Can We Ditch the Air Gap with Shielded Dosimeters?

Investigation of Backscatter Mitigation In Shielded Solid-State Radiation Detectors

Peter Watson
Medical Physics Unit, McGill University
Montreal, QC, Canada

Sarthak Mendiratta
Department of Physics, McGill University
Montreal, QC, Canada

TL;DR – Yes, the backscatter contribution measured with an AGMS-DM+ and a RaySafe X2 dosimeter was within the manufacturers' stated dose uncertainty (5%), suggesting that these detectors can be used to measure incident air kerma without requiring an air gap.

INTRODUCTION

Accurate estimation of entrance skin dose (ESD) is important in diagnostic radiology. ESD can be calculated by measuring incident (scatter-free) air kerma and applying an appropriate backscatter factor (BSF) dependent on field size and beam quality.

Scatter-free measurement conditions can be achieved using a large air gap between dosimeter and phantom surface, however several commercially available solid-state dosimeters claim to be shielded from backscatter.

Here, we quantified the backscatter reduction for two widely used shielded solid-state dosimeters: an IBA Radcal AGMS-DM+ and a Raysafe X2.

MATERIALS & METHODS

BSFs were measured for a variety of beam qualities (50-125 kV for two filtrations: 3.1 mm Al and 3.1 mm Al + 0.9 mm Cu), with a field size of 28x28 cm^2 on a Siemens ARTIS Zee fluoroscopy system. BSFs were determined for both PMMA (25.8 cm thick) and a leaded apron (Ultraray UltraXTLite, 97% Pb, 0.5 mm Pb eq. @ 130 kV). An unshielded ionization chamber (IBA Radcal 10X6-60) provided reference BSFs for comparison with published values. Measurement uncertainty estimated from positioning uncertainty (± 2 mm) and exposure reproducibility (1%).

RESULTS

Ionisation chamber BSFs agreed with recent experimental literature, but were 6-8% lower than IAEA TRS-457 values. For the shielded dosimeters, BSFs showed no significant energy dependence, nor a material dependence between PMMA and leaded apron. **BSFs ranged from 1.001 to 1.046, with mean values of 1.03±0.02 (AGMS) and 1.02±0.02 (X2) for PMMA, and 1.03±0.01 (AGMS) and 1.01±0.01 (X2) for leaded apron.**

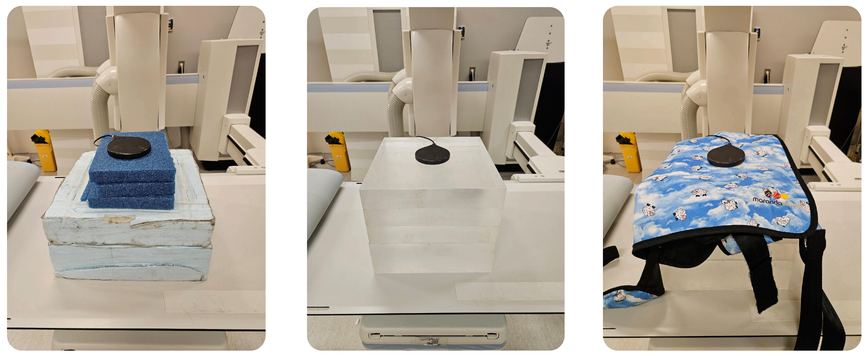
CONCLUSIONS

Backscatter contribution for AGMS-DM+ and RaySafe X2 contact measurements on a PMMA phantom and leaded apron was within the manufacturers' stated dose uncertainty (5%), suggesting that these detectors can be used to measure incident (i.e. backscatter-free) air kerma without requiring an air gap.

