Comparison of ssWW VBS MCs between ATLAS & CMS

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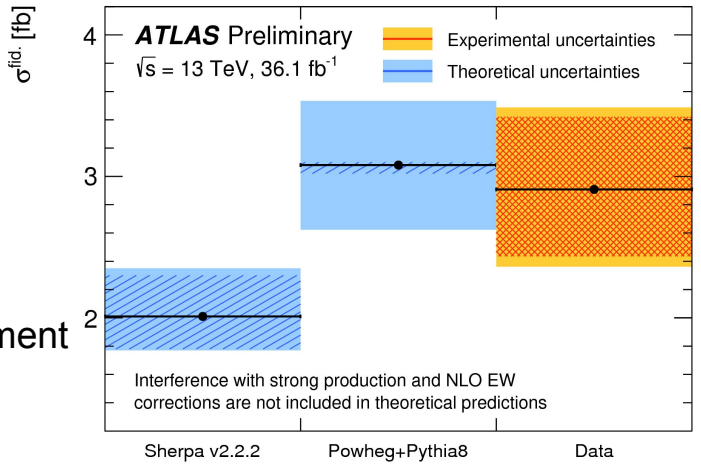
CMS: Xavier Janssen, Ankita Mehta
ATLAS: Kristin Lohwasser, Karolos Potamianos, Marjorie Shapiro

Overview

- Multiboson and VBS/VBF processes entering precision area
  - But are we able to keep up with theorists?

- VBS signal strength extracted using fits → based on **SM MC predictions**
  - But which? Potentially large differences
  - Different interference / NLO EW correction treatments

- But how different are CMS/ATLAS?
  - Step 1: Compare MC predictions (shower, color-flow, tuning)
    - Easier: Compare MC using RIVET
    - Evaluate data difference w/o adapting measurement
  - Step 2: Compare data
    - Needs to extrapolate in same phase space



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Comparisons VBS: same-sign WW final state

- First ATLAS/CMS multiboson comparisons
  - ssWW: https://arxiv.org/pdf/1709.05822
    https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2018-030/
    Updated ATLAS MC configurations:
    https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PUBNOTES/ATL-PHYS-PUB-2019-004/

- Comparisons using RIVET (https://rivet.hepforge.org/)
  - Based on public codes of general VBS phase spaces:
    - ssWW: VBScan theory comparison (https://arxiv.org/abs/1803.07943)

  - Gathered here: https://gitlab.cern.ch/lhcewkwg/lhcewkwg-multiboson/mc-comparison
  - Added QCD Control Region

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VBS with ssWW

- Cuts: emu final state **only**
  - Leptons with pT > 20 GeV & |eta| < 2.5
  - MET>40 GeV, pT(jet) > 30 GeV, & |eta} < 4.5
  - Δη_jj > 2.5, mjj > 200 GeV
  - dR(jj),dR(ll),dR(jl) > 0.3
  - **Leptons from taus are excluded!!**
- CMS Samples : MADGRAPH, POWHEG
- ATLAS Samples: SHERPA, POWHEG, MADGRAPH
- VBScan samples: only with W+W+
- Only statistical uncertainty included in the plots

DISCLAIMER: All plots are normalised to unity

(simulation details in the backup!)

