LO* PDF tuning, performance and validation

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7. Jul. 2009

LO* PDF tuning, performance and validation

Motivation:
- description of shapes and hard process closer to NLO
- smaller K-factors (for some processes)
- up-to date PDFs (experim. data), smaller χ^2 ($0.001<x<0.1$)
- see e.g. A. Sherstnev, R.S. Thorne, Eur.Phys.J.C55:553-575,2008

Need to check:
- use for UE and min.bias (Perugia X, PROFESSOR tune)
- any problems in some areas of phase-space (very high-pt processes . . .)?

This talk:
- comparison to Tevatron and low energy data for UE and min.bias
- test of LO* PDFs for high-pt processes @ LHC energies
- current use for (Fortran) Pythia, (Fortran) Herwig + Jimmy, AcerMC
- using MRST2007lomod (LO* for MC), also briefly report on CTEQ LO*

Remarks:
- generator = Fortran Pythia (new PS/MI used @ ATLAS) unless specified otherwise
- generator level
- MC08, MC09 : ATLAS Pythia parameter sets (see next page)
- work of many people, presentation bias twd. high-pt, tT (L.M.)

Pythia tunes parameters, tech. info and references

Pythia (6.4.20) tune parameters:

parameter	MC08 (CTEQ6L1)	MC09 (MRST LO*)
mstp(81)	21	21
mstp(82)	4	4
mstp(52)	2	2
mstp(51)	10042	20650
pmas(6,1)	172.5	172.5
pmas(24,1)	80.403	80.403
pmas(24,2)	2.141	2.141
pmas(23,1)	91.1876	91.1876
pmas(23,2)	2.4952	2.4952
mstp(70)	0	0
mstp(72)	1	1
mstp(88)	1	1
mstp(90)	0	0
parp(78)	0.3	0.3
parp(80)	0.1	0.1
parp(82)	2.1	2.3
parp(83)	0.8	0.8
parp(84)	0.7	0.7
parp(90)	0.16	0.25
parj(81)	0.29	0.29
mstp(95)	1	6
mstj(11)	3	4
mstj(22)	2	2
parj(41)	/	0.3
parj(42)	/	0.58
parj(46)	/	0.75
parj(54)	-0.07	/
parj(55)	-0.006	/
mstp(84)	1	1
mstp(85)	1	1
mstp(86)	2	2
mstp(87)	4	4
mstp(89)	1	1
parp(89)	1800.	1800.

Generators versions:
- Pythia 6.4.20 (UE, min. bias)
- Pythia 6.4.21 (high-pt)
- AcerMC 3.6
- Jimmy 4.31
- Herwig 6.510
- MC@NLO 3.1

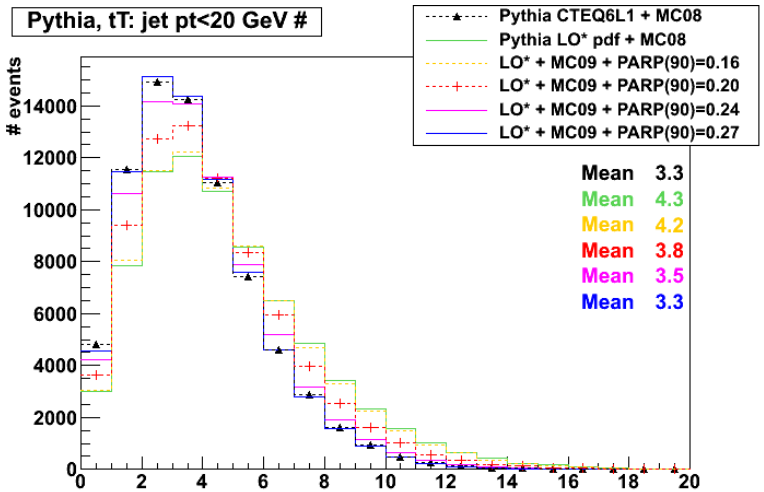
Software:
- Rivet for UE, min. bias plots
- jets : ATLAS cone (04)

Analysis References:
- Leading Jets:
CDF Run I, PRD 65, 092002 (2002)
- Min-Max:
CDF Run I, PRD70, 072002 (2004)
- Min. bias:
CDF Run I, PRD 65 072005 (2002)

Tune References:
- Perugia Tunes:
FERMILAB-CONF-09-113-T
`home.fnal.gov/ skands/leshouches-plots/`
- PROFESSOR Tune:
arXiv:0906.0075v1

LO* for UE and min.bias data: increased soft activity

Observed: if LO* used with LO tune (CTEQ6L1,MRST2007lomod,MC08):
- increased soft jets # [large impact: PARP(90)]
- increased event-size ($\sim$ 20%) [large impact: PARP(82),PARP(90)]
- due to too much UE activity (indep. UE check)



Reminder:
PARP(82): MI(ISR) ptmin cutoff
PARP(90): PARP(82)$\propto E_{CM}^{PARP(90)}$

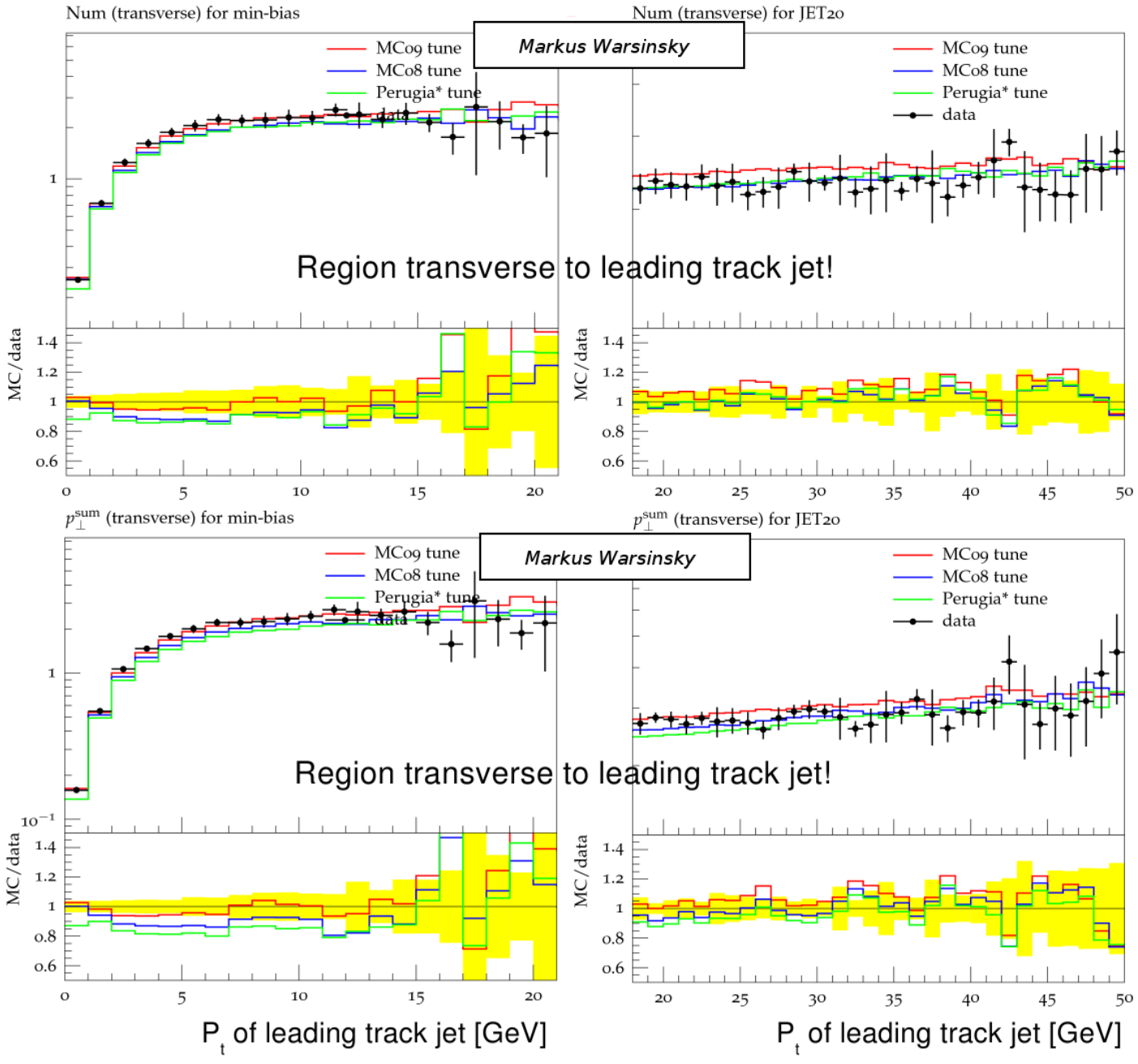
Check: soft activity: CTEQ6L1 + MC08 tune $\sim$ MSTW08 + MC08 tune

