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Direct Contact Liquid Cooling on a Project Olympus Server

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Agenda

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- Case study objective
- Overview of the Project Olympus Server
- Specification of the components needed to implement a liquid cooling solution on the Project Olympus Server
- Test setup and constants
- Results from testing
- Changes required to support the harmonization effort

Case Studies

Objective

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Determine the performance and efficiency improvements achieved by using Direct Contact Liquid Cooling on a **Project Olympus 1U Universal Server** as compared to air.

CoolIT systems™

Rack DCLC™

Project Olympus

Case Studies

Project Olympus Server

https://www.opencompute.org/wiki/Server/ProjectOlympus

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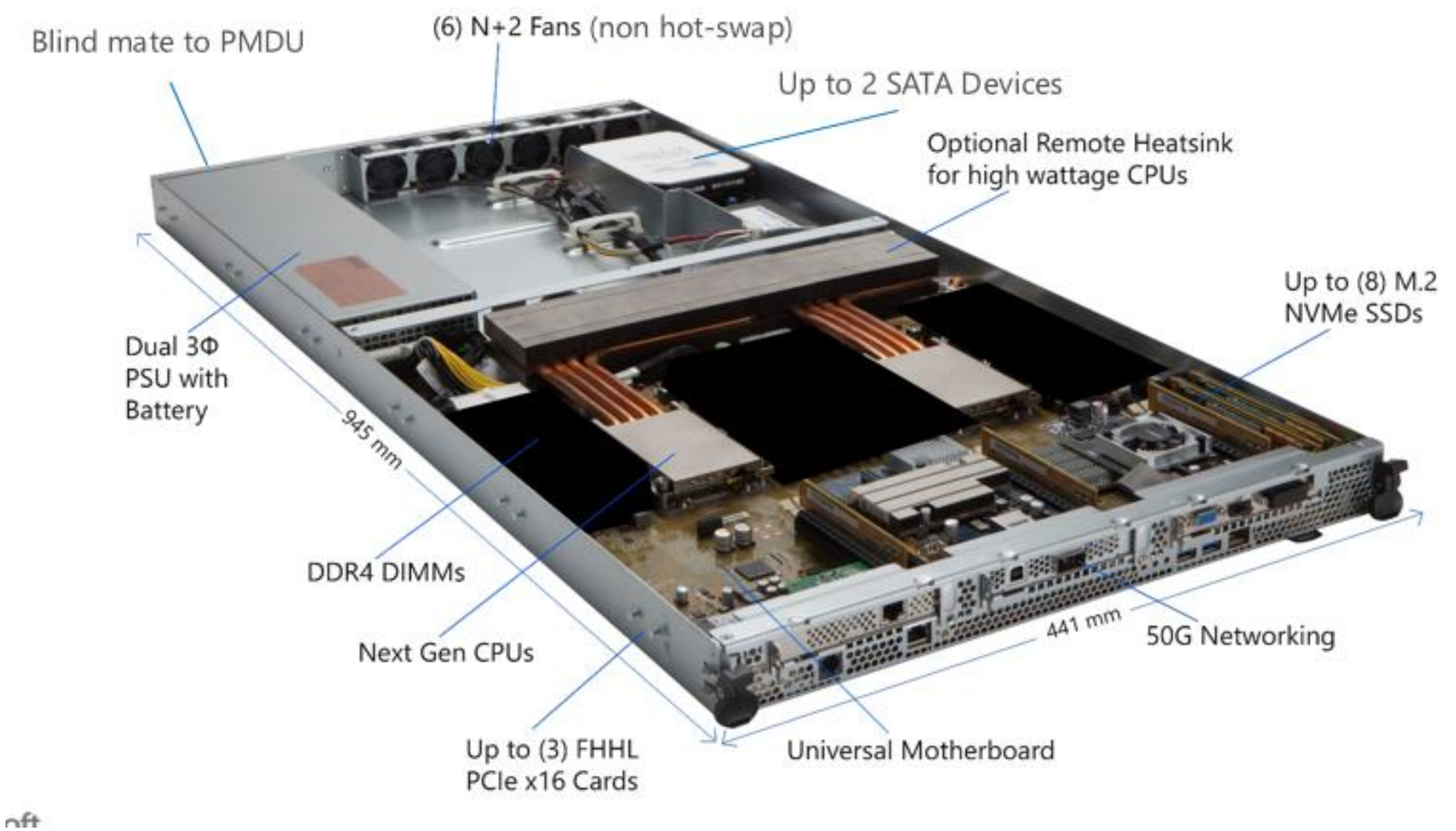

Configuration:
- 2x Intel(R) Xeon(R) Platinum 8168 CPU @ 2.70GHz
- 24x 32GB DIMM
- 1x PCIe

Case Studies

Why The Project Olympus Server?

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The Project Olympus Server was chosen for this case study because:

- It is a versatile server designed around modular building blocks
- It is an OCP Server Project
- It has an efficient air cooling solution

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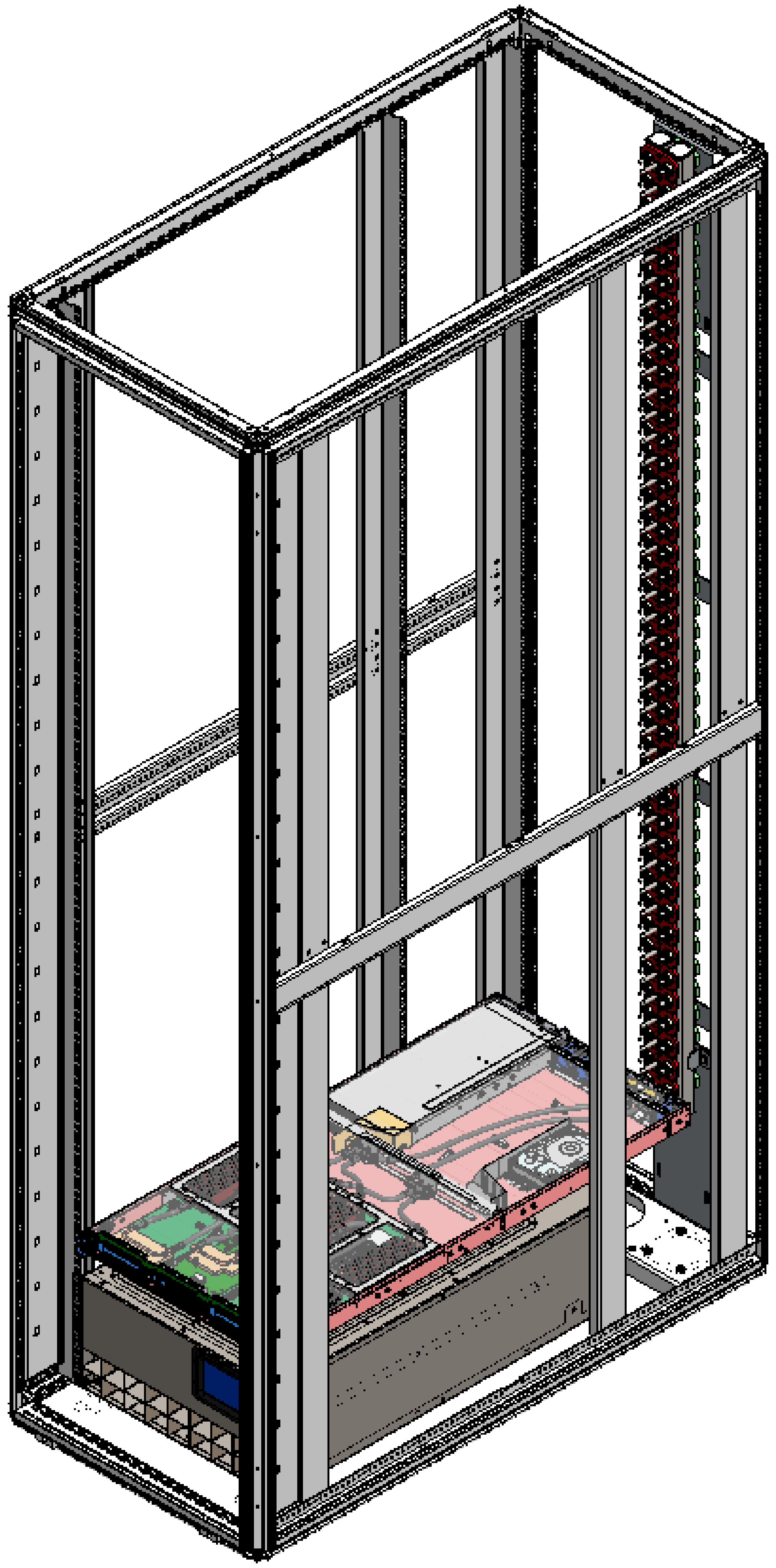
Components Required for DCLC

