Summary of MC workshop

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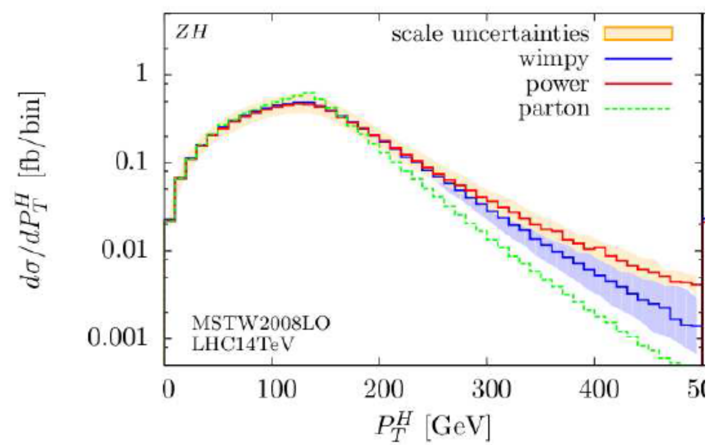
Matrix-element generators: general

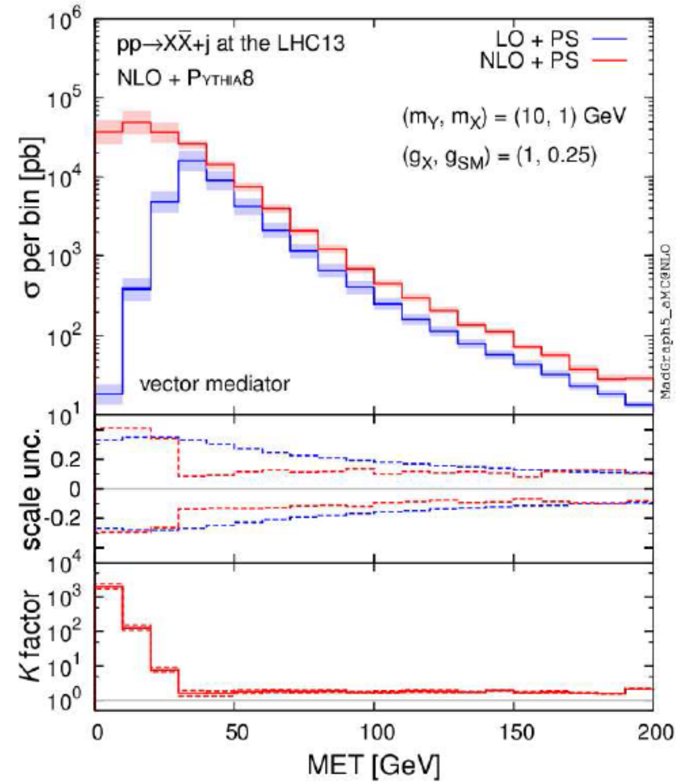
- Important developments in most used matrix-element generators. General effort to include in most of them:
  - NLO QCD calculations (automated in MadGraph/Sherpa) and multileg merging
  - Reweighting for QCD scale, PDF uncertainties etc. in LHA3
  - Parallelisation methods for the generator set-up (amplitude generation, phase-space sampling, MC integration)
  - Loop-induced processes:
    - Possible with internal or external OLPs
    - Timing depending on the method used
    - Not widely used in experiments yet



POWHEG and MadGraph5_aMC@NLO

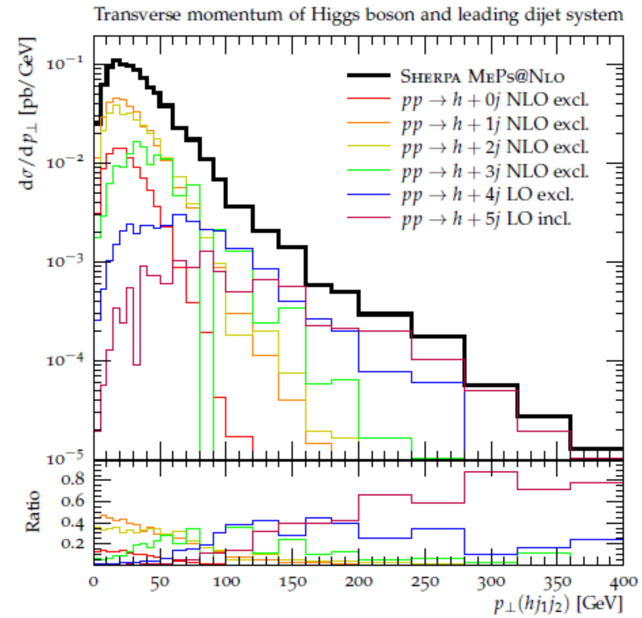
- POWHEG recent updates:
  - ttbar with QCD radiation in decays
  - MiNLO' method (to be) extended to include new processes

- MadGraph5_aMCatNLO recent updates:
  - Effort towards mixed coupling expansion (QCD + EW corrections)
  - General framework for NLO QCD corrections of general Lagrangians (NLO QCD)
    - Case-by-case support for EFTs



Sherpa and AlpGen

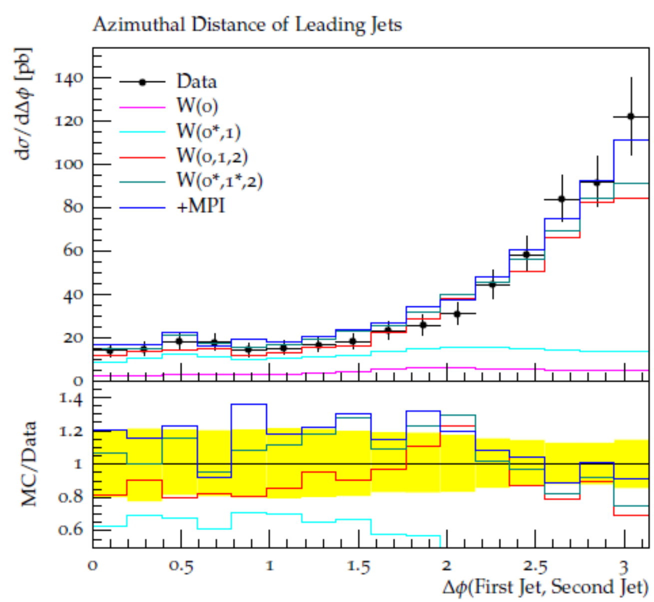
- Sherpa recent updates:
  - Several bugfixes (forward jets)
  - Multileg merging for loop-induced tested for large set of processes
  - New dipole parton-shower



- AlpGen: high-jet multiplicity specialist
  - Maximum njet (further) increased
  - Inclusion of EW corrections
  - More hard processes and interfaces to parton-showers
  - First tested using special setup on Argonne HPC

Pythia8 and Herwig

- Both now with possibility of including external ME provider (MadGraph)
- Pythia8 recent updates:
  - More matching/merging options supported / «weak merging»
  - New color reconnection model
  - More processes included (double quarkonia)
- Herwig++ → Herwig7 a major update:
  - End-to-end event simulation
    - ME level via Matchbox (supports NLO, NLO multileg merging in 7.1)
    - Internal q-ordered and dipole showers
    - Hadronization and decays
  - Parallelisation methods available

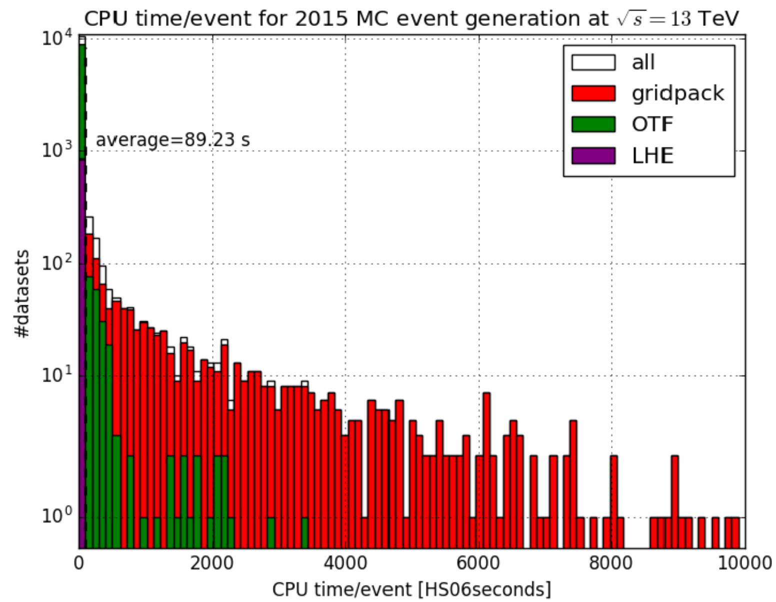


Generator integration (1)

- Large manpower in both ATLAS and CMS needed
- Similar implementation:
  - Event production run safely on the Grid (including LHE event production): in some cases use LHE external sources, by means of an internal (CMS) or general (ATLAS) parser
  - Bottleneck is generator set-up for complex processes («gridpack» production)
    - Running this step on the Grid unsuccessful → need for local running on batch farms
    - Very time consuming, not safe for job failures, hitting CPU and memory limit
    - ATLAS use of supercomputers improves a little the situation

Generator integration (2)

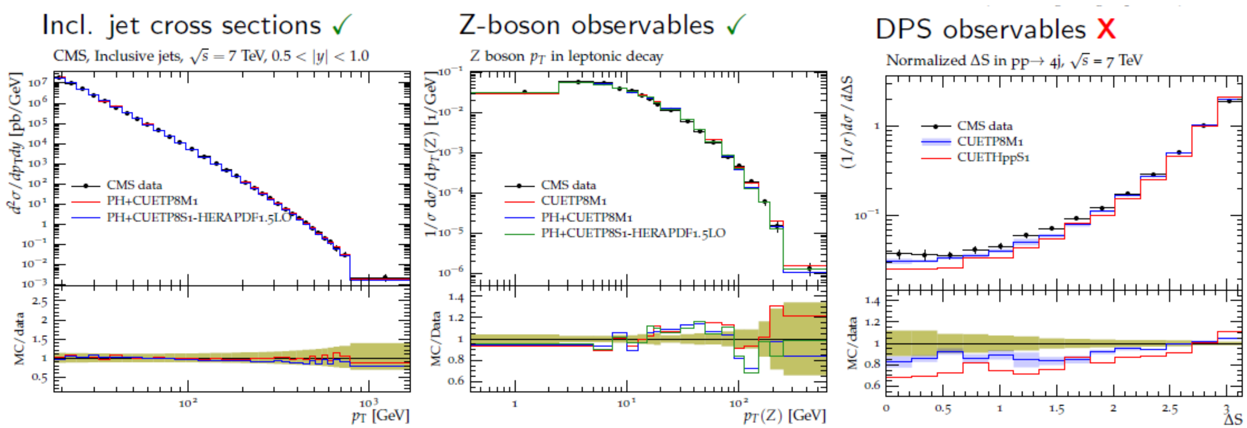
- At event production level, ATLAS reports very large running time per event, CMS does not
  - Main differences: more intensive use of Sherpa, aggressive pT binning



- Discussion: how much this should be uniformed between experiments, avoiding work overlap
  - At gridpack level?
  - At LHE-event level?
  - At HepMC event level?

Underlying event tuning

- Very detailed tuning efforts from experiments
  - UE, DPS, quark vs. gluon-induced processes
  - Optimised tunes for both Pythia8 and Herwig++

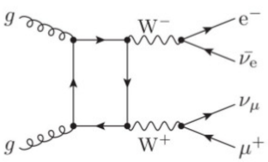


- Non-universality of tunes: a problem?
  - Test different samples/phase space regions systematically
- PS MC soon with possibility to include some tuning uncertainties (e.g. on pT0) as event weights

V+jets, VV, multijets and photons

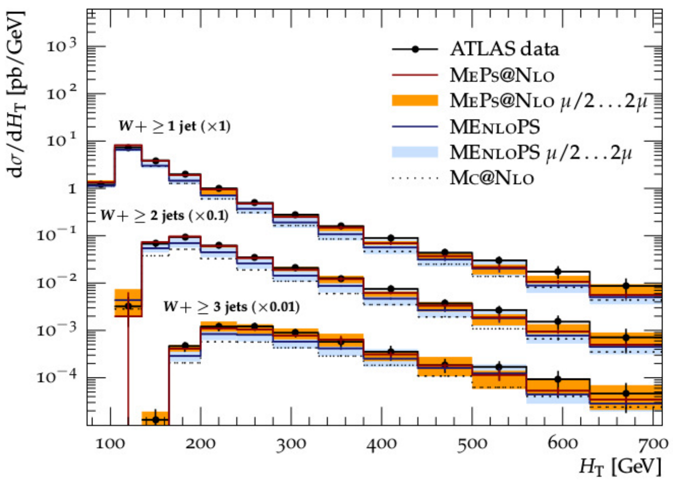
V+jets and VV

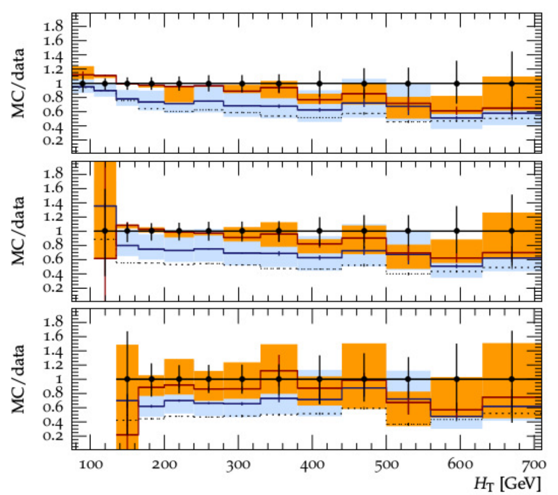
- Complete review of tools on the market and their accuracy, with emphasis on V+jets at NLO+Ps, V + heavy flavor and DY production at NNLO+PS
- Sherpa: MEPS@NLO



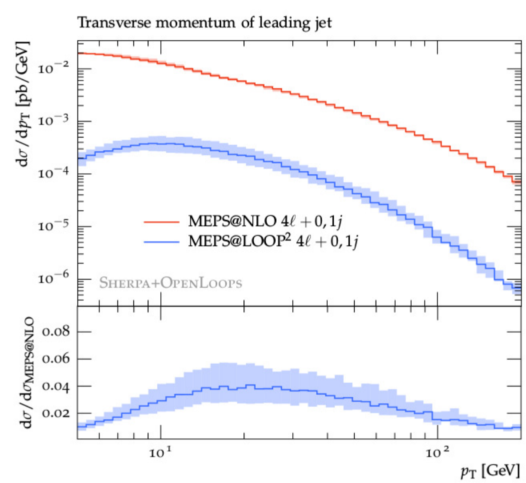
★ V + 0,1,2,(3,4) jets

[Hoeche,Krauss,Schoenherr,Siegert '12]



