Electronics and Software: System architecture

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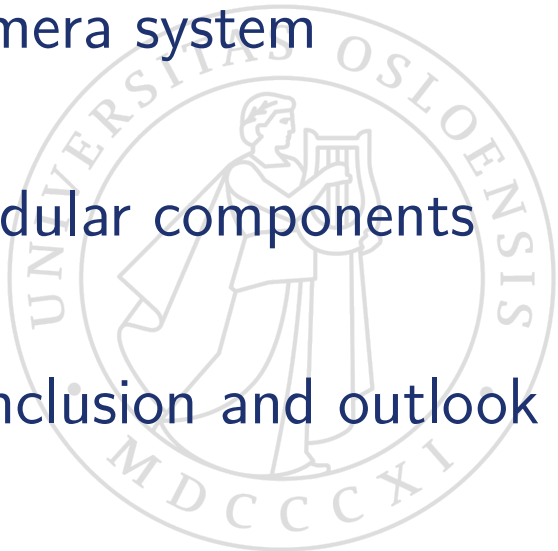
CDR for ESS Imaging Systems — 2017-10-24

Outline



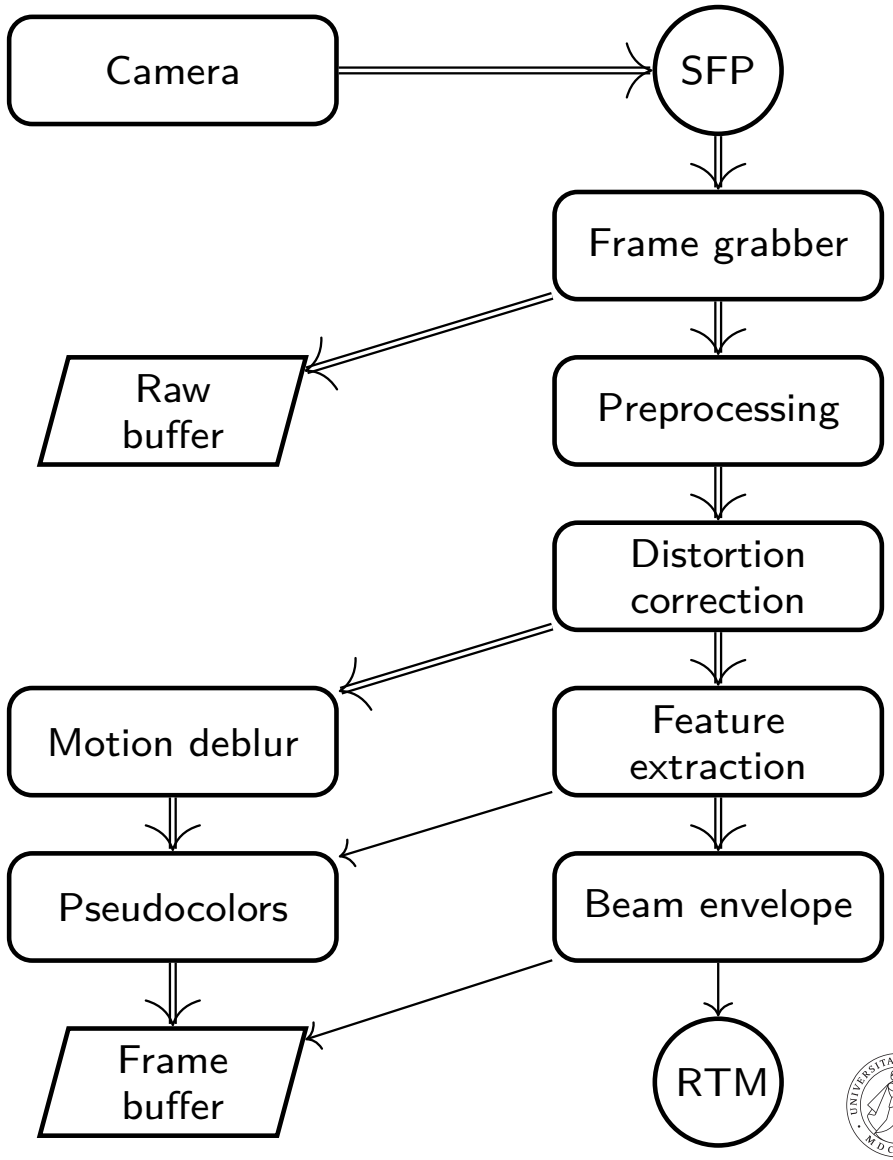
Scope of processing architecture

Modular uTCA processing system

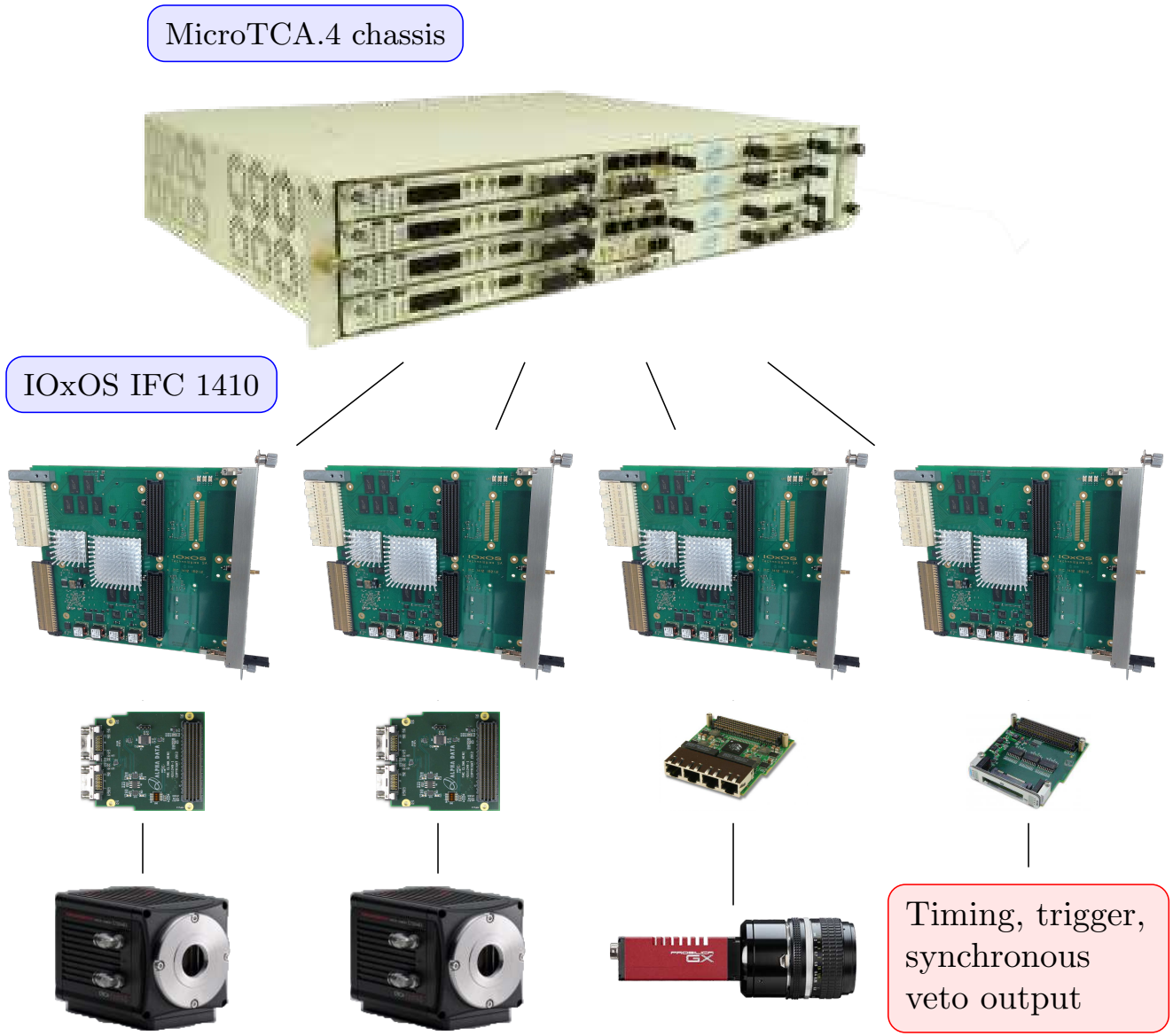
- Cameralink and GigE Vision input
- Support hybrid HW/SW processing pipeline
- Numerous full pixel maps, SRAM or auxiliary streams
- Synchronous veto signal
- Preprocessed streams and parameters to SW subsystem

Software processing system

- Direct interface to AXI-registers and streams
- Fast SIMD/OpenCL capacity
- Write streams to permanent storage
- Export to EPICS PV



