Close Coupled Cooling for Datacentres

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Agenda

- Increasing Power Densities
- Raised Floor Limitations
- Hot and Cold Aisle Enclosures
- Close Coupled Cooling (CCC)
- Design Application – Oliver's Yard

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Recent evolution of datacentre design

1970 - 1990

- Monolithic custom designed rooms
- Datacentre information is processed in batches
- Raised floor cooling systems
- Unable to scale without disruption
- Low density (< 450 W/m^2)

1990 – 2010

- Information is processed in real time
- Mainframes replaced by servers
- Datacentre demands high power (>1500 W/m^2)

Room design power density is continuing to increase.

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Increasing rack density loads

Rack power density has increased 10x

- 2003 < 1.7 kW average per rack
- 2006 ~ 5.0 kW average per rack
- 2009 ~ 6 kW average per rack
- 2010 ~ 20 kW per rack peak loads

Peak rack densities will continue to increase.

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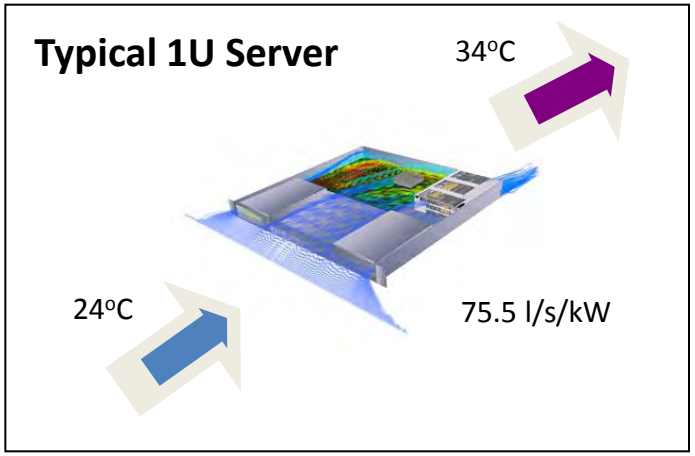
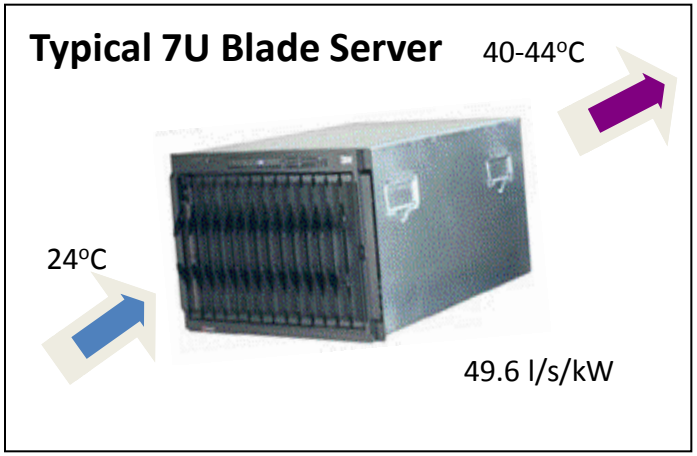
IT server air requirements

- **42U rack**
- **250 W per server is 10.5 kW**
- **requires 790 l/s of air**



- **42U rack**
- **3 blade chassis is ~12 kW**
- **requires 590 l/s of air**



Temperature rise and air volume varies with server type

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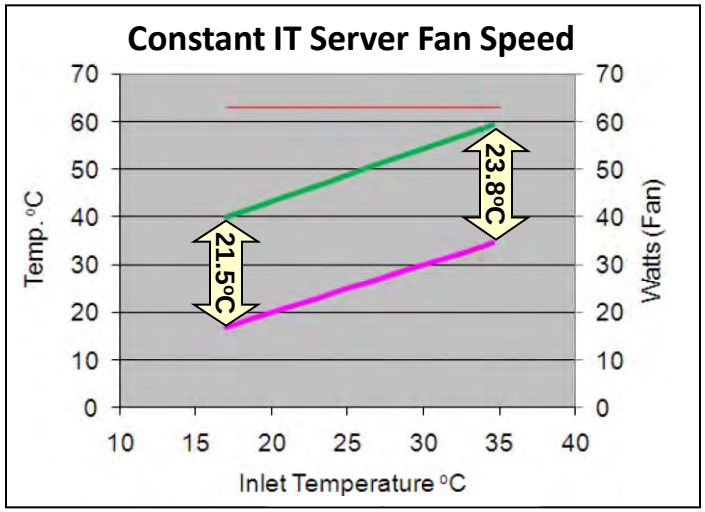
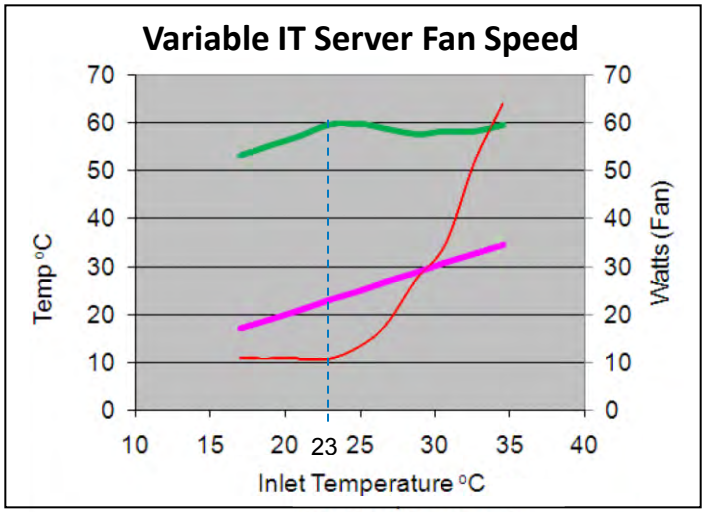
Impact on IT Equipment Power





- 17°C to 38°C fan power is constant
- Component temp tracks inlet temp over range
- Maintains almost constant component temp

- < 23°C fan power is constant, > 24ºC increases
- Component temperature tracks inlet temp
- Maintains constant component temp
- Fan power 11 W at 23°C to >60 W at 35°C
- Increased inlet temp does not effect reliability

Total fan power (IT + facilities) may go up with warmer temperatures

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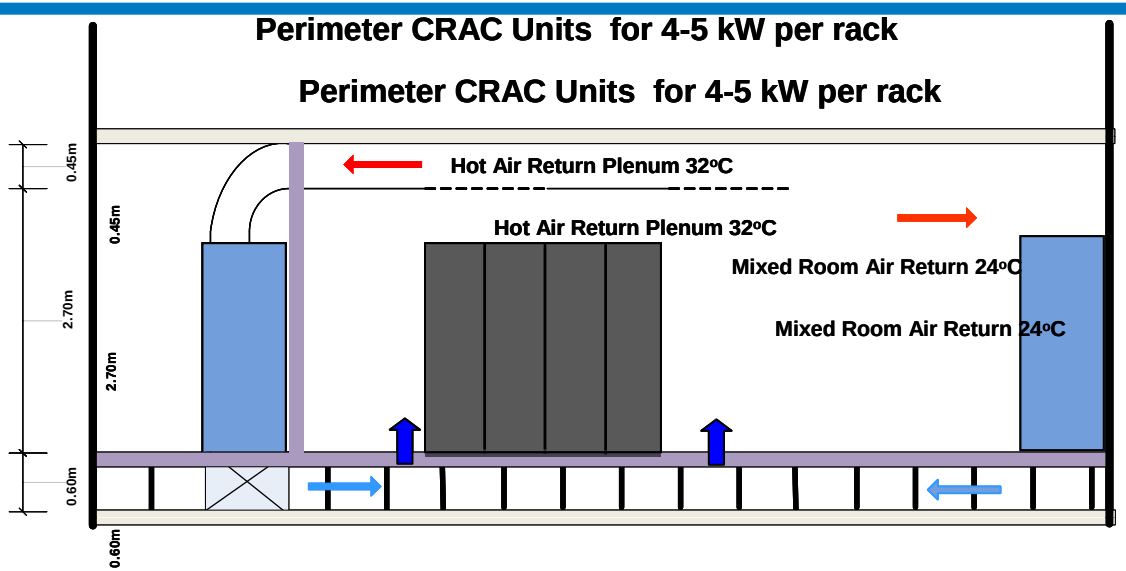
Cooling Designs - Perimeter CRAC



Design Concepts

- CRACs in room or mechanical corridor
- Ceiling void return air plenum
- Open room return air
- Supply air under floor

Advantages

- Widely used for 40 years
- Large design base experience
- Low CRAC CapEx
- Large vendor base

Disadvantages

- Limited density approx 4-5 kW/rack
- Less predictable performance
- Difficult to scale
- Room dimensions critical

Floor depth, air leakage, room dimensions limit predictable cooling performance

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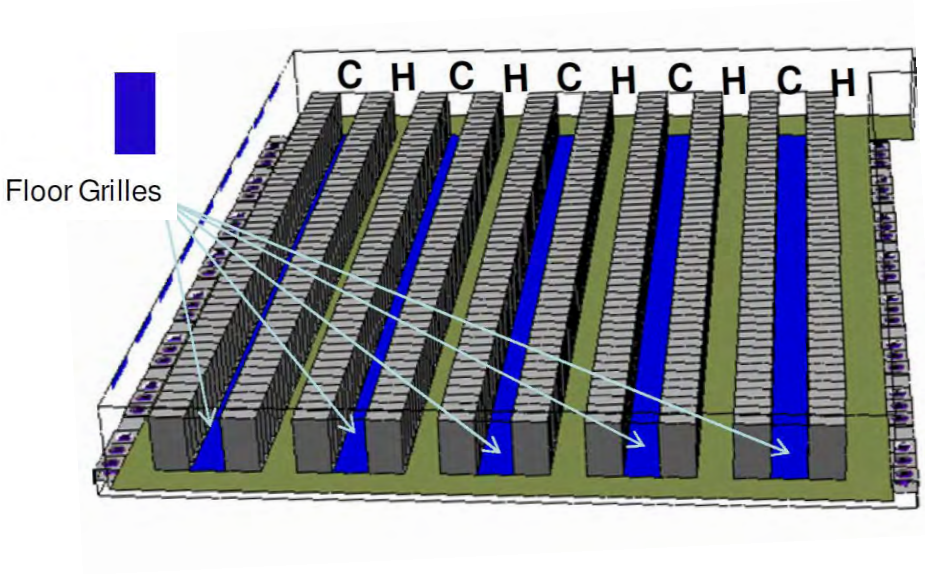
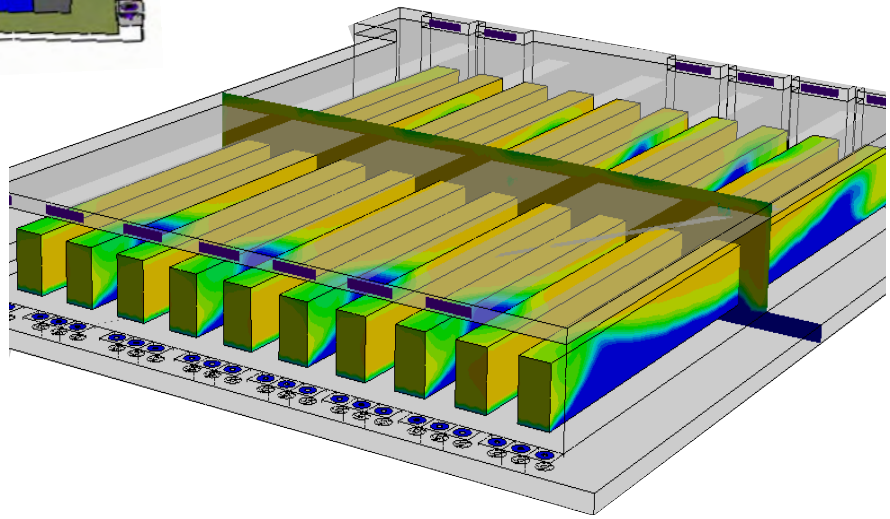
Air distribution issues





