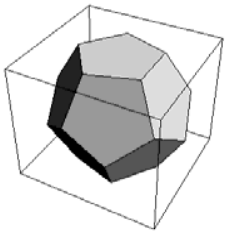
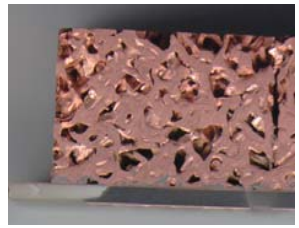




OZER ADVANCED TECHNOLOGIES

Mechanical, Materials and Thermal Engineering
Advanced Thermal Solutions, Reticulated Metal Foams,
Microelectronics, RF and Power Electronics Packaging
Thermal and Structural Reliability Analysis

Dr. Burhan Ozmat

Principal

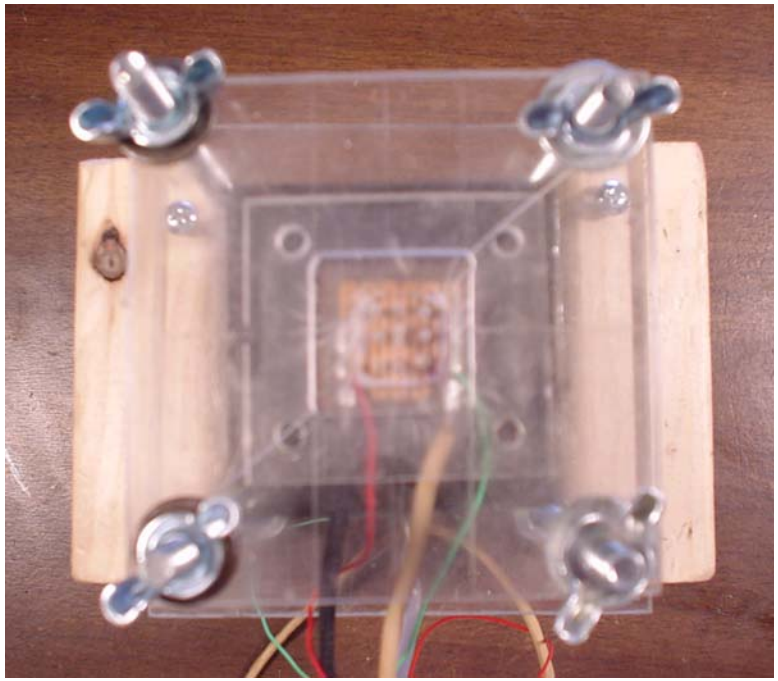
53 Helderhill Road, Voorheesville NY 12186

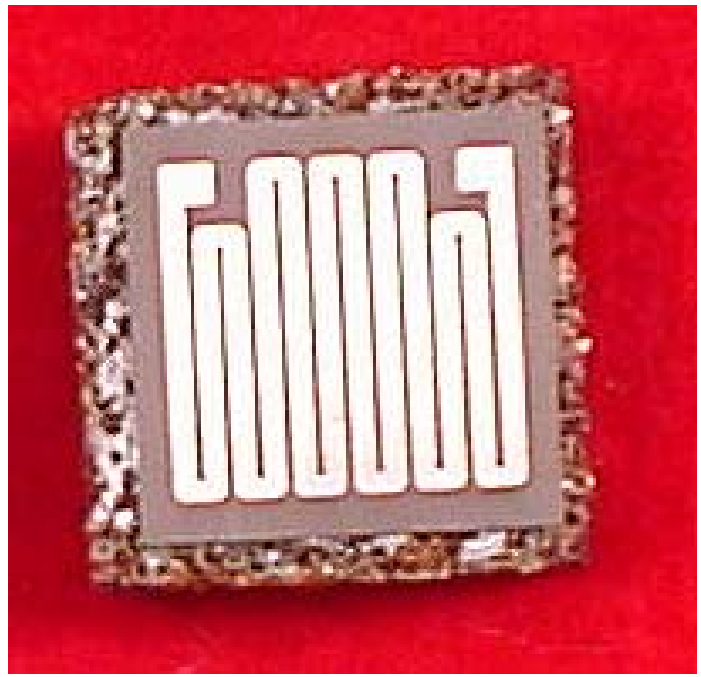
Tel: (518) 765-3803 Fax: (518) 765-9005 Cellular (518) 330-6120

In house capabilities:

