AbstractID: 10778 Title: Feasibility analysis on converting conventional orthovoltage biological irradiator to a micro-beam array for small animal/cell irradiation

Purpose:

To evaluate the feasibility and restrictions in converting an X-ray orthovoltage biological irradiator, PXI-X-RAD-320, to a micro-beam array using Geant4 Monte Carlo Simulation. Two important aspects of the beam, the peak-to-valley ratio (PVR) and beam flux, were evaluated quantitatively.

Method and Materials:

X-ray tube used in the irradiator (MXR-321) was simulated to generate the angular dependent X-ray spectrum. With this spectrum, X-ray beams impinged onto a plate with micro-grids (micro-beam plate) or a control plate (normal-beam plate), with photons collected by detectors underneath at spatial resolution of 0.02mm. The impact of such factors as source-to-plate distance, plate-to-detector distance, with/without blocking, and the diameter of blocking on the beam profiles and flux was evaluated. Kodak EDR2 films were analyzed by VIDAR-Dosimetrypro-Advantage scanner.

Results:

PVR increased and beam flux decreased with decreasing plate-to-detector distance. For instance, keeping the source-to-plate distance at 345mm from source, a decrease of the plate-to-detector distance from 5cm to 1mm led to PVR increase from 1.3 to 687.3 and beam flux increase from 1.16% to 1.27%. The relative low resolution of scanner caused micro-beam doses being averaged within vicinity area. It was showed that a PVR of 1.916 got from film was consistent with 1.843 from average of the simulation data for 1mm plate-to-detector distance. As the source-to-plate distance became larger at constant plate-to-detector distance, PVR increased whereas beam flux decreased. In situations where a larger plate-to-target distance is desired, a blocking with small orifice must be used. While providing an outstanding PVR at orifice diameter of 0.65mm, this method resulted in an extremely low beam flux.

Conclusion:

A conventional x-ray irradiator can be converted to a micro-beam array but with limitations. The primary restriction is caused by machine’s large irradiation angular coverage. Advanced method should be developed to evaluate micro-beam dose from film.