



Radiation Protection Dosimetry in Pulsed Fields

Oliver Hupe

Hayo Zutz and Jana Klammer

Introduction: Pulsed Radiation Fields

- Application of pulsed fields increased remarkably



Germany:
about 70 % of 340 000 occupational exposed workers in pulsed fields

Introduction: Pulsed Radiation Fields

- Application of pulsed fields increased remarkably
- ... can be produced as a pulsed field or can appear pulsed for the dosimeter
- “Pulsed”: duration less 10 s

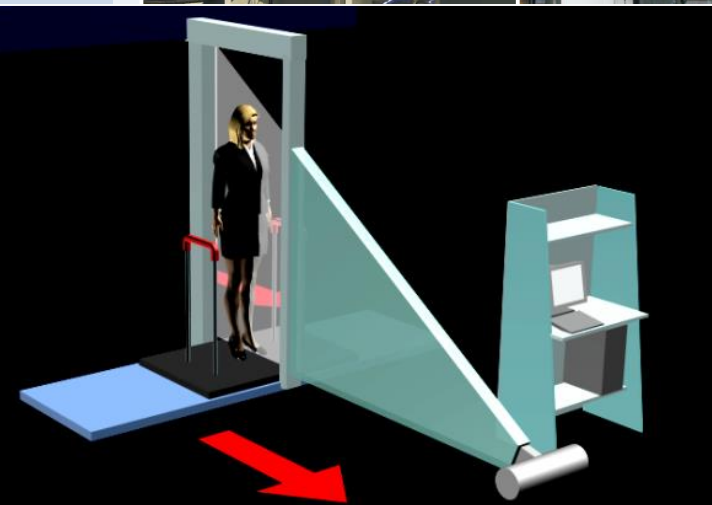
X-ray diagnostics



X-ray scanner



Science and material testing



- Application of pulsed fields increased remarkably
- ... can be produced as a pulsed field or can appear pulsed for the dosimeter
- “Pulsed”: duration less 10 s
- Dosimeters are only tested in continuous fields
- Characteristics of dosimeters determined in cont. fields can't be transferred to those in pulsed fields
- **Electronic dosimeters could measure considerably wrong, or even fail completely in pulsed fields**

U. Ankerhold, O. Hupe and P. Ambrosi:

Deficiencies of active electronic radiation protection dosimeters in pulsed fields
Radiation Protection Dosimetry Vol. 135, No. 3, pp. 149-153 (2009)

