

The Large Scale European XFEL Control System

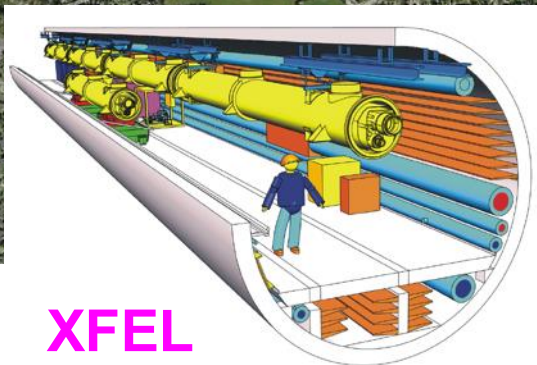
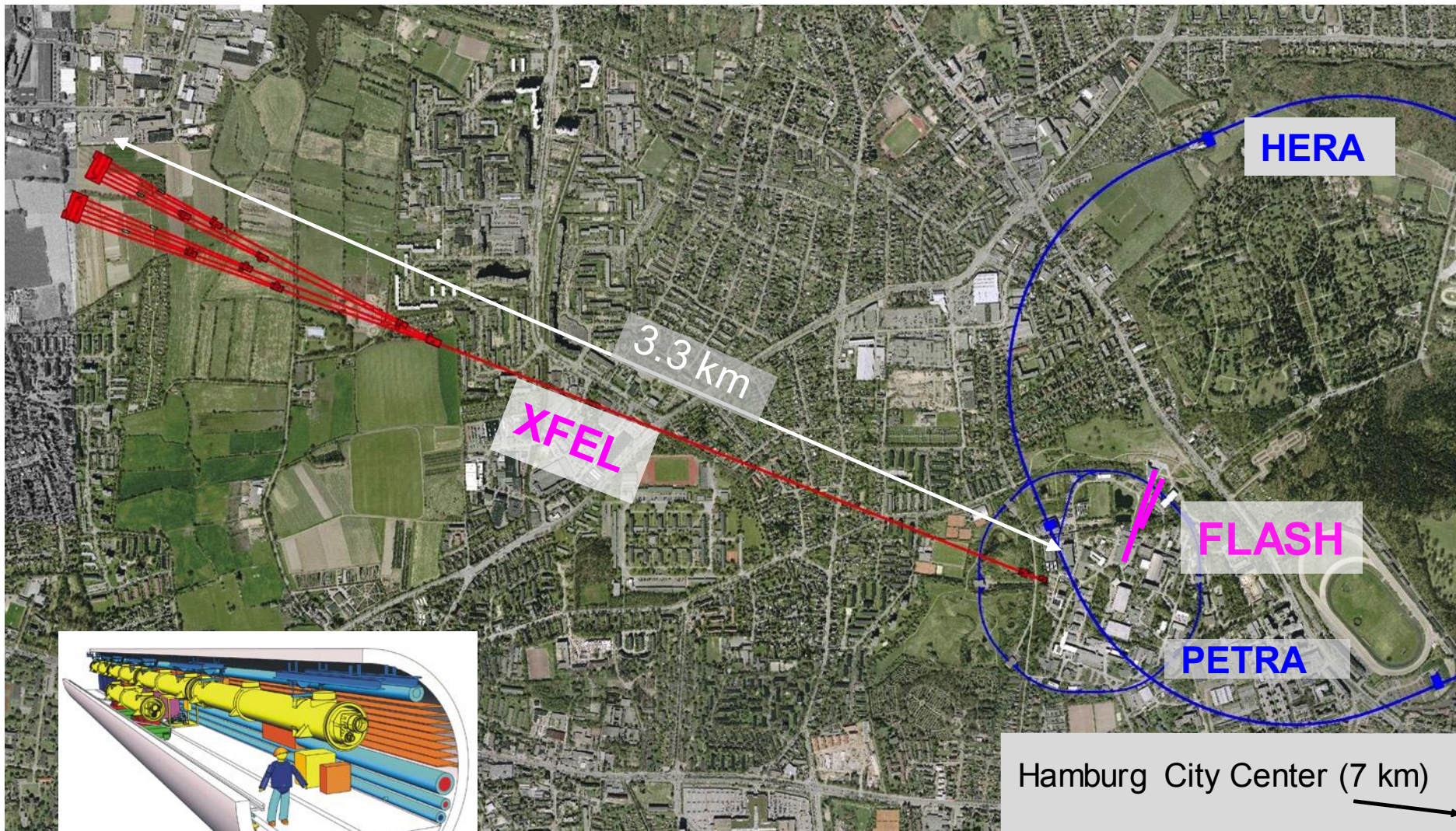
Overview and Status of the Commissioning

