The Structure Function analysis at LEP and implications for a LC

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ECFA DESY Linear Collider Workshop

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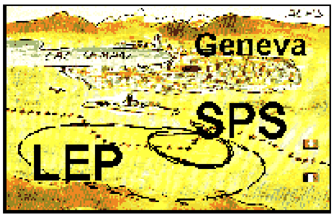
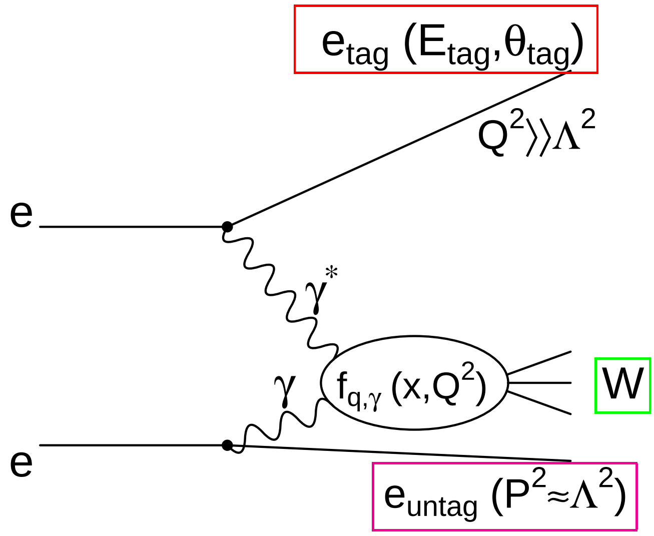


Electron-Photon Scattering



$$\frac{d^2\sigma_{e\gamma\rightarrow eX}}{dx dQ^2} = \frac{2\pi\alpha^2}{x\,Q^4}\cdot$$

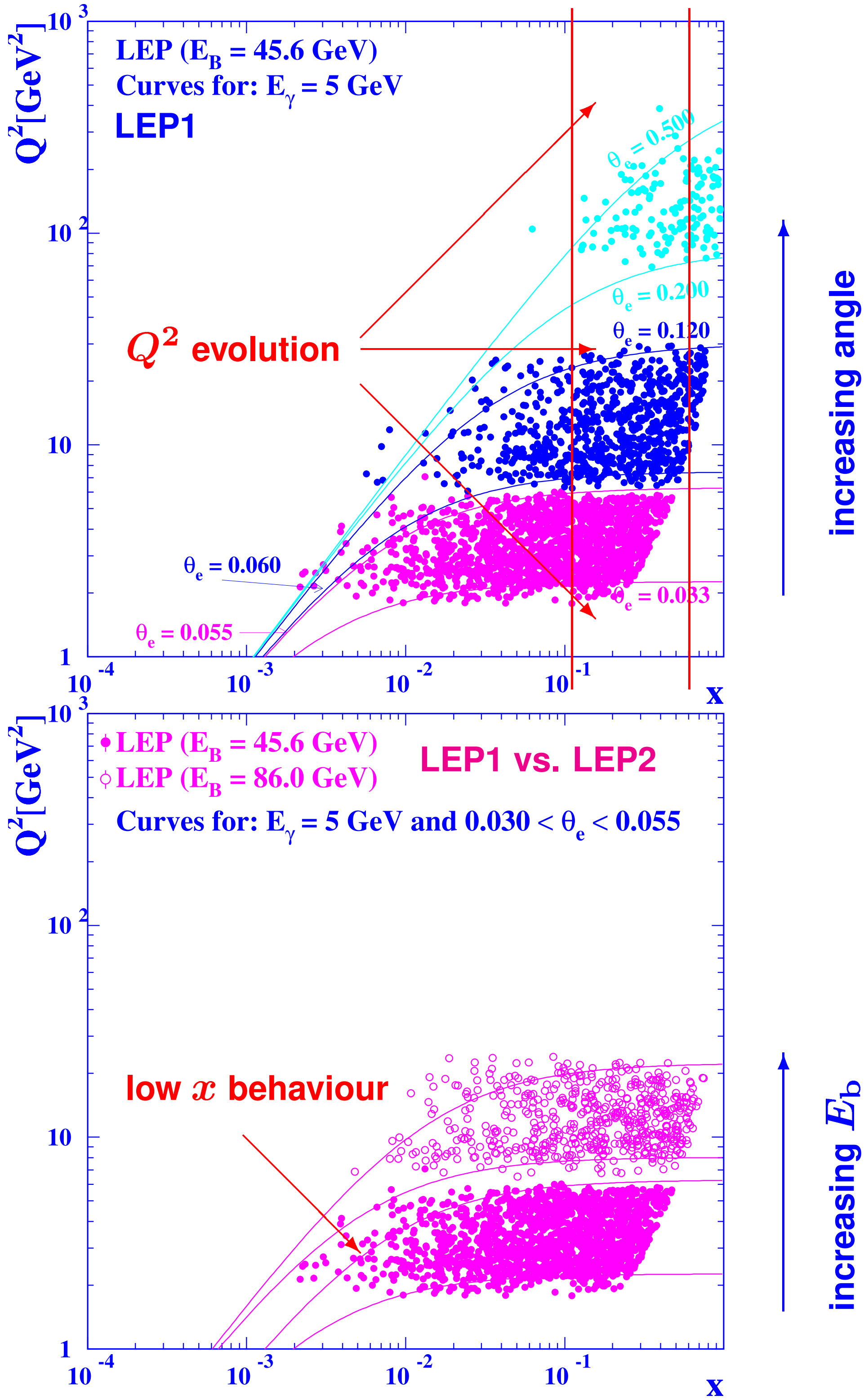
$$\left[(1+(1-y)^2)\,F_2^\gamma(x,Q^2) - \underbrace{y^2 F_L^\gamma(x,Q^2)}_{\rightarrow 0}\right]$$

