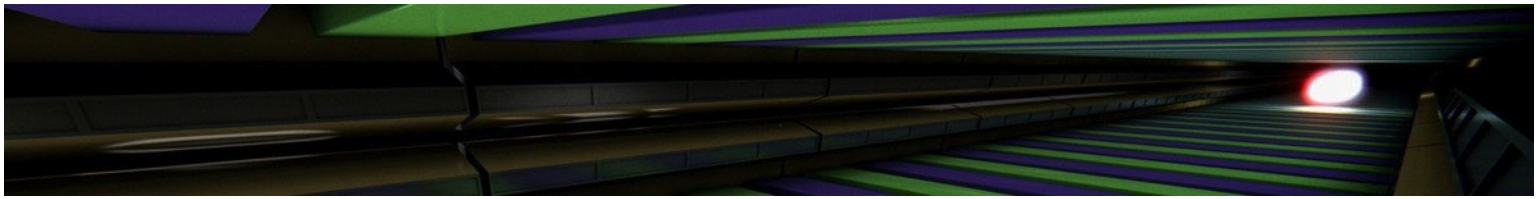
European XFEL



MicroTCA Development and Status

Kay Rehlich

19. Mar. 2013

DESY

European XFEL

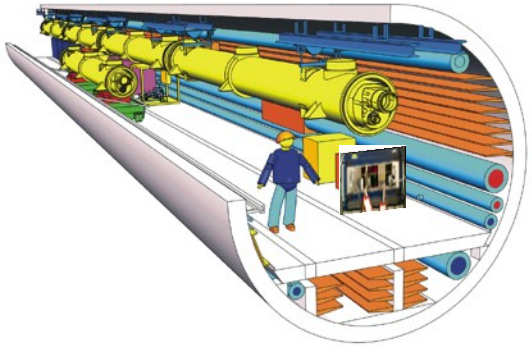
Motivation and Outline

1993 2015

FLASH + FLASH 2

XFEL start

- History
- Concepts
- Helmholtz Validierungs Fond
- Status
  - Hardware
  - Software
- Conclusions



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History of MircroTCA @ DESY

- **Nov. 2005: Reliability Workshop in Grömitz**
  - Joint meeting with ILC
- **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 Validierungs Fond**
  - „MicroTCA.4 for Industry"

European XFEL

First µTCA Systems: BPM / Toroid ... LLRF

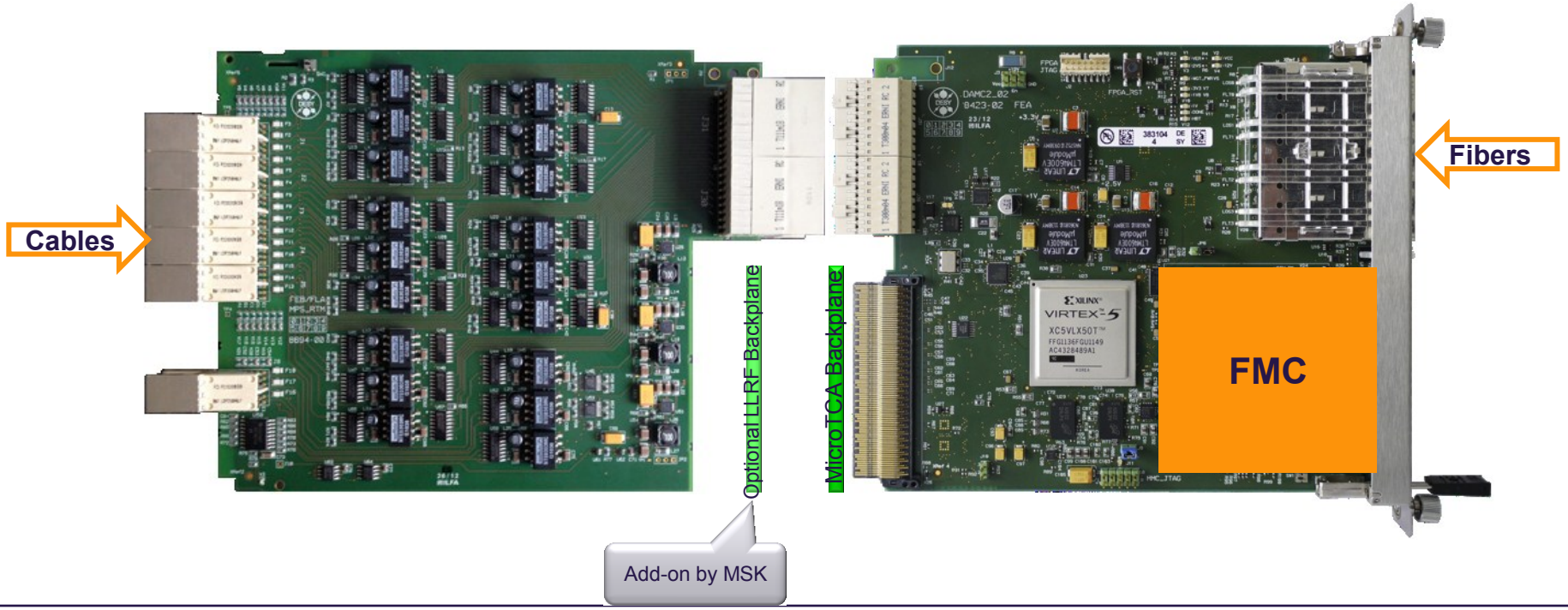
- **2009**
- System includes:
  - Single size AMC with ADC mezzanine
  - Timing with IP carrier
- Start working on **MTCA.4**

- **2011**
- System includes:
  - Double size ADCs + RTMs
  - Timing AMC with trigger distribution on backplane
- Implements new **MTCA.4** standard

European XFEL

MTCA.4: a Modular Concept

- **R**ear **T**ransition **M**odule
  - Interface adapter
  - Direct connection to subsystems
- Front **AMC**
  - Complex Modules with standard interfaces



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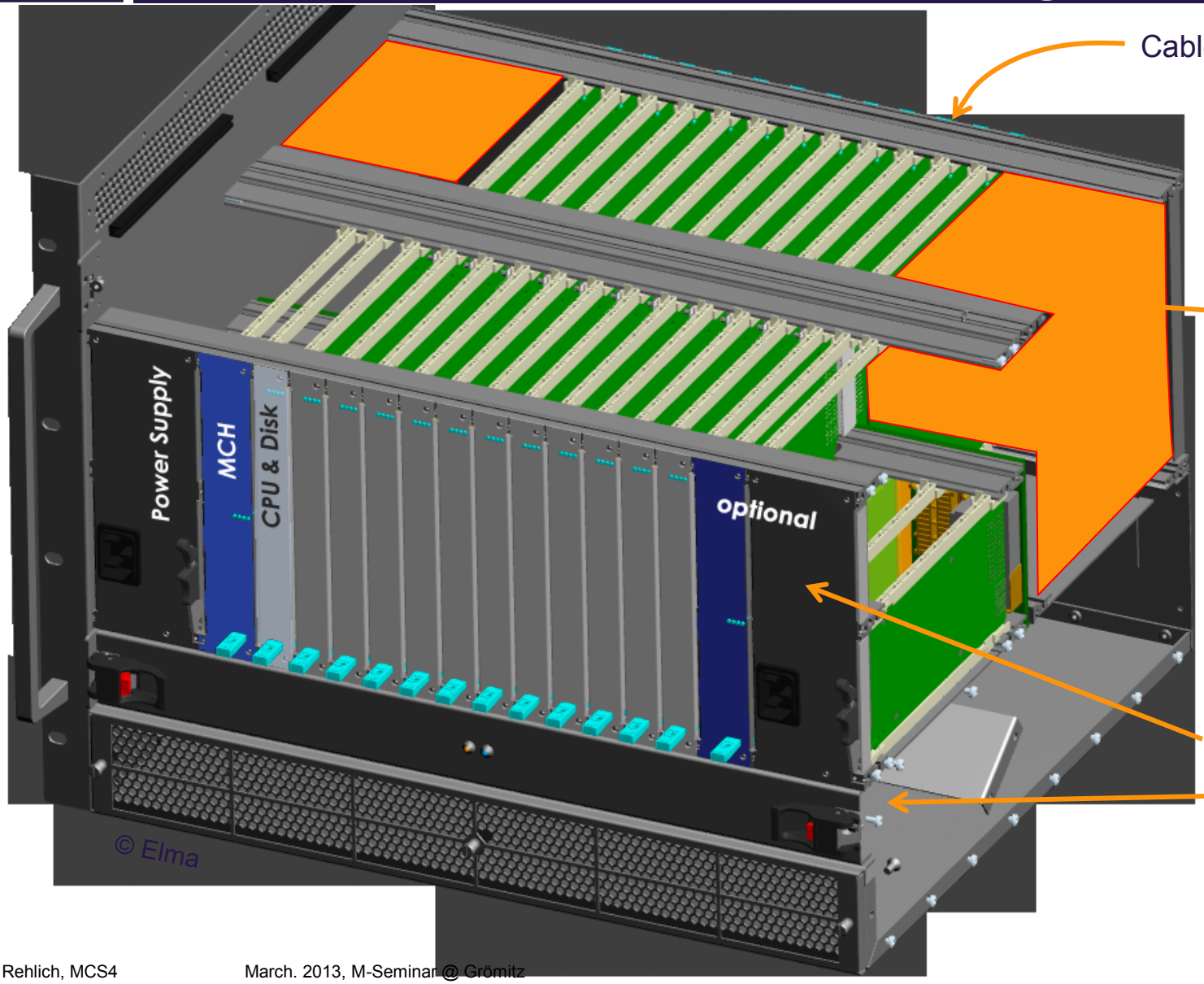
MicroTCA.4: Compact Modular Design



Cables from rear side

Space for ….

