Summary of ATLAS MC Tools

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Existing MC Tools on ATLAS

- For LO MC Generators, MRST2007-LO* pdf is used.
- For NLO, CTEQ6.6 is used for MC@NLO
  - Parton showering was done through HERWIG/JIMMY
  - The established tunes were done using HERWIG/JIMMY for CTEQ6.6
- UE and MB tunings were done for PYTHIA and HERWIG/JIMMY

Versions of MC Tools

- HERWIG: 6.510
- JIMMY: 4.1
- PYTHIA: 6.421
- MC@NLO: 3.41
- MadGraph: 4
- ALPGEN: 2.13
  - Use HERWIG/JIMMY for PS/MPI
- POWHEG
  - Interfaced to both PYTHIA and HERWIG
- SHERPA:1.0.8
- RIVET: 1.2.0a0
- AGILe:1.1.4
- PROFESSOR?
- HDECAY for BR calculations
- PROPHECY4f

SM MC Parameters Used in ATLAS

Parameter	ATLAS Higgs = LHC H x-sec group	ATLAS MC
PDF	MSTW2008/CTEQ6.6 (NLO)	MSTW2008/CTEQ6.6 (NLO)
M_t	172.5±2.5 (GeV)	172.5±2.5 (GeV)
M_b	4.75	4.95
M_c	1.40	1.55
M_W	80.398	80.403
M_Z	91.1876	91.1876
Γ_W	2.141	2.141
Γ_Z	2.4952	2.4952
M_u	0.190	0.32
M_d	0.190	0.32
M_s	0.190	0.5

Some minor differences between ATLAS common SM MC parameter set vs Higgs

Higgs NLO MC Tools @ ATLAS

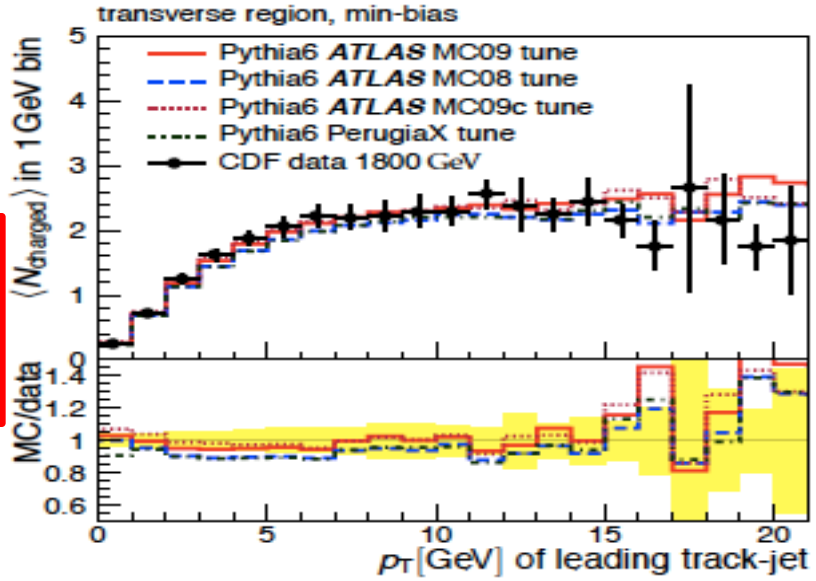
Name	Order	Mode	Channel
HIGLU	NLO	inclusive	ggF
Hpro	NLO	exclusive	ggF
MCFM	NLO	exclusive	ggF, WH/ZH
VV2H	NLO	inclusive	VBF
V2HV	NLO	inclusive	WH/ZH
VBFNLO	NLO	exclusive	VBF
CDD	NLO (QCD+EW)	No H decays	VBF
HQQ	NLO(?)		ttH
4 flavor	NLO	Exclusive	MSSM Neutral H
Feynhiggs	NLO	Exclusive	MSSM Charged H
HggTotal	NNLO	Exclusive	ggF
De Florian & Grazzini	NNLO	Inclusive	ggF
HEPLiP	NNLO	Exclusive	ggF
HNNLO	NNLO	Exclusive	ggF
5 flavor	NNLO		MSSM Neutral H

