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Small-Strip Thin Gap Chambers for the Muon Spectrometer Upgrade of the ATLAS Experiment (12' + 3')

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The instantaneous luminosity of the Large Hadron Collider at CERN will be increased up to a factor of five with respect to the design value by undergoing an extensive upgrade program over the coming decade. Such increase will allow for precise measurements of Higgs boson properties and extend the search for new physics phenomena beyond the Standard Model. The largest phase-1 upgrade project for the ATLAS Muon System is the replacement of the present first station in the forward regions with the so-called New Small Wheels (NSWs) during the long-LHC shutdown in 2019/20. Along with Micromegas, the NSWs will be equipped with eight layers of small-strip thin gap chambers arranged in multilayers of two quadruplets, for a total active surface of more than 2500 m^2. All quadruplets have trapezoidal shapes with surface areas up to 2 m^2. To retain the good precision tracking and trigger capabilities in the high background environment of the high luminosity LHC, each sTGC plane must achieve a spatial resolution better than 100 μm to allow the Level-1 trigger track segments to be reconstructed with an angular resolution of approximately 1mrad. The basic sTGC structure consists of a grid of gold-plated tungsten wires sandwiched between two resistive cathode planes at a small distance from the wire plane. The precision cathode plane has strips with a 3.2mm pitch for precision readout and the cathode plane on the other side has pads for triggering. The position of each strip must be known with an accuracy of 30 µm along the precision coordinate and 80 µm along the beam. On such large area detectors, the mechanical precision is a key point and then must be controlled and monitored all along the process of construction and integration. The pads are used to produce a 3-out-of-4 coincidence to identify muon tracks in an sTGC quadruplet. A full size sTGC quadruplet has been constructed and equipped with the first prototype of dedicated front-end electronics. The performance of the full size sTGC quadruplet has been studied at the Fermilab (May 2014) and CERN (October 2014) test beam facilities to study spatial resolution and trigger efficiencies. We will describe the technological novelties, production challenges, performance and test results of the sTGC detectors. The status of the project and the plan for the completion will also be discussed.

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