Passive Coldplate Loop (PCL)

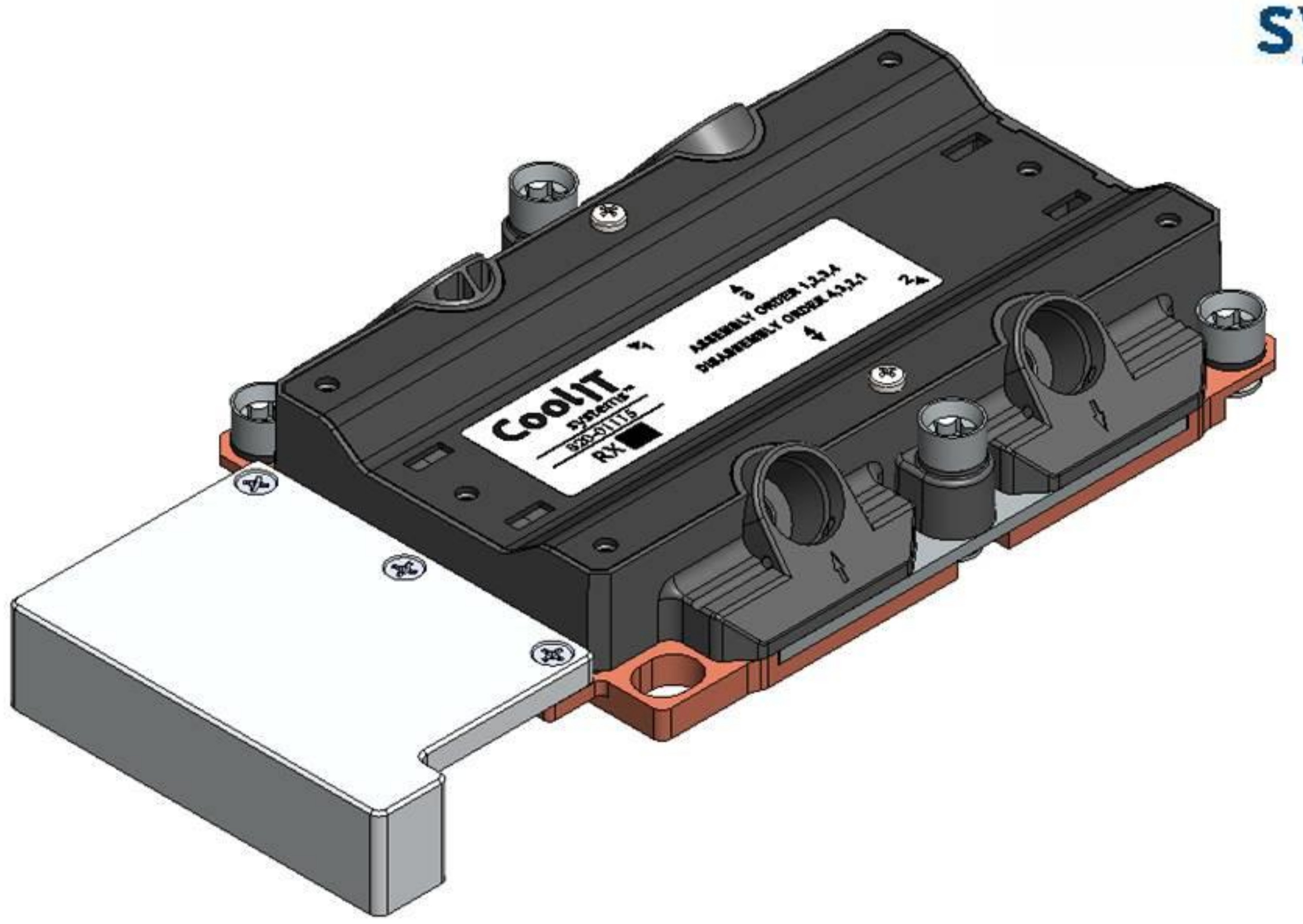
Rack Manifold

Coolant Distribution Unit



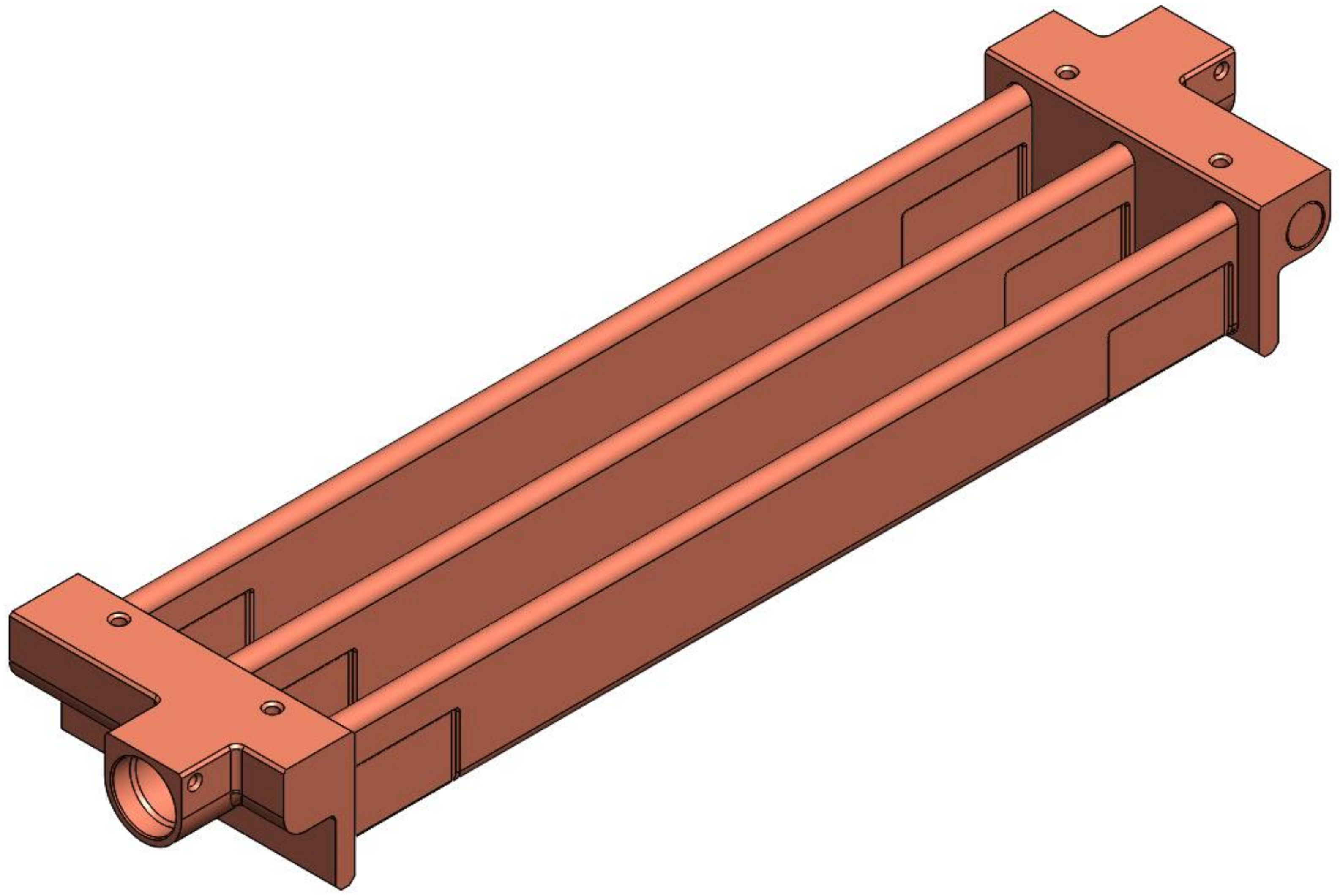
PCL Components

The Olympus Server is cooled using several different coldplate technologies…



- Microchannel Coldplate - CoolIT RX1 Server Modules for Intel Skylake CPU’s (x2)

