Multijet Production at High Q^2

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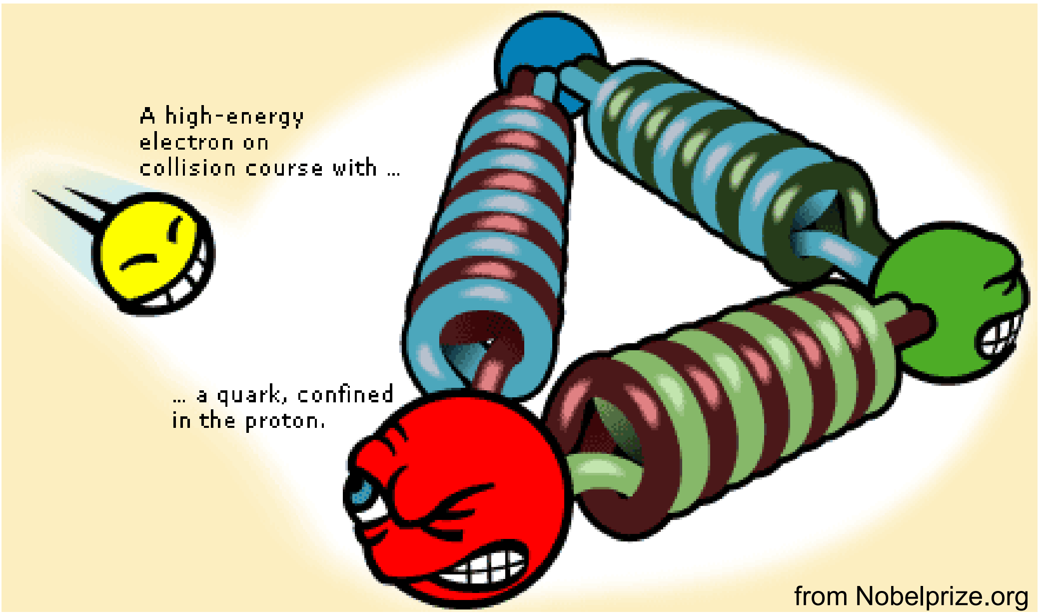
on behalf of the H1 Collaboration

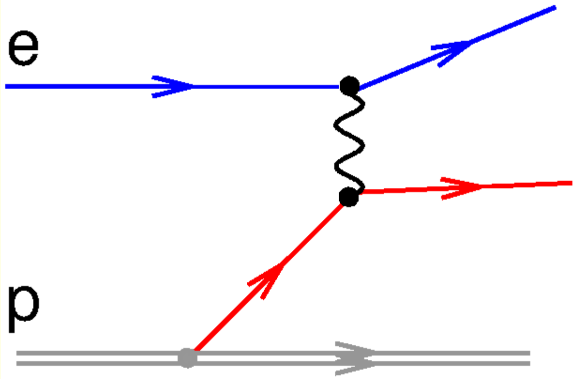
- Motivation
- Measurement
- QCD Analysis
- Summary



