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)

Quantum Chromo-Dynamics

The CDF-QCD Group

Thanks Mario!

Conveners:

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

I have a present for Mario, but I will wait and give it to him in Barcelona!

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!

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 χ_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
- **γ+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
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- **Diffractive Physics:** The "Diffractive Group"

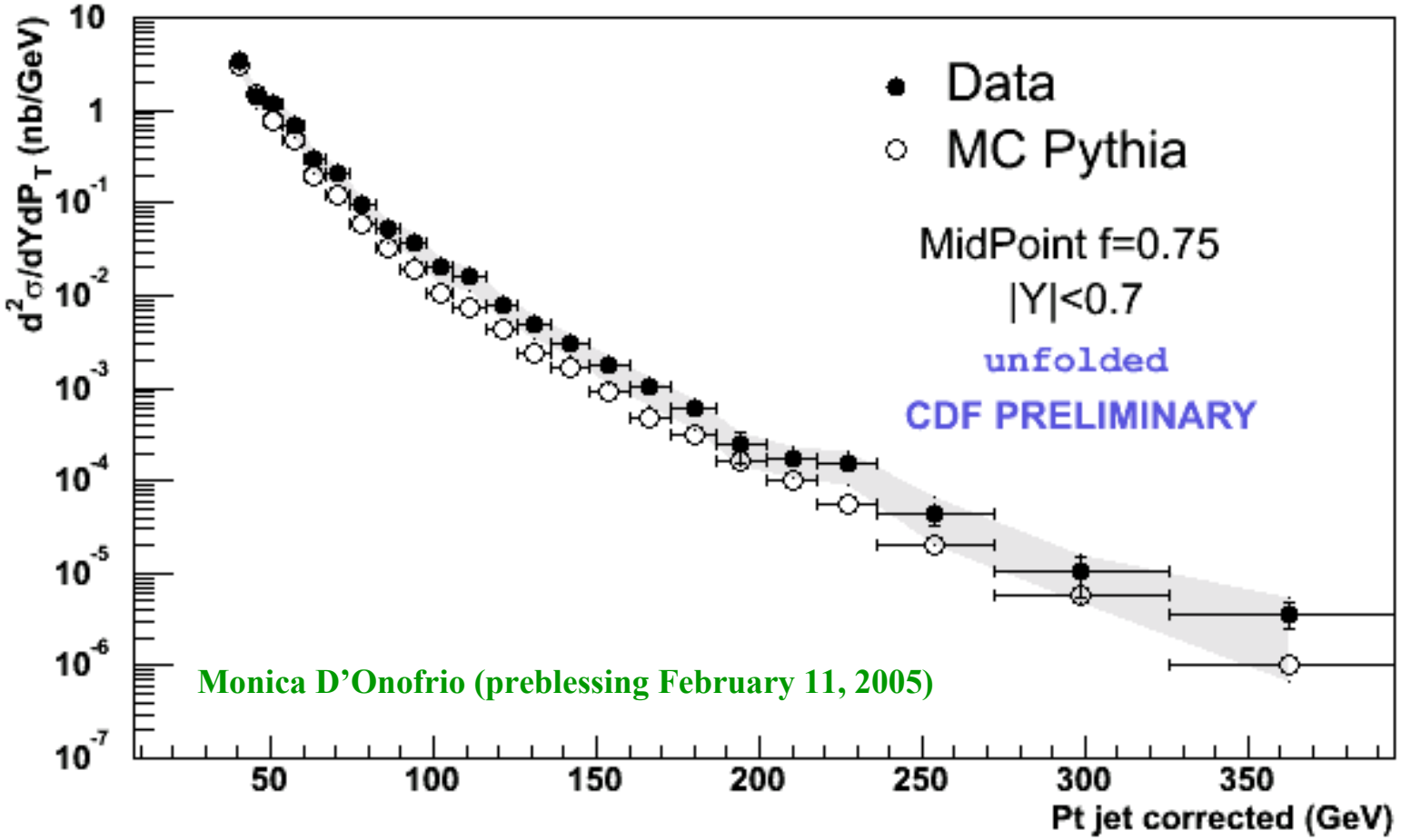
Submitted to PRD!

Final CDF Draft soon!

See talk by Michelle!

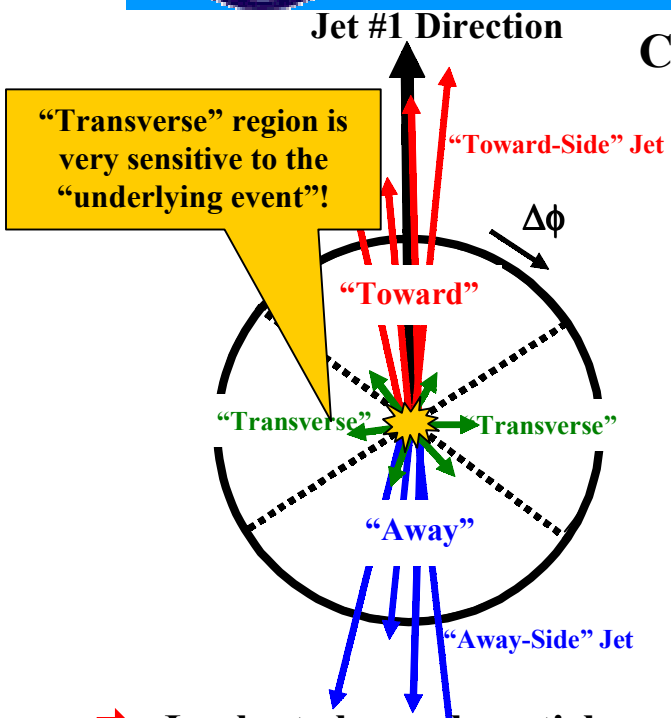
The QCD Group
Run 2 Analyses

CDF Run 2 b-Jet Cross Section



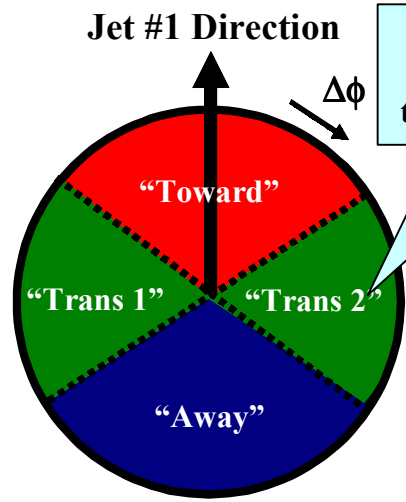
Monica D'Onofrio (preblessing February 11, 2005)

