A NEW DOSEMETER FOR MEASUREMENTS OF Hp(3) FOR MEDICAL STAFF

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MOTIVATION OF WORK

There is no dedicated eye-lens dosimeters, designed for correct measurements of Hp(3)

ORAMED project Work Package 2 “Development of practical eye lens dosimetry in interventional radiology”

Objective: “Design and development of new practical dosemeters that are suitable to respond in terms of Hp(3) (measurement of eye lens dose)”
GOAL

To design and develop a new TLD based dosemeter, which will fulfil the following conditions:

• measuring correctly Hp(3) for eye-lens
• comfortable for users and for dosimetric services
• waterproof
• inexpensive
DESIGNING OF THE DOSEMETER

To be universal, the dosemeter should have a modular construction.

the dosemeter will consist of two separate parts:

- Measuring element: capsule with TLD detector
- Holder: to fix position of the capsule close to eye
DESIGNING OF THE DOSEMETER

Characteristics to be optimized:
- energy response
- angular response

What may be varied:
- TLD detector type
- TLD dimensions
- Capsule material
- Capsule dimensions
DESIGNING OF THE DOSEMETER

Choice of TLD type

Two detectors types of different energy response available:

LiF:Mg,Cu,P (MCP-N)

LiF:Mg,Ti (MTS-N)
DESIGNING OF THE DOSEMETER

Choice of capsule material

A variety of available polymers:

- PMMA
- polyurethane
- polystyrene
- polyamide
- polyethylene
- PVC
- PTFE
- many others
DESIGNING OF THE DOSEMETER

Tools for optimization:

1) Computer simulations
2) Test measurements with X-rays
DESIGNING OF THE DOSEMETER

Computer simulations

Source - detector distance 1 m

Cylindrical phantom

Square (24x24cm) planar source, parallel beam

Monte Carlo code MCNPX
DESIGNING OF THE DOSEMETER

Computer simulations

Microdosimetric model of TL efficiency developed by Olko, *RPD 65, 1996*  
*RPD 99, 2002*

Relative TL efficiency of MCP-N for secondary electrons

![Graph showing relative thermoluminescent efficiency vs. Electron energy (MeV)]
DESIGNING OF THE DOSEMETER

Test measurements

Irradiations at CEA, Saclay, France

X-ray spectra: IEC RQR series, ISO narrow N series
DESIGNING OF THE DOSEMETER

Steps of dosemeter development:

1. Working model: only capsule, technology: cutting
DESIGNING OF THE DOSEMETER

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3. Final prototype
RESULTS

Simulations: various capsule materials

ISO narrow spectra
RESULTS

Simulations: TLD thickness

[Diagram showing the relationship between mean energy (MeV) and Hp(3) relative response for Polyamide with different TLD thicknesses: 0.90 mm, 0.15 mm, and 0.10 mm (two-layer pellet).]
RESULTS

Measurements
tests with capsule models made of various materials

- polyamide + MCP
- PVC + MCP
- PMMA + MCP
- polyamide + MTS

Mean energy [MeV]

RQR spectra
FINAL CHOICE

**TLD:**
MCP-N LiF:Mg,Cu,P
4.5 mm diameter, 0.9 mm thick

**Capsule:**
Polyamide, thickness 3 mm
Test X-ray irradiations of pre-prototypes at CEA, Saclay, France

Dosimeters on the water filled cylindrical phantom- 20cm height, 20 cm diameter

Irradiations with X-rays
RESULTS

Energy response

Calculated response:
- ISO narrow N-series spectra
- IEC RQR-4, RQR-7, RQR-9 spectra

Measured response:
- IEC RQR-4, RQR-7, RQR-9 spectra
- ISO N-30, N-80, N-120 spectra
- Cs-137

Photon energy [MeV]

Hp(3) relative response
RESULTS

Angular response

![Graph showing the angular response of Hp(3) relative response with different angles of radiation incidence for RQR4, RQR7, and RQR9.](image-url)
FINAL VERSION

EYE-D™ dosimeter
In frame of the FP7 ORAMED project, a new dosemeter *EYE-D™*, dedicated for measurements of eye-lens doses, has been developed.

The performed tests, proved that *EYE-D™* measures correctly \( \text{Hp}(3) \) within the relevant energy range. The dosemeter posses also a flat angular characteristic.

The *EYE-D™* dosemeter is produced and offered by the Radcard company.