

The Completion of the 6 GeV Program

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Introduction

Completion of the 12 GeV Upgrade and the start of its exciting science program is the lab's highest priority

BUT, IN ADDITION

- **There is outstanding physics is still to be done utilizing the capabilities of the present CEBAF accelerator and its experimental equipment**
 - Completion of data-taking for milestone-related physics: HDIce, FROST, DVCS, SANE, and d_2^n
 - Important new data on subjects ranging from strange quark distributions to $N-N$ correlations
 - Unique new experimental directions: PREx and Q_{Weak}
 - Measurements in new areas of research that will be a focus of science with the 12 GeV Upgrade
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- **Completing this research is important both for continued progress in our field *and* for the health of our user community while we wait for 12 GeV**
 - Jobs and tenure decisions for postdocs and young faculty
 - Training of the next generation of PhD students

SO

- **Completion of as much of the “6 GeV” program as possible, consistent with delivering the 12 GeV Upgrade on time and on budget will be a major focus at the lab over the next 4 years**

Background

- **Essential ingredients of our success at the 2007 NSAC Long Range Plan included:**
 - The quality and scientific relevance of the research program planned for the 12 GeV Upgrade
- ***AND***
 - The outstanding quality of the JLab physics program to date
 - *The quality and relevance of the 6 GeV experiments still “on the books”*
 - Our willingness to make a substantial contribution from our operations budget to the 12 GeV Upgrade by planning to run CEBAF at only ~80% of nominal utilization
- **Also essential were the breadth of both the 6 and 12 GeV programs, with substantial elements relevant to nuclear structure and fundamental symmetries in addition to the core hadronic physics program**

This Presentation

- **What is the science we would like to complete?**
- **How did we develop the schedule that was posted?**
- **What is the schedule?**
- **What resources will be necessary to complete this program?**
- **How will we proceed from here?**

What is the Science Remaining for CEBAF@6 GeV?

- **Completion of data-taking for milestone-related physics**
 - Baryon spectroscopy (FROzen Spin Target and HDIce target data)
 - DVCS (CLAS Phase II and Hall A separation of BHxDVCS and DVCS²)
 - Structure function moments (SANE, d_2^n)
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- **Important new data on:**
 - Strange quark distributions (HAPPEX III)
 - Hypernuclear spectroscopy (HKS)
 - Correlations (⁴He(e,e'pN) data extended)
 - Dispersive effects in electron scattering [(e⁺,e⁺) vs (e⁻,e⁻)]
 - Transversity
 -
- **Unique new experimental directions:**
 - PREx (rms radius of neutron dist. for nuclear structure, astrophysics, and atomic PV Standard Model tests)
 - Q_{Weak} (Weak charge of the proton for a Standard Model Test)
- **Measurements in new areas of research that will be a focus of science with the 12 GeV Upgrade, such as:**
 - Single spin asymmetries
 - DVCS w/ Longitudinally polarized target
 - Hadronization
 - PVDIS,

Its completion is an essential component of our goals for the next four years

We Have More Outstanding Science than Can be Completed in the Time Remaining \Rightarrow Hard Choices

Approved Experiments Following PAC33

- **HALL A: 19 experiments, 11 rated A or A-**
 - **5.2 years operation @ ~ 32 weeks/yr**
- **HALL B: 16 experiments, 13 rated A or A-**
 - **5.2 years operation @ ~ 32 weeks/yr**
- **HALL C: 7 experiments, 6 rated A or A-**
 - **4.9 years operation @ ~ 32 weeks/yr**

These backlog estimates are at ~80% of nominal ops in a “good year” (FY05) and use historical multiplicities (2.2-2.4) and major installation times

Note: There are roughly three years of running at 6 GeV remaining

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However, we can do better than these backlogs would imply because:

- **We can utilize downtime not driven by the experimental program,**
- **There will be fewer major installations (on average), and**
- **Higher multiplicity (on average) is feasible with careful, long-range planning and fewer major installations)**

How Did We Develop the Posted Schedule?

