Cooling of 19" systems

Approaches to protecting sensitive electronics

Ralf Waldt– Field Application Engineer

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Agenda

Types of cooling solutions

- Introduction of different types cooling solutions that been used for modular 19″ systems, Such as free convection, forced convection, Air-Water cooling.

Cooling Strategies for MicroTCA System

- Thermals of MicroTCA System
- How to cooling MicroTCA inside of electronic cabinet

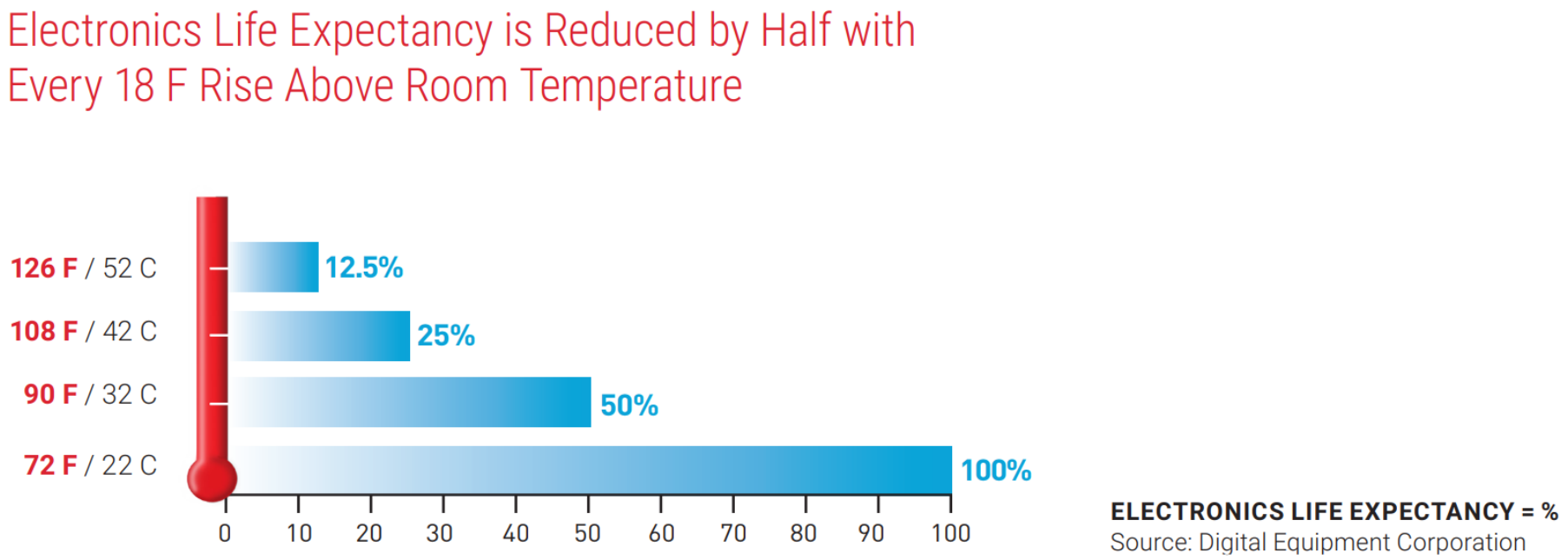
Cooling Solutions for Big Science

- Challenges for High-Precision Electronics of Physics Applications and How to find the right cooling solutions?
- Introduction of Air-Water Cooling Solutions for Big Science

Why Use Cooling?

Keeping your electronics cool is essential to maximizing the life cycles of your electronic devices, reducing capital expenses, and keeping your business running.

Heat can have a significant impact on electronics, reducing performance, causing damage, and affecting manufacturer warranties.