Electronic dosimeters in pulsed fields

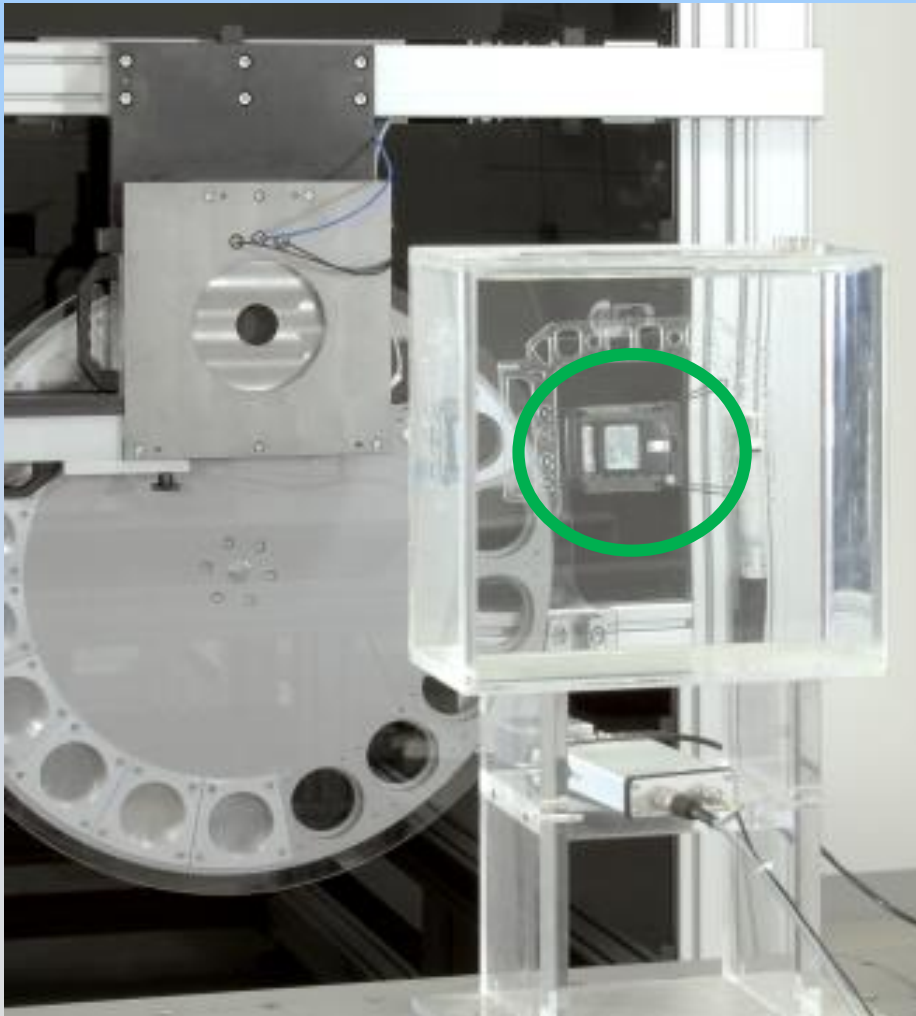


Let's see what happens ...

Electronic dosimeters in pulsed fields

Pulsed X-ray fields at PTB

Let's see what happens ...

