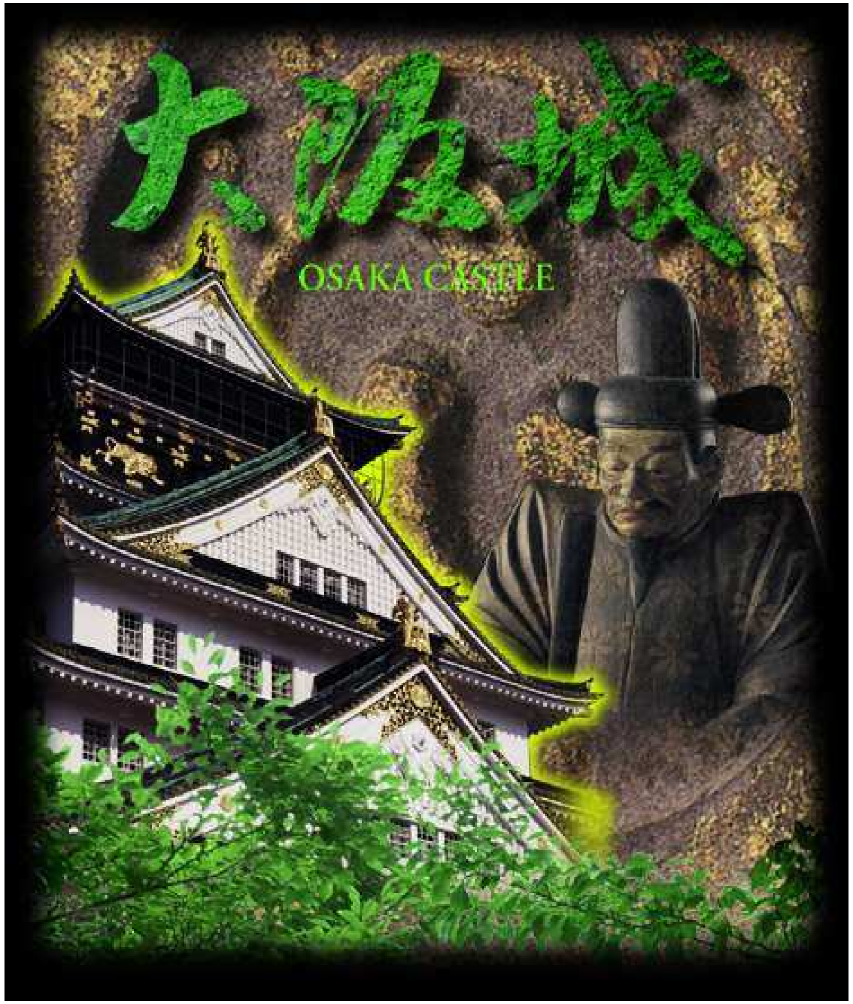
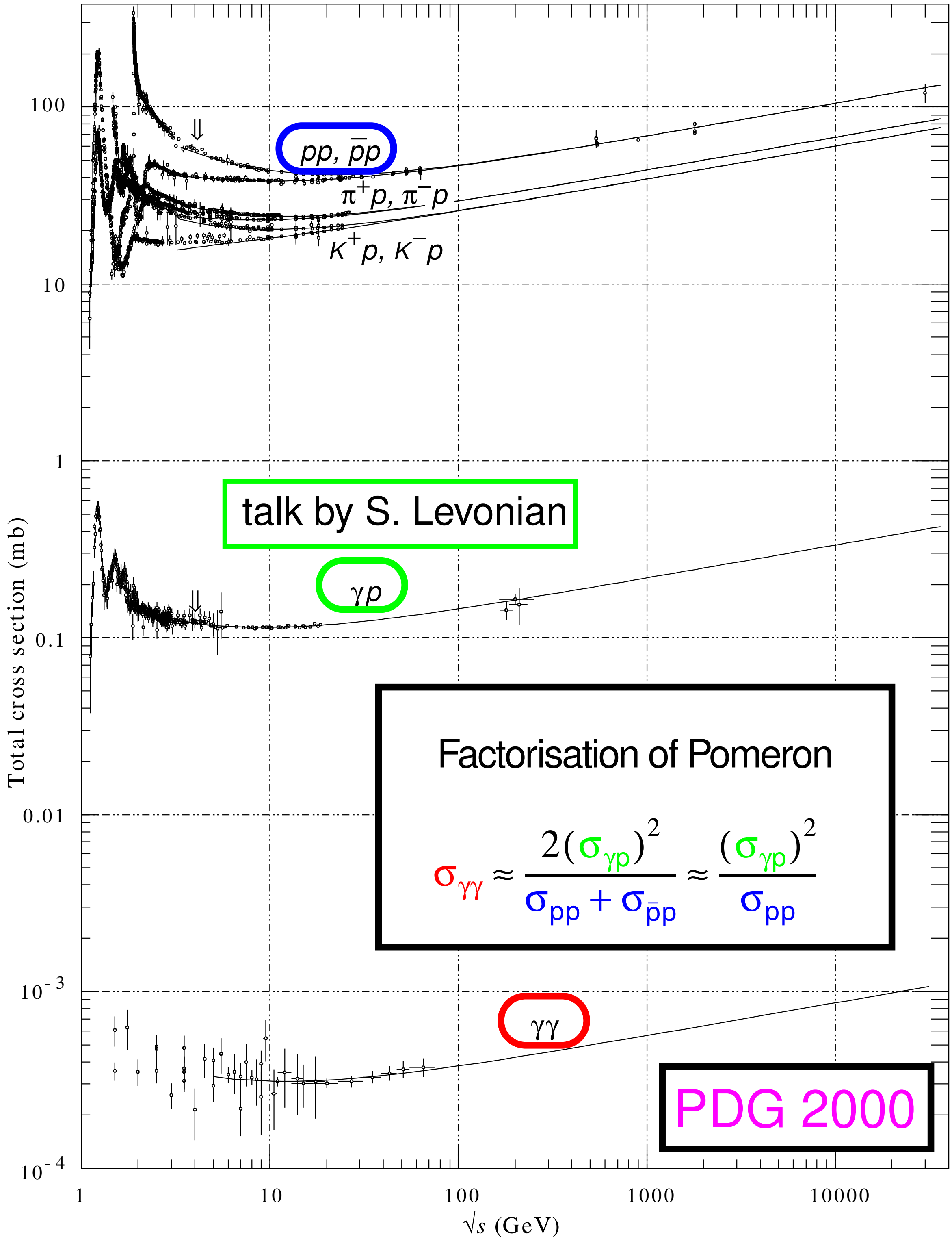
THE HADRONIC PICTURE OF THE PHOTON