- Direct Contact Memory Cooling - CoolIT MX4 DIMM Liquid Cooling Array

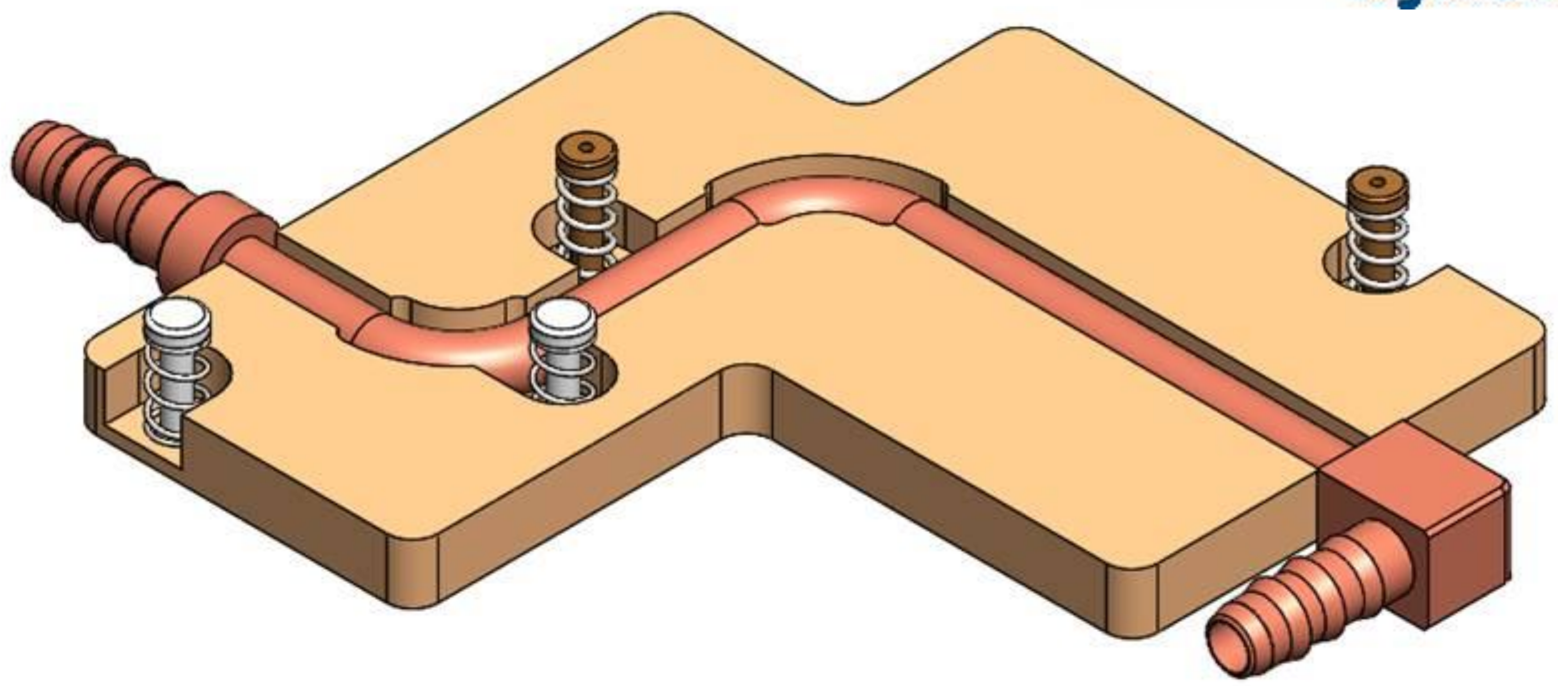


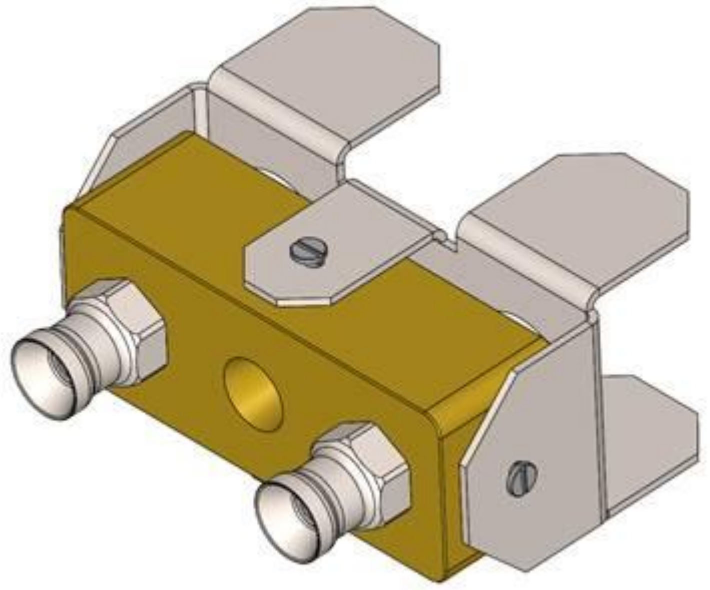
PCL Components

The Olympus Server is cooled using several different coldplate technologies…

