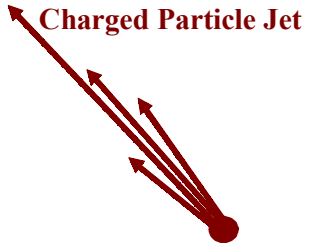
The "Underlying" Event in Run II
ChgJets versus JetClu Jets

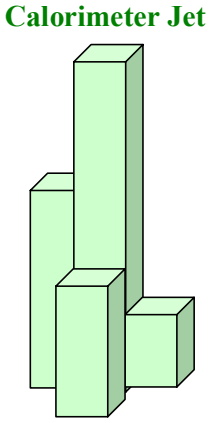
Outline of Talk

- The evolution of "charged particle jets" and the "underlying event". Study the event topology relative to the leading "chgjet" and compare with Run I.

- The evolution of "calorimeter jets" and the "underlying event". Study the event topology relative to the leading "JetClu" jet.

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





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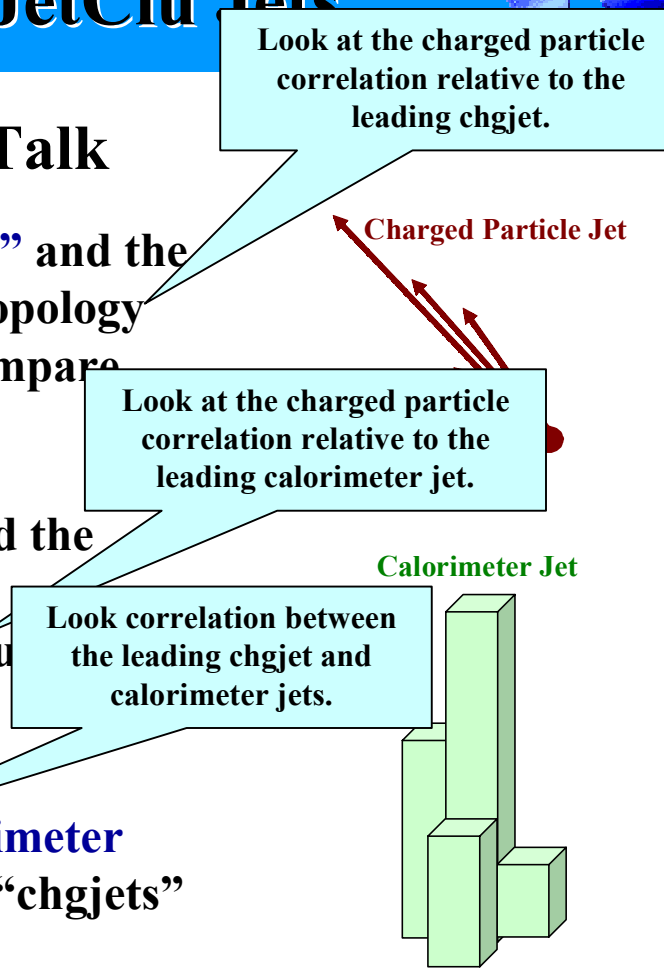


Data Selection

Event Selection

Good Runs
Bad Stntuples Removed
MetSig < 5 sumET < 2 TeV
One and only one Z-vertex
$|z_0| < 60$ cm

Anwar's New Stntuples	JET20	JET50	JET70	JET100
Total Events	7,388,639	1,844,407	826,597	1,052,530
Good Events (Rob's WEB)	5,185,515	1,397,771	642,289	822,466
Met Cut (MetSig < 5, sumET < 2 TeV)	5,177,984	1,370,267	607,794	690,242
1 ZVTX $\|z\| < 60$ cm	3,038,879	793,145	350,146	391,034
JetClu ($\|\eta(\text{jet})\| < 2$, R = 0.7)	2,422,404	728,816	336,238	386,991
JetClu ($\|\eta(\text{jet})\| < 0.7$, R = 0.7)	1,118,787	379,443	188,441	240,296
ChgJet ($P_T > 0.5$ GeV, $\|\eta\| < 2$, R = 0.7)	3,018,847	790,136	349,135	390,276

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 $|\eta| < 1$

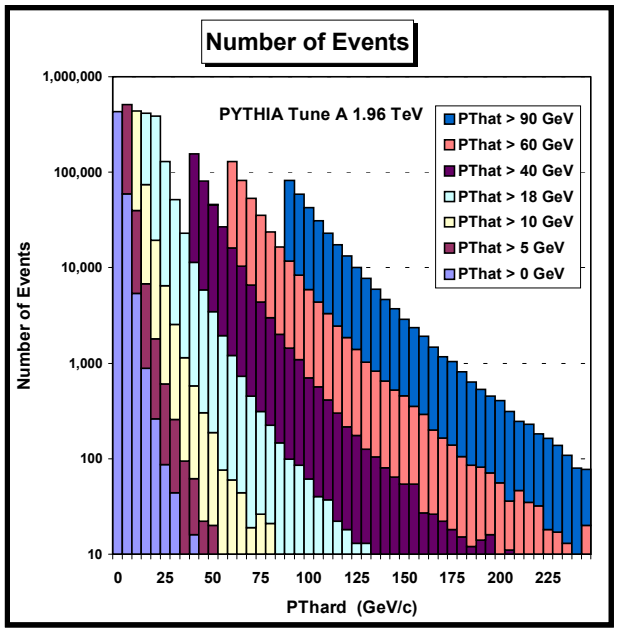
Form charged particle jets (R = 0.7) as we did our Run 1 analysis

Calorimeter Jet Selection

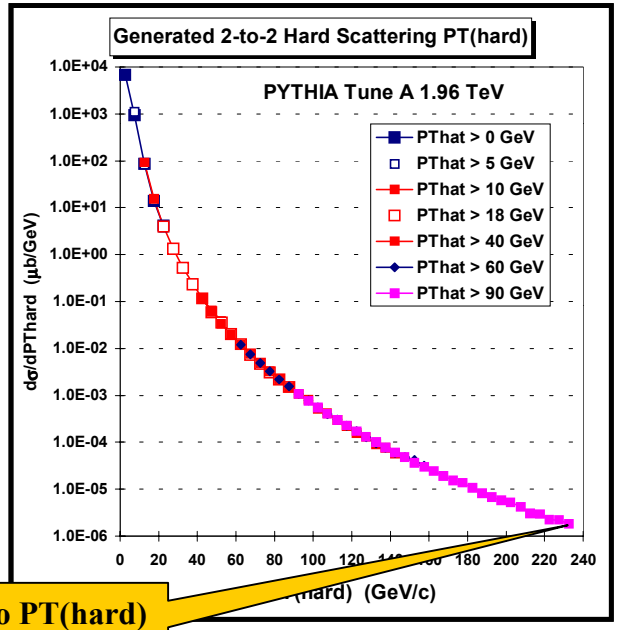
JetClu (R = 0.7)
$|\eta(\text{jet})| < 2$ or $|\eta(\text{jet})| < 0.7$

PYTHIA Tune A

Charles Currat's Stntuples
(PYTHIA Tune A at 1.96 TeV)



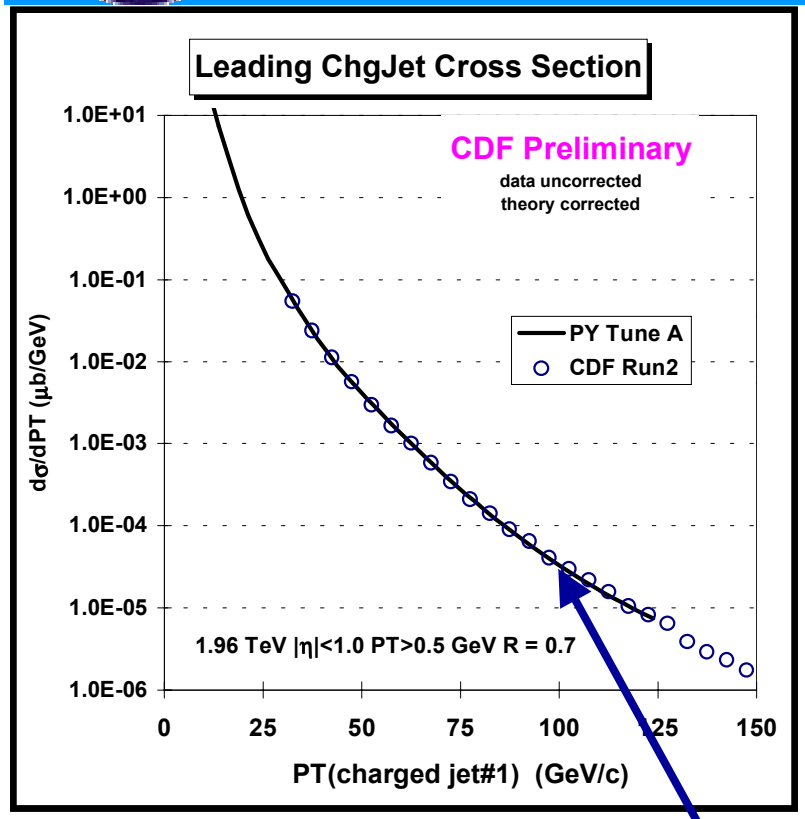
PT(min)	N(events)
0	500,000
5	497,500
10	497,500
18	927,000
40	331,500
60	338,000
90	271,900
Total	3,363,400

