Signal and background modeling in Higgs searches at DØ

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Higgs systematics meeting, May 18th 2010

MANCHESTER 1824

DØ

Outline

Discussing some aspects of:

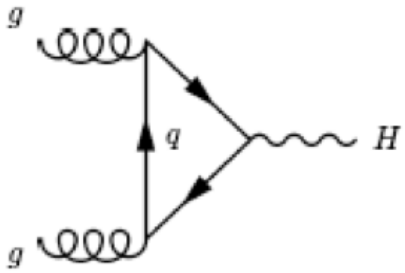
Signal modeling

Main backgrounds:

- For $H \rightarrow WW$ - W-pair production
- For $H \rightarrow bb$ - W/Z + Jets

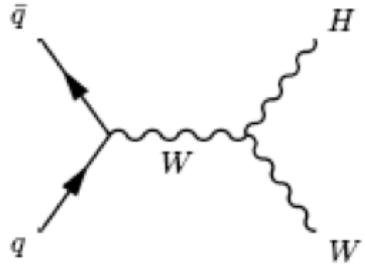
Signal cross section and BR

Gluon fusion, vector boson fusion, WH/ZH



Gluon fusion cross section is normalized to NNLO and includes soft gluon resummation to NNLL order, using MSTW2008 PDFs

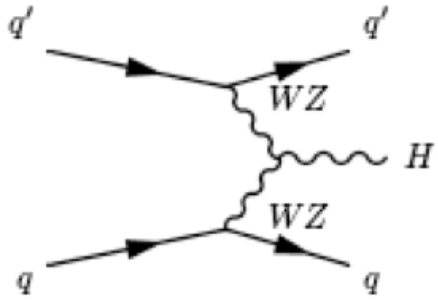
deFlorian and Grazzini, PLB 674, 291 (2009), Anastasiou et al., JHEP0904 (2009) 003



Associated production is normalized to ~NNLO

Brein et al., PLB 579,149 (2004), Ciccolini et al., PRD68 073003 (2003)

Signal cross section and BR



Vector boson fusion is normalized to NLO (computed with MCFM)
Berger and Campbell, PRD 70 (073011) 2004

Note: NNLO QCD corrections computed very recently (arXiv:1003.4451), numbers for TeV expected in a follow-up publication

Higgs decay branching ratios were computed with HDECAY. New version (v3.53) available and CDF/DØ will update to these numbers

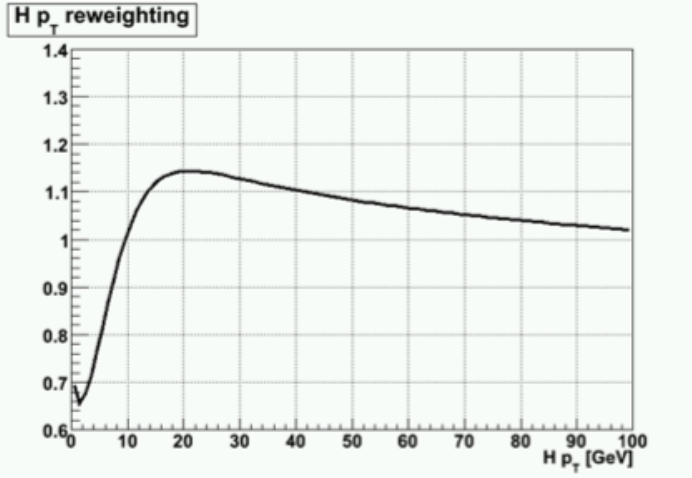
We also update the WH/ZH xsections with MSTW2008 PDFs (was MSTW2002)

