Status of MLM/CKKW and NLO Comparisons in W+Jet Events at CDF

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Introduction and Outline

Goal #1: To try and properly combine events from different Matrix Element (ME) + Parton Shower (PS) event samples.
Goal #2: To try and use Next-to-Leading Order theory predictions of W,Z + jet events in our comparisons with CDF data.

This talk:

- Summary of Ben and my comparisons between MLM and CKKW matching schemes applied to Madgraph + Pythia filesets.
- Some plots of Joey H. and John C.'s MCFM work.

Matching Study Filesets

Steve Mrenna has done all the hard work implementing CKKW into Madgraph+Pythia. Claudio Ferretti has written code to do the MLM matching.

Using Madgraph+Pythia W^++N parton filesets: (These have a k_T cut of 10 GeV applied.)

- Steve's CKKW Files: $W^+ \rightarrow (e^+ + v)$ + N partons

  N = 1 ; events = 106,677 ; σ_1 = 277.2 (pb)
  N = 2 ; events = 101,608 ; σ_2 = 81.0 (pb)
  N = 3 ; events = 71,605 ; σ_3 = 19.4 (pb)
  N = 4 ; events = 46,407 ; σ_4 = 7.6 (pb)

- Steve's Non-CKKW Files: $W^+ \rightarrow (e^+ + v)$ + N partons

  N = 1 ; events = 172,722 ; σ_1 = 317.8 (pb)
  N = 2 ; events = 171,468 ; σ_2 = 81.6 (pb)
  N = 3 ; events = 115,214 ; σ_3 = 18.6 (pb)
  N = 4 ; events = 36,911 ; σ_4 = 3.9 (pb)

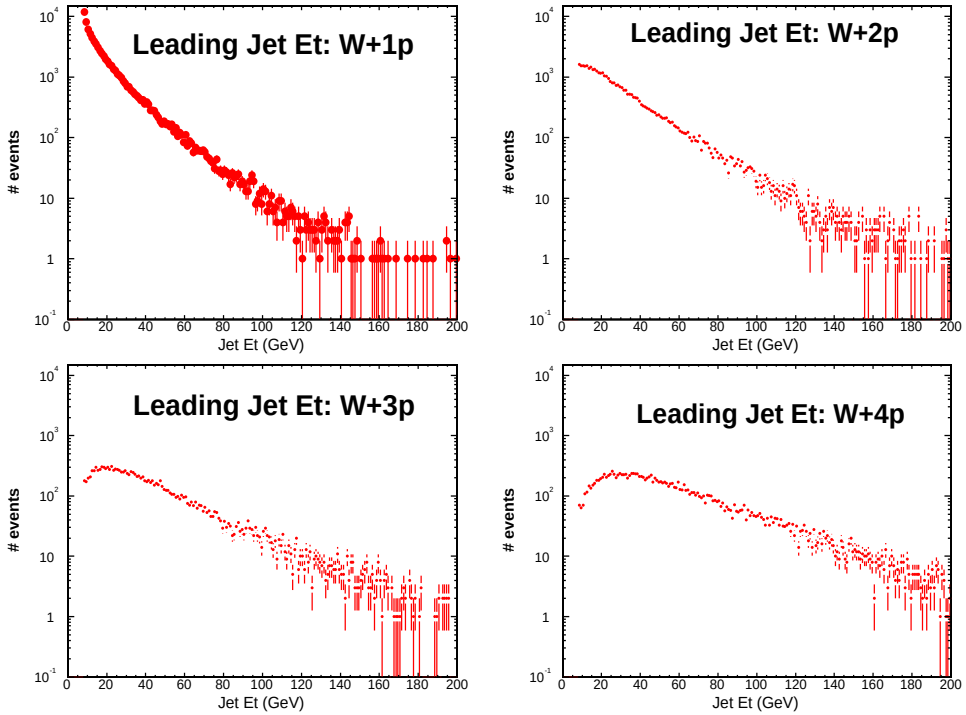
A little about matching schemes and jet code

- We use the same code on all samples to form jets out of final-state HEPG particles, so we have consistent jet definitions.
- The jet code clusters final-state HEPG particles around a seed particle using a JetClu-*esque* algorithm with a cone size of 0.4 .
- In the following plots, HEPG jets must have:
  1. $|\eta| \leq 3.0$
  2. At least 2 constituent particles
  3. $E_T \geq 8.0$ GeV
  4. Electromagnetic Energy Fraction ≤ 0.95
- We're using exclusive MLM matching for N=1,2,3 parton samples, inclusive for N=4 parton sample

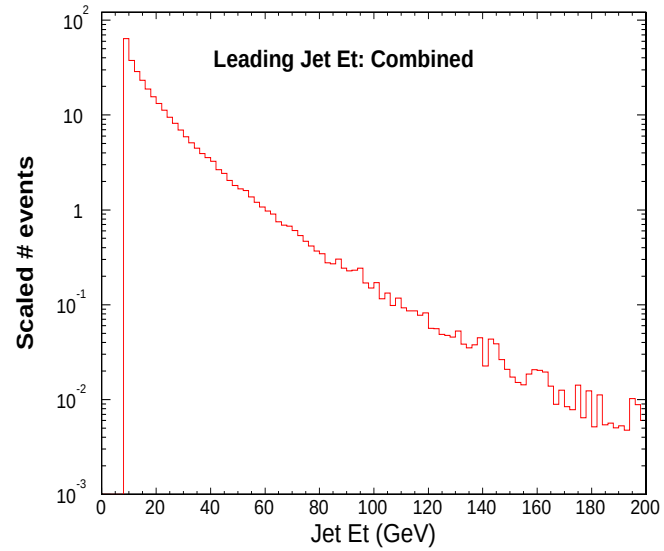
How I merge the parton samples together

Make plots of quantities of interest on each individual $W + N$ parton event sample.

