Di-jet production in $\gamma\gamma$ collisions in OPAL

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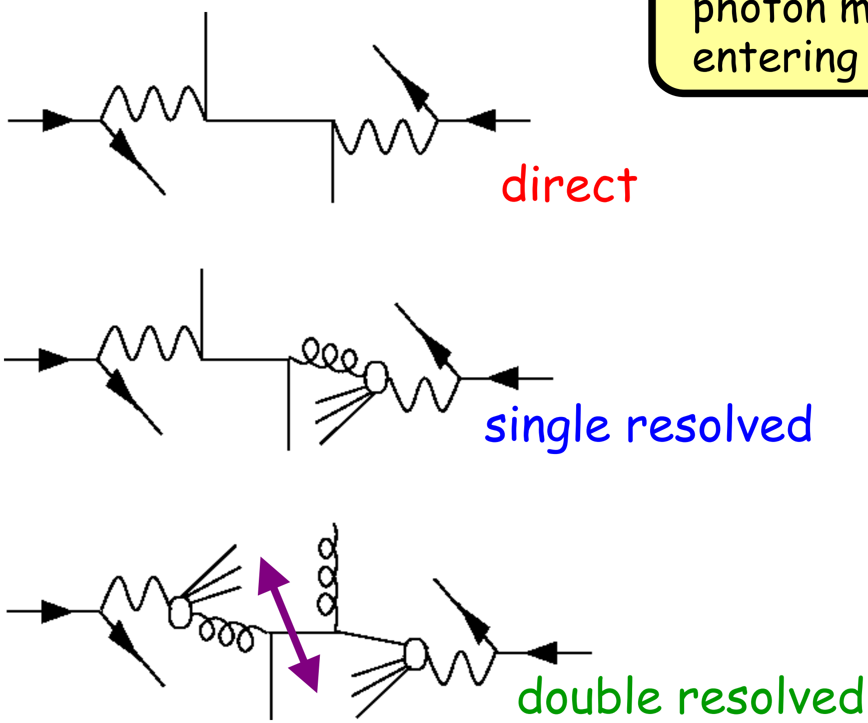
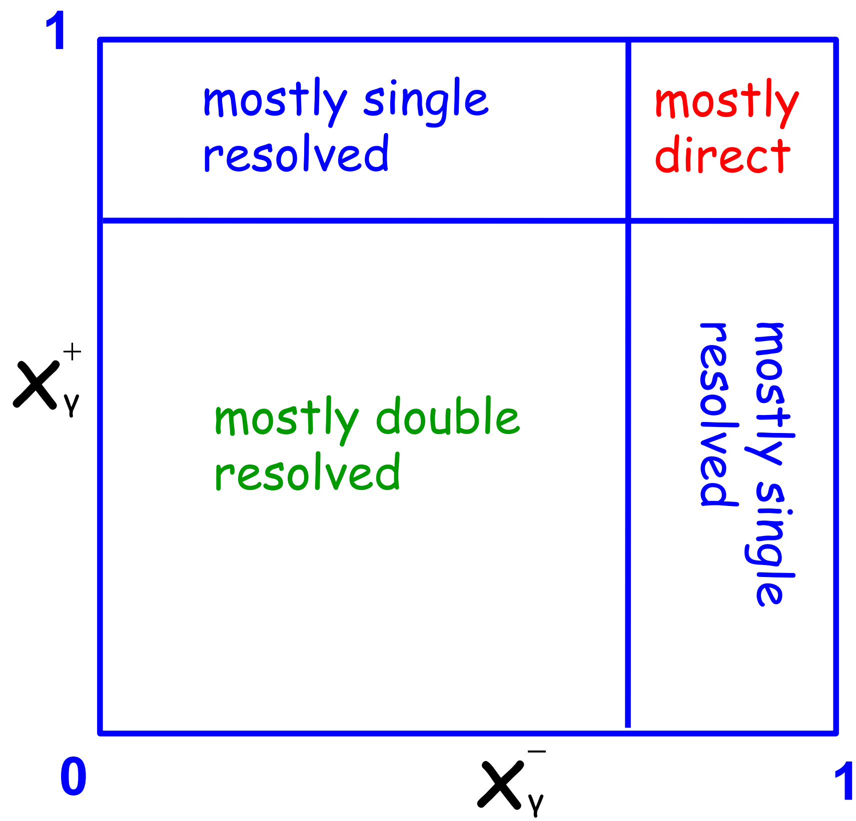
Photon 2003
Organised by the Laboratori Nazionali di Frascati

Di-jet production mechanisms in $\gamma\gamma$-collisions

Estimate of fraction of photon momentum entering hard collision

$$x_\gamma^\pm = \frac{\sum_{\text{jet}1,2} E \pm p_Z}{\sum_{\text{hadrons}} E \pm p_Z}$$





multiple parton interactions (MIA)?

Data selection and background

Data sample

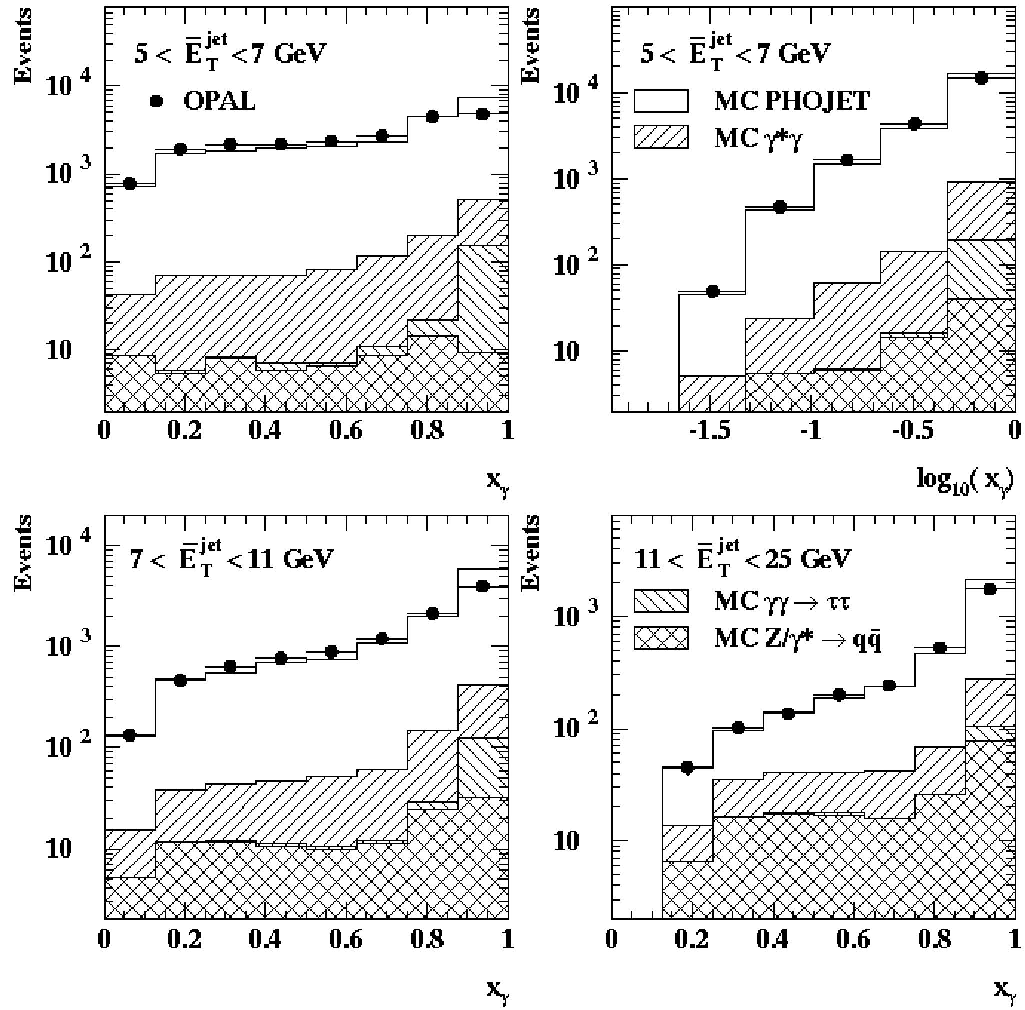
- $\sqrt{s}$= 189-209 GeV, $\mathcal{L}$ = 593 pb^{-1}

