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ltcm

Two-Phase Microchannel Thermosyphon Cooling System for Blade/2U Servers

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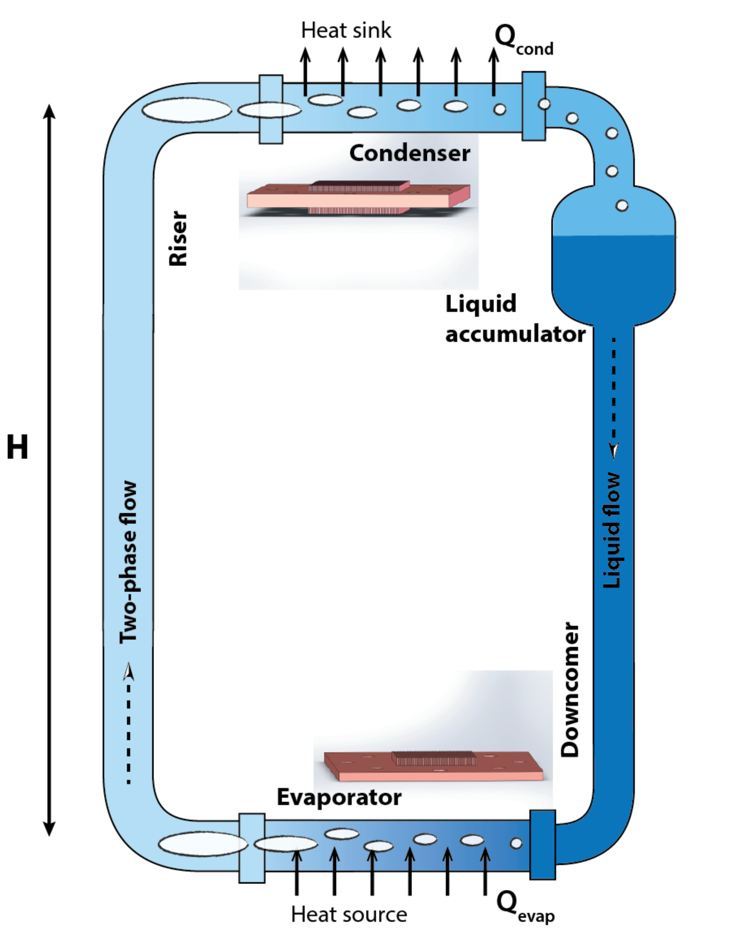
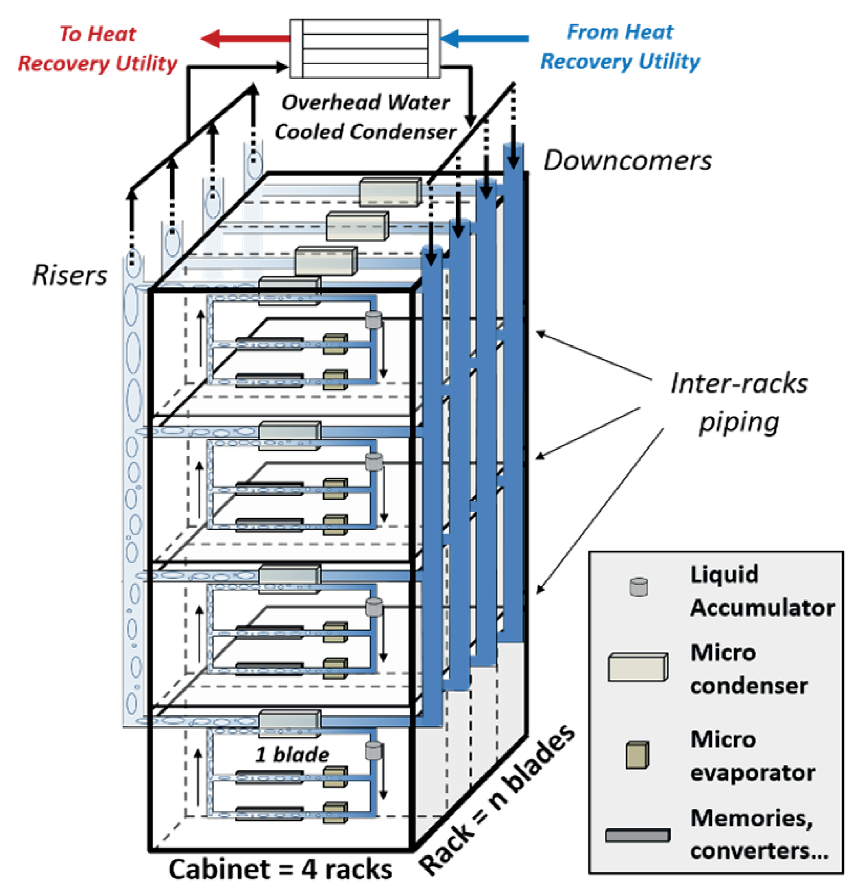
1 - Context and Motivation

