xTCA Evaluation Project Update

8th xTCA Interest Group
CERN 17/03/2014

Collaboration (CERN PH-ESE-BE)
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Sylvain Mico and Francois Vasey

Outline

- Introduction
- MicroTCA evaluation
- AdvancedTCA evaluation
- Conclusions & Questions

Introduction

- **At CERN the first xTCA systems are being installed during the current Long Shutdown (LS1) while larger quantities are planned for the Long Shutdown 2 (2018).**

  MicroTCA: CMS

  ATCA: ATLAS and potentially LHCb & Alice

- **xTCA evaluation project in Electronics support group for experiments (PH-ESE) group launched in 2011**
  - Technical evaluation of components for **MicroTCA** and **ATCA** systems as well as AC/DC rectifiers
  - Development of tools (H/W and S/W) for the testing of commercial components
  - Conduct market surveys
  - Report and share results (xTCA Interest Group)

- **Next phase**
  - Try to standardize MicroTCA and ATCA shelves, power supplies, MCHs..
  - Define acceptance test procedures
  - Propose a selected set of equipment to the experiments
  - Provide centralized support for these items

Introduction – MicroTCA Equipment (1/2)

MicroTCA Crates

Vadatech MTCA.0
VT892

Schroff MTCA.4
11890

Schroff MTCA.4 + AC/DC CM100

ELMA MTCA.4
043-012

Power Modules (PM)

NAT DC780
792W

Vadatech UTC010
792W

Wiener AC/DC
Prototype, 800W

MicroTCA Carrier Hubs (MCH)

Vadatech
UTC001

NAT

Kontron
AM4904

AMCs

ELMA Load Board

Processor
Kontron AM5030

ESD ADIO24

Processor
CCT AM310

Introduction – MicroTCA Equipment (2/2)

MicroTCA Crates

Vadatech MTCA.0
VT892

Schroff MTCA.4
11890

Schroff MTCA.4 + AC/DC CM100

ELMA MTCA.4
043-012

NEW **ELMA MTCA.4**
045-821

NEW **ELMA Blu!Eco**

Power Modules (PM)

NEW **NAT DC840**
840W

Vadatech UTC010
792W

NEW **Wiener AC/DC**
1000W

NEW **Telkoor AC/DC**
600W

MicroTCA Carrier Hubs (MCH)

Samway

Vadatech
UTC001

NAT

Kontron
AM4904

AMCs

ELMA Load Board

Processor
Kontron AM5030

ESD ADIO24

Processor
CCT AM310

Introduction – AdvancedTCA Equipment

AdvancedTCA Crates

Schroff 14-slot 13U ATCA
11596-150

ASIS 14-slot 13U ATCA
144D422

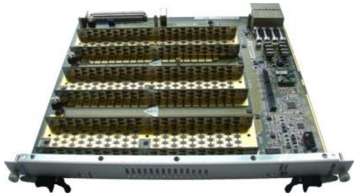
NEW

ELMA 14-slot 13U ATCA
190186

AdvancedTCA blades

Kontron AMC Carrier
AT8901M

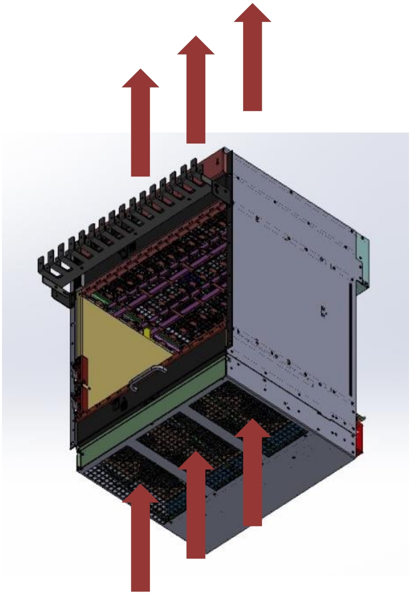
Comtel load boards
(Front and rear)



Introduction – Custom designs under development

AdvancedTCA

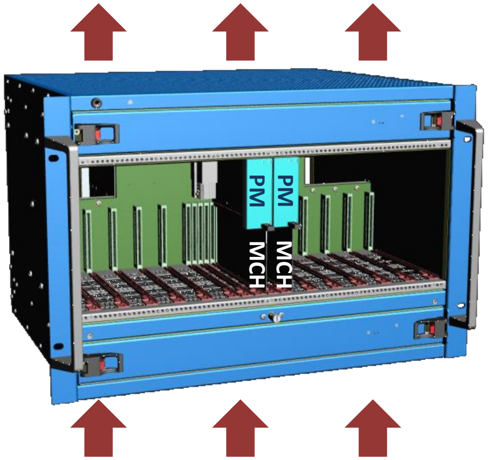
- Commercially available shelves implement a front-bottom to rear-top airflow
- In order to adapt the ATCA shelves cooling to the existing rack cooling system a modification of the mechanics is required
- Vertically cooled shelf under development

