MEASUREMENT OF TMR AND PDD PROFILES IN SMALL FIELDS

SB Crowe, E Whittle, C Jones, T Kairn

SMALL FIELD DOSIMETRY

The measurement of small field tissue-maximum ratio (TMR) and percentage depth dose (PDD) data is necessary for the calculation of dose by TPSs and/or dose verification software.

Dosimetry is complicated in small fields - loss of lateral charged particle equilibrium, volume averaging effects. See: TRS-483; papers by Kairn, Charles, Morales, etc.

For this reason, various small-field-suitable dosimeters (e.g. diodes, scintillators) are recommended in the literature in place of the large ionisation chambers typically used for beam configuration data measurements in larger fields.

The objective of this study was to evaluate whether relatively large volume chambers, that are unsuitable for other small field applications (e.g. $S_{c,p}$ measurement) might be used for accurate TMR or PDD measurements.

PROFILE MEASUREMENTS

PDD and TMR measurements were performed in an IBA BluePhantom 3D water tank with 100 cm source-to-surface distance and 100 cm source-to-detector distance, respectively

Four dosimeters: PTW 60017 (Diode E), IBA CC04, PTW 31010 (Semiflex) and PTW 30013 (Farmer); with active volumes of 0.00003, 0.04, 0,125 and 0.6 cc, respectively

Data was acquired for four field sizes (0.5×0.5, 1×1, 2×2 and 3×3 cm^2) produced using an Elekta linear accelerator.

PROFILE MEASUREMENTS

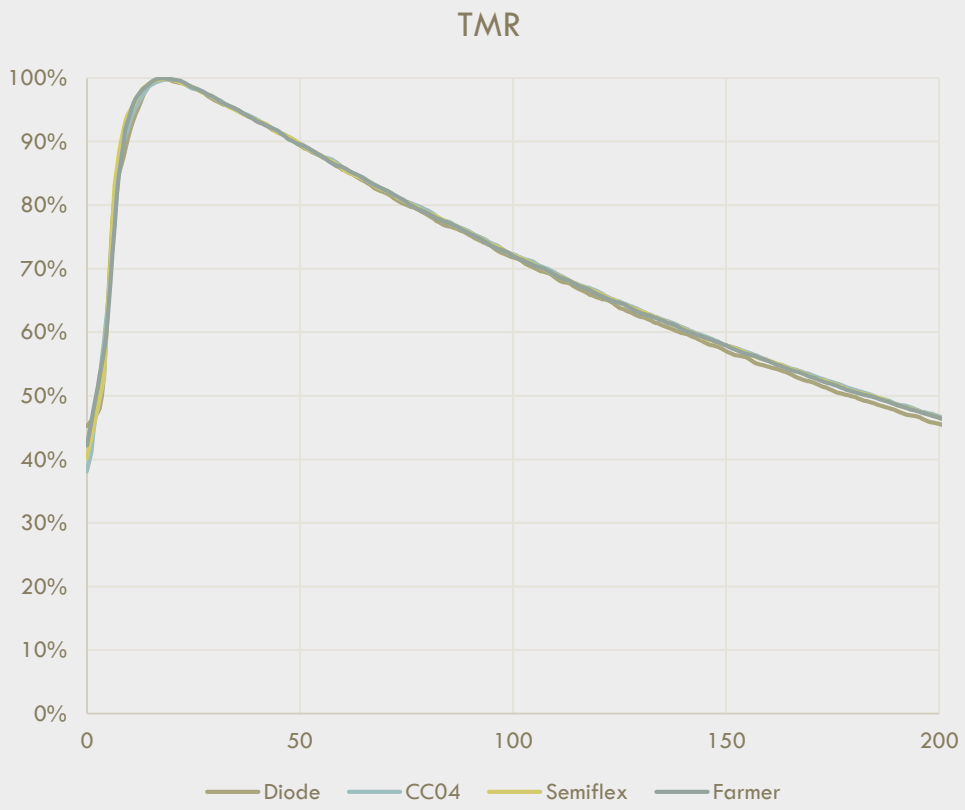
Scans were done consistent with small field dosimetry recommendations[1]. Lateral scans were repeated for each field size to verify the positioning of the dosimeter in the centre of the field.