Planning Constraints

- **The current planning for the Upgrade has:**
 - A major accelerator shutdown beginning in May 2011 (for ~6 months)
 - 6 months of additional 6 GeV running (in 2012), and then
 - The final shutdown (in May 2012) for the completion of the Upgrade and the beginning of 12 GeV commissioning (mid-May 2013).
- **This means that there will be about 3 years of beam/hall ops between January 2009 and the start of 12 GeV science**
- **We have been planning on operations at a level such that we could deliver ~30 weeks/year (or ~80% of the traditional level of accelerator/hall ops)**
- **Q_{Weak} beam and helium requirements and the total time approved for Q_{Weak} running will be a real complication for scheduling for the last ~2 years of running**

Process to Date

We began by asking, hall-by-hall, how we could carry out the highest priority science, including the usual issues of technical readiness and experiment sequences that use the same setup

Boundary conditions:

- The initial program begins with the experiments that *HAD* been planned for FY07 and early FY08 (delayed by budget constraints)
- The final portion of the program begins by placing Q_{Weak} on the schedule (finishing with the last 6 GeV beam available and working backward), and limiting Q_{Weak} maximum beam current to 150 μA to permit Halls A and B to run in parallel
- The Hall A parity program (HAPPEX-III, PREX, and PVDIS) was given priority in planning late FY09 and FY10
- g_1^d and HKS running were fit between SANE and Q_{Weak} to complete the Hall C Schedule
- The Hall A and B schedules were then laid out to maximize science w/ beam conditions consistent with available energies

What Will the Draft Schedule Support IF JLab Budgets in FY09 and Beyond are at the President's Budget Proposal for FY09 and Constant Effort Beyond?

Anticipated accelerator operation:

- **32 weeks in FY09 (w/ Multiplicity of 2.7)**
- **35 weeks in FY10 (w/ Multiplicity of 2.1)**
- **28 weeks in FY11 (w/ Multiplicity of 2.8) (pre-installation 6 month shutdown)**
- **27 weeks in FY12 due to 12 GeV installation shutdown (w/ Multiplicity of 2.5)**
30 weeks/year average (w/ average multiplicity of 2.5)

This will enable us to complete much of the currently approved program

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First Cut in Plan??

Impact of FY08 CR and reduced
FY09 budget likely to cut planned
FY09 running to 26 weeks

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What is the Draft Schedule?

Next VGs summarize the experiments included in the draft schedule hall-by-hall and in order by fiscal year.

The “day-by-day” version has been posted on the web.

They also identify the work needed to mount the 6 GeV program, including:

- Equipment construction needed
- Major installation efforts
- Accelerator performance requirements
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Hall A 1 of 3

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days
FY2009					
E06-010	Transversity	Polarized ^3He , BigBite	Standard	A	29
E07-013	Normal SSA in DIS on pol. ^3He	Polarized ^3He , BigBite	Standard	B	0 (parasitic on E06-010)
E06-014	d_2^n	Polarized ^3He , BigBite		A	13
E05-015 E08-005	Pol. ^3He target SSA	Polarized ^3He , BigBite		B+	8
3 Experiments Dropped if FY09@26 weeks					
E05-102	QE ^3He	Polarized ^3He , BigBite		A-	15
E05-109	HAPPEX-III	Møller and Compton upgrade	Small helicity correlations (~ 1/20*HAPPEX I)	A-	30 (start)

