Characterization of OSL and TL Dosimeters with Data Collected at the MT25 Cyclic Electron Accelerator

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Introduction

UHDpulse - Metrology for Advanced Radiotherapy using Particle beams with Ultra-High Pulse Dose Rates is a joint European research project aimed at developing novel dosimetry standards, as well as improving existing ones, for FLASH-RT, VHEE RT, and laser-driven medical accelerators.

A dedicated work package focuses on the development of traceable and validated methods for characterizing stray radiation fields which may deliver parasitic dose to healthy tissue and organs outside the targeted area. Secondary radiation fields have the same pulsed time structure of the primary beams. Additionally, they are composed of different types of particles with different energies. The various field components need to be identified, thus adding to the metrological difficulties.

The use of thermoluminescence (TL) and optically simulated luminescence (OSL) detectors in this context is being investigated. In Jan. 2020, a dedicated data-taking campaign was performed at the Microtron MT25 a cyclic electron accelerator in Prague, Czech Republic.

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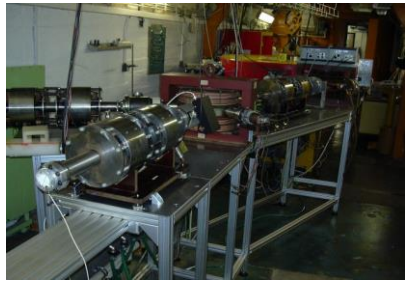
Microtron MT25

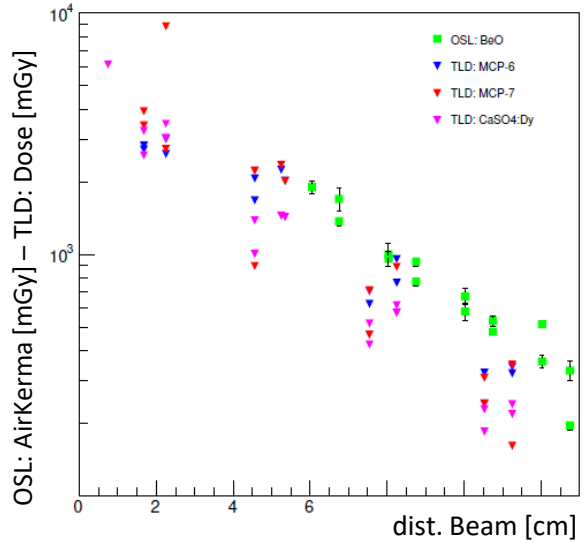
Pulsed high-current electron beams are produced and accelerated in a radio-frequency cavity. The electron beams have energies of up to 25 MeV, pulse length of 3.5 µs, repetition rate of 423 Hz, and a mean maximum current of 30 µA.



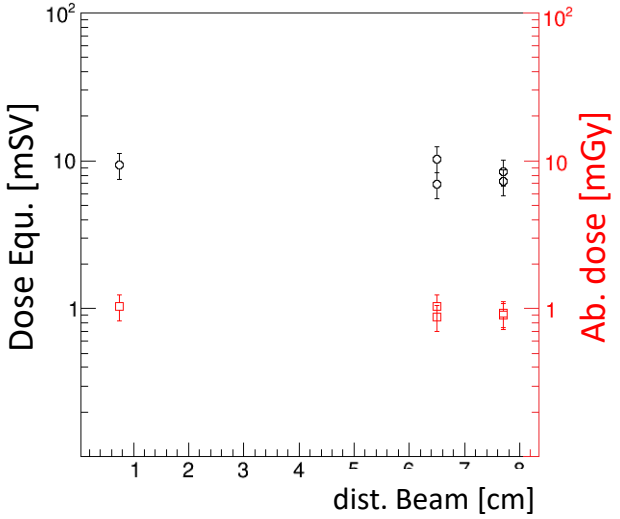
Experiments performed with conventional radiation beams allow to characterize the dosimeters in known and controllable radiation fields.

Experimental Setup

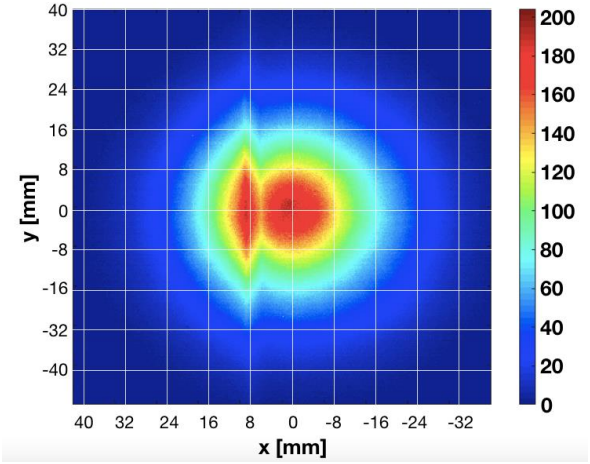
- 23 MeV electron beam
- PMMA phantom 25x25x1.3cm^3 in air
- Lead/iron bunker
- 7 different detector technologies
  - BeO OSL dosimeters
  - 3 different TL dosimeters
    - LiF:Mg,Cu,P doped Li-6
    - LiF:Mg,Cu,P doped Li-7
    - CaOS4:Dy
  - Columbian resin 39 (CR-39)
  - GAFChromic™ films
- 8cm PE moderator



OSL and TL response as a function of the distance from the beam axis.



Absorbed dose and dose equivalent measured by CR-39 nuclear track detectors



Dose measured by the GAFChromic™ film placed behind the PE moderator. The double-peak structure indicated a structural defect in the moderator.

Conclusions

OSL and TL dosimeters were characterized in pulsed mixed radiation fields at the Microtron MT25. A good agreement among the different detector technologies was seen. The recorded discrepancies are explained by different detector sensitivities, disuniformity in the geometrical setup, and structural defects of the shielding. The beam profile was studied using GAFChromic films, while heavy particle background was analyzed using CR-39 nuclear track detectors.

1. A. Schuller et al. Phy. Med. 80 (2020) 134-150
2. A. Mackova et al. Eur. Phys. J. Plus 136 (2021) 558
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Acknowledgements: This project 18HLT04 UHDpulse has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme.