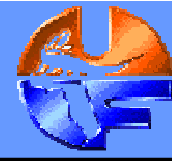




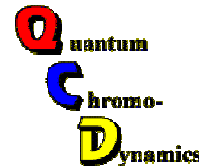
MPI@LHC 2011



The Underlying Event in Hadronic Collisions



Rick Field
University of Florida



Outline

- ➔ How **Universal** are the QCD MC Model Tunes?
 - Do we need a separate tune for each **center-of-mass energy**? 900 GeV, 1.96 TeV, 7 TeV, etc.
 - Do we need a separate tune for each hard **QCD subprocess**? Jet Production, Drell-Yan Production, etc.
 - Do we need separate tunes for “Min-Bias” (**MB**) and the “underlying event” (**UE**) in a hard scattering process?
 - Do we need separate fragmentation tunes for e^+e^- and hadron-hadron collisions?
- ➔ I will examine the first two points using two PYTHIA tunes.
 - PYTHIA 6.2 **Tune DW** (CDF UE tune).
 - PYTHIA 6.4 **Tune Z1** (CMS UE tune).

MPI@LHC 2011
3rd International Workshop on Multiple Partonic Interactions at the LHC

21 - 25 November 2011
DESY, Hamburg

Topics:

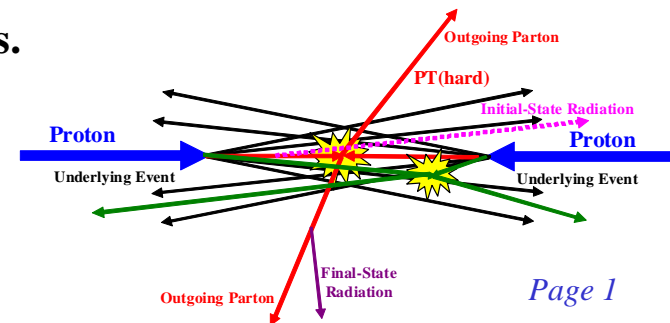
- Phenomenology of MPI processes and multiparton distributions
- Theoretical considerations for the description of MPI
- Measuring multiple partonic interactions
- Experimental results on inelastic hadronic collisions: underlying event, minimum bias, forward energy flow
- Monte Carlo development and tuning
- Connections with diffraction, heavy-ion physics and cosmic rays

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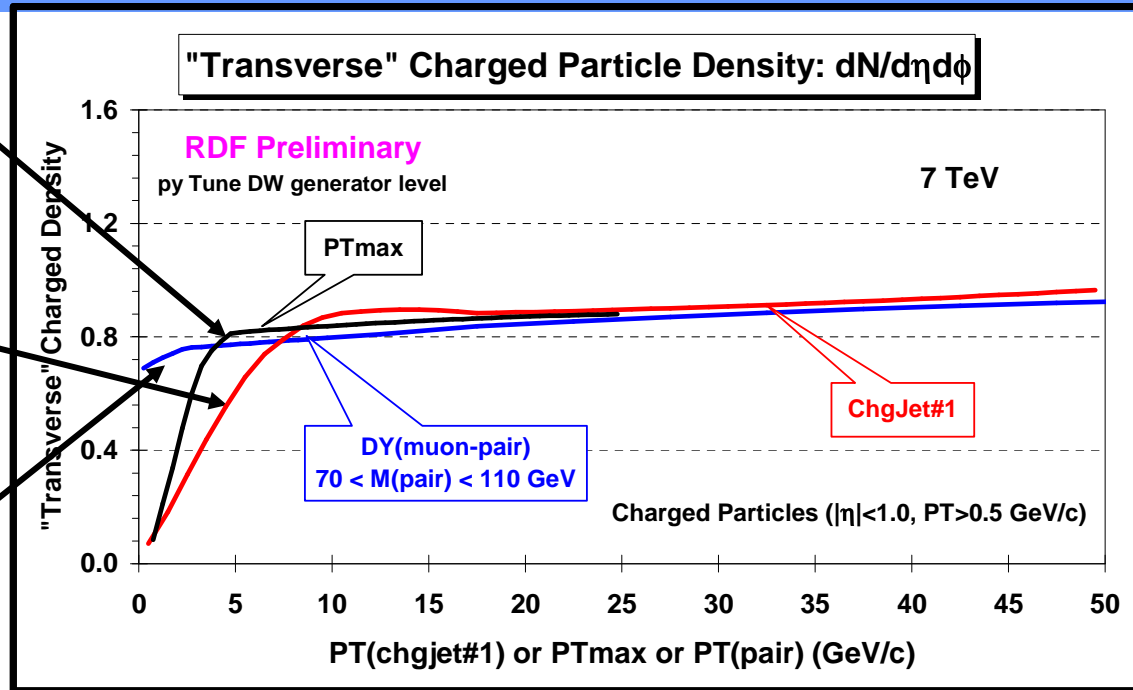
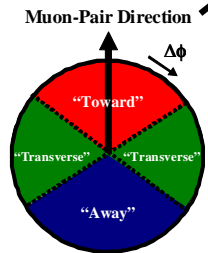
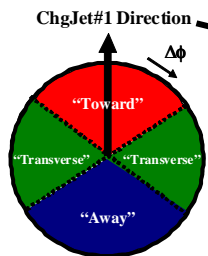
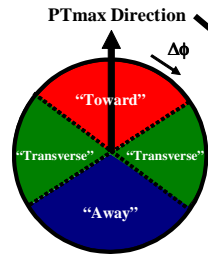
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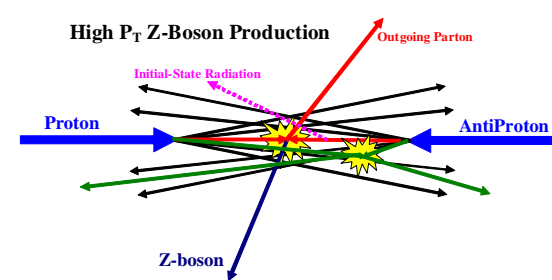
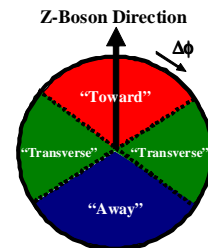
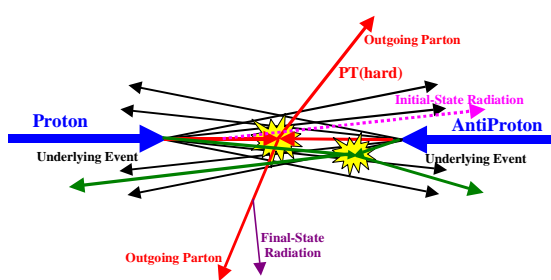
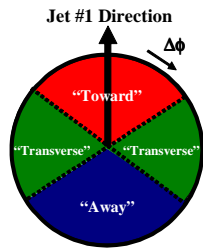
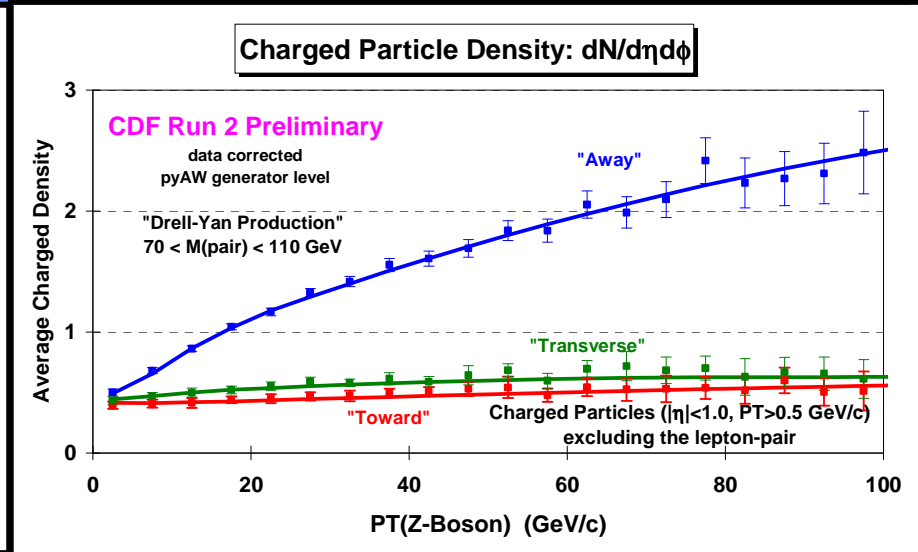
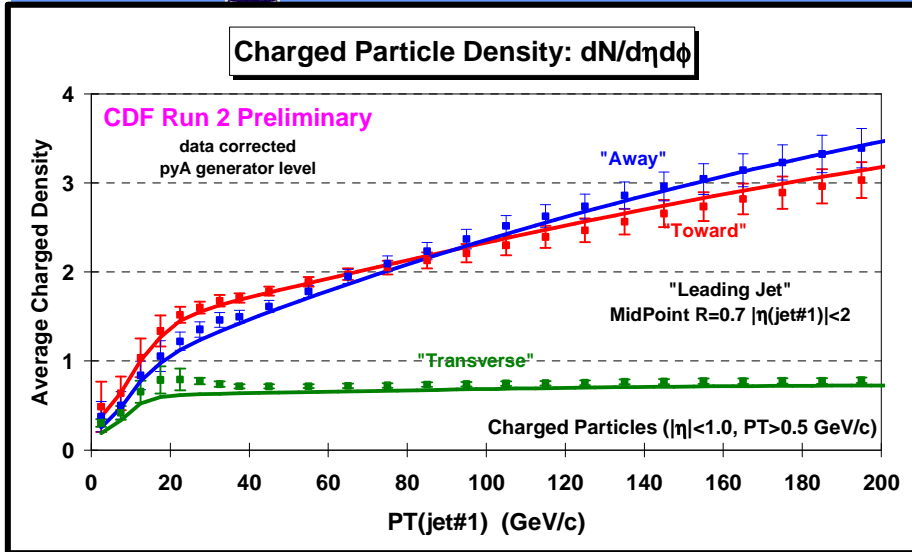
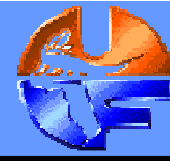
“Transverse” Charged Density



- ➔ Shows the charged particle density in the “transverse” region for charged particles ($p_T > 0.5 \text{ GeV/c}$, $|\eta| < 1$) at 7 TeV as defined by PTmax, PT(chgjet#1), and PT(muon-pair) from PYTHIA Tune DW at the particle level (*i.e.* generator level). Charged particle jets are constructed using the Anti-KT algorithm with $d = 0.5$.



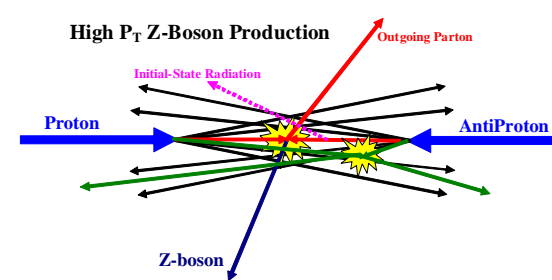
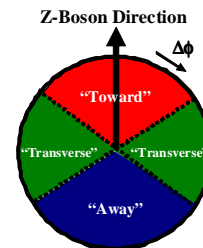
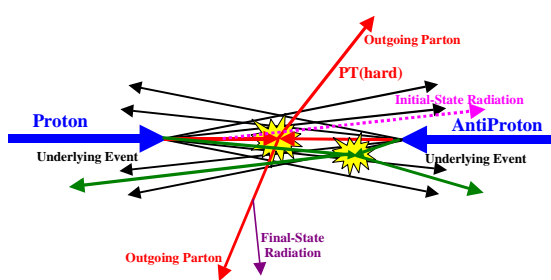
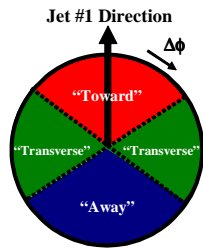
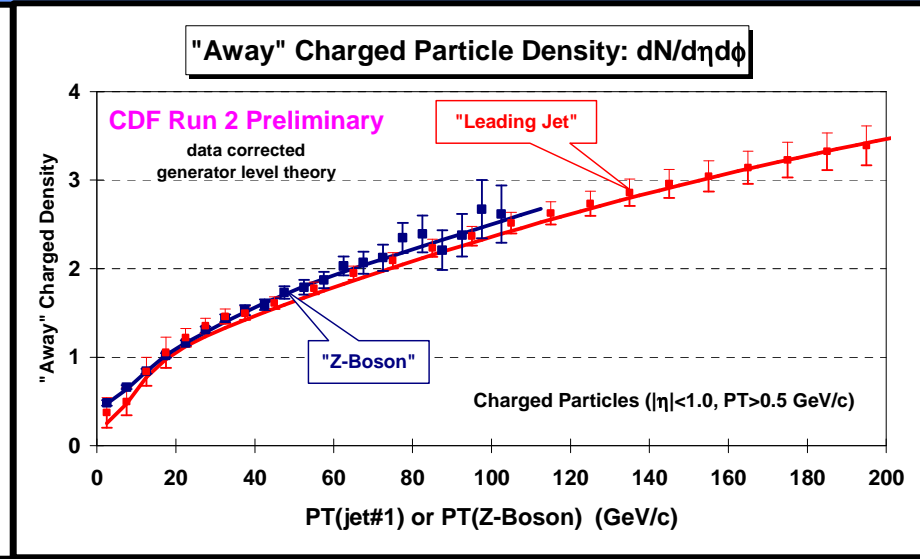
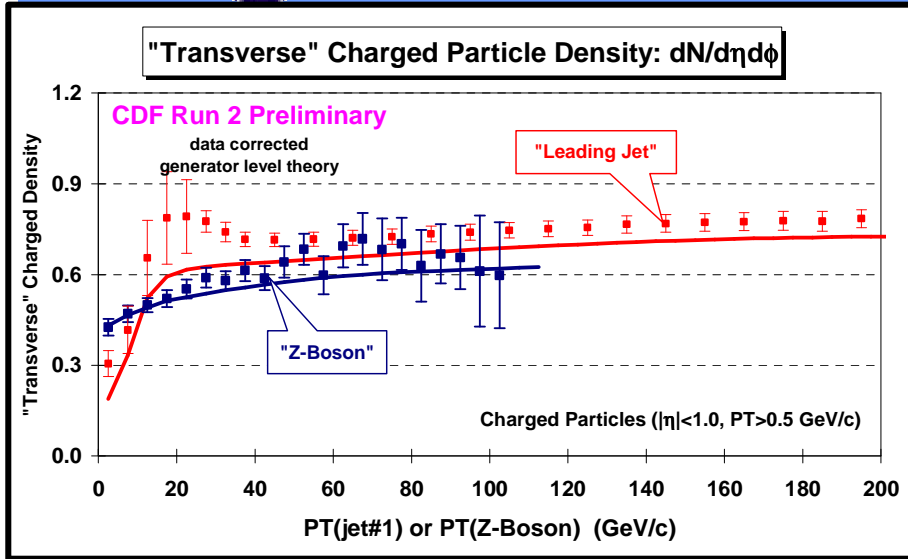
Charged Particle Density



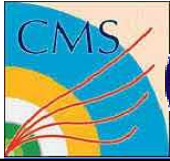
➔ **CDF data at 1.96 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for “Z-Boson” and “Leading Jet” events as a function of the leading jet p_T or $P_T(Z)$ for the “toward”, “away”, and “transverse” regions. The data are corrected to the particle level and are compared with **PYTHIA Tune AW** and **Tune A**, respectively, at the particle level (*i.e.* generator level).



