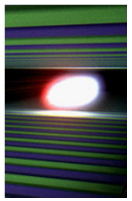
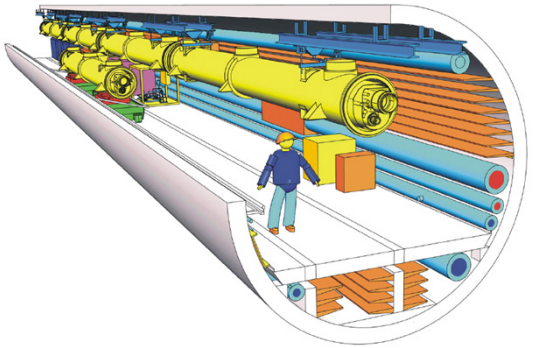


Next Generation Electronics based on µTCA for Beam-Diagnostics at FLASH and XFEL

Patrick Gessler, DESY/XFEL

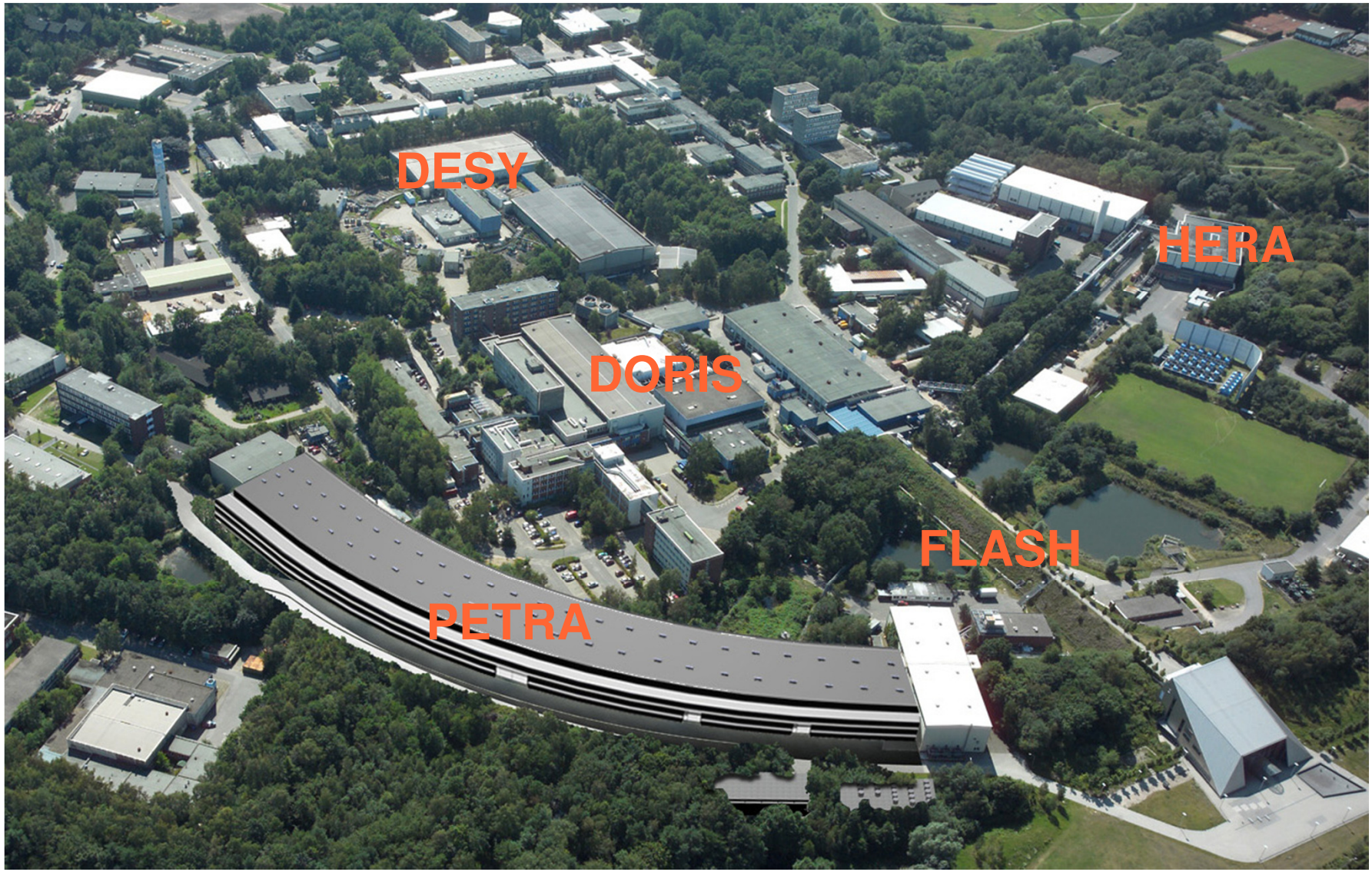
Motivation and Outline



- Introduction: DESY and the XFEL
- Features of the new µTCA standard (MTCA.4)
- Management features
- Required components for Diagnostics

