A portable test-bench for real-time radiation damage measurements in scintillating and wavelength-shifting fibres

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Motivation

A portable test-bench has been designed and constructed as part of the AIDA-2020 project\textsuperscript{[1]} to enable the real-time measurement of radiation-induced absorption in scintillating and wavelength-shifting fibres typically used in the readout of fibre calorimeters or scintillating tiles such as those used in some hadron calorimeters. The test-bench has been designed to be used in a range of facilities, such as \textsuperscript{56}Co irradiators or high-intensity test beam facilities, and can accommodate fibres with length up to 300 mm and diameter greater than 1.0 mm.

Test-bench Operation

Fibres are illuminated by a combined deuterium and halogen light source focussed onto the end of the fibre with a 0.25 NA radiation-tolerant quartz lens. Light transmitted by the fibre is collected by an identical lens and measured as a function of wavelength with a linear CCD spectrometer covering a wavelength range of 190 to 850 nm. We simulated the sensitivity to misalignment using ZEMAX\textsuperscript{[2]}.

Experimental Results

The result of a four-day continuous gamma irradiation, to a total dose of approximately 10 kGy, of a 3 mm diameter commercial polymethyl methacrylate (PMMA) rod that was highly absorbing prior to irradiation at wavelengths shorter than 390 nm due to a UV absorbing additive.

The result of a three-day continuous gamma irradiation, to a total dose of approximately 0.44 kGy, of a 3 mm diameter silica rod. Data are dark count corrected\textsuperscript{[3]}. The transmission dip near 725 nm is due to the 40 m of high-OH silica fibre in the total light path.

The major systematic error is the stability of the light sources which show peak variations of up to 1% between successive measurements taken at 120 s intervals or between repeated measurements taken 360 s after switching on the light sources from cold.

We considered the possibility to measure in real-time the effect of radiation on fluorescent properties of scintillating and WLS fibres.

Using an 80 ps 377 nm diode laser, a fast SiPM based photon detector and a PicoHarp 300 time correlator the effect of time dispersion via the large core diameter multi-mode fibre was investigated.

We used 10 cm (reference), 1 m and 20 m long optical fibres and measured the decay time constant of a fast plastic scintillator (polystyrene with PPO and PPOP fluor) at 20 °C.

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References: