The Large Scale European XFEL Control System

Overview and Status of the Commissioning

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on behalf of the controls groups

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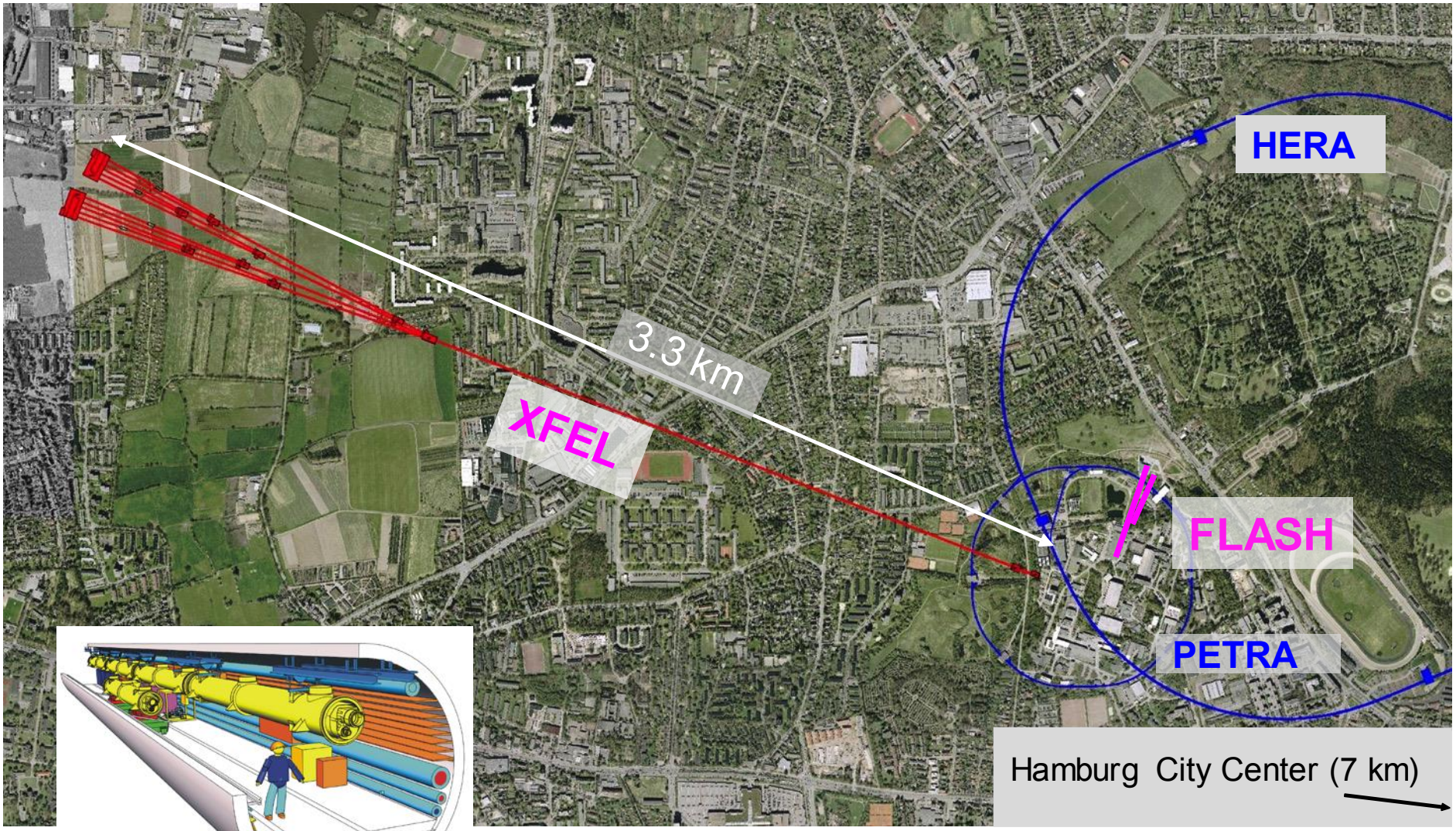
HELMHOLTZ ASSOCIATION

