FAKULTÄT für PHYSIK
LUDWIG-MAXIMILIANS-UNIVERSITÄT
MÜNCHEN/GARCHING

PHYSIK-DEPARTMENT
TECHNISCHE UNIVERSITÄT MÜNCHEN
MÜNCHEN/GARCHING

MLL-KOLLOQUIUM

Donnerstag, 14.01.2016, 16^{15} Uhr

Seminarraum 127, TUM, Physik II, Erdgeschoss/Nord
Treffen zum gemeinsamen Kaffee 16 Uhr

Dr. Brendan Dromey

(Queens University Belfast, UK)

Temporal characterization of picosecond bursts of laser-driven ions in SiO_2

Nanoscale simulations [1] for ion damage in condensed matter suggest that the macroscopic response and recovery of the medium is encoded in a rapidly evolving nanostructured dose distribution. Rapid carrier diffusivity in the immediate aftermath of an initial excitation by swift ions implies that accessing this regime experimentally requires few picosecond (10^{-12} s, ps)/femtosecond (10^{-15} s, fs) ion pulses. Here we show how laser driven proton bunches [2] can seed ultrafast ionisation dynamics ($<<$ ps) in fused silica (a-SiO_2) that reveal ion pulse durations as short as 3.5 ± 1 ps [3].
This is in close agreement with numerical simulations. The measured incident proton flux and excited electron density suggest an inhomogenous dose distribution (IDD) of nanotracks with carrier densities on the order of 10^{21}-10^{22} cm^{-3}. The combination of ultrashort excitation lifetime and near solid carrier density is in direct contrast to measurements for homogenous photo-excitation in a-SiO_2, where the lifetime is shown extend to $>>$ 10 ps for densities $> 10^{20}$ cm^{-3}. For our conditions, we show how swift electron diffusivity within the proton-generated IDD permits an ultrafast evolution of peak density, promoting rapid exciton trapping of free carriers. Nanostructured a-SiO_2 is shown to mitigate this process due to dose localization, increasing carrier lifetimes to $>>$ 100 ps. The ultrafast evolution of IDD and the corresponding relationship to size effects in a-SiO_2 are revealed by proton pulses that drive excitations on the timescale of carrier diffusion. These results demonstrate a new approach to studying ion damage in condensed matter - ultrafast nanodosimetry.

[1] O. Osmai et al., e-J. Surf. Sci. Nanotech. Vol. 8 278-282 (2010)
[2] A. Macchi et al. Rev. Mod. Phys., 85, 751 (2013)
[3] B. Dromey et al., Nature Communications, Accepted 2016

gez. Peter Thirolf
Tel. 289-14064

gez. Norbert Kaiser
Tel. 289-12367