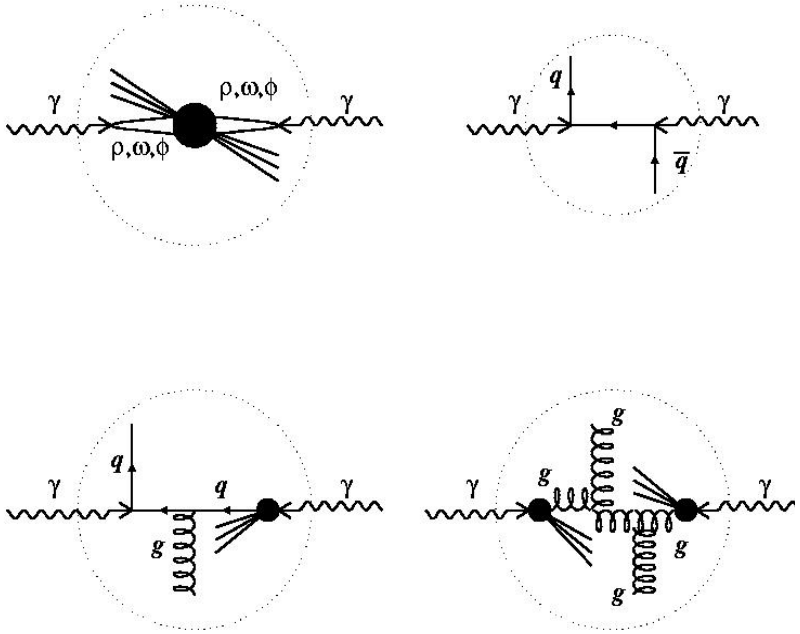
Higt-p_T di-jet production in $\gamma\gamma$ collisions with DELPHI

CONTENT:

- *$\gamma\gamma$ collisions , jet reconstruction algorithm*
- *Data, MC, background …*
- *Results*
- *Summary*

$\gamma\gamma$ collisions, jet reconstruction algorithm

Diagrams of $\gamma\gamma$ scattering



k_T-clustering algorithm is used for jet reconstruction

Data selection

LEP2 data: $L \cong 550\ pb^{-1}$, $(189 \div 208)\ GeV$ of $\sqrt{s_{e^+e^-}}$

- $\gamma\gamma$ multihadron events: $N_{charged} > 4$, $P > 200$ MeV/c, $\theta \in [20^o - 160^o]$, the impact parameters are smaller than 4 cm in $R\phi$ and 10 cm in z

- background suppression: $W < 35\ GeV/c^2$ ($E_{EM,min} = 0.5$ GeV) and $|P_{T,balance}| < 30\ GeV/c$

- anti-tagging condition: no $E_{Lum\text{-}monitor} > 25$ GeV

- di-jet event selection: there are 2 jets reconstructed by the k_T-clustering with $|\eta| < 1$ and $p_t > 3\ GeV/c$ for each jet
- minimum of mean p_t of jets: $(p_{t,1} + p_{t,2})/2 > 4\ GeV/c$

5147 events have been selected

triggered with efficiency estimated to be close to the unity

Monte Carlo, background

Leading order MC generator PYTHIA (v. 6.205) is used. The program contains an interface to the external library of the parton density functions (PDF). Default SaS1D PDF is taken.Soft underlying events is modeled through the multiple interactions (MIA) of several parton pairs which interact at the same event.

`non–γγ` background

- background process (e^+e^- ⇨ hadrons) is simulated by the KK2f event generator (version 4.14). Its contribution is estimated to (500±5) events.
- contamination of τ–pairs produced in the two-photon interactions is evaluated to (43±3) events using the BDKRC program. The background of τ–pairs produced in the annihilation is negligible.
- W, Z bosons contribute to (38±4) events.

