Criteria for the evaluation of the percentage depth dose for electron beam based on OSLD measurements

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Introduction: The remote audit program at IROC Houston monitors the output of photon and electron beams on an annual base. This service is a requirement for institutions that are clinical trials participant. The detector used was TLD powder in capsule presentation. The program for electron beam was implemented in 1982. The program checked output as well as percentage depth dose PDD values. The acceptance criteria was 5% in dose measurements and 5mm in PDD agreement. In 2010 the program switched to OSLD. The acceptance criteria established for the TLD system were not changed based on results from commissioning. The dimension of the OSLD presents an advantage compare to TLD capsules (2 mm and 4 mm respectively). The technique for PDD measurements has improved. Both aspects of the PDD verification program motivate the idea to re-evaluate acceptance criteria for OSLD audit program.

Aim: Establish new remote dosimetry audit criteria for verification of PDD for electron beams.

Method: Acrylic phantoms with a dosimeter insert (Figure 1) that hold nanodots are irradiated with a vertical electron beam with energies ranging from 6 to 22 MeV, under reference conditions. Two OSLD are located a depth close to dmax and two OSLD are located at depth between 80% and 50% of the maximum. PDD is calculated as ratio of doses from OSLD at depth to OSLD at dmax. The difference between the depth were OSLD are located and the depth derived from the institution PDD data at the value defined from the OSLD ratio was compared. The average difference and standard deviation (sigma) were calculated. A normal distribution was assumed. Acceptance criteria was defined to be 3 sigma of experimental data.

Results: A total of 14,230 irradiations from 12,620 electron beams from 1,753 institutions were evaluated. The values included in this analysis had dose agreements at dmax within 5% and PDD agreements within 10mm. The data is presented in Table 1.

The data were analyzed by nominal electron beam energy. The sigma value for energies between 6 and 16 MeV was close to 1.0mm; 1.3mm for energies between 18 and 20 MeV and 2.0 for energies greater that 20 MeV.

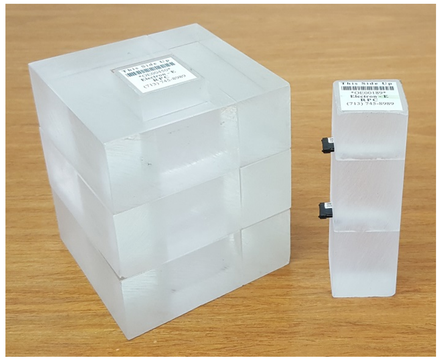

Figure 1: Electron beam block and special insert for 16 MeV electron beam with OSLD at both levels

Table 1: Statistics for the difference in PDD value presented by energy

Energy (MeV)	6	9	12	15 and 16	18	20	21 and 22
Average (mm)	0.5	0.0	0.2	-0.2	-0.5	-0.6	-1.4
stdev (mm)	0.83	0.90	0.93	1.02	1.29	1.38	2.02
3stdev (mm)	2.48	2.69	2.80	3.06	3.88	4.13	6.05
# beams	2936	2724	2880	2609	1045	1410	259

Conclusion: The origin of the original 5mm criterion for electron beam PDD audits is not known. A more scientific assessment of the data have indicated that the criteria should change. The new acceptance criteria, supported by audit data from the past 9 years, will be 3mm for 6-16 MEV electron beams and 4mm for electron energies greater than 16 MeV.

References:

Alvarez, P., S.F. Kry, F. Stingo, and D. Followill, TLD and OSLD dosimetry systems for remote audits of radiotherapy external beam calibration. Radiation Measurements, 2017. 106: p. 412-415.

Link: http://dx.doi.org/10.1016/j.radmeas.2017.01.005

Acknowledgements:

This investigation was supported by PHS grants CA180803 awarded by the NCI, DHHS.

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