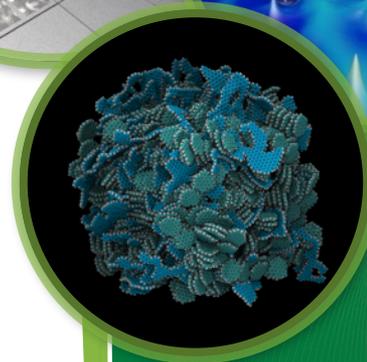
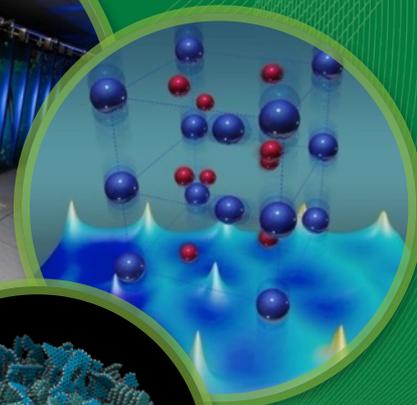


Summary of the 2015 FRIB DAQ Meeting

Robert Varner

2016 LECM Satellite Meeting

Data Acquisition



Overview

- July 29-30, 2015 - The FRIB Data Acquisition Working Group met at the Physics Division of the Argonne National Laboratory to discuss data acquisition needs with representatives of the FRIB community.
- **Information Gathering**
 - Detector Working Group Requirements
 - NSCL Support and Ideas about the Future
 - Community Experiences with Merged Data Acquisition Streams and Systems
- **Issues and Directions**
 - Discussions of perceived needs for development in data acquisition.
 - Data Acquisition support
 - Data Analysis support
 - Interface support for multiple detector systems
 - Identify new developments needed to support issues raised during the discussion
 - Involvement of the community

Detector Working Group Requirements

- **SECAR Data Acquisition Plans**
 - Ulrike Hager (NSCL)
 - 150 ch., 0-10kHz rates, D
- **HiRA***
 - Andrew Rogers (UMass, Lowell)
 - 2000 ch., 0-5kHz rates, A; <1TB/run
- **ORRUBA***
 - Steve Pain (ORNL)
 - 2000 ch., 0-10kHz rates, A
- **S800 Data Acquisition**
 - Daniel Bazin (NSCL)
 - 763 ch., H, timestamp
- **AT-TPC Data Acquisition**
 - Daniel Bazin (NSCL)
 - 10,000 ch., high rate, D
- **Decay Spectroscopy Station**
 - Sean Liddick (NSCL)
 - 0.5 to 10 MB/s, 6Tb/week; timestamp D
- **Solenoid Spectrometer**
 - Calem Hoffmann (ANL)
 - 300 ch., 0.1 to 5kHz, A->D, <8TB/wk, timestamp (MyRIAD)
- **ANASEN**
 - Jeff Blackmon (LSU)
 - mixed A+D (Si A, IC D)
- **MONA/Sweeper Data Acquisition**
 - Paul deYoung (Hope College)
 - 700 ch., 0-3kHz, 0 - 0.6 MB/s, A->D
- **BECOLA**
 - Paul Mantica (NSCL)
- **ASICs for detector readout***
 - Lee Sobotka (Washington University)
 - Widely used, A
 - Performant and inexpensive
- **High Performance Data Acquisition System**
 - Wojtek Skulski (SkuTek)
 - Digitizer+system (LUX), D, Potential Readout integration for FRIB

NSCL Support and Ideas About the Future

- **NSCL Support and Ideas About the Future**
 - Jeromy Tompkins (NSCL) - NSCLDaq and SpecTCL
- **NSCL Compute and Storage**
 - Tom Rockwell (NSCL) - Existing network and storage infrastructure, experiences
- **NSCL Network**
 - Bob Ruigh (NSCL) - NSCL network, need to plan for 40G and faster networks
- **FRIB Accelerator DAQ/Controls overview**
 - Mark Hausmann (NSCL) - FRIB control planning
- **Current NSCL support for mounting experiments**
 - Jeromy Tompkins/ Ron Fox (NSCL)

