

MEMORANDUM

Date: May 2, 2016
To: Distribution
From: Rolf Ent and Arne Freyberger for the Nuclear Physics Experiment
Scheduling Committee
Subject: Accelerator Schedule through December 2017

Schedule

Attached is the accelerator operations schedule through December 2017. It has also been posted at http://www.jlab.org/div_dept/physics_division/experiments/schedule.html. The operations schedule is based on expected fiscal 2017 and 2018 funding and, consequently, subject to adjustments due to actual funding. This schedule has the PRad experiment running in Hall B in synchrony with the Torus magnet cool down during the May-June 2016 period. FY2017 begins with experiments in Halls A and D. By the second quarter of FY2017, Hall C is proceeding through various beam line and detector checkouts and first set of commissioning experiments to establish its Key Performance Parameters (KPP), as required by the 12 GeV project. The later half of FY2017 has two halls running physics experiments (A and C) while Hall B proceeds through beam line commissioning, CLAS12 detector checkout to establish its KPP, followed by an engineering run and its first set of commissioning experiments. The schedule represents a very ambitious program, which makes use of many of the new Accelerator capabilities. For that reason, it was deemed prudent to take a couple of decisions directed to enhance the multi-hall operations reliability of the machine and the likelihood of successfully completing the experiments scheduled for this period – lower the energy per pass and constraint beam operations to a maximum of three halls simultaneously. The three-hall constraint, the logistics imposed by a ^3H target in Hall A and the high priority to commission and operate Halls B and C led to break experiment E12-06-102 in Hall D into two pieces. One piece of the experiment appears in this schedule while the remaining hours allocated by the Physics Advisory Committee (PAC) will be scheduled in the future. Scheduling has been done at the rate two experiment floor days per one PAC day to account for the combined efficiency of hall and accelerator operation. The schedule has been reviewed and approved by the Director.

The Jefferson Lab Nuclear Physics Experiment Scheduling Committee developed the schedule. Committee members are: Volker Burkert, Eugene Chudakov, Rolf Ent (Co-Chair), Arne Freyberger (Co-Chair), Javier Gomez, Cynthia Keppel, Robert McKeown, Fulvia Pilat, Matt Poelker, Patrizia Rossi and Mike Spata.

Supplementary Information

Accelerator

The 12 GeV project demonstration of an energy gain of 2.2 GeV/pass in Feb. 2014 provided evidence that the CEBAF linacs were not quite capable of delivering 12 GeV beam with a high reliability. During Summer 2015, the SRF and OPS staff Helium processed every CEBAF cavity in order to recover any lost gradient due to field emitter sites on the cavity surface. The reduction or elimination of field emitters mainly benefits the 29 original C20 cryomodules in CEBAF as field emission in these modules results in a cavity trip.

With the Helium processing complete, along with the repair of the SC1 2K cold-box CEBAF was ready to attempt 5.5 pass beam setup at the design energy, 2.2 GeV/pass, 12 GeV to Hall-D in Fall 2015. The Fall 2015 run was a short, 5 week run, to establish a design energy setup and measure the beam parameters at 12 GeV. The 5 week program included systematic centering of the beam trajectory through each quadrupole magnet and matching the beam parameters at the start of each arc (11 locations including the Injector-North linac match). Additional measurements included the beam bunch length and energy spread. The end result of this effort was the first 12 GeV beam delivered to the Hall-D tagger. The measurements of beam parameters agreed well with expectations and are within the Physics specifications for the initial and out-year program. The accelerator design is sound and the effects of synchrotron radiation in the upper arcs is as expected.

In addition to establishing 12 GeV beam to the Hall-D tagger, 11 GeV beam was extracted to the Hall-A dump. Up to 70 micro-Amperes of CW current was delivered to the Hall-A dump, with no ill effects due to beam loading at design energy. 5-th pass RF separation was also established at the design energy. The 5-th pass RF separators are new 750 MHz separation cavities that provide the additional capability of Hall-D plus A, B & C to share 5-pass beam (so-called D+3 capability). These new separators did not quite deliver the design kick, but with an optics modification 11 GeV beams were separated sufficiently enough to allow Hall-A and Hall-D to receive CW beam simultaneously on 5-th pass for a few days at the end of the run.

After a short Winter break, beam operations resumed at the end of January 2016. The configuration remained identical to the Fall 2015 setup, 2.2 GeV/pass. Halls A, B and D received beam during this period. In the first week of March, contamination of the CHL1 heat exchanger was identified and required the suspension of beam operations to resolve. Beam operations resumed in the last week of March. Unfortunately the first week of beam delivery post cryo maintenance was problematic. The optics configuration had drifted and the beam was no longer on-design. This resulted in large beam loss at the 5-th pass separation.

