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Your submission:

DoseWire: optical fiber-based real-time dosimetry for microCT and radiation therapy applications

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Introduction

Ionizing radiation is frequently used in pre-clinical research for diagnostic and therapeutic purposes. Radiation based imaging, such as micro-computed tomography (µCT) is a powerful tool for non-invasive longitudinal follow-up of animal models. A lot of interest has also been directed towards the optimization of small animal radiation therapy (SmART), for subsequent translation to patients. In both cases (imaging and therapy), the animal models involved in the studies may be exposed to significant amounts of radiation. Therefore, an accurate monitoring of radiation doses is crucial to avoid excessive exposure of healthy tissues.

DoseWire is a dosimetry device based on an optical fiber, allowing real-time radiation monitoring. The device is portable and user-friendly and can also be used within a mouse for in-situ measurements in a minimally invasive way. DoseWire is characterized by an elevated signal to noise ratio and can therefore be used without need of corrections for the so-called stem effect [1]. This is particularly important when using large irradiation fields (as in imaging) and/or when the beam axis is close to 45°.

Methods

DoseWire was used with a small animal µCT (SkyScan 1076, 1276 and 1278, Bruker microCT, Kontich, Belgium) and on a small animal irradiation platform (SARRP, Xstrahl, Surray, UK). Measurements on the µCT were performed for different protocols (changing mAs, kV (35-70 kV range) and filter combinations) and scanner types. Measurements on the SmART system were all performed at 220keV using different tube currents (dose rates). In all cases, DoseWire was calibrated by an ionization chamber.

Results

The graph below shows a linearity test for measurements performed on a SmART system, demonstrating that the response of the DoseWire is linear within a broad range of dose rates. Measurements were reproducible with a variability below 1-2%. DoseWire was also tested on imaging fields, using different protocols covering a broad range of microCT imaging applications on different scanner types. DoseWire allowed real-time feedback on the effect on dose rate when changing scan parameters (tube current, filter type, kV), thereby allowing optimization of scan settings in function of minimal dose. Reproducibility of the measured dose within the FOV, to the animal and to organs was found to be excellent.

Conclusions

Real-time dose measurements are an important asset when performing studies involving intensive use of ionizing radiation, either for imaging purposes, or for therapy studies. In both cases, monitoring the dose in real-time can contribute to optimized experimental protocols, thereby allowing to maximize the quality of the study and to prevent over-exposure of tissues, possibly leading to significant experimental bias. DoseWire proved to be an accurate and user-friendly tool for systematic real–time dose monitoring in different experimental conditions.

[1] On the nature of the light produced within PMMA optical light guides in scintillation fiber-optic dosimetry, Therriault-Proulx et al. *Phys. Med. Biol.* 58 2073

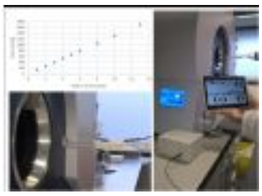

Figure 1:

Figure 1:
DoseWire

Best regards

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