Electronics system



Target imaging camera: Hamamatsu ORCA-Flash4.0 V3

Features and specifications

Sensor type	Hamamatsu sCMOS
Quantum efficiency	$82\ \%$ @ $560\ \mathrm{nm}$
Pixel size	$6.5 \times 6.5 \mu\mathrm{m}^2$
Pixel count	2048×2048
Full well capacity	$30\ \mathrm{ke}^-$ (typ)
Readout noise	$1.4\ \mathrm{e}^-$ (rms)
Resolution ADC	$16\ \mathrm{bit}$
Interface	Camera Link, USB 3.0
Frame rate	$30 - 100\ \mathrm{fps}$

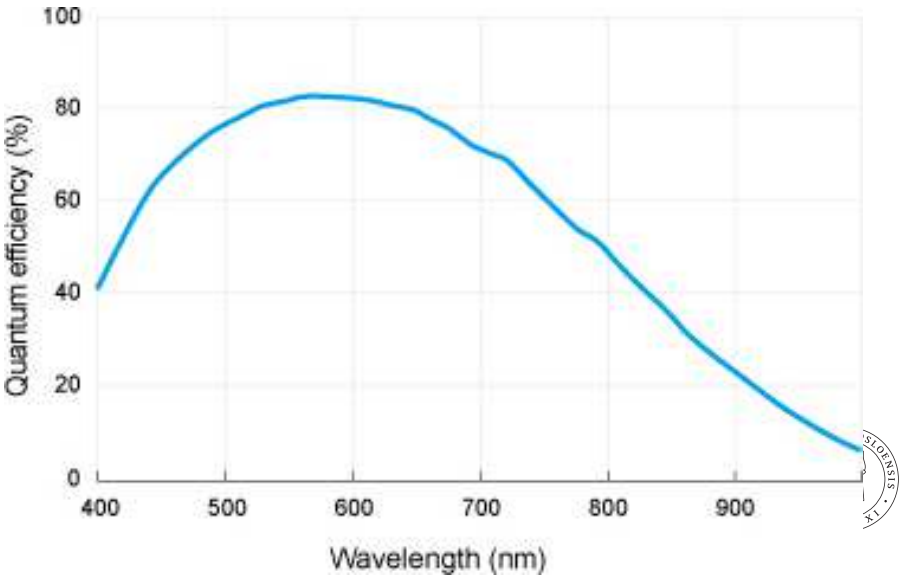
ORCA:Flash

Baseline low-noise camera

Unit cost: $12\ \mathrm{kEUR}$. Integrating the camera, including the Camera Link (or USB 3.0) interface represents a significant effort on behalf of the ICS team.

Testing/prototyping: Allied Vision Manta G-419B

Unit cost: $2\ \mathrm{kEUR}$. GigE Vision interface already integrated.
Resolution $4\ \mathrm{Mpix}$, pixel size $5.5 \times 5.5 \mu\mathrm{m}^2$.
Full well $13.5\ \mathrm{ke}^-$, noise floor $13\ \mathrm{e}^-$. Dynamic range $60\ \mathrm{dB}$, much below the ORCA-Flash4.0.