- Total $\gamma\gamma$ hadronic cross-section
- Di-Jet Production in $\gamma\gamma$ -collisions
- Summary



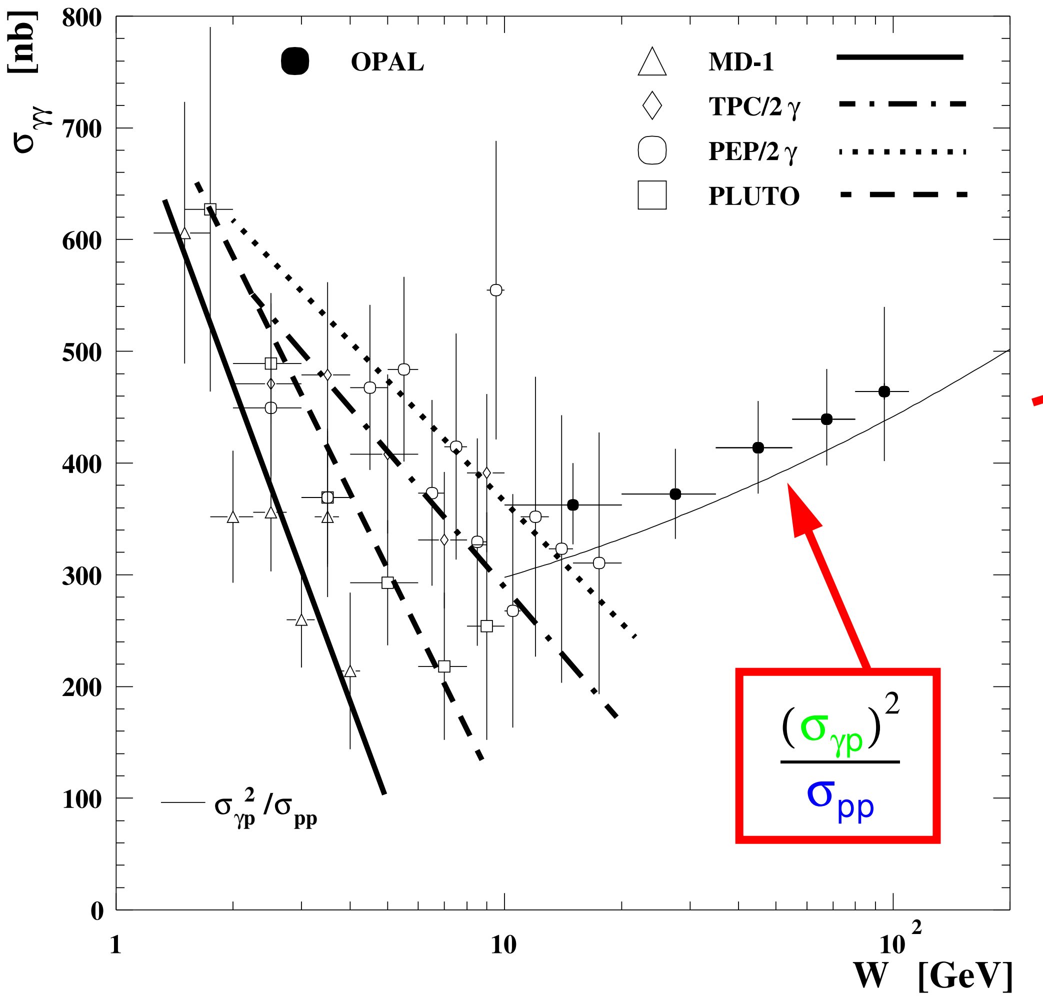
Total hadronic cross-section



$$\sigma_{tot}(s) = As^{\varepsilon} + Bs^{\eta} \pm Cs^{\kappa}$$

$\varepsilon = 0.093(2)$ $\eta = -0.358(15)$ $\kappa = 0.560(17)$

Total hadronic cross-section in $\gamma\gamma$ - collisions



Note: Pre-LEP low W data are inconsistent

The Pomeron factorisation picture works pretty well already

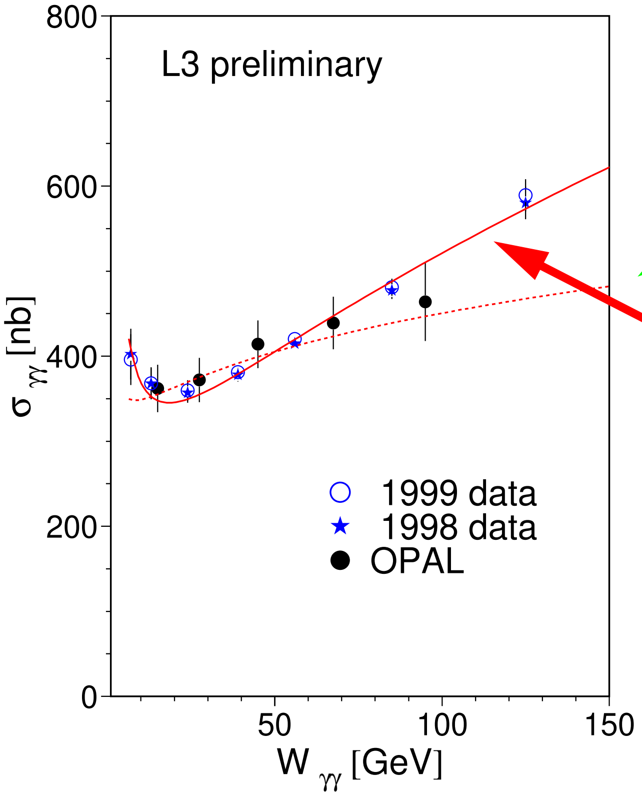
But: Expect steeper rise of $\sigma_{\gamma\gamma}$ due to direct $\gamma\gamma$ interactions