$\gamma\gamma$ collsions and jet composer

The interaction of bare photons is described by the Born-box diagram (direct or QPM term). If one (both) photon is resolved into a partonic structure, the process is called as a single- (double-)resolved.
Variables sensitive to an expected difference in the event topology.

$$x_\gamma^+ = \frac{\sum_{jets}(E_{jet}+p_{jet})}{\sum_{part}(E_{part}+p_{part})} \quad \text{and} \quad x_\gamma^- = \frac{\sum_{jets}(E_{jet}-p_{jet})}{\sum_{part}(E_{part}-p_{part})}$$

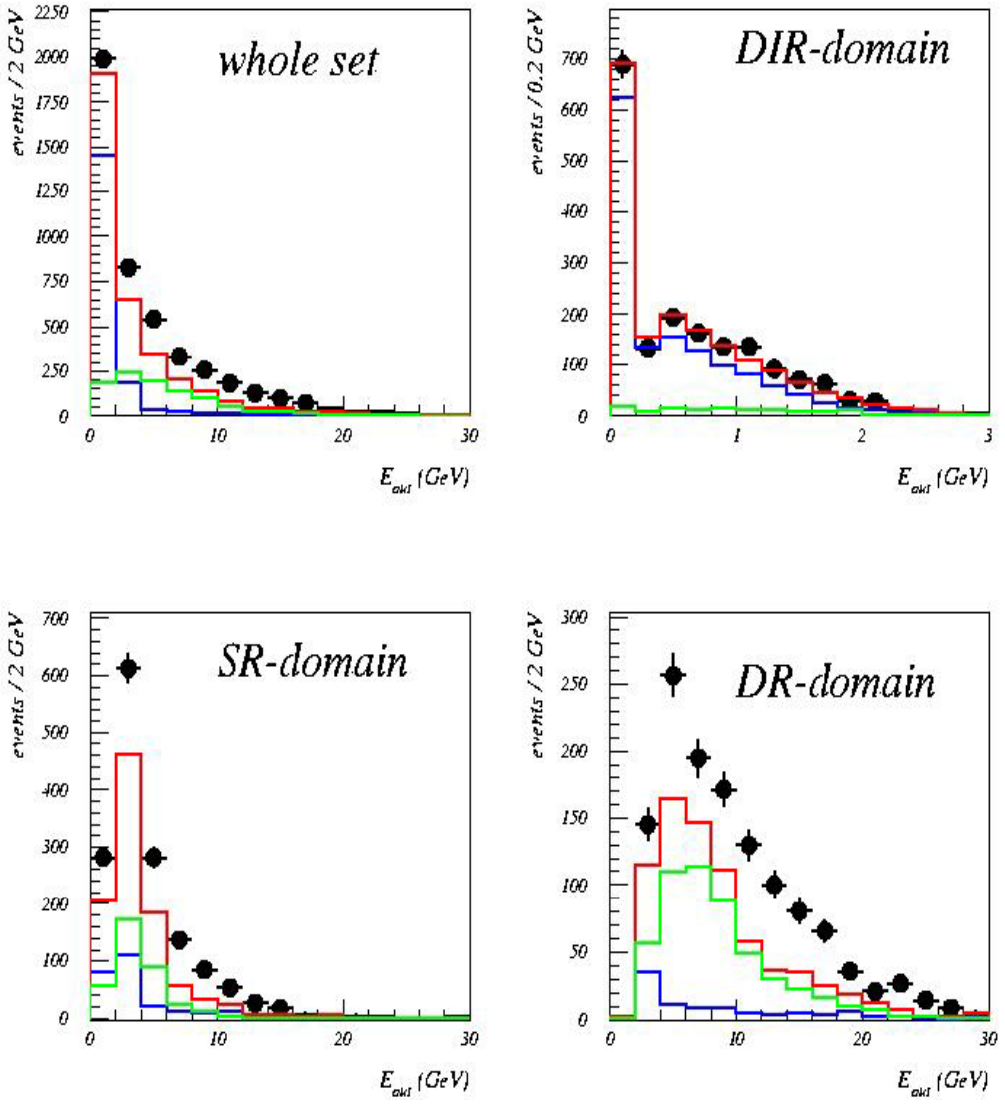
They are the estimators of the photon's momentum fraction involved into the hard interaction. The photons in the QPM-like events participate in the interaction entirely and both x_γ^+ and x_γ^- should be equal to one. While the presence of the remnant (single-resolved photon) moves x_γ^+ or x_γ^- to some lower values. For the double-resolved case, both variables are far from 1.
Split $x_{+/-}$-space into four quadrants by x_γ of 0.85:
both x_γ^+ and x_γ^- greater than 0.85 (`Dir` domain)
both values are below 0.85 (double-resolved domain, `DR`)
$x_\gamma^{+(-)} > x_\gamma$ while $x_\gamma^{-(+)} < x_\gamma$ (single-resolved, `SR`)

Data vs Monte Carlo

Energy outside reconstructed jets (E_{out}) versus the simulation
Red histograms – PYTHIA $\gamma\gamma$ interactions, QPM term (blue), double-resolved (green).
Single-resolved is not shown

Model doesn't describe the data in the parts of $x_{+/-}$-space where the contribution of the resolved processes is essential.