$$Q^2 = 2\,E_b\,E_{tag}\,(1-\cos\theta_{tag}) \gg P^2$$

$$x = \frac{Q^2}{Q^2+W^2+P^2}$$

$$y = 1-\frac{E_{tag}}{E_b}\cos^2(\frac{\theta_{tag}}{2}) \ll 1$$

The $x - Q^2$ plane



The general procedure to measure F_2^γ

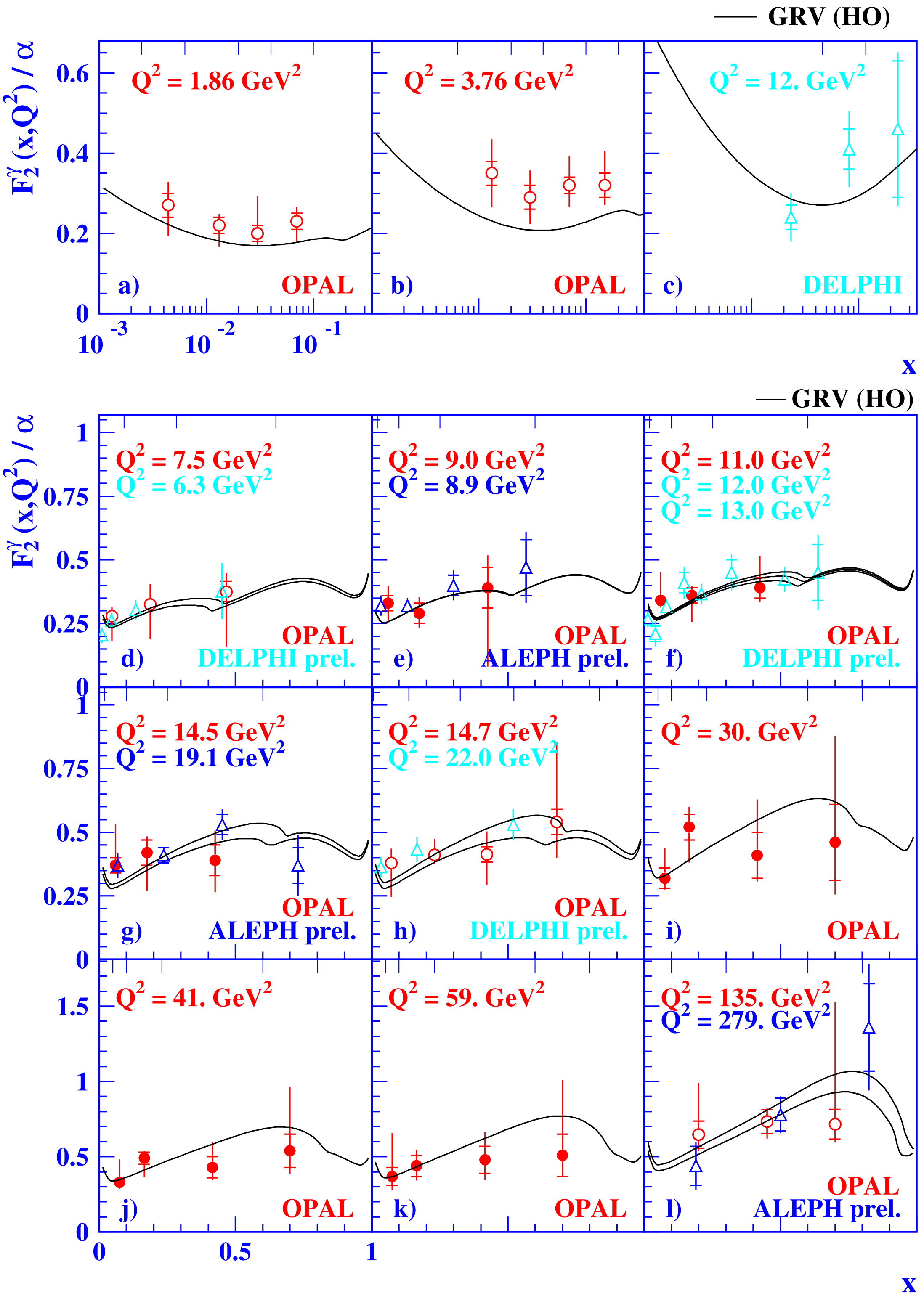
1. Events are triggered with high efficiency by the luminosity detectors nearly independent of the hadronic final state.

