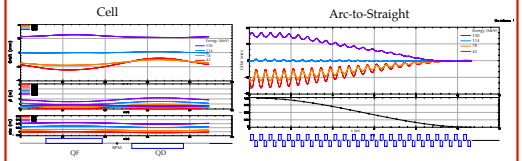
The Cornell/BNL 4-Turn ERL with FFAG Return Arcs for eRHIC Prototyping

Georg Hoffstaetter for the CBETA team

FFAG Sensitivity and Correction

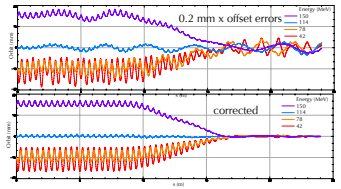


13.3 cm
-10 T/m
-4 mm offset

12.2 cm
10 T/m
17 mm offset

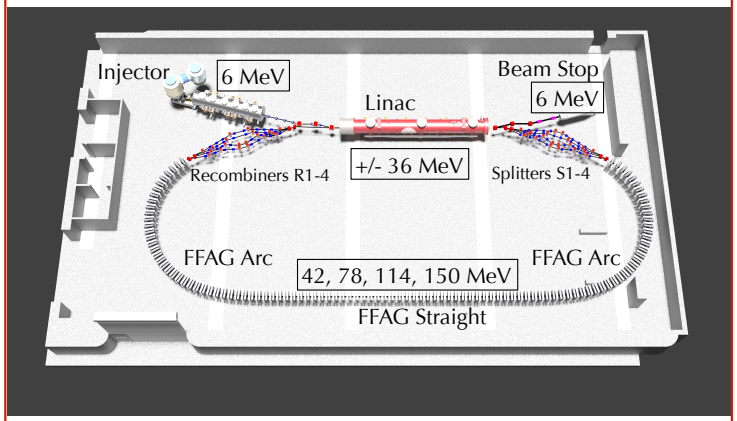
The final 24 cells of the arc are adjusted to merge all orbits onto the same axis

4-beam orbit correction simulation in the FFAG Arc and Arc-To-Straight



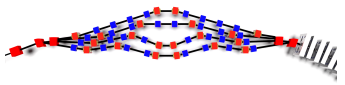
SVD correction given BPM readings for separate beams and correction coils on every other dipole

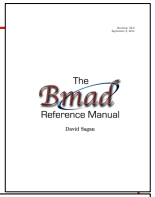
Layout



Cornell's hall L0E has been cleaned out and its high-current DC gun, its high brightness injector linac, its ERL merger, its ERL Main-Linac Cryomodul (MLC), and its high power beam-stop have already been installed already.

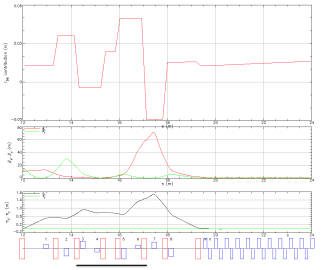
Splitters





http://www.lepp.cornell.edu/~dcs/bmad/

Splitter S1 (42 MeV)



Relative splitter lengths are chosen for the correct total path lengths for all passes.

Reverse bends to aid in r56 control.

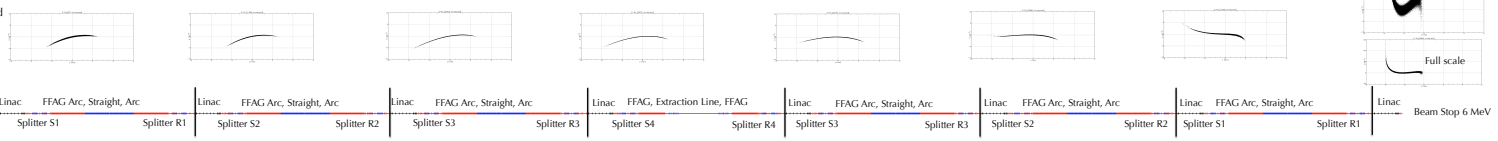
Optics must match large beams from the Linac to small beams in the FFAG arc.

