Investigation of the dosimetric parameters of the PorTL thermoluminescent dosimetry system

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Introduction

The PorTL System, a portable, lightweight thermoluminescent (TL) dosimeter system developed by the Hungarian Academy of Sciences Centre for Energy Research consists of a relatively small size reader device and a set of special dosimeters. The development was based on the Pille thermoluminescent space dosimetry system, which has been on board all space stations orbiting the Earth since 1980. The latest version of the Pille system, which has been the service dosimeter system of the Russian expeditions of the International Space Station since 2003, provided more than 30 000 valuable read-outs on board the station including personal dose data of extravehicular activities and high resolution dose monitoring.

Fig. 1: The PorTL Reader

Description

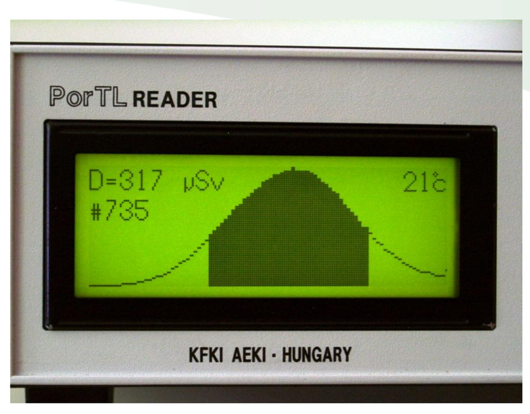

Fig. 2: LCD display of the PorTL reader

Fig. 3: The PorTL Cell

The PorTL Dosimeter System (Fig. 1, 2 and 3) was developed based on the Pille Space Dosimetry System. The light weight (1.4 kg) and the small size of the Pille reader allow the Pille system to be the only TL dosimeter system capable of carrying out readouts onboard spacecrafts. The main goal of the development was to combine the flexibility, reliability and robustness of the space qualified Pille system with the expectations for a common-use dosimeter system. Therefore, the main structure of the reader device was preserved, and several user friendly features were added.

Measurements and methods

The main dosimetric parameters of the PorTL system with ^{6}LiF and ^{7}LiF dosimeters were measured during the past years according to the IEC 61066 International Standard for Thermoluminescence dosimetry systems for personal and environmental monitoring. The linearity, the reusability as well as the radiation energy and angle of incidence dependence were measured.
Six dosimeters were used during the experiment. (X0039, X0040, X0041, X0043, X0044, X0045) The calibration of the dosimeters was performed with ^{137}Cs source, and with exposure of 2 mGy. The dosimeters were irradiated in their plastic case. According to the IEC 61066 standard, the dosimeter system was calibrated to display the measurement result in Sv [1]. The dose conversion coefficient of 1.2 was used during the calibration.
On every measured energy and angle the difference from the expected dose was calculated. The calculation of the expected doses is based on a reference energy (662 keV, ^{137}Cs) and angle (0°), and the angle of incidence conversion coefficients given in the ISO-4037-3 standard. This difference can not be lower than -29% or higher than +67% of the expected dose.
Due to their geometry, there are two possible ways of rotating the dosimeters (Fig. 5).
The X-ray measurements were performed in the Ruđer Bošković Institute in Zagreb, Croatia (Fig. 4).

