Outline of Talk

- Alberto and I are working on the publication level “underlying event” analysis.

- We have corrected the “underlying event” observables to the particle level using two methods (one-step method and two-step method).

- I am also checking to see if we need to make any corrections for “pile-up” (I showed this at the Jet Energy meeting on Wednesday).

- Today I will show you the “transverse” charged particle density, the “transverse” charged PTsum density, the “transverse” ETsum density, and the “transverse” charged fraction PTsum/ETsum.
Look at charged particle correlations in the azimuthal angle $\Delta \phi$ relative to the leading calorimeter jet (JetClu R = 0.7, $|\eta| < 2$).

- Define $|\Delta \phi| < 60^\circ$ as “Toward”, $60^\circ < -\Delta \phi < 120^\circ$ and $60^\circ < \Delta \phi < 120^\circ$ as “Transverse 1” and “Transverse 2”, and $|\Delta \phi| > 120^\circ$ as “Away”. Each of the two “transverse” regions have area $\Delta \eta \Delta \phi = 2 \times 60^\circ = 4\pi/6$. The overall “transverse” region is the sum of the two transverse regions ($\Delta \eta \Delta \phi = 2 \times 120^\circ = 4\pi/3$).
“Transverse” Charge Density versus $E_T$(jet#1)

Shows the average charged particle density, $dN_{\text{chg}}/d\eta d\phi$, in the “transverse” region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $E_T$(jet#1) for JetClu, $R = 0.7$, $|\eta\text{(jet#1)}|<2$ (zero or 1 vertex). Includes systematic errors.

Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
“Transverse” Charged Particle Density

- Shows the average charged particle density, \( dN_{\text{chg}}/d\eta d\phi \), in the “transverse” region (\( p_T > 0.5 \) GeV/c, \( |\eta| < 1 \)) versus \( E_T(\text{jet#1}) \) for JetClu, \( R = 0.7 \), \(|\eta(\text{jet#1})| < 2 \) (zero or 1 vertex).

- Shows the average charged particle density, \( dN_{\text{chg}}/d\eta d\phi \), in the “transverse” region (\( p_T > 0.5 \) GeV/c, \( |\eta| < 1 \)) versus \( P_T(\text{jet#1}) \) for MidPoint, \( R = 0.7 \), \( f = 0.75 \), \(|\eta(\text{jet#1})| < 2 \) (zero or 1 quality 12 vertex).

- Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
"Transverse" Charged PTsum Density

- Shows the average charged PTsum density, \( \frac{d\text{PT}_{\text{sum}}}{d\eta d\phi} \), in the “transverse” region (\( p_T > 0.5 \text{ GeV/c}, |\eta| < 1 \)) versus \( E_T(\text{jet#1}) \) for JetClu, \( R = 0.7 \), \( |\eta(\text{jet#1})| < 2 \) (zero or 1 vertex).

- Shows the average charged PTsum density, \( \frac{d\text{PT}_{\text{sum}}}{d\eta d\phi} \), in the “transverse” region (\( p_T > 0.5 \text{ GeV/c}, |\eta| < 1 \)) versus \( P_T(\text{jet#1}) \) for MidPoint, \( R = 0.7 \), \( f = 0.75 \), \( |\eta(\text{jet#1})| < 2 \) (zero or 1 quality 12 vertex).

- Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.

CDF-QCD Group Meeting
Rick Field - Florida/CDF
May 13, 2005
"Transverse" ETsum Density

Shows the "generator level" average ETsum density, $dE_T/d\eta d\phi$, in the "transverse" region ($p_T > 0$ GeV/c, $|\eta| < 1$) versus $P_T(\text{particle jet#1})$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$.

Shows the average tower ETsum density, $dE_{T,\text{sum}}/d\eta d\phi$, in the "transverse" region ($E_T > 0.1$ GeV, $|\eta| < 1$) versus $P_T(\text{jet#1})$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$ (zero or 1 quality vertex).

Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
"Transverse" Charged Fraction: PTsum/ETsum

![Graph showing charged fraction comparison]

- Shows the "generator level" charged fraction, PTsum/ETsum, in the "transverse" region (|η| < 1) versus PT(particle jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2 for pT(charged) > 0 and > 0.5 GeV/c.
- Shows the charged fraction, PTsum/ETsum, in the "transverse" region (pT(charged) > 0.5 GeV/c, tower ET > 0.1 GeV, |η| < 1) versus PT(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2 (zero or 1 quality 12 vertex).
- Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
Correcting to the Particle Level

Method 1 versus Method 2

One-Step Method – Method 1

- (1) Compare the Monte-Carlo at the generator particle level (GEN) with the detector level (CDFSIM). Correct the data by the factor GEN/CDFSIM without correcting the leading the jet $P_T$.

Two-Step Method – Method 2

- (1) Correct the leading jet $P_T$ by matching the leading calorimeter jet (data) with the particle level jets.

- Shows the $P_T$(corrected) – $P_T$(uncorrected) versus $P_T$(uncorrected) for the leading jet $|\eta(\text{jet#1})| < 2$ from PYTHIA Tune A and HERWIG.

- (2) Compare the Monte-Carlo at the generator particle level (GEN) with the detector level (CDFSIM) after correcting the leading jet $P_T$. Correct the data by the factor GEN/CDFSIM after correcting the leading jet $P_T$. 
Shows the charged particle density, \(dN_{\text{chg}}/d\eta d\phi\), in the “transverse” region \((p_T > 0.5 \text{ GeV/c}, |\eta| < 1)\) versus \(P_T(\text{jet#1})\) for MidPoint, \(R = 0.7, f = 0.75, |\eta(\text{jet#1})| < 2\) (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 1.

Shows the charged particle density, \(dN_{\text{chg}}/d\eta d\phi\), in the “transverse” region \((p_T > 0.5 \text{ GeV/c}, |\eta| < 1)\) versus \(P_T(\text{jet#1})\) for MidPoint, \(R = 0.7, f = 0.75, |\eta(\text{jet#1})| < 2\) (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 2.
"Transverse" Charged Particle Density

- Shows CDFSIM/GEN for the charged particle density, \( \frac{dN_{\text{chg}}}{d\eta d\phi} \), in the “transverse” region \( (p_T > 0.5 \text{ GeV/c}, |\eta| < 1) \) versus \( P_T(\text{jet#1}) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(\text{jet#1})| < 2 \) (PYTHIA Tune A) for method 1 and method 2.

- Shows CDFSIM/GEN for the charged particle density, \( \frac{dN_{\text{chg}}}{d\eta d\phi} \), in the “transverse” region \( (p_T > 0.5 \text{ GeV/c}, |\eta| < 1) \) versus \( P_T(\text{jet#1}) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(\text{jet#1})| < 2 \) for PYTHIA Tune A and HERWIG for method 1.
"Transverse" Charged Particle Density

Shows the data on the charged particle density, $dN_{\text{chg}}/d\eta d\phi$, in the "transverse" region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $P_T(\text{jet#1})$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})|<2$ corrected to the particle level using method 1 and method 2.

Shows the ratio (method 2 divided by method 1) for the charged particle density, $dN_{\text{chg}}/d\eta d\phi$, in the "transverse" region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $P_T(\text{jet#1})$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$. 
“Transverse” Charged Particle Density

- Shows the uncorrected data for the charged particle density, $dN_{\text{chg}}/d\eta d\phi$, in the “transverse” region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $p_T(\text{jet#1})$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$ compared with PYTHIA Tune A and HERWIG after CDFSIM.

- Shows the corrected data for the charged particle density, $dN_{\text{chg}}/d\eta d\phi$, in the “transverse” region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $p_T(\text{jet#1})$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$ compared with PYTHIA Tune A and HERWIG at the particle level.
"Transverse" Charged PTsum Density

- Shows the charged PTsum density, \(dP_{T\text{sum}}/d\eta d\phi\), in the “transverse” region (\(p_T > 0.5 \text{ GeV/c}, |\eta| < 1\)) versus \(P_T(\text{jet#1})\) for MidPoint, \(R = 0.7, f = 0.75, |\eta(\text{jet#1})| < 2\) (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 1.

