

CEBAF Performance and Outlook

C.M. Ginsburg
Director of Accelerator Operations
CPP Project Director
PAC49
July 19, 2021

 Jefferson Lab



Outline

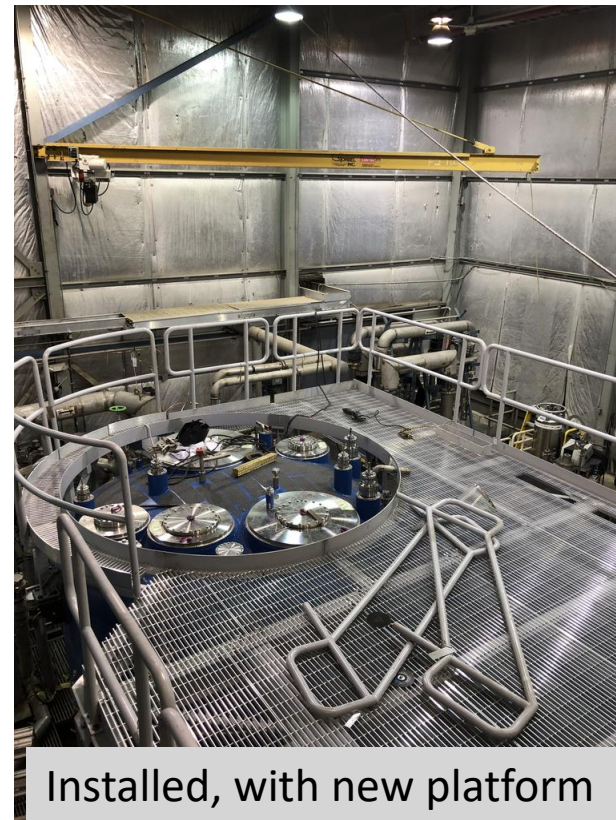
- FY21 SAD
- Reliability and energy reach activities
- Startup and FY22

FY21 SAD: CHL1 cold box replacement (for South Linac)

- JLab in-house design / build
- Demolition and removal of the old cold box
- Fabrication and installation of the new one
- Commissioning complete



PAC49: CEBAF Performance and Outlook



FY21 SAD: SRF and beamline vacuum

- New cryomodule type C75-01 installed at 1L05
 - New RF (power, digital controls)
 - New cavity design (low loss)
- Refurbished P1 cryomodule installed at 1L07
- C100-09 removed from 1L26

- North Linac girders
 - Beampipes cleaned (~25%)
 - Viton-seal VAT valves replaced (~80%)
 - Rusted beamline bellows replaced (few)
- Other NL CM work as needed
 - Beamline vac to ins vac CM O-rings
 - Warm RF window replacements
- New rad-hard neutron detectors
 - Installed around C100's etc.
 - Continual field emission monitoring

