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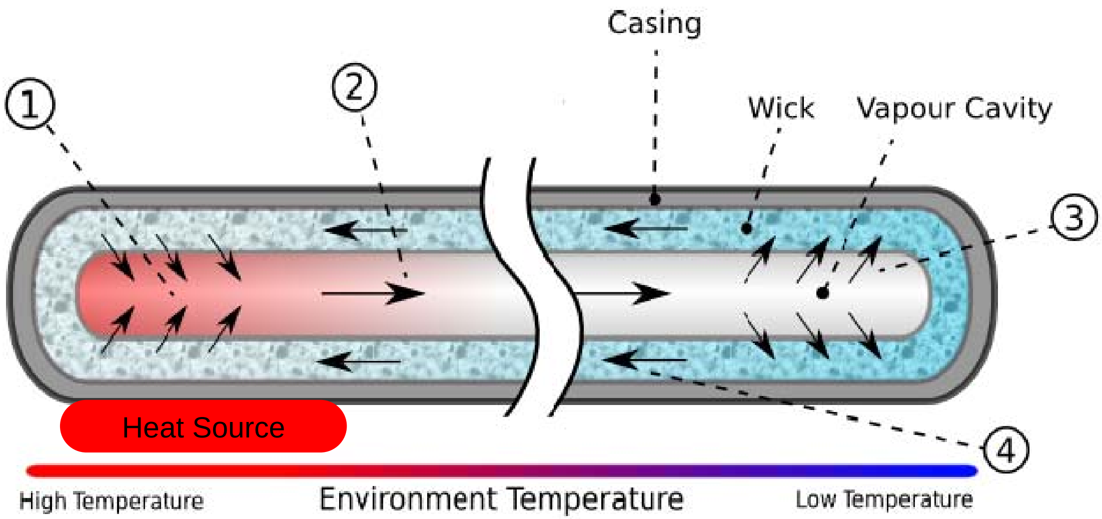
Making Hot Technology Cooler™

Frequently Asked Questions 2010

What is a NanoSpreader and how does it work?

- It is a patented copper encased two-phase vapor chamber into which pure water is vacuum sealed.



1. Liquid evaporates to vapor, absorbing thermal energy
2. Vapor migrates along the cavity toward areas with lower temperature
3. Vapor condenses back to liquid and is absorbed by the wick, releasing thermal energy. Fins and fans can be used to dissipate heat.
4. Liquid flows back to higher temperature end

