ERF Technology Transfer and Industrial Relations in Research Infrastructures
NH Hotel / Trieste, Italy / 6-7 June 2013

Commercializing of new technologies from Research Institutes focused on MTCA.4 at DESY

Friedrich Fix / AD-TE-C
Dr. Frank Ludwig / DESY for the LLRF Team
Trieste 06.06.2013

Content

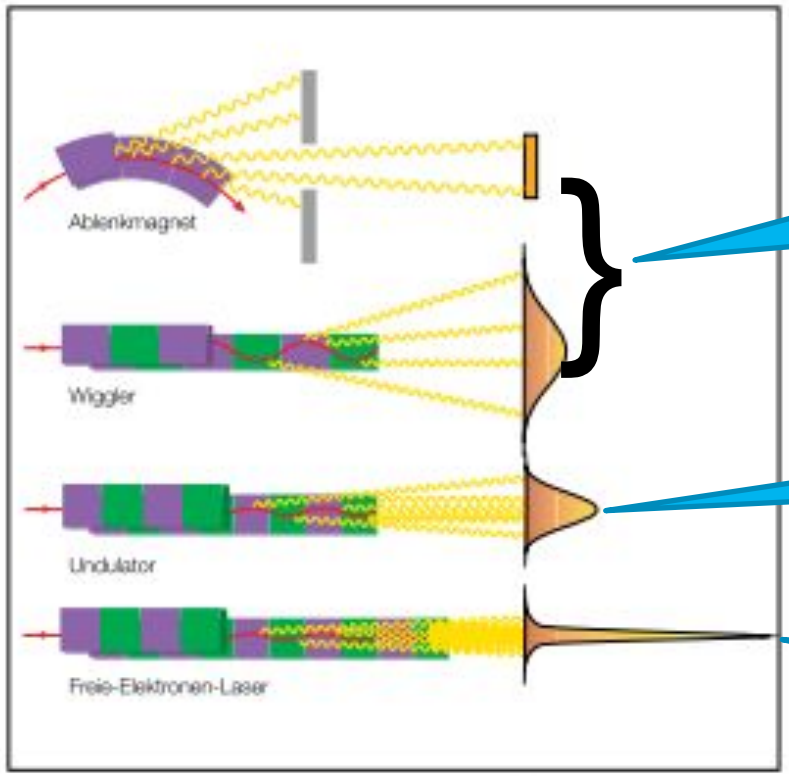
- Motivation for researching of new Technology

  (Example: High-frequency cavity control for the European XFEL)
- Validation project at DESY „MTCA.4 for Industry“ (HVF-0016)
- Module Production Process and Commercialization via Licensing

- High End Systems for High End Applications
- Difference between industry and Research requirements
- Entering the Market with industrialized research Systems

Motivation for Researching of New Technology

> Evaluation steps of X-Ray sources :



First Measurement way in static Accelerators ≥ 20 ms

First Measurement Results in ring accelerators ≥ 100 ns

First Results in FLASH ≥ 2.7 fs

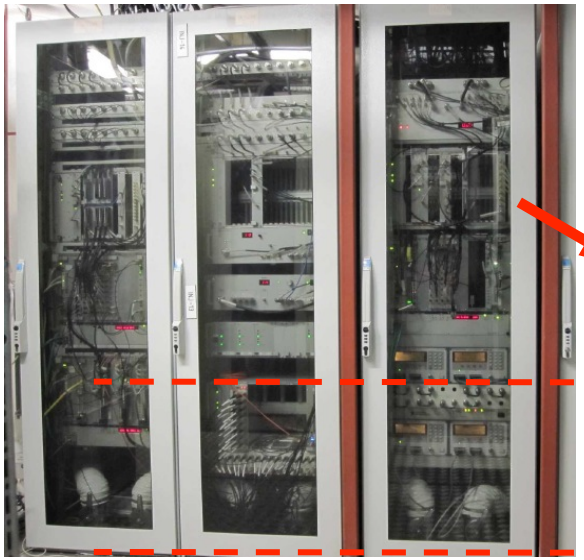
Quelle: DESY Broschüre Blitzlicht

European XFEL at DESY

- 808 superconducting 1.3 GHz RF cavities
- 101 cryomodules (8 cavities)

- 25 RF stations (4 cryomodules)

> From electronic standard VME (30 years running) to modern MTCA.4 :



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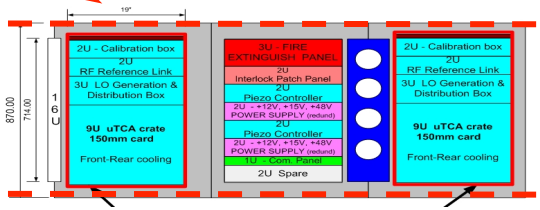


- Cavity regulation systems are in the tunnel
- Distributed FPGA concept
- High speed data processing
- Process 6 times more signals
- Lowest spectral density (16-bit ADCs)
- Redundant systems in the injector

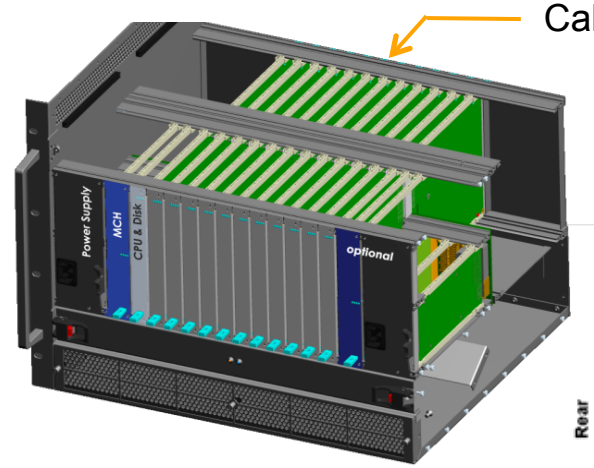
> Review meeting 12/2007: XFEL will be based on xTCA

