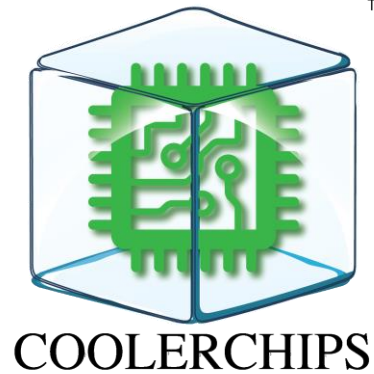


High-Density Air Cooling System

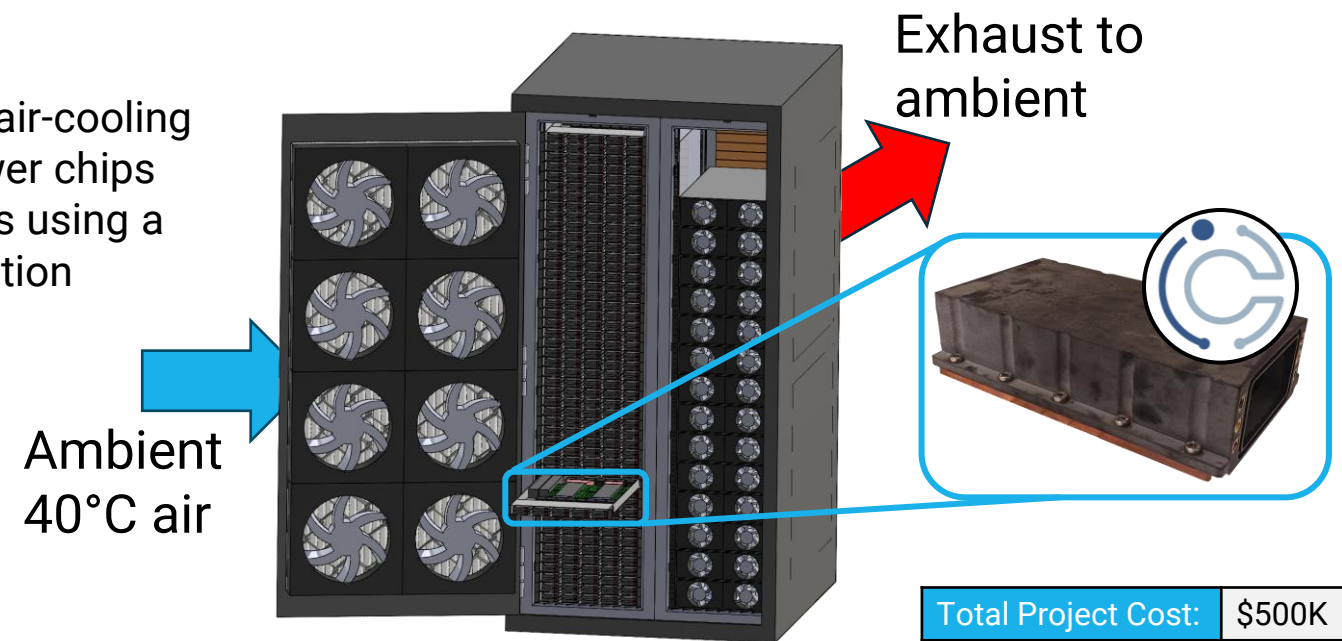
David Hobby, Impact Cooling

Team Members: Colorado State University



Project Vision

- Extend the capabilities of air-cooling into the future of high-power chips
- Eliminate adoption barriers using a simple, easy-to-adopt solution



Total Project Cost:	\$500K
Length	24 mo.

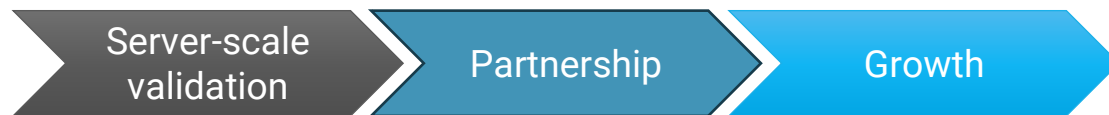
Brief COOLERCHIPS Project Overview

Fed. funding:	\$500K
Length	24 mo.

