Beam-Synchronous Data Acquisition for SwissFEL injector test facility

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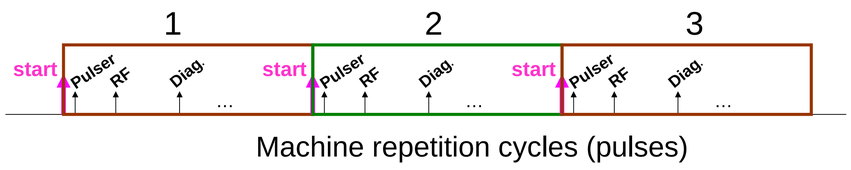
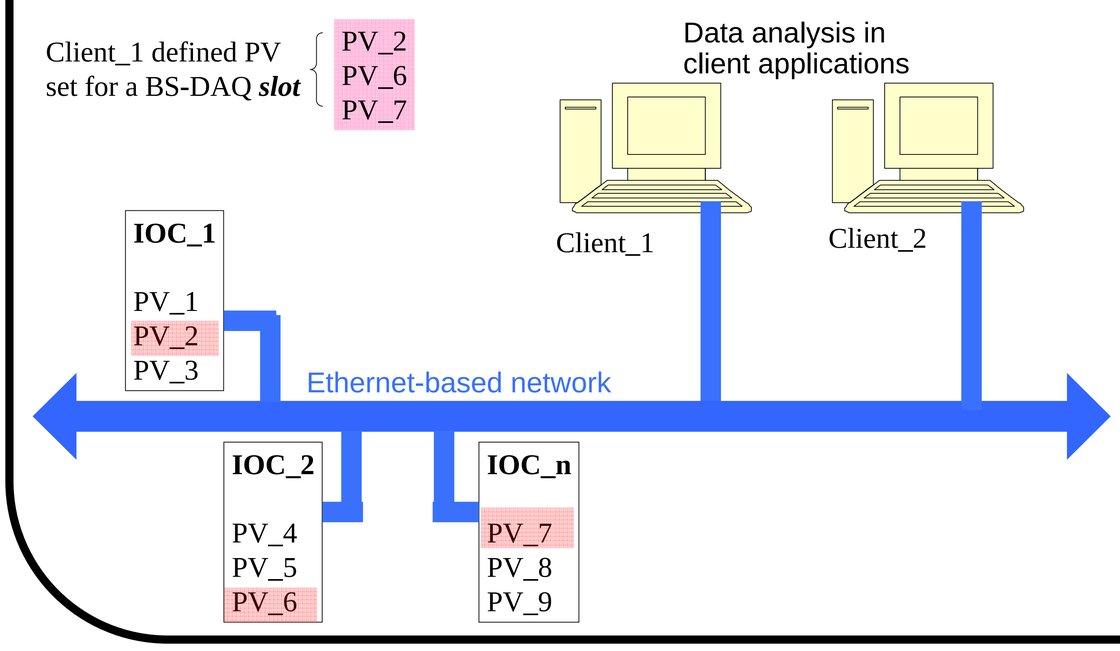
Abstract

A 250 MeV injector facility at PSI has been constructed to study the scientific and technological challenges of the SwissFEL [1] project. Since in such pulsed machines in principle every beam can have different characteristics, due to varying machine parameters and/or conditions, it is very crucial to be able to acquire and distinguish control system data from one pulse to the next. In this paper we describe the technique we have developed to perform beam synchronous data acquisition at 100 Hz rate. This has been particularly challenging since it had to provide us with a reliable and real-time data acquisition method in a non real-time control system. We describe how this can be achieved by employing a powerful and flexible timing system with well defined interfaces to the control system.

Beam Synchronous Data Acquisition (BS-DAQ)





Goal:

❑ acquire a set of measurement Process Variables (PV) for a time specified such that they can be distinguished from pulse to pulse. The acquisition time is normally specified by number of pulses or beams.

Challenge:

❑ Input Output Controller (IOC) nodes communicate via control system network. Our control system toolkit is EPICS and IOCs use Channel Access protocol which is Ethernet-based.

