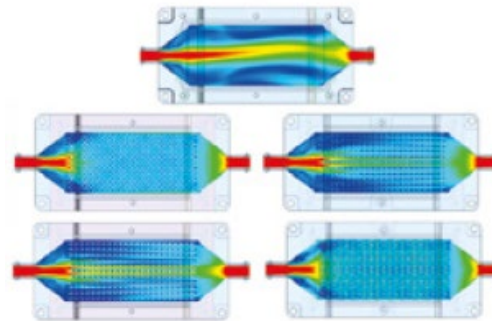
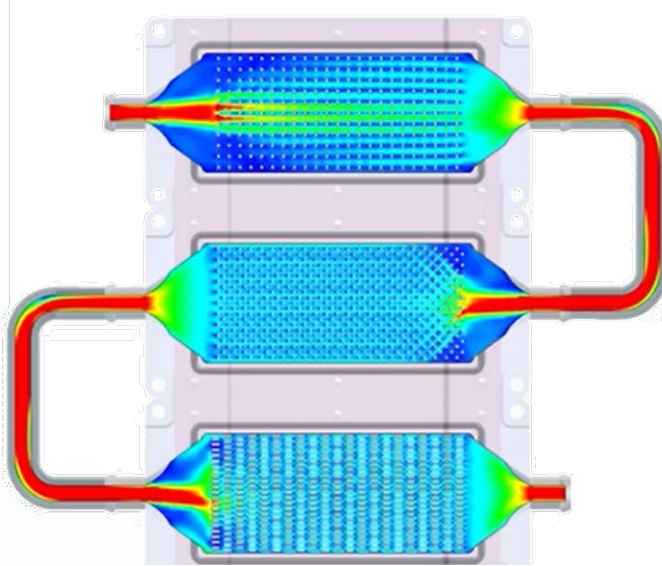
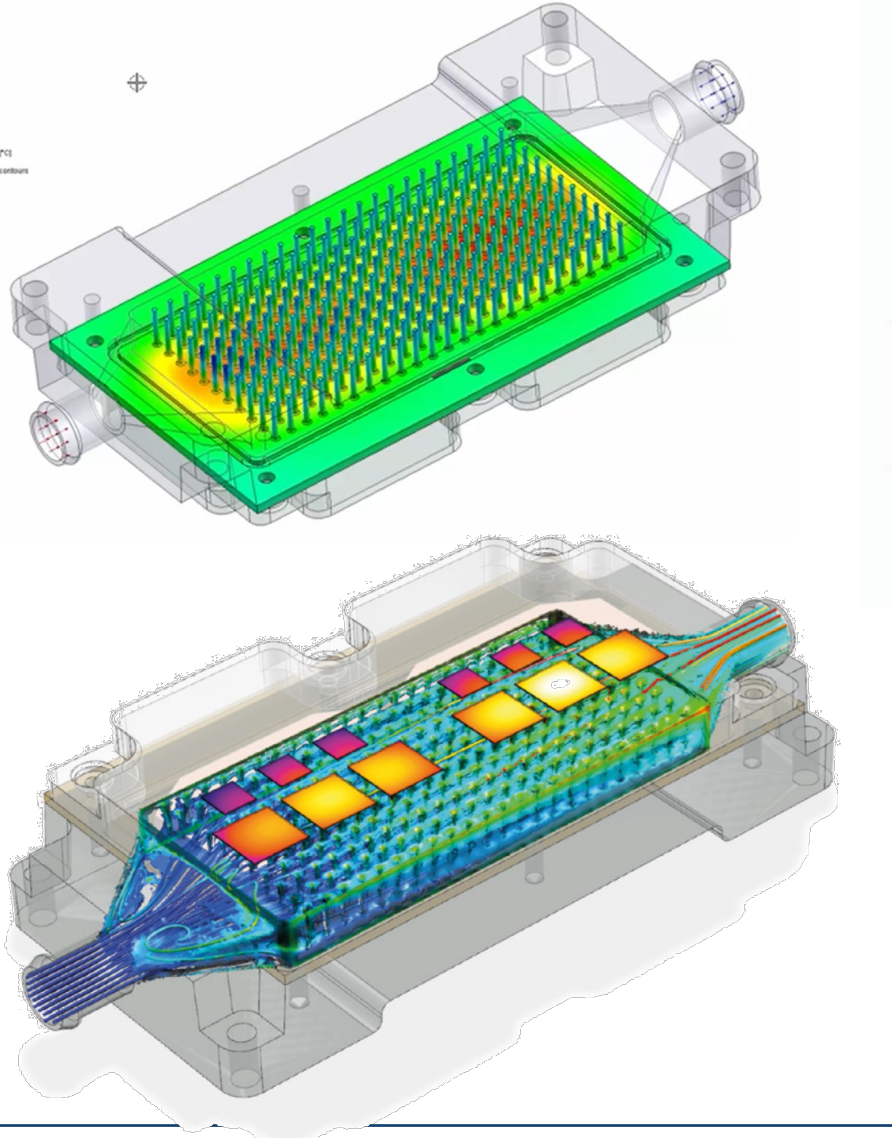
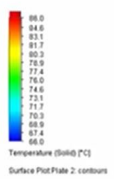


