MY EXPERIENCES WITH FAST SIMULATORS

JOSEPH LYKKEN

FERMILAB

FAST SIMULATORS FOR THE LHC, JUNE 11, 2012

What have I used?

- Pythia -> SHW (1998!)
- Pythia -> PGS -> LHCO (2008)
- MadGraph -> Pythia -> Delphes -> Root (2010)
- MadGraph -> MadEvent -> Pythia -> PGS -> LHCO -> Root (2012)

What have I compared the output to?

- CMS Physics TDR (2008)
- CMS fullsim MadGraph QCD, MadGraph TTJets, etc
- CMS fastsim SUSY SMS's

How much did I modify the out-of-the-box products?

- Pythia (2008); I had to increase the default event size otherwise LHC events with simulated pile-up crashed!
- PGS (2008): added basic simulation of 3.8T CMS solenoid and better representation of CMS calorimeter segmentation. Not sure that this mattered, but it does have an effect on the jets
- PGS (2012): added a detailed emulation of CMS "tight" and "loose" TCHE b-tagging efficiency and mis-tag rate. This was absolutely essential for our study of stop searches!
- PGS (2012) Added a lot of extra info to the LHCO default output

How good were the results compared to CMS full or fast sim?

- Quite good! By eye the PGS and Delphes distributions look similar to full/fast sim.
- Able to match line-by-line signal cut efficiencies to a few %
- Able to match background cut efficiencies to ~10-20% in good cases, as bad as 50% if you cut very hard

2008 comparison of signal efficiencies for CMS jetMET SUSY analysis

	CMS TDR	PGS (tweaked)
Trigger and $E_T^{\rm miss} > 200$ GeV	53.9%	54.5%
$N_j \geq 3$	72.1%	71.6%
$\lvert\eta_d^{j1}\rvert \geq 1.7$	88.1%	90.0%
QCD angular	75.6%	77.6%
$Iso^{lead\ trk} = 0$	85.3%	85.5%
$E_{T,1} > 180$ GeV, $E_{T,2} > 110$ GeV	63.0%	63.0%
$H_T > 500$ GeV	92.8%	93.9%
Total efficiency	12.9%	13.8%

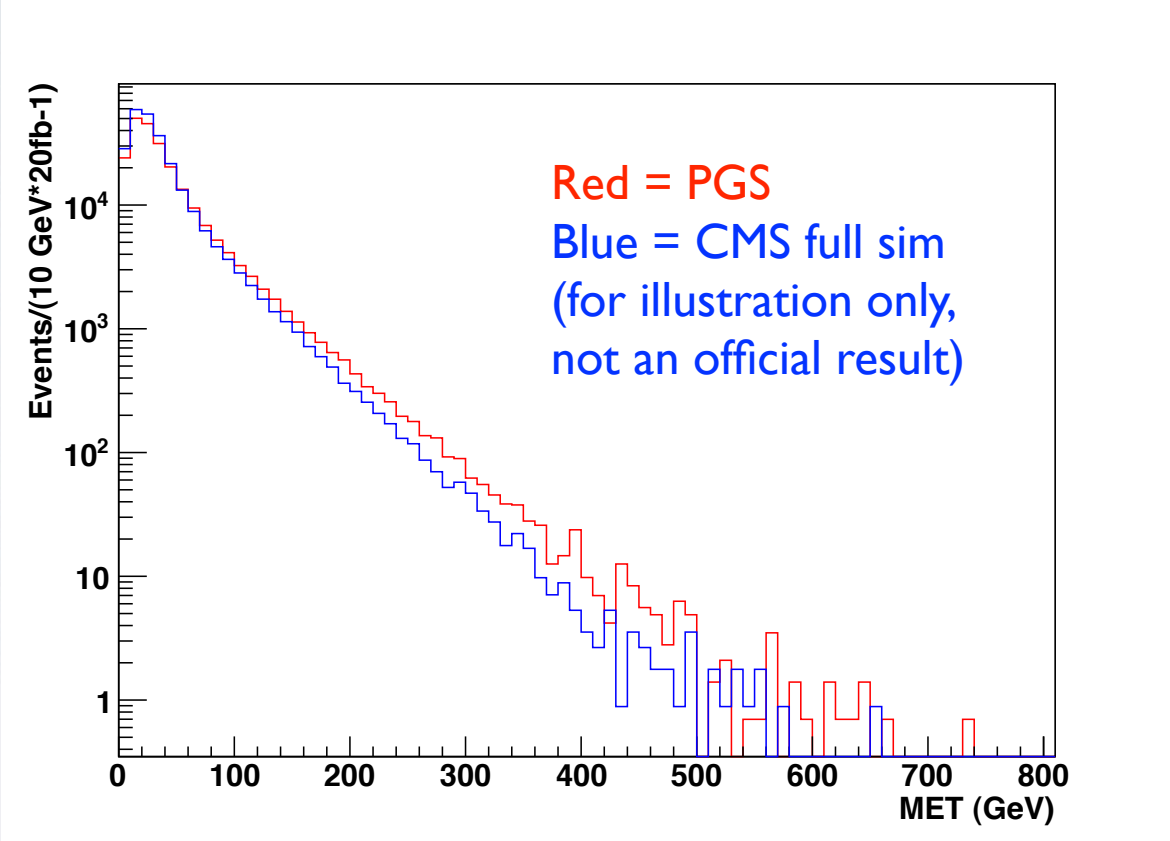
J. Hubisz, J. Lykken, M. Pierini, M. Spiropulu, arXiv:0805.2398

