Question:

Does the energy loss and spread induced by synchrotron emissions, wake-fields etc…. necessitate the use of energy compression by riding off-crest in the energy recovery and if so how it that controlled.

-Minimization of energy spread of decelerated beam is one of most important and challengeable subject of studies for ERL-based design and is a focus of our present work

"eRHIC Design Study " report (Dec. 2014):

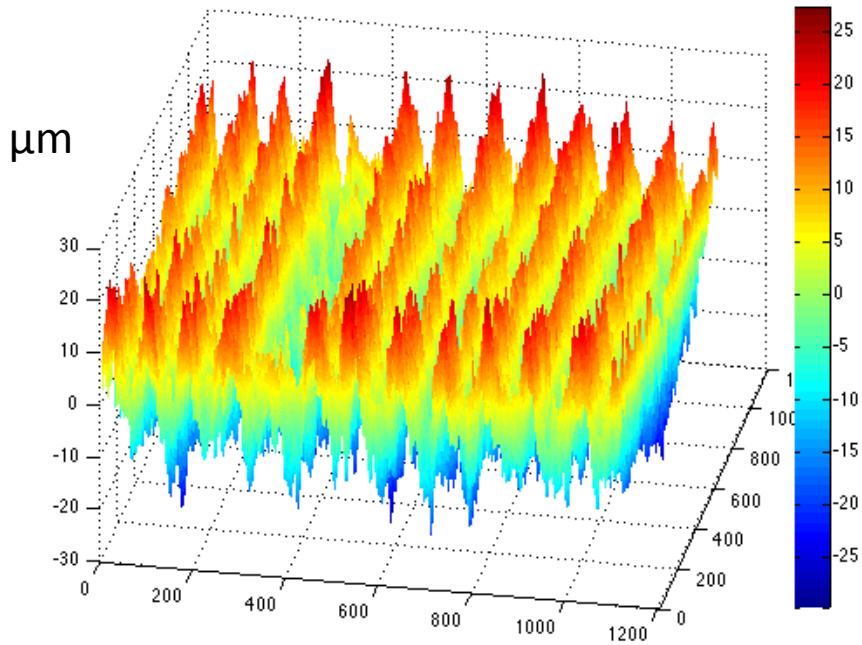
	CSR	Machine impedances	Wall roughness	Synchrotron Radiation	Total
Energy loss, MeV	Suppressed	2.4	Negligible	221	223
		1.2		540	541
Full energy spread, MeV	Suppressed	3.8	Negligible	2.8	~5
		2		6.7	~7
Power loss, MW	Suppressed	0.024	Negligible	2.2	2.2
		0.004		2.0	2.0

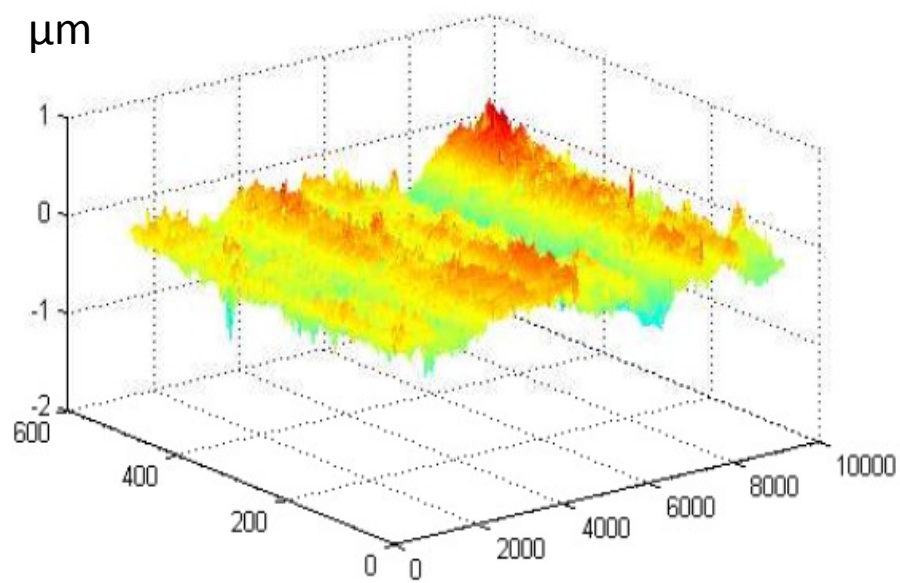
Table 3-7: energy losses and energy spreads due to various collective effects with the top electron energy of 15.9 GeV (top) and 21.2 GeV (bottom).

Machine impedances in the Table include resistive wall and main linac cavities.

SR causes the energy spread in two ways: directly (by quantum fluctuations) and indirectly (different orbit of accelerated and decelerated beams in FFAG -> different pathlength -> linac voltage slopes at acceleration and deceleration)

Energy Spread and Energy Losses due to Wall Roughness: Measured surface:





"surface-1". extruded aluminum from the NSLS-II vacuum chamber.
Extrusions are along the mountain ridges (red).

"surface-2": from the vacuum chamber for superconducting undulator. Extrusions were done by "Cardinal Aluminum" at Louisville, KY.

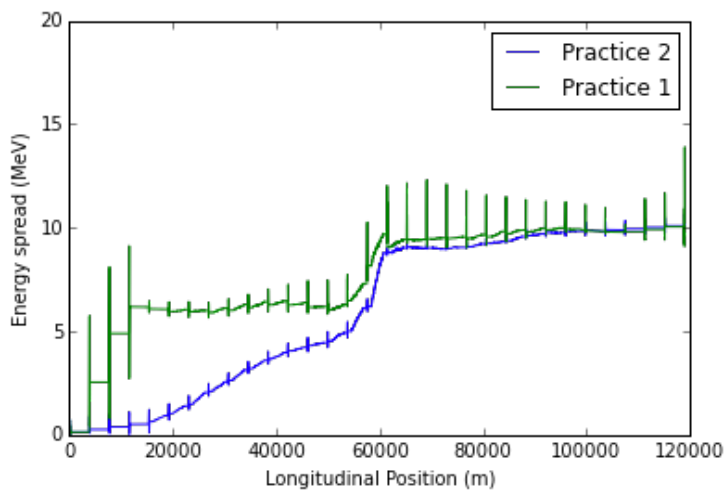
Measurements are courtesy of P. Takacs of the Instrumentation Division of BNL.

The sample beam pipe was provided by Emil Trakhtenberg (ANL).

Courtesy of A. Fedotov

- Each Spreader/Merger arm contains a chicane for pathlength adjustment and an optics section for R_{56} adjustment.

-Detailed studies of energy spread minimization scheme for FFAG-based design have started few months ago.



Example of acceleration-deceleration energy spread evolution for 21.2 GeV operation with optimized pathlength and R_{56} adjustments done in the spreader. (**Yue Hao**, ELEGANT)

(Green: only pathlength, Blue: pathlength+R_{56})

Cavity and resistive wall wakes has been also incorporated into ELEGANT (**Yichao Jing, Yue Hao**)

On the basis of these studies one can make decision on:
- Required range of pathlength and R_{56} adjustment in the spreader arms
- Injector/Dump energy

- Presently we are considering a scheme with longer linac (2 GeV) and, consequently, less re-circulations (10x2).

- Among other good things, it reduces effect of resistive wall wake and synchrotron radiation on energy spread.

- In the same time, we are exploring a possibility to exclude the energy loss and energy spread compensation cavities. And it would provide additional complication for the energy spread control.

- In collaboration with JLab accelerator scientists the proposal for CEBAF-ERL experiment is being developed (to be ready at the end of this year). (F. Meot (BNL), T. Satogata (JLab))