

CEBAF Status: Next Step 12GeV

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JLAB

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Accelerator Operations Department



Outline

CEBAF Accomplishments

- Machine Setup
- 750MHz Separation
- Energy Reach
- March 25th
- post March 25th Beam Operations
- 🕽 Rumor Mill
- CEBAF Present: Preparing for 12GeV
 - UIM
 - Cryo Plant Repair and Efficiency Improvements
 - 750MHz Separator Cavities
 - Dogleg upgrade
 - Energy Reach: Helium Processing
 - Operations StayTreat

CEBAF Near Future: 12GeV Beam Operations in FY16

- Fall2015 Beam Operations
- Spring2016 Beam Operations







Construction is complete





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$\begin{array}{l} \mbox{Spring2015 Beam Operations} \\ \mbox{2015-Feb-12} \rightarrow \mbox{2015-May-04} \end{array}$

Accelerator Goals of the run period:

Commission the 5-pass separation system.

- Commission the 249.5MHz laser drive system.
- Commission the 750MHz cavities.

CEBAF setup at $E_{5.5pass} \leq 11$ GeV, using new 12GeV Beam Configuration Process.

- Minimal orbit offsets in the Arcs, to minimize emittance growth due to non-linear fields (multipoles).
- Beam matched at the **entrance** to each Arc to minimize emittance growth due to propagation of mis-matched beams.
- Measure CEBAF beam transverse and longitudinal evolution and compare with expectations.

Physics Goals:

- Hall-A DVCS, desires highest possible energy.
- Hall-B HPS, desires extremely stable beam conditions.
- Hall-D GlueX, coherent bremsstrahlung and detector commissioning.

Machine setup: $E_{5.5pass} = 10.5$ GeV

 $Feb-13 \rightarrow Feb-21$ Re-establish 5.5 pass beam using 6 GeV process.

Feb-21 \rightarrow Feb-22 Adjust MO frequency ($\Delta_{499MHz} = 2400Hz$) and establish Arc orbits with minimal offsets.

Feb-22 \rightarrow Mar-05 Beam matching at Arc entrance.





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750MHz separation commissioning with beam 2015-Feb-25->2015-Mar-23

- 249.5MHz digital laser system problematic, fallback to analog.
- Cavity kick (power) less than anticipated, alter optics to reduce the required kick from the separator cavity.
- In addition to 750MHz hardware challenges, CEBAF was battling a LCW stability issue that was causing instability in the beam energy for most of March.





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Energy Reach: Trip Rate at $E_{5.5 pass} = 10.5 \text{GeV}$



RF trip rate at $E_{5.5pass} = 10.5$ GeV \approx 2-3 trips/h



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March 25th Power Event

- Failed power arrester offsite caused CEBAF to loose power.
 - All systems affected, including cryo plants.
- Power restored in a couple of hours.
- Some Helium inventory vented.
- CHL1→SC1→SouthLinac cannot start due to issue with cold compressor 4 in SC1
- CHL2→SC2→NorthLinac cannot achieve stable 2K operations due to contamination issues.





Power Event Impact on Cryogenics 2015-Mar-25 -> 2015-Apr-15

- Warm up 2K cold box on CHL2 to remove contaminants, about one week.
- Investigate SC1 CC4 failure.
 - Compressor wheel stuck, will not rotate, seized, not good.
 - CC4 safe shutdown system found not working.
 - Conjecture is that the wheel at full speed (>30000rpm) crashed during the power outage.
- Reconfigure cryo plants so that CHL2 \rightarrow SC2 can maintain CEBAF (both linacs) at 2K.

Last week, CC4 completely disassembled, mechanical bearing and shaft damaged:





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CEBAF Operations on One CHL: $E_{5.5pass} = 5.5$ GeV

Hall-A Polarimeter Commissioning













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Private comment at the June 2015 Users Group Meeting:

Among us (the users) there is some fear that we'll never have 12 GeV beam for physics.

Contributing factors include:

- SRF gradient
- 5-pass RF separation (750MHz cavtities)
- CEBAF availability, mainly cryogenics
- Beam restoration/tuning time





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2 Rumor Mill

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OEBAF Near Future: 12GeV Beam Operations in FY16





750MHz Separator Cavities: Full Power $(E_{5pass} = 11 \text{GeV})$ Capability

- Increase power input by operating the Inductive Output Tubes (IOT) at 100%.
- Improve resonance control. These are warm Cu RF cavities. Resonance control is through cooling water temperature/flow control.
- Improve coupling into the cavity with improved coupling design and alignment. Improve field flatness, see below.

