High Q^2 two-photon events

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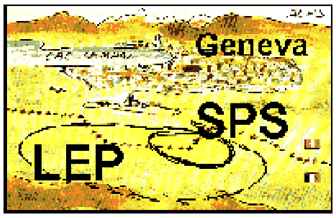
CERN, March, 13 1999

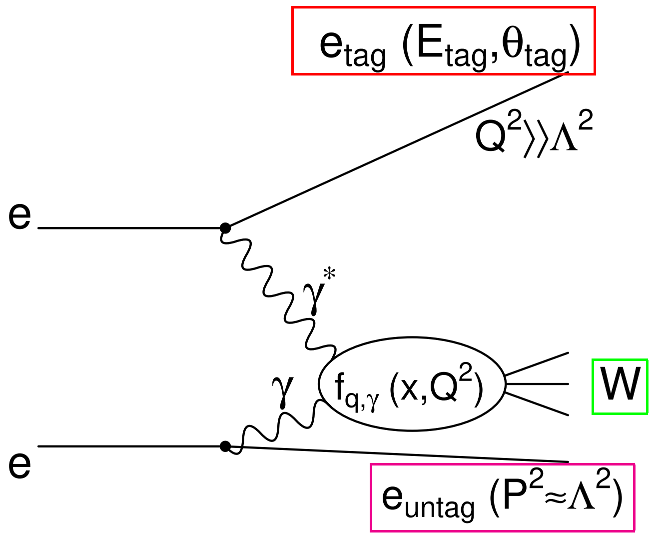
- Introduction

1. NC deep inelastic $e\gamma$ Scattering

- Conclusions



Electron-Photon Scattering



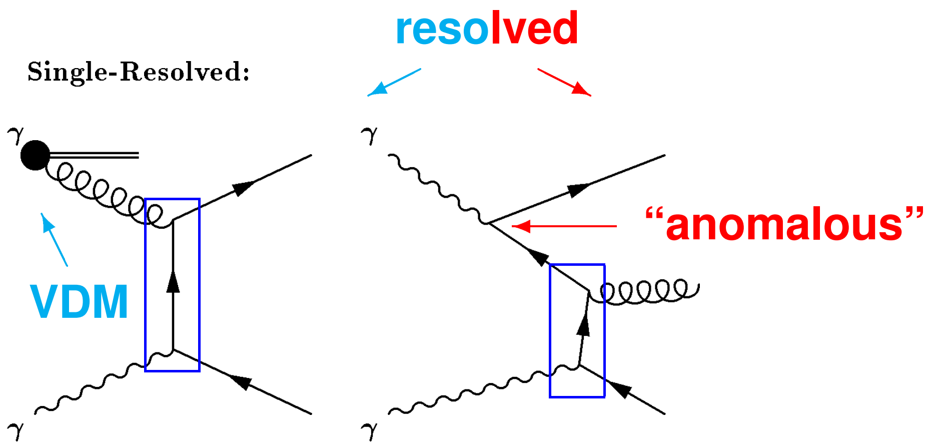
$$\frac{d^2\sigma_{e\gamma\to eX}}{dx dQ^2} = \frac{2\pi\alpha^2}{x\, Q^4}\cdot$$
$$\left[(1+(1-y)^2)\, F_2^\gamma(x,Q^2) - \underbrace{y^2 F_L^\gamma(x,Q^2)}_{\to 0} \right]$$

$$\begin{aligned} Q^2 &= 2\, E_b\, E_{tag}\, (1-\cos\theta_{tag}) \gg P^2 \\ x &= \frac{Q^2}{Q^2+W^2+P^2} \\ y &= 1-\frac{E_{tag}}{E_b}\cos^2(\frac{\theta_{tag}}{2}) \ll 1 \end{aligned}$$

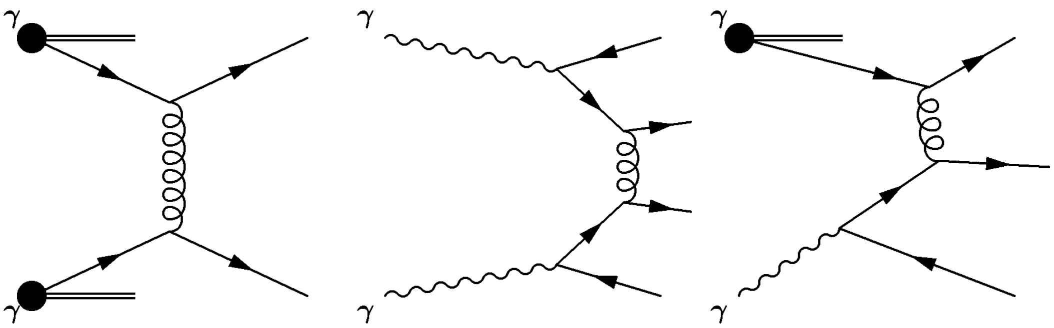
Leading order diagrams

Direct:

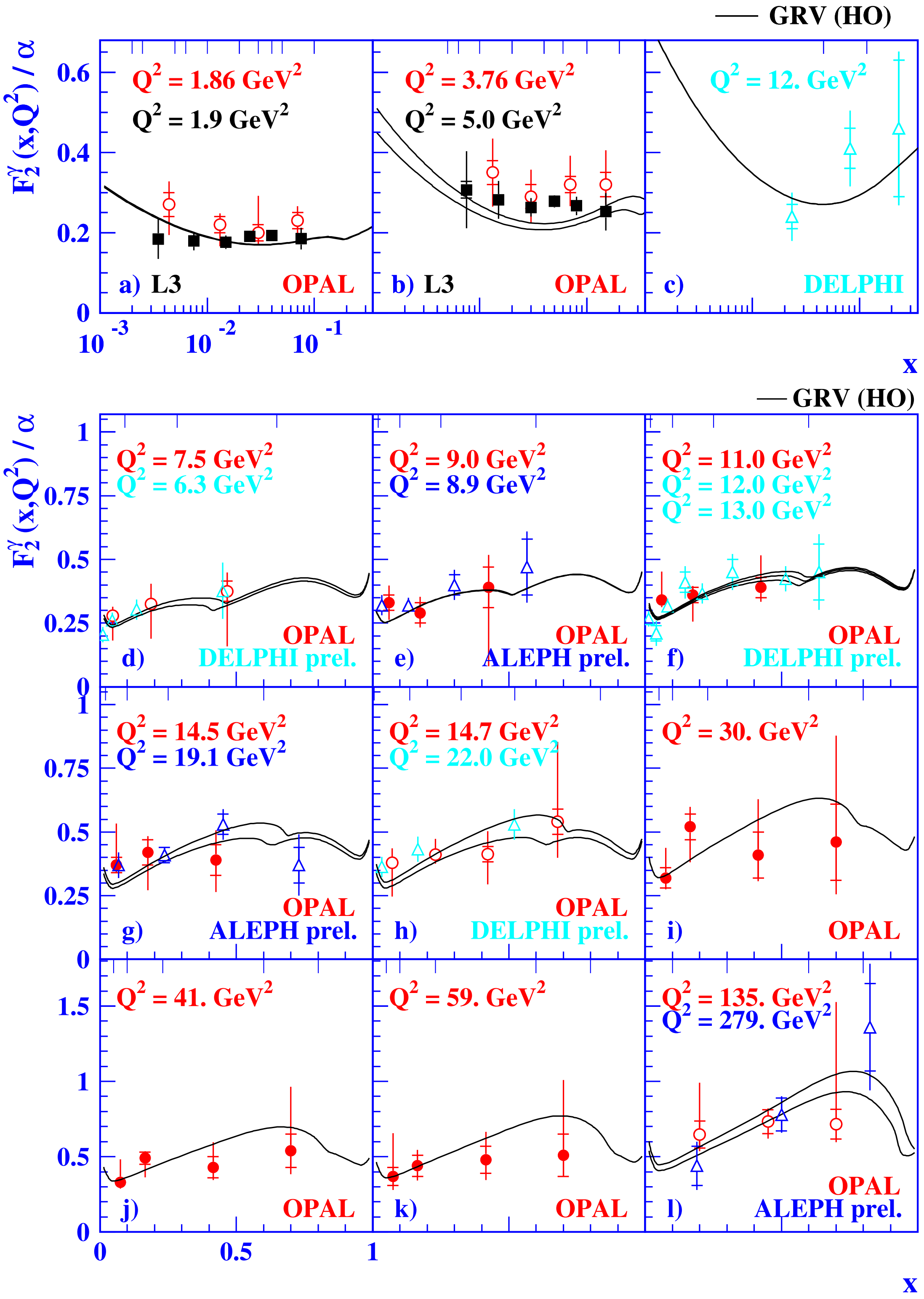
Single-Resolved:



Double-Resolved:



The LEP data on F_2^γ



MC generators for DIS $e\gamma$

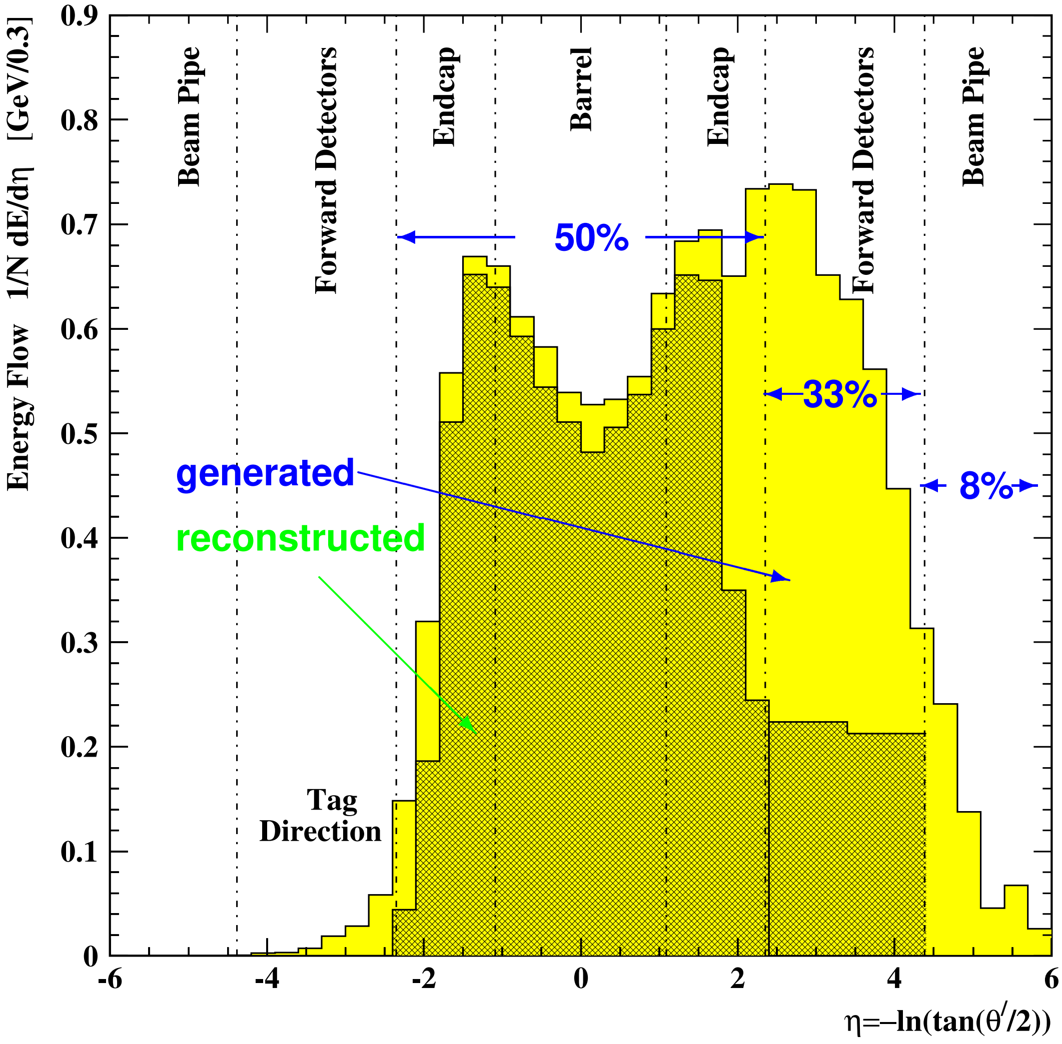
Special purpose generators

1. There exist several special purpose, home made, MCs (F2GEN,TWOGAM,...) for Two-Photon physics at LEP.
2. They usually have simple hadronisation models (NO parton shower, backward evolution, multiple interactions,...).
3. The turnaround time for changes required is usually short.
4. They cannot be cross-checked with other reactions.

General purpose MCs

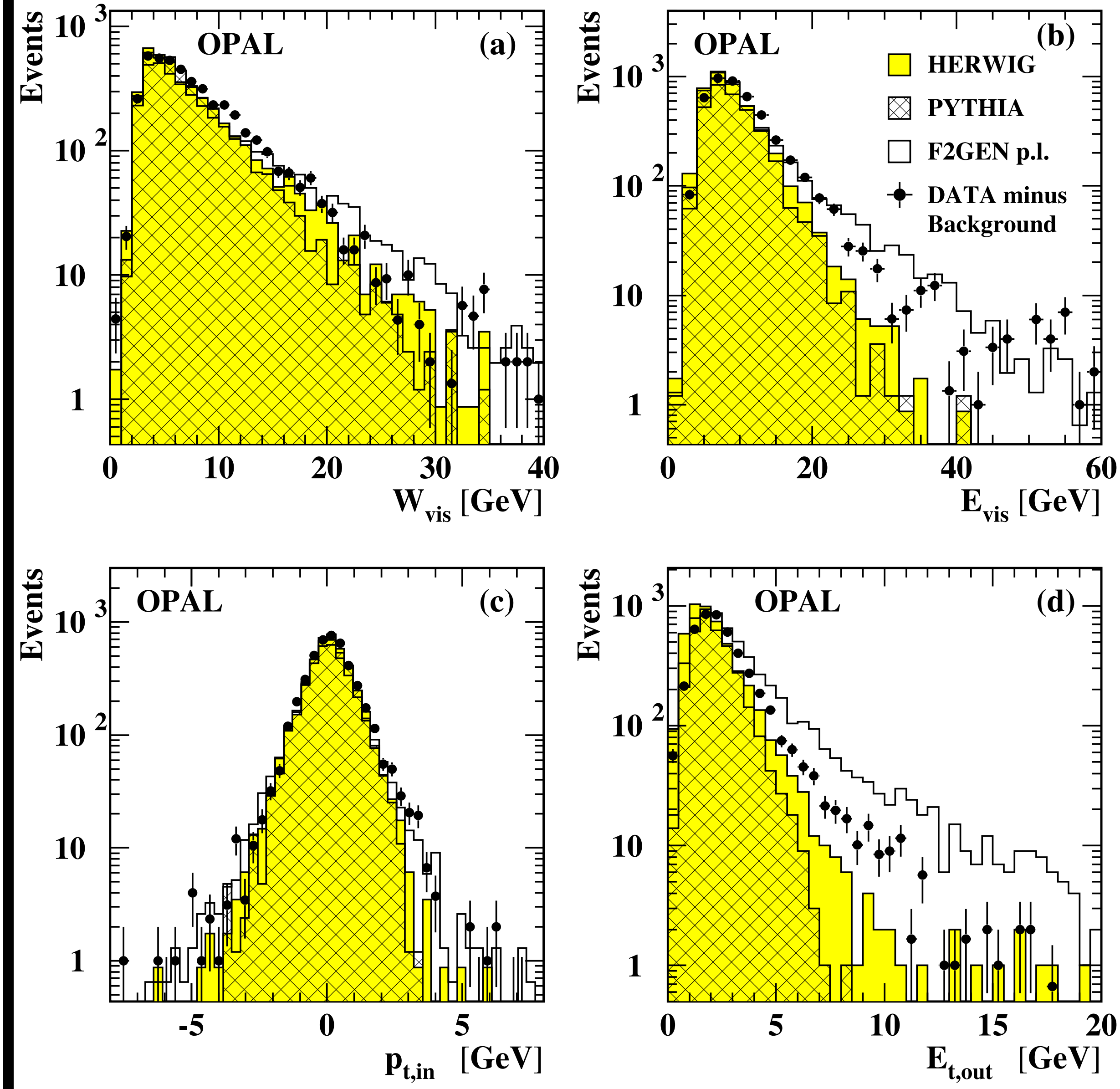
1. There exist several general purpose MCs (HERWIG, PYTHIA, PHOJET).
2. They have better hadronisation models tuned to other reactions, e.g. they can only be modified within the limits set by the HERA data.
3. The turnaround time for changes required is too (?) long.

