Impact of pixel crosstalk, after-pulse and recovery time in Multi-Pixels Photon Counter™ (MPPC) response

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The Tokai to Kamioka (T2K) near detectors will be instrumented with ~56,000 MPPCs to readout fibres embedded in scintillator bars. T2K will be the first experiment to use these novel silicon sensors in such a large scale.

The calibration and Monte Carlo simulation of the T2K near detectors rely on a very good understanding of the energy response of the MPPC.

This response is a non-trivial function of the number of pixel in the array due to pixel to pixel crosstalk and after-pulse (total fraction is ~20% at G=7.5x10^5 at 25 °C). Further complications arise with the recovery time of the device pixel being comparable to the fibre and hot carrier trapping decay constants. We studied these effects for MPPC excited with blue laser LED (463 nm) and Y-11 wavelength shifting fibre light to characterise the impact on energy measurements.
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We report a study of:

- Effects of crosstalk and after-pulse in charge integrated signals in the case of a Photon Detection Efficiency (PDE) measurement
- MPPC energy response
- Recovery effects with MPPC coupled to integrating amplifiers
- The impact of time distributed photons in MPPC response

PDE measured at 24 ºC for MPPC coupled to Y-11 fibre as a function of over-voltage using 2 methods to extract the mean value of photo-electrons: (blue) is Poisson mean (red) is Poisson zero probability (free from crosstalk and after-pulse)