Redundant:
- Power
- Fan

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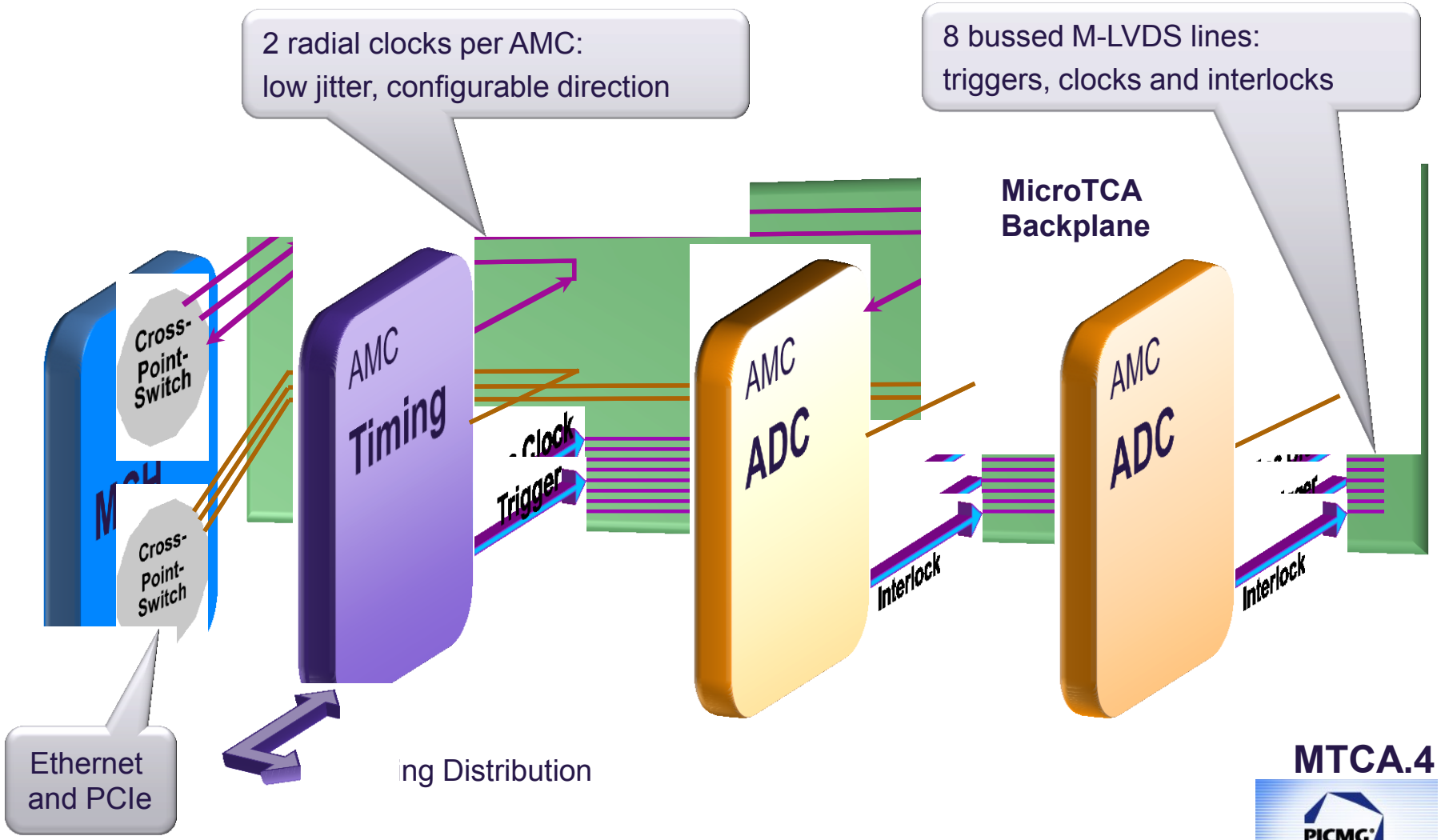
MTCA.4: Clocks, Triggers and Interlocks



MTCA.4

PICMG

DESY HELMHOLTZ ASSOCIATION

Helmholtz Validierungs-Fond

MTCA.4 for Industry and Research

HELMHOLTZ | ASSOCIATION

DESY

struck innovative systeme

ELMA Your Solution Partner

Schroff®

AD-TE-C

N.A.T.

TEWS TECHNOLOGIES

THOMSON

4 Mio. €

Support from Helmholtz Association

- To foster industrialization of MicroTCA.4 incl. LLRF
- DESY designs → industry (licensing)
  - Cost and quality improvements
  - New modules to complete portfolio
- Supporting industry to
  - Add missing modules
  - Improve EMI with test environments and shielding
  - Gain new MicroTCA.4 applications in more markets
- Support for institutes and industry
  - Consulting: Help to start with MicroTCA
  - User guide and Web Site
  - Organization of workshops and contributing at exhibitions
- Project duration: mid 2012 … mid 2014

MTCA.4: DESY has a leadership role

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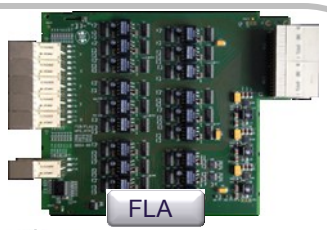
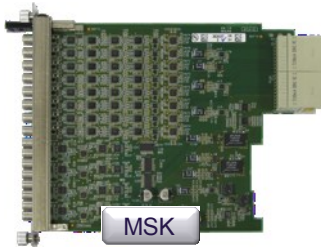
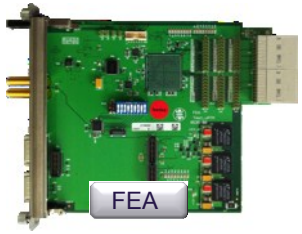
Digital AMC's and RTM's

RTM

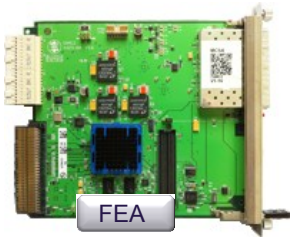
- MPS Signal adapter
- ADC and DAC – *DRTM-AD84*
  - 8 ch ADC 95 MSPS, 16bit
  - 4 ch DAC 16 MSPS, 16bit
- Test RTM
- Coupler Interlocks
- Beam Loss Monitors MDI
- Toroid protection / readout MDI
- Wire Scanner MDI
- Clock & Trigger Contr. for Exp.







AMC



- DAMC2
  - Virtex 5
  - FMC
  - 4 * SFP
  - **100 available**

- TAMC651
  - Spartan 6
  - 1 SFP

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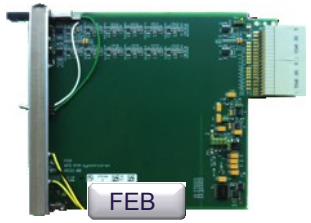
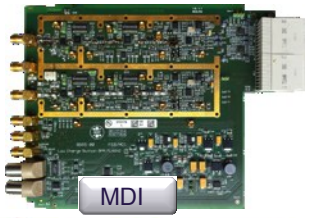
Analog AMC's and RTM's

RTM

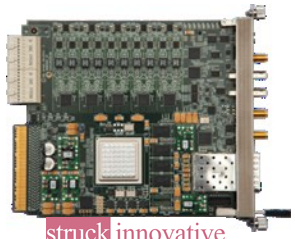
- 1,3 .. 3.9 GHz down converter
- 2 ch APD pulse stretcher
- BPM
- LEMO adapter SIS8900





struck innovative systeme

AMC



struck innovative systeme

- 10 ch. 16 bit ADC
  - 125 MSPS
  - 2 ch DAC
- SIS8300
  - Virtex 5
  - 2 * SFP
- SIS8300L
  - Virtex 6
  - In preparation

vadatech THE POWER OF VISION

- AMC520
  - Virtex 6

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MTCA.4: Available Shelfs @ DESY

