Effective point of measurement for parallel plate chambers using PTW TRUFIX®

Introduction

The German standard DIN 6800-2 defines specifications for the determination of absorbed dose to water with air-filled ionization chambers in radiation therapy. In the current version (DIN 6800-2:2020 [1]) the positioning of ionization chambers in reference conditions has been updated. Changes concerning the positioning of plane parallel chambers will be explained in this technical note.

Positioning of plane parallel chambers according to DIN 6800-2 [1]

The position of an ionization chambers in space is described by the location of the reference point. In addition, the orientation of the ionization chamber with respect to the direction of the central beam (e.g. radial or axial) must be specified.

For plane parallel chambers the preferred orientation is axial to the central beam, this means that the central beam is perpendicular to the surface of the entrance window. The reference point is located on the inner surface of the entrance widow, at the centre of the window, see Figure 1.

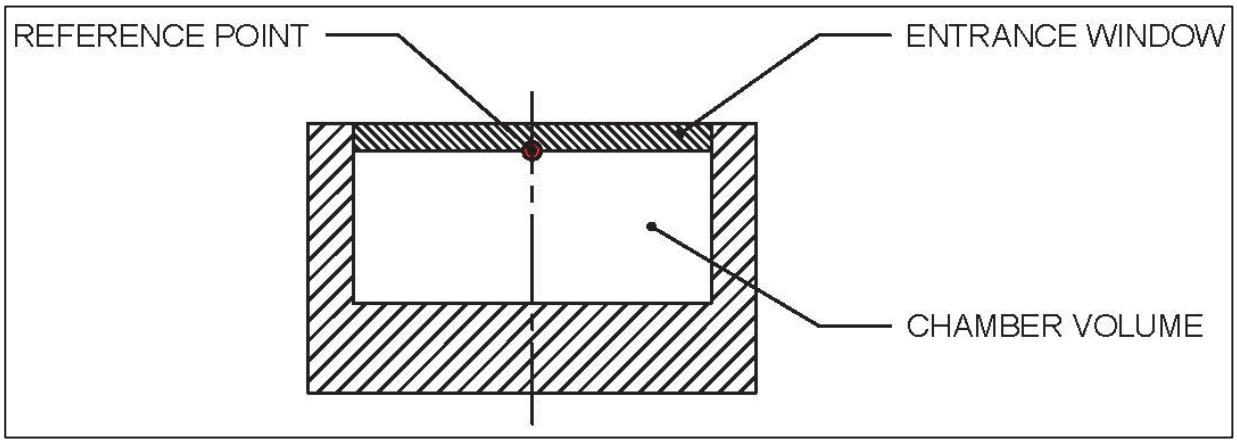

Figure 1: Reference point of a plane parallel chamber (sectional view)

To measure the absorbed dose to water in a water phantom, the effective point of measurement (EPOM) of the ionization chamber needs to be positioned in the measurement depth z_M, rather than the reference point. This is achieved by moving the reference point of the chamber to the depth

$z_B = z_M + \Delta z$, see Figure 2.

Values for the reference point shift Δz are given in Table 1. These values apply to all radiation qualities discussed in the standard DIN 6800-2:2020 including Co-60 gamma radiation. For plane parallel chambers the reference point is at a shallower depth than the effective point of measurement, this means that the chamber is shifted towards the focus.

Ionization chamber	Reference point	Reference point shift Δz	Correction factor k_r
T23343 Markus chamber 0.055 cm³	1.3 mm below surface of protection cap	-0.3 mm	0.9982
PTW 34001 Roos chamber 0.35 cm³	1.13 mm below surface [a]	-0.4 mm	0.9976
PTW 34045 Advanced Markus chamber 0.02 cm³	1.3 mm below surface of protection cap	0.0 mm	1

a According to manufacturer

Table 1: Shift between EPOM and reference point of PTW plane parallel chambers [1]

The correction factor k_r considers the different positioning of ionization chambers during calibration and measurement. During calibration in Co-60, the ionization chamber is positioned at the measurement depth in the reference point. In the measurement situation at the clinic, the chamber position is shifted by Δz. The product of the calibration factor and k_r corresponds to the calibration factor that would have been obtained in Co-60 if the chamber had been positioned at the calibration depth + Δz. Hence, in all cases where the depth-positioning at calibration and at measurement is different, the correction factor k_r has to be applied to the measured reading when following the regulations of DIN 6800-2:2020.

