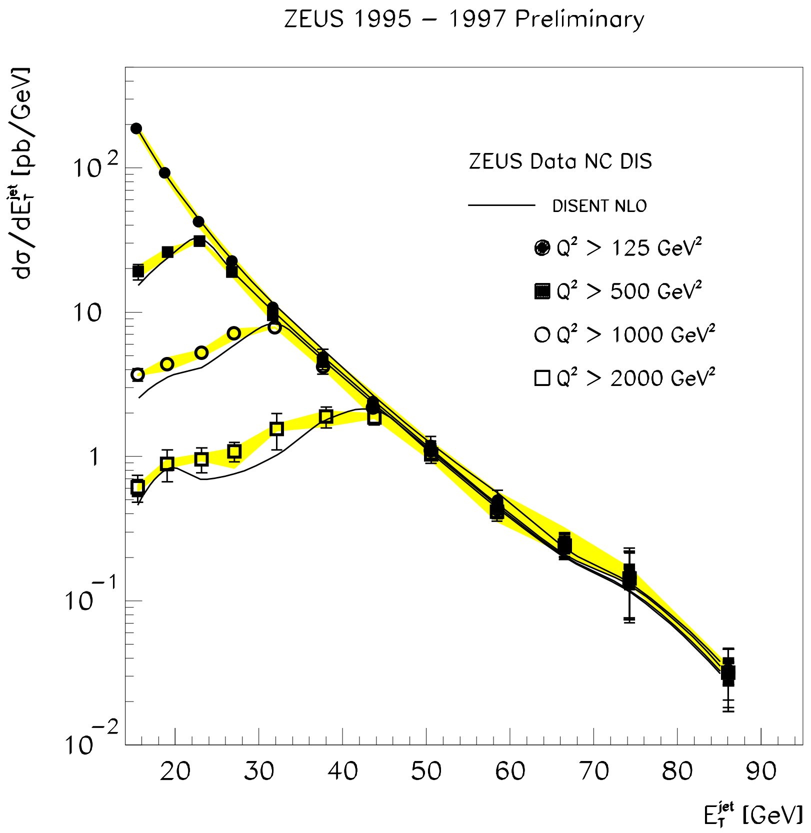
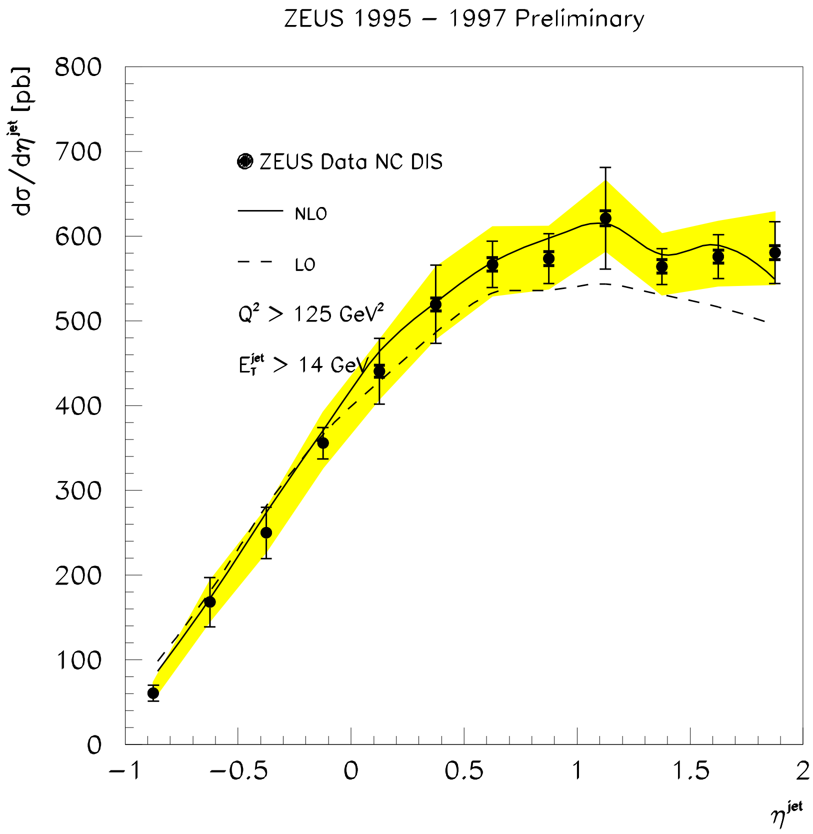
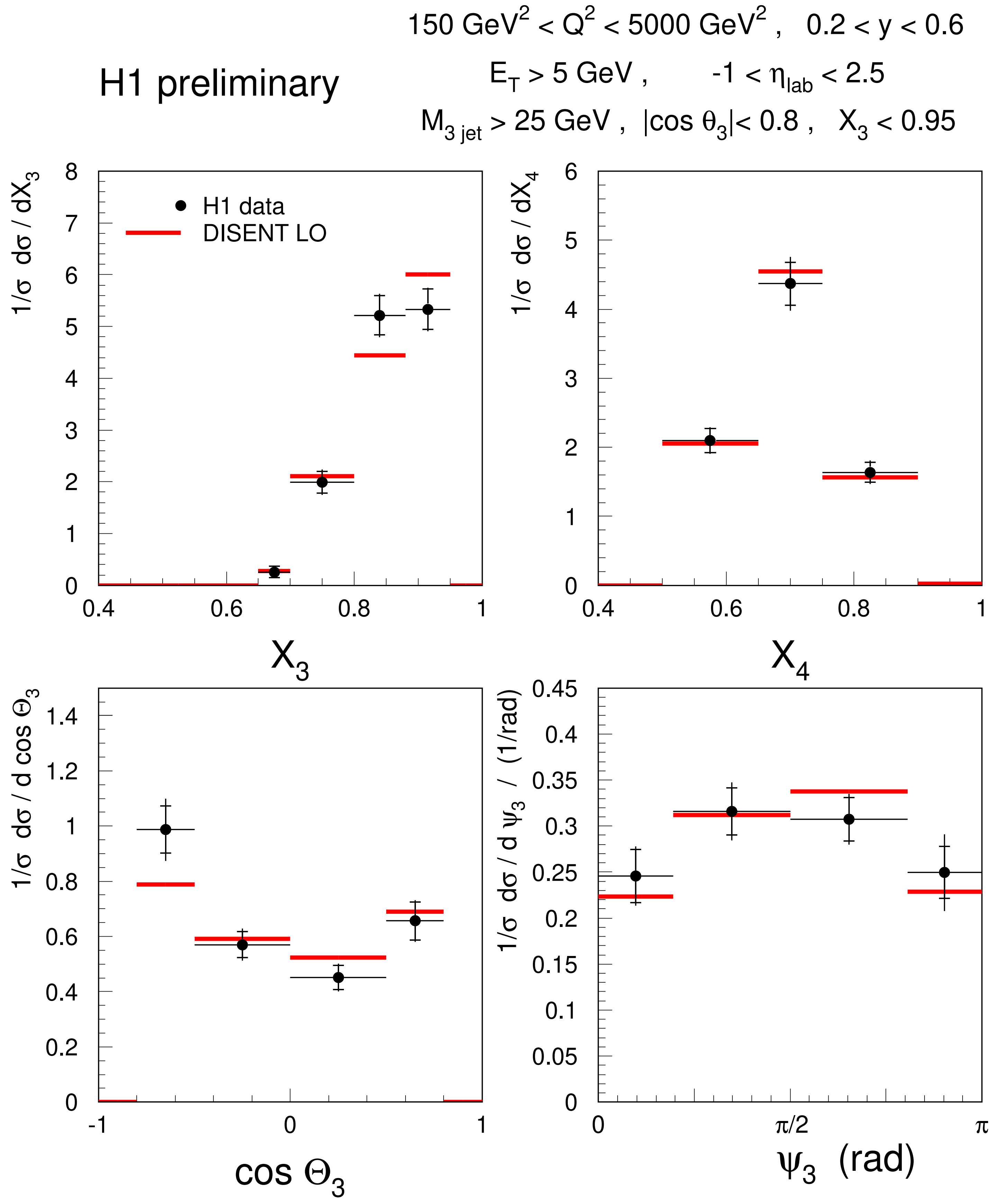
Jets in DIS events: Inclusive