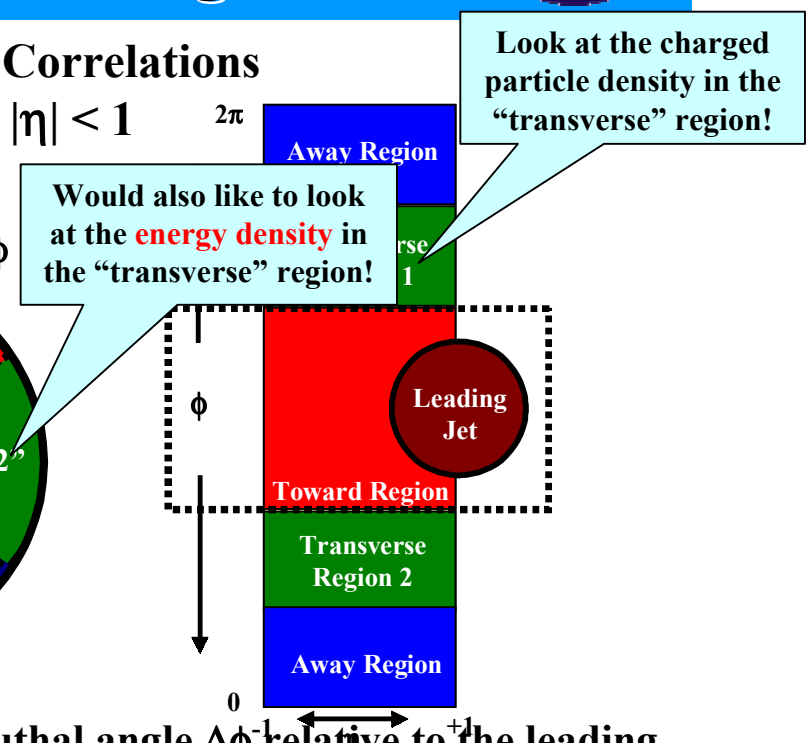
The "Transverse" Regions
as defined by the Leading Jet