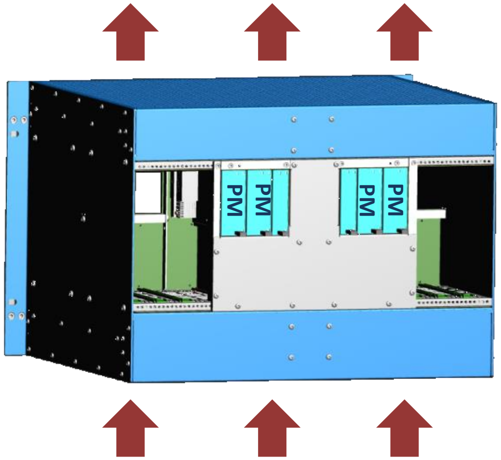


ATCA vertically cooled shelf

MicroTCA

- 12 full size-double width AMCs, six RTMs, six PMs and two MCHs
- Fully redundant and fully loaded
- Vertical cooled





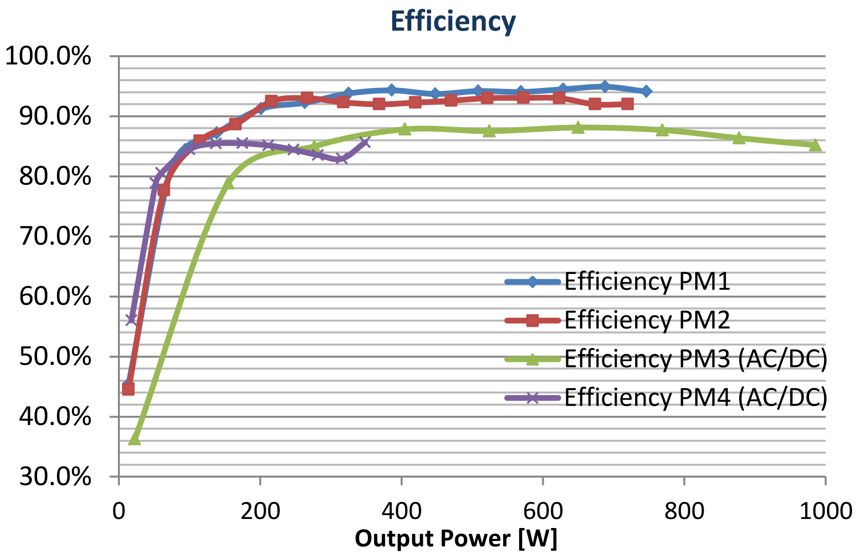
Introduction – Tests Performed

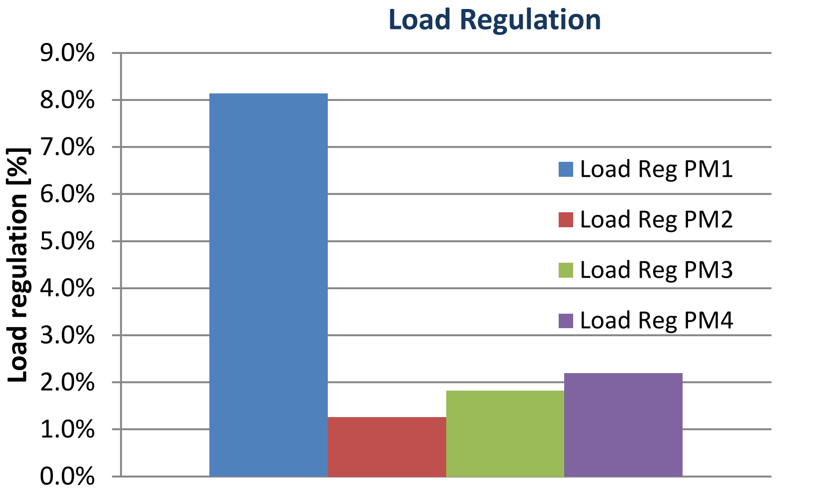
	MicroTCA	ATCA
Electrical tests	- Static regulation - Dynamic regulation - Ripple and noise - Efficiency and PF - Overcurrent protection	
	- AC/DC rectifiers	- AC/DC rectifiers
Cooling and mechanics	- Cooling performance - Mechanical aspect and layout - Backplane alignment	- Cooling performance - Mechanical aspect and layout
Software (IPMI)	- IPMI interoperability tests - IPMI conformity - Load sharing configuration	- IPMI interoperability tests - IPMI conformity