European XFEL

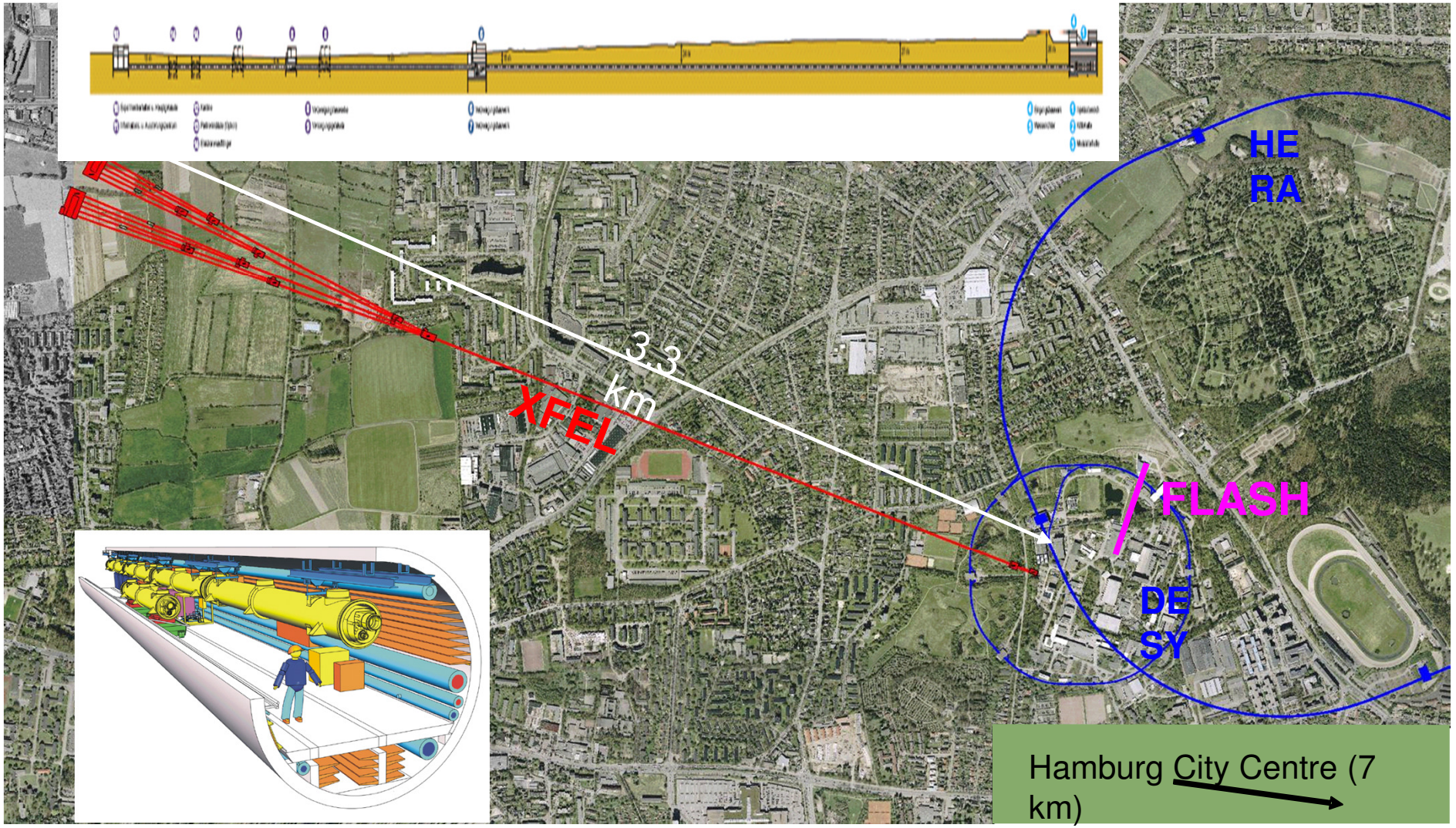
Accelerators @ DESY



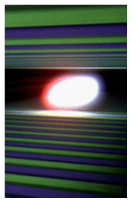
DESY

HELMHOLTZ ASSOCIATION

The XFEL Project



Control System of an Accelerator



- About 200 µTCA crates
- Data acquisition from DC to 3.9 GHz
- High speed communication
  - PCIe to I/O
  - Ethernet 3 km
- Has to operate 24/7
  - Some redundancy
- Well defined management
  - A must for large systems and for high availability
- Hot-swap
  - Safe against hardware damage and software crashes

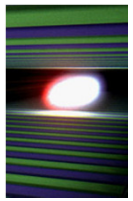
The XFEL will be Based on µTCA



- Scaleable modern architecture
  - From 5 slot single … 12 slot double size
- High availability
  - Redundant power and fan optional
  - Well defined management
- Differential links only: high analog signal processing quality

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

Results of the µTCA Evaluation



- We did it the hard way:
  - Crates, CPUs, IO and MCH from different vendors
- Management of crates is well defined
  - Dynamic module and crate info gives all relevant info
- Fast data transfers (>400MB/s on 4 lanes PCIe)
- Hot-swap (implemented and tested with Solaris and Linux)
- Good decoupling of modules on the backplane
- Good analog performance
- µTCA standard requires a few additions
  - The specs are made for telco, customized solutions, we want COTS → xTCA for Physics @ PICMG

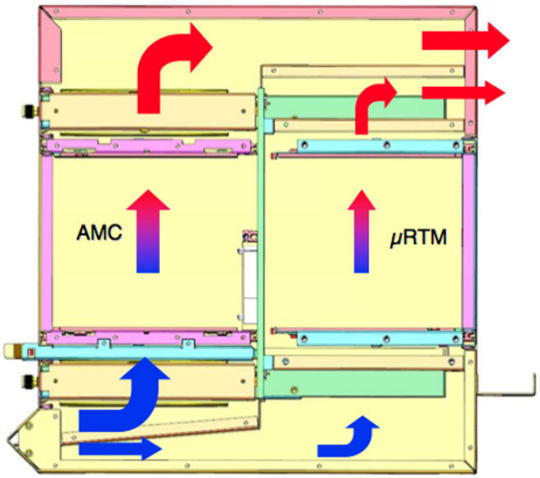
→ xTCA platform is a good basis for large installations

PICMG Group: „xTCA for Physics“ - Members

MTCA.4 was developed by

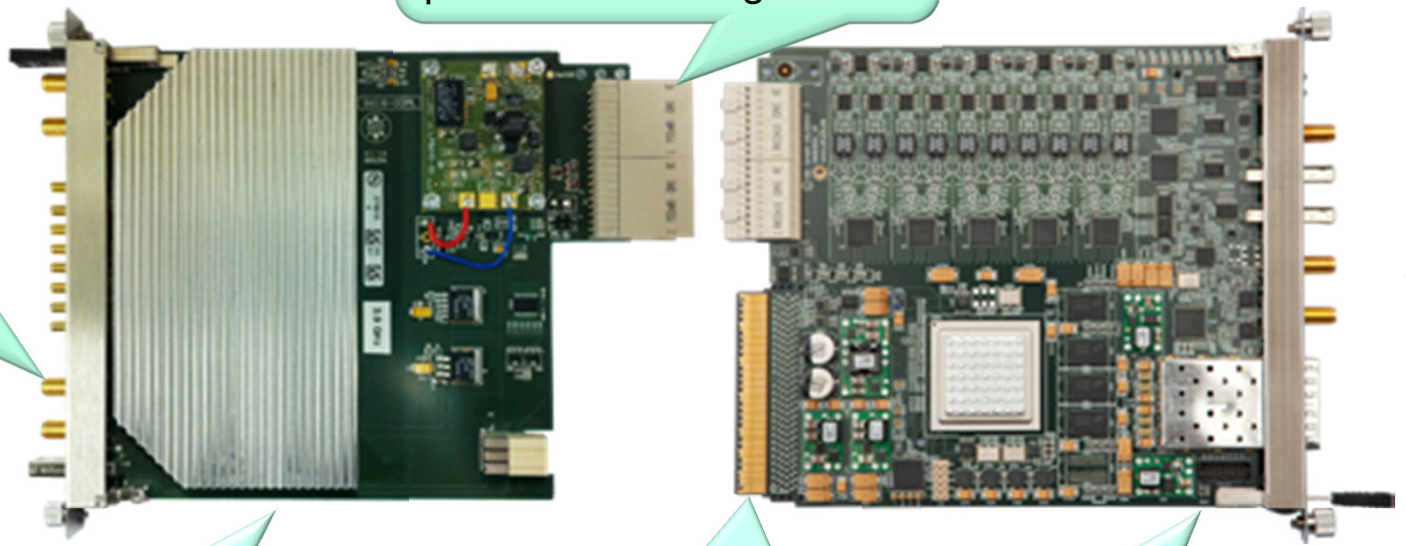
- Science
  - SLAC, California
  - FNAL, Chicago
  - IHEP, Beijing
  - IPFN, Lisboa
  - ITER, Cadarache
  - DESY, Hamburg
- 38 corporations
  - Crate, board, system and connector manufactures