The hadronic Energy Flow from HERWIG



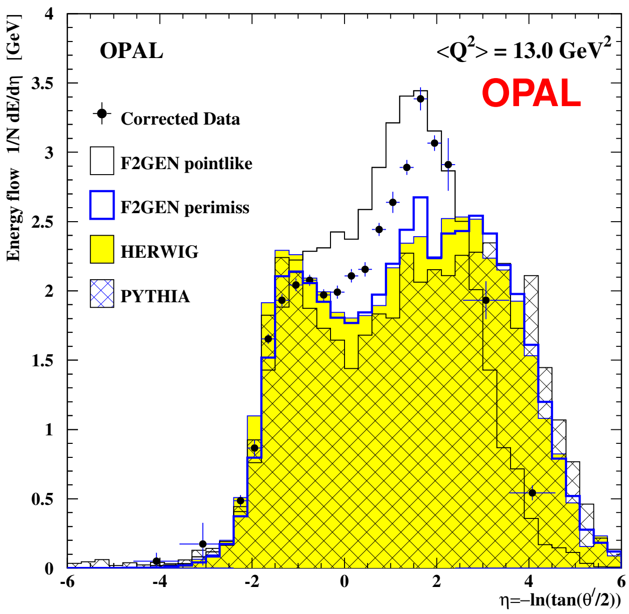
Only about 10% of the energy is deposited outside of the detector acceptance

Some global quantities



The energy flow Part I

$1/N \, \mathrm{d}E/\mathrm{d}\eta$



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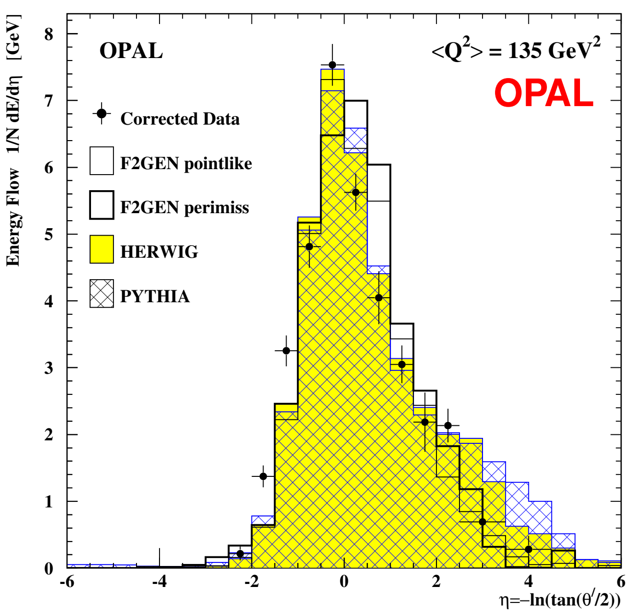
$1/N \, \mathrm{d}E/\mathrm{d}\eta$



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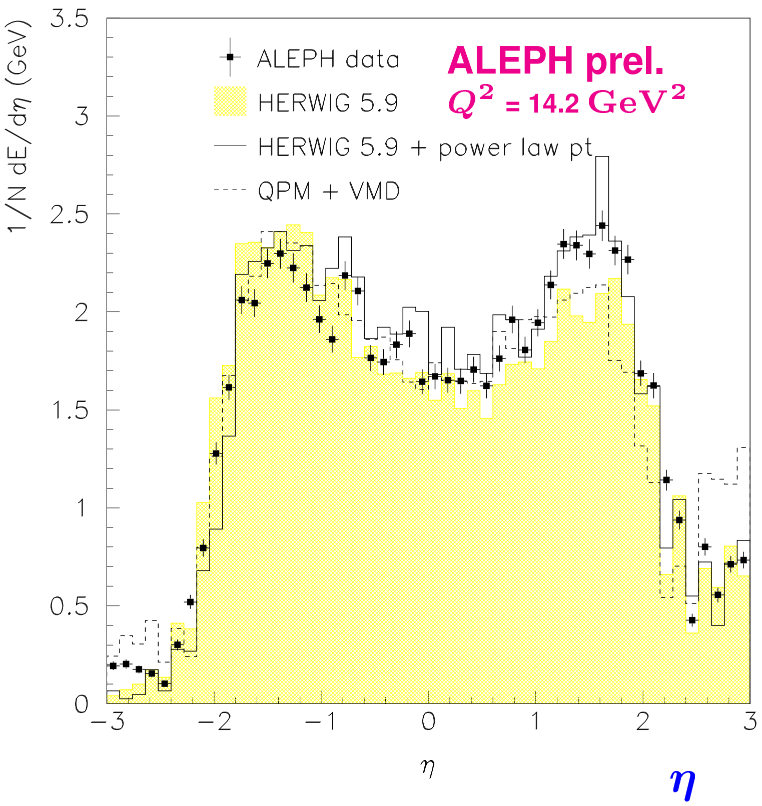

