AbstractID: 9441 Title: Development of a carbon-nanotube field emission based multi-pixel microbeam cellular irradiation system

Purpose:
High spatial and temporal resolution cellular microbeam irradiation is important in studying dynamic radiation response at the cellular level. Existing systems include charged particle, x-ray, and electron single beam irradiators. We have proposed a multi-pixel electron microbeam array irradiator based on carbon nanotube (CNT) field emission with individually controllable beams to irradiate cellular scale regions in a Petri dish under real time microscope observation.

Method and Materials:
We have developed and tested a prototype single pixel 30keV electron irradiator utilizing a CNT field emission cathode. The cathode is temporally modulated to deliver a calibrated electron dose to the target. Microfabrication methods are used to develop beam collimators of fine aperture. Dosimetry is performed using GAFCHROMIC film, and system feasibility is demonstrated via Rat-1 cell line irradiation. A multi-pixel system with a cathode chip and electron transparent window has been built, and the multi-pixel method has been demonstrated via field emission testing.

Results:
Preliminary data show the CNT electron microbeam irradiator is capable of 100 Gy/sec dose rate and 23um beam diameter. An "L" shaped irradiation pattern was used in feasibility demonstration using plated Rat-1 cells. Irradiation was visualized via Gamma-H2AX fluorescence marking of DNA damage. The multi-pixel microbeam concept has been demonstrated through fabrication and testing of a 5x5 microbeam array cathode. A 2.5mA field emission current was achieved with all pixels emitting.

Conclusion:
We have demonstrated the feasibility of a carbon nanotube field emission based single microbeam cellular irradiation system as well as the cathode fabrication for the multi-pixel microbeam prototype system still under development. The CNT microbeam irradiator is capable of delivering radiation over a large dynamic dose rate range with high temporal resolution. The eventual CNT based cellular irradiator is expected to be compact and made available for broad application.