

LIMA²

THMBCM031

Lima2: Edge Distributed Acquisition and Processing Framework for High Performance 2D Detectors

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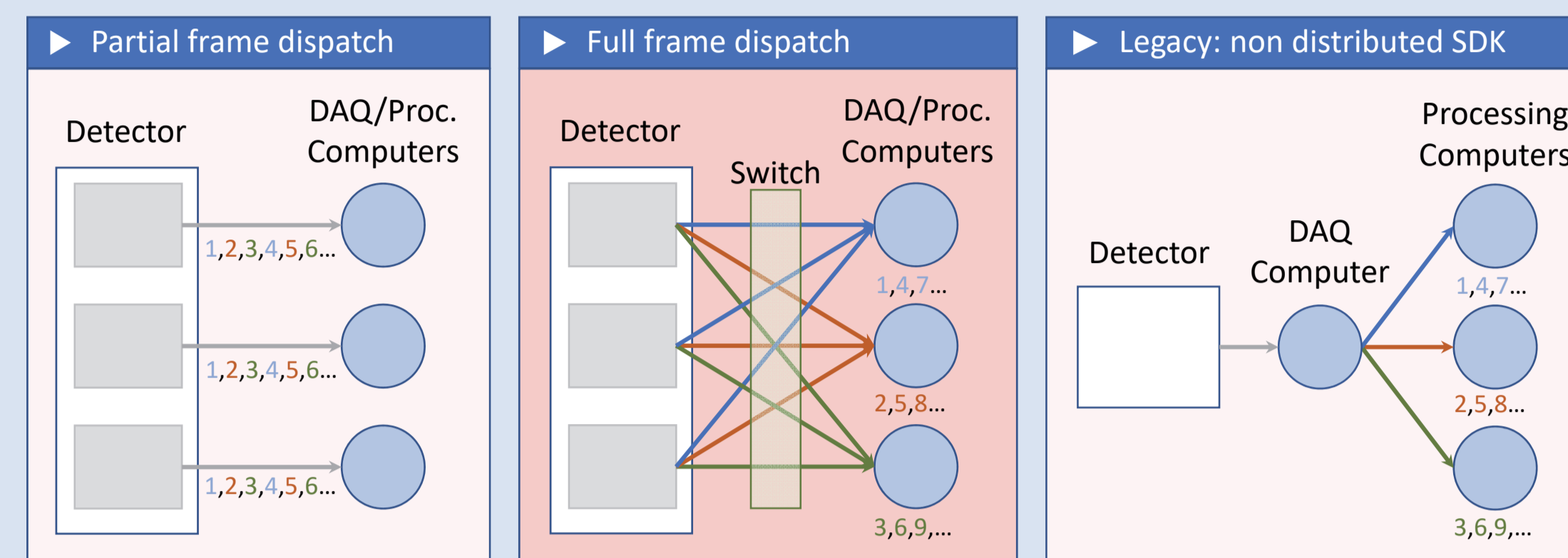
Motivations

High Performance 2D Detectors keep growing in size and frame rate. DAQ and data processing can not always be performed by a single computer.

Lima, a Library for Image Acquisition developed at the ESRF more than 10 years ago^[1], was not designed to scale to multiple backend computers.

Scalable solution

a Distributed MPI application with one control process and multiple data receivers