Liquid cooling(cold plates)



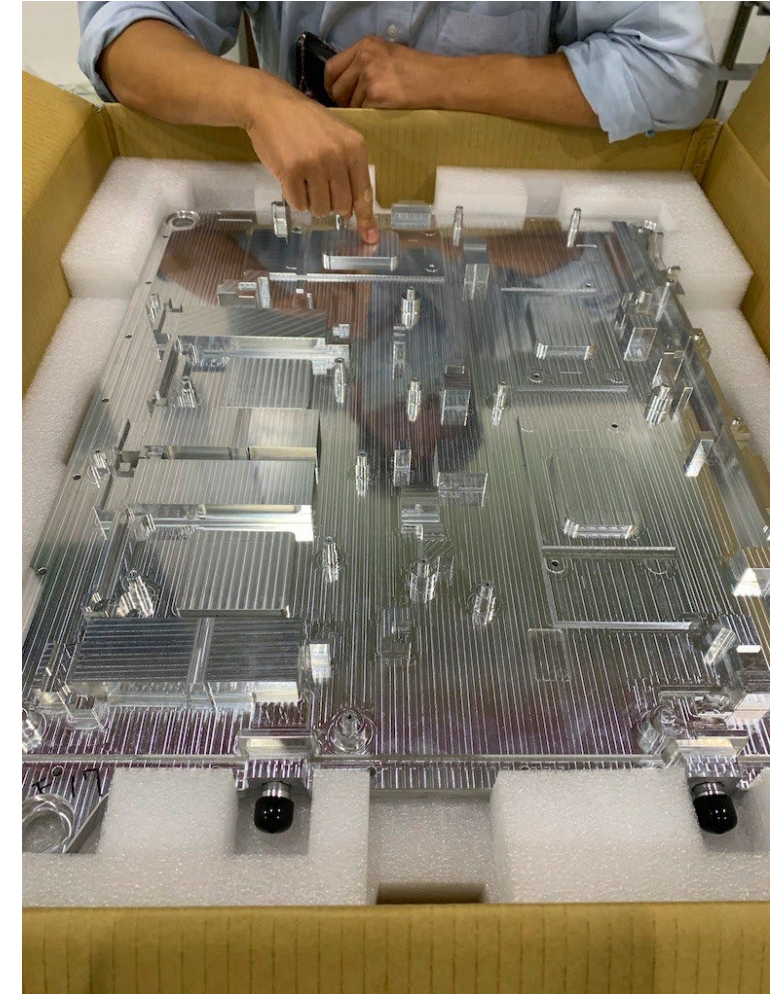


Automotive IGBT cooling module