Hall A 2 of 3

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days
FY2010					
E05-109	HAPPEX-III	Completion	Small helicity correlations (~ 1/20*HAPPEX I)	A-	Complete
E08-011	DIS-parity	High-speed DAQ		A-	32
E06-002	PREx: Lead Parity	Room-temperature septa Møller and Compton upgrade	Small helicity correlations (~ 1/20*HAPPEX I)	A	30
E07-007 E08-025	DVCS on the proton and neutron	PbF ₂ calorimeter	Equipment funding not fully identified	A, B ⁺	40
FY2011					
E07-007 E08-025	DVCS on the proton and neutron	Completion		A, B ⁺	40
E08-008	Deuteron electrodisintegration near threshold	BigBite		B ⁺ (C3)	18
E07-006	Short Range Correlations via (e,e'pN)	BigBite		A-	23
E08-010	N-Δ Coulomb quadrupole amplitude at low Q ²			B ⁺	3
E08-014	Three-nucleon correlations (x>2)			A-	12
	Accelerator Down for 12 GeV Work				

Hall A 3 of 3

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days
FY2012					
	Accelerator Down for 12 GeV work				
E08-027	g_2^p and the LT Spin polarizability	Septa + beamline chicane Polarized target	Equipment funding not fully identified	A-	24
E08-007	G_E^p at low Q^2			A-	14
E08-027	g_2^p and the LT Spin polarizability	Completion		A-	24
E07-012	Hypernuclear ^{16}O and production	Septa		B+	12

Hall B 1 of 2

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days
FY2009					
E06-003	E1-DVCS(b)		Standard (E>5.9GeV)	A	35 (remaining)
E06-113 E06-114	EG1-DVCS, Pion Single Spin Asymmetries	Polarized target, ~ 3 weeks installation	Standard	A, A-	60
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;"> Partial Data Loss (~25%) for eg1-dvcs if FY09@26 weeks </div>					
E06-113 E06-114	EG1-DVCS, Pion Single Spin Asymmetries	Polarized target, ~ 3 weeks installation	Standard	A, A-	60

Hall B 2 of 2

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days	
FY2010						
E07-009 E08-024	Eg6: DVCS and meson spectroscopy on ^4He	Modified e1-DVCS setup	Standard ($E > 5.9\text{GeV}$)	A, A-	45	
E02-112 E03-105 E04-102 E05-012 E06-013	G9 – Frost Missing N^* Resonances (completion – started in 2008)	Partial Data Loss (~30%) for eg6 if FY09@26 weeks (eg6 start will be delayed)		3 A-, 2B+	91 (remaining 60 days here)	
	HDIce Install	Frozen spin target	Standard			
FY2011						
E06-101	G14 – N^* Searches (HDIce)	HD polarized target	Standard	A	85	
	Accelerator Down for 12 GeV work	Equipment funding not fully identified				
FY2012						
	Accelerator Down for 12 GeV work					
E08-015 E08-021	DVCS and SIDIS w/ HDIce Target	Conversion of HD polarized target for electron beam operation	Technical feasibility to be established; Equipment funding not fully identified		A and A-	25
E08-023	PRIME _x -II	Re-Install PRIME _x	Beam Stability	A-	20	
E07-005	EG5-Two Photon exchange in elastic e^+p/e^-p scattering	Installation of conversion/target apparatus	Standard	A	35	
		Equipment funding not fully identified				

Hall C 1 of 2

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days
FY2009					
E07-003	Spin Asymmetries of the Nucleon	UVa polarized target installation - ~ 2 months	$E0 \geq 5.7$ GeV	A	34
E07-011	g_1^d	(part of SANE)		A	8
E05-115	HKS/HES (Installation, commissioning, and initial running)	Major Installation 5 months	Pre-target beamline chicane; Energy stability of 10^{-4} , Position stability < 100 μm	A-	20

Hall C 2 of 2

Year (Expt. #)	Experiment	Major Installation Tasks	Special Accel. Requirements	Scientific Rating	PAC Days
FY2010					
E05-115	HKS/HES (completion)	Run (to completion w/ part of recent approved extension added???)	Energy stability of 10^{-4} , Position stability < 100 μm	A-	20
E08-016	Q_{Weak} (Install and begin commissioning)	Major installation 6 months	Complete overhaul of Hall C beamline New Polarimeter Major Cryo Load See Published Beam Specs.	A	198
FY2011					
E08-016	Q_{Weak} (complete commissioning and run Phase I)		See Published Beam Specs.	A	198
	Accelerator Down for 12 GeV work				
FY2012					
	Accelerator Down for 12 GeV work				
E08-016	Q_{Weak} (run Phase II)		See Published Beam Specs.	A	198

What Resources Will be Necessary to Complete This Program?

