Z + jets results from DØ

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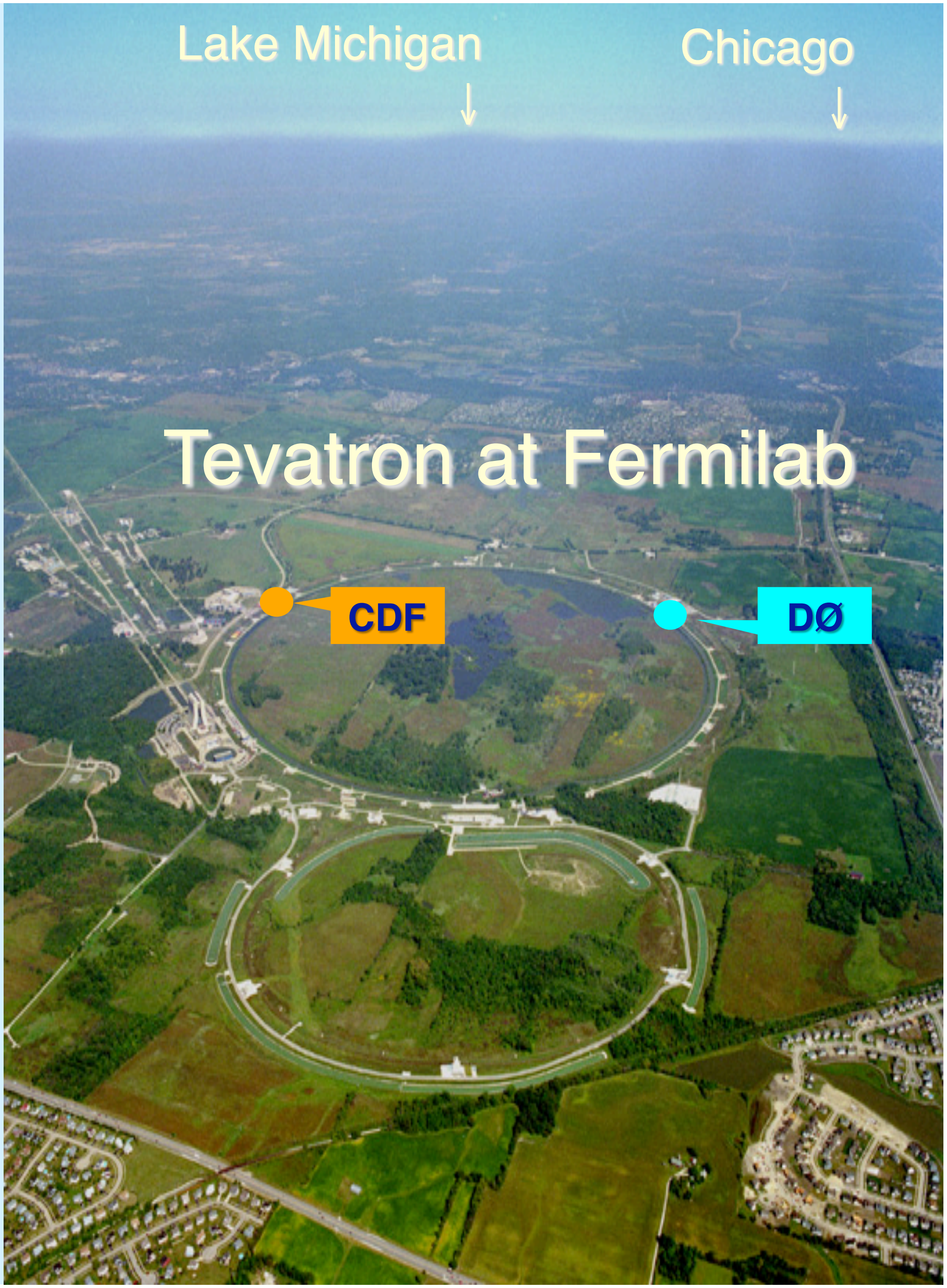
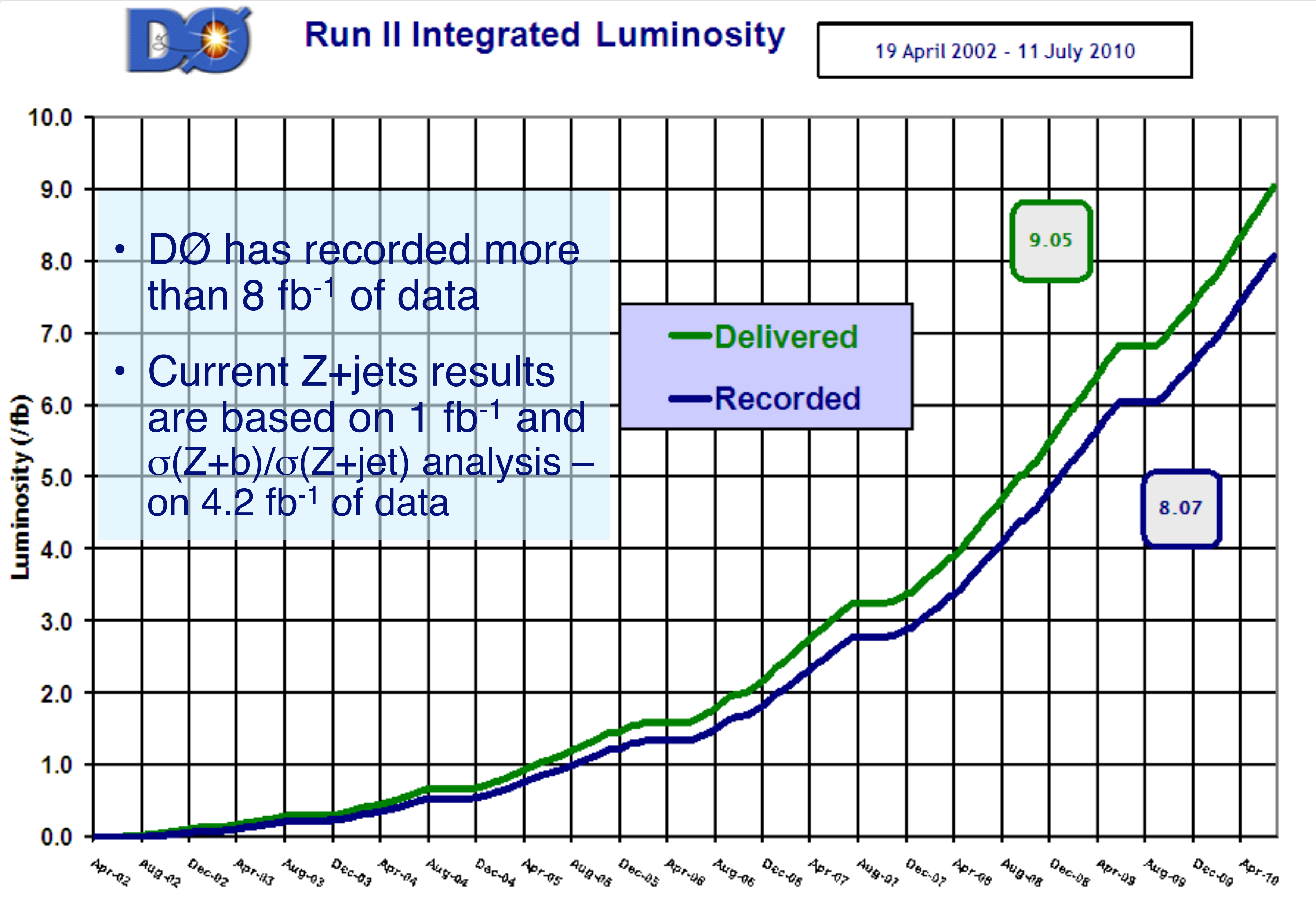


