Chapter 6

Conclusions

We have made an investigation to find a possibility of measuring the luminosity of the LHC through the weak bosons production channels $q\bar{q} \rightarrow W^+W^- \rightarrow \mu^{\pm}\nu_{\mu}(\bar{\nu}_{\mu})$ and $q\bar{q} \rightarrow Z^0Z^0 \rightarrow 2\mu^+2\mu^-$. We have focused our study on muons because they are the primary particles that the CMS detector is designed to exploit. Our investigations are divided into three parts: 1) the potential background study, 2) the effect from CMS muons detection efficiency and 3) the effect from CMS muons reconstruction system efficiency. In background analysis, the background candidates are the Drell-Yan process, $q\bar{q} \rightarrow \gamma^*\gamma^* \rightarrow \mu^+\mu^-$, $q\bar{q} \rightarrow \gamma\gamma \rightarrow \mu^+\mu^-$ and minimum bias process.

After all processes were passed through the full chain of the CMS simulation, we found the following results:

1. The Drell-Yan process is the most potential background of the $W^{\pm}$ and Z^0 production. This is because muons from the Drell-Yan process possess sufficiently high transverse momentum that can be mistaken as our signal of $W^{\pm}$ and Z^0.

   On the other hand, other background processes: $q\bar{q} \rightarrow \gamma^*\gamma^* \rightarrow \mu^+\mu^-$, $q\bar{q} \rightarrow \gamma\gamma \rightarrow \mu^+\mu^-$ and minimum bias are low-transverse momentum background. A cut on $P_T > 6$ GeV/c will completely remove them from the signal of $W^{\pm}$ and Z^0.

2. Within the Z^0 mass window ($75 < M_{\mu^+\mu^-} < 105$ GeV/c^2), we found that there is 14% contamination of the Drell-Yan process.

3. In reconstruction efficiency, we obtain 91.28% efficiency of reconstruction of Z^0's muons. This number is in agreement with the $> 90\%$ efficiency expected

in the CMS Trigger and Data Acquisition system. However, the efficiency for reconstructing muons from $W^{\pm}$ is only 66.83%. The problems could arise from computer bugs or programming error in stages of the simulation chain or reconstruction, for which I do not know the solution. This low efficiency could cause high uncertainties in luminosity measurement. More investigatións is needed.

The work in this thesis is a first approach to see how the CMS detector's detecting and reconstructing capability effect on the luminosity estimation using the $W^{\pm}$ and Z^0 particle production. It also shows the percentage of Drell-Yan background contamination to the count of the Z^0 for luminosity measurement. The work was dóne on available version of OSCAR and ORCA at the time; as of now the two softwares should have been much improved. With very limited time, only small number of events were able to be processed. Therefore, for the future work, we propose to run more simulated and digitized event using newer versions of OSCAR and ORCA to obtain better statistical results and more accuracy. Furthermore, a different Parton Distribution Functions and types of event generators can also be applied to see how the outcome will be depended on them.