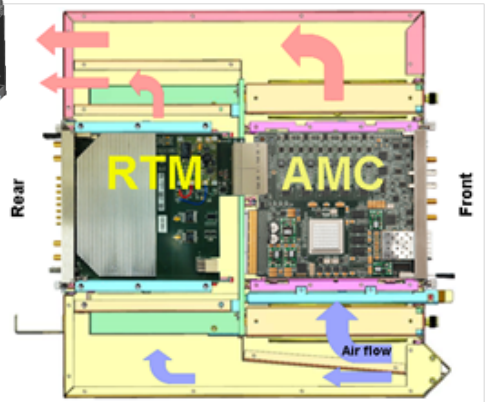
> XFEL fast electronics and controls will be based on MTCA.4: > 200 crates

MTCA.4 Crate Standard

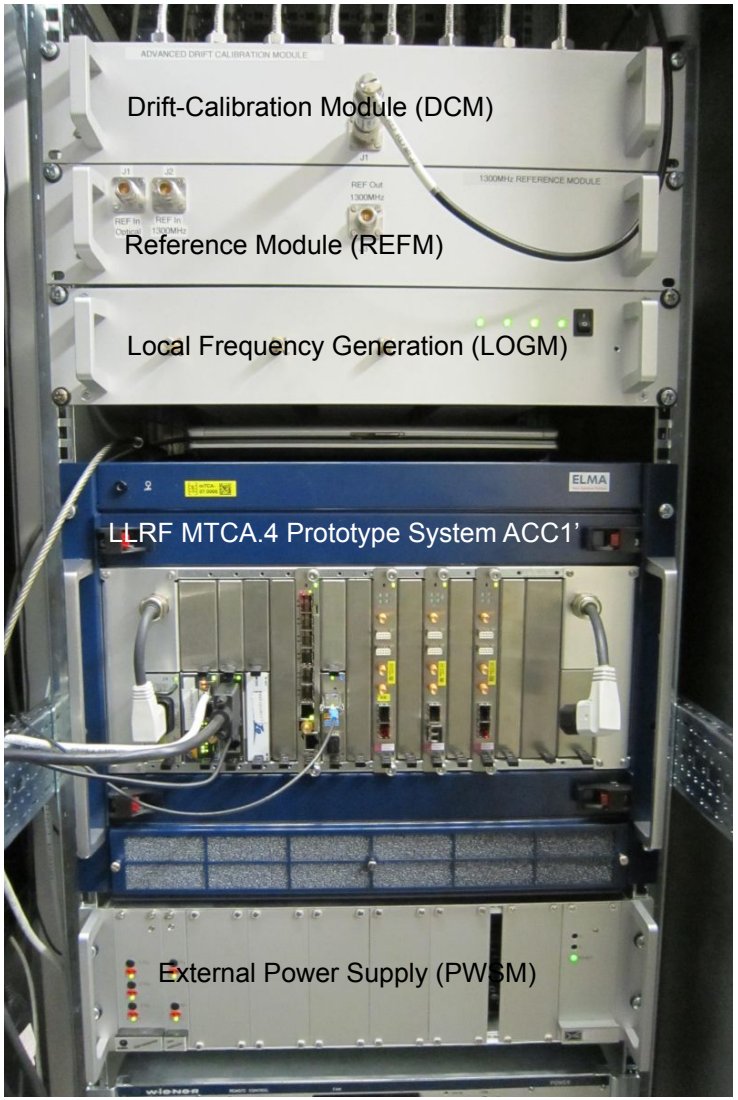
- Development partnership „xTCA for Physics“ (38 partner): 03/2009
  - **Research insitute:** SLAC, FNAL, IHEP, IPFN, ITER, DESY
  - **Industry:** connector-, board-, crate-, system manufacturer
- Ratification PICMG 2011 (http://www.picmg.org)
  - **M**icro **T**elecommunications **C**omputing **A**rchitecture .4 (MTCA.4)

- Modular + modern architecture
  - Reusability + PCIe + Ethernet
- High availability
  - Redundant power and fan optional
  - Well defined remote management
- High digital performance
  - Very low analog distortions
  - 4 lanes PCIe: 400 MB/s ... 3.2 GB/s

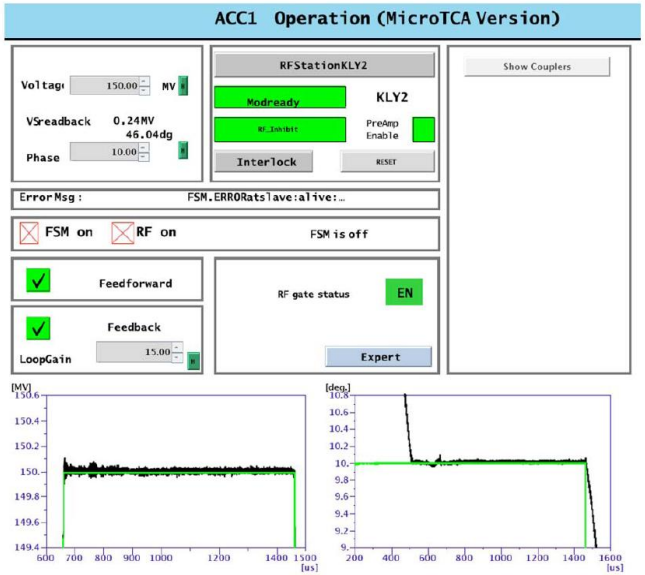




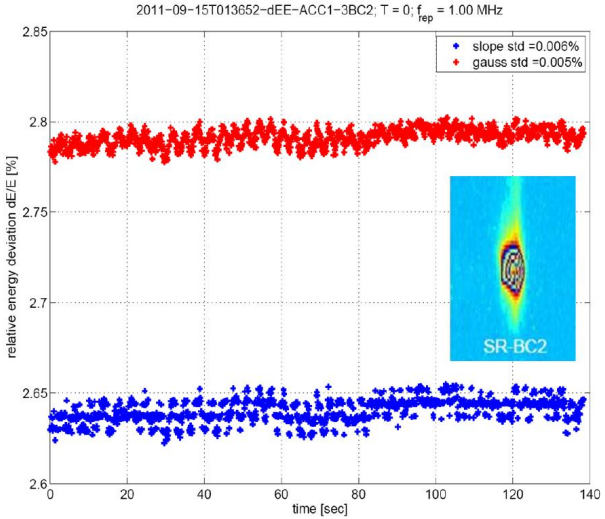
LLRF System Performance Test at FLASH using MTCA.4



- FLASH operation:



- On-crest energy stability (SR-3BC2)