Team member	Location	Role in project, core competencies
Impact Cooling, Inc.	Ft Collins, CO	Development of impingement cooling architectures
Colorado State University	Ft Collins, CO	Facility construction and device testing

Context/history of the project

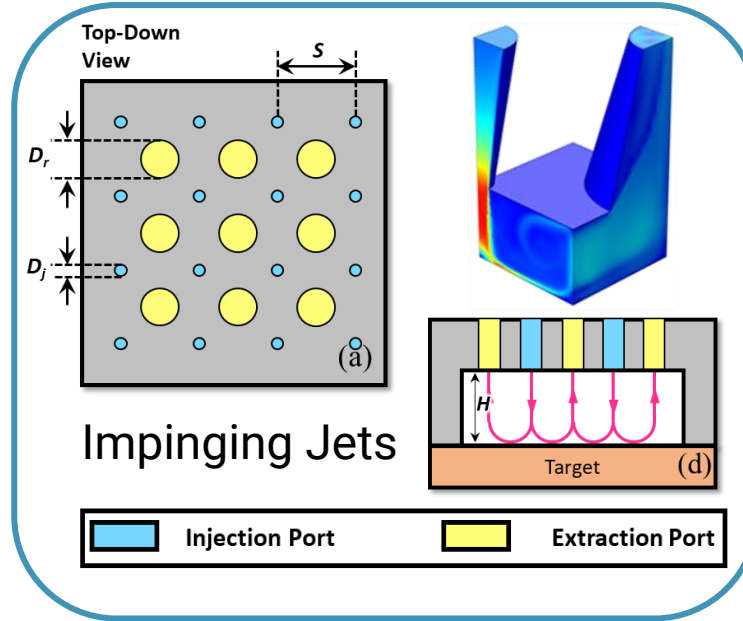
- Born out of Colorado State University
 - Thermal systems and impingement research
- Impact Cooling
 - Offering accessibility to efficient data center cooling
 - Simple solutions with exceptional heat transfer
- SEED SBIR Grant



Concept Detail



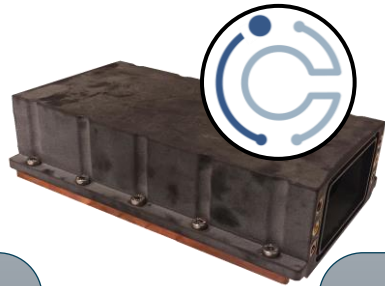
- ▶ **Lots of Area!**
- ▶ **Low Pressure Drop!**
- ▶ **Poor Convection!**