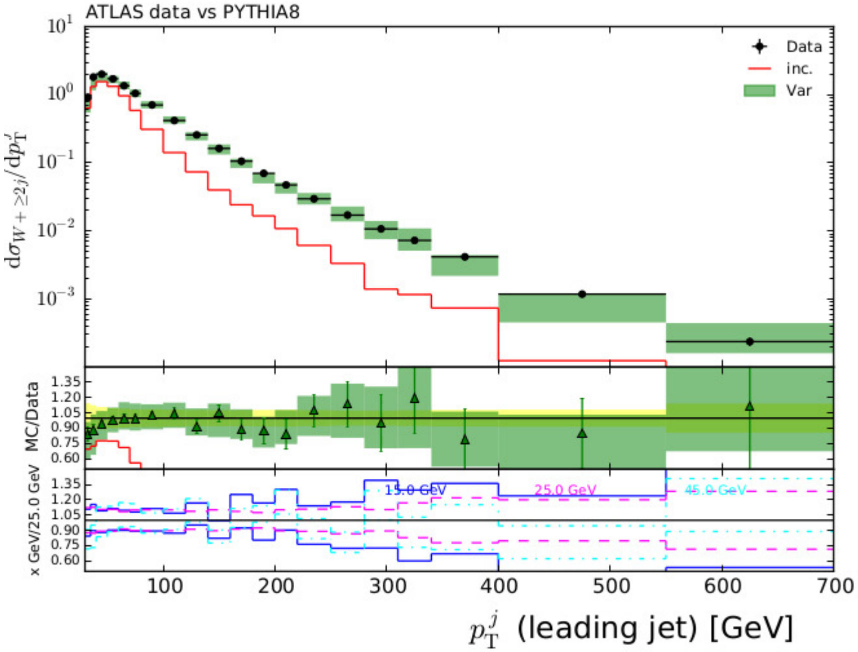


★ 4 leptons + 0,1 jets

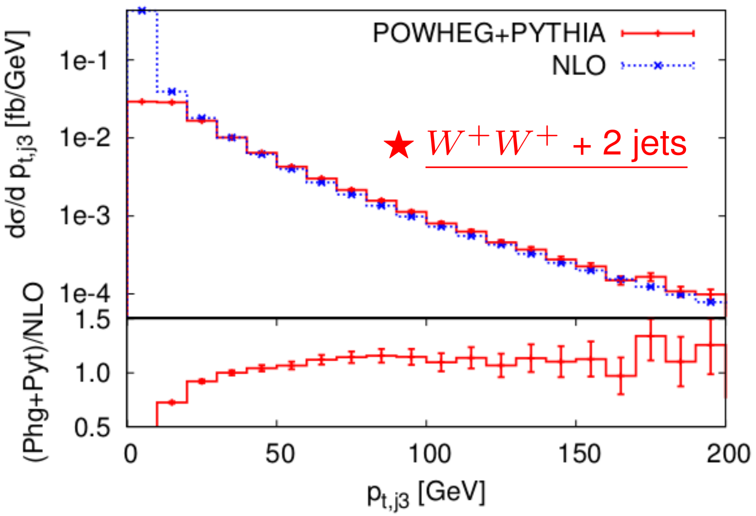


V/VV MG5_aMC@NLO and Powheg

- Very good performance of MG5_aMC@NLO FxFx



- Powheg has several processes @NLOPS with 1 or 2 vector bosons and up to 2 jets

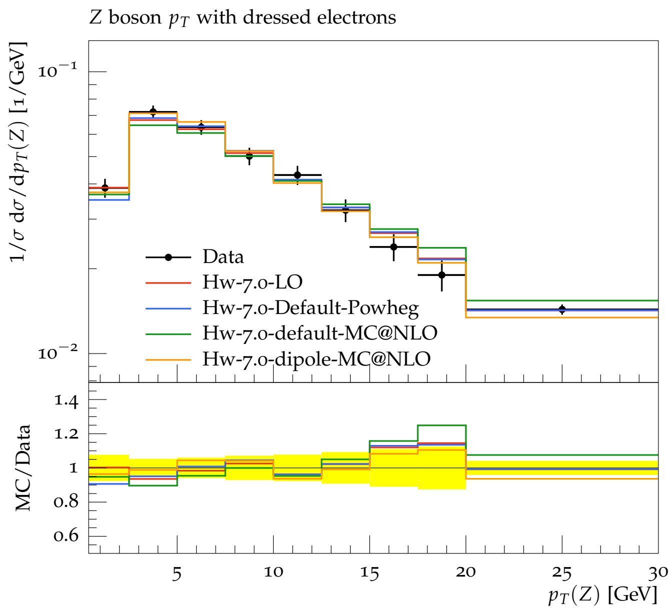


- estimation of perturbative uncertainty + shower "uncertainty"

1. $Q_{\rm MS}$ dependence is at most 1.5%. FxFx total typically 3-6% larger than exact inclusive NLO+PS
2. once $V + 2$ jets at NLO+PS is included, also higher jet multiplicities are described reasonably well
3. the inclusive NLO+PS result depends much more on the PS used

Herwig 7 and more

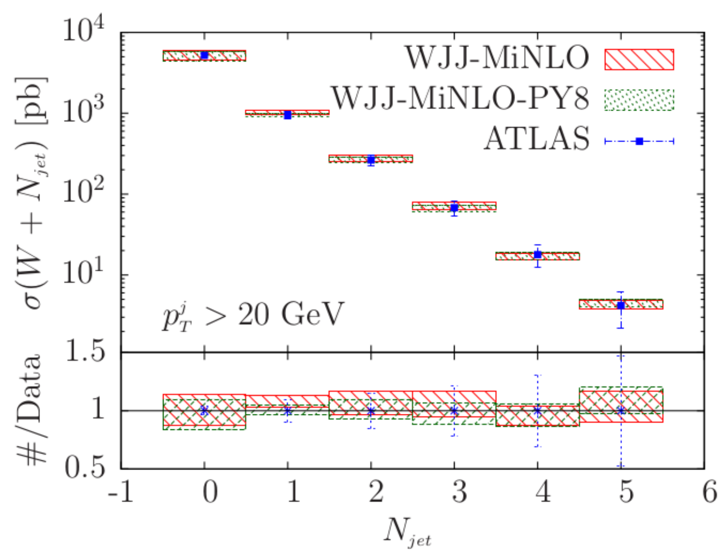
- Herwig NLO+PS matching



- Other tools and generators
  - UNLOPS
  - Powheg + MiNLO

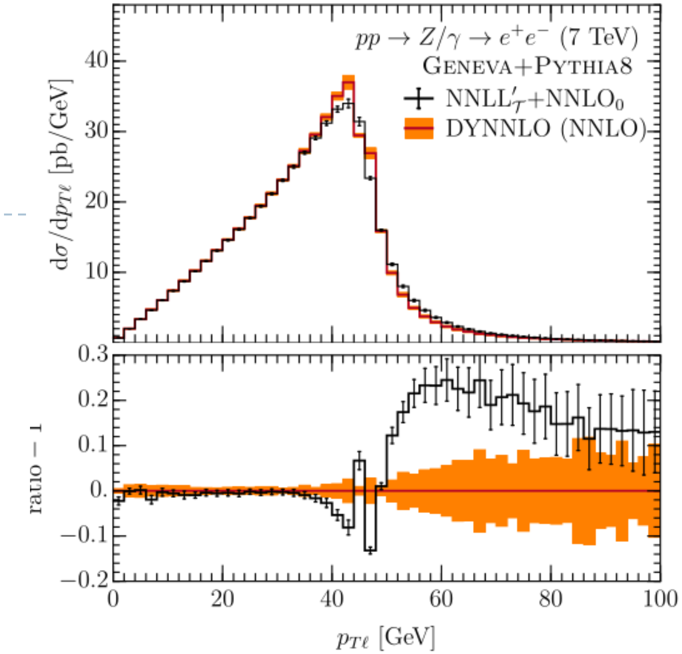
- New default: NLO matrix elements matched to the parton shower
  [Plätzer,Bellm,Wilcock,Rauch,Reuschle]
- NLOPS automated thanks to `Matchbox`: ME from external provider via BLHA [`GoSam`, `MadGraph`, `NJet`, `OpenLoops`, `VBFNLO`]
- internal `POWHEG` and `MC@NLO` NLOPS matching
- two different parton showers: angular-ordered, dipole

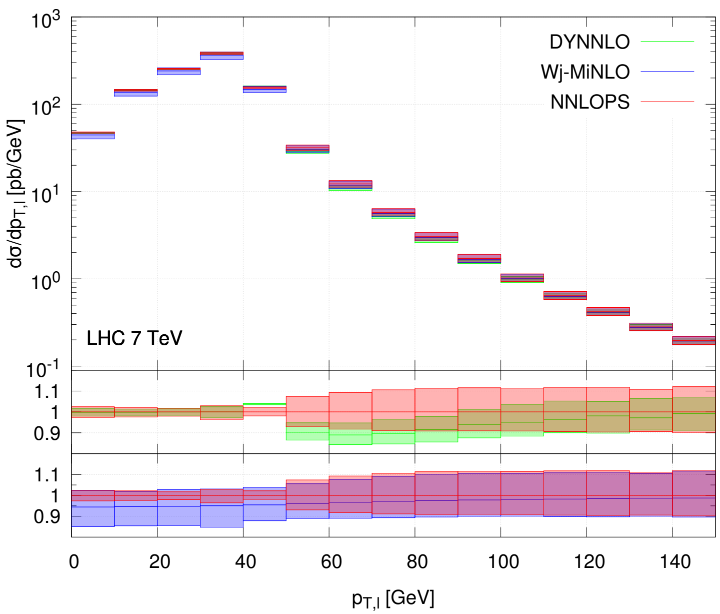
★ V + 0,1,2 jets



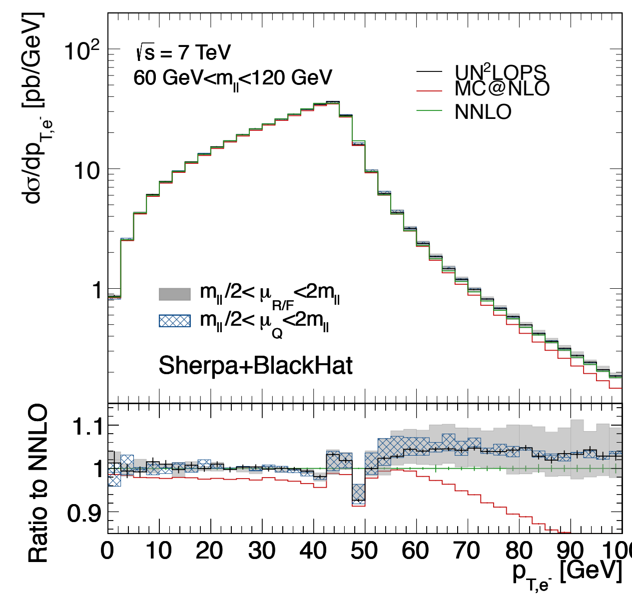
DY@NNLOPS

- Reach NNLO + PS with Geneva
- Powheg+MiNLO





- UNNLOPS



V+jets and VV from ATLAS/CMS

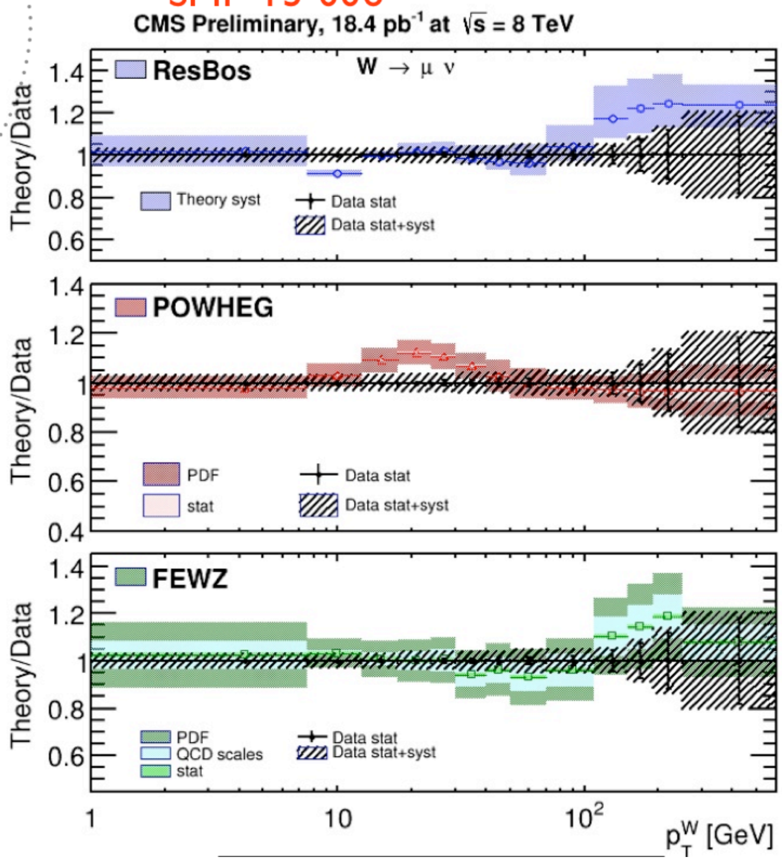
- Both experiments presented the status of the art of data/MC studies on V, V+jets and VV and set up currently used or planned for 2016 data
- General phisolophy:
  - 7, 8 TeV unfolded data used to develop 13 TeV set up
  - Comparisons with Run 1 samples also performed as legacy in lack of unfolded data (e.g. Multi-boson)
  - Approaches to estimate uncertainties on modeling also discussed in certain cases
- Preliminary results on data at 13 TeV for V+jets also shown
  - More to be understood and developed:
    - CMS: MG5_aMC@NLO 13 TeV comparisons show slightly higher predictions wrt to data
    - ATLAS: exploit more FxFx, understand remaining discrepancies Sherpa – MG + Py8

'inclusive V'

- V

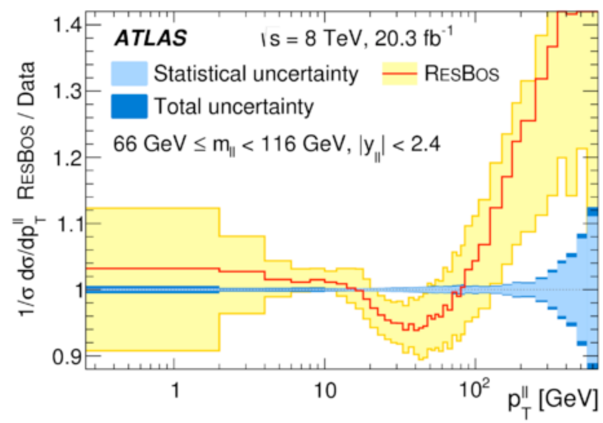
W Pt (8 TeV)

SMP-13-006



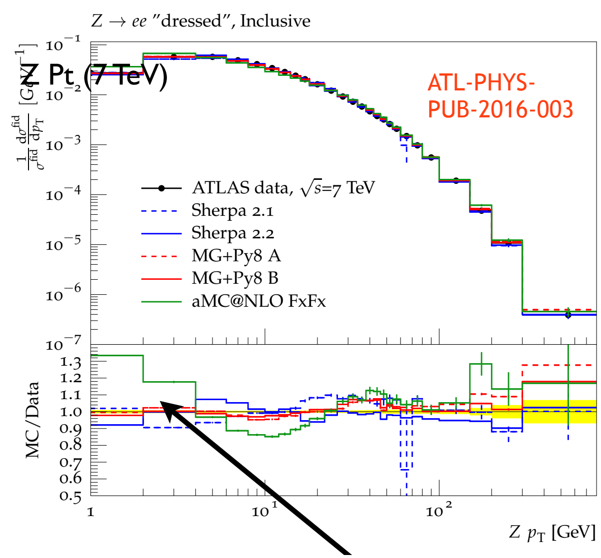
Z Pt (8 TeV)

arXiv:1512.02192

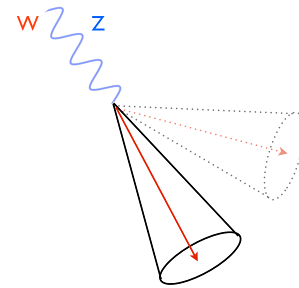


Z Pt (7 TeV)