- Embedded Tube Coldplate - CoolIT designed custom low heat density coldplates

- Chassis blind-mate quick disconnects

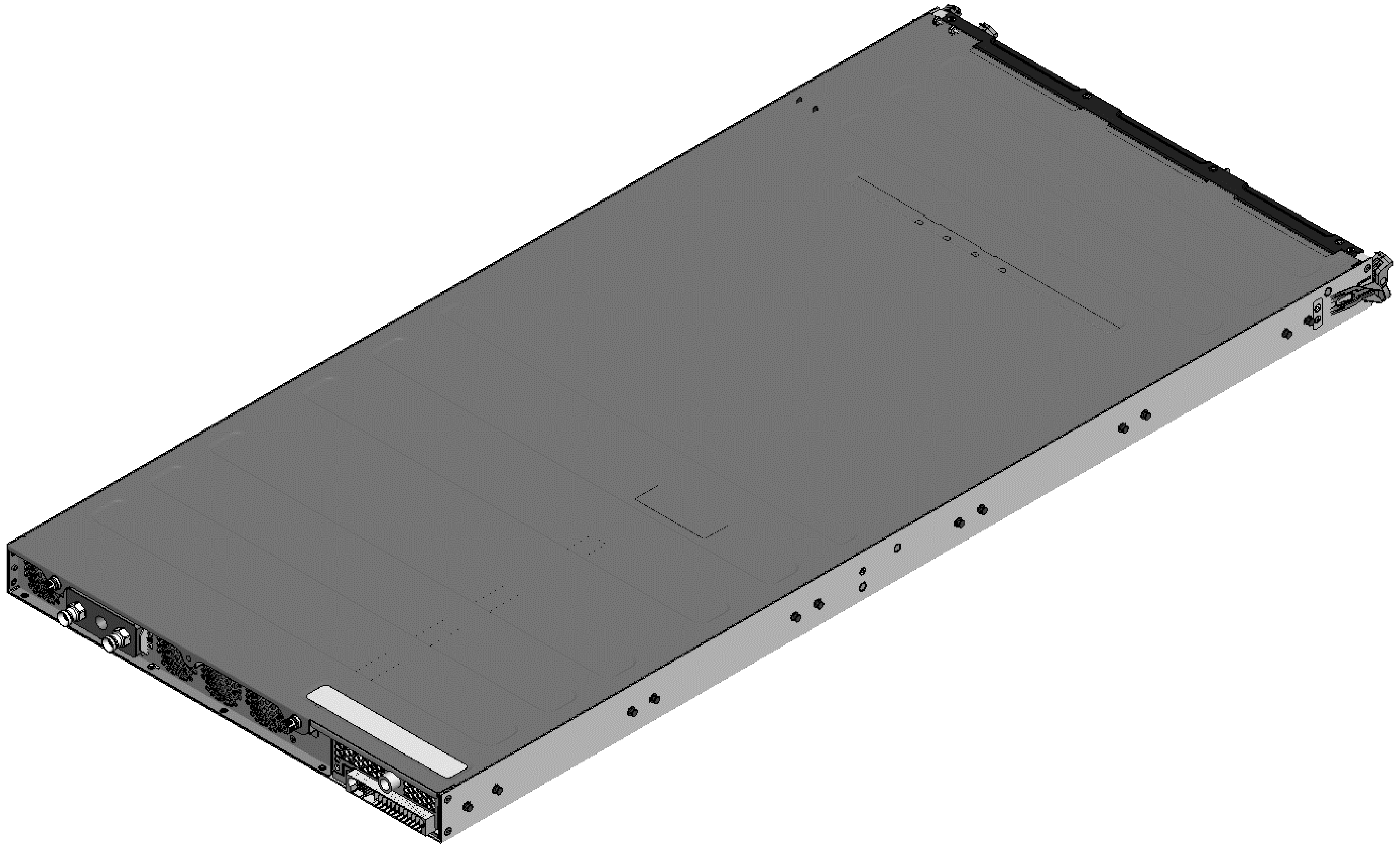




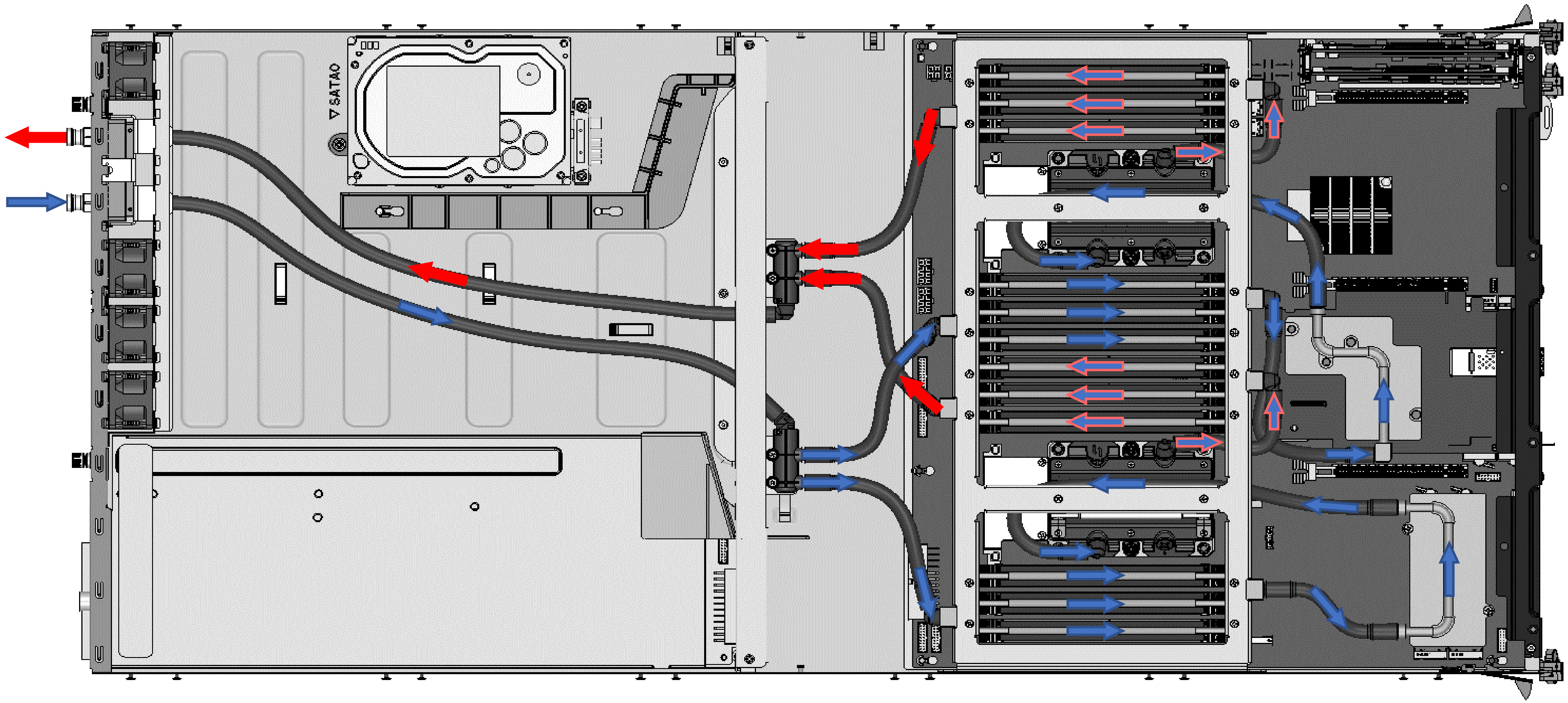
PCL Specification

Treating the PCL as a black box, the specification is as follows:

- Nominal Flow Rate: 1.0 L/min
- Nominal Pressure drop: 4.5 PSI
- Quick Disconnect Diameter: 3mm
- Complies with [TCS/DECS wetted material list]



PCL Direction of Flow



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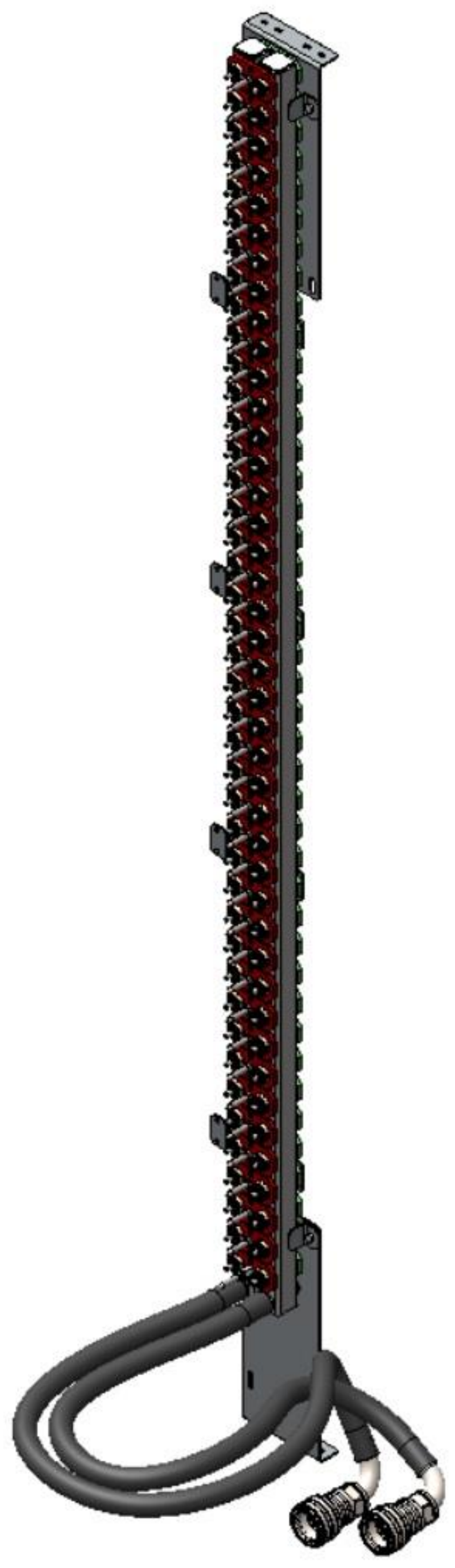
Manifold Specification

Blind-mate Manifold

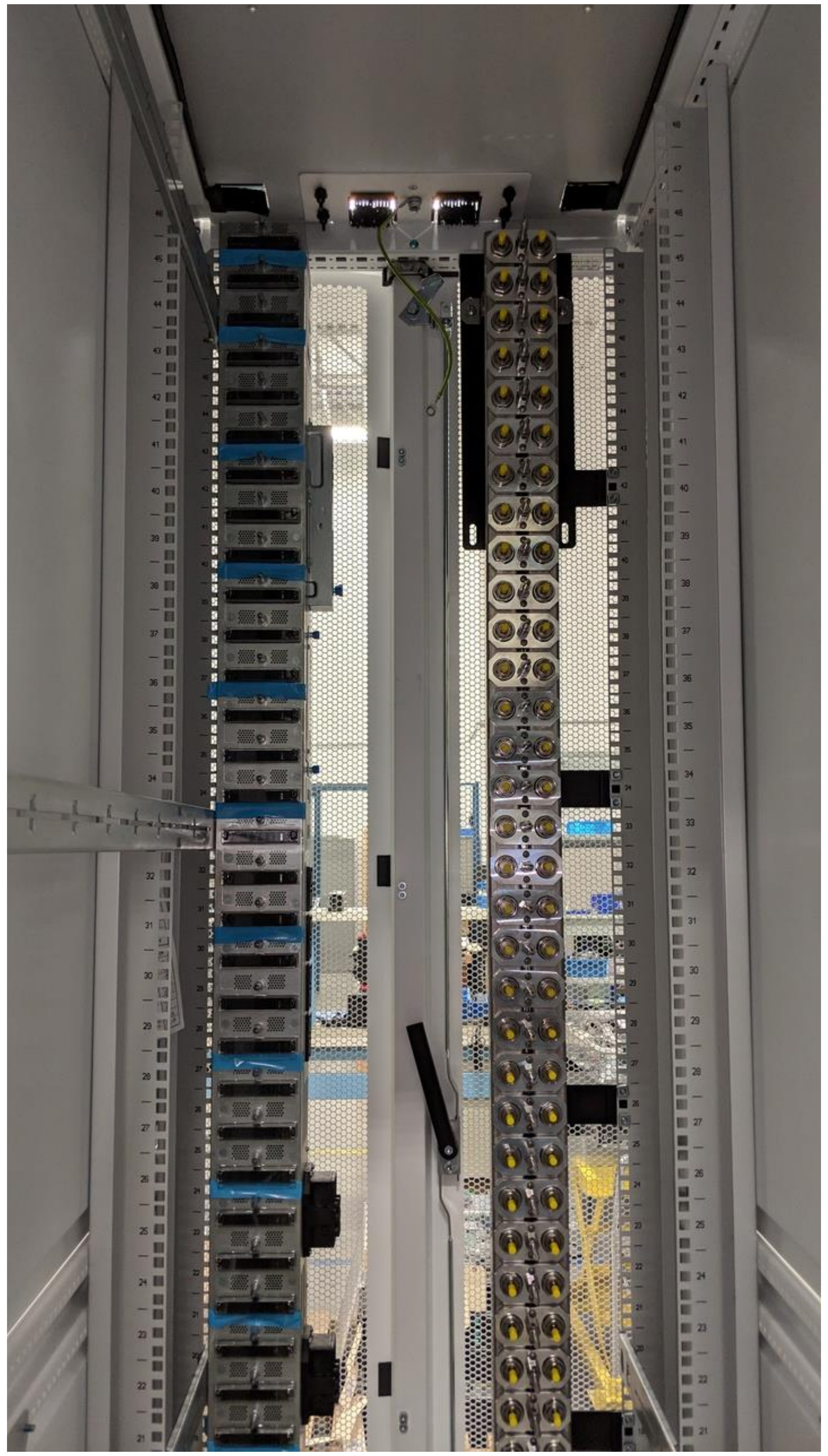
Project Olympus has a blind-mate PMDU, so blind-mate liquid connection is also required.

