UNI.T™

CALOGY

Thermal
Management
Redefined

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About Calogy Solutions™

Experts & Innovator in Thermal Management

Started in 2020, in Sherbrooke, Qc, Canada

Strong IP Portfolio

8.5M Grants granted as of April 2024

Among top 5 automotive startups worldwide enabling Battery Thermal Management (StartUs insights, 2022)

Foreseight 50 – Canada's Most Investable GreenTech Companies (2023)

Aero-Montreal Gala - Jury's Favorite Award (2023)

Winner of the open innovation competition for ABB (2024)







Dare us. To be the solution.

Thermal management: the power-electronics bottleneck

Heat sets the limit on every KPI that matters: density, lifetime, footprint, cost.

Higher heat fluxes than ever

Increasing system performance, gravimetric and volumetric density

Hot spots create mechanical constraints and drive premature aging

Non-uniform die temperature concentrates fatigue on bond wires, solder joints, unbalanced Li-ion system aging

Volume & weight penalty

Heat sinks and cold plates already dominate the footprint of inverters, OBCs, motor drives, Chips/GPUs/IGBTs

Liquid cooling has a real cost

Pumps, plumbing, glycol, leak risk, service intervals: many platforms simply can't afford it.

- Added BoM and assembly complexity
- Reliability hit: pumps, seals, fluid loss
- Maintenance footprint over service life

Uni.T™ Thermal Management Platform

Our innovative approach

Super Thermally-Conducting Plate



Performance
Up to 100x more thermally conductive than copper

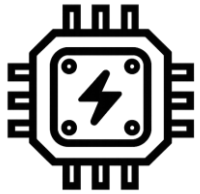
Economical and Environmental
Recyclable, No toxic fluids, Dual use Structural+Thermal

Safety
No coolant leakage

Practical and Reliable: No moving parts, no fluidic connections, Fully passive, Maintenance free

Uni.T™ Thermal Management Platform

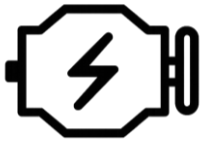
UNI.T™ Platform



Servers &
Power Electronics



Li-ion Battery
Packs



Electric
Motors

Tier 1

OEM

BELL

SAFRAN

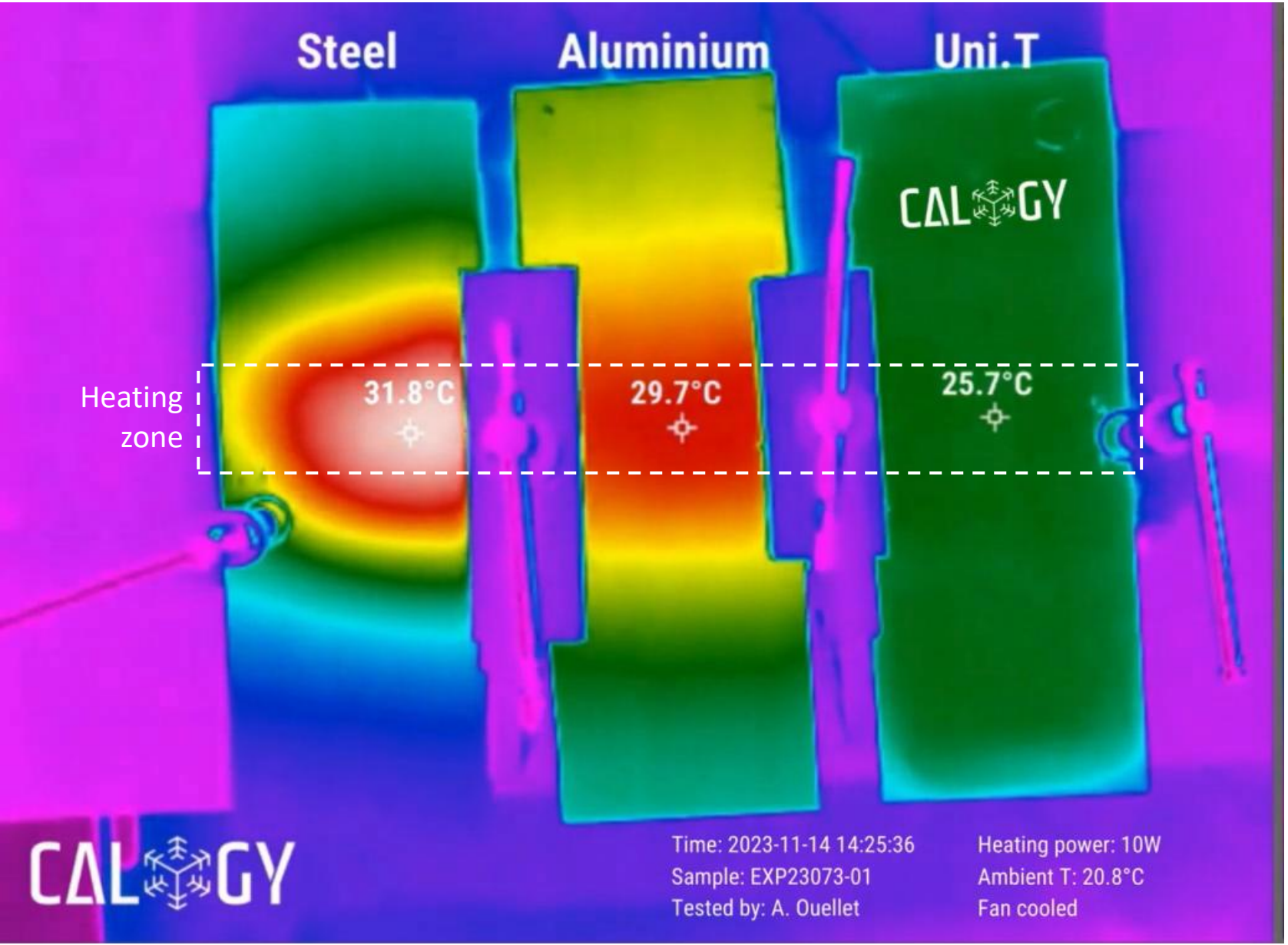
YAMAHA
Revs Your Heart

ABB

VOLVO
CampX by Volvo Group

Mercedes-Benz

Illustration of Thermal Performance



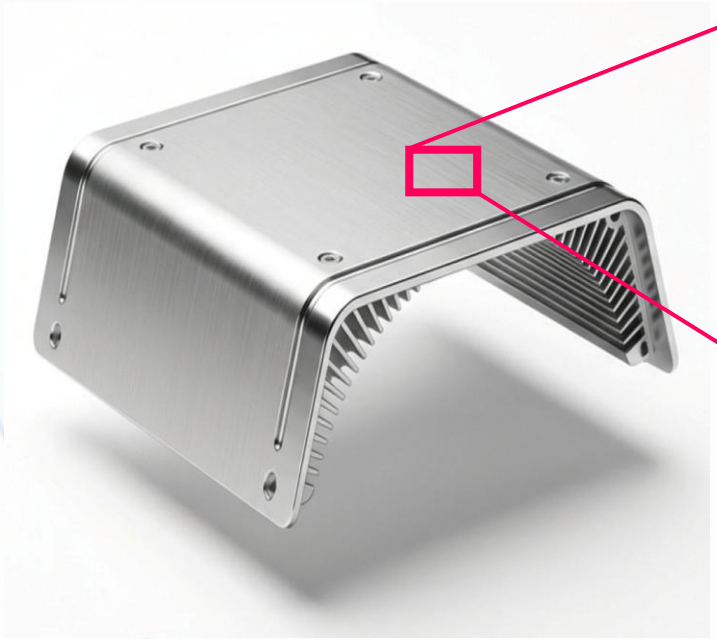
Spreads heat like a super-conducting material

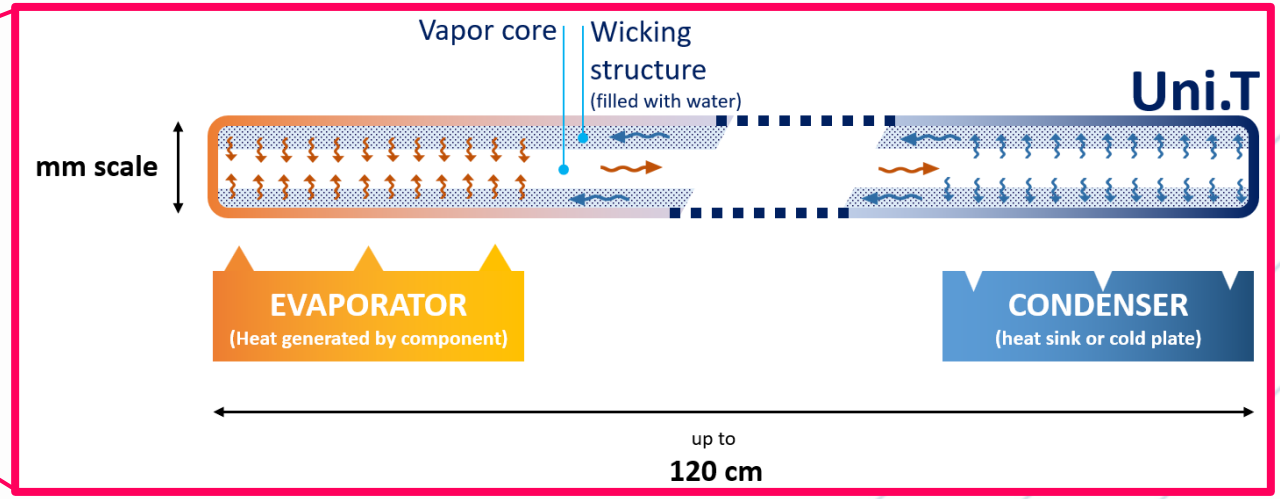
Up to 100x better than copper

Uni.T™ - How it works

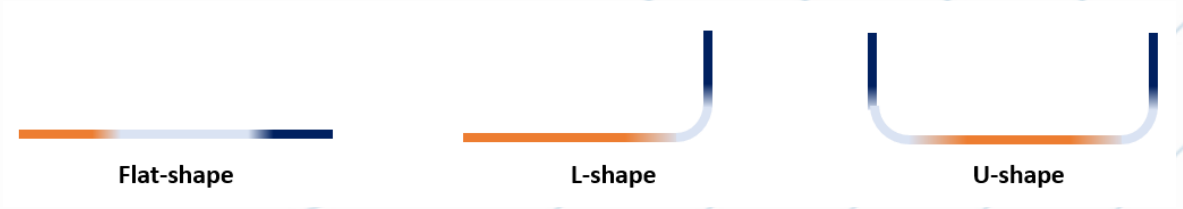
Uni.T Acts as a Highway for Heat

Allowing Efficient Heating and Cooling with Uniform Temperature





Flexible design



One Technology, No Compromise

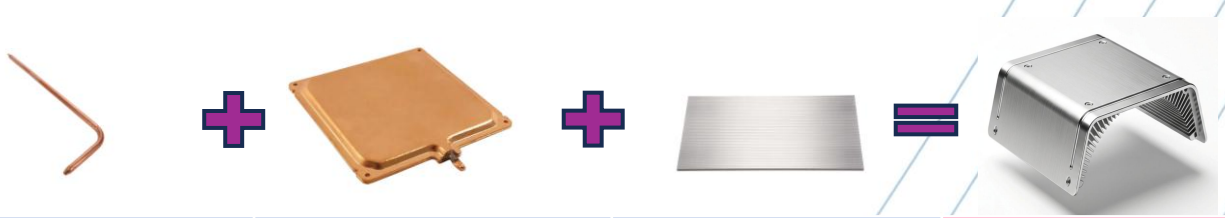
Uni.T™ combines the advantages of multiple technologies without the drawbacks