DESY

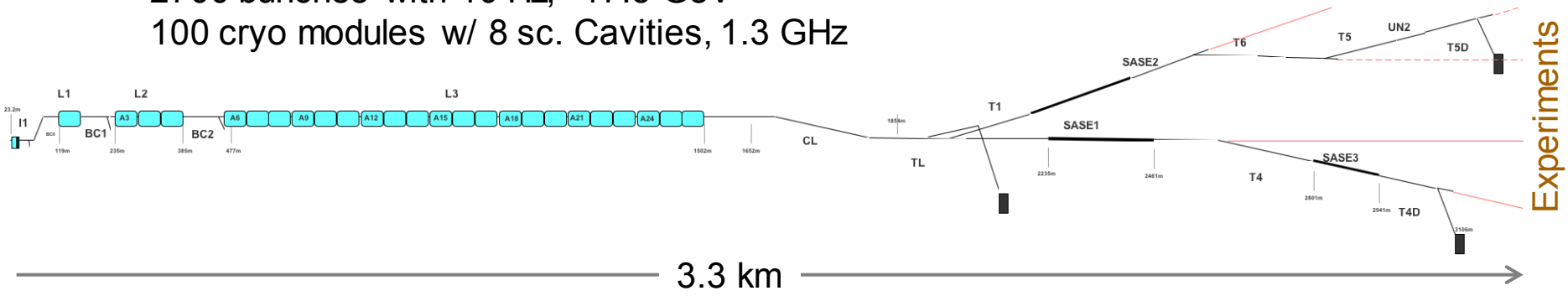
The European XFEL



XFEL

XFEL Control Systems

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

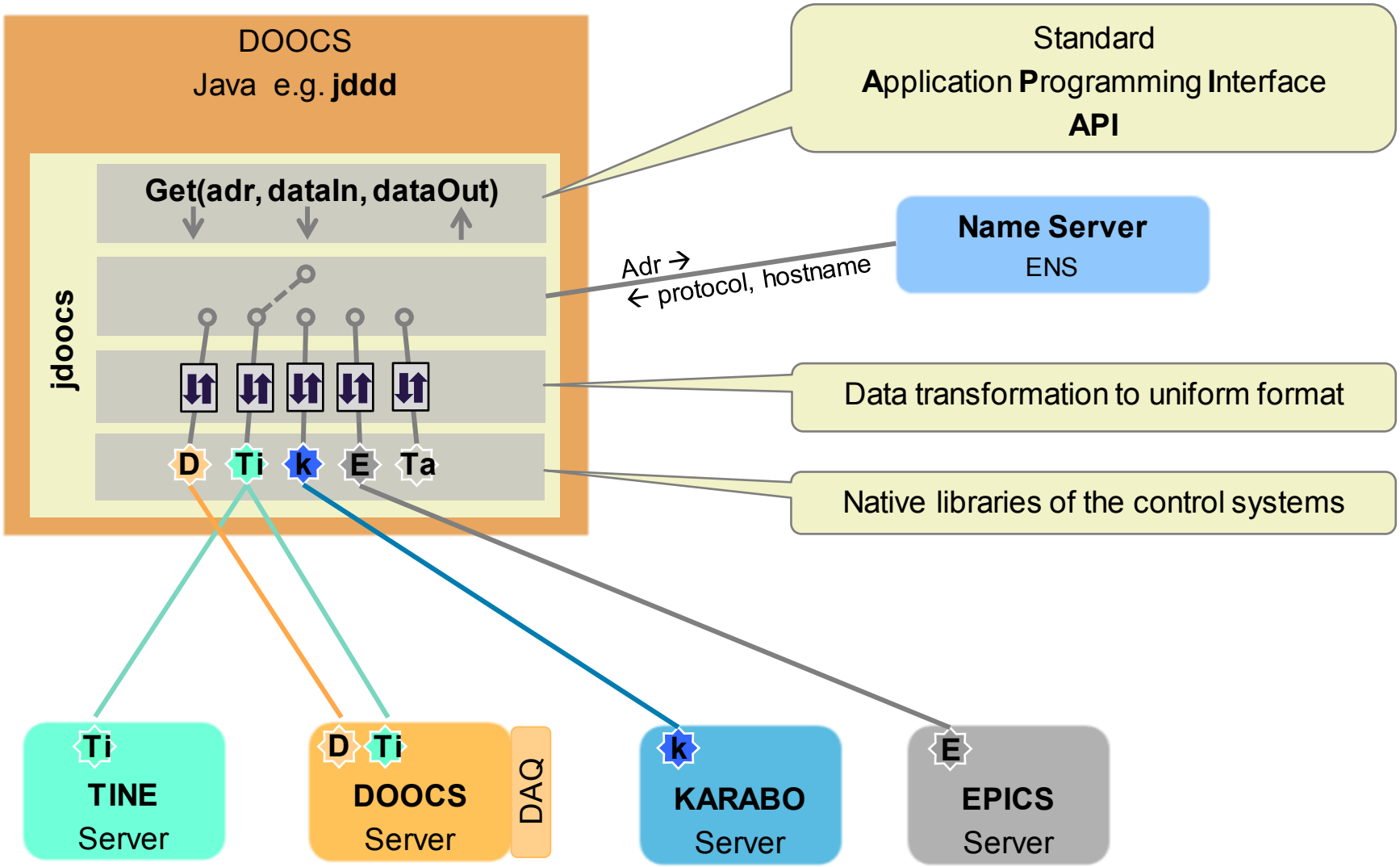


- DOOCS — all beam based fast controls
- TINE — magnets, vacuum

} Tight interconnection