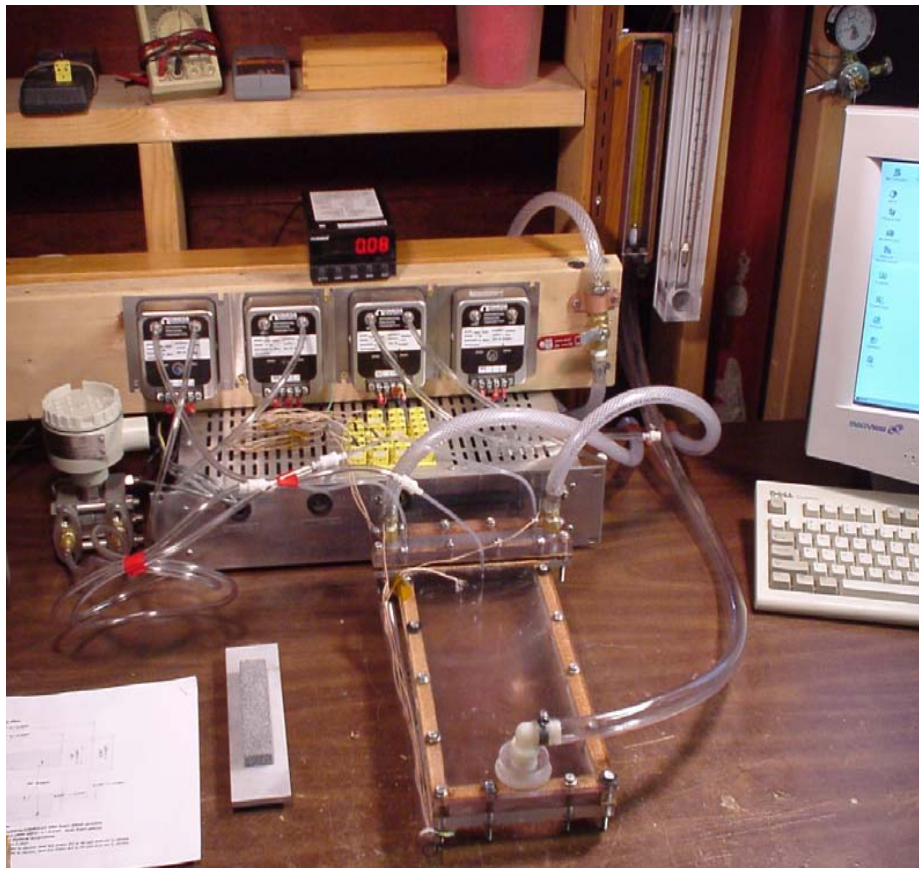
- Heat Transfer and Fluid flow laboratory services.
- Large scale computerized data acquisition and processing;
- High temperature, inert atmosphere brazing, soldering
- FEA (Structural and Thermal), CFD, CAD
- Metallurgical sample preparation, optical microscopy
- Model shop to fabricate prototypes fixtures and articles (NC milling, NC EDM, drilling, cutting).

Characterizing thermal performance :





Characterizing thermal performance :



CROSS/COUNTER FLOW HX UNIT UNDER TEST

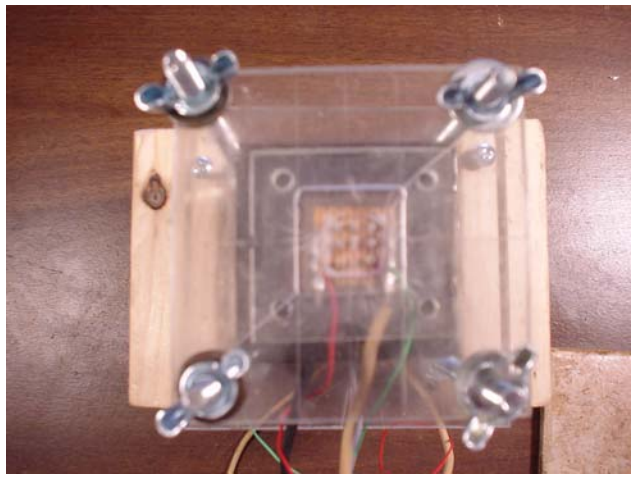
Characterizing thermal performance :

