Upgrade of SACLA DAQ System Adapts to Multi-beamline Operation

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DAQ for user experiments
Outline

• DAQ overview
• DAQ upgrade
  • Reliability
  • Secure system
  • Throughput
  • Offline analysis power
• Items to be done
• Summary
Experiment with MPCCD Sensors

Octal MPCCD (Multiport CCD) Sensor

Resolution: 1024x512 px
Data depth: 16 bit
Single-sensor data rate is 0.5Gbps @ 60Hz (max)
DAQ Requirements

• 6Gbps data throughput
  (=MPCCD image sensor x 12 sensors x 60Hz)
• Shot by shot beam synchronization
  (The sample is likely destroyed by a single shot)
• Common analysis platform
  (Computing farm : Basic data processing tools)

→ Operating since 2012.
DAQ Overview

- Online
  - 10GbE for image data
  - 1GbE for other data and meta data
  - Detectors synchronized to accelerator cycle
  - Cache storage / Database
  - Data-handling servers
DAQ Overview

- Offline
  - Archive tape storage
  - PC cluster
  - Tool: Online format to HDF5 format
Data accumulation history
Various experiments → various slopes
Total ~300TB
Motivation for the DAQ upgrade +Beamline (BL2) in 2014

Upgrade for BL2

Multi-beamline capability

More offline analysis power
Upgrades: 4 items
Upgrade 1: Reliable Synchronization

- Local counting system
  - Each subsystem has its own counter. Once some misbehave (loss or overcount), it needs a manual reset.

- Tree structure system
  - Tag Data Master delivers the tag number and the timestamp to all subsystems.
  - Installed and stably working since April.
The separation between beamlines and access groups is secured by the VLAN settings. The access control is centralized in the BL_master.

(The messaging is based on MADOCA II framework.)
Upgrade3 : Keeping full throughput

- BL3 sync data
- DB
- Image data
- Data-handling Servers
- Cache_bl3
- Archive storage
Upgrade3: Keeping full throughput

- Add network line for image data physically.
- Downstream (offline) is unchanged.

![Diagram of data flow](image)

- BL2 sync data flows into Cache1.
- BL3 sync data flows into Offline DB.
- Image data from BL2 is cached in Cache2.
- Archive storage is connected to Cache2.

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Upgrade4: Additional offline analysis power

New 90TFLOPS supercomputer K computer compatible

FX10 + 1PB storage

Database System (MySQL)

High-speed Cache Storages

Archive Tape Storage

High-performance PC Cluster 13TFLOPS

250TB

200TB

7PB

250TB

200TB

7PB
Upgrade4: Additional offline analysis power

- **Database System (MySQL)**
  - 250TB
- **Archive Tape Storage**
  - 7PB
- **High-speed Cache Storages**
  - 200TB
- **High-performance PC Cluster**
  - 13TFLOPS
- **FX10 + 1PB storage**
- **K computer in Kobe**
  - 10PFLOPS

New **90TFLOPS supercomputer**

Recorded **6.4Gbps data transfer speed** between SACLA and K-computer (Kobe) → Not a bottleneck for 1day/exp analysis.

PCaPAC2014 16
More to come

• Switching beamlines with any intended (not fixed) pattern
  • Delivery of beamline information shot by shot

• Safe data transfer from Cache to Archive
  • Manual → Automation

• Industrial users
  • Data ownership management

• Next generation high resolution image sensor
  • An order more capability is required.
    → Next major upgrade.
Summary

• SACLA DAQ provides the common data stream for users. (online + offline)

• In 2014, several upgrades are made towards multi-beamline experiments.
  • Reliability:
    • Tree structure tag supply system
  • Secure system:
    • Access Control
  • Throughput:
    • Additional data line for image data
  • Offline analysis power:
    • 90TFLOPS supercomputer

• Some items already on the To-Do list

SACLA DAQ continues to evolve!