PROCEEDINGS OF SCIENCE

Measurement of the Muon Charge Asymmetry in the $pp \rightarrow W + X \rightarrow \mu\nu$ process at $\sqrt{s} = 14$ TeV

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We present estimates for the measurement of the muon charge asymmetry in $W \rightarrow \mu\nu$ events with the Compact Muon Solenoid (CMS) at the Large Hadron Collider (LHC). We consider proton-proton collisions at center of mass energy $\sqrt{s} = 14$ TeV for integrated luminosities in the range from 10 to 100 pb^{-1}. The muon charge asymmetry is studied up to 2 units of muon pseudo-rapidity, $|\eta| < 2$.

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1. Introduction, Signal Selection and Background

The muon charge asymmetry in the $pp \rightarrow W + X \rightarrow \mu\nu$ process is a clean observable at the LHC.

$$A(\eta) = \frac{\frac{d\sigma}{d\eta}(W^+ \rightarrow \mu^+\nu_\mu) - \frac{d\sigma}{d\eta}(W^- \rightarrow \mu^-\bar{\nu}_\mu)}{\frac{d\sigma}{d\eta}(W^+ \rightarrow \mu^+\nu_\mu) + \frac{d\sigma}{d\eta}(W^- \rightarrow \mu^-\bar{\nu}_\mu)} \tag{1.1}$$

It is directly sensitive to parton density function (PDF) for u and d-quarks, as already observed at the Tevatron [1]. This study is based on Monte Carlo full simulations of the CMS detector. For the estimate of PDF uncertainties, we employ a reweighting method according to the recommendations of the Les Houches Accord [2].

We have considered five background contributions to the signal: Drell-Yan, $t\bar{t}$, $W \rightarrow \tau\nu$, $W \rightarrow e\nu$ and $pp \rightarrow \mu\nu X$ (QCD). Main selection cuts are [3]:

- $p_T^\mu > 25$ GeV
- $|\eta^\mu| < 2$
- Muon Isolation: $\sum p_T^{calo}/p_T^\mu < 0.09$ GeV (in a cone $\Delta R < 0.03$)
- Invariant mass of the muon and event transverse energy unbalance, $M_{\mu-MET} \in [50, 200]$ GeV

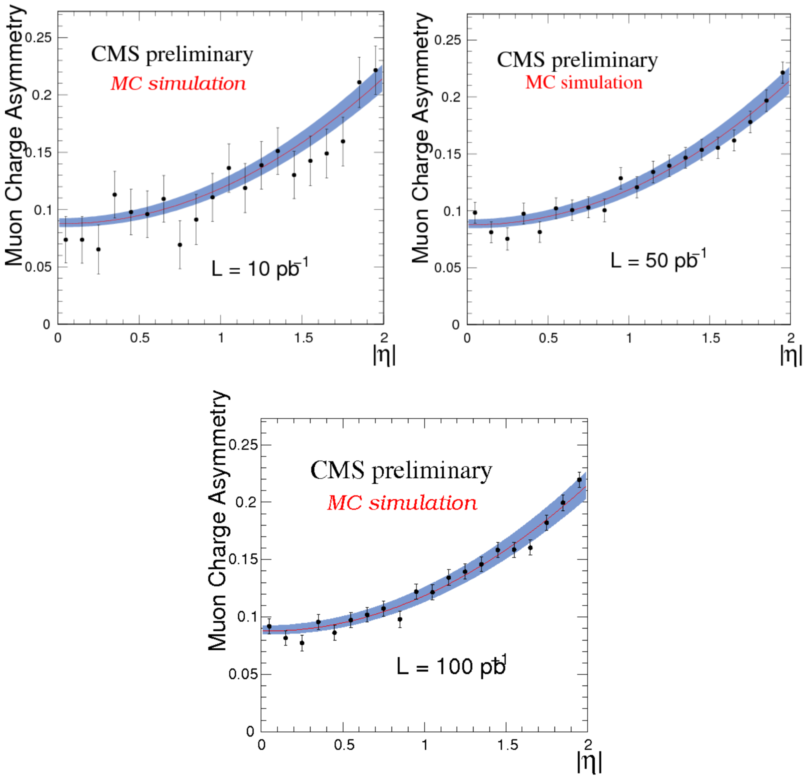

Figure 1: Muon charge asymmetry distributions for simulated samples at different integrated luminosities: up-left) 10 pb^{-1}, up-right) 50 pb^{-1} and bottom) 100 pb^{-1}. The blue band represents the size of the PDF uncertainties (CTEQ6). Only statistical uncertainties are included in the simulated experimental points.

2. Muon Charge Asymmetry

Background contributions of the measured muon charge asymmetry are subtracted in order to extract the asymmetry of the signal component [4]. Only statistical uncertainties are considered for the experimental points.

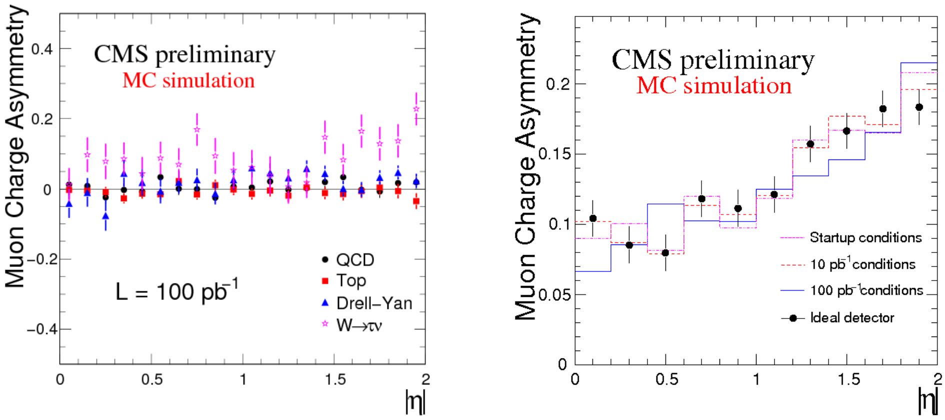

Figure 2: Left: Asymmetries for each of the background contributions. Right: Muon charge asymmetry for the $W \rightarrow \mu\nu$ signal for different calibration/misalignment scenarios: start-up, 10 pb^{-1}, 100 pb^{-1} and ideal detector conditions are shown. Only $\sim$ 10 pb^{-1} of integrated luminosity are considered in the comparisons.

Possible systematic uncertainties due to misalignment and miscalibration have a negligible effect within the available statistics, as shown in Figure 2.

3. Conclusions

Muon charge asymmetry is a robust observable, relatively free from systematics effects, and possess an *easy* and clean experimental signature which can be asserted at the level of few percent –depending on the η range– from the very earliest data taking period. With about 50 pb^{-1} of luminosity, muon charge asymmetry will start to constrain the current PDF sets and therefore improve them; with 100 pb^{-1}, an asymmetry measurement with few percent accuracy will be achieved.

References

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