High Throughput Data Acquisition with EPICS

neutron **E**vent **D**istributor (nED)

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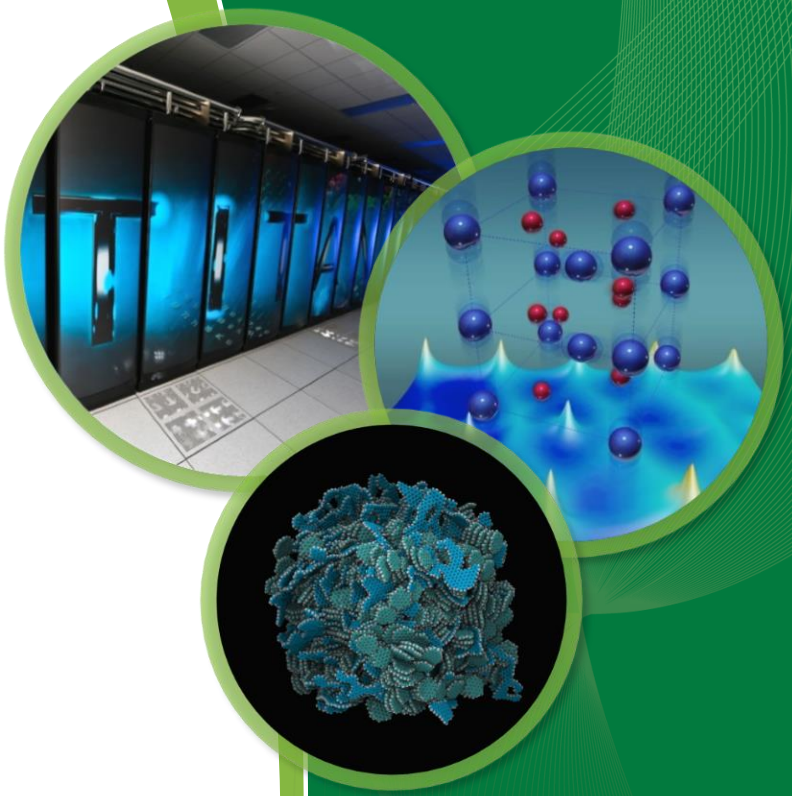
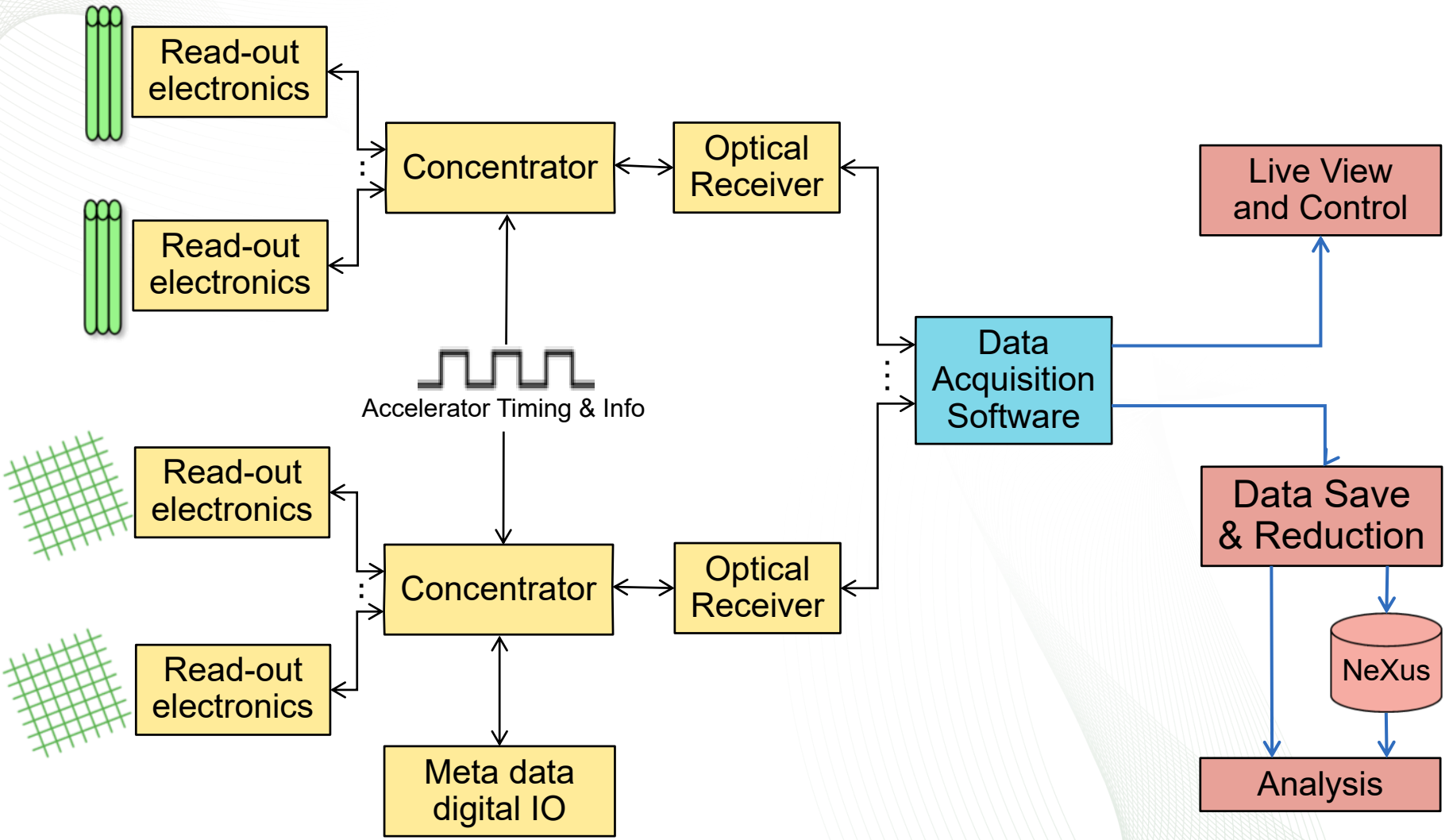
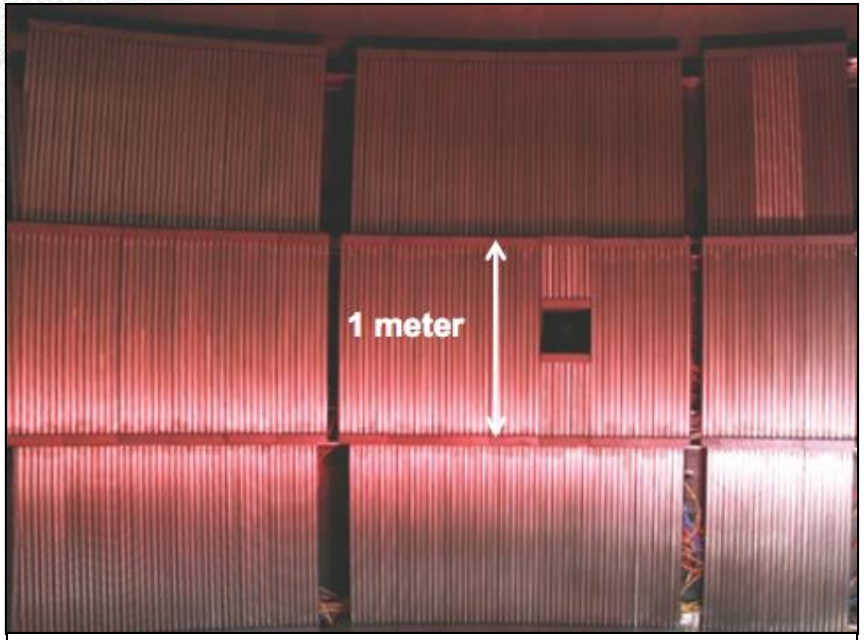