- EPICS — cryogenics, water, power
- KARABO — photon beam lines and experiments

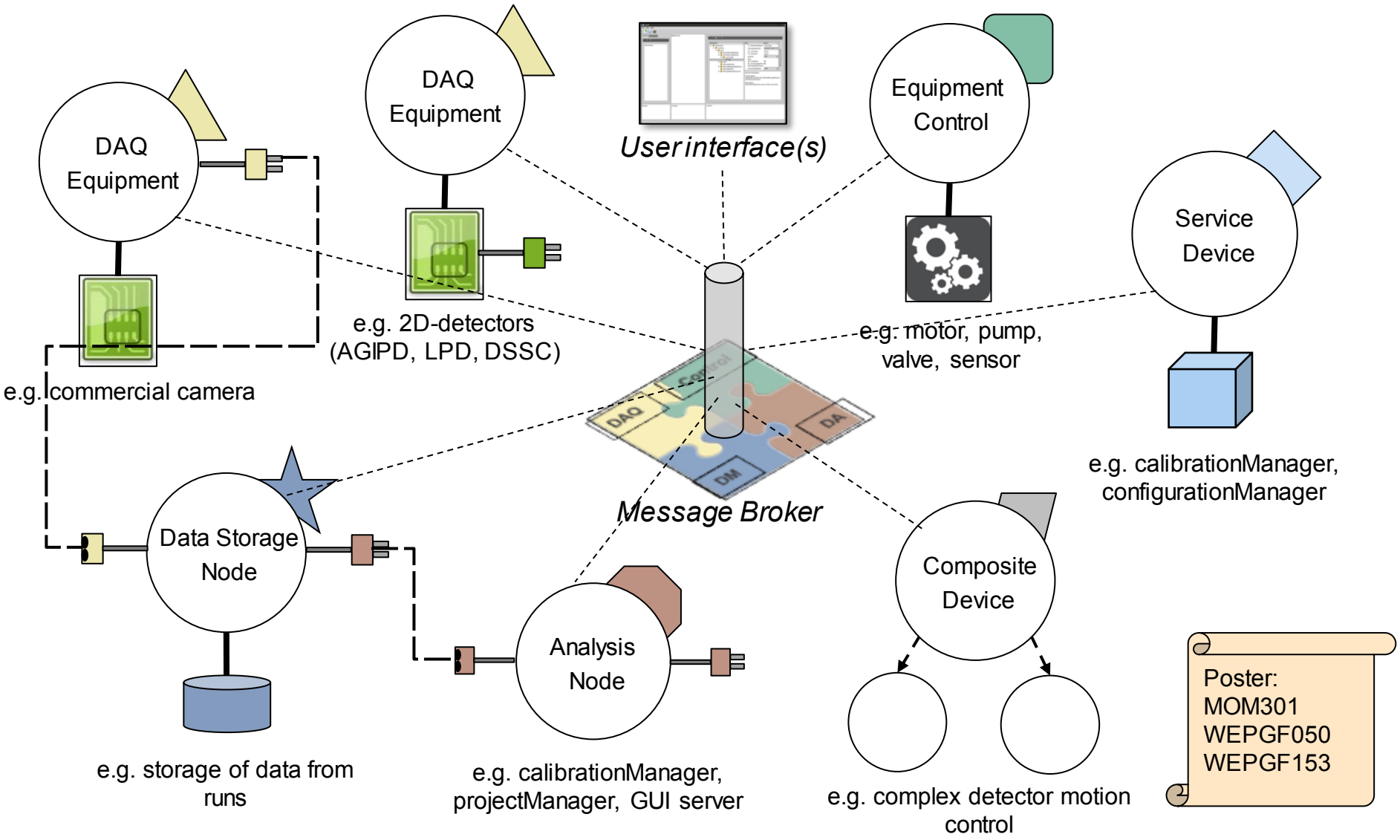
Multi Control System Interface



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

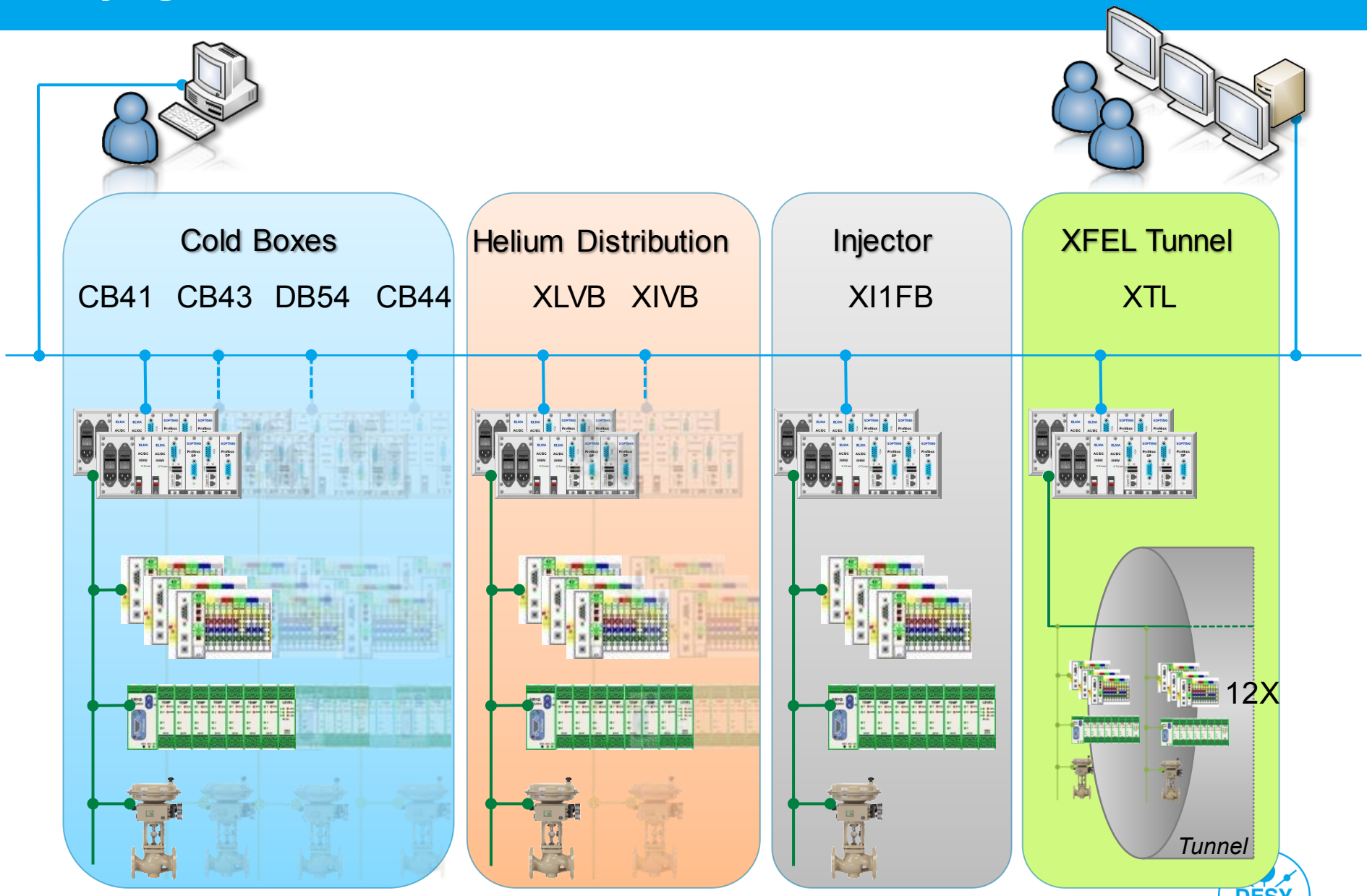


Control system features:

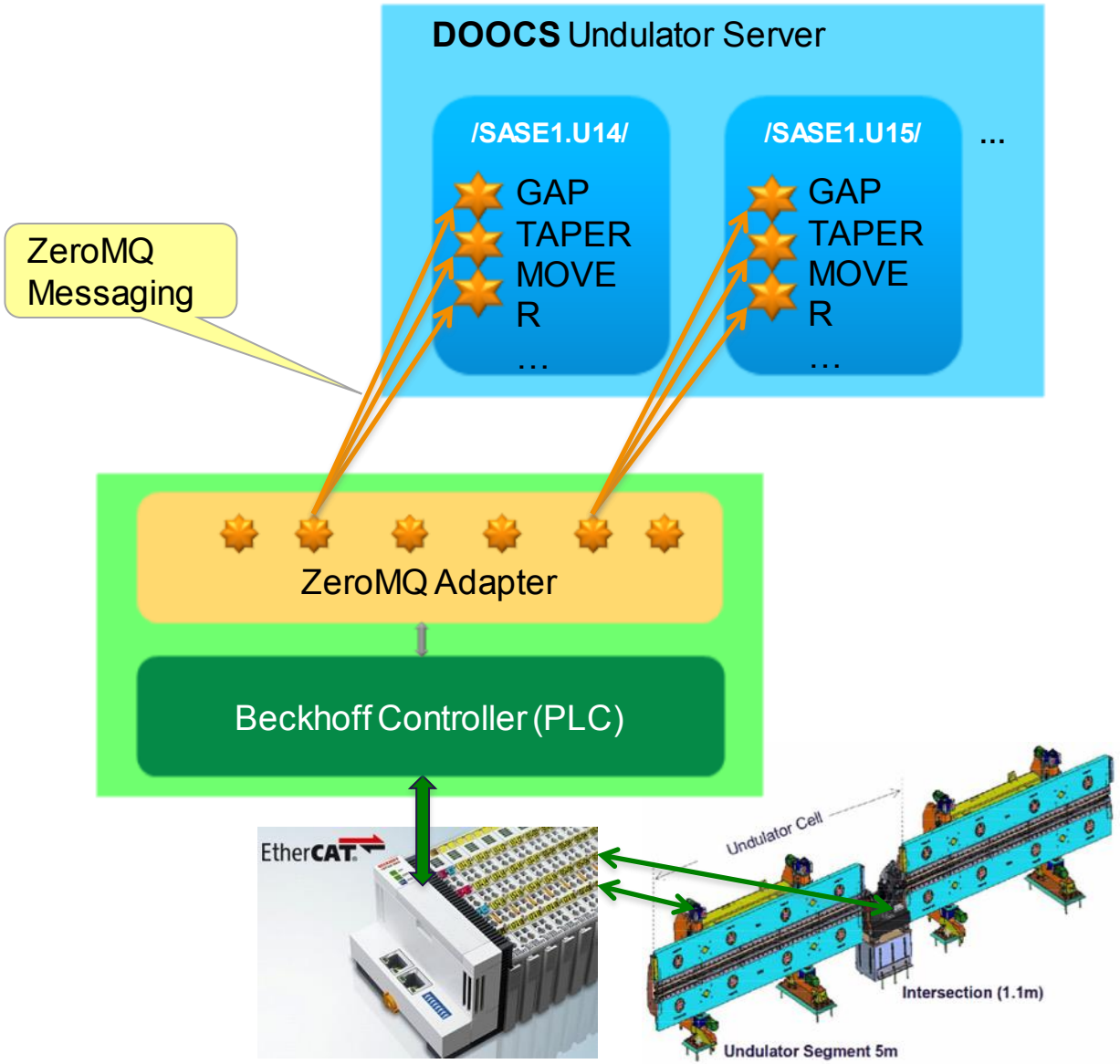
- Process control system running 24/7 , uninterrupted > 1 year!
  - **Reliability and availability is an important issue**
- Closed loop controls and state notation programs are implemented in EPICS IOCs (Input Output Controller)
  Only machine protection runs on PLCs
- Redundant process controllers, 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)

Cryogenic Controls

Process Controller and I/O Infrastructure



Integration of the Undulator Controls



LINUX server

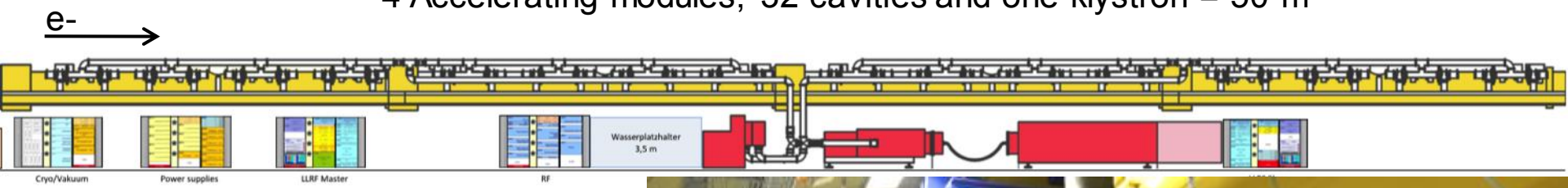
Windows PC
with **turnkey system**
Beckhoff software
and ZeroMQ interface