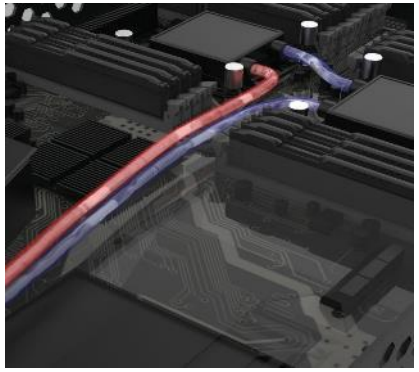
HEAT DAMAGES AND REDUCES THE LIFE OF YOUR ELECTRONICS

Types of cooling solutions for modular 19″ systems

FREE CONVECTION

CONDUCTION

FORCED CONVECTION



WATER/LIQUID COOLING

Cooling capacity

MTCA.4.1 Thermals

Power losses in an MTCA.4.1 CRATE

- 12x ~160 W per AMC / RTM slot -> max. 2240 W heat dissipation
- 2x MCH + RTM -> 160 W
- 2x Cooling units -> 160 W
- Power modules (88% efficiency) ~ 300 W heat dissipation

Crate heat dissipation > **2.86 kW**

Power losses in the whole cabinet

- 3 to 4 MTCA Crates + other Electronics

Cabinet heat dissipation -> 8 to 12 kW

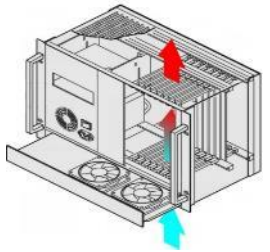
MTCA.4.1 Crates Cooling solutions

Cooling solutions

Many 19" applications based on subracks are still cooled by **forced convection**. With relatively cost-effective and very high-power losses can be dissipated.

CRATE & Modules must be optimized for air flow

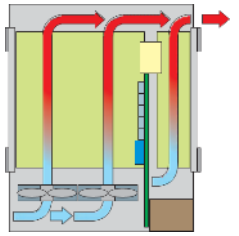
- Guarantee sufficient bulk air flow of the crate
- Proper air distribution to each slot inside the chassis
- Air impedance balancing of AMC modules / slots
- Cover empty slots with filler panels, either with or without air blockers
- MCH and AMC modules must be optimized for air flow and hot spot cooling



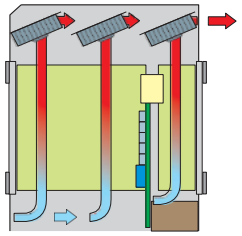
BOTTOM TO TOP

widely used in low-cost systems

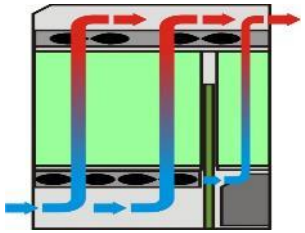
FRONT TO BACK



Push cooling

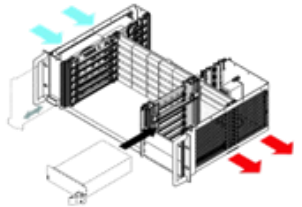


Pull cooling



Push cooling + Pull

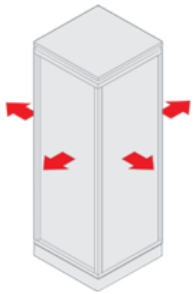
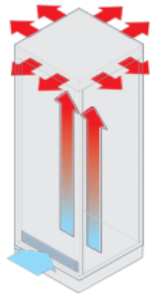
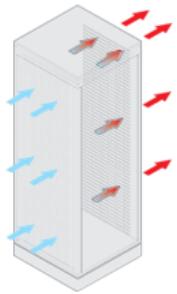
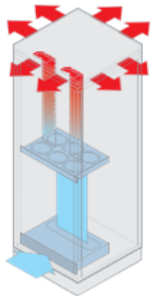
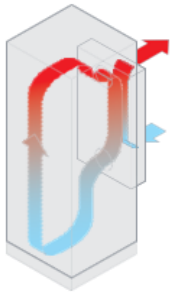
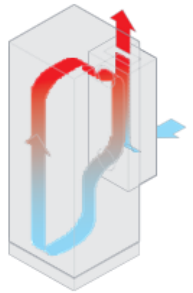
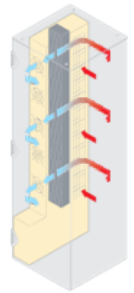
- Prevent unwanted air short-circuits in cabinet.
- Avoid turbulence and hot spot