Perugia X very useful reference, but we have specific requirements

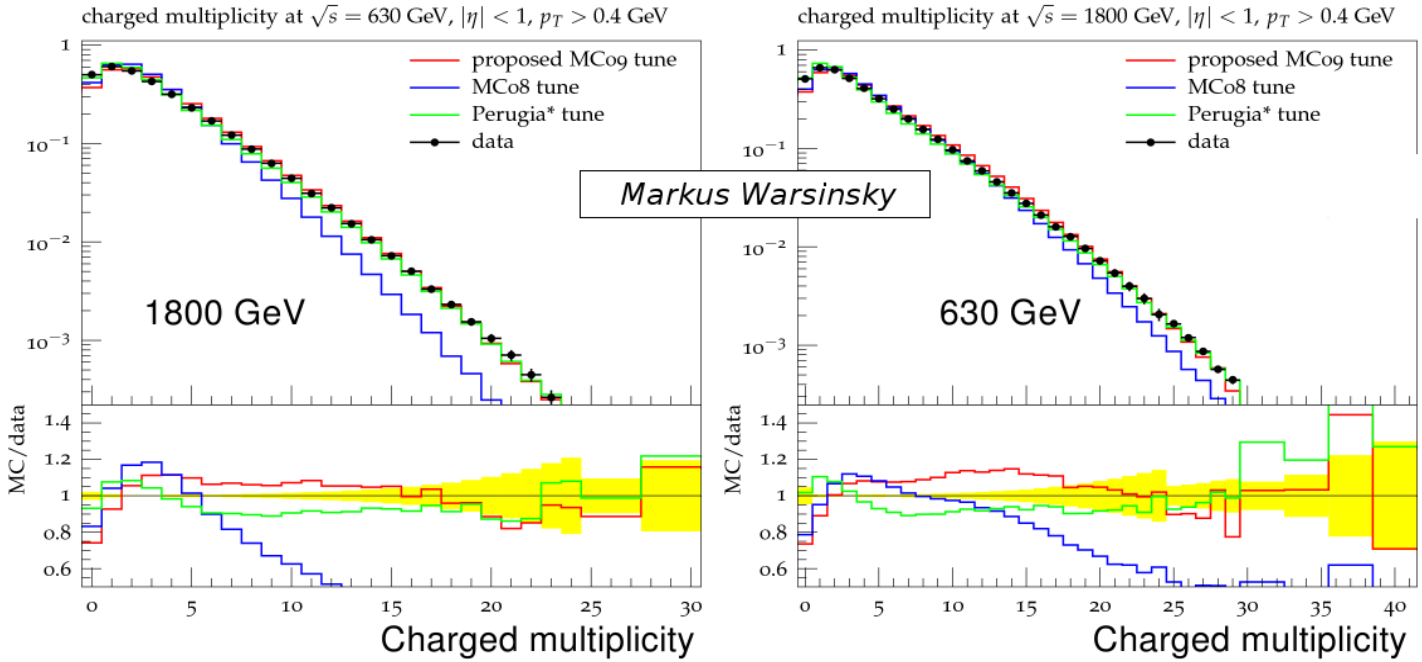
$\Rightarrow$ **Tuning**
- use MC08 as baseline
- ISR/FSR parameters left as in MC08 (if possible)
- b-fragmentation function tune

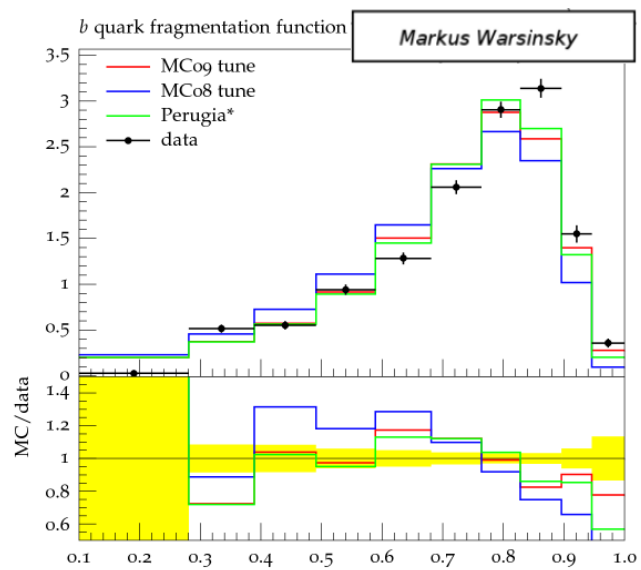
Result: MC09 tune

LO* for UE and min.bias data: MC09 - Leading Jets



LO* for UE and min.bias data: MC09 - Min. Bias and b-fragm.





Peterson → Lund-Bowler
compare to DELPHI CONF. NOTE: 2002-069-CONF-603
$r_b = r_c = 0.75$

Also: good news: Min.-Max. analysis problem solved, MC09: good description of the data.

LO* for UE and min.bias data: predictions for LHC

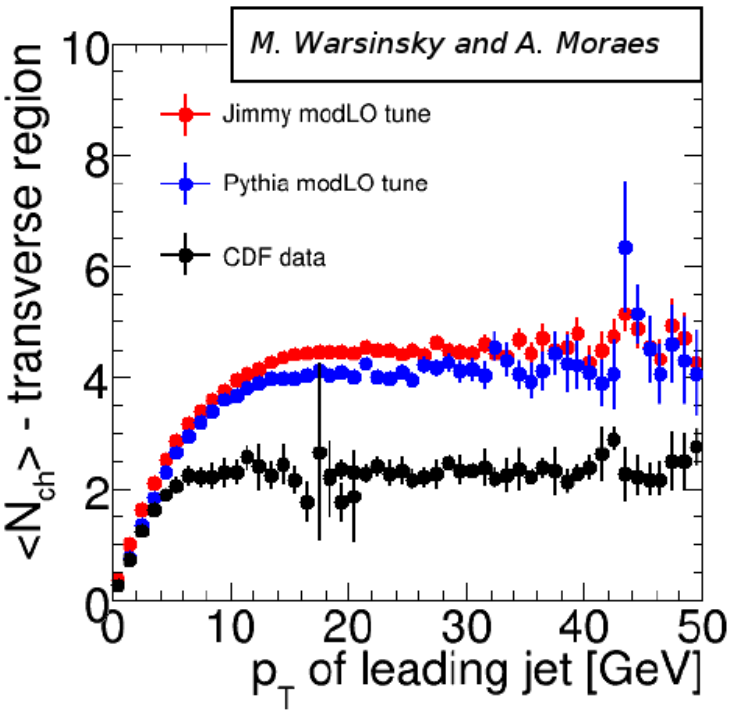
Status Summary:

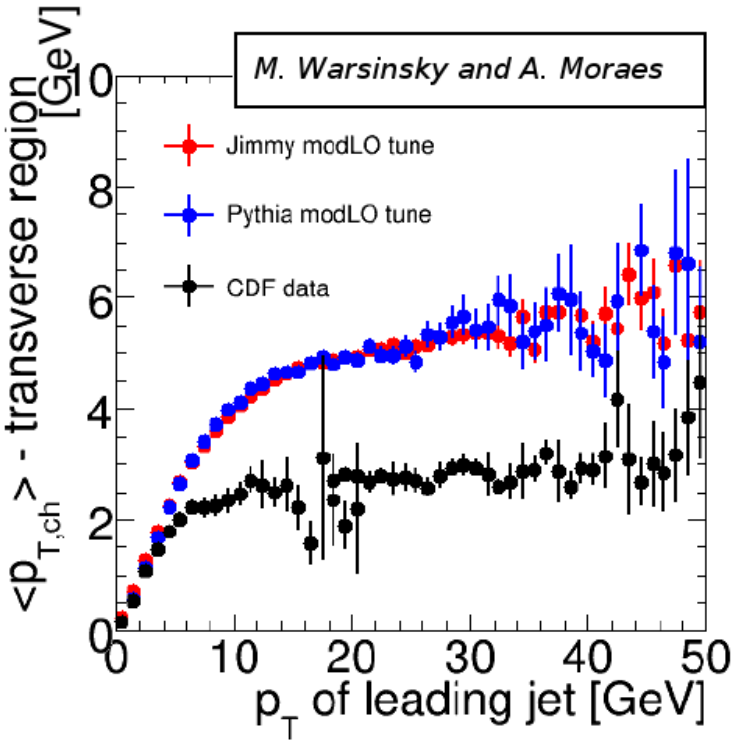
parameter sets that are able to describe UE and min.bias data have been identified for:

- LO* PDF: MRST2007lomod (LO* for MC)
- Jimmy 4.31 + Herwig 6.510
- Pythia 6.4.20 (6.421)

Predictions @ LHC energies (10 TeV):