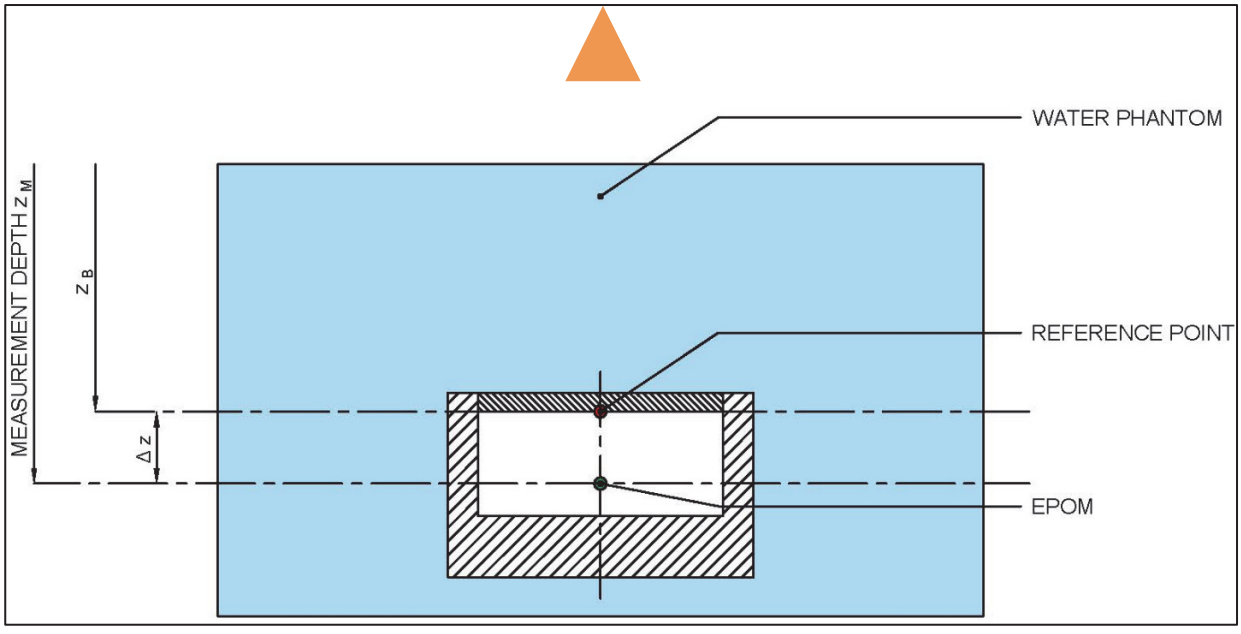

Figure 2: Positioning of a plane parallel chamber in a water phantom (sectional view). The focus is located above the water phantom.

Positioning of plane parallel chambers with TRUFIX

PTW developed the TRUFIX mounting system for easy installation and positioning of various ionization chambers and detectors in the BEAMSCAN and MPx – systems. It accurately positions the different detectors in the effective point of measurement at the water surface in these water phantoms.

With the update of the DIN 6800-2:2020, there will be new holders for the plane parallel chambers T34001 Roos and T34045 Advanced Markus. In Table 2 it is described which holder is used for measurements according to which standard, the green marked entries are the new holder types.

For the T23343 Markus chamber there will be no new TRUFIX holder. If you want to position the T23343 according to DIN 6800-2:2020, you have to shift the chamber manually.

Water Phantom	Chamber	TRUFIX Holder		Standard		
	Type number	Type Number	Name	DIN 6800-2:2008-03	DIN 6800-2:2020-08	TRS 398 (2006) / TG 51 (2014)
BEAMSCAN & BEAMSCAN MR	T23343 Markus chamber 0.055 cm³[b]	T21008.1.310[b]	TRUFIX BS holder for Markus chamber	X		
	T34045 Advanced Markus chamber 0.02 cm³	T21008.1.340	TRUFIX BS holder Adv. Markus cha. DIN/TRS		X	X
	T34001 Roos chamber 0.35 cm³	T21008.1.320[b]	TRUFIX BS Halter für Roos-Kammer	X		
		T21008.1.350	TRUFIX BS holder Roos chamb. TRS398/TG51			X
		T21008.1.360	TRUFIX BS holder Roos chamber DIN 6800-2		X	
MPx	T23343 Markus chamber 0.055 cm³[b]	T4316/U451[b]	TRUFIX holder for type 23343 and 34045	X		
	T34045 Advanced Markus chamber 0.02 cm³	T4316/U461[b]		X		
		T4316/U621	TRUFIX holder Adv. Markus cha. DIN/TRS		X	X
	T34001 Roos chamber 0.35 cm³	T4316/U471[b]	TRUFIX holder for Roos chamber	X		
		T4316/U631	TRUFIX holder Roos chamber DIN 6800-2		X	
		T4316/U641	TRUFIX holder Roos chamb. TRS398/TG51			X

b Discontinued

Table 2:TRUFIX holder for BEAMSCAN, BEAMSCAN MR and MPx-system

Difference of positioning between DIN 6800-2:2020 and TRS 398/TG 51

The definition of the EPOM depends on the dosimetry standard which is employed. In comparison, the differences between these standards are rather small. For the sake of consistency, this is nevertheless briefly described here: The main differences between the positioning regulation of DIN 6800-2:2008, DIN 6800-2:2020 and TRS 398/TG 51 is that the TRS 398/TG 51 uses the geometrical thickness of the entrance window to position plane-parallel chambers in the EPOM, which coincides with the reference point, while the outdated DIN 6800-2:2008 regulation used the water equivalent thickness of the entrance window to position the chamber. The current version of the DIN 6800-2:2020 uses a Monte Carlo deduced shift, where the advantage is that the full product of all correction factors is – in good approximation – not depth dependent anymore.

For the Advanced Markus chamber there will be only one new TRUFIX holder, as the MC deduced shift is 0 mm (cf.Table 1). This means that the EPOM of the Advanced Markus chamber coincides with the reference point.

For the Roos chamber the TRS 398/TG 51 holder positions the chamber in the reference point, while the holder T21008.1.360 or T4316/U641 positions the chambers EPOM according to DIN 6800-2:2020.

[1] DIN, „DIN 6800-2:2020-08 Procedures of dosimetry with probe-type detectors for photon and electron radiation – Part 2: Ionization chamber dosimetry of high energy photon and electron radiation,“ 2020-08.

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