Photon dose measurements with Thermoluminescence Detectors in mixed neutron-gamma radiation fields at the research reactor TRIGA Mainz

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With respect to a future application in the boron neutron capture therapy (BNCT) the photon dose distributions have been measured in a phantom of a simple geometry and free in air in the thermal column of the TRIGA Mainz [1].
The estimation of the photon dose in this mixed neutron-gamma radiation field has been carried out using thermoluminescence detectors (TLD) made of CaF_2:Tm (TLD-300) and detector pairs of LiF:Mg,Ti materials with different ^{6}Li concentrations and in different thicknesses. The thermal neutron response R_{th} of the detectors was measured at the Geesthacht Neutron Flux facility of PTB(GeNF) before [2,3].
The TLD-300, which is not tissue equivalent, but shows a negligible R_{th} value, measures the most reliable photon dose, provided that Bi filters are used in the thermal column, the amount of low energetic photons is low and do not overestimate the TLD-300 read out. For pairs of tissue equivalent LiF-detectors, the estimated photon dose is in good agreement with that of TLD-300, only for detectors with natural ^{6}Li concentration.
The other TLD types of LiF:Mg,Ti overestimate the photon dose in comparison to TLD-300. This is caused on the one hand by differences between the neutron spectra present at the TRIGA Mainz and at GeNF facility and on the other hand in the self absorption and the direction dependence of the detector response.
The photon dose contributions are estimated with TLD-300 in roll axis and diagonal axis in phantom and free in air over the whole length of the central radiation channel of the thermal column for reactor power from 10 W to 100 kW.
The ^{6}Li detectors with a high R_{th} value are used here to measure the thermal neutron flux. Thin layer detectors (0,1 mm) are in good agreement to measurements with gold foils.
The photon background of the reactor depends on the reactor irradiations at the day before and will be taken into account for low reactor power.

In conclusion the results show, that TLD-300 as well as LiF pairs optimized in thickness and fraction of ^{6}Li are able to estimate the photon dose component in the Bi shielded thermal column at TRIGA Mainz. Thin LiF detectors with a high fraction of ^{6}Li could be used to measure the thermal neutron flux.

Fig. 1 Phantom and tubes for the irradiation of TLDs in the thermal column.

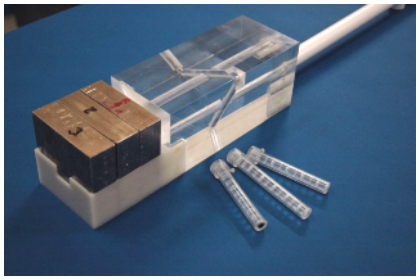


Fig. 2 Depth dose in phantom and free in air in the Thermal column at a reactor power of 100 W and with an irradiation time of 30 minutes

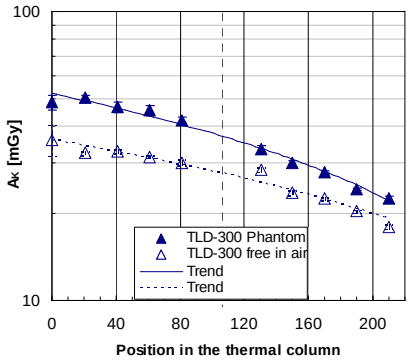
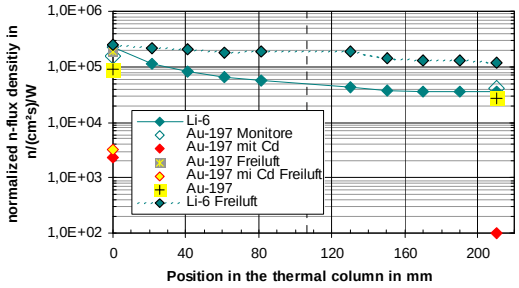


Fig. 3 Neutron Flux density measured with TLD 600 and gold foils in roll axis of the phantom and free in air normalized to the reactor power



References

[1] Ch. Krey, Messung des Anteils der Energiedosis in Wasser durch Photonen mit TLD in Neutronen-Strahlungsfeldern für die Bor-Neutroneneinfang-Therapie (BNCT), Diplomarbeit, September 2005
[2] Burgkhardt,B., et al., *Application of different TL-Detectors for the Photon Dosimetry in mixed Radiation Fields used for BNCT,* RPD Proceedings of the 14th Solid State Dosimetry Conf., New Haven, June 2004
[3] Ch. Krey, Kalibrierung verschiedener TLD-Arten in der Messgröße Energiedosis in Wasser durch Photonen, Studienarbeit II, Juli 2005.