Physics 56500 Assignment #5 - Due April 17th

1. The three files on the Physics 56500 web site each contain data from 100,000 2-jet events generated using the Pythia Monte Carlo event generator. The jet p_T spectrum is steeply falling and so rather than generate an inclusive sample of jets, it is more inefficient to generate separate samples which restrict the hard process to satisfy $\hat{p}_T > \hat{p}_T^{min}$. The $\hat{p}_T$ ranges of the three samples, and the corresponding cross sections calculated by Pythia are shown below:

File	$\hat{p}_T^{min}$ (GeV/c)	σ (mb)
jet_example_20GeV.root	20	0.3573 ± 0.0006
jet_example_50GeV.root	50	$(9.675 \pm 0.016) \times 10^{-3}$
jet_example_200GeV.root	200	$(1.865 \pm 0.003) \times 10^{-5}$

The variables stored in the n-tuples correspond to the following physical quantities:

Name	Description
ppt1	Transverse momentum of highest p_T parton
ppt2	Transverse momentum of second highest p_T parton
hpt1	Transverse momentum of hadron jet matched to highest p_T parton
hpt2	Transverse momentum of hadron jet matched to second highest p_T parton
dr1	ΔR between highest p_T parton and matched hadronic jet
dr2	ΔR between second highest p_T parton and matched hadronic jet

(a) Plot a histogram of $d\sigma/dp_T$ for the highest p_T parton jet using data from all three files. Be sure to normalize the data consistently and make sure to correctly label the x- and y-axes.

(b) The jet p_T spectrum can be crudely approximated by a power law. Fit the spectrum of the parton jet p_T to a function of the form
$$\frac{d\sigma}{dp_T} \propto \frac{1}{p_T^\alpha}$$
Describe the quality of the fit and the value obtained for α.

(c) There are only two jets in the hard scattering process but Pythia also simulates the parton shower and hadronization. The jets found by clustering the stable particles were matched by finding the hard parton that was closest in the space of $\Delta R = \sqrt{(\Delta y)^2 + (\Delta \varphi)^2}$. Produce six histograms of $p_T^{parton} - p_T^{jet}$ for the highest and second-highest p_T jets in each of the three samples.

(d) You should find that the distributions obtained in (c) are more or less symmetric for the highest p_T jet, but are asymmetric for the second-highest p_T jet, at least for large p_T^{jet}. Explain why this would be the case.

2. Following the example UnfoldTests.C do some unfolding with the simulated jet spectrum... more details are soon to be forthcoming...