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Power scaling of extreme-ultraviolet frequency combs to the mW level per high-harmonic order STEPHEN SCHOUN, GIL PORAT, CHRISTOPH HEYL, CRAIG BENKO, JUN YE, JILA, NIST and the University of Colorado, Boulder — The extreme ultraviolet (XUV) presents a barely-explored region for precision spectroscopy studies with promising targets such as ground-state transitions in few-electron atoms and ions, and even nuclear transitions. Newly-developed XUV frequency combs can reach Hz-level linewidths, but their usefulness for precision spectroscopy has been limited by their low power. XUV frequency combs are produced via high-order harmonic generation (HHG) in a weakly-ionized gas medium driven by an intense IR laser. A high repetition rate ($\gg$10 MHz) is needed for stable frequency-comb operation, but the short time interval between consecutive laser pulses ($\ll$100 ns) leads to the accumulation of a high-density steady-state plasma which inhibits phase-matching of HHG, thus restricting the conversion efficiency. By heating the gas nozzle and seeding the heavy generation gas (xenon) in a light carrier gas (helium), we significantly increase the supersonic jet velocity, thus reducing the number of laser pulses that interact with the same atom/ion, reaching the single-pulse regime at 77 MHz repetition rate. We demonstrate phase-matched high-repetition-rate HHG for the first time, and generate 2 mW at 97 nm and 0.9 mW at 63 nm, surpassing previous XUV-comb power records by an order of magnitude.

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