ATL-PHYS-PUB-2016-003



New data/MC comparisons. Agreement to ~1σ for most of prediction (tree-l. or NLO)

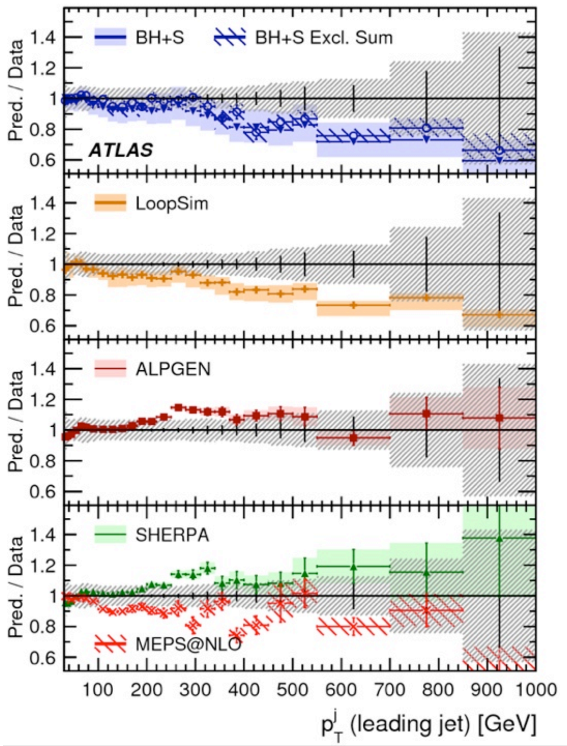


V+jets

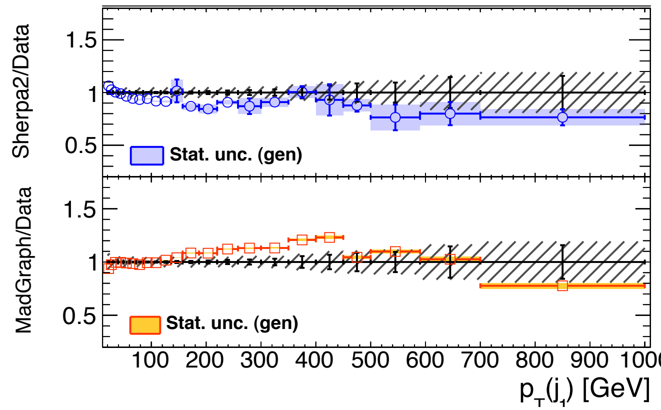
- Leading jet kinematics

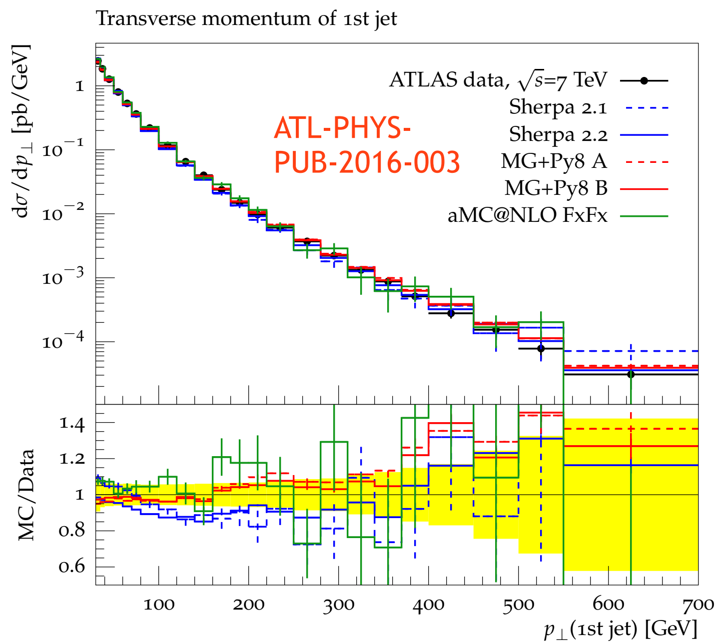
Eur. Phys. J. C (2015) 75:82

W+jets (7 TeV)



Z+jets (8 TeV)



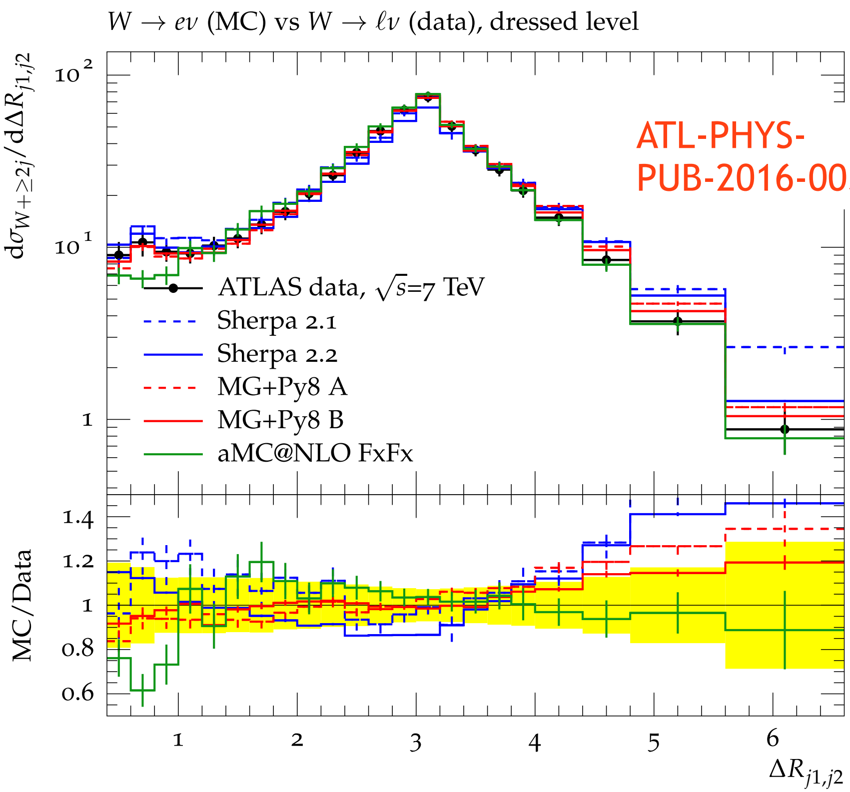


Also for second leading jet pT

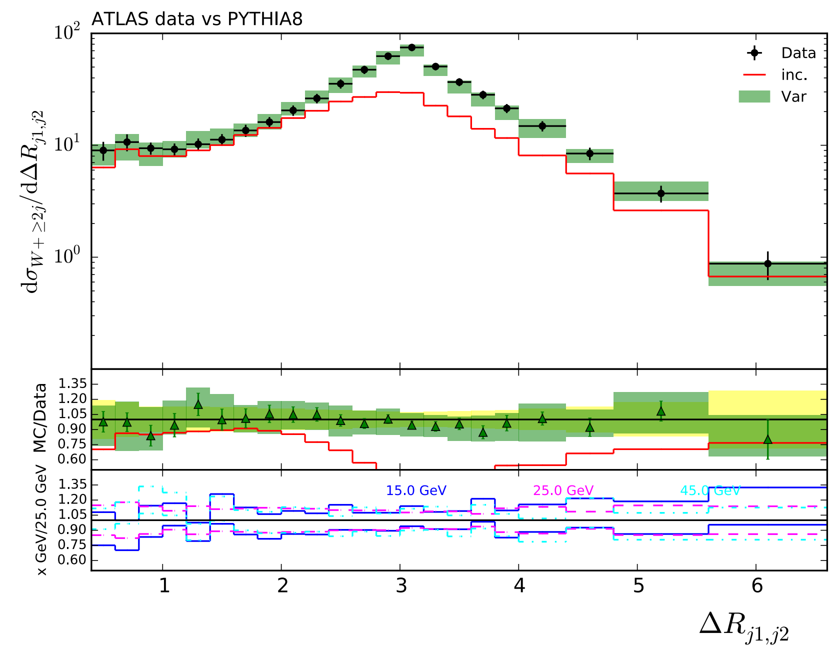
V+(2)jets angular correlations

- Relevant for several searches as well as higgs analyses …

W+jets (7 TeV)



arXiv:1511.00847

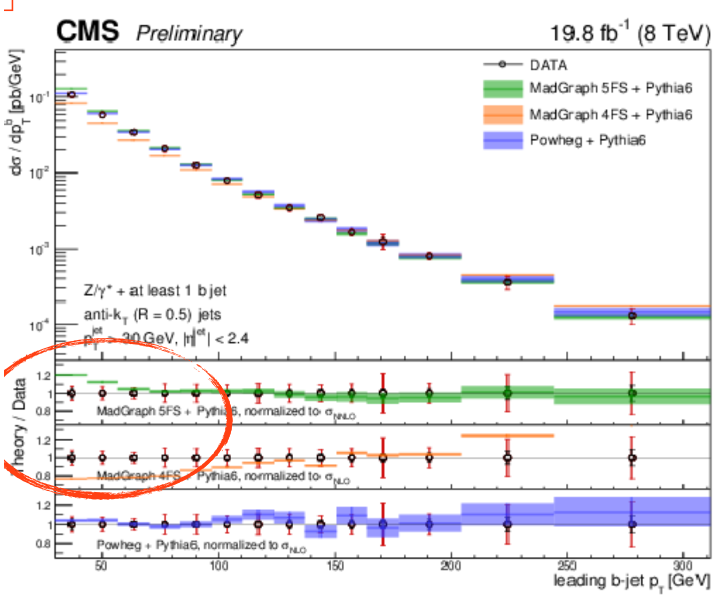


Excellent description with aMC@NLO

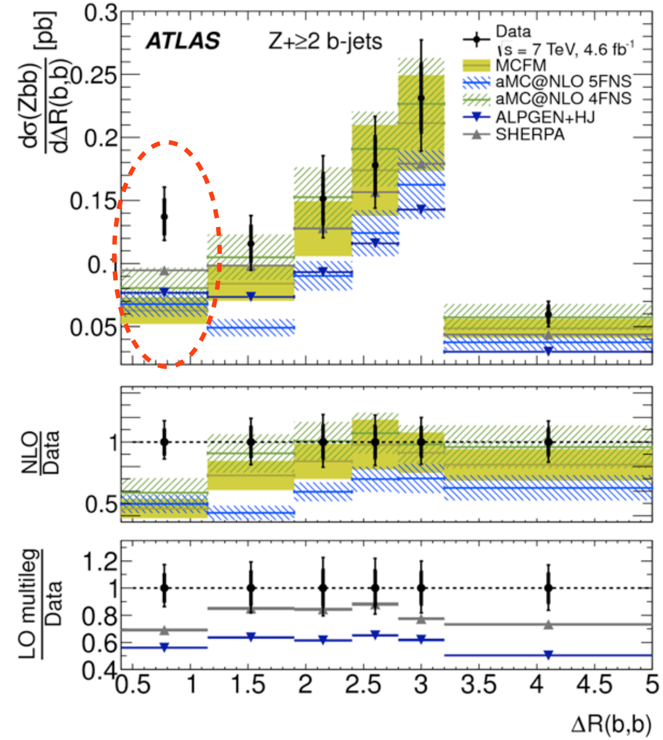
V + 1 and 2 b-jets

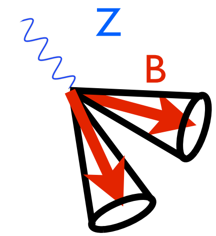
- crucial for VH and several BSM and relevant standalone measurements. Use Run 1 7 and 8 TeV data. Angular correlations very crucial

CMS-PAS-SMP-14-010

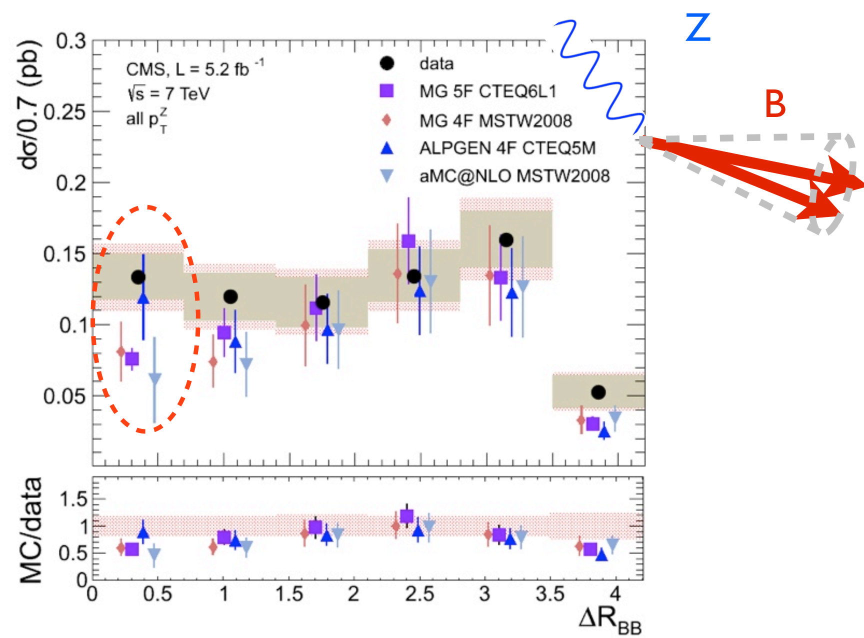


ALPGEN+H, Sherpa: shape ok, normalisation off
MG 4F/5F+P6: large disagreement in soft Pt region only





Z+2b excess in collinear bb region



V + 1 and 2 b-jets

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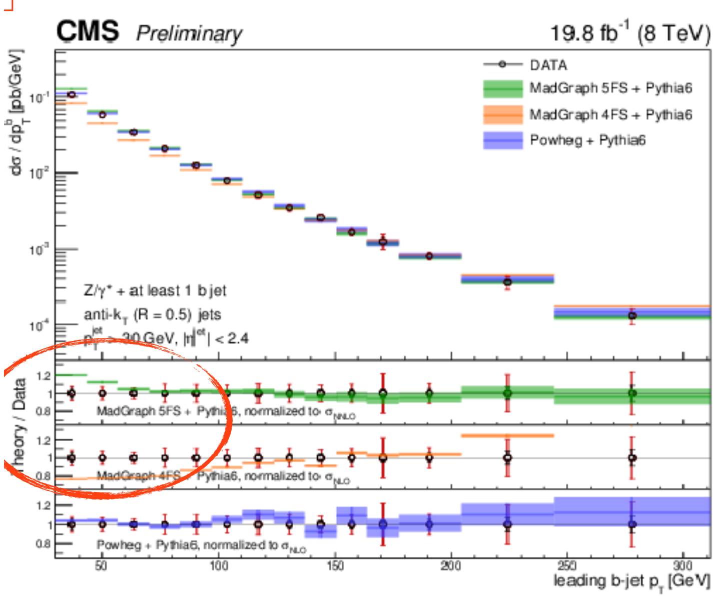
CMS-PAS-SMP-14-010