Installed: Poor coupling to second, power coupler on first cell.



After new coupler and alignment: Better coupling to first cell, power coupler on second cell.



Dogleg upgrade

- Magnet modifications completed Summer 2014.
- Cable pulls completed Summer 2014.
- Nine power supplies arrive Summer 2015.
 - Requires intermediate control card (in-house) to achieve the required specifications.
 - Integration with CEBAF control system.
 - Cable terminations and connections.
 - Full power test.

First article: Dogleg power supply received and accepted.





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Energy Reach



Helium Processing

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- Previously (6GeV era) utilized technique to improve maximum operating gradient of SRF cavities.
 - Estimated gain on previous chart based on these prior applications of Helium Processing: C20(1.2MV/m), C50(1.9MV/m), C100(3.8MV/m).
- Insert small amount of gaseous He into the cavity.
- Process cavity with RF power, watch radiation signature drop (field emitters extinguished).
- Cryo-cycle the cavity to remove the He.
- Determine the maximum operating gradient.





- Process all SRF cavities in the North and South Linac
 - ► All C100, C50, C20 modules will be processed.
 - ► There are 50 cryomodules, 400 cavities in the CEBAF linacs.
 - Process injector modules (18) if time allows.
- Process four cryomodules at a time.
- Takes about eight days per cryomodule.
- Requires the tunnel to be in Power Permit (locked up).
- Scheduled for Swing shifts, tunnel work during the day prevents day shift work.
- Might transition to Day **and** Swing shift once tunnel work is complete.
- Schedule could be impacted by at present unknown cryogenic activities, ie. bringing SC1 back online.