Outline

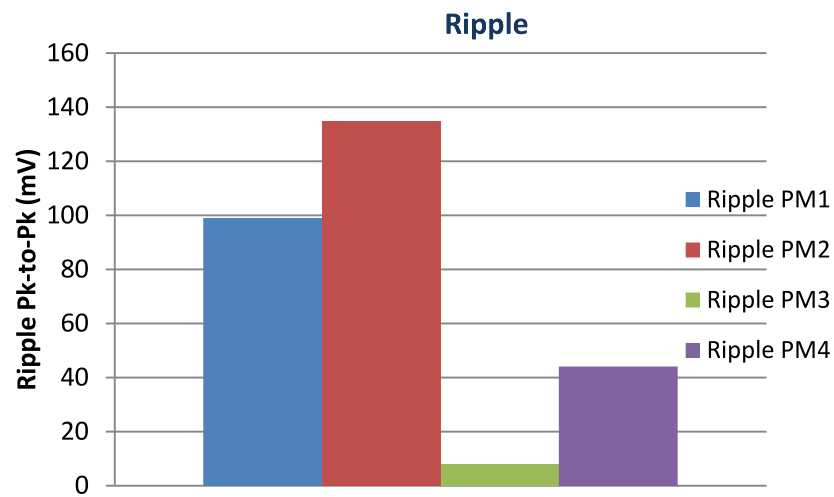
- Introduction
- **MicroTCA evaluation**
  - Power Modules
  - Schelves
  - Interoperability
- AdvancedTCA evaluation
- Conclusions & Questions

MicroTCA evaluation (1/4) – Power Modules





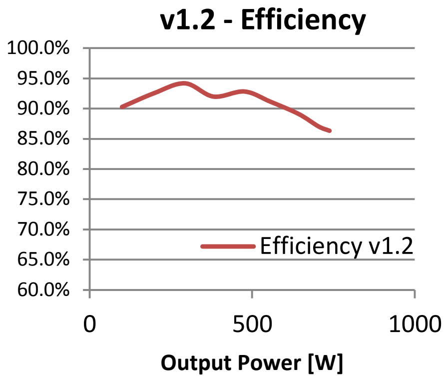
- $\eta = \frac{P_{out}}{P_{in}}$
- $\% \, Load \, Regulation = 100\% \, \frac{V_{NOM} - V_{max \, LOAD}}{V_{NOM}}$
- Ripple measured at 90% of full load



MicroTCA evaluation (2/4) – Power Modules

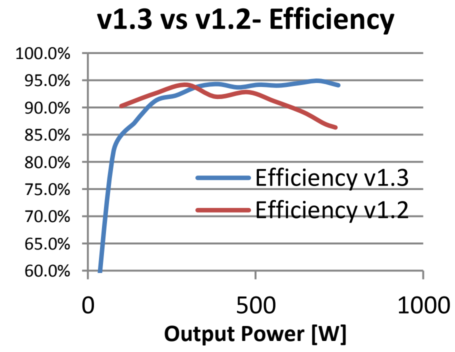
PM1 v1.2

	Test Conditions	Measured	PM Specs
Maximum Power	Vi=-48V	730W	780W
Input Voltage		-48V to -53V	-40V to -60V
Load Regulation	Full power	8.6%	10%
Line Regulation	Full load, Vin: -40V to -53V	2mV (max) before failure	Not reported
Efficiency	Vi = -48V, 1-100% of full power	94% (max)	95.5% (min)
Ripple	Full power	20mV	Not reported
Voltage transient deviation	Load step from 25% to 75% of full load	±0.5V	Not reported



PM1 v1.3

	Test Conditions	Measured	PM Specs
Maximum Power	Vi=-48V	780W	780W
Input Voltage		-40V to -60V	-40V to -60V
Load Regulation	Full power	8.6%	10%
Line Regulation	Full load, Vin: -40V to -53V	2mV (max)	Not reported
Efficiency	Vi = -48V, 1-100% of full power	94% (max)	95.5% (min)
Ripple	Full power	20mV	Not reported
Voltage transient deviation	Load step from 25% to 75% of full load	±0.5V	Not reported

