LDRD Streaming Readout Testing Plan

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Abstract

Testing plan for the FY24 Jefferson Lab LDRD project on Streaming Data Acquisition.

1 Overview

Development of *The SRO Real-Time Testing and Development Platform* (RTDP) will include multiple testing campaigns requiring collections of resources from the experimental program which include front-end electronics, high speed networks, storage systems, and compute systems. The testing campaigns will be performed in phases and done to minimize interference with existing operations. One major campaign is planned as specified in the proposal as the fifth major objective of the project. The text describing it is copied here for convenience:

> **Objective 5:** High Bandwidth Test: Configuring a full scale system that includes both real and proxy components and testing it at high bandwidth is necessary to demonstrate the platform's core functionality. Current expectations are to have a 400Gbps link available between the Hall A,B,C counting house and the Computer Center in CEBAF Center sometime in FY2024. The high speed testing will be coordinated to occur when the beam is down so that the full bandwidth will be available for the testing periods. The SoLID experiment serves as an example of the type of high bandwidth experiments being anticipated to run at JLab in the future. It will then serve as a useful guide for the testing configuration, even if the configuration is not an exact match for SoLID. There are currently eight U280 FPGA cards in the Computer Center purchased for use with the EJFAT project which would be available to use for these tests. Similarly, the Scientific Computing farm will have a few dozen GPUs (mostly Tesla T4's) available that could also be utilized for these tests. Utilizing real hardware components will be an important part of the platform and so will need to be included for the full scale configuration testing. We will utilize existing components developed outside of this project to exercise the heterogeneous components. For example, PHASM, CLAS12 tracking, and the EIC R&D project: ML4FPGA [1].

There is also some additional text in section 3 of the proposal alluding to testing with direct beam that says:

> ... Moreover, considering the current physics program and the number of scheduled experiments, JLab represents the ideal test bed for the final system in real conditions. It is noted that CLAS12 already has a full set of VTP hardware and upcoming network upgrades will provide for the full infrastructure to stream data. They are also considering a GPU-based tracking system as part of a level-3 trigger design. This could be incorporated as a component of the proposed platform.

2 Collection of Streaming Data from CLAS12

Development of the platform will benefit the most with a complete set of stream data from the full CLAS12 detector. This can be done by simply dumping the outputs of all VTP modules while operating in streaming mode to individual files while beam is on. It will be important for the streams to contain accurate time information for synchronization. It will also be important to capture meta data on the more macro time structure that will allow the streams to be played back with similar "burstiness" as when running in real time.

The best opportunities for collecting full streaming data from the CLAS12 detector will be near configuration changes. Periods near the configuration changes will have some time when the beam is off allowing for setup and DAQ configuration changes. This will include changing the firmware on the VTP modules. Also, beam has historically been more likely to be of lower quality after configuration changes to the accelerator. This tends to make it less valuable to the running experiment and therefore, a good option for this type of beam test.

start date	end date		target
2023-09-15	2023-11-19	Run Group D	-
2023-11-20		pass change Halls B and C	
2023-11-21	2023-12-18	Run Group K	LH_2
2023-12-18	2023-12-21	Beam Off	
2023-12-22	2024-01-01	Winter Break	
2024-01-02	2024-02-07	Beam Off	
2024-01-08	2024-02-11	Restore	
2024-01-12	2024-03-03	Run Group K	LH_2
2024-03-04	2024-03-07	Reconfigure	
2024-03-08	2024-05-20	Run Group E**	Nuclear
2024-04-08		pass change Hall C	
2024-03-08	2024-05-20	Run Group E**	Nuclear
2024-05-20		start of SAD	

Table 1: Hall-B Schedule for FY24[2]. The green lines are planned configuration changes adjacent to beam-on days. The yellow lines are periods when beam will be off. White lines are beam-on production periods. The target information comes from the Hall-B Run Groups page[3].

Table 1 shows the latest schedule for Hall-B running in FY24[4][2]. A good opportunity will be on Nov. 20, 2023 when the conditions are changed from Run Group D to Run Group K accompanied by a corresponding pass change for Hall-B. Up to two hours should be dedicated for the exercise with a goal of capturing at least 10min of beam on data with a typical trip rate during that time.

Additional opportunities should be tentatively scheduled for Dec. 18, 2023 (just before beam goes off for the winter break) and March 4, 2024 (just before the Run Group K run ends). Other opportunities can be found during target filling and emptying exercises when beam may be available, but not as useful to the running experiment. These will need to be coordinated with the Run Group K Run Coordinator(s).

