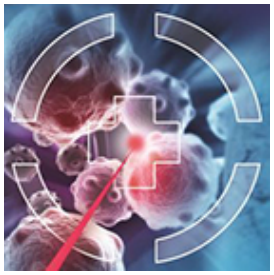

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Monitoring intra-fractional motion using a novel range telescope in a mixed He/C beam

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It has been proposed recently that a mixed helium carbon beam could be used for online monitoring of carbon ion therapy. At the same energy per nucleon, helium ions have about three times the range of carbon ions, which would allow for certain tumours to simultaneously use the carbon beam for treatment and the helium beam for imaging (theranostics). Here, the results of a measurement in which simple PMMA phantoms as well as anthropomorphic phantoms have been irradiated with a helium and a carbon beam with the same parameters are presented. The helium peak and the carbon tail exiting the phantoms are detected using a novel range telescope made of thin plastic scintillator sheets read out by a flat panel CMOS sensor. It is shown that a 10:1 carbon to helium mixing ratio generates a helium signal well above the carbon background while only adding 0.5% to the RBE-corrected dose in the carbon SOBP. A small air gap of 1 mm thickness in the simple PMMA phantom can be detected, demonstrating the achievable sensitivity of the presented method. In anthropomorphic phantoms it is shown that small displacements and rotations of the phantom as well as simulated rectal gassing cause detectable changes in the He/C beam exiting the phantom. The future prospects and limitations of the helium-carbon mixing as well as its technical feasibility are discussed. The group is currently working towards a system for real-time theranostics for carbon therapy.

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