Parton Distributions Functions and QCD

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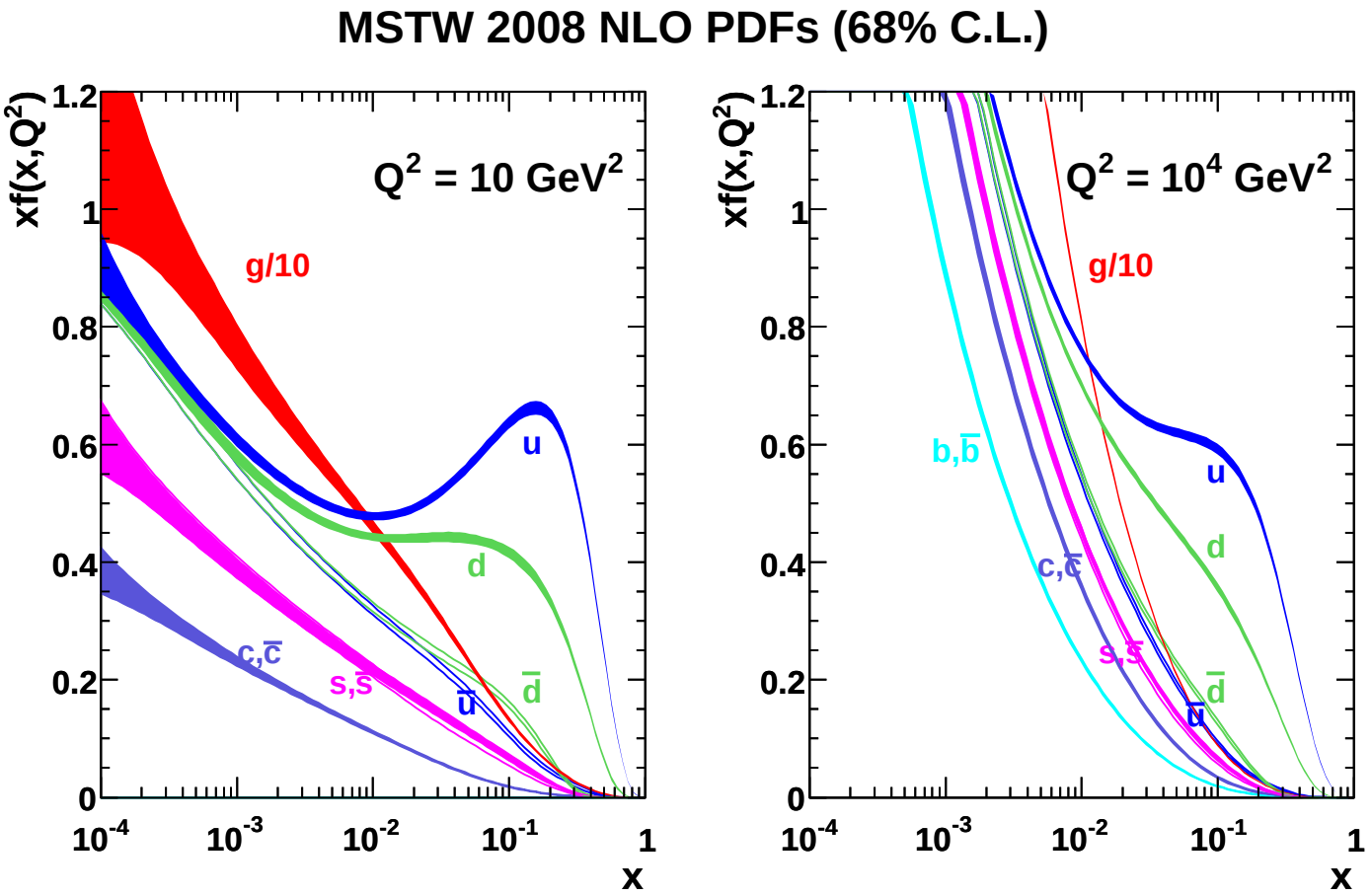
Part of Martin, Stirling T Watt parton distribution collaboration. This is a large-scale, ongoing project. Obtain PDFs by fitting all possible data and most appropriate theory – testing the latter. Results in partons of the form shown.



