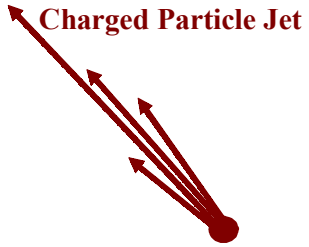
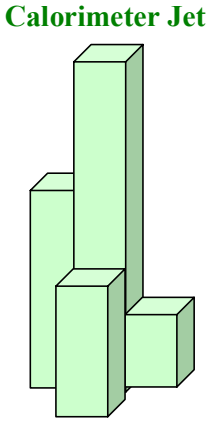
"Jet" Evolution and the "Underlying Event" in Run 2

Outline of Talk

- Study the evolution of "charged particle jets" and the "underlying event" and compare with Run I.
- Study the evolution of "calorimeter jets" and the "underlying event" and compare with the "charged particle jet" analysis.
- "Charged particle jets" versus "calorimeter jets". Study the relationship between "chgjets" and "JetClu" jets.
- Study some of the characteristics of the leading "charged particle jet" and the leading "calorimeter jet".





"Jet" Evolution and the "Underlying Event" in

Outline of Talk

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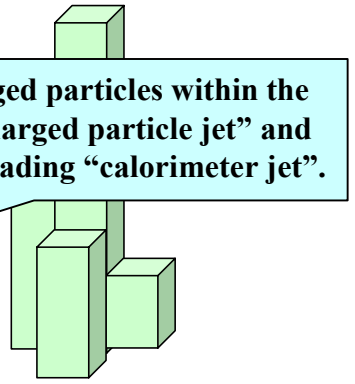
- Study the evolution of "calorimeter jets" and the "underlying event" and compare with the "charged particle jet" analysis.
- "Charged particle jets" versus "calorimeter jets". Study the relationship between "chgjets" and "JetClu" jets.
- Study some of the characteristics of the leading "charged particle jet" and the leading "calorimeter jet".

Look at the charged particle correlation relative to the leading "charged particle jet".

Look at the charged particle correlation relative to the leading "calorimeter jet".

Look correlation between the leading "charged particle jet" and "calorimeter jets".

Look charged particles within the leading "charged particle jet" and within the leading "calorimeter jet".



"Jet" Evolution and the "Underlying Event" in

Talk

Contains all the plots (jpeg and eps)!

- Study the evolution of "cha rticle jets" a the "underlying event" and co with Run

- Study the evolution of "calorimeter jets and the "
  "cha

www.phys.ufl.edu/~rfield/cdf/UE_run2/

- "Charged particle jets" versus "calorimet jets". Study the relationship between "chgjets" and "JetClu" jets.

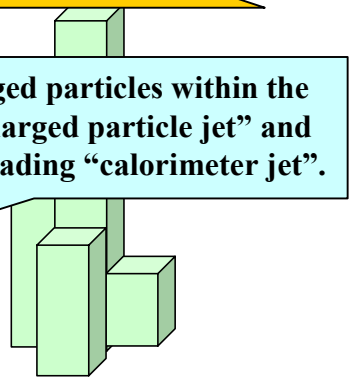
- Study some of the characteristics of the leading "charged particle jet" and the leading "calorimeter jet".

Look at the charged particle correlation relative to the leading "charged particle jet".

Look at the charged particle correlation relative to the leading "calorimeter jet".

ween the

Look charged particles within the leading "charged particle jet" and within the leading "calorimeter jet".



Data Selection

Event Selection
Good Runs
Bad Stntuples Removed
MetSig < 5
sumET < 1.5 TeV
Zero or one Z-vertex
$|z_0| < 60$ cm

Anwar's Stntuples	Min-Bias	JET20	JET50	JET70	JET100
Total Events	3,716,068	7,388,639	1,844,407	826,597	1,052,530
Good Events (Rob's WEB)	3,094,114	5,185,515	1,397,771	642,289	822,466
MetSig < 5, sumET < 1.5 TeV	3,093,888	5,177,984	1,370,267	607,794	690,239
0 or 1 ZVTX $\|z\| < 60$ cm	2,596,553	3,127,001	802,003	352,820	393,118
JetClu ($\|\eta(\text{jet})\| < 2$, R = 0.7)	587,154	2,473,013	735,893	338,668	389,006
JetClu ($\|\eta(\text{jet})\| < 0.7$, R = 0.7)	270,725	1,135,226	381,934	189,439	241,306
ChgJet ($P_T > 0.5$ GeV, $\|\eta\| < 2$, R = 0.7)	2,114,276	3,079,553	796,977	351,294	391,886

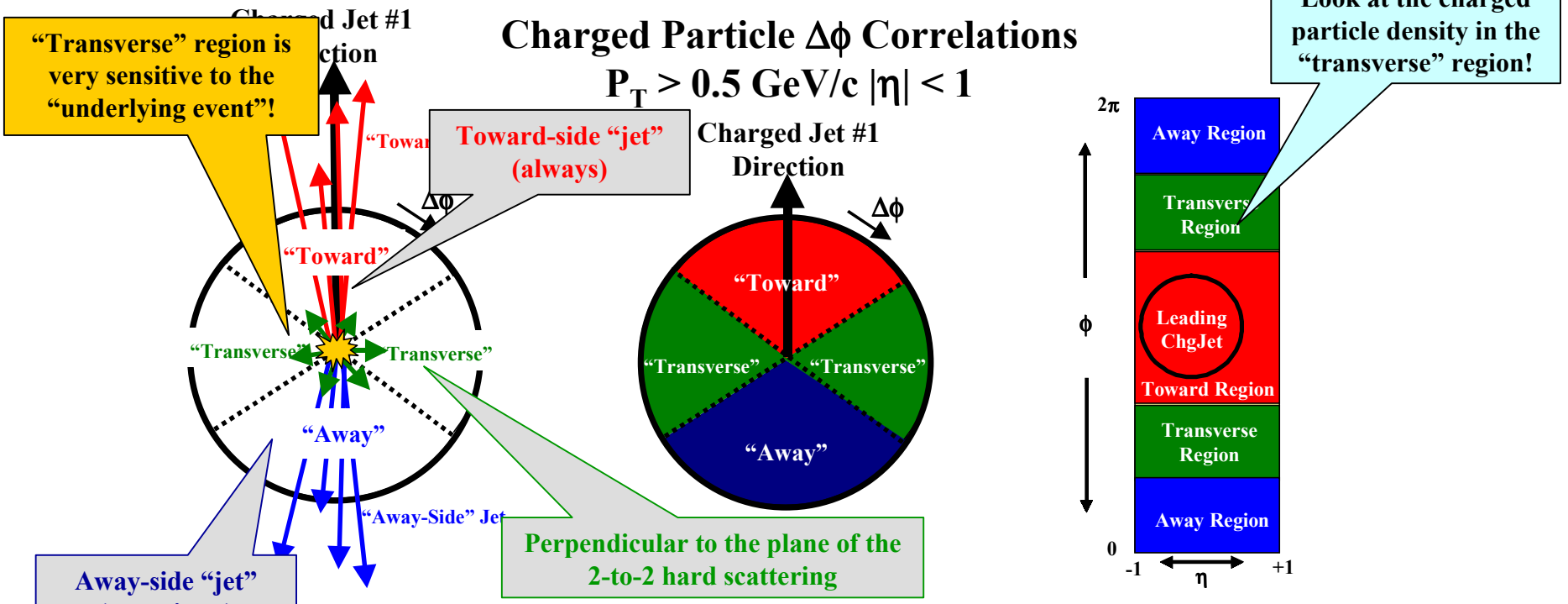
Same as our Run 1 analysis!

Track Selection
COT measured tracks
$|z\text{-}z_0| < 2$ cm
$|d_0| < 1$ cm
$P_T > 0.5$ GeV/c $|\eta| < 1$

Form charged particle jets (R = 0.7) as we did our Run 1 analysis

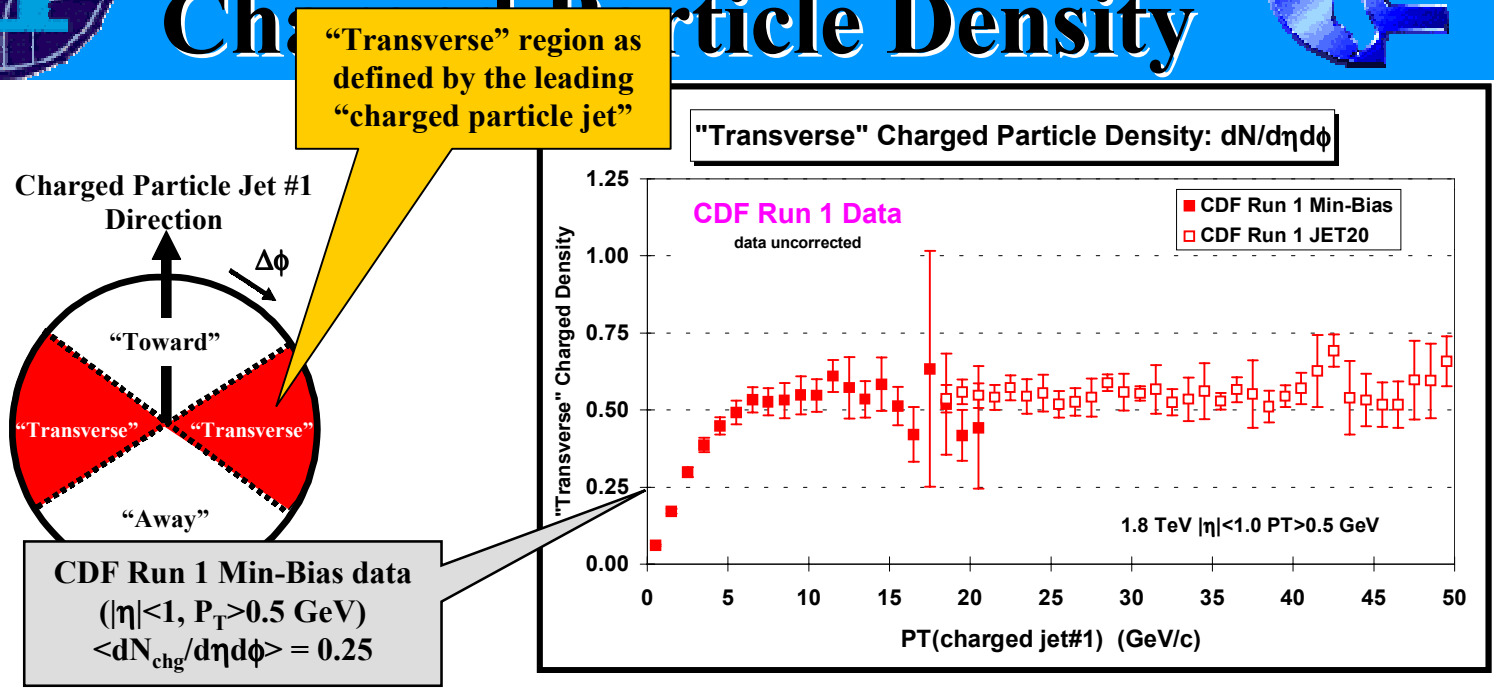
Calorimeter Jet Selection
JetClu (R = 0.7)
$|\eta(\text{jet})| < 2$ or $|\eta(\text{jet})| < 0.7$

Evolution of Charged Jets "Underlying Event"



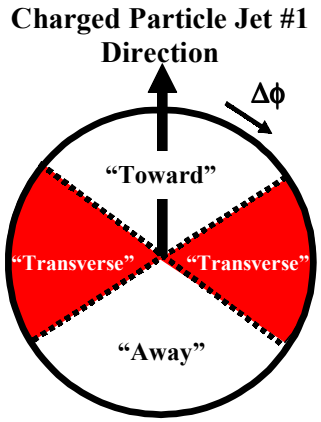
- Look at charged particle correlations in the azimuthal angle Δφ relative to the leading charged particle jet.
- Define $|\Delta\phi| < 60^o$ as "Toward", $60^o < |\Delta\phi| < 120^o$ as "Transverse", and $|\Delta\phi| > 120^o$ as "Away".
- All three regions have the same size in η-φ space, $\Delta\eta \times \Delta\phi = 2 \times 120^o = 4\pi/3$.

