SMALL FIELDS DOSIMETRY: OUTPUT FACTORS AND CORRECTION FACTORS DETERMINATION FOR AN ELEKTA AXESSE MEDICAL LINAC EQUIPPED WITH CIRCULAR CONES

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IAEA/AAPM formalism for small field dosimetry

$$\Omega_{Q_{clin},Q_{msr}}^{f_{clin},f_{msr}} = \frac{M_{Q_{clin}}^{f_{clin}}}{M_{Q_{msr}}^{f_{msr}}} \times k_{Q_{clin},Q_{msr}}^{f_{clin},f_{msr}}$$

f_{msr}: machine-specific reference field

f_{clin}: clinical field

The correction factors *k* can be determined through:

– primary standard

– passive dosimeter (alanina, radiochromic films)

– MonteCarlo simulations

Purpose

–to determine **<u>OUTPUT FACTORS</u>** Ω for several active detectors and one passive dosimeter (Gafchromic EBT3 films) for an Elekta Axesse with circular collimator (diameter 5 – 30 mm)

–to determine the **CORRECTION FACTORS** *k* for the active detectors for comparison with films

$$\Omega^{f_{clin}, f_{msr}}_{Q_{clin}, Q_{msr}} = \frac{M^{f_{clin}}_{Q_{clin}}}{M^{f_{msr}}_{Q_{msr}}} \times \boxed{k^{f_{clin}, f_{msr}}_{Q_{clin}, Q_{msr}}}$$

Detectors Overview

Detector	Density	Active volume	Additional components
Gafchromic EBT3	1.1 g/cm^3	72 dpi → voxel size ≈ 0.080 mm^3	Polyester
Exradin A16	0.0013 g/cm^3	7 mm^3	Shonka C-552
Exradin A26	0.0013 g/cm^3	15 mm^3	Shonka C-552
Exradin W1	1.05 g/cm^3	3 mm^3	Optical fiber
PTW microLion	0.69 g/cm^3	1.7 mm^3	Graphite electrode
IBA Razor	2.33 g/cm^3	0.006 mm^3	ABS plastic + epoxy

Measurements geometry

–Active detectors in PTW MP^3 phantom (axially)

