Inclusive Production of Charged Hadrons and Jets in Photon-Photon Collision at LEP2

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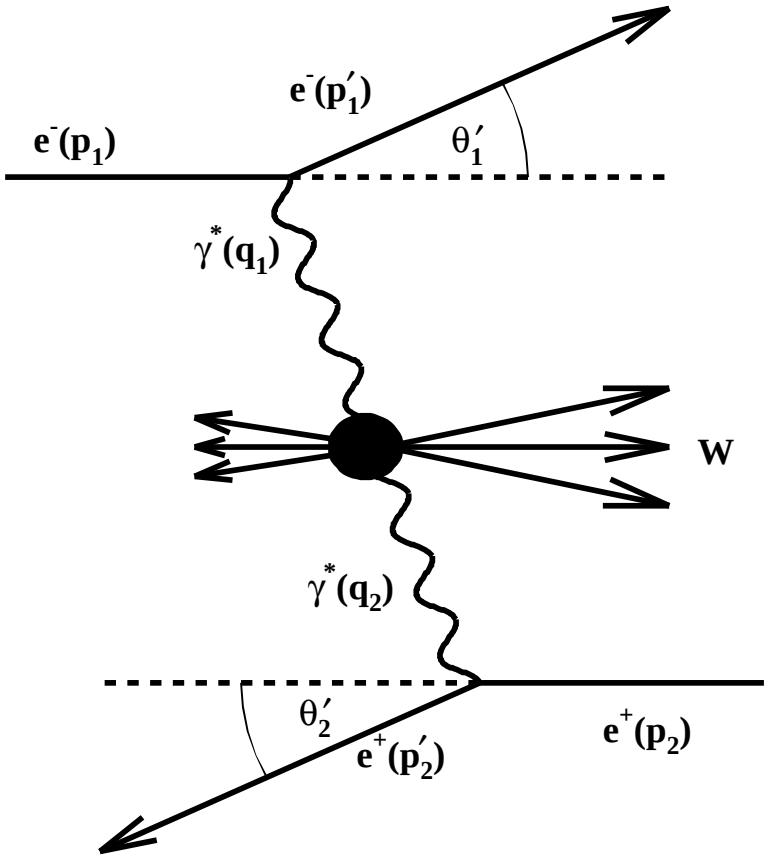
- **Kinematics**
- **Data set, selection cuts**
- **Results**

Kinematics



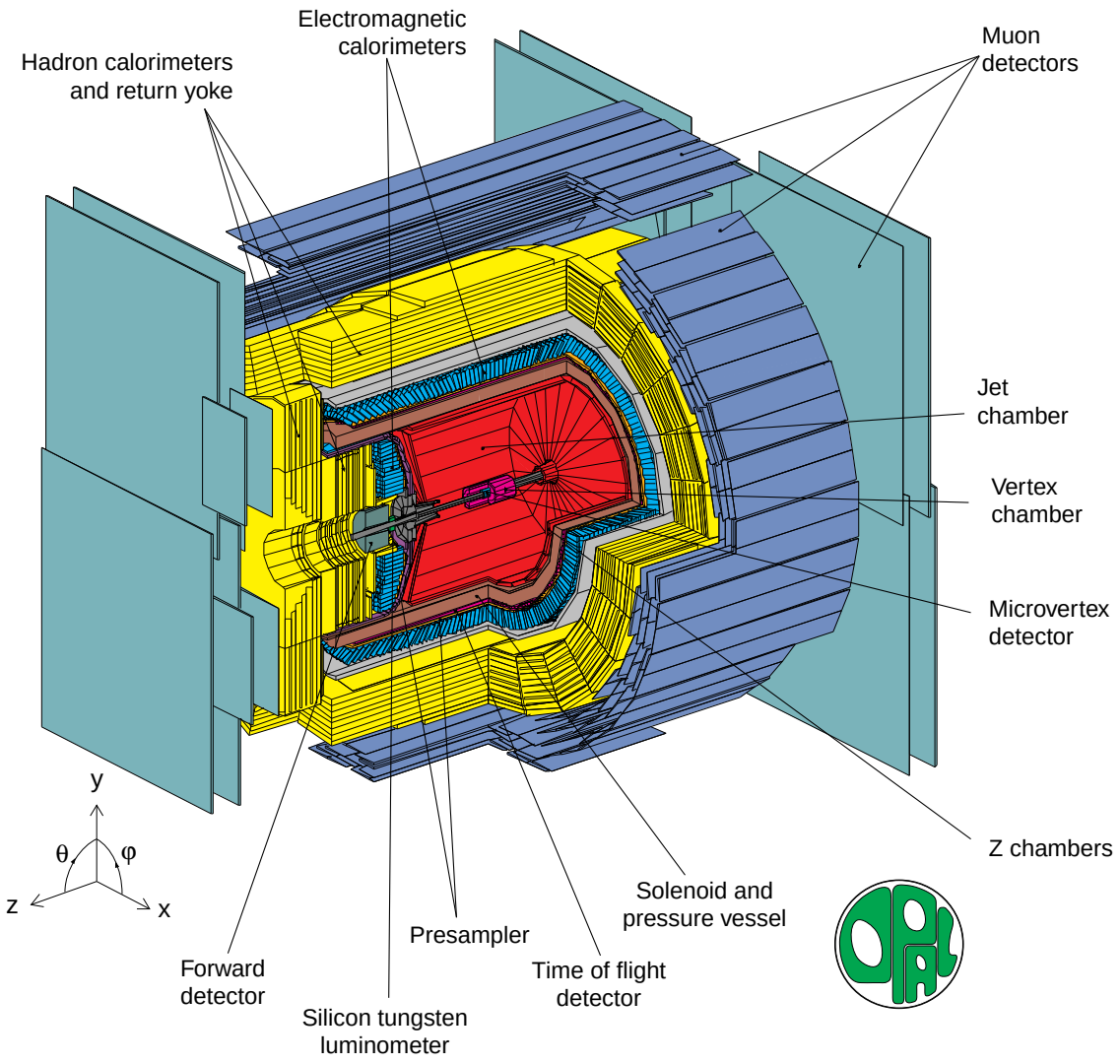
$Q_i^2 \equiv -q_i^2 = -(p_i - p_i')^2 > 0$ virtuality