Advantage	Uni.T™	Liquid cooling	Forced air
No leak	✓	X	✓
Performance	✓	✓	X
Reliability	✓	X	✓
Weight	✓	X	X
100% recyclable	✓	X	✓

Reinvented legacy two-phase cooling

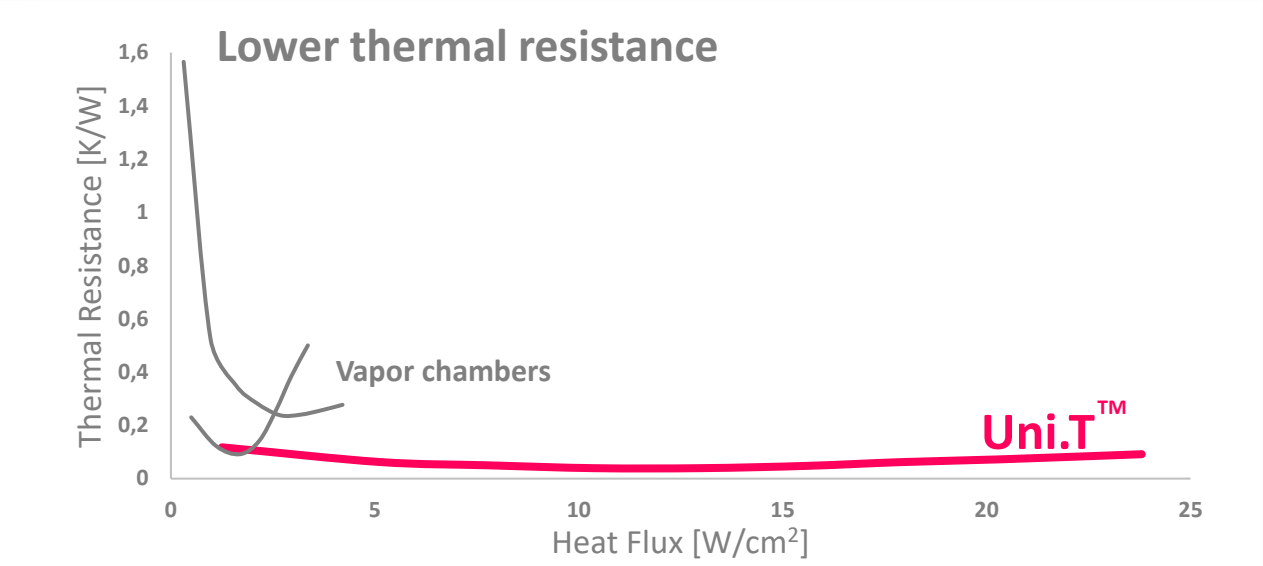
Opening a new range of applications

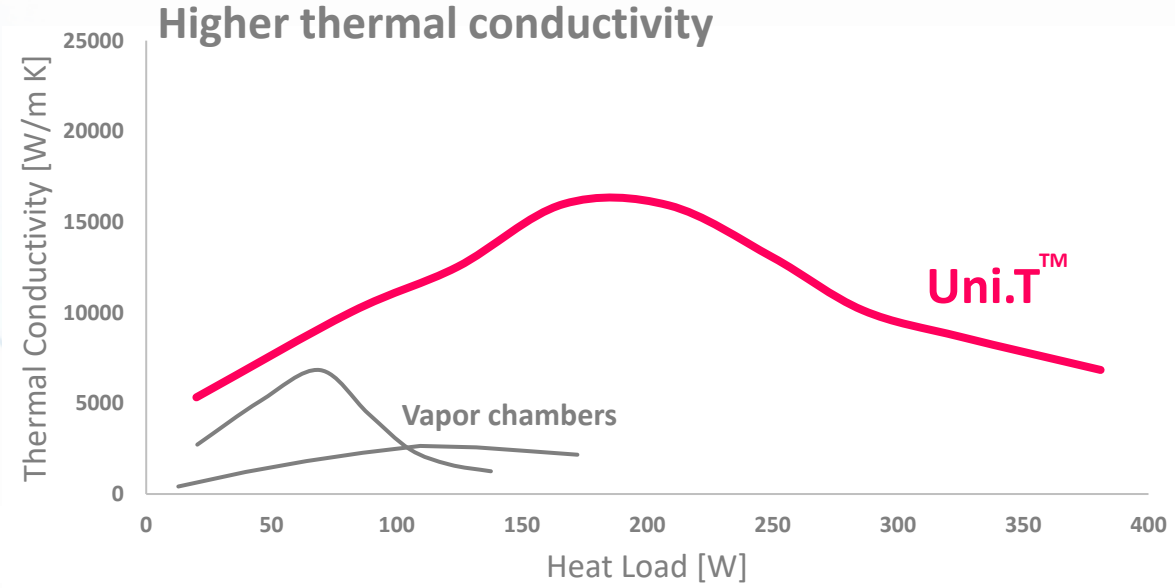
Current products on the market



	Heat Pipe	Vapor Chamber	Flat Heat Pipe	Uni.T™
Configuration	Cu + water porous wick	Cu + water porous wick	Al + acetone microchannels	Al/Cu + water porous wick
Performance	High	High	Low	High
All orientations	Yes	Yes	Horizontal only	Yes
Cost	Low	Expensive	Low	Low
Form / Weight	Not for planar	Heavy	Lightweight	Lightweight
Bendable / 3D	Yes	No	Yes	Yes
Production	Continuous	High T (900°C)	Continuous	Continuous

Bring heat spreading to the next level



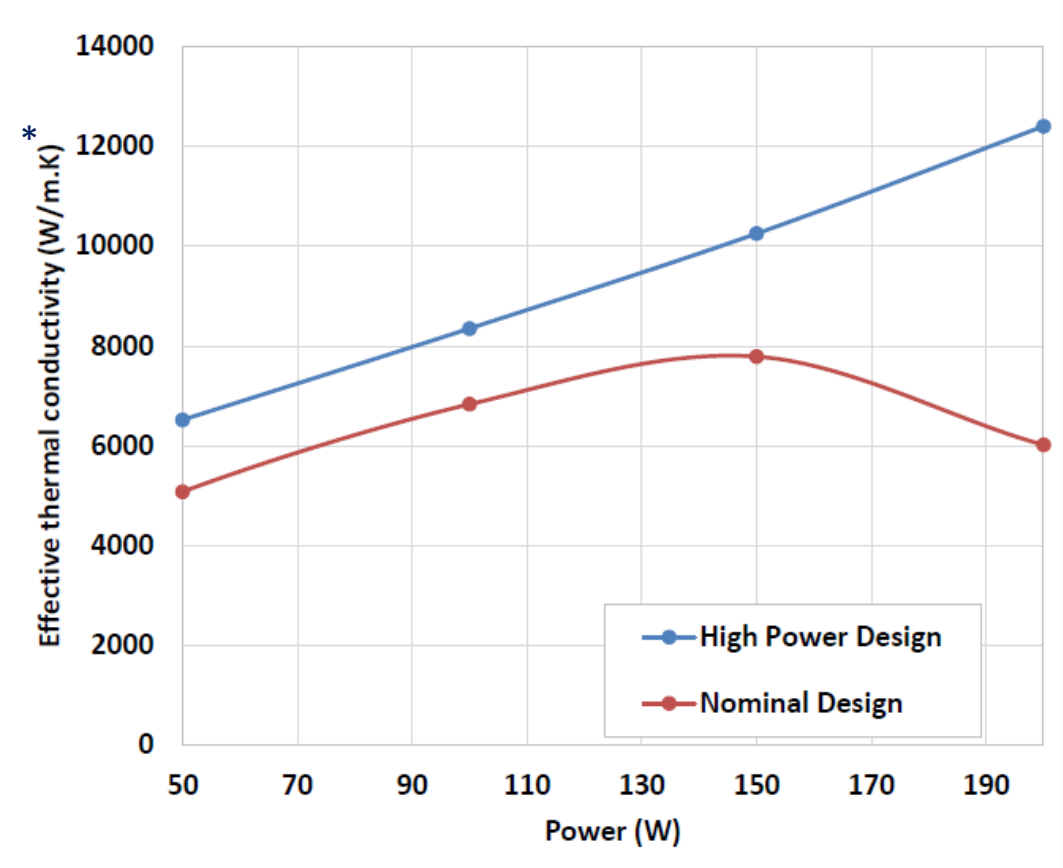


Compared to state-of-the-art Copper vapor chambers, **Uni.T offers**:

- **3x better thermal conductivity**, so less temperature increase for the same power, or more power for the same temperature
- **4x more power** can be transfered for a given size
- **Low thermal resistance** at high heat flux
- Up to **60% weight reduction**
- **Unmatched dimensions and footprint**

* Components of same dimensions tested under equivalent conditions

Uni.T Custom Designed for Your Application



Size and shape customized to application needs.

Nominal Design
Typically limited to 8,000 W/mK

High Power Design
reaches up to 40,000 W/mK

*Maximum power and thermal conductivity is a design variable and can be increased even with the current dimensions

Uni.T™ Development Roadmap

Uni.T Line





Product commercially available

- Thermal performance: 2 000 W/m.K to 10 000 W/m.K
- Minimum thickness 2.5 mm
- Customizable dimensions and performance
- Option to be structural
- Flat or bent shape available
- High production volumes available

Uni.T Edge





Prototyping samples availables

- Thermal performance: 10 000 W/m.K to 40 000 W/m.K
- Thickness as low as 1 mm
- Flat or bent shape available
- Unique patent-pending fabrication approach adapted for automotive-scale volumes and low cost

Application to Li-ion batteries

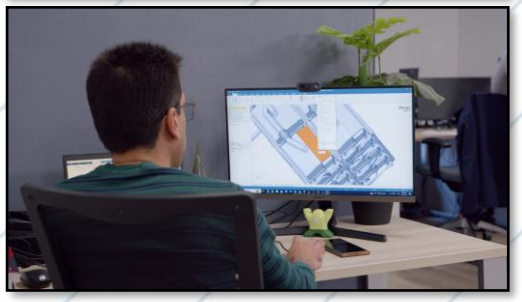
IN-HOUSE CAPABILITIES



- Electrical engineering
- Mechanical engineering
- Thermal engineering
- Software development
- Design for manufacturing
- Prototyping & production manufacturing









Dare us. To be the solution.