Kay Rehlich

on behalf of the controls groups

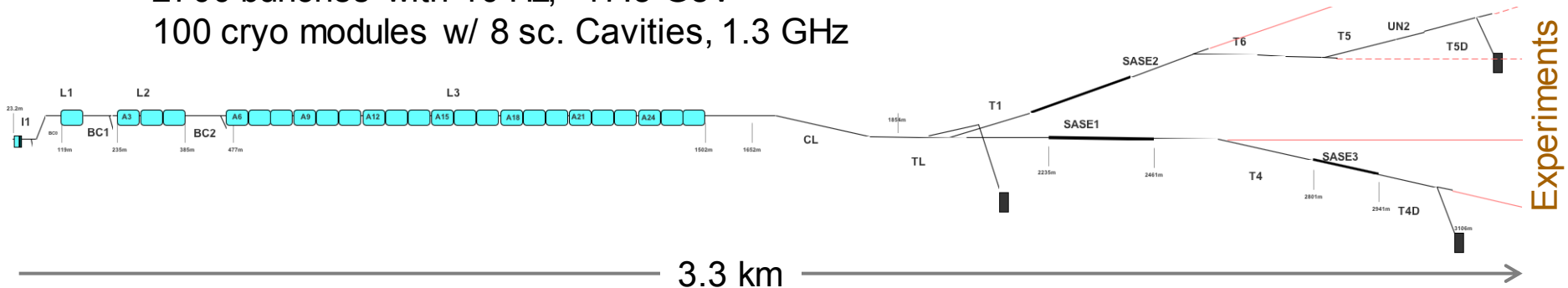
ICALEPCS 2015, 19. Oct. 20145

The European XFEL



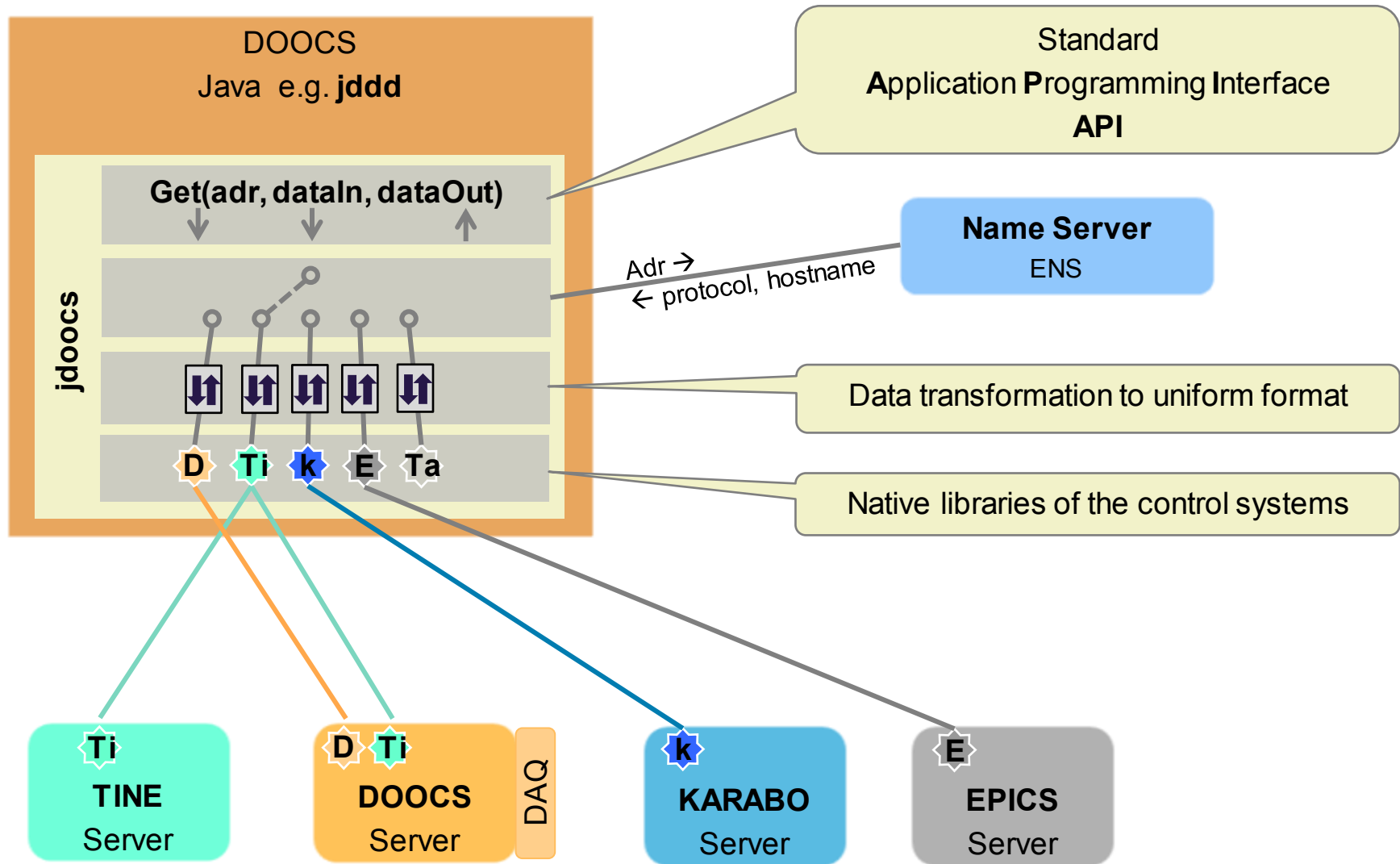
XFEL Control Systems

2700 bunches with 10 Hz, 17.5 GeV
100 cryo modules w/ 8 sc. Cavities, 1.3 GHz



- > DOOCS all beam based fast controls
 - > TINE magnets, vacuum
 - > EPICS cryogenics, water, power
 - > KARABO photon beam lines and experiments
- } Tight interconnection