Standard $\gamma\gamma$ event selection:

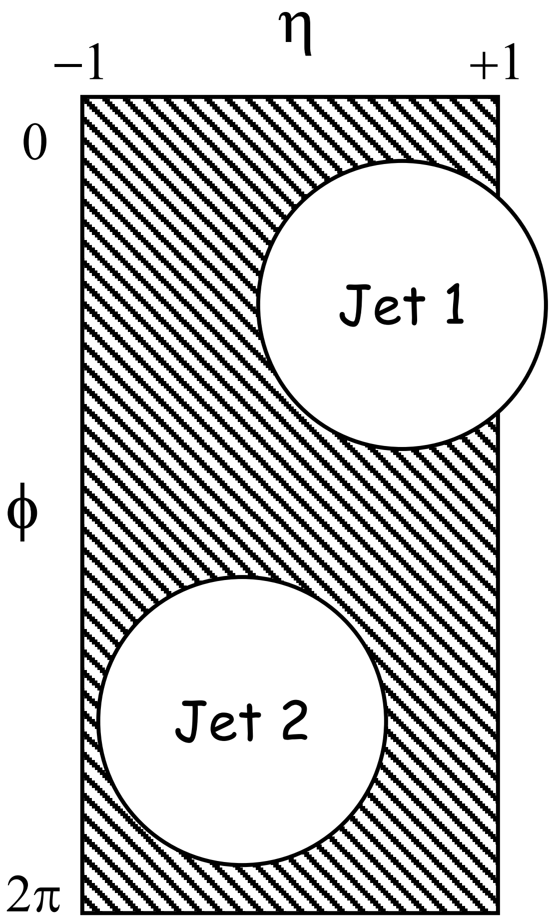
- ΣE_{calo} & (Leading jet ,opposite hemisphere)$_{inv.mass}$ < 55 GeV
- Number of tracks > 6
- Antitag in forward detectors
- Quality cuts on missing momentum, vertex position
- Total remaining background is about 5%

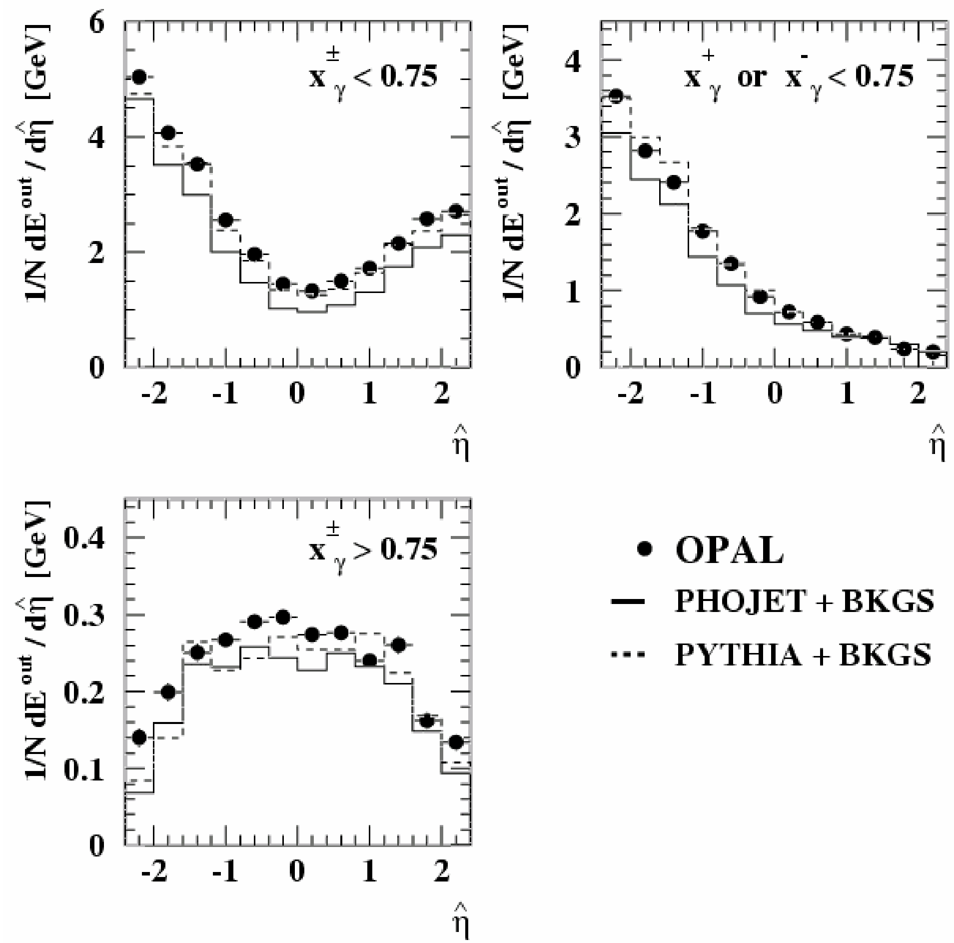
Jet selection

- Inclusive $k_\perp$ with R_0=1.0
- Cone with $\eta\phi$-radius = 1.0 for jet structure comparisons



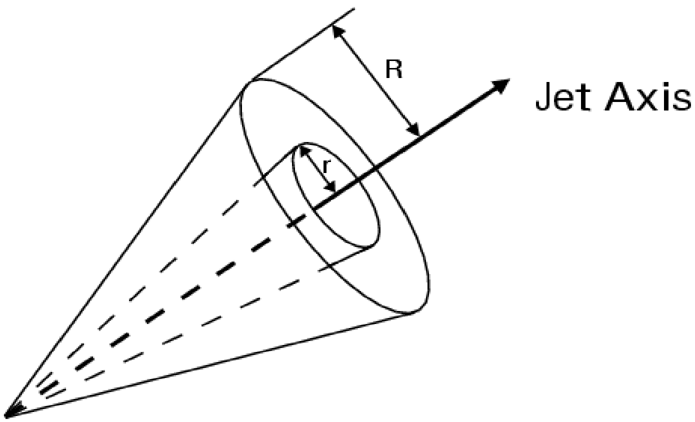
Energy flow outside the two leading jets





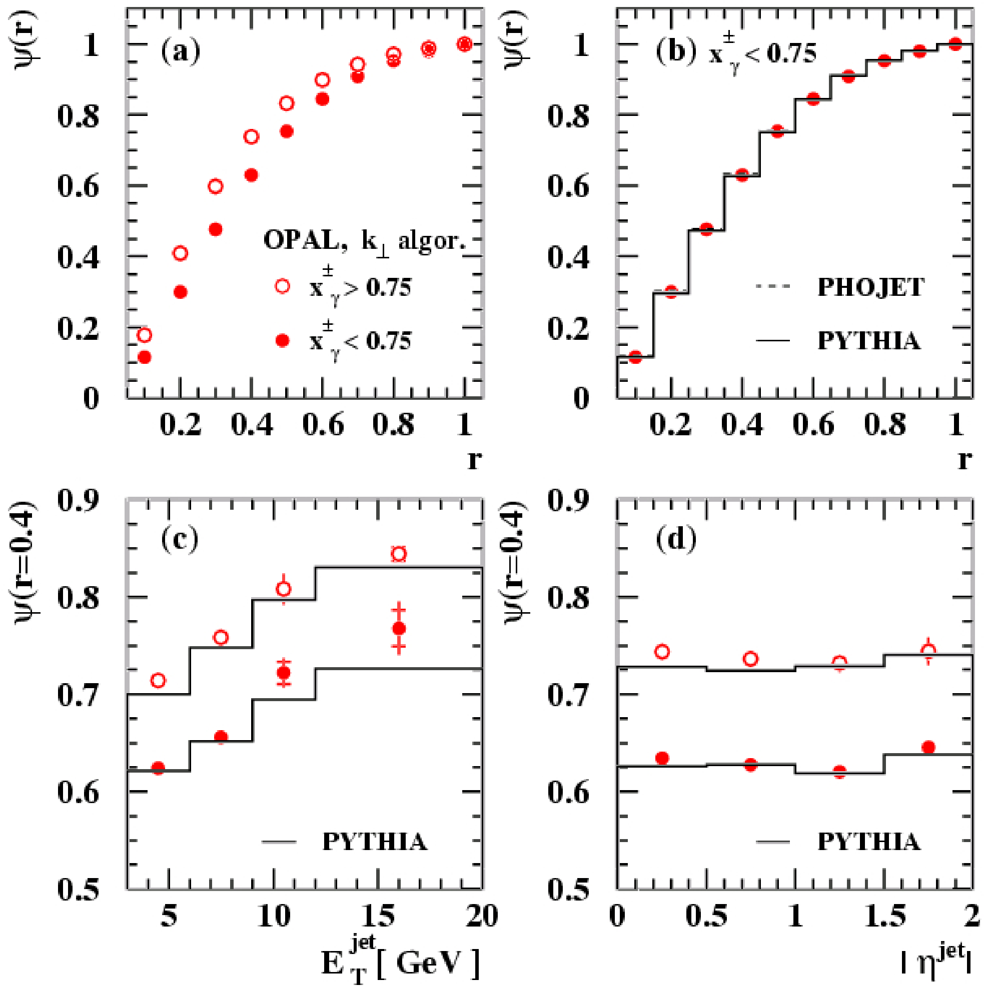
Energy flow in shaded region vs. η ordered by x_γ (more resolved γ is left)

