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A Novel Method for Determining the Intrinsic Detector Resolution on Monolithic Crystals

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The aim of this work is to provide a method to retrieve the intrinsic resolution of PET detector blocks based on monolithic crystals. Estimating the intrinsic detector resolution is challenging, this resolution is limited by several factors that cannot easily be isolated and studied experimentally, for this reason many works focused on exploring the resolution limits through Monte Carlo simulations or other models.
The proposed method can be done in-situ, and it is validated against the approach of using bench-top set-up where the coincidence detector is moved backwards. In our set-up each detector block is composed of a monolithic LYSO crystal, two different crystal thicknesses have been studied. The detector exit face is coupled to an array of 16×16 SiPMs. The proposed method consists on a software collimation of the measured data and on an empirical equation that has been deduced to fit the experimental data in which the detector intrinsic resolution follows a Gaussian distribution whereas the source shape, given its small size, follows a Lorentzian profile. We have alternatively analyzed the measured source profiles for very tiny collimation angles, and the intrinsic detector resolution was deduced using Voigt functions (convolution of Gaussian and Lorentzian profiles).
The experiments resulted on a detector intrinsic spatial resolution of 0.6±0.1 mm and 0.7±0.1 mm in the case of 10mm and the 15 mm thick crystal, respectively. We found a good agreement between both methods. These tests show a method to determine the intrinsic resolution of monolithic-based detector blocks, with high accuracy.

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