Schroff

Requirements for a MTCA- Crate

Pre-Workshop MTCA

Real Time Conference

June, 2018

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June, 2018

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Agenda

- Building a crate
- Mechanics
- Environmental Conditions
- Hardware Management
- Backplane Specification
- Cooling Requirements
- MTCA.4 Crates

BUILDING A CRATE IN ACCORDANCE TO MTCA.4

- The technical characteristics' of a crate are defined in the MTCA.4 specification
- Everybody can develop a MTCA.4 crate
- But… MicroTCA is a complex, leading edge technology
- How to make sure everything is working as required?
- Extensive DVT testing is essential

MECHANICS

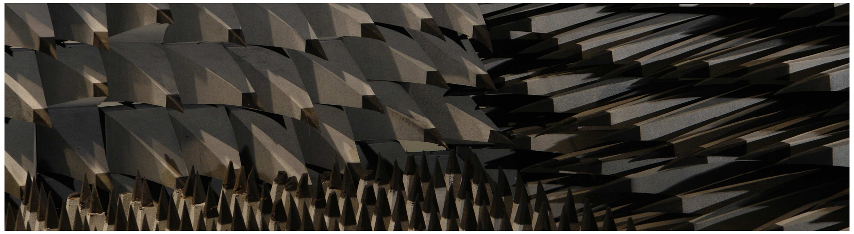
- **For new technologies, new products or if issues arise, mechanical measurements are required, samples:**
  - 3D Measurements
  - Crimp-pull machine measurements
  - Material testing with Microscope
  - IP protection testing in water cabin




ENVIRONMENTAL CONDITIONS

To ensure the conformity with the given environmental specifications, environmental tests are required:

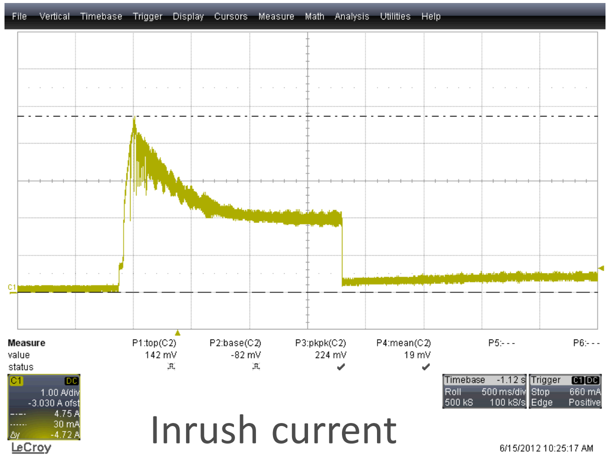
- Climate chamber
- Noise measurement
- EMC measurement (HF shielding & RF material tests)
- Shock & vibration
- static & dynamic load
- dust, water and salt spray tests



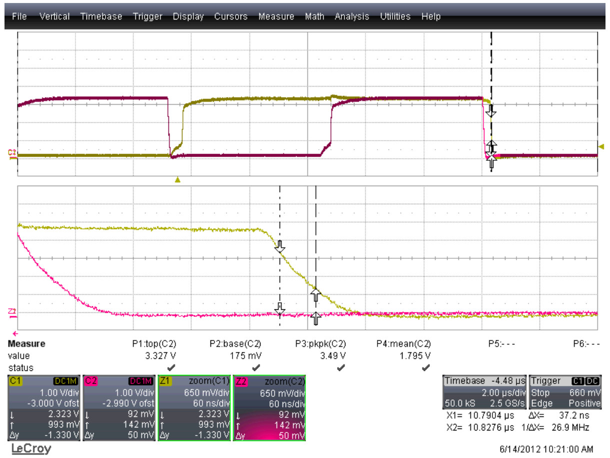
HARDWARE MANAGEMENT

Hardware Management DVT testing

- **Functional tests**
    - Power, hot swap, sensors, IPMI, redundancy, …
- **IPMB signal integrity**
    - Rising Edge, Falling Edge
- **Stress tests**
    - Turn_ON_OFF_stresstest
- **Current tests**
    - Inrush current, ripple
- **Component temperatures**
- **Tests with different MCHs / AMCs**



