



Architect of an Open World™

Direct liquid cooling by bull

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Green datacenter characteristics

- PUE small as possible → 1
- Energy reuse : warmer liquid may open new usage
 - 65°C outlet temperatures open « central heating » market
- Reduce liquid cooling footprint within the data-center
 - Mobull, new racks...
- Today Bull focuses on smaller PUE by using liquid cooling
 - Current DLC offer
 - 2nd generation improvements
 - Research activities

Water cooling & PUE

- Water cooled blade don't need ice-cold water
- Cooling with hot water improves significantly the PUE

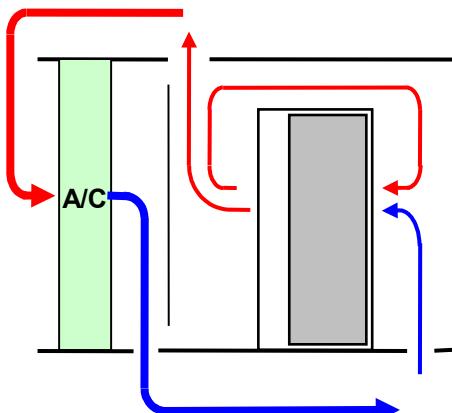
Air-Cooled

10(-20) kW/rack

Room 20°C

A/C water 7-12°C

PUE **≥ 1.7**