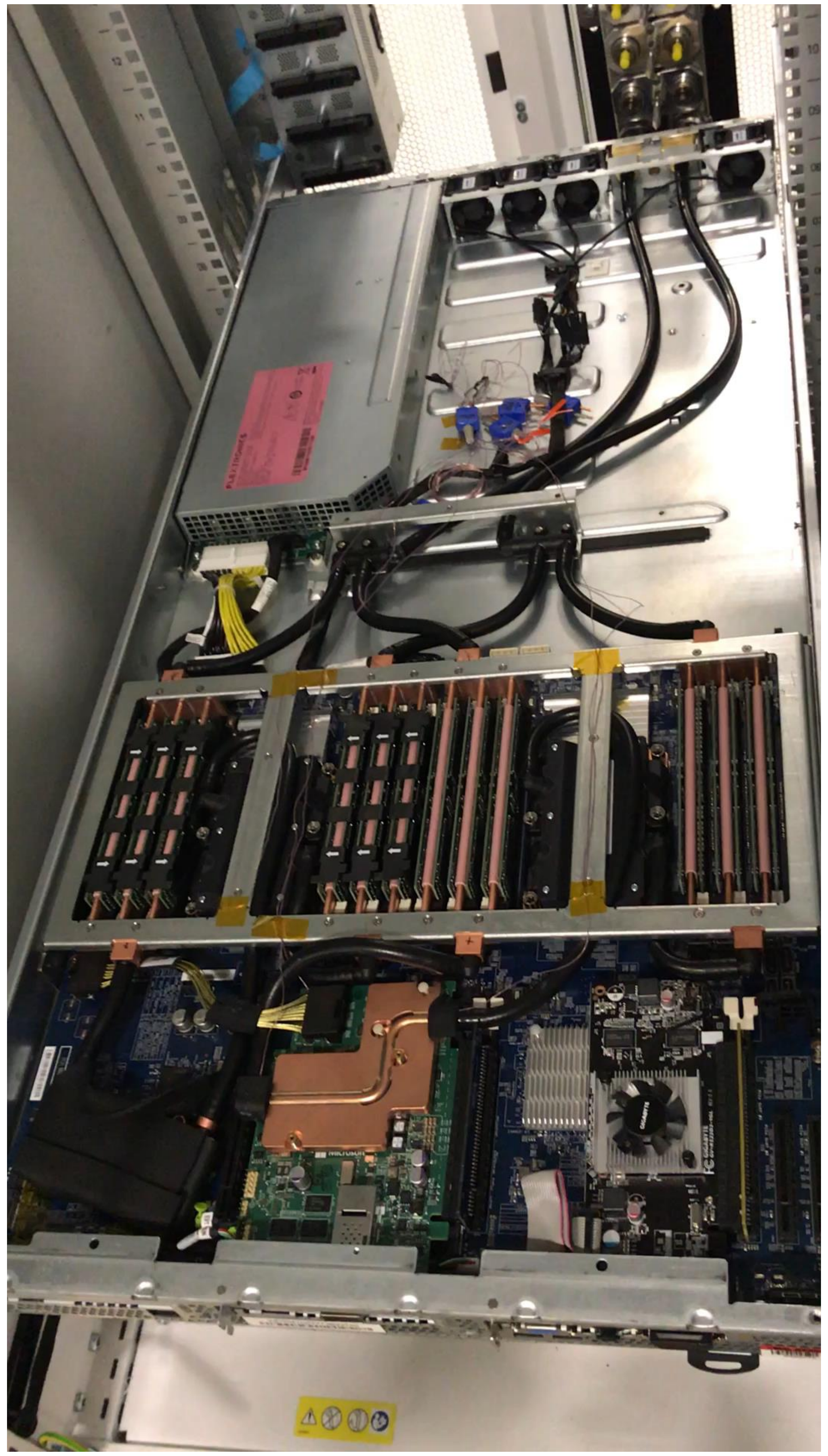
The manifold specification is as follows:

- Nominal Flow Rate: 42.0 L/min
- Nominal Pressure drop: 3 PSI
- Quick Disconnect Diameter = 20mm
- 25.4mm Nitrile Tubing
- Complies with TCS/DECS wetted material list
- Dimensions:
  - 38mm square tube
  - 1905mm tall by 83mm wide



Blind-mate power and cooling





CDU Specification

CHx80 Rack-mount liquid-to-liquid CDU

4U Rack-mount CDU capable of handling up to 42 Olympus servers. 2U is left open unoccupied for networking.

The CDU specification for this setup is as follows:

- Nominal Flow Rate: 42.0 L/min
- CDU External Pressure Differential: 7.5 PSI
- Quick Disconnect Diameter = 20mm
- Total power dissipated in Liquid = ~25kW
- Approach Temperature = 5C @ W4, Qprimary=65 L/min
- Complies with [TCS/DECS wetted material list]

Test Setup and Constants

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Constants:

- Ambient air temperature = 35°C
- Liquid flowrate = 1.0 L/min
- Intel PTU Software recording CPU and Memory Temperature
- Thermocouples recording liquid and air temperatures

Variables:

Secondary fluid temperate ASHRAE W1, W2, W3, W4

- W1 = 17 °C
- W2 = 27 °C
- W3 = 32 °C
- W4 = 45 °C

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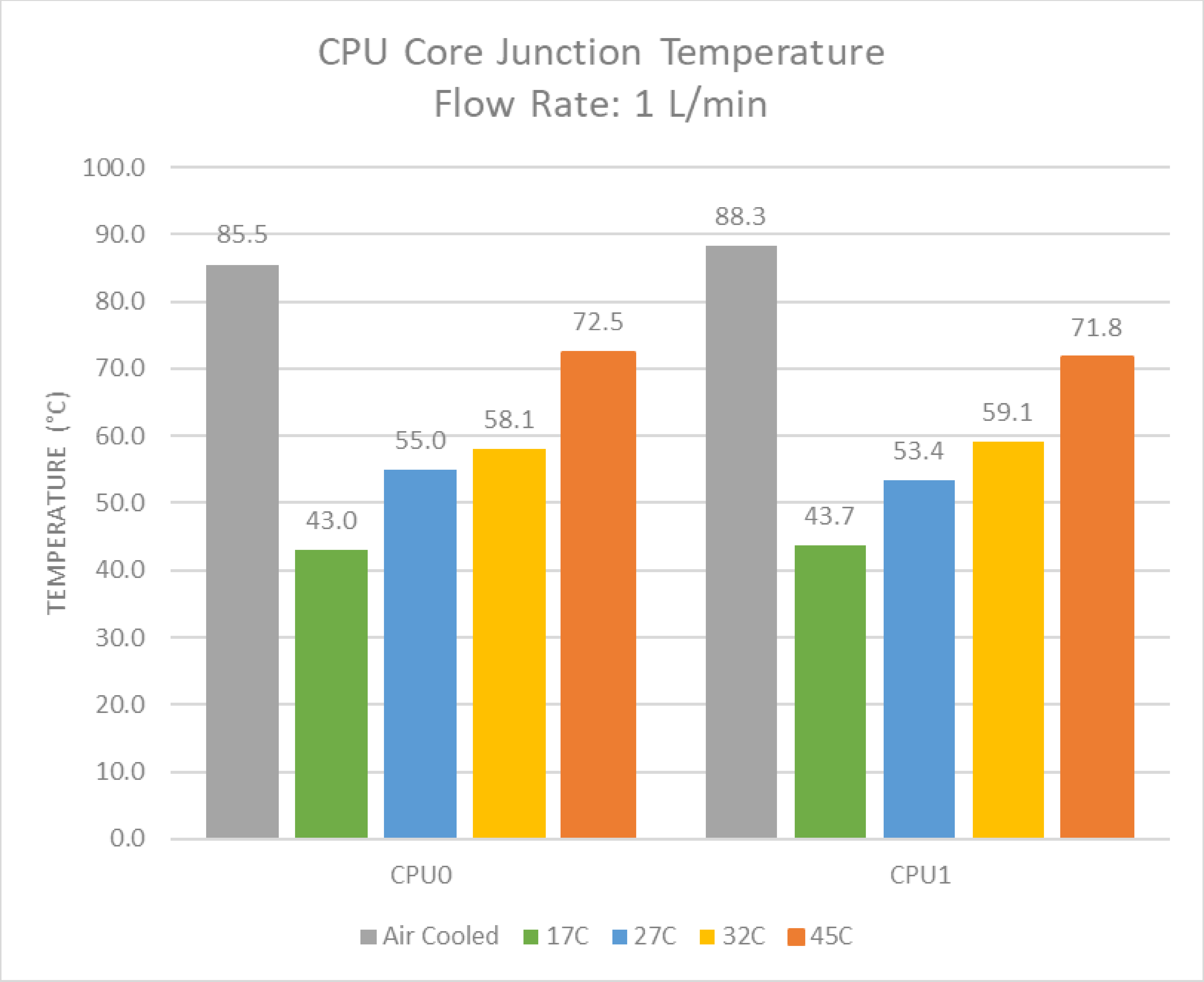
Results – CPU Core Temperature