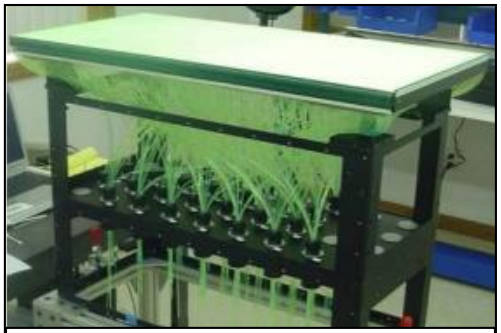
Data Acquisition System at SNS Instruments



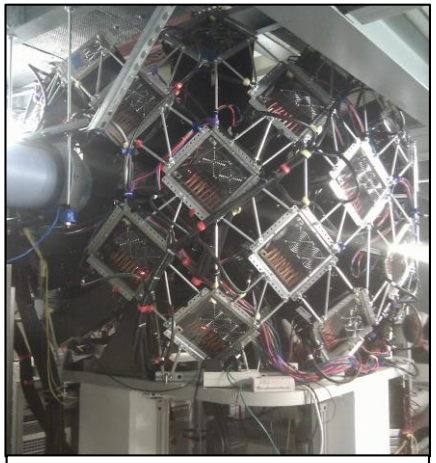
Data Acquisition Electronics



Linear Position Sensitive Detector array

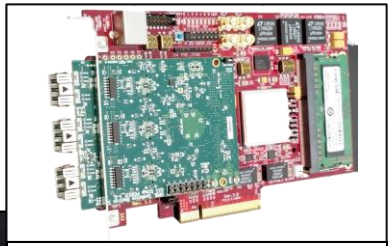


Wavelength-shifting-fiber scintillation detector



Anger camera installation

Read-out electronics



Optical receiver PCIe board

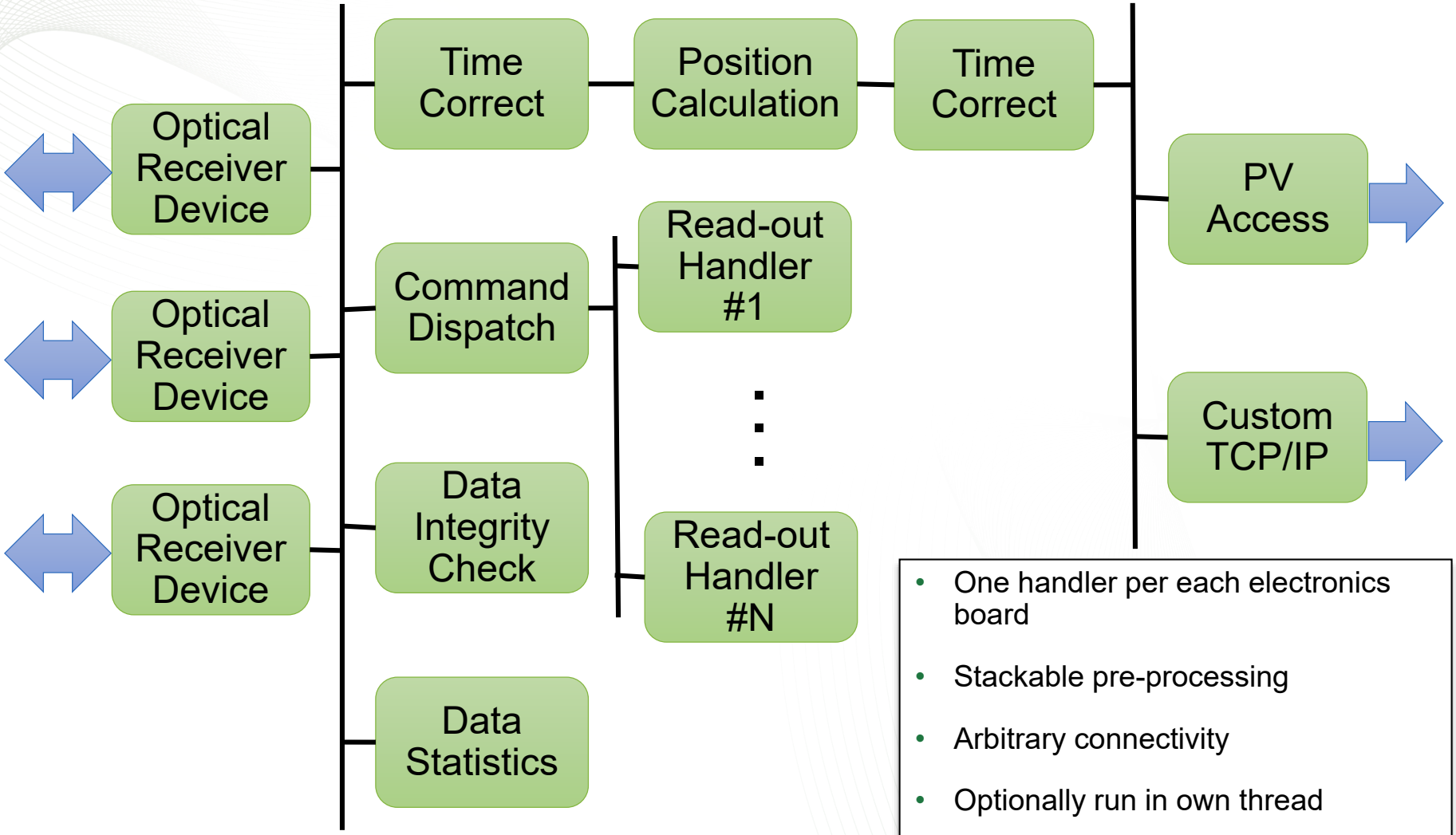
BNL 2D position-sensitive He-3 detector

Concentrator electronics

Data Acquisition Software requirements

- Interfacing custom hardware
  - Detector read-out electronics over custom communication channels
  - Optical receiver PCIe board (DMA and fast MSI interrupts)
- One or more neutron events pre-processing
  - Time adjustment for selected neutron speed/wavelength
  - Position calculation for detectors in development