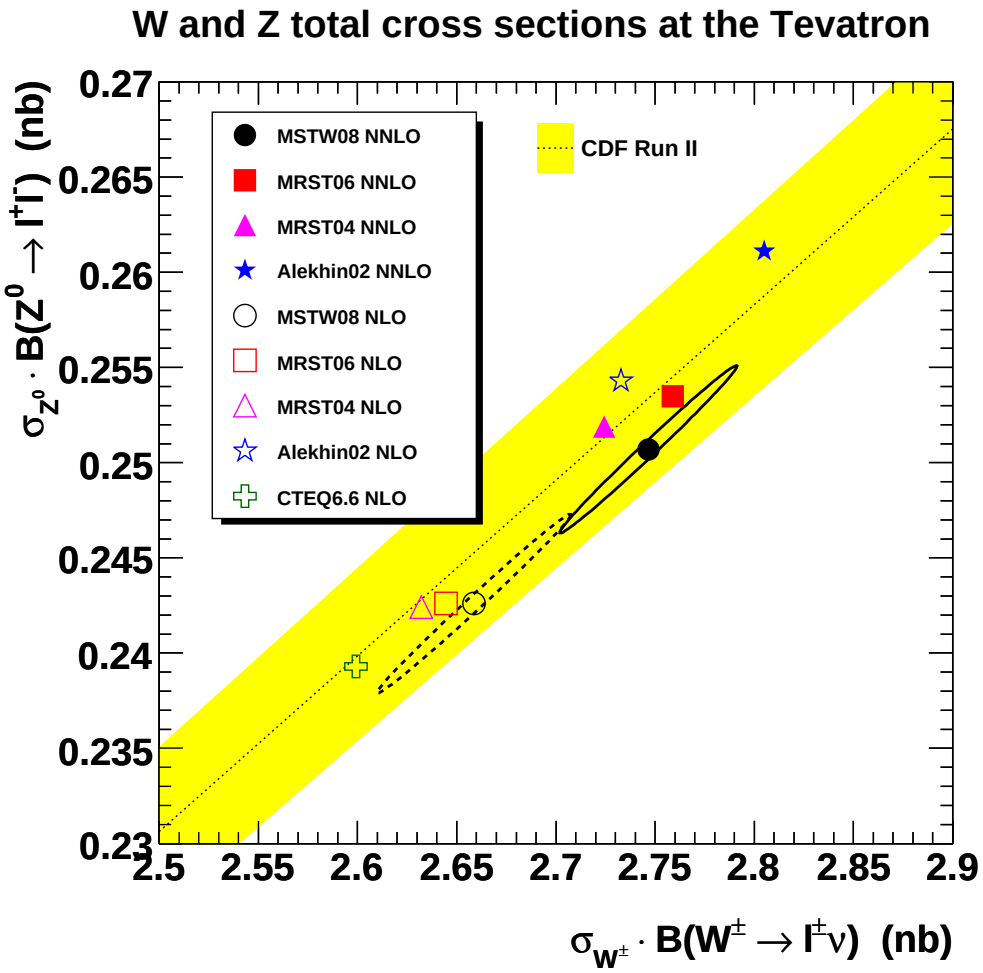
All LHC cross-sections rely on our understanding of these partons.

Predictions

Look at precision predictions for standard model processes, e.g. W+ and W- cross-sections at LHC and Tevatron.

Quoted uncertainty , particularly for the ratio very small. Only from experimental sources.

Work on best central values and also size of the uncertainties – both experimental and theoretical.

