FY25 Run Summary and FY26 Projections

2025 Run Retreat

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Eduard Pozdeyev

Director of Accelerator Operations

Jefferson Lab

U.S. DEPARTMENT of ENERGY

Retreat Goals

- Summarize the FY25 run
- Identify strengths and weaknesses. Identify opportunities for improvement
- Outline goals and discuss technical plans, ensure they are aligned

- Address charge with respect to your systems. Do others see it same way?

- Written report after the Run with input from presentations

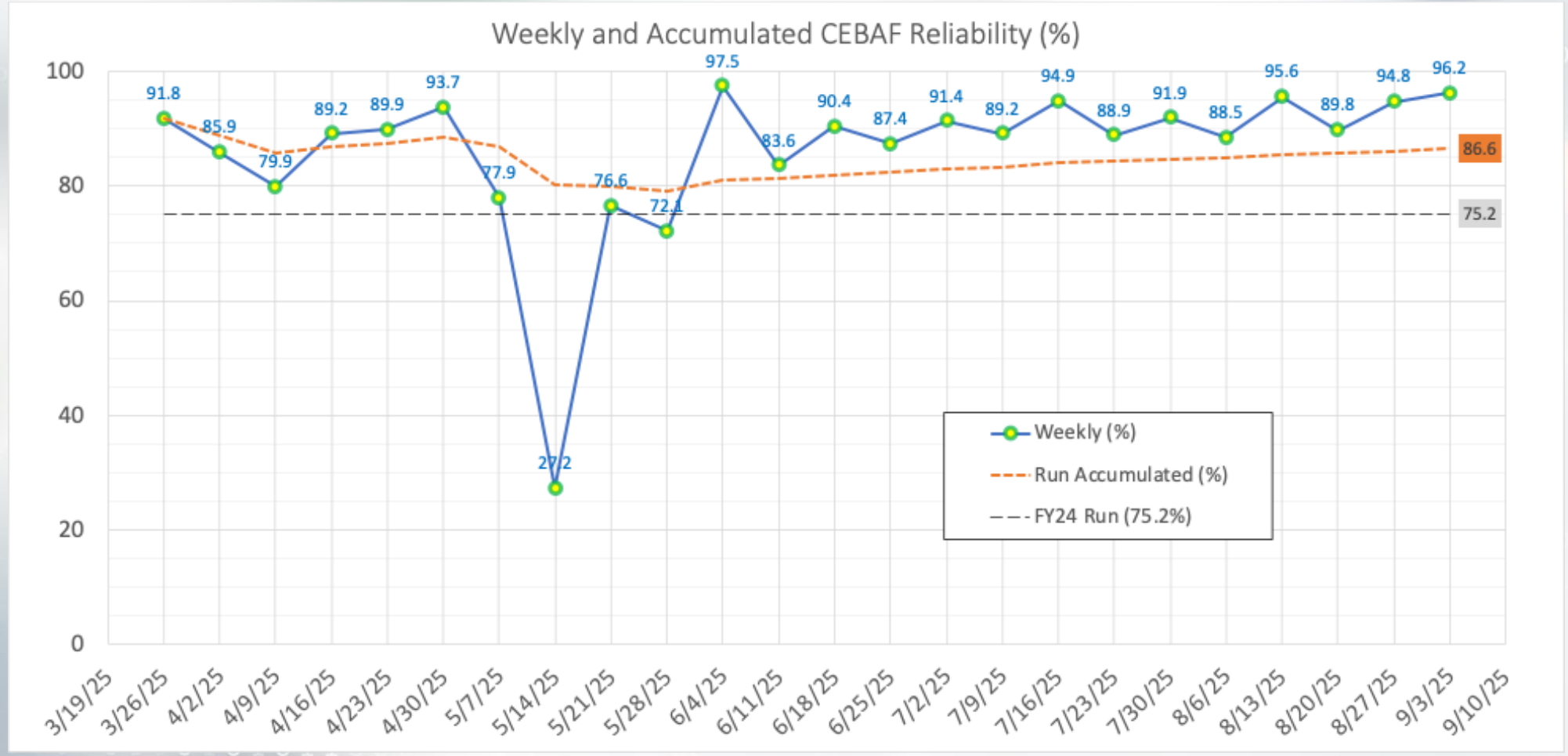
FY25 Run

- 22 weeks of Physics + 2 weeks of beam restore (03/19 – 09/03, 2025)
  - Hall A operations stopped on 08/25 (21 weeks of Physics)
- Energy gain 1060 MeV/linac ($E_{5.5}$ = 11.7 GeV)
- Delivered beam power up to 830 kW
- Polarized beams to Halls A, B, C, D
- FY25 Delivered Beam Statistics (hours)