One-parameter renormalization of the model as a whole is not adequate since its components have to be tuned separately with different factors

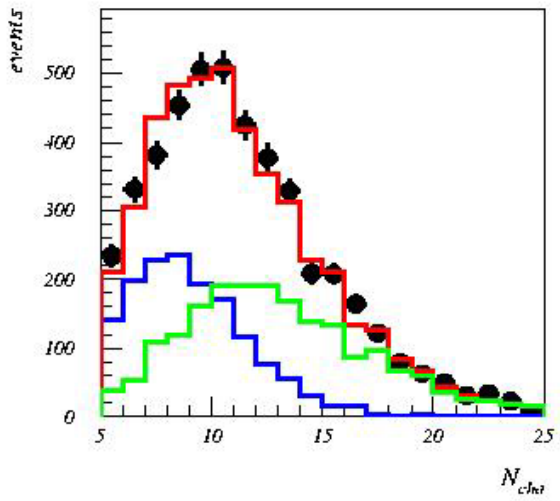


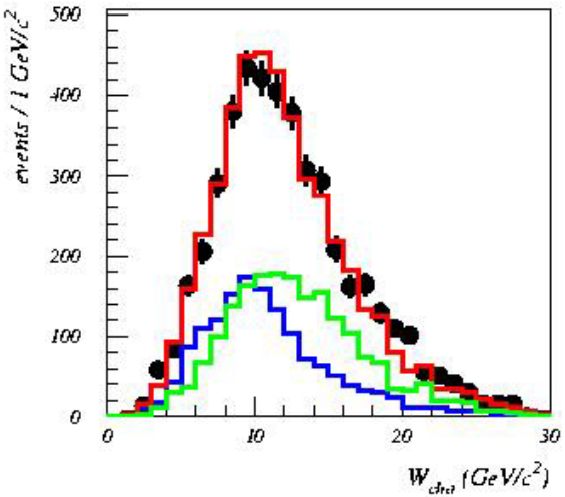
Data vs tuned Monte Carlo

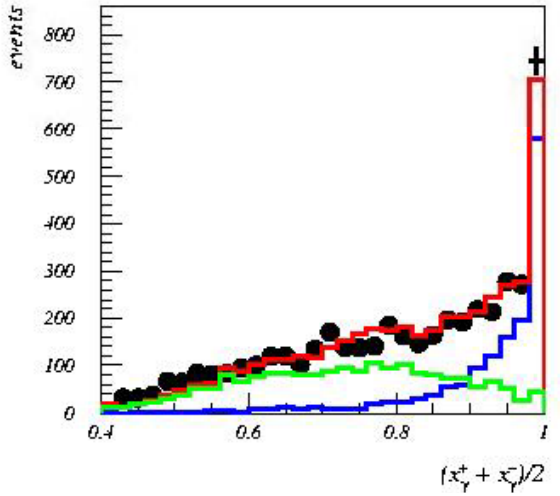
α_{dir}=(0.86 $\pm$ 0.02)
⇨fraction=33%