$W_{vis}^2 = (\sum_h E_h)^2 - (\sum_h \vec{p}_h)^2$ visible invariant mass

$W^2 = s_{\gamma\gamma} = (q_1 + q_2)^2$ invariant mass of two-photon system

$\eta = -\ln\tan(\theta/2)$ pseudorapidity

Data set



The data taken by the OPAL-detector 1997-2000

$\sqrt{s_{ee}} = 183 - 209$ GeV

L=616pb^{-1}(hadrons)

and 1998-2000

$\sqrt{s_{ee}} = 189 - 209$ GeV

L=593pb^{-1} (jet)

Selection for charged hadrons and jets

Charged Hadrons

$E_{\mathrm{ECAL}}+E_{\mathrm{HCAL}} < 50$ GeV

$E_{\mathrm{FD}}+E_{\mathrm{SW}} < 60$ GeV

$P_{\mathrm{t,ECAL+FDmissing}} < 8$ GeV

$r_{primary-vertex} < 2$ cm
$z_{primary-vertex} < 3$ cm

$n_{\mathrm{track}} \geq 6$

quality cuts: $P_{\mathrm{t,min}}$, number of hits, $W_{\mathrm{vis,ECAL}}$, d_0

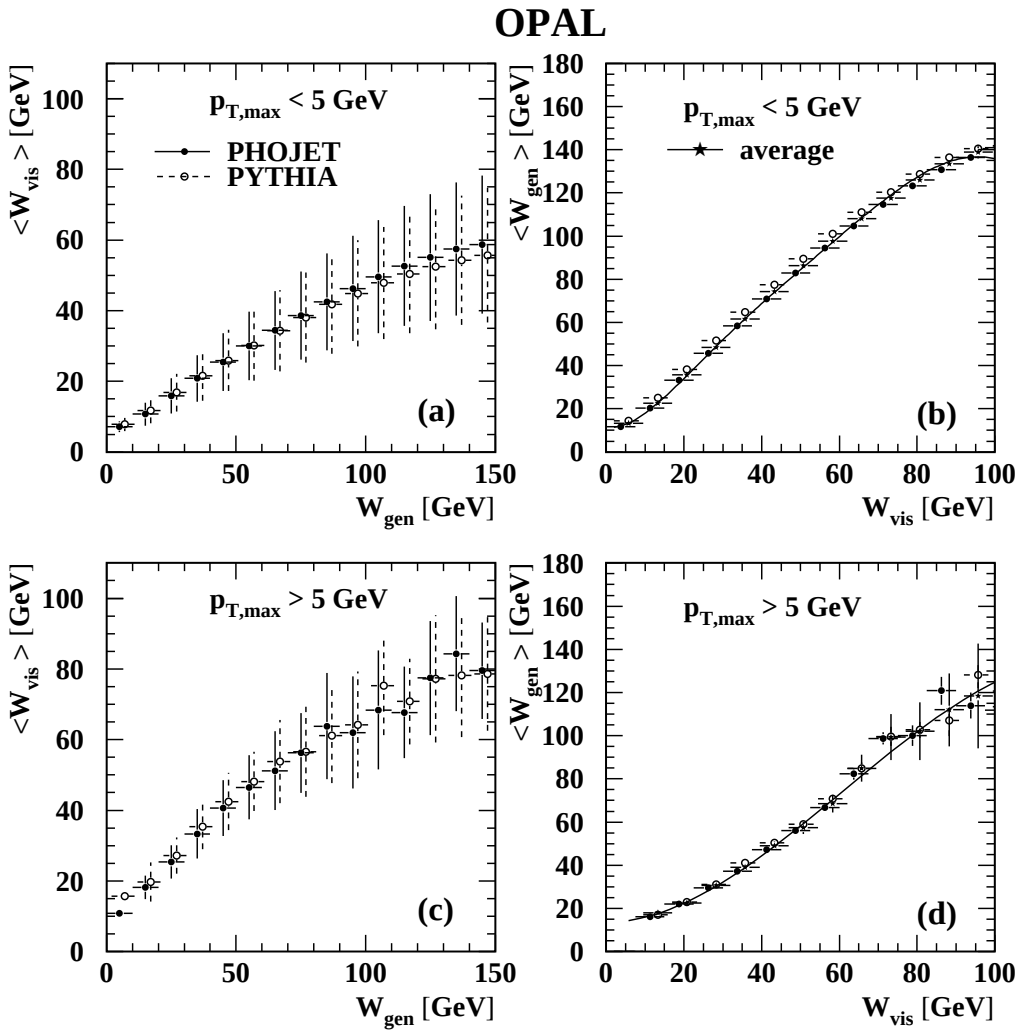
Jets

quality cuts: $P_{\mathrm{t,min}}$, number of hits, $W_{\mathrm{vis,ECAL}}$, d_0

preselection: $E_{\mathrm{ECAL+HCAL}}$, E_{FD}, E_{SW}, r, z, P_t^{jet}

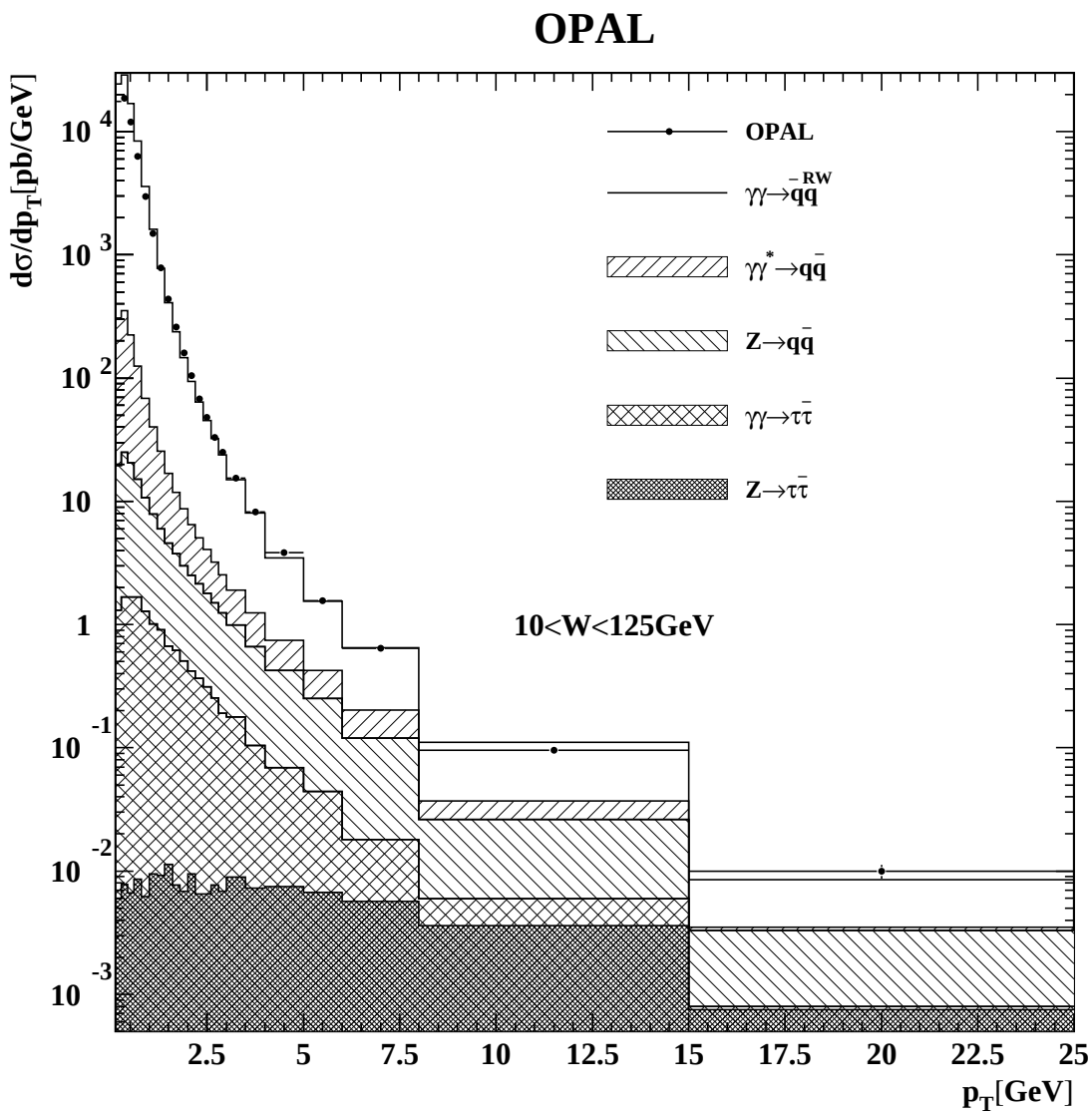
likelihood selection: W_{ECAL}, W_{vis}, E_{ECAL}, E_{HCAL}, $\sqrt{s_{ee}}$, M_{J1H2}

W reconstruction for charged hadrons



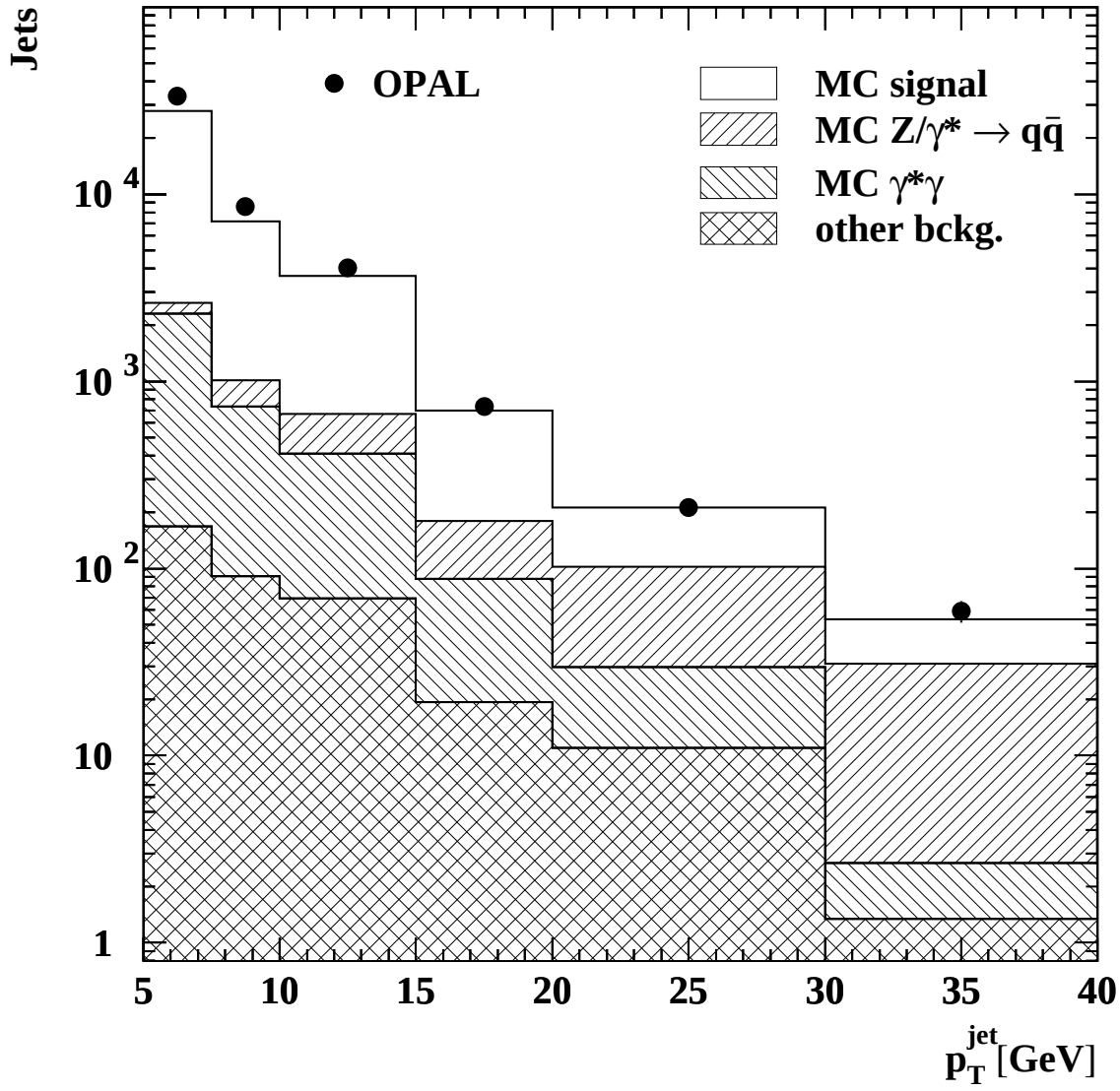
The inclusive charged hadron distributions are measured for invariant masses
$10 < W < 30$ GeV,
$30 < W < 50$ GeV,
$50 < W < 125$ GeV,
$10 < W < 125$ GeV.
The ratio of $W_{\rm gen}$ and $W_{\rm vis}$ depends on the event kinematics, and was therefore determined separately in two distinct regions of phase space.

Backgrounds



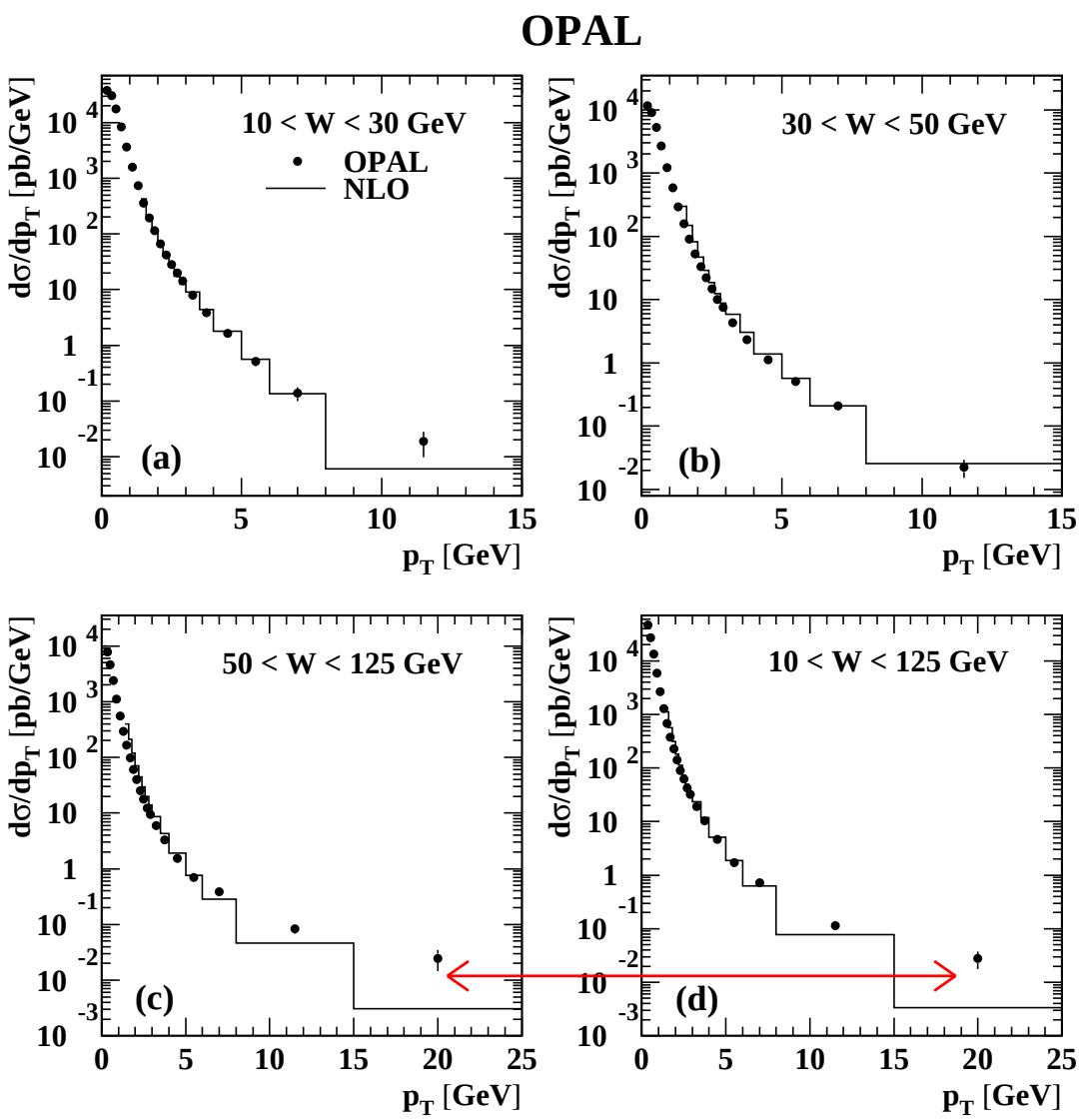
The total remaining background is below 2% overall, but increasing at very high transverse momentum, mainly hadronic Z decays and deep-inelastic eγ scattering.

Backgrounds



At 40 GeV the background is about 50% dominated by also hadronic Z decays.