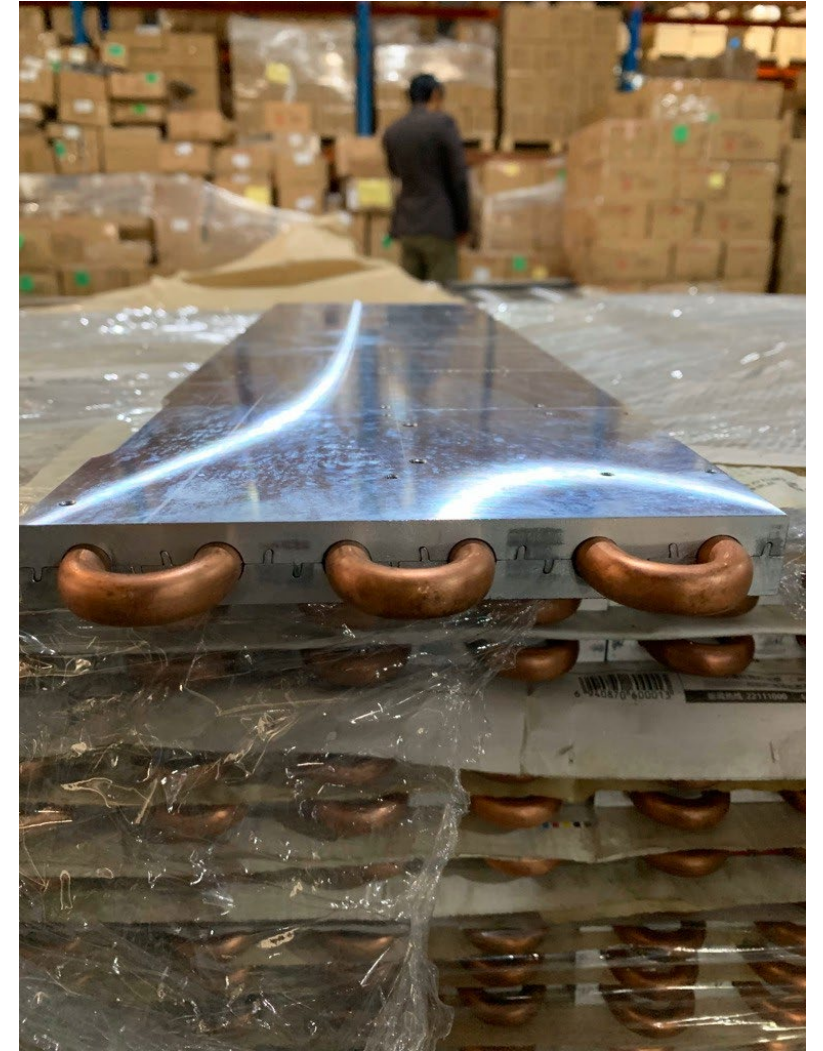
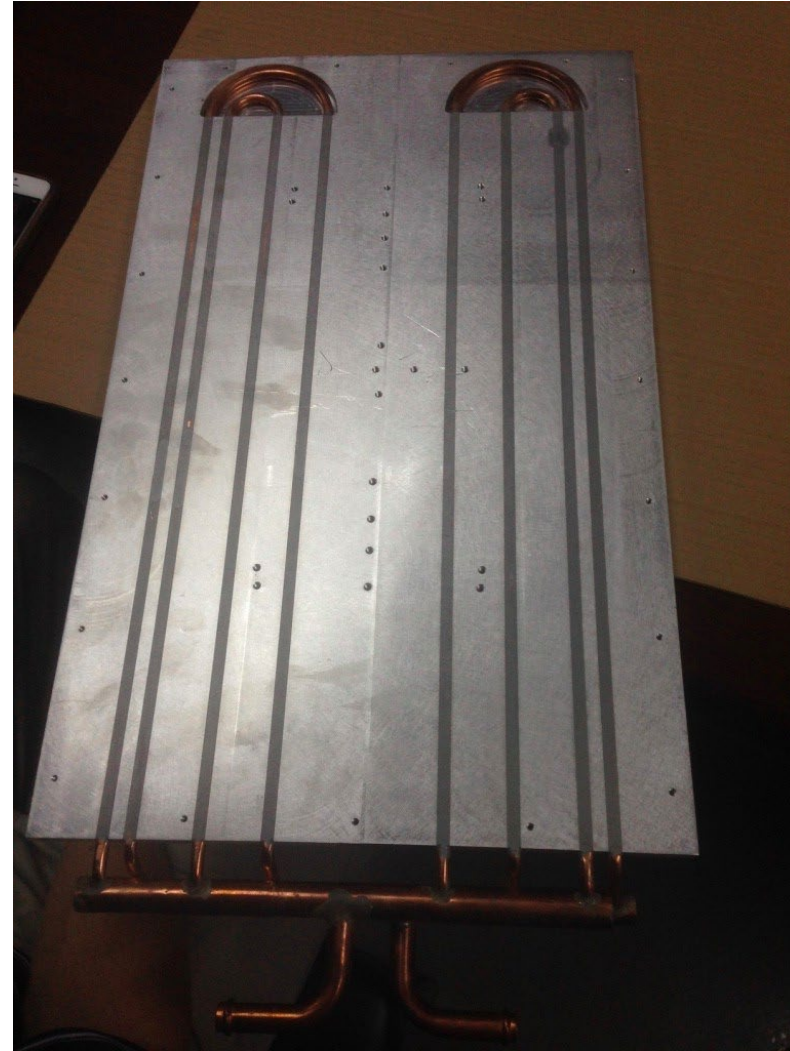