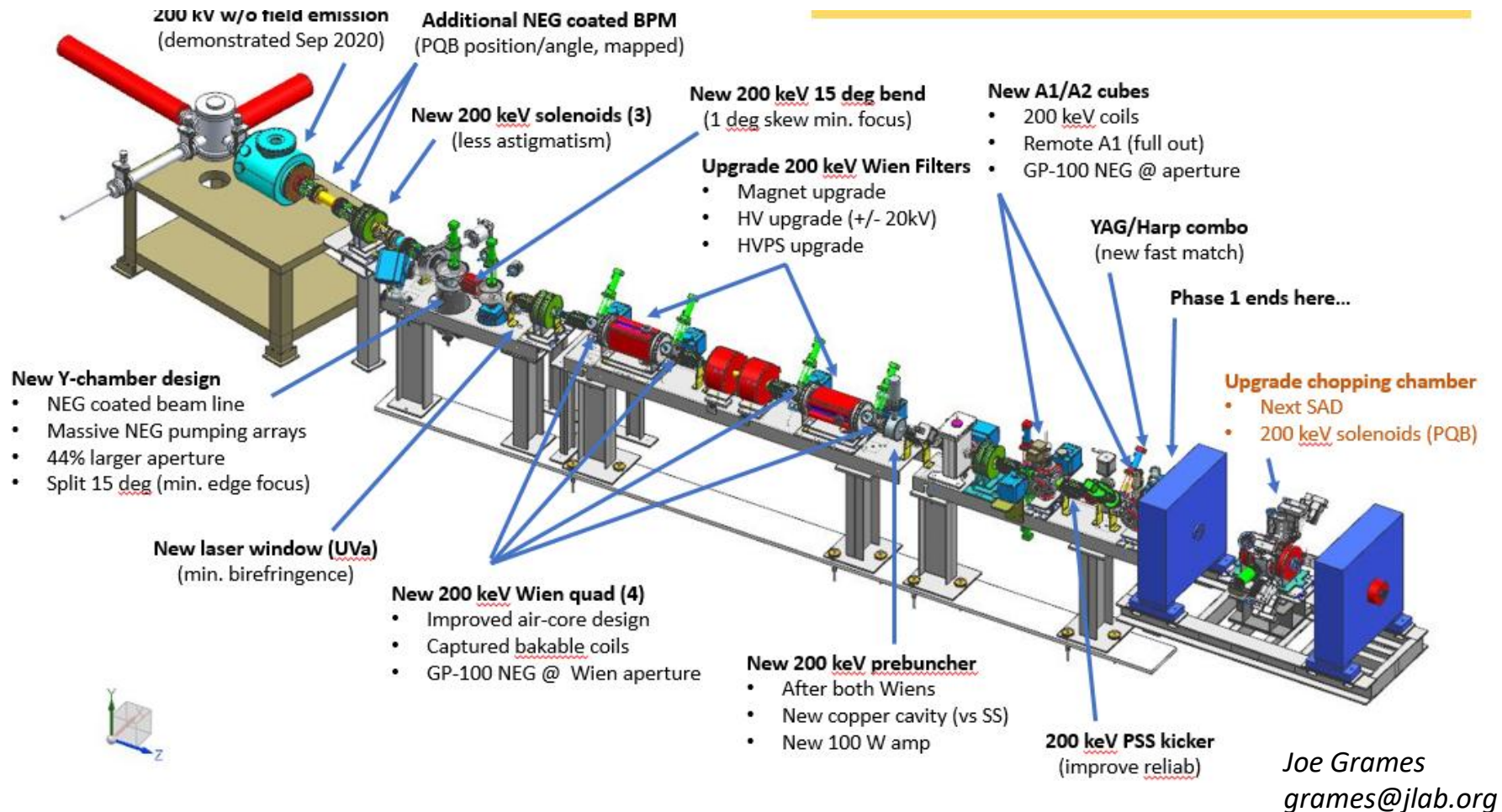


Energy Reach for FY21 run

- FY21 run requirements
 - 1.82 GeV/pass: 102.7/910/910 MeV (injector/NL/SL) – first part of the run
 - 1.96 GeV/pass: 110.6/980/980 MeV (injector/NL/SL) – second part of the run
- CPP assumptions (Oct 2020)
 - NL start 1010 MeV
 - Fix 1L11-5,6 WG pump +11.5 MeV
 - Remove 1L05, 1L07, 1L26: -27, -45, -38
 - Add C75-01 (1L05), P1-R (1L07): +67.5*, 67.5**
 - 300K thermal cycle loss: -40
 - Annual (average) loss: -18
 - NL finish 998.5 MeV
 - More uncertainty: a lot of NL work occurred during SAD for girder refurbishment, etc.
 - Algorithm assumes a goal of 3 RF trips/hour/linac or max 10 trips/hour from all sources
 - we can increase gradient if we accept more trips
 - More info: rad hard cables installed, new neutron detectors around C75-01 & P1
- *C75-01 performance in tunnel uncertain, but now have more info
 - VTA single-cavity tests: 62-68 MeV depending on acceptable FE
 - CMTF CM single-cavity tests: 57-70 MeV depending on acceptable FE
 - Did not yet start gradient performance commissioning in tunnel
- **P1-R performance in tunnel uncertain, but now have more info
 - No CMTF test, but cavity tests would imply 76.7 MeV max
 - In recent commissioning, module provided 80 MeV for 2.5 h in test configuration