12 Slot

✔

6 or 7 Slot

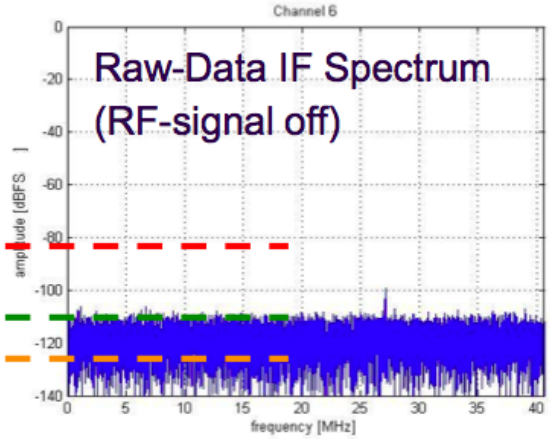
Elma

Schroff

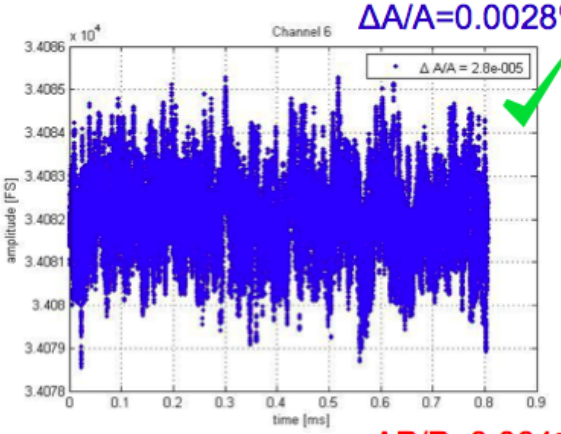
Power Supplies

- Short term stability in an MTCA.4 crate (laboratory) :

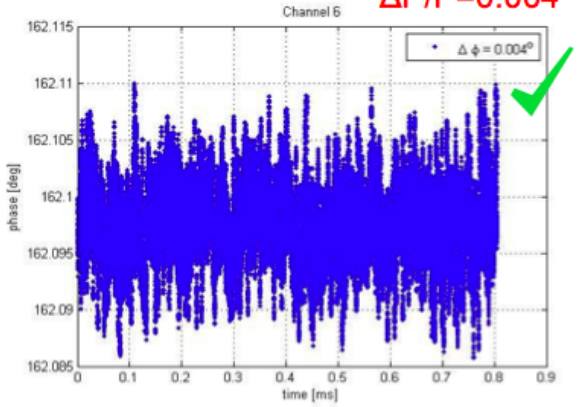
Series Available mid 2013



ΔA/A=0.0028%



ΔP/P=0.004°



Poor Power Supplies : > -80dB SFDR

Power-Entry-Modules: < -110dB spurious free

VS-Scaling : < -120dB SFDR

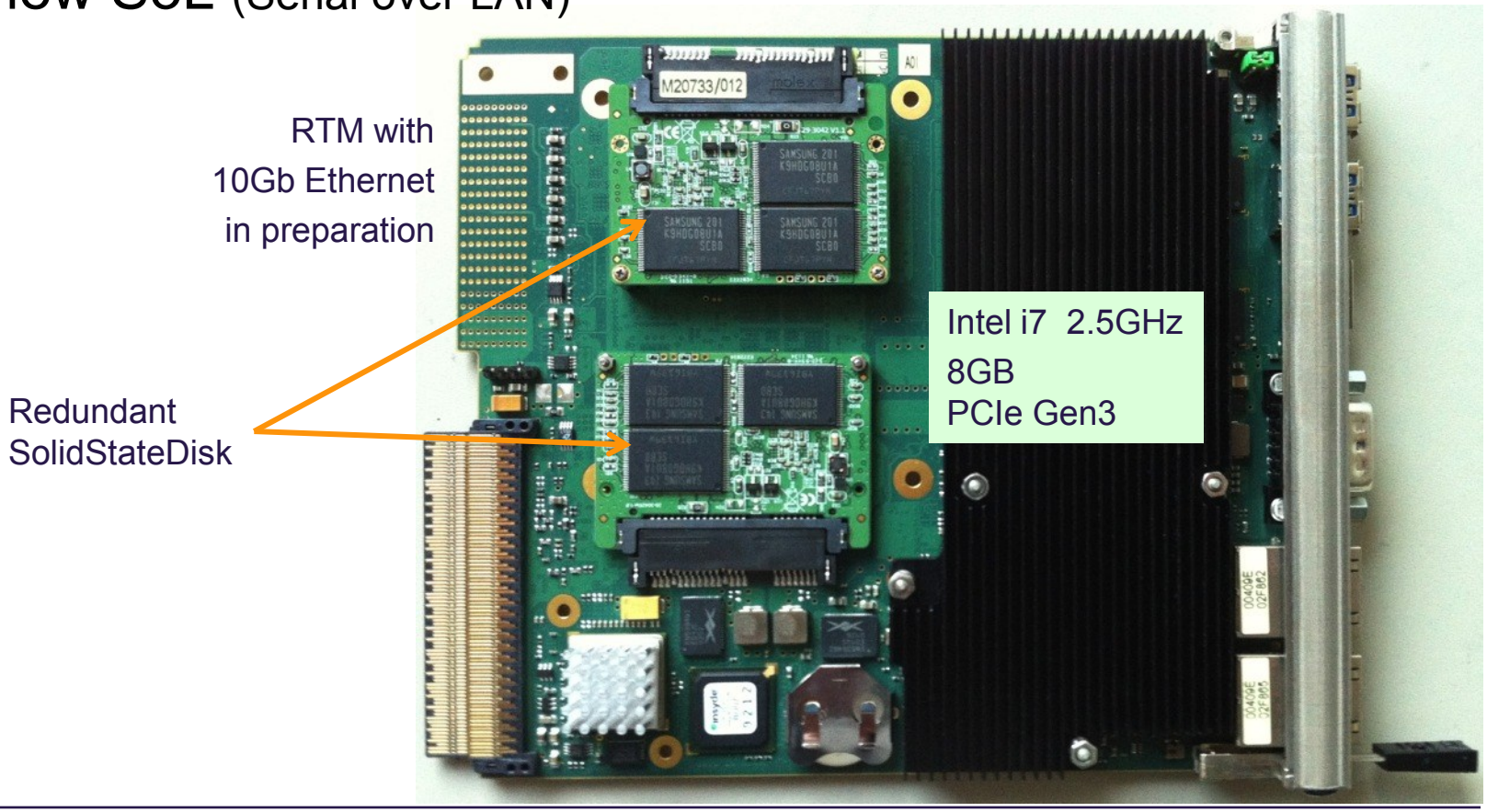
- Single cavity resolution of dA/A=2.8E-5 (<6 fs) is achieved ✓
- Signal integrity in MTCA.4 crate achieved ADC Eval board performance. ✓
- Low distortion MTCA.4 power supplies. ✓
- AMC and RTM module EMC classification is needed.

© Frank Ludwig

European XFEL

ConcurrentTechnologies AM900 CPU

- Was delayed → now in series production
- We had to debug with Concurrent the management and new SoL (Serial over LAN)



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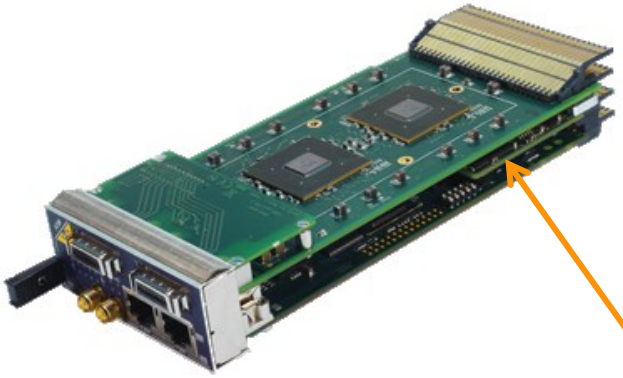
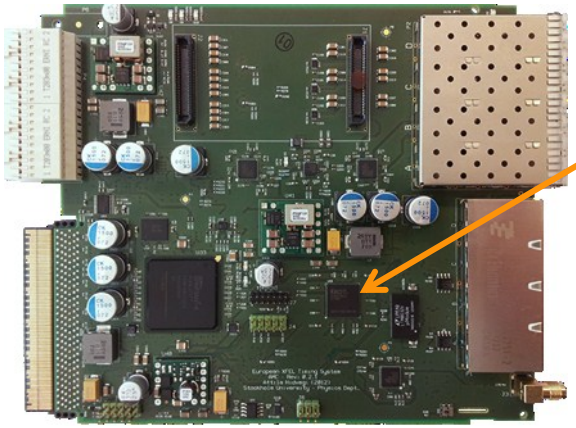
MicroTCA Carrier Hub





