Constraints on Anomalous Quartic Gauge Boson Couplings at OPAL and the System Test of the ATLAS barrel SCT

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Synopsis

Reported in this thesis is an analysis of OPAL data collected during the last four years of LEP operation at CERN, a review of the principal results of the ATLAS SCT barrel system test and a preliminary ATLAS Monte Carlo study.

Anomalous quartic couplings between the electroweak gauge bosons may contribute to the $e^+e^- \rightarrow \nu\bar{\nu}\gamma\gamma$ process. The main analysis uses 652 pb^{-1} of OPAL data recorded at 183-209 GeV centre-of-mass energies. A sample of 20 acoplanar photon pair events is selected and a binned maximum likelihood method used to constrain the possible $WW\gamma\gamma$ and $ZZ\gamma\gamma$ couplings. The 95% confidence level limits on the anomalous coupling parameters a_0^W, a_c^W, a_0^Z and a_c^Z are found to be

$$\begin{aligned}
-0.040\ \mathrm{GeV}^{-2} < & \quad a_0^W/\Lambda^2 & < 0.037\ \mathrm{GeV}^{-2}, \\
-0.114\ \mathrm{GeV}^{-2} < & \quad a_c^W/\Lambda^2 & < 0.103\ \mathrm{GeV}^{-2}, \\
-0.009\ \mathrm{GeV}^{-2} < & \quad a_0^Z/\Lambda^2 & < 0.026\ \mathrm{GeV}^{-2}, \\
-0.034\ \mathrm{GeV}^{-2} < & \quad a_c^Z/\Lambda^2 & < 0.039\ \mathrm{GeV}^{-2},
\end{aligned}$$

where Λ is the energy scale of the new physics. Limits obtained when allowing two or four parameters to vary are also presented. The results are combined with those from the $W^+W^-\gamma$ and $q\bar{q}\gamma\gamma$ processes also studied at OPAL.

Additionally, results are reported of the system test of 12 silicon micro-strip detector modules, operated on a prototype partial section of the inner-most ATLAS SCT barrel. The performance of the modules was found to be within the specified limits of the design. Methods have also been developed to measure the common-mode noise present in binary read-out systems, and their functionality is demonstrated by application to the ATLAS detector modules operated at the system test.

Finally, a Monte Carlo study of the $W\gamma\gamma$ final state produced in pp collisions is presented, using ATLFAST to model the events in the ATLAS detector. This tri-boson process may be sensitive to a possible anomalous $WW\gamma\gamma$ vertex.