

High Data Throughput Detectors

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on behalf of the
ISDD Software Beamline Control Unit
(former BLISS)***

Talk outline

- Introduction to *Espia* card
 - ESRF-developed detectors
 - CameraLink detectors
- Data saving performance
 - Local disks
 - Network storage
- Latest developments
 - Recently acquired detectors
 - Prepare for next generation

Espia card



- ✓ Designed to interface the FReLoN 2k
- ✓ Collaboration ⇔ ESRF + SECAD, S.A.
- ✓ 2 Gbps fiber optic link (> 100 m)
- ✓ PCI 64 bits / 66 MHz
- ✓ ~180 MB/s maximum data rate
- ✓ Driver developed in-house



New *FReLoN* Generation



FReLoN 2k (ATMEL):

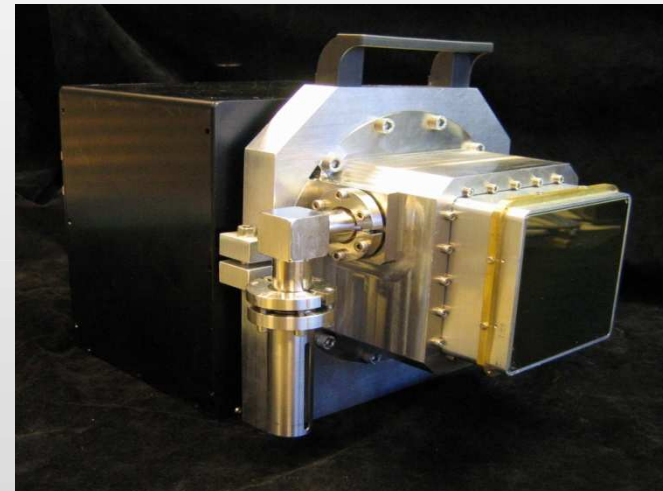
- ✓ 2048 x 2048 – 14 bit – 4 ADCs
- ✓ Frame Transfer Mode
- ✓ 2048 x 1024 @ 16 fps \Rightarrow 66 MB/s

FReLoN 4M (KODAK):

- ✗ High dynamic range

FReLoN HD (PSB-2):

- ✓ 2048 x 1024 @ 32 fps \Rightarrow ~125 MB/s



Camera Link: FOCLA

- Connects to the Espia
- 2 x Camera Link connectors:
- Multiple pixel packing formats
- Test image generator @ ~180 MB/s



Dalsa Pantera 1M60

- ✓ Frame transfer technology
- ✓ 1024 x 1024 @ 60 fps \Rightarrow 120 MB/s
- ✓ 1 x Camera Link [Base] Connector
- ✓ Compact!
- ✗ Image not reconstructed
- ✓ FOCLA does reconstruction



Sarnoff CAM512

- ✓ 512 x 512 @ 300 fps \Rightarrow 150 MB/s
- ✓ 512 x 128 @ 500 fps \Rightarrow 125 MB/s
- ✓ 2 x 8 ADCs – 12 bit
- ✓ 2 x Camera Link [Base] Connectors
- ✗ Separate RS-232 serial line

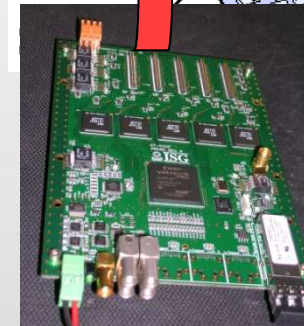
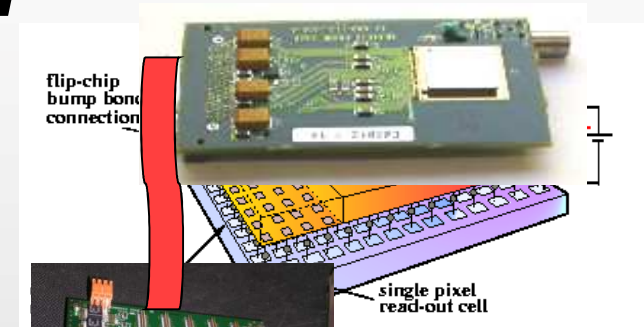
- ✓ Tomography in 0.5 sec @ 500 fps