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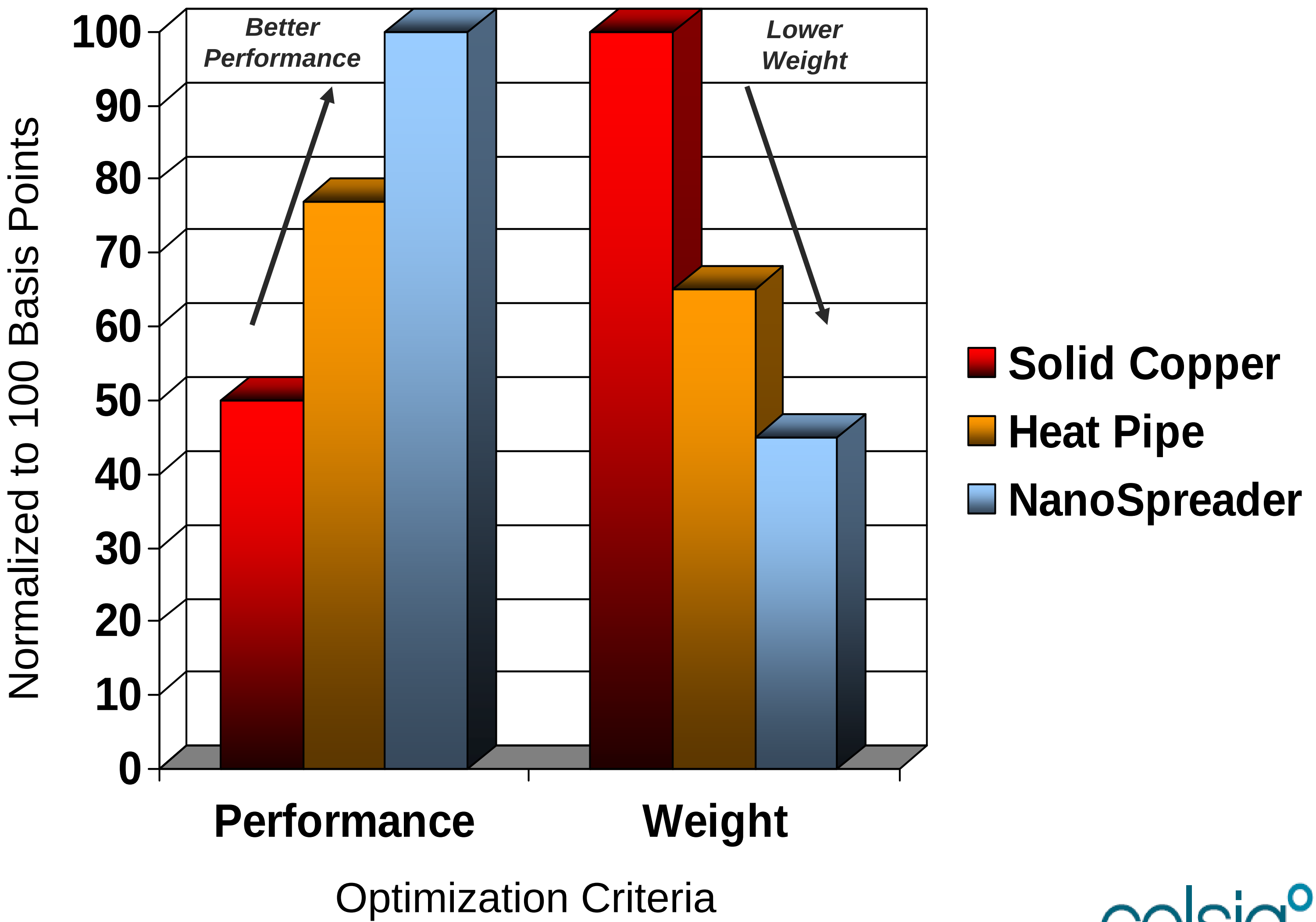
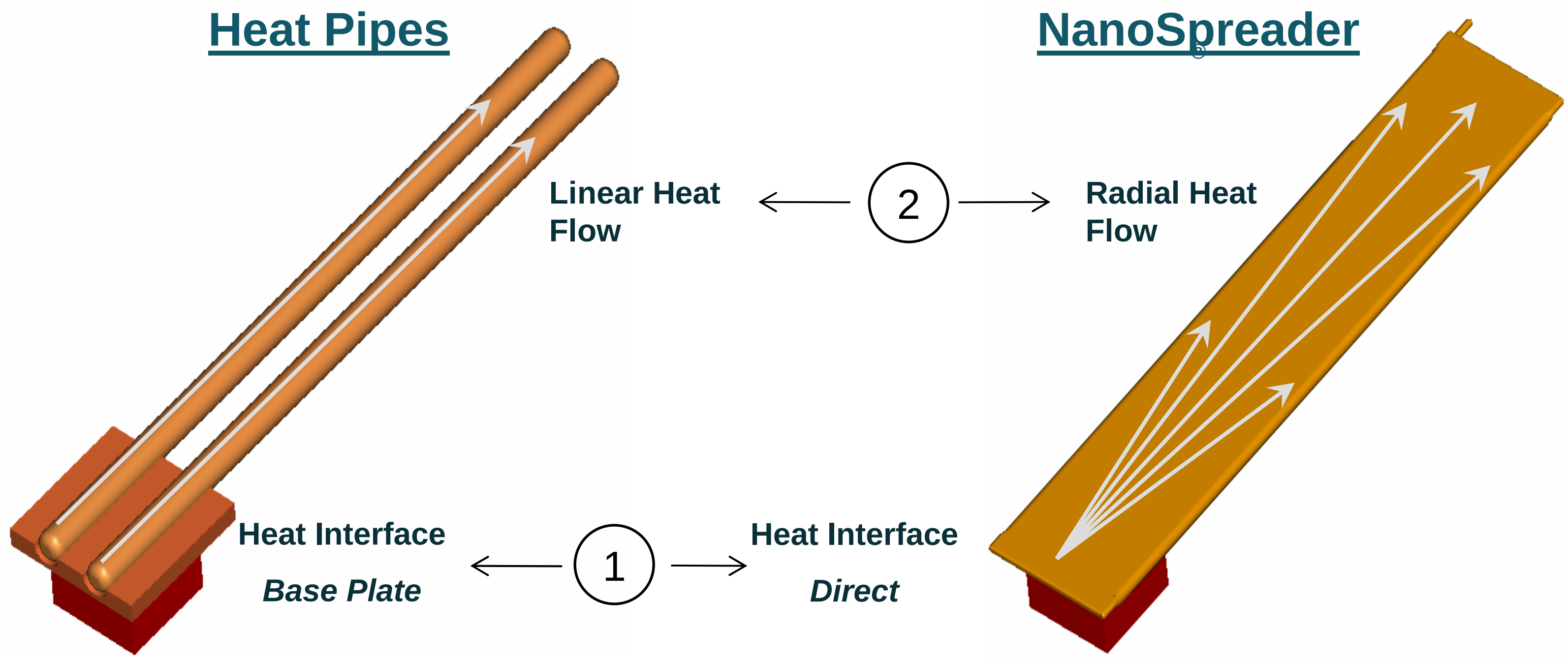
How do NanoSpreaders compare to heat pipes and solid copper solutions?



