Evaluation results of xTCA equipment for HEP experiments at CERN

Topical Workshop on Electronics for Particle Physics
Perugia 24/9/2013

Collaboration (CERN PH-ESE-BE)
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PH-ESE-BE

Outline

Introduction
- xTCA Evaluation Project
- Tests performed

MicroTCA evaluation
- MicroTCA Equipment
- Test tools and setup
- Test results
- Summary

ATCA evaluation
- ATCA Equipment
- Test tools and setup
- Test results
- Summary

Conclusions

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ATCA evaluation

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Conclusions

- **The MicroTCA and AdvancedTCA industry standards are candidate platforms for modular electronics for the upgrade of the current generation of high energy physics experiments.**

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

- **Technical evaluation of AC/DC converters**

- **Longer term goal**
  - 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

Tests Performed

Today

	MicroTCA	ATCA	AC/DC PSU
Electrical tests	- Static regulation - Dynamic regulation - Ripple and noise - Efficiency and PF - Overcurrent protection		xTCA Interest Group Thursday 26
Cooling and mechanics	- Cooling performance - Mechanical aspect and layout - Backplane alignment	- Cooling performance - Mechanical aspect and layout	
Software (IPMI)	- IPMI interoperability tests - IPMI conformity	- IPMI interoperability tests - IPMI conformity	

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Conclusions

MicroTCA Crates

Vadatech VT892 MTCA.0

ELMA 043-012 MTCA.4

Schroff MTCA.4 11890

Schroff MTCA.4 + AC/DC CM100

Power Modules (PM)

NAT DC780 (792W)

Vadatech UTC010 (792W)

Wiener AC/DC (Prototype, 800W)

MicroTCA Carrier Hubs (MCH)

Samway

Vadatech UTC001

NAT

Kontron AM4904

AMCs

ELMA Load Board

Processor Kontron AM5030

ESD ADIO24

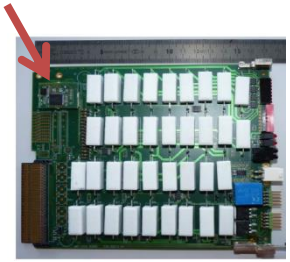
Processor CCT AM310

➢ **AMC** and **RTM** load modules developed in-house based on switched resistive loads

- Control via **MMC ,** based on code received by DESY
- Used for power supply and cooling performance measurements

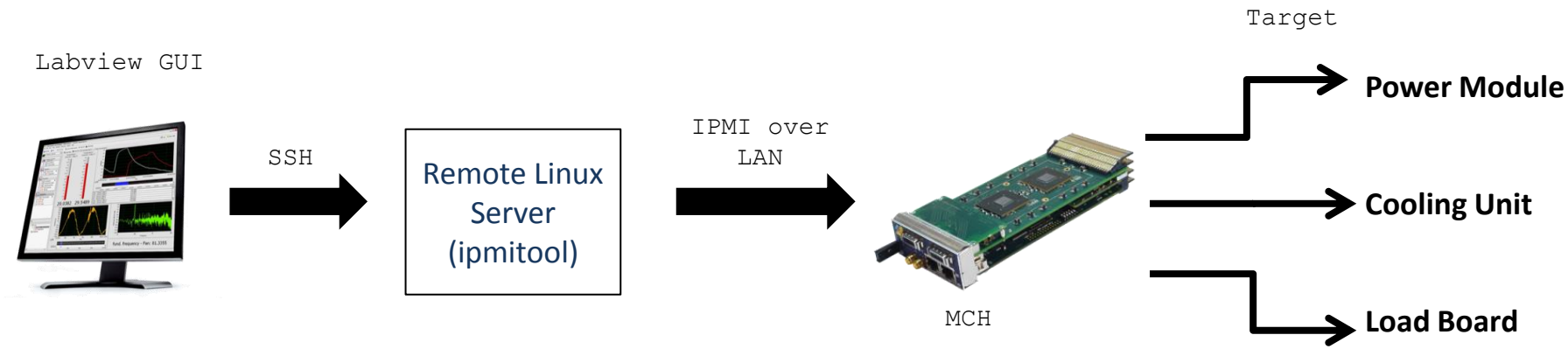
MMC

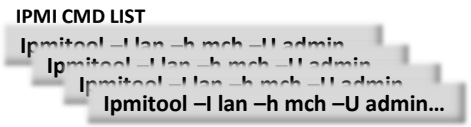
RTM Load Board

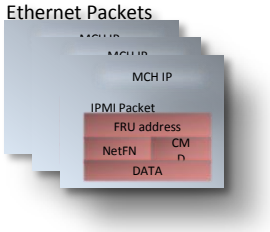


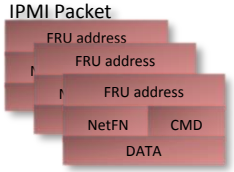
AMC Load Board

➢ IPMITOOL based Labview interface to communicate with load boards and components