Total delivered beam (h)	3236
Delivered research (h)	2767.4
Delivered beam study (h)	142.9
Delivered tuning, setup, restore (h)	325.7
Unscheduled failure (h)	500
Total scheduled (h)	3736
Reliability (%)	86.6

DOE Requirement for FY25, total delivered 3000 h, exceeded by 8%.

FY25 Run Reliability

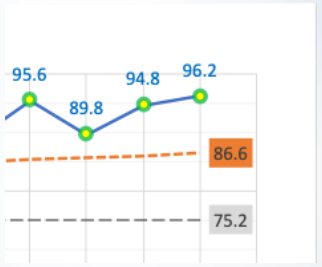


CEBAF reliability, weekly and average since 03/19 (beginning of the run) until 09/03.
The figure also shows the CEBAF average FY24 run reliability (09/23 – 05/24), 75.2%, for reference.

FY25 Run Was a Success

- Highest reliability in 12 GeV era
- Downtime was reduced by nearly factor of two

$$\frac{100 - 86.6}{100 - 75.2} = 0.54$$



- Less FSD trips and better beam quality
  - More RF energy margin (especially in North Linac)
  - Reduced beam losses due to addition of Ion Chambers (!)
- Letter from JLab User Organization Board of Directors

Jefferson Lab
Thomas Jefferson National Accelerator Facility

INTERNAL MEMO

September 11, 2025
Sent on behalf of the Jefferson Lab Users Organization (JLUO) Board of Directors

SUBJECT: Thank You for the Successful CEBAF Run!

Dear Colleagues,

On behalf of the entire user community, the JLUO Board of Directors extends its gratitude to you, the staff of Jefferson Lab, for the successful CEBAF run completed on Sept. 3. This run significantly advanced the scientific program of the community, with highlights including:

- Completion of the GEp run in Hall A, paving the way for the installation of MOLLER
- Installation and operation of A Low Energy Recoil Tracker (ALERT) in Hall B and the completion of the four run group experiments
- Completion of the Large Acceptance Detector (LAD) experiment in Hall C
- Commissioning of a new calorimeter in Hall D and acquiring over 5 petabytes of raw data for the JLab Eta Factory (JEF) and GlueX experiments

We deeply appreciate being able to call on you as engineers, technicians, machine operators, run coordinators and shift workers at any time, even in the middle of the night, and to have you answer that call with such support and enthusiasm for the scientific mission of the lab. You weren't deterred by the challenges along the way, whether they were caused by the high water table, the Virginia summertime heat or simply a curious snake!

Congratulations to you for setting a CEBAF reliability record in the 12 GeV era and doing so while operating at higher beam energy and current than in years past. We look forward to continuing to work together to pursue the ambitious future nuclear physics program that draws us to Jefferson Lab from institutions around the world.

With sincere thanks,

The Jefferson Lab Users Organization Board of Directors

Factors Contributing to Higher Reliability

- Fixed Time Accounting inconsistencies
  - Fixed downtime assigned to accelerator in case of inability to deliver beam to a specific hall.
  - Better planning for recovery time after maintenance, recovery, etc. Underpromise, overdeliver.
- Better maintenance planning
  - Improved RF Maintenance Planning (Jayendrika's RF Table)
  - Weekly RF maintenance supported gradient margin
  - Less entries to the tunnel help with stable operations
- Improved communication between technical teams
  - Gradient Team
  - SRF/RF/Ops meeting
  - Communication between technical teams improved in general
- Investment into CEBAF accelerator systems and infrastructure
  - Reliability, Energy Reach, Beam Loss Detection, Injector, Facilities, and other projects.
- Investment into personnel
  - CEBAF Operator team staffing allows for operating CEBAF without extreme stress and training new operators

