

MEMORANDUM

Date: 12 October 2023
To: Jefferson Lab Community
From: Douglas Higinbotham and Eduard Pozdeyev
for the Nuclear Physics Experiment Scheduling (NPES) Committee
Subject: Updated Accelerator Schedule

Schedule:

Jefferson Lab undertook the proactive step of performing a number of safety pauses to ensure the safety of our staff and users. As these pauses took place during the Scheduled Accelerator Down (SAD), an additional two month of time was required to finish the planned work; but the lab has now both officially completed the SAD while also strongly reinforcing our safety culture.

Attached is the updated accelerator operations schedule. It has also been posted at http://www.jlab.org/div_dept/physics_division/experiments/schedule.html. Access to the database format of the same schedule, as used by the beam accounting system, can be found at <https://cebaf.jlab.org/btm/schedule>.

The operations schedule is based on an anticipated funding profile, and may be subject to change due to this or other major forces (e.g. such were caused by the COVID-19 virus).

For the upcoming fiscal years, the lab has scheduled 33 weeks of operations with two of those weeks dedicated to accelerator restoration and the rest for physics experiments. During the 2023 SAD, there was the successful installation of two refurbished C100 cryomodules, one in the north linac and one in the south linac, along with plasma processing of several modules during the 2023. Though the current run is just starting, there has already been a very notable reduction in the RF trip rate though the gradient of the machine is the same as last year.

A summary of the 2023 SAD and upcoming experiments:

During the 2023 scheduled accelerator down, the Hall A crane was successfully repaired. Hall A will now continue running the SBS high- Q^2 form factor program, starting with finishing the polarized ^3He target measurements of the neutron form factor at high four-momentum transfer (E12-09-016). Once this experiment is done, Hall A will then return to cryo-targets first using a deuterium target, an alternative measurement of the neutron form factor using recoil polarization transfer (E12-17-004) followed by an experiment to measure polarization transfer in wide-angle charged pion photoproduction (E12-20-005). Finally, the high impact experiment (E12-07-109) to measure the proton electric form factor at high Q^2 is planned to start in late 2024. In early 2025, the SBS form factor program is planned to come to an end with Hall A ready to begin the installation of the Moller experiment.

Hall B will be running a number of solid and cryo-target experiments to understand color transparency and hadronization (Run Groups D & E) as well as continuing a series of experiments to further our understanding of confinement and QCD (Run Group K). After the 2024 SAD, Hall B plans to run the ALERT experiments and then complete the Run Group K run. A detailed listing of the experiments within each of the Hall B run groups can be found at: https://userweb.jlab.org/~doug/Schedule/2022/HallB_RunGroup_2022102.pdf.

Hall C installed the Neutral Particle Spectrometer (NPS) during the 2023 SAD. The NPS experiments have formed into an run group of DVCS (E12-13-010 and E12-13-007) and the recently approved E12-22-006 and E12-23-014. During the 2024 SAD, Hall C will switch from the NPS to the Large Acceptance Device (LAD) to measure short-range correlations (E12-11-107) followed by E12-12-104 which will measure σ_L/σ_T in SIDIS and E12-06-107 which will measure pion color transparency in nuclei.

Hall D has begun a major upgrade in preparation for the next generation of GlueX experiments and the run group JLab Eta Factory (JEF) experiments: experiments: E12-12-002 and E12-12-002A.

The table at the end of this document provides day-by-day details about the run conditions. A simplified version of the schedule is visualized in Figure 1. A full list of all 12 GeV experiments can be found at: <https://www.jlab.org/physics/experiments>.

