DIS 2003

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Measurement of Inclusive Jet Cross-Sections in Deep Inelastic Scattering at low Q^2 at HERA

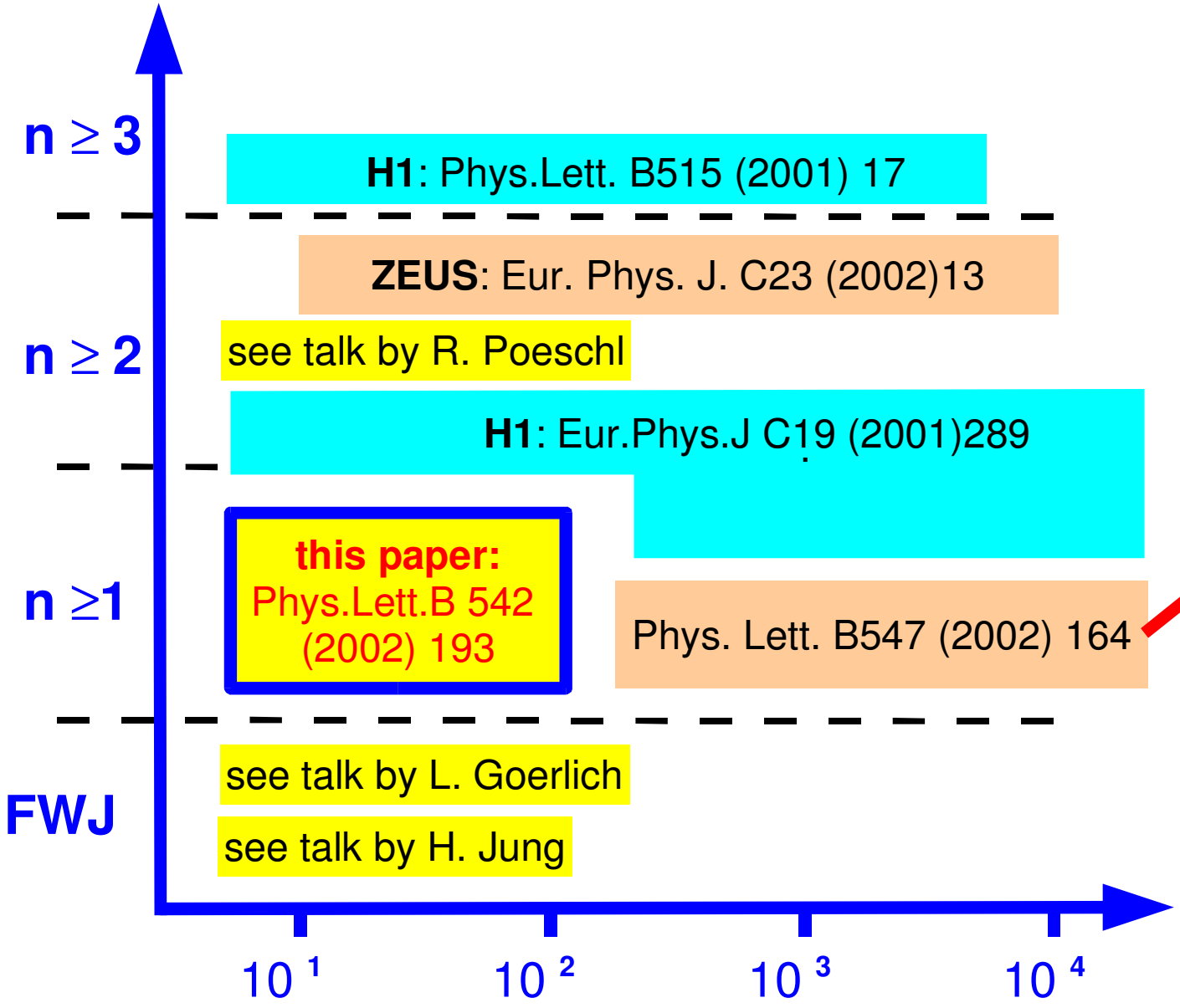
Arnd Specka

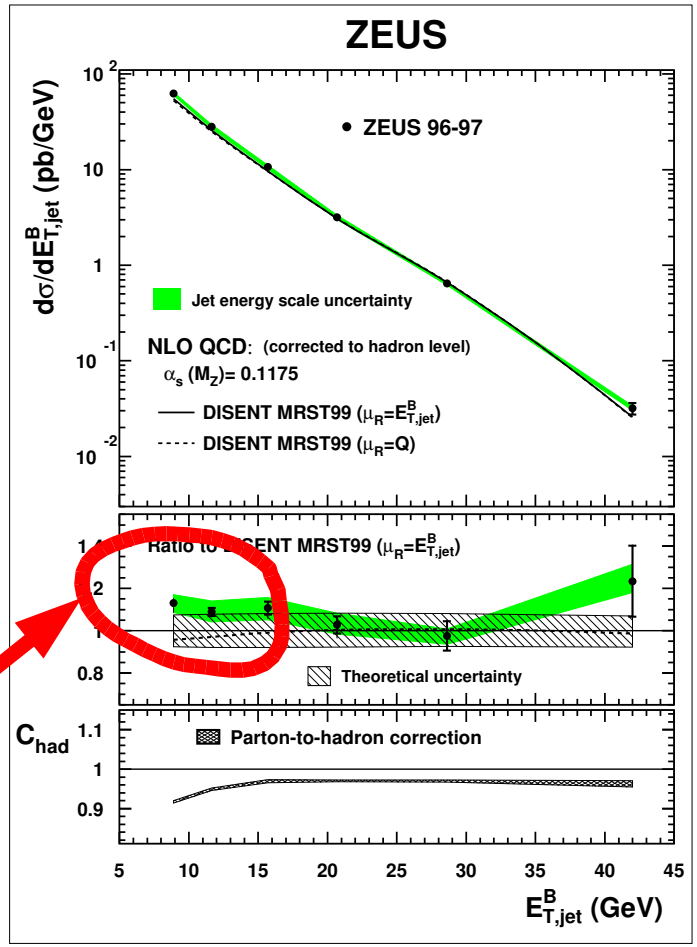
Ecole Polytechnique, France and DESY, Germany