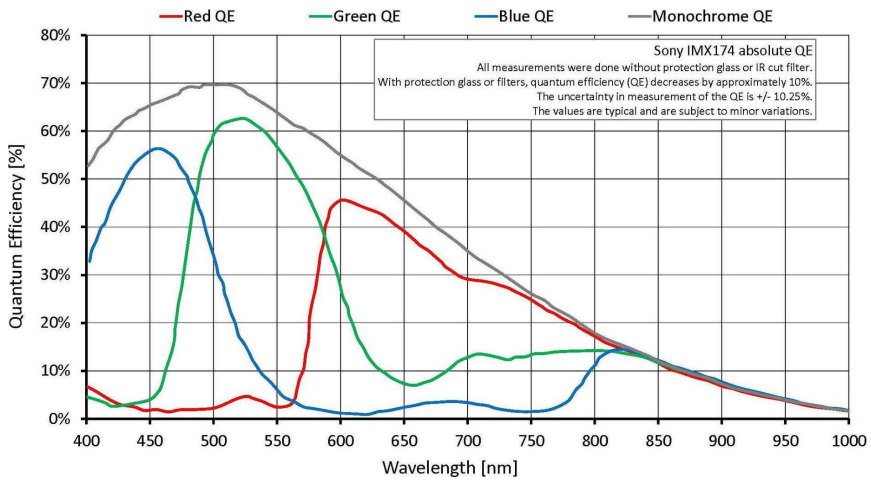


Beam dump camera - Allied Vision Manta G-235B GigE Vision

Features and specifications

Sensor type	Sony IMX174
Quantum efficiency	$70\ \%$ @ $510\ \mathrm{nm}$
Pixel size	$5.86 \times 5.86 \mu\mathrm{m}^2$
Pixel count	1936×1216
Readout noise	$\simeq 7 - 10\ \mathrm{e}^-$ (rms)
Resolution ADC	$12\ \mathrm{bit}$
Full well capacity	$32\ \mathrm{ke}$
Interface	GigE Vision with PoE
Frame rate	$50.7\ \mathrm{fps}$

Allied:Manta



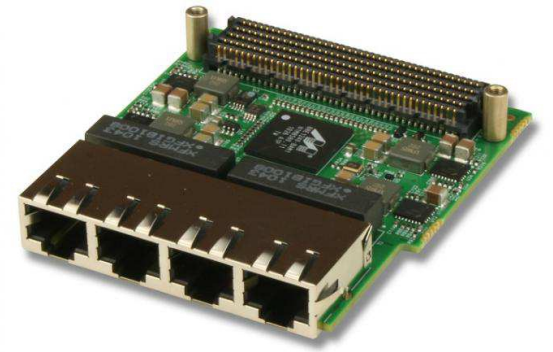
Baseline replacable camera

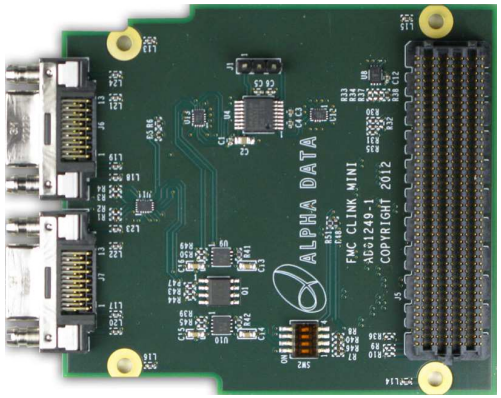
Unit cost: $1.2\ \mathrm{kEUR}$. Industrial type cameras are relatively low-cost and easy to use, featuring GigE Vision readout and Power-over-Ethernet (PoE).
Due to the limited dynamic range this camera type is not sufficient for the target imaging low-light scenario.

FMC GigE Frame grabber/splitter

Interface card

- GigE Vision, just needs a PHY-implementation
- Cameralink FMC also exists
- (assuming USB is not industrial-grade)





AMC IOxOS IFC1410

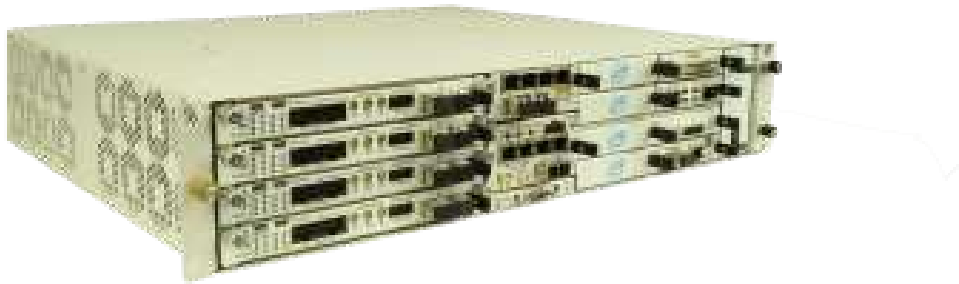
FPGA/CPU resources

- FPGA: Xilinx Kintex UltraScale KU040/KU060
- CPU: NXP QorIQ T2081 Quad core Power/AltiVec @ 1.8 GHz
- PCIe: Data stream to CPU-board

MicroTCA.4 chassis and infrastructure

MicroTCA.4 chassis

- Power supply, possibly redunant
- MicroTCA Carrier Hub and CPU
- Rear Transition Module, for synchronous signals



Services infrastructure

- Power, cooling networking
- Remote power-up, booting
- Data recording/storage

Example (Non-supported chassis)

- vadatech VT812
- Representative size
- MCH/CPU
- Power

Summary and outlook: System architecture

- Standard camera: Allied Vision Manta G-235B
- Low noise camera: Hamamatsu ORCA-Flash4.0
- Modular electronics: ESS selection
- Need practical experience with target platform