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Pulsed Compton gamma-ray beam generation using pulsed FEL beam

Monday 2 June 2025 16:00 (2 hours)

Gamma-ray induced nuclear physics experiments rely on good signal-to-noise ratio, requiring accurate rejection of detector background. One source of this background is the interaction of cosmic rays with nuclear detectors. The Duke High Intensity Gamma-ray Source (HIGS) is typically operated in quasi-CW mode, requiring background measurements to be conducted independently of data production runs. A pulsed mode of HIGS beam operation enables improved rejection counts by allowing time discrimination between detector counts in coincidence with the gamam beam and detector counts out of coincidence with the beam.

To achieve a HIGS beam with good pulse quality, a fast steering magnet has been used to decouple the FEL beam from the HIGS beam in the interaction region. By periodically overlapping the electron and FEL beams, gamma production can be limited to only the periods of overlap. Gating on these gamma pulses has been shown to reduce signal to noise ratio by at least 3 orders of magnitude.\,\,** However, this technique produces poor results at low energies, requiring development of more sophisticated gating techniques.

Footnotes

*Developing an Improved Pusled Mode Operation for Duke Storage Ring Based FEL, S. Mikhailov et al., Proceedings of IPAC2015, Richmod, VA (2015)Background Reduction in FEL-Generated γ-Ray Beam Experiments Using Giant High-Peak Power Pulses, M. Ahmed et al., Nuclear Instruments & Methods in Physics Research A 516 (2004)***Generation of Superposed Orbital Angular Momentum Beams Using a Free-Electron Laser Oscillator, P. Liu et al., Optics Express Vol. 32, No.2 (15 Jan 2024)

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Author: YATES, Stephen (Triangle Universities Nuclear Laboratory)

Co-authors: MIKHAILOV, Stepan (Duke University); WU, Ying (Duke University)

Presenter: YATES, Stephen (Triangle Universities Nuclear Laboratory)

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