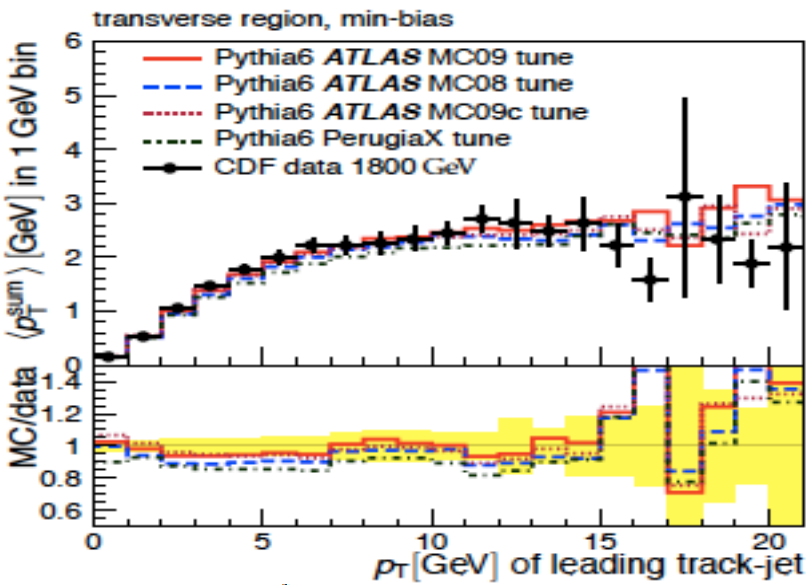
MC09 Tune – PYTHIA6

- Newest version of the color connection
- Bowler fragmentation function for heavy quarks
- Latest tune to LO*PDF set derived based on previous MC tunes ➔ Increased cut-off scale (PARP(82)) of 2.3GeV and rescale exponent (PARP(90)) to 0.25
- Significantly lower UE at the LHC energy than the previous version
- Tunes using PROFESSOR gives better description