Uniform air distribution is difficult in large rooms

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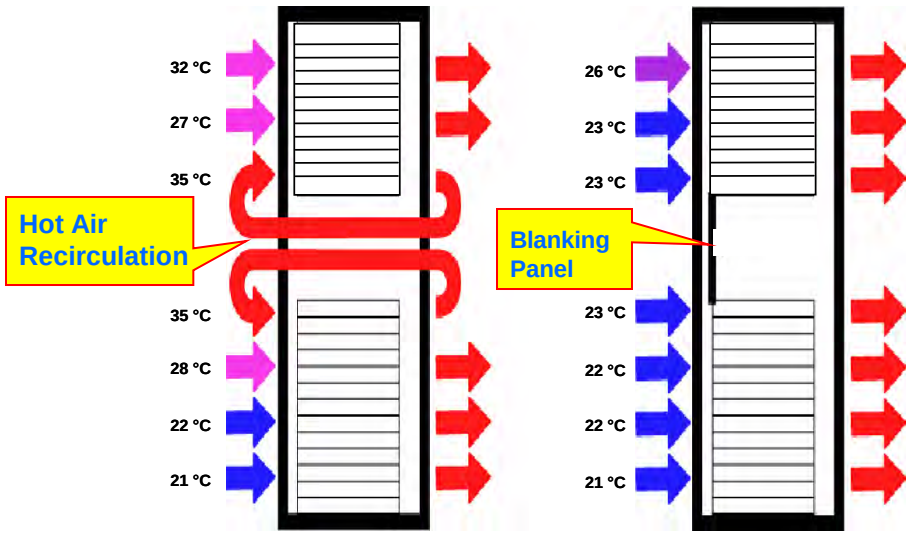
Recirculation of hot air

Two issues: Heat recirculation at row level and rack level

Rack Level



Blanking panels stop heat recirculation in the rack.

Row Level

Cold aisle enclosure prevents heat recirculation in the row.

Enclosures stop recirculation of heat, allow full use of rack space

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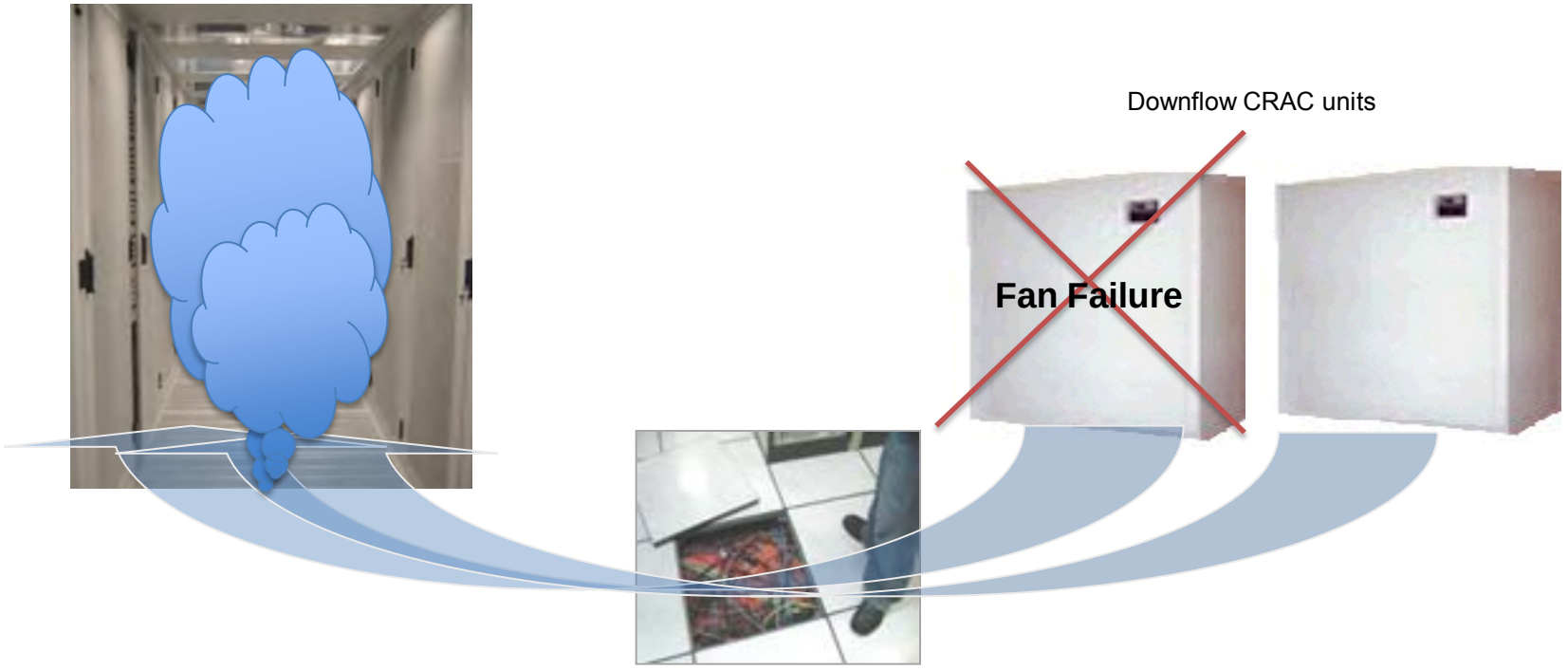
Raised floor cooling with Cold Aisle Enclosure



CAE with CRAC Supply Air

- Flooded cold aisle supplied from downflow CRACs
- Eliminates hot air recirculation
- Actual cooling capacity limited by finite volume of air under floor

Eliminates hot aisle air recirculation but can cause hot spots elsewhere

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No Raised floor for cool air distribution

- Horizontal air distribution
- Piping protection on slab floor
- Solves raised floor air problems
- Reduced installation time
- Reduced cost

Add power and cooling capacity as you add computing power

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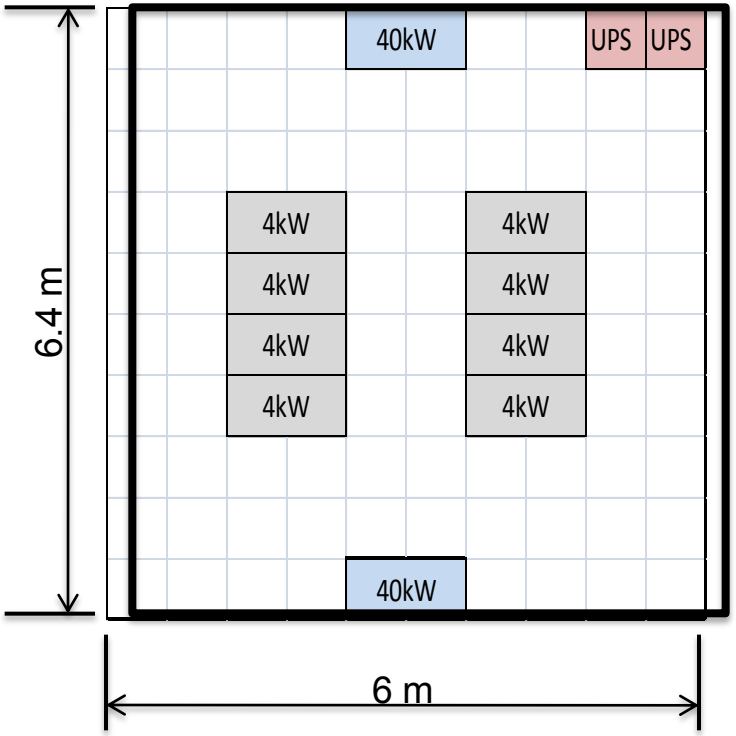
The infrastructure paradigm shift

