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Investigating the effect of spatial and temporal fractionation of proton irradiation to the blood in a blood-flow simulation chamber

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Radiotherapy is one of three methods used to fight against cancer along with surgery and chemotherapy, and has currently attracted a lot of scientific interest particularly due to novel techniques, like Proton Minibeam Radiotherapy (pMBT) and FLASH therapy. The latter can deliver an ultra-high dose rate of radiation to the target (>40 Gy/s). From a biological aspect, the main target of radiotherapy, is the DNA of the cancer cells due to its radiosensitivity. Simultaneously, the gold standard for radiotherapy is, achieving optimal tumor control, with minimal healthy tissue complications. Finally, it has been shown that other biological factors, like cell oxygenation and the irradiated blood volume, are contributing aspects to better understanding the effects of radiation on cancerous and healthy tissues alike. Here, we investigate the outcomes of different types of radiation, and different dose rates, on the simulated flow of a specific blood volume.

Collaboratively with Helmholtz-Zentrum Dresden-Rossendorf (HZDR), we create an artificial capillary of materials, selected after running simulations of desired cases on TOPAS (Tool for Particle Simulation), through which, blood cells will flow during irradiation at the 10 MeV proton beam at HZDR, to simulate real-time blood flow irradiation. This might also apply to dose rates used for FLASH therapy, because of the short irradiation times which could mean that a considerably smaller blood volume receives a potentially better tolerated dose compared to doses given at conventional radiotherapeutic sessions. This project aims to test the possible correlation between irradiated blood volumes, different dose distributions within the blood volume, and side effects of radiotherapy, possibly due to that depending on the amount of blood volume that receives a certain dose at a specific dose rate, the corresponding amount of blood components like white cells, receive doses, probably critical to their survival, thus making the side effects more severe.

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