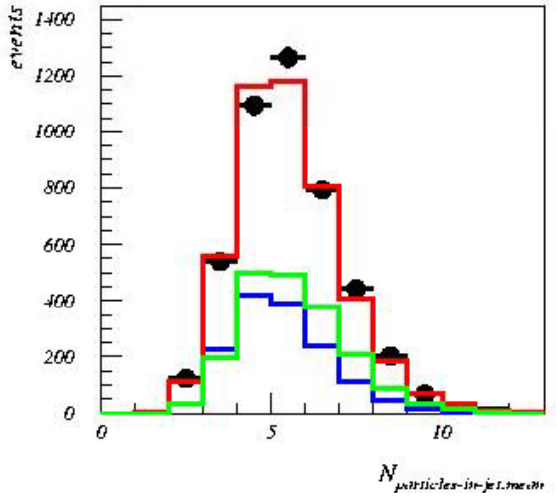
α_{SR}=(1.49 $\pm$ 0.09)
⇨fraction=23%

α_{DR}=(1.93 $\pm$ 0.05)
⇨fraction=44%









Data and calculations corrections

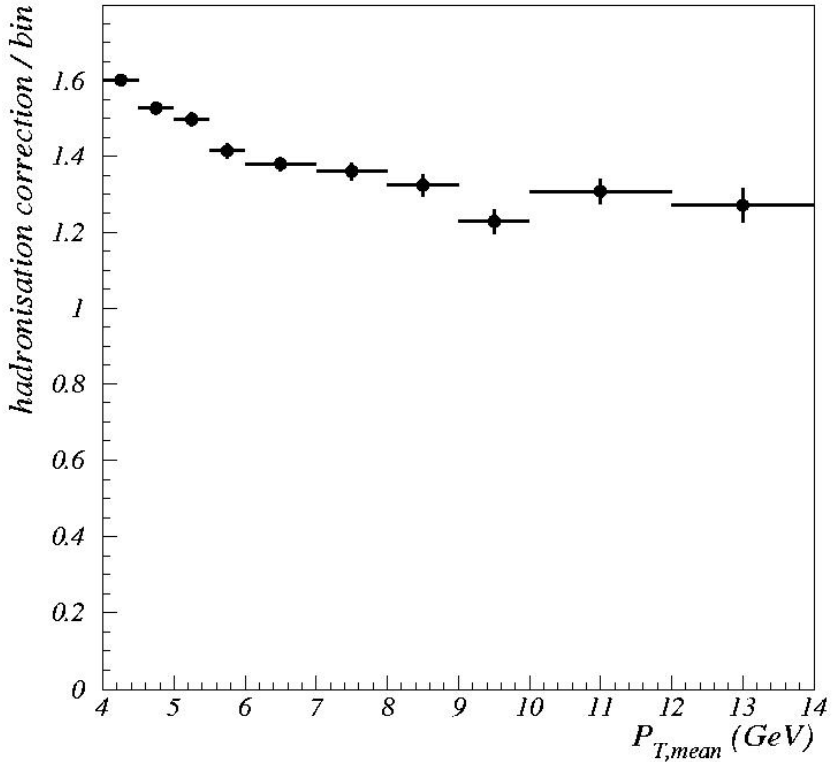
Partons in theoretical predictions

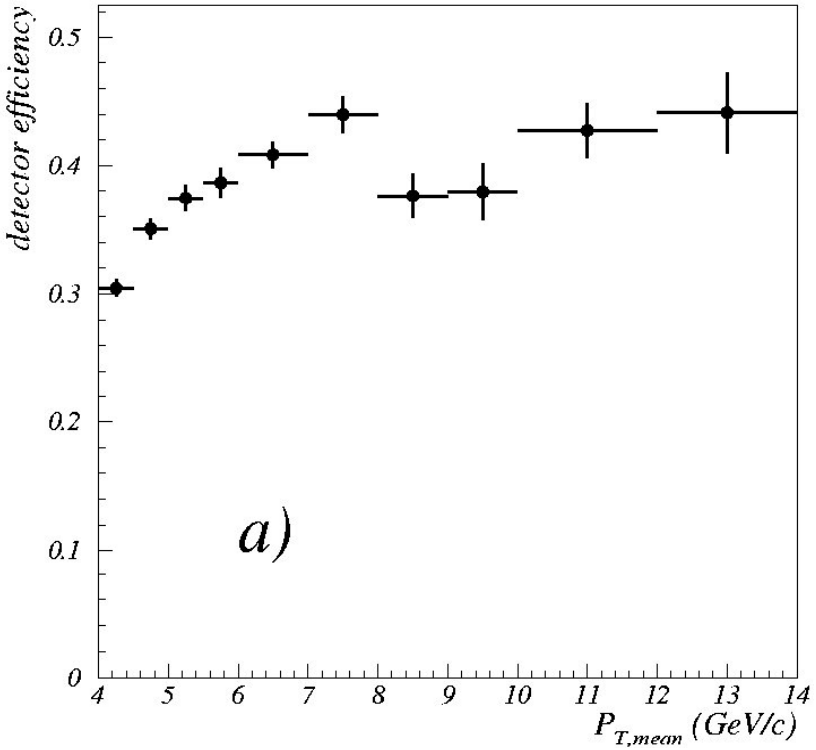
hadronisation ⇦⇨ corrections

Particles produced in $\gamma\gamma$ vertex