Room Level



Small Server Rooms

32kW IT load

40kW N+1

Increased Free Cooling

79% less fan power used

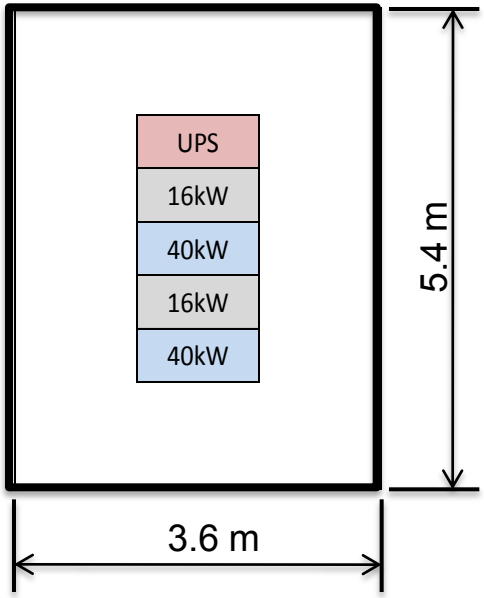
49% less floor space

38% fewer racks

No raised floor required

No ceiling height restriction

Rack Level



Less Space, Less cost, Lower CO_2 Emissions and much greater flexibility

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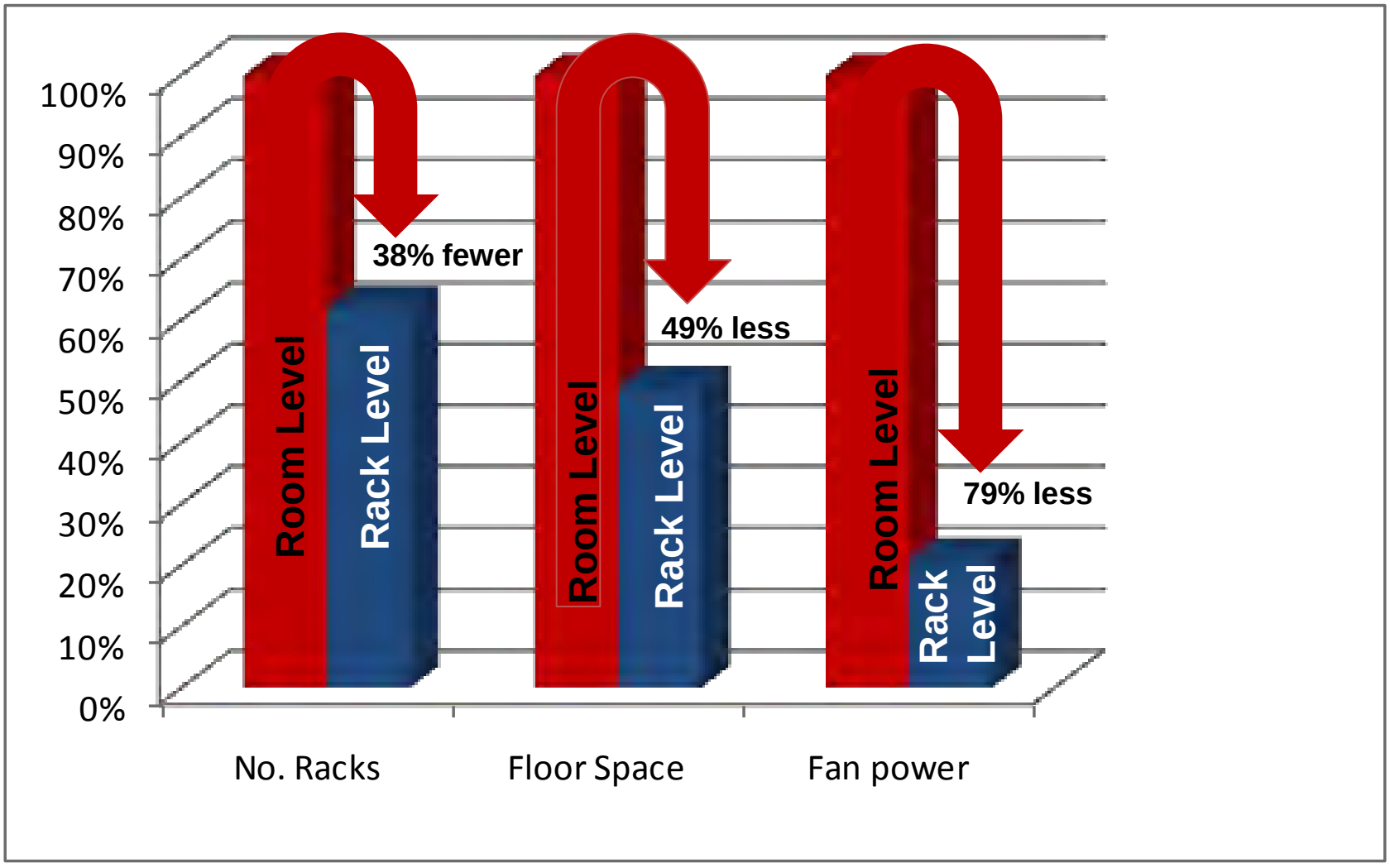
The infrastructure paradigm shift



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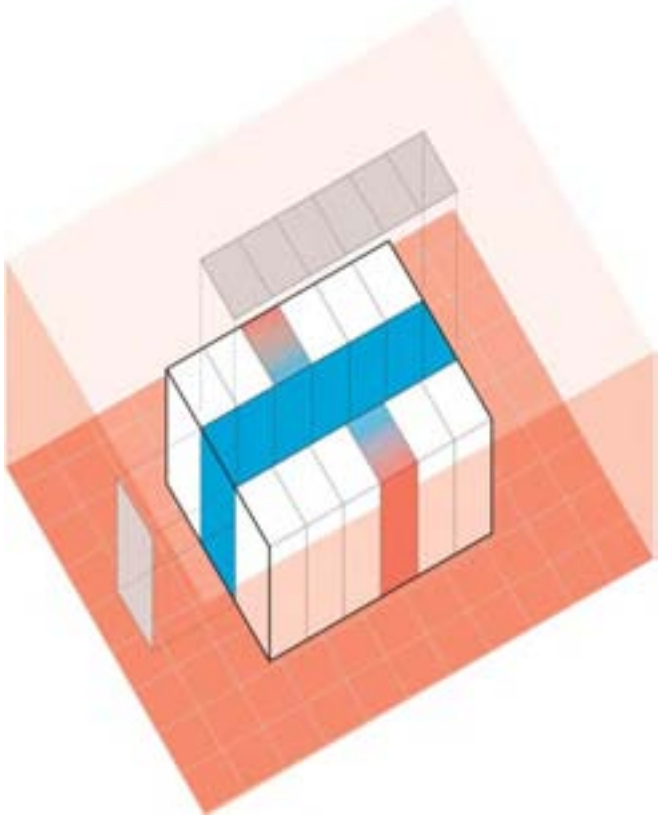
Cold aisle enclosure with CCC

Cold Aisle Enclosure



- **No raised floor required**
- **Ceiling height not an issue**
- **Redundancy at row level**
- **Eliminates warm air recirculation**
- **Cooling units can be fully or semi recessed**

BUT

- **Mixed return air to CCC unit**

Predictable air distribution with close coupled cooling in the rack

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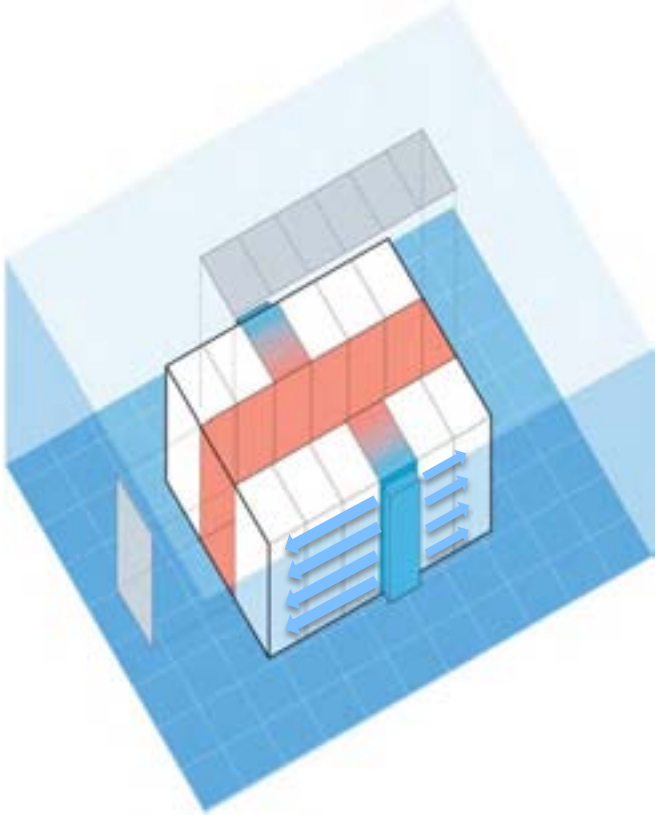
Hot aisle enclosure with CCC

Hot Aisle Enclosure



- **No raised floor required**
- **Ceiling height not an issue**
- **Redundancy at row level**
- **Eliminates warm air recirculation**
- **Cooling units can be fully or semi recessed**

AND

- **Maximises coil capacity**
- **Reduces chiller power**
- **Increases free cooling opportunity**

Heat removal at the source

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Enclosed high density zones

Zones can be replicated for consistent predictable performance

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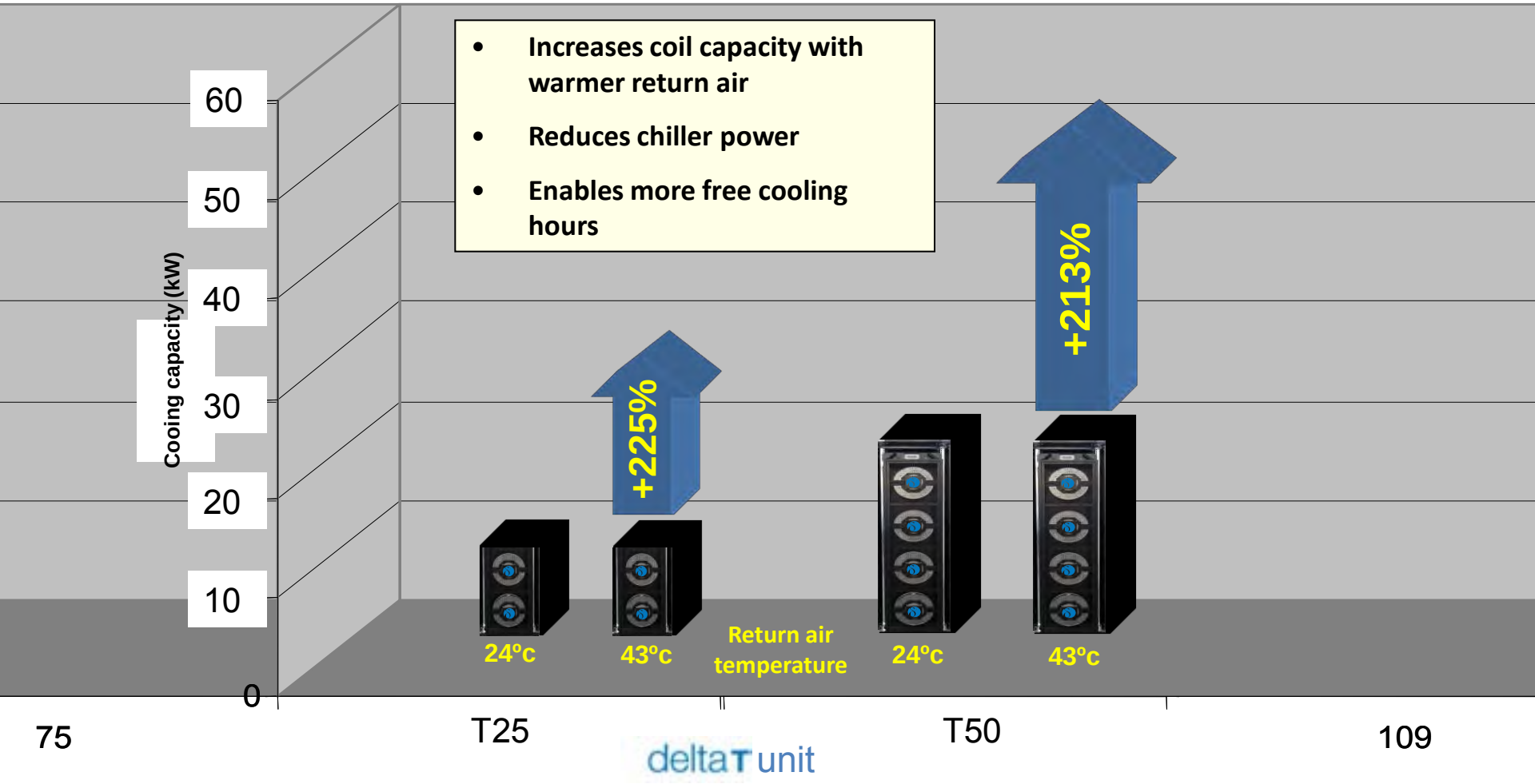
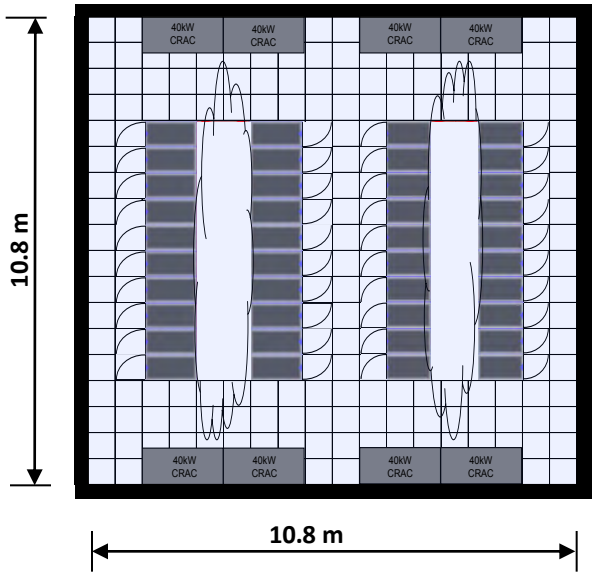
Improved cooling capacity with HAE



