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Bright attosecond electron beams and brilliant gamma ray sources with the Resonant Multi-Pulse Ionization Injection

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High-brightness e-beams with duration of a few hundreds of attoseconds can be employed as direct probes, as drivers of Compton/Thomson X/γ or single-spike FEL sources. We show, by means of theory and quasi-3D-PIC simulations, that GeV scale electron beam sources having duration widely tunable in the interval 100–2000 as, with 6D brightness exceeding 10^17A/m^2/0.1% and normalized emittances below 100 nm×rad can be obtained with the ReMPI scheme.
In the simplified simulations setup, a train of two pulses resonantly excite the plasma wave on He-Ar mixture plasma target. A pulse in second/fourth harmonics extracts electrons from the inner shell of the dopant ions, placing them the favorable phase of the wakefield as in the Two Color ionization injection. During the slippage in the bucket and up to the trapping point, the bunch length reduces down to tiny fraction of the initial one.
The tuning of beam duration is obtained by changing the delay between the ionization and the drivers pulses. Results of the model giving the beam duration obtainable with a given ionization pulse/driver delay are confirmed by simulations. Compton/Thomson backscattering process simulations showed that quasi monochromatic attosecond X/γ beams with high brilliance can be obtained with current technology PW-class lasers.

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