on behalf of the

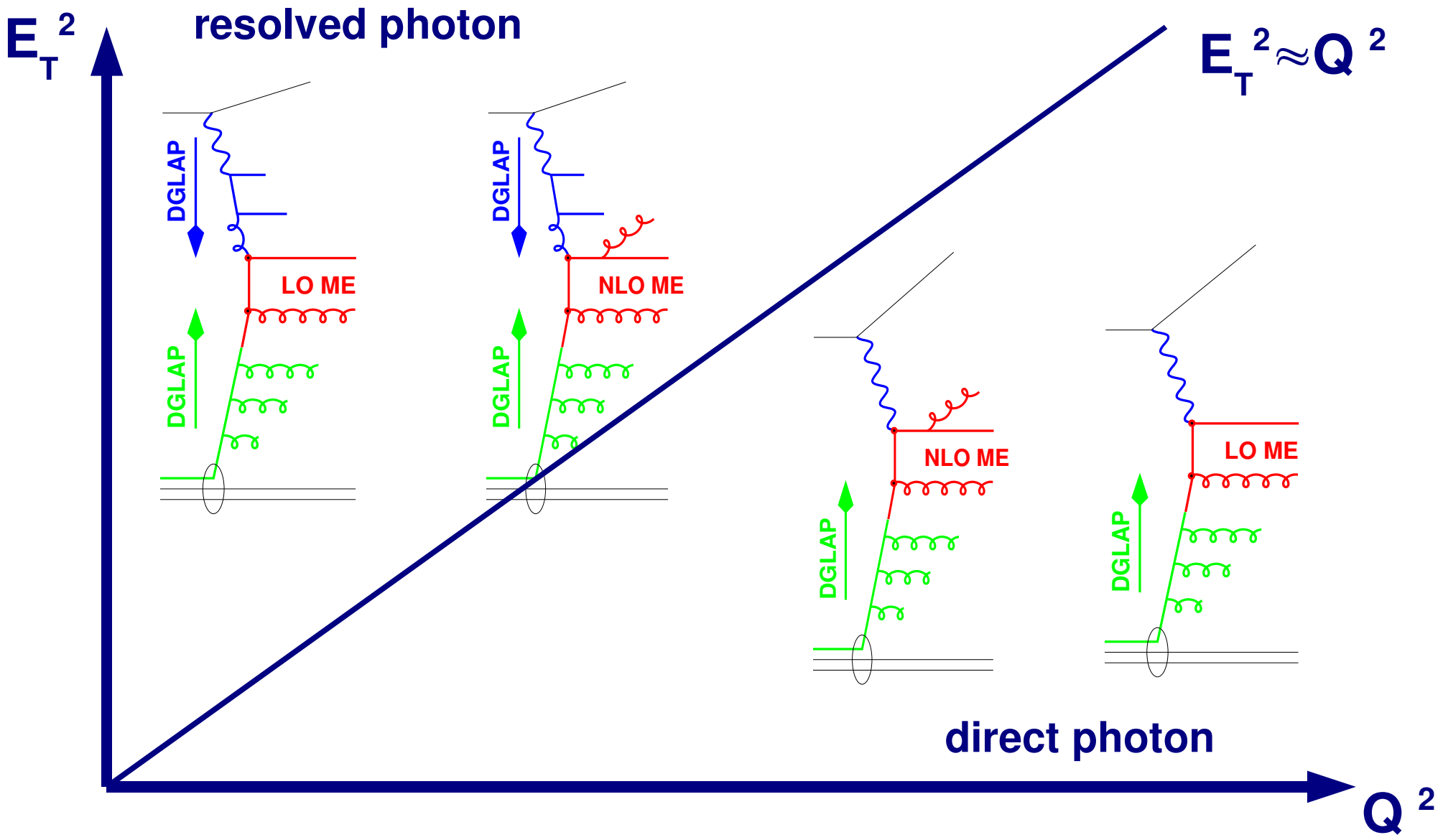
collaboration

Jet Production in DIS = Testing Ground for pQCD





Hard Scales inpQCD Calculations of Jet Production



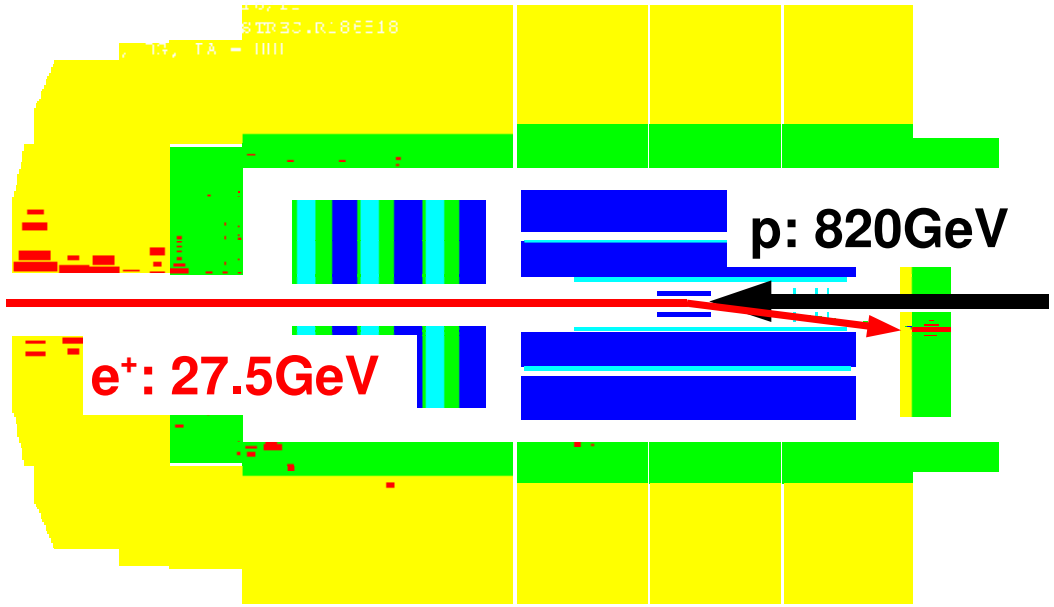
Motivation

How well do **NLO** (i.e. $\alpha_s^{2)}$ **QCD** calculations describe **inclusive** jet production in DIS?

- **extend and complement existing measurements by H1:** inclusive single jet at high Q^2, dijet and 3-jet production in DIS
- **bigger phase space, higher statistics**
- **avoid phase space regions were fixed order QCD calculations are infrared-sensitive (no asymmetric cuts like in dijet production)**
- **asses dependence on choice of and sensitivity to the renormalization scale**
- **look for higher order effects: NNLO, BFKL, CCFM, resolved γ^* ?**