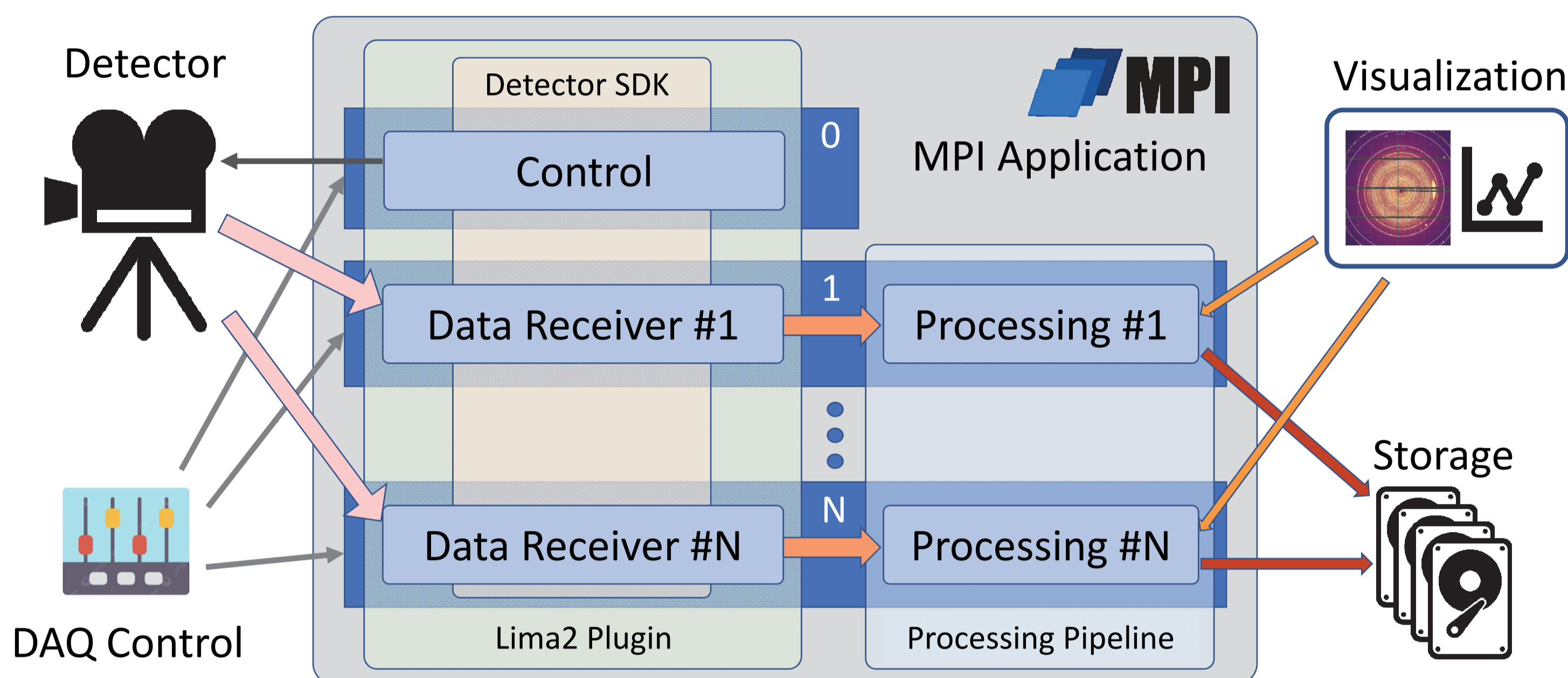
Low Latency Processing

with soft real-time constraints for online feature extraction and data reduction

Edge, on-the-fly image processing in frontline DAQ computers, targeting:

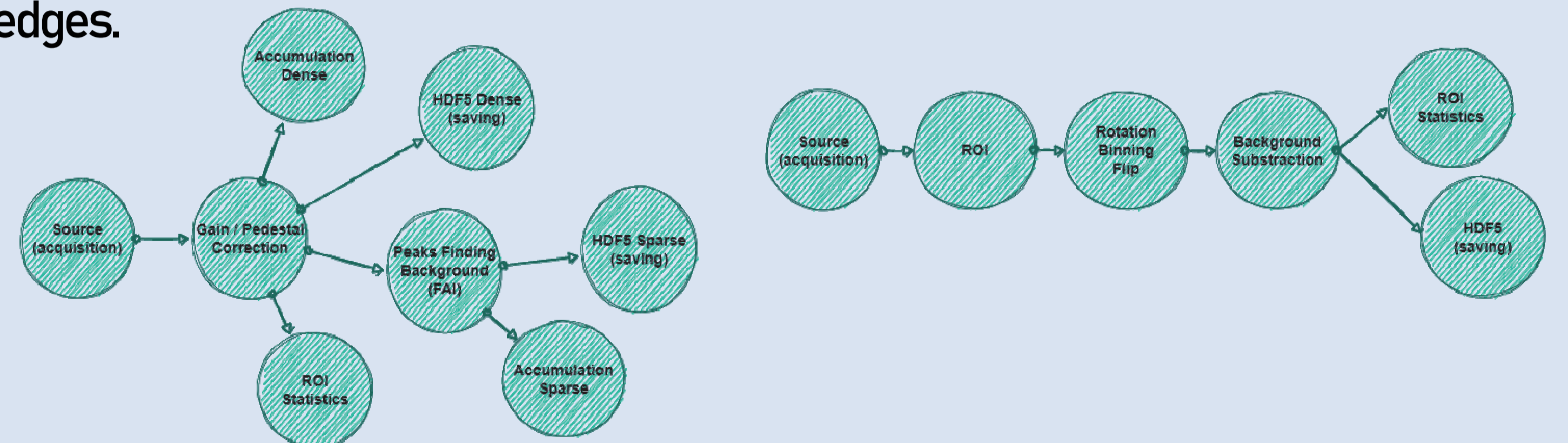
- Experiment Feedback: closed-loop control & dynamic strategy determination
- Reduced data volumes for storage
- Visualization
- Modular, optimized processing for specific applications