Motivation

- Vector bosons production in association with jets can serve as an important test of perturbative QCD calculations
- As a background, they contribute to many other processes and searches, such as ttbar production, Higgs, SUSY signatures
- Measurements of events kinematic properties are important for tuning MC event generators applicable at the Tevatron and LHC

Data samples

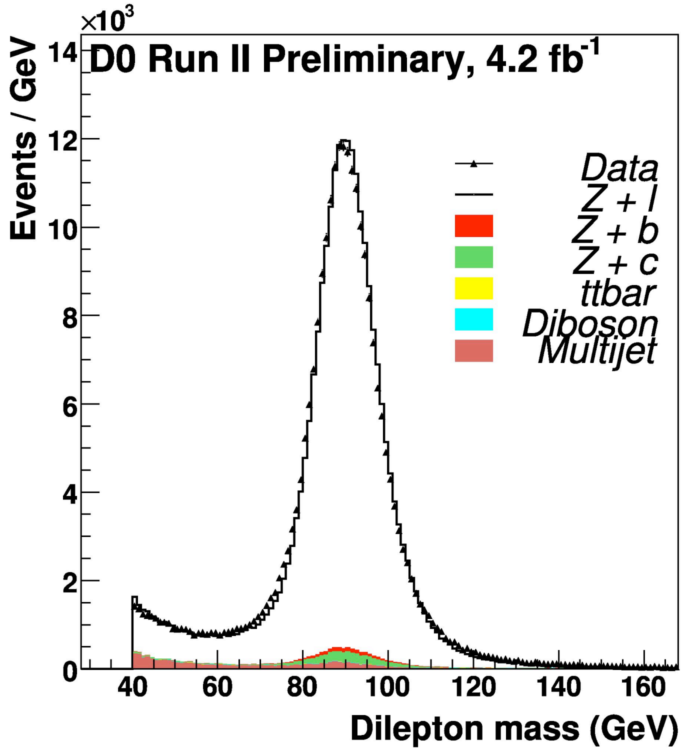


- DØ has recorded more than 8 fb^{-1} of data
- Current Z+jets results are based on 1 fb^{-1} and $\sigma(Z+b)/\sigma(Z+jet)$ analysis – on 4.2 fb^{-1} of data

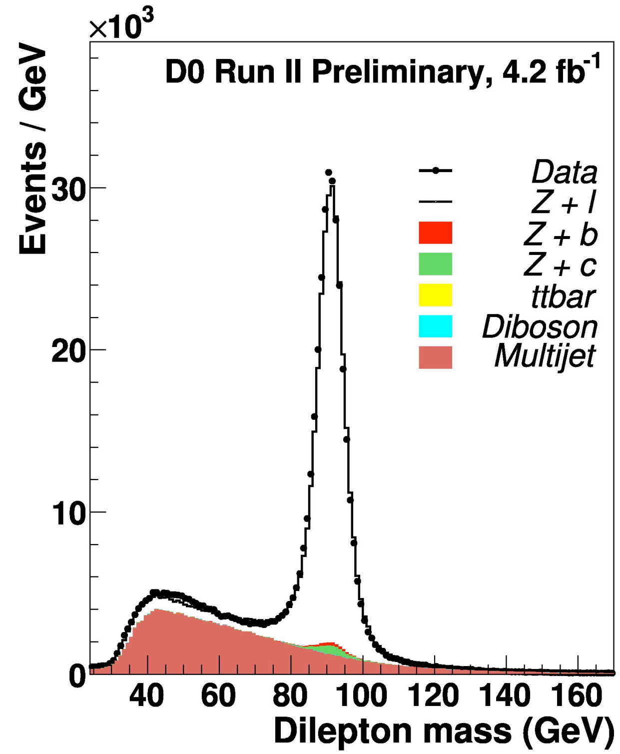
$Z/\gamma^* \rightarrow e^+e^-/\mu^+\mu^-$ candidates

- $Z/\gamma^* \rightarrow e^+e^-/\mu^+\mu^-$ decays are easily identified with little background

- $Z/\gamma^* \rightarrow \mu^+\mu^-$ typical selections:
  - Suite of single/dimuon triggers, ~90% efficient
  - $p_T > 10$ GeV, $|\eta| < 2$
  - 65 GeV $< M_{\mu\mu} <$ 115 GeV



- $Z/\gamma^* \rightarrow e^+e^-$ typical selections:
  - Suite of single/diEM triggers, ~100% efficient
  - $p_T > 15$ GeV, $|\eta| < 2.5$
  - 65 GeV $< M_{ee} <$ 115 GeV



