Overview of MicroTCA usage at European XFEL

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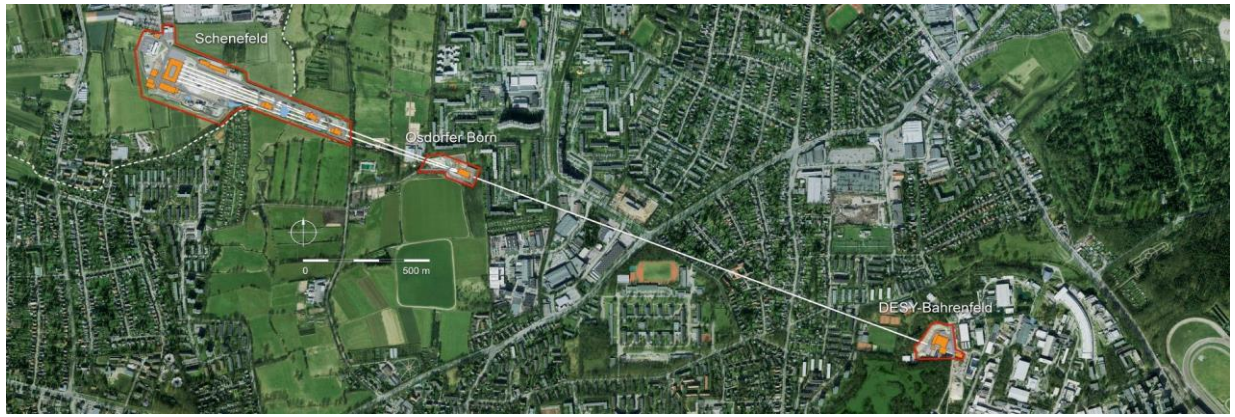
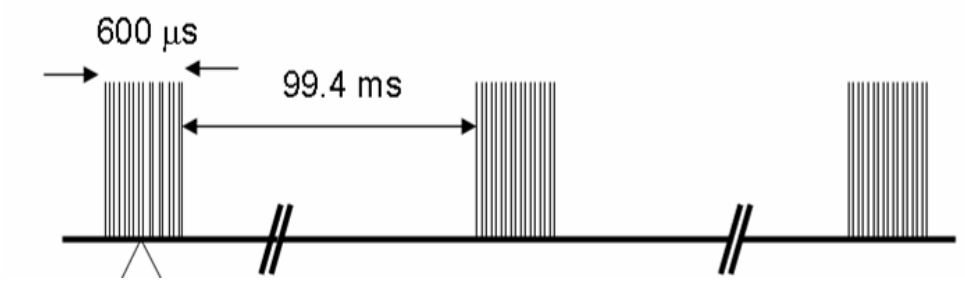
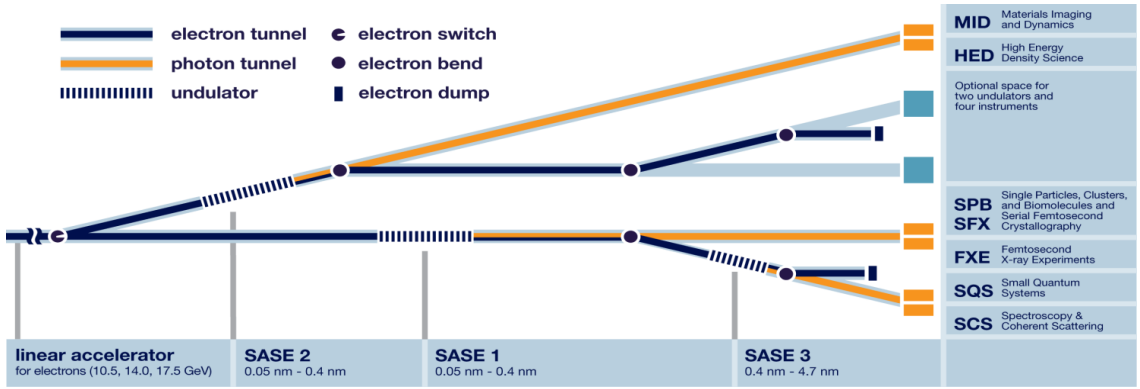
XFEL Overview