Multi Control System Interface



The KARABO System

> Fast point-to-point communication

- A single Mpixel detector reaches up to **10 GB of image data every second**
- A broker negotiates the connections
- Includes PC farm layer, online data cache and offline data archiving with computing clusters

> Basic device communication via a message-oriented middleware

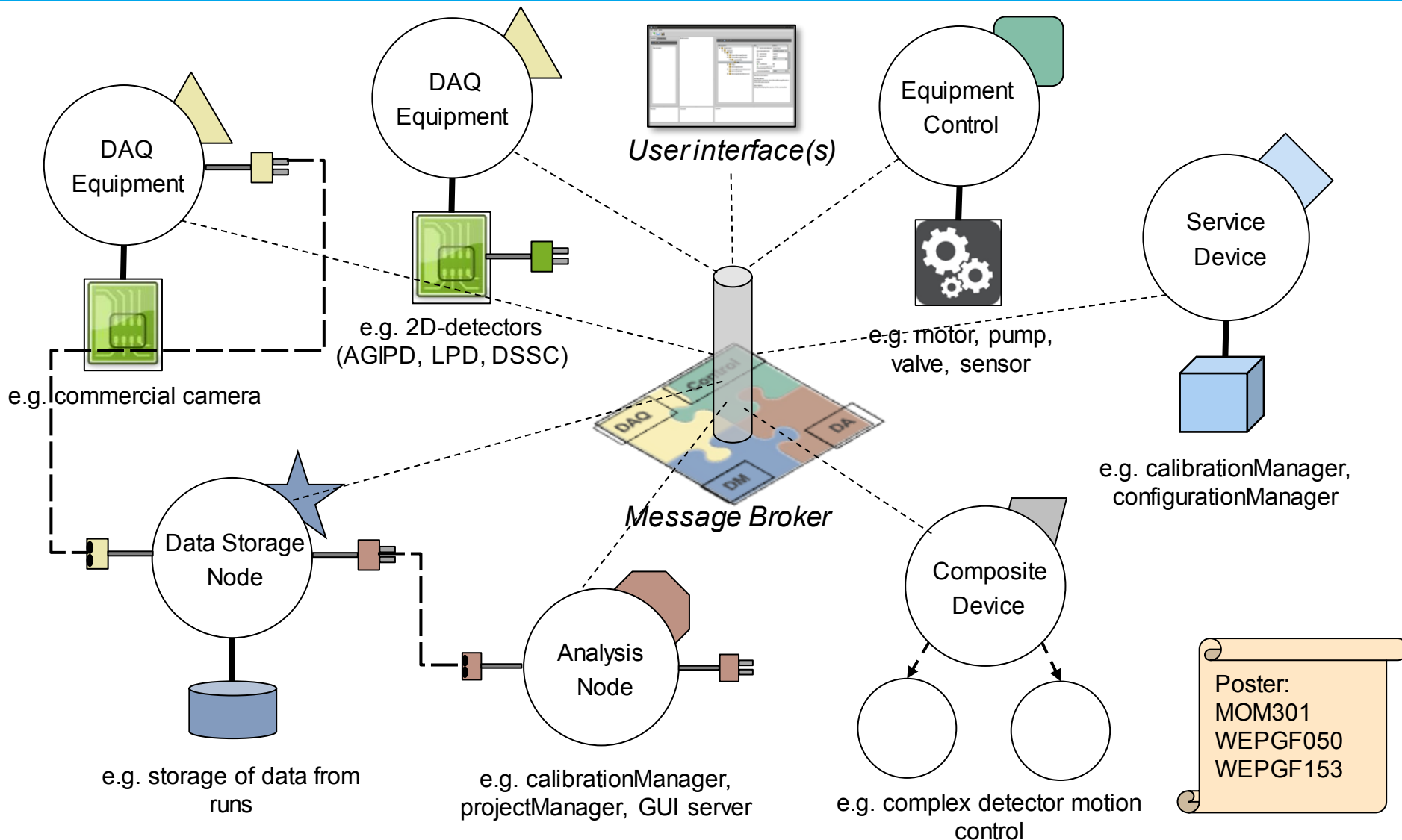
- Used for pumps, motors, PLCs, Protection systems, ...

> Detectors are synchronized with the accelerator by a MTCA.4 Timing Receiver

- Pulse frequency up to 4.5 MHz
- Provides: Unique train IDs, clocks, triggers, ...



Karabo: Control System of the Photon Experiments

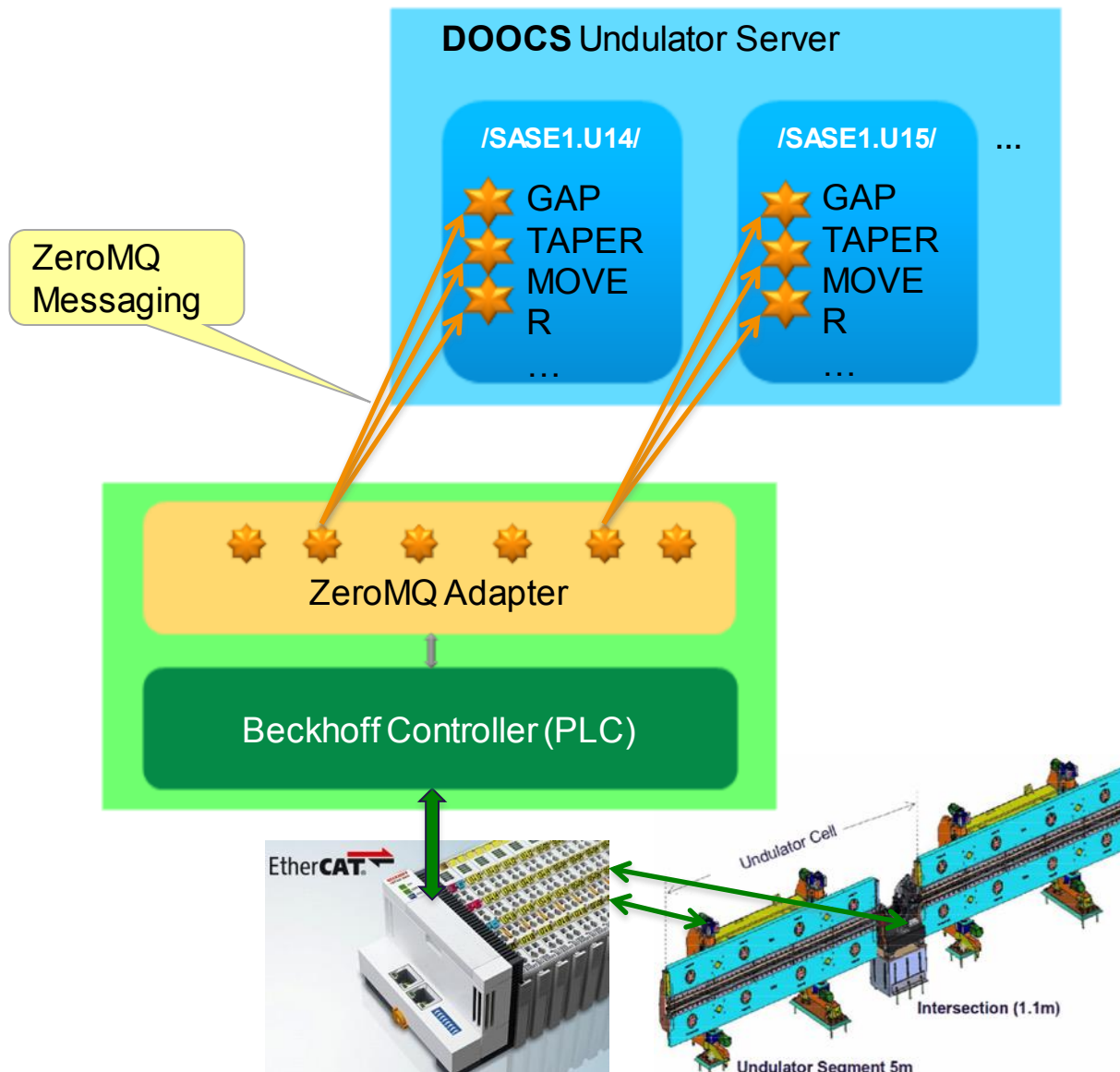


Control system features:

- > Process control system running 24/7 , uninterrupted > 1 year!
 - **Reliability and availability is an important issue**
- > Closed loop controls and state notation programs are implemented in EPICS IOCs (Input Output Controller)
Only machine protection runs on PLCs
- > Redundant process controllers, networks and power supplies on UPS
- > Archiving ~21.000 channel (700 values/ sec (total) sustained rate)
- > Profibus is used for the redundant field bus on single mode fiber:
 - 13 Profibus lines
 - Cryogenic plant: 210 Profibus nodes with 6.400 EPICS records.
 - Helium distribution system: 330 nodes and 6.300 records.
- > Control System Studio (CSS) is an Eclipse application comprising operator applications diagnostic tools and a framework to configure cryogenic control systems (from sensor to graphic)



Integration of the Undulator Controls



LINUX server

Windows PC
with **turnkey system**
Beckhoff software
and ZeroMQ interface

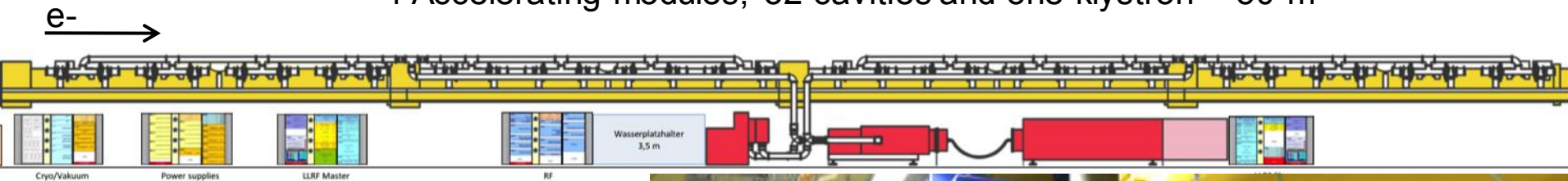
3 sections with
35 Undulators each
~600 m total

