Lima1 latest developments the kilo-Hertz regime

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OUTLINE

Introduction:

- Challenging detectors

Latest features:

- Sideband data & saving
- Core-level improvements
- CPU & NUMA affinity control

Conclusions:

- Lessons learned

Dectris/EIGER2

Detector capabilities

- 4x 10 Gbit Ethernet links
- Up to 4 GByte/s of decompressed data
- 4 MB in 8-bit ⇨ 1 kHz

DAQ context

- Compressed data is received from DCU ZMQ stream
- Pixel depth depends on detector speed, 8-, 16- or 32-bit

Overhead in LImA plugin

- Data is decompressed
- Expanded to 16/32-bit
- Recompressed for saving

PSI/SLS DETECTORS: CHALLENGES

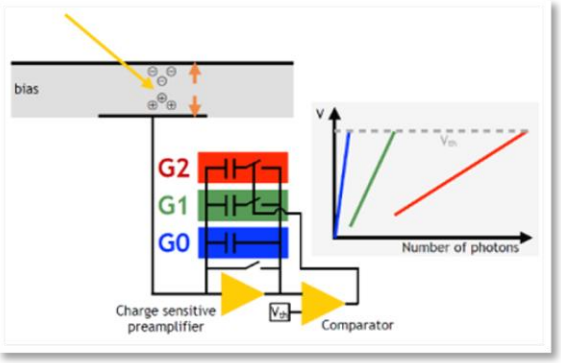
PAUL SCHERRER INSTITUT

Critical issues

- UDP data streams ⇨ packet lost if receiver is not ready
- Linux is not a real-time OS

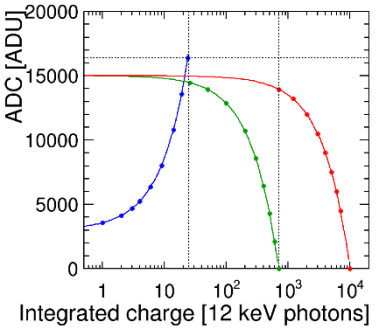
PSI/Eiger

- One 500k module ⇨ 2 GByte/s
- Data transfer speed 8 kHz @ 4-bit (sensor speed: 22 kHz)
- 4-to-8-bit expansion ⇨ 4 GByte/s



PSI/Jungfrau

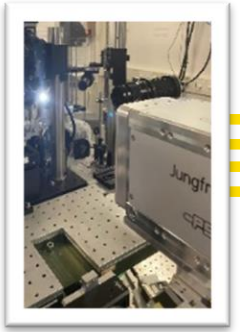
- Adaptive 3-gain per pixel per frame
- CPU-intensive correction
- 32-bit linear scale ⇨ 4 GByte/s @ 1 kHz



PSI/Jungfrau-1M

Beamline

1 kHz @ 16-bit
data transfer
Max: 2 kHz



4x 10 Gbit

4-ch CWDM
MUX/DEMUX

Data Center

1 kHz @ 32-bit
4 GB/s effective rate
Max: 8 GB/s

25 Gbit

(~10 Gbit)

(~10 Gbit)