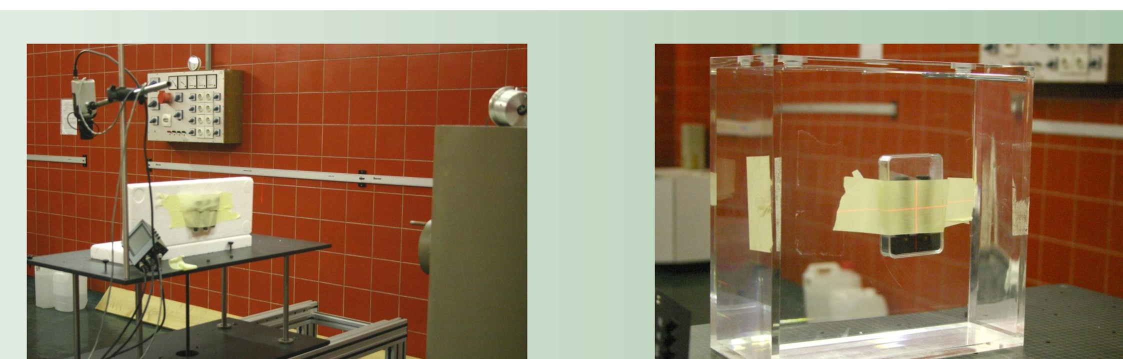

Fig. 4: Irradiation in the Ruđer Bošković Institute, Zagreb

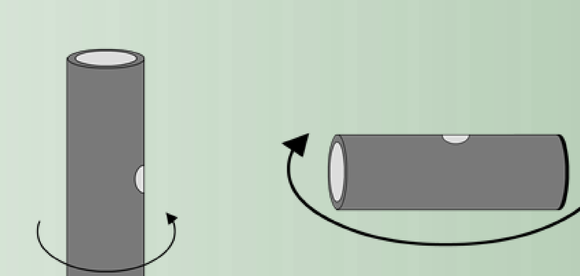

Fig. 5: Measuring geometries (vertical and horizontal)

Results

After the N-60 (48 keV) X-ray irradiation all results were 50-60% below the reference dose equivalent level, therefore the PorTL system failed to fulfill the requirements.
On N-80 (65 keV) X-ray energy the results were in the range of -29% to -17% of the reference level when the dosimeters were rotated in vertical direction. When they were rotated in horizontal direction, the results were in the range of -55% to -21% (Fig. 6). The system has partially fulfilled the requirement on this energy.
On N-100 (83 keV) X-ray energy all results (both vertical and horizontal rotations) were in the range of -33% to +5% of the reference level (Fig. 7). At N-100 X-ray energy all measurements were in the desired range – except one measuring point. The relative response of dosimeter X0039 was -33% when it was rotated by 60° horizontally. The average response of the six investigated dosimeters in this measurement point is -22%.