Uni.T™ for Li-ion Battery Cooling/Heating

Performant
- Cell uniformity (ΔT < 3°C)
- Rapid and efficient heating in cold ambient
- No derating: all conditions performance

Economical and Environmental
- 100% Recyclable
- Rapid ROI (less aging)
- No cells over-capacity required

Safe
- Reduce risk of thermal runaway propagation
- no coolant leakage

Practical and reliable
- Passive solution
- No moving parts
- No fluidic or power connections
- No maintenance

Added Value for EVs

AGING Down to 15%	CHARGING FAST Enabled
WEIGHT Down to 50%	RANGE Up to 15%
SAFETY RISK	SWAPPING ✓ Enabled

Benchmark Tests on Li-ion batteries – Ford Mach-E

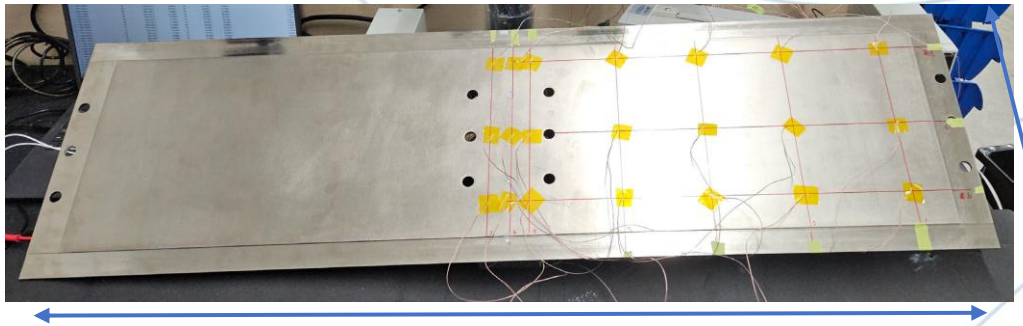
Ford Mach-E battery pack

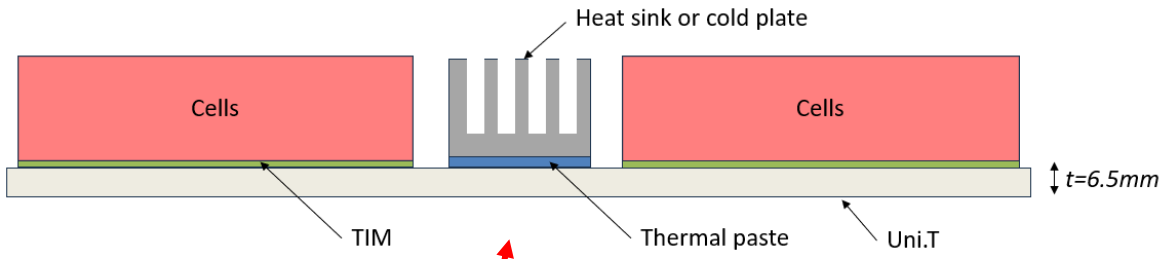




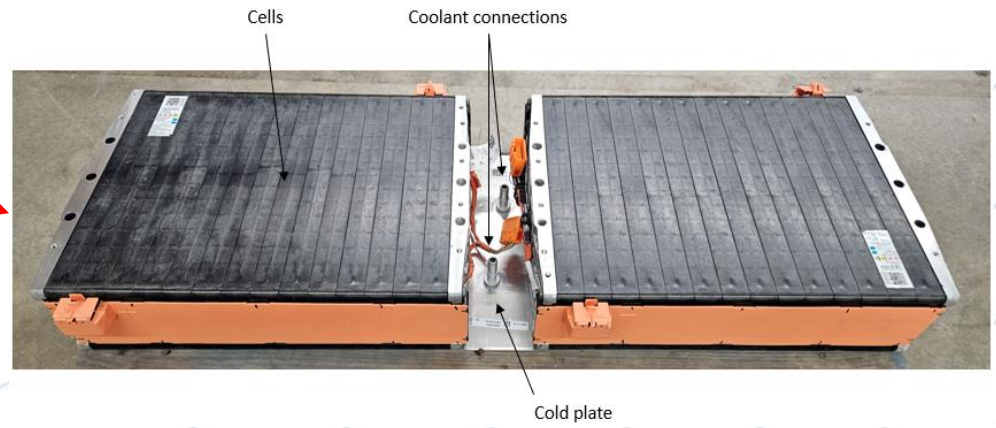
Battery pack

Original Mach-E Configuration



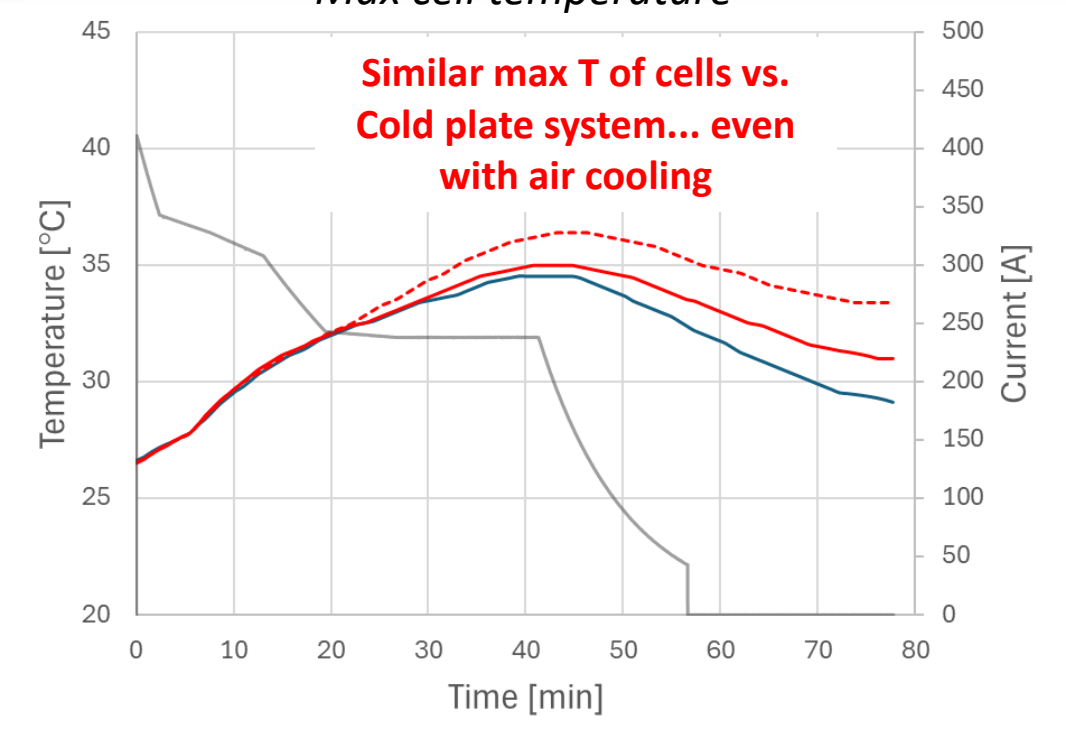


Uni.T plate in bottom cooling (new configuration)

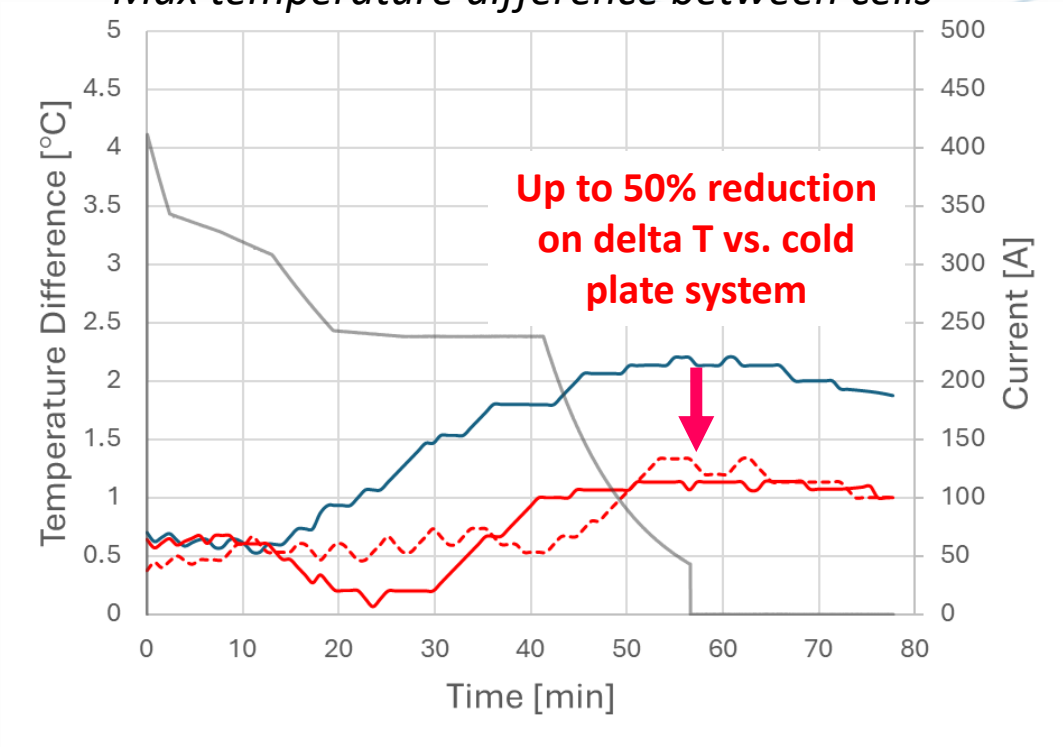


Benchmark Tests – Fast Charging Performance

Max cell temperature



Max temperature difference between cells



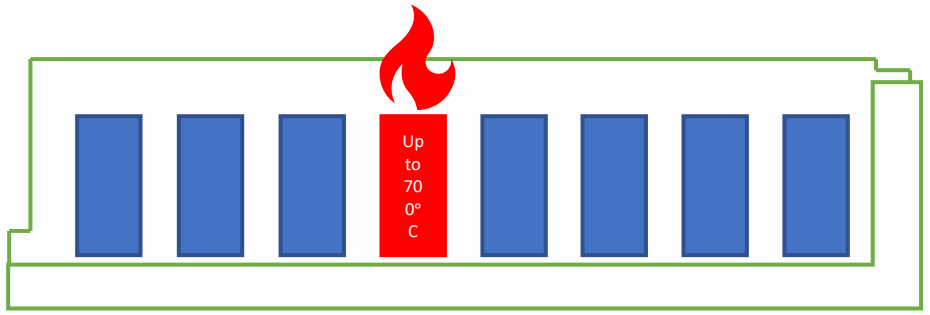
Cold plate — Uni.T + cold plate — Uni.T + heat sink