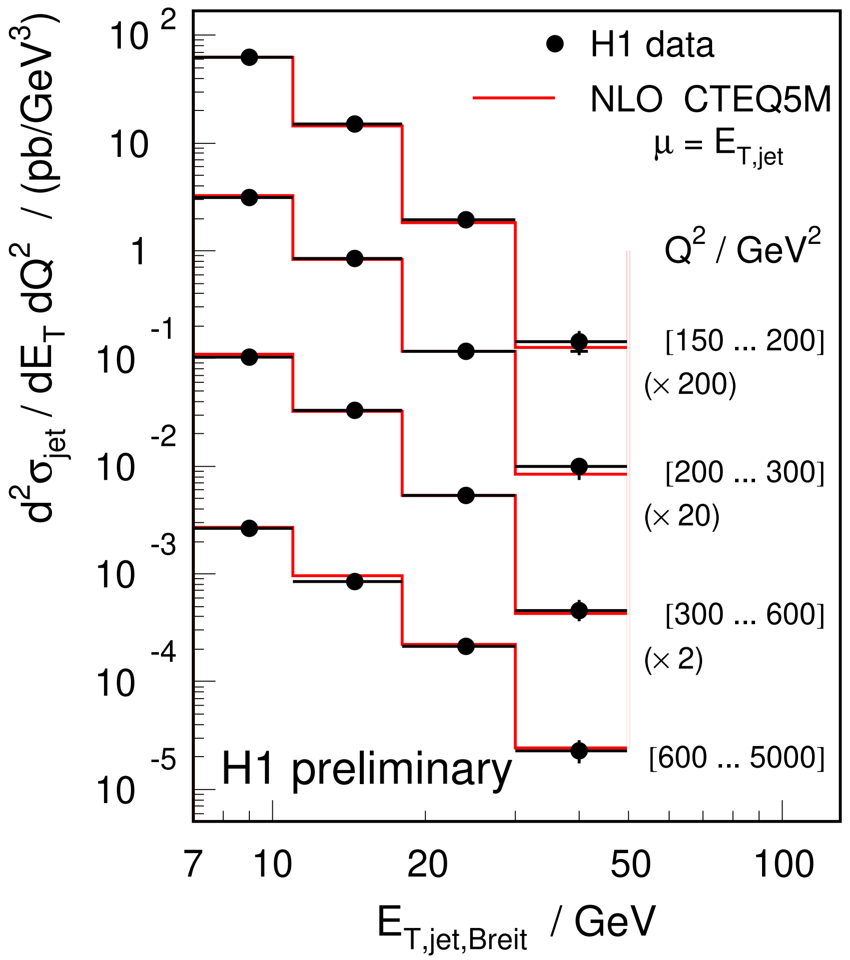




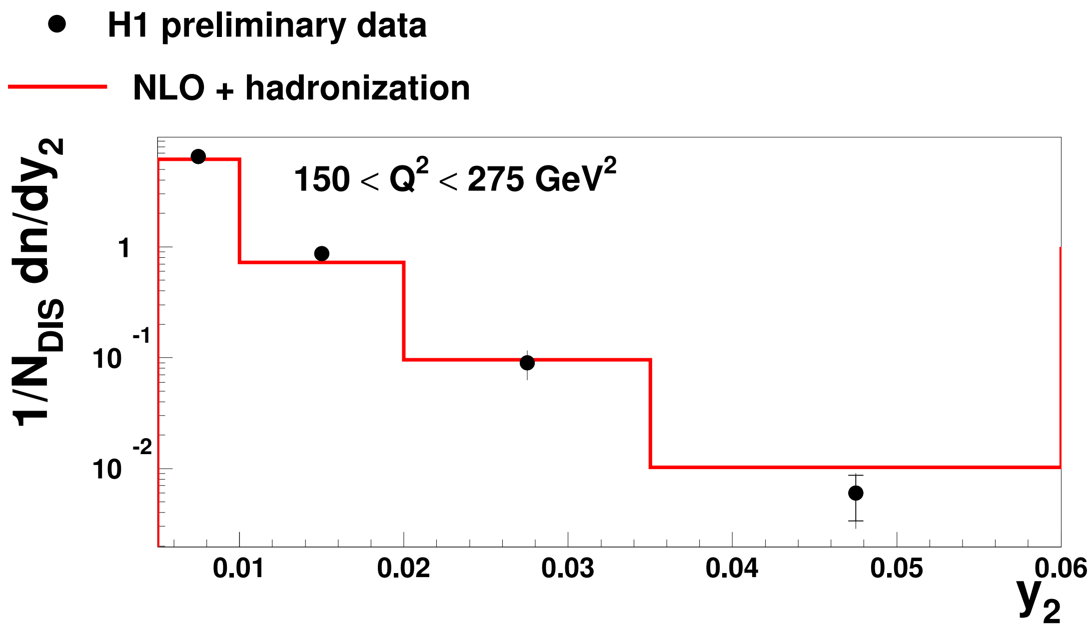
Jets in DIS events: Three jets



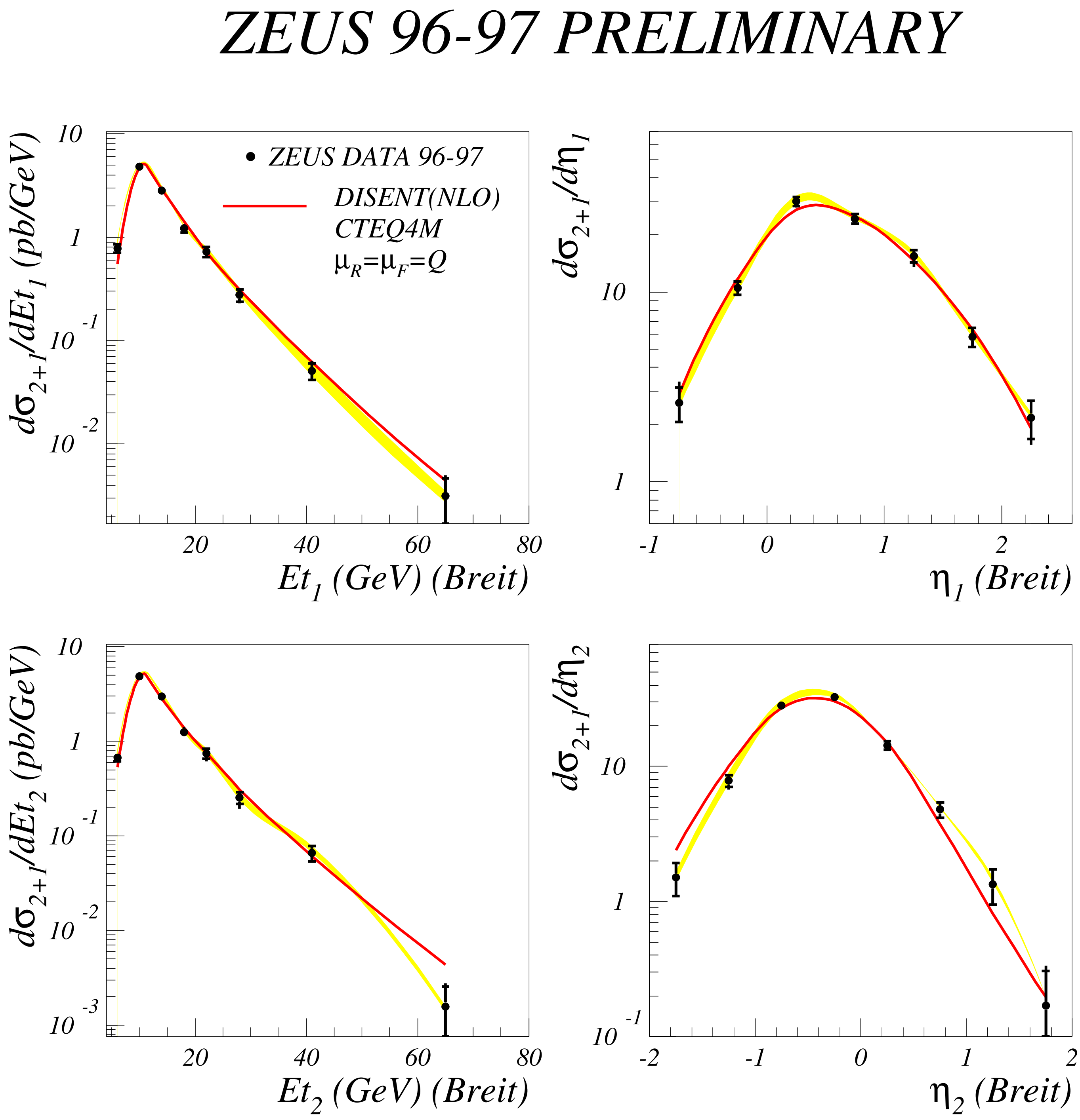
Inclusive and Di-Jets in DIS events



modified Durham algorithm, $y_2 > 0.005$



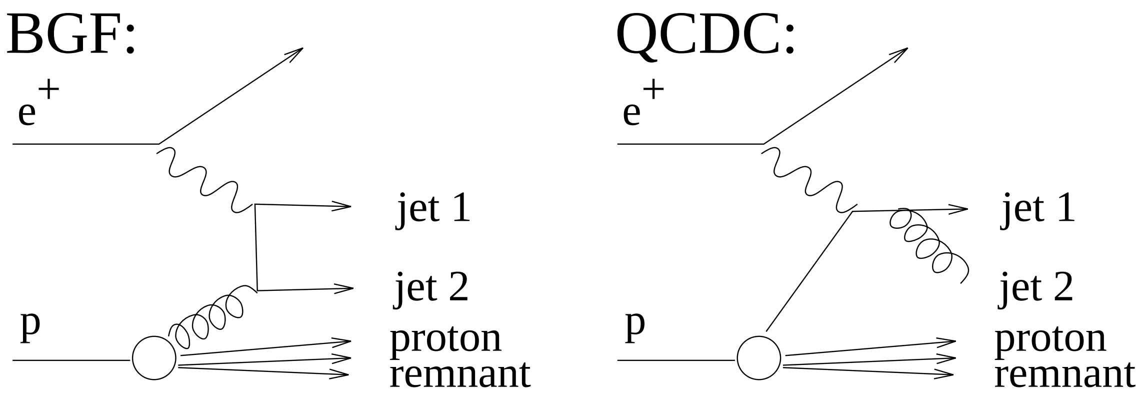
Di-Jets in DIS events



