Jet studies at CDF in Run II

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Outline
Motivation
• Inclusive jet cross section
• Dijet mass
• Jet shapes
Summary
Motivation

• Tevatron = jet factory
• Probe highest energy scales
  – Higher vs $\Rightarrow$ higher $s$ (factor 3 for $E_T > 500$ GeV)
  – Already more jets than in Run I
• Test fixed-order QCD
  – look for deviations $\Rightarrow$ new physics
• Constrain PDFs
• Analyses:
  – Inclusive jet cross section (counting jets)
  – Dijet Mass (bump hunting)
  – Jet Shapes & Energy Flow
Tevatron & CDF

Upgraded Tevatron at Fermilab

vs = 1.8 TeV $\rightarrow$ 1.96 TeV
Higher $s$ (jet)

Collider Detector at Fermilab (CDF)
- New plug calorimeter ($1.1 < |\eta| < 3.6$)
- New tracking system
- Upgraded trigger
Highest Energy Jets in Run II

Jet 2
$E_T = 546$ GeV (raw)
$\eta_{det} = -0.30$

Jet 1
$E_T = 583$ GeV (raw)
$\eta_{det} = 0.31$

Run 152507 Event 1222318
Dijet Mass = 1364 GeV (corr)

CDF Run II Preliminary
Inclusive Jet Cross Section

- Repeat Run I analyses
  - Use CDF cone jet algorithm with $R = 0.7$ (JetClu)

- Event selection cuts
  - $|z_{\text{vertex}}| < 60 \text{ cm}$
  - $E_T < 1500 \text{ GeV}$
  - $E_T^{\text{missing}} \sqrt{\sum E_T} < 2 \text{ to } 7$

$$\frac{d\sigma}{dE_T} = \frac{N}{\varepsilon L \Delta E_T \Delta \eta}$$

- Require fully efficient trigger
- Apply jet energy corrections (same as in Run I)

CDF Run II Preliminary
Integrated $L = 85 \text{ pb}^{-1}$

JetClu Cone $R = 0.7$
$0.1 < |\eta_{\text{Jet}}| < 0.7$

Inclusive Jet Measured $E_T$ (GeV)
Systematic Uncertainties

Luminosity uncertainty = 6%

Largest uncertainty
Corrected: Log

- 8 orders of magnitude!
- Highest $E_T$ jets ever!

CDF Run II Preliminary
Integrated $L = 85 \text{ pb}^{-1}$
$0.1 < |\eta_{\text{Det}}| < 0.7$
JetClu Cone $R = 0.7$

CTEQ 6.1: hep-ph/0303013
**Corrected: Linear**

CDF Run II Preliminary

JetClu cone $R = 0.7$, vs $= 1.96$ TeV

Good agreement (within uncertainties)
Run II & I

- Higher $\sigma$ in Run II due to higher $p_T$
- Many uncertainties cancel in the ratio
• Higher $\sigma$ in Run II due to higher $\sqrt{s}$

• 3 more bins at high dijet mass!
Consistent with inclusive jet cross section
Differential jet shape definition

\[ \rho(r) = \frac{\sum_{\Delta r} E_T(r + \Delta r/2) - E_T(r - \Delta r/2)}{N_{\text{jets}} \Delta r} \]

\[ \sum_{r=0}^{R} \Delta r \cdot \rho(r) = 1 \]

⇒ Jet Shape computed using CAL towers
⇒ Plots ARE NOT corrected to the hadron level
- Narrower jets at high $E_T$ & low $\eta$
- **HERWIG** agrees well with data
Calorimeter vs. tracking

- Use COT tracks with $p_T > 0.5$ GeV
- Agrees with calorimeter-based shape
- Agrees with PYTHIA

CDF Run II Preliminary
Energy flows

• Look *outside* the jet
• Probe the underlying event
Energy flows

CDF Run II Preliminary

$E_{T}^{\text{jet}} \geq 30 \text{ GeV}$

uncorrected (detector level)

$1/N_{c} dE_{T}/d\phi$ (GeV/bin)

Increasing $\Delta\eta^{\text{jet}}$

Increasing $\eta^{\text{jet}}$
Summary

• CDF has preliminary measurements in Run II
  – Inclusive jet cross section
  – Dijet mass
  – Jet shapes & energy flow

• Higher vs → more jets at high $E_T$
• Data samples w/ higher statistics than Run I
• Dominant systematic: jet $E$-scale
• General agreement w/ fixed-order QCD calculations & Monte Carlos
## Outlook

- **Reduced systematics**
- **More data**
- **Forward jets**
- **Different jet algorithms**
- **Other jet analyses**
  - Dijet angular distribution
  - $s$ ($b$-jet)

![CDF Run II Preliminary](image)

Integrated $L = 85$ pb$^{-1}$
Uncorrected
JetClu Cone $R = 0.7$