Do fit to $\gamma\gamma$ data:

$$\sigma_{tot}(s) = As^{\varepsilon} + Bs^{\eta}$$

$$\sqrt{s} = W$$

Fits to the $\gamma\gamma$ data



New L3 measurement:

189 to 202 GeV (~ 390 pb^{-1})

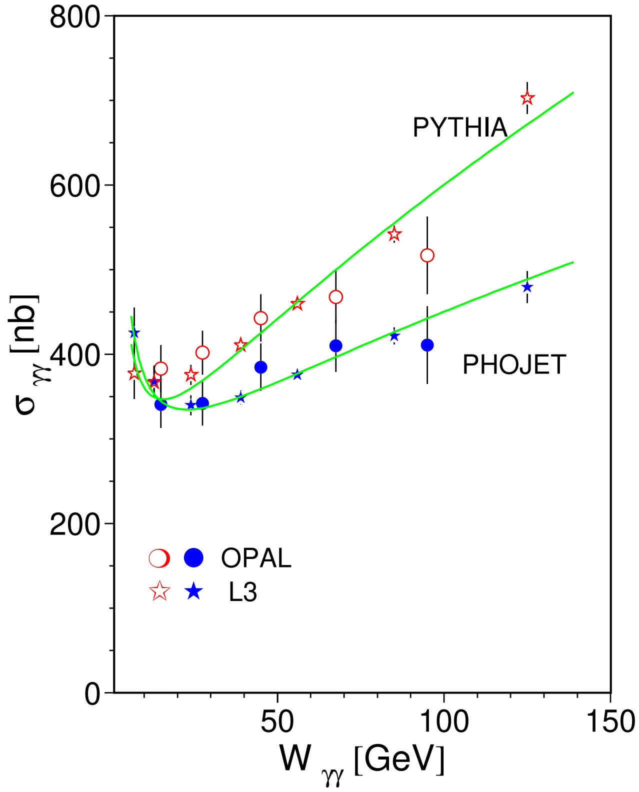
η, ε set to universal values

ε as additional free parameter

$\varepsilon = 0.250 \pm 0.016$

L3 obtains larger ε from very low (Reggeon) and very high W region

OPAL fit: $\varepsilon = 0.101 \pm 0.025$



OPAL and L3 data are consistent

LEP: need to understand increasing model dependence of correction with W (diffraction ?)