Demonstrates that Uni.T can match or even surpass the performance of the industry standard cold plates … but cheaper, lighter and safer

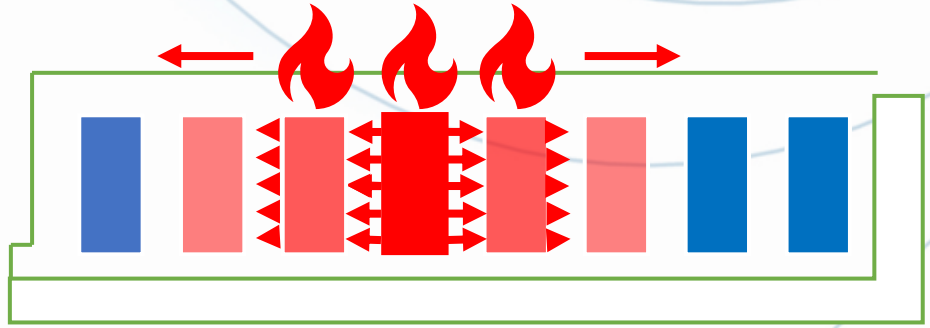
5% to 80% SoC Charging

Thermal Runaway Propagation & Mitigation Strategy

PROBLEM



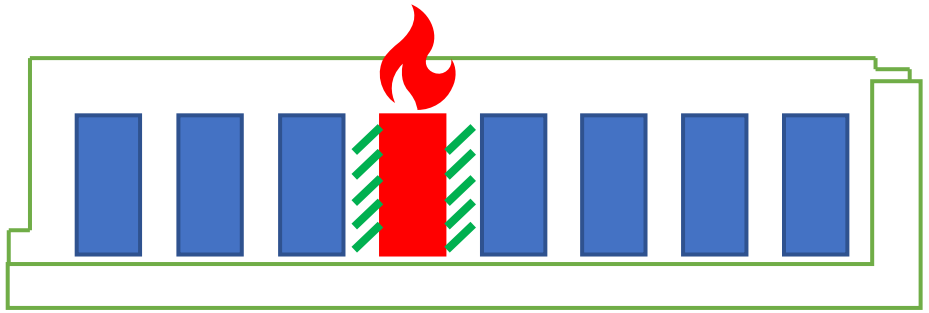
Thermal runaway of a cell generates heat and hot gases



Heat is transfered to the adjacent cells making them also overheat

SOLUTIONS

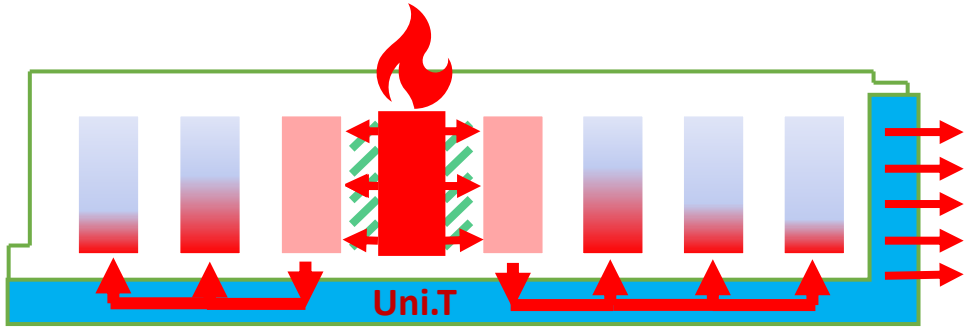
Mitigation strategy #1



Insulate the burning cell to prevent overheating of adjacent cells

X **Requires heavy/thick/costly materials between all the cells**

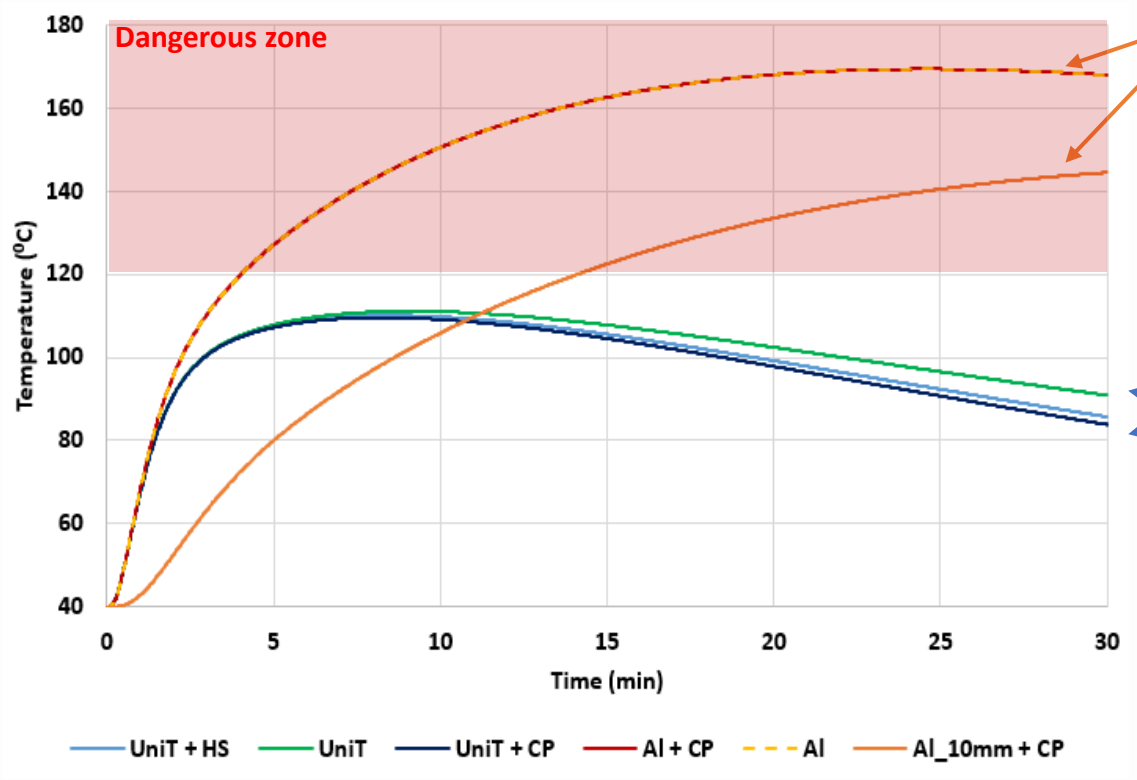
Mitigation strategy #2 (proposed by Calogy)



Cool the adjacent cells to prevent their overheating using a good heat spreader (Uni.T)

✓ **Spreading heat to all cells in the module**
✓ **Extracting heat to ambient**

Additional studies on mitigation of thermal runaway propagation



Aluminum plate as heat spreader

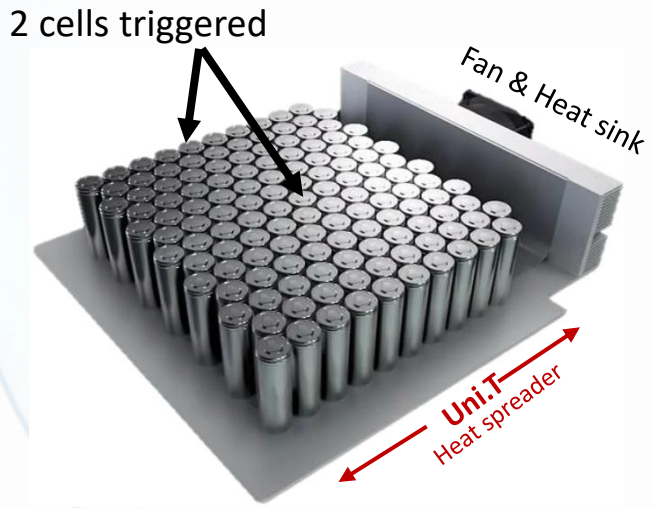
Uni.T as heat spreader

Thermal Runaway Propagation : Mitigation Demonstration

Test conditions:
- Thermal Runaway tests conducted by NRC-CNRC
- Triggered cells brought into thermal runaway by local overheating

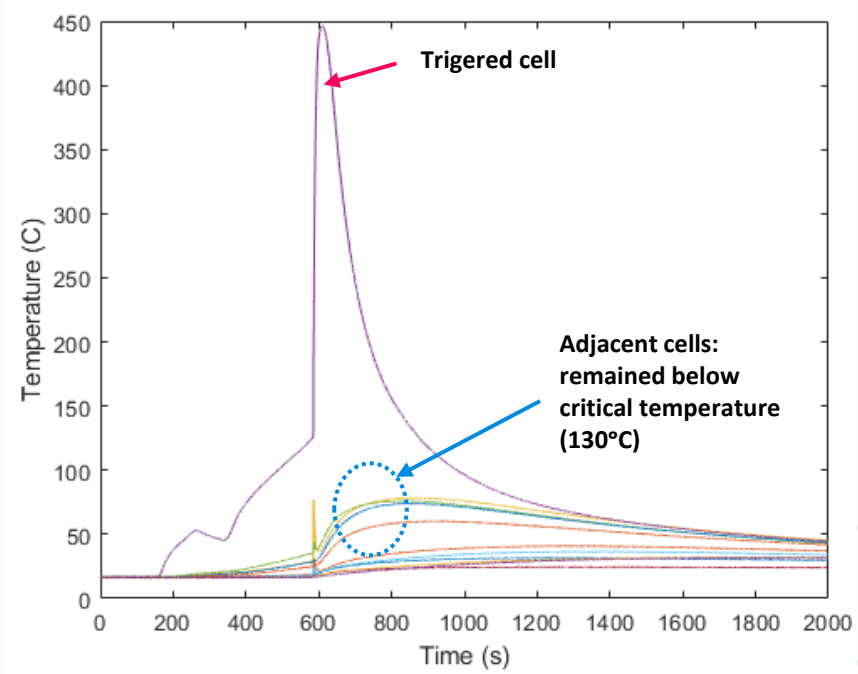
Results:
- No thermal runaway propagation: adjacent cells remained cool
- Battery still providing 48V after test
- Test campain validated our mitigation strategy based on Uni.T