SIDE TO SIDE

- Suitable for heat dissipation of horizontally placed circuit boards
- Not fit to Cabinet cooling concepts

Modular Cooling solutions

	FREE	AIR FORCED CONVECTION					COOLANT	AIR TO WATER			WATER
Description	**Natural convection via thermal radiation**	**Free convection through top cover opening**	**Free convection through openings in the doors/ rear panels**	**Forced cooling with air**	**Forced cooling with air**	**Forced cooling with air**	**Cooling with coolant**	**Cooling with Air to water**	**Cooling with Air to water**	**Cooling with Air to water**	**Cooling with water**
	 Closed cabinet	 Raised cover, ventilation slots	 Perforated doors	 19" fans, top-cover fans	 Air filtered fans	 Air/air heat exchanger	 Air conditioners	 Air/water heat exchanger (LHX)	 Rear Door Cooling (Passive/Active)	 In Row Cooling – LX	 Direct to Chip Liquid Cooling
Type of protection	≤ IP 55	≤ IP 20	≤ IP 20	≤ IP 20	≤ IP 54	≤ IP 54	≤ IP 54	≤ IP 55	≤ IP 20	≤ IP 20	≤ IP 20
Noise level approx.	0	0	55 ... 65 dB (A)	34 ... 67 dB (A)	39 ... 71 dB (A)	55 ... 75 dB (A)	50 ... 81 dB (A)	50 ... 60 dB (A)			
Ambient conditions	$T_i > T_u$	$T_i > T_u$	$T_i > T_u$	$T_i > T_u$	$T_i > T_u$	$T_i > T_u$	$T_u \leq 55°C$	$T_u \leq 70°C$	$T \leq 70°C$	$T \leq 70°C$	$T \leq 70°C$
Cooling capacity approx.1)	< 500 W	< 500 W ... 800 W	< 500 W ... 6000 W2)	< 2000 W	< 1500 W	< 2000 W	< 2600 W	< 40000 W	25-55 kW	30-75 kW Per Cooler	60-800 kW

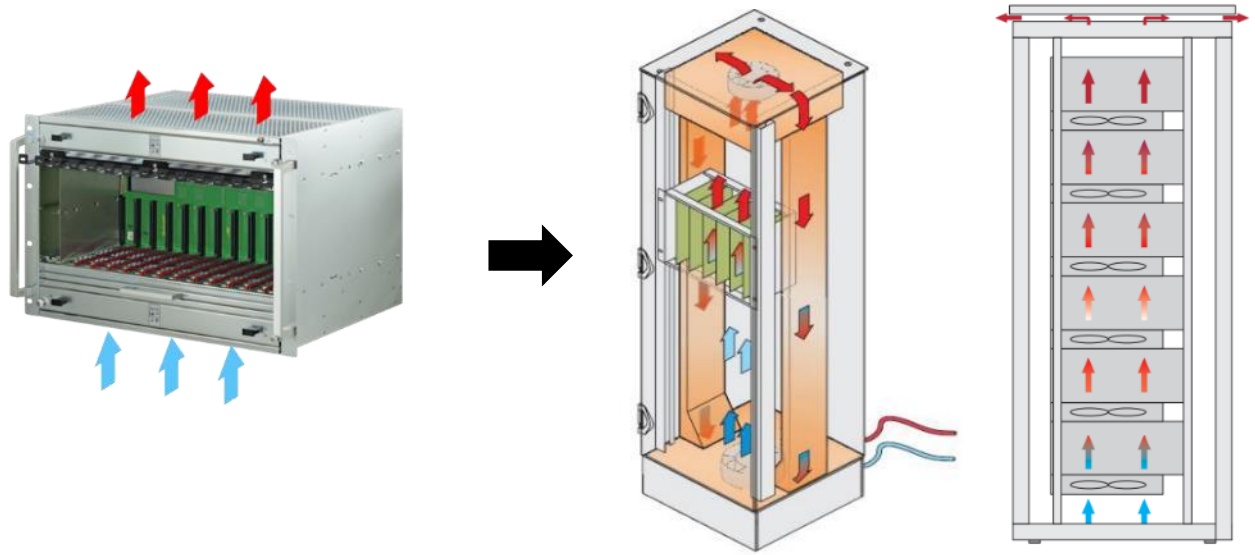
1) should be depending on cabinet size, electronic components, location and room cooling concept. 2) >800 W are only possible with own, active cooling through components like servers, etc.