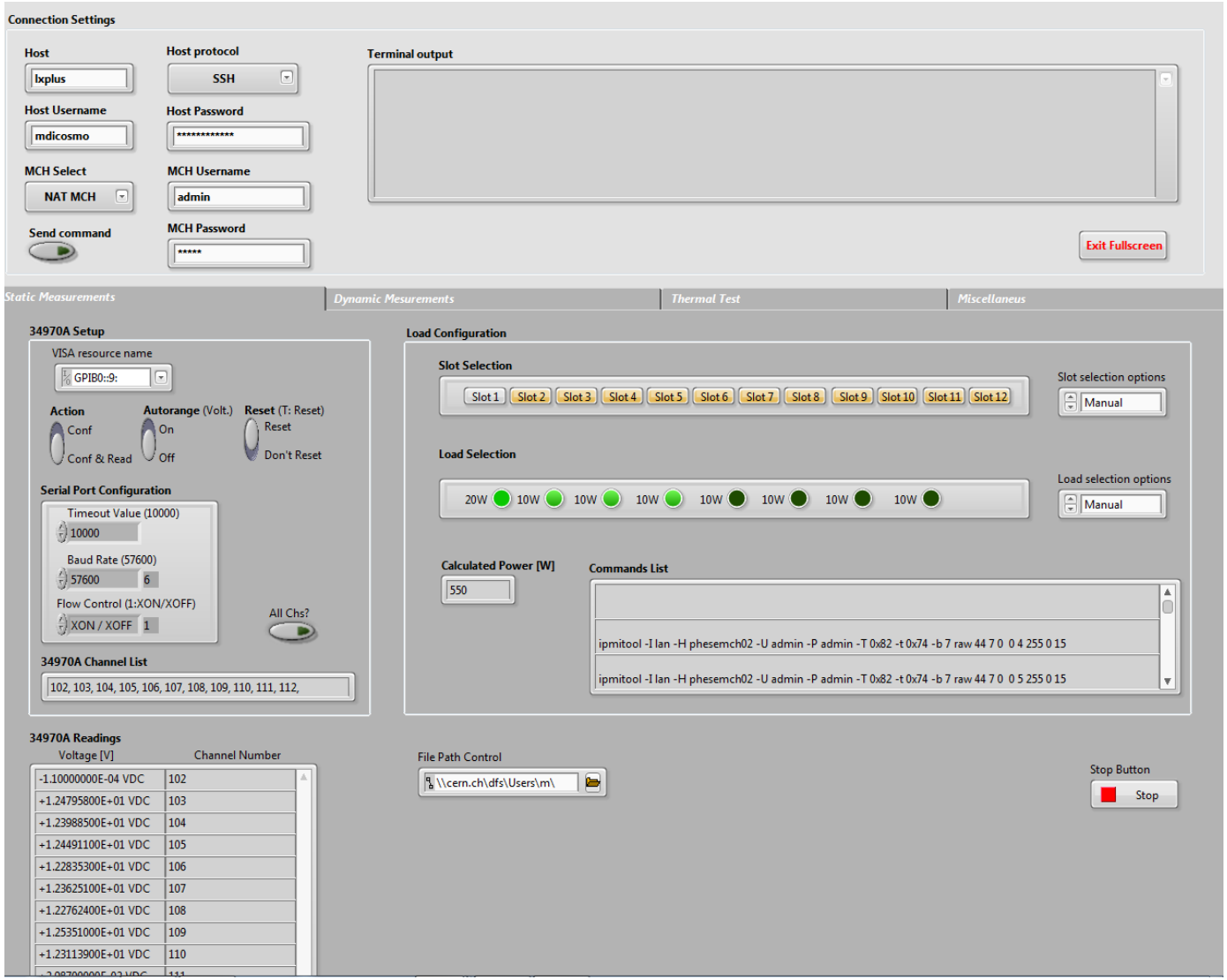






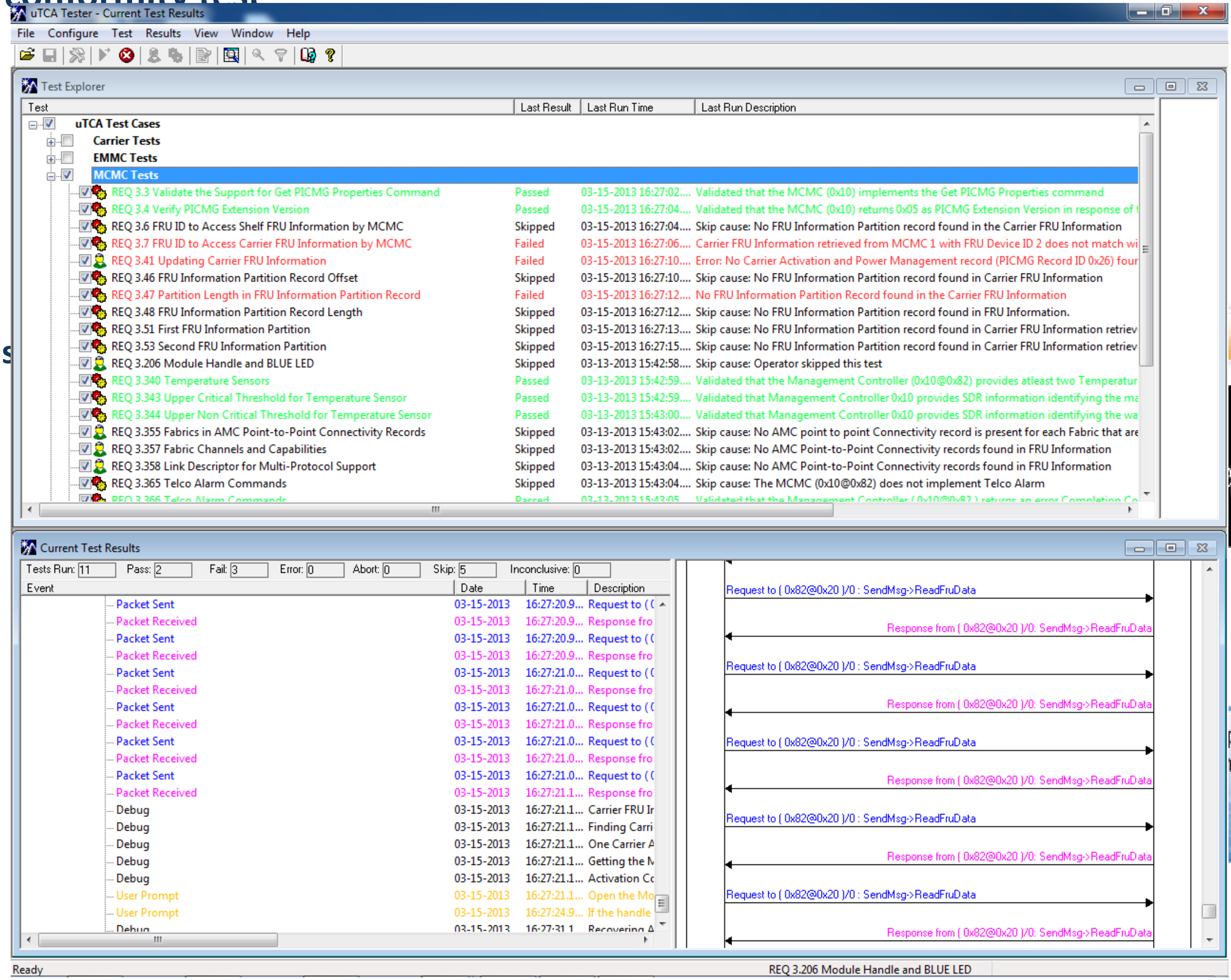


Labview test GUI



IPMI conformity test

Polaris



Test	Last Result	Last Run Time	Last Run Description
☑ uTCA Test Cases			
☐ Carrier Tests			
☐ EMMC Tests			
☑ MCMC Tests			
☑ REQ 3.3 Validate the Support for Get PICMG Properties Command	Passed	03-15-2013 16:27:02....	Validated that the MCMC (0x10) implements the Get PICMG Properties command
☑ REQ 3.4 Verify PICMG Extension Version	Passed	03-15-2013 16:27:04....	Validated that the MCMC (0x10) returns 0x05 as PICMG Extension Version in response of
☑ REQ 3.6 FRU ID to Access Shelf FRU Information by MCMC	Skipped	03-15-2013 16:27:04....	Skip cause: No FRU Information Partition record found in the Carrier FRU Information
☑ REQ 3.7 FRU ID to Access Carrier FRU Information by MCMC	Failed	03-15-2013 16:27:06....	Carrier FRU Information retrieved from MCMC 1 with FRU Device ID 2 does not match wi
☑ REQ 3.41 Updating Carrier FRU Information	Failed	03-15-2013 16:27:10....	Error: No Carrier Activation and Power Management record (PICMG Record ID 0x26) four
☑ REQ 3.46 FRU Information Partition Record Offset	Skipped	03-15-2013 16:27:10....	Skip cause: No FRU Information Partition record found in Carrier FRU Information
☑ REQ 3.47 Partition Length in FRU Information Partition Record	Failed	03-15-2013 16:27:12....	No FRU Information Partition Record found in the Carrier FRU Information
☑ REQ 3.48 FRU Information Partition Record Length	Skipped	03-15-2013 16:27:12....	Skip cause: No FRU Information Partition record found in FRU Information.
☑ REQ 3.51 First FRU Information Partition	Skipped	03-15-2013 16:27:13....	Skip cause: No FRU Information Partition record found in Carrier FRU Information retriev