http://www.picmg.org/



Airflow of a MTCA.4 shelf

PICMG MTCA.4



Connector:
Analog or digital signals, power and management

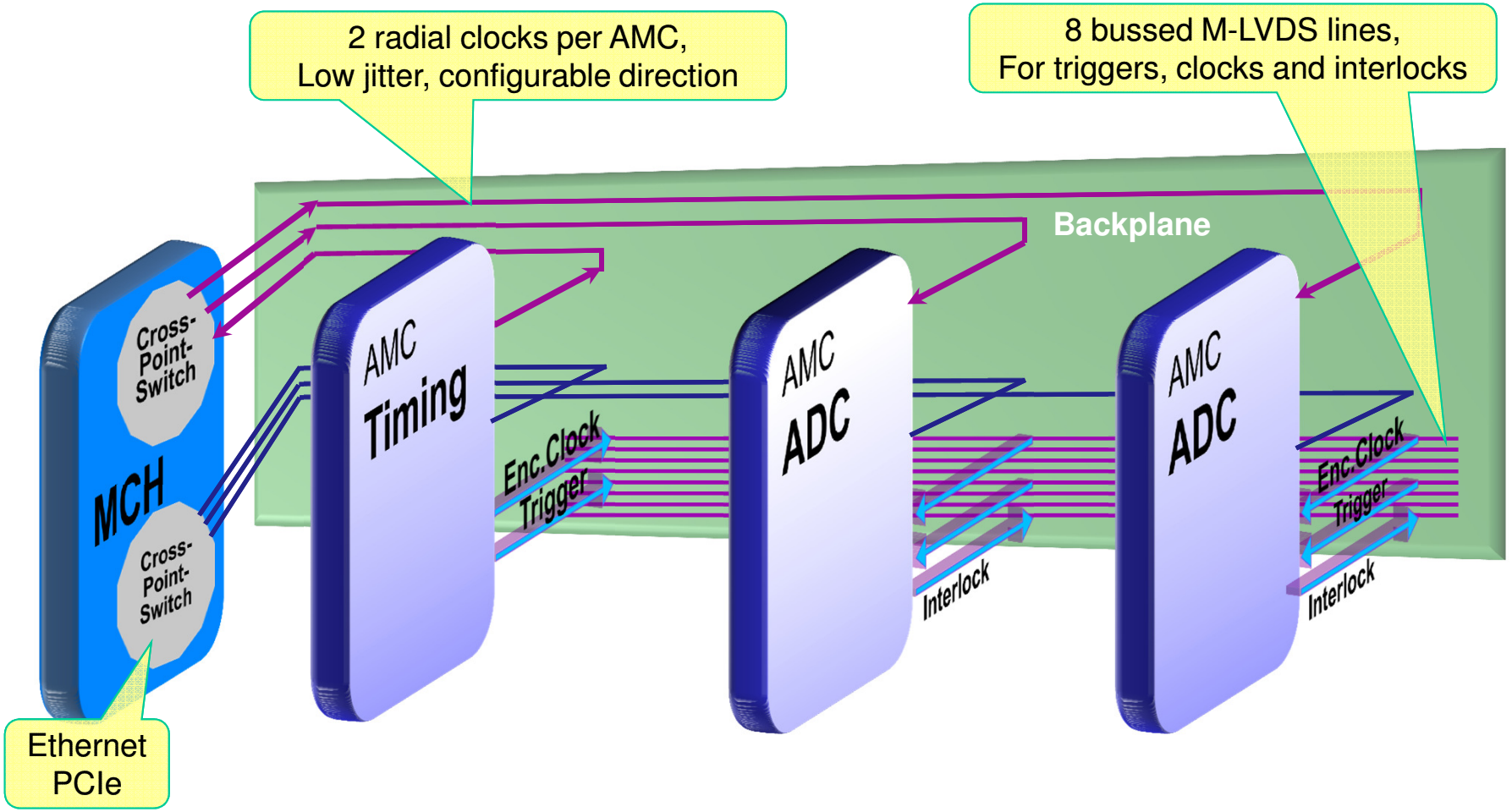
Cables from rear e.g. SMA 1.3GHz

µRTM:
I/O adapter,
Application specific signal conditioning and cable adapters

AMC connector:
Ethernet and PCIe, Clock and Trigger

Standard front **AMC**:
FPGA with high speed data links,

Clock, Trigger and Interlock Signals



MTCA.4: Available Shelfs

12 Slot