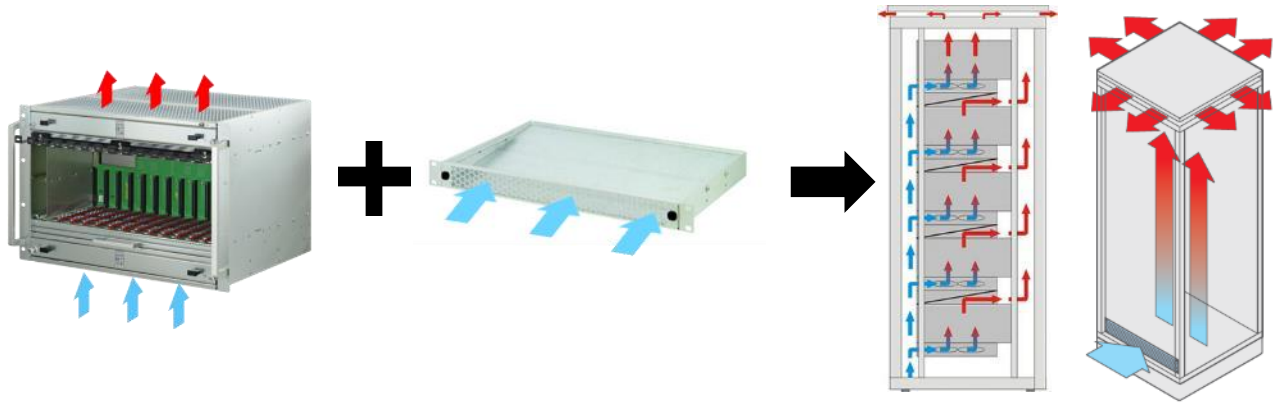
Cooling Strategies: Choosing a solution to maximize the operational life of your electronics

Cooling MicroTCA Crates inside the cabinet

BOTTOM TO TOP

- MTCA chassis with bottom to top air flow
- Chassis with front to back or side to side will not get sufficient air
- Warm air from the lower crate will be the inlet air for upper crate
- Air flow can be optimized with water cooling
  - Dedicated cabinet ventilation with water heat exchanger
  - Air chiller in between the MTCA Crates