☑ REQ 3.53 Second FRU Information Partition	Skipped	03-15-2013 16:27:15....	Skip cause: No FRU Information Partition record found in Carrier FRU Information retriev
☑ REQ 3.206 Module Handle and BLUE LED	Skipped	03-13-2013 15:42:58....	Skip cause: Operator skipped this test
☑ REQ 3.340 Temperature Sensors	Passed	03-13-2013 15:42:59....	Validated that the Management Controller (0x10@0x82) provides atleast two Temperatur
☑ REQ 3.343 Upper Critical Threshold for Temperature Sensor	Passed	03-13-2013 15:42:59....	Validated that Management Controller 0x10 provides SDR information identifying the ma
☑ REQ 3.344 Upper Non Critical Threshold for Temperature Sensor	Passed	03-13-2013 15:43:00....	Validated that Management Controller 0x10 provides SDR information identifying the wa
☑ REQ 3.355 Fabrics in AMC Point-to-Point Connectivity Records	Skipped	03-13-2013 15:43:02....	Skip cause: No AMC point to point Connectivity record is present for each Fabric that are
☑ REQ 3.357 Fabric Channels and Capabilities	Skipped	03-13-2013 15:43:02....	Skip cause: No AMC Point-to-Point Connectivity records found in FRU Information
☑ REQ 3.358 Link Descriptor for Multi-Protocol Support	Skipped	03-13-2013 15:43:04....	Skip cause: No AMC Point-to-Point Connectivity records found in FRU Information
☑ REQ 3.365 Telco Alarm Commands	Skipped	03-13-2013 15:43:04....	Skip cause: The MCMC (0x10@0x82) does not implement Telco Alarm
☑ REQ 3.366 Telco Alarm Commands	Passed	03-13-2013 15:43:05	Validated that the Management Controller (0x10@0x82) returns an error Completion Co

Tests Run: 11 Pass: 2 Fail: 3 Error: 0 Abort: 0 Skip: 5 Inconclusive: 0

