

High-Performance Two-Phase Cooling Under Different Cold Plate Orientations

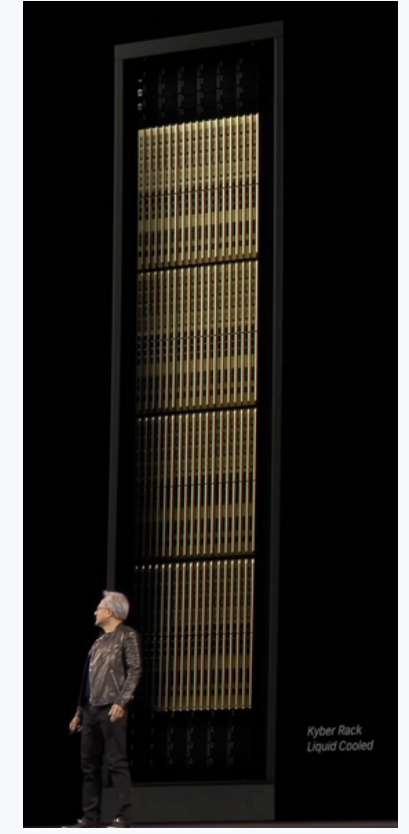


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Introduction

- **Thermal design power of processors is surging driven by AI workloads**
 - Current: ~1000W; Future: approaching 2000W
- **Two-phase direct-to-chip cooling offers great advantages**
 - Superior heat transfer (via nucleate boiling)
 - Isothermal processor case surface
 - Dielectric safety vs. water in case of leaks
 - Cost-effective and retrofittable to existing data centers
- **Higher chip- and rack-level power densities necessitate innovative thermal packaging and management designs:**
 - Traditional cold plates have standard horizontal upward orientation
 - New server designs (e.g., vertical blades, upside-down racks, double-sided cooling) require cold plates with horizontal downward or vertical orientations

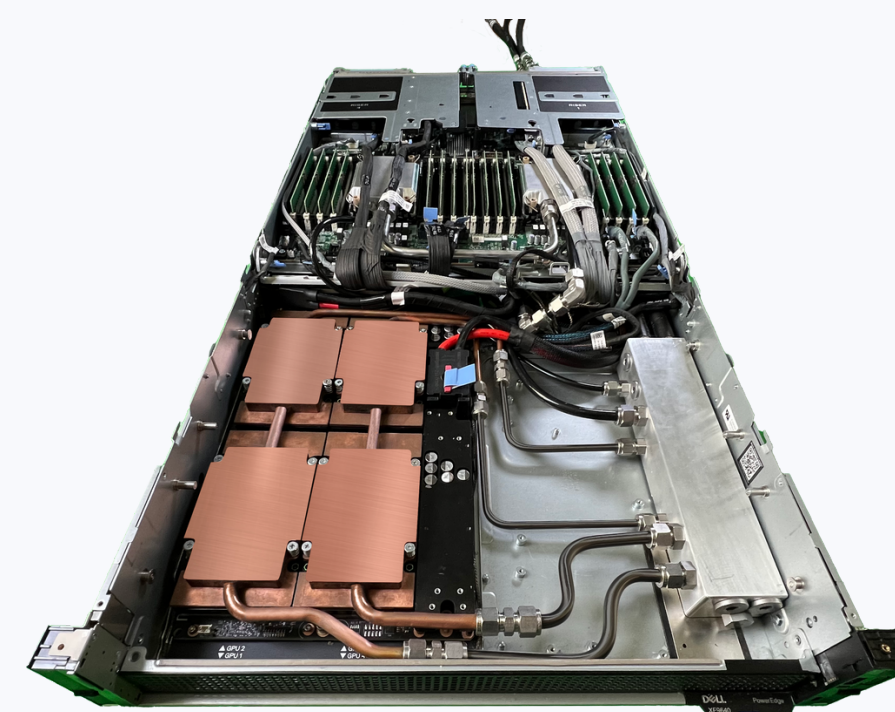


Liquid Cooled Kyber Rack with Vertical Servers Set for Deployment 2027 (NVIDIA at GTC March 2025)