2. Q^2 is accurately measured from the electron.

3. E_γ is unknown and varies from event to event $\Rightarrow W_{\mathrm{vis}}$ has to be measured from the hadrons. (No electron alone method as e.g. at HERA)

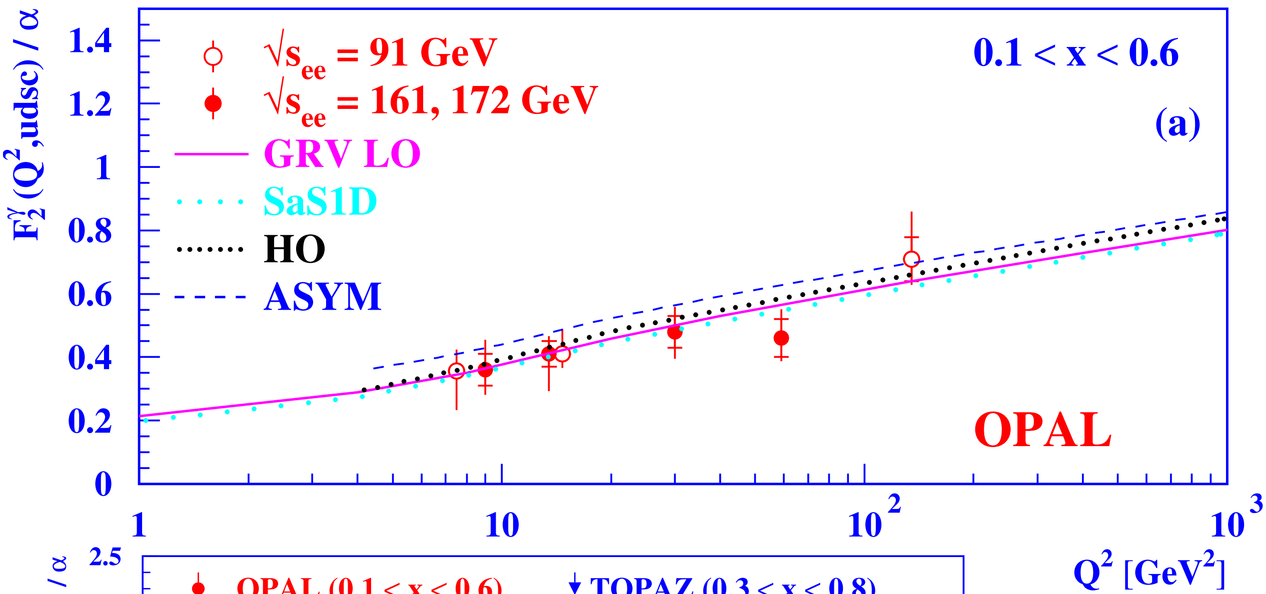
4. x is obtained from x_{vis} via unfolding (Blobel, ...) $\Rightarrow$ Dependence on the formation of the hadronic final state as assumed by the Monte Carlo models!