Multiply each N parton plot by $\frac{\sigma_{W+Npartons}}{\#Events}$

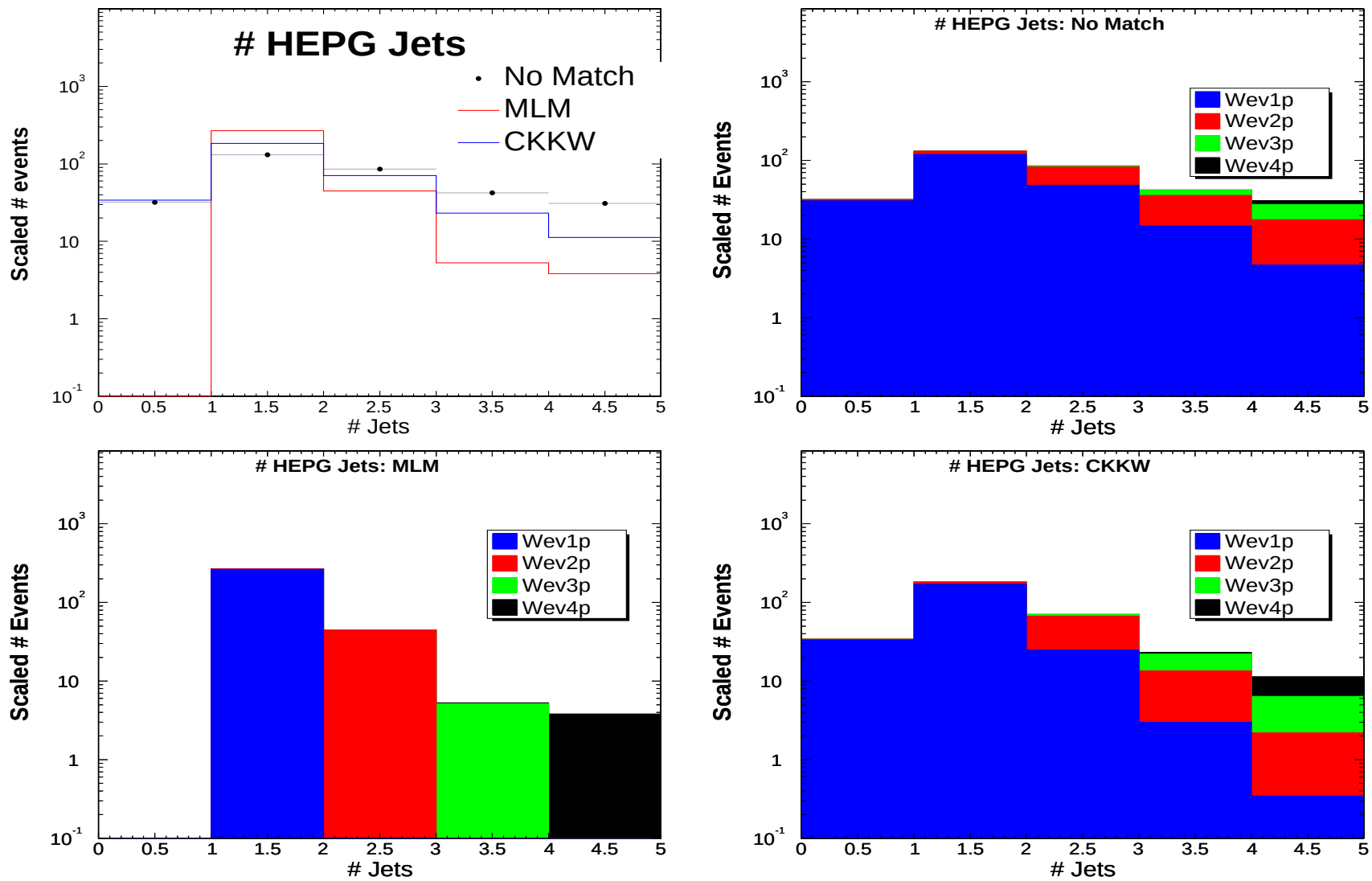


Add together scaled plots



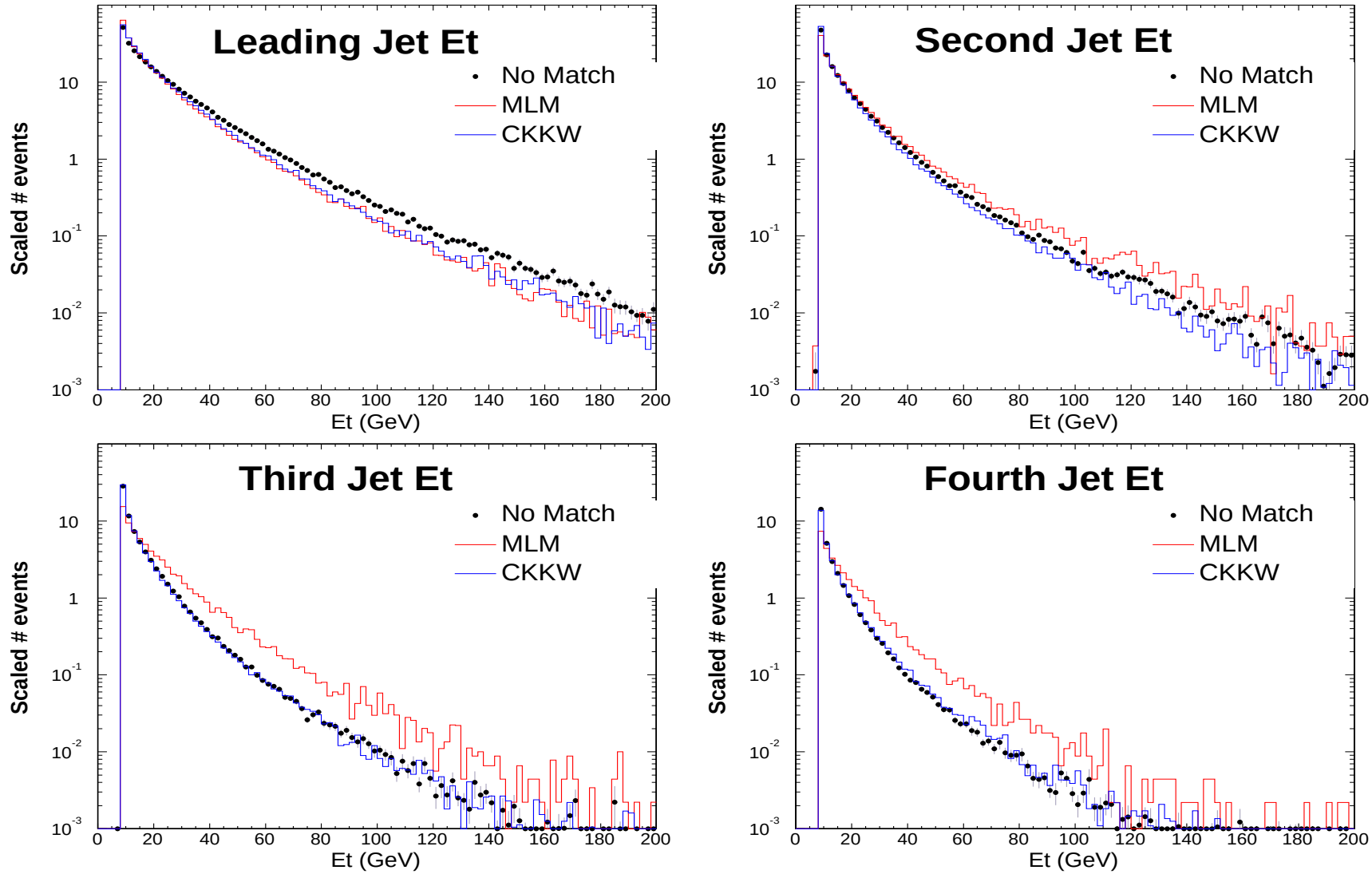
So this is only a shape comparison so far....

Number of HEPG Jets



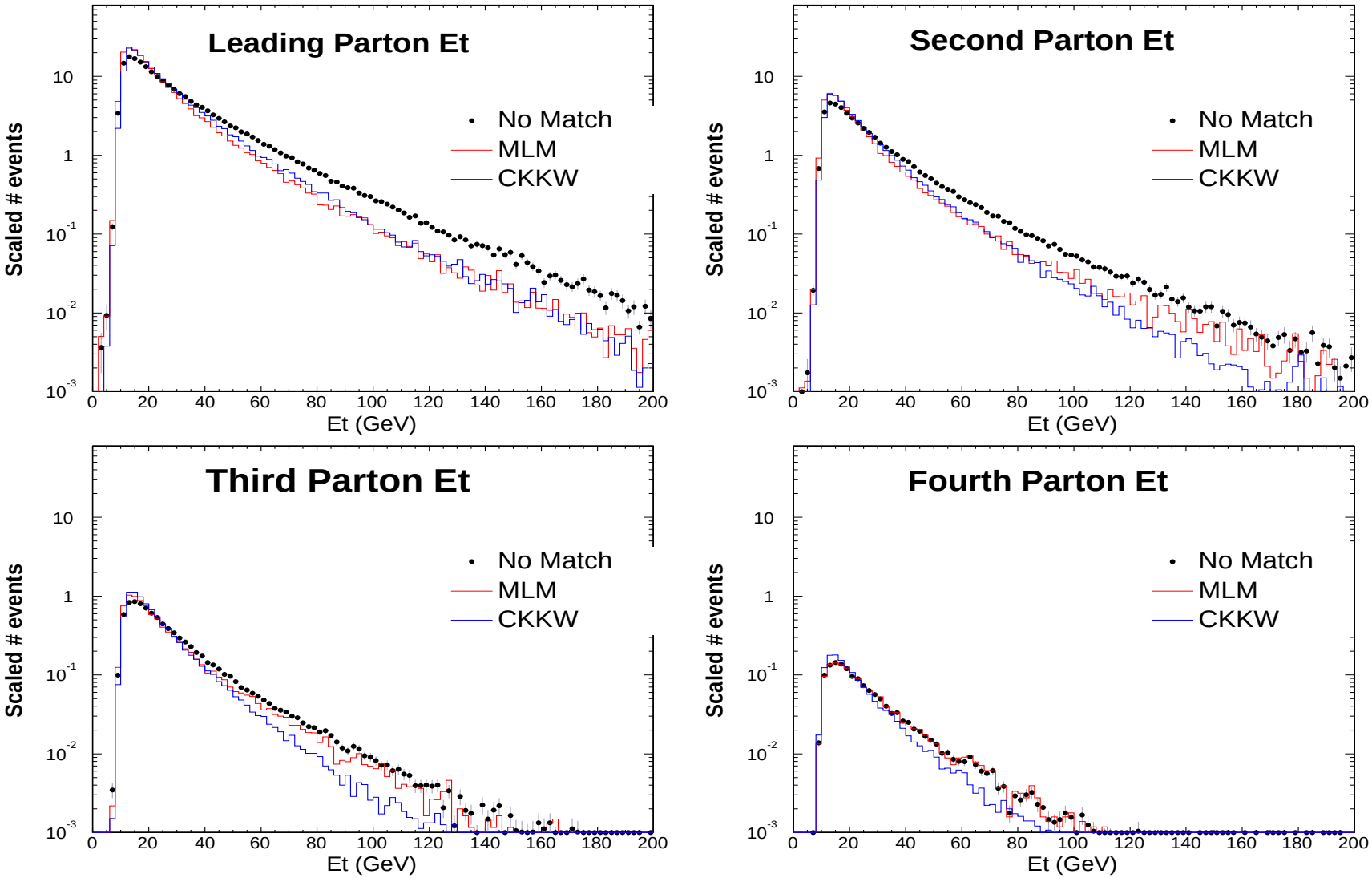
MLM matching cuts out almost all intermingling of various N parton samples into jet bins $\neq$ N. Note: 4 jet bin is an overflow bin ($\geq$ 4 jets).