In order to correct the beam transport, the physics program was halted as a complete Injector to Hall-D setup was executed. This time the matching process took about 3-days

and represents the time it presently takes for a complete machine setup. After this setup, the beam size as measured at the 5-th pass extraction point was about a factor of two smaller and 5-th pass extraction was now loss-less. The 5-th pass separation remains a bit below specification and there is no margin in the system, however with perfect beam optics 5-th pass beam can be cleanly separated and supported.

The remaining weeks of the run went very smoothly. Beam operations required only the nominal orbit steering, gradient management and end-line focus adjustments. The run ended on Monday morning April 25th.

The Summer 2016 plans include beam operations in a low power consumption configuration to support PRad experiment in Hall-B, cryogenic maintenance, installation of C50-12, improvements to the 5th-pass RF separation system, new digital laser controls, the addition of a fourth laser and more. Additionally Operations will be supporting the DarkLight run in the LERF.

Due to the low CEBAF reliability during Spring 2016 operations, the energy for Fall 2016 and Spring 2017 will be reduced to 1050 MeV/linac. This lower linac energy will provide more gradient margin and allow the lowering of gradient on problematic cavities. This lower energy and efforts on all systems to improve reliability are in support of increasing CEBAF reliability for the future Physics programs.

Hall A

Since last fall, Hall A has continued with the E12-06-114, "Measurements of the Electron-helicity Dependent Cross sections of the DVCS with CEBAF at 12 GeV" (DVCS), and E12-07-108, "Precision Measurement of the Proton Elastic Cross-Section at High Q^2 " (GMp). Though still far from smooth running, beam quality has steadily improved and DVCS was able to run with 15 uA beam at 2.2, 4.4, 8.8, and 11 GeV. At the end of the spring run, GMp was able to test 40-60 uA of 8.8 GeV beam and complete a 11 and 12 GeV² Q^2 point. During the run period both Moller and Compton were used to measure polarization and the beam energy was determined both with the ARC magnets and spin precession. Reoccurring problems with the Hall A raster system are being reviewed during the summer down. Also during the summer, the remaining superconducting Q1 will be replaced with a normal conducting Q1. The next run period will continue with DVCS and GMp data.

Hall B

Construction and installation activities for the Hall B 12 GeV upgrade project continued during the fall of 2015 and the spring of 2016. The Heavy Photon Search (HPS) experiment was brought back into operation for the spring run in 2016. HPS took data in

one-pass at 2.3 GeV beam energy. The run was successfully completed on April 25 with over 75% of the goals achieved in terms of integrated beam charge hitting the target, corresponding to about 5 to 6 PAC days. Both the HPS equipment and the accelerator performed very well during the critical period of the experiment. The machine delivered a "ribbon" beam of only 12 micrometer in vertical extension, a critical parameter for HPS.

Hall C

Completion of the construction of the Super High Momentum Spectrometer awaits delivery this summer of the superconducting coils for Q2/Q3 quadrupoles and the dipole. The horizontal bender and Q1 quadrupole are installed and have been fully tested to above their required operating currents. The detectors installed in the SHMS, the heavy gas Cerenkov, scintillator and quartz hodoscopes planes, Aerogel Cerenkov, pre-shower and shower detectors are installed in the SHMS detector hut and are being integrated into the data acquisition system. Upgrades to the Hall C beam line, beam line polarimeters and the dump have been completed. The counting house has a new console for operations and the new DAQ is being installed in the counting house.

Hall D

Hall D took a short (1 week) run in Spring of 2015 at 5.5 GeV, commissioning a diamond radiator, and producing a coherent Bremsstrahlung beam. In the Fall of 2015 certain modifications to the cooling circuit of the superconducting solenoid were implemented. In the Spring of 2016 the engineering run of GlueX took place, at the nominal accelerator energy of 12 GeV. Several diamond radiators were used. The main parameters of GlueX were achieved, including the DAQ rate of about 30 kHz at a 5-10% dead time. The schedule till mid-2017 provides the experiment E12-06-102 - low-intensity GlueX – with about 133 calendar days.

Notes to the Schedule

We summarize here the detailed notes to the schedule. They appear in the rightmost column of the schedule listing, and are listed at the earliest date in the schedule when they are applicable but they extend for a considerable time after they first appear. All of the notes are repeated here for clarity and information.

Detailed notes,

NOTES 3-5. PRad is to be installed, commissioned and take data if it does not interfere with Hall B's 12 GeV installation and testing activities. Construction of the EHS&Q building may also preclude Accelerator beam operation and PRad data taking during day shifts (7 AM – 5 PM).

NOTE 6. Perform Hall C beam line checkout if it does not interfere with the 12 GeV Project installation schedule.

NOTE 8. Maximize readily achievable longitudinal polarization to Hall A.

