CEBAF Status and Plans

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Operations Dept Accelerator Division

JLAB

January 14, 2016



Thomas Jefferson National Accelerator Facility



Accelerator Operations Department

Summer 2015

1 Summer 2015

- Summer 2015 tasks
- Fall2015 Goals
- 2 12 GeV!
- 3 CEBAF Up Time
- 4 Energy Reach







Summer 2015: Final 12 GeV Preparations

12GeV Project related tasks:

Cryo CHL2 Heat exchanger installation Facilities Arc tunnel air-conditioning.

OPS tasks:

Cryo Repaired 2K cold box (SCM) via the SNS spare cold compressor.

DCpower Dogleg upgrade.

RFpower&Software 750Mhz separator cavities.

SRF Helium processing of the majority of CEBAF cavities. IC&Software Hall-D Fastback, nA BPMs

Utilities Infrastructure and Modernization (UIM) tasks:

Facilities Upgraded cooling towers on accelerator site.





Fall2015 Goals:

- Systematic, deliberate, sequential machine setup at design energy.
 - Quad center every Quad-BPM combination with beam.
 - Minimize Arc orbit offsets, utilize the upgraded Dogleg system.
 - Beam matching at the entrance to each ARC.
- Establish 12 GeV CW beam operations to the Hall-D tagger vault.
- Measure beam parameters (ε , bunch length, TWISS parameters) at design energy.
- Evaluate energy reach, minimize trip rate.
- Establish 11 GeV separation, required to support 5th pass separation of A/B/C beam simultaneously with beam to Hall-D.
- Establish high power CW operations to Hall-A at 11 GeV.
- Establish the machine setup for Spring 2016 Physics program



12 GeV!

🚺 Summer 2015

2 12 GeV!

- Beam Emittance
- TWISS β 's
- Bunch Length

3 CEBAF Up Time

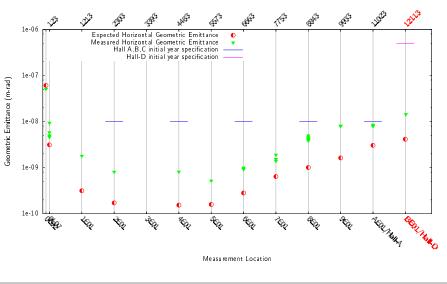
4 Energy Reach

Future





Horizontal Emittance



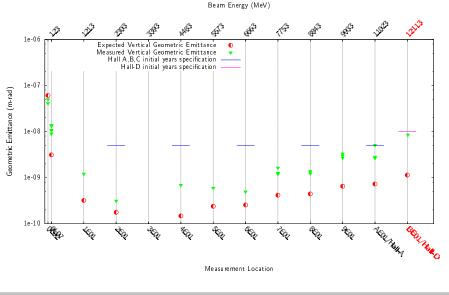
Beam Energy (MeV)

Jefferson Lab OPS

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Vertical Emittance

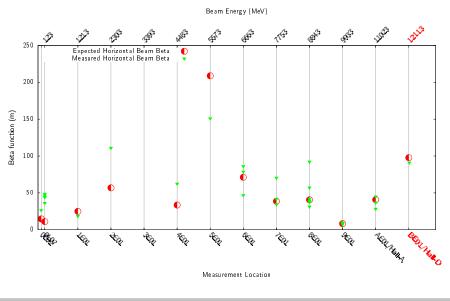




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Horizontal Beta's

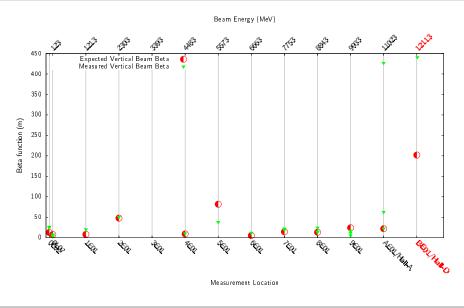




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Vertical Beta's

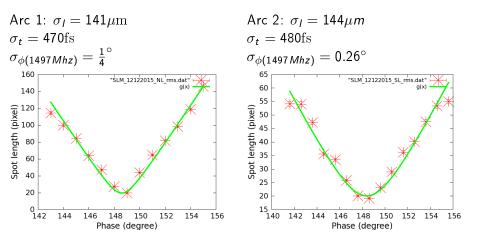


Jefferson Lab OPS

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Beam Bunch Length Mahmoud Ahmad, ODU Graduate Student



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CEBAF Up Time

1) Summer 2015

2 12 GeV!