Event	Date	Time	Description
Packet Sent	03-15-2013	16:27:20.9...	Request to ((
Packet Received	03-15-2013	16:27:20.9...	Response fro
Packet Sent	03-15-2013	16:27:20.9...	Request to ((
Packet Received	03-15-2013	16:27:20.9...	Response fro
Packet Sent	03-15-2013	16:27:21.0...	Request to ((
Packet Received	03-15-2013	16:27:21.0...	Response fro
Packet Sent	03-15-2013	16:27:21.0...	Request to ((
Packet Received	03-15-2013	16:27:21.0...	Response fro
Packet Sent	03-15-2013	16:27:21.0...	Request to ((
Packet Received	03-15-2013	16:27:21.0...	Response fro
Packet Sent	03-15-2013	16:27:21.0...	Request to ((
Packet Received	03-15-2013	16:27:21.1...	Response fro
Debug	03-15-2013	16:27:21.1...	Carrier FRU Ir
Debug	03-15-2013	16:27:21.1...	Finding Carri
Debug	03-15-2013	16:27:21.1...	One Carrier A
Debug	03-15-2013	16:27:21.1...	Getting the M
Debug	03-15-2013	16:27:21.1...	Activation Cc
User Prompt	03-15-2013	16:27:21.1...	Open the Mo
User Prompt	03-15-2013	16:27:24.9...	If the handle
Debug	03-15-2013	16:27:31.1	Recovering A

Request to (0x82@0x20)/0 : SendMsg->ReadFruData
Response from (0x82@0x20)/0: SendMsg->ReadFruData
Request to (0x82@0x20)/0 : SendMsg->ReadFruData
Response from (0x82@0x20)/0: SendMsg->ReadFruData
Request to (0x82@0x20)/0 : SendMsg->ReadFruData
Response from (0x82@0x20)/0: SendMsg->ReadFruData
Request to (0x82@0x20)/0 : SendMsg->ReadFruData
Response from (0x82@0x20)/0: SendMsg->ReadFruData
Request to (0x82@0x20)/0 : SendMsg->ReadFruData
Response from (0x82@0x20)/0: SendMsg->ReadFruData

PM test – First results obtained (Beginning of 2013)

Power modules

NAT DC780
HW v1.2

	Test Conditions	Measured	DC780 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