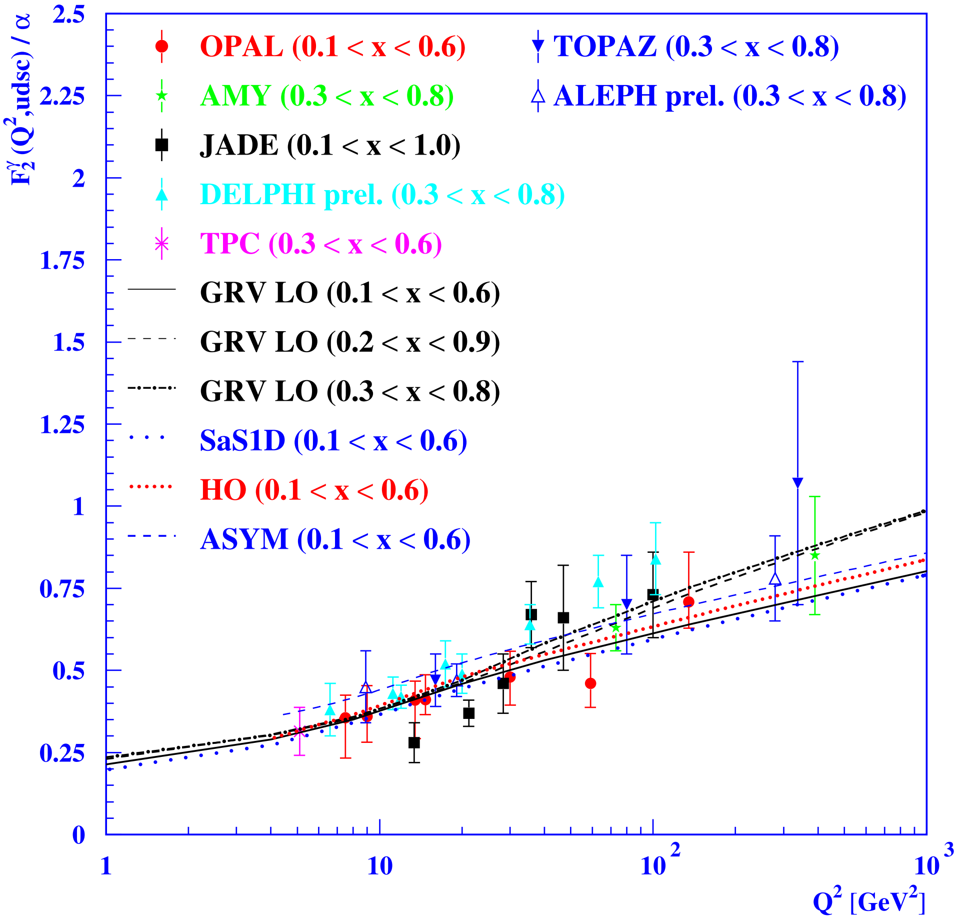
The LEP data on F_2^γ



The Q^2 evolution of F_2^γ

$$F_2^\gamma = (0.16 \pm 0.05^{+0.17}_{-0.16}) + (0.10 \pm 0.02^{+0.05}_{-0.02}) \ \ln (Q^2/\mathrm{GeV}^2)$$





The Status of MC generators for DIS

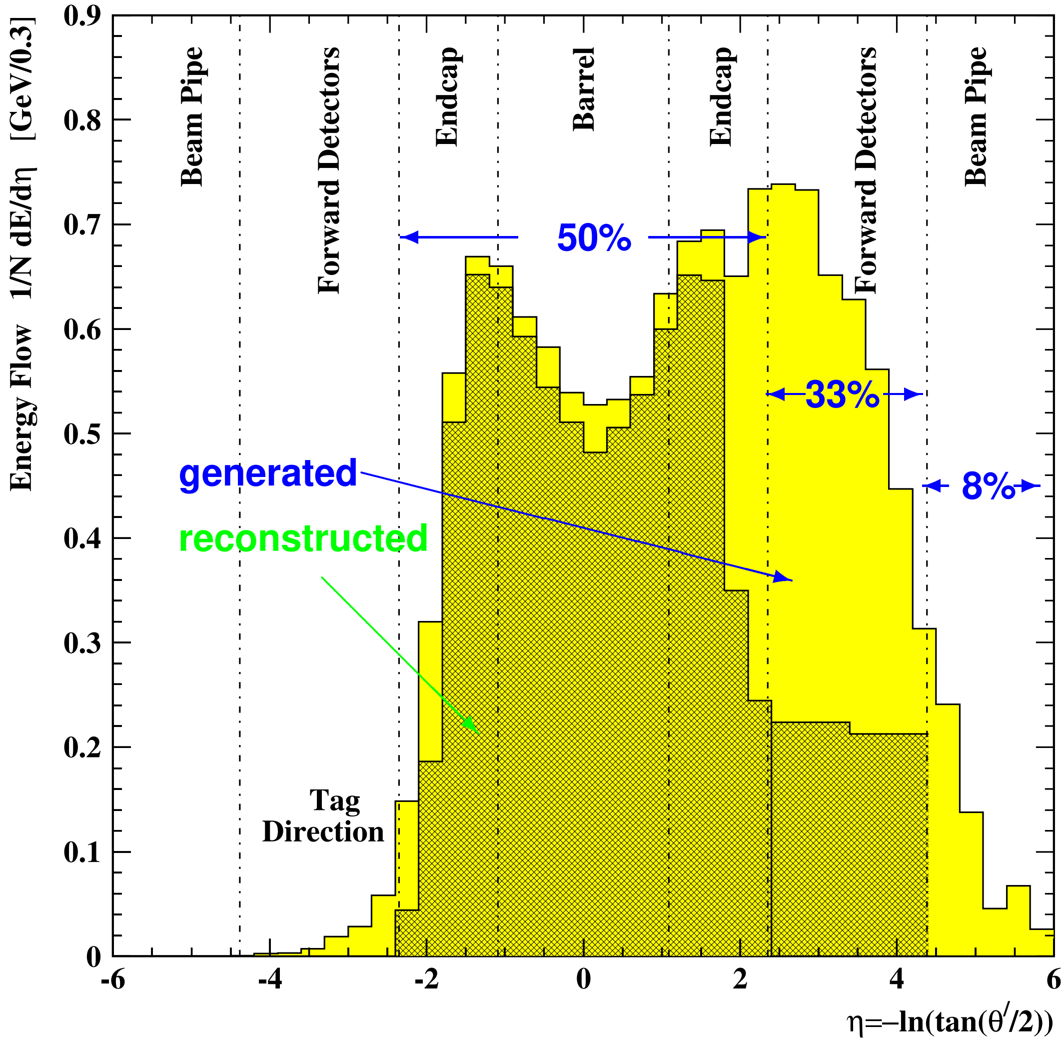
Home made generators

1. There exist several special purpose 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 short.
4. They cannot be cross-checked with other reactions.

