Multi-jet measurements at DØ

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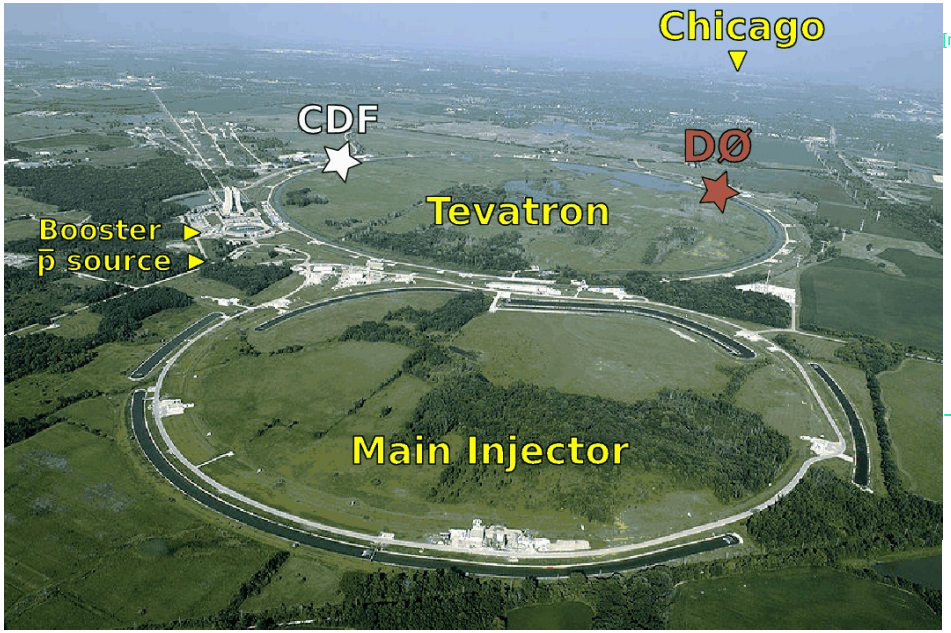
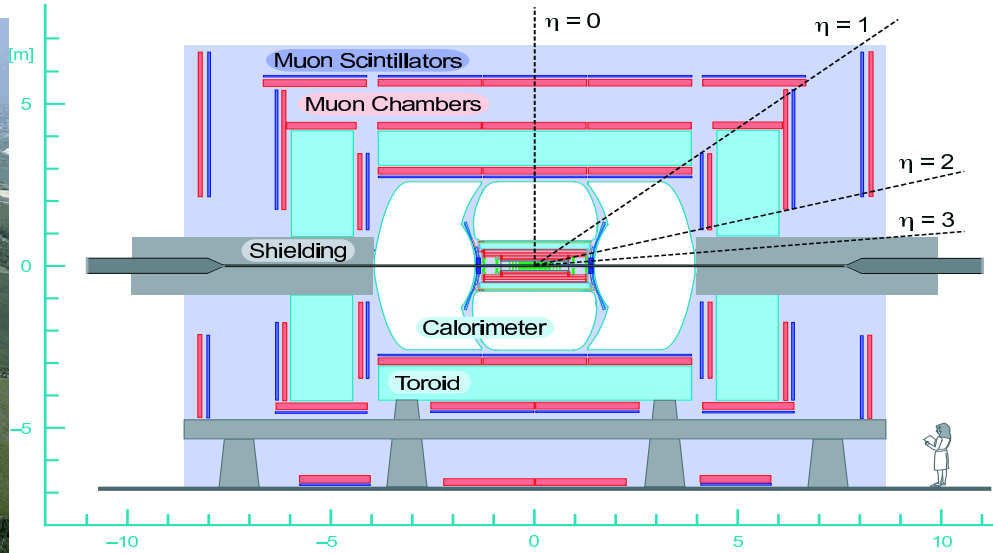
XIX International Workshop on Deep-Inelastic Scattering
and Related Subjects
Newport News, VA, USA
April 11–15, 2011

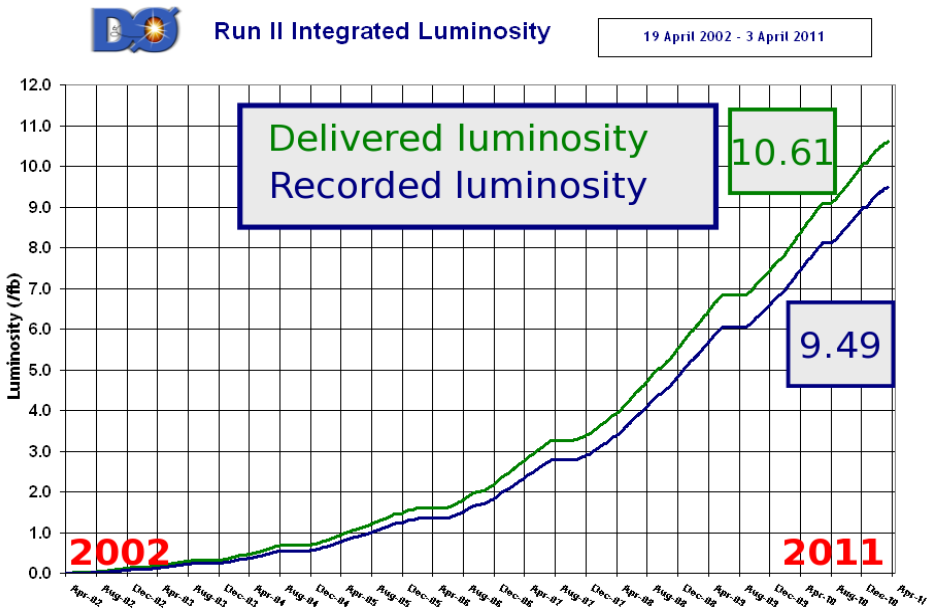
OUTLINE

- Tevatron and DØ Experiment
- Jet Production
- Differential Cross Sections in Dijet Invariant Mass
- Differential Cross Sections in Three-jet Invariant Mass
- Conclusions