Shelves

Vadatech
UTC010
FW v3.0

	Test Conditions	Measured	UTC010 Specs
Maximum Power	Vi=-48V	600W	780W
Input Voltage		-38V to -53V	-36V to -75V
Load Regulation	Full power	1.2%	Not reported
Line Regulation	Full load, Vin: -38V to -53V	1.93V	Not reported
	Minimum load, Vin: -38V to -53V	1.22V	Not reported
Efficiency	Vi = -48V, 1-100% of full power	93% (max at 300W)	95% (full load)
Ripple	Full power	73mV	Not reported
	Minimum Power	700mV	Not reported
Voltage transient deviation	Load step from 25% to 75% of full load	±0.4V	Not reported

MCH

Wiener AC PM
Prototype

	Test Conditions	Measured	Wiener Specs
Maximum Power		800W	800W
Load Regulation	1-100% of full power	3.5%	Not reported
Efficiency	1-100% of full power	Not possible to measure	93% (min)
Power Factor		Not possible to measure	0.99
Ripple	Full power	10mV	<10mV Pk-to-Pk
Voltage transient deviation	Load step from 25% to 75% of full load	To be done	Not reported

PM test – New results obtained (July 2013)

- Communication with manufacturer: Efficiency, output power improvements

Power modules

Shelves

MCH

NAT DC780
HW v1.3
(Patch version)

	Test Conditions	Measured	DC780 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

Vadatech
UTC010
FW v.4.0

	Test Conditions	Measured	UTC010 Specs
Maximum Power	Vi=-48V	780W	780W
Input Voltage		-38V to -75V	-36V to -75V
Load Regulation	Full power	1.2%	Not reported
Line Regulation	Full load, Vin: -38V to -53V	1.93V	Not reported
	Minimum load, Vin: -38V to -53V	1.22V	Not reported
Efficiency	Vi = -48V, 1-100% of full power	93% (full load)	95% (full load)
Ripple	Full power	73mV	Not reported
	Minimum Power	700mV	Not reported
Voltage transient deviation	Load step from 25% to 75% of full load	±0.4V	Not reported

Wiener AC PM
Prototype

	Test Conditions	Measured	Wiener Specs
Maximum Power		800W	800W
Load Regulation	1-100% of full power	3.5%	Not reported
Efficiency	1-100% of full power	Not possible to measure	93% (min)
Power Factor		Not possible to measure	0.99
Ripple	Full power	10mV	<10mV Pk-to-Pk
Voltage transient deviation	Load step from 25% to 75% of full load	To be done	Not reported

new version
test pending

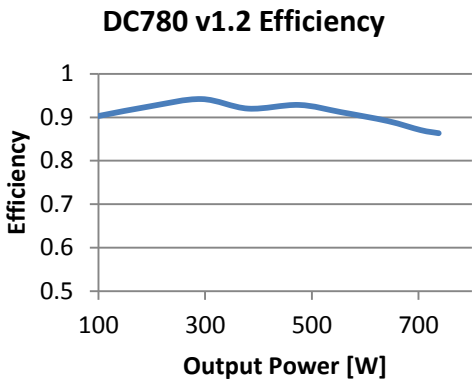
PM test results: Efficiency improvements

