

CEBAF Status and Plans

Arne Freyberger

Operations Dept.
Accelerator Division

JLAB

January 14, 2016

Accelerator Operations Department

Summer 2015

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

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.

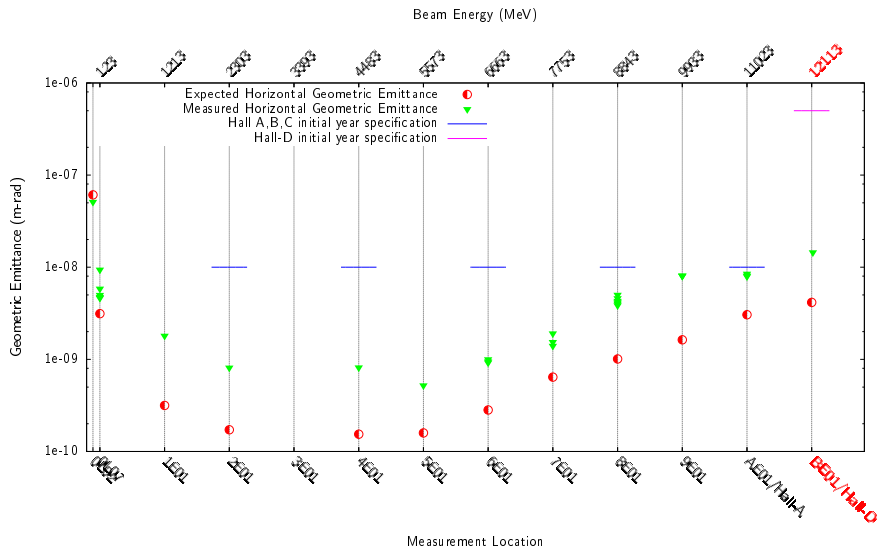
Fall2015 Goals:

- 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**

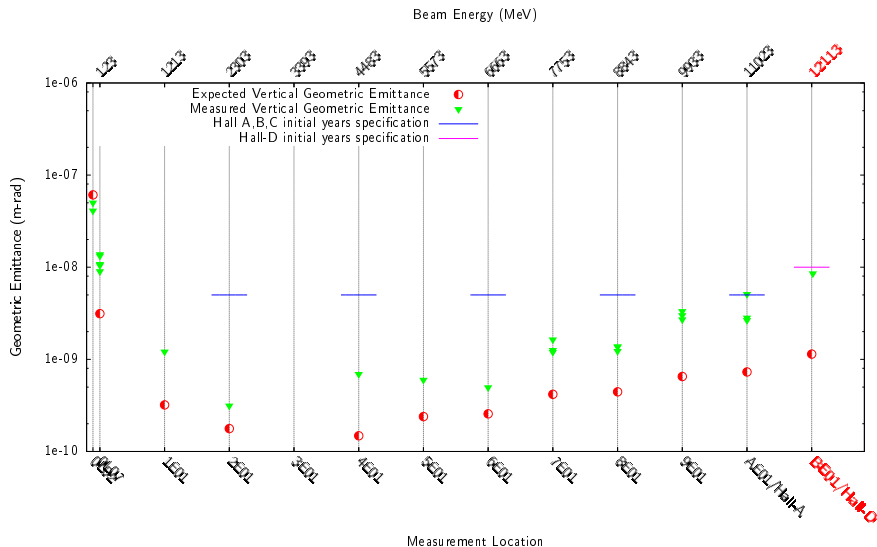
12 GeV!

- 1 Summer 2015
- 2 12 GeV!
 - Beam Emittance
 - TWISS β 's
 - Bunch Length
- 3 CEBAF Up Time
- 4 Energy Reach
- 5 Future