Results

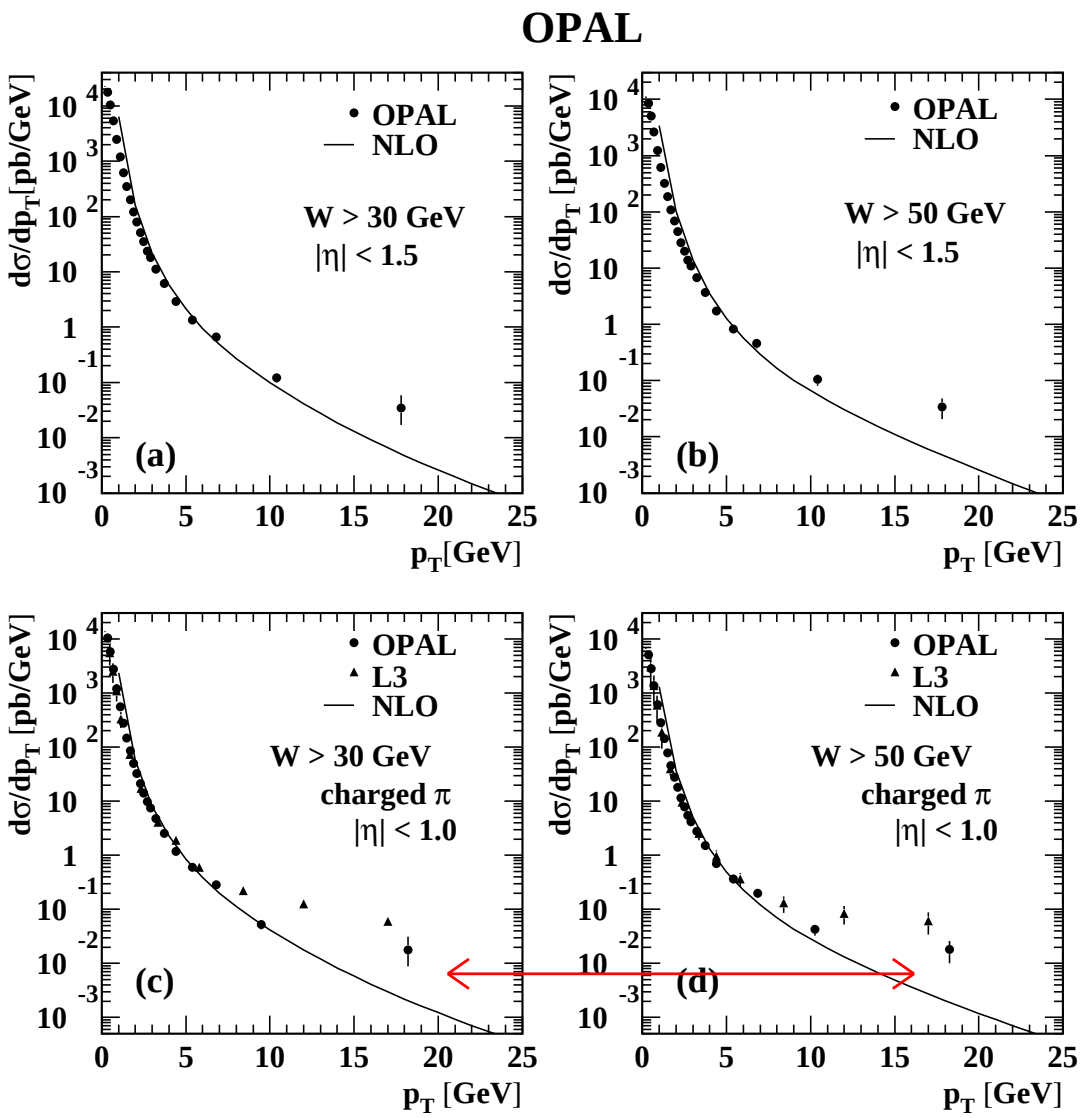


Calculations in NLO QCD was repeated for the kinematic conditions of the present analysis are compared to the data.

AFG-HO parametrisation, $\Lambda^5_{\overline{MS}} = 221$ MeV

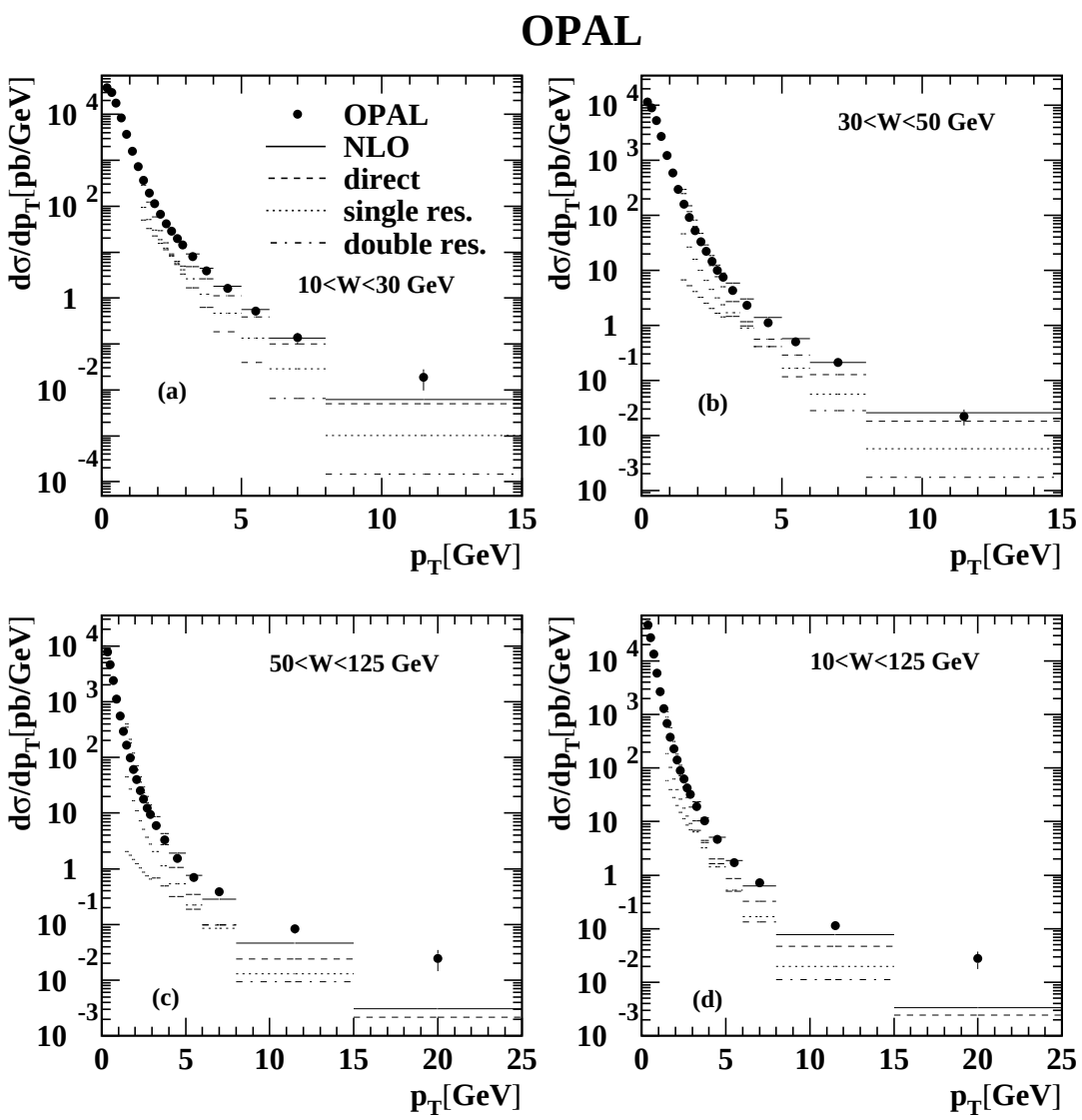
The renormalisation and factorisation scales in the calculation are set equal to p_{T}.