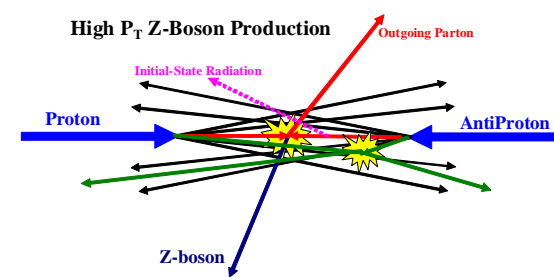
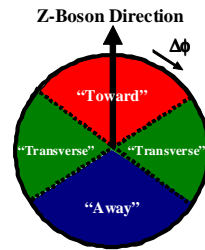
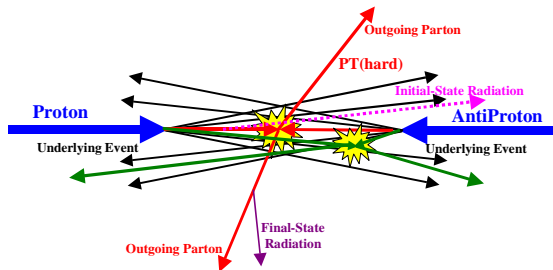
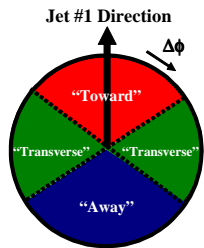
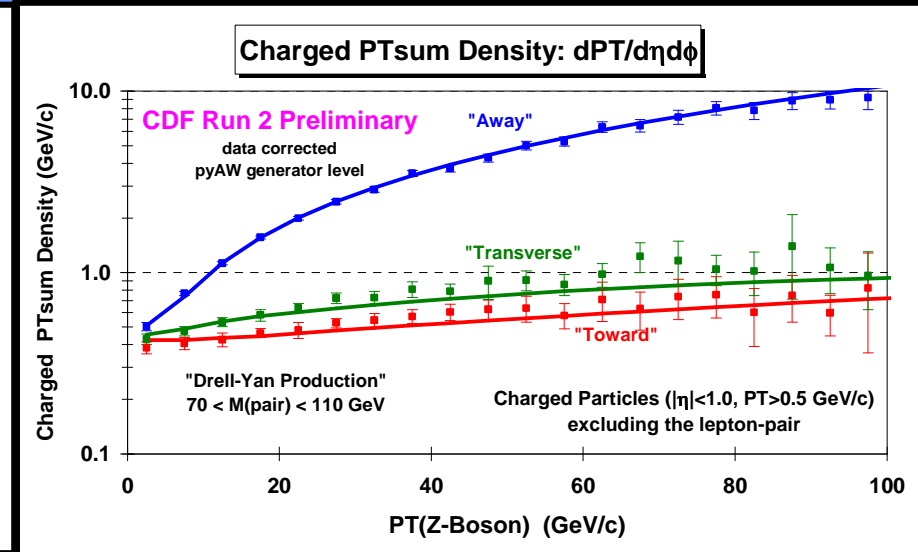
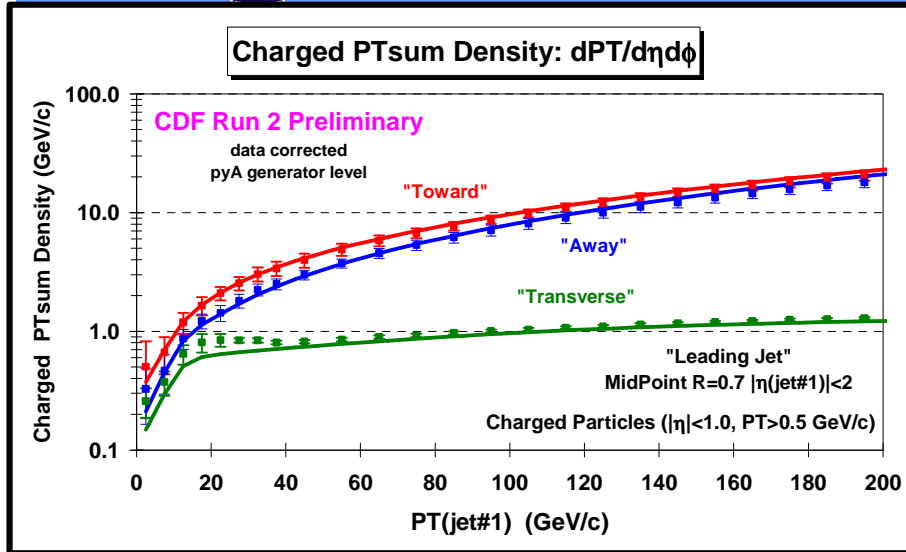
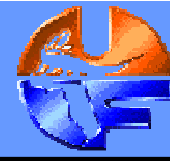
Charged Particle Density



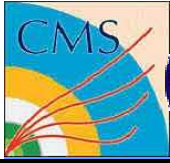
➔ **CDF data at 1.96 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for "Z-Boson" and "Leading Jet" events as a function of the leading jet p_T or $P_T(Z)$ for the "toward", "away", and "transverse" regions. The data are corrected to the particle level and are compared with **PYTHIA Tune AW** and **Tune A**, respectively, at the particle level (*i.e.* generator level).



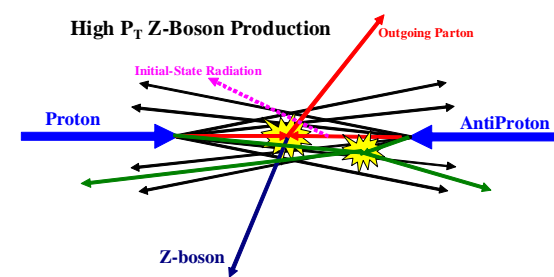
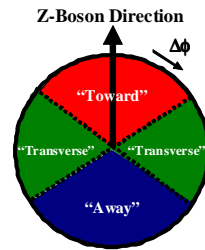
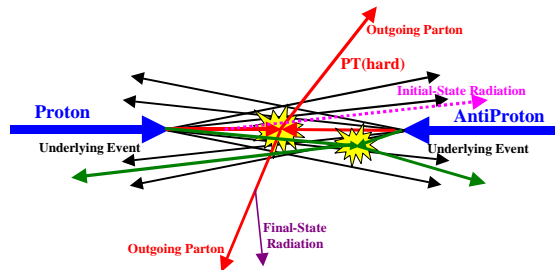
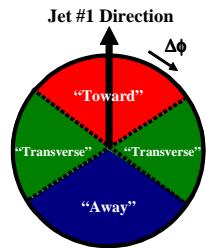
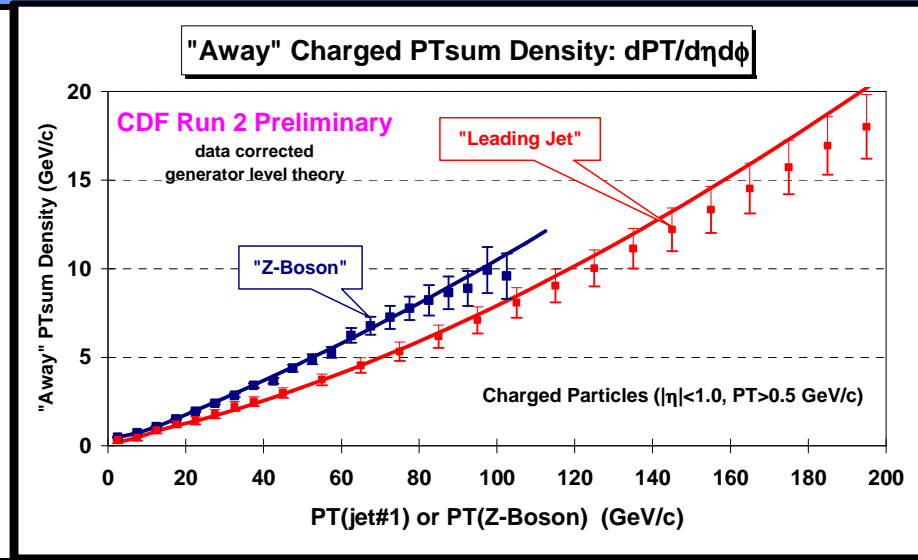
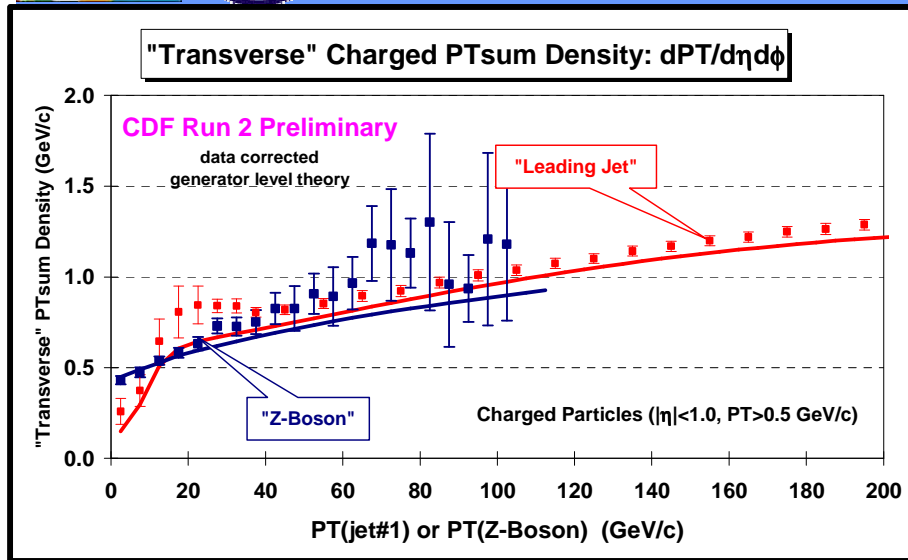
Charged PTsum Density



➔ **CDF data at 1.96 TeV** on the charged *scalar* PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for “Z-Boson” and “Leading Jet” events as a function of the leading jet p_T or $P_T(Z)$ for the “toward”, “away”, and “transverse” regions. The data are corrected to the particle level and are compared with **PYTHIA Tune AW** and **Tune A**, respectively, at the particle level (*i.e.* generator level).



