



# Lima2 project overview

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## Introduction to LImA2:

- Motivations
- Goals & considerations

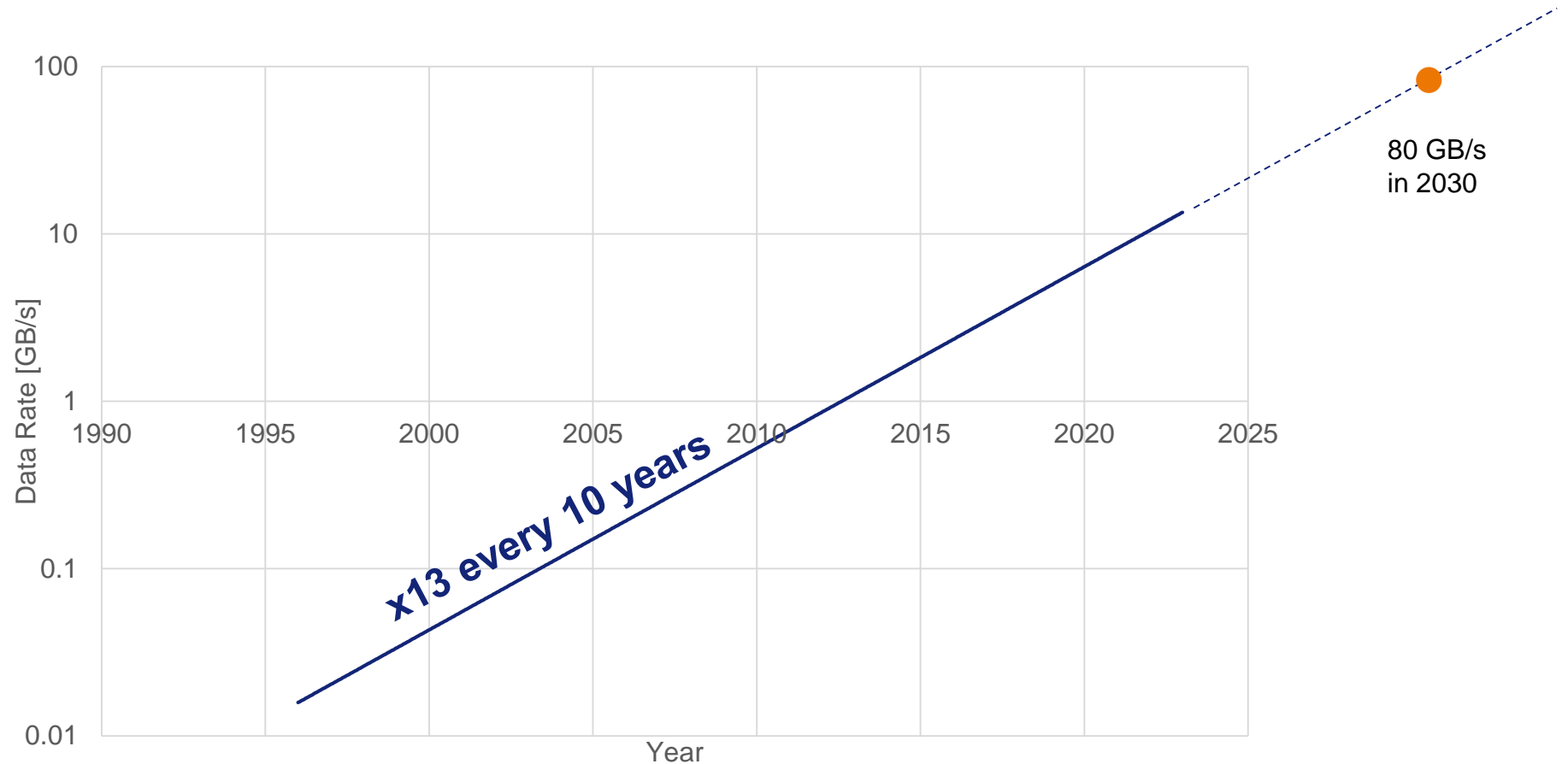
## LImA2 design:

- Application structure
- Camera plugins
- Processing pipelines

## Status:

- Current detectors

# DETECTOR DATA RATE OVER TIME AT THE ESRF



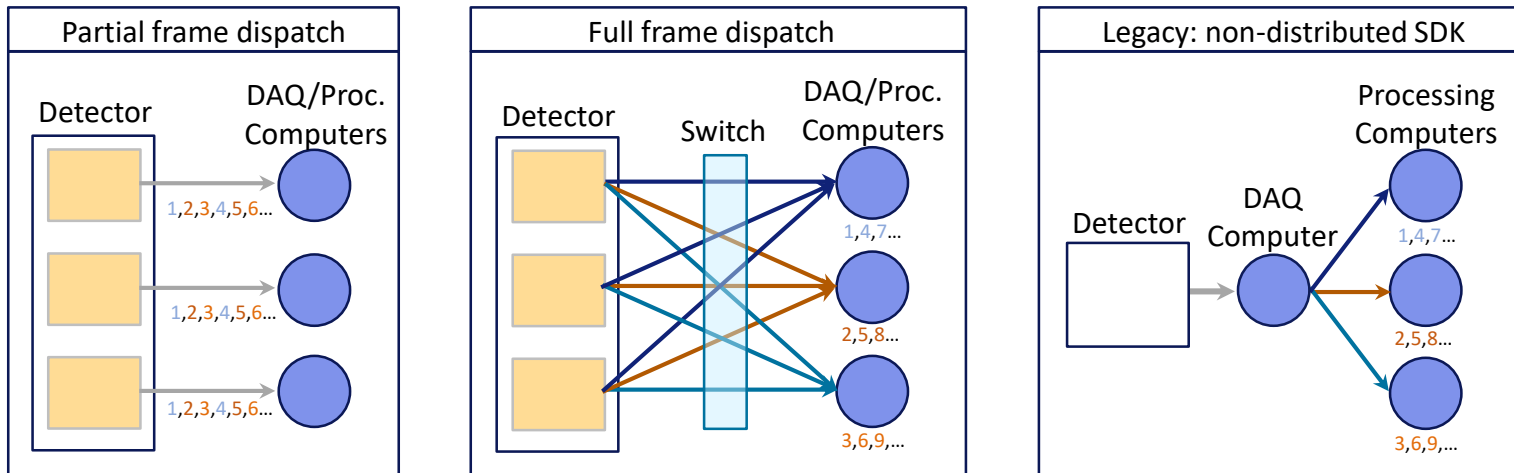
# LImA2: INTRODUCTION

DAQ & Processing cannot always be done on a single computer



**LImA2**: evolution of LImA towards distributed systems (from scratch)

## Goals: **Scalable** DAQ and **Edge low latency** Processing

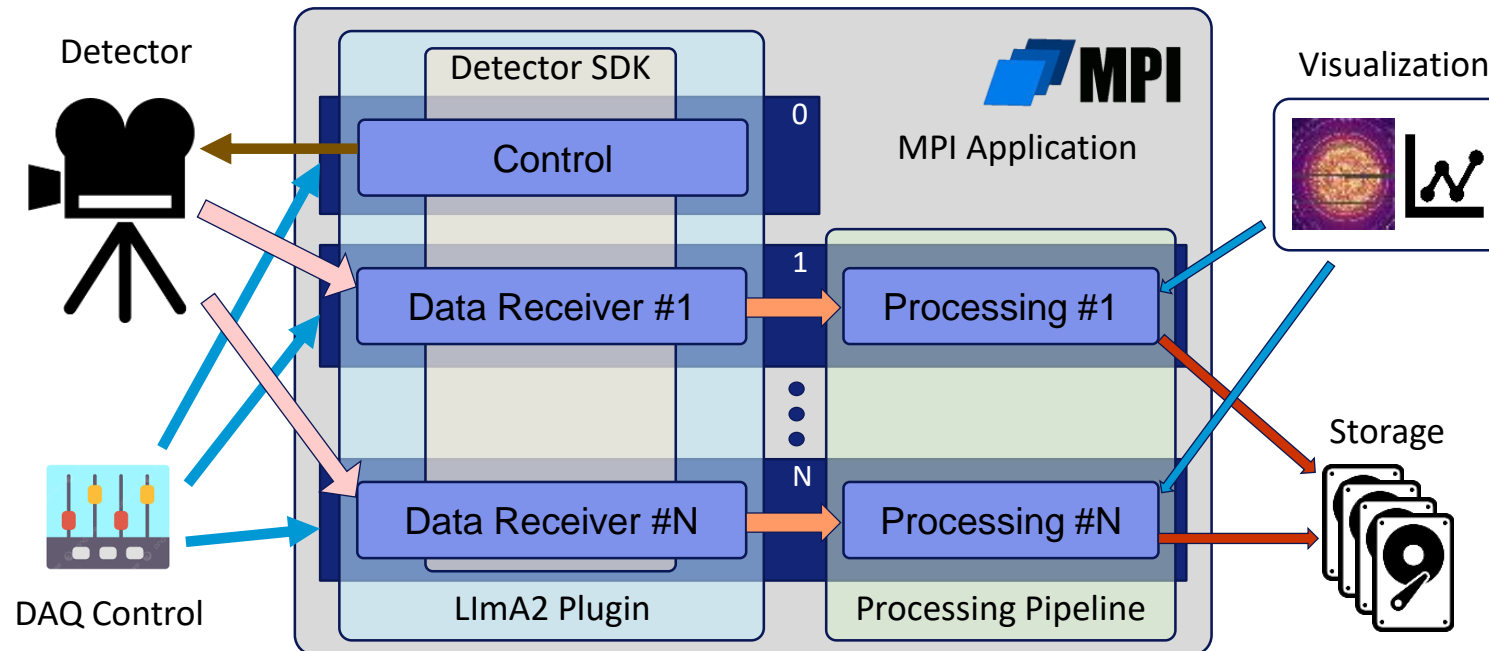


# LImA2: DESIGN CONSIDERATIONS

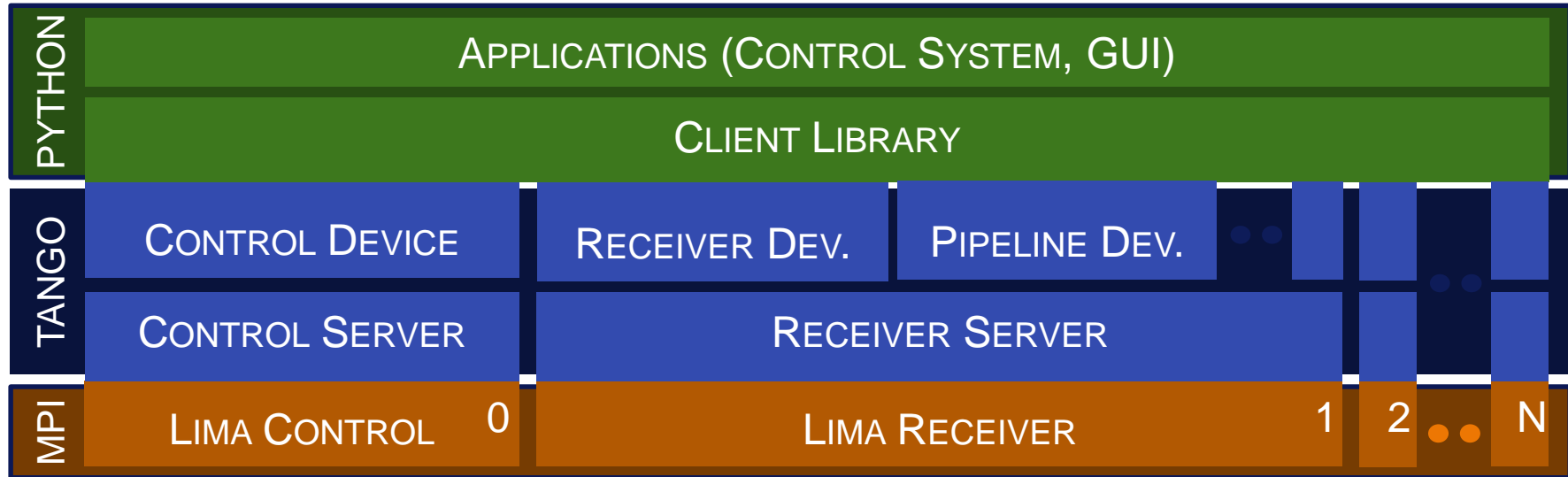
- Scalable topology
  - Most SDKs have a single instance of the detector control API
  - One system controller
  - One or more data receivers
- Separate DAQ from processing
  - Reuse processing code with different detectors
- Start a new HW acq. while still processing and old one
  - Multiple processing pipelines can coexist at the same time
  - Only limited by processing resources
  - Universally Unique Identifier (UUID)
- Set the DAQ parameters at once
  - Avoid issues associated to temporary incoherence
  - *prepareAcq* receives the full configuration

