

# "MTCA.4 for Industry"

DESY technology transfer through the HGF Validation Fund



## Outline

- **MTCA.4 Crate Platform**
- **RF Control systems for SRF accelerators**
- **Validation Fond Project „MTCA.4 for Industry“**

Dr. Holger Schlarb

MSK, DESY

Athen, 03.12.2013

PICMG = PCI Industrial Computer Manufacturers Group

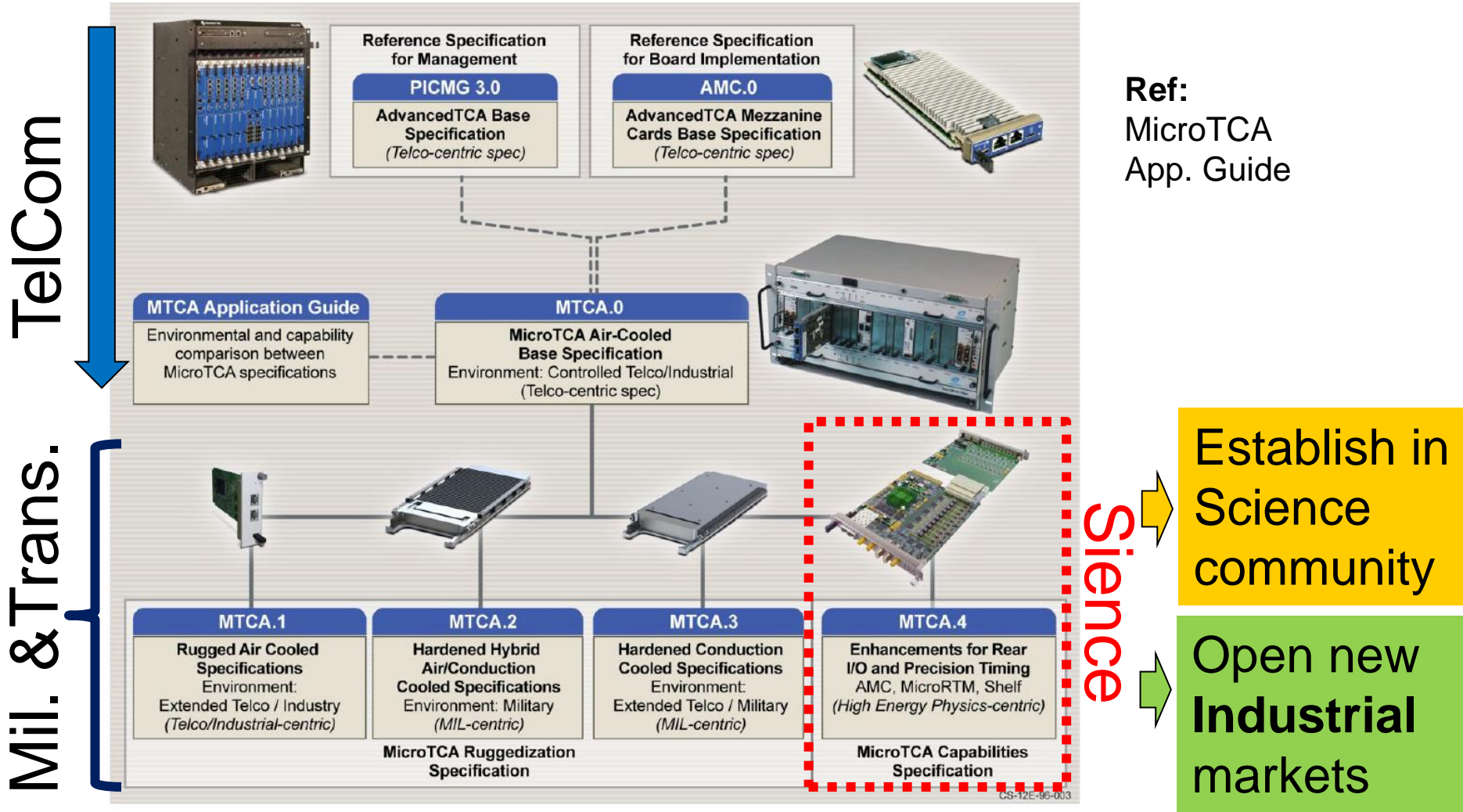
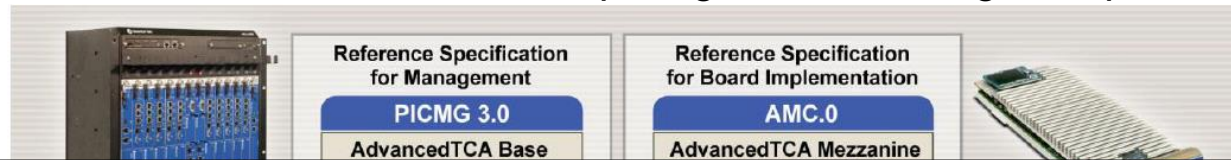


Figure 1. The MicroTCA family of specifications maximizes reuse from its ATCA and AMC parent specifications.

PICMG = PCI Industrial Computing Manufacturing Group



Ref:  
MicroTCA

## Modular Open Systems Approach (MOSA)

*What is MOSA* - A Modular Open System Approach to computer architecture design is based on open architecture and open source constructs that ensure reduced development expense, design cycle time and manufacturing cost at a time when product complexity and reliability demands are increasing.

Open architecture and open source are hardware or software architectures based on specifications:

- Available to the public and generated, approved and controlled by various standards and trade associations (e.g., PICMG®), or
- Uniquely generated, provided they are made public by its owners (e.g., Peripheral Component Interconnect, or PCI).

**Only standard with IPMI included in standard:**

**Intelligent Platform Management Interface**

Figure 1. The MicroTCA family of specifications maximizes reuse from its ATCA and AMC parent specifications.

- Nov. 2005: Reliability Workshop in Grömitz, Germany
  - **Joint meeting with ILC (intern. linear collider, 33km, 500GeV)**
- Dec. 2007: XFEL Crate-Standard Workshop
  - **MicroTCA and ATCA was defined to be used**
- Mar. 2009: First PICMG Meeting “xTCA for Physics”
  - **Hardware group: rear I/O and timing**
  - **Software group: standardization of interfaces for FPGAs...OPsys**
- Oct. 2011: Official announcement of PICMG Specification
  - **“MTCA.4 Enhancements for Rear I/O and Precision Timing“**
- Jul. 2012: Start of Helmholtz Validation Fund
  - **„MicroTCA.4 for Industry“**

> „xTCA for Physics“ interest group (38 partners): 03/2009

- **Research institutions:** SLAC, FNAL, IHEP, IPFN, ITER, DESY
- **Industry:** Connector-, Board-, Crate-, System vendors

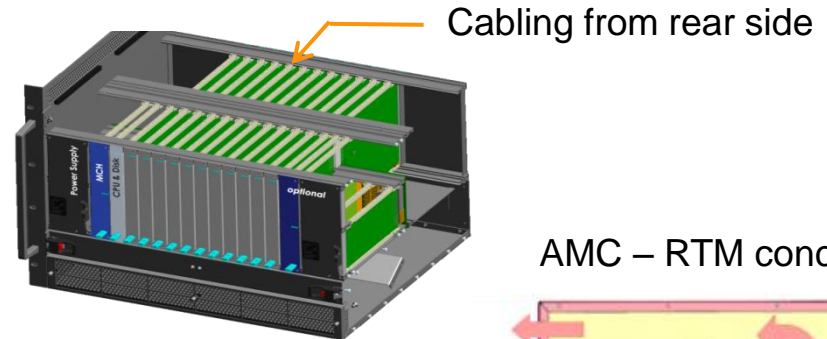


> Released PICMG 2011 (<http://www.picmg.org>)

- **Micro Telecommunications Computing Architecture .4 (MTCA.4)**

> Modular & Modern architecture

- Reusability + PCIe + Ethernet



> High reliability

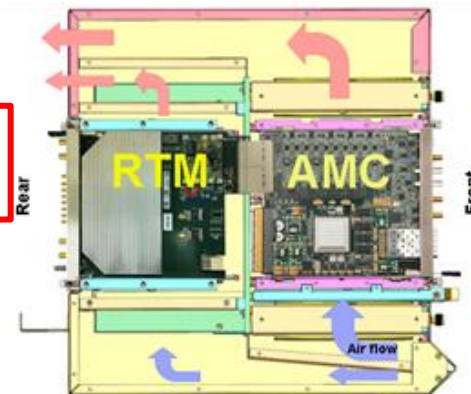
- Redundant Power Supply / Fans
- Remote Maintenance thr. Management

> High Performance

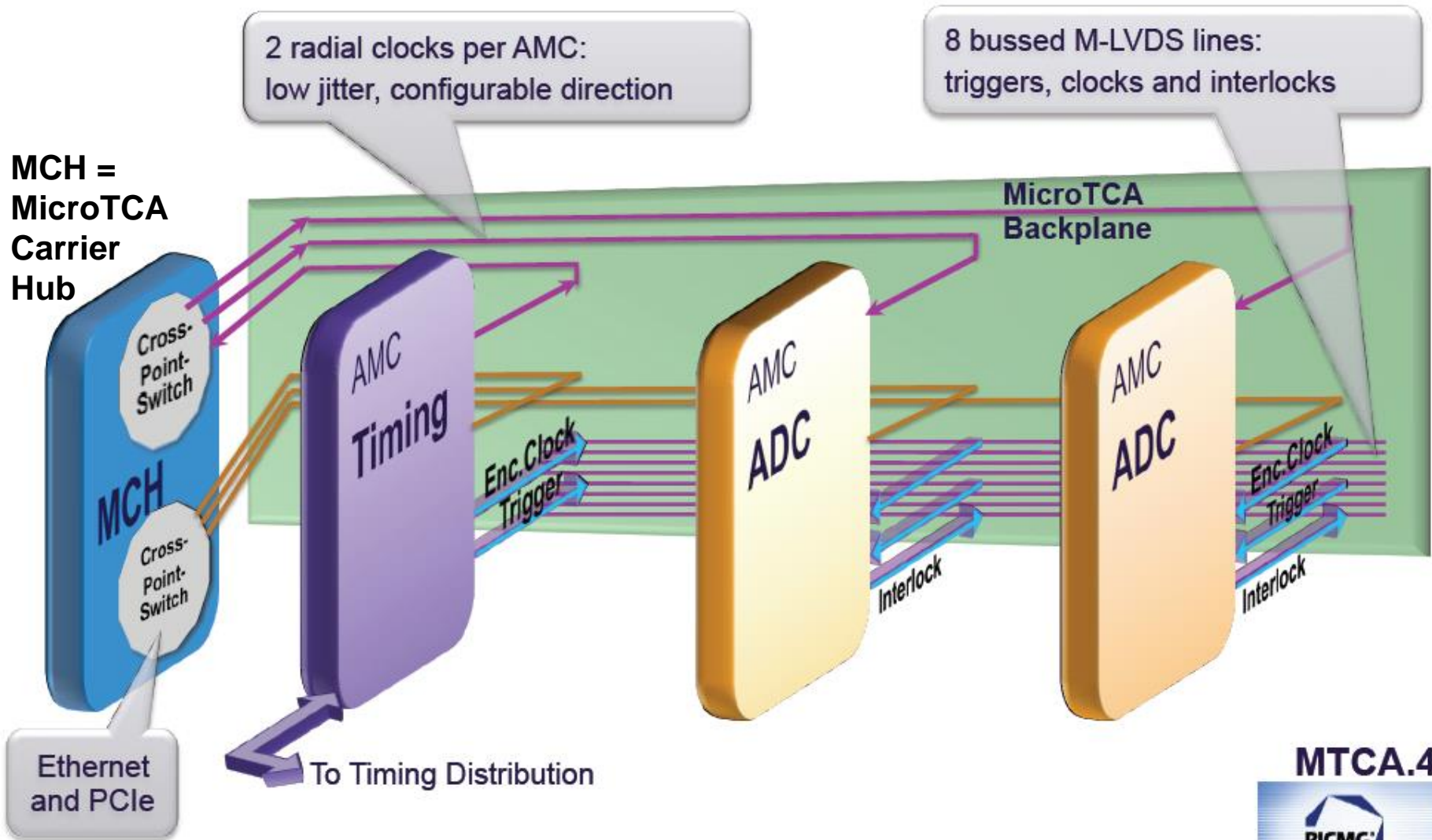
- 4x PCIe gen3 lane, 10GbE... 40 GBit/s
- Low analog noise ...