Air TO On-chip 2phase TO Thermosyphon cooling in DC

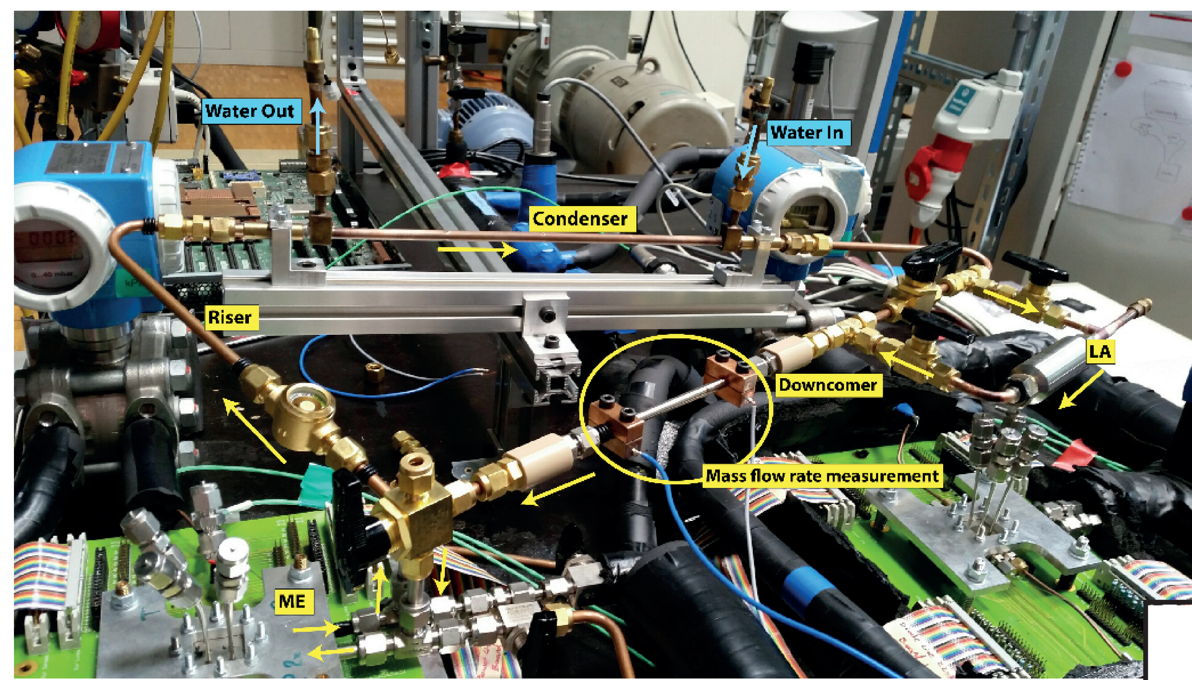
- Better cooling performance
- Reduce the power consumption
- Allow the reuse of evacuated heat