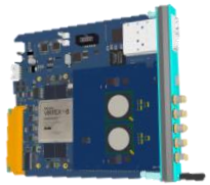
- The European XFEL generates up to 2700 X-Ray pulses
  - Inter pulse separation of 220 ns
  - Train repetition of 10 Hz
  - 3 beamlines, 6 instruments
    - ► 2 more beamlines are planned
- First user operation started in September 2017



MicroTCA in XFEL

Clock & Control RTM

DAMC2 (DESY)



High-Speed Digitizer Family (Teledyne)

Timing System (Stockholm University / DESY)

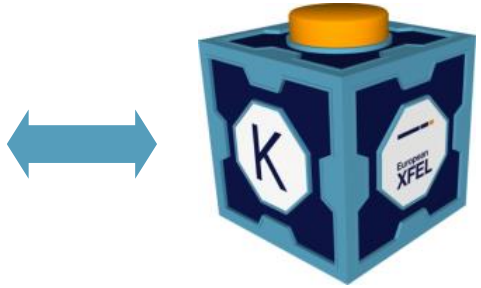
MicroTCA Carrier Hub (N.A.T.)

SIS8300 (Struck Innovative Systems)

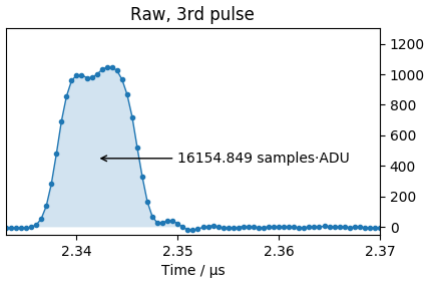
- MicroTCA platform is **the key component** for
  - Timing distribution (both in and outside the crate)
  - Digitizer raw and process data
  - Detector triggering and synchronization
- At photon beam lines, experiments and related laboratories at XFEL are **~60 MicroTCA crates (more already planned)**
  - 300 fast data channels (SIS8300, 16 bit @ 125MHz)
  - 108 high speed data channels
    - ► ADQ412, 12 bit @ 2 GHz
    - ► ADQ14, 14 bit @ 1 GHz
  - XFEL will continue to grow (SASE4 and 5, new instruments)
- On Call Duty has significant **low activity** when compared to other groups
  - This year the team received **19 calls, of which only 1 was a 'real' hardware issue**
  - Some systems have been working reliably for **5 years now**
  - Stability of MicroTCA and XFEL's FPGA solutions

MicroTCA @ XFEL in 2022

- MicroTCA setups **mostly remain static**
  - Restructuring of the team and Institute priorities
  - Review of data acquisition and processing workflow
  - Evaluation of other FPGA platforms