  - Geometrical distortion correction
  - Others
- Publish data over Ethernet
  - Custom TCP/IP protocol to save data for reduction and analysis
  - EPICSv4 protocol to live view client !?
- EPICS integration

nED modular design



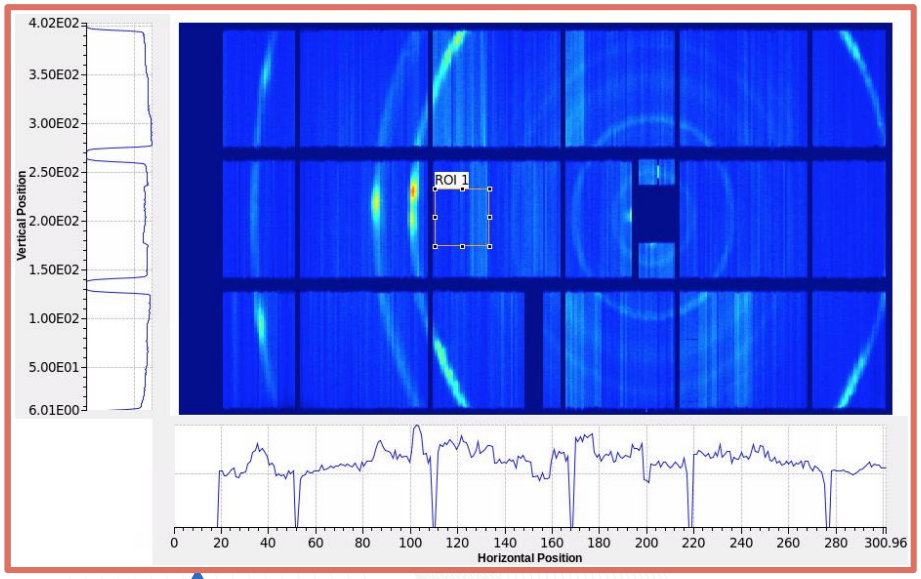
- One handler per each electronics board
- Stackable pre-processing
- Arbitrary connectivity
- Optionally run in own thread

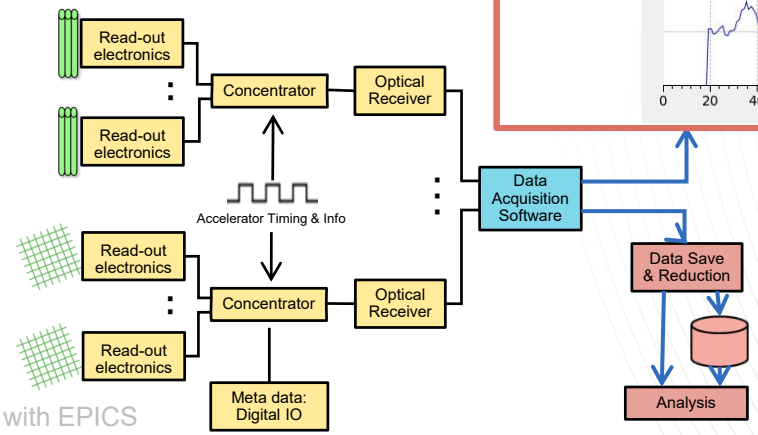
EPICS Rationale

- SNS initiative to adopt EPICS
  - EPICS used as accelerator control system since start-up (or before)
- Control system oriented API suits DAQ well
- Little or no performance penalty
- EPICS connectivity
  - Process variables environment
  - EPICS7 PV Access network protocol
    - SNS first facility using PV Access in production
    - Before EPICS7 was even released