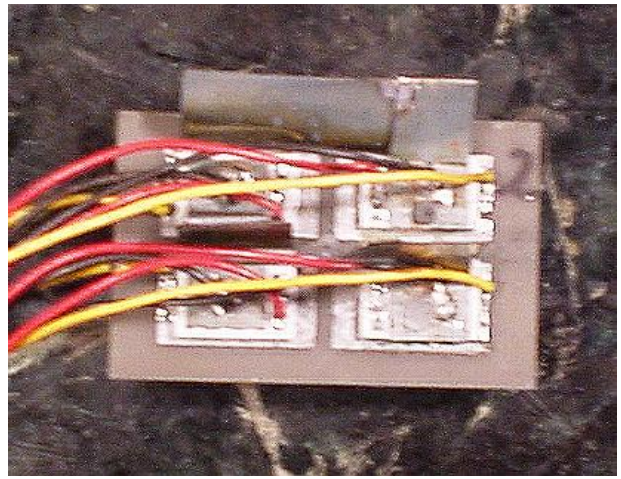
RMF Based 1KW Air to Liquid HX, 0.3 lb, 5.3 in^3 (0.003 ft^3)

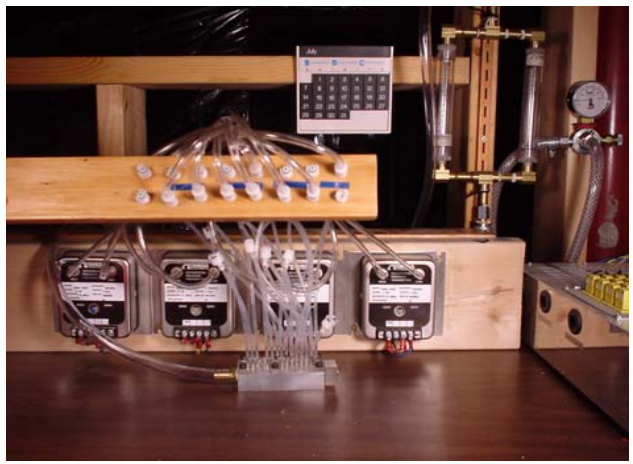
Characterizing thermal performance :

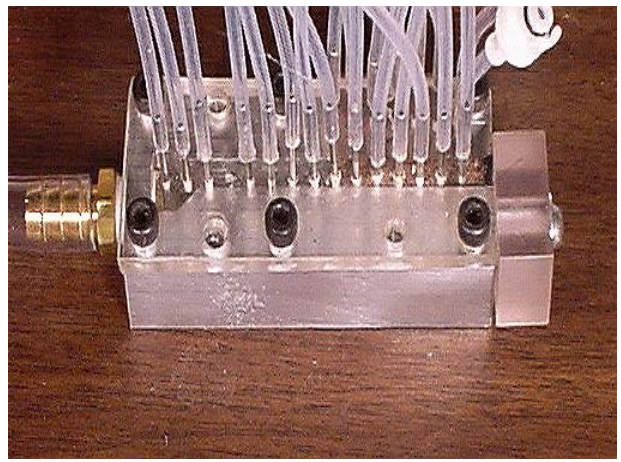
COUNTER FLOW HX UNIT UNDER TEST

Characterizing thermal performance :



