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Development and performance of a fast timing micro-pattern gaseous detector for future collider experiments and medical diagnostics

The fast timing MPGD (FTM) is a result of an ongoing effort for developing an MPGD with a time resolution under one nanosecond, while maintaining the excellent rate capability (tens of MHz/cm2) and the good space resolution (150 μm) of the present-generation micro-pattern gaseous detectors, whose reliability has been demonstrated at present colliders and ongoing upgrades of LHC experiments. The natural scope of application of the FTM would be in the instrumentation of areas in high-pileup environments at future collider experiments, such as in muon systems or as calorimeter readout. In medical imaging, the FTM is being studied as a possible affordable detector for PET using time-of-flight methods.
This presentation starts by formulating the working principle of the FTM, whose geometry is made of a stack of decoupled ionization layers, each with its own amplification structure; the improved time resolution is guaranteed by the competition in the arrival times of the signals due to the different ionization clusters created by an incident charged particle in each layer. Maintaining good signal transparency across the entire detector requires a fully resistive structure; the latest advancements in the manufacturing of GEM foils with DLC coating have been implemented, and additional techniques are being explored. The development of the FTM will be described with focus on the most recent results of the latest FTM prototype assembled, summarizing the laboratory measurements on gain, choice of operating gas mixture, efficiency and time resolution; an overview on the most challenging aspects of the FTM R&D will also be given, including the requirements of a fast, low-noise readout electronics, the setup of a high-precision test stand for gain and signal transparency measurements and the necessity for new methods for the simulation of signal formation in resistive detectors.

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