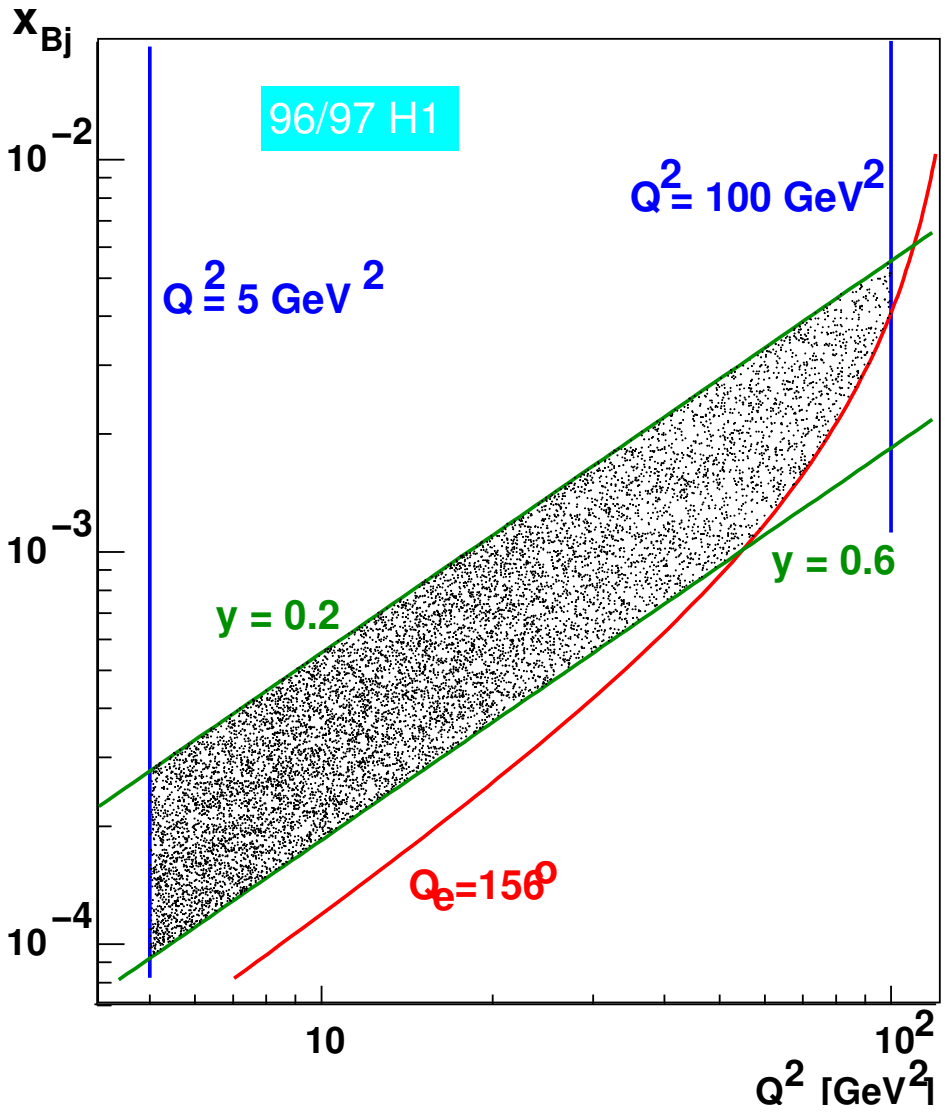
Selection of DIS Events

H1 data: 21.1 pb^{-1}



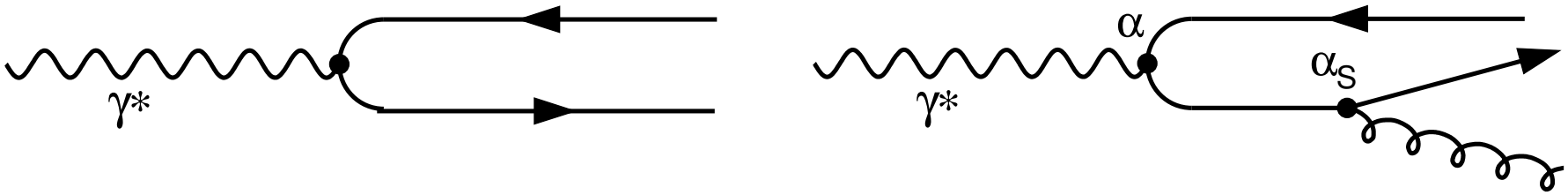
- scattered electron in backward calo
  $E'_e > 10$ GeV $\theta_e > 156^o$
- $5 < Q^2 < 100$ GeV^2
- $0.2 < y < 0.6$

(and minor BG suppression cuts)



Selection of Jets

- ***Breit frame:*** E_T **stems only from QCD process (LO,NLO)**



- ***inclusive, longitudinally invariant k_t algorithm:***
  - **collinear and infrared safe**
  - **iterative clustering** $d_{i,j} = \min(E_{T,i}^2, E_{T,j}^2) \cdot [(\eta_i - \eta_j)^2 + (\phi_i - \phi_j)^2] / R_0^2$
  - **result: n jets with mutual distance** $d_{i,j} > R_0 \; (R_0 = 1)$
  - **count all jets with:**

$E_T^{jet} > 5$ GeV (in Breit Frame)

$-1 < \eta_{Lab}^{jet} < 2.8$ (in Lab Frame)