Recent Experiences Merging Data Acquisition Streams and Systems

- **Digital Acquisition with DANCE**

- Shea Mosby (LANL) - Two generations of experience with DDAS

- **Digital Gammasphere**

- Mike Carpenter (ANL) - Gretina digitizers, trigger, MyRIAD

- **S800+DDAS and S800+VMUSB**

- Jeromy Tompkins (NSCL) - experience with distributed clock

- **Digital FMA**

- Dariusz Seweryniak (ANL) - Digital GS + Digital FMA

- **GRETINA interface and experience**

- Chris Campbell (LBNL) - merging Aux detectors

- **Synchronization and triggering**

- John Anderson (ANL) - discussion in terms of Gretina, DGS and MyRIAD

- **Event fragment collection, ordering and event building**

- Torbin Lauritsen (ANL) - Sorting DGS data, where, how and problems

Common Themes

- TimeStamping for integrating heterogenous data streams
- Digital signal analysis
 - Analyzed in module
 - Traces as part of the data stream
- Large scale systems
 - Hundreds to thousands of channels
- Potentially high count rates, despite the rare beams

Data Acquisition Protocols and Interfaces

- Consensus protocols and interfaces to support experimenters to develop data acquisition applications
 - **Shared and supported practices**
 - **Common styles of system interfaces**
 - **Develop facility resources to implement the protocols and interfaces**

Data Acquisition Protocols and Interfaces

- The **areas for development** we identified in this meeting are:
 - **Accelerator and beam line controls Interfaces:** working with the FRIB controls group to develop efficient interfaces to accelerator and beam line information and controls, especially identifying those parameters and controls that require experimenter access
 - **Run Control:** interfaces that enable unified control of complex detector arrays and accelerator resources

Data Acquisition Protocols and Interfaces

- **Time:** identification or development of time distribution protocols, interfaces and hardware to enable high precision coordination of experimental systems and event data time stamping
- **Trigger Exchange:** standards that allow detector systems to exchange and record event-by-event information about trigger conditions
- **Event Builder:** application programming interfaces to the event builder, protocols for exchange of event building information and specification of metadata that supports event building
- *Some members of the community have already volunteered to assist in these tasks*

Topical Panels

- The FRIB data acquisition working group will oversee the operation of the panels. Panels will:
 - **Determine the needs** of the FRIB research community within the scope of the charge
 - **Research solutions**, either in use by existing experiments, in development or available through industry standards,
 - Represent the needs of FRIB working groups, supporting many users and experiments,
 - **Find consensus** on one or more solutions
- FRIB DAQ working group member acts as chair and point of contact
- Regular (quarterly or monthly) reports to the Working Group as a whole
- To keep the efforts focused and to not overburden the community, we will startup only **one or two panels at a time**. Some will resolve their discussions quickly, others may take a few years of development.

Data Analysis

- **Concerns about data storage and analysis**
 - **Sufficient resources to analyze experimental data** during the measurement to understand the functioning of the experiment online
 - very important for some experiments with
 - High latency event building e.g., Decay Station
 - Complex reconstruction e.g., AT-TPC
 - High priority, high throughput computing is needed for these experiments

Data Analysis

- **Sufficient resources to analyze the merged dataset in the same or less time than was required to make the measurement**
- **Short and long-term storage of data**
 - Experimental event data to be retained for a long enough time on servers at FRIB
 - FRIB datasets will be multi-terabyte in size, driven by flash ADC acquisition and the growing complexity of experiments

Data Analysis

- Access to FRIB data (multi-terabyte)
 - Very high bandwidth connections to the Internet
 - Transfer of data to and from large data centers
 - Home institutions
 - Offsite access
 - Limited network bandwidth to researcher home institutions
 - Processing resources at FRIB will be required to help in data analysis.

