Fanless Servers Are Coming:
The Peripheral Coldplate Roadmap Behind 100% Heat Capture

Brad Zakaib, VP Product Engineering



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Agenda

1. Introduction
2. Cooling the Processor
3. Cooling the Peripheral Components
4. Cooling the Server
5. Conclusions



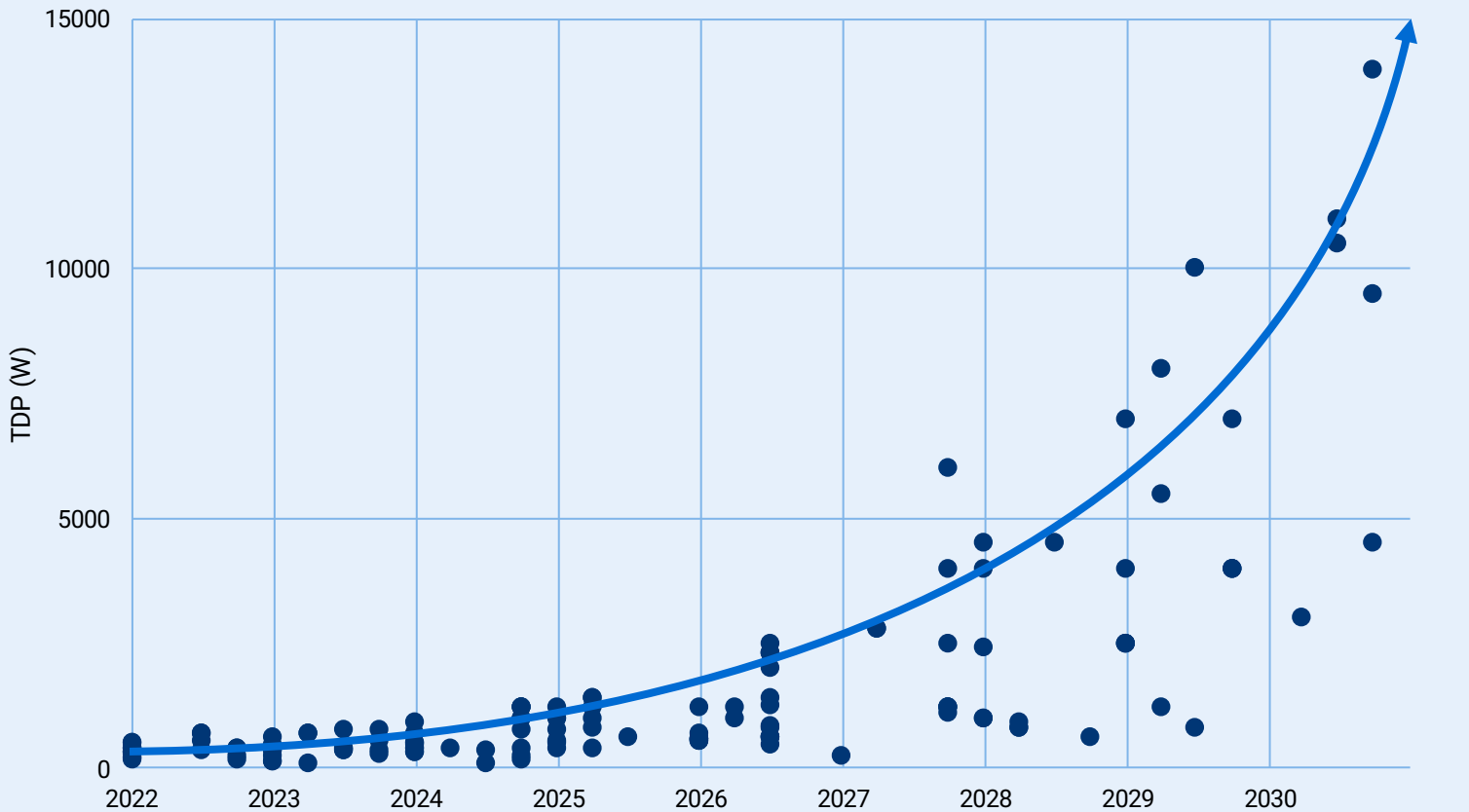
Brad Zakaib
VP Product Engineering

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Processor Thermal Trends

THERMAL DESIGN POWER (TDP) TRENDS

TDP is increasing with larger, multi-die packages.



Source: **SemiAnalysis & CoolIT**

2023-2030 TRENDS

Average Dies per Package

1 → **14**

×14

Average Silicon Area per Package

700 → **9,000mm²**

×12

Average Heat Flux per Package

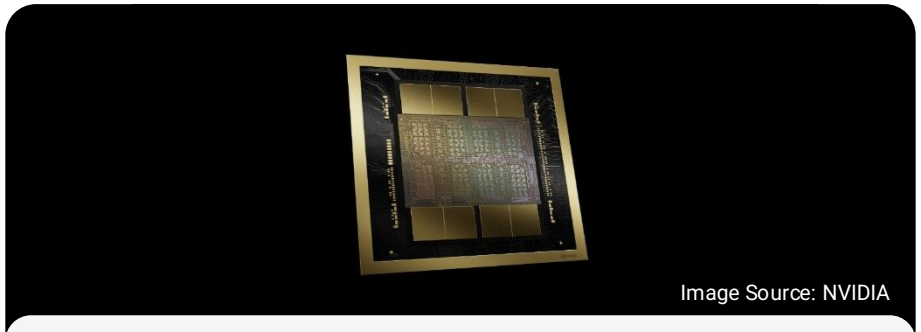
70 → **110w/cm²**

×1.6

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Critical Layers of Thermal Management