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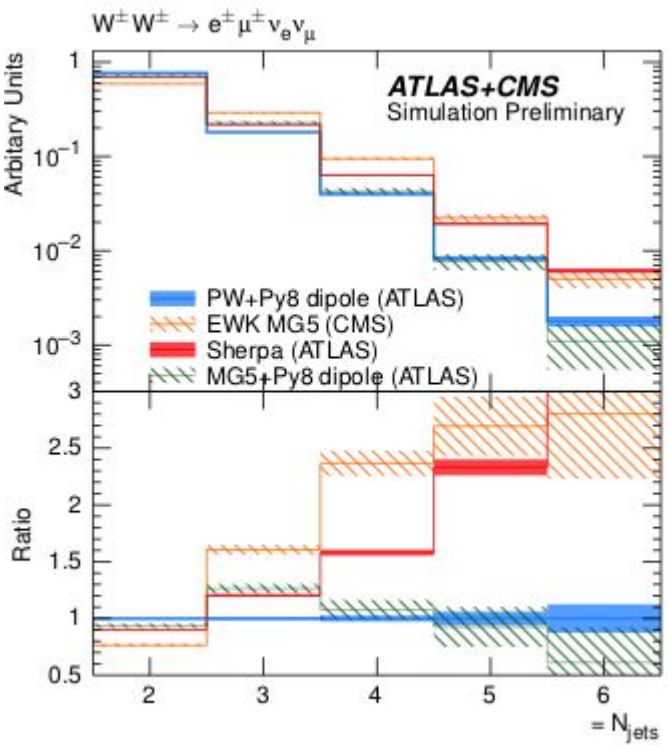
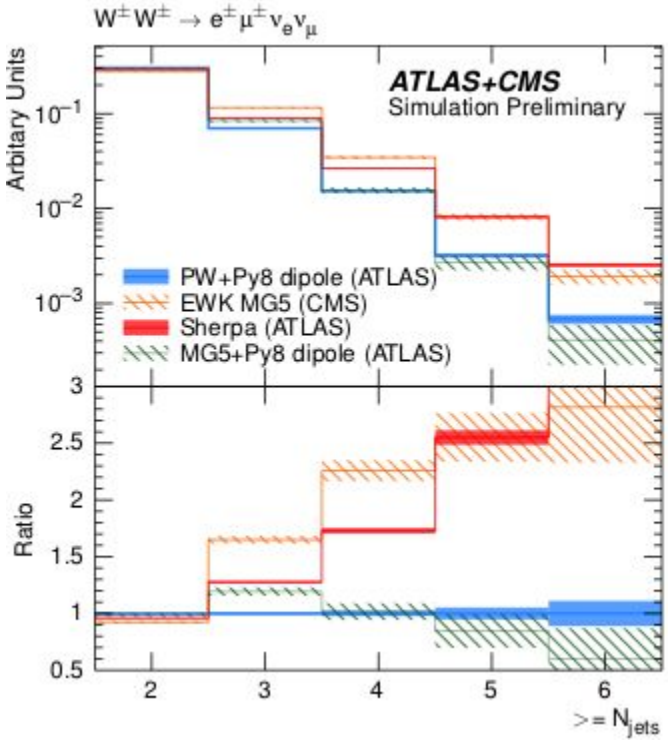
Number of jets





CMS MG5 with large number of jets (more than ATLAS SHERPA sample)
Lower numbers esp. at high njets for new ATLAS samples with dipole recoil scheme

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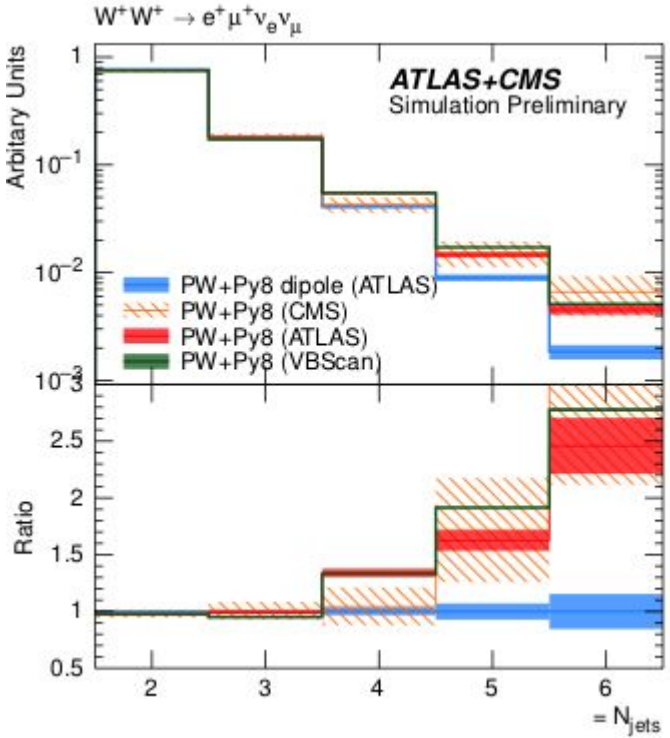
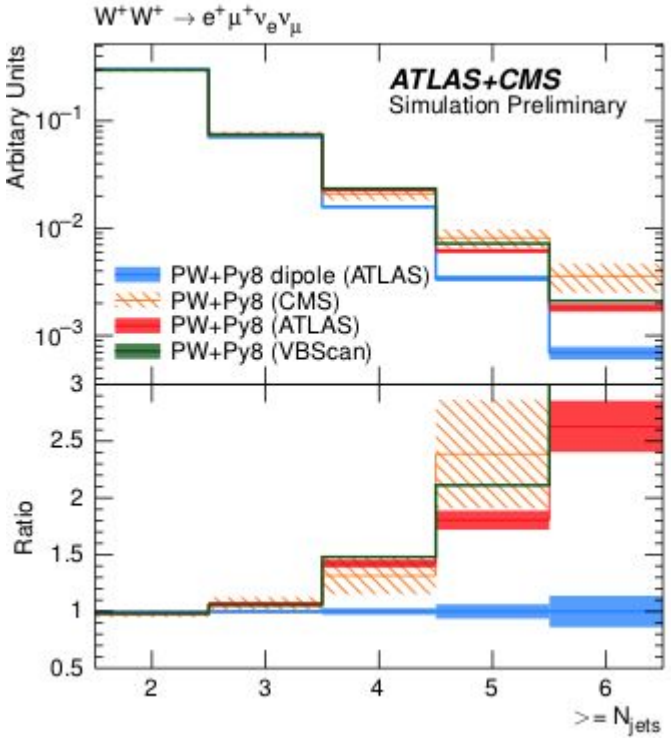
Number of jets (W+W+)