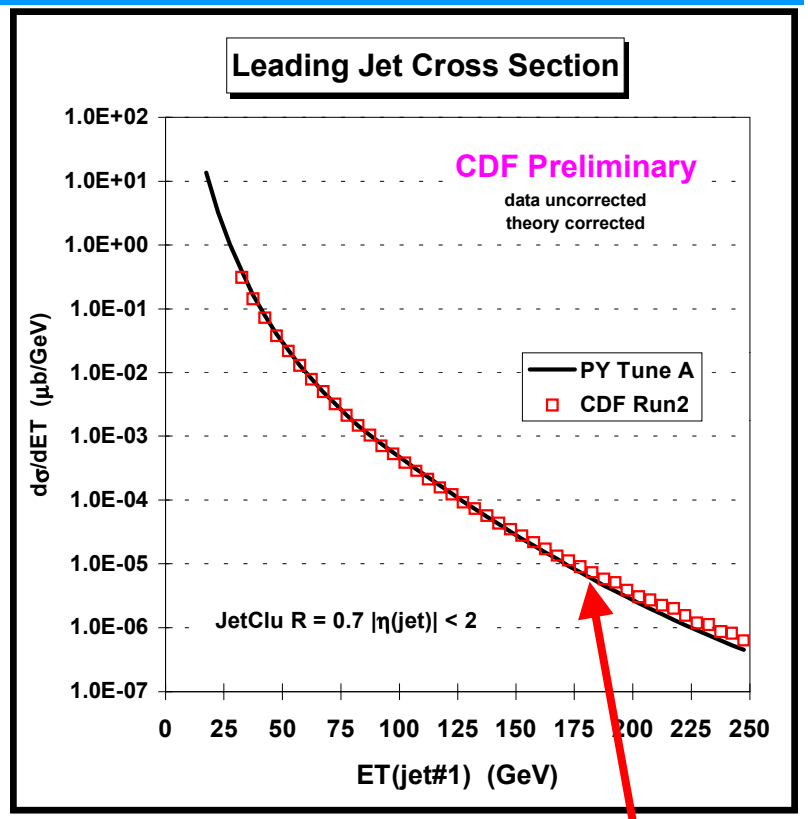


Can only go out to PT(hard)
of about 250 GeV/c.

➡ **Form "weighted" histograms using P_T(hard) so that I can use all 3,363,400 generated events!** **Need another run with PT(min) = 125 GeV/c!**

Cross-Sections

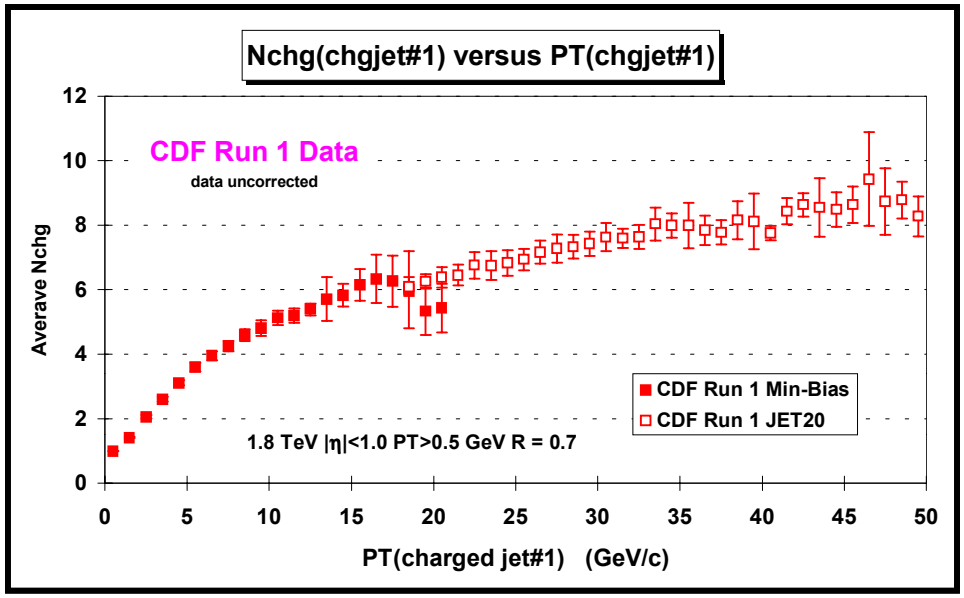




➡ **Normalize PYTHIA Tune A to fit the leading chgjet cross-section predict the leading JetClu jet cross-section!**

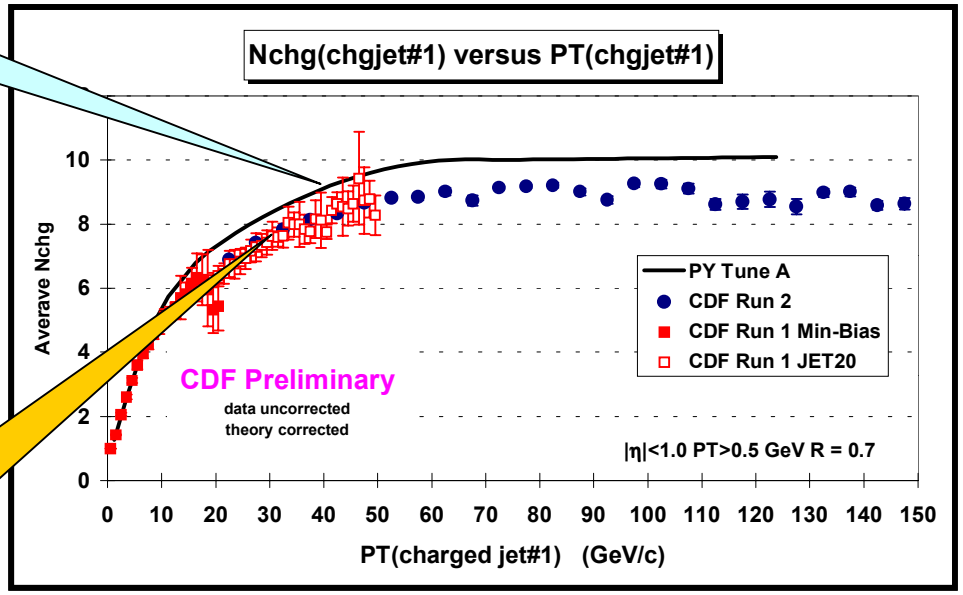
Evolution of Charged Jets

- **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.**



Evolution of Charged Jets

PYTHIA produces too many charged particles in the leading chgjet!

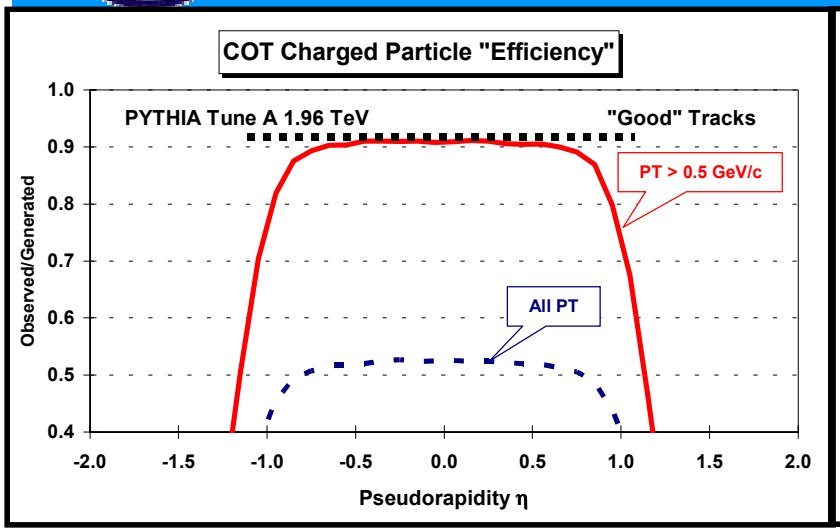


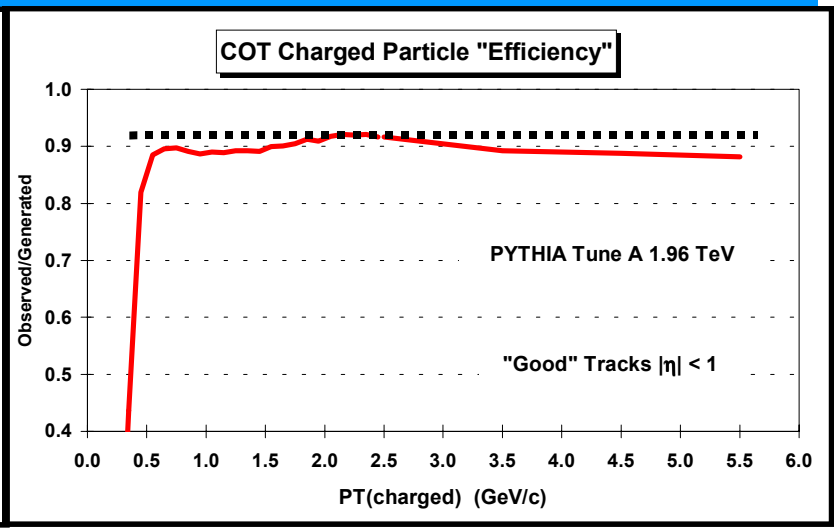
- Shows the data on the average number of charged particles within the leading charged particle jet ($|\eta|<1$, $P_T>0.5$ GeV, R = 0.7) as a function of the transverse momentum of the leading charged particle jet from Run 1.

Excellent agreement between Run 1 and 2!