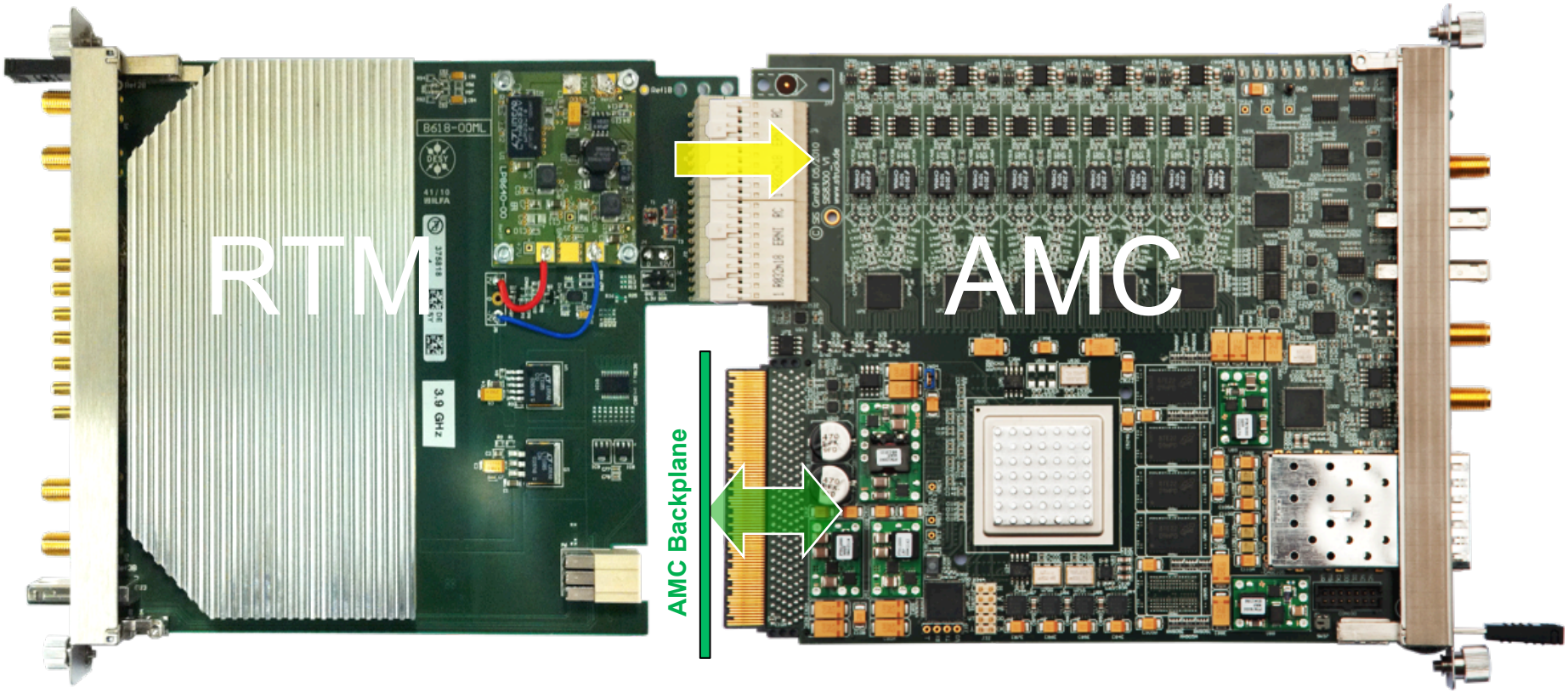
Energy stability dE/E = 5E-5. ✓

High-End Applications

> Analog Signal Conditioning
(Developed by DESY)

> Digital Signal Processing
(Developed from Industry with DESY)

struck innovative systeme

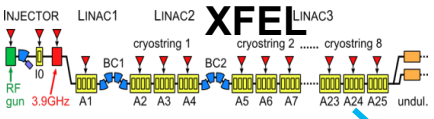


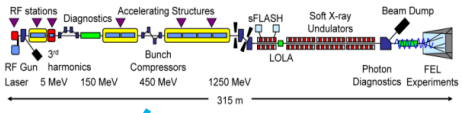
- 10 channel down-converter
  (1.3 GHz, …, 3.9 GHz)
- Resolution, 0.003 %, 0.003 deg, < 10 fs

- 10 channel ADCs (125 Msps, 16-Bits)
- FPGA pre-processing partial cavity vector sum
- Low latency links via MTCA-backplane

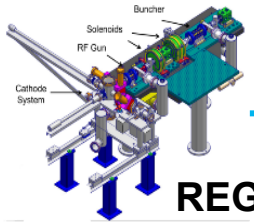
Single Cavity LLRF Systems in MTCA.4 Europe / Worldwide

> Involvement in Facilities:

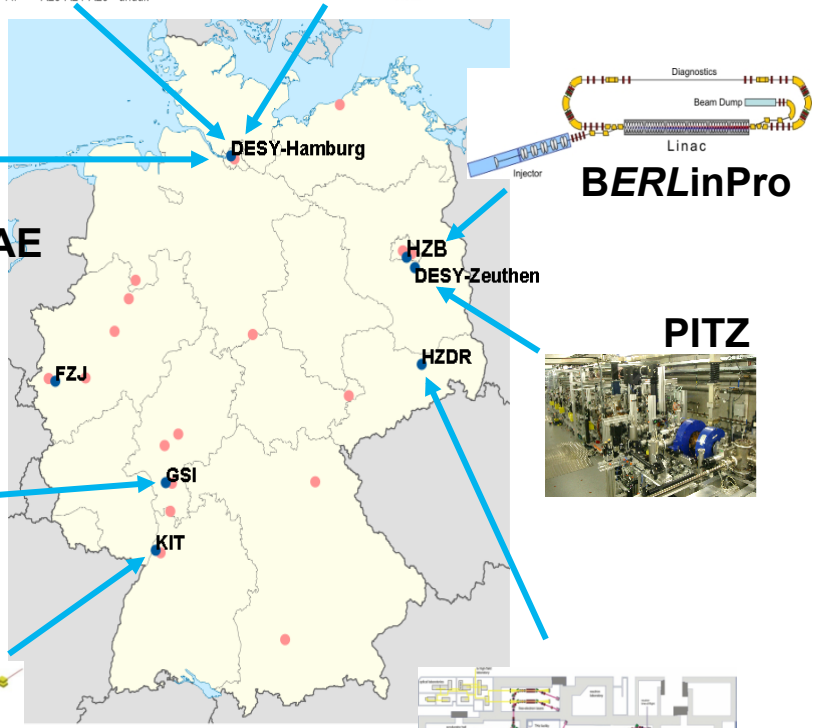




FLASH



REGAE

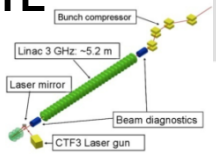


BERLinPro

FAIR

PITZ

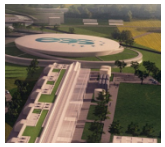
FLUTE



ELBE

> … and in Europe:

- ✓ ESS EUROPEAN SPALLATION SOURCE — Total budget ~ 1,47B€ Construction: **2013-2019**



- ✓ iter — the way to new energy — Total budget ~ 1,47B€ Construction: **2013-2019**

- polfel
- ✓ AMPEGON

- STFC ASTeC

TARLA, . . .

> Worldwide:

- ✓ SLAC NATIONAL ACCELERATOR LABORATORY
- ✓ KEK HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION
- PAL POHANG ACCELERATOR LABORATORY

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HELMHOLTZ GEMEINSCHAFT

AD-TE-C

DESY

„MTCA.4 for Industry“ (HVF-0016)

To foster industrialization of MTCA.4:

- Commercialization of DESY designs → industry (licensing)
  - Cost and quality improvements
  - New modules to complete portfolio
- Completion of standard for industry and institutes
  - Add missing modules
  - Improve EMI with test environments and shielding
  - Gain new MTCA.4 applications in more markets
- Support for institutes and industry
  - Consulting: Help to start with MTCA
  - User guide and Web Site
  - Organization of workshops and exhibitions

→ Technology Transfer Division / DESY

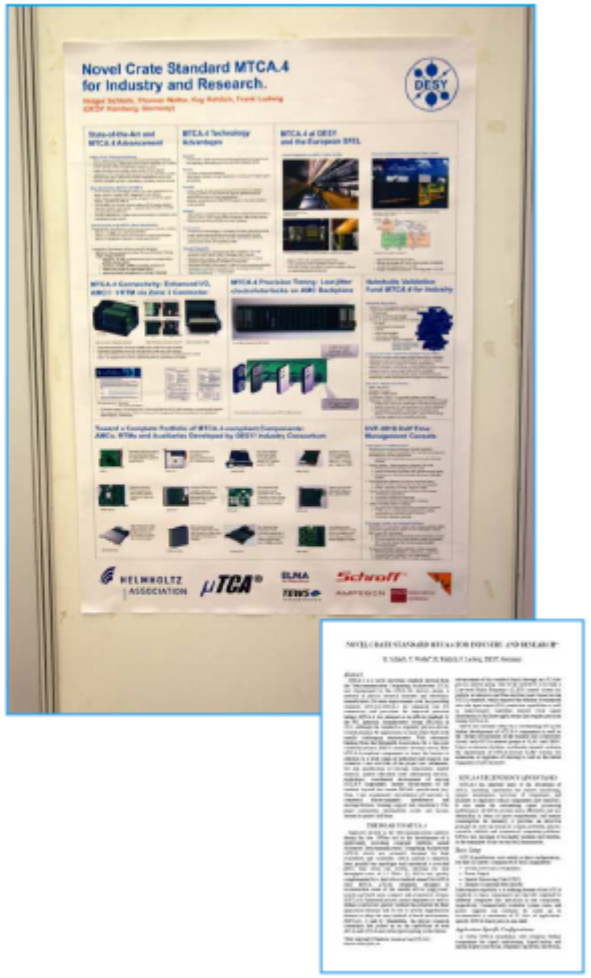
Project duration: mid 2012 … mid 2014

„MTCA.4 for Industry“ (HVF-0016) - Marketing

MTCA-Flyer

Website

Data sheets



Poster / Paper

„MTCA.4 for Industry“ (HVF-0016) - Events

MTCA Workshop (12/2012)

embeddedworld (02/2012)

MTCA Tutorial (05/2013)

IPAC (05/2013)

Module Commercialization via Licensing to Industry

> Why :

- Main business for DESY is research, development and prototyping.
- Industry is better prepared for low prices and quality improvements.
- Institutes, facilities and industry can buy standard components.
- Broad MTCA.4 market -> long-term availability of components.

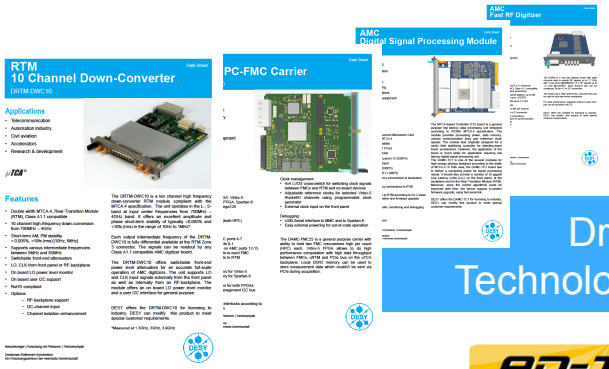
> How : Via non-exclusive, multiple and time limited licenses

- License covers only the production of a module, IP stays in-house
- License partner = production, sales and distribution partner
- Extended license offering all sources for industry developments

> What : Total 14 AMC and RTM Modules will be available:

- DAMC-TC7
- DRTM-VM02
- DRTM-DWC8VM1
- eRTM-LOG1300
- DAMC-DS800
- DRTM-DSCLK
- DAMC-DSCLK
- DAMC-FMC20
- DAMC-FMC25
- DFMC-MD22
- DAMC, DRTM-EMI

… and more …



Dr. Ilka Mahns / DESY
Technology Transfer Division

Design and Production Process

> Board Specification:

1 Electrical and Mechanical Specifications

- Operation Pair (connector pin compatibility):	DAMC2 RTM (Zone3) Connector
- Total power dissipation	<25W

Functions: ----------

- Switchable ADC input impedance (50 Ohms and high impedance)
- Anti-aliasing filter (could by bypassed)
- All ADC and DAC-Channels independent Controllable