$$x_p = \frac{Q^2}{Q^2+M_{jj}^2}, \xi = \frac{x}{x_p}, z_p(i) = \frac{p\cdot p(i)}{p\cdot q} = \frac{1}{2}\cdot(1-\cos\theta^*(i))$$

Measurement of α_s from Jet Cross Sections

Leading Order $O(\alpha_s)$:



Next-to-Leading Order $O(\alpha_s^2)$:

$$\boxed{\sigma_{2+1}(Q^2) \;=\; \alpha_s(Q^2)c_1(Q^2,\alpha_s) \;+\; \alpha_s^2(Q^2)c_2(Q^2,\alpha_s)}$$

where $c_i = c_i(PDF)$

To determine α_s use inclusive cross section or ratio of 2-jets

$$\boxed{R_{2+1}(Q^2) \;=\; \sigma_{2+1}(Q^2)/\sigma_{tot}(Q^2)}$$

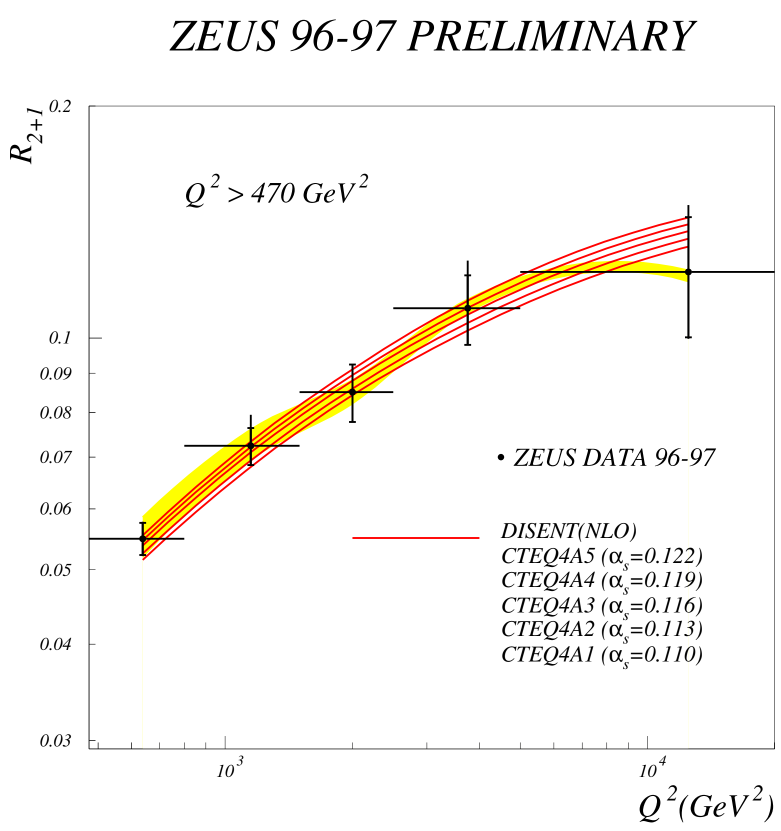
Four Different NLO Programs now available:

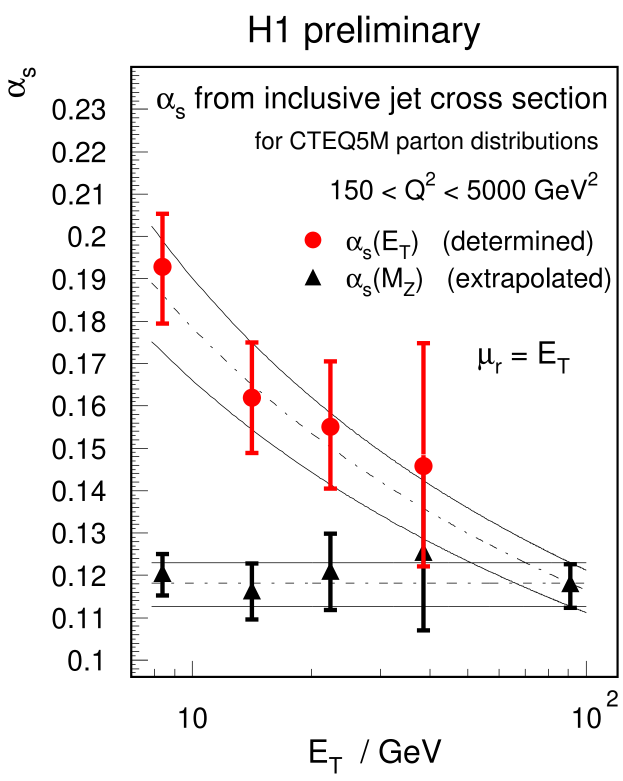
subtraction: DISASTER++ (Graudenz), DISENT (Catani/Seymour),