Preparing for Fall2015: OPS 3-day workshop

	FIRM! See Indico Site for Final/Working Agenda: https://www.jlab.org/indico/conferenceDisplay.py?confld=10									
		Link to Indico								
		Arc Auditorium								
	Wednesday, July 15, 2015				Thursday, July 16, 2015 Friday, J					
	SRF/RF/Cryo			OP8			OPS			
08:15-08:30	Assemble: Coffee and Pastries provided			Assemble: Coffee and Pastries provided			Assemble: Coffee and Pastries provided			
08:30-10:15 1h45m	Intro & SRF Data and Cryogenics			OPS and the Users			Tools and Software			
AM1		Chair: Geoff Kraft			Chair: Ame Freyberger			Chair: Matt Bickley		
	8:30	Welcome and Meeting Goals Review action items from last years StayTreat	Ame Freyberger	8:30	Welcome and Meeting Goals	Ame Freyberger	8:30	CED status: new features and data maintenance	Theo Larrieu	
	8:50	SRF CEBAF Operational Performance	Rama Bachmanchi	9:00	Hall-A User feedback	Thia Keppel	9:00	Lock configuration and mangement	Brian Bevins	
	9:40	CEBAF SRF Data management	Geoff Kraft	9:15	Hall-B User feedback	F-X Girod	9.20	FSD Fault Categorization	Ryan Slominski	
	9.55	Cryo status and plans: include info on He and N2 losses, contamination mitigation	Jonathan Creel	9:30	Hall-D User feedback	Hovanes Egiyan	9:40	Getting the most from your requests for help with software	Michele Joyce	
				9:45	Hall-C Status and plans	Thia Keppel	10:00	Content of a good log entry	Ron Lauze	
				10:00	OPS & the users	Mike McCaughan				
10:15-10:30	Break: Cold coffee and stale pastries			Break: Cold coffee and stale pastries			Break: Cold coffee and stale pastries			
10:30-12:00 1h30m	Operations			Beam Transport			Safety and Metrics			
AM2		Chair: Arne Freyberger			Chair: Mike Spata			Chair: Bill Merz		
	10:30	C100 microphonics update	Kirk Davis	10:30	Status of the injector process-driven setu	Alicia Hofler	10:30	PSS status and plans	Henry Robertson	
	10.55	EmaxOPS vs Operational value	Ciyde Mounts	10:50	ORFP Status	I odd Satogata	10.50	OPS and PSS	Paul Vasilauskis	
	11:10	Gradient calibration	Jay Benesch	11:15	Pathlength/MO Setup	Michael Tiefenback	11:10	Service Buildings, B&D rapid access plans	Vashek Vylet	
	11:30	MOLO Performance Summary and Maintenance plans.	Tomaz Plawski	11:30	Extraction/Separator Setup	Mike Spata	11:30	DOE Metrics Reliability	Arne Freyberger	
	11:45	RF Separation status	Mark Wissman	11:45	Discussion	Al				
12:00-13:30	Lunch: On your own		Lunch: On your own			Lunch: On your own				
13:30-15:15 1h45m	Field Emission and Q9			Reliability			Projects			
PM1		Chair: Rongli Geng		Chair: Steve Suhring			Chair: Ken Baggett			
	13:30	HeProc status and results to date	Mike Drury	13:30	RAR Summary	Randy Michaud	13:30	Dogleg upgrade	Andrew Kimber	
	13:45	C20/C50/C100 RF Soak plans: Fault minimizing, Egain maximize	Rama Bachmanchi	13:50	Bellows: RAR report summary	Brian Freeman	13:45	Hall-D feedback	Trent Alison	
	14:00	CEBAF particulate field emitter Control	Rongli Geng	14:05	Vacuum: 12GeV hardening	Anthony Dipette	14:00	High Power Dumps	Dipette/Michalski	
	14:30	Dynamic heater controls	Tom Powers	14:20	Harps: Reliability improvement plans	Omar Garza	14:20	Laser/Inj. Upgrades to support 4-hall ops	Joe Grames	
	14:45	Q0 precision: what is required, what has been achieved?	Jay Benesch	14:35	Downtime: Global analysis	Randy Michaud	14:40	AIP Plans	Arne Freyberger	
	15:00	LEM upgrade path	He Zhang						4.0.10	
15:15-15:30	Break: Cookies, H2O, Ice Tea? Cold soda? Warm soda?			Break: Cookies, H2O, Ice Tea? Cold soda? Warm soda?			Break: Cookies, H2D, Ice Tea? Cold soda? Warm soda?			
15:30-17:00 1h30m	Projects and R&D			Beam Physics			Long Range Plans and Close Out			
PM2	Chair: Jay Benesch			Chair: Todd Satogata			Chair: Joe Grames			
	15:30	New ideas and approaches to raise CEBAF Q0 - initial results and proposed studies	Rongi Geng	15:30	Transverse Emittance	Todd Satogata	15:30	SRF Long Range PIT	Geoff Kraft	
	15:50	The C75	Bob Rimmer	15:50	Model Developments/Status	Yves Roblin	15:50	Partity Quality Beam Working group report	Riad Suleiman	
	16:10	Klystrons and 20yr vision for RF power	Rick Nelson	16:05	qsUtility / eDT Update	Dennis Tumer	16:10	LERF Plans	Steve Benson	
	16:30	Obsolence and anticipated upgrades	Curt Hovater	16:20	Bunch Length Measurements and Plans	Mahmoud Ahmad	16:30	UITF Status and Plans	Matt Poelker	
	16:45	1/4 cryomodule and C50-12 Status update	Tony Reilly	16:40	Discussion	All	16:50	Wrap Up	Arne Freyberger	
17:00	END			END			END?			



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Fall2015 Run (7wks) 2015-Oct-26 $\rightarrow 2015$ -Dec-21

Accelerator Goals of the run period:

Establish 12GeV 5.5pass configuration:

- Optimize SRF/RF/Cryo systems for full energy operation.
- Establish 750MHz separation at **11GeV** (5pass).
- Scrub beam pipe with synchrotron radiation, if needed deal with vacuum loading.
- Commission and operate synchrotron compensation coils in the Arcs.

Setup as per the 12GeV design:

- Minimal Arc orbit offsets, new dogleg capability should help here.
- Match at the **entrance** to each Arc.
- Measure CEBAF beam transverse and longitudinal evolution and compare with expectations.

Physics Goals

Opportunistic beams for physics during this setup period.

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Accelerator Goals of the run period:

- Restore 12GeV configuration from 2015-Dec.
- 2 Deliver Physics quality beams to the users.

Physics Goals







Turbulent Spring 2015 run:

- Beam matching at entrance to Arc is a valid approach to establishing proper CEBAF configuration.
 - Process will become faster as the tools improve.
 - Path towards transitioning from Accelerator scientists as drivers of this process to the Operator staff needs to be defined and executed.
- 4-hall separation system commissioned.
 - Cavity power and control issues identified and being addressed.
 - Laser 249.5MHz drive system being redesign, to be ready to support four-hall operation by Fall2016.
- Cryogenic remains a single point of failure.
- Achieving multi-hall operation has been particularly challenging.

Majority of Summer 2015 shutdown work is in support of operating CEBAF at 12GeV energy.





