

Next-Generation MTCA Platform and Advanced Cooling Solutions

for Large Scientific Facilities

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Challenges in Next-Generation Scientific Facilities

Evolution of large scientific facilities

- Particle accelerators
- Synchrotron light sources
- Neutron sources
- Fusion research facilities
- Quantum computing control systems

Increasing requirements on control platforms

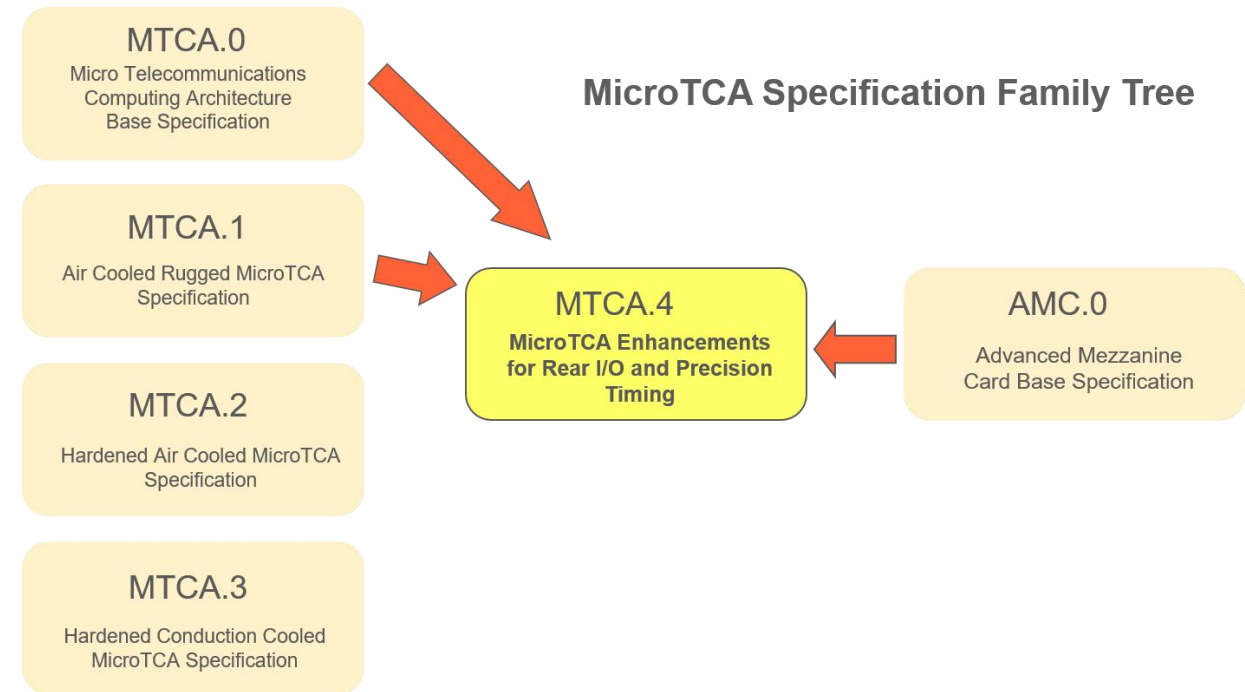
- Higher data throughput
- More precise synchronization
- Higher computing density
- Long-term lifecycle support
- High system availability



Scientific facilities are moving from traditional data acquisition systems toward high-speed, high-power and highly integrated control architectures

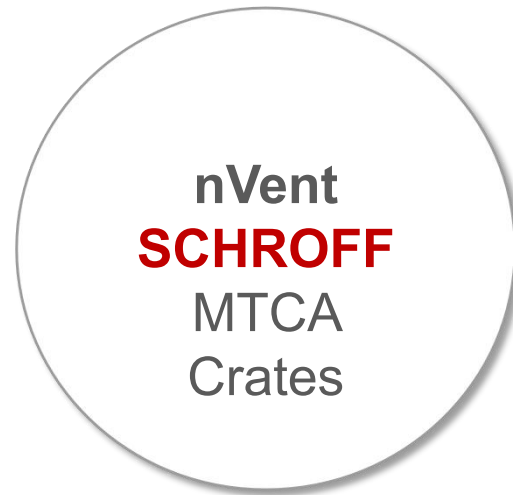
MicroTCA | Features

- Small form factor (compared to ATCA, CPCI or VME)
- Modularity and Maintainability
- High-Bandwidth Data Processing
- Precision Timing and Synchronization
- Redundant or non-redundant systems available
- Hot-swap capability ensures uninterrupted operation
- Remote Management and System Availability
- Open Ecosystem and Long-Term Sustainability