- ▶ **Little Area!**
- ▶ **High Pressure Drop!**
- ▶ **Excellent Convection!**

Applying

High-Performance
Microfluidic
Impinging Jets

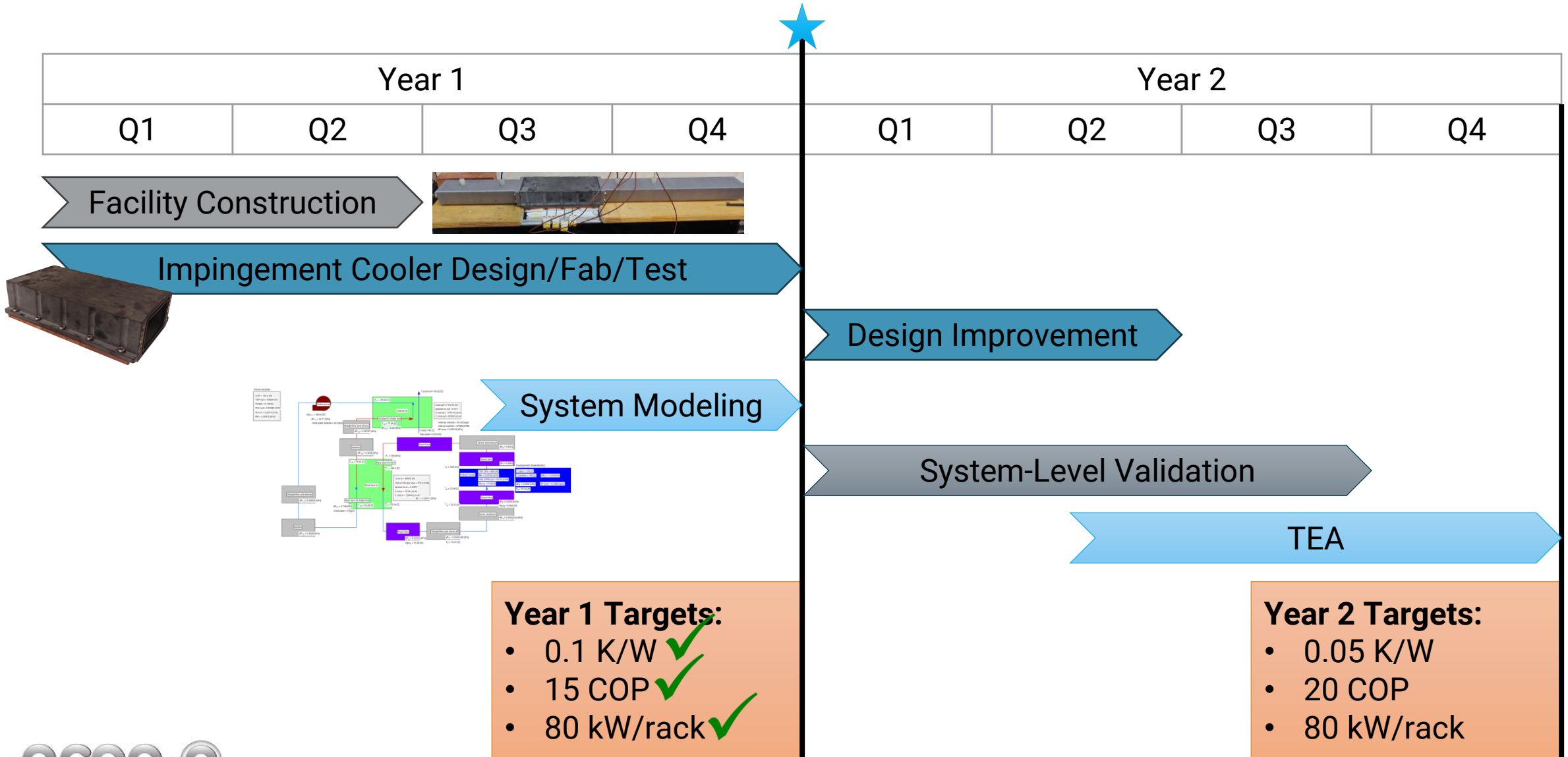


To

Low dP, Compact
Area Enhancement
Architecture

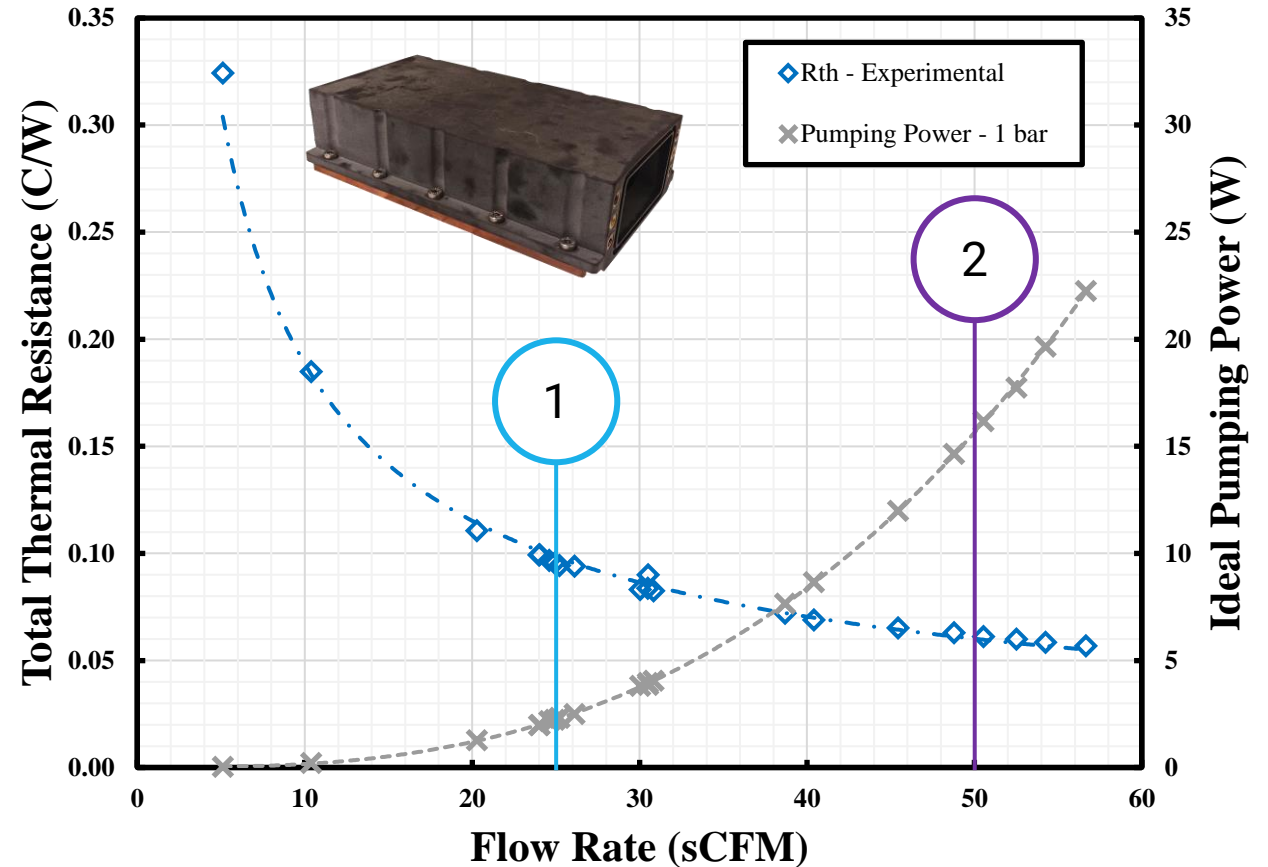
FOA Metrics	Units
Resistance Target	0.05 K/W
Cooling Power % of IT_power	5 %
System availability	Server fan life
Chipset	Surrogate Heater (42 cm ²)
Chip Power	800 W
Power per server	3200 W/U
Demonstration power mid project	N/A