Increased cooling capacity with warmer return air

The high density advantage



160 kW total IT load

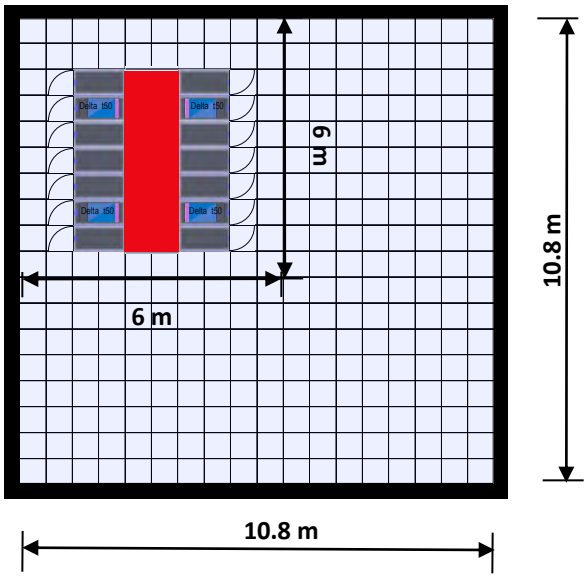
Raised floor not required

Increased server density

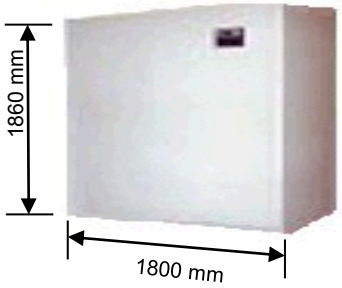
88% less fan power used

65% fewer racks

69% less space



Perimeter CRAC
40kW

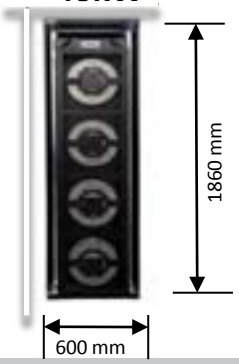


Same cooling capacity

50% lower fan power

52% smaller footprint

In-row
40kW



Reduces CapEx and OpEx

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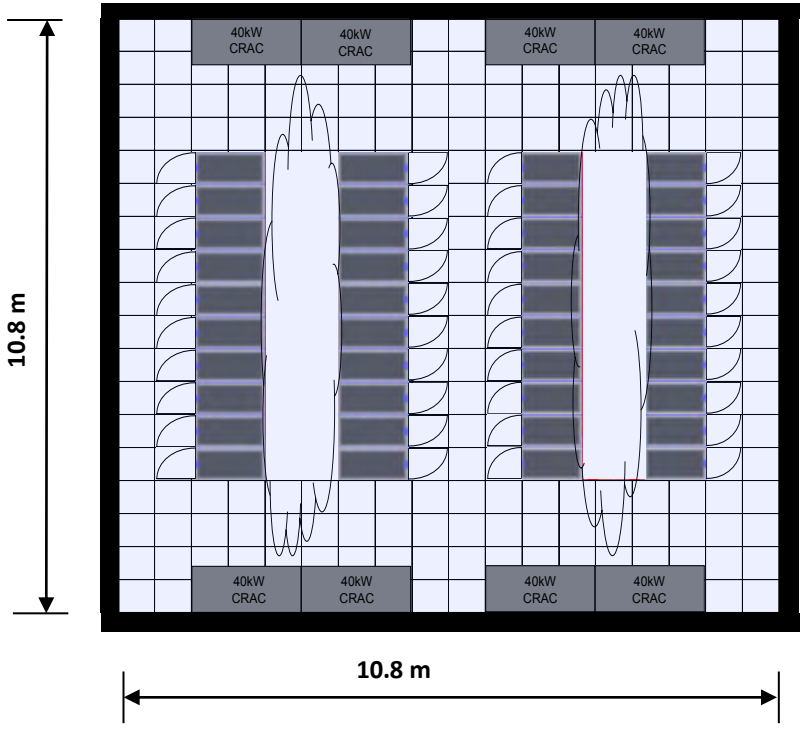
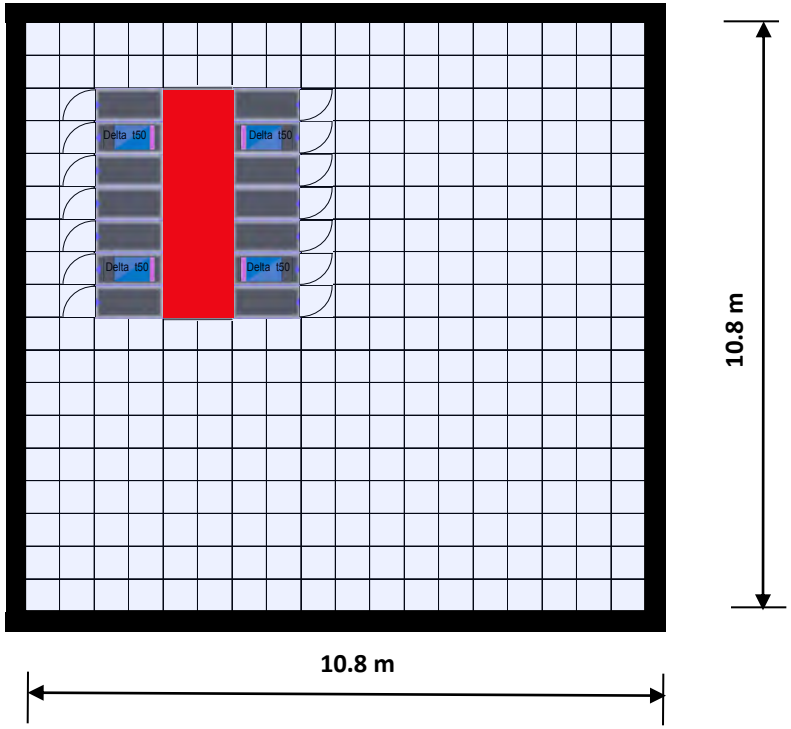
CCC scalability





- **Same sever load, fewer racks**
- **Less first cost for cooling units**
- **Less floor space**

For Concurrent Maintenance: Downflow CRACs N+1 = 8; CCC N+1 = 4

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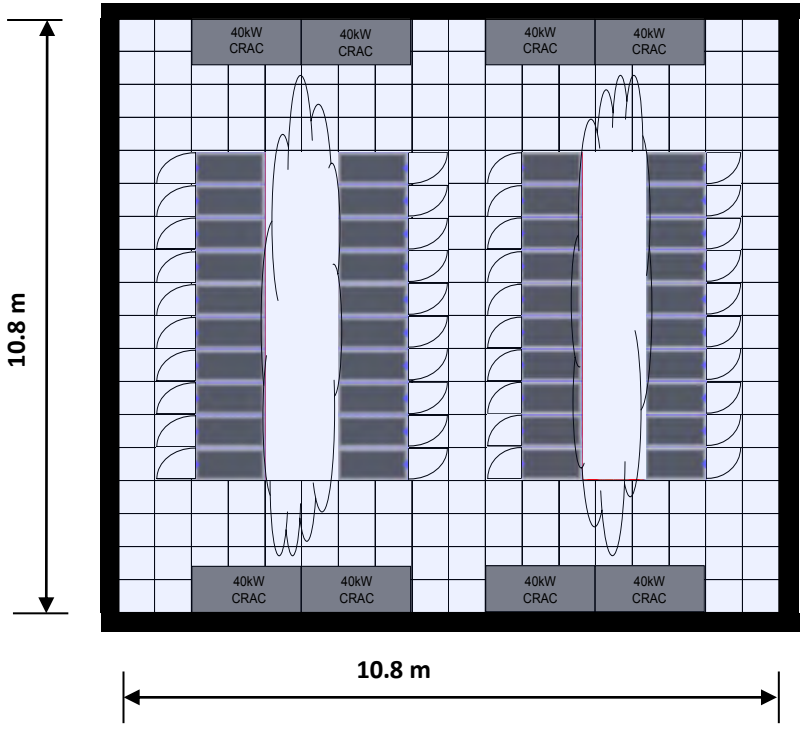
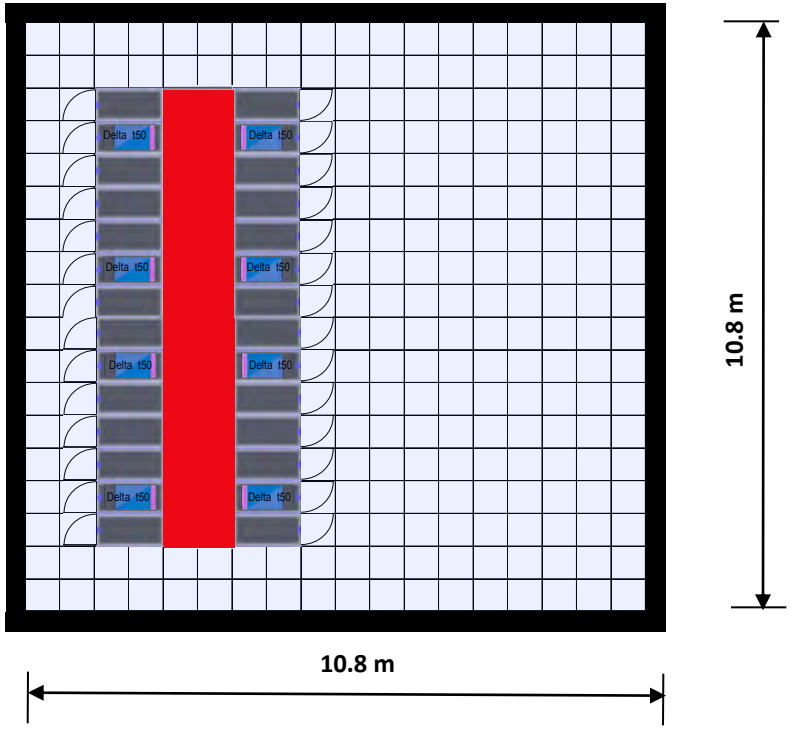
CCC scalability





