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Advanced bandwidth control of an all-optical Compton source

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Bright, high-energy X-ray beam sources with narrow bandwidths and tunable energies hold great potential for widespread use in a variety of novel applications as alternatives to large-scale and costly radiation sources. Inverse Compton scattering sources based on electron beams from laser-plasma accelerators represent a promising candidate for increasing availability. However, in practice these sources are currently limited to bandwidths of tens of percent, making them unsuitable for many applications. We present results of a proof-of-principle experiment designed to mitigate these restrictions using an active plasma lens to tailor the electron-photon interaction, allowing for reduced bandwidth and tunability of the generated radiation. In the experiments, tunability of the central X-ray energy in the range from 34 keV to 81 keV was demonstrated by changing the focusing strength of the plasma lens. At the same time, bunch shaping by the plasma lens reduced the bandwidth of the produced photon beams. Our results closely follow theory, highlighting the potential of this technique as a future small-scale high-quality X-ray source that provides bandwidth and X-ray energy control.

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