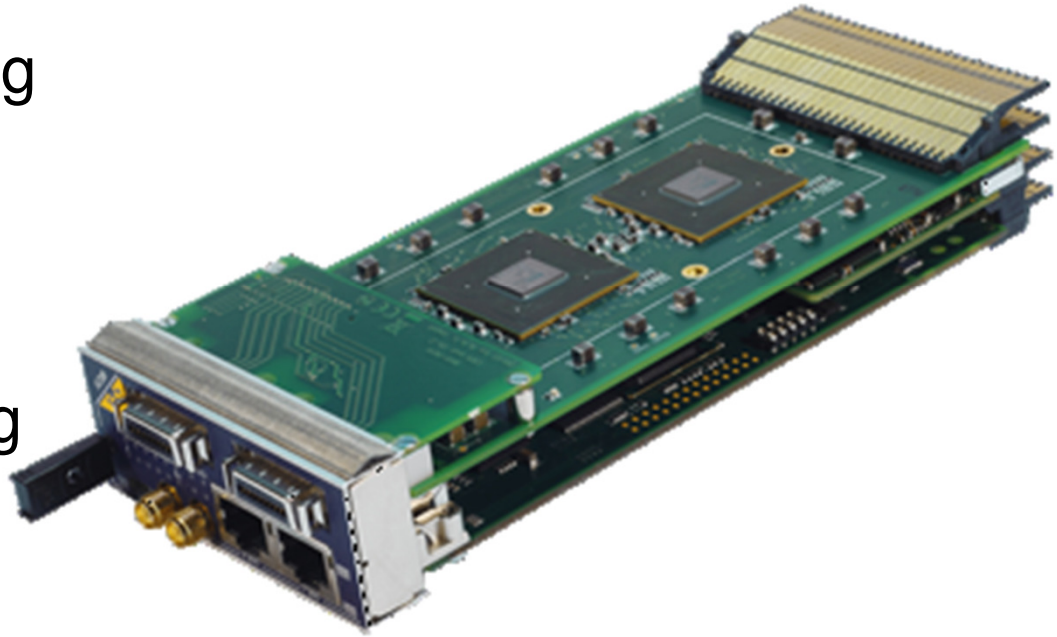
6 Slot

Elma

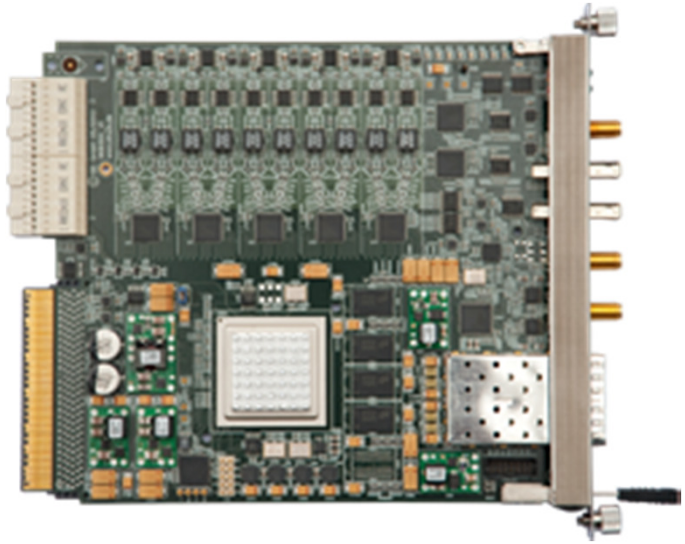
Schroff

µTCA Carrier Hub (MCH)

- Management
  - Cooling
  - Power supply
  - Hot-swap
  - Electronic keying
  - Remote access
  - Alarms
- PCIe switching
- Gb Ethernet switching
- Clock distribution



Analog-to-Digital Conversion

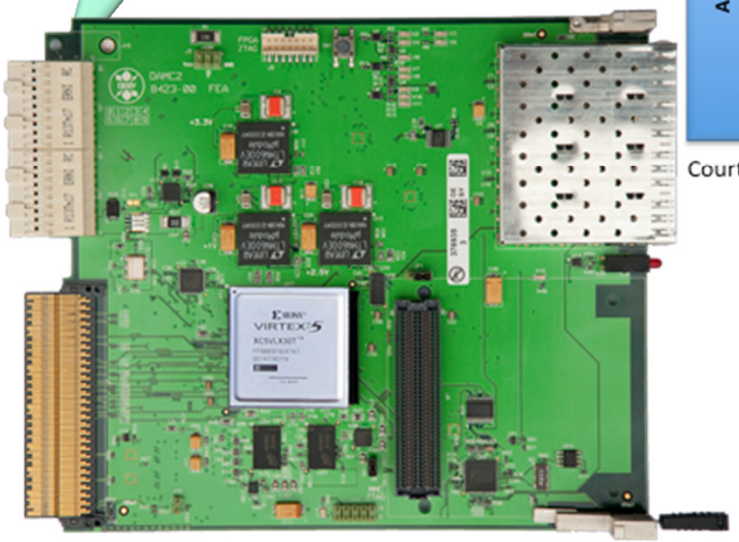


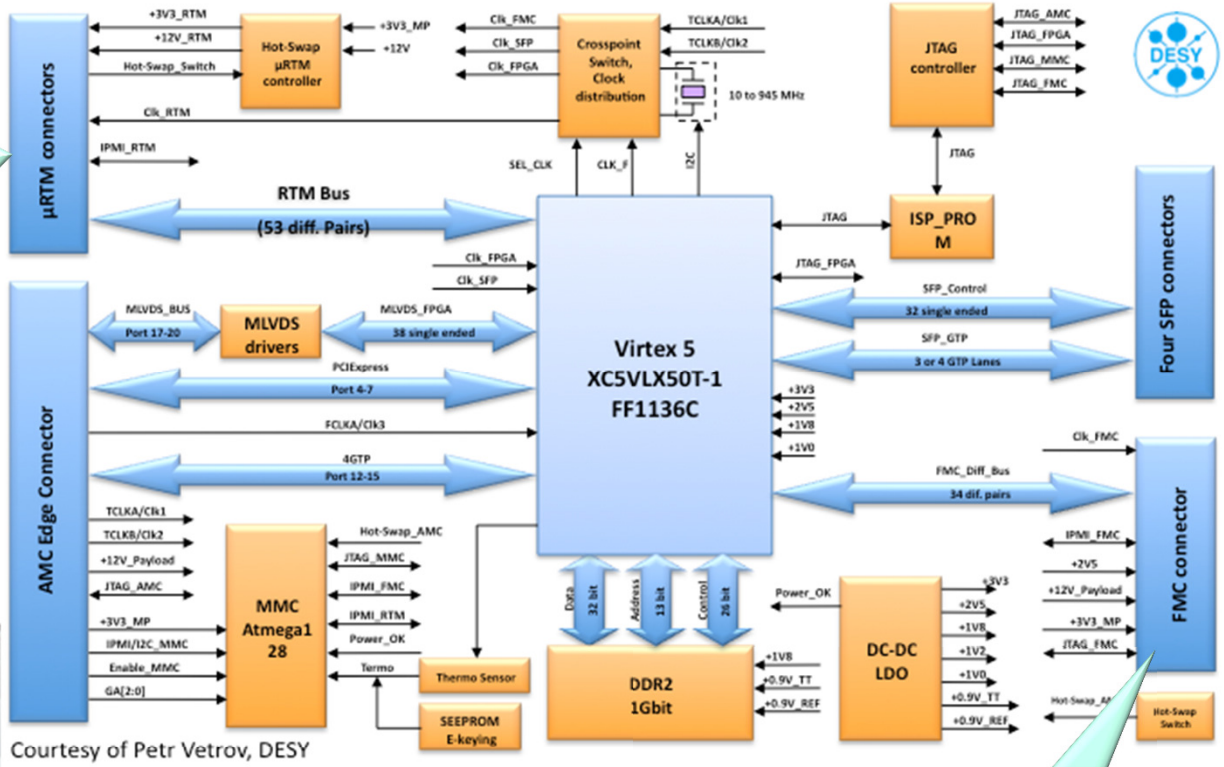
Signal Conversion
Splitting
Integration
Filtering
…