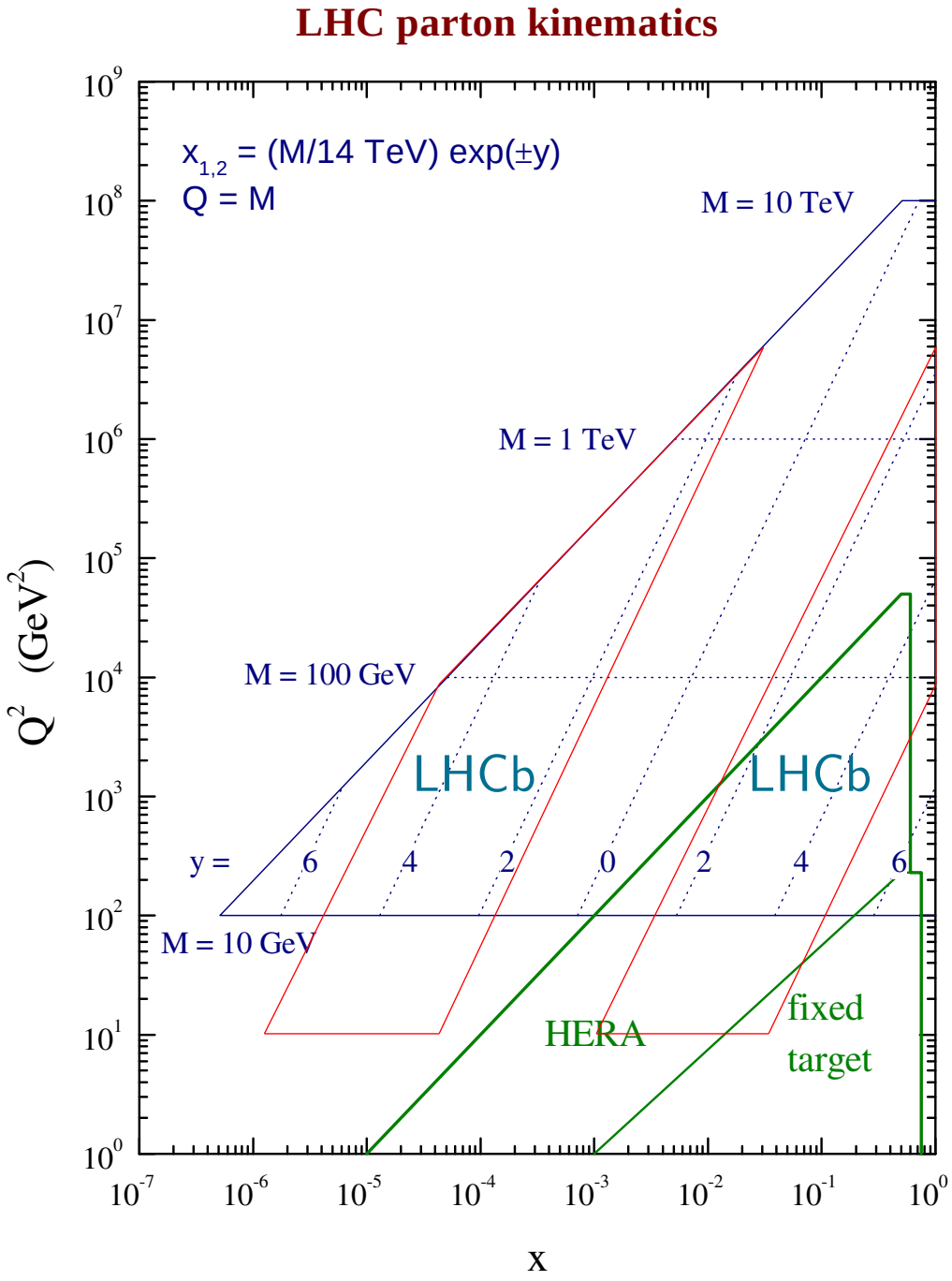


Predictions at the LHC

New kinematic regime.

PDFs mainly extrapolated via evolution rather than measured directly.