Charged Particle Δφ Correlations

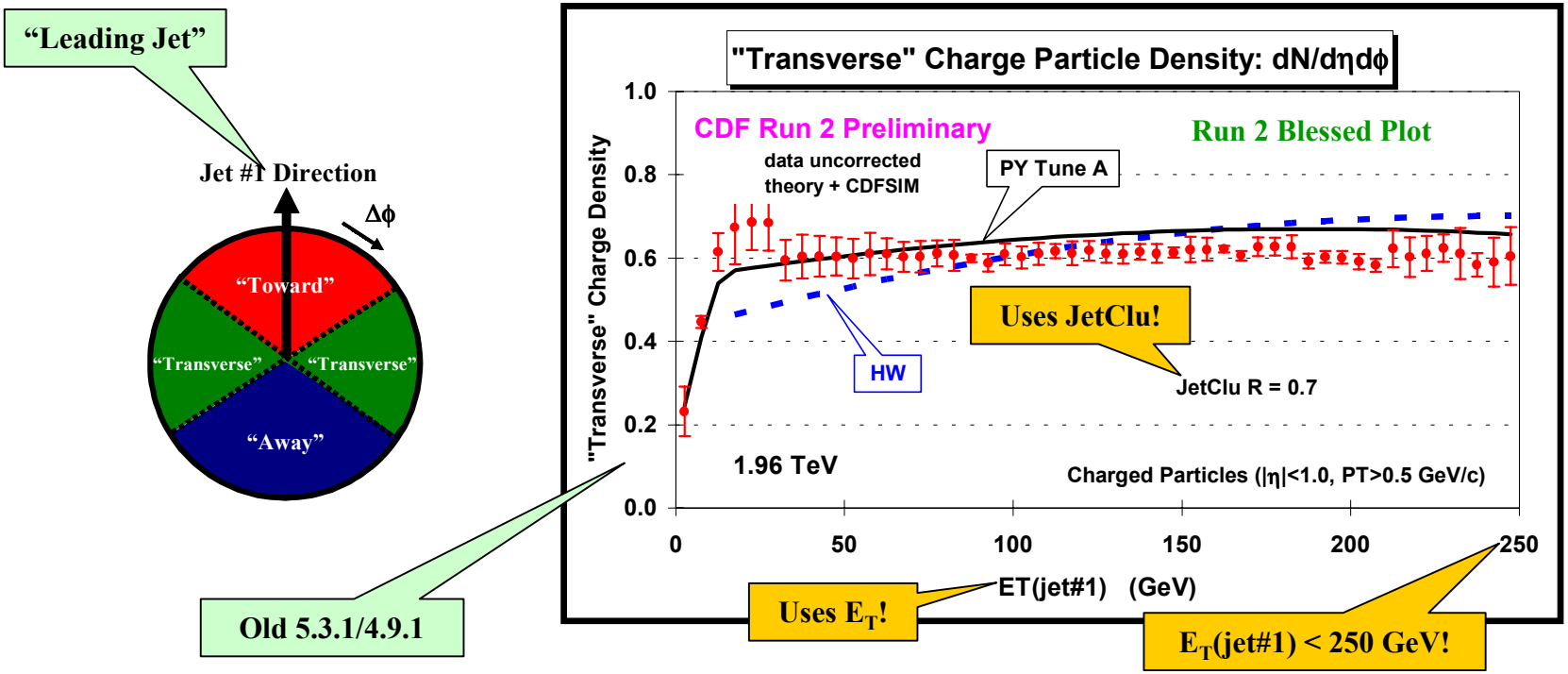
$p_T > 0.5$ GeV/c $|\eta| < 1$





- Look at charged particle correlations in the azimuthal angle Δφ relative to the leading calorimeter jet (JetClu R = 0.7, $|\eta| < 2$).
- Define $|\Delta\phi| < 60^o$ as "Toward", $60^o < -\Delta\phi < 120^o$ and $60^o < \Delta\phi < 120^o$ as "Transverse 1" and "Transverse 2", and $|\Delta\phi| > 120^o$ as "Away". Each of the two "transverse" regions have area $\Delta\eta\Delta\phi = 2x60^o = 4\pi/6$. The overall "transverse" region is the sum of the two transverse regions ($\Delta\eta\Delta\phi = 2x120^o = 4\pi/3$).

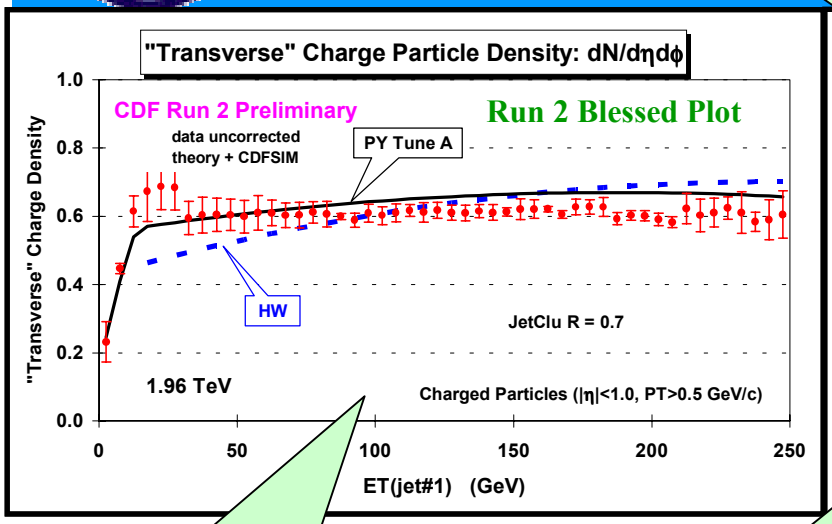
"Transverse" Charge Density versus E_T(jet#1)

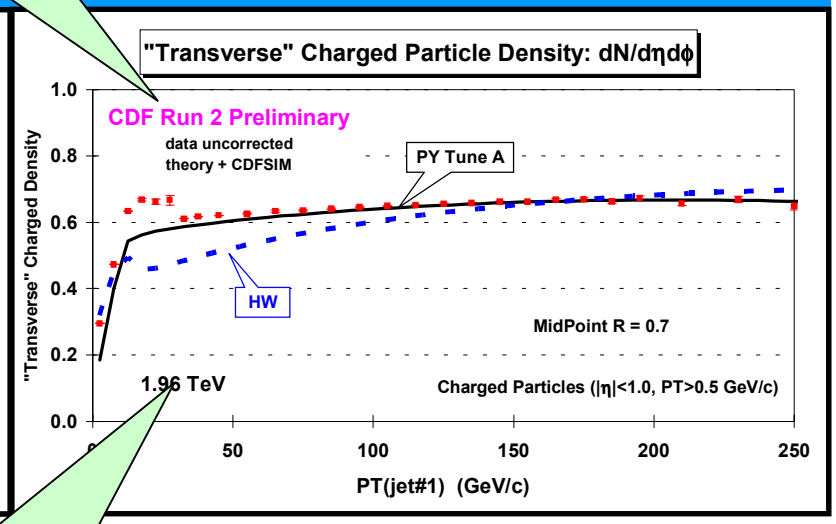


- Shows the average charged particle density, $dN_{chg}/d\eta d\phi$, in the "transverse" region (p_T > 0.5 GeV/c, $|\eta|$ < 1) versus E_T(jet#1) for JetClu, R = 0.7, $|\eta(\text{jet\#1})|<2$ (zero or 1 vertex). Includes systematic errors.
- Compares the (*uncorrected*) data with PYTHIA Tune A and HERWIG after CDFSIM.

"Transverse" Charge Density

Alberto's thesis!