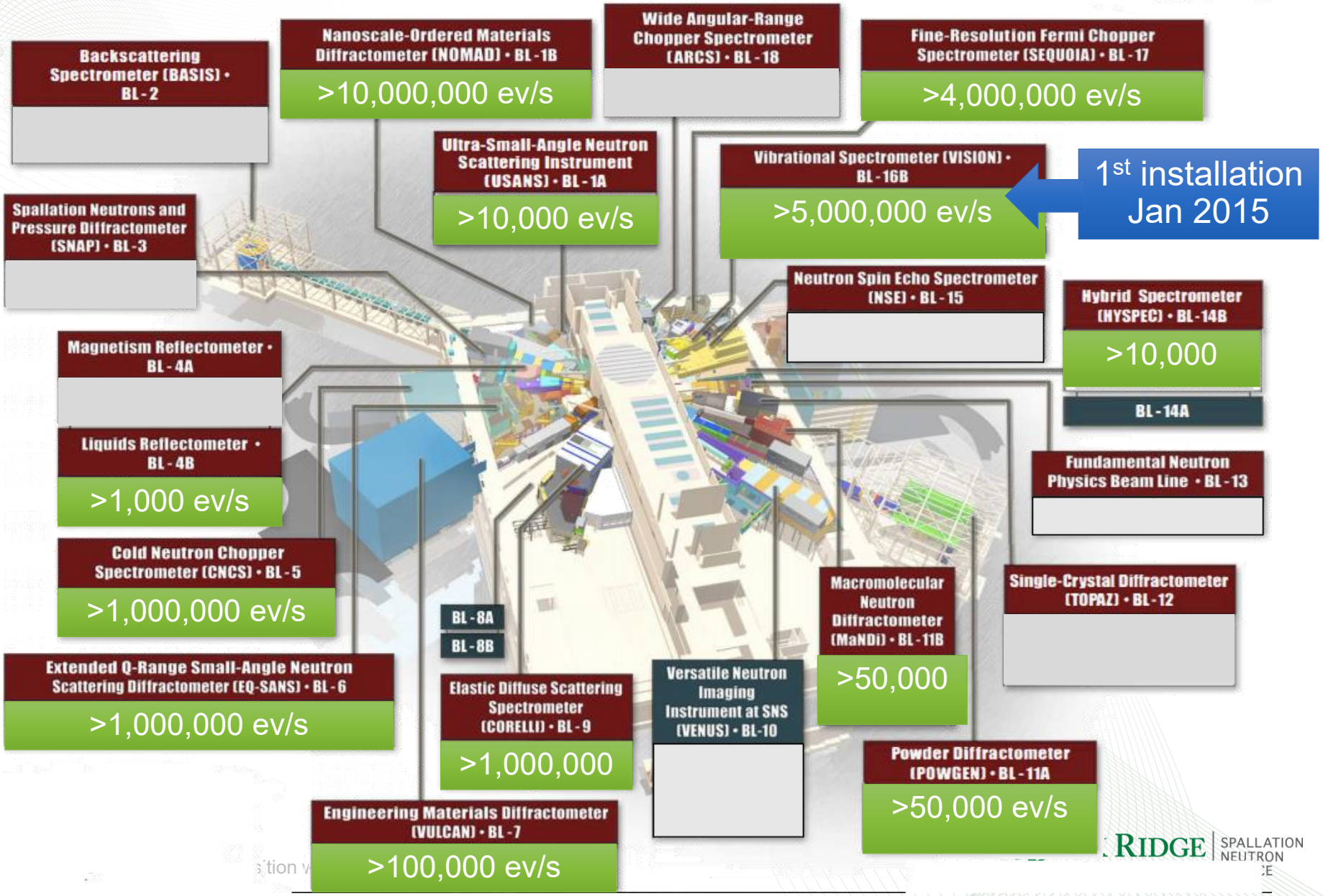
Compared to AreaDetector

- Similar but not same as areaDetector
  - Based on asynPortDriver, architecturally same as areaDetector
  - Data as stream of [time-of-flight, pixel] events
  - Two-way communication between plugins
  - Multi-publish/*multi-subscribe** plugin communication
    (new in areaDetector R3-0)*
- Live view uses areaDetector





Deployment status



Maximum throughput

- Test scope: data transport throughput using EPICS framework, not event pre-processing
- Test in lab measured 50 million ev/s = ~400 MB/s
  - Two optical input channels maxed out
  - No pre-processing
  - Two publish channels, remote clients verifying data
- 5 times higher than present SNS needs
- Not CPU bound, input/output channels are bottlenecks
  - CPU utilization ~5% on Intel(R) Xeon(R) CPU E5-2690

Thank you