Results



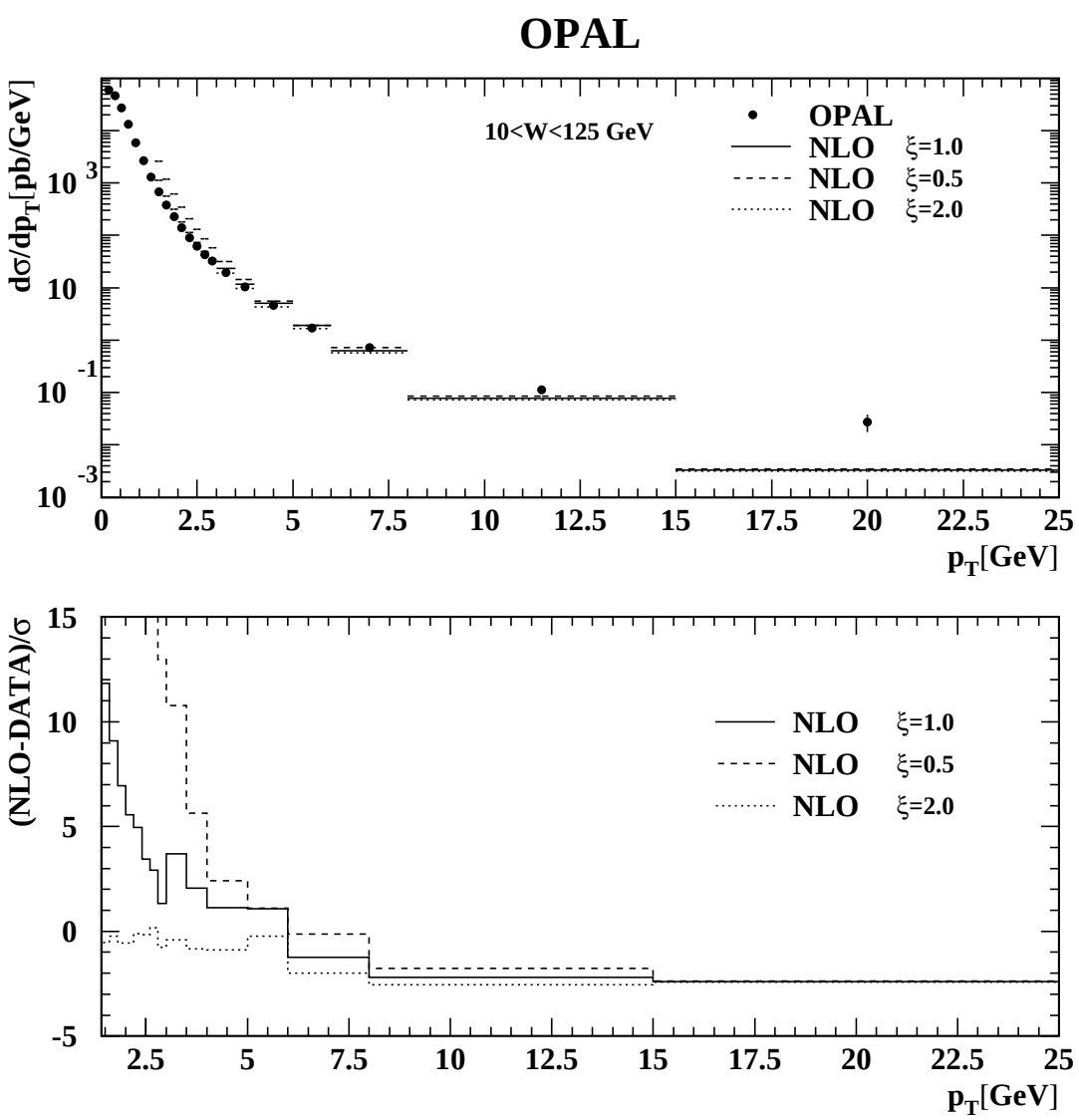
The differential inclusive charged pion production cross-sections in the W ranges $W > 30$ GeV and $W > 50$ GeV. The $|\eta| < 1.0$ range and the fraction of charged pions of all charged hadrons were determined by using MC simulations

Results



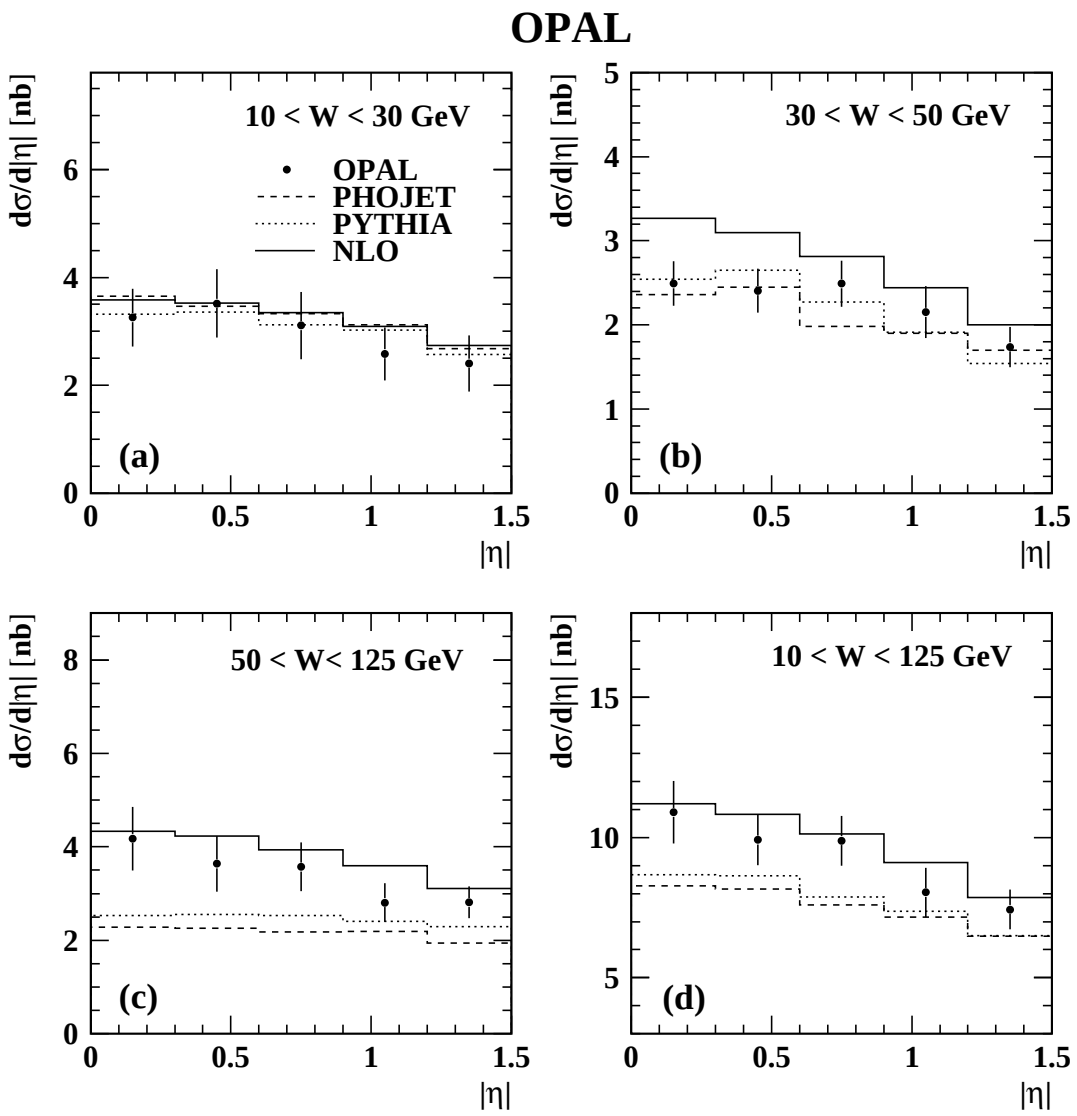
The cross-sections are calculated using the QCD partonic cross-sections in NLO for direct, single- and double-resolved processes.