3 CEBAF Up Time

- Trip Rate
- CEBAF Reliability
- Critical Spares

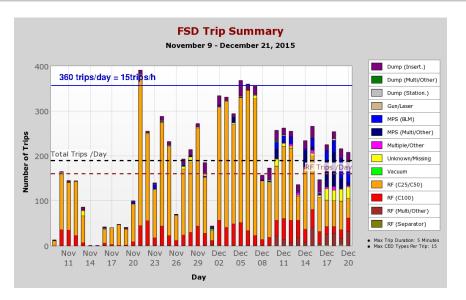
4 Energy Reach

Future





The Struggle: Trip Rate OK!



Jefferson Lab OPS

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CEBAF Reliability: The Struggle

Accelerator Incident Downtime (Hours) from November 9 - December 21, 2015 (07:00 - 07:00)

Summary

Total Downtime (Hours):	266.0	
MTTR (Hours):	2.1	
Total Suspend (Hours):	250.3	
Total Restore (Hours):	15.7	
Period Duration (Hours):	1,008.0	5w

5w*168h/w= 840

• Raw Reliability:
$$100(\frac{840-266}{840}) = 68\%$$

- 1 Downtime every 5 hours
- Mean time to repair 2.1h
- 42% chance of a new downtime event starting before the first downtime is resolved.



Given the constraints of the long term schedule and funding: How do we reduce the number of downtime incidents? How do we reduce the MTTR?Tools at our disposal include: Short term schedule

Short term schedu

Communication

Organization

Process





CEBAF Reliability: Critical Spares

On-going discussion with Eng. and Lab leaders.

Analysis of CEBAF systems required for 12 GeV operations has identified a list of single point failures that would have a large impact (t>3months) on the CEBAF Schedule.

Cold Compressor March 2014 cold compressor failure consumed the only spare cold compressor (nationwide).