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

Run 2 COT "Efficiency"



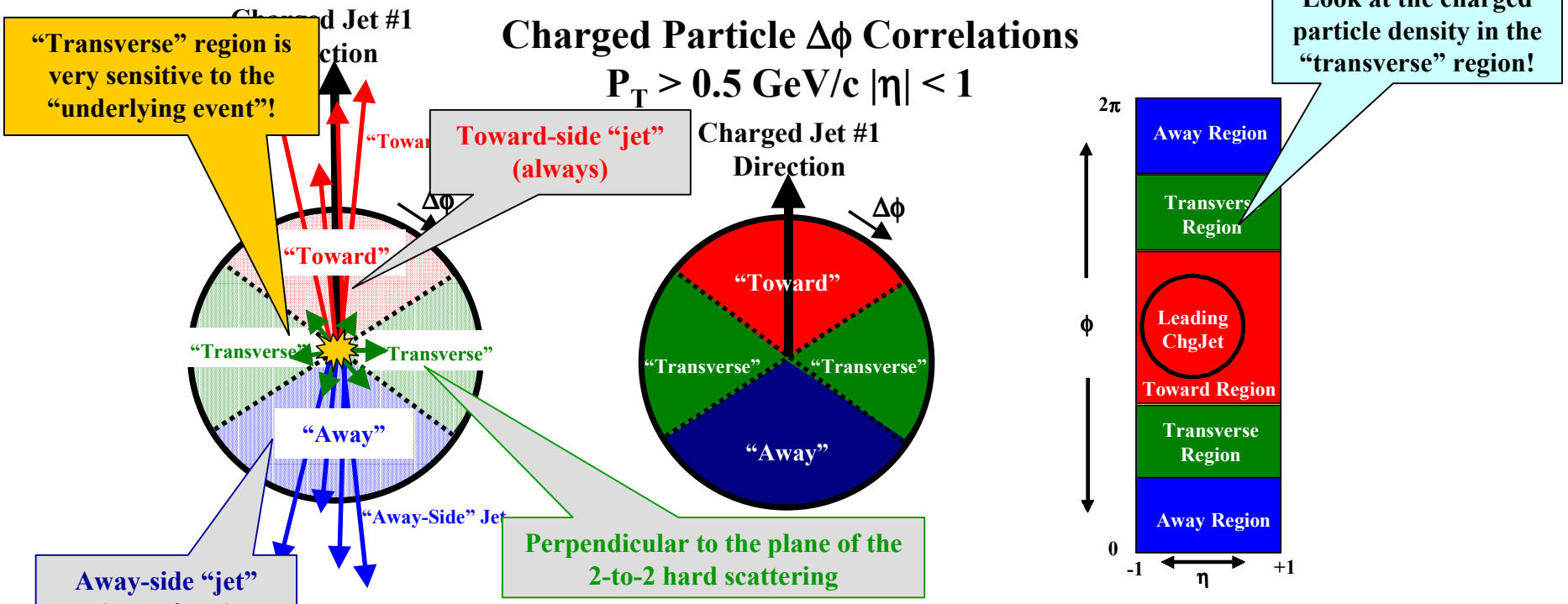


- **Shows the Run 2 COT "efficiency" versus η for "good" tracks with $P_T > 0.5$ GeV/c and all P_T. The "efficiency" is the ratio of the observed "good" tracks (after CDFSIM) to the generated charged particles.**

- **Shows the Run 2 COT "efficiency" versus P_T for "good" tracks with $|\eta| < 1$.**

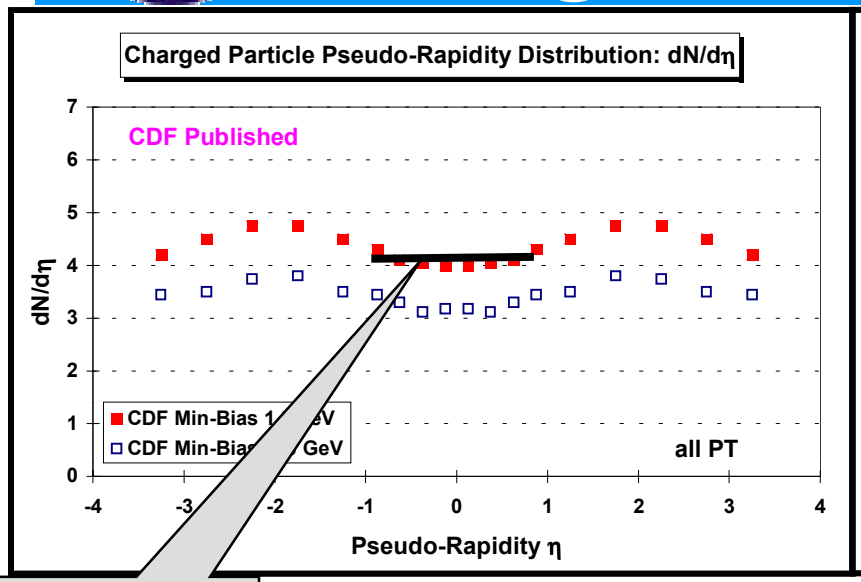
- **In Run 1 we assumed a COT "efficiency" of 92% for $P_T > 0.5$ GeV/c and $|\eta| < 1$.**

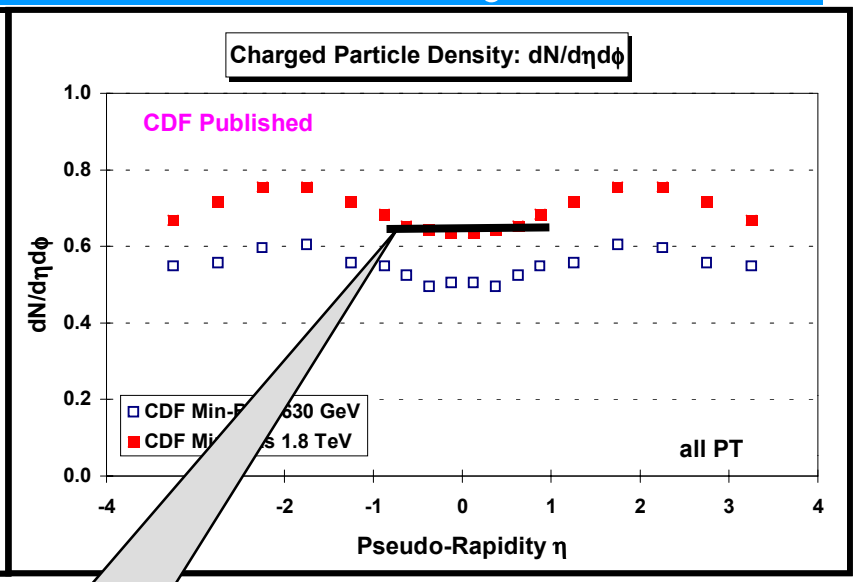
Evolution of Charged Jets "Underlying Event"



- 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, $\Delta\eta \times \Delta\phi = 2 \times 120^o = 4\pi/3$.

CDF "Min-Bias" Data
Charged Particle Density



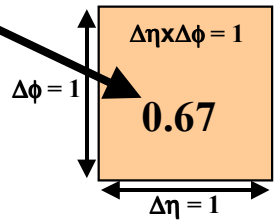


$\langle dN_{chg}/d\eta \rangle = 4.2$

$\langle dN_{chg}/d\eta d\phi \rangle = 0.67$

F "Min-Bias" data on the [illegible] particles per unit pseudo-rapidity at 630 and 1,800 GeV. There are about **4.2 charged particles per unit η in "Min-Bias" collisions at 1.8 TeV** ($|\eta| < 1$, all P_T).

- Convert to charged particle density, $dN_{chg}/d\eta d\phi$, by dividing by 2π. There are about **0.67 charged particles per unit η-φ in "Min-Bias" collisions at 1.8 TeV** ($|\eta| < 1$, all P_T).



CDF "Min-Bias" Data
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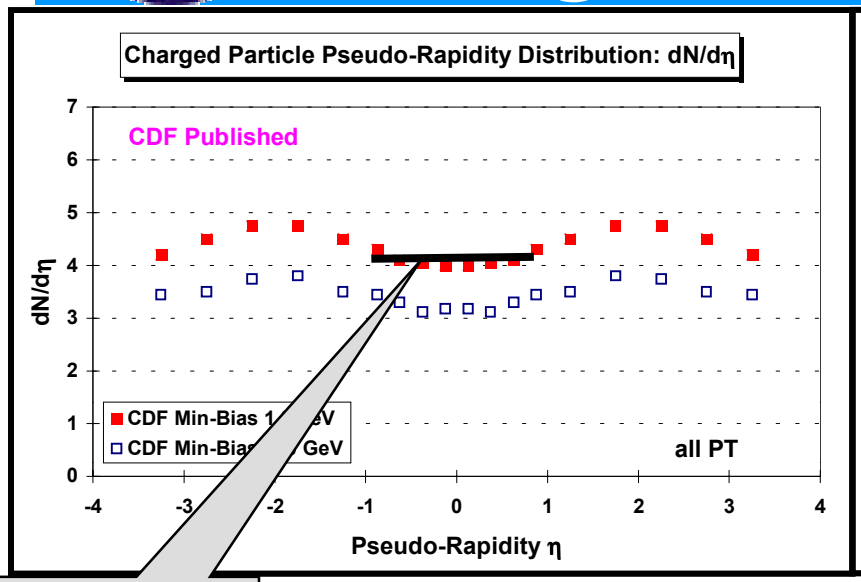

