XFEL Crate Standard Workshop

Requirements

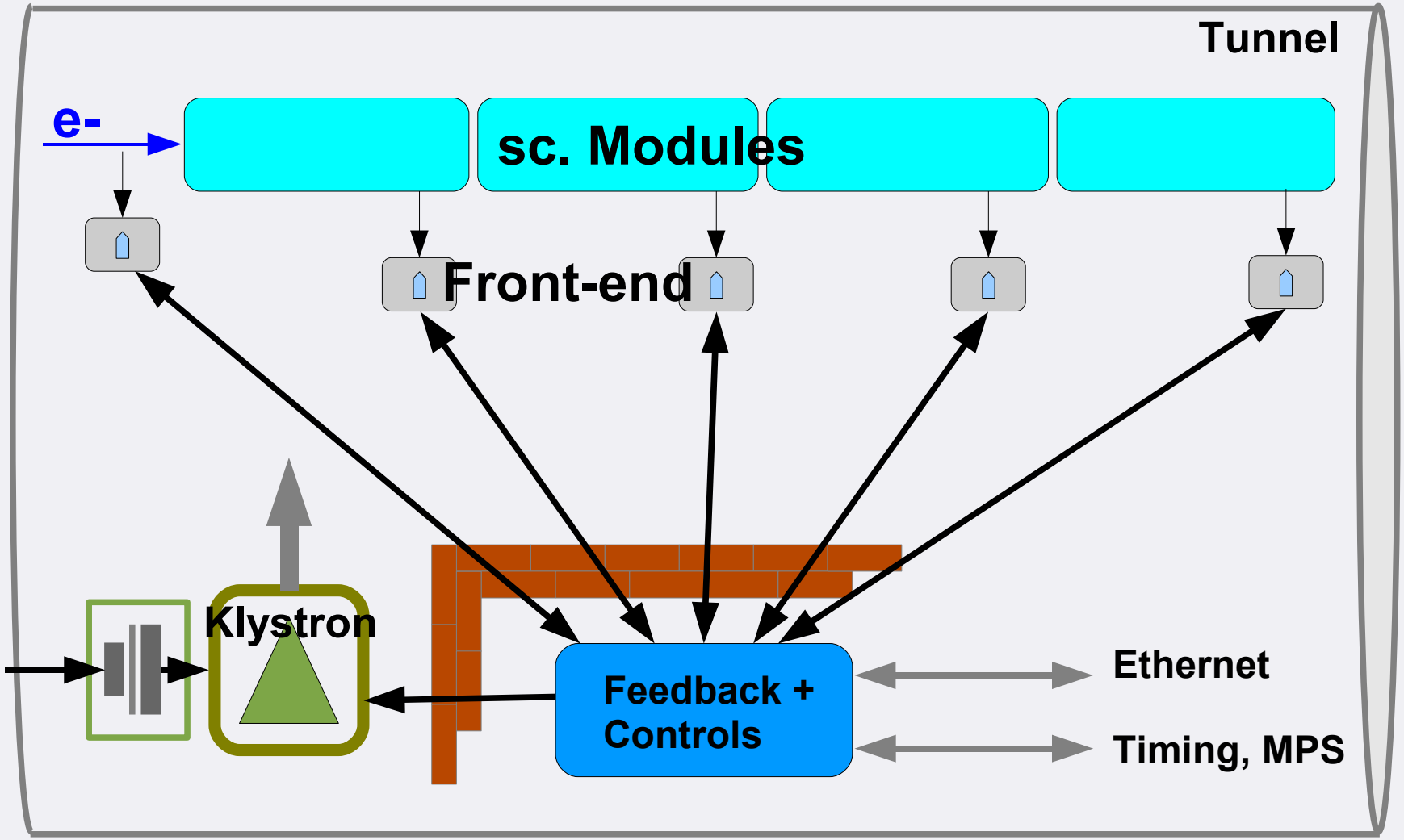
Possible solutions

Kay Rehlich

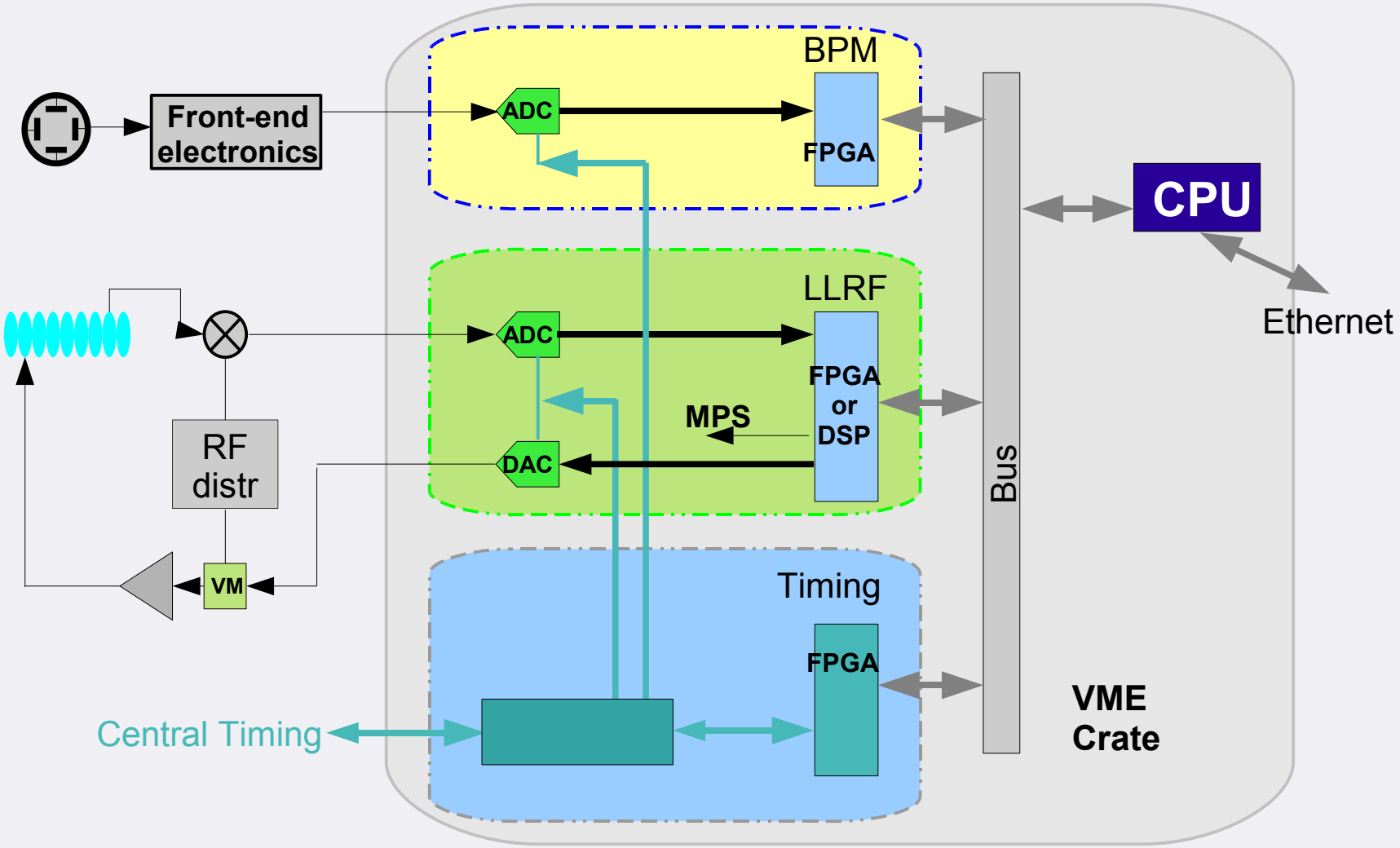
Motivation

- Consistent data acquisition of all XFEL sub-systems
- Manageable and reliable system
- Find today a solution with support for the next 10 years
- Can we agree on common hardware, interfaces and software for the XFEL?