- Gravity driven
- No power consumption
- Passive system control



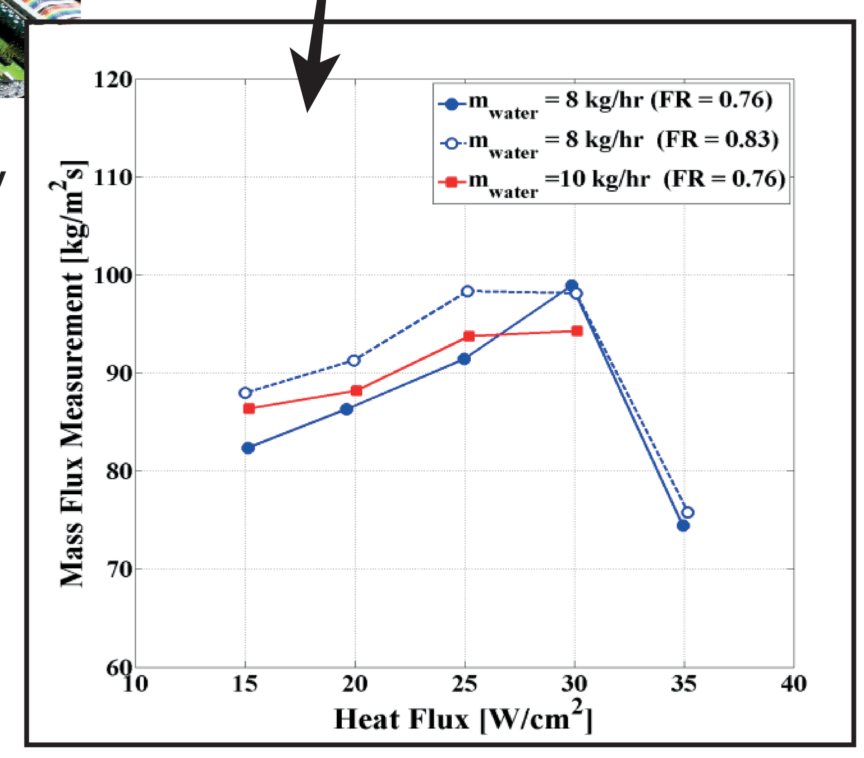


2 - Experimental Test bench and Results



New non intrusive low mass flow rate measurement with an accuracy of about 8%

--> Decisive for comprehension of phenomena ruling mini thermosyphon systems

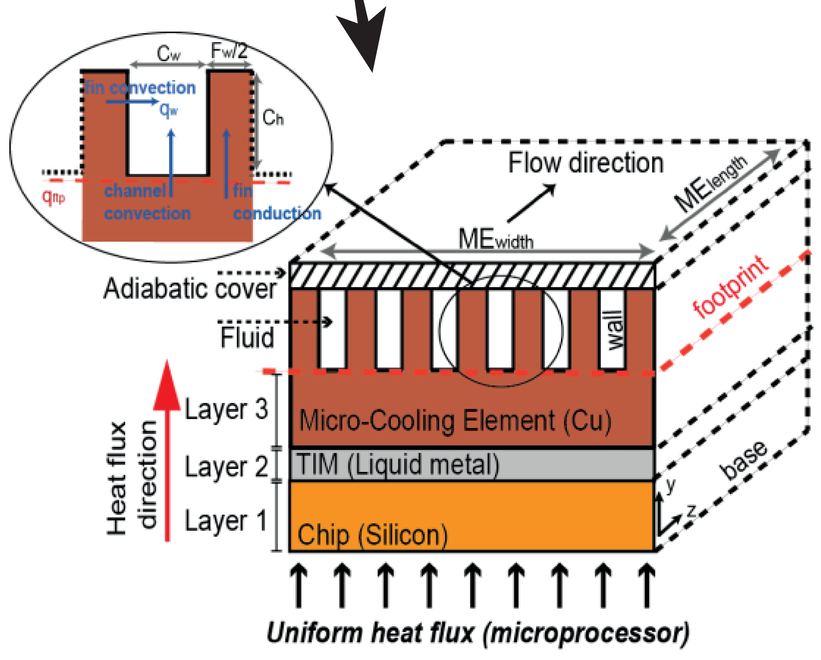


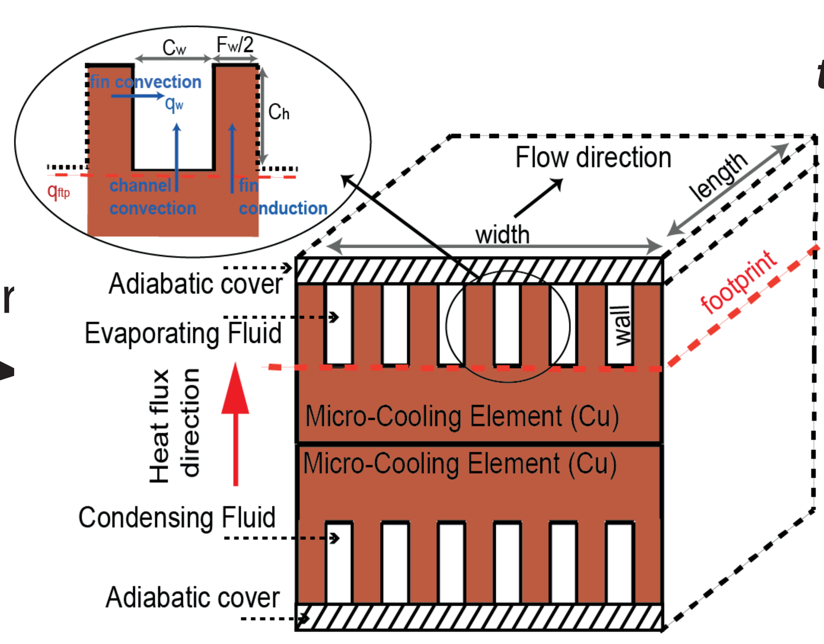
- Carry heat 15cm vertically and 20cm horizontally
- Uniform Heat Fluxes tested up to 61W/cm²
