Z+jets/γ+jets

Crucial for searches based on MET because γ+jets is used to estimate $Z \rightarrow \nu\nu$ background

Results recently submitted by CMS: arXiv.1505.06250

- measures both Z and γ differential p_T distribution vs number of jets and calculate the ratio
- many details and plots can be found in https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSMP14005

For Z+jets events we select:

- two same flavour opposite sign leptons with $pT > 20$ GeV and $|\eta| < 2.4$ and $71 < Mll < 111$ and $pT(ll) > 40$ GeV
- $Njet \geq 1$, jet selection: $pT > 30$ GeV and $|\eta| < 2.4$, we remove jets within a radius of $\Delta R < 0.5$ with respect to the axes of each lepton

For γ+jets events we select:

- a photon with $pT > 100$ GeV and $|\eta| < 1.4$
- $Njet \geq 1$, jet selection: $pT > 30$ GeV and $|\eta| < 2.4$, we remove jets within a radius of $\Delta R < 0.5$ with respect to the axis of the photon

Theory predictions

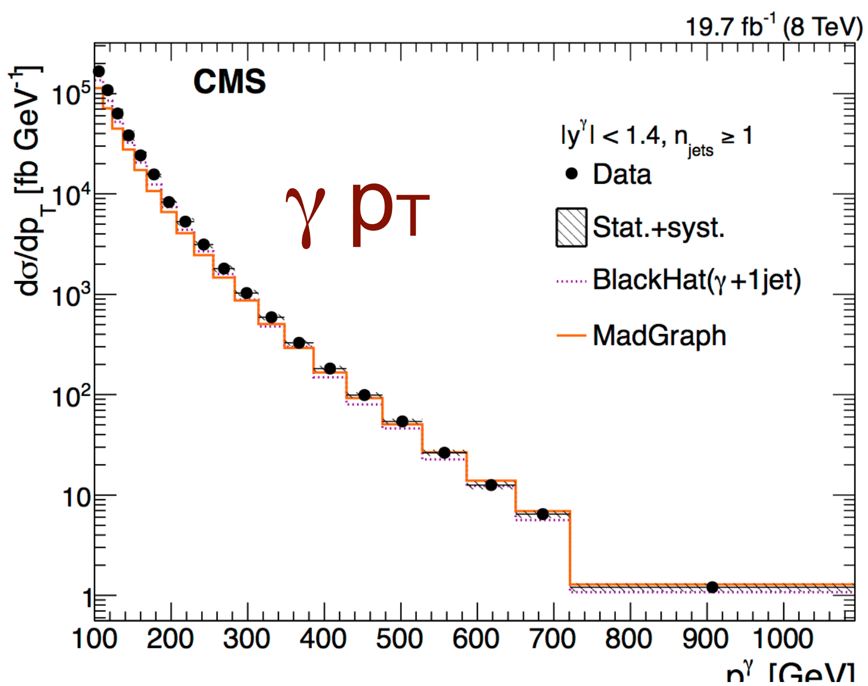
For Z+jets events we compare results to:

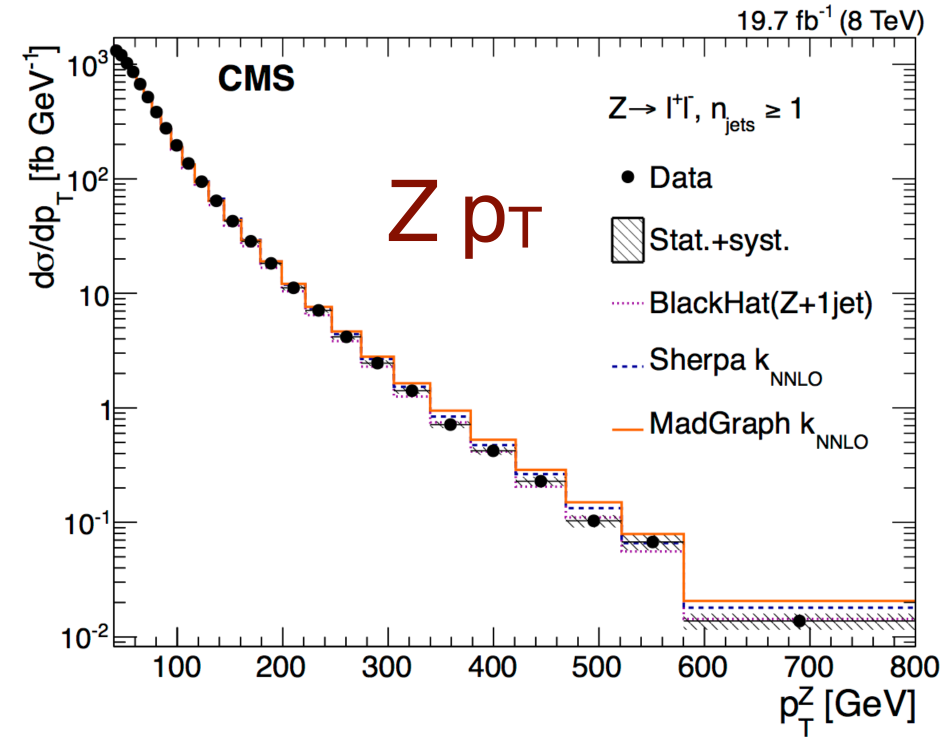
- MadGraph5.1.3.30+Pythia6.4.26 (in orange)
- Sherpa 1.4.2 (in blue)
- BlackHat+Sherpa (in magenta) (using MSTW)
- we apply NNLO k-factor to MadGraph and Sherpa
- BlackHat/data ratio using the NNPDF2.3 set (dashed blue) and the CT10 PDF set (dashed brown) are also shown

