AbstractID: 3122 Title: Quantum efficiency of an MCP detector: Monte Carlo calculation

Purpose: To calculate quantum efficiency (QE) of the microchannel plate (MCP) detector at different x-ray tube voltages using Monte Carlo method.

Methods and Materials: Monte Carlo calculation of the QE was performed using GEANT4. The MCPs with channel diameters of 2-25 µm and lead contents of 50%, 38%, 20%, 8% and 0% were considered. QE calculations were performed using GEANT4 for monochromatic photons at 200 energy points in the 0-200 keV range with 1 keV steps. QE of MCP was calculated for 35, 45, 90, and 120 kVp photon beams from tungsten target x-ray tube, passed through corresponding soft tissue equivalent filters. QE for polychromatic photon beams were calculated by weighting the monochromatic QE with the photon energy distribution of the filtered x-ray spectra.

Results: The QE for 35 kVp beam was 83% and 86% for MCPs with 2 µm channel diameter and 50% lead content, and 5 µm channel MCP with no lead in the material, respectively. Efficiency was decreased to 51% at 35 kVp for MCP with 50% lead content and 5 µm channel diameter. The efficiencies for 45 kVp photon beams were 68% and 76% for MCPs with 50% lead and no lead, respectively, and 5 µm channel diameter. QE was increased at 45 kVp to 91% for 2 µm channel MCP with 50% lead. The QE of the 90 kVp and 120 kVp beams were in the 81-92% ranges except the lead free MCP, for which it was decreased to 20-30%.

Conclusion: Monte Carlo calculations of the quantum efficiency of the edge on MCP detector shown that the smaller the MCP channel diameter, the higher the QE. Commercially available MCPs with 5-6 µm channel diameters can provide sufficiently high quantum efficiency for medical x-ray imaging applications.