

# Linac Twins with Flatness Filter Free Option in a Radiotherapy Department

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## Introduction

Having two (or more) equal treatment machines (linac twins) enables a radiotherapy department to facilitate the workflow and to reduce the amount of quality assurance. The major part of the German standards (DIN) regarding quality assurance of medical linear accelerators has been reworked or has been published for the first time in the recent years due to technical developments. The aim of this study is to setup a commissioning procedure and a quality assurance program for linac twins with flattening filter free option and to investigate if time required for commissioning and quality assurance can be reduced as compared to 2 linacs of different types. This includes the radiotherapy planning system (RTPS).

## Material and Methods

Tenders were invited to provide two linacs of the same type to replace the old Siemens Primus machines. We asked for linacs with two photon energies (6 and 15 MV) flattened beams (FB), additional flattening filter free (FFF) option for 6 MV, capability of intensity modulated radiotherapy (IMRT) and volumetric modulated arc therapy (VMAT), and 5-6 different electron energies between 4 MeV and 22 MeV. Our requirement was that patients should be treatable at both machines with the same treatment plan. The first of the twin machines, an Elekta Synergy with Agility head, XVI Cone Beam CT, and Iview Portal Imaging has been installed and commissioned according to earlier experiences [1] and has been running in the clinical routine for several months, but initially not FFF. For the second linac the installation has been completed in June.

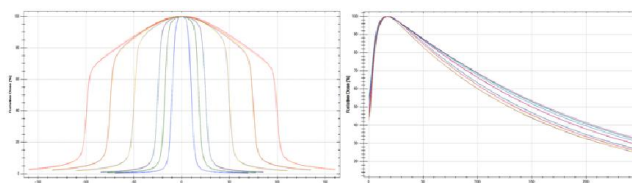
Although commissioning tests, the determination of basic performance characteristics, and consistency tests for linacs according to the German standards [2] have to be accomplished for each machine, they can at least be set up identically without modifications for twin machines. This is also applicable for performance characteristics and consistency testing concerning special techniques as stereotactic radiotherapy [3; 4], and IMRT [5; 6], as well as electronic portal imaging devices (EPID) [2].

For commissioning of the linac in the RTPS Oncentra 4.3 (by Nucletron an Elekta Company) a set of geometrical data, absolute, and relative dose measurements have been measured. The data are processed by the company to create a model of the treatment unit, which takes several weeks according to our experience. Once the model is delivered by the company, it has to be validated by the customer. One aim of the study is to investigate, if this procedure can be reduced to the validation process for the second linac.

The draft of the German standard for consistency tests of RTPS DIN 6873 – 5 [7] requires calculations for each treatment machine. Probably part 1 of DIN 6873 for commissioning of RTPS which is in development will demand this too. Having only one treatment machine model reduces time and effort for quality assurance.

The German directive "Strahlenschutz in der Medizin" [8], paragraph 2.3.4, requires a concept to ensure patient treatment even during machine down times (e.g. maintenance or breakdown). Linac twins allow shifting all patients from one machine to the other without calculating new treatment plans. The record and verify system (Mosaik) can be configured in a manner that fields for one machine can be delivered at the other without warnings or password confirmation. Some IMRT plans (FB and FFF) calculated with the beam model for the first machine were measured on the other to verify the exchangeability using the Matrix phantom and software of IBA.

## Results



The figures 1 and 2 show profiles in 10cm depth and depth dose curves for both machines in the FFF mode for square fields from 2 to 20 cm. Similar accordance could be demonstrated for the flattened photon modes.

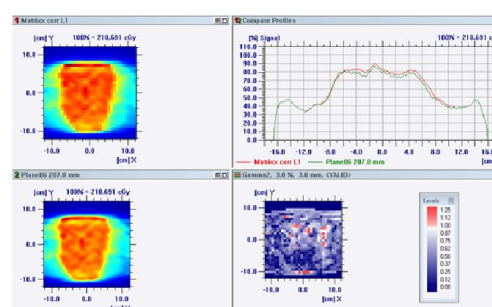


Figure 3 demonstrates the plan verification of an IMRT plan (FFF) calculated for one machine and treated at the other. The gamma image was evaluated with 3% and 3mm and passed with 97% of pixels in range.

## Discussion and Conclusion

Our first results confirm that the time and effort for commissioning and quality assurance can be reduced for linac twins:

- There will be only one set of quality checklists including the tolerance values.
- Additionally one beam model for both machines is sufficient in the therapy planning system.

## References

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