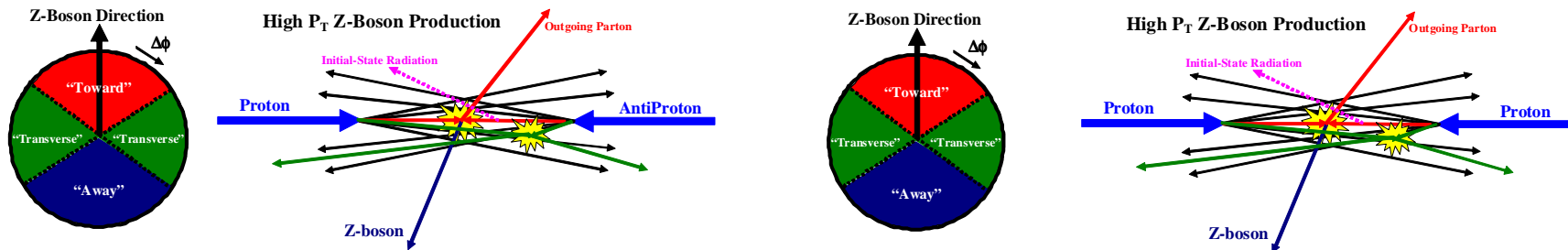
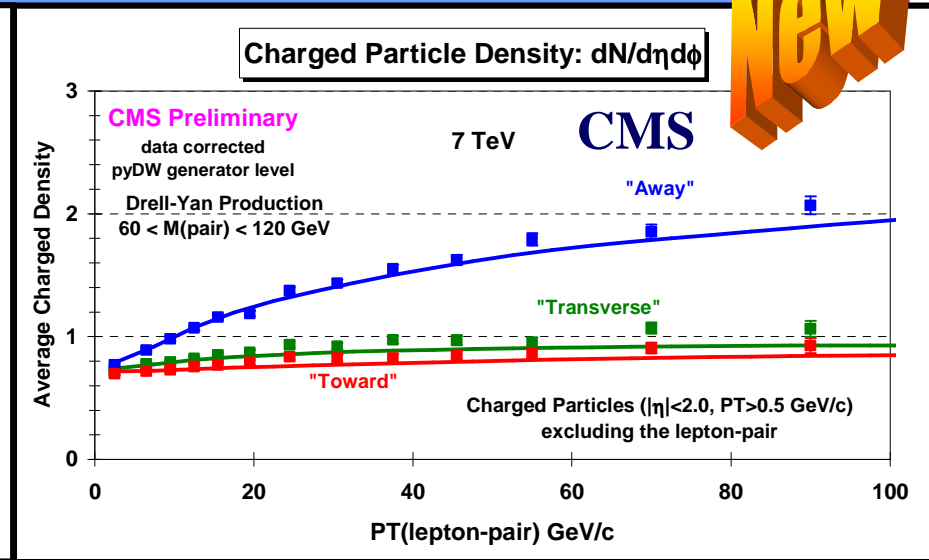
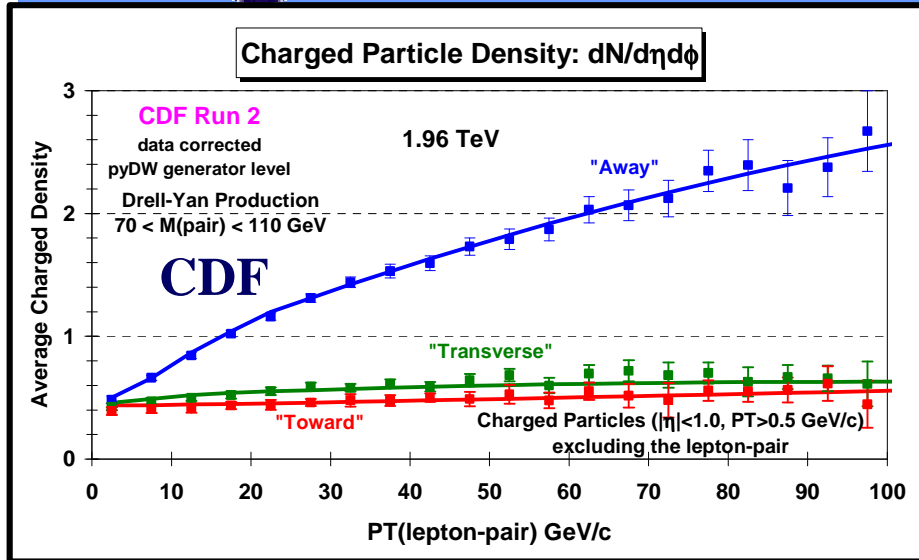
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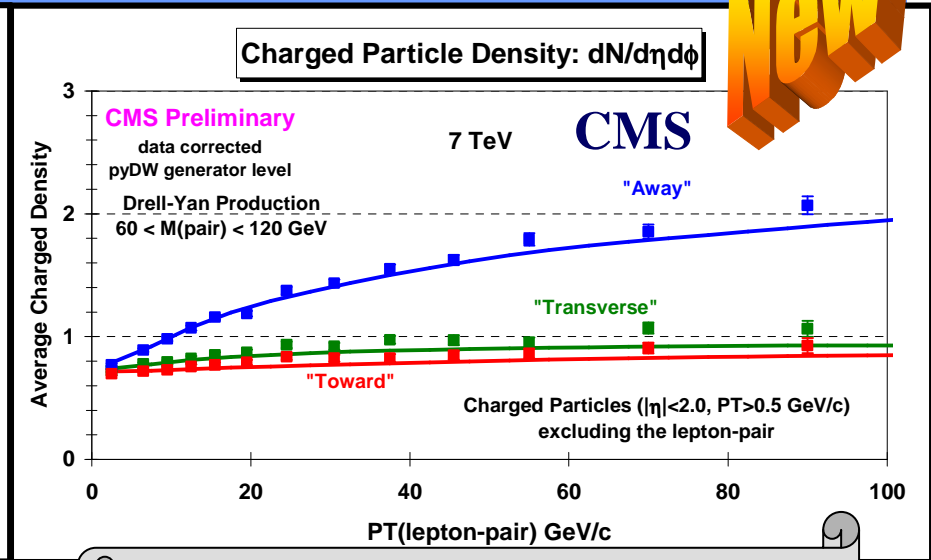
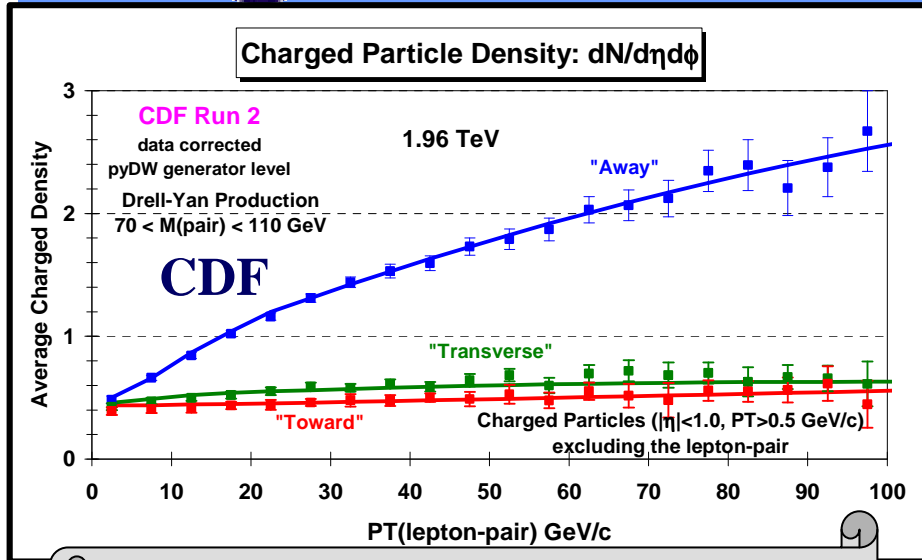
Charged Particle Density



- ➔ **CDF data at 1.96 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5 \text{ GeV}/c$ and $|\eta| < 1$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune DW**.
- ➔ **CMS data at 7 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5 \text{ GeV}/c$ and $|\eta| < 2$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune DW**.



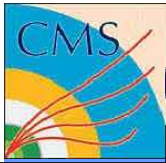
Charged Particle Density



CDF: Proton-Antiproton Collisions at 1.96 GeV
 Lepton Cuts: $p_T > 20 \text{ GeV}$ $|\eta| < 1.0$
 Mass Cut: $70 < M(\text{lepton-pair}) < 110 \text{ GeV}$
 Charged Particles: $p_T > 0.5 \text{ GeV/c}$ $|\eta| < 1.0$

CMS: Proton-Proton Collisions at 7 GeV
 Lepton Cuts: $p_T > 20 \text{ GeV}$ $|\eta| < 2.4$
 Mass Cut: $60 < M(\text{lepton-pair}) < 120 \text{ GeV}$
 Charged Particles: $p_T > 0.5 \text{ GeV/c}$ $|\eta| < 2.0$

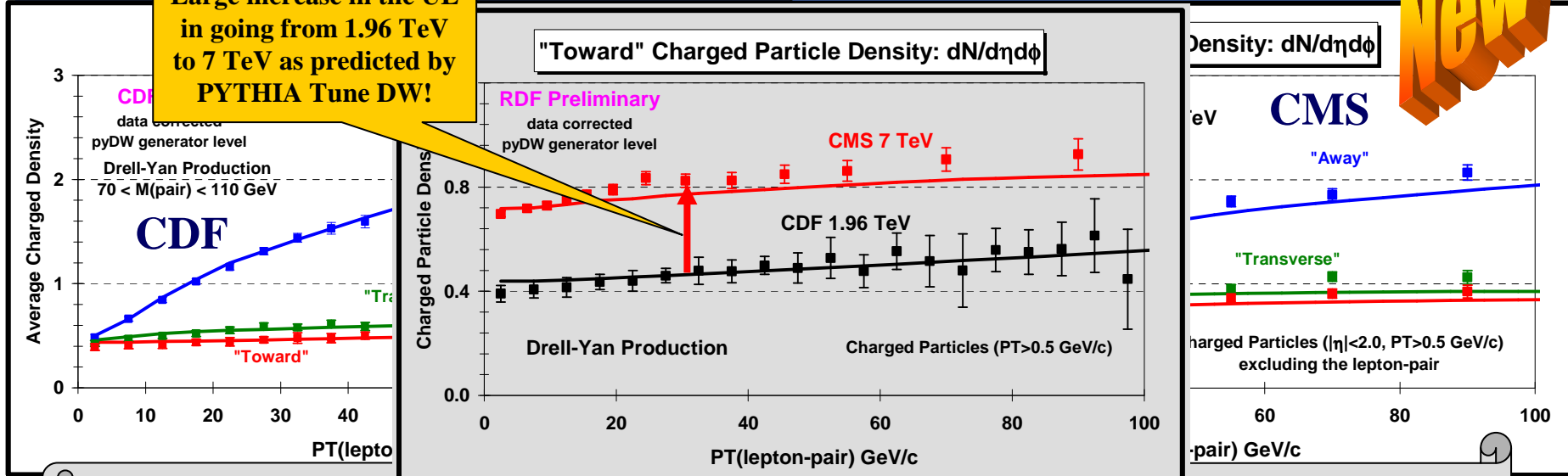
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Charged Particle Density



Large increase in the UE in going from 1.96 TeV to 7 TeV as predicted by PYTHIA Tune DW!

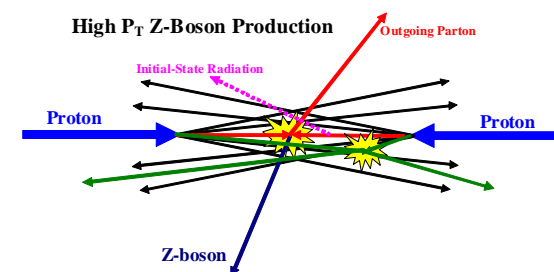
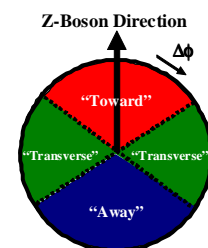
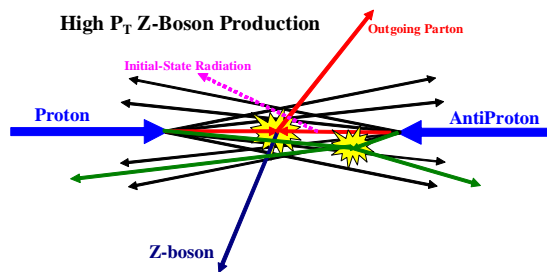
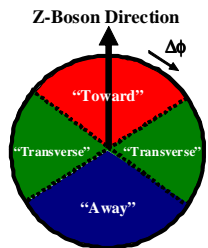
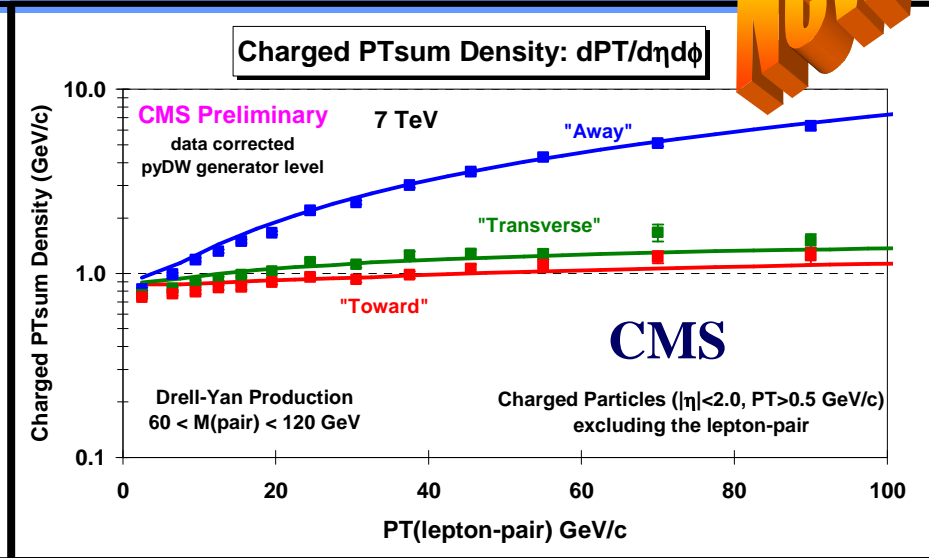
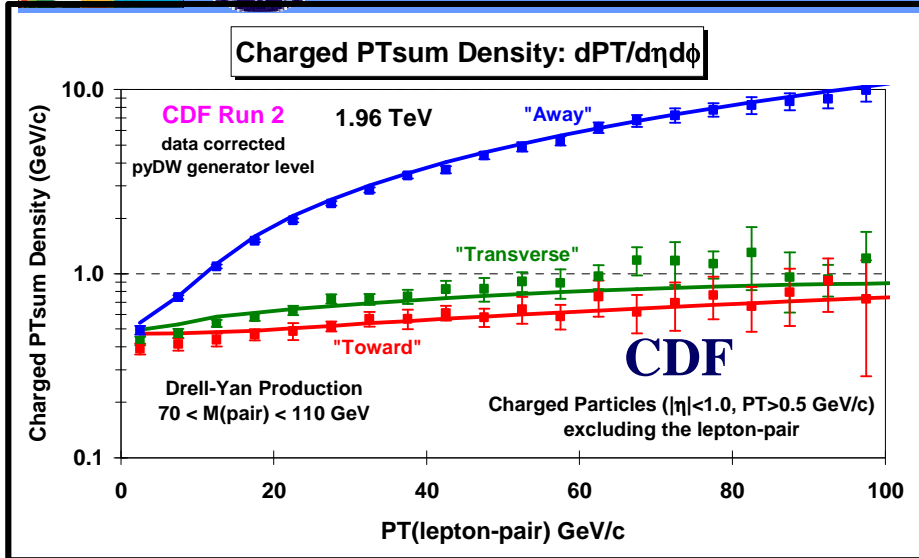


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- ➔ **CDF data at 1.96 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5 \text{ GeV/c}$ and $|\eta| < 1$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune DW**.
- ➔ **CMS data at 7 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5 \text{ GeV/c}$ and $|\eta| < 2$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune DW**.

