AbstractID: 8397 Title: Enhanced Energy Transfer from Mega-Voltage Radiation to the Tumor Cell Killing Singlet Oxygen by Semiconductive Nanoparticles

Purpose: To investigate a novel energy transfer pathway from 6 MV therapeutic X-rays to Quantum dots (QDs), which further activates Photofrin to produce reactive singlet oxygen species by a process known as Foster Resonance Energy Transfer, and subsequently enhances cell kill.

Methods and Materials: The photon emission efficiency of QDs upon excitation by 6 MV X-rays was measured as a function of the dose rate from 100 cGy/min to 600 cGy/min. A conjugate was synthesized based on the conjugation of Photofrin and QDs. The quenching of the photon emission was measured with the conjugate. The energy transferred to the photofrin was calculated based on the principle of Foster Resonance Energy Transfer (FRET) that the energy transfer efficiency is proportional to the degree of quenching. The cell kill enhancement with the conjugates was studied using A549 human lung carcinoma cells and an optical density based assay. The cellular distribution of the conjugates was imaged by a confocal microscope.

Results: QDs were found to be excited by the 6 MV radiation and the number of visible photons generated from QD depended linearly on the radiation dose rate. The FRET efficiency increases as the number of Photofrin molecules conjugated to the quantum dots increases. The conjugate resulted in a statistical significant 34% increased cell kill at 24 pmol/ml conjugate concentration compared to radiation alone with minimal toxicity in non-irradiated controls. Fluorescence microscopy revealed that the conjugates were distributed within the cytoplasm.

Conclusions: This conjugate shows distinct properties as a novel media for generating singlet oxygen and enhanced tumor cell killing, which is achieved synergistically with radiation through a physical and linear interaction between QDs and X-ray; the conjugate itself shows minimal dark toxicity at nM concentration, thus can be readily targeted by conformal radiotherapy with high geometrical specificity.