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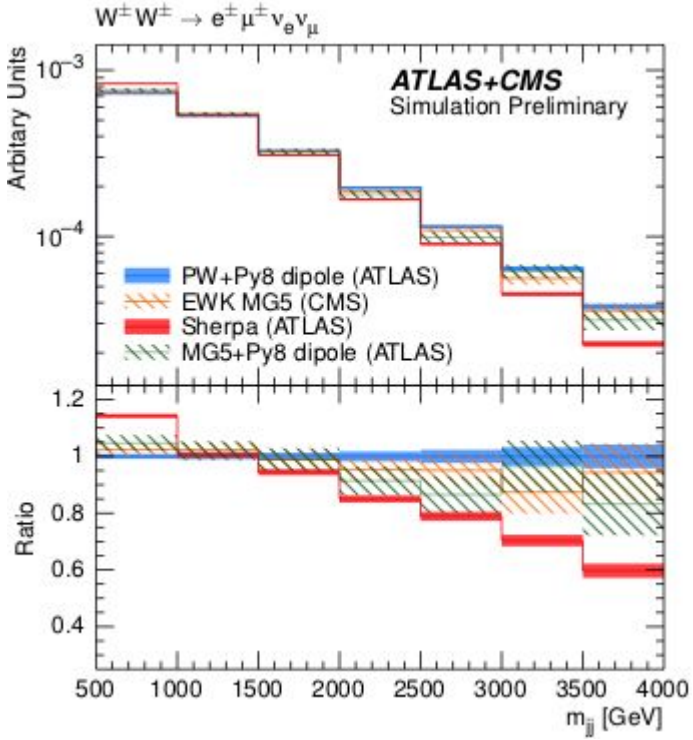
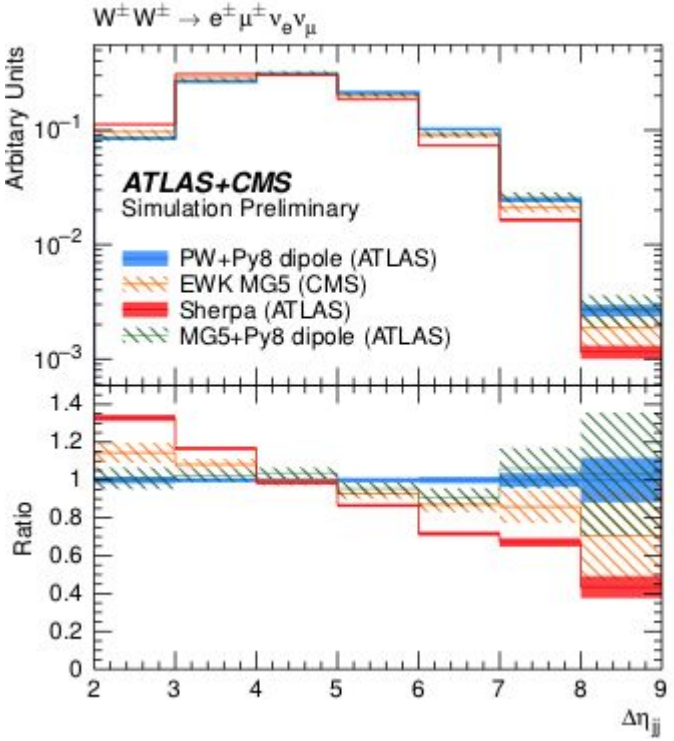
mjj & Δηjj