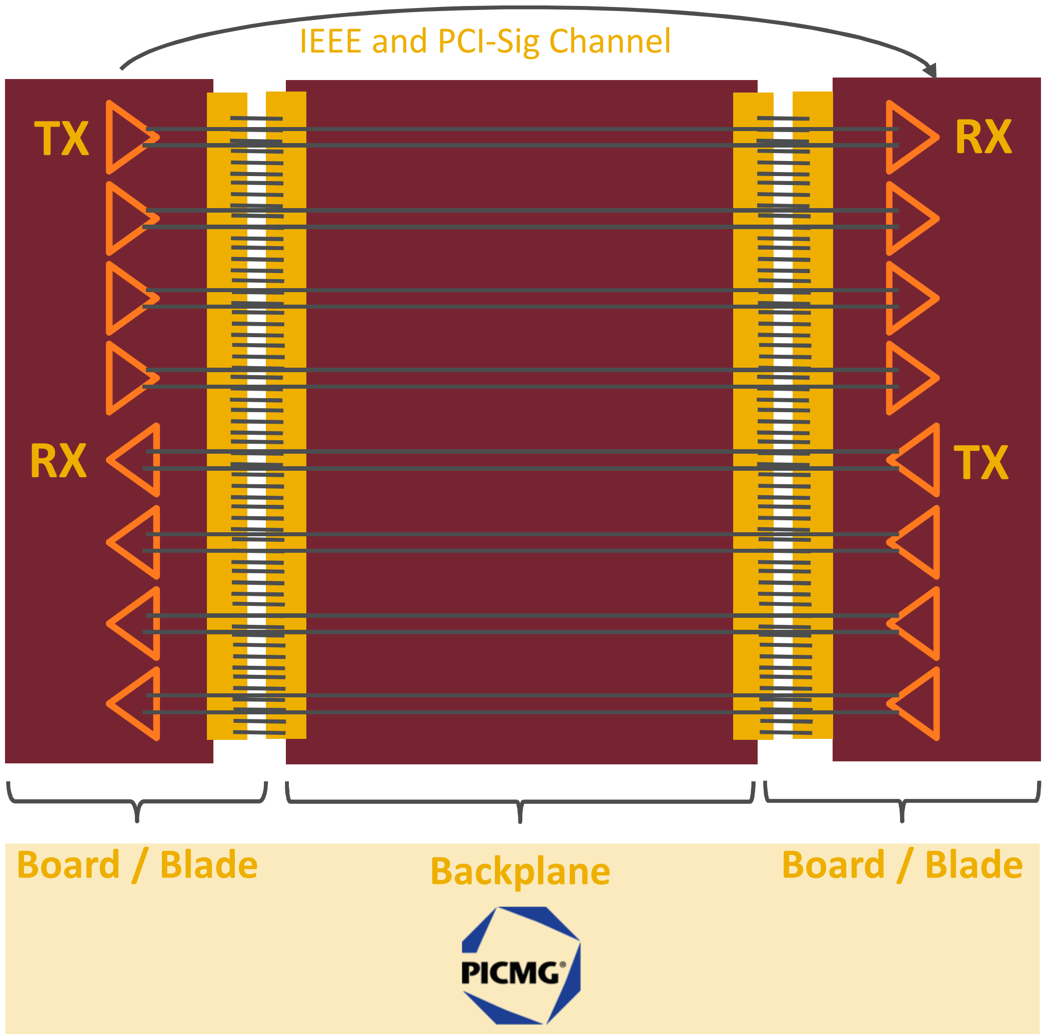
Inrush current



IPMB signal integrity test

BACKPLANE - SPECIFICATION

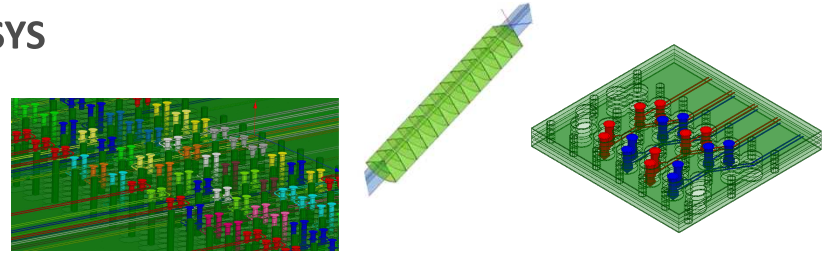
- **IEEE and PCI-Sig describe in their specification the channel parameter between TX and RX**
  - 40GBASE-KR4 (40 GbE -> 4 ports, 10 Gbps each)
  - 100GBASE-KR4 (100 GbE -> 4 ports, 25 Gbps each)
  - PCIe Gen 1, 2, 3 (4)
- **PICMG adapts the IEEE specification to the xTCA environment and splits the channel into segments (board / connector pair / backplane / board)**
  - PICMG working group adds 40GBASE-KR4 to MTCA right now
  - PICMG 3.1 R3.0 (Chapter 5.6 adds 100GBASE-KR4)
- **In addition the test adapter and test methology are specified by PICMG**



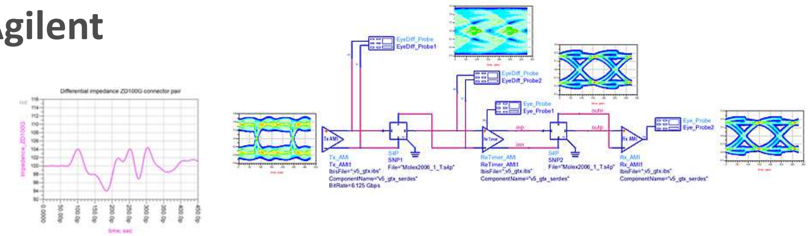
BACKPLANE - SPECIFICATION

Pre- and Post-layout simulation

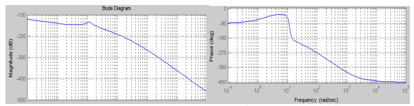
- **3D electromagnetic field solver HFSS from ANSYS**
  (3D structure simulation, vias, connectors …)



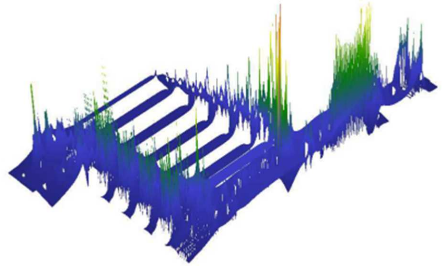
- **ADS (Advanced Design System) from Keysight/Agilent**
  (Channel performance simulation/validation)



- **MATLAB**
  (Channel performance simulation/validation)



