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Optical fibers as dosimeter detector for proton/neutron fields –a biological dosimeter

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Dosimetry is an important part of radiation therapy, ensuring the prescribed treatment is delivered to the patient and avoiding accidental overexposure of adjacent healthy tissue. This includes characterizing proton beams for proton therapy. However, patients in proton therapy facilities are typically also exposed to secondary neutron fields, that are generated in all materials intercepted by the proton beam delivery. As the biological dose from neutrons is larger than from protons, depending on the proton beam delivery, these neutron fields can account for several percent of the overall dose to the patient outside the treated organ. While dosimeters measure the physical deposited dose, they typically do not give information on what type of particle the dose is coming from. Consequently, the biological effect is not well determined if a significant mixed field is present, and the dosimeter cannot completely confirm that the treatment plan is correctly implemented.

As ionizing radiation causes light emission in optical fibres combined with scintillators (Radiation Induced Luminescence –RIL), fibre detectors can be used as dosimeters for radiation therapy, with real-time response. Dosimeters constructed from fibres are extremely compact providing superior spatial resolution, even with the potential of in-vivo dosimetry. Here, we present a combination of several scintillator/fibre detectors that have different sensitivity to proton and neutrons. We tested fibre detectors made with Gd2O2S:Eu, Y2O3Eu, Gd2O2S:Tb, Y2O2S:Eu, YVO4, IG260 and a pure PMMA fibre with 0-400 MeV neutrons and 223 MeV, 63 MeV, 36 MeV and 9 MeV protons. Such a fibre detector combination has the potential to not just measure the physical dose but also to estimate the biological dose.

Primary author: Ms NIEDERMEIER, Jana (TRIUMF)

Co-authors: Dr BÉLANGER-CHAMPAGNE, Camille (TRIUMF); Dr HOEHR, Cornelia (TRIUMF); Ms PENNER, Crystal (TRIUMF); Prof. PAULSSEN, Elisabeth (Aachen University); Dr WOULFE, Peter (University of Limerick)

Presenter: Ms NIEDERMEIER, Jana (TRIUMF)

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