Jet E_T



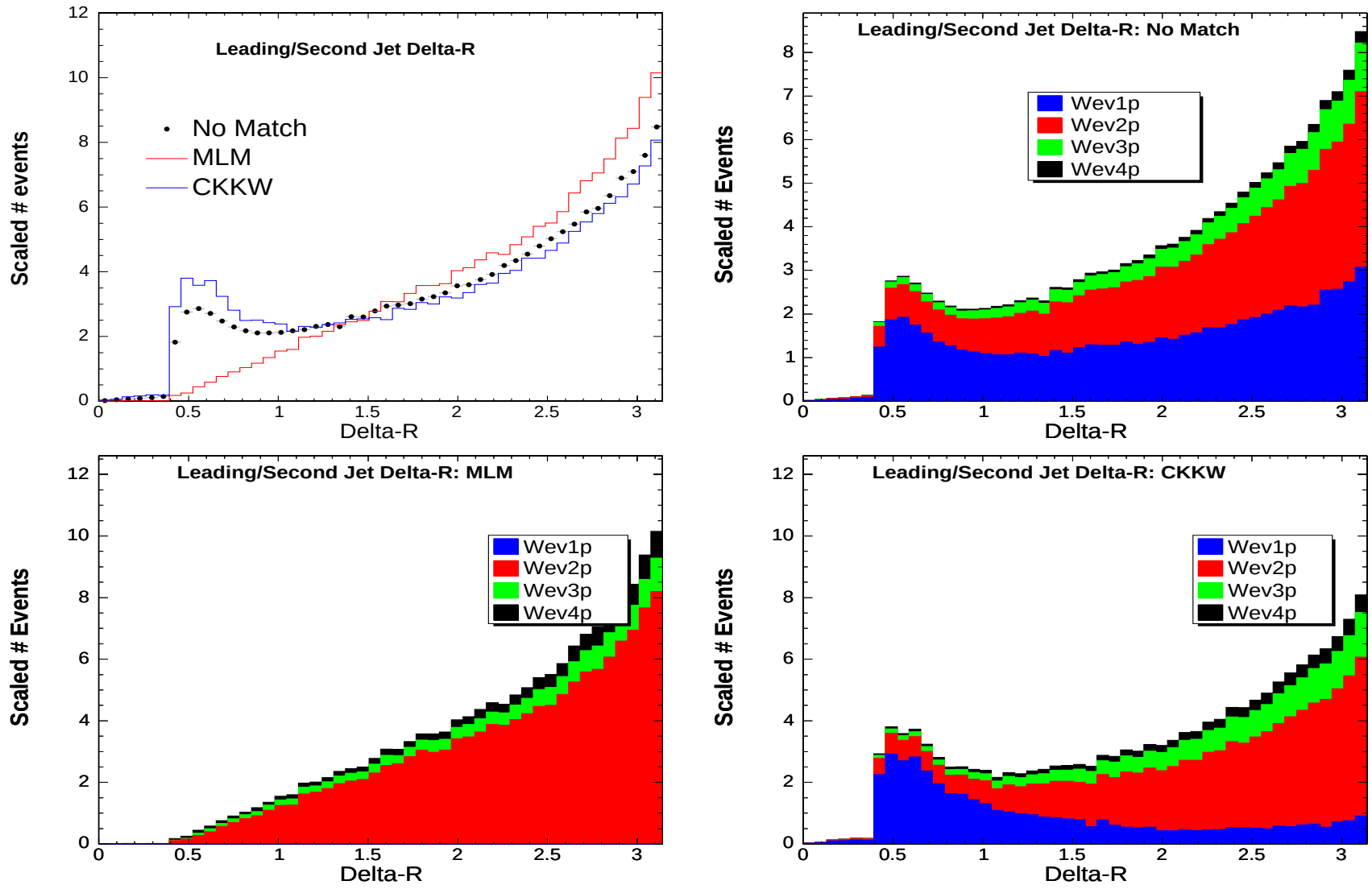
MLM jet E_T is harder than CKKW and No-Match for higher jet multiplicities. Could be due to 1 parton sample's dominating contribution to CKKW and No-Match plots.

Parton E_T



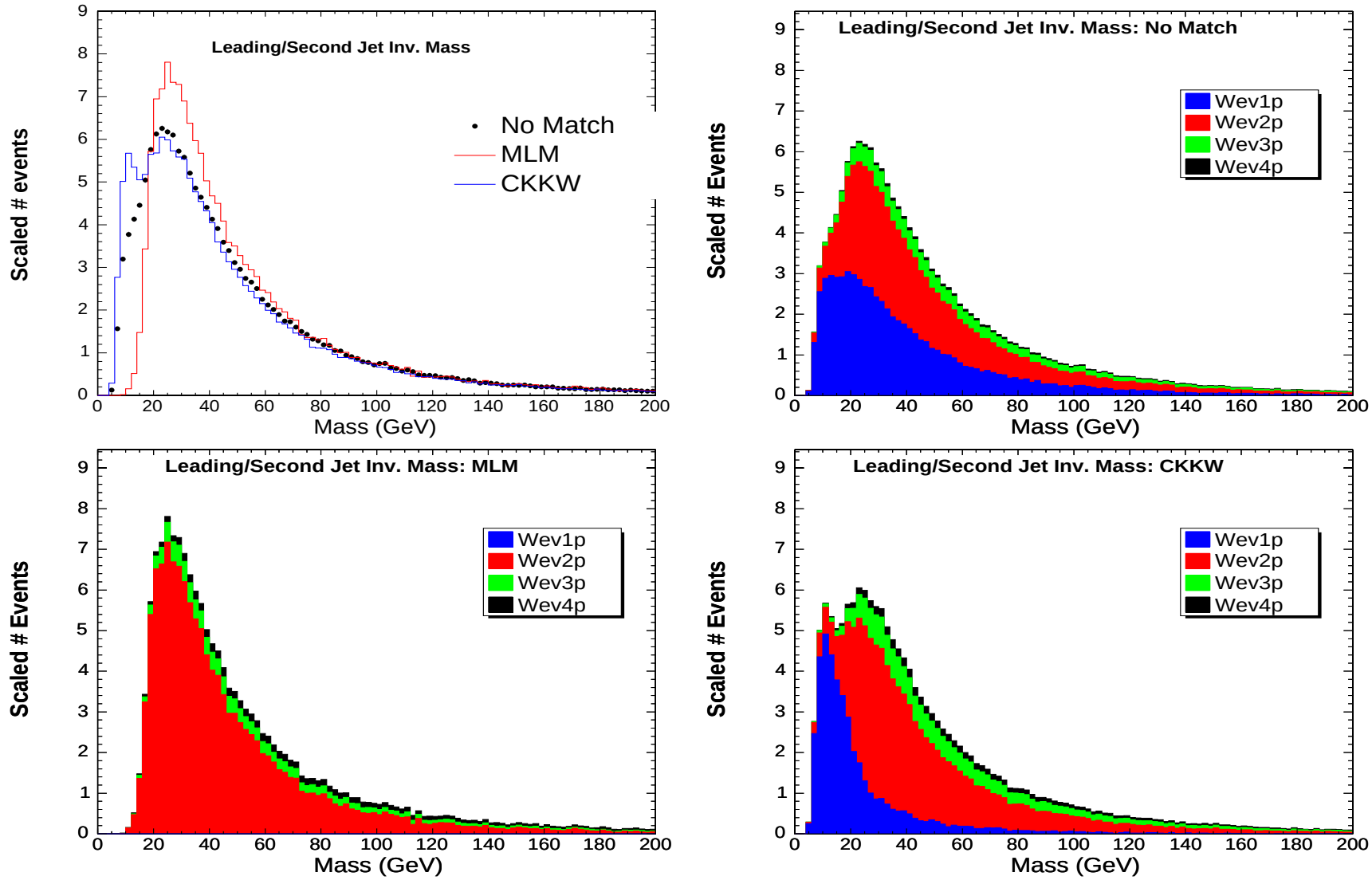
MLM parton E_T becomes harder than CKKW E_T for higher jet multiplicites. No-Match sample remains the hardest E_T in all plots, unlike it's behavior in the previous jet plots.

Leading Jet / Second Jet ΔR



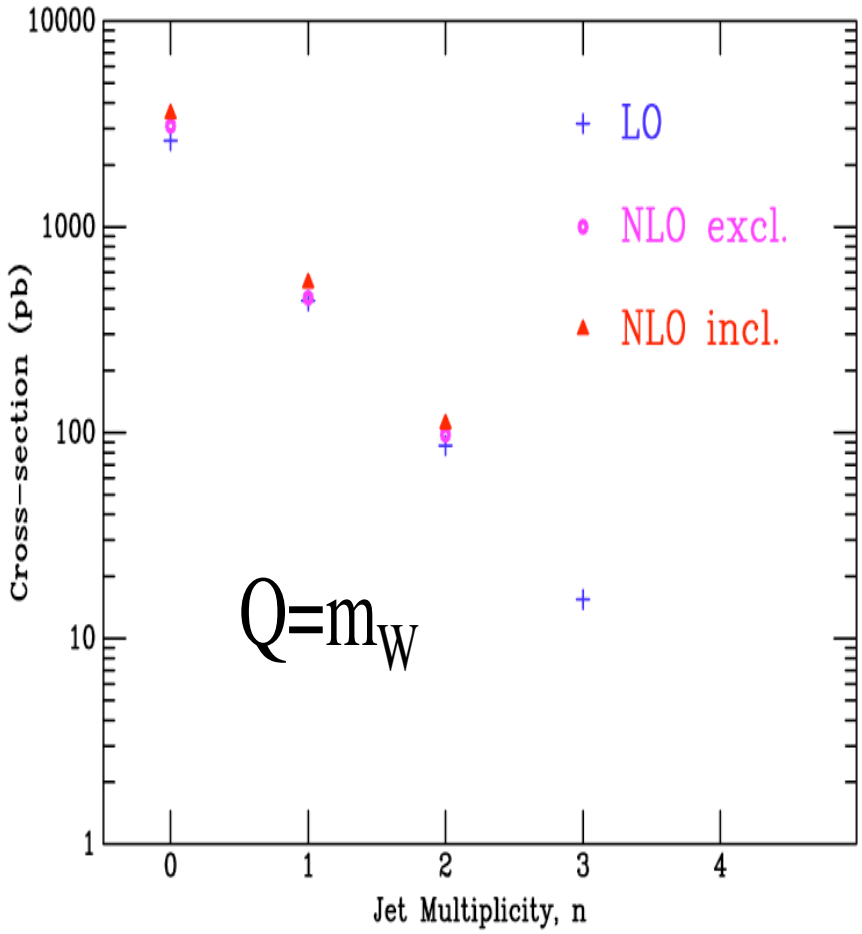
Collinear peak in ΔR distributions of CKKW/No-Match is not present in MLM plot due to 1 parton sample not being allowed to "feed up" into the 2 jet bin.