3 sections with
35 Undulators each
~600 m total

Talk:
MOD3O05

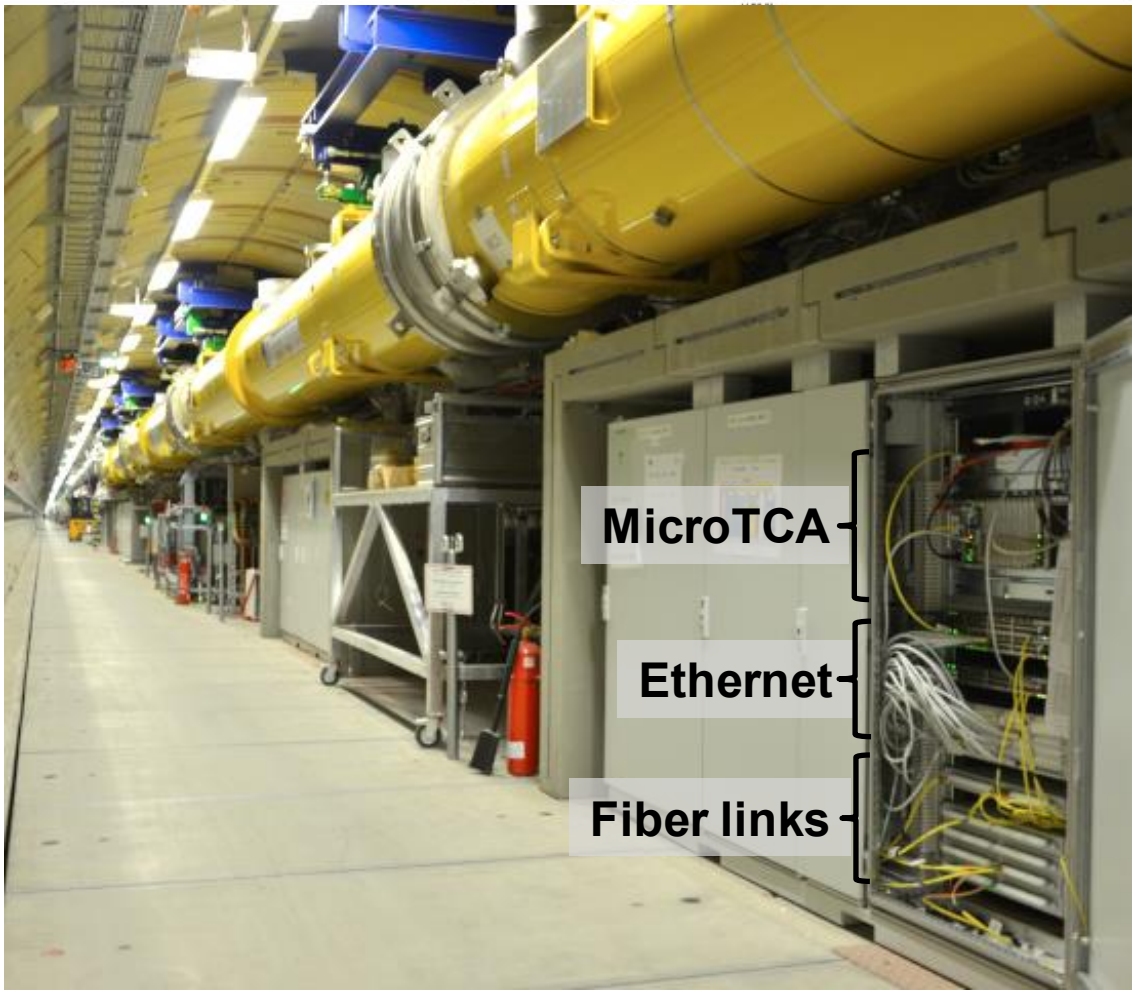
XFEL Tunnel: One out of 25 Klystron Sections

