Theory systematics in $p_{\mathrm{T}}^{\mathrm{miss}}$ + jet(s)

Christian Gütschow

$p_{\mathrm{T}}^{\mathrm{miss}}$ + jets analysis

25 March 2020

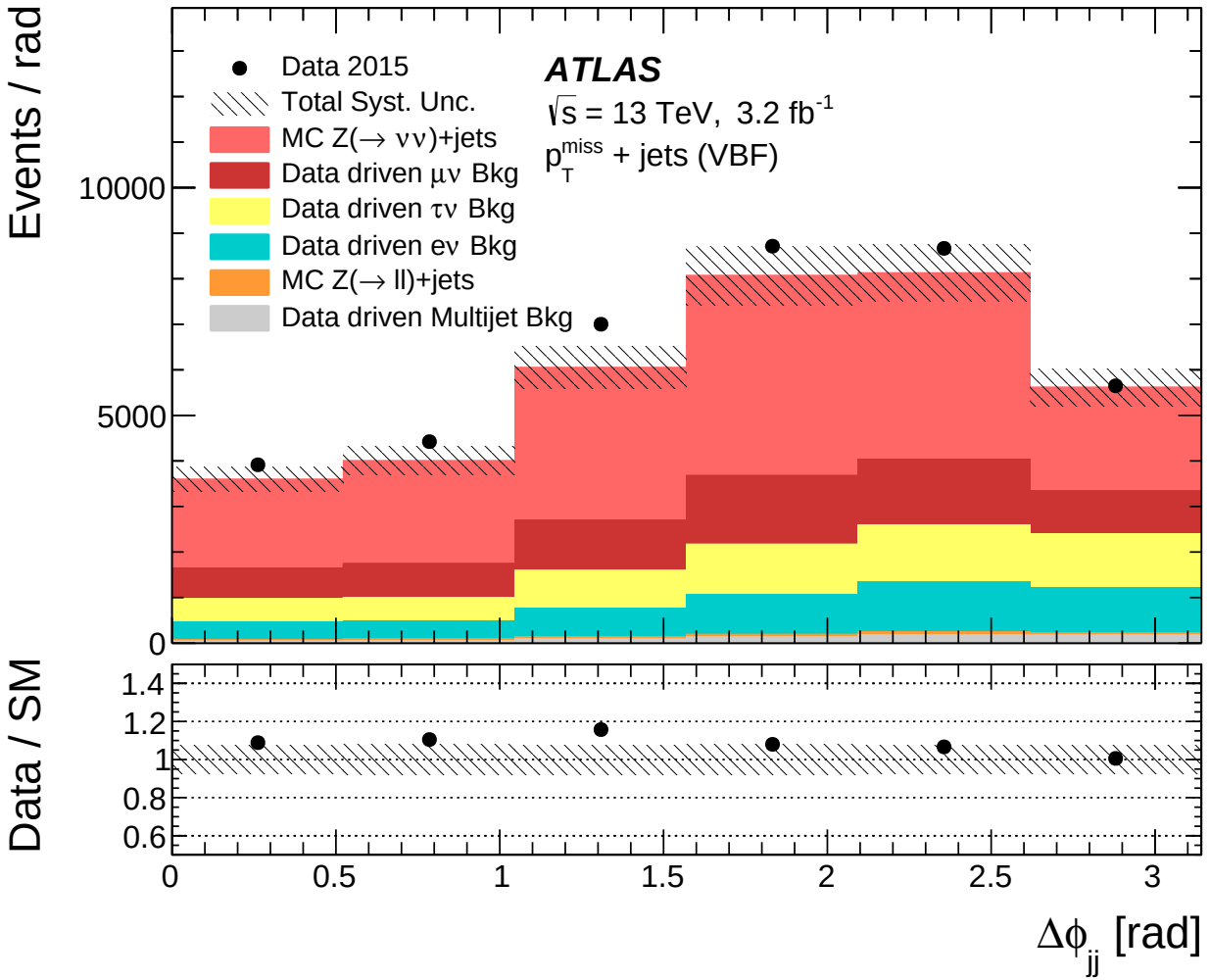
ATLAS EXPERIMENT

CERN

Overview

- we are measuring the tails of V+jets with a focus on minimising model-dependence in the analysis
  - the measurement is performed fully fiducially, i.e. without subtracting SM backgrounds
  - the leptons in the control regions (CRs) are 'marked invisible', i.e. they are removed from the final state to make the CR-based pseudo-$p_{\mathrm{T}}^{\mathrm{miss}}$ as similar as possible to the actual $p_{\mathrm{T}}^{\mathrm{miss}}$ in the 0-lepton signal region (SR)
- we measure 1D and 2D differential cross-sections for $p_{\mathrm{T}}^{\mathrm{miss}} > 200$ GeV in a monojet-like phase space, a 2-jet inclusive phase space as well as a VBF phase space (with a central-jet veto)