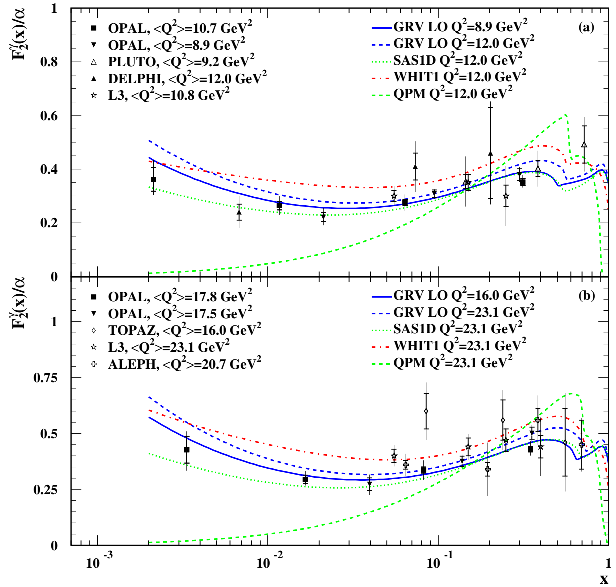
Why di-jet production in $\gamma\gamma$ - collisions

How does the photon behave in interactions ?

How do we find out ?

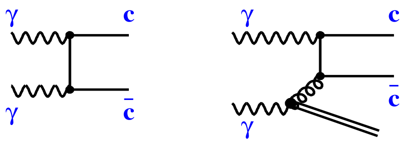
one way is

DIS e-γ scattering

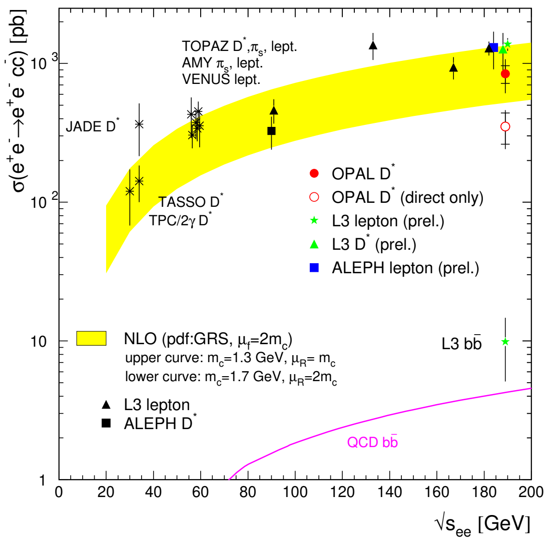


But: mostly (through leading order graphs) sensitive to quark densities, since photon couples to elm. charge

see talk by S. Söldner-Rembold



We also want processes directly sensitive to the gluon



e.g. charm production
(see talk by A. Boehrer)

OR: Di-Jet Production in $\gamma\gamma$ collisions

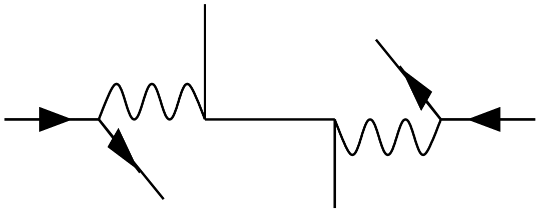
(and γp-collisions: see talk by J.Butterworth)

Studying QCD / Photon Structure with Di-jets

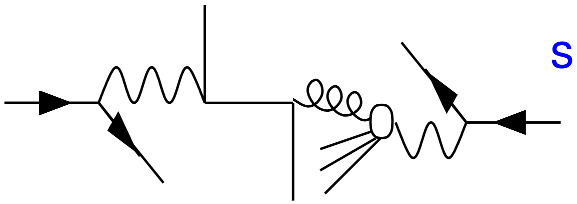
Di-Jet Production Processes
in Photon-Photon collisions . . .

. . . and their separation
(ambiguous at higher orders)

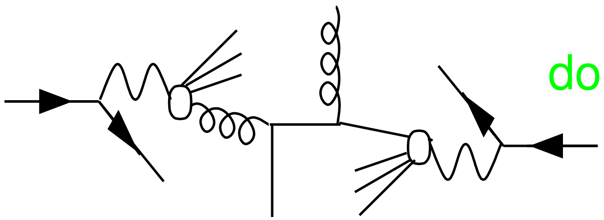
$$x_\gamma^{\pm} = \frac{\sum_{\mathrm{jet1,2}} (E \pm p_z)}{\sum_{\mathrm{hadrons}} (E \pm p_z)}$$



