Contribution ID: **73** Type: **not specified**

High-precision timing for high-rate environments with Micro-Pattern Gaseous Detectors

The use of fast timing detectors (~10 ps) is crucial for the exploitation of the full potential of the future LHC operation at the highest luminosity. Ongoing R&D on Avalanche PhotoDiodes (APD) and Low Gain Avalanche Diodes (LGAD) has shown that a timing precision of ~30 ps is possible with small size prototypes. However there are issues with the radiation hardness of such devices that needs to be addressed. Concerning the state-of-the art gaseous detectors, RPCs show excellent timing properties (<30 ps) but suffer from rate limitations (maximum few kHz); on the other hand, the MPGDs that are ideal for high rate environments, have a limited time resolution in the order of few ns due to the nature of the interaction of the particles with the detector gas and the electron diffusion mechanism.

We present here a Micromegas based solution that bypasses these limitations and offers an improvement of the established timing performance of MPGDs by ~2 orders of magnitude. The Micromegas acts as a photo-multiplier coupled to a Cerenkov-radiator, aiming to provide a timing resolution of about ~20 ps per incident particle. A prototype has been built in order to demonstrate this performance. The first laboratory tests with a femto-second UV laser have shown a time resolution of 27 ps for ~40 photoelectrons, or ~180 ps per photoelectron. First results with 150 GeV muons are showing time resolution better than 50 ps (data taking & analysis in progress).

In order to improve the aging properties of the solid photocathodes, diamond based secondary emitters are examined as an alternative to the radiator-photocathode setup, while the option of using photocathodes with a graphene protection layer is also being considered.

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