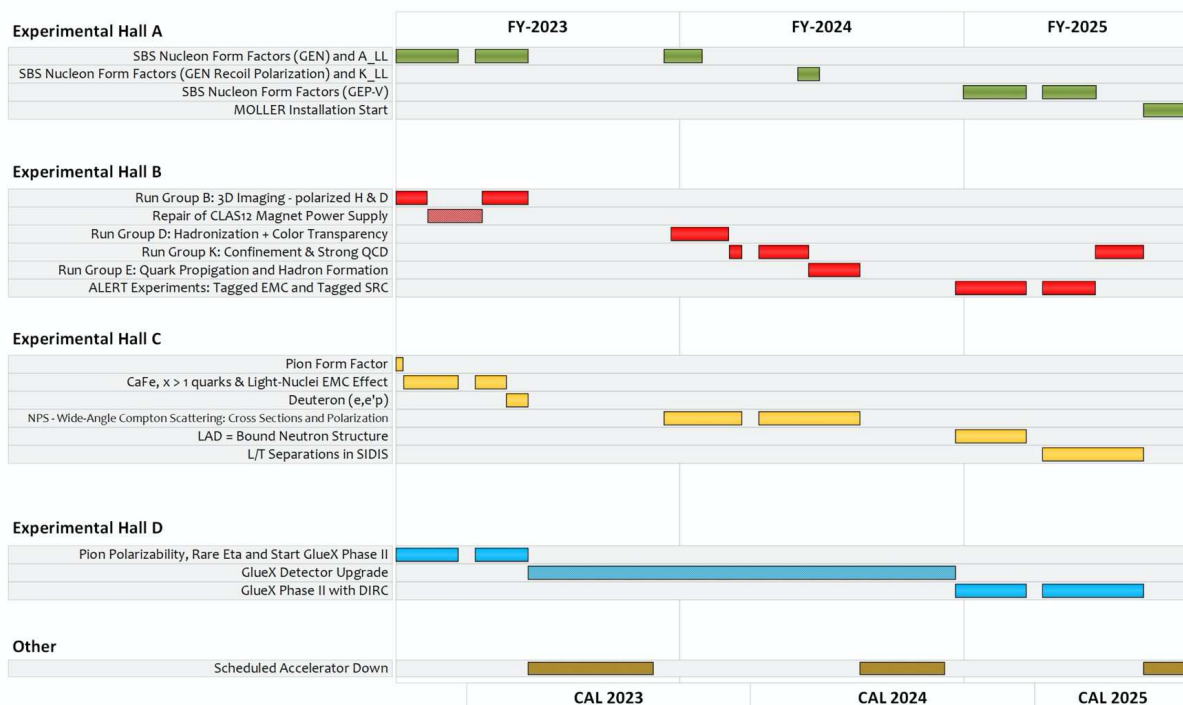


Figure 1 - Experiment schedule Gantt chart. Experiments that have completed their ERR and are scheduled for the upcoming year are considered firm while all other experiments shown which have not completed their ERR should only be considered as tentative.

On the schedule, each Program Advisory Committee (PAC) approved day is mapped onto two calendar run days. This factor of two accounts for projected accelerator and Hall inefficiencies due to system failures - not experiment overhead. It also accounts for 12 hours of beam-off time for maintenance and up to 12 hours a week for scheduled beam studies. An additional 8 hours a week is allocated for beam tuning to support program changes or to address beam quality issues. The remaining 136 hours a week, 87 % of beam-on time, is scheduled for physics.

The Jefferson Lab Nuclear Physics Experiment Scheduling Committee developed the schedule. Committee members are: Patrick Achenbach, Eugene Chudakov, Douglas Higinbotham (Co-Chair), Eduard Pozdeyev (Co-Chair), Joe Grames, Mark Jones, Cynthia Keppel, David Dean, Patrizia Rossi and, Mike Spata with valuable input provided from both accelerator and physics division support groups as well as facilities and engineering teams with special thanks to Jay Benesch for his invaluable input. After final review by the NPES committee, the schedule goes to the JLab Director Stuart Henderson for final approval.