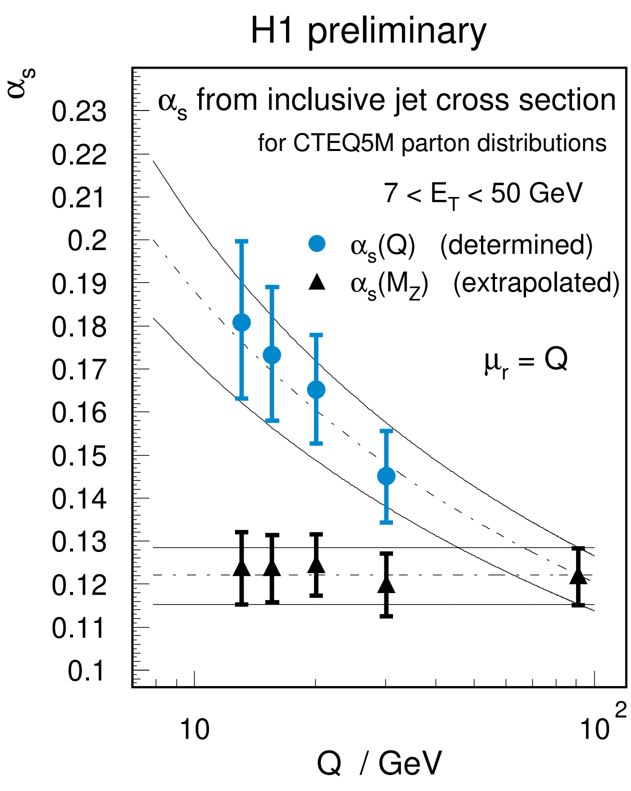
phase-space-slicing: JETVIP (Pötter), MEPJET (Mirkes/Zeppenfeld)

- Highly non trivial test of pQCD
- Sensitive to α_s and g(x,μ_F^2)

α_s extraction







Event Shapes and Power Corrections

Thrust $\tau \equiv 1 - T$ measures the longitudinal momentum components projected onto the current hemisphere axis

$$\tau = 1 - \frac{\sum |\mathbf{p}_h \cdot \mathbf{n}|}{\sum |\mathbf{p}_h|} = 1 - \frac{\sum |\mathbf{p}_{z\,h}|}{\sum |\mathbf{p}_h|}$$

Thrust $\tau_C \equiv 1 - T_C$ uses the direction $\mathbf{n}_T$ which maximizes the sum of the longitudinal momenta of all particles in the current hemisphere along this axis

$$\tau_C = 1 - \max_{\mathbf{n}', \mathbf{n}'^2 = 1} \frac{\sum |\mathbf{p}_h \cdot \mathbf{n}'|}{\sum |\mathbf{p}_h|} = 1 - \frac{\sum |\mathbf{p}_h \cdot \mathbf{n}_T|}{\sum |\mathbf{p}_h|}$$

This definition is analogous to that used in e^+e^- experiments and represents a mixture of longitudinal and transverse momenta with respect to the boson axis.

The *Jet Broadening* B measures the scalar sum of transverse momenta with respect to the current hemisphere axis

$$B = \frac{\sum |\mathbf{p}_h \times \mathbf{n}|}{2 \sum |\mathbf{p}_h|} = \frac{\sum |\mathbf{p}_{\perp\,h}|}{2 \sum |\mathbf{p}_h|}$$

The squared *Jet Mass* ρ is normalized to four times the squared total energy in the current hemisphere

$$\rho = \frac{(\sum p_h)^2}{(2 \sum E_h)^2}$$

The C *Parameter* is derived from the eigenvalues λ_i of the linearized momentum tensor Θ^{jk}

$$\Theta^{jk} = \frac{\sum p_h^j p_h^k / |\mathbf{p}_h|}{\sum |\mathbf{p}_h|}$$

$$C = 3(\lambda_1\lambda_2 + \lambda_2\lambda_3 + \lambda_3\lambda_1)$$

Another class of event shapes investigates the number of $(n+1)$ jets found in an event, where $+1$ denotes the proton remnant. Jets are searched for in the complete accessible phase space, i.e. in both the current and target hemispheres of the Breit frame.

The following distance measures are used: Durham or k_t algorithm

$$\begin{aligned} y_{ij} &= \frac{2\min(E_i^2, E_j^2)(1-\cos\theta_{ij})}{Q^2} \\ y_{ir} &= \frac{2E_i^2(1-\cos\theta_{ir})}{Q^2} \end{aligned}$$

factorizable JADE algorithm

$$\begin{aligned} y_{ij} &= \frac{2E_iE_j(1-\cos\theta_{ij})}{Q^2} \\ y_{ir} &= \frac{2E_i x E_p(1-\cos\theta_{ir})}{Q^2} \end{aligned}$$

where θ_{kl} is the angle between the two momentum vectors.