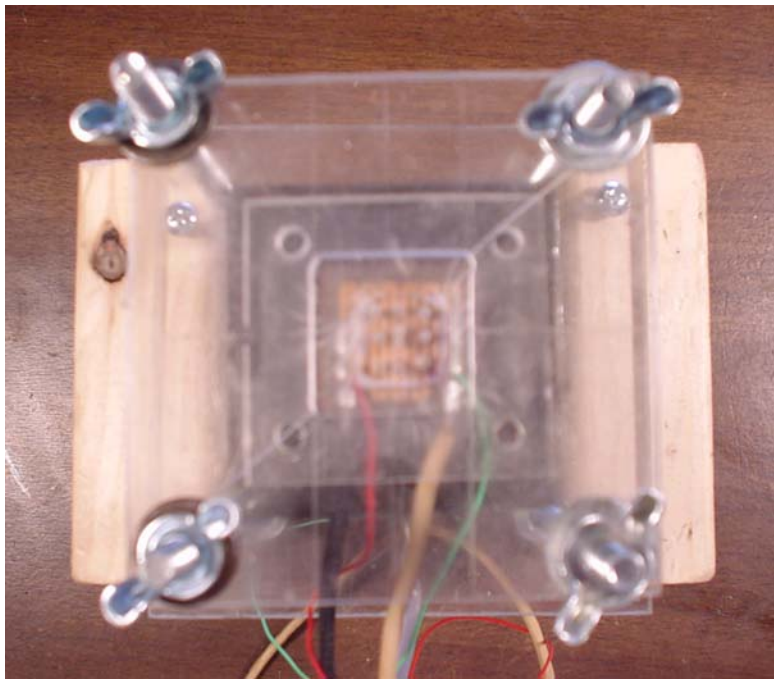


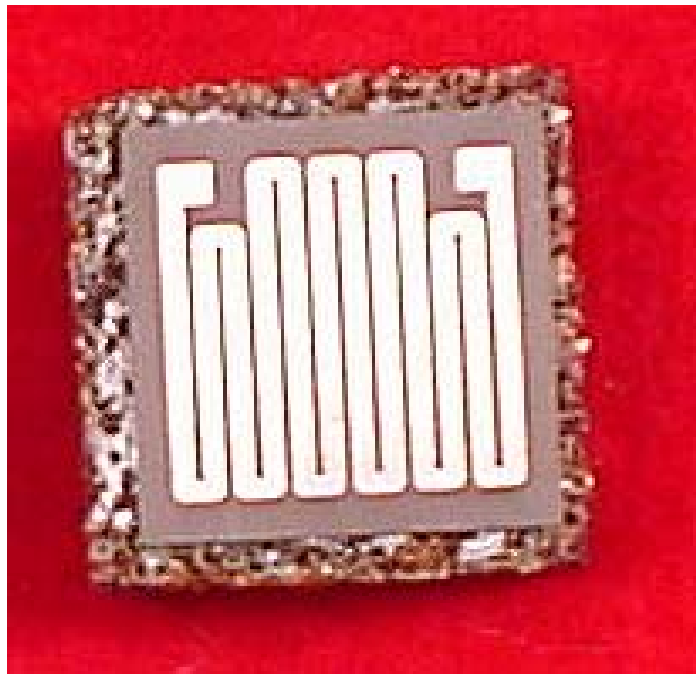




Thermal performance characterization- Power Electronics and Server applications

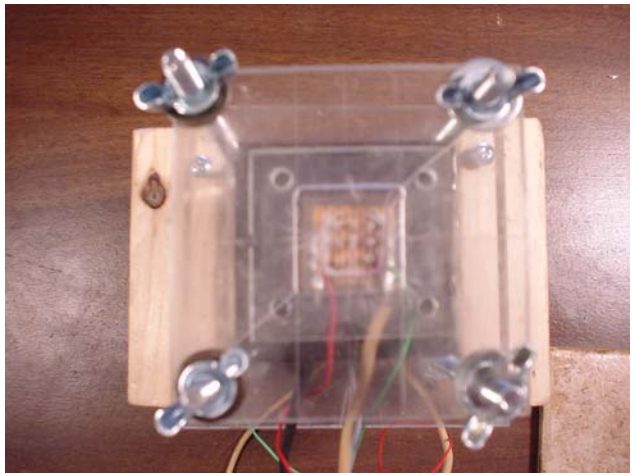
Characterizing thermal performance :