Example Two-Phase Products

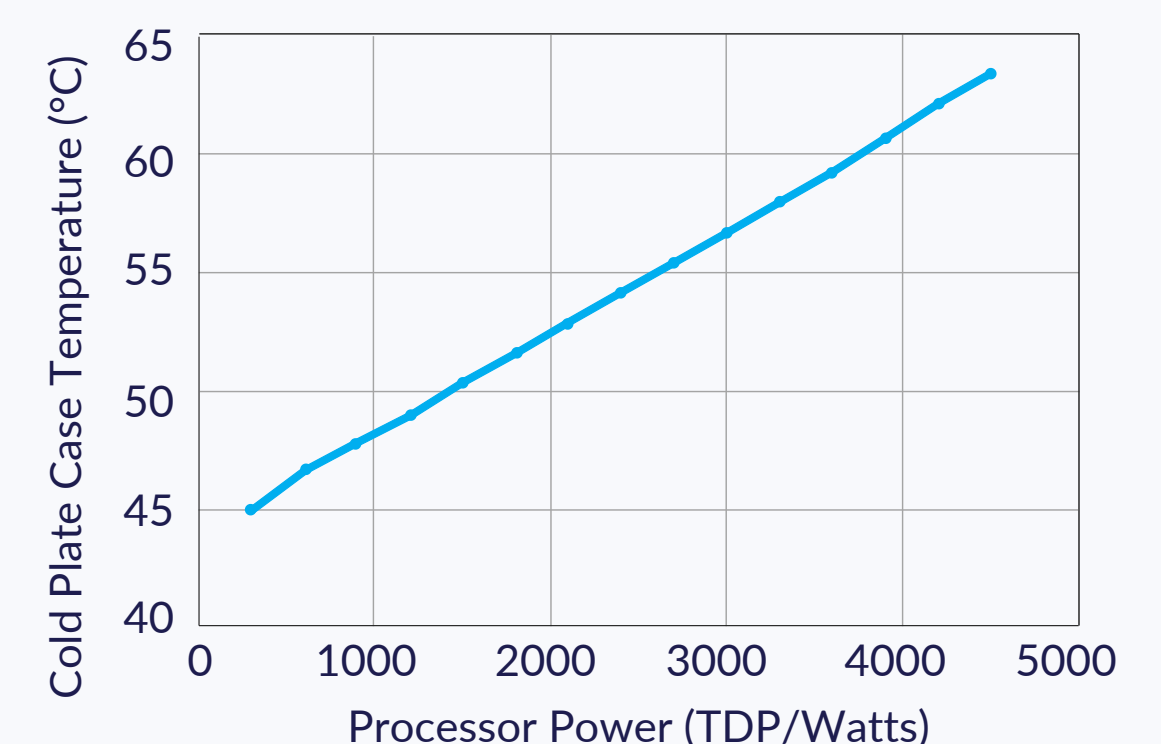
CDU:

- Closed-loop system with dielectric fluid (eco-friendly R1233zd(E) or high-performance R515B)
- The largest cooling capacity two-phase in-row CDU: MR250
- Able to cool 250kW of H100 servers with 40°C facility water

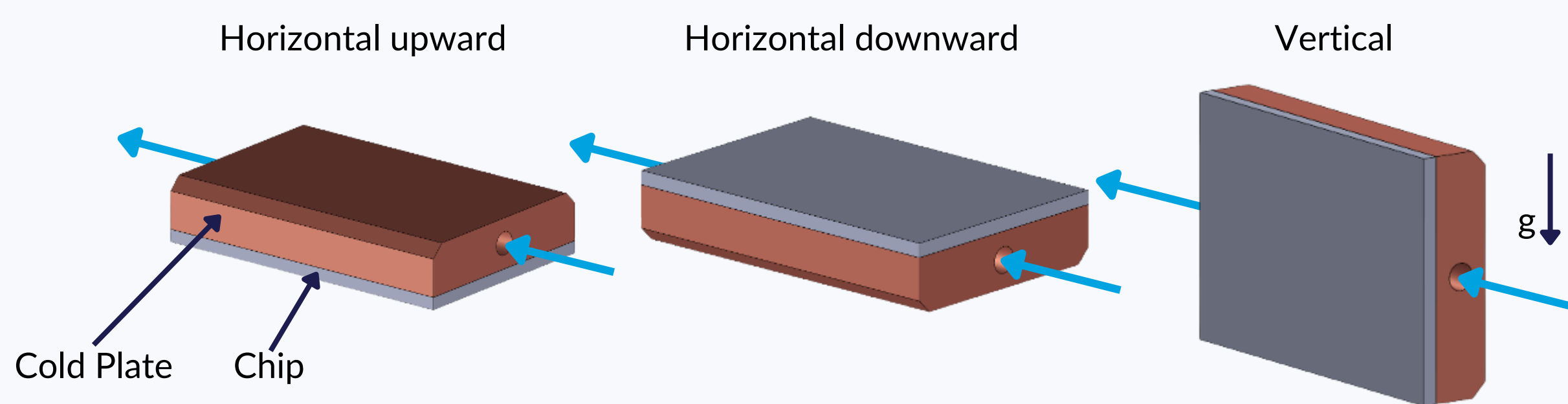


Cold Plate:

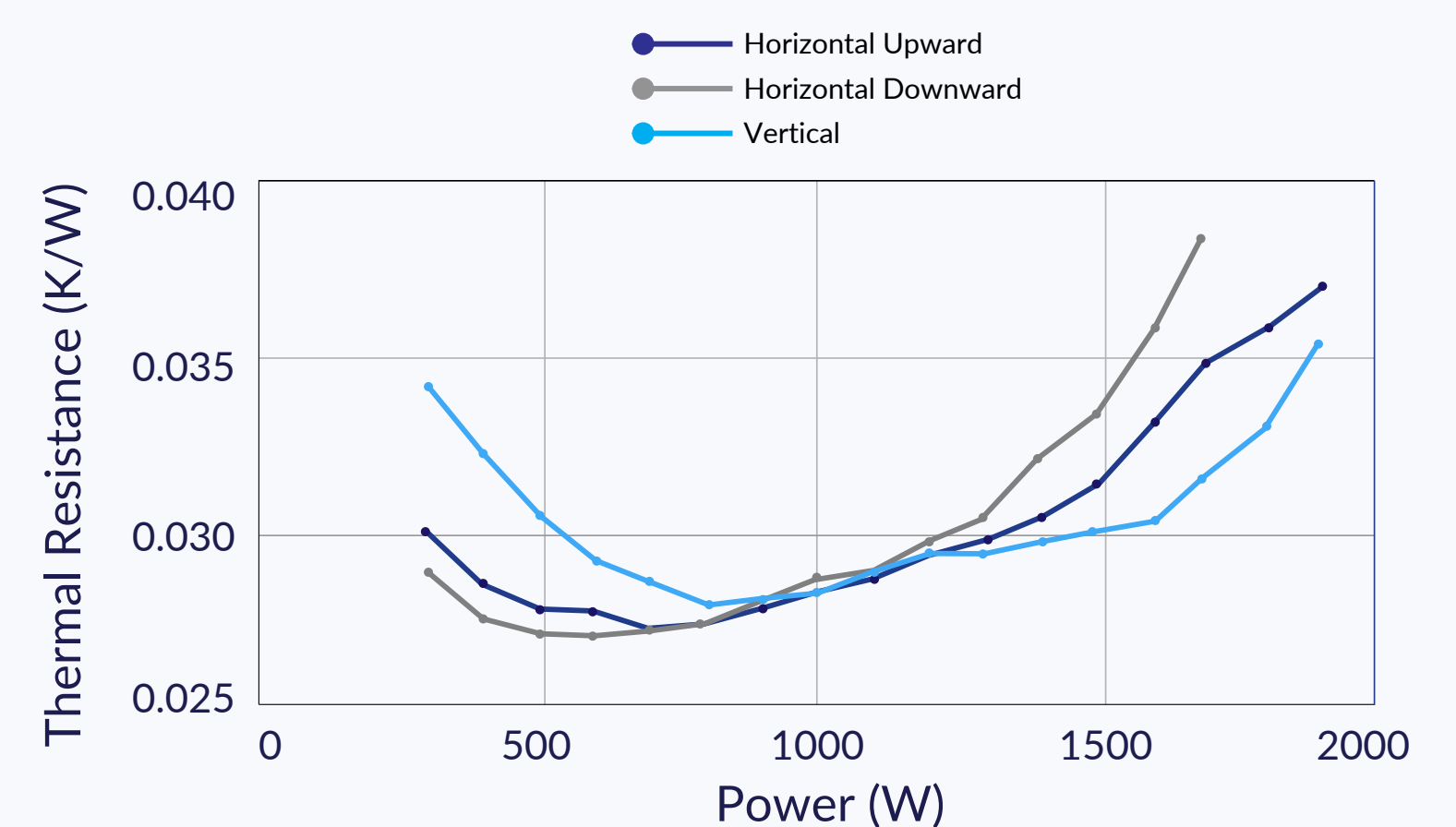
- Standard skived copper cold plate with flow boiling design
- Tested using R515B on a GPU TTV with saturation temperature at 40°C
- 4,500W was removed efficiently before wall power limitations were reached



Orientation Effects on Performance



- Three orientations tested for a cold plate tested without any orientation-specific modifications
- Performance Differences attributed to vapor bubble behavior and buoyancy-driven flow patterns
- All orientations maintained high thermal performance; no dry-out observed
- Orientation-specific design should yield even better performance



Summary: Orientation-Resilient Design

- Two-phase cooling delivers superior performance, enabling 250kW racks and 4500W TDP processors
- Future high-power racks and processors will require vertically mounted servers/processors or downward cooling
- Accelsius' two-phase flow boiling cold plates demonstrated reliable high performance in all orientations under consideration
- Our technology supports flexibility in server architecture (e.g., blades, edge racks, double-sided cooling), and enables thermal management of high-power processors in compact, high-density layouts

References

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