# LImA2: APPLICATION STRUCTURE

- C++ library
- **Feature extraction** and **advanced data reduction**
- Specific & optimized pipelines
- **Low-latency** feedback to experiment

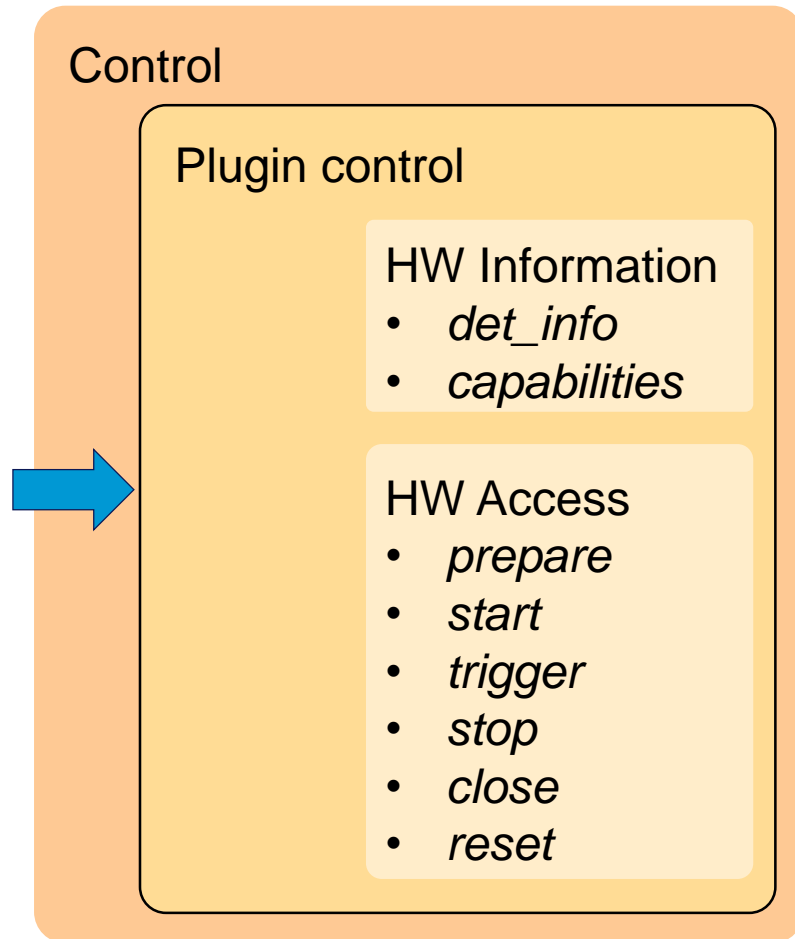


# LImA2: SOFTWARE STACK



- **Client Library:**

- High level entry point to the system
- Can help in configuring the different components
- Hide the complexity of the distributed topology



Plugin *configuration* define structures for

- Plugin instantiation: *init\_params*
- Preparing ACQ: *acq\_params*
  - Generic parameters: *nb\_frames*, *exp\_time*
  - SDK & detector specific: *energy\_threshold*
- Connection to processing: *acq\_info*
  - Input frame size, pixel depth, multi-band