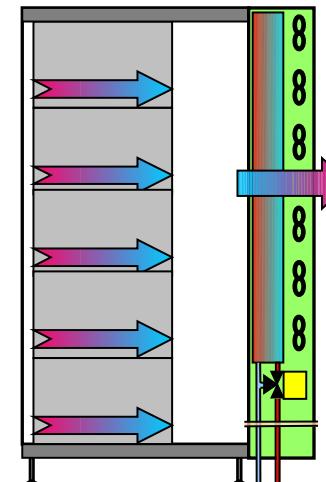
Cool doors

40 kW/rack

Room 20°C

Water 7-12°C

PUE **1.5-1.6**



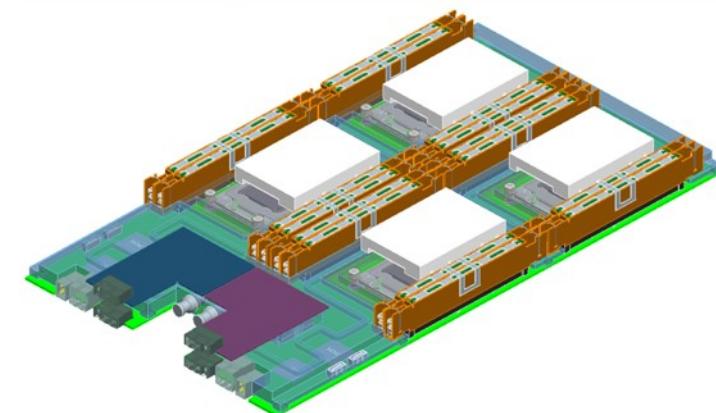
Direct Liquid Cooling

60 kW/rack

Room up to 27°C

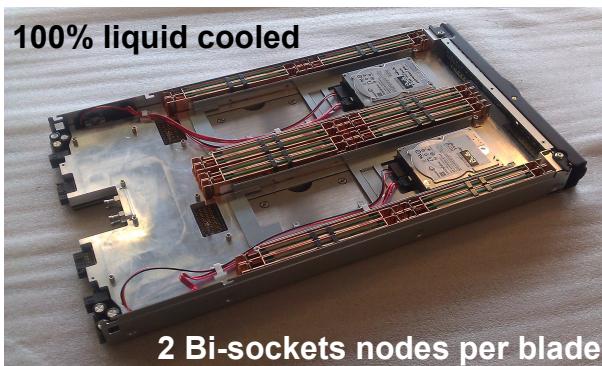
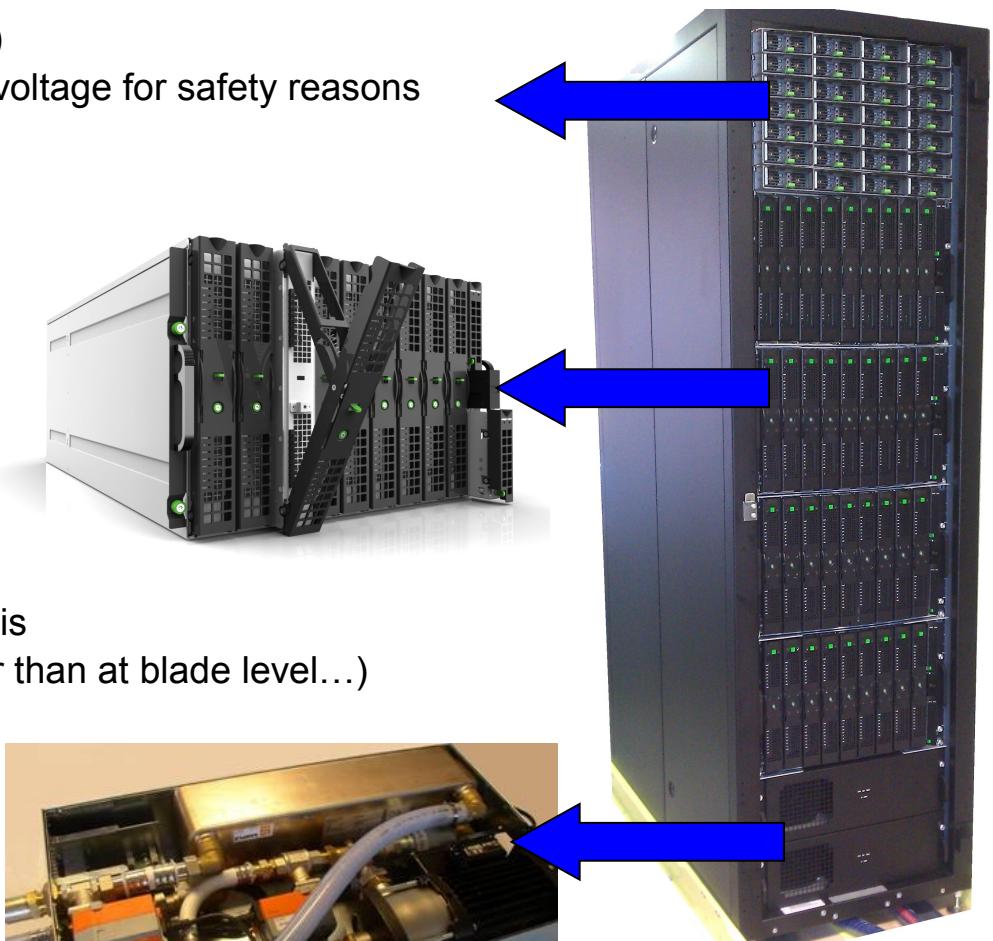
Water **30-40°C**

PUE **1.1-1.2**



Bullx direct liquid cooling technology

- Cooperative Power Chassis (CPC)
 - Partitioning of water cooling and AC voltage for safety reasons
 - 54V DC to the chassis
- Chassis
 - 18 bi-sockets blades
 - Switch IB & Ethernet embedded
 - 7U
 - 100% water cooled \Rightarrow fan less
 - Noiseless...
- Hydraulic Chassis (HYC)
 - Provide water cooling for the 5 chassis
 - Redundant 2N at rack level (Cheaper than at blade level...)



42U Bull rack (19")