- Shows the charged PTsum density, \(dP_{T\text{sum}}/d\eta d\phi\), in the “transverse” region (\(p_T > 0.5 \text{ GeV/c}, |\eta| < 1\)) versus \(P_T(\text{jet#1})\) for MidPoint, \(R = 0.7, f = 0.75, |\eta(\text{jet#1})| < 2\) (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 2.
"Transverse" Charged PTsum Density

- Shows CDFSIM/GEN for the charged PTsum density, \( d\text{PT}_\text{sum}/d\eta d\phi \), in the “transverse” region \( p_T > 0.5 \text{ GeV/c}, |\eta| < 1 \) versus \( p_T(\text{jet#1}) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(\text{jet#1})|<2 \) (PYTHIA Tune A) for method 1 and method 2.

- Shows CDFSIM/GEN for the charged PTsum density, \( d\text{PT}_\text{sum}/d\eta d\phi \), in the “transverse” region \( p_T > 0.5 \text{ GeV/c}, |\eta| < 1 \) versus \( p_T(\text{jet#1}) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(\text{jet#1})|<2 \) for PYTHIA Tune A and HERWIG for method 1.
“Transverse” Charged PTsum Density

Shows the data on the charged PTsum density, \( d\text{PT}_{\text{sum}}/d\eta d\phi \), in the “transverse” region \((p_T > 0.5 \text{ GeV/c}, |\eta| < 1)\) versus \(P_T(\text{jet#1})\) for MidPoint, \(R = 0.7, f = 0.75, |\eta(\text{jet#1})|<2\) corrected to the particle level using method 1 and method 2.

Shows the ratio (method 2 divided by method 1) for the charged PTsum density, \( d\text{PT}_{\text{sum}}/d\eta d\phi \), in the “transverse” region \((p_T > 0.5 \text{ GeV/c}, |\eta| < 1)\) versus \(P_T(\text{jet#1})\) for MidPoint, \(R = 0.7, f = 0.75, |\eta(\text{jet#1})|<2\).
"Transverse" Charged PTsum Density

- Shows the uncorrected data for the charged PTsum density, $dP_{T\text{sum}}/d\eta d\phi$, in the "transverse" region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $P_T(jet\#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet\#1)| < 2$ compared with PYTHIA Tune A and HERWIG after CDFSIM.

- Shows the corrected data for the charged PTsum density, $dP_{T\text{sum}}/d\eta d\phi$, in the "transverse" region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $P_T(jet\#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet\#1)| < 2$ compared with PYTHIA Tune A and HERWIG at the particle level.
“Transverse” ETsum Density

Shows the ETsum density, $d\text{ET}_{\text{sum}}/d\eta d\phi$, in the “transverse” region (tower $E_T > 0.1$ GeV, $|\eta| < 1$) versus $P_T(jet#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet#1)|<2$ (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 1.

Shows the ETsum density, $d\text{ET}_{\text{sum}}/d\eta d\phi$, in the “transverse” region (tower $E_T > 0.1$ GeV, $|\eta| < 1$) versus $P_T(jet#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet#1)|<2$ (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 2.
"Transverse" ETsum Density

- Shows CDFSIM/GEN for the ETsum density, $dE_T/da_{\eta}d\phi$, in the "transverse" region (tower $E_T > 0.1$ GeV, $|\eta| < 1$) versus $p_T(jet#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet#1)| < 2$ (PYTHIA Tune A) for method 1 and method 2.

- Shows CDFSIM/GEN for the ETsum density, $dE_T/da_{\eta}d\phi$, in the "transverse" region (tower $E_T > 0.1$ GeV, $|\eta| < 1$) versus $p_T(jet#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet#1)| < 2$ for PYTHIA Tune A and HERWIG for method 1.
"Transverse" ETsum Density

Shows the data on the ETsum density, dET_{sum}/d \eta d\phi, in the “transverse” region (tower E_T > 0.1 GeV, |\eta| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |\eta(jet#1)|<2 corrected to the particle level using method 1 and method 2.