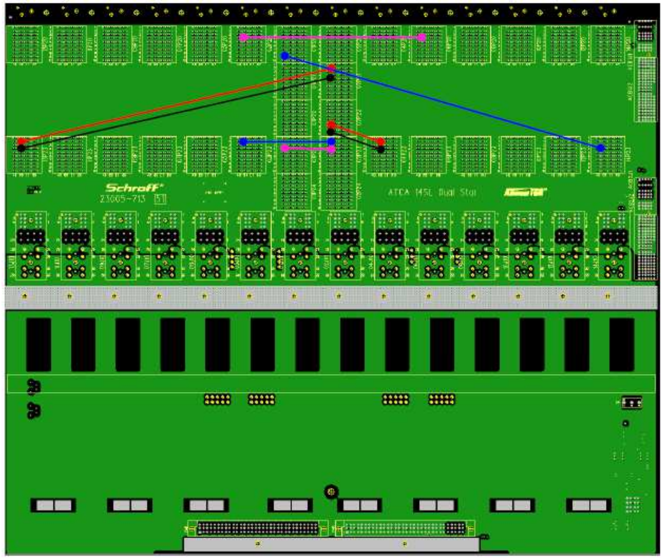
- **HyperLynx PI from MENTOR** (Power simulation)



Max Current Density: 52.8A/mm^2, Current Density for layer „1_Top“: 27.3A/mm^2

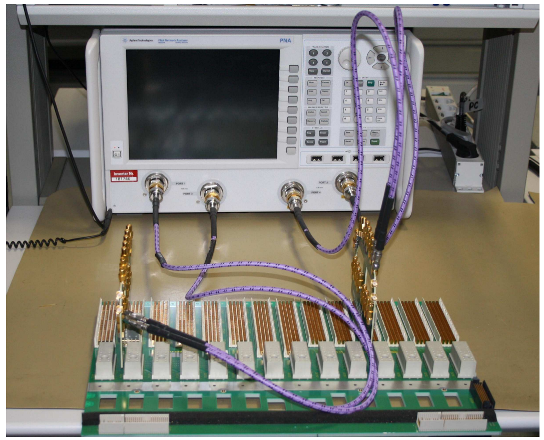
BACKPLANE - DESIGN VALIDATION

Measurement and validation of (at least) the critical channels/traces



Some important parameters to validate:

- Impedance
- Return Loss
- Insertion Loss
- Insertion Loss deviation
- Cross Talk (near & far end in time and frequency domain, power sum of all aggressors)
- Insertion Loss to Cross Talk Ratio
- Eye pattern
- BER (Bit Error Rate)
- Skew (inter- and intra pair)



BACKPLANE - DESIGN VALIDATION

Cross talk

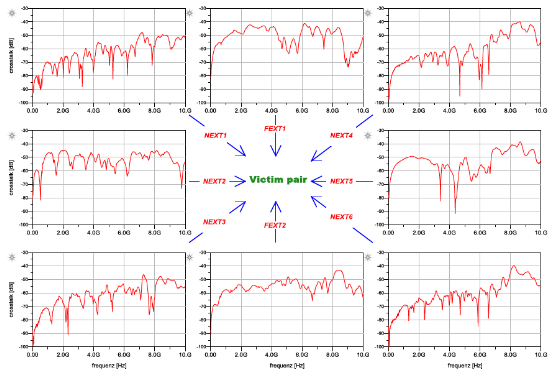
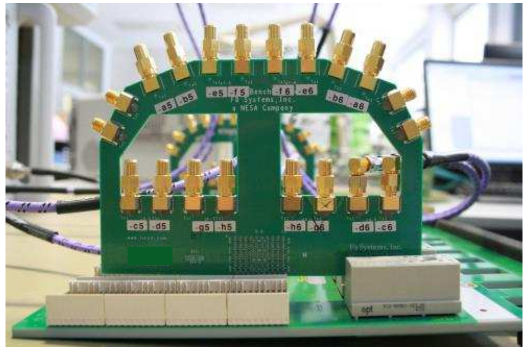
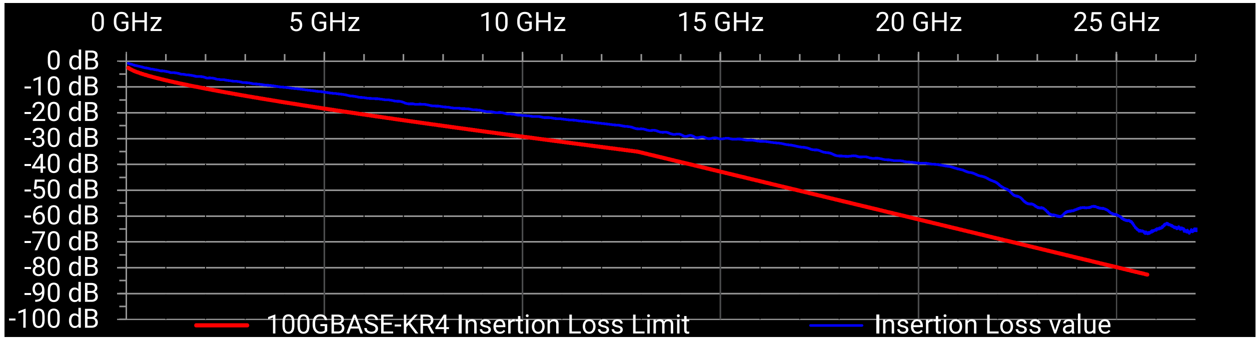