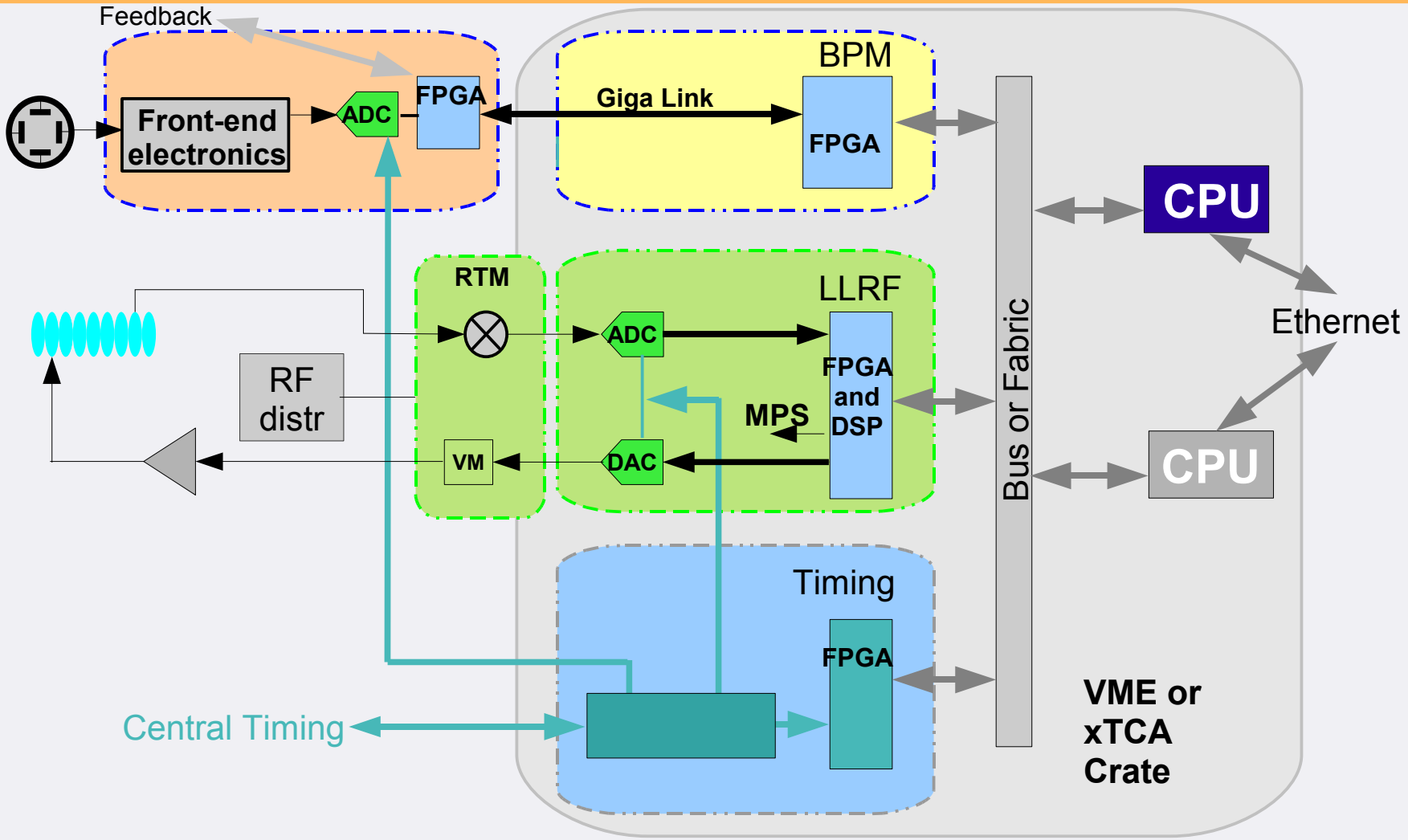
Geographical Layout



The Front-end: FLASH Example

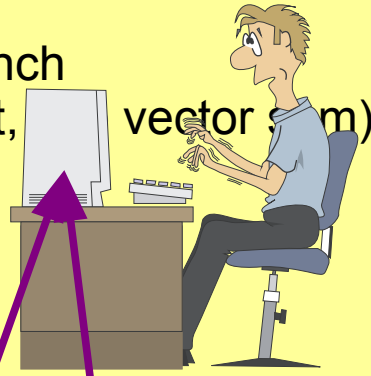


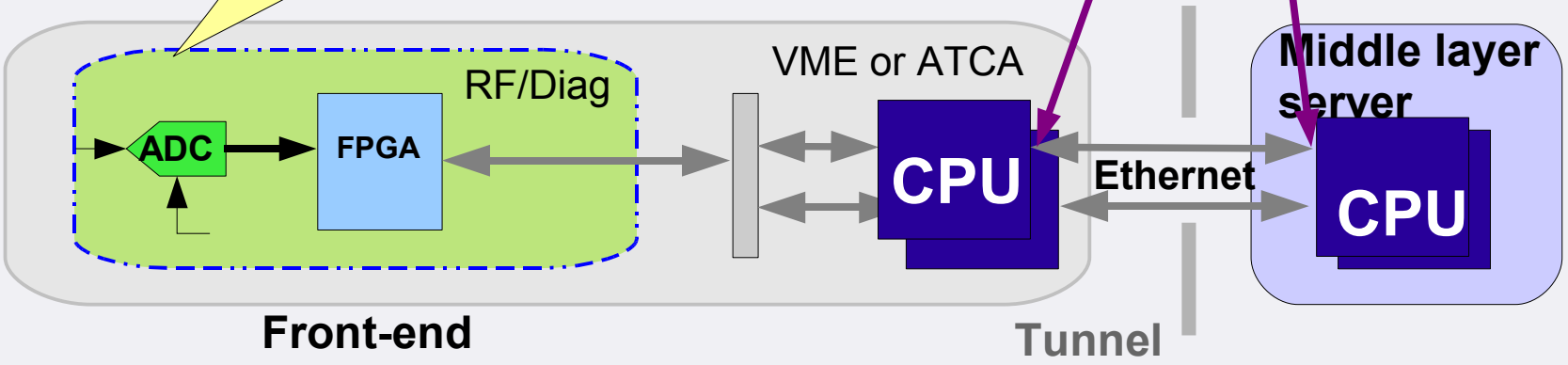
The Front-end: Alternatives



Data Flow: Front-end

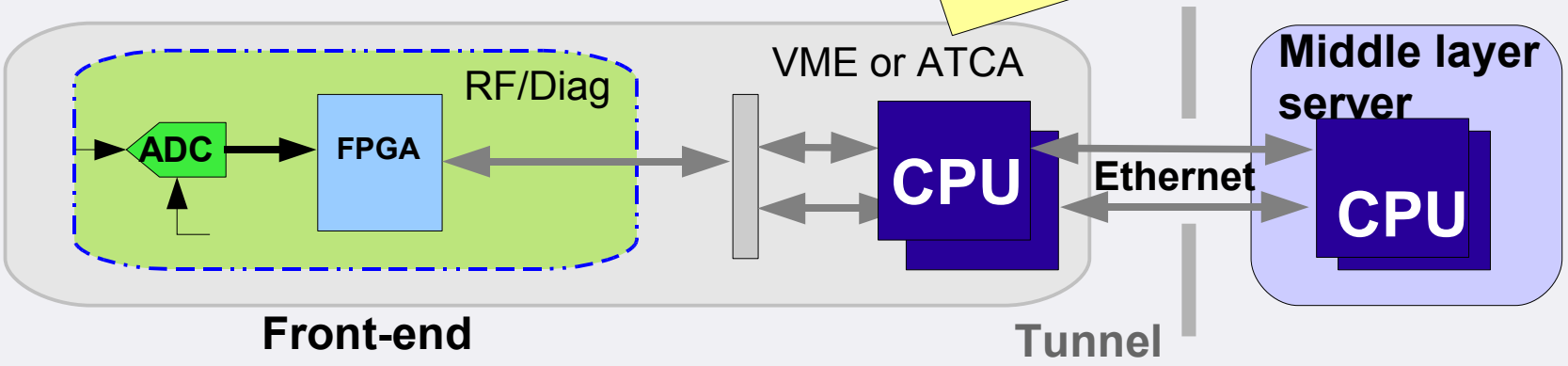
- Preprocessing: **reduce data** to e.g. one set per bunch
  channel based calculations (e.g. peak detect, vector sum)
- Timing: adjust clock and triggers
- Program (FPGA) loading and verification
- Feedback algorithm
- Data buffer (several XFEL shots)
- Self-tests / calibrations
- Provide debug data (e.g. full samples) on request