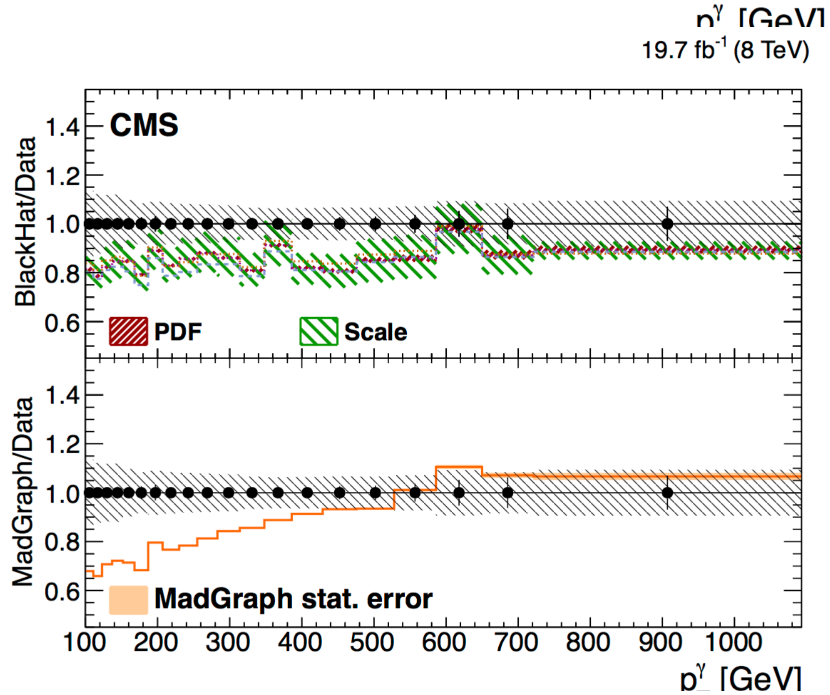
For γ+jets events we compare results to:

- MadGraph5.1.3.30+Pythia6.4.26 (in orange)
- BlackHat+Sherpa (in magenta) (using MSTW)
- no k-factor is applied to MadGraph
- BlackHat/data ratio using the NNPDF2.3 set (dashed blue) and the CT10 PDF set (dashed brown) are also shown