- Filling ratio from 60 to 83% (36 to 56g of R134a)
- Condenser Water flow rate from 6 to 12kg/h
- Condenser Water temperature from 12 to 40°C

--> Promising results achieved with heat sink performance similar as in pump mode and total system thermal resistance of about 0.17 K/W.

3 - Dynamic Modeling and Validation

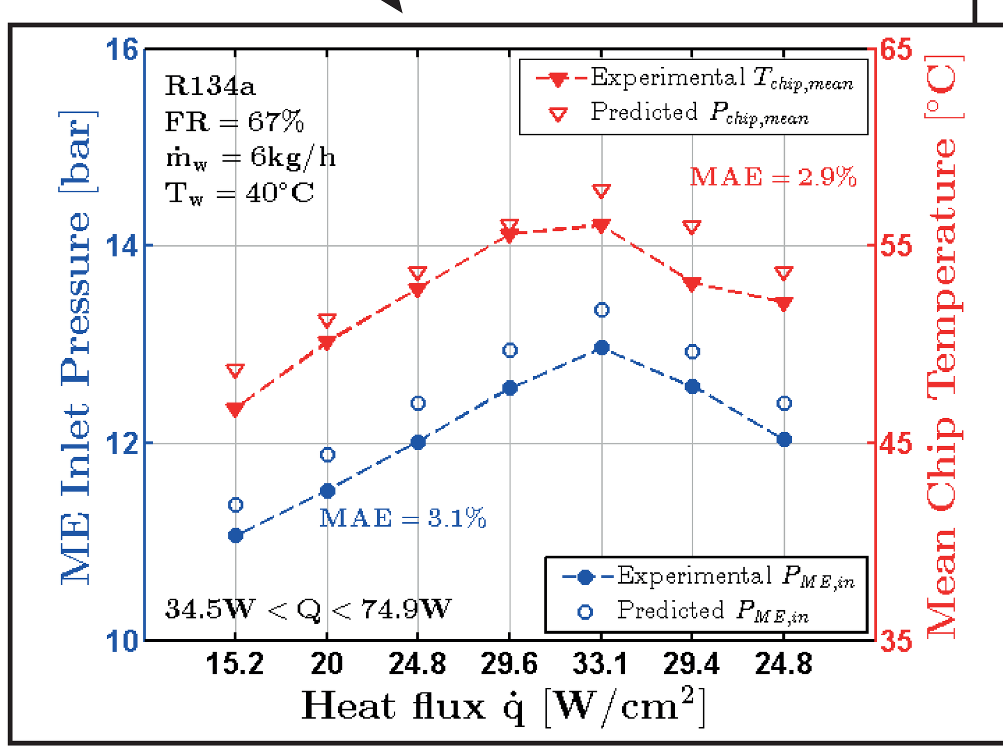
- 1D Homogeneous flow model
- Thermodynamic equilibrium
- 2D conduction in ME package
- Lumped capacitance in accumulator
- PDEs in heat sink, piping and condenser