Clock shifting
Signal digitizing
Processing
Controlling
…

DAMC2: a Versatile Digital AMC (DESY)

MTCA.4 µRTM:
53 diff. Lines for general I/O applications,
Standard management



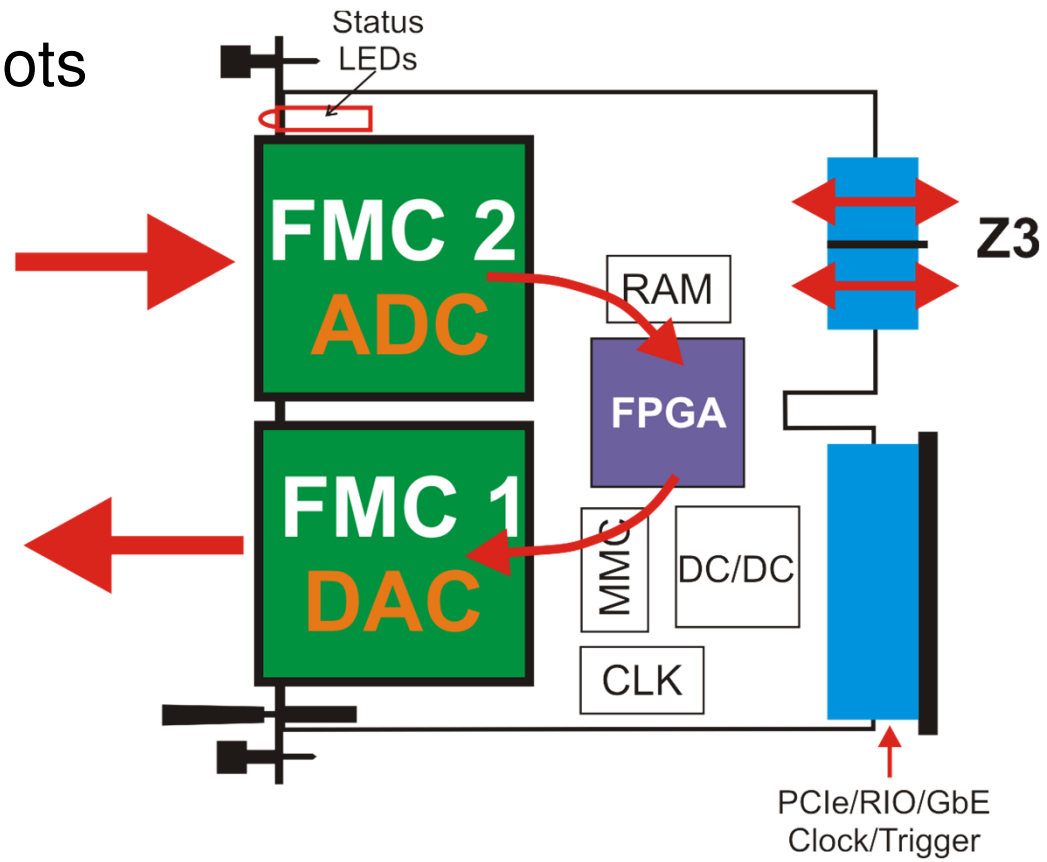


Courtesy of Petr Vetrov, DESY

FMC (Vita 57) Slot:
Additional I/O

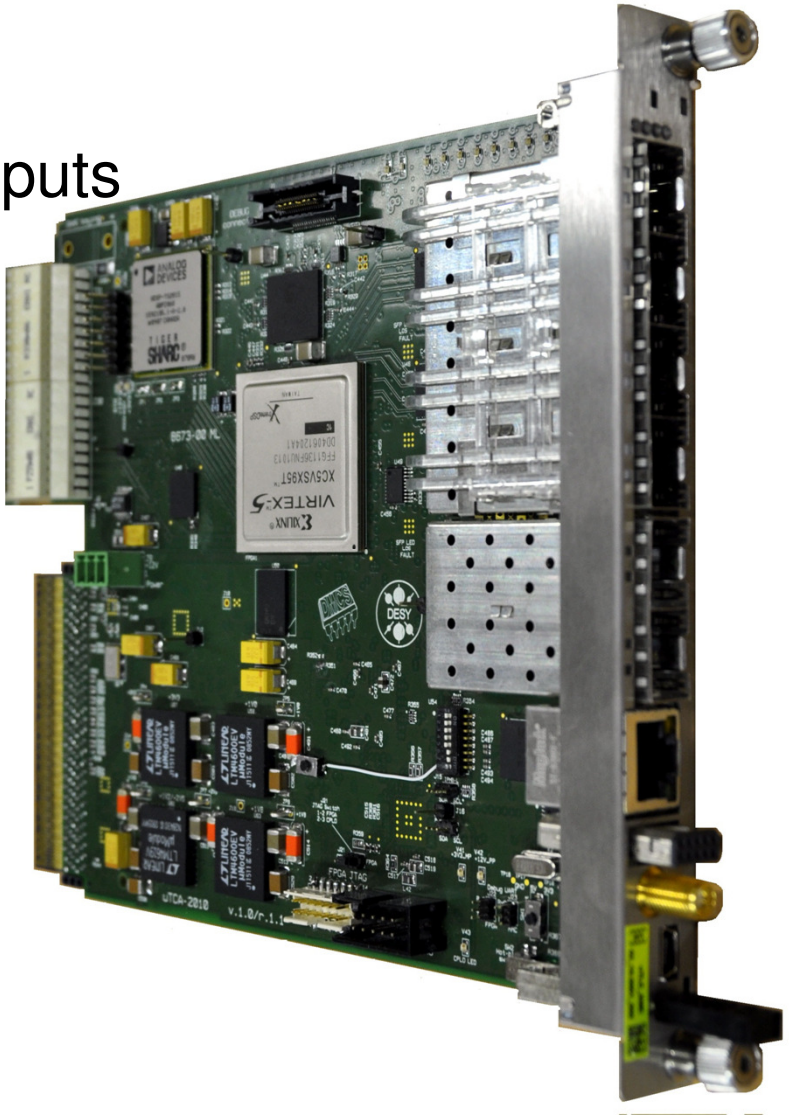
Low Cost Double FMC Board

- Low cost FPGA
- Two or double FMC slots
- Possible Applications
  - ADC
  - DAC
  - DSP
  - I/O