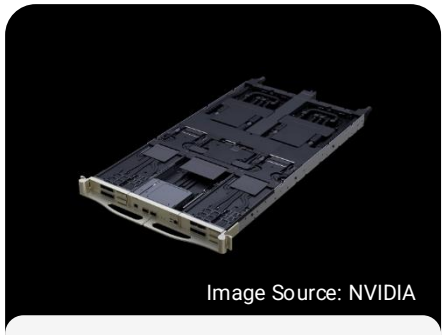
MARKET TODAY


Image Source: NVIDIA

PROCESSOR

150W/cm²
HEAT FLUX

2400W
TDP


Image Source: NVIDIA

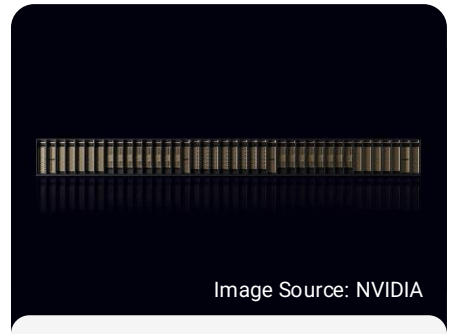
SERVER

10kW
LOOPS


Image Source: NVIDIA

RACK

250kW
DENSITY

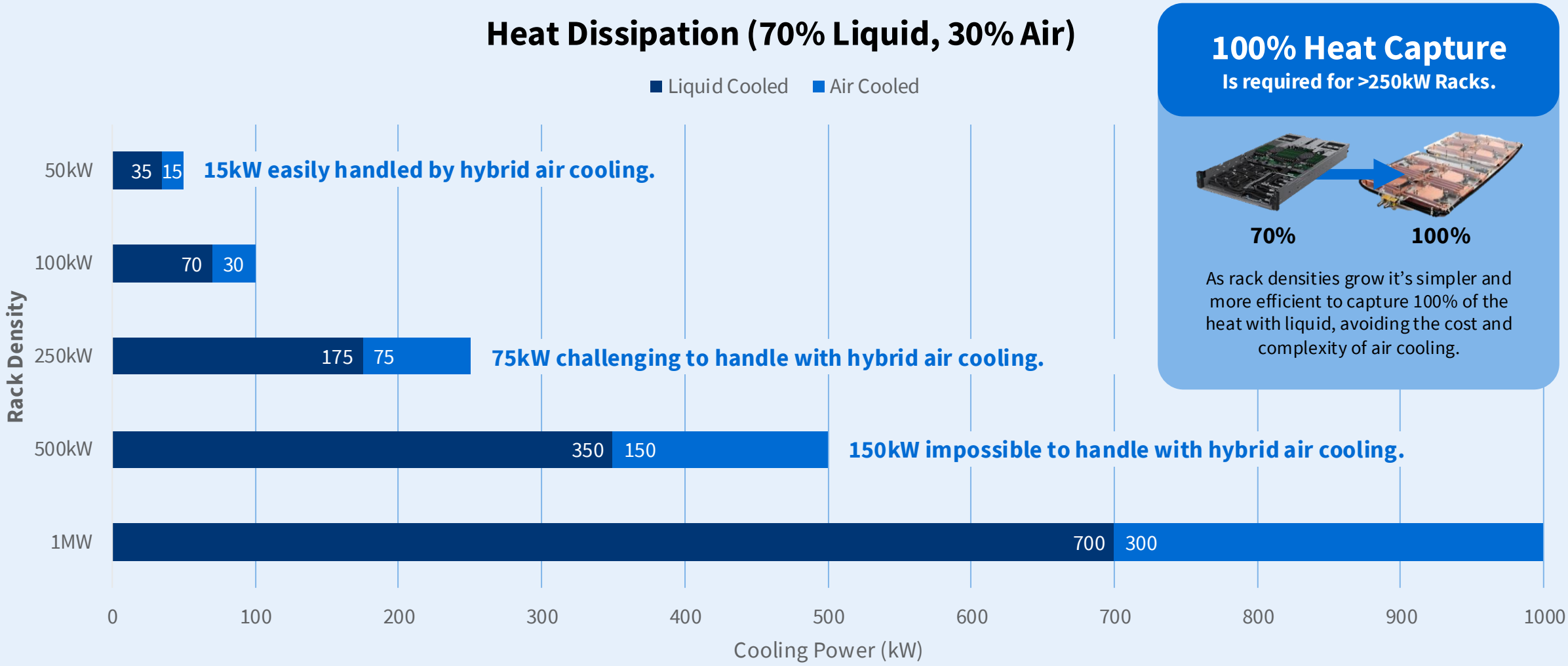

Image Source: NVIDIA

POD

9MW
CLUSTER

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Heat Capture is the next Challenge



100% Heat Capture

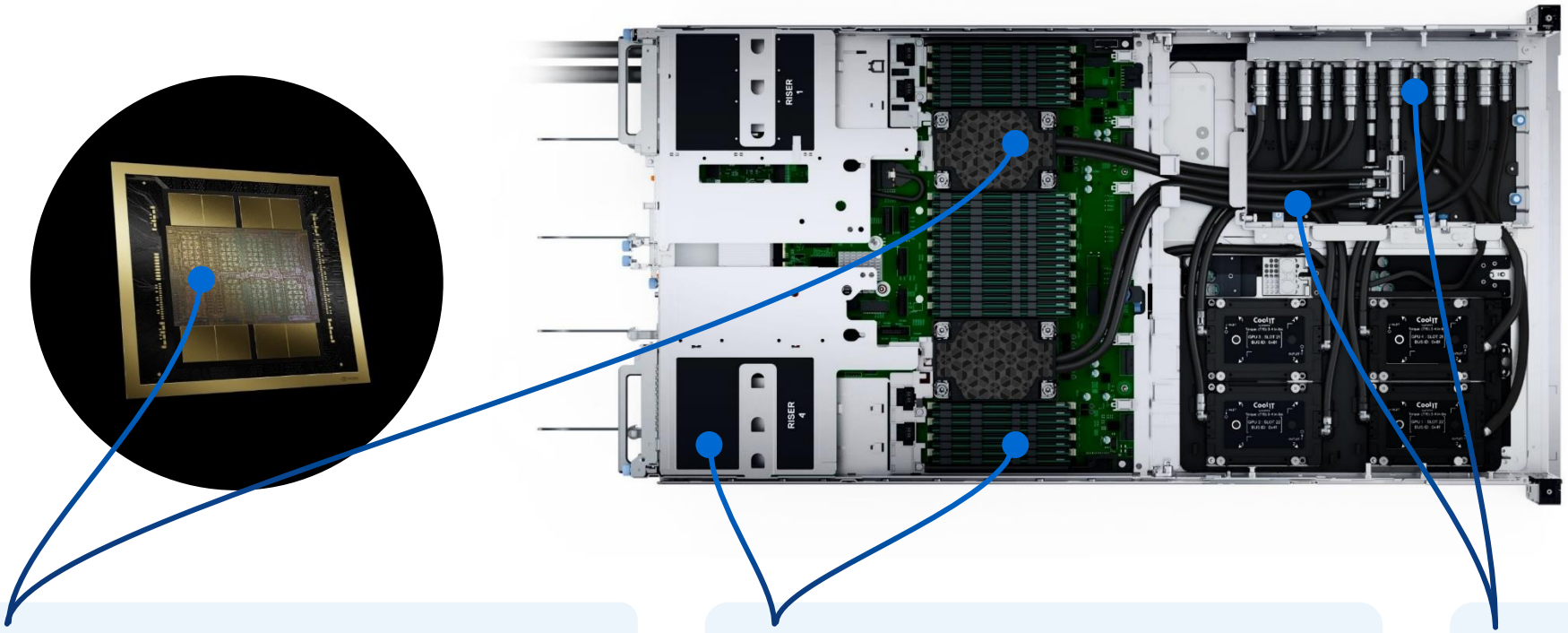
Is required for >250kW Racks.

70% **100%**

As rack densities grow it's simpler and more efficient to capture 100% of the heat with liquid, avoiding the cost and complexity of air cooling.

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Server Cooling Challenges



Processors

- TDP
- Heat flux / hotspots
- Thermal mapping – HBMs, Dies
- Building Representative TTV's

Peripherals

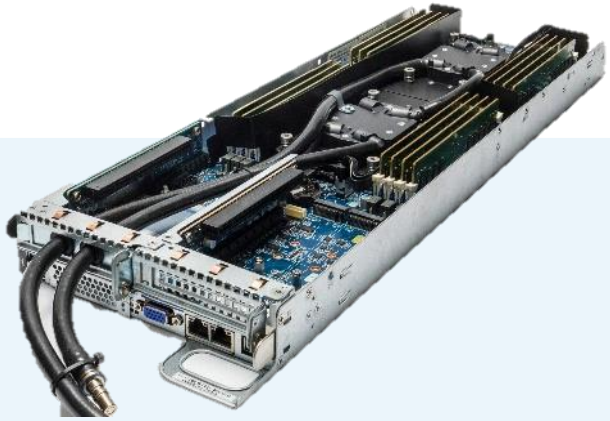
- Reaching 100% heat capture
- Thermally sensitive components
- Different form factors
- Loop integration

Server

- Design Height & Flow routing
- Modularity & serviceability
- Installation time
- Reliability of connections

Coldplate Loops

Using modular coldplate building blocks, CoolIT can scale the amount of heat capture as required.

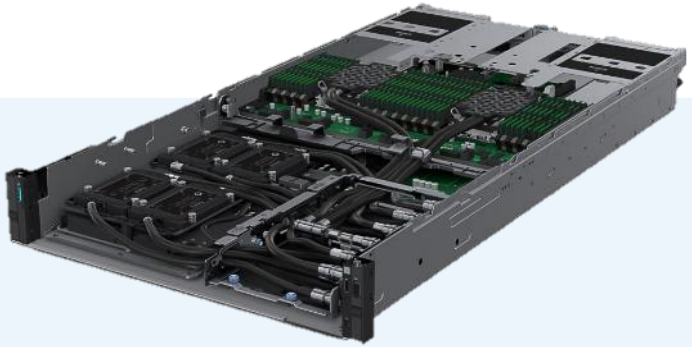


70%

HEAT CAPTURE

GENERAL COMPUTING

Capture heat from the highest TDP components, typically CPUs, GPUs, TPUs and ASICs.



85%

HEAT CAPTURE

HPC AI

Capture heat from OSFPs and DIMMs to further boost



100%

HEAT CAPTURE

SUPERCOMPUTE AI

Capture all the heat from a server, via a coldplate array, including conductive plates.

Scale cooling performance all the way to 100% heat capture.

