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ABSOLUTE DOSE DETERMINATIONS IN ELECTRON BEAMS – INTERCOMPARISON OF METHODOLOGIES

M.C. LOPES, C. ALVES, M. CAPELA, J. MATEUS
Centro Regional de Oncologia de Coimbra do IPOFG, Coimbra, Portugal

The use of plane parallel ionization chambers for the dosimetry of electron beams has been extensively recognized in national and international recommendations and codes of practice.

The construction details of different chambers and their influence on the measure, which should be converted in suitable perturbation factors, have also been published [1].

Updated information, new data, refined investigations have recently been gathered in IAEA TRS 398 [2] where the major efforts of Primary Standard Dosimetry Laboratories (PSDLs) in providing calibration factors in terms of absorbed dose to water at a reference quality is reflected.

From the users point of view, and specially concerning electron beams, one can probably get confused with different methodologies and procedures in order to accurately determine absorbed dose to water.

The aim of this work is to explore the different methodologies and procedures concerning absolute dose determinations, in a hospital and using different chambers, in order to appreciate the relative deviations in absolute dose values.

Despite the fact that Markus chamber does not meet all the minimum requirements namely concerning scattering perturbation effects due to the geometry and dimensions of the guard electrode, it is still a quite used chamber type in current clinical practice. So we have included dose determinations with this plane parallel chamber (PTW 23343) and also with a Roos chamber (PTW 34001).

Markus chamber is provided with a standard calibration certificate in terms of absorbed dose to water (N_W) and also in terms of absorbed dose to air (N_A), referred to a high energy electron beam whereas Roos chamber has a calibration factor in terms of absorbed dose to water referred to ^{60}Co.

Starting from these materials different methodologies have been applied:

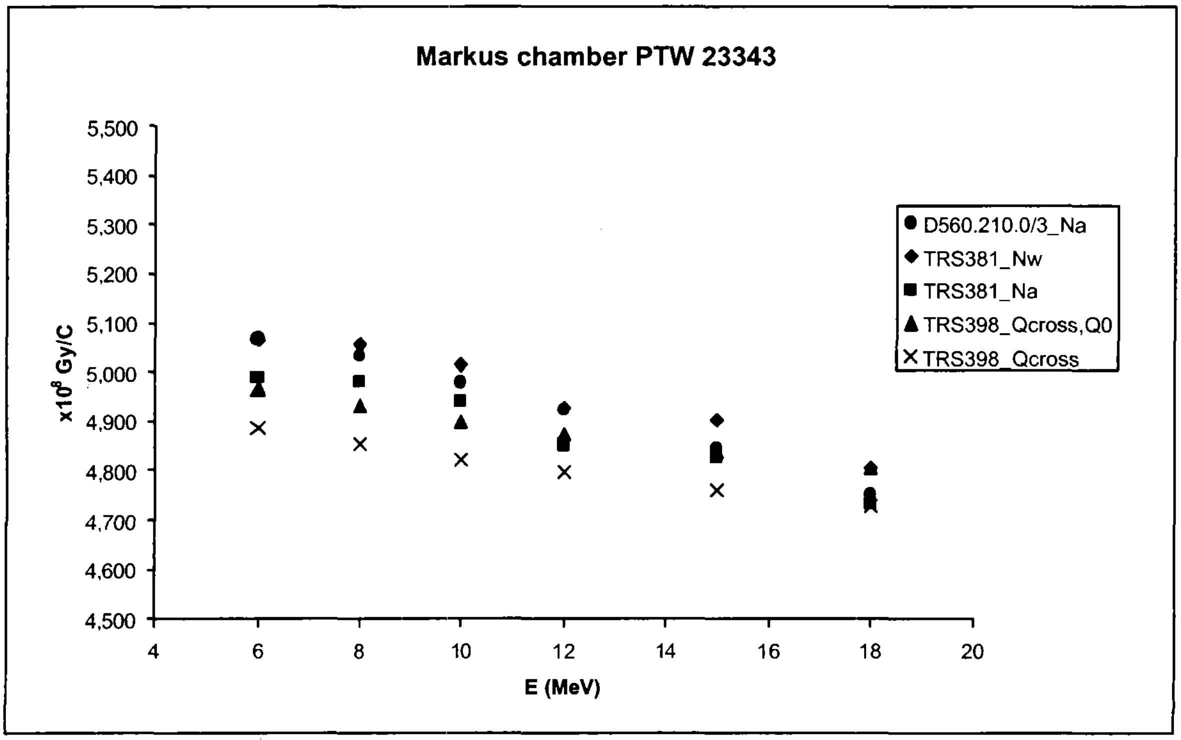
i) Using N_A of Markus chamber according to the users instruction manual [3] which refers DGMP Report N°6: Praktische Dosimetrie von Elektronenstrahlung und ultraharter Rontgenstrahlung, 1989.
ii) With that N_W value and the high energy electron quality taken as Q_0, the formalism of TRS 381 has been applied, using the beam quality correction factors $k_{Q,Q0}$ for our electron beam qualities (nominal energies: 6, 8, 10, 12, 15 and 18 MeV).
iii) The cross calibration methodology using the electron energy beam quality of the certificate taken as Q_{cross} at the highest electron energy available (18 MeV), has been used according to TRS 398.
iv) To become independent of the calibration certificate, the same cross calibration procedure has been used but this time against a calibrated reference cylindrical chamber calibrated in ^{60}Co by the Portuguese SSDL.
v) For the Roos chamber, and in order to appreciate the influence of chamber type, we have used the general $N_{D,w}$ based formalism with k_Q quality correction factors. We have also compared the results of TRS 381 and TRS 398 as these codes of practice differ in electron beam quality specification – TRS 381 uses E_0, the mean energy at the phantom surface, whereas TRS 398 uses R_{50}, the half-value depth of absorbed dose in water as the beam quality index.

vi) Also with Roos chamber, we have used the cross calibration methodology against two different reference cylindrical chambers (PTW 31003 and PTW 30006 Farmer) calibrated both in ^{60}Co, but in different SSDLs.

Whenever a ratio of measures is involved an external monitor chamber has been used in order to minimize the effect of any variation in the accelerator output.

The analysis has been done by chamber type (in Gy/C to became independent of the measure itself) and the deviations encountered can reach up to 2.5%. An example is presented in the figure. Also dose determinations have been compared for each nominal electron energy and independently of chamber type. An uncertainty analysis has also been done including an estimate of the combined uncertainty associated to each methodology.

For a common user in a typical hospital where different chambers may exist, many are indeed the possibilities in terms of dose determination methodologies. The ultimate choice should rely on an external international audit like ESTRO Quality Assurance Network (EQUAL).



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[3] PTW Report D560.210.0/3, "Absorbed Dose Determination in Photon and High Energy Electron Beams, PTW Freiburg, 2000