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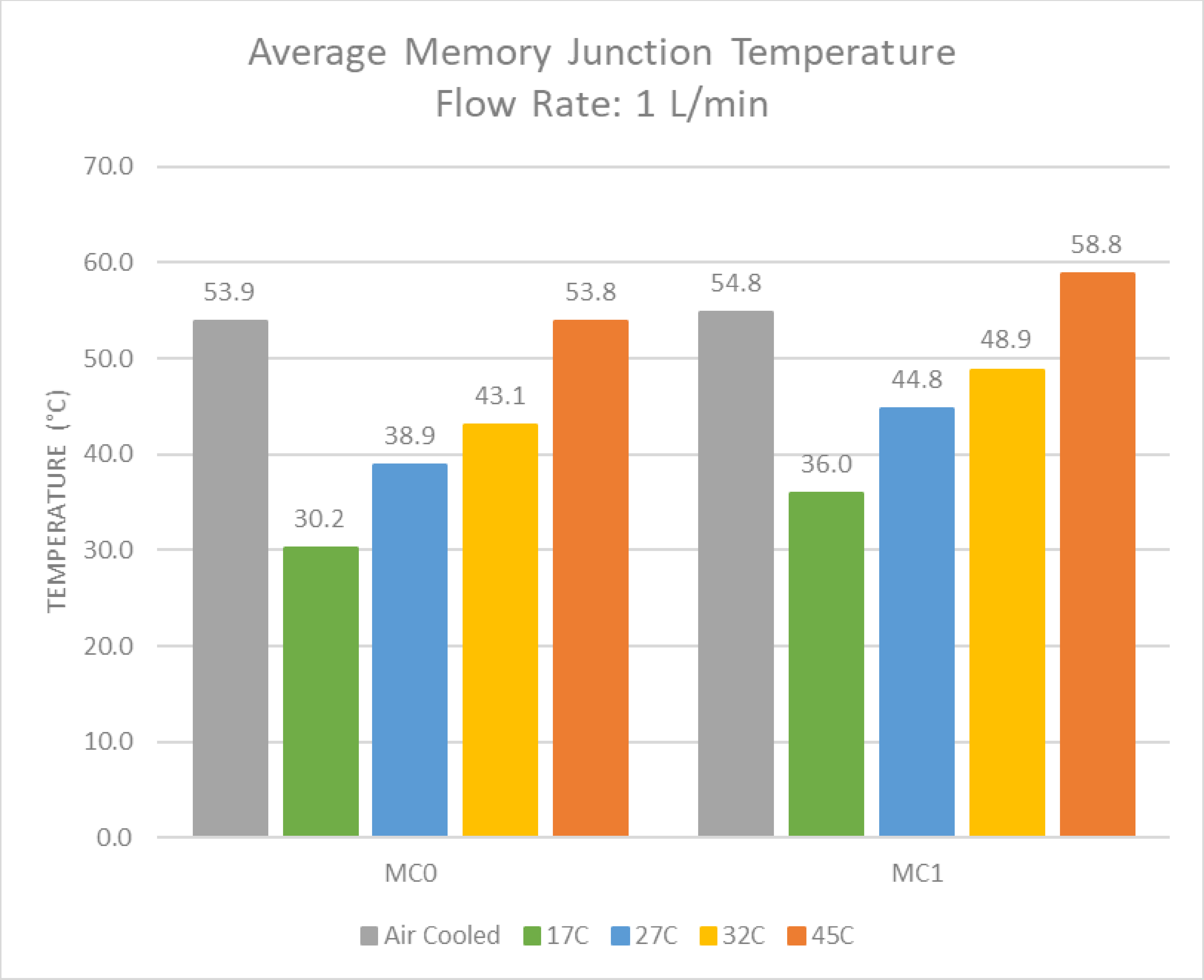
Results – Memory Temperature



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Margin to Max Operating Temp

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Max Temp	Margin to Max (°C)
CPU	28.5
Mem	26.2
Low Density	12.0

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Component Thermal Resistance