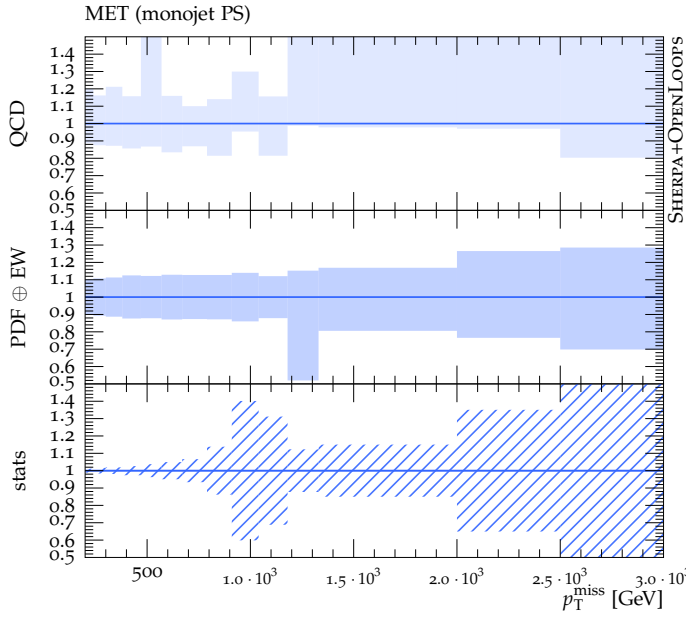
Process composition

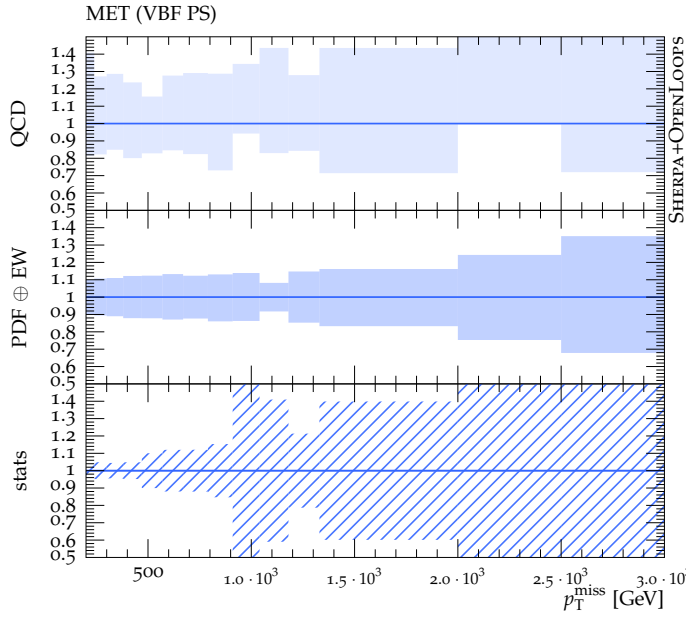


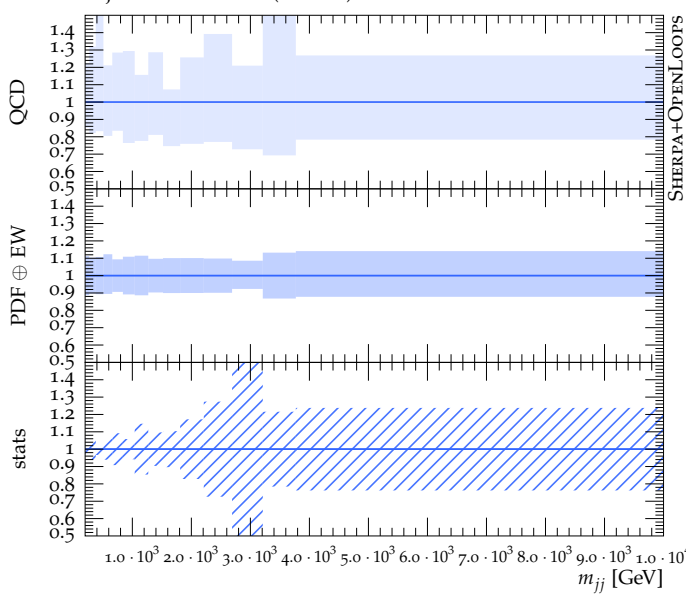
Calculation setup

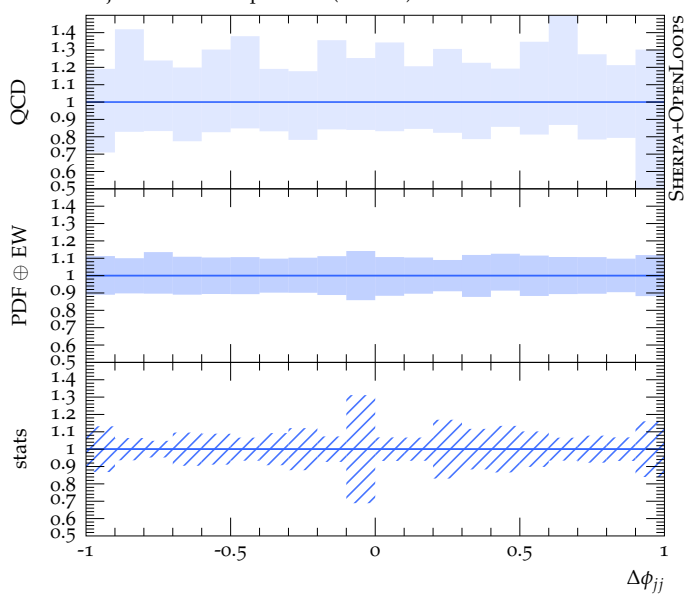
- we are producing $V + 0, 1, 2j$@NLO+$3, 4j$@LO with Sherpa 2.2.8
  - the ATLAS central samples are still without PS scale variations
  - we stick to NLO as NNLO is only available for the monojet phase space, and we will want to be able to correlate variations between all analysis regions
  - all calculations done in the G_μ scheme and using an H_{T}' scale for the RS:
    `PP_RS_SCALE VAR{sqr(sqrt(H_T2)-PPerp(p[2])-PPerp(p[3])+MPerp(p[2]+p[3]))/4}`
- pure QCD uncertainties estimated using on-the-fly ME+PS scale variations