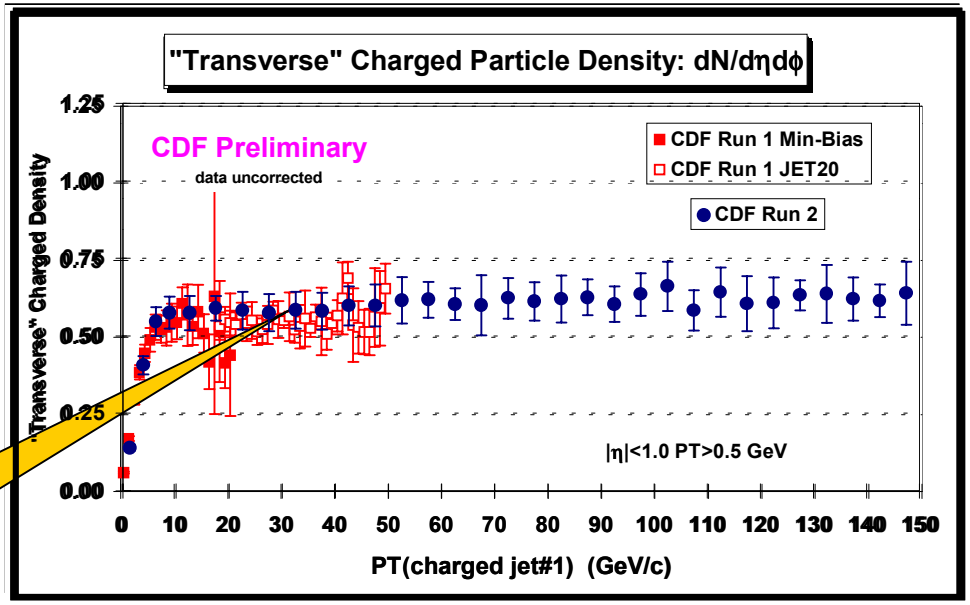
"Transverse" Charged Particle Density



➡ **Shows the data on the average "transverse" charge particle density (|η|<1, P_T>0.5 GeV) as a function of the transverse momentum of the leading charged particle jet from Run 1.**

"Transverse" Charged Particle Density

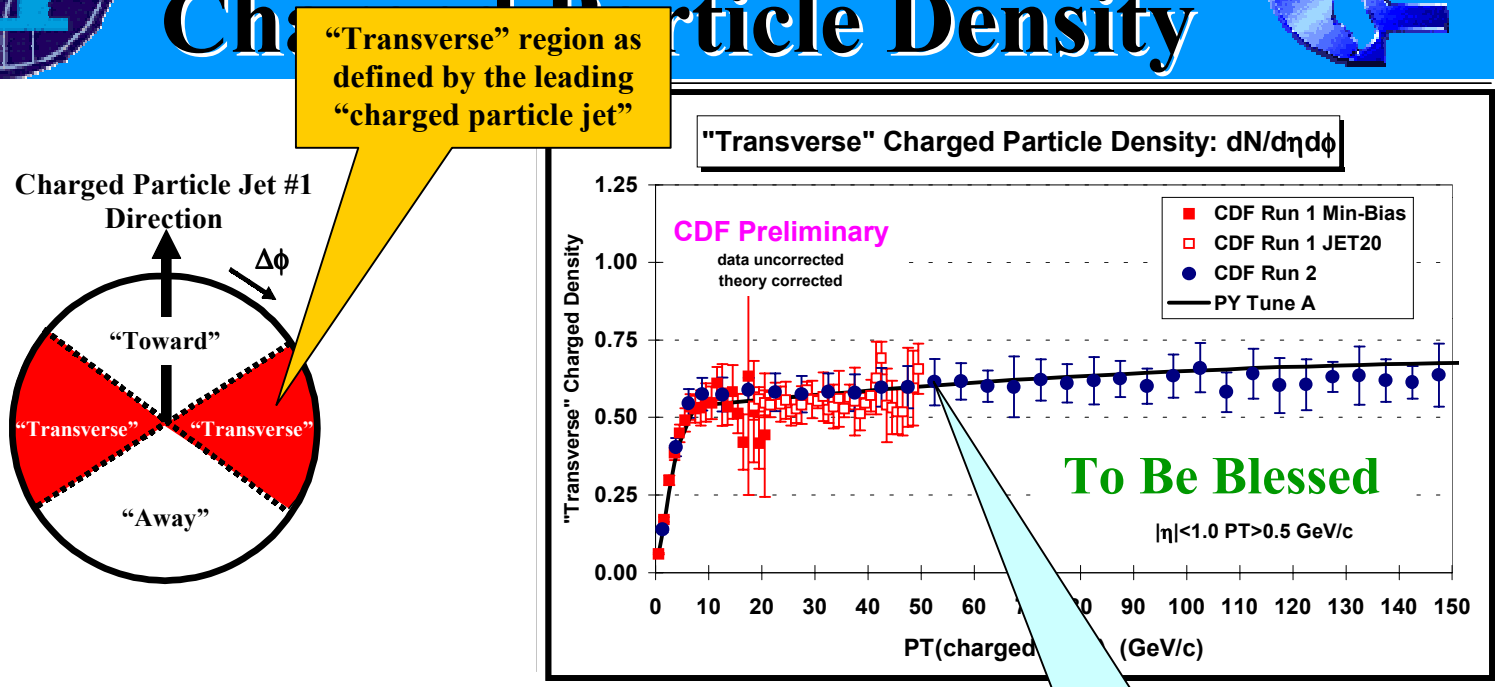




Excellent agreement between Run 1 and 2!

- Shows the data on the average "transverse" charge particle density ($|\eta|<1$, $P_T>0.5$ GeV) as a function of the transverse momentum of the leading charged particle jet from Run 1.
- Compares the Run 2 data (Min-Bias, JET20, JET50, JET70, JET100) with Run 1. The errors on the (*uncorrected*) Run 2 data now include both statistical and correlated systematic uncertainties.

"Transverse" Charged Particle Density



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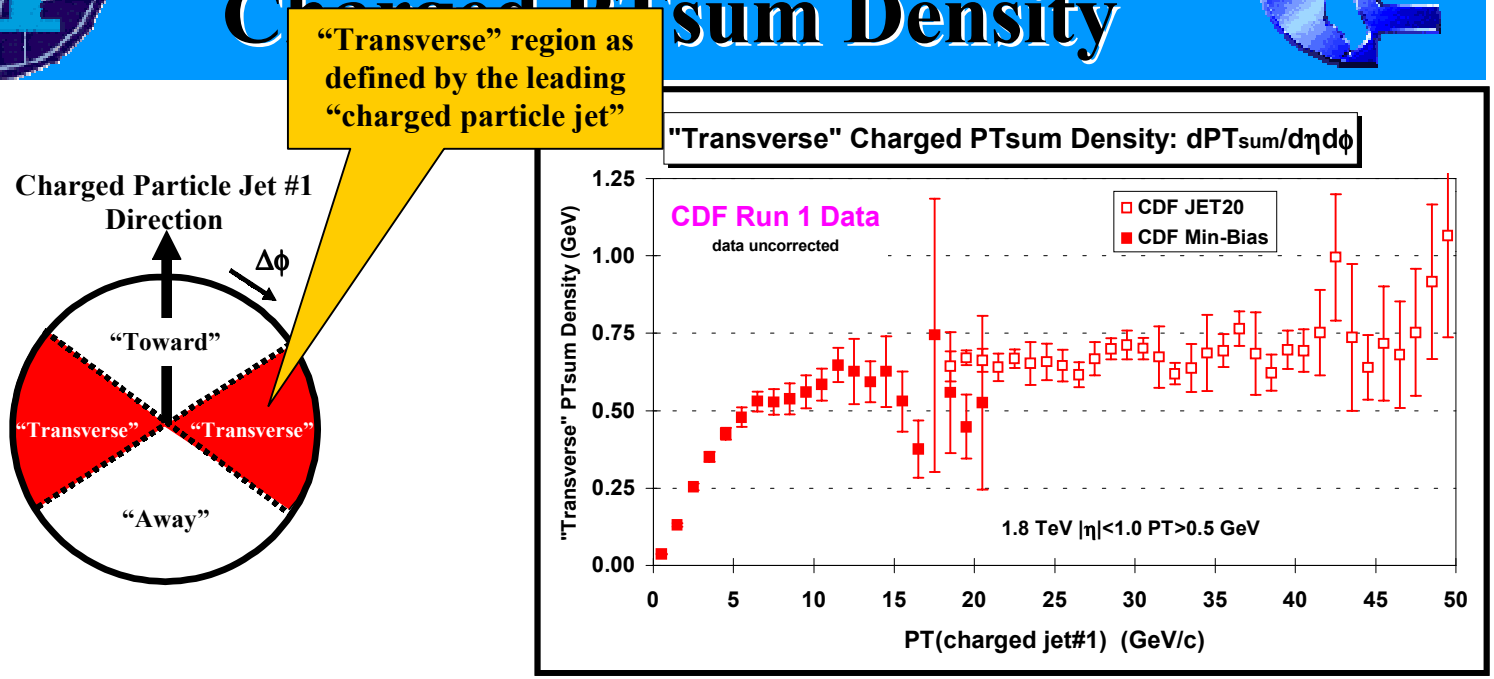
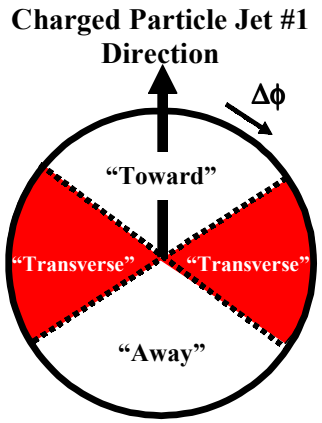
  The errors on the (*uncorrected*) Run 2 data now include both statistical and correlated systematic uncertainties.

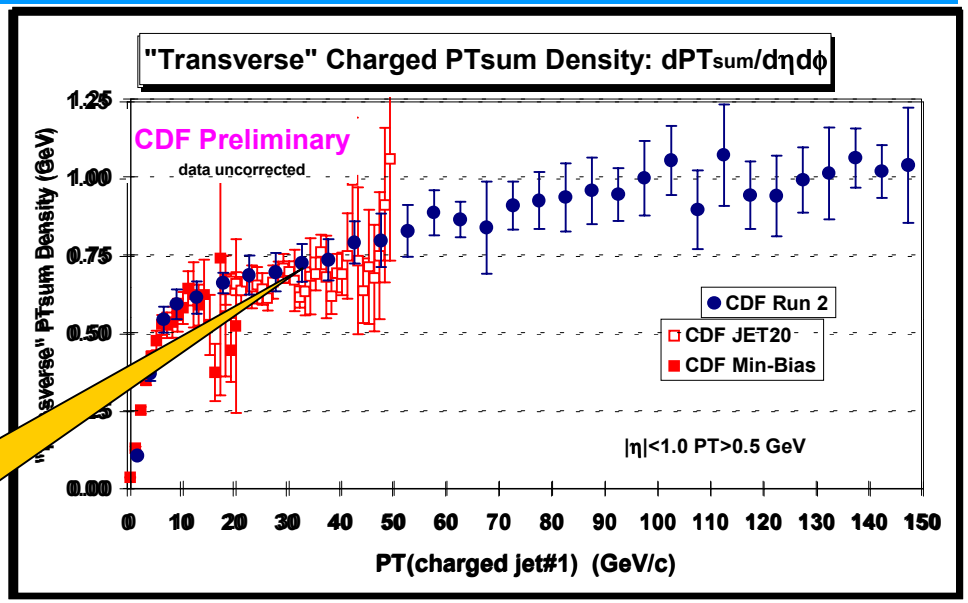
"Transverse" Charged PTsum Density



➡ **Shows the data on the average "transverse" charged PTsum density ($|\eta|<1$, $P_T>0.5$ GeV) as a function of the transverse momentum of the leading charged particle jet from Run 1.**