- Water cooling for IGBT modules
- Velocity
- Pressure drop
- IGBT temperature

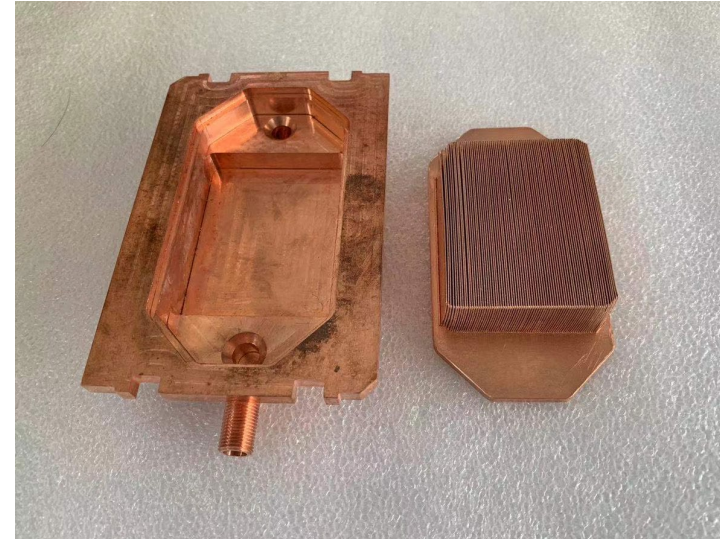
Appendix – Cold plate Type



Cold Plate Type #2



CPU liquid cooling



(CAB brazing)

AL Brazing



(Vacuum brazing)