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

European XFEL

Commercial I/O AMCs, a Few Examples

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

  - AMC703 (Hytec)

- ADIO24 Analog/digital IO (ESD)

- PMC Module carrier:
  - PMC A

  - 4 port Ethernet Switch (Vadatech)

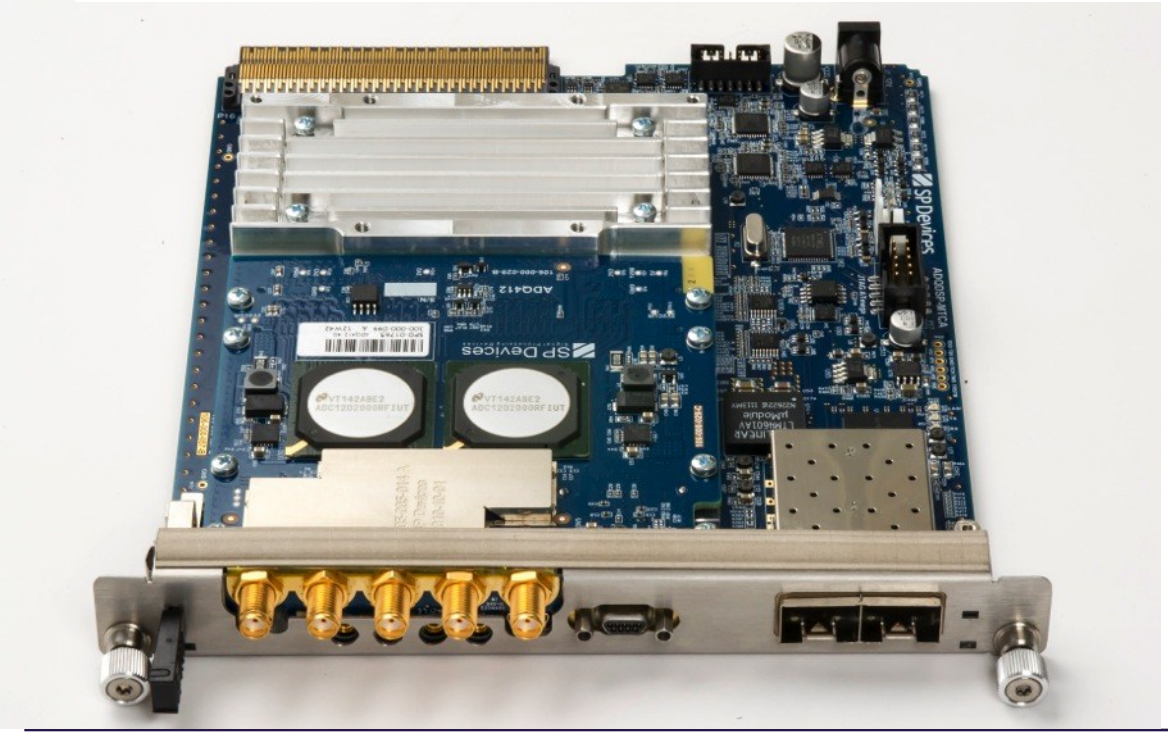
  - FMC Module carrier:
  - TAMC631/640/641 and others

European XFEL

Giga Sampling ADCs: 0.8 … 7 GSPS

- A development with SP Devices Sweden AB, prototype beg. Aug. 2012

Product	Resolution	Maximum Sample Rate	Analog Bandwidth	Channels	On-Board Memory Size	Interface
SDR14	14bit in 14bit out	800 MSPS in 1600 MHz out	500 MHz	2 in 2 out	2 x 500 Mbyte	USB, cPCIe/PXIe, PCIe
ADQ108	8 bit	7 GSPS	2 GHz	1	1024 MS	USB, cPCIe/PXIe, PCIe
ADQ412	12 bit	1.8/3.6 GSPS	2/1.3 GHz	4/2	700 MS	USB, cPCIe/PXIe, PCIe
ADQ1600	14 bit	1.6 GSPS	800 MHz	1	500 MS	USB, cPCIe/PXIe, PCIe
ADQ DSP	-	-	-	-	1 GByte	USB, cPCIe/PXIe, PCIe



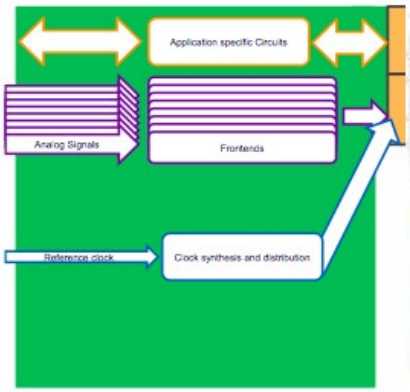
Applications

- Photon Diagnostics
  - XGMD
  - XBPM
  - PES
- Detectors
  - 0D (e.g. APD)
  - 2D (e.g. pnCCD)
- Experiments
  - eTOF, iTOF
- ...

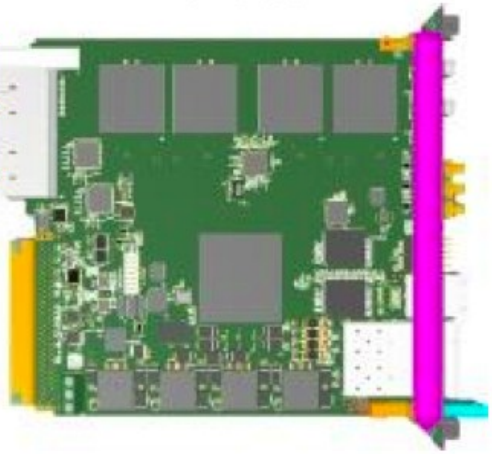
MSK: Coming Soon …

- **Ultra-fast Klystron Protection**
  High-Speed Sampling
  - 8/4 channel ADC (12-bits, 800/1600Msps, 2.7GHz)
  - 2 channel DAC (16-bits, 160Msps, 400Msps)
  - Xilinx Virtex 6, DDR Memory
  - SFP support
  - Gigabit Ethernet, IPMI

DRTM-DSCLK



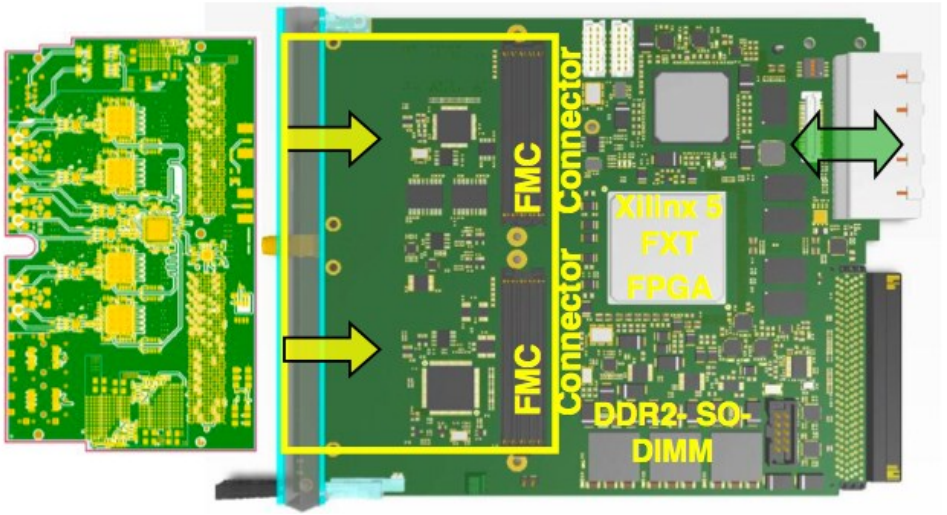
DAMC-DS800



- **Universal 2 Slot FMC AMC Processing**
  - 2x1 or 2x2 FMC mezzanine support;
  - Virtex5 with Spartan6
  - DDR2 SO-DIMM RAM support
  - IPMI unit
  - Gigabit Ethernet, Serial port, JTAG