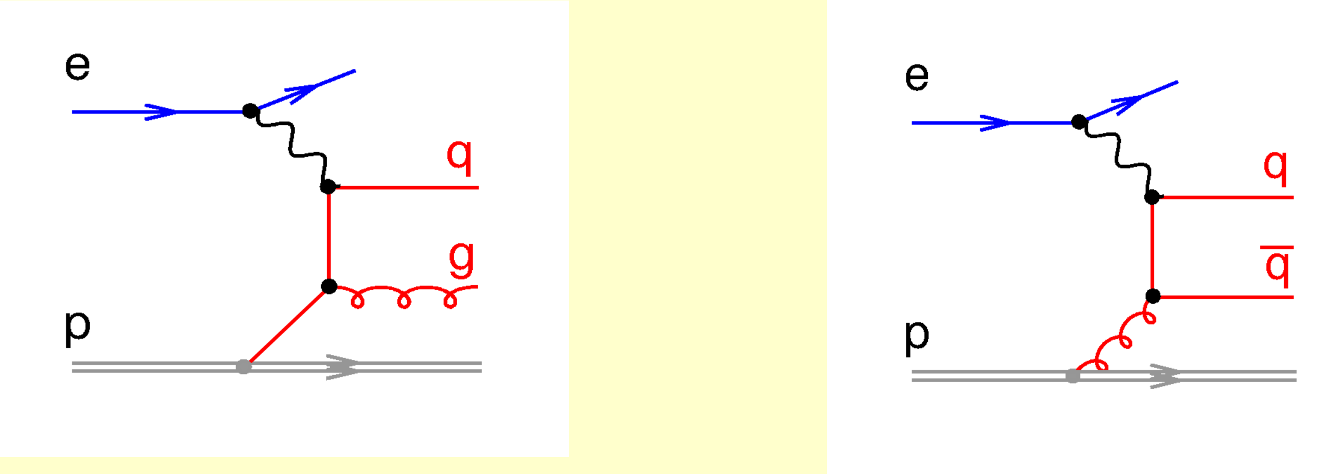
from Nobelprize.org

DIS 2005 XIII International Workshop on Deep Inelastic Scattering

QCD and Deep Inelastic Scattering



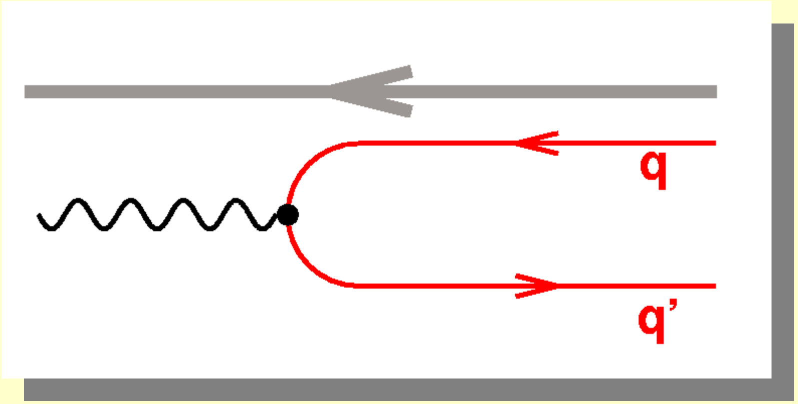
- inclusive DIS sensitive to quark densities
- QCD effects via scaling violations



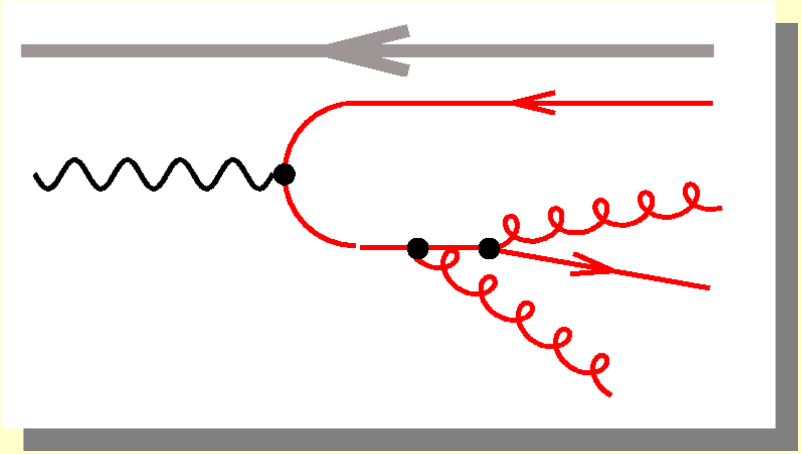
- exclusive signatures: jet cross sections, Born term at $O(\alpha_s)$
- direct sensitivity to QCD radiation, α_s , gluon density

Perturbative QCD

hard scales: Q^2 and jet E_t



Breit frame: jet at Born level has no E_t
may have high E_t in lab. frame



require minimum E_t in Breit frame ->
pQCD reliable

But: small cross section, tri-jet NLO needed (NLOJET++ 2.0.1)

H1 Multijet Measurement

H1: measurement of differential dijet and trijet cross section in neutral current DIS at high Q^2

kinematic range: $\sqrt{s}=318\,GeV$, $150<Q^2<15000\,GeV^2$, $0.2<y<0.6$, $L_{int}=65.4\,pb^{-1}$