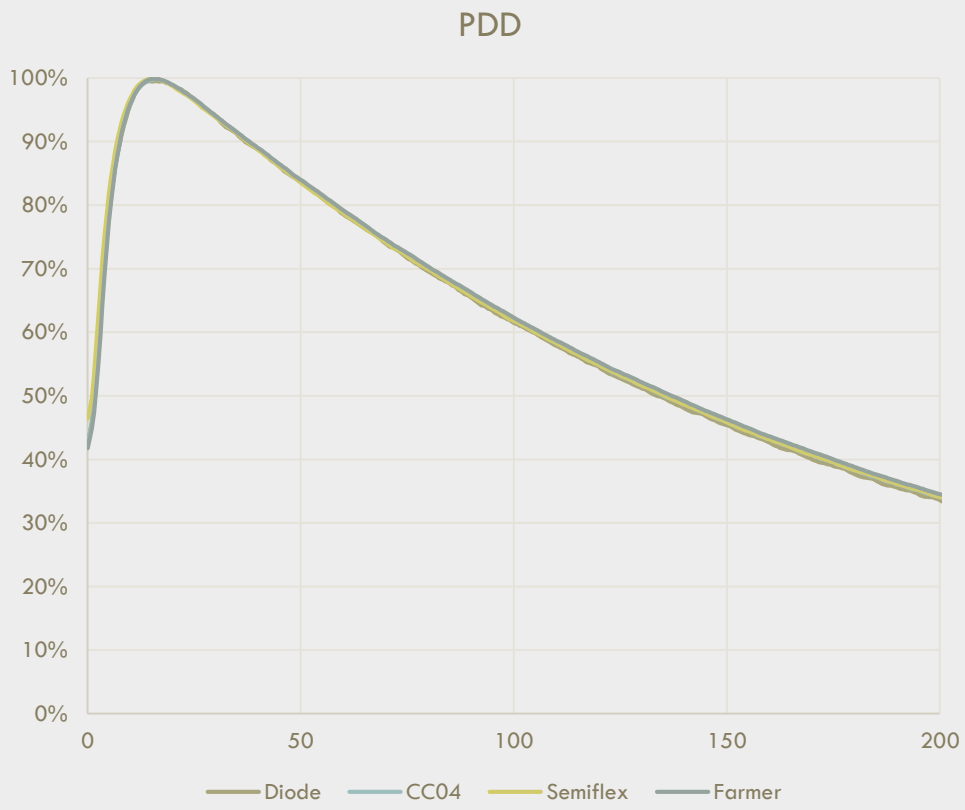
Measurement data was resampled to a resolution of 0.5 mm, where necessary, and smoothed with a mean filter with a 2 mm window.

Root-mean-square deviations (RMSD) were calculated between diode measurements (the "gold standard" data) and measurements acquired using the other dosimeters.

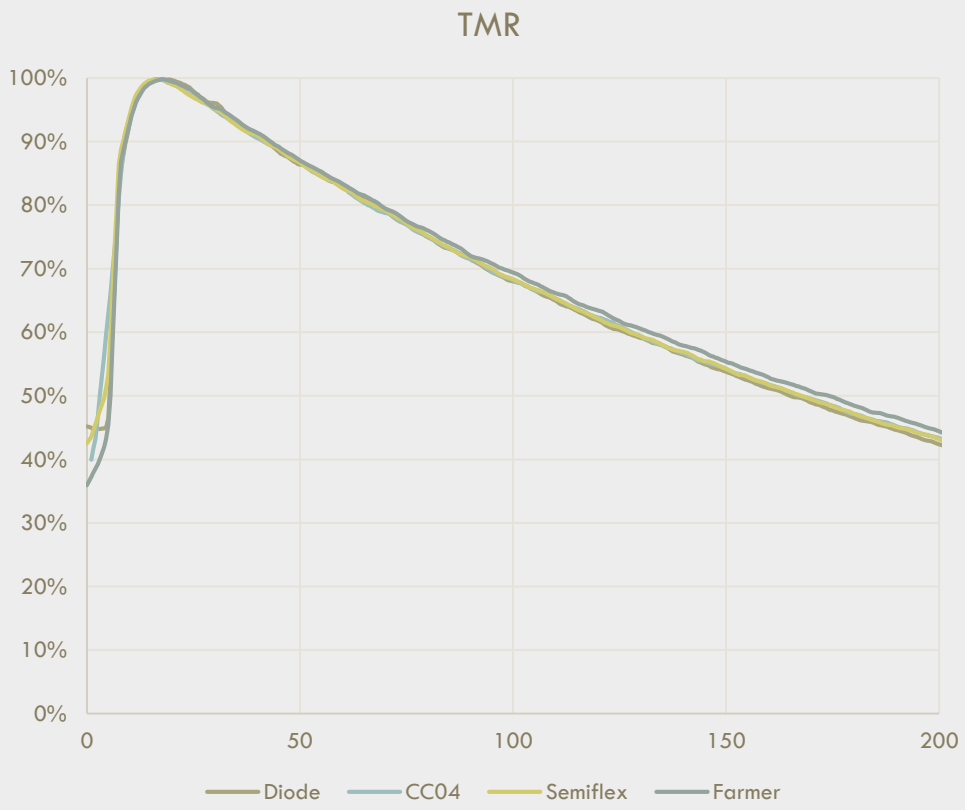
[1] e.g. Kairn et al.'s Clinical use of diodes and micro-chambers to obtain accurate small field output factor measurements, APESM 38:357-367, 2015