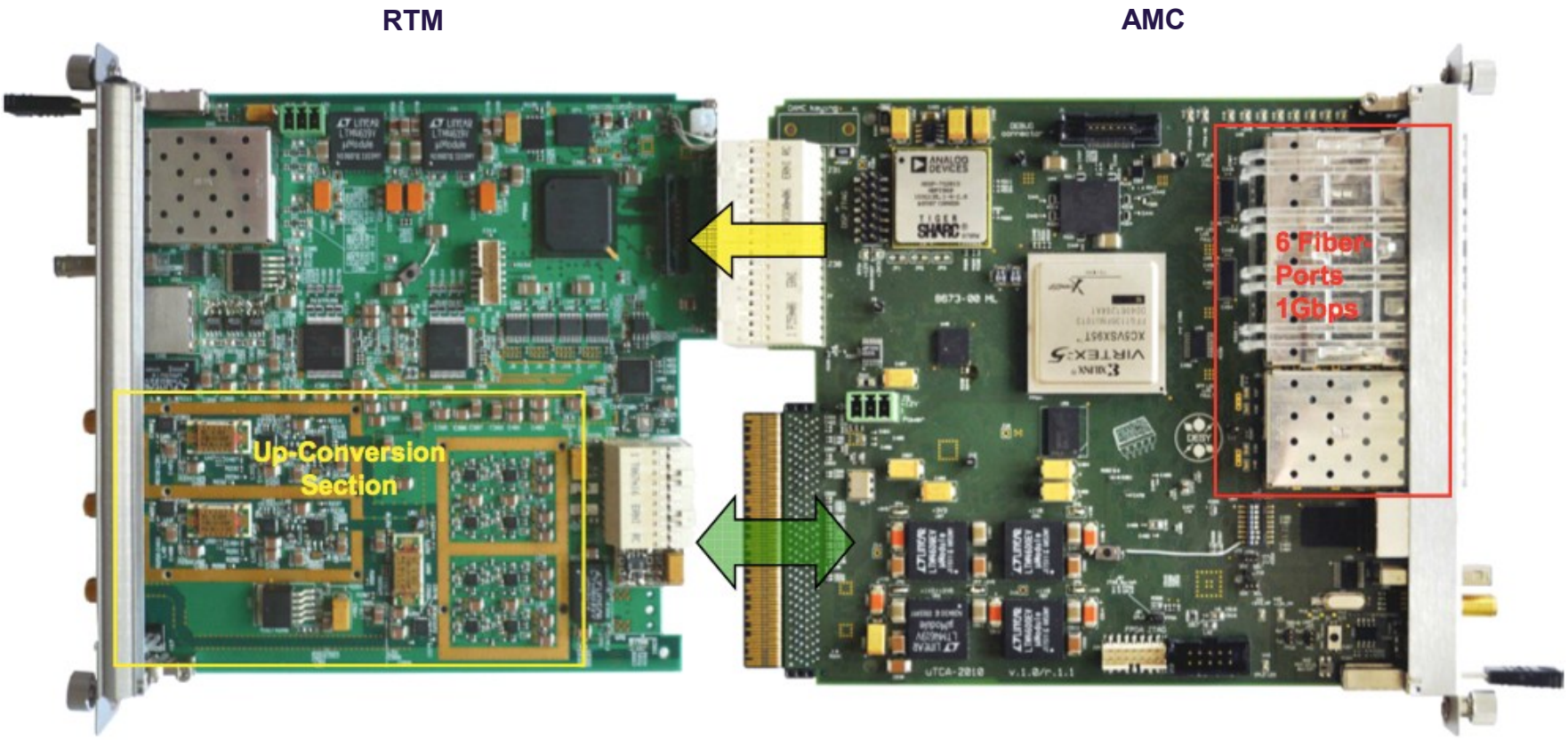
- **2x HPC FMC Card for BAM monitors**
  Pulsed-signal conditioning

DAMC-FMC25



European XFEL

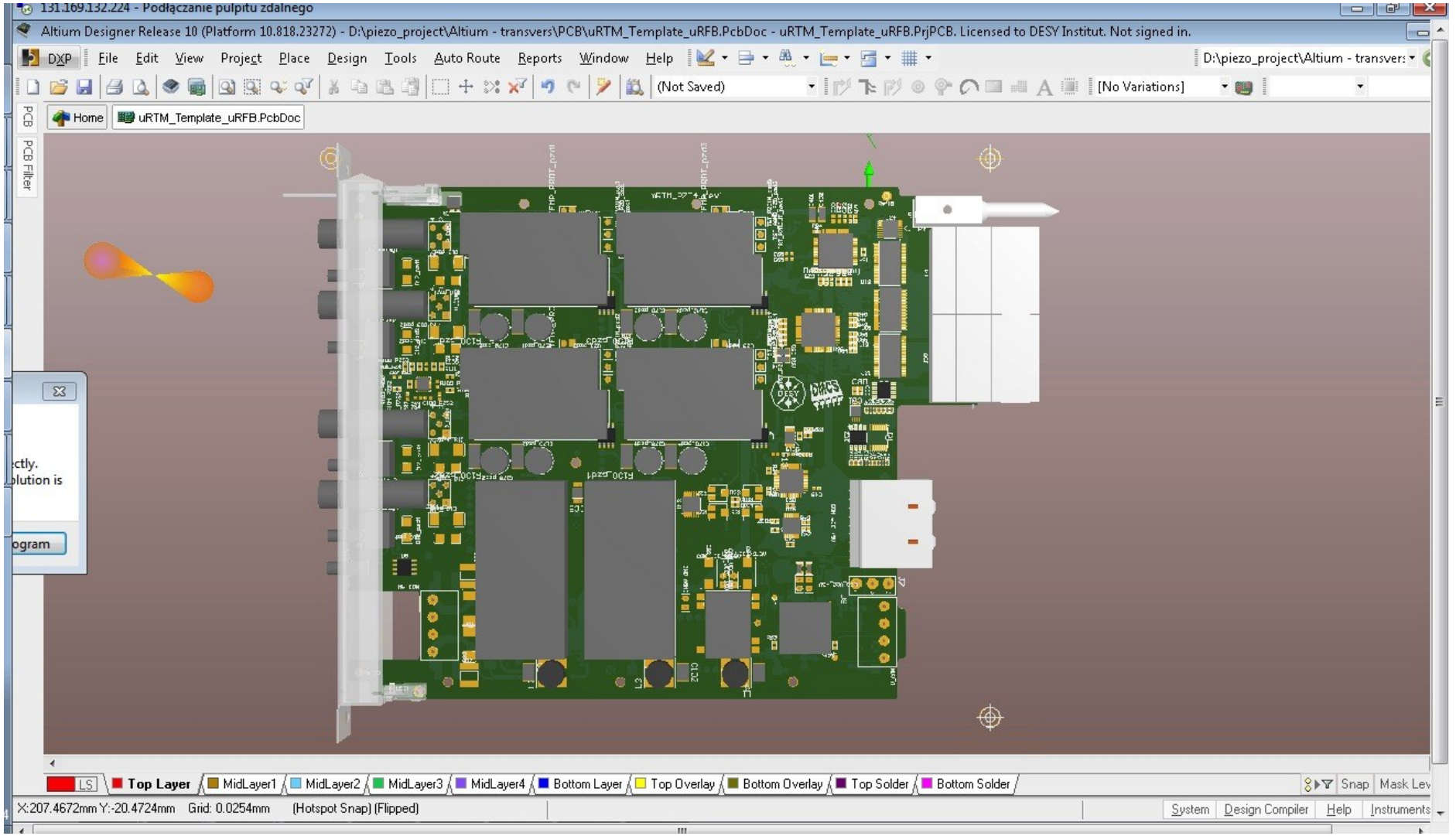
MSK: Controller and Vector Modulator



- 2 ch Vector Modulator:
  - 1.3 GHz … 3.9 GHz
  - 16 bit DAC
- LLRF Controller:
  - 6 Fiber-Ports on front
  - 8 Gb-Links to backplane