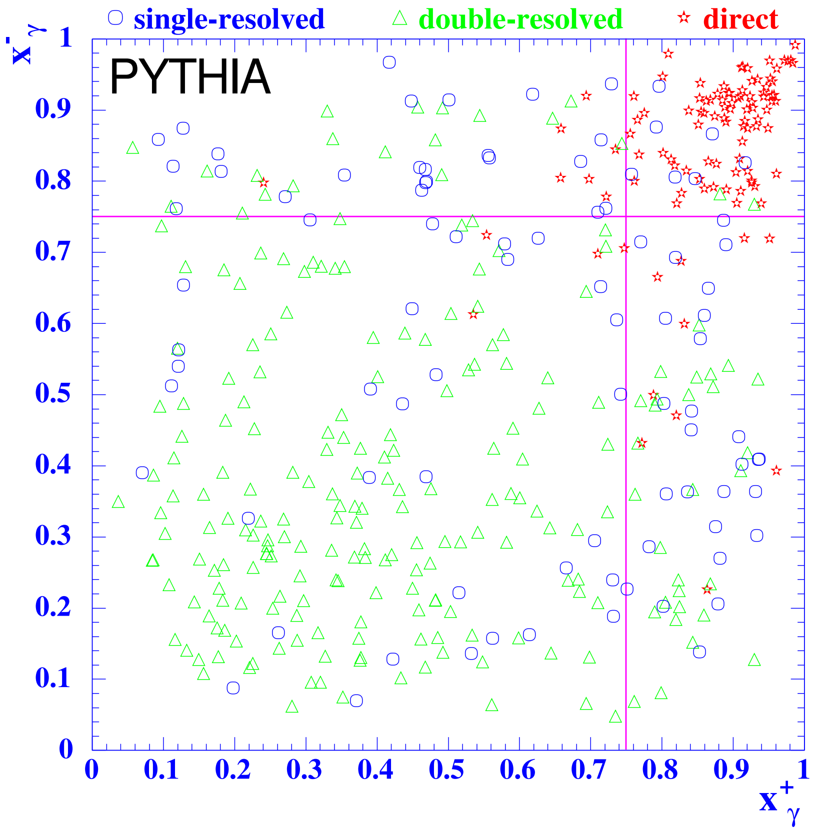
direct



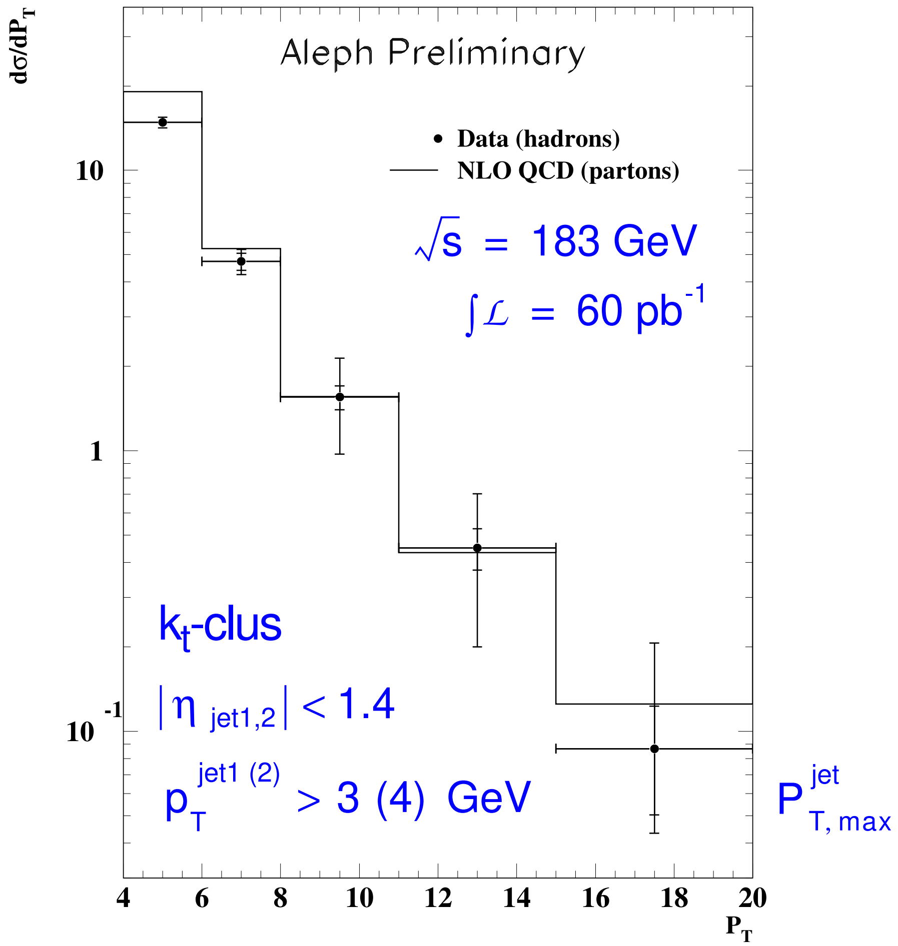
single - resolved

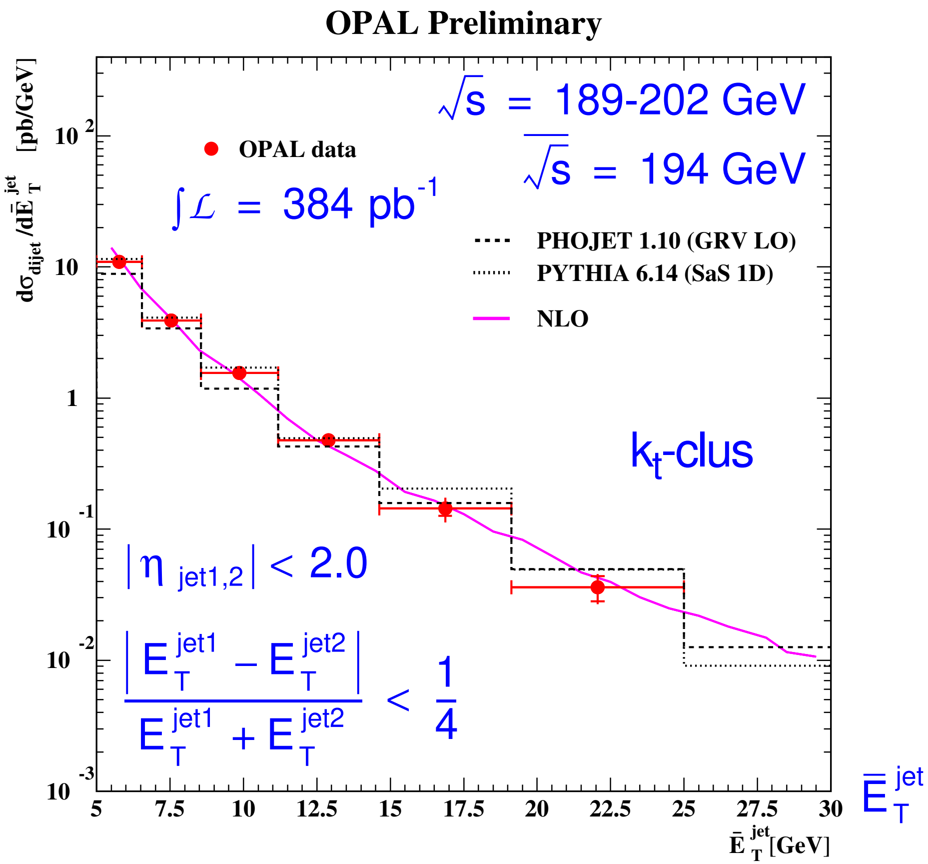


double - resolved



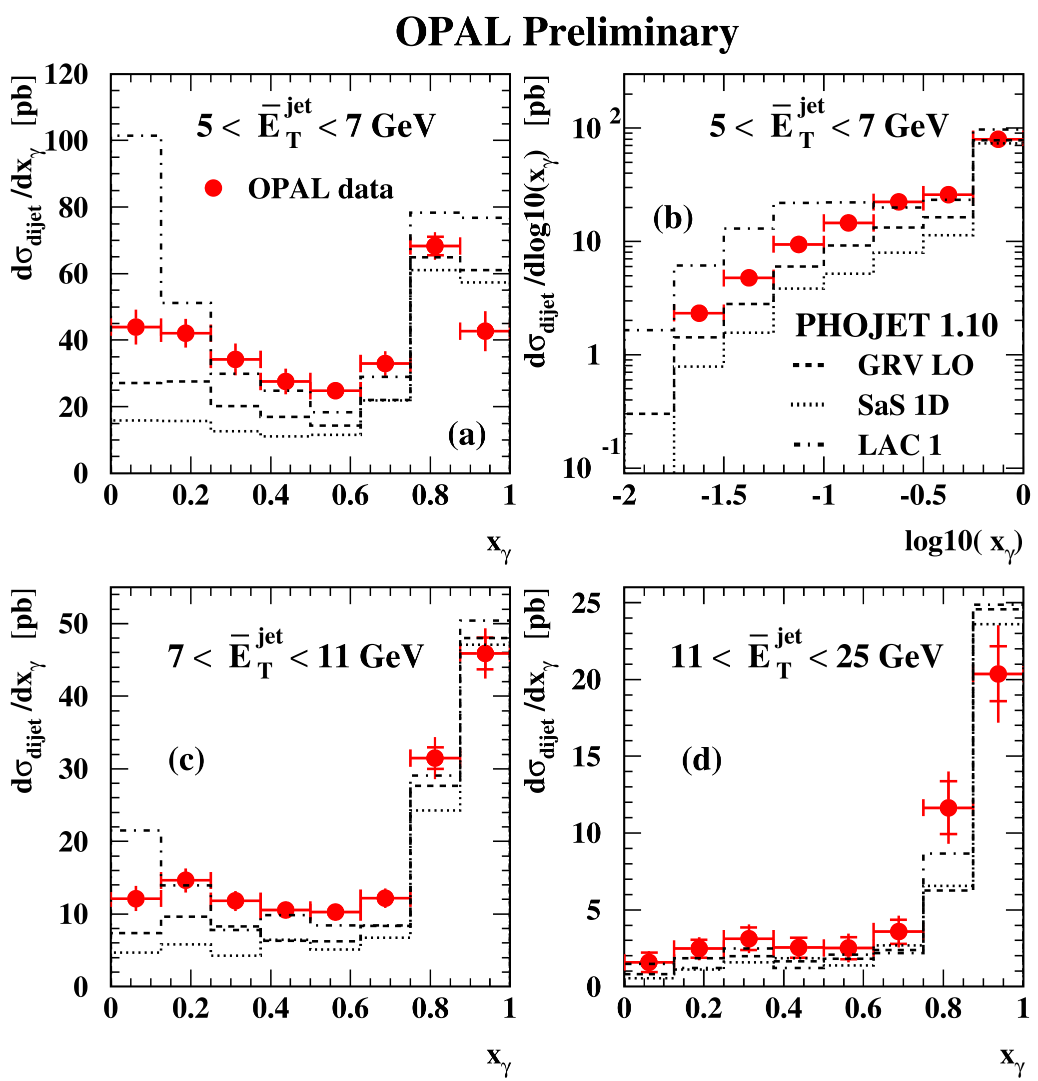
Di-Jet Cross-Sections vs. Transverse Energy