The internal structure of jets: quarks vs. gluons

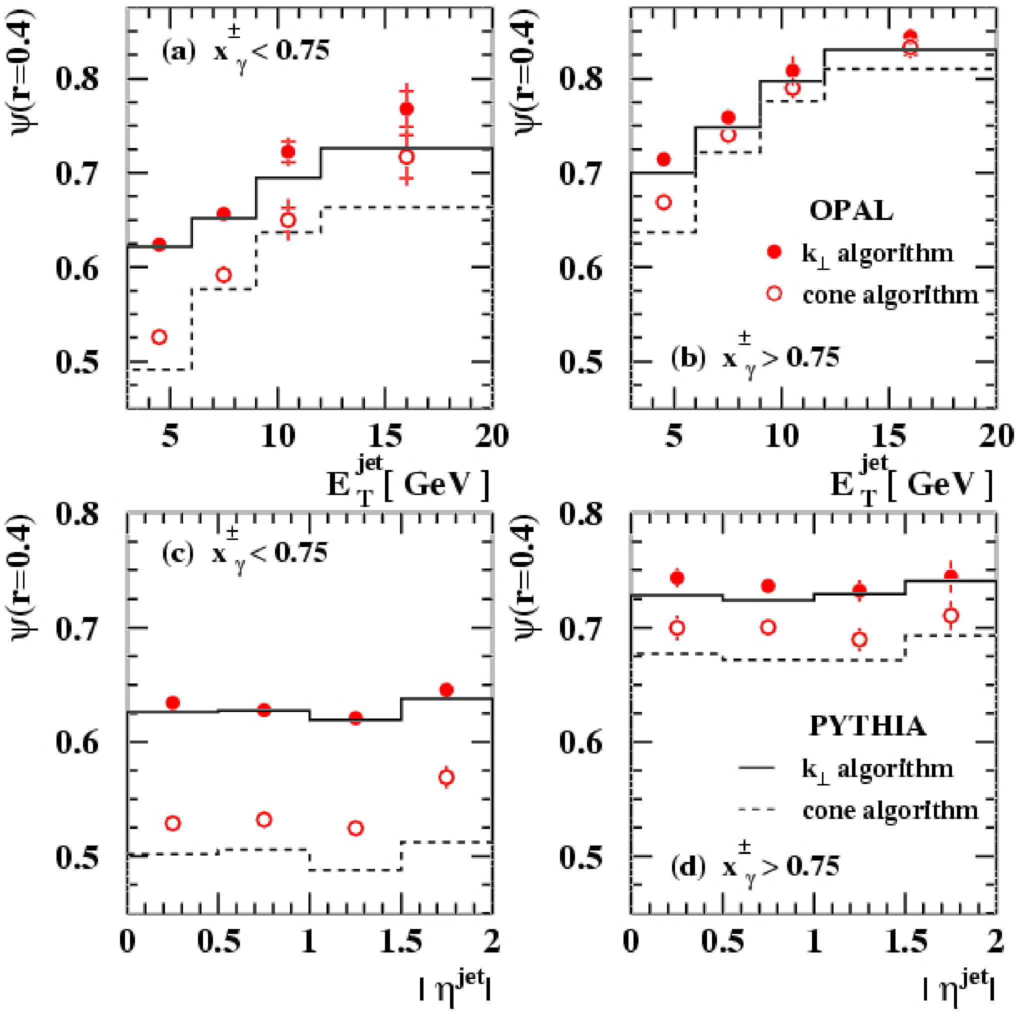


$$\psi(r) = \frac{1}{N_{jets}} \sum_{jets} \frac{E_T^{jet}(r)}{E_T^{jet}(R = r\,|_{1.0})}$$

$$r = \sqrt{(\Delta\eta)^2 + (\Delta\varphi)^2}$$



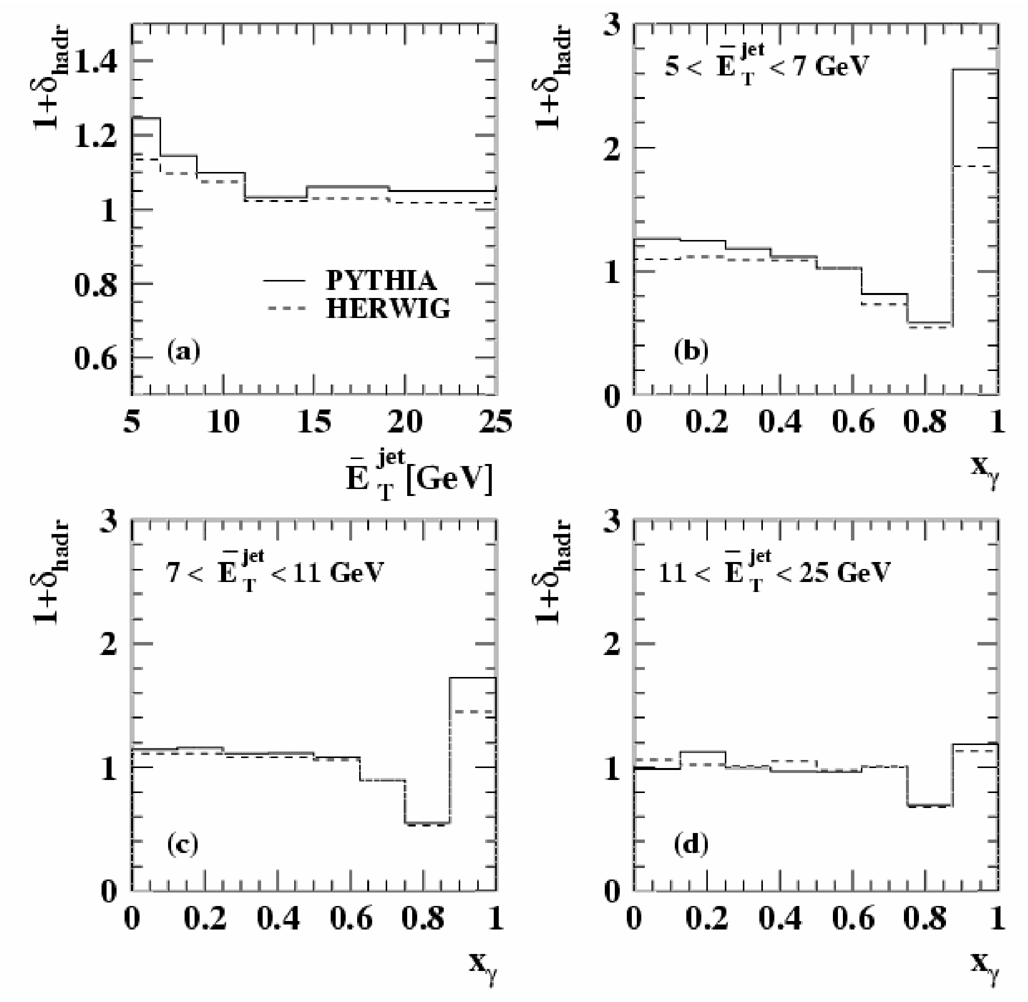
The internal structure of jets cont.