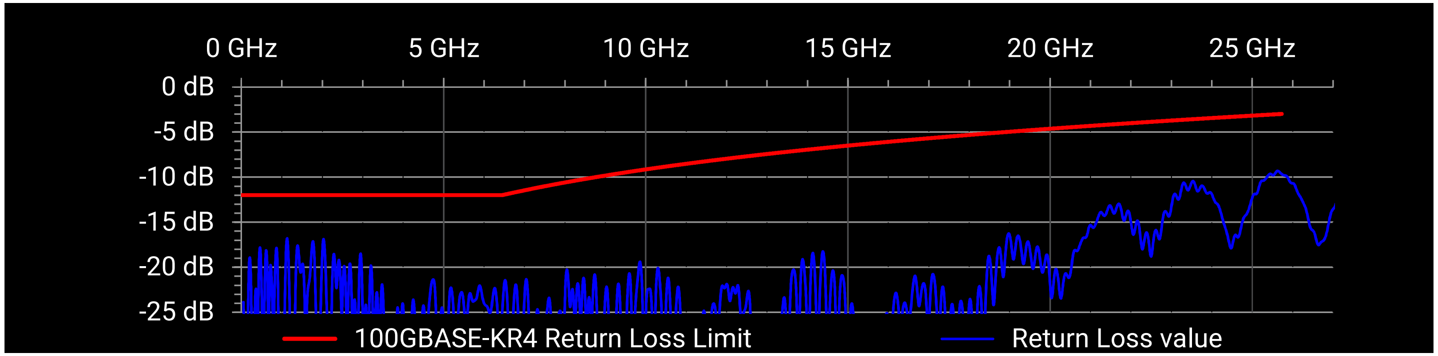
Figure 12: Overview individual 2P22c10d10 NEXT and FEXT values



Insertion loss



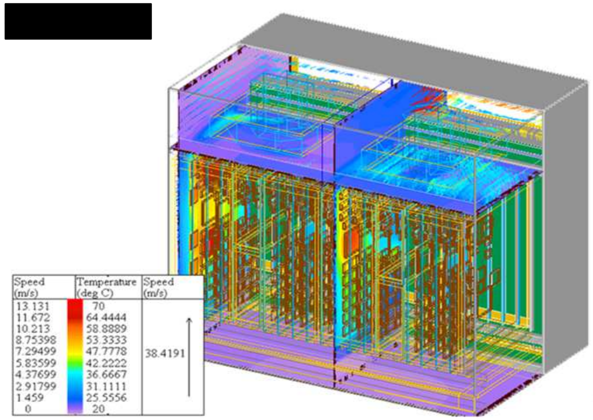
Return Loss



COOLING – DETERMINE WHAT’S ACHIEVABLE

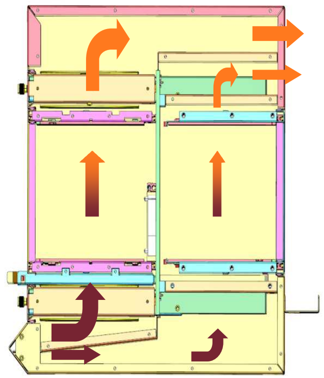
Sometimes it’s useful to perform thermal simulations before starting into a new crate development:

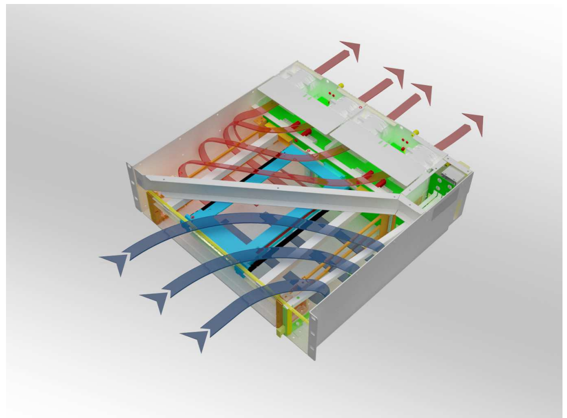
[redacted]



- **cooling requirements increase**
- ATCA: 300W/slot to 450W/slot
- **New air flow path requirements**
- Front to rear @ horizontal boards
- **New technologies**

- Pull vs. push vs. push/pull fan configurations
- Pull/pull vs. counter rotating fan

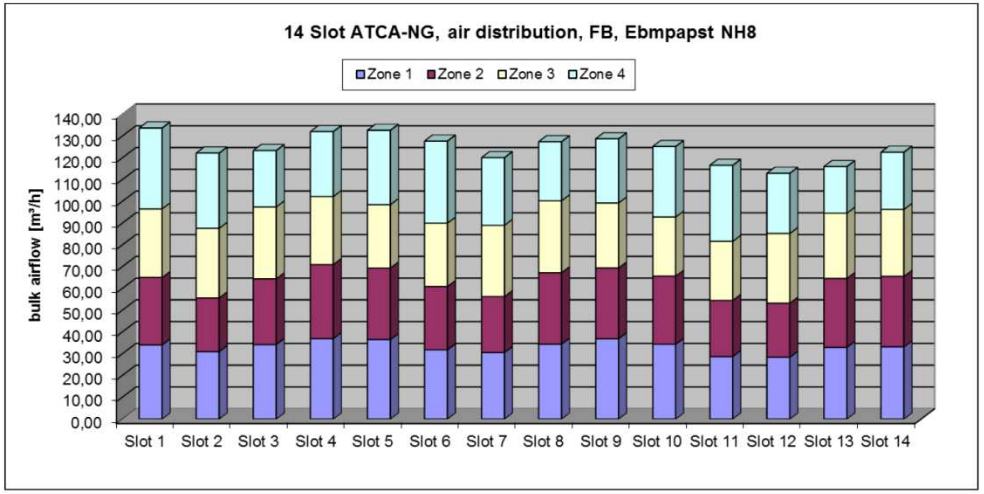




COOLING – VERIFICATION AFTER DEVELOPMENT

- **AdvancedTCA (cp-ta) is defining a test method for comparable and reproducible air flow measurements**
  - defined Measurement cards with defined air impedance are used
  - airspeed is measured in 4 defined areas
- **Easy to check if chassis is suitable for the application**

