INTEGRATION AND COMMISSIONING OF THE ATLAS MUON-TRIGGER SYSTEM, TGC*

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(Received November 29, 2007)

Thin Gap Chamber (TGC) is a technology which is used in the endcap region of ATLAS spectrometer for triggering muons. On both sides of the interaction point, three disc-shaped stations with a diameter of 24 m are placed. Each station consists of 12 sectors, in total 72 sectors are assembled on the surface and integrated in the ATLAS cavern. The sector assembly project started in March 2005 and completed in August 2007. All six discs were integrated by the end of September 2007. The commissioning task for the assembled sector was performed intensively, as a result, the rate of dead channel was controlled at the level of 10^{-4}, and all chambers are working stably with normal operation condition in the pit.

PACS numbers: 29.40.Gx

* Presented at the Symposium "Physics in Collision", Annecy, France, June 26–29, 2007.
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The ATLAS experiment at the Large Hadron Collider (LHC) has a characteristic muon spectrometer with toroidal magnetic-field for the purpose of stand-alone tracking and a momentum selective trigger. The trigger system covers the pseudo-rapidity range of $|\eta| < 2.4$ and its endcap region is covered by Thin Gap Chamber. The trigger logic is based on coincidence between 7 layers and according to the hit pattern between them, momentum is roughly estimated and a number of trigger candidates is sent to the central trigger with information of evaluated momentum and hit location.

The basic structure of TGC is a Multi Wire Proportional Chamber (MWPC) with a graphite cathode having a surface resistivity of 1 MΩ per square. The distance of anode wire and cathode strip is 1.4 mm, smaller than the space between anode wires of 1.8 mm. The diameter of anode wire is 50 micron to give high electric field for over all space in the cell. The gas mixture is CO_2 (55%) and n-Pentane (45%) which has strong quenching qualities to avoid the production of streamers. The timing jitter is less than 25 nsec corresponding to the bunch space of LHC. The hit signals are read from both anode wires and cathode strips made of a copper foil arrayed in orthogonal to the wires. Each chamber has an effective area of 1 to 2 m^2, and two or three single layers are glued as doublet or triplet unit. In total 3600 chambers were produced in Israel, Japan, and China.

All the chambers were tested with cosmic-rays under normal operation condition and the overall efficiency was measured. The cut criteria was set to the layer efficiency of 95% , and most of the chambers have efficiency better than 99% in the active region. About 70% of the chambers were tested with high rate gamma-ray flux of 200 to 1000 Hz/cm^2 depending on the η region to be installed. The operation stability and comparison of leak current, single rate before and after irradiation were checked. After the shipment to CERN, again all chambers were operated for 3 weeks.

Finally chambers are installed into fan-shaped mechanical structure which forms a 1/12th of the station. The structure is made of aluminum, 10 I-profiles length of 10 m, 8 rectangle transversal-bars and one thick outer beam. These pieces are aligned with a precision of 2 mm within the tolerance for the connection between sectors. All the services, gas tubes, signal cables, HV cables, trigger cables (CAT6), LV cables, CAN control cables, slow monitor cables and their support structures are installed in the first stage. The on-sector trigger electronics for taking the first coincidence are mounted on the same structure. Then 22 chambers are installed and each service is connected to them.

The final commissioning on the surface is performed using test pulses and cosmic-rays. The functionality of the chain Amplifier-Shaper-Discriminator on chambers, followed by the signal cables and on-sector electronics is verified by test pulses injected at the ASD. Following this test, the chambers

are made operational by turning the HV and cosmic-ray data is taken in a self-trigger made by a coincidence of multi layers. The hit-profile, noise level and functionality of the trigger path are checked in situ. All 72 sectors were tested and installed in the ATLAS experiment. The rate of dead channels was found to be at the level of 10^{-4} for the 320 k channels of the system.

REFERENCES

[1] ATLAS Muon Spectrometer Technical Design Report, CERN/LHCC 97-22, CERN 1997.