Lima2 Application Structure



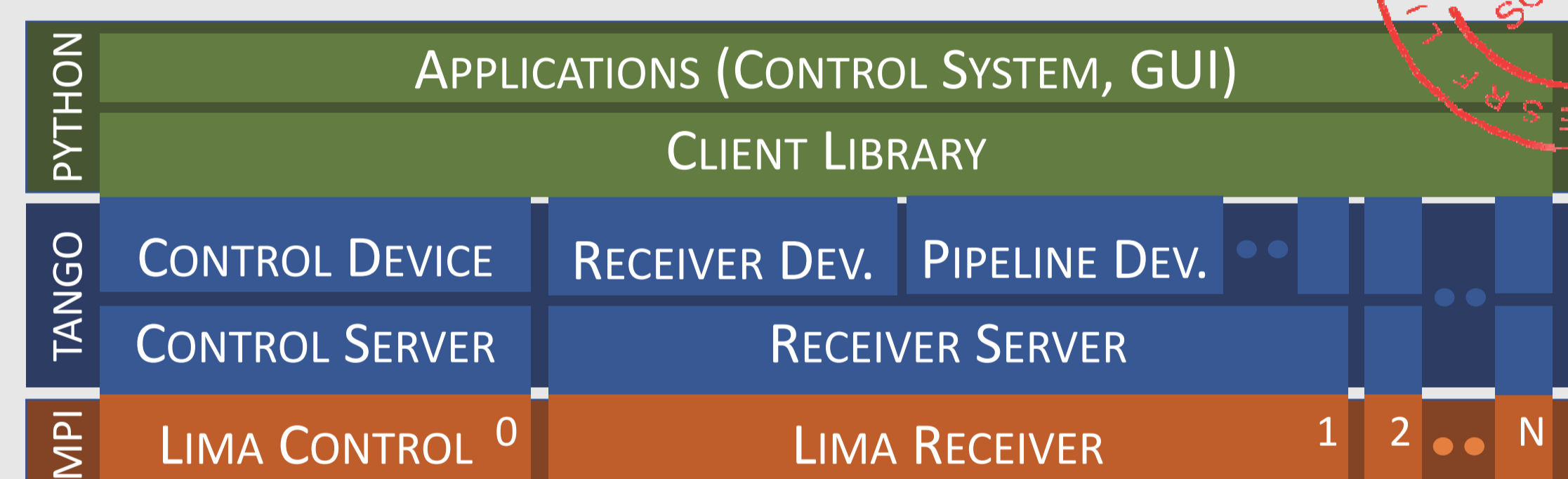
Processing Graphs with OneAPI TBB for Online Pipelines

Using graph parallelism, computations are represented by nodes and the communication channels between these computations are represented by edges.



Software stack

C++ library, Tango servers, Python client



New features from Lima1 to Lima2

- Scalability with multiple receivers
- Simplified, single-command configuration
- Decoupled DAQ & processing life-cycles
- Provides a high-level API to experiment orchestrators like BLISS^[4], mxCube & GUIs hiding the distributed process topology



High Performance optimizing for fast HW

- Manage process CPU & NUMA affinity
- Accelerators support to offload computation from CPU to GPU (using OpenCL, Cuda) & IBM Power9 NX GZIP
- RDMA Data Transfer from the detector using Rashpa^[5]

