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Development of High Spatial Resolution Dosimeter for Medical Uses by Colorimetric Discrimination Method

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It is of vital importance to measure accurately X-ray dose with high spatial resolution in medical radiation treatments. For that purpose, plastic scintillator detectors (PSDs) are often used, because good spatial resolutions can be achieved. The scintillation light from a PSD is, however, often contaminated by the Cherenkov light due to X-ray irradiation on the optical fiber particularly for high energy X-rays. One of the common methods of separating Cherenkov and scintillation light is a subtraction method, in which two identical optical fibers are tied together and a PSD is attached to only one of them. The difference in the light output from the two fibers can then be regarded as the scintillation light. This method requires two fibers tied together and works only with the assumption that the two fibers are exposed exactly to the same amount of irradiation. To overcome these difficulties, we have developed a PSD detector system by using a colorimetric discrimination method[1]. In our system, we attached a CMOS with a color filter array to one end of the optical fiber. The difference in the spectral shapes between Cherenkov and scintillation lights allows us to achieve the desired separation. Among the three given color components, red, green and blue, two of them are used for the estimation of the Cherenkov and scintillation lights, and the remaining information is used for the verification of our method. Since a CMOS has a large number of pixels, several optical fibers can be attached at the same time to a single CMOS, and we can measure simultaneously X-ray doses at different locations exposed to X-rays by using, for instance, 9 PSDs bundled together. Scintillators of 1 mm length and 1 mm diameter (Bicron BCF-60) are used to obtain high spatial resolution. We have performed demonstration experiments by using a Leksell Gamma Knife Perfexion and a Novalis Brain Lab.

1. Frelin, A.M., et al., Spectral discrimination of Cerenkov radiation in scintillating dosimeters. Med Phys, 2005. 32(9): p. 3000-6.

Has accepted

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