NOTE 9. Hall C spectrometer checkout period shown includes one week of pre-OPS and demonstration of Key Performance Parameters (KPP).

NOTE 10 - 11. E12-06-102, the low-intensity GlueX experiment, will continue taking data during these periods only if the Accelerator is shown to be capable of efficient four hall operation or if Hall B is delayed. If the experiment cannot be run, the remaining PAC days will be scheduled in the future.

Additional Schedule Information

- 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 250MHz for those halls. A laser frequency of 500 MHz can be used otherwise. For the same average beam current, the charge per micro-bunch when operating the laser at 250 MHz will be twice that of 500 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. We will do our best 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 that would affect planned running in the other halls without the consent of the other halls. Of course, final authority for decisions about unplanned changes in machine operation will rest with the laboratory management.

The operation of more than one hall at Jefferson Lab substantively complicates the interaction between the experimenters and the accelerator operations group. 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 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 all 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, of course, highly preferred that these measurements be scheduled at the morning meeting of the run coordinators whenever possible, and coordinated between halls whenever possible.

When the priority hall has requested a re-tune, if the re-tune 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 the Accelerator and Physics Division for changes in scheduled energy changes (either direction).

Initial Tune-up of New Beams:

Normally one and one half shifts (12 hours) is set aside for tune-up whenever a new beam setup is being tuned (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/Development. Accelerator Division may request up to sixteen hours per week. Users will be consulted in deciding how these sixteen hours per week are placed on the calendar, i.e. five shorter or three long blocks of time.