$$V = \frac{E[Uptime]}{E[Uptime] + E[Downtime]}$$

AMC – RTM concept





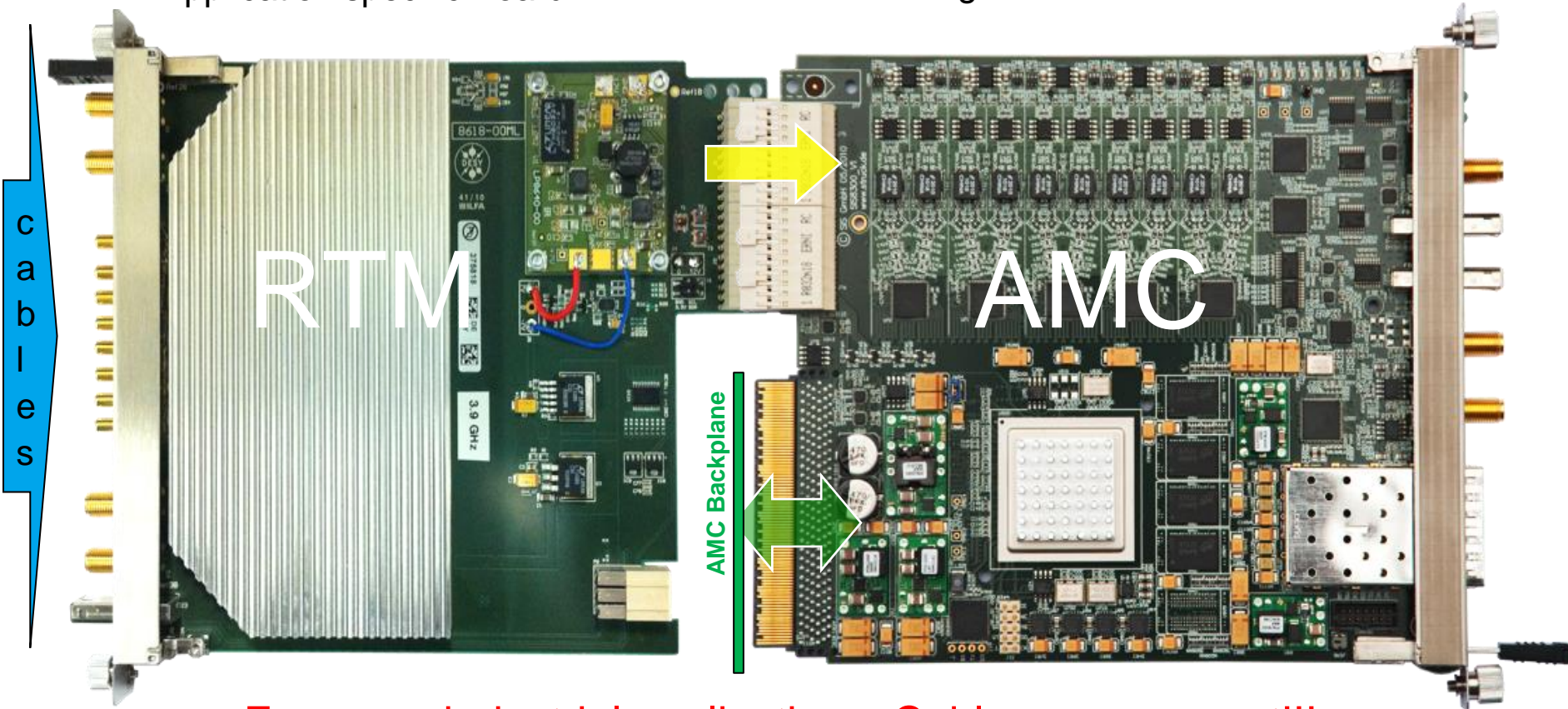


- Analogue Signal Conditioning (Rear-Transition Module)

- Application specific Board

- Digital Signal Processing (Advanced-Mezzanine Card)

- Scaling with Moore's Law ...



For many industrial applications: Cable management!!!



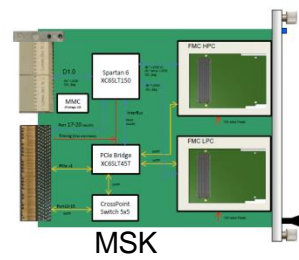
## RTM

- MPS Signal adapter
- ADC and DAC – *DRTM-AD84*
  - 8 ch ADC 95 MSPS, 16bit
  - 4 ch DAC 16 MSPS, 16bit
- Test RTM
- Coupler Interlocks
- Beam Loss Monitors MDI
- Toroid protection / readout MDI
- Wire Scanner MDI
- Clock & Trigger Contr. for Exp.



## AMC

- DAMC2
  - Virtex 5
  - FMC
  - 4 \* SFP
  - **100 available**
- TAMC651
  - Spartan 6
  - 1 SFP
- DAMC\_FMC20
  - Spartan 6
  - 2 FMC





- 1,3 .. 3.9 GHz down converter

- 2 ch APD pulse stretcher

- BPM

- LEMO adapter SIS8900



## AMC

- 10 ch. 16 bit ADC
  - 125 MSPS
  - 2 ch DAC



- SIS8300
  - Virtex 5
  - 2 \* SFP
- SIS8300L
  - Virtex 6
  - In preparation



- AMC520
  - Virtex 6

- In MTCA.4 the RTM has much high relevance than any other modular architectures
- Space wise comparable in size!
- Allow to separate complex digital and analog boards
  - Different expertize for the development AMC/RTM
  - Components life cycle management
    - Analog electronics ~ 10 years
    - AD/DA converter ~ 3-5 years
    - FPGA/CPU/DSP ~ 2 years
- Cost/Performance optimization (family of AMC for 1 RTM)
- Reduced risk for “end of life” components



12 Slot



6 or 7 Slot

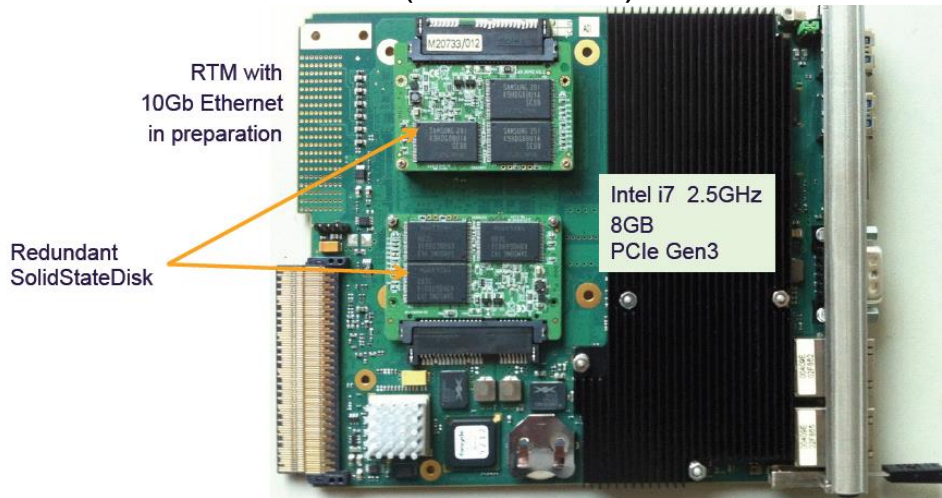


Elma

Schroff



## Dual Core i7 CPU (Concurrent)

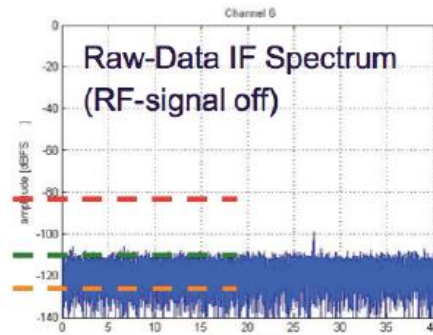


## Low noise Power Modules



Poor Power Supplies : > -80dB SFDR

Power-Entry-Modules: < -110dB spurious free  
VS-Scaling : < -120dB SFDR



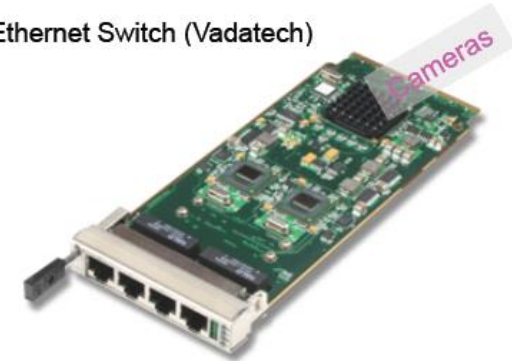
- IP Module carrier:
  - TAMC100/200 (Tews)



- PMC Module carrier:
  - PMC AMC (NAT)



- 4 port Ethernet Switch (Vadatech)

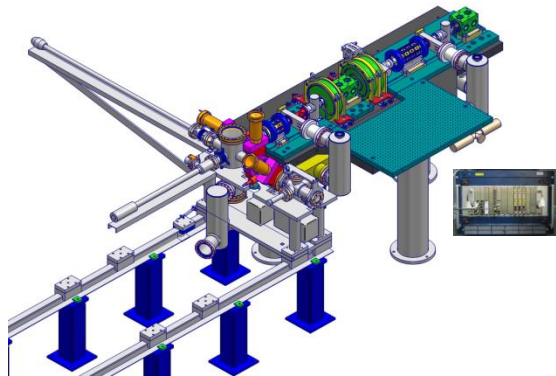


## MTCA.4 history at DESY:

- Equipping of facilities ...

Labs for development ~ 15 crates  
Operation at accelerators ~ 20 crates

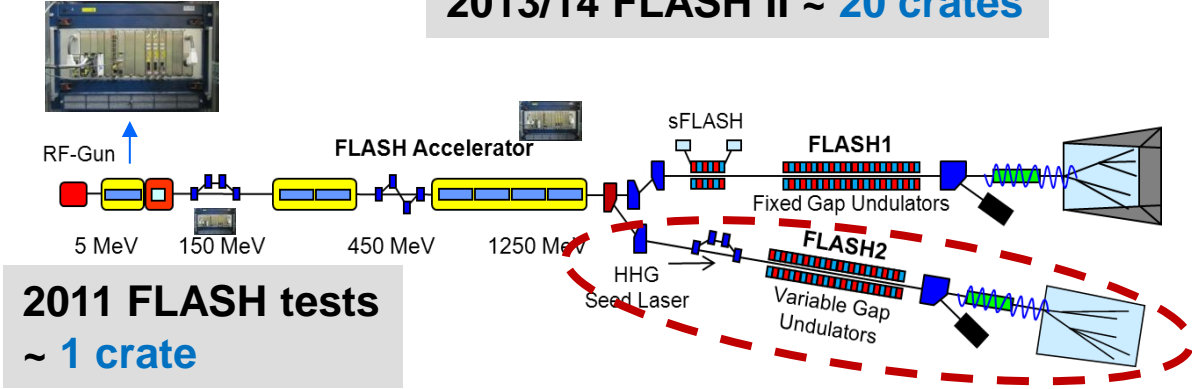
2012 REGAE ~ 1 crate



RF controls

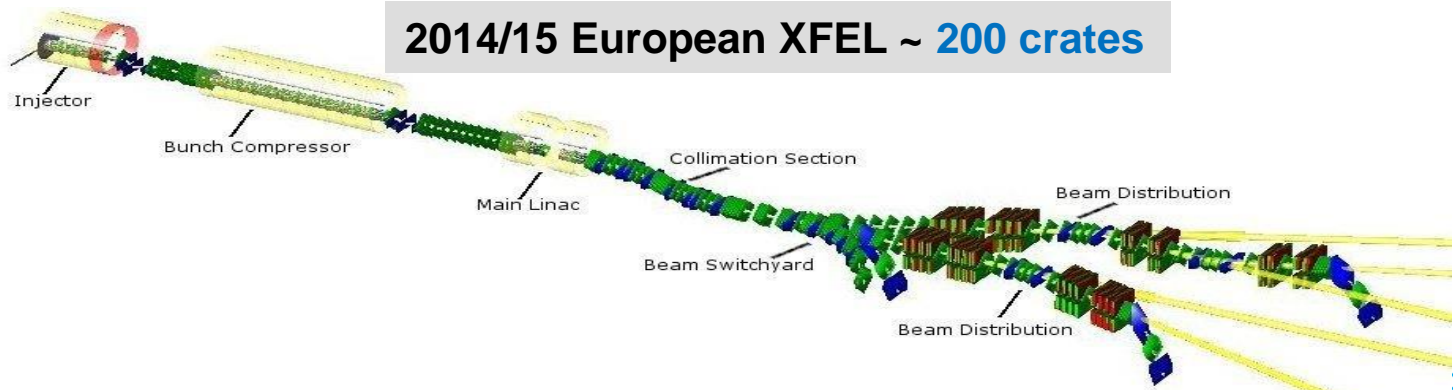


2013/14 FLASH II ~ 20 crates



2011 FLASH tests ~ 1 crate

2014/15 European XFEL ~ 200 crates



## Board developed for X-FEL/FLASH

- ... 2012 substantial investment to develop platform and various modules:

### AMCs

DAMC02  
X1TIMER  
X2TIMER  
uTC-V5  
uTC-K7  
DS800  
...

### RTMs

RTM test boards  
MPS signal adapter  
AD-DA-converter  
Coupler interlock  
Beam loss monitor  
Toroid readout  
Wire scanner  
...

uDWC  
APD stretcher  
BPM  
uDWC-VM  
uVM  
uLOG (eRTM)  
Adapters uRFB  
...

RTM backplane (precision analog, here RF/Clk distribution)

### Industry

Crates  
PS-1138/...  
PM Wiener  
SIS8300/8900  
AM900  
uLOG (RTM)  
ADQxxx  
MCH  
TAMC900  
ADIO24  
...

struck innovative  
systeme

powerBridge  
Computer

Schroff®

ELMA  
Your Solution Partner

CONCURRENT  
TECHNOLOGIES

TEWS  
TECHNOLOGIES

Telkoor  
Power Supplies Ltd.

