PhD Thesis title: **'**Monte Carlo simulation of modern techniques of intensity modulated radiation therapy (IMRT)**'**

Author: Panagiotis Tsiamas
Email: ptsiamas@lroc.harvard.edu
Institution: Dana-Farber Cancer Institute, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts 02115 and Medical Physics Department, Medical School, University of Thessaly, Larisa 41100, Greece
Supervisors: Piotr Zygmanski – Constantinos Kappas
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ABSTRACT:
Clinical delivery of radiation therapy faces an old dilemma: how to maximize the dose to tumoral cells while spearing the surrounding healthy tissue. Along this path two major innovations will most likely play an important role in the future. The first has to do with the employment of the so far unutilized physical processes and effects of radiation on matter. The second one is associated with the development of new radiation sources whose properties are better suited to achieve the initial dual goal of radiation therapy. An important question arises in this respect: how to introduce new treatment modalities with minimal risk relying on our extensive past clinical experience with the conventional treatment techniques.
The current PhD dissertation tries to answer this question by investigating alternative ways to modify the linear accelerator beam line and characterizing dosimetric properties at the macroscopic and nanoscopic level in application to Intensity Modulated Radiotherapy (IMRT) and/or Gold Nanoparticle Therapy (GNPT). Emphasis is given to IMRT with and without the presence of gold nanoparticles while the main tool used for all the studies is the Monte Carlo method of radiation transport.
The dissertation is divided into three major parts. In the first one, an alternative linac design is investigated by removing the flattening filter of the beam and by studying its impact on IMRT delivery. The flattening free linac design keeps all the benefits of the standard linac, while significantly improving dose rate and limiting head scatter. On the other hand it presents challenges for large IMRT fields and far off-axis points. In the second part of the dissertation an extensive qualitative and quantitative beam quality / spectra study is carried for over 1,300 different clinical irradiation conditions. The results from the second part are used in the third and last parts of the dissertation in which the dosimetric impact of these different beam qualities on gold nanoparticle radiotherapy are studied. Optimal clinical irradiation techniques are identified which guarantee efficient and safe delivery of nanoparticle-enhanced radiotherapy. In summary, in this dissertation unutilized physical processes are investigated as the principle of new treatment modality (GNPT) and optimal radiotherapy techniques are determined for their gradual and safe introduction into the clinic.

References to author publications that relate specifically to the dissertation:

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