A Signal Processing and Controller AMC

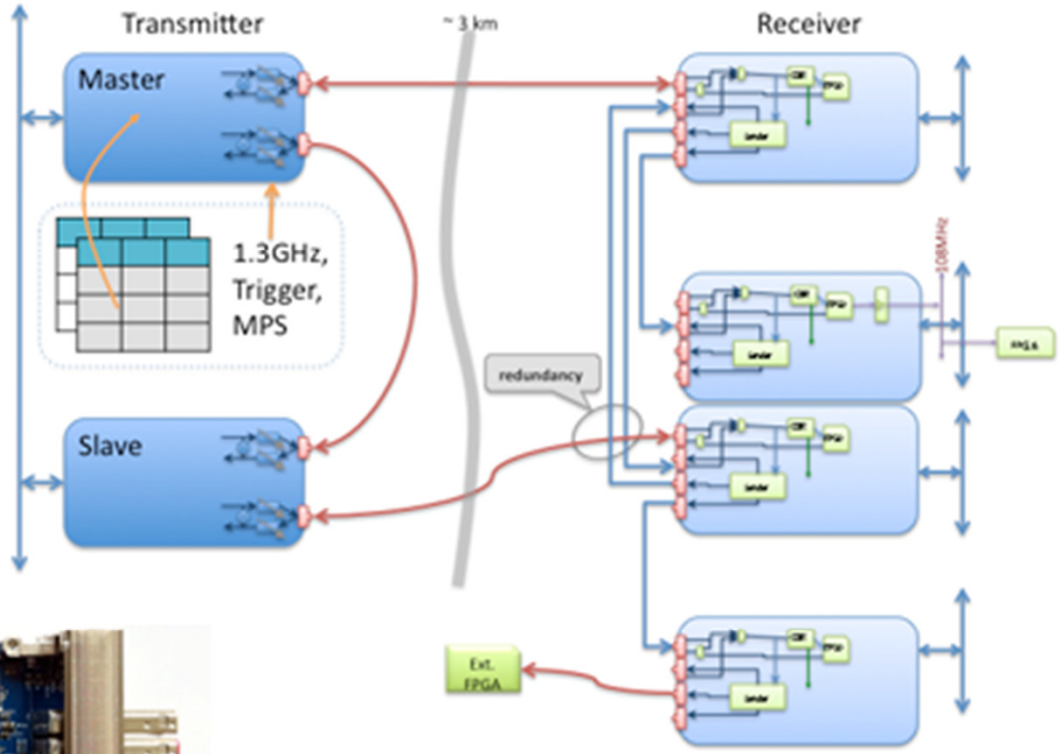
- High performance FPGA
- Many high speed inputs and outputs
  - SPF on the front
  - On the RTM connector
  - On the AMC connector
- Dedicated DSP (Tiger Sharc)
- Applications
  - Data processing
  - Data reduction
  - Real time feedback



A Timing System to Sync the Overall Facility

Goal:
Stability of <= 5ps RMS

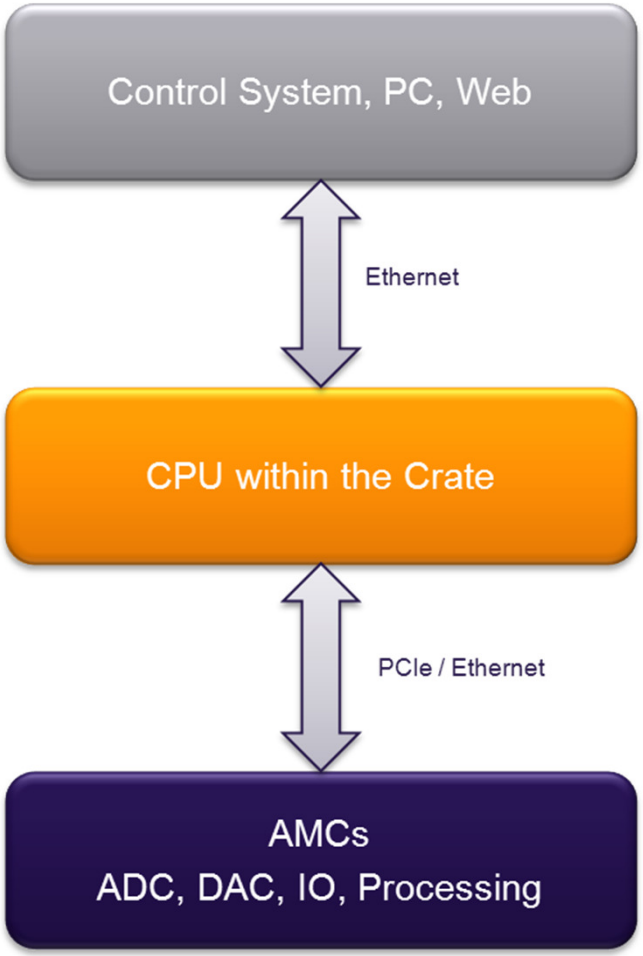
Transmitter <-> Receiver Connections



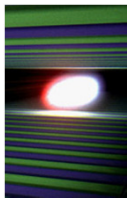
Prototype receiver / transmitter with
MTCA.4 clock and trigger distribution

> 3 km

Central Processing Unit (CPU)



Status and Conclusions

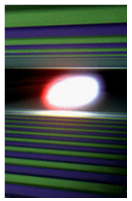


- MTCA.4 Specification will be published in June ‘11
- Is fully compatible to AMC and MicroTCA standards
- Provides extensions for
  - Rear I/O with adequate space for I/O
  - Timing and synchronization
- Prototypes of required hardware and crates are available
- Excellent analog performance has been demonstrated
- Well defined (remote) management supported

