PROPERTIES OF A NEW BEAM QUALITY IDENTIFIER FOR SMALL-FIELD RADIOTHERAPY

J. Niemelä[1], M. Partanen[2], J. Ojala[2], M. Björkqvist[1], P. Sipilä[3], M. Kapanen[2], J. Keyriläinen[1]

[1]Department of Medical Physics & Department of Oncology and Radiotherapy, Turku University Hospital, P.O.Box 52, FI-20521 Turku, Finland
[2]Department of Oncology, Unit of Radiotherapy & Department of Medical Physics, Tampere University Hospital, P.O. Box 2000, FI-33521 Tampere, Finland
[3]Radiation Practices Regulation, Radiation in Health Care, Radiation and Nuclear Safety Authority, Helsinki, Finland
email: jarkko.niemela@tyks.fi

The use of traditional beam quality identifier such as tissue-phantom-ratio $TPR_{20,10}$ in external small-field radiotherapy (RT) has many challenges. Beam diameters of less than 20 mm exhibit a loss of lateral electron equilibrium consequently increasing the detector induced perturbations [1]. The positioning accuracy of a point-like detector also reduces with decreasing field size. To overcome these challenges, a new beam quality identifier i.e. dose-area product ratio $DAPR_{20,10}$ was studied. It consists of a ratio of the dose-area products (DAP) at 20 and 10 cm depths in water. Thus, this is a transition from a point-dose measurement to a dose-area measurement, where the ionization chamber diameter is larger than the beam diameter.

The $DAPR_{20,10}$ values of cone-collimated 6 MV photon beams from 4 to 40 mm in diameter were determined with measurements and calculations by Monte Carlo (MC) method. Two large-area plane parallel chambers (LAC) with measuring radii of 19.8 and 40.8 mm were used to measure the $DAPR_{20,10}$. Varian iX linear accelerator was modelled with the *BEAMnrc* MC user code from *EGSnrc* MC software package and the absorbed dose in water slabs and in two LACs in water phantom was calculated with the user code *egs_chamber* [2].

Measurements revealed increase in $DAPR_{20,10}$ with increasing size of LAC. MC calculations showed a linear increase in $DAPR_{20,10}$ with DAP radius of 10-50 mm and logarithmic increase with DAP radius of 50-100 mm for the cone-shaped beam of 7.5 mm in diameter. The $DAPR_{20,10}$ was found to be constant with 20-40 mm circular beams. Contrary to previous data, the $DAPR_{20,10}$ values were found to be field size dependent for 4-20 mm circular beams with a relative increase of 7.0% [3]. Dissimilar results are due to variable beam qualities and LACs. The $DAPR_{20,10}$ measurement was found to be straightforward, encouraging further investigations in transition from $TPR_{20,10}$ point-dose to $DAPR_{20,10}$ dose-area measurements in small-field RT.

[1] I. Das, G. Ding, A. Ahnesjö Med. Phys. 35 (2008) 206–215.
[2] J. Ojala, Doctoral dissertation, Tampere University of Technology (2014).
[3] S. Dufreneix et al, Phys. Med. Biol. 61 (2016) 650–662.