Wechselwirkung intensiver XUV-Impulse mit kondensierter Materie

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The **X-RAY OPTICS GROUP** of the INSTITUTE FOR OPTICS AND QUANTUM ELECTRONICS of the FRIEDRICH-SCHILLER UNIVERSITY JENA has experience in spectroscopy in the VUV- and x-ray range for several decades. Combining knowledge from crystallography, high-precision x-ray diffraction and crystal treatment, the group is one of the rarely found manufacturers of toroidally bent crystals for imaging and high-resolution x-ray spectroscopy of laser-produced plasmas. Our band-target laser-plasma-source is flexible and can serve as a short-pulse x-ray source at any laser system with matching parameters.

Time-resolved x-ray diffraction became a field of huge interest in the last decade with the appearance of laser-plasma sources. It allows to map ultrafast effects like phase transitions and phonons which are up to know excited by optical short-pulse laser irradiation. Using FLASH’s VUV pulses, a totally new excitation mechanism is available. Therefore, an x-ray probe pulse from a laser-plasma source combined with focussing bent-crystal optics is the logical future instrumentation at FLASH experiments planned in the BMBF project.

Furthermore, a high-throughput high-resolution transmission-grating spectrometer with a toroidal Nickel-coated mirror was developed and built for the VUV range of 1..40nm. Combined with a VUV CCD detector, we demonstrated a resolution of $\Delta\lambda/\lambda \approx 0.01$ (see Fig.1). In 2007, emission spectra from VUV-FEL heated Aluminium and also Self-Thomson-scattering from a liquid Hydrogen beam were measured at FLASH.

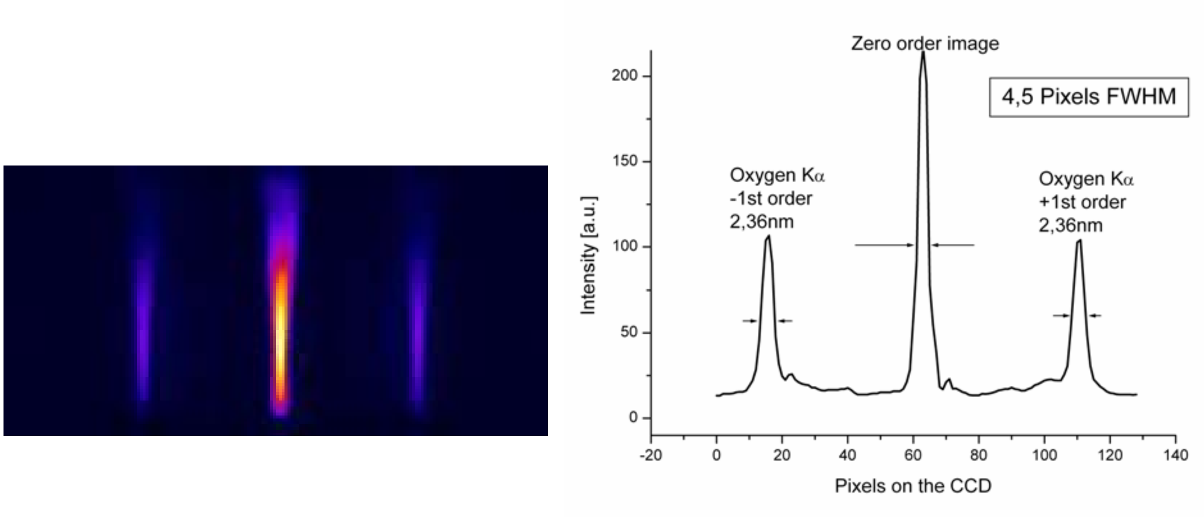

Fig. 1 CCD Image (left) and lineout (right) of zero and 1^{st} order of O-Kα radiation as a resolution test.

It was necessary to change to reflection grating system, because a free-standing transmission grating is always mounted on a 2D-support grid, which causes diffraction artefacts at sharp monochromatic peaks. Since FLASH is emitting such a signal, transmission gratings are not the optimal choice for plasma spectroscopy at FLASH. In this BMBF project, we develop a reflection grating spectrometer which increases resolution to $\Delta\lambda/\lambda \approx 0.005$, throughput by a factor of 6 and is most versatile compared with other available spectrometers with the same characteristics.