Power Corrections

$$\langle F \rangle = \langle F \rangle^{\mathrm{pert}} + \langle F \rangle^{\mathrm{pow}}$$

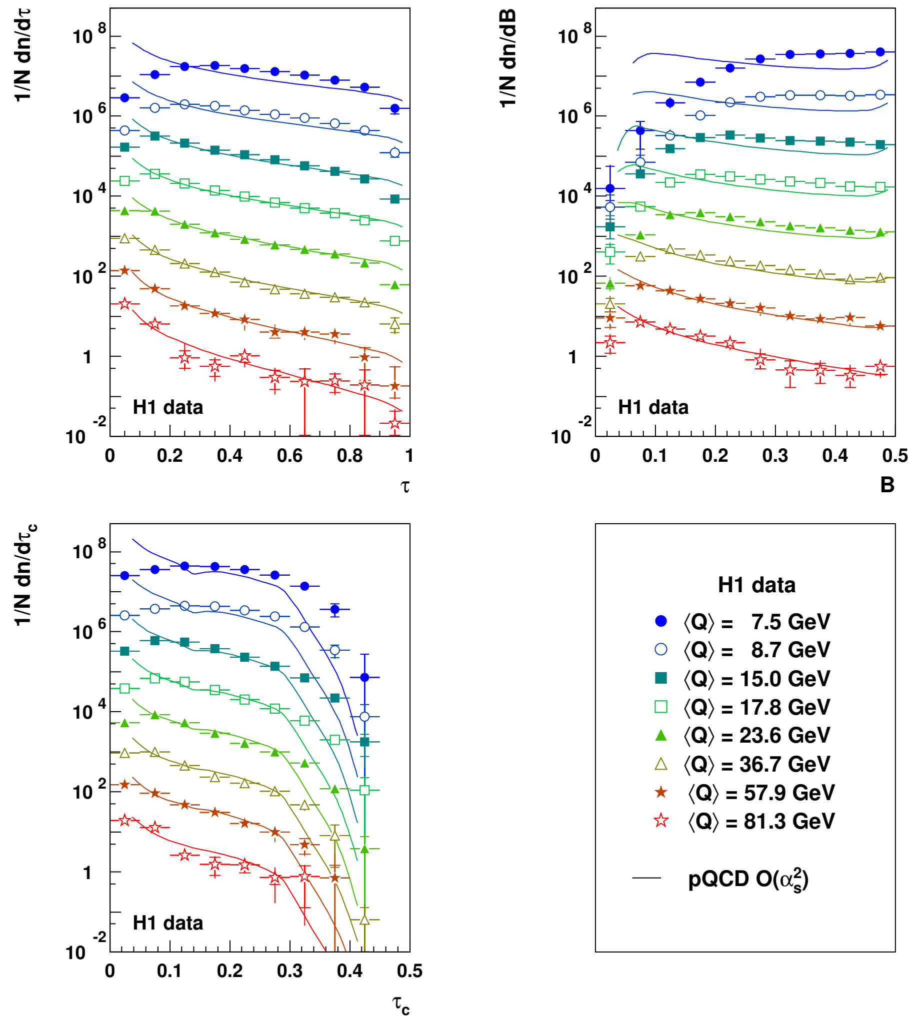
$$\langle F \rangle^{\mathrm{pert}} = c_1(x,Q)\,\alpha_s(\mu_R) + \left[c_2(x,Q) + \frac{\beta_0}{2\pi}\ln\frac{\mu_R}{Q}c_1(x,Q)\right]\alpha_s^2(\mu_R)$$

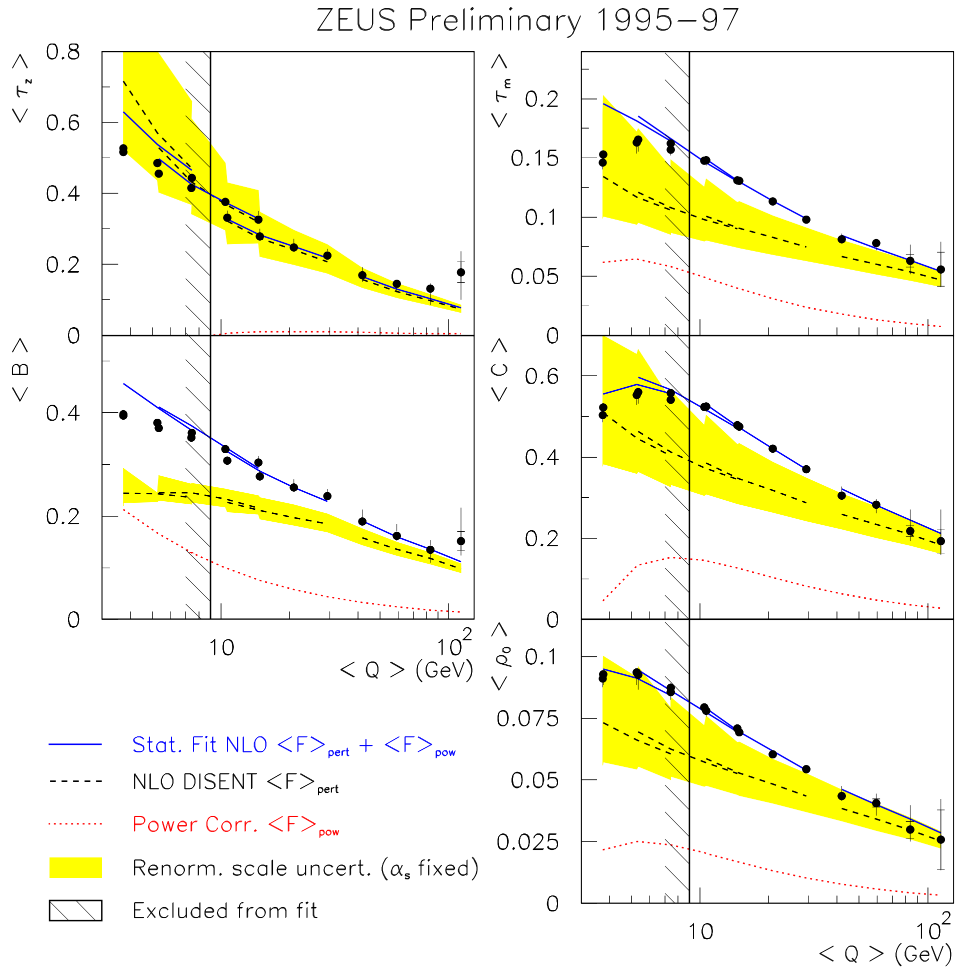
$$\langle F \rangle^{\mathrm{pow}} = a_F\,\mathcal{P},$$

