

MEMORANDUM

Date: Updated 24 July 2022, Original 10 June 2022
To: Distribution
From: Camille Ginsburg and Douglas Higinbotham
for the Nuclear Physics Experiment Scheduling Committee
Subject: Accelerator Schedule through March 2024

Update

The schedule for the experimental halls has been updated to reflect a slower than expected startup. As of the writing of this memo, the experiments in Halls B & D are now fully underway and Hall C is receiving 65 uA out of an expected 80 uA with efforts underway to achieve full current. Independently, the polarized ^3He cell production for Hall A has also been slow to ramp up, which has shifted the expected start date to late September.

Schedule

Attached is the accelerator operations schedule through March 2024. 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 such as could be caused by the COVID-19 virus or major technical concerns.

For fiscal years 2022 and 2023, we are scheduling 33 weeks of operations with two of those weeks dedicated to accelerator restoration. Installation of several new cryomodules to increase the energy reach of CEBAF will take place during the Scheduled Accelerator Down (SAD) downs, along with Hall equipment installations and site maintenance activities.

A summary of the upcoming experiments are as follows:

Hall A will continue running the SBS program of experiments, starting with a polarized ^3He target from September 2022 through March 2023 to make measurements of the neutron form factor at high four-momentum transfer (E12-09-016). Hall A will then return to cryo-targets in July 2023. Using a deuterium target, an alternative measurement of the neutron form factor using recoil polarization transfer (E12-17-004) will be performed, followed by an experiment to measure polarization transfer in wide-angle charged pion photoproduction (E12-20-005). Finally, a high impact experiment (E12-07-109) to measure the proton electric form factor is

tentatively scheduled for October 2023 thru March 2024. As noted by a ** on the table, several of the Hall A experiments still require completion of their Experimental Readiness Review (ERR) which must be completed prior to a run certificate being issued.

Hall B will perform measurements using a longitudinally polarized target to study the 3D structure of the nucleon (Run Group C) and then proceed to a number of solid and cryotarget experiments to understand color transparency and hadronization (Run Groups D & E), continuing to a series of experiments to further our understanding of confinement and QCD (Run Group K). In this run period, RG-C and RG-D will complete the running of their approved beamtime. A detailed listing of the experiments within each of these run groups can be found at: https://userweb.jlab.org/~doug/Schedule/2022/HallB_RunGroup_2022102.pdf.

Hall C is finishing the high epsilon part of the high impact pion form-factor and longitudinal-transverse separated pion electroproduction cross section experiments (E12-19-006). Then Hall C will perform measurements of short-range pairing mechanisms (E12-17-005), nuclear dependence of F_2 (E12-10-008), and a high impact measurement of inclusive scattering from nuclei at $x > 1$ (E12-06-105). And finally, the completion of the deuteron electro-disintegration experiment (E12-10-003), an experiment partially run to commission the Hall, will follow. During the next SAD, Hall C will install the Neutral Particle Spectrometer (NPS). The first NPS run group will be the DVCS (E12-13-010 and E12-06-114) and the π^0 SIDIS (E12-13-007) experiments. This will be followed by the second run group which will use a radiator before the target to measure wide angle Compton cross sections (E12-14-003) and wide angle exclusive π^0 photoproduction (E12-14-005).

Hall D plans to measure the charged and neutral pion polarizability (E12-13-008), followed by the final set of measurements of the η radiative decay width via the Primakoff effect (E12-10-011). Next is the GlueX study of the decays of mesons and baryons to final states containing strange quarks (E12-12-002) using the newly added DIRC (Detection of Internally Reflected Cherenkov) particle detector. After this running is complete, Hall D will begin a major upgrade in preparation for the next generation of GlueX experiments.

Figure 1 graphically summarizes the experiment schedule. The tables further below list those experiments that have been run to completion, partially run, and those scheduled for this run period.

A full list of all 12 GeV experiments can be found at: <https://www.jlab.org/physics/experiments>.