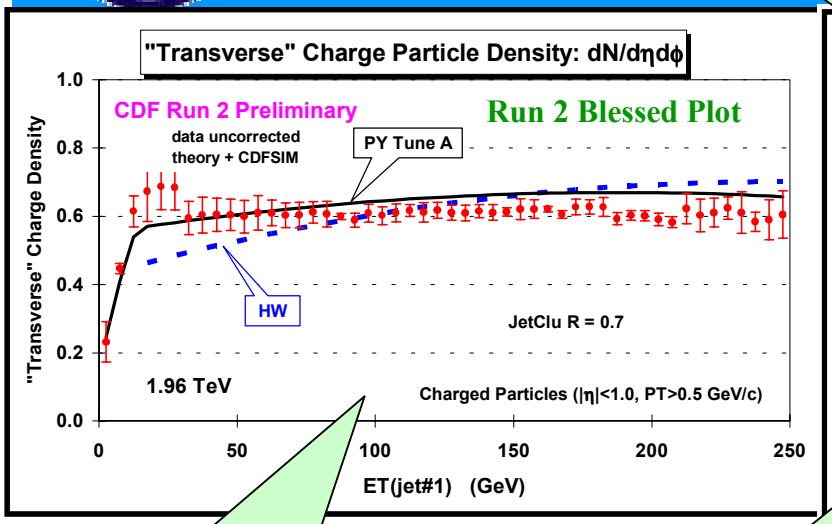


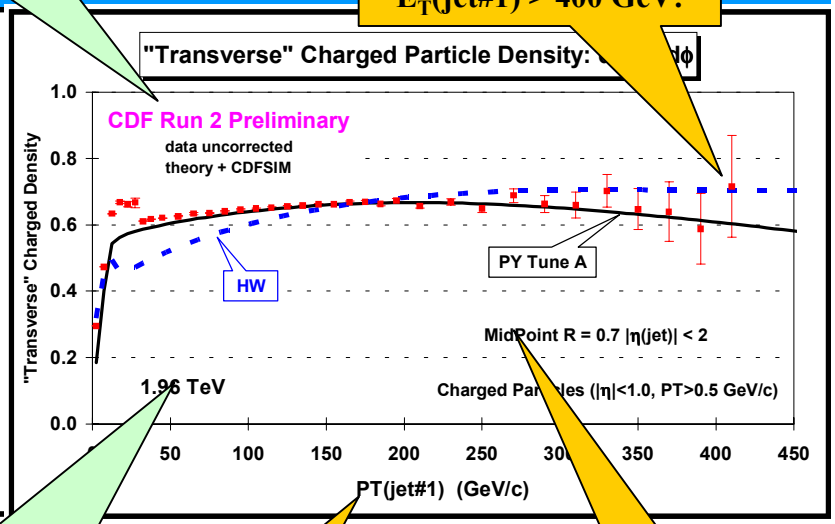
Old 5.3.1/4.9.1 with sys errors

New 5.3.3nt no sys errors
Data up to Aug. 22, 2004

- 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, $|\eta(\text{jet\#1})|<2$ (zero or 1 vertex).
- 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 P_T(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" Charge Density





Alberto's thesis!

E_T(jet#1) > 400 GeV!

Old 5.3.1/4.9.1 with sys errors

New 5.3.3nt no sys errors
Data up to Aug. 22, 2004

Uses P_T!

Uses MidPoint!

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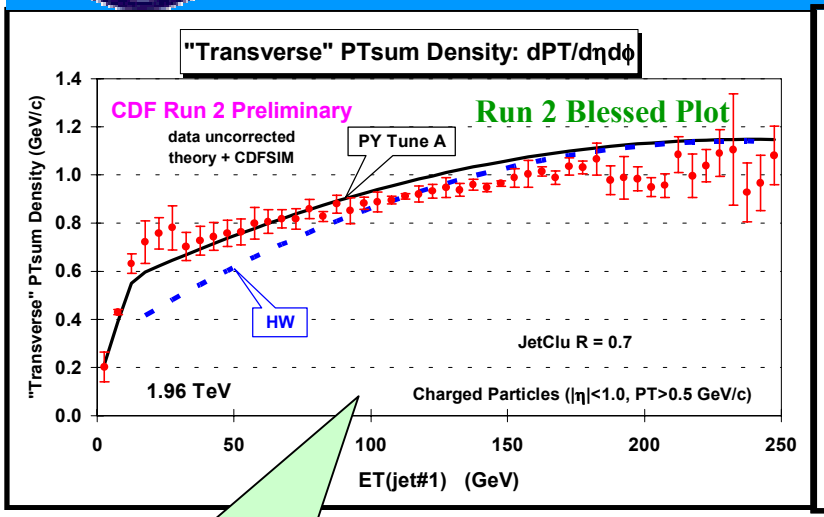
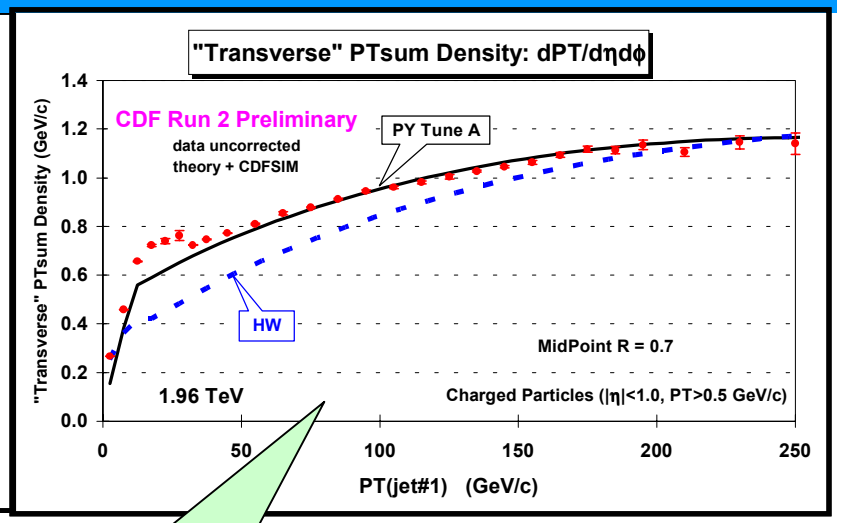
- Compares the (*uncorrected*) data with PYTHIA Tune A and HERWIG after CDFSIM.