NLO QCD prediction (M.Klasen et. al) describes the data well
(somewhat too high at high Energies ?) ... hadronisation corrections to be studied

Di-Jet Cross-Sections vs. x_γ



First measurement of x_γ - distributions in $\gamma\gamma$ - collisions

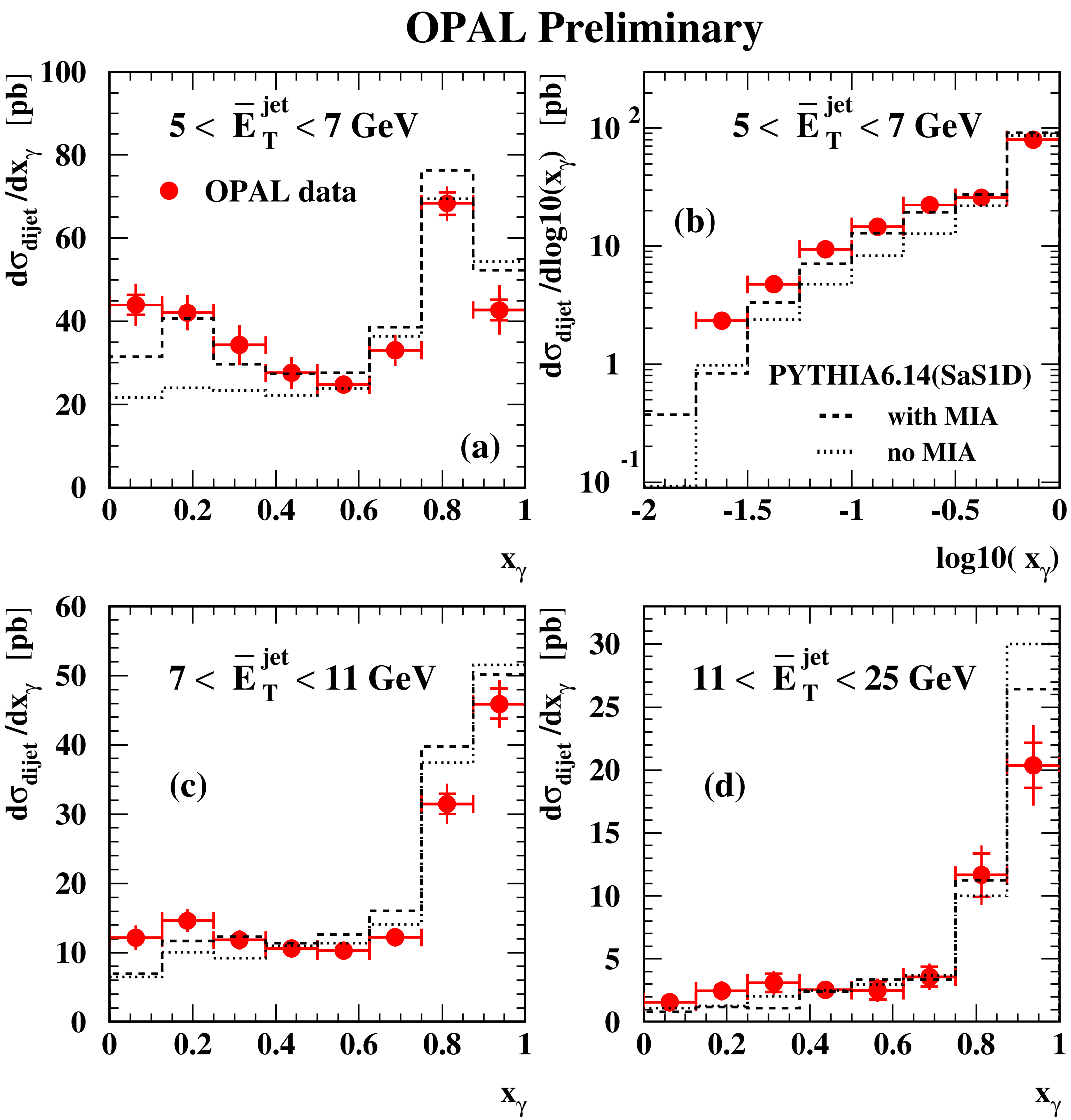
x_γ - distributions unfolded for detector resolution and acceptance