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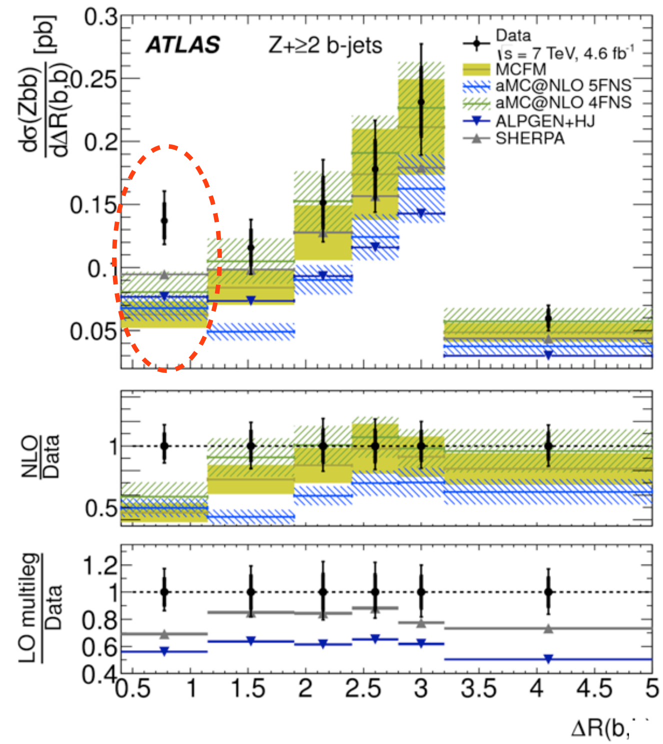
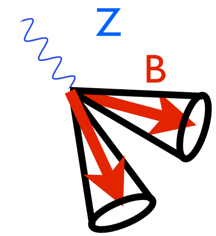
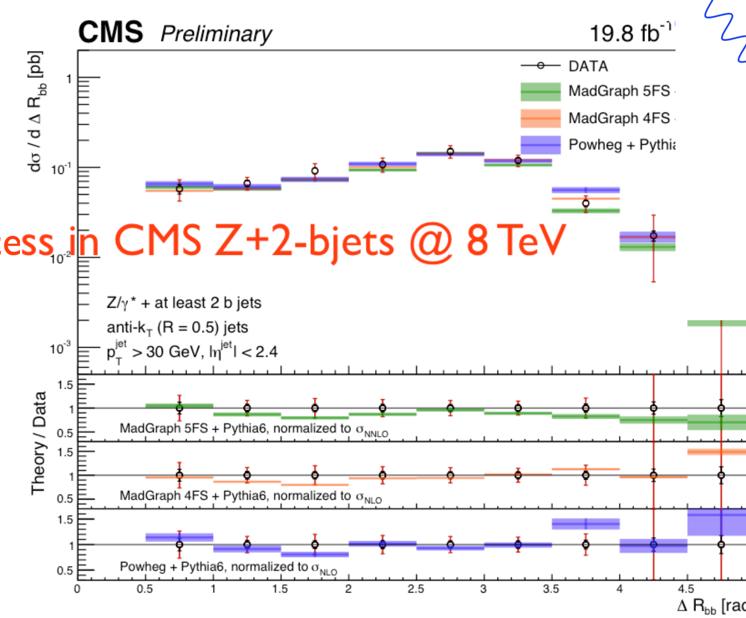
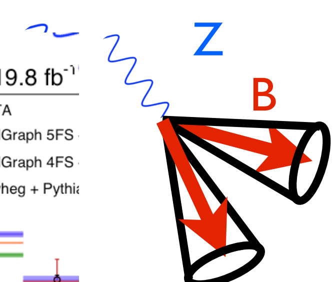




Z+2b excess in collinear bb region

No excess in CMS Z+2-bjets @ 8 TeV





V + 1 and 2 b-jets

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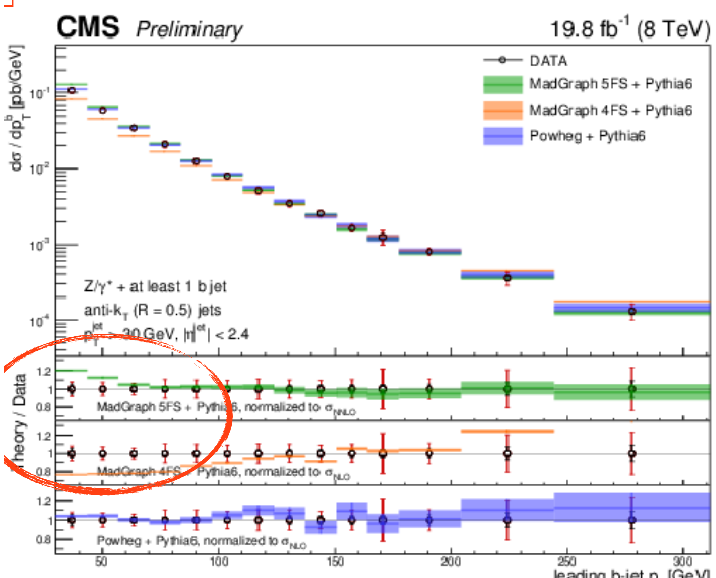
CMS-PAS-SMP-14-010



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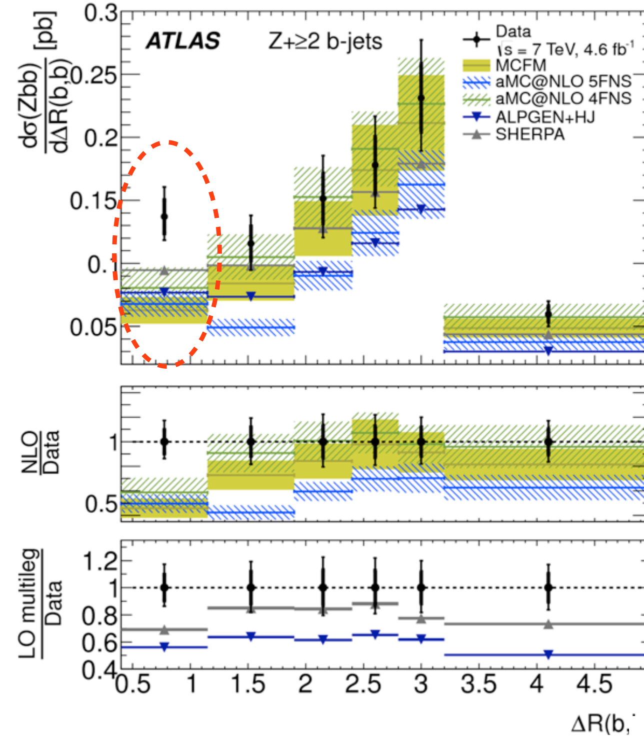

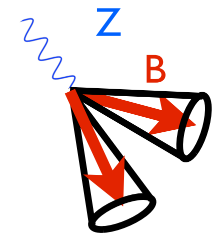

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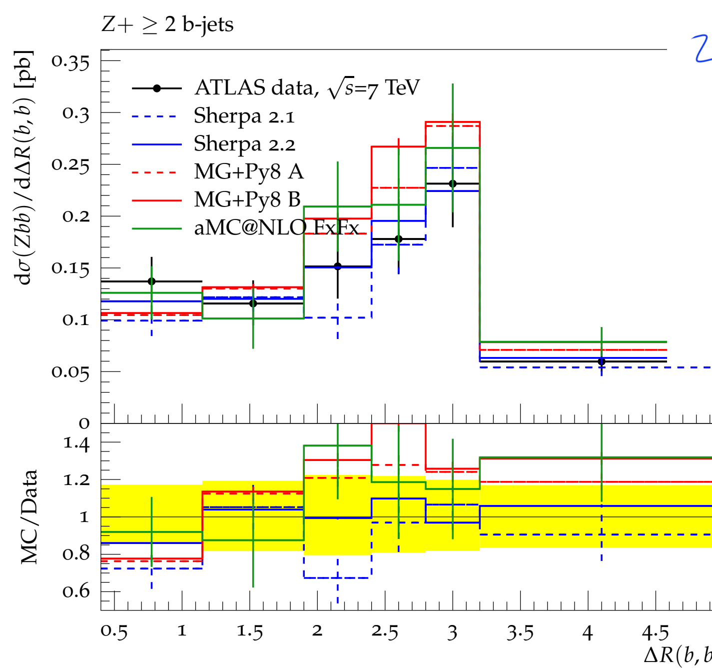
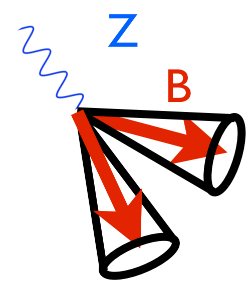
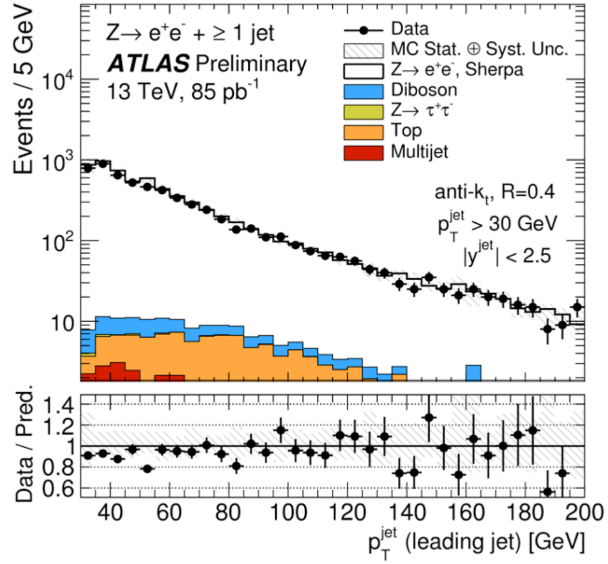


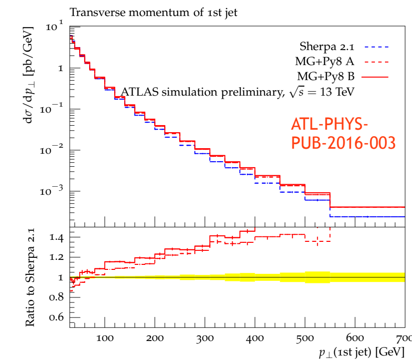


13 TeV V+jets

- ATLAS

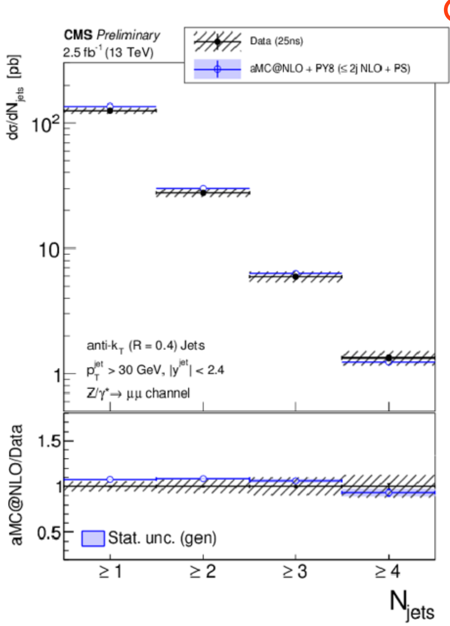


Generator	ME	PS	ME+PS	PDF
MG+P8 A	V+0..4p v5.2.2.2	v8.186	Kt-MLM @20 GeV	NNPDF NLO v3.0
MG+P8 B	V+0..4p v5.2.2.3	v8.210	Kt-MLM @30 GeV	NNPDF NLO v2.0
Sherpa 2.1	V+0..2 NLO V+3..4 LO v2.1.1	v2.1.1	CKKW-L @20 GeV	NLO CT10

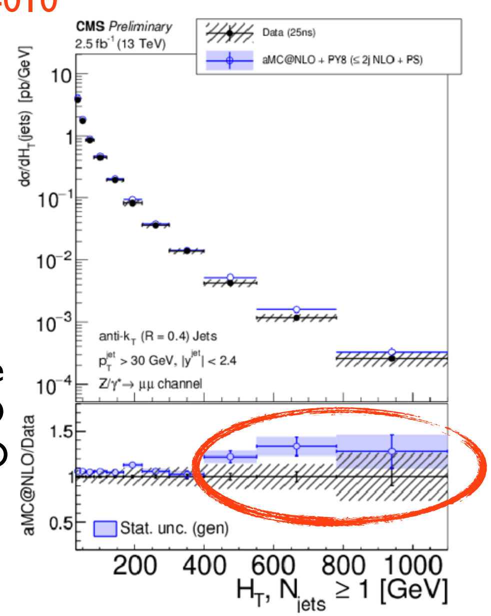


- CMS

CMS-PAS-SMP-15-010



MGaMC+P8
CUETP8M1 tune
Norm. to NNLO
NNPDF 3.0 NLO



Crucial understanding of high pT regions for both ATLAS and CMS

Multi-boson

- Several types of multi-boson
- Several generators used

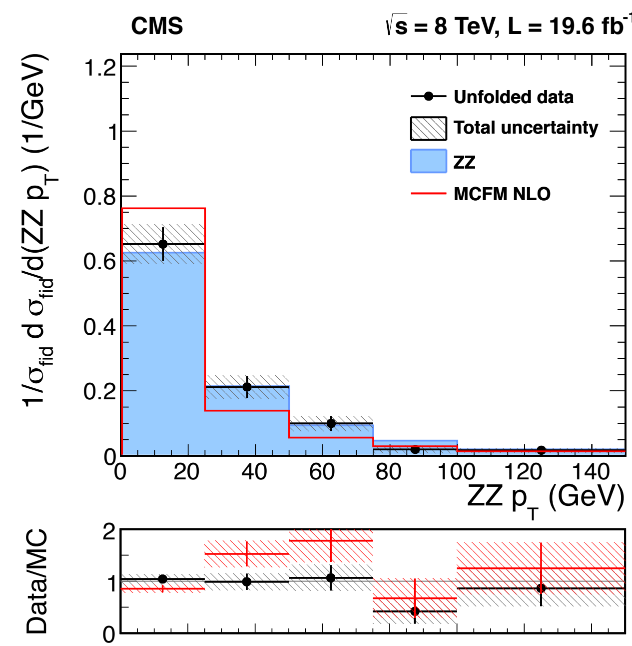
- Tree-level *VV*
- Loop-induced *VV*
- Electroweak diboson production (*VVjj*)
- Tri-boson (*VVV*)

CMS

Generator	Process	Setup
Powheg v2 + PYTHIA6	$qq \to ZZ \to 4\ell$ (8 TeV) $qq \to WW$ (8 TeV)	NLO, CT10
MadGraph5 + PYTHIA6	$WZ \to 3\ell\nu$ (8 TeV) $qq \to WW$ (8 TeV) $qq \to ZZ \to 2\ell 2\nu$ (8 TeV) VVV (8 TeV)	LO, CTEQ6L
MC@NLO 4.0 + HERWIG 6	$qq \to WW$ (8 TeV)	NLO, CT10
Sherpa v1	$qq \to ZZ$ (8 TeV)	LO, CTEQ6L
GG2ZZ	$gg \to ZZ$ (8 TeV)	LO
GG2WW 3.1	$gg \to WW$ (8 TeV)	LO
PYTHIA6	WV (8 TeV)	LO
Powheg v2 + PYTHIA8	$WZ \to 3\ell\nu$ (13 TeV) $qq \to ZZ$ (13 TeV)	NLO, NNPDF3.0
MCFM + PYTHIA8	$gg \to ZZ$ (13 TeV)	LO, NNPDF3.0
MadGraph5 aMC@NLO	VVV (13 TeV)	NLO, NNPDF3.0