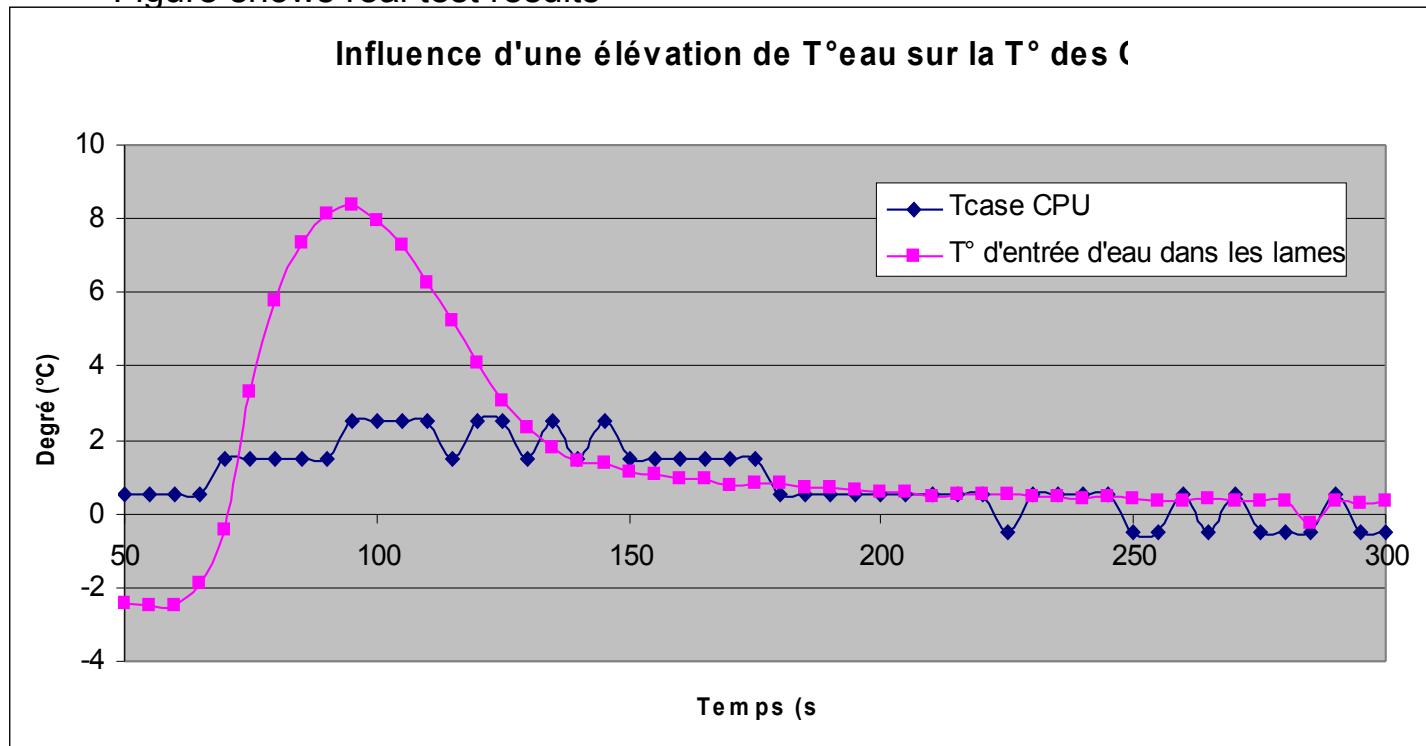
Bullx dlc – Main features

- Bullx dlc technology allows to implement more powerful blades
 - Double EP node blades, Single EP node blade plus accelerators...
 - 2kW blade with 1 EP node plus custom accelerators
 - It supports largest MIC adaptors
 - Maintainability remains as it was in an air flow design
 - Direct access to CPU sockets
 - Direct access to Dimms
 - Direct access to disks
 - Maximum rack water inlet temperature:

Type of blade	CPU power	Node power	Water T° (customer loop)
2 Bi-sockets nodes blade	EP 130W	820W	35°C
	EP 115W	790W	40°C
1 EP node with GPU	MIC 300W	1400W	40°C
1 EP node with accelerators		> 2000W	20°C