MTCA - a Common Modular Control Platform for Large Scientific

MicroTCA Crates

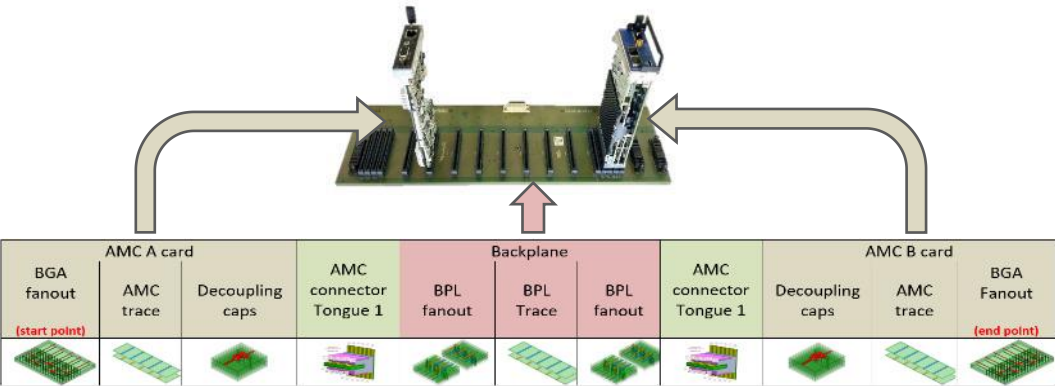
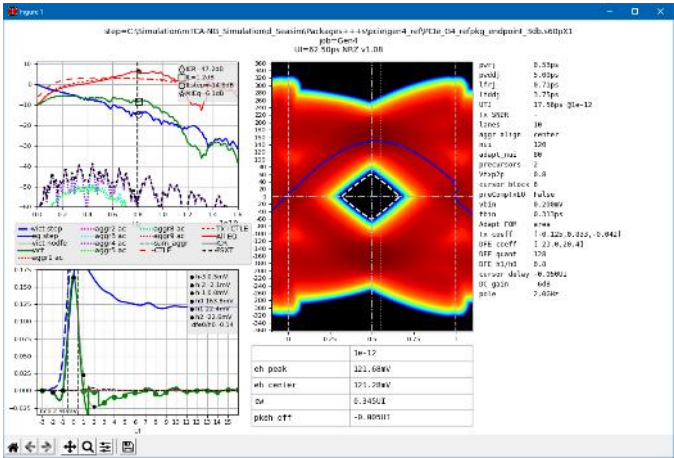


Evolution to MTCA.0 Rev3

PICMG released MTCA.0 Rev 3.0 in September 2023

NEW FEATURES

- Supports PCI Express Gen 4 & 5
- Supports 100 Gb Ethernet (100GBASE-KR4)
- MCH with new management features
- MCH slot gets 110 W of power to support 100 GbE or PCIe Gen 4 / 5 switches
- Power Module with 110 W channels for MCH and CU



Evolution to MTCA.0 Rev3

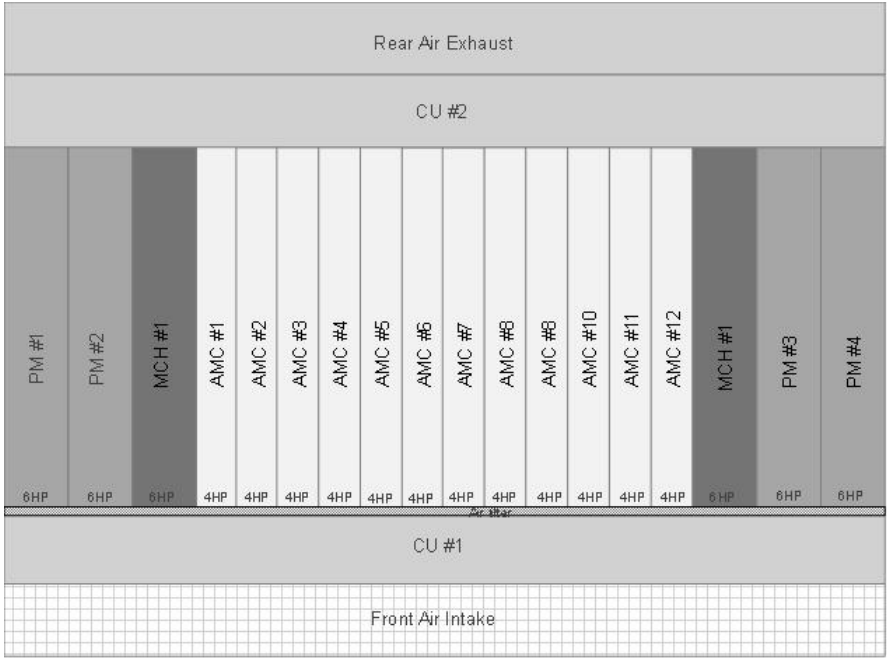
- In accordance with **PICMG MTCA.0 R3.0** and **MTCA.4 R1.0**
- Supports **PCIe Gen5** and **100GBase-KR4**
- MTCA.4 is using the **Double Mid-size AMC modules** with 4 HP width
- With this, 12 AMC's + 2 MCH's and up to 4 PM's fit into a 19" (84 HP) card cage
- The RTM section can be populated with 12 AMC RTM's + 2 MCH RTM's and up to 4 RPM's