Standardized air measurement card
with removed cover



Result of an air distribution measurement

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COOLING – VERIFICATION AFTER DEVELOPMENT

- Measuring the air volumes in the 4 different zones
- Sum of the 4 zones is the air volume of the slot
- Sum of the air volumes of the slots is in the total air volume and thus cooling capacity of the crate
- The cooling performance can be calculated
  „airflow [m³/h] = 3 * power [W] / ΔT“ considering the board pressure drop is 37Pa at 0.85 m3/min as defined in the ATCA specification)

	Zone1 [m³/min]	Zone2 [m³/min]	Zone3 [m³/min]	Zone4 [m³/min]	Σ [m³/min]	Σ [m³/h]	Σ CFM	Cooling Capacity Δt=10K	Cooling Capacity Δt=12K	CP-TA Cat.
Slot 1	0,28	0,3	0,29	0,32	1,19	71,58	42,11	240 W	288 W	>B4
Slot 2	0,29	0,3	0,28	0,29	1,16	69,64	40,97	234 W	280 W	>B4
Slot 3	0,28	0,3	0,28	0,3	1,15	69,3	40,76	233 W	279 W	>B4
⋮										
Slot 14	0,26	0,28	0,26	0,27	1,08	64,55	37,97	217 W	260 W	B3
Σ	3,8	4,14	3,93	4,19	16,06	963,67	566,87	3234 W	3880 W	

COOLING – VERIFICATION AFTER DEVELOPMENT

- Schroff has implemented a similar test for MicroTCA
- The air impedance from different AMC and MCH modules have been determined
- The worst case have been chosen as the reference for the air measurement card

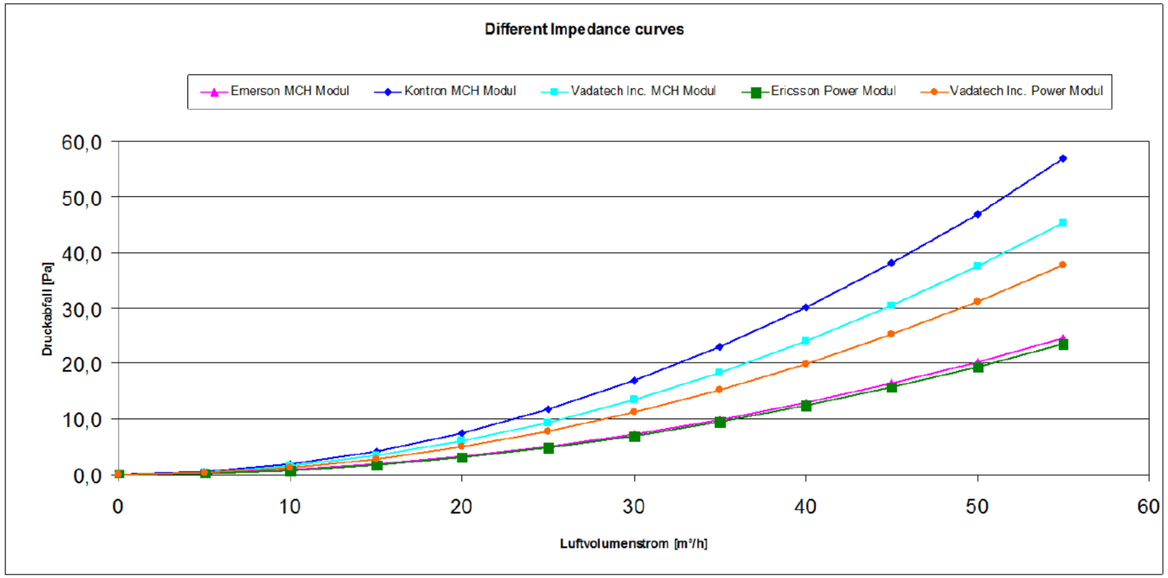
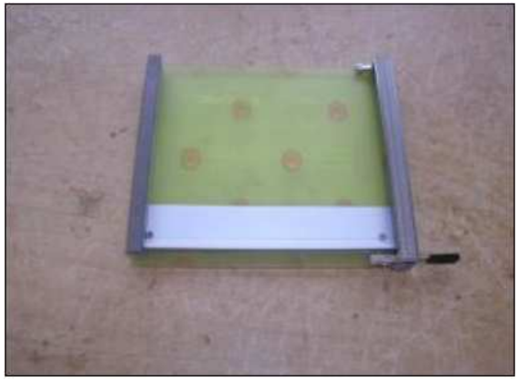