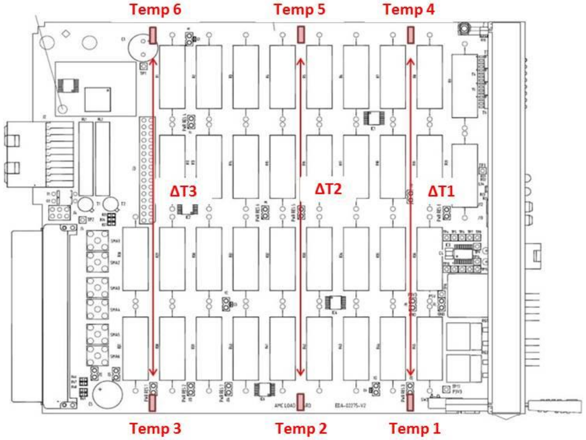


MicroTCA evaluation (3/4) - Shelves

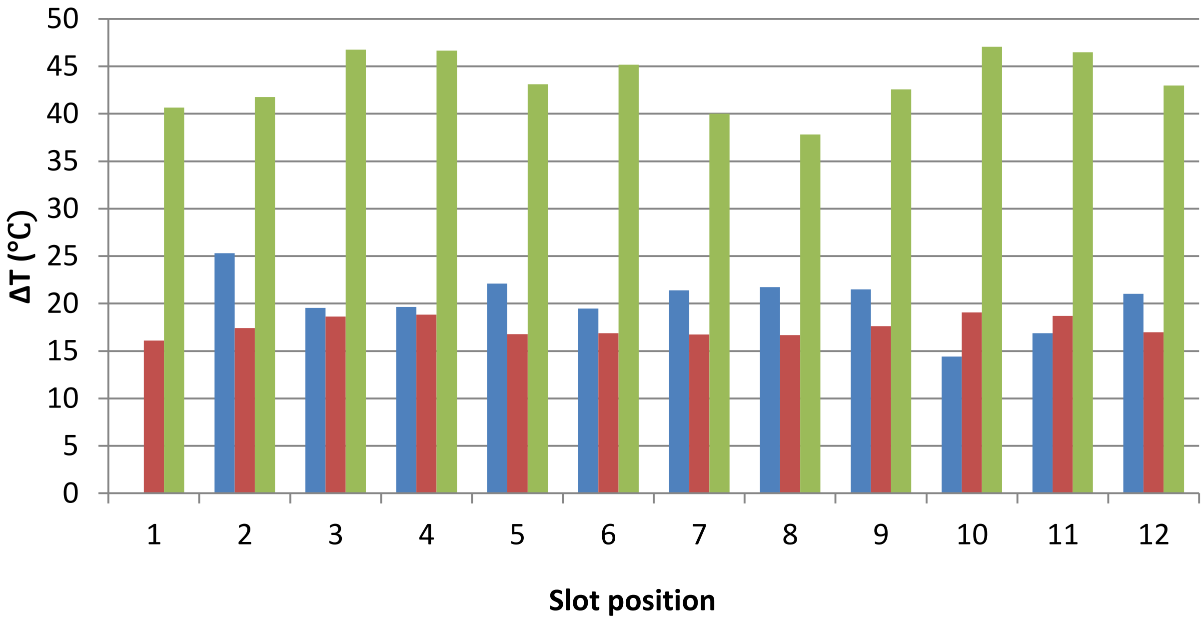
The aim is to evaluate the maximum vertical temperature variation and cooling homogeneity between AMC and **RTM slots.**

- Load modules configured to dissipate their maximum power
- Fans are driven at maximum speed
- Temperature is sensed in six points

AMC Load Board



AMC vertical temperature variation



	Fans specs	Max delta
Shelf1	CFM 60 x 10	AMC 25 °C
Shelf2	CFM 171 x 3 (AMC) CFM 130 x 2 (RTM)	AMC: 19 °C RTM: 14 °C
Shelf3	CFM 100 x 3 (AMC) CFM 100 x 3 (RTM)	AMC: 47 °C RTM: 23 °C

MicroTCA evaluation (4/4) – Interoperability

Example: Load Sharing Topology

- Required to fully load the crate
- More than one Primary PM
- Each PM powers a defined set of FRUs
- Load configuration defined in Backplane FRU Info