New launched in 2025

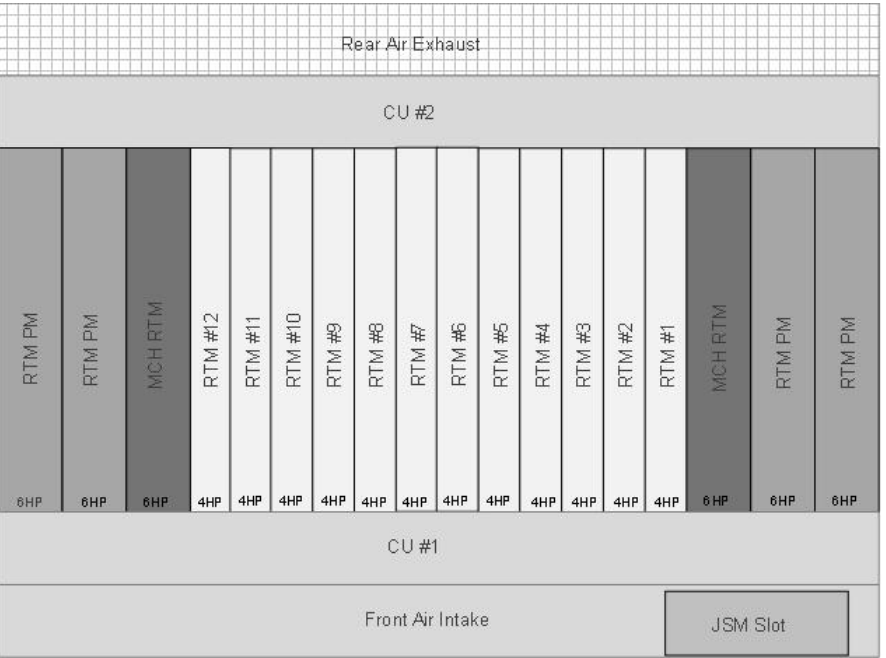


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Front View



Rear View



New Requirement for MTCA

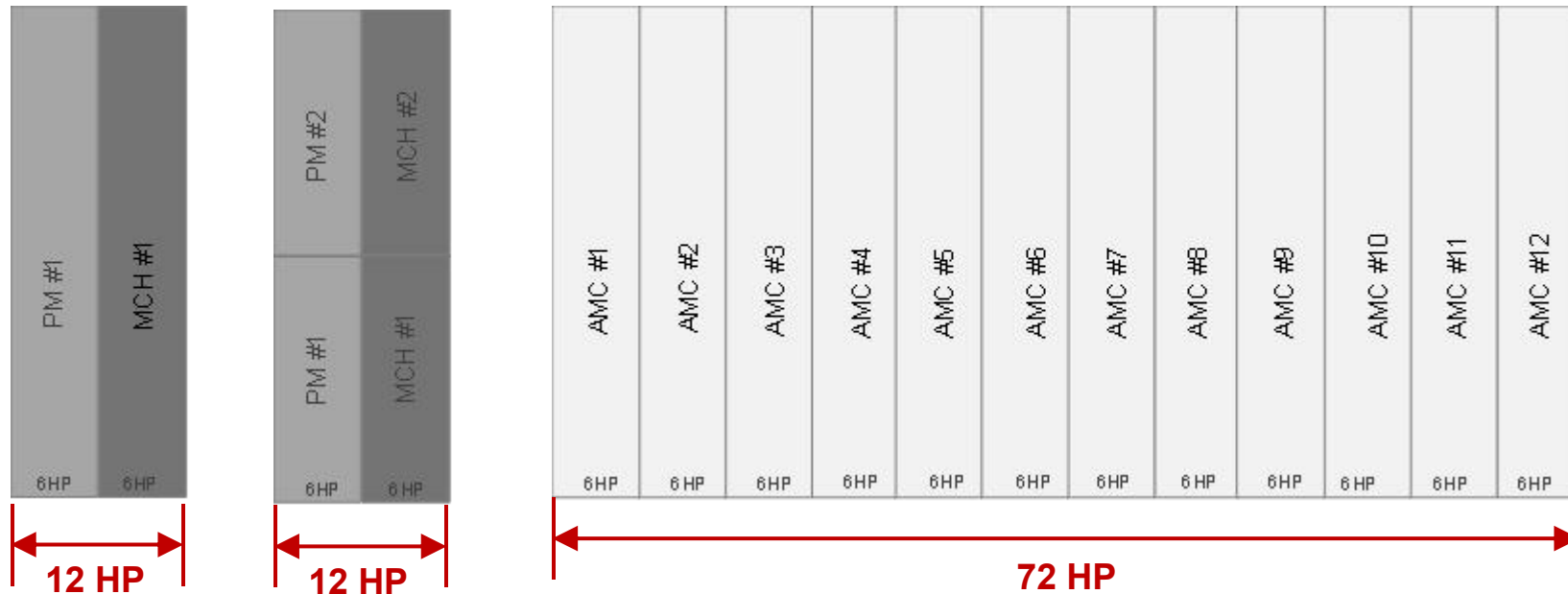
- The maximum number of AMC modules - 12 - is mandatory
- The preferred size of the AMC's and RTM's is **Double Full-size** (I/O & Cooling)
- Some users demand **> 80 W per AMC**
- Depending on the architecture and transfer protocol, 1 or 2 MCH's
- Minimum 1400 W (MTCA.0 Rev. 3.0), redundancy optional
- **Needs a new Crate architecture**



High power boards that require big heat sinks and more space for front panel interface connectors