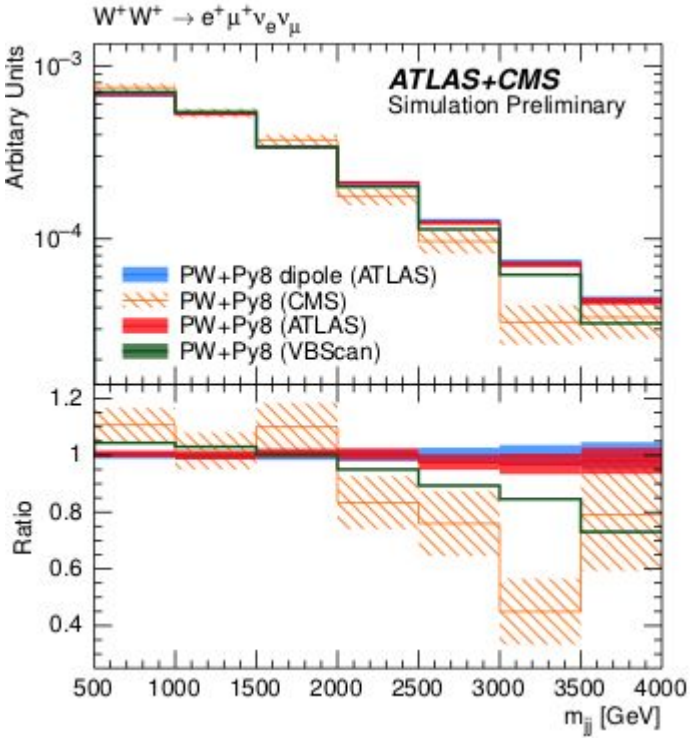


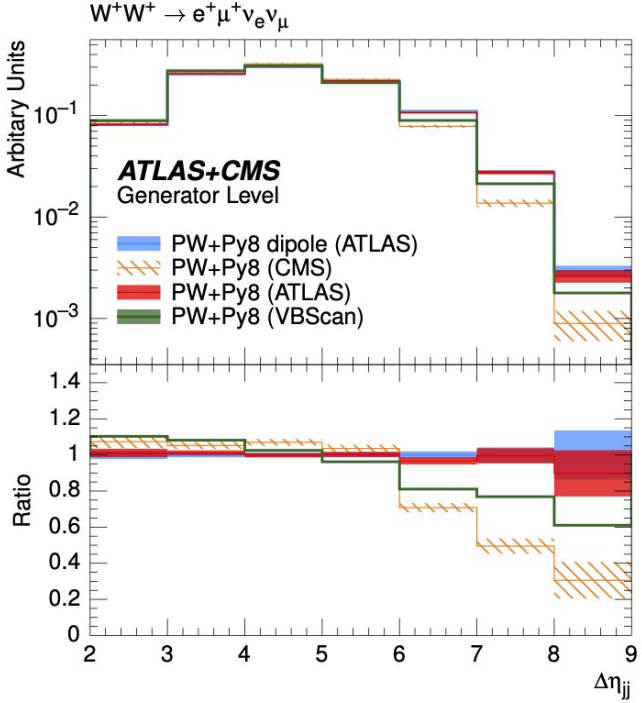


ATLAS SHERPA sample behaves differently

CMS: Xavier Jansen, Ankita Mehta
ATLAS: Kristin Lohwasser, Karolos Potamianos, Marjorie Shapiro

mjj & Δηjj (W+W+)