Test configuration

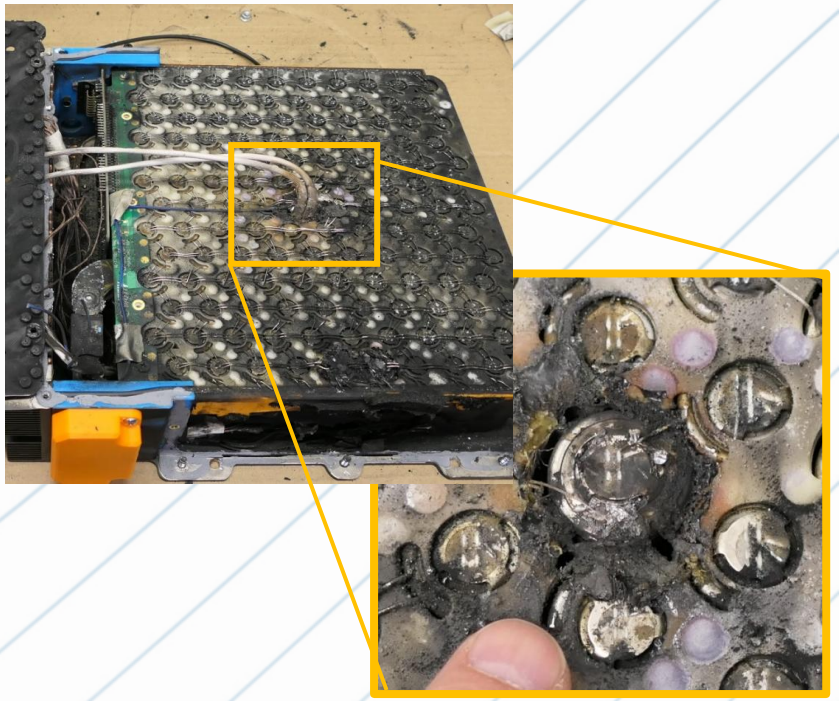


Module overview

Cells temperature profile during thermal runaway test



Module after thermal runaway test: no propagation



Dare us. To be the solution.

Product Portfolio Summary

3 Modular Approach – wide range of Applications







	L.PACK™ – HIGH POWER	L.PACK™ – POWER	POWERMODULE® - ENERGY
Max voltage	450V	120V	800V
Chemistry	NMC/NCA		LFP
Module size	2 kWh – 48V	8 kWh - 50 V	5 kWh – 50V
Optimal system size	2 to 16 kWh	8 to 64 kWh	5 to 680 kWh
Energy density	172 Wh/L 139 Wh/kg	280 Wh/L 166 Wh/kg	201 Wh/L 123 Wh/kg
Thermal management	✓ Heating ✓ Cooling+++	✓ Heating ✓ Cooling+	✓ Heating
Cycle life *(1C - 80% DoD)*	1500	2000	4500

ePTO Case studies

First 100% electric Tow Truck with CAA
L.Pack powering tow platform 2-4 kWh 48V



10 ton tow truck 100% electric – hydraulic – 8kwh with NRC Industries. L.Pack powering for the towing platform



Electric trash compactor (with Pakmat Industries)
20 kWh to 8 kWh lifting 3-ton payload
Integrated regen and winter ready





16kwh – Cable installer (with Bell)
Electric – Hydraulic PTO

eVTOL Case studies



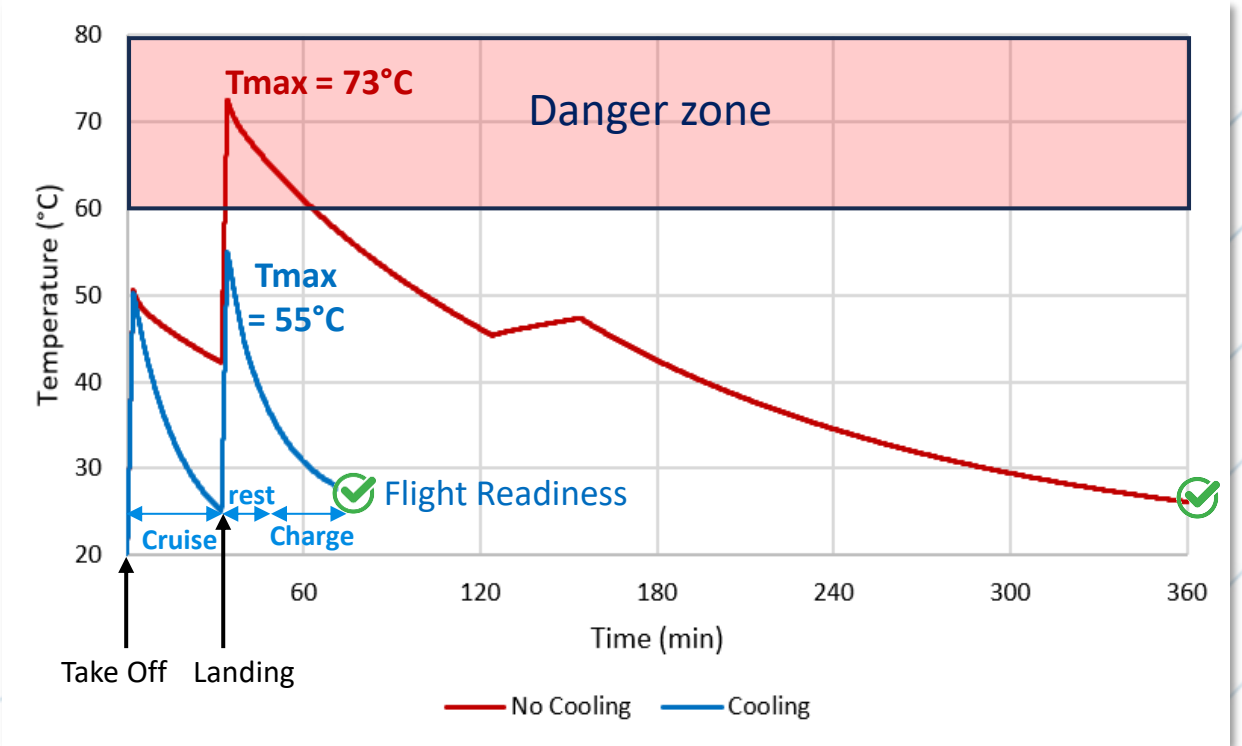
2022 – 2024: design and prototyping of a H2 helicopter

- Partners: Bell Textron, IRH-UQTR
- Funding: CRIAQ

- Calogy Expertise:
  - thermoelectric modeling of the propulsion system
  - Prototyping of the Li-ion battery system

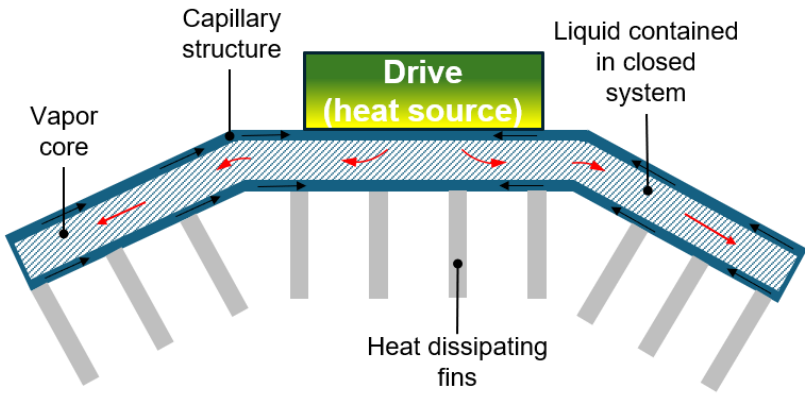
2022 – ongoing: design and prototyping of a Li-ion battery system for a H2 eVTOL

2026 – ongoing: design and prototyping of a Li-ion battery system for a drone



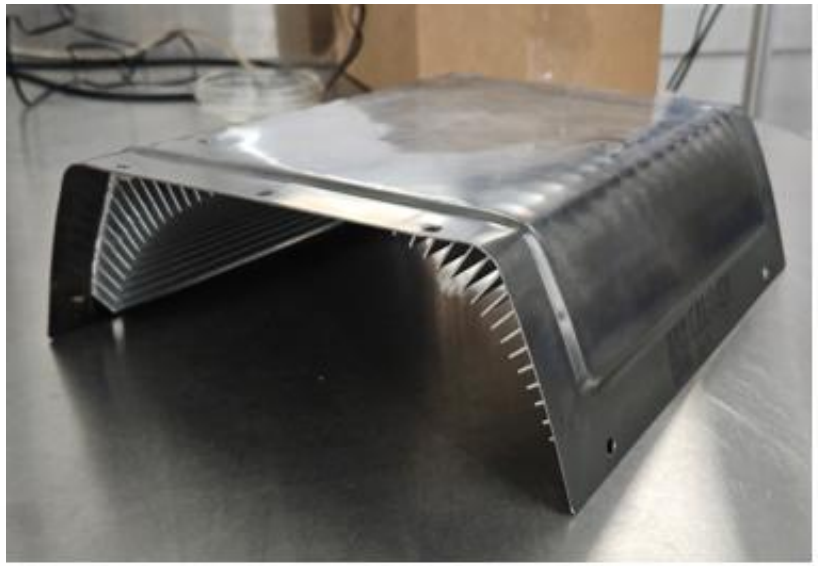
Application to Power Electronics components

Case Study Electronic motor & drive cooling

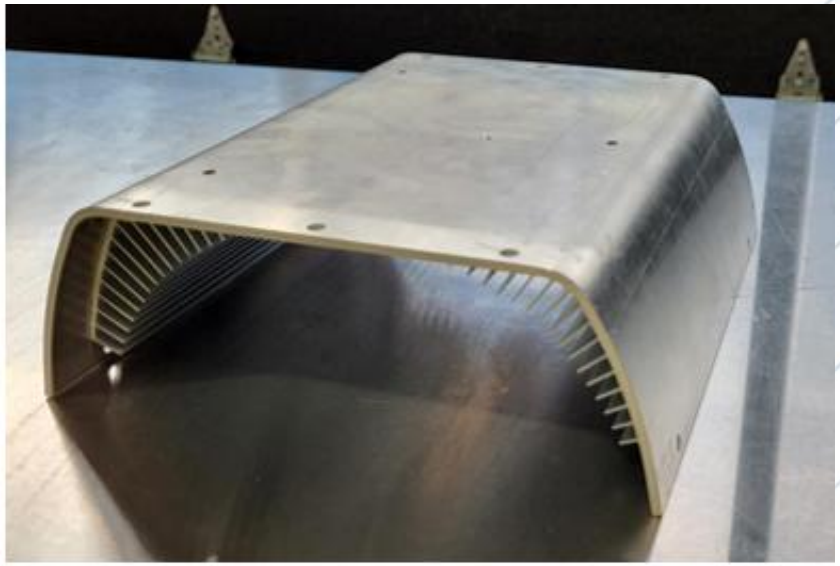


Project outputs

- 10x more efficient at heat distribution compared to OEM heat sink
- Reduced internal drive temperature by 19 °C
- 55% lighter than the OEM heat sink