Why do NanoSpreaders work better than heat pipes?



1. NanoSpreaders can be attached directly to the heat source, whereas an additional base plate is almost universally used with heat pipe solutions
2. Heat is spread in a more uniform pattern (radial heat flow) across a large thin surface area

Are NanoSpreaders the same as other vapor chambers?

- Celsia uses a unique manufacturing process that requires no costly sheet metal stamping, less welding, and fewer secondary operations than traditional vapor chambers
  - 56 patents / patent applications
- Solutions using NanoSpreaders repeatedly outperform those using competitors' vapor chambers
  - Typically 5-10% better
- Celsia can produce more NanoSpreader vapor chambers per month than any other manufacturer
  - Roughly 3-6 times the capacity
- Celsia is probably already an approved vendor of one of your ODMs and/or thermal solution vendors
  - Celsia is ISO / RoHS certified and approved by some of the worlds largest OEMs, ODMs and thermal solution providers

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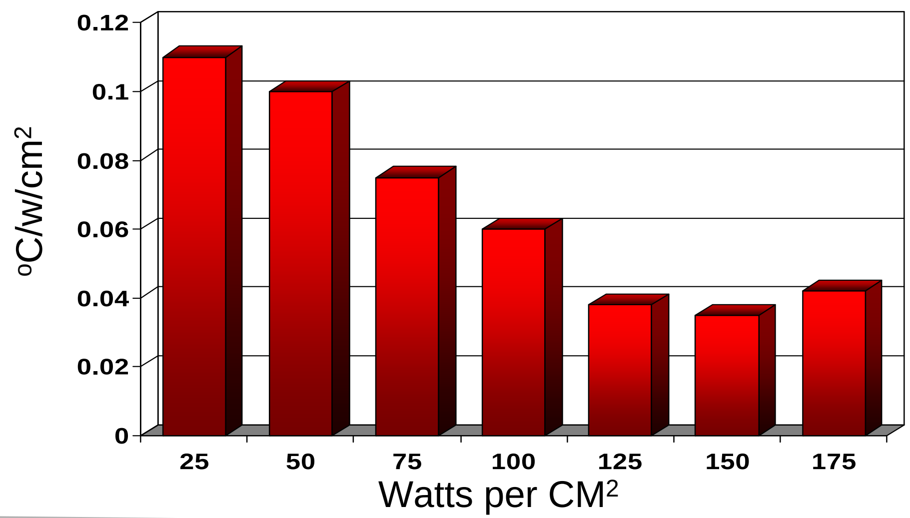
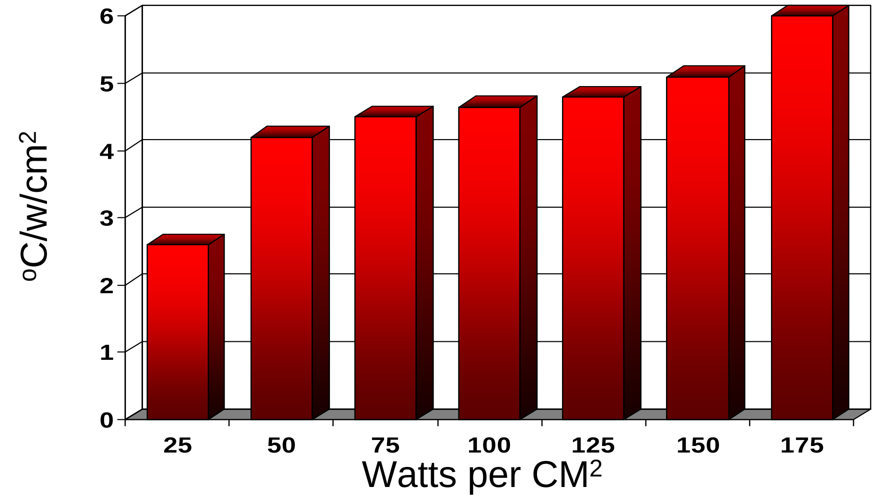
What's the resistance/delta-T at various power densities?