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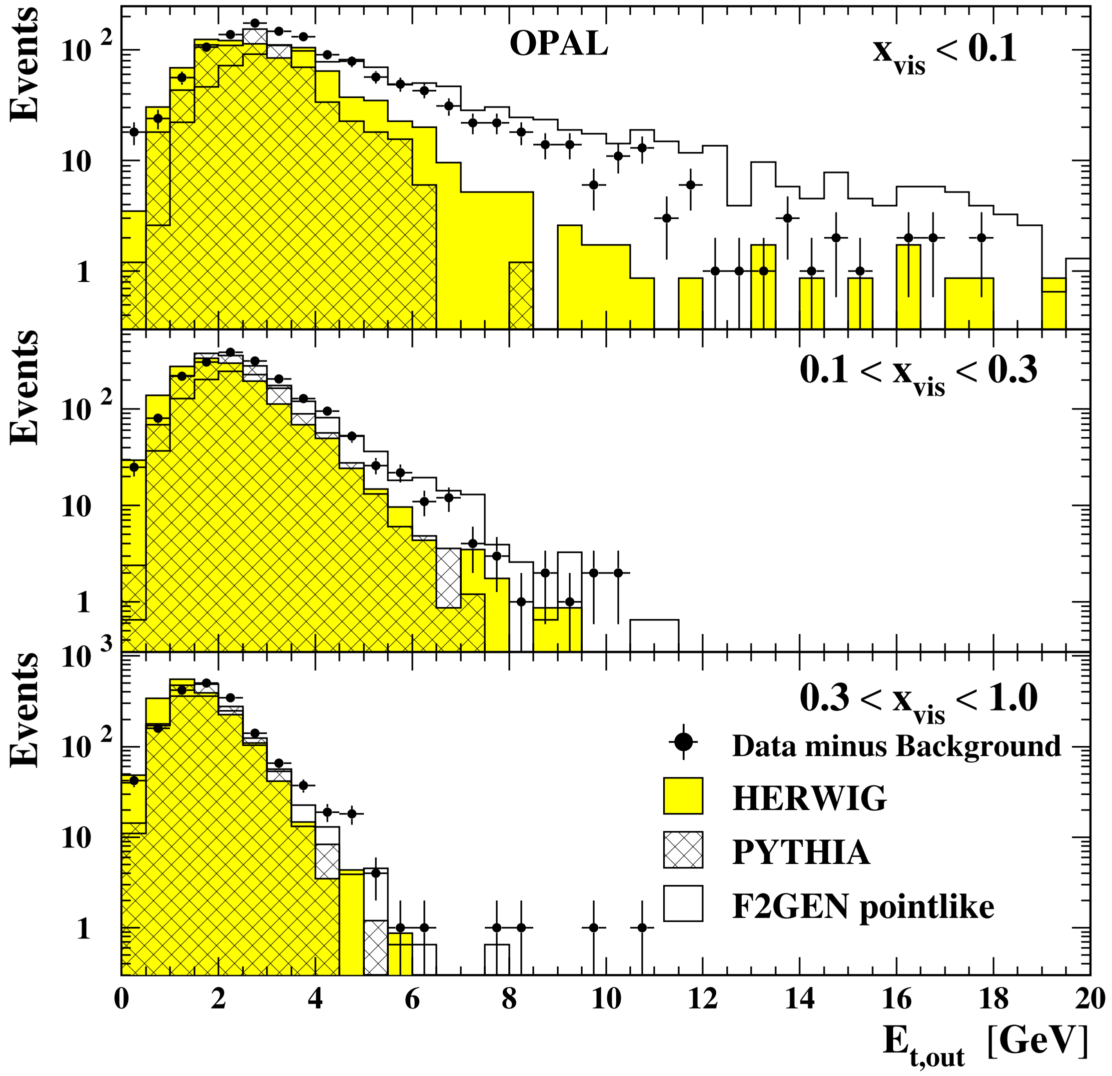
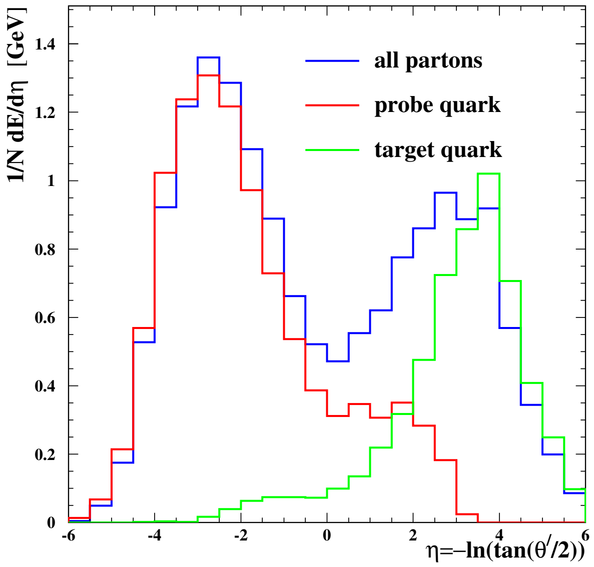
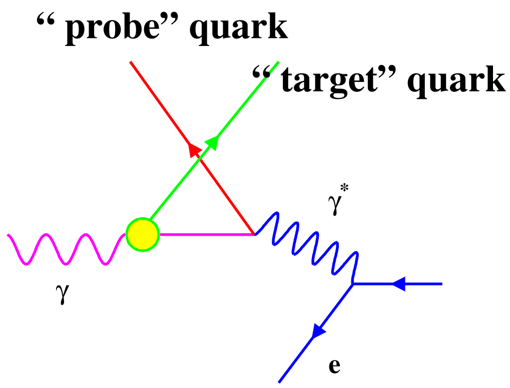
The model dependence as a function of x_{vis}

