The Munich Microprobe Setup for Single Ion Irradiation of Cells

A. Hauptner, T. Cremer [a], G. Datzmann, G. Dollinger, A.A. Friedl [b], P. Hartung, H.-J. Körner, S. Koschartz, R. Krücken, and P. Reichart
[a] Institut für Anthropologie und Humangenetik, LMU München
[b] Strahlenbiologisches Institut, LMU München

The irradiation of living cells with a focussed beam of energetic ions allows various experiments in the field of radiation biology and genetics. Especially the role and temporal activity of repair proteins reconstructing broken DNA-molecules can be studied by the specific irradiation of cell nuclei. In single particle mode the ion microprobe SNAKE currently delivers a beam spot size of 1 μm in x- and 260 nm in y-direction. So it represents a suitable device for the selective irradiation of cell components. Furthermore the LET (= linear energy transfer) value of the beam can be varied over three orders of magnitude by using light and heavy ions supplied by the 14 MV Tandem accelerator. In the last three years a setup for irradiation experiments adapted to the ion microprobe SNAKE has been designed and is now installed [1,2,3]. A technical drawing of the setup is shown in fig.1.

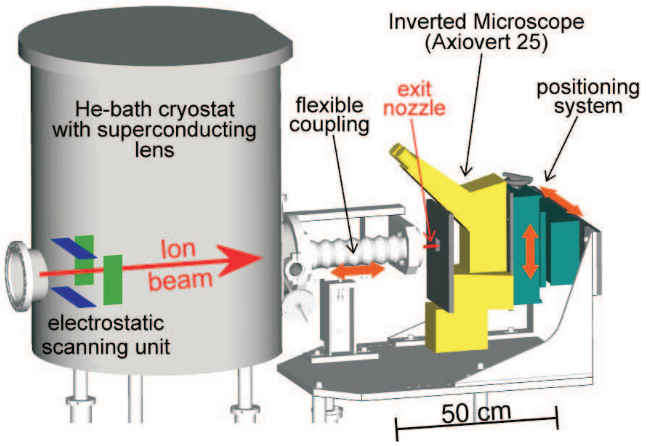

Fig. 1: The irradiation setup

The ion beam, focussed by the superconducting multipole lens of SNAKE, is transported under vacuum conditions through a flexible coupling to a beam exit nozzle. There the horizontal beam enters the atmosphere by passing a 1 mm bore covered with a 7.5 μm Kapton foil. The cells to irradiate are plated onto a thin foil in a specially prepared container (fig.2).

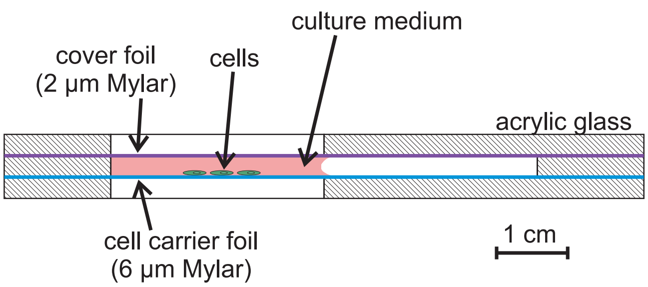

Fig. 2: Cell container (cross section) in horizontal position

As the irradiation takes place at a horizontal beam this cell container then is turned upright and the culture medium flows into the reservoir at the bottom. The cover foil sealing the container provides for a saturated atmosphere above the cells and prevents them from drying. During the irradiation the cell container is attached on the table of an inverted microscope (Axiovert 25) defining the focal plane of the ion microprobe (fig.1). With this optical microscope looking from the back side to the container the cells can be observed and aligned to the ion beam. As the beam exit nozzle cannot only be moved laterally but also along the beam direction, it is possible to insert a microscope condensor for transmitted light illumination with phase contrast. Thus the cells can be made visible without using staining technics which may disturb normal biological processes.

The irradiation experiments are done with single, counted particles. This allows to apply a defined radiation damage to the cells. The single particle preparation is carried out using an electrostatic deflection system (Posselt Chopper) powered by a fast high voltage MOSFET switch. To ensure a successful operation of this facility regular patterns consisting of etched tracks in glass plates were generated with single 170 MeV ^{127}I ions(fig.3).

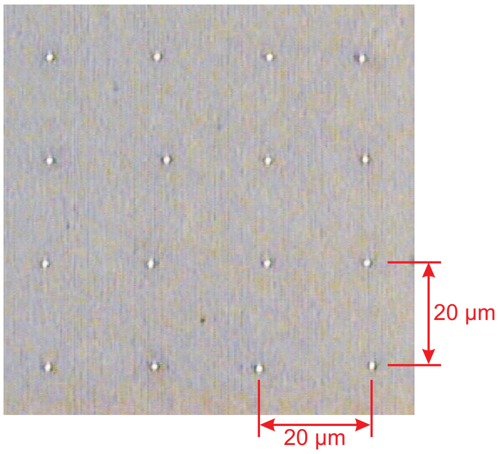

Fig. 3: Pattern of etched tracks in glass, irradiated with single 170 MeV ^{127}I ions

The positioning of the beam to the irradiation points is done with an electrostatic scanning unit in front of the multipole lens (fig.1). For the particle detection during the cell irradiation experiments a detector on the microscope turret stops the ions passing through the vacuum exit window, the cell carrier foil and the irradiated cell. Thus the single particles can be detected with high reliability.

References

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[2] A. Hauptner *et al.*, Annual report 2000, p. 72
[3] A. Hauptner *et al.*, Rad. Res. **158** (2002) 367-368