Selection of jets

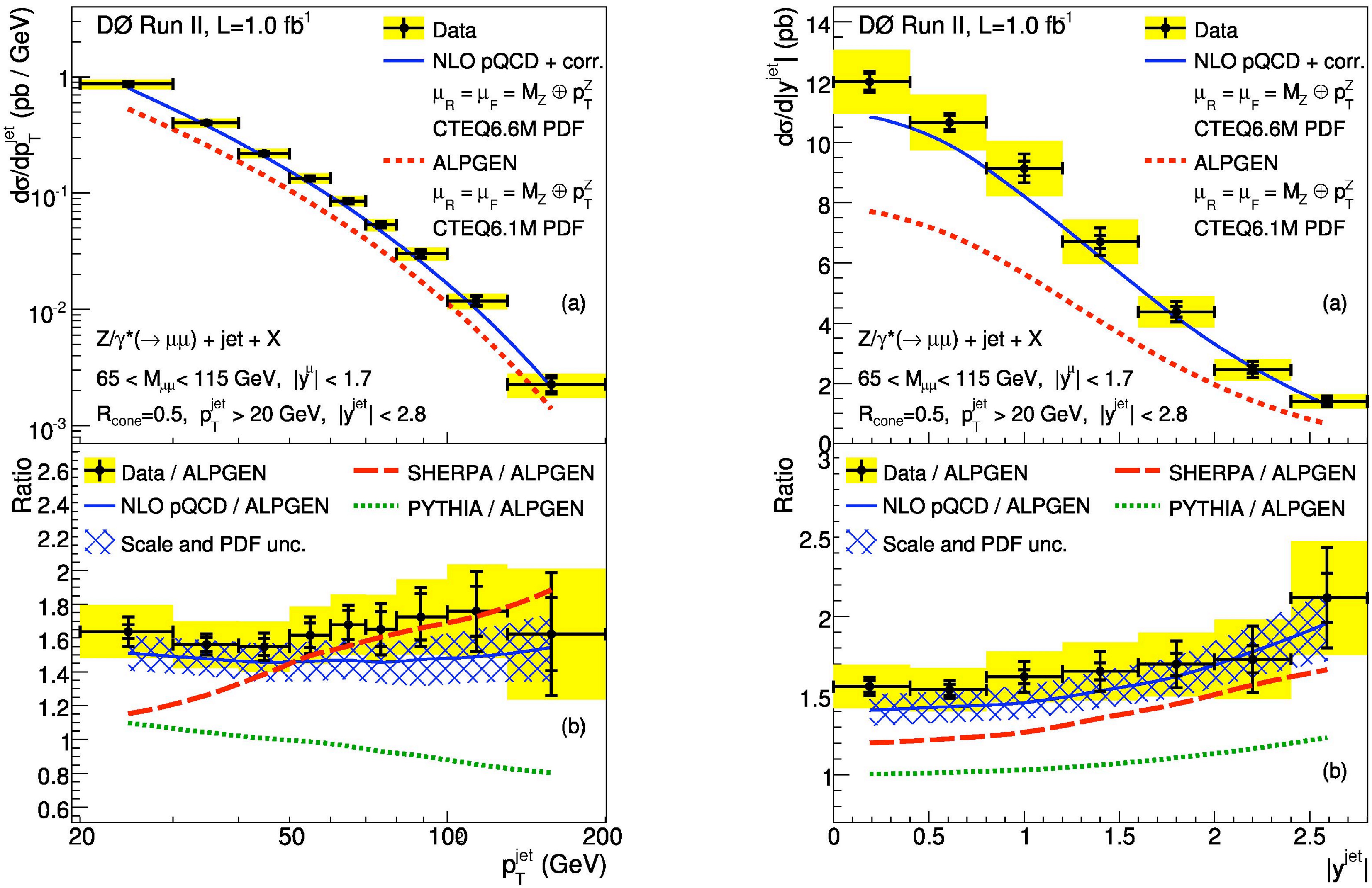
- Jets are identified with the DØ Run II midpoint cone algorithm
  - $R_{cone} = 0.5$, $p_T > 15$ GeV, $|y| < 2.8$
- Jets are corrected for the calorimeter response, instrumental out-of-cone showering and pile-up effects
- These jet energy scale corrections are determined in-situ using γ+jet, di-jet and minimum bias collider data
- Resulting calorimeter jets are corrected to the particle level jets using detailed simulations of the DØ detector
- These particle level jets then are unfolded for the detector resolution effects and compared to a model/theory predictions

pQCD calculations and MC event generators

- Z+2 jets (+3 jets) at NLO (LO) evaluated with MCFM v5.4
  - $\mu^2_r = \mu^2_f = p^2_{T,Z} + M^2_Z$
- Parton shower event generators
  - PYTHIA v6.420
    - Tune Perugia (p_T ordered showers)
    - Tune QW (Q^2 ordered showers)
  - HERWIG v6.510 +JIMMY v4.31
- Matrix element generators matched with parton shower generators
  - ALPGEN v2.13+PYTHIA v6.420
  - ALPGEN v2.13+HERWIG v6.510
  - Sherpa 1.1.3

Z/γ*(→μ⁺μ⁻) + jets production (1)