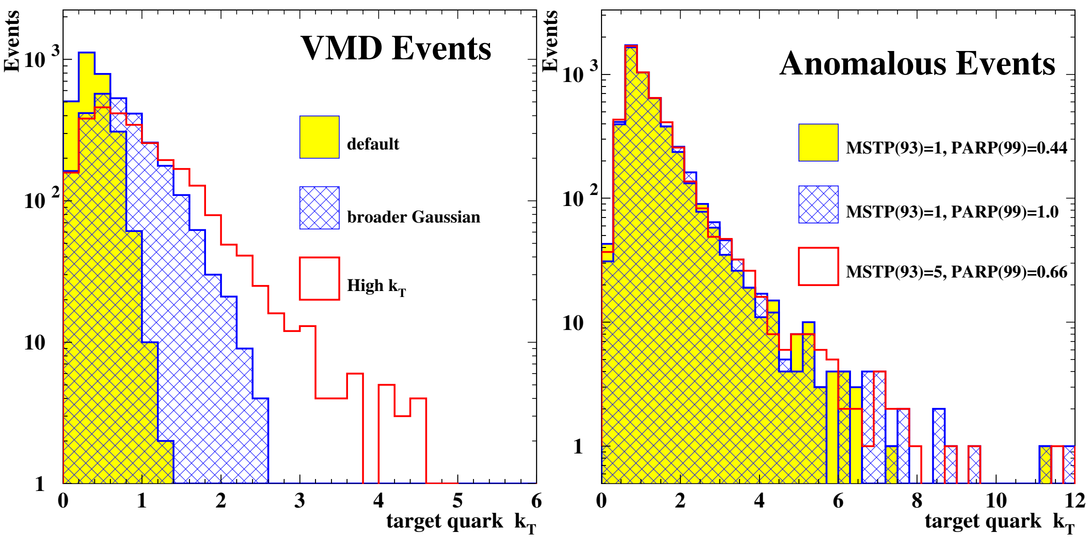


The agreement gets better for increasing x_{vis}

Pythia: photon k_T

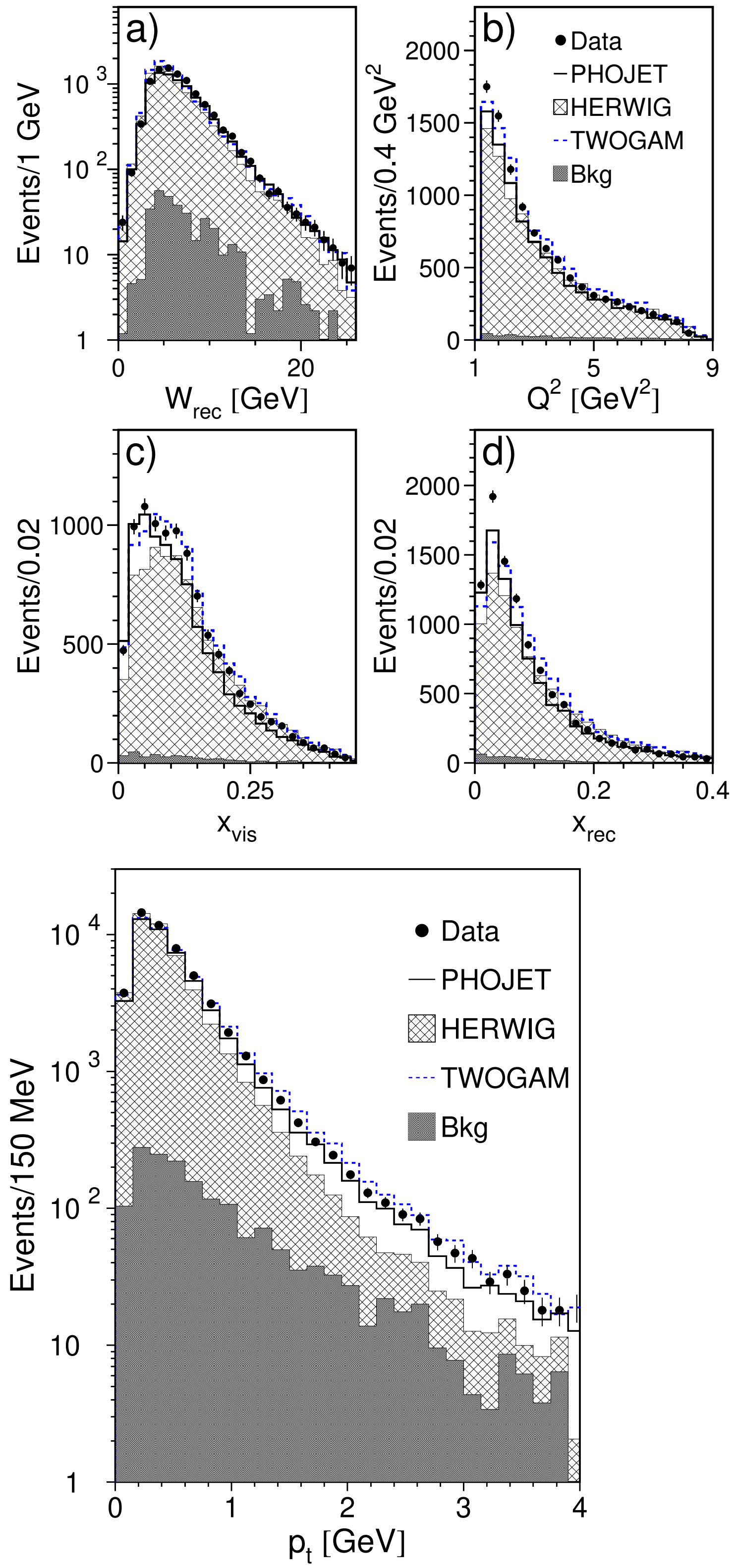




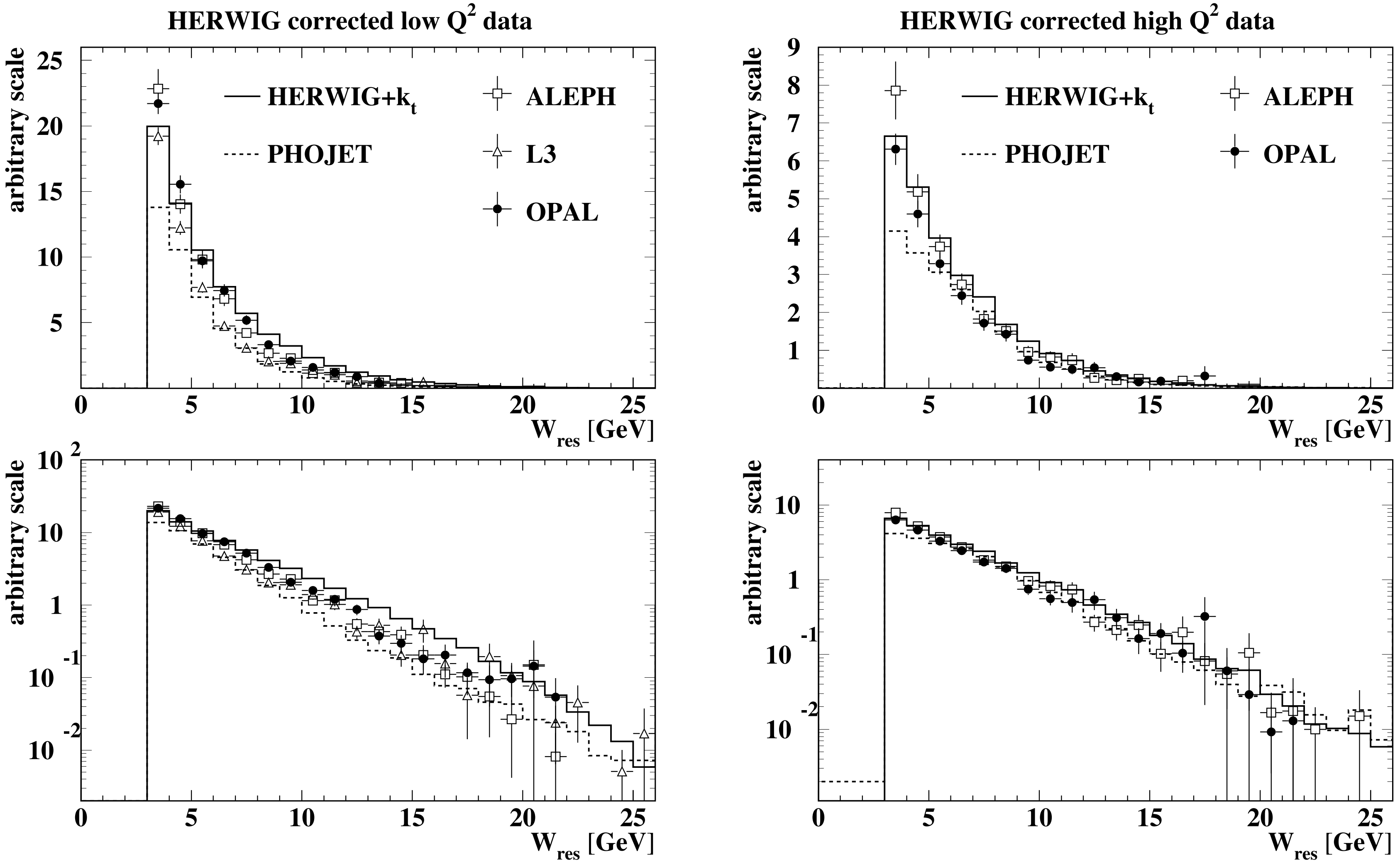


tunable **Not tunable**

Global event quantities from L3

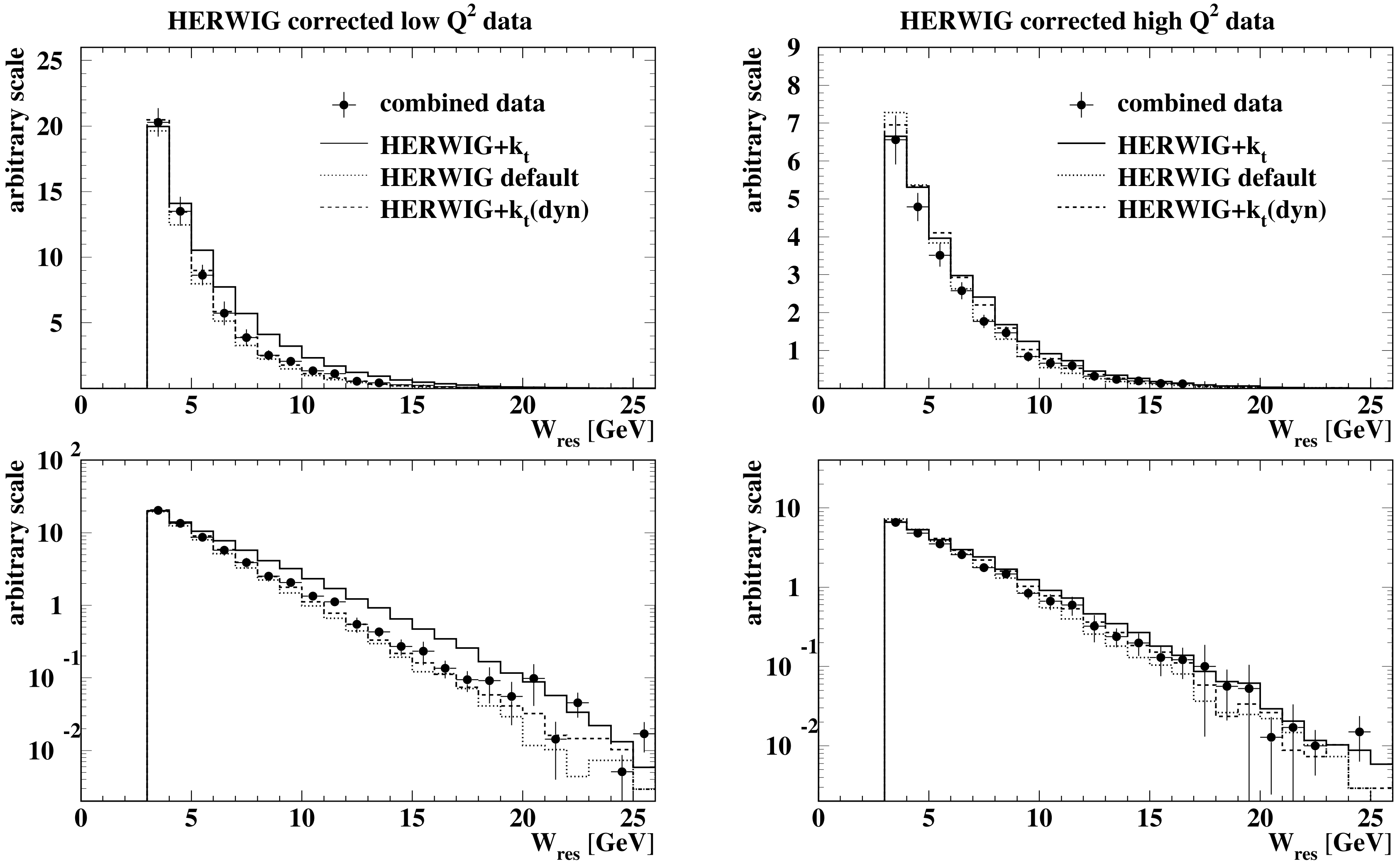


Individual LEP data corrected to the hadron level



⇒ PRELIMINARY ⇐

Combined LEP data corrected to the hadron level



⇒ PRELIMINARY ⇐

Improvements on MCs Part I

HERWIG 5.9 $\longrightarrow$?

1. Dynamically adjusted $k_{\rm t}$ for partons within the photon.

$\Rightarrow$ Small improvement which originated from careful cross-checks with data

PYTHIA 5.7 $\longrightarrow$ 6.x

1. The photon flux for transverse and longitudinal virtual photons is included.
2. DIS is no longer modelled as eq- scattering, but as superposition of hard $2 \longrightarrow 2$ matrix elements, using direct and resolved photon processes. (No PDF's for longitudinal photons exist, and simple scale factors are used.) The matrix elements need a $\hat{p}_t$ cut-off and soft processes are not yet in.
