Test of BFKL-NLO: Motivation

- See hep-ph/0411338 with L.Schoeffel, R.Peschanski
- Effective BFKL LO phenomenology: LO BFKL successful for F_2(proton) for $x \leq 10^{-2}$, but with effective $\alpha_S \sim 0.1$!
- Tests of BFKL NLO: Theoretical problems, Expected NLO improvement fails (without resummation), creating spurious divergences
- Resummed NLO BFKL kernels: Theoretically improved, but practical complexity
- BFKL NLO phenomenology: Direct tests of BFKL NLO resummations using data, 2 aspects: F_2 NLO fits inspired by LO experience, direct tests in Mellin space

"Effective" NLO BFKL phenomenology

- Idea: perform the same saddle point approximation as at LO using χ_{NLO} given by BFKL NLO

- Saddle point approximation

$$F_2 = C e^{\alpha_{RGE}\chi_{eff}(\gamma_c,\alpha_{RGE})Y} \left(Q^2/Q_0^2\right)^{\gamma_c} e^{-\frac{log^2(Q/Q_0)}{2\alpha_{RGE}\chi''_{eff}(\gamma_c,\alpha_{RGE})Y}}$$

  γ_C and χ_{eff}: (properties of BFKL NLO if small-x structure function is dominated by the perturbative Green function) (ω is the Mellin transform of Y)

$$\frac{d\chi_{eff}}{d\gamma}(\gamma_C, \alpha_{RGE}(Q^2)) = 0$$

$$\chi_{eff}(\gamma, \alpha_{RGE}) = \omega(\gamma, \alpha_{RGE})/\alpha_{RGE}$$

- 2 parameters fit: C and Q_0, (α given by RGE at NLO)

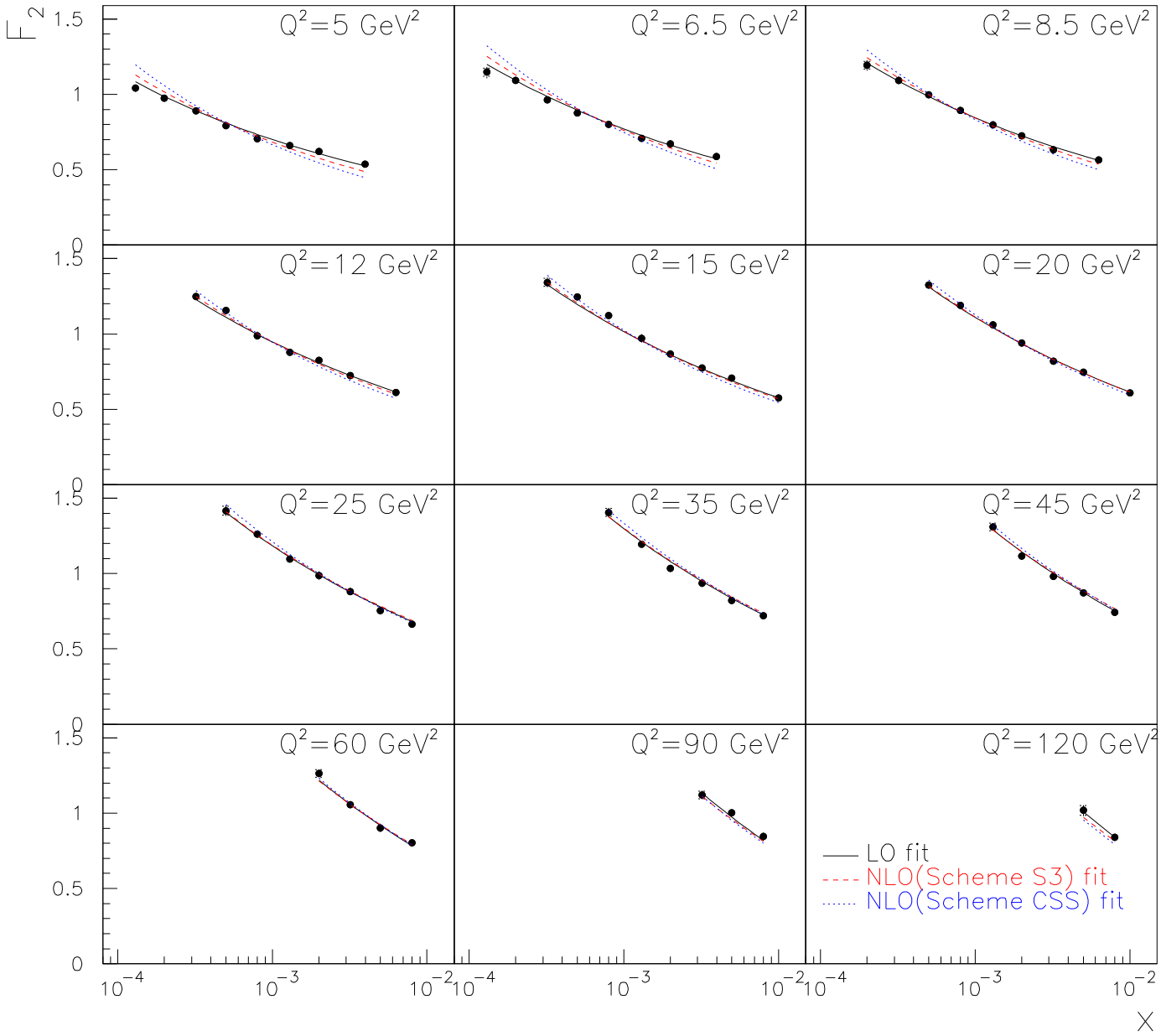
- Difficulties: χ complicate formula at NLO and scheme dependent