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Coldplate Coverage

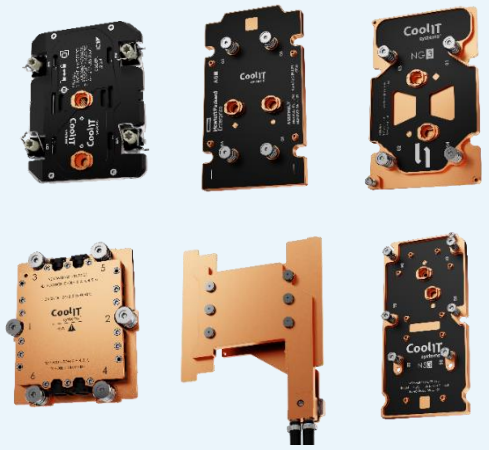
COOLING THE

Components

COOLING THE

Processors

CPUs | GPUs | TPUs | ASICs



COOLING THE

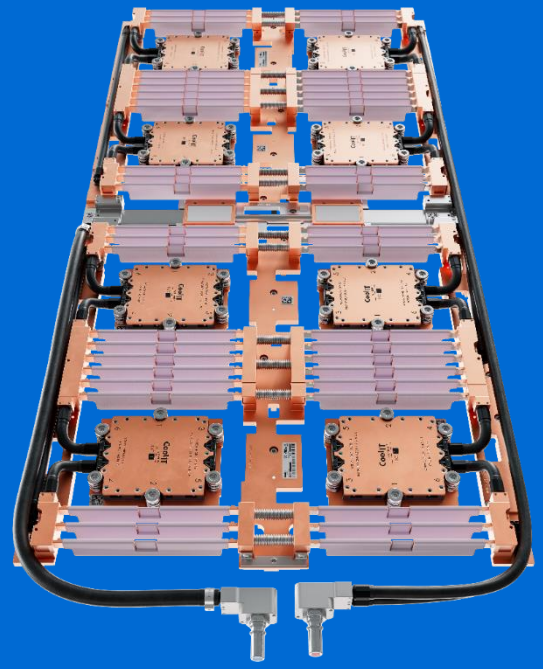
Peripherals

NICs | PSUs | SSDs | VRMs | OSFPs | QSFPs | DIMMs



COOLING THE

Servers



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Agenda

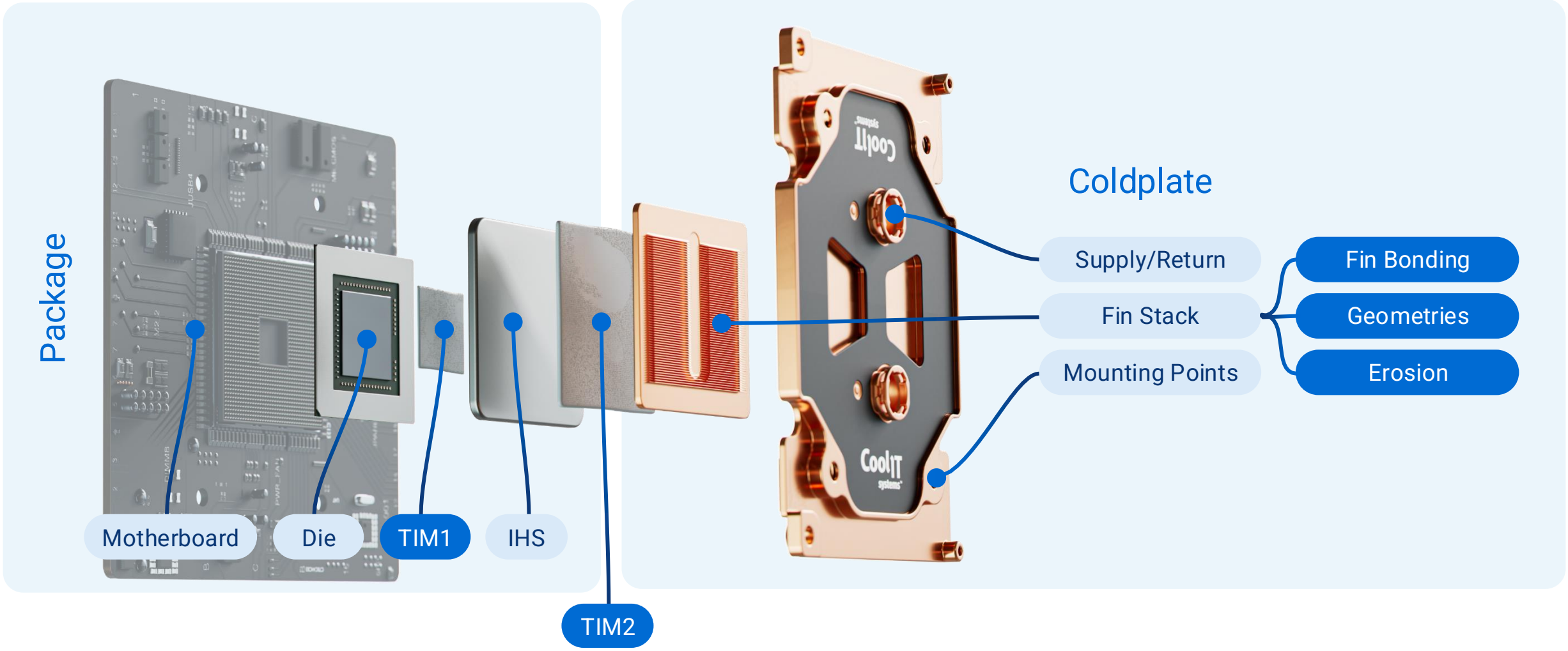
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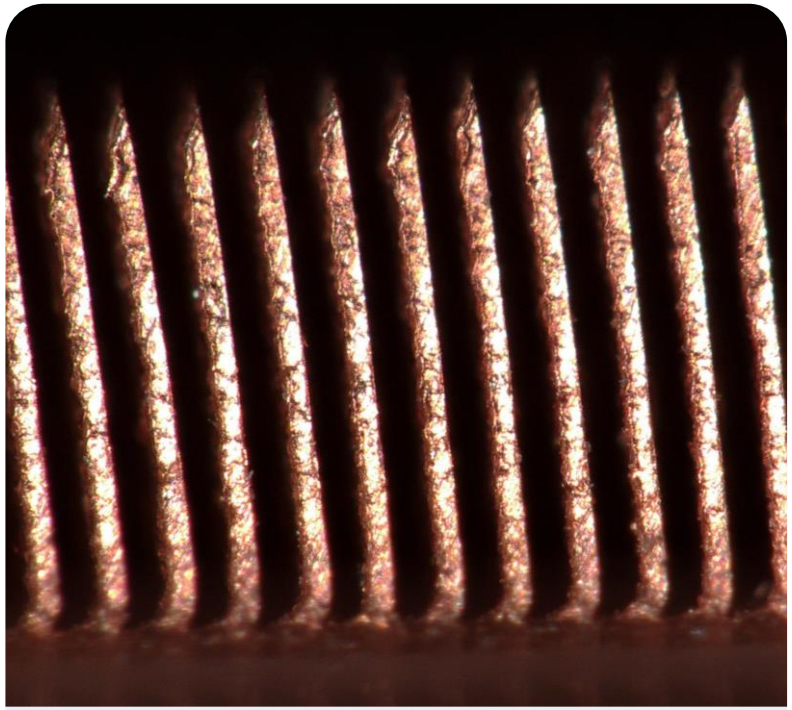
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VP Product Engineering

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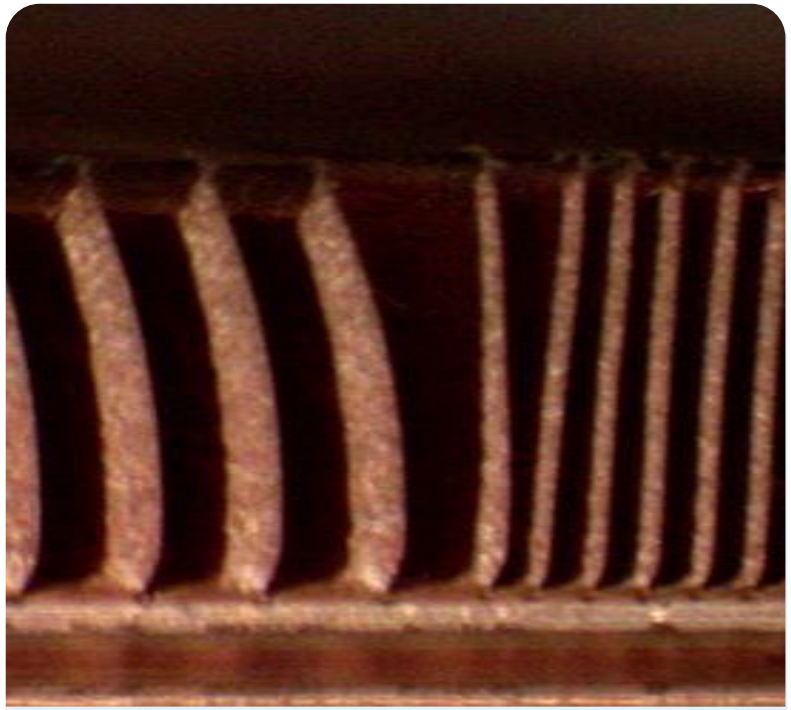
Thermal Stack