Results



For the differential cross-section a minimum p_{T} of 1.5 GeV is required to ensure the validity of the perturbative QCD calculation. Even at $p_{\mathrm{T}} = 1.5$ GeV the cross-sections change by up to 80% when varying the renormalisation and factorisation scales by factors of two. This uncertainty decreases rapidly to between 10% and 15% for $p_{\mathrm{T}} = 3.5$ GeV and above.

Results



The differential cross-section $\mathrm{d}\sigma/\mathrm{d}|\eta|$ is restricted to the region $p_{\mathrm{T}} > 3.5$ GeV

Systematic Uncertainties

- The multihadronic background is varied by $\pm 10\%$
  The effect on the measured cross-section is usually 1 % or less for low transverse momenta, increasing to up to 7 % at the highest momenta measured
- Selection criteria based on energy measurements are varied by 5% in the ECAL and HCAL, and by 10% in the FD and SW calorimeters. The number of tracks required is changed by ± 1. The allowed radial distance of the tracks is varied by 5%. The uncertainty on the cross-section derived from all these variations is typically 1-6%
- The distributions obtained from PHOJET and PYTHIA have been reweighted for a better description of the data, below 5%
- Due to the energy scale of the ECAL is up to 4%
- Beam-gas or beam-wall interactions, about 2%

Table

	$50 < W < 125$ GeV	
p_{T} [GeV]	p_{T} [GeV]	$\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}}$ [pb/GeV]
2.00–2.20	2.09	$(4.01 \pm 0.09 \pm 0.15) \times 10^{1}$
2.20–2.40	2.29	$(2.53 \pm 0.07 \pm 0.10) \times 10^{1}$
2.40–2.60	2.50	$(1.76 \pm 0.06 \pm 0.09) \times 10^{1}$
2.60–2.80	2.70	$(1.22 \pm 0.05 \pm 0.06) \times 10^{1}$
3.00–3.50	3.23	$(5.99 \pm 0.22 \pm 0.30) \times 10^{0}$
3.50–4.00	3.73	$(3.33 \pm 0.16 \pm 0.22) \times 10^{0}$
4.00–5.00	4.40	$(1.52 \pm 0.08 \pm 0.15) \times 10^{0}$
5.00–6.00	5.43	$(7.02 \pm 0.83 \pm 0.81) \times 10^{-1}$
6.00–8.00	6.83	$(3.89 \pm 0.45 \pm 0.49) \times 10^{-1}$
8.00–15.00	10.18 ± 0.01	$(8.40 \pm 1.34 \pm 0.90) \times 10^{-2}$
15.00–25.00	18.26 ± 0.09	$(2.46 \pm 0.96 \pm 0.26) \times 10^{-2}$

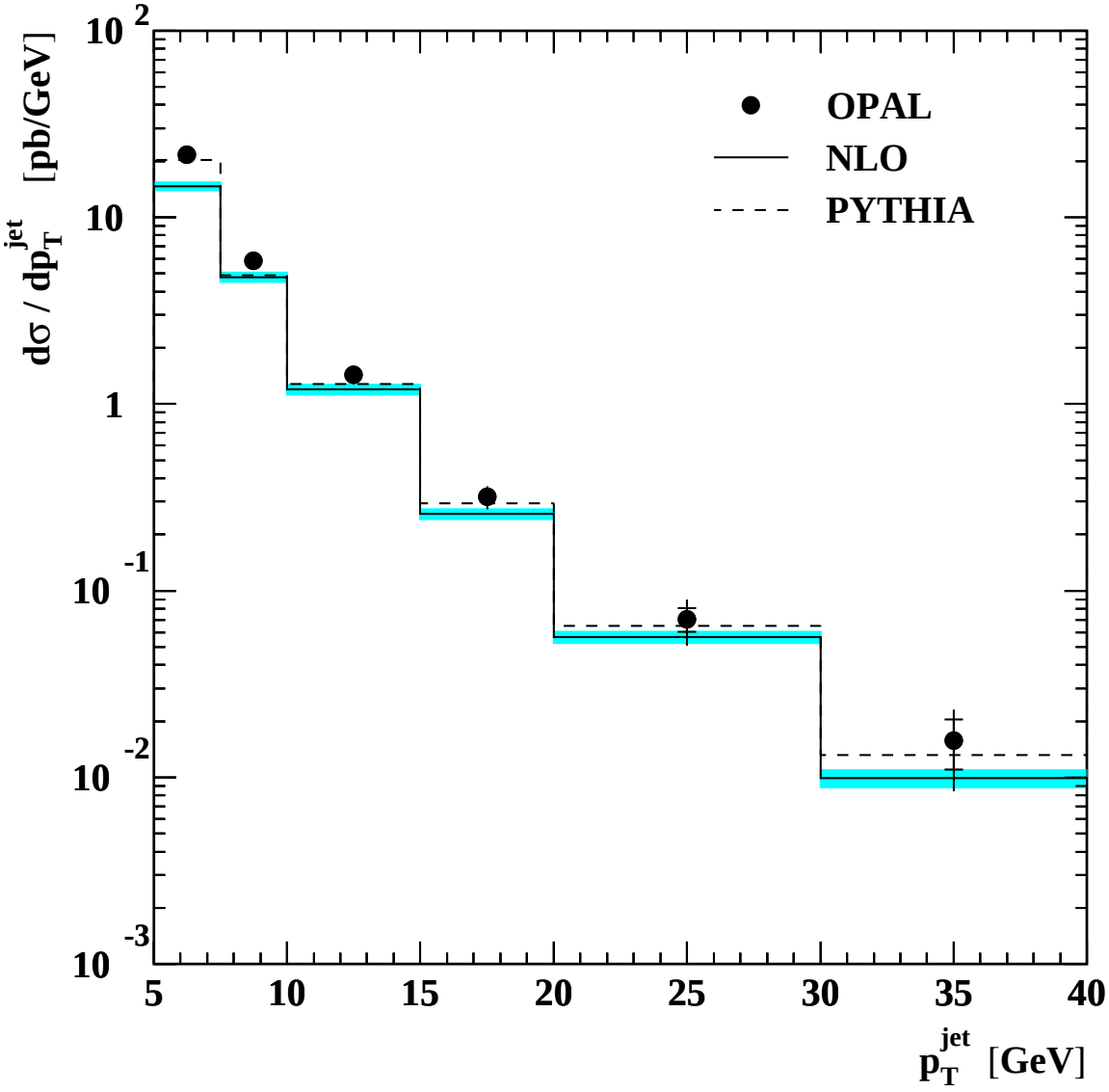
Table 1: Differential inclusive charged hadron production cross-sections $\mathrm{d}\sigma/\mathrm{d}p_{\mathrm{T}}$ for $|\eta| < 1.5$ and in the W ranges $50 < W < 125$ GeV. The first uncertainty is the statistical uncertainty and the second uncertainty is the systematic uncertainty.