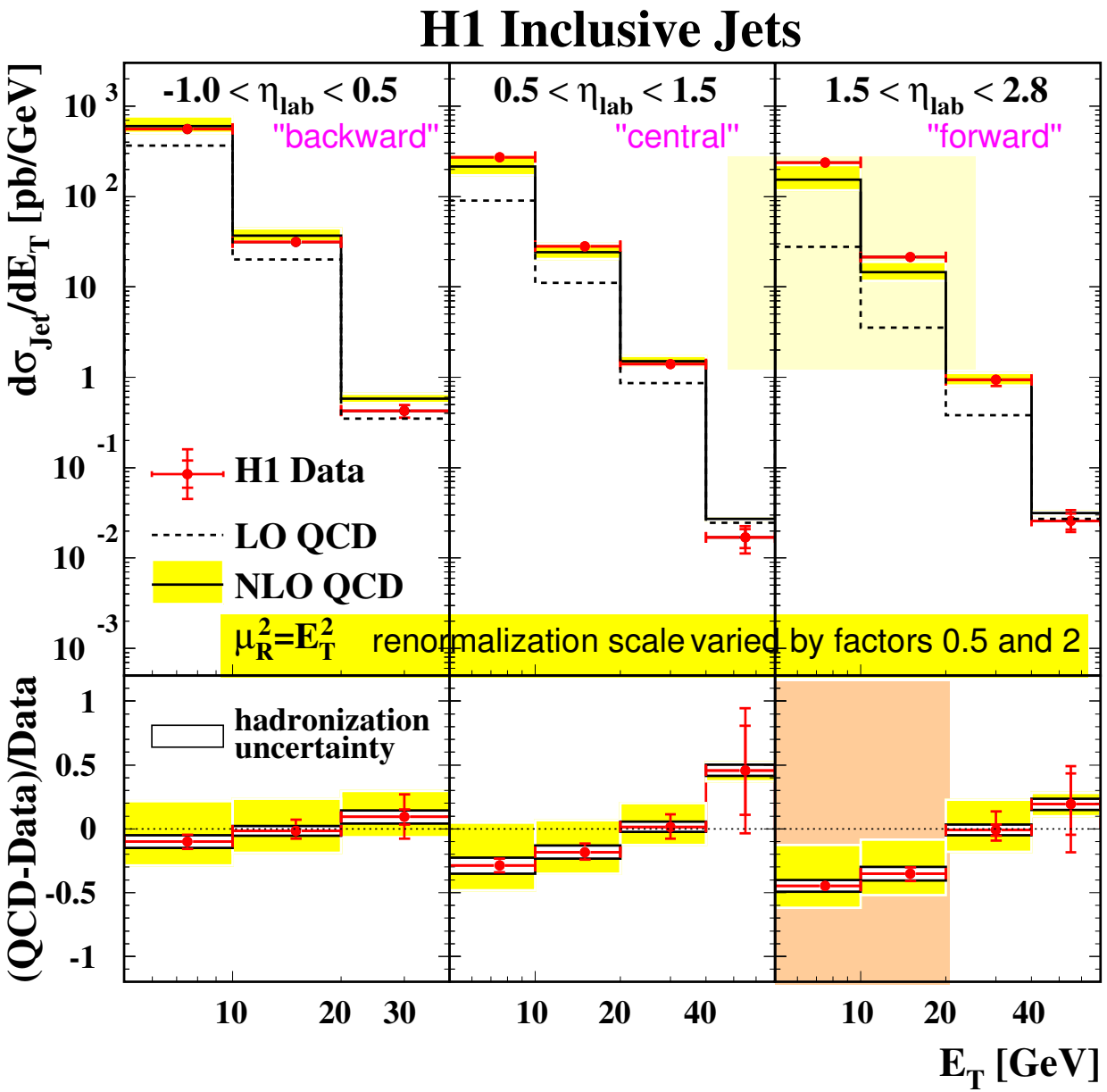
Experimental Observables and QCD Predictions

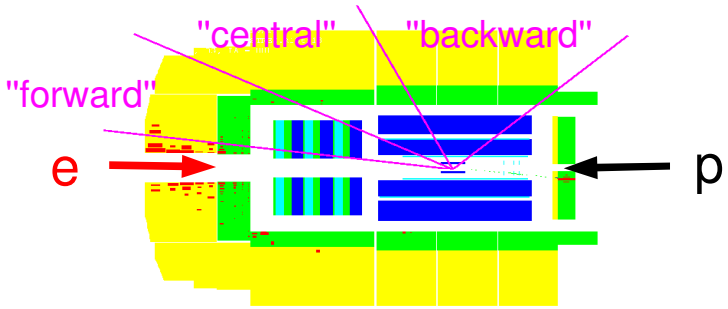
- ***Observables:*** **inclusive** cross-sections (i.e. every jet counts):

$$\frac{d\sigma}{dE_T}(E_T,\eta) \qquad \frac{d\sigma}{dE_T}(E_T,Q^2) \qquad \frac{d\sigma}{d(E_T^2/Q^2)}(E_T^2/Q^2,\eta)$$