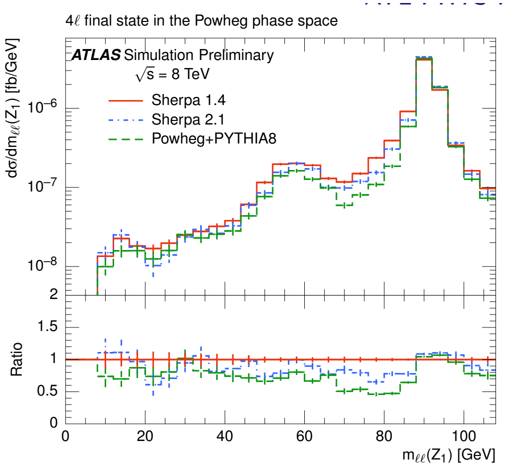
ATLAS

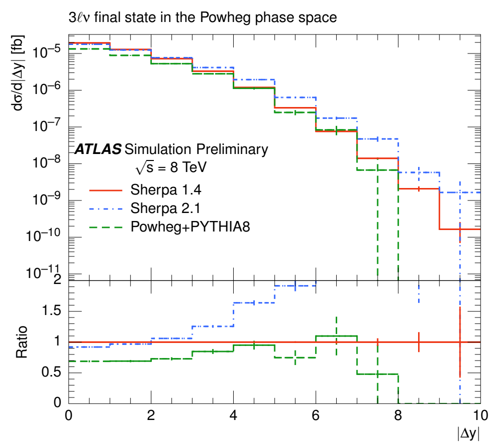
Generator	Process	Setup
Sherpa 2.1.1	$qq \to VV \to 4\ell, 2\ell 2\nu$	0,1j@NLO + 2,3j@LO, CT10
	$qq \to VV \to 3\ell\nu, 4\nu$	0j@NLO + 1,2,3j@LO, CT10
	$qq \to ZZ \to 2\ell qq, 2\nu qq$	0,1j@NLO + 2,3j@LO, CT10
	$qq \to WZ, WW \to \ell\nu qq, 2\ell qq, 2\nu qq$	0j@NLO + 1,2,3j@LO, CT10
	$gg \to VV \to 4\ell, 2\ell 2\nu$	0,1j@LO, CT10
	$VVjj$ EWK	0,1j@LO, CT10
	VVV fully leptonic	0j@NLO+1,2j@LO, CT10
Powheg v2 + PYTHIA8	$qq \to WW, WZ, ZZ$	NLO, CT10 (CTEQ6L1), EvtGen
gg2VV + PYTHIA8	$gg \to VV \to 4\ell, 2\ell 2\nu$	LO, CT10
VBFNLO + PYTHIA8	WWW	LO, CT10

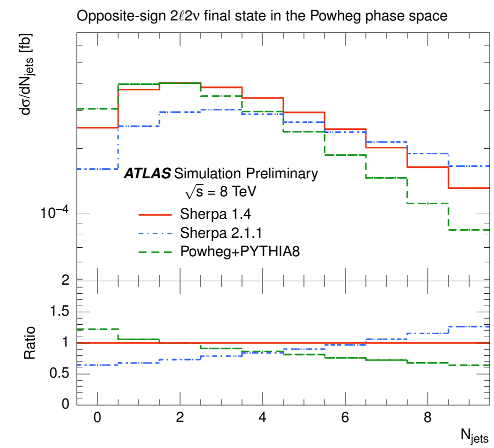


Relevance of comparing generators and calculations using coherent scales

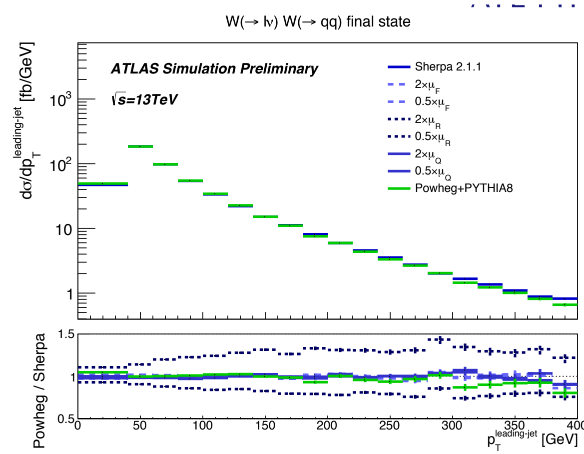
ATLAS studies

- **Fully leptonic WW, WZ, ZZ**: powheg+pythia8 and sherpa used. Differences under investigation
- 





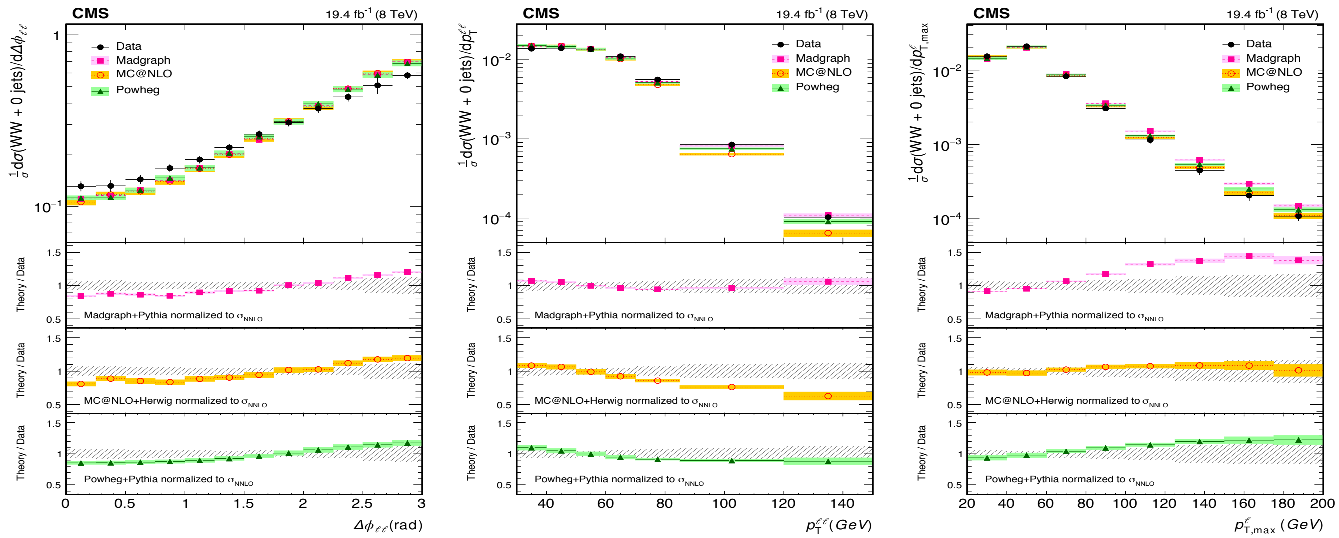
- **Semi-leptonic**: 13 TeV simulation
  - powheg v2 + pythia8 and sherpa 2.1
  - Good agreement, well within uncertainties
  - Similar studies and conclusions for
    - W(lν)W(qq)
    - Z(ll)Z(qq)
    - W(lν)Z(qq) etc…



CMS studies

- 8 TeV results

arXiv:1507.03268



- Comparison of MadGraph+Pythia, MC@NLO+Herwig, Powheg+Phythia with 8 TeV data
- No single generator better than the others for all distributions, some differences for all generators in $\Delta\phi_{\ell\ell}$
- Good agreement for $p_T^{\ell\ell}$ except for MC@NLO
- For leading lepton p_T, MadGraph predicts too many events in the tails

More work ahead…

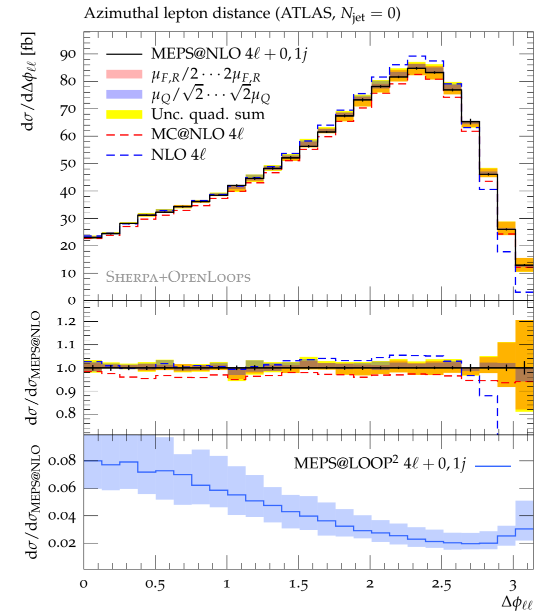
- Further studies on diboson and triboson
- Establishment of estimates of **systematic uncertainties**
  - **ATLAS/CMS could try to agree on the overall approach**
- More studies on **loop-induced and EWK processes**
  - On this, a theoretical overview from Marek
  - For vector boson production:

- relative size of contribution strongly dependent on observable, but typically $< 10\%$

Hirschi, Mattelaer JHEP10(2015)146

Process Double bosons + jet		Syntax	Cross section (pb) $\sqrt{s} = 13$ TeV	$\Delta_{\hat{\mu}}$	Δ_{PDF}	Ref.
b.6	$gg \to ZZ$	`g g > z z [QCD]`	1.313 ± 0.004	$^{+27.1\%}_{-20.1\%}$	$^{+0.7\%}_{-1.0\%}$	[42]
*b.7	$gg \to ZZg$	`g g > z z g [QCD]`	0.6361 ± 0.002	$^{+45.4\%}_{-29.1\%}$	$^{+1.0\%}_{-1.2\%}$	[54]
b.8	$gg \to Z\gamma$	`g g > z a [QCD]`	1.265 ± 0.0007	$^{+30.2\%}_{-22.2\%}$	$^{+0.6\%}_{-1.0\%}$	[42]
*b.9	$gg \to Z\gamma g$	`g g > z a g [QCD]`	0.4604 ± 0.001	$^{+43.7\%}_{-28.4\%}$	$^{+0.8\%}_{-1.1\%}$	[55]
b.10	$gg \to \gamma\gamma$	`g g > a a [QCD]`	$5.182 \pm 0.010 \cdot 10^{+2}$	$^{+72.3\%}_{-43.4\%}$	$^{+1.0\%}_{-1.3\%}$	[42]
*b.11	$gg \to \gamma\gamma g$	`g g > a a g [QCD]`	19.22 ± 0.030	$^{+59.7\%}_{-35.7\%}$	$^{+0.7\%}_{-1.0\%}$	[56]
b.12	$gg \to W^+W^-$	`g g > w+ w- [QCD]`	4.099 ± 0.010	$^{+26.5\%}_{-19.7\%}$	$^{+0.7\%}_{-1.0\%}$	[57
*b.13	$gg \to W^+W^-g$	`g g > w+ w- g [QCD]`	1.837 ± 0.004	$^{+45.2\%}_{-29.0\%}$	$^{+0.9\%}_{-1.1\%}$	[58

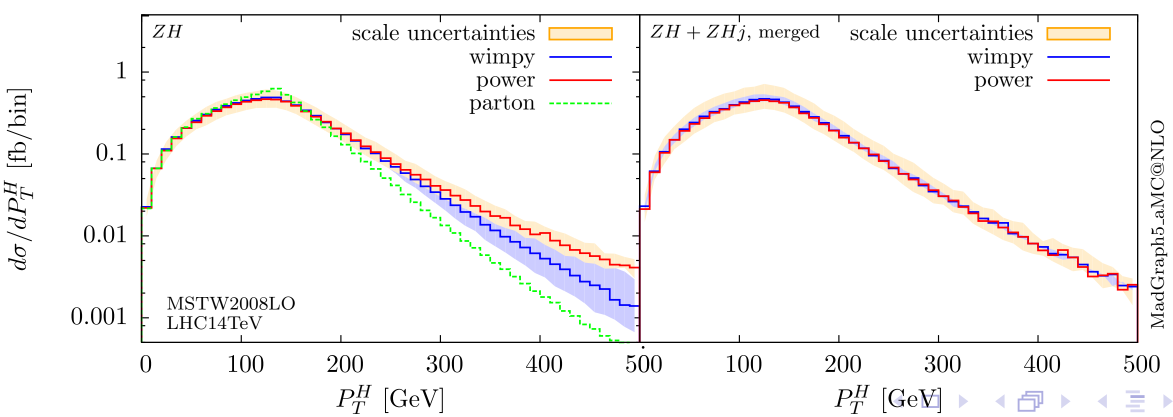
$pp \to 4\ell + 0, 1$ jets



- includes loop-induced $gg \to 4\ell$, $gg \to 4\ell + g$, $gq \to 4\ell + q$, $q\bar{q} \to 4\ell + g$

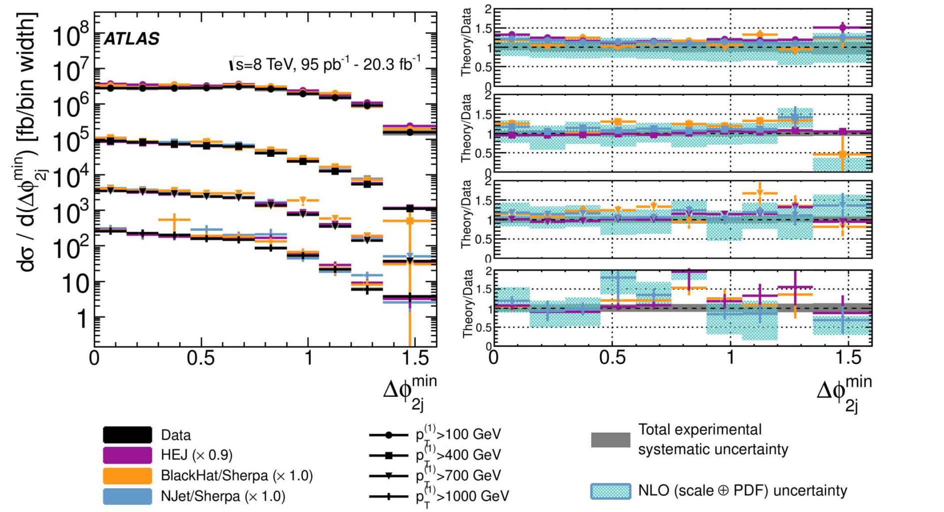
More on loop-induced progresses

- Multiple boson production (VVV,V including gamma, W, Z, H)
- Higgs production in gluon fusion
  - For ggh correction to loop-induced flat and incorporated
  - For pp → h + n-jets can be incorporated in all the multijet merged at NLO machinery – avialable in MG, OpenLoops, GoSam
- Interference in higgs production (e.g. new physics in pp → 4l, qqbar @NLO, gg @LO)
- Double/triple higgs production in gluon fusion
- Associated higgs production (gg →HZ, gg→HZg, gq →HZq, gg→Hγg)

