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dkfz. GERMAN CANCER RESEARCH CENTER IN THE HELMHOLTZ ASSOCIATION

Research for a Life without Cancer

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**Gutachten zur Doktorarbeit -**

**Opinion of the PhD Doctoral thesis**

**„ Pseudo-3D IMRT Verification with Film and Its Sensitivity to Errors Compared to 2D Methods “**

From Ms **Tereza Hanusova**, from Czech Technical University in Prague Faculty of Nuclear and Physical Engineering.

Ms Hanusova PhD project was to develop a simple dosimetric method that would enable quantitative 3D evaluation of measured data only, without the use of any reconstruction algorithms. The method uses a water equivalent slab phantom and radiochromic film, so it is accessible to all clinics using their existing resources. The main advantages of the method develop by Ms Hanusova are the excellent spatial resolution within each plane and the water equivalence of the detection system. The main disadvantage of the method is some extra time needed for each measurement compared to commercial electronic devices. Compared to gel dosimetry, the new method is more precise and less demanding. The thesis in divided into a introduction and methodology chapters (Chapters 1, and 2), a results and discussion chapter (Chapters 4) and a conclusion chapter (Chapter 5).

In Chapter 3 (Methods chapter), Ms Hanusova provides all the needed framework and benchmarking for addressing the main question of the thesis.

Ms Hanusova main results chapter is divided into the following sub-sections:

i) Chapter 4.1: Ms Hanusova performs the benchmarking of the film dosimetry against current practice;

ii) Chapter 4.2: Ms Hanusova performs pseudo-3D verification with films for various types of clinical treatment plans obtained via IMRT or VMAT;

In section (i) (Chapter 4.1) Ms Hanusova compares film dosimetry (EBT3 film) and clinically used (PTW array Seven29) alternative for field-by-field and pseudo-3D IMRT and VMAT verification. In this section Ms Hanusova demonstrates that film dosimetry can perform equally well or even better than electronic devices for IMRT field-by-field verification. In a subsequent study, error-induced plans were generated, where MLC positioning errors and dose errors were introduced. The goal was to assess if the novel method could capture these errors. Both methods were shown to perform well at identifying the errors, however the new method provided better statistics in the error identification.

In section (ii) (Chapter 4.2) Ms Hanusova performed various comparisons between pseudo-3D verification with field-by-field. The key idea was to study whether pseudo-3D method could provide more information than the 2D method during the QA process of IMRT or VMAT fields. In some of the studies the 3D gamma results produced higher values of gamma when compared to the 2D gamma estimates. MLC positioning error introduced into several fields of clinical IMRT treatments were not revealed with field-by-field EBT3 film verification. However, pseudo-3D gamma score did reveal these errors. For VMAT, the pseudo-3D film method was able to detect 1mm and 3mm MLC leaf positioning errors with 3%/3mm criteria and 95% tolerance level. Generally speaking, the clinically standard 2D gamma analysis (field-by-field or plane-by-plane) can give false positive results because it is likely find the wrong dose value in the surrounding 3D geometry. From the PhD work by Ms Hanusova it is more appropriate to use pseudo-3D method when novel complex techniques are introduced into the clinic.

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Ms Hanusova has done a very good PhD. His project focused on the on developing and testing a novel strategy to identify errors in IMRT and VMAT treatments. The errors assessed with her novel method were primarily MLC positioning errors and dosimetric errors. She has worked very independently, task-oriented and carefully developed the appropriate tools for the project. The physical principles, the results and their implications as well as the limiting factors are well discussed and in detail. The topic of thesis is very up to date, since there is no standard 3D QA method for identifying delivery errors during IMRT or VMAT treatments. The goal of thesis has been achieved and scientific value of the work within is very important to the community.

**I recommend the thesis for presentation and defense,**

**And the overall score of the thesis is Very Good**

**Prof. Dr. DABR. Joao Seco**

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