Medipix2 / Maxipix

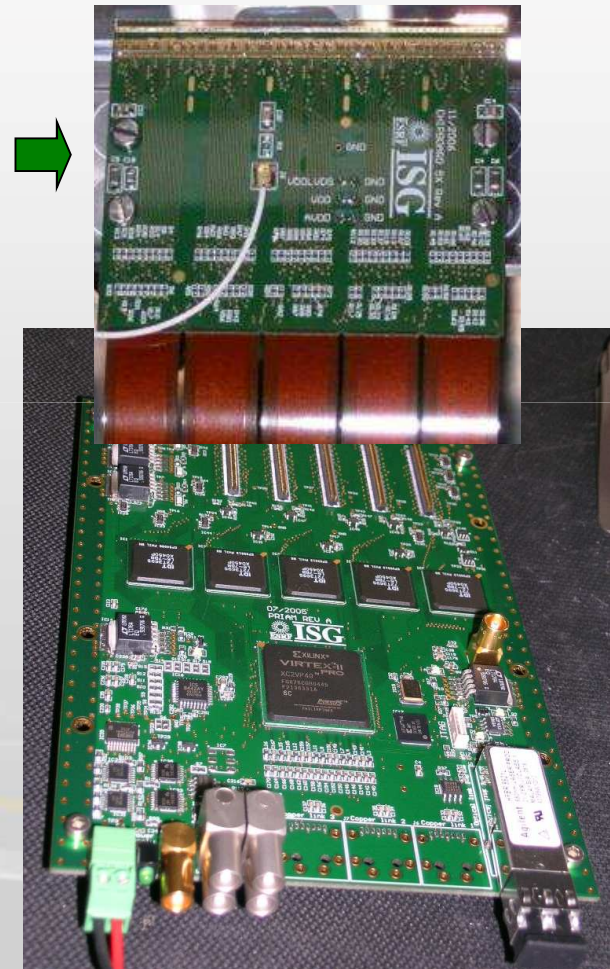
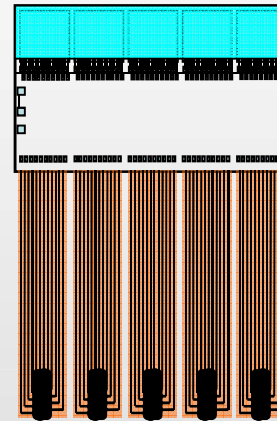
- ✓ Pixel detector \Rightarrow photon counting
- ✓ 256 x 256 – 13 bit
- ✓ 0.3 ms readout time
- ✓ 1000 fps \Rightarrow 130 MB/s
- ✓ Max: 1400 fps \Rightarrow 180 MB/s

- ✓ Chipboard: University of Geneve
- ✓ PRIAM: ISG/ESRF
- ✓ Interfaced to the Espia



Multichip Maxipix

- Medipix2 array
- 5 x 1 \Rightarrow 1280 x 256
- 2 x 2 \Rightarrow 512 x 512
- ✘ 1000 fps \Rightarrow 650 MB/s
- ✘ PRIAM multiple FO links
- ✘ Future configs: 5 x 2



Sarnoff @ ID15

- ✓ 512 x 512 12 bits @ 300 fps \Rightarrow 150 MB/s
- ✓ Write to local disks: 360 MB/s
- ✓ Write to remote disks: 300 MB/s



Central Data Server



10 Gbps Ethernet



“Bestia”

