Three-dimensional dose measurements of proton therapy for tumour sites influenced by internal organ motion in human-like phantoms.

DCCC report: December 2020

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1. ½ page report

My research revolves around using 3D dosimeters to investigate the effects of motion and deformation in proton radiotherapy.
This year I published an article concluding that the dose-response of the applied 3D dosimeters is unaffected by deformation. This was shown by compressively straining multiple cylindrical 3D dosimeters to various degrees and comparing the measured signal with Monte Carlo simulations. The first article serves as a foundation for further work with deformation in the project. This year I finished construction a motion-stage that allows for dynamic translation and deformation. The 3D dosimeters are compressively strained between two acrylic plates where the one plate was attached to a spring, thereby allowing for translation. The motion-stage moves sinusoidally, which is supposed to roughly simulate the motion of a lung.
The intricate part of this experiment is knowing the timing of the proton beam delivery and correctly reconstructing the setup with accuracy. Therefore, the most time-consuming part of this experiment was the timing.
Recently the first dynamic motion and deformation experiment was conducted with success. Currently, I am working on reconstructing the experiment in a Monte Carlo simulation based on experimental recordings. Other endeavours this year include; successfully producing a 3D dosimeter with an internal structure resembling a trachea and the two primary bronchi. The internal structure was 3D printed and removed after the dosimeter cured. Furthermore, we found a way to produce anthropomorphic 3D moulds, giving the dosimeters a potential to be used for patient-specific irradiations.

2. Published articles

- Dose-response of deformable radiochromic dosimeters for spot scanning proton therapy. Simon V. Jensen, Lia B. Valdetaro, Per R. Poulsen, Peter Balling, Jørgen B.B. Petersen, Ludvig P. Muren. Phys Imag radiat onc 2020. https://doi.org/10.1016/j.phro.2020.11.004.
- Measurements and FLUKA simulations of aluminium, bismuth and indium activation by stray radiation from the annihilation of low energy antiprotons. C. Ahdida, R. Froeschl, E. Iliopoulou, A. Infantino, Simon Vindbæk Jensen. Nuclear Inst. and Methods in Physics Research, A 2020. https://doi.org/10.1016/j.nima.2019.162972.
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3. Posterpresentations

I will hold a poster presentation for the PhD day 2021 in January.

4. Talks

In 2020 I've presented my project and achievements four times in a quarterly meeting regarding 3D dosimetry, given a public presentation of my project and achievements at the Danish Center for Proton Therapy, and given a brief overview in a journal club. Many activities was cancelled due to COVID-19.

5. Future activities

In 2021 I will continue my research using the motion-stage to test complex radiation plans along with anthropomorphic dosimeters deformed in realistic ways.