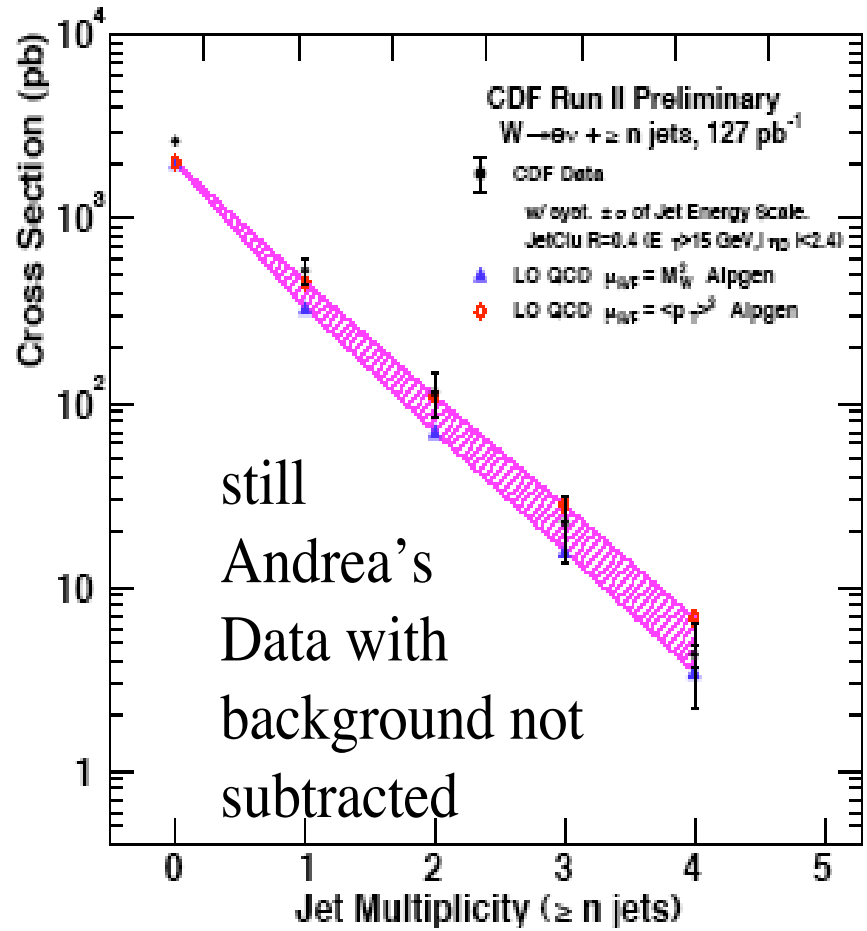
Leading Jet / Second Jet Inv. Mass



Again, lack of "feed up" of 1 parton sample is causing MLM distributions to be harder. CKKW plots have an interesting behavior at low invariant mass values.

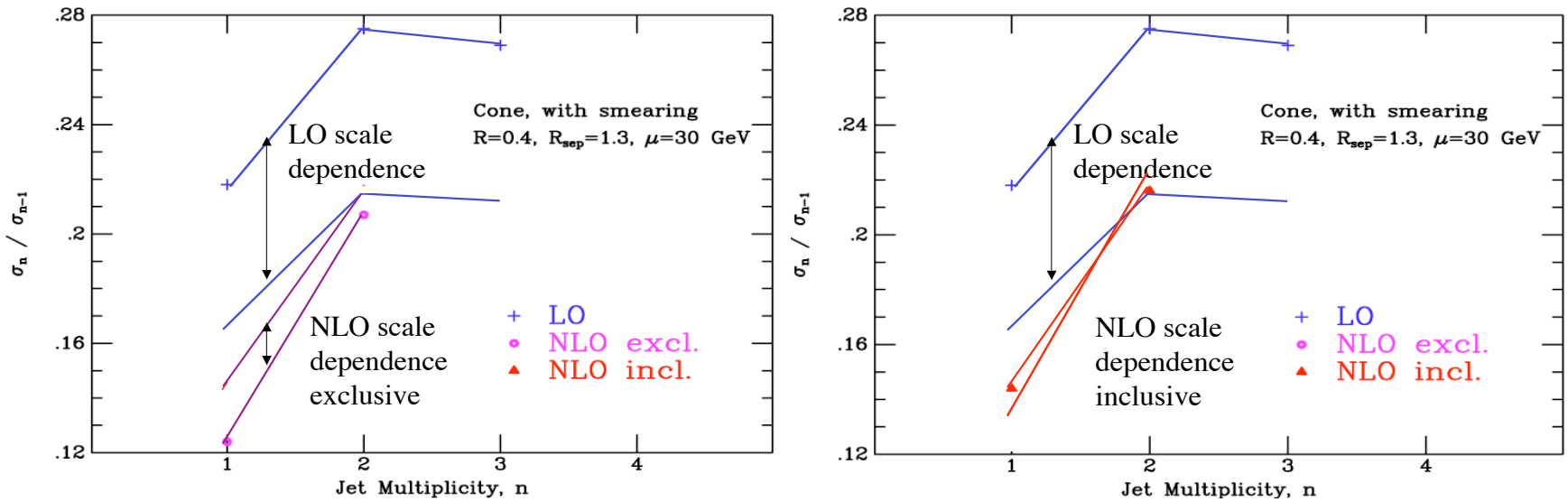
NLO N-jets from MCFM (left), and data N-jets (right)

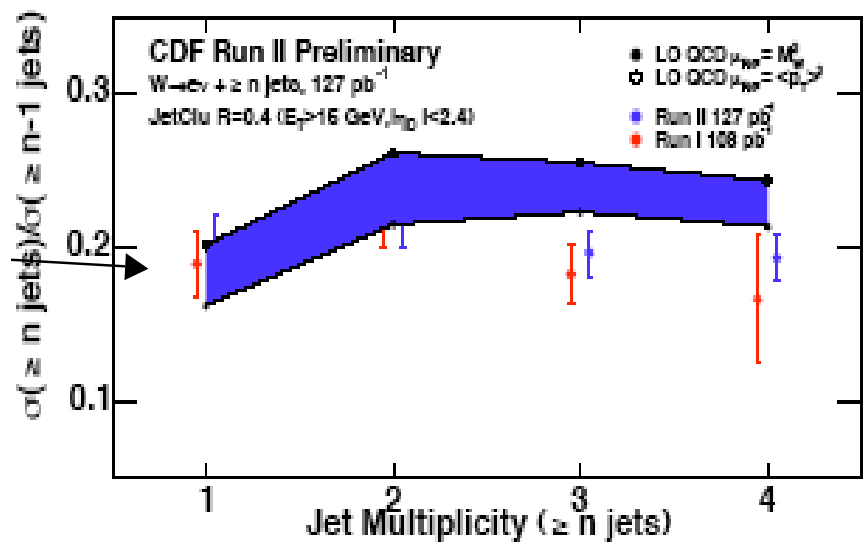




MCFM allows NLO predictions for $W^{\pm}$ + 0,1,2 jet quantities.
Exclusive means: $W^{\pm}$+N jets. Inclusive means: $W^{\pm}+\geq$ N jets.

Some Ratio Plots for MCFM and for CDF data





Top plots show ratio of $\frac{\sigma_n}{\sigma_{n-1}}$ for two scales: 30 GeV and 80 GeV.
Plot on top-left is for NLO exclusive, top-right is NLO inclusive.

