

CEBAF Status & Plans

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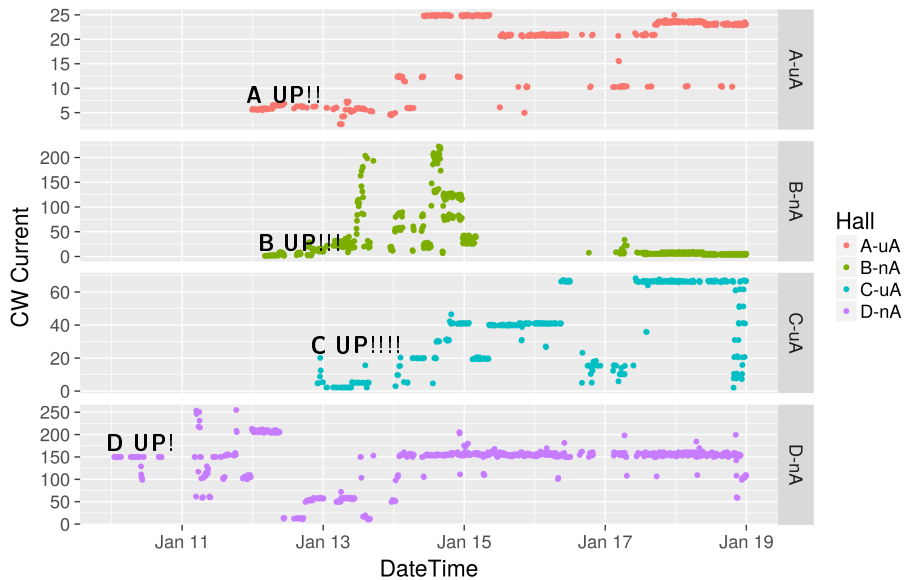
May 23, 2018

Accelerator Operations Department

FY18 Operations (to-date)

- 1 FY18 Operations (to-date)
- 2 CEBAF Performance Plan
- 3 Future Schedule

Four Hall Operations!



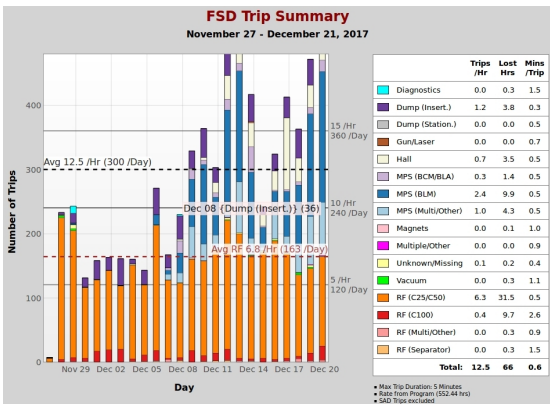
Preceding Activities Operations post Summer2017 shutdown

- $\approx 50\%$ of CEBAF warmed to room temperatures (for maintenance and due to unplanned loss of Cryogenics)

Plan 3 week physics program: establish a four hall Program

Reality 2 weeks of beam delivery, 2-3 hall program

Availability sub 50%, 748.5 MHz RF separators, magnet, ... issues



Accelerator Availability*: 48.4%

Loss Due to Events*: 39.6%

Loss Due to Trips*: 12%

Event Availability*: 60.4%

Trip Availability*: 88%

- Machine setup took longer than expected
- Energy Reach OK, ≈ 7 trips/h
- 748.5 MHz separator challenges, operational near end of run.

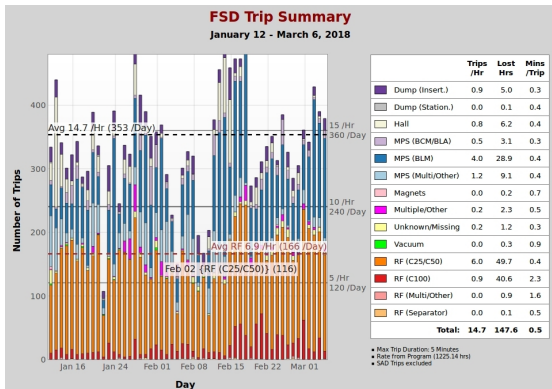
Preceding Activities Winter Break, minimal maintenance activities

- CEBAF @2K during break

Plan Establish and execute a 3+ hall Program

Reality 3+ halls, unable to sustain high current delivery to Hall-C

Availability improving to 56%, beam tuning, not hardware, dominates the downtime



Accelerator Availability*: 55.9%

Loss Due to Events*: 32.1%

Loss Due to Trips*: 12%

Event Availability*: 67.9%

Trip Availability*: 88%

- Transformer failure on March 5th terminated beam operations
- Energy Reach OK, ≈ 7 trips/h, *trips trending up?*
- Too many MPS (beam loss)

Technical Stop: Transformer Failure and Repair

2018-03-05 – 2018-03-21

Top of the failed transformer, black is cracked oil the spewed out the top relief port.