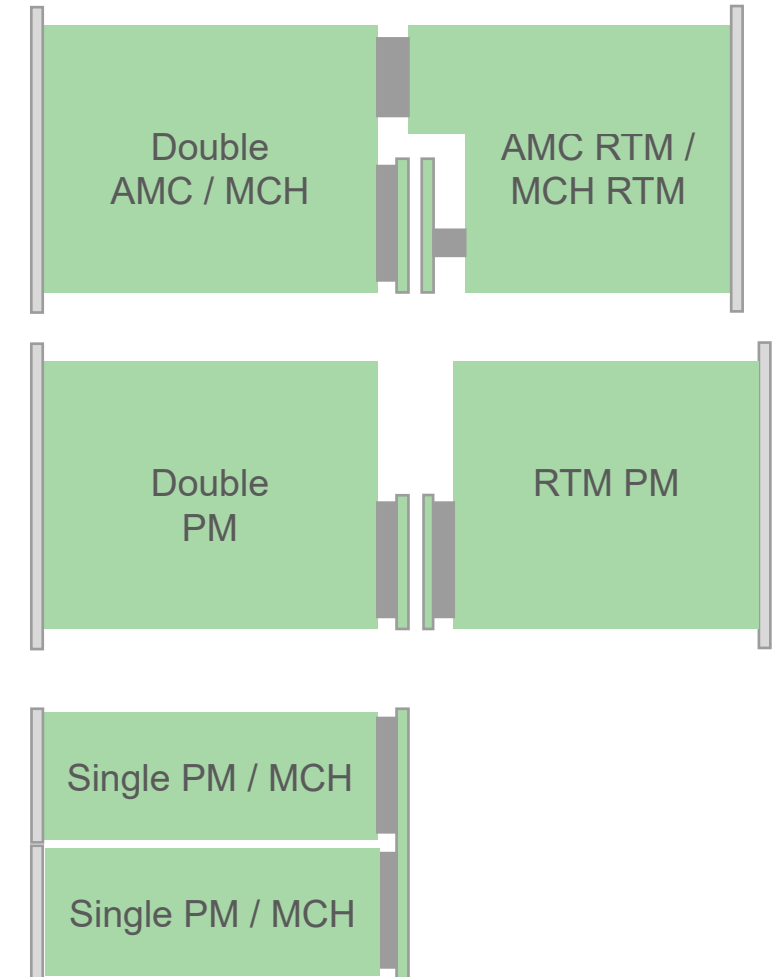
Challenge - Front-Layout of 19" Crate with 12 Double Full-size AMC Modules

- 12 Double Full-size (6 HP width) AMC Modules already occupy 72 HP of space
- Only 2 Full-size slots left for MCH and PM
 - Either 1x Double Full-size PM and 1x Double Full-size MCH
 - Or 2x Single Full-size PM and 2x Single Full-size MCH



Challenge - Rear-Layout of 19" Crate with 12 Double Full-size AMC Modules

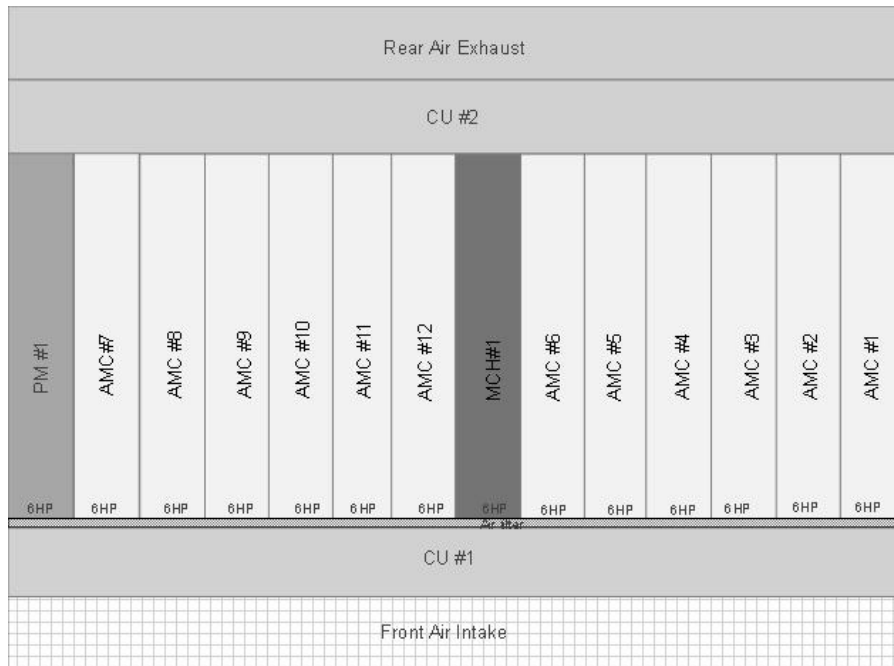
- 12 Double Full-size (6 HP width) RTM's already occupy 72 HP of space
- Only the 2 Full-size slots behind the MCH and PM left
 - With Double Front Modules, RTM's are possible
 - Single Module connectors cover all space on the backplane, no RTM's