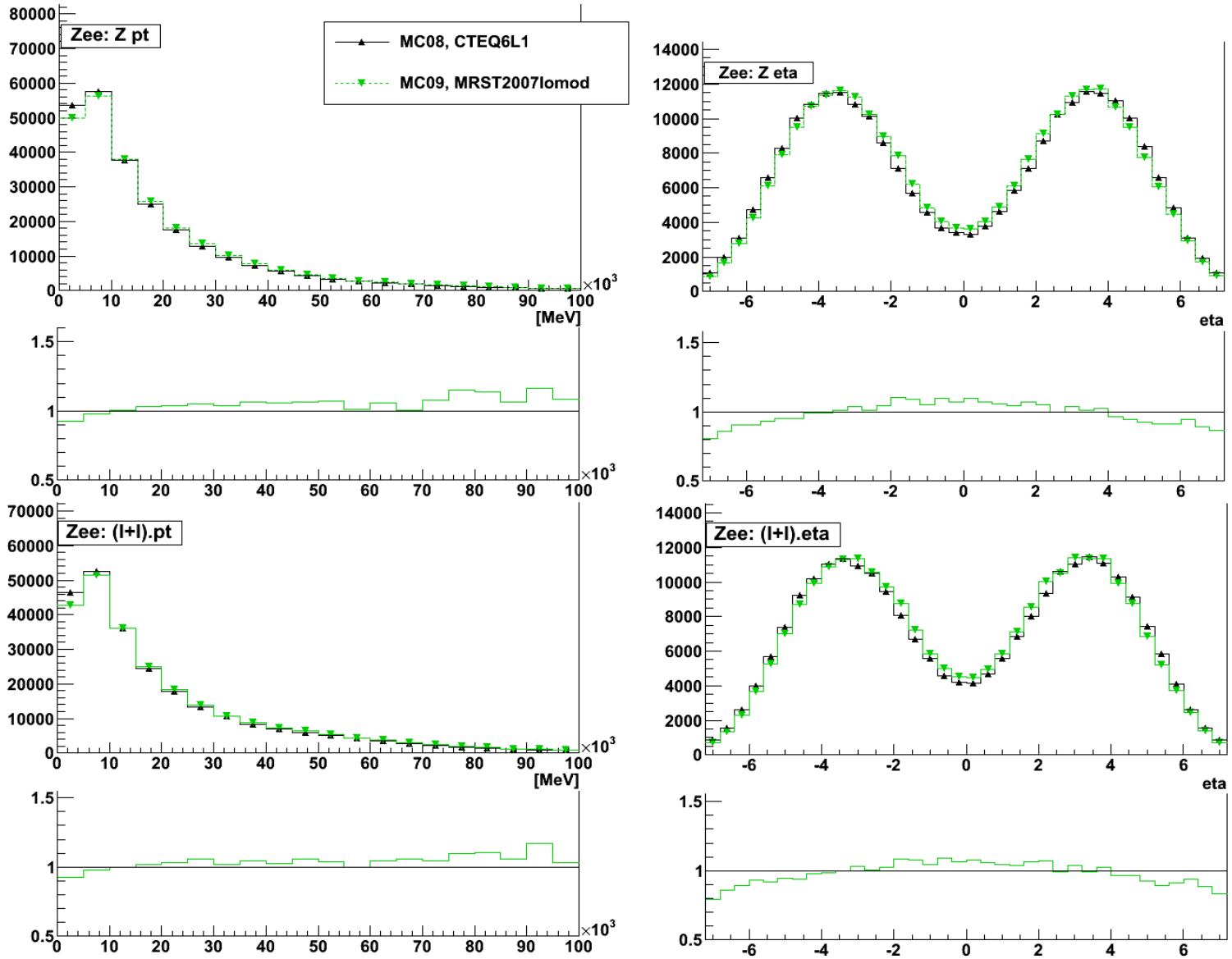
- strong dependence on power of energy rescaling of (MI) ptmin cutoff
- Fortran Pythia and Jimmy tunes: similar predictions for LHC energies
- $\sim$ factor of two more activity than at Tevatron energies





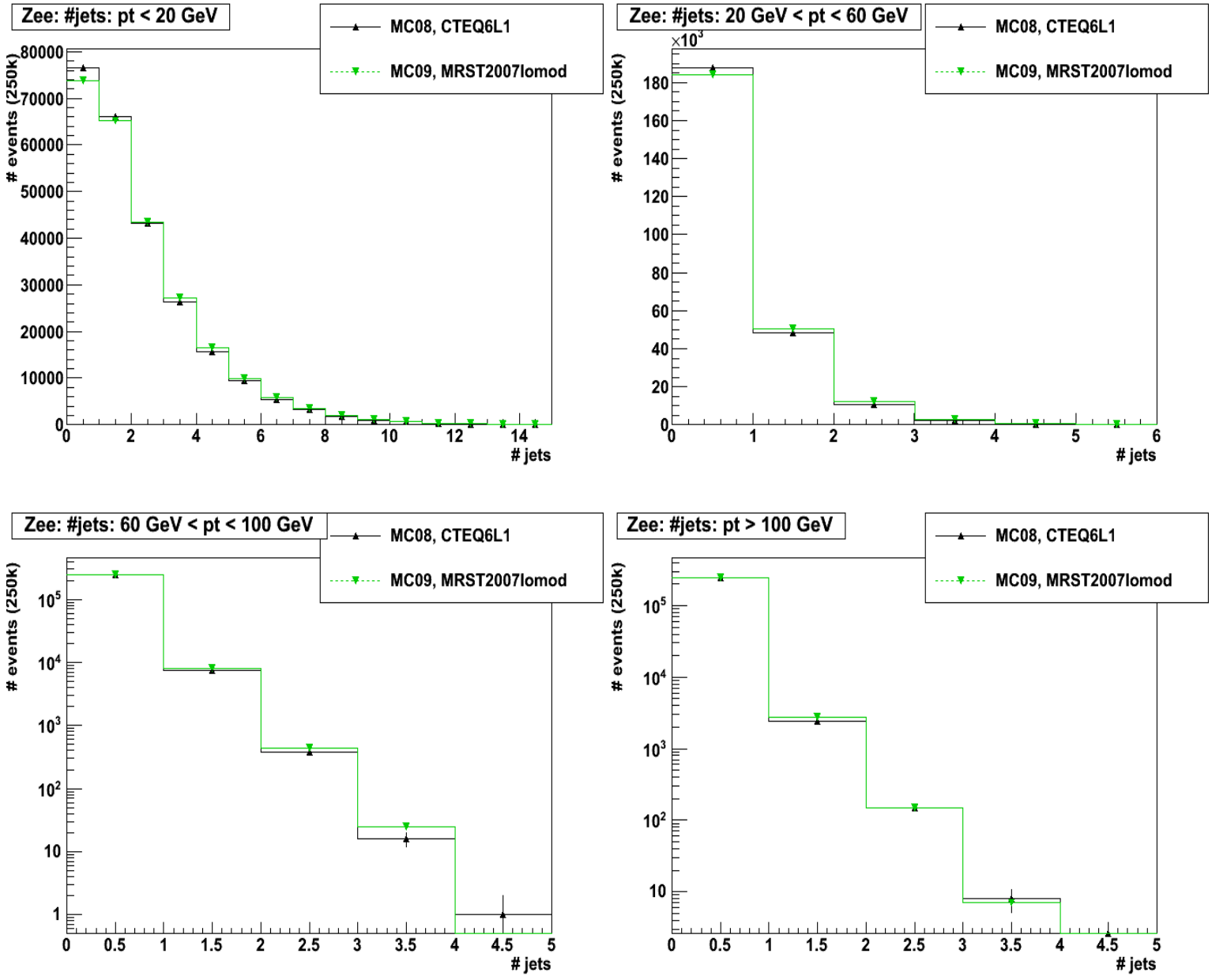
High-pt processes @ 10 TeV: Zee - 1

Z→ee, imass (CKIN(1)) >60 GeV, # l: pt>10.GeV≥ 1, η<2.7, 250k anal. events, no norm.