04/25/2016 - 12/31/2017 Experiment Schedule

| 1 | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|------|-------------|-----------|---------------------------|------------------------|---------------------|-------------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|---------------|----------|--------------|-------------|
| 2 | Date | Weekday | (GeV/pass)/Pol | Operations Status | Hall A Experiment | Hall A GeV/nA/Pol/MHz | Hall B Experiment | Hall B GeV/nA/Pol/MHz | Hall C Experiment | Hall C GeV/nA/Pol/MHz | Hall D Experiment | Hall D GeV/nA/Pol/MHz | Priority Hall | FFB Hall | Pass A/B/C/D | Notes Notes |
| 5791 | 07/21/16 | Thursday | down | | | | | | | | | | | | | |
| 5792 | 07/22/16 | Friday | down | | | | | | | | | | | | | |
| 5793 | 07/23/16 | Saturday | down | | | | | | | | | | | | | |
| 5794 | 07/24/16 | Sunday | down | | | | | | | | | | | | | |
| 5795 | 07/25/16 | Monday | down | | | | | | | | | | | | | |
| 5796 | 07/26/16 | Tuesday | down | | | | | | | | | | | | | |
| 5797 | 07/27/16 | Wednesday | down | | | | | | | | | | | | | |
| 5798 | 07/28/16 | Thursday | down | | | | | | | | | | | | | |
| 5799 | 07/29/16 | Friday | down | | | | | | | | | | | | | |
| 5800 | 07/30/16 | Saturday | down | | | | | | | | | | | | | |
| 5801 | 07/31/16 | Sunday | down | | | | | | | | | | | | | |
| 5802 | 08/01/16 | Monday | down | | | | | | | | | | | | | |
| 5803 | 08/02/16 | Tuesday | down | | | | | | | | | | | | | |
| 5804 | 08/03/16 | Wednesday | down | | | | | | | | | | | | | |
| 5805 | 08/04/16 | Thursday | down | | | | | | | | | | | | | |
| 5806 | 08/05/16 | Friday | down | | | | | | | | | | | | | |
| 5807 | 08/06/16 | Saturday | down | | | | | | | | | | | | | |
| 5808 | 08/07/16 | Sunday | down | | | | | | | | | | | | | |
| 5809 | 08/08/16 | Monday | down | | | | | | | | | | | | | |
| 5810 | 08/09/16 | Tuesday | down | | | | | | | | | | | | | |
| 5811 | 08/10/16 | Wednesday | down | | | | | | | | | | | | | |
| 5812 | 08/11/16 | Thursday | down | | | | | | | | | | | | | |
| 5813 | 08/12/16 | Friday | down | | | | | | | | | | | | | |
| 5814 | 08/13/16 | Saturday | down | | | | | | | | | | | | | |
| 5815 | 08/14/16 | Sunday | down | | | | | | | | | | | | | |
| 5816 | 08/15/16 | Monday | down | | | | | | | | | | | | | |
| 5817 | 08/16/16 | Tuesday | down | | | | | | | | | | | | | |
| 5818 | 08/17/16 | Wednesday | down | | | | | | | | | | | | | |
| 5819 | 08/18/16 | Thursday | down | | | | | | | | | | | | | |
| 5820 | 08/19/16 | Friday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5821 | 08/20/16 | Saturday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5822 | 08/21/16 | Sunday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5823 | 08/22/16 | Monday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5824 | 08/23/16 | Tuesday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5825 | 08/24/16 | Wednesday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5826 | 08/25/16 | Thursday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5827 | 08/26/16 | Friday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5828 | 08/27/16 | Saturday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5829 | 08/28/16 | Sunday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5830 | 08/29/16 | Monday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5831 | 08/30/16 | Tuesday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5832 | 08/31/16 | Wednesday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5833 | 09/01/16 | Thursday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5834 | 09/02/16 | Friday | Injector | Injector Facility Dev. | | | | | | | | | | | | |
| 5835 | 09/03/16 | Saturday | down | | | | | | | | | | | | | |
| 5836 | 09/04/16 | Sunday | down | | | | | | | | | | | | | |
| 5837 | 09/05/16 | Monday | down | | | | | | | | | | | | | |
| 5838 | 09/06/16 | Tuesday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5839 | 09/07/16 | Wednesday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5840 | 09/08/16 | Thursday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5841 | 09/09/16 | Friday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5842 | 09/10/16 | Saturday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5843 | 09/11/16 | Sunday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5844 | 09/12/16 | Monday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5845 | 09/13/16 | Tuesday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5846 | 09/14/16 | Wednesday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5847 | 09/15/16 | Thursday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5848 | 09/16/16 | Friday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5849 | 09/17/16 | Saturday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5850 | 09/18/16 | Sunday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5851 | 09/19/16 | Monday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5852 | 09/20/16 | Tuesday | Cryo Configuration Change | | | | | | | | | | | | | |
| 5853 | 09/21/16 | Wednesday | down | | | | | | | | | | | | | |
| 5854 | 09/22/16 | Thursday | down | | | | | | | | | | | | | |
| 5855 | 09/23/16 | Friday | down | | | | | | | | | | | | | |
| 5856 | 09/24/16 | Saturday | down | | | | | | | | | | | | | |
| 5857 | 09/25/16 | Sunday | down | | | | | | | | | | | | | |
| 5858 | 09/26/16 | Monday | down | | | | | | | | | | | | | |
| 5859 | 09/27/16 | Tuesday | down | | | | | | | | | | | | | |
| 5860 | 09/28/16 | Wednesday | down | | | | | | | | | | | | | |
| 5861 | 09/29/16 | Thursday | down | | | | | | | | | | | | | |
| 5862 | 09/30/16 | Friday | down | | | | | | | | | | | | | |
| 5863 | FY17 Begins | | | | | | | | | | | | | | | |
| 5864 | 10/01/16 | Saturday | 2.1 | Restore | | | | | | | | | | | | |
| 5865 | 10/02/16 | Sunday | 2.1 | Restore | | | | | | | | | | | | |
| 5866 | 10/03/16 | Monday | 2.1 | Restore | | | | | | | | | | | | |
| 5867 | 10/04/16 | Tuesday | 2.1 | Restore | | | | | | | | | | | | |
| 5868 | 10/05/16 | Wednesday | 2.1 | Restore | | | | | | | | | | | | |
| 5869 | 10/06/16 | Thursday | 2.1 | Restore | | | | | | | | | | | | |
| 5870 | 10/07/16 | Friday | 2.1 | Restore | | | | | | | | | | | | |
| 5871 | 10/08/16 | Saturday | 2.1 | 2 halls | DVCS | 2.2/20/p=1/500 - NOTE 8 | | | | | GlueX | 11.7/200/-/500 | D/A | | 1/-/-/5.5 | |
| 5872 | 10/09/16 | Sunday | 2.1 | 2 halls | Pass change (12hrs) | | | | | | GlueX | 11.7/200/-/500 | D/A | | 3/-/-/5.5 | |
| 5873 | 10/10/16 | Monday | 2.1 | 2 halls | DVCS | 6.4/20/p=1/500 | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |
| 5874 | 10/11/16 | Tuesday | 2.1 | 2 halls | Pass change (12hrs) | | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |
| 5875 | 10/12/16 | Wednesday | 2.1 | 2 halls | DVCS | 8.5/20/p=1/500 | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |
| 5876 | 10/13/16 | Thursday | 2.1 | 2 halls | DVCS | 8.5/20/p=1/500 | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |
| 5877 | 10/14/16 | Friday | 2.1 | 2 halls | DVCS | 8.5/20/p=1/500 | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |
| 5878 | 10/15/16 | Saturday | 2.1 | 2 halls | DVCS | 8.5/20/p=1/500 | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |
| 5879 | 10/16/16 | Sunday | 2.1 | 2 halls | DVCS | 8.5/20/p=1/500 | | | | | GlueX | 11.7/200/-/500 | A/D | | 4/-/-/5.5 | |

NOTE 8
Maximum readily achievable longitudinal polarization