Power Supply: ----------

- 2 stage DC/DC, Analog regulator chain

Back-Panel Connections: ----------

- ADC inputs:	8 channels
- Bandwidth / with filter:	95MHz / 2MHz
- Voltage Level / Damage	- 1V...+1V / >±2.5V
- Type / Impedance	single ended (Potential free) / 50 Ohm or 1kOhm
- Connector	Lemo (single)
- Location	REAR panel RTM
- DAC outputs (high voltage):	4 channels
- Output Update Rate / with Filter:	2MSPS / 16MSPS
- Voltage Level	- 3V...+3V @ 50 Ohms
- Type / Impedance	single ended / 50 Ohm
- Connector	Lemo (single)
- Location	REAR panel RTM
- DAC outputs (low voltage):	4 channels
- Output Update Rate / with Filter:	2MSPS / 16MSPS
- Voltage Level	- 1V...+1V @ 50 Ohms
- Type / Impedance	single ended / 50 Ohm
- Connector	Lemo (single)
- Location	REAR panel RTM

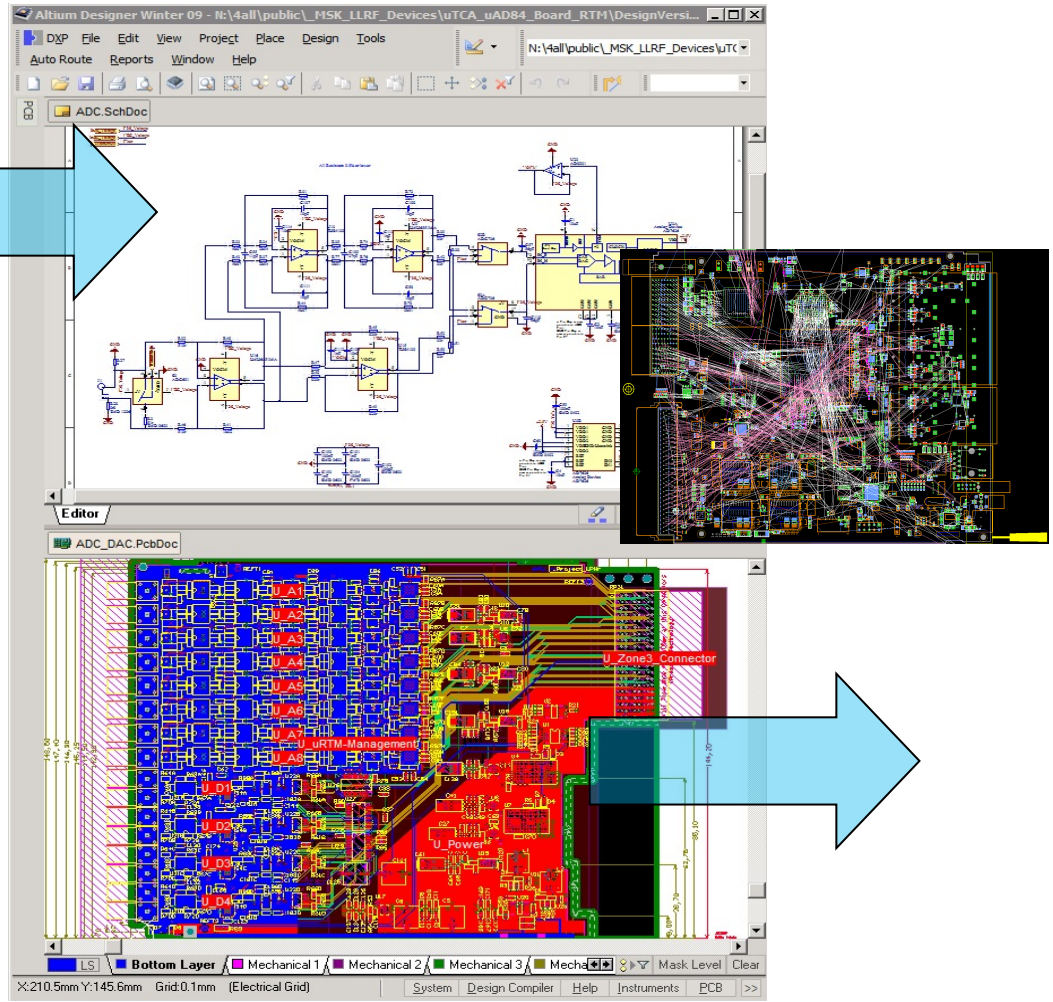
IO-Signals: ----------

- Status LEDs for operation	location lower side of RTM
- Standard Sensor Readout	MTCA.4, EEPROM, IO Extender

Packaging: ----------

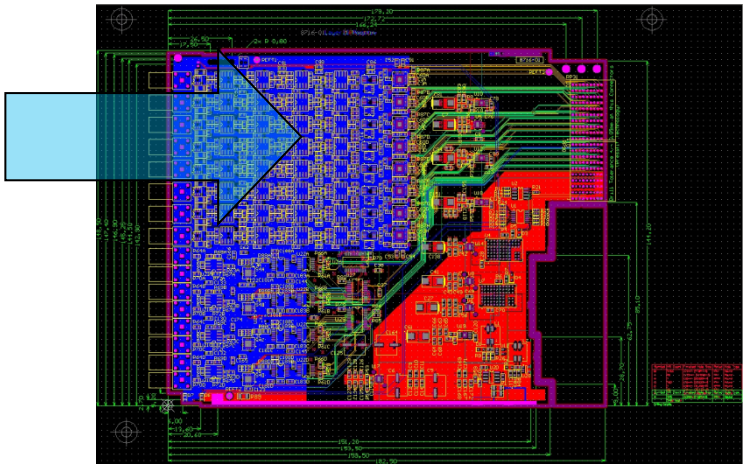
- Form Factor:	Double Mid-size, 4 TE RTM Module
- Board Package	Substrate material FR408

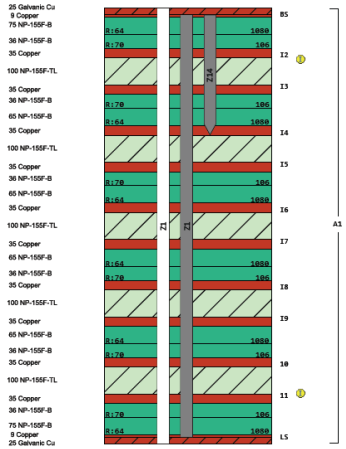
> Board Design (Source Data):



