LEUTL Description

The low-energy undulator test line (LEUTL) (Fig. 1) and its various component systems were designed to achieve and explore the Self Amplified Spontaneous Emission (SASE) Free-Electron Laser (FEL) process to saturation in the visible and ultraviolet wavelengths and to explore topics of interest for a next-generation linac-based light source.

The LEUTL employed a normal-conducting, S-Band, photocathode RF gun and linear accelerator system along with nine, 2.4-m-long undulators with a suite of electron and photon-beam diagnostics. Since the 650-MeV Advanced Photon Source's linear accelerator was only used twice a day as the injector for the light source, it was leveraged for the LEUTL, saving money and resources, while proving the SASE principal to full saturation and rapid tunability from 530 to 190 nm. Saturation and tunability had not been proven for a high-gain, single pass device before the LEUTL.

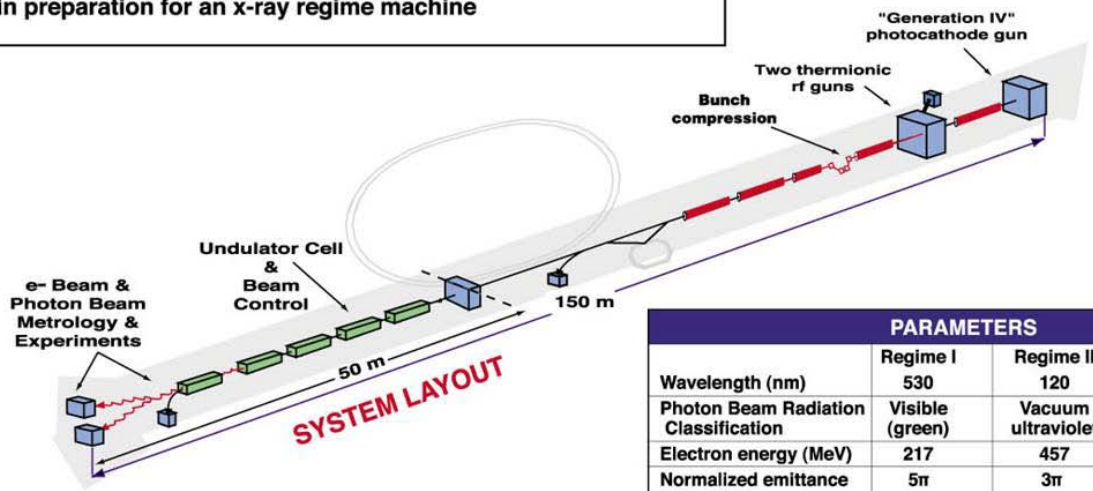
Many archival journal publications focusing on experiment, theory, and simulation resulted from this research and development activity through talent matrixing across Argonne (including the Argonne Wakefield Accelerator) and with other national laboratories (including Brookhaven and SLAC). Yhe publications are noted in this collection.

LEUTL helped have the way for the myriad of next-generation light sources. These free-electron lasers are making rapid progress in their study of matter through the use of their ultra-short (femtoseconds), high-brightness, coherent pulses over the vacuum ultraviolet to x-ray wavelength range. Some examples include DESY's FLASH soft x-ray source, the Linac Coherent Light Source at the SLAC Accelerator, the SCSS at Spring-8, FERMI in Trieste, Italy, and the European XFEL in Hamburg, Germany.

LOW-ENERGY UNDULATOR TEST LINE PARAMETERS

PROJECT GOALS

- **Perform experiments with the SASE FEL output**
- **Assess the challenges associated with producing a SASE FEL in preparation for an x-ray regime machine**



PARAMETERS

	Regime I	Regime II	Regime III
Wavelength (nm)	530	120	51
Photon Beam Radiation Classification	Visible (green)	Vacuum ultraviolet	Vacuum ultraviolet
Electron energy (MeV)	217	457	700
Normalized emittance (mm mrad)	5π	3π	3π
Energy spread (%)	0.1	0.1	0.1
Peak current (A)	100	300	500
Undulator period (mm)	33	33	33
Magnetic field (T)	1.0	1.0	1.0
Undulator gap (mm)	9.3	9.3	9.3
Cell length (m)	2.73	2.73	2.73
Gain length (m)	0.81	0.72	1.2
Undulator length (m)	9 x 2.4	9 x 2.4	10 x 2.4

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