Lowest x_γ reached is ~ 0.02

The various pdf´s used demonstrate the sensitivity to the gluon at low x_γ

GRV LO and SaS1D appear to underestimate the gluon

The Influence of the Underlying Event



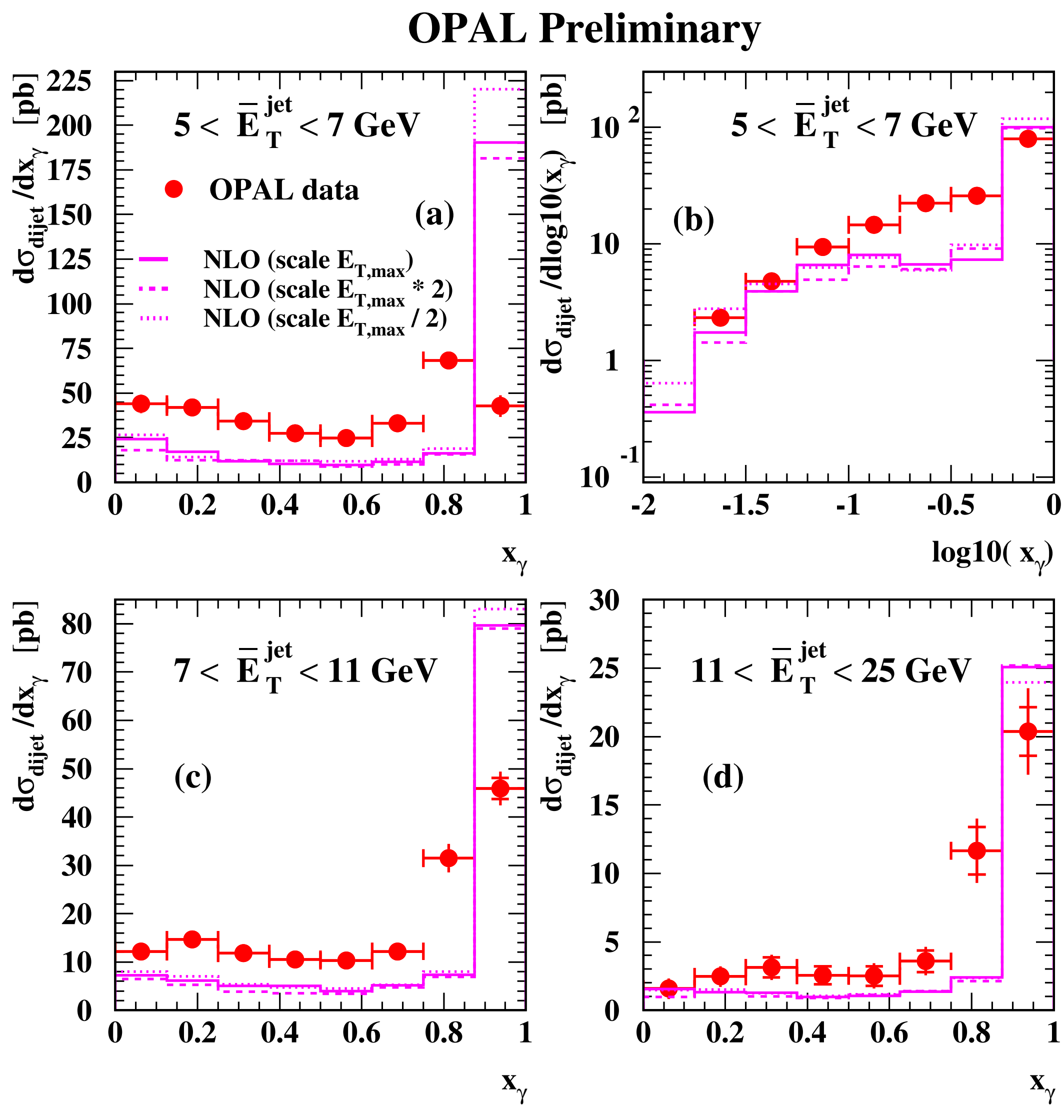
Preliminary study:

Compare data to PYTHIA (SaS1D, $p_{t,\,mia}$=1.4 GeV) with MIA turned on and off

Influence mainly visible at low E_T and x_γ

Higher ET - regions less affected - but still sensitive to low x_γ

The x_γ - distributions in NLO



Hadronisation changes shape - also compare in 2 bins of x_γ:

		data [pb]	NLO [pb]
5 GeV $< \bar{E}_T^{jet} <$ 7 GeV	$x_\gamma > 0.75$	111.0 ± 3.8	206.5
	$x_\gamma < 0.75$	205.5 ± 4.8	84.4
7 GeV $< \bar{E}_T^{jet} <$ 11 GeV	$x_\gamma > 0.75$	77.4 ± 2.6	87.0
	$x_\gamma < 0.75$	71.5 ± 2.2	32.6
11 GeV $< \bar{E}_T^{jet} <$ 25 GeV	$x_\gamma > 0.75$	32.0 ± 2.5	27.4
	$x_\gamma < 0.75$	15.8 ± 1.7	7.5

Large discrepancies at low E_T - better only at high E_T and x_γ

Do we need a larger gluon contribution ?

Summary

Total hadronic $\gamma\gamma$ cross-section

- New measurement by L3 including data up to 202 GeV CME
- The OPAL and L3 measurements are consistent (. . . Pre-LEP low W data are not)
- L3 sees steeper rise of $\sigma_{\gamma\gamma}$ than σ_{had} (due to very low/very high W points)

Di-Jet Production in $\gamma\gamma$ - collisions

- New measurements by ALEPH (183 GeV) and OPAL (189-202 GeV)
- Transverse energy / momentum distributions described by NLO
- First measurement of x_γ - distributions down to 0.02 in bins of E_T by OPAL
- First studies show sensitivity to gluon exceeding the influence of MIA
- First comparisons suggest that gluon is underestimated in GRV and SaS1D

Thanks to M.Klasen for providing the NLO calculations