SP Devices  
Signal Processing Devices

Instrumentation  
Technologies



Many of the module being design within collaboration





## What is the HGF validation fond?

- Finance instrument to support the spin-off and technology transfer from scientific, technical inventions or developments from HGF centers to the industry and society
- Validation: increase of value (material/immaterial) with direct application to society / industry
- Ideally: generate commercial product

## Boundaries:

- Duration max. 2 years
- Funding max. 2 M€/a (50% by HGF)

## Screening of DESY (2011):

- “MTCA.4 ....” good candidate

Helmholtz-Validierungsfonds auf einen Blick



Weitere Informationen finden Sie im Leitfaden der Antragstellung, der wie die Ausschreibung und die Antragsformulare zum Download zur Verfügung steht: [www.helmholtz.de/ausschreibungen](http://www.helmholtz.de/ausschreibungen)

**Ansprechpartner**

**Kontakt:**  
Für weitere Fragen stehen Ihnen die Technologietransferstellen der Helmholtz-Zentren zur Verfügung.

**Ihr Ansprechpartner in der Geschäftsstelle der Helmholtz-Gemeinschaft ist:**  
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Fotocredit: Helmholtz-Berlin



HELMHOLTZ-GEMEINSCHAFT  
DEUTSCHER FORSCHUNGSZENTREN  
HELMHOLTZ-VALIDIERUNGSFONDS



## Main objectives of project:

Establish MTCA.4 electron crate system

- In accelerator community
- Industrial branches
- Scientific community

by reducing the market entry barriers and foster MTCA.4 to industry

Business model:

- Marketing for the RF controls modules via Company using DESY License

Consortium:

**Funding 4 Mio€**

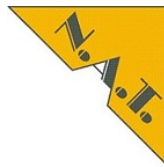


## > Status 29. October 2013

### ▪ Cooperation partners

#### • Original HVF Consortium (7):

**ELMA**  
Your Solution Partner



struck innovative  
systeme

AMPEGON

**Schroff**<sup>®</sup>

**TEWS**  
TECHNOLOGIES

**AD-TE-C**

#### • New Partners (5):

**IC** INTERFACE  
CONCEPT  
ADVANCED ELECTRONIC SOLUTIONS

**eicSys GmbH**  
Embedded Integrated Control Systems

**COSYLAB**

powerBridge  
Computer

**CAEN**  
Tools for Discovery

#### • Negotiation phase(5):

**vadatech** Inc  
THE POWER OF VISION

**HARTING** Pushing Performance

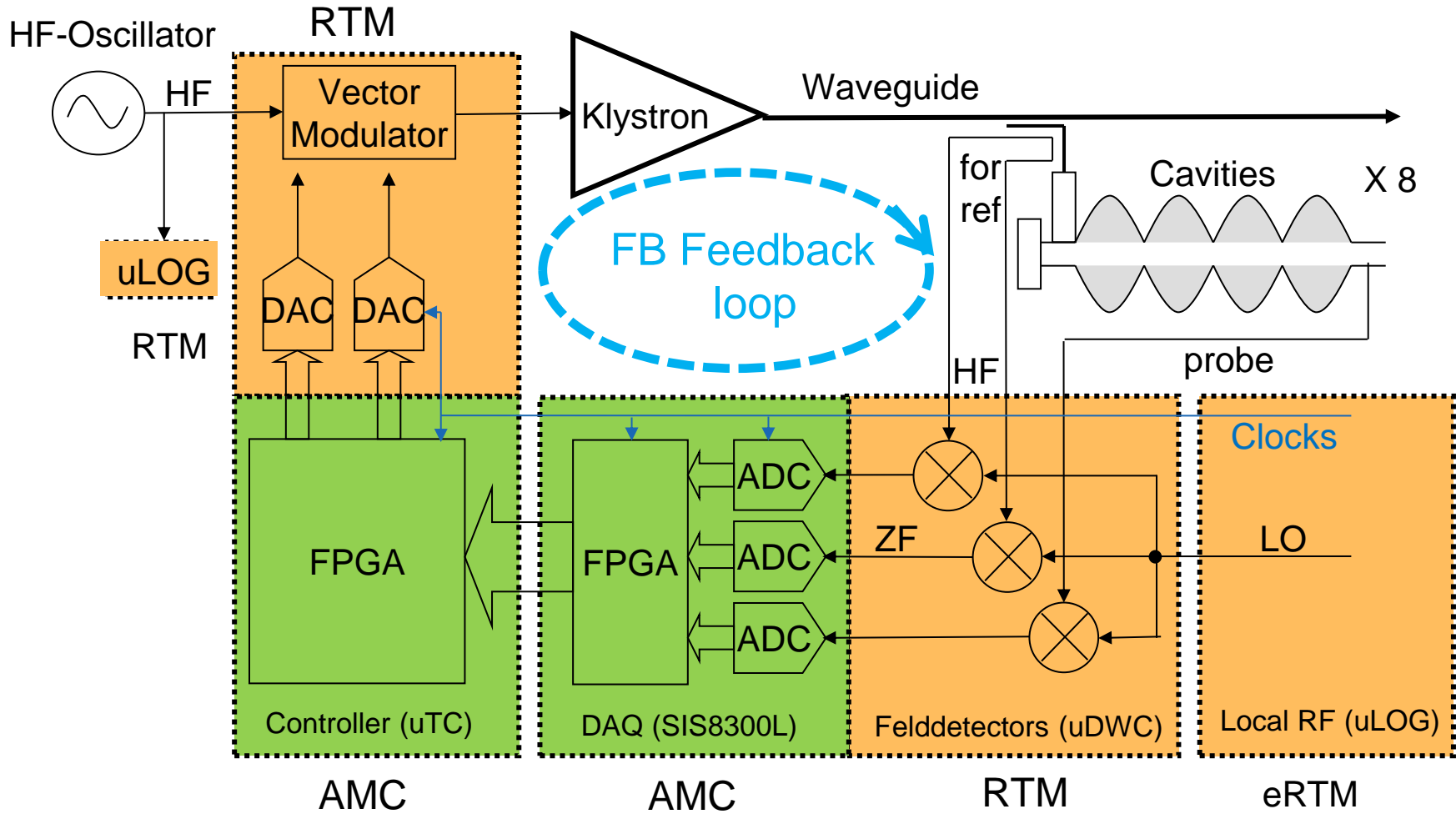
**kontron**

Laurin AG

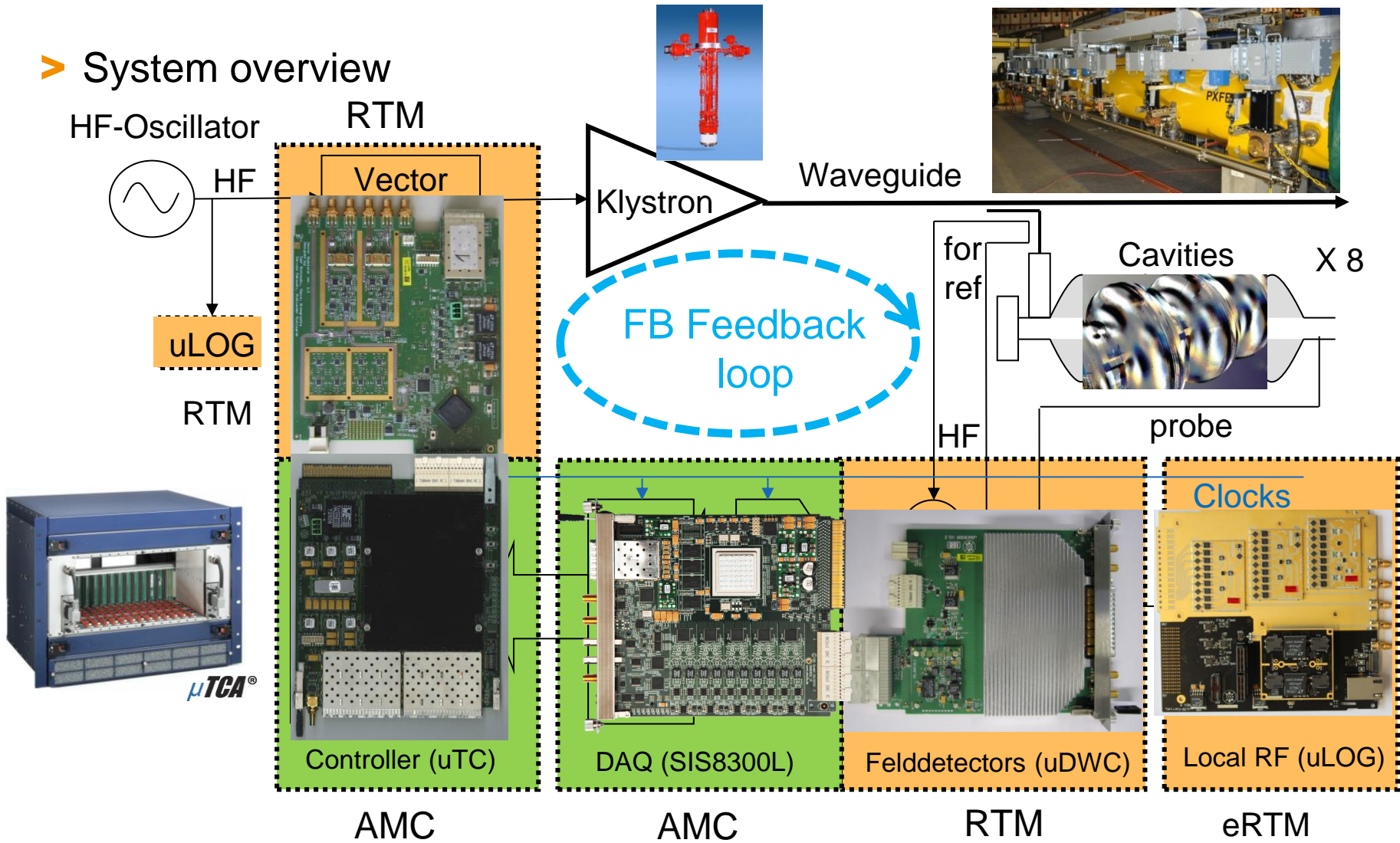
**wieNER**  
Plein & Baus Elektronik  
Work für  
Industrie-  
Elektronik  
Nuclear-  
elektronik  
Explosion-  
schutz

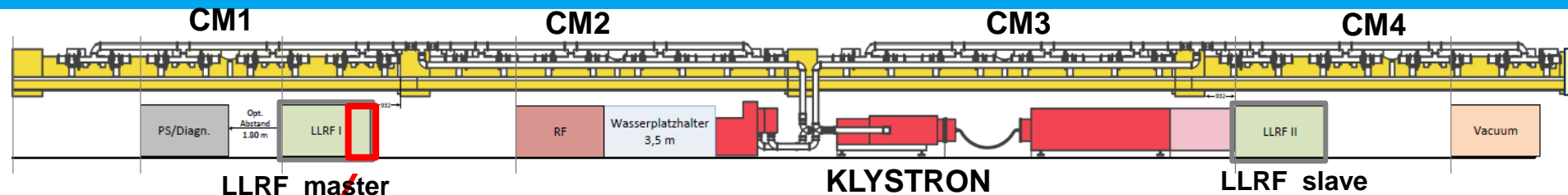


## > System overview

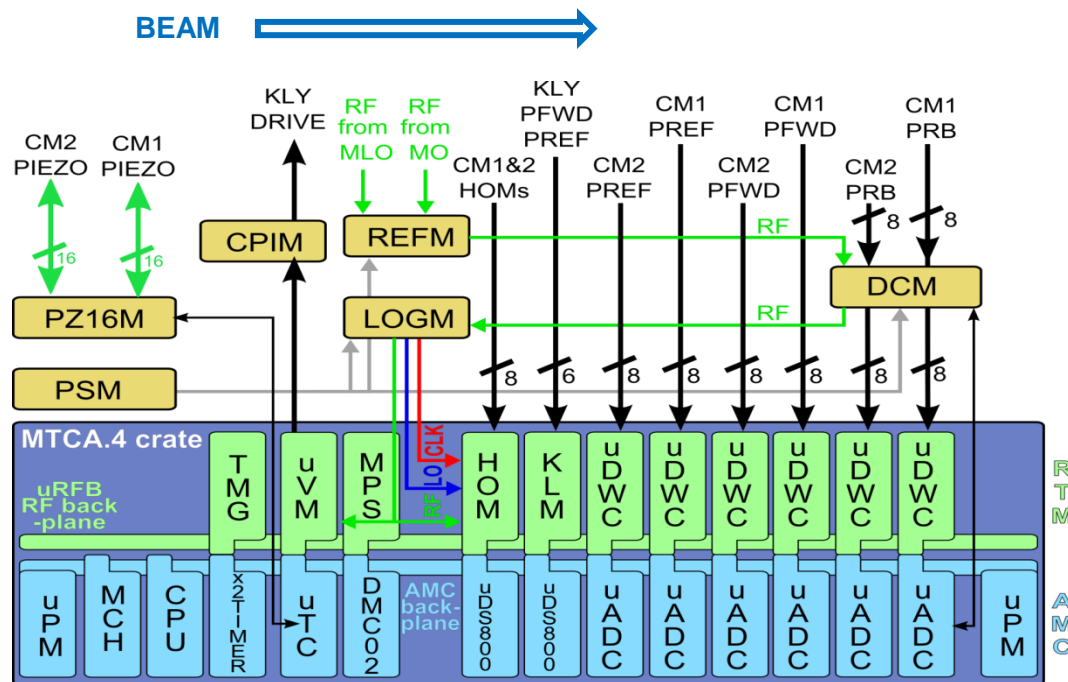
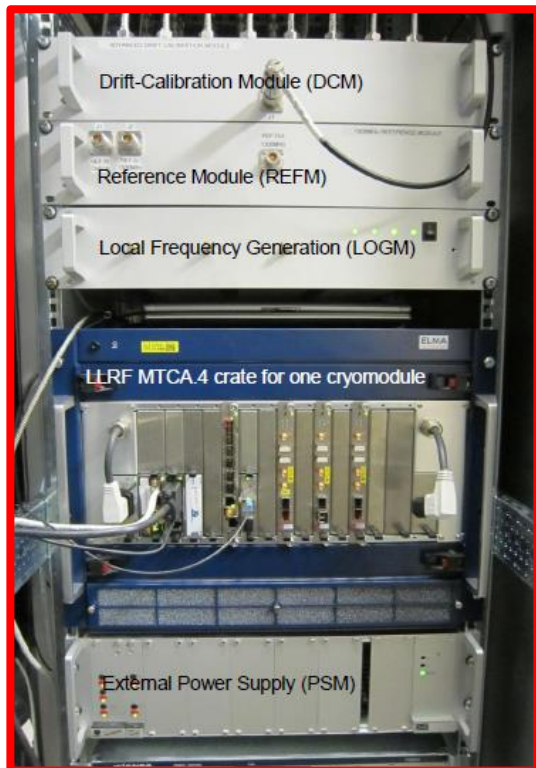


## > System overview





< 28U Rack



- MTCA.4 incl. complete sweet: LLRF/Diag./ Interlocks/HOM

### Challenges:

- Total: 27 RF station / 800 cavities / >3000 RF signals
- Stability requirements < 0.01% & 0.01deg