Evaporator resistance with a 1cm² heat source



Evaporator delta-T with a 1cm² heat source



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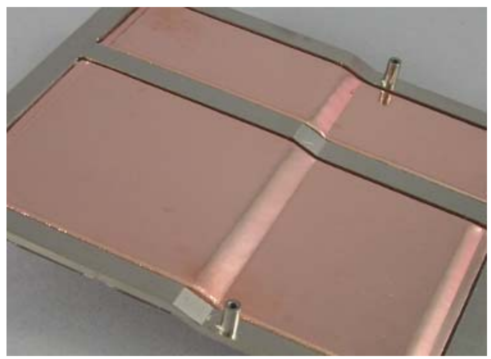
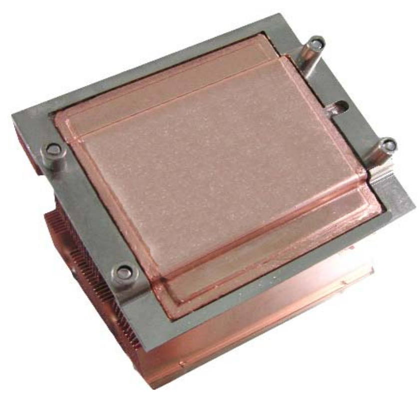
Can NanoSpreader vapor chambers be bent?

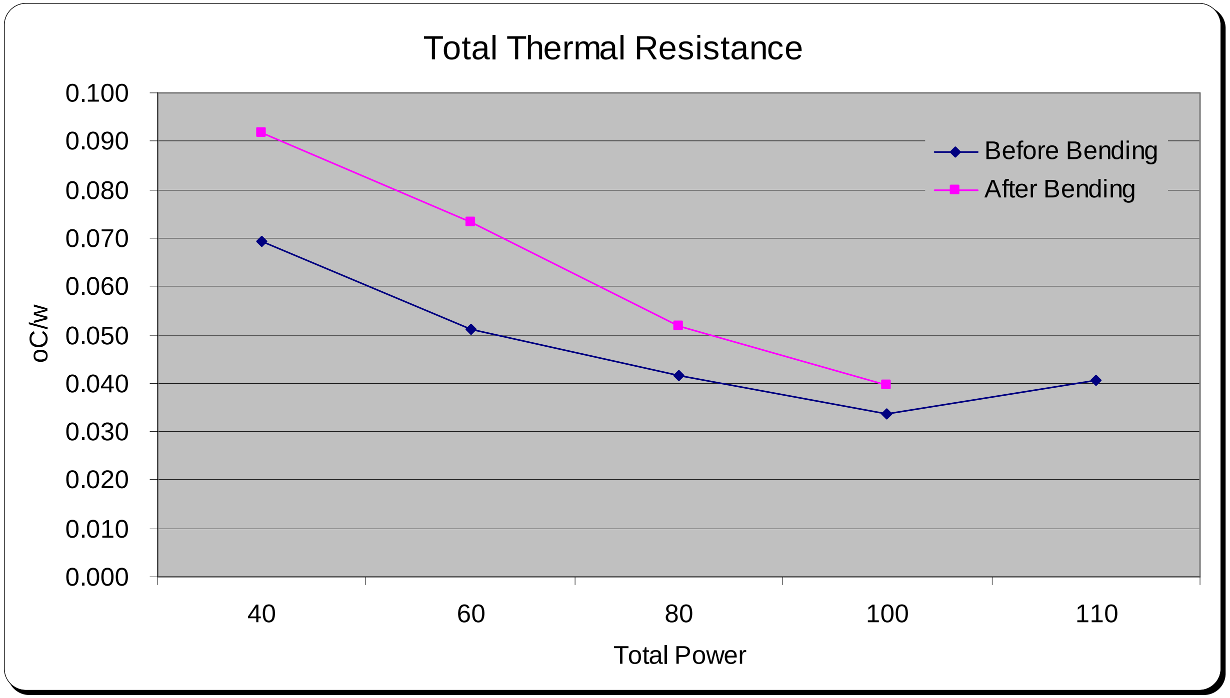
- Yes, with a nominal bend radius of 10mm
  - The bends can be a simple offset of a few millimeters to complex bends
  - Bends must occur along the thin plane of the unit





How much is performance affected by a 180 degree bend?