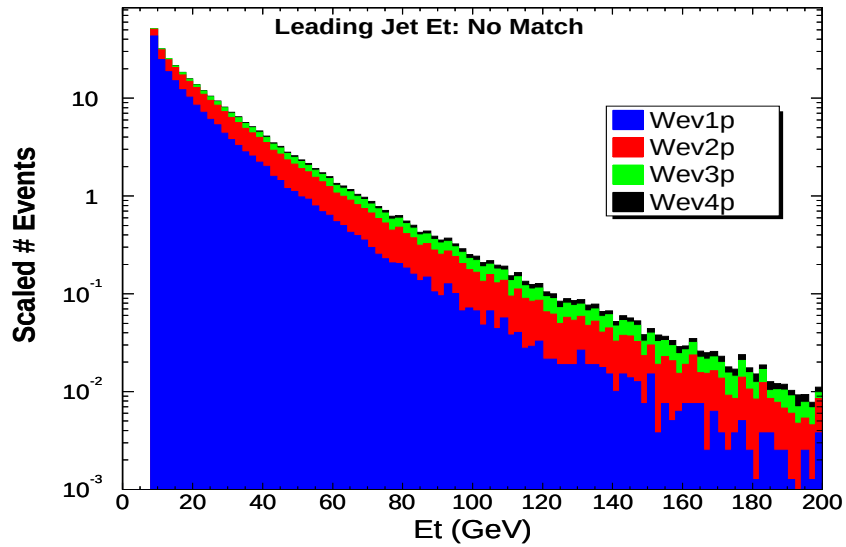
Conclusions and Plans

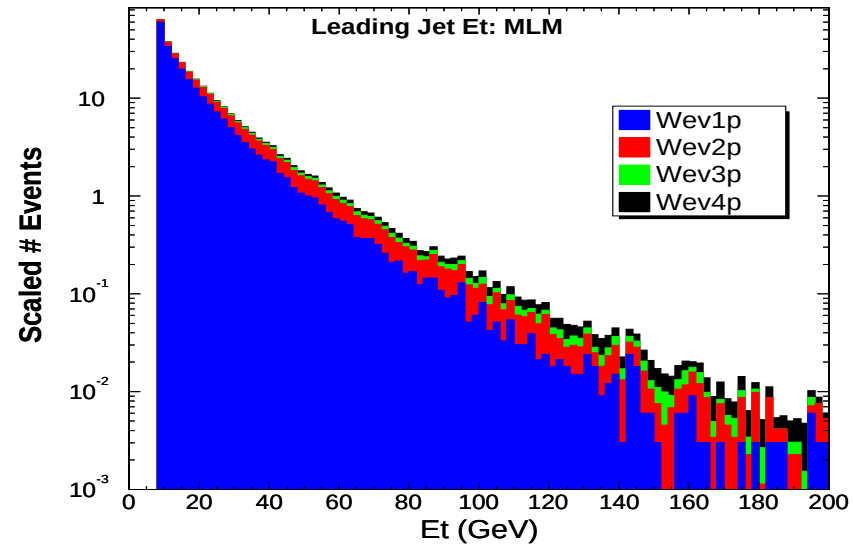
- There are some substantial differences between the output of the MLM/CKKW matching schemes (Jet-Jet ΔR, Inv. Mass).
- Steve also has produced filesets with different k_T cuts, so we will soon reproduce these plots in those filesets.
- Next step is to fully simulate all these ME+PS filesets and compare reconstructed jets.
- Ultimate goal is to overlay these ME+PS filesets with CDF data.
- NLO work with MCFM shows behavior similar to CDF data.
- Jump in cross-section ratio from 1 jet to 2 jet bin is larger at NLO than LO.
- Work is underway to "smear" MCFM predictions to model detector effects, allowing for direct comparisons to data.

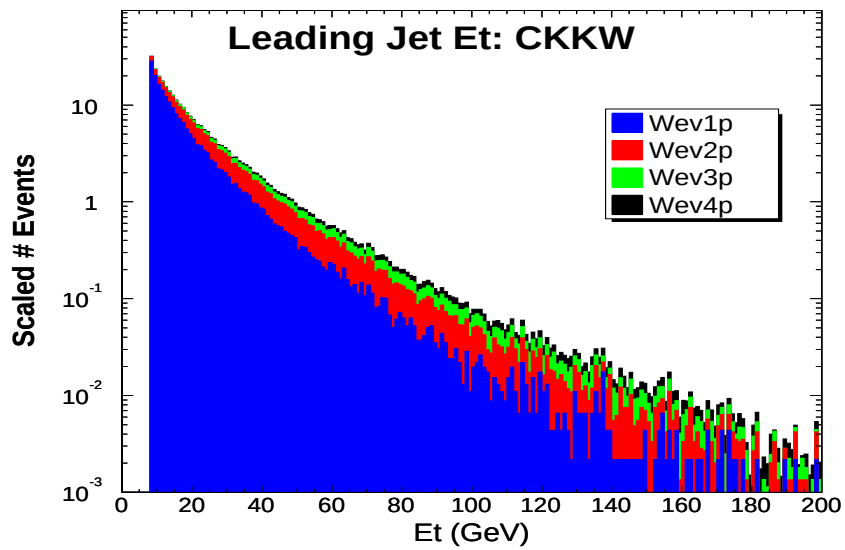
Many thanks to Steve Mrenna for providing us with the files with CKKW implemented.
Many thanks to Claudio Ferretti for his work on the MLM code.