"Transverse" PTsum Density





Old 5.3.1/4.9.1 with sys errors

New 5.3.3nt no sys errors

- Shows the average charged PTsum density, $dPT_{sum}/d\eta d\phi$, in the "transverse" region (p_T > 0.5 GeV/c, $|\eta| < 1$) versus E_T(jet#1) for JetClu, R = 0.7, $|\eta(\text{jet\#1})|<2$ (zero or 1 vertex).
- Shows the average charged PTsum density, $dPT_{sum}/d\eta d\phi$, 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, $|\eta(\text{jet\#1})|<2$ (zero or 1 quality 12 vertex).
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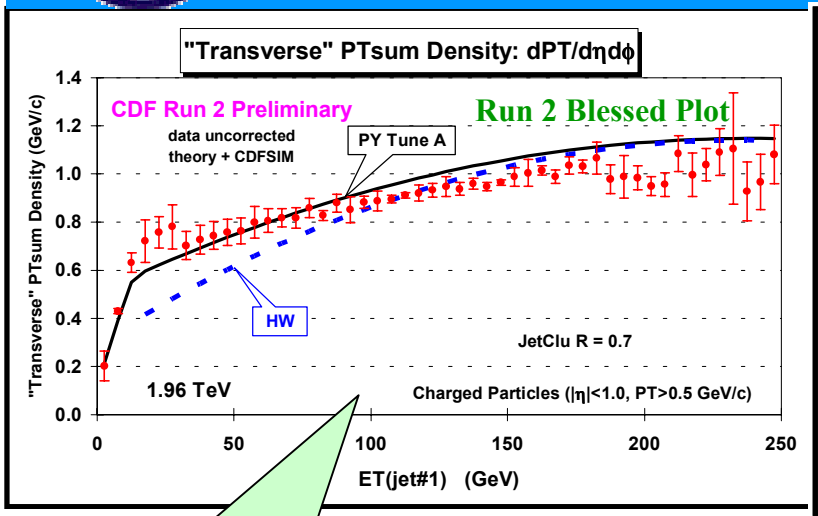
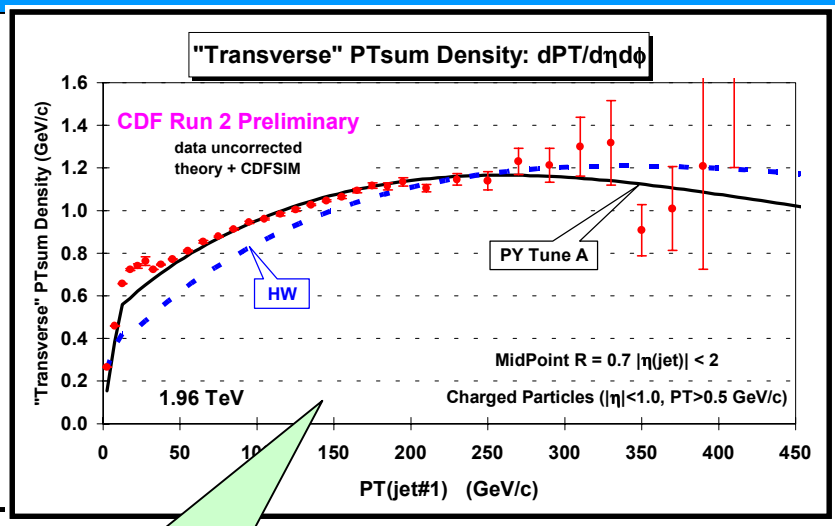
"Transverse" PTsum Density





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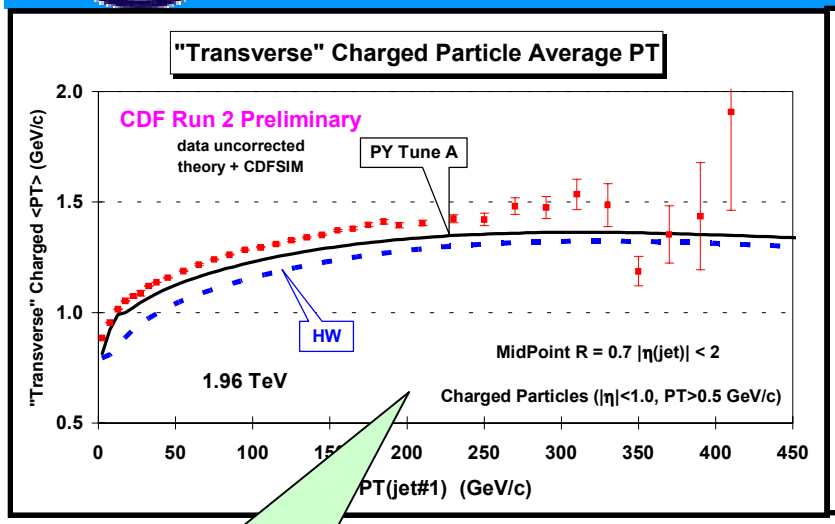
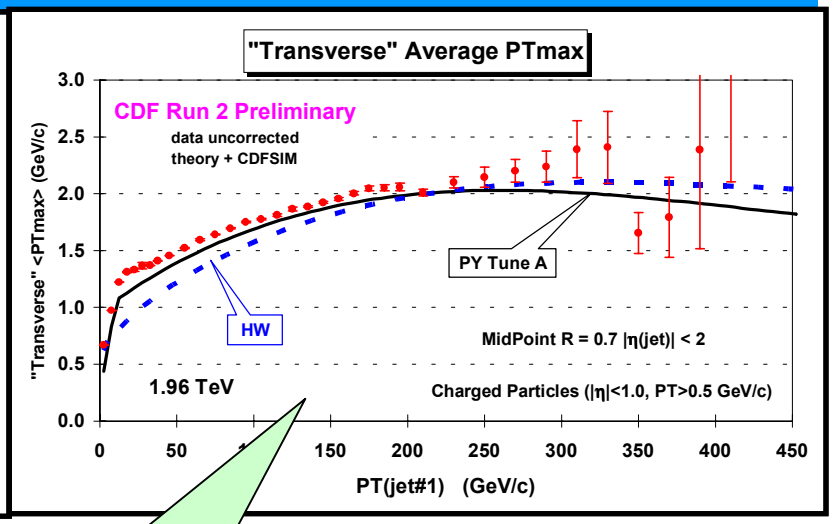
- Compares the (*uncorrected*) data with PYTHIA Tune A and HERWIG after CDFSIM.

"Transverse" <P_T> & <PTmax>



New 5.3.3nt no sys errors



New 5.3.3nt no sys errors

- Shows the charged particle <P_T>, in the "transverse" region (p_T > 0.5 GeV/c, |η| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2 (zero or 1 quality 12 vertex).
- Shows the average maximum charged particle p_T, PTmax, in the "transverse" region (p_T > 0.5 GeV/c, |η| < 1) versus P_T(jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2 (zero or 1 quality 12 vertex).
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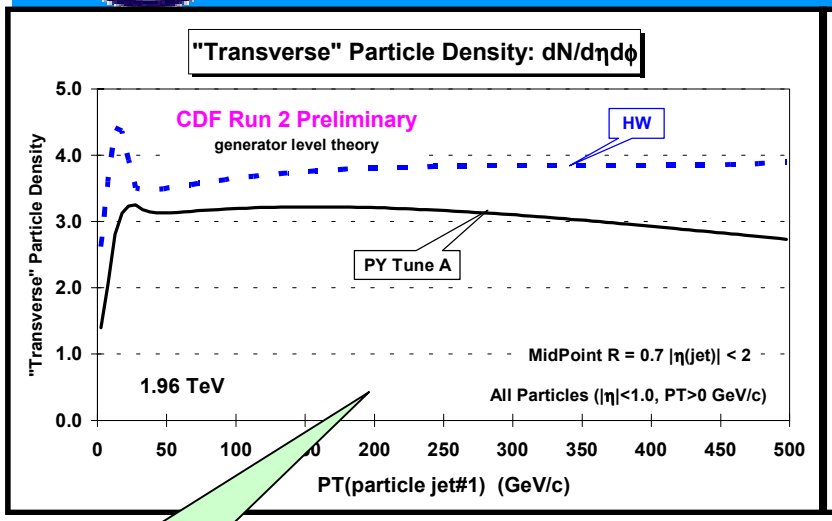
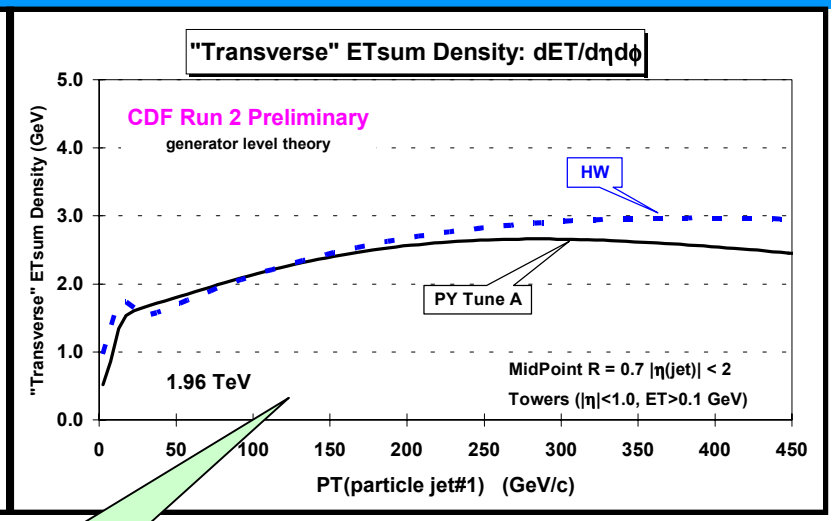
Generator Level





