Recent advances on laser-plasma based soft x-ray lasers

Stephane Sebban[1], Adeline Kabacinski[1], Eduardo Oliva[2], Fabien Tissandier[1], Michaela Kozlova [3,4], Jean-Philippe Goddet[1], Igor Andriyash[1], Cédric Thaury[1], Philippe Zeitoun[1] and Julien Gautier[1]

[1]Laboratoire d'Optique Appliquée, ENSTA-Paris, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, Palaiseau, France

[2]Instituto de Fusion Nuclear "Guillermo Velarde" and Departamento de Ingenier´ıa Energética, E.T.S.I. Industriales, Universidad Politécnica de Madrid, Spain

[3]ELI Beamlines Project, Institute of Physics CAS, Praha 8, Czech Republic

[4]Institute of Plasma Physics CAS, Praha 8, Czech Republic

Intense and short soft X-ray light pulses offer unprecedented possibilities for studying ultrafast phenomena in matter at the nanometer scale. Plasma-based soft X-ray lasers (SXRLs) have the avantage of being compact sources. We report recent achievement aiming to demonstrate the control and reduction of duration of a seeded collisional soft X- ray laser induced by the anticipated interruption of the gain lifetime at high densities [1]. By controlling the peak intensity velocity of an ultrashort beam by spatio-temporal couplings we improve the performances of a SXRL, which intrinsically suffers from the group velocity (v_g) mismatch between the infrared pump beam used to generate the plasma amplifier and the XUV seed. The energy extraction was measured to raise from 19 to 59% when the pump v_g ranges from 0.55c to 1.05c. We also demonstrate that the SXRL pulse duration is governed by the pump beam velocity and can be maintained constant along its propagation, resulting in energetic pulses as short as 350 fs [2]. The measurements, in good agreement with simulations from a 3D Maxwell-Bloch code, have been performed thanks to an original method allowing to recover the temporal profile of any kind of soft X-ray laser pulse in single-shot operation.

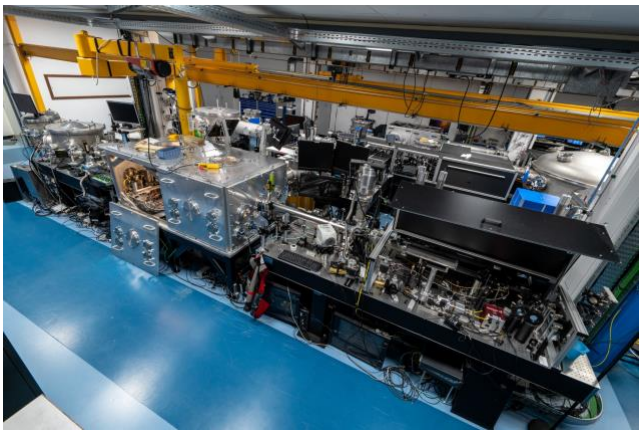

Figure 1. Soft X-ray laser beamline at LOA (Palaiseau, France)

References

[1] Adeline Kabacinski, Fabien Tissandier, Julien Gautier, Jean-Philippe Goddet, Igor Andriyash, Philippe Zeitoun, Stéphane Sebban, Eduardo Oliva, and Michaela Kozlová, Physical Review Research 4 (3), L03200

[2] Adeline Kabacinski, Eduardo Oliva, Fabien Tissandier, Julien Gautier, Michaela Kozlová, Jean-Philippe Goddet, Igor Andriyash, Cédric Thaury, Philippe Zeitoun, Stéphane Sebban, Nature Photonics, 202

* E-mail: stephane.sebban@ensta.fr