To address these topics, we will form a data analysis special interest group

Data Analysis

- Applying “Big Data” methods to nuclear physics data analysis
- Huge amounts of data,
 - GRETA
 - AT-TPC
- Analysis can take a long time with the usual resources available in the community.
- "Workshop on New Methods in Data Analysis"
 - Explore new computing resources and techniques
 - Enabling analyses that look deeper into the data and in shorter processing time

March 2016 DAQ Survey of the Working Groups

1. Does your group intend to request funding for its own data acquisition resources and experts?
 - A. If your answer is no or if you intend to split development between your collaboration and FRIB personnel, can you:
 1. Describe the boundaries of this split
 2. Provide an estimate of effort and cost of the components you expect from FRIB.
 - B. If your answer is yes,
 - A. How do you envision their interaction with the FRIB data acquisition group?
 - B. What do you feel are the boundaries between your experts' work and the work on data acquisition at FRIB?
2. What do you view the role of the FRIB data acquisition system (if any) to be?
3. At what point in time will you be expecting your data acquisition needs to start ramping up?

Survey Summary

- **Merged data streams**, using global time stamping
 - Data from beamline, fragment analysis system
 - Versatility to accept event streams from non-FRIB systems
 - Common event buffer formats?
- **Hundreds to thousands of channels**
- **High data rates**
- **Online analysis a big concern**
 - Flexibility to analyze entire event stream
 - Speed to analyze online
 - Lightweight tools for online analysis
- **Run configuration/state database?** Recorded in event stream
- **Offsite Access to data acquisition and online analysis**

Summary

- Details on the web site, <https://www.phy.ornl.gov/fribdaq>
- **Annual FRIB data acquisition working group Meetings**
 - to discuss progress on current issues
 - to publicize completed work and
 - learn about new issues.
- Start planning **Data Analysis Workshop**
- Panels
 - **Accelerator/Beamline interface and controls**
 - **Time**
- Join
 - the working group
 - a topical panel
- ***Community's input to this is critical.*** Consensus can only happen from community effort
- Email Robert Varner (varnerrl@ornl.gov) to participate

Extra Slides

Survey Responses

- Scintillator Working Group
 - Depending completely on FRIB to instrument the DAQ
 - When beam comes
- Silicon Array Working Group
 - No separate DAQ funding
 - FRIB should provide standardized system for merging data from large instruments (Si array and spectrometer)
 - Light-weight tools for data stream manipulation - online decision making is important
 - When beam comes
- AT-TPC
 - Fully funded data acquisition
 - Need
 - Merge data streams with other systems (time stamping)
 - Online analysis capability for complex data stream
 - Next few years

Survey Response (continued)

- Decay Station
 - Custom system exists
 - Development of custom software (2 FTE) to use FRIB solution
 - Needs
 - timing - clock synchronization and TOD data in data stream
 - Ion beam identification data in event stream
 - FRIB DAQ needs to accommodate Decay DAQ, if not the same, “non-intrusively”
 - Off-site access to the DAQ systems and efficient graphics required
- 2018

Survey Responses (continued)

- Spectrometers - ISLA and HRS
 - DAQ development follows FRIB recommendations
 - Merge Data stream with beamline and fragment analyzer
 - Global Time Stamps
 - Software trigger scheme
 - High rates
 - Run state database system (MIDAS)- records in the event stream
- 2019

Survey Responses

- Gas Jet Working Group
 - No separate DAQ development
 - FRIB DAQ “flexible, portable, robust, simple, and easy-to-use”
 - Mixed Analog and digital data acquisition
 - Merged data streams
 - Online Analysis needs to support 1000’s of channels
 - Common event structure - supported by all kinds of analysis code, online and offline
 - World class development desired
- SECAR
 - FRIB DAQ system, based on Digital data acquisition support at FRIB