Implementations for 12 Full-size AMC Crates in accordance to Rev 3.0

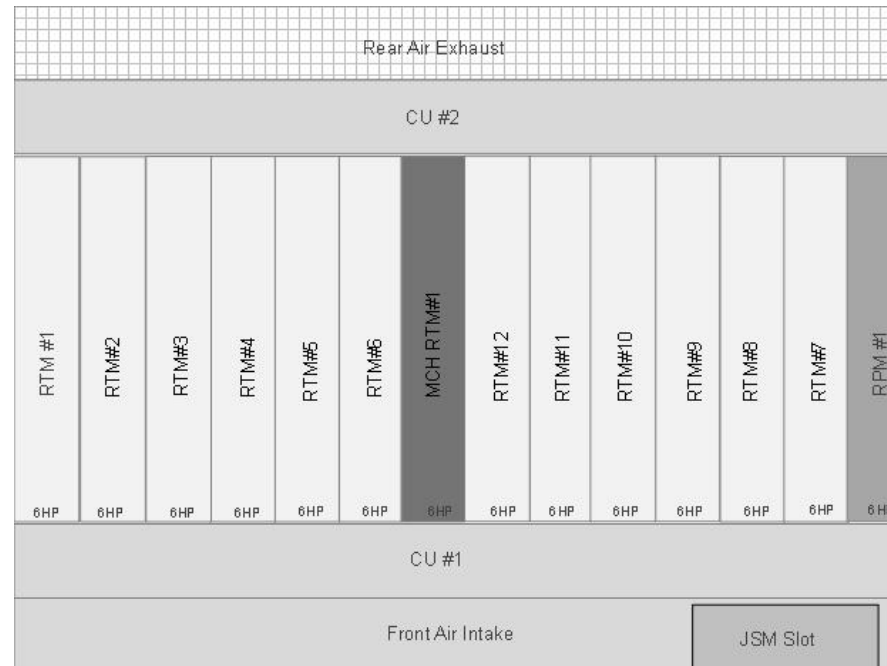
■ Front (**Non-redundant Version**)

- 1 Double Full-size PM Slot
- 1 Double Full-size MCH Slot
- 12 Double Full-size AMC Slots

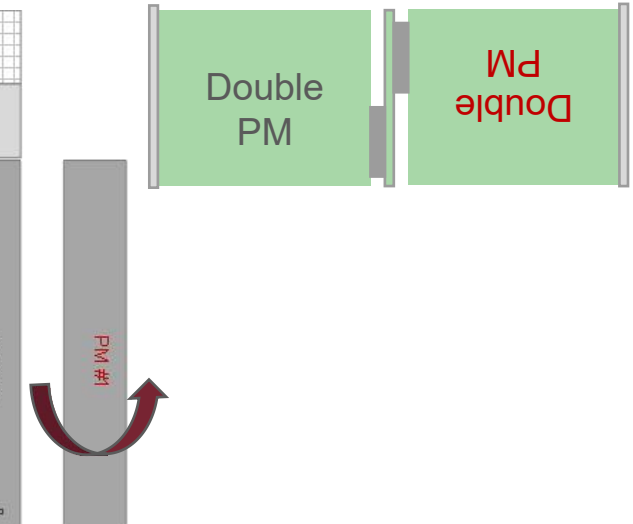


■ Rear (**Non-redundant version**)

- 1 Double Full-size RPM Slot or PM 180° rotated
- 1 Double Full-size MCH RTM Slot
- 12 Double Full-size RTM Slots
- 1 Single Full-size JSM Slot