- ***dominating systematic errors:***
  - model dependence of **detector and QED corrections**: 5 - 10 %
  - 3% uncertainty of hadronic **calorimeter energy scale**: 10 -15 %
- ***comparison to LO + NLO QCD predictions:***
  - **DISENT** (direct photon) + DGLAP evolved p.d.f.s (CTEQ 5M/L)
  - factorisation scale: $\mu_F^2 = Q^2$
  - renormalisation scale $\mu_R^2 = E_T^2$ (mainly) or $\mu_R^2 = Q^2$ (for comparison)
  - variation of the renormalisation scale: $\mu_R \searrow 0.5\,\mu_R$ and $\mu_R \nearrow 2\,\mu_R$
  - hadronization corr's: ME+PS (Lepto) and CDM (Ariadne): ↘ 5 -15 %

E_T dependence of $d\sigma/dE_T$ in different η regions



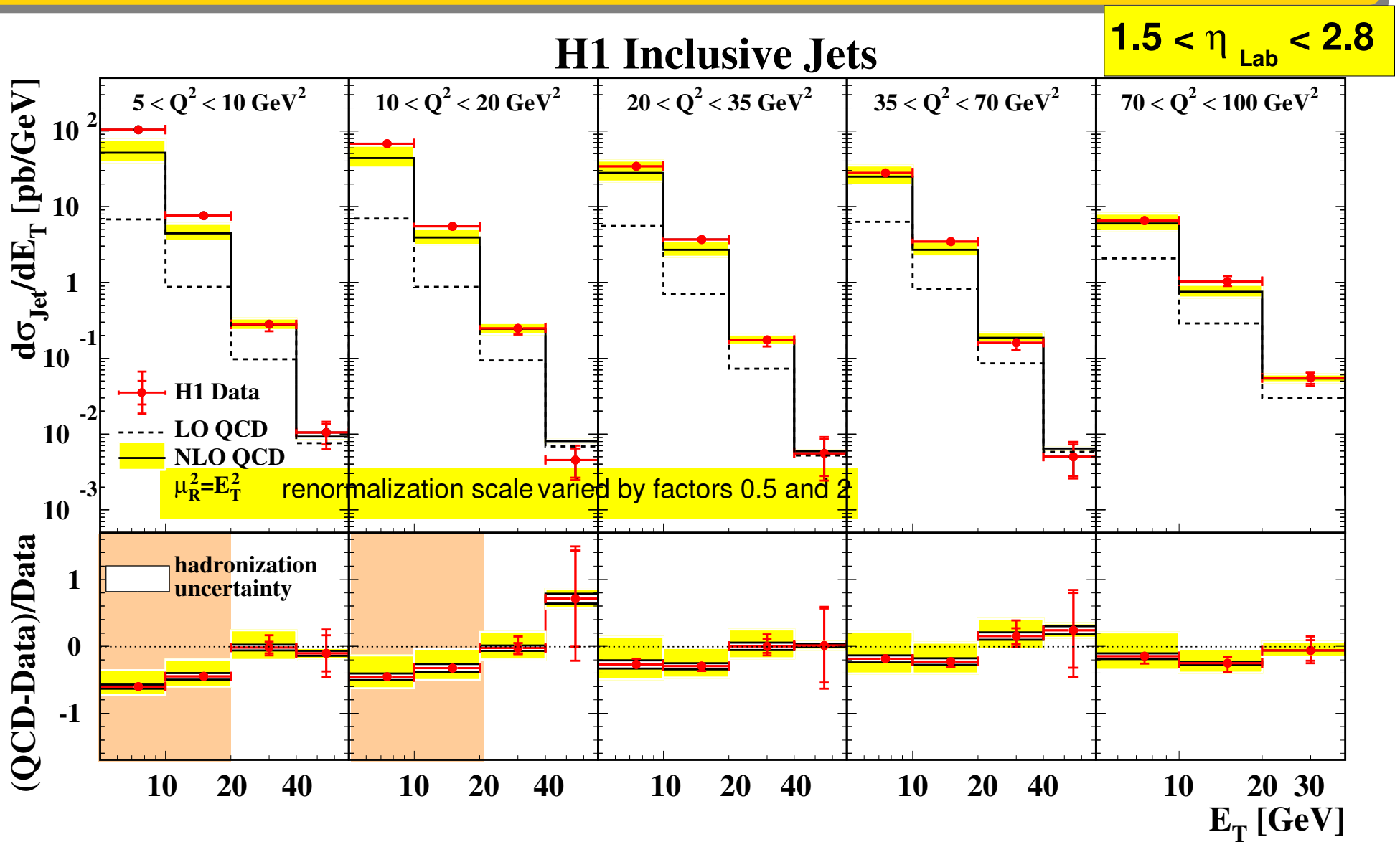


Good agreement of NLO QCD with data in backward and central regions

Large NLO corrections for low ET and in forward region. (NLO / LO ~ 5)

NLO predictions below data for ET < 20 GeV, in forward region.