Shows the ratio (method 2 divided by method 1) for the ETsum density, dET_{sum}/d \eta d\phi, in the “transverse” region (tower E_T > 0.1 GeV, |\eta| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |\eta(jet#1)|<2.
“Transverse” ETsum Density

shows the data on the ETsum density, \( \frac{dE_{T\text{sum}}}{d\eta d\phi} \), in the “transverse” region (tower \( E_T > 0.1 \text{ GeV}, |\eta| < 1 \)) versus \( P_T(jet#1) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(jet#1)|<2 \) corrected to the particle level using method 1 and method 2.

shows the ratio (method 2 divided by method 1) for the ETsum density, \( \frac{dE_{T\text{sum}}}{d\eta d\phi} \), in the “transverse” region (tower \( E_T > 0.1 \text{ GeV}, |\eta| < 1 \)) versus \( P_T(jet#1) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(jet#1)|<2 \).
“Transverse” ETsum Density

- Shows the uncorrected data for the ETsum density, $d\text{ET}_{\text{sum}}/d\eta d\phi$, in the “transverse” region (tower $E_T > 0.1$ GeV, $|\eta| < 1$) versus $P_T$ (jet#1) for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$ compared with PYTHIA Tune A and HERWIG after CDFSIM.

- Shows the corrected data for the ETsum density, $d\text{ET}_{\text{sum}}/d\eta d\phi$, in the “transverse” region (tower $E_T > 0.1$ GeV, $|\eta| < 1$) versus $P_T$ (jet#1) for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})| < 2$ compared with PYTHIA Tune A and HERWIG at the particle level.

CDF-QCD Group Meeting
May 13, 2005
“Transverse” Charged Fraction
PTsum/ETsum

Shows the charged fraction, PTsum/ETsum, in the “transverse” region (tower $E_T > 0.1$ GeV, $p_T(chg) > 0.5$ GeV/c, $|\eta| < 1$) versus $p_T(jet#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet#1)| < 2$ (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 1.

Shows the charged fraction, PTsum/ETsum, in the “transverse” region (tower $E_T > 0.1$ GeV, $p_T(chg) > 0.5$ GeV/c, $|\eta| < 1$) versus $p_T(jet#1)$ for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(jet#1)| < 2$ (PYTHIA Tune A) at the particle level (GEN), detector level (CDFSIM), and the ratio CDFSIM/GEN for method 2.
"Transverse" Charged Fraction
PTsum/ETsum

Shows CDFSIM/GEN for the charged fraction, PTsum/ETsum, in the “transverse” region (tower ET > 0.1 GeV, p_T(chg) > 0.5 GeV/c, |η| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2 (PYTHIA Tune A) for method 1 and method 2.

Shows CDFSIM/GEN for the charged fraction, PTsum/ETsum, in the “transverse” region (tower ET > 0.1 GeV, p_T(chg) > 0.5 GeV/c, |η| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2 for PYTHIA Tune A and HERWIG for method 1.
"Transverse" Charged Fraction
PTsum/ETsum

Shows the data on the charged fraction, PTsum/ETsum, in the "transverse" region (tower E_T > 0.1 GeV, p_T(chg) > 0.5 GeV/c, |η| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)| < 2 corrected to the particle level using method 1 and method 2.

Shows the ratio (method 2 divided by method 1) for the charged fraction, PTsum/ETsum, in the "transverse" region (tower E_T > 0.1 GeV, p_T(chg) > 0.5 GeV/c, |η| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)| < 2.
**“Transverse” Charged Fraction**

PTsum/ETsum

- Shows the uncorrected data for the charged fraction, PTsum/ETsum, in the “transverse” region (tower ET > 0.1 GeV, \( p_T(chg) > 0.5 \text{ GeV/c, } |\eta| < 1 \)) versus \( P_T(jet#1) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(jet#1)| < 2 \) compared with PYTHIA Tune A and HERWIG after CDFSIM.

- Shows the corrected data for the charged fraction, PTsum/ETsum, in the “transverse” region (tower ET > 0.1 GeV, \( p_T(chg) > 0.5 \text{ GeV/c, } |\eta| < 1 \)) versus \( P_T(jet#1) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(jet#1)| < 2 \) compared with PYTHIA Tune A and HERWIG at the particle level.

*CDF-QCD Group Meeting*  
*Rick Field - Florida/CDF*  
*May 13, 2005*  
*Page 25*