QCD Physics at CDF
Overview

Outline

- The QCD Group: Organization, Activities, Run 2 Analyses
- QCD Update: “New Analysis on the Underlying Event in Run 2”
- Other QCD Group Presentations:
  - “Jet Production using a Cone Algorithm” - Gene Flanagan (15 min)
  - “Jet Production using the KT Algorithm” - Regis Lefevre (15 min)
  - “W/Z Hadronic Search in Photon Events” - Andrea Bocci (15 min)
  - “Jet Corrections” – Ken Hatakeyama (15 min)
  - “Diffraction @ CDF” - Michele Gallinaro (15 min)
Conveners:

- Rick Field (2nd year)
- Mary Convery replaces Mario Martinez

Meetings:

- On Weeks 9:00-11:30am CDF Theater
- Off Weeks 11:30-1:00pm Trailer 159

QCD Internal WEBSITE:

- Meeting Agenda & Archived Talks (with author index)
- Blessed Plots and Analyses
- Information of Monte-Carlo Datasets
- QCD Secondary Datasets
- QCD Stntuples

Thanks Alberto!
Thanks Ken!
Thanks Mario!
I have a present for Mario, but I will wait and give it to him in Barcelona!
Good luck Craig!
The QCD Group
Run 2 Analyses

- Inclusive Jet Cross Section (JetClu & MidPoint): Frank Chlebana, Anwar Bhatti, Ken Hatakeyama, Giuseppe Latino, Joey Huston, Gene Flanagan
- Inclusive Jet Cross Section (KT Algorithm): Regis Lefevre, Olga Norniella
- DiJet Mass/Angular Distribution: Ken Hatakeyama, Robert Harris, Lee Pondrom
- DiPhoton Production: Yanwen Liu
- b-Jet & b-bbar Jet Cross Sections: Monica D'Onofrio, Anant Gajjar, Greg Williams
- b-bbar Correlations: Sofia Vallecorsa
- Exclusive $\chi_c$ Production: Angela Wyatt
- Jet Shapes (light and heavy quarks): Mario Martinez, Olga Norniella, Alison Lister
- Quark and Gluon Fragmentation: Andrey Korytov, Sasha Pronko, Lester Pinera, Sergo Jindariani
- W+Jets: Andrea Messina, Ben Cooper
- The Underlying Event in WW Production: Mike Albrow
- $\gamma$+jets, Z+jets (event structure & underlying event): Rick Field, Craig Group
- The Underlying Event in Jet and Di-Jet Production: Rick Field, Alberto Cruz
- Diffractive Physics: The “Diffractive Group”
The QCD Group
Run 2 Analyses

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- Diffractive Physics: The “Diffractive Group”

Final CDF Draft soon!
Submitted to PRD!
See talk by Michelle!
The QCD Group
Run 2 Analyses

CDF Run 2 b-Jet Cross Section

- Data
- MC Pythia

MidPoint f=0.75
|Y|<0.7
unfolded
CDF PRELIMINARY

Monica D’Onofrio (preblessing February 11, 2005)
The “Transverse” Regions as defined by the Leading Jet

Charged Particle $\Delta \phi$ Correlations

$\mathbf{p_T > 0.5 \, \text{GeV/c} \ |\eta| < 1}$

Jet #1 Direction

$2\pi$

Away Region

Transverse Region 1

Transverse Region 2

Away Region

Leading Jet

Δφ

Φ

0

ΔηΔφ = 2x60° = 4π/6

The overall “transverse” region is the sum of the two transverse regions ($\Delta \eta \Delta \phi = 2 \times 120° = 4\pi/3$).

- Look at charged particle correlations in the azimuthal angle $\Delta \phi$ relative to the leading calorimeter jet (JetClu R = 0.7, $|\eta| < 2$).

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

Look at the charged particle density in the “underlying event”!

Would also like to look at the energy density in the “transverse” region!
"Transverse" Charge Density versus $E_T(jet#1)$

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

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

CDF Run 2 Preliminary Data uncorrected theory + CDFSIM

Run 2 Blessed Plot PY Tune A

1.96 TeV Charged Particles ($|\eta|<1.0$, $PT>0.5$ GeV/c)

ET(jet#1) (GeV) E_T(jet#1) < 250 GeV!

Uses ET! Uses JetClu!

Collaboration Meeting Rick Field - Florida/CDF

January 21, 2005
"Transverse" Charge Density

- Shows the average 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 \(E_T(\text{jet#1})\) for JetClu, \(R = 0.7, |\eta(\text{jet#1})|<2\) (zero or 1 vertex).

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

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

Collaboration Meeting

Rick Field - Florida/CDF

January 21, 2005
**“Transverse” Charge Density**

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**Collaboration Meeting**

**January 21, 2005**

**Rick Field - Florida/CDF**

**Page 9**
Shows the average charged PTsum density, \( \frac{dPT_{sum}}{d\eta d\phi} \), in the “transverse” region (\( p_T > 0.5 \) GeV/c, \(|\eta| < 1\)) versus \( E_T(jet#1) \) for JetClu, \( R = 0.7 \), \(|\eta(jet#1)| < 2 \) (zero or 1 vertex).

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

Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
Shows the average charged PTsum density, $dP_{T\,\text{sum}}/d\eta d\phi$, in the “transverse” region ($p_T > 0.5$ GeV/c, $|\eta| < 1$) versus $E_T(jet\#1)$ for JetClu, $R = 0.7$, $|\eta(jet\#1)|<2$ (zero or 1 vertex).

Shows the average 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, $R = 0.7$, $f = 0.75$, $|\eta(jet\#1)|<2$ (zero or 1 quality 12 vertex).

Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
Shows the charged particle \( \langle P_T \rangle \), in the “transverse” region \( (p_T > 0.5 \text{ GeV/c}, |\eta| < 1) \) versus \( P_T(jet\#1) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(jet\#1)| < 2 \) (zero or 1 quality 12 vertex).

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

Compared the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
Shows the “generator level” average particle density, $dN/d\eta d\phi$, in the “transverse” region ($p_T > 0$ GeV/c, $|\eta| < 1$) versus $P_T$ (particle jet#1) for MidPoint, $R = 0.7$, $f = 0.75$, $|\eta(\text{jet#1})|<2$.

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

HERWIG produces more “soft” particles than PYTHIA Tune A!
Shows the “generator level” average particle density, dN/d\eta d\phi, in the “transverse” region (p_T > 0 GeV/c, |\eta| < 1) versus P_T(particle jet#1) for MidPoint, R = 0.7, f = 0.75, |\eta(jet#1)|<2.

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HERWIG produces more “soft” particles than PYTHIA Tune A!
Show the “generator level” average ETsum density, \( \frac{d\text{ET}}{d\eta d\phi} \), in the “transverse” region \( (p_T > 0 \text{ GeV/c, } |\eta| < 1) \) versus \( P_T(\text{particle jet#1}) \) for MidPoint, \( R = 0.7, f = 0.75, |\eta(jet#1)| < 2 \).

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

Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
Shows the "generator level" average ETsum density, dET_{sum}/d\eta d\phi, in the "transverse" region (p_T > 0 GeV/c, |\eta| < 1) versus P_T(particle jet#1) for MidPoint, R = 0.7, f = 0.75, |\eta(jet#1)|<2.

Shows the average tower ETsum density, dET_{sum}/d\eta d\phi, in the "transverse" region (E_T > 0.1 GeV, |\eta| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |\eta(jet#1)|<2 (zero or 1 quality 12 vertex).

Compares the (uncorrected) data with PYTHIA Tune A and HERWIG after CDFSIM.
*Transverse* ETsum Density

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

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

**Shows the average tower ETsum density, \( \frac{d \text{ETsum}}{d \eta d \phi} \), in the “transverse” region (\( E_T > 0.1 \text{ GeV}, |\eta| < 1 \)) versus \( p_T(\text{jet#1}) \) for MidPoint, \( R = 0.7 \), \( f = 0.75 \), \( |\eta(\text{jet#1})|<2 \) (zero or 1 quality 12 vertex).**

**The energy problem still exists! The data have more energy in the “transverse” region then PYTHIA Tune A or HERWIG!**

- New 5.3.3nt no sys errors
- PTsum(charged, \( p_T>0.5 \text{ GeV/c} \))
- ETsum(towers, \( E_T>0.1 \text{ GeV} \))