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High-Rate Fast-Time GRPC for the high eta CMS muon detectors

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With the increase of the LHC luminosity foreseen in the coming years many detectors currently used in the different LHC experiments will be dramatically impacted and some need to be replaced. The new ones should be capable not only to support the high particle rate but also to provide time information to reduce the data ambiguity due to the expected high pileup.

RPC using low-resistivity materials are proposed to equip the very forward region of the CMS detector. In their single-gap version they can stand rates of few kHz/cm2. This was checked in two beam tests, first at DESY in 2012 and then at the CERN PS in August 2014 and will be tested in June 2015 at SPS on RPC using low resistivity glass.

The single-gap can also allow to reduce the noise contribution by providing a good timing measurement (of the order of 1 ns) and hence it improves the trigger rate but for this a TDC is needed. A new Printed Circuit Board (PCB) with 2.5 mm pitch strips on both sides was conceived. The strips that are read out by the HARDROC ASIC and the NOR64 signal of the 64 channels of each of the 4 ASIC was used to read out the strips were used to record the signal timing. The timing measurement at the CERN PS as well with the cosmic bench in laboratory shows a time resolution of few nanoseconds. Another feature obtained with such PCB is the spatial resolution such a detector could provide. Resolution better than 2 mm was indeed obtained.

A more sophisticated PCB with strips of 4 mm pitch read out on both sides thanks to another ASIC called PETIROC featuring an excellent timing behaviour was conceived and produced. A TDC with a time resolution of 25 ps is to be used. The strips are read out from both ends. Preliminary results on this PCB show excellent time resolution (< 50 ps).

The PCB will be inserted between two large GRPC detectors built by combining small pieces of glass. Two kinds of these detectors were built. One was obtained by gluing small pieces of glass to build large plate (the glass limitation of 30x30 cm2 is due to the fabrication procedure). The second was produced by assembling mechanically the glass pieces inside a gas-tight cassette. Both were tested and found to have excellent efficiency.

The comparison between the two kinds will allow to choose the procedure to propose for the CMS TDR. In addition to the single-gape R&D, another activity on the multi-gap version is being followed. The multi-gap GRPC can do indeed better in both the particle rate detection and the time precision measurement. Time precision of better than 150 ps could be obtained. This aims at reducing the ambiguity the expected high pileup will introduce. Both construction techniques developed for the single-gap version are being followed for the multi-gap as well Also the same electronics developed for the single gap GRPC will be used to test the multi-gap.

Both single gap and multi-gap detectors were tested at the GIF++ facility to check their robustness in a very aggressive irradiation environment as the one to prevail in the high eta region of the CMS detector. Further tests are planed.

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