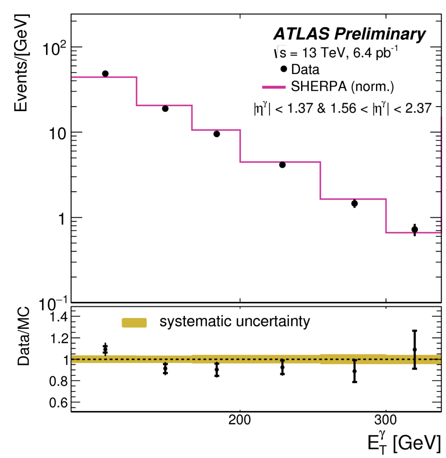


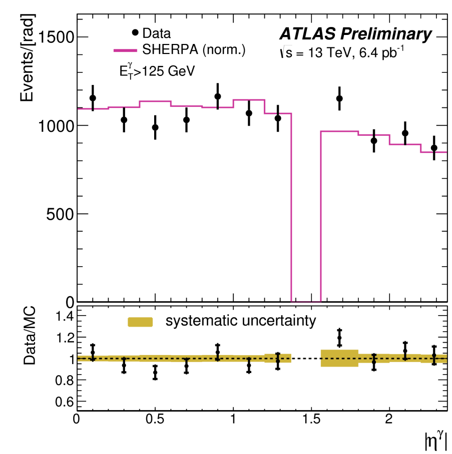
Jets, photon+jet, diphoton production

- Highest order calculations accurately predict the inclusive jet cross-sections across phase-space
- As expected, PS MCs fail → need to use multi-leg generators
- Highest order calculations also able to predict photon and di-photon spectra
- Still more to be understood, possibly with **new measurements from ATLAS and CMS**

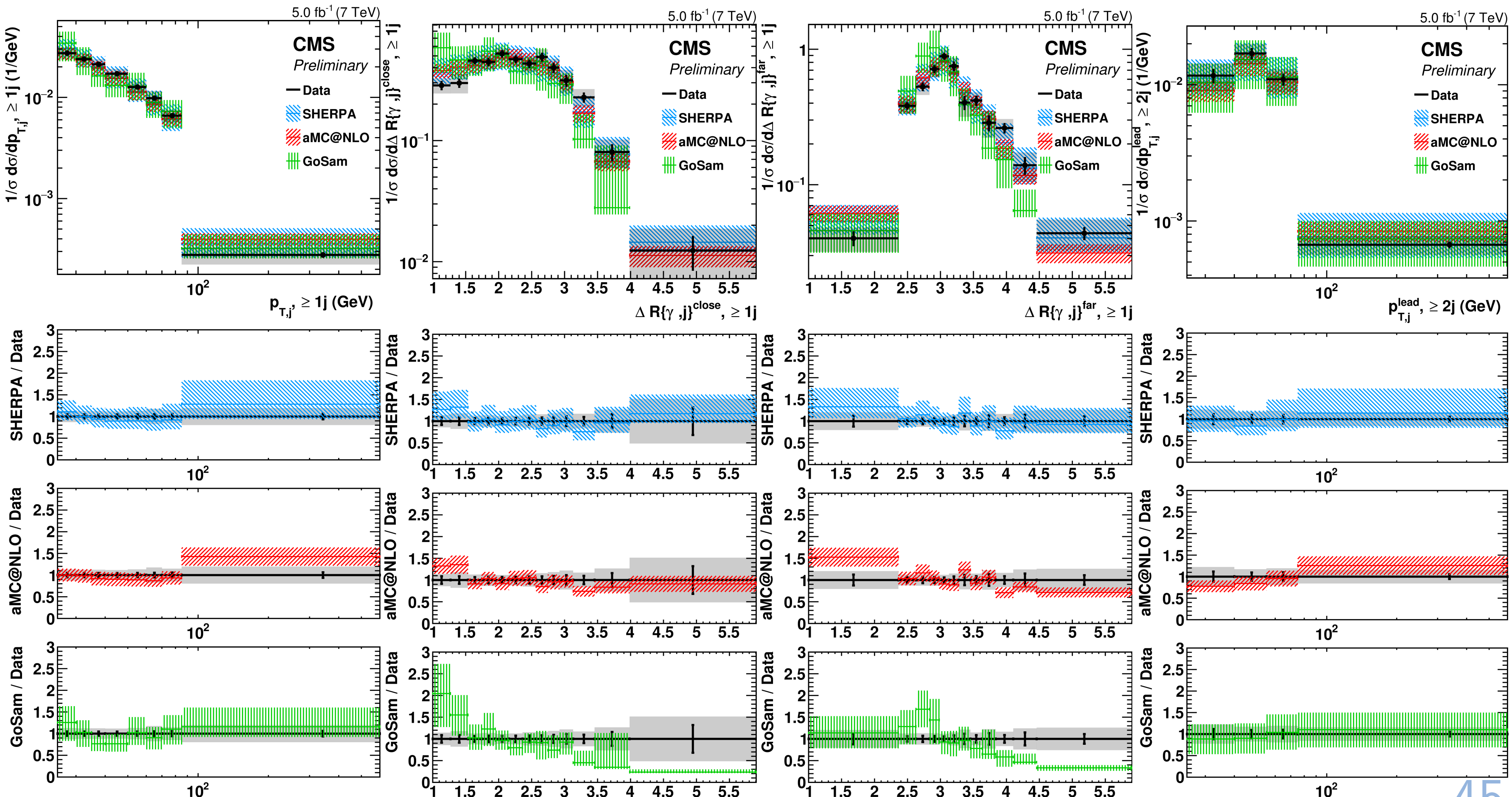


- Initial agreement with the SHERPA Monte-Carlo appear to be favourable.





diphoton



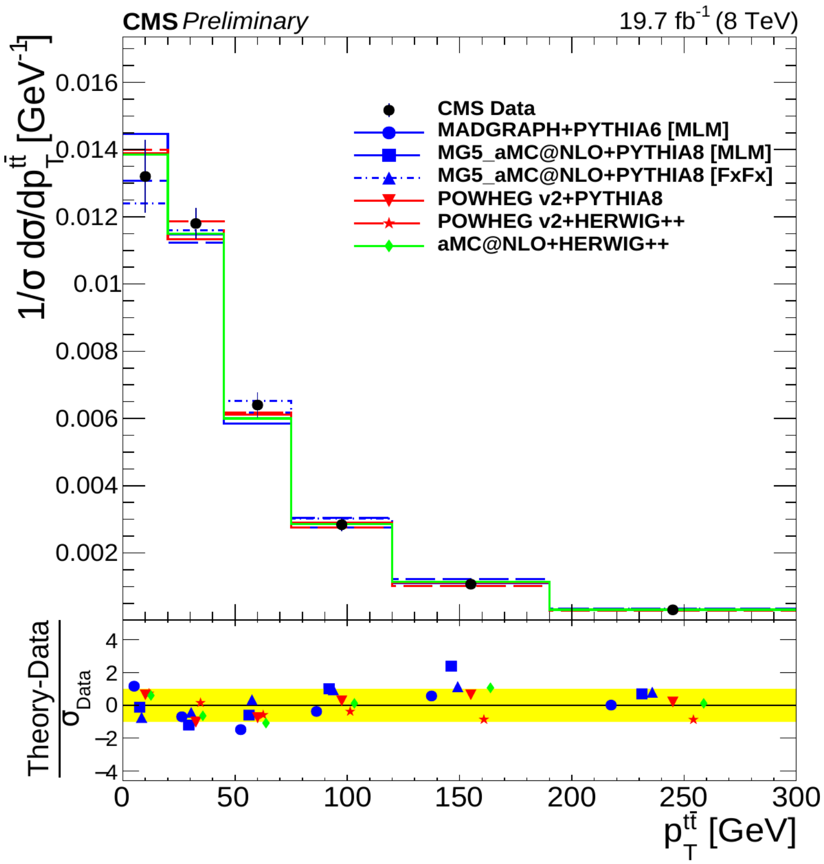
5.0 fb-1 (7 TeV)
CMS
Preliminary
Data
SHERPA
aMC@NLO
GoSam
1/σ dσ/dp_T,j, ≥ 1j (1/GeV)
p_T,j, ≥ 1j (GeV)
1/σ dσ/dΔ R{γ ,j}^close, ≥ 1j
Δ R{γ ,j}^close, ≥ 1j
1/σ dσ/dΔ R{γ ,j}^far, ≥ 1j
Δ R{γ ,j}^far, ≥ 1j
1/σ dσ/dp^lead_T,j, ≥ 2j (1/GeV)
p^lead_T,j, ≥ 2j (GeV)
SHERPA / Data
aMC@NLO / Data
GoSam / Data

45

Top production and more

Top Physics

- Extensive tests and comparisons of many generator setups for tt, ttH, ttW/Z
- Some attempts at tuning MC's
  - Need to understand most appropriate parameters to tune in this case (parton shower parameters, jet matching/emission veto parameters, etc)



Heavy Flavour/Overlap Removal Discussion

- W/Z+bb and tt+bb are important processes
- Requirements from experiments:
  - Efficient generation of large statistics W/Z/tt + bb samples which can be consistently combined with inclusive W/Z/tt+jets sample
- Current approaches
    - 4fs X+bb generation (issue: not easily combinable with inclusive sample)
    - 5fs X+bb generation (plus maybe additional filtering/ enhancement of parton-shower b contribution) (issue: several samples to combine, not straightforward to do efficiently at NLO)
  - Possible solutions:
    - Procedure to merge 4fs X+bb with inclusive X+jets
    - Ability to enhance b contribution in ME and/or PS for inclusive X +jets sample

Theory Uncertainties Discussion

- Per-event weights are the most convenient mechanism to evaluate MC uncertainties
  - Currently available for ME renormalization/factorization scale and PDF variations
  - Available in the future for some PS uncertainties
- Evaluating shape uncertainties associated with renormalization/factorization scale variations is not fully well-defined:
  - Possible approaches:
    - Ad-hoc shape uncertainties (introduce linear slope/etc in 1D distributions)
    - Vary functional form for dynamic renormalization/factorization scales (possible with per-event weights with modest changes to workflow and/or MC tools)
  - Monte Carlo tools with higher order resummation might provide more systematic prescription (eg. GENEVA)

BSM, jet sub-structures

EFT: the analysis approach and implementation in generators

Cen Zhang

- SM Lagrangian supplemented with DIM-6 operators (hence SMEFT)

$$\mathcal{L}_{\mathrm{EFT}} = \mathcal{L}_{\mathrm{SM}} + \sum_i \frac{C_i O_i}{\Lambda^2}$$

- The physics goal is to **determine the SM Lagrangian at Dim-6.**

IMPLEMENTATIONS

UFO

EFT with MG5

EFTs with Sherpa

- First EFT applications with tree-level merging
- First steps towards fixed-order NLO with OpenLoops

EFT with Whizard

SM EFT at Dim-6, Some Dim-8 operators available

EXAMPLES

Top EFT

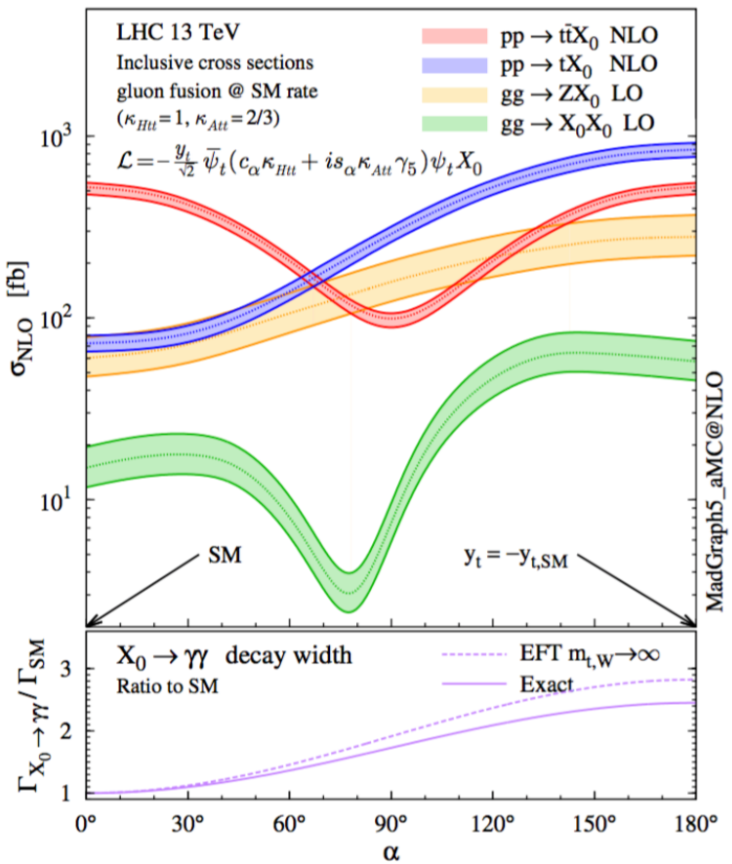
Multi-vector boson

Higgs Eff. Lagrangian

...and many more

all you can do with the SM can be done with higher-dim operators.

Going to NLO in QCD with EFT



On going developments:
HEL at NLO
(Degrande, Fuks, Mawatari, Mimasu, Sanz)

Top FFT

Flavor-conserving

Process	O_{tG}	O_{tB}	O_{tW}	$O_{\varphi Q}^{(3)}$	$O_{\varphi Q}^{(1)}$	$O_{\varphi t}$	$O_{t\varphi}$	O_{4f}	O_G	$O_{\varphi G}$
$t \to bW \to bl^+\nu$	X		X	X				X		
$pp \to t\tilde{q}$	X		X	X				X		
$pp \to tW$	X		X	X				X	X	X
$pp \to t\bar{t}$	X						X	X	X	X
$pp \to t\bar{t}\gamma$	X	X	X				X	X	X	X
$pp \to t\gamma j$	X	X	X					X		
$pp \to t\bar{t}Z$	X	X	X	X	X	X	X	X	X	X
$pp \to tZj$	X	X	X	X	X	X		X		
$pp \to t\bar{t}h$	X						X	X	X	X
$pp \to t\bar{j}h$	X						X	X		X
$gg \to H, HZ$	X			X	X	X	X			X

Flavor-changing

Process	$O_{\phi q}^{(3)}$	$O_{\phi q}^{(1)}$	$O_{\phi u}^{(1)}$	O_{uW}	O_{uB}	O_{uG}	$O_{u\phi}$	O_{4f}
$t \to qZ^*, \gamma^* \to ql^+l^-$	X	X	X	X	X	X		X
$t \to q\gamma$				X	X	X		
$t \to qH$						X	X	
$pp \to t$						X		X
$pp \to tZ$	X	X	X	X	X	X		X
$pp \to t\gamma$				X	X	X		X
$pp \to tH$						X	X	X

eventually full SMEFT@NLO can be expected.