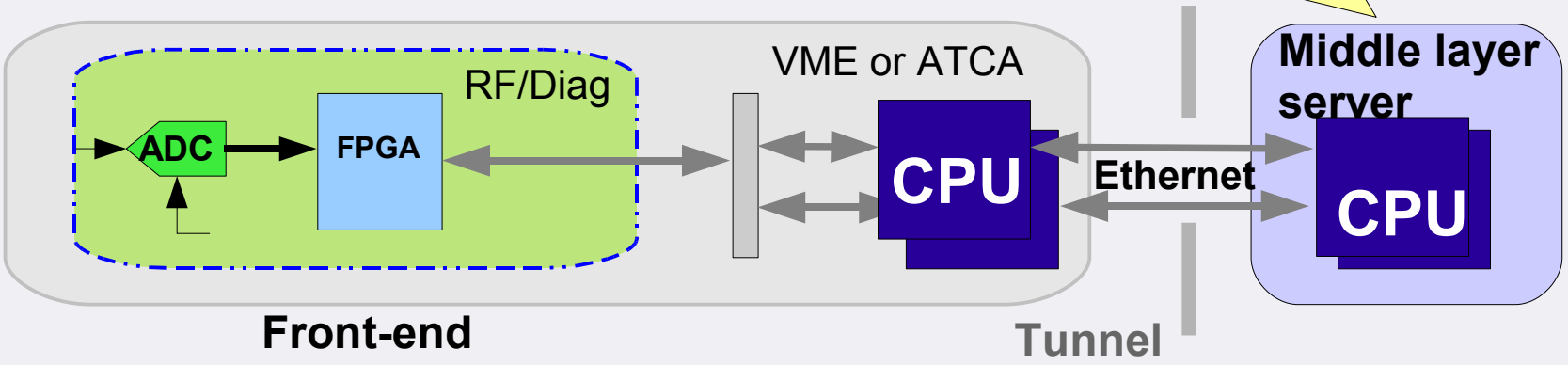
Data Flow: Device Server

- DOOCS device server process
- Data buffer for the control system
- 'self-healing' of the feedback and diagnostics controllers: check/restart programs, parameters and processors
- State machines
- 'fail-over' control (e.g. feedforward only operation)
- Redundant CPU possible (ATCA)
- Auto tuning cavity f, adaptive feedforward, loop phase, calibrations



Data Flow: Service Tier

- **Global services** (for multiple devices)
- Alarming
- Automation (start-up, optimization, calibration, operation..)
- Data Acquisition
- Slow feedbacks
- Global momentum manager or global orbit ...



Requirements (1)

- **Must provide a connection to the XFEL timing/clock system (hardware and software)**
- **Ethernet as data transport and controls network**
- **Performance**
  - data transfer speed (different requirements of subsystems)
  - analog signal quality
- **Modular**
  - same components usable in different XFEL subsystems
- **Common software interface**
  - similar solutions for different subsystems

Requirements (2)

- **Reliability and availability**
  - high MTBF
  - redundancy for components with lower MTBF (e.g. fans)
  - redundancy for central systems (e.g. Timing, MPS)
- **Decoupled**
  - no single point of failure
  - no influence between subsystems (e.g. one module in a crate should not harm others)

Requirements (3)

- **Hot-swap**
  - if more than one subsystem uses the same crate
- **Maintainable: safe exchange of modules**
  - Without opening boxes etc.
  - Cable connections (few at front, rear if possible)
- **Remote manageable**
  - Detection of all crates and modules
  - reset and other commands to modules
- **Good fault diagnosis**
  - detect defect or degraded modules