European XFEL

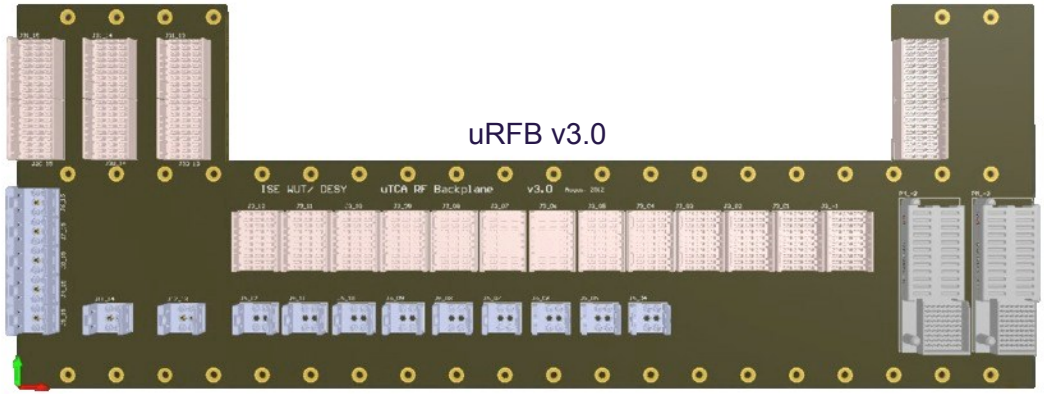
MSK: Piezo Controller RTM

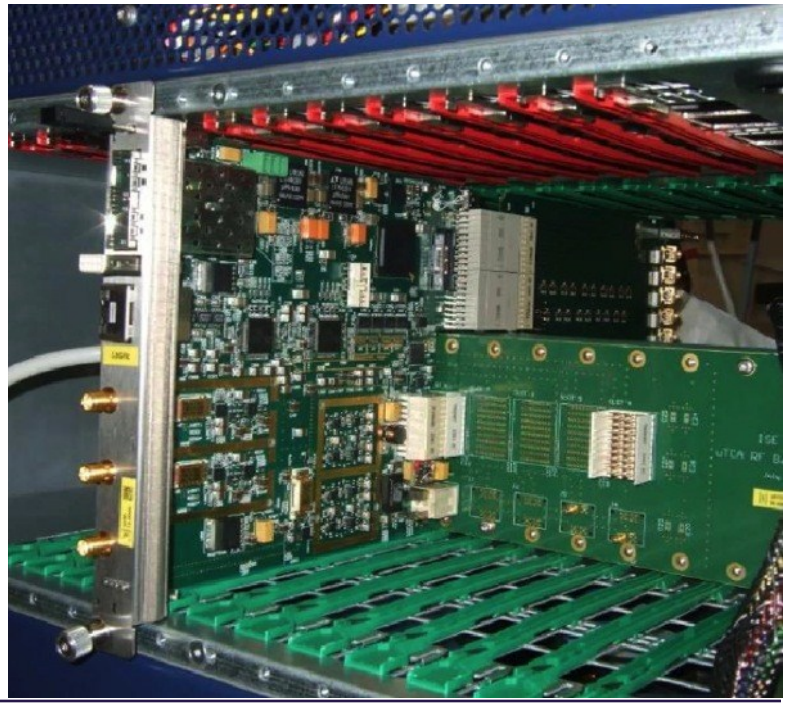


European XFEL

MSK: RF Backplane

- **uRFB**: MTCA.4 RF backplane
  - Several prototypes successfully tested
  - PCB ready end of Nov.'12
  - Full integration with uLOG Spring'13
  - Mass production Summer'13
  - RF jitter < 10 fs





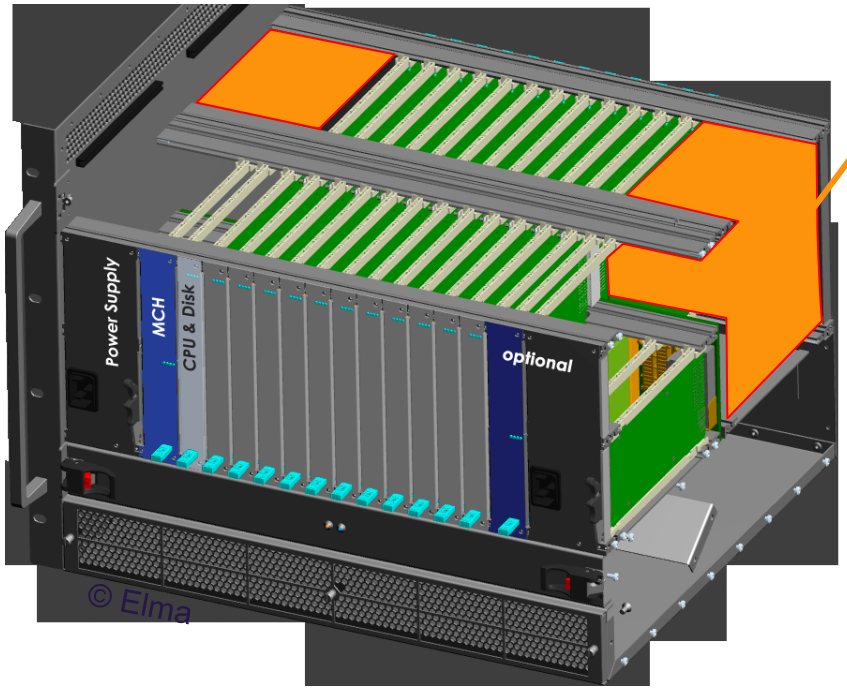
© J. Branlard, MSK

European XFEL

MSK: Local RF Generation (in Preparation)

