DETECTIVE QUANTUM EFFICIENCY (DQE) OF THE DEXELA 2923MAM DETECTOR ACCORDING TO IEC 62220-1-1:2015

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Introduction

* In recent years, novel digital X-ray imaging devices based on complementary metal oxide semiconductors (CMOS) are increasingly used in many fields of medical imaging.

* The purpose of the present study was to determine the Detective Quantum Efficiency (DQE) of the Dexela 2923MAM CMOS detector, following the new IEC 62220-1-1:2015 International Standard.

Methods 1

DQE was assessed after the experimental determination of the Modulation Transfer Function (MTF) and the Normalized Noise Power Spectrum (NNPS). The CMOS sensor had a pixel size of 74.8 μm coupled to a 200 μm CsI:Tl screen.

Fig. 1: The Dexela 2923MAM digital CMOS detector.

Methods 2

The MTF was measured following both the IEC 62220-1:2003 and IEC 62220-1-1:2015 methods, while NNPS was determined by 2D Fourier transforming of uniformly exposed images. Both parameters were assessed by irradiation under the RQA-3 beam quality.
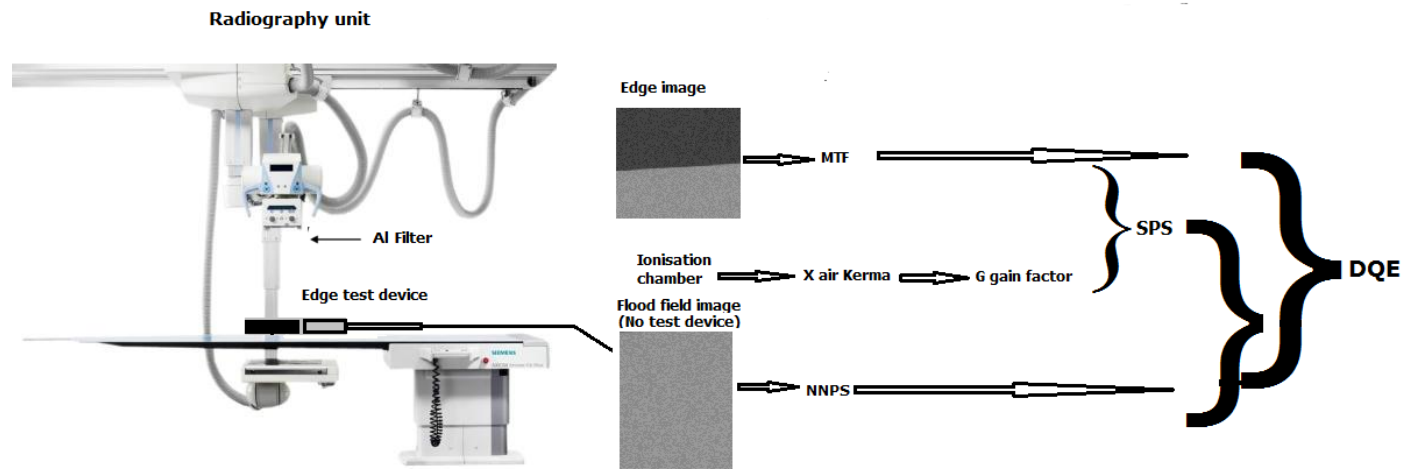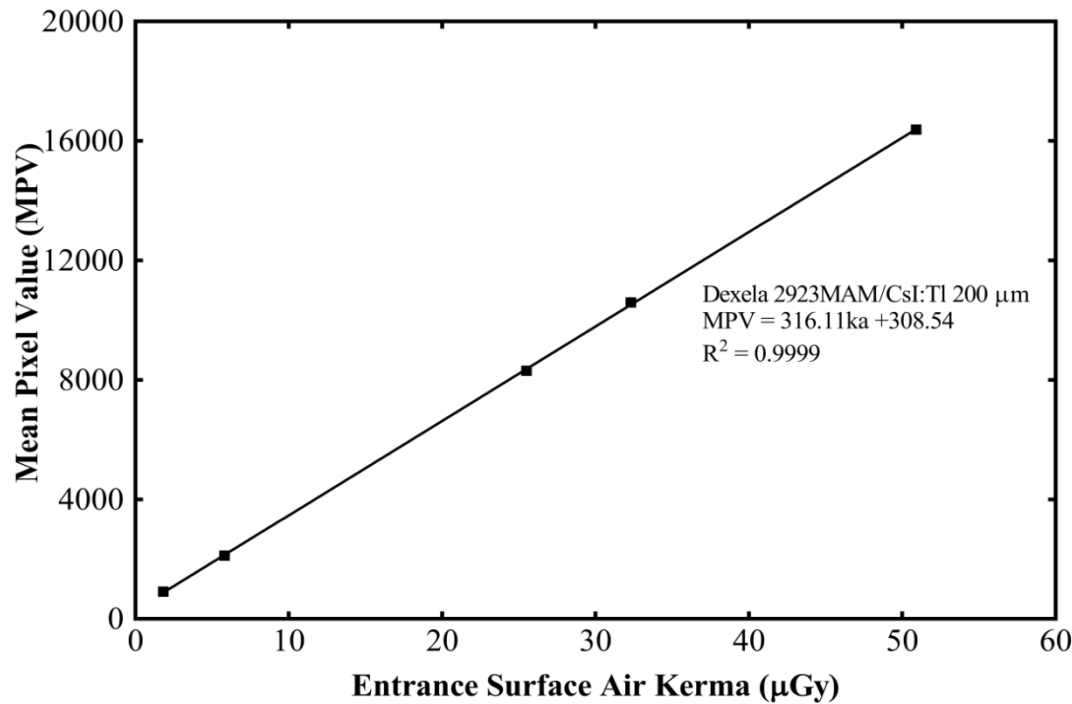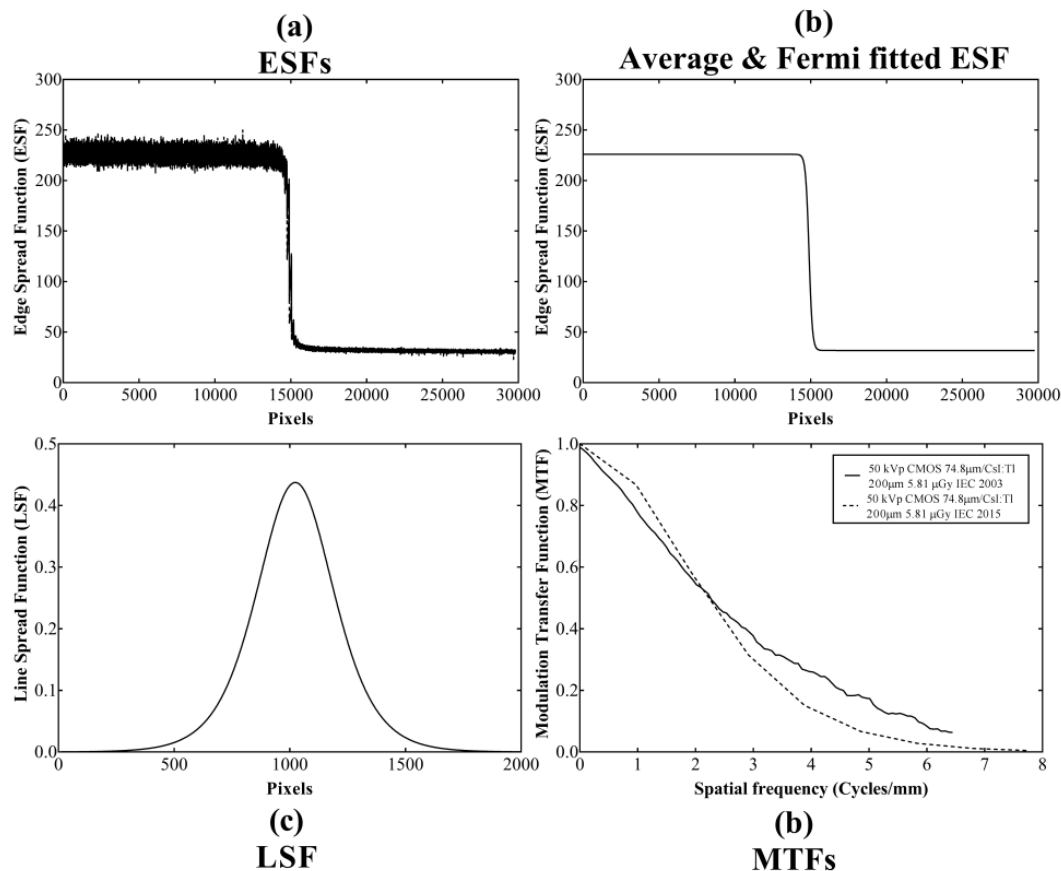

Fig.2: Experimental set-up.