detector ⇦⇨ efficiency

Detected particles

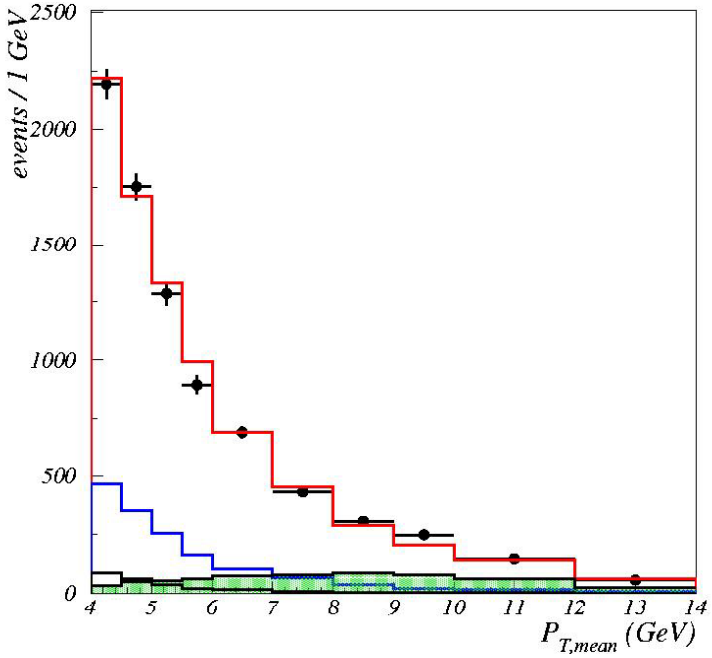


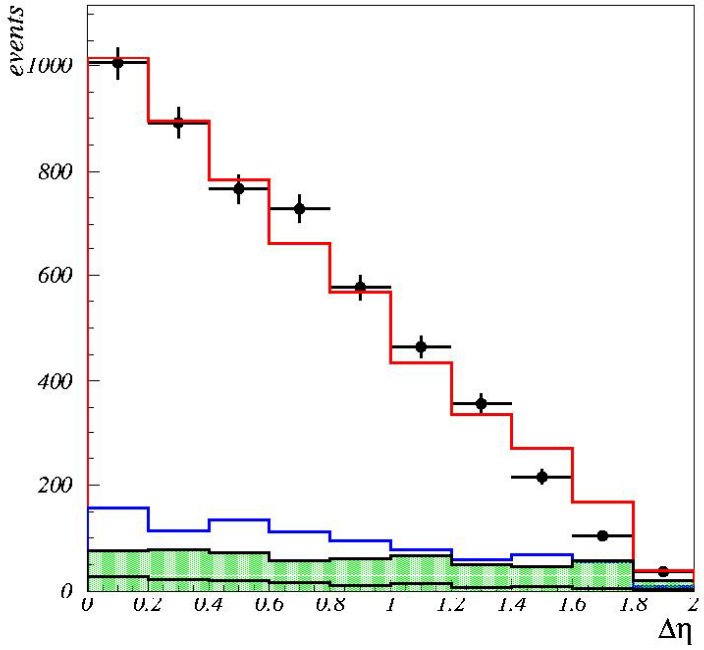


$\gamma\gamma$ background

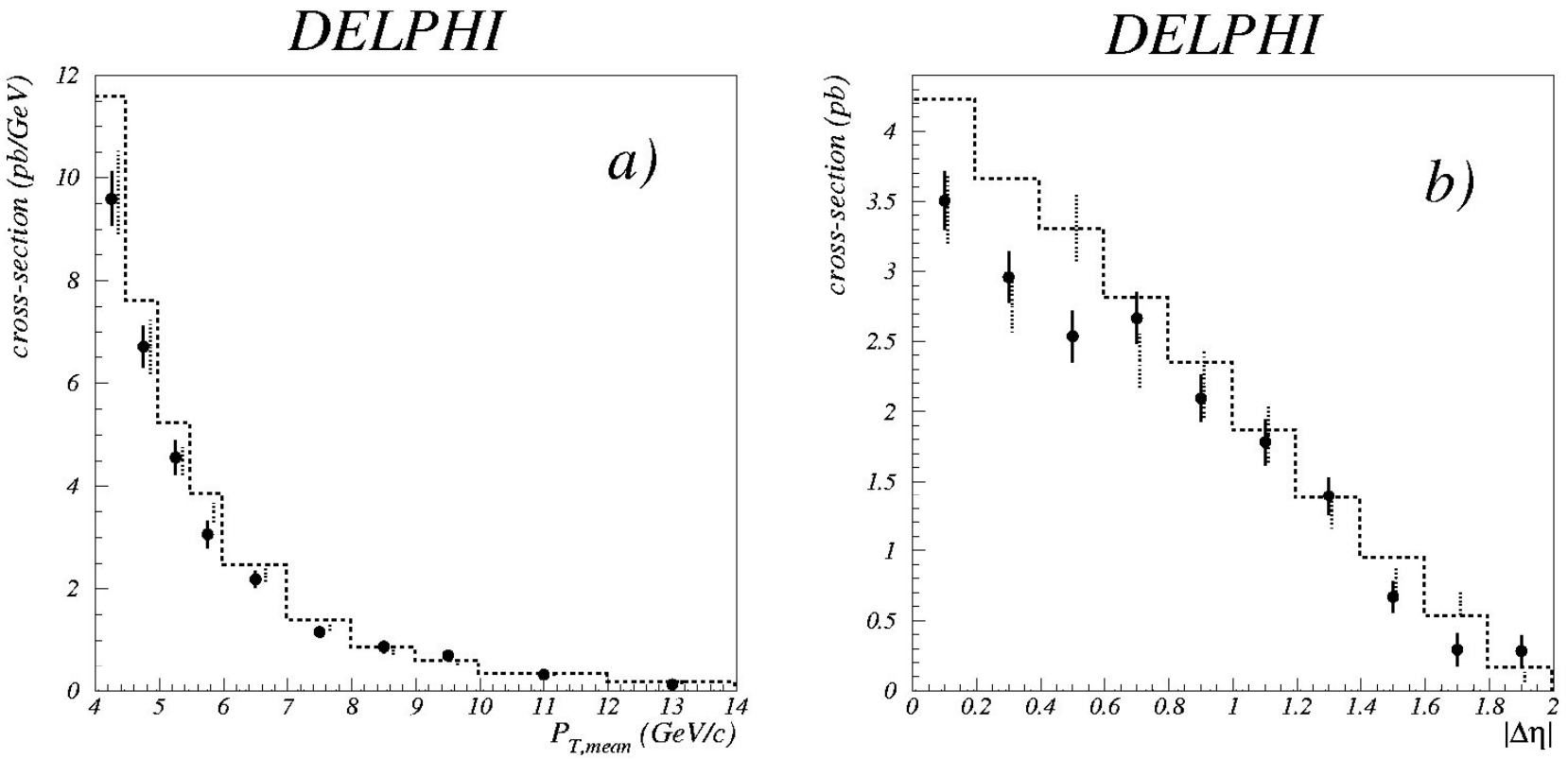
MIA initiated background: Hard process alone does not provide two jets passing through the selection criteria but being combined with MIA initiated particles it provides - contribution is estimated to (131$\pm$7) events (solid hists, green hists show non-$\gamma\gamma$ background).

`non2-2` background: Event, being non-two-jet event on the level of the produced particles, is reconstructed as two-jet event due to undetected particles - (893$\pm$13) events (blue hists).