Backup Slides

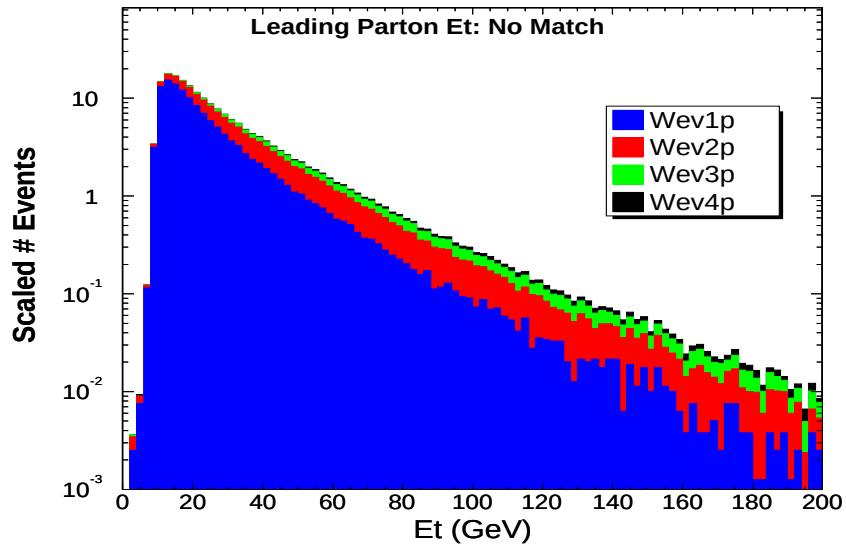
Stack plots of Leading Jet E_T

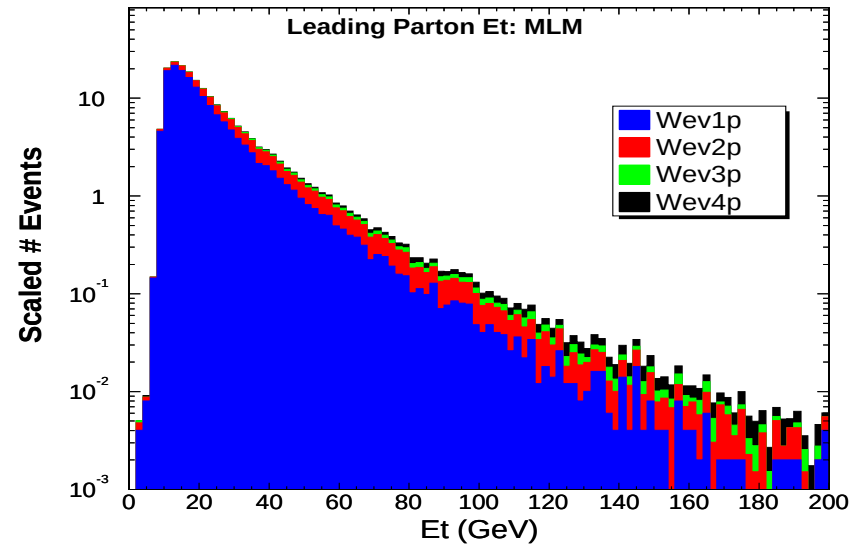


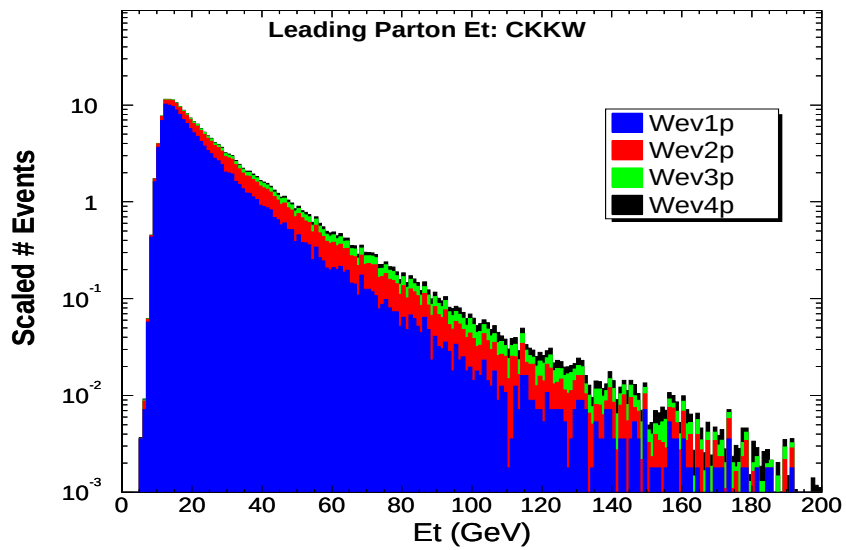




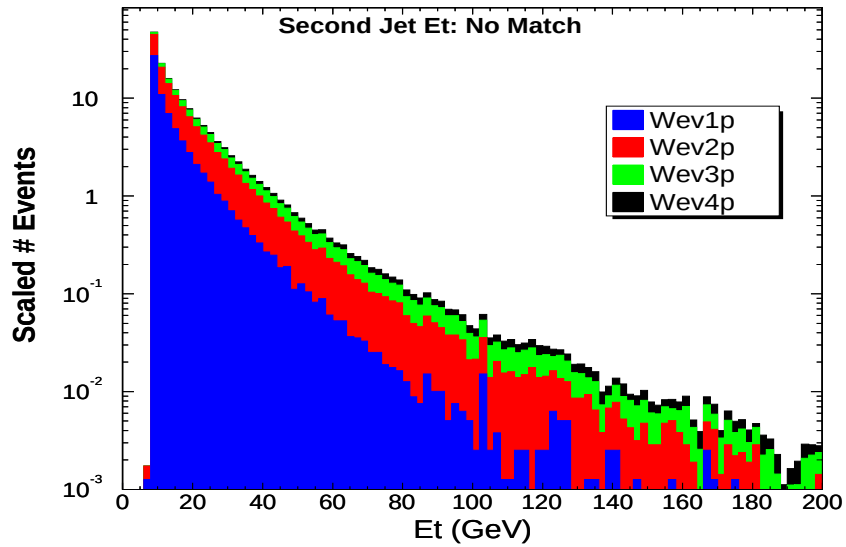
Stack plots of Leading Parton E_T

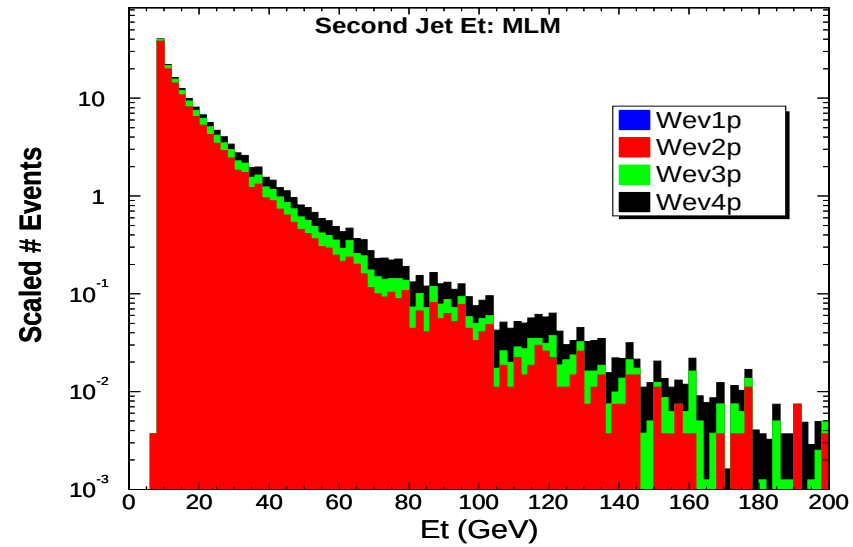


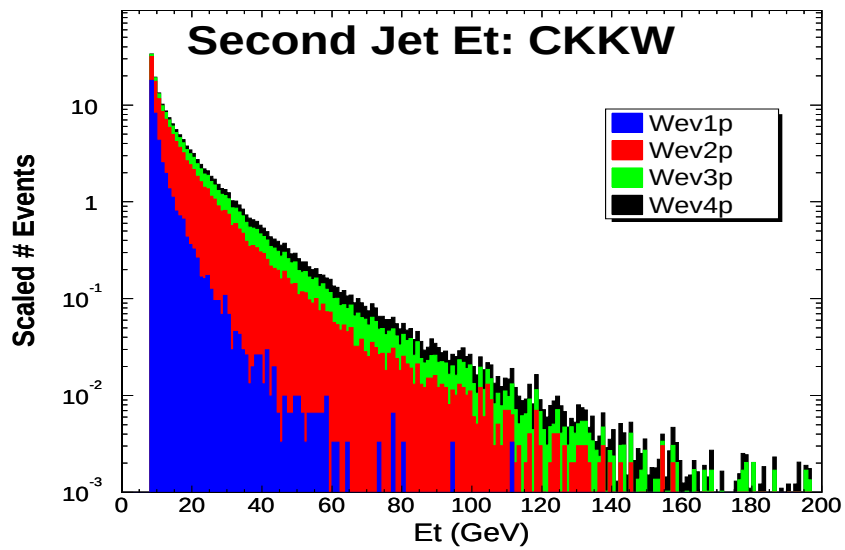




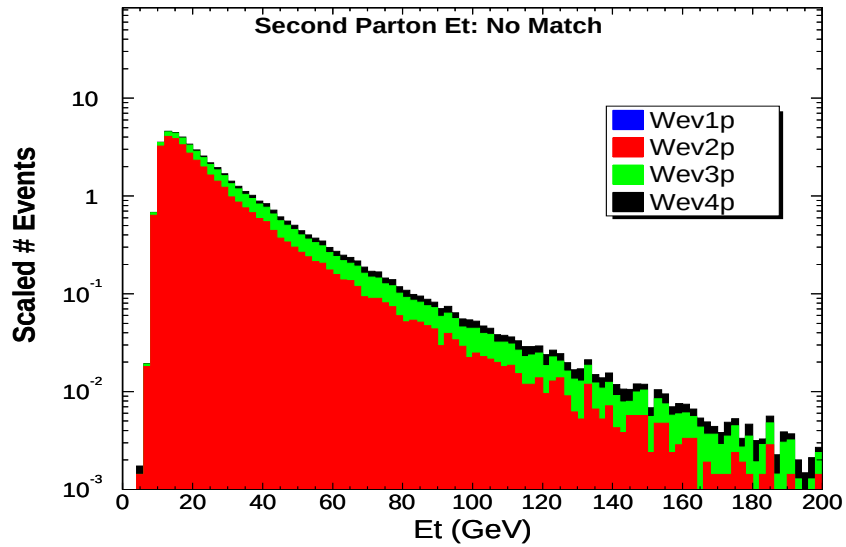