Specific steps in the data capture run plan for this exercise can be seen in table 2

3 High Bandwidth Test

High Bandwidth testing will occur mainly during the FY24 and FY25 (Schedule Accelerator Down) SAD periods. Currently, the FY24 SAD is scheduled to begin May 20, 2024 (see table 1). The FY25 SAD will coincide with the Y2Q3 milestones listed in the proposal. Specifically:

Run Plan for CLAS12 SRO beam-on data Capture	
step	**Task**
1	Ensure adequate disk space for storing stream file on CLON cluster
2	Update VTP firmware with SRO version
3	Load CODA configuration for SRO test
4	Ensure LH_2 target is full
5	Request **10nA** beam
6	Wait for beam to stabilize
7	Start run
8	Capture data for up to 10 minutes ensuring at least 50% of time beam is on and at least 1 beam trip
9	Request **50nA** beam
10	Wait for beam to stabilize
11	Start run
12	Capture data for up to 10 minutes ensuring at least 50% of time beam is on and at least 1 beam trip
13	Request **75nA** beam
14	Wait for beam to stabilize
15	Start run
16	Capture data for up to 10 minutes ensuring at least 50% of time beam is on and at least 1 beam trip
17	Restore VTP firmware
18	Restore CODA configuration

Table 2: Specific steps in the run plan for beam-on data capture of the CLAS12 detector.

Y2Q3
M22: Establish working test of system that transfers >=100Gbps from CH to compute center
M23: Establish working test of system that includes GPU component for portion of stream
M24: Establish working test of system that includes FPGA component for portion of stream
M25: Test system with remote compute facility (e.g. BNL or NERSC) at limits of available resources

Table 3 list specific tasks that would be done during the Y2Q3 High Bandwidth test. As a reminder, the goal of the test is not simply to prove operability at high bandwidth but to show that the platform can be used to test complex, high bandwidth designs containing multiple components which may interact in unforeseen ways once inserted into a larger ecosystem.

High Bandwidth Test	
step	**Task**
0	Reserve *Nnodes* on SciComp farm + 1 SciML node with GPU
0	Prepare EJFAT node(s) and configure to use reserved pool
0	Start idle data movement, calibration, and reconstruction jobs manually on CC nodes
1	Update VTP firmware with SRO version with testing support
2	Stage prepared data files from earlier beam-on capture
3	Activate RTDP monitoring
4	Begin synchronized playback at low rate (5% of estimated maximum)
5	Monitor operation. Identify any bottlenecks
6	Increase stream rate to 10% of estimated maximum and repeat
7	Increase stream rate to 50% of estimated maximum and repeat
8	Increase stream rate to 100% of estimated maximum and repeat
9	Remove limits on stream rate and observe response to backpressure
10	Change configuration to pass Drift Chamber Streams through GPU node
11	Observe performance for minimum of 1hr
12	Change configuration to include FPGA modules
13	Observe performance for minimum of 1hr
14	Run failure mode tests (TDB)
15	Stop streams and RTDP programs.
16	Clear temporary disk space. Release CC resources.
17	Restore VTP firmware

Table 3: Specific steps in the run plan for beam-on data capture of the CLAS12 detector.

Required Resources FY24	
Exclusive use period	14 days
Storage Hall-B CH	?TB
Storage Bandwidth Hall-B CH	?Gbps
Networking	- VTP to switch 10Gbps optical links - 100Gbps switch to CH

Table 4: Specific steps in the run plan for beam-on data capture of the CLAS12 detector.

Required Resources FY25	
Exclusive use period	14 days
Disk Storage Computer Center	?TB
Storage Bandwidth	?Gbps
Networking	- 400Gbps switch to CH - 400Gbps Hall-B CH to CC

Table 5: Specific steps in the run plan for beam-on data capture of the CLAS12 detector.

References

[1] F. Barbosa, L. Belfore, N. Branson, C. Dickover, C. Fanelli, D. Furletov, S. Furletov, L. Jokhovets, D. Lawrence, and D. Romanov. Development of ml fpga filter for particle identification and tracking in real time. *IEEE Transactions on Nuclear Science*, 70(6):960–965, 2023.

[2] Updated Experiment Schedule September 2023 - March 2024 (full memo in progress). https://www.jlab.org/sites/default/files/user-liaison/files/Experiment-Schedule-2023-08-24.pdf.

[3] Hall B – Run Groups. https://userweb.jlab.org/~doug/Schedule/2022/HallB_RunGroup_20222102.pdf.

[4] October 2022 - March 2025 Updated Experiment Schedule and Memo (20230508). https://www.jlab.org/sites/default/files/user-liaison/files/CEBAF-Schedule-Update-5June2023.pdf.