

Ion-beam therapy quality monitoring using secondary-ion tracking with Timepix3: first results of the InViMo clinical trial

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Ion-beam radiotherapy uses steep dose gradients which makes it a highly effective cancer treatment but also susceptible to anatomical variations and patient setup shifts between treatment fractions. In-vivo monitoring with secondary radiation promises to reveal information about the daily treatment quality. The InViMo clinical trial at the Heidelberg Ion-Beam Therapy Center (HIT) aims to explore the benefit of periodical measurements of the secondary-ion emission from head cancer patients.

A tracking system made of 28 hybrid silicon pixel detectors (Timepix3) has been developed at the German Cancer Research Center (DKFZ) in collaboration with Advacam. Moreover, a Monte Carlo (MC) simulation of the tracking system was implemented in FLUKA to support the interpretation of the measured signals and estimate the dose changes in the patient. A clinical trial was conceptualized and approved by the local ethics committee at Heidelberg University Hospital. In the frame of the InViMo clinical trial, the secondary-ion emission of at least two treatment fractions are being measured, with the aim of detecting inter-fractional anatomical changes.

In this contribution, preliminary results from the first patient cohort of the InViMo trial are presented. Over 50 fraction measurements of the secondary-ion emission have already been conducted successfully. Sub-millimeter patient setup shifts along the beam axis were resolved. Signals that hint at filling level changes of oral and nasal cavities were observed in several patients. Those might result in relevant dose-distribution changes as demonstrated by the MC simulations. The continuation of the ongoing InViMo clinical trial will show which patients benefit most of this novel treatment monitoring method.

Author: Dr KELLETER, Laurent (German Cancer Research Center DKFZ)

Co-authors: Mrs ECHNER, Gernot (German); Dr JAKUBEK, Jan (Adv); Prof. DEBUS, Juergen (Heidelberg University Hospital); Mr MAREK, Lukas (Advacam); Dr WINTER, Marcus (Heidelberg University Hospital); Dr MARTISIKOVA, Maria (German Cancer Research Center); Prof. JAEKEL, Oliver (German Cancer Research Center); Mrs OCHOA-PARRA, Pamela (German Cancer Research Center); Mrs SCHLEGEL, Patrice (Germ); Mrs KIRCHGAESSNER, Rebekka (German Cancer Research Center); Dr HARRABI, Semi (Heidelberg University Hospital)

Presenter: Dr KELLETER, Laurent (German Cancer Research Center DKFZ)

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