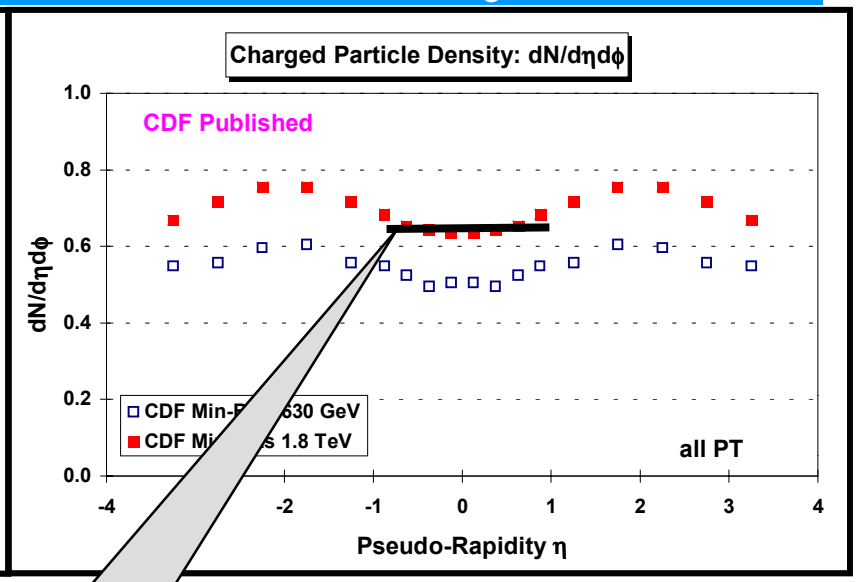

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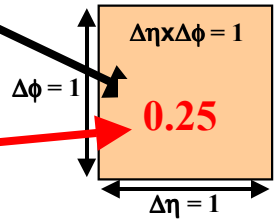
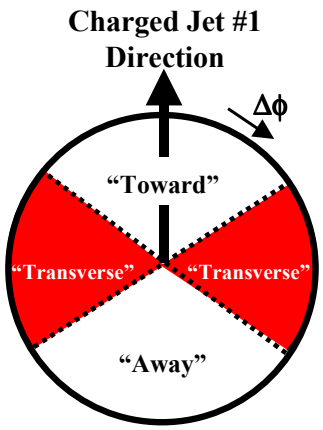
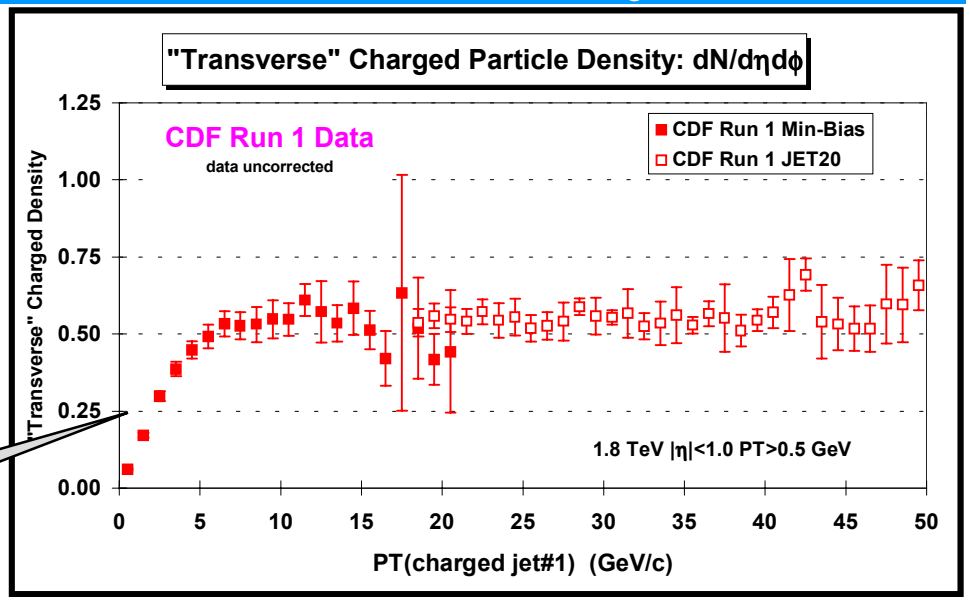
- There are about 0.25 charged particles per unit η-φ in "Min-Bias" collisions at 1.8 TeV ($|\eta| < 1$, $P_T > 0.5$ GeV/c).



"Transverse" Charged Particle Density



CDF "Min-Bias" data
(|η|<1, P_T>0.5 GeV)
<$dN_{chg}/d\eta d\phi$> = 0.25



➡ **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.**

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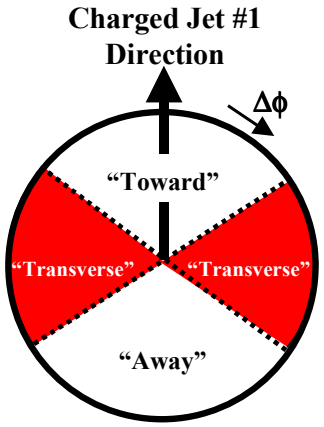

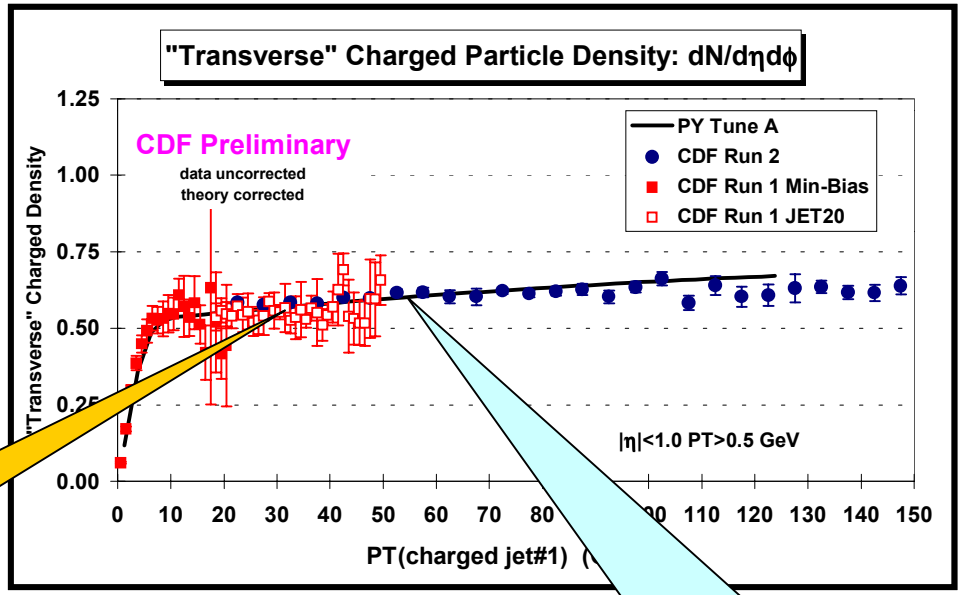

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PYTHIA Tune A was tuned to fit the "underlying event" in Run I!

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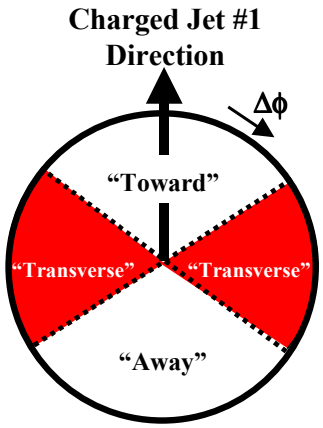
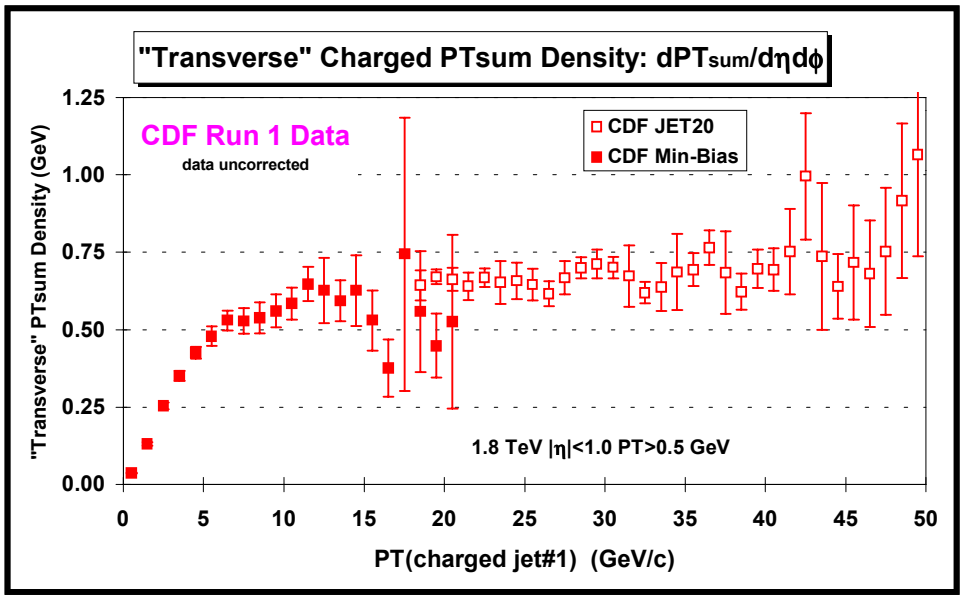
"Transverse" Charged PTsum Density





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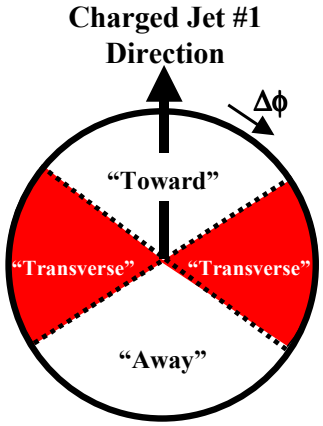