Charged PTsum Density



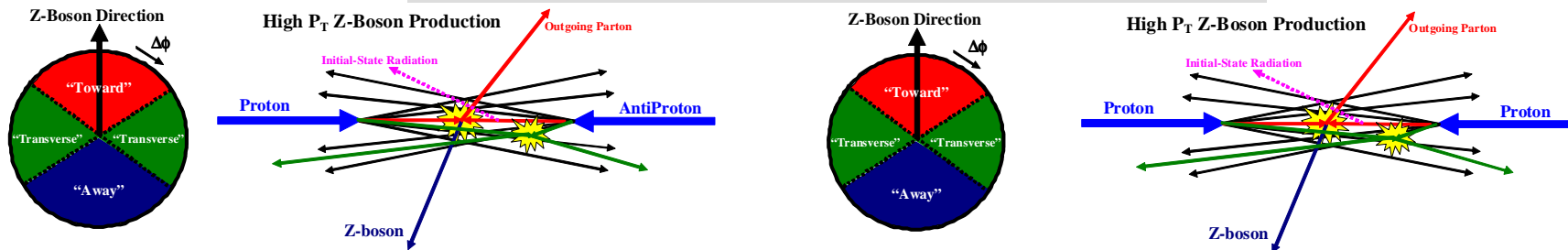
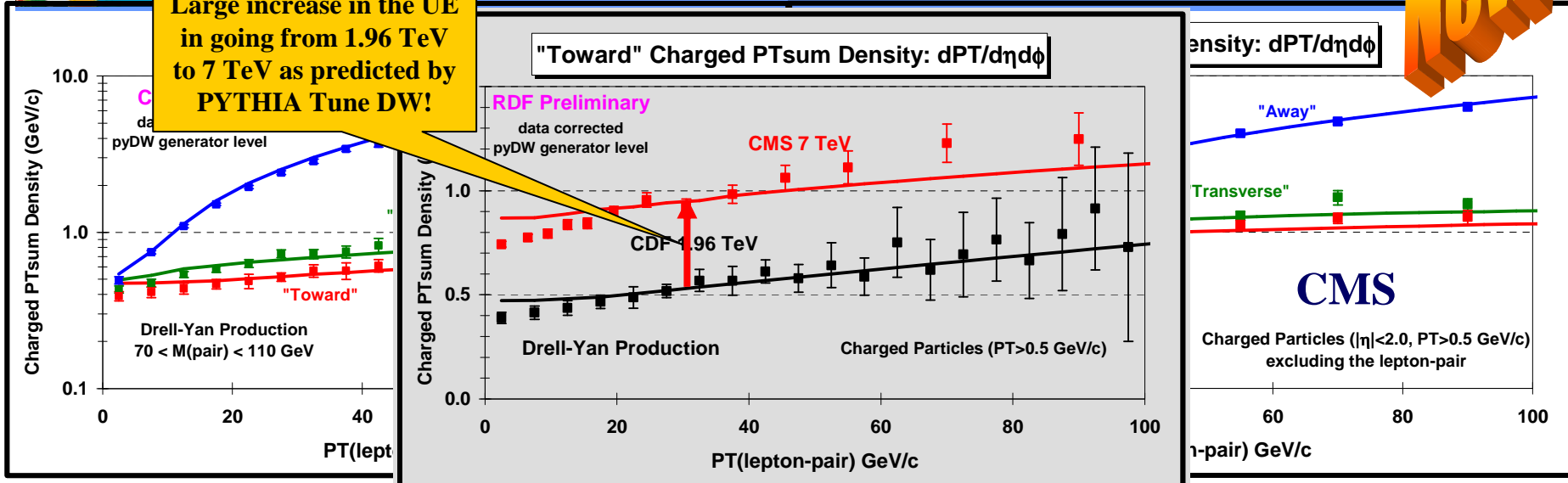
- ➔ **CDF data at 1.96 TeV** on the charged PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for Drell-Yan production as a function of $PT(Z)$ for the “toward”, “away”, and “transverse” regions compared with PYTHIA Tune DW.
- ➔ **CMS data at 7 TeV** on the charged PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for Drell-Yan production as a function of $PT(Z)$ for the “toward”, “away”, and “transverse” regions compared with PYTHIA Tune DW.



Charged PTsum Density



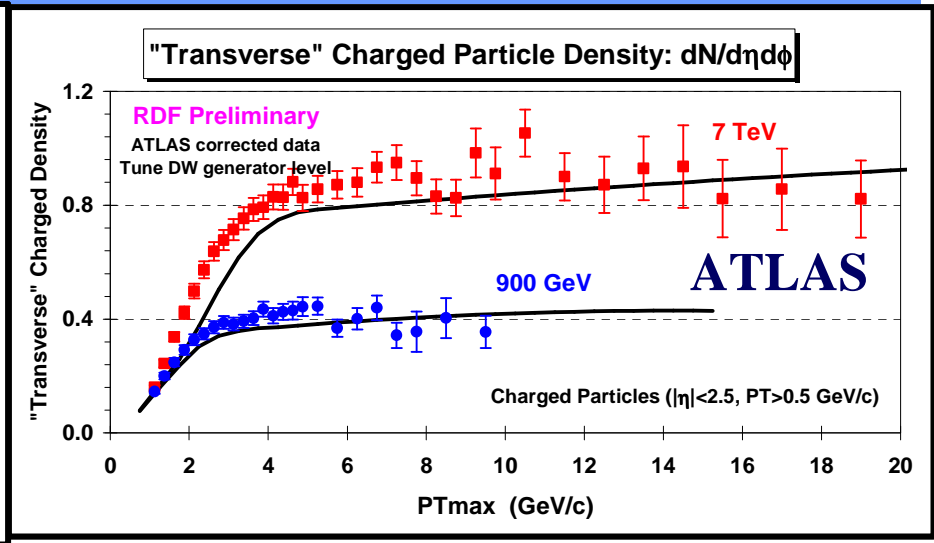
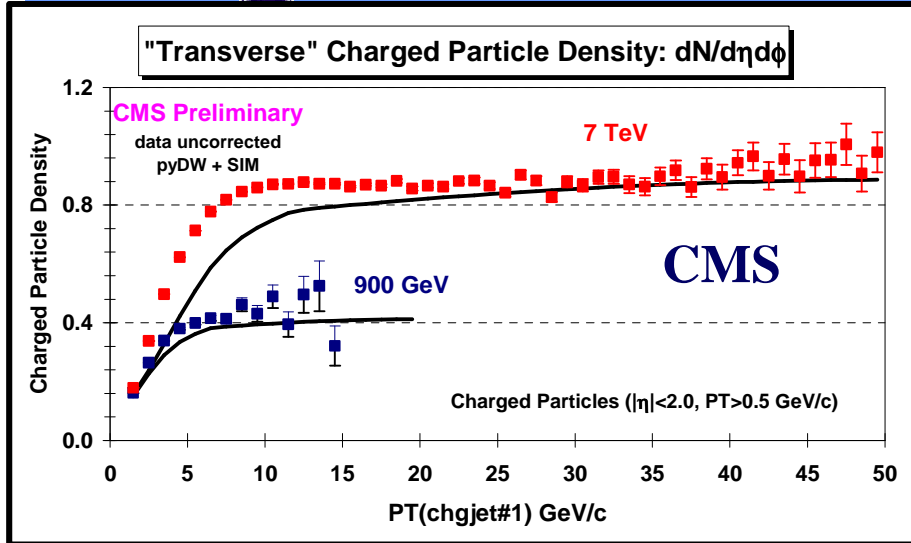
Large increase in the UE in going from 1.96 TeV to 7 TeV as predicted by PYTHIA Tune DW!



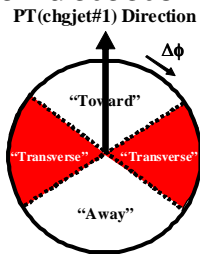
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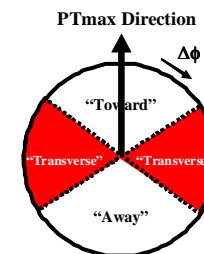
PYTHIA Tune DW



→ **CMS preliminary data at 900 GeV and 7 TeV** → on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2$. The data are uncorrected and compared with PYTHIA **Tune DW** after detector simulation.

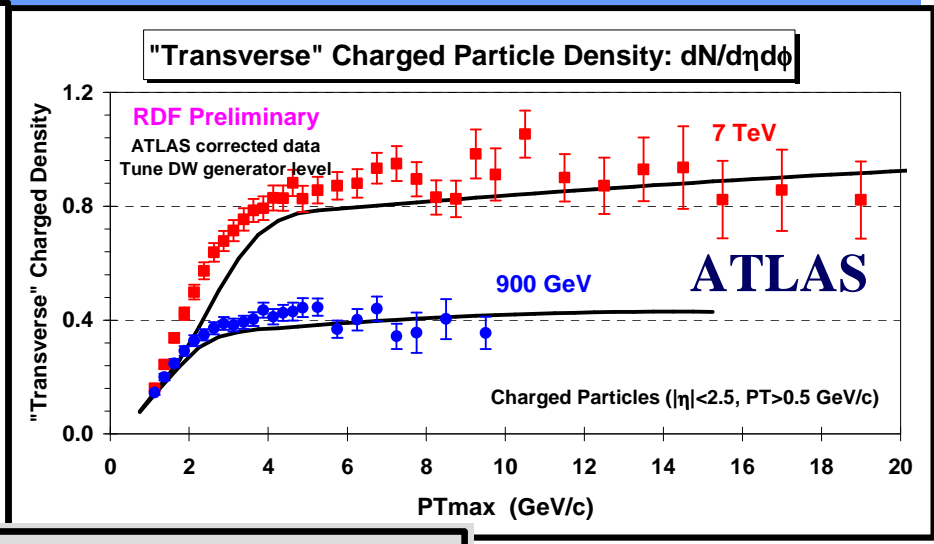
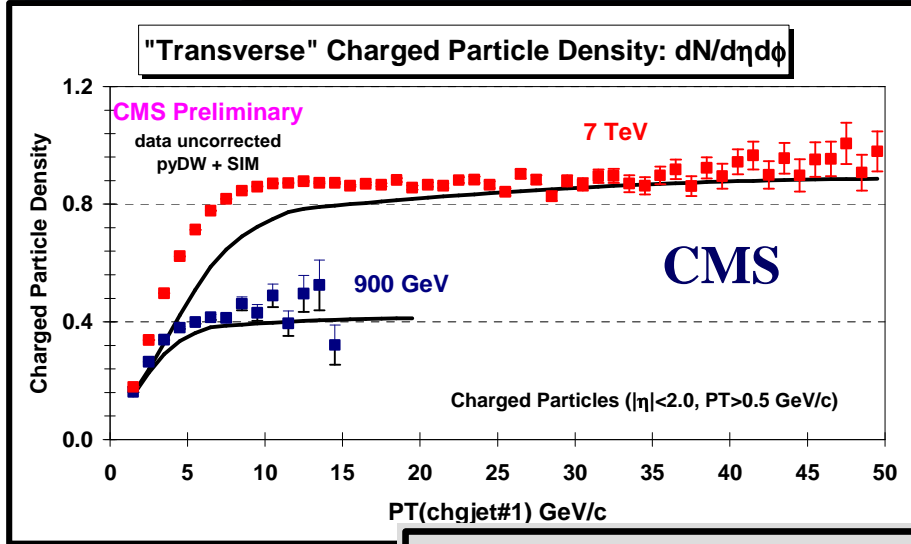


→ **ATLAS preliminary data at 900 GeV and 7 TeV** → on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle (PTmax) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. The data are corrected and compared with PYTHIA **Tune DW** at the generator level.

