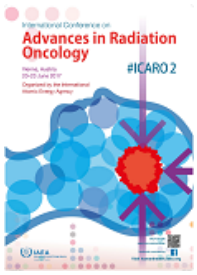

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Nationwide audit of small fields output calculations in Poland

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Introduction
Modern radiotherapy is mostly based on the modulation of the beam intensity and on the sterotactic dose delivery. These techniques require very accurate imaging of the patient and very accurate tumour delineation. They also require very accurate dose distribution calculation by the treatment planning systems (TPS). The calculation algorithms use the basic data such as multileaf collimator parameters and beam output factors. Of special importance are the output factors for small field sizes since they are extensively used in stereotactic techniques and in the intensity-modulated radiation therapy. Since the measurements of the output factors for small field size is not an easy task and cannot be properly performed in every radiotherapy facility, a set of such basic data would be of great value. Such a set of data has been prepared by the Radiological Physics Center (RPC), the University of Texas M. D. Anderson Cancer Center, Houston, Texas, USA) and published by Followill et al. The RPC has gathered multiple small field size output factor datasets for X-ray beam qualities, ranging from 6 to 18 MV, from Varian, Siemens and Elekta linear accelerators. These datasets were measured at 10 cm depth and ranged from 10×10 cm2 to 2×2 cm2. The RPC's measured small field output factors provide institutions with a standard dataset against which to compare their TPS calculated values. Within the framework of the CRP E2.40.16 project "Development of Quality Audits for Radiotherapy Dosimetry for Complex Treatment Techniques", run by the Health Section of the international Atomic Energy Agency (IAEA), a methodology of the audit of small field output performance was established.

Material and Methods
The participants had to calculate the output factors for the beams formed by the multi-leaf collimator (MLC), using their planning software. The results of their calculations were compared with the reference RPC data. All 35 Polish radiotherapy departments invited to take part in the audit, and 32 of them responded and provided their results. In Poland, there are medical accelerators from three manufacturers: Varian; Elekta, and Siemens. In total, 65 beams were audited: 20 from Elekta, 15 from Siemens and 30 from Varian accelerators. In some cases, the calculations were performed with different TPS or calculation algorithms for the same beams.
The participants of the audit were asked to calculate the number of monitor units (MU) for the delivery of a prescribed dose to water with square fields of different sizes. A dose of 10 Gy was prescribed to a reference point at 10 cm depth on the central axis, at 100 cm source-to-phantom distance (SFD). The output factors for five field sizes, 10×10 , 6×6 , 4×4 , 3×3 and 2×2 cm2, shaped by a multileaf collimator (MLC), were calculated. Numbers of MU, obtained for specified field size f and beam quality Q, were then normalized to (divided by) the numbers of MU calculated for a field size of 10×10 and for the same beam quality, thus providing the normalized output factor.
A number of treatment planning systems (TPS) were examined during the audit. The participants were obliged to use the clinically used TPS together with an approved beam model for the calculations. The following TPS and related calculation algorithms were examined : Monaco –Monte Carlo (MC), XiO –Convolution (CV) and Superposition (SP), Oncentra MasterPlan –Pencil Beam Convolution (PBC) and Collapsed Cone Convolution (CCC) , Pinnacle and Prowess Panther –CCC and Eclipse –PBC, Analytical Anisotropic Algorithm (AAA) and Acuros XB (AXB).
Results
For Elekta accelerators, all the calculation results show a deviation from the reference values lower than 3%. For Siemens and Varian accelerators, the resulting calculations for fields larger than 2×2 cm2 differ less than 4%. For 2×2 cm2 large fields formed by Siemens and Varian MLC, the differences between the calculated and measured output factors often exceed 5%, but still are below 10%.

Conclusions
The set of measured small field output factors provided by the RPC is a very good tool for QA of the treatment planning systems. A comparison of particular institution's data with the RPC data is very helpful in quality assurance of IMRT treatments. Such quality control should be performed before the IMRT is used in clinical practice.
In Poland, the results of the audit were found very useful for the participants who should carefully investigate any detected discrepancies between the standard dataset and calculated values, with attention to the specific beam model.

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