Quark jets are more collimated than gluon jets, but both show the same dependence on E_T and η

$k_\perp$ jets are more collimated than cone jets and are better described by the Monte Carlo

Example of hadronisation corrections

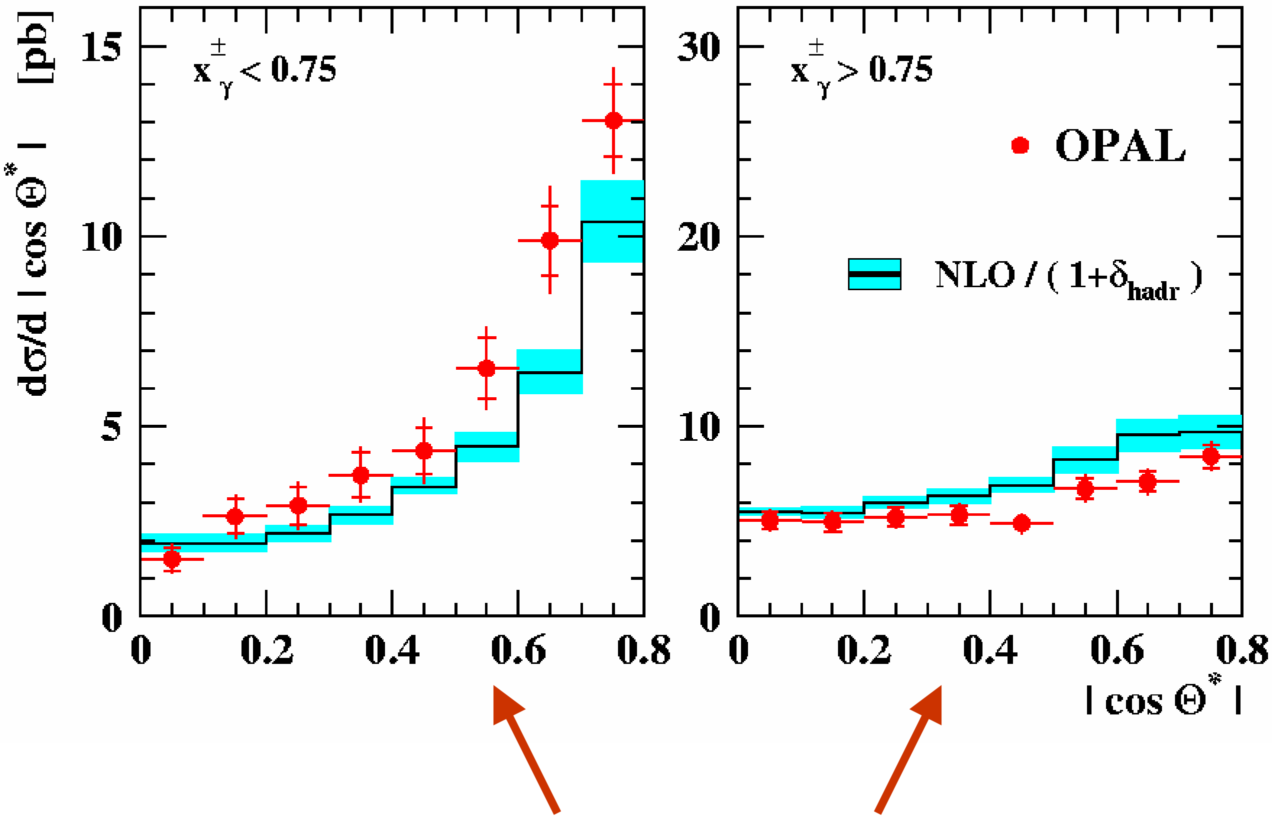


Large corrections at $x_\gamma \approx 1$
(better look at sum of the highest two bins in x_γ)

At high ET hadronisation corrections are small ~ 5%

Di-jet angular distributions: quarks vs. gluons

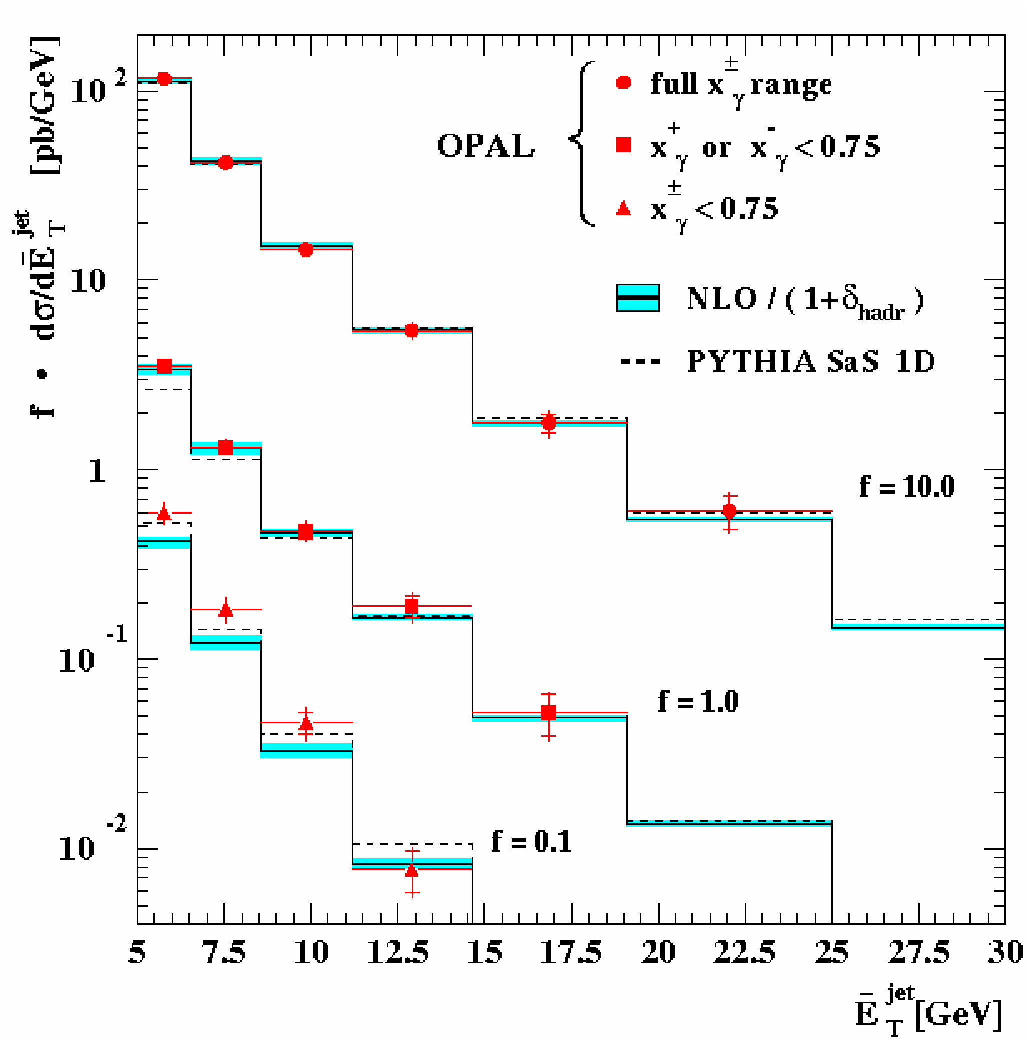
NLO: Klasen et al.