- **Twice the server load**
- **Half the floor space**

Same number of cooling units for twice the IT load

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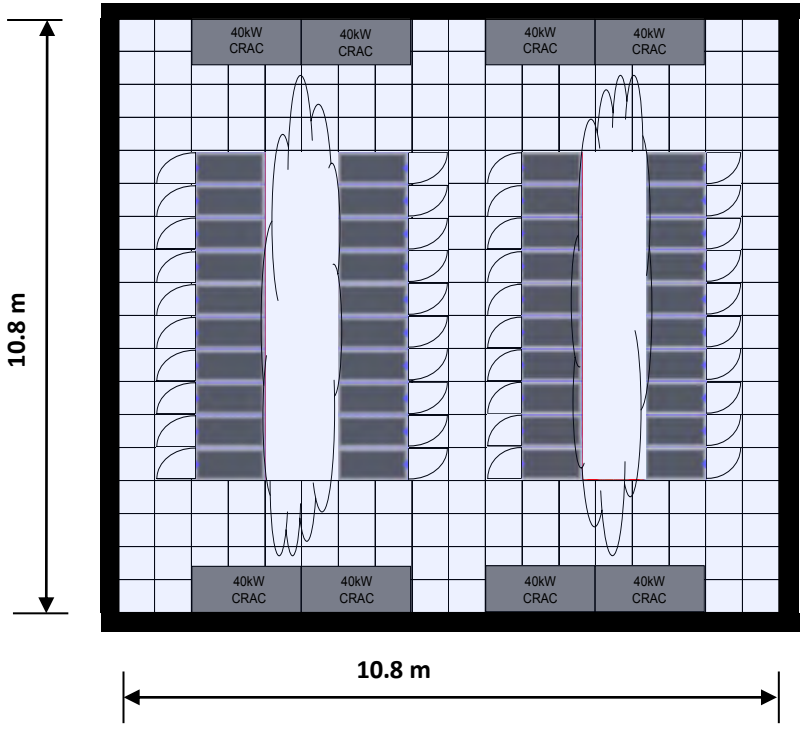
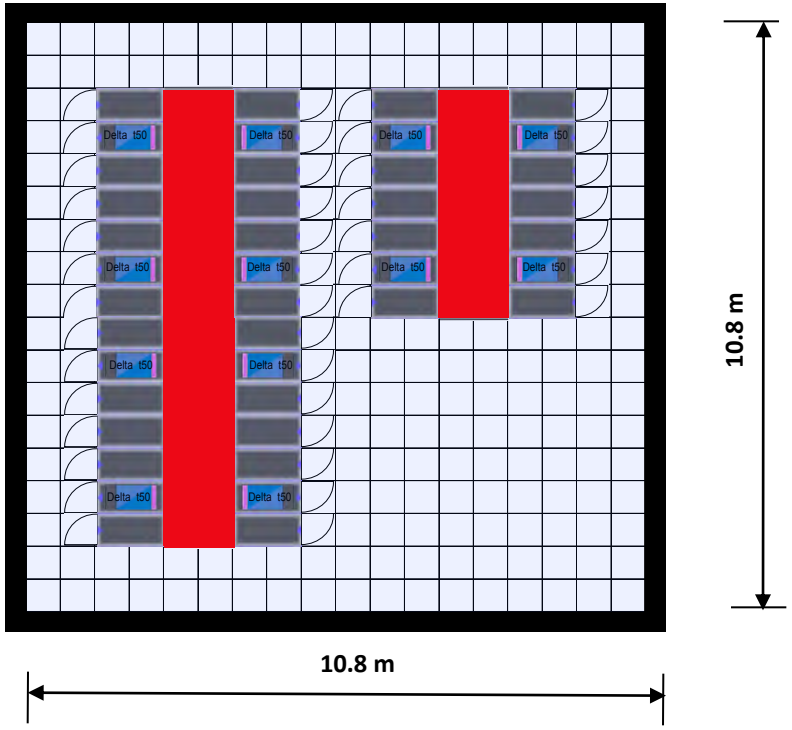
CCC scalability



- No scalability with CRACs
- Difficult to exceed average density



- Zones can be replicated
- High peak density anywhere in row

CCC is highly scalable

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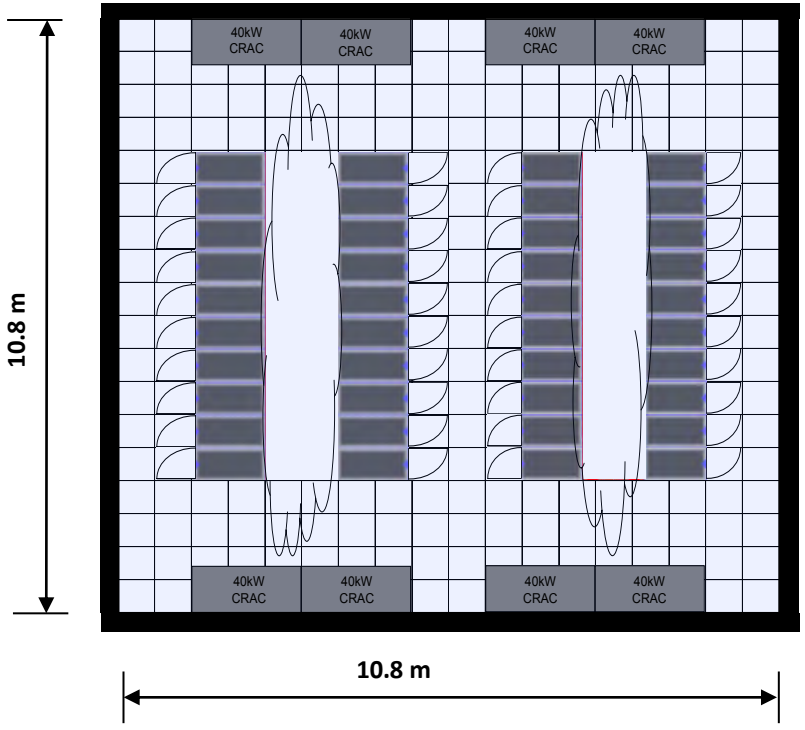
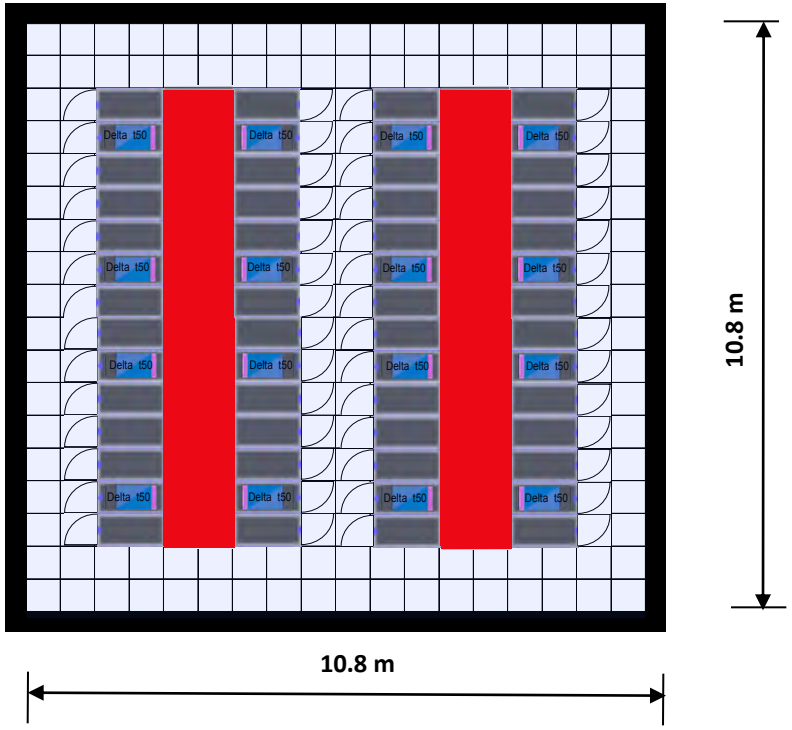
CCC scalability



- **Limited to initial design load**



- **4 times the server power**
- **Peak load in any rack**
- **Fast dynamic response**

CCC reduces first cost and allows future growh

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CCC Solutions

Rittal LCP

ENP (Knürr)

Datacentience Delta-T

Liebert XD CRV

IBM Cool Blue

APC InRow

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Single row fully enclosed

LCP cooling unit

CCC Solutions

Rittal LCP

ENP (Knürr)

Datacentience Delta-T

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IBM Cool Blue

APC InRow

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XD Pumped Refrigerant Systems

CRV

Close Coupled Cooling Solutions

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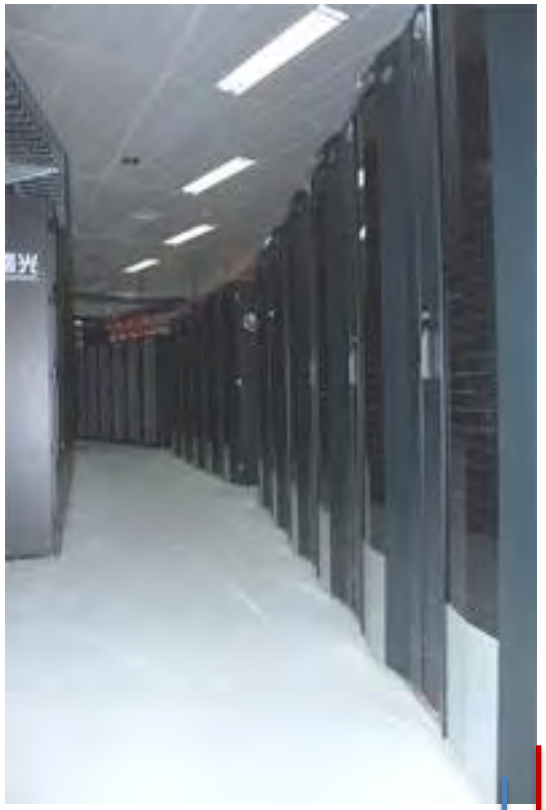
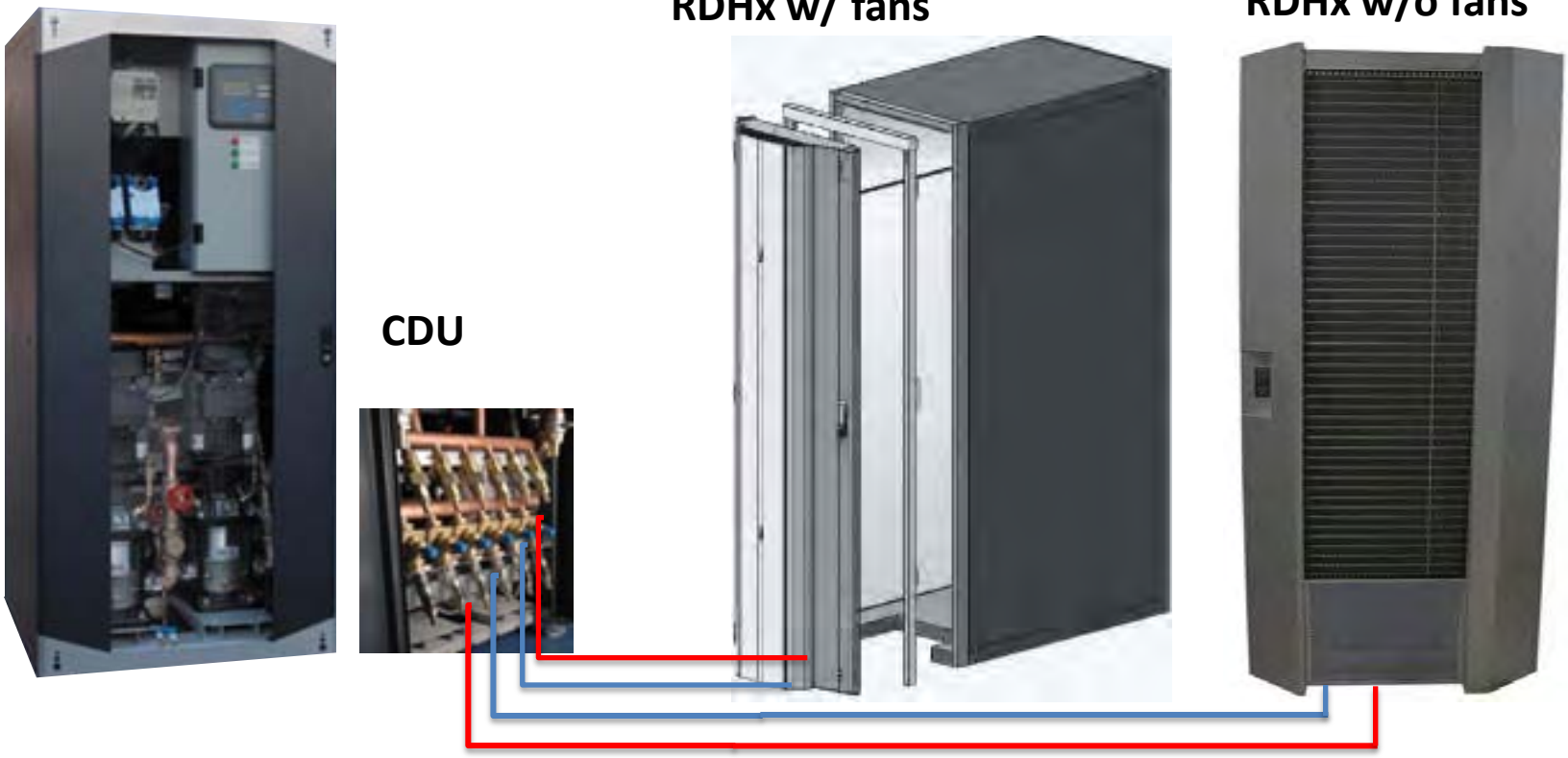
Individual sealed racks