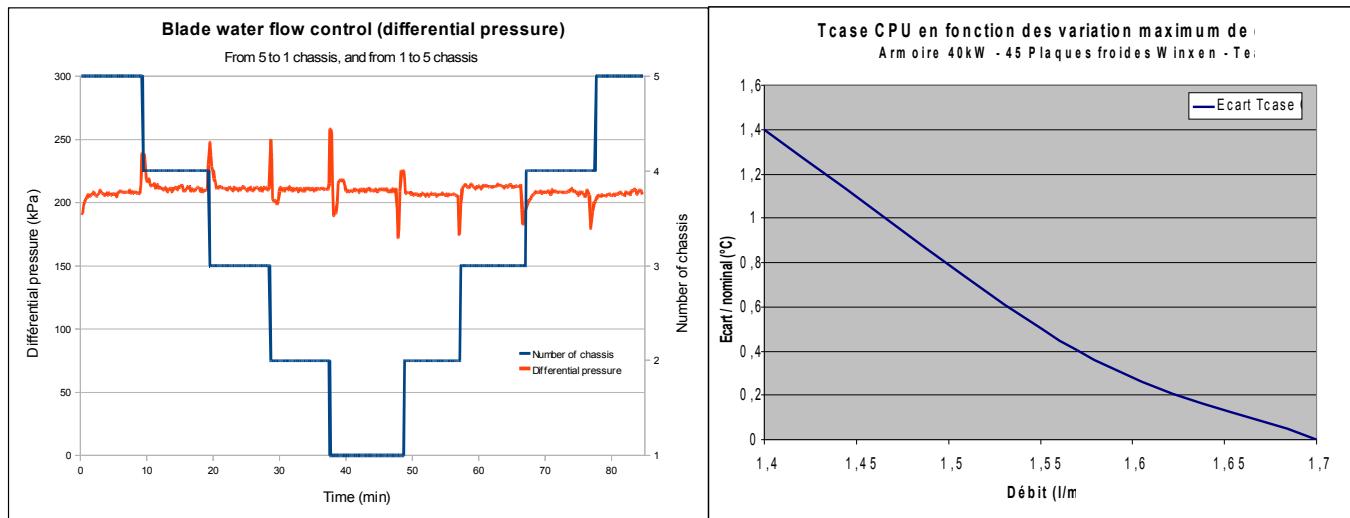
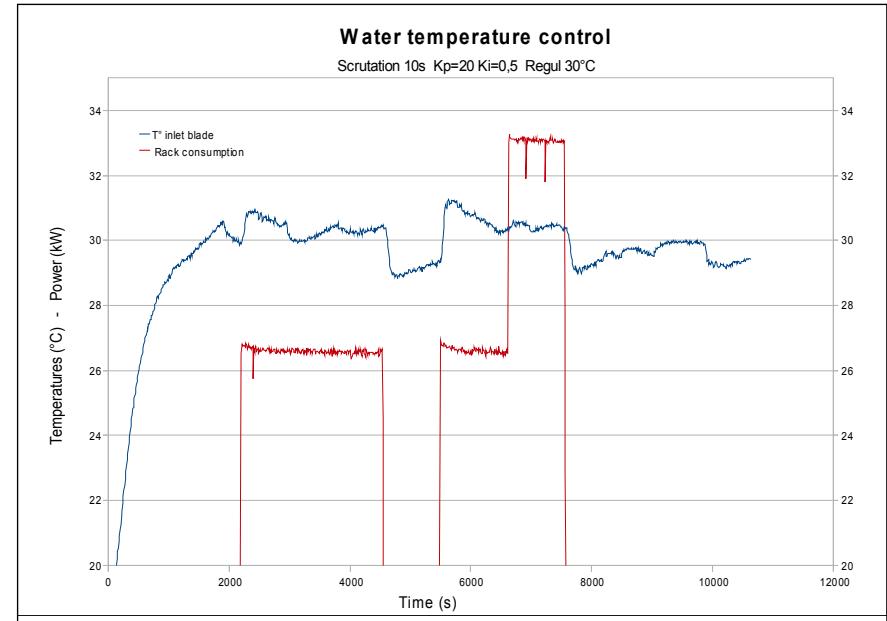
Bullx dlc – Very accurate Blade cooling control (1)

- Blade Water inlet temperature is regulated by setting appropriate inlet valve openness
- Water Redundancy is provided by putting 2 Hydraulic Controller per rack. One HYC is active at a time
- Regulation worst case is when one active HYC fails:
 - Tcase CPU variation is much smaller than water inlet temperature variation : 2-3°C
 - Figure shows real test results



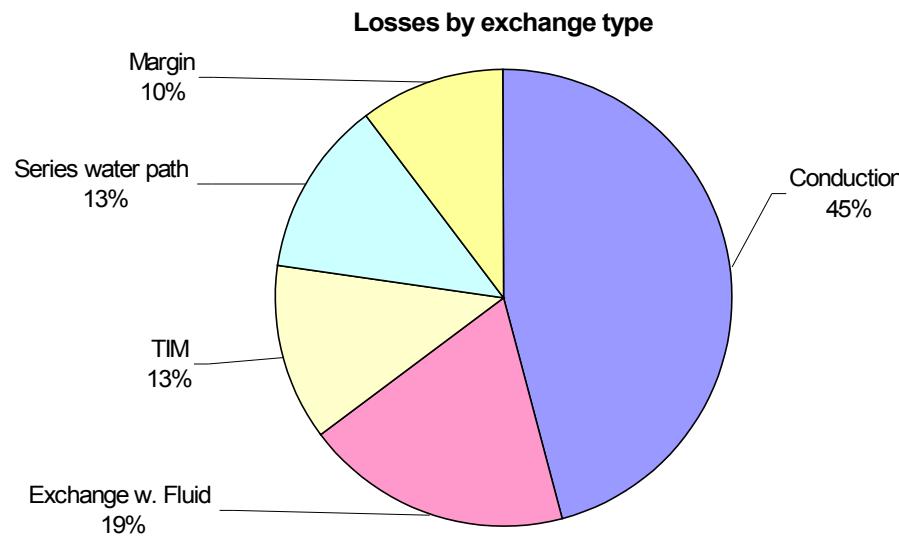
Bullx dlc – Blade cooling control accuracy (2)

- Other source of variation:
 - Start at warm or cold water condition, blade power variations ($\pm 1^\circ\text{C}$ around reference temperature)
- Water flow is regulated depending on the rack configuration
 - Resulting measured water flow variation : (1,4 à 1,7 l/min)
 - Related Tcase CPU variation ($1,4^\circ\text{C}$)



Bullx dlc technology 2nd generation (1)

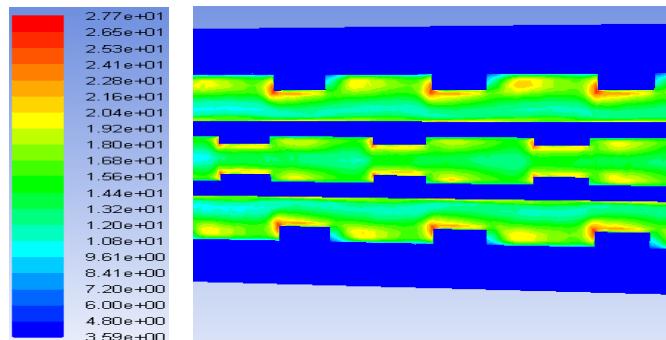
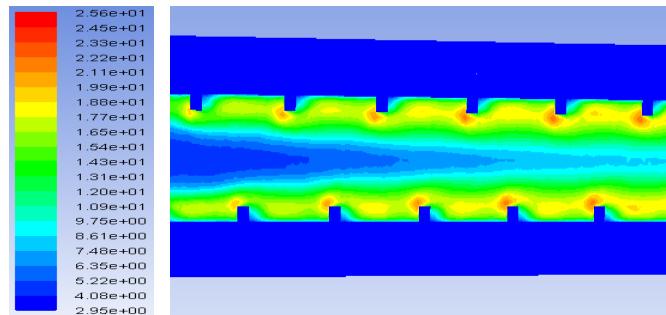
- Today, a good solution is based on free cooling (warm water system)
- Tomorrow, a warmer outlet temperature may help for energy reuse
- Here is the split of the temperature difference between CPU case and water



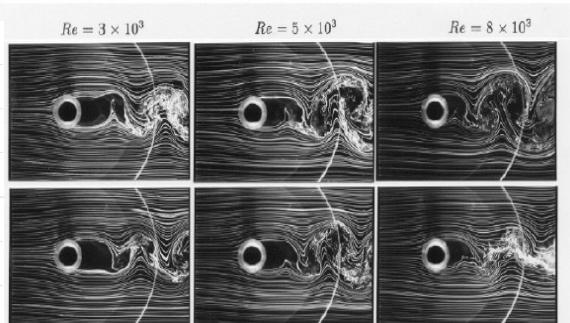
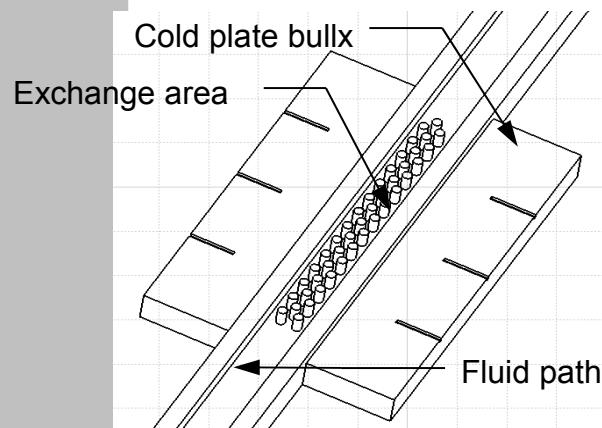
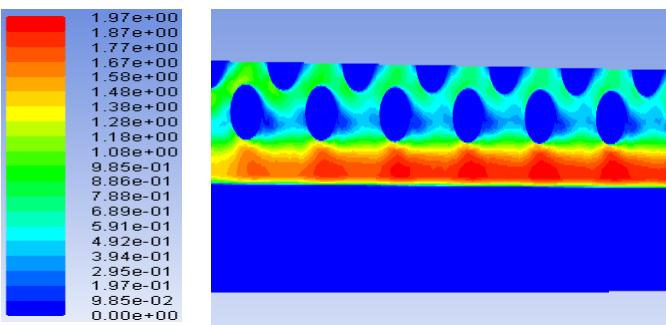
- 2 main candidates for an optimization are the heat spreader geometry and the heat exchange at cold plate level