Figure 5 Determining the Impedance of the Double Mid-Size MTCA impedance boards

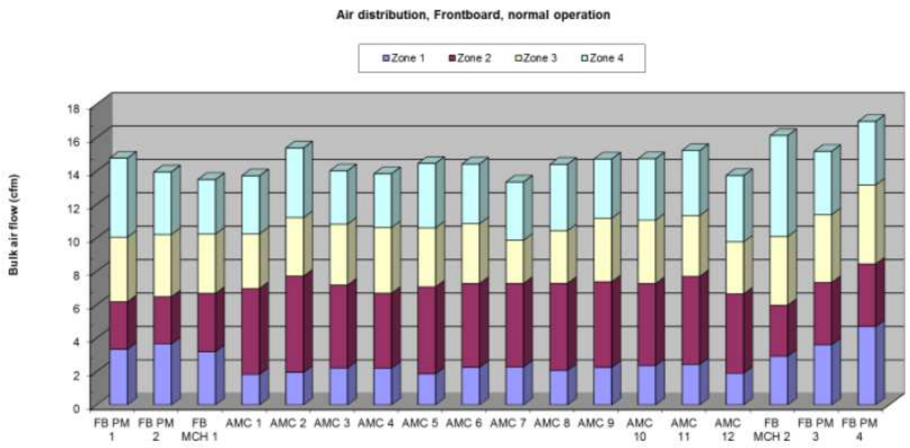
Air flow measurement board

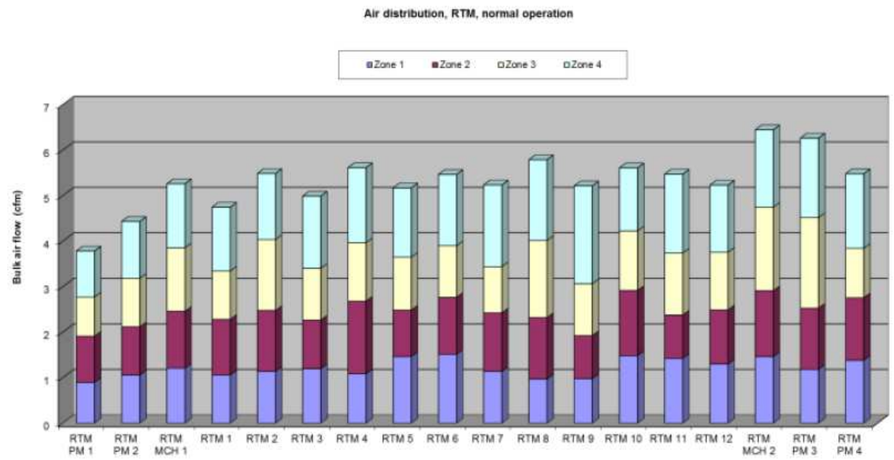


Air impedance board

COOLING – VERIFICATION AFTER DEVELOPMENT

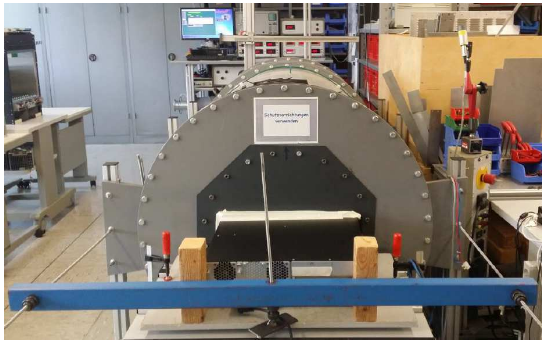
- Result can be displayed in a graphical way
- Air flow for front and RTM slots is determined
- All different scenarios can be measured:
  - Normal operation
  - Fan failure
  - Cooling unit replacement
- Power = Air Flow * ΔT / 3.3!
  - The cooling capability of a crate is very much dependent on the environmental temperature
  - AMC slot 1: 24.3 m3/h
    - cooling capability (at ΔT=12k) ~ 88 Watts
    - cooling capability (at ΔT=25k) ~ 184 Watts
  - RTM slot 7: 12.1 m3/h
    - cooling capability (at ΔT=12k) ~ 44 Watts
    - cooling capability (at ΔT=25k) ~ 92 Watts

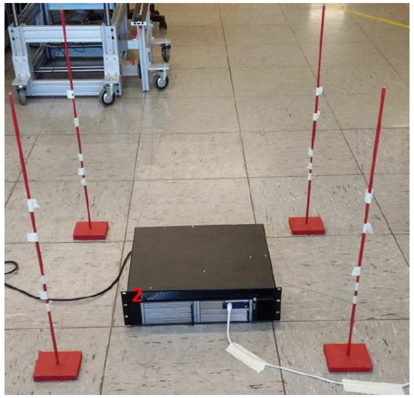




COOLING – VERIFICATION AFTER DEVELOPMENT

- Additional cooling verifications
  - Bulk air flow
    - For mock-up crates to proof if the concept works as expected
    - To verify the air measurement / slot results
  - Acoustic noise measurement





MTCA.4 CRATE

MTCA.4 CUBE SYSTEM

- 5 U, 42 HP cube system for 6 double mid-size and 1 double full-size AdvancedMC modules, 1 double full-size MCH and 1 double full-size power module
- 6 rear transition module slots for double mid-size modules and one slot for double full-size

- Backplane with star topology, direct connections for S-ATA/SAS, clock and trigger lines as per PICMG MTCA.4
- Clock topology to PICMG AMC.0 R2.0
- Hot-swap fan module with cooling unit manager (CU EMMC), airflow from bottom to top, fan speed for front and rear sections can be separately adjusted via MCH
- Air filter, exchangeable from front