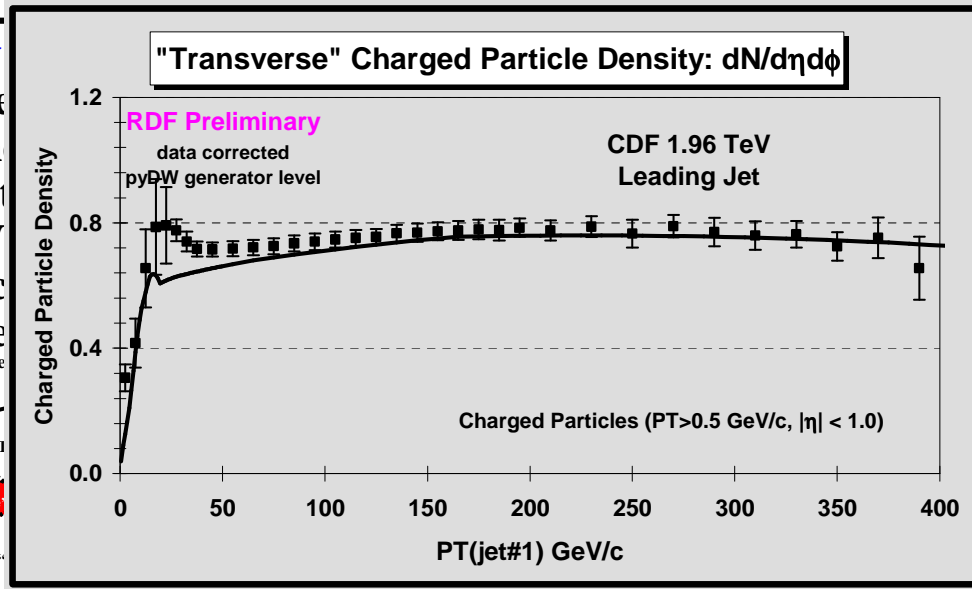




PYTHIA Tune DW

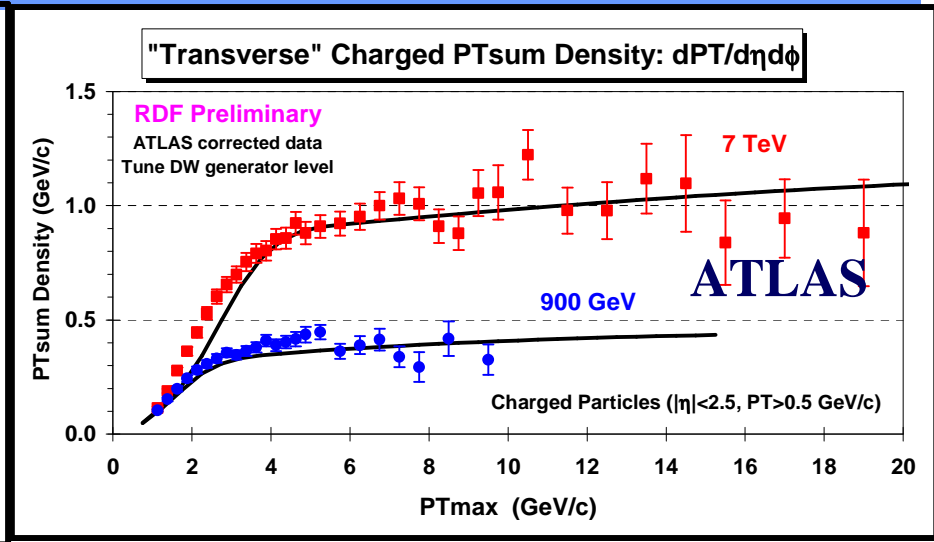
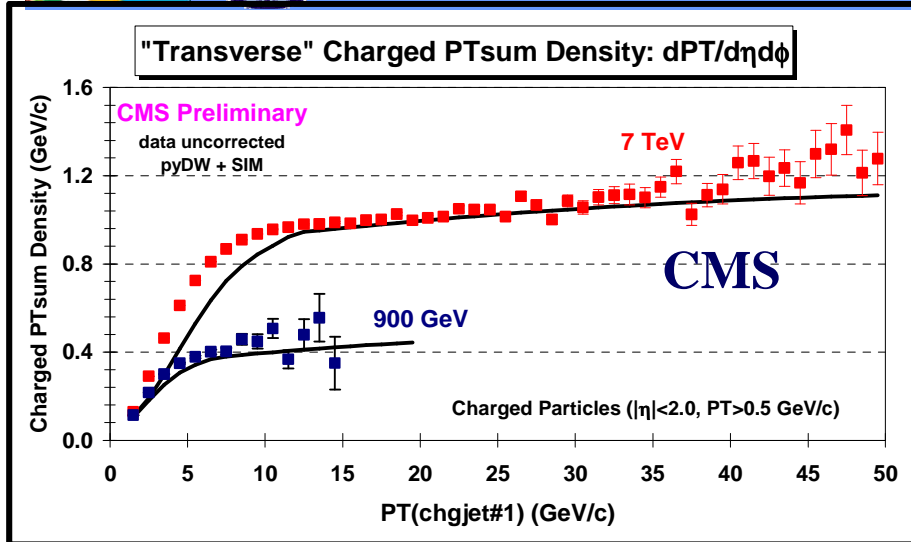


→ **CMS preliminary** on the “transverse” charged particle density $dN/d\eta d\phi$, as defined by the leading particle jet (chgjet#1) with $p_T > 0.5$ GeV/c, uncorrected and compared with the **Tune DW** after deconvolution.

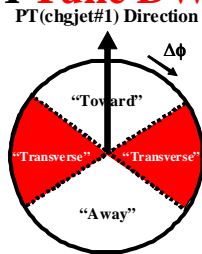


data at 900 GeV and 7 TeV. The data are defined by the leading particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. The data are compared with the **Tune DW** generator level.

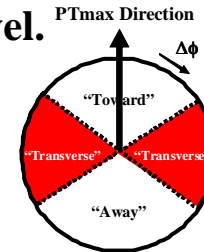




➔ **CMS preliminary data at 900 GeV and 7 TeV** on the “transverse” charged PTsum density, $dPT/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2$. The data are uncorrected and compared with **PYTHIA Tune DW** after detector simulation.

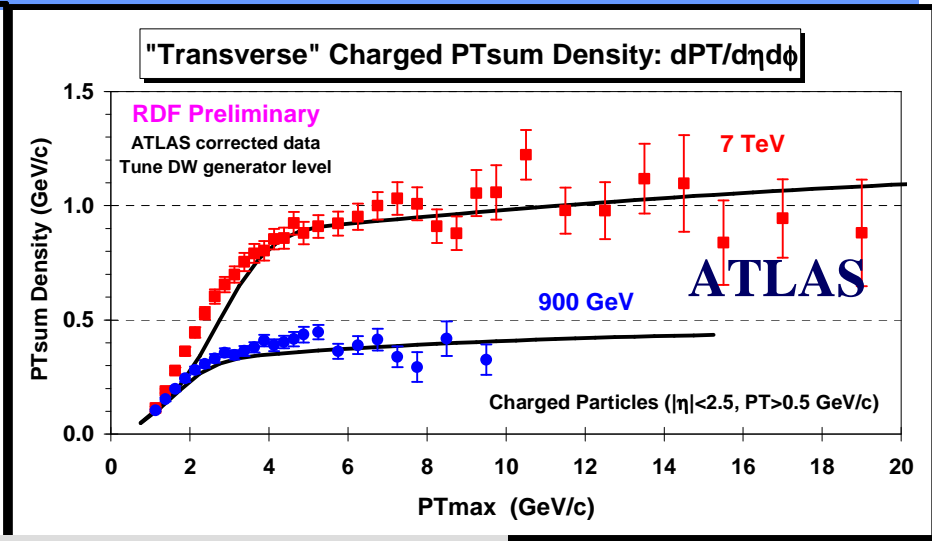
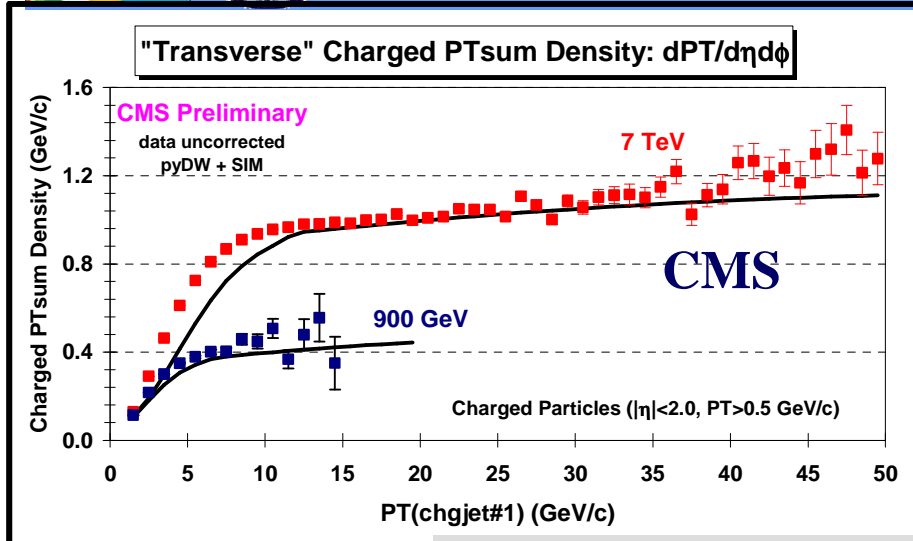
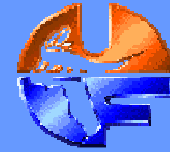


➔ **ATLAS preliminary data at 900 GeV and 7 TeV** on the “transverse” charged PTsum density, $dPT/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. The data are corrected and compared with **PYTHIA Tune DW** at the generator level.

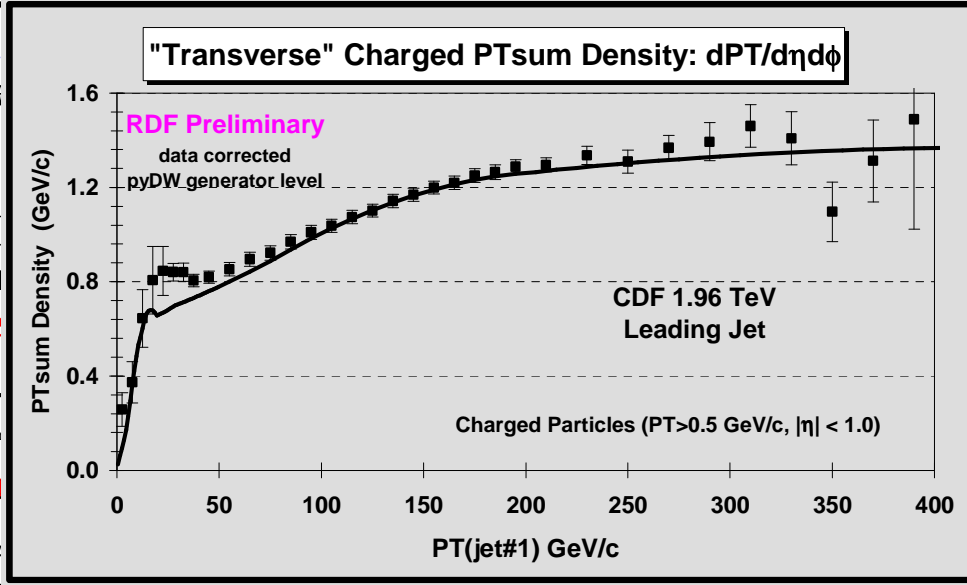




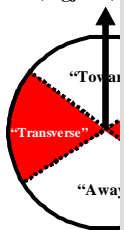
PYTHIA Tune DW

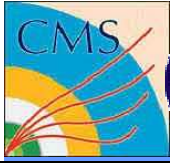


→ CMS preliminary data at 7 TeV on the "transverse" charged PTsum density, $dPT/d\eta d\phi$, for charged particle jet particles with $p_T > 0.5$ GeV/c. The data are uncorrected and compared with PYTHIA Tune DW simulation.