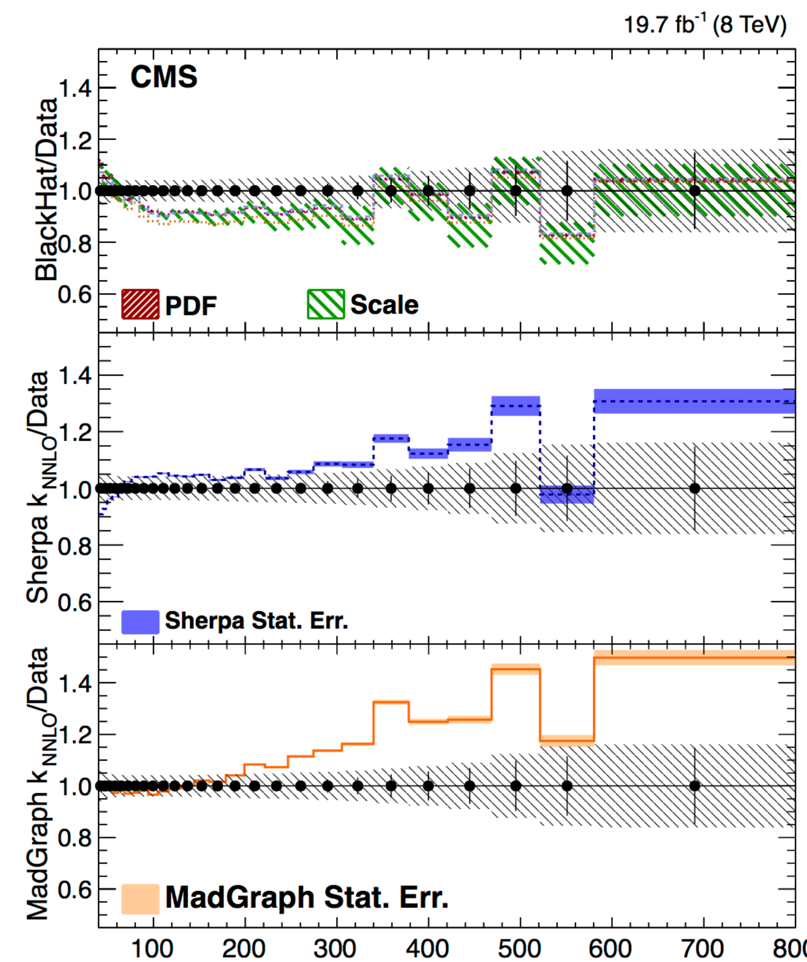
Z+jets/γ+jets results: Z and γ p_T





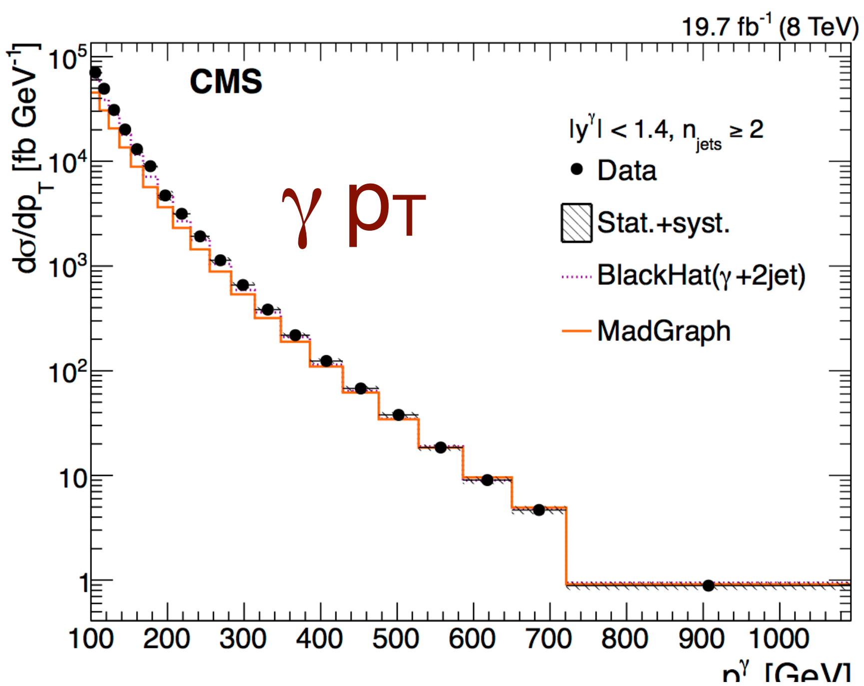


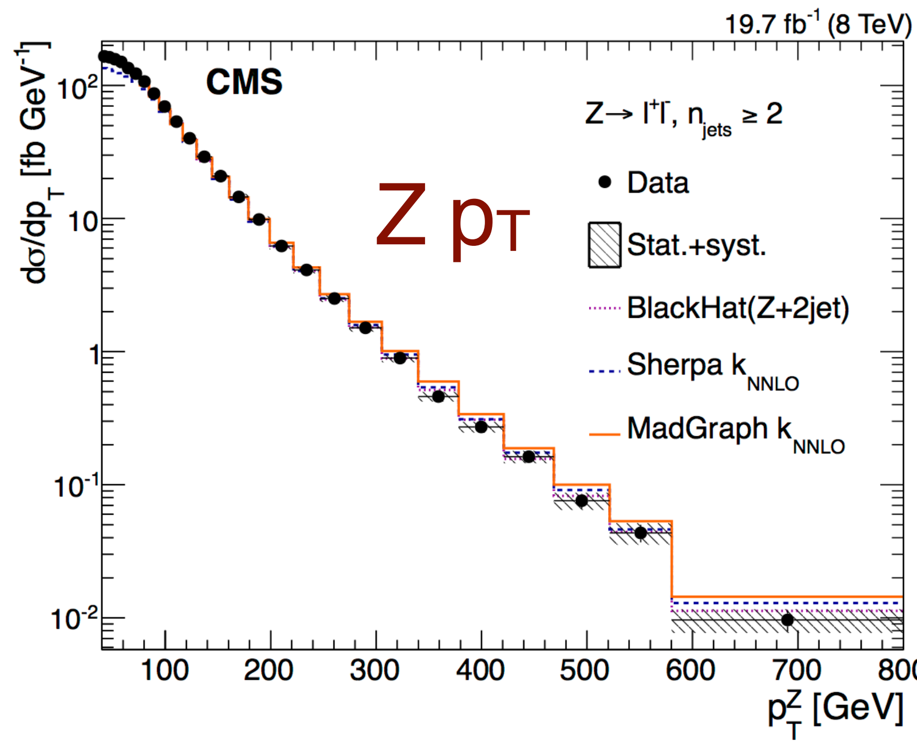
Njet ≥ 1

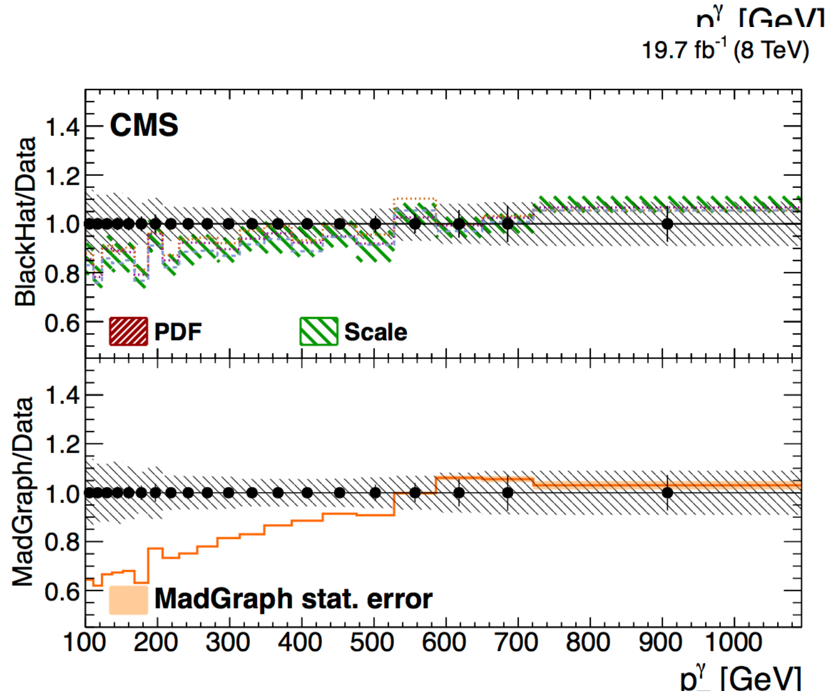


- ME+PS does not correctly describe the p_T of both bosons
- BlackHat+Sherpa (top) flat at high boson p_T but 10%-20% lower