A Closer Look at the Forward Region: Q^2 dependence



NLO predictions up to 50% lower than data where NLO corr's are largest

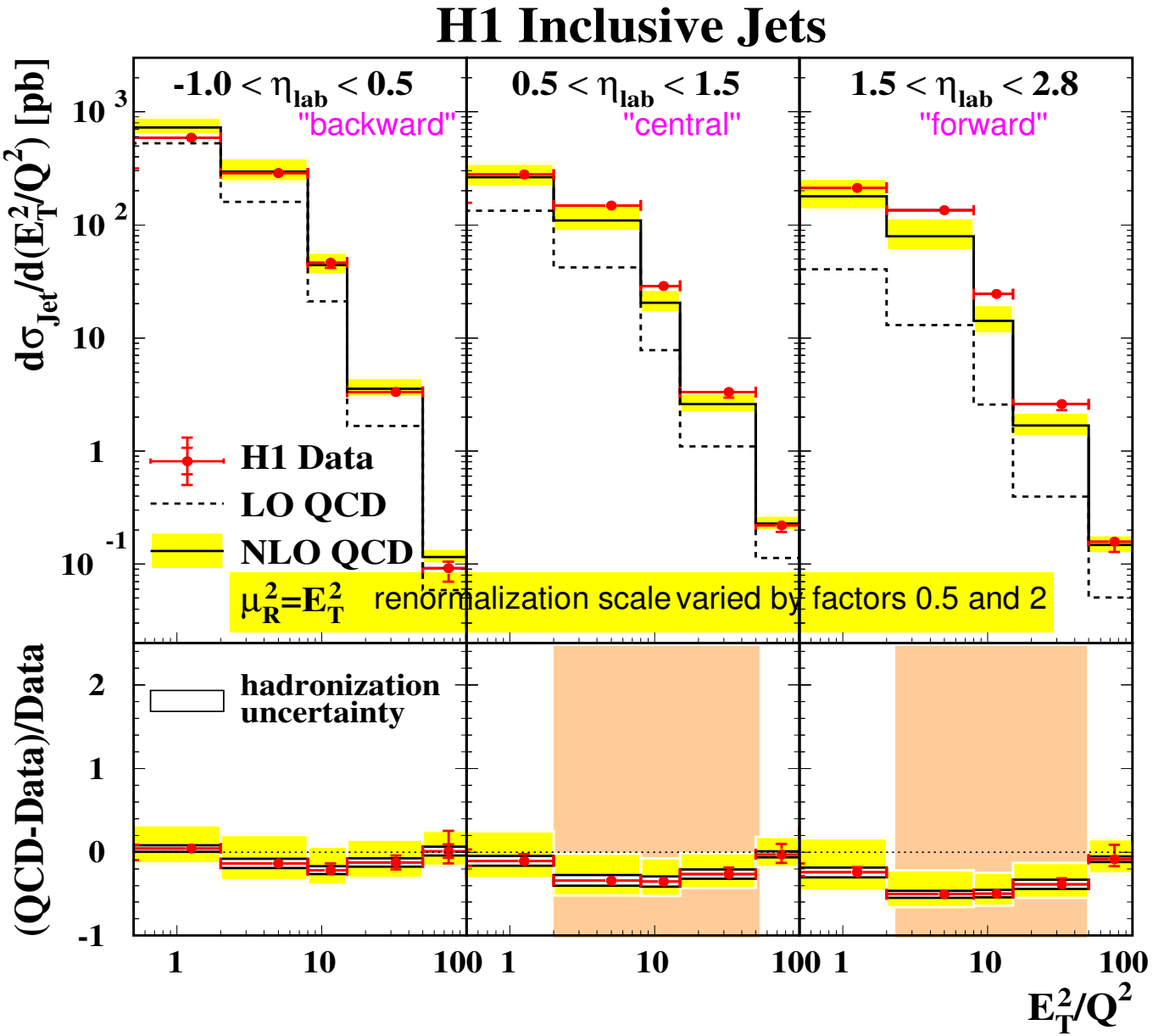
Interplay of the 2 hard scales: E_T^2/Q^2-dependence

original motivation

- In DGLAP, emission of forward jets with $E_T^2/Q^2 \approx 1$ (Muller-Navelet jets) are suppressed.
- resolved photons mimicks higher orders at high E_T^2/Q^2

only the backward region is well described by NLO QCD

for central and forward regions, NLO prediction is lower in medium range: $2 < E_T^2 / Q^2 < 50$ GeV^2 dominated by small values of both E_T^2 and Q^2.