Other Developments

- Upgraded gun and injector
- Improvements in accelerator systems
  - MO fiber distribution in North Linac
- Progress with MOLLER studies and hardware development
- Degrader installed and commissioned
- 5D line re-installed and commissioned
  - Experimental cryostat is not ready yet
- Fast Feedback revival and test
- Deployment of LabJacks to monitor beam stability around CEBAF
- Continuing development and deployment of software to monitor beam stability

Opportunity For Improvement (OFI): Beam Transport

- We still can acquire significant downtime due to unexplained issues with beam
  - Example: Hall B halo in May 2025
- Beam-based information is utilized insufficiently
  - Mis-wired quads during March Beam Restore
  - Noise, oscillations, instabilities…
- What can we do
  - Improved and additional instrumentation
    - Beam quality, Halo
    - Continue deployment of ion chambers to improve beam loss detection – significant improvement in FY25
    - System upgrades (BPM, timing, etc.)
  - Focused interdisciplinary teams and campaigns (e.g., Ops/CASA Beam Transport Downtime Team)
  - Development and use of new software stools to collect and process beam data
    - Adam, Dennis, Kyle, Tom's loggers and watchers
    - ML/AI can provide significant help in processing data and detecting issues

OFI: RF and High Intensity Performance

- Need to resolve issues with 8 kW circulators
  - This issue impacts performance of C75 CMs
- Need to improve performance of 13 kW klystrons
  - Some improvement (~10%) was achieved last run
  - Some klystrons still perform at ~8 kW level
- CEBAF beam intensity limit needs to be understood
  - CEBAF beam intensity limit is below expected value
  - Possible contributors (not blaming, just asking):
    - LLRF is not performing as expected - ?
      - Klystron power-dependent phase shift was brought up as one possibility
      - Did we have a comprehensive review
    - Microphonics is larger than expected - ?
    - Other sources of instability - ?

OFI: Project Planning, Approval, and Execution

- We are lacking process to initiate, approve, and track CEBAF improvement projects
- Projects do not follow best practices
  - This is related in part to the first bullet but partially to established culture
- This results in
  - Underperforming or failed CEBAF systems
  - Unplanned work requests, schedule conflicts, unplanned funding requests
  - Inconsistent approach to reviews and approvals
- We need to establish
  - Process to initiate, approve, and track CEBAF projects on the division level
    - Graded, with clear rules, tracking on the division level
  - CEBAF configuration Control Committee to ensure projects follow established process and best engineering practices

Systematic Effort To Improve Reliability [1]

- Systematic improvement of reliability requires systematic approach to addressing issues causing downtime

- Continue investments in reliability of accelerator systems
- Time to review and refresh inventory of critical spares
- Need a well-thought, integrated plan to address Obsolescence

- To address these issues efficiently, SMEs need to understand main contributions to downtime on the sub-system level
  - Ops provide downtime report by accelerator systems – it is just an indicator, insufficient to understand what specifically causes downtime
  - SMEs and system owners need to dig a level down into failure data to find main contributors to downtime
  - Some system owners do it better than others
- Obsolescence analysis is required to predict future needs

Systematic Effort To Improve Reliability [2]

- DOE wants 85% CEBAF reliability
- Data-driven approach to meet reliability is to
  - Allocate reliability numbers for each high-level system
  - Group leaders/system owners develop a plan how they are going to meet the allocated downtime number and provide the plan to the Director of Accelerator Ops and Division
  - This requires understanding main downtime contributions for each system based on the actual downtime data and developing a plan
  - This plan will have to be executed working with the Division
- Target reliability numbers are those during June – August 2025
  - I'll distribute those numbers
  - The numbers can be iteratively adjusted and redistributed depending on feedback and projected cost/effort
- Analize what you need to do to meet those numbers
- Develop and provide plans clearly showing analysis and response to it

FY26 Run Projections

- Halls B,C,D
- Polarized bam
- FY26 Run to begin in February, Feb 6th (dates are tentative)
- 25 weeks of running including restore and reconfiguration: 23 + 2
- Two runs in one
  - Low energy run: 700 MeV/pass, Feb 20 – Apr 20
  - High energy run: 2.1 MeV/pass, Apr 4 – Jul 27
- Beam intensity and power: up to 80 uA to xC and 860 kW
- Arc magnet reconfiguration between the low and high energy runs

