

High repetition rate, high average power XUV sources based on High Harmonic Generation

B. Manschwetus¹, T. Braatz¹, S. Rajhans², E. Escoto², M. Sumfleth³,
D. Laumer³, H. Goudarzi¹, S. Skruszewicz³, C. M. Heyl^{2,4,5}, M. Wieland³,
M. J. Prandolini^{1,3}, T. Gorkhover³, M. Drescher³, M. Schulz¹, R. Riedel¹

Bastian.Manschwetus@class5photonics.com

1 Class 5 Photonics, Notkestraße 85, 22607 Hamburg, Germany

2 Deutsches Elektronen Synchrotron (DESY), Notkestraße 85, 22607 Hamburg, Germany

3 Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg, Germany

4. Helmholtz-Institut Jena, Fröbelstieg 3, 07743 Jena, Germany

5. GSI Helmholtz Zentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

High harmonic generation (HHG) sources [1] provide fully coherent laser-like radiation in the Extreme-Ultraviolet (EUV/XUV) and soft X-ray spectral range with femto- or attosecond pulse duration. These sources are ideal metrology tools in scientific or industrial applications: The short wavelength allows very high spatial resolution in scattering or imaging of nanostructures created by state-of-the-art microchip EUV lithography. Their spectral bandwidth and ultrashort pulse durations are very useful in ultrafast spectroscopy to investigate the fast reactions occurring in solar cells, catalysis or to observe directly the carrier dynamics in superconductors or next generation semiconductors. For all these applications, HHG sources with high repetition rates and high average powers are required to minimize the acquisition times, leading to a fast turnaround in sample characterization. At the same time, a high robustness and stability of the source is needed for low-maintenance operation with minimal downtimes. Based on robust high-power femtosecond Ytterbium (Yb) laser systems together with the multipass cell pulse post compression technology [2], Class 5 Photonics is developing the Moonlander high harmonic generation source to fulfill these requirements.

In our contribution, we will present the current status of our HHG source driven by the Class 5 Black Dwarf laser, providing 17 W average power at 100 kHz repetition rate and a pulse duration of 29 fs. We measured an XUV output power of 1.4 μW for argon target gas and 2.8 μW for krypton target gas within the aluminum filter window (22-75 eV). The measured key parameters are shown in Figure 1. We will also show first results with a driver at an average power of 50 W at much high repetition rate of 750 kHz. Our next steps are the demonstration of stable operation of our HHG source for driver lasers at 200 W and 500 W average power within the joint research project MEGA-EUV with DESY, University of Hamburg and Amphos. We will discuss the technical challenges and prospects in the power scaling of these XUV sources.

[1] X. F. Li et al., Phys. Rev. A 39, 5751–5761 (1989)

[2] A. Viotti et al., Optica 9, 197-216 (2022)