–SSD = 90 cm, depth = 10 cm

–MLC Collimation upstream of the cone:
$f_{MLC} = 4 \times 4$ cm^2

– Dosimetrical positioning (Trufix tool) relative to 5 mm cone

– $f_{msr} = 10.4 \times 10.4$ cm^2 , $d(f_{clin}) = 5 \div 30$ mm

– Films placed in Solid Water phantom

–Measurements repeated three times for each field

Results

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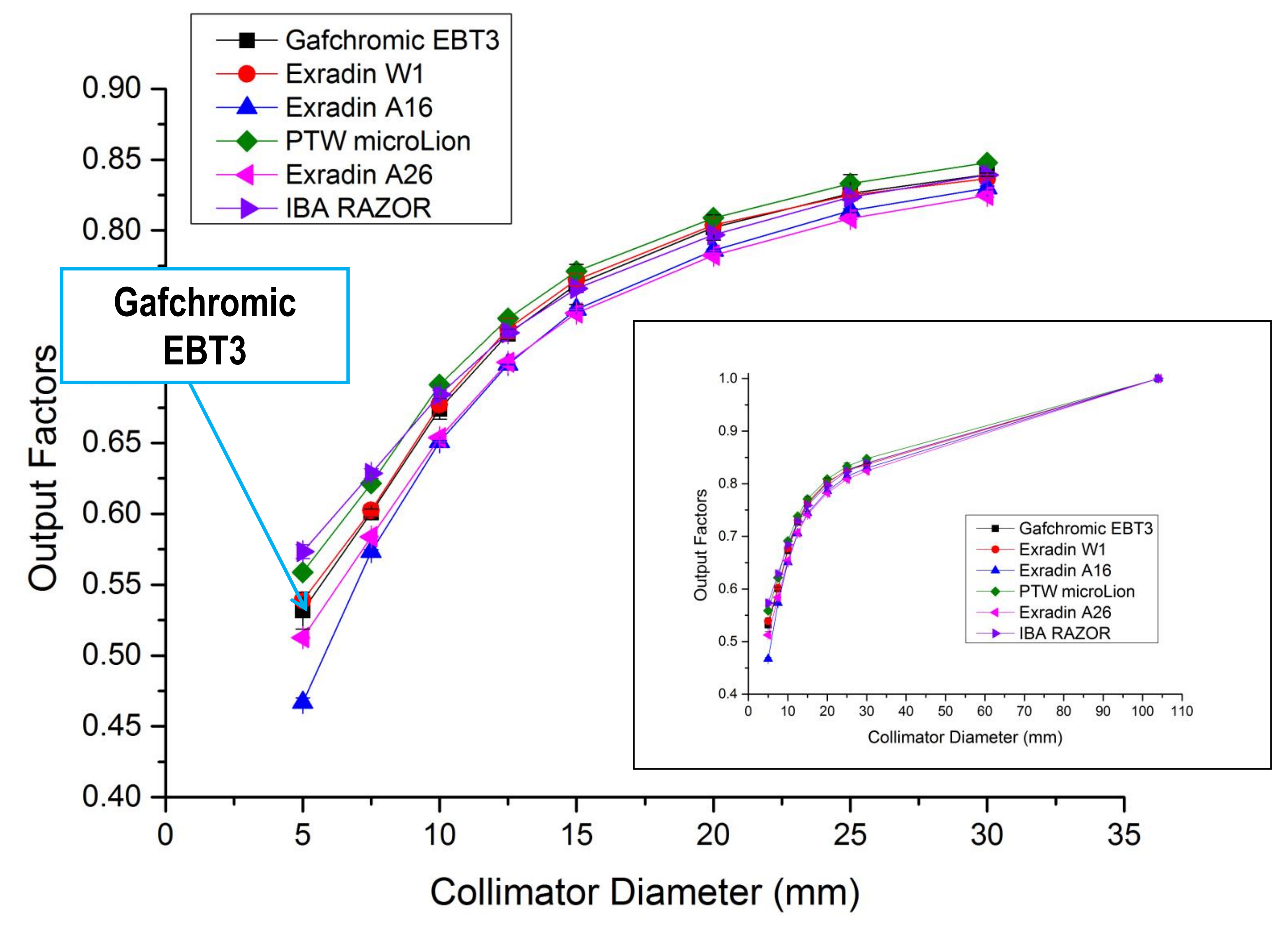
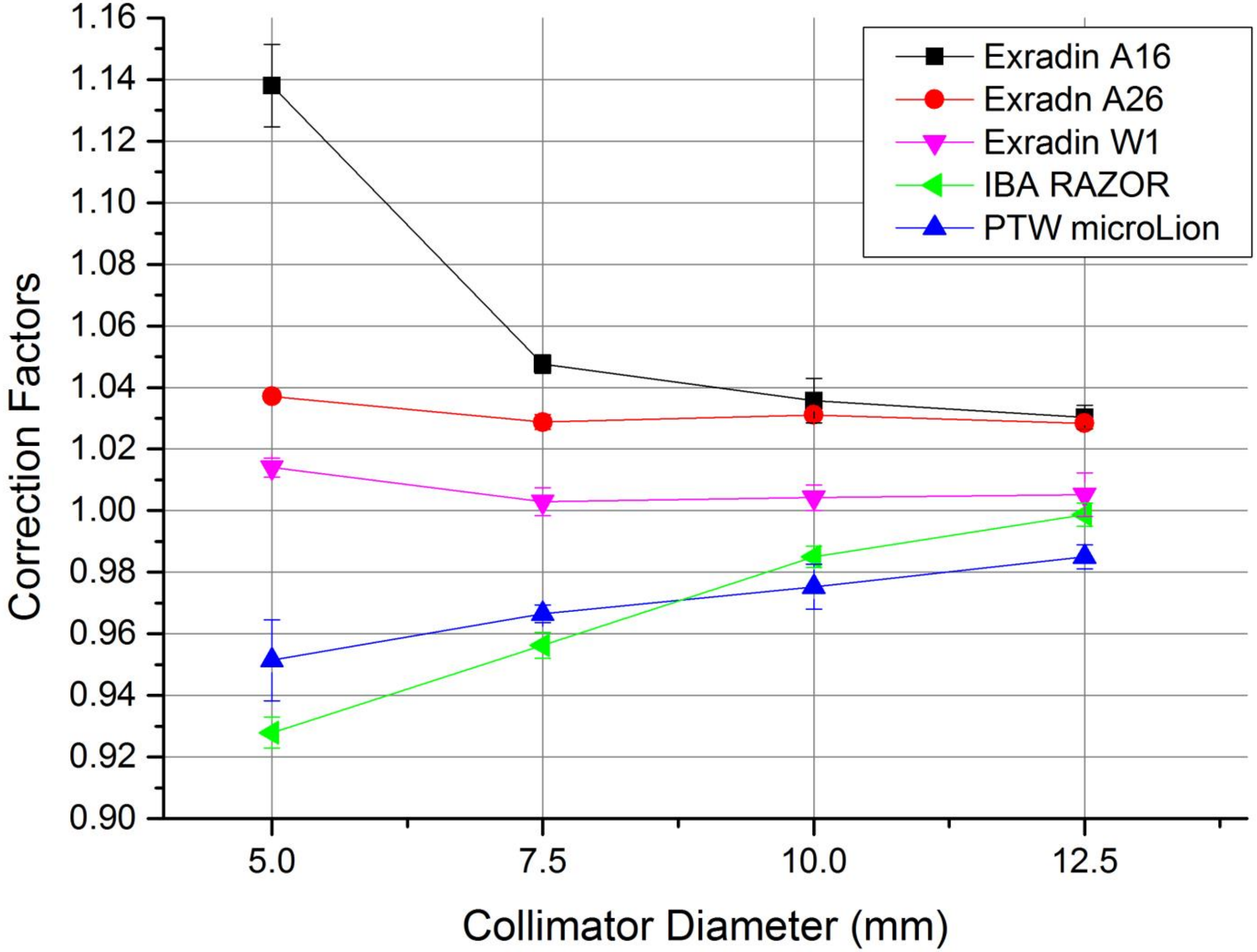