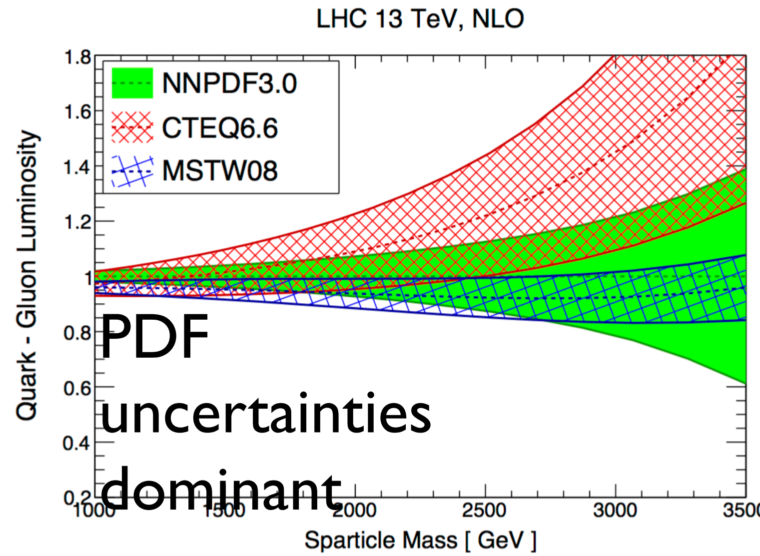
QCD corrections to SUSY particle production at the LHC

Michael Krämer

Squark and gluino production

- large cross sections
- largely model-independent
- large higher-order QCD effects

The cross sections only depend on the SUSY masses



PDF uncertainties dominant

NLO-QCD corrections for generic MSSM spectra

→ Effect of O(10%) on σ x BR for generic MSSM benchmark scenarios

Hollik, Lindert, Pagani; Goncalves-Netto, Lopez-Val, Mawatari, Plehn, Wigmore, Gavin, Hangst, MK, Mühlleitner, Pellen, Popenda, Spira

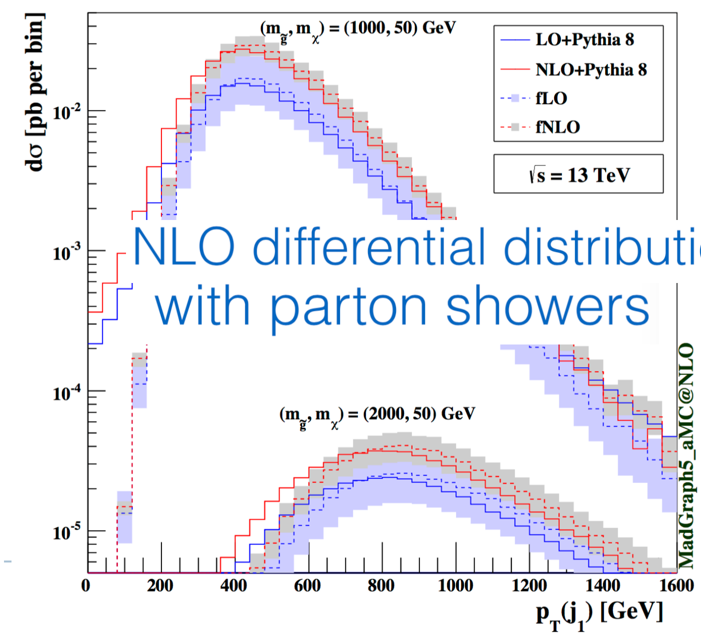
EWK corrections (EWK loops, EWK x QCD, γ-induced processes)

→ model dependent

→ O(few %) for inclusive cross sections

→ more significant for specific processes and large Q^2

see e.g. Hollik, Lindert, Mirabella, Pagani (1506.01052 [hep-ph]) and references therein



NLO differential distributions with parton showers

Squark and gluino production: tools

Prospino, NLL-fast, MadGolem, sPOWHEG, MadGraph5_aMC@NLO, …

The LHC SUSY cross section working group

will

- provide an update of the SUSY cross section recommendation at NNLL, and including recent pdfs;
- quantify the difference between Mellin space ↔ SCET resummation;
- collect benchmark results for EWK corrections;
- provide links to NLO SUSY tools, together with benchmark results for validation.

Squark and gluino production

A lot of effort (> 20 years) went into calculating higher-order QCD corrections for squark and gluino production

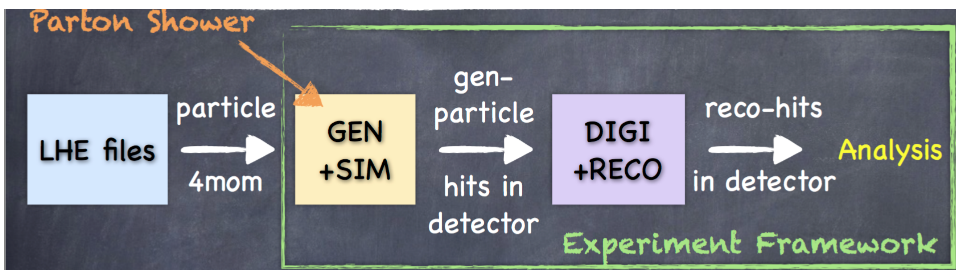
The theoretical uncertainty for inclusive cross sections is $\lesssim$ 15%, and is now dominated by the pdf error

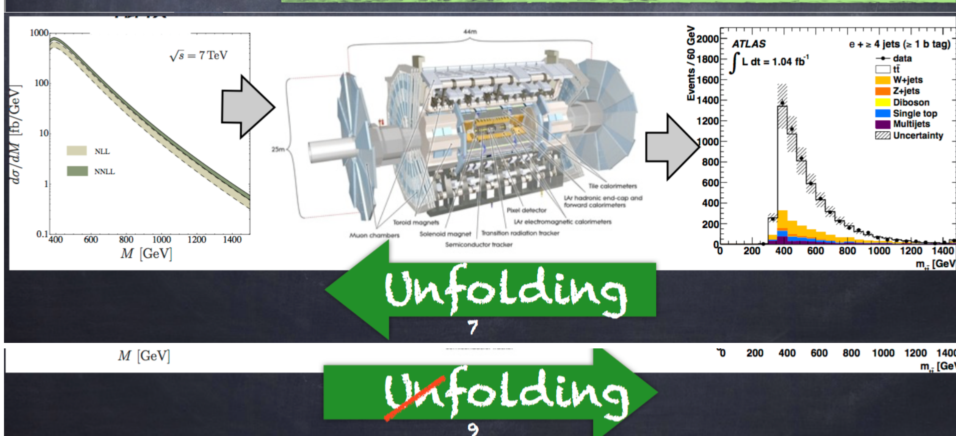
In the future, we need to work towards automated NLO calculations for more generic models, including NLL resummation

Exotica Monte Carlo and formats for reporting results

Maurizio Pierini

- Three messages to convey
  - Common repository for MC samples (a new MCDB)
  - Official detector simulation to fold detector effects
  - (Even better) supporting RECAST to use official MC/analysis tool (also good for long-term preservation)

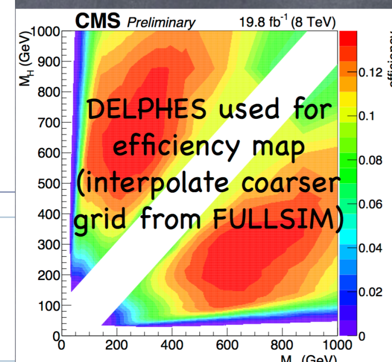


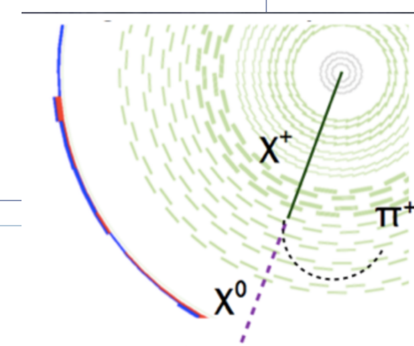


An Official Detector Parameterisation?

- Often, inaccuracy on detector resolution is the perturbation
- Sometimes the signature is more detector specific

CMS-PAS-HIG-15-001





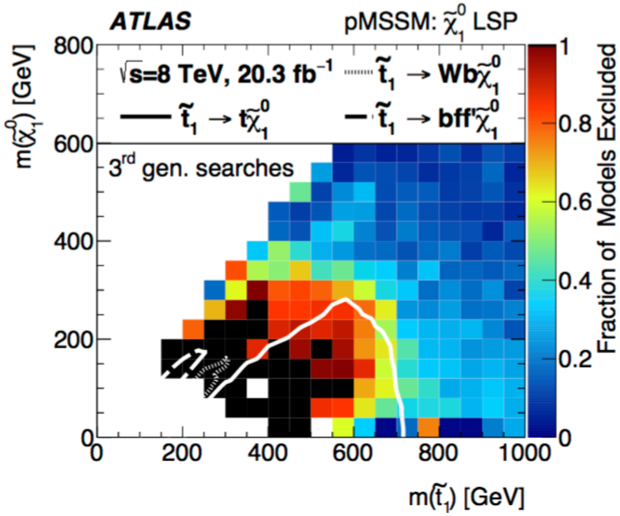
Having the likelihood, would be IMPORTANT

- For the Experiments:
  - use of LHE files makes easier to integrate generators in experimental frameworks
  - **A common repository** (of LHE files? Gridpacks? UFOs?) would be very beneficial (for analyses and phone studies). A new life for MCDB?
- For Pheno studies:
  - for plain signatures, fastsim MC codes exist
  - integrated with **official detector tuning** by ATLAS & CMS
  - BUT sometimes a "good-enough" fastsim is not enough (e.g. exotic signatures)
- The ultimate solution:
  - a system like **RECAST** would solve the problem of re-producing and re-interpreting results.
  - With a complete RECAST library and enough CPU resources all phone needs would be covered
- Our community should (in my opinion) push **in these directions** more

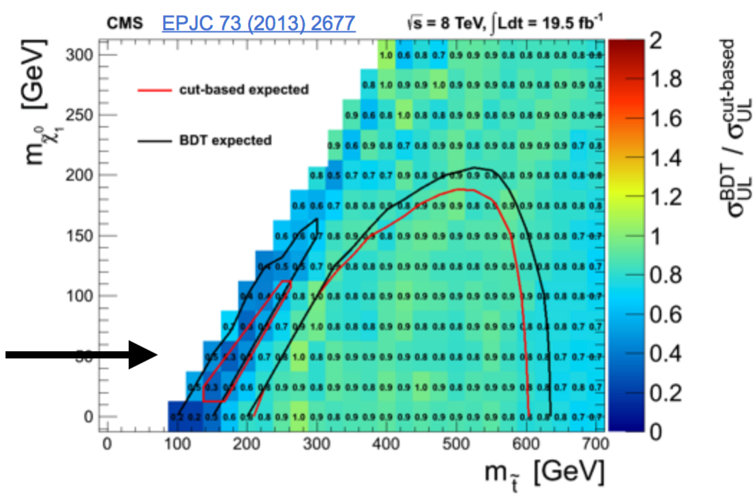
SUSY MC and formats for reporting results

Benjamin Nachman

Complete models



Simplified models



- **Theory Systematic Uncertainties**

  ATLAS: use uncertainties from LHC XS WG (1407.5066)

  CMS: 10% for PDF (based on 100 NNPDF variations), independent fact. and ren. scales, ISR modeling (next slide)

- **(Extra) Radiation**

  ATLAS: Vary ISR/FSR in Pythia for sensitive models/selections only

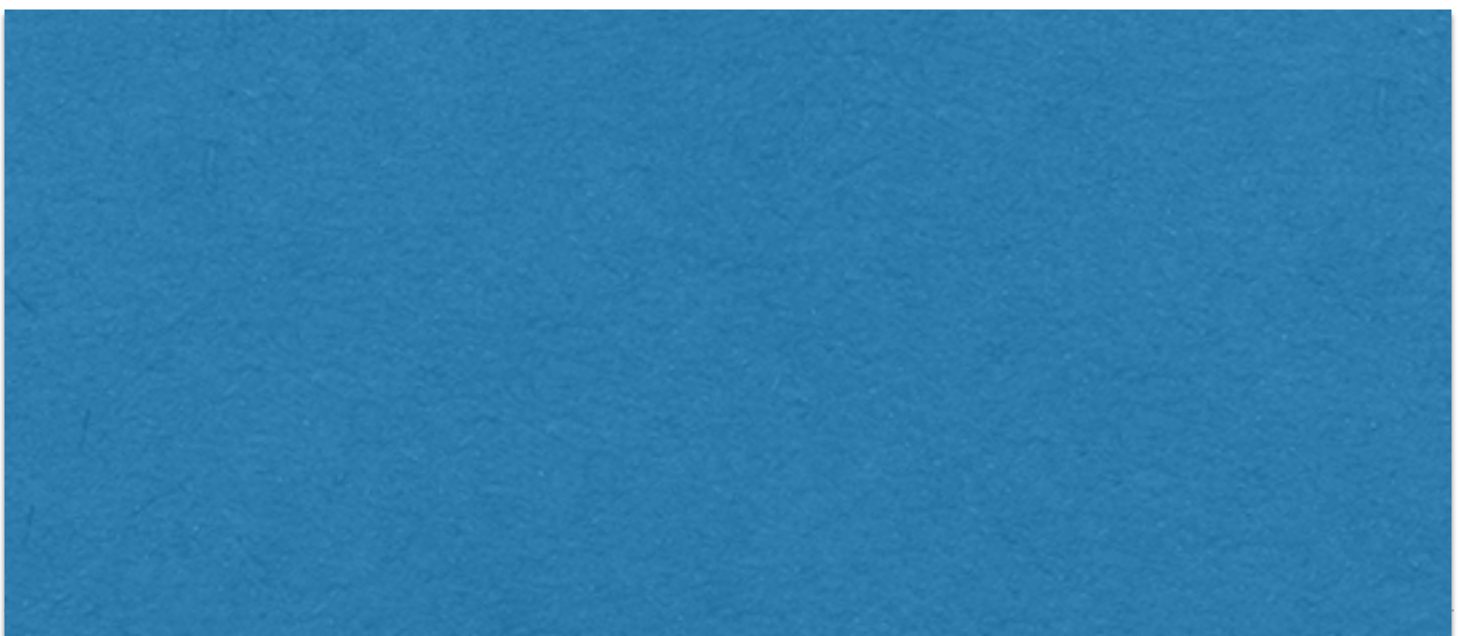
  CMS: (Re-weight*) and take the uncertainty from Z+recoil and ttbar+recoil measurements

- Both **ATLAS** and **CMS** use unpolarized decay and then re-weight after-the-fact (not the case for ATLAS in Run I)

- **Saving Generation Time: Matrix Element Calculations**
  Detector Sim *Generator Filters*
- **Truth Definitions** The definitions are very similar between **ATLAS** and **CMS**, and likely for SUSY searches the subtle differences are not important.
- **Presentation of results**

Repo for plots and tables: HepData

Repo for plots and tables: CMS public twiki (ROOT files)



Theoretical status and progress of jet substructure

Gavin Salam

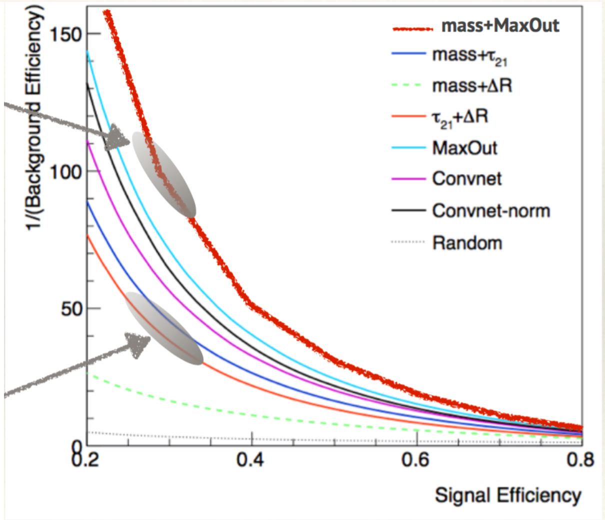
Principles

#1: the jet mass, a fragile observable.