Bullx dlc technology 2nd generation (2)

- Example of heat exchange optimization at coldplate level
 - More turbulence involves the heat exchange between cold plate en fluid
 - Several simulations done with different shapes of fins



Intensity of turbulence (%)



Fluid speed spectrum (m/s)

Bullx dlc – research activities (1)

- Experiment new fluid : Nano-fluid
 - Copper nano-particles fluid has been tested : 1°C improvement might be expected
- 1-2 kW Blade immersion while saving easy access to the different removable parts
- 1-2 kW blade without liquid connectors

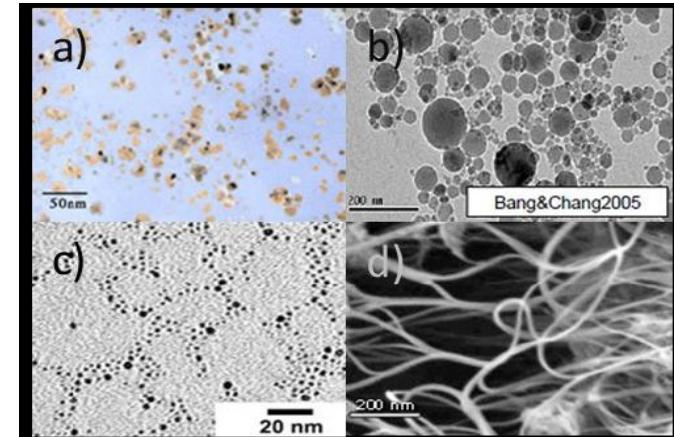
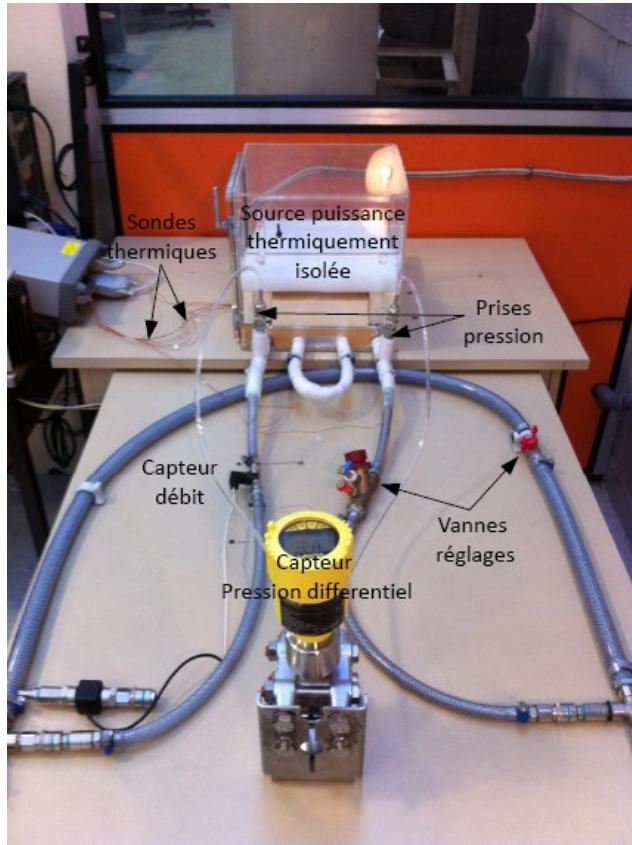
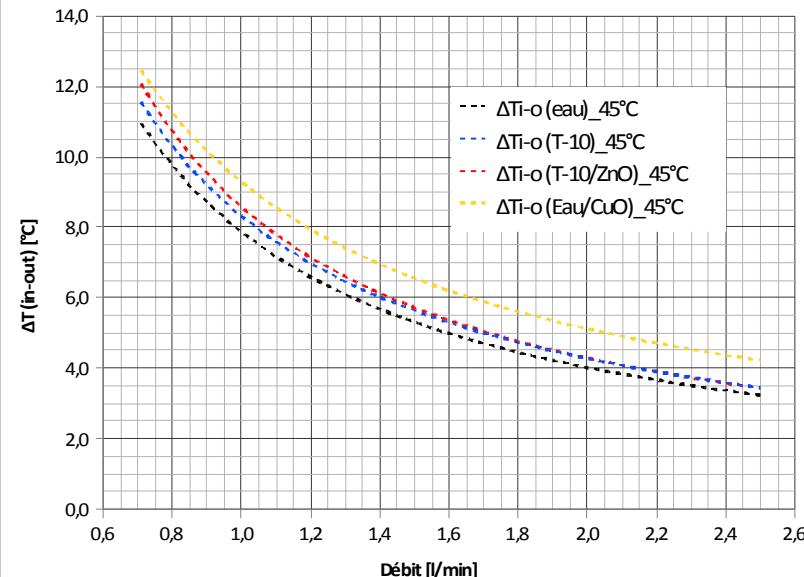