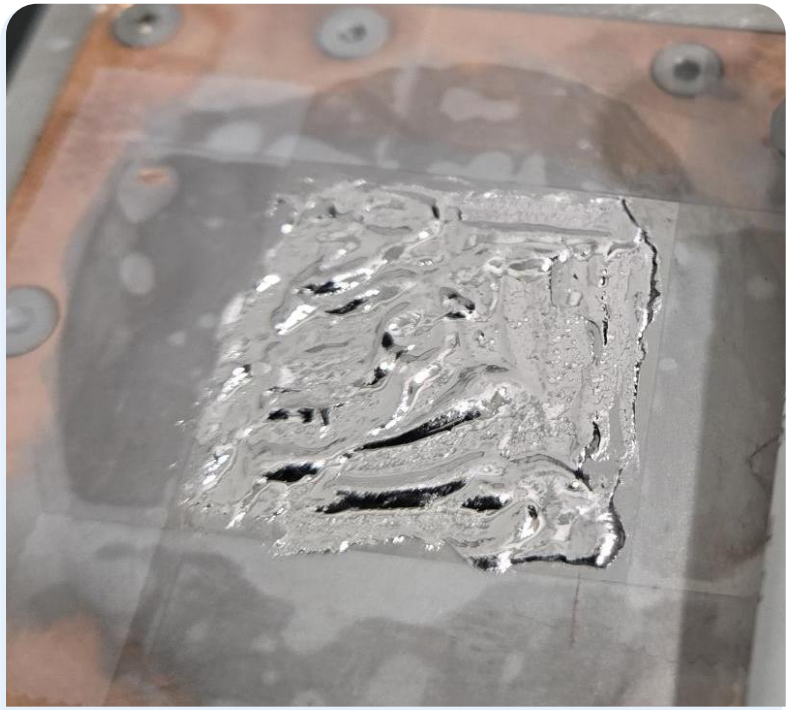
Fin Geometries & TIM2



Reduced Pitch for Improved Performance



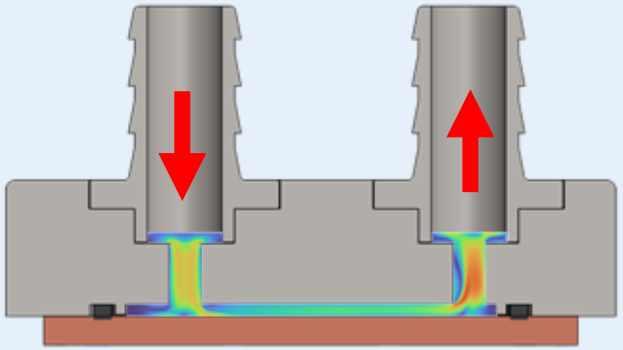
Variable Fin Pitch



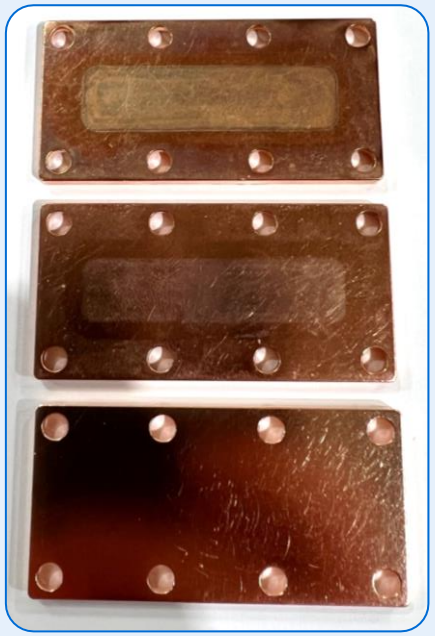
Reduces Thermal Bottleneck

CoolIT continues to evolve our skiving approaches to suit different applications.