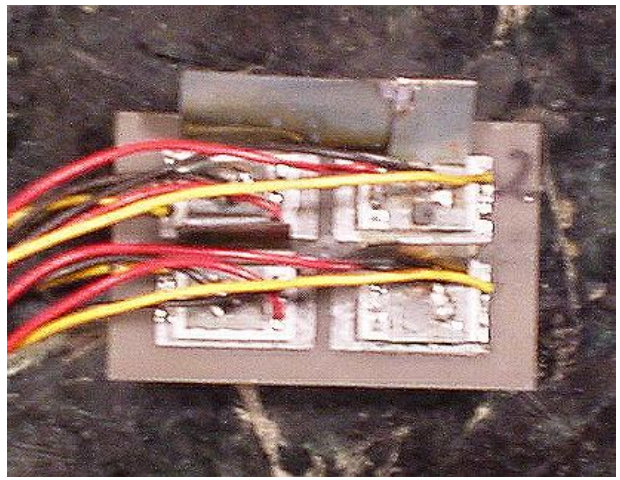


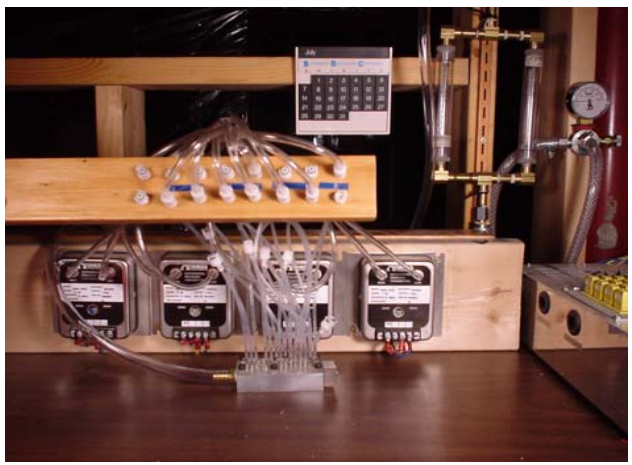


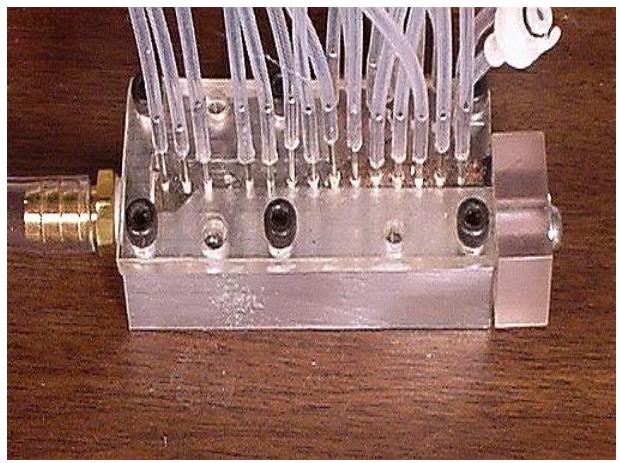
Cu foam HX for a 8 CPU server application under test
Metalized AlN resistor simulates Thermal load

Characterizing thermal performance :









Applications:

- Power modules
- Microprocessors
- MCM
- Smart skins
- Secondary HX.

Advantages:

- Delaying transition to water cooling
- Improved size, performance, system reliability
- Ease of upgrading electronics on existing platforms
- Reduced system cost/performance

Advantages of Metal Foam HX $$$

- Reduced spacing between processors.
- Shorter bus lengths,
- Simpler design
- Lower loses
- Increased timing and noise margins
- Increased processor speed (duty factor)
- Increased performance
- Lower Cost/Performance indice
- Lower chasis volume, weight and cost
- More added value and higher profit margin (DB Slots)
- Higher system reliability

Advantages of Metal Foam HX $$$

- Thermal performance of Power Modules ↑ by ≈ 2.5X
  - Lower T_j ⇒Improves reliability,
  - Device ratings increase , ⇒ less Silicon, lower cost
  - Package power devices more closely ⇒
    - Smaller module size/performance
    - Lower weight/performance ,
    - Lower material cost

- Ldi/dt is reduced ⇒(lower V_b rating)
  - Higher device efficiency & lower device cost
  - Faster switching ⇒ smaller filter C and L ($,Lb)

Characterizing thermal performance :

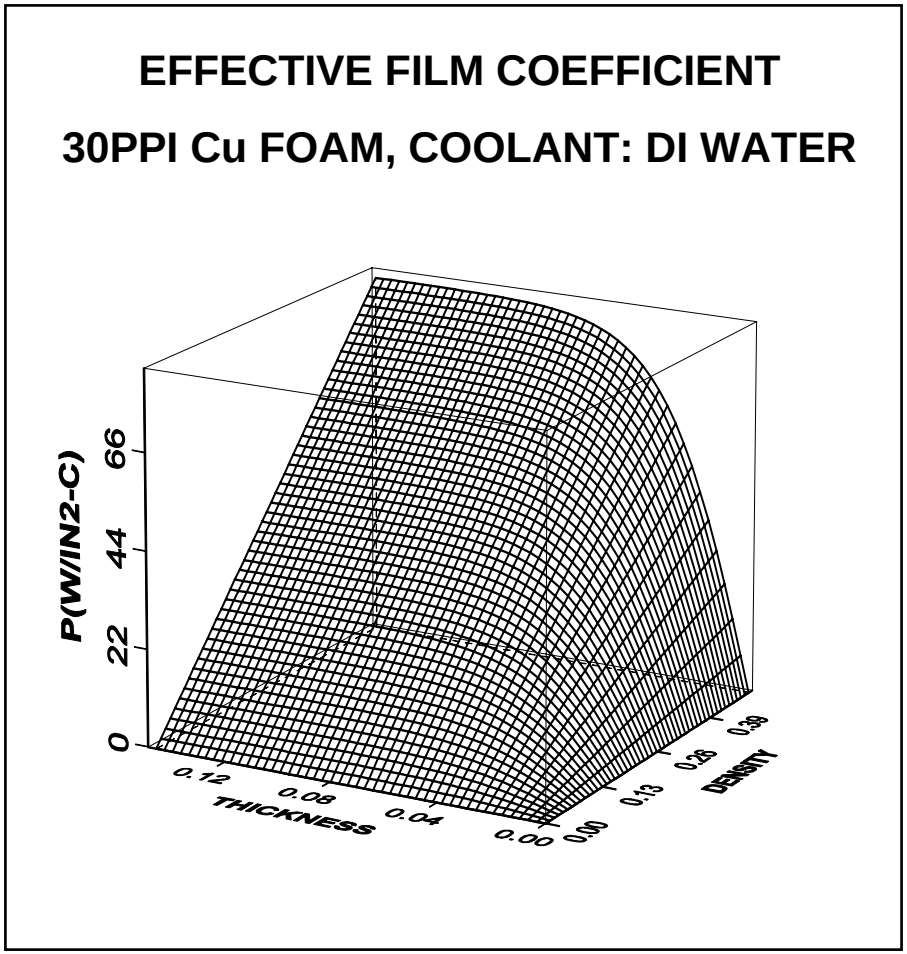
Results of the experiments and 3D FEAs of various power module configurations