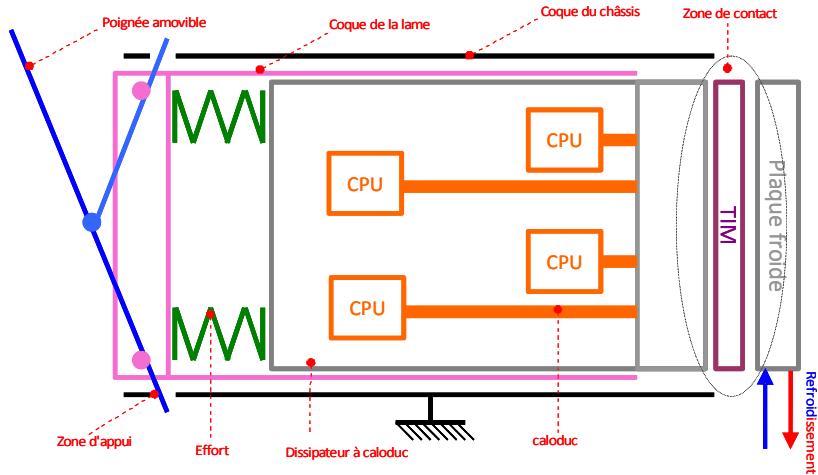
Illustration 2: Nanofluides vus au microscope électronique:
(a) éthylène glycol + cuivre à 0,5 %; (b) eau + alumine ; (c)
eau + or à 2 nm; (d) eau + nanotubes

Critère 2: Performances thermiques "Pouvoir calopréteur" à 45°C

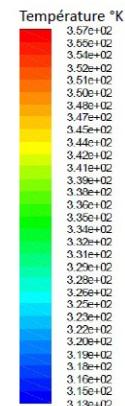


Bullx dlc – research activities (2)

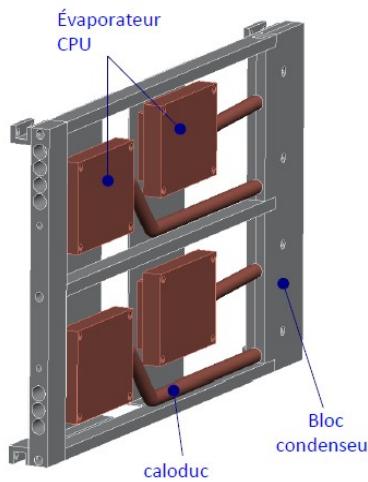
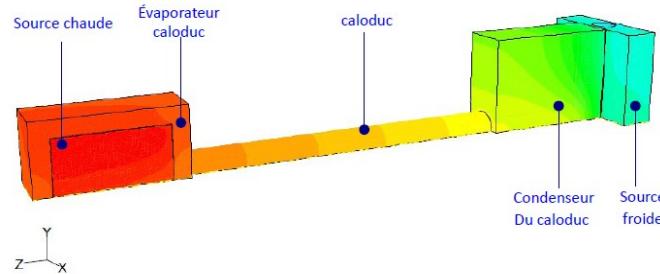
- Water cooling with no liquid in the board
- Advantage : No hydraulic disconnection during maintenance operations (security & cost improvement)
- Technical stakes : Electronic components are far from the cooling liquid
 - Thermal : The usage of heat pipes is mandatory to drive heat toward the thermal exchange surface of the blade
 - Mechanical : Need perfect alignment between blade and cold plate in order to use very thin high performance TIM
 - Mechanical Test vehicle has been done : first results are promising