General purpose MCs

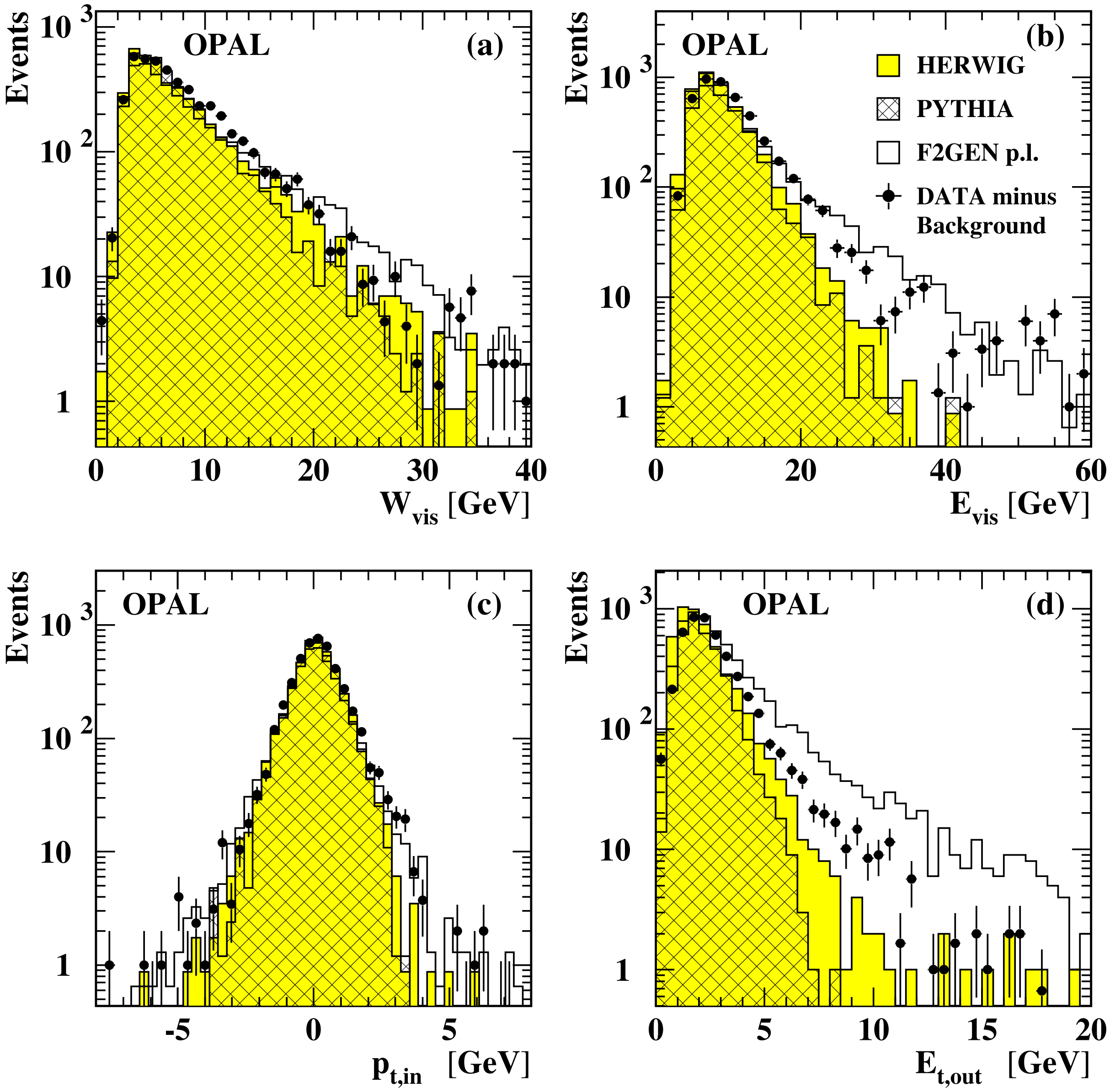
1. There exist several general purpose MCs (HERWIG, PYTHIA, PHOJET).
2. They have better hadronisation models tuned to other reactions, e.g. they can only be modified within the limits set by the HERA data.
3. The turnaround time for changes required is too long.

