Monitoring LSO/LYSO Crystal Based Calorimeters

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Because of their high stopping power ($X_0 = 1.14$ cm), fast ($\tau = 40$ ns), bright (4 times BGO) scintillation and superb radiation hardiness, cerium doped lutetium oxyorthosilicate (Lu$_2$SiO$_5$:Ce, LSO) and lutetium-yttrium oxyorthosilicate (Lu$_2(1-x)$Y$_2x$SiO$_5$:Ce, LYSO) crystals have attracted broad interest in the high energy physics community for future experiments. For example, LYSO crystals were chosen by the SuperB and Mu2e experiments to construct electromagnetic calorimeters (ECAL) with total absorption nature. LSO/LYSO crystals are also proposed as the active material for a Shashlik calorimeter which is currently an option for the proposed CMS forward calorimeter upgrade. Precision light monitoring is crucial for keeping excellent energy resolution promised by LYSO crystals in severe radiation environment. It is usually carried out by injecting light pulses around crystal’s emission peak, e.g. CMS at LHC [1], or around the excitation peak, e.g. PHENIX at RIHC [2].

In this paper, we discuss the wavelength choice for monitoring LYSO crystal based calorimeters. Five crystals of 20×20×200 mm$^3$ from different vendors were irradiated step by step from 100 rad to 1 Mrad with $\gamma$-ray sources. Longitudinal transmission, light output and its longitudinal response uniformity were measured at each step. Fig. 1 shows the monitoring sensitivity as a function of wavelength, which is defined as the ratio between the relative losses of the longitudinal transmittance and the light output, for five crystals. Fig. 2 shows a comparison between the average monitoring sensitivity and its rms with that obtained using excitation light (emission weighted longitudinal transmission or EWLT). The pros and cons of these two choices and their practical implementation will be discussed.

![Figure 1](image1.png)

Figure 1. Monitoring sensitivity is shown as a function of wavelength for 5 LSO/LYSO crystals.

![Figure 2](image2.png)

Figure 2. A comparison of the average monitoring sensitivity (red dots) and its rms (blue squares) as a function of wavelength with that using excitation.

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References