jet definition: incl. k_t cluster algorithm,

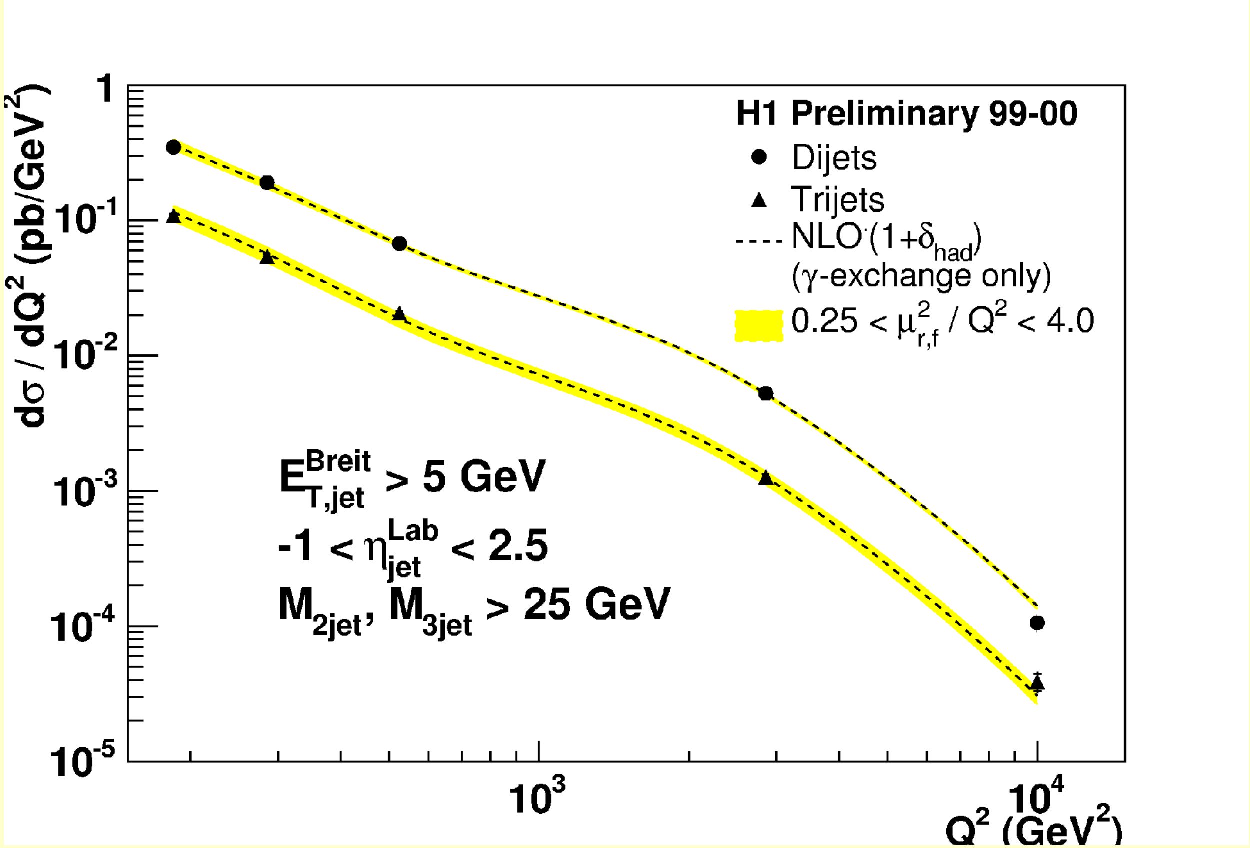
$E_t>5\,GeV$ $-1.0<\eta_{lab}<2.5$ $M_{jj}>25\,GeV$ $M_{jjj}>25\,GeV$

High Q^2:

- smaller correction from higher orders
- reduced μ_r dependence

Di- and Trijet Cross Sections

Theory:
NLOJET++,$\overline{\mathrm{MS}}$
CTEQ5M pdf, $\mu_r=\mu_f=Q$

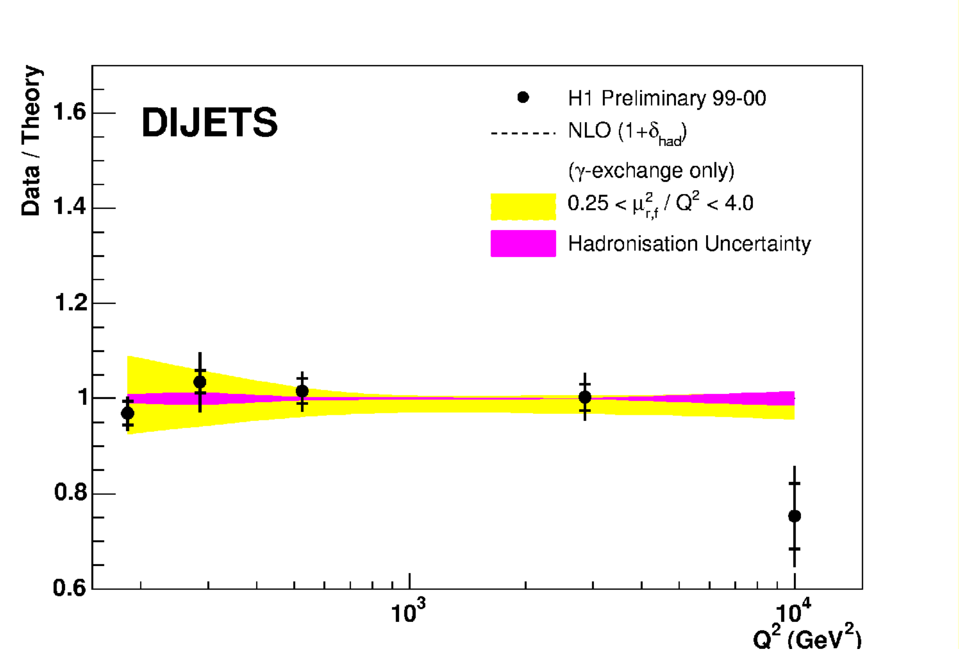


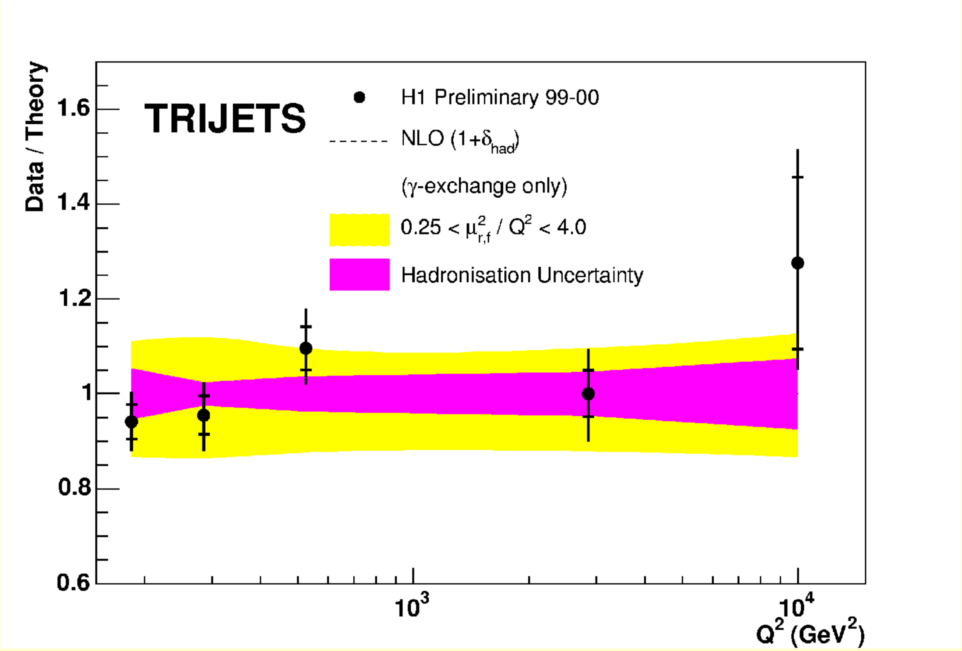
- Data well described
- Highest Q^2 bin lacks electroweak contributions