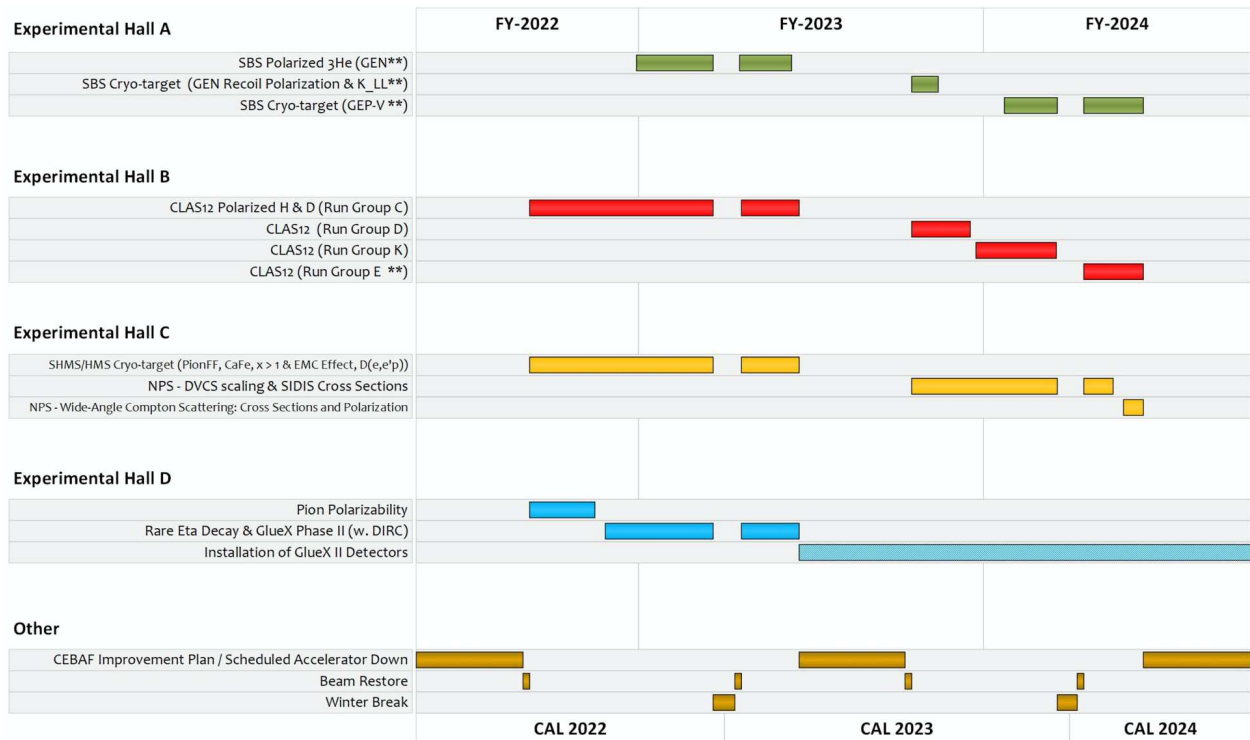


Figure 1 – Experiment schedule Gantt chart. Experiments that have completed their ERR and are scheduled for the upcoming year are considered firm while all others experiments shown should be considered as tentative.

On the schedule, each Physics Advisory Committee (PAC) approved day is mapped into 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 4 hours of beam-off time for maintenance, 8 hours of beam-off time for SRF maintenance, and up to 12 hours a week of scheduled beam studies and RF recovery. An additional 8 hours a week is allocated for beam tuning to support program changes or to address beam quality issues and to restore beam operations for physics post beam studies/maintenance periods. The remaining 136 hours a week, 87 % of beam-on time, is scheduled as research.

The Jefferson Lab Nuclear Physics Experiment Scheduling Committee developed the schedule. Committee members are: Stepan Stepanyan, Eugene Chudakov, Douglas Higinbotham (Co-Chair), Camille Ginsburg (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. The schedule has been reviewed and approved by the Director.

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 for those halls. 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.

The Meaning of Priority on the Accelerator Schedule

Generally, the assignment of priority to a Hall means that the identified Hall will have the primary voice in decisions on beam quality and/or changes in operating conditions. Best effort will be made to deliver the beam conditions identified in the schedule for the priority Hall. It will not, however, mean that the priority hall can demand changes in beam energy, polarization, current, or other that would affect the planned running in the other halls without the consent of the other Halls. Final authority for decisions about unplanned changes in Hall configuration or machine operation will rest with the laboratory management.