The hadronic Energy Flow from HERWIG

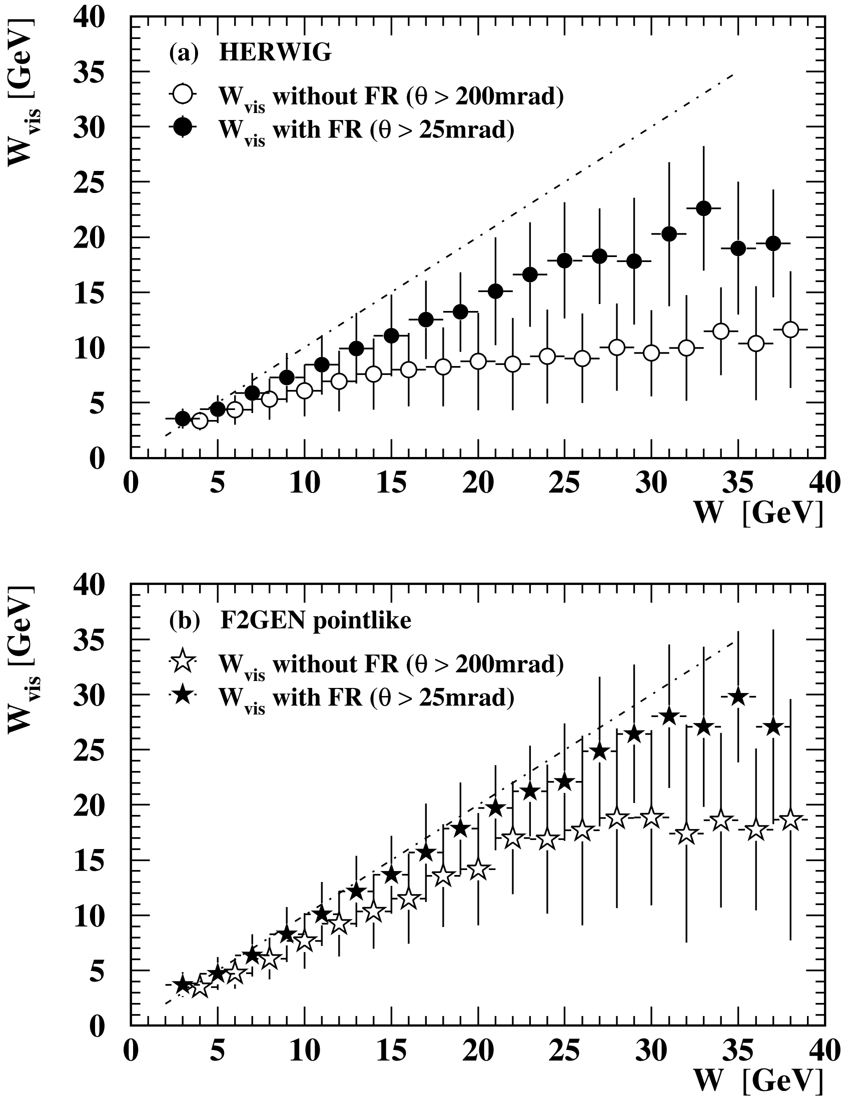


Only about 10% of the energy is deposited outside of the detector acceptance

Some global quantities