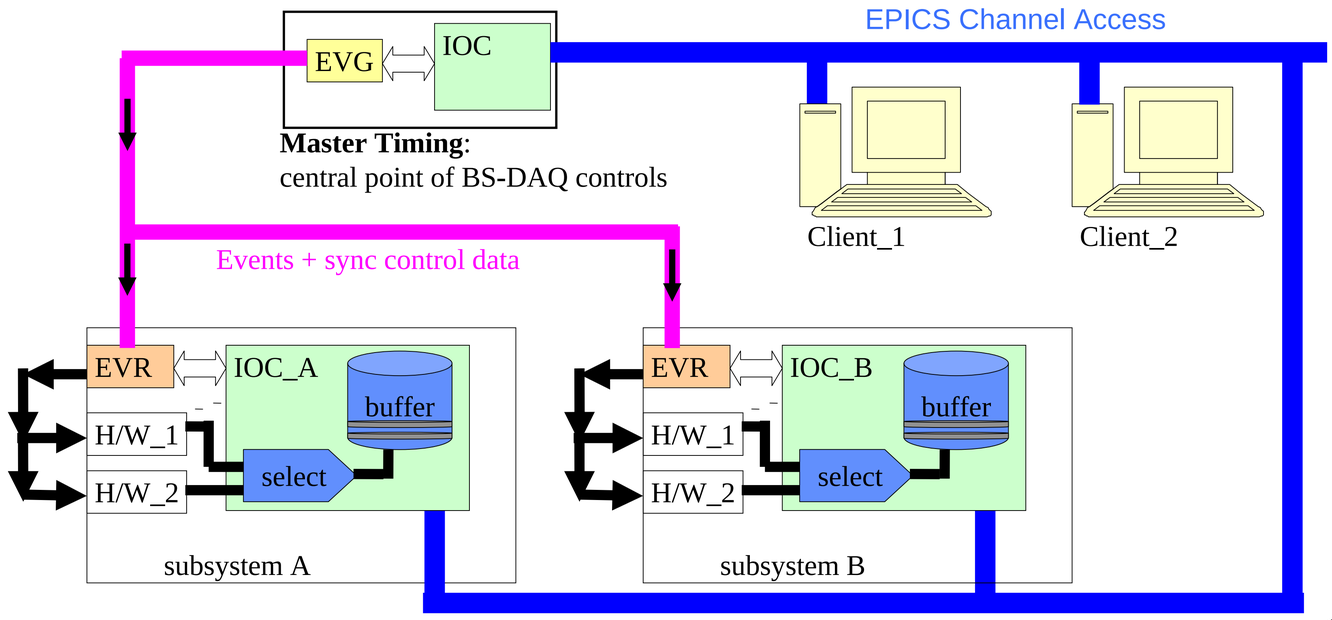
❑ BS-DAQ requires a real-time acquisition of PVs at 100 Hz (machine rep rate) in a non real-time network

❑ in addition it must be possible to separate collected PVs of pulse to another in order to be able to have a meaningful analysis of the machine behavior

❑ allow several clients to simultaneously run their own independent BS-DAQ

Our Technique for BS-DAQ:

- Collect the acquired data at individual IOCs: ***local buffering***
  - to avoid no-deterministic cross-IOC communication
- Timing system (MRF event system) assistance:
  - precise, distributed triggering (when to measure/actuate)
  - reliable, synchronous communication for DAQ controls (62.5 MB/s)
- Unique pulse ID generation/distribution by the timing system to distinguish pulse-to-pulse data
- Collected data tagged with pulse IDs are retrieved by CA client after DAQ completion



- Generic IOC S/W application package
  - is maintained and installed from a central location
  - does not modify existing IOC S/W only adds to it
  - couple of macros to be specified by IOC developers
- Low level configuration/controls provided through medm
- Machine experts use Matlab for config./control/retrieval/analysis
  - automated procedure involves:
    1. Find and *Lease* a free slot
    2. Locate IOC for each PV of ineteresst
    3. Find a free buffer for each PV and assign it to the DAQ slot
    4. Specify no. DAQs, spacing, defer cycles, etc.
    5. Start/stop/resume/abort
    6. Retrieve data + pulse ID buffers for each PV
    7. Consistency checks / analysis
    8. Free the DAQ slot

- Several users can perform simultaneous BS-DAQ in dedicated ***slots***
- Users need to ***lease*** BS-DAQ slots and must ***free*** them when finished
- ***Slot*** configuration & controls (start/stop, etc.) are totally independent