→ **µTCA** is a good platform for large installations in industry and science

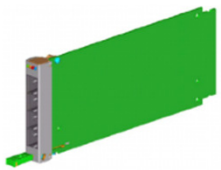
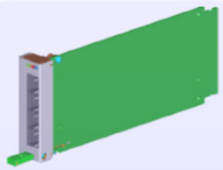
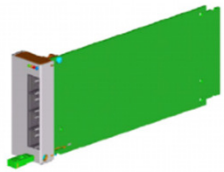
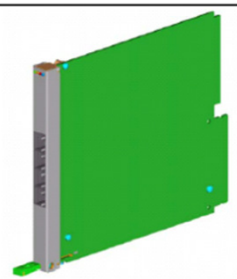
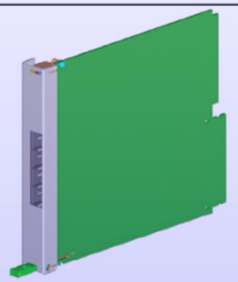
Status of the XFEL

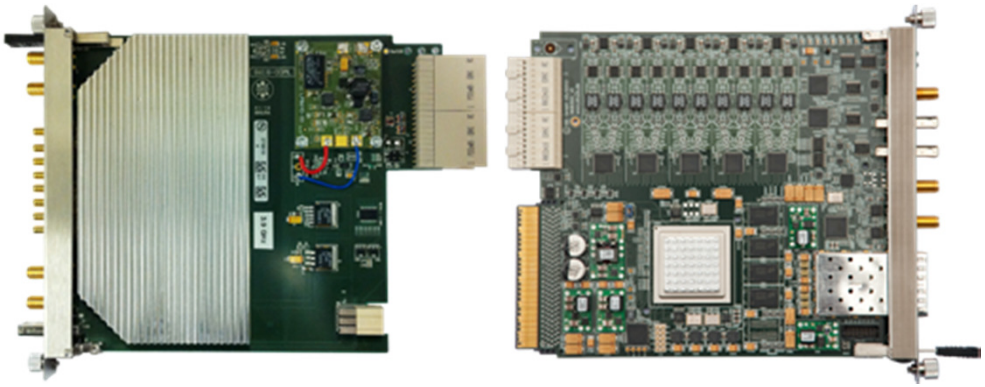
Thank you
for your attention



Spare Slides

µTCA Form Factors

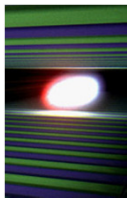
	Compact-Size (3HP)	Mid-Size (4HP)	Full-Size (6HP)
Single modules	 73.8x13.88x181.5mm	 73.8x18.96x181.5mm	 73.8x28.95x181.5mm
Double modules	 148.8x13.88x181.5mm	 148. 8x18.96x181.5mm	 148. 8x28.95x181.5mm

