performance testing and development of a micro-calorimeter based on Superconducting QUantum Interference Devices (SQUIDs) (1). Unlike other microdosimetric detectors that are used for investigating the energy distribution, this detector provides a direct measurement of energy deposition at the micrometer scale, that can be used to improve our understanding of biological effects in particle therapy application, radiation protection and environmental dosimetry. Temperature rises of less than 1µK are detectible and when combined with the low specific heat capacity of the absorber at cryogenic temperature, extremely high energy deposition sensitivity of approximately 0.4 eV can be achieved (2).

The detector consists of 3 layers: a tissue equivalent (TE) absorber, a superconducting absorber and a silicon substrate. Ideally all energy would be absorbed in the TE absorber and heat rise in the superconducting layer would arise due to heat conduction from the TE layer. However, in practice direct particle absorption occurs in all 3 layers and must be corrected for.

To investigate the thermal behavior within the detector, and quantify any possible correction, particle tracks were simulated employing Geant4 (v9.6) Monte Carlo simulations. The track information was then passed to the COMSOL Multiphysics (Finite Element Method) software. The 3D heat transfer within each layer was then evaluated in a time-dependent model. For a statistically reliable outcome, the simulations had to be repeated for a large number of particles. An automated system has been developed that couples Geant4 Monte Carlo output to COMSOL for determining the expected distribution of proton tracks and their thermal contribution within the detector.

Preliminary results of a 3.8 MeV proton beam showed that the detector reaches the equilibrium state after 8 ns. It is estimated that 20% of the temperature rise in the superconducting absorber is due to heat conduction from the adjacent absorber which needs to be corrected for. The simulations were repeated for proton beams with energies of 2, 10, 62 and 230 MeV.

Keywords: micro-dosimetry, Monte Carlo simulations and micro-calorimeter

References:
and, if needed, a new plan was re-optimized adaptively. Set up was verified with gated orthogonal X rays and non-gated cone beam CT in treatment room. Threshold for gate-on signal was initially set at 10% pressure signal dynamic and qualitatively adjusted in an asymmetric way according to results of plan recalculation in 30% expiration and inspiration. Gating signal was fed to the accelerator to enable beam delivery. Each slice was re-scanned 5 times to smear out possible interplay effects. Acute and early toxicity was scored according to CTCAE 4.0 scale.

Results: GTV and diaphragm excursion between end expiration and adjacent 30% phases was reduced to less than 5 mm. GTV (D95%) and critical OAR (D1%) DVH in 30% inspiration and expiration phases showed on average minimal (less than 3%) differences as compared to planning end expiration plan. Toxicity was minimal with no G3 event; 15% acute G2 and 10% G2 toxicity at 3 months was observed. Median follow up was rather short (3 months) nevertheless in 23 patients the dose limiting OAR was either stomach or small bowel or esophagus, therefore early toxicity data are informative.

Conclusion: Active scanning with carbon ion beams for the treatment of moving target using abdominal compression, 4D simulation, robust planning gating and rescanning is feasible and safe. Longer follow up is needed to evaluate oncological outcome.

Keywords: organ motion, active scanning

86 Carbon ion radiotherapy: do we understand each other?

How to compare different RBE-weighted dose systems in the clinical setting?

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In carbon ion radiotherapy (CIRT), mainly two calculation models are adopted to define relative biological effectiveness (RBE)-weighted doses ($D_{RBE}$): the Japanese Kanai model and the Local Effect Model (LEM). Taken the Japanese longest-term clinical data as a reference, the use of a different RBE model, with no correction for the Gy (RBE) scale, leads to deviations in target absorbed dose ($D_{abs}$) with no correction for the Gy (RBE) -weighted doses ($D_{RBE}$): the Japanese Kanai model and the Local Effect Model (LEM). Taken the Japanese Kanai model and the Local Effect Model (LEM). Taken the Japanese Kanai model and the Local Effect Model (LEM).

The agreement between MC and measured depth dose profiles in water, in terms of particle range, peak to plateau ratio, and spread out profile shape, are therefore believed to be much more harmful to the cell than dispersed DNA damage, which are primarily produced by alpha electrons can produce a cluster of complex DNA damage. These clusters of DNA damage are much harder to repair and are therefore believed to be much more harmful to the cell than dispersed DNA damage, which are primarily produced by low LET radiation. Due to their short tissue range and the severe DNA damage produced, Auger emitters may be able to kill only the target cell while sparing non-targeted cells. This makes them a potential tool for radionuclide therapy (1,2,3,4).

Purpose: The aim of this study is to compare the radiation induced DNA damage done by internal Auger-electron cascades with external exposures of sparsely ionizing radiation such as γ-rays.

Background: Auger emitters decay by internal conversion (IC) or electron capture (EC) producing a number of Auger cascade electrons. These electrons are so low in energy that their range in tissue is in the order of nm-mm. This means that if the decay happens nearby the DNA, the Auger cascade electrons can produce a cluster of complex DNA damage. These clusters of DNA damage are much harder to repair and are therefore believed to be much more harmful to the cell than dispersed DNA damage, which are primarily produced by low LET radiation. Due to their short tissue range and the severe DNA damage produced, Auger emitters may be able to kill only the target cell while sparing non-targeted cells. This makes them a potential tool for radionuclide therapy (1,2,3,4).

Material/Methods: In order to compare the radiation effects by the Auger emitter to that of external γ-rays we need to be able to estimate the dose delivered. As Auger cascade electrons have a very short range the precise spatial distribution of the decays is of high importance.

We are currently working with two Auger emitters, Cs-131 and La-135. First experiments have been performed using HeLa cells, which were incubated with either Cs-131 or La-