MEMORANDUM

Date: August 1, 2008
To: Distribution
From: Larry Cardman and Arne Freyberger for the Nuclear Physics Experiment Scheduling Committee
Subject: Accelerator Schedule: Through June 2009

Schedule

It is with great regret that we inform you that budgetary pressures have forced us to change the "firm" portion of Accelerator Operations schedule that was released on June 10. Attached is an updated accelerator operations schedule through June 2009. It is firm through December 2008 and tentative for January through June 2009.

It has been clear for while that at the start of the new fiscal year we will not get the 29% increase in total JLab funding that was contained in the President's budget request despite the fact that this budget level was approved by the Senate in its "mark-up" of the DOE funding bill, and was exceeded by the House "mark-up" of that bill. Consequently the Lab has prepared a number of operating scenarios, each corresponding to a different estimate of total funding for FY09 but all starting with the assumption of a continuing resolution (implying funding at FY08 levels) for the first six months of FY09. Recent guidance by the DOE urges conservative planning for FY09, i.e. warns against initial overspending in the hope of later budgetary redress. This situation has been exacerbated by a 40 % increase in the power rate the Lab is charged, which became effective July 1, 2008. For the remainder of FY 08 alone this has increased the power bill for the entire Lab by over $600 k. In FY09 the 24 week running scenario commensurate with one likely budget outcome the power bill increase would be $ 2.5 M over the FY08 cost, and the increase would be higher still for the full 32 week scenario that we envisage if the FY09 budget is fully restored.

To minimize the impact of this increase, the portion of the running that is planned for the six month continuing resolution period (i.e., through 3/31/09) has been shifted toward the end of that period in an effort to move running (and the related power bill) to as late in the period as possible. This will provide us with maximum flexibility in dealing with the budget constraints during a continuing resolution. The changes to the schedule include: delaying the start of physics running in October by two weeks; running over Thanksgiving for improved efficiency (rather than shutting down, as we have often done, for the holiday); and extending the December holiday shutdown. The same net physics running can be completed by the end of March 2009 by shortening the March-April down to the minimum compatible with the installation of the last of the upgraded cryomodules necessary to achieve 6.0 GeV by April.

The schedule as posted still includes the first three quarters of the full 32 week program we would like to run in FY2009. The funding required to realize this program is a final

budget that is close to the President's budget proposal for FY2009. As you know, the final budget received in FY2008 forced us to cut running by almost a third (down to 24 weeks of operations). If (as expected) there is an extended continuing resolution in FY2009 and if the final budget for the year is roughly constant effort relative to FY2008, we will only be able to run 24 weeks in FY2009.

Unfortunately, given the realities of the scheduling conflicts anticipated in future running between now and the 12 GeV shutdown, together with likely restrictions on the total running feasible in the years before the shutdown, it is probable that experiments unable to run at the scheduled time will never be run. In addition, the eg1-dvcs and eg6 experiments may not ever receive the full PAC-recommended beam time. A decision on running during this period will be made as soon as possible, once the full FY09 budget is known.

The Jefferson Lab Nuclear Physics Experiment Scheduling Committee developed the schedule. Committee members are: Larry Cardman and Arne Freyberger (Co-Chairmen), Hari Areti, Volker Burkert, John Domingo, Kees de Jager, Lia Merminga, Will Oren, Matt Poelker, Joe Prebble, Mike Seeley, Dennis Skopik, Mike Spata, Steve Suhring, and Steve Wood. Dave Richards provided advice. As has been the norm, a number of meetings of this committee were necessary to resolve conflicting requirements and to ensure that sufficient resources would be available at the laboratory to properly stage and carry out each of the experiments. The schedule was derived by looking at the requests for major installation work in the experimental halls and the accelerator, evaluating the number and kinds of people needed, and then scheduling to minimize overlap. The schedule request forms were useful in identifying the detailed requirements of each experiment. Information on other laboratory engineering priorities was included to ensure that the required preparatory work could be completed in time. This provided a rough overview of when each hall would be down.

The final schedule was then reached by a series of compromises in running order within each experiment and between halls to work around incompatibilities. It was reviewed and approved by the Chief Scientist and the Director.

