An Innovative Electronic Detector for Computed Tomography Dosimetry

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INTRODUCTION

Computed Tomography (CT) dosimetry is normally reported in function of the computed tomography dose index (CTDI) which is performed with one single slice at the middle of a 100 mm pencil ionization chamber. However, in general, clinical CT examinations involve exposures from multiple rotations of the X ray tube and another specific quantity is defined: the multiple scan average dose (MSAD). Actually, the MSAD value is a calculus based on the CTDI value which is obtained at the center and the periphery holes of a head phantom, for instance. However, the MSAD value can be estimated using a film or thermoluminescent dosimeters (TLDs). Generally, these methods require a considerable time interval due to the nature of calibration, handling, and reading. In this work an innovative detector is proposed based on an array of high sensitivity miniature photodetectors plus its electronic circuit embedded in an encapsulation like a 160 mm pencil.

METHODOLOGY

- The dosimetric system consists of: the detector, an electrometer and a computer with the DoseX® software, which controls the electrometer.

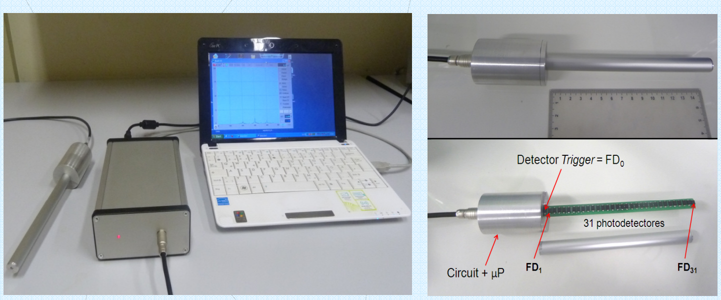

Figure 1: Dosimetry system and the CTDI-MSAD Detector (Patent Reg. #020110098616).

- Tests were performed free in air and in the center hole of the head phantom, both in the gantry isocenter; using a sequential CT scanner, Toshiba Asteion.
- Irradiation parameters: 120 kV, 200 mA and 3 s of scan time; nominal thickness of 5 mm (free in air) and 10 mm (free in air and head phantom).

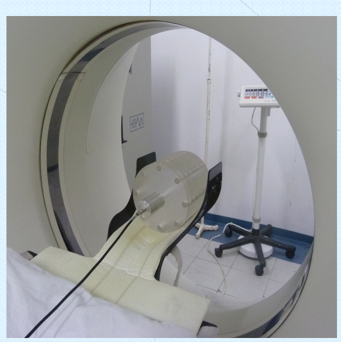

Figure 2: Experimental arrangement in the head phantom.

- For the CTDI, the central region of the detector (16th photodetector) was exposed to a single slice providing the profile slice dose profile.
- For the MSAD, the measurements were made by moving the detector in steps of 10 mm along the rotation axis of the tube. The MSAD was measured by means of 16 slices along 150 mm.

RESULTS

CTDI Measurements

Figure 3 shows the results for the single slice dose profiles and Table 1 presents some data to compare them with the pencil chamber undergoing to the same irradiation conditions.

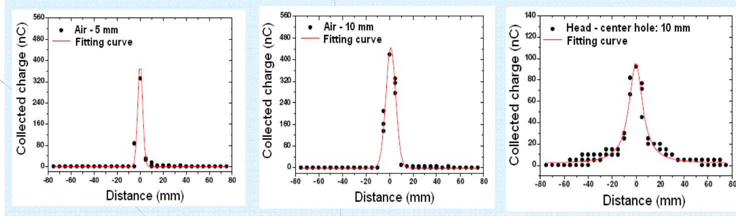

Figure 3: Single slice dose profile obtained free in air and in head phantom.

Table 1: Profile details

	Thickness [T] (mm)	FHWM (mm)	Area/T (nC)	CTDI (mGy)	Conversion factor ($\times 10^{-2}$ mGy/nC)
Air	5	5,2 ± 0,5*	448 ± 22	173,0 ± 0,2	38 ± 2
	10	10,0 ± 0,3*	464 ± 5	194,3 ± 0,1	42 ± 1
Head Phantom	10	13,3 ± 0,4**	194 ± 6	111,3 ± 0,3	57 ± 2

* Estimated by a Gaussian; ** Estimated by a Lorentzian

MSAD Measurements

Figures 4 and 5 illustrates the experimental results from MSAD curve showing the contribution of the adjacent slices.

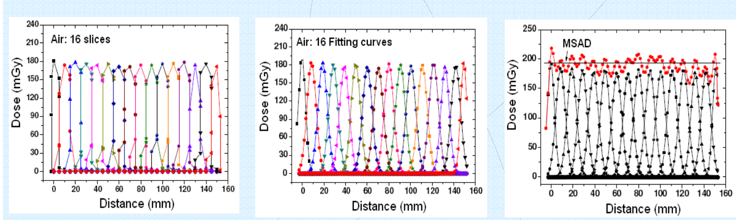

Figure 4: 16 dose profiles with their fitting curves and each integrated value obtained free in air.

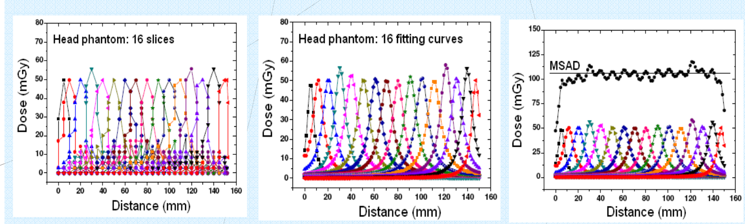

Figure 5: 16 dose profiles with their fitting curves and each integrated value obtained in head phantom.

Theoretically, the CTDI and MSAD should be equal for these cases because the table increment was equal to nominal thickness (10 mm). The results obtained in the air were 194.3 mGy and (194 ± 1) mGy for CTDI and MSAD, respectively. Results from the head phantom were 111.3 mGy and (106 ± 2) mGy for CTDI and MSAD, respectively. Thus, the innovative detector can be used for measuring the dosimetry quantities applied to computed tomography.

CONCLUSIONS

The CTDI-MSAD detector represents an innovation for dosimetry in computed tomography. The results showed that the detector has an advantage in relation to detectors normally used for measuring the MSAD and CTDI: the possibility of obtaining isolated (single slice) or adjacent (various slices) dose profiles in detail and in real time. It provides an advance for CT dosimetry and quality assurance.

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