- Differential cross sections in p_T and y of the leading jet

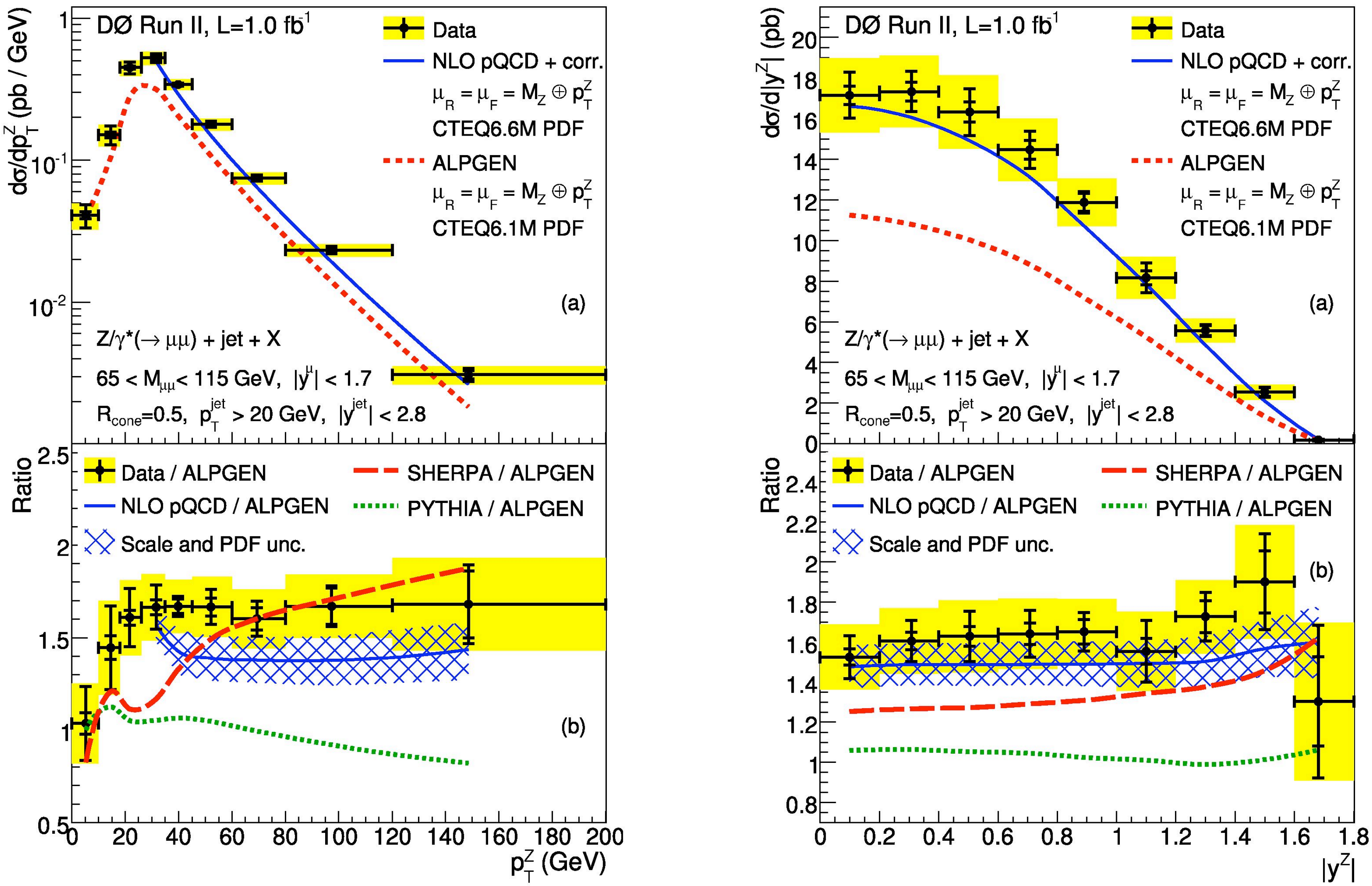


Phys. Lett. B 669, 278 (2008)

- NLO pQCD better describes data

Z/γ*(→μ⁺μ⁻) + jets production (2)

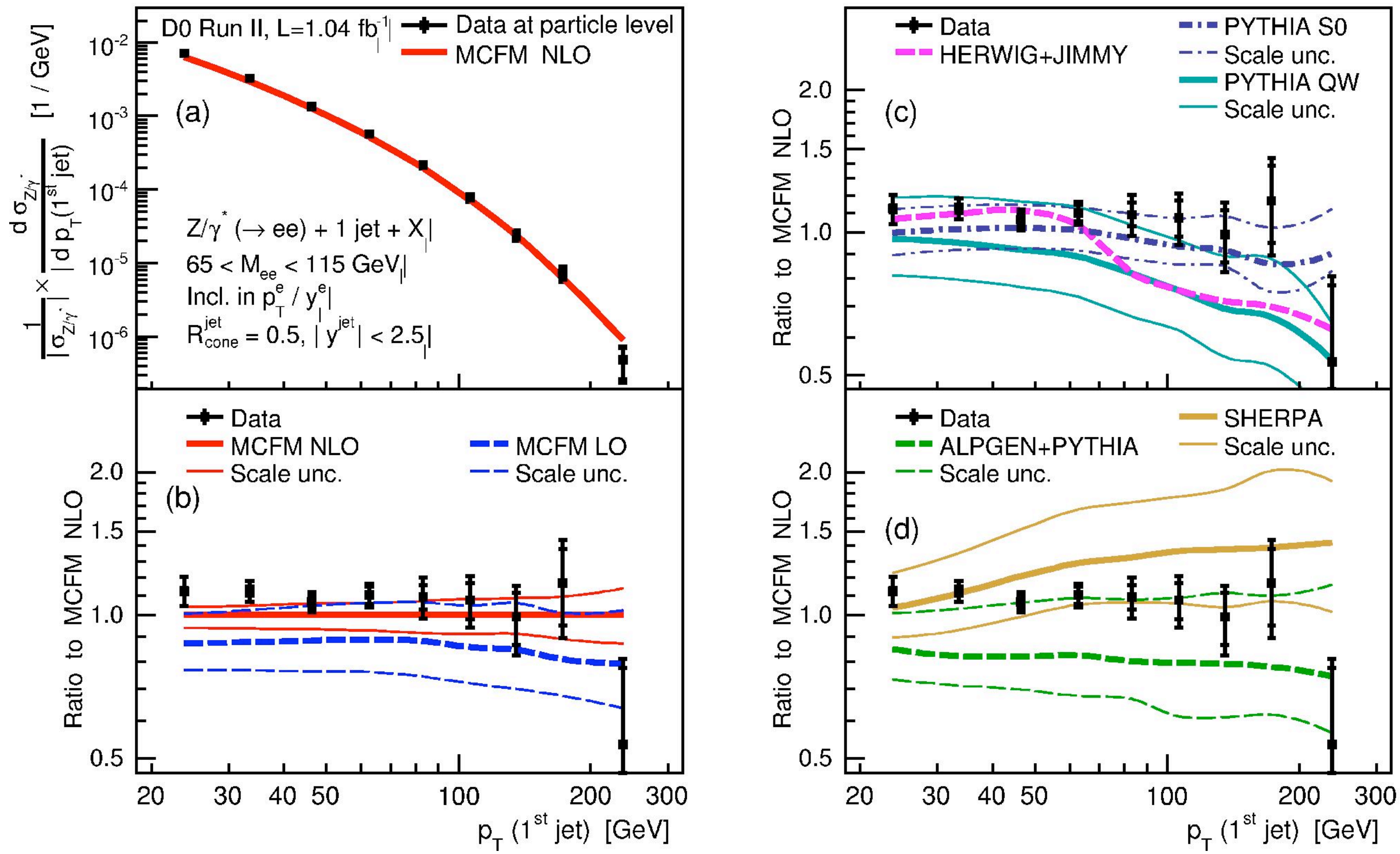
- Differential cross sections in p_T and y of the Z boson



- NLO pQCD better describes data at large p_T^Z

Z/γ*(→e⁺e⁻) + N jets production (1)