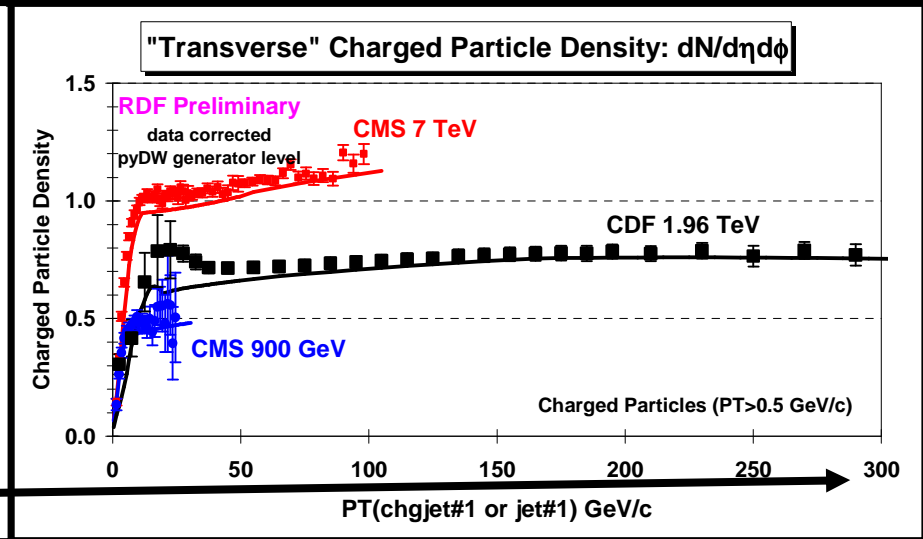
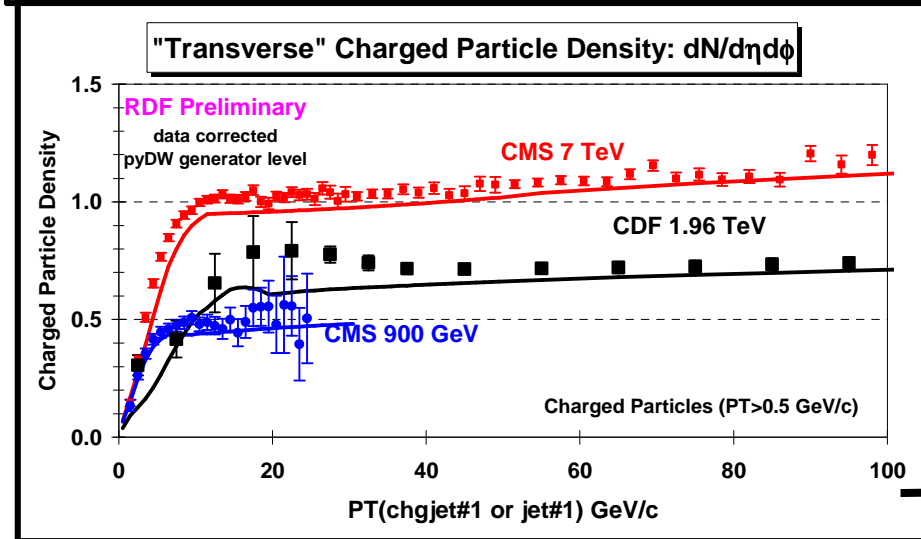
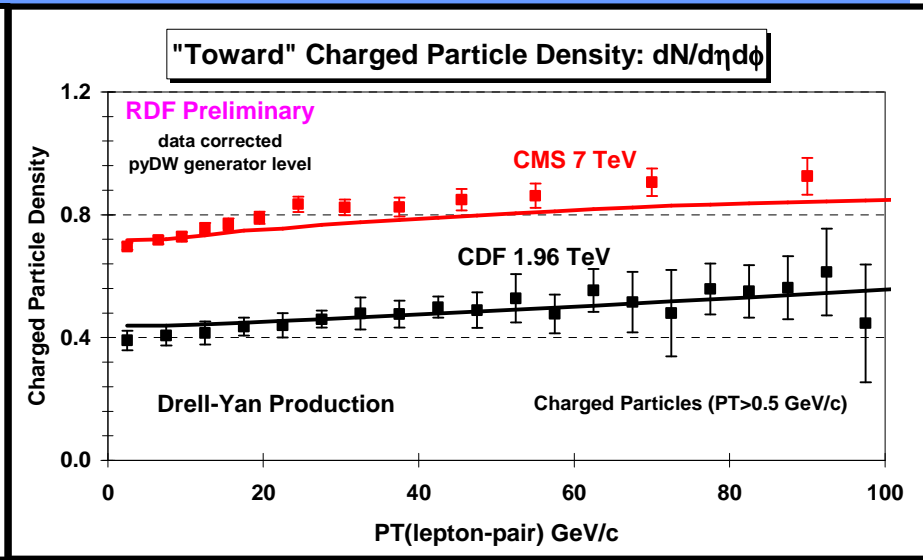
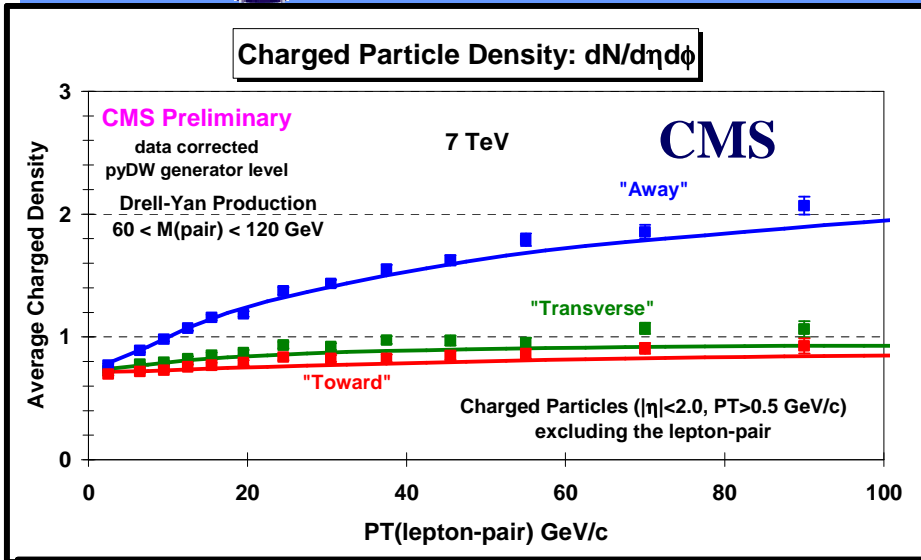


data at 900 GeV and 7 TeV on the "transverse" charged PTsum density, $dPT/d\eta d\phi$, for charged particle jet particles with $p_T > 0.5$ GeV/c and corrected and compared with ATLAS Tune DW at the generator level.





PYTHIA Tune DW



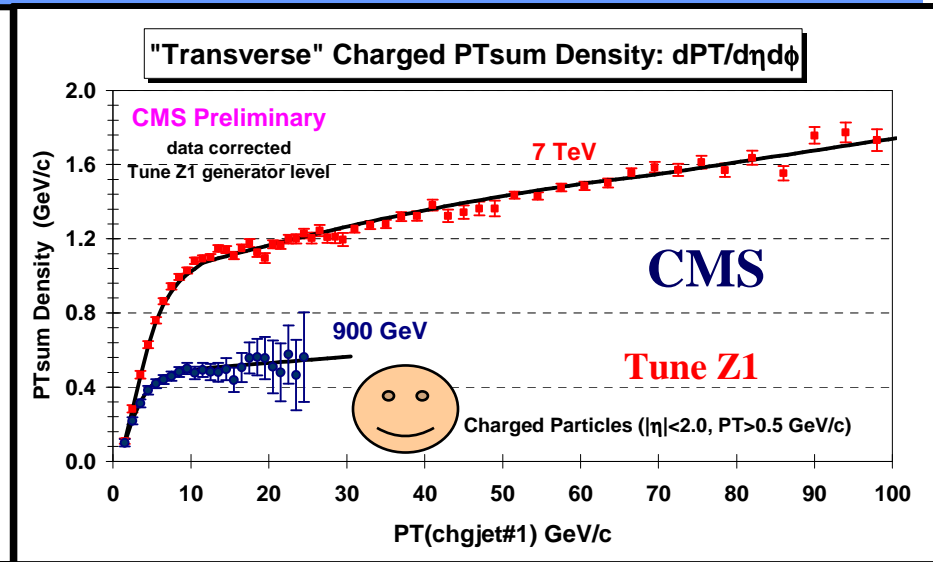
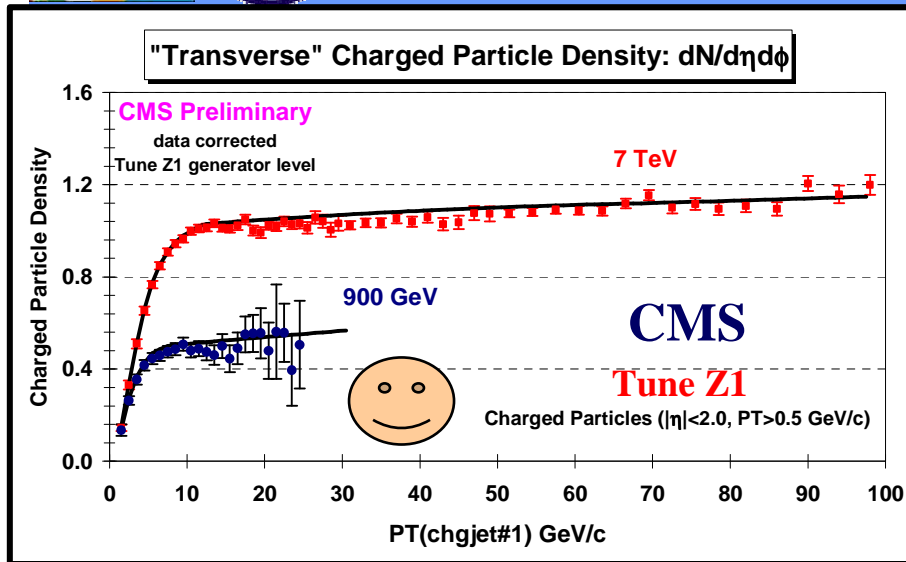


PYTHIA Tune Z1



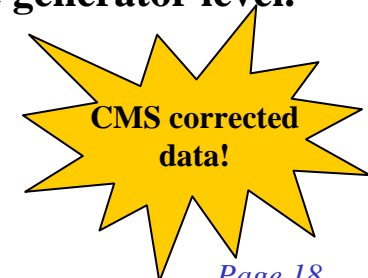
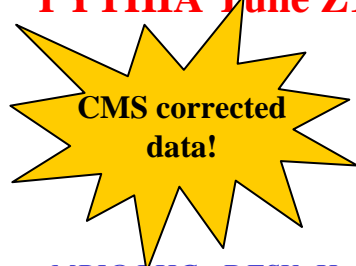
Parameters not shown are the PYTHIA 6.4 defaults!

Parameter	Tune Z1 (R. Field CMS)	Tune AMBT1 (ATLAS)
Parton Distribution Function	CTEQ5L	LO*
PARP(82) – MPI Cut-off	1.932	2.292
PARP(89) – Reference energy, E0	1800.0	1800.0
PARP(90) – MPI Energy Extrapolation	0.275	0.25
PARP(77) – CR Suppression	1.016	1.016
PARP(78) – CR Strength	0.538	0.538
PARP(80) – Probability colored parton from BBR	0.1	0.1
PARP(83) – Matter fraction in core	0.356	0.356
PARP(84) – Core of matter overlap	0.651	0.651
PARP(62) – ISR Cut-off	1.025	1.025
PARP(93) – primordial kT-max	10.0	10.0
MSTP(81) – MPI, ISR, FSR, BBR model	21	21
MSTP(82) – Double gaussian matter distribution	4	4
MSTP(91) – Gaussian primordial kT	1	1
MSTP(95) – strategy for color reconnection	6	6



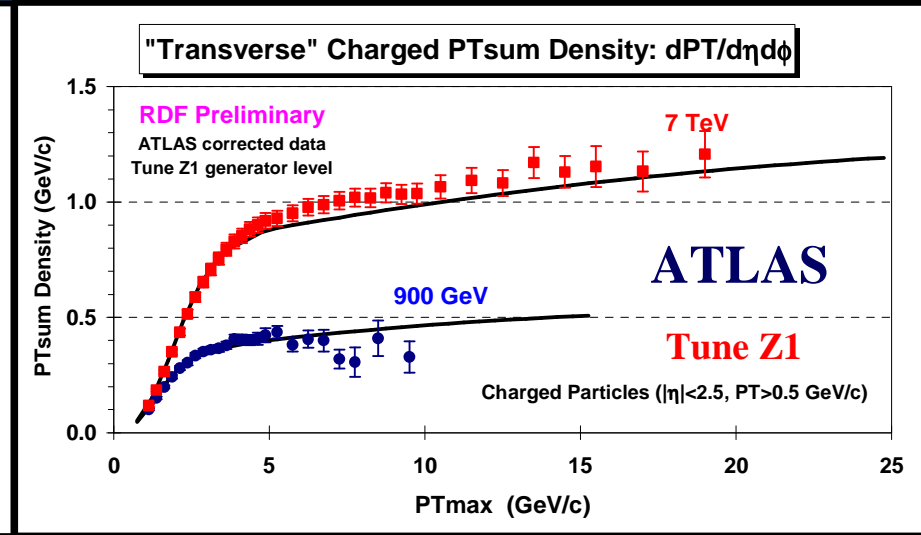
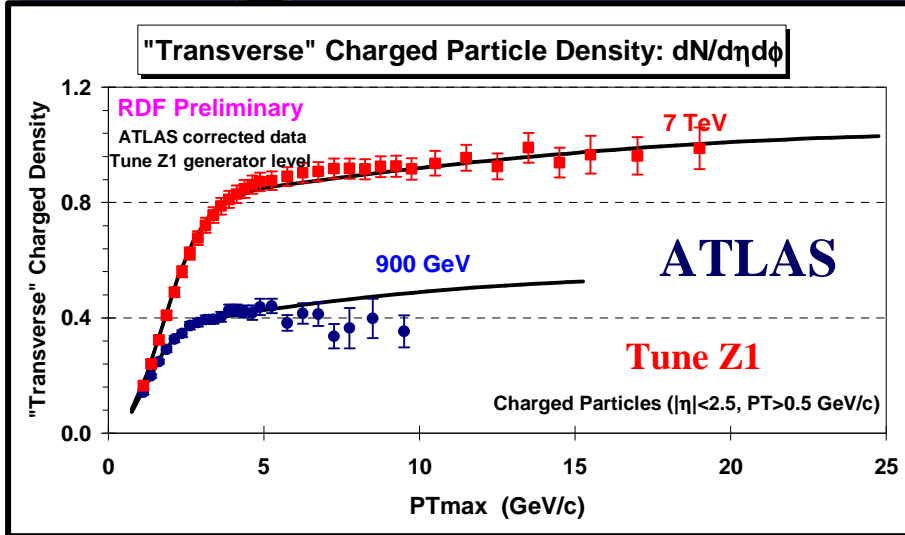
→ CMS preliminary data at 900 GeV and 7 TeV on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

→ CMS preliminary data at 900 GeV and 7 TeV on the “transverse” charged PTsum density, $dPT/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.