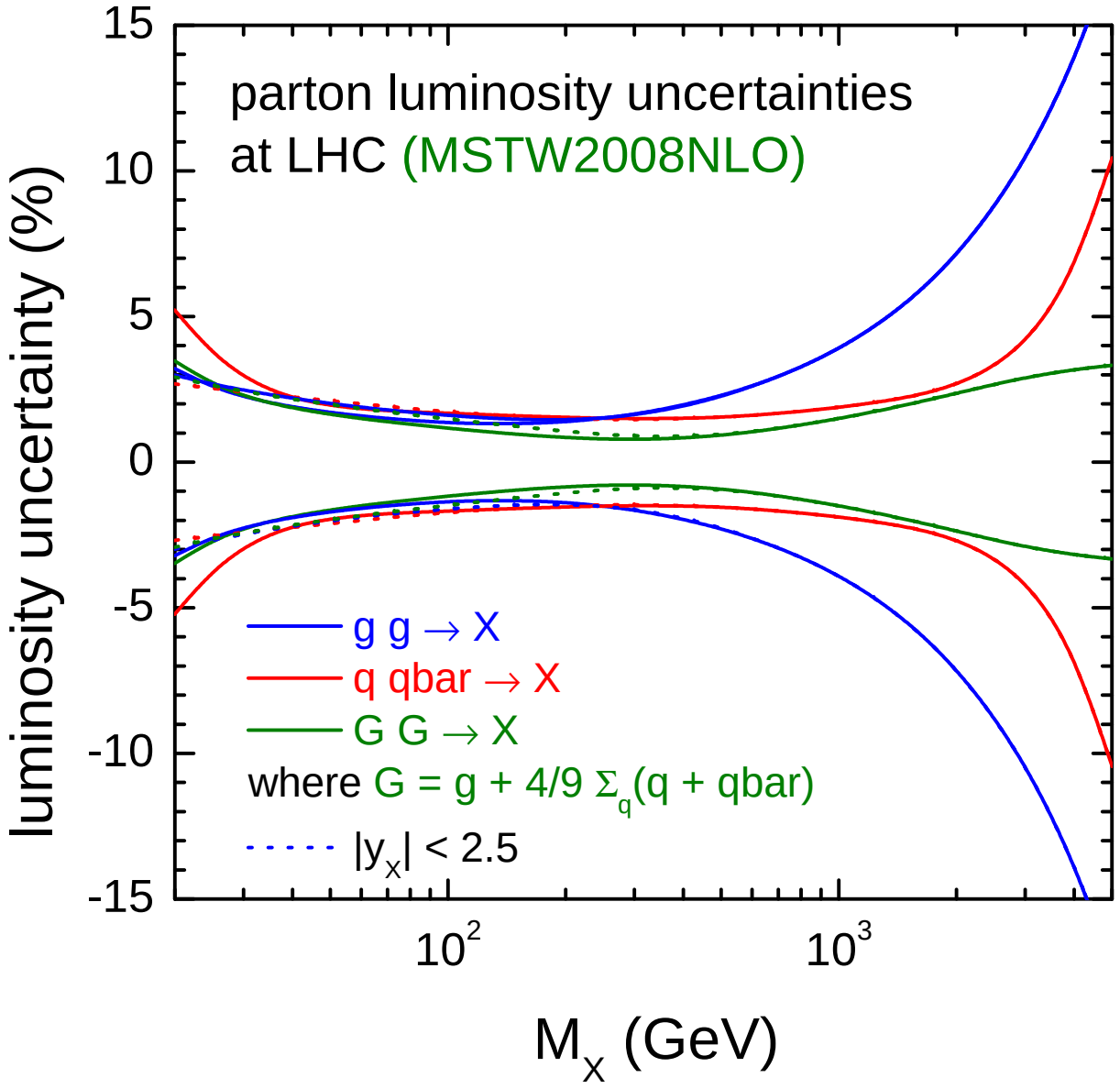
High scale and small-x parton distributions are vital for understanding processes at the LHC.



Parton Luminosity Uncertainies

Uncertainties on parton luminosities, i.e. of fundamental rates for creation processes, are optimum for standard model particle production.

Start to worsten at highest masses where sensitive to large-x PDFs.



