Energy Recovery Linac Source Properties and X-ray Optics Needs

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Cornell University plans to add an energy recovery linac (ERL) as an upgrade to the existing Cornell Electron Storage Ring. This new X-ray facility will offer great operational flexibility, providing both highly coherent hard X-ray beams and intense short duration (<100 femtosecond) X-ray bursts at a high repetition rate. Three different operational modes – high coherence, high flux, and ultrashort pulse – are illustrated in Table 1. The parameters presented in Table 1 are planned to be available at the startup of this new machine, and future developments in photoemission injectors, bunch compressors, and insertion devices can be expected to give further improvements to the parameters listed.

This unique X-ray facility will allow novel scientific investigations that are difficult or impossible to perform with existing X-ray sources. In order to realize the outstanding potentials of the ERL source, three challenges in x-ray optics developments would have to be met: (1) handling high heat loads, (2) preserving brilliance for high transverse coherence beams, and (3) preserving and manipulating <100 femtosecond x-ray pulses. In this presentation, we briefly discuss each of these areas in connection with possible usages of diamond crystals.

Table 1: Basic parameters of the Cornell ERL facility, in three operational modes

	High coherence	High flux	Short pulse
Energy (GeV)	5.3	5.3	5.3
Average current (mA)	10	100	1
Charge per bunch (nC)	0.008	0.08	1.0
Transverse emittance (nm-rad)	0.015	0.1	1
Bunch rms length (ps)	2	2	0.1
Maximum repetition rate (Hz)	1.3×10^{9}	1.3×10^{9}	1×10^{6}
Highest diffraction-limited energy (keV)	6.6	1	0.1
Undulator fundamental energy (keV)	8.3	8.3	8.3
Average flux (ph/s/0.1%)	9×10^{14}	9×10^{15}	8×10^{12}
Average brilliance (ph/s/0.1%/mm^2/mr^2)	3×10^{22}	1.6×10^{22}	2×10^{17}
Peak brilliance (ph/s/0.1%/mm^2/mr^2)	5×10^{24}	2×10^{24}	8×10^{23}
Peak flux (ph/s/0.1%)	1.3×10^{17}	1.3×10^{18}	3×10^{19}