



钛芯智冷
TYSON COOLING

Pumped-Refrigerant Cooling: A Strategic Solution for AI Data Centers

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Outline

- **Why Two-Phase Cooling is Essential?**
- **Our Core Innovation: Two-Phase Cold Plate and CDU Development for Direct-To-Chip Cooling.**
- **Technical Excellence & Performance Data**
- **Path Forward & Commitment**

Why Two-phase Cooling?

AI computing

Ultra-low PUE (<1.2)
for new mega-data
centers.

Air cooling is
insufficient for next-
gen AI clusters
(50kW+/rack).

Dual Carbon goal

Problem: IT sector's
energy consumption
is growing
exponentially.

Opportunity: Cooling
can be the biggest
lever for direct
energy savings.

Semiconductor Sovereignty

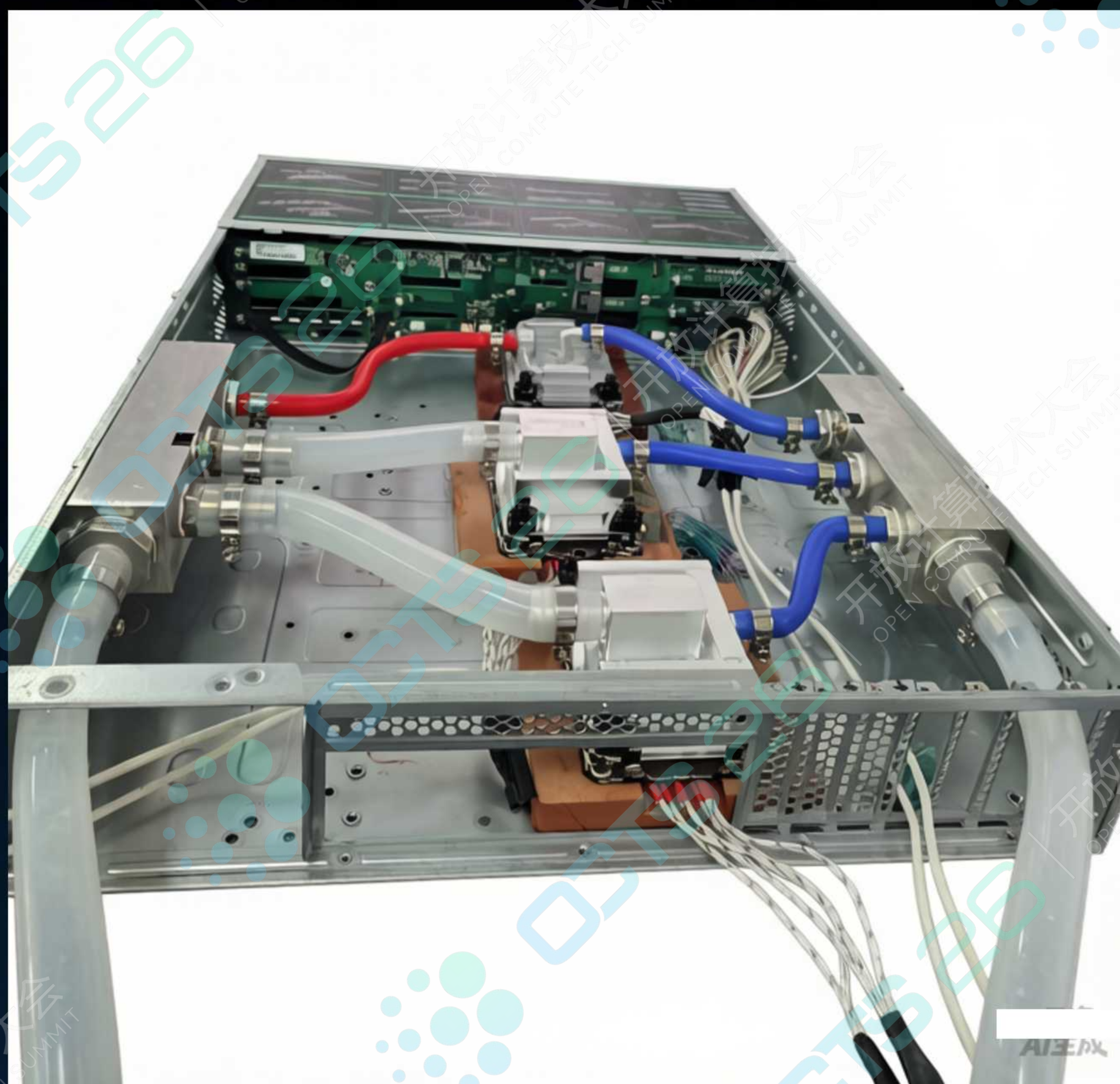
Need: To fully utilize
and push the limits of
high-performance
chips, we need world-
leading thermal
management.