AB		C	D	E	F	G			
Potential Down Hard Failures	Cost Estimate Of Spare	Likelihood	Schedule	Capability	Combined Risk	Impact			
BCOM Coil	\$100,000	1	4	4	17	Down hard			
ZA Coil	\$100,000	2	4	3	14	No 4&5 extraction to ABC			
Magnet Box Power Supply	\$100,000	2	4	3	14	No 3 rd pass or higher			
Dogleg Coils	\$50,000	1	4	3	13	Limited passes/pathlength control			
Capture Window	\$25,000	1	3	4	13	Down hard, only needed for 3 more years			
MBL Chicane dipoles	\$15,000	1	3	4	13	Down hard			
RF Separator HV PS	\$200,000	1	3	4	13	No RF separation			
Master Oscillator: Both Fail	\$250,000	1	2	4	11	Down hard: Should be L=0?			
BCOM Vacuum Chamber	\$15,000	1	2	4	11	Down hard			
RF Sep. SS Amplifier	\$70,000	3	2	3	10	Limited option on passes to ABC			
Chopper Amplifier	\$75,000	2	3	3	10	No low current running (B and D)			
ZA Vacuum Chamber	\$15,000	2	2	3	9	No 15.5 extraction to ABC			
YP Vacuum chambor	\$15,000	2	2	3		No 165 pass beam			
TB Vacuum Chamber	\$15,000	2	2	3	9	no 1 st or 2 nd pace extraction or beam to D.			
DogLeg Vacuum Chambers	\$15,000	2	2	2	9	Limited paccoc/pathlongth control			
		2	2		8	Limited passes/pathlength control			
	Hard Failures BCOM Coil ZA Coil Dogleg Coils Capture Window MBL Chicane dipoles RF Separator HV PS Master Oscillator: Both Fail BCOM Vacuum Chamber RF Sep, SS Amplifier Chooper Amplifier	Hard Failures Of Spare BCOM Coil \$100,000 ZA Coil \$100,000 Magnet Box Power Supply \$100,000 Dogleg Coils \$50,000 Capture Window \$22,000 RBL Chicane dipoles \$15,000 RF Separator HV PS \$220,000 BCOM Vacuum Chamber \$15,000 RF Sep. SA Amplifier \$70,000 Chooper Amplifier \$75,000 Chooper Amplifier \$15,000 TA Vescum Chamber \$15,000 TA Vescum Chamber \$15,000 TA Vescum Chamber \$15,000 The Vacuum Chamber \$15,000	Hard Failures Of Spare Likelihood BCOM Coil \$100,000 1 ZA Coil \$100,000 2 Magnet Box Power Supply \$100,000 2 Dogleg Coils \$50,000 1 RALL Children Window \$22,000 1 MBL Chicane diplots \$10,000 2 Magnet Box Power Supply \$200,000 1 Master Oscillator. Both Fail \$250,000 1 Master Oscillator. Both Fail \$250,000 1 BCM Vacuum Chamber \$15,000 1 RF Sep, SA Ampliffer \$75,000 2 ZA Vesouw Chamber \$15,000 2 Vacuum Chamber \$15,000 2 ZA Vesouw Chamber \$15,000 2 Subawer \$15,000 2 ZA Vesouw Chamber \$15,000 </td <td>Potential Down Hard Failures Cost Estimate Of Spare Likelihood Schedule BCOM Coil \$100,000 1 4 ZA Coil \$100,000 2 4 Magnet Box Power Supply \$100,000 2 4 Dogleg Coils \$50,000 1 4 Capture Window \$25,000 1 3 MBL Chicane dipoles \$15,000 1 3 RF Separator HV PS \$200,000 1 2 RCM Vacuum Chamber \$15,000 1 2 RY Sep, SA Amplifier \$75,000 2 3 A Vescum Chamber \$15,000 1 2 R Vescum Chamber \$15,000 2 3 Z Vescum Chamber \$15,000 2 3 Rescum C</td> <td>Potential Down Hard Failures Cost Estimate Of Spare Likelihood Schedule Capability BCOM Coil \$100,000 1 4 4 ZA Coil \$100,000 2 4 3 Magnet Box Power Supply \$100,000 2 4 3 Dogleg Coils \$50,000 1 4 4 Agnet Box Power Supply \$100,000 2 4 3 Capture Window \$25,000 1 3 4 MBL Chicane dipoles \$15,000 1 2 4 RF Separator HV PS \$200,000 1 2 4 BCOM Vacuum Chamber \$15,000 1 2 4 RF Sep.STAMplifier \$75,000 3 2 3 RA Veseum Chamber \$15,000 2 3 3 RA Veseum Chamber \$15,000 2 2 3 RA Veseum Chamber \$15,000 2 2 3 RA Veseum Chamber \$15,000 2</td> <td>Potential Down Hard Failures Cost Estimate Of Spare Likelihood Schedule Capability Combined Risk BCOM Coil \$100,000 1 4 4 107 BCOM Coil \$100,000 1 4 4 107 Agnet Box Power Supply \$100,000 2 4 3 14 Dogleg Coils \$50,000 1 4 4 133 Capture Window \$22,000 1 3 4 133 MBL Chicane dipoles \$15,000 1 3 4 133 Master Oscillator: Both Fail \$250,000 1 2 4 11 RF Separator HV PS \$200,000 1 2 4 11 BCOM Vacuum Chamber \$15,000 1 2 4 11 RF Sep.SS Amplifier \$75,000 3 2 3 100 Chopper Amplifier \$15,000 2 2 9 9 Vacuum Chamber \$15,000 2 2</td>	Potential Down Hard Failures Cost Estimate Of Spare Likelihood Schedule BCOM Coil \$100,000 1 4 ZA Coil \$100,000 2 4 Magnet Box Power Supply \$100,000 2 4 Dogleg Coils \$50,000 1 4 Capture Window \$25,000 1 3 MBL Chicane dipoles \$15,000 1 3 RF Separator HV PS \$200,000 1 2 RCM Vacuum Chamber \$15,000 1 2 RY Sep, SA Amplifier \$75,000 2 3 A Vescum Chamber \$15,000 1 2 R Vescum Chamber \$15,000 2 3 Z Vescum Chamber \$15,000 2 3 Rescum C	Potential Down Hard Failures Cost Estimate Of Spare Likelihood Schedule Capability BCOM Coil \$100,000 1 4 4 ZA Coil \$100,000 2 4 3 Magnet Box Power Supply \$100,000 2 4 3 Dogleg Coils \$50,000 1 4 4 Agnet Box Power Supply \$100,000 2 4 3 Capture Window \$25,000 1 3 4 MBL Chicane dipoles \$15,000 1 2 4 RF Separator HV PS \$200,000 1 2 4 BCOM Vacuum Chamber \$15,000 1 2 4 RF Sep.STAMplifier \$75,000 3 2 3 RA Veseum Chamber \$15,000 2 3 3 RA Veseum Chamber \$15,000 2 2 3 RA Veseum Chamber \$15,000 2 2 3 RA Veseum Chamber \$15,000 2	Potential Down Hard Failures Cost Estimate Of Spare Likelihood Schedule Capability Combined Risk BCOM Coil \$100,000 1 4 4 107 BCOM Coil \$100,000 1 4 4 107 Agnet Box Power Supply \$100,000 2 4 3 14 Dogleg Coils \$50,000 1 4 4 133 Capture Window \$22,000 1 3 4 133 MBL Chicane dipoles \$15,000 1 3 4 133 Master Oscillator: Both Fail \$250,000 1 2 4 11 RF Separator HV PS \$200,000 1 2 4 11 BCOM Vacuum Chamber \$15,000 1 2 4 11 RF Sep.SS Amplifier \$75,000 3 2 3 100 Chopper Amplifier \$15,000 2 2 9 9 Vacuum Chamber \$15,000 2 2			



