

IMPROVEMENTS IN ELECTRONIC DOSIMETERS, 2015

Author: Zim Sherman

Co-authors: Ben Liley

Introduction

Electronic dosimeters (or badges) have been useful tools to study human behaviour and health. After six years of use, some problems have been identified regarding the stability of the calibrations. Much work has been done in 2015 to improve this, and to enhance other aspects of the instruments' performance.

Method

In early 2015, it was noticed that calibrations of dosimeters produced after February 2013 drift significantly more than earlier dosimeters. Investigations revealed two separate issues that adversely affect the dosimeters' performance.

First, the factory that makes the UV-sensitive AlGaIn photodiodes changed the packaging of the sensor in January 2011. The sensor window was changed from quartz glass to a hardened silicone encapsulant. At our request, manufacturer's test data was provided, showing that the encapsulant becomes more opaque to UV with time and exposure. Similar tests on quartz glass show no such change.

Second, calibration offsets can cause the dosimeters to measure zero when the ambient radiation is small. Dosimeters that show excessive offsets during production tests have been set aside and not distributed. However, offsets have recently appeared in some dosimeters coming back from the field; these units had previously passed production tests. Offsets shift the entire calibration curve, sometimes as much as 20%.

Outcome

The photodiode factory has been made aware of the issue with the silicone encapsulant, and they plan to re-launch the quartz glass version of the photodiode in Q4 2015.

Experiments to pinpoint the cause of the calibration offset were inconclusive, but an extensive firmware revision has eliminated it. Other firmware improvements include the ability to extrapolate beyond the upper limits of the measurement scale, and the ability to better determine battery health.

Relevance

For researchers who use dosimeters with serial numbers 2200 to 2999, it is now advised to calibrate the dosimeters at least annually, and apply a correction to account for drift between the calibrations. A method of linear interpolation developed by Gröbner et al [1] yields overall uncertainties of $\pm 12\%$ using old firmware.

Dosimeter users with firmware versions 26 and below should update the firmware. This should be performed when the dosimeters are not in use, and after all calibration work for previous studies has been completed. After updating, the dosimeters ideally should be recalibrated; but if this is impractical, you may simply set the offset to zero.

[1] M. Gröbner, J. Gröbner and G. Hülsen, Quantifying UV exposure, vitamin D status and their relationship in a group of high school students in an alpine environment, *Photochem. Photobiol. Sci.*, 2015,14, 352-357.