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ER@CEBAF - A 7 GeV, 5-PASS, ENERGY RECOVERY EXPERIMENT*†

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Abstract

A multiple-pass, high-energy ERL experiment at the JLab CEBAF will be instrumental in providing necessary information and technology testing for a number of possible future applications and facilities such as Linac-Ring based colliders, which have been designed at BNL (eRHIC) and CERN (LHeC), and also drivers for high-energy FELs and 4th GLS.

ER@CEBAF is aimed at investigating 6D optics and beam dynamics issues in ERLs, such as synchrotron radiation effects, emittance preservation, stability, beam losses, multiple-pass orbit control/correction, multiple-pass beam dynamics in the presence of cavity HOMs, BBU and other halo studies, handling of large (SR induced) momentum spread bunches, and development of multiple-beam diagnostics instrumentation.

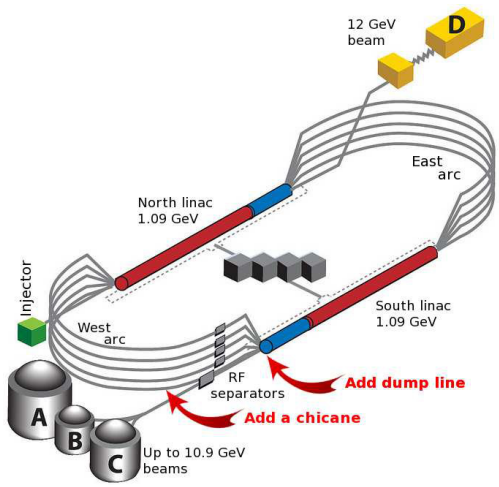

Figure 1: 12 GeV CEBAF recirculating linac. Location of chicane and dump line for ER@CEBAF.

Since it was launched 2+ years ago, the project has progressed in defining the necessary modifications to CEBAF (Fig. 1, Tab. 1, 2), including a 4-dipole phase chicane in recirculation Arc A, beam extraction and a dump line at the end of the south linac, and additional dedicated multiple-beam diagnostics. This equipment can remain in place to permit ER@CEBAF tests without hardware reconfiguration. Dedicated optics settings are required in the linacs (60^o phase advance), in arcs 1 and 2 (low dispersion), as well as *ad hoc* spreader and combiner tunings for linac to arc matching. Longitudinal match will require specific settings (arc M_{56}, RF phasing). These evolutions make ER@CEBAF an expansion of CEBAF capability to a 5-pass ERL, with modest switch over time and minor impact to the CEBAF physics program.

A costing of these changes to CEBAF has been performed, amounting to below $1M. Nine months will be required to have the ER installation ready for operation.

Hardware commissioning will include 3 different recirculation regimes, namely 1 linac up/1 linac down, 1-pass up/1-pass down starting with reduced energy (400∼500 MeV/linac), and eventually 5-pass up/5-pass down, to be concluded with completion of ER at 7 GeV.

The project has been submitted to, and has received approval from, JLab Program Advisory Committee (PAC 44) in July 2016 [1]. A next major objective in demonstrating readiness is a technical review as mandated by PAC 44.

Table 1: Machine/Lattice Parameters of ER@CEBAF

f_{RF}	1497	MHz	RF frequency
E_{linac}	700	MeV	Gain per linac (baseline)
E_{inj}	79	MeV	$= E_{\mathrm{linac}} \times 123/1090$
ϕ_{FODO}	60	deg	Per cell, at first NL pass and last SL pass
M_{56}	<90	cm	Compression, Arc A
Extraction	8	deg	Angle to dump line
Dump power	20	kW	
$\Delta\phi_{\mathrm{tol}}$	0.25	deg	Req$^{\mathrm{ed}}$ path-length control

Table 2: Beam Parameters

f_{beam}	31 - 499	MHz	Bunch rep. freq., CW
	7.485	MHz	Bunch rep. freq., tune mode
I_{beam}	100	μA	Max. CW beam current
q_{bunch}	0.2	pC	Bunch charge at 100 μA
σ_l	90 - 150	μm	Bunch length, high energy
σ_t	0.3 - 0.5	ps	
$\epsilon_{\mathrm{x,y}}$	$\sim 10^{-8}$	m	Geom. emitt. at injection
dp/p	$< 10^{-4}$		Energy spread at injection
$\epsilon_{\mathrm{x,y}}$	$\mathcal{O}(10^{-8})$	m	Geom. emitt., after ER
dp/p	2-3	%	At extraction

REFERENCES

[1] S.A. Bogacz et al., ER@CEBAF: A Test of 5-Pass Energy Recovery at CEBAF, JLab Tech. Note, June 6, 2016, eRHIC Tech. Note 54, BNL, June 2016.

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