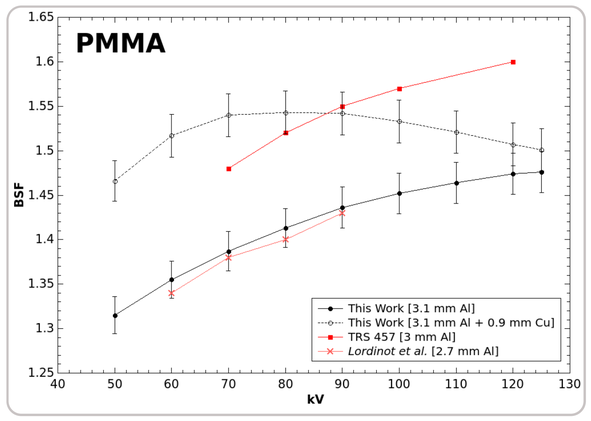
IBA Radcal AGMS-DM+ (left) and Raysafe X2 (right) solid-state dosimeters

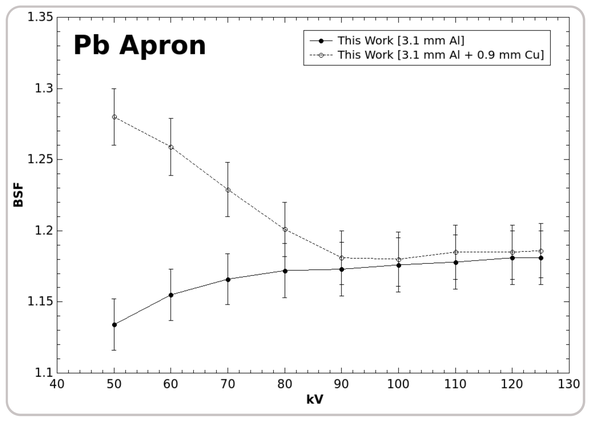
kV	HVL (mm Al)	
	3.1 mm Al	3.1 mm Al + 0.9 mm Cu
50	1.9	5.3
60	2.3	6.7
70	2.7	7.8
80	3.0	8.9
90	3.4	9.7
100	3.8	10.5
110	4.2	11.0
120	4.5	11.5
125	4.7	11.7

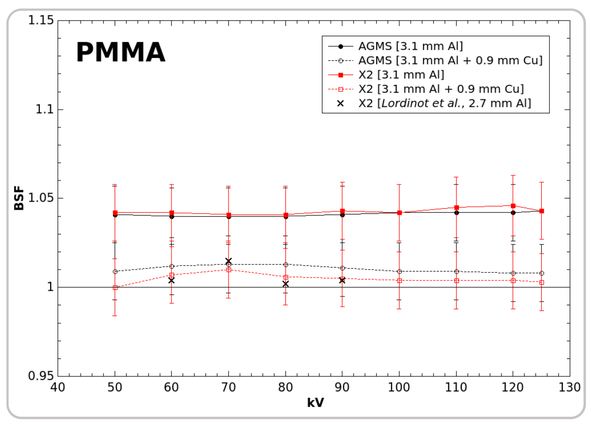
Beam qualities used in this study

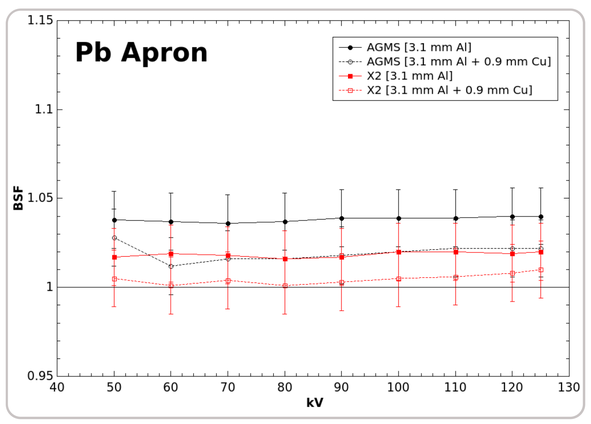


Experimental setup for BSF measurement: "in air" (left), on PMMA (center), and leaded apron (right). IBA Radcal 10X6-60 pictured









References:
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