Task Outline & Technical Objectives



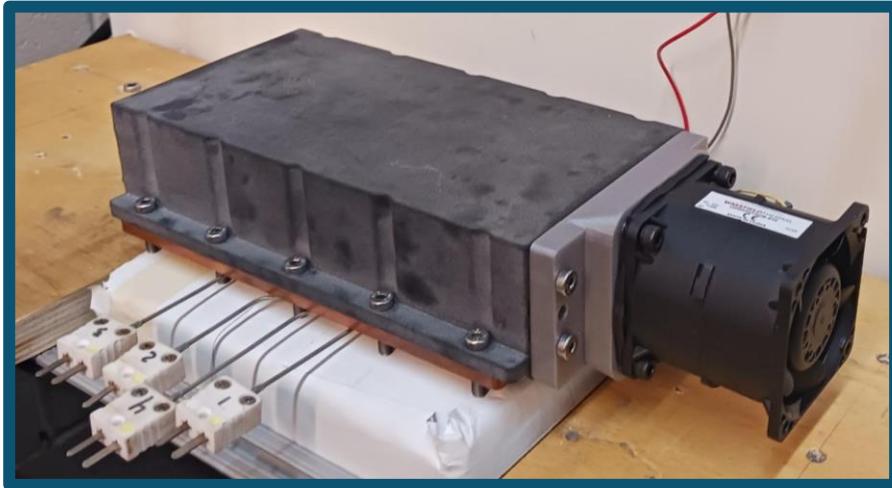
Technical Progress

- ▶ Test facility constructed
- ▶ Designed, manufactured, and tested impingement cooler
- ▶ Demonstrated Year 1 targets
 - 0.1 Total Rth
 - 15 COP
 - 80 kW/Rack density
- ▶ Closing in on Year 2 targets
- ▶ **Check out our poster for more!**



