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ENVIRONMENTAL DOSE MEASUREMENT WITH MICROPROCESSOR BASED PORTABLE TLD READER

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INTRODUCTION

Application of TL method for environmental gamma-radiation dosimetry involves uncertainty caused by the dose collected during the transport from the point of annealing to the place of exposure and back to the place of evaluation. Should an accident occur read out is delayed due to the need to transport to a laboratory equipped with a TLD reader.

A portable reader capable of reading out the TL dosemeter at the place of exposure ("in situ TLD reader") eliminates the above mentioned disadvantages. We have developed a microprocessor based portable TLD reader for monitoring environmental gamma-radiation doses and for on board reading out of doses on space stations. The first version of our portable, battery operated reader (named Pille - "butterfly") was made at the beginning of the 80th [1,2]. These devices used $CaSO_4$ bulb dosemeters and the evaluation technique was based on analogue timing circuits and analogue to digital conversion of the photomultiplier current with a read out precision of 1 μGy and a measuring range up to 10 Gy. The measured values were displayed and manually recorded. The version with an external power supply was used for space dosimetry as an onboard TLD reader [3].

RESULTS OF RECENT DEVELOPMENT

Based on a microprocessor an up to date version of the battery operated portable reader was developed in 1994-95 at the Atomic Energy Research Institute. The main results of the development were:

1. Increased sensitivity of the reader by one order of magnitude.
2. Improved precision of the measurement using automatic correction of the individual dosemeter sensitivity and of the temperature dependence.
3. Programmable heating current profile, e.g. to product a quasilinear temperature increase up the bulb heating plate.
4. Automatic data processing and subsequent storage on a memory card of the processed data, date, time, dosemeter identification number, dose, the digital glow data and environmental temperature.
5. Possibility of the programmed automatic read out of a dosemeter placed in the reader to measure the time distribution of the dose rate.

CONSTRUCTION

The new system consists of a set of TL bulb dosemeters with built in memory chips, and the microprocessor based reader. The $CaSO_4$:Dy bulb dosemeter is the same as the earlier one [1].

A block diagram of the reader is given in Fig.1. The TLD bulb has a common case with the memory chip containing the identification number and individual readout characteristics (sensitivity, time limits of integration and background) of the bulb.

The DC/DC converter type heating supply as well the high voltage supply for photomultiplier tube are controlled via digital-analogue converters by the microprocessor thereby providing the possibility to program the time dependence both of the heating current (e.g. to obtain quasilinear or steplike temperature profiles) and of the high voltage (to change the sensitivity of the photomultiplier tube in autorange mode).

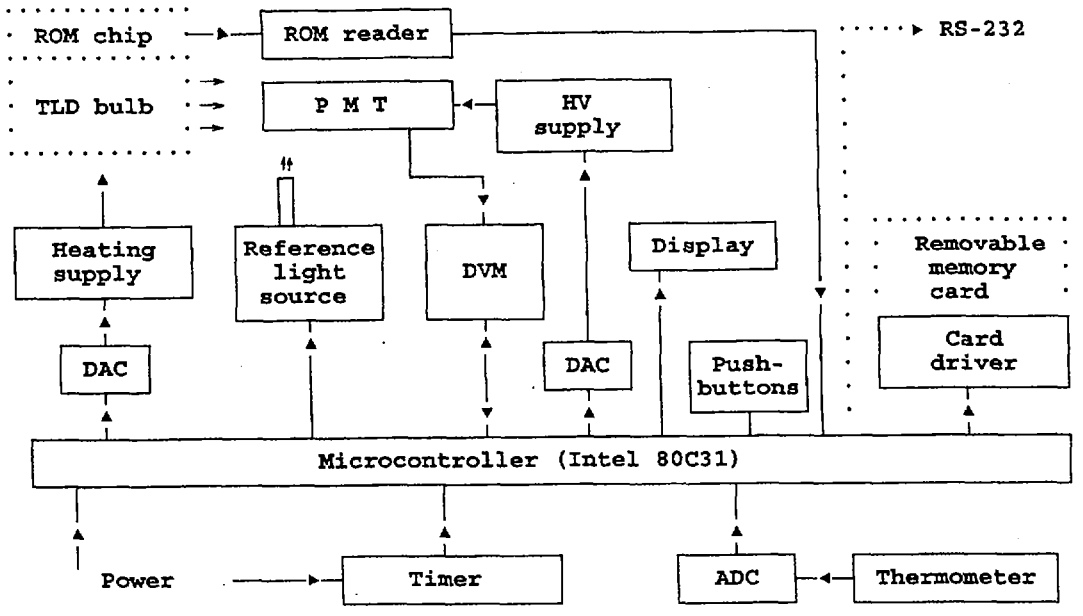

Fig. 1: Simplified block diagram of the reader.

The light output of the bulb dosemeter is measured by a photomultiplier, a wide range I/U converter, and a digital voltmeter. (The range of the light detecting system exceeds 8 orders of magnitude.) The built in, stabilized LED light source controls the light sensitivity of the reader in each measuring cycle.

The four digit alphanumeric LED display indicates the measured dose in exponential form, the possible error codes and the menu/submenu points of the setup. The removable memory card can store up to 4000 measured data sets (dose, identification number, date and time, and digital glow curves).