"Transverse" Charged PTsum Density





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- Shows the data on the average "transverse" charged PTsum density ($|\eta|<1$, $P_T>0.5$ GeV) as a function of the transverse momentum of the leading charged particle jet from Run 1.
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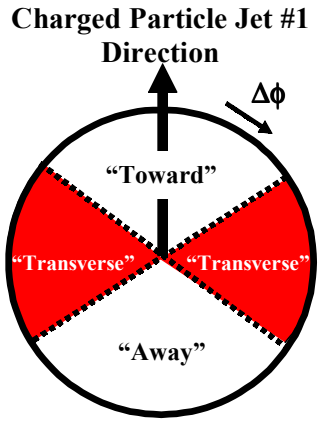
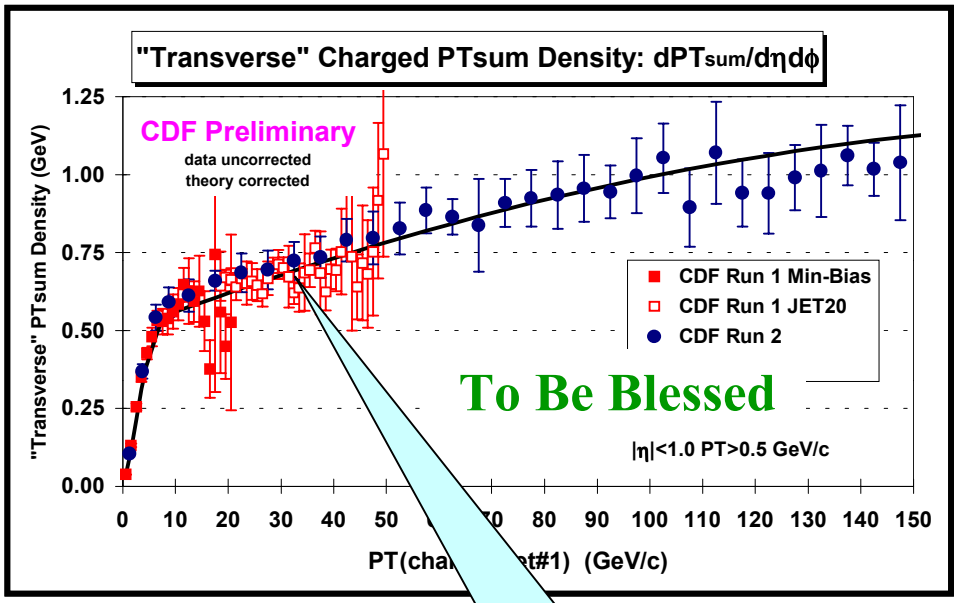
"Transverse" Charged PTsum Density





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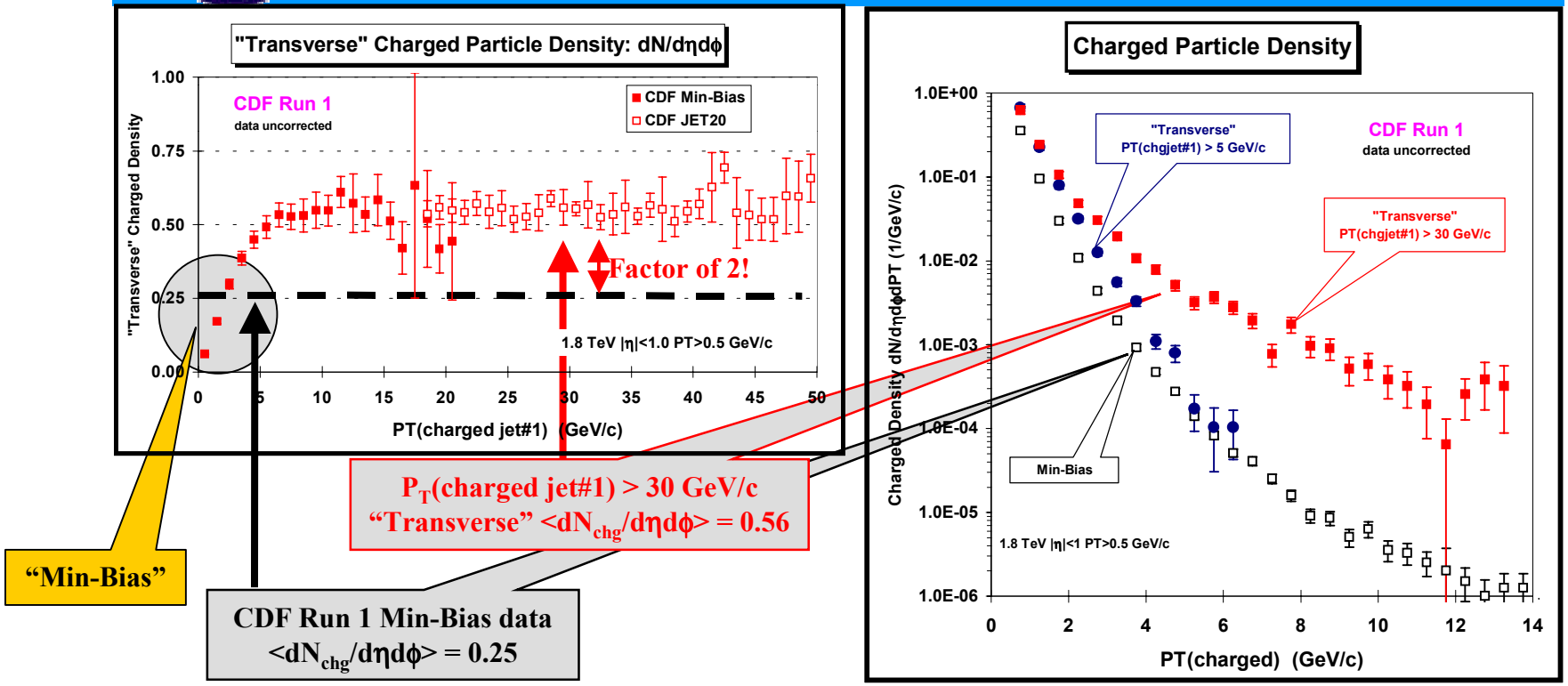
- Compares the Run 2 data (Min-Bias, JET20, JET50, JET70, J errors on the (*uncorrected*) Run 2 data now include both statis systematic uncertainties.

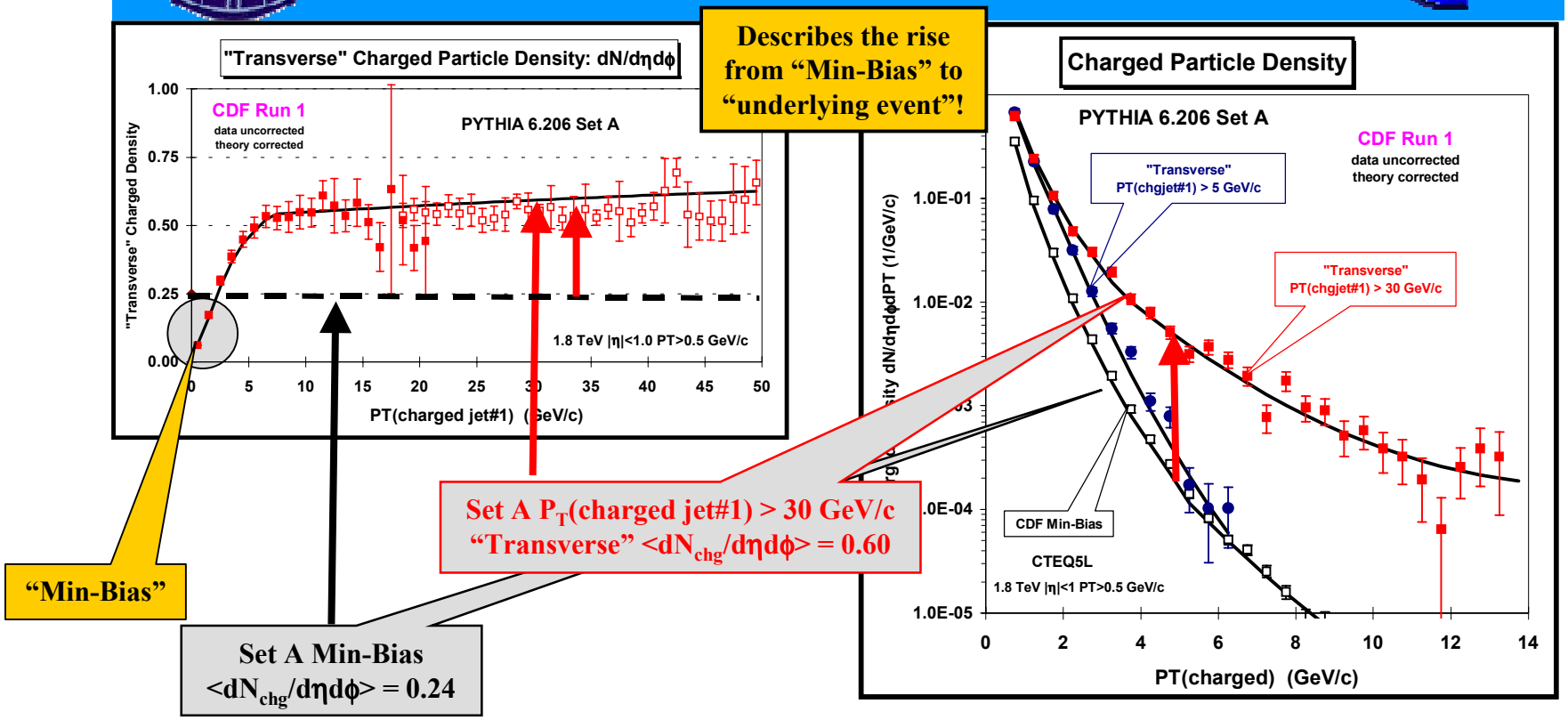
PYTHIA Tune A was tuned to fit the "underlying event" in Run I!