Uni.T heat sink



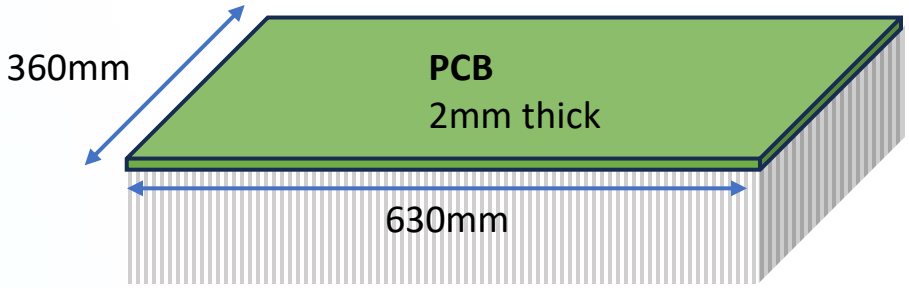
OEM Aluminum heat sink

Case Study EV onboard charger

Automotive
Tier 1

Total heat loss: 600W (25W/cm^2)

Original solution



- 2 fans
- Heat sink additional mass ~10kg

Proposed solution

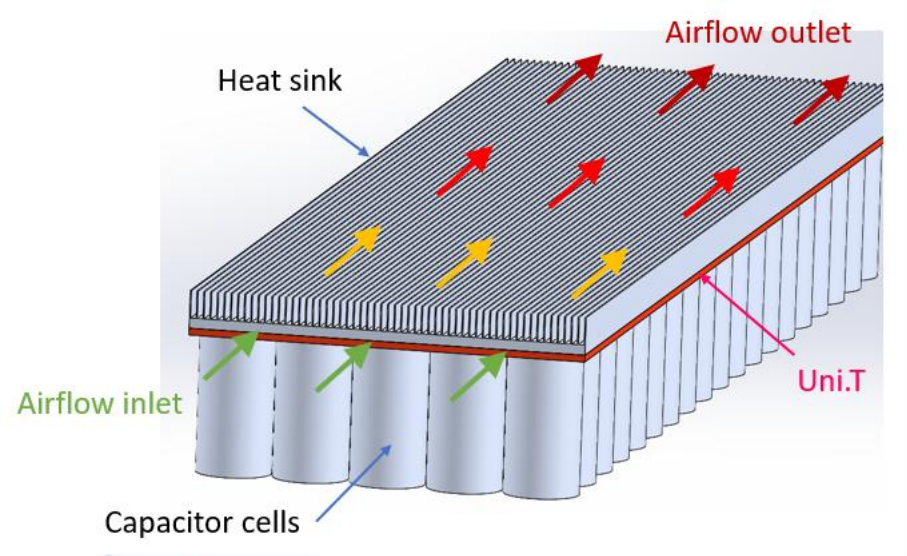


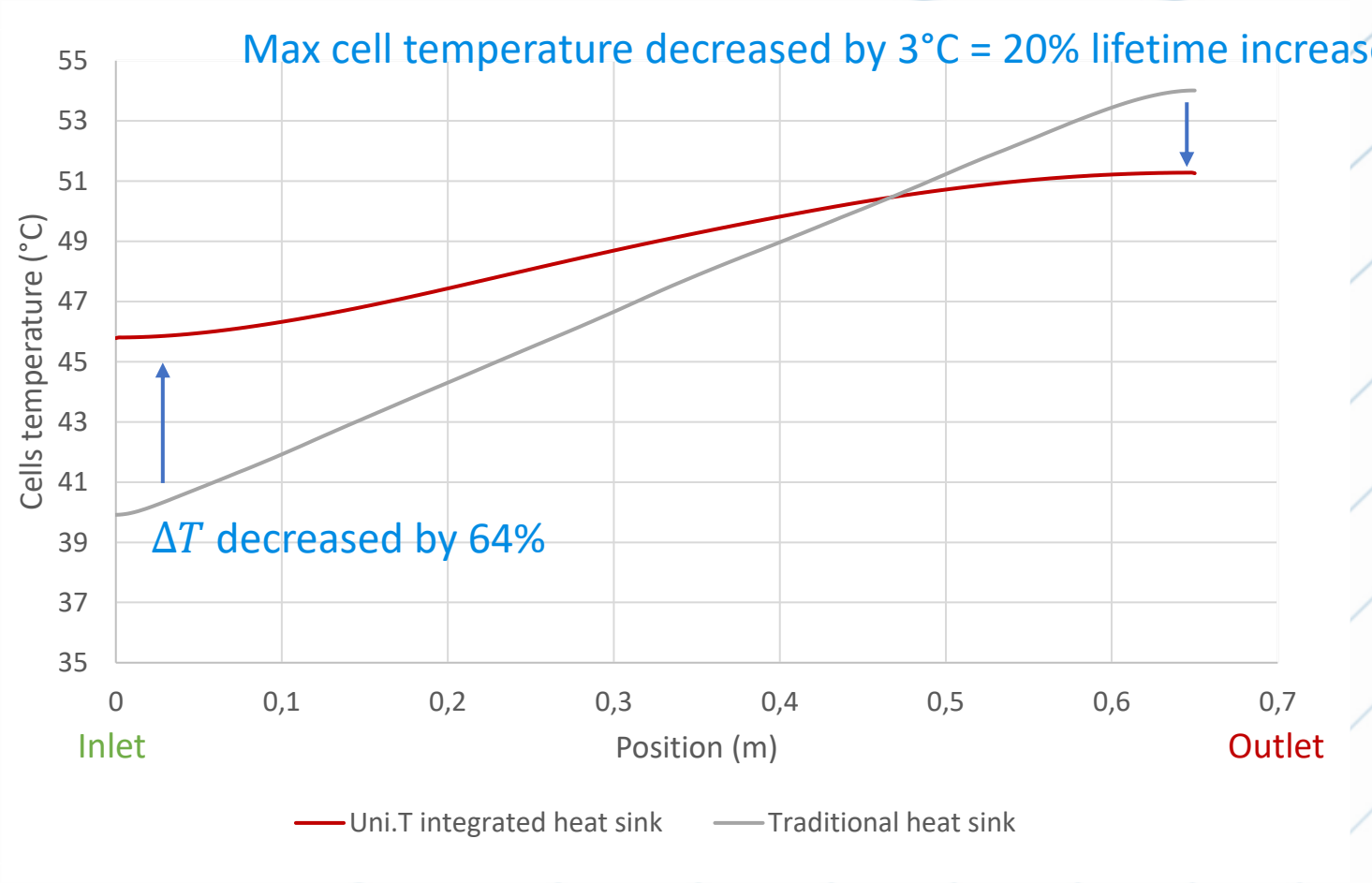
- Small sid heat sink
- 1 fan

Benefits

- 16% power increase
- 69% size reduction
- 64% weight reduction
- 0% cost increase

Case Study Supercapacitor cooling





Application to AI chip cooling

Problem: The Inference Cooling Gap

aws groq Google

NVIDIA

AI Inference | AI Training

$



$3B to Switch to Overkill Liquid

Legacy Air Cooling



?

350 W

750 W

1000 W

Power

Problem - The Inference Cooling Gap

aws groq Google

NVIDIA

AI Inference | AI Training

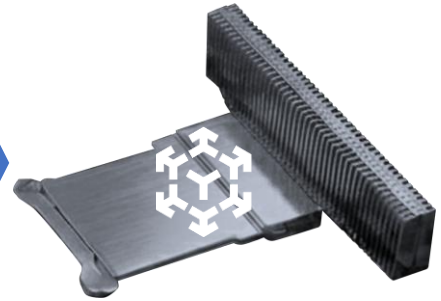
$



$3B to Switch to Overkill Liquid

Legacy Air Cooling





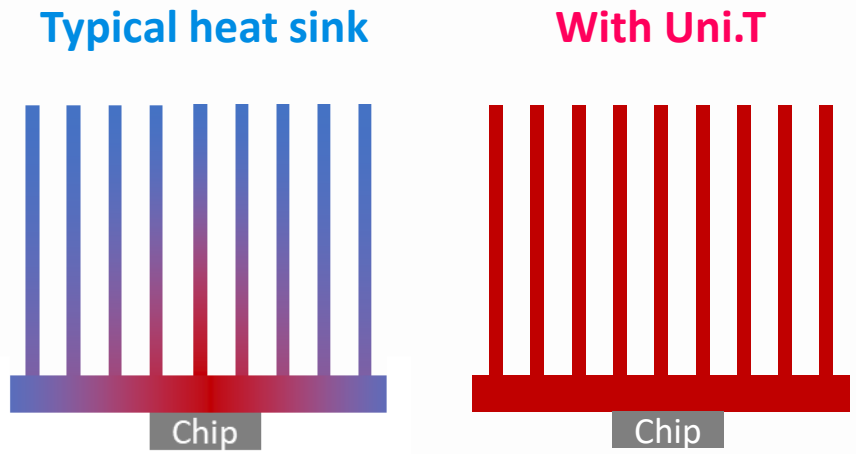
Enable AI in existing data centers:
5x Cheaper than Liquid Cooling
3x Better than Legacy Air Cooling

350 W 750 W 1000 W

Power

How Uni.T Boosts Heat Exchange

Due to Uni.T's efficient heat spreading, all fins are hot: everywhere, during all operational time.



Benefits:

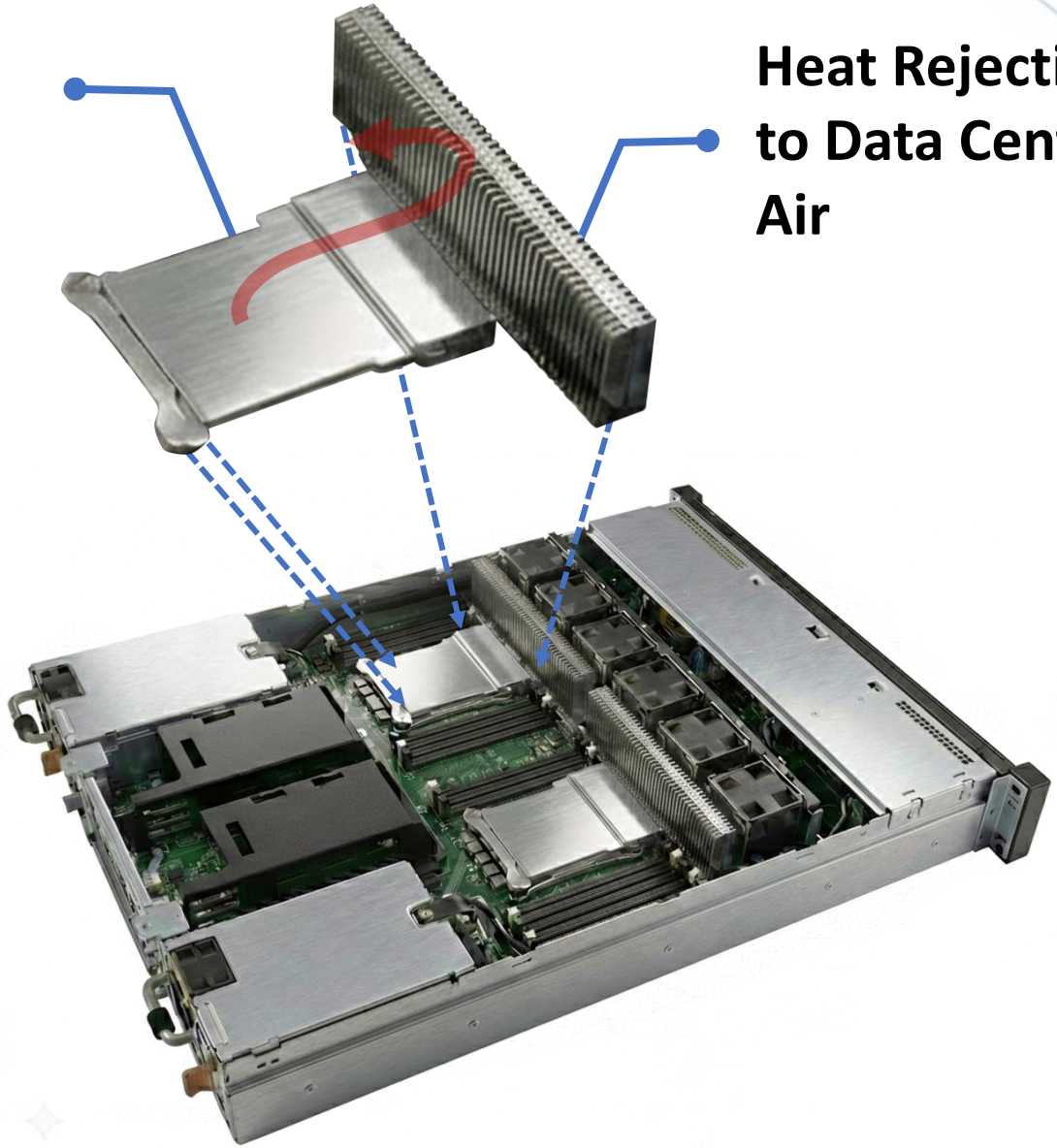
- **More compact** : Entire heat sink is hot, reducing the fin surface area required for heat load. More compact heat sink is possible, allowing more servers per rack.
- **Consume less air flow** : No air flow wasted through cold portion of fins, reducing fan power consumption.
- **Can use warmer inlet air :** Reducing HVAC cooling load and power consumption, or avoiding air conditioning entirely.

Solution: Uni.T™ - Superconductor Air Cooling

Drop-in thermal superconductor

Installation in < 5 minutes

No plumbing.
No pumps.
No tanks.



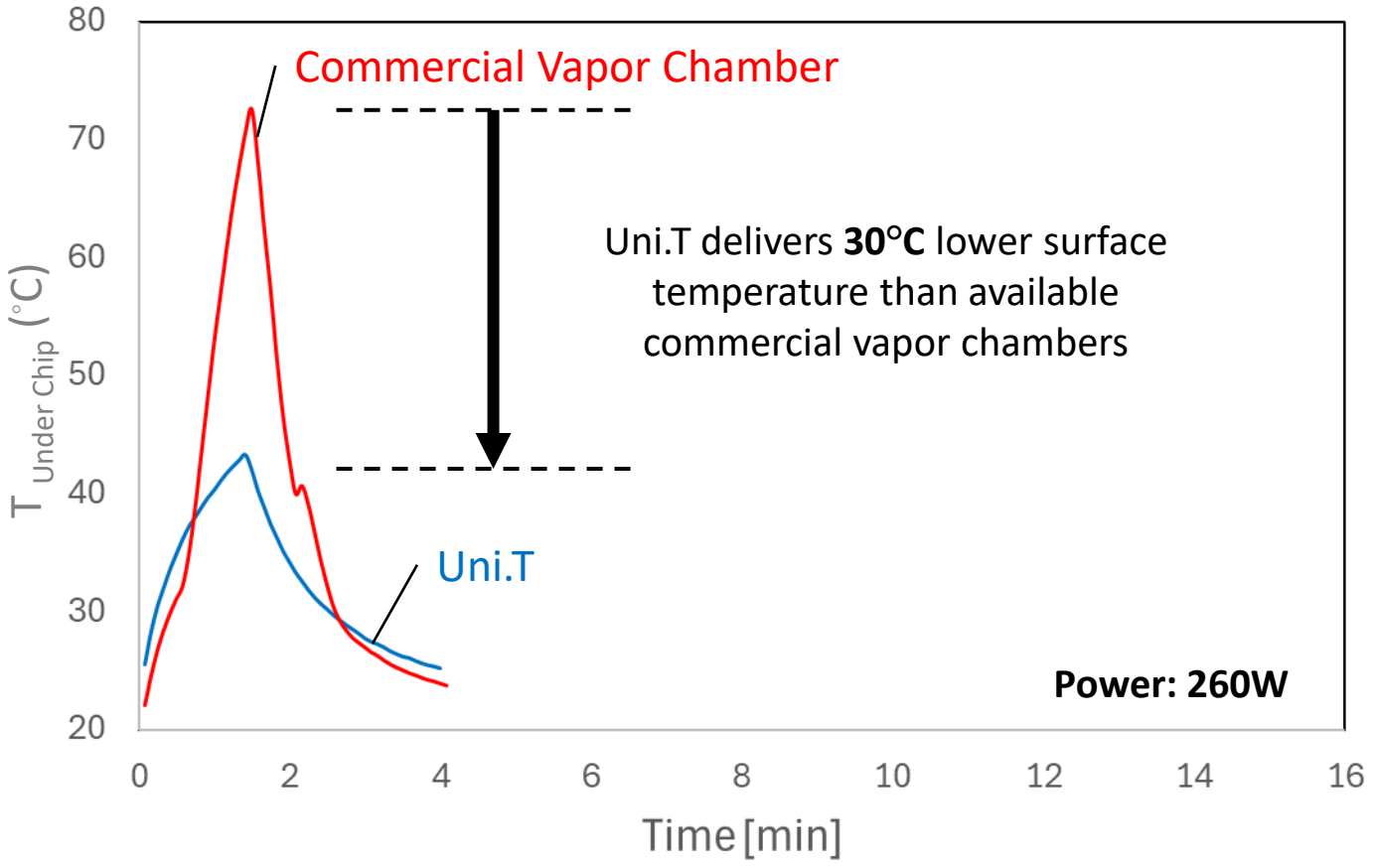
Heat Rejection to Data Center Air

Best cooling for AI inference data centers:

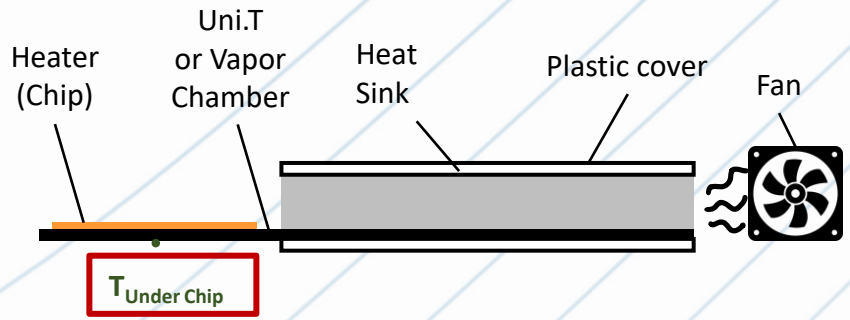
- ✓ High-density
- ✓ Reliable
- ✓ Energy Efficient
- ✓ Existing Infrastructure

Server Validation

1. Heat Extraction from High Power Chips

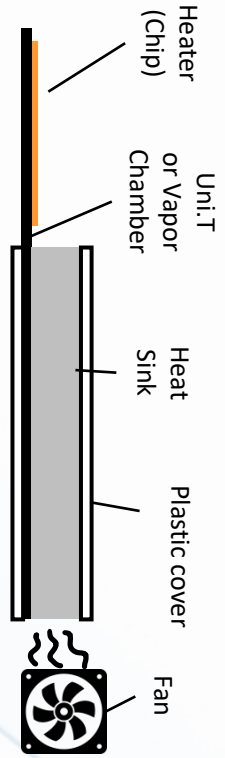


☑ High heat extraction validated

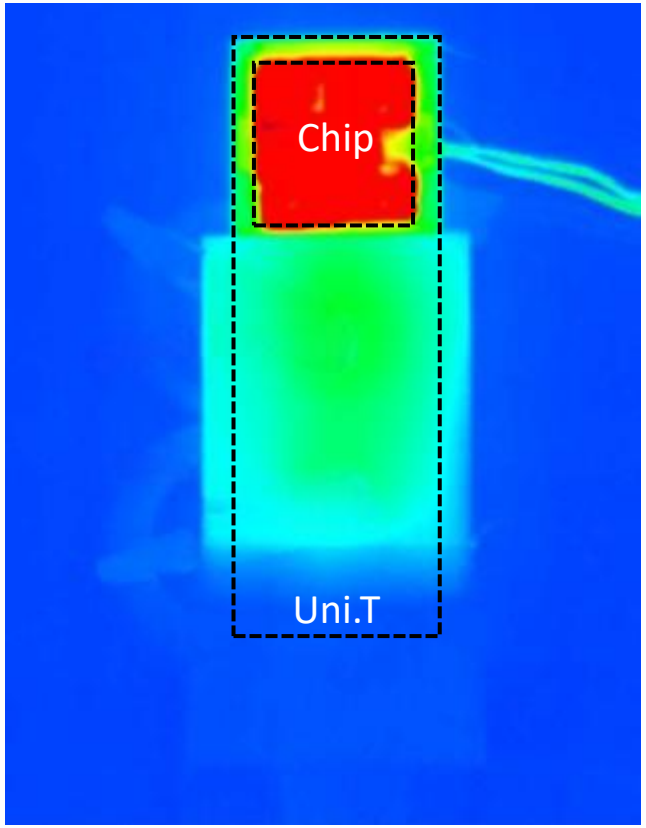


Server Validation - High Performance Heat Sink

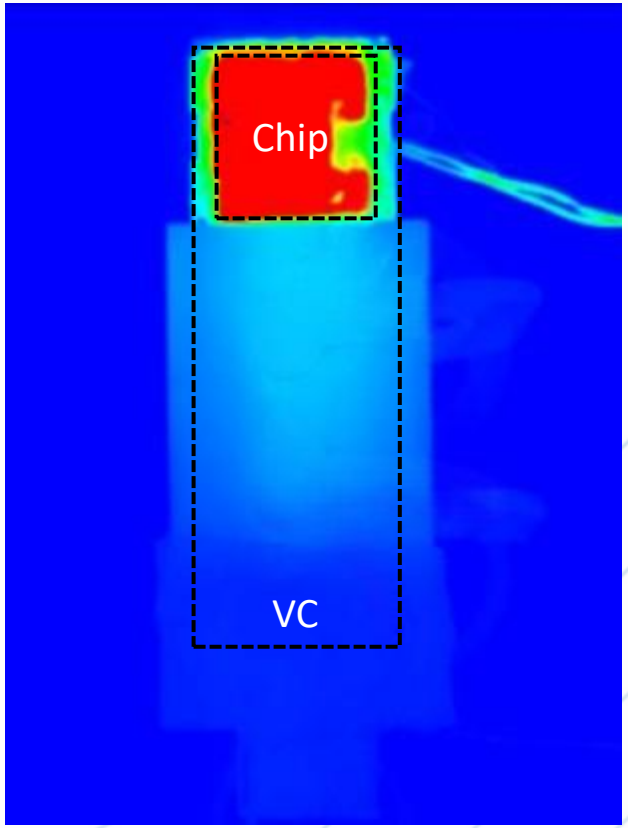
Heat sink average temperature is higher with Uni.T which increases the heat transfer drastically.