# LIMA2 RECEIVER STRUCTURE

## Receiver

### Plugin acquisition

#### HW Access

- *prepare*
- *start*
- *stop*
- *end*
- *get\_frame*

### Acquisition Thread

### Processing pipeline (*prev*)

### Processing pipeline (*prev*)

### Processing pipeline (*curr*)

- Configuration
- Monitoring
- Data retrieval

### Processing creation:

- *acq\_info* from HW plugin
- Configuration parameters

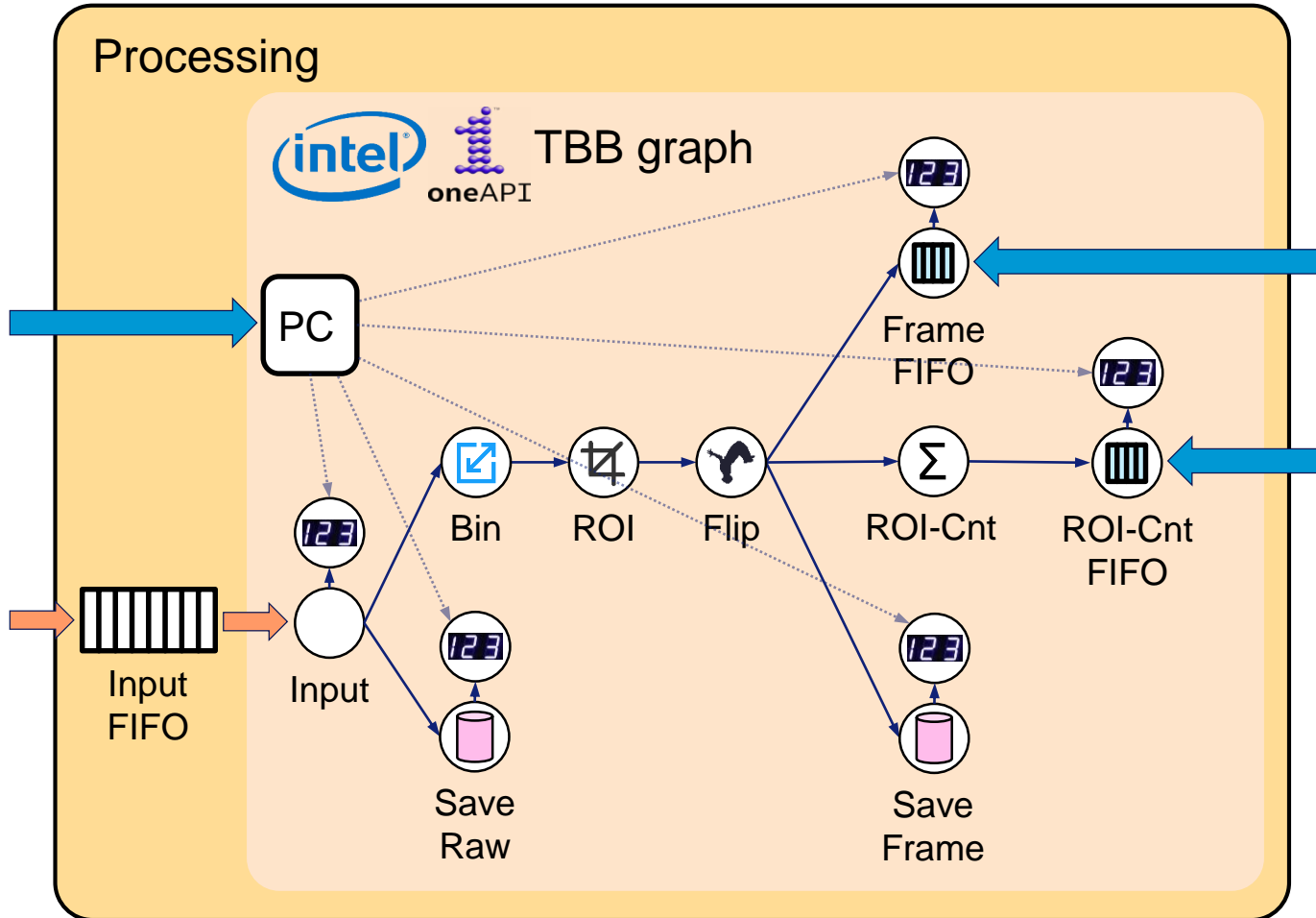
### Processing monitoring:

- *progress\_counters*

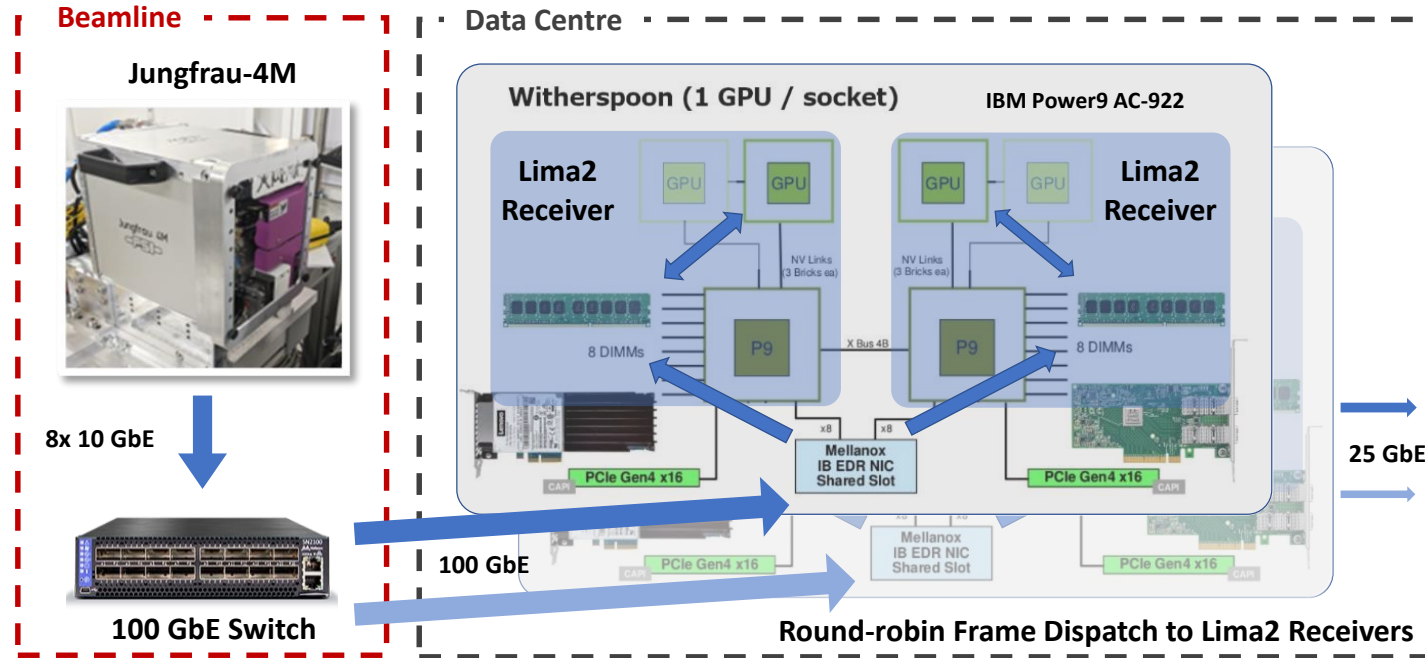
### Data retrieval:

- Raw frame
- Transformed frame
- ROI counters
- Sparse data
- ...

# LIMA2 PROCESSING STRUCTURE



# PSI JUNGFRAU 4M FOR SERIAL MX @ ID29



Parallel data streams:

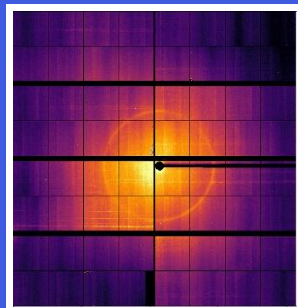
- 2x computers in the data center
- 2x data receivers / computer

ESRF PSI/SLS Detector Receiver:

- Works @ 1 kHz: 8 GByte/s raw data
- First exploitation of Round-robin

# PSI JUNGFRAU 4M FOR SERIAL MX @ ID29

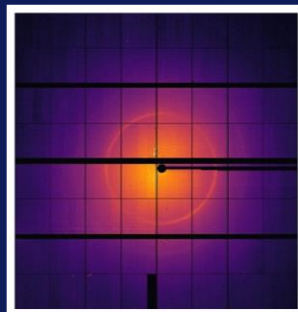
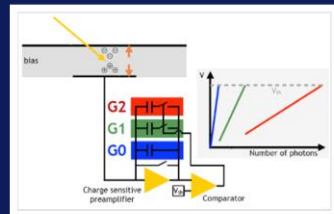
## ▶ Image Reconstruction



Raw UDP packets data from detector are geometrically assembled using a LUT



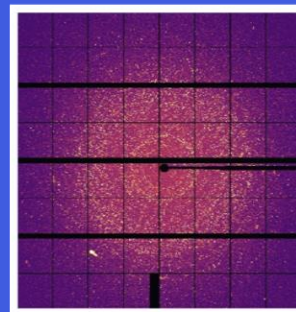
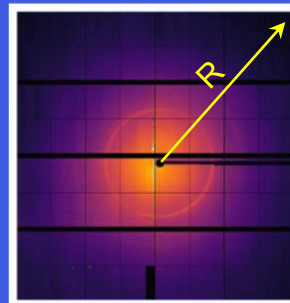
## ▶ Background and Gain Corrections