3. The parton showers are set up differently.

$\Rightarrow$ Many improvements which will need careful cross-checks with data

Improvements on MCs Part II

PHOJET 1.10 $\longrightarrow$ 1.x

1. Improved treatment of massive charm quarks.
2. Improved matching of F_2^γ to the cross-section.
3. Improved treatment of intrinsic k_t in the photon
4. Inclusion of QED radiation

$\Rightarrow$ Improvement are expected 'soon?' which will need carefull cross-checks with data

Some wishes for the Workshop

1. Improve on the energy flow in order to better describe the data.
2. Consistently include the contribution to F_2^γ from massive charm quarks in the MCs, e.g. use the matrix elements for massive quarks with charm masses matched to the ones used in producing the PDFs.
3. Include QED corrections in all MCs.
4. Remove the low W restriction in PHOJET.
5. Include also the low-p_t physics in PYTHIA.
6. ...

Get a smooth transition between the regions of $Q^2 \approx 0$ and $Q^2 \gg 0$.

Conclusions

1. There are several conceptual differences between the Monte Carlo models, which lead to sizeable differences in the predictions for the signal region.
$\Rightarrow$ Also sizeable differences in the predictions for the searches background region are to be expected, and seen. Therefore several different Monte Carlo models should be used, to get an estimate of the 'theoretical' uncertainty.

2. There is a coherent, combined effort within the LEP Two-Photon Working Group to confront the Monte Carlo models with the data in the signal region. This has proven to be very useful and already let to improvements of Monte Carlo models.

3. The present Monte Carlo situation is not perfect, but the two-photon processes get more and more serious attention from theoretical side.

4. It has to be kept in mind that also the experimental data are limited. So all experiments should be encouraged to provide more two-photon data.

slides: http://wwwhome.cern.ch/~nisius/talks