$$\mathcal{P} = \frac{4C_F}{\pi\;p}\mathcal{M}'\left(\frac{\mu_I}{\mu_R}\right)^p\left[\overline{\alpha}_{p-1}(\mu_I) - \alpha_s(\mu_R) - \frac{\beta_0}{2\pi}\left(\ln\frac{\mu_R}{\mu_I} + \frac{K}{\beta_0} + \frac{1}{p}\right)\alpha_s^2(\mu_R)\right]$$

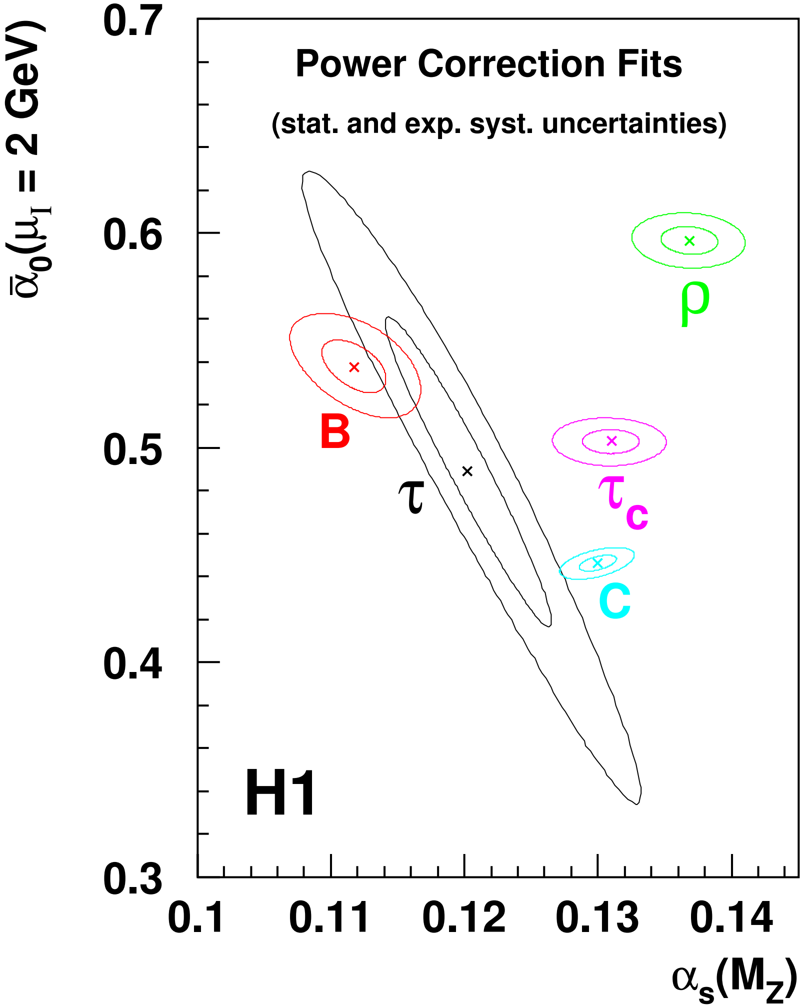
$C_F = 4/3$, $K = 67/6 - \pi^2/2 - 5/9\,N_f$ and $N_f = 5$ as in the perturbative part.

