Performance of small-diameter muon drift tube chambers with new fast readout ASIC at high background rates

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Experiments like ATLAS at the HL-LHC or detectors at future hadron colliders need muon detectors with excellent momentum resolution at the percent level up to the TeV scale both at the trigger and the offline reconstruction level. This requires muon tracking chambers with high spatial resolution even at the highest background fluxes. Drift-tube chambers are the most cost effective technology for the instrumentation of large-area muon systems providing the required high rate capability and three-dimensional spatial resolution. Thanks to the advances in analog and digital electronics, the new generation small-diameter Muon Drift Tube (sMDT) detectors with 15 mm tube diameter can be used in stand-alone mode up to the background rates as high as expected at future hadron collider experiments, providing event times and second coordinates without the necessity of additional trigger chambers. New key developments in the integrated front-end electronics are fast baseline restoration of the shaped signal and picosecond time-to-digital converters for second coordinate measurement with double-sided read-out of the tubes. Self-triggered operation has become possible using modern high-performance FPGAs allowing for real-time pattern recognition and track reconstruction. A new amplifier shaper discriminator chip in 65 nm TSMC CMOS technology with increased sensitivity and faster baseline recovery has been developed to cope with very high background fluxes. Extensive test beam campaign using sMDT chamber equipped with new readout electronics has been performed at the CERN Gamma Irradiation Facility (GIF++). The results which will be discussed in this contribution shown that thanks to the shorter peaking time of the new chip, in comparison to its predecessor, leads to an enhancement in the spatial resolution of the drift tubes by up to 100 μm up to a background rate of 1 MHz which is the maximum rate expected at the 100 TeV collider experiment.