2012 comparison of ttbar + jets background efficiencies for an all-hadronic stop analysis

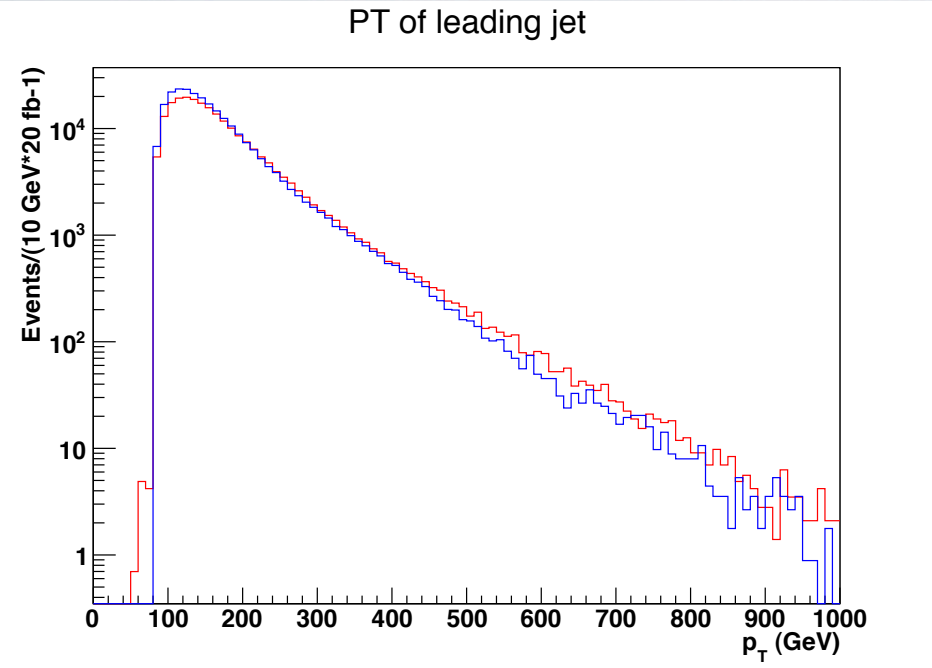
- Compare MadGraph/Pythia/PGS matched ttbar+jets samples versus CMS MadGraph/Pythia/fullsim ttbar+jets matched samples
- Compare PGS 0.5 cone jets versus CMS ak5 PF jets
- Compare PGS MET versus CMS PF MET
- Make comparison AFTER the stop analysis baseline selection:
  - 4 jets, two with pT > 80 GeV, |eta| < 3, two more with pT > 50 GeV
  - 1 tight TCHE b-tag, 1 loose TCHE b-tag
  - isolated lepton veto

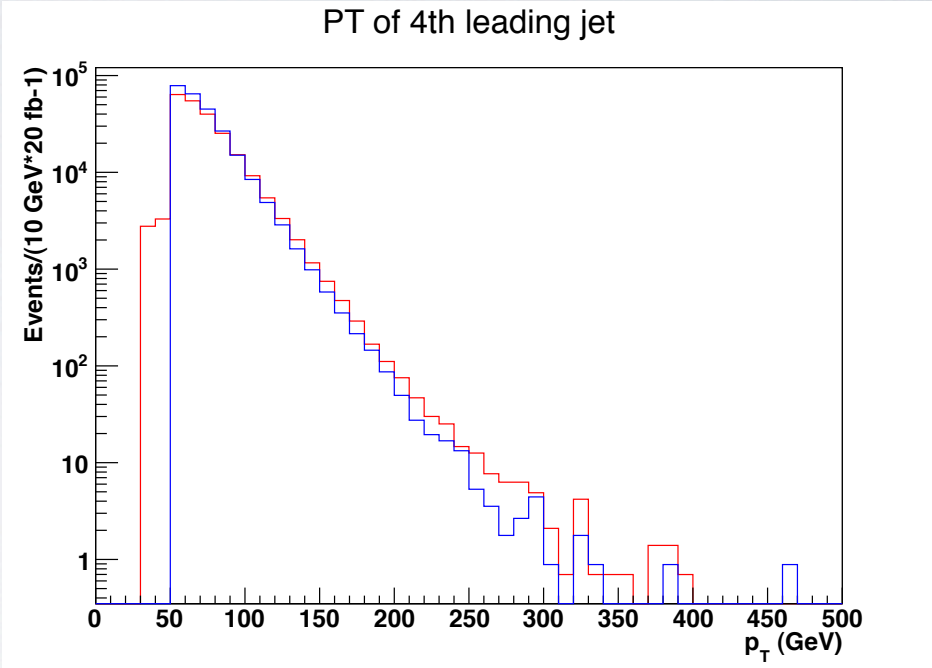
D. Alves, M. Buckley, P. Fox, J. Lykken, C-T Yu, arXiv:1205.5805

2012 comparison of ttbar + jets background efficiencies for an all-hadronic stop analysis



- Note: the MET is a combination of fake MET from mismeasurement and leptons including hadronic taus that passed the lepton veto
- Conclusion: PGS is too pessimistic compared to the actual CMS PF MET tail!





- Similar results for jet pTs

Comments

- Theorists use PGS because it has been around longer, so they are more familiar with it
- But John Conway doesn't want to support it forever by himself
- It would make sense to encourage migration to Delphes, IF it will be adequately supported
- Given how well PGS (tuned for CDF 1.8 TeV) emulates CMS, I have no doubt about Delphes as a reliable tool
- However at least in CMS there is at present no official route for validation