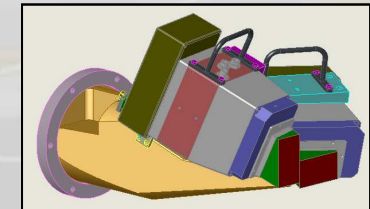
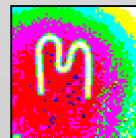
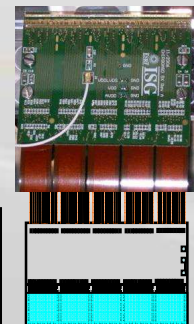
- ✓ Dell PowerEdge 2900
- ✓ Similar to Ecrin/Trenton + 16 GB RAM
- ✓ 4 + 6 = 10 disks \Rightarrow 530 MB/s (800 MB/s raw)
- ✓ Super Sarnoff: 2x FOCLA test image
- ✓ Acquisition rate: \sim 360 MB/s



Espia applications



40 detectors:
ESRF, ANKA & DESSY



LIMA: Library for Image Acquisition

- ✓ Reuse of common code ⇒ generic procedures + interfaces
- ✓ Software “features” fallback if hardware has limited capabilities:
 - ✓ RoI, Binning, Frame Accumulation
- ✓ Basic processing and data reduction:
 - ✓ Centroid, RoI statistics, background subtraction, parallel saving
 - ✗ Sinogram
- ✓ Low level: C++ (multi-threaded)
- ✓ High level: Python (SIP)
- ✓ Generic TANGO interface + detector specific configuration
- ✓ Currently integrated: Frelon, Pilatus, Multichip Maxipix
- ✗ Next in the queue: PCO.dimax
- ✗ Specific data reduction algorithms through “plug-ins”

Espia Next Generation

- ✓ PCI-Express 8x lanes
- ✓ 4 fiber optic links @ 250 MB/s \Rightarrow 1 GB/s
- ✓ 100% register backward compatibility
- ✗ 64-bit DMA support



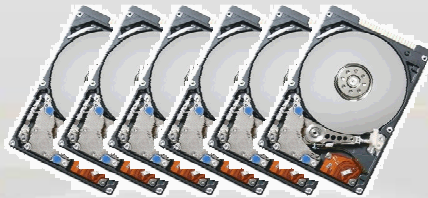
Turbo Bestia

- ✓ 4 + 6 + 8 = 18 disks
- ✗ Single RAID 0 array \Rightarrow 840 MB/s raw
- ✓ 3 RAID 0 arrays + parallel write \Rightarrow 1.5 GB/s raw

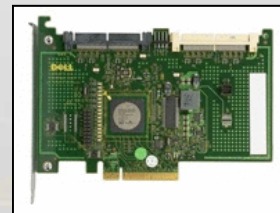
4x



6x

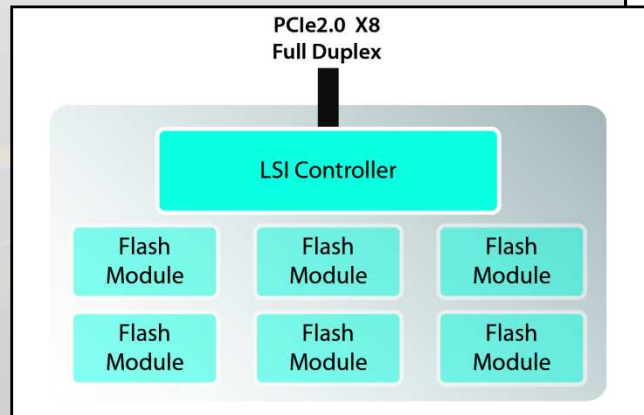
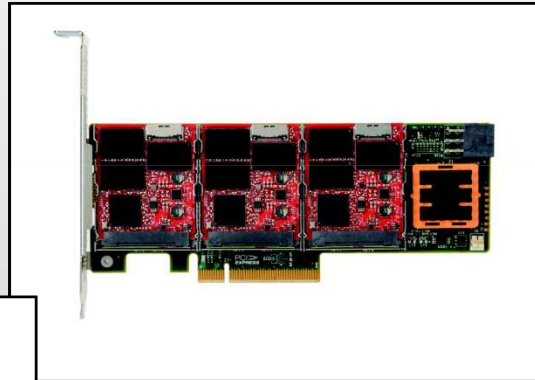


