

Summary of Research Interests

Treatment dose verification using EPIDs

Award-winning research carried out at CCMB has led to the development of an algorithm that is able to predict portal dose images. The approach utilizes our detailed understanding of the underlying physics taking place in radiation transport and scatter in the patient, as well as the energy response of the detector system. This takes us a step closer to being able to verify the actual dose distribution that a patient receives during treatment.

Currently we are investigating real-time algorithms to extract and analyze the differences between the predicted and measured portal dose maps.

We are also implementing this work for volumetric modulated arc therapy delivery.

Our labs' portal dosimetry related research is performed in collaboration with Dr. Peter Greer and his research group located at the Calvary Mater Newcastle Hospital in Newcastle, Australia.

Patient dose reconstruction

By exploiting our ability to predict separate components (primary and scatter) of portal dose images, we are able to reconstruct dose actually delivered during a treatment to a three-dimensional model of the patient.

This approach allows us to use any new image-guidance modalities, such as at-treatment cone-beam computed tomography or real-time MRI, to provide updated patient models and therefore increase the accuracy of our patient dose estimates.

We then use non-linear deformation software to accumulate delivered patient dose over the course of a typical 4-7 week treatment regimen.

Adaptive image-guided radiation therapy

Our research into portal dosimetry with EPIDs and three-dimensional patient dose reconstruction leads naturally into adaptive radiation treatment. We are using our novel ability to estimate actual delivered dose to test various optimization strategies to adapt patient treatments as they progress through their treatment regimen. Previous work has demonstrated significant dosimetric errors (ranging up to >10% of prescription dose) will occur in a portion of the patient

population. Thus, there is great opportunity to improve patient outcomes with this research.

Entrance fluence and dose verification using COMPASS

In addition to our research work in portal or 'exit' dosimetry, we are interested in a novel patient dose verification approach that involves directly measuring beam fluence entering a patient (ie. entrance dosimetry). This work is performed collaboratively with IBA Dosimetry (Schwarzenbruck, Germany). We test their transmission detector array (1600 miniature ionization chambers) together with their COMPASS software that allows three-dimensional patient dose reconstruction on CT or CBCT data sets. We have thoroughly characterized the detector system, implemented components of the system into our routine clinical QA protocols, and are now examining novel uses of the system.

MR spectroscopy imaging for treatment planning

This work is performed in collaboration with Dr. Lawrence Ryner of the National Research Council of Canada's Institute for Biodiagnostics, located about a 20 minute walk southeast of our facility.

We have developed novel pulse-sequence programs combined with novel conformal excitation techniques for prostate cancer patients that allow significantly improved number and quality of in vivo MR spectra. These spectra correlate to aggressiveness of prostate cancer, and allow us to tailor treatment to patients based on this new functional imaging information. Currently we are translating this imaging work into our clinic and quantifying the improvement in patient treatments based on radiobiological models.

Multi-objective optimization in radiation therapy

This work is performed in collaboration with Professor Jason Fiege of the Department of Physics and Astronomy at the University of Manitoba. Professor Fiege is a world expert in multi-objective optimization using genetic algorithms.

We use a highly customized genetic algorithm to solve the competing objectives of target dose coverage (including uniformity and conformity) and reduced doses to organs-at-risk. Fluence maps are optimized simultaneously with beam angles (for static field IMRT) or arc orientations (for arc IMRT). The algorithm will populate the Pareto trade-off surface with several hundred solutions automatically – without the need for human intervention, as required by current commercial software. The clinician then utilizes a novel graphical interface to quickly navigate the database of solutions to select the most appropriate solution for their patient.

We are currently testing this software with our clinician collaborators at CancerCare Manitoba and the Stereotactic Radiosurgery Program at the Kleyesen Institute for Advanced Medicine.