Di- and Trijet Cross Sections

Missing higher orders <=>
μ_r variation
>10% uncertainty for 3-jet

Sizable statistical errors for 3-jet
-> use HERA II statistics





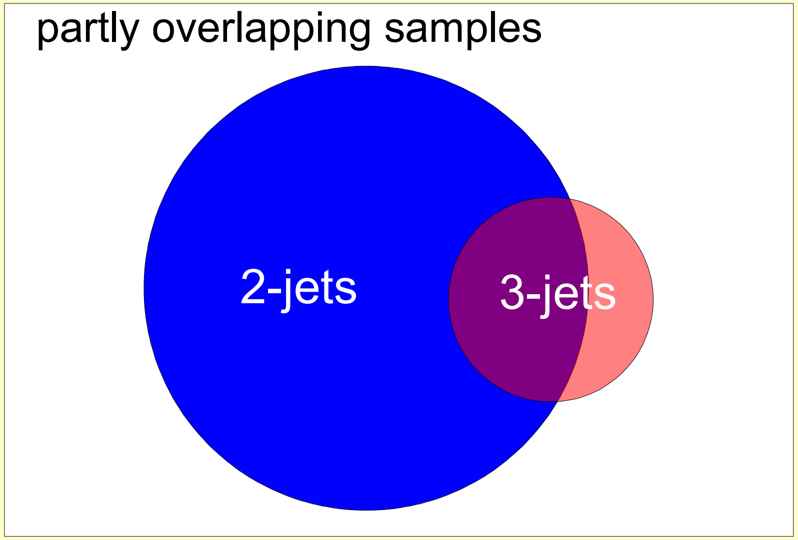
Trijet to Dijet Cross Section Ratio

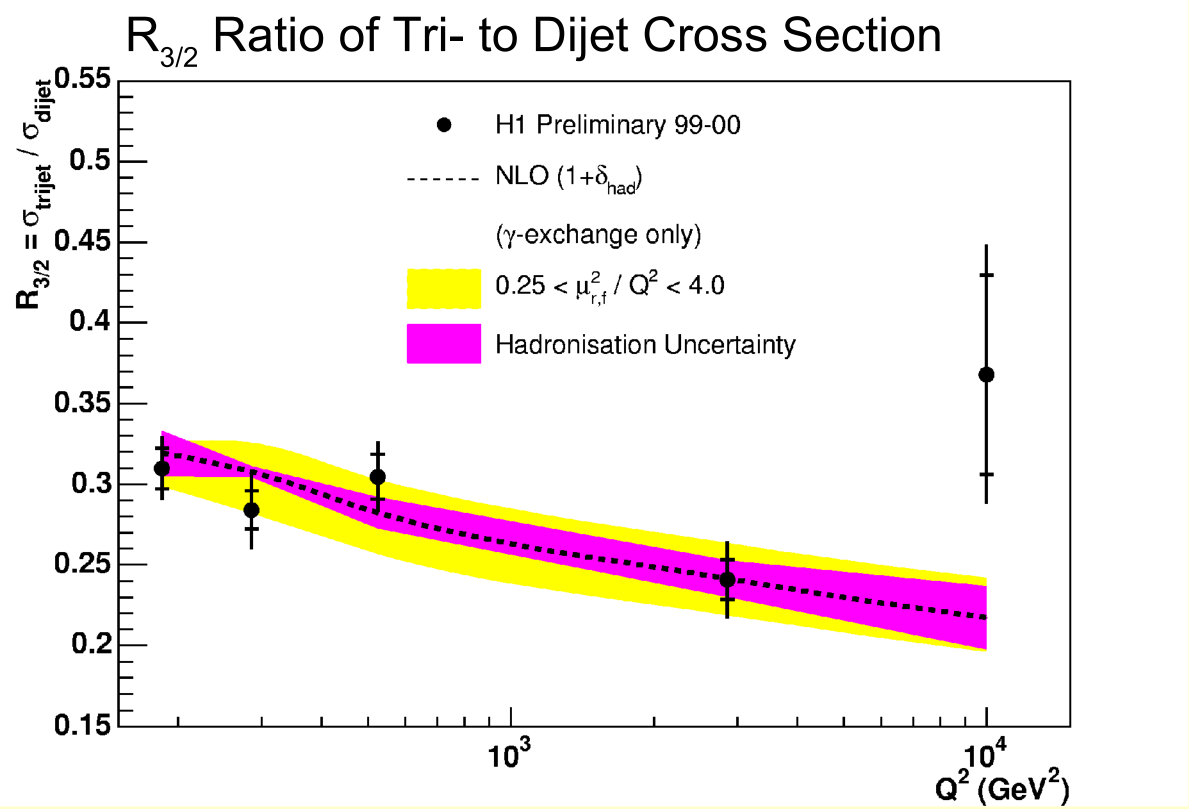
$R_{3/2} := \sigma_{3jet}/\sigma_{2jet}$ incl. jet cross sections, cancellations of uncertainties

Born Level: $R_{3/2} \sim \alpha_s$ Used here: $R_{3/2} \sim c_1\alpha_s + c_2\alpha_s^2$