Power Module	PM Role	FRUs
PM1	Primary	MCH1, CU1, AMC1 to AMC6
PM2	Primary	MCH2, CU2, AMC7 to AMC12

- Proper operation of the system depends on components used and FW versions
- Several equipment combinations tested (Shelves, MCHs, PMs)
- Some no-systematic issues encountered
- Significant improvements

Name	Value	Format
Record Type ID	OEM Record	Predefined
EOL / Record version	02	Hexadecimal
Manufacturer ID	12634	Decimal
OEM Record ID	Carrier Power Policy Record	Predefined
Record Format Version	00	Hexadecimal
Number of PMs	2	Decimal
Power Policy Descriptor No.1	-	String
1: PM Site Number	1	Decimal
1: Maximum Current Override	E803	Hexadecimal
1: PM Role	Primary PM	Predefined
1: Power Channel Count	8	Decimal
1.1: Power Channel	1	Decimal
1.2: Power Channel	3	Decimal
1.3: Power Channel	5	Decimal
1.4: Power Channel	6	Decimal
1.5: Power Channel	7	Decimal
1.6: Power Channel	8	Decimal
1.7: Power Channel	9	Decimal
1.8: Power Channel	10	Decimal
Power Policy Descriptor No.2	-	String
2: PM Site Number	2	Decimal
2: Maximum Current Override	03E8	Hexadecimal
2: PM Role	Primary PM	Predefined
2: Power Channel Count	8	Decimal
2.1: Power Channel	2	Decimal
2.2: Power Channel	4	Decimal
2.3: Power Channel	11	Decimal
2.4: Power Channel	12	Decimal
2.5: Power Channel	13	Decimal
2.6: Power Channel	14	Decimal
2.7: Power Channel	15	Decimal
2.8: Power Channel	16	Decimal

Power Policy Record editing in NatView

MicroTCA PM Test Pad (1/2)

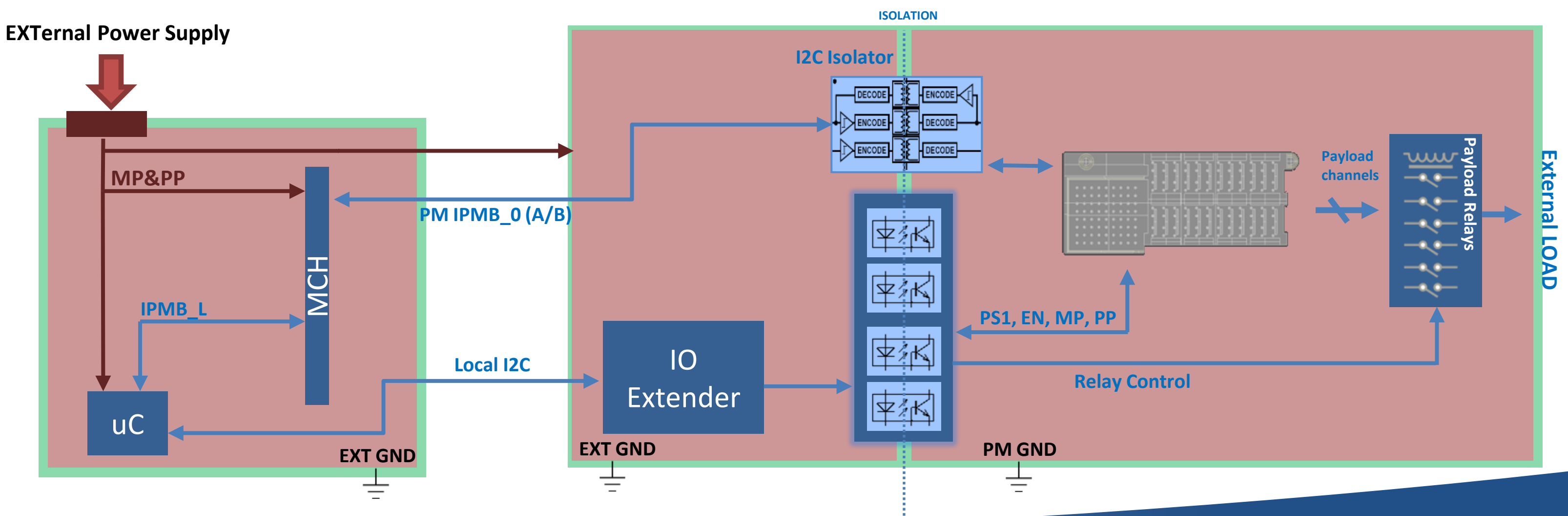
So far the test architecture consisted of

- Commercial crate where load modules were hosted and used to perform test
- Load Sharing Topology: PM under test assigned to AMC slots. Auxiliary PM used to power CUs and MCH.