The standard section at the end of this memo on "the meaning of priority on the accelerator schedule" is included for reference but all users should read it carefully.

Supplementary Information

Accelerator

The May 1 2006 memo, "Cryomodule Refurbishment and the Maximum Energy Available from CEBAF" presented a plan to extend the energy reach of CEBAF to 6 GeV. This plan called for the removal, refurbishment and reinstallation of the original CEBAF cryomodules as well as installation of new high gradient prototype cryomodules. Through improved material processing and cleaner processing environment the integral gradient from the original CEBAF cavities is increased to nearly 50 MeV. As of April

2008, five refurbished C50 cryomodules have been in operation. During the Summer 2008 down period one more C50 cryomodule will be installed and commissioned. The expected energy reach after the summer down is 5.9 GeV and the schedule reflects this energy reach. The cryomodule refurbishment will continue beyond the 6 GeV maximum in order to reduce the RF trip rate when operating at 6 GeV. The CEBAF transport (arc magnets) will then be the energy reach limitation (6 GeV). An energy reach of 6 GeV is expected after the installation of the eighth C50 module in February 2009.

During the Spring 2008 run we discovered that RF trip model predicts a higher trip rate than observed during the run. At the same time, we learned that the heat load (watts/MeV) of the new C50 modules is much greater than the old cryomodules. This extra heat load has pushed the cryogenic plant (CHL) to its limit. We are in the process of gathering data on the cryomodule heat load. This data will be used to develop a new Linac Energy Management (LEM) algorithm that will set the Linac gradients to minimize the required CHL cooling and the overall RF trip rate. Presently the LEM algorithm ignores the heat load issue. We are also investigating why the trip rate model no longer accurately predicts the RF trip rate. At present this new constraint (CHL capacity) does not change the energy reach as a function of time enough to warrant a change to the longterm schedule.

We continue operate with a superlattice photocathode that produces a maximum beam polarization greater than 80%, typically 85%, with good lifetime.

We will continue to reserve 16-hours every week in order to recover RF cavities and perform other limited beam development activities deemed critical to successful accelerator operations. We have recently been choosing to take this time in 2 periods each week, typically on Tuesday and Thursday. The time required for linac energy changes is now 12 hours (was 8 hours). This new value is based on the experience during the Spring 2007 run period, which had frequent energy and pass changes. We continue the effort in operator training, and procedure and tool development to minimize the time needed for accelerator configuration changes.

Hall A

In February and March the Big Bite spectrometer was installed in Hall A to be used first in E04-007, a study of π^o electroproduction on the deuteron near threshold (Annand, Higinbotham, Lindgren, Moffit, Nelyubin, Norum), that successfully ran in April and May.Following that, E08-007, a measurement of the proton elastic form-factor ratio at low Q^2 (Arrington, Day, Gilman, Higinbotham, Ron, Sarty) has started running and will continue until June 8.

After the completion of E08-007, the polarized ^{3}He target will be installed for a total of six experiments intended to be completed by the end of the spring of 2009. The first of those, E06-010, measuring the transverse target spin asymmetry in semi-inclusive pion production (Chen, Cisbani, Gao, Jiang, Peng), is scheduled to start running in early

October, followed by E06-014, a measurement of d_2^n (Choi, Jiang, Meziani, Sawatzky). Experiment E07-013, measuring the target normal SSA in Inclusive DIS n(e,e') with a polarized ^{3}He target (Averett, Holmstrom, Jiang), will run parasitically to E06-010. After a brief down in March to move BigBite backwards of HRS-right, data taking will start on E05-015 (Averett, Chen, Jiang), a measurement of the target SSA in quasi-elastic scattering off ^{3}He, followed by E05-102, measurements of the target asymmetries in the quasi-elastic ^{3}He(e,e'd) reaction (Gilad, Higinbotham, Korsch, Norum, Sirca). Experiment E08-005, measuring the target SSA in the quasi-elastic ^{3}He(e,e'n) reaction from a polarized ^{3}He target (Averett, Higinbotham, Sulkosky), will run parasitically in parallel with E05-015. As explained elsewhere in this memo, the running of the last three experiments is conditional on a favorable budget resolution.

