Progress on laser-driven soft x-ray lasers at LOA

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We report here recent work on an optical-field ionized (OFI), high-order harmonic-seeded EUV laser.

The gain lifetime of the EUV laser amplifier strongly depends on the depletion rate of the lasing ion population because of collisional ionization during the lasing process. When increasing the plasma density from 3×10^{18} cm^{-3} up to 1.2×10^{20} cm^{-3}, the gain duration monotonically decreased from 7 ps to an unprecedented shortness of 450 fs FWHM [2]. The integrated energy of the EUV laser pulse was also measured, and found to be up to 4 µJ per shot. It is to be noted that in the ASE mode, longer amplifiers were achieved (up to 3 cm), yielding EUV outputs up to 14 µJ.

We employed ptychographic coherent diffraction imaging [3] for characterizing the beam of the 32.8 nm SXRL in amplitude and phase with high fidelity. Backpropagation of the field allows determining source properties. We find that HHG seeding results in excellent spatial coherence properties, while a high degree of temporal coherence is maintained through the narrow-band amplification. Further, we find that the time delay dependence between the pump and seed pulses causes significant reshaping of the amplified laser beam hinting at a complex seed-plasma interaction.

More recently, we demonstrate second harmonic generation (SHG) on a table-top XUV source for the first time by observing SHG at the Ti M2,3-edge with a high harmonic seeded soft x-ray laser (HHG-SXRL).