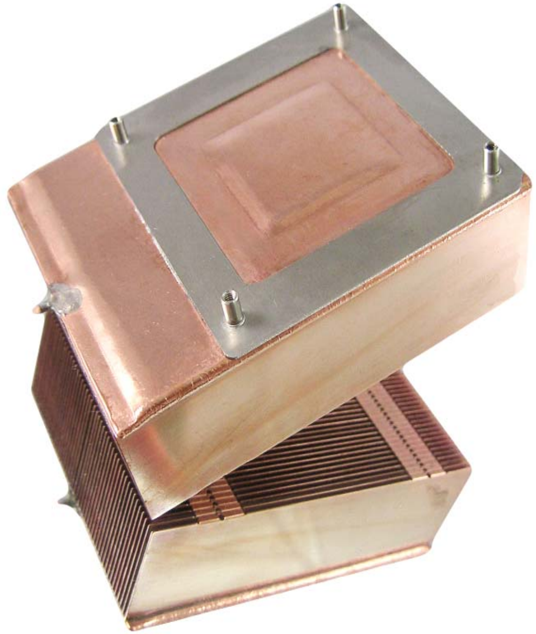
- The effect on total thermal resistance is between 18% and 40%
- At 100 watts the thermal resistance pre-bend is 0.034 ^{o}C/w while after bending the resistance is 0.040.
- This is only a 0.6 degrees difference in the delta-T of the NanoSpreader®

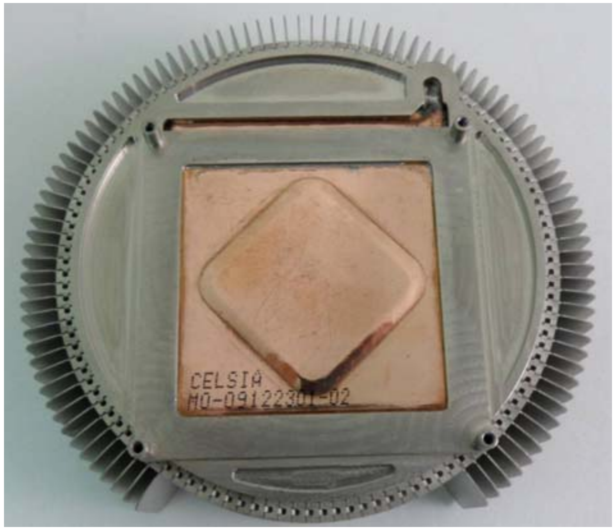


Note: less extreme bends like “steps” have little effect on thermal resistance

Is it possible to bend just an interior section?

- Yes, embossing is a common design requirement when the heat source is recessed.
  - Typical embossment dimensions are 25mm x 25mm x 0.5mm high
  - The back-side of the NanoSpreader remains flat for optimal connection to the fin stack

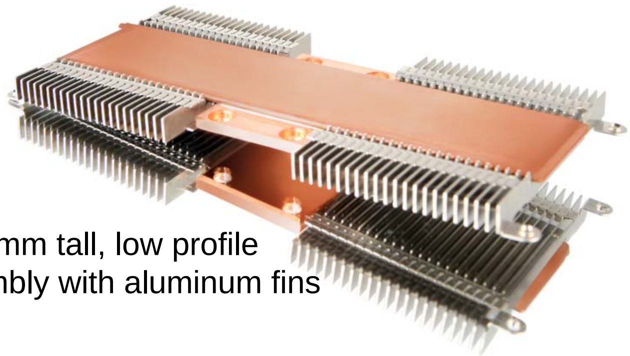




Graphics Card Applications

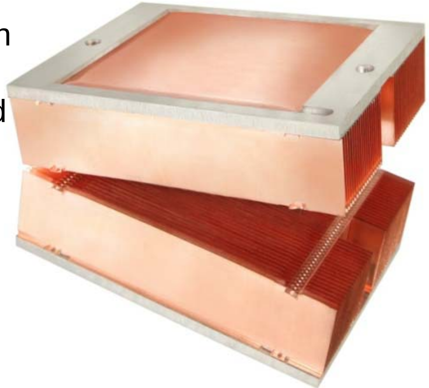
How are NanoSpreaders attached to fin arrays?

