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# The CMS Muon system

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The CMS (Compact Muon Solenoid) is one of the detectors designed to study the future p-p interactions of the LHC (Large Hadron Collider) accelerator at CERN. Muons from p-p collisions are expected to provide clean signatures for many of the interesting processes which will be studied at LHC. CMS has put a big emphasis on developing a highly efficient muon system. It consists of four layers of concentric stations integrated in the return yoke of the 4T superconducting solenoid. This system will allow identification, track reconstruction and trigger of muons with momenta from a few GeV to a few TeV. It uses three different technologies of gaseous detectors:
For the barrel region, where the expected particle rates are low and the magnetic field will not be too high, Drift Tube Chambers (DT) have been chosen. The chambers are made by three independent subunits called SuperLayers (SL) ($2\Phi$, $1\theta$) consisting on 4 layers of drift tubes staggered by half a cell. In addition to the anode wire and two I-beams with aluminium strips forming the cathodes, the cell design incorporates two aluminium strips facing the wire which shape the electric field and improve the linearity in the space-time relation. Each cell has a resolution $<250\mu m$ thus ensuring a resolution $<100\mu m$ per station. The tests performed in presence of magnetic field showed that the degradation in the performance is not significant for the values expected in CMS. Efficiencies per cell bigger than 99% were obtained.
Chamber electronics include a local trigger system. At the SL level, the Bunch and Track Identifier identifies the position, angle and time of passage of the particle by using a meantimer technique. It provides an efficient local standalone bunch crossing identification. The two $\Phi$SLs are combined in a Track Correlator which reduces the noise and improves the angular resolution to 10mrad.
For the endcaps Cathode Strips Chambers (CSC) will be better suited: they must operate with high rates, and, in addition, the magnetic field will not be uniform and can reach 3.5 Teslas. The chambers consist of 6 detecting layers, with strips in the radial direction providing precise position measurement on the bending plane (resolutions better than 75 micron can be achieved), and wires perpendicular to them providing measurement in the radial direction and giving timing information. Chambers are equipped with trigger electronics. Muon segments are first found separately by anode and cathode electronics and then time correlated. A Local Charged Track

(LCT) is formed when a coincidence of ≥4 hit strips (CLCT) or wires (ALCT) in different layers, belonging to a predefined road occurs. Cathode trigger is optimised to measure Φ precisely and anode trigger is optimised for high efficiency bunch crossing identification A third detector, Resistive Plate Chambers (RPC), located both in the barrel and in the endcaps, provides a redundant and complementary trigger. The RPC are gaseous detectors made by two resistive parallel plates (Bakelite) separated by a few millimetres gas gap. It can operate in streamer or in avalanche mode but the streamer mode is not adequate for LHC because the rate capability in this case is limited ˜100Hz/cm2. The RPC design on CMS is made of two gaps, with common pickup strips in the middle to enhance the signal. To improve the rate capability Bakelite with "low" resistivity has been chosen. An excellent time resolution below 3ns, even at very high rates, is achieved. RPC trigger is performed by the Pattern Comparator Trigger. It requires a temporal coincidence of hits in at least 3 muon stations and compares the observed hit patterns with predefined valid patterns with defined pT. The bunch crossing is determined by the time coincidence of hits.

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