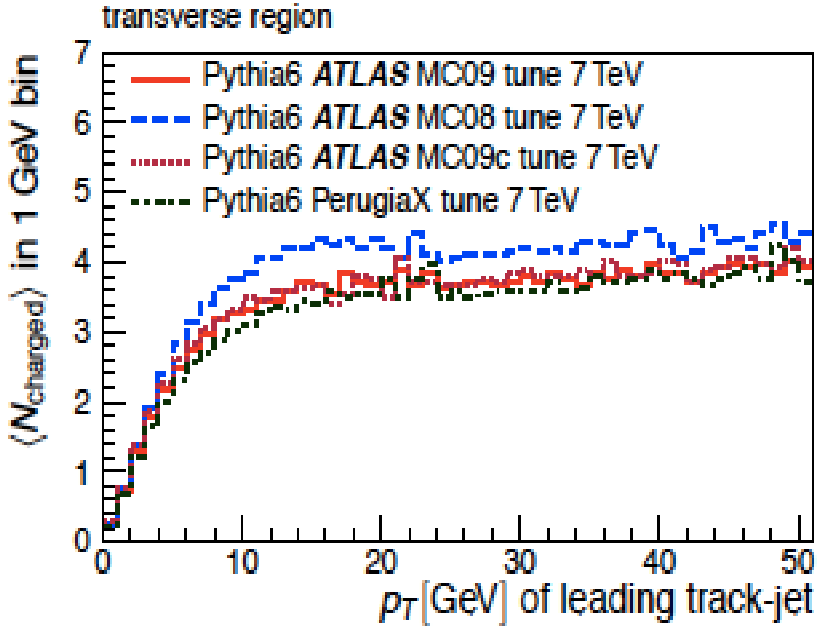
PYTHIA6 Tuning Performance

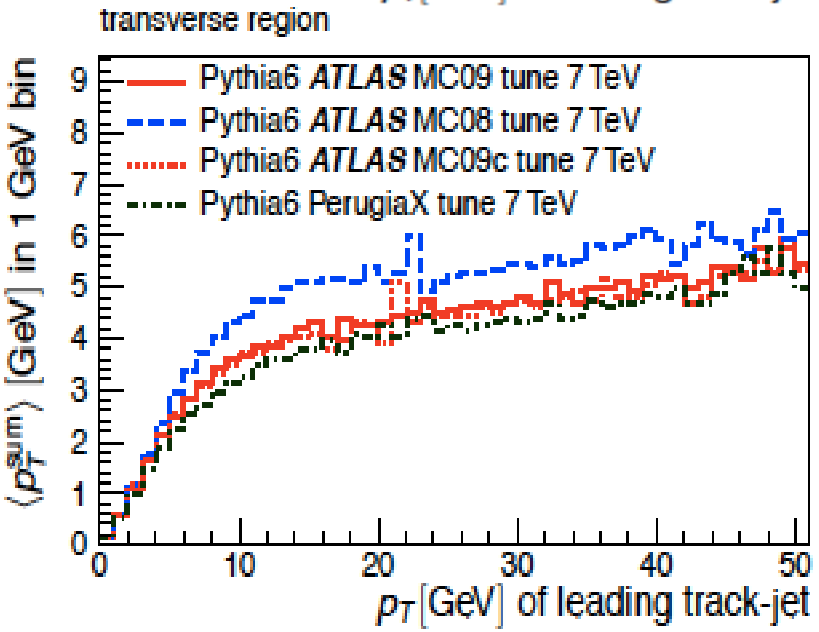
1.8TeV





7TeV



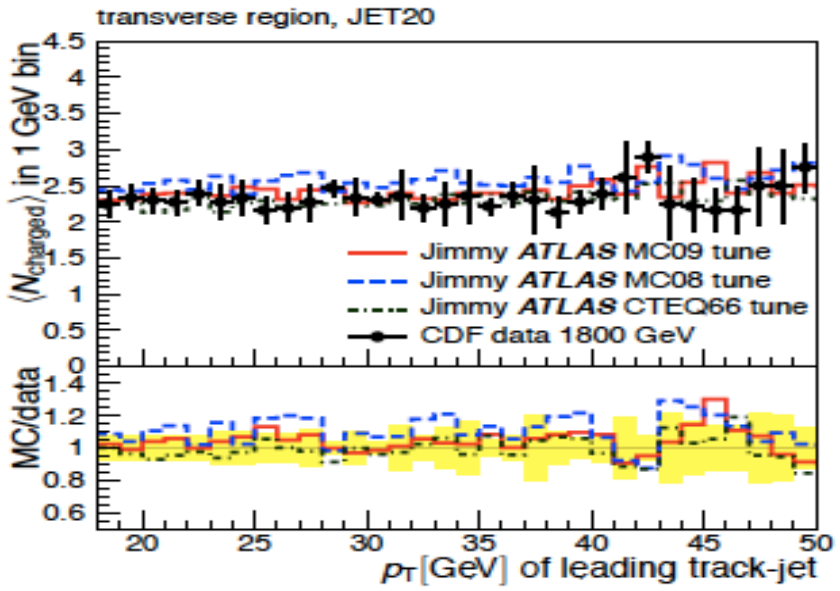


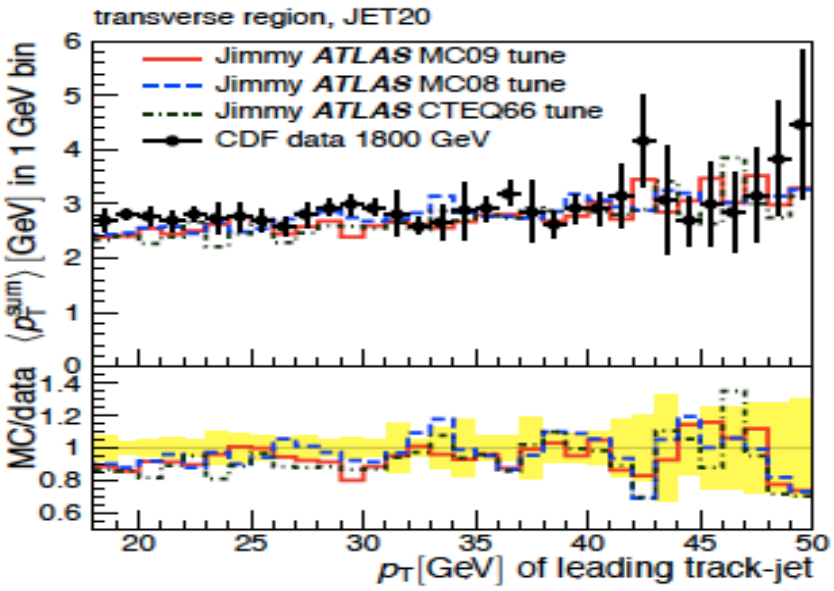
MC09 Tune – JIMMY/HERWIG

- Two parameters optimized comparing to TeVatron data
  - JMRAD(73) – had parton scatter probability
  - PTJIM: Cutoff for MPI
- Tune for LO*pdf: to correct for higher low-x g activity
  - PTJIM: $2.8(\sqrt{s}/1.8\text{TeV})^{0.274}$ → $3.6\text{GeV}(\sqrt{s}/1.8\text{TeV})^{0.274}$
  - JMRAD(73): 1.8→2.2
- Tune for CTEQ6.6 MC@NLO and POWHEG using PROFESSOR
  - PTJIM: $2.8(\sqrt{s}/1.8\text{TeV})^{0.274}$ → $3.14(\sqrt{s}/1.8\text{TeV})^{0.274}$
  - JMRAD(73) 1.8 → 2.64