DRTM-LOG1300

Low jitter signal generation for 1.3GHz

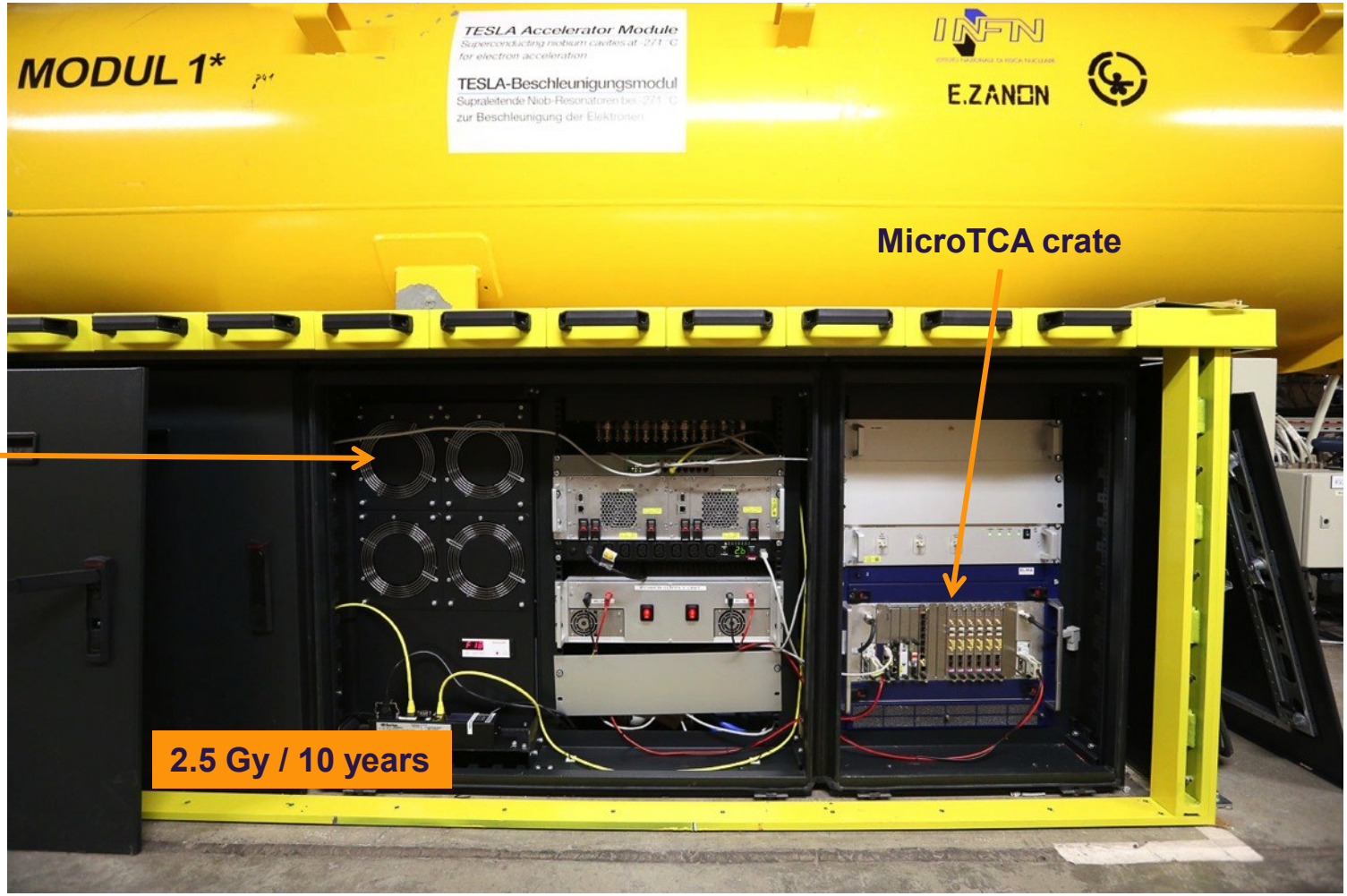


Prototype

European XFEL

FLASH: ACC1 LLRF Controls Below Cavities

- **Goal: operate LLRF after shut-down with MicroTCA**



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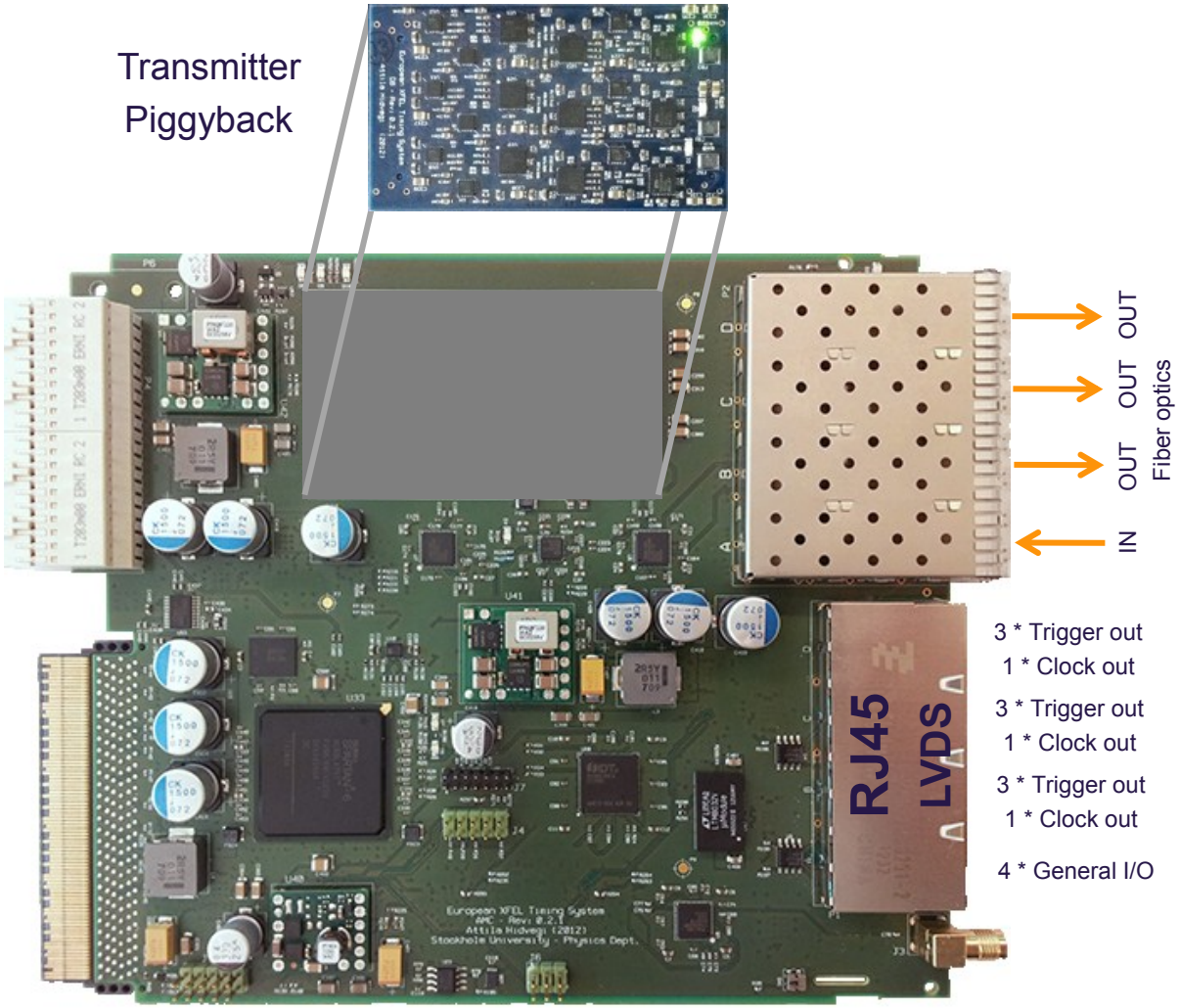
XFEL Timing System



- **Two new prototypes last Friday** ✔

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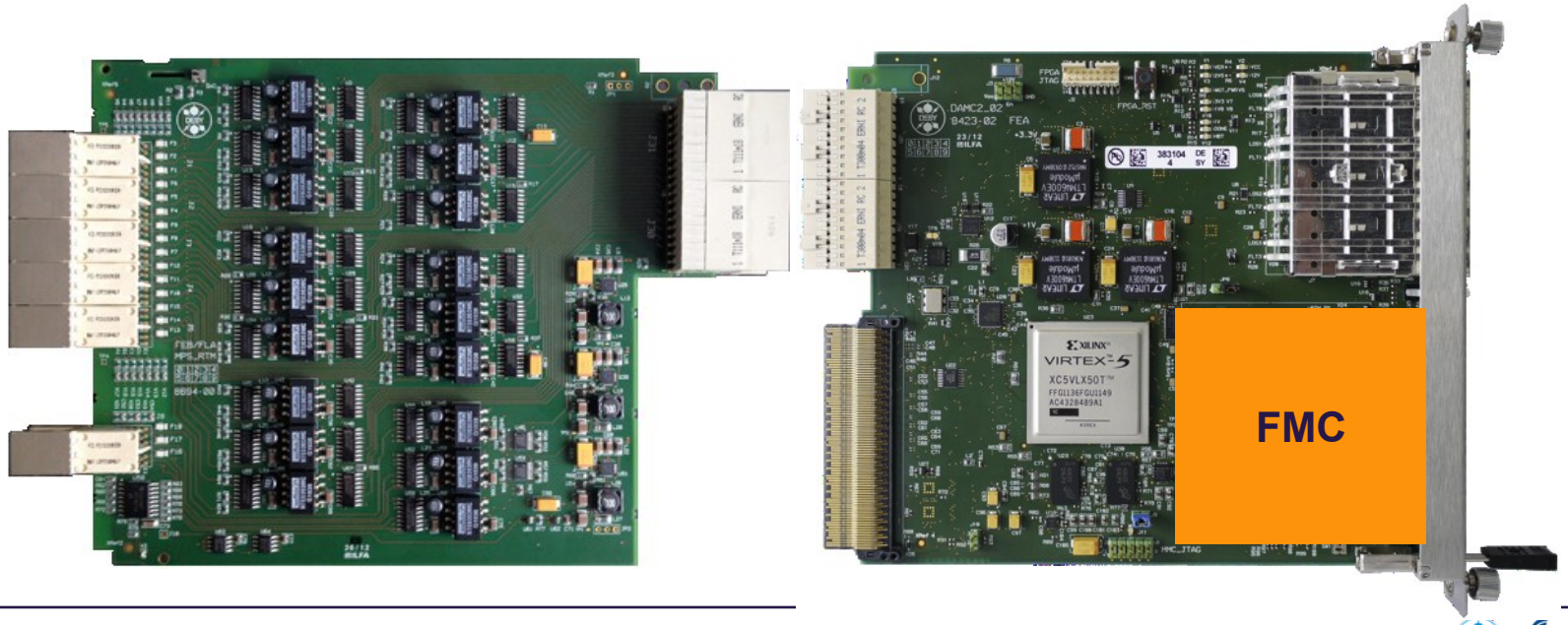
Machine Protection System for FLASH and XFEL

- Rear Transition Module
  - MPS
  - 30 RTMs available
  - Can be used for FLASH laser pulse controller too
- Front AMC (DAMC2)
  - 700 modules required for XFEL
  - 100 modules available



