論文内容の要旨

論文題目　Measurement of the Weak Boson Production Cross Section in the Events with Muons in Proton-Proton Collisions at $\sqrt{s} = 7$ TeV with the ATLAS Detector
(アトラス検出器を用いた重心系エネルギー **7TeV** での陽子・陽子衝突におけるミューオンを伴う事象でのウィークボソンの生成断面積の測定)

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The Large Hadron Collider (LHC) – a proton-proton collider with the highest center-of-mass energy which surpasses the previous energy frontier – was built at CERN to investigate the TeV energy region where the existence of undiscovered physics such as the origin of the electroweak symmetry breaking and the Supersymmetry is expected. The LHC started operation on 30 March, 2010, then has been delivering proton-proton collision events.

The ATLAS (A Toroidal LHC ApparatuS) experiment is held using one of the two general purpose detectors placed at the LHC. The detector is designed to exploit the full physics potential of the LHC.

In this thesis, a measurement of the W and Z-boson production cross sections in proton-proton collisions at $\sqrt{s} = 7$ TeV are presented in the $W \to \mu\nu$ and $Z \to \mu\mu$ processes using the data collected with the ATLAS detector. The integrated luminosity used in the $W \to \mu\nu$ analysis is 310 nb^{-1} and in the $Z \to \mu\mu$ analysis is 331 nb^{-1}.

This production cross sections measurement is particularly significant in two aspects. One is to provide the first test of QCD prediction on the distribution of partons in proton-proton collisions at $\sqrt{s} = 7$ TeV. This will constitute a solid basis for every physics analysis performed in the ATLAS experiment. The other is to establish an event selection criterion for $Z \to \mu\mu$ process. This process plays a central role in the precise calibrations of detectors and algorithms for its ease of identification and the precise knowledge of the Z-boson mass and width.

The muon detection efficiency of the ATLAS detector is estimated using experimental data. The muon trigger efficiency is estimated by counting the number of muon trigger signatures on the path of a given reconstructed muon track. The data taken by triggers based on the calorimeter information are used to avoid trigger biases. The muon reconstruction efficiency is estimated with respect to a track reconstructed in the inner tracking detector. In the estimation, about half the number of the layers in the muon spectrometer are required to be fired on the

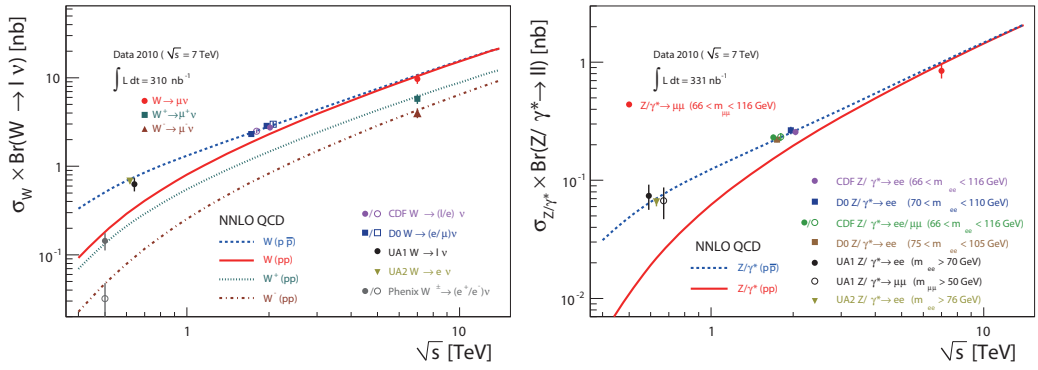
extrapolated path of a given inner detector track to reject non-muon backgrounds.

The results of both efficiency estimations are confirmed by other independent estimation using muons in $Z \to \mu\mu$ process. This estimation provides the first trial of the detector performance measurement utilizing $Z \to \mu\mu$ process in the ATLAS experiment.

The results of the cross sections measurement are as follows.

$$\begin{aligned}
\sigma_W \times BR\,(W \to \mu\nu) &= 9.57 \pm 0.31\ (\text{stat}) \pm 1.15\ (\text{syst})\ \text{nb}. \\
\sigma_{W^+} \times BR\,(W^+ \to \mu^+\nu) &= 5.69 \pm 0.23\ (\text{stat}) \pm 0.69\ (\text{syst})\ \text{nb}. \\
\sigma_{W^-} \times BR\,(W^- \to \mu^-\nu) &= 3.87 \pm 0.20\ (\text{stat}) \pm 0.47\ (\text{syst})\ \text{nb}. \\
\sigma_Z \times BR(Z \to \mu\mu) &= 0.87 \pm 0.08\ (\text{stat}) \pm 0.12\ (\text{syst})\ \text{nb}.
\end{aligned}$$

1181 W-bosons and 109 Z-bosons are observed in data. The $\sigma_W \times BR\,(W \to \mu\nu)$ is measured with a transverse mass cut of $M_{\mathrm{T}} > 40$ GeV and $\sigma_Z \times BR\,(Z \to \mu\mu)$ is measured within an invariant mass window of $66 < m_{\mu\mu} < 116$ GeV. All the results are in agreements with the theoretical prediction including next-to-next-to leading order QCD corrections. Comparisons between the measurement results and theoretical predictions are shown in Figure (a) and (b). (a) is for the $W \to \mu\nu$ and (b) is for the $Z \to \mu\mu$, respectively. The results of the previous experiments are also shown.



(a) (b)

This measurement is the W and Z-boson production cross sections measurement performed at the highest center-of-mass energy ever.