Biological studies using the proton beam produced at the PHELIX laser at GSI

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Developments in the field of laser-plasma-acceleration of ions have made progress over the last decades. It was proposed that this technique could replace linear and synchrotron accelerators used for therapy by smaller and more cost efficient devices [1,2]. However up to now progress is much slower and the necessary ion energies are neither in sight in near future nor a technique for a conform beam

However the very short pulses in the femto and pico second range make it interesting to use the existing ion beams from PHELIX to study fast reaction responses especially chemical and biochemical reactions [3,4]. Therefore we have continued the investigation of laser accelerated ion beams and established the necessary irradiation conditions for biological samples .

To extract the beam in air an re-entry tube with a 10 µm Ti vacuum window was constructed .Cells were mounted vertically in a special designed holder behind the Ti window. With this setup DNA damage and chromosomal aberrations in biological cells can be studied

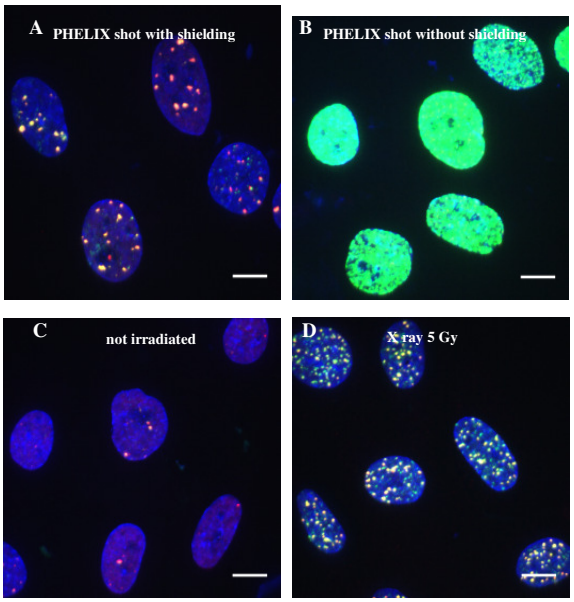

Fig 1: Foci analysis after PHELIX irradiation. Human Skin Fibroblasts (AG-D cells) were irradiated as indicated and fixed 2 h after irradiation. DNA was stained with DAPI (blue) and γH2AX (green) and 53BP1 (red) were stained with antibodies. A and B: DNA damage foci after PHELIX irradiation with and without shielding by a MD-V2 Gafchromic film; C: Not irradiated cells. D: Cells after X-ray irradiation with a dose of 5 Gy. Scalebar: 10 µm.

The foci assay is a method to analyze DNA damage. Results from experiments after PHELIX and X-ray irradiation are shown in Fig. 1. Cells were chemically fixed 2h after irradiation. After PHELIX exposure the cells showed a clear reaction forming gH2AX and 53BP1 foci. Shielding the cells with one MD-V2 Gafchromic film drastically reduced the cell reaction, but foci were still clearly visible. The comparison to the X-ray irradiated sample yielded doses well below and above 5 Gy in the shielded and unshielded case, respectively.

Besides the foci assay, analysis of chromosomal aberrations is certainly the most established method to quantify DNA damage. Results after PHELIX irradiation are shown in Fig. 2. Obviously the exposure to laser accelerated ions largely influences the chromosome structure and produces small chromosomal fragments.

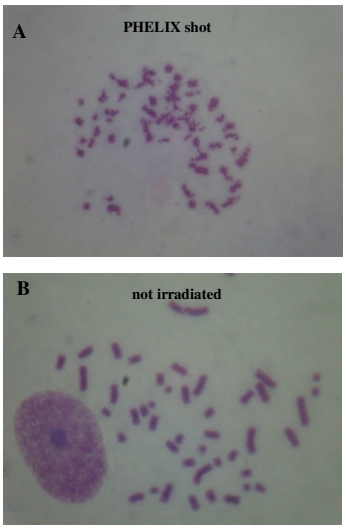

Fig 2: Analysis of chromosomal aberrations after PHELIX irradiation. Human Skin Fibroblasts (AG-D cells) were irradiated as indicated and fixed 2 h after irradiation: a large amount of chromosomal damage in form of small fragment is visible.

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