$$= \left| \tanh\left(\frac{\eta_1^{jet} - \eta_2^{jet}}{2} \right) \right|$$

Different shape for gluon and quark dominated sample

The di-jet cross-section vs. mean E_T^{jet}



Well described by NLO for total sample and

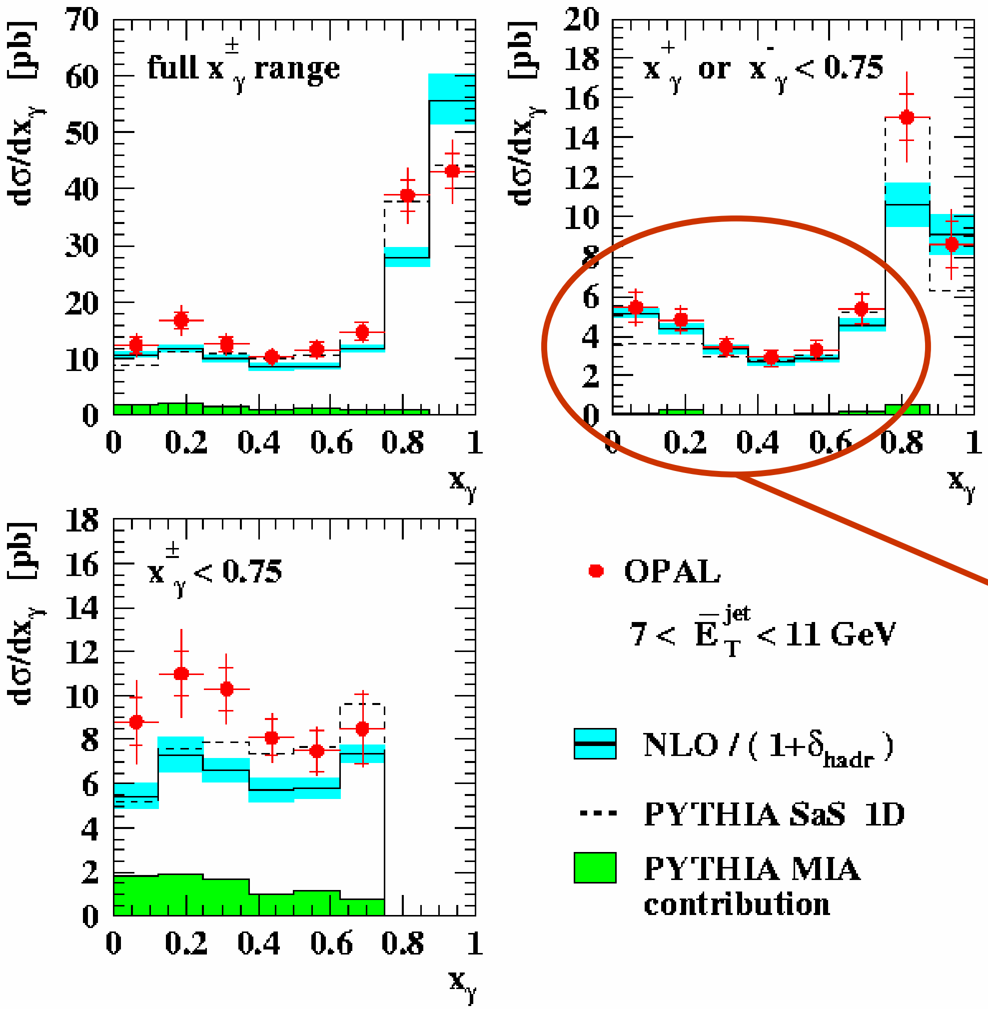
"single resolved enhanced"

But too low for

"double resolved enhanced"

Which might be due to …

The di-jet cross-section vs. x_γ



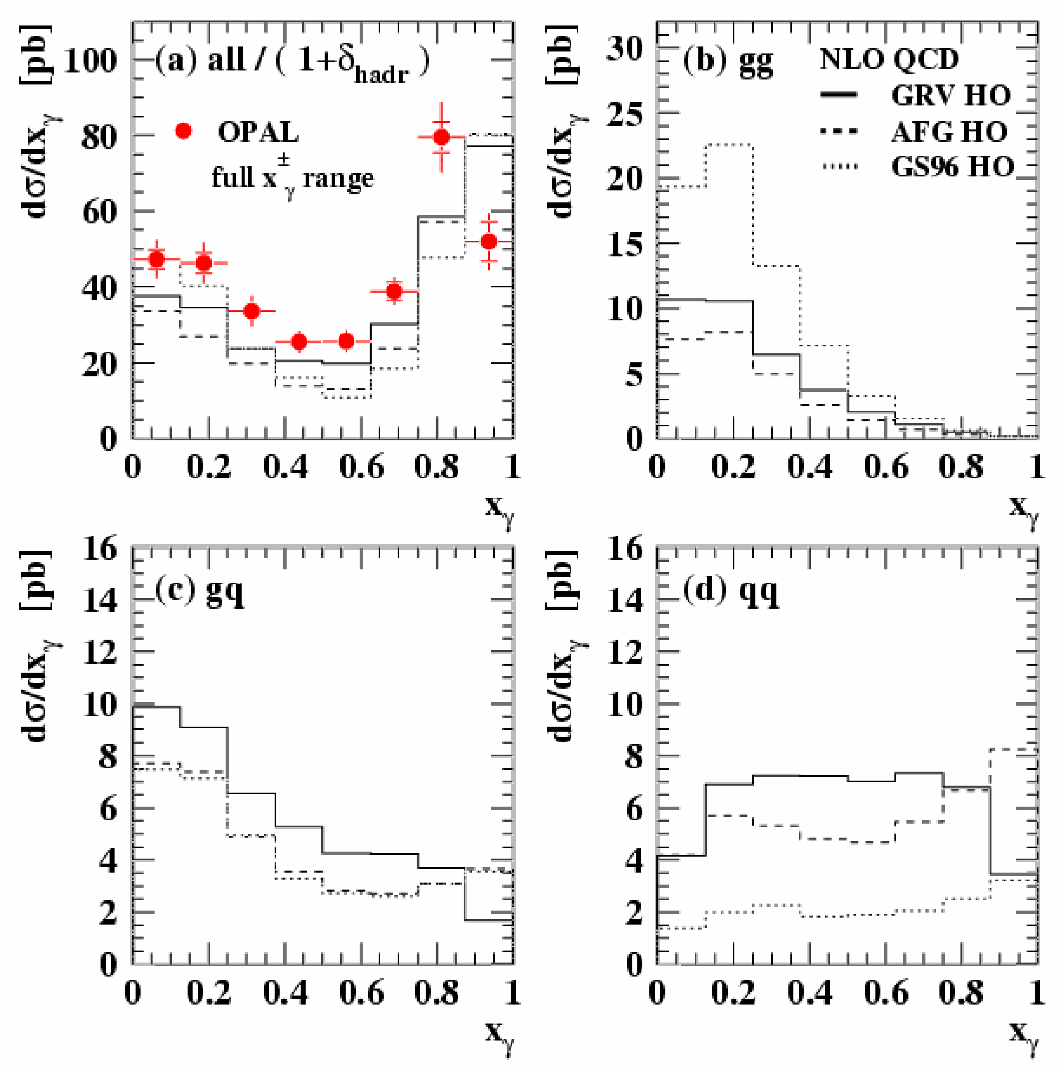
…MIA, which (PYTHIA says), are very small for single res. enhanced sample, as expected.

↓

Small hadronisation corrections and no disturbance from MIA

NLO should work here – and it does!