MTCA.4 CRATE

MTCA.4 19” SYSTEM WITH WHITE RABBIT SUPPORT AND JSM SLOT

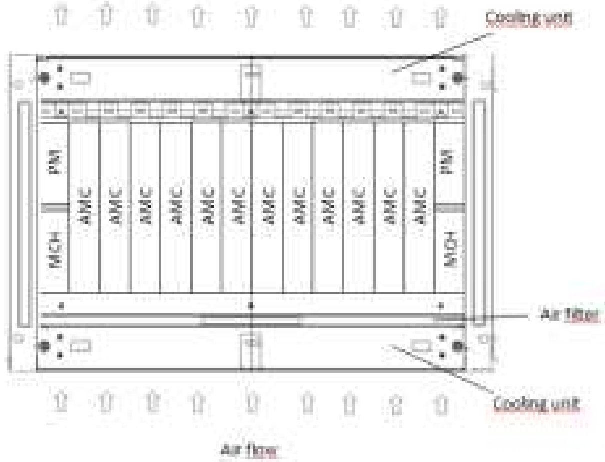
New version of the 19” MTCA.4 chassis with special backplane routing for deterministic Ethernet (White rabbit) and with rear side Single Full-size JSM slot.

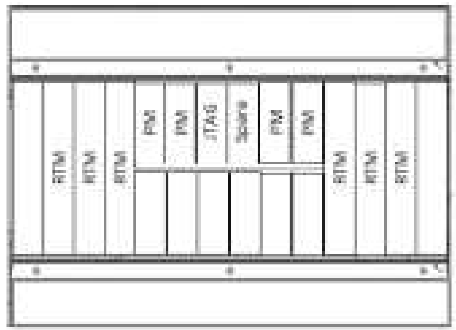
- 9 U, 84 HP cube system for 12 double mid-size-AdvancedMC modules, 2 double full-size MCHs and 4 double full-size power modules
- 12 rear transition module slots for double mid-size
- Backplane with dual star topology, direct connections for S-ATA/SAS, clock and trigger lines as per PICMG MTCA.4
- Clock topology to PICMG AMC.0 R2.0
- 2 hot-swap fan module with cooling unit manager (CU EMMC), airflow from bottom to top, fan speed for front and rear sections can be separately adjusted via MCH

MTCA.4 CRATE

MTCA.4 19" SYSTEMS FOR DOUBLE FULL-SIZE AMC'S

- Special requirement from Cern: Full-size AMC modules -> Power modules move to the backside
- Full-size slots for MTCA.4
- Cooling bottom to top and front to back
- Versions with MTCA.4 backplane routing and with AMC.0 R1.0 routing





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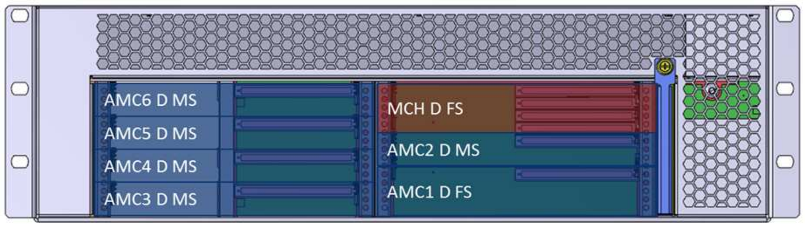
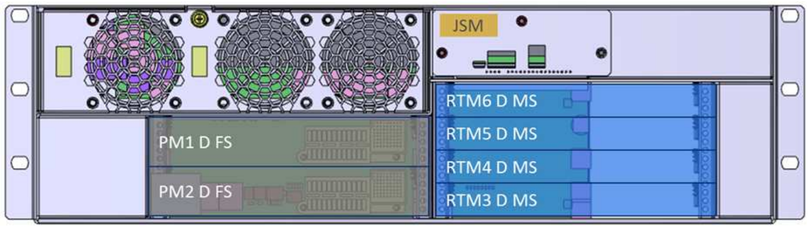
MTCA.4 CRATE