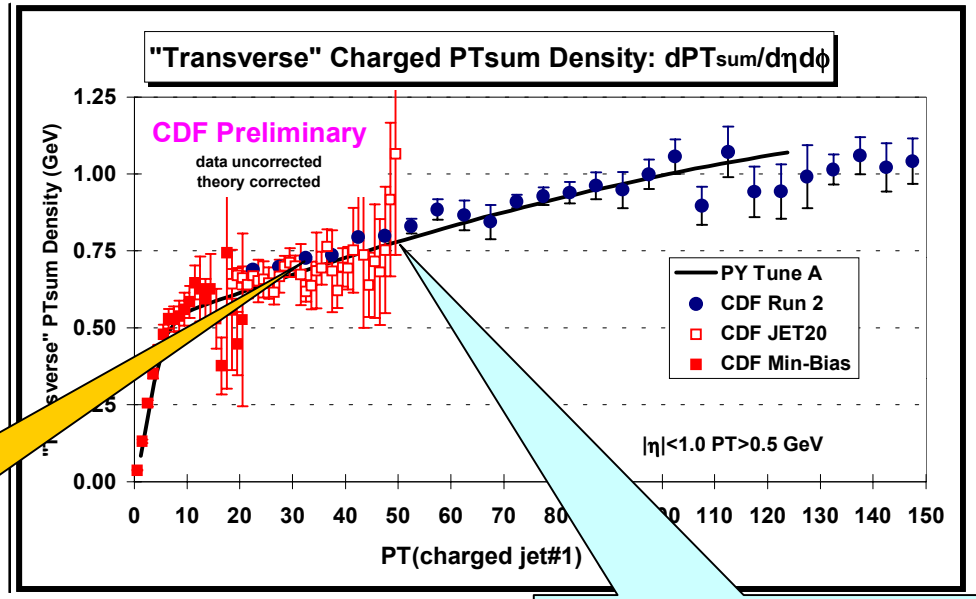

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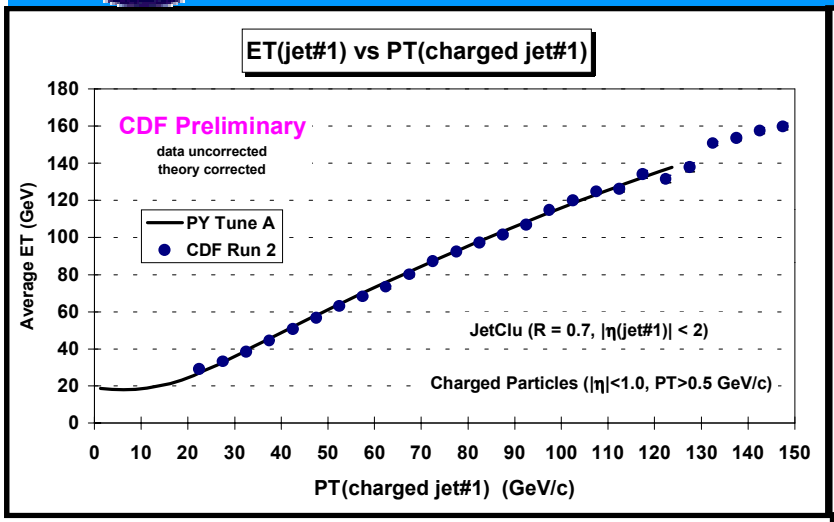
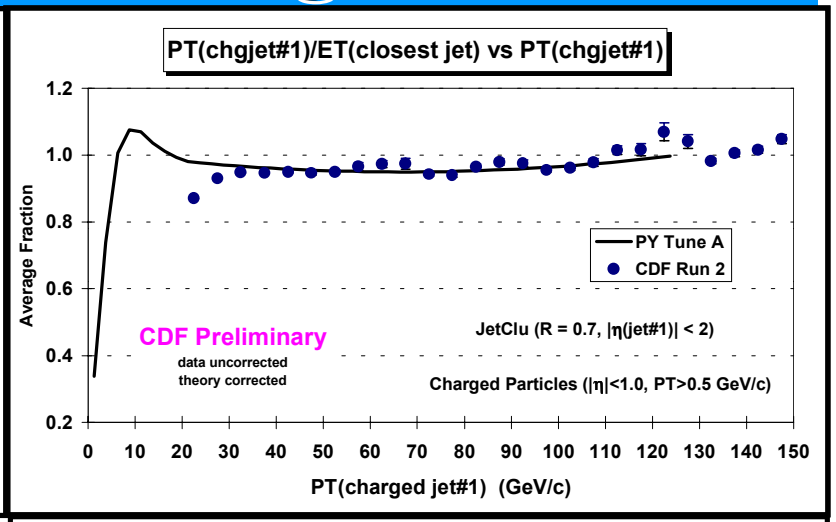
- Shows the data on the average "transverse" charged PTsum density ($|\eta|<1$, $P_T>0.5$ GeV) as a function of the transverse momentum of the leading charged particle jet from Run 1.

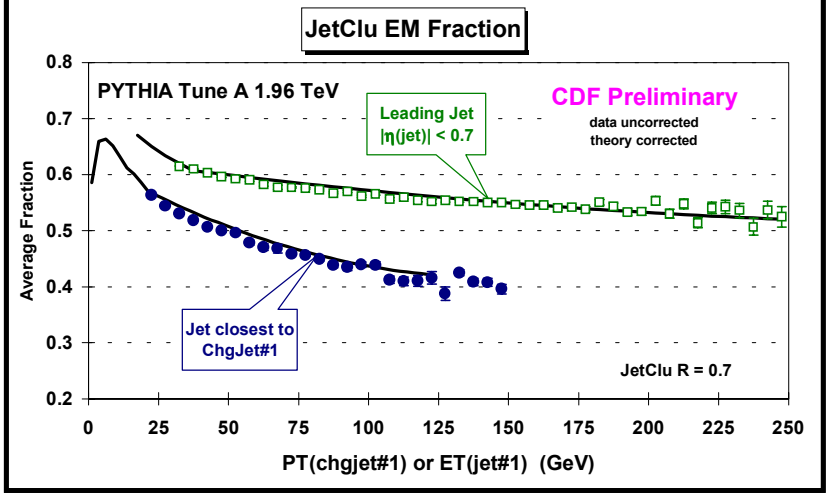
- Compares the Run 2 data (JET20, JET50, JET70, JET100) with Run 1.

Relationship Between JetClu Jets and ChgJets

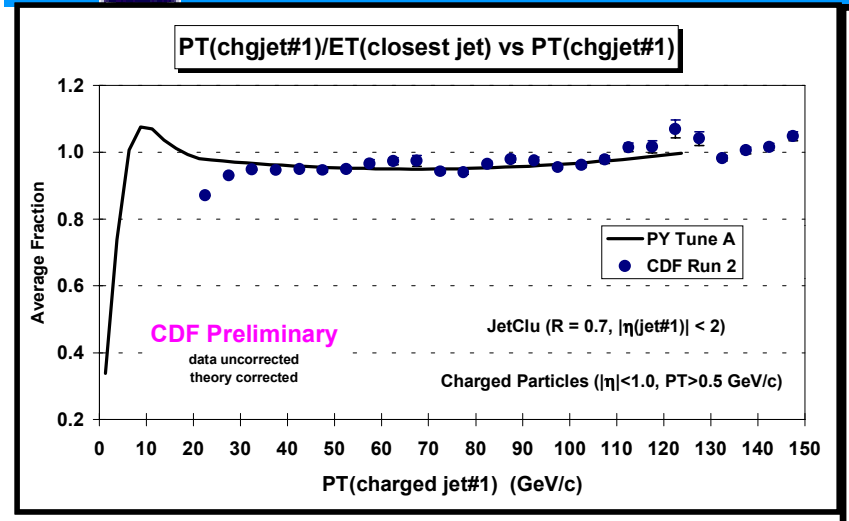


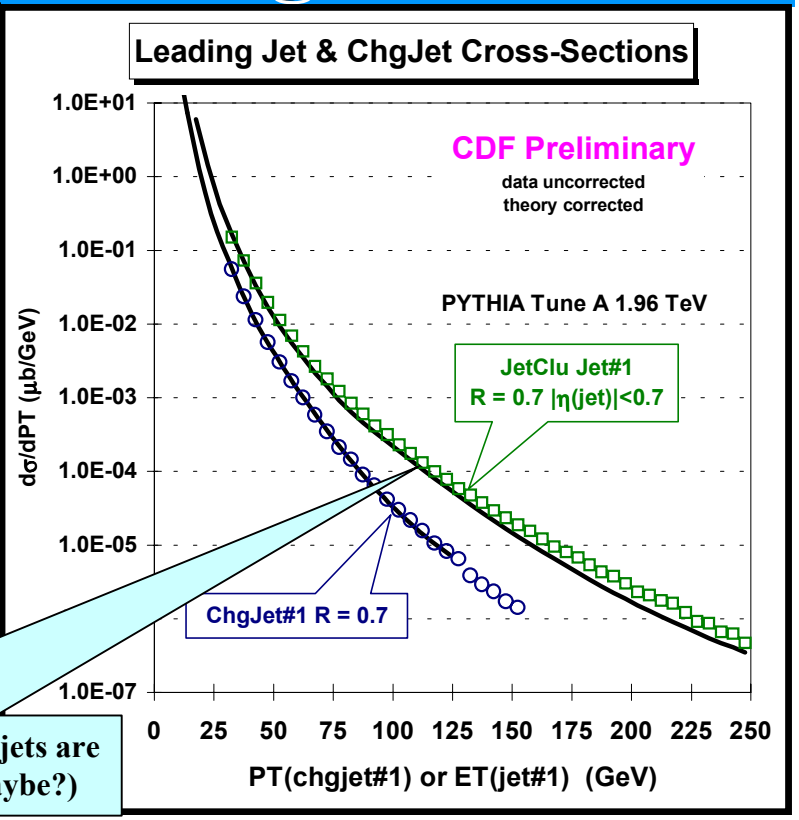


- Shows the leading JetClu jet ET versus the transverse momentum of the leading charged particle jet.
- Shows the ratio of P_T(chgjet#1) to the closest JetClu jet ET versus P_T(chgjet#1).
- Shows the EM fraction of the closest JetClu jet versus P_T(chgjet#1) together with the EM fraction of a typical JetClu jet.