#2: QCD gluon emission is soft; V/H→qq is not

#3: Radiation patterns differ in V/H/top v. QCD

Computer-vision

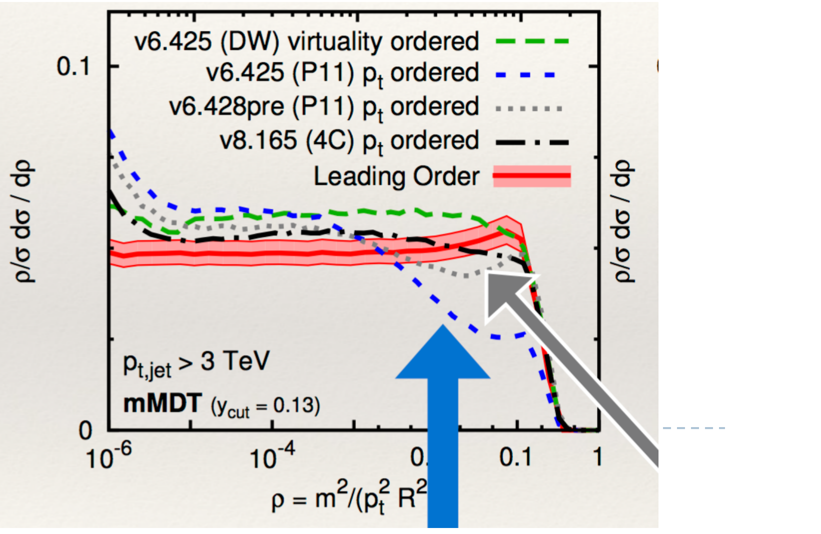


What theory aims?

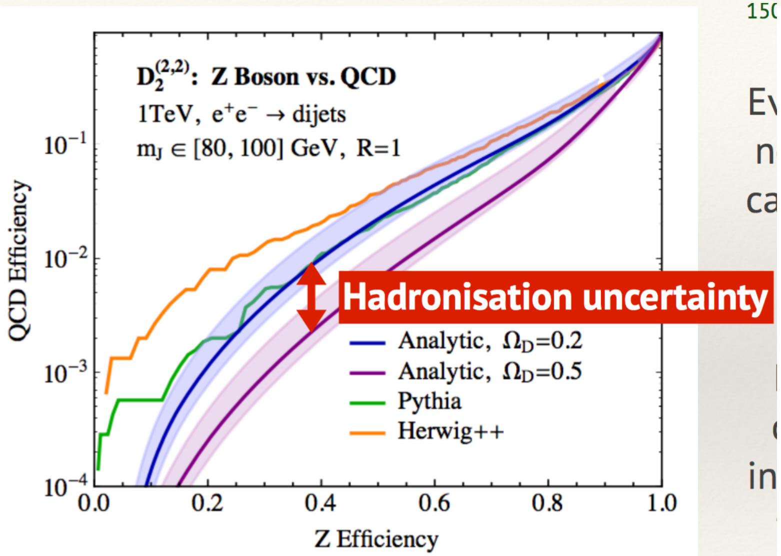
- Develop more powerful methods for discriminating signal/ background
- Understand what physics various "taggers" are actually tagging on:
  - to know whether it's reliably modeled by MCs
  - to know what "features" tagging might induce in data
  - as a guide to developing better tools & for predicting signals & backgrounds

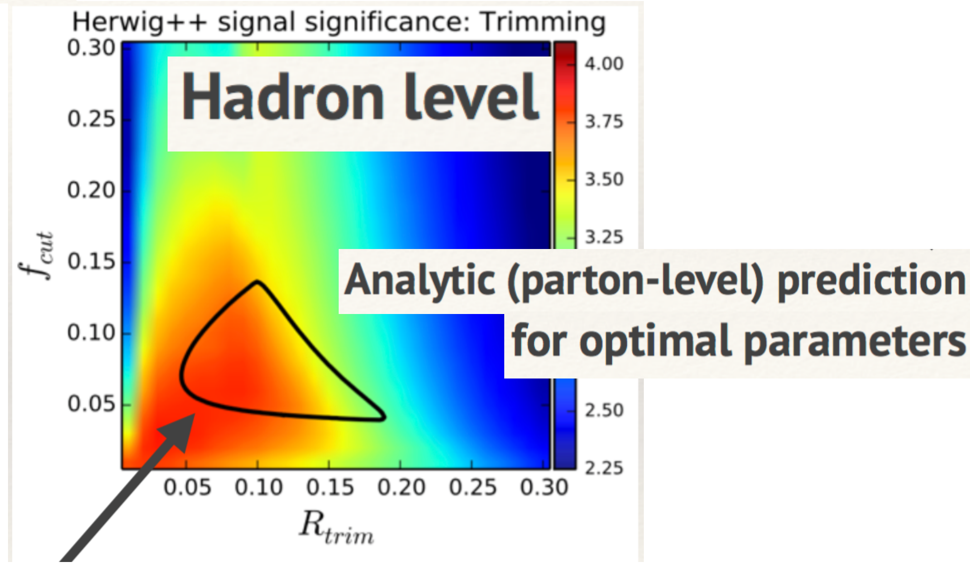
Event generators play key role in testing methods

& theory calculations may teach us things about event generator

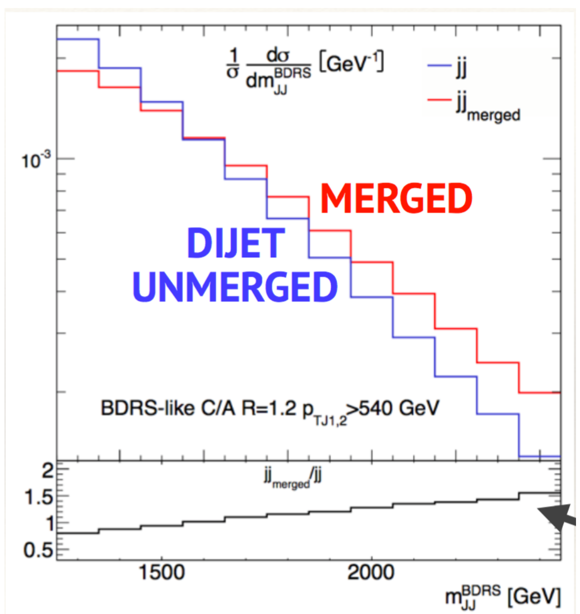


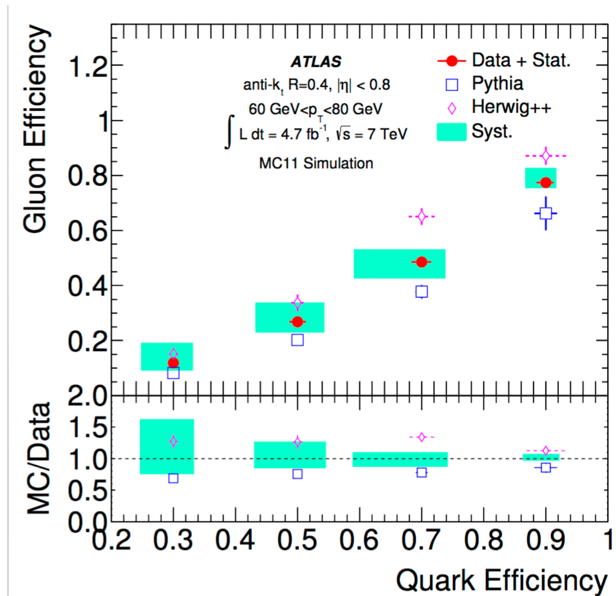
Better discrimination?





Questions



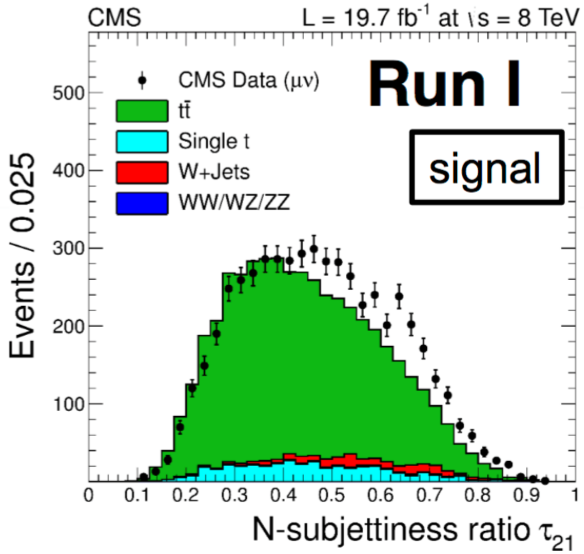


proper evaluation of theoretical uncertainties

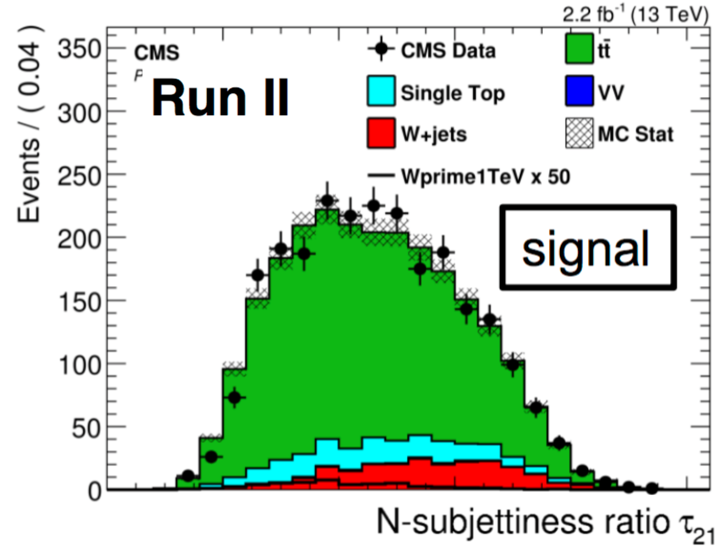
Jet Substructure Tools in CMS

W/Z/H/t

Matthias Mozer

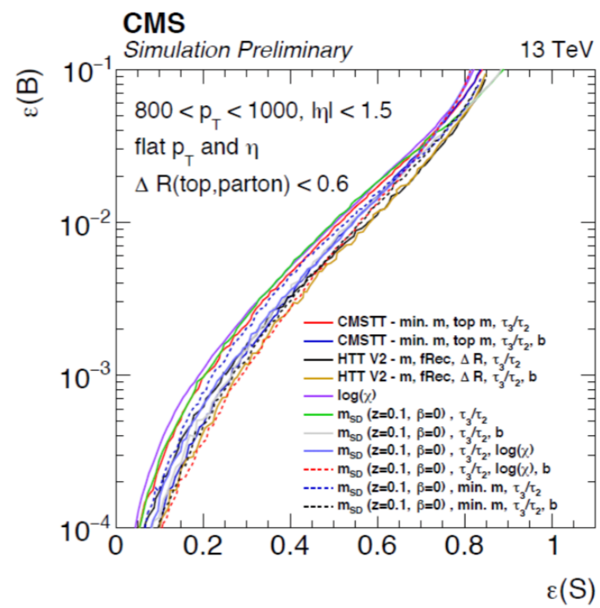


updated:
- reco
- simulation
- Pythia version



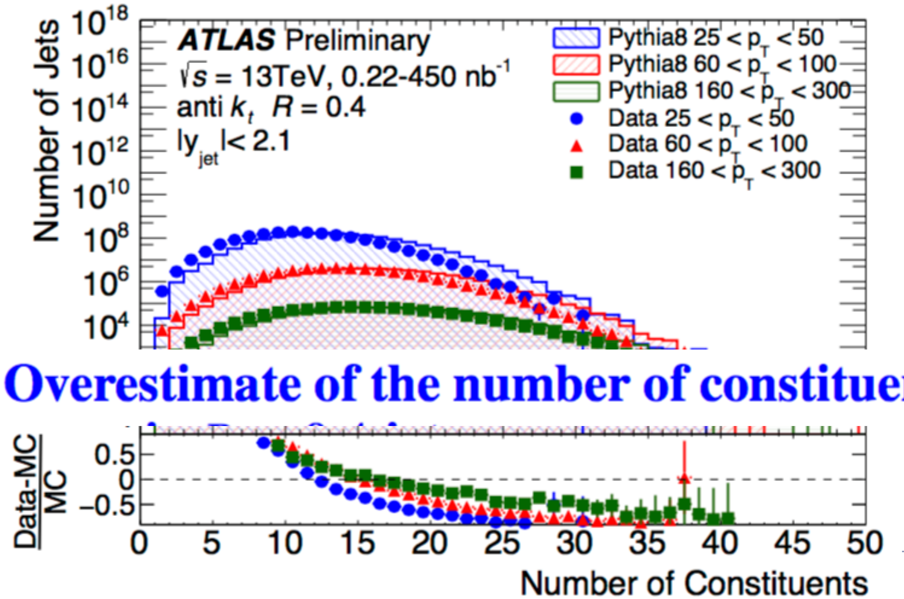
Run II plans

- Significant gains from MVA
  => will need more commissioning work
- Complete revamp **for subjet b-tag**
- CMS-Top-tagger (updated)
- softdrop + PUPPI jet masses



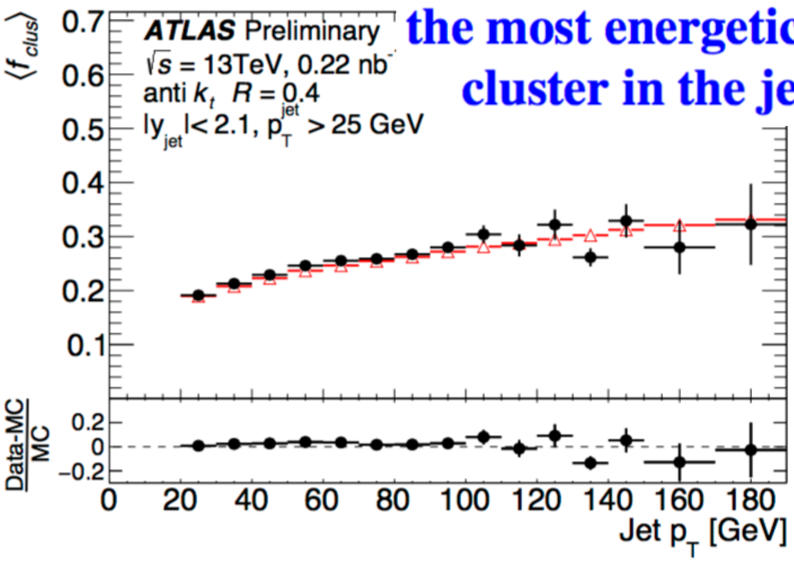
Boosted searches and merged-jet techniques in ATLAS

David W. Miller,



Overestimate of the number of constituents

Accurate description of the fraction of the most energetic cluster in the jet,



- **Accurate description at detector-level of the calorimeter jet width across a substantial range in p_T using the A14 tune**
- **Accurate description of the jet p_T and D_2 in a W/Z+jets dominated final state**
- **Excellent modeling of both the jet mass and τ_{32} for trimmed jets with $p_T > 300$ GeV**
- **Excellent modeling of both the jet mass and D_2 for trimmed jets with $p_T > 200$ GeV**

Closing remarks

- ***Aim of this workshop**: have a workshop focused on the discussion of the status, issues, needs and prospects for further development of the MC generators for LHC physics.*
- ***Outcomes**: establish common strategies where possible, follow up with theorists the several improvements on the market, have the best set up for generators to get the best out of 2016 analyses*
- ***Action items:** ATLAS/CMS representatives will follow up with theorists and groups on the various topics discussed*

Thanks for the great workshop and in particular to all speakers!