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P2.72: Eye Lens Dosimetry with Dosepix

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The eye lens is one of the most radiation sensitive organs of the human body [1]. Therefore, the maximally allowed organ equivalent dose to the eye lens per year for occupationally exposed personnel has been reduced from 150 mSv/a to 20 mSv/a within a 5-year average with the dose not exceeding 50 mSv in any year [2]. Active eye lens dosimeters are of need in interventional radiology and cardiology marking the fields of largest dose exposure to the lens of the eye [3]. No active eye lens dosimeter certified in accordance with IEC standards is available on the market at the time of this abstract (March 23). In this work, first measurements of an active personal eye lens dosimeter prototype in photon reference fields are presented.
The dosimeter prototype (Figure 1) is based on the hybrid photon-counting energy-resolving pixelated detector Dosepix [4] which has been developed by a collaboration of Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) and the European Organisation for Nuclear Research (CERN). A 300 µm thick silicon sensor layer is attached to Dosepix ASIC. Deposited energies are sorted into a histogram of 16 energy bins by the individual pixel electronics. The eye lens dose is estimated via a weighted sum of the entries of those histograms where the weighting factors are determined from simulation results and measurements at reference conditions. The quantities of interest are the operational dose quantity for eye lens dose $H_\mathrm{p}(3)$ [5] and the response which is given by the measured dose divided by the actually applied dose.
No significant influence of the photon pulse duration on the response of the dosimeter is found for pulse durations ≥1 ms (Figure 2). The response also stays within the official limits, stated in IEC/EN 61526:2020, for irradiations of RQR-5 and RQR-8 (acc. IEC/TS 61267:2005) with dose rates up to 1 Sv/h (Figure 3). Continuous irradiations with mean photon energies from 12 keV to 248 keV and irradiation angles from -75° to +75° show no deviation of the response, normalized to the response of the radiation quality N-60 at 0° angle of incidence (acc. ISO 4037-1:2021), of more than ±20% from 1.0 fulfilling the official limit stated in IEC/EN 61526:2020 (Figure 4). Reproducibility of dose estimation within the limits according to IEC/EN 61526:2020 is shown by applying selected radiation qualities at least four times at two identical eye lens dosimeter prototypes (Figure 5). The influence on the measured dose value of beta radiation from a ^{85}Kr-source (acc. to ISO 6980-1 and ISO 6980-3) is shown to be less than 0.1% of the irradiated personal surface dose $H_\mathrm{p}(0.07)$.

The results show the ability of the presented active eye lens dosimeter prototype to estimate the eye lens dose in real time in continuous and pulsed photon fields. This enables active radiation protection of occupationally exposed staff in interventional medicine.

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