A 28: Interaction with VUV and X-ray light

Time: Thursday 16:30–18:30 Location: P

A 28.1 Thu 16:30 P

An XUV and soft X-ray split-and-delay unit for FLASH2 — •Matthias Dreimann[1], Dennis Eckermann[1], Felix Rosenthal[1], Sebastian Roling[2], Frank Wahlert[2], Sven Eppenhoff[2], Marion Kuhlmann[3], Sven Toleikis[3], Rolf Treusch[3], Elke Plönjes-Palm[3], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience, WWU Münster, 48149 Münster, Germany — [2]Physikalisches Institut, WWU Münster, 48149 Münster, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

A split-and-delay unit for the XUV and soft X-ray spectral range has been installed at beamlines FL23 and FL24 at the FLASH2 Free-Electron Laser at DESY. It enables time-resolved pump-probe experiments covering the whole spectral range of FLASH2 from 30 eV up to 1800 eV. Using wavefront beam splitting and grazing incidence mirrors a sub-fs resolution with a relative pulse delay of $-5\,ps \leq \Delta\tau \leq +18\,ps$ is achieved. Two different mirror coatings are required to cover the complete spectral range and thus, a design that is based on a three dimensional beam path was developed. This allows the choice between different sets of mirrors with either coating for the fixed branch. A Ni coating allows a total transmission above T $>$ 0.50 for photon energies between hν = 30 eV and 650 eV at a grazing angle of a $\vartheta_{variable}$ = 1.8° in the beam path with variable delay. With a Pt coating a transmission of T $>$ 0.06 is possible for photon energies up to hν = 1800 eV. In the fixed beam path at a grazing angle of ϑ_{fixed} = 1.3° a transmission of T $>$ 0.61 with a Ni coating and T $>$ 0.23 with a Pt coating is possible.

A 28.2 Thu 16:30 P

Analysis of x-ray single-shot diffractive imaging using the propagation multislice method — •Paul Tuemmler, Björn Kruse, Christian Peltz, and Thomas Fennel — Institut für Physik, Universität Rostock

Single-shot wide-angle x-ray scattering has enabled the three-dimensional characterization of free nanoparticles from a single scattering image [1,2,3]. Key to this method is the fact, that the scattering patterns contain information of density projections on differently oriented projection planes. Wide-angle scattering typically requires XUV photon energies where absorption and attenuation cannot be neglected in the description of the scattering process [4,5]. The multislice Fourier transform (MSFT) method, which provides a fast scattering simulation within the Born approximation, can be extended to also include these propagation effects. In this presentation the performance of conventional MSFT and propagation MSFT will be discussed and compared to exact results obtained from Mie theory. As a first application, selective resonant scattering from core shell systems is explored.

[1] I. Barke , Nat. Commun. 6, 6187 (2015).
[2] K. Sander , J. Phys. B 48, 204004 (2015).
[3] C. Peltz , Phys. Rev. Lett. 113, 133401 (2014).
[4] D. Rupp , Nat. Commun. 8, 493 (2017).
[5] B. Langbehn , Phys. Rev. Lett. 121, 255301 (2018).

A 28.3 Thu 16:30 P

Coherent population transfer techniques for the ^{229}Th nuclear clock candidate — •Tobias Kirschbaum and Adriana Pálffy — Friedrich-Alexander-Universität Erlangen-Nürnberg, 91058 Erlangen, Germany

The ^{229}Th nucleus posses a metastable first excited state, i.e., an isomer, at around 8.19 eV. This state should be accessible via VUV light and presents a radiative lifetime of a few hours. These unique properties make ^{229}Th a promising candidate for a nuclear clock with excellent accuracy [1]. However, due to the relatively large uncertainty on the isomeric state energy, efficient laser manipulation with VUV light has proven cumbersome so far.

Here, we investigate theoretically an alternative to populate the isomeric state by indirect excitation via the second excited nuclear state at 29.19 keV. We make use of quantum optics schemes to achieve the population transfer via Stimulated Raman adiabatic passage (STIRAP) or two π-pulses. The coherent x-ray pulses that we consider are generated by x-ray lasers or using UV pulses at the Gamma Factory in combination with relativistic acceleration of the nuclei in a storage ring. The two scenarios are discussed in view of experimental feasibility.

[1] E. Peik *et al.*, Quantum Sci. Technol. **6**, 034002 (2021).