Charged Particle Density "Transverse" P_T Distribution



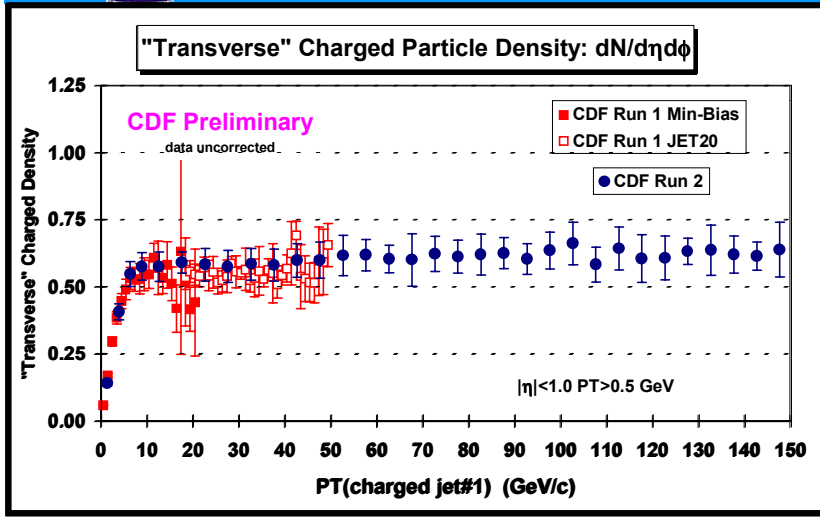
➡ **Compares the average "transverse" charge particle density with the average "Min-Bias" charge particle density ($|\eta|<1$, $P_T>0.5$ GeV). Shows how the "transverse" charge particle density and the Min-Bias charge particle density is distributed in P_T.**

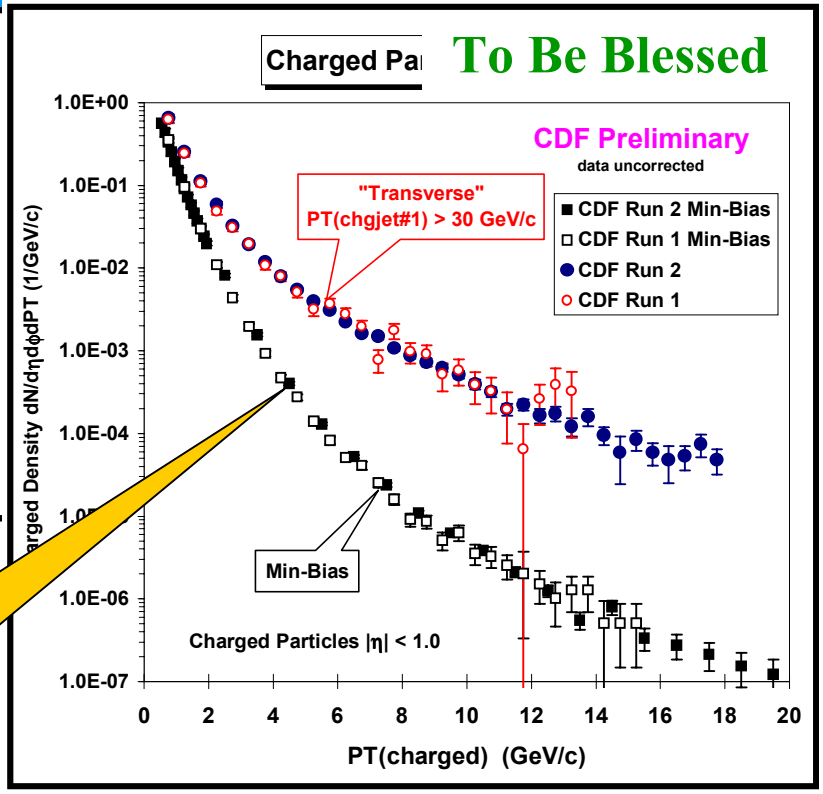
Tuned PYTHIA 6.206 Run 1 Set A



➡ **Compares the average "transverse" charge particle density ($|\eta|<1$, $P_T>0.5$ GeV) versus P_T(charged jet#1) and the P_T distribution of the "transverse" and "Min-Bias" densities with the QCD Monte-Carlo predictions of a tuned version of PYTHIA 6.206 (P_T(hard) > 0, CTEQ5L, Set A). Describes "Min-Bias" collisions! Describes the "underlying event"!**

Charged Particle Density "Transverse" P_T Distribution



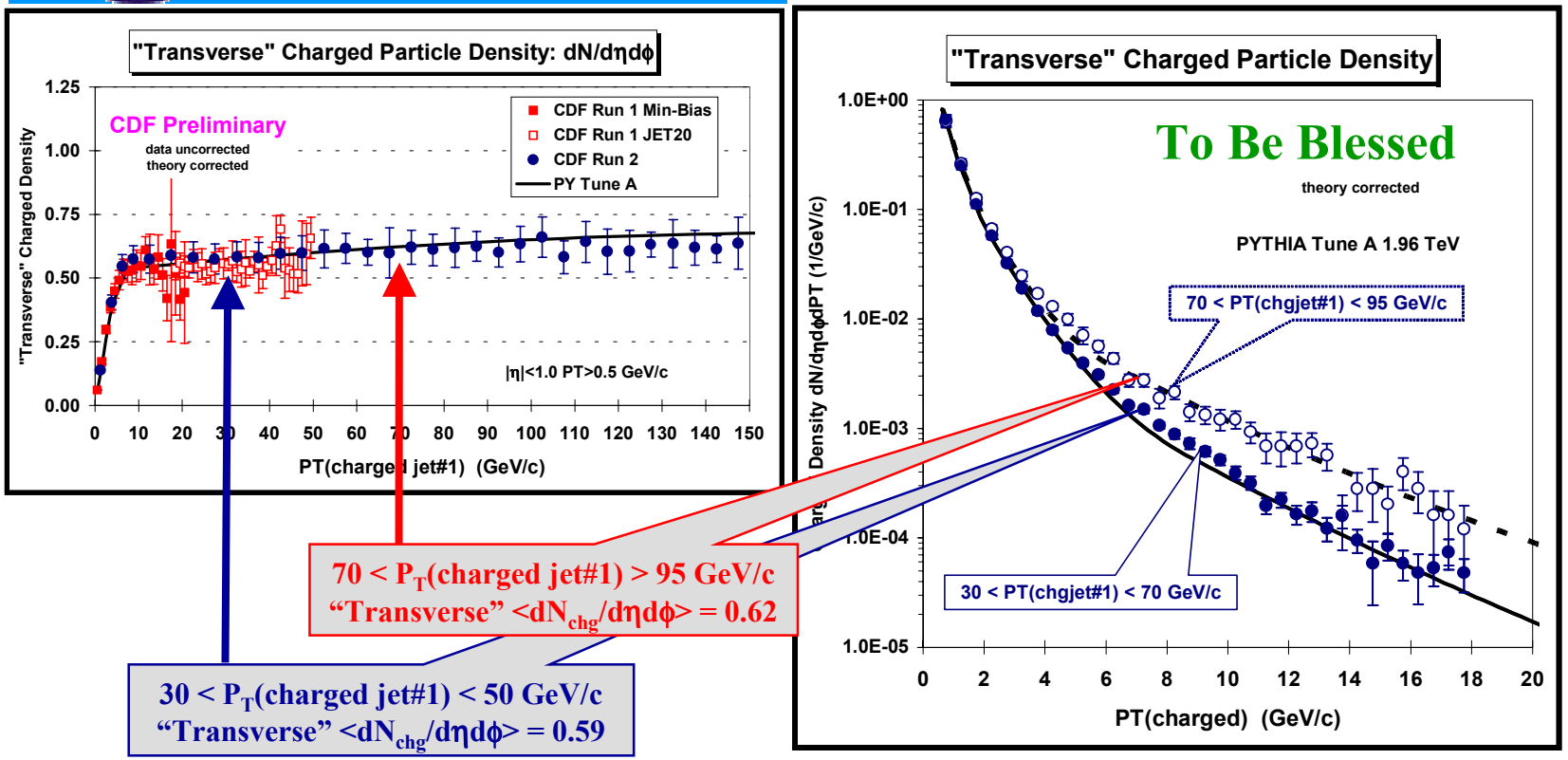


- Compares the average "transverse" charge particle density (|η|<1, P_T>0 GeV) versus P_T(ch… P_T distribution of … density, $dN_{chg}/d\eta d\phi dP_T$. Shows how the "transverse" charge particle density is distributed in P_T.

Excellent agreement between Run 1 and 2!

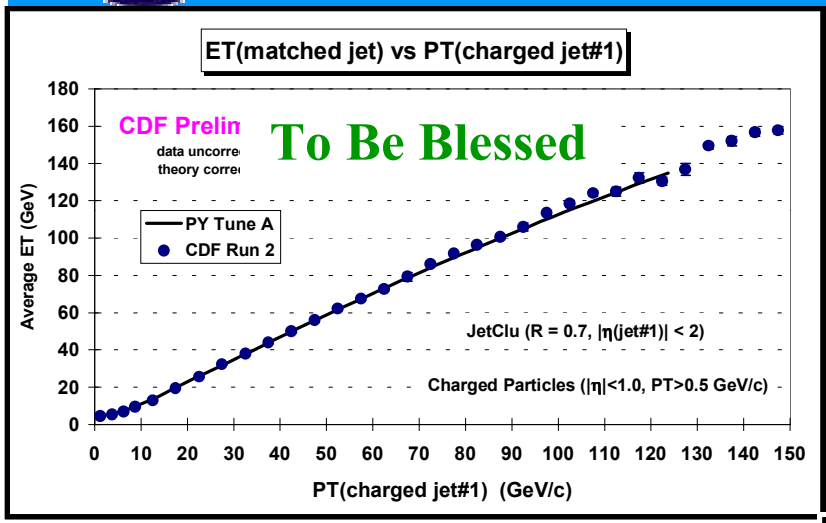
- Compares the Run 2 data (Min-Bias, JET20, JET50, JET70, JET100) with Run 1.

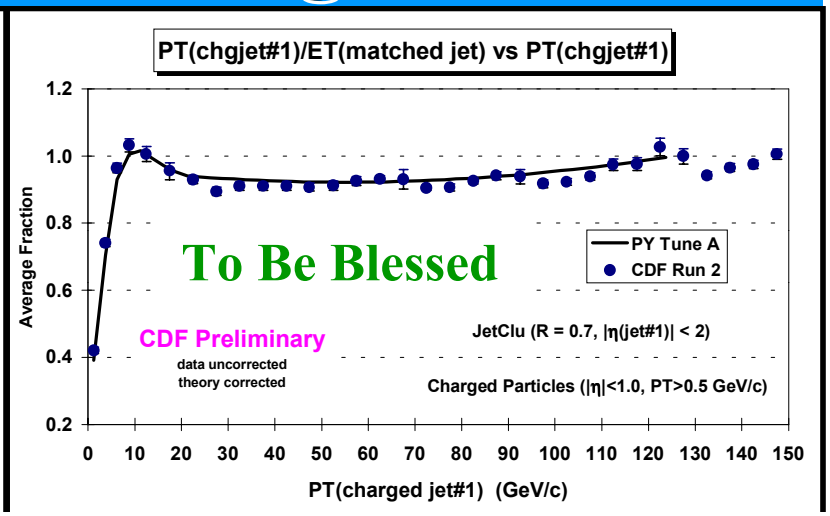
Charged Particle Density "Transverse" P_T Distribution



- Compares the average "transverse" charge particle density ($|\eta|<1$, $P_T>0.5$ GeV) versus P_T(charged jet#1) with the P_T distribution of the "transverse" density, $dN_{chg}/d\eta d\phi dP_T$. Shows how the "transverse" charge particle density is distributed in P_T.

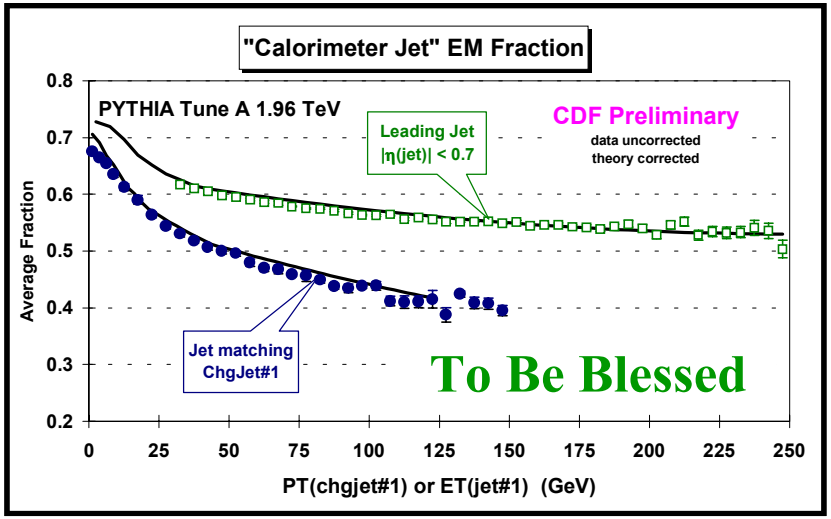
Relationship Between JetClu Jets and ChgJets



