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Novel Gas-based Detection Techniques

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100 years ago, in Manchester, Hans Geiger operated the first gaseous detector, which was the basis for 'wire chambers', widely applied as track imaging in particle physics experiments.
In wire chambers gas amplification occurs, close to the wire surface, due to he strong (1/R) electric field. This enables the detection of the few single electrons created in the gas by ionisation radiation.

In Micro Pattern Gas Detectors, areas with a strong electric avalanche field are created by one or more conductive perforated planes (grid). The granularity of such a detector is determined by the hole pitch and can be much better in comparison to wire chambers.
With each grid hole equipped with its own readout channel (preamp, shaper, discriminator) in the form of an active pixel array in a CMOS chip, this micro-granularity is pursued: each hole is a stand-alone detector. This matches future demands on occupancy, position resolution and time resolution for high radiation trackers at future ILC, CLIC or sLHC colliders.
Chip manufacturing processes made two innovations possible: the integration of Micro Pattern Gas Detectors with pixels chips (Integrated Grid, InGrid), and the deposit of a high-resistivity protection layer on top of pixel chips. This 'wafer post processing' technology may enable next innovations such as micro channel plates and secondary emission foils.
Essentially, the application of gas as detection material, compared to, for instance, Si, offers several advantages, relevant for future tracking and imaging detector developments. For this, the development of TimePix-2, a new general-purpose pixel chip, is essential.

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