FY21 SAD: Injector Upgrade Phase 1 Complete

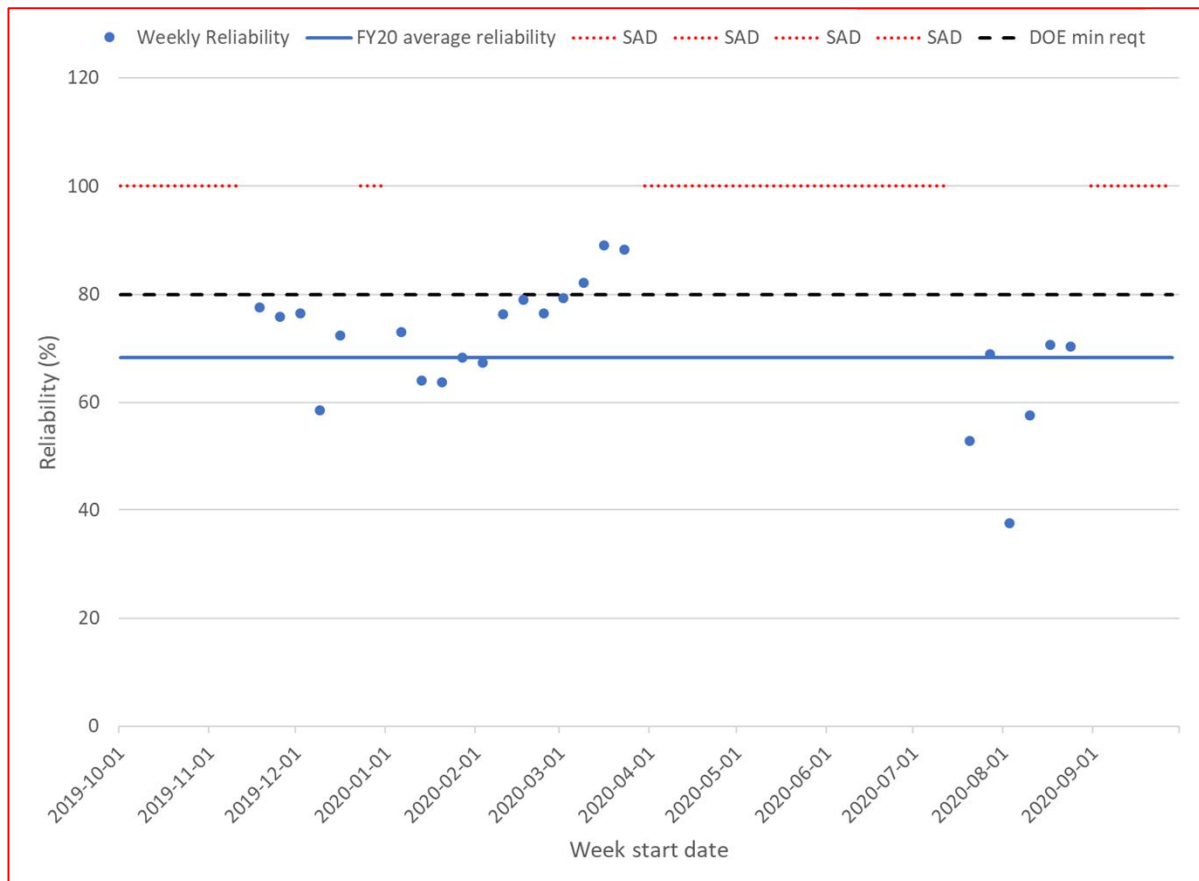
Improvements for PQB, Setup, Reliability, Future Physics



FY21 SAD: selected other work addressing reliability

- Facilities
 - Grounding improvements
 - HVAC improvements in service buildings
 - Power distribution panels to support SRF/RF
 - Entire fire protection system replaced
- High-power RF
 - Studied effect of lightning on RF
 - Lightning protection system inspected, to be improved FY22

