University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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"Developing a QA Procedure for Gated VMAT SABR Treatments Using 10 MV Beam in Flattening-Filter Free Mode"

Department of Physics and Astronomy

Tuesday, June 28, 2016
10:00 A.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. Magdalena Bazlova-Carter, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Ante Mestrovic, Department of Physics and Astronomy, UVic (Co-Supervisor)
Dr. Derek Wells, Department of Physics and Astronomy, UVic (Member)

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Dr. Richard Lee, British Columbia Cancer Agency

Chair of Oral Examination:
Dr. Patricia Kostek, School of Music, UVic

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Abstract

Respiratory gating limits the radiation to a specific part of the breathing cycle and reduces the size of the Planning Target Volume (PTV). This thesis describes a novel quality assurance method for amplitude gating of Stereotactic ABlative Radiotherapy (SABR) treatments of liver delivered using Volumetric Modulated Arc Therapy (VMAT) using a 10 MV beam in Flattening Filter Free (FFF) mode. This method takes advantage of the high dose gradient region of SABR treatments to detect any inaccuracies in the performance of the Varian Real-time Position Management (RPM) gating system. This study involves the design and construction of an interface that connects the translation stage of the Quasar respiratory motion phantom to an ion chamber insert. This insert can hold and drive a pinpoint ion chamber inside the ArcCheck diode array based on the breathing pattern imported into the Quasar phantom.

The pinpoint ion chamber dose measurements were acquired at the isocentre and along the penumbra using synthetic breathing traces. Our results show that the changes in PTV size and exhale duration do not influence the dose measured by the pinpoint ion chamber. Changes in gate width and baseline drift, however, affect the detector residual motion, which results in variation in the level of dose-blurring and interplay effects. A new parameter, Average Residual Detector Displacement (ARDD), is introduced in this thesis and is used to take into account the effect of dose-blurring. For gate widths smaller than 8 mm and baseline drift levels smaller than 4 mm, if the effect of dose-blurring is taken into account, the pinpoint ion chamber dose measurements are mostly within 2σ positional uncertainty from the Eclipse dose profile. As the gate width and baseline drift increases, accounting for the dose-blurring effect is no longer sufficient to explain the discrepancy between measured and calculated doses.

This thesis also includes dose measurements for radiation deliveries that are gated using six real breathing traces with gate widths of 2 mm, 2.8 mm, and 4 mm. Once the parameter ARDD is used to account for dose-blurring, the dose measurements are mostly within 2σ positional uncertainty from Eclipse calculated doses. These results demonstrate the reliability and accuracy of the RPM gating system at British Columbia Cancer Agency - Vancouver Island Cancer Centre (BCCA - VICC). Lastly, the overall dose distribution was monitored using the ArcCheck diode array measurements under various gating schemes and was compared to the Eclipse calculated dose map using a 2D Gamma analysis. The Gamma pass rates for 2mm/2% criteria show that the beam interruptions during the treatment do not degrade the fidelity of the radiation delivery in a gated treatment.