- Stamped fin arrays
  - Fins are soldered directly to the vapor chamber to assure a robust thermal and mechanical attachment



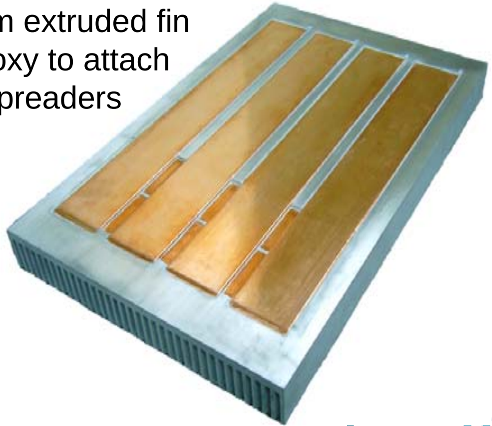
7mm tall, low profile assembly with aluminum fins

1U Server copper fin stack soldered to a mounting frame and NanoSpreader



- Large extruded fin arrays
  - Thermally conductive epoxy is commonly used to attach very large aluminum fin arrays to NanoSpreaders as it reduces cost by eliminating the need to nickel plate the aluminum

250mm x 350mm extruded fin array using epoxy to attach four NanoSpreaders



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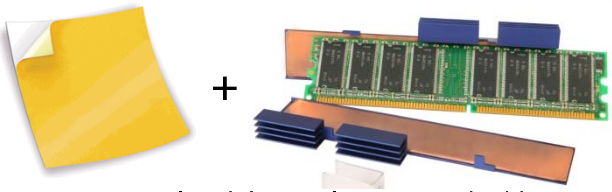
How are NanoSpreaders attached to the heat source and PCB?

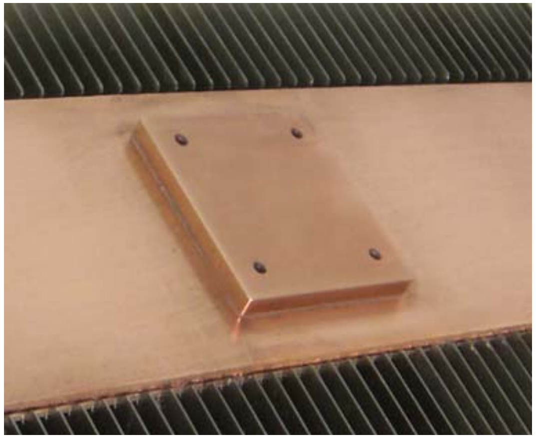
- A thermal interface material is used between the NanoSpreader and the heat source
  - Usual: thermally conductive grease like Shin-Etsu G751

  - Occasional: Thermal adhesive tape



Example of thermal tape used with 1.5mm thick DDR memory cooler

- In some cases the heat source is *directly attached* to the NanoSpreader based thermal solution



A solid copper block with four threaded holes is soldered to the vapor chamber

A high power LED array (not shown) can then be directly mounted to the copper block

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How are NanoSpreaders attached to the heat source and PCB? ……*Continued from last page*

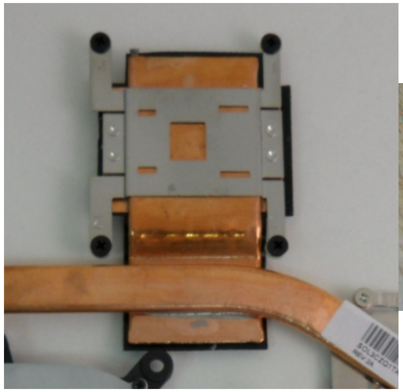
- The most common method is to use a *spring based* mounting solution
  - Spring-loaded screws w/backer plate

1U heat sink using 4 spring loaded screws that attach through the PCB to a pressure lessening backer plate

Backer plate is mounted to the underside of the PCB

  - Spring clips

For applications where the clamping force required is lower, the vapor chamber can be attached to the board using a spring steel clip. The clip is attached to the vapor chamber and push pins are used to attach through holes in the PCB.