Table

	$50 < W < 125$ GeV	
$\lvert\eta\rvert$	$\langle\lvert\eta\rvert\rangle$	$\mathrm{d}\sigma/\mathrm{d}\lvert\eta\rvert$ [pb]
0.0–0.3	0.149	$4.17 \pm 0.27 \pm 0.63$
0.3–0.6	0.449	$3.63 \pm 0.25 \pm 0.53$
0.6–0.9	0.759	$3.57 \pm 0.25 \pm 0.46$
0.9–1.2	1.048	$2.81 \pm 0.23 \pm 0.34$
1.2–1.5	1.345	$2.81 \pm 0.22 \pm 0.25$

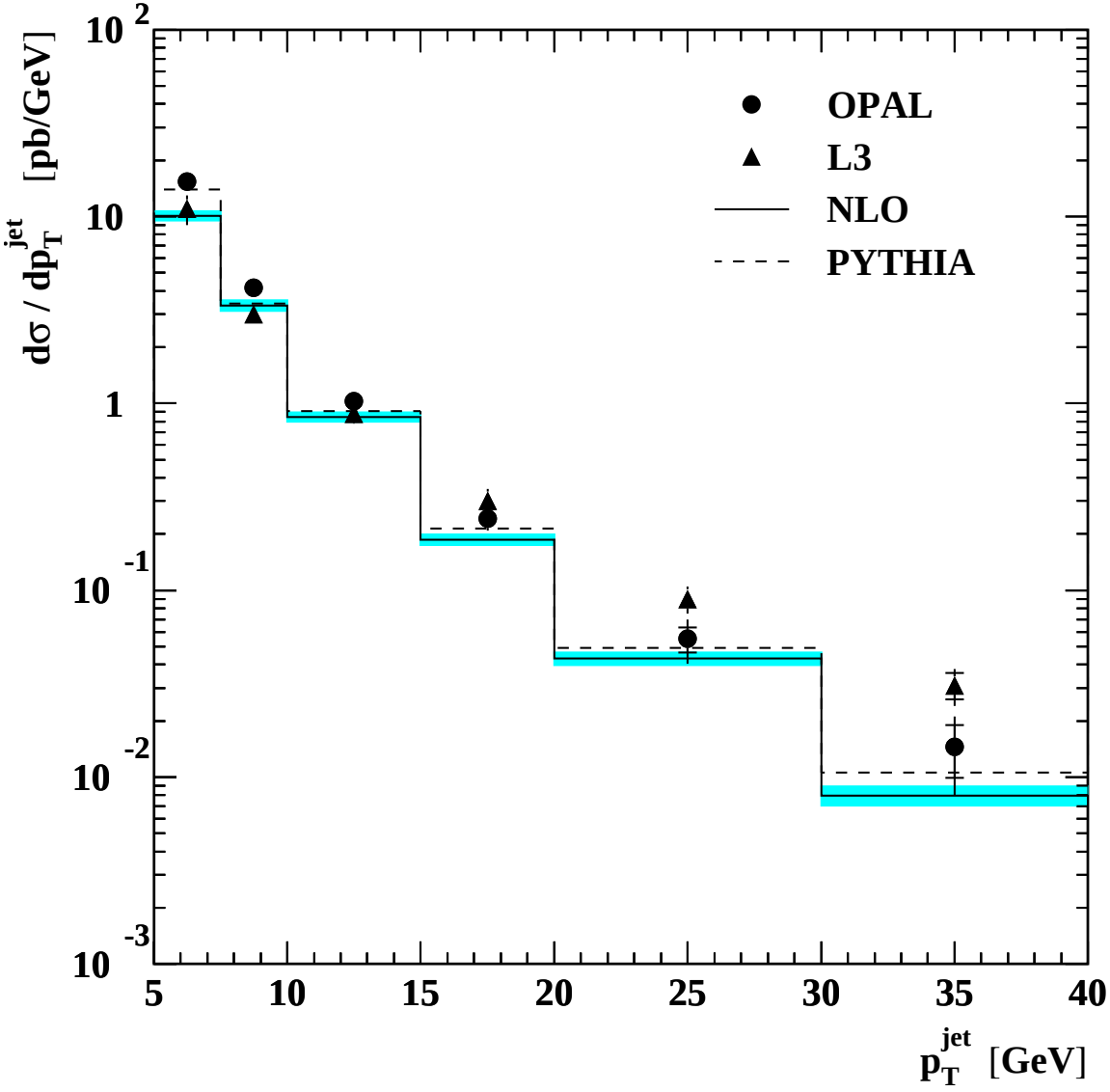
Table 2: Differential inclusive charged hadron production cross-sections $\mathrm{d}\sigma/\mathrm{d}|\eta|$ for $p_{\mathrm{T}} > 3.5$ GeV and in the W range $50 < W < 125$ GeV.

Result



GRV-G HO parametrisation, $\Lambda^5_{DIS} = 131$ MeV
The renormalisation and factorisation scales in the calculation are set equal to p_{T}^{jet}.
Nice agreement with NLO and PYTHIA.

Result



The analysis was repeated with L3's kinematic conditions

Conclusion

- **The inclusive production of charged hadrons and inclusive jet production in the collisions of quasi-real photons has been measured using the OPAL detector at LEP.**
- **The NLO calculation reproduces the data well, but below at large and W and p_{T}**
- **Inclusive charged hadrons distribution measured by OPAL falls more rapidly towards high transverse momenta than those measured by L3**