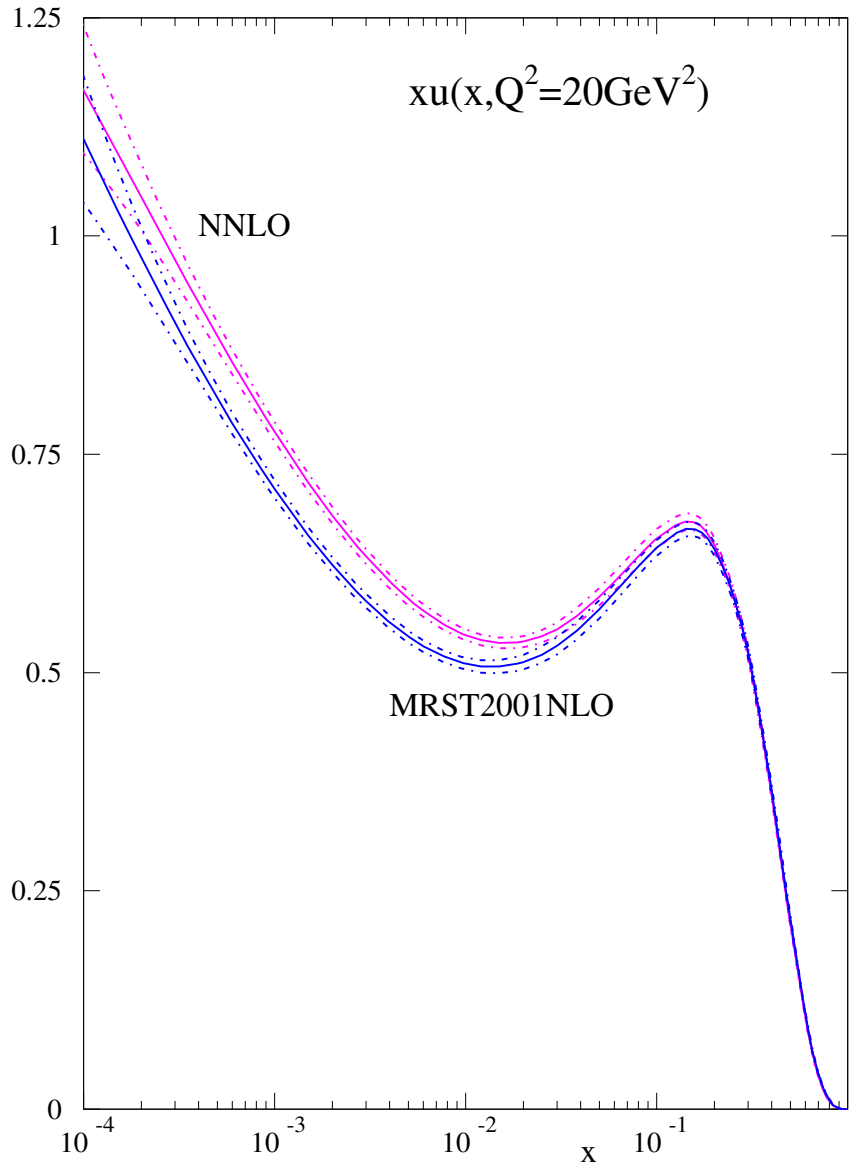
NNLO

MSTW has pioneered extraction and use of PDFs at NNLO.

NNLO coefficient functions for structure functions know for many years.

Splitting functions now complete. (Moch, Vermaseren and Vogt). Improve consistency of fit very slightly and reduces $\alpha_S(M_Z^2)$, $0.120 \rightarrow 0.117$.

