

PAC40: 12GeV CEBAF Status and Plans

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Accelerator Operations Department

Outline

- 1 12GeV Upgrade: Status
 - 12GeV Accelerator Design
 - Down Schedule: LSD
 - Shutdown Work Planning
 - Cryogenics
 - Beam Transport: Magnets
 - Acceleration: SRF
- 2 Path to Beam Operations
- 3 Commissioning Schedule
- 4 Beyond the Upgrade
- 5 Summary



The Last e^- ?

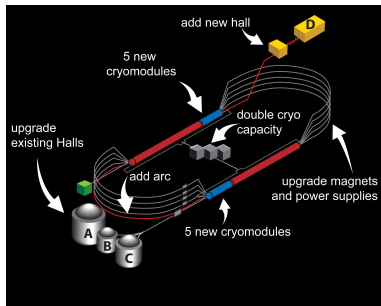
2011-May-18 08:10



12 GeV CEBAF Design

Constraints/Parameters:

- Use existing 6-GeV CEBAF tunnel
- $E_{GlueX} \geq 12\text{GeV}$
- $P_{beam} < 1\text{MW}$

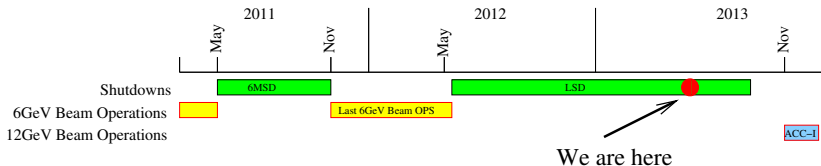


Design:

- Increase the linac energy gain from 600MeV/linac to 1100MeV/linac with the addition of five C100 cryomodules per linac.
- Add an additional arc (Arc10) and pass through the North Linac to bring the beam energy to 12 GeV.
- Add magnetic extraction and Hall-D beamline at the end of the North Linac for the GlueX experiment.
- Upgrade magnets, power supplies, cooling and cryogenics to support the higher beam energy.

Down Schedule: LSD

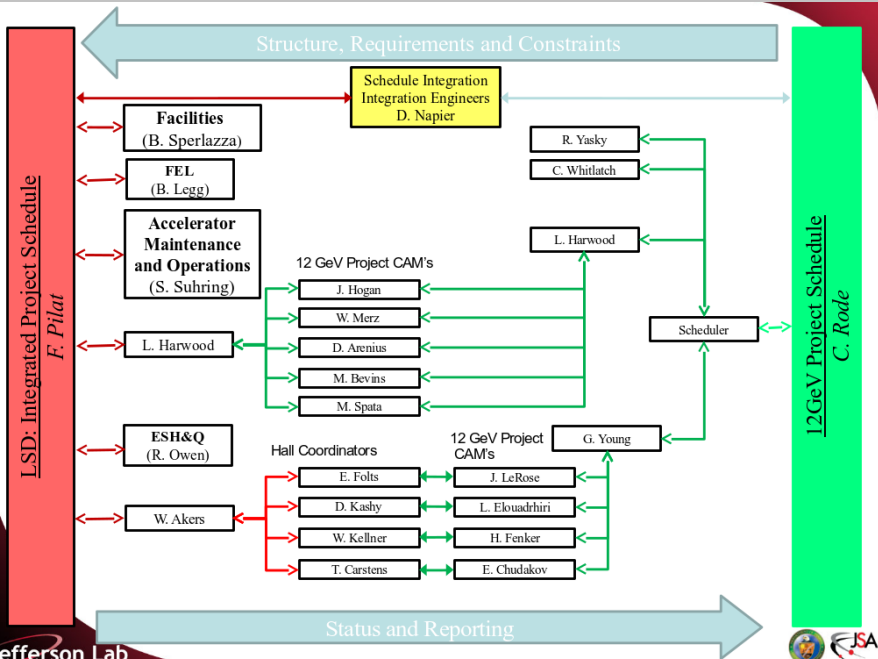
Quick Summary



- Long Shutdown, 16 months long. Scheduled from May-2011 to Sep-2013.
- Overall tasks have gone well, there were a few big surprises:
 - ▶ Underground cooling water pipe for CHL-1 fractured. Three month delay in the start-up of CHL-1 and SRF cavity recommissioning.