Replacement transformer delivered in 5-days!



Maintenance work in parallel with transformer repair and restart of CHL1->SCM system.

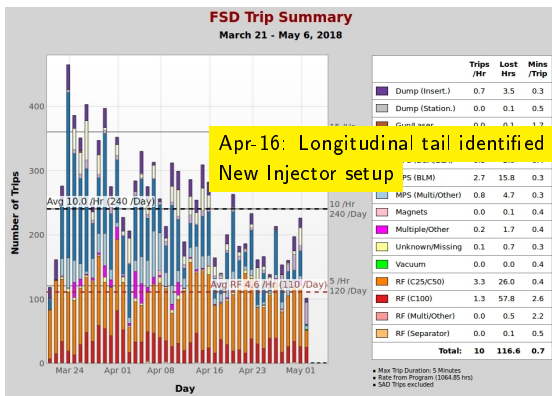
- RF maintenance activities to arrest the trend of increasing RF trip rate.

Preceding Activities Transformer repair and RF maintenance

Plan Continue to execute a 3+ hall Program

Reality 4 hall program

Availability 71%, best availability to-date in the 12 GeV era



Accelerator Availability*: 70.8%

Loss Due to Events*: 18.2%

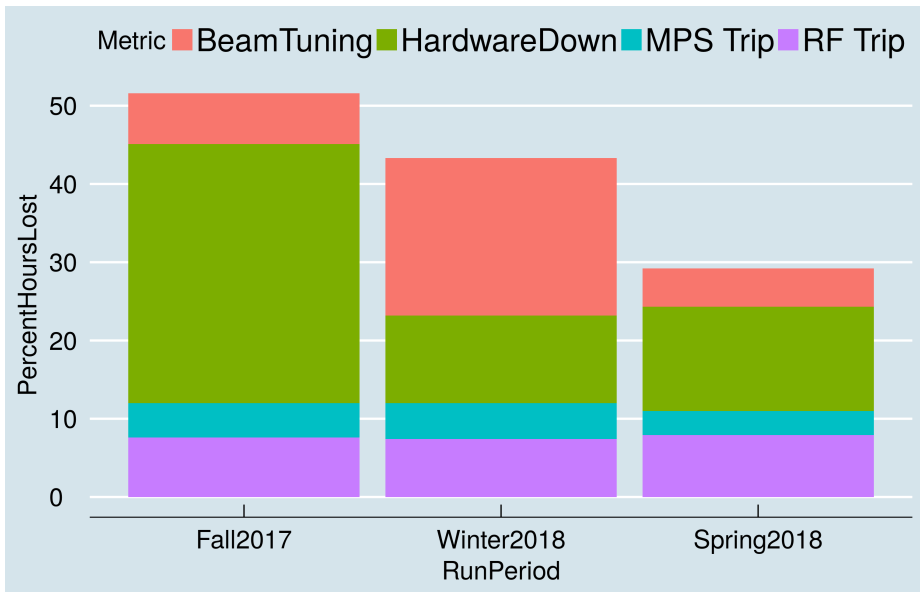
Loss Due to Trips*: 11%

Event Availability*: 81.8%

Trip Availability*: 89%

- High current limitation attributed to a longitudinal beam tail
- Reduction of MPS trips
- Energy Reach improved, < 5 trips/h

Lost Hours: Evolution



CEBAF Performance Plan

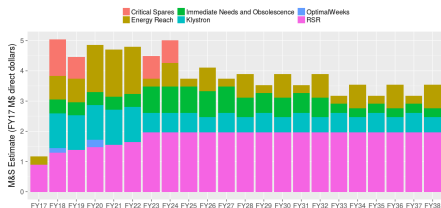
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CEBAF Performance Plan

JLAB-TN-17-022

Strategy to improve CEBAF performance through:

- 1 Purchase Critical Spares to mitigate the impact of single point failures.
- 2 Replenish consumed hardware spares (i.e. Klystrons)
- 3 Increase Energy Reach to support design energy with robust energy margin.
 - C75 Refurbish 8 original C20 modules, including new cavities and digital controls.
 - C100 Develop and execute C100 refurbishment plan
- ParticulateControl Clean warm girder regions and upgrade vacuum systems
- 4 Upgrade original CEBAF hardware to mitigate obsolescence issues in a timely manner (ie. before it becomes an issue)
- 5 Procure equipment to minimize future maintenance duration (to support up to 35 weeks-per-year of operation).