Our Core Innovation - A Leap in Cooling Architecture

Cold plate validation



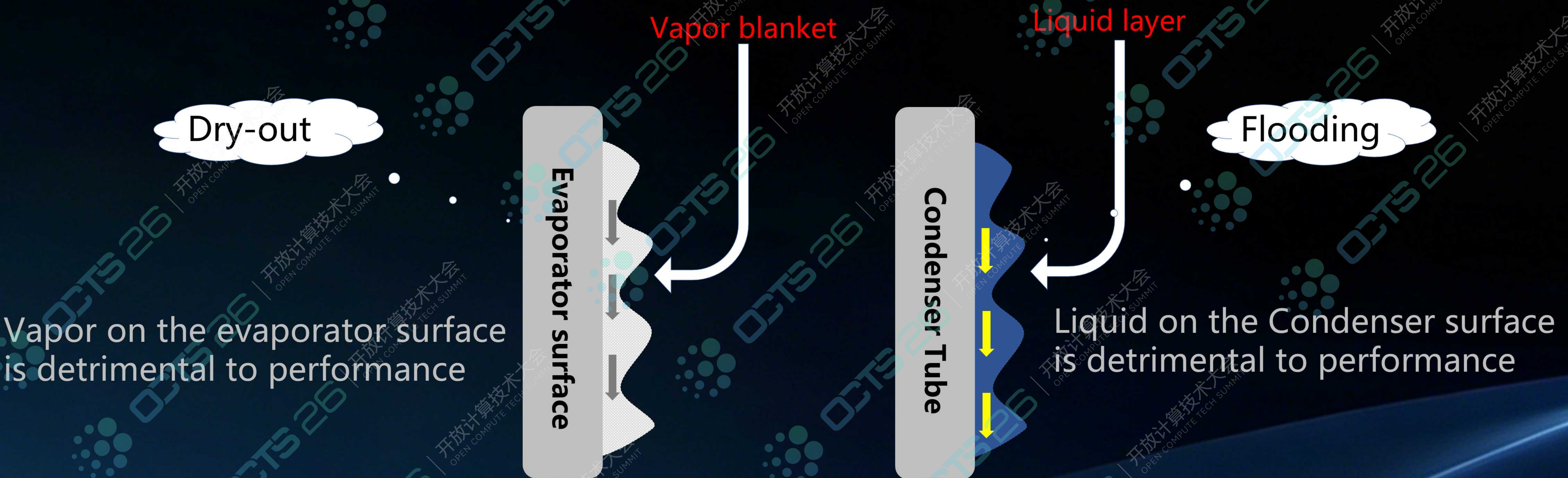
Cold plate Loop Architecture



CDU Prototype



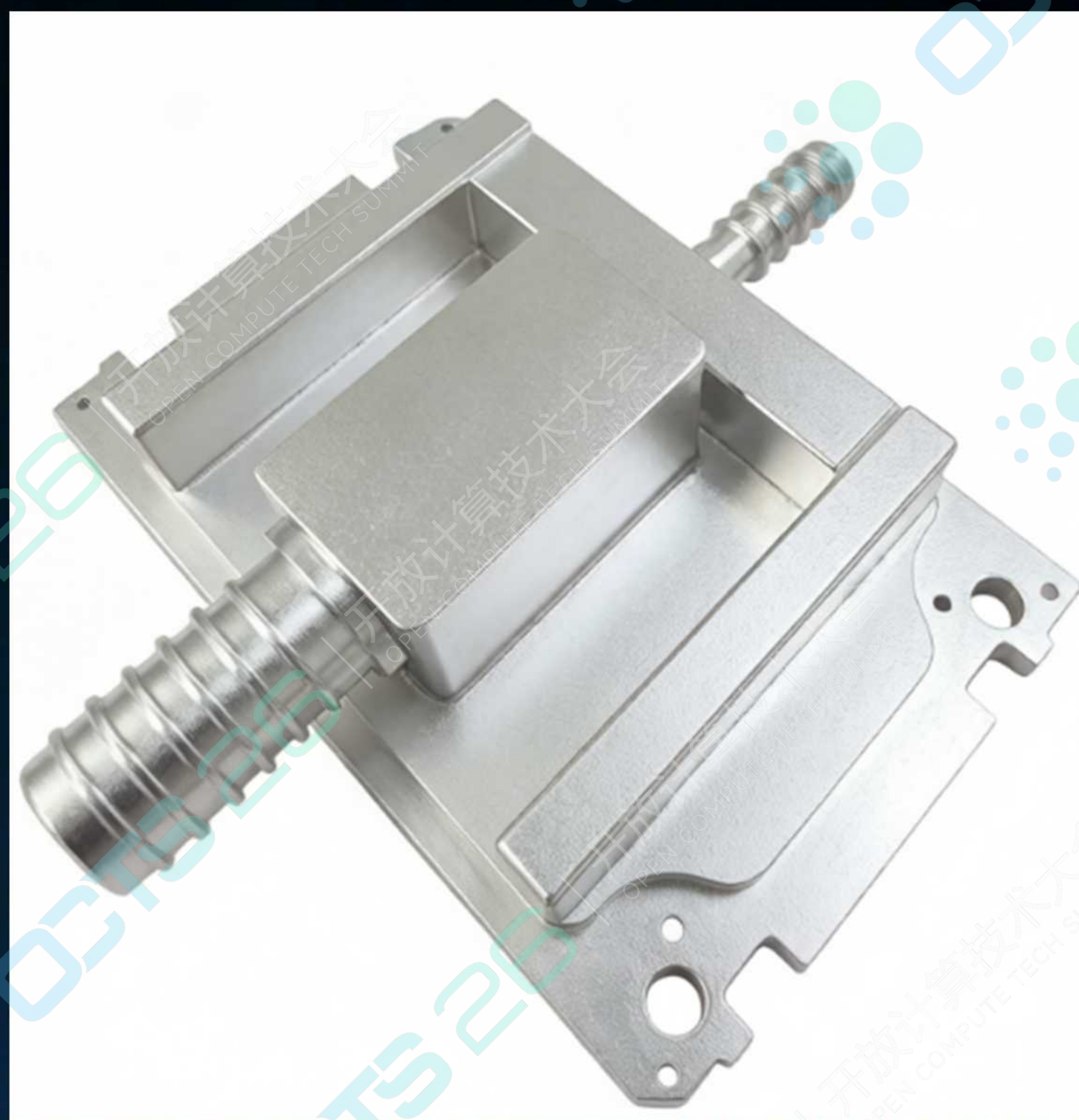
Evaporator/Condenser: Main Challenge



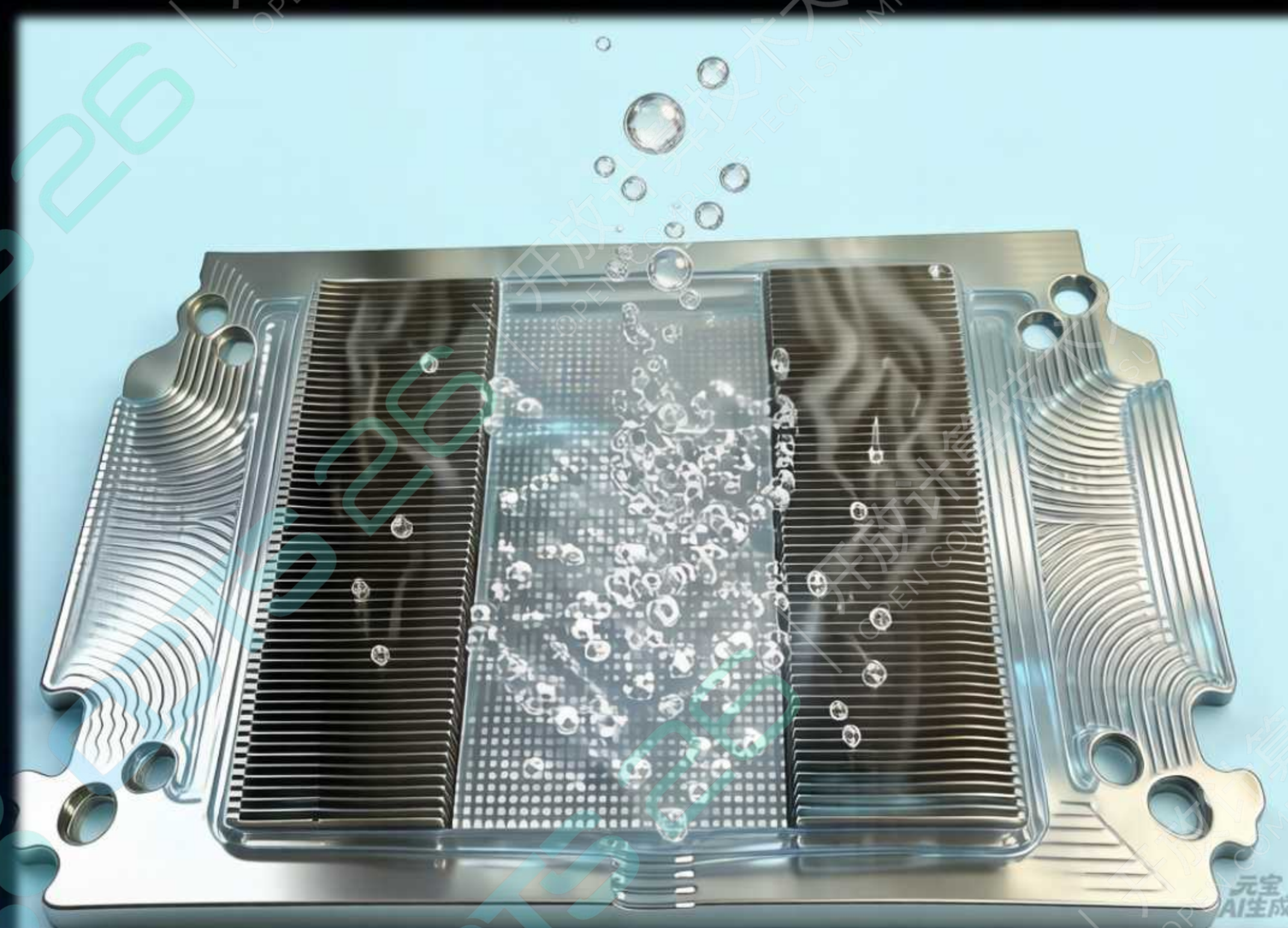
Removing the unwanted phase is necessary to improving the heat transfer performance.

Our Core Innovation – Boiling Assisted Cold Plate

Hybrid micro-structured Cold Plate



Cold plate Internal Fins

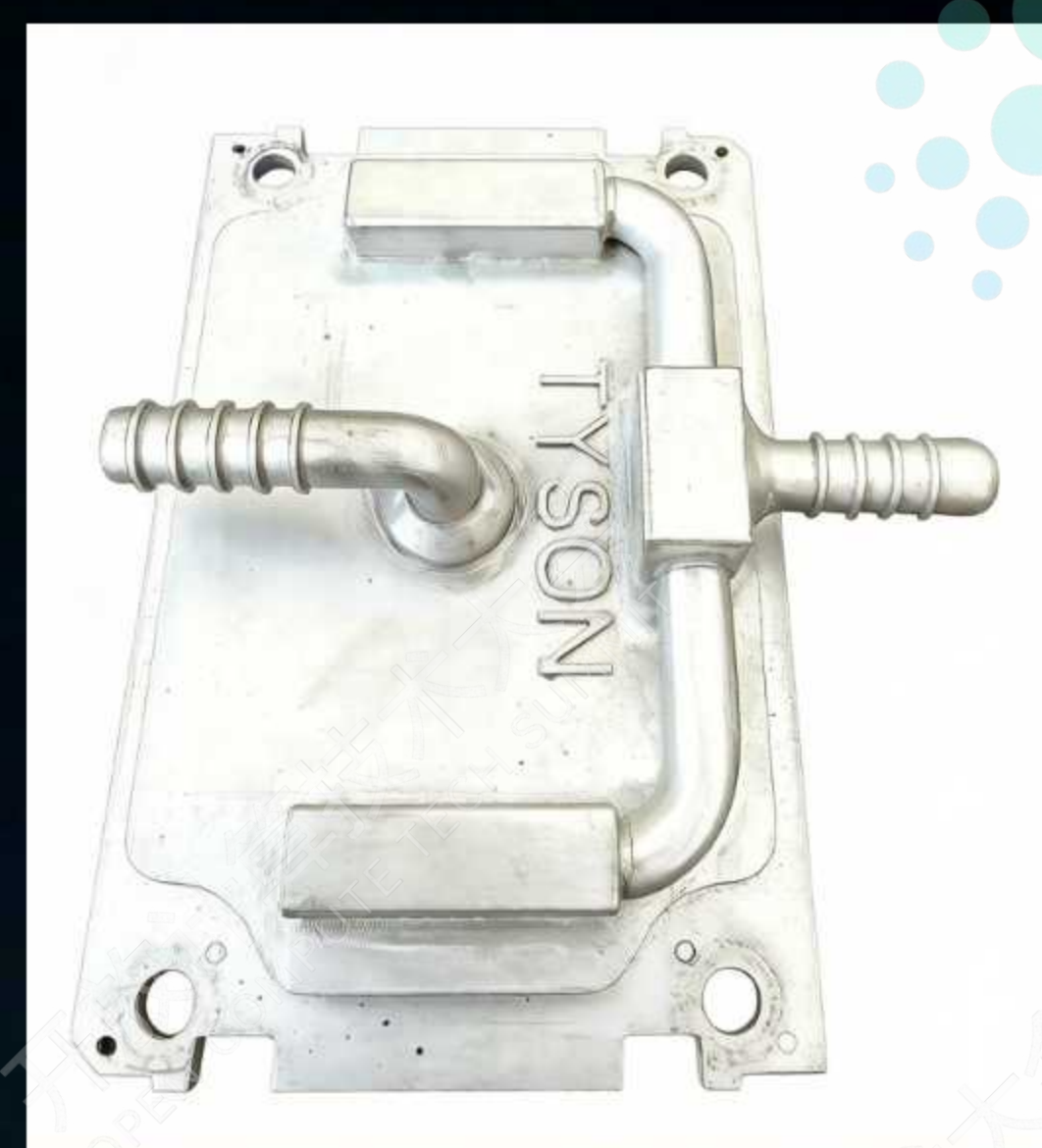


Key Design Considerations

1. Bubble density
2. Bubble size
3. Departure frequency

- Boiling gives a higher heat transfer coefficient than single-phase water.
- Better temperature Uniformity.
- Increase in serviceability due to low operating temperature.
- Use an environmentally friendly liquid for a sustainable cooling platform.