8x



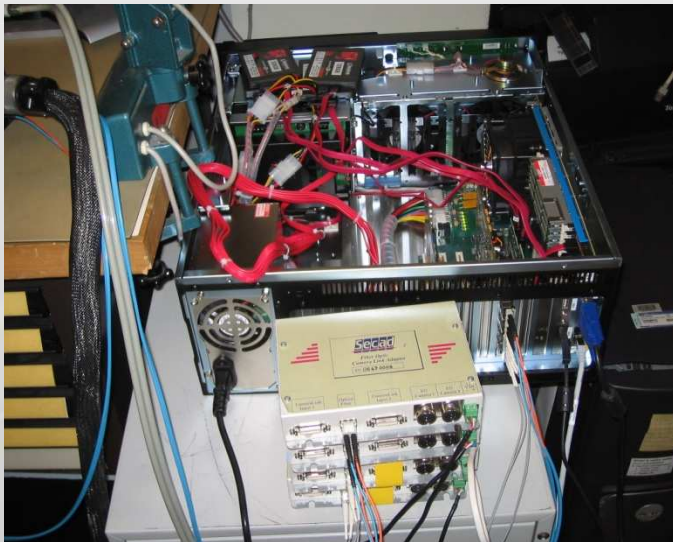
Solid State Storage

- ✓ Current capacities: 300 GB
- ✗ Future roadmap: 1.2 TB
- ✓ Reading: 1.5 GB/s
- ✓ Writing: 1.2 GB/s



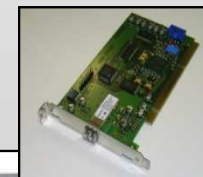
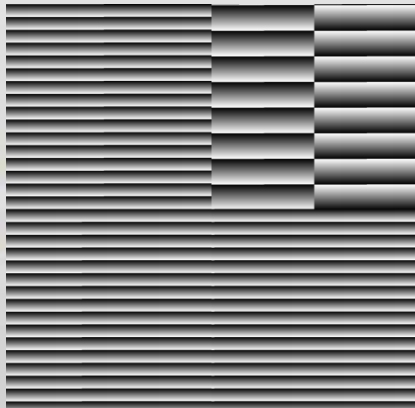
EspiaExpress first tests

- ✓ 4 FOCLA data generators @ 180 MB/s \Rightarrow 720 MB/s
- ✓ 4 SSD SATA disks @ 190 MB/s \Rightarrow 760 MB/s
- ✓ Preliminary acquisition: 20 s \Rightarrow 14 GB



