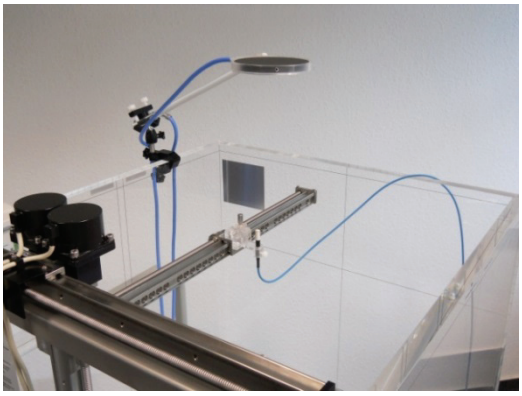
T-REF chamber



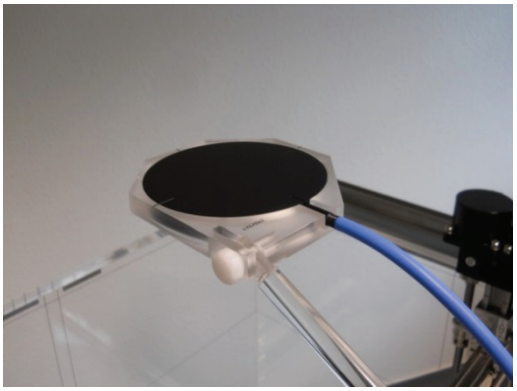


Figure 1: T-REF chamber mounted on water tank

About the T-REF chamber

Where to place a reference detector for profile and percentage depth dose (PDD) measurements in small fields? One PTW solution is to use a large-area parallel-plate transmission chamber: the T-REF chamber. The T-REF chamber proves to be easy to use and as long as the minimum distance of 20 cm above the water surface is respected, no perturbations can be seen in PDD measurements. In profiles no deviations between different distances to the water surface and no perturbations in the out-of-field-fractions appear. There is no influence of vibrations and the reference signal of the chamber is highly stable. Its signal to noise ratio (SNR) even exceeds that of a classical Semiflex 0.125 cm³ chamber placed in a corner of the field.
(Further Information: D. Ceska: *Reference detector for small fields – the T-REF chamber*, Medical Physics International Journal, accepted April 2016)

Different techniques

In small fields there are several techniques concerning reference measurements.

1. measure without reference detector
2. ionisation chamber outside the field
3. a large area chamber used as transmission detector

Disadvantages of mentioned techniques:

1. takes longer, rely on stability of linac, linac might exhibit drifts
2. bad signal to noise ratio
3. beam will be modified; if chamber linac-head mounted, signal might drift, caused by heat

The T-REF chamber features

- Very low total window area density of 72 mg/cm²
- Very stable signal
- No contact to linac head

T-REF properties

The T-REF chamber delivery includes a holder to mount the detector to a PTW water tank. The detector itself is a parallel-plate vented chamber with the following specifications:

- Nominal volume: 10.5 cm³
- Vented, waterproof (not for use in deep water depths)
- Nominal response: 325 nC/Gy (at ^{60}Co free in air)
- Entrance window: 0.1 mm varnish, 0.5mm PMMA, 0.02 mm graphite
- Total window area density: 72 mg/cm²
- Sensitive volume: radius 40.8 mm, depth 2 mm
- Chamber voltage: ± (300…500) V, nominal: +400 V

MEASUREMENTS

Signal-to-noise ratio: Semiflex 0.125 cm³ vs. T-REF chamber

The field signal, here generated by a micro Diamond T60019, is divided by the reference signal, generated by the reference detector. The better the signal-to-noise-ratio of the reference detector, the more precise the relative measurement curve:

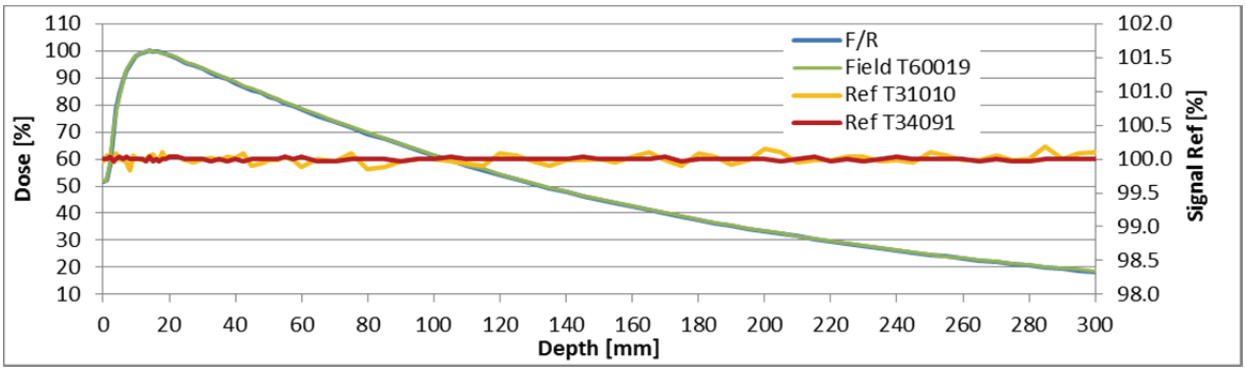


Figure 2: 4x4 cm², Varian Truebeam 6MV. A semi flexible chamber T31010 (orange) and a T-REF chamber T34091 (red) used as reference chamber. Measuring time per data point 0.5s.

No perturbation can be seen

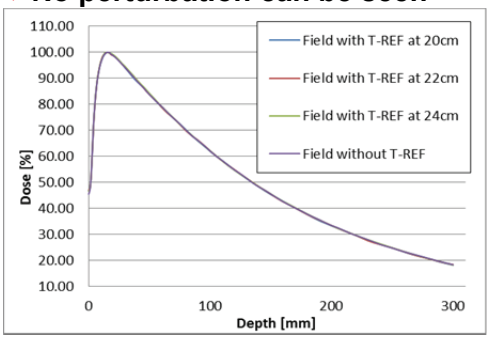


Figure 3: PDD 4 cm x 4 cm, 6 MV

No perturbations caused by the presence of T-REF chamber (Figure 3) or the influence from the guard ring or edge of the T-REF chamber (Figure 4) can be seen. Hence, PDDs and profiles can be measured with stable reference signal and without falsification through the presence of the chamber.

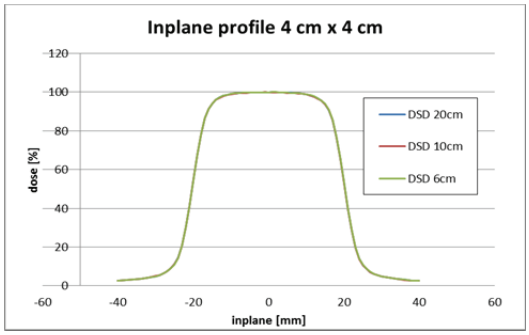


Figure 4: Inplane profile 4 cm x 4 cm, 6 MV

Detector surface distance

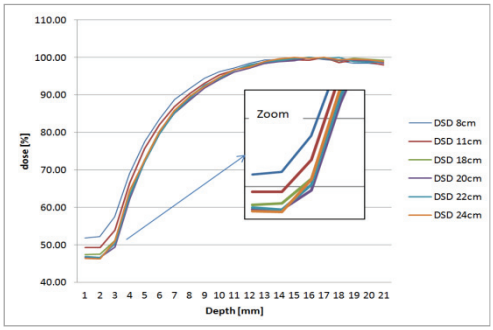


Figure 5: PDD 4 cm x 4 cm, 6 MV

If the detector surface distance (DSD) is less than 20 cm, partial build-up can be seen (Figure 5). For larger DSDs no differences in PDDs are visible (Figure 6). I.e. the user has freedom in positioning the T-REF chamber but has to keep the minimum DSD of 20 cm in mind.

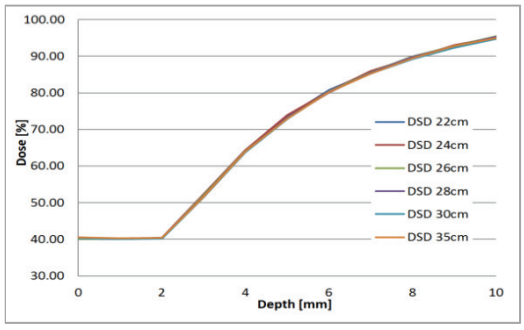


Figure 6: PDD 2 cm x 2 cm, 6 MV

Mounting

The T-REF chamber can be easily mounted on the edge of the water phantom. The acrylic glass rod with the holder enables a continuous positioning without increments. On the flat area on the top of the chamber it is possible to read the SSD value, which is projected on it by the linac. The physicist can either use the SSD projection or a ruler for positioning the chamber at the wanted distance to the water surface. Thus, the positioning is not difficult and does not require a high precision because the T-REF chamber operates on the principle of a DAP chamber. For that reason the position in z-direction is not that important and the adjusting can be done quick and easy as long as the user makes sure that the DSD is at least 20 cm.