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CHARACTERIZATION OF AN OPTICALLY STIMULATED LUMINESCENCE READER FOR OCCUPATIONAL MONITORING

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ABSTRACT

The optically stimulated luminescence (OSL) technique may be applied to different areas, including personal dosimetry. The OSL system reader requires permanent verifications of its operation to guarantee correct measurements with minimum variation. The assurance of the adequate performance of the OSL reader is obtained by the result of operational tests, within a quality control program, being evaluated the quality and the stability of the equipment operation. The objective of this work was the characterization of an OSL reader in relation to the main quality control tests. The results showed that the OSL reader parameters are within the acceptable limits for use in personal dosimetry.

1. INTRODUCTION

Dose limits are extremely important as part of the evaluations in occupational exposure to ionizing radiations [1]. The optically stimulated luminescence (OSL), originally applied to archaeological and geological dating, medical and environmental dosimetry [2], has been applied to personal dosimetry in recent years [3].

The OSL technique has several advantages over the thermoluminescence (TL) technique: the readout method is optical, requiring no heating of the samples; the measurement is less destructive and potentially more sensitive than TL; and the response may be evaluated several times on the same sample [4, 5, 6]. Moreover, the OSL technique presents faster readouts and maximum efficiencies.

In order to utilize the OSL as a personal dosimetry technique, it is necessary to certificate its operation to guarantee correct measurements with minimum variations. The assurance of the adequate performance of the OSL reader is obtained by the results of operational tests, within a quality control program, being evaluated the quality and the stability of equipment operation. In Brazil, the evaluation criteria of the performance of the measurement systems of measures utilized in personal monitoring are established by the Brazilian Commission of Nuclear Energy [7**]**.

The objective of this work was the characterization of an OSL reader in relation to the main quality control tests: stability, reproducibility, calibration curve, and lower detect limit, using the InLight System, Landauer.

2. MATERIALS AND METHODS

The measurements were obtained using the InLight portable reader, Landauer coupled to a notebook with the microStar software, Landauer. Al_2O_3: C type dots and InLight case dosimeters (Fig. 1) were utilized.

(a) (b)

Figure 1. InLight dot dosimeters (a) and InLight case dosimeters (b)

To determine the calibration curve, a set of InLight case dosimeters previously irradiated by the manufacturer, with doses varying from 5 mSv to 5000 mSv (^{137}Cs), were utilized.

For the reproducibility test, dot detectors were utilized, and the irradiations were realized with gamma and beta standard sources of the Calibration Laboratory (LCI) of IPEN. The beta (^{90}Sr + ^{90}Y) secondary standard system utilized is from Buchler GmbH & Co, Germany, and its radiation sources were calibrated by the primary standard laboratory Physikalisch - Technische Bundesanstalt (PTB), Germany. For the gamma irradiations, the ^{60}Co irradiator, model CPIO-AO 0197/82, was utilized. The irradiations were performed at 30 cm and 125 cm from the beta and gamma radiation sources, respectively.

The measurements were always taken immediately after the irradiations. The detectors were optically treated with $26x10^3$ lux from a fluorescent light inside a box during one hour, prior to each re-use.

3. RESULTS AND DISCUSSION

3.1. Stability of the OSL system

In order to verify the OSL system stability, tests in three different positions of the InLight microStar System measurement dial, i.e., to monitor the reader performance, were realized. The dial measuring positions were DARK, CAL and LED.

The DARK position represents the measure counts from the photomultiplier tube (PMT) with the shutter closed and the LED off, indicating the amount of PMT inherent electronic noise. At the CAL position, the measure counts are the indication from the PMT with the shutter open, using a small, exempt amount of ^{14}C radioactive material, embedded in a plastic scintillator, to indicate the sensitivity and consistence of the PMT. The LED position shows the measure counts from the PMT with the LED on, to indicate the beam intensity.

Two hundred (200) measurements were realized for each dial position in an interval of 10 seconds in each case.

The DARK counts (Fig. 2) did not exceed the limit of 30 counts [7]. The CAL and LED counts were normalized to the average value of the measurements. Most of the measurements from CAL and LED counts were within ± 10% of the established mean value (Fig. 3 e 4) [7]. Only 10% and 4.5% of the counts were out of this range at CAL and LED counts respectively.

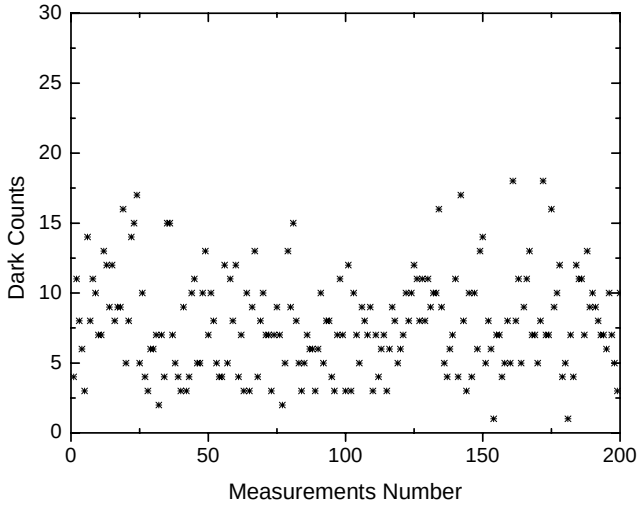

Figure 2. Stability of the OSL reader: DARK counts.