Scheduling Information

Reminders

- On the schedule, daily status changes take place at the end of the owl shift (~ 7 AM) unless otherwise indicated.
- Operating one or more of Halls A, B and C at five passes together with Hall D at 5.5 passes requires a polarized gun laser frequency of 249.5 MHz. A laser frequency of 499 MHz can be used otherwise. For the same average beam current, the charge per micro-bunch when operating the laser at 249.5 MHz will be twice that of 499 MHz. For each hall, the energy, current, polarization column now also includes the laser frequency.

Constraints and Special Experiment Requirements

Each experimental hall has an Accelerator-Physicist Experimental Liaison (APEL) that serves to aid the Nuclear Physicists in beam related issues during all phases of an experiment: proposals, commissioning, operating and analysis. The APELs, with input from the Halls, injector, and diagnostics staff have developed a beam parameter table for the 12 GeV era ([JLAB-TN-18-022](#)). Experiments requiring more stringent beam parameters should consult the APEL of the Hall in question: Yves Roblin (Hall A), Mike Tiefenback (Hall B), Jay Benesch (Hall C) and Edith Nissen (Hall D). Some of the key machine constraints are as follows:

- Total power limited to 1.1 MW with the Hall A and C dumps limited to 0.9 MW
- 4-hall operations require at least one of the original Halls (ABC) to receive 5th pass beam.
 - It is strongly preferred that the original Halls be A or C. Coupling B-D, while possible, places additional constraint on B & D currents.
 - Any of the original Halls receiving 5th pass beam concurrently with Hall-D will receive beam with a 249.5 MHz repetition rate.
 - 499 MHz repetition rate is available when a Hall is receiving pass 1-4 beam.

- Hall-D must be at 249.5 MHz repetition rate whenever an original hall is simultaneously receiving 5th pass beam.
- Hall-D can only receive 499 MHz beam when only two of the original Halls are receiving beam on the lower passes (1-4). In this case, only three Halls are in operation.

Daily Accelerator Schedule

The operation of more than one Hall at Jefferson Lab substantially complicates the interaction between the experiment and accelerator operations groups. It is in the interests of the entire physics community that the laboratory be as productive as possible. Good communication between the halls and accelerator is absolutely essential. Thus, the Run Coordinators for all experiments either receiving beam or scheduled to receive beam in the coming days should meet with the Program Deputy, either in person or via zoom, at 7:45am in the MCC on weekdays and at the Program Deputy's discretion on weekends: typically, around 9:00am via zoom.

While zoom is very convenient and can often be used quite effectively, Run Coordinators are strongly encouraged to attend the weekday 7:45am and 8am meetings in person. When an experimental hall is having beam issues or making special requests, Run Coordinators are required to attend morning meetings in person. This helps not only with communicating the needs of the experiment but also allows for in-depth, multi-person conversations that are not easily done remotely.

Run Coordinators for all operating halls should do their best to respond flexibly to the needs of the experiments running in other halls and it is best when the Run Coordinators coordinate actions (such as a half-wave plate change) along themselves; though even these coordinated actions should be discussed at the daily meetings to ensure everyone is aware of upcoming changes. Also, Halls should minimize non-emergency requests for beam delivery modifications during accelerator shift changes, nominally 7:30-8:30am, 3:30-4:30pm, and 11:30pm-12:30am.

Best effort will be made to deliver the beam conditions identified in the schedule, but when those parameters cannot be achieved or when Run Coordinators cannot agree on parameters effecting multiple halls, the Director of Physics Operations (Douglas Higinbotham) in close collaboration with the Director of Accelerator Operations (Eduard Pozdeyev) will communicate the best course of action to the Program Deputy.

To provide some guidance to operations and to add some order to the process of resolving short-term difficulties running multiple Halls, we have assigned a priority Hall for each day beam delivery has been scheduled. This should simply be thought of as a *primus inter pares*, Latin for "first among equals". As always, accelerator division will do their best to deliver the required beam to all halls; but when that is not possible and assuming no special guidance from the Program Deputy has been given, operations will use the priority hall designation to determine which hall takes precedence in delivering the beam.