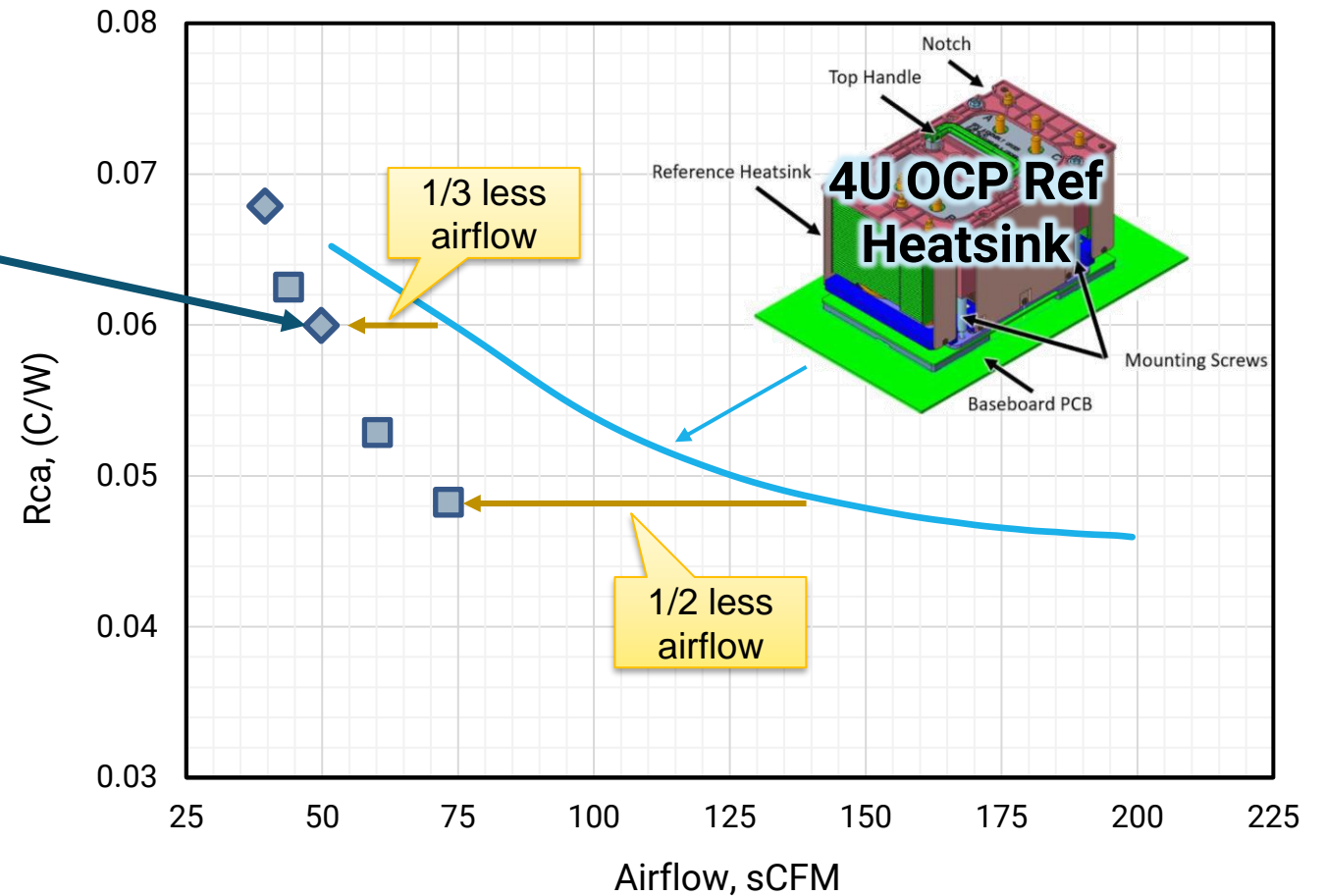
	Flow Rate (sCFM)	Heat Load (W)	Thermal Resistance (K/W)	Impingement device COP	Full System COP
1	25	600	0.098	281	88.0
2	50	800	0.061	47.0	15.3