Evolution of Cold Plate Design



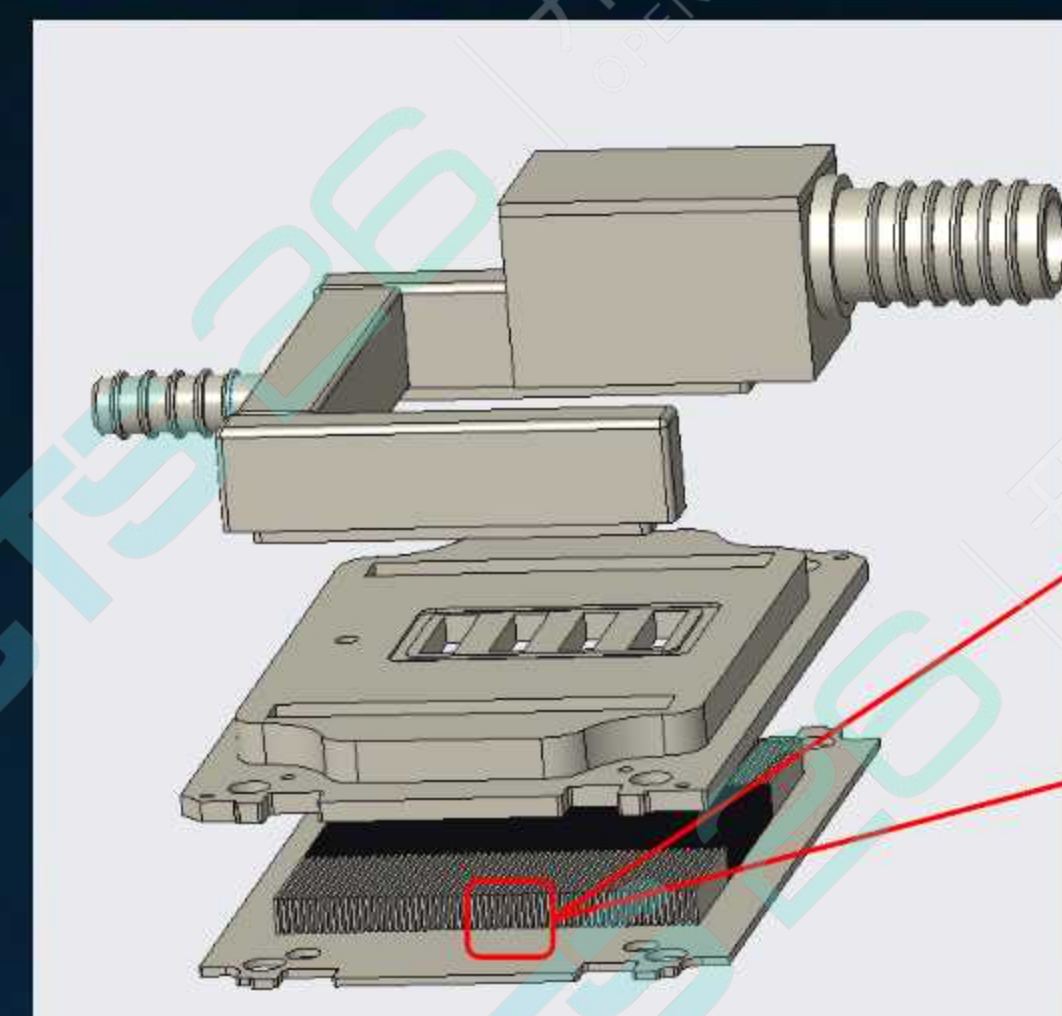
800W



1500W



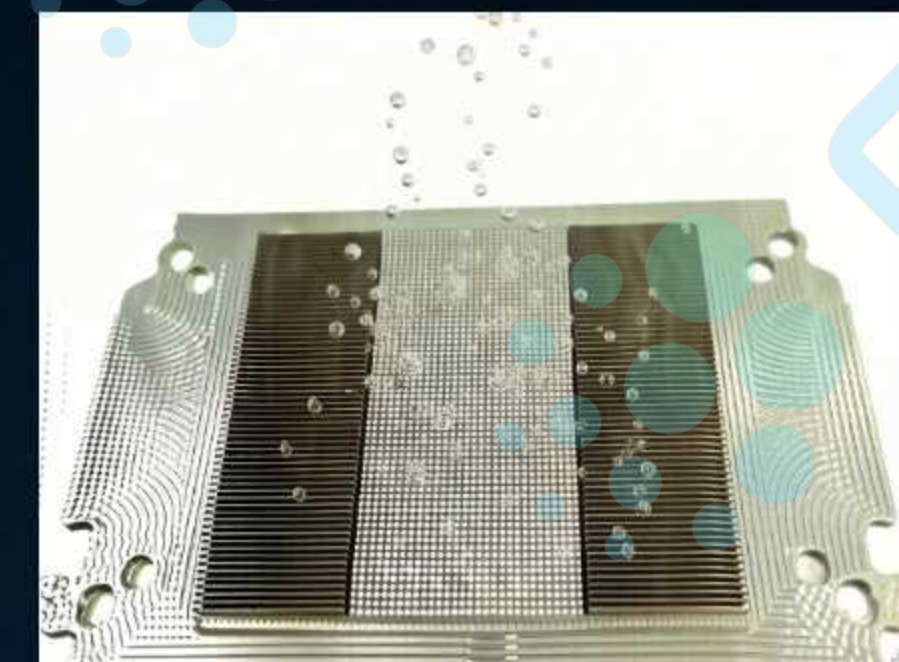
>2000W



Hybrid fins

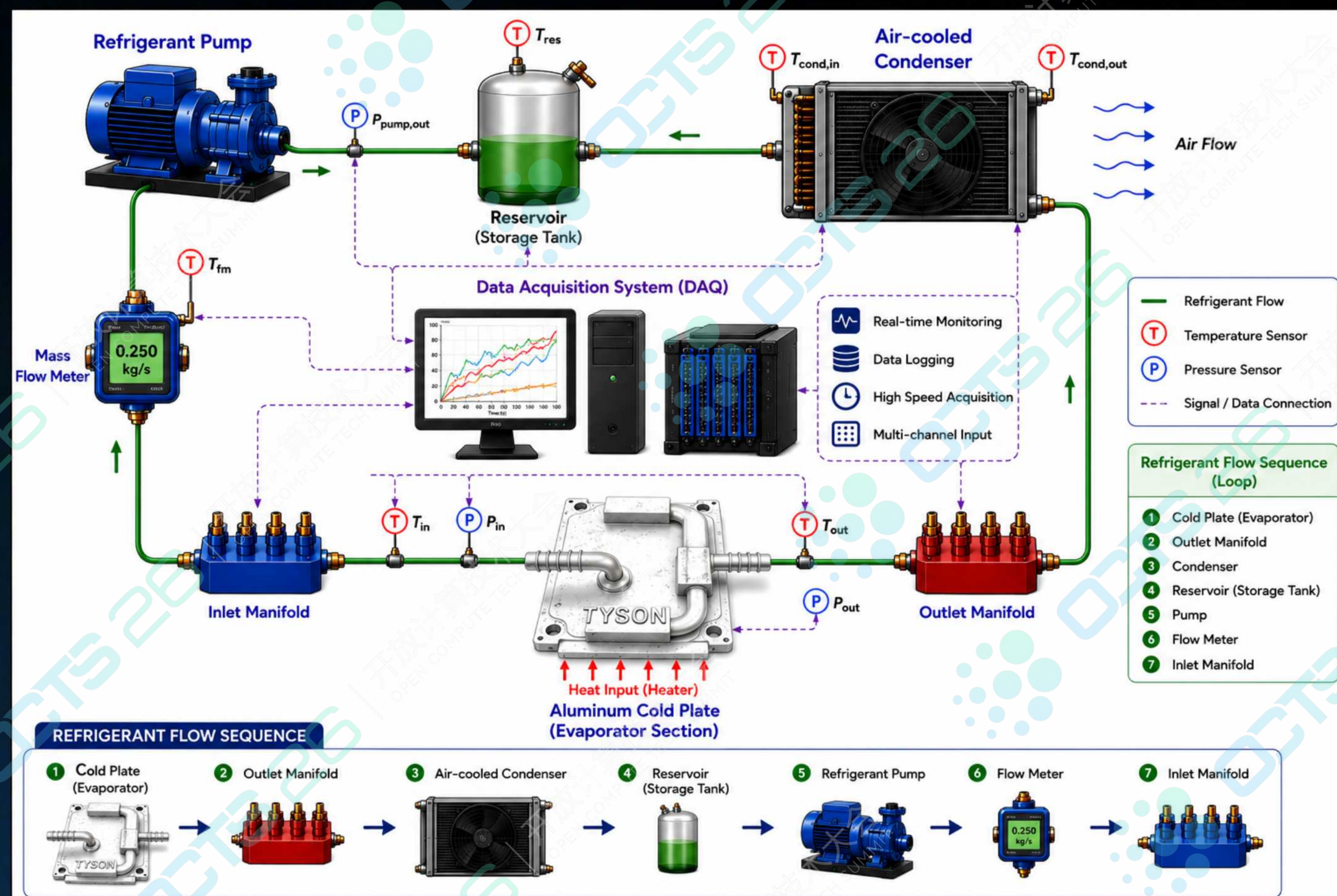


Boiling

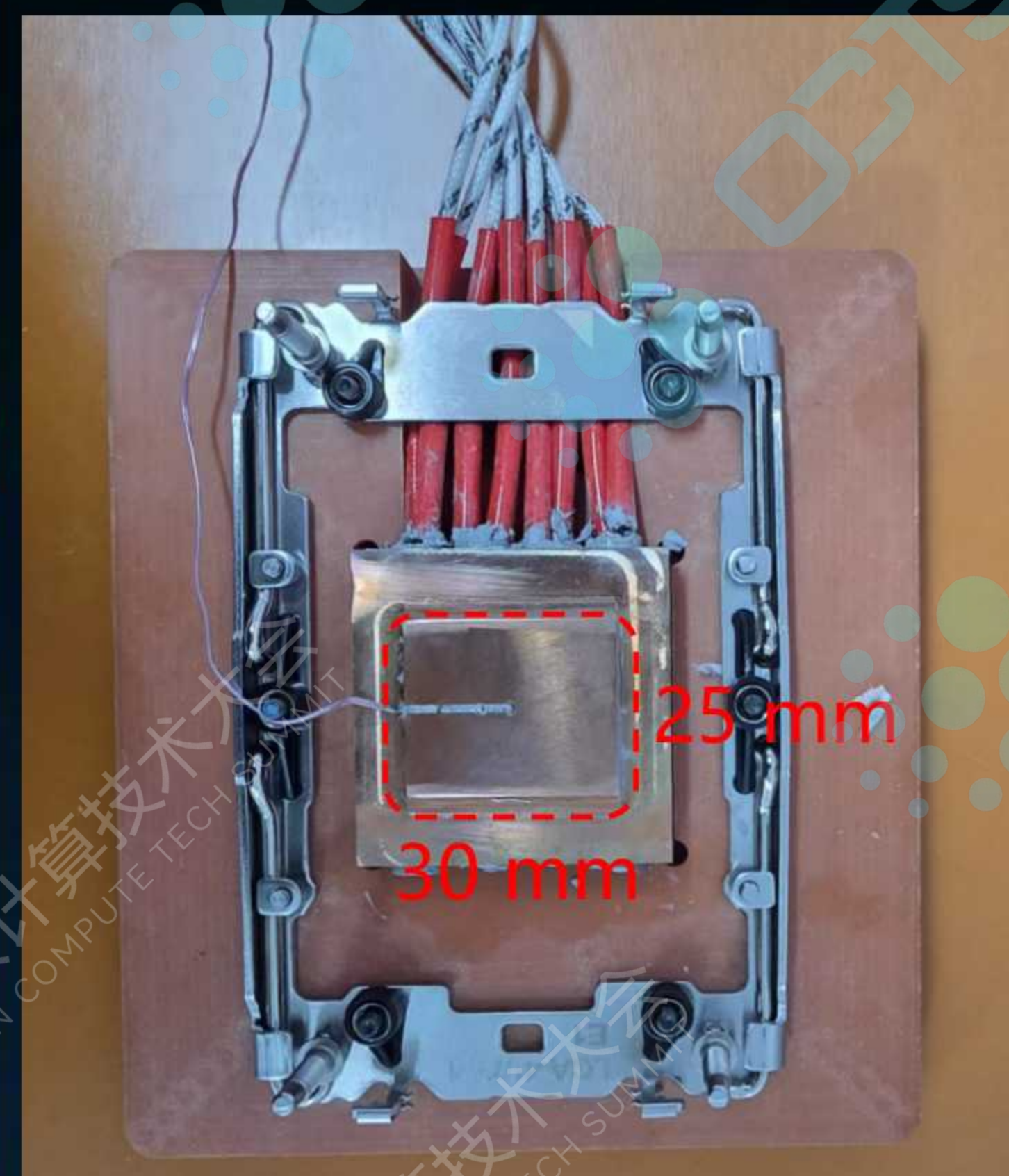


- **Material:** Brazed Aluminum cold plate
- **Internal Fins:** Microscale structures made from Wire cutting, laser cutting, and Skiving to ensure efficient boiling and capillarity.
- **Flow Physics:** Vapor expansion needs a larger area to escape, and the design should accommodate the vapor and liquid flow efficiently.
- **Boiling:** Boiling enhancement, efficient vapor flow, and increased departure frequency.