		AREA (In^2)	HEAT SPREADER	HEAT SINK	ΔT_{max} (^oC)	R_{ja} ($^oC/W$)	$P_{max.}$ $\Delta T=60\ ^oC$
1	**C**	10.2	AlSiC - 0.100"	EXTERNAL	178	0.127	470
2	**C**	10.2	AlSiC - 0.200"	EXTERNAL	163	0.116	515
3	**C**	10.2	AlSiC - 0.200"	EXTERNAL	150[s]	0.107	560
4	**C**	10.2	CuMo - 0.200"	EXTERNAL	147	0.105	571
5	**C**	10.2	CuMo - 0.200"	EXTERNAL	129 [s]	0.092	651
6	**C**	10.2	CuMo - 0.100"	EXTERNAL	164	0.117	512
7	**C**	10.2	CuMo - 0.100"	BAFFLED CAVITY	121	0.086	694
8	**C**	10.2	CuMo - 0.100"	INTEGRAL	70	0.050	1,200
9	**C**	10.2	Cu - 0.150"	EXTERNAL	137	0.980	613
10	**C**	3.2	NONE	EXTERNAL	264	0.189	318
11	**C**	3.2	NONE	BAFFLED CAVITY	162	0.116	519
12	**C**	3.2	NONE	INTEGRAL	60	0.043	1,400
13	**E**	3.2	NONE	BAFFLED CAVITY	75 ^{o}C @ 800W	0.095	640
14	**E**	3.2	NONE	EXTERNAL	95 ^{o}C @ 800W	0.120	505
15	**E**	3.2	NONE	INTEGRAL-40ppiAl-10%	86 ^{o}C @ 800W	0.108	560
16	**E**	3.2	NONE	INTEGRAL-40ppiAl-20%	69 ^{o}C @ 850W	0.080	740
17	**E**	3.2	NONE	INTEGRAL-40ppiAl-36%	47 ^{o}C @ 850W	0.059	1020
18	**E**	3.2	NONE	INTEGRAL-40ppiCu-40%	38 ^{o}C @ 800W	0.047	1265
19	**E**	3.2	NONE	INTEGRAL-40ppiCu-40%	63 ^{o}C @ 1000W$^{E/G}$	0.063	950
20	**E**	3.2	NONE	INTEGRAL-40ppiCu-40%	35 ^{o}C @ 500W^{EO}	0.070	860