- Normalized differential cross section in p_T of the leading jet

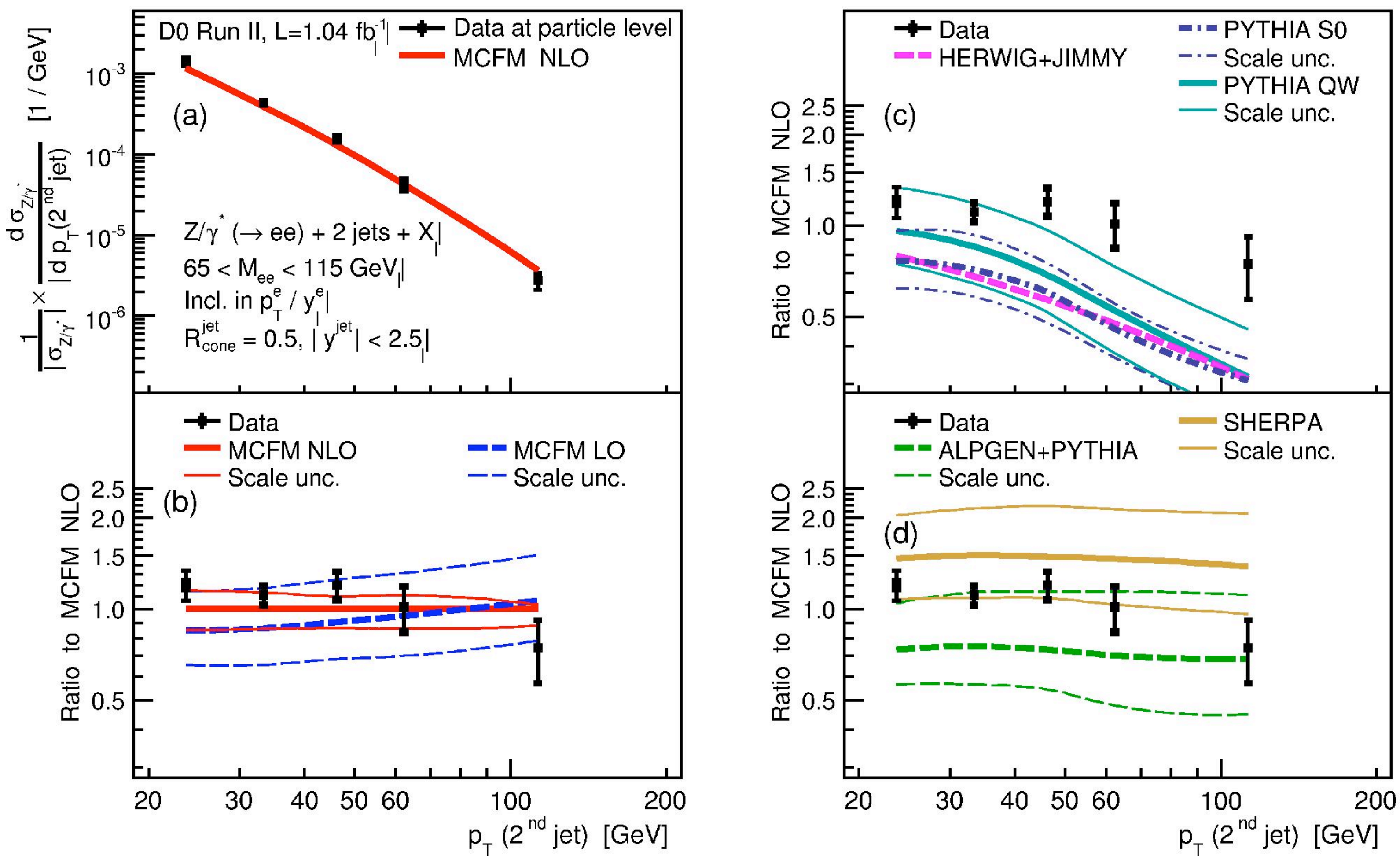


Phys. Lett. B 678, 45 (2009)

- Data described well by NLO QCD

$Z/\gamma^*(\rightarrow e^+e^-)$ + N jets production (2)

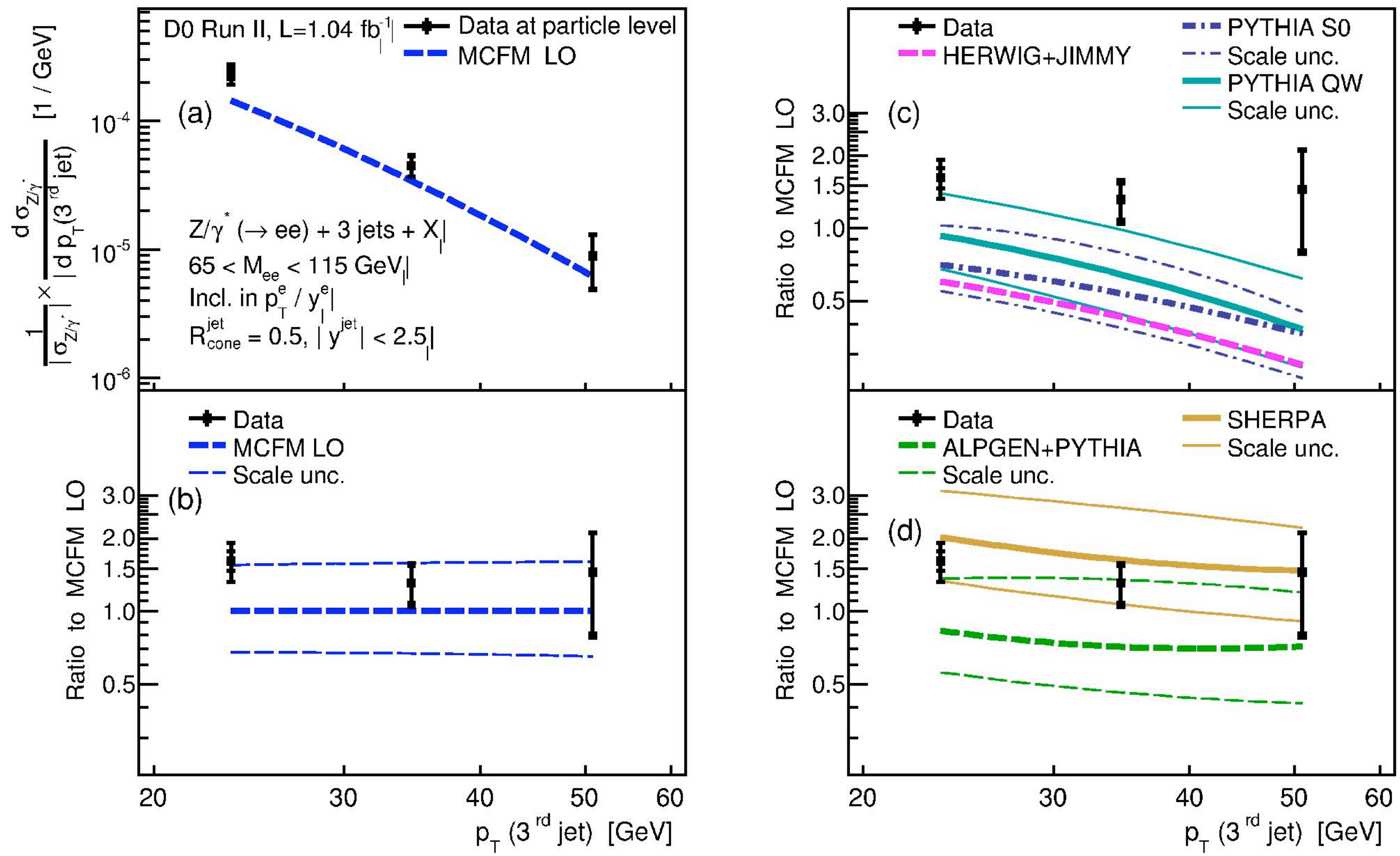
- Normalized differential cross section in p_T of the 2^{nd} jet