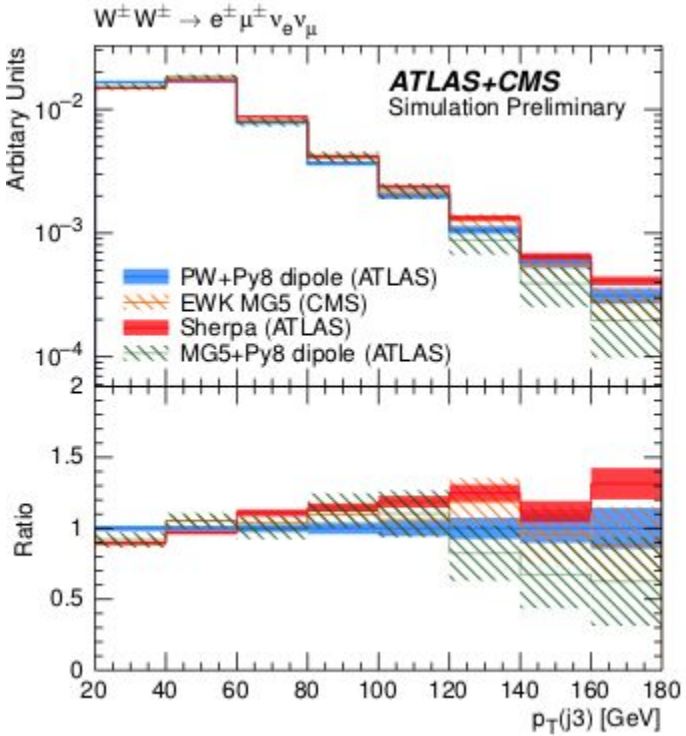


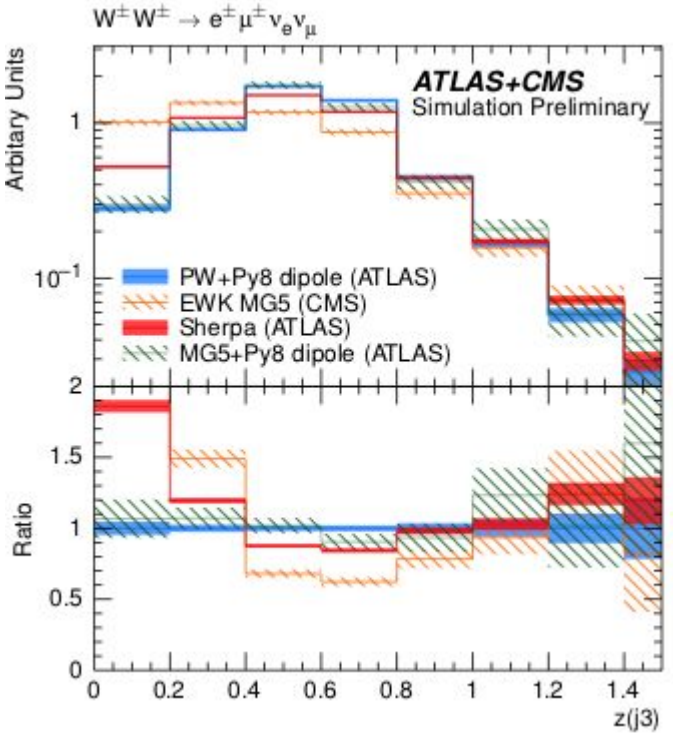


CMS MG & VBScan samples softer dijet mass spectrum

CMS: Xavier Janssen, Ankita Mehta
ATLAS: Kristin Lohwasser, Karolos Potamianos, Marjorie Shapiro