Generator Level

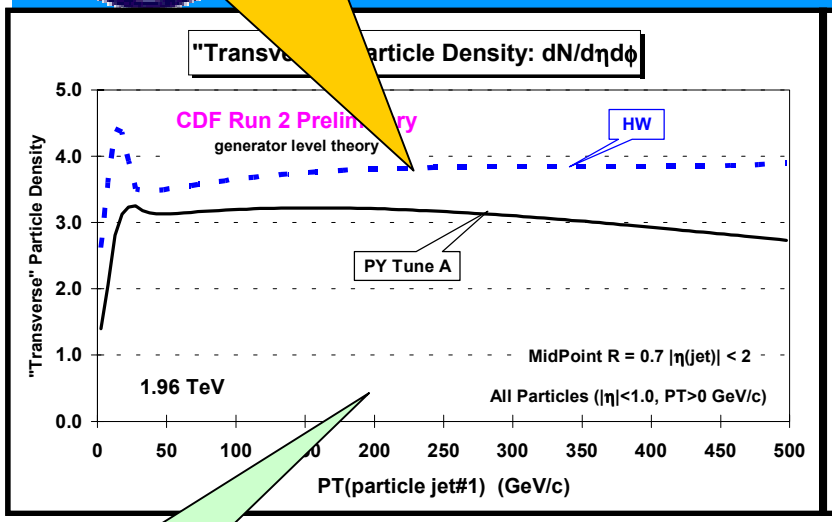
Generator Level

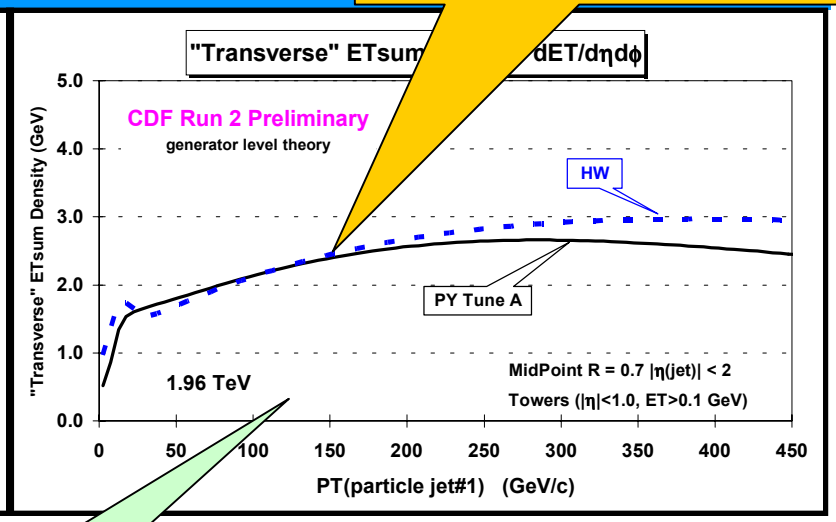
- **Shows the "generator level" average particle density, dN/dηdϕ, in the "transverse" region (p_T > 0 GeV/c, |η| < 1) versus P_T(particle jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2.**
- **Shows the "generator level" average ETsum density, $dET_{sum}/d\eta d\phi$, in the "transverse" region (p_T > 0 GeV/c, |η| < 1) versus P_T(particle jet#1) for MidPoint, R = 0.7, f = 0.75, |η(jet#1)|<2.**
- **HERWIG produces more "soft" particles than PYTHIA Tune A!**

Generator Level

HERWIG produces more particles than PYTHIA Tune A!

HERWIG produces about the same ETsum as PYTHIA Tune A!





Generator Level

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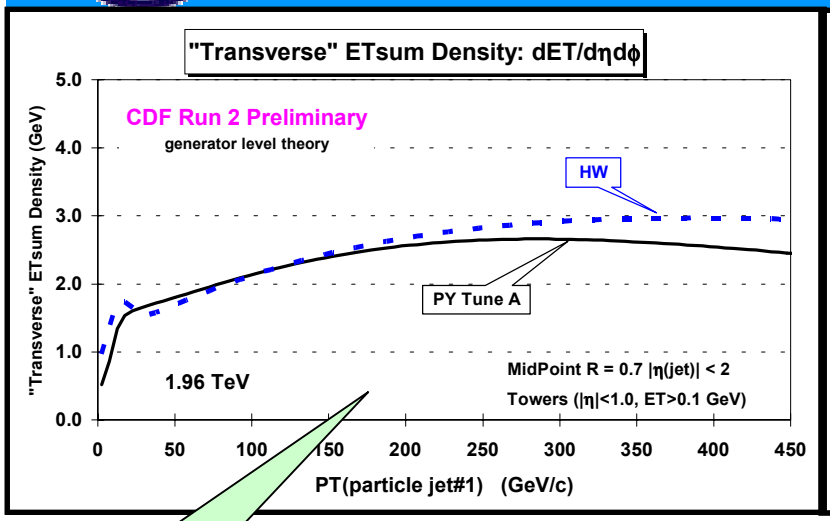
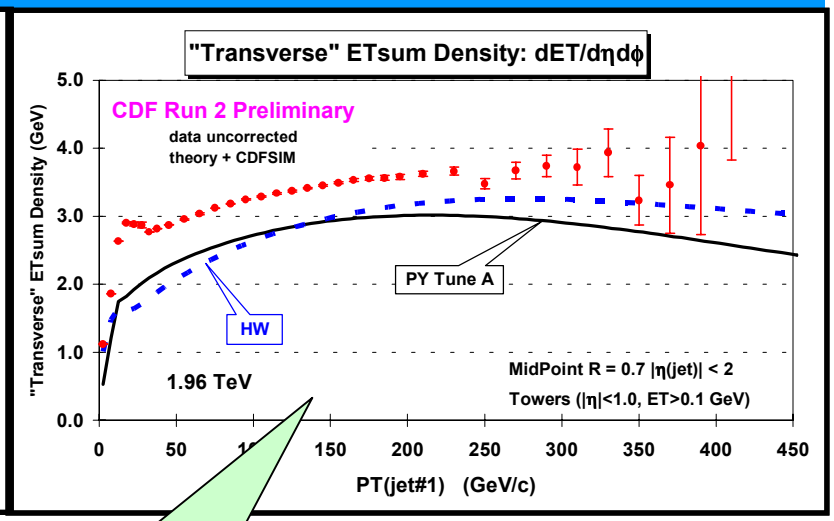
- HERWIG produces more "soft" particles than PYTHIA Tune A!