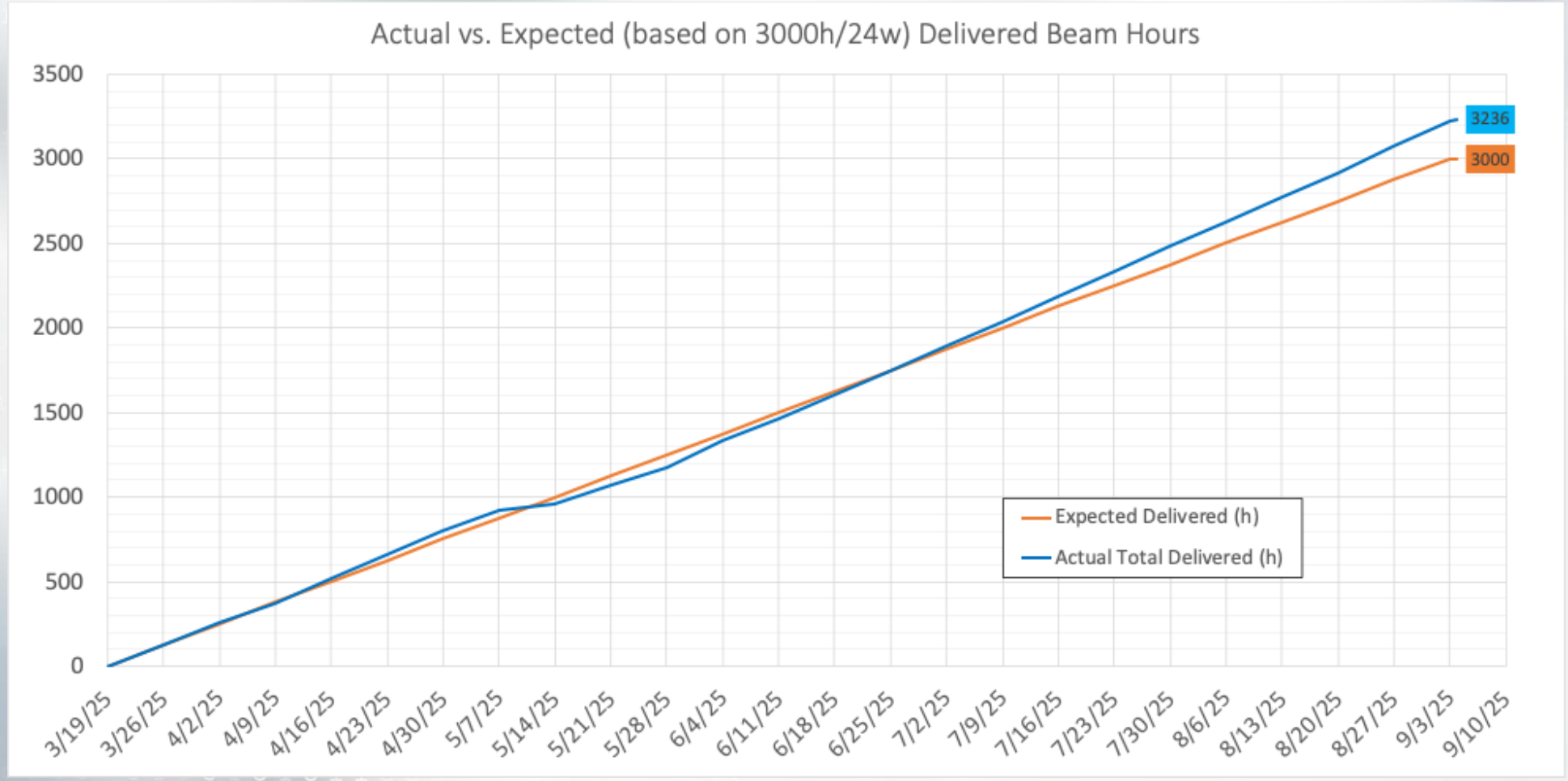
Conclusions

- Excellent FY25 Run with 12 GeV era record reliability
- Issues and opportunities for improvement exist. They will be discussed today
- Need consistent effort to maintain CEBAF Operations at this level

I WANT YOU

TO IMPROVE CEBAF OPERATIONS

FY25 Delivered Beam Hours



Integrated total delivered beam hours. The plot shows DOE expected hours calculated from the assumption of 3000h over 24 weeks (orange) and the actual delivered beam hours (blue).