## AP1: RF control system in MTCA.4

### AP1.1 Revision of existing modules

- AP 1.1.1 Field Detection (uDWC)
- AP 1.1.2 Controller (uTC)
- AP 1.1.3 RF driver unit (uVM)
- AP 1.1.4 Local RF-Generation (uLOG)

32 cavities  
~mdeg precision



### AP1.2 Cost opt. for Single Cavities Applications

- AP 1.2.1 Field detector with RF driver (uDWC-VM)
- AP 1.2.2 High-end Digitizer (DAQ-LNC)

### AP1.3 Extending Portfolio in Frequency

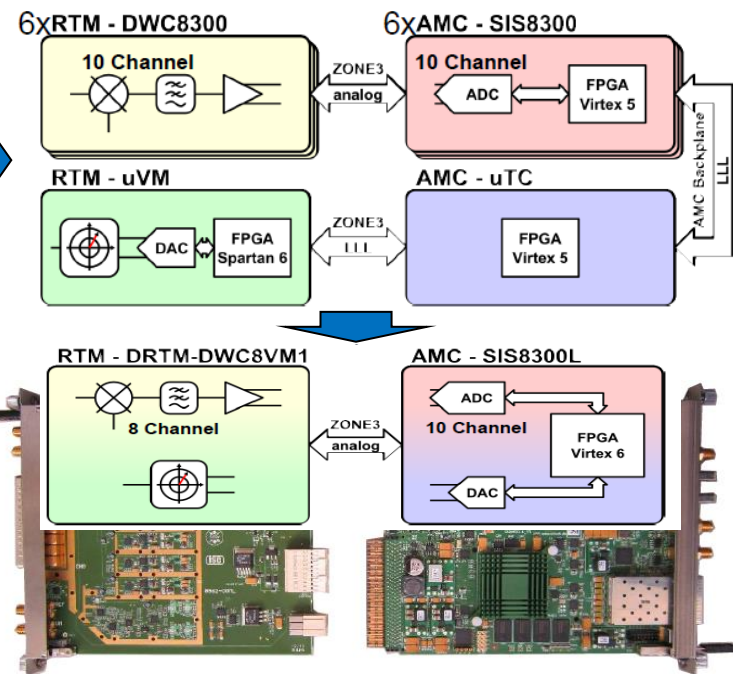
- AP 1.3.1 Field detector with RF driver (uVM, 0.35-6GHz)
- AP 1.3.2 Local RF-Generation (uLOG, 0.35-6GHz)
- AP 1.3.3 RTM with local clock circuit (uCLK-RTM, 10-350MHz)
- AP 1.3.4 Global clock generation (uCLK-eRTM, 10-350MHz)
- AP 2.2.8 Backplane Development for 10 Gbit/sec Transfer Speed

### AP1.4 Supplementary systems for RF control

- AP 1.4.1 Multi-channel Direct RF-sampling (uDS800)
- AP 1.4.2 AMC carrier with motor/RTM with Piezo driver (uFMC20)

### AP1.5 Introduction of RTM-RF Backplane

- AP 1.5.1 Development of RTM-RF Backplane concept
- AP 1.5.2 Crate integrated RF source (uOSC\_eRTM)



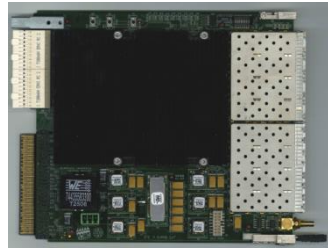
Due to modularity only moderate effort required to develop RF controls for

- 1/2/4/.. Cavities
- NRF/SRF
- 10-6000 MHz
- valuable add on's

## ➤ Board developed for licensing ...



DRTM-DWC10



DAMC-TCK7



DRTM-VM2HF



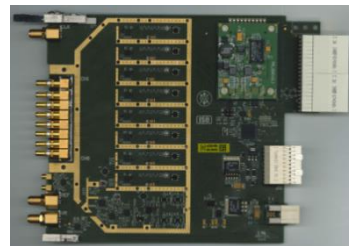
eRTM-LOG1300



DRTM-VM2LF



DRTM-VM2LF



DRTM-DS8VM1



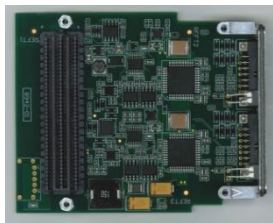
DAMC-FMC20



DRTM-PZ4



DRTM-DWC8VM1



DFMC-MD22



DAMC-DS800

- ... Together 27 hardware projects,
- ~ 16 developed by DESY
  - ~ 6 developed by Industry,
  - ~ 5 joint effort DESY & Industry

## AP2: Completion of MTCA.4 for industry and institutions

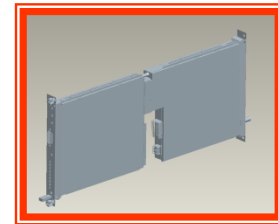
### Extension of product portfolio for MTCA.4

1. Industrial production of timing module
2. 2 GSPS, 4 channel , 12bit ADCs on RTM & AMC
3. 32 ch., 40MSPS, AMC-RTM with analog shaping capability
4. Management low noise power supplies



### EMI optimization and classification of MTCA.4 components

1. EMI test board development
2. EMI current distribution in MTCA.4 crate
3. Optimization of crate-contact transitions
4. Shields for AMC/RTM boards
5. EMI Bypass-concept
6. Vibration studies and vibration reduction
7. EMI classification of AMC and RTM boards commercially available
8. AMC Backplane/connector/board development towards 10Gbit/sec



**ELMA**  
Your Solution Partner

→ 4x25 Gbps



Pushing Performance

### Application of MTCA.4 in industry

1. Integrated klystron life-time and LLRF system

### Evaluation of MTCA.4 market

1. Market evaluation for industry
2. Market evaluation for institutes
3. Optional industry order after evaluation

### Integral test of MTCA.4 in large facility, availability, failure analysis

1. Inter-compatibility of boards/sub-systems, radiation, remote controllability

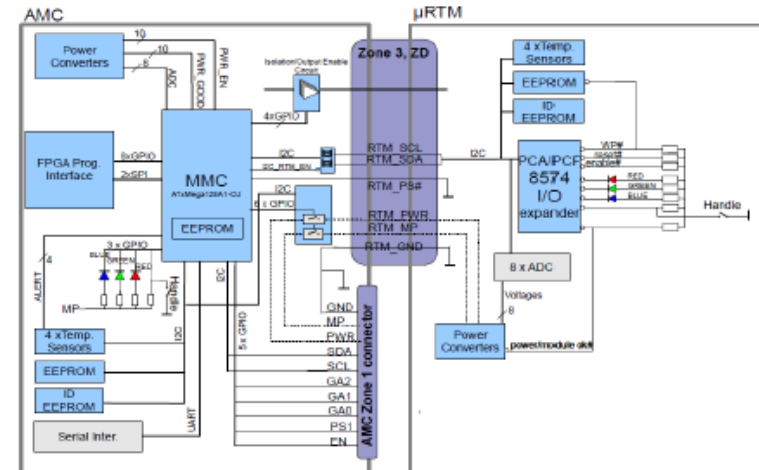


- Z3 pin-assignment not standardized in MTCA.4 (AMC – RTM pairs)
  - > Higher compatibility between AMC's and RTM's
  - > Class A1.1 (analog), Class D1.x (digital)

- Module Management Controller (MMC V1.0)
  - Advanced Version,
  - Basic (low cost) Version
  - Single Firmware, PCB Templates

Class A1.1 / Zone		a	b	c	d	e	f
MTCA.4 management	1	PWRG1	PWRB1	PSA	SDA	TCU	TDO
	2	PWRG2	PWRB2	MP	SDI	TDI	TMS
	3	SFP_CLK+	SFP_CLK-	SFP_P0+	SFP_P0-	SFP_T0+	SFP_T0-
	4	D0+	D0-	D4+	D4-	D5+	D5-
	5	D6+	D6-	D7+	D7-	D8+	D8-
	6	AMC_TCLK+	AMC_TCLK-	OUT0+	OUT0-	OUT1+	OUT1-
	7	INT	INT	INT	INT	INT	INT
	8	RTM_CLK+	RTM_CLK-	RTM_CLK+	RTM_CLK-	RTM_CLK+	RTM_CLK-
	9	RTM_CLK+	RTM_CLK-	RTM_CLK+	RTM_CLK-	RTM_CLK+	RTM_CLK-
	10	INT	INT	INT	INT	INT	INT
Analog signals	1	CH0_PA+	CH0_PA-	DAC0+	DAC0-	CH0_TF+	CH0_TF-
	2	CH0_TF+	CH0_TF-	INT	INT	CH0_PA+	CH0_PA-
	3	CH1_PA+	CH1_PA-	DAC1+	DAC1-	CH1_TF+	CH1_TF-
	4	CH1_TF+	CH1_TF-	INT	INT	CH1_PA+	CH1_PA-
	5	CH2_PA+	CH2_PA-	DAC2+	DAC2-	CH2_TF+	CH2_TF-
	6	CH2_TF+	CH2_TF-	INT	INT	CH2_PA+	CH2_PA-
	7	CH3_PA+	CH3_PA-	DAC3+	DAC3-	CH3_TF+	CH3_TF-
	8	CH3_TF+	CH3_TF-	INT	INT	CH3_PA+	CH3_PA-
	9	CH4_PA+	CH4_PA-	DAC4+	DAC4-	CH4_TF+	CH4_TF-
	10	CH4_TF+	CH4_TF-	INT	INT	CH4_PA+	CH4_PA-

Class D1.1 / Zone		a	b	c	d	e	f
MTCA.4 management	1	PWRG1	PWRB1	PSA	SDA	TCU	TDO
	2	PWRG2	PWRB2	MP	SDI	TDI	TMS
	3	RTM_CLK+	RTM_CLK-	RTM_CLK+	RTM_CLK-	OUT2+	OUT2-
	4	AMC_TCLK+	AMC_TCLK-	OUT0+	OUT0-	OUT1+	OUT1-
	5	P00_I0+/CC	P00_I0+/CC	P00_I0+	P00_I0-	P00_I0+	P00_I0-
	6	P00_I0+/CC	P00_I0+/CC	P00_I0+	P00_I0-	P00_I0+	P00_I0-
	7	P00_I0+	P00_I0+	P00_I0+	P00_I0+	P00_I0+	P00_I0+
	8	P00_I0+	P00_I0+	P00_I0+	P00_I0+	P00_I0+	P00_I0+
	9	P00_I0+/CC	P00_I0+/CC	P00_I0+	P00_I0+	P00_I0+	P00_I0+
	10	P00_I0+/CC	P00_I0+/CC	P00_I0+	P00_I0+	P00_I0+	P00_I0+
User Configuration	1	P01_I0+/CC	P01_I0+/CC	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	2	P01_I0+/CC	P01_I0+/CC	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	3	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	4	P01_I0+/CC	P01_I0+/CC	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	5	P01_I0+/CC	P01_I0+/CC	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	6	P01_I0+/CC	P01_I0+/CC	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	7	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	8	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	9	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+	P01_I0+
	10	GTPH1_CLK_IN	GTPH1_CLK_IN	GTPH_RX	GTPH_RX	GTPH_TX	GTPH_TX



**MTCA.4 for Industry and Research**

HELMHOLTZ ASSOCIATION

Home	Components	Community	Support	Resources	Directs	News	Contact
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**Broad Alliance for MTCA in Industry**

MTCA (MicroTC) is a standard defined by the PICMG (<http://www.picmg.org>). MTCA.4 is an MicroTC4 enhancement for near I/O and precision timing. It was developed by several institutes and industry and published in October 2011 by PICMG.

A broad alliance of developers, users, module manufacturers and system integrators has formed to develop new boards, refine the specification of the backbone and resolve any interoperability issues that may arise from applications in the field.

MicroTC (MicroTC) is a standard for high-speed digital and analog processing in the MTCA community.

14 December 2012 Workshop on ESD techniques and collaborations in the MTCA community.

SEI-Tagung 11.-13.03.13, FZ Jülich, Germany  
Frank Ludwig, DESY





## AP3: Support and consulting for industry and institutions

### MTCA.4 support and consulting

FAQ

Hotline

1 FTE for direct support

Tutorial, every 1 month hands on  
6 in 2013 / 18 in 2014

### MTCA.4 users guide

Book published by DESY/NAT

### Products marketing & information

2 MTCA.4 workshops

Special task forces

Marketing on industrial exhibitions

Roadshow through HGF

Webpage



MTCA Tutorials at DESY (05/2013)

(TT & Industry)

Webpage URL <http://mtca.desy.de/>



MTCA.4 for Industry and Research

Home Components Community Support Resources Events News Contact

**Broad Alliance for MTCA in Research and Industry**



MTCA (Micro Telecommunications Computing Architecture), also known as MicroTCA™ and  $\mu$ TCA™, has rapidly evolved to become a viable standard for demanding applications in large-scale research facilities of the high-energy physics and photon science community. Originally derived from AdvancedTCA™ or ATCA™ (Advanced Telecommunications Computing Architecture), the MTCA standard has gained popularity as a compact, versatile and cost-efficient alternative wherever ultra-high speed analog and digital signal processing is required.

MicroTCA is a standard defined by the PICMG (<http://www.picmg.org>). MTCA 4 is an MicroTCA enhancement for rear I/O and precision timing. It was developed by several institutes and industry and published in October 2011 by PICMG.

