High-order harmonic generation (HHG) using an ultrashort high-peak power laser pulse is a powerful method for the generation of extreme-ultraviolet and soft X-ray light. We are researching the efficient generation of HHG with the aim of generating coherent water window soft X-rays (0.28 – 0.54 keV), which are attractive for high-contrast biological imaging. In addition, we are developing a high-power IR laser system in order to perform energy scaling of water window harmonic beams.

We have demonstrated the generation of coherent water window X-rays by extending the plateau region of high-order harmonics under neutral-medium conditions. Our proposed procedure for generating water window X-rays is efficient and scalable in output yield. By using our concept, we successfully obtained high conversion efficiency and good beam quality of harmonic beams in the water window. We believe that the method presented here paves the way for the generation and application of intense ultrafast coherent water window X-rays.

Fig.1: Experimentally obtained harmonic spectra in Ar. The red and blue profiles depict the spectra using a 0.8 µm pump and 1.4 µm pump, respectively. The inset shows an image of the measured two dimensional harmonic spectrum driven by the 1.4 µm pump.

Fig.2: Measured He harmonic spectra driven by a 1.55 µm pulse with a focused intensity of $5 \times 10^{14}$ W/cm². The red line and the blue line correspond to the spectra with and without a 1-um-thick Mylar filter (C₁₀H₈O₄), respectively. The inset depicts a 2D HH spectrum image with a Mylar filter placed in front of the MCP.