Cold Plate Testing Platform

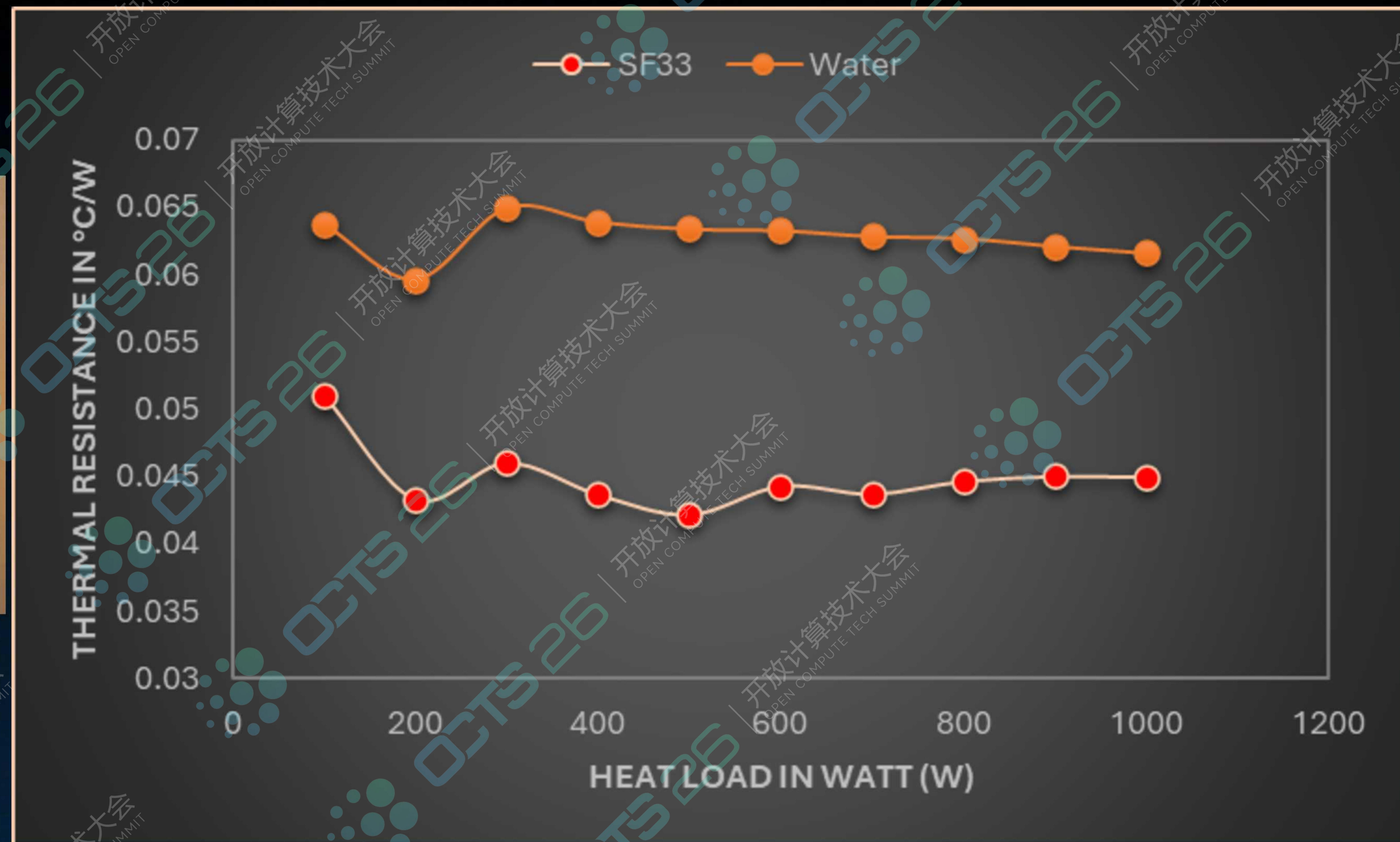


Cold Plate Testing Result



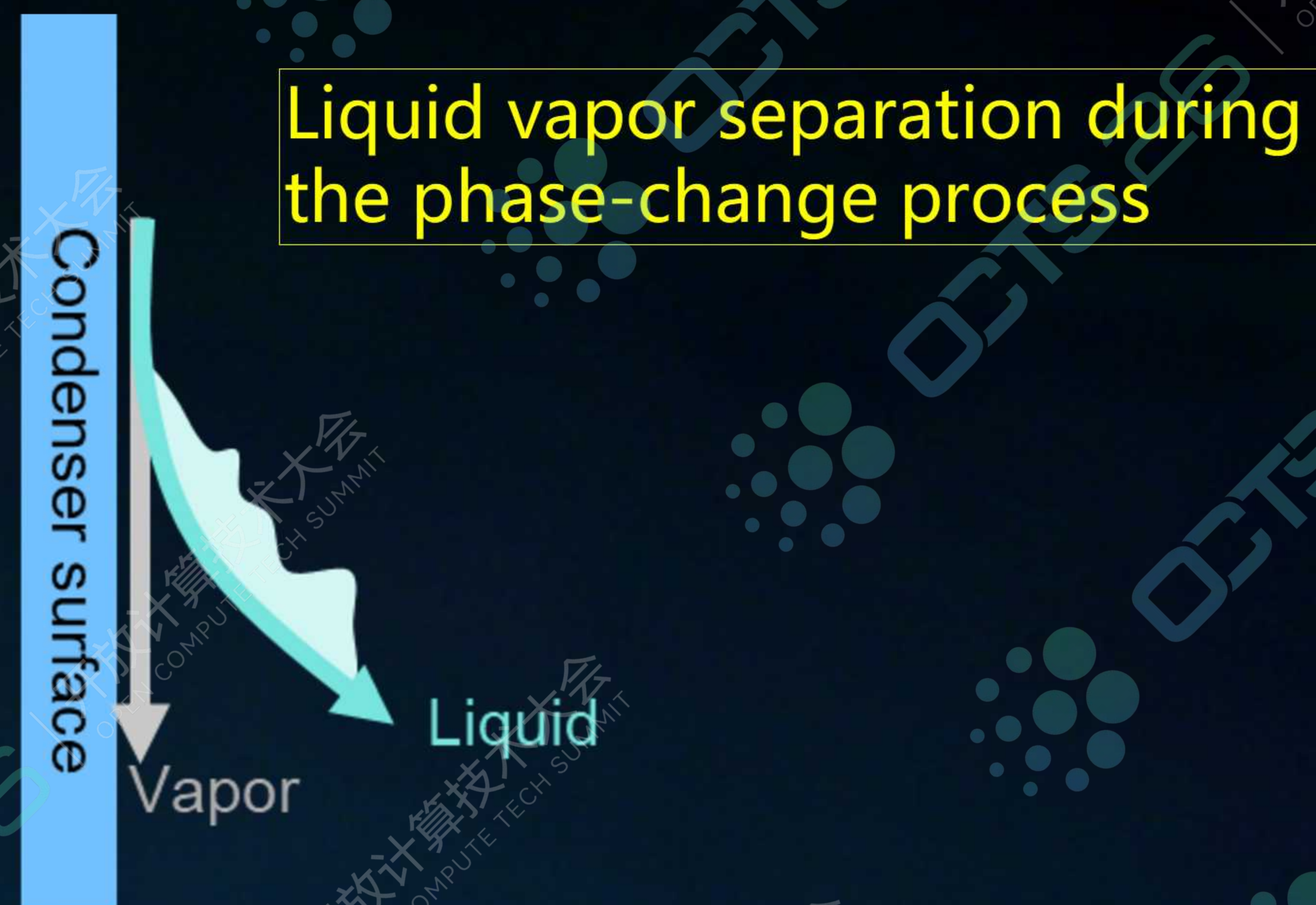
$$Q = 100 \sim 1000W$$

$$\dot{m} = 1 \text{ lpm}$$

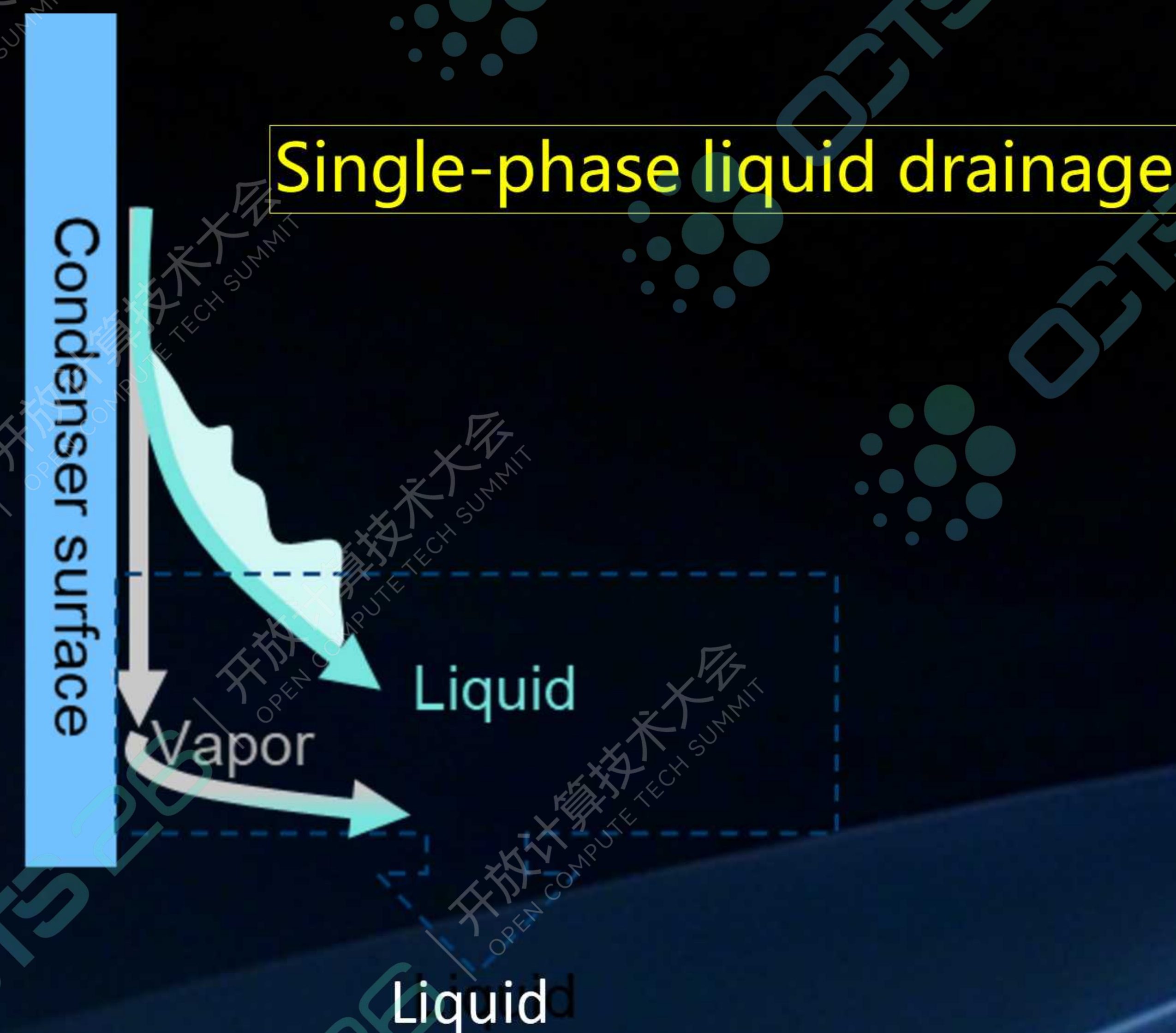


Two-Phase Condenser: Performance Improvement by Phase Separation

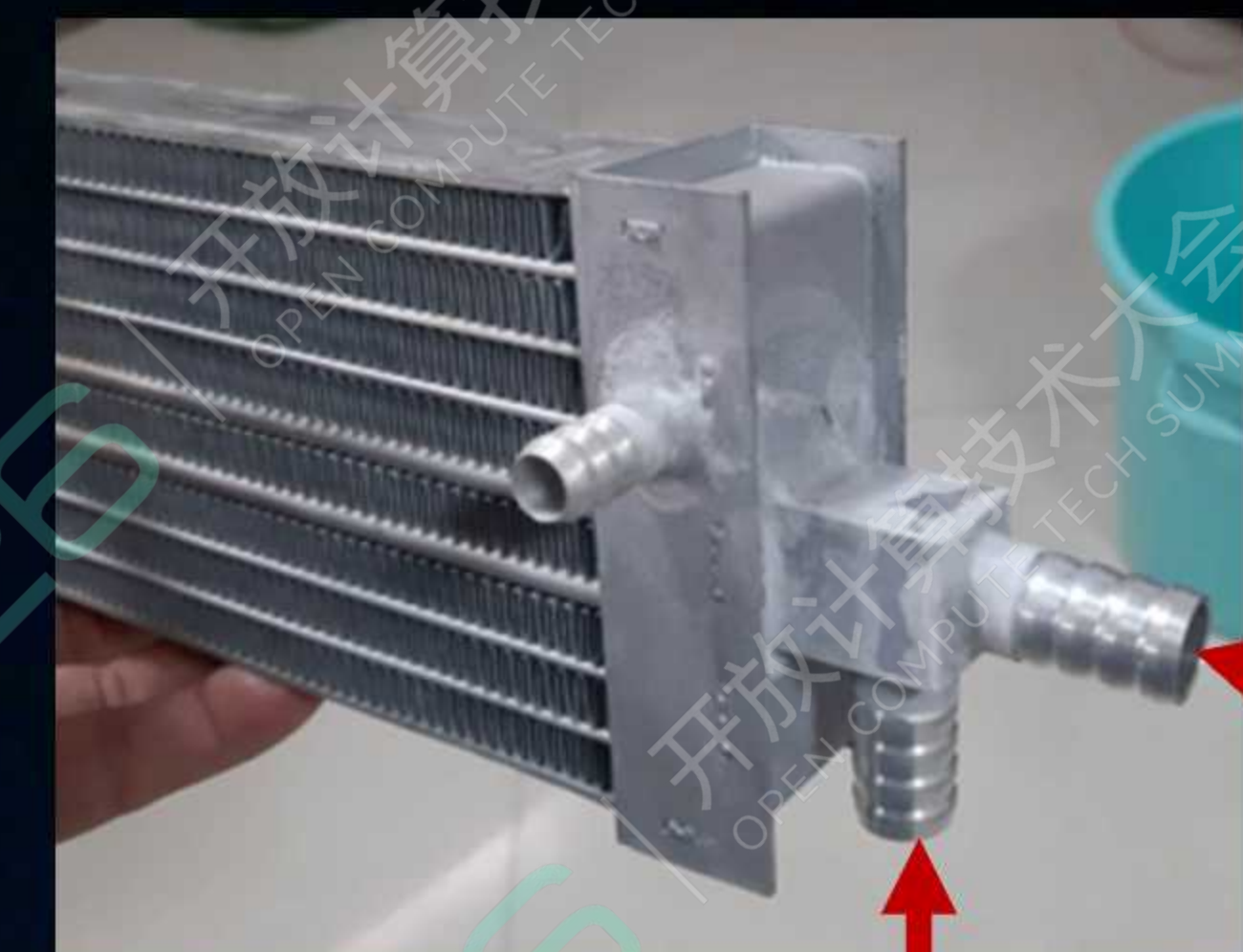
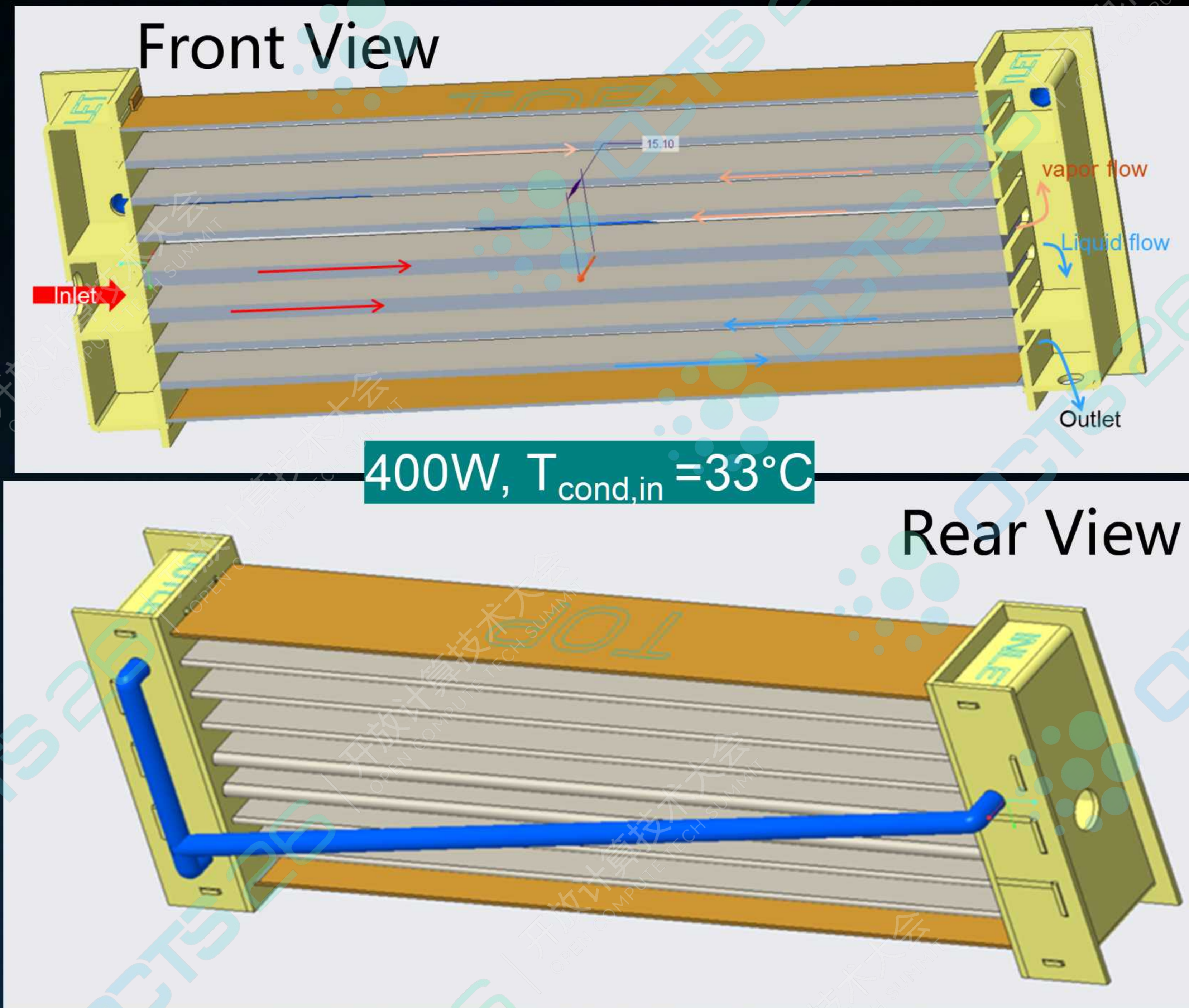
