AbstractID: 6514 Title: Development of a novel electronic portal imaging device based on Cherenkov radiation

Purpose: Most electronic portal imaging devices (EPIDs) developed so far use a Cu plate/phosphor screen to absorb x rays. The main problem with this approach is that the Cu plate/phosphor screen must be thin (~ 2 mm) in order to obtain a high spatial resolution, resulting in a low quantum efficiency (QE) for megavoltage (MV) x rays (typically 2-4%). In addition, the phosphor screen contains high atomic number (high-Z) materials, resulting in an over-response of the detector to low energy x rays in dosimetric verification. Our goal is to develop a new high QE MV x-ray detector made of a low-Z material for both geometrical and dosimetric verification in radiotherapy.

Method and Materials: Our approach uses radiation-induced light (Cherenkov radiation) in optical fibers that are made of low-Z materials. With our approach, a thick (~ 10-30 cm) fiber-optic taper consisting of a matrix of optical fibers aligned with the incident x rays is used to replace the thin Cu plate/phosphor screen to dramatically increase the QE. The feasibility of this approach has been investigated using a single optical fiber embedded in a solid material. The spatial resolution expressed by the modulation transfer function (MTF) and the signal-to-noise ratio of the proposed detector at low doses (~ one Linac pulse) have been measured.

Results: It is predicted that, using this approach, a detective quantum efficiency (DQE) of an order of magnitude higher at zero frequency can be obtained while maintaining a reasonable MTF, as compared to current EPIDs.

Conclusion: This work demonstrated the feasibility of using Cherenkov radiation for portal imaging applications [Work supported by the Individual Discovery Grant Program awarded by National Sciences and Engineering Research Council of Canada (NSERC)].