The continuous increase in the number and typology of Interventional Radiology procedures, as well as Haemodynamic and Vascular Surgery treatments, coupled with the new international limits for medical personnel exposure to ionizing radiation, makes very important to enhance the operators’ quantitative awareness of their exposure[1]. Active Personnel Dosimeters promise in principle to satisfy such request, however the current products have some problems for pulsed mode and high dose-rate, and none of them is qualified as dosimeter, only as educational device[2].

The INFN RAPID project (Real-time Active Pixel Dosimeter) has developed a completely wearable wireless prototype based on a new sensing device, a commercial CMOS Imager (VGA format). It has already been calibrated and validated as proof of concept on more than 50 clinical procedures[3].

Device is operated through rechargeable batteries, > 8 hours continuous functioning. Communications with control unit are established using the standard 868 MHz frequency and SimpliTT protocol (Texas Instruments). The receiving antenna is located inside the operating room to minimize the packet loss, and is connected via an active USB cable with the control station outside. All devices are synchronized among them and use the same integration time (200 ms). Being capable of detecting single diffused photons, RAPID devices have a very low threshold for measuring the dose-rate (~ 12 pGy/200 ms) [3].

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The phantom (PMMA slabs) used has 30x30x24 cm³ dimensions, 4 RAPID devices have been situated in position A, B, C, D, and a direct dosimeter (RaySafe Xi) in position E.

AIM OF THE TEST AND SETUP

This work aims at demonstrating that operating the RAPID devices in a clinical environment, using a PMMA phantom to diffuse the X-ray radiation, both the relative precision of the measurement and the linearity of the response are well below the 10% figure.

The main factors causing uncertainty in the measurement of dose-rate are both the number of interacting photons and the fluctuation of signal produced by each interacting photon in the pixel matrix. Hence the uncertainty could be modeled by Poisson statistics, convoluted with a variable gaussian distribution.

For low signal we do expect to have a greater relative uncertainty, but this should not weight too much in the total dose measurement uncertainty.

We observe that for most of the conditions the relative uncertainty is below 10% if the measured dose rate is greater than 100 pGy/pulse.

SIGNAL DEPENDENCE FROM X-RAY PARAMETERS

Scan in delivered dose / pulse : [30 – 450 μGy (measured by RaySafe Xi)]

Scan in mA [50-500 mA @ 100 ms pulse width]

Scan in X-ray tube HV [50-120 kV @ 100 mA and 100 ms]

For all the parameters range the relative deviation from the predicted behaviour (linear or quadratic) is in average less than 3% with almost all points lying in a ± 10% range.

MEASUREMENT UNCERTAINTY

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CONCLUSIONS

We have operated 4 RAPID sensors at the same time on a photon field generated by an angiograph and diffused by PMMA phantom.

Several X-ray tube parameters have been varied to study the uncertainty in the measurements and we have found it to be smaller than 10% in most of the interesting dose-rate range.

The correspondence of the dose-rate measurement to the expected dependence from parameters has been found to be better than 5%.

REFERENCES


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