Hall B

After the summer shutdown in 2007 the g9-FROST experiment was commissioned, and production data taking started at the end of October with a longitudinally polarized target and using a variety of different beam energies and combinations of photon beam polarizations (circular and linear). This experiment was completed February 11, 2008. After the winter shutdown from February 11 until late March, the g12 run group (A search for new forms of hadronic matter; E-04-005 and E-04-017; P. Eugenio, D. Weygand) started to take data. Data on inverse DVCS (time-like Compton scattering) and on vector meson photoproduction on the proton (via e^+e^- decay) will are also being taked parasitically during this run, which is scheduled to end June 7, 2008.

The long summer down time will be used for repair work on the drift chamber system, tests of a prototype tracking detector in a magnetic field, and the installation of additional Møller shielding, and the installation of equipment for the 2nd part of e1-dvcs (V. Burkert, L. Elouadrhiri, M. Garcon, R. Niyazov, S. Stepanyan). This run is scheduled to begin October 10, and finish by the end of the CY08. Early January the eg1-dvcs run group, composed of two experiments (E05-114: A. Biselli, L. Elouadrhiri, K. Joo, S. Niccolai, and E05-113: H. Avakian, P. Bosted, D. Crabb, K. Griffioen) will be installed. This experiment uses the standard Hall B polarized target for electron beam operation and the DVCS inner calorimeter. Also, a new Møller shielding will be needed. The experiment will run until the summer shutdown and continue after that until completion. As noted earlier, if a full budget isn't received for FY2009, the total running for eg1-dvcs will have to be curtailed and the eg6 run (tentatively planned to start in the last part of FY2009) will also receive significantly less than the full PAC-allocated beam time.

Hall C

Since the release of the last schedule E07-002 (Wojtsekhowski, Nathan, Gilman), a measurement of polarization transfer in Wide Angle Compton Scattering, was completed and E04-108 (Brash, Jones, Perdrisat, Punjabi), which is measuring G_{Ep}/G_{Mp} at high Q^2 will finish data-taking early in June. These experiments use the "BigCal" large

electromagnetic calorimeter and a new Focal Plane Polarimeter (FPP) that was installed in the HMS.

This summer the hall will be reconfigured to run two experiments that use the UVA polarized target. In additional to the installation of this target, the HMS will be restored to the standard configuration (no FPP) and BigCal will be augmented with a gas Cerenkov, lucite hodoscope and scintillator tracking detectors to convert it into the Big Electron Telescope Array (BETA). In October, operations resume with E07-003 (Choi, Rondon, Meziani), which will measure inclusive parallel and perpendicular spin asymmetries in the Q^2 range of 2-6 GeV^2 and in the deep inelastic and resonance region to extract the g_1 and g_2 spin structure functions. E07-011 (Bosted, Jiang, Wesselmann), "A High Precision Measurement of the Deuteron Spin-Structure Function g_1^d/F_1^d" is planned for early 2009.

After the polarized target experiments, the Hall will enter a long down for the installation of a beamline chicane and the HES and HKS spectrometers for E05-115 (Hashimoto, Nakamura, Reinhold, Tang), "Spectroscopic investigation of the hypernuclei in the wide mass region using (e,e'K^+) reaction".

Footnotes to the Schedule

We summarize here the detailed footnotes 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; many extend for a considerable time after they first appear. The first five footnotes apply to the entire schedule. All of the footnotes are repeated here for clarity and information.

1. When two or three halls are scheduled, the relative priority listed in the schedule (in the order listed from left to right) is the relative priority of the halls. For example, A/B/C means that Hall A is the highest priority, Hall B has second priority, and Hall C has the lowest priority. If one of the halls has an asterisk, it means that its priority is conditional, and the conditions are given in appropriate footnotes at the beginning of the running of the affected experiment. If the conditions are not met, then the remaining two halls will have priority in the order listed.

2. Energies listed in the schedule for the halls receiving polarized beam are the actual, delivered energies; they include the energy of the injector.