The operation of more than one Hall at Jefferson Lab substantively 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. Therefore, we require that the Run Coordinators for all operating halls do their best to respond flexibly to the needs of experiments running in other halls. The Run Coordinators for all experiments either receiving beam or scheduled to receive beam that day should meet with the Program Deputy at 7:45 AM in the MCC on weekdays and at the Program Deputy's discretion on weekends.

To provide some guidance and order to the process of resolving the differing requirements of the running Halls, we have assigned a "priority Hall" for each day beam delivery has been scheduled. We outline here the meaning of priority and its effect on accelerator operations.

The priority hall has the right to:

- require a relatively minor re-tune of the accelerator to take place immediately when beam quality is not acceptable
- insist that energy changes occur as scheduled
- obtain Hall access as desired
- request that beam delivery interruptions for experiment-related operations which temporarily block normal beam delivery to other Halls take place as requested. Mott measurements of the beam polarization or pulsed operation for current monitor calibrations represent examples of such interruptions. Interruptions of this type require, at a minimum, 24 hours advance notification and coordination with the Program Deputy and the other Halls.

These interruptions shall be limited by a sum rule - the total time lost to the non-priority hall(s) due to such requests shall not exceed 2.5 hours in any 24-hour period. It is highly preferred and expected that these measurements be scheduled at the morning meeting of the Run Coordinators whenever possible, and coordinated between Halls whenever possible.

If the priority Hall requests a re-tune that degrades a previously acceptable beam for one of the other, lower priority, running halls, then the re-tune shall continue until the beam is acceptable to both the priority Hall and the other running Halls that had acceptable beam at the time the re-tune began.

Non-priority halls can:

- require that a retune of the accelerator take place within 2.5 hours of the desired time (it will nominally occur at the earliest convenient break in the priority hall's schedule)
- require access to the Hall within 1 hour of the desired time (again, it will nominally occur at the earliest convenient break in the priority Hall's schedule)
- request that beam delivery interruptions for experiment-related operations which temporarily block normal beam delivery to all other halls occur within 2.5 hours of the desired time. Interruptions of this type require, at a minimum, 24 hours advance notification and coordination with the Program Deputy and the other Halls.

The ability of non-priority halls to request retunes and accesses shall be limited by a sum rule - the total time lost to the priority hall due to such requests shall not exceed 2.5 hours in any 24-hour period. To facilitate more extended tuning associated with complex beam delivery, with the agreement of the run coordinators for all operating halls, the sum rule may be applied over a period as long as three days, so long as the average impact is less than 2.5 hours/day. In the event that two non-priority Halls are running, the 2.5 hours shall be split evenly between them in the absence of mutual agreement on a different split.

All Halls:

- can negotiate with other Halls, and with Physics Division for changes in scheduled energy, polarization current or other changes.

Halls should minimize non-emergency requests for beam delivery modifications during accelerator shift changes, nominally 7:30-8:30 am, 3:30-4:30pm, and 11:30pm-12:30am.

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). In the event that obtaining the new beam setup requires more than the scheduled time, the Accelerator Program Deputy is authorized to spend up to one additional shift of tuning in an effort to deliver all scheduled beams instead of just the "priority Hall" beam.

Maintenance/Beam Studies. As noted on page 3, Accelerator Division may request up to twenty-four hours per week for maintenance and beam studies, including recovery: 12h beam studies + 4h general maintenance + 8h SRF maintenance. Users 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 block of time but still averaging twenty-four hours per week.

Constraints and Special Experiment Requirements

Each end-station 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 Edy Nissan (Hall D). What is not in this document is that there are additional constraints that need to be applied during the scheduling process. Most of these constraints derive from the 4-hall system and are as follows:

- 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.

Accomplishments

Accelerator

The 2022 SAD included work on both the North and South Linacs. Two modules have been swapped in the North Linac and one in the South Linac in support of the 1047 MeV/linac desired to support polarization in Hall B at fifth pass and Hall A on second, third and fourth passes in parallel. This energy will also allow Hall C to have nearly full polarization for the July 2023 through March 2024 running.

