

# Data Acquisition and Processing at MAX IV

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4<sup>th</sup> September 2024

# MAX IV

4<sup>th</sup> generation synchrotron  
at Lund University, Sweden

High Photon Flux  $\approx 10^{13} \frac{\text{ph}}{\text{s}}$

- ▶ Negligible exposure time
- ▶ Limited by orchestration

Usual Operation

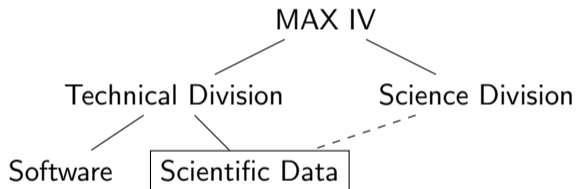
- ▶ Fly scans
- ▶ High data rates



# Scientific Data

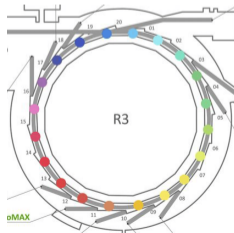
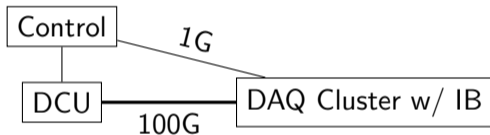


You! We are hiring!



# Storage Architecture at MAX IV

- ▶ Infiniband is expensive
- ▶ No GPFS at beamlines
- ▶ NFS mounts for viewing



## GPFS cluster information

```
=====
GPFS cluster name:      daq.maxiv.lu.se
GPFS cluster id:       1615490..
GPFS UID domain:      daq.maxiv.lu.se
Remote shell command:  /usr/bin/ssh
Remote file copy command: /usr/bin/scp
Repository type:      CCR
```

Node	Daemon node name	IP address	Admin node name	Designation
1	p-daq-cn-4	172.18.10.104	p-daq-cn-4	quorum-mar
2	p-daq-cn-3	172.18.10.103	p-daq-cn-3	quorum-mar
8	p-daq-cn-2	172.18.10.102	p-daq-cn-2	quorum-mar
17	p-jupyter-0	172.18.1.240	p-jupyter-0	perfmom
18	p-jupyter-1	172.18.1.241	p-jupyter-1	perfmom
19	p-jupyter-a100-0	172.18.1.250	p-jupyter-a100-0	perfmom
20	p-jupyter-a100-1	172.18.1.251	p-jupyter-a100-1	perfmom
21	p-compr-0	172.18.10.80	p-compr-0	perfmom
22	p-daq-k8s-kirk-2	172.18.10.227	p-daq-k8s-kirk-2	perfmom
23	p-daq-k8s-kirk-3	172.18.10.228	p-daq-k8s-kirk-3	perfmom
24	p-daq-k8s-kirk-4	172.18.10.229	p-daq-k8s-kirk-4	perfmom
25	p-daq-k8s-picard-2	172.18.10.224	p-daq-k8s-picard-2	perfmom
26	p-daq-k8s-picard-3	172.18.10.225	p-daq-k8s-picard-3	perfmom
27	p-daq-k8s-picard-4	172.18.10.226	p-daq-k8s-picard-4	perfmom
29	p-daq-k8s-infra-p0	172.18.10.240	p-daq-k8s-infra-p0	perfmom
30	p-daq-k8s-infra-k0	172.18.10.241	p-daq-k8s-infra-k0	perfmom
31	p-dqd-picard-0	172.18.10.17	p-dqd-picard-0	perfmom
32	p-dqd-kirk-0	172.18.10.16	p-dqd-kirk-0	perfmom
33	p-daq-k8s-formax-0	172.18.10.230	p-daq-k8s-formax-0	perfmom
34	p-daq-k8s-kirk-0	172.18.10.242	p-daq-k8s-kirk-0	perfmom
35	p-daq-k8s-picard-0	172.18.10.244	p-daq-k8s-picard-0	perfmom
36	p-daq-k8s-kirk-1	172.18.10.243	p-daq-k8s-kirk-1	perfmom

# Kubernetes at MAX IV

## Kubernetes

- ▶ Used by Software Group
- ▶ Cluster management experience
- ▶ CI/CD tools maintained
- ▶ Dockerized packaging
- ▶ Infrastructure as code (helm/ansible)