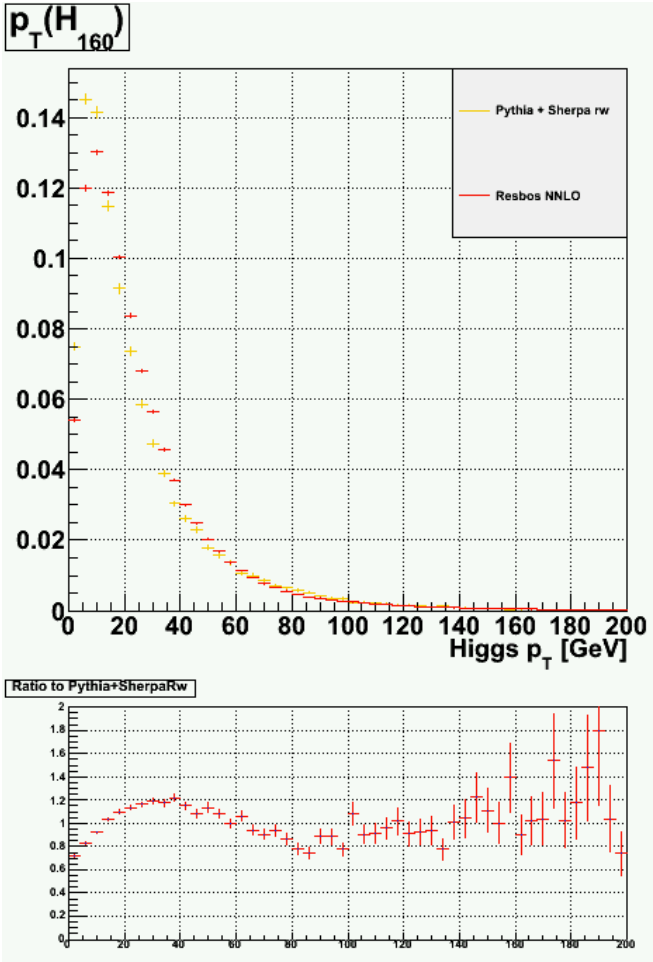
Higgs pT spectrum

All our Higgs MCs are generated with:
Pythia - using LO CTEQ6L1 PDFs

Corrections to the Higgs pT spectrum in gg→H:

In the past: reweight to Sherpa





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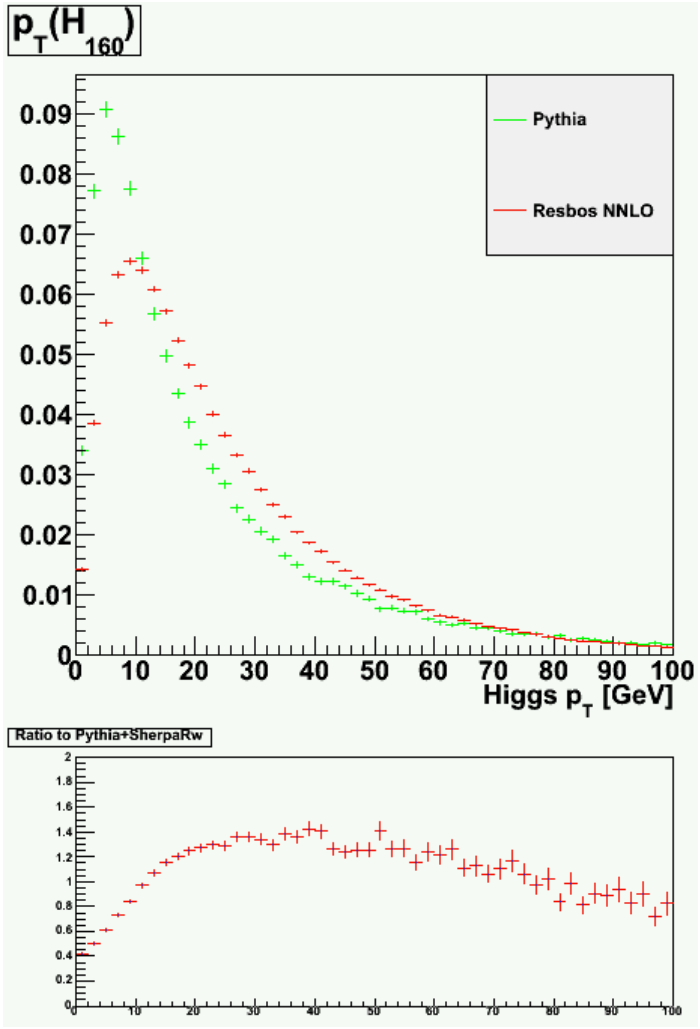
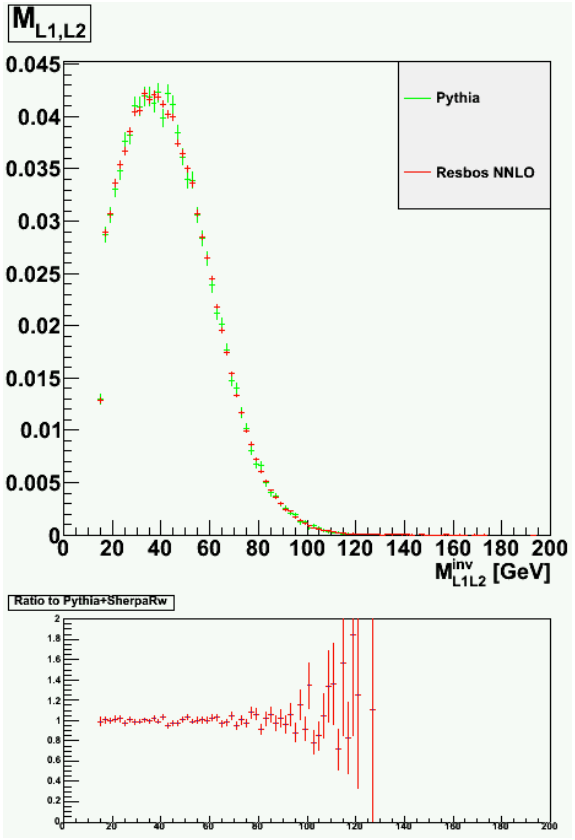
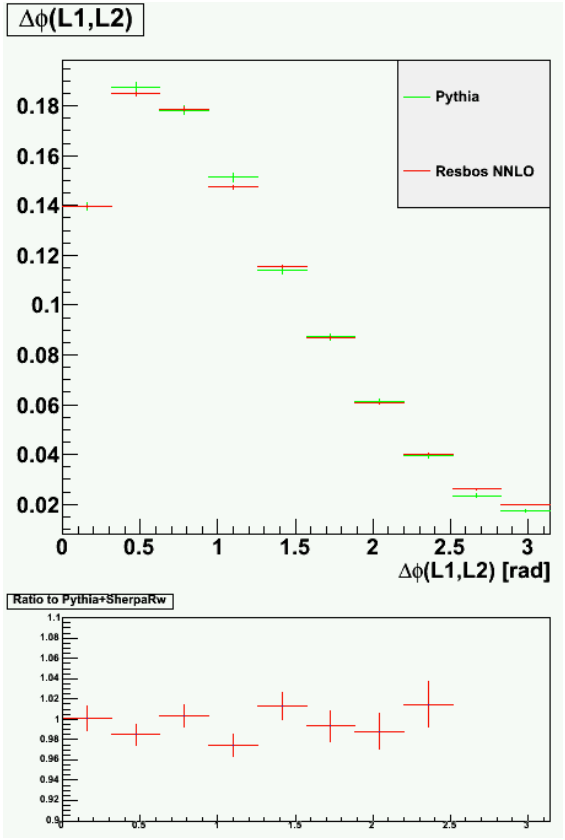
Plan: reweight to Resbos