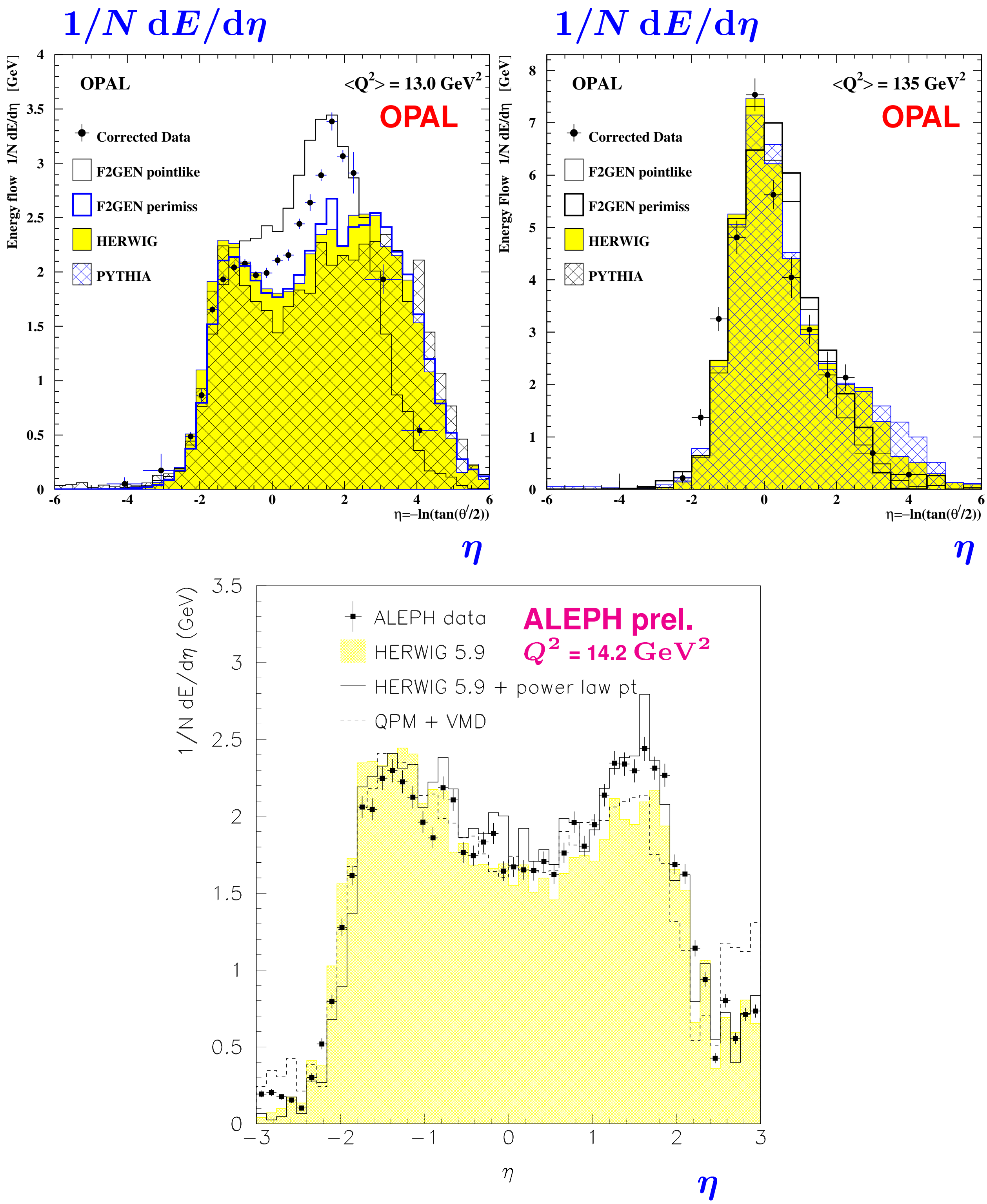
The $W - W_{\mathrm{vis}}$ correlation



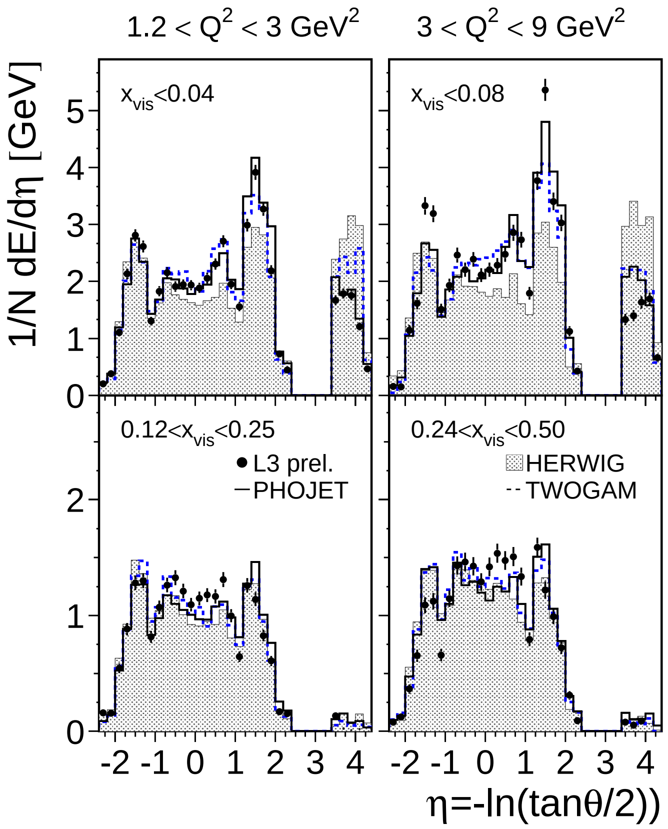
The correlation based on F2GEN is much stronger