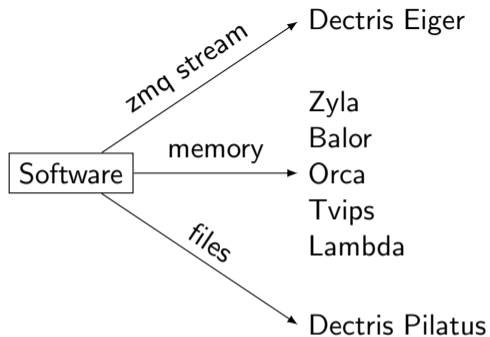
## DAQ K8s Cluster

- ▶ 100 Gbits dedicated network (purple)
- ▶ 10 × 100 Gbits ingest servers
- ▶ On demand load based scheduling
- ▶ Deploy on git push

```
---
global:
  beamline: flexpes

daq:
  # Pipeline Template
  pipeline:
    template: streaming_receiver
    override: |
      configfiles:
        - name: detector.yaml
          content: |
            detector:
              class: Eiger
              dcu_host_purple: 172.18.31.4
              api_port: 5000
              data_port: 5556
              dset_name: /entry/instrument/eiger/data
  # Enable Purple Ingest
  purple_network:
    enabled: true
  # Enable all IDs from AD (SGIDs)
  ad_admission: true
```

# Unified Streaming



## Streamer

- ▶ Take frame buffers from SDK
- ▶ Opt. read files from local disk
- ▶ Wrap data in zmq frames
- ▶ Send to receiver

## Format

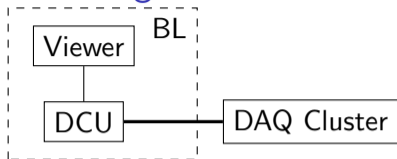
Zmq multipart messages  
similar to legacy Dectris Eiger

```
{msg_number=374,htype='header',  
filename='/data..test.h5'}
```

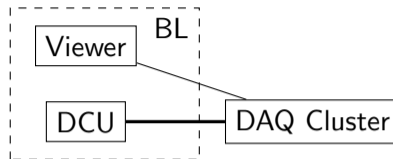
```
{msg_number=375,htype='image',  
frame=0,shape=[831, 1475],  
type='float32',compression='none'}  
<raw bytes>
```

```
{msg_number=376,htype='series_end'}
```

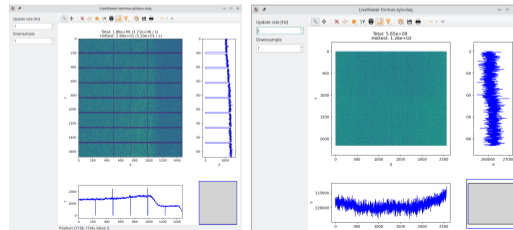
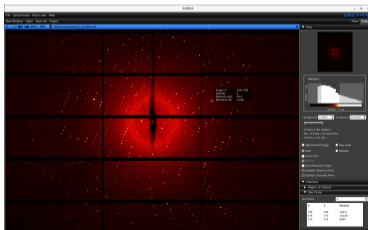
# Live Viewing



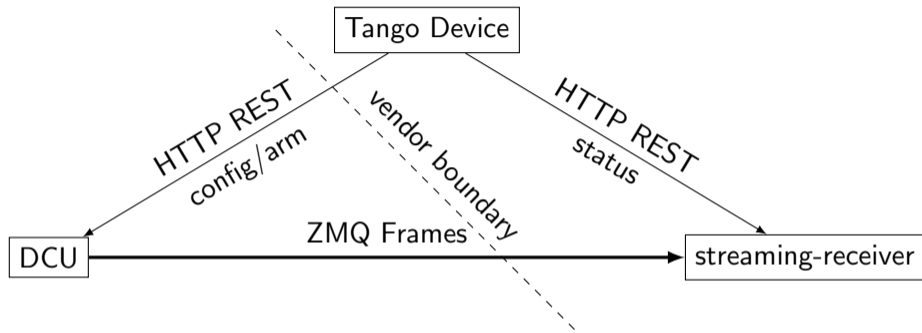
- ▶ Often provided by vendor
- ▶ Just works™
- ▶ Local network load



- ▶ More network load
- ▶ Reusable and common to all 2d
- ▶ Fast integration of new detectors
- ▶ Heavy processing possible