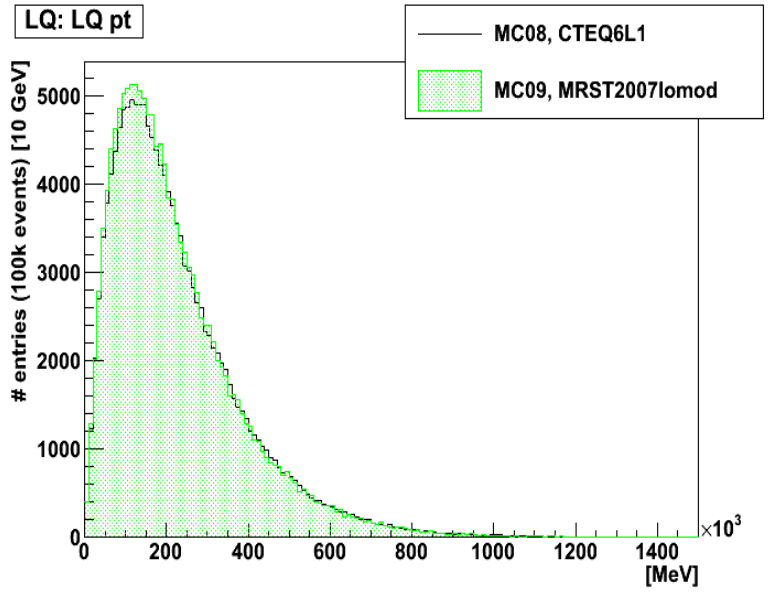
High-pt processes @ 10 TeV: Zee - 2

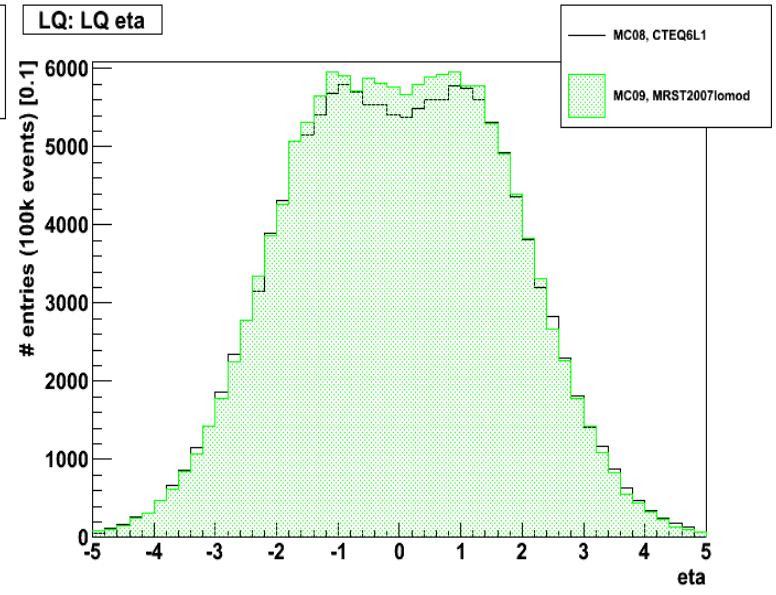
Z→ee, imass (CKIN(1)) >60 GeV, # l: pt>10.GeV≥ 1, η<2.7, 250k anal. events, no norm.

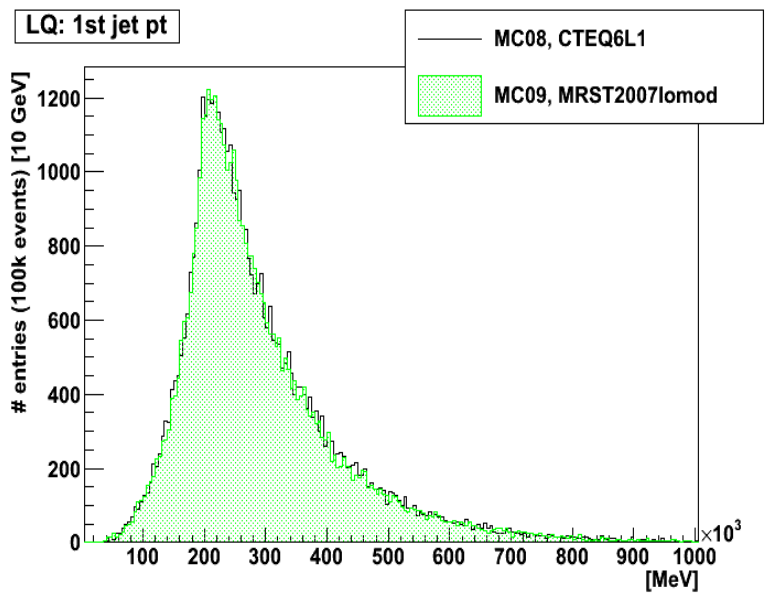


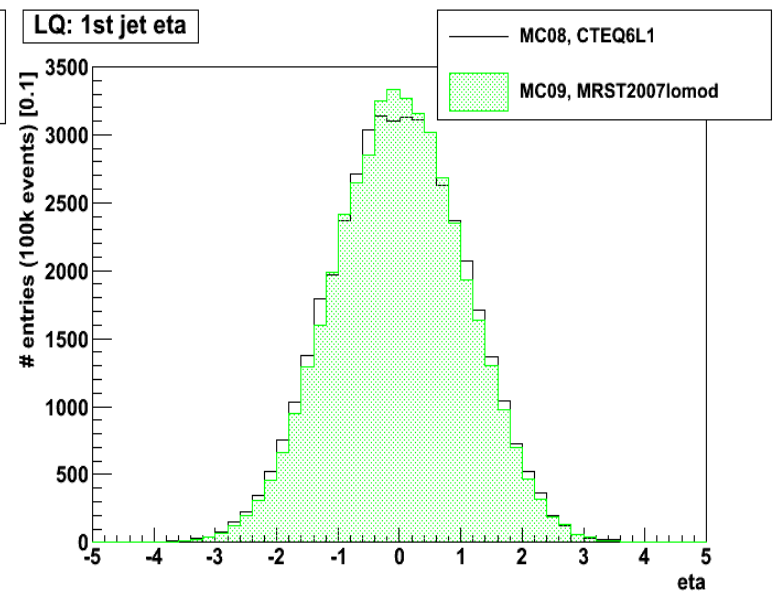
High-pt processes @ 10 TeV: LQ - 1

LQ (ue) production: qg→eLQ, gg→LQLQbar, qqbar→LQLQbar, LQ mass=400 GeV
100k analyzed events, el.-jet OL cone: 0.4









High-pt processes @ 10 TeV: LQ - 2

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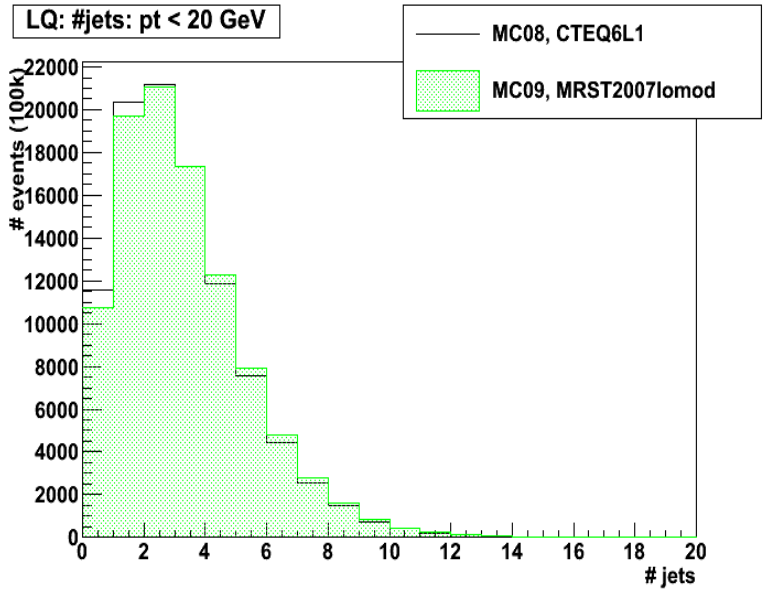
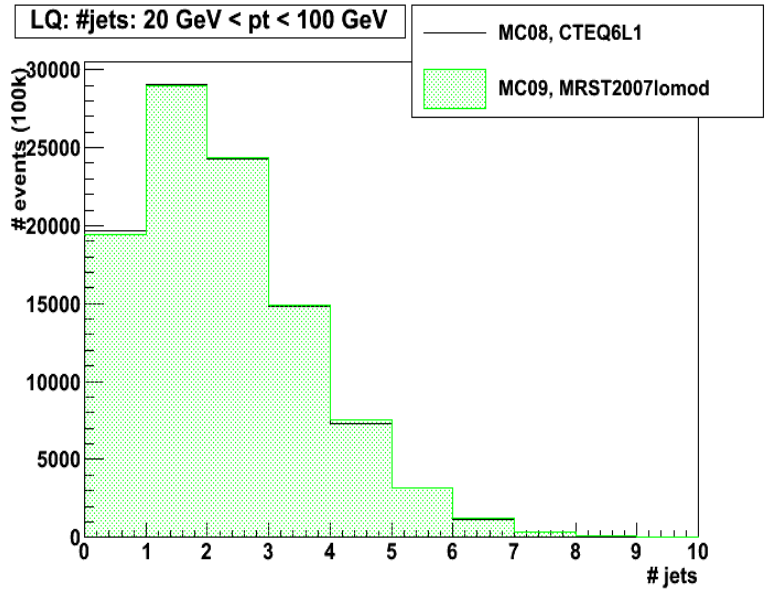
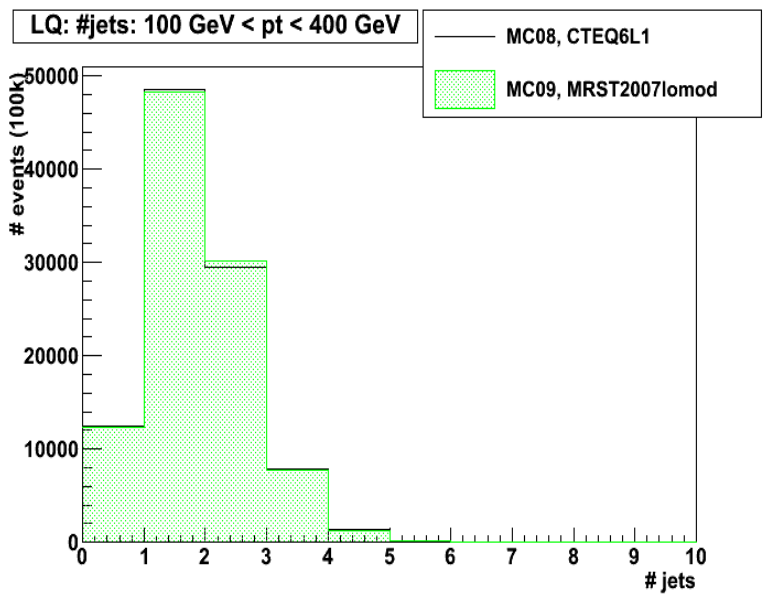
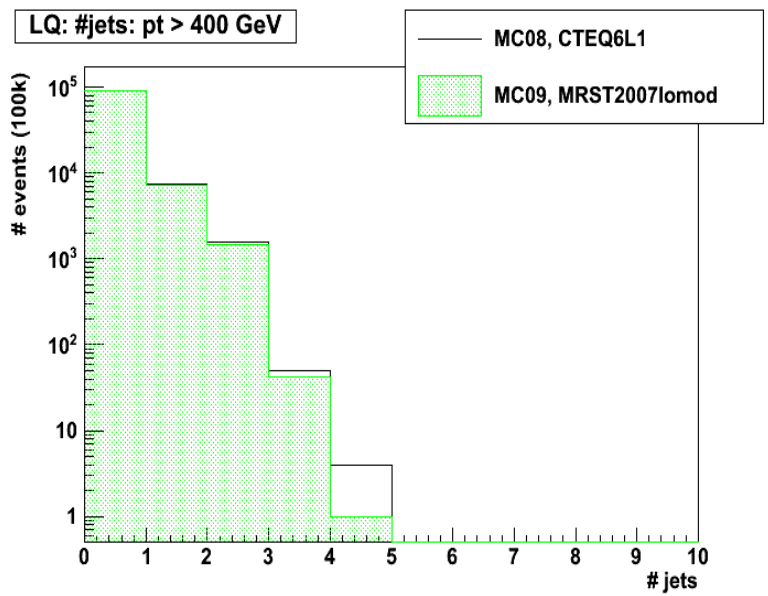
100k analyzed events, el.-jet OL cone: 0.4