Production Data for Licensing

> Board production Gerber Files: (Structure data)



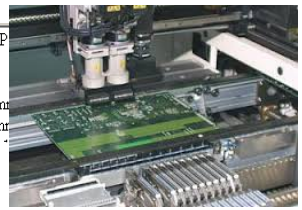


> Board production BOM (Bill Of Material):

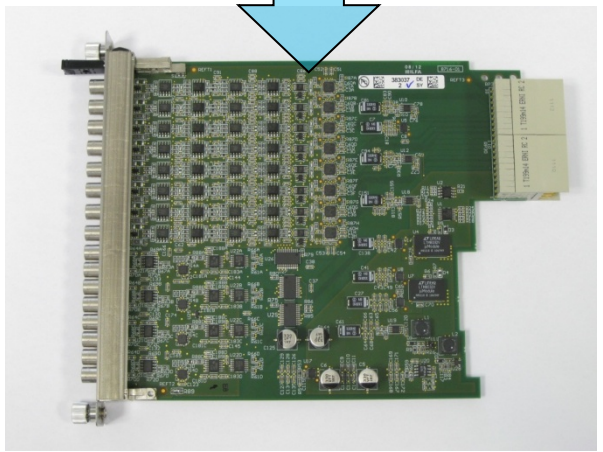
	Comme	Toleran	Volta	Manufacturer	ManufacturerNr	Distributo	DistributorNr
2	10uF	20%	10V	TDK	C1608X5R1A106M	Farnell InOne	1962113
3	10nF	10%	25V	AVX	06033C103KAT2A	Farnell InOne	2280646RL
4	330uF	20%	35V	Panasonic	EEEFT1V331AP	Farnell InOne	1868419RL
5	330uF	20%	10V	VISHAY SPRAGUE	TR3D337M010C0125	Farnell InOne	1754080RL
6	22uF	20%	16V	AVX	1206YD226MAT2A	Farnell InOne	1833823RL
7	1uF	10%	25V	Murata	GRM188R71E105KA12D	Farnell InOne	1735540RL
8	100nF	10%	25V	AVX	06033C104JAT2A	Farnell InOne	1740614RL
9	11pF	5%	50V	Kemet	C0603C110J5GACTU	Farnell InOne	1865472RL
10	56pF	5%	100V	Kemet	C0603C560J1GACTU	Farnell InOne	1865485RL

> Assembly stage: Pick & place lists

Designator	Footprint	Mid X	Mid Y	Ref X	Ref Y	Pad X	P
R89	R1206	31.4mm	4mm	31.4mm	4mm	32.9mm	
REFB2	REF_1.5mm	25.5mm	4.1mm	25.5mm	4.1mm	25.5m	
REFT2	REF_1.5mm	25.5mm	4.1mm	25.5mm	4.1mm	25.5m	
REFT1	REF_1.5mm	37.1mm	144.6mm	37.1mm			

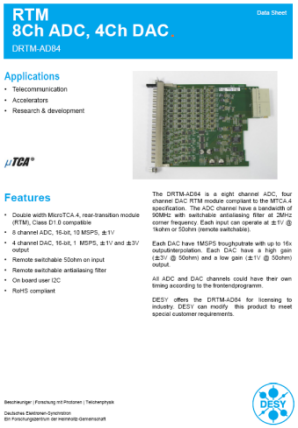


> Board production (External company)



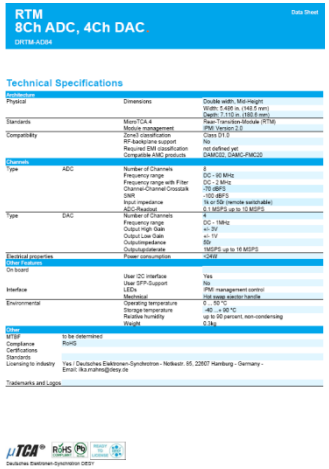
Other Data for Licensing

> Datasheet :


RTM
8Ch ADC, 4Ch DAC
DRTM-AD84

Applications
- Telecommunication
- Accelerators
- Research & development

Features
- Double width MicroTCA.4, rear-transition module (RTM), Class D1.0 compatible
- 8 channel ADC, 16-bit, 10 MSPS, ±1V
- 4 channel DAC, 16-bit, 1 MSPS, ±1V and ±3V output
- Remote switchable 50ohm on input
- Remote switchable antialiasing filter
- On board user I2C
- RoHS compliant

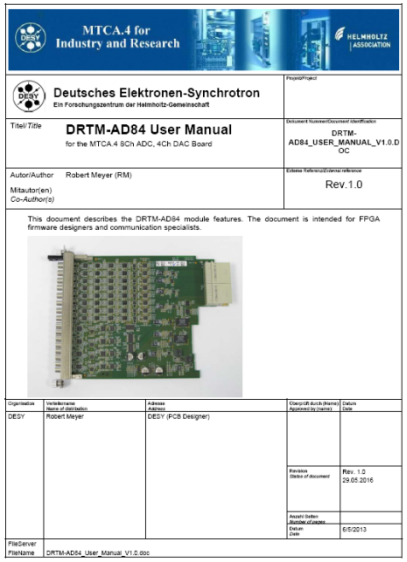

RTM
8Ch ADC, 4Ch DAC
DRTM-AD84

Technical Specifications

Physical	Dimensions	Double width, Mid-Height
Standards	MicroTCA.4	Rear-Transition-Module (RTM)
Compatibility	Zone3 classification	Class D1.0
	RF-backplane support	No
	Required EMI classification	not defined yet
	Compatible AMC products	DAMC02, DAMC-FMC20
Channels		
Type	ADC	8
	Number of Channels	DC - 90 MHz
	Frequency range	DC - 2 MHz
	Frequency range with Filter	-70 dBFS
	Channel-Channel Crosstalk	-100 dBFS
	SNR	1k or 50r (remote switchable)
	Input impedance	0.1 MSPS up to 10 MSPS
	ADC-Readout	4
Type	DAC	Number of Channels
	Frequency range	DC - 1MHz
	Output High Gain	+/- 3V
	Output Low Gain	+/- 1V
	Outputimpedance	50r
	Outputupdaterate	1MSPS up to 16 MSPS
Electrical properties	Power consumption	<24W
Other Features		
On board		
	User I2C interface	Yes
	User SFP-Support	No
Interface	LEDs	IPMI management control
	Mechanical	Hot swap ejector handle
Environmental	Operating temperature	0 ... 55 °C
	Storage temperature	-40 ... + 85 °C
	Relative humidity	up to 95 percent, non-condensing
	Weight	0.1kg
Other		
MTBF	to be determined	
Compliance	RoHS	
Certifications		
Standards		
Licensing to industry	Yes / Deutsches Elektronen-Synchrotron - Notkestr. 85, 22607 Hamburg - Germany - Email: ilka.mohnke@desy.de	