Stage 1: Phase Separation



Stage 2: Drainage



Two-Phase Condenser: Performance Improvement by Phase Separation



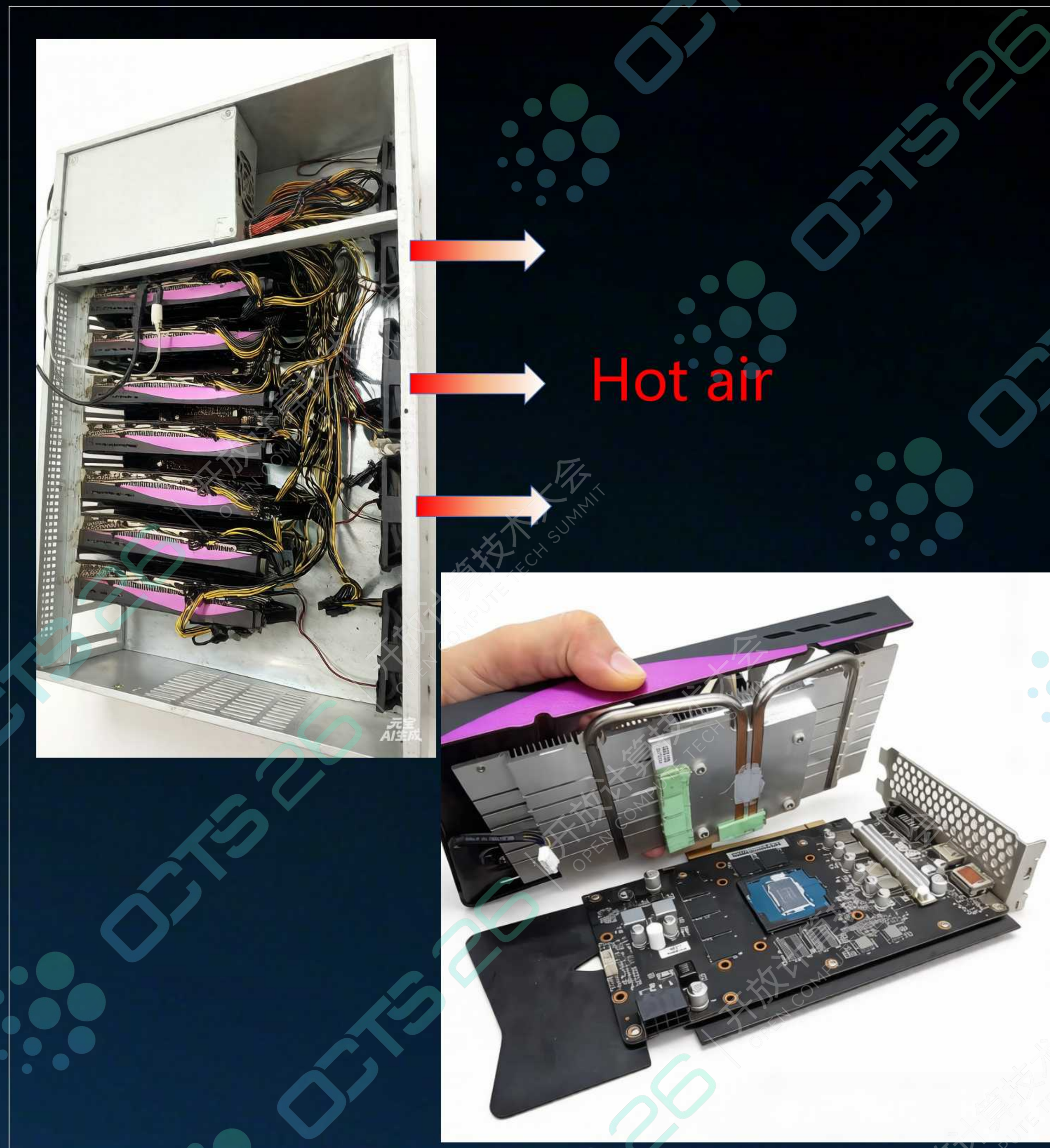
Inlet:
Liquid-vapor mixture



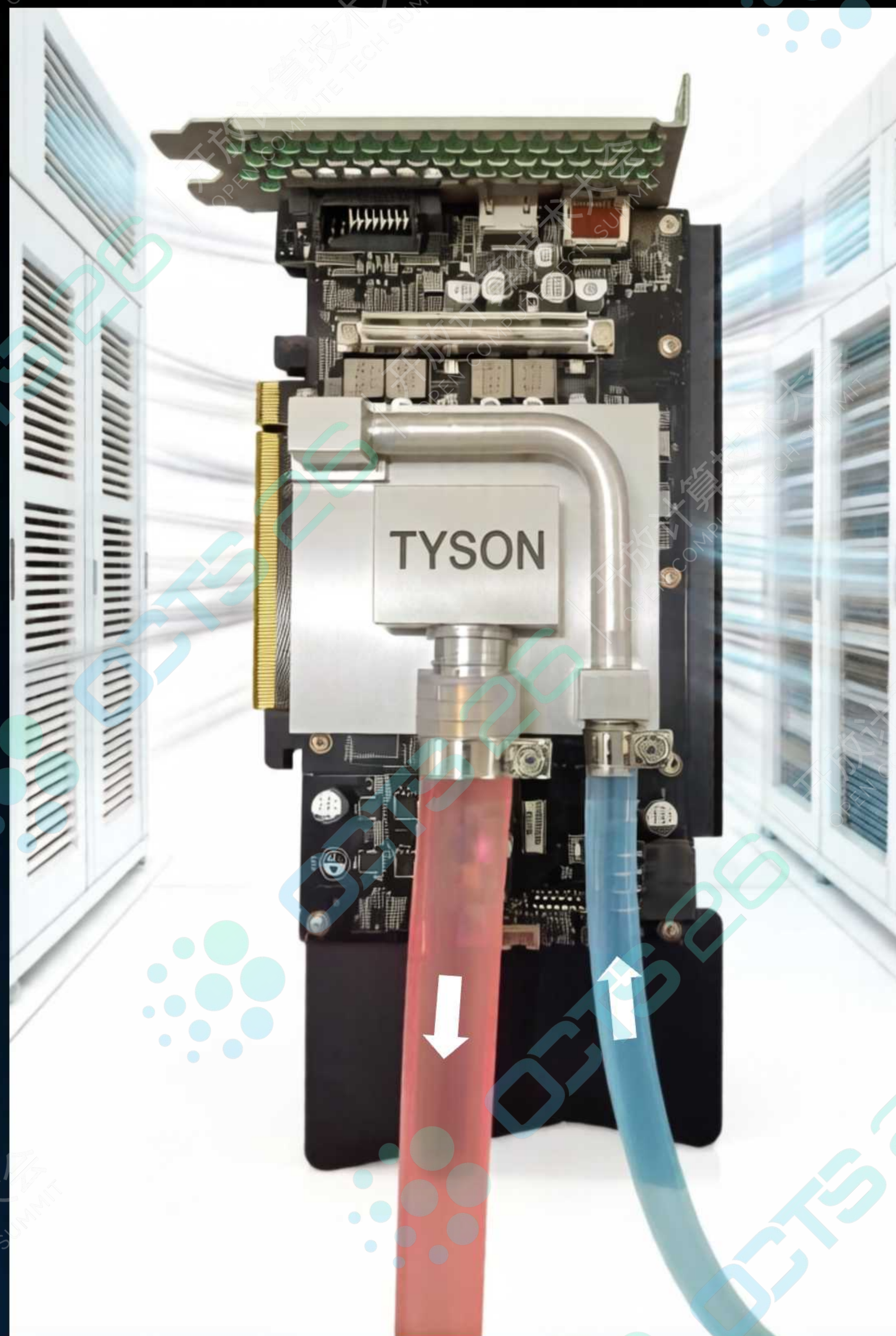
Outlet:
Liquid-vapor mixture

The Outlet Temperature is reduced by $\sim 3^{\circ}\text{C}$ by comparing with the original (without phase separation, no rear tube connection)