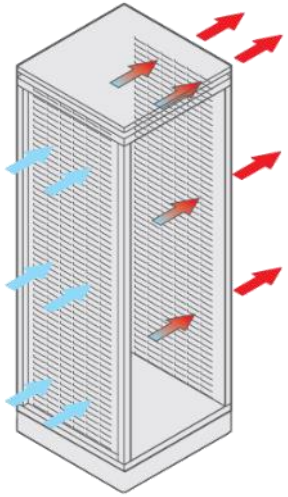


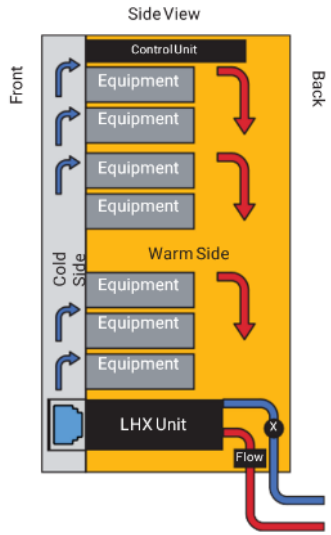


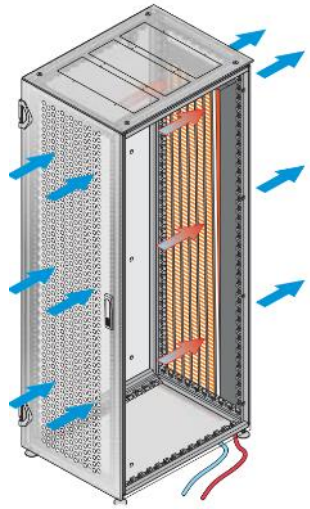
Cooling MicroTCA Crates inside the cabinet

FRONT TO BACK

- Divider between cold and hot air is the front 19” flange
- MTCA Crates must be adapted to the Cabinet cooling concept
  - Front air inlet, rear air outlet
  - Bottom to top air flow Crate only works with air guiding devices below and above the Crate



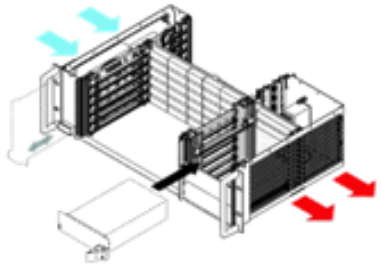


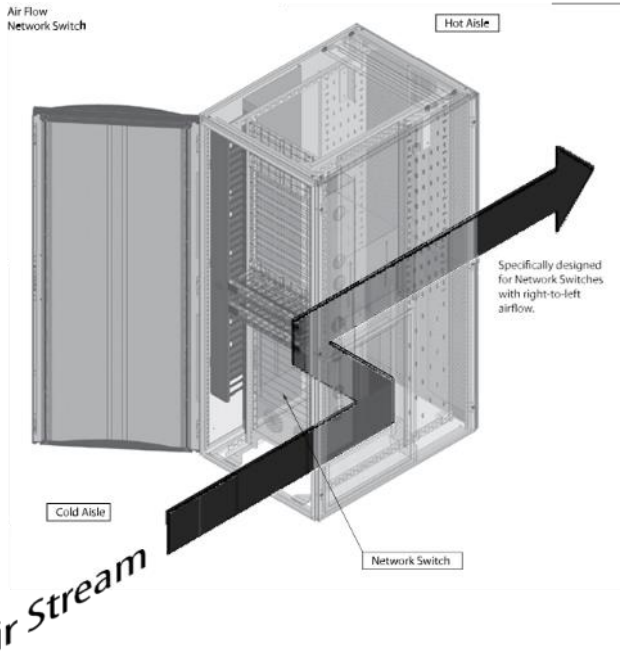


Cooling MicroTCA Crates inside the cabinet

CRATES WITH SIDE-TO-SIDE COOLING

- To achieve minimum crate height, card cages can be built for horizontal mount of the AMC modules
- ATTENTION: Air flow can be right to left or left to right (MTCA is usually right to left)
- Doesn’t fit to Cabinet cooling concepts
- Dependent on the space in the side of the Cabinet and what is installed (cables?)
- Workarounds to adapt the air flow direction (some more professional than the others)

