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Millipede - Millimeter sized particle exposure for dedicated biological experiments at the IBC

Particle radiation research is crucial for advancing our understanding of radiobiology and its applications in medicine. As an evolving field, it focuses on studying the interactions of charged particles, such as protons and heavy ions, with biological tissues. This research provides insights into the effects of particle radiation on cells, DNA, and tissues, enabling us to develop safer and more effective radiation therapies. Furthermore, it offers the potential to enhance cancer treatment by harnessing the unique properties of particle radiation, such as its precise targeting and reduced damage to surrounding healthy tissues. For proper research in this field dedicated setups at particle accelerators are necessary.
Here we are introducing a new experimental setup dedicated for radiobiological research using cells and tissue at the 6MV tandem accelerator located at the Ion Beam Center of the Helmholtz Center Dresden Rossendorf. The Millipede (Millimeter sized particle exposure for dedicated biological experiments) setups provides homogeneous field irradiation with field sizes up to 6.5 mm x 6.5 mm, with homogeneity larger than 90%.
Stitching of single fields allow for irradiation of larger fields, limited by the exposure time and lifetime of the cells in the setup to approx. 2.5 cm x 2.5 cm.
The setup was successfully tested for protons and helium, lithium, boron and carbon ions, covering a large range of LET (linear energy transfer, 4 keV/µm (proton) - ~500 keV/µm (carbon)), which is the important parameter for radiobiology.
Successful tests of the setup were performed using staining of radiation induced foci for varying doses and all types of ions.
Furthermore, cell survival measurements were performed for 10 MeV protons, 12 MeV Helium ions and 35 MeV Boron ions using the colonyforming assay, which is the gold standard method in radiobiology.
The survival curves show an enhanced effectiveness for both Helium and Boron, as it was expected.
These tests show that the setup can be used as a tool for performing basic and applied radiobiological research for light and heavy ions.
Applications, which are currently under investigation are the basic mechanisms of Boron Proton Capture Therapy, Proton Minibeam Therapy, FLASH Therapy and the biodosimetry of heavy ions.

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