Cooling of VGA Chips with SF33

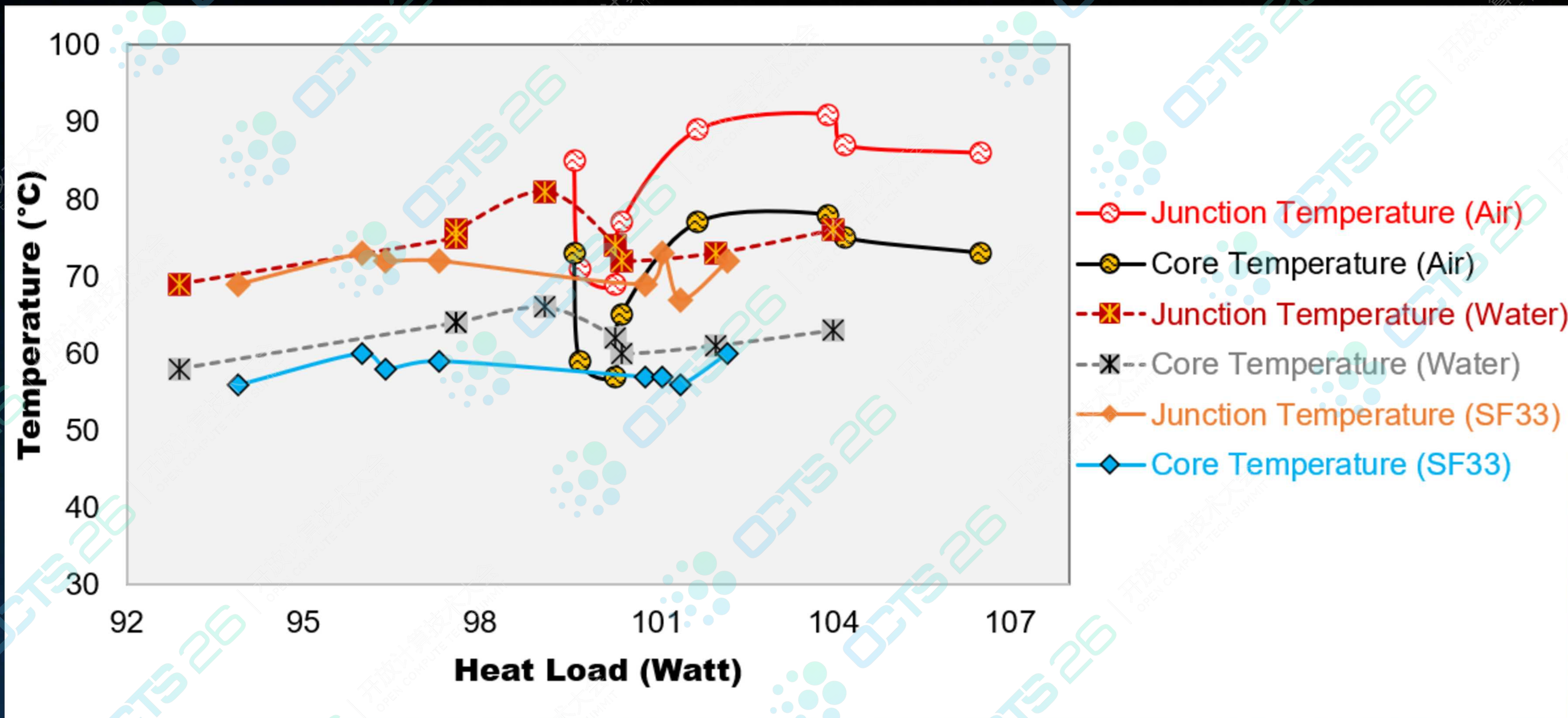


Air cooling



Liquid cooling

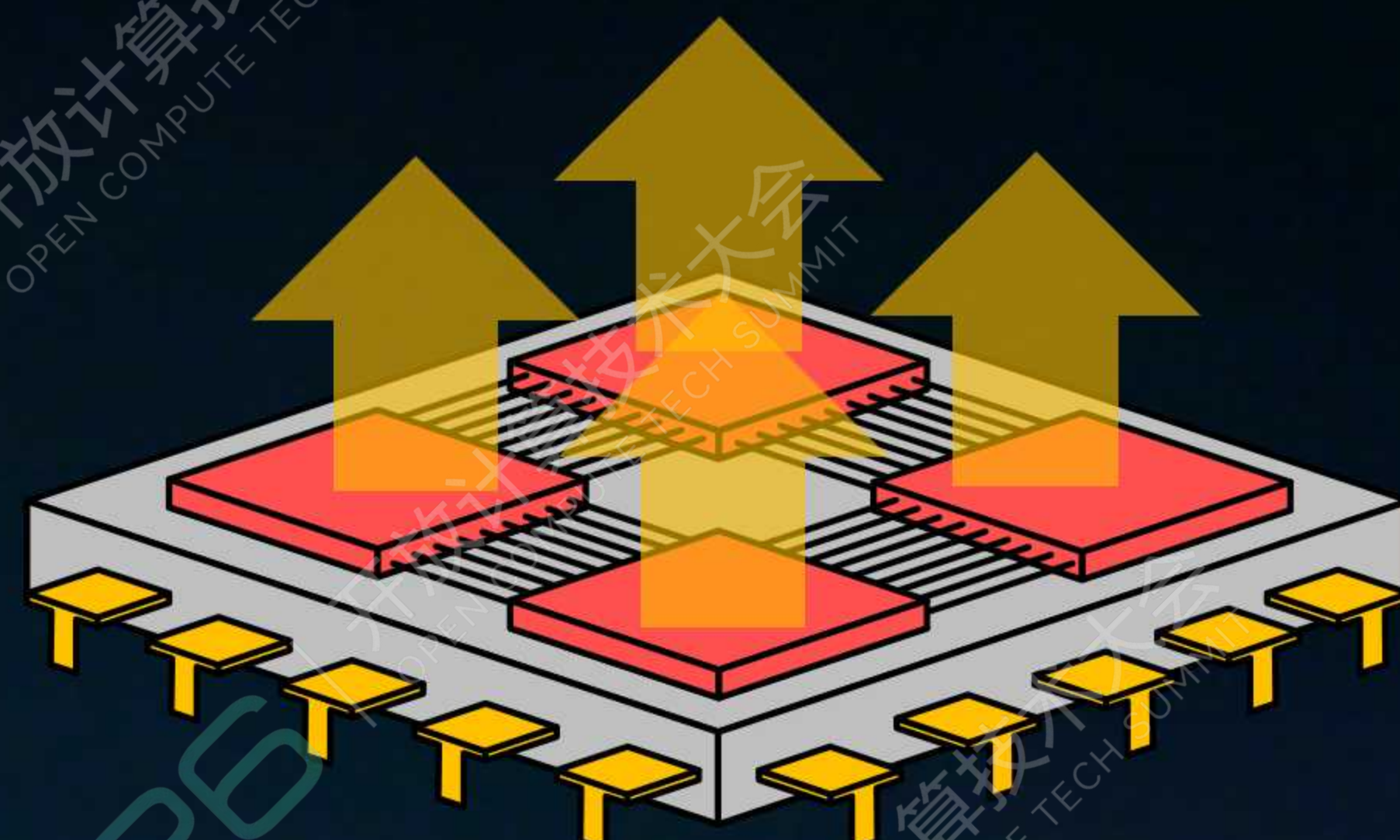
VGA Card: Air/Water/Refrigerant



3D ICs Cooling

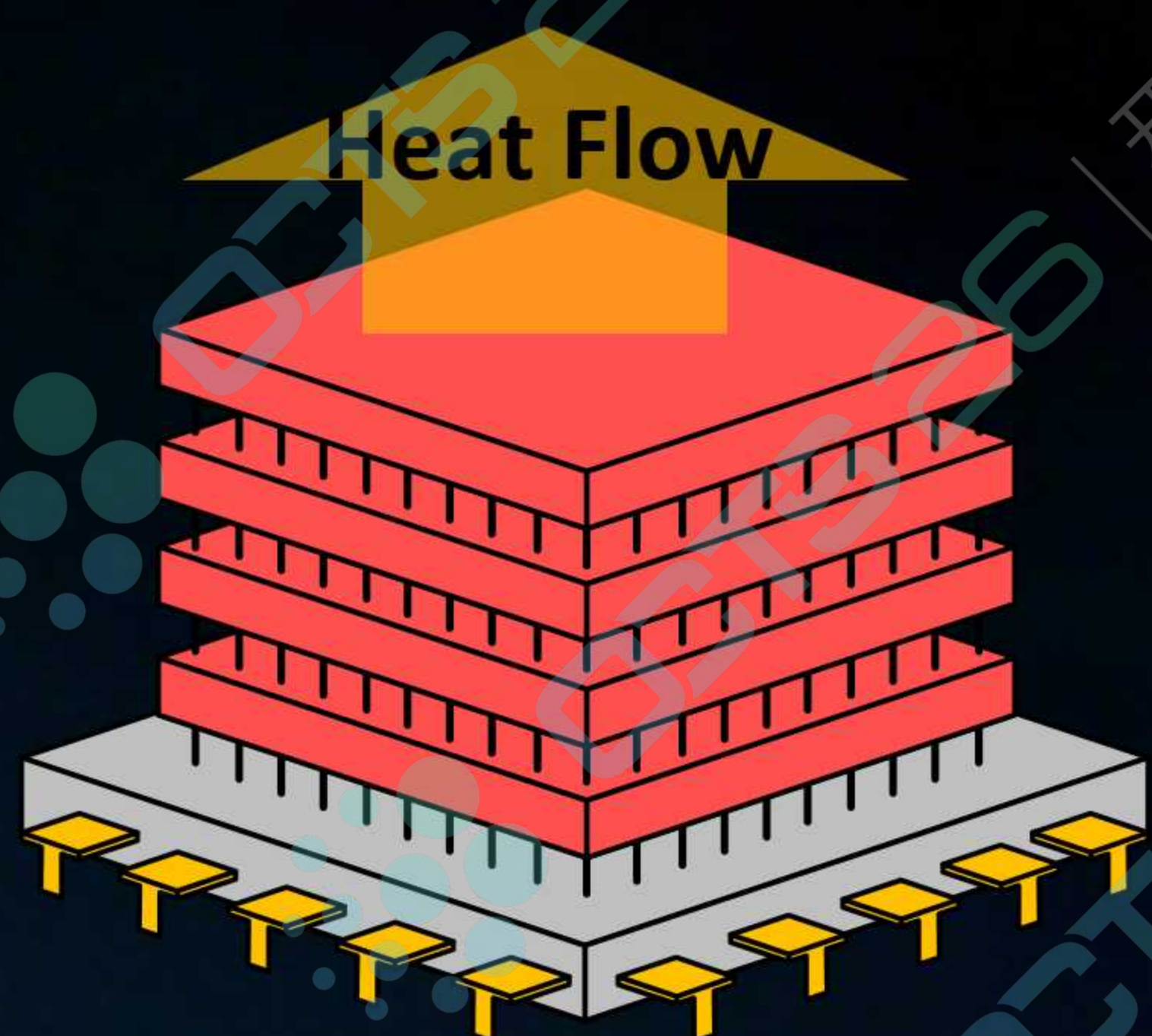
2.5D

Heat Flow

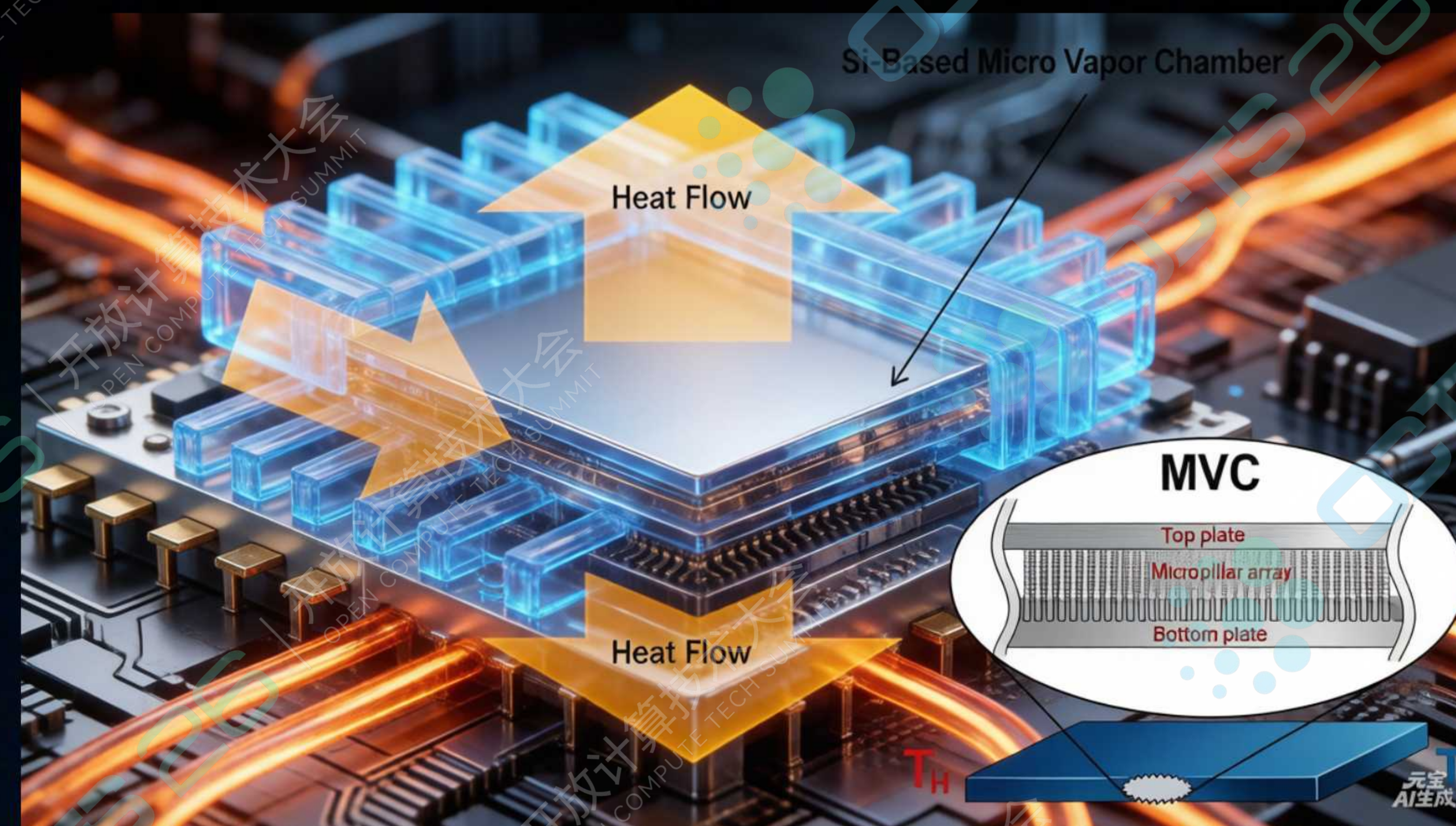


3D

Heat Flow



3D IC Cooling Module