EspiaExpress first tests

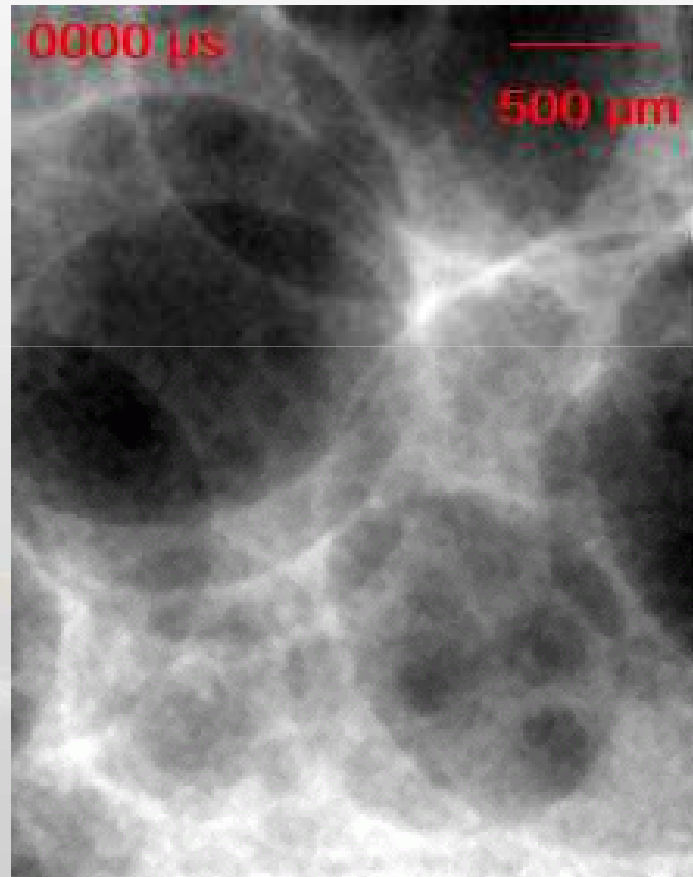
- ✓ 4 FOCLA data generators @ 180 MB/s \Rightarrow 720 MB/s
- ✓ 4 SSD SATA disks @ 190 MB/s \Rightarrow 760 MB/s
- ✓ Preliminary acquisition: 20 s \Rightarrow 14 GB
- ✗ Intensive frame-to-high-memory copy



Photron CMOS results @ ID15 (2009)

Photron CMOS results @ ID15 (2009)

- 40,000 fps !!



J. Synch. Rad. (2009) 16, 432-434

pco.dimax

- CMOS detector
- 2016 x 2016 – 12 bit
- 1279 fps \Rightarrow 9 GB/s
- 36 GB internal RAM
- GigE: 90 MB/s
- Camera Link:
 - Standard 16-bit packing: 160 MB/s
 - Fast 2x12-bit packing: 240 MB/s



Windows 7 workstation

- ✓ Local 4 disks RAID-0 \Rightarrow 400 MB/s
- ✓ NAS + 10 Gigabit \Rightarrow 240 MB/s