Can be big change from NLO $\rightarrow$ NNLO



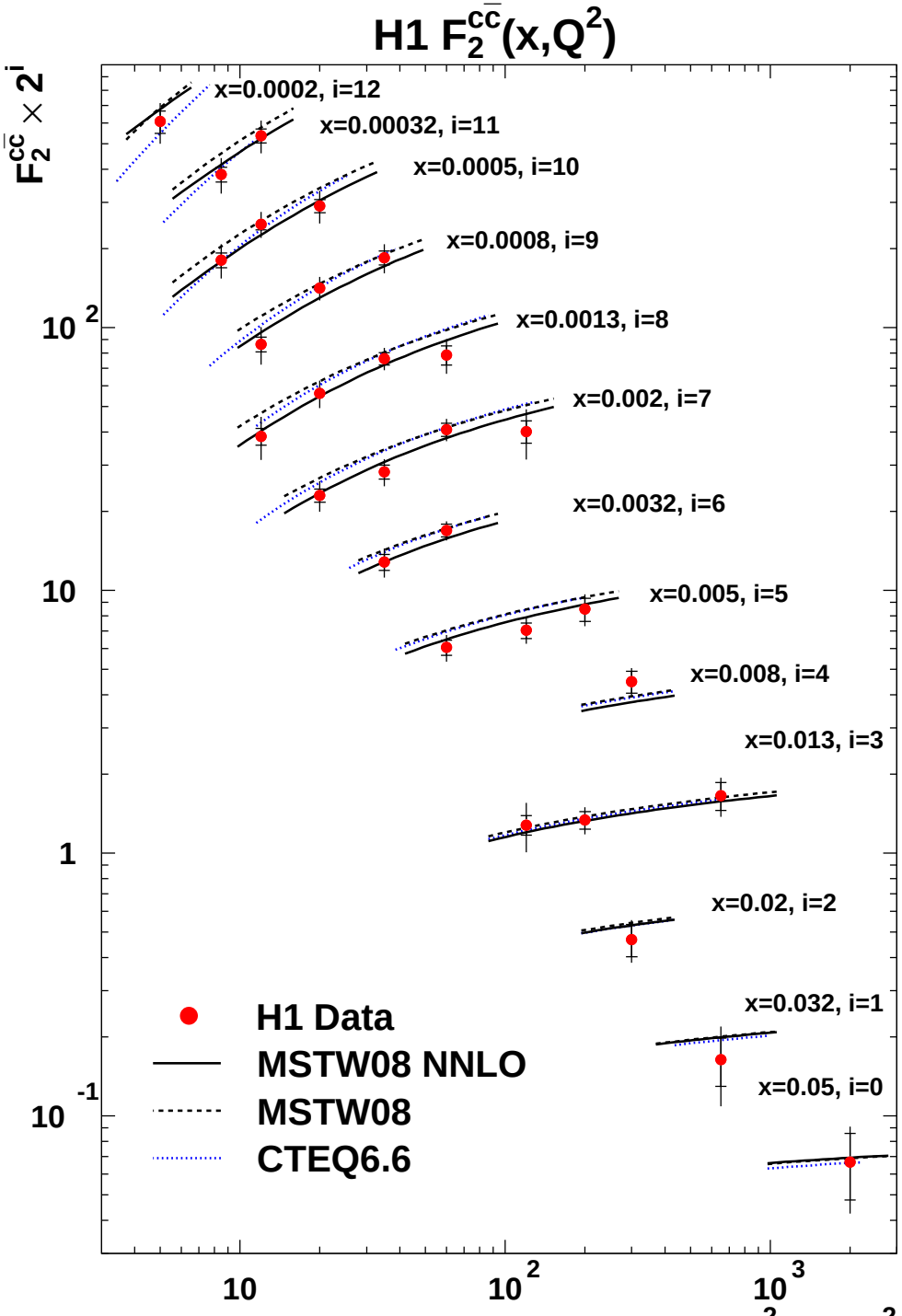
Heavy Quarks – Essential to treat these correctly.

Need to go from threshold $Q^2 \sim m_H^2$ to high scales $Q^2 \gg m_H^2$ where heavy quarks behave like massless partons while including all $\mathcal{O}(m_H^2/Q^2)$ corrections.

Work on **General-Mass Variable-Flavour-Number Scheme** (GM-VFNS) which achieves this.