## Example: Dectris Eiger

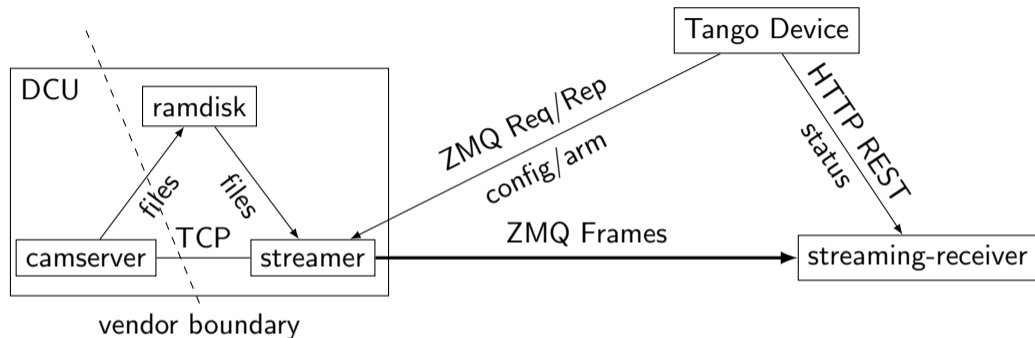


### Plug'n'Play

- ▶ Minimal integration effort
- ▶ Little debugging on DCU possible



## Example: Dectris Pilatus (< 4)

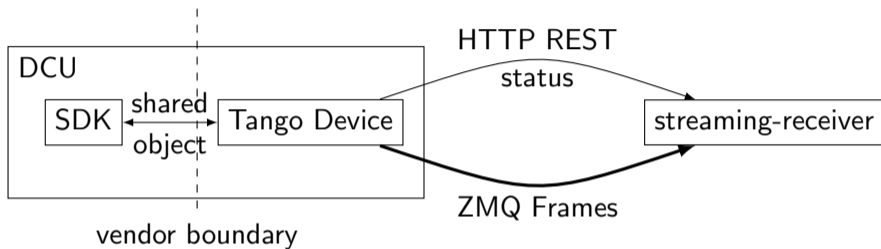


### Camserver

- ▶ DCU is Tango incompatible
- ▶ No memory access to frames

## Example: Andor3 SDK

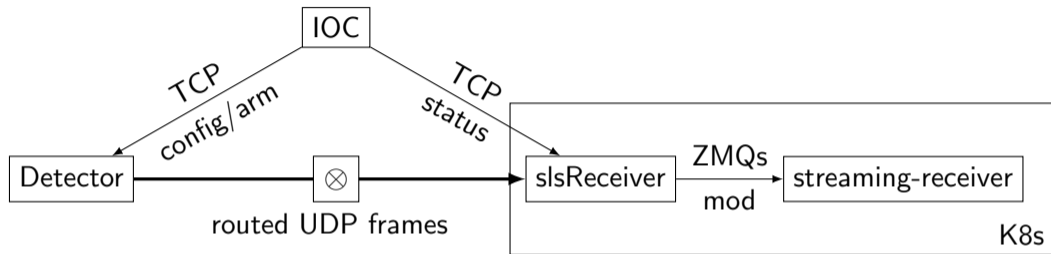
<https://github.com/maxiv-science/andor-streamer>



## Tango Streamer

- ▶ Simple state management (2 instead of 3 components)
- ▶ Development effort to combine SDK and Tango
- ▶ Bad software quality from vendors (requires libc hacks)

## Example: SLS detector Eiger at SoftiMAX (Sofie)

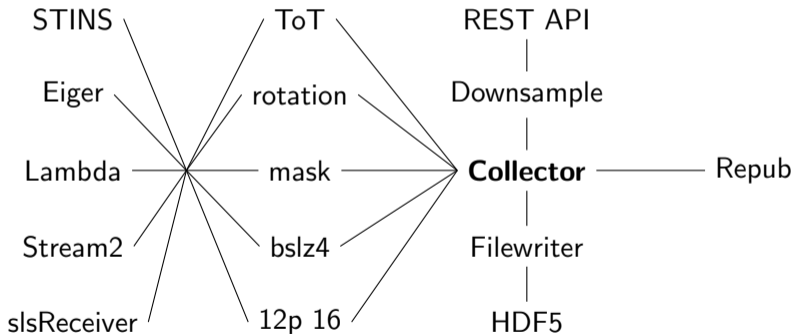


### Virtual DCU

- ▶ Route UDP data over fabric
- ▶ Assemble modules in Kubernetes pod (slsReceiver)
- ▶ Assemble frames in streaming-receiver

## streaming-receiver

multithreaded Python with zmq, numpy, bitshuffle, 3GB/s, 4kHz  
<https://github.com/maxiv-science/streaming-receiver>



# Single Beamtime Detectors

## Pilatus4 at DanMAX

- ▶ Added Stream2 receiver (multiple thresholds)
- ▶ Reuse Eiger Tango device

## Rigaku XSPA-1M

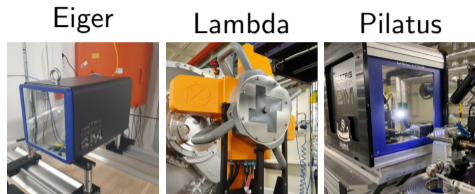
- ▶ Local script to configure and arm
- ▶ Data streaming and live viewing

## Lumentum RAD

- ▶ Added zmq stream to DCU software
- ▶ Full Tango device support



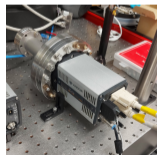
# High-Bandwidth DAQ scheme



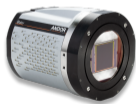
└─ Fiber / Twisted Pair ─┘



└─ CameraLink / CoaXPress ─┘



Zyla



Balor



Orca