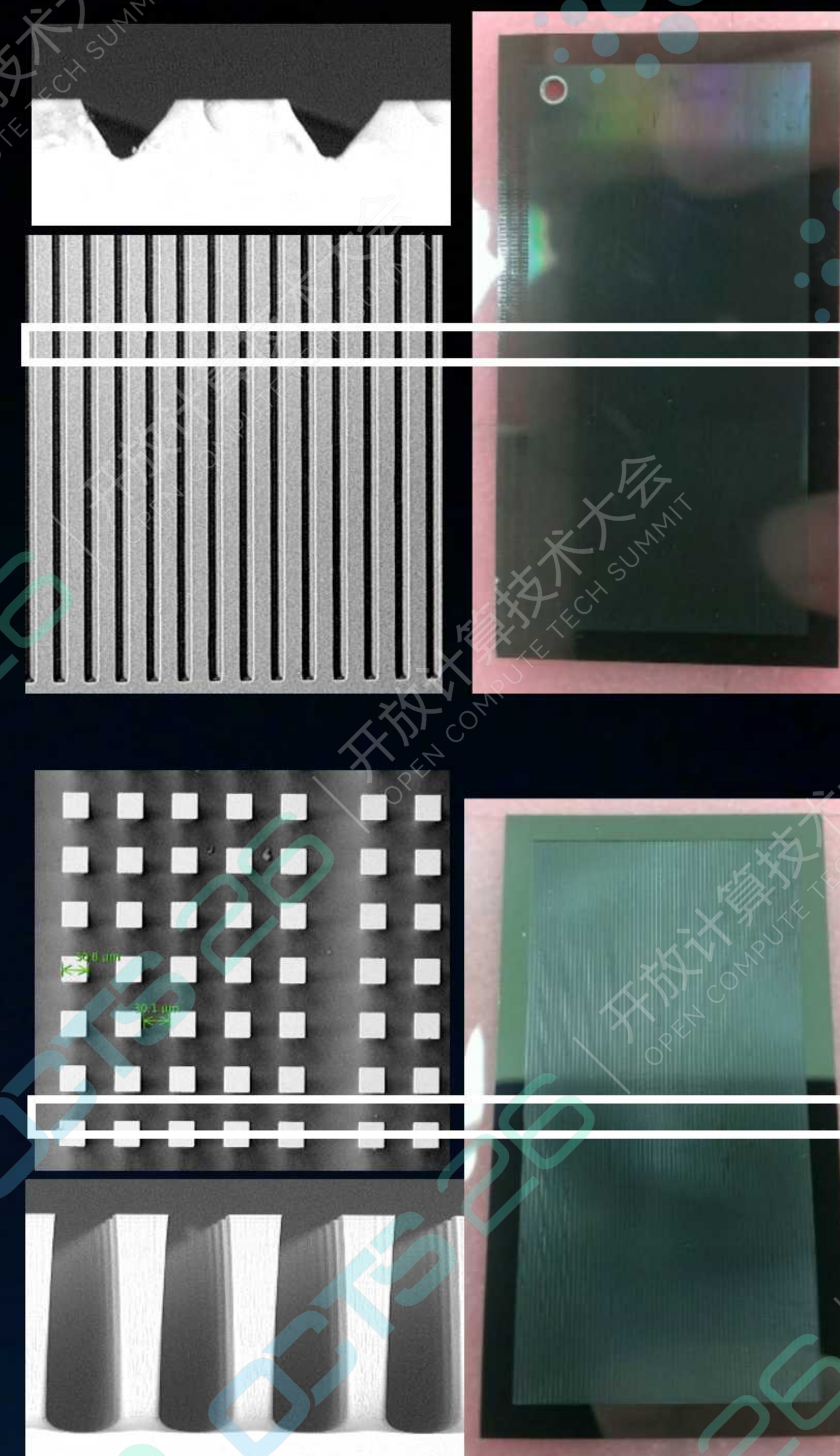
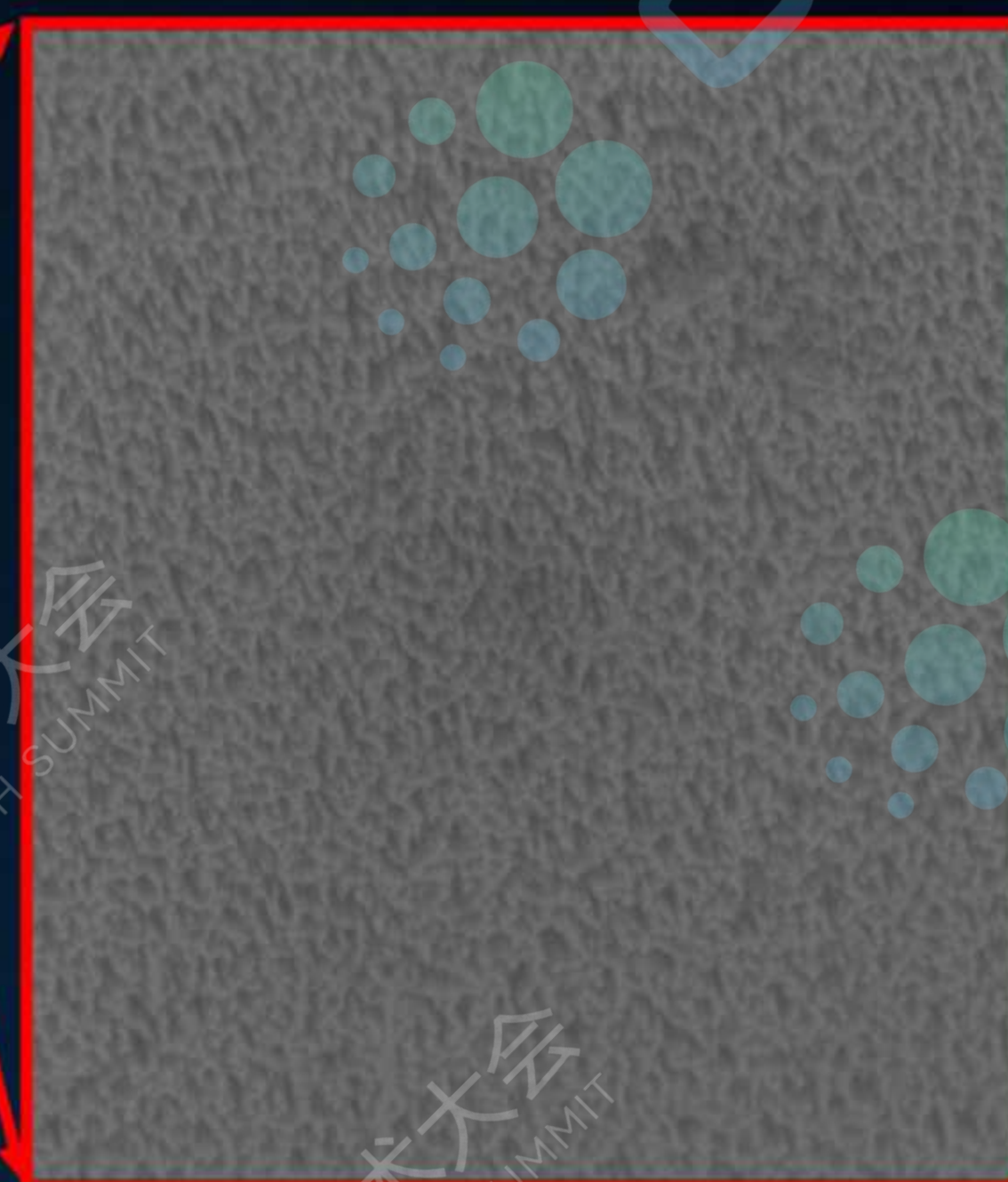
Micro vapor chamber (MVC)

Silicon Vapor Chamber

Micro vapor chamber (MVC)



SINW + FOTS coating (CA ~ 150°)



Gradient wick structure
Synthesis

Air-Cooled Product Portfolio

Recent Innovation in Air Cooling (3U)



Standard (2U)