$M_{jj} > 25$ GeV

$M_{jjj} > 25$ GeV





Theoretical uncertainty from μ_r reduced to 5%

Determination of α_s

Shown for one bin in Q^2

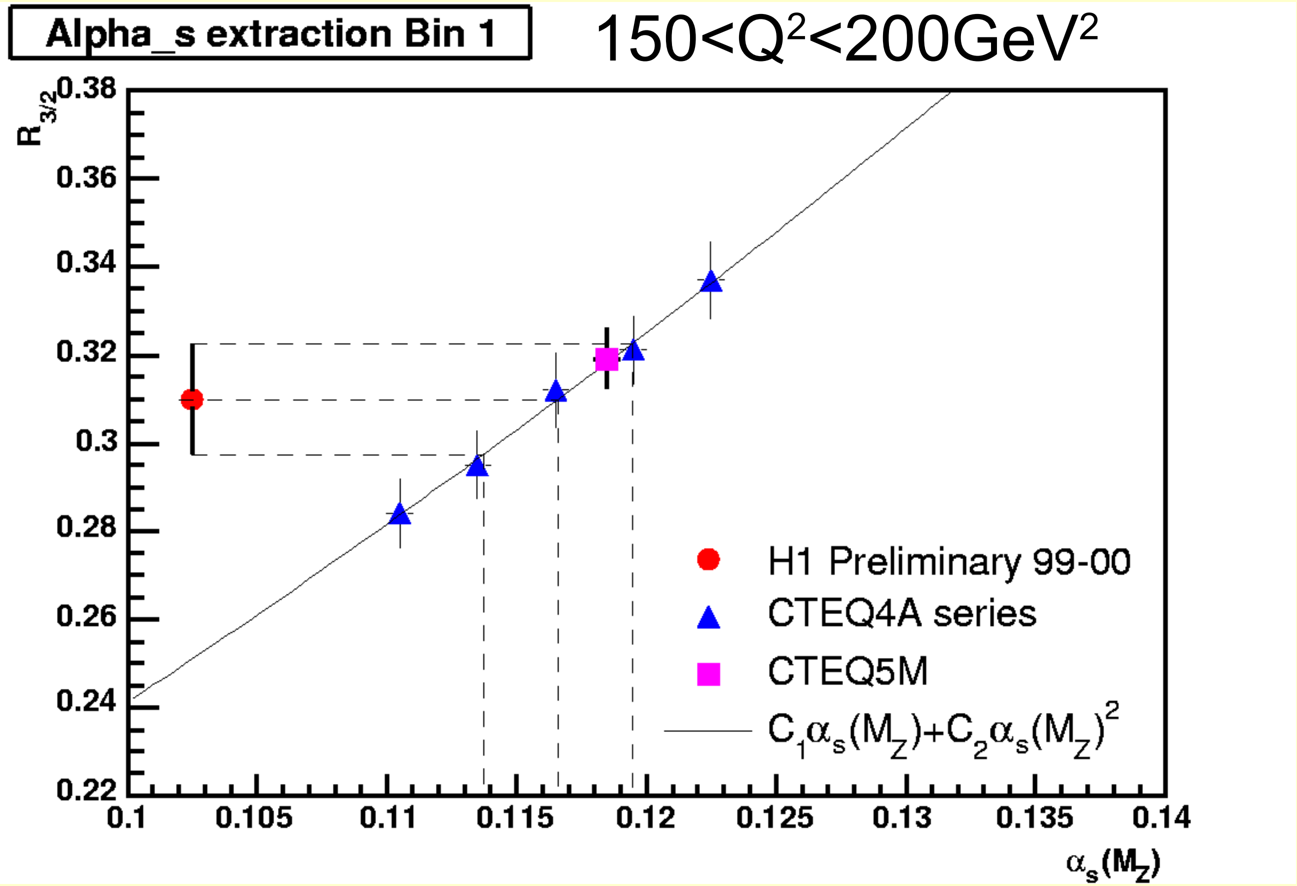
Make use of CTEQ4A

α_s variation, CTEQ5M

and MRST as cross check

Fit of $R_{3/2} \sim c_1\alpha_s + c_2\alpha_s^2$

works well

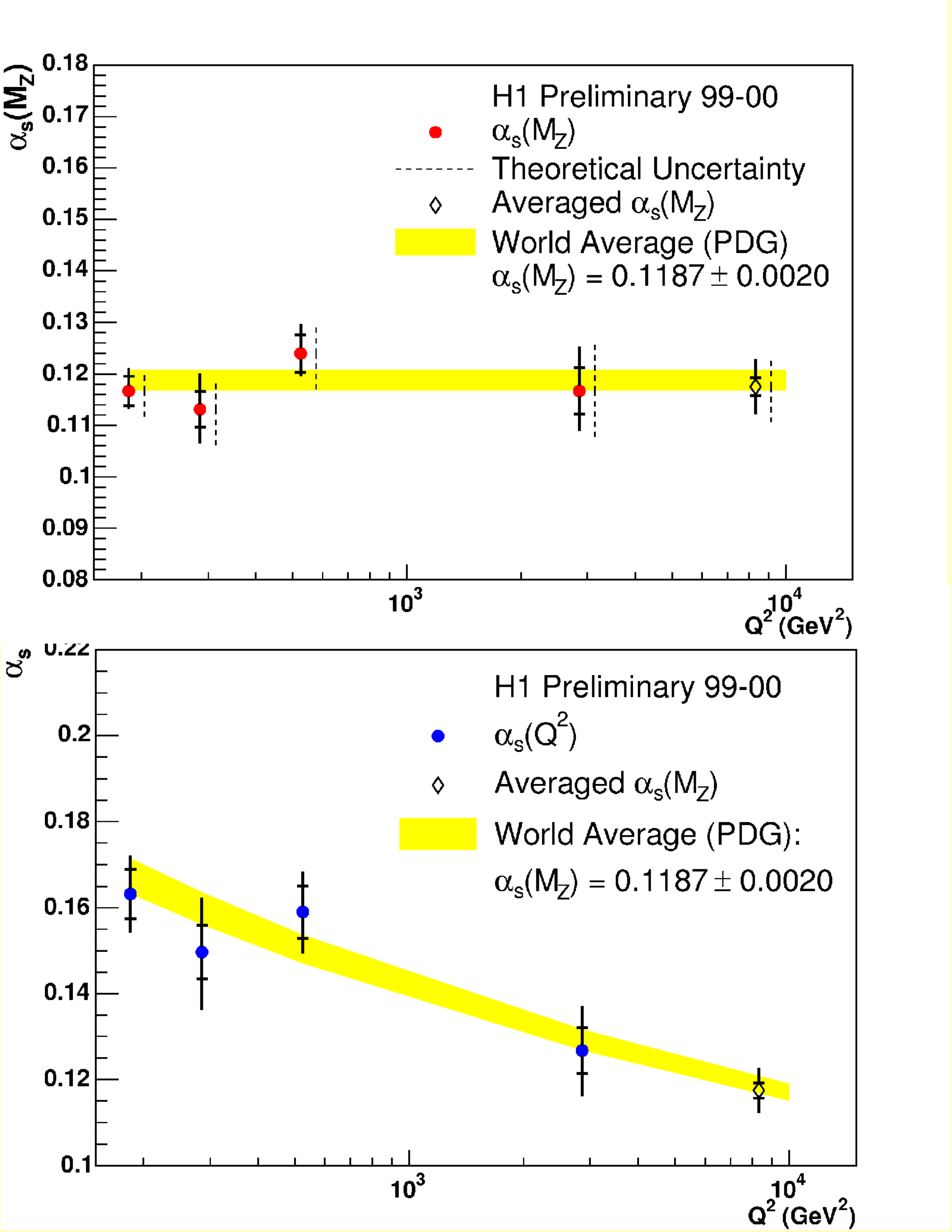


$150<Q^2<200\text{GeV}^2$

Experimental error on $R_{3/2}$ translated to α_s ~linearily

Determination of α_s

- $R_{3/2}$ determined at four points of $\mu_r^2 = Q^2$
- Corresponding $\alpha_s(m_Z)$ via RGE
- Fit average with χ^2 minimisation
- $\alpha_s(m_Z)$ can be evolved back to Q
- $\alpha_s(m_Z)$ from $R_{3/2}$ in DIS consistent with world average