Tevatron & DØ Experiment

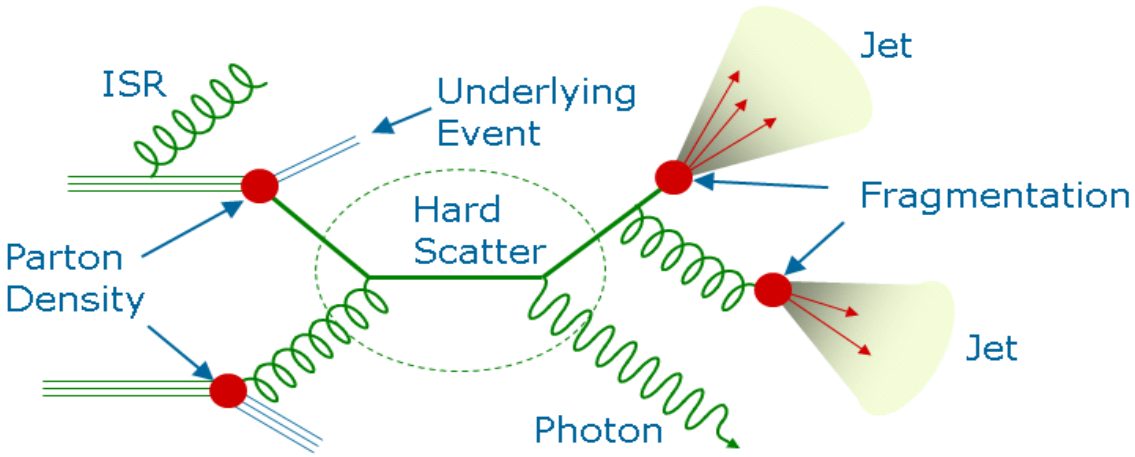




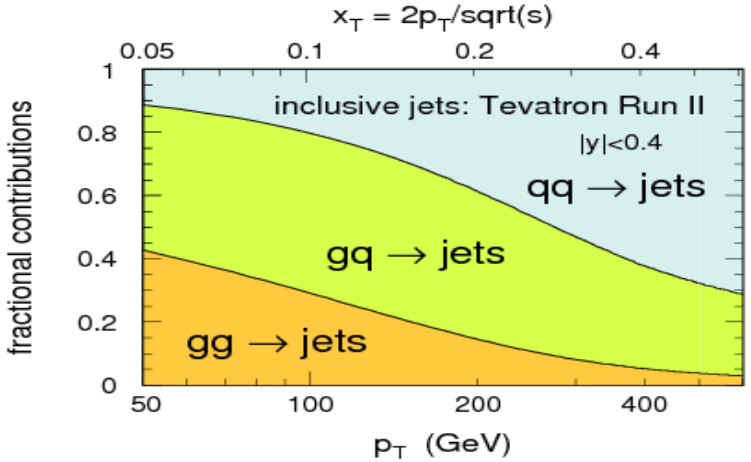


- $\sqrt{s} = 1.96\,\mathrm{TeV}$
- Peak luminosity $4.024 \cdot 10^{32}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$
- Delivered luminosity $> 10\,\mathrm{fb}^{-1}$

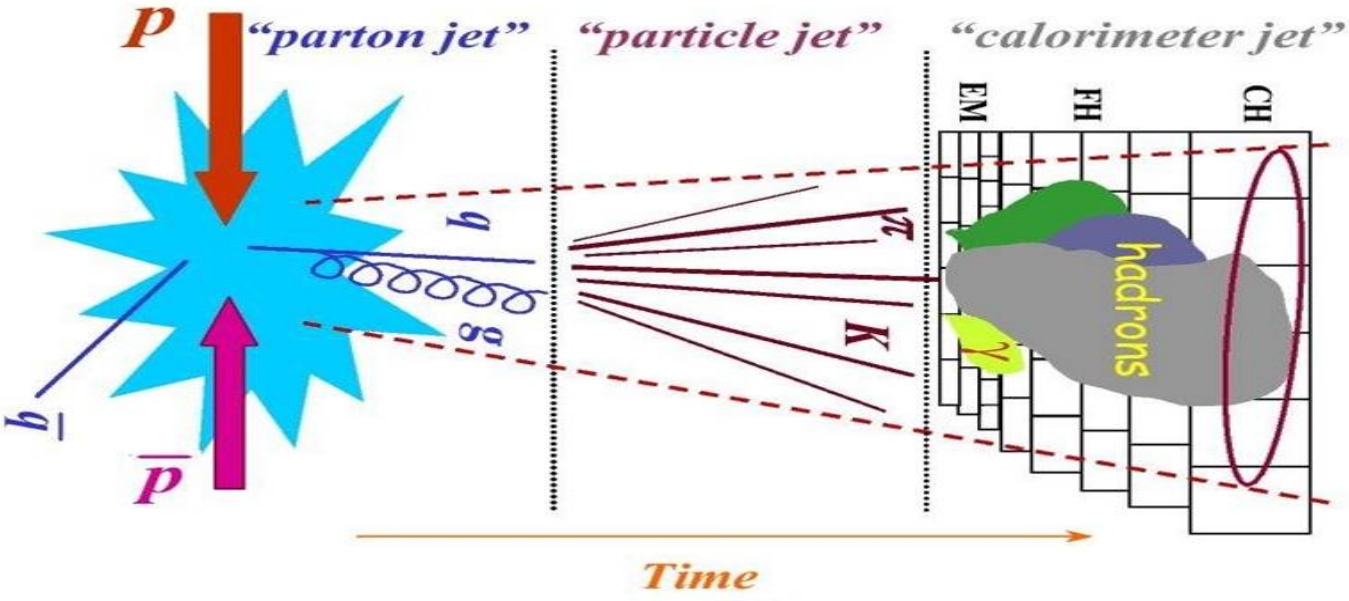
Jet Production



- has highest cross section at hadron colliders ⇒
  - unique sensitivity to new physics - new particles, quark compositeness, extra dimensions
- test of perturbative QCD: 2-,3- jet jet cross sections available at NLO
- sensitivity to PDF
- sensitivity to α_S