Operations Funding and Accelerator Developments

Realizing this schedule fully will require that many things “fall right”.

The core requirement will be:

- Overall laboratory operations funding at a level consistent with the 30 weeks/year average needed and with the hall operations and
 - Funding for the equipment construction necessary to complete the apparatus needed
- This corresponds roughly to the lab receiving the President’s Budget request level of funding in FY09 and cost of living increases in subsequent years.***

In addition, technical developments must continue as foreseen for the accelerator – notably:

- The restoration of 6 GeV maximum beam energy capability and
- The improvement in the polarized beam stability to the level needed by both the Hall A parity experiments and Q_{weak}
- Position and energy stability requirements for HKS

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The Necessary Technical Developments of the Needed Accelerator Capabilities are Progressing Well, and Expected to Meet Goals

Experimental Equipment Issues

The major experimental apparatus construction necessary for which funding is not yet fully identified includes:

Hall A:

- the g_2^p measurement (E08-027); and
- the DVCS experiments on the proton (E07-007) and neutron (E08-025)

Hall B:

- the two photon exchange experiment (E07-005); and
- the N^* searches on polarized neutrons using the planned HDIce target (E06-101).
- the DVCS and SIDIS measurements on the neutron (E08-015 and -021), for which *both* equipment development *and* significant technical developments must take place before the experiments can be mounted.

We will work with the proponents of these experiments to identify the needed funding, but for now they must be considered at higher risk of cancellation

How Will We Proceed From Here?

Process

- **The Schedule Has Been Posted for Public Review and Consideration.**
 - Written comments may be submitted anytime between now and PAC34
 - All written comments received will be shared with lab management and the PAC
- **PAC34 will be charged to comment on the 6 GeV running plan**
 - A day will be set aside at the PAC meeting for this review
 - It will include both public and executive sessions.
 - Mont will participate in both the public and executive session PAC discussions of the schedule.
- **Following the PAC meeting, the laboratory will issue a “Final Draft Schedule” that incorporates its response to that discussion and any further internal review deemed appropriate.**

Process after “Final Draft” Schedule Release

- **Once the “Final Draft Schedule” has been issued, it will be subject to periodic revision depending on the details of laboratory funding and technical issues that may arise in the interim.**
 - We will post updates each year once a final budget for the year has been issued
 - We may post additional updates as our understanding of likely budget scenarios evolves.
- **We will make every effort to have the issued schedules “firm” for at least the following six months, as has been tradition, but we may be forced by budget developments to make adjustments.**
- **We will include to the extent possible guidance about potential budget consequences on the remaining program in the “style” of what was done in the latest schedule release indicating the vulnerability of the April/May 2009 running.**

Conclusions

- **There *is* outstanding physics is still to be done utilizing the capabilities of the present CEBAF accelerator and its experimental equipment**
 - Completion of data-taking for milestone-related physics
 - Important new data on subjects ranging from strange quark distributions to N - N correlations
 - Unique new experimental directions: PREx and Q_{Weak}
 - Measurements in new areas of research that will be a focus of science with the 12 GeV Upgrade
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- **A Draft Schedule has been assembled that completes a substantial fraction of this science**
- **It will be reviewed by PAC34, with full consideration of input from the User Community and, in particular, the experiment spokespersons**
- **It will then be “finalized” and executed to the best of our ability, consistent with:**
 - Actual funding received for Operations
 - Essential Accelerator Technical Developments meeting the needs of the program
 - Funding received for key major experimental apparatus
- **The result will be essential additions to the 6 GeV Science emerging from CEBAF and important work laying the foundations of the 12 GeV program**