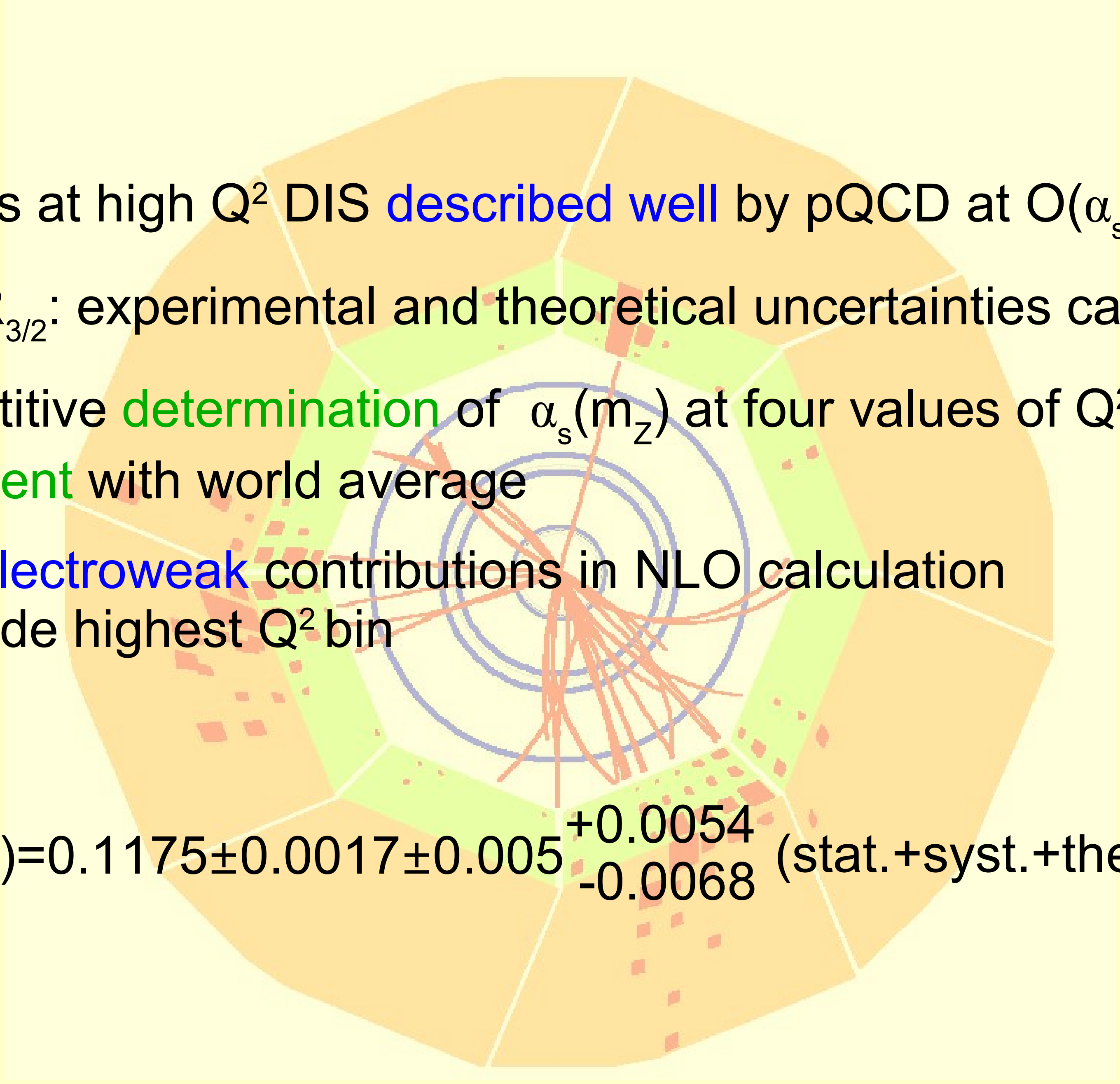
Determination of α_s

H1 Preliminary

Q^2 / GeV^2	α_s (mZ)	statistical	systematical	theoretical
150-220	0.1166	±0.0028	+0.0035	+0.0035
			-0.0034	-0.0054
220-350	0.1131	±0.0035	+0.0061	+0.0052
			-0.0066	-0.0074
350-700	0.1239	±0.0036	+0.0043	+0.0059
			-0.0044	-0.0070
700-5000	0.1167	±0.0045	+0.0074	+0.0089
			-0.0077	-0.0089
Average	0.1175	±0.0017	+0.0050	+0.0054
			-0.0050	-0.0068

- Theoretical error 5-6% limiting
  mainly renormalisation scale, pdf <1%
- Experimental systematic error dominated by hadronic energy scale uncertainty

Summary



- Multijets at high Q^2 DIS described well by pQCD at $O(\alpha_s^3)$ (NLOJET++)
- Ratio $R_{3/2}$: experimental and theoretical uncertainties cancel partly
- Competitive determination of $\alpha_s(m_Z)$ at four values of Q^2 consistent with world average
- Need electroweak contributions in NLO calculation to include highest Q^2 bin

$$\alpha_s(m_Z)=0.1175\pm0.0017\pm0.005^{+0.0054}_{-0.0068}\ \text{(stat.+syst.+theo.)}$$