Development of a Dosimeter for High Energy Photon Radiation

G. Fehrenbacher[1], A. Sokolov[1], T. Radon[1]

[1]GSI, Darmstadt, Germany

At high energy accelerators purpose-built dosimeters are necessary for the radiation survey in accelerator specific radiation fields. In recent years effort was dared to develop neutron dosimeters with an improved response to high energy neutron radiation. In this work a dosimeter is developed for the angular independent measurement of photon radiation in a wide energy range from about 100 keV up to 10 GeV or even higher energies. Basis of the dosimeter is a detection system using TL (**T**hermo**L**uminescence) and a design which is suitable to measure photon radiation in a conventional energy range (100 keV to some MeV) as well as for the high energy region. While for the conventional energy range only a PE scattering body around the TL cards can be used, for the high energy photons a metallic core has to be applied. The metallic core causes electromagnetic showers from the impinging high energy photons within the dosimeter and further energy deposition events in the TL elements occur. Figure 1 shows a picture of the dosimeter design. The dosimeter comprises 3 TL cards arranged as a triangle with 4 TL chips per card. In the center of the dosimeter a metallic core is mounted, consisting of 3 iron plates.

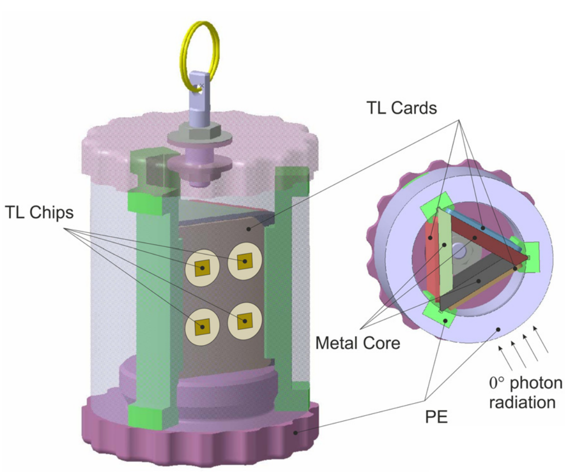

Figure 1: Design of the high energy photon dosimeter with a PE body, 3 TL-cards each with 4 chips and a metal core inside the dosimeter.

Response of the Dosimeter

The dosimeter is constructed for an optimized dose reading for high photon energies. Nevertheless the design of the dosimeter is appropriate to give a sufficient dose estimation in the lower photon energy region except for the energy range around 50 keV. The official dose quantity for area monitoring is the ambient dose equivalent H*(10). H*(10) is defined for the energy range from 10 keV to 10 MeV. For high energy accelerators photon energies higher than 10 MeV can occur and a conservative estimation of the effective dose is necessary. Therefore the effective dose for the isotropic irradiation was chosen as reference quantity. For the calculation of the dosimeter response a geometrical model was developed for FLUKA simulation calculations [1]. In figure 2 the response of the dosimeter irradiated along 0° direction (see fig. 1). For the predominant energy range from 10 keV to 10 GeV the dosimeter reading in isotropic irradiation geometry gives a conservative dose assessment either for the ambient dose equivalent or for the effective dose. The recommended energy range for application in photon fields is from 100 keV to 10 GeV or higher energies.

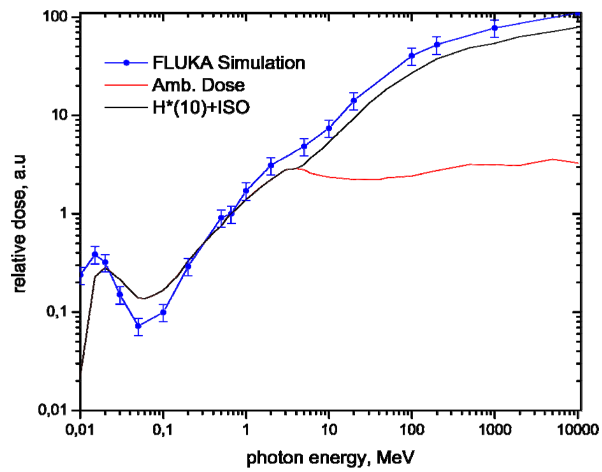

Figure 2: Calculated dosimeter response for the design of fig. 1 with 0° photon radiation incidence from 10 keV to 10 GeV.

Summary

A passive dosimeter using TL elements (3 cards with 4 TL chips per card) was developed for the high energy photon radiation. By means of metal layers inside the dosimeter the response to energetic photons is substantially improved. In the predominant energy range the dosimeter gives a conservative dose estimation with respect to the quantities H*(10) and the effective dose (ISO). The name of the dosimeter is *'**GA**mma dosimeter for **LIN**ear and Synchrotron Accelerators (**GALINA**)'*.

References

[1] www.fluka.org