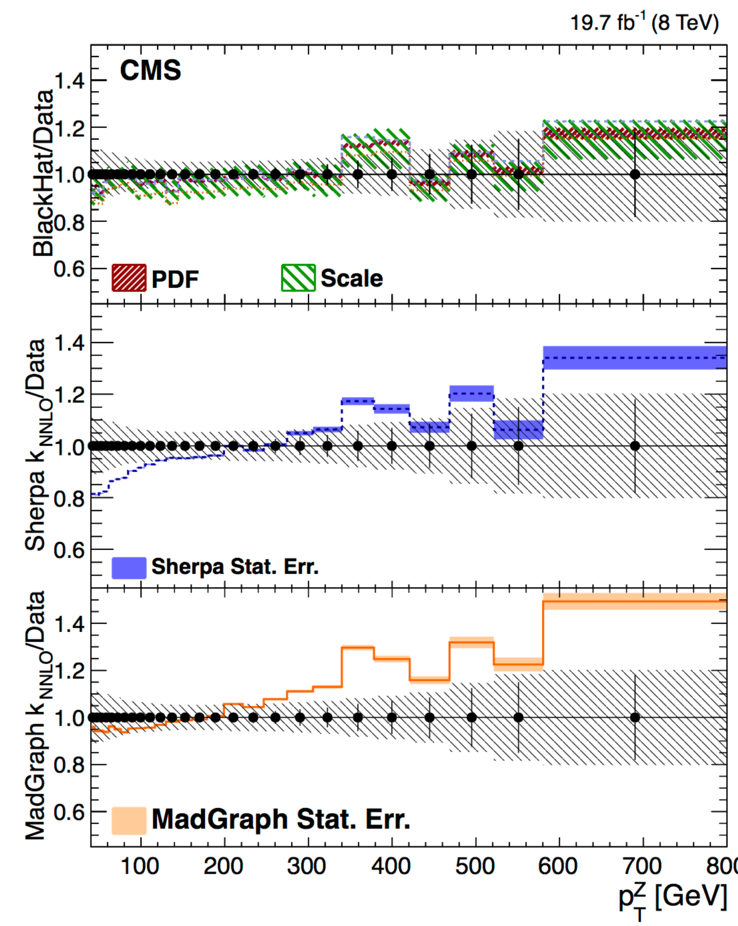
Z+jets/γ+jets results: Z and γ p_T





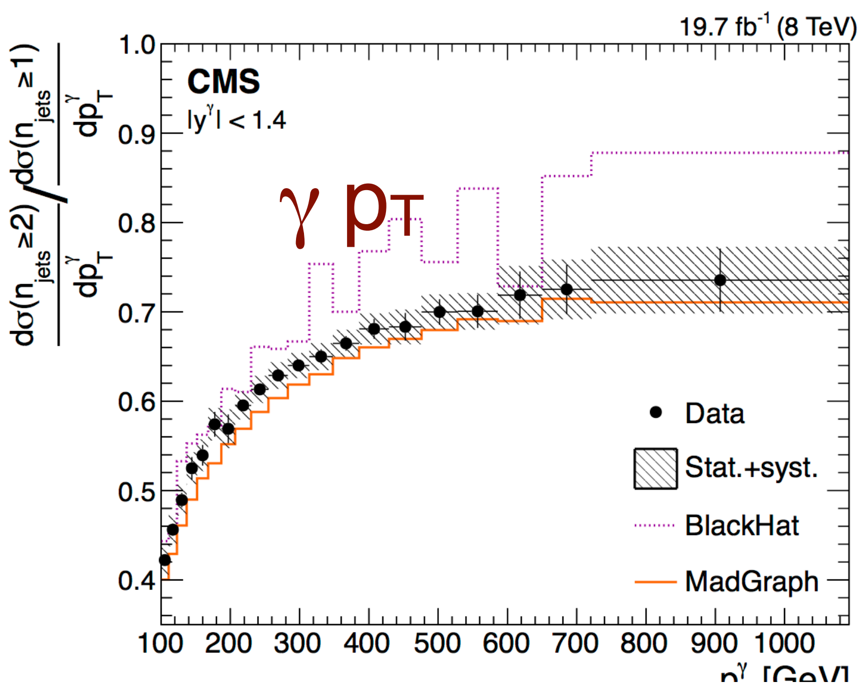


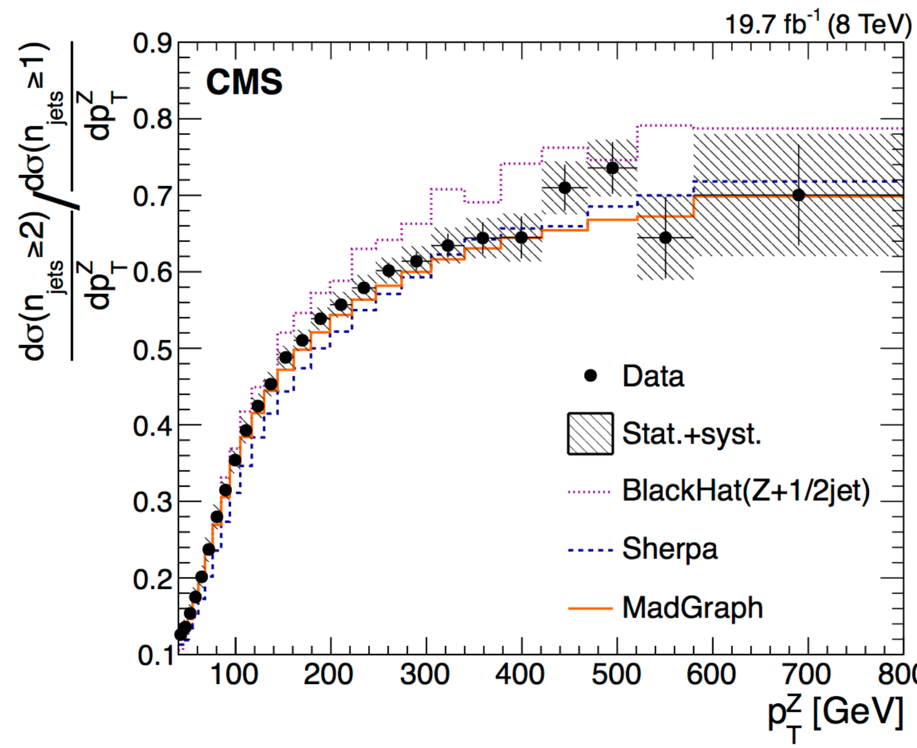
Njet ≥ 2



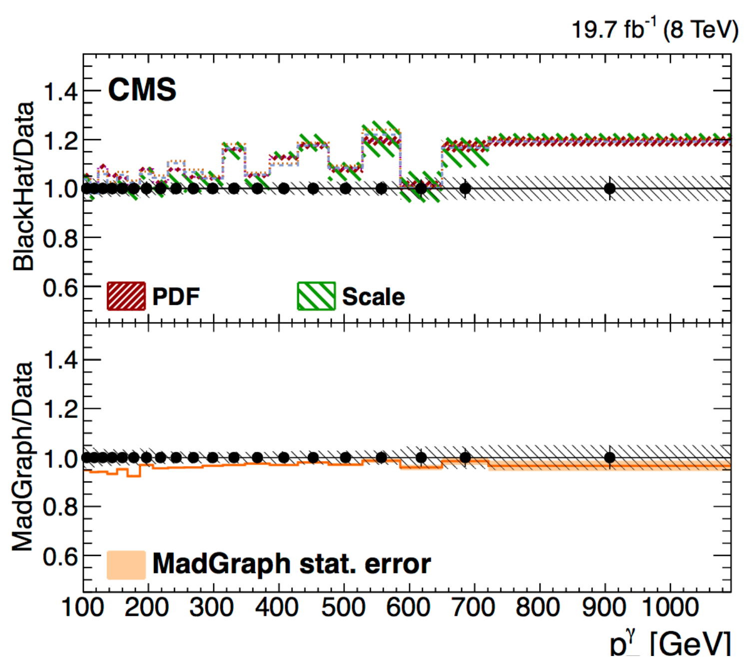
- ME+PS does not correctly describe the p_T of both bosons
- BlackHat+Sherpa (top) flat at high boson p_T but 10%-20% lower