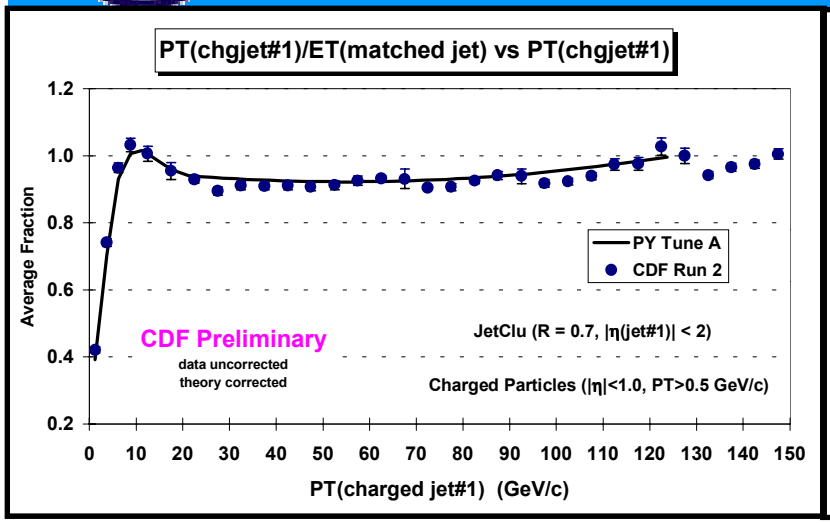


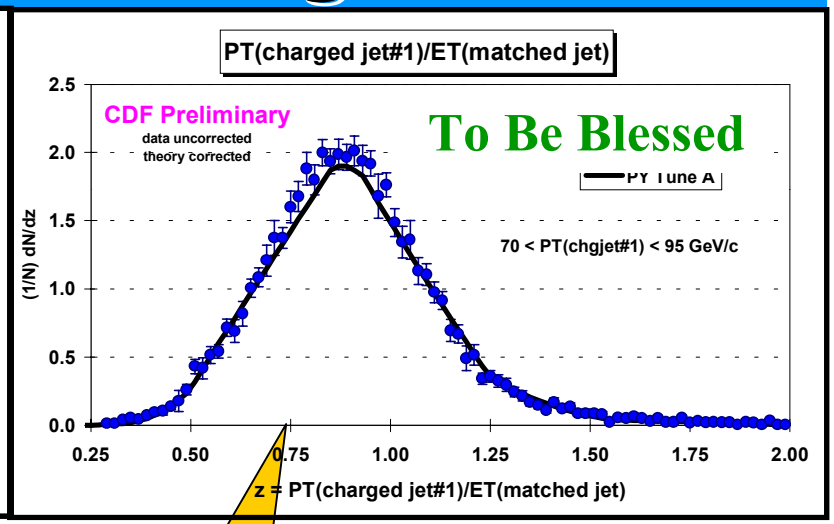
- Shows the "matched" JetClu jet E_T versus the transverse momentum of the leading "charged particle jet" (closest jet within R = 0.7 of the leading chgjet).

- Shows the EM fraction of the "matched" JetClu jet and the EM fraction of a typical JetClu jet.



Relationship Between JetClu Jets and ChgJets

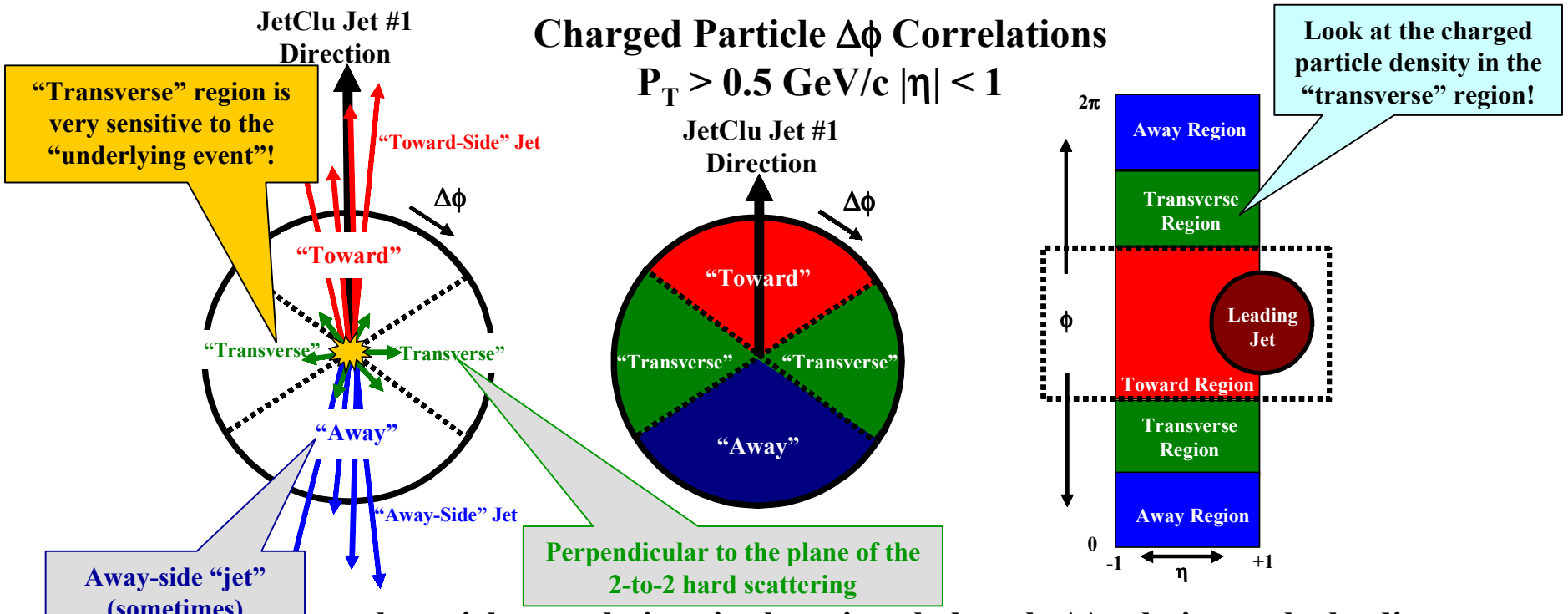




- Shows the ratio of P_T(chgjet#1) to the "matched" JetClu jet ET (closest jet within R = 0.7 of the leading chgjet).
- Shows the distribution of z = P_T(chgjet#1)/ET(matched jet) for 70 < PT(chgjet#1) < 95 GeV/c.

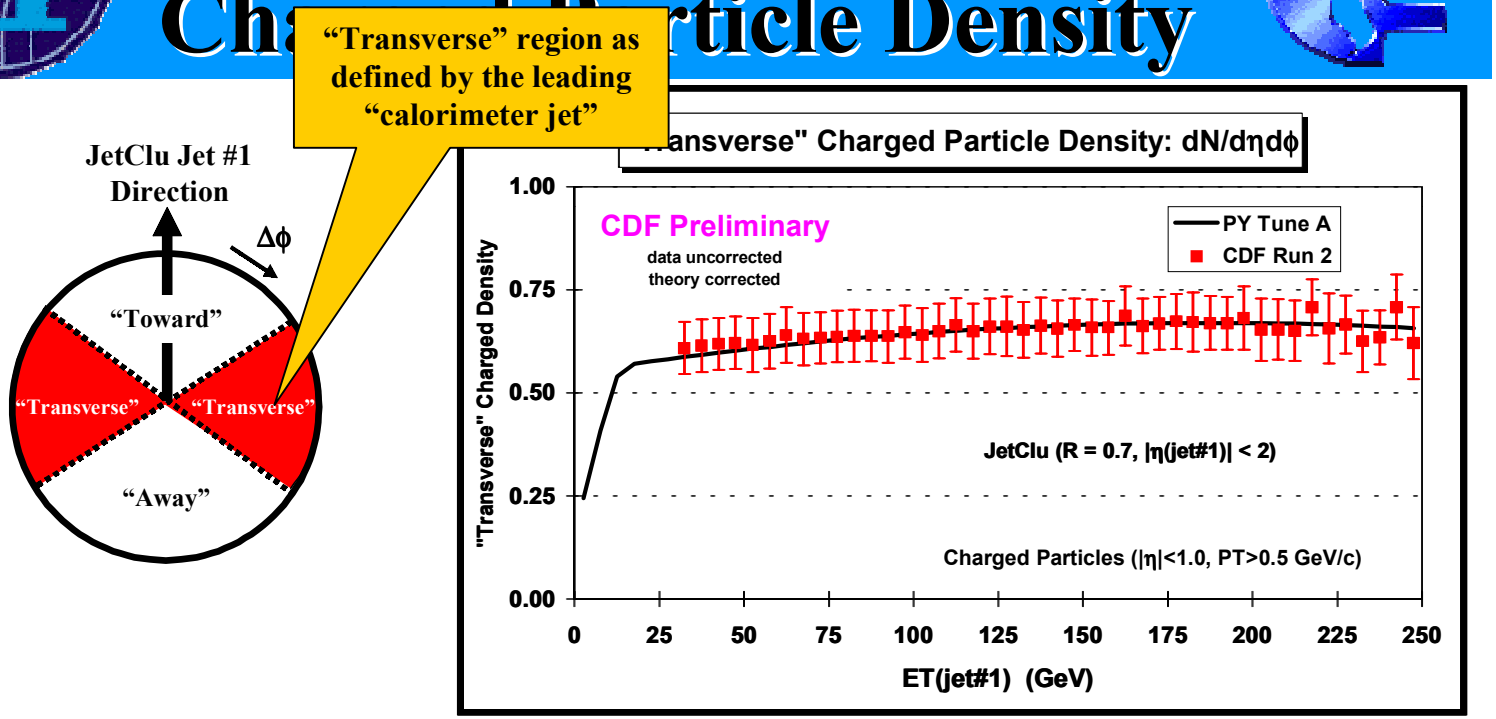
About 77% of charged jets (70 < PT(chgjet) < 95 GeV/c) come from jets in which they carry greater than 75% of the overall jet energy!

Evolution of JetClu Jets "Underlying Event"



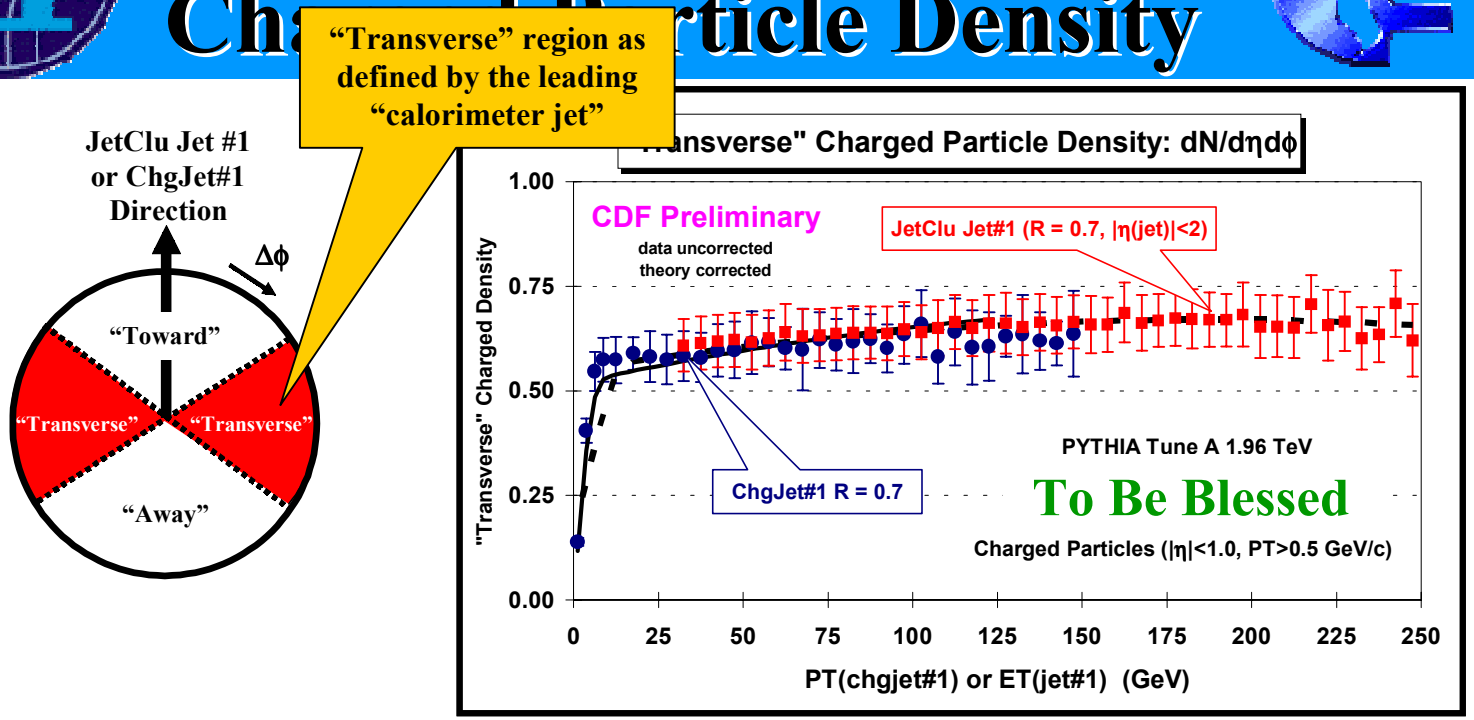
- Look at charged particle correlations in the azimuthal angle $\Delta\phi$ relative to the leading JetClu jet.
- Define $|\Delta\phi| < 60^o$ as "Toward", $60^o < |\Delta\phi| < 120^o$ as "Transverse", and $|\Delta\phi| > 120^o$ as "Away".
- All three regions have the same size in η-ϕ space, $\Delta\eta \times \Delta\phi = 2 \times 120^o = 4\pi/3$.