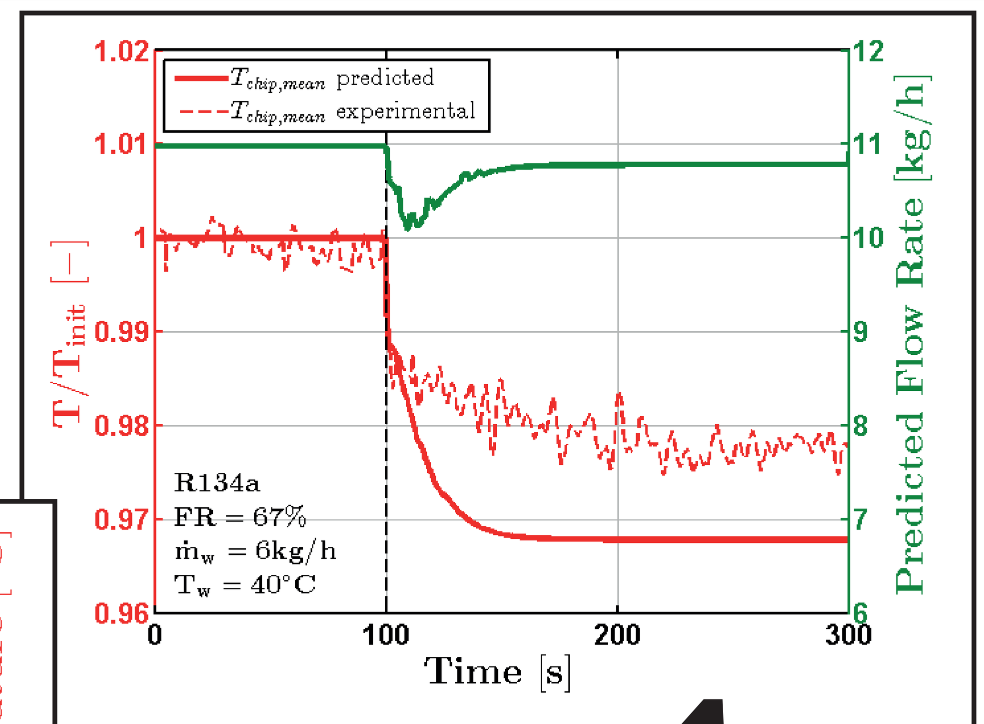




- Entire system modeled
- Best available HTC and ΔP methods
- Fin equations implemented
- Flow rate based on ΔP balance
- Semi-implicit LSODE solver used

