Low Dose Rate Verification for UAMS Cs-137 Irradiator

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In-vivo monitoring of chronic low dose rate radiation is essential for dose verification and associated biological impact. Traditional low dose rate work relies on indirect measurements and modeling developed for health physics applications. Research using direct measurements for this subject is lacking. The difficulty of *in-vivo* dosimetry over extended periods of time results in increased uncertainties resulting from detectors used at body temperature. This work sought to characterize a Cs-137 source, determine dose delivered to mice, and determine if TLDs experience fading over time when held at body temperature.

A NIST traceable ionization chamber was used to determine output from the isotropically emitting unattenuated Cs-137 source. Tables were placed around the source and the location marked where ion chamber readings were equivalent within ±0.005% to allow for setup reproducibility when the animal cages were used. Additional attenuators were then placed around the source and ion chamber readings were taken to determine their impact. The resulting dose was determined using TG-21 and ICRU47 formalism, and was found to range from 0.263 to 0.014 Gy per day ± 0.52%, depending on the attenuator selected.

To characterize possible TLD fading at body temperature, TLD100 chips were exposed to Cs-137 and allowed to incubate at either room or body temperature for seven days. TLDs were exposed to 1 Gy over several fractions during that time to simulate chronic exposure in the mouse studies, keeping the TLDs at 37°C and another set at 20C during exposure and afterwards. Another two sets of TLDs were exposed to 1 Gy in one fraction on day one before incubation as the control using the two temperatures. Comparing all the results, the signal of the TLDs at 37°C apparently faded on the order of 8% with an uncertainty of 4%.

This work showed that measurement tools traditionally used in high dose rate applications, such as ion chambers and TLDs, can be used in chronic low dose applications for radiobiology. Additionally, TLD response needs to be characterized for temperatures near the conditions used for the experiments. These preliminary results will be investigated further in the future.

Gy/Day	Days	Incubation (°C)	Reading [nC]
0.143	7	37	1189 ± 42
0.143	7	20	1472 ± 52
1	1	37	1428 ± 51
1	1	20	1604 ± 57

Table 1: TLD fading study conditions and results