HELMHOLTZ ASSOCIATION

Google™ Custom Search

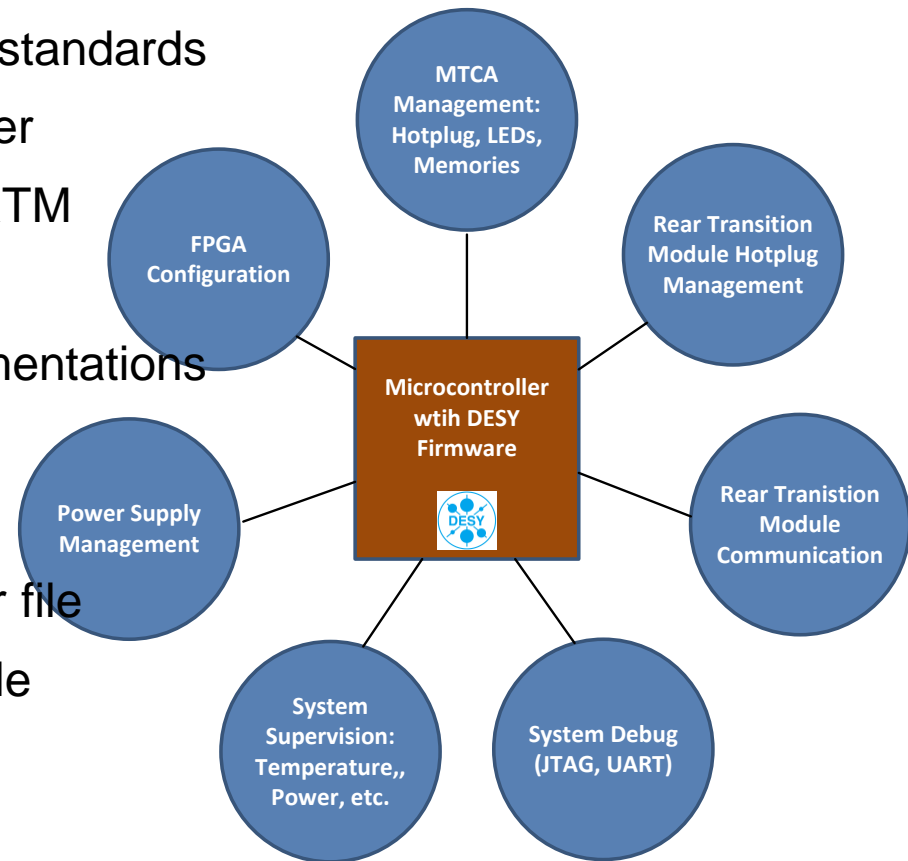
**Latest News**

11-12 December  
MTCA Workshop for Industry and Research at DESY Hamburg  
[more](#)

# Thanks for your attention

# Modul Management Controller 1.00 – Smart and Easy MMC

- Complete solution of **Module Management Controller**
- Compliant with IPMI, AMC and MTCA.4 standards
- Based on Atmel ATXmega Microcontroller
- Implementation available for AMC and RTM
- Basic and Advanced configuration
- Available **Evaluation Kit** for both implementations
- Complete source code written C
- Atmel Studio project
- Schematics as PDF and Altium Designer file
- Layout as Gerber and Altium Designer file



# Structure of HGF Validation-fund proposal

## **AP1 Commercialization of LLRF module developments:**

- AP1.1 Industrialization of existing modules**
- AP1.2 Optimization for single (small number of cavities) LLRF systems**
- AP1.3 Extension of portfolio for frequencies 10MHz – 6 GHz**
- AP1.4 Supplementary systems for RF controls**
- AP1.5 Full integration of RTM-RF Backplane in MTCA.4**

## **AP2: Completion of MTCA.4 for industry and institutions:**

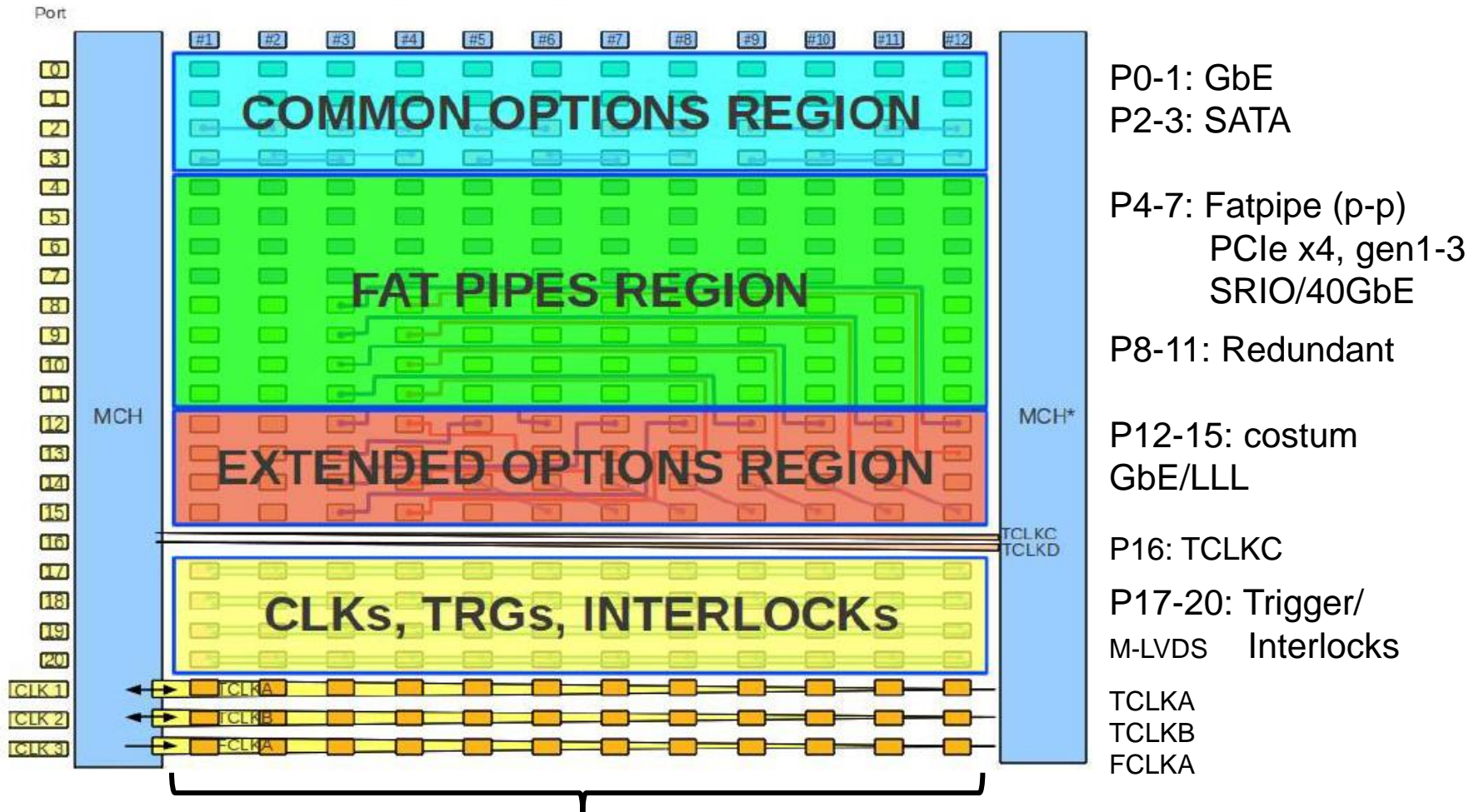
- AP2.1 Extension of product portfolio for MTCA.4**
- AP2.2 EMI optimization and classification of MTCA.4 components**
- AP2.3 Applications of MTCA.4 in industry (*LLRF system...*)**
- AP2.4 Industrial market evaluation / demands in scientific community**
- AP2.5 Large scale integral system test MTCA.4 and reliability study (*FLASH ...*)**

## **AP3: Consulting and support for industry and institutions:**

- AP3.1 MTCA.4 support and consulting**
- AP3.2 Users guide for MTCA.4**
- AP3.3 Exhibition and marketing**
- AP3.4 Workshops**



# AMC Backplane Topology

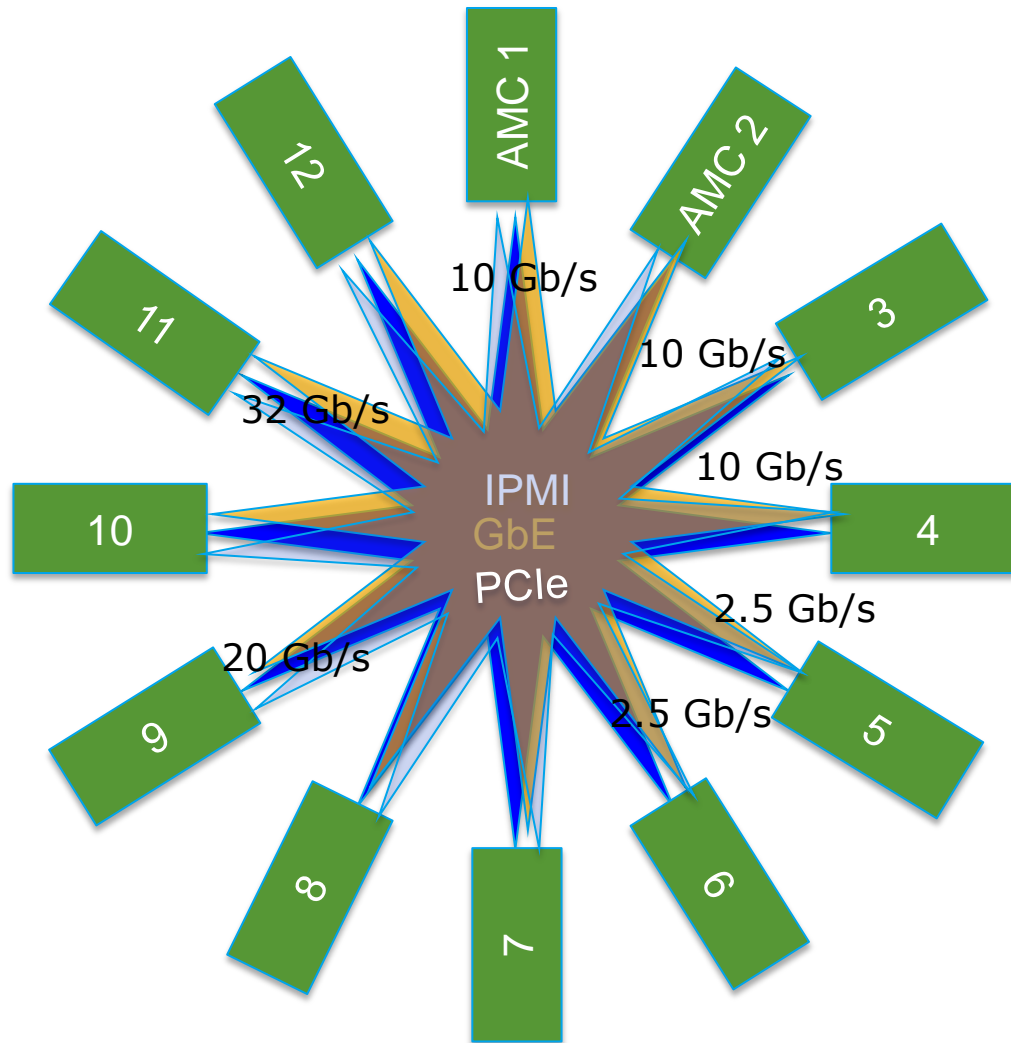


- P0-1: GbE
- P2-3: SATA
- P4-7: Fatpipe (p-p)  
PCIe x4, gen1-3  
SRIO/40GbE
- P8-11: Redundant
- P12-15: costum  
GbE/LLL
- P16: TCLKC
- P17-20: Trigger/  
M-LVDS Interlocks
- TCLKA  
TCLKB  
FCLKA

AMC Slot #1-#12

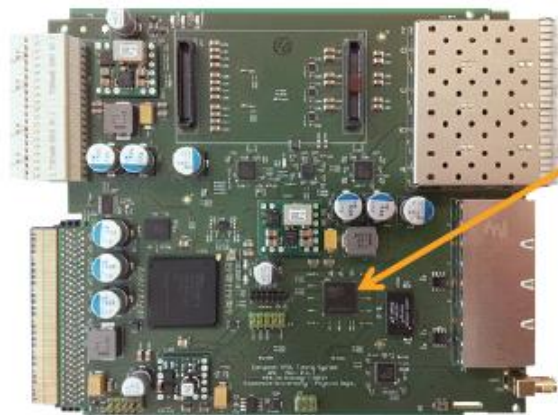
# Star Topology

## IPMI, PCIe (SRIO, XAUI) and GbE



# MTCA.4 hardware platform – timing/interlock –

MicroTCA Carrier Hub supporting  
Precision timing ~ few ps



## MCH status:

- NAT is MTCA.4 ready
- Supports PCIe gen3 (8 GT/s)
- CPU as RTM in preparation
  
- Kontron is second source
  - Test with our DAMC2

## Low Jitter Clock Cross-Point-Switch

- 16 ports
- IDT developed a chip for:
  - N.A.T MCH
  - x2timer

# Helmholtz validation-fund (HVF)

“xTCA for Physics” ⇒ MTCA.4 for industry!

