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Gas Pixel Detectors and Beyond

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With the Gas Pixel Detector (GPD), the class of micro-pattern gas detectors has reached a complete integration between the gas amplification structure and the read-out electronics. To obtain this goal, three generations of application-specific integrated circuit of increased complexity and improved functionality has been designed and fabricated in deep sub-micron CMOS technology. This implementation has allowed manufacturing a monolithic device, which realizes, at the same time, the pixelized charge-collecting electrode and the amplifying, shaping and charge measuring front-end electronics of a GPD. A big step forward in terms of size and performances has been obtained in the last version of the 0.18 micron CMOS analog chip, where over a large active area of 15x15mm2 a very high channel density (470 pixels/mm2) has been reached. On the top metal layer of the chip, 105,600 hexagonal pixels at 50 micron pitch have been patterned. The chip has customable self-trigger capability and includes a signal pre-processing function for the automatic localization of the event coordinates. In this way, by limiting the output signal to only those pixels belonging to the region of interest, it is possible to reduce significantly the read-out time and data volume. In-depth tests performed on a GPD built up by coupling this device to a fine pitch (50 micron) gas electron multiplier or microchannel plates are reported. Matching of the gas amplification and read-out pitch has let to obtain optimal results. A possible use of this detector for X-ray polarimetry of astronomical sources and other imaging applications are discussed. Results from test of a fourth generation very large area ASIC working in counting mode will also be presented for the first time.

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