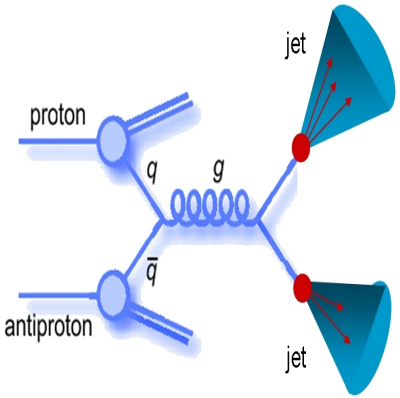


Comparing Data and Predictions



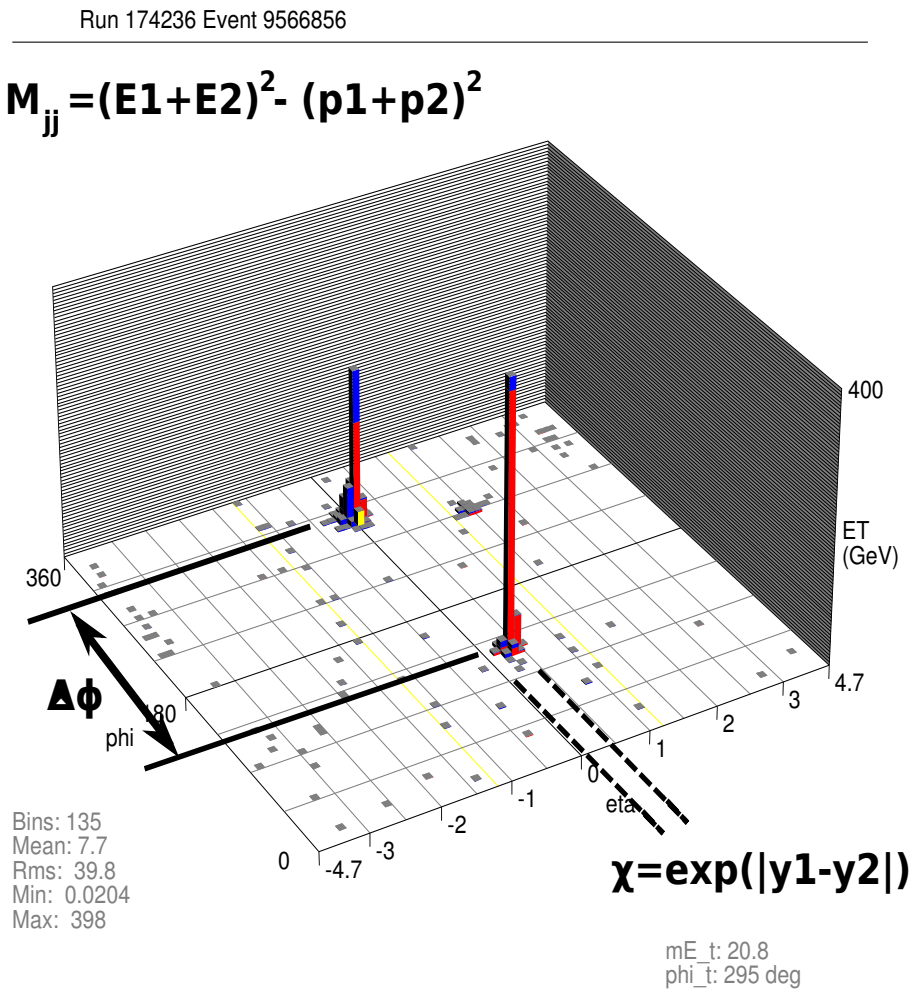
- NLO pQCD prediction calculated in fastNLO/NLOJET++
- The same jet algorithm for theory and data
- Compare at "particle" level:
  - correct data for exp. effects (efficiencies, resolutions, . . .) calculated using parameterized detector simulation
  - correct pQCD calculation for nonperturbative effects (hadronization, underlying event)

Dijet Production



- Dijet invariant mass, angular variables - $\chi, \Delta\phi$
- $\sigma \propto \alpha_S^2 \cdot \mathrm{PDF}^2$

Real dijet event display:



Dijet Invariant Mass Cross section

- $0.7\,\mathrm{fb}^{-1}$
- first measurement of the y dependence of the dijet mass spectrum
- 6 bins of rapidities of the most forward jet $|y|_{\max}$
- NLO pQCD = MSTW2008 PDF