- LSD tasks likely to extend beyond Sep-2013
 - ▶ To be performed in || with System Check Out.
- Still maintaining a Nov-2013 start-up

Shutdown Work Planning



Cryogenics

Done Maintenance on existing 6GeV infrastructure. Includes: transfer line maintenance and CHL-1 maintenance.

Done Restart CHL-1, **cooldown CEBAF Linacs**

Nearly Done CHL-2 Commissioning

In Progress Support 2K operations for SRF commissioning

In Progress Build transfer lines between CHL-2 and CEBAF

Not Started Commissioning 2nd 2K cold box. scheduled for 2013-Aug

The installed SRF cavities were all thermally cycled for the first time since hurricane Isabel. No **issues** on the subsequent cool down to 2K!!!



Magnets: Spreaders and Recombiners

4-corners of the machine



Done Tear out magnets, stands, girders in the 1S, 1R, 2S, 2R

Done Modified existing magnets, receive new magnets from vendor

Done Install new stands and girders

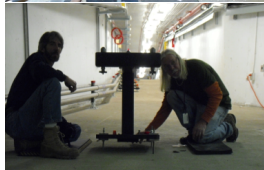
Nearly Done Field measurements of each (old and new) dipole

Done Install 1R region

Nearly Done Install 1S, 2S and 2R regions



Magnets: BSY, A,B,C & D transport



Done Remove magnets and girders in A, B & C beam lines

Done Removes stands, girders in the Transport/BSY region.

Done Modified existing magnets, receive new magnets from vendor

Done Install new stands in BSY, Transport and D lines

Nearly Done Field measurements of each (old and new) dipole

In Progress Install magnets in Transport and BSY region

In Progress Install magnets in the D transport and beam line

Not Started Install magnets in the A, B & C lines

Acceleration: SRF



Done Install R100 cryomodule in Injector (0L04 slot)

In Progress Install and commission ten C100 cryomodules. 9 out of 10 installed, 5 commissioned.

In Progress Recommission C20/C50 SRF base. About 25% complete.

In Progress Upgrade R100 RF controls and power to support 100MeV energy gain.

In Progress Refurbish weakest C20 module, resurrection of the C50 program (C50-11) for gradient maintenance.

Not Started Commission R100 and C50-11

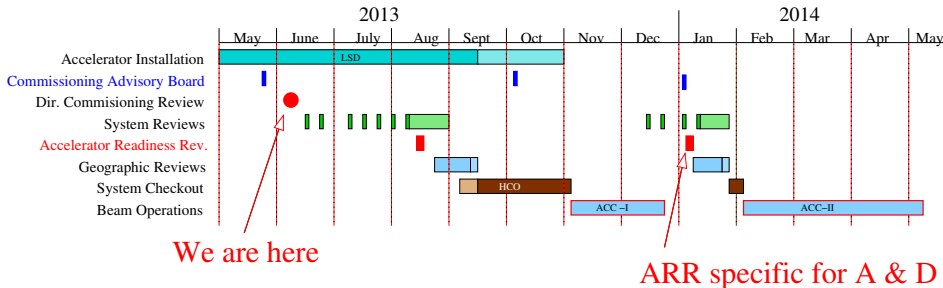
Not Started Helium process identified weak

Outline

- 1 12GeV Upgrade: Status
- 2 Path to Beam Operations
 - Roles and Responsibility
- 3 Commissioning Schedule
- 4 Beyond the Upgrade
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Path to Beam Operations



Many concurrent tasks and efforts.

- ~Four months remaining of accelerator installation.
- We are at the start of a process to thoroughly review accelerator system status, commissioning plans and process in preparation for the Accelerator Readiness Review(ARR).
- Accelerator Readiness Review process will be a phased approach with the first review scheduled for August 2013.

