Overview of Data Acquisition (DAQ) electronics systems for Photon Beamlines and Experiments at the European XFEL

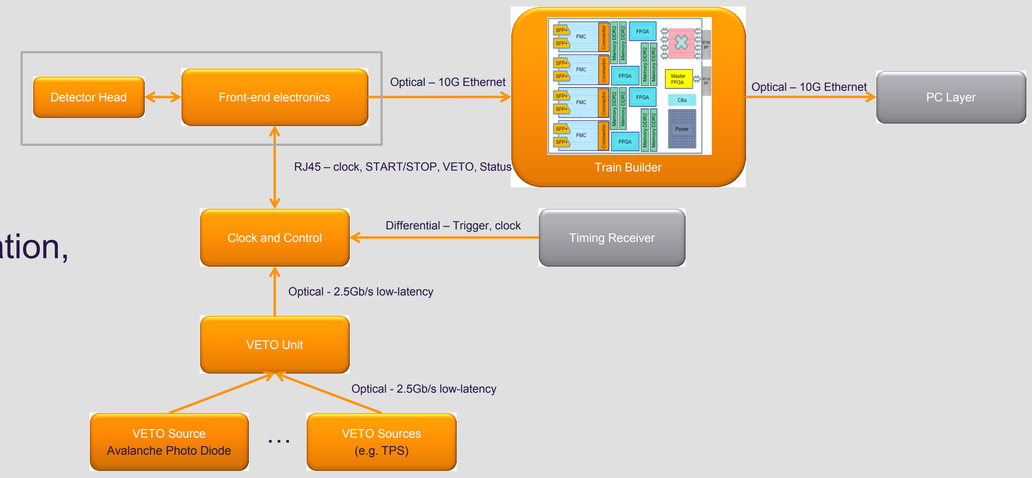
P. Gessler, O. Batindek, N. Coppola, B. Fernandes, M. Kuster, C. Youngman European XFEL GmbH

2D Detectors DAQ Overview

2D detectors are organized as tiles providing 10G Ethernet serialized portions of the full frame. The Train Builder collects all the fragments and reorganize them into a complete series of frames per train. It also allows online processing before transfer to the PC Layer.

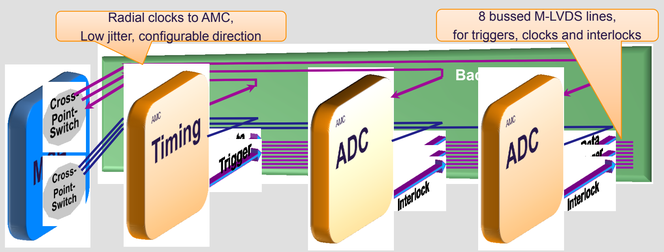
The Clock and Control System (based on the MicroTCA standard) allows synchronization, control, VETOing and status request of all detector tiles.

The connected VETO system allows most efficient use of the limited storage capacity of the detectors and also allows data reduction in later stages to save bandwidth and storage for archiving.



Timing System Interfaces

The Timing System Receiver is based on an AMC board and resides in a MTCA crate. Different in-crate connections exist.



For interfacing to other systems special interfaces and adapters will be available.

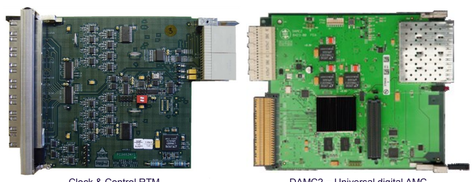
- Native Interface provides on RJ45
  - 3x Trigger, Clock or Data as CML
  - Power (5V)
- Special RTM for long distance connections (e.g. RS422) with same signals

Application Examples

- Laser Synchronization (Gating)
- Image acquisition triggering
- Synchronizing Beckhoff PLCs

Single Crate DAQ System Framework

- MicroTCA based crate standard for universal use
- Provides a small, flexible, and scalable system
- Integrated Clocking and Synchronization
- Fast and low-latency point-to-point interconnections
- Multi-lane PCI Express for CPU connection
- Remote monitoring and control via crate management
- Fast data streaming within crate and to other systems

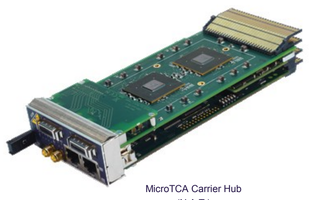


Clock & Control RTM
(University Collage London)

DAMC2 – Universal digital AMC
(DESY)

Timing System
(Stockholm University / DESY)

SIS8300 – ADC AMC
(Struck Innovative Systems)