Talk:
MOD3005



XFEL Tunnel: One out of 25 Klystron Sections

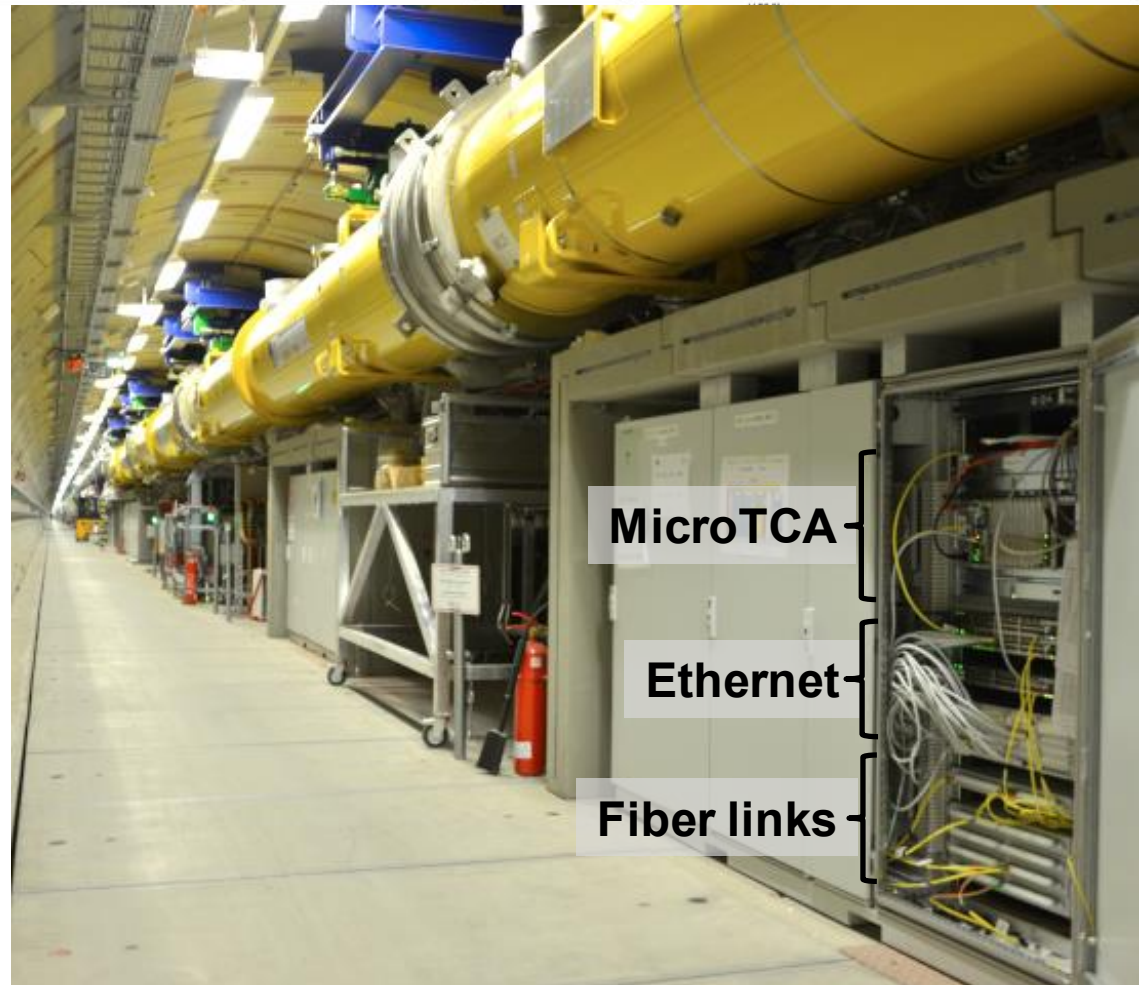
4 Accelerating modules, 32 cavities and one klystron = 50 m



