

M. Abujami^{a,b}, S.Riga^b, M. Felisi^b, A.F. Monti^b, M.G. Brambilla^b, C. Carbonini^b, H.S. Mainardi^b,
C. De Mattia^b, M.B. Ferrari^b, A. Torresin^b

^aInternational Centre for Theoretical Physics (ICTP), ^bMedical Physics Department, ASST Grande Ospedale Metropolitano Niguarda, Milan

* Corresponding author: Mo.Abujami@gmail.com

Background and Objective

Evaluating the dosimetric accuracy of VMAT for a new Versa HD linear accelerator (Elekta, Stockholm, Sweden) for 6 MV and 6 MV FFF (flattening filter-free) photon beams. All measurements were done accordingly the American Association of Physicist in Medicine (AAPM) Task Group (TG) 119 report [1] adapting it to the VMAT technique using EPID dosimetry, comparing the results obtained with a 3D cylindrical dosimetric phantom.

Methods

VMAT plans were calculated and optimized following the AAPM TG-119 dose prescriptions and planning objectives, using the Monte Carlo based Treatment Planning System (TPS) Monaco 5.51 (Elekta, Stockholm, Sweden) for 6 MV and 6 MV FFF photon beams. The set of cases of the report consists of five tests called: Multitarget, Prostate, Head-and-Neck and C-Shape easy and C-Shape hard. All the plans were delivered with a LINAC Versa HD and were measured with an integrated iViewGT™ EPID MV panel (Elekta AB, Stockholm, Sweden) with a distance from the source to of 160 cm and an active imaging area of 41x41cm². The EPID image matrix is constituted of an array of 1024x1024 photodiodes with a pitch of 400 μm. EPIDose software (SunNuclear, USA) was used to convert EPID images in terms of dose maps.

Delta⁴ Phantom+ with 1069 p-Si detectors was used as reference and to obtain a 3D dose distribution. Each p-type diode has a sensitive volume of 0.04 mm³ with 5 mm spacing in a central region of 6x6 cm² and 10 mm outside up to 20 cm from the center. The global gamma index of the 2D dose distribution obtained with the EPID system and the Delta⁴ Phantom+ 3D dose distributions were compared with TPS calculations using global gamma criteria of 3%/3 mm.

Confidence Limits (CL = |100 – mean| +1.96*SD) were also calculated as suggested by TG119. In this study, we also used the pass criteria 2%-2mm in order to have a stricter acceptance criterion.

Results and Discussion

The overall combined passing rates with 3%/3 mm and with 2%/2 mm for 6 MV obtained with EPID were 98.30 and 93.34 respectively; instead, the results with Delta⁴ were 99.05 and 92.27. The overall combined passing rate with 3%/3 mm and with 2%/2 mm for 6 MV FFF obtained with EPID were 96.29 and 86.56 respectively; instead, the results with Delta⁴ were 98.82 and 96.87. The obtained passing rates with 3%/3 mm for the 6 MV plans are higher than that reported in TG-19 (93.50), also in the case of 6 MV FFF. However, the results for 6MV FFF and the 2mm/2% passing rate are not mentioned in the TG 119 work.

As seen, passing rates for EPID are generally lower than the same for Delta⁴; this is also due to the fact that Delta⁴ measure the actual dose distribution. On the contrary, the EPID obtains the dosimetric information indirectly and measures the dose condensed in a single plane, thus condensing all the delivery inaccuracies in a single image. Moreover, the EPID has a higher spatial resolution than Delta⁴ and it is also more sensitive to beam dose accumulation.

Conclusions

- TG-119 methodology has successfully been used to evaluate the commissioning accuracy of VMAT on a Versa HD linear accelerator via EPID Dosimetry.
- Local institutional CLs were established which can be used as benchmarks for future measurements and as a baseline for future patient-specific pre-treatment quality assurance.

Gamma index analysis was compared between EPID and Delta4 and TG 119 in Figure 1. All gamma evaluation results show more than 96% data points pass the criteria of 3%DD and 3 mm DTA and the result is acceptable for Delta⁴ and EPID on both 6 MV and 6 MV FFF beam energy compared with TG 119. Both results were satisfied with TG-119 confidence limit that is 7.33.

Figure 1 - Gamma analysis comparison for 6 MV and 6MV FFF by Delta4 and EPID.