LATEST DEVELOPMENTS: SIDEBAND DATA

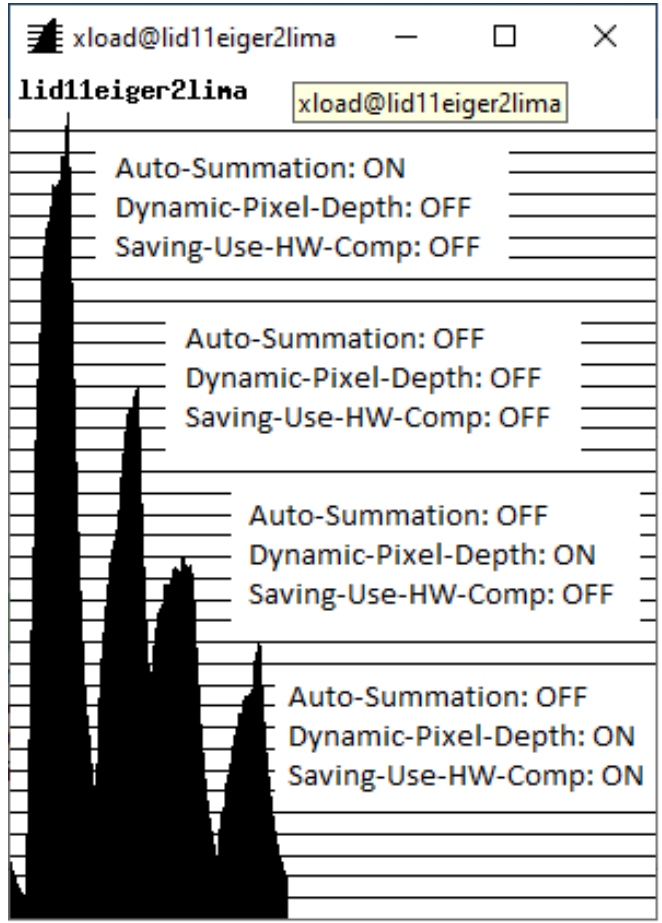
Design considerations

- Per-frame binary data
- Travels with image through the processing chain
- Avoid global containers ⇨ better processing scalability

Dectris/Eiger2

- **Dynamic pixel depth** ⇨ avoid data expansion
- Camera plugin inserts blob as sideband data
- Used by reconstruction task ⇨ reduced thread contention
- **Reused for saving compression**

LImA PERFORMANCE: SIDEBAND DATA



LATEST DEVELOPMENTS: NEW FEATURES

Improved frame accumulation

- Added MEAN mode, calculating the average images
- Accumulation is now parallelised for high-throughput plugins like Iris & SlsDetector

More efficient saving subsystem

- Use sideband saving data ⇨ avoid access to global containers
- Improves scalability at high frame rates

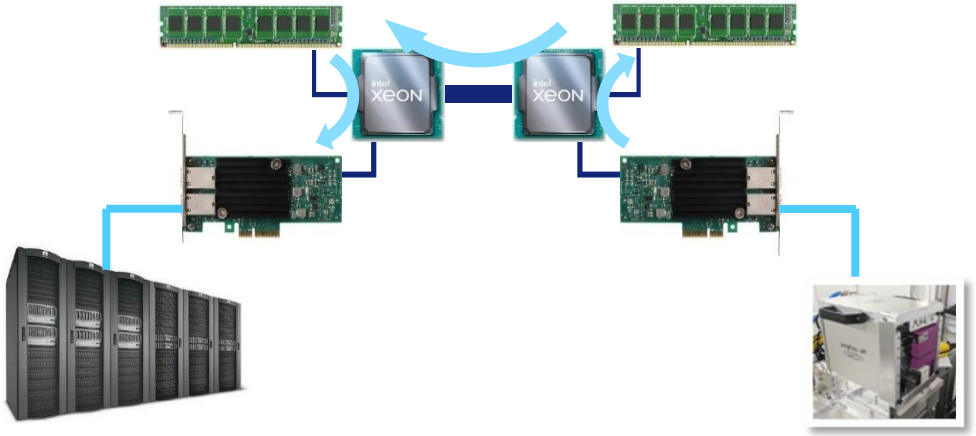
LATEST DEVELOPMENTS: THE KILO-HERTZ REGIME

Improved processing buffer management

- Allocate auxiliary buffers in advance

CPU & NUMA affinity control

- Assign CPU core/threads to each active task in the system
- Optimize memory access time in NUMA environments



Results

- Jungfrau-1M:
  - Gain & pedestal correction @ 1 kHz
- Eiger-500k:
  - 4-to-8 bit expansion @ 8 kHz
- 4 GByte/s internal data rate
- ~1 GByte/s corrected & compressed output

LESSONS LEARNED

- Computers die, detectors survive!
- Versatile + High Performance control systems
- Limits in HW resources
  - Backend must be over-dimensioned!
- Optimise the code:
  - For scalability
  - Pre-allocate buffers
  - CPU & NUMA affinity control can help
- Additional challenges
  - Integration into IT infrastructure [GPFS]
  - (Continuous) OS upgrade

THE END

Thank you very much!

Any question?