Results 1

Dexela 2923MAM/CsI:Tl 200 μm
MPV = 316.11ka +308.54
$R^2 = 0.9999$

The detector response function was linear for the exposure range under investigation.

Fig.3: STP curves for the Dexela 2923MAM under the RQA-3 beam quality.

Results 2

> ➤ MTFs calculated following the 62220-1:2003 protocol, were found overestimated for spatial frequencies higher than 2 cycles/mm.

Fig.4: a) ESFs of the Dexela 2923MAM detector, following the IEC 2015 method, b) averaged and Fermi fitted ESF, c) LSF, d) Comparison of the resulted MTFs following IEC 2003 and IEC 2015 protocols, under the RQA-3 beam quality.
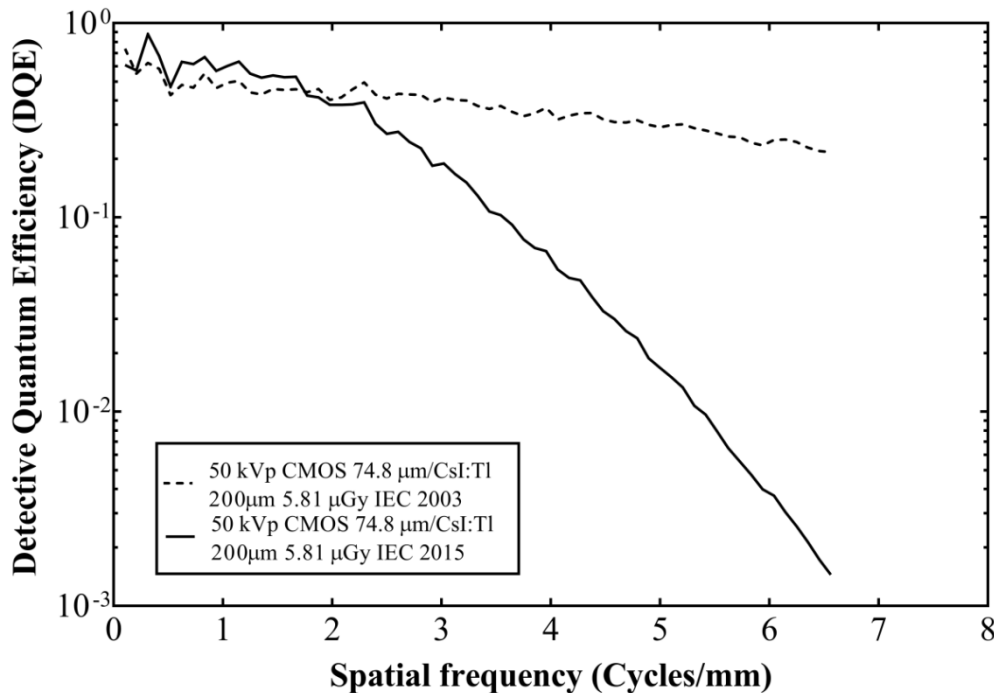
Results 3

DQE values, determined with the IEC 62220-1:2003 method, were also found overestimated (spatial frequencies higher than 2 cycles/mm), due to the influence of both MTF and NNPS.

Fig.5: Comparison between the DQE curves of the Dexela 2923MAM detector, under the RQA-3 beam qualities following IEC 2003 and IEC 2015 protocols.

Results 4

Table 1: Lag effects.

Method	CMOS-scintillator combination Dexela 2923MAM/CsI:Tl 200 μm
Additive lag effects (method 1)	0.000188
Multiplicative lag effects (method 2)	0.0000943

The influence of both additive and multiplicative lag effects were found below 0.005, insuring that lag contributes less than 0.5% of the effective exposure.

Conclusions

The artificially overestimated MTF values resulting following the 2003 protocol is attributed to the MTF averaging, which also averages noise, that is transferred more efficiently than signal through the imaging chain.

References

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