The front view of the reader is to be seen in Fig.2. The mass of the battery operated version of the reader is about 2.5 kg, its dimensions are 190 x 155 x 70 mm. The rechargeable battery (10.8 V) provides capacity for about 200 read-outs. The reader also works from a 12 V or 24 V car battery in buffer mode. The space version is supplied by 27 V d.c.

The glow curve of a $CaSO_4$:Dy bulb irradiated with 0.5 mGy dose of gamma-radiation is given in Fig.3. At higher doses the glow curve is distorted by high temperature peaks. This effect requires nonlinearity correction, performed by the software of the reader.

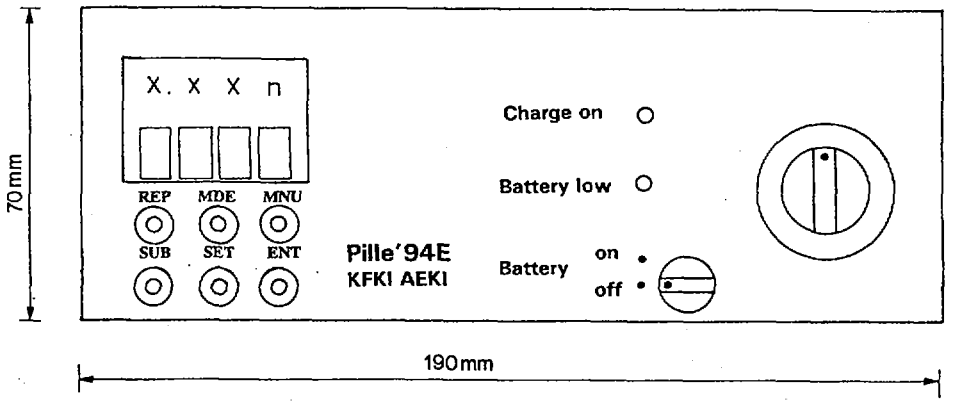

Fig. 2: The front view of the reader.

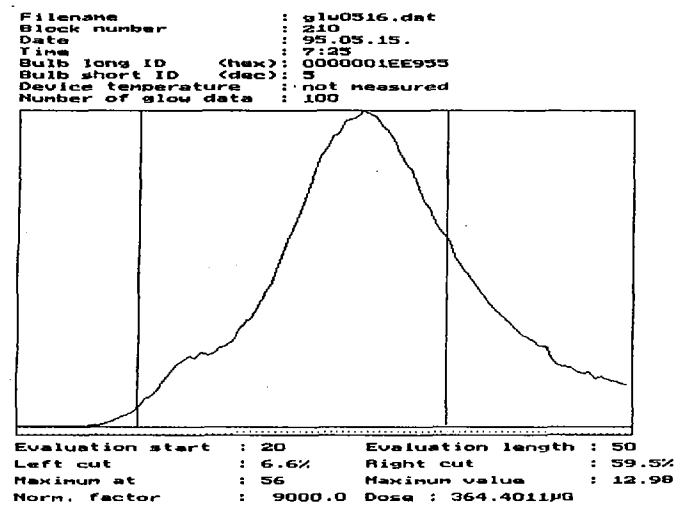

Fig. 3: The glow curve of a $CaSO_4$:Dy bulb irradiated with 0.5 mGy dose and additional data stored in memory card.

The environmental temperature influences both the position and the area of the glow curve. Using the built in digital thermometer this effect can be taken into account.

The lower limit of the dose measurement with $\sigma = 10\%$ is equal to 3 µGy, i.e. an environmental dose of one or two days.

The dosemeter has low light sensitivity: it can be evaluated in a room having moderate illumination from filament lamps, or in scattered daylight of low intensity.

APPLICATIONS

The system is utilizable both for environmental monitoring and measurement of doses on board manned and unmanned space vehicles.

Environmental doses can be measured using in situ read out of the dosemeters. The wide measuring range of the system (3 µGy - 10 Gy) provides the possibility to measure dose values from natural background up to very large accidental doses. The in situ measurement makes it possible to avoid the transit dose when monitoring the normal environmental gamma radiation and to obtain the dose values immediately in case of an accident.

CONCLUSIONS

The development of an up to date microprocessor based portable battery operated reader was completed during 1994-1995. The lower limit of measurement with $\sigma = 10\%$ is equal to 3 µGy, at higher doses up to 10 Gy, the reproducibility is in the range of 1-2%. The measured data together with digital glow curves are stored in the removable memory card of the reader. With a portable TLD system the transport dose - that normally gives a systematic error during environmental dosimetry - is avoided and the data availability accelerated in the event of a nuclear accident.

REFERENCES

1. Szabó, P.P., Fehér, I., Deme, S., Szabó, B., Vágvölgyi, J., Germán, E., *Environmental monitoring with a portable TLD system.* Radiat. Prot. Dosim. **6**(1-4) 100-103 (1983).
2. Szabó, P.P., Fehér, I., Deme, S., Szabó, B., Vágvölgyi, J., *Dosimetrical properties of the portable wide dose range TLD reader "PILLE".* Radiat. Prot. Dosim.. **17**(1-4) 279-282 (1986).
3. Akatov, Yu. A., Arkhangelsky, V.V., Aleksandrov, A.P., Fehér, I., Deme, S., Szabó, B., Vágvölgyi, J., Szabó, P.P., Csőke, A., Ránky, M., Farkas, B., *Thermoluminescent dose measurements on-board Salyut type orbital stations.* Adv. Space Res. **4**(10) 77-80 (1984).