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

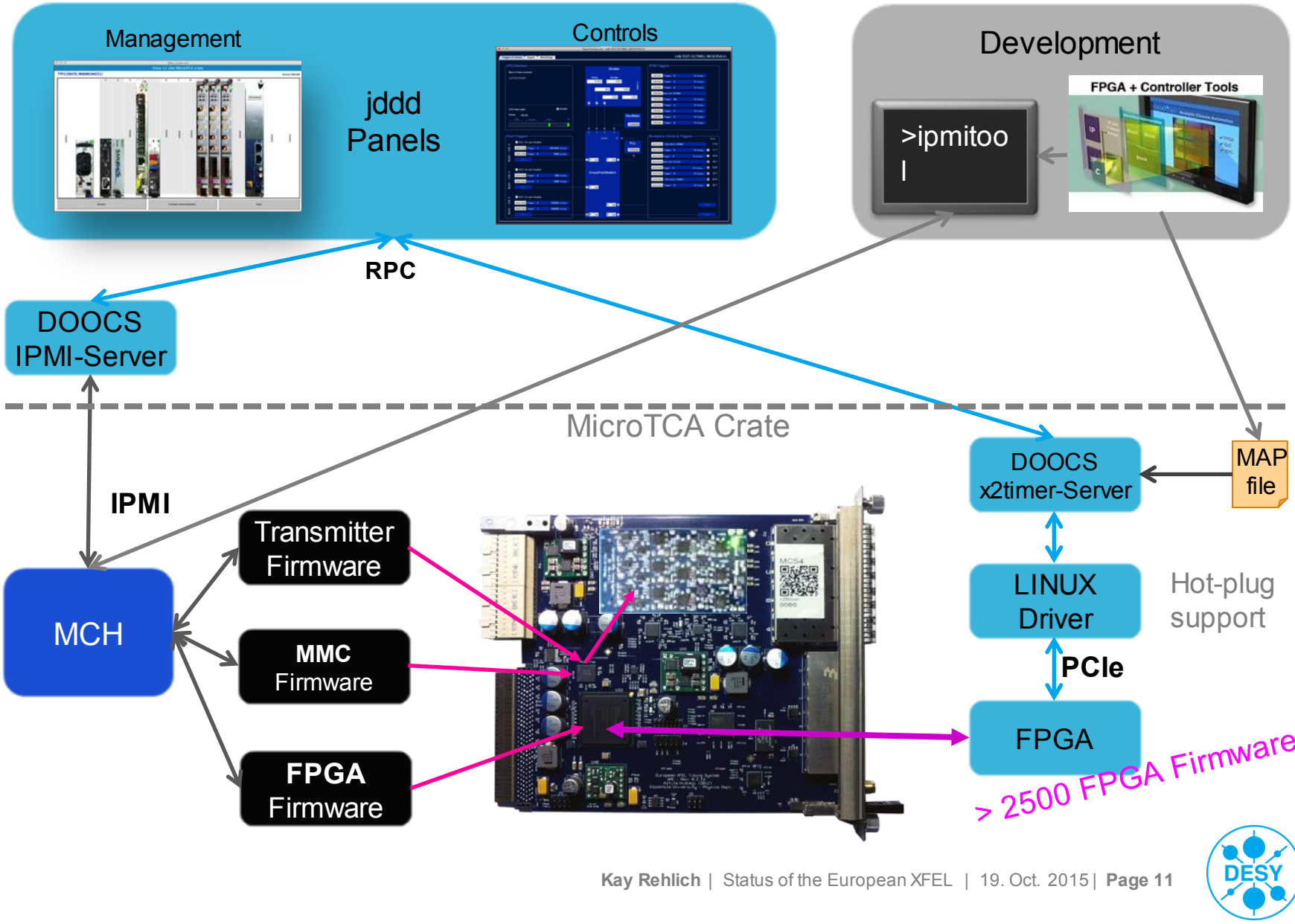


> 200
MicroTCA crates:

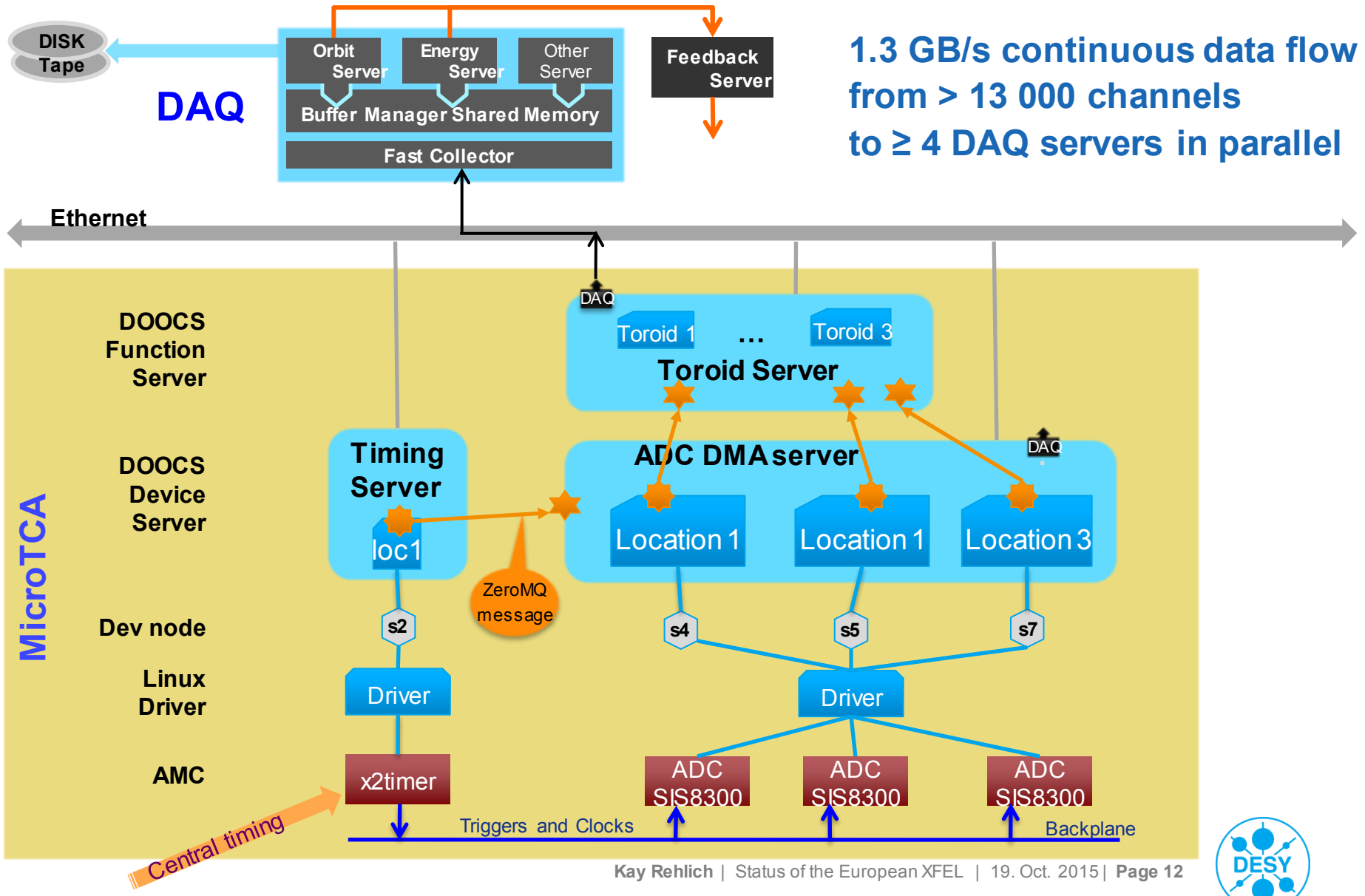
- 58 LLRF
- 53 Coupler Interlocks
- 50 Diagnostics
- 21 Special Diagnostics
- 20 Vacuum, Magnets
- + Experiments