- numerical data for NLO electroweak corrections + uncertainties, PDF variations (`NNPDF31_nnlo_as_0118_luxqed`) and mixed QCD+EW uncertainties taking from **arXiv:1705.04664**
- PDF α_{S} variations estimated using envelope from 0.118 ± 0.001 on-the-fly variations using `NNPDF31_nnlo_as_011x`, then transferred onto actual nominal
- we also produce γq-induced W+jets at LO with Sherpa 2.2.8

0-ℓ SR

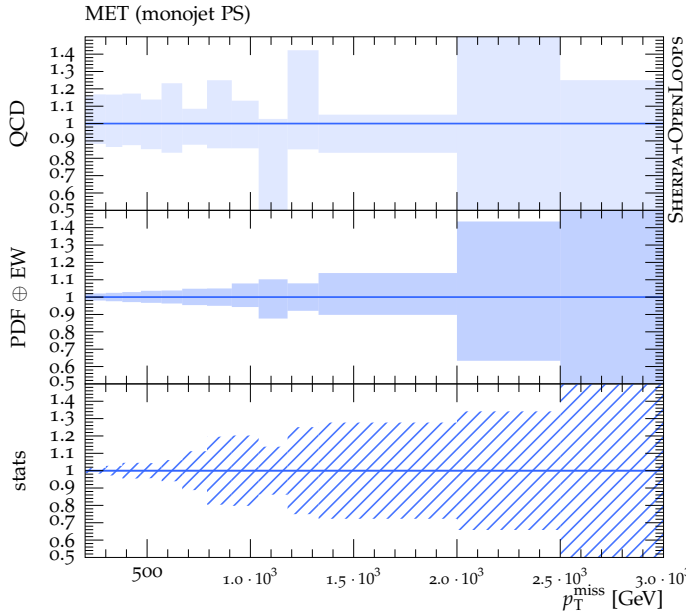

MET (monojet PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]

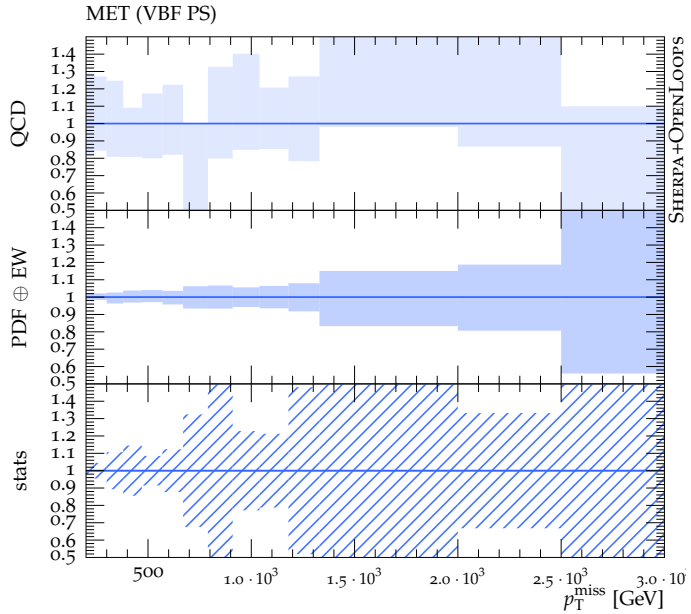

MET (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]

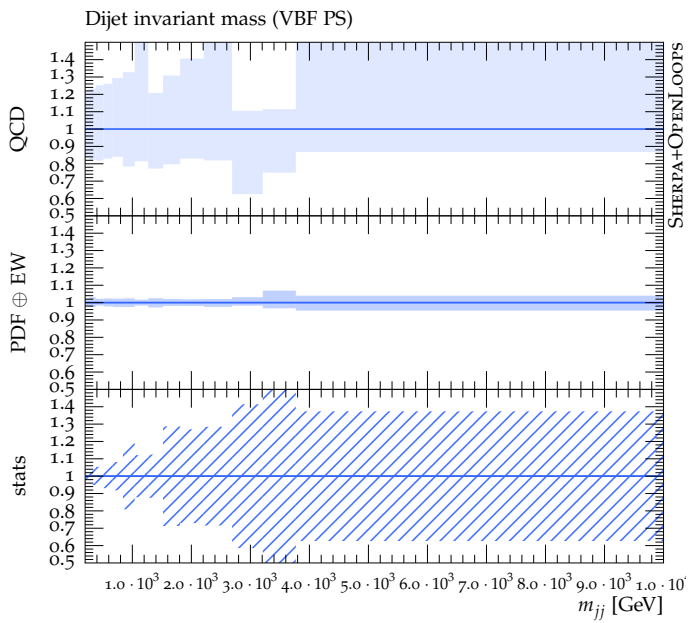

Dijet invariant mass (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
m_{jj} [GeV]