DAQ



FET – FPGA Firmware

ICI – Karabo Integration

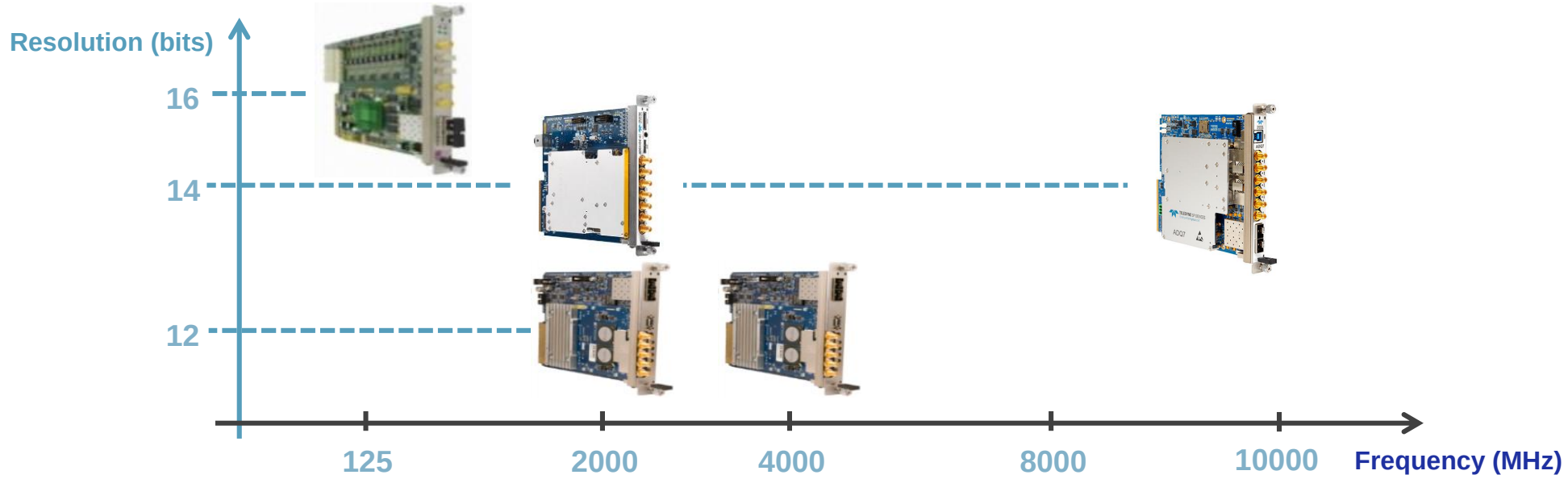
ITDM

Data Analysis

CPU installation/maintenance with Foreman and Puppet

- OS installation + Puppet **via network**
  - New CPU shows up on Network
    - ► Foreman install OS and configures target Puppet Manifest
  - Puppet guarantees that CPUs have the same environment
  - Monitor Host resources
- This solution as proven **very successful** for maintenance, testing and migration of our MicroTCA CPUs
  - Roll out of updates/bug fixes
  - Management of hosts groups
- MicroTCA hosts have increasingly more specific configurations
  - Next step is FPGA/MCH management

XFEL's integrated digitizers

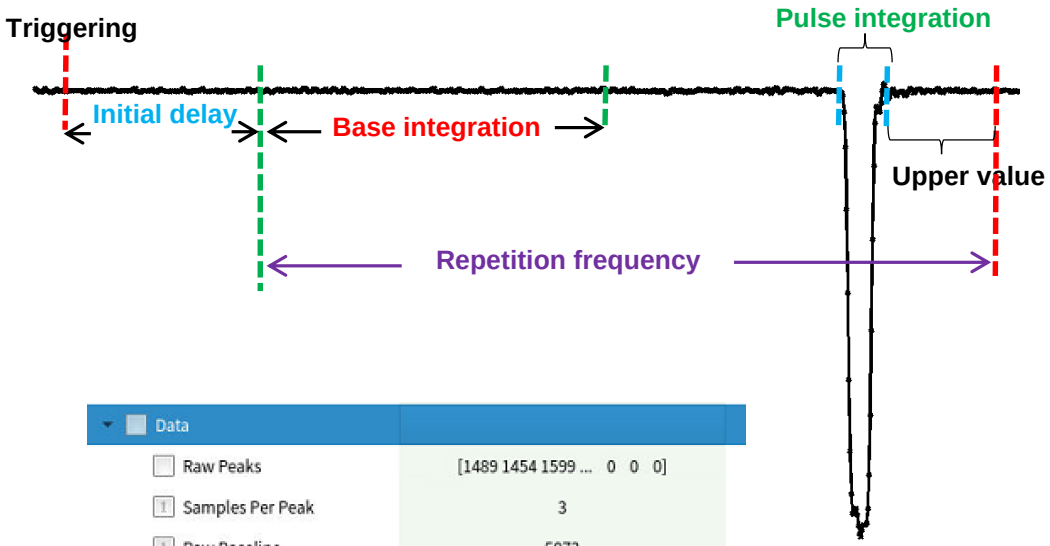


- ADQ7
  - 1 channel @ 10GSPS or 2 channels @ 5 GPSP

- SIS8300 KU Integration
  - Board functionality is being evaluated
  - Update of XFEL Simulink library

