FOA proposals
old & new

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So far

CBETA

The DOE post Funding Opportunity Announcements on the web & solicit proposals.

January 2018: BNL, Cornell & JLab submitted a CBETA proposal "High Intensity Tests for Electron Cooling".

- It reviewed positively in most ways, but proposal 235252 was nonetheless rejected.

October 2018: U.S.-Japan FOA posted by DOE-HEP, with matching funds from Japan.

2019: Be ready with a proposal, even though an EIC FOA appears unlikely …

CBETA 2018 proposal

CBETA

1) Simulations

- Beam loss
- High-bunch-charge
- Magnetized beam-transport
- Nonlinear dynamics

2) Diagnostics

- Halo
- Coherent synchrotron radiation & microbunching
- Time-resolved beam-losses for machine protection

3) Low Level RF

- RF stability in the injector & main linac cryomodule

4) Commissioning to high-intensity

5) Extraction design

Simulations - 1

Beam loss

Develop halo-simulations to compare loss mechanisms:

- ghost pulses from the laser,
- field emission at the cathode and in cavities
- Touschek (residual gas) scattering.

High-bunch-charge

Simulate bunch-charge limits for CBETA:

- coherent synchrotron radiation,
- microbunching,
- longitudinal space charge,
- wakes.

Simulations - 2

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Magnetized beam-transport

The [JLEIC] cooling rate such an [electron-ion cooling] interaction achieves can be improved by approximately two orders of magnitude if the interaction occurs within an appropriate solenoid field.

Nonlinear dynamics

Maintain a high-quality longitudinal distribution to avoid particle loss & maintain ER efficiency.

The very high chromaticity of CBETA may have an impact on transverse instabilities.

Compare simulations with beam studies experiments.

Diagnostics - 1

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Halo diagnostics

A High Dynamic Range transverse beam profile monitor was developed for the LERF FEL & the Dark Light experiment.

Propose a version of this device to image the tails of the beam by having the core pass through a hole in the center of the Optical Transition Radiation device: only image the halo.

Diagnostics - 2

Coherent Synchrotron Radiation & microbunching

See microbunching by looking for the coherent radiation enhancement at short wavelengths.

The CSR effects can be imaged CW with synchrotron light: the effect is seen and the electron beam begins to separate out to distinct filaments.

Passing the signal into a visible/near IR spectrometer can quantize the effect.

Diagnostics - 3

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Time-resolved beam-loss diagnostics for machine protection

Aid beam loss cause determination by first fault capability in the machine protection system logic chain.

Enable more sensitive determination by triggering sampling scopes (that monitor some key parameters) on a loss event.

Then look back to the time before the trip to see what led to the event.

Low Level RF

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RF stability in the injector & main linac cryomodules

Ramping up the DC current presents important problems with beam scraping, halo, & beam loading.

The JLab approach used at LERF:

1) tune a 250 μs macropulse at 2 Hz
2) increase the rep rate from 2 Hz to 60 Hz
3) increase the pulse width, achieving good transport without tripping the beam loss monitor system.

Develop a beam mode table defining all of the required time structures and bunch charge parameters.

This is necessary to define the machine protection system and to understand the RF drive requirements.

Commissioning to high-intensity

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1 nC bunch charge at a reduced repetition rate

The CBETA photoinjector has produced low emittance bunches with charges up to 2 nC per bunch.

1-pass energy recovery at 42 MeV

The highest average current in superconducting ERLs to date is 9.1 mA at LERF.

Understanding & mitigating beam losses will require guidance from the simulations discussed elsewhere.

4-pass energy recovery at 150 MeV

1 mA operation is significantly more complicated: identify & overcome average current limitations.

Extraction design

CBETA could be used for EIC R&D or other purposes in a configuration in which beam is extracted at 150 MeV, and also returned for subsequent energy recovery.

A number of concepts have been proposed but none of them have been developed far enough to evaluate their performance and practicality.

Develop these concepts further, supported where possible by beam studies.

U.S.-Japan FOA

Posted last week, with matching funds from Japan

MODEST funding for materials & travel, not labor.

cERL goes to 10 mA in 2019 (see Tsukasa's talk)

Topics? For example:

- Collimation / halo / machine protection
- Beam manipulation: longitudinal gymnastics, extraction, …

Successful proposal MUST be generic, benefitting HEP, photon generation, EIC, et cetera ….

ERL parameters for SHC

Parameter	Units	eRHIC MBEC [2]	eRHIC PCA [2]	JLEIC ERL [3]	JLEIC CCR [3]	CBETA [4]	cERL [5]	ER@ CEBAF [6]	LERF [7]
Number of passes		3		1	11	4	1	5	1
Top energy	MeV	149.8		110		150	20	7,000	135
Average current, 1 beam	mA	110		140	1,520	40	100	0.1	8.5
Total current, all beams	mA	660		140	–	320	200	1	17
RMS bunch length	mm	4 – 20	1.2	20		1.0	0.6	0.15	1
RMS energy spread	10^{-4}	1	3	< 3					5
RF frequency	MHz	563		476	–	1300	1300	1497	1497
Bunch frequency	MHz	112.6		43.3	476	41.9	1300	249.5	75
Electron bunch charge	pC	1,000		3,200		123	77	0.2	135
Normalized emittance	μm	1 – 2	4	36		2	>1.3		15

ERL parameters required for EIC strong hadron cooling.

Compare with design parameters of contemporary facilities.