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A large-area detector module based on SiPM and pixelated LYSO crystal arrays

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The optimization and characterization of a large area detector module, aimed at constructing a positron emission mammogram prototype, is presented. The device features a SensL ArrayC-60035-64P-PCB solid state detector (8x8 array of tileable SiPM by SensL, 7.2 mm pitch) covering a total area of 57.4×57.4 mm2. The array was tested using 10 mm thick, LYSO pixelated crystal arrays of different pitches (1.075, 1.683, 2.080, 2.280 mm) to determine the optimum, resolvable crystal size. With these results a detector module was developed using a 40x40 LYSO pixelated array, 1.43 mm pitch. A coupling light guide was used to allow light sharing between adjacent SiPM; 7 mm thickness was found to be the optimum for all crystal pitches. A 16-channel symmetric charge division readout board was designed to multiplex the number of signals from 64 to 16 (8 columns+8 rows) and a center-of-gravity algorithm to identify the position. Data acquisition and digitization was accomplished using a custom-made system based on FPGAs boards. Crystal maps were obtained using a Cs-137 source and Voronoi diagrams were used to correct for geometric distortions and to generate a non-uniformity correction matrix. All measurements were taken at a controlled room temperature of 22℃.The crystal maps showed minor distortion, 90% of the 1600 total crystal elements could be identified, a mean 3.1 peak-to-valley ratio was obtained and a 9.6% mean energy resolution for 662 keV photons was determined. The performance of the detector using our own readout board was compared to that using two different commercially readout boards using the same detector module arrangement. We show that these large area SiPM arrays, combined with a 16-channel SCD readout board, can offer high spatial resolution, excellent energy resolution and detector uniformity. We thank the support from PAPIIT-UNAM IN110616 and IN108615, Conacyt Problemas Nacionales 2015-612, PAEP-UNAM and Conacyt MSc scholarship.

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