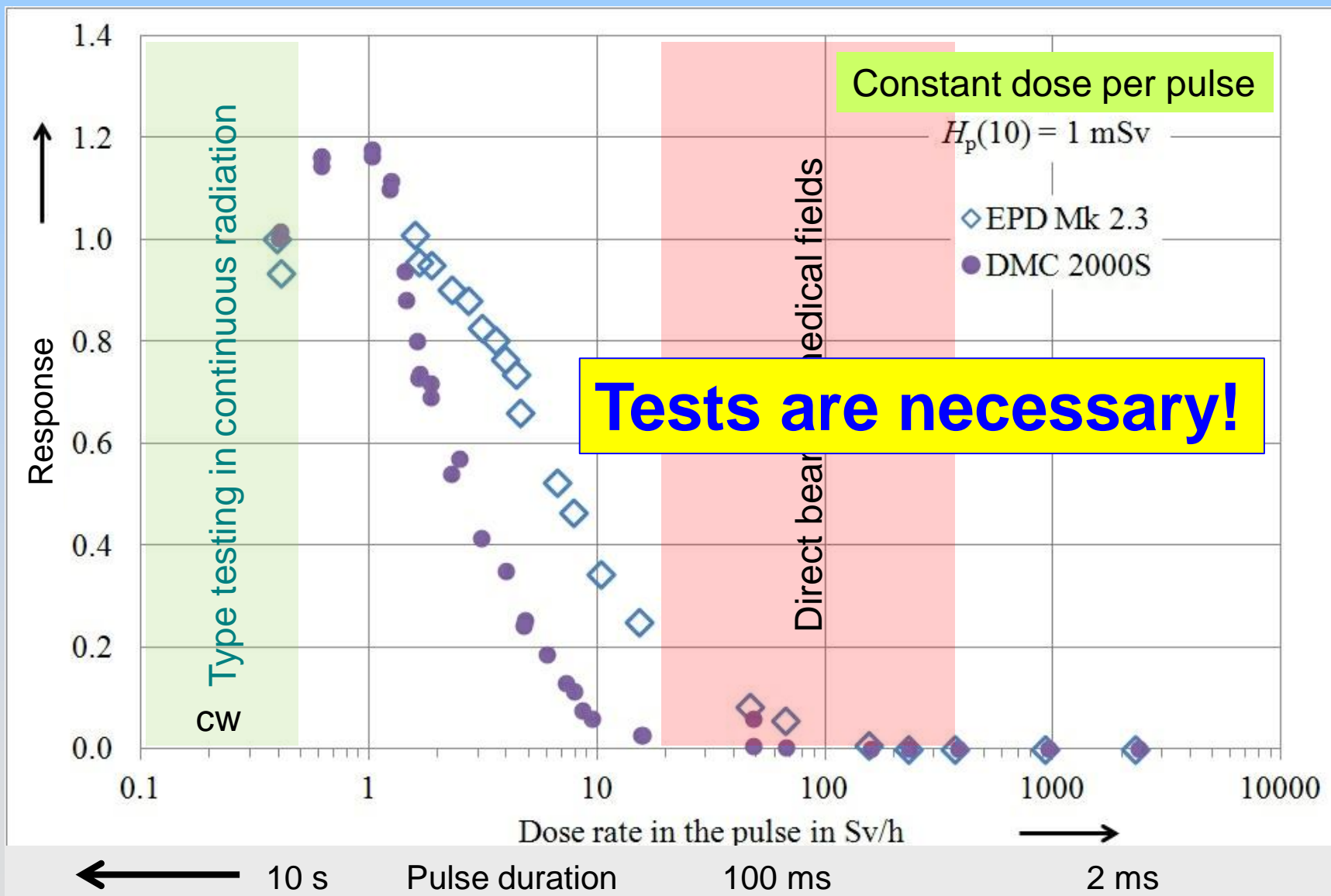


EPD Mk2

DMC 2000 S

Typical electronic personal dosimeters
(results also valid for area dosimeters!)

Electronic dosimeters in pulsed fields



Electronic personal and area dosimeters

- Detector: e.g. Semiconductor, GM-tube
- Measuring mode: **counting**
- Dose rate range: **50 nSv/h - 1 Sv/h**
- Properties:
 - ✓ direct indication
 - ✓ adjustable alarm function
 - limited dose rate range

Examples:



Reasons for problems in pulsed fields

- **dead time** of the detector/electronics
 - > correcting algorithms assume a constant dose rate during the **measuring cycle (several seconds)**

Important field parameters:

- Tube voltage U_{tube} 40 kV to 125 kV
- Tube current I_{tube} 0.5 mA to 800 mA
- Pulse duration t_{pulse} 0.2 ms to cw
- Frequency f_{pulse} up to 100 Hz



Characterisation of a radiation pulse:

Time-resolved measurement of

- dose
- dose rate
- high voltage during the radiation pulse

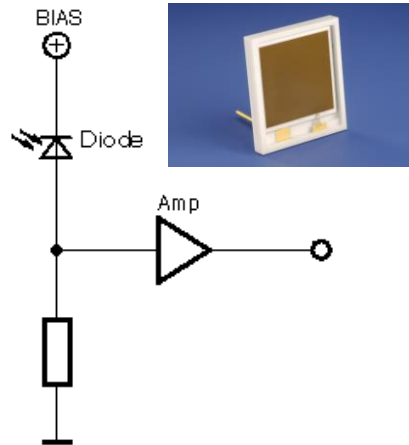
J. Klammer, J. Roth and O. Hupe:

Novel reference radiation fields for pulsed photon radiation installed at PTB
RPD, doi: 10.1093/rpd/ncs043 (2012)

P02.260
Klammer, J.