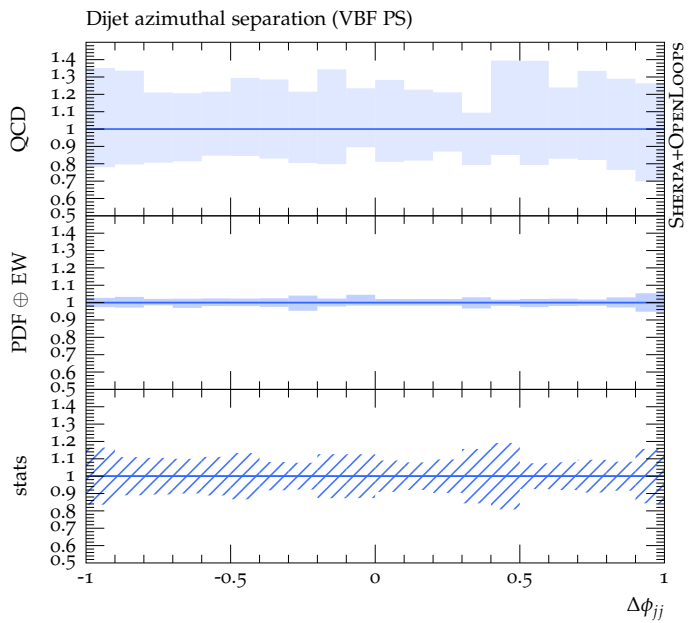

Dijet azimuthal separation (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
$\Delta\phi_{jj}$

1-*e* CR

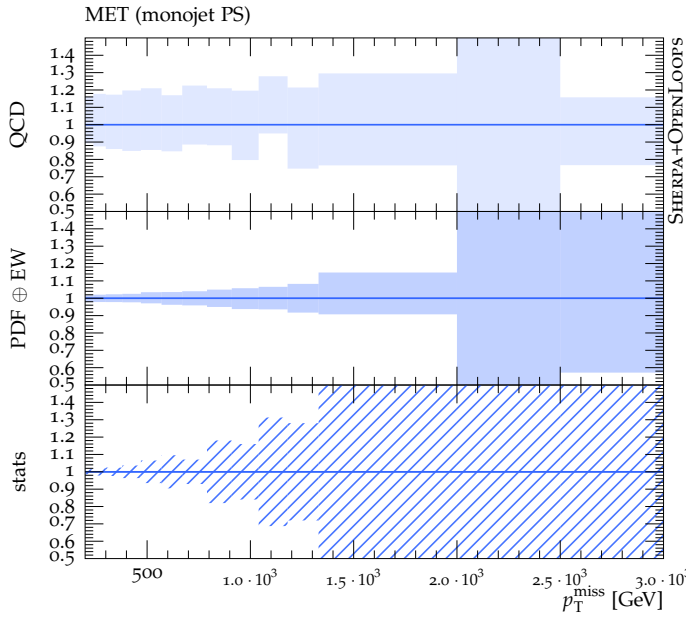

MET (monojet PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
500
1.0 · 10^3
1.5 · 10^3
2.0 · 10^3
2.5 · 10^3
p_T^miss [GeV]

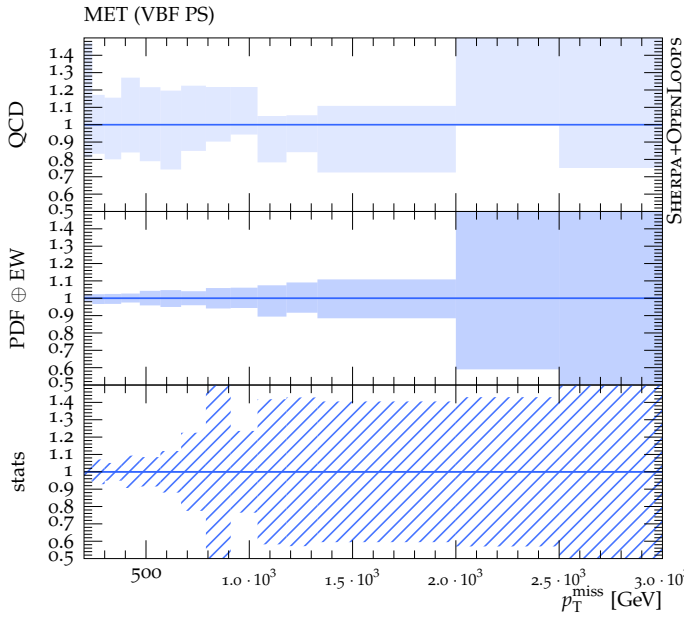

MET (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
500
1.0 · 10^3
1.5 · 10^3
2.0 · 10^3
2.5 · 10^3
p_T^miss [GeV]

