Type of presentation: Poster

IT-8-P-6038 Towards RF photo injector based dynamic transmission electron microscopy with REGAE

Manz S.[1], Casandruc A.[1], Keskin S.[1], Zhang D. F.[1], Bayesteh S.[2], Hirscht J.[1], Felber M.[2], Gehrke T.[4], Loch R. A.[1], Marx A.[1], Delsim-Hashemi H.[2], Schlarb H.[2], Hoffmann M.[2], Hada M.[1], Epp S. W.[2], Floettmann K.[1], Miller R. J.[1,3,4]

[1]Max Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany, [2]DESY, Hamburg, Germany, [3]University of Toronto, Toronto, Canada, [4]University of Hamburg, Hamburg, Germany

Email of the presenting author: stephanie.manz@mpsd.mpg.de

The relativistic electron gun for atomic exploration (REGAE) has been designed to study structure and dynamics in a wide range of systems. Aiming for a time resolution of far less than 100 fs, we plan to observe fast structural changes in solid, solution and gas phase with single-shot femtosecond electron diffraction in the energy range from 2 - 5 MeV.
As a prove of principle study, we investigated static electron diffraction of sample thicknesses close to micrometer.
This poster will present latest feasibility studies of performing dynamic single shot real space imaging with REGAE. The requirements for single shot imaging result in bunch charges beyond pC. Both the electron's high energy as well as space charge in the electron bunches call for a special lens column pre- and post-sample.
The lenses need to be strong enough to diminish spherical and chromatic aberrations. In order to achieve nanometer resolution a focal length in the millimeter to centimeter rage is necessary. For electromagnetic solenoid lenses this means peak currents on the order of Tesla. Although the relativistic energy of the electrons decreases space charge fields compared to a dc electron gun or conventional electron microscopes, they come back in play when considering single shot imaging. We study the effects of space charge on the resolution for our newly designed lens system. We find that the bunch charge strongly affects both chromatic and spherical aberrations. Simulations show, that space charge fields affect the resolution already from fC bunch charges on, even though only the meanfield is considered yet. An optimized imaging system will be presented as well as strategies to circumvent chromatic aberrations by temporal pulse shaping with an additional RF cavity in order to achieve nanometer spatial resolution.

Acknowledgement: The project receives funding from the Centre for Ultrafast Imaging (CUI) at the University of Hamburg.