Z+jets/γ+jets results: Z and γ p_T

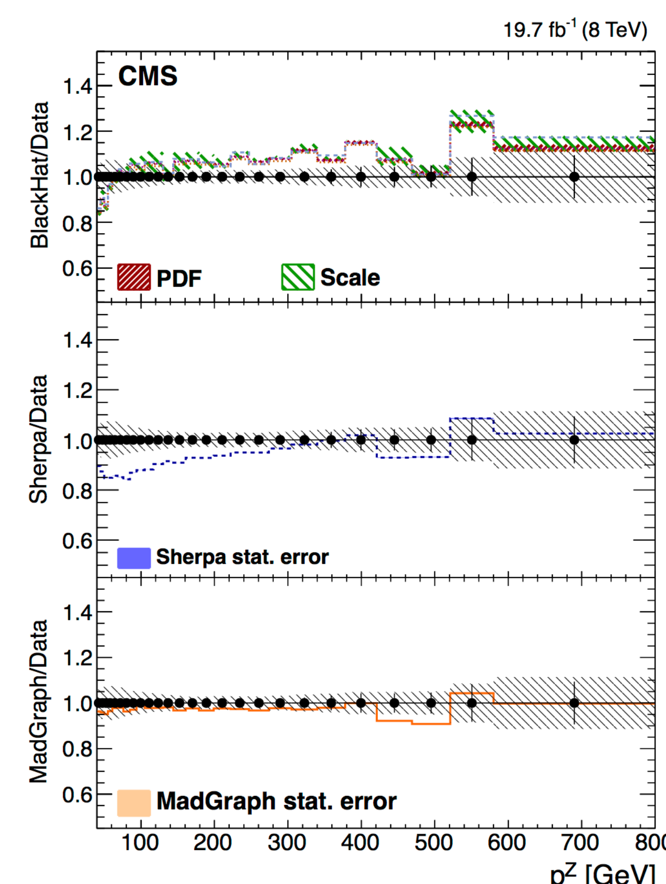




Z p_T



Njet ≥ 1/Njet ≥ 2

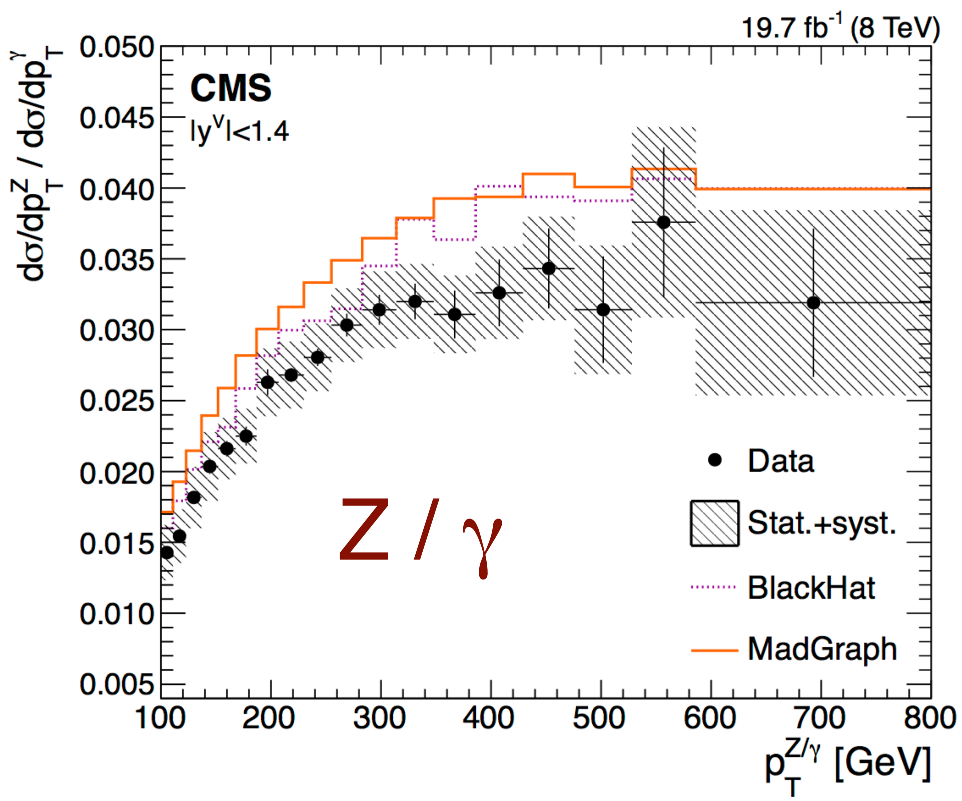


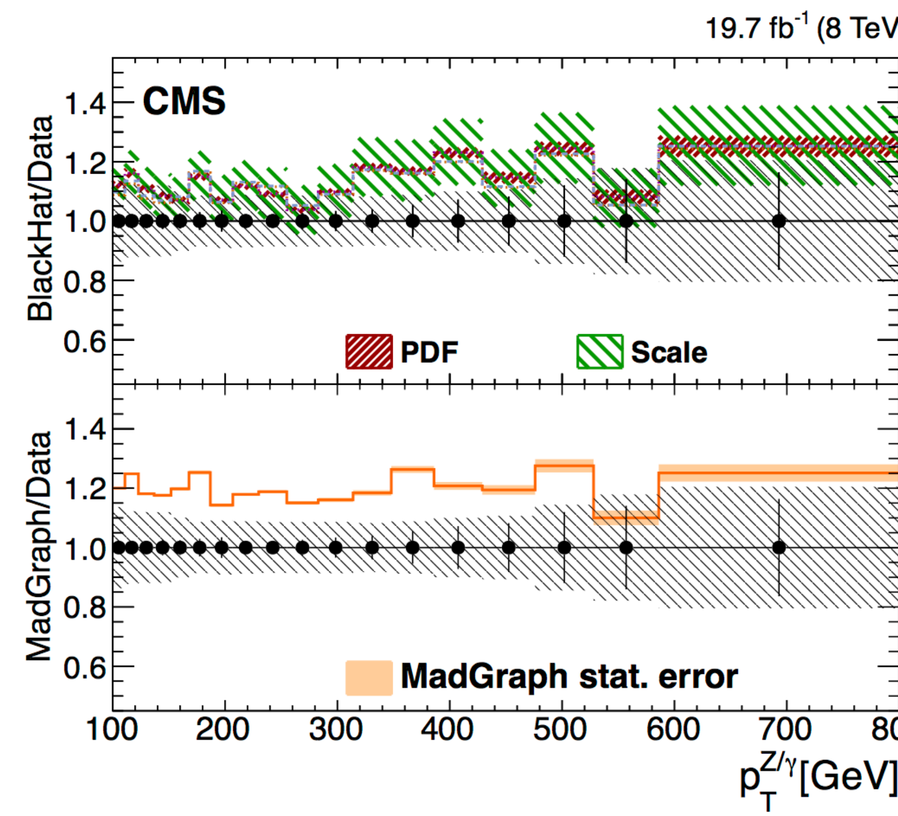
- ratio Njet ≥ 1/Njet ≥ 2 is well described by MadGraph and BH
- some discrepancy at low p_T in Sherpa

Z+jets/γ+jets

LO predictions for the ratio vs data off by 20% but flat!

BH prediction (NLO for both processes) are also ~10% larger than data