JetClu "Transverse" Charged Particle Density



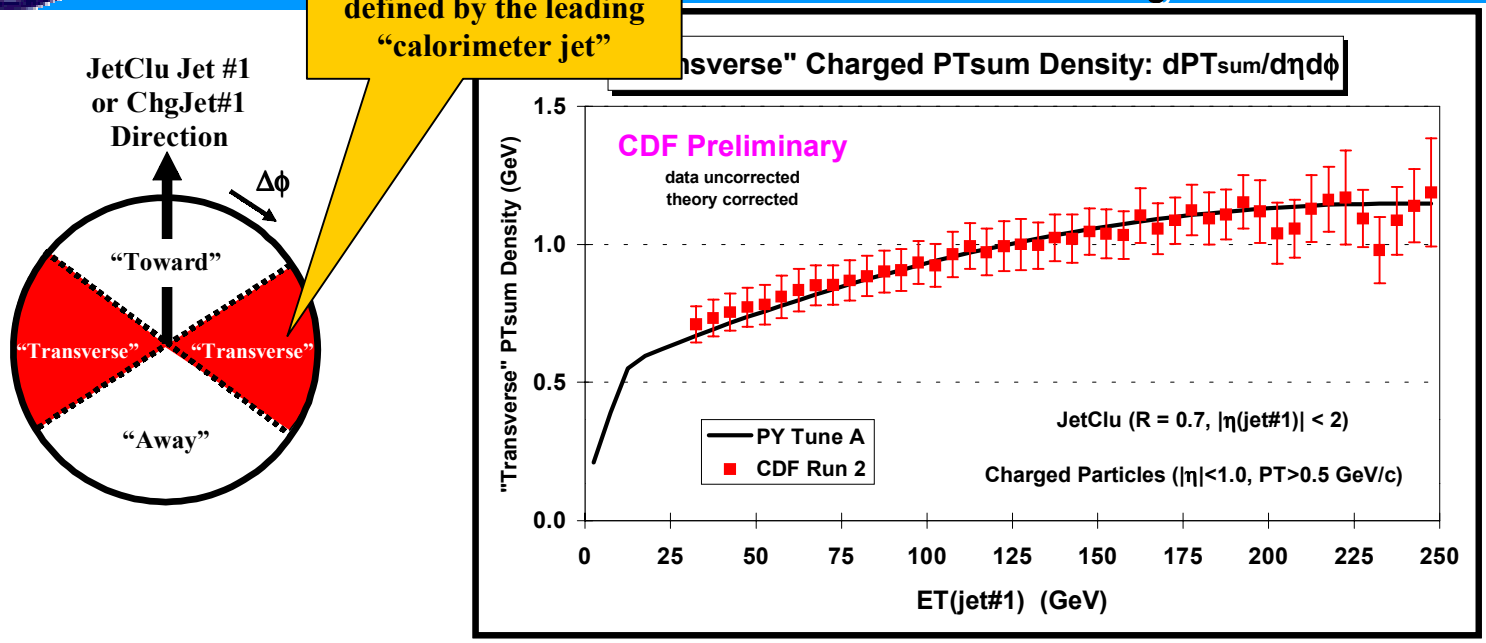
- **Shows the data on the average "transverse" charge particle density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2, compared with PYTHIA Tune A.**

JetClu "Transverse" Charged Particle Density



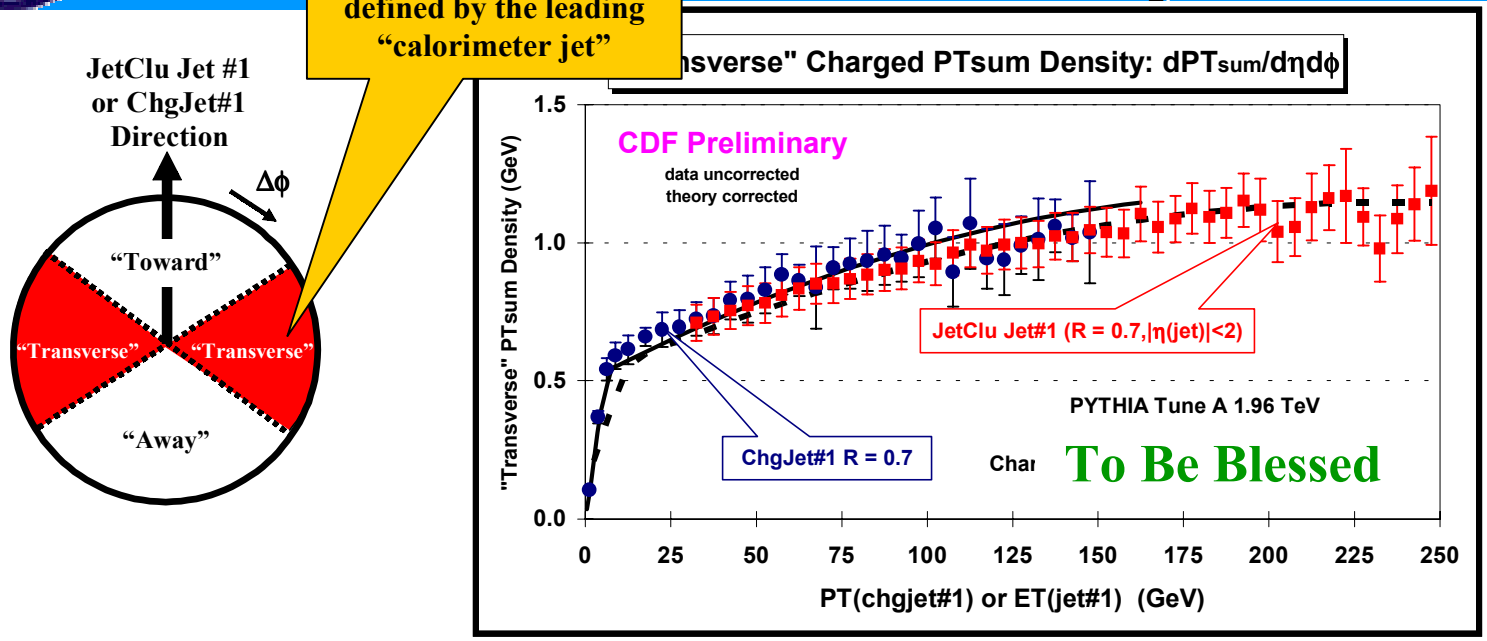
- Shows the data on the average "transverse" charge particle density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2, compared with PYTHIA Tune A.
- Compares the "transverse" region of the leading "charged particle jet", chgjet#1, with the "transverse" region of the leading "calorimeter jet" (JetClu R = 0.7), jet#1.

JetClu "Transverse" Ch[illegible]sum Density



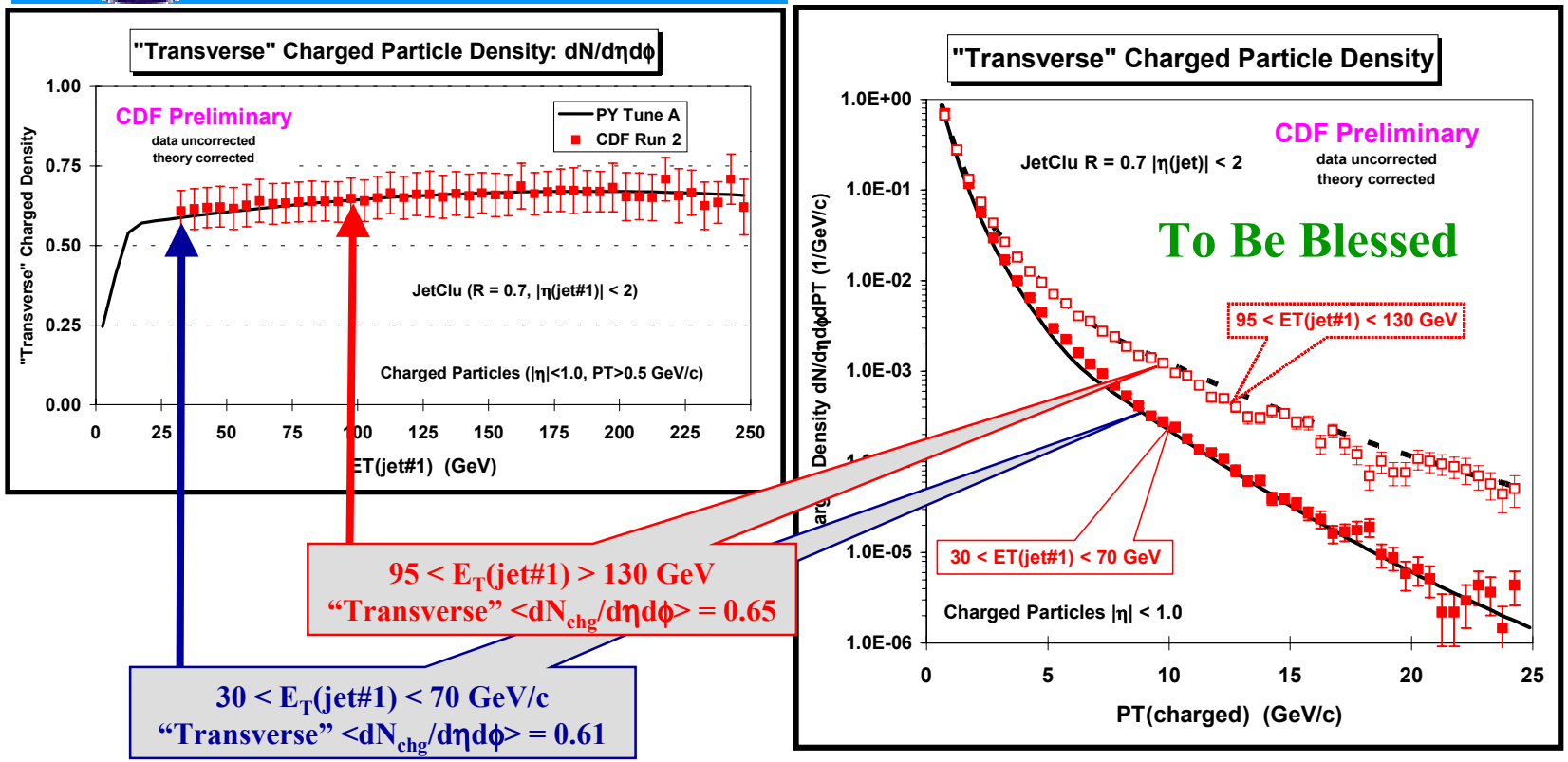
- Shows the data on the average "transverse" charged PTsum density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2, compared with PYTHIA Tune A.