Instruments

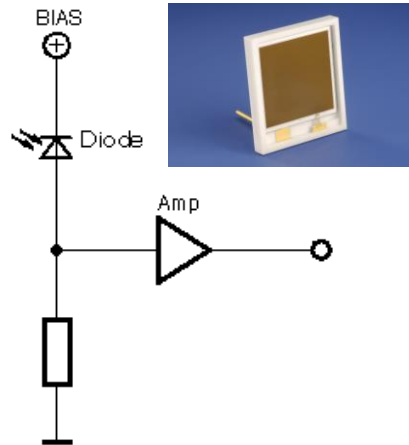
Scope & diode



Characterisation: Measurement of pulse shape

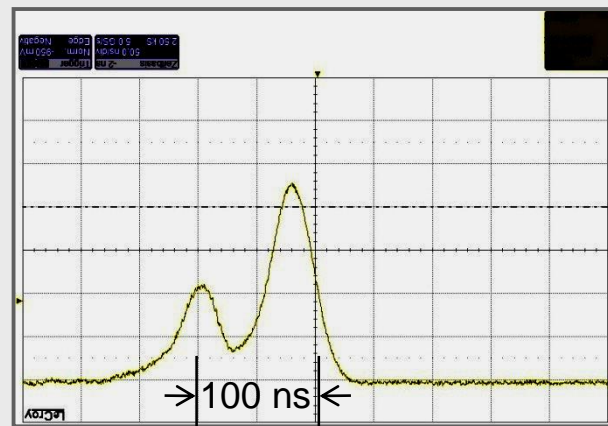
Instruments

Scope & diode

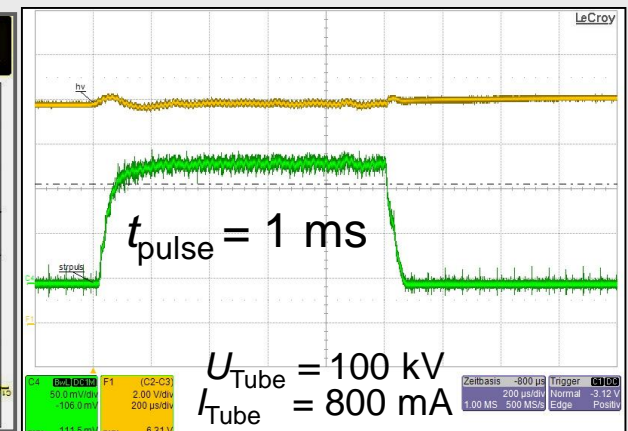
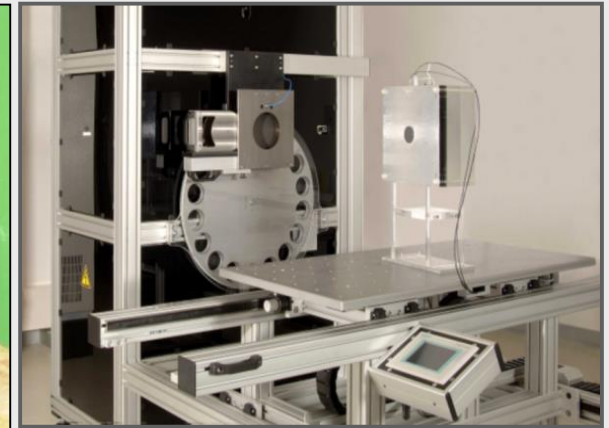