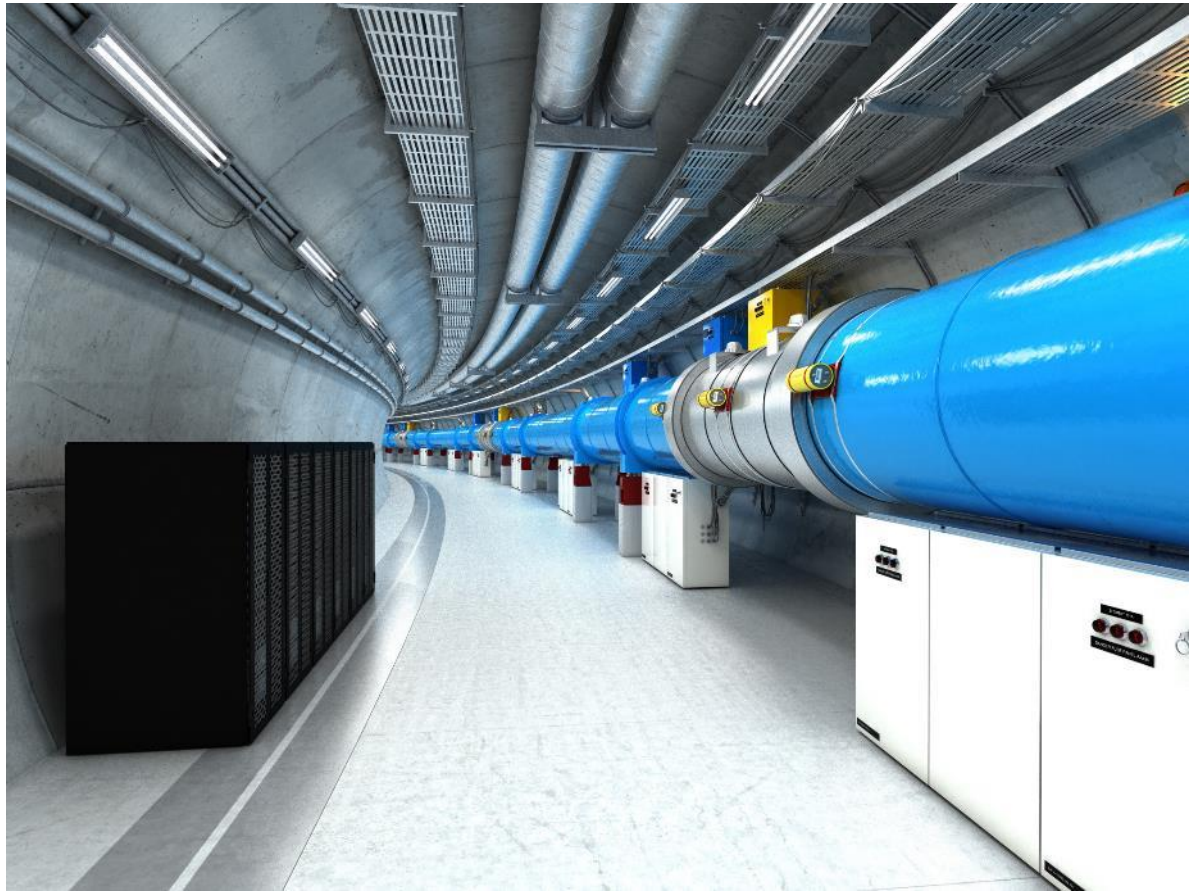




Cooling system requirements

Depending on the application’s requirements, various alternatives are more or less suitable for cooling the systems. In order to decide which cooling concept is the most suitable for which application, some key criteria must be considered in more detail:

- Power or power loss of the application
- Ambient temperature
- Required temperature accuracy
- Required IP protection
- Required EMC protection
- Noise emission
- Reliability
- Durability



Challenges VS Countermeasures of Physics Applications

In Advanced Physics applications you face several cooling requirements such as:

Avoiding temperature fluctuations in electronics cabinets is a basic requirement for highly complex physical applications.

- The electronics enclosed need **precise temperature control** to ensure performance and accuracy in measurements.

Normally, the tunnels that surround a particle accelerator's kilometer-long pipes are unmanned environment

- Efficient **EMC/IP** environment to avoid interference.
- **Remote monitoring** due to closed operating environment of the tunnel.
- Modular design for **easy expansion**