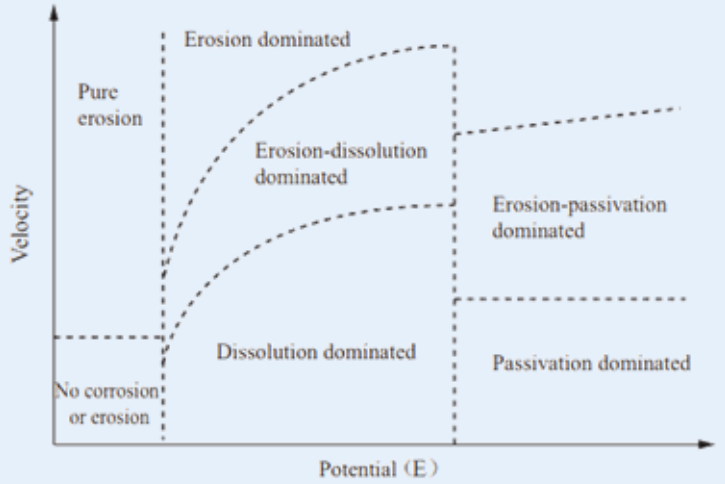
Corrosion Effects- Reliability Study



More heat, higher flow



Increased Velocity/Shear

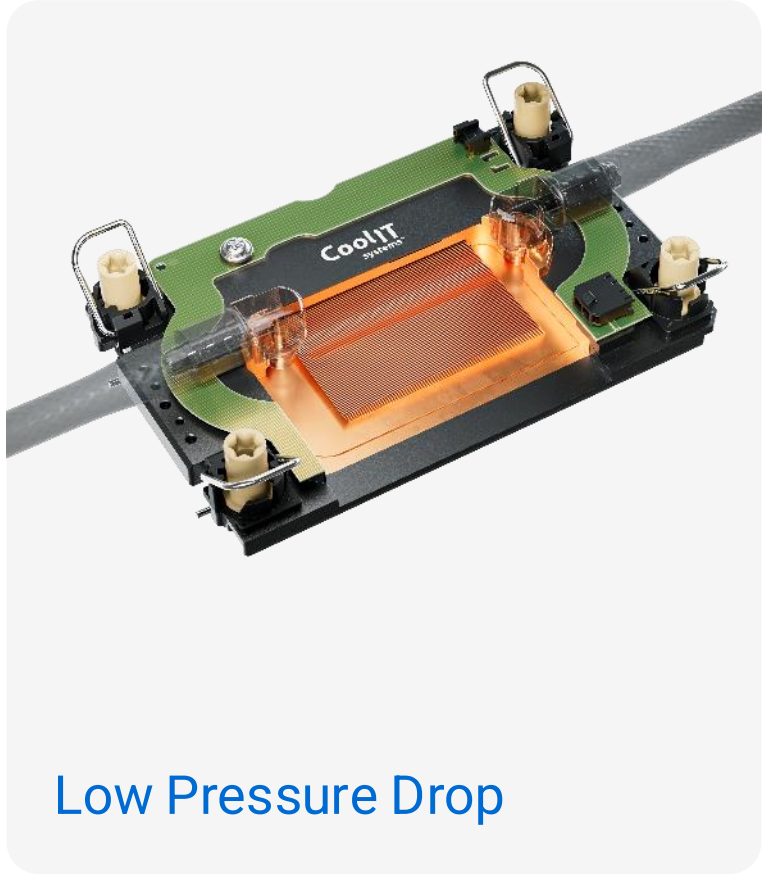


Minimize Durability Concerns

Understanding the limits on material durability

Coldplate Technologies

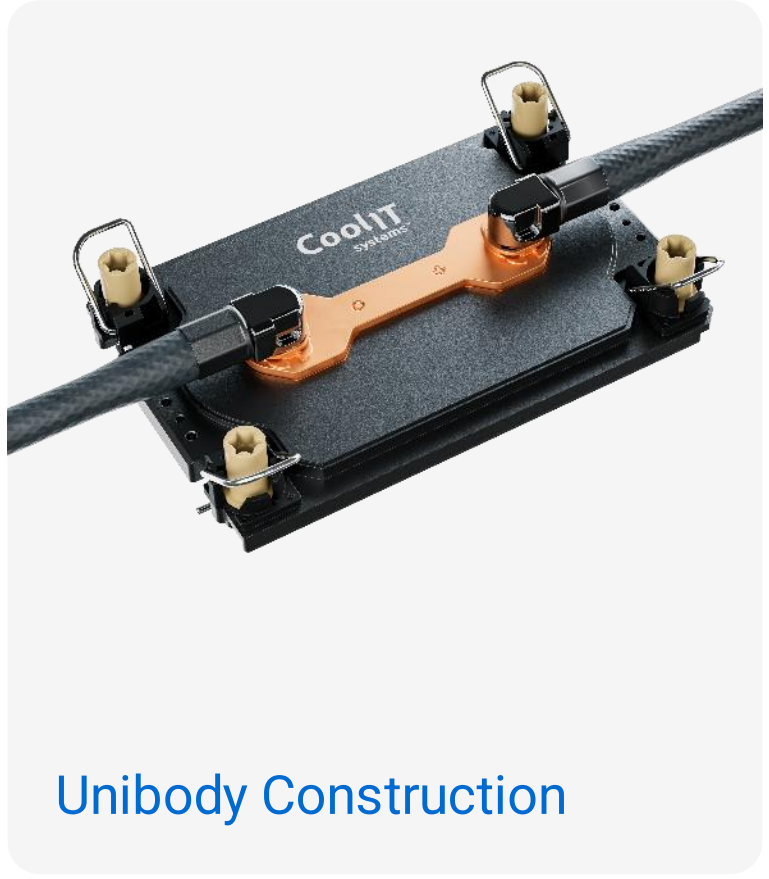
CoolIT is renowned for designing and producing best-in-class coldplates.



Low Pressure Drop



Low Thermal Resistance



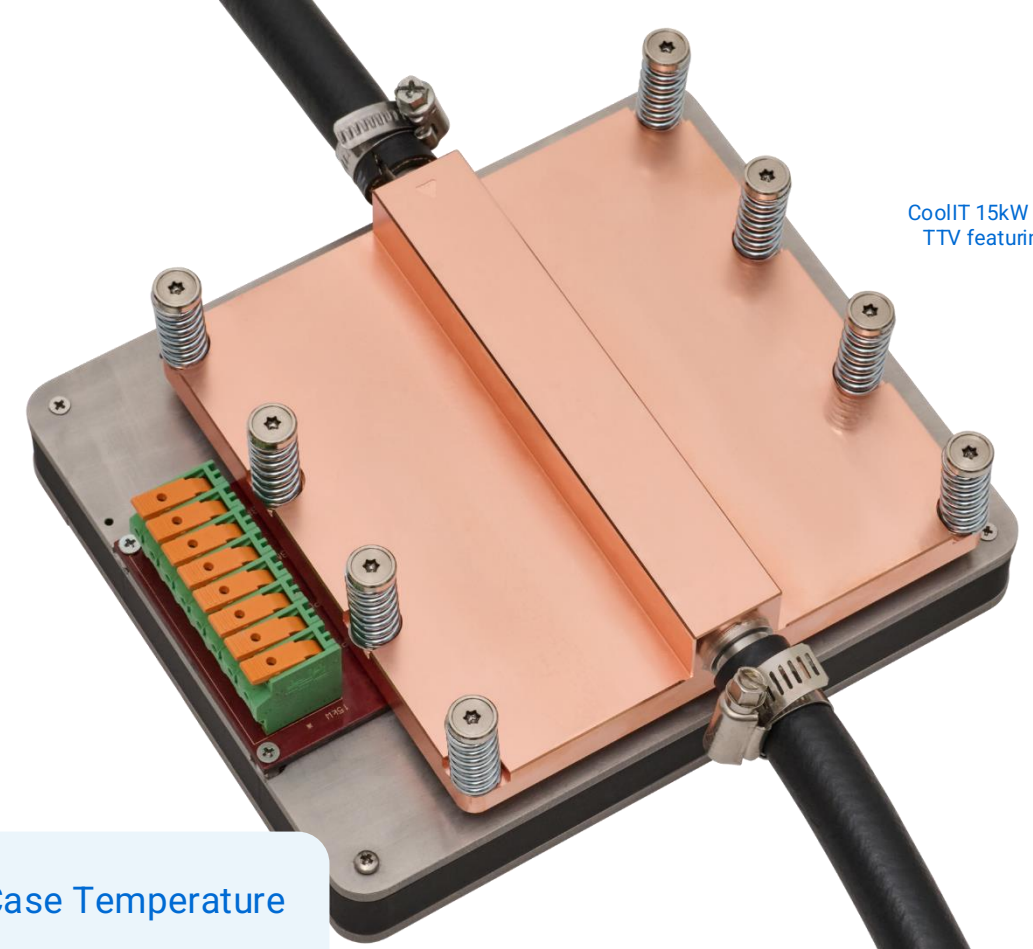
Unibody Construction

Industry's best performing, most reliable coldplate.

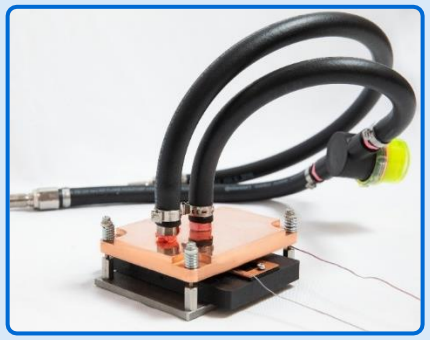
Scaling to 15kW

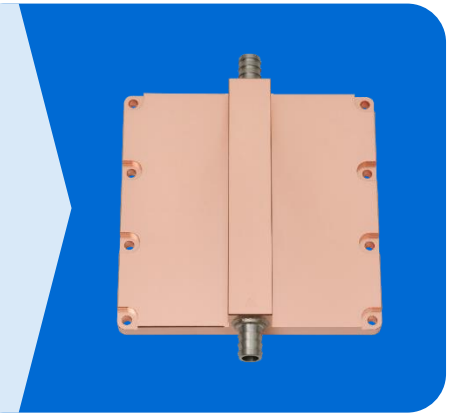
15kW validation proves mainstream approach to liquid cooling can scale beyond the next five generations of AI GPUs.

- Validated at 15kW TDP using current DLC architecture
- Achieved with AI-class flow rates and facility water
- Demonstrates ~4× scaling from prior 4kW design on the same foundation



CoolIT 15kW Coldplate & TTV featuring OMNI™ & SplitFlow™





80°C Case Temperature

35°C ΔT

45°C Facility Water

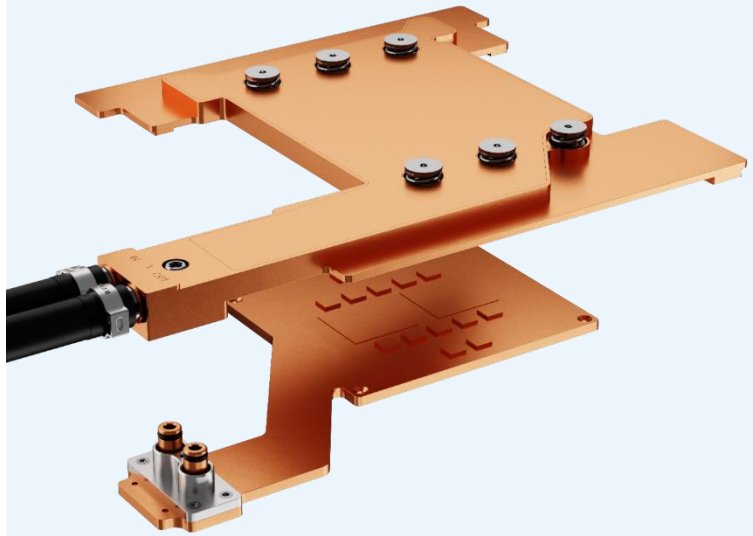
15kW TDP

1.2LPM/kW FLOW RATE

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Double Sided Processor Cooling

Dual Sided PCBs



Conduction Through-Plane Limited



Dual Sided Cooling Required



Unlocking future chip architecture with cooling for the underside power delivery.