Thomas Jefferson National Accelerator Facility CEBAF-UGBOD Update





Energy Reach

Summer 2015

2 12 GeV!

3 CEBAF Up Time

4 Energy Reach

- Gradient Distribution
- Energy Reach

Future





Gradient Distribution at 12 GeV

Dec 17 2015: RF trips < 5 trips/h

RF and arc1/arc2 status at: 2015-12-17 05:00

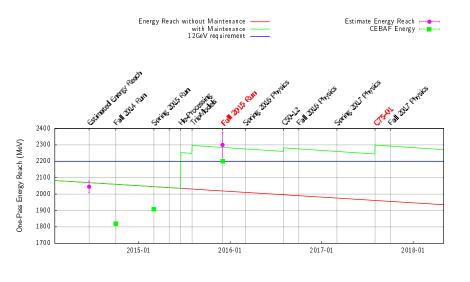
Linac	Туре	Ncav	<gmes> (MV)</gmes>	GMES <i>rms</i> (MV)		Egain (MeV)
Inj	C20	8	8.24	2.15	4.96-11.02	33.0
Inj	C100	8	15.87	0.22	2 15.49-16.01	. 88.9
NL	C20	120	6.57	1.73	3 2.97-11.48	394.1
NL	C50	40	10.12	3.20	4.40-13.98	202.4
NL	C100	39	17.57	2.43	3 10.62-21.00	479.6
SL	C20	106	7.44	1.78	3 2.96-12.01	394.5
SL	C50	45	11.13	1.78	6.13-13.85	250.5
SL	C100	38	15.69	2.20) 10.53-18.20	417.3
Linac		0	ain eV)	Σ _E Sp (MeV)	ectrometer M	omentum (MeV/c)
Injector:		121	.86 1	21.86	INJ:p	121.35
North Linac:		1076	.04 11	97.91	Arc1:p	1212.98
South Linac:		1062	. 35 22	60.26	Arc2:p	2302.92