MTCA.4 19” SYSTEMS FOR DOUBLE FULL-SIZE AMC’S

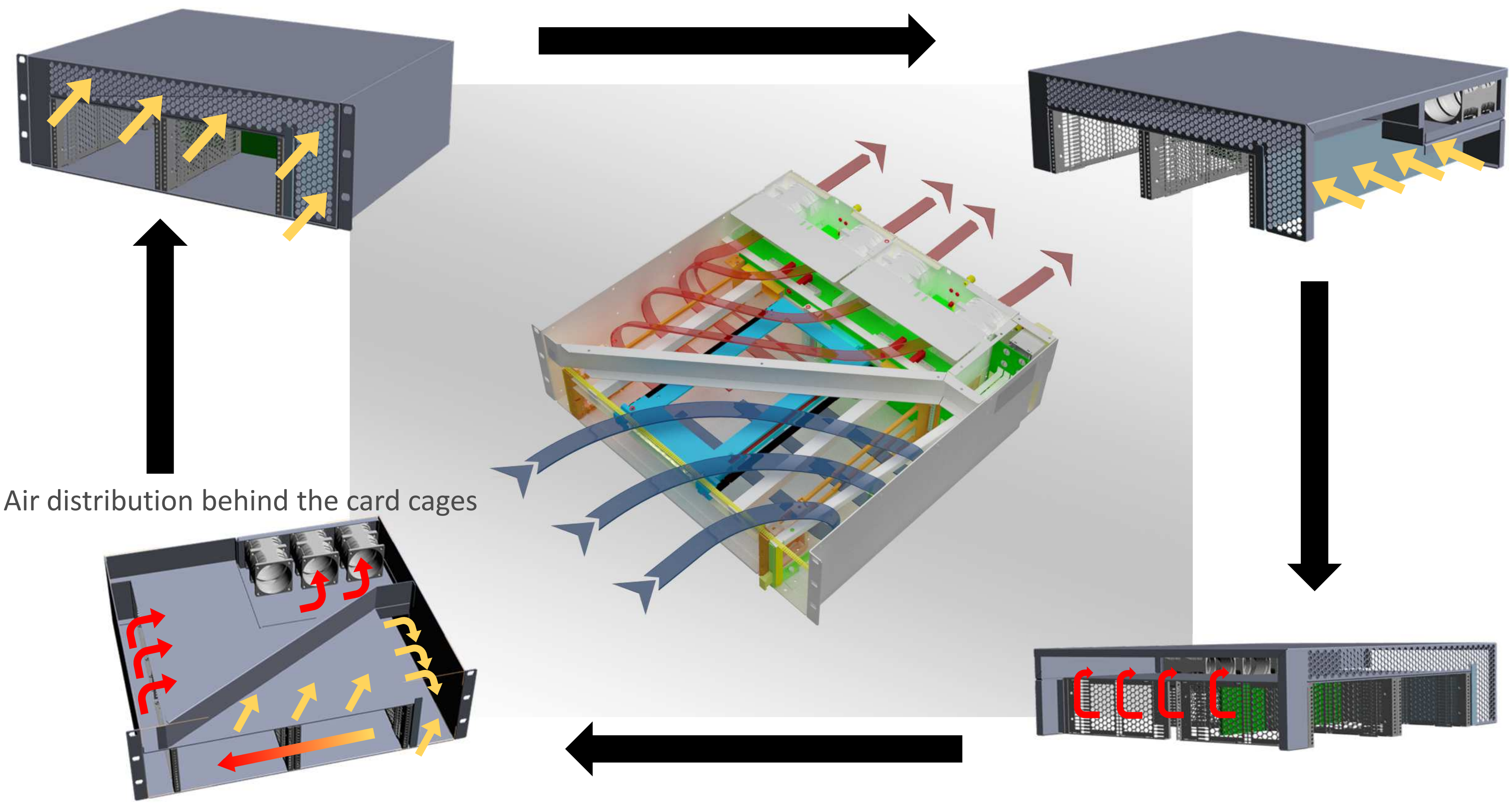
- 3U MTCA.4 system with horizontal card cage and front to rear cooling
- 4 double Mid-size AMC slots with double Mid-size RTM slots
- 1 double Full-size and one double Mid-size AMC slot
- 1 double Full-size MCH slot with double Full-size RTM
- 2 rear pluggable double Full-size PM slot
- 1 rear accessable JSM module





COOLING CONCEPT 3U CRATE

Air inlet area



Air distribution behind the card cages

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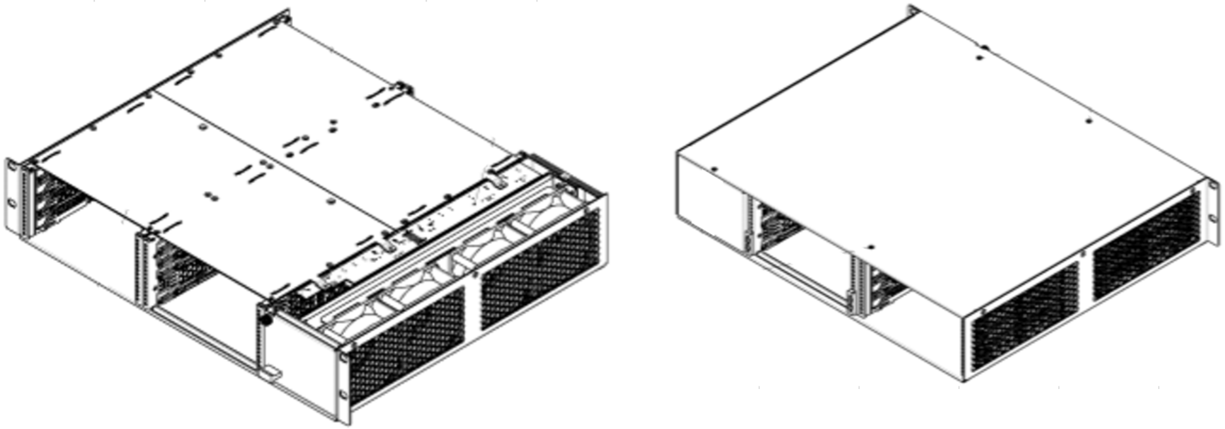
MTCA.4 CRATE

MTCA.4 19” SYSTEMS 2U FOR HORIZONTAL ASSEMBLY OF THE AMC MODULES

- Customized solution for:
  - Six horizontally-mounted AMC mid-size (five double mid-size and one double full-size),
  - Max. five MicroRTMs double mid-size
  - One JTAG switch module (JSM)
  - One power module double full-size
  - One MCH
  - One MCH-RTM
- Cooling from right to left side with one cooling unit



Thank You