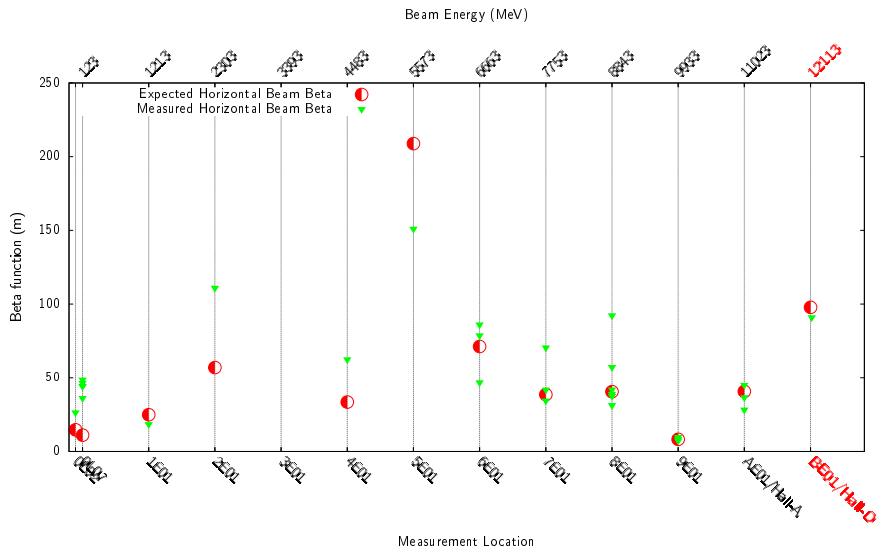
Horizontal Emittance



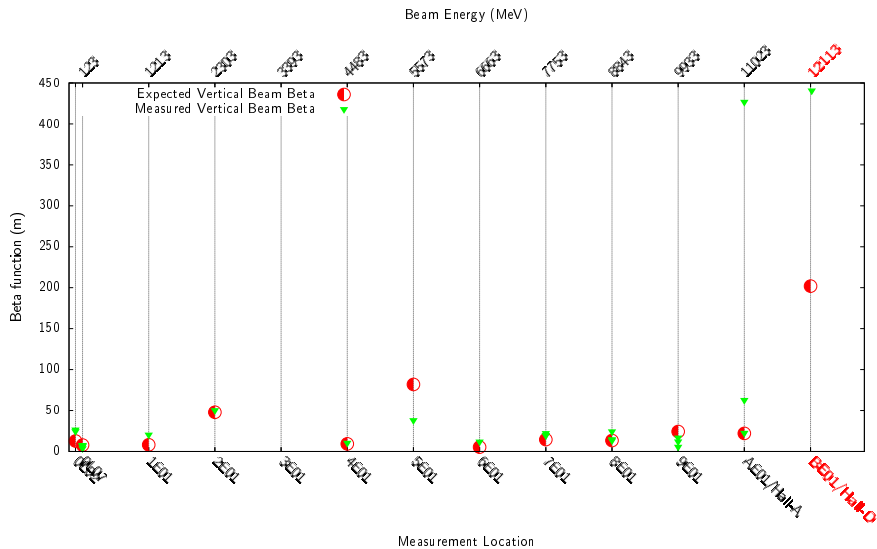
Vertical Emittance



Horizontal Beta's



Vertical Beta's



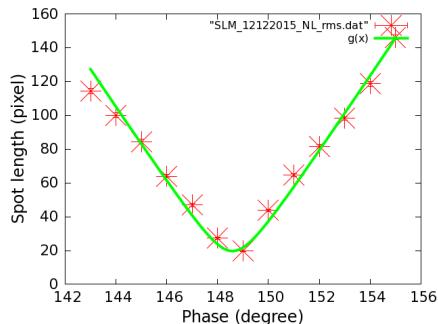
Beam Bunch Length

Mahmoud Ahmad, ODU Graduate Student

Arc 1: $\sigma_l = 141\mu\text{m}$

$\sigma_t = 470\text{fs}$

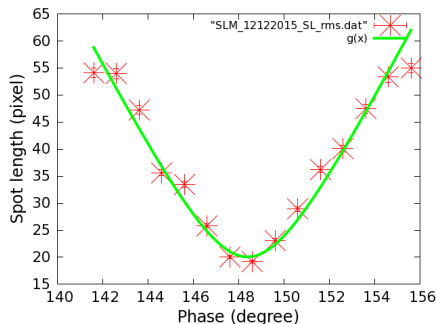
$\sigma_{\phi}(1497\text{Mhz}) = \frac{1}{4}^\circ$



Arc 2: $\sigma_l = 144\mu\text{m}$

$\sigma_t = 480\text{fs}$

$\sigma_{\phi}(1497\text{Mhz}) = 0.26^\circ$



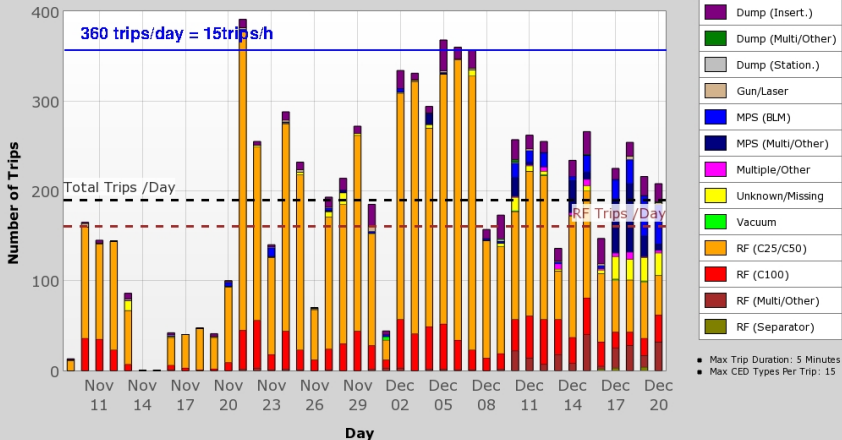
CEBAF Up Time

- 1 Summer 2015
- 2 12 GeV!
- 3 **CEBAF Up Time**
 - Trip Rate
 - CEBAF Reliability
 - Critical Spares
- 4 Energy Reach
- 5 Future

The Struggle: Trip Rate OK!

FSD Trip Summary

November 9 - December 21, 2015



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*168h/w= 840

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

CEBAF Reliability: Path Forward

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

- 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 ($t > 3$ months) on the CEBAF Schedule.