JetClu "Transverse" Charged PTsum Density



- Shows the data on the average "transverse" charged PTsum density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2, compared with PYTHIA Tune A.
- Compares the "transverse" region of the leading "charged particle jet", chgjet#1, with the "transverse" region of the leading "calorimeter jet" (JetClu R = 0.7), jet#1.

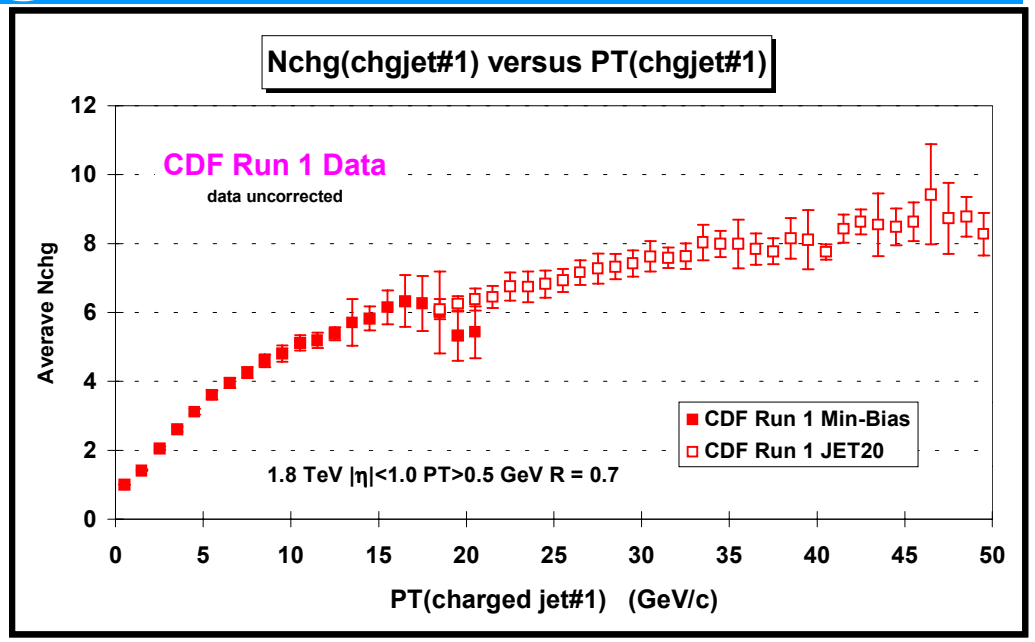
Charged Particle Density "Transverse" P_T Distribution



- Compares the average "transverse" charge particle density ($|\eta|<1$, $P_T>0.5$ GeV) versus E_T(jet#1) with the P_T distribution of the "transverse" density, $dN_{chg}/d\eta d\phi dP_T$. Shows how the "transverse" charge particle density is distributed in P_T.

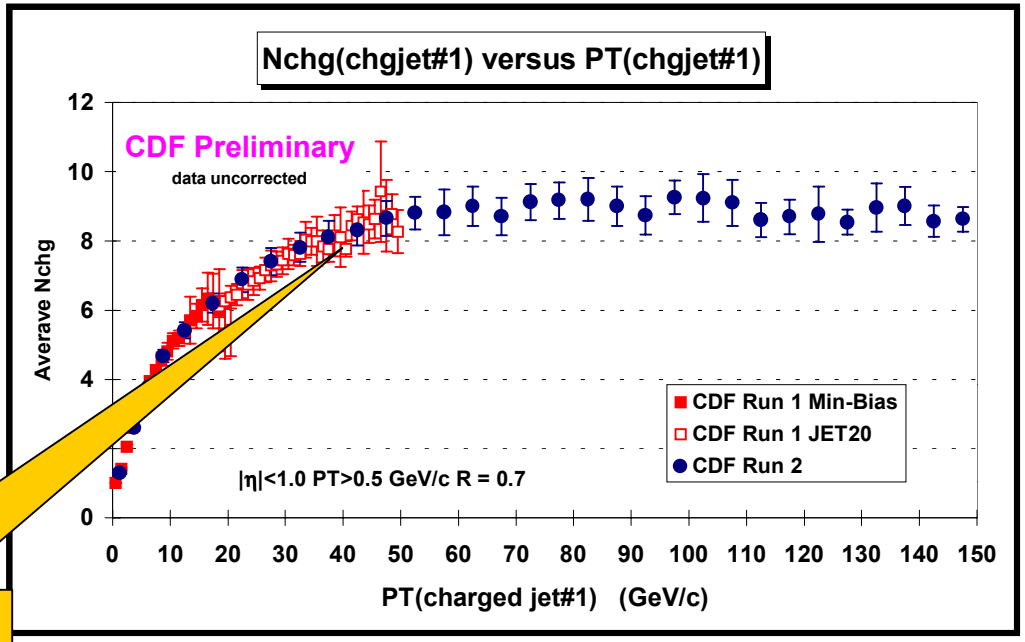
The Leading "Charged Particle" Jet

- Shows the data on the average number of charged particles within the leading "charged particle jet" ($|\eta|<1$, $P_T>0.5$ GeV, R = 0.7) as a function of the transverse momentum of the leading "charged particle jet" from Run 1.



The Leading "Charged Particle" Jet

- Shows the data on the average number of charged particles within the leading "charged particle jet" ($|\eta|<1$, $P_T>0.5$ GeV, R = 0.7) as a function of the transverse momentum of the leading "charged particle jet" from Run 1.

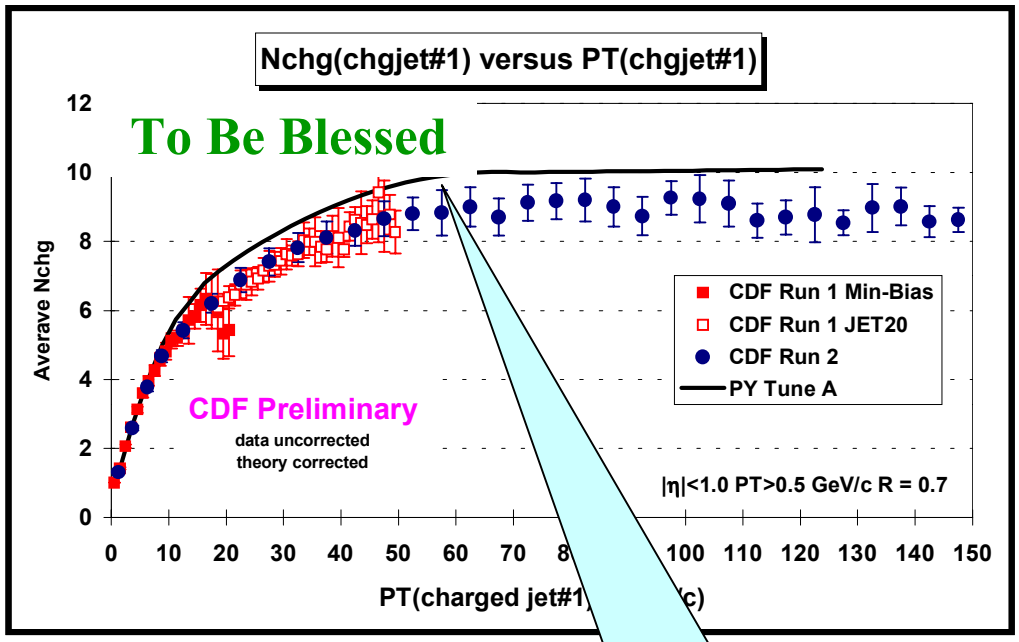


Excellent agreement between Run 1 and 2!

- Compares the Run 2 data (Min-Bias, JET20, JET50, JET70, JET100) with Run 1. The errors on the (*uncorrected*) Run 2 data now include both statistical and correlated systematic uncertainties.

The Leading "Charged Particle" Jet

- Shows the data on the average number of charged particles within the leading "charged particle jet" ($|\eta|<1$, $P_T>0.5$ GeV, R = 0.7) as a function of the transverse momentum of the leading "charged particle jet" from Run 1.

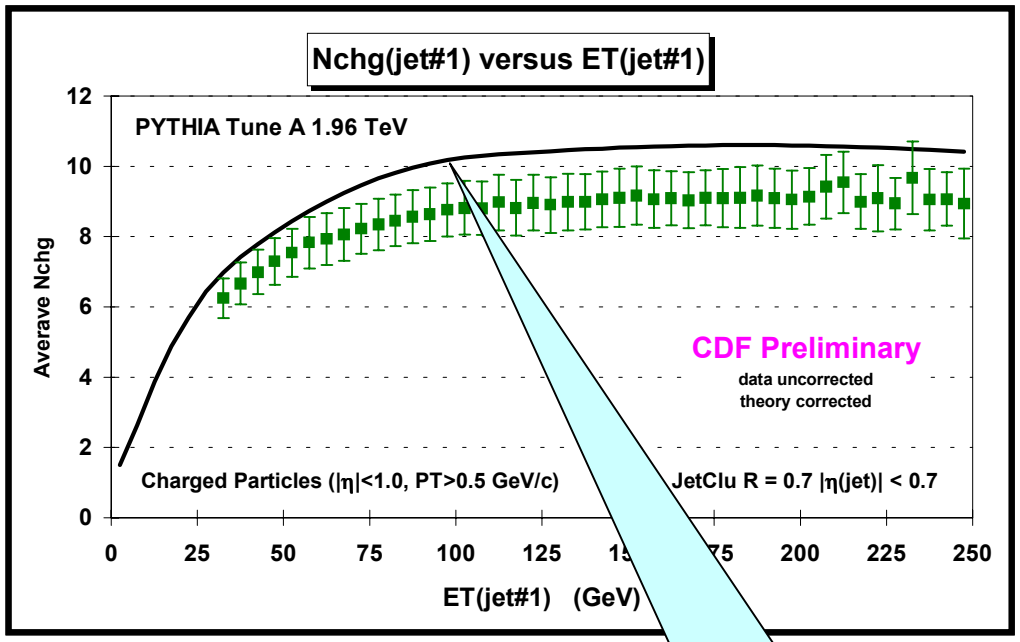


- Compares the Run 2 data (Min-Bias, JET20, JET50, JET70
errors on the (*uncorrected*) Run 2 data now include both sta
systematic uncertainties.

PYTHIA produces too many charged particles in the leading "charged particle jet"!

The Leading "Calorimeter" Jet

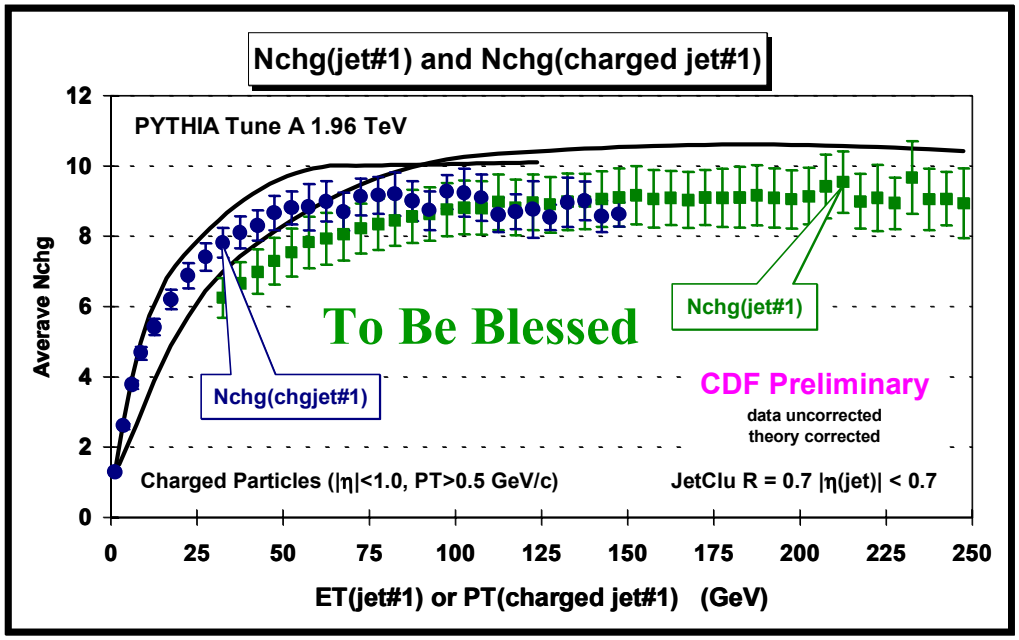
- Shows the Run 2 data on the average number of charged particles ($|\eta|<1$, $P_T>0.5$ GeV, R = 0.7) within the leading "calorimeter jet" (JetClu R = 0.7, $|\eta(\text{jet})|< 0.7$) as a function of the transverse energy of the leading "calorimeter jet".