Requirements (4)

- **Costs**
  - Compatible with XFEL budget book
  - Should allow high and low end solutions
- **Development effort**
  - Number of modules to be [re]designed for the XFEL
  - Experience of developers
- **Common parts available from industry (e.g. crates, CPUs, I/O)**
- **RoHS compliant**
- **Life time of the products (new developments) > 2014**

Possible Solutions

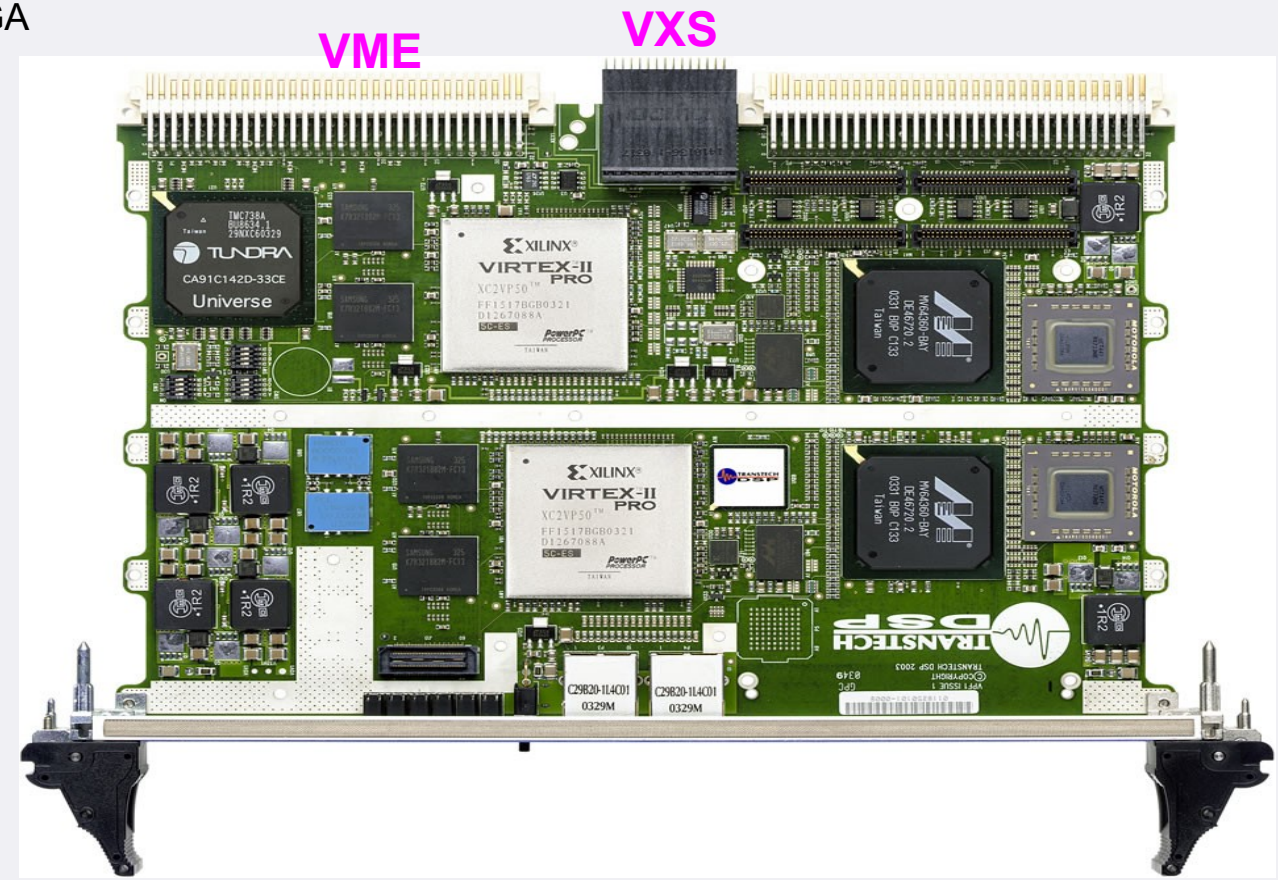
- VME (+ VXS...)
- xTCA (ATCA + µTCA)
- cPCI
- Network attached devices
- ...

