

## First personalized dosimetry for embedded kV-CBCT imaging

kV-CBCT imaging exams are increasingly used in image-guided radiotherapy (IGRT) protocols, in order to position accurately the patient just before treatment delivery. They could be used on a daily basis, depending on the treatment protocol, which could lead to questions about doses delivered to the patient. The effects of these low doses to healthy tissues and organs at risk are still currently widely unknown. Nevertheless, some initial epidemiological studies alerted about potential risks of secondary cancers occurrence, and hence the necessity to estimate these doses in order to report them in the patient record, or to reduce them by optimizing imaging protocols.

The main goal of this thesis is to develop the needed tools for an accurate dosimetric assessment of kV-CBCT imaging systems. To this end, measurements were performed on the kV-CBCT XVI system embedded on the ELEKTA VersaHD linac installed on the DOSEO platform. Spectrometry measurements as well as in-water measurements were first performed in order to characterize the physics of kV-CBCT irradiation beams. Then, dose measurements were done in anthropomorphic phantoms equipped with OSL dosimeters and XRQA2 films, for standard imaging protocols. A dosimetric protocol for dose measurements in the kV energy range was preliminary developed and validated in order to correct the dosimeter signal from its energy dependence on this energy range. Then, in order to calculate personalized dosimetry for each patient, a Monte Carlo-based software was developed to estimate the 3D delivered doses, based on the code PENELOPE. This software was extensively validated against the numerous measurements set acquired during the previous beam characterization study. Finally, the software was used to compute dosimetric maps for the XVI system, for a paediatric cohort (40 children) and for 10 patients treated for a prostate cancer. This study showed the dosimetric variations caused by differences in patient morphologies, and demonstrated the possibility to infer simple predictive models for a fast estimation of the mean dose delivered to organs of interest, from a pre-calculated database. The different developments conducted during this thesis, either experimental or numerical, form a basis of necessary tools to further build an efficient strategy for kV-CBCT dose optimisation in a clinical context.