PYTHIA produces too many charged particles in the leading "calorimeter jet"!

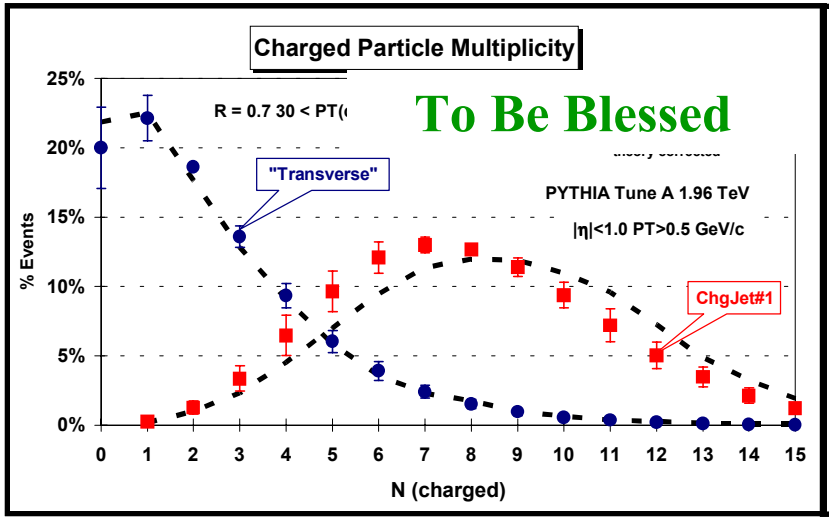
The Leading "Calorimeter" Jet

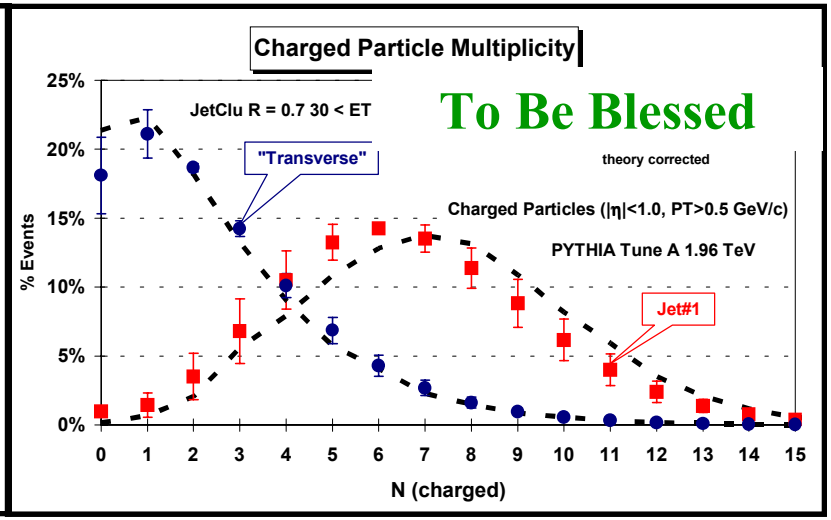
- Shows the Run 2 data on the average number of charged particles ($|\eta|<1$, $P_T>0.5$ GeV, R = 0.7) within the leading "calorimeter jet" (JetClu R = 0.7, $|\eta(\text{jet})|< 0.7$) as a function of the transverse energy of the leading "calorimeter jet".



- Compares the number of charged particles within the leading "charged particle jet", chgjet#1, with the number of charged particles within the leading "calorimeter jet" (JetClu R = 0.7), jet#1.

The Leading "Jet"

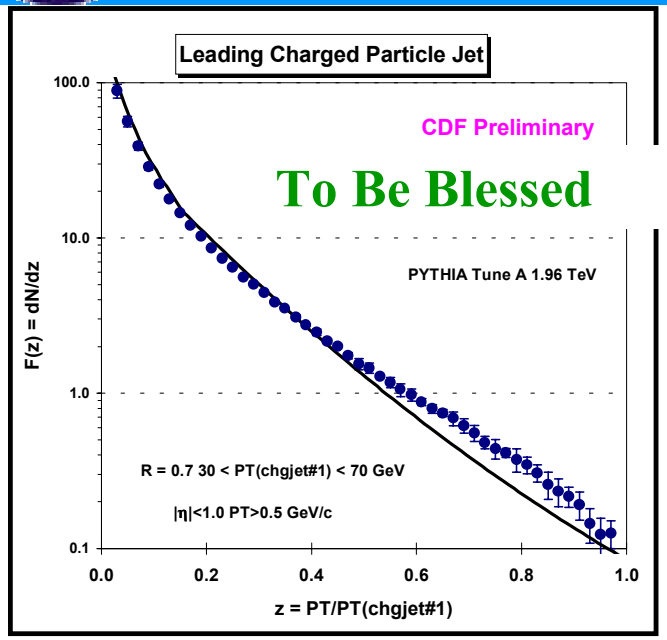


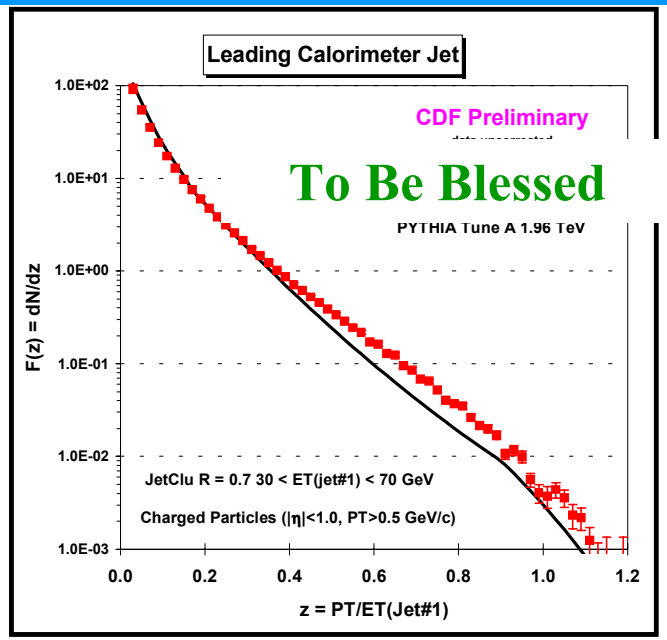


- **Shows charged particle multiplicity distribution ($|\eta|<1$, $P_T>0.5$ GeV/c) within the leading "charged particle jet" and in the "transverse" region as defined by the leading "charged particle jet" for the range $30 < P_T(\text{chgjet\#1}) < 70$ GeV/c compared with PYTHIA Tune A.**

- **Shows charged particle multiplicity distribution ($|\eta|<1$, $P_T>0.5$ GeV/c) within the leading "calorimeter jet" (JetClu, R = 0.7, $|\eta(\text{jet})| < 0.7$) and in the "transverse" regions as defined by the leading "calorimeter jet" (JetClu, R = 0.7, $|\eta(\text{jet})| < 2$) for the range $30 < E_T(\text{jet\#1}) < 70$ GeV compared with PYTHIA Tune A.**

The Leading "Jet"

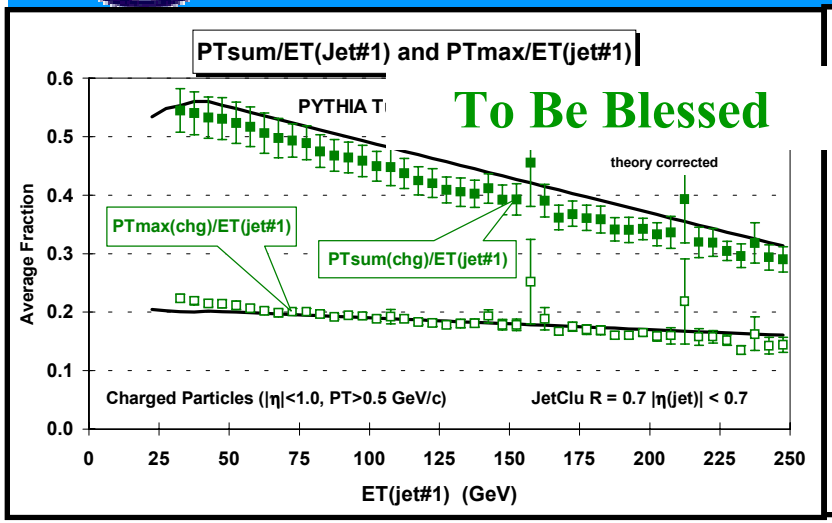


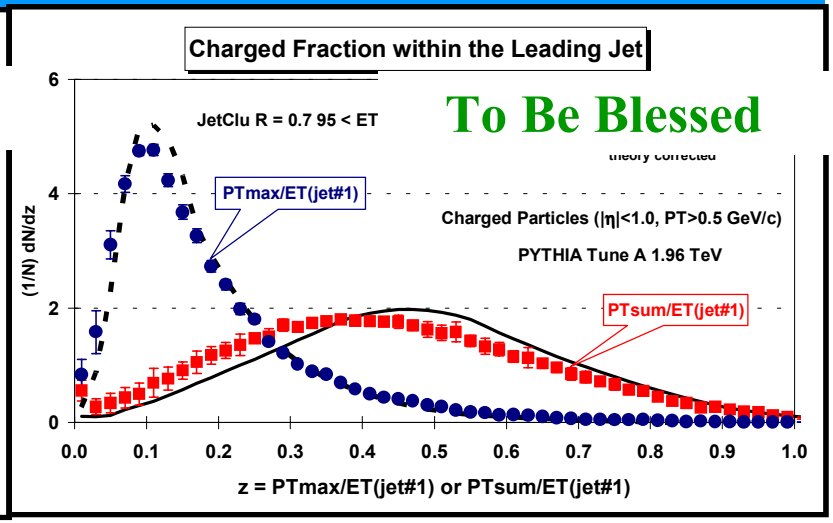


- **Shows the transverse momentum distribution of charged particles (|η|<1) within the leading "charged particle jet" compared with PYTHIA Tune A. The plot shows dN_{chg}/dz with $z = P_T/P_T(chgjet\#1)$ for the range $30 < P_T(chgjet\#1) < 70$ GeV/c.**

- **Shows the transverse momentum distribution of charged particles (|η|<1) within the leading "calorimeter jet" (JetClu, R = 0.7, |η(jet)| < 0.7) compared with PYTHIA Tune A. The plot shows dN_{chg}/dz with $z = P_T/E_T(jet\#1)$ for the range $30 < E_T(jet\#1) < 70$ GeV.**

The Leading "Calorimeter Jet"





- Shows average charged PTsum fraction, PTsum/E_T(jet#1), and the average charged PTmax fraction, PTmax/E_T(jet#1), within the leading "calorimeter jet" (JetClu, R = 0.7, |η(jet)| < 0.7) compared with PYTHIA Tune A.

- Shows distribution of the charged PTsum fraction, z = PTsum/E_T(jet#1), and the distribution of charged PTmax fraction, z = PTmax/E_T(jet#1), within the leading "calorimeter jet" (JetClu, R = 0.7, |η(jet)| < 0.7) for the range 95 < E_T(jet#1) < 130 GeV compared with PYTHIA Tune A.