CEBAF FY20 reliability



- Reliability is defined as hours delivered divided by hours scheduled
- FY19 reliability: 81.3%
- FY20 reliability: 68.3%
- Some FY20 issues
 - Beam losses and steering
 - Component failures
 - Unfamiliarity with and inadequate responses to novel targets (Halls A&C)
 - Safety stand down due to several problems
 - Slow startup due to COVID

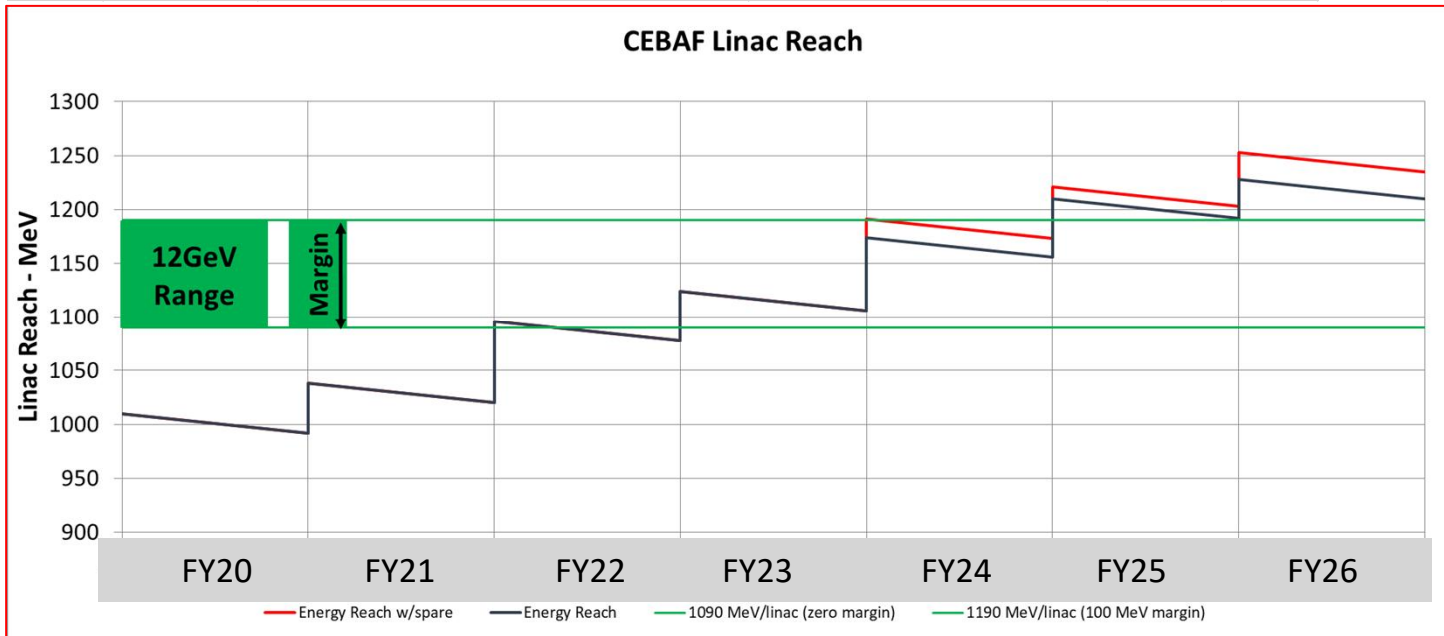
CEBAF Performance Plan (CPP): Reliability & Energy Reach

- CPP Project Description submitted to DOE in October 2020
 - 2017 plan updated to reflect current accomplishments and status
 - Six-year plan
 - Cost/staffing profile required to reach 12 GeV with adequate margin and adequate reliability by FY26
 - Option included to speed up goals by one year by building a spare C100 cryomodule
 - Not funded in FY21; expected to start FY22