ATLAS UE Data



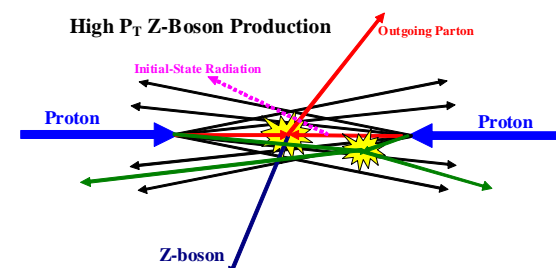
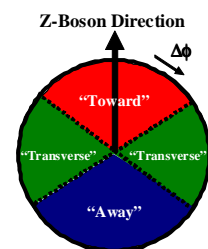
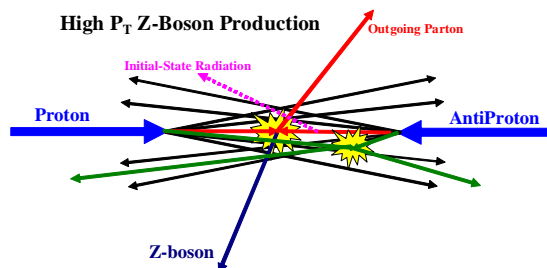
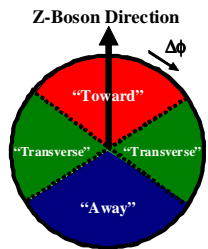
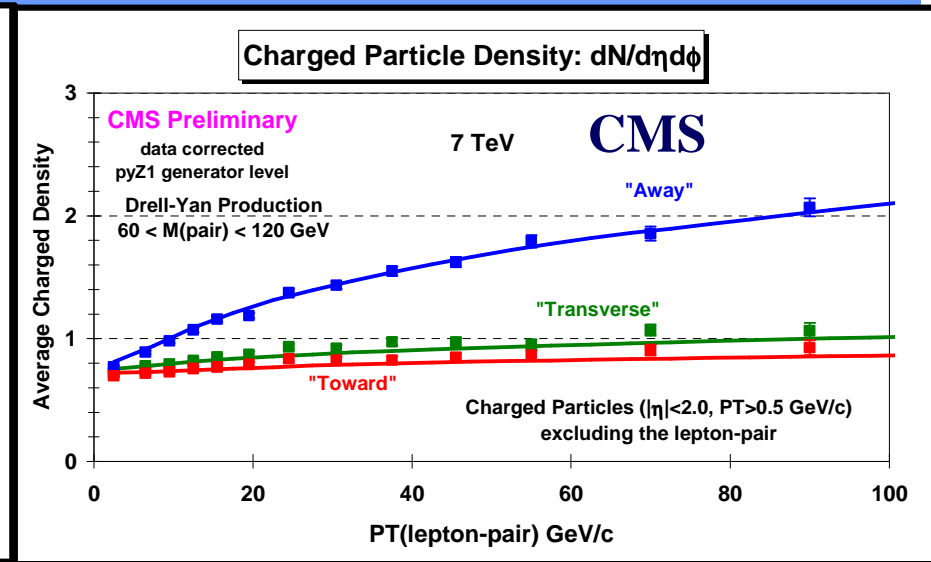
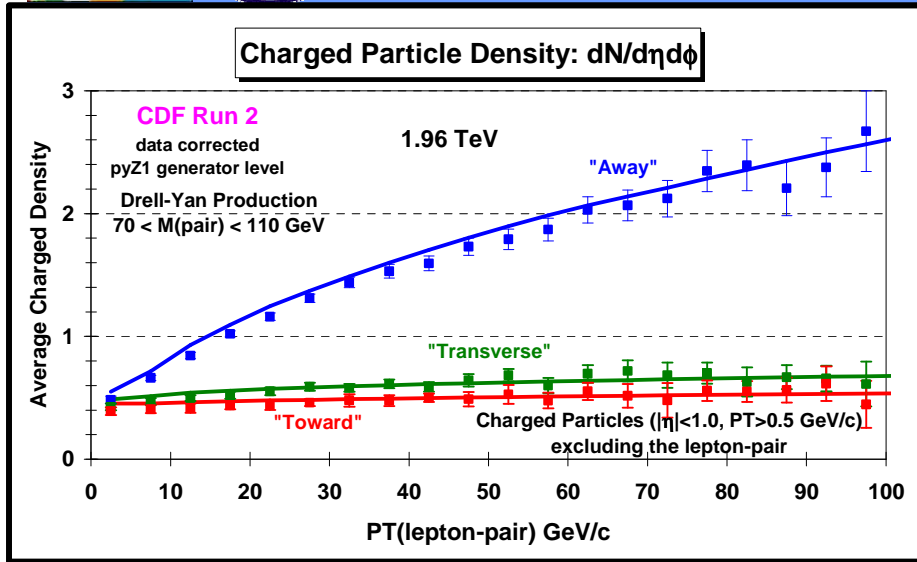
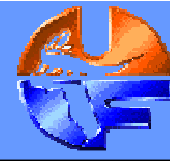
➔ **ATLAS published data at 900 GeV and 7 TeV** on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

➔ **ATLAS published data at 900 GeV and 7 TeV** on the “transverse” charged PTsum density, $dPT/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

ATLAS publication – arXiv:1012.0791
December 3, 2010



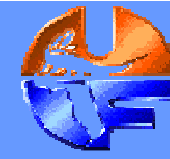
PYTHIA Tune Z1



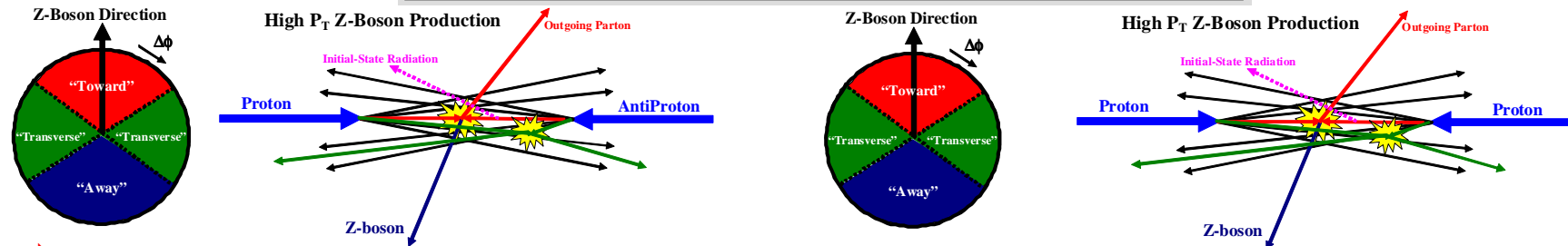
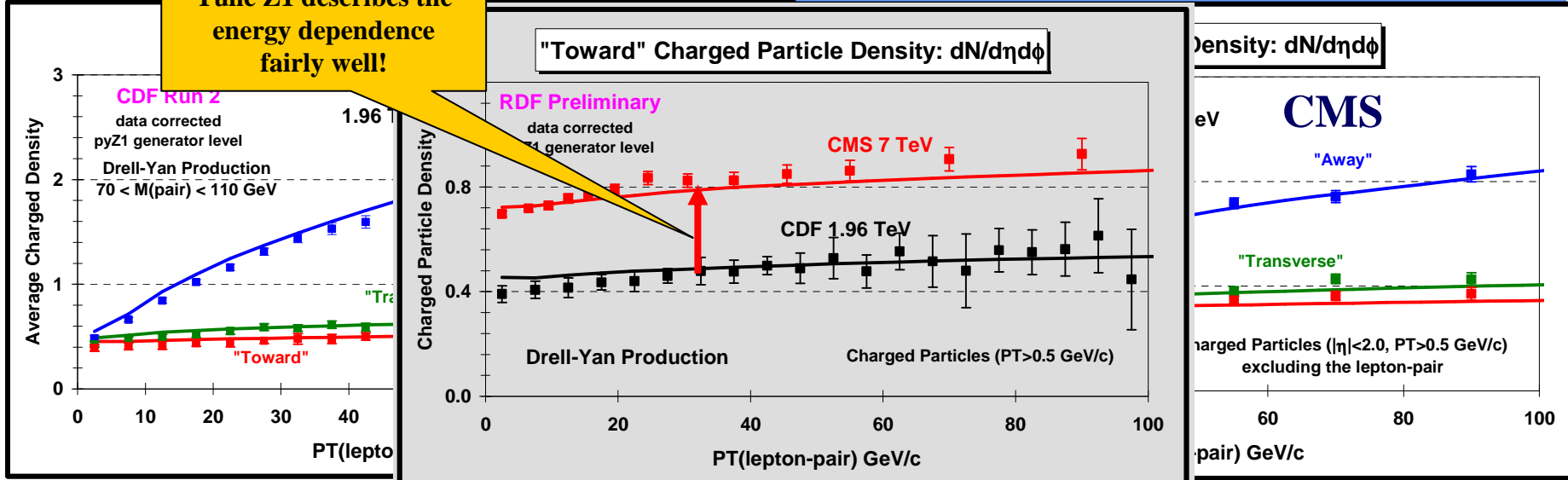
- ➔ **CDF data at 1.96 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune Z1**.
- ➔ **CMS data at 7 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 2$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune Z1**.



PYTHIA Tune Z1



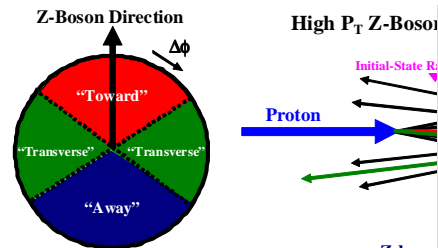
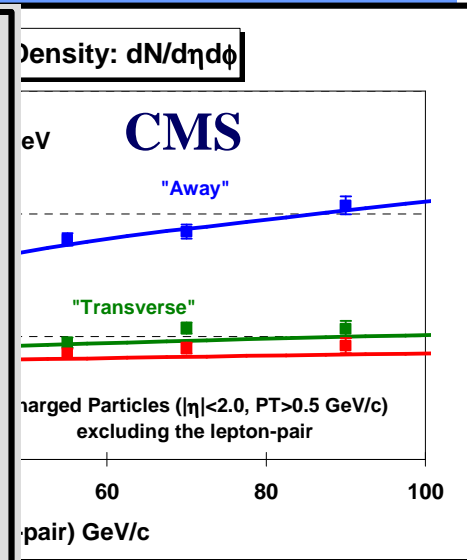
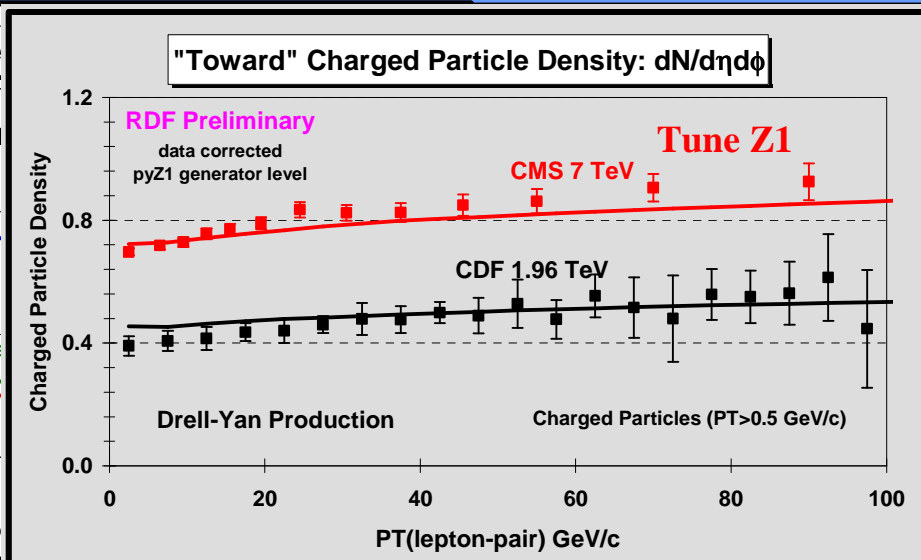
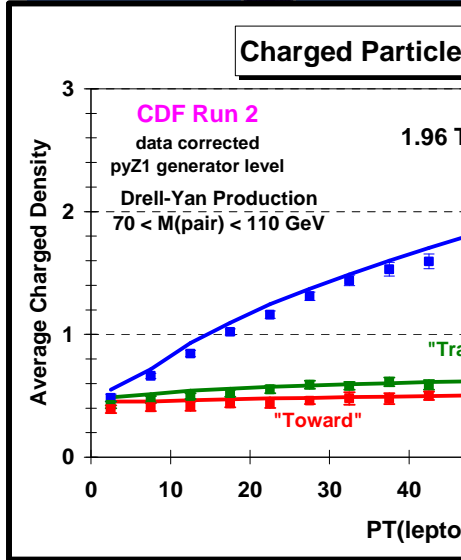
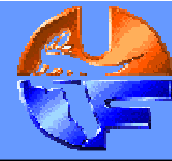
Tune Z1 describes the energy dependence fairly well!