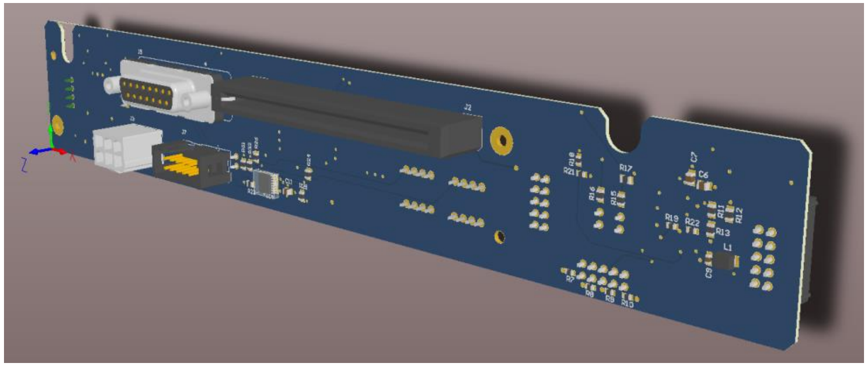
Limitation:

- Backplane influence on measurements (Ripple and noise are influenced by CU and shelf)
- The test is limited to the 12 AMC channels since the CU and MCH channels cannot be easily measured in a crate
- In the perspective of performing EMC measurements, this setup is not suitable for this kind of measurements
- Full automatic test procedure not possible

❑ **Design a stand-alone test device to perform automatically static and dynamic regulation tests, efficiency and ripple and noise measurements.**



MicroTCA PM Test Pad (2/2)

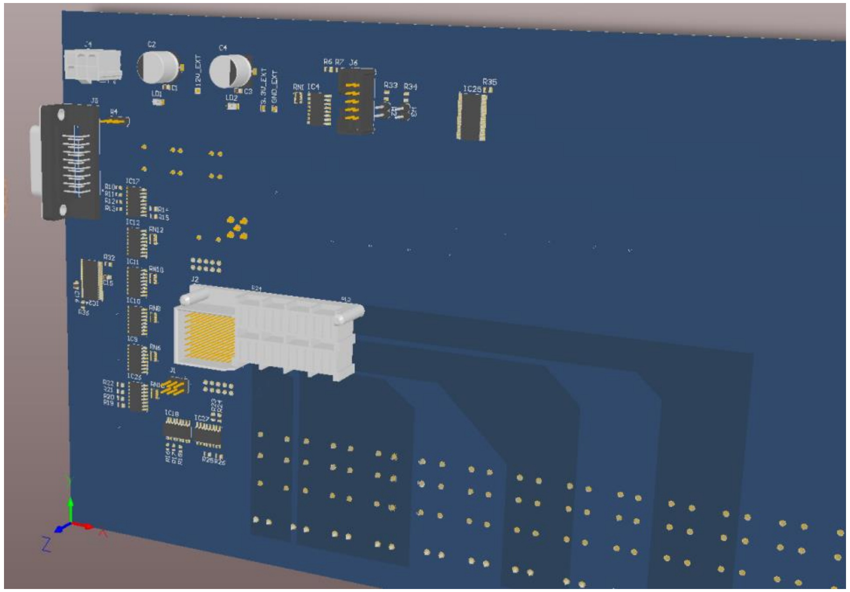


MCH PCB CAD view

Ready for manufacturing

The test pad will provide:

- Shelf environment simulation
- Isolation between PM and test control circuitry
- PP and MP voltages measurement features
- Connection to an external electronic load
- EMC measurements features (EMI receiver)
- Noise rejection ratio across channels
- IPMB-0 Analyzer
- Cooling