FPGA processing algorithms

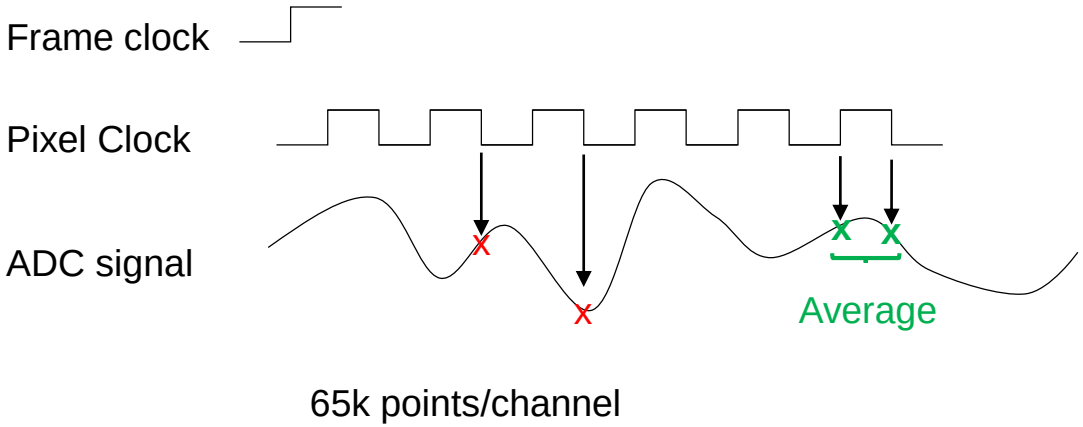
- Peak Integration
  - User definition of integration value
  - Based on user threshold value
  - Baseline per trace or pulse
- Virtual ADC channels (add/subtraction of raw data)
- Based on **Bunch Pattern decoding**
  - Automatic Peak Integration
  - Conditional and Dynamic Trigger
  - VETO decision for 2D Detectors

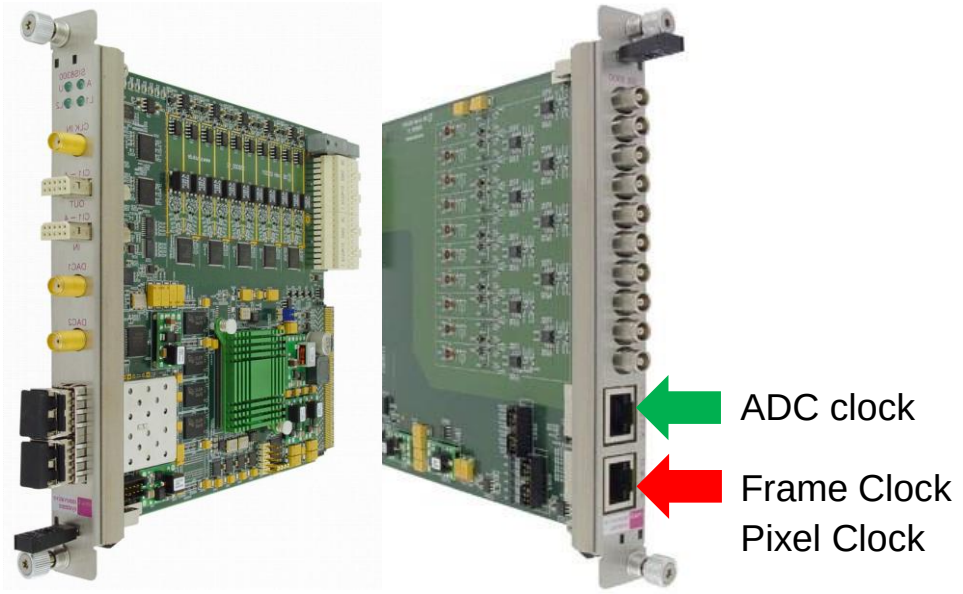


Data	
Raw Peaks	[1489 1454 1599 ... 0 0 0]
Samples Per Peak	3
Raw Baseline	5073
Raw MultiBaseline	[5073 0 0 ... 0 0 0]
Samples For Baseline	10
Baseline Value	0.009675979614257812
Peak Values	[-0.00020917 -0.0004317 0.00049019 ... ...
Mean Peak Value	0.00029987761129935585
Std. Dev. Peak Value	0.00042693489473406566
Raw Data	[512 520 462 ... 520 507 516]
Raw Data [V]	[0.00976562 0.00991821 0.00881195 ... 0....