AL Vacuum Brazing



FSW



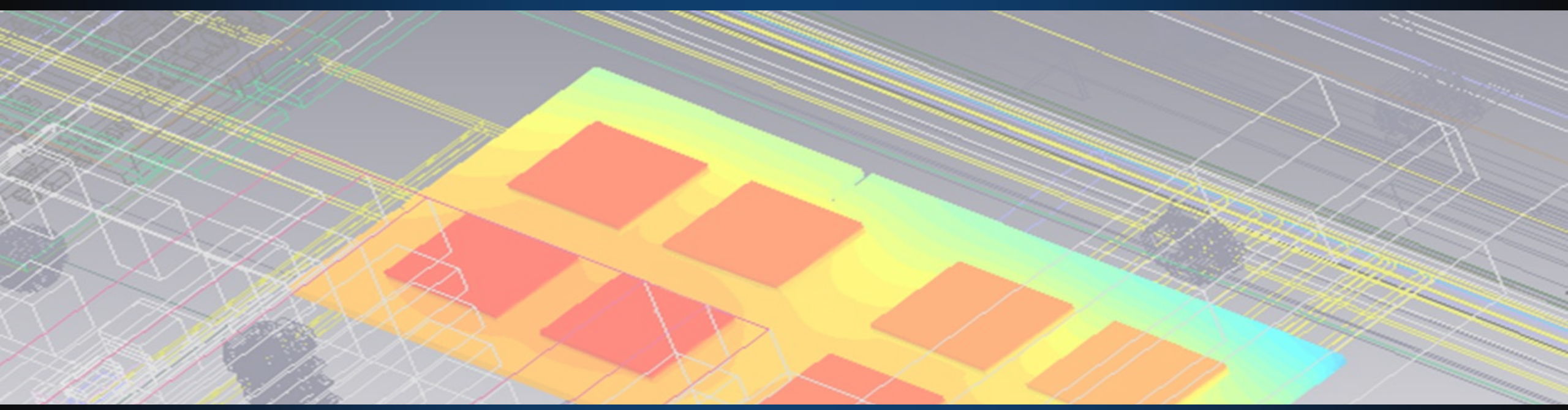
The Material vs. Manufacturing Process

Material	Mfg. Process	Al Vacuum Brazing	FSW	
Plate	Al 3003	Flow path design reinforcer	Turbulator/Folded fin/Stacked fin	Pin fin/turbulator
		Pre-brazing temper	H18	H18
		Post-brazing temper	O	H18
		Heat treatment	N (not heat treatable)	N (not heat treatable)
		Post-HT temper	x	x
	Al 6061	Flow path design reinforcer	Turbulator/Folded fin/Stacked fin	Pin fin/Turbulator
		Pre-brazing temper	T6	T6
		Post-brazing temper	O	T6
		Heat treatment	Y	N
		Post-HT temper	≅T6 (better machinability)	T6
	Al 6063	Flow path design reinforcer	Turbulator/Folded fin/Stacked fin	Pin fin/turbulator
		Pre-brazing temper	T5/T6	T5/T6
		Post-brazing temper	O	T5/T6
		Heat treatment	Y	N
		Post-HT temper	T5	T5/T6

The Material vs. Mfg. Process (cont'd)

Material		Mfg. Process	Al Vacuum Brazing	FSW
Casting	44300	Flow path design reinforcer	Not applicable	Pin fin/groove
		Pre-brazing temper		Not required
		Post-brazing temper		Not required
		Heat treatable		Not required
		Post-HT temper		Not required
	ADC12	Flow path design reinforcer		Pin fin/groove
		Pre-brazing temper		Not required
		Post-brazing temper		Not required
		Heat treatable		Not required
		Post-HT temper		Not required

- (1) Nitrogen high pressure test: 35PSI/5minutes , criteria<0.35PSI (to test the structural strength)
 - (2) Ultrasonic flaw detection test: to test the brazing penetration rate of the product
 - (3) Pressure drop test: make sure the flow path is not blocked
 - (4) Vacuum baking: make sure the flow path is free of water which may affect the leak test result
 - (5) Helium leakage test: 220kPa/5min ,MAX 0.0018 SCCM (to test the micro leakage rate)
 - (6) Nitrogen pressure holding test: 80KPa/12hrs pressure loss<4KPa(5%)
-



• **Thank You** •

your thermal selection