INCLUSIVE JET PRODUCTION IN PHOTON-PHOTON COLLISIONS AT $\sqrt{s} = 130$ and 136 GeV

RICHARD NISIUS, OPAL COLLABORATION

CERN- PPE Division, CH-1211 Geneve 23, Switzerland

The inclusive one-jet and two-jet cross-sections are measured in collisions of quasi-real photons at e^+e^- centre-of-mass energies of 130 and 136 GeV using the OPAL detector at LEP, for a luminosity of 4.9 pb^{-1}. The transverse energy flow in the jets is studied separately for direct and resolved events. The differential jet cross-sections are compared to next-to-leading order perturbative QCD calculations.

1 Introduction

Jet production is measured in the interactions of two photons in e^+e^- collisions at centre-of-mass energies of 130 and 136 GeV. Both scattered electrons [a] are not detected ("anti-tagged"), and the photons can be considered quasi-real ($Q^2 \approx 0$). In the quark parton model jets are produced by the interaction of bare photons, $\gamma\gamma \rightarrow q\overline{q}$, the direct process. The largest part of the total cross-section, however, is due to interactions where the photon fluctuates into a hadronic state, the resolved processes. The measured jet cross-sections, using a cone jet finding algorithm, are compared to next-to-leading order (NLO) QCD calculations [1].

2 Event Selection and Monte Carlo Simulation

The kinematics of the $\gamma\gamma$ process at a given centre-of-mass energy are described by the negative square of the four-momentum transfers, $Q_i^2 = 2EE_i'(1-\cos\Theta_i')$, carried by the two ($i = 1, 2$) photons, and by the invariant mass of the hadronic final state. E is the beam energy, the E_i' are the energies of the scattered electrons and the Θ_i' are their polar angles. The event selection requires a low mass hadronic final state with small missing transverse energy. An anti-tagging condition restricts the photon virtualities to $Q_i^2 < 0.8$ GeV^2. 6813, 709, 132, 8, 1 events for 0-jets up to 4-jets are selected. The total background is about 1%.

The Monte Carlo generators PYTHIA 5.721 [2] and PHOJET 1.05 [3] are used. They are based on leading order (LO) QCD calculations, for the direct and resolved processes. Initial and final state parton radiation and multiple parton interactions are included.

[a]Positrons are also referred to as electrons.

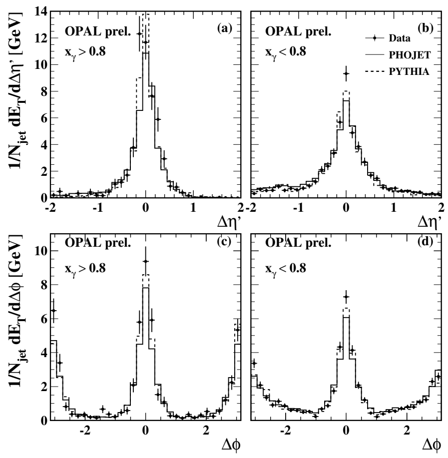

Figure 1: Uncorrected energy flow transverse to the beam direction measured relative to the direction of the jet in two-jet events with $x_\gamma > 0.8$ (a,c) and $x_\gamma < 0.8$ (b,d). The energy flow is integrated over $|\Delta\phi| < \pi/2$ for the $\Delta\eta'$ projection (a,b) and over $|\Delta\eta'| < 1$ for the $\Delta\phi$ projection (c,d), where $\Delta\eta'$ and $\Delta\phi$ are the differences between the jet axis and the particle direction. Statistical errors only are shown.

3 Energy flow and inclusive jet cross-sections

The cone jet finding algorithm is used with a cone radius of $R = 1$. Jets with a pseudorapidity in the range $|\eta^{\rm jet}| < 1$, and with a transverse energy with respect to the beam axis of $E_T^{\rm jet} > 3$ GeV are considered.

In leading order QCD two hard jets are produced in $\gamma\gamma$ interactions. They are accompanied by remnant jets in resolved interactions. Direct and resolved events can be separated experimentally by measuring x_γ, the fraction of the photon energy participating in the hard scattering, which in the ideal case is one for direct events. The experimental cut to separate the components is $x_\gamma = 0.8$. The transverse energy flow for two-jet events is shown in Fig. 1. Jets in events with $x_\gamma > 0.8$ are observed to have on average more transverse energy and to be more collimated than jets in events with $x_\gamma < 0.8$. The description of the data by the Monte Carlo models is reasonably good, but both models underestimate somewhat the transverse energy flow in the jet direction.

The measured jet cross-sections are corrected to the hadron level using the method of regularised unfolding [4]. The systematic uncertainty is determined by varying the energy scale of the central electromagnetic calorimeter by $\pm 5\%$, by degrading the resolution of the track parameters and by unfolding with both Monte Carlo models. The inclusive one-jet and two-jet cross-sections as a func-

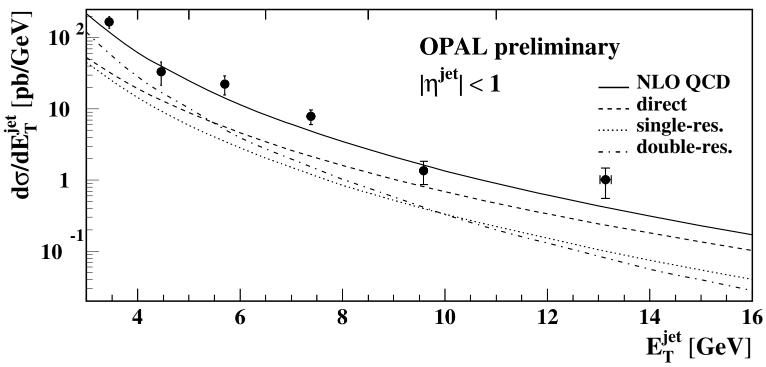

Figure 2: The inclusive one-jet cross-section compared to NLO calculations. The error bars show the statistical and the systematic errors added in quadrature.

tion of $\eta^{\rm jet}$ are found to be independent of $\eta^{\rm jet}$ within in the kinematic range studied, in agreement with the Monte Carlo. In Fig. 2, the measured inclusive one-jet cross-section on the hadron level, as a function of $E_T^{\rm jet}$ is compared to NLO calculations [1] obtained for massless partons. The resolved processes dominate for $E_T^{\rm jet} \lesssim 5.5$ GeV, whereas, at high $E_T^{\rm jet}$, the direct component is largest. The agreement between the calculation and the data is good both for the one-jet and for the two-jet cross-sections.

4 Conclusions

Jet production in photon-photon interactions has been investigated at centre-of-mass energies of 130 and 136 GeV. The inclusive one-jet and two-jet cross-sections were measured as a function of $E_T^{\rm jet}$ and $\eta^{\rm jet}$ for $E_T^{\rm jet} > 3$ GeV and $|\eta^{\rm jet}| < 1$. The Monte Carlo models PYTHIA and PHOJET describe the transverse energy flow distributions reasonably well. The jet cross-sections are independent of $\eta^{\rm jet}$ and the predictions of NLO QCD calculations for the $E_T^{\rm jet}$ dependent cross-sections are in good agreement with the data

References

1. T. Kleinwort, G. Kramer, DESY 96-035 (1996);
   T. Kleinwort, G. Kramer, *Phys. Lett.* B **370**, 141 (1996).
2. T. Sjöstrand, *Comp. Phys. Comm.* **82**, 74 (1994).
3. R. Engel and J. Ranft, ENSLAPP-A-540/95 and Siegen SI 95-08 (1995).
4. V. Blobel, DESY 84-118 and CERN 85-09.