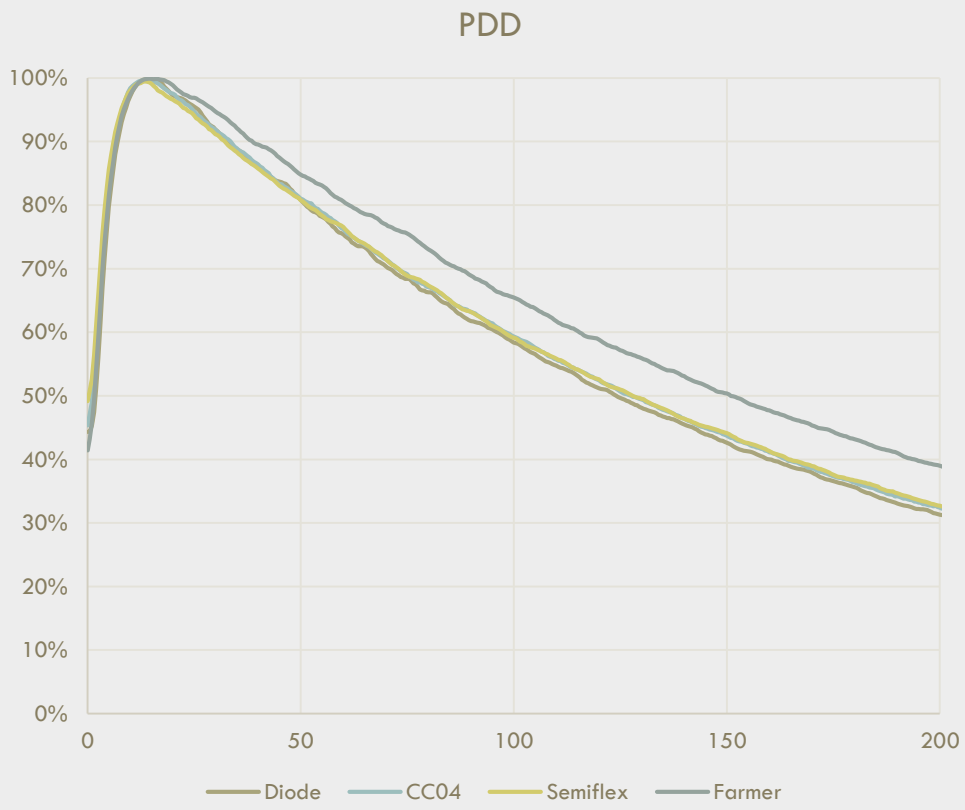
RESULTS – 30×30 MM² FIELD



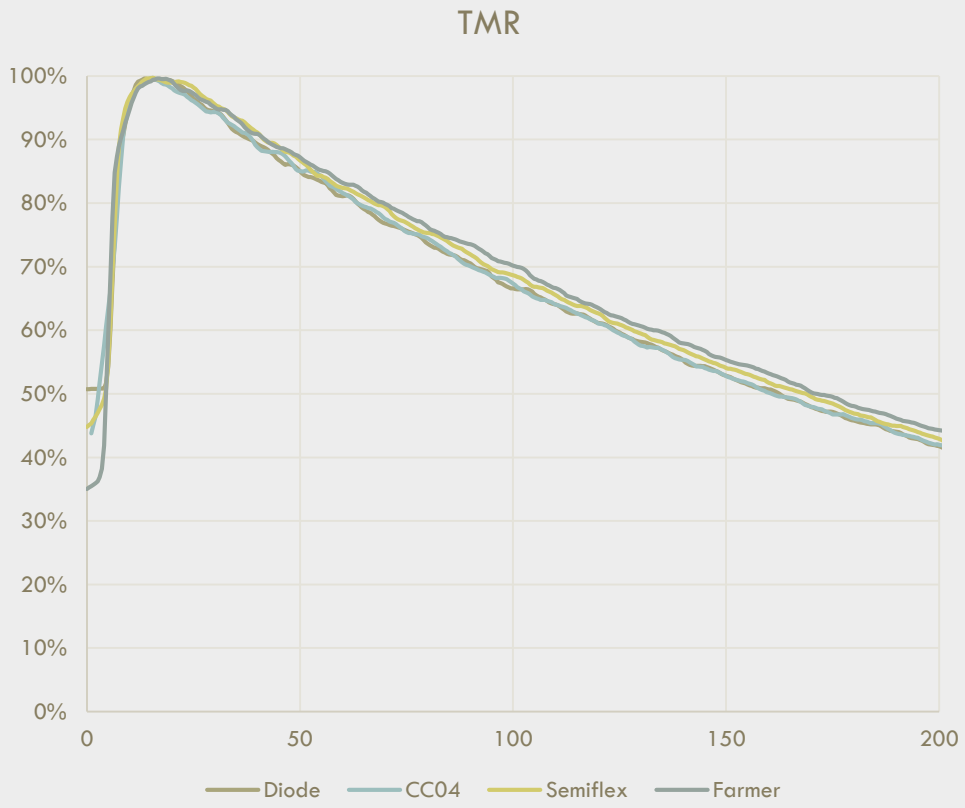


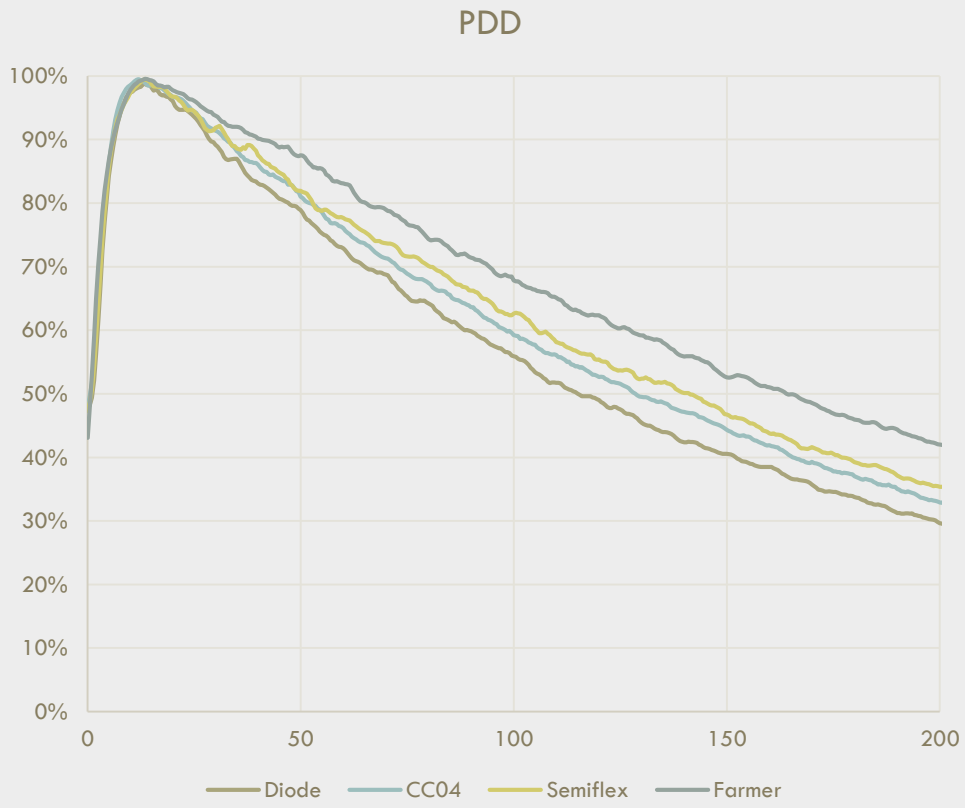
RESULTS – 10×10 MM² FIELD



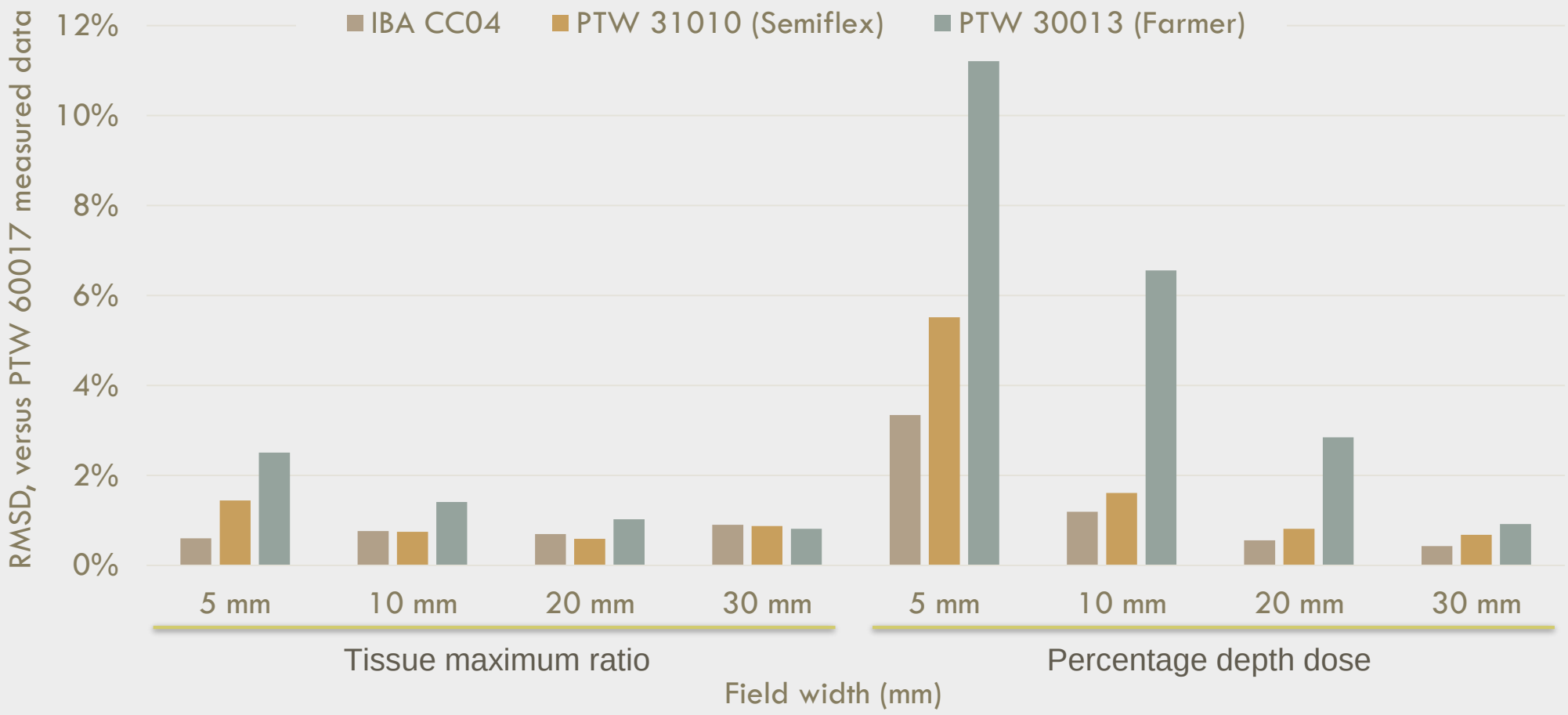


RESULTS – 5×5 MM^2 FIELD





RMSD VS. DIODE MEASUREMENTS



DISCUSSION

The largest disagreement in PDD profiles existed between the PTW 60017 diode and PTW 30013 chamber measurements at the smallest field size, with an RMSD of 11.2%.

The corresponding RMSD for TMR data was 2.5%.

The impact of a larger active volume is reduced when measuring TMRs, where the field size varies minimally with depth (i.e. where conditions relating to volume averaging and lack of lateral charged particle equilibrium vary minimally).

Accurate TPR measurements may be obtained using dosimeters otherwise considered unsuitable for small field applications.

CONCLUSION

While the PTW 30013 is not suitable for small field dosimetry, it provides a useful example of how TMR measurements are less sensitive to the active volume of the dosimeter than PDD measurements.

If small-field-suitable dosimeters are unavailable, TMR measurements may provide more accurate beam characterisation data than PDD measurements

In practice, this is complicated by the lack of an established PDD-TMR conversion: check out the poster by Emma Whittle: **"Conversion of PDDs to TMRs for small radiotherapy fields"**