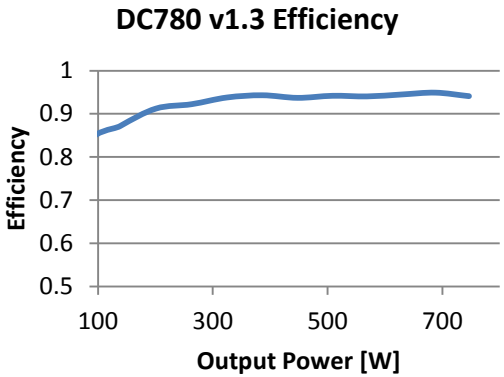
Power modules

Shelves

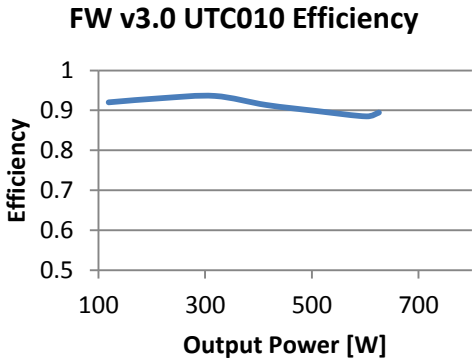
MCH

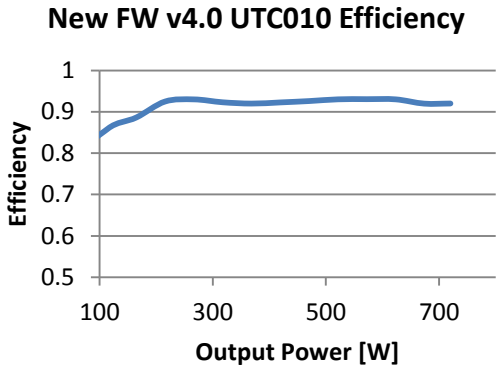
NAT DC780





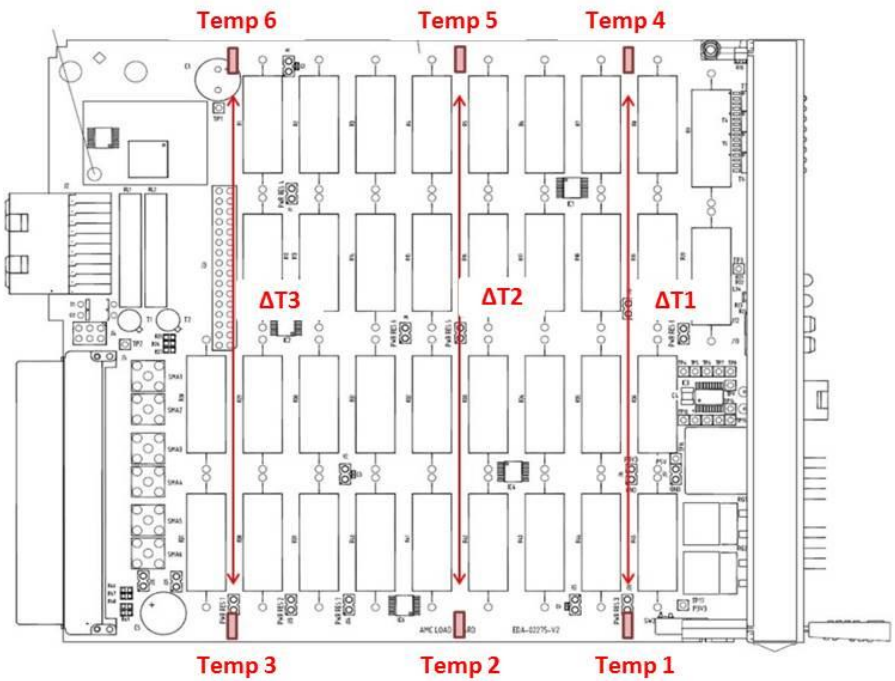
Vadatech UTC010



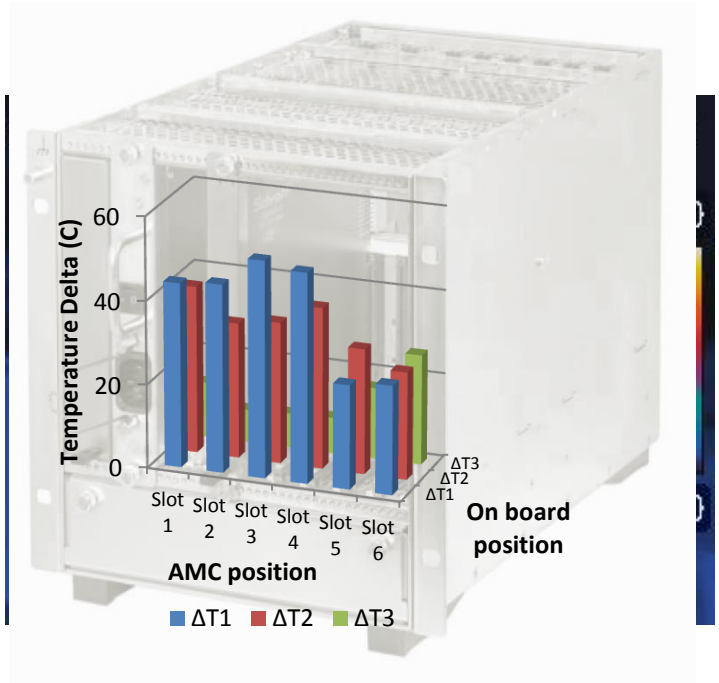


Cooling performance

- The aim is to evaluate the maximum temperature difference and the cooling homogeneity between slots
- Temperature measured on six different points on load boards



ALB temp sensors position



Cooling unit test results

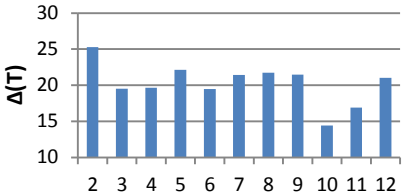
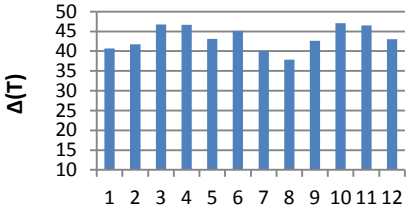
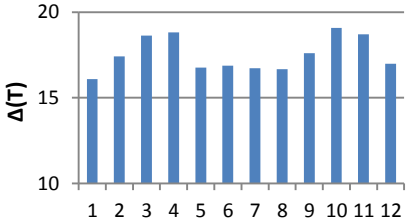
CFM Cubic Feet per Minute