Rear Door Heat Exchangers



Delta-T rack mounted cooling

T25

T50

T25

T50

Slides in like a server

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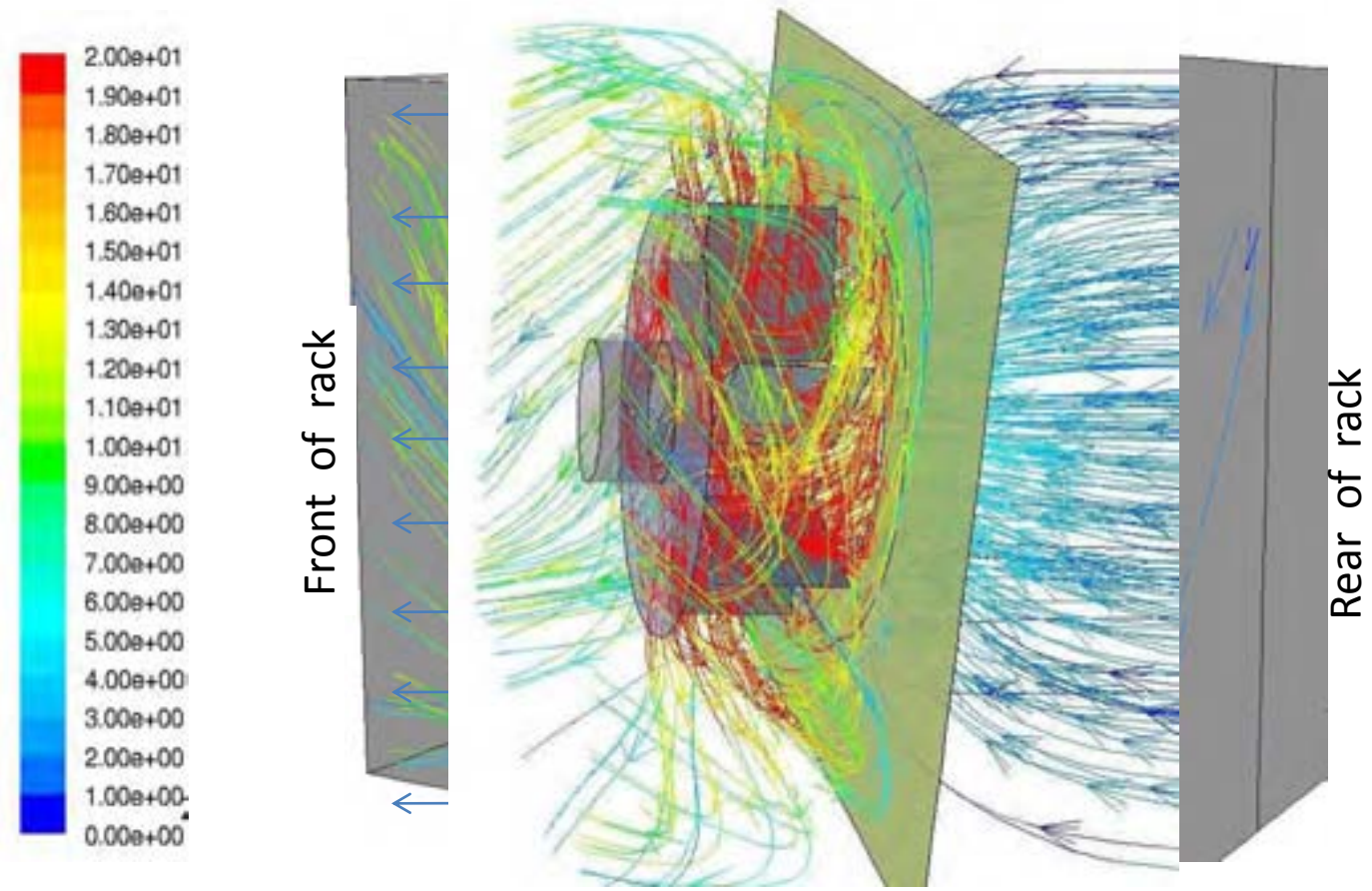
Delta-T fully enclosed fan

Flow paths out of the fully recessed fan.



Increased fan power needed in fully recessed position

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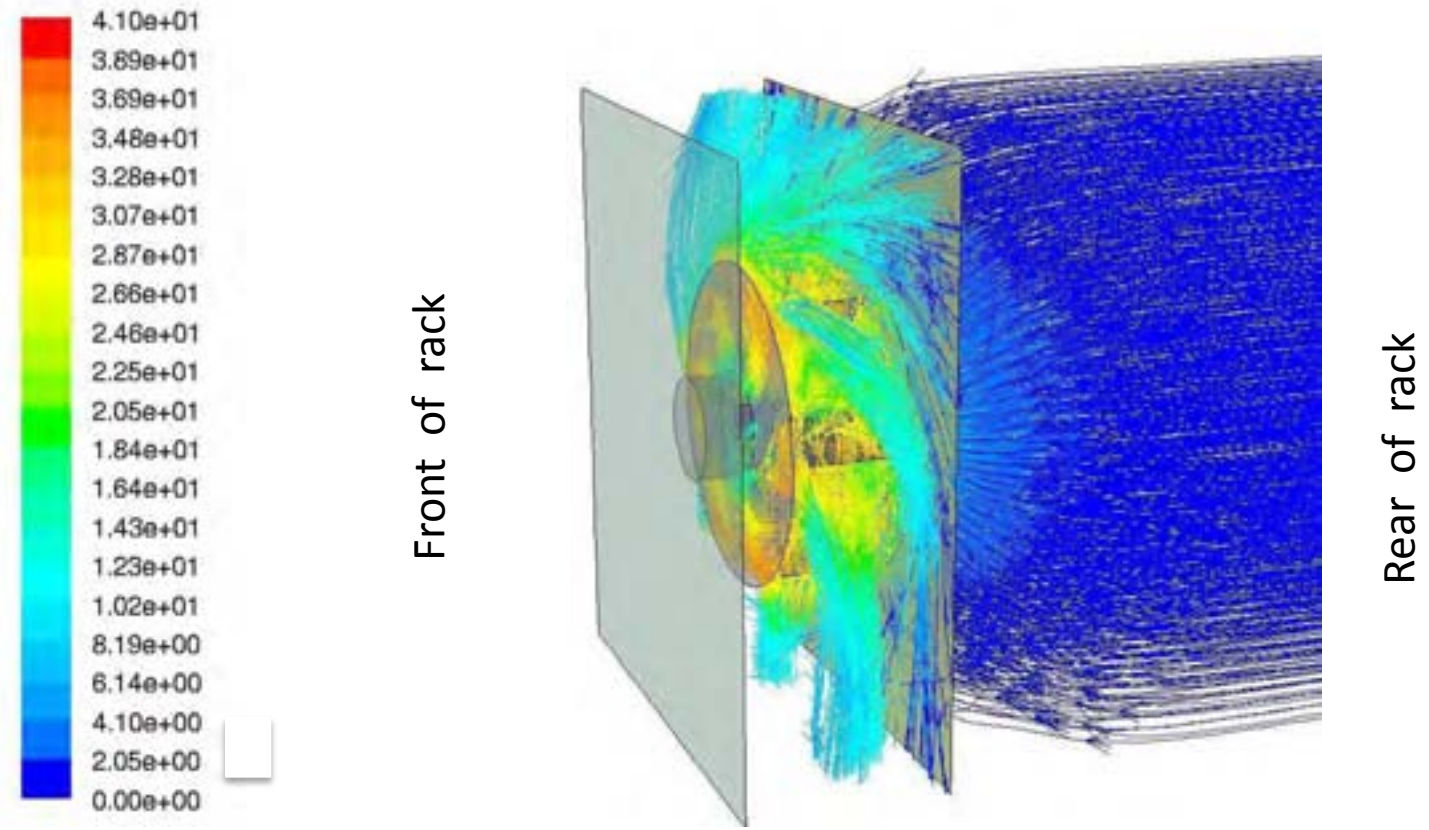
Delta-T semi-recessed fan

Removal of cabinet side panels allows natural radial air discharge and lower fan power.



All air flow becomes radial with fan wheel outside of rack

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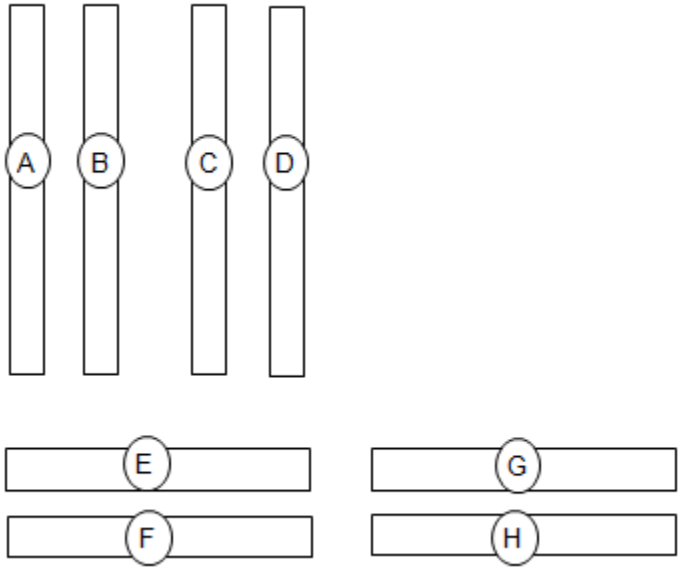
Room Configuration