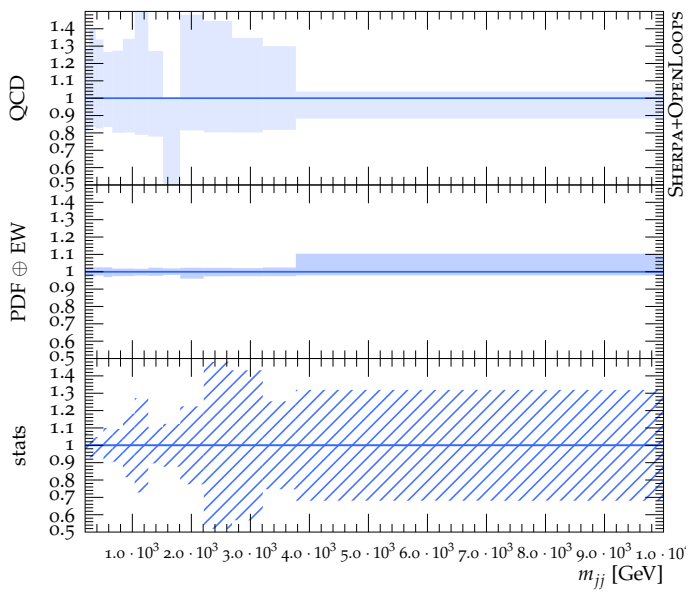

Dijet invariant mass (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
1.0 · 10^3
2.0 · 10^3
3.0 · 10^3
4.0 · 10^3
5.0 · 10^3
6.0 · 10^3
7.0 · 10^3
8.0 · 10^3
9.0 · 10^3
m_jj [GeV]

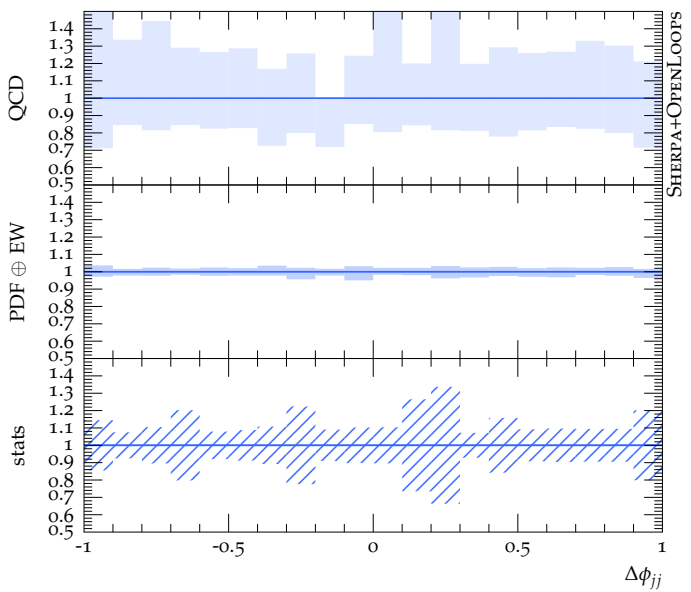

Dijet azimuthal separation (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
-1
-0.5
0
0.5
1
Δφ_jj

1-μ CR

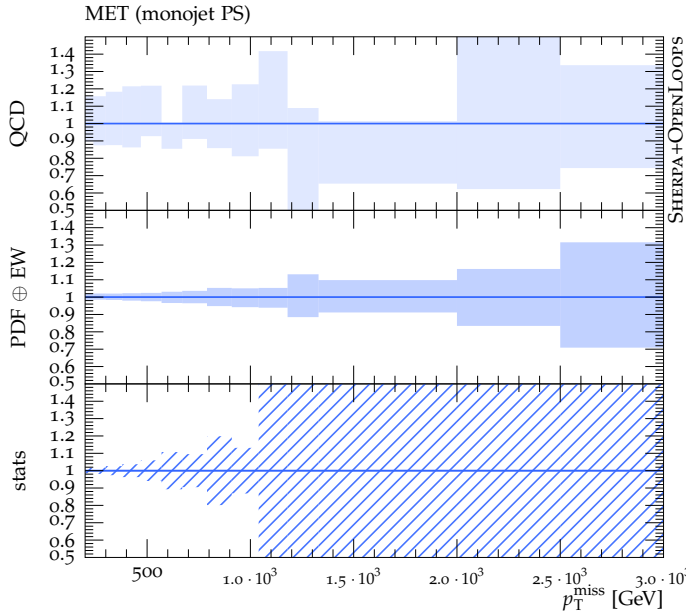

MET (monojet PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]

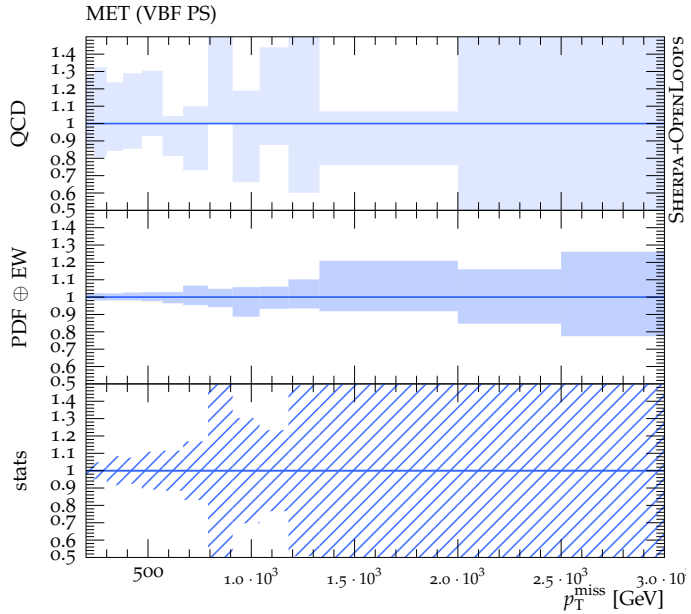

MET (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]

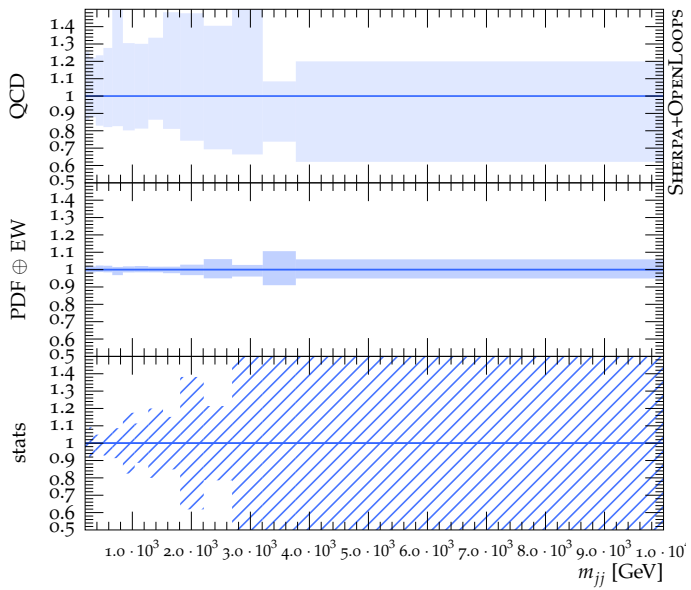

Dijet invariant mass (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
m_{jj} [GeV]

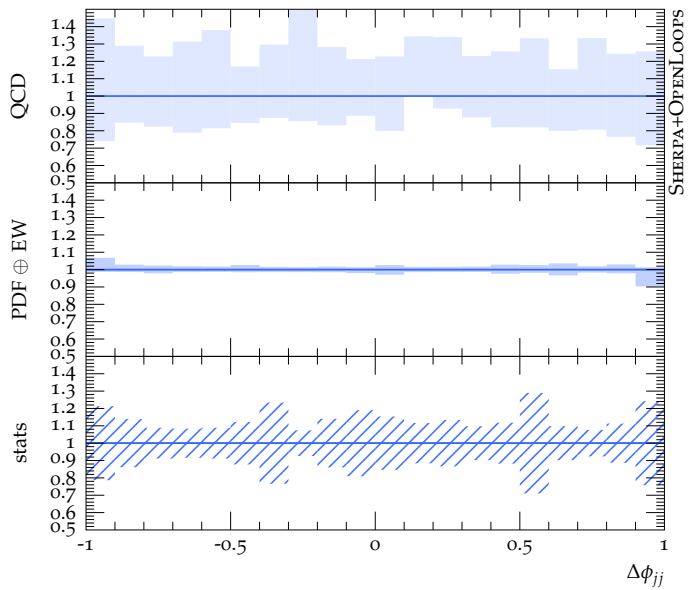

Dijet azimuthal separation (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
$\Delta\phi_{jj}$

2-*e* CR

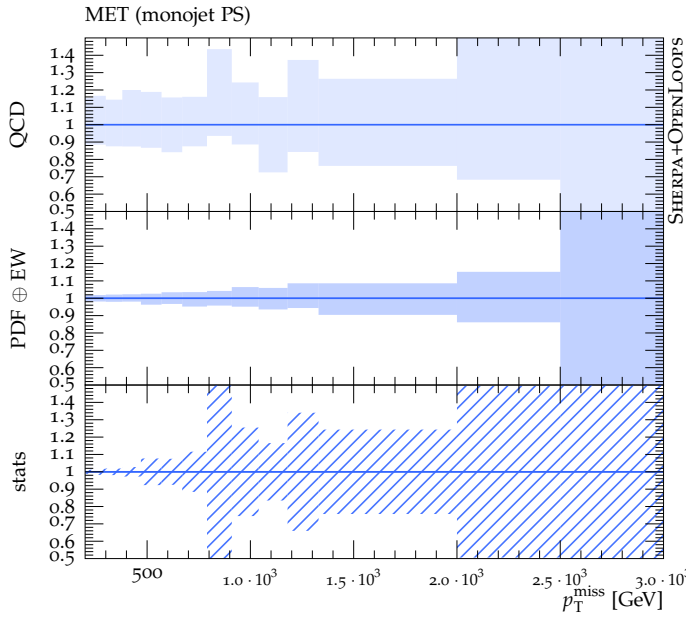

MET (monojet PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]

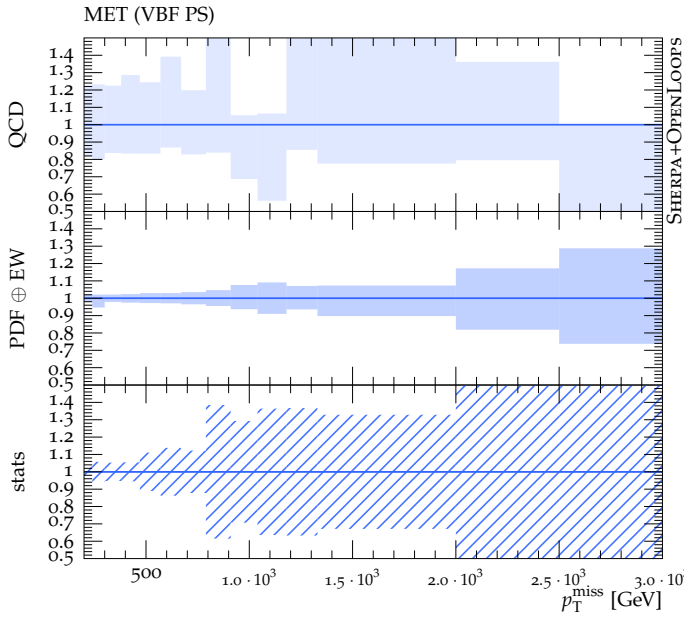

MET (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]

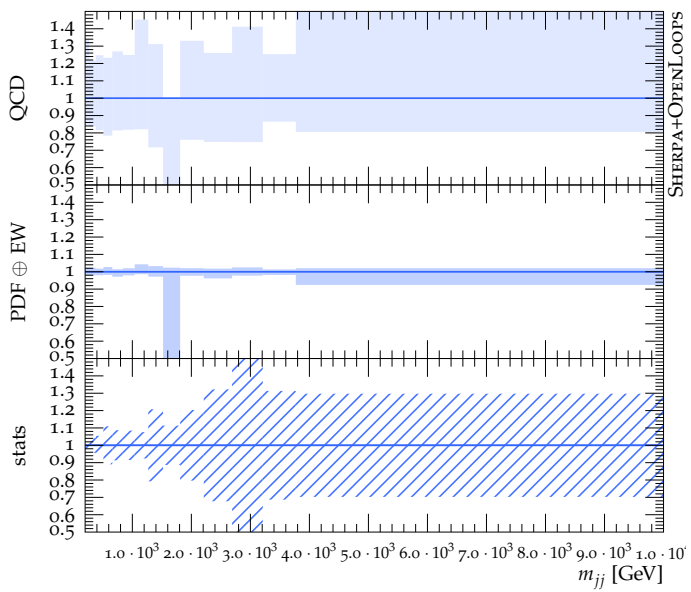

Dijet invariant mass (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
m_{jj} [GeV]

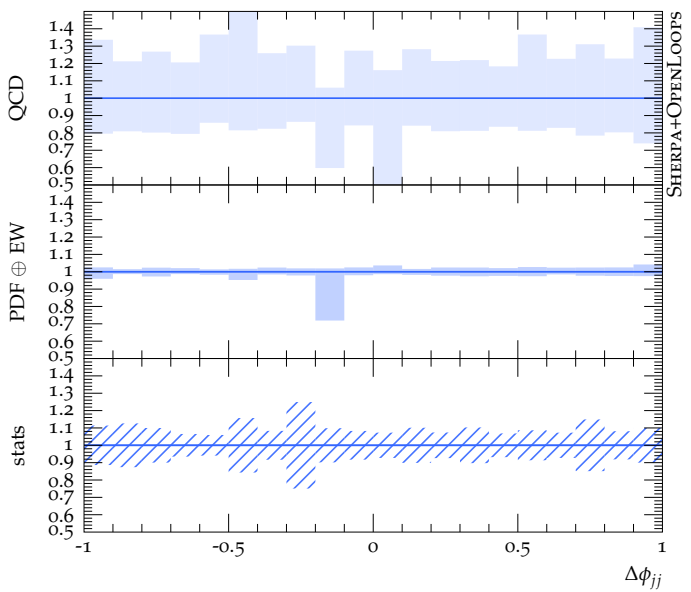

Dijet azimuthal separation (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
$\Delta\phi_{jj}$

2-μ CR


MET (monojet PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]


MET (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
p_T^{miss} [GeV]


Dijet invariant mass (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
m_{jj} [GeV]