- **AMC** and **RTM** load modules dissipating max power (90W AMC, 40W RTM)
  - Fans model and mechanical layout have significant impact on the cooling capability

Power modules

Shelves

MCH

Crate	AMC delta plot (Average)	Max delta (°C)
Vadatech VT892 (2PM, 2MCH, 12 AMC)		
		AMC 25 °C FAN spec.: CFM 60 x 10
ELMA 043-012 (4PM, 2MCH, 12 AMC,RTM)		
		AMC: 47 °C RTM: 23 °C FAN spec.: CFM 100 x 3
Schroff 11890-035 (4PM,2MCH,12 AMC,RTM)		
		**AMC: 19 °C** **RTM: 14 °C** FAN spec.: CFM 171 x 3

MCH test

- Interoperability tests
  - Several issues have been experienced mixing PMs and MCHs by different vendors
- IPMI conformity test
  - Polaris tester is a useful tool to predict interoperability problems
- MicroTCA.4 (MicroTCA for physics) support
  - NAT MCH, Vadatech UTC001 and Kontron AM49090 are MicroTCA.4 compliant
- MCH Command Line interface, configuration and management software are evaluated

MicroTCA Summary

Power Modules:

- Some non-conformities with technical specification have been found, reported and discussed with the manufacturer
- Significant efficiency improvement (>93%)
- Sometimes incomplete documentation provided by the manufacturer

Shelves

- Non-negligible difference regarding the cooling efficiency
- Different fan models across the manufacturers

MCH

- Complete interoperability between manufacturers seems to be far
- Some non-conformities with the IPMI standard have been found by Polaris Tester

- **New products sometimes lacking maturity**
- **Good communication and support with manufacturer is essential**

Outline

ATCA Crates

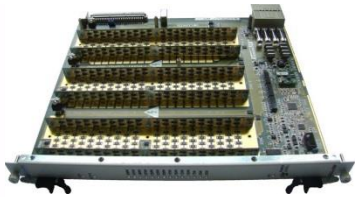
Schroff 14-slot 13U ATCA
11596-150

ASIS 14-slot 13U ATCA
144D422

ATCA boards

Kontron AMC Carrier
AT8901M

Comtel load boards
(Front and rear)



ATCA Evaluation

- Commercial load boards for thermal tests

- Front and rear boards
- IPMI controlled
- On board temperature monitoring

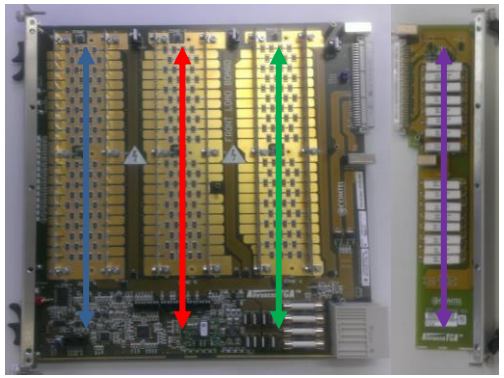
- IPMITOOL based Labview interface to communicate with load boards