Orbits must match from the centered orbit in the Linac to the periodic orbit in the FFAG arc.

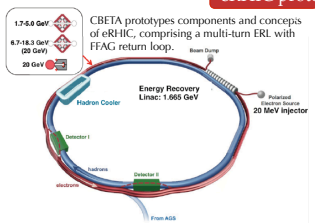
Each splitter's inner bends can be changed to provide both coarse and fine path-length adjustment

Optics & Bunch Tracking

Z phase space at the end of the linac, 1% scale
100,000 particles



eRHIC prototyping and risk

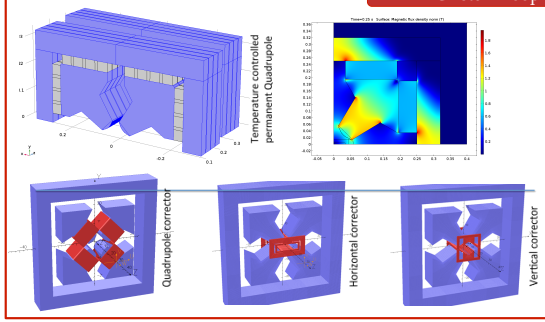


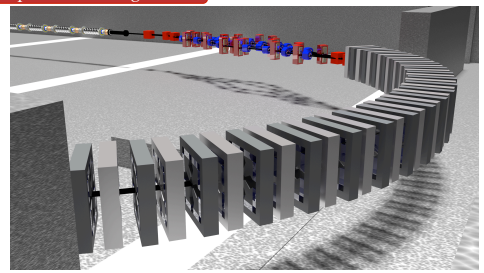
CBETA prototypes components and concepts of eRHIC, comprising a multi-turn ERL with FFAG return loop.

eRHIC is to collide electrons of up to about 20GeV with ions from RHIC. Providing the electrons by a multi-turn Energy Recovery Linac (ERL) can yield more luminosity than storing them in a storage ring. The ERL design for ERIC uses FFAG optics of large momentum aperture to store several beam on their return to the linac, saving return loops around RHIC.

Cornell University has prototyped technology essential for any high brightness electron ERL. This includes a DC gun and an SRF injector Linac with world-record current and normalized brightness in a bunch train, a high-current CW cryomodule for 70MeV energy gain, a high-power beam stop, and several diagnostics tools for high-current and high-brightness beams, e.g. slid measurements for 6-D phase-space densities, a fast wire scanner for beam profiles, and beam loos diagnostics. All these are now available to equip a one-cryomodule ERL, and laboratory space has been cleared out and is radiation shielded to install this ERL at Cornell. BNL has designed a multi-turn ERL for eRHIC, where beam is transported more than 20 times around the RHIC tunnel. The number of transport lines is minimized by using two non-scaling (NS) FFAG arcs. A collaboration between BNL and Cornell has been formed to investigate the new NS-FFAG optics and the multi-turn eRHIC ERL design by building a 4-turn, one-cryomodule ERL at Cornell. It has a NS-FFAG return loop built with permanent magnets and is meant to accelerate 40mA beam to 150MeV.

FFAG return loop with permanent magnets





Strong focusing permanent magnets in an FFAG channel allows the transport of all 4 accelerated and of 3 decelerated beam to travel in the same channel. The separator region with electro-magnets matches the orbit and optics of each beam into its periodic solution for the FFAG cells.

Acknowledgements

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White Paper and CDR

The Cornell-BNL FFAG-ERL Test Accelerator: White Paper
Ivan Bazarov, John Dobbins, Bruce Dunham, Georg Hoffstaetter, Christopher Mayes, Ritchie Patterson, David Sagan, Ilan Ben-Zvi, Scott Berg, Michael Blaskiewicz, Stephen Brooks, Kevin Brown, Wolfram Fischer, Yue Hao, Wuzheng Meng, François Méot, Michiko Minty, Stephen Peggs, Vadim Ptitsyn, Thomas Roser, Peter Thieberger, Dejan Trbojevic, Nick Tsoupas

http://arxiv.org/abs/1504.00588