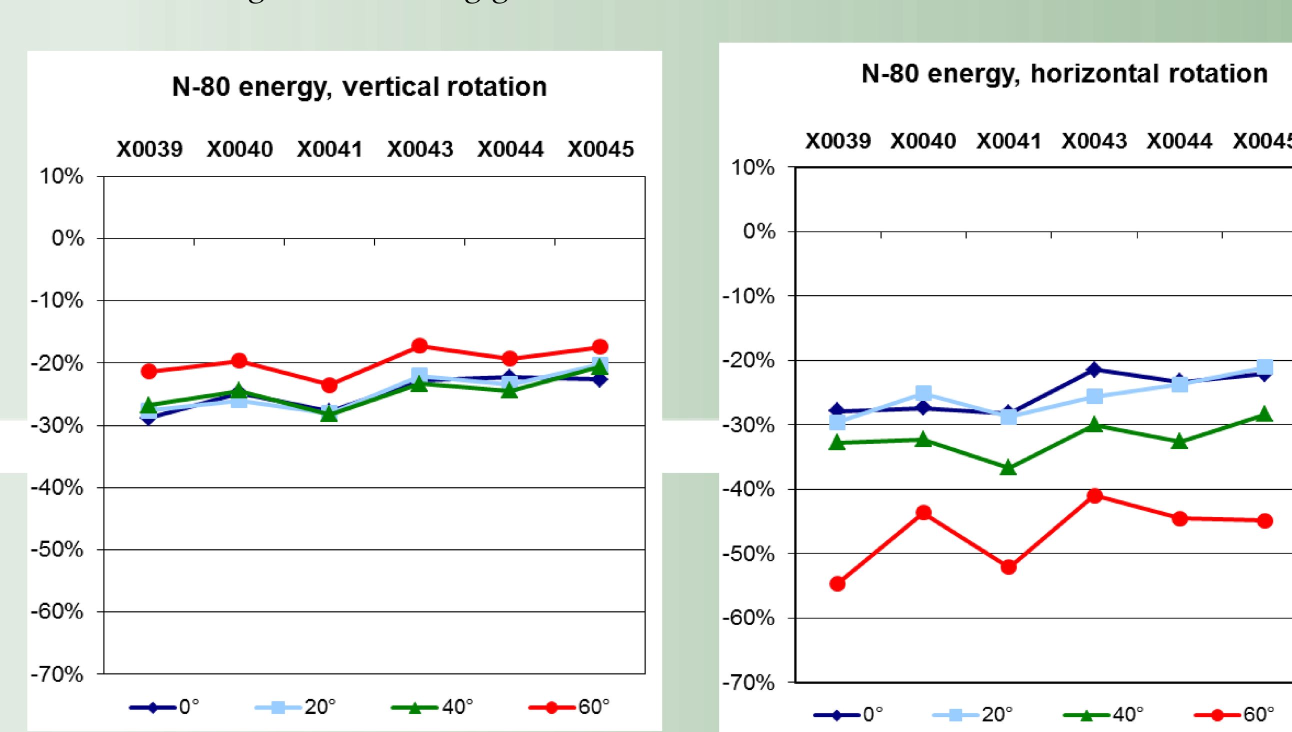

Fig. 6: Results on N-80 X-ray energy, vertical and horizontal rotation

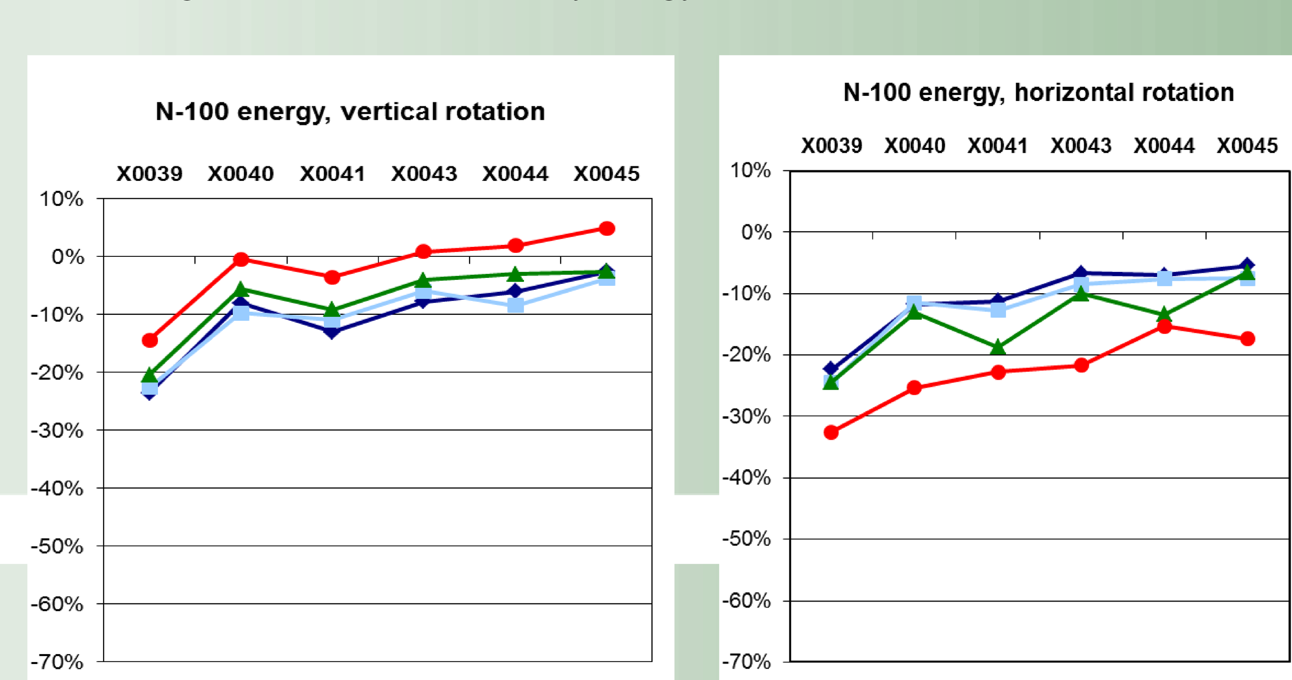

Fig. 7: Results on N-100 X-ray energy, vertical and horizontal rotation

Conclusion

The experiments show that PorTL dosimeter system fulfills the requirements of the IEC-61066 International Standard on relative response due to radiation energy and the angle of incidence above N-100 X-ray energy.

Reference

[1] IEC-61066 : Thermoluminescence dosimetry systems for personal and environmental monitoring; IEC; 1999
[2] ISO-4037-3: Calibration of area and personal dosimeters and the measurement of their response as a function of energy and angle of incidence; ISO; 2006
[3] PorTL Dosimeter System Technical Description and User's Manual; István Apáthy, Sándor Deme, Péter Szántó; KFKI-AEKI-SKL-2006-366-01-02-0; 2006
[4] PorTL website; http://portl.kfki.hu