3. When polarized beam is delivered to all three halls, it is not, in general, possible to provide pure longitudinal polarization to all users. We have optimized the beam energies to provide the highest longitudinal polarization (generally over 90%) to all halls during extended periods of scheduled two- and three-hall operation with polarization. For two-hall operation we have occasionally used less than ideal linac energy settings when one or more of the halls has a scheduled pass change in order to optimize polarization delivery over the entire run. This avoids the loss

of beamtime associated with a linac energy change, and it avoids energy shifts in the hall that has no interest in changing energy at the time of the transition in the other hall. See the note in the "polarization" subsection of the text on the meaning of priority in the schedule; the note is attached below.

4. In all cases, the orientation of the polarization at the injector will be optimized by setting the Wien angle to a value that minimizes the differences between the hall polarizations (by minimizing the dispersion) so long as this scheme does not result in a reduction of the "sum of squares" figure of merit by more than 2% compared to the optimum figure of merit as determined by summing the squares of the polarization provided to all halls scheduled to receive polarized beam. If minimizing the dispersion results in a loss of more than 2% relative to the optimum figure of merit, we will revert to our earlier algorithm of setting the Wien filter to maximize the overall figure of merit. In all cases involving polarized beam delivery the setting of the Wien Filter shall be fixed throughout the running period unless all parties scheduled to receive polarized beam agree to a different setting.

5. When polarized beam is provided at a new energy, as much time as necessary during the first shift of polarized beam operation will be used to verify polarization in the halls. This can be done by direct polarimetry in the hall(s) and/or by taking data on a reaction that is adequately sensitive to the beam polarization. By the end of the first shift of production running with polarized beam, the run coordinator(s) for any experiment(s) receiving polarized beam must report to the Program Deputy that they have measured the beam polarization and determined it to be acceptable. Otherwise, a measurement of the beam polarization will be scheduled immediately. When the polarized beam energy is being changed in only one hall (e.g. a "pass change") then that hall should measure beam polarization by the end of the first shift of production running. Further, if the change in settings of the Wien filter are substantial, all three halls should measure and report beam polarization by the end of the first shift of production running with the new setup.

6. Accelerator development time will be allocated 16 hours/week for the duration of this schedule.

7. Collaborative test will be performed to determine the beam quality delivered to the halls after a major down. Halls should be ready and locked at the start of the collaborative checkout. If beam conditions meet the experiment's requirements before the scheduled time, the experiments will be able to use the beam time for production running.

8. Physics production running stops at the end of the owl shift.

9. E08-003, originally scheduled to run if g12 completed data taking, was interleaved with g12 running.

10. The running tentatively scheduled in April and May will be cancelled unless the lab's budget for FY09 includes adequate funds for the full fiscal year to allow us to support this running. A decision on running during this period will be made no later than early March.

Additional General Information on Operations and Scheduling Constraints

As noted earlier in this memo, the operation of polarized beams in more than one hall puts severe constraints on our ability to change beam energies.

Technical support from the Accelerator Division for the firm schedule is expected to be adequate. However, experiments that require significant technical support, and are anticipated to run in the next run cycle should be carefully coordinated with the Hall and Accelerator Division engineering staff to avoid possible conflicts with the future demands of the 12 GeV upgrade.

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, 8:30 AM 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 beam delivery interruptions for experiment-related operations such as Mott measurements of the beam polarization or pulsed operation for current monitor calibrations, temporarily blocking normal beam delivery to all 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 Mott measurements in the injector within 2.5 hours of the desired time (it is preferred that this be scheduled at the morning meeting of the run coordinators and coordinated between the running halls whenever possible).

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.

Polarization:

Note that the setting of the Wien filter, which determines the polarization orientation in all halls, is NOT affected by the hall priority assignment. For two-hall operation we will always optimize the figure of merit for the two running experiments by setting the Wien filter to a value that results in identical longitudinal polarization components for the two halls. For three-hall operation we set the Wien angle to a value that minimizes the differences between the hall polarizations (by minimizing the dispersion) so long as this scheme does not result in a reduction of the “sum of squares” figure-of-merit by more than 2% compared to the optimum figure of merit as determined by summing the squares of the polarization provided to all halls scheduled to receive polarized beam. If minimizing the dispersion results in a loss of more than 2% relative to the optimum figure of merit, we will revert to our earlier algorithm of setting the Wien filter to maximize the overall figure of merit. In all cases involving polarized beam delivery the setting of the Wien Filter shall be fixed throughout the running period unless all parties scheduled to receive polarized beam agree to a different setting.