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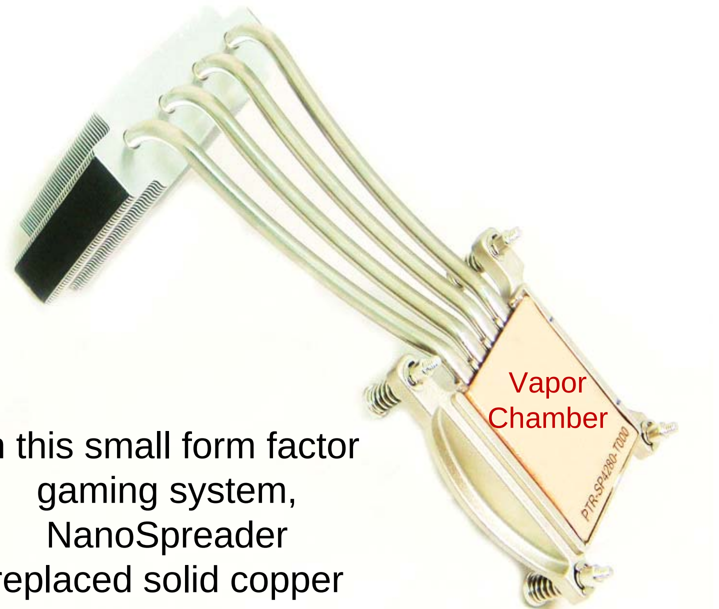
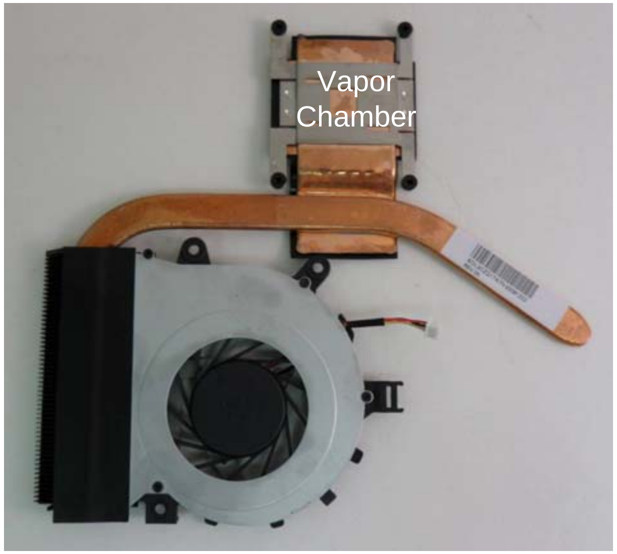
Can NanoSpreader vapor chambers be used in conjunction with heat pipes?

- This is sometimes done to increase thermal performance when the existing thermal module design has already been finalized. Basically, the copper base plate gets replaced with a NanoSpreader



In this small form factor gaming system, NanoSpreader replaced solid copper base plate resulting in a 22% thermal performance gain



For this thin notebook, NanoSpreader replaced base plate AND 1 of the 2 original heat pipes. Result was a thinner overall thermal solution with 7% better thermal performance

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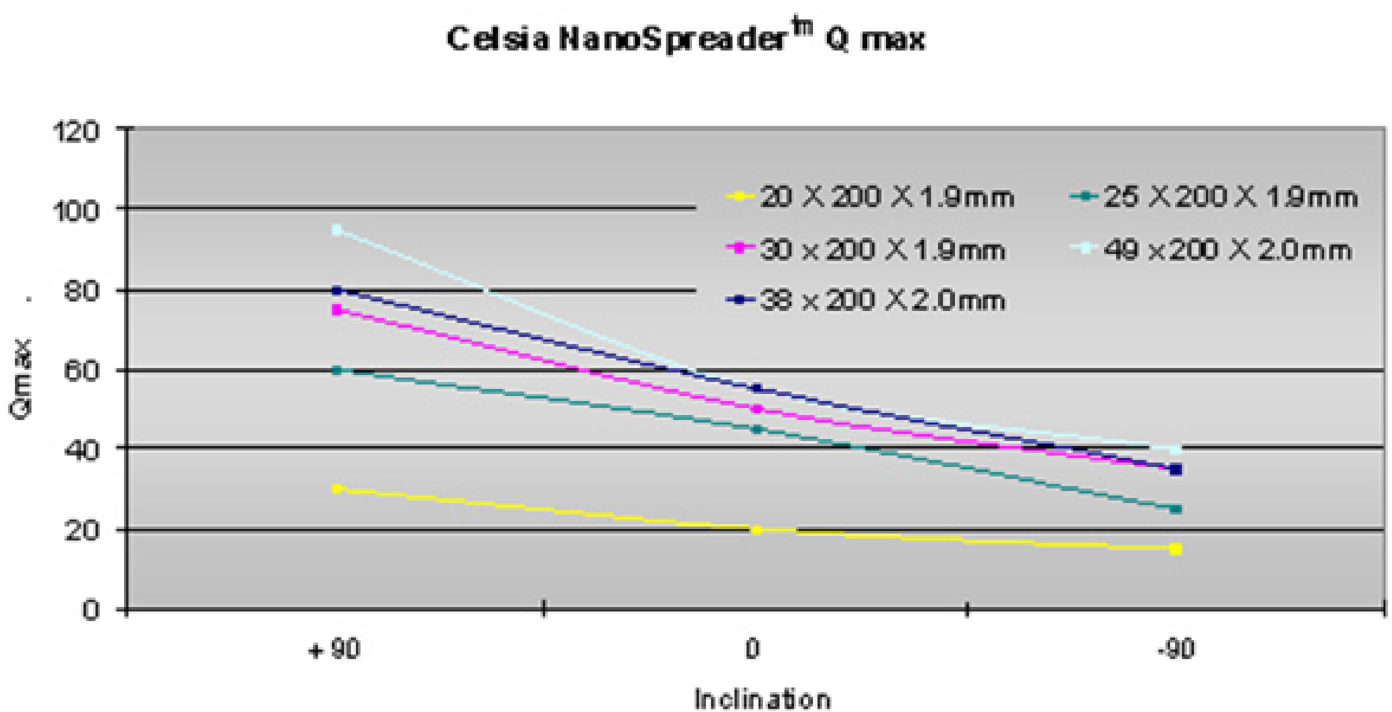
Does orientation affect NanoSpreader performance?