Looking to the future, between two and four more modules will be refurbished during each SAD through 2026, funding permitting, as part of the CEBAF Performance Plan (CPP), with the goal of achieving adequate headroom to keep fault rate low or deal with a cryomodule failure while operating at the design energy of 1090 MeV/linac. After achievement of the CPP scope, periodic cryomodule refurbishments are anticipated as part of regular CEBAF maintenance.

Additional major 2022 SAD work to address machine reliability included a replacement of the carbon purification bed for CHL1, testing electrical breakers and repair of those which were faulty, refurbishment of 6 girders between cryomodules, and replacement of 14 Viton-seal vacuum valves.

Work has also begun to increase the current capability of CEBAF to allow for higher total power beam delivery to the halls. Work is underway to update the FSAD document to allow up to 1.1 MW total beam power. This increase is not expected to require additional hardware, though confirmation is required that the high-power dumps' cooling water temperature stays within nominal limits. The dumps will still limit the beam power to 900 kW per hall for Halls A and C.

Hall A

The Super Big-bite Spectrometer (SBS) program has begun, with an initial completion of the first of its proposed series of form factor measurements to unprecedented high precision and momentum transfer. The first of these, a measurement of the magnetic form factor of the neutron (E12-09-019), was completed along with a later-proposed measurement of the two-photon exchange contribution to the electron-neutron elastic scattering cross section (E12-20-010).

Hall B

In Fall 2021, RG-I (HPS) accumulated 168 pb-1 of data in its second physics run using 27 PAC days of their beamtime. HPS collected data with an electron beam of 3.7 GeV energy impinging on a 20 mm W-target. The HPS, followed by RG-M with two experiments - the study of SRC in the electron scattering reactions with 2- and 3-body final states and electrons for neutrinos measurement to test vector-current part of neutrino event generators. RG-M run from November 10, 2021, to February 8, 2022, and collected data at three beam energies, 2 GeV, 4 GeV, and 6 GeV, using various nuclear targets ranging from LD2 to Sn, including doubly magic isotopes ^{40}Ca and ^{48}Ca .

Hall C

Hall C completed the low epsilon (relative virtual photon polarization) part of the longitudinal-transverse separations necessary to the high impact pion form factor [two run numbers/experiments?] and pion production experiments (E12-19-006). These require high precision measurements over a range in epsilon. The rest of this experiment will be completed to fill out the range in epsilon at the rest of the upcoming run period - along with a series of nuclear target experiments to understand short-range correlations and the EMC effect.

Hall D

In Nov 2021 Hall D finished the second run of PrimeX-eta (E12-10-011) for 50 calendar days at 10.1 GeV beam energy. The experiment will measure the two-photon coupling of the eta meson. The 1-st PrimeX-eta run in 2019 took place with the solenoid turned off in order not to compromise the azimuthal correlation of Compton pairs. The drift chambers were also off since they can operate at low luminosity only with no magnetic field. The solenoid and DCs were turned on in the 2021 run for a short period. It occurs that the background for the 2-photon decay was much reduced, while the Compton pairs were still reliably reconstructed. It would also allow to use the charged $3\text{-}\pi$ decay of η . Using the field is considered for the 2022 run of PrimeX-eta. After PrimeX-eta Hall D ran a new experiment SRC-CT (E12-19-003) for 43 calendar days to completion. The experiment ran at 10.9 GeV electron beam energy and used LHe, LD and carbon targets. It was the first experience in Hall D with LD and carbon targets. It was found that the neutron background downstream of the solenoid, divided by the target thickness in g/cm^2 was about the same for all the targets including LH. The events of interest in the production of ρ were properly reconstructed.

In 2022 Hall D will run a new experiment CPP/NPP (E12-13-008) to measure charged and neutral pion polarizability. This experiment will run mostly at a low beam current $<30\text{nA}$. It will be followed by PrimeX-eta (E12-10-011) to completion, and then by GlueX-II (E12-12-002).