Agenda

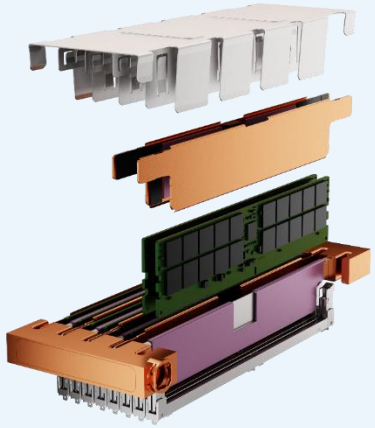
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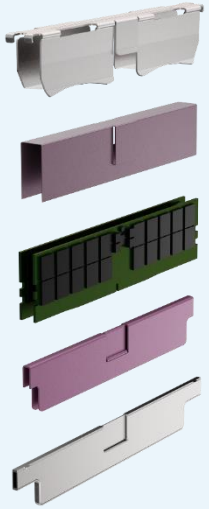
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CPU + DIMM



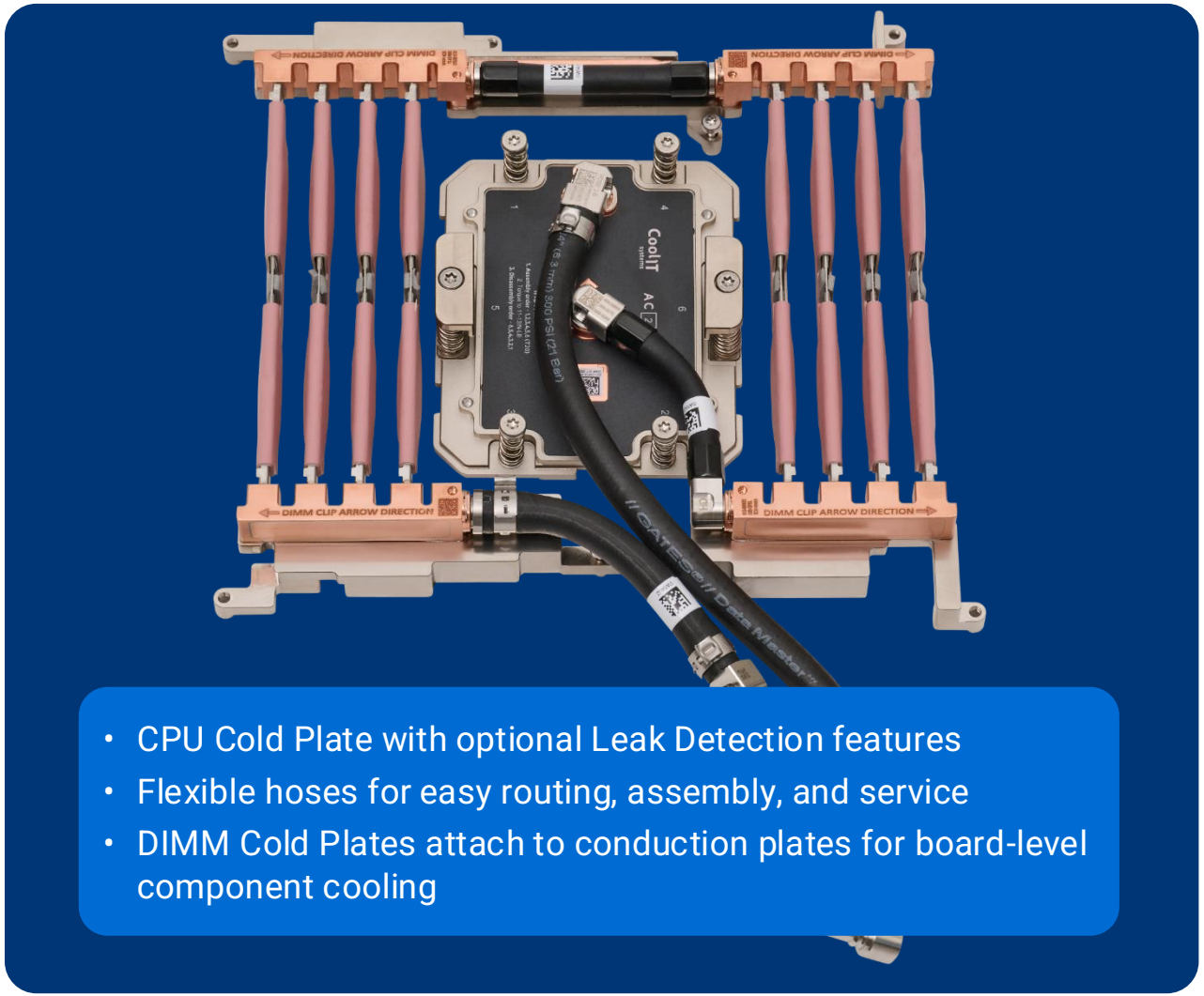
TWO-SIDED COOLING

- Vapor Chamber or Tube-Only
- Top-down Serviceability
- >20-40W DIMMs (DDR5+)



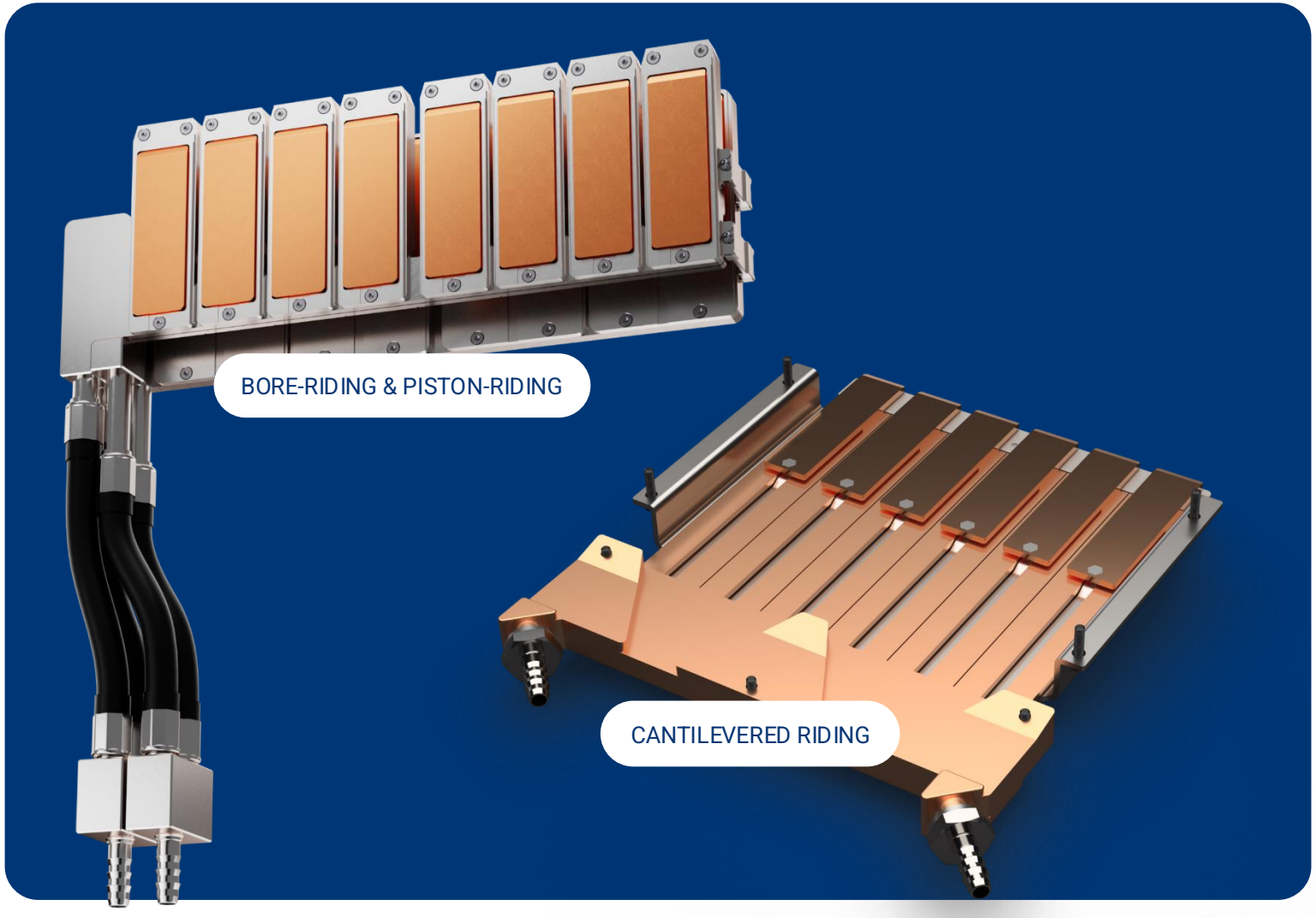
ONE-SIDED COOLING

- Tube-Only + Clip
- Maximum Serviceability
- <20W DIMMs (DDR4)



