Multi-photon final states in e+e− collisions at $\sqrt{s} =$130–172 GeV

The OPAL Collaboration
Abstract. The process $e^+e^- \rightarrow \gamma\gamma(\gamma)$ is studied using data recorded with the OPAL detector at LEP. The data sample corresponds to a total integrated luminosity of 25.38 pb$^{-1}$ taken at centre-of-mass energies of 130-172 GeV. The measured cross-sections agree well with the expectation from QED. In a combined fit using data from all centre-of-mass energies, the angular distribution is used to obtain improved limits on the cut-off parameters: $A_+ > 195$ GeV and $A_- > 210$ GeV (95% CL). In addition, limits on non-standard $e^+e^-\gamma$ couplings and contact interactions, as well as a 95% CL mass limit for an excited electron, $M_* > 194$ GeV for an $e^+e^-\gamma$ coupling $\kappa = 1$, are determined.

1 Introduction

This paper reports a study of the annihilation process $e^+e^- \rightarrow \gamma\gamma(\gamma)$ using data recorded with the OPAL detector at LEP. At LEP energies, this is one of the few processes having negligible contributions from the weak interaction. Since the QED differential cross-section is precisely predicted in theory, deviations from the expected angular distribution are a sensitive test for non-standard physics processes contributing to these photonic final states.

The OPAL collaboration has previously published a study of photonic final states, with and without missing energy, at $\sqrt{s} = 130-172$ GeV [1]. The present analysis concentrates on final states with two or more detected photons, but no missing transverse momentum, to study only the QED process. Photonic final states with missing energy have been analysed separately [2].

Any non-QED effects described by the general framework of effective Lagrangian theory should increase with centre-of-mass energy. Existing OPAL limits on deviations from QED can be improved by using the data at centre-of-mass energies of 161.3 GeV and 172.1 GeV. A small amount of data taken at 170.3 GeV is included in the 172 GeV sample. The corresponding integrated luminosities of these data sets are 9.97 and 10.13 pb$^{-1}$, respectively. Since the selection criteria have changed, previously analysed data taken at centre-of-mass energies of 130.3 GeV (2.69 pb$^{-1}$) and 136.2 GeV (2.59 pb$^{-1}$) are reanalysed here to allow for a coherent treatment. The 136 GeV sample includes a small amount of data taken at $\sqrt{s} = 130-140$ GeV [1]. The present analysis concentrates on final states with two or more detected photons, but no missing transverse momentum, to study only the QED process. Photonic final states with missing energy have been analysed separately [2].

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