**Advanced TCA<sup>®</sup>**

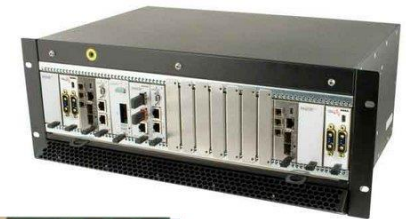


**MicroTCA<sup>®</sup>**

PICMG<sup>®</sup> Specification MTCA.4



**μTCA<sup>®</sup>**



## Advantages compared to other standards:

- Management ⇒ Availability
- High-digital & high-analog performance
- Modularity ⇒ upgradability/customizable
- AMC/RTM ⇒ reduced project scopes / diff. skills



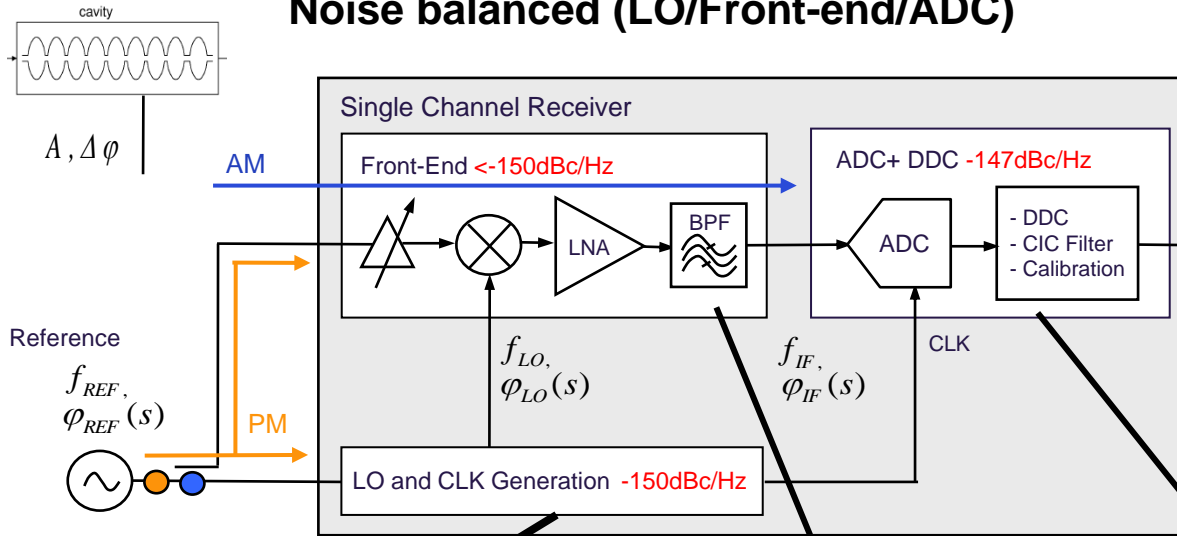
Well suited for  
Industrial  
Applications



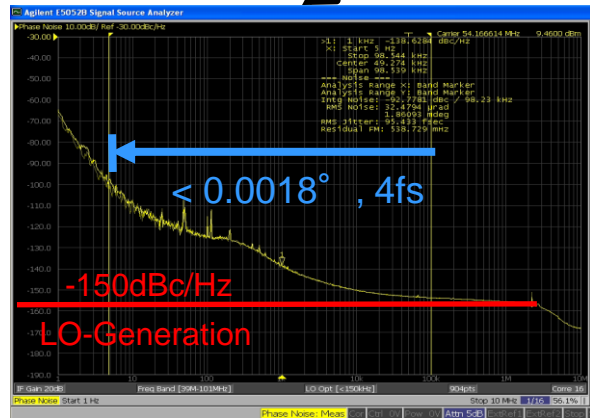
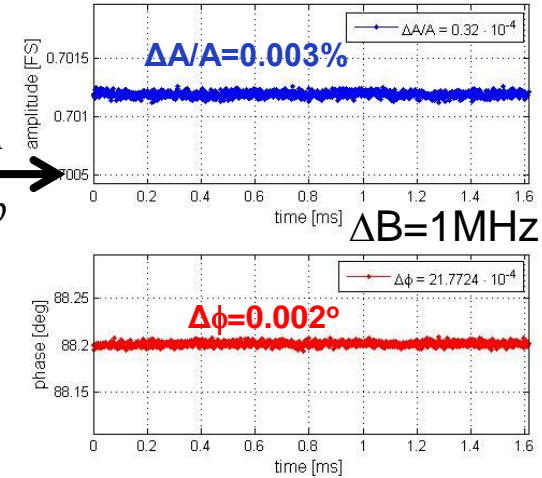
# RF control system

## RF receiver developments & noise limitations

### Noise balanced (LO/Front-end/ADC)

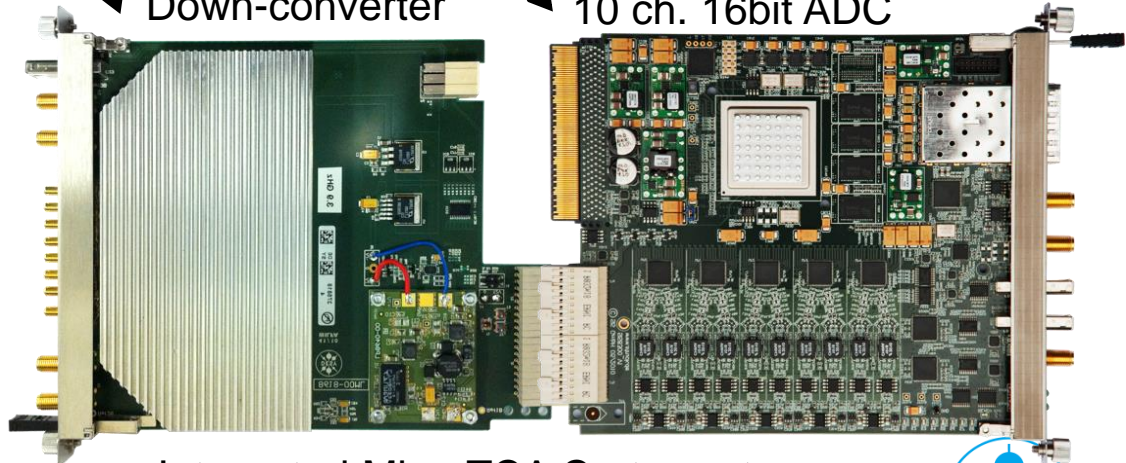


Resolution: Factor of 5 improved primarily by ADC improvements



Down-converter

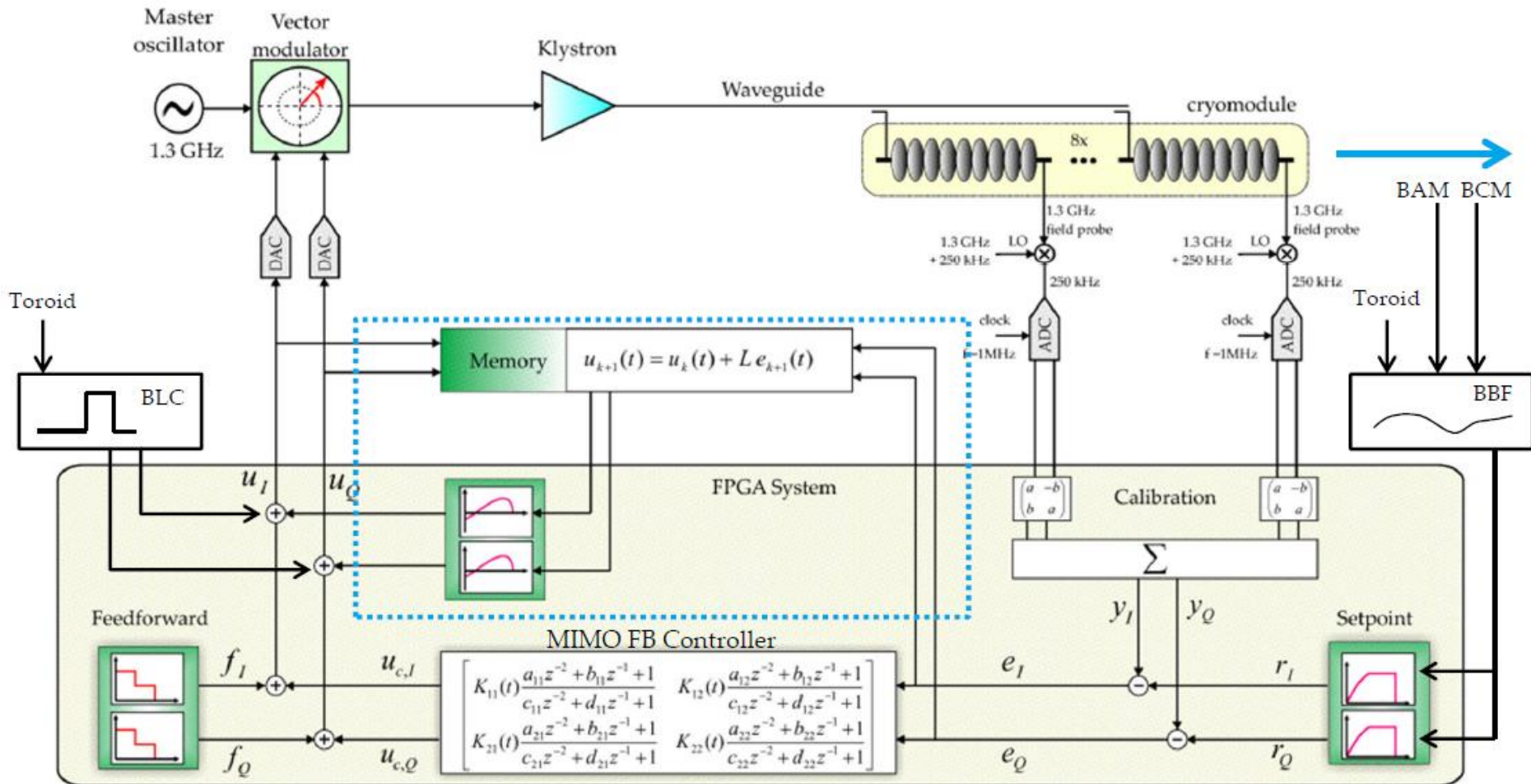
10 ch. 16bit ADC



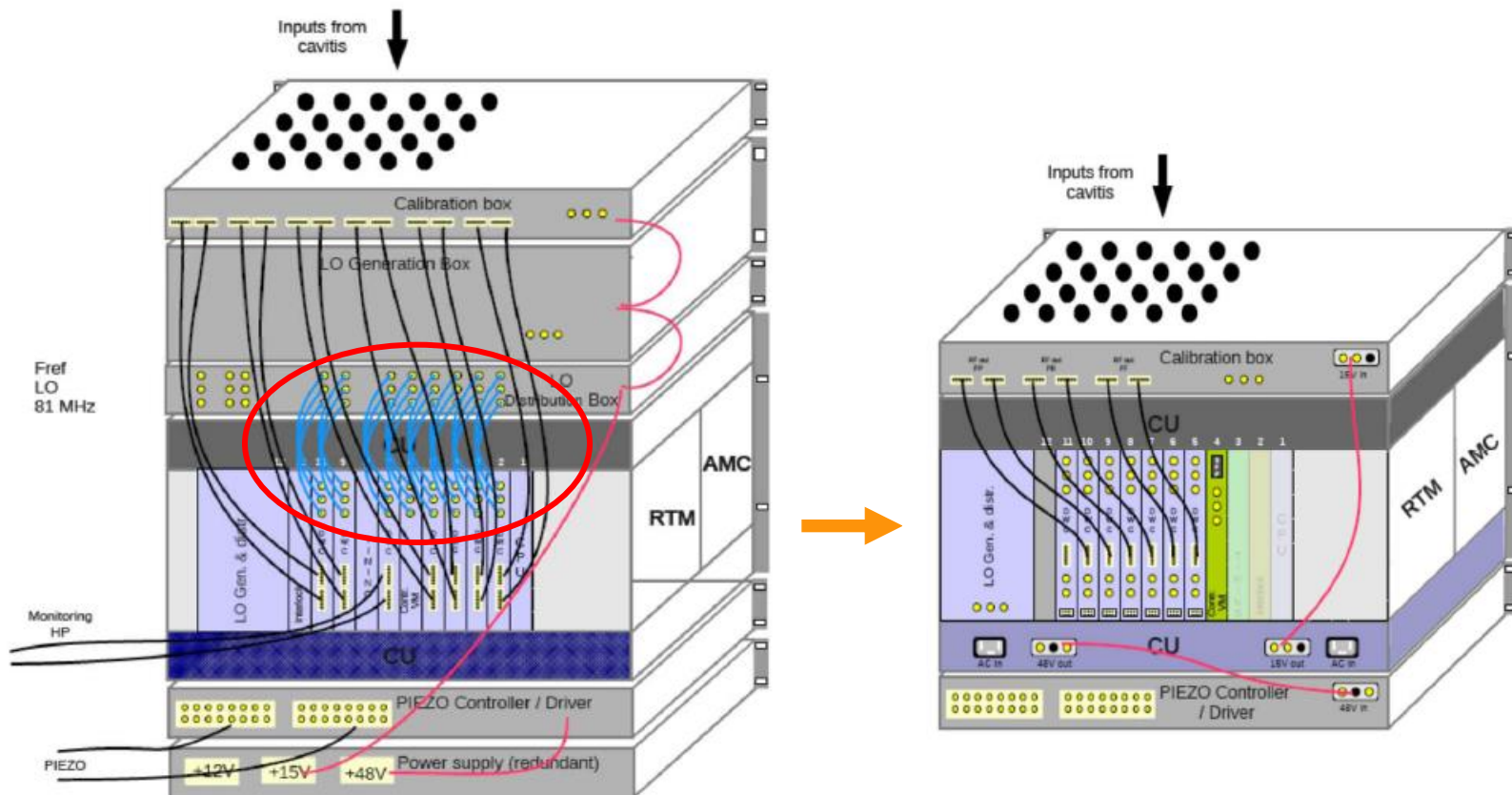
Integrated MicroTCA Crate system

# RF controls feedback loop architecture

Complex real time feedbacks with low latency ~ us



## Introduction of an MTCA.4 RTM-backplane



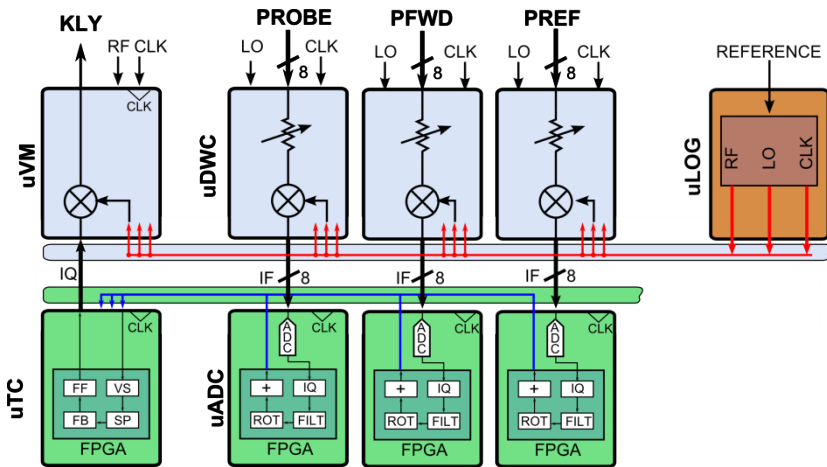
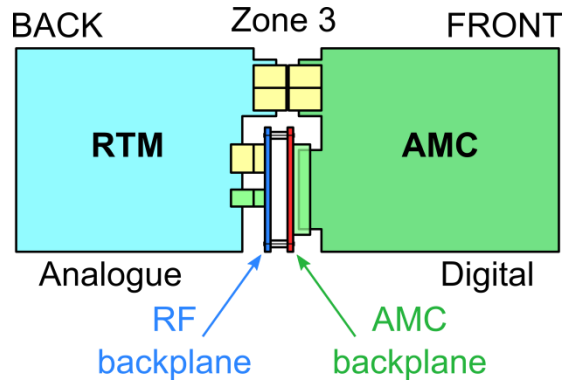
Complicated cable management