Dijet azimuthal separation (VBF PS)
QCD
PDF ⊕ EW
stats
SHERPA+OPENLOOPS
$\Delta\phi_{jj}$

Correlation model

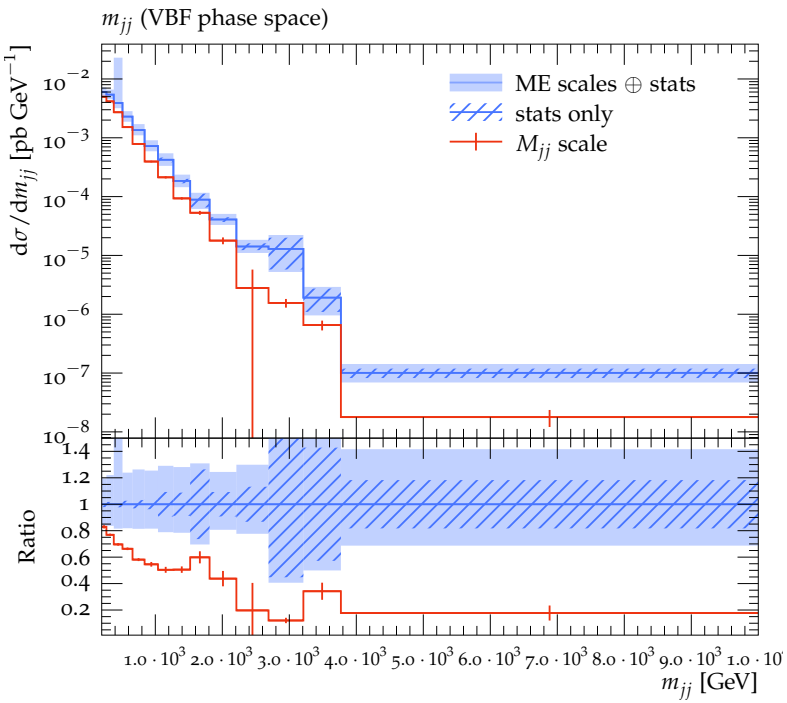
- assume all components are fully correlated between different V+jets channels/regions
  - apart from `d2kappa_EW` and `d3kappa_EW` which are fully uncorrelated between different V+jets channels/regions
- following the paper, we estimated an uncertainty on the non-correlation by working out the difference in the SR-to-CR ratio at NLO and LO
  - not clear how to assign an uncertainty on the ratio in a fit to the absolute cross-sections

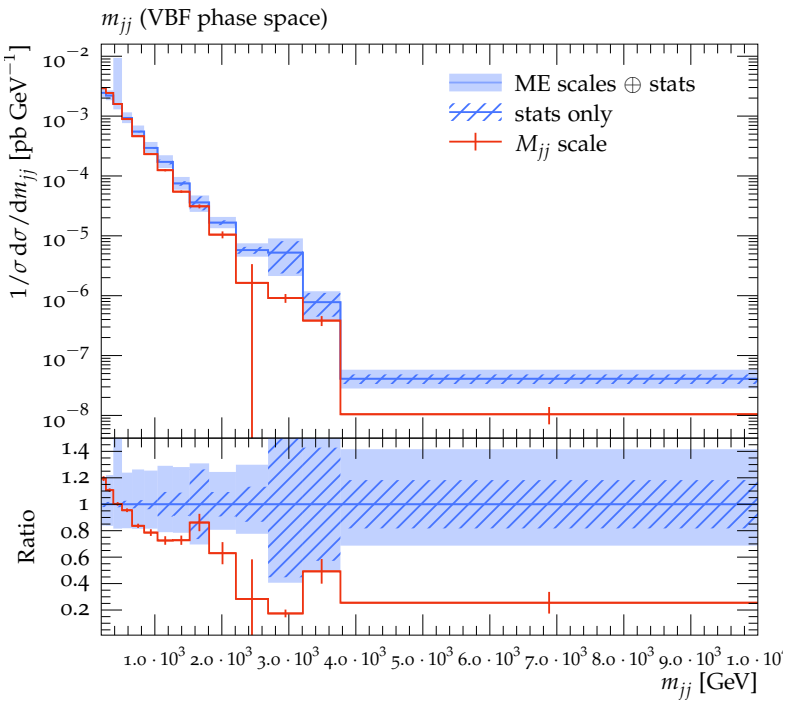
Remaining SM processes

- we will use the central ATLAS samples for these
  - they will typically have 7-point scale variations in the ME, NNPDF3.0nnlo replicas and α_s variations
    + possibly some others for top processes
- assume the uncertainties are uncorrelated between different different regions/classes of SM processes

Dealing with the m_{jj} mismodelling

- we also produced a dedicated calculation for $V + 2j$@NLO+$3, 4j$@LO using the default `STRICT_METS` scale setter and another one with `SCALES FASTJET[A:kt,PT:20,R:0.4,M:0]{Abs2(p[4]+p[5])}` as an alternative central scale choice





- currently this is applied as a shape uncertainty with a NP in the fit
- should this be applied as a pre-fit correction?