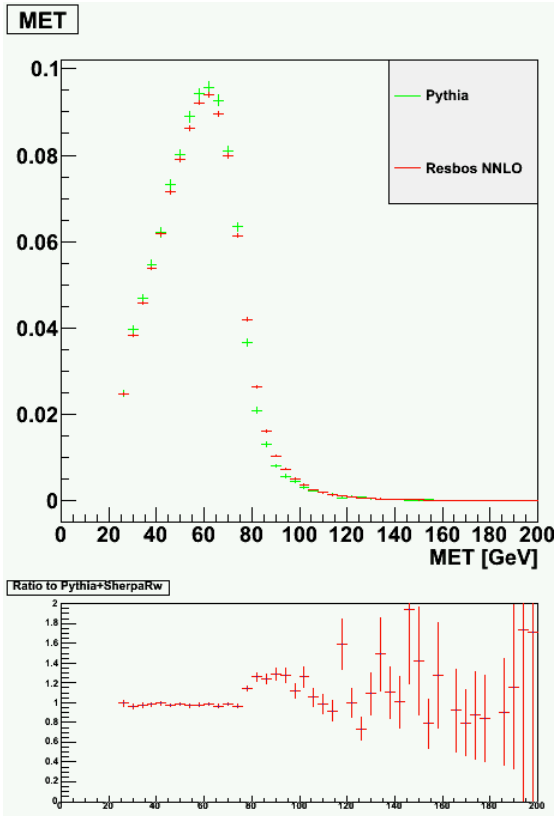


Correcting to Resbos

Small effect on observables, even at generator level







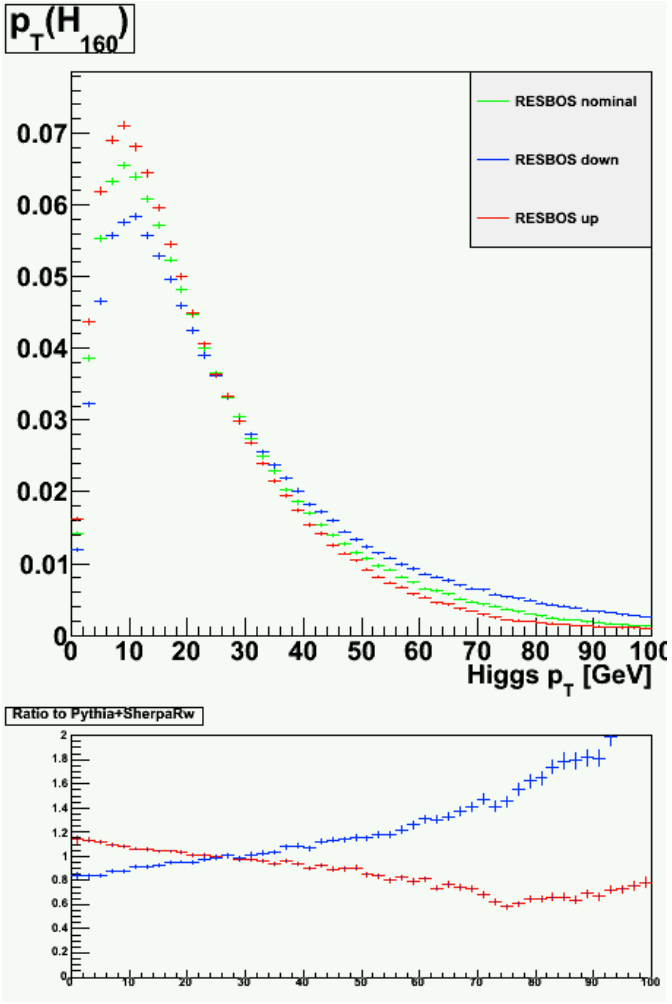
Associated uncertainties

Corrections to the Higgs pT spectrum in gg→H:

Reweight to Resbos

Acceptance and shape uncertainties from scale variation grids (renorm. / fact. scale change of 2.0/0.5 at high Pt, change effective resummation constant at low Pt)

Note: the same procedure should be applied to WH/ZH (included now in Resbos)

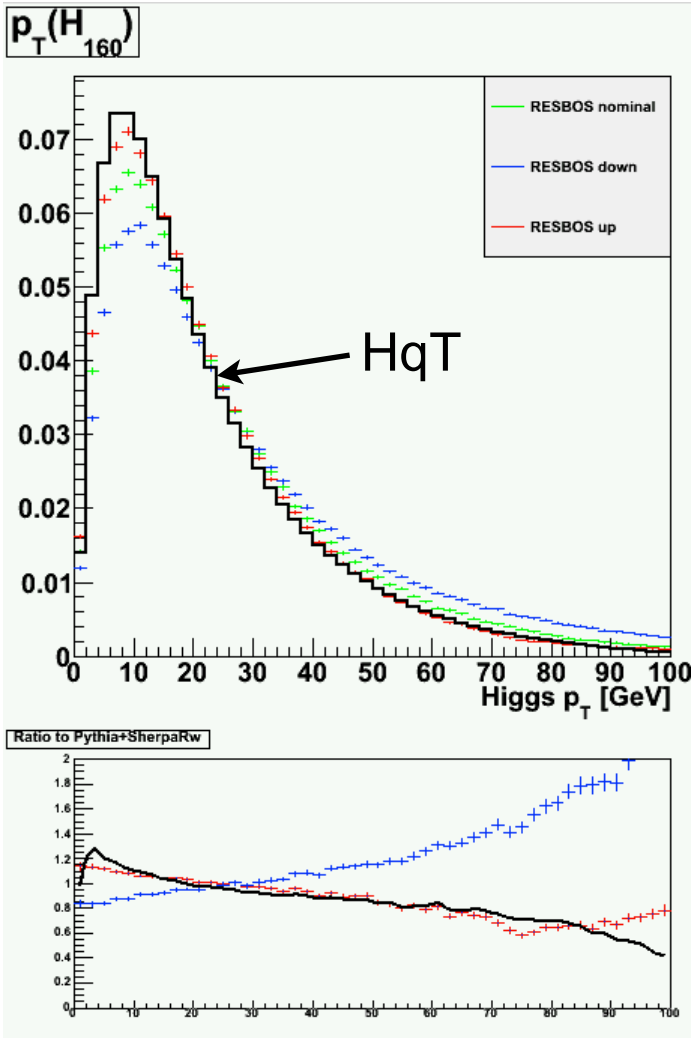


Resbos comparison to HqT

HqT: NNLL+NLO

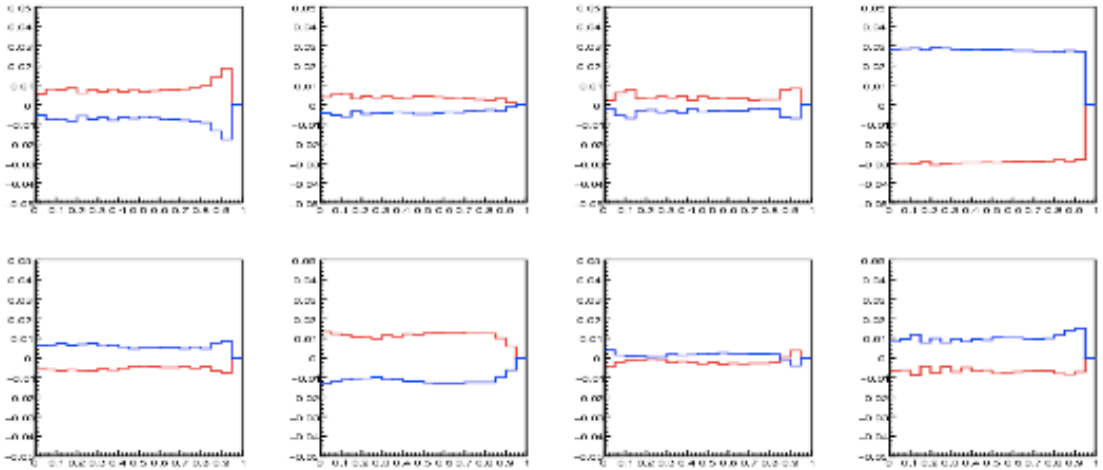
Both use ~mH as scale
Different PDFs
…

Should agree on common procedure (to discuss)



Other uncertainties

Signal generated with CTEQ6L1 PDF, to assess the PDF uncertainty perform a per-event reweighting (based on the properties of the incoming partons) to CTEQ6.1M and the 20 pairs of associated error sets



+ 12 more

Further uncertainties on the signal theory prediction were discussed yesterday in length (alpha_s, scale, PDF etc.)

Diboson production

Normalized to NLO calculation, computed with NLO MCFM and MC@NLO
Campbell and Ellis, PRD60, 113006 (1999)

Theoretical cross section uncertainty 7%
(Limiting factor in current H → WW search!)

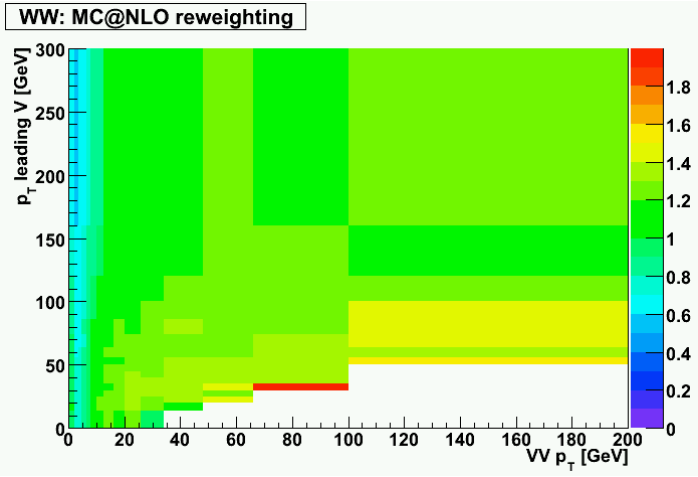
Generated with Pythia CTEQ6L1 PDFs

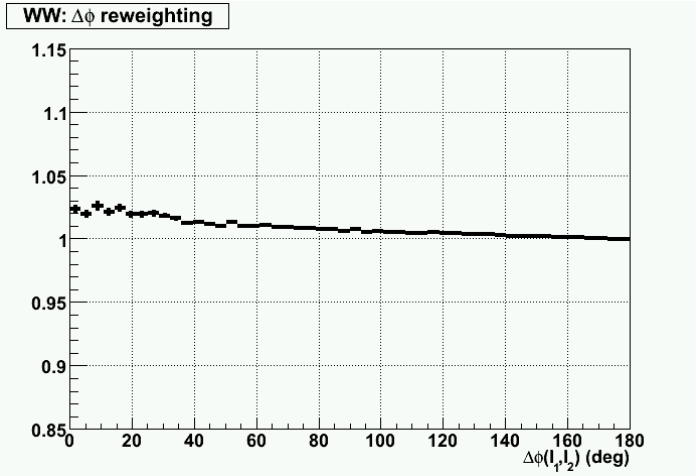
In the past: reweight Pythia to MC@NLO
(will only get high pT right)

Plan: reweight to Resbos (NLO + resum)
(When scale variation grids available)

Correct Δϕ spectrum to account for
gg→WW production

Binoth et al., JHEP 0612, 046 (2006)





W/Z + jets cross section

Generated with ALPGEN (+Pythia for hadronization) with CTEQ6L PDFs

Inclusive cross section normalized to NNLO

Hamberg et al., (NPB359, 343 (1991)

ALPGEN LL cross section need to be corrected with a k'-factor of 1.3

Heavy flavor fractions are further corrected by the ratio of heavy to light NLO k-factors (~1.5) obtained using MCFM

The uncertainty on the (W/Z)bb and (W/Z)cc cross sections is calculated within MCFM to be +19/-18% (We use ±20%.)

When cross sections normalized to data (sideband fit in the limit setting) result within 10% of these estimates

W/Z + jets modeling

Reweight Z pT distribution to DØ data

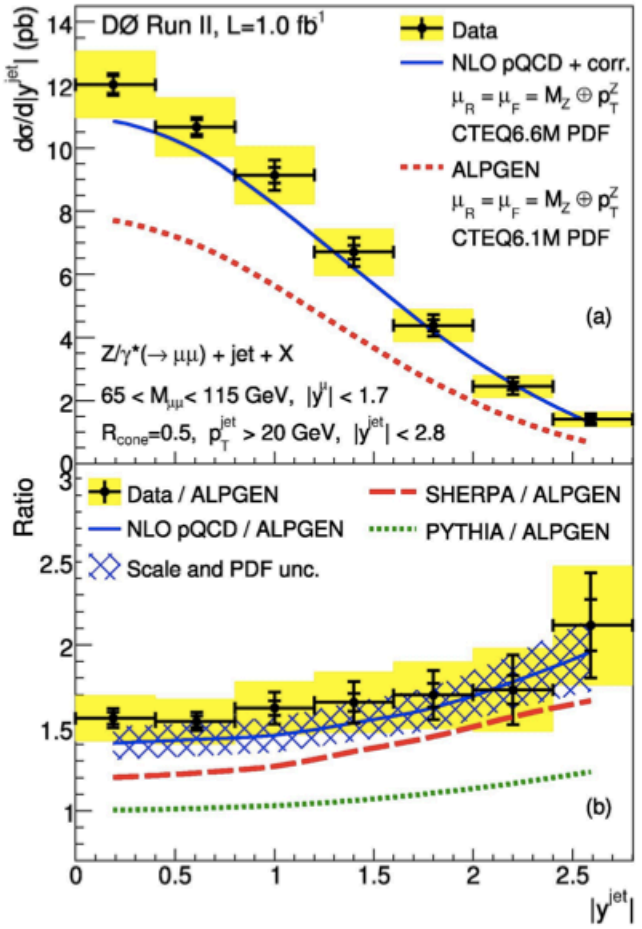
Transfer to W pT distribution using FEWZ
Melnikov and Petriello, PRD 74, 114017 (2006)

Correct jet angular distributions to match data
Data agree better with MCFM/ SHERPA than with ALPGEN (broader jet rapidity distribution)

All the above corrections derived with the assumption that they are not flavor dependent (not very safe, but little impact on dijet mass)

Various systematic uncertainties for the modeling of W/Z + jets shape

PLB 669, 278 (2008)



W/Z + jets modeling uncertainties

Systematic uncertainties due to the reweightings to data from previous slide

Tune ALPGEN parameters on data and derive range for systematic variations:

- Renormalization / factorization scale
- k_T (alpha_s) scale
- Parton-matching pT threshold in MLM procedure
- Parton-matching radius in MLM procedure

Underlying event and fragmentation modeling:

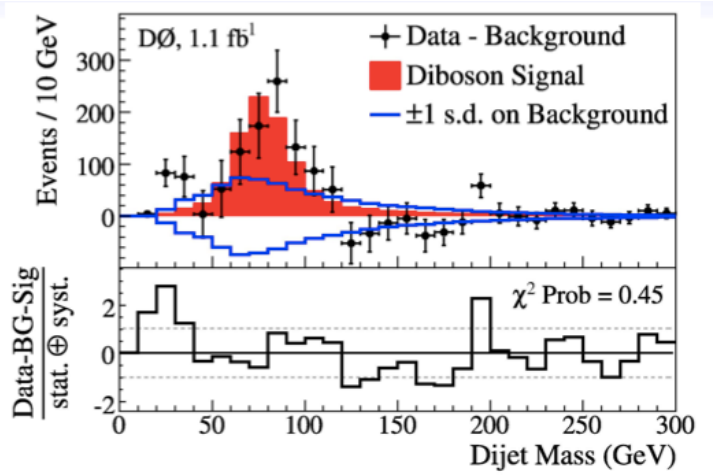
- Comparison of ALPGEN+PYTHIA to ALPGEN+HERWIG and PYTHIA tunes

Other studies:

- Check bottom quark mass dependencies with MCFM

More work needs to be done

VV(jj) and VZ(bb) searches ideal testing cases



W/Z + jets modeling uncertainties

Uncertainties on ALPGEN parameters are combined into two independent shape-only uncertainties:

- related to the MLM algorithm (only applied to V+light flavor)
- related to the light and heavy flavor scaling parameters