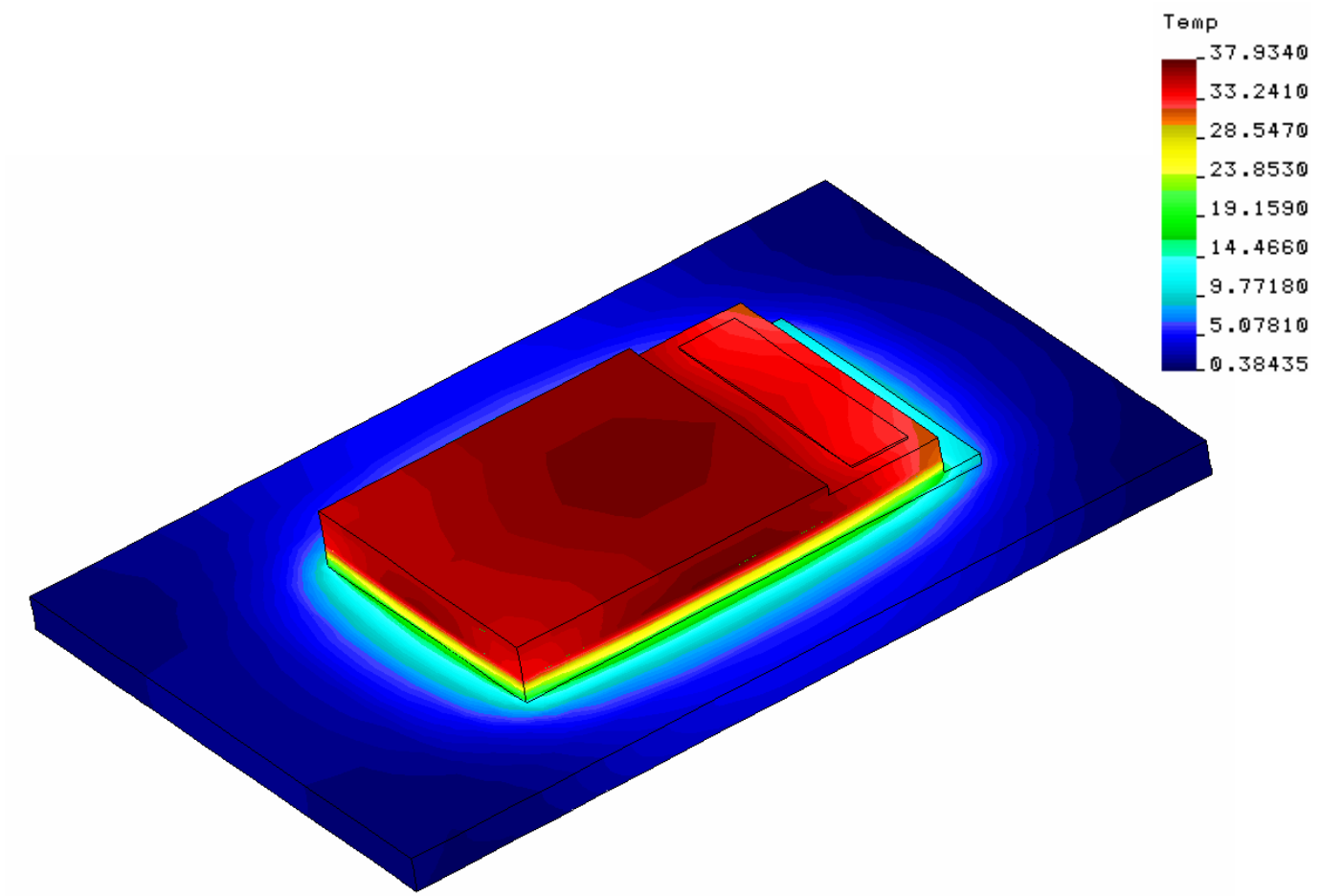
E :Experimental, C:Calculated,

E/G: 50% Water-Ethylene Glycol mixture , EO : Motor Oil, Castrol 399

Characterizing thermal performance :