Initial Tune-up of New Beams:

Normally 1.5 shifts (12 hours) is set aside for tune-up whenever a new beam setup has been requested. For unusual beam setups more time may be scheduled explicitly for tuning at the discretion of the scheduling committee. It is understood that beam tune-ups shall *always* be done in the order that the accelerator operations group believes will minimize the *total* time needed to tune *all* scheduled beams (i.e., the "priority Hall" beam is not necessarily tuned first).

Maintenance/Beam Studies.

As noted earlier, Accelerator Division may request up to twenty-four hours per week for maintenance and beam studies, including recovery: 12h beam studies + 12h general and SRF maintenance. This total time should include any restoration time needed to return to nominal operations. The Run Coordinators will be consulted in deciding how this time is scheduled, e.g. several shorter or a few longer blocks of time. During the upcoming run period, accelerator may switch to a bi-weekly maintenance/beam studies period making use of larger single blocks of time but still averaging twenty-four hours per week.

Accomplishments and Outlook

Jefferson Lab completed its scheduled 2022/23 run period at 7 a.m. on March 20. This marked the end of a 33-week run period, with two weeks dedicated to the tuning of the machine and 31 weeks for physics. CEBAF successfully maintained a gradient of 1047 MeV/linac. Including the injector energy, this meant that the classic Experimental Halls A, B and C received electron beams at energies of up to 10.54 GeV, while the new Experimental Hall D, which gets an extra pass through one linac, received 11.6 GeV electrons for the entire run period. As is typical for the Jefferson Lab CEBAF accelerator, the electron beam was sent to all four halls simultaneously, with the different halls getting different currents, up to 70 uA, and with up to 85% longitudinal polarization.

Experimental Hall A's Super BigBite program, presently focused on making high precision, high four-momentum transfer measurements of the nucleon form factors, transitioned from measuring the magnetic form factor of the neutron to measuring the electric form factor of the neutron. This latter measurement makes use of optically-pumped polarized ^3He targets, which achieved up to 55% polarization using delicate glass target cells operating at 10 atm.

Experimental Hall B began the run group C experiments. This run group is made up of seven approved experiments using a vector polarized proton and deuteron ammonia target to make measurements of the spin structure of protons and neutrons and various meson production channels via deep inelastic scattering and deeply virtual Compton scattering. Unfortunately, there was a problem with the power supply for the CLAS12 magnet during this run period. Thanks to the support of Danfysik, a problem with the power supply firmware was found, the supply was fixed, and the experiment continued. Due to Jefferson Lab Target Group's novel method for changing the polarized target material, a rather significant amount of beamtime was saved.

Experimental Hall C saw a number of experiments completed. First, the pion longitudinal-transverse separation experiment took its final data. This high-impact experiment required many different beam energies and took several years to complete. After this experiment was complete, solid target ladders were installed for the next experiment. This one measured more than 20 different solids to further our understanding of the possible connection between the EMC effect and short-range correlations with both inclusive scattering and a proton knock-out reaction. Finally, Hall C took measurements on deuterons in extreme quasi-elastic kinematics to further our understanding of the nucleon-nucleon potential.

Experimental Hall D completed its measurements of the charged and neutral pion polarizabilities and its precision measurement of the eta radiative decay width via the Primakoff effect. After completion of these experiments, the hall was reconfigured, and the first part of the GlueX-II run was started.

The CEBAF accelerator has been upgraded with two refurbished C100 accelerating modules. This further improves the reliability of the machine as work continues to get the CEBAF accelerator up to its full 12 GeV operational limit. The 2023/24 run period will see Hall A continue its high Q² form factor program; Hall B will continue its 3D imaging of the proton and deuteron; and Hall C will start the NPS, neutral particle spectrometer, experiments. Experimental Hall D has started a year-long shutdown to upgrade its calorimeter in preparation for the final part of the GlueX-II experiment.