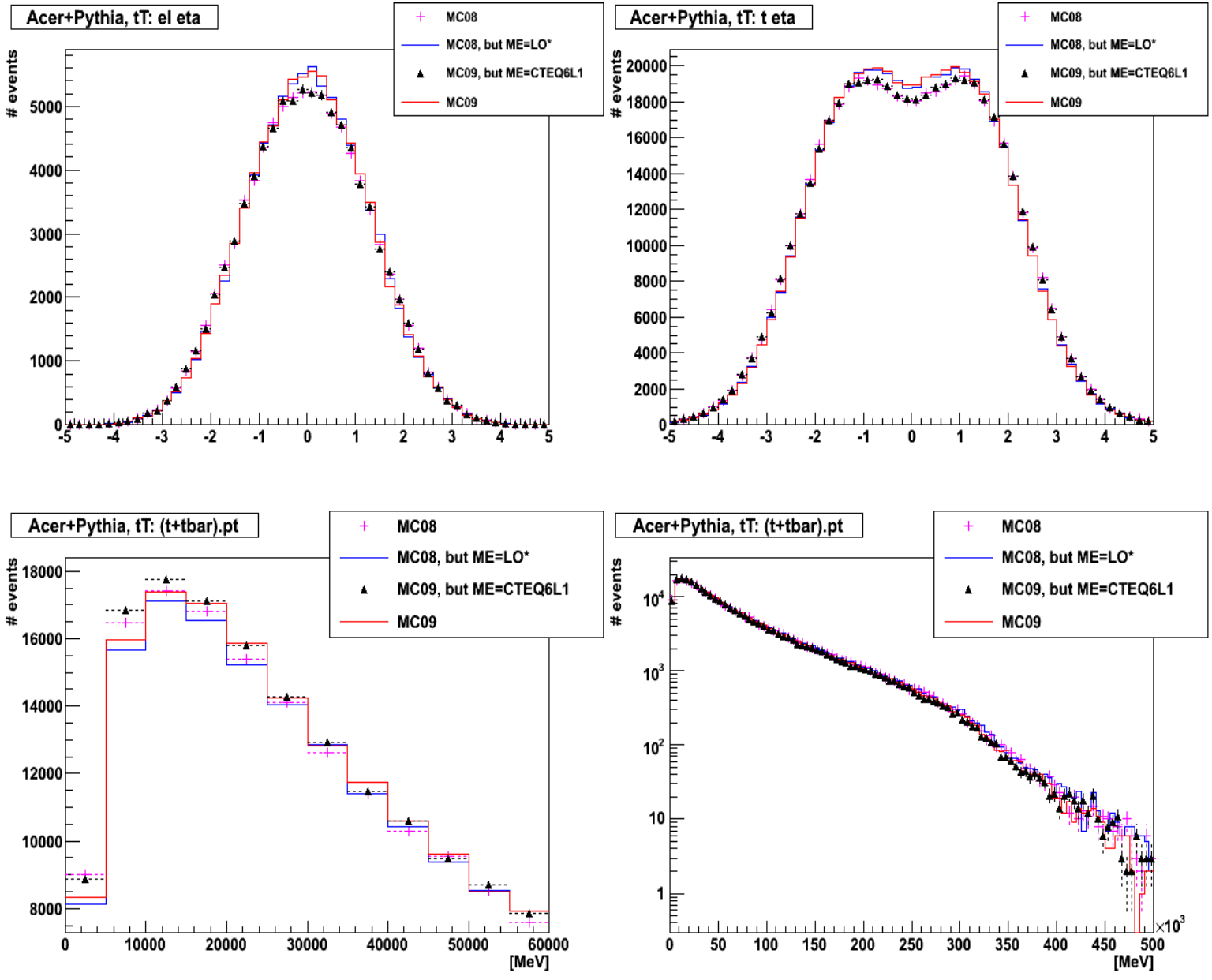






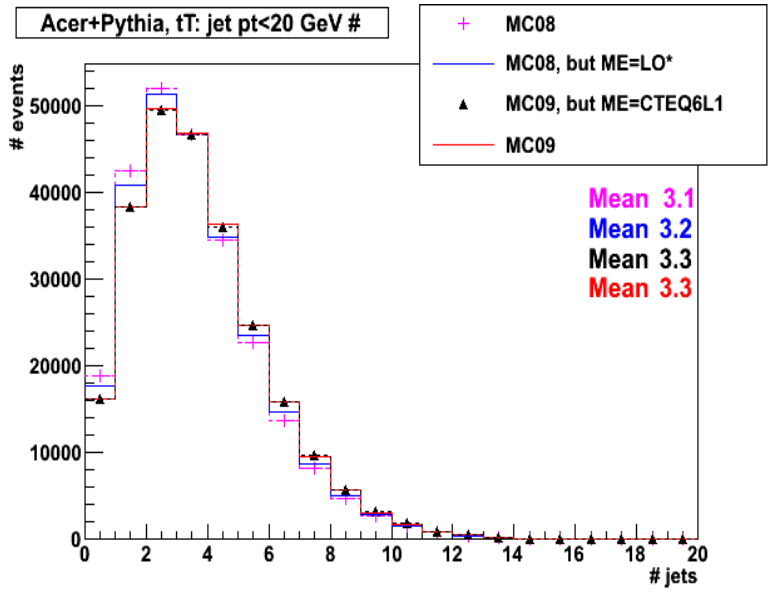
High-pt processes @ 10 TeV: tT - 1

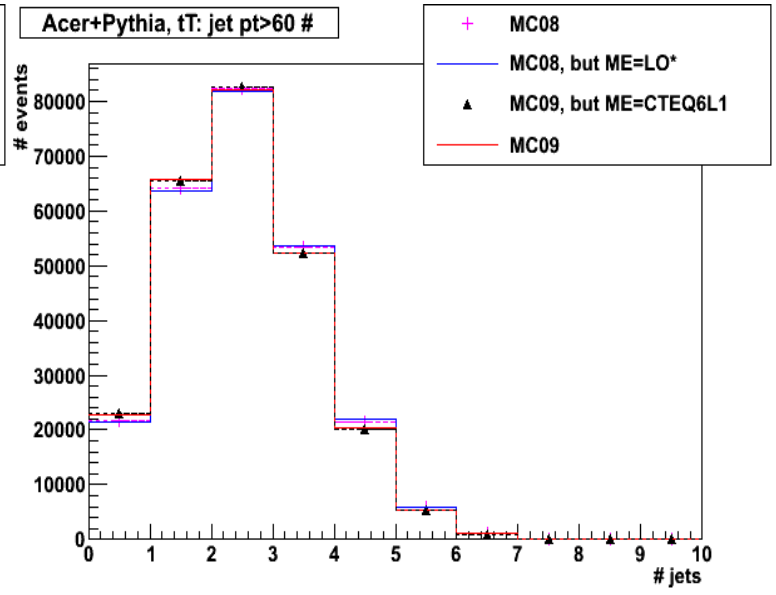
tT, # lepton>=1, 250k analyzed events, no norm., bug: #events→#entries