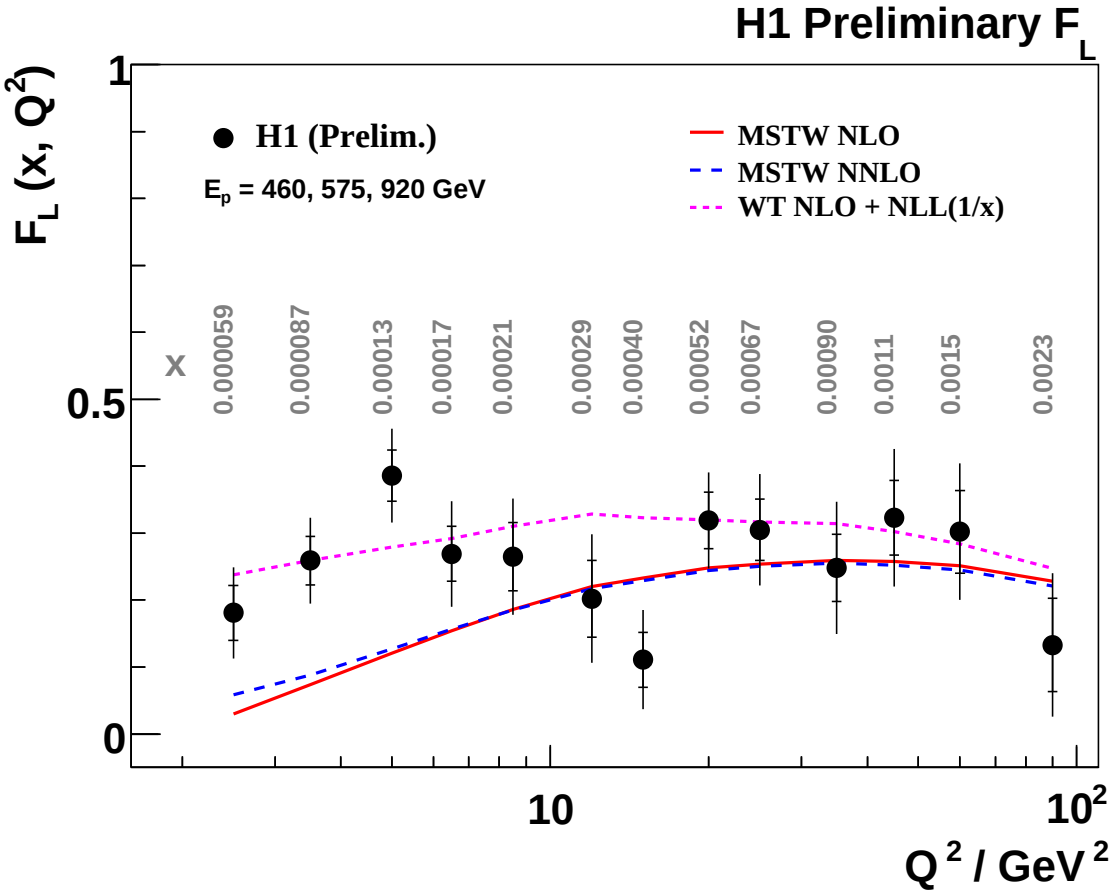
Results shown compared to H1 charm data.

Note big predicted change at NNLO.