Third Jet Kinematics





CMS MG sample larger activity in central region

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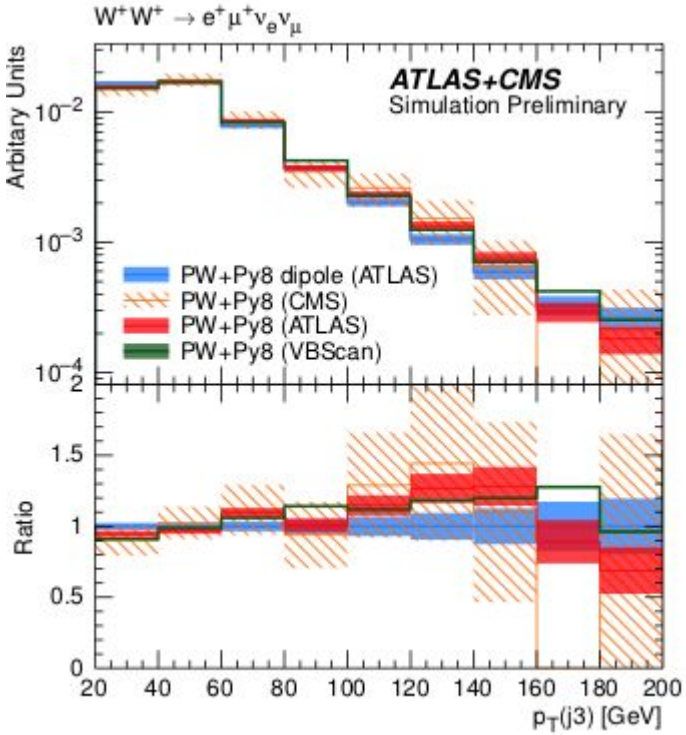
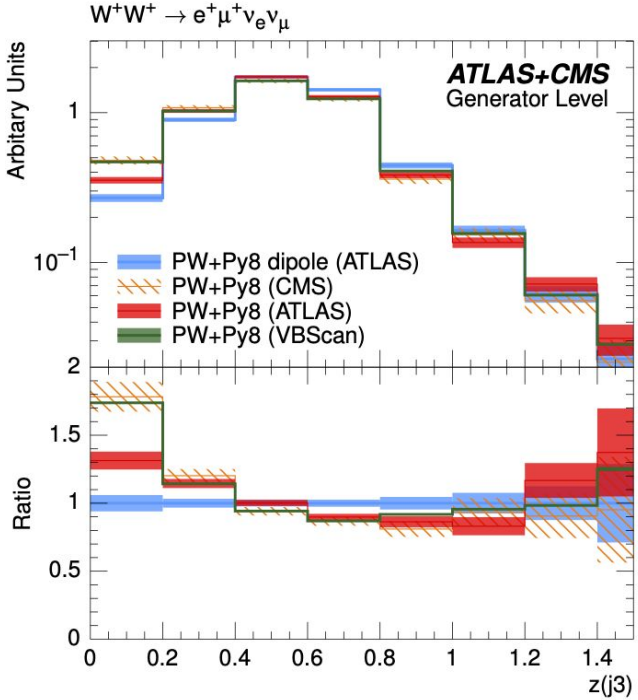
Third Jet Kinematics (W+W+)





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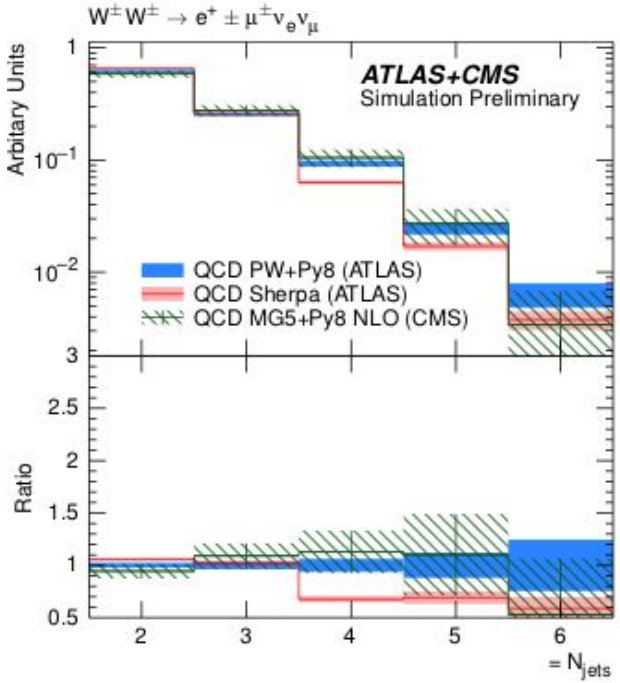
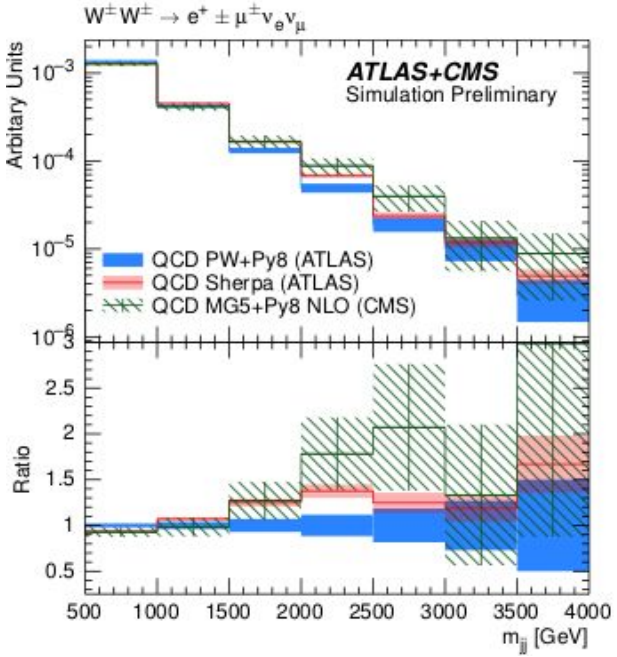
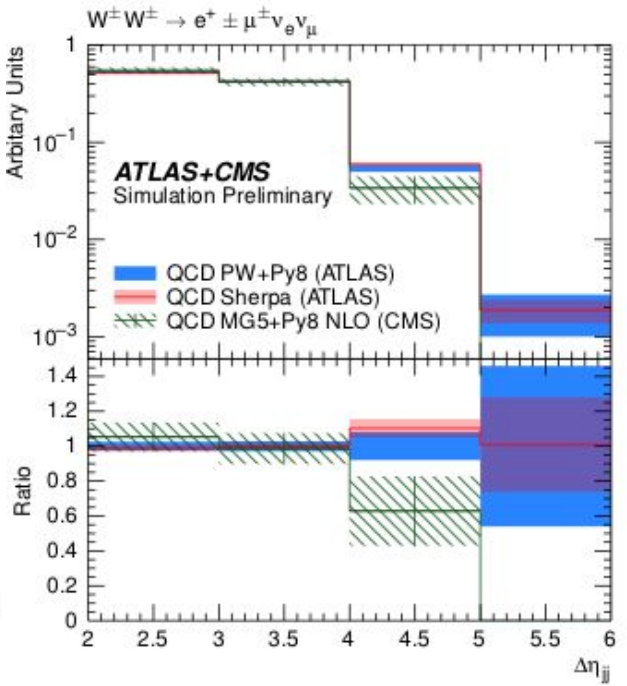
QCD samples