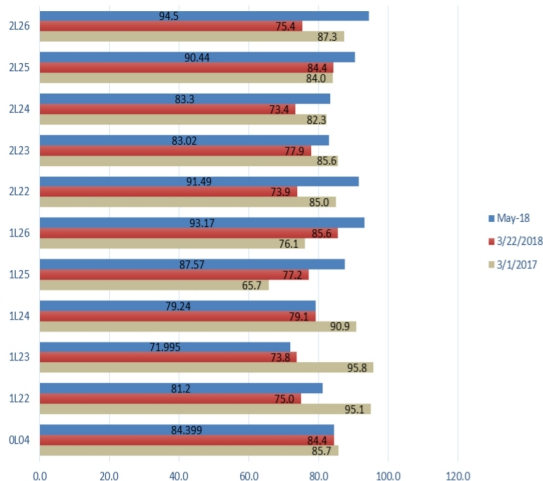


Energy Reach: C100 Status

- Started on March 23
- South **up** 18.6MeV/m from 2017
 - gradient was just sitting there, sad and forgotten
- North **down** 10.5MeV/m from 2017
 - cryo events, vacuum, FE

MeV/m	Total	North	South
March 2017	933.5	423.6	424.2
March 2018	860.1	390.8	384.9
May 2018	940.5	413.2	442.8

- North is up 22.4 MeV/m from the start
- South is up 58 MeV/m



Energy reach: NL 1079MeV; SL 1080MeV

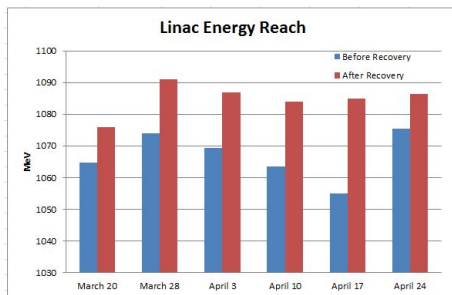
Slide: Anna Solopova

RF Recovery Days

During beam delivery cavity gradients can sometimes be lowered or turned off due to:

- Perceived excessive trip rate
- Difficulty recovering the cavity after a trip
- Hardware failures

Planned work during RF recovery day is to *recover* gradient so that the RF margin remains in the positive range.



Graphic: Ken Baggett

Energy Reach: Plans

Near Term: Summer2018

Goal is to **maintain** CEBAF energy capability at 1050 MeV/linac for the next run.

- Install the LERF **F100** in NL23 slot. C100 style cryomodule.
- Install the LERF **P1** in NL07 slot. P1: First post-C20 cryomodule
- Helium process poorest performing cavities
- Thermal cycle NL C100 to remove frozen gases
- Install rad-hard turbo pumps on insulating vacuum space

