ELECTRONIC DOSEMETERS IN PULSED PHOTON FIELDS: RELEVANT PARAMETERS

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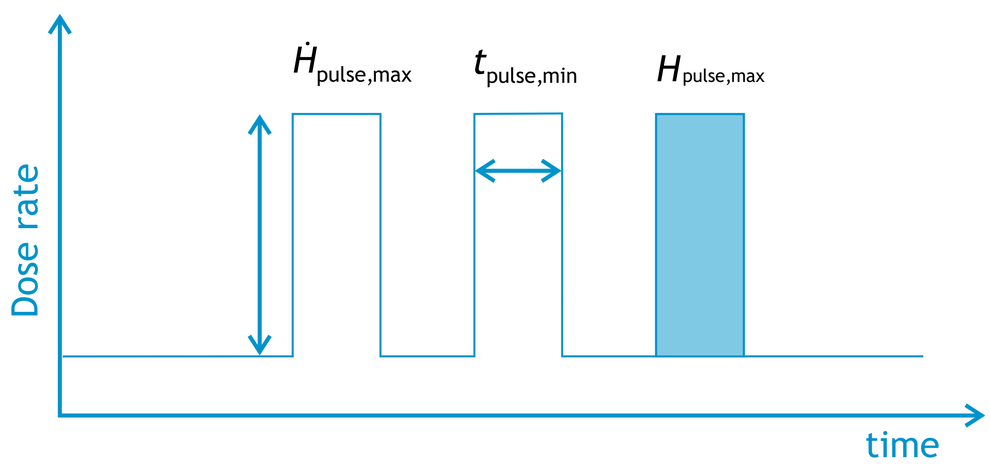
Introduction

Active electronic dosemeters employing counting techniques are used in radiation fields for X-ray diagnostics in human and veterinary medicine and in accelerator-driven fields for therapy or science.
In case of a pulse dose rate above the limit of the dosemeters, the indicated value for the acquired dose may be considerably wrong.
The specifications and requirements for dosemeters in pulsed radiation fields have been included in the new IEC Technical Specification IEC 62743.
For electronic counting dosemeters, a set of relevant parameters of a dosemeter is described, which can be used to decide whether the dosemeter is applicable in a specific radiation field or not.

Concept of IEC TS 62743:

The pulsation is treated as additional influence quantity like e.g. the photon energy in the standards for continous radiation.
The important parameters are:

Parameters of the radiation field



$\dot{H}_{pulse,max}$ Maximum value of the dose rate in one pulse

$t_{pulse,min}$ Minimum value of the radiation pulse duration

$H_{pulse,max}$ Maximum value of the dose in one radiation pulse

Parameters of the dosmeters

T_{cycle} Measurement cycle time of the dosemeter

G_{count} Dose indication per counting event

t_{dead} Non-extendable dead time of the counting dosemeter

$\dot{H}_{count,max}$ Maximum measurable dose rate in the pulse

Model function of the dosemeter

$$G_{dose} = k_{int} \cdot G_{count} \cdot n_{count} \cdot k_{dead,int}$$

- G_{dose}: Dose indication
- k_{int}: Product of internal correction factors of the dosemeter
- G_{count}: Dose indication per counting event
- n_{count}: Number of counting events
- $k_{dead,int}$: Internal correction factor for dead time

Requirements for counting dosemeters for measuring pulsed photon radiation

According to IEC Technical Specification IEC 62743 TS.

No.	Requirement	Relevance
1	for $t_{pulse} \geq t_{dead}$ applies $\dot{H}_{pulse} \leq \dot{H}_{count,max}$	specific for the workplace
2	for $t_{pulse} < t_{dead}$ applies $H_{pulse} \leq 0{,}2 \cdot G_{count}$	specific for the workplace
3	$T_{cycle} \leq 30$ s	otherwise reaction- or alarm time too long
4	$G_{count} \leq 10$ nSv	otherwise resolution too low
5	$t_{dead} \leq 10$ µs	otherwise count rate in the dosemeter too
6	$\dot{H}_{pulse,max} \geq 1$ Sv/h	otherwise not applicable for any realistic workplace
7	pulse overload alarm for $\dot{H}_{pulse} > \dot{H}_{count,max}$	otherwise no warning for accidental exposure
8	$G_{dose}(100 \cdot \dot{H}_{pulse,max}) \geq G_{dose}(\dot{H}_{pulse,max})$	otherwise wrong conclusions in overload

Reference
IEC 62743 TS Ed.1 „Radiation protection instrumentation – Electronic counting dosemeters for pulsed fields of ionizing radiation“
H. Zutz, O. Hupe, P. Ambrosi, J. Klammer: Determination of relevant parameters for the use of electronic dosemeters in pulsed fields of ionizing radiation, Radiat. Prot. Dosimetry (accepted, 2012).

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