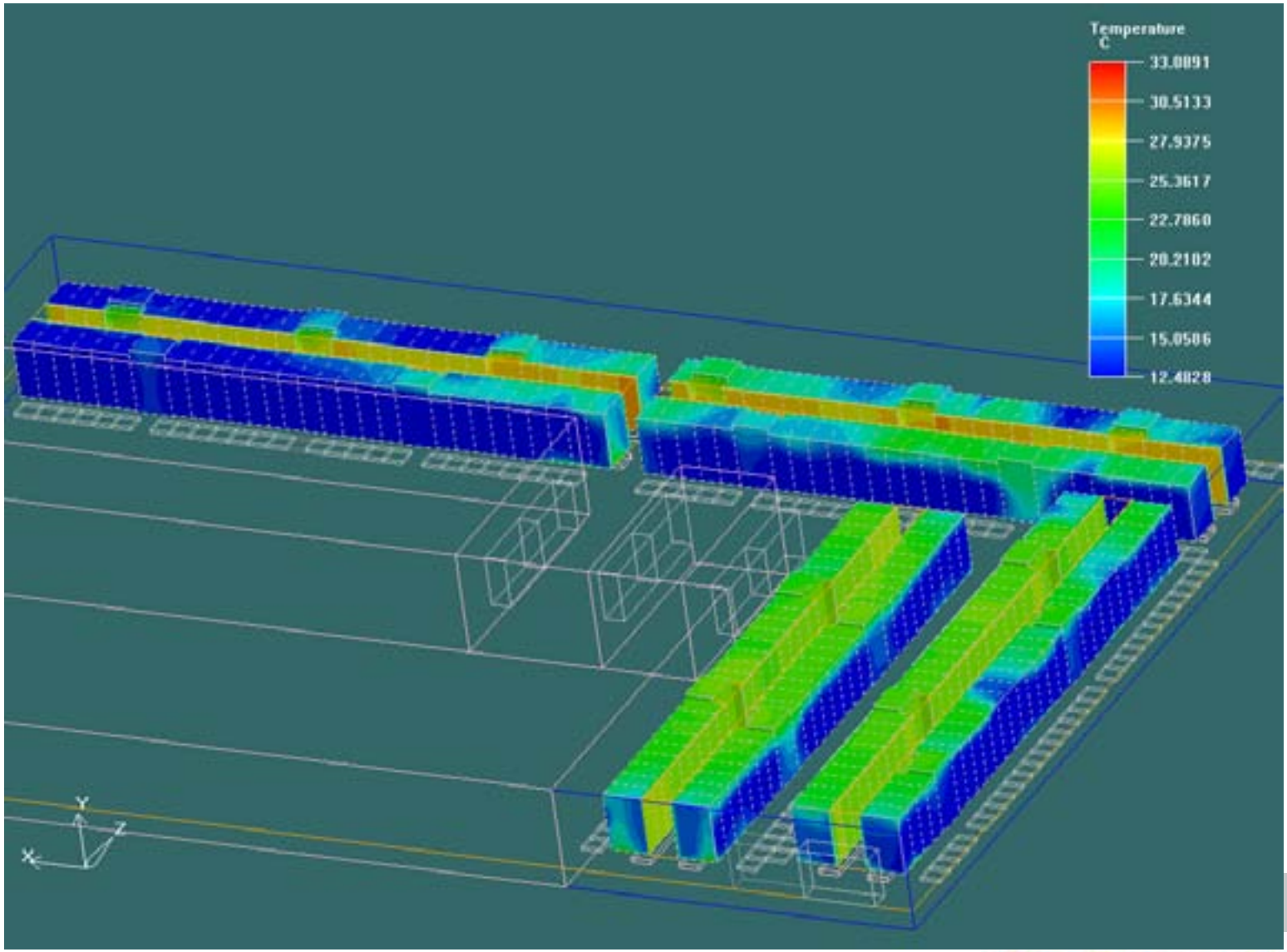
Row Layout



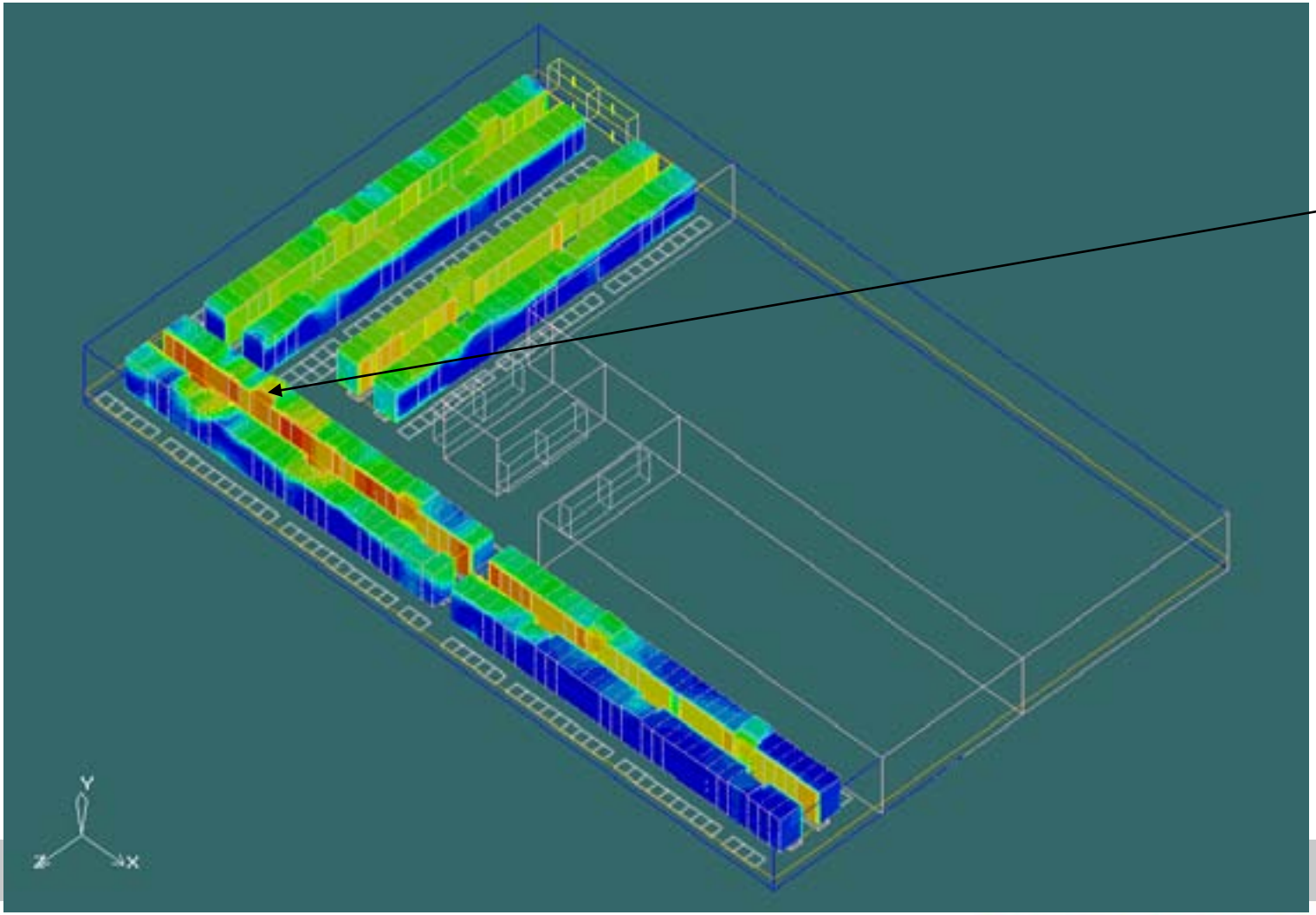
Objects Modelled in CFD

- **Objects modelled:**
- **Racks (standard 3 kW racks in Rows A/B, C/D & higher rated 3.9 kW racks in Rows E/F, G/H)**
- **Weiss Technik downflow units**
- **8 number Power Distribution Units STS-PC-400-E454P (each producing 2 kW of waste heat)**
- **Underfloor cable racks**
- **Ventilated floor tiles**

Normal Operation N+1 Units



Failed Controls & Unit for N Units Running



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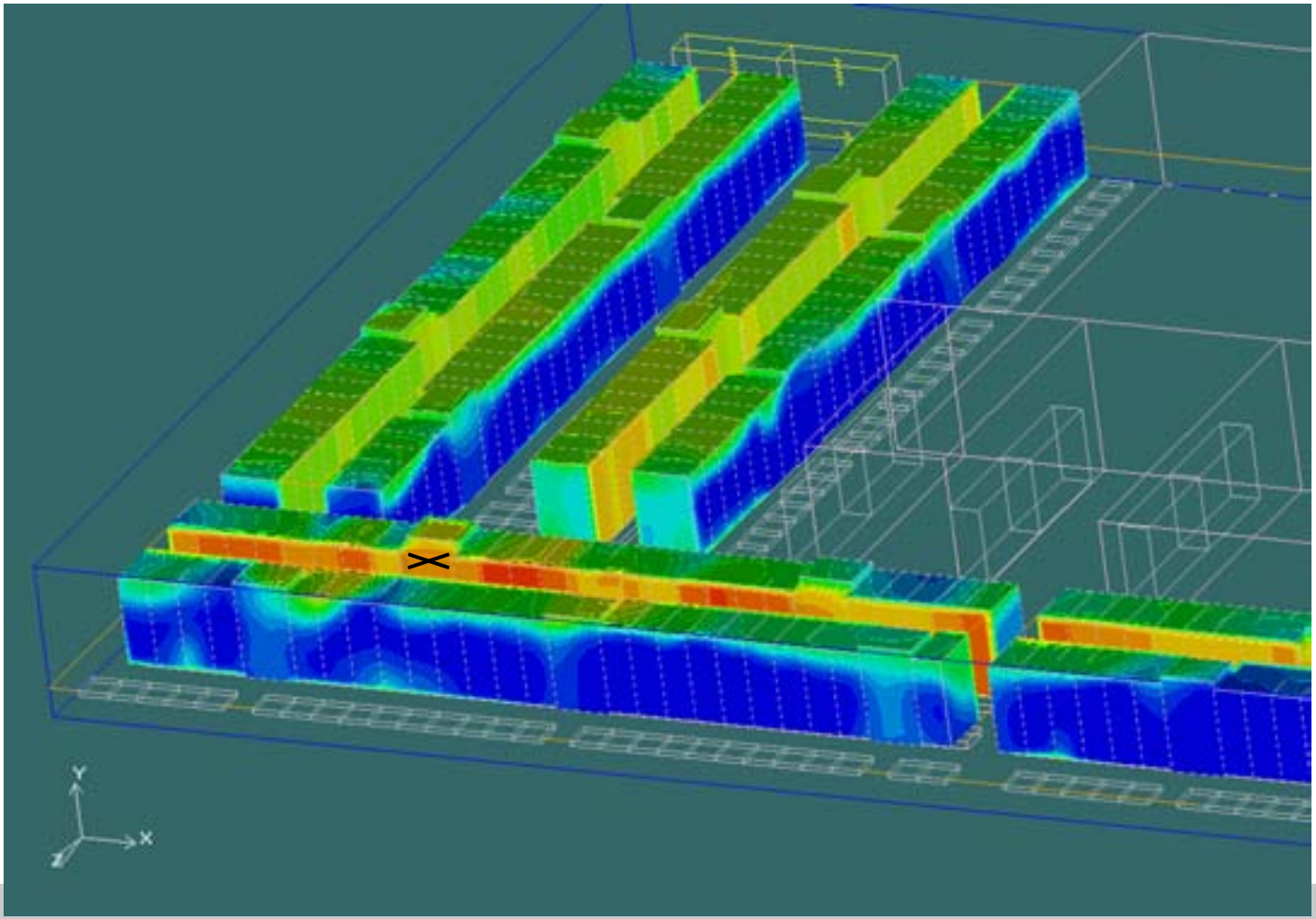
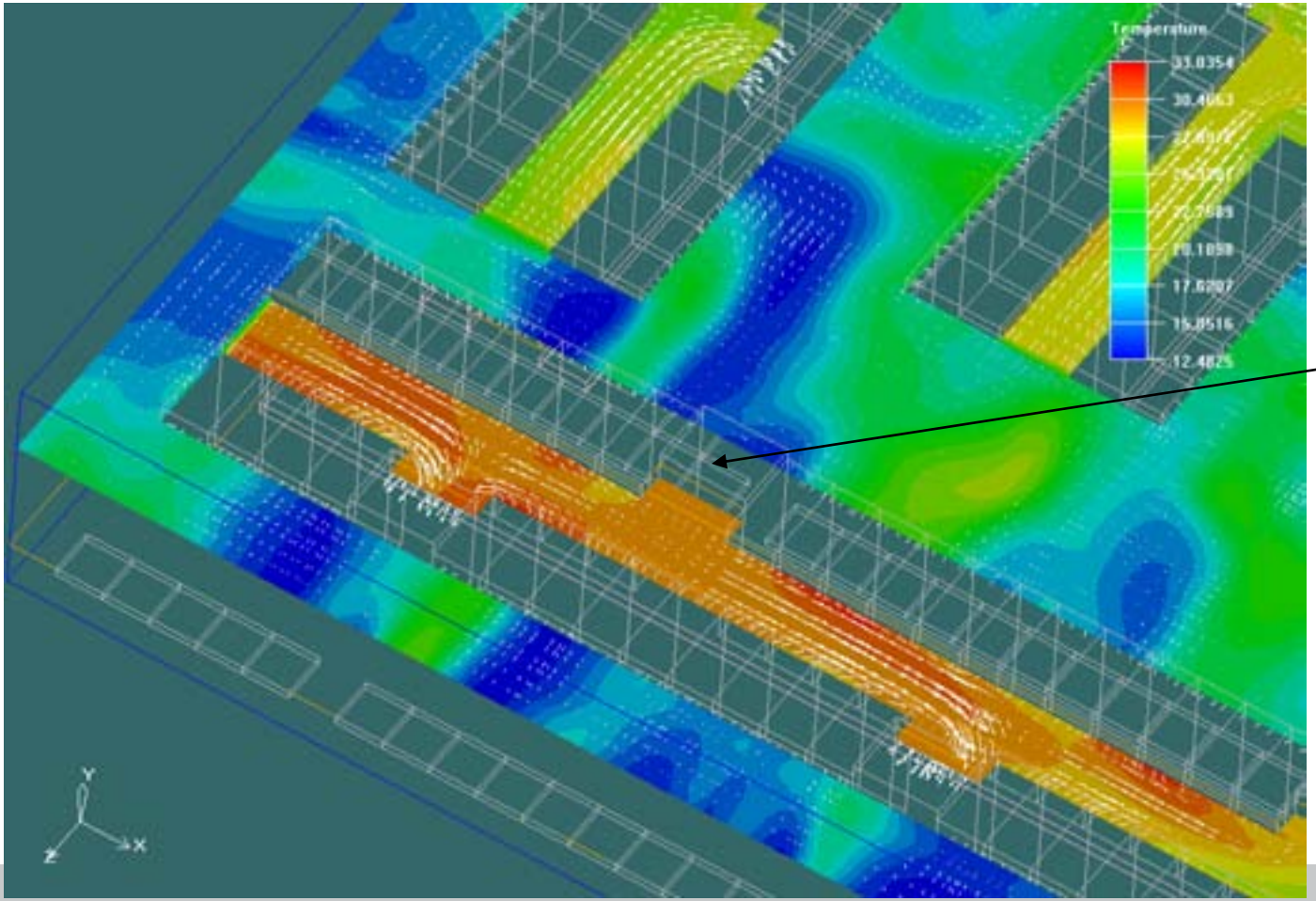