Trademarks and Logos

> User manual to operate the module :


MTCA.4 for Industry and Research

Deutsches Elektronen-Synchrotron
Ein Forschungszentrum der Helmholtz-Gemeinschaft

Titel/Title: DRTM-AD84 User Manual
for the MTCA.4 8Ch ADC, 4Ch DAC Board

DRTM-AD84_USER_MANUAL_V1.0.DOC

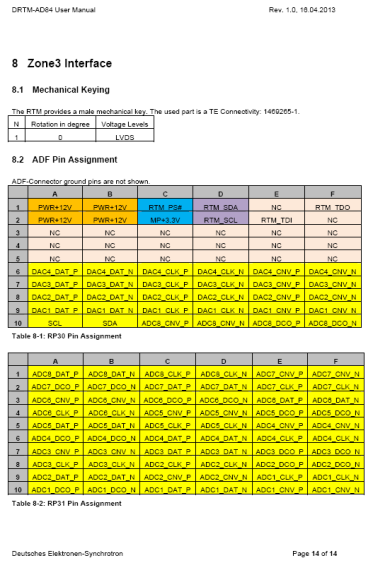
Autor/Author: Robert Meyer (RM)
Mitautor(en)
Co-Author(s)

Rev.1.0

This document describes the DRTM-AD84 module features. The document is intended for FPGA firmware designers and communication specialists.

Organisation	Verteilername / Name of distribution	Adresse / Address	Überprüft durch (Name) / Approved by (name)	Datum / Date
DESY	Robert Meyer	DESY (FCB Designer)		
			Revision / Status of document	Rev. 1.0 29.05.2013
			Ausgabe Datum / Release of copies	6/5/2013

FileServer FileName: DRTM-AD84_User_Manual_V1.0.doc


DRTM-AD84 User Manual Rev. 1.0, 16.04.2013

8 Zone3 Interface

8.1 Mechanical Keying

The RTM provides a male mechanical key. The used part is a TE Connectivity: 1469265-1.

N	Rotation in degree	Voltage Levels
1	0	LVDS

8.2 ADF Pin Assignment

ADF-Connector ground pins are not shown.

	A	B	C	D	E	F
1	PWR+12V	PWR+12V	RTM_PS#	RTM_SDA	NC	RTM_TDO
2	PWR+12V	PWR+12V	MP+3.3V	RTM_SCL	RTM_TDI	NC
3	NC	NC	NC	NC	NC	NC
4	NC	NC	NC	NC	NC	NC
5	NC	NC	NC	NC	NC	NC
6	DAC4_DAT_P	DAC4_DAT_N	DAC4_CLK_P	DAC4_CLK_N	DAC4_CNV_P	DAC4_CNV_N
7	DAC3_DAT_P	DAC3_DAT_N	DAC3_CLK_P	DAC3_CLK_N	DAC3_CNV_P	DAC3_CNV_N
8	DAC2_DAT_P	DAC2_DAT_N	DAC2_CLK_P	DAC2_CLK_N	DAC2_CNV_P	DAC2_CNV_N
9	DAC1_DAT_P	DAC1_DAT_N	DAC1_CLK_P	DAC1_CLK_N	DAC1_CNV_P	DAC1_CNV_N
10	SCL	SDA	ADC8_CNV_P	ADC8_CNV_N	ADC8_DCO_P	ADC8_DCO_N

Table 8-1: RP30 Pin Assignment

	A	B	C	D	E	F
1	ADC8_DAT_P	ADC8_DAT_N	ADC8_CLK_P	ADC8_CLK_N	ADC7_CNV_P	ADC7_CNV_N
2	ADC7_DCO_P	ADC7_DCO_N	ADC7_DAT_P	ADC7_DAT_N	ADC7_CLK_P	ADC7_CLK_N
3	ADC6_CNV_P	ADC6_CNV_N	ADC6_DCO_P	ADC6_DCO_N	ADC6_DAT_P	ADC6_DAT_N
4	ADC6_CLK_P	ADC6_CLK_N	ADC5_CNV_P	ADC5_CNV_N	ADC5_DCO_P	ADC5_DCO_N
5	ADC5_DAT_P	ADC5_DAT_N	ADC5_CLK_P	ADC5_CLK_N	ADC4_CNV_P	ADC4_CNV_N
6	ADC4_DCO_P	ADC4_DCO_N	ADC4_DAT_P	ADC4_DAT_N	ADC4_CLK_P	ADC4_CLK_N
7	ADC3_CNV_P	ADC3_CNV_N	ADC3_DAT_P	ADC3_DAT_N	ADC3_DCO_P	ADC3_DCO_N
8	ADC3_CLK_P	ADC3_CLK_N	ADC2_CLK_P	ADC2_CLK_N	ADC2_DCO_P	ADC2_DCO_N
9	ADC2_DAT_P	ADC2_DAT_N	ADC2_CNV_P	ADC2_CNV_N	ADC1_CLK_P	ADC1_CLK_N
10	ADC1_DCO_P	ADC1_DCO_N	ADC1_DAT_P	ADC1_DAT_N	ADC1_CNV_P	ADC1_CNV_N

Table 8-2: RP31 Pin Assignment

Deutsches Elektronen-Synchrotron Page 14 of 14

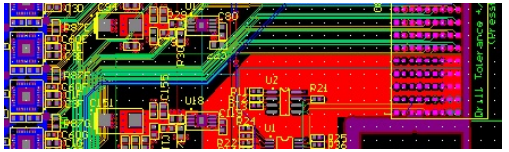
> Functional test procedures

For securing the quality of the product there are some tests and functional checks to be made:

1. PCB-Manufacturer: electrical test report
2. PCB-Manufacturer: impedance control.
3. Visual inspection of PCBs: bad soldering (PB-free), connections and Jumper, all needed components soldered?
4. Measuring all voltages and/or the power consumption of the Boards.
5. LED, MMC, Functional test (Power, hot/swap).
6. Quality check with Signals and AMC in Test crate configuration (uBLade PWS, Schroff Crate, AMC Backplane Schluss, AMC EMI Bypass), channel wise in time- und Spectral:
   a. ADC: RAW-Spectrum, SNR, SFDR, distortions?
   b. ADC: check if Input impedance is Switchable
   c. ADC: check if Filter is on and off switchable
   d. DAC: check if max and min Values are reachable
7. Short Test Report. Relevant measurement data (Spectrum) packed for saving.