The influence of the choice of PDF on NLO



Gluonic processes are very sensitive to the amount of glue at low xg

But for the cross-section this is compensated by inverse behavior of quark densities

Need global fit to fix both at the same time …

Conclusions

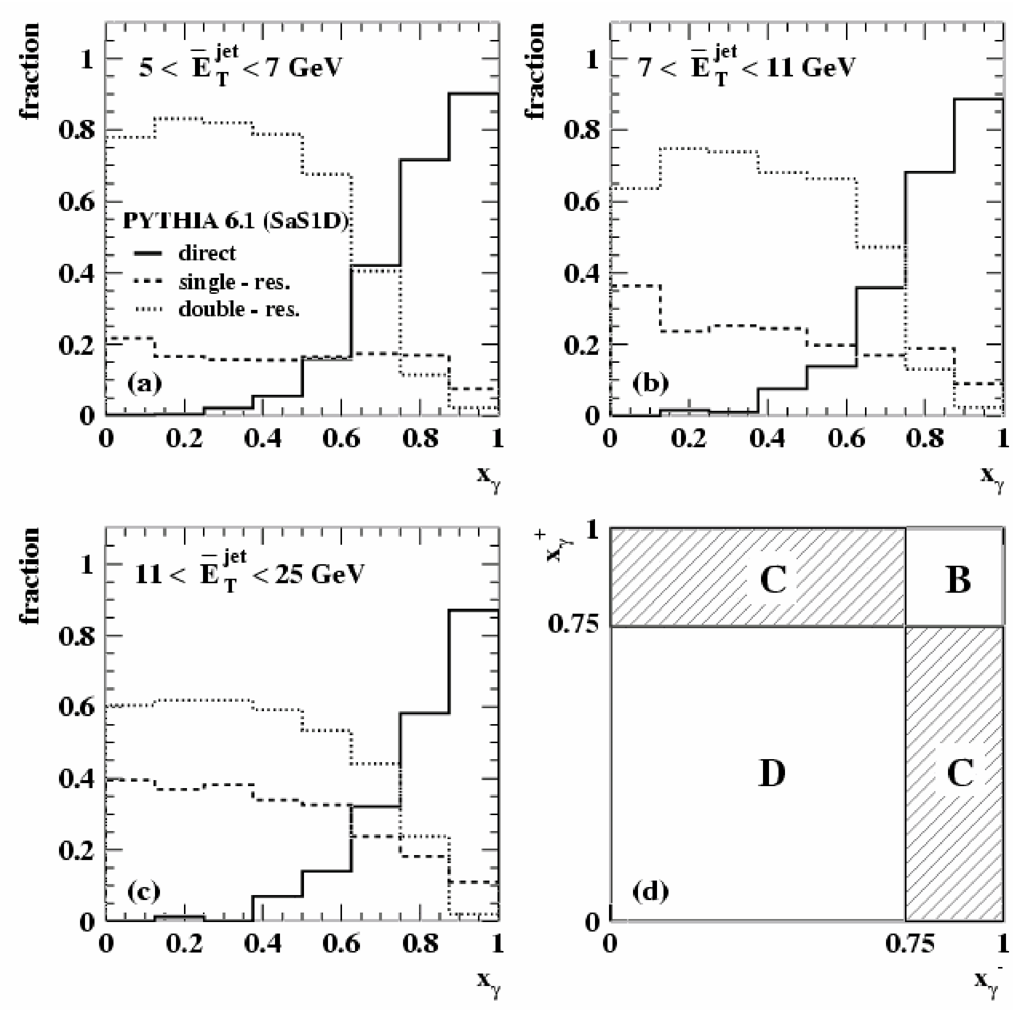
We have studied di-jet production in 593pb^{-1} of data taken at $\sqrt{s}$ from 189 to 209 GeV

Quark and gluon dominated sub-samples are studied and show the behavior expected from QCD for jet structure and angular distributions

Di-jet cross-section are measured in regions with small and regions with large expected contributions from MIA

NLO QCD agrees well with the data in regions where it is expected to be reliable.

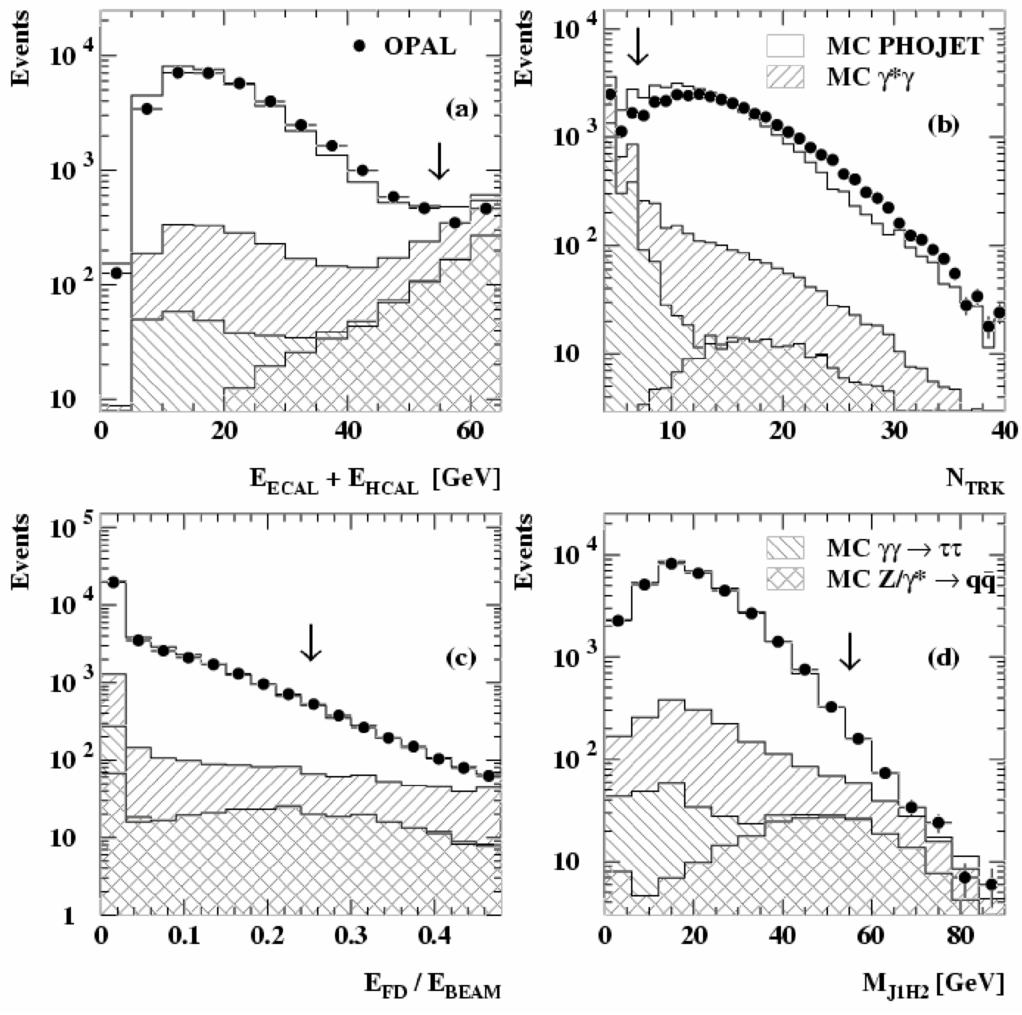
Resolved vs. direct event fractions



For higher jet energies the fraction of resolved events at low x_γ is still high

(but the cross-section decreases)