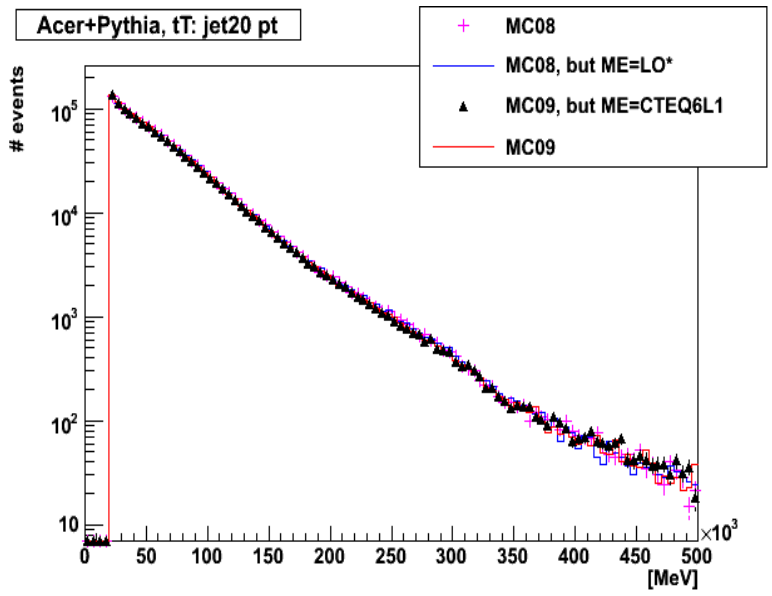


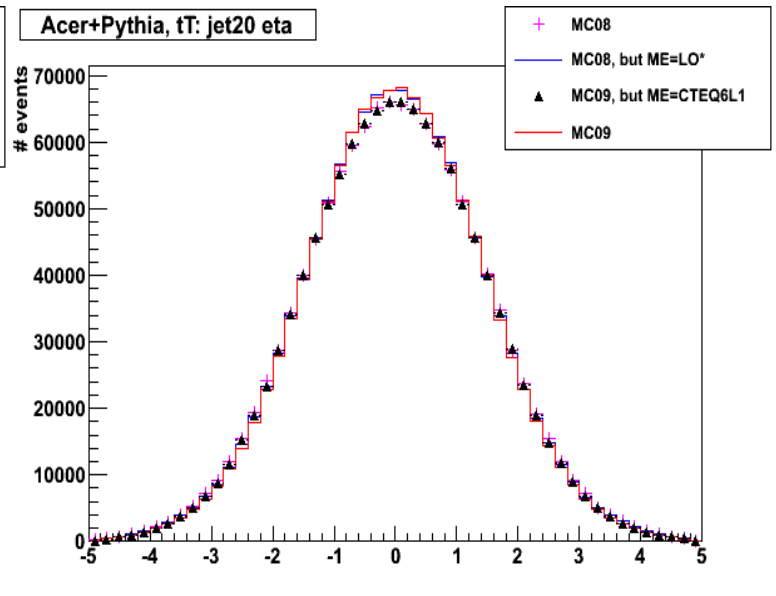
High-pt processes @ 10 TeV: tT - 2

tT, # lepton>=1, 250k analyzed events, no norm., bug: #events→#entries





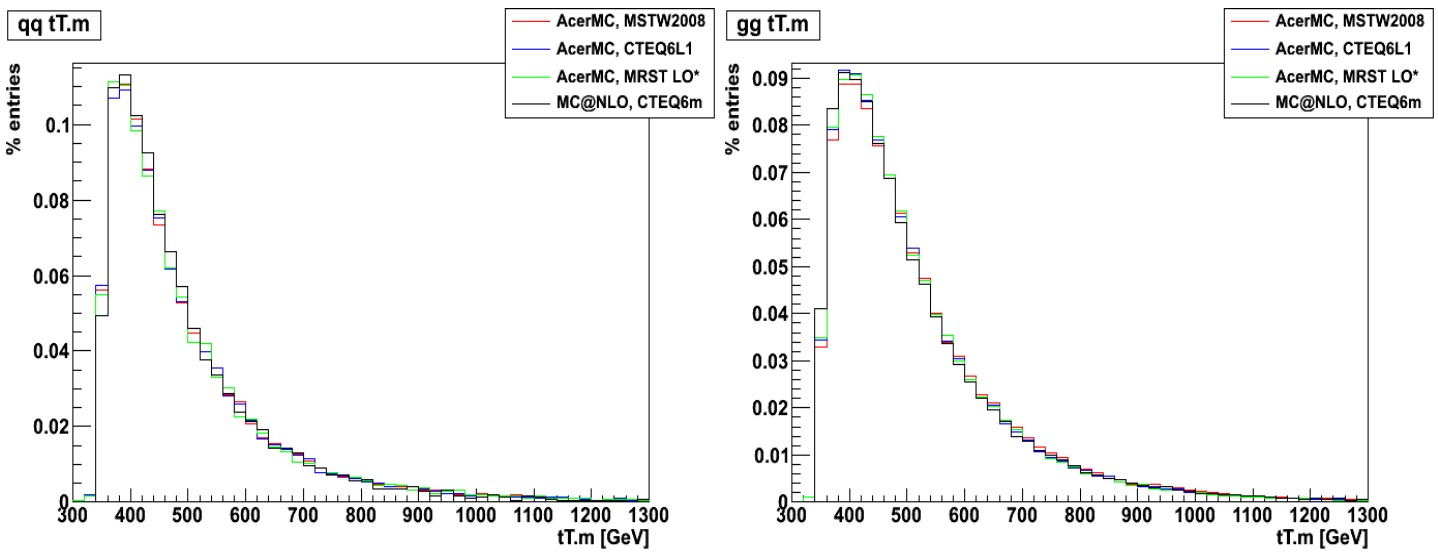




High-pt processes @ 10 TeV: tT - 3; qq/gg ratio, K-factors

t mass = 172.5 GeV, 100k events

generator	PDF set	qq ($\pm$ 0.3%)	σ/σ_{NLO}	K-fact [1]
Pythia 6.4.21	CTEQ6L1	18%	1.9	2.1
Pythia 6.4.21	MRST2007lomod	15%	1.3	1.5
AcerMC 3.6 + Pythia 6.4.21	MSTW2008	19%	1.8	2.0
AcerMC 3.6 + Pythia 6.4.21	CTEQ6L1	19%	1.8	2.0
AcerMC 3.6 + Pythia 6.4.21	MRST2007lomod	16%	1.3	1.4
MC@NLO 3.1 + Herwig 6.510	CTEQ6M	14%	1.0	1.1



- LO* K-fact. $<$ LO K-fact. ✓
- LO* qq/gg ratio and tT.m ✓
- remark: qq/gg ratio diff $\Rightarrow$ t η diff

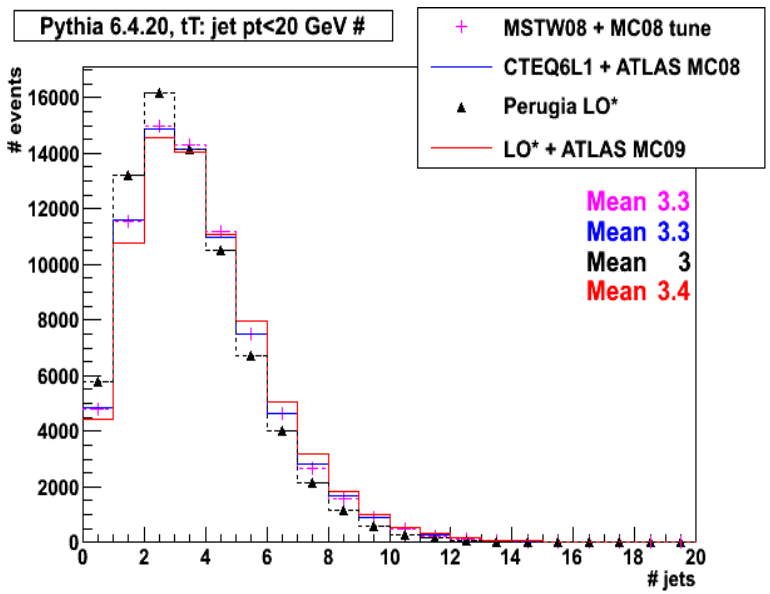
[1] reference x-sect.: $\sigma \sim$ 407.3 pb, CTEQ6M, t mass=172.5 GeV: M.Cacciari et al., JHEP 809, 127 (2008)