Examples

X-ray flash unit



Reference Facility at PTB

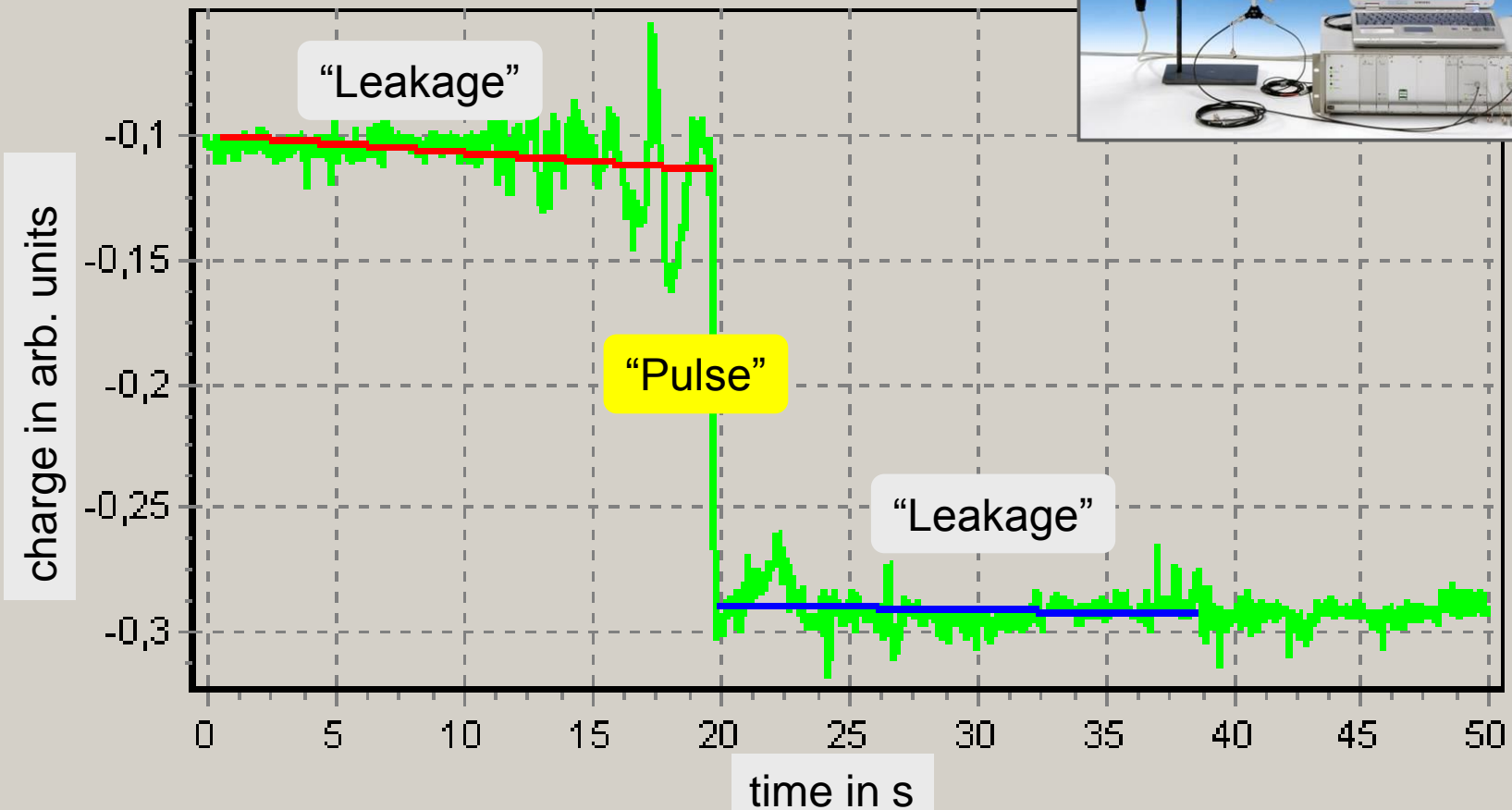


Characterisation: Measurement of pulse dose

Radiation produced charge could be in the order of those produced by other influences



Messkurve



Time-resolution about 100 ms

Next step: Standardisation



International
Organization for
Standardization

&



ISO 18090 TS: “Radiological Protection – Characteristics of reference pulsed radiation”

- Based on concept of ISO 4037: Adequate reference fields for testing instead of diverse workplace fields
- No definition of new radiation qualities necessary
- Definition and description how to measure the relevant parameters, e.g.
 - pulse duration
 - pulse dose rate
 - dose per radiation pulse

IEC 62743 TS: “Radiation Protection Instrumentation – Electronic counting dosimeters for pulsed fields of ionizing radiation”

- The concept is similar to that used for other influence quantities:
 1. Determination of the dosimeter’s parameter range
 2. Parameter range of the pulsed workplace field must be known
 3. User has to judge if the dosimeter can be used

- Electronic personal and area dosimeters may measure considerably wrong or even fail completely in pulsed fields
- Novel reference field for pulsed X-ray at PTB
- ISO 18090 TS “Radiological Protection – Characteristics of reference pulsed fields” (started)
- IEC 62743 TS “Radiation Protection Instrumentation – Electronic counting dosimeters for pulsed fields of ionizing radiation” (finished this year)

P02.260: Klammer, J. et. al: Novel Reference Field for Pulsed Radiation

P02.275: Zutz, H. et. al: Electronic dosimeters in Pulsed Fields ... IEC 62473

Physikalisch-Technische Bundesanstalt

Department 6.3 „Radiation Protection Dosimetry“
Bundesallee 100, D-38116 Braunschweig

O. Hupe et al., PTB: IRPA,
17.05.2012 Glasgow, UK