- Data described well by NLO QCD

Z/γ*(→e⁺e⁻) + N jets production (3)

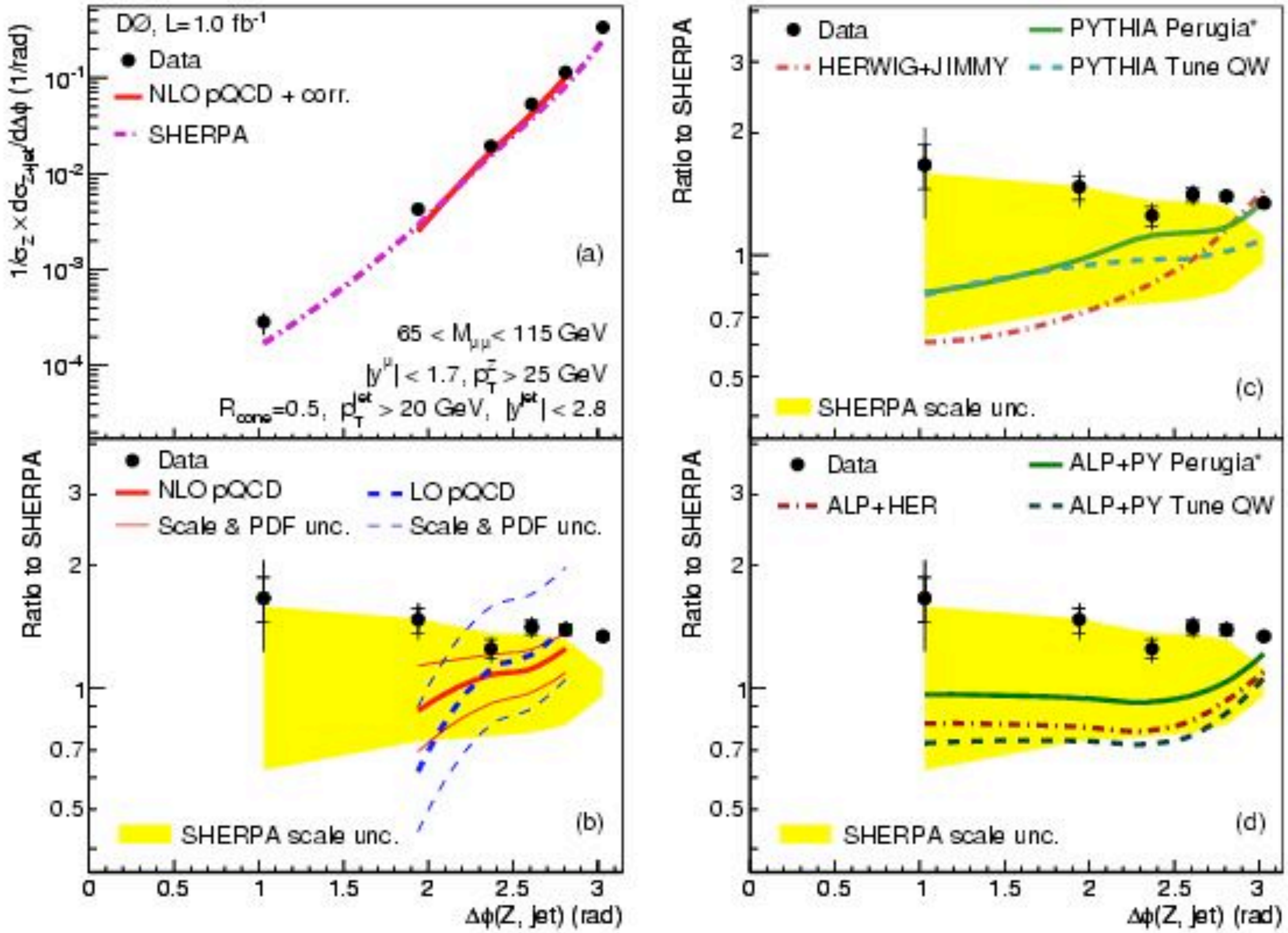
- Normalized differential cross section in p_T of the 3[rd] jet



- MCFM LO and Sherpa are preferred. Uncertainties in data and predictions due to scale variations are large