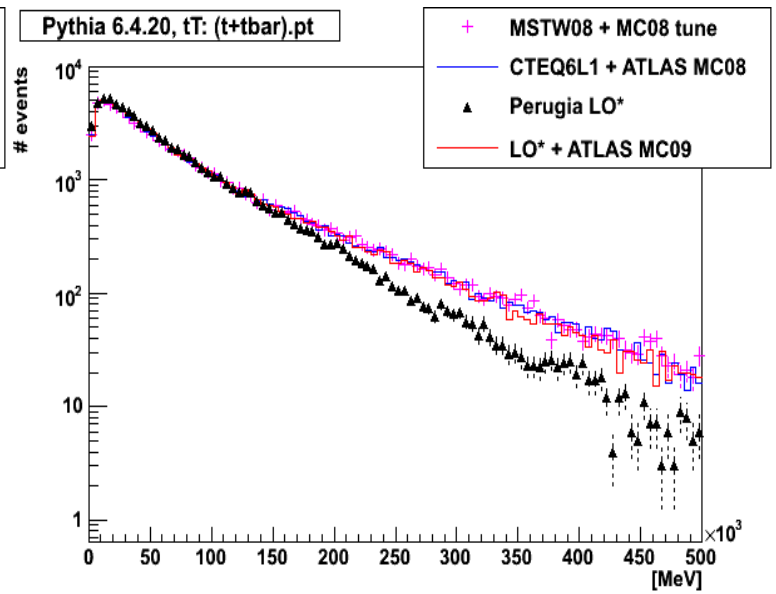
High-pt processes @ 10 TeV: Perugia X for tT

tT, # lepton>=1, 250k analyzed events, no norm.

parameter	type	P-X	MC09
MSTP(64)	ISR	3	2
PARP(64)	ISR	2.0	1.0
MSTP(67)	ISR	2	2
PARP(67)	ISR	1.0	4.0
MSTP(70)	ISR	2	0
PARP(62)	ISR	-	1.0
MSTP(72)	ISR	1	1

parameter	type	P-X	MC09
PARP(82)	UE	2.2	2.3
PARP(71)	FSR	2.0	4.0
PARJ(81)	FSR	0.257	0.29
PARJ(82)	FSR	0.8	1.0

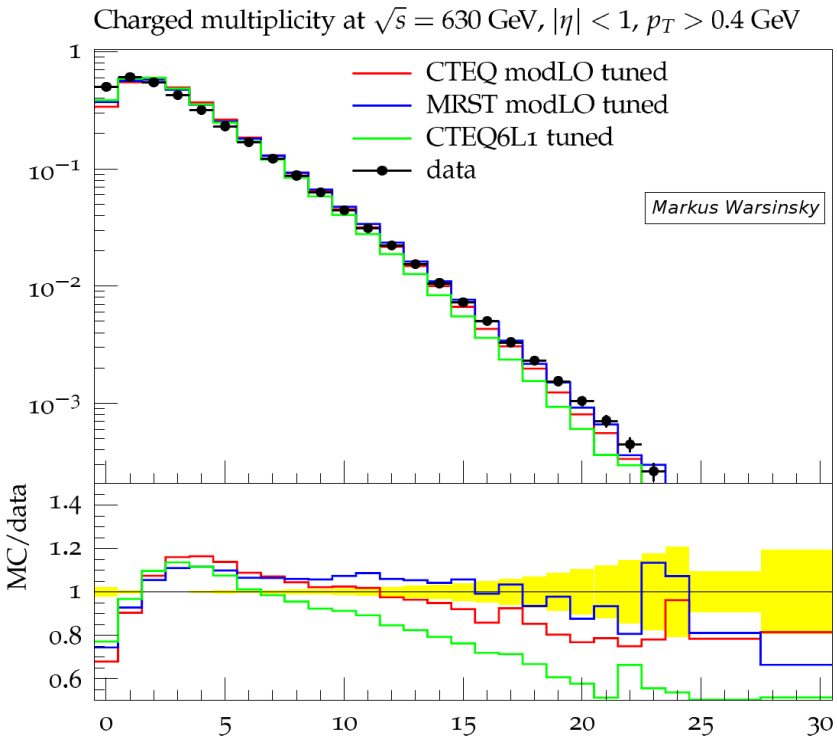


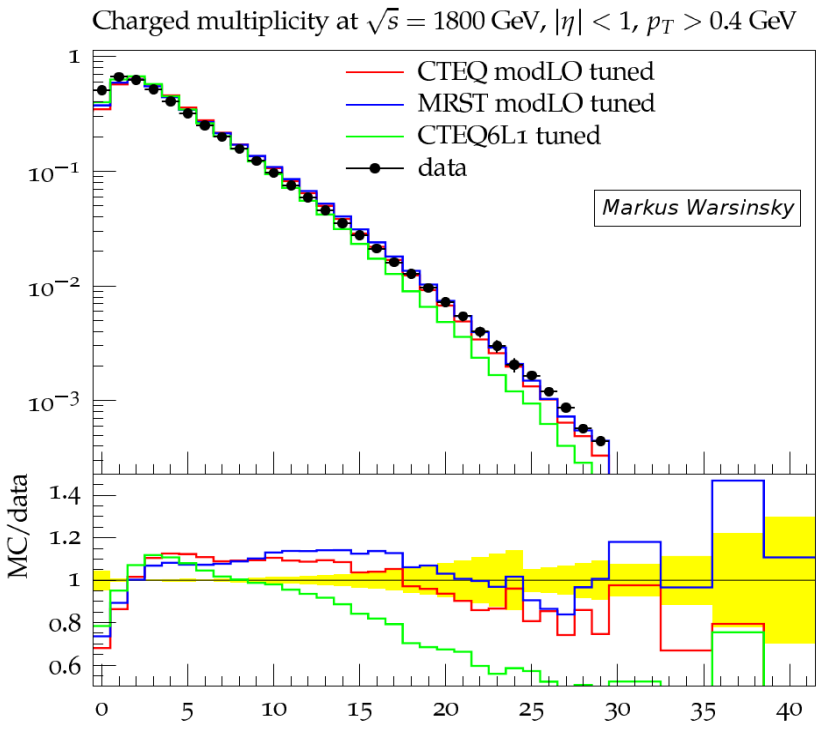


- Perugia tune for LO* has less soft jets than MC09,
- also has less hard jets (PARP(67)=1 vs PARP(67)=4)

Brief report on CTEQ LO*

- provided privately by Joey Huston
- Pythia parameters set that gives reasonable description of "Leading Jets", "MIN-MAX" and "Min. Bias" (plots below) already identified
- work in progress (note: both CTEQ modLO and CTEQ6L1 tunes experimental)





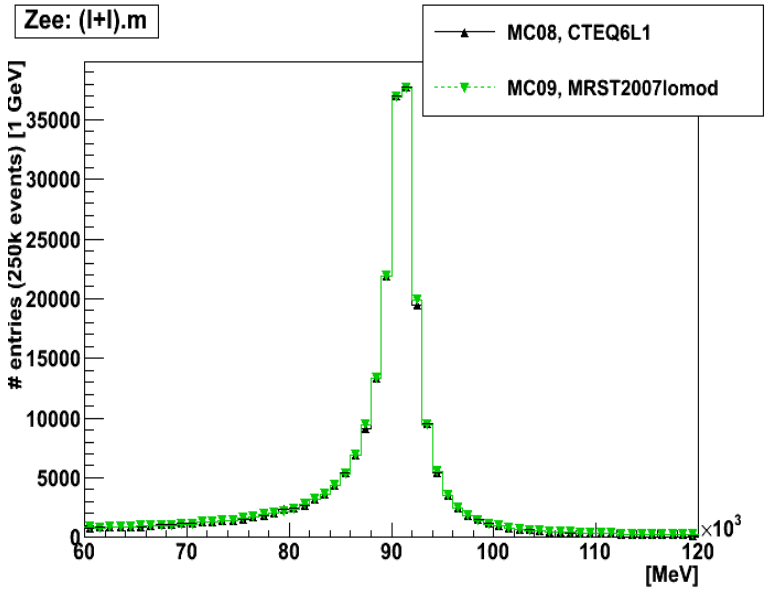
Results Summary

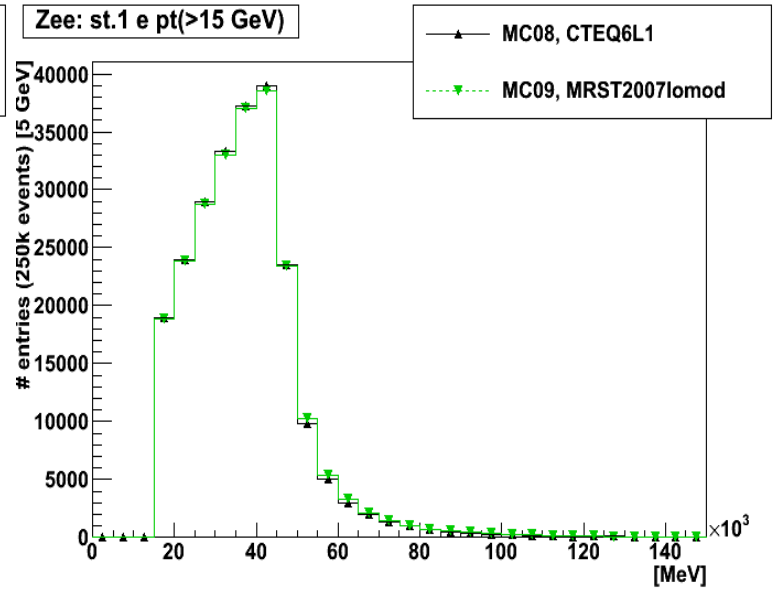
- Fortran Pythia and Jimmy + LO* : can be tuned to describe min.bias and UE data
- no problems found for high-pt processes
- Note: extensive tuning and testing done for MRST2007lomod (LO* for MC), results of first tuning attempts for CTEQ LO* encouraging