Management, Controls and Development Interfaces



Fast Data Processing from MicroTCA to DAQ Server

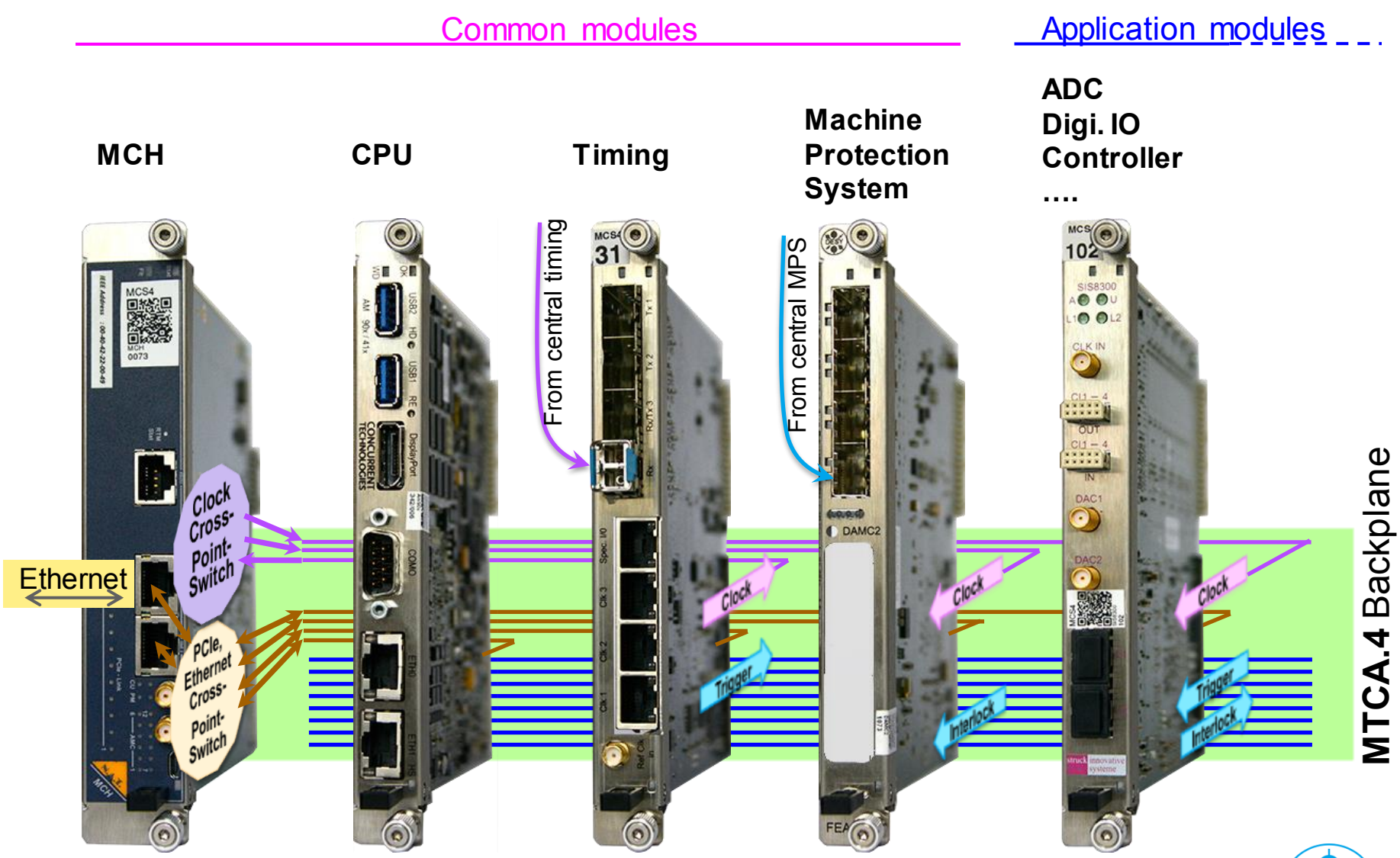


Conclusions

- 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

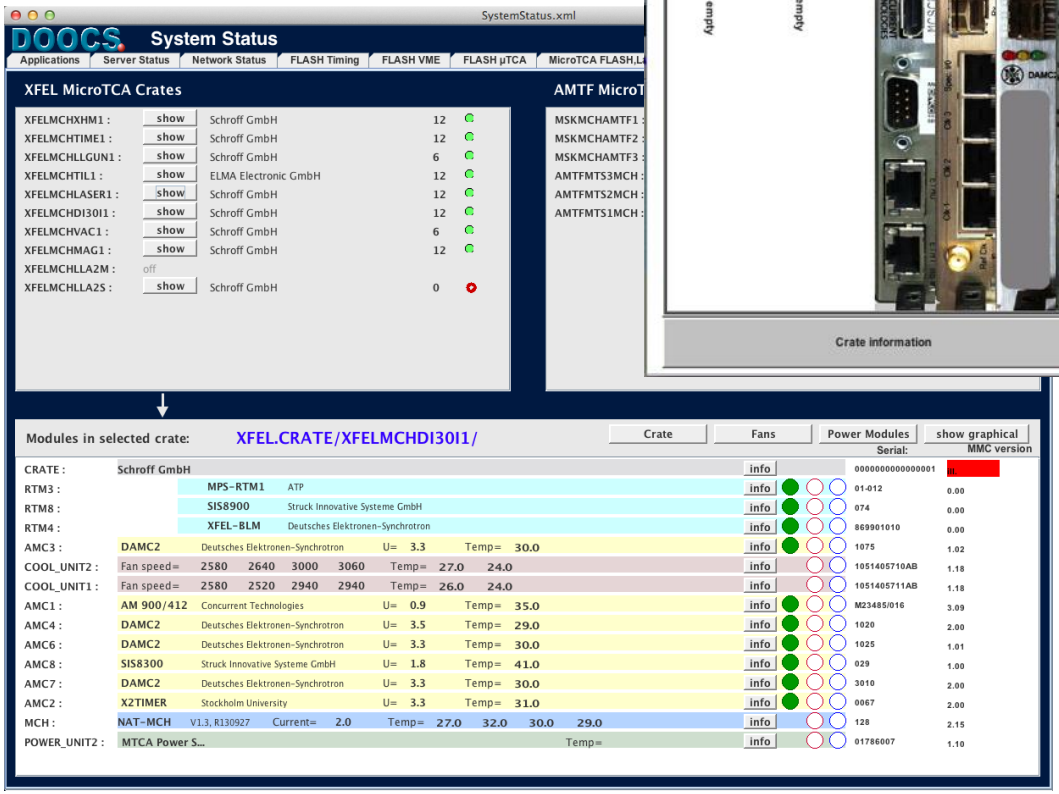
Backup