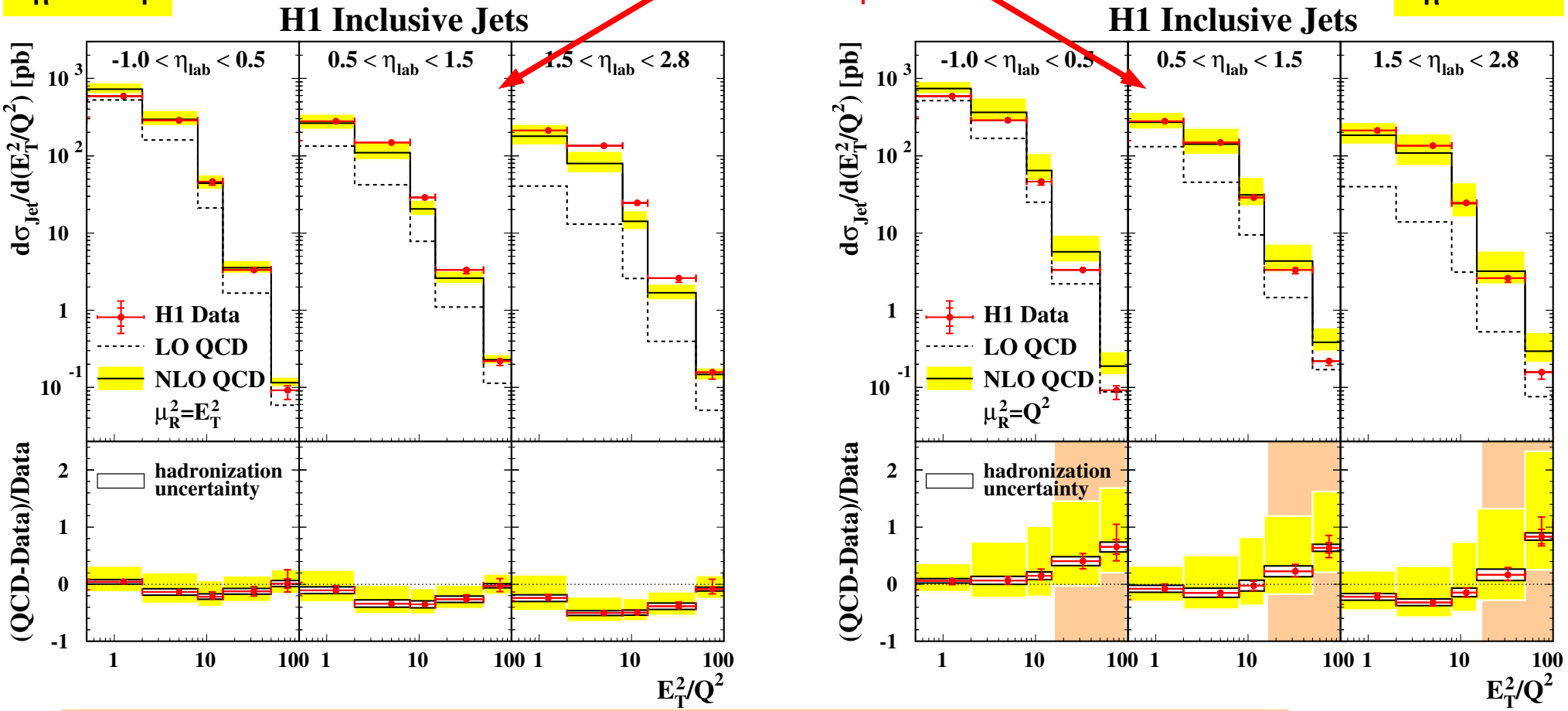


Influence of the renormalisation scale $\mu_R^2 = E_T^2$ v/s Q^2

$\mu_R^2 = E_T^2$

same data points!

$\mu_R^2 = Q^2$



$\mu_R^2 = Q^2$: disagreement for large E_T^2 / Q^2, i.e. where Q^2 is small

strongly increased sensitivity to variation of renormalisation scale

$\Rightarrow \mu_R^2 = Q^2$ seems not to be the appropriate choice for NLO QCD

Summary

- inclusive jet cross-section at "low" Q^2 measured by H1
- good overall agreement with NLO QCD calculations
- NLO QCD predictions below data

  in the forward region for small E_T^2 and Q^2
- NLO QCD depend on the choice of renormalisation scale μ_R
- lower scale sensitivity for $\mu_R^2 = E_T^2$ than for $\mu_R^2 = Q^2$.