PSI JungFrau Acquisition a challenging Data Throughput



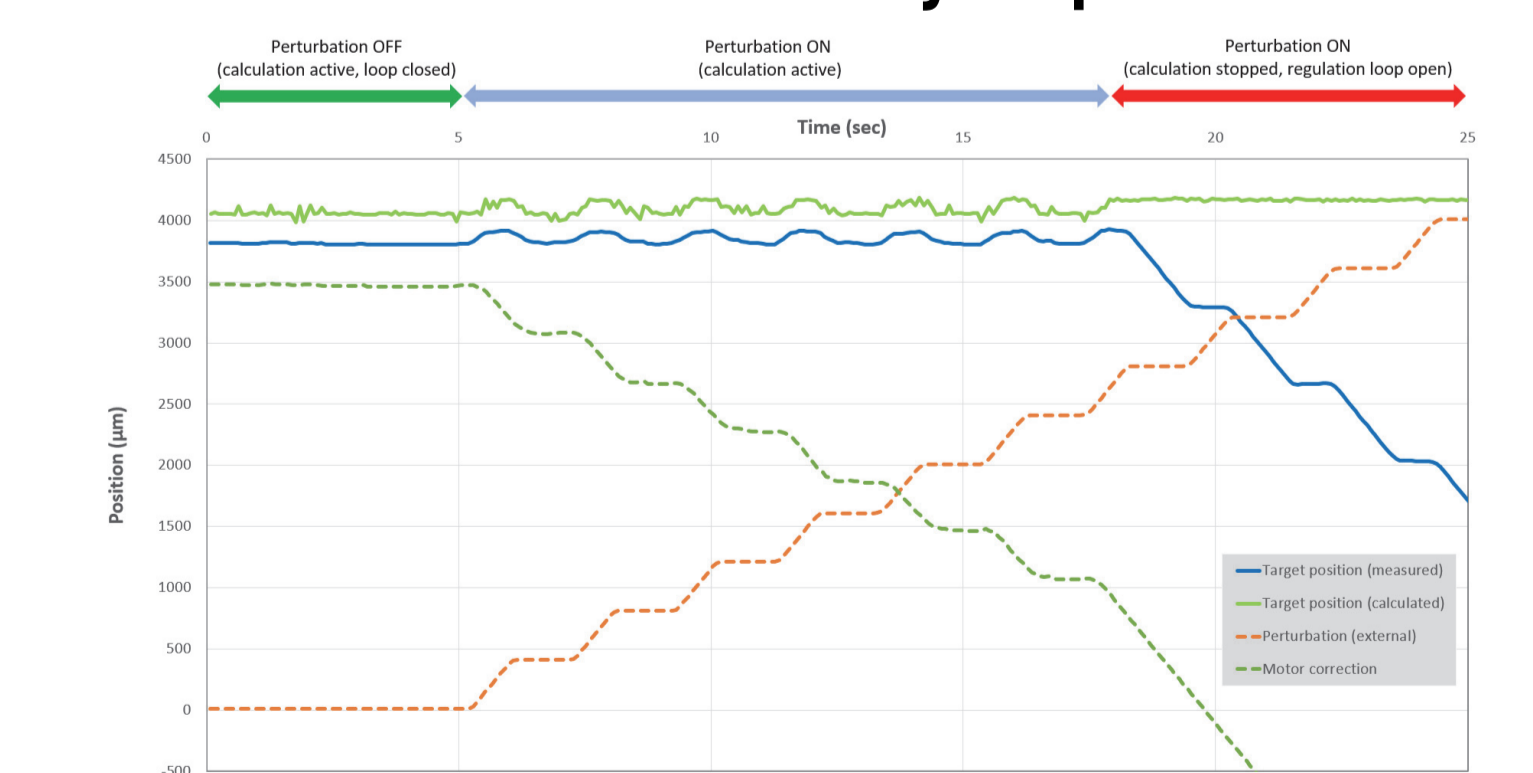
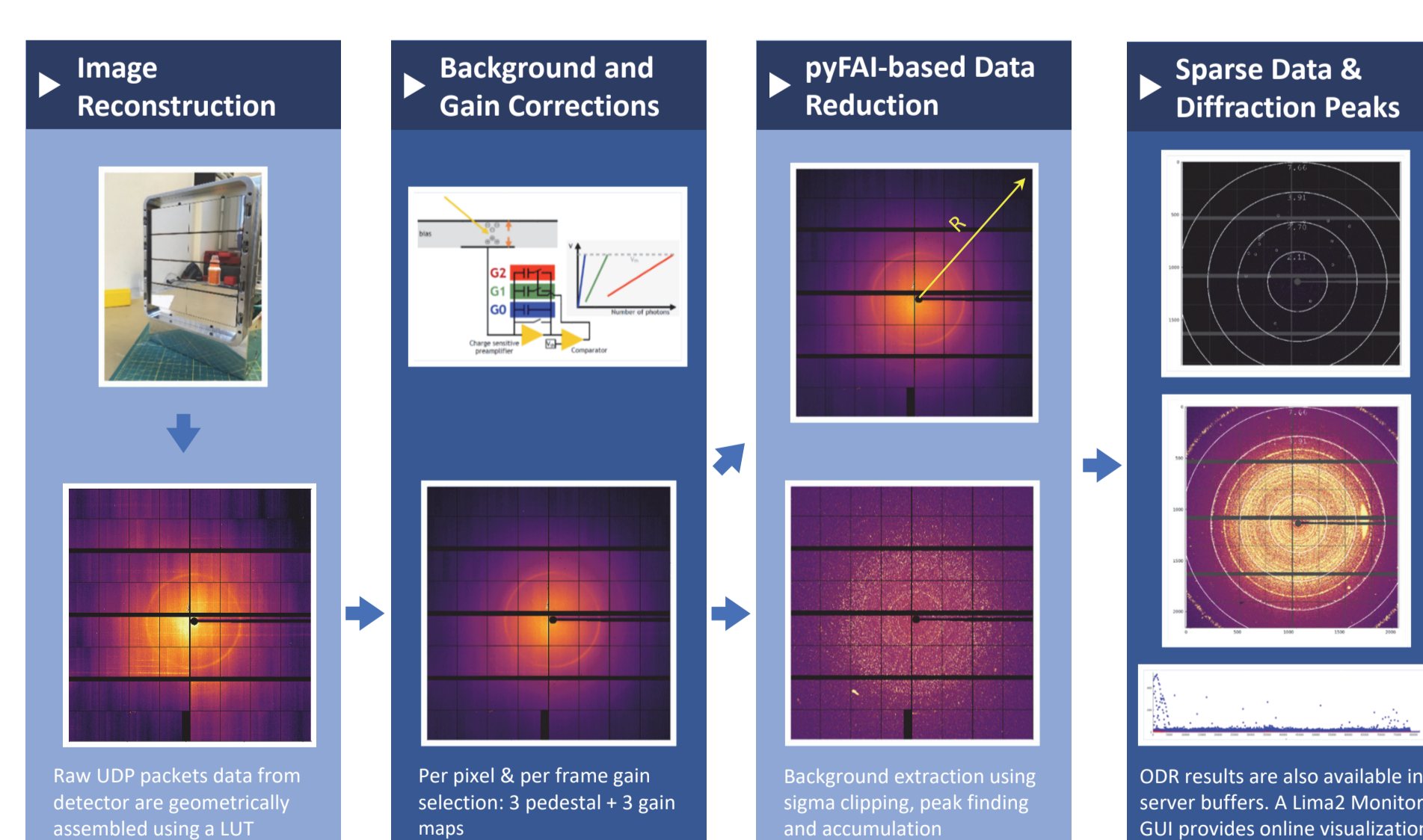
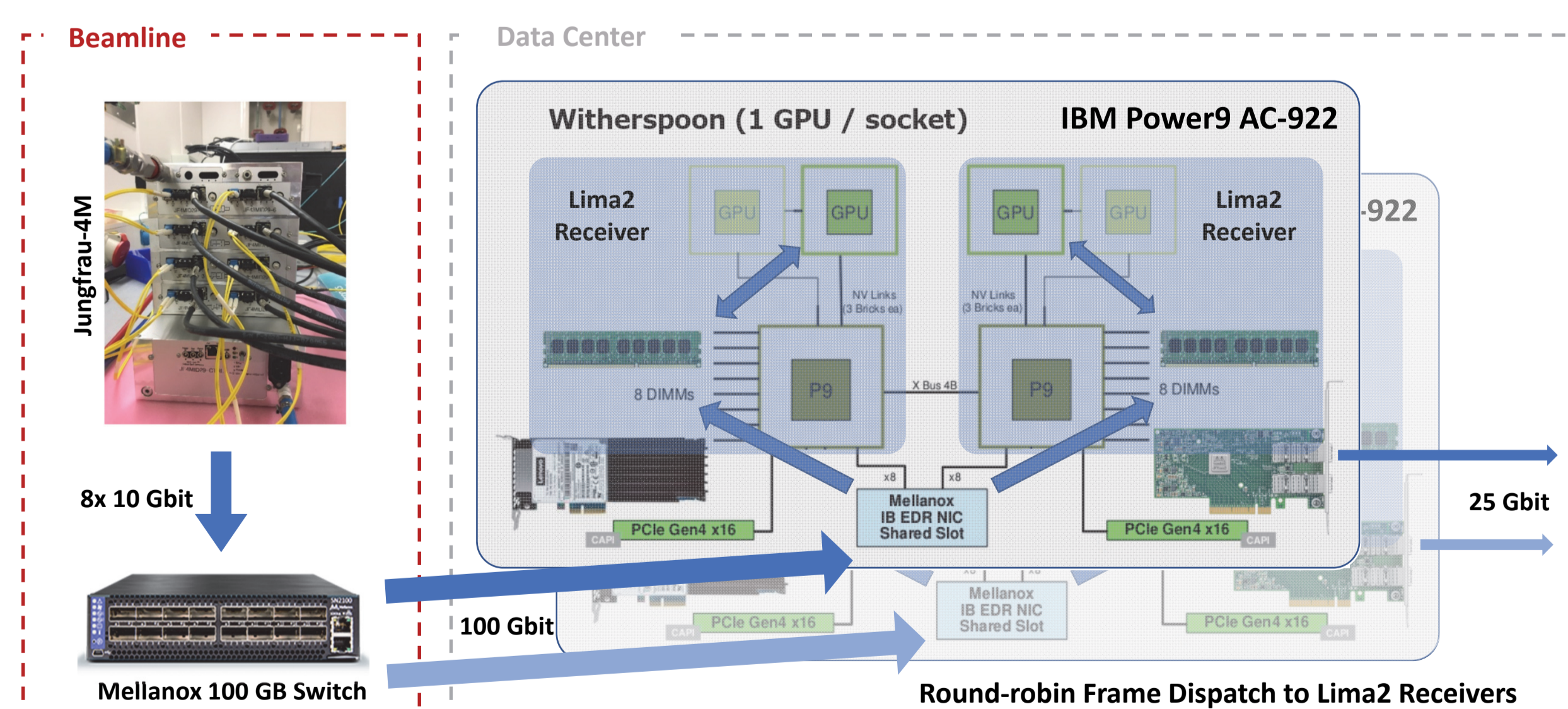
PSI JUNGFRAU-4M^[2] is an integrating 2D pixel detector for high performance X-ray photon science that generates an UDP data stream of 8 GB/s at 1 kHz frame-rate. Two computers are currently used at ID29, each running two parallel data receivers. Raw and corrected dense images can be independently saved.