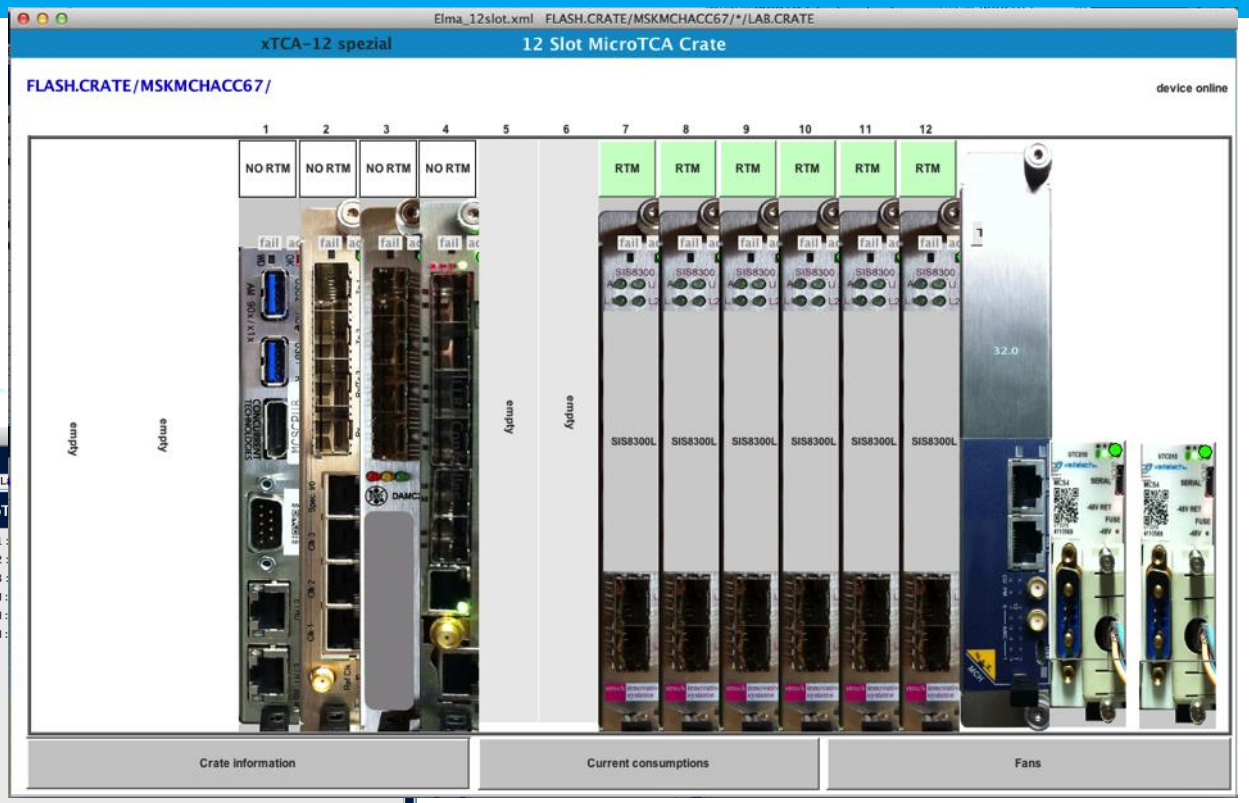
XFEL MicroTCA Crates



MicroTCA Remote Management Software

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





Display by standard controls tool jddd

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

> 2500 FPGA Firmwares