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

	A	B	C	D	E	F	G
	Potential Down Hard Failures	Cost Estimate Of Spare	Likelihood	Schedule	Capability	Combined Risk	Impact
1							
2							
3							
4	BCOM Coil	\$100,000	1	4	4	17	Down hard
5	ZA Coil	\$100,000	2	4	3	14	No 4&5 extraction to ABC
6	Magnet Box Power Supply	\$100,000	2	4	3	14	No 3 rd pass or higher
7	Dogleg Coils	\$50,000	1	4	3	13	Limited passes/pathlength control
8	Capture Window	\$25,000	1	3	4	13	Down hard, only needed for 3 more years
9	MBL Chicane dipoles	\$15,000	1	3	4	13	Down hard
10	RF Separator HV PS	\$200,000	1	3	4	13	No RF separation
11	Master Oscillator: Both Fail	\$250,000	1	2	4	11	Down hard: Should be L=0?
12	BCOM Vacuum Chamber	\$15,000	1	2	4	11	Down hard
13	RF Sep. SS Amplifier	\$70,000	3	2	3	10	Limited option on passes to ABC
14	Chopper Amplifier	\$75,000	2	3	3	10	No low current running (B and D)
15	ZA Vacuum Chamber	\$15,000	2	2	3	8	No 4&5 extraction to ABC
16	YP Vacuum chamber	\$15,000	2	2	3	8	No 4&5 pass beam
17	YB Vacuum Chamber	\$15,000	2	2	3	8	No 1st or 2nd pass extraction or beam to D
18	Dogleg Vacuum Chambers	\$15,000	2	2	3	8	Limited passes/pathlength control
19	Dogleg Vacuum Bellows	\$15,000	2	2	3	8	Limited passes/pathlength control

Energy Reach

- 1 Summer 2015
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- 4 **Energy Reach**
 - Gradient Distribution
 - Energy Reach
- 5 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

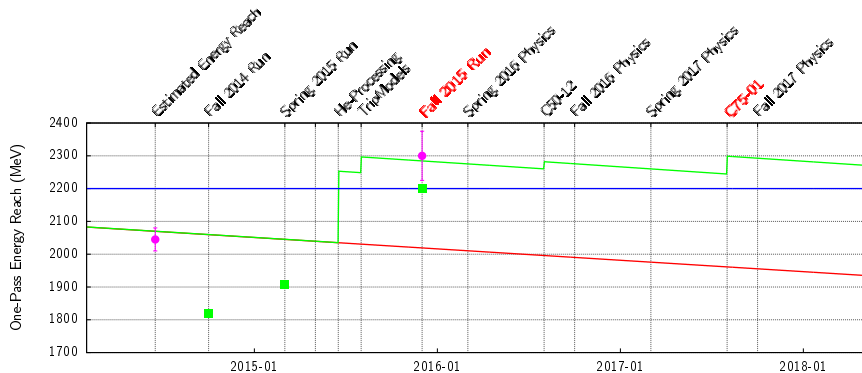
Linac	Type	Ncav	<GMES> (MV)	GMES _{RMS} (MV)	Min-Max (MV)	Egain (MeV)
Inj	C20	8	8.24	2.15	4.96-11.02	33.0
Inj	C100	8	15.87	0.22	15.49-16.01	88.9
NL	C20	120	6.57	1.73	2.97-11.48	394.1
NL	C50	40	10.12	3.20	4.40-13.98	202.4
NL	C100	39	17.57	2.43	10.62-21.00	479.6
SL	C20	106	7.44	1.78	2.96-12.01	394.5
SL	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	Egain (MeV)	Σ_E (MeV)	Spectrometer	Momentum (MeV/c)
Injector:	121.86	121.86	INJ:p	121.35
North Linac:	1076.04	1197.91	Arc1:p	1212.98
South Linac:	1062.35	2260.26	Arc2:p	2302.92

Energy Reach

Energy Reach without Maintenance —
with Maintenance —
12GeV requirement —

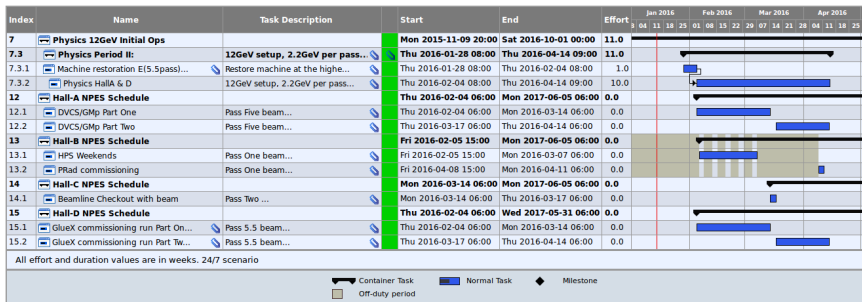
Estimate Energy Reach —
CEBAF Energy —



Future

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 - Spring 2016
 - Summer 2016
 - Summary

CEBAF Spring 2016 Beam Operations



- 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.