LLRF RTM backplane concept



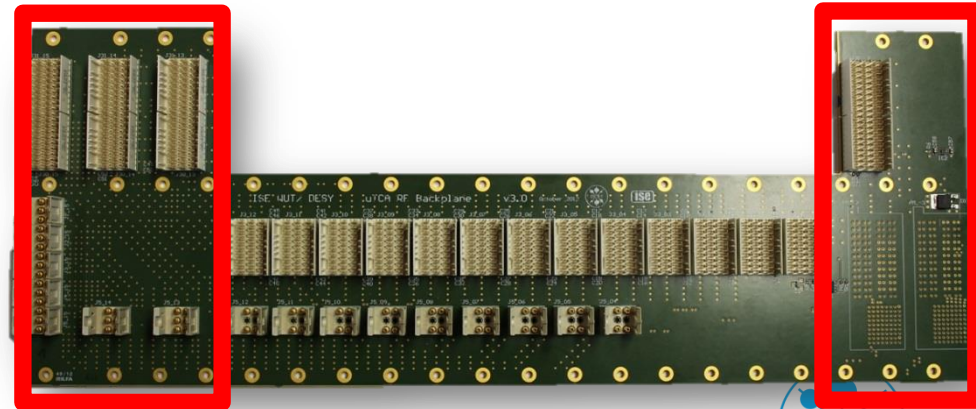
## > RF backplane: uRFB



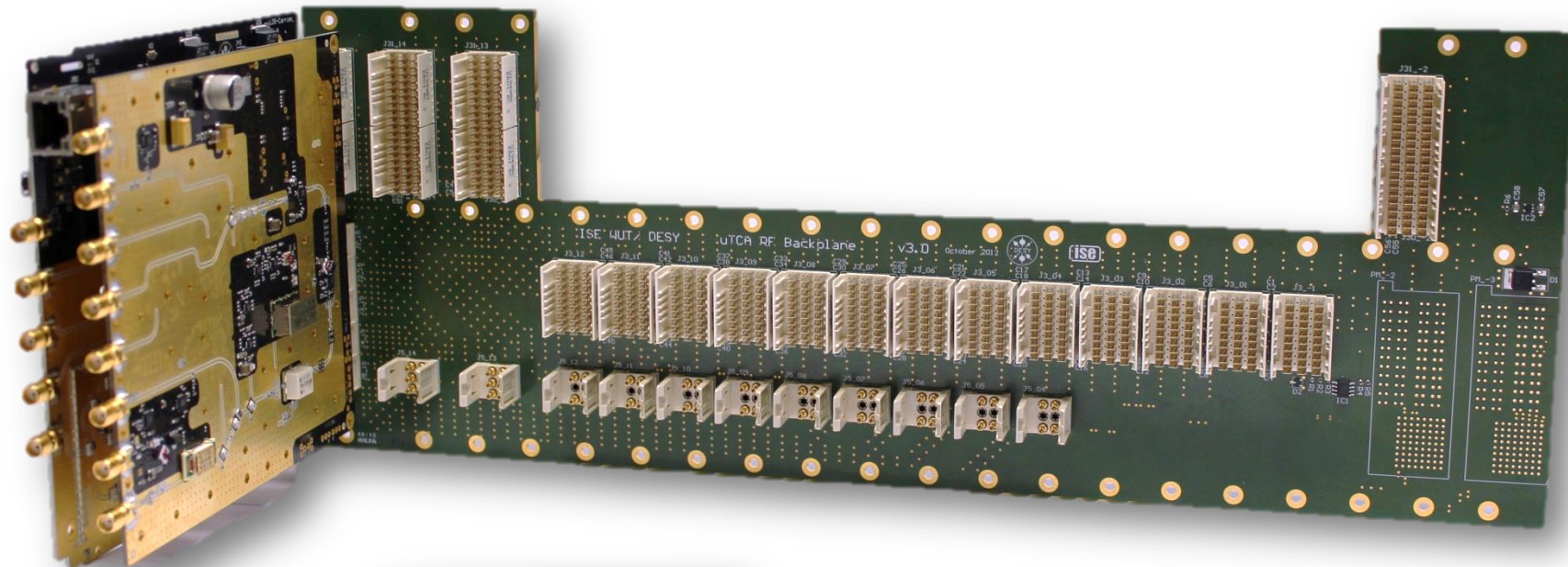
Managed RF/LO/Clk



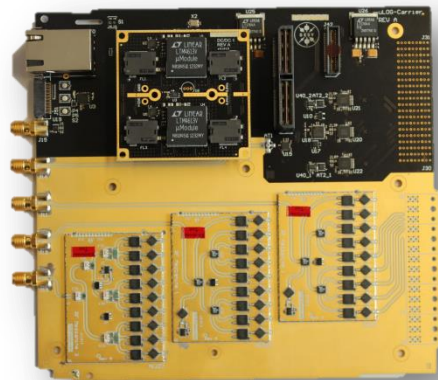
## ■ Extended rear module: eRTM



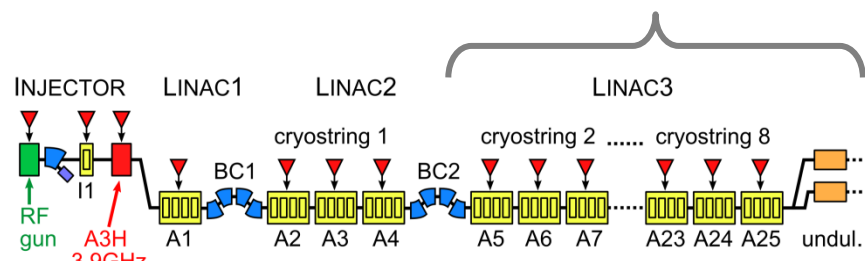
## ➤ uRFB with uLOG



uLOG RF carrier



L3 = 21 RF stations  
➔ 42 crates equipped with uRFB + uLOG



# Helmholtz Validierungsfond “MTCA.4 for Industry”

# Status: Kommerzialisierung von LLRF Modulen

## > a) Ergebnisse /Erfolge der wissenschaftlichen Arbeiten

- Komponenten: Module für Single/Multi Cavities (AP1.1-AP1.3)

### AP1.1.1: uDWC

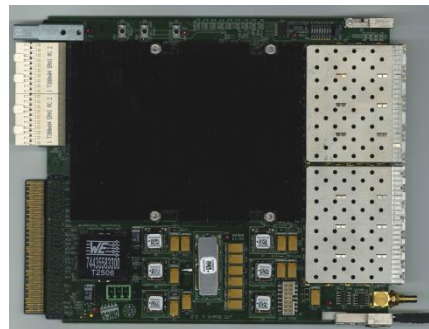
Entwicklung abgeschlossen  
**Lizenz an Struck vergeben**  
Produktion bei Struck erfolgreich  
Vorserie (40) in Lieferung



HF Felddetektor

### AP1.1.2: uTC

Prototyp im Test  
8 x 10GbE ok (32 MGT)  
Kintex7 K355/K420  
Nur kleinere Fehler/MMC  
Lizenz: Vadatech/I-TECH



Controller

### AP1.1.3: uVM

Prototyp im Test  
Analog (ok)/Digital ok  
Footprint Fehler  
Impedance matching  
Lizenz: I-TECH



HF-Steuereinheit

### AP1.1.4: uLOG

Prototyp im Test  
**Lizenz an Sandona vergeben**  
Peltier Regelung fehlt  
HF Mezzanine im Test



Lokale Frequenz & Clock Generierung



# Status: Kommerzialisierung von LLRF Modulen

## > a) Ergebnisse /Erfolge der wissenschaftlichen Arbeiten

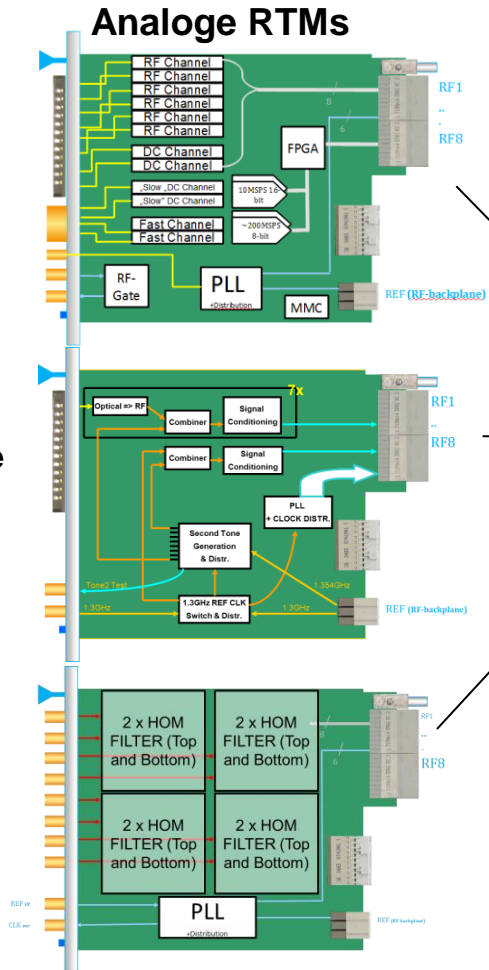
- Komponenten: Supplementäre Module (AP1.4)

### Anwendungs- Beispiele:

Klystron  
life-time  
Management

High-Order Mode  
Messungen  
(1.3/1.7/2.4GHz)

Femtosecond  
Fiberoptic  
Synchronization



### AP1.4.1: uDS800

#### Prototyp im Test

8 x 800MSPS, 12 bit  
Bestückungsfehler Firma  
Lizenz:Struck/Vadatech/CAEN



Sehr breites  
Anwendungsspektrum

Anfrage von  
ITER/Frankreich  
INFN/Italien  
KIT/Deutschland  
Uni. of Hawaii

Direkte HF Abtastung

DAMC-DS800

# Status: Kommerzialisierung von LLRF Modulen

## ➤ a) Ergebnisse /Erfolge der wissenschaftlichen Arbeiten

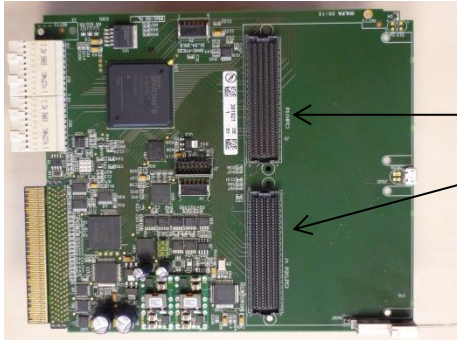
- Komponenten: Supplementäre Module (AP1.4)

**AP1.4.2.1: uFMC20**  
**Prototyp im Test, Rev.1**  
 Kostengünstig, FMC Carrier  
 Bauteilbeschaff., MMC  
**Breites Anwendungsfeld!**  
 Lizenz: Eicsys

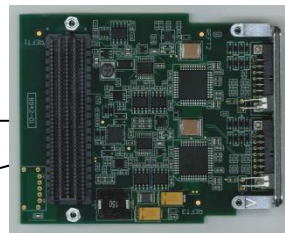
**AP1.4.2.2: FMC\_MD**  
**Entwicklung abgeschl.**  
 Kostengünstig  
 Real Time Motoranst.  
**Nicht Beschl. Spez.**  
 Lizenz: ESD, TEWS

**AP1.4.2.3: uPZ4**  
**Prototyp im Test**  
 HV-DCDC inkl.  
 kleine Fehler  
**Nicht Beschl. Spez.**  
 Lizenz: I-TECH, ...