- CPU Cold Plate with optional Leak Detection features
- Flexible hoses for easy routing, assembly, and service
- DIMM Cold Plates attach to conduction plates for board-level component cooling

Pluggable Networking & Storage



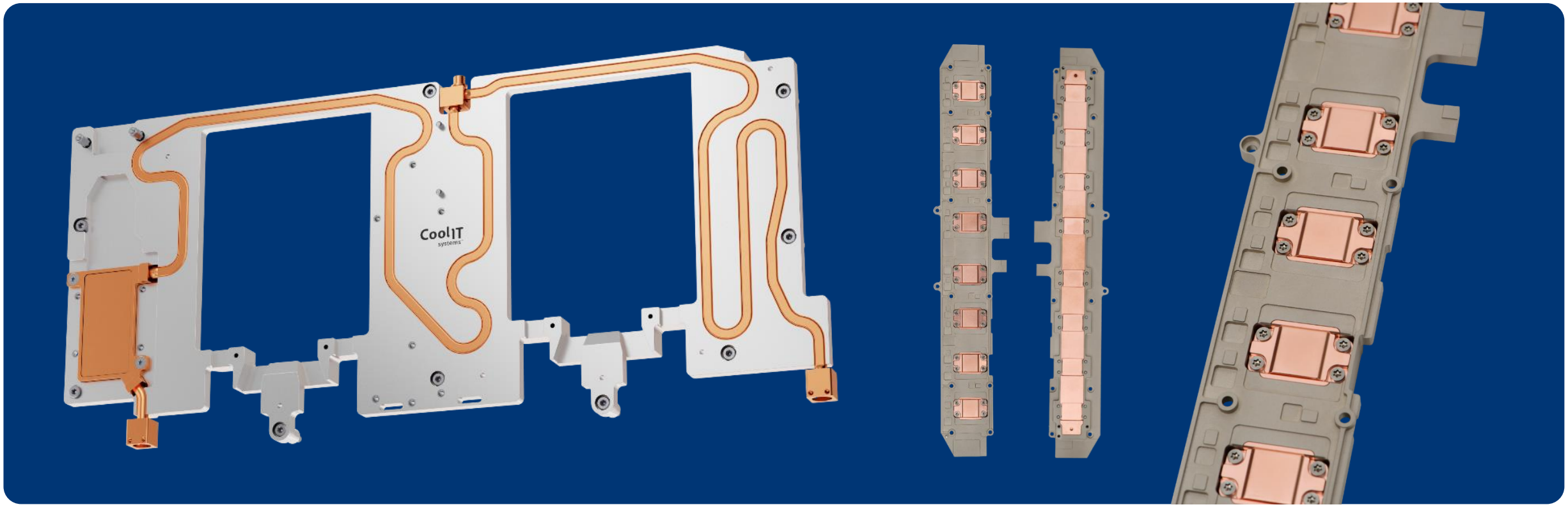
RIDING COLD PLATE

- Maximum Performance (>15W)
- High TC Abrasion Resistant TIM
- Oring and non-Oring Riding Cold Plates available
- Various formfactors support unique spatial requirements

FIXED COLD PLATE

- Maximum Simplicity
- Ultra-Compliant Abrasion Resistant TIM
- <15W thermal capacity

Thermal Transfer Plate



Supports 100% heat capture of board-level components.

NICs | SSD | SOCAMM | VRM | Board-Referenced + Gap Pad | Die-Referenced + PCM | Two-Sided Cooling | Under-Board Cooling

Built for purpose.

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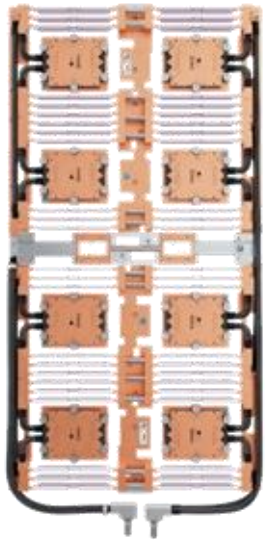
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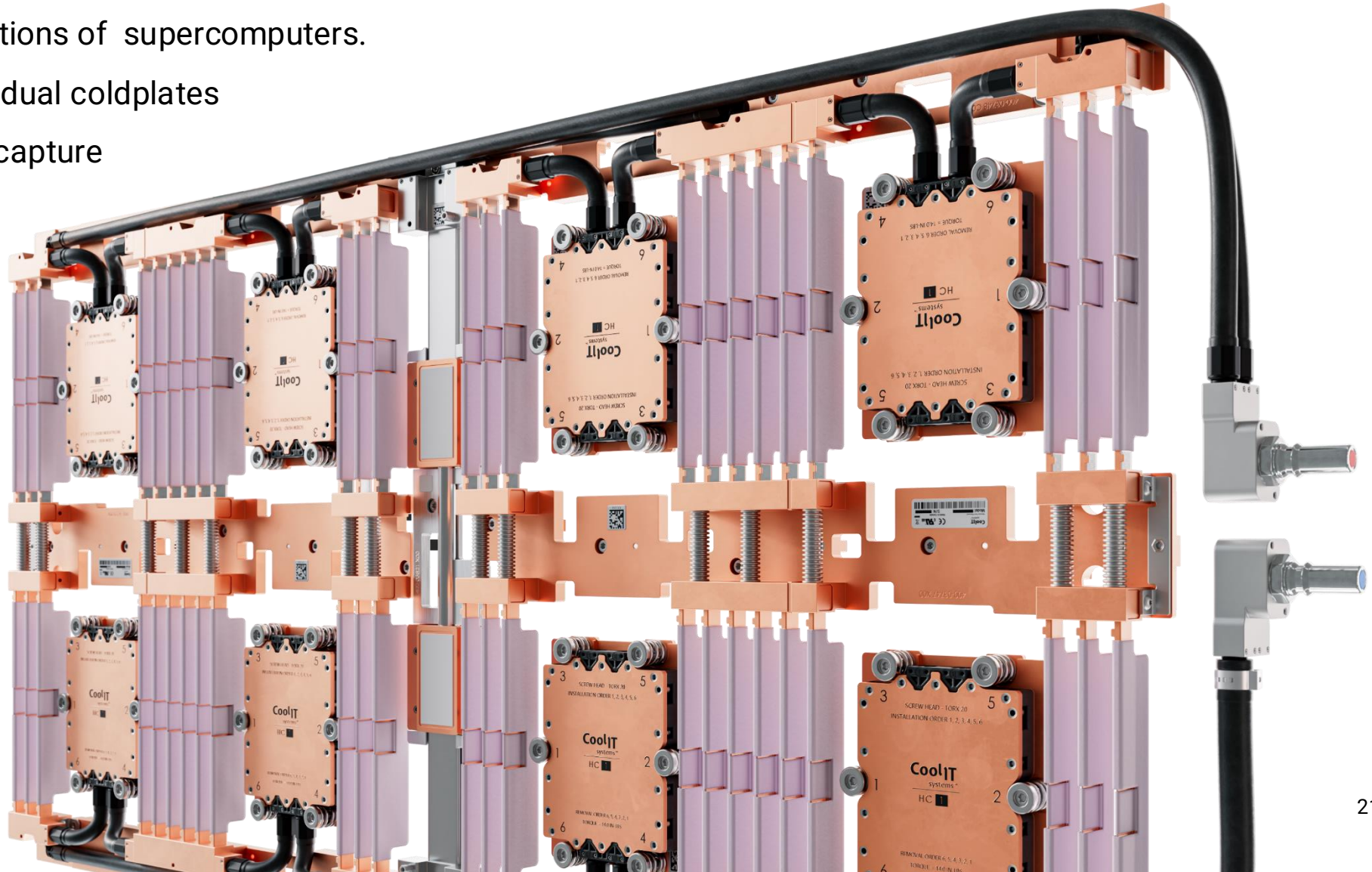
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Coldplate Loop Architecture

70-100% Scalable Heat Capture

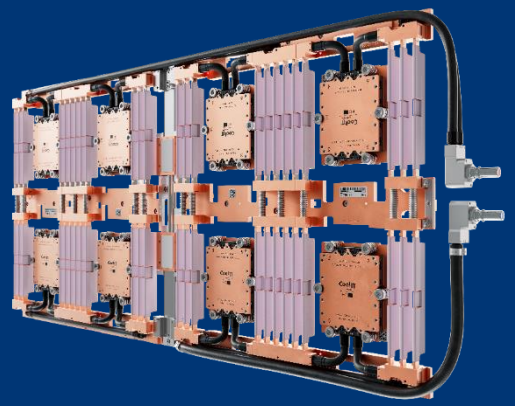
- A proven backbone of 6 generations of supercomputers.
- Fully modular design with individual coldplates
- Customize from 70-100% heat capture
- Easily service electrical components