Program Planning and Execution

PROGRAM PLANNING

Commissioning Advisory Board

Accelerator Division Deputy (Leader)
12 GeV Associate Project Manager
Director of CASA
Physics Division Deputy
Source/Injectors Department Head
Engineering Division Head

Commissioning Planning Team

Director of Accelerator Operations (Leader)
CASA Deputy
Engineering Support Liaison
Operations Group Leader
B-Team Leader
Operability Manager
Program Deputy

Geographic Integrators

Operability Manager (Leader)
Injector Integrator
Linac Integrator
Transport Integrator
Hall A Integrator
Hall B Integrator
Hall C Integrator
Hall D Integrator
Program Deputy (attends meetings)

Beam Transport Team (B-Team)

B-Team Leader
CASA Department Staff
Source Department Staff
Injector Group Staff

PROGRAM EXECUTION

Program Deputy

Two-Week Rotation

Crew Chiefs

Controls Support

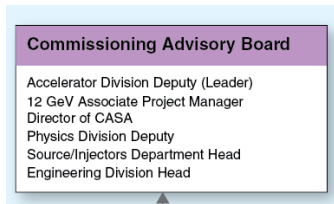
Engineering Support

Operators

Accel Scientists

“Accelerator Operations Directives (AOD) Supplement for 12GeV Beam Commissioning” establishes the roles, responsibility and program execution during the 12 GeV CEBAF commissioning.

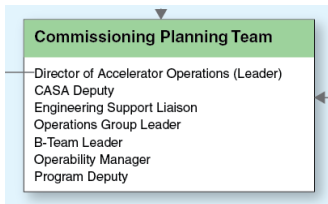
Commissioning Advisory Board (CAB)



- New advisory board for 12GeV Commissioning
- Board leader is the Accelerator Division Deputy.
- Senior level managers from Physics, Accelerator and Engineering divisions and 12GeV Project management team.
- Periodically review the commissioning plan and progress
- Makes recommendations to the Commissioning Planning Team (CPT).

CAB reviews will assess whether the commissioning plan and activities are optimized to achieve the 12 GeV Project and Nuclear Physics commissioning goals and in line with overall JLab priorities.

Commissioning Planning Team (CPT)



- New planning team for 12GeV Commissioning
- Team leader is the Director of Accelerator Operations
- Representation from OPS Dept., CASA, Engineering
- The team will meet at least once per week during the commissioning period.

Develops, coordinates, and ensures the execution of the commissioning plan.

Outline

- 1 12GeV Upgrade: Status
- 2 Path to Beam Operations
- 3 Commissioning Schedule
 - Creating the Schedule
 - Beam Operations Schedule
- 4 Beyond the Upgrade
- 5 Summary

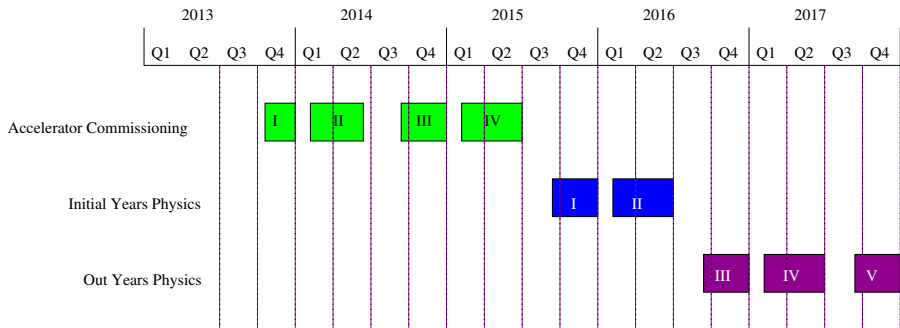


Creating the Beam Commissioning Schedule

Plan First, then Schedule

- Beam Commissioning plan was developed bottoms. The plan includes:
 - ① 12GeV Project tasks (pre-ops).
 - ② Tasks required to span gaps in the 12GeV Project pre-ops tasks (Support pre-ops).
 - ③ Tasks needed to achieve *physics quality* beams.
 - ④ Tasks to establish routine operations.
- Beam commissioning tasks duration estimated based on previous experience. Estimate includes the expected initial low reliability of the hardware (50% in FY14).
- Number of operating weeks per Fiscal Year developed as part of the annual budgetary process with DOE.
- Beam commissioning **schedule** created that meshes the **plan** with the funded weeks of operation.
 - ▶ The original estimated task duration is retained.