Uni.T

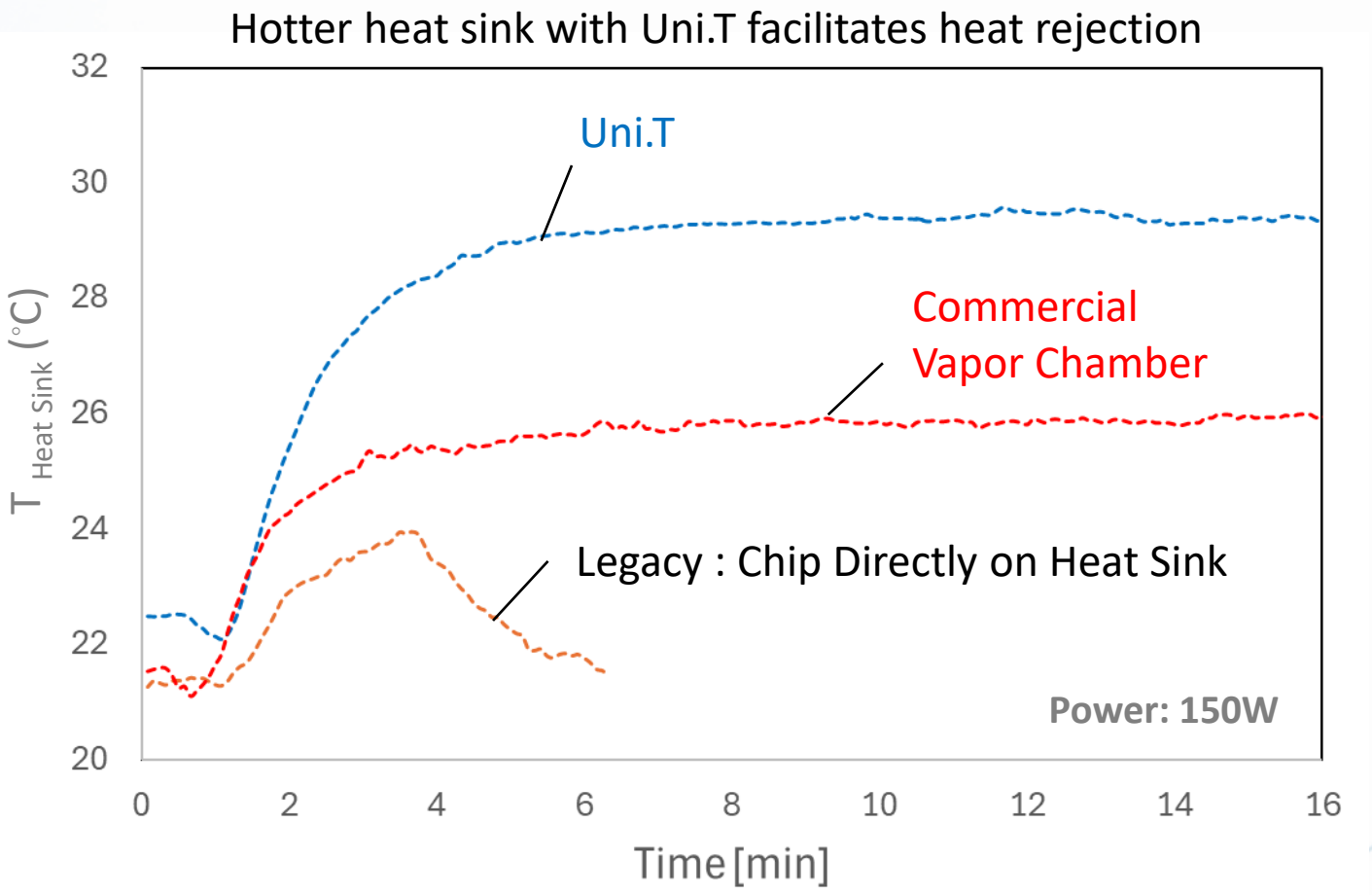


Commercial Vapor Chamber

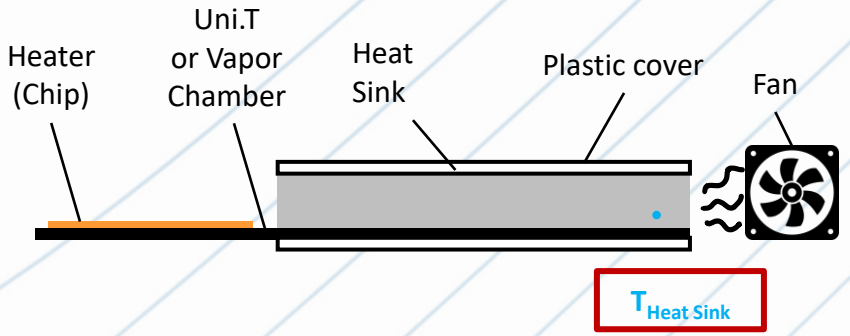


Server Validation

2. High Performance Heat Sink



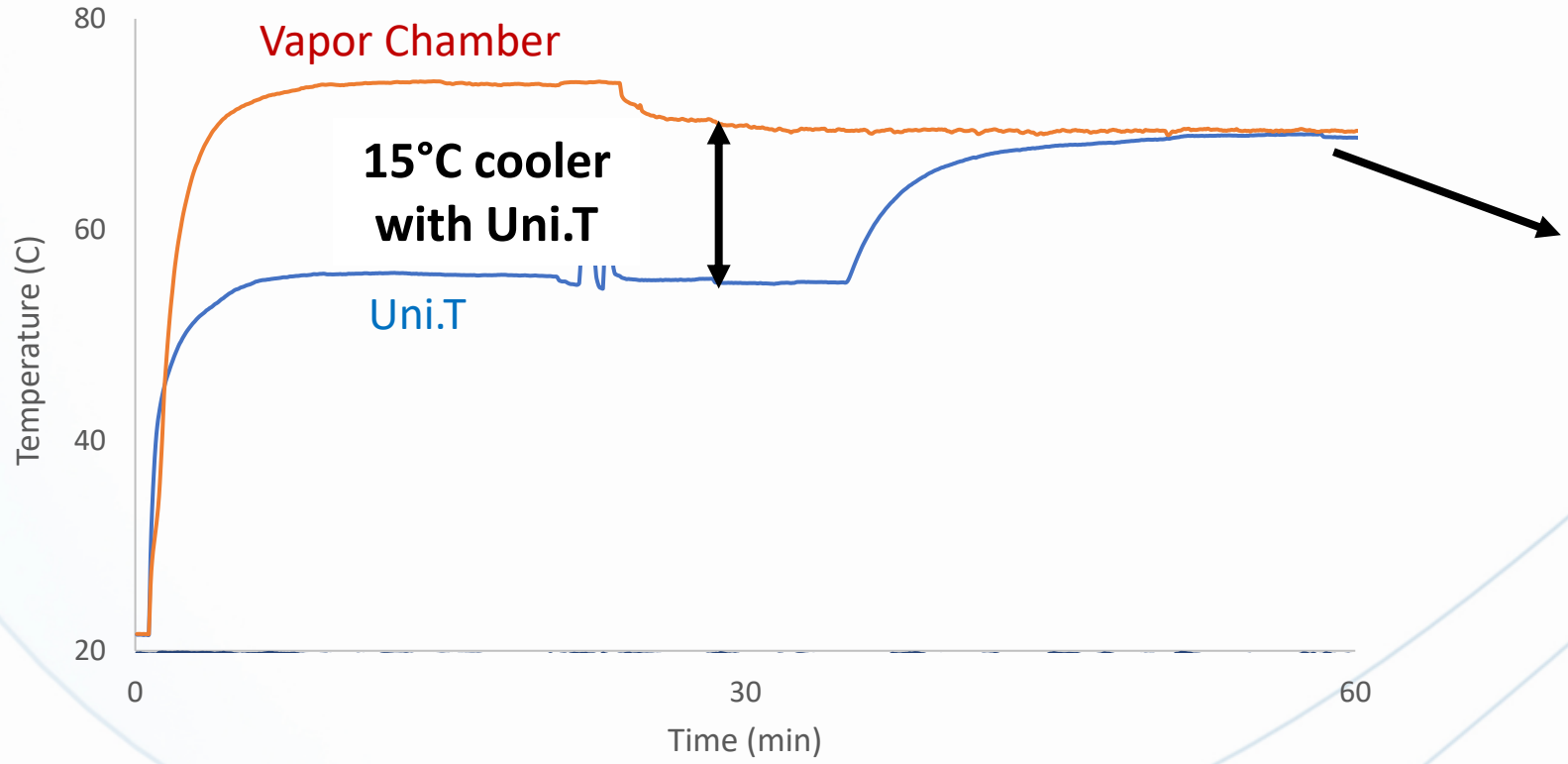
- ☑ High heat spreading across heat sink
- ☑ Higher temperature fins



Server Validation

3. Reduced Energy Consumption

Same Fan Power | Reduced Fan Power



Energy Savings:

Fan power reduced by

4.4x

for same chip temperature

Power: 206 W, Ambient T=21C

The Only Solution Solving the CAPEX/Performance Trade-off

Metric	Legacy Air Cooling	Enhanced Air Cooling Calogy Uni.T™	Direct Liquid Cooling	Immersion cooling
Implementation complexity	-	Drop-in replacement	Facility modifications Liquid cooling loop	Facility modifications Liquid cooling loop Tank for servers
CAPEX per rack	-	$8,000	$50,000+	$100,000+
Annual energy savings	-	$9,093	$10,002	$16,064
Payback (months)	-	10.5	60	75

15% more compute with same power
$20M CAPEX savings and **$2M** annual energy savings / data center
6x faster payback period than liquid cooling

Manage heat. Get the most of your systems.

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