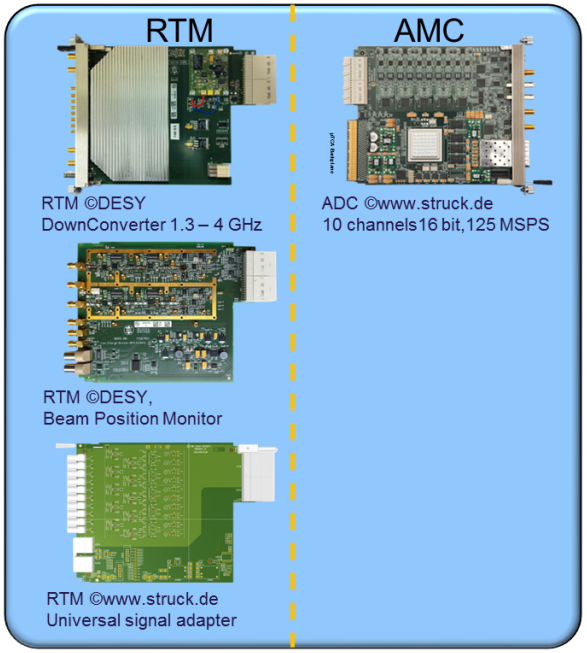
> Optional :

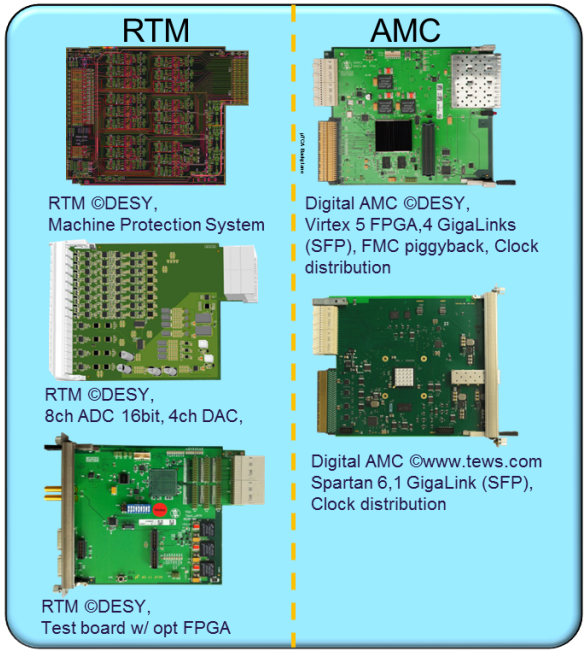
- Schematics (pdf versions for QA & QC)
- PCB sources (ASCII versions for production)



High End Systems for Industry?

- DESY developing boards for their own application continuously but they don ´t like to produce big quantities.
- DESY has neither experience nor recourses for series production.





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

. . . and more and more from Industry . . . http://mtca.desy.de

High End Systems for Industry?

DESY could not use the own high performance systems in big quantities.

> The best opportunity to solve this problem is:

- Takeover licenses for the boards to the industry.

S W O T for DESY

Strength	**Weakness**
Free recourses for new developments License incoming for the board design	Dependency to the supplier Dictations for prices?
Chances	**Threats**
Get lower prices in depend of bigger production lots by suppliers Get a continuous quality of boards Possibilities for design extensions	Copying of designs from industry Destroy the IP Rights The biggest problem is if the supplier or License holder is not able to deliver boards

What is the Advantage for the Industry?

S W O T for Industry

Strength
Short time to market with new developments
Increase the business with high end boards

Weakness
Dependency to the institutes
In case of to much license holders to less prices with less profit
No vendors beside the institutes

Chances
To have the edge over the competitors
Enter the research market with this new boards
To establish the company in new markets

Threats
Block of production resources
Renewing the systems with other boards the license becomes worthless
The institutes don´t use the boards

Difference between Industry and Research

Development at Institutes	Development at Industry
Driven by highest ability	Driven by the market
Highest performance	Necessary performance for applications
Choice of best components	Choice of components in depence of prices
Longest lifecycle	Lifetime calculated up to 3-5 years
Result oriented developments	Development for a convenient and mass production procedure

Entering the Market with industrialized research Systems

- The MTCA.4 Systems are developed for control and measurement in accelerators, at DESY especially at XFEL.
- Which kind of industry could use such systems?
- For which branches could MTCA.4 becomes interesting?
- Where is the highest performance needed?
- Where is the best quality needed?
- Where is the longest lifetime needed?

Entering the Market with Industrialized Research Systems

The answer is:

Everywhere

- A license holder could enter the markets, for instance:
  - Medical
    - Therapeutic radiology
    - MRT
    - CT
  - Communication
    - LTE Technology
    - Mobile telecommunication
    - Satellite communication
  - Transportation
    - Traffic Management
    - Driver Assistance Systems
  - Military
    - Radar
    - Unmanned systems

Examples from Industry using MTCA.0, MTCA.4

- Printing industry: (MTCA.0,4)

- Production inspection: (MTCA.0)

FTA GROUP

- LTE Mobile baseband stations: (MTCA.0)

- Telecom networks: (MTCA.0)

- Fiber to building / fiber to home: (MTCA.0)

- Intelligent traffic management: (MTCA.0)

- To be explored ...

Energy Management

Process Industry

Medical Industry

Thanks for your attention!