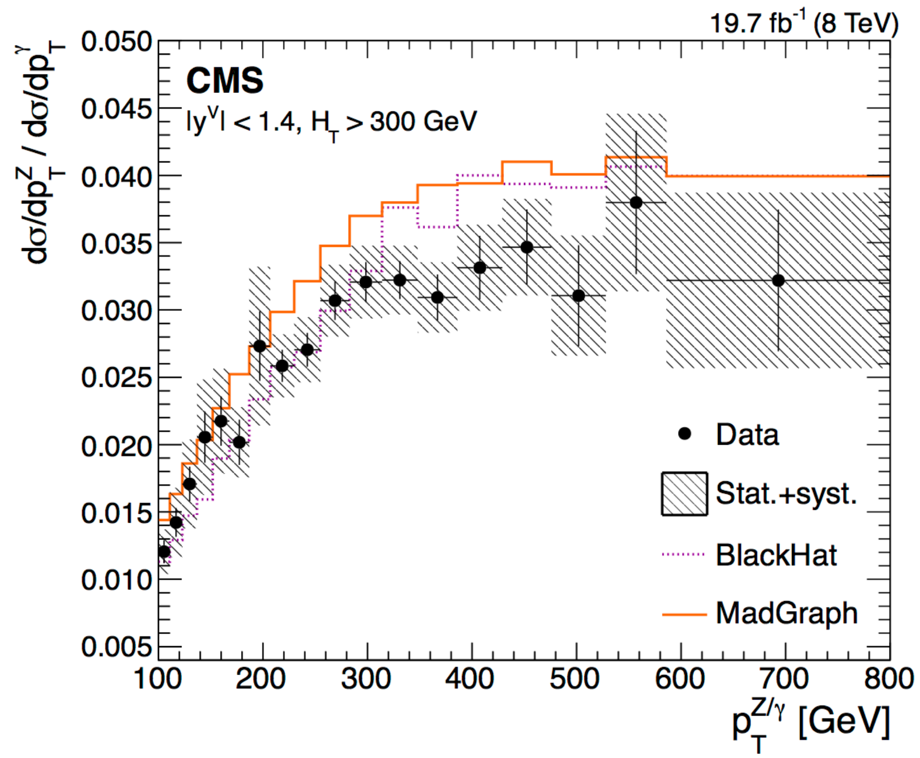
Scale uncertainty of NLO predictions

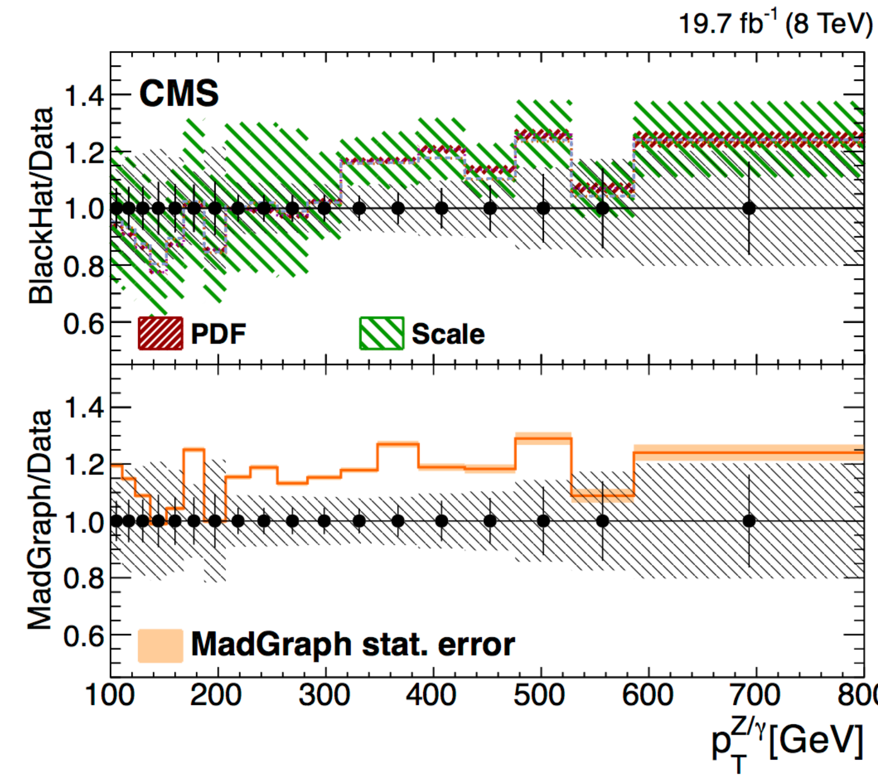
- scale $H_T' = H_T + E_T(Z,\gamma)$
- cancel in the ratio if considered fully correlated between the two processes
- would clearly underestimate the theoretical uncertainty
- largest relative scale uncertainty on each process used for the uncertainty on the ratio

Z+jets/γ+jets

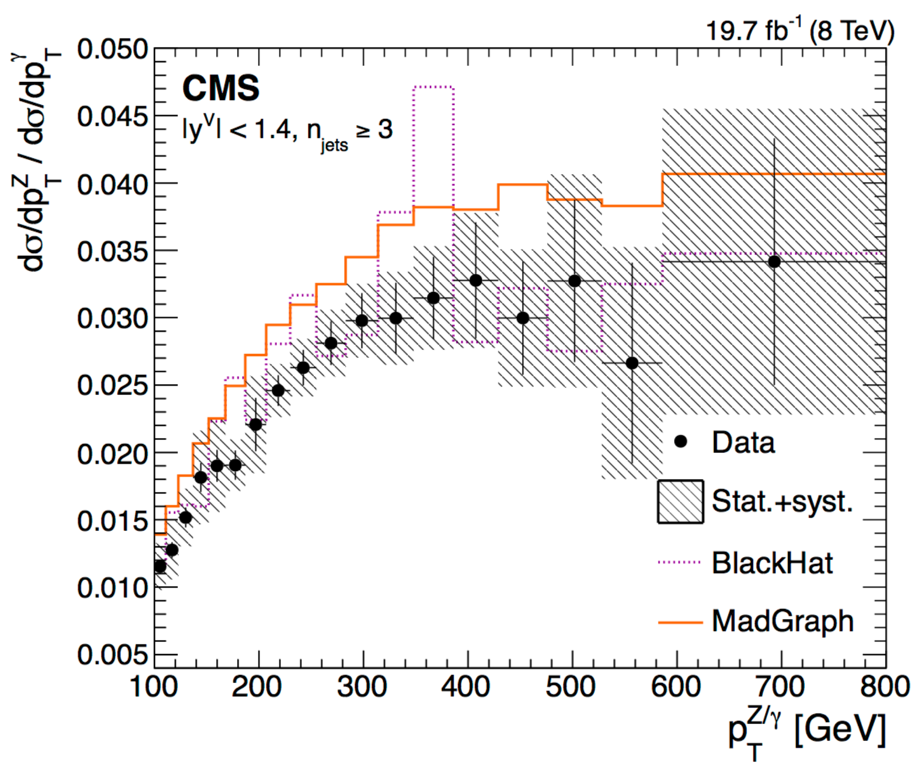
The ratio mc/data improves for events with many jets or larger HT