Relationship Between JetClu Jets and ChgJets



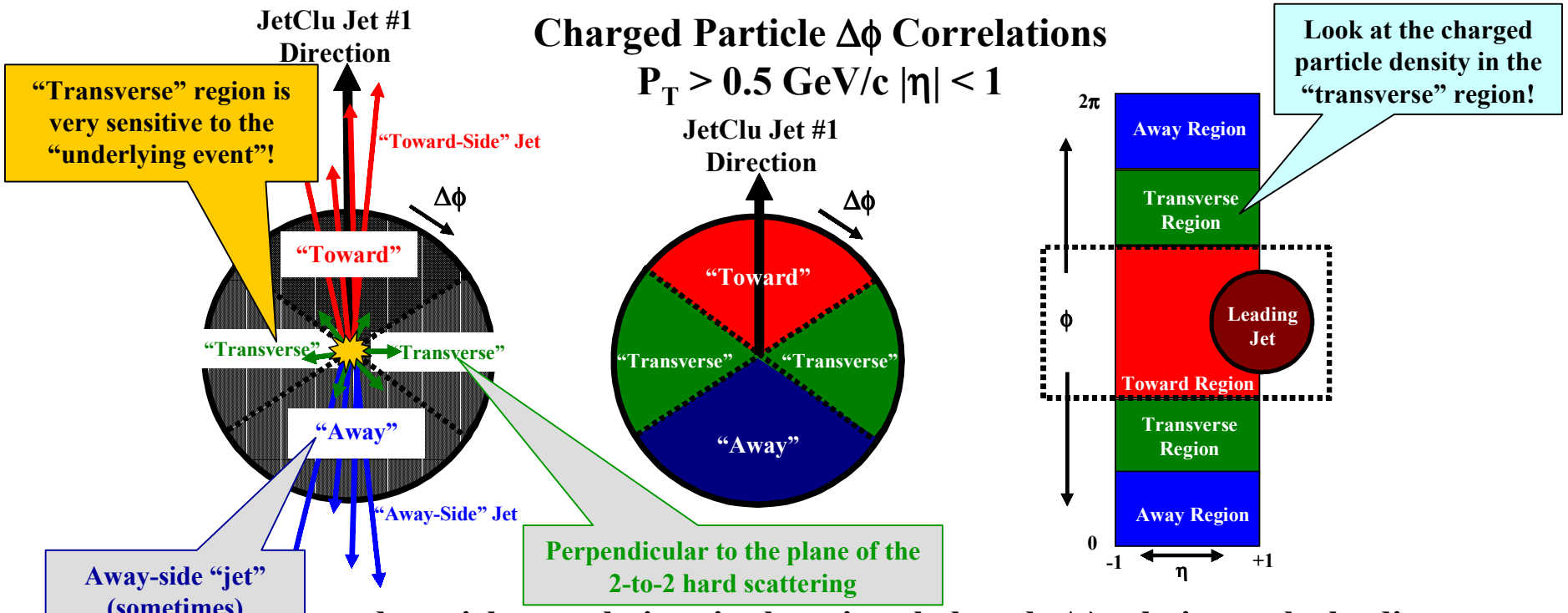


- Shows the ratio of P_T(chgjet#1) to the closest JetClu jet E_T versus P_T(chgjet#1).

At E_T(jet#1) = 125 GeV about 1 in 10 JetClu jets are composed of > 90% charged particles! (maybe?)

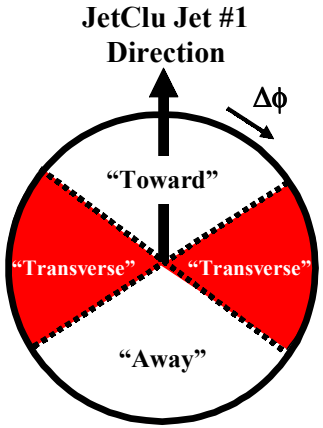
- Shows relative cross-sections for producing a leading chgjet with transverse momentum P_T(chgjet#1) ($|\eta| < 1$) and for producing a leading JetClu jet ($|\eta| < 0.7$) with transverse energy E_T(jet#1).

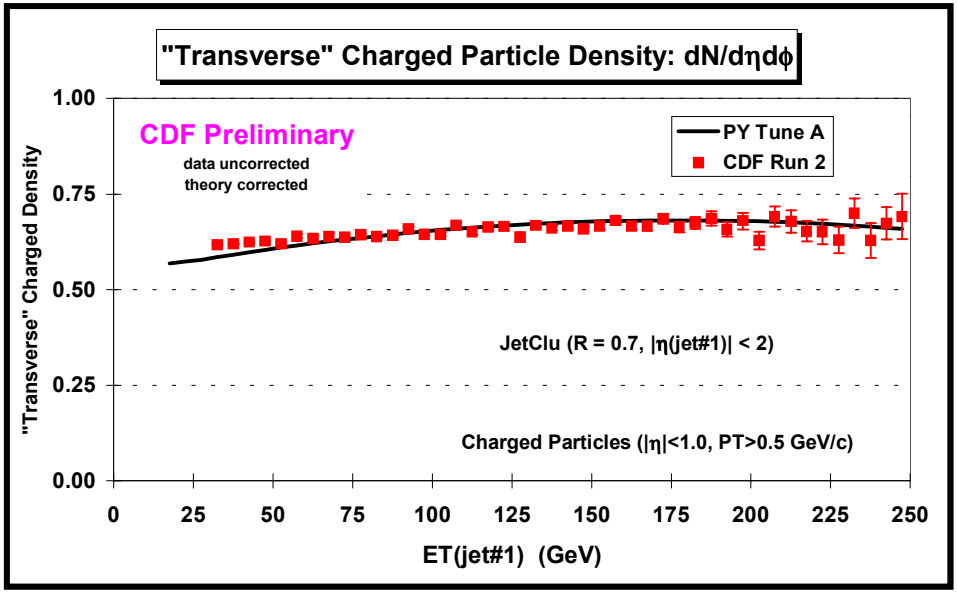
Evolution of JetClu Jets "Underlying Event"



- 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, $\Delta\eta \times \Delta\phi = 2 \times 120^o = 4\pi/3$.

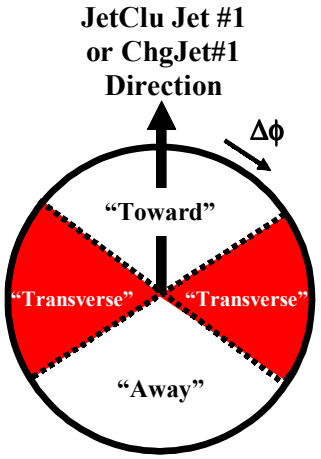
JetClu "Transverse" Charged Particle Density

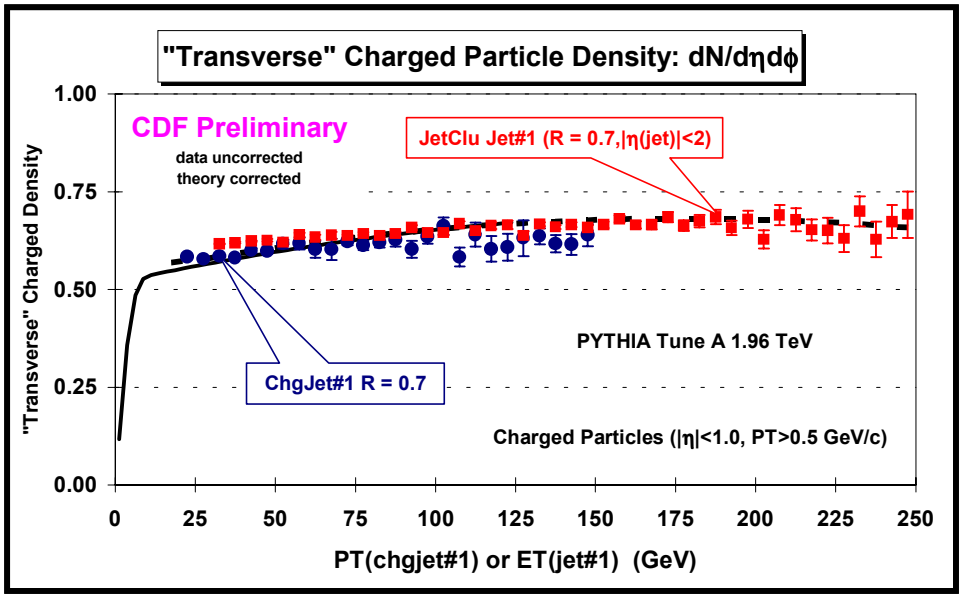




- **Shows the data on the average "transverse" charge particle density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2 compared with the predictions of PYTHIA Tune A.**

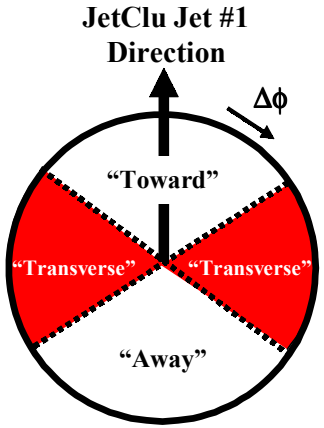
JetClu "Transverse" Charged Particle Density

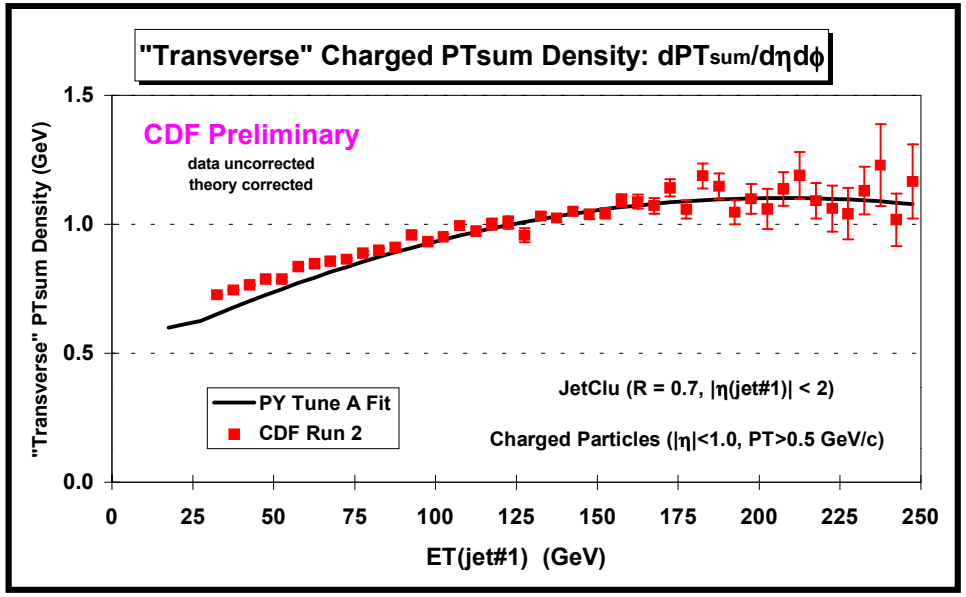




- Shows the data on the average "transverse" charge particle density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2 compared with the predictions of PYTHIA Tune A.
- Compares the "transverse" region of the leading chgjet with the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