Consistent behaviour within uncertainty

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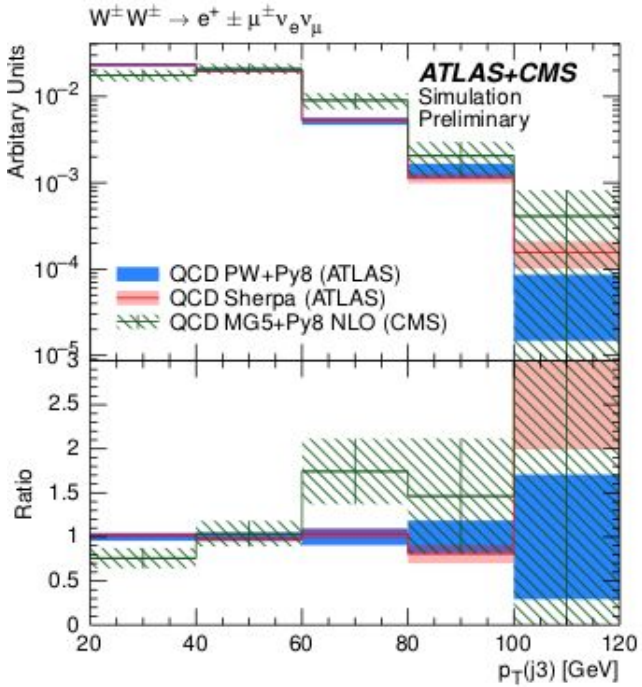
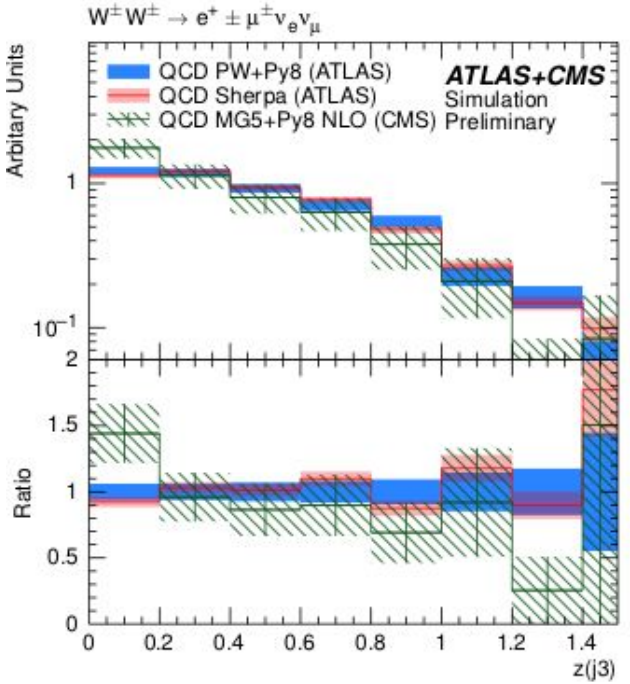
QCD samples