Status of 12 GeV Experiments

Table 1 - Completed Experiments

Experiment	Hall	Contact	Beam Req. Submitted
Run Group F	B	S. Kuhn	28-July-2017
E12-06-102	D	C. Meyer	1-Aug-2014
E12-06-110	C	X. Zheng	30-May-2018
E12-06-121	C	B. Sawatzky	30-May-2018
E12-07-108	A	B. Wojtsekhowski	20-Aug-2014
E12-09-002	C	K. Hafidi	2-July-2015
E12-09-017	C	R. Ent	2-July-2015
E12-09-019	A	B. Wojtsekhowski	31-July-2017
E12-10-002	C	S. Malace	21-Aug-2014
E12-10-103	A	G. Petratos	1-Sept-2014
E12-11-101	A	K. Paschke	28-July-2017
E12-11-106	B	A. Gasparian	22-June-2015
E12-12-004	A	K. Paschke	28-July-2017
E12-14-011	A	L. Weinstein	24-June-2015
E12-14-012	A	C. Mariani	26-June-2015
E12-15-001	C	N. Sparveris	19-July-2017
E12-17-003	A	L. Tang	27-July-2017
E12-19-003	D	O. Hen	9-Sep-2020

Table 2 - Partially Completed Experiments

Experiment	Hall	Contact	Beam Req. Submitted
Run Group A	B	F. Sabatié	1-Jul-2015
Run Group B	B	K. Hafidi	31-Jul-2016
Run Group I	B	J. Jaros	27-Jul-2017
Run Group K	B	A. D'Angelo	13-Jul-2017
Run Group M	B	O. Hen & L. Weinstein	14-Aug-2019
E12-06-101	C	G. Huber	1-Aug-2016
E12-06-107	C	D. Dutta	6-Aug-2014
E12-06-114	A	C. Hyde	6-Aug-2014
E12-07-105	C	T. Horn	1-Aug-2016
E12-09-011	C	T. Horn	2-July-2015
E12-10-003	C	W. Boeglin	6-Aug-2014
E12-10-008	C	D. Gaskell	6-Aug-2014

E12-10-009	A	B. Wojtsekhowski	27-Jul-2016
E12-10-011	D	A. Gasparian	1-Aug-2017
E12-11-008	LERF	P. Fisher	6-Jul-2015
E12-11-112	A	D. Higinbotham	30-Jul-2014
E12-12-002	D	M. Shepherd	23-May-2019
E12-14-009	A	D. Higinbotham	29-Jun-2015
E12-16-007	C	Z.E. Meziani	27-Jul-2017
E12-19-006	C	T. Horn & G. Huber	1-Aug-2016

Table 3 - Scheduled Experiments

1 = TBD, passed ERR

2 = Pending ERR completion

Experiment	Hall	Contact	Beam Req. Submitted
Run Group C	B	S. Kuhn	8-Aug-2019
Run Group D	B	L. El Fassi	29-July-2017
Run Group E	B	W. Brooks	28-July-2017
Run Group K	B	A. D'Angelo	14-Feb-2022
E12-06-105	C	J. Arrington	28-July-2017
E12-06-114	C	C. Hyde	*1*
E12-07-109	A	B. Wojtsekhowski	*2*
E12-10-003	C	W. Boeglin	6-Aug-2014
E12-10-008	C	D. Gaskell	6-Aug-2014
E12-10-011	D	A. Gasparian	1-Aug-2017
E12-12-002	D	M. Shepherd	23-May-2019
E12-13-008	D	R. Miskimen	14-Jun-2021
E12-13-007	C	R. Ent	16-Aug-2019
E12-13-010	C	C. Muñoz Camacho	16-Aug-2019
E12-14-003	C	B. Wojtsekhowski	11-April-2022
E12-14-005	C	D. Dutta	*1*
E12-19-006	C	T. Horn & G. Huber	1-Aug-2016
E12-09-016	A	B. Wojtsekhowski	*2*
E12-17-004	A	B. Sawatzky	10-Nov-2020
E12-17-005	C	O. Hen	31-Jul-2017
E12-20-008	A	A. Puckett	14-Dec-2020
E12-21-005	A	B. Wojtsekhowski	*2*