CEBAF Performance Plan: Cryomodule dance proposal FY21-FY26

	#CM assembled (previous year)	CM serial number	removals	NL margin (MeV)	SL margin (MeV)
FY21	2	P1 (NL), C75-01 (NL)	C20 (NL), C50 (NL), C100 (NL)	-51.5	-42.2
FY22	3	C75-02(SL), C50 (SL), C100-09R(NL)	C20 (NL), C20 (SL), C20 (SL)	6	10
FY23	4	C75-03(SL), C75-04 (NL), C100-10R (SL), C100-X1R (SL)	C20 (SL), C20 (NL), C100 (SL), C100 (SL)	34	75
FY24	4	C75-05 (NL), C75-06 (SL), C100-X2R (SL)	C20 (SL), C100 (SL)	101	108
FY25	3	C75-07 (NL), C75-08 (SL), C100-X3R (NL)	C20 (NL), C20 (SL), C100 (NL)	137	131
FY26	2	C75-09 (NL), C100-XR4 (SL)	C20 (NL), C20 (NL), C100 (SL), C100 (SL)	163	180

Achieve 12 GeV with adequate margin in FY25 w/C100 spare



Progress in CEBAF Performance Plan

- Installed first refurbished C100 prior to FY20 run met energy gain expectations – best CM in CEBAF
- Installed first C75 CM (C20 conversion) and refurbished P1 CM prior to FY21 run
- Received 18 of 20 ordered 8-kW klystrons; placed order for 5 13-kW klystrons
- Procured many critical spares: magnet chambers/coils, RF separator cavity, etc.
 - Close to completing critical spares task in FY21
- Girder refurbishment- good progress in FY21 SAD
 - Replaced 80% Viton-seal valves in North Linac
- Plasma processing in preparation for C100-9R
 - At room temperature, inject O₂ or Ar, ignite a plasma
 - Eliminate hydrocarbons, reduce field emission
 - Check whether performance improved enough
 - Decision to refurbish will be based on performance and funding

Commissioned at 104 MeV;
operated at 97 MeV



Refurbished C100 In North Linac

Preparing for Next Run

- FY21 SAD: principle driver CHL1 cold box replacement
 - SAD task force established to monitor work and avoid scope creep
- CHL1 (for South linac) commissioning in progress
- North linac is cold (2K)
- Cryomodule installations in progress
- Injector restarted with beam in May
- Beam back to the halls mid-August-ish

- Reliability is usually lower at the start of a run
 - FY21 will be a short run, and a lower reliability may be expected
- We have not done such a substantial startup, after such a substantial amount of work during covid work restrictions
 - Last June we started up during Covid, but with many fewer changes
 - Possible changes to work process during start up would add uncertainty
- Staff are instructed regularly that safety comes before schedule

Preparing for future runs

- Halls A/C have asked us to investigate increasing the beam current
 - Request upgrade to 730 μA in the North Linac. This includes 140 μA five passes to Halls A/B/C and 5 μA six passes to Hall D.
 - Present limit, set in 2005 before the 2007 Environmental Assessment was done, allows 1 MW total to Halls, 460 μA in North Linac
 - ~60% increase requested
 - EA allows 1 MW each to Halls A and C and 27.5 kW (2.5 μA) to Hall B
- Safety documentation being updated by ESH
 - Either full update, or documentation supporting request to DOE for exception
- A beam test at 550 μA was scheduled for FY20, but had to be postponed. Now likely to occur FY22 (mid-Dec goal)
 - Goal: investigate limitations in existing machine
- Costs for required upgrades (e.g., to dump cooling) to be estimated
- This work, led by Jay Benesch, is in progress

Conclusions

- FY21 SAD successful, finishing up
- Good progress on CPP energy reach & reliability in FY20/FY21
 - Expect good support in FY22
- Uncertainty in energy reach for FY21
 - It will take a few weeks before determined
 - Our best guess is that we will achieve the required energies
- Uncertainty in schedule
 - Unknown unknowns
- Restart is proceeding
- We look forward to a physics-productive FY21 run

- Many thanks for your continued collaborative support