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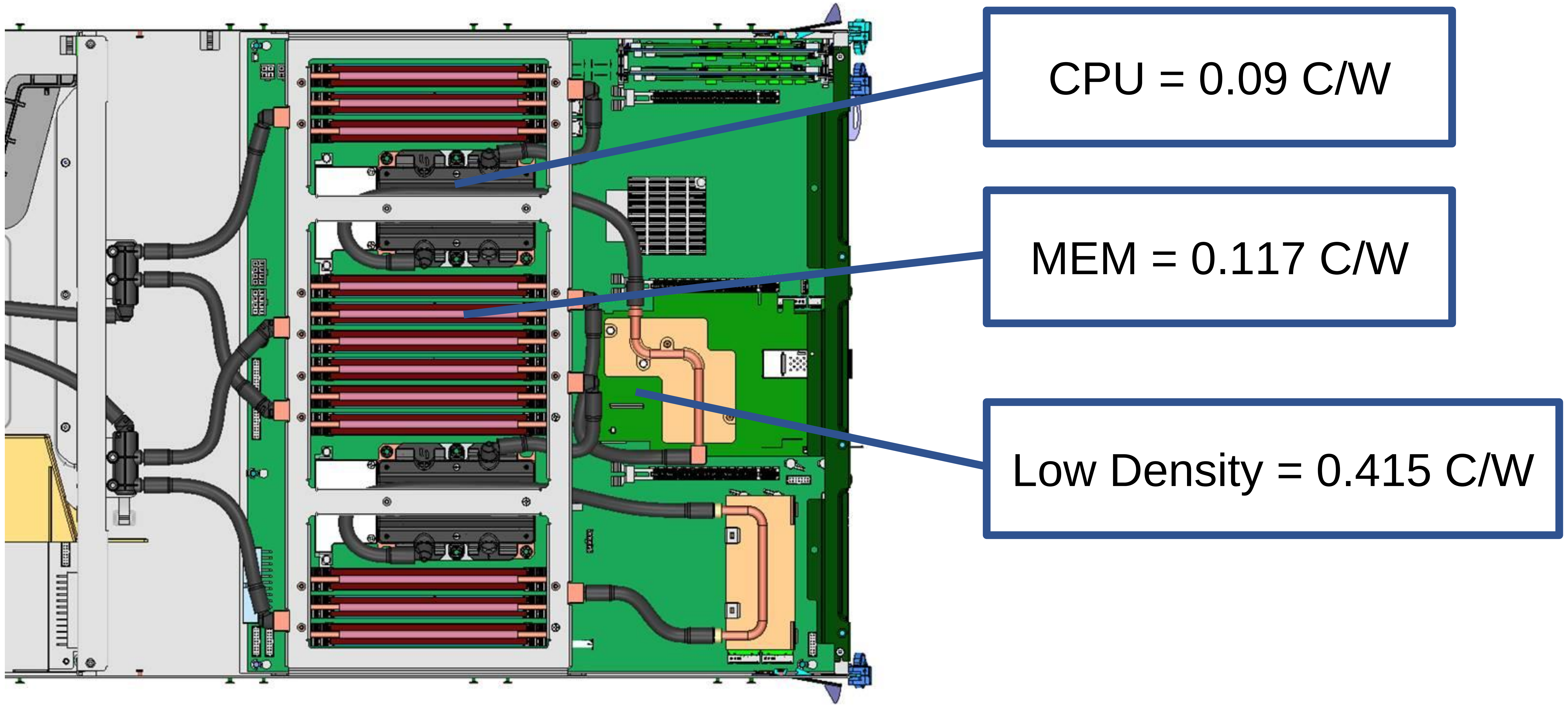

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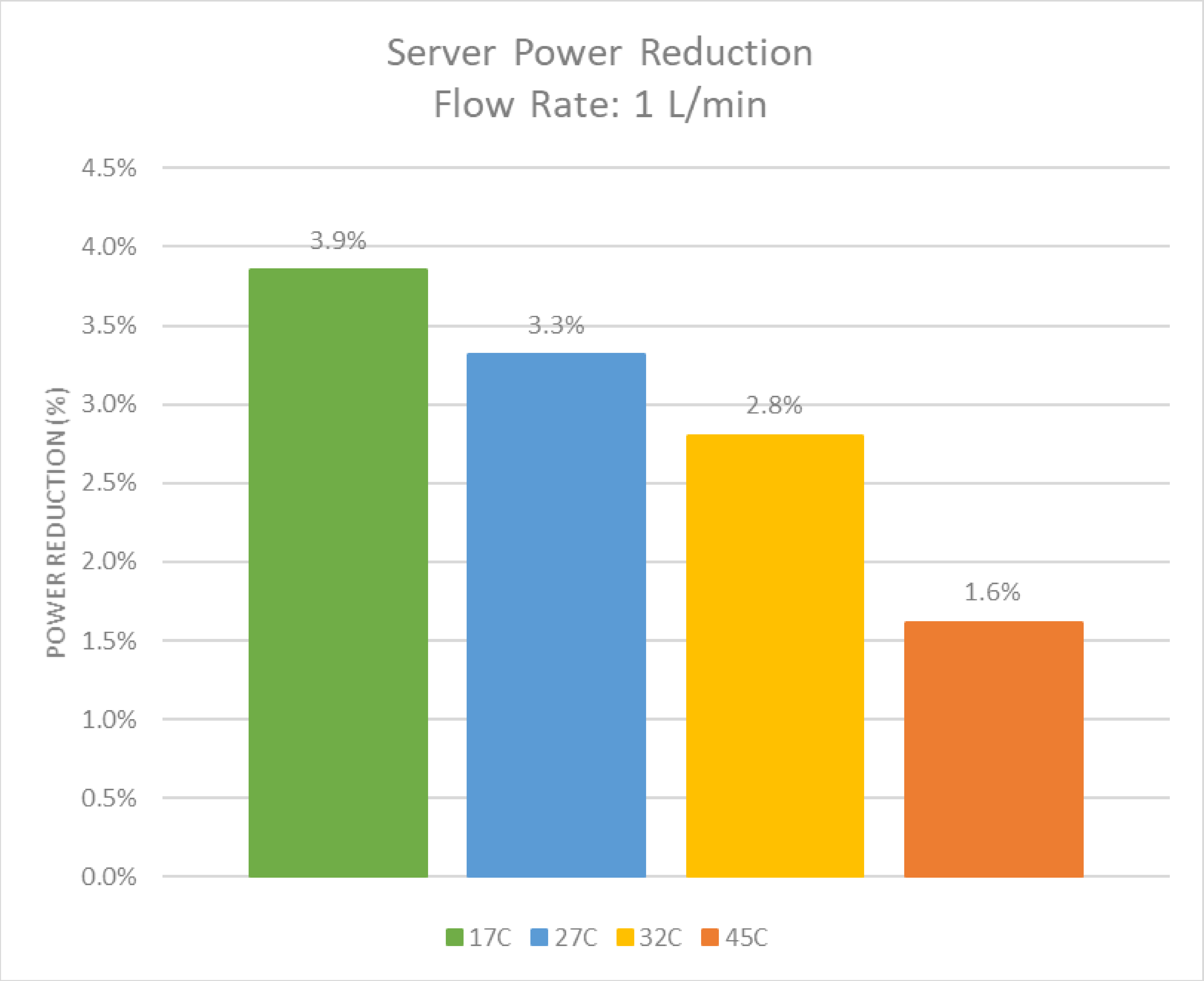
Server Power Savings



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Conclusion

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Using the Project Olympus server as an example, CoolIT Systems Direct Contact Liquid Cooling solution was able to:

- Utilize W4 facility water
- Capture over 20 kW of heat in liquid per rack
- Reduce server power consumption by up to 4%, including pumping power
- Maintain a margin of at least 12 °C to maximum operating temperature

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Changes Required for Harmonization

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Once the harmonization specification is complete, we anticipate the following changes will need to be made:

- Adopt the OCP Universal Quick Disconnects for both the PCL and the Manifold to CDU interface
- Validate the wetted material list against the OCP specification
- Validate performance with OCP specified transfer fluids
- Ensure operability within the PQ envelope specification

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Call to Action

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This case study presents specifications required for CoolIT Systems to enable liquid cooling on a Project Olympus server.

For liquid cooling to reach wide scale adoption in hyperscale data centers, a harmonization effort is underway to enable interoperability between various liquid cooling solution vendors and technologies. That is the goal of OCP's Advanced Cooling Solutions Coldplate workgroup.

Project Wiki with latest specification:
https://www.opencompute.org/wiki/Rack_%26_Power/Advanced_Cooling_Solutions

Mailing list: https://ocp-all.groups.io/g/OCP-ACS-Cold-Plate

Please join the group and help develop the harmonization standards that will enable advanced cooling solutions for OpenCompute solutions.

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Questions?

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