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A proposal for generating fully coherent X-ray FEL with femtosecond pulse based on fresh-slice

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X-ray free electron lasers, especially fully coherent femtosecond free-electron laser (FEL) pulses, are widely used in numerous fields. This study aims to propose a new principle for generating fully coherent femtosecond X-ray pulse based on the Shanghai soft X-ray Free Electron Laser User Facility (SXFEL-UF). The principle was based on fresh-slice technique. First of all, the electron beam was kicked transversely to get a time-related transverse tilt. Then, the sub-10-femtosecond bunch was achieved because of the spatiotemporal synchronization effect of the seed laser modulation. The FEL pulse duration was even shorter because of harmonic lasing. In the cascaded HGHG mode, the laser generated by the beam tail modulated the beam head in the second stage to reach higher harmonics, while in the EEHG mode, the same part of the electron beam was modulated twice. The influence of emittance and energy chirp of the electron beam on the scheme was analyzed, and the instability caused by transverse position jitter and energy jitter of the chirped beam was evaluated. The relationship between the pulse duration and the transverse deflection of the beam is verified. The scheme is also explored to generate linearly polarized femtosecond pulse at 6 nm and circularly polarized femtosecond pulse at 3 nm simultaneously by means of the elliptically polarized undulator (EPU) afterburner.

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Footnotes

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