Long term and stable operation of major scientific infrastructure

- **Long-term availability**
- **Timely service**

Varistar LHX+ Precise Liquid Cooled Cabinet

Key components of the LHX+ cabinet

Cooling capacity from 5kW up to 10 kW

Control unit with remote control

Temperature regulation accuracy of +/- 0.1°C

Static load of 1,000 kg

EMC protection

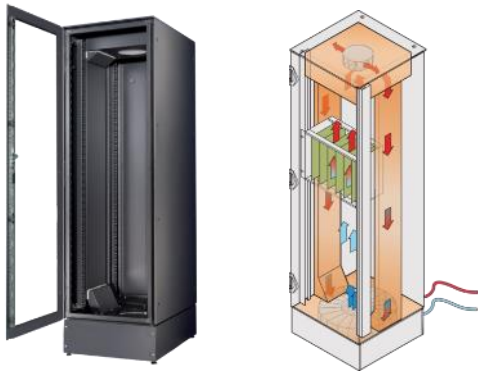
IP55

Protection class IP 55

nVent

Air-Water Cooling

- **Bottom to top cooling:** Warm air is drawn from above downwards by a fan through the air/water heat exchanger; the air flows through a special air channel in the side panel
- **Front to rear cooling:**
  1. Warm air is drawn from the bottom side by the fans of the cooling module through the air/water heat exchanger. Cold air is provided on the front side of the 19” area.
  2. Warm air is drawn from the rear side by the fans of the cooling module through the air/water heat exchanger. Cold air is provided on the front side of the 19” area.
  3. Cold air—> Warm air —> Cold air

LHX3 3KW	**LHX+3/5/10** 3KW-10KW	**LHX+30** 30KW	**RDC** >20KW
			
Bottom to top cooling		Front to rear cooling	

Cooling Solutions of the Physics Applications

1. Varistar LHX+ Precise Liquid Cooled Cabinet

2. Instrument Control Systems

3. Row Aisle Containment

Select the right cooling solution

Supporting High-End Research Facilities

The **European Spallation Source (ESS)** is a multi-disciplinary research facility based on what will be the world's most powerful pulsed neutron source.
Application: Linear accelerator
Solution: Hot aisle 2x18 racks containments plus 8x SHX30

Located in Germany ,The **FLASH** of DESY is an X-ray free-electron laser for material research.
Application: Beam generation – RF Gun
Requirements: Rack row 16U with air-water-heat exchanger
Challenge: Narrow temperature tolerance of **± 0,8%**
Solution: Modified VARISTAR based on LHX solution

The **SwissXFEL** generates very short pulses of X-ray light with laser-like properties for biomedical and material research.
Application: Housing for high sensible control equipment
Requirements: Rack with air-water-heat exchanger
Challenge: Temperature tolerance of **± 0,1%**
Solution: VARISTAR LHX20

Constant Temperature Control for the High-Precision Electronics of Physics Applications