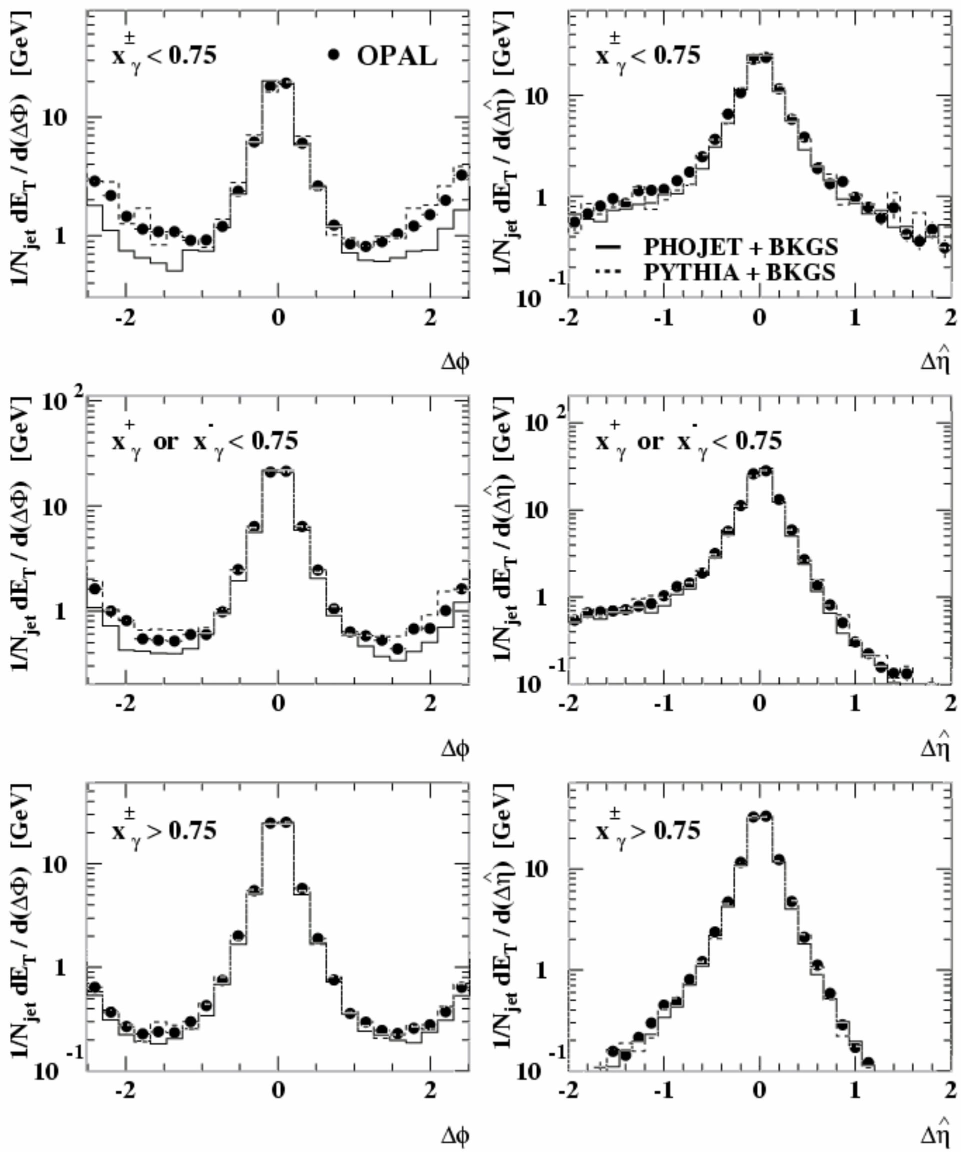
Selection of the γγ-sample



The arrows indicate the cut value

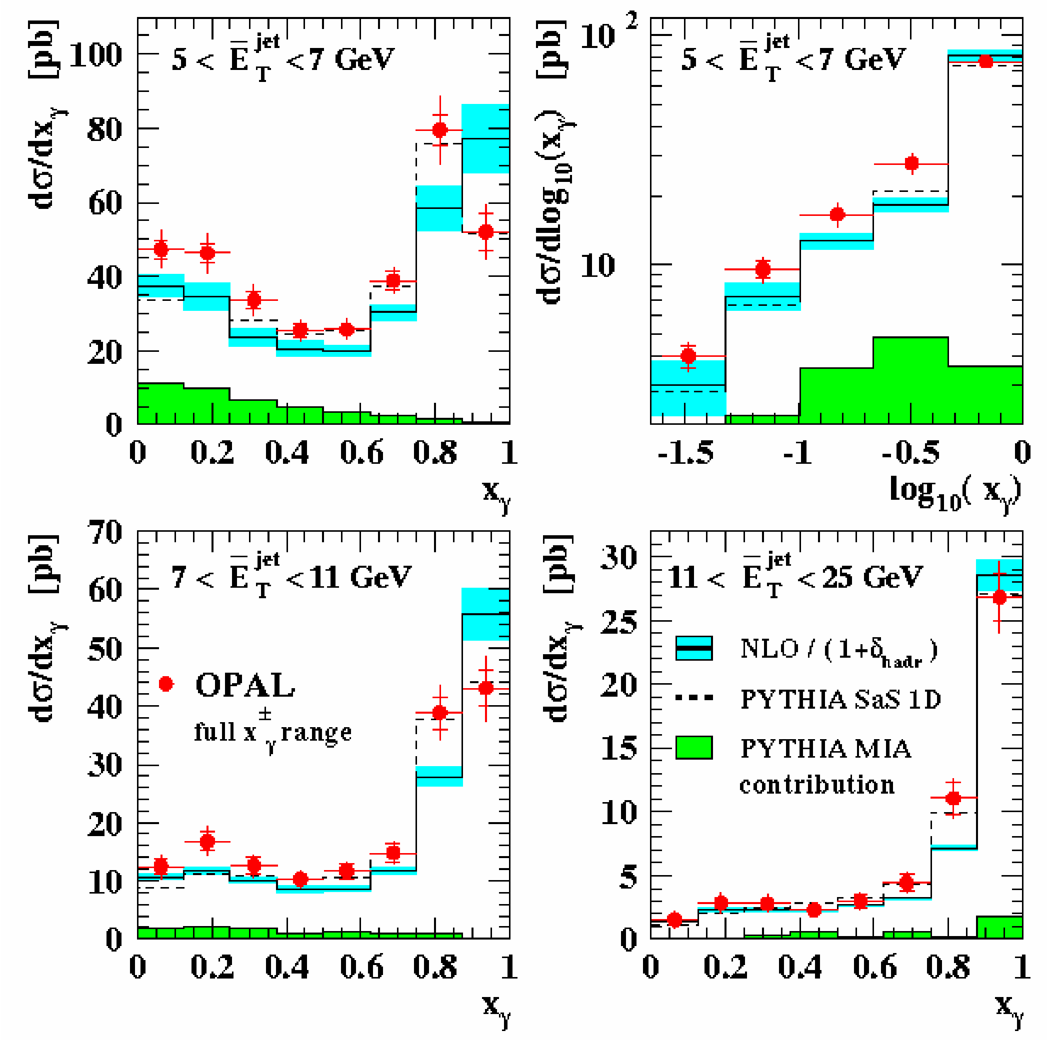
In each case all cuts are applied except on the quantity shown

Energy flow around jets (jet profiles)



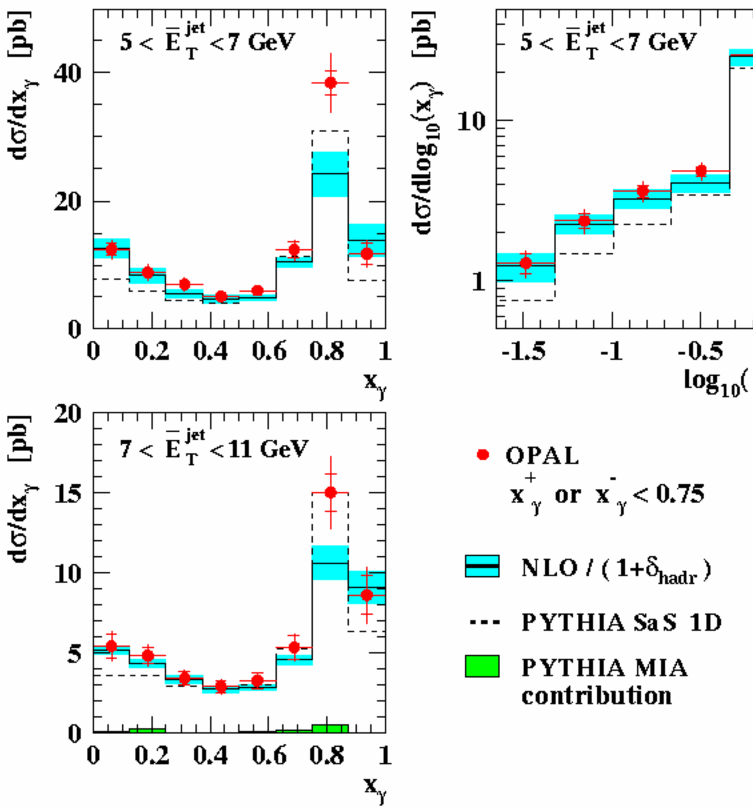
Some discrepancy for PHOJET in region between jets, but well described by Monte Carlo in general