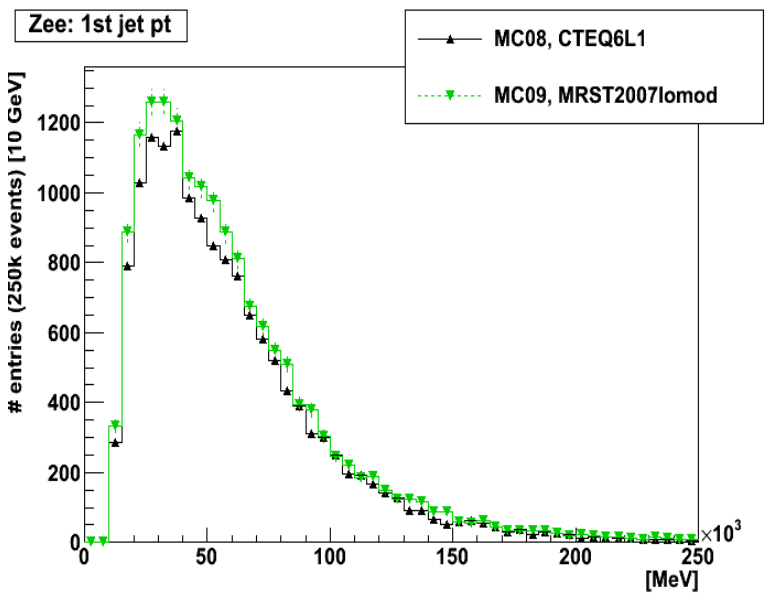
Additional Slides

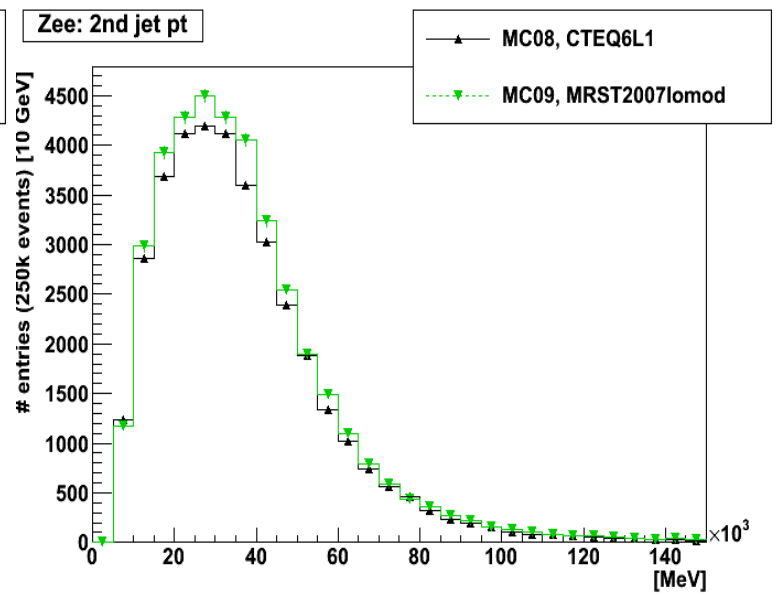
High-pt processes @ 10 TeV: Zee - 3

Z→ee, imass (CKIN(1)) >60 GeV, # l: pt>10.GeV≥ 1, η<2.7, 250k anal. events, no norm.





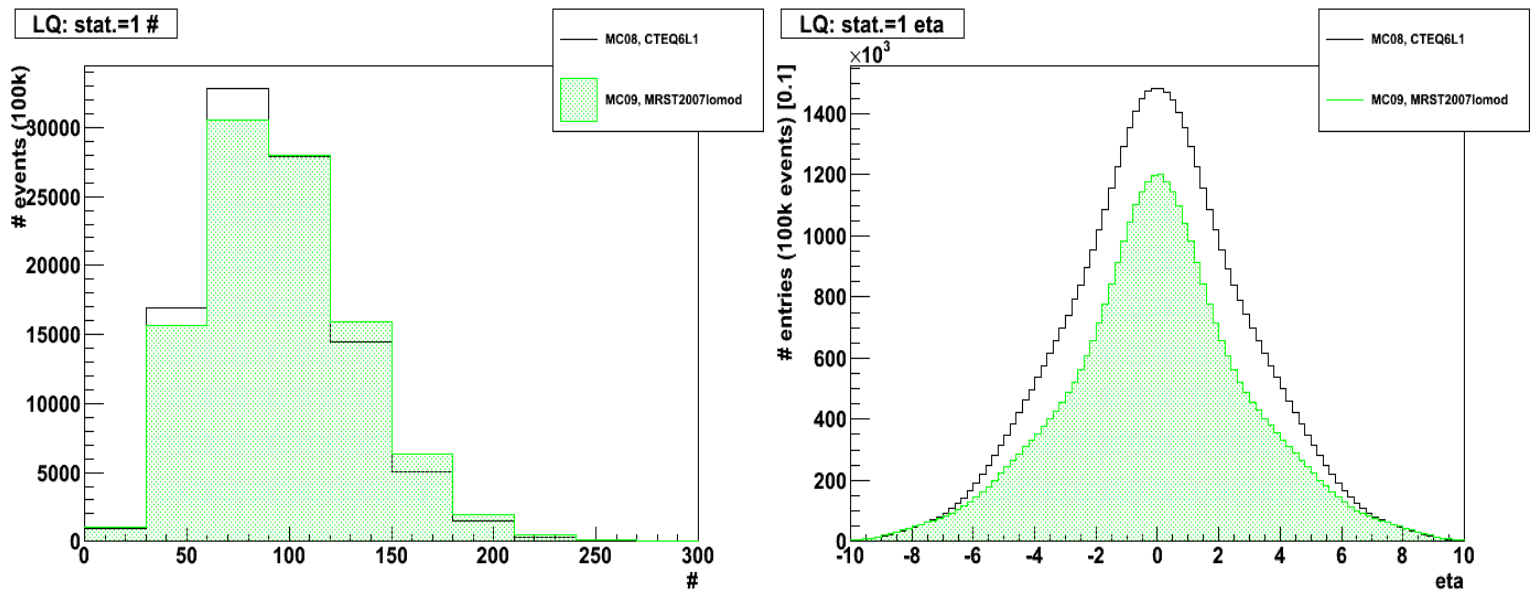




High-pt processes @ 10 TeV: LQ - 3

LQ (ue) production: qg→eLQ, gg→LQLQbar, qqbar→LQLQbar, LQ mass=400 GeV
100k analyzed events, el.-jet OL cone: 0.4

left plot: cuts: pt>1 GeV η<7., right plot: no cuts

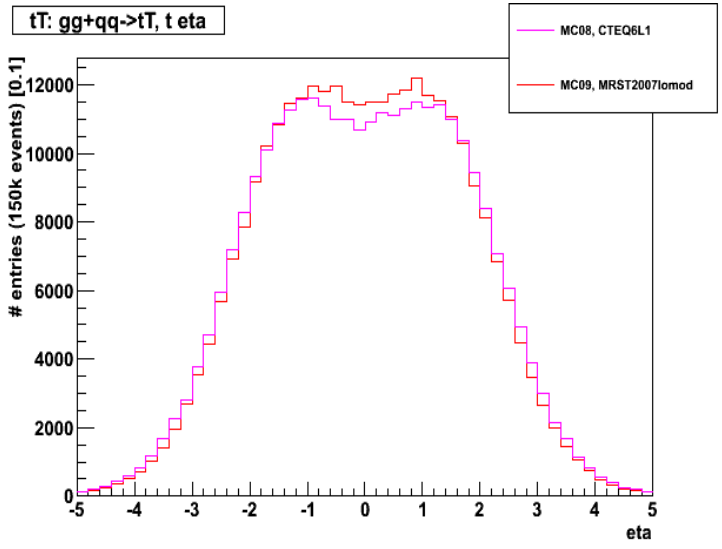


x-section info:
σ_{LO}=0.92 pb, σ_{LO*}=1.20 pb, σ_{LO*}/σ_{LO}=1.30

Conclusions on LQ production:
- no problems found
(- LO*(+MC09) : more small η LQ, hard jets than CTEQ6L1(+MC08))

High-pt processes @ 10 TeV: tT t η shape

tT, # lepton>=1, 150k analyzed events, no norm.



Why t η (LO* vs LO) diff.?
- due to ME/PDF
- explained by qq vs gg t η diff.