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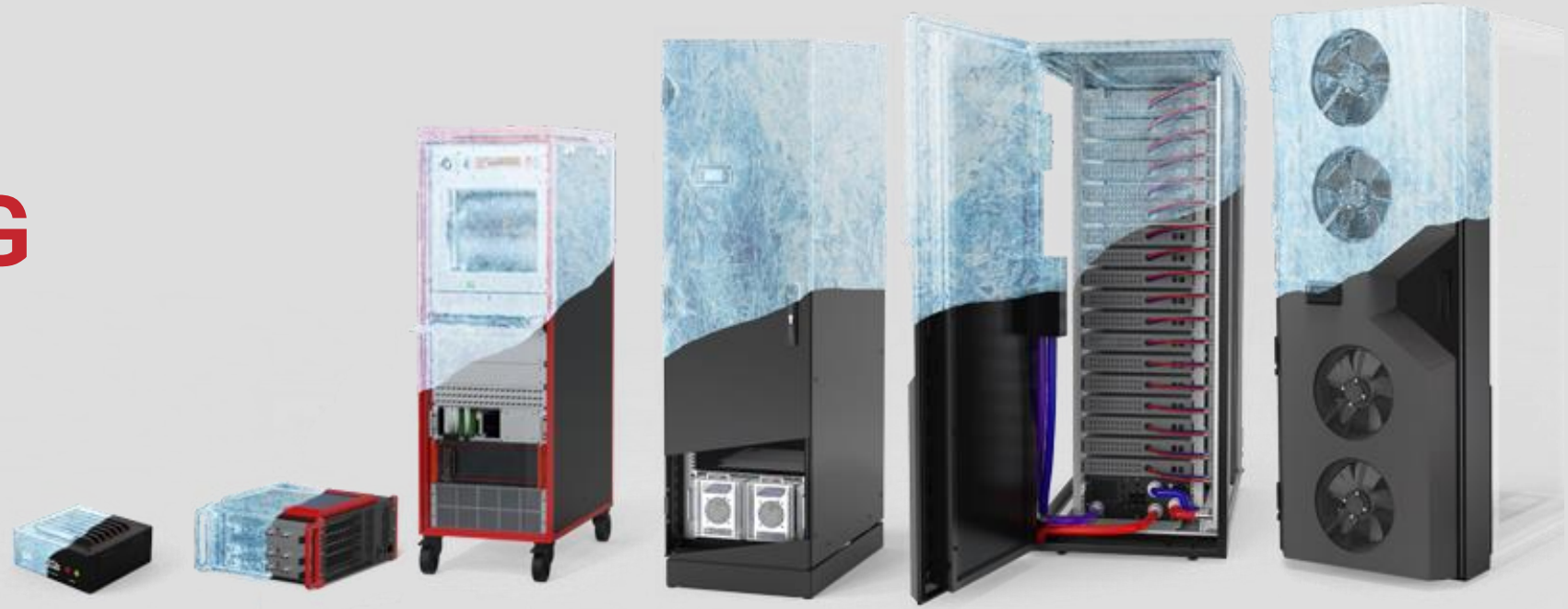
YOUR COOLING EXPERT



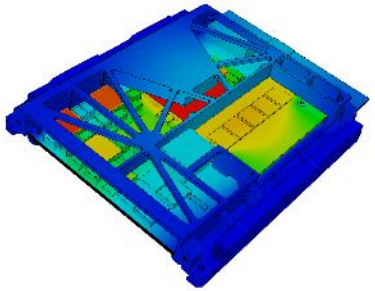
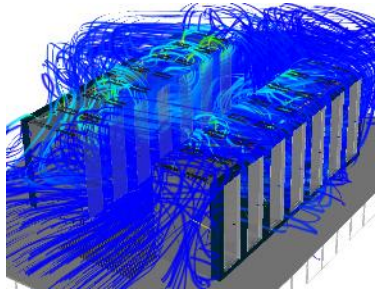
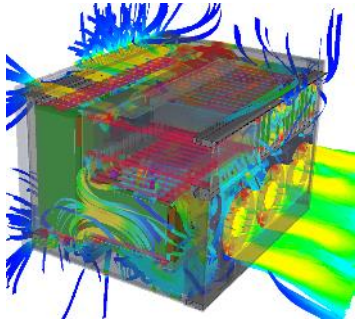
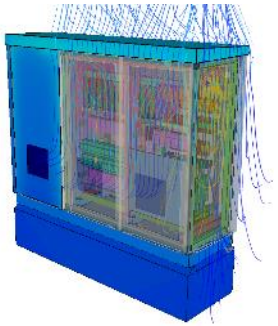
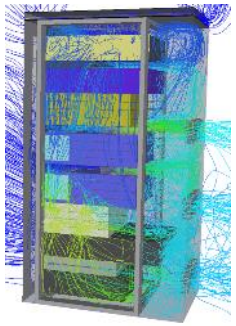
FROM BOARD-LEVEL TO DATACENTER COOLING

As thermal load and packing densities increase, thermal management has become a key consideration for most design engineers. nVent SCHROFF has always had a strong emphasis on the thermal design, and has the equipment, expertise, and experience to assist customers overcome difficult thermal challenges.

How do you find the right cooling solutions to protect your electronics?

nVent SCHROFF has always had a strong emphasis on the thermal design, and has the equipment, expertise, and experience to assist customers overcome difficult thermal challenges.

Thermal Modelling and Simulation

IP and Thermal Testing



Work with experts to get the best fitting solution

Thank You

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