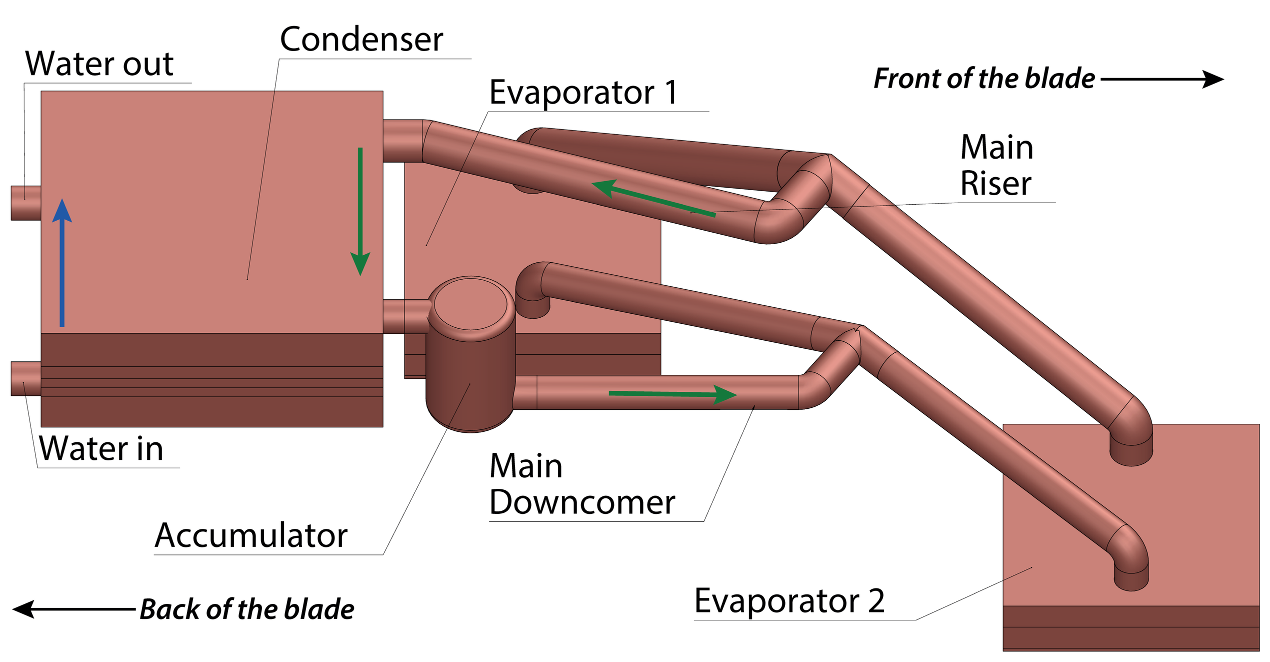
--> 6 steady-states predicted with MAE of 2.9 and 3.1% respectively for mean chip temperatures and heat sink inlet pressure.