Stack plots of Second Jet E_T

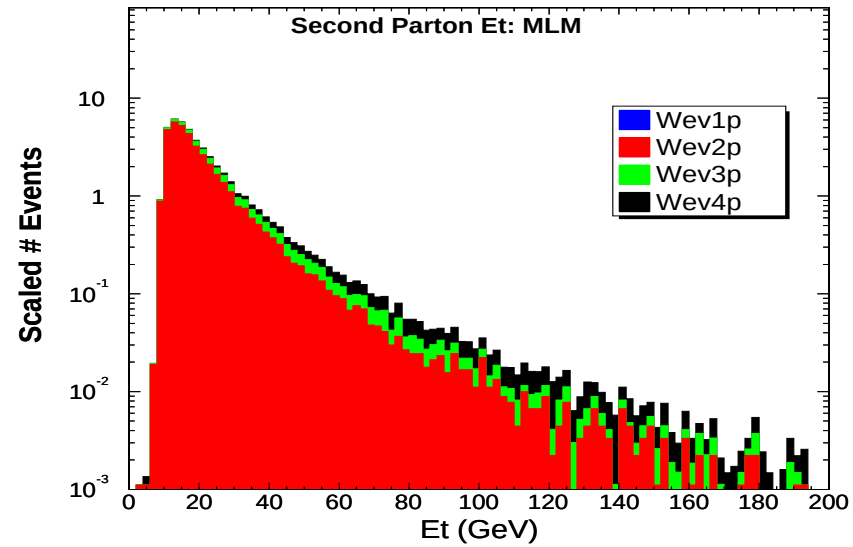


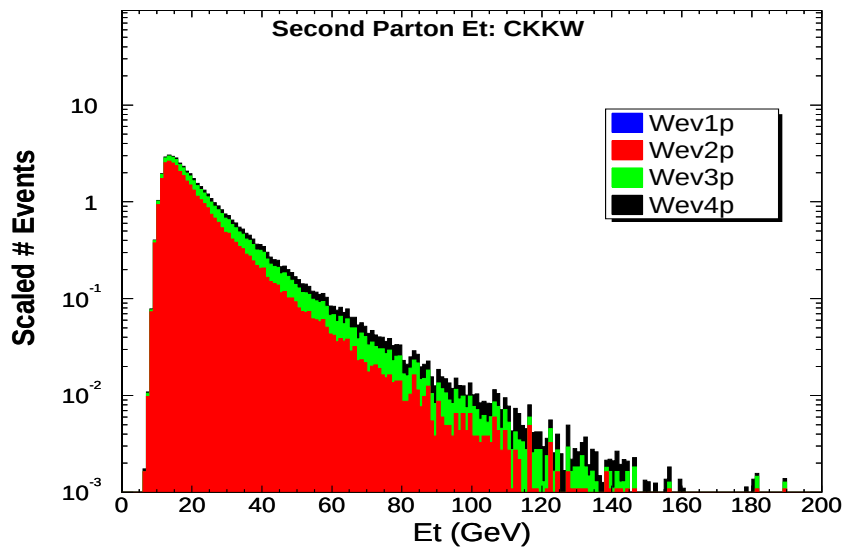




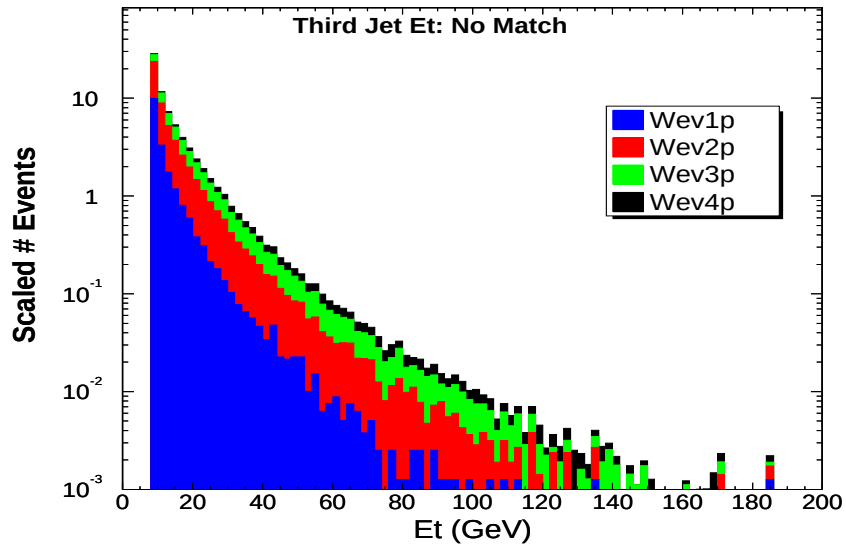
Stack plots of Second Parton E_T

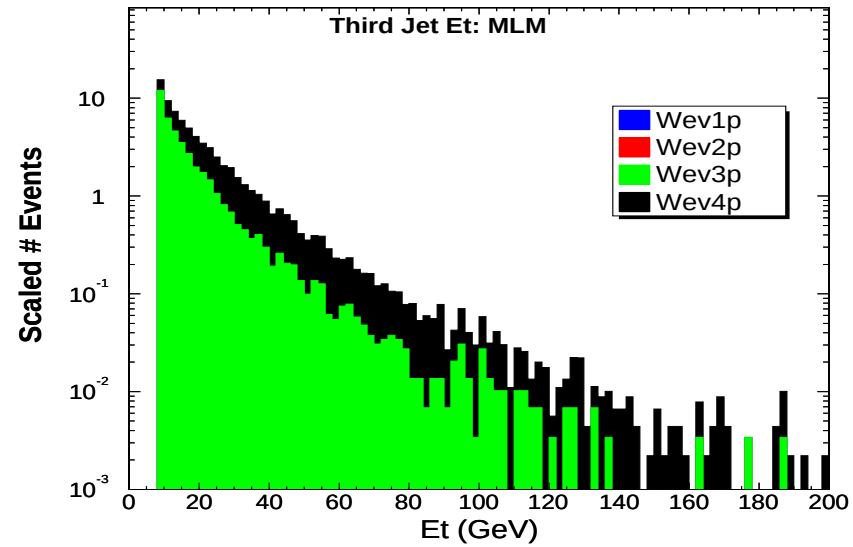


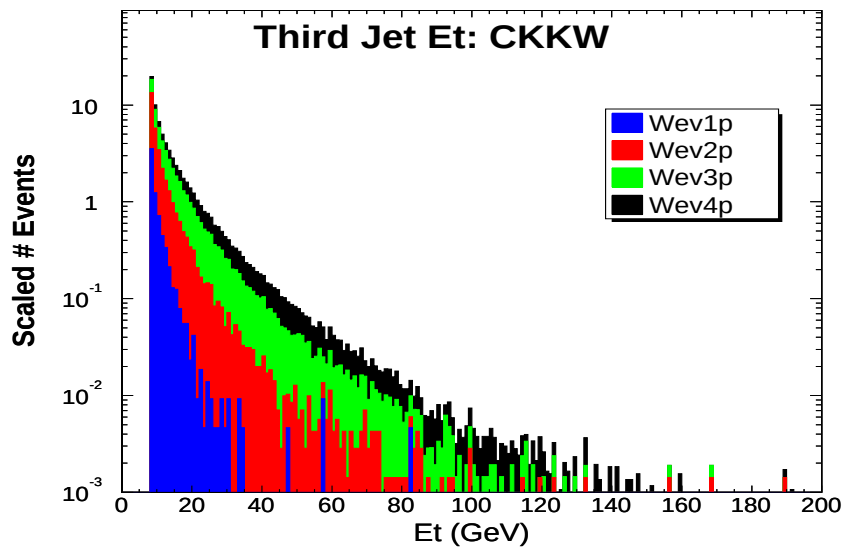




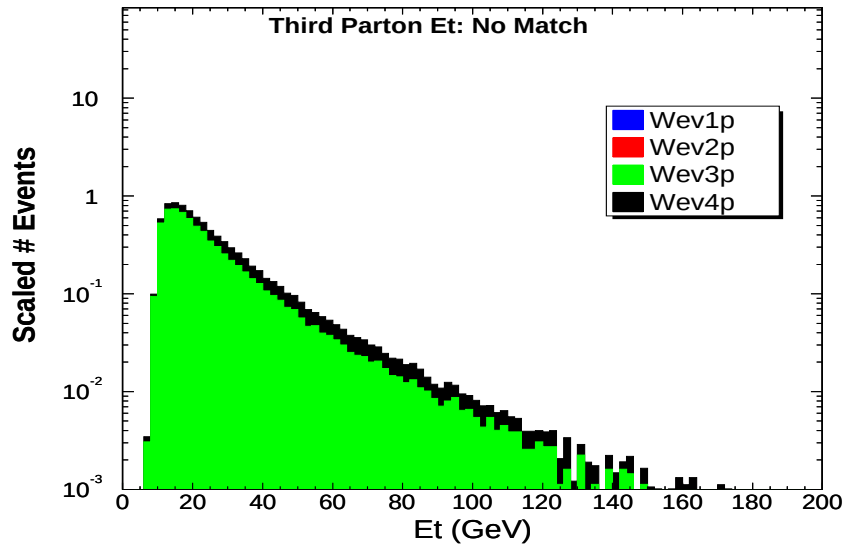
Stack plots of Third Jet E_T

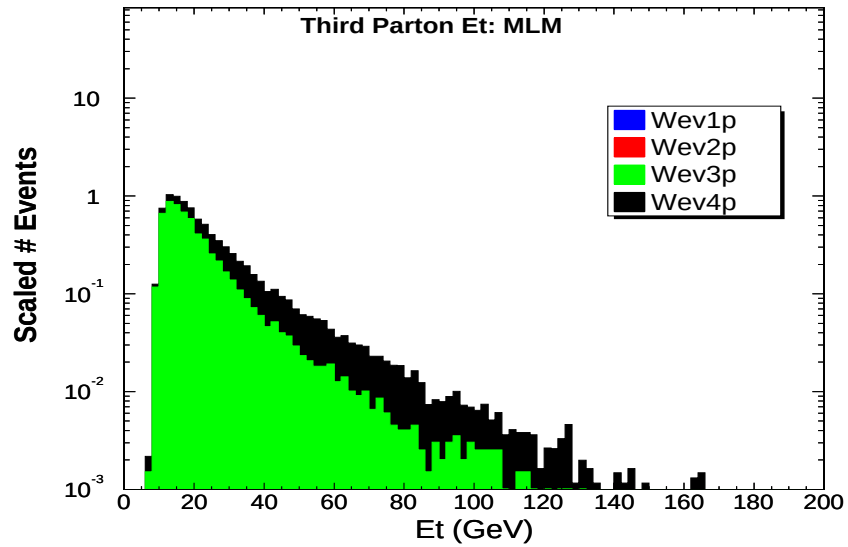