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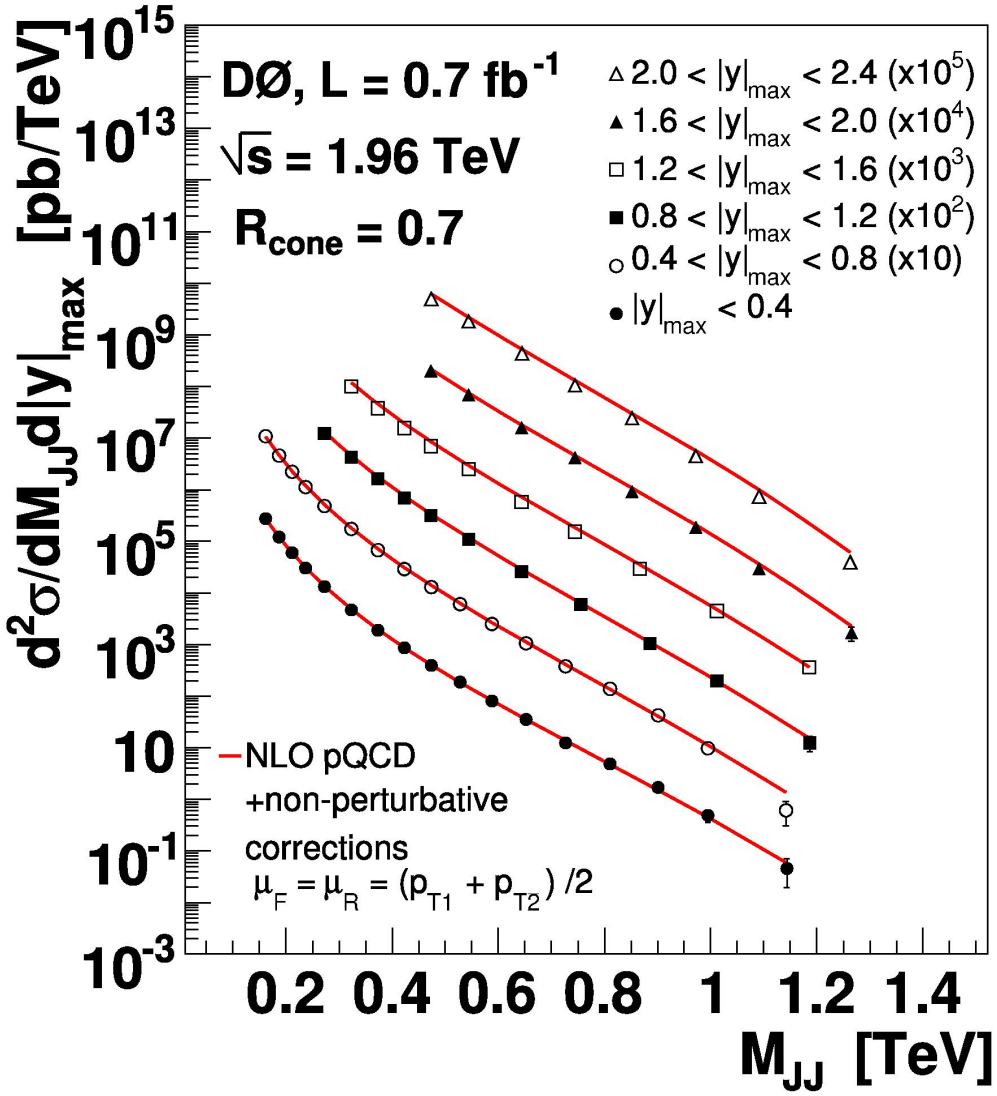
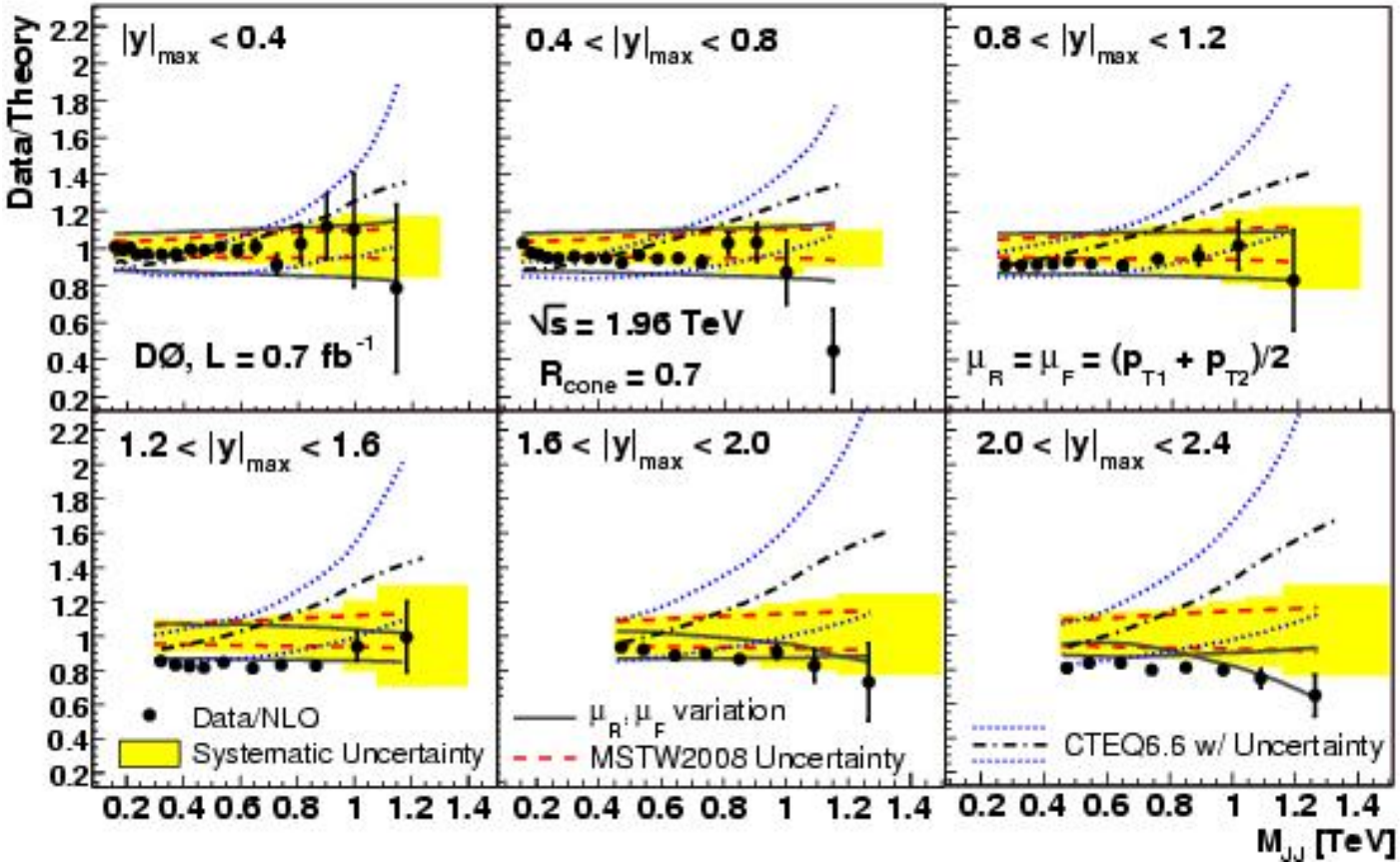
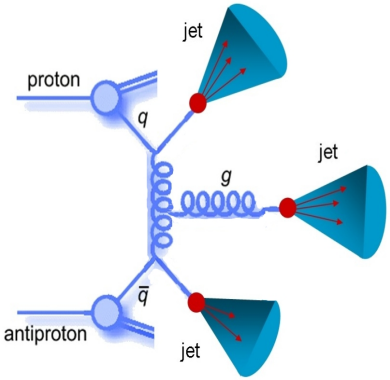