- > Excellent Performance
- > Perfect Fitting (Intel EGS)
- > Cost Saving



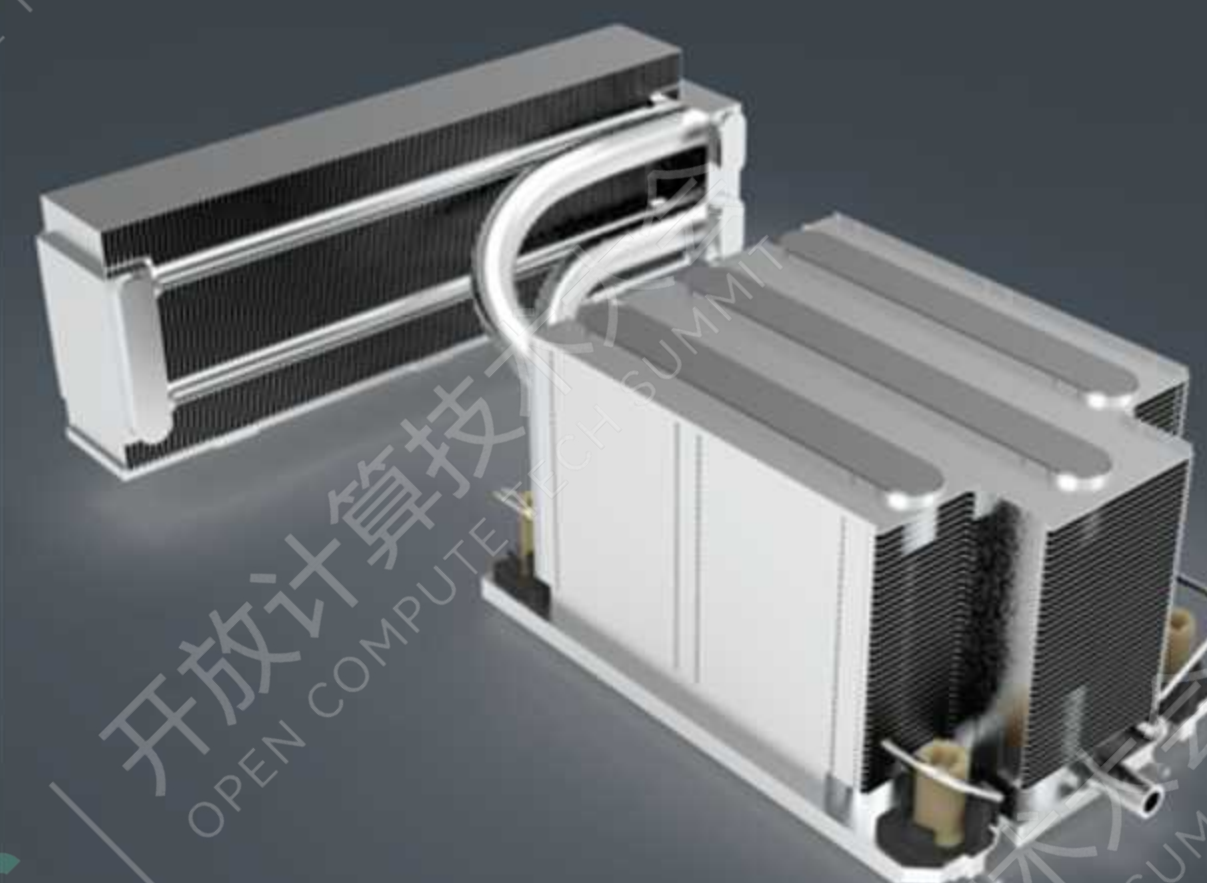
T Type (2U)

- > Extend the volume of the heat dissipation area



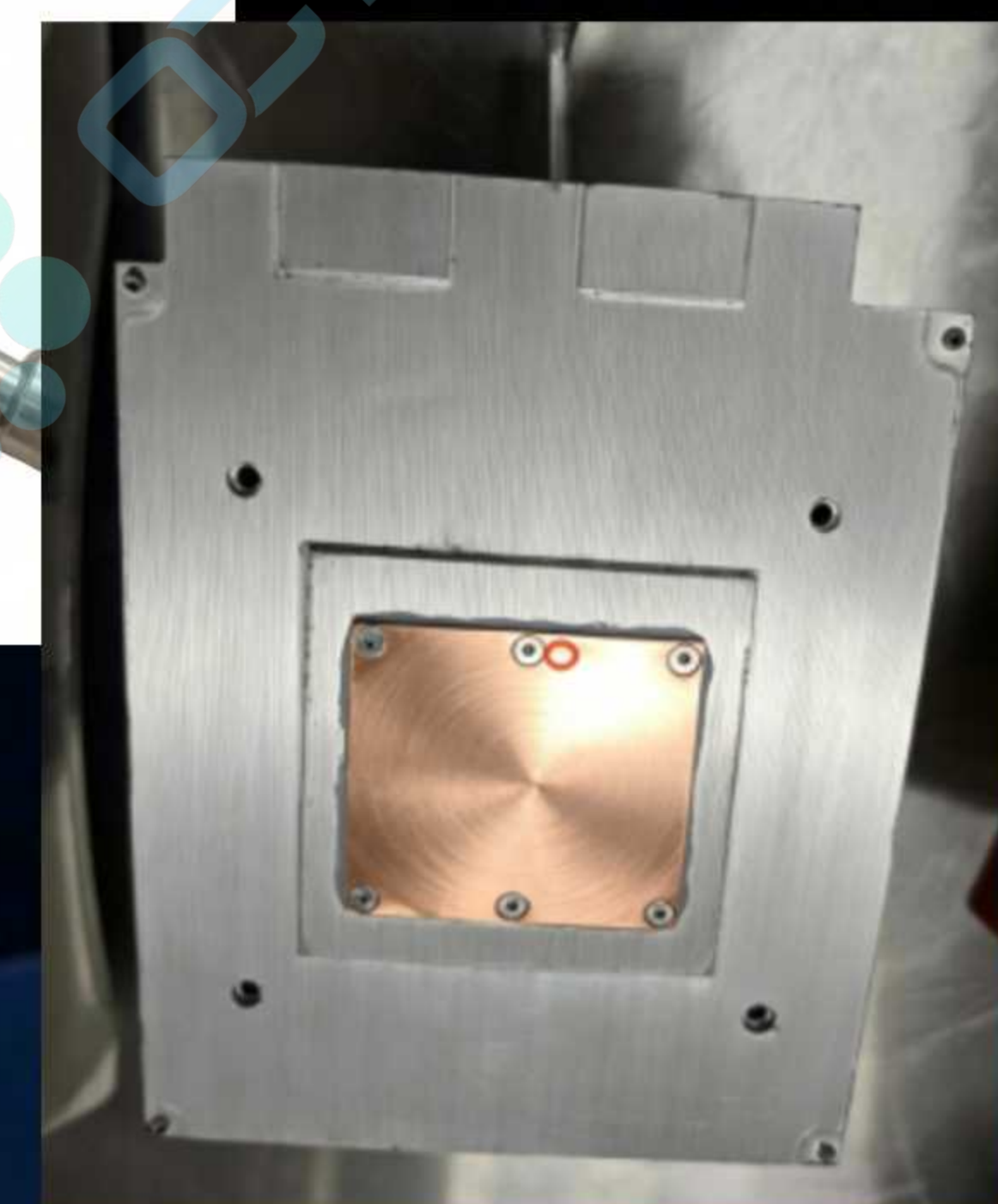
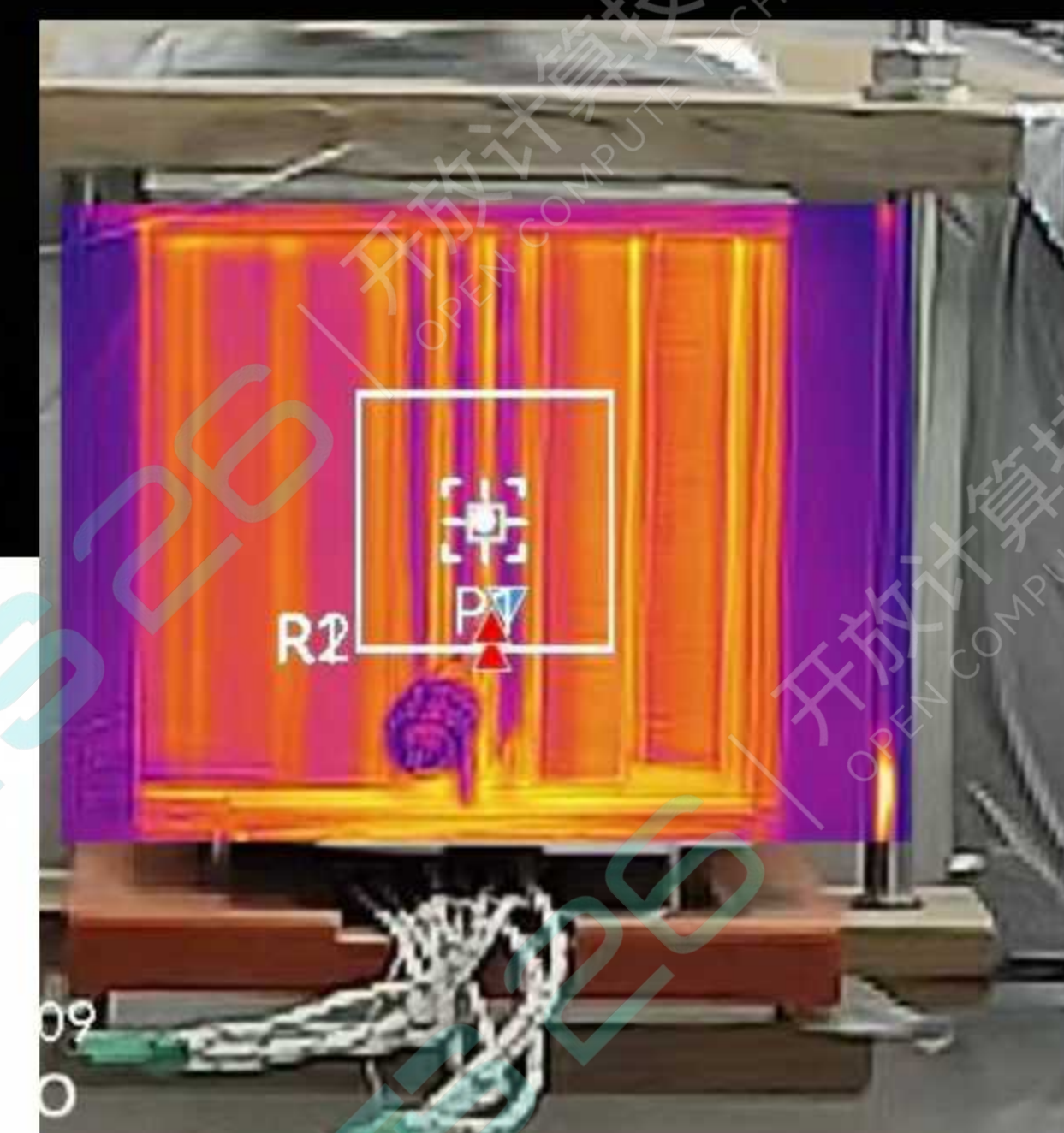
Remote Type (2U)

- > Flexible design to fit the mechanical design of inner rack.
- Maximum: 600mm



Dual-loop Type (2U)

- > High Performance
- > Multi-row design to enhance the efficiency of heat dissipation.



Best R Value

0.033 °C/W

700 W @ 250 CFM

700W @ 200 CFM

0.036 °C/W

CPU $\Delta T = 25.5^{\circ}\text{C}$

1200W @ 200 CFM

0.044 °C/W

CPU $\Delta T = 53.1^{\circ}\text{C}$

Test Range

700~1200W

Q=200/250 CFM



The Path Forward and Our Commitment

- Our Proposed Next Steps:

Pilot Project: Propose to deploy a full-scale module at data centers.

- Our Commitment:

To provide a secure, and reliable cooling solution that underpins the digital future and green transition.

THANKS