Z/γ*(→μ⁺μ⁻) + jets: angular correlations

- Normalized diff. cross section in Δϕ(Z,leading jet), $p_T^Z > 25$ GeV

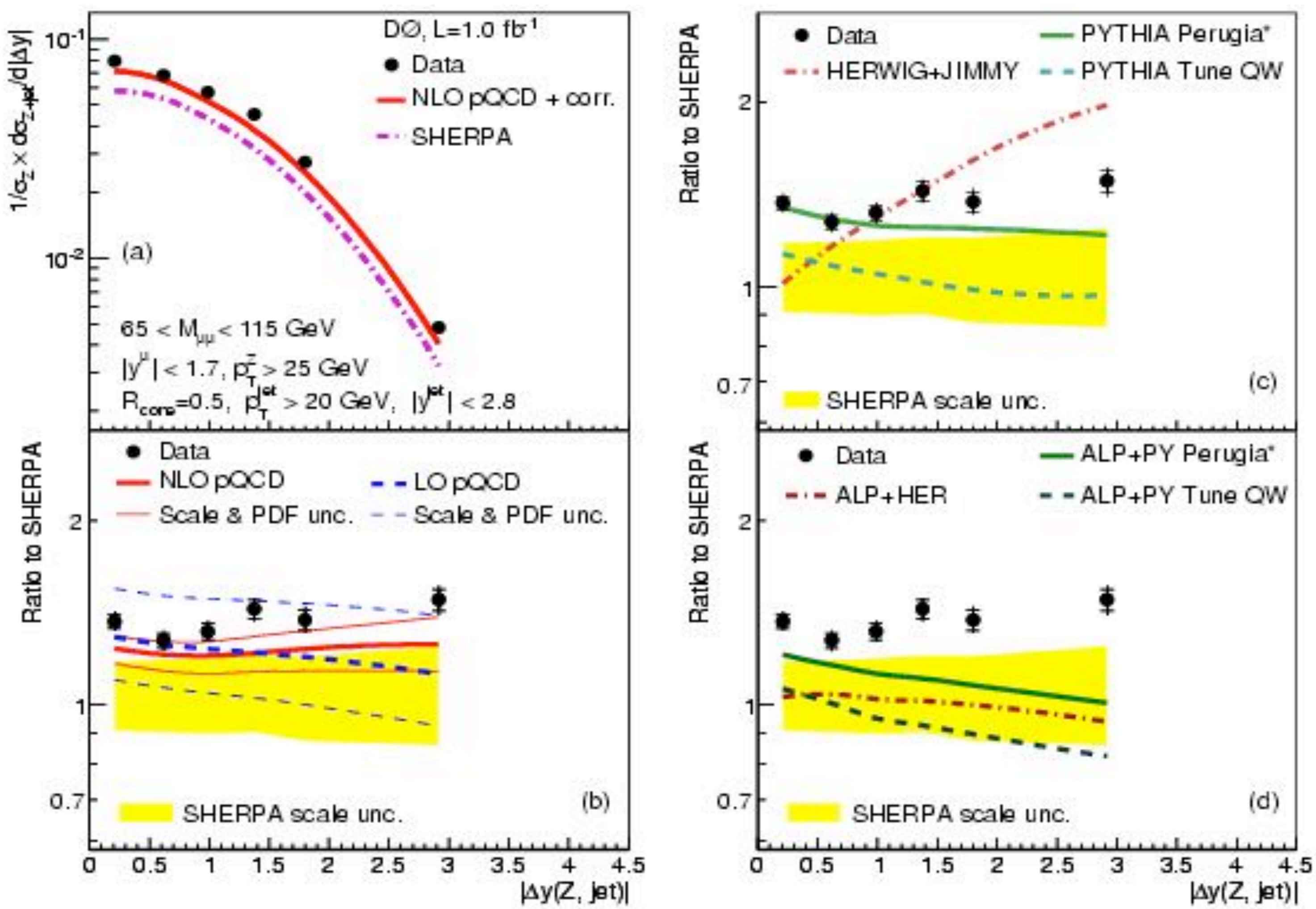


Phys. Lett. B 682, 370 (2010)

- Sherpa is preferred by data

Z/γ*(→μ⁺μ⁻) + jets: rapidity correlations

- Normalized diff. cross section in Δy(Z,leading jet) , $p_T^Z > 25$ GeV

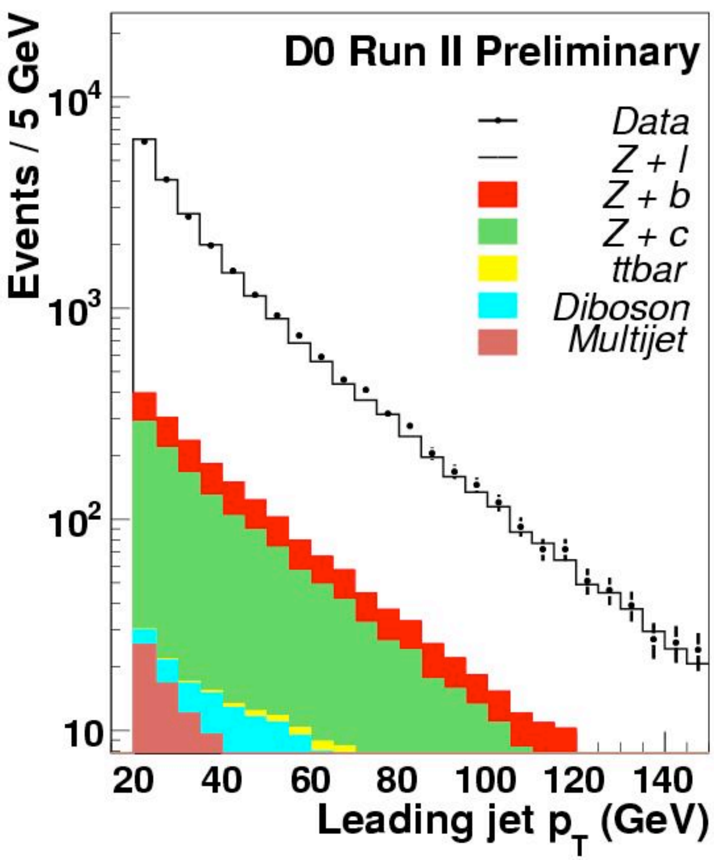


- NLO pQCD is preferred by data

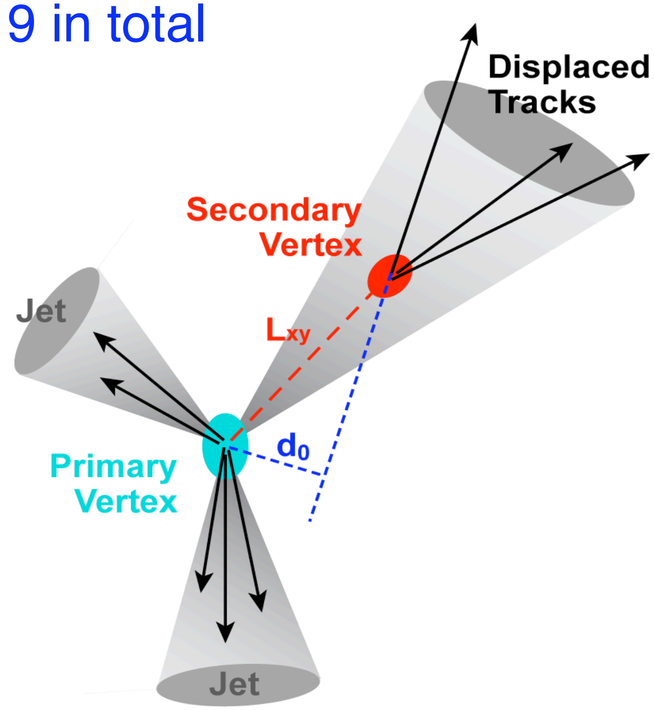
σ(Z+b)/σ(Z+jet) ratio measurement

- Event Selection
  - Dilepton mass 70≤M≤110 GeV
  - ≥ 1 jet: p_T> 20 GeV, |η|<1.1