- Possibility for optional RTM Backplane
- **Max 1300 W with DC Power Module**



Implementations for 12 Full-size AMC Crates in accordance to Rev 3.0

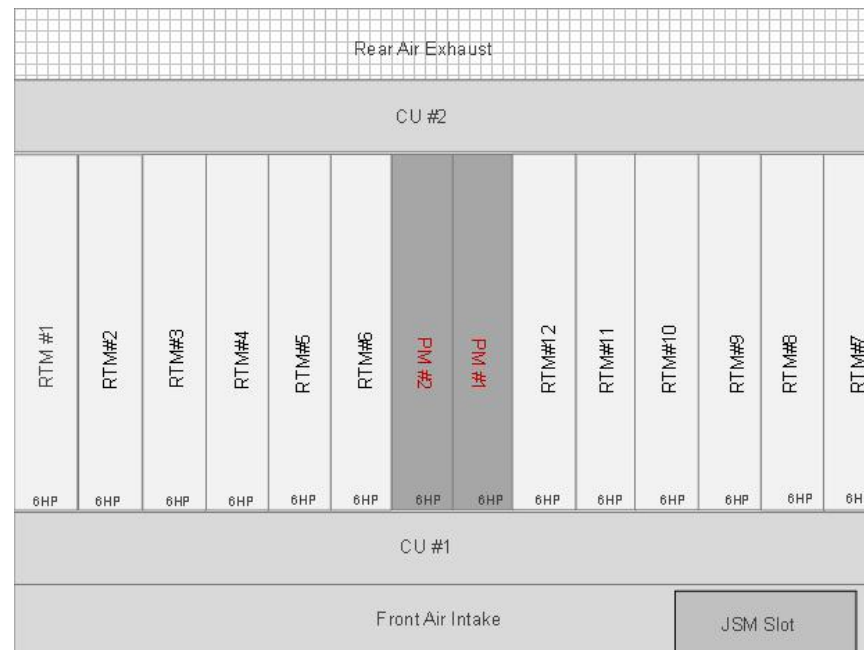
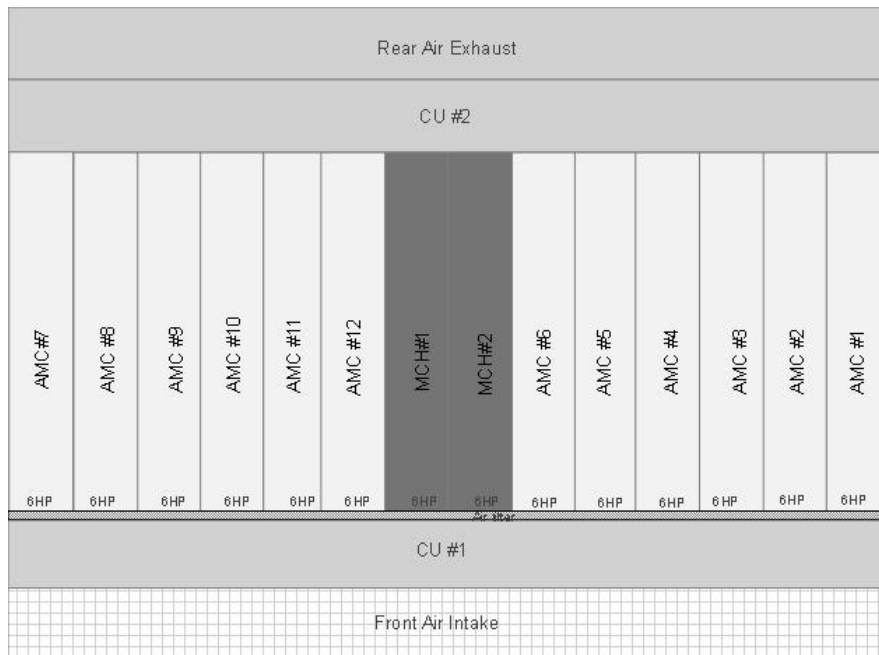
- Front (**Redundant version**)

- 2 Double Full-size MCH Slots
- 12 Double Full-size AMC Slots

- Rear (**Redundant version**)

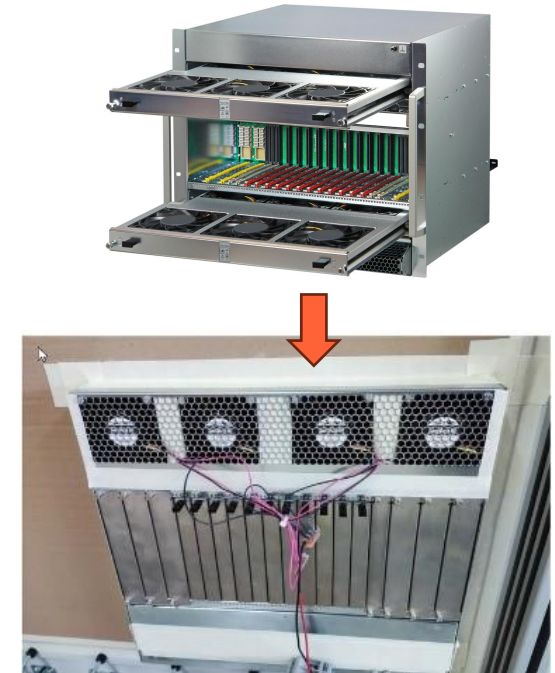
- 2 Double Full-size PM Slot (rotated by 180°)
- 12 Double Full-size RTM Slots
- 1 Single Full-size JSM Slot

- Option for Rear Backplane
- No RPM's possible
- No MCH RTM's possible



Conclusion

- There are several different options to implement 12 Double Full-size AMC's into a 19" Crate
- **Trade-offs** either in redundancy, number of Power Modules and Rear Power Modules
- As soon as Power **exceeds 80 W** per Module, further changes are required:
 - **New air flow** concept with 4 counter rotating fans, pulling air out at the top rear (up to 2500 W cooling capacity)
 - Above 2500 W, **24 V or 48 V fans** are needed, powered by separate power input;
 - **MTCA.0 Version 4.0 for >200W/board?**
- **Alternatively: Cooling solutions based on liquid cooling**