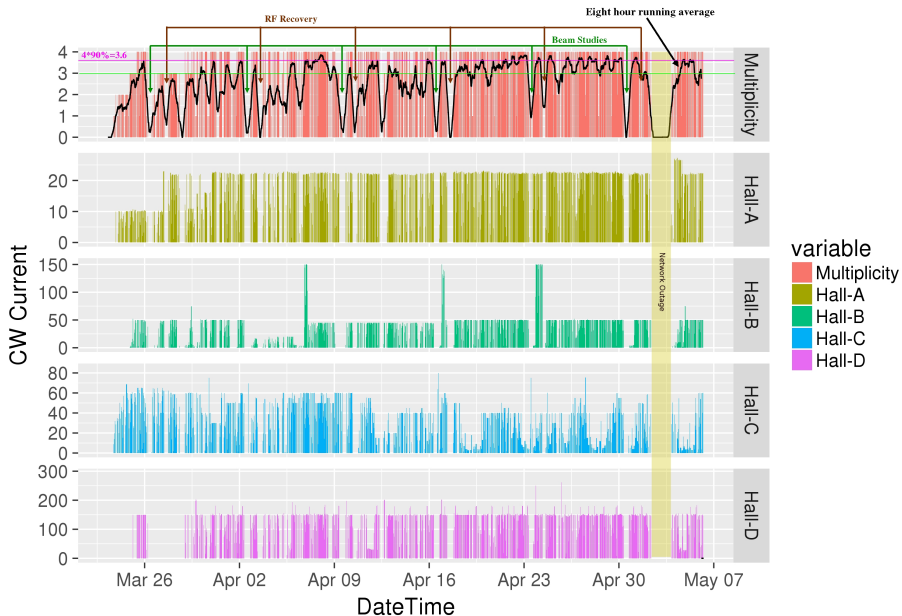
Long Term

Goal is to **improve** CEBAF energy capability at 1090 MeV/linac with robust margin by 2021-Oct(FY22).

	FY	Proposed Linac Energy Setting for FY	Linac Margin	Rebuilt cryomodules completed in FY	Comment
Date		MeV linac	MeV linac		
2017-10-01	FY18	1050	25	F100, P1	Install Two FEL hot modules
2018-10-01	FY19	1050	31	C75-1	First C75 Installed Summer 2019
2019-10-01	FY20	1050	37	C75-2/C100-Refurb-1	First C100 Refurb module installed
2020-10-01	FY21	1050	50	C75-3/C75-4/C100-Refurb-2	First year of two C75s
2021-10-01	FY22	1090	36	C75-5/C75-6/C100-Refurb-3	
2022-10-01	FY23	1090	72	C75-7/C75-8/C100-Refurb-4	

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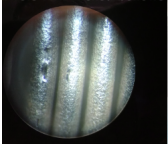
Hall Multiplicity



Summer2019: Ongoing Shutdown Activities

- CHL1 and ESR maintenance
- Repair leak in 5th-pass RF separator (done)
- Detailed analysis of optics data from Spring2018, to identify and correct model error(s)
- Modify Hall-C line to be a near mirror image of Hall-A line
- Gradient maintenance (Helium processing, cryomodule swaps, ...)
- Grid maintenance: Transformer/Breakers
- Upgrade original 4 GeV box power supplies

748.5 MHz nicked bellows



Future Schedule: Fall2018-Summer2019

Fall2018: 2018-08-22 — 2018-12-20

- Three energies: 1050 MeV/linac, 930 MeV/linac, 805 MeV/linac
- 4-hall and 3-hall program
- E12-17-003 requires beam with a very small energy spread

Winter2019: 2019-01-30 — 2019-03-11

- One energy: 1050 MeV/linac, no pass changes
- 4-hall program
- Full power, 900 kW, program

Summer2019: 2019-06-10 — 2019-08-04

- One energy: 450 MeV/linac, no pass changes
- 2-hall program
- Parity experiment in Hall-A, 70 μ A, 1-pass
First parity experiment in the 12 GeV era

Future Schedule: Fall2019→

Fall2019: 2019-10-01 — 2019-12-18

- One energy: 1050 MeV/linac
- 4-hall and 3-hall program
- CRex parity violation experiment in Hall-A
150 μA \rightarrow high bunch charge
1-pass

Summer+Fall2020: New 2K Coldbox

- CEBAF on one Cryo plant
- Low energy beam operation in parallel with the 2K cold-box commissioning is under evaluation once the cryogenic capabilities are fully understood for this period
- Beam operations with two 2K plants resume 2021-Jan/Feb.

202[1-2]: New End Station Refrigerator (ESR)

- Schedule impact limited to when loads are switched from old ESR to new ESR.

Summary

- Beam availability to date this year has steadily improved
- Accelerator ability to support four halls established
 - ▶ Achieved shift (8h) multiplicity greater than 3.6 ($4 \times 90\%$ (FSD eff))
 - ▶ Achieved week averaged multiplicity greater than 3.1 ($4 \times 90\% \times 85\%$ (sch. eff.)) in the final weeks of operation (prior to network outage)
- Achieved full beam power (900 kW)
 - ▶ RF ability to support full beam load established (significant effort)
 - ▶ Identification and mitigation of longitudinal tail as the initial limitation to sustained full power beam delivery
- Energy Reach maintained and improved throughout the run
- Shutdown tasks targeted to build upon the Spring performance