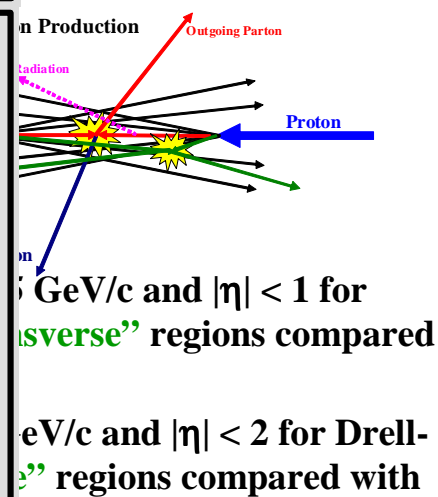
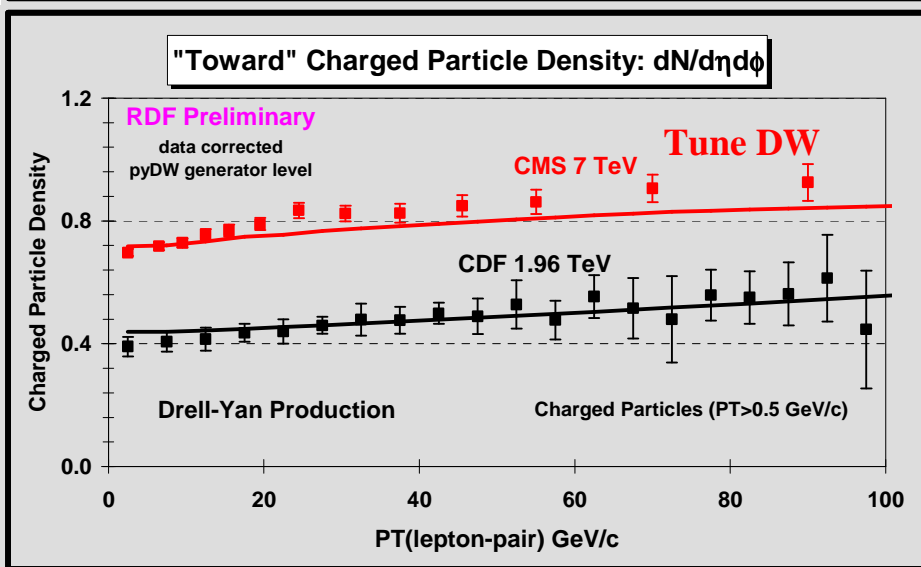
- ➔ **CDF data at 1.96 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune Z1**.
- ➔ **CMS data at 7 TeV** on the density of charged particles, $dN/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 2$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune Z1**.



PYTHIA Tune Z1

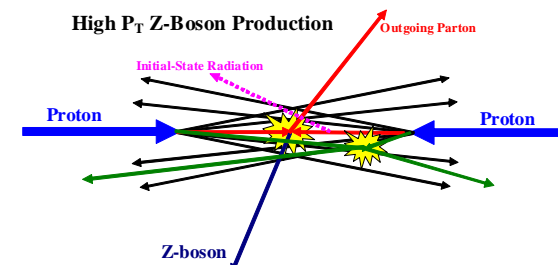
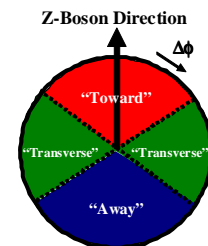
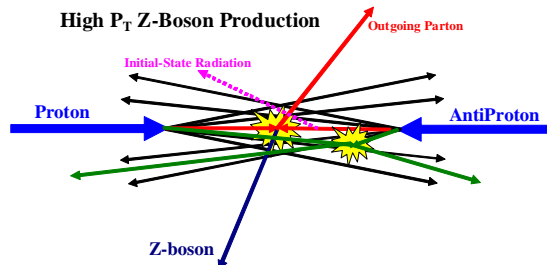
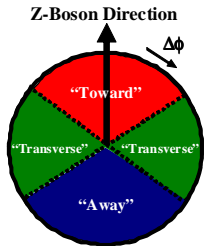
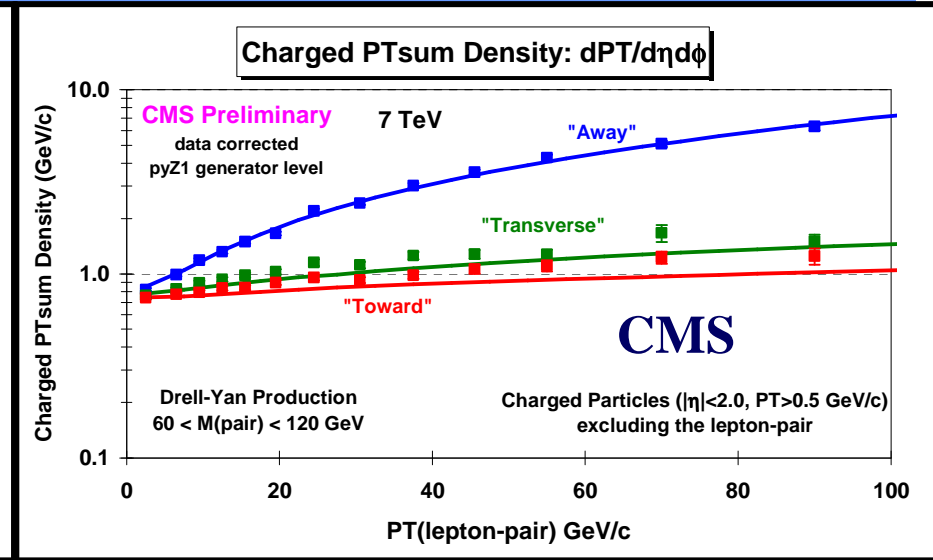
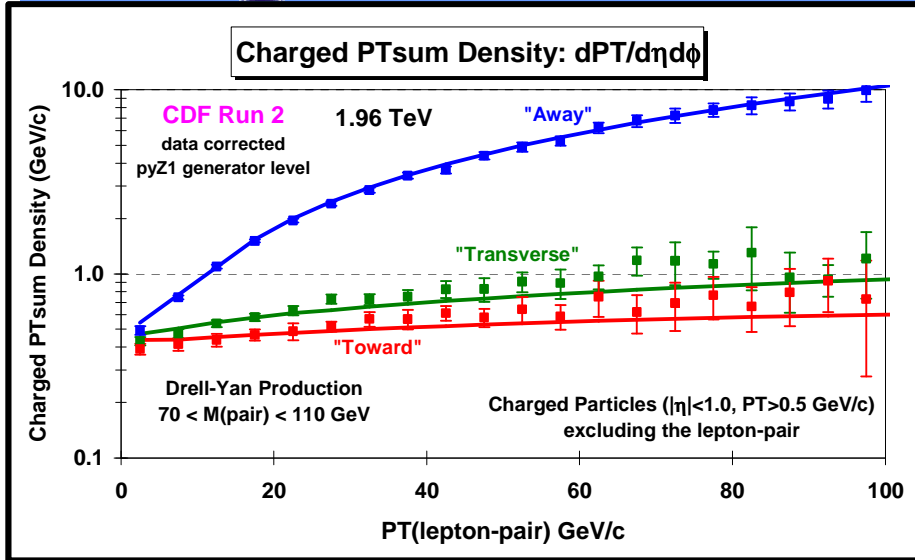


- ➔ CDF data at 1.96 TeV Drell-Yan production with PYTHIA Tune Z1
- ➔ CMS data at 7 TeV Drell-Yan production as a function of PYTHIA Tune Z1.





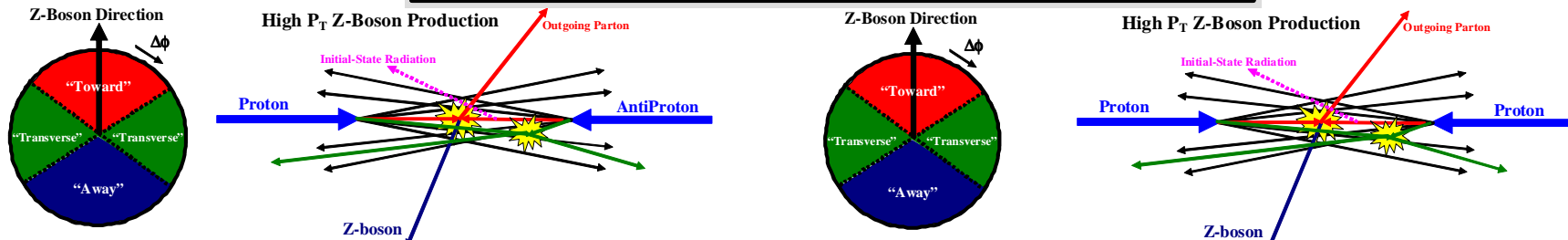
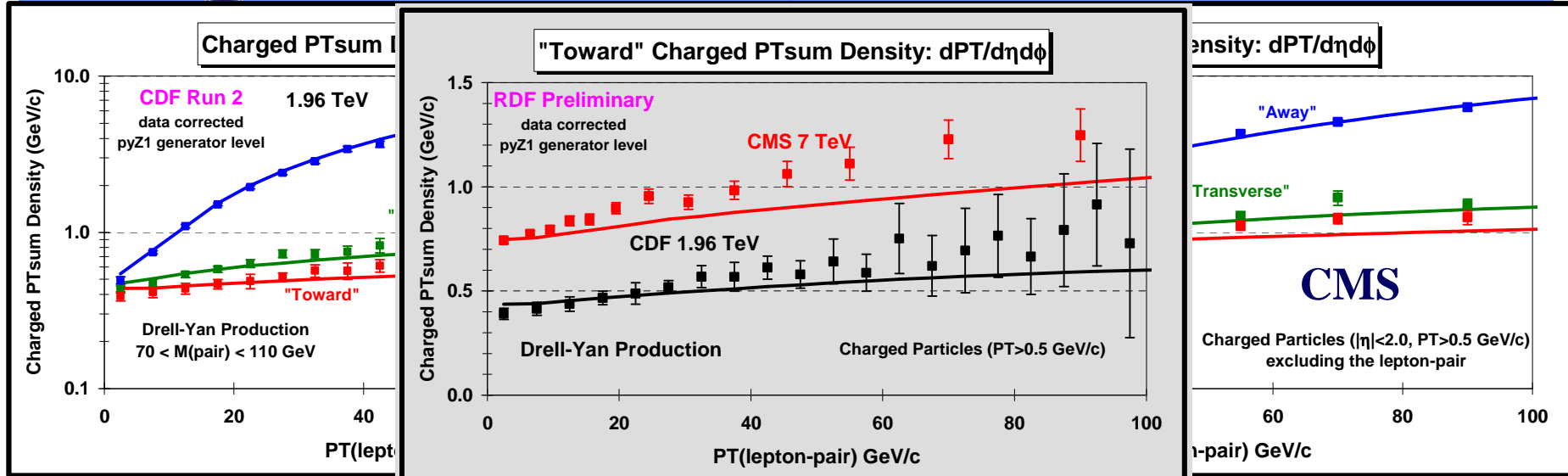
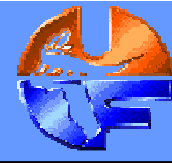
PYTHIA Tune Z1



- ➔ **CDF data at 1.96 TeV** on the charged PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune Z1**.
- ➔ **CMS data at 7 TeV** on the charged PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 2$ for Drell-Yan production as a function of $P_T(Z)$ for the “toward”, “away”, and “transverse” regions compared with **PYTHIA Tune Z1**.



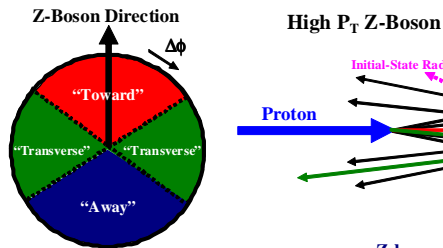
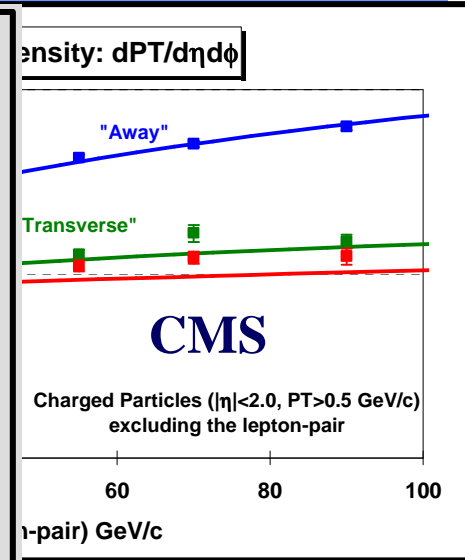
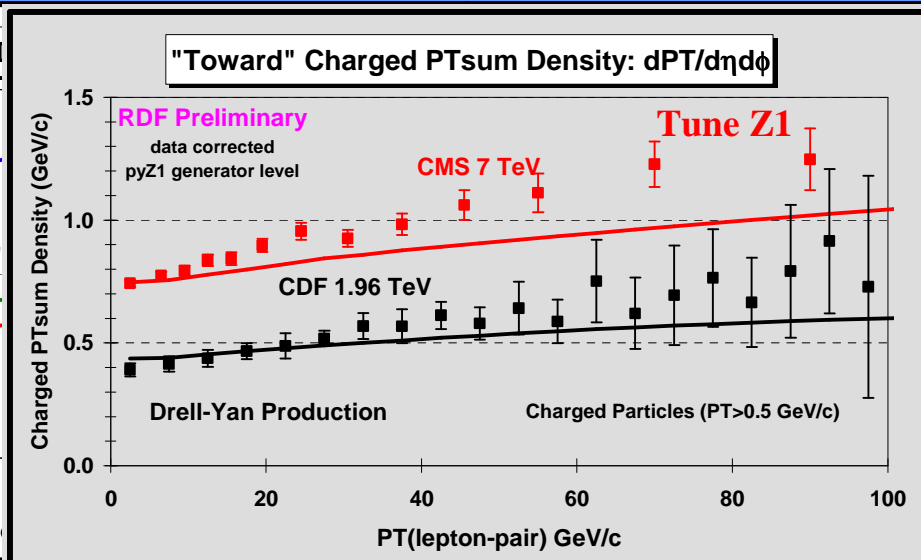
