Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **3434** Type: **Poster Competition (Undergraduate Student) / Compétition affiches (Étudiant(e) du 1er cycle)**

(U*) (POS-55) HEDGEHOG: a ridge filter design for FLASH proton therapy

Tuesday, 7 June 2022 17:50 (2 minutes)

Damage to healthy tissue is a major concern in external beam radiation therapy. The risk of normal tissue complications from dose delivered outside the target reduces the effectiveness and safety of treatment. To mitigate this, research is oriented towards improving dose conformity to the target, and towards limiting damage inflicted by any wayward dose. Recent studies have reinforced older findings that increasing beam dose rates by around a thousand-fold offers superior sparing of normal tissue, known as the FLASH effect. This protective factor has been observed by several groups with various beam particles and targets, and the first patient was treated with electron FLASH in 2019. However, despite these promising results the underlying mechanism is not well understood. More research is needed to explore the FLASH effect and evaluate its clinical safety and effectiveness.
TRIUMF has an experienced passive scattering proton therapy setup which treated patients for three decades and could be adjusted to conduct critical FLASH research. The modulator wheel currently used to create spread-out Bragg peaks does not spin fast enough to function properly at FLASH dose rates. An alternative based on the static ridge filter was proposed in 2017 and adapting it for use at TRIUMF is underway. This adaptation is referred to as the Homogeneous Energy Distribution GEnerator for tHerapeutic prOton beam shapinG (HEDGEHOG), and the new design offers more versatile beam control, instant energy modulation and quick production through 3D printing. This project aims to develop a Python script which takes the target parameters as input and generates a HEDGEHOG geometry which will shape the beam as required. This geometry can be imported into Monte Carlo simulation packages FLUKA and GEANT4 for testing, and the same file can be prepared for 3D printing. This will maximise similarity between simulated and physical HEDGEHOGs allowing experiments to be planned accurately and efficiently.
We will present the progress of this work including simulation results, comparisons between simulated and printed designs, and physical dose distributions measured at the TRIUMF Proton Therapy Research Centre.

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Session Classification: DPMB Poster Session & Student Poster Competition (17) | Session d'affiches DPMB et concours d'affiches étudiantes (17)

Track Classification: Technical Sessions / Sessions techniques: Physics in Medicine and Biology / Physique en médecine et en biologie (DPMB-DPMB)