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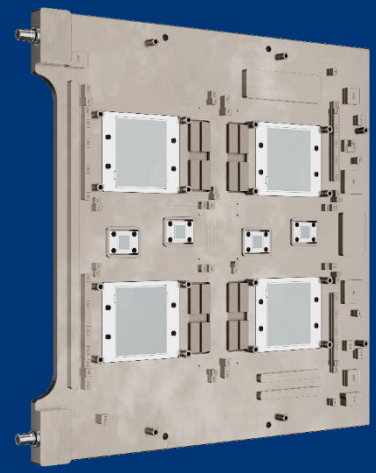
Fanless Server Cooling Architectures



COLDPLATE LOOP
ARCHITECTURE



MIXED
ARCHITECTURE



MONOLITHIC COLDPLATE
ARCHITECTURE

INTEGRATED COMPONENTS

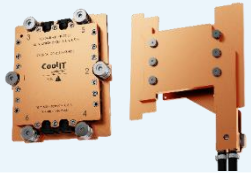
CPU



GPU



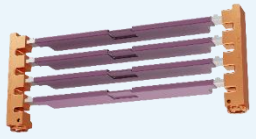
ASIC



Switch



DIMM



SFP



SSD, SOCAMM, ETC



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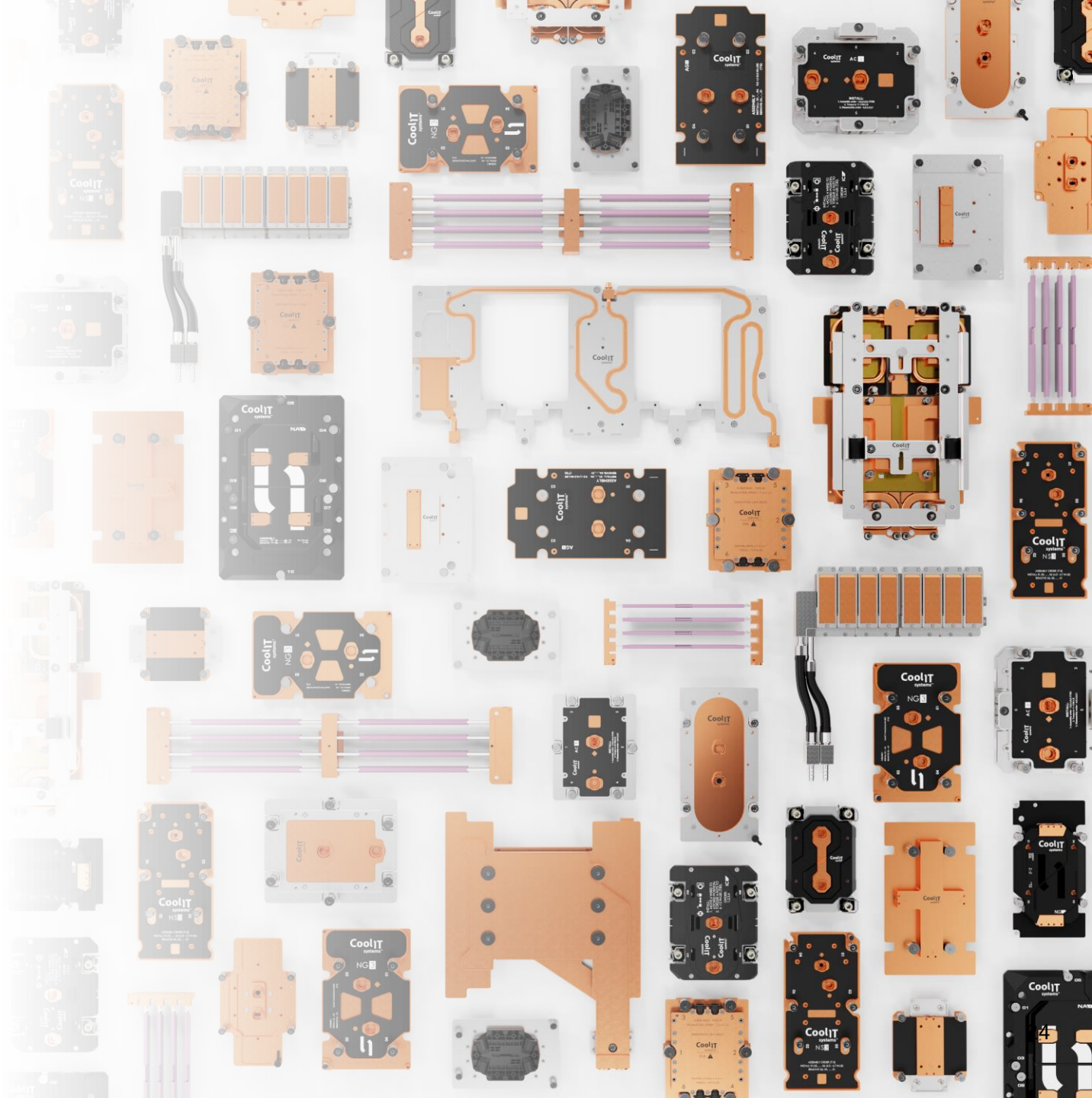


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VP Product Engineering

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Heat Capture Toolkit

CoolIT has a library of components that can be integrated into loops or plates to deliver 100% heat capture.



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Critical Layers of Thermal Management

	PROCESSOR	SERVER	RACK	POD
MARKET TODAY	150 W/cm² HEAT FLUX 2400 W TDP	10 kW LOOPS	250 kW DENSITY	9 MW CLUSTER
CIT TODAY	300 W/cm²+ HEAT FLUX 4000 W+ COLDPLATES	15 kW+ LOOPS	500 kW+ DLC RACKS	30 MW+ GROUPED CDUS
CIT TOMORROW	500 W/cm²+ HEAT FLUX 15000 W+ COLDPLATES	50 kW+ LOOPS	1 MW+ DLC RACKS	60 MW+ GROUPED CDUS

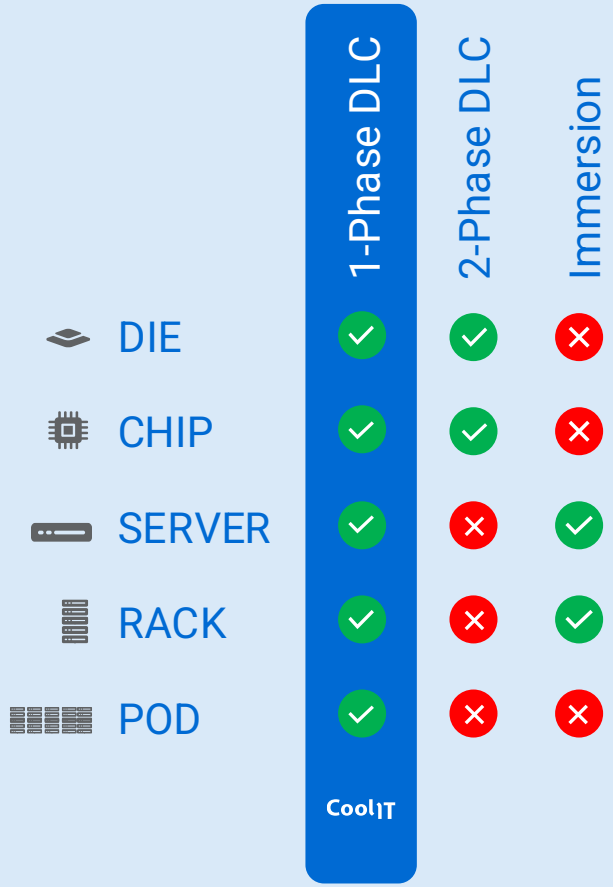
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Why Single-Phase DLC is the platform for the future.

1 **Effective Heat Capture at All Levels**
From ultra high heat flux, to long distance transportation – 1-phase wins.

2 **Multi-Vendor, Interoperable Ecosystem**
With well established suppliers, installers and operators.

3 **Simple & Scalable by Design**
Already being deployed on mass in GW Data Centers today.



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Fanless Servers Are Coming:
The Peripheral Coldplate Roadmap Behind 100% Heat Capture

Brad Zakaib, VP Product Engineering

Visit our booth #E9



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