Next Generation Laser-Compton Sources for Nuclear Photonics and Medicine

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Abstract

Tunable, polarized, mono-energetic, laser-like beams of x-rays and gamma-rays may be created via the optimized Compton scattering of pulsed lasers off of ultra-bright, relativistic electron beams. At x-ray energies, these extremely compact sources rival the output of the world's largest synchrotrons, exceed the flux of the highest performance medical sources and are enabling to new techniques that may significantly reduce dose to the patient during imaging procedures and/or increase the efficacy of radiation treatments of cancer. Above 2 MeV, the peak brilliance of compact laser-Compton sources can exceed that of world's largest synchrotrons by more than 15 orders of magnitude.

These sources enable for the first time the efficient pursuit of nuclear science and applications with photon beams, i.e. Nuclear Photonics. Potential applications are numerous and include isotope-specific nuclear materials management, element-specific medical radiography and radiology, non-destructive, isotope-specific, material assay and imaging, precision spectroscopy of nuclear resonances and photon-induced fission. This presentation will review activities at the Lawrence Livermore National Laboratory related to the design and optimization of laser-Compton systems and to the development of the unique science and applications enabled by them.