Comparison with pQCD



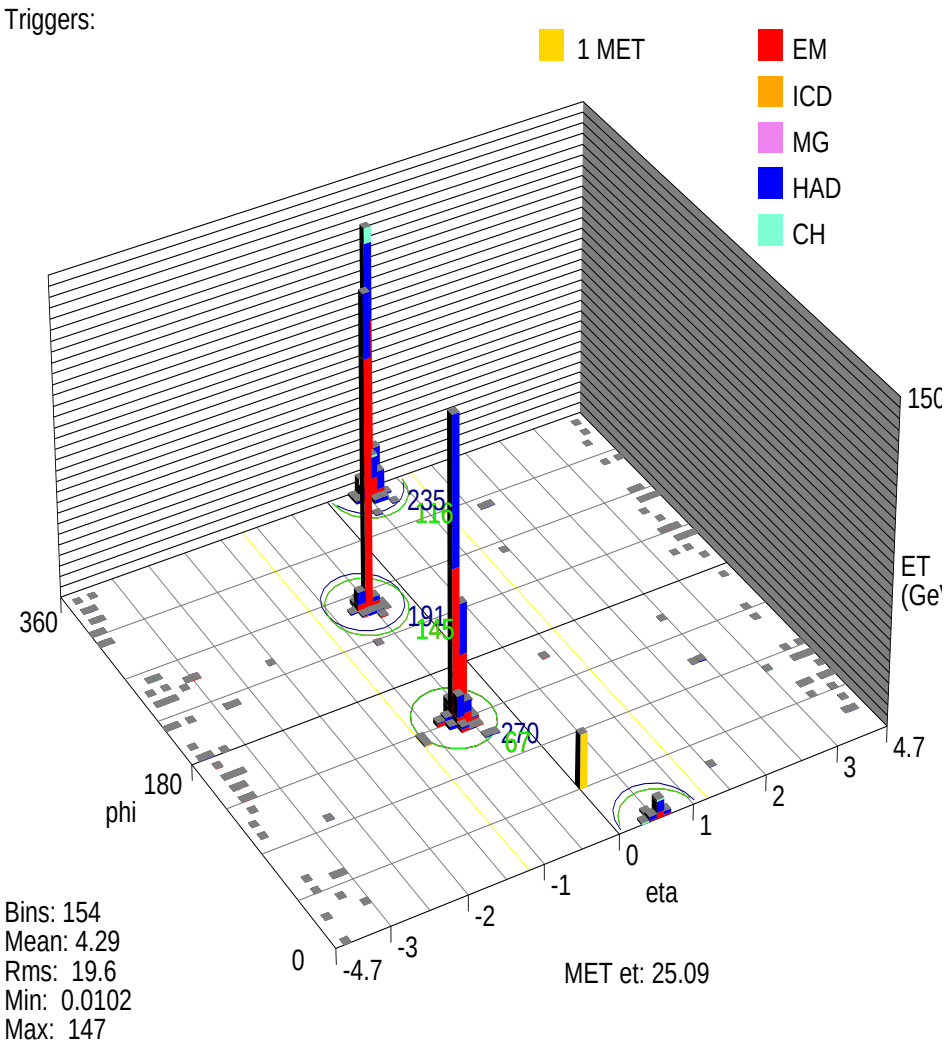
- MSTW2008 uses RunII inclusive jet data in PDF fits
- Good agreement within uncertainties
- 40 – 60% difference between MSTW2008 and CTEQ6.6

Three-jet System



- More complex system ⇒ more variables
- Three-jet invariant mass, Dalitz variables, angular variables, jet masses
- $\sigma \propto \alpha_S^3 \cdot \mathrm{PDF}^2$

Real three-jet event display:

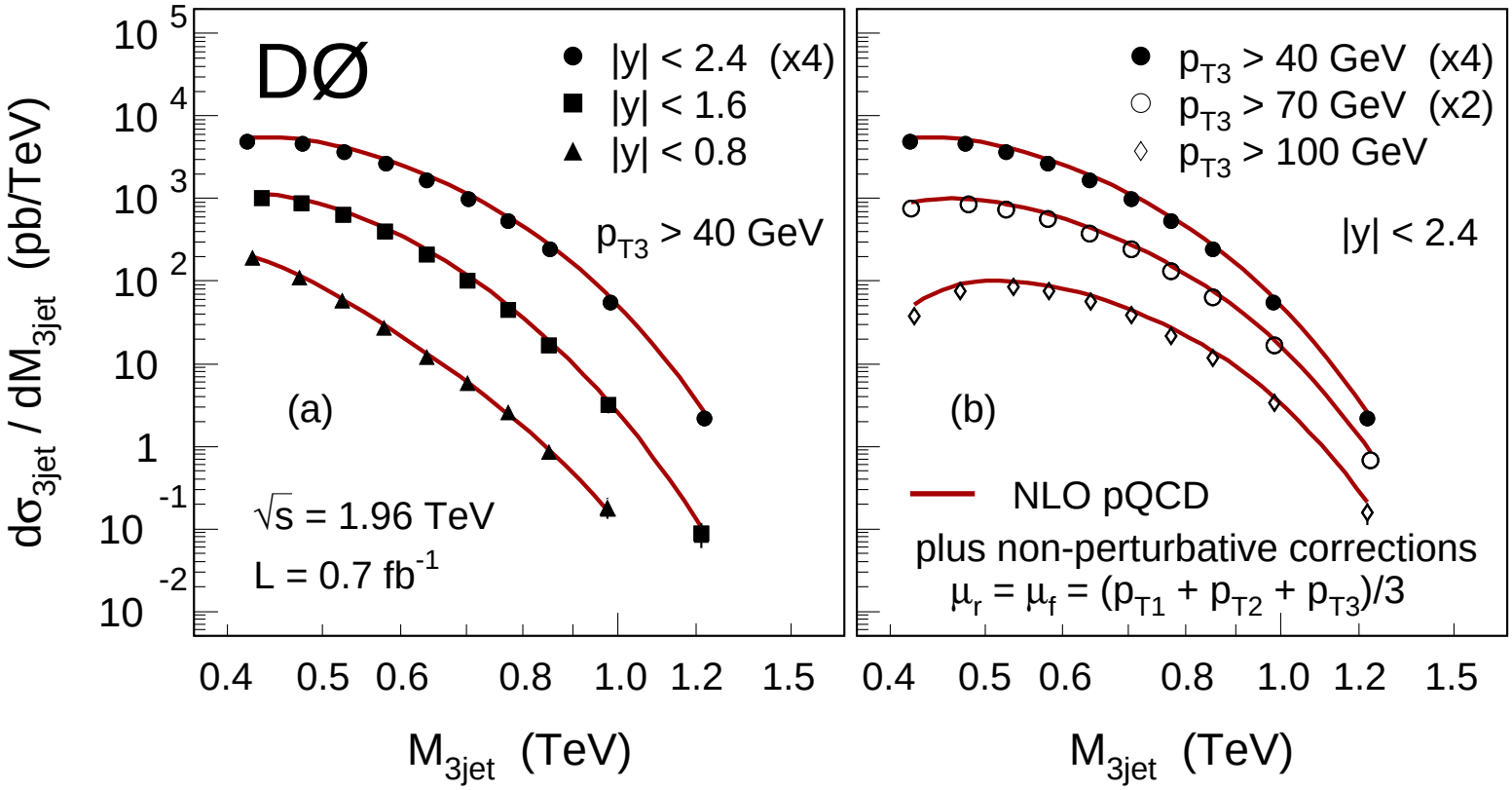


Three-jet Invariant Mass Measurement

- $0.7\,\mathrm{fb}^{-1}$ dataset
- at least 3 jets, $p_T^{1\mathrm{st}} > 150\,\mathrm{GeV}$, $p_T^{3\mathrm{rd}} > 40\,\mathrm{GeV}$
- all three jets separated by $\Delta R > 1.4 = 2 \cdot R_{\mathrm{cone}}$ (avoid overlap region between jets, IR sensitive regions)
- in 3 different rapidity intervals ($|y| < 0.8, 1.6, 2.4$ for all 3 jets)
- for different p_T requirements on the p_T of the 3rd jet ($|y| < 2.4$ and $p_T^{3\mathrm{rd}} > 40, 70, 100\,\mathrm{GeV}$)

