

Detection of high energy muons with sub-20 ps timing resolution using L(Y)SO crystals and SiPM readout

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Precise timing capability will be a key aspect of particle detectors at future high energy colliders, as the time information can help in the reconstruction of physics events at the high collision rate expected there. Other than being used in detectors for PET, fast scintillating crystals coupled to compact Silicon Photomultipliers (SiPMs) constitute a versatile system that can be exploited to realize an ad-hoc timing device to be hosted in a larger high energy physics detector.

In this work we present the timing performance of LYSO:Ce and LSO:Ce codoped 0.4% Ca crystals coupled to SiPMs, as measured with 150 GeV muons at the CERN SPS H2 extraction line. Small crystals, with lengths ranging from 5 mm up to 30 mm and transverse size of 2x2 mm² or 3x3 mm², were exposed to a 150 GeV muon beam. SiPMs from two different companies (Hamamatsu and FBK) were used to detect the light produced in the crystals. The best coincidence time resolution value of (14.5±0.5) ps, corresponding to a single-detector time resolution of about 10 ps, has been measured for 5mm long LSO:Ce,Ca crystals coupled to FBK SiPMs, when time walk corrections are applied.

The results obtained in this test improve our understanding of the several factors influencing time resolution in light based devices, e.g. light production and light transport, and confirm the potential of this technology for precise time measurements.

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