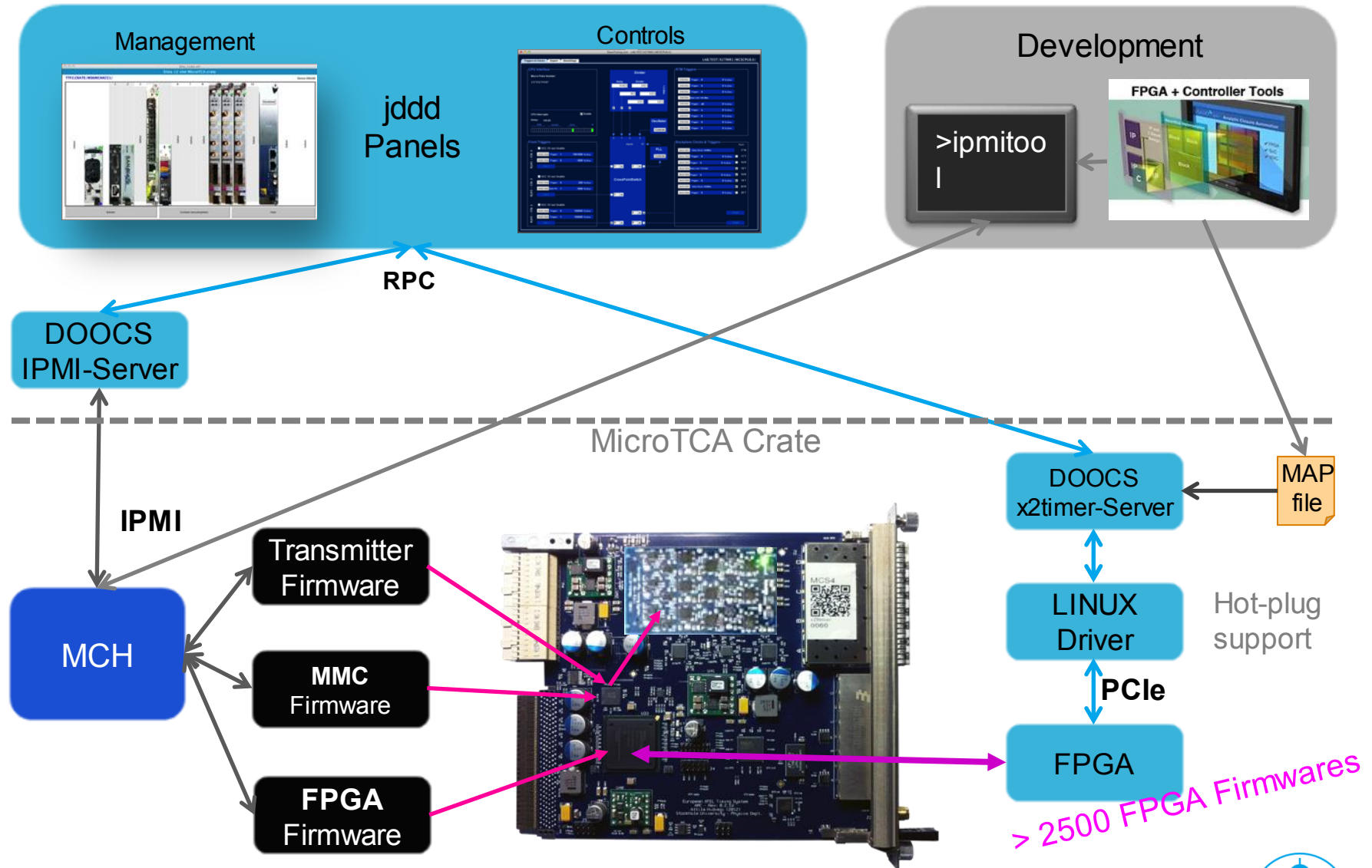
> 200

MicroTCA crates:

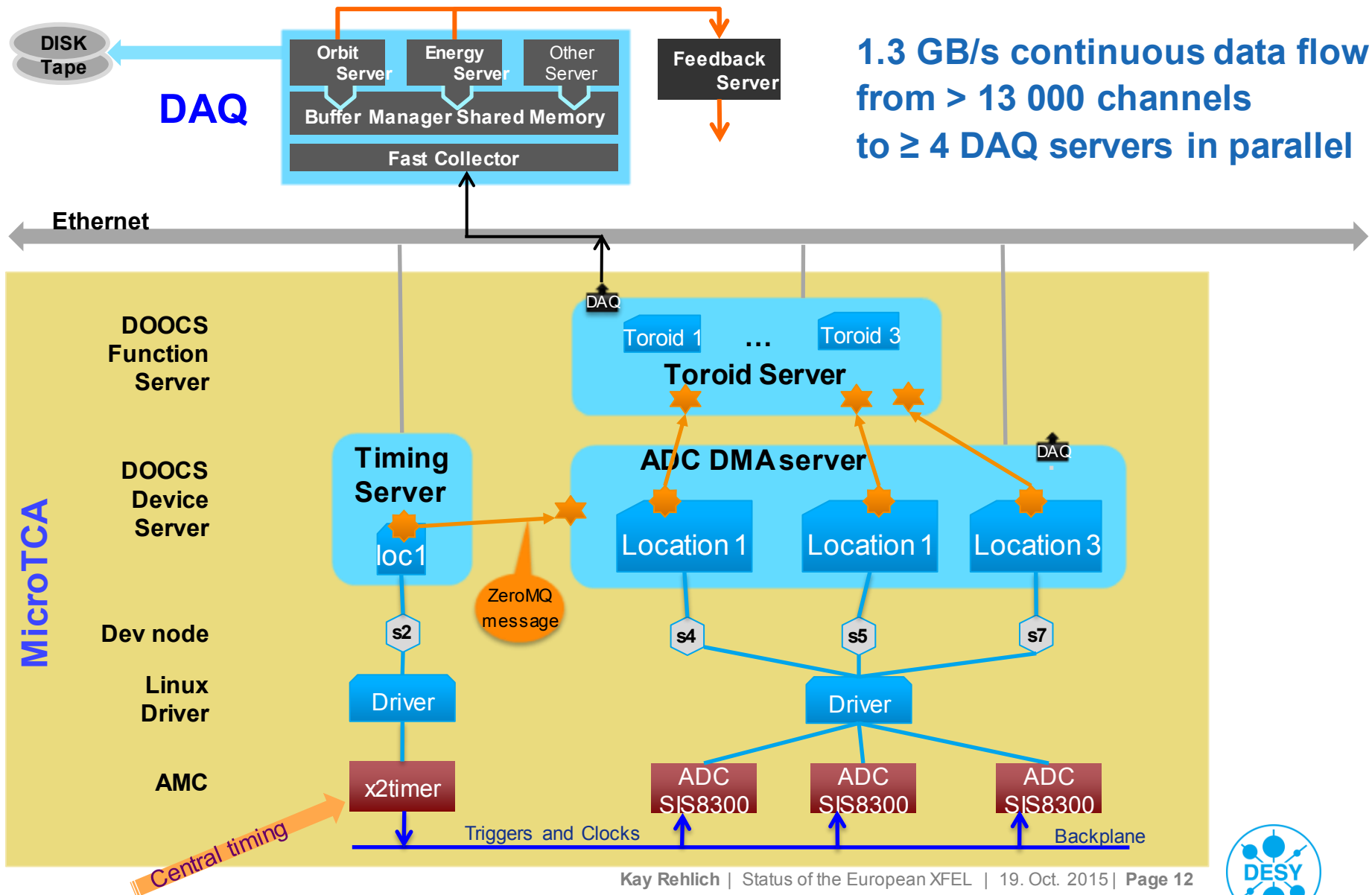
- 58 LLRF
- 53 Coupler Interlocks
- 50 Diagnostics
- 21 Special Diagnostics
- 20 Vacuum, Magnets
- + Experiments



Management, Controls and Development Interfaces



Fast Data Processing from MicroTCA to DAQ Server



Conclusions

- Most parts of the hardware and software are in successful operation:
 - **FLASH:** 20 crates installed, 6 RF stations are controlled 24/7 by MicroTCA
 - Multibeamline operation with timing and machine protection
 - **XFEL:** One RF section with 32 cavities is commissioned inside the tunnel
 - VirtualXFEL: software simulation installed
 - Cryogenic plant runs since half a year
 - Undulator controls are demonstrated in a mock-up
 - Experiment controls operate e.g. a large pump-probe laser
- Next steps
 - Operation of the XFEL Injector end 2015
 - 2016: full operation of XFEL



XFEL MicroTCA Crates

Common modules

Application modules . . .