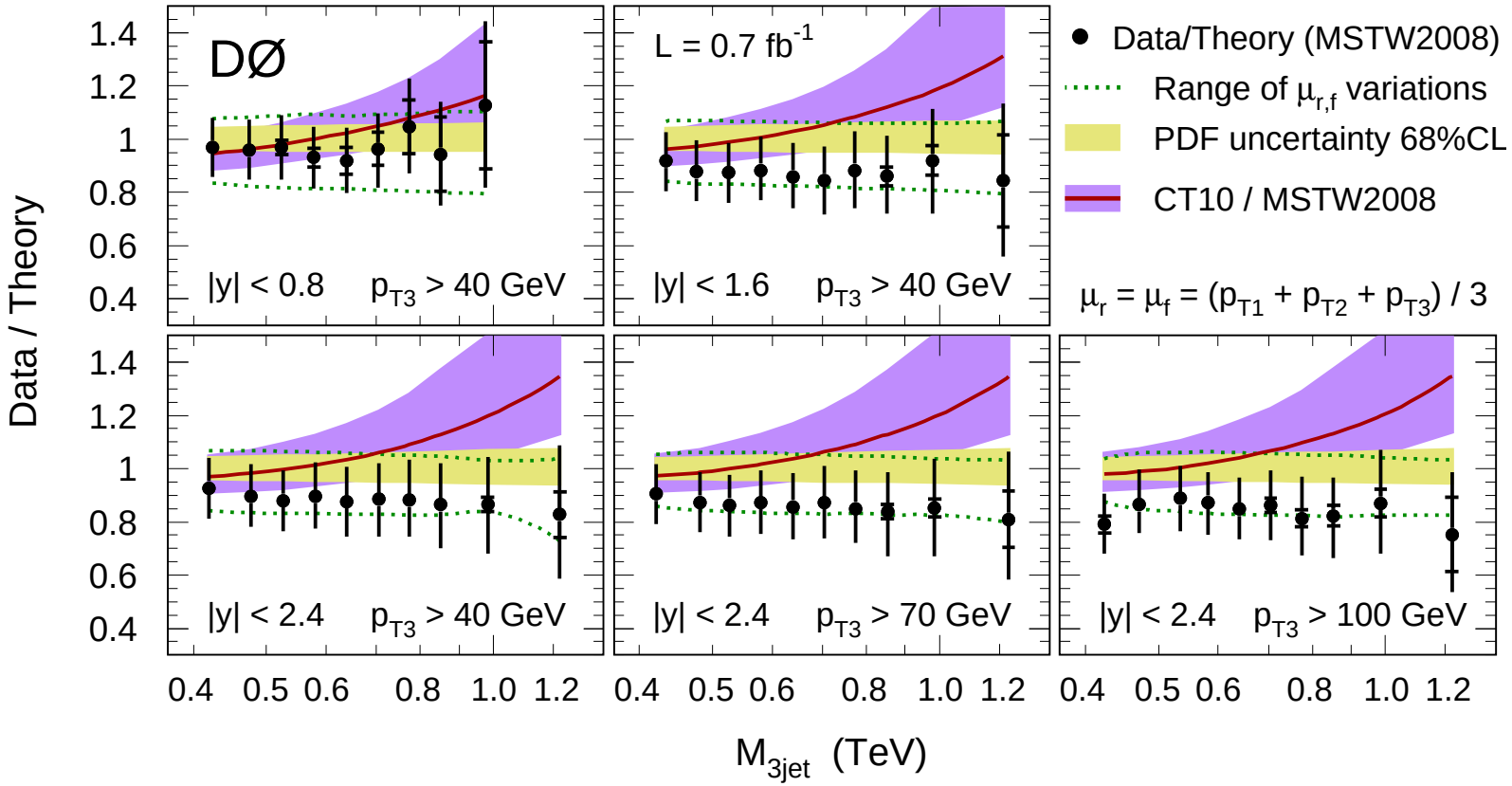
Three-jet Invariant Mass Cross Section

Submitted to Phys. Lett. B!