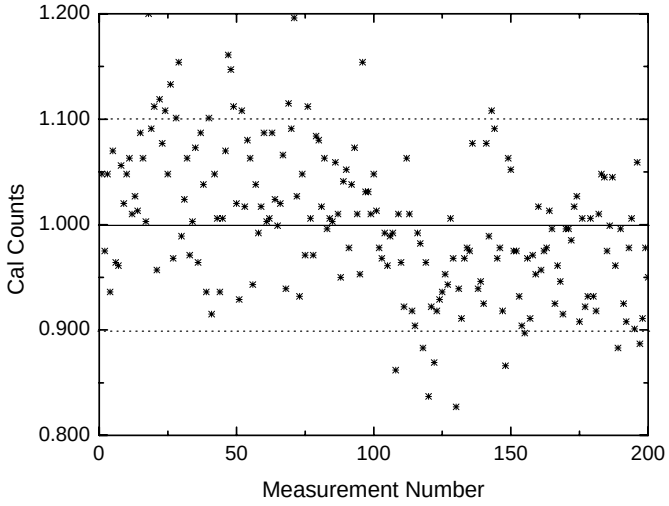

Figure 3. Stability of the OSL reader: CAL counts.

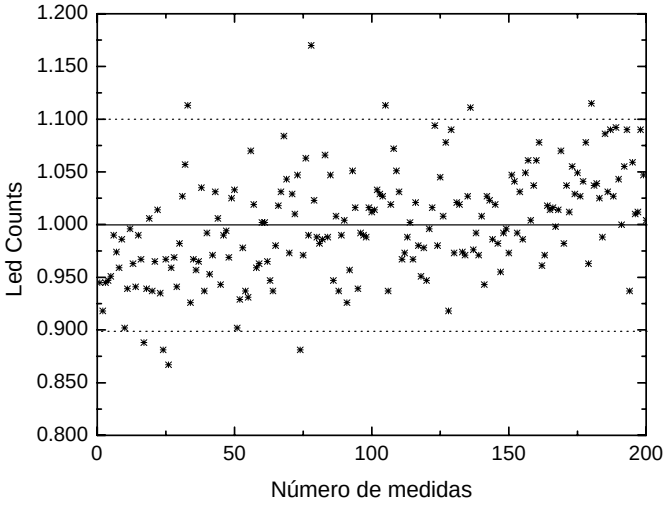

Figure 4. Stability of the OSL reader: LED counts.

3.2. Calibration curve of the OSL system

The calibration curve was determined using the pre-irradiated InLight case dosimeters set with doses of 5 mSv, 100 mSv, 500 mSv and 5000 mSv irradiated with gamma radiation (^{137}Cs). The results are shown in Fig. 5. These results are very important to determine the correct absorbed doses by the OSL reader.

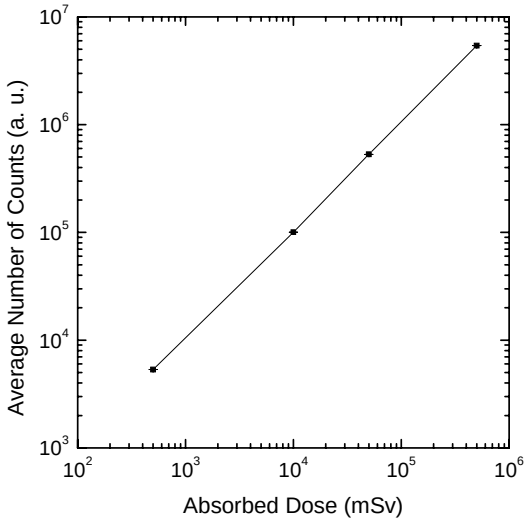

Figure 5. Calibration curve of OSL System using pre-irradiated case dosimeters.

3.3. Reproducibility

The reproducibility test was performed realizing ten consecutives measurements for each detector, using beta radiation ($^{90}Sr + ^{90}Y$) and gamma radiation (^{60}Co) sources. The obtained results were 2.6% and 4.5% respectively. They are within the 7.5% acceptable Brazilian limit for personal monitoring services [6].

3.4. Lower detection limit

The lower dose detection limit obtained in all performed tests was far below (70μGy) the acceptable limit that is 0.2 mGy [6].

4. CONCLUSION

The results show that the InLight System presents parameters as stability, calibration curve, reproducibility and lower detection limit within the acceptable Brazilian limits for use in personal dosimetry.

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