Strategy for NLO fits

- First step: Knowledge of $\chi_{NLO}(\gamma, \omega, \alpha)$ from BFKL equation and resummation schemes
- Second step: Use implicit equation $\chi(\gamma, \omega) = \omega/\alpha$ to compute numerically ω as a function of γ for different schemes and values of α
- Third step: Numerical determination of saddle point values γ_C as a function of α as well as the values of χ and χ''
- Fourth step: Perform the BFKL-NLO fit to HERA F_2 data with two free parameters C and Q_0^2

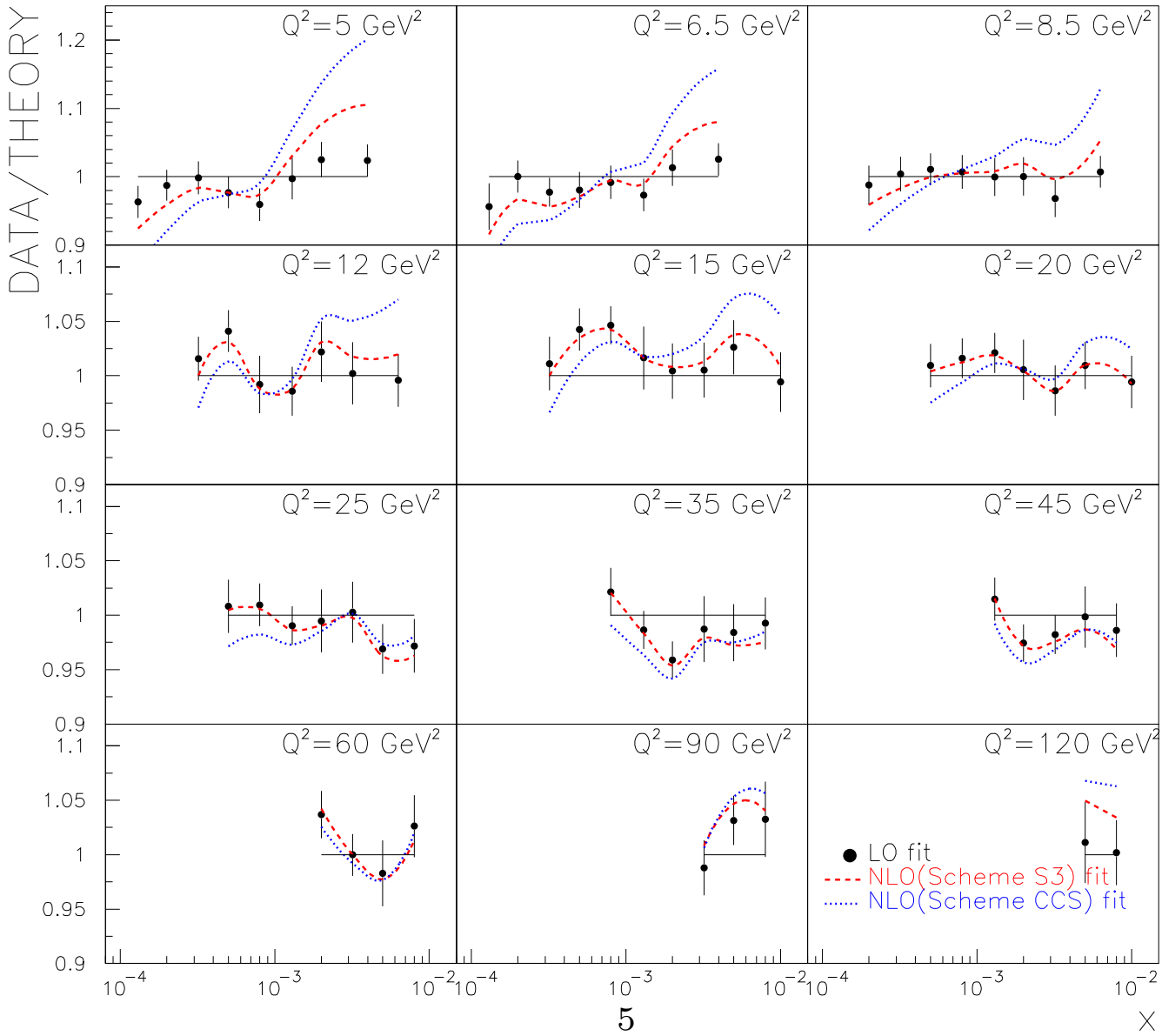
BFKL NLO fit to H1 data

Result of the NLO BFKL fit shown for 2 schemes: disagreement at low Q^2



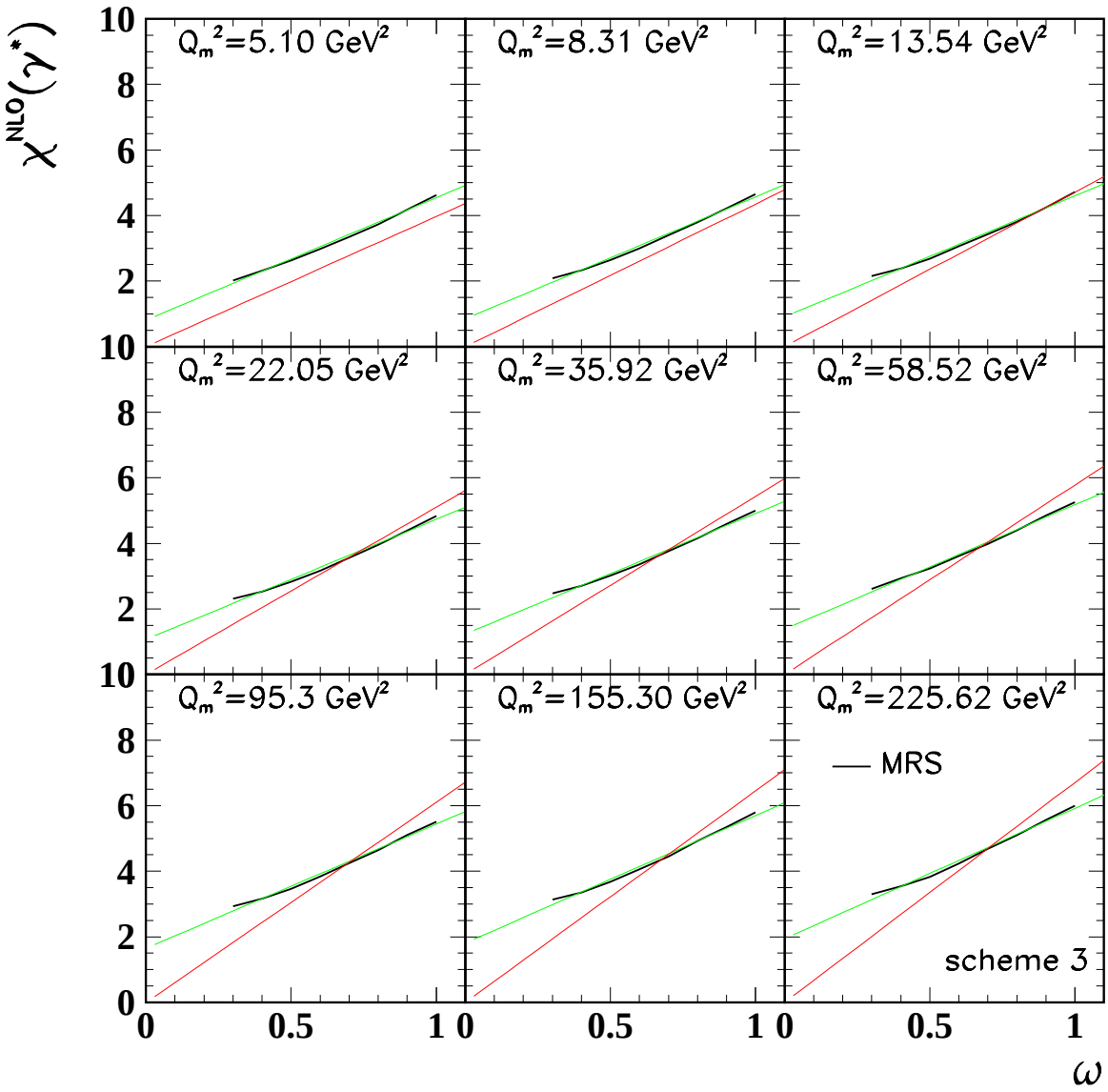
Data / theory

- Data / theory: points: LO fit, curves: NLO fit for S3 and CSS
- Why such a difference: analysis in Mellin space



Test in Mellin space

- In Mellin space, γ^* defined as $dlogF_2(\omega, Q^2)/dlogQ^2$ is the saddle point of the structure function
- It is possible to check that γ^* verifies the property $\chi(\gamma^*(\omega, Q^2), \alpha_{RGE}(Q^2)) = \omega/\alpha_{RGE}(Q^2)$
- Idea: Use different parametrisations of F_2, and perform a Mellin transform of these parametrisations
- 3 parametrisations based on DGLAP evolution equation: Martin, Roberts, Stirling (MRS 2001), Glück, Reya, Vogt (GRV 98), CTEQ (CTEQ 6.1)
- 1 additional parametrisation based on a Regge analysis of proton structure function data: ALLM

$\chi(\gamma^*)$ at NLO - scheme 3

- black: MRS, green: linear fit to MRS, red: consistency check
- Consistency check fails!