- Generally these devices work equally well from orientations of +90 degrees to -5 or -10 degrees.
- At angles lower than -10 degrees where the heat source is higher than the heat sink then the device relies on the pumping capability of the wick.
- This chart shows the q-max vs angle. In this case at powers lower than 15 watts the unit is unaffected by gravity.



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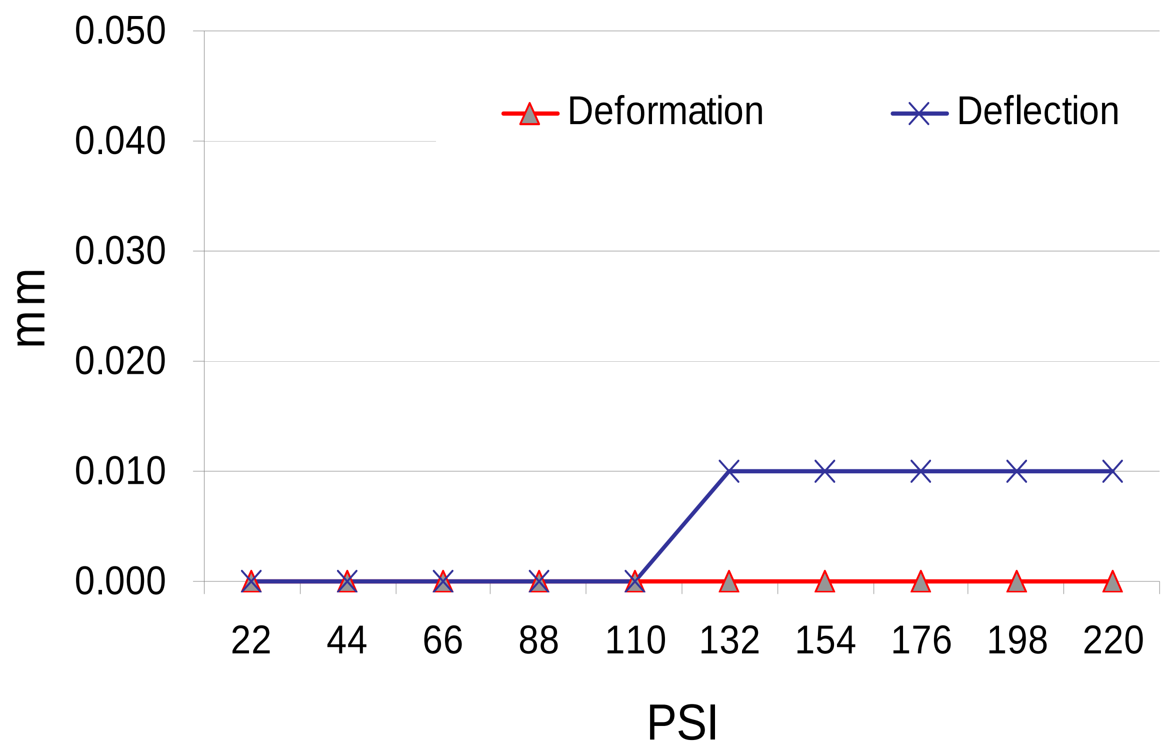
Can NanoSpreaders resist deformation under high clamping pressures?

- Celsia's vapor chambers incorporate a patented internal support for added strength
  - Test was conducted using an 18mm x 18mm slug



What reliability testing is done on NanoSpreaders?

- Celsia Products are designed and tested to meet industry standards for reliability
- 100% of Celsia vapor chambers are tested

Thermal Shock	**1000 cycles, -35 °C to 80 °C**
High Temperature	**120°C for 28days & 200°C for 48 hours**
Low temperature	**-40 °C for 96hrs**
High Temp and High Humid	**65 °C at 85% humidity for 96 hrs**
Operating Temperature	**10°C to 100 °C**
Non-Operating Temperature	**-40 °C to 100 °C**