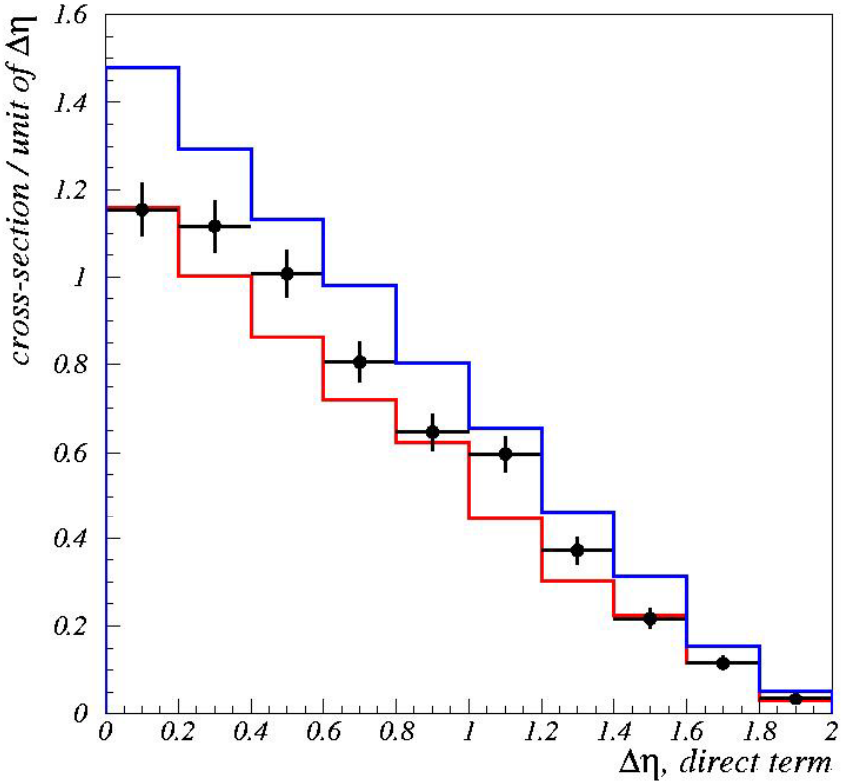


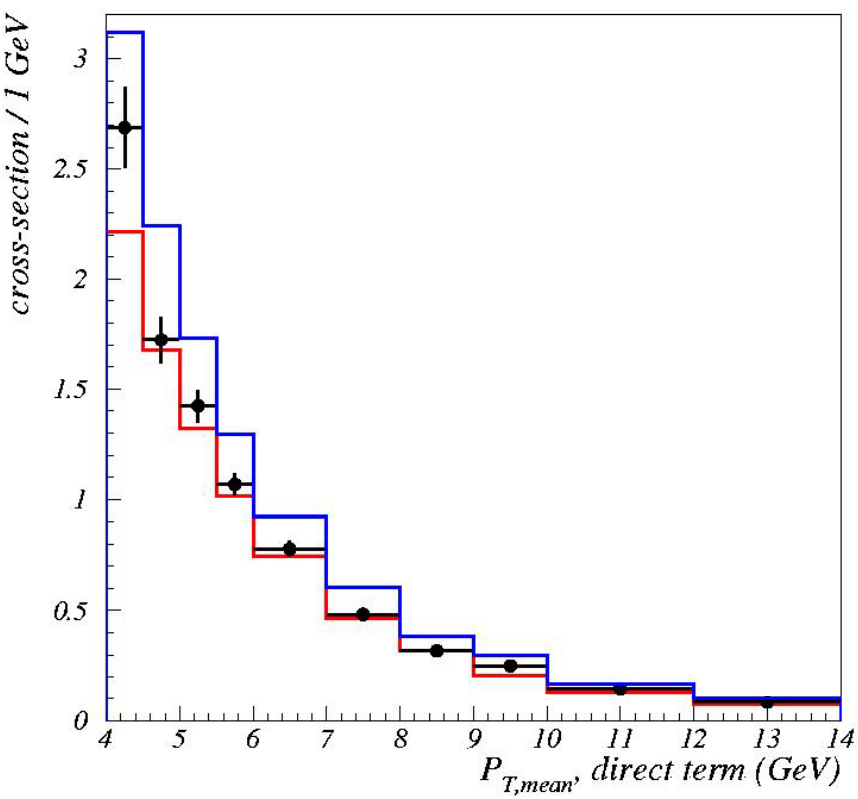
Results



Measured total di-jet cross-section is (18.0 ± 0.4) pb.
Leading (dashed hists) and Next-To-Leading (dotted bars) order calculations are (20.9 ±0.1) and (18.3 ± 0.4), respectively.

Results – QPM part





Scaled QPM MC is shown by bars. Leading and Next-To-Leading order calculations are presented by blue and red hists, respectively.

Conclusions

- Production of high-p_T di-jets in the interactions of quasi-real photons is studied with the DELPHI data taken at LEPII at an integrated e^+e^- luminosity of 550 pb^{-1}. The jets, reconstructed by the k_T-clustering algorithm, are defined within the pseudo-rapidity range of $-1<\eta<1$ and the jet transverse momentum p_T above 3 GeV/c;
- Total and differential cross-sections are measured for mean jets momentum $p_{T,mean}$ between 4 GeV/c and 14 GeV/c;
- Total cross section agrees with the next-to-leading order perturbative QCD calculations within the experimental uncertainties while they are 18% below the calculations carried out in the leading order;
- Measured differential di-jet cross section is also found in good agreement with NLO QCD predictions.