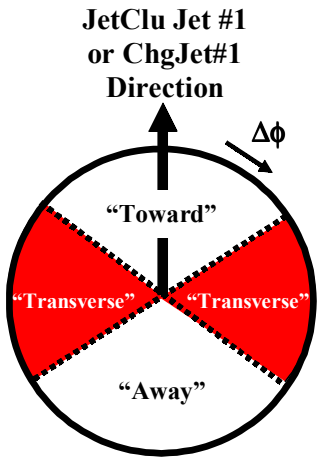
JetClu "Transverse" Charged PTsum Density

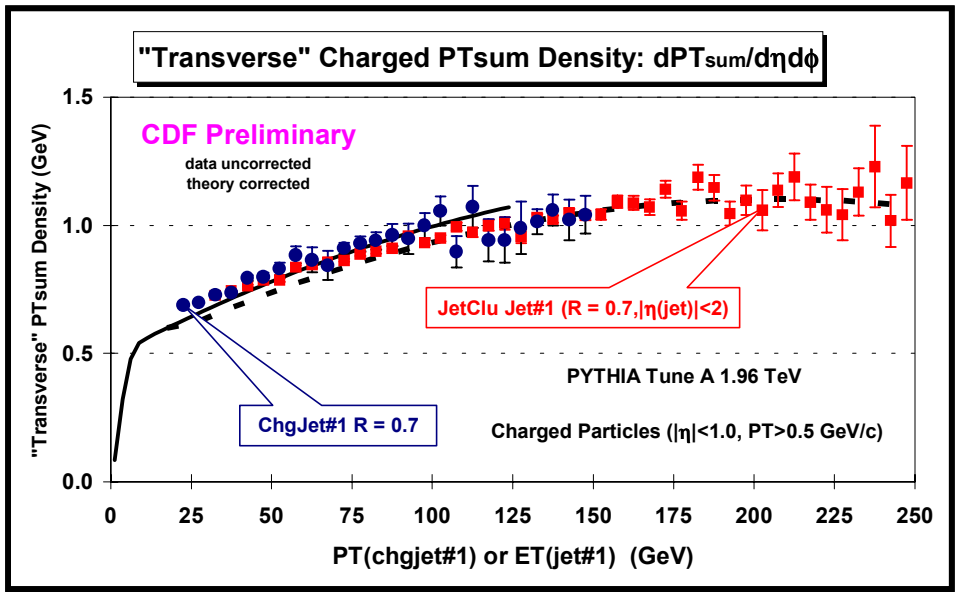




- **Shows the data on the average "transverse" charged PTsum density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2 compared with the predictions of PYTHIA Tune A.**

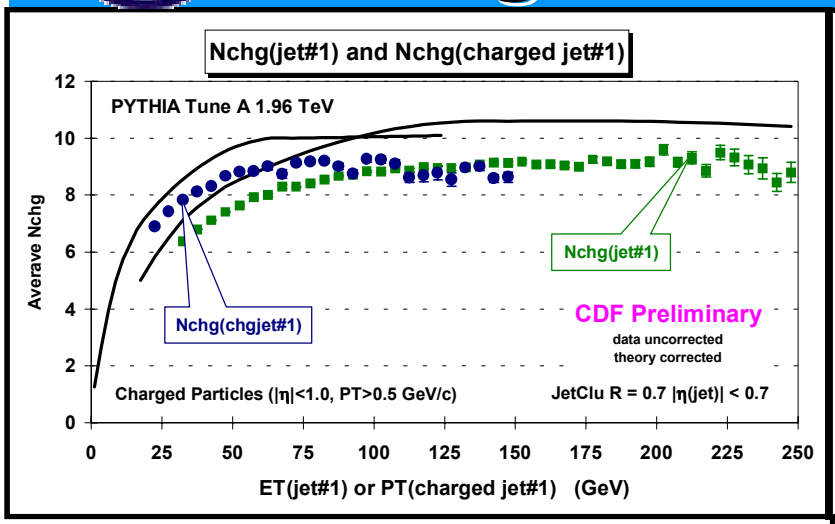
JetClu "Transverse" Charged PTsum Density

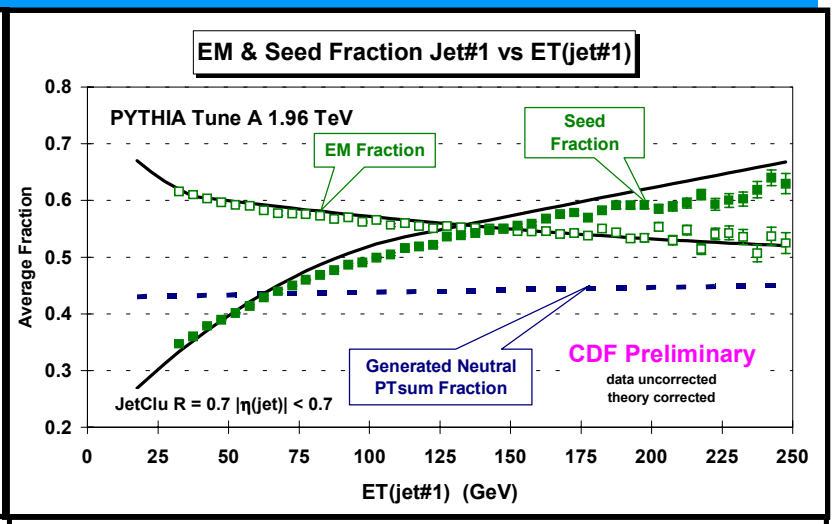




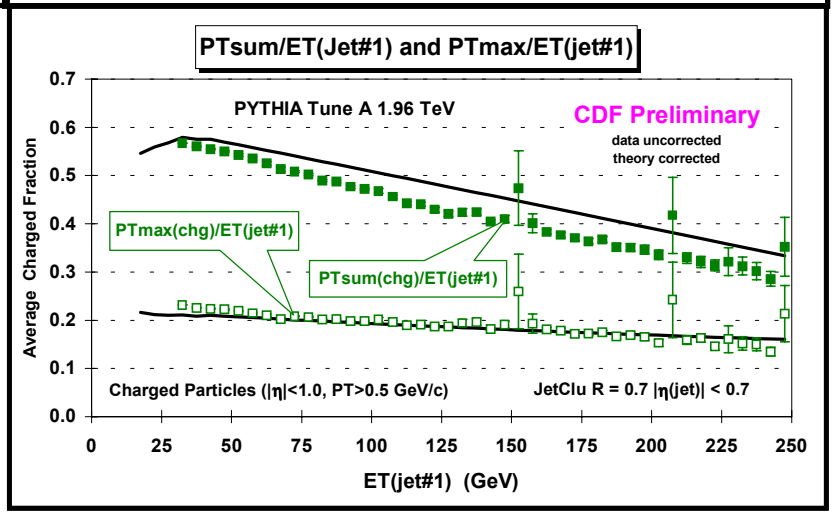
- Shows the data on the average "transverse" charged PTsum density (|η|<1, PT>0.5 GeV) as a function of the transverse energy of the leading JetClu jet (R = 0.7, |η(jet)| < 2) from Run 2 compared with the predictions of PYTHIA Tune A.
- Compares the "transverse" region of the leading chgjet with the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

Structure of the Leading ChgJet and JetClu Jet

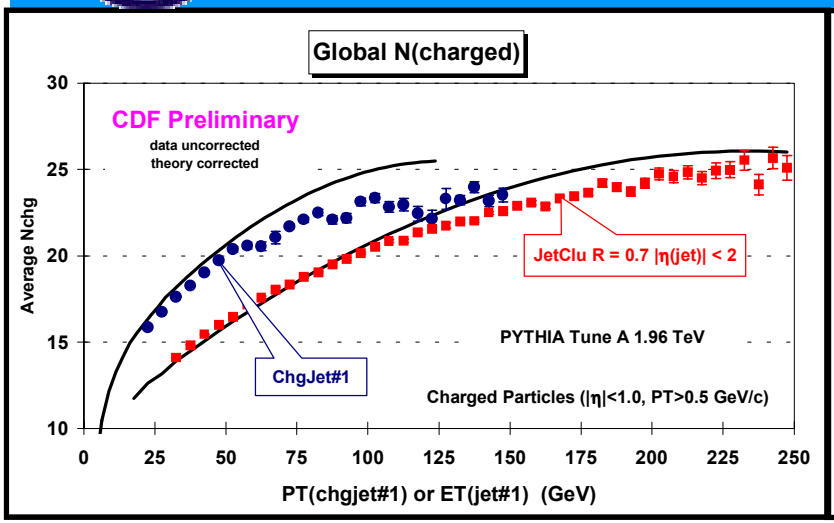


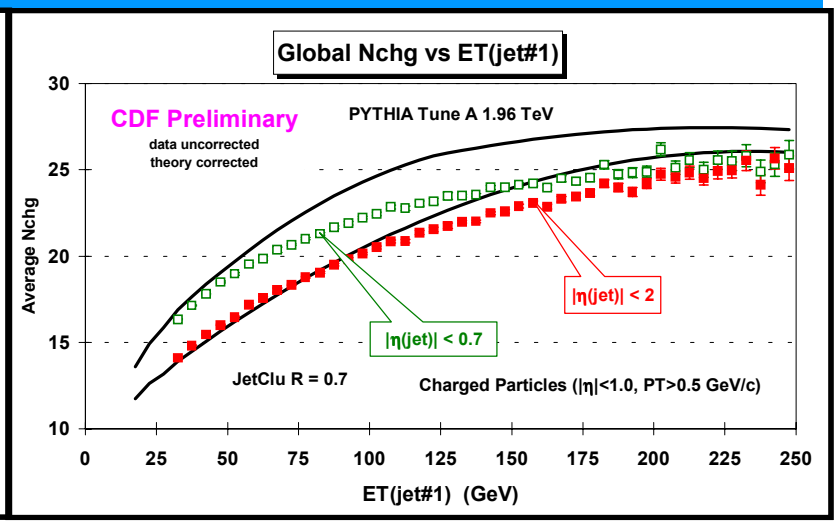


- Shows the average number of charged particles within the leading JetClu jet and within the leading chgjet.
- Shows the EM fraction and the Seed fraction of the leading JetClu jet.
- Shows the fraction of charged PTsum and the charged PTmax fraction within the leading JetClu jet.