Possible Solutions: VME

Example
- 2x PowerPC 7447 CPU nodes
- 2x Xilinx Virtex-II Pro FPGA
- 8X 2.0-3.125 Gbit/sec VMETRO

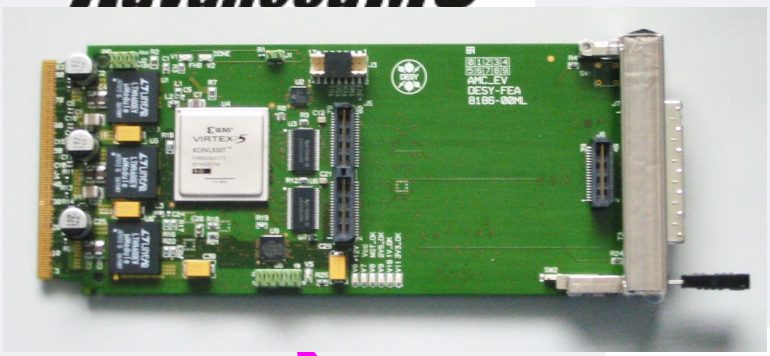
> 40 VME Crates @ FLASH

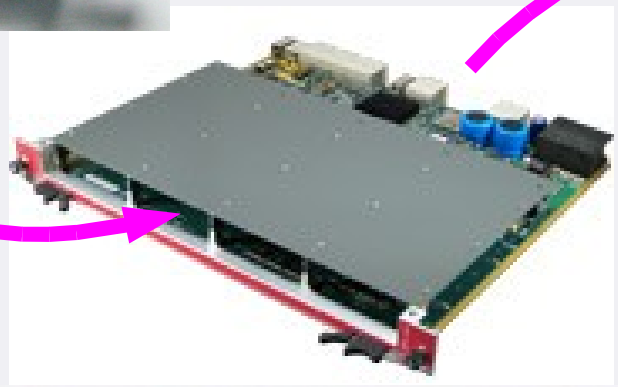
since 1993



Possible Solutions: xTCA

AdvancedMC™



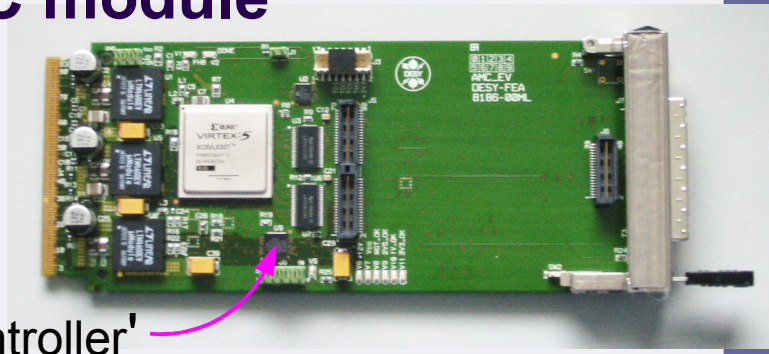


AdvancedTCA®

µTCA™

xTCA Evaluation

- **Evaluation of industrial products (crates, CPUs, IO)**
- **Ordering of a AMC module (DESY specs)**
  - ADC with 8 ch., 100 MHz, 14 bit
  - not yet ready: problem with CAD for PCB layout
- **Development of an universal AMC module**
  - FPGA code with PCIe interface
  - DOOCS server and OS driver
  - IPMI DOOCS server and displays
  - IPMI code for 'Module Management Controller'
  - Piggy-back with 2 ADC and 2 DAC channels in preparation
- **More Projects for LLRF --> S. Simrock talk**



Objectives for the workshop

- **Requirements for the electronics of the XFEL**
  - general and for specific subsystems
- **Discussion of possible solutions**
- **Experience reports for different solutions**
- **Market development for standard crates and modules**
- **Comparison of the solutions with respect to the requirements**