Finally, any change in the accelerator schedule that has implications for running beyond one week and/or is not agreed to by the run coordinators for all affected experiments and the accelerator program deputy must be discussed and confirmed at meetings to be held (as required) each Tuesday and Friday afternoon at 4:00 in the office of the AD for Physics.

Maintenance/Development The twelve hours per week allotment for both maintenance and beam studies in previous memos proved insufficient for preparation for recent experiments. Beginning in Jan. 2005, the Accelerator Division has asked instead that sixteen hours per week be explicitly assigned for RF recovery, cathode work, operability improvement studies and beam studies in support of PAC approved experiments. 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.

Holidays For holidays shown on the schedule as down when we plan to run beam just up to the holiday, the beam will be shut down at ~8 AM on the last day shown as beam delivery.

Energy Constraints on Multiple Hall Operations The standard constraints for the different energies in the three halls during multiple hall operation are reiterated here for your information. The RF separators are able to extract one beam after each pass or, alternatively, to deliver beam to all three halls after five passes. Therefore, it is always the case that: 1. All three beams can have the same energy only on the fifth pass. 2. No two halls can have the same energy, except on the fifth pass. 3. Unusual beam energies in one hall will sometimes preclude multiple beam operation and impose shutdowns on the other halls, unless one or more of the other halls can also use a commensurate, unusual energy.

Polarization Constraints on Multiple-Hall Operations There are only two beam energies (2.115 and 4.230 GeV) at which purely longitudinal spin can be delivered simultaneously to all three halls when the halls have the same energy. There are, however, many combinations of passes and linac energies at which it is possible to deliver beams with precisely longitudinal polarization to two halls simultaneously, and many combinations at which it is possible to deliver nearly longitudinal polarization to three halls. A technical note covering all combinations of 2-hall polarized beam running is available (TN 97-021). Tables of ideal energies for two-hall operation and optimal energies for three-hall operation are available at the url: http://clasweb jlab.org/spin_rotation/

You can also determine the dependence of the polarization in all three halls on the Wien filter angle for the actual settings of the accelerator. Experimenters scheduled for periods involving multiple-hall polarized beam delivery should consider the possible impact of a transverse polarization component on their measurements, and provide the laboratory with a maximum allowable transverse component if appropriate. Because of the limitations on beam energies associated with the different combinations of linac settings and numbers of passes delivered to the different halls, we have a great deal less flexibility for changing energies in the different halls during polarized beam running. This is because there are many instances where the nominal linac energy and number of recirculations for the running halls provide reasonable polarization, but where changing the number of recirculations for one of the running halls results in nearly transverse polarization.

In an effort to optimize polarized beam running, we schedule many weeks of operation at energies that are consistent with good polarization in multiple halls. The details vary from run period to run period and hall by hall. In the worst case, the effective polarization delivered to a hall is typically reduced to no less than ~90% of the nominal maximum available from the cathode. This reduction is due to the angle at which the polarization vector will be set relative to the beam direction in the hall in a compromise that will optimize delivery to all halls. For two-hall operation we can optimize the figure of merit for both running experiments by simply setting the Wien filter to a value that results in identical longitudinal polarization components for the two halls. For three-hall operation we have previously used an algorithm that set the Wien filter to a value that maximized the overall figure of merit (the sum of the squares of the polarization provided to all halls scheduled to receive polarized beam). It has been noted that this sometimes results in

situations where the delivered polarization is significantly different for the three halls. To "equalize the pain" for three-hall operation, we are adopting a refinement to this algorithm. The Wien angle for three-hall operation will now be set to minimize the differences between the hall polarizations (by minimizing the dispersion) *so long as this scheme does not result in a reduction of the "sum of squares" figure of merit by more than 2% compared to the optimum figure of merit.* In all cases involving polarized beam delivery the setting of the Wien Filter shall be fixed throughout the running period unless all parties scheduled to receive polarized beam agree to a different setting.