- First study of the three-jet invariant mass dependence
- NLO pQCD = MSTW2008

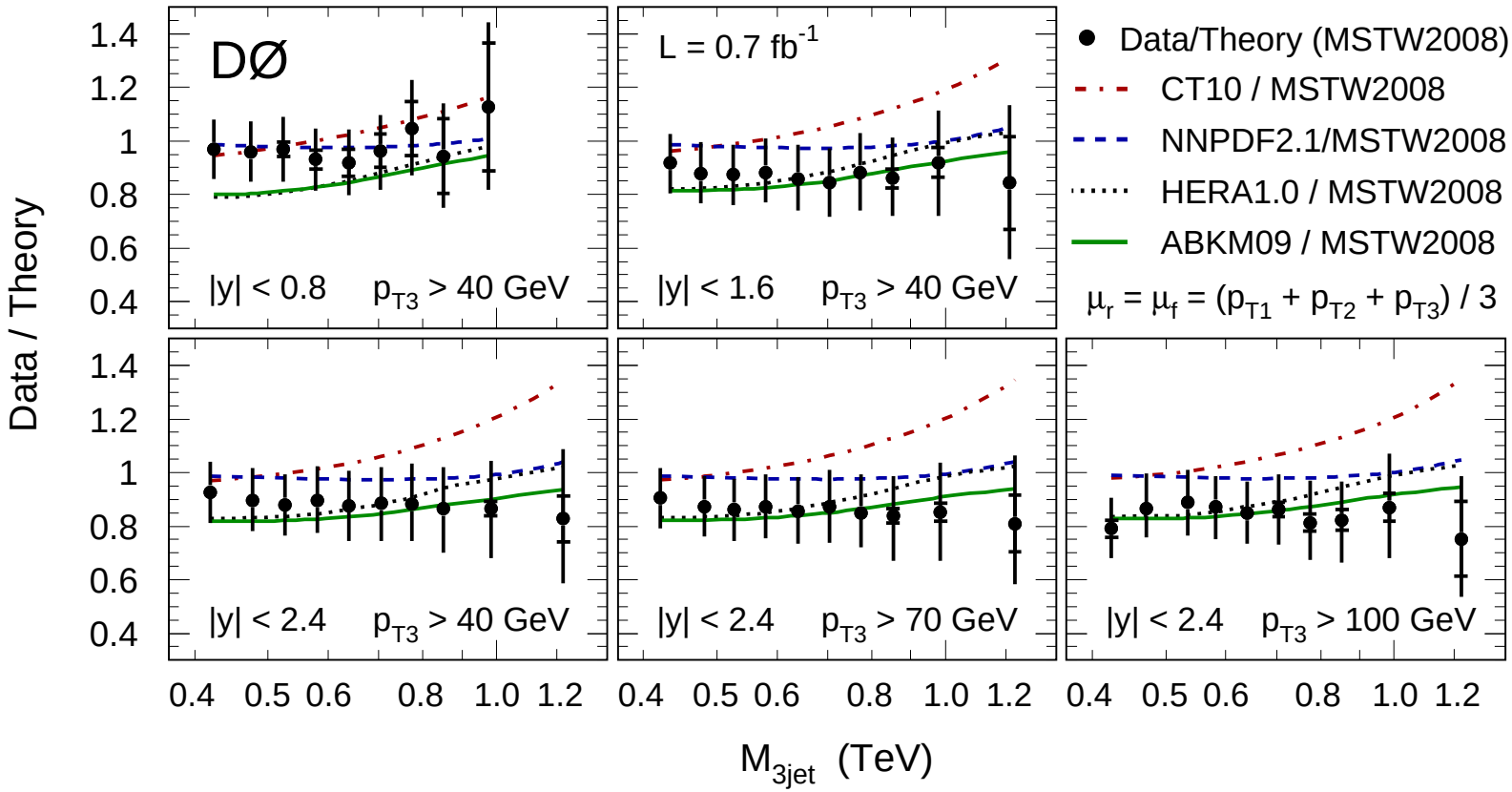
Comparison to MSTW2008 and CT10



- MSTW2008 good agreement in shape
- CT10 agreement at low mass, but shape is different

Comparison to other PDF sets

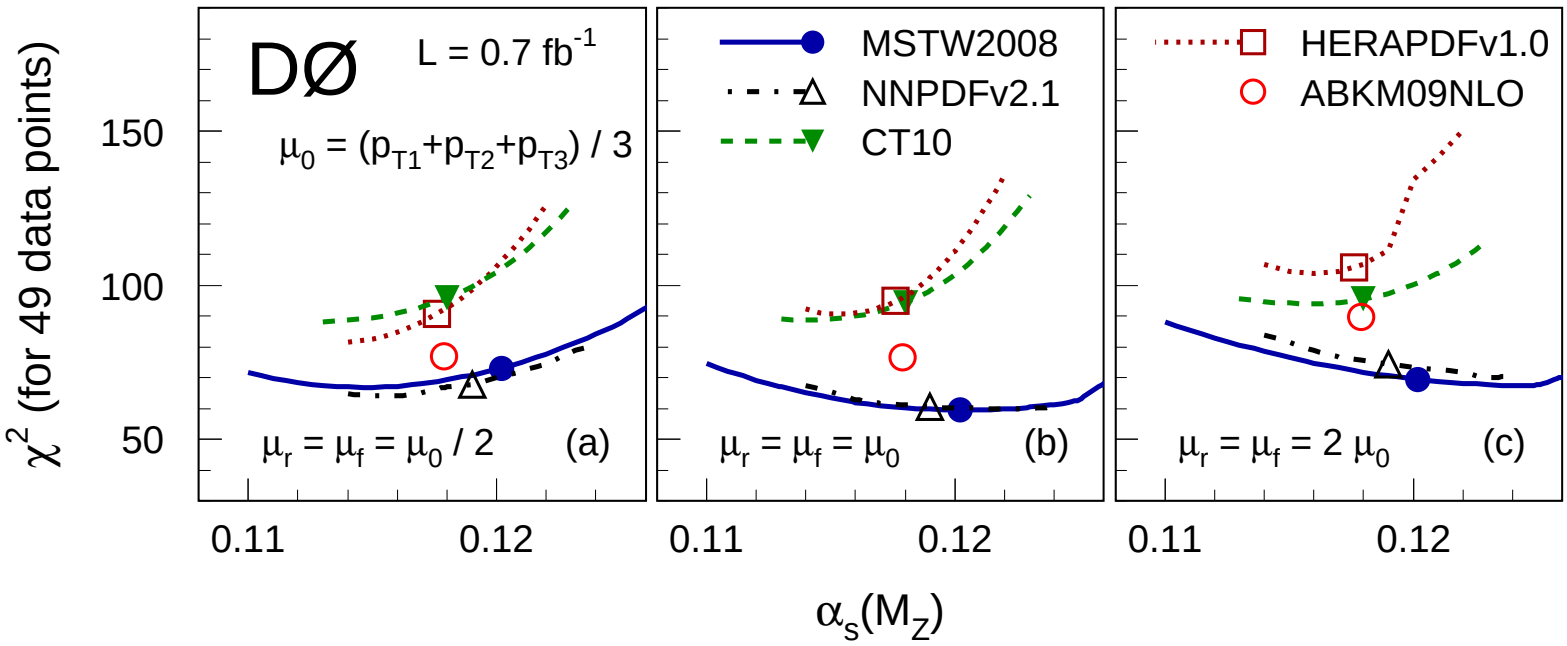
Using recent PDF sets (MSTW2008, CT10, NNPDFv2.1, HERAPDF1.0, ABKM09NLO)



- NNPDFv2.1 similar to MSTW2008
- HERAPDF1.0 similar shape to CT10

PDF TESTS

- Cross section depends on the choice of PDF, α_S, scales
- Calculate χ^2 for all data points including all correlated uncertainties except PDF uncert. (test of central PDF)



- for α_S close to the world average, observed lowest χ^2 for the default scales
- lowest χ^2 for MSTW2008 and NNPDFv2.1

Summary and Conclusions

- Dijet system studied extensively, dijet invariant mass cross section shown in this presentation in good agreement with NLO pQCD
- First submitted three-jet measurement from the Tevatron RunII
- First comparison of the NLO prediction for three-jet cross section with different PDF, scale and α_S choices
  - Best description with MSTW2008 and NNPDFv2.1
- New observable with impact in PDF fits