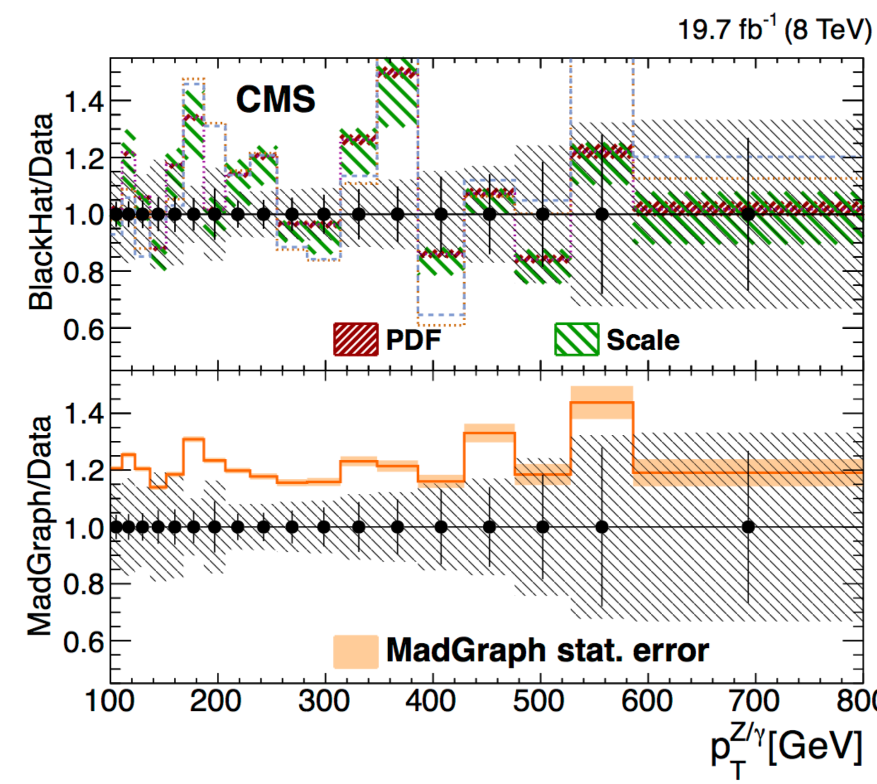
HT > 300 GeV





Njet ≥ 3



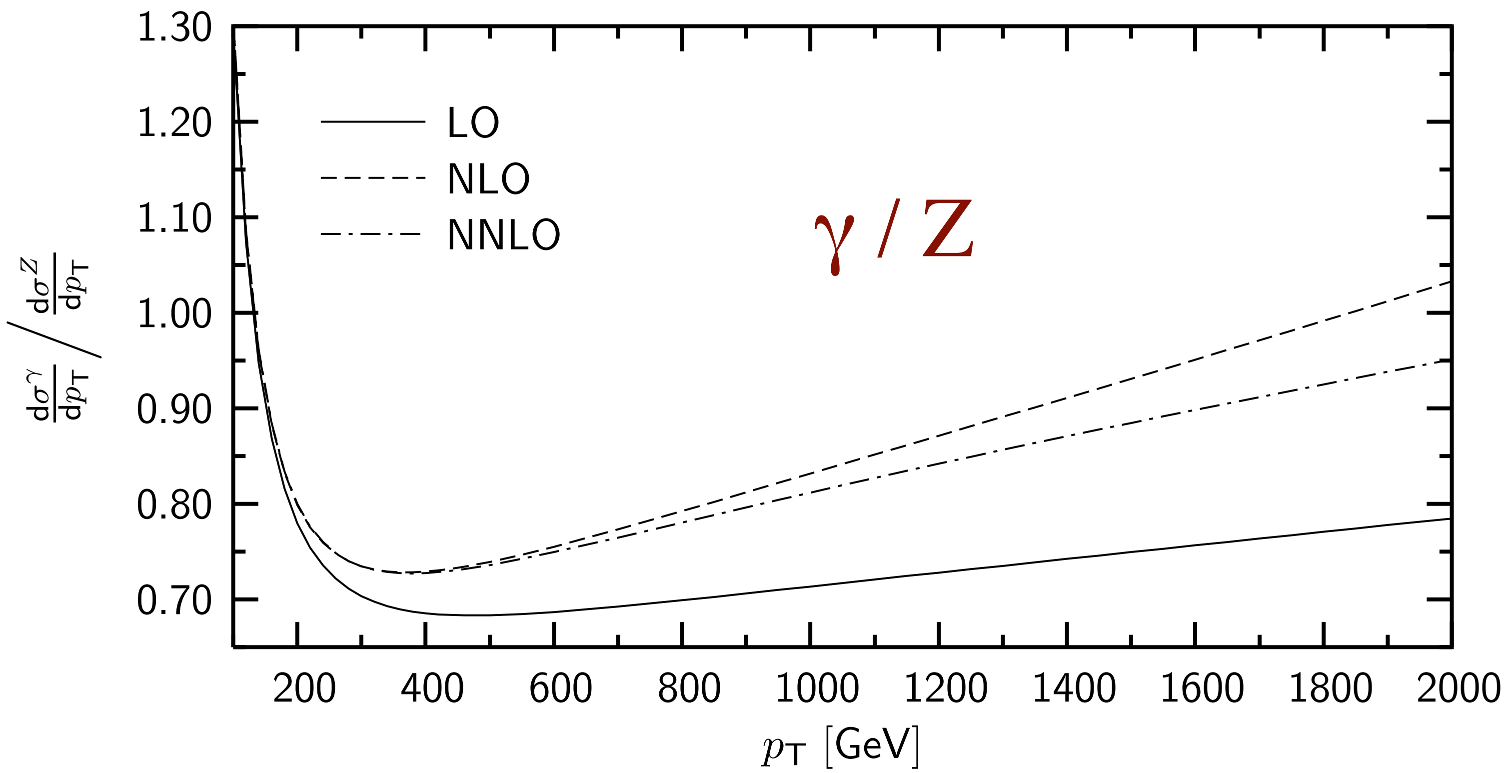


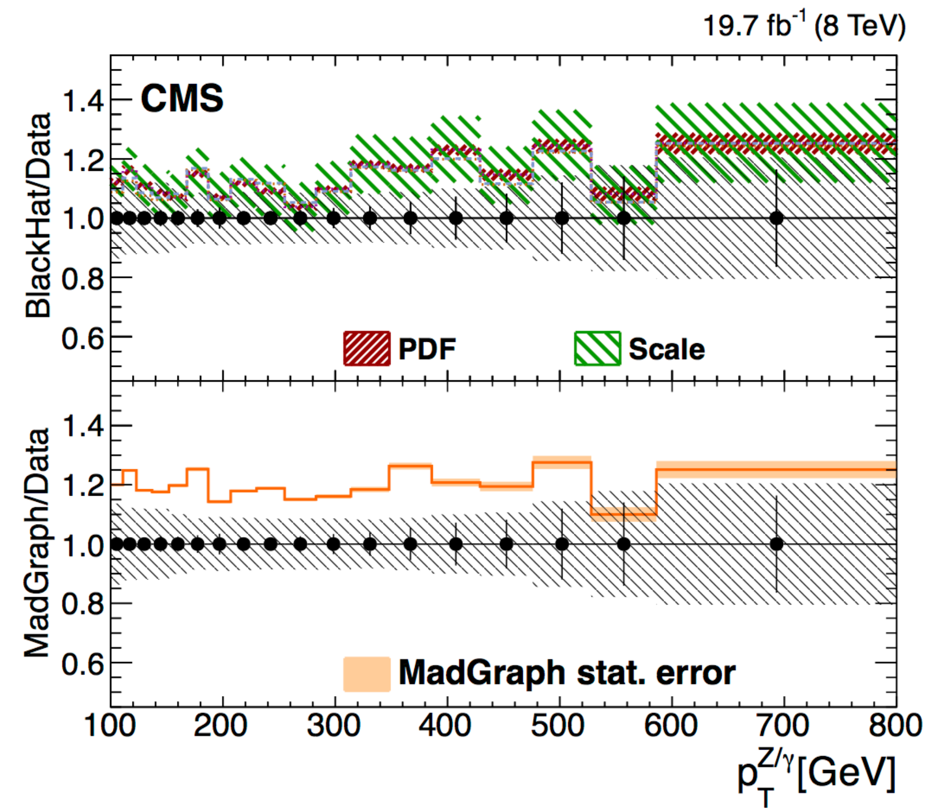
EWK corrections to Z+jets/γ+jets

Khün et al. JHEP0603:059,2006

EWK corrections are ~10% at √s = 14 TeV for up to 1 TeV

- *NNLO here means dominant 2-loop EWK*





Somewhat smaller at 8 TeV but they could explain the difference

- *for √s = 2 TeV corrections are < 5% for up to 400 GeV p_T)*