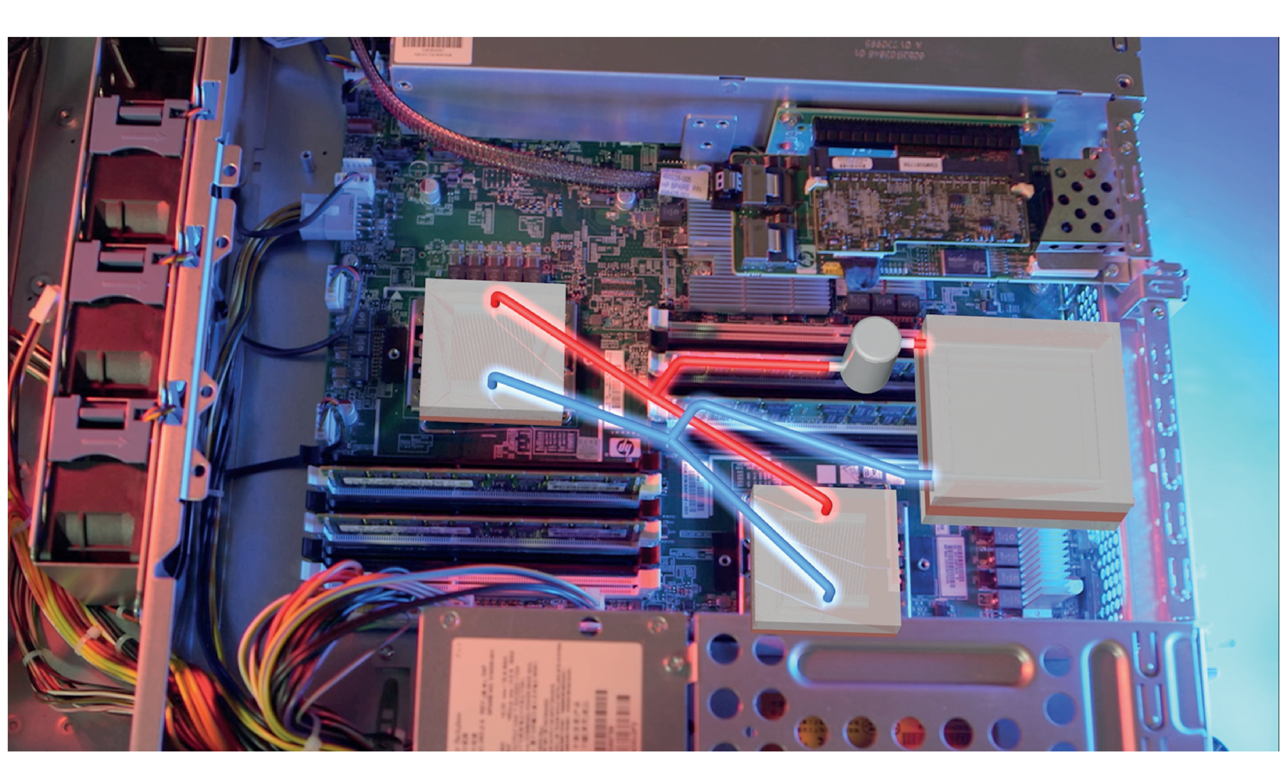




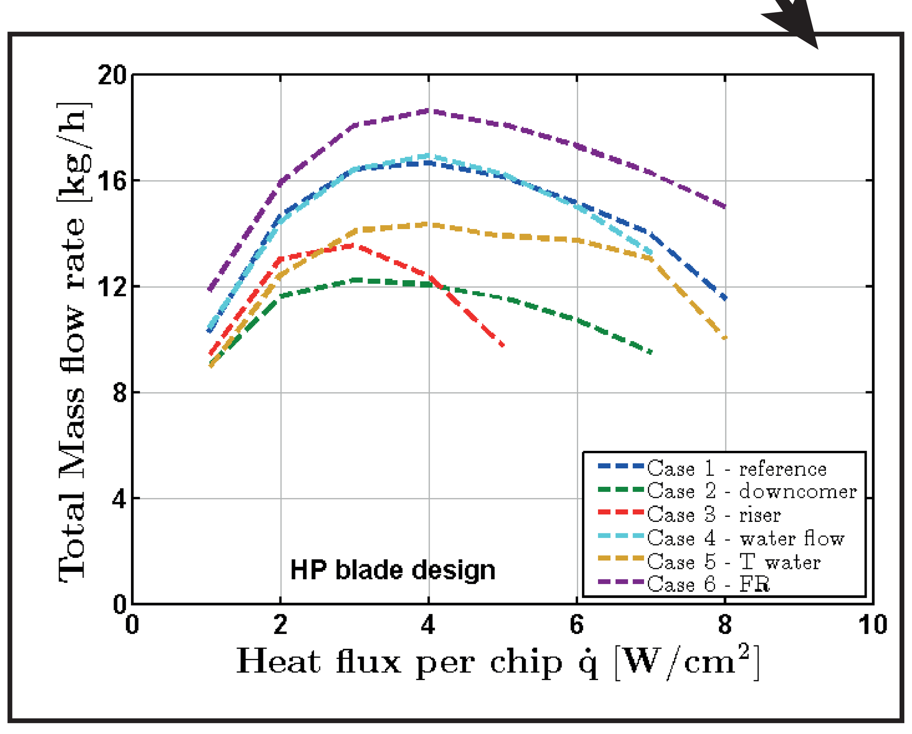
--> Temporal predictions of heat load disturbance. Fast (conduction) and long (pressure transient) constant time reactions are both predicted. Additional insights with flow rate prediction

4 - Application to 2U Servers





- Steady-state and dynamic simulations
- Iteration geometry/simulations
- Sensitivity analysis performed
- Unbalanced heat loads tested



--> Theoretical multiple solutions found for the equilibrium mass flow rate
--> Desired flow distribution obtained for unbalanced heat loads
--> Safety factor of 1.3 obtained for the final geometry compared to the TDP. (Thermal Design Power)

5 - Conclusions and Perspectives

- Fully instrumented mini-thermosyphon built
- New insights gained thanks to this laboratory setup
- Dynamic model of the entire system developed
- Validation of the code using the experimental setup
- Simulation code used to design a 2U server-scale thermosyphon cooling system
- 4 part series of papers published in ITHERM2016.

- 2U thermosyphon demonstrator under manufacturing
- Installation of the thermosyphon inside the 2U blade
- Monitor performance (power consumption and thermal characteristics) using a home-made Python-based platform and compare with air cooled blade
- Work continuing on a blade cooling server application

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