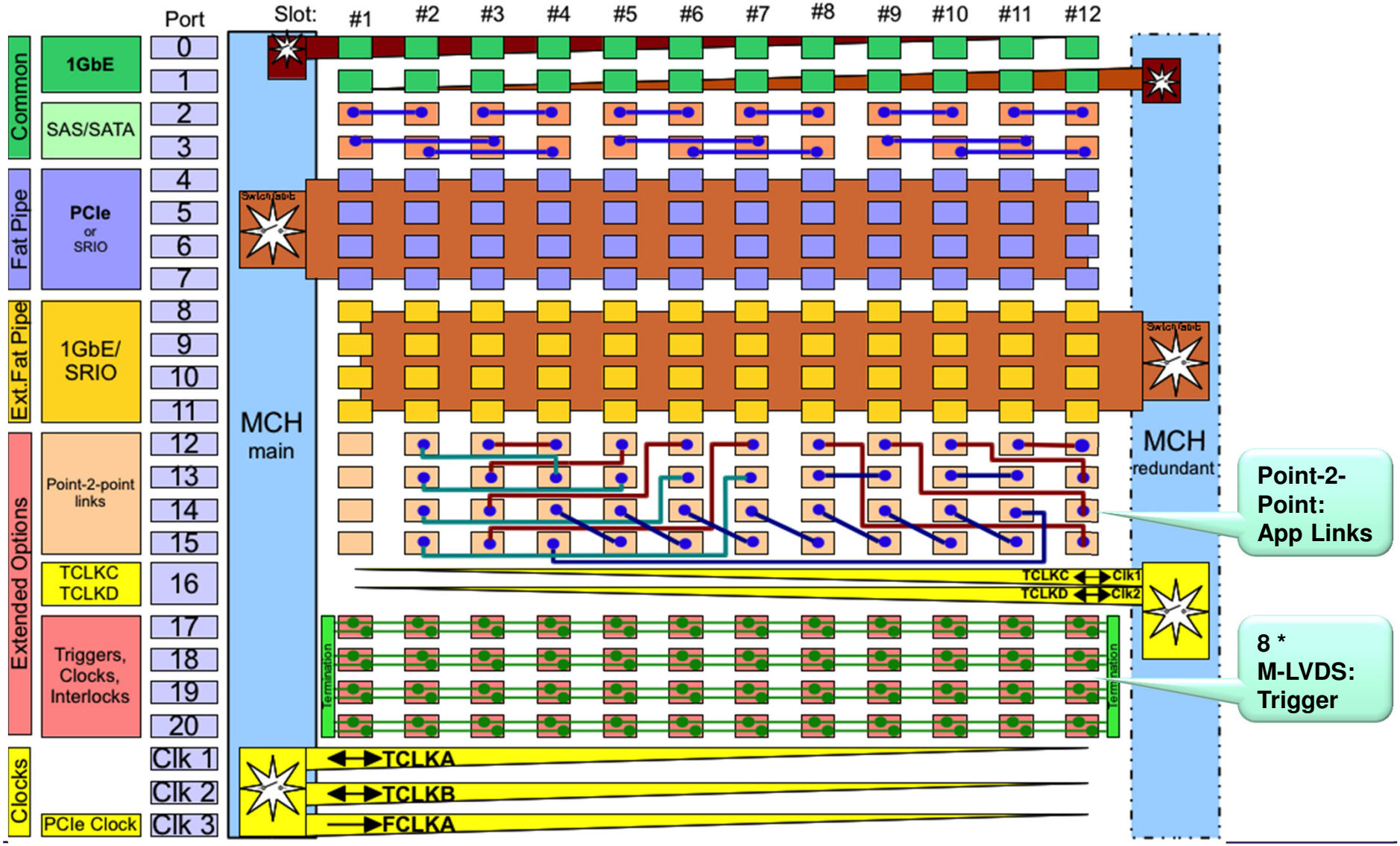


MTCA.4 Extension

European XFEL

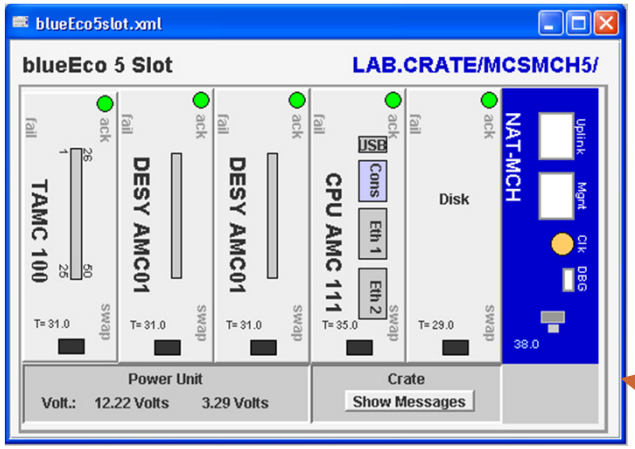
12 Slot MTCA.4 Backplane





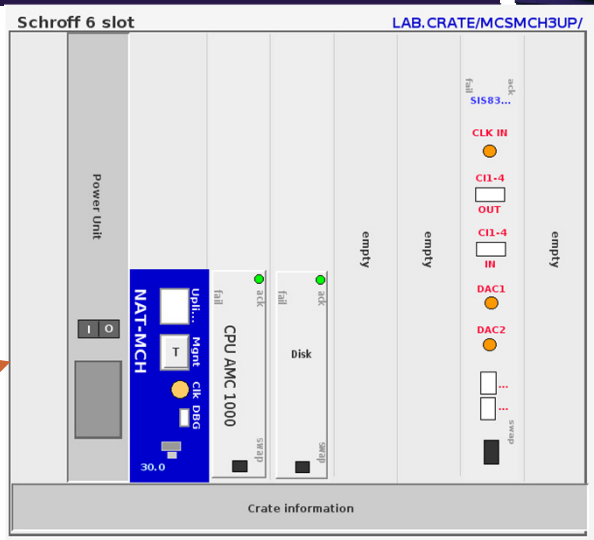
DESY HELMHOLTZ ASSOCIATION

Management Integration



jddd

JAVA Application

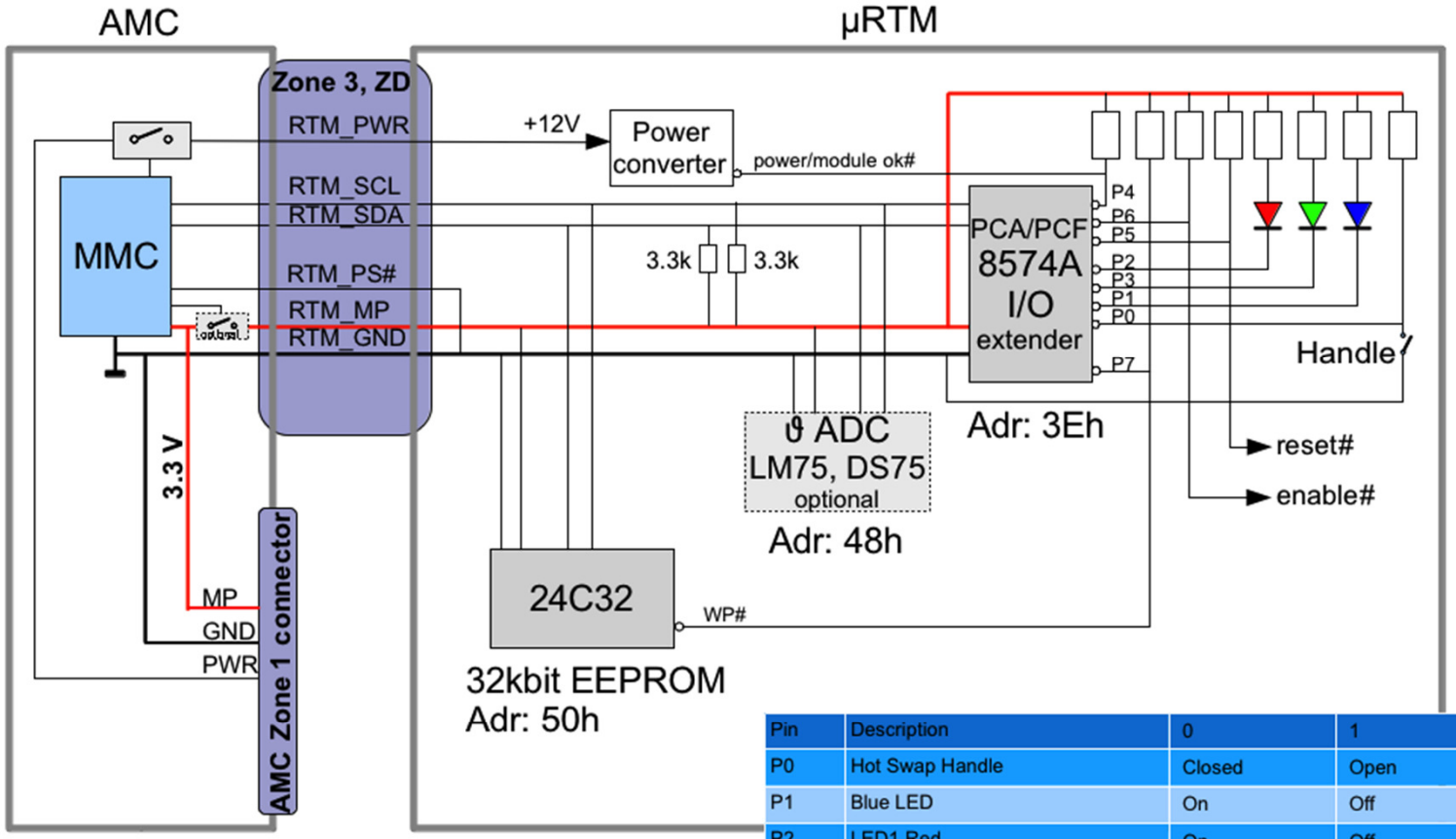


DOOCS

XFEL IPMI Server

IPMI

µRTM Management: one Solution



Pin	Description	0	1
P0	Hot Swap Handle	Closed	Open
P1	Blue LED	On	Off
P2	LED1 Red	On	Off
P3	LED2 Green	On	Off
P4	MRTM Power Good# (Optional)	good	Not good
P5	MRTM Reset# (Optional)	Asserted	Not Asserted
P6	MRTM Enable# (Optional)	Enabled	Disabled
P7	EEPROM Write Protect (Optional)	Write enable	Protected

I/O pin assignment of the 8574 I/O extender

Standard µRTM Interface
Version 5. 5. 2011, KR