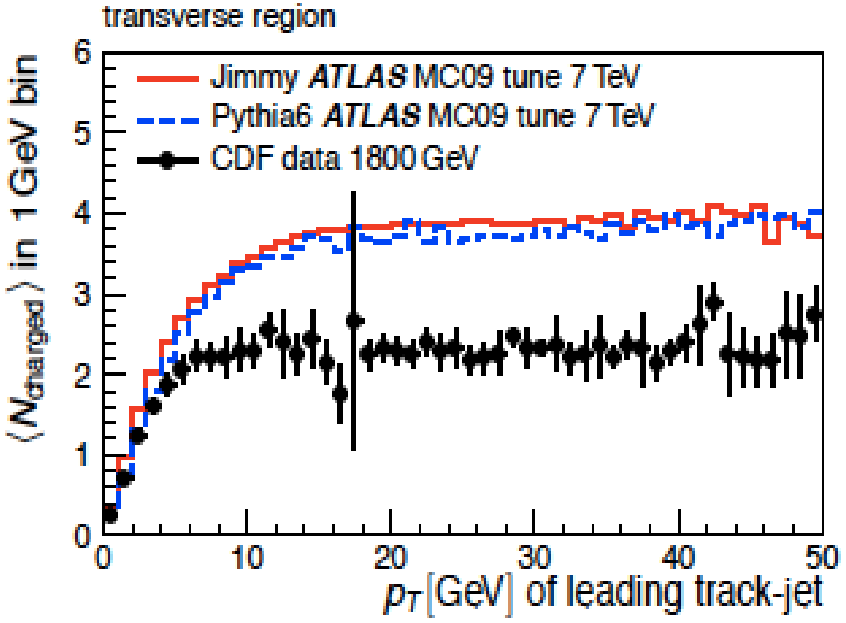
HERWIG/JIMMY Tuning Performance

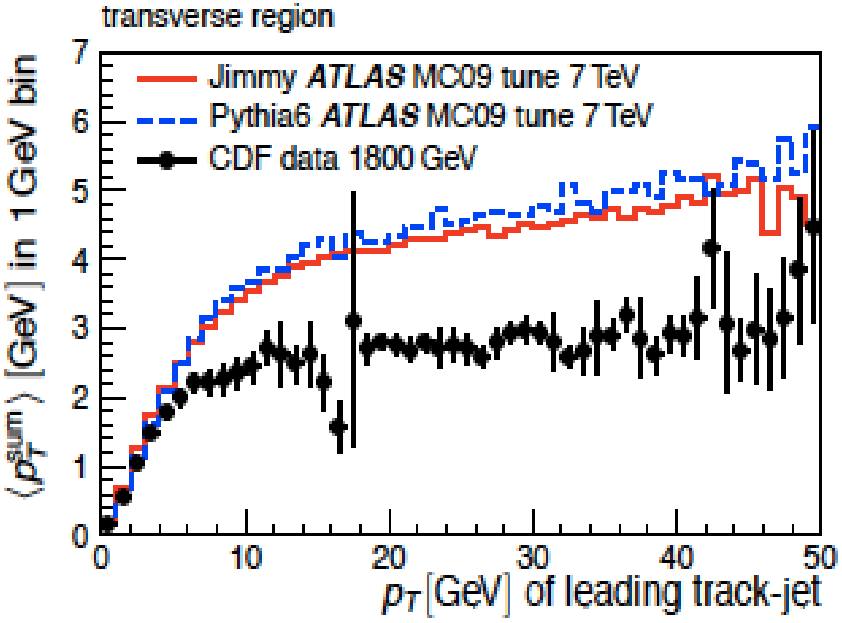
1.8TeV





7TeV

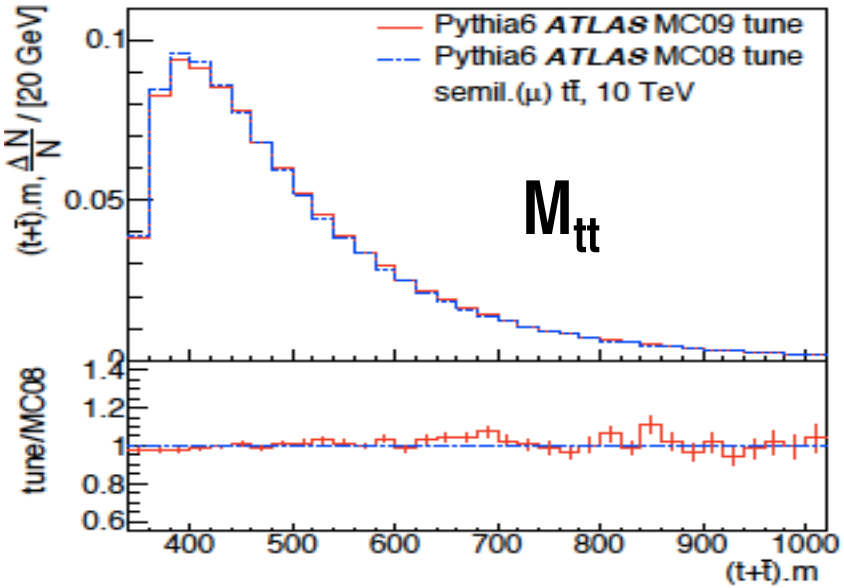


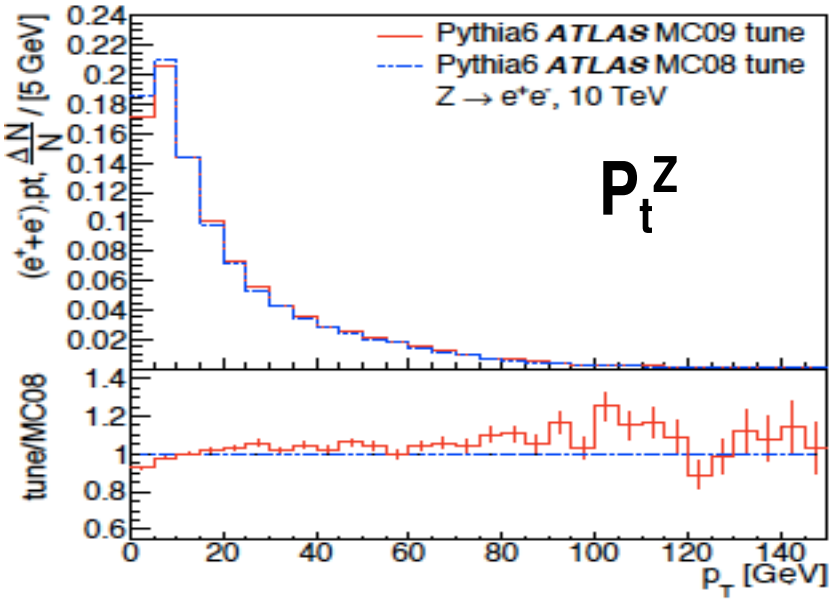


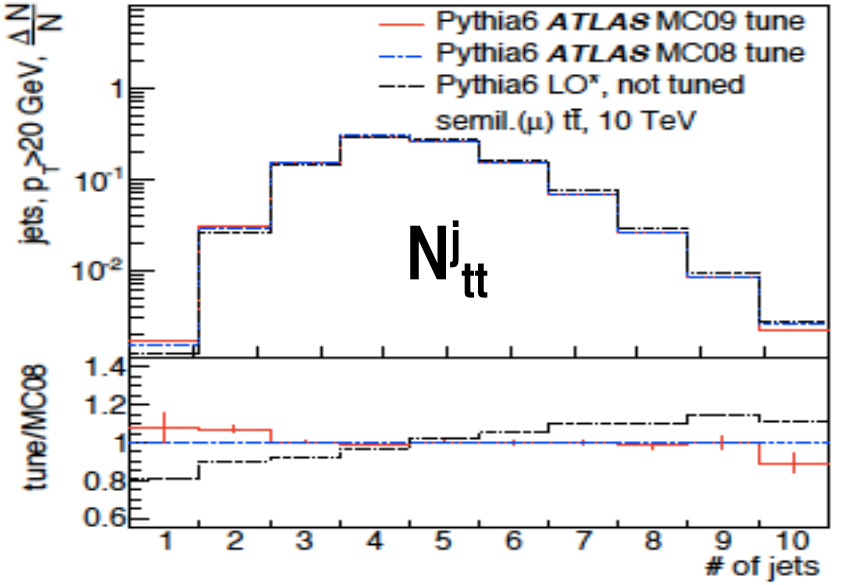
MC09 Tune Validation

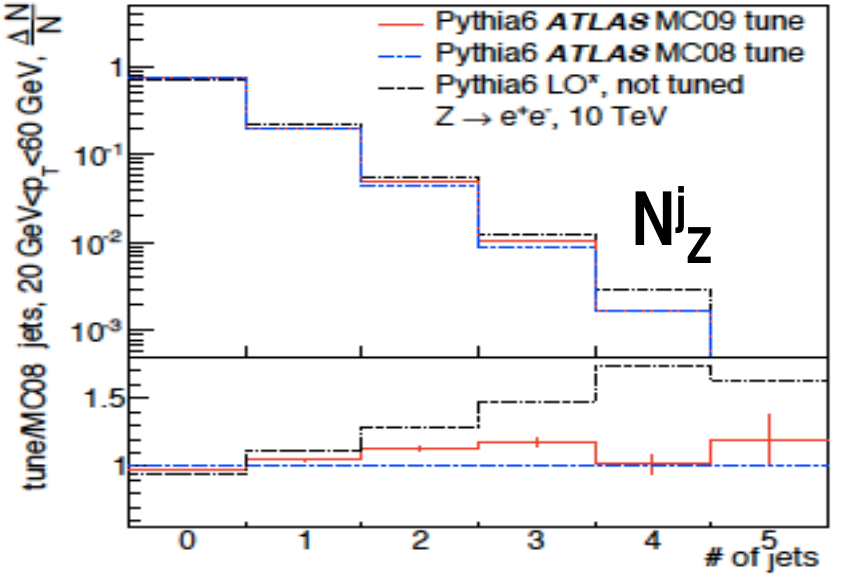
- PYTHIA 6.421 w/ LO*MRST2007lomod
- Processes: tt, DY ($Z \rightarrow ee$) and LQ production
- $\sqrt{s}$=10TeV
- Cone jet algorithm (R=0.4) $|\eta|<5$, Pt>7GeV
- For DY, jets overlapping with e removed

MC09 Tune Validation









Summary

- Most of the advanced and popular MC tools are implemented in ATLAS
  - Including many NLO and NNLO x-sec calculators and generators
- Tunes need to be re-established as components in tools change
  - PDF changes
  - Order of calculation changes
  - New code and physics process inclusions
- MSSM MC tools not fully incorporated
- Some privately provided codes are used ➔ need to have more uniform prescription to incorporate them
- Flexibility of the tools
- Guaranteed access and consistency of theoretical tools by establishing a central repository
- Usability of the advanced calculations by turning them into event generators (preferably un-weighted)