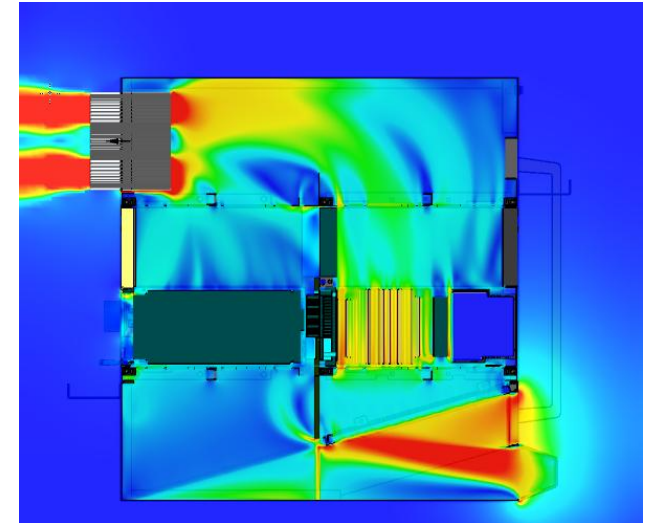
New Cooling Solutions

From air to liquid



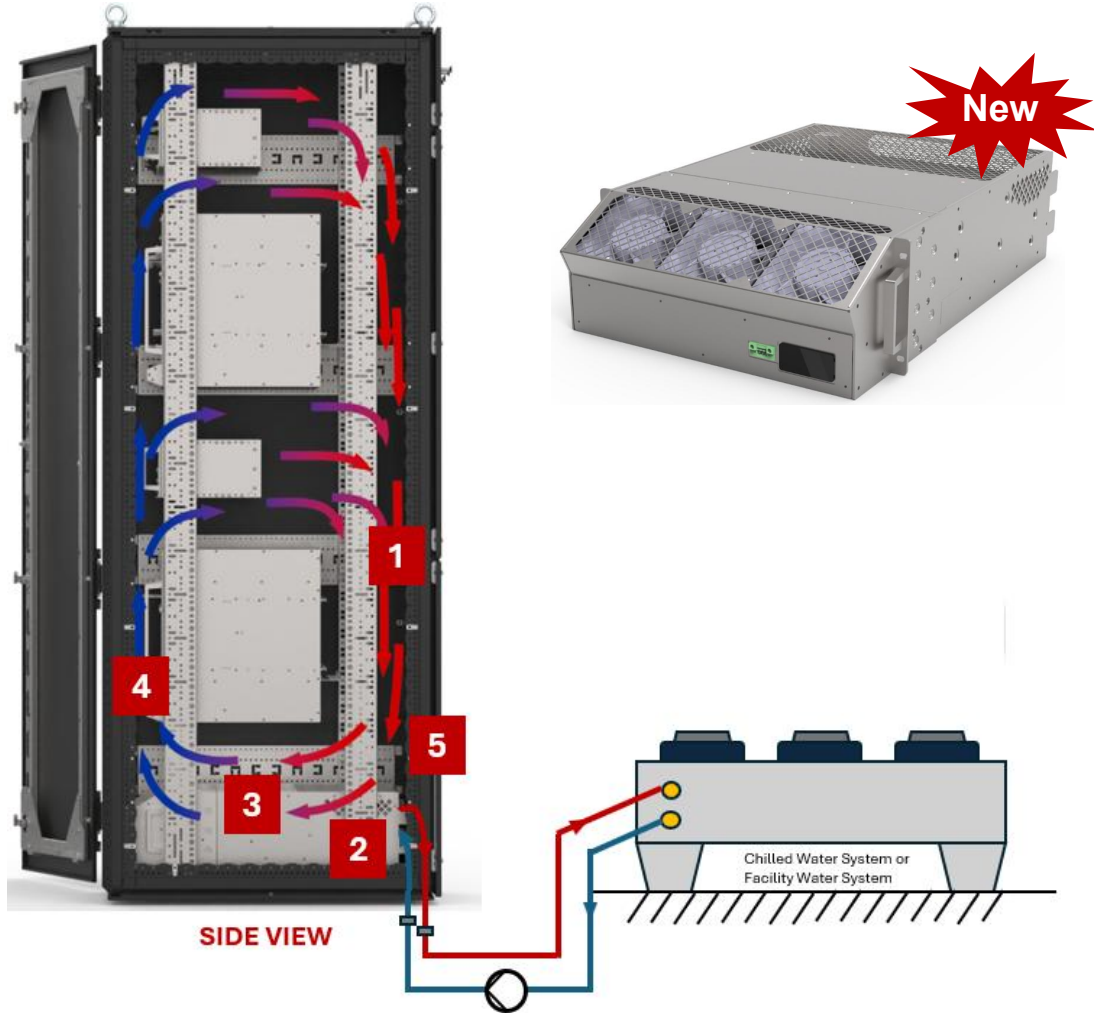
Thermal Challenge: The Real Bottleneck

- Higher bandwidth means more powerful switches, processors, FPGAs and converters
- Front AMC and rear MicroRTM areas may have different airflow and cooling requirements
- Maintaining predictable temperature distribution becomes critical for measurement stability and system reliability
- Cooling architecture must evolve together with backplane and processing performance



Fan-cooling is reaching its thermal dissipation limit

New 4U LHX – Cabinet Level Air/Water heat exchanger



Small Form Factor (4U)

- More space available for mission critical components installation

Thermal = 7.5KW

- Cover most of thermal req in A&D and T&M application

OPERATION PRINCIPLE

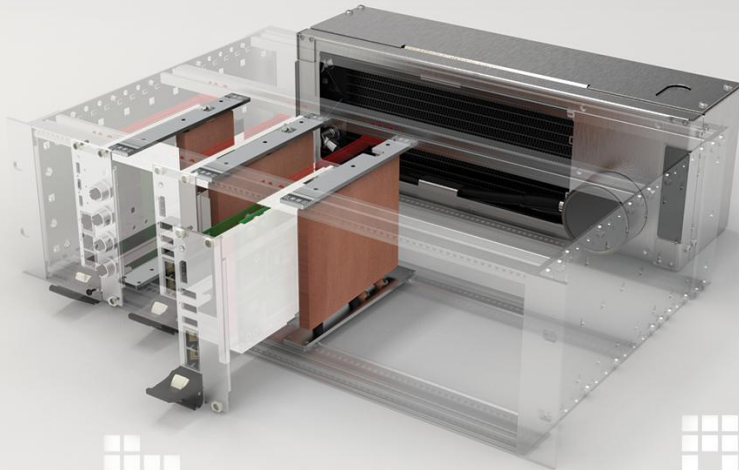
- 1 Fans from the cooling unit draw warm air from rear section of cabinet into air/water heat exchanger
- 2 Cold water comes into the inlet from a Chilled Water System or Facility Water System
- 3 The warm air transferred to a medium of cold water
- 4 The cool air is blown into the front area of the cabinet
- 5 Water circulates to connected external reciprocal water unit where water is cooled down again