Per pixel & per frame gain selection: 3 pedestal + 3 gain maps



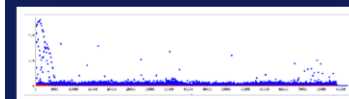
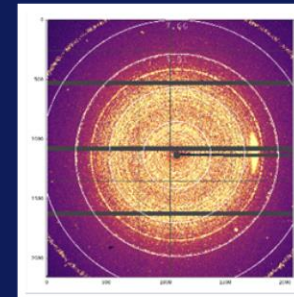
## ▶ pyFAI-based Data Reduction



Background extraction using sigma clipping, peak finding and accumulation



## ▶ Sparse Data & Diffraction Peaks



ODR results are also available in server buffers. A Lima2 Monitor GUI provides online visualization

## Detector integration

- Dectris STREAM2 transfer protocol
- Multi-band image for **dual-threshold** capability
- Integration into **BLISS** scanning engine ongoing
- Classic pipeline with ROI counters

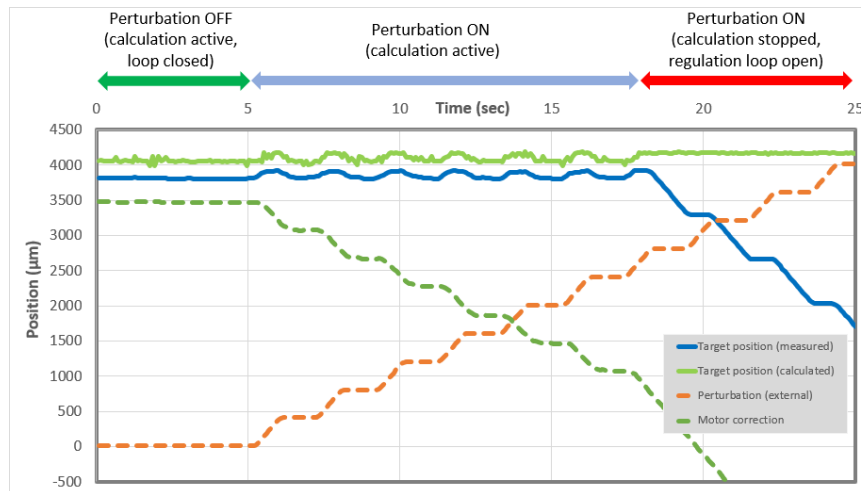
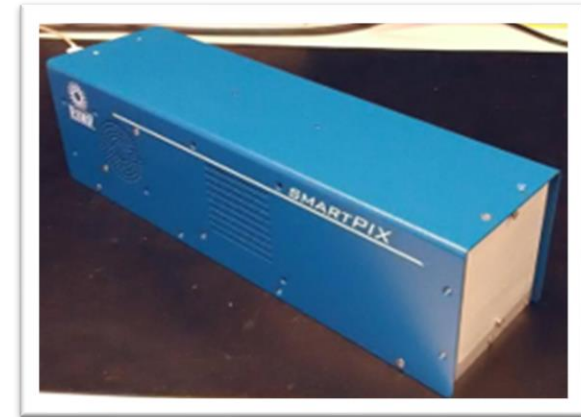
## XPCS Processing pipeline

- Speed-up XPCS processing reading: **x100**
- Saving both dense & sparse datasets
- In production @ ID10



# ESRF SMARTPIX/RASHPA

- Medipix3 chip, modular design
- 1 MPixel @ 6 kHz: 6 GB/sec
- Data transfer: PCIe & **RoCEv2**
- GPUDirect Technology
- Very low latency: 1 msec
- **Active feedback** in advanced experiments



## Low-level device access

- Coordination of the controller and data receiver(s)
- Global state machine management

## Topology agnostic layer

- Retrieval of data reduction results
- Master file creation helpers

## High-level helpers

- Accumulation mode
- HW & SW image transformations



## Image Size (in Pixels)

- 2073 x 2180 (~4 Mpixels)

## Image Size (in Bytes)

- ~4 MB @ 8-bit

## Connections

- 16x 10-bit Ethernet fiber optic cables
- 16 GByte/s of decompressed data – *new*

## Frame Rate

- 4 kHz @ 8-bit – *interesting*

## Control & Data Acquisition (DAQ)

- Detector Control Unit (DCU) computer – *black box*
- Same interface used for Eiger/Eiger2 detector family – *known*
- Multiple Lima computers for data acquisition & reduction – *selected & procured*

## PILATUS 4 for Synchrotrons





# Thank you very much!!