Power Module PCB CAD view

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- ❑ Introduction
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- ❑ **AdvancedTCA evaluation**
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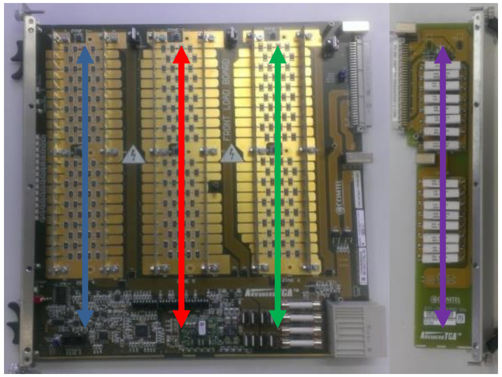
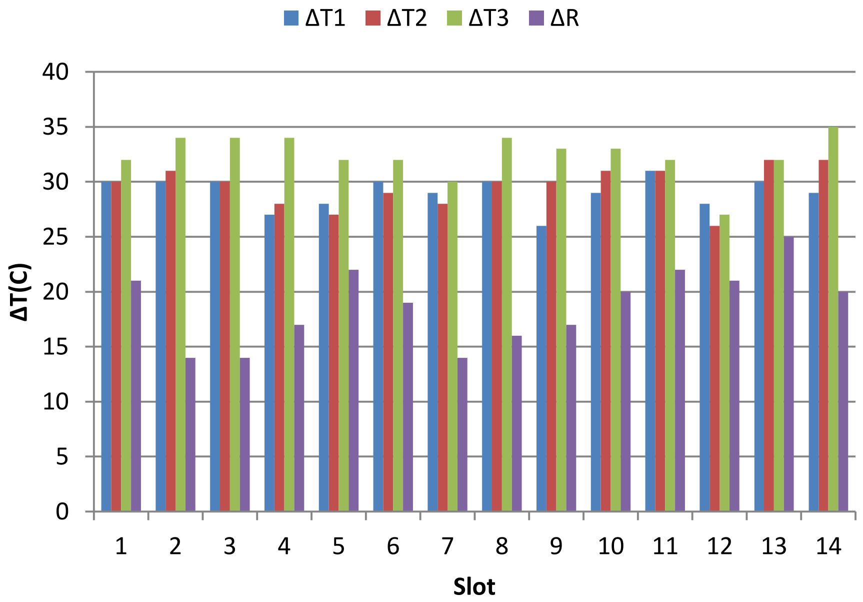
ATCA Evaluation

➢ Test is performed with fans at maximum speed and:
- 250W for front modules (Power Entry Module limitation)
- 50W for rear modules

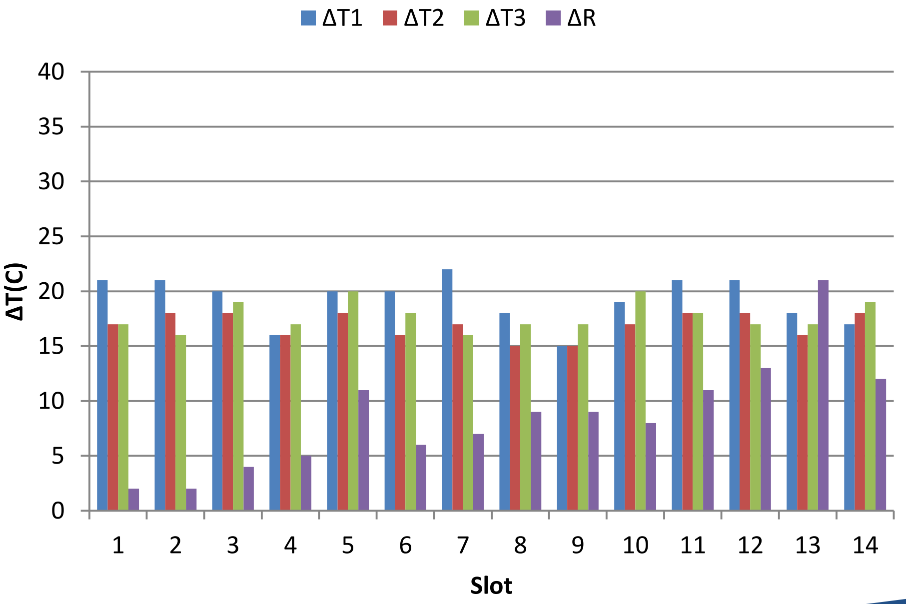


Load boards

Chassis1 MAX front ΔT = **35 °C**



Chassis2 MAX front ΔT = **23°C**



ATCA Evaluation – Specific case study


(1)

ATLAS is using a 6 slots ATCA shelf as single instance infrastructure for the trigger upgrade.