Gafchromic EBT3

Detector	Behavior in small fields	5 mm cone	7.5 mm cone	10 mm cone
Exradin A16	Underestimation	- 12 %	- 5 %	- 3.5 %
Exradin A26	Underestimation	- 3.7 %	- 2.8 %	- 3 %
Exradin W1	Very close to films	+ 1.5 %	k = 1	k = 1
PTW microLion	Overestimation	+ 5 %	+ 3.5 %	+ 2.5 %
IBA Razor	Overestimation	+ 8 %	+ 4.6 %	+ 1.5 %


Correction Factors
1.16
1.14
1.12
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
5.0
7.5
10.0
12.5
Collimator Diameter (mm)
Exradin A16
Exradn A26
Exradin W1
IBA RAZOR
PTW microLion

Correction factors interpretation

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$$k_{Q_{clin},Q_{msr}}^{f_{clin},f_{msr}} = p_{vol} \times p_{fl} \cdot p_{spec}$$

Azangwe et al., Med Phys 2014

- p_{vol}: volume averaging correction
- $p_{fl} \cdot p_{spec}$: perturbation detector correction

Medium density≠1 g/cm^3

Scott et al., Phys. Med. Biol. **57 (2012): “***The variation at small field sizes is shown to be due to differences between the densities of detector active volumes and water, rather than differences in atomic number.*”

Conclusions

Using an accuracy level of 2% (Underwood et al. Phys. Med. Biol. 60,2015):

- Exradin W1 does not need corrections, even for collimator diameter below 10 mm

-IBA RAZOR can be used to measure 10 mm cone without corrections

-Other detectors should be not used below 10 mm diameter cone without correction factors