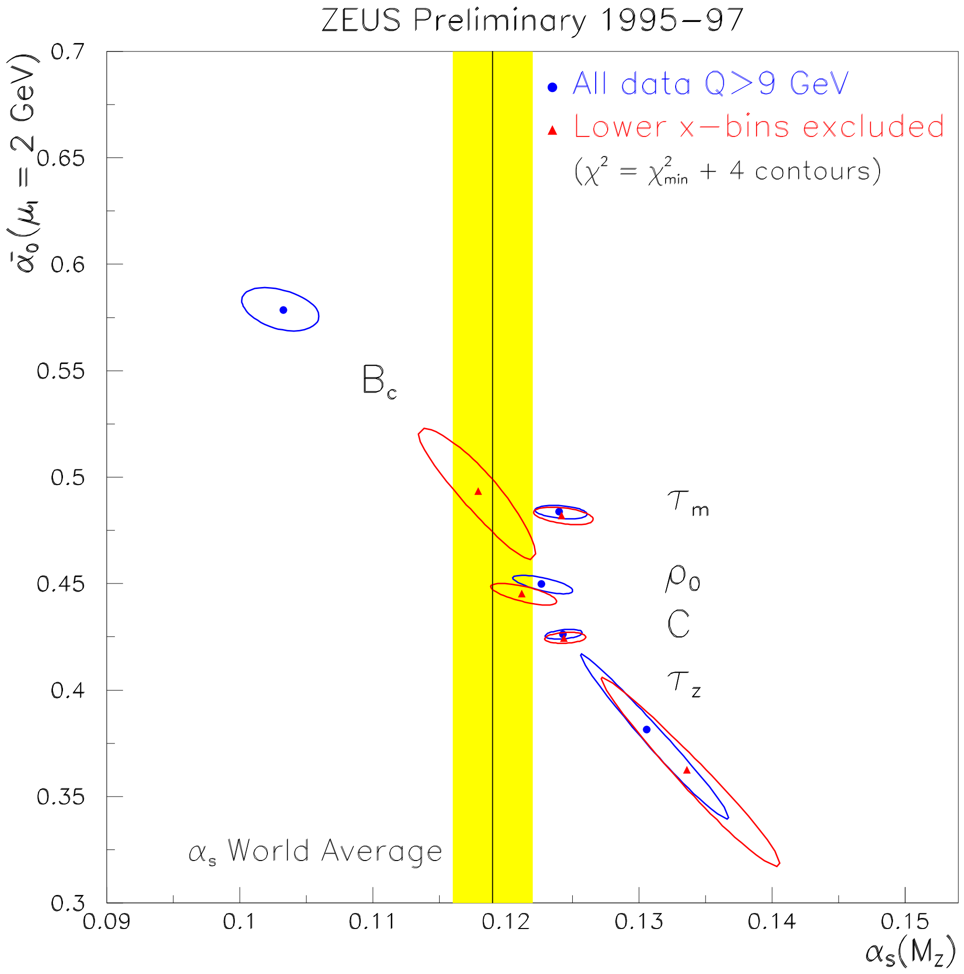
Event Shapes



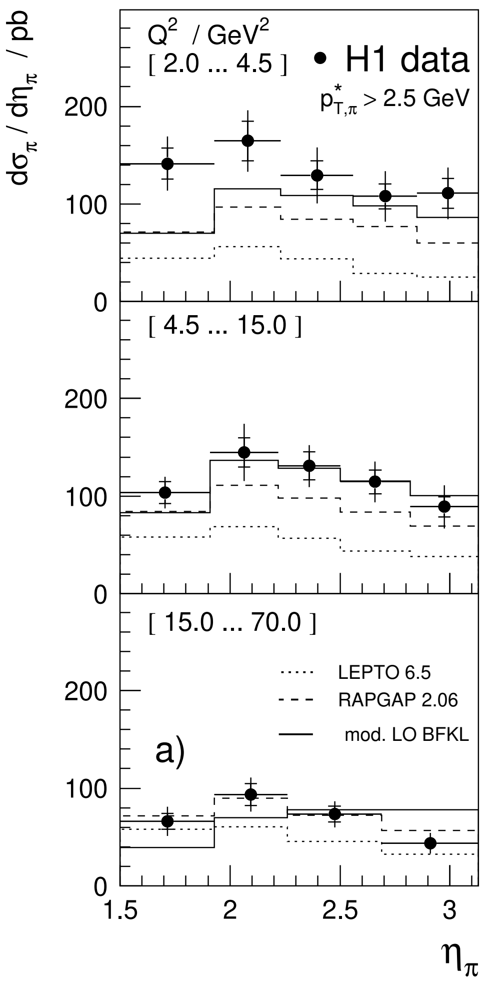


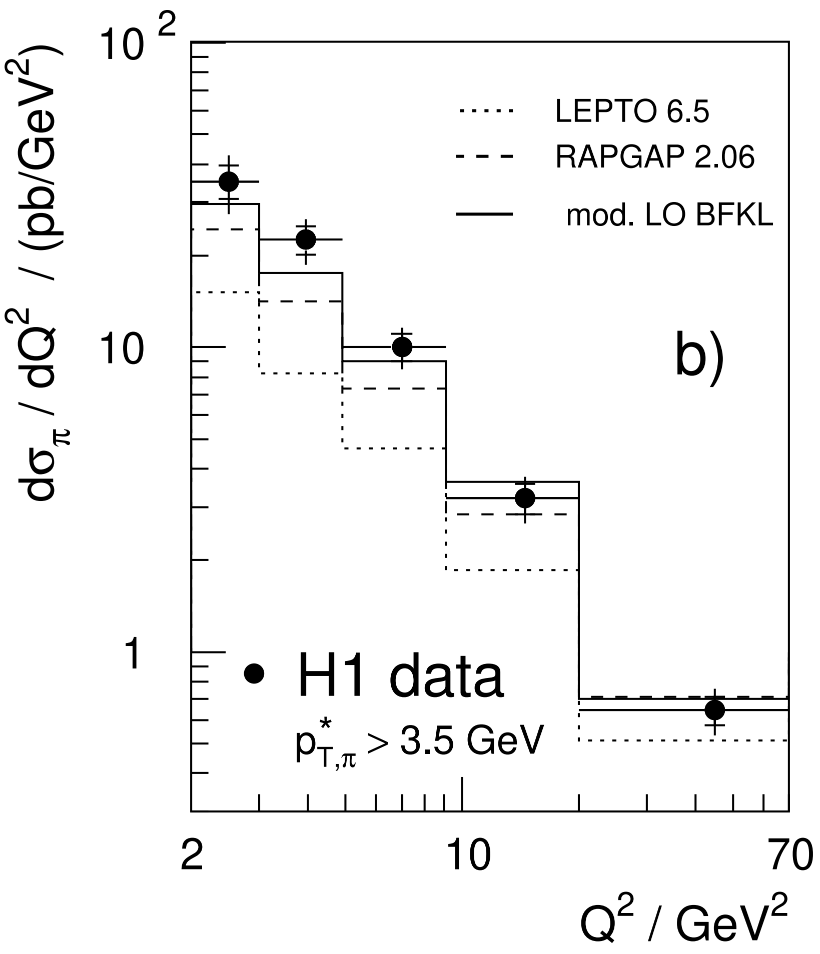
Event Shapes





"Forward" particle production





"Forward" jet production