Consistent behaviour within uncertainty

Status of ATLAS-CMS Combined Note

- A preliminary version of the analysis note available under review by CMS SMP & GEN groups (ATLAS has signed off)
- Includes details about the MC samples used, analysis cuts, plots & fiducial cross sections

Needs some additions to justify the observed differences (~10%) in POWHEG fiducial cross sections between ATLAS & CMS. *suggestions are very welcome!!*

Conclusions & Outlook

1) In some cases striking differences between ATLAS and CMS
   - **a)** In terms of the code both ATLAS & CMS are consistent
   - b) We did some tests on the MG5 samples to check the reason for differerence
2) Effect of different Pythia8 tunes: No significant change observed in fiducial cross sections when CMS LHE files are showered with pythia8 tunes from ATLAS and vice-versa.
3) Spin correlations: CMS did not use MadSpin while ATLAS did: We checked this effect by turning off MadSpin in ATLAS samples and the changes are minor.

Conclusions & Outlook

5. Effect of PDF choice

- Ran the ATLAS samples with LO PDF sets being used in the CMS samples and the acceptance turns out to be the same.

6. Effect of Scale choice

- CMS scale choice: "Cluster external states until reducing the system to a 2->2 topology whose transverse mass is used for setting the scale." ATLAS and VBScan are using the same functional form for the scale (sqrt(ptj1*ptj2))
- To be checked using ATLAS PW+H7 dipole samples-> checked and the difference would be larger than 10%

Conclusions & Outlook

7. ΔR cuts

- CMS run_card.dat has generation level cut of 0.4 on ΔRjj, ΔRll & ΔRjl 0.4
- SR has ΔR=0.3, so there is some missing phase space
- Effect 1-2% from tests on inclusive ATLAS (no generation level cuts!)

8. W-->l nu Width & semi-leptonic Branching Ratio

If MadSpin is not used then MG5 uses the NLO-level W width and not the LO one. Thus no rescaling is needed for CMS samples which don’t use MadSpin.

Backup

Sample name	Generator	μ-scale	Shower	Tune	PDF	further settings
ATLAS						
Sherpa (ATLAS)	SHERPA v2.2.2	dynamic scale, m_{WW}	internal	internal	NNPDF3.0-NNLO	multileg-LO, exactly six EW vertices with one additional parton at LO accuracy in QCD
PW+Py8 (ATLAS)	POWHEG v2, VBS approx.	fixed scale, m_W	PYTHIA 8.212	AZNLO	NNPDF3.0-NLO	
PW+Py8 dipole-recoil (ATLAS)	POWHEG v2	fixed scale, m_W	PYTHIA 8.235	AZNLO	NNPDF3.0-NLO	Dipole Recoil [5]
MG5+Py8 dipole-recoil (ATLAS)	MG5_AMCNLO v2.6.2	dynamic scale, $\sqrt{pT^{\mathrm{jet1}}pT^{\mathrm{jet1}}}$	PYTHIA 8.235	A14	NNPDF3.0-NLO	LO, Dipole Recoil [5]
CMS						
MG5+Py8 (CMS)	MG5_AMCNLO v2.3.3	dynamic scale, using a 2→2 topology from the clustered external state	PYTHIA 8.226	CUETP8M1 [6]	NNPDF3.0-LO	LO, exactly six EW vertices
PW+Py8 (CMS)	POWHEG v2	fixed scale, m_W	PYTHIA 8.226	CUETP8M1	NNPDF3.0-NLO	NLO
generic samples (VBScan)						
PW+Py8 (VBScan)	POWHEG v2	dynamic scale, $\sqrt{pT^{\mathrm{jet1}}pT^{\mathrm{jet2}}}$	PYTHIA 8.230	Monash	NNPDF3.0-NLO	NLO

Table 2: Summary of the samples that are compared in this note.

Screenshot