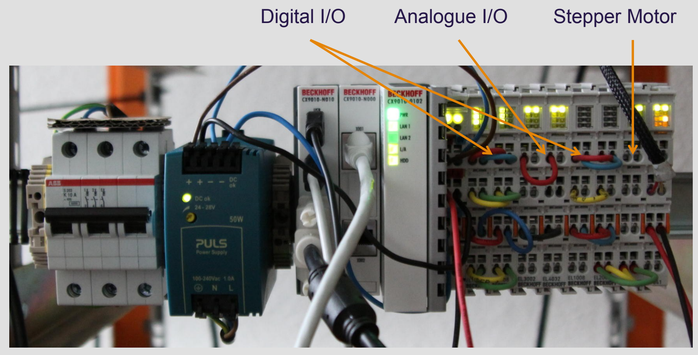
MicroTCA Carrier Hub
(N.A.T.)

High-performance DSP and FPGA board
(DMCS/DESY)

Beckhoff PLC System

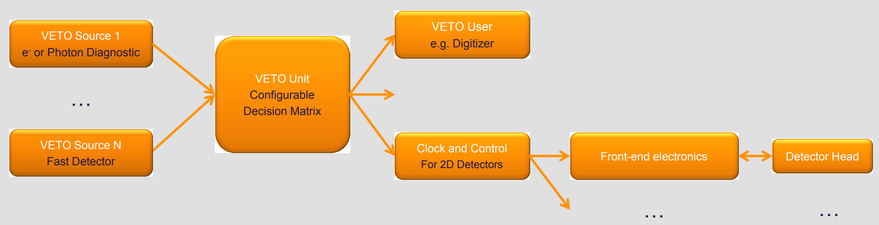
Integration of Beckhoff EtherCAT PLC rails in the DAQ and control systems (Linux based) allows complete software and hardware redundancy, steering and complete synchronization of slow varying quantities (~100 Hz)

- Digital I/O quantities
- Analog I/O quantities
- Environmental quantities
- Synchronized and unsynchronized movements of motors for positioning at the highest resolution
- Vacuum pumps
- Vacuum gauges
- Synchronized with TB/CC system
- Interfacing with MPS



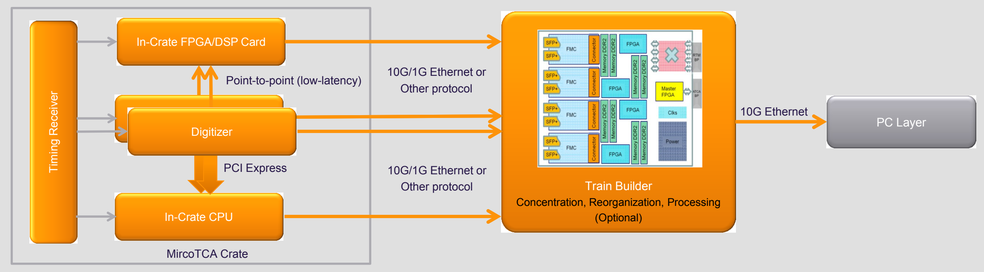
VETO System

- Make most efficient use of limited storage (2D detectors)
- Reduce amount of data to be transferred or saved
- Use fast diagnostics and detectors to estimate measurement quality per pulse
- Reject bad measurements and keep promising ones



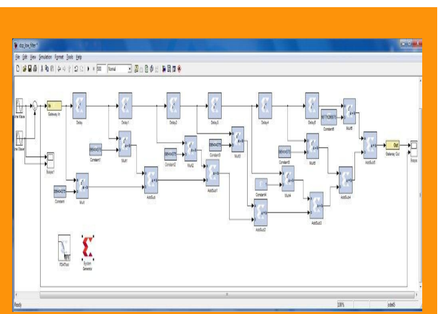
Digitizers and Detectors

Many detectors require analog-to-digital conversion of rates between 4.5MSPS and some GSPS. This is done via digitizers in MicroTCA standard, allowing complete data streaming and archiving as well as online processing on-board in FPGA, in a Train Builder (FPGA) or on GPUs and CPUs in the PC Layer.



Simulink based FPGA Programming Framework

- Easy block based graphical interface
- Allows non-programmers design and simulation of algorithms
- Direct implementation in FPGA
- Availability of many tools (e.g. filter design)



Further Information

- MTCA.4 Standard *http://www.picmg.org*
- MicroTCA for XFEL *http://doocs.desy.de → MicroTCA*
- Beckhoff PLCs *http://www.beckhoff.de*
- Related Posters: *131, 150 (XFEL Users Meeting 2012)*
- DAQ and Electronics (WP76)
  https://www.xfel.eu/project/organization/work_packages/wp_76/

www.xfel.eu, patrick.gessler@xfel.eu