

Development of a dedicated optical system fully metrologically traceable for quantitative film dosimetry

Purpose : To overcome flatbed scanners limitations by proposing a new instrument dedicated to quantitative film dosimetry.

Methods : Radiochromic films are perturbation-free dosimeters with ideal properties to be used as a detector for any kind of application involving ionizing radiations. Despite this, use of films is today underexploited. The main reason for this arises from its quantitative exploitation through current digitizing devices (flatbed scanners), which are the weakness part of the film dosimetry process. It's worth noting that these scanners were initially developed for photographic applications and are not designed for scientific purposes: in that way, suppliers does not guarantee the scanning results. The reliability of the quantitative information obtained is then questionable. To address this issue, the Laboratoire National Henri Becquerel (LNHB), the French Primary Dosimetry Standards Laboratory, took the initiative to develop its own dedicated instrument that ensures traceability for both optical density and dose.

Results :

The optical system is specifically designed to eliminate common artifacts encountered with flatbed scanners. It features a monochrome sCMOS camera coupled with a bi-telecentric lens and a specially designed high-output uniform LED source. It can digitize films up to 6x6 cm² and has been extensively tested for repeatability, reproducibility, and stability. The system's reproducibility was evaluated using 10 calibrated neutral filters over a month, with an average standard deviation of less than 0.2%. Repeatability was examined by acquiring 1000 consecutive images of each filter, with a standard deviation consistently lower than 0.1%. Stability measurements over 36 hours and 1800 images showed a drift of less than 0.2%.

Conclusion : This promising dedicated instrument opens the door of a paradigm shift in quantitative film dosimetry by providing a reliable information with a rigorous control of uncertainties. The independent control of each component of the system allows for greater flexibility in both image acquisition and image processing.