Introduction and Motivation

Dosimeters are devices used to monitor environmental and personnel radiation dose. Passive dosimeters such as thermoluminescent dosimeters (TLDs) capture ionizing radiation. The energy from the ionizing radiation is converted into electron-hole pairs. Electron-hole pairs resultant from the radiation exist in different energy (trap) states. In TLDs, heating causes the recombination of electron hole pairs which induces a release of visible light proportional to the dose received. Traps are liberated at different threshold temperatures corresponding to their respective energies.

This project is focused on using Monte Carlo method simulation to evaluate passive integrating TLD materials as temporal chain-of-custody detectors.

Technical Work and Results

Each trap state will decay under environmental conditions at a different rate according to its energy state or “trap depth”. These decays can be represented as fading functions shown empirically to follow the equation:

\[ G(t) = Ae^{-k_1t} + Be^{-k_2t} \]

Thus the signal read out from the TLD becomes:

\[ S = D \cdot G \]

where \( S \) is the signal (1 x n), \( D \) is the dose (n x 1), \( G \) is the decay matrix (n x n), and \( n \) is the number of peaks. Each element in the signal and dose matrices will intrinsically correspond to different time intervals in the usage period of the dosimeter. These will be called “dose reconstruction time intervals” when calculated from the signal and decay matrices. For ease of use and cost efficiency, a Monte Carlo method simulation has been written to preliminarily evaluate the merit of this method, that is the topic of this poster.

Conclusion

From this data it is reasonably clear that the simulation functions as expected and that it can find the time intervals of lowest error. Further experiments are required to better assess our objectives.

References