CEBAF 12GeV Beam Operations



- *Constant Effort* scenario: 30 weeks of operation per year.
- Two running periods per year
 - ▶ Fall run typically about 13-14 weeks
 - ▶ Spring run typically 16-17 weeks
- Avoid running in summer months (June, July, Aug) to save power bill





Acc-I Schedule

2013-11-04 → 2013-12-20

Accelerator Run Period I Plan

WBS	Name	Note	Start	End	Duration	ProjectAccount	Oct 2013			Nov 2013			Dec 2013			
							30	07	14	21	28	04	11	18	25	02
2	Long Shutdown/Upgrade	Thi...	Tue 2013-01-01	Mon 2013-11-04	307.0											
2.2	Linac Tasks		Thu 2013-04-11	Mon 2013-11-04	207.0											
2.2.1	North Linac		Thu 2013-04-11	Mon 2013-11-04	207.0											
2.2.1.3	R100 Cryomodule		Mon 2013-06-03	Mon 2013-11-04	153.3											
2.2.2	South Linac		Thu 2013-04-11	Fri 2013-11-01	204.0											
2.2.2.3	CS0-11 Cryomodule		Mon 2013-09-09	Fri 2013-11-01	53.0											
3	Hot Check Out		Tue 2013-08-27	Tue 2013-11-19	84.0											
3.3	LEM Data Collection	Ope...	Tue 2013-10-29	Tue 2013-11-19	21.0	MD_NP										
4	12GeV CEBAF Commissioning		Mon 2013-11-04	Fri 2015-06-12	585.0											
4.1	Accelerator Period I: 2.2GeV/pass to 2R, tune-mode beam	The...	Mon 2013-11-04	Fri 2013-12-20	46.5											
4.1.1	Recover: Beam up to 5MeV	Est...	Mon 2013-11-04	Mon 2013-11-11	7.0	Spreops_NP										
4.1.1.1	Beam to FC1		Mon 2013-11-04	Wed 2013-11-06	2.0	Spreops_NP										
4.1.1.2	Beam to 6MeV Spectrometer/Mott		Wed 2013-11-06	Mon 2013-11-11	5.0	Spreops_NP										
4.1.2	Spin up 1pass beam to 2R		Mon 2013-11-11	Fri 2013-12-20	39.5	Preops_12GeV										
4.1.2.1	Beam to the Inj. Spectrometer		Mon 2013-11-11	Sat 2013-11-16	5.0	Preops_12GeV										
4.1.2.2	Beam to the End of the Injector Chicane		Sat 2013-11-16	Tue 2013-11-19	3.8	Preops_12GeV										
4.1.2.3	Beam to End of North Linac		Tue 2013-11-19	Wed 2013-11-27	7.3	Preops_12GeV										
4.1.2.4	Beam to the 1R dumplette		Wed 2013-11-27	Sat 2013-12-07	10.0	Preops_12GeV										
4.1.2.5	Beam to End of South Linac		Sat 2013-12-07	Sat 2013-12-14	7.3	Preops_12GeV										
4.1.2.6	Beam to the 2R dumplette		Sat 2013-12-14	Wed 2013-12-18	4.0	Preops_12GeV										
4.1.2.7	Establish 2.2GeV/pass beam to 2R	Rai...	Wed 2013-12-18	Fri 2013-12-20	2.0	Preops_12GeV										