Small-x Theory

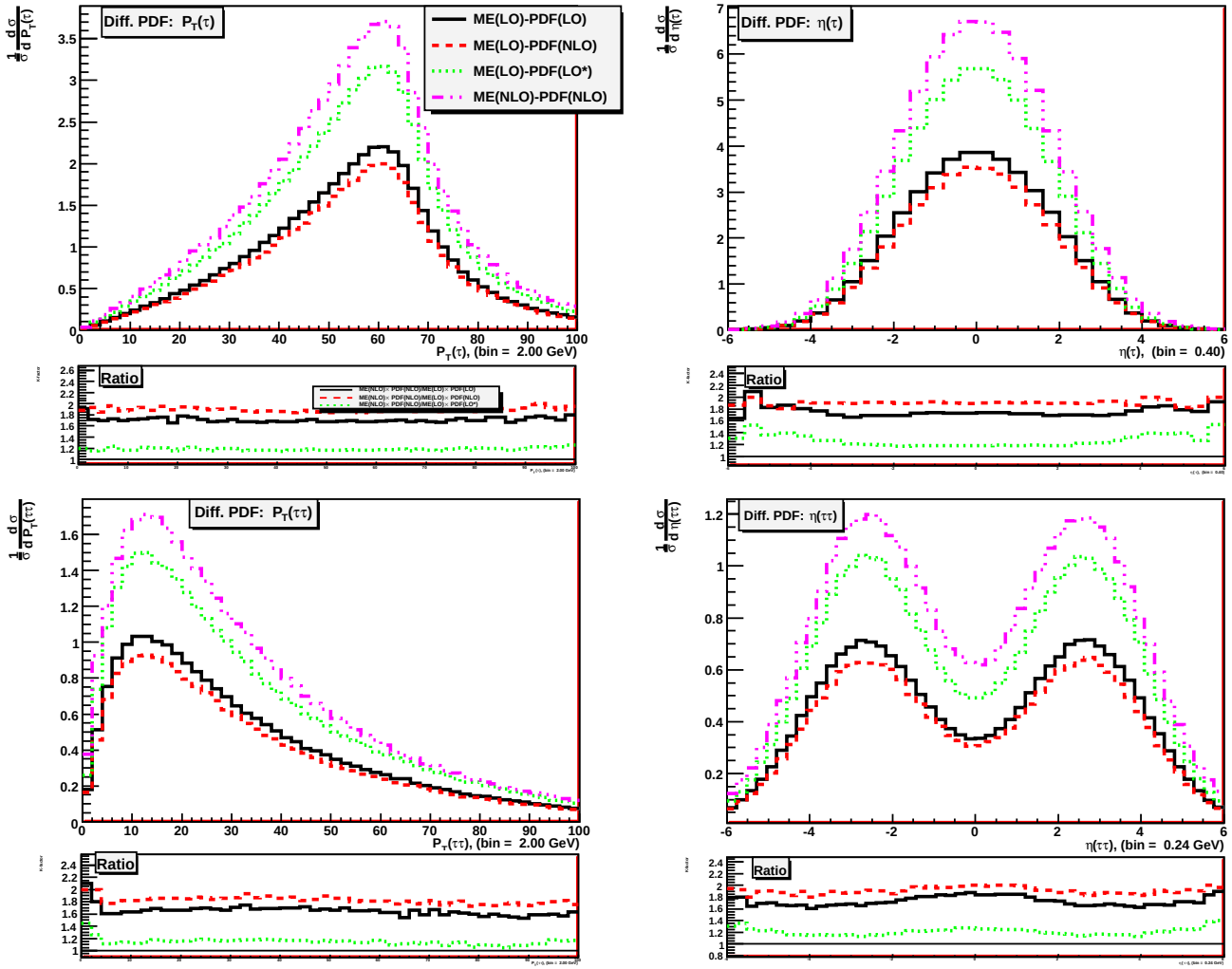
Potential instability – at each order in α_S each splitting function and coefficient function obtains an extra power of $\ln(1/x)$ (some accidental zeros in P_{gg}), i.e. $P_{ij}(x, \alpha_s(Q^2)), C_i^P(x, \alpha_s(Q^2)) \sim \alpha_s^m(Q^2) \ln^{m-1}(1/x)$.



Work on resummations with White. Comparison to H1 prelim data on $F_L(x, Q^2)$ at low Q^2 suggests resummations may be important.

PDFs for LO Monte Carlo generators (with Shertsnev).

Neither standard LO or NLO PDFs appropriate. Devised modified LO*.



Results using LO*/LO** partons clearly best if compared to full NLO (if available).

Summary

To learn more about any of these topics come to the colloquium on Wednesday and PDF4LHC discussion sessions on Thursday and Friday.

Initial Running

Of course, will be starting the LHC running at 10 TeV rather than the full 14 TeV.

Roughly $60 - 70\%$ the full cross-sections for most standard model (including light Higgs) processes.