Technical Progress – Fan Integration

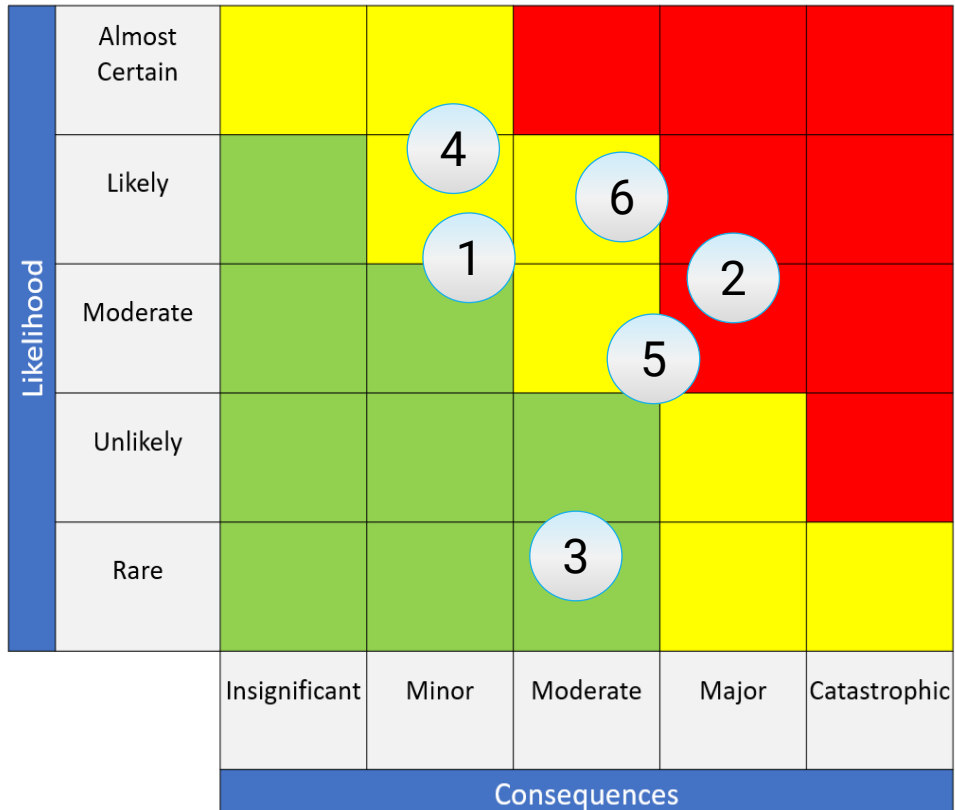


700W test with single fan:

- 1/3 less airflow
- > Double the density
- 23.6C inlet, 64.2C Case



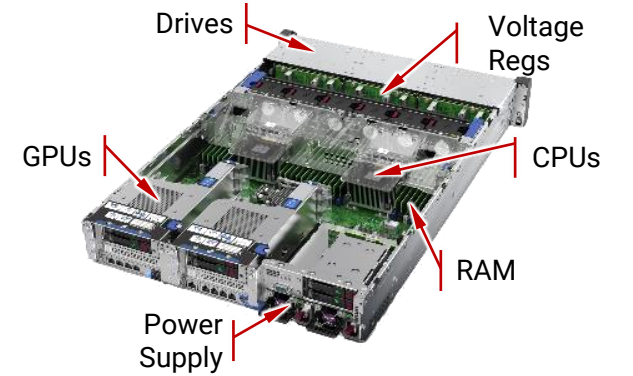
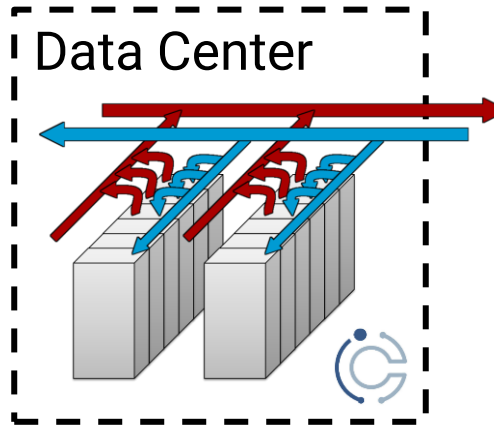
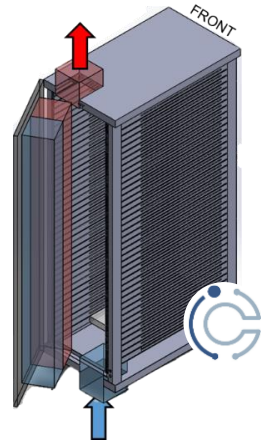
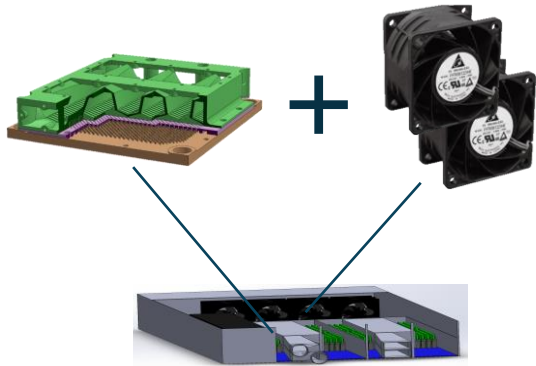
Challenges and Risks



Risk Status

Risk	#
Fluid leaks	1
Performance and Reliability	2
Fan Failure	3
Limited heat capacity of air	4
Scaled-up manufacturing and component cost	5
Package integration	6

Technology-to-Market Approach



Easier Implementation

Better Performance

Needs and Potential Partnerships

- ▶ ***Looking for Pilot Partners!***
 - *Transition our technology onto real, in-need hardware*
 - *Server manufacturer partners*
 - *Chip manufacturer partners*
 - *End user for rack pilot*
- ▶ *Package integration expertise*

Q & A



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