Case with One CRAC Unit Failed



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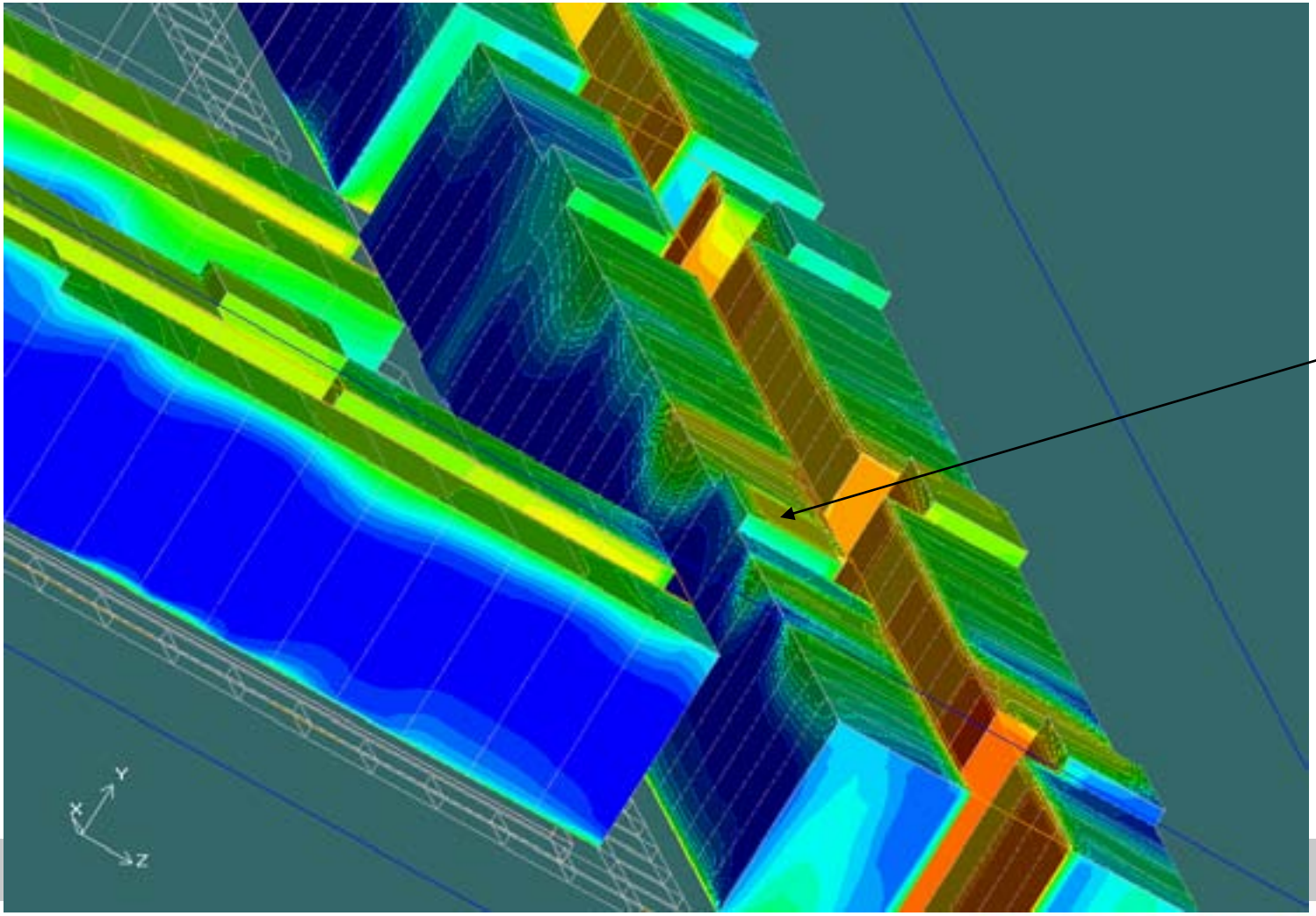

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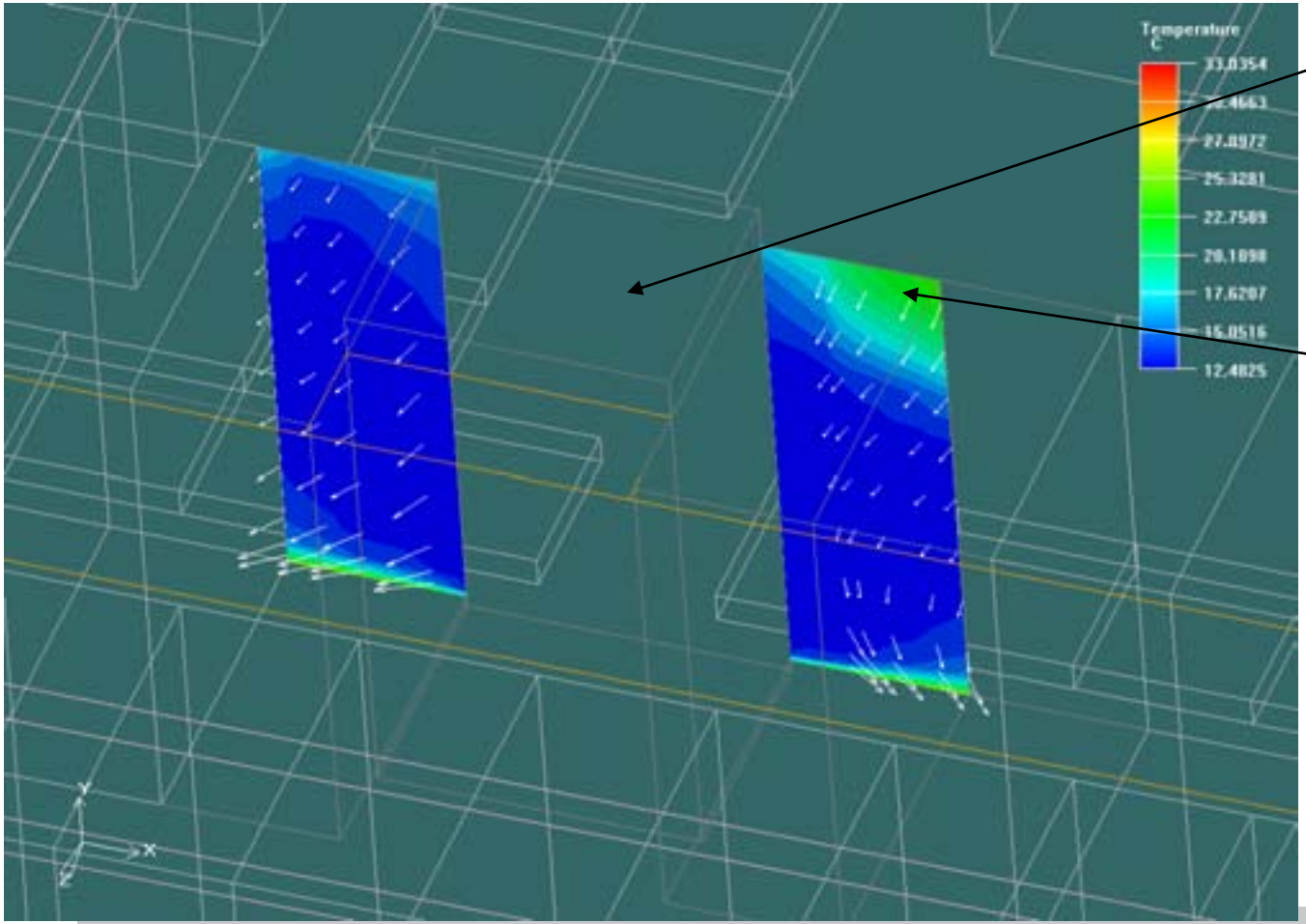
Failed Controls & Unit for N Units Running



Failed CRAC unit

Peak rack inlet temperature = 27.1 ° C

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