COMTEL Front and rear boards

Schroff crate test setup

ATCA Evaluation: Schroff and ASIS crate

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



Load boards

Schroff crate

ASIS crate

ATCA Evaluation: Schroff and ASIS crate

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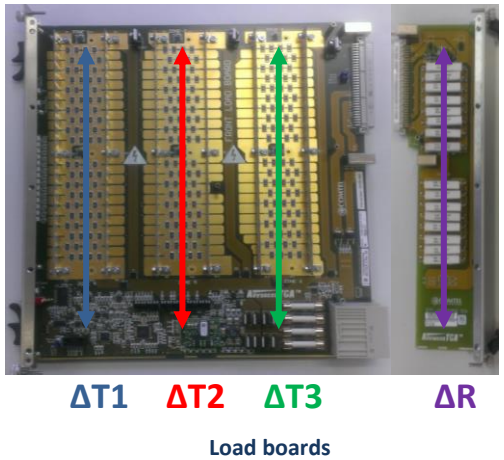
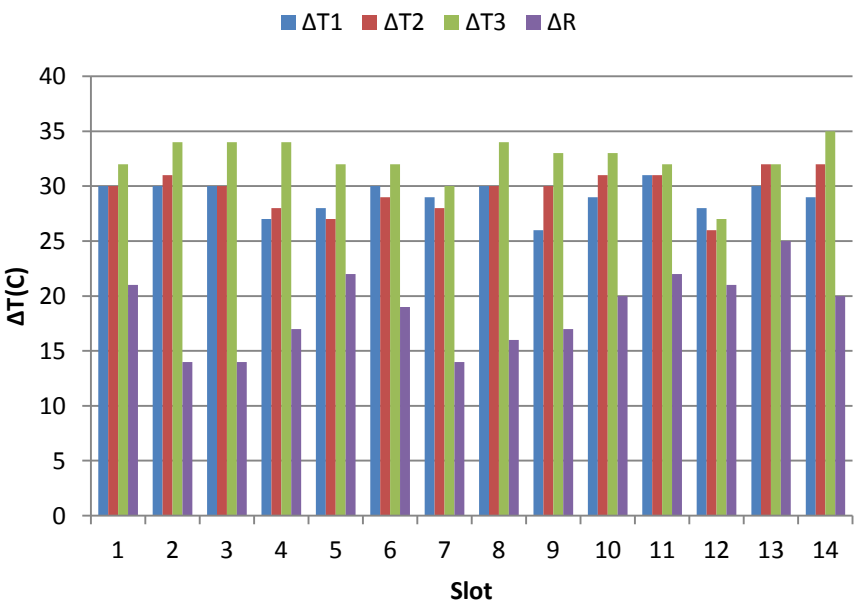
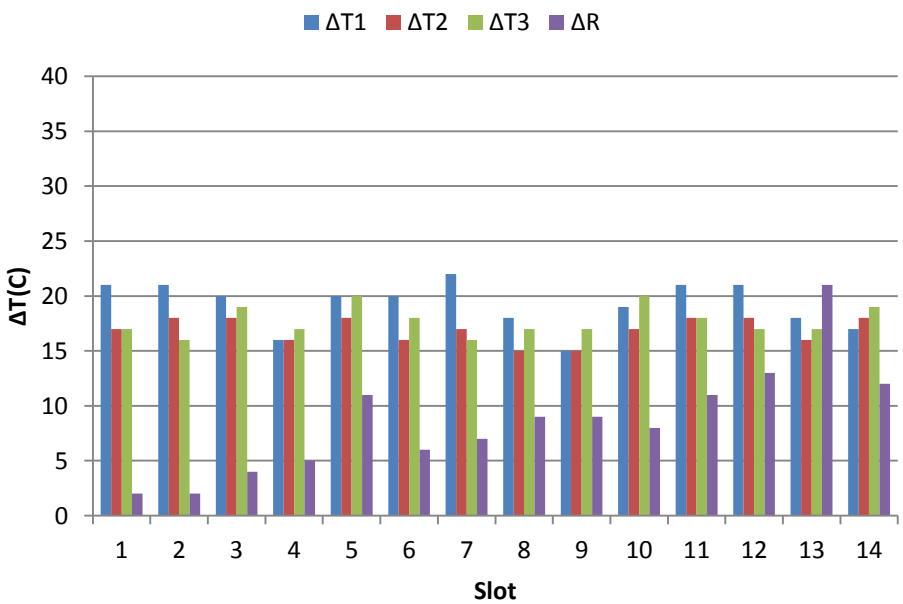
  - 50W for rear modules



Schroff crate MAX front ΔT = **35 °C**



ASIS crate MAX front ΔT = **23°C**



ATCA Summary

- Different cooling performance depending on number of fans, model and mechanical layout
- The maximum power per slot is limited by the Power Entry Module and backplane power distribution
- Both Shelf Manager based on Pigeon Point Shelf Management Mezzanines (ShMMs)
- The evaluation will continue with Polaris tester

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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
- Comprehensive set of tests performed for MicroTCA crates, PMs and MCH. ATCA in progress.
- Interaction with manufacturers (HW and SW modifications introduced)
- Detailed evaluation reports published

Available on the uTCA/ATCA Repository

Lessons learned

- Good communication with support is essential
- New products lacking maturity

This leads us to the next project phase:

- Technical specifications in view of future equipment purchase
- Equipment recommendations
- Provide support and tools to the xTCA community

THANK YOU

Next xTCA events:

Thursday 26, 5p.m. - Room Trumpet 1:

- *Summary of evaluation results of xTCA equipment* – Matteo Di Cosmo
- *Evaluation results from AC/DC converters for xTCA* – Vincent Bobillier

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
- NAT Website http://www.nateurope.com/
- Vadatech Website http://www.vadatech.com/
- Schroff Website http://www.schroff.de/
- ASIS Website http://www.asis-pro.com/
- Wiener http://www.wiener-d.com/
- ELMA http://www.elma.com/
- COMTEL http://www.comtel-online.com/