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DEVELOPMENT OF AN OSL SYSTEM WITH BERYLLIUM OXIDE FOR APPLICATION IN PERSONAL DOSIMETRY

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Introduction: In the last decades, Optically Stimulated Luminescence (OSL) has become a widely used technique in personal, and clinical dosimetry due to its fast and multiple reading, elimination of complex thermal annealing steps, high precision and accuracy, and stable sensitivity. In Brazil the individual monitoring services using OSL technique has increased around 22% during the period from 2008 to 2016 [1]. However, the low advance in the use of the OSL dosimetry is due to the cost of importing the reader equipment and the difficulty of maintenance in the country. The aim of this work is to develop an OSL reading system with beryllium oxide (BeO) dosimeter for application in personal dosimetry, with the objective of supplying the national market and contributing to the increase in the number of users of OSL personal dosimetry.

Material and method: The OSL system consists of an optical stimulation unit based on a high-power light-emitting diode (LED) in the visible region of the electromagnetic spectrum, transmission geometry and continuous wave (CW) stimulation mode. The luminescence emission of BeO is measured using a photomultiplier tube module (PMT), H7421-40, which operates in photon counting mode and produces pulses as output. Pulses from the PMT module are registered using a digital counter circuit designed and timed with fast control signal via microcontroller. The developed OSL system is characterized with BeO, BeOSL dosimeters of Dosimetrics, used in personal whole body dosimetry measurements, according to the CASEC/IRD:2014 [2] standards of the National Nuclear Energy Commission (CNEN).

Results: The OSL system developed, called OSLMeter3001, has the following characteristics: (a) modular design with expansion of device functions by easily adding components; (b) optical detection filters optimized for collecting luminescence light from BeO; (c) PMT UV-VIS with sensitivity of 300-720nm and thermoelectric control; (d) digital counter with high resolution 24bits and fast pulse readings from 20 to 30ns; (e) optical stimulation based on 445nm blue LED, continuous wave stimulation mode (CW-OSL), maximum power of 112mW/cm² at sample position and rise/fall response time <40µs; (f) OSLMeter3001 V1.2 software has self-test, user-defined reading parameters, data analysis and dose algorithm; (g) protection against damage to the PMT during OSL measurement; (h) remote operation with technical support and fault diagnosis.

The experimental evaluation of the reference light reproducibility showed that the variation is less than and equal to 1% in daily control measurements. The reproducibility of the response of the OSL reader with a dose of 1mSv, in Hp(10), was less than 4%. The study of the stability of the OSL reader showed a variation of less than 5% between the groups of dosimeters evaluated in 24h and 168h (7d). The linearity of the dose response in the range of 0.08mSv to 2000mSv, in terms of Hp(10), showed adequate linearity with $R^2 = 0.9992$ and within the acceptance range of less than 10%. Figure 1 presents the result obtained in the study of linearity.

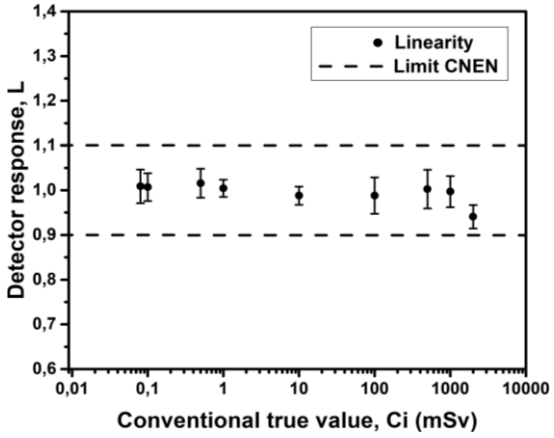

Figure 1: Linearity of the dose response in Hp(10).

The lower detection limit found was 0.003mSv lower than 0.1mSv minimum dose, as required by CNEN.

Conclusions: The developed OSL system attend the compliance requirements established in the CASEC/IRD:2014 CNEN. This OSL system will contribute to Brazilian personal dosimetry services to implement the OSL dosimetry.

References:

1. M.A.V. Alencar et al. Panorama da Monitoração Individual e Calibração de Monitores de Radiação no País. IRD/CNEN, (2017).
2. CASEC- Comitê de Avaliação de Serviços de Ensaios e Calibração. Desempenho de Sistemas de Monitoração Individual, Critérios e Condições. IRD/CNEN, (2014).