The inclusion of the Forward Region significantly improves the correlation

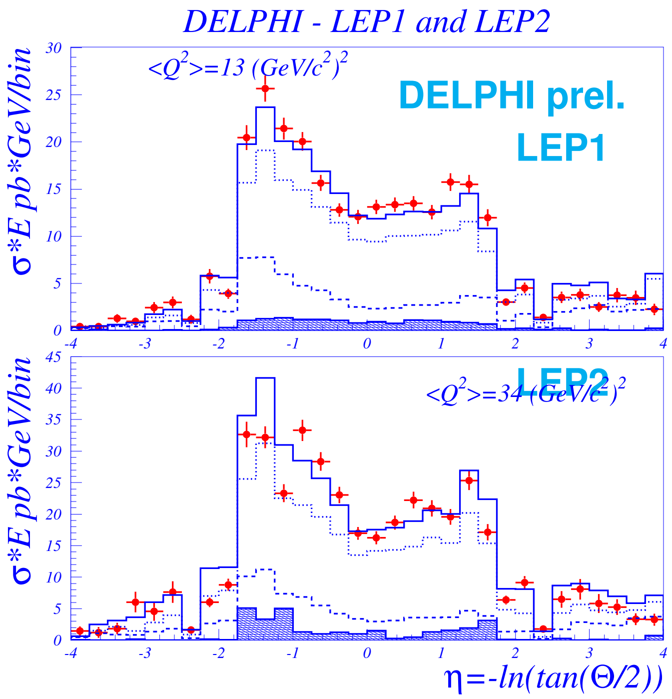
The energy flow Part I



The energy flow Part II



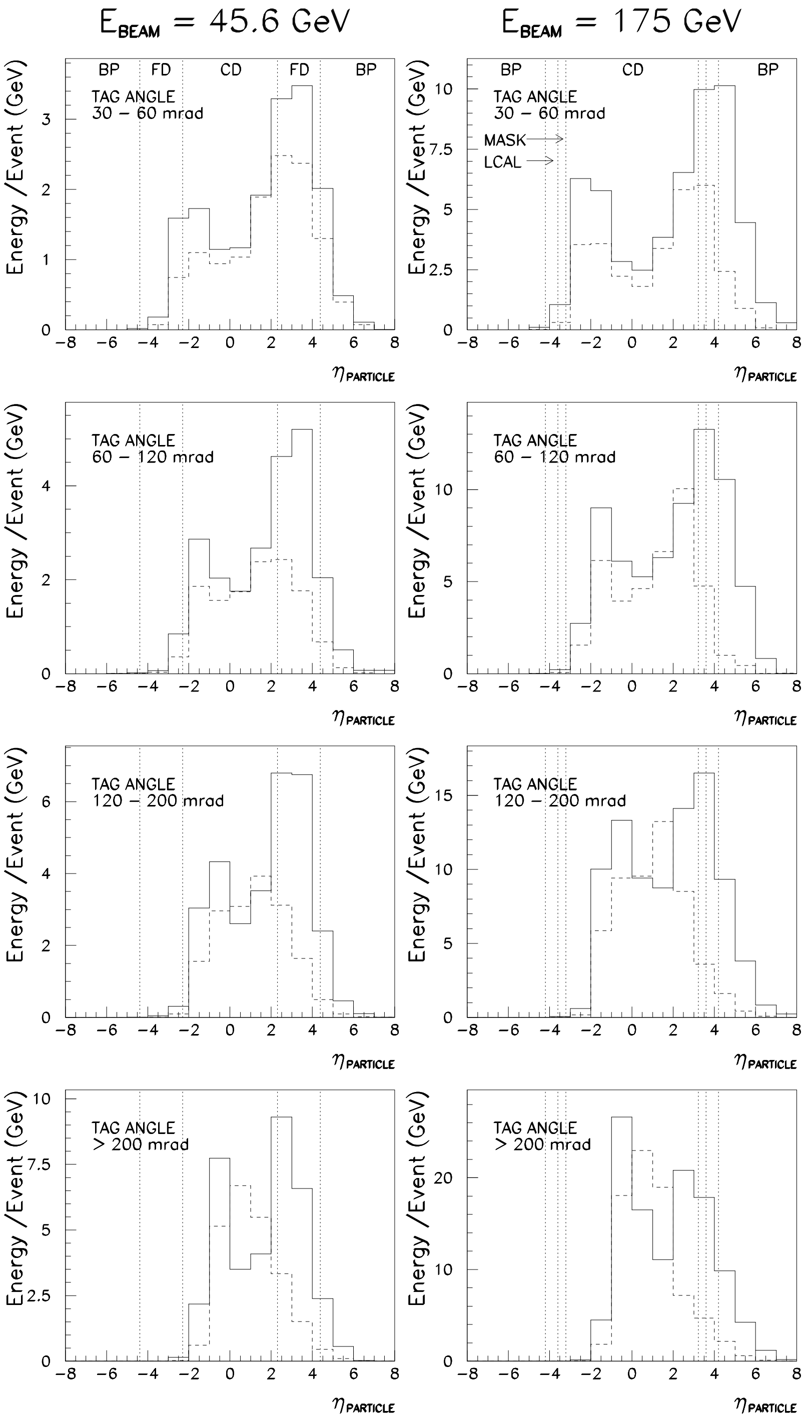
L3 (LEP1) prel.



Improvements on the Monte Carlo programs are needed

The hadronic energy flow LEP vs LC

LEP1 $\sqrt{s} = M_Z$ LC $\sqrt{s} = 2m_{top}$



dash: $x > 0.1$

full: $x < 0.1$

By J.Jason Ward (Glasgow U.) hep-ex/9711019

Conclusions

1. The measurement of $F_2^\gamma(x, Q^2)$ at LEP is systematics limited and most of it comes from the dependence on the simulation of the hadronic final state.

2. The physics results from LEP and also from a future LC would considerably profit from improvements of the Monte Carlo models.

3. As the Monte Carlo models differ significantly in the hadronic final state good hermeticity for the measurement of the hadronic energy is very desirable for a LC, especially for low values of x.

4. The tagging of the second electron which is scattered under almost zero angle with reduced energy after radiating the quasi-real photon would make the measuremend independent of the hadronic final state. The experimental possibilities for zero-angle tagging at a LC should be explored.

slides:

http://wwwinfo.cern.ch/˜nisius