All effort and duration values are in days. 24/7 scenario

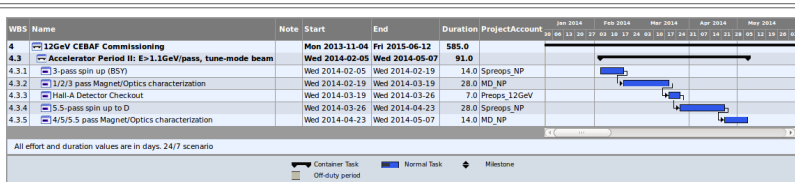
 Container Task
  Normal Task
  Milestone
 Off-duty period

The goal of this 6week run period is to establish 2.2GeV/pass tune-mode beam to the 2R dumplette. If successful, satisfies 12GeV Project CD4A-IV deliverable one year ahead of schedule: 2014-12-19

Acc-II Schedule

2014-02-05 → 2014-05-07

Accelerator Run Period II Plan



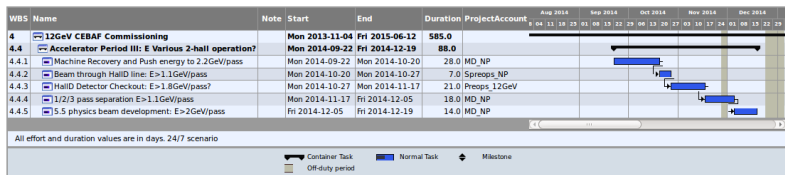
The goals of this run are:

- 1 Establish beam to CW capable dumps, Hall-A, Hall-D or BSY dump
- 2 First CW beam operations in the 12GeV era
- 3 Multi-pass steer up
- 4 Beam to Hall-A for detector tests

Acc-III Schedule

2014-09-22 → 2014-12-19

Accelerator Run Period III Plan



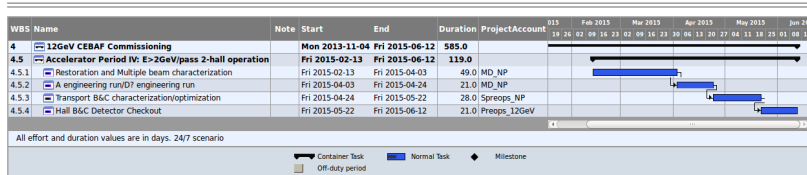
The highlight of this run period is the Hall-D detector checkout (WBS: 4.4.3) to satisfy CD4B-III which has a date of 2016-06-30.

Once the RF separators are commissioned CEBAF will be in a position to support simultaneous activities. With the caveat that the beam to A (or B and C) be at lower pass than where the beam commissioning effort is focused.

Acc-IV Schedule

2015-02-13 → 2015-06-12

Accelerator Run Period IV Plan



The impact of the 12GeV re-baseline has not been incorporated yet into the schedule. Some of these tasks are likely to be deferred.

Converting task 4.5.4 three weeks of 12GeV pre-ops to beam for physics will require NP funding.

Task 4.5.3 likely to be moved to FY16 as well (four weeks of B&C transport optimization) is NP funded.

There is potentially a 10wk physics run in this run period (4.5.2 + 4.5.3 + 4.5.4).

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 - Projects beyond commissioning 12GeV CEBAF
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Beyond the Upgrade

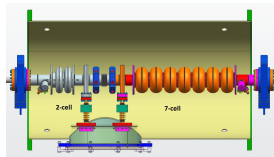
Accelerator Projects in Support of NP

Dogleg Upgrade:



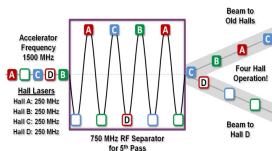
Restore path length adjustment range via the Dog-leg chicane to nearly the same as in the 6GeV era.
Planned completion:
Summer 2014

Injector Upgrade:



Major upgrade of warm and cold Injector.
Better support for parity quality beams.
Planned completion:
2016

Four Hall Operation:



Change in D+2 design to support D+3
New 750MHz Cavities
New laser configuration
Planned Completion:
Summer 2015

Outline

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 - The Final Word



Summary

The seas are challenging:

- The work is not yet complete.
- The number of tasks that extend beyond the Sep-19 (end of the LSD) is growing.

