# IRRADIATION OF LIVING CELLS WITH SINGLE IONS AT THE ION MICROPROBE SNAKE

A. Hauptner[1], T. Cremer[2], M. Deutsch[3], S. Dietzel[2], G. Dollinger[4], G. A. Drexler[3], A. A. Friedl[3], C. Greubel[1], V. Hable[4], R. Krücken[1], R. Löwe[3], and H. Strickfaden[2]

[1] *Physik Department E12, Technische Universität München, Germany*
[2] *Department Biologie II, Ludwig-Maximilians-Universität München, Germany*
[3] *Strahlenbiologisches Institut, Ludwig-Maximilians-Universität München, Germany*
[4] *Institut für Angewandte Physik und Messtechnik (LRT 2), Universität der Bundeswehr München, Germany*

Energetic ions in the MeV-range delivered by an accelerator form defined tracks of damage in all kinds of materials and especially in biological systems like living cells. In combination with a microprobe for these ions radiation damage can be applied well directed in a quantifiable manner to certain cell compartments. The most serious damage appearing in a cell nucleus is a complete breakage of the DNA-molecule called double-strand break. By using light and heavy ions for the irradiation the damage density can be varied by more than three orders of magnitude. This is demonstrated in figure 1 showing the relationship between ion velocity and energy deposition for a representative selection of ion species. Marked by continous line sections one can see the available energy regions at the Munich tandem accelerator which represents the basis for the presented irradiation experiments.

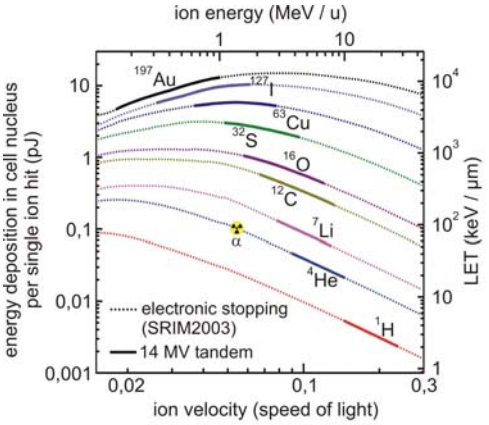


figure 1

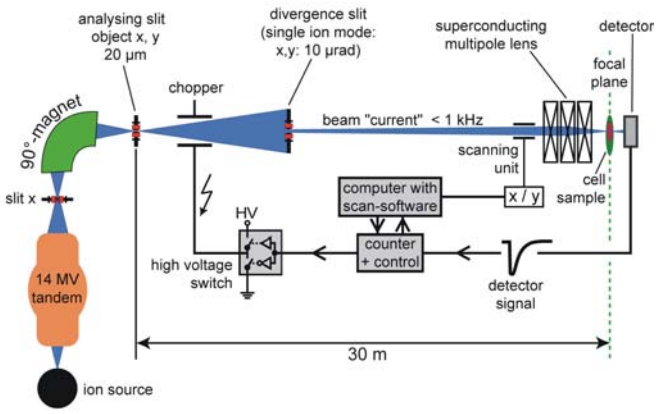


figure 2

Irradiation experiments with microscopic resolution were done using the ion microprobe SNAKE (Supraleitendes Nanoskop für Angewandte Kernphysikalische (nuclear) Experimente). This microprobe consisting of a precision slit system and a superconducting magnetic lens for beam focussing (figure 2) was upgraded with a preparation setup for single ion irradiation and a handling system for living cells. In several experiments HeLa-cells were irradiated and observed afterwards using immunofluorescence techniques. Thus proteins involved in the repair of DNA double-strand breaks could be visualized forming so-called foci. By software deconvolution of microscope images optical resolution could be improved and 3-dimensional ion track structures were reconstructed. In doing time-series experiments the spatiotemporal dynamics of repair processes in living cells could be investigated. In latest studies a new kind of experiments inducing chronologically and spatially separated irradiation damages in one single cell nucleus was performed. The obtained results indicate a competition effect in the distribution of repair proteins.