Easy Swap LFT – Board level Liquid Flow Through Cold Plate

INTRODUCING

EASY SWAP LFT

Advanced Liquid Cooling
for Modular Systems

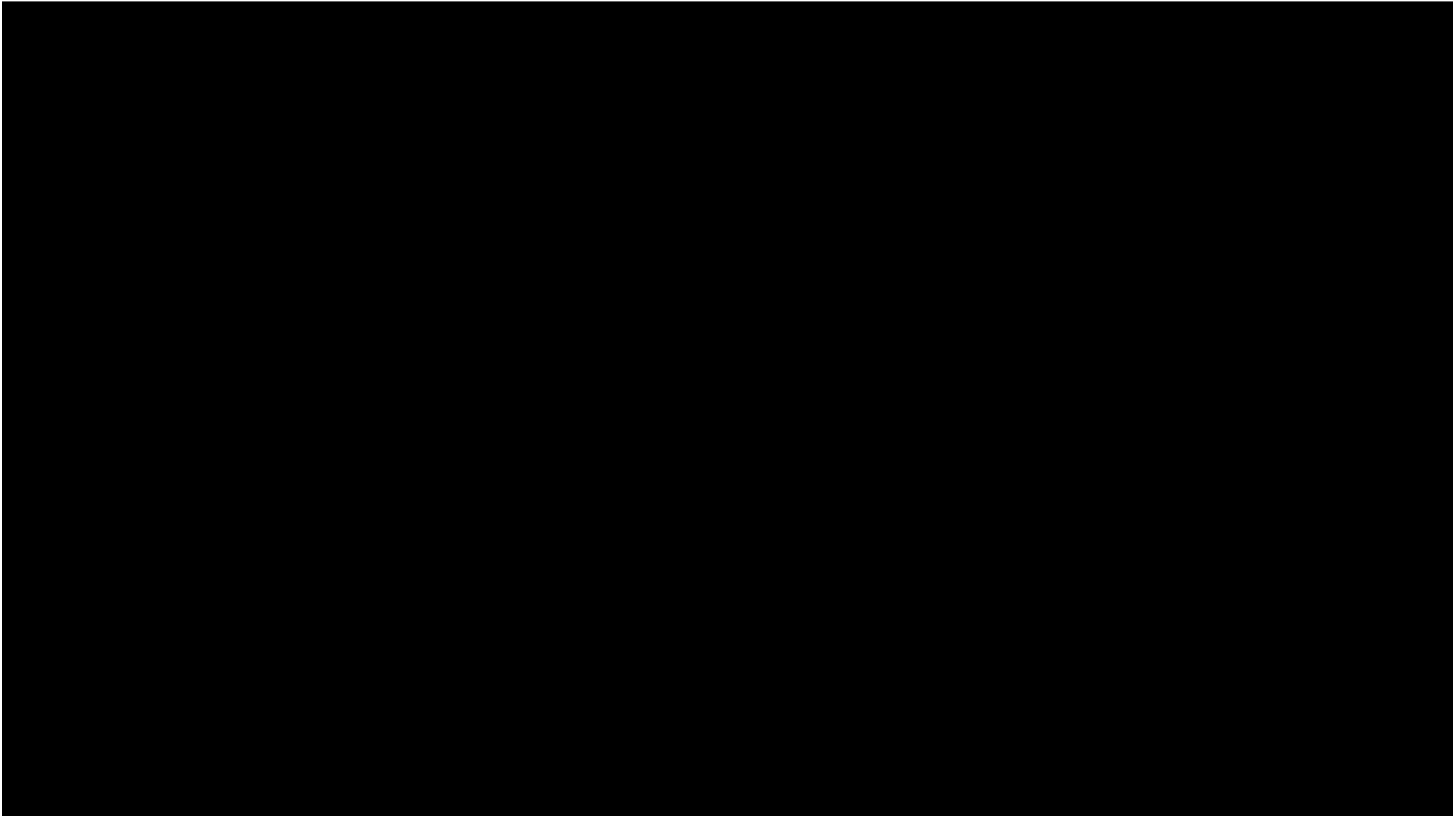


We connect and protect

Features and benefits

- Up to 600 W cooling capacity with integrated circuitry
- 200 W+ per cold plate
- Operates at ambient temperatures up to 50°C
- Reduces hot spot temperature by >30 K vs. forced air cooling
- Supports hybrid cooling (air + liquid in one subrack)
- Fully retrofittable into standard 19" subracks and systems

Easy Swap LFT - Functional Video



Thank You!