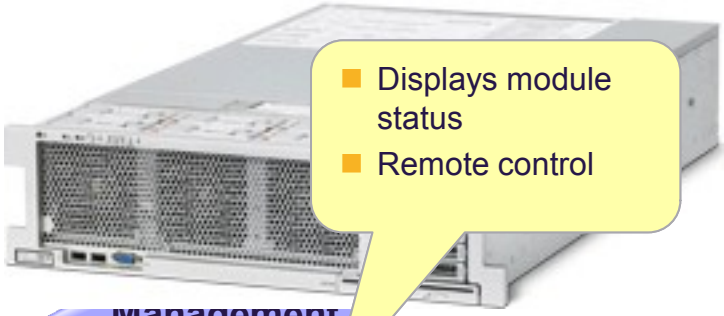
European XFEL

Front-end Software Infrastructure

- Software for µTCA

- Automatic operating and control system loading

- Client interface to all device functions
- Data archive
- DAQ interface



- Displays module status
- Remote control

CPU

DOOCS server

IO lib

Boot service

Linux driver

Linux Hot-swap

Management

Management clients

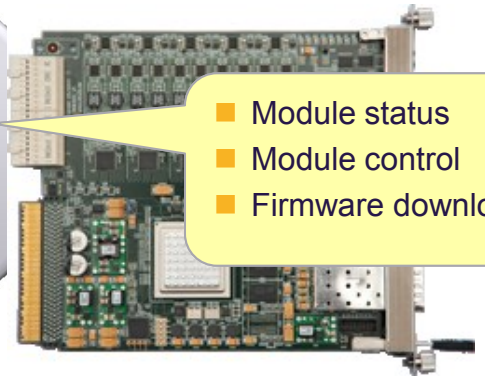
Management server

- Readout and control
- Configuration
- Hot-swap

FPGA firmware

Management controller

IO module



- Module status
- Module control
- Firmware download

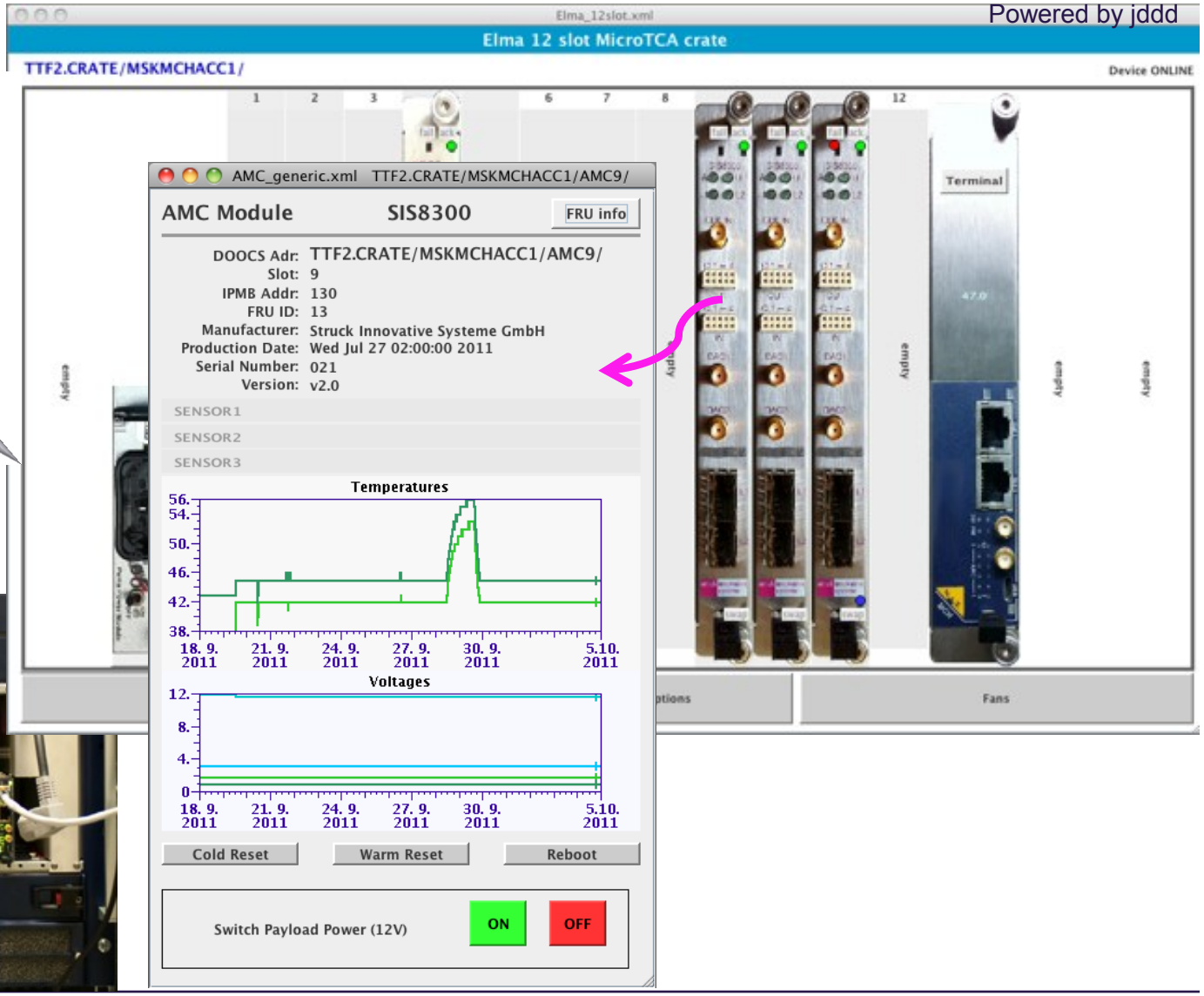
- Data processing
- Device configuration
- DMA data transfer
- Interrupts

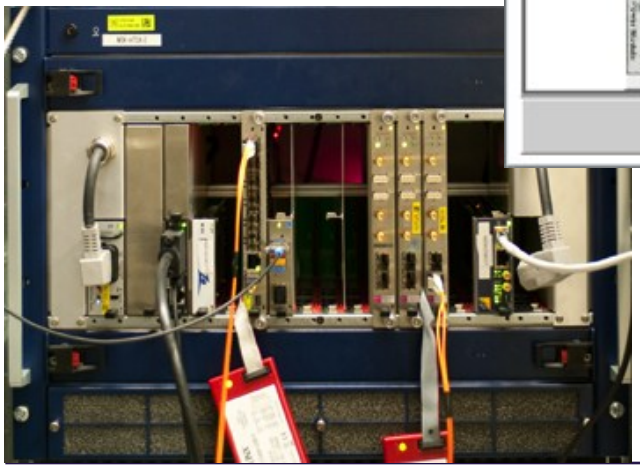
European XFEL

MicroTCA Remote Management

Powered by jddd

Online status of modules:
- Is-inserted, fault, …
- Temperatures, voltages
- Reset, power on/off
- Act. Power consumption





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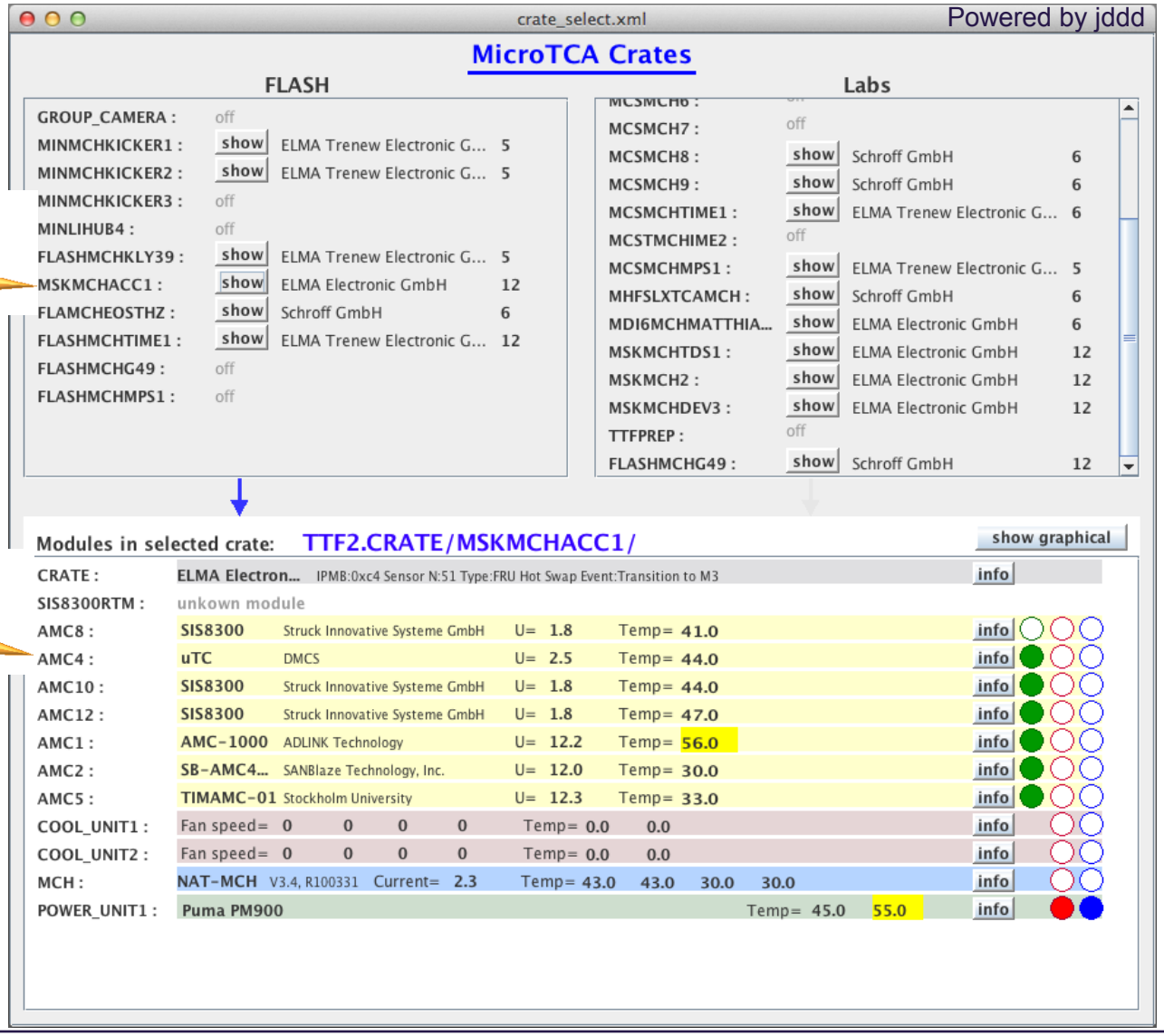
MicroTCA Crate Overview

Shows all Crates Ordered by Name

Shows all Modules in Selected Crate



Conclusions

- **XFEL** fast diagnostics and controls will be based on µTCA™
- **FLASH** upgrades → MTCA.4

- Successful system test of key MicroTCA modules
  - Excellent performance

- Migration to a new standard takes a while …
  - The required stuff for FLASH2 should be ready in time

- MicroTCA integration in DOOCS demonstrated:
  - Hardware management and control system integration