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Energy Reach





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Future



Future

- Spring 2016
- Summer 2016
- Summary





CEBAF Spring 2016 Beam Operations

Index Name							Jan 20	016 Feb 2016	Mar 2016	Apr 2016
	Name	Task Description		Start	End	Effort				
7	- Physics 12GeV Initial Ops			Mon 2015-11-09 20:00	Sat 2016-10-01 00:00	11.0				
7.3	- Physics Period II:	12GeV setup, 2.2GeV per pass 📎		Thu 2016-01-28 08:00	Thu 2016-04-14 09:00	11.0		-		
7.3.1	Machine restoration E(5.5pass)	Restore machine at the highe 🔇		Thu 2016-01-28 08:00	Thu 2016-02-04 08:00	1.0		—		
7.3.2	Physics HallA & D	12GeV setup, 2.2GeV per pass	5	Thu 2016-02-04 08:00	Thu 2016-04-14 09:00	10.0		+		
12	🕶 Hall-A NPES Schedule			Thu 2016-02-04 06:00	Mon 2017-06-05 06:00	0.0				
12.1	DVCS/GMp Part One	Pass Five beam		Thu 2016-02-04 06:00	Mon 2016-03-14 06:00	0.0				
12.2	DVCS/GMp Part Two	Pass Five beam	5	Thu 2016-03-17 06:00	Thu 2016-04-14 06:00	0.0				
13	Hall-B NPES Schedule			Fri 2016-02-05 15:00	Mon 2017-06-05 06:00	0.0				
13.1	HPS Weekends	Pass One beam	5	Fri 2016-02-05 15:00	Mon 2016-03-07 06:00	0.0			-	
13.2	PRad commissioning	Pass One beam		Fri 2016-04-08 15:00	Mon 2016-04-11 06:00	0.0				
14	🕶 Hall-C NPES Schedule			Mon 2016-03-14 06:00	Mon 2017-06-05 06:00	0.0			-	
14.1	 Beamline Checkout with beam 	Pass Two	5	Mon 2016-03-14 06:00	Thu 2016-03-17 06:00	0.0				
15	Hall-D NPES Schedule			Thu 2016-02-04 06:00	Wed 2017-05-31 06:00	0.0		-		
15.1	🖃 GlueX commissioning run Part On 🔇	Pass 5.5 beam	5	Thu 2016-02-04 06:00	Mon 2016-03-14 06:00	0.0				
15.2	GlueX commissioning run Part Tw	Pass 5.5 beam		Thu 2016-03-17 06:00	Thu 2016-04-14 06:00	0.0				
All et	ffort and duration values are in weeks. 24/	scenario								
		• • •		r Task 📰 Normal 1 period	Task 🔶 Milestone					



Thomas Jefferson National Accelerator Facility CEBAF-UGBOD Update



- Laser table upgrade to support 4-hall simultaneous running
- Install and commission C50-12
- Repair MYR6T02: Magnet coil leak. Found yesterday. No 3rd-pass extraction until repaired.
- Low power bill operations
 - 1.1GeV/pass, 1-pass beam for Hall-B (PRad)
 - Injector Bubble Chamber engineering run
 - 1.1GeV/pass, 5-pass beam for Hall-C pre-checks





Summary

- 12 GeV CEBAF CW operations have been established.
 - Spring 2016 Physics program will be at the design energy.
- RF separation on 5th pass (11 GeV) has been established.
 - ► Enables simultaneous Hall-D and A, B, or C operation on 5th pass.
 - Presently limited to 3-hall operation, due to laser table configuration.
- Effort to improve CEBAF Reliability on-going.
 - Energy reach is a constant concern and requires vigilance.
 - A new cryomodule refurbishment program that provides 75MeV/cryomodule (C75) per year will increase the gradient margin.
 - CEBAF Downtimes are tracked and analyzed.
 - Performance data is used to develop near term fixes, annual work plans and long-term projects.
- Laser table upgrade planned for Summer 2016.
 - ► Four operations at design energy planned for Spring 2017.