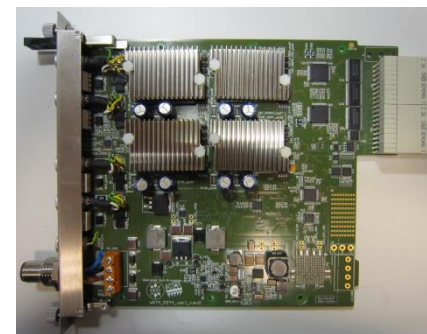
**AP1.4.2.4: uHVPS\_eRTM**  
**Projekt verschoben**  
 HV mit hoher Leistung  
 Steckmodul eRTM  
**Industrieauftrag**  
 Management AP1.5.1.1



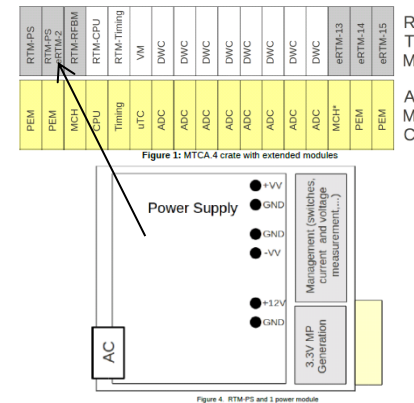
**FMC Trägerboard**



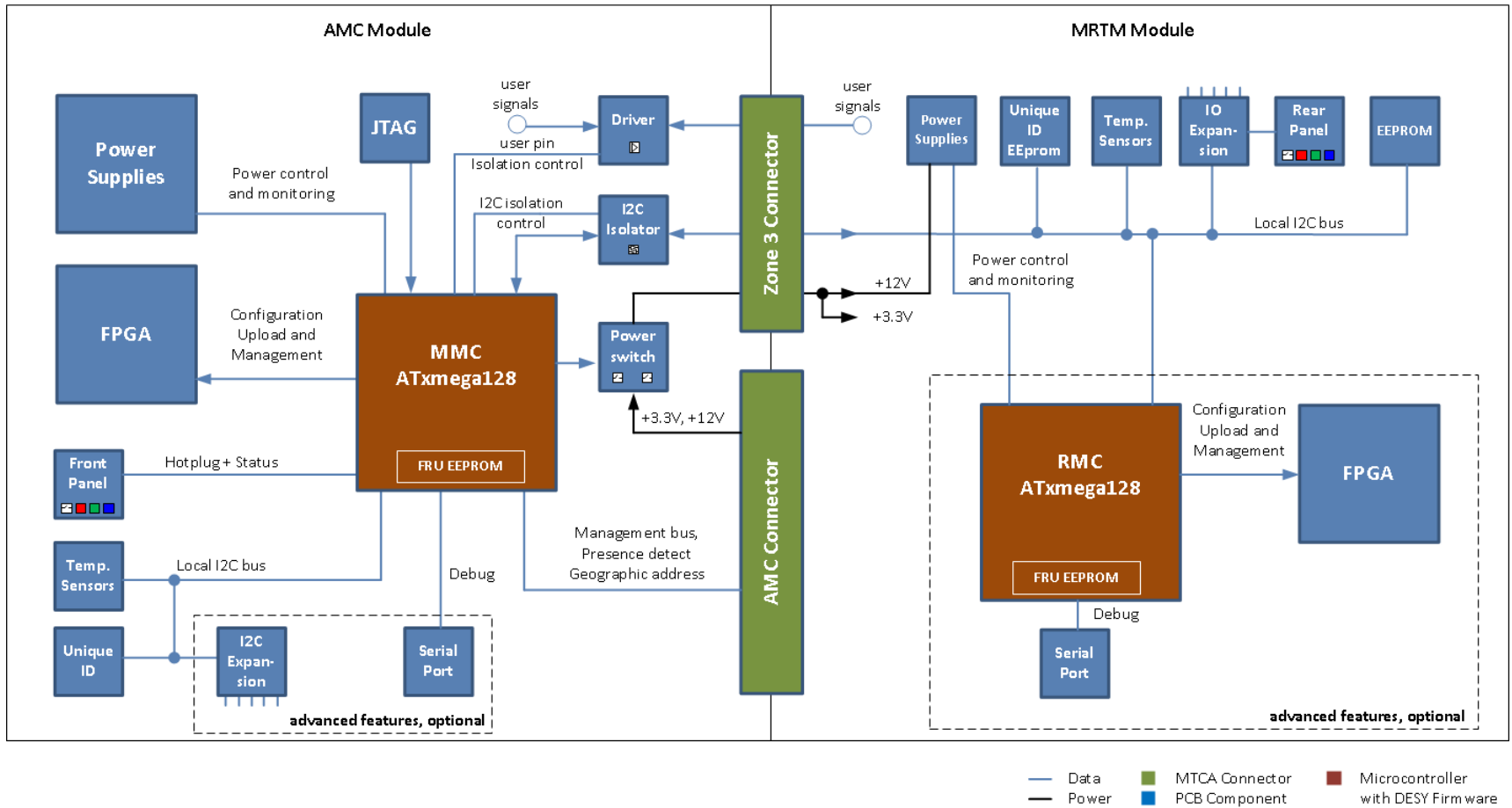
**Motor Treiber**

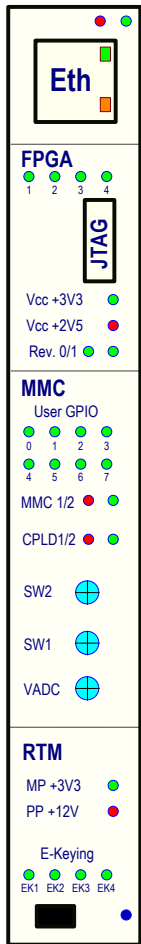


**Piezotreiber**

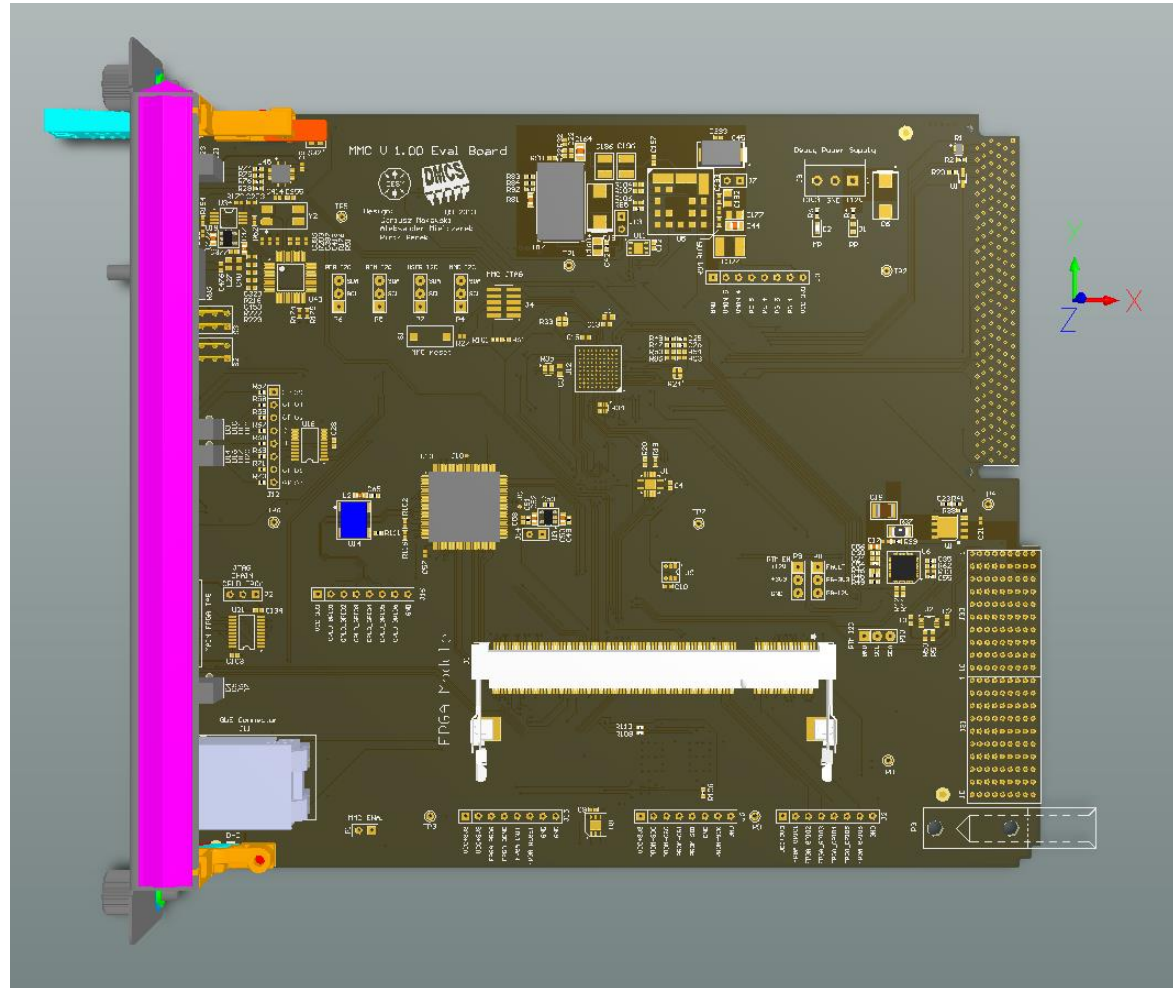


**HV-PowerSupply**

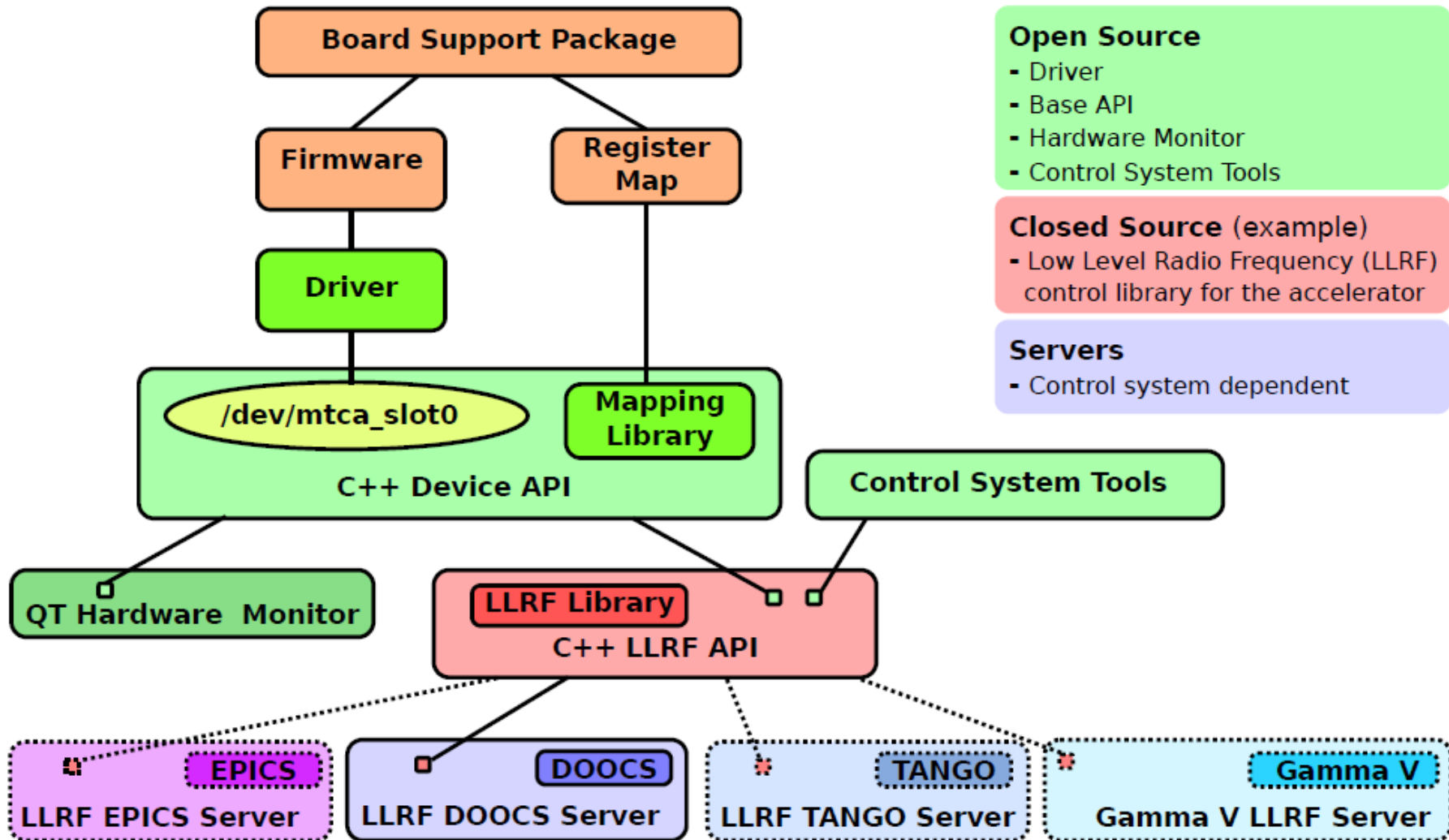




- > **FPGA**
- > Ethernet
- FPGA Interface**
- JTAG
- Dagnostic LEDs
- MMC**
- User GPIO LEDs
- MMC LEDs
- CPLD LEDs
- Switch, potentiometer
- RTM**
- MP and PP LEDs
- E-keying LEDs







## > b) Einsatzbereiche von LLRF Modulen

- Industrie: Exkurs zum Vorgehen

MTCA.4 Vorteile gegenüber dem Stand der Technik >> Relevanz für Industrie ?

### Powerful

- Outstanding digital signal processing performance through serial bus topology (dedicated point-to-point links between slots)

### Precise

- Low jitter clocks and interlocks
- High signal integrity through separation of analog and digital signal processing

### Versatile

- Large variety of crate sizes and board form factors available
- Growing portfolio of specialized as well as general purpose applications
- Multiple combinations of AMC/RTM boards

### Reliable

- High system availability through extensive component redundancy options (redundant power supply, MCH controller, AMC/RTM boards)
- Reduced down-time through *hot swap* capability

### Economical

- Proven ATCA technology in a compact format at affordable prices
- Lower space requirements and energy consumption levels
- Advanced remote diagnostics/ remote maintenance features reduce down-time and operating costs

### Broadly Supported

- "xTCA for Physics" interest group (40+ members, incl. Intel, Kontron, SLAC, DESY, FNAL, NAT, Pentair)
- Modular open system approach: open architecture, multiple vendors supply standard-compliant components
- Dedicated PICMG subcommittee on MicroTCA® advances standard
- Growing community of manufacturers, developers and users (<http://mtca.desy.de> ↪ "Community")

- Signalverarbeitungskapazität
- Signalintegrität/ Präzision
- Skalierbarkeit
- Zuverlässigkeit/ Redundanz
- Wartungsfreundlichkeit
- Preis/Leistungsverhältnis
- Offener Standard mit breiter Unterstützung

# Marktstudie begonnen

## > b) Einsatzbereiche von LLRF Modulen

- Industrie: Vorläufige Einschätzung Stand August 2013