Global Charged Multiplicity

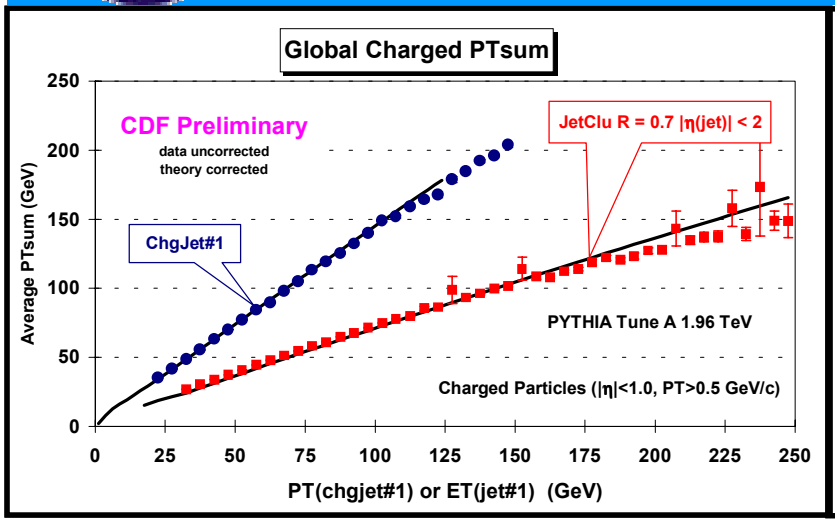


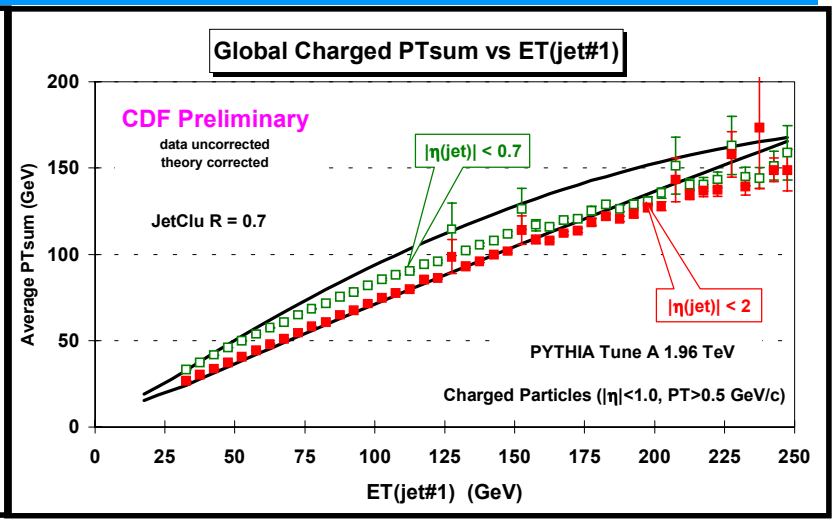


- **Shows the overall average number of charged particles ($P_T > 0.5$ GeV/c, $|\eta| < 1$) as a function of the leading JetClu jet ET and as function of the transverse momentum of the leading chgjet.**

- **Shows the overall average number of charged particles ($P_T > 0.5$ GeV/c, $|\eta| < 1$) as a function of the leading JetClu jet ET for $|\eta(\text{jet\#1}) < 2|$ and $|\eta(\text{jet\#1})| < 0.7$.**

Global Charged PTsum

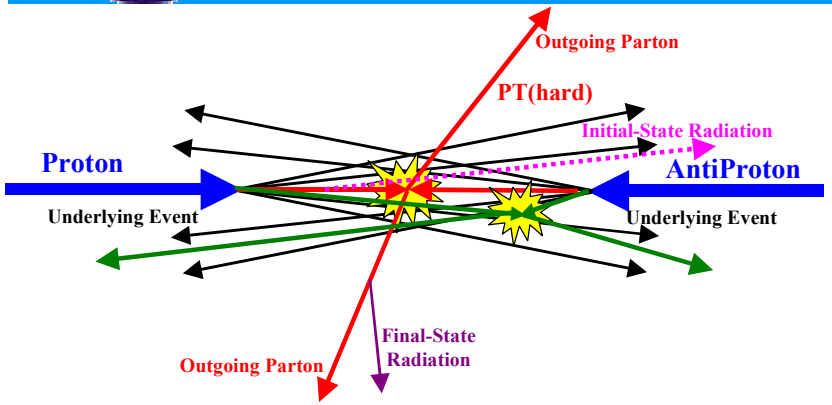




- **Shows the overall average charged PTsum (PT > 0.5 GeV/c, |η| < 1) as a function of the leading JetClu jet ET and as function of the transverse momentum of the leading chgjet.**

- **Shows the overall average charged PTsum (PT > 0.5 GeV/c, |η| < 1) as a function of the leading JetClu jet ET for |η(jet#1) < 2| and |η(jet#1)| < 0.7.**

Summary

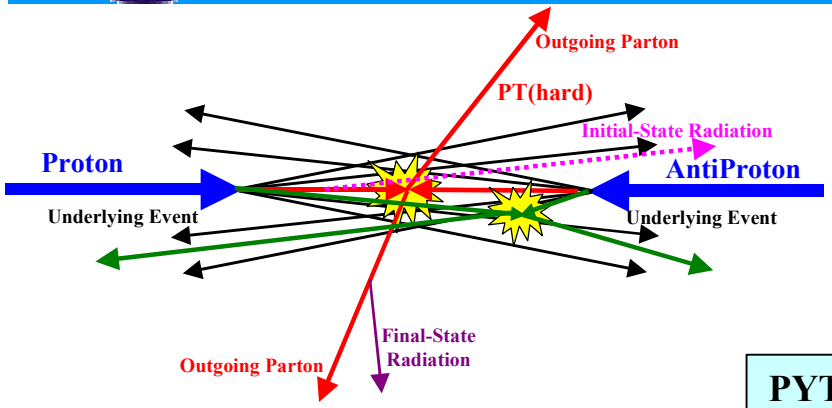


The "Underlying Event" in Run 2

Same conclusion as Mario!

- **There is excellent agreement between Run 1 and Run 2 for charged particles. The "underlying event" is the same in Run 2 as in Run 1 but now I can study the evolution out to much higher energies!**
- **PYTHIA Tune A does a good job of describing the "underlying event" in the Run 2 data for both charged particle jets and calorimeter jets. However, I still need to study the distributions in the "transverse" region.**
- **I need Min-Bias Stntuples so I can follow the evolution of charged particle jets (and calorimeter jets) to lower energies. (I will learn how to make Stntuples!)**
- **Lots more to come including MAX/MIN "transverse" and MAX/MIN "cones" and "transverse" P_T distributions.**

Summary

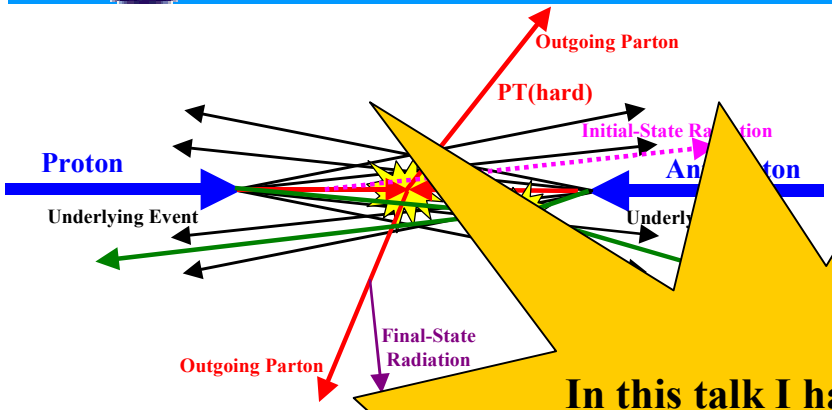


The "Overall Event" in Run 2

PYTHIA Tune A does not fit everything!

- **PYTHIA Tune A (CTEQ5L) does not agree with the shape of the calorimeter jet cross-section and it predicts a larger charged particle fraction (*i.e.* larger charged PTsum) within the leading calorimeter jet than in the Run 2 data. I still need to study the distributions!**
- **PYTHIA Tune A produces too many charged particles within the leading calorimeter jet and within the leading chgjet. (I tuned the "underlying event" not the jet fragmentation!).**
- **Much more to come, but we need another PYTHIA Tune A run with PT(min) = 125 GeV/c so we can compare at high ET.**

Summary



The "Overall Event" in Run 2

In this talk I have presented mostly average quantities. Now I must study the distributions from which these averages came.

- **PYTHIA Tune A (CTEQ … the calorimeter jet cross-section and it predicts a … r charged PTsum) within the leading ca… I still need to study the distributions!**
- **PYTHIA Tune A produces to… rg… ticle… hin the leading calorimeter jet and within the leading chgje… (I tu… he "… rlying e… nt" not the jet fragmentation!).**
- **Much more to come, but we need an… er PYTHIA Tune A run with P_T(min) = 125 GeV/c so we can compare at high ET**