"Transverse" ETsum Density





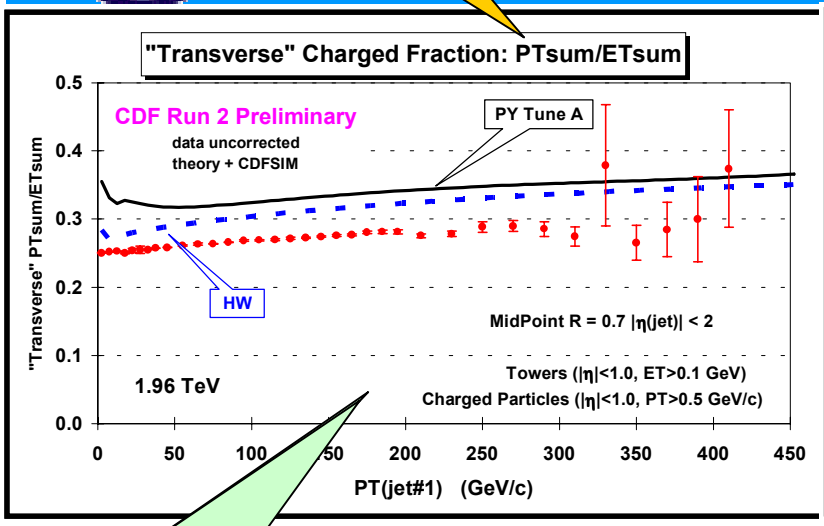
Generator Level

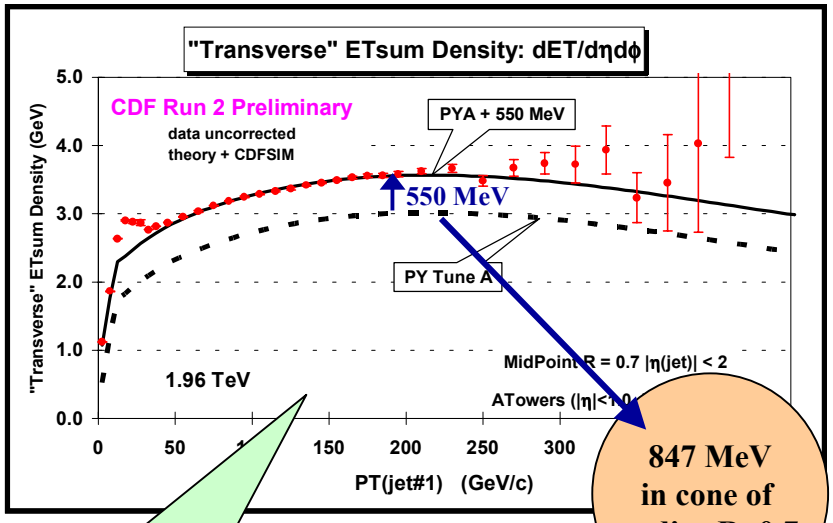
New 5.3.3nt no sys errors

- **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.**

ransverse" ETsum Density

PTsum(charged, p_T>0.5 GeV/c)
ETsum(towers, E_T>0.1 GeV)





New 5.3.3nt no sys errors

New 5.3.3nt no sys errors

847 MeV in cone of radius R=0.7

- 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.
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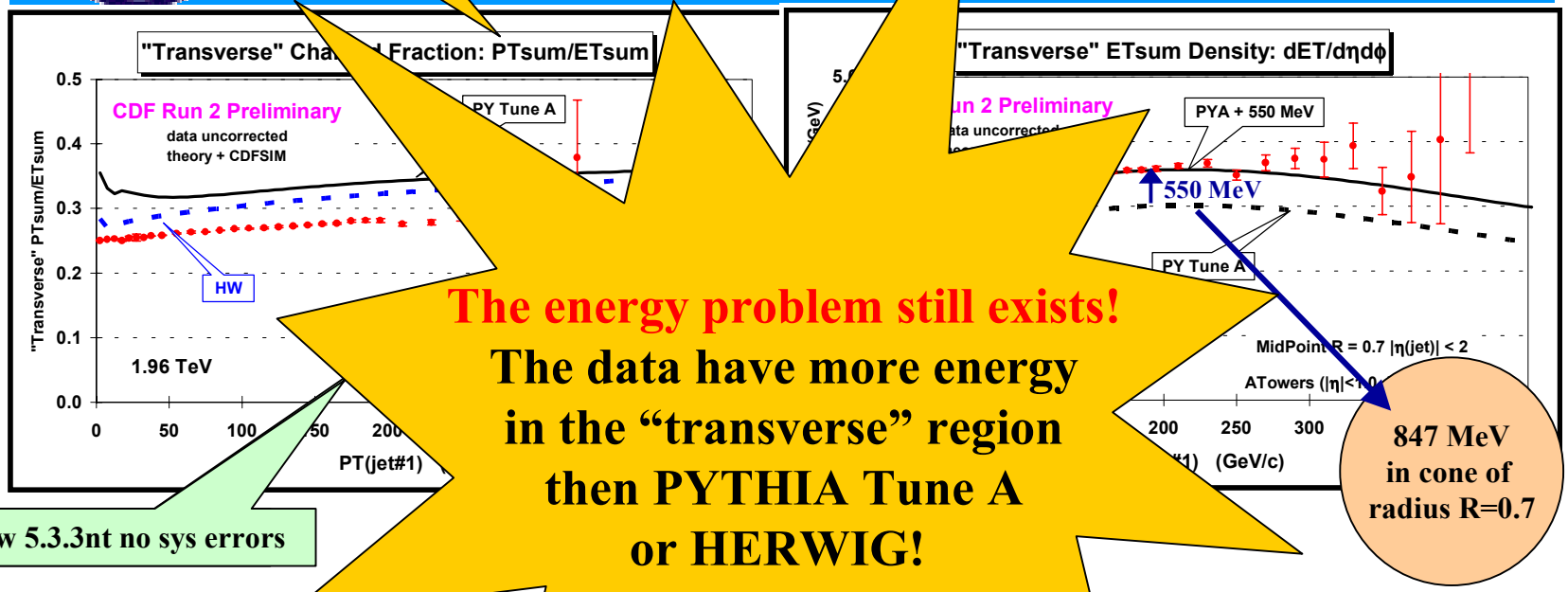
ransverse" ETsum Density

PTsum(charged, p_T>0.5 GeV/c)
ETsum(towers, E_T>0.1 GeV)



New 5.3.3nt no sys errors

847 MeV in cone of radius R=0.7

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

- **Shows the "generator level" av ηdϕ, in the "transverse" region (p_T > 0 GeV/c, |η| < 1) tic) for oint, R = 0.7, f = 0.75, |η(jet#1)|<2.**
- **Shows the average tower ETsum den dET$_{sum}$ dϕ, in the ransverse" region (E_T > 0.1 GeV, |η| < 1) versus P_T(jet#1) for Mid nt, R = 0 f = 0.75, |η(jet#1)|<2 (zero or 1 quality 12 vertex).**
- **Compares the (*uncorrected*) data with YTHIA Tune A and HERWIG after CDFSIM.**