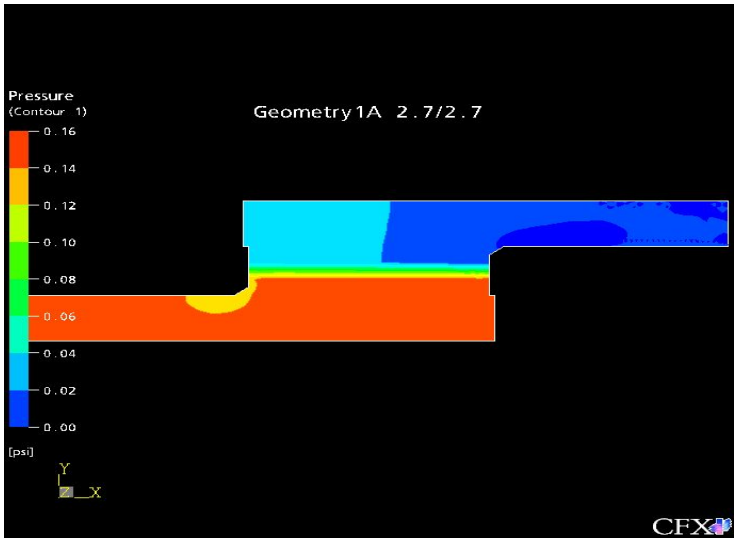


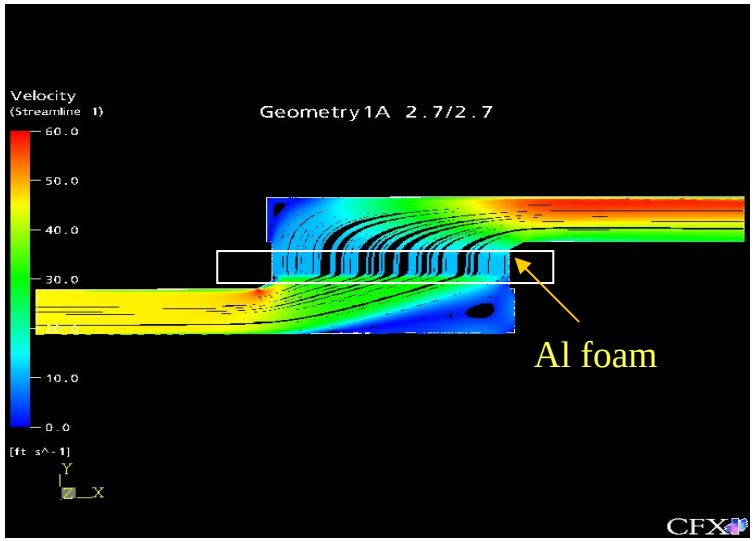
An experimental study of RMF based HX

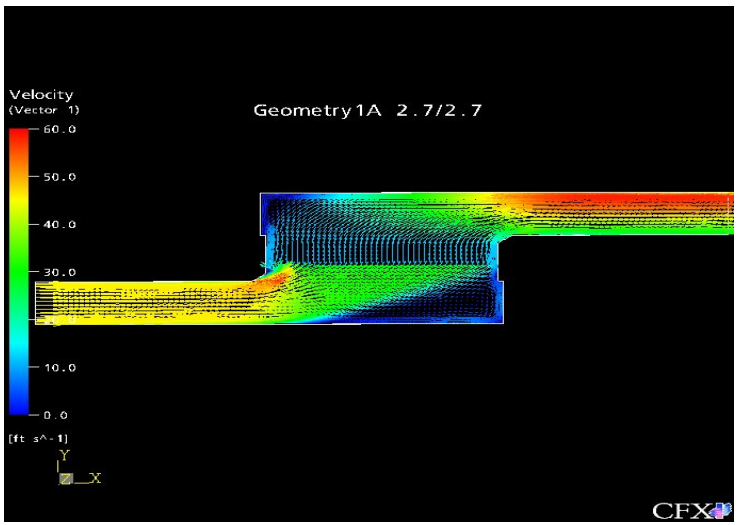


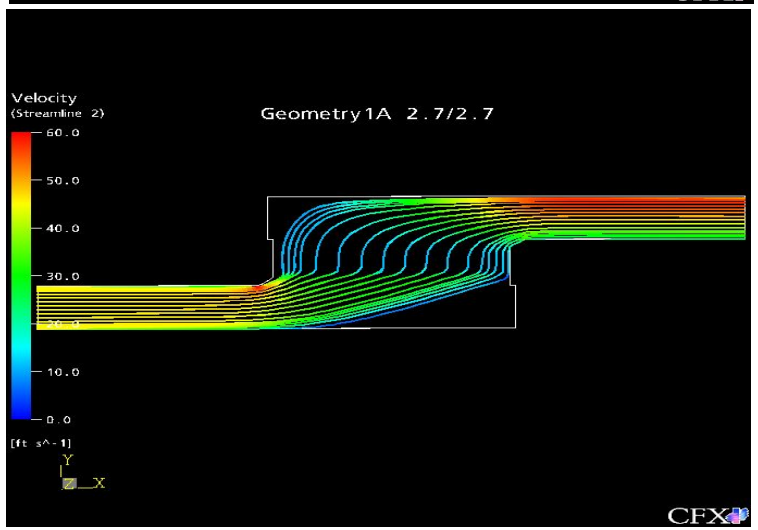
CFD analysis of angled flow through Aluminum RMF

Air temperature: 80 F; Length scale = 0.008”; Inlet flow = 160 cfm









In house capabilities

NC EDM (top left), (5) axis NC Machining (lower right) and Milling (upper left)