Serial MX Online Data Reduction (ODR) on GPU

The ID29 approach for Serial MX ODR uses the peak finding algorithm in pyFAI^[3]. Sparse images are saved together with the identified peaks, reducing the data throughput by a factor of x4 - x100. An *is-hit* flag indicates meaningful frames (future veto).

ESRF Smartpix & Rashpa Medipix3 with RDMA & direct GPU

The ESRF Smartpix detector integrates Rashpa, a powerful, versatile and scalable platform providing high-speed data transfer to CPU & GPU memory using the RoCEv2 technology. With latency times as low as 1 ms, the system targets active feedback in X-ray experiments.



Preliminary real-time GPU-assisted position tracking with Smartpix detector + IcePAP motor controller

Current Status

PSI Jungfrau-4M @ ID29:

- In production since Jan/2023, currently supports continuous processing at ~500 fps (*uint32/int16* dense data saving)
- A Lima2 monitor GUI provides online visualization

ESRF Rashpa / Smartpix integration:

- RoCEv2 implementation with direct-GPU

Dectris Eiger2:

- Stream2 protocol with multi-band & integration in Bliss

Acknowledgements

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References

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- [2]. Jungfrau - <https://doi.org/10.1080/08940886.2018.1528429>
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<https://limagroup.gitlab-pages.esrf.fr/lima2/>