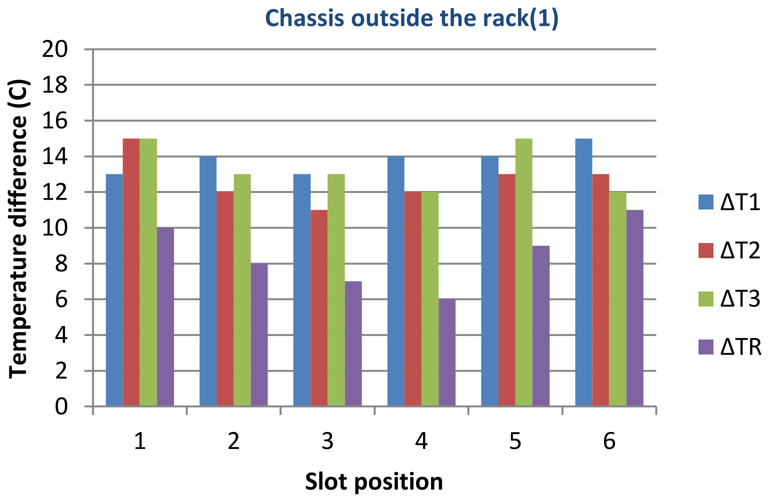
- Shelf airflow direction is horizontal (left to right)
- The shelf will be located on the bottom side of the LHC rack
- Outside the turbine circulation

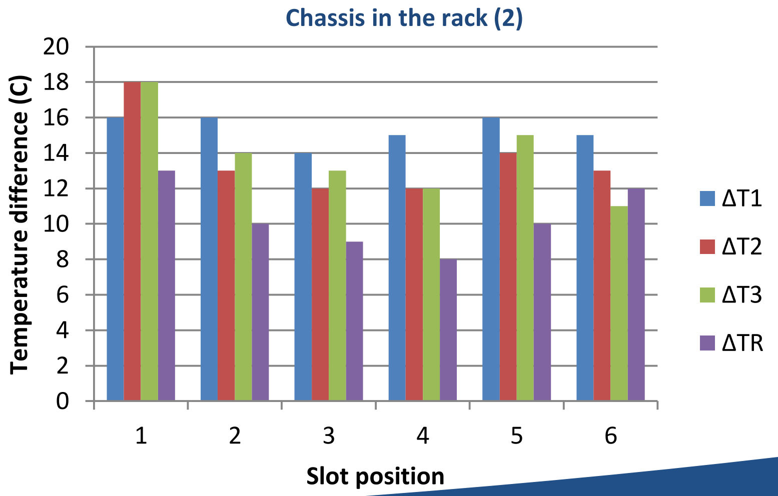

(2)

Test has been carried out on the table and inside the rack with the following load conditions:

- 250W on each slot (200W front, 50W rear)
- 350W on three slot (300W front, 50W rear)

Test showed that the temperature increase in the two cases was not excessive **(+ 4°C)**
However, it should not be scaled to full system.





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Conclusions

Results obtained

- Detailed test procedures defined
- Test systems developed (Modules, systems and software)
- xTCA standards, systems and equipment know-how gained
- Comprehensive set of tests performed for MicroTCA: crates, PMs and MCH and ATCA.
- Interaction with manufacturers (HW and SW modifications introduced)
- Detailed evaluation reports published
  (https://espace.cern.ch/ph-dep-ESE-BE-uTCAEvaluationProject/default.aspx)

Lessons learned

- Some new products lacking maturity in MicroTCA format
- Good communication with vendor support is essential

Evaluation program ongoing

- PMs, MCHs, Shelves
- PM Test Pad, DESY MMC, LAPP ANNECY IPMC

New project phase launched

- Make equipment recommendations
- Define technical specifications jointly with experiments in view of future equipment purchase and maintenance
- Make reference equipment available to users for evaluation
- Provide support service and tools to the xTCA community

Thank you

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Useful links

- MicroTCA Evaluation Repository https://espace.cern.ch/ph-dep-ESE-BE-uTCAEvaluationProject/default.aspx
- ATCA Evaluation Repository https://espace.cern.ch/ph-dep-ESE-BE-ATCAEvaluationProject/SitePages/Home.aspx
- PICMG Website http://www.picmg.org/
- MicroTCA Short Form Specification http://www.picmg.org/pdf/MicroTCA_Short_Form_Sept_2006.pdf
- AMC Short Form Specification http://www.picmg.org/pdf/AMC.0_R2.0_Short_Form.pdf
- ATCA Short Form Specification http://www.picmg.org/pdf/PICMG_3_0_Shortform.pdf
- IPMI, IPMB Specification http://www.intel.com/content/www/us/en/servers/ipmi/ipmi-specifications.html
- Polaris Tester http://www.polarisnetworks.net/atca-test-tool.html