SEARCHES FOR Z' AND HIGGS BOSONS DECAYING INTO HADRONIC TAU PAIRS AT CMS/LHC

Abstract

by

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An elegant solution to the mystery of electroweak symmetry breaking and the origin of mass was proposed in the 1960s, yet it has taken several generations of particle accelerators and detectors to discover a strong candidate for the so-called *Higgs boson*, which is implied by the theory. A positive identification would complete the *Standard Model* (SM): the most successful description of elementary particles and interactions to date. Searches for the SM Higgs boson production in association with top-quark pairs will provide additional confirmation of SM Higgs boson detection by the ATLAS and CMS experiments at the LHC in 2012, as well as the only means of measuring its coupling to top quarks. The first CMS search for the SM Higgs boson decaying to hadronic tau pairs in association with top-quark pairs is presented in this dissertation: with 19.4 fb^{-1} of p–p collision data at $\sqrt{s} = 8\,\text{TeV}$ collected by the CMS experiment, the expected and observed upper limits on the product of the cross section and branching ratio for the $t\bar{t}H \to \tau_h^+\tau_h^-$ process are roughly 20 times the SM background expectation.

Strong experimental evidence has exposed several limitations of the SM: it fails to provide a description of neutrino-flavor mixing, cold dark matter candidates, gravitation, and the matter-antimatter asymmetry, for example. Numerous models in beyond-the-Standard-Model theories (e.g. *grand unification*, *extra dimensions*) suggest new neutral gauge bosons (Z'), some of which would appear with enhanced couplings to tau leptons. A search for a *sequential SM* and a ψ-model Z' bosons decaying to tau pairs with $4.94 \pm 0.11\,\mathrm{fb}^{-1}$ of p–p collision data at $\sqrt{s} = 7\mathrm{TeV}$ collected by the CMS experiment is also presented, the results of which show an incompatibility with such neutral gauge bosons with masses below $1.4\,\mathrm{TeV}/c^2$ and $1.1\,\mathrm{TeV}/c^2$ respectively at 95% C.L.