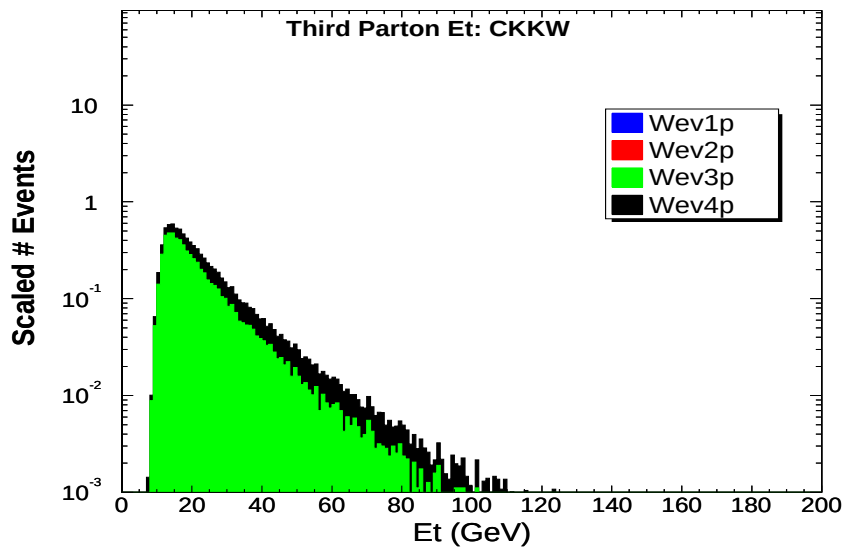




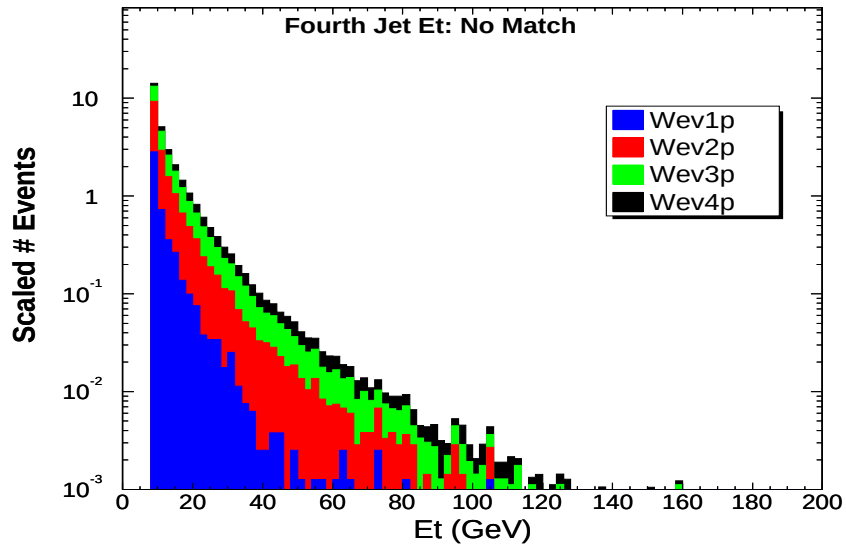
Stack plots of Third Parton E_T

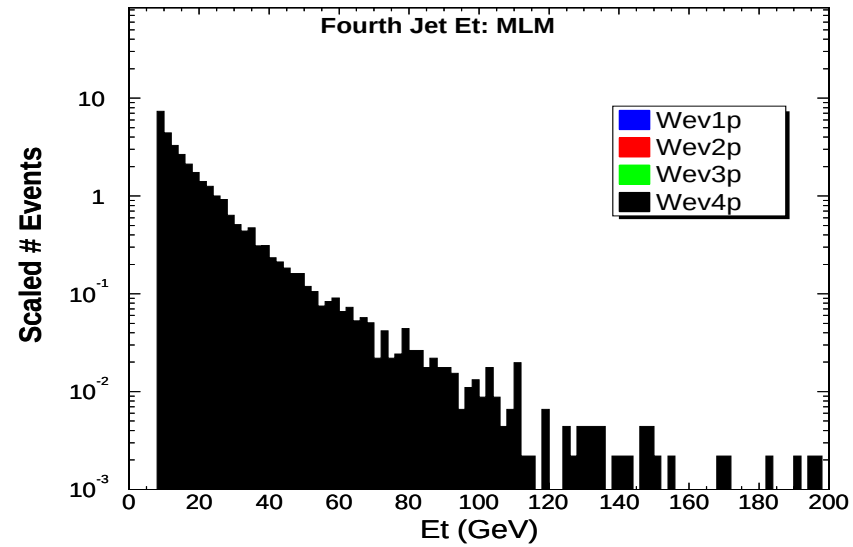


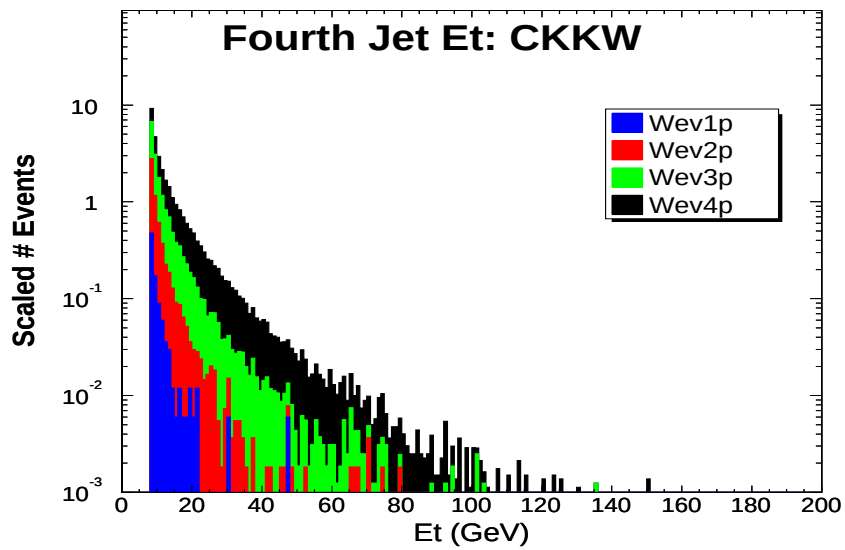
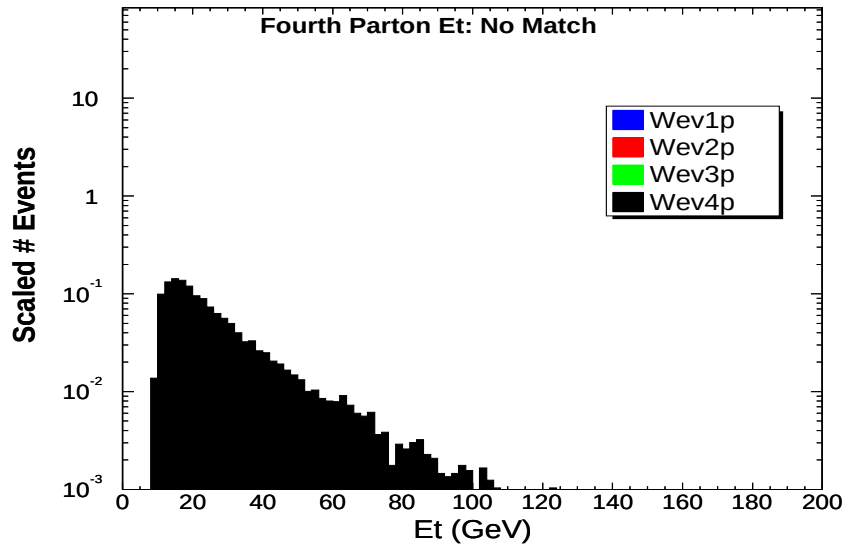
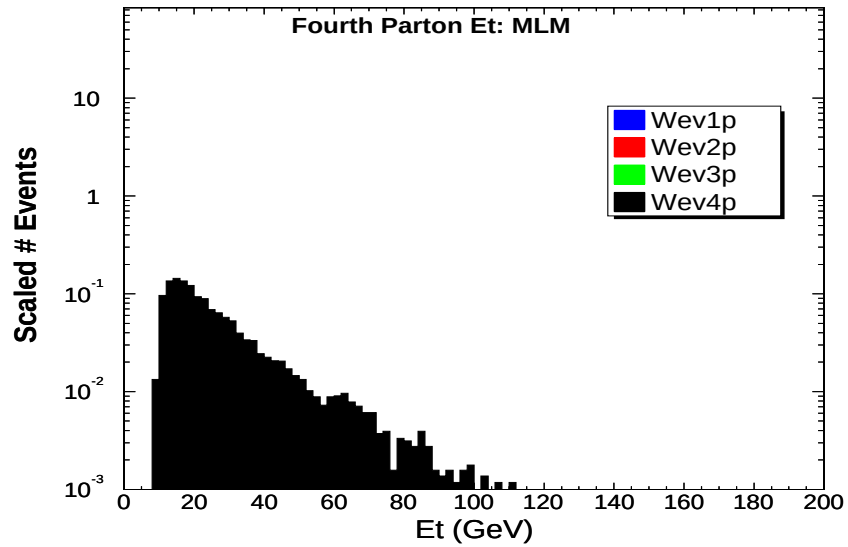
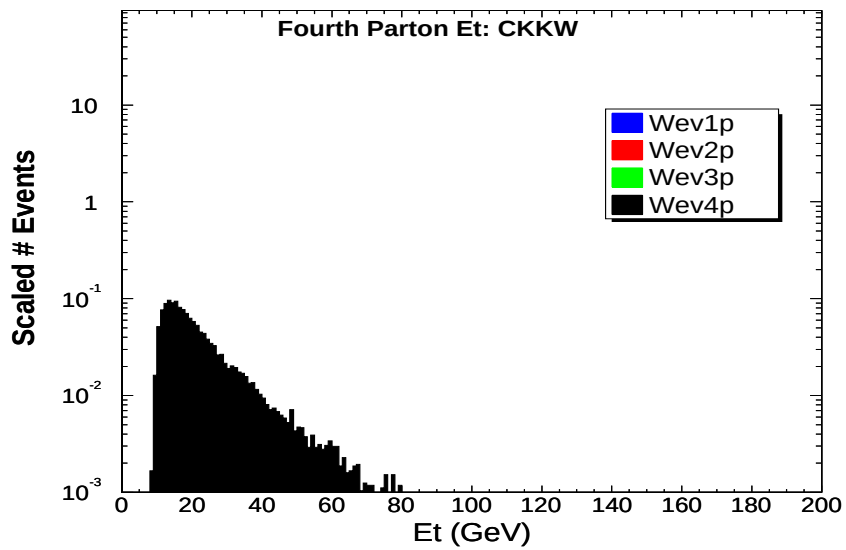




Stack plots of Fourth Jet E_T







Stack plots of Fourth Parton E_T