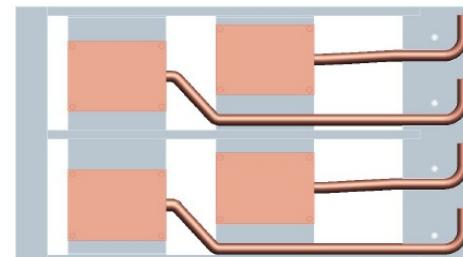
Design principle that ensures a uniform compression of the TIM



Design of a 400mm high performance heat pipe



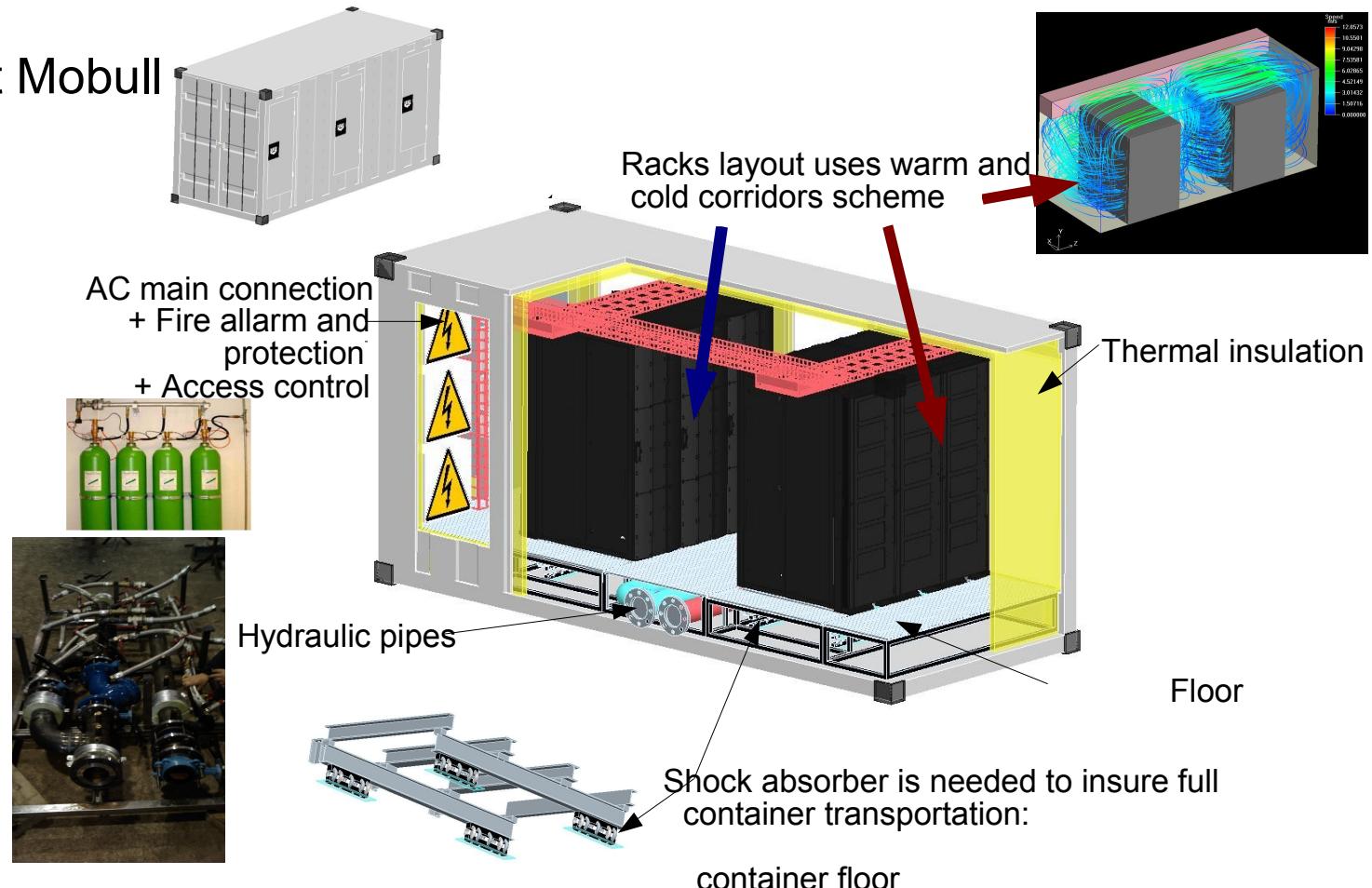
a) Vue isométrique du dissipateur



a) Vue de dessus du dissipateur

Make datacenter easier

Current Mobull





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