The winds are favorable:

- There have been a few challenges to the Accelerator upgrade; those that have presented themselves have been squashed without major impact to the schedule.
- An extensive review cycle in preparation for the Accelerator Readiness Review has started.
 - ✓ The Director's Review of the Beam Commissioning plan was held recently. Generally positive comments.
- Discussions on scheduling experiments have started.
- We are looking beyond 12GeV commissioning.

END HERE!!!

Thank You for your time and attention.

Beam Requirements for Initial Operations

Hall	Emittance (nm-rad)	Energy Spread σ (%)	Spot Size σ (μm)	Halo
A	$\varepsilon_x < 10$ $\varepsilon_y < 5$	< 0.05 (12 GeV)	$\sigma_x < 400$	$< 1 \times 10^{-4}\dagger$
		< 0.003 (2-4 GeV)	$\sigma_y < 200$ ($\sigma_y < 100$) (2-4 GeV)	
B	$\varepsilon_x < 10$ $\varepsilon_y < 10$	< 0.1	$\sigma_x < 400$	$< 2 \times 10^{-4}\dagger$
			$\sigma_y < 400$	
C	$\varepsilon_x < 10$ $\varepsilon_y < 10$	< 0.05	$\sigma_x < 500$	$< 2 \times 10^{-4}\dagger$
			$\sigma_y < 500$	
D	$\varepsilon_x < 50$ $\varepsilon_y < 10$	< 0.5	At Radiator: $\sigma_x < 1550, \sigma_y < 550$	$< 1\%\ddagger$
			At Collimator $\sigma_x < 540, \sigma_y < 520$	

\dagger Ratio of the integrated non-Gaussian tail to Gaussian core.

\ddagger Ratio of Halo background event rate to physics event rate.

(GlueX-doc-775-v4, GlueX-doc-646-v5)

Beam Requirements for Out-Year Operations

Hall	Emittance (nm-rad)	Energy Spread σ (%)	Spot Size σ (μm)	Halo
A	$\epsilon_x < 10$ $\epsilon_y < 5$	< 0.05 (12 GeV)	$\sigma_x < 400$ $\sigma_y < 200$	$< 1 \times 10^{-4}\dagger$
		< 0.003 (2-4 GeV)	$(\sigma_y < 100)$ (2-4 GeV)	
B	$\epsilon_x < 10$ $\epsilon_y < 10$	< 0.1	$\sigma_x < 400$ $\sigma_y < 400$	$< 1 \times 10^{-4}\dagger$
C	$\epsilon_x < 10$ $\epsilon_y < 5$	< 0.05	$\sigma_x < 400$	$< 1 \times 10^{-4}\dagger$
		< 0.03 (6 GeV)	$\sigma_y < 200$	
D	$\epsilon_x < 10$ $\epsilon_y < 5$	< 0.5	At Radiator: $\sigma_x < 1550, \sigma_y < 550$	$< 1\%\ddagger$
			At Collimator: $\sigma_x < 540, \sigma_y < 520$	

\dagger Ratio of the integrated non-Gaussian tail to Gaussian core.

\ddagger Ratio of Halo background event rate to physics event rate.

([GLueX-doc-775-v4](#), [GLueX-doc-646-v5](#))

Beam Requirements

Endstations	6GeV	12 GeV					
	OPS	CD-4		Initial 12GeV		Out-Years	
	ABC [†]	ABC	D	ABC	D	ABC	D
Energy (GeV)	6	≥6	≥10	11 [‡]	12 [‡]	11	12
Current (μA)	200	0.002	0.002	85	5	85	5
ϵ_x (nm-rad)	<1	NA	20	10	50	10	10
ϵ_y (nm-rad)	<1	NA	20	5	10	5	5
$\delta p/p$ (% RMS)	0.003	NA	NA	0.05	0.5	0.05	0.5
HALO (ppm)	ND	NA	NA	100	100	100	10

[†] The values for ABC represent the most stringent requirement of the three end-stations during the 6 GeV era.

[‡] High availability 5.5(5) pass operation restricted to be at or below 10(9) GeV for Hall-D(ABC) in FY14 due to insufficient Dog-Leg range.