1 Gbps Ethernet



Thecus 7700Pro NAS



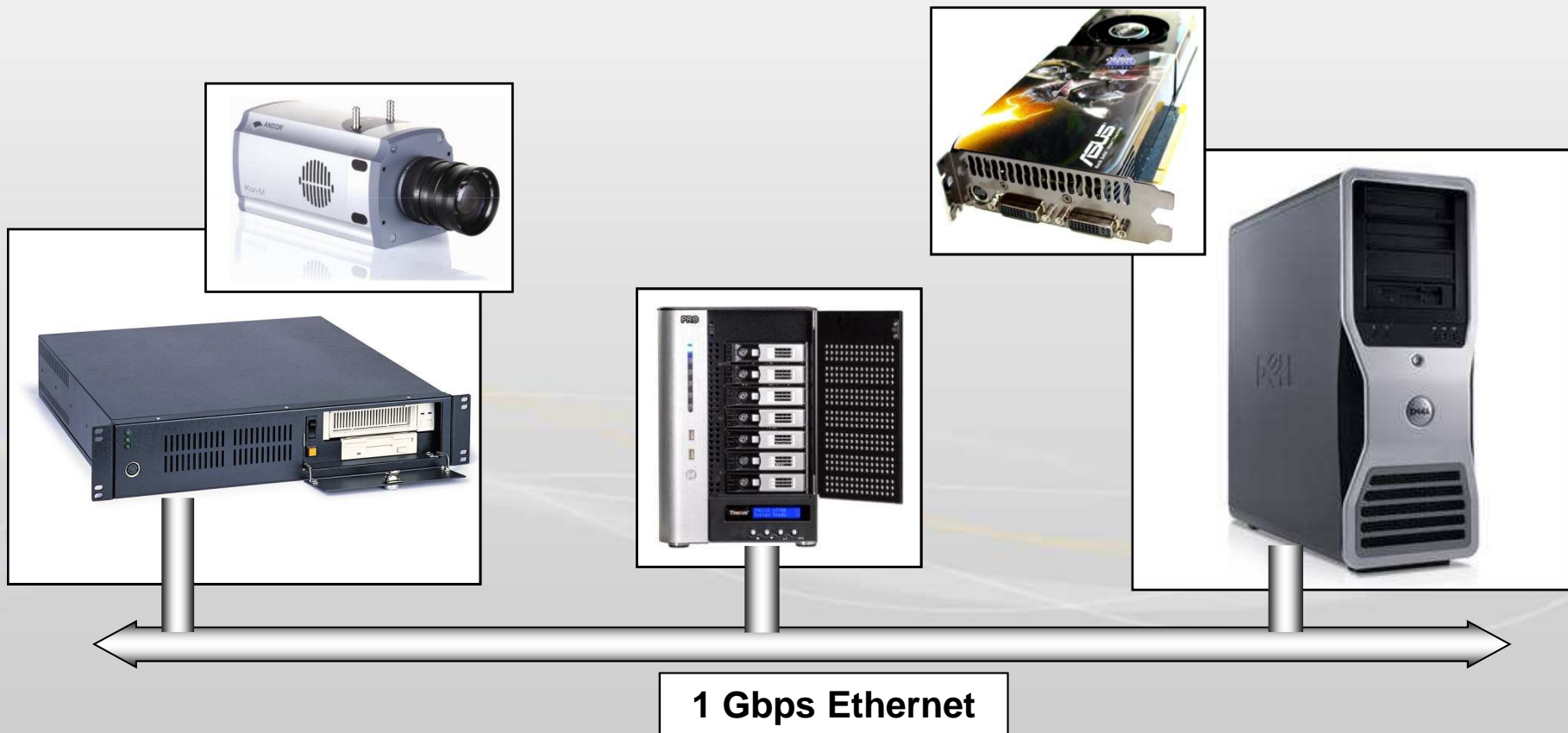
10 Gbps Ethernet



Sneakernet

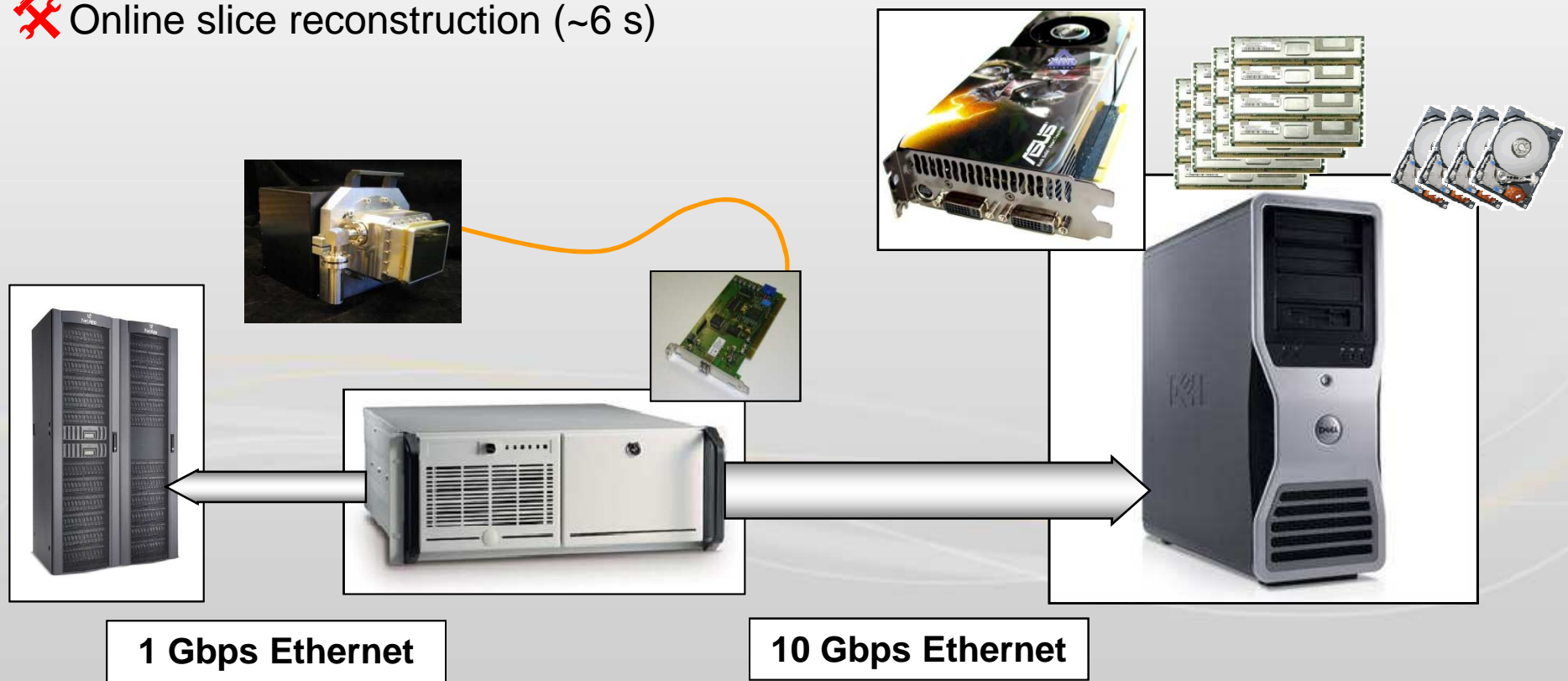
XPCS GPU workstation @ ID10

- ✓ Fast data retrieval for online data analysis \Rightarrow 75 MB/s



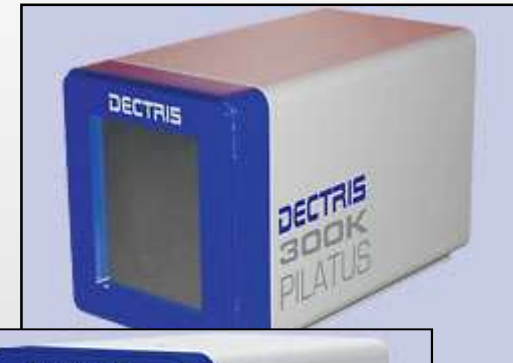
Tomography GPU workstation @ ID19

- ✓ Data replication into GPU workstation:
 - ✓ 10 Gbps + 4 disks + NFS4 \Rightarrow 300 MB/s !
 - ✗ Online slice reconstruction (~6 s)



Dectris Pilatus 300K – 1M – 6M

- Pixel detector \Rightarrow photon counting
 - 487 x 619 @ 200 fps
 - 981 x 1043 @ 30 fps
 - 2463 x 2527 @ 120 fps
 - Effective speed \Rightarrow 75 MB/s
 - TVX control software \Rightarrow socket interface
- ✓ Included in LIMA
- ~~✗~~ Definitive saving configuration under design



Next generation PC

- E4/Supermicro vs. Ecrin/Trenton
- Dual six core
- Latest Intel chipset
- Up to 8 disks
- Possibility of GPU included
- Evaluation arrived yesterday ...



Fast DAQ infrastructure

- Generate 10 GB/s in the near future
- 10 (40) Gbps Ethernet is the common choice
- External PCI-Express?

- Common hardware architecture
- Flexible, scalable, software friendly
- Looking for (EU) resources (P. Fajardo)
- XNAP, MEDIPIX3
- EIGER

Conclusions

- ✓ Significant number of supported 2D detectors
- ✗ This number keeps raising ...
- ✓ Experience in high speed acquisitions
- ✗ New detectors demand high performance control
- ✗ A unified hardware infrastructure is desirable ...
- ✓ Common LIMA library is helping!

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