The di-jet cross-section vs. x_γ

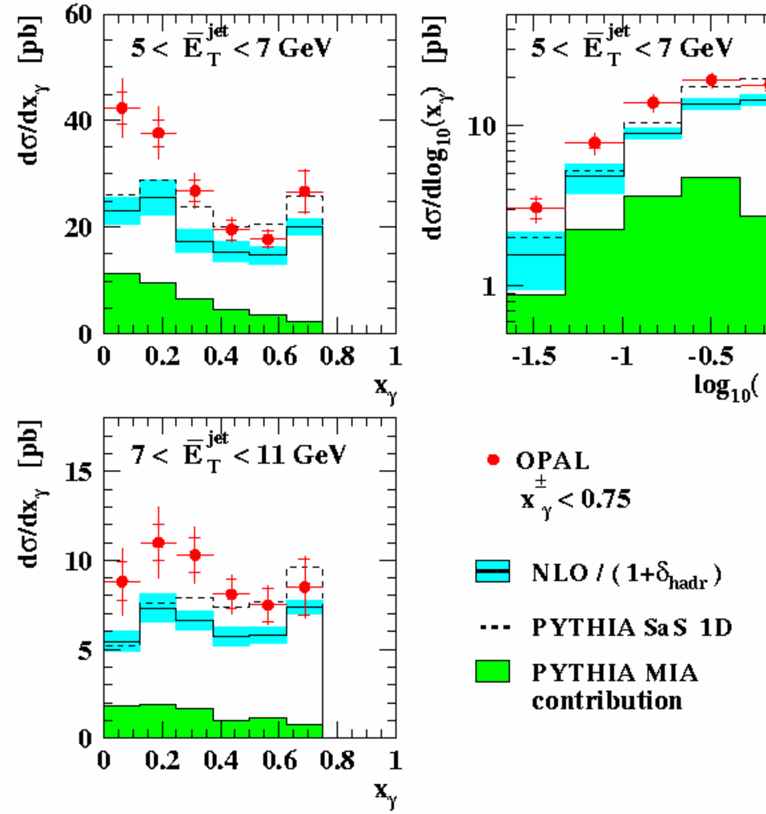


Measurement for the full x_γ^- - x_γ^+ - space

The di-jet cross-section vs. x_γ

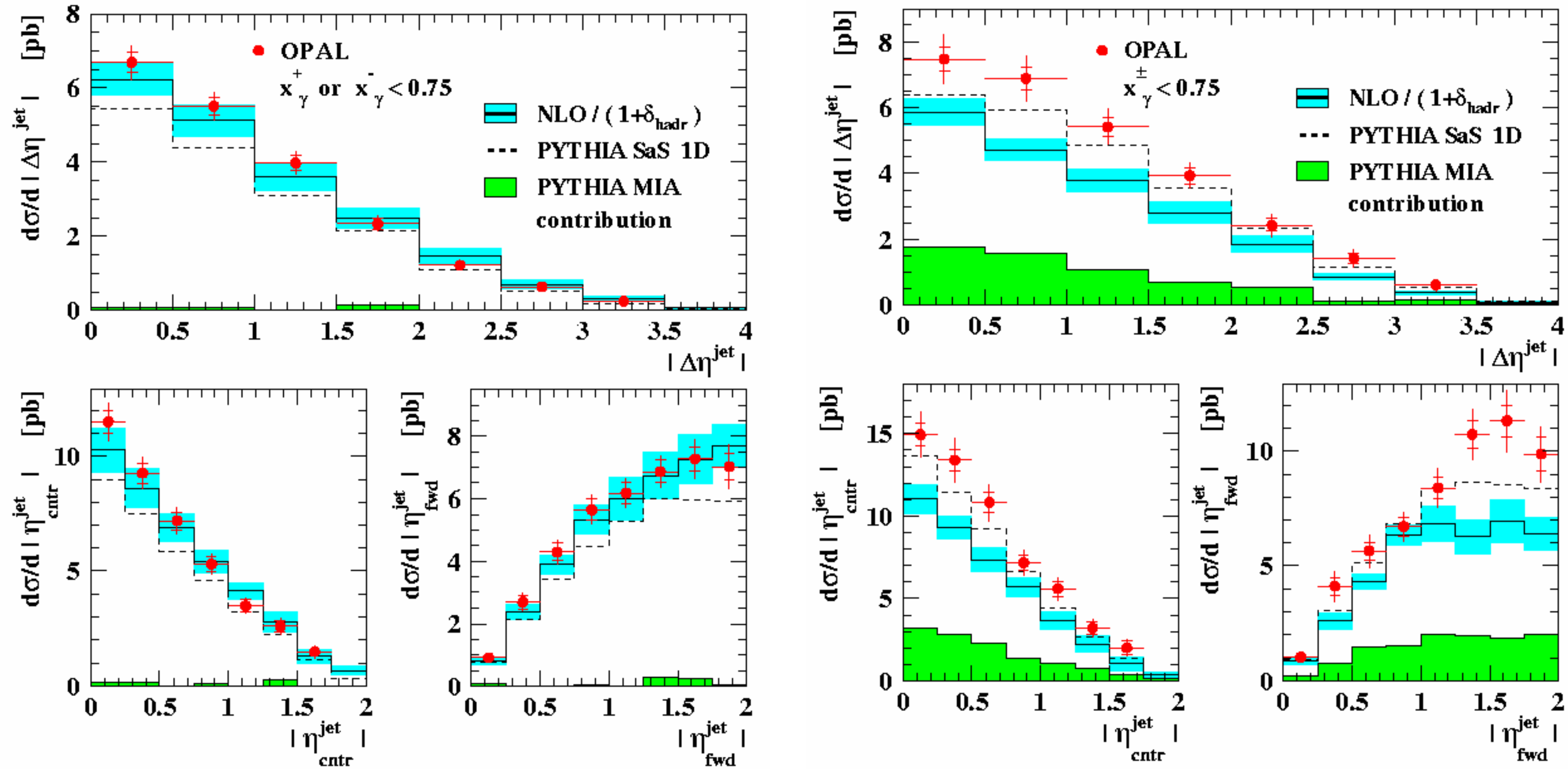


"Single resolved enhanced"



"Double resolved enhanced"

The di-jet cross-section vs. η^{jet}



"Single resolved enhanced"

"Double resolved enhanced"

Definition of the di-jet cross-section observables

$$\frac{d\sigma_{\rm dijet}}{d\bar{E}_T^{\rm jet}} \qquad \text{with } \bar{E}_T^{\rm jet} \equiv \frac{E_{T,1}^{\rm jet} + E_{T,2}^{\rm jet}}{2} \text{ and } \bar{E}_T^{\rm jet} > 5 \text{ GeV}$$

$$\frac{d\sigma_{\rm dijet}}{dx_\gamma} \qquad \text{in 3 bins of } \bar{E}_T^{\rm jet}\ [5-7-11-25] \text{ GeV}$$

$$\frac{d\sigma_{\rm dijet}}{d\log_{10}(x_\gamma)} \qquad \text{for } 5 \text{ GeV} < \bar{E}_T^{\rm jet} < 7 \text{ GeV}$$

$$\frac{d\sigma_{\rm dijet}}{d|\eta_{\rm cntr}^{\rm jet}|}, \frac{d\sigma_{\rm dijet}}{d|\eta_{\rm fwd}^{\rm jet}|}, \frac{d\sigma_{\rm dijet}}{d|\Delta\eta^{\rm jet}|} \qquad \text{for } \bar{E}_T^{\rm jet} > 5 \text{ GeV}$$

$$\frac{d\sigma_{\rm dijet}}{d|\cos\Theta^*|} \qquad \text{for } \bar{E}_T^{\rm jet} > 5 \text{ GeV}, \ |\bar{\eta}^{\rm jet}| < 1, \ M_{\rm jj} > 15 \text{ GeV}$$

with in all cases

$$|\eta_{1,2}^{\rm jet}| < 2 \qquad \text{and} \qquad \frac{|E_{T,1}^{\rm jet} - E_{T,2}^{\rm jet}|}{E_{T,1}^{\rm jet} + E_{T,2}^{\rm jet}} < \frac{1}{4}$$