SIS8300 firmware for pnccd Detector

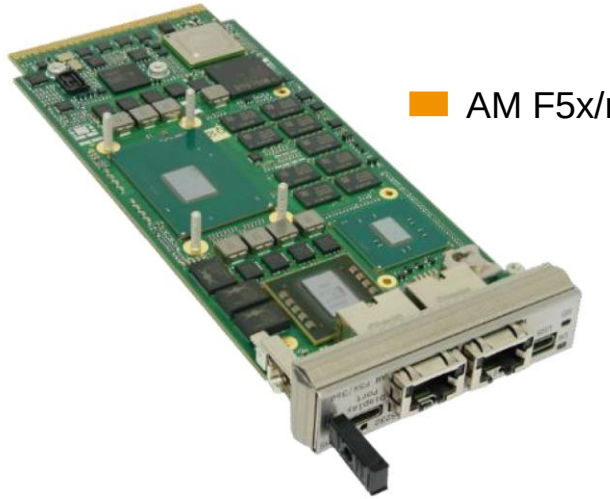
- Dedicates firmware for pnccd Detector setup
  - 2x SIS8300 board with data from 10 channels
  - Reduced amount of data
  - Allows for Raw Data, sampling of only falling/rising edge or average





nVent's 1U Crate

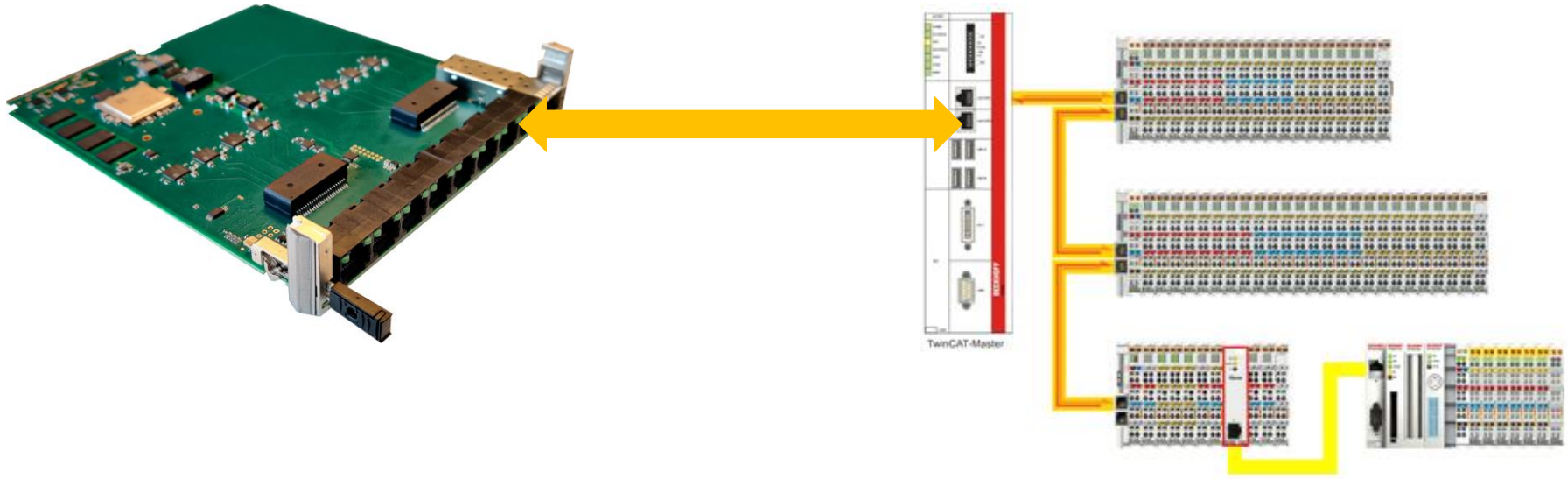
- Successful integration of 1U crate
  - Includes integration of Concurrent's AM F54/391 CPU
  - Compatible with all of XFEL's AMCs
  - **Third party clock module needed**



AM F5x/msd Processor AMC

NAT Ethercat AMC

- **EtherCat AMC** solution from N.A.T. for communication with the PLC hardware
  - Uses Zynq UltraScale+
  - Direct communication of Information (TrainID, Beam Modes…)
  - Use of FPGA processing to communicate PLC actions
    - ► **Bunch Pattern decoder information**
  - Syncronization of PLC equipment with Timing System



Questions?

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