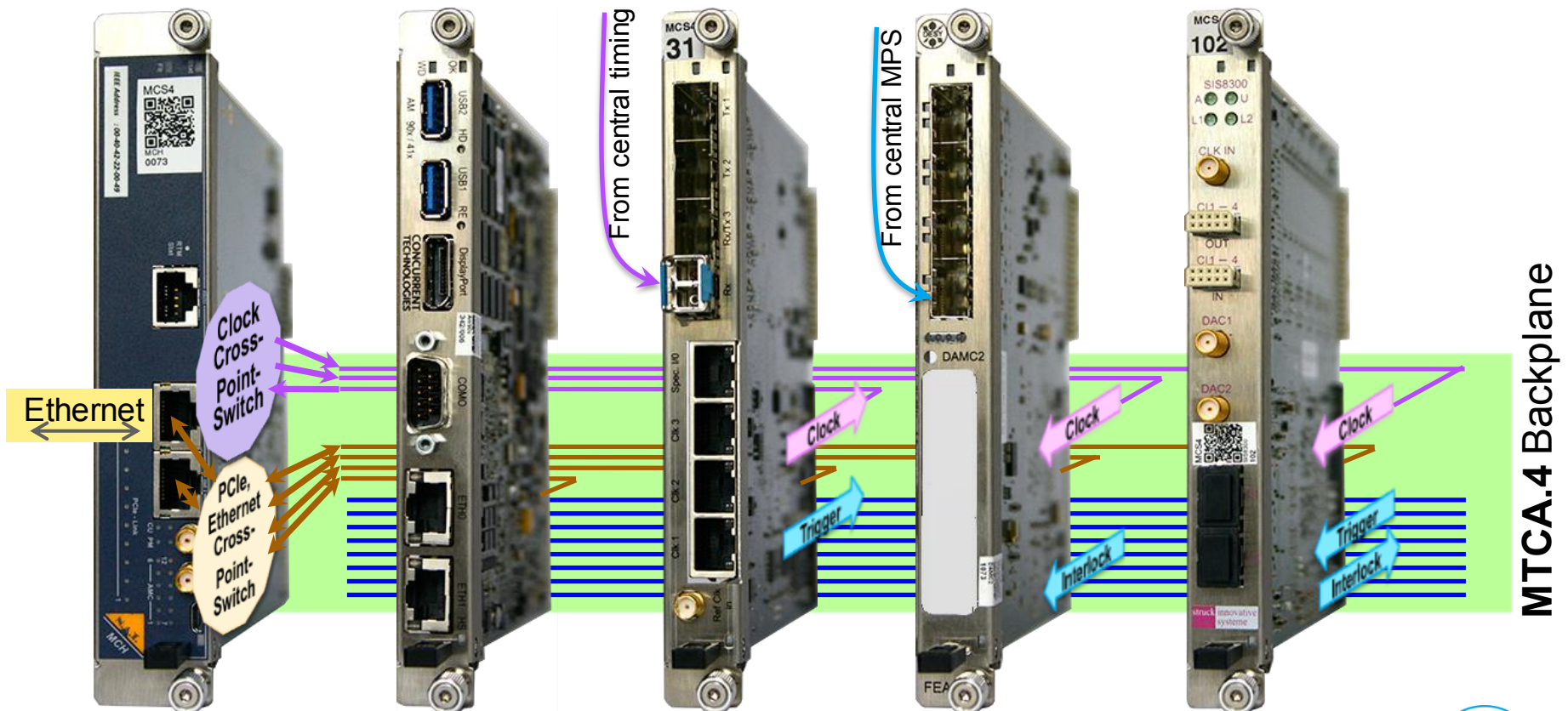
MCH

CPU

Timing

Machine
Protection
System

ADC
Digi. IO
Controller
....



MicroTCA Remote Management Software

Graphical representations:

- Is-inserted, fault, ...
- Temperatures, voltages
- Reset, power on/off
- Act. Power consumption

SystemStatus.xml

DOOCS System Status

Applications Server Status Network Status FLASH Timing FLASH VME FLASH uTCA MicroTCA FLASH.L

XFEL MicroTCA Crates

Module	Manufacturer	Status
XFELMCHXM1:	Schroff GmbH	12
XFELMCHTIME1:	Schroff GmbH	12
XFELMCHLLGUN1:	Schroff GmbH	6
XFELMCHTIL1:	ELMA Electronic GmbH	12
XFELMCHLASER1:	Schroff GmbH	12
XFELMCHDI30I1:	Schroff GmbH	12
XFELMCHVAC1:	Schroff GmbH	6
XFELMCHMAG1:	Schroff GmbH	12
XFELMCHLA2M:	off	
XFELMCHLA2S:	Schroff GmbH	0

AMTF MicroTCA Crates

Module	Manufacturer	Status
MSKMCHAMTF1:	Schroff GmbH	12
MSKMCHAMTF2:	Schroff GmbH	12
MSKMCHAMTF3:	Schroff GmbH	12
AMTFMTS1MCH:	Schroff GmbH	12
AMTFMTS2MCH:	Schroff GmbH	12
AMTFMTS1MCH:	Schroff GmbH	12

Elma_12slot.xml FLASH.CRATE/MSKMCHACC67/*/LAB.CRATE

xTCA-12 special 12 Slot MicroTCA Crate

FLASH.CRATE/MSKMCHACC67/ device online

Crate information Current consumptions Fans

Display by standard controls tool jdd

Modules in selected crate: **XFEL.CRATE/XFELMCHDI30I1/**

CRATE: Schroff GmbH

Module	Manufacturer	U	Temp	Status	Serial	MMC version
RTM3:	MPS-RTM1 ATP				01-012	0.00
RTM8:	SIS8900 Struck Innovative Systeme GmbH				074	0.00
RTM4:	XFEL-BLM Deutsches Elektronen-Synchrotron				969901010	0.00
AMC3:	DAMC2 Deutsches Elektronen-Synchrotron	U= 3.3	Temp= 30.0		1075	1.02
COOL_UNIT2:	Fan speed= 2580 2640 3000 3060	Temp= 27.0 24.0			1051405710AB	1.18
COOL_UNIT1:	Fan speed= 2580 2520 2940 2940	Temp= 26.0 24.0			1051405711AB	1.18
AMC1:	AM 900/412 Concurrent Technologies	U= 0.9	Temp= 35.0		M23485D016	3.09
AMC4:	DAMC2 Deutsches Elektronen-Synchrotron	U= 3.5	Temp= 29.0		1020	2.00
AMC6:	DAMC2 Deutsches Elektronen-Synchrotron	U= 3.3	Temp= 30.0		1025	1.01
AMC8:	SIS8300 Struck Innovative Systeme GmbH	U= 1.8	Temp= 41.0		029	1.00
AMC7:	DAMC2 Deutsches Elektronen-Synchrotron	U= 3.3	Temp= 30.0		3010	2.00
AMC2:	XZTIMER Stockholm University	U= 3.3	Temp= 31.0		0067	2.00
MCH:	NAT-MCH V1.3, R130927	Current= 2.0	Temp= 27.0 32.0 30.0 29.0		128	2.15
POWER_UNIT2:	MTCA Power S...				01786007	1.10

Remote upgrade of Firmware
Remove/insert of modules
in a running system

> 2500 FPGA Firmwares