Before tagging

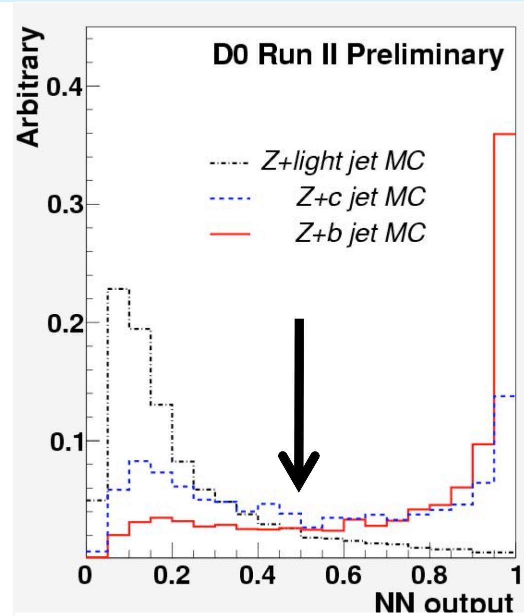


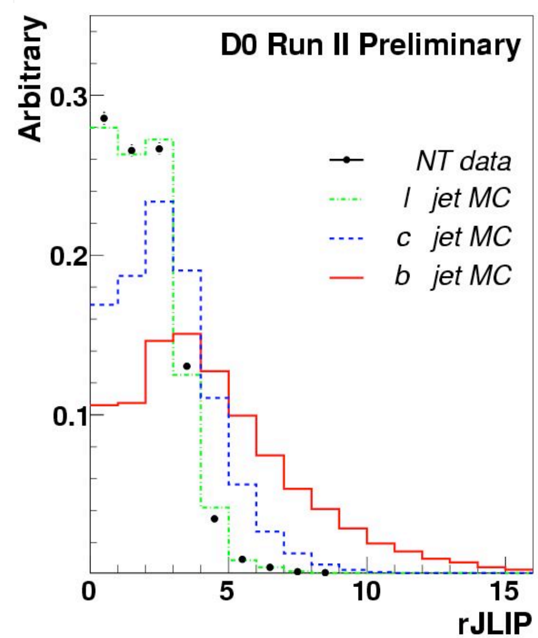
- Inputs for NN tagging algorithm
  - Decay length significance of sec. vtx.
  - No. of tracks associated to sec. vtx.
  - Mass of the sec. vertex
  - (reduced) Jet Lifetime Probability, rJLIP: confidence level that all tracks in a jet originate from primary vertex
  - etc., 9 in total



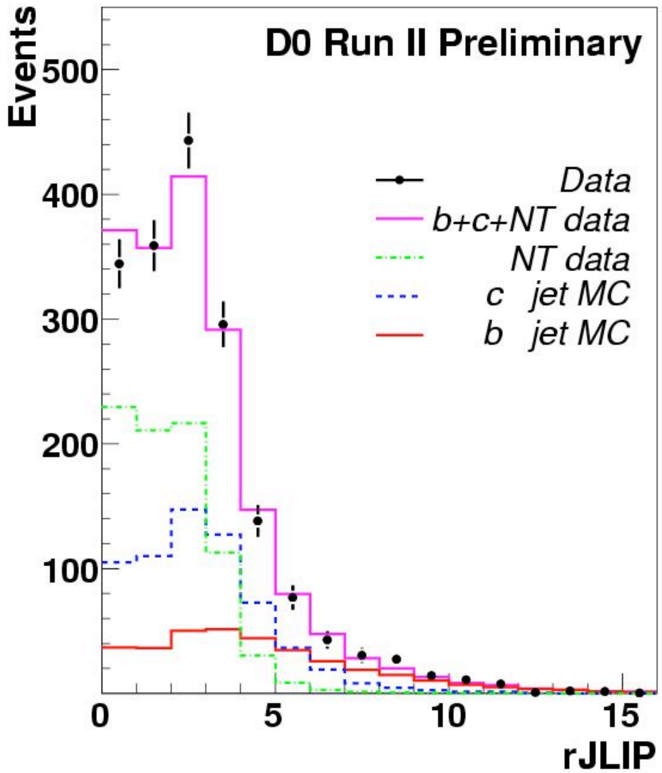
Separation of light, c and b jets

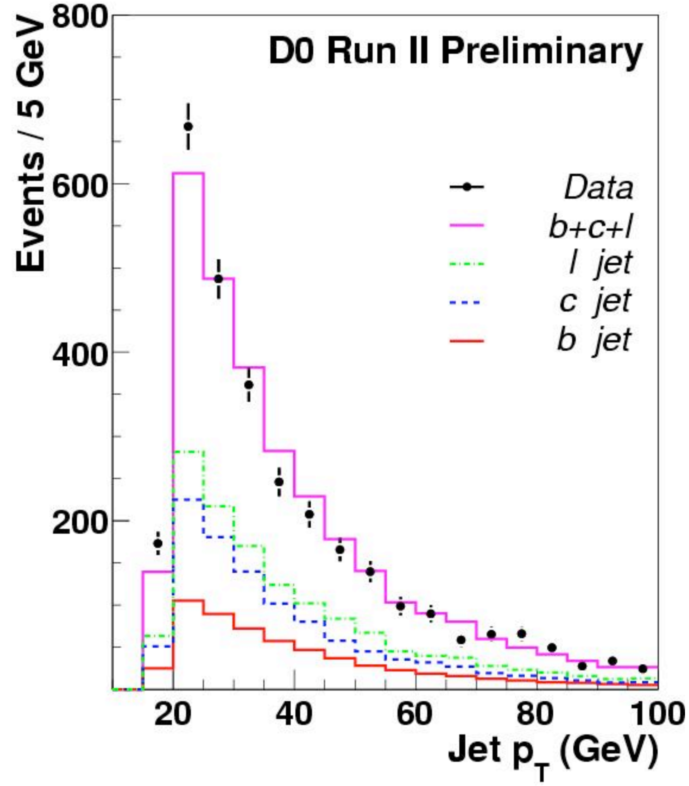
- Apply Neural Network tagging algorithm on jets to enrich b content
- Use rJLIP variable to discriminate between light, c and b jets
- Light jet template is derived from "Negatively Tagged" (NT) data
  - Jets are formed from tracks that have negative values for some of the inputs for the NN algorithm
- Use Alpgen+Pythia for b and c jet templates
- Use log likelihood fit to extract Z+b fraction from the preselected sample





σ(Z+b)/σ(Z+jet): preliminary results





Z+b fraction	**0.191 ± 0.030**
Z+c fraction	0.384 ± 0.072
Z+light jet fraction	0.424 ± 0.054
σ(Z+b)/σ(Z+jet) NLO/MCFM	**0.0176 ± 0.0024 (stat) ± 0.0023 (syst)** 0.0184 ± 0.0022

Summary

- DØ has an active program to measure various properties of vector boson production is association with jets
- First measurement at hadron collider for: $\Delta\phi(Z,jet)$, $\Delta y(Z,jet)$
- Generally, NLO pQCD calculations using MCFM describe data well, while Sherpa and Alpgen require large scaling
- Preliminary result for $\sigma(Z+b)/\sigma(Z+jet)$ agrees well with the theoretical prediction given by MCFM
- More results on vector boson production in association with (b/c) jets are expected soon