The hadronic structure function F_2^γ for quasi-real photons

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Abstract
Results on the hadronic structure of the photon are presented, including recent measurements of F_2^γ from the ALEPH, L3 and OPAL experiments.

1. Introduction

Electron-positron colliders provide the opportunity to investigate the hadronic structure of the photon through the two-photon reaction $e^+e^- \to e^+e^- +$ hadrons. Single-tag events, where one electron remains in the beam pipe and the other is measured with an angle $\theta_{\rm tag}$ and energy $E_{\rm tag}$, can be viewed as the deep inelastic scattering of an electron and an (almost) real photon. The differential cross section of $Q^2 = 2E_{\rm tag}E_{\rm beam}(1-\cos\theta_{\rm tag})$ and $x = Q^2/(Q^2+W^2)$, where W is the invariant mass of the hadrons, can be directly related to the photon structure function $F_2^\gamma(x,Q^2)$. The formalism of single-tag $\gamma\gamma$ collisions is described in e.g. [1].

Here recent measurements of F_2^γ based on data from the ALEPH [2], L3 [3, 4] and OPAL [5] experiments at the LEP e^+e^- collider are presented.

2. Unfolding F_2^γ

An important source of uncertainty in measurements of the x distribution are the corrections that must be introduced to account for detector acceptance and resolution (unfolding). These corrections require a response matrix, obtained by means of a Monte Carlo model where events are generated and the detector response simulated.

Scatter plots from Monte Carlo studies by ALEPH of measured vs. true values of x are shown in Fig. 1. The four plots are for events with different values of the variable E_{17}, defined as the total energy of the particles within 17° of the beam line. One can see that events with low E_{17} have much better x resolution. The response matrix for x obtained from a Monte Carlo model corresponds to the average x resolution resulting from the model's E_{17} distribution. The uncertainty in the unfolded x distribution due to this model dependence has been an important source of systematic error in previous measurements. If, however, E_{17} is measured from the data, then this uncertainty is avoided. In addition, one obtains smaller statistical errors, since those events for which x is well measured (low E_{17}) are given a higher weight and their information is not diluted by events with poor x resolution.

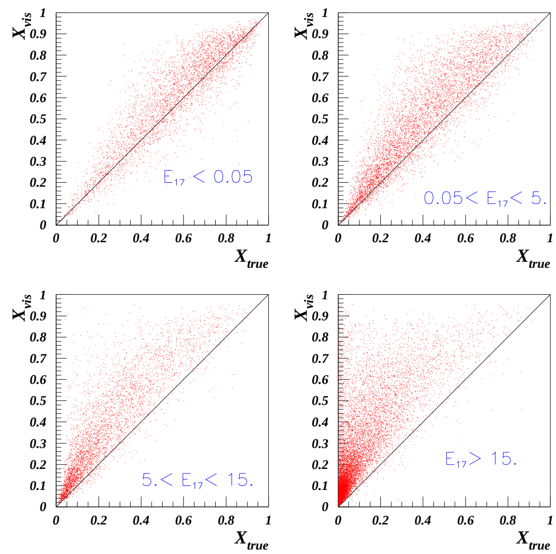

Figure 1. Plots of the measured vs. true values of x for events with different values (in GeV) of E_{17} (see text).

The results presented here by the ALEPH and OPAL experiments are based on two-dimensional unfolding methods using both x and an additional variable such as E_{17}. More information on unfolding can be found in [6, 7]. Further improvements have been obtained by OPAL and L3 by including kinematic information from the tagged electron in order to estimate the hadronic mass W.

3. Results and conclusions

Figures 2–4 show the photon structure function in several Q^2 ranges measured using data from LEP2 by the ALEPH, L3 and OPAL experiments. Also shown on the plots are predicted parametrisations of F_2^γ from several groups identified by the initials of the authors; the references can be found in [2, 3, 4, 5]. The measurements from ALEPH and OPAL show good agreement with the prediction of GRV [8], while the L3 measurement is somewhat higher, especially at low x. Improved measurements are to be expected in the future as more of the LEP2 data are analysed.

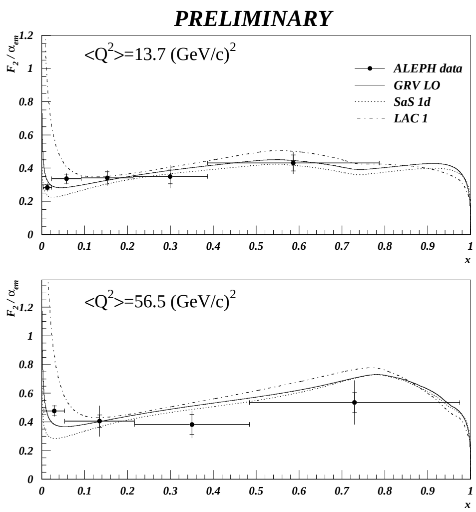

Figure 2. F_2^γ measured by ALEPH [2].

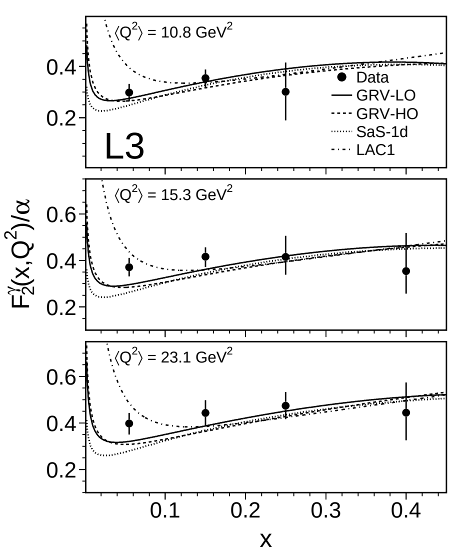

Figure 3. F_2^γ measured by L3 [4].

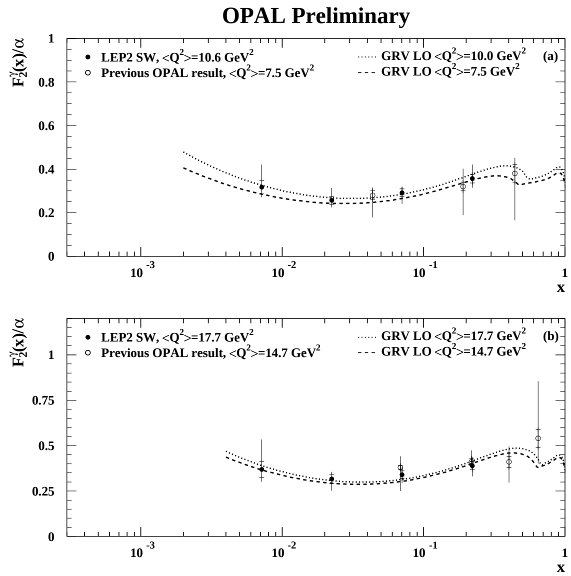

Figure 4. F_2^γ measured by OPAL [5].

4. Acknowledgements

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