300. 标题: Constraints on photon pulse duration from longitudinal electron beam diagnostics at a soft x-ray free-electron laser
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摘要: The successful operation of x-ray free-electron lasers (FELs), like the Linac Coherent Light Source or the Free-Electron Laser in Hamburg (FLASH), makes unprecedented research on matter at atomic length and ultrafast time scales possible. However, in order to take advantage of these unique light sources and to meet the strict requirements of many experiments in photon science, FEL photon pulse durations need to be known and tunable. This can be achieved by controlling the FEL driving electron beams, and high-resolution longitudinal electron beam diagnostics can be utilized to provide constraints on the expected FEL photon pulse durations. In this paper, we present comparative measurements of soft x-ray pulse durations and electron bunch lengths at FLASH. The soft x-ray pulse durations were measured by FEL radiation pulse energy statistics and compared to electron bunch lengths determined by frequency-domain spectroscopy of coherent transition radiation in the terahertz range and time-domain longitudinal phase space measurements. The experimental results, theoretical considerations, and simulations show that high-resolution longitudinal electron beam diagnostics provide reasonable constraints on the expected FEL photon pulse durations. In addition, we demonstrated the generation of soft x-ray pulses with durations below 50 fs (FWHM) after the implementation of the new uniform electron bunch compression scheme used at FLASH.
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