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Measurement and simulation of the background at the CMS muon detectors

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The CMS muon system presently consists of three detector technologies equipping different regions of the spectrometer. Drift Tube chambers (DT) are installed in the central region, while Cathode Strip Chambers (CSC) cover the high pseudorapidity regions; both serve as tracking and triggering detectors. Moreover, Resistive Plate Chambers (RPC) complement DT and CSC in barrel and end-caps respectively and are used in the trigger. Finally, Gas Electron Multiplier (GEM) chambers are getting installed in the muon spectrometer end-caps at different stages of the CMS upgrade programme. The study of the different backgrounds the muon detectors are exposed to, is fundamental to assess the system longevity and project its performance to the conditions expected for HL-LHC. In this respect, an accurate modelling of the backgrounds in simulation is of prime importance as many studies rely on simulation-based predictions while these future conditions have never been experienced in reality. The state of the art of the work carried out to understand backgrounds observed with data collected during the LHC runs, as well as at CERN high-intensity gamma irradiation facility, (GIF++), will be presented. Furthermore, the effort made to improve the accuracy of Fluka and GEANT4 based simulations of background will be thoroughly described.

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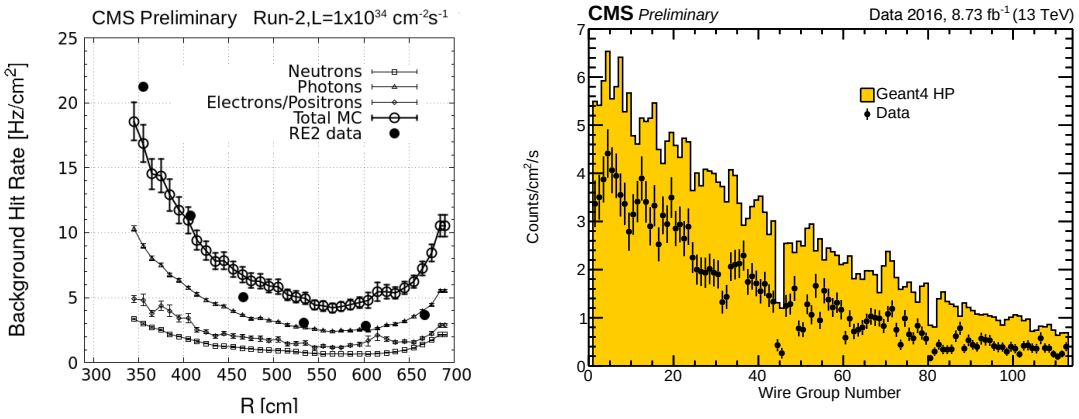
1. Introduction

The High Luminosity LHC (HL-LHC) upgrade is planned to extend the capability for new physics searches and precision measurements. The maximum instantaneous luminosity is expected to increase up to $7.5 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$, with the average number of pileup interactions per event is expected to be around 200 (in the ultimate scenario). To keep the current performance in the forward region, there are ongoing upgrades planed for the CMS muon system including several upgrades of the electronics for presently installed detectors and the installation of new detectors in the forward region (details in Ref. [2]).

2. Background of CMS Muon system

The CMS muon detector performance groups made a comparison of simulation and data from the data collected during Run2. This step is an essential validation of simulation to constrain the prediction for HL-LHC. The simulation has a maximum factor of 2 difference compared to data in the CSC and RPC cases, as shown in Fig. 1.



(a) (b)

Figure 1: (a) : Comparison of background hit rate between FLUKA simulation and RPC measurements for the second RPC endcap station. The MC predicted hit rate has been evaluated as a convolution between the particle fluxes, obtained with FLUKA and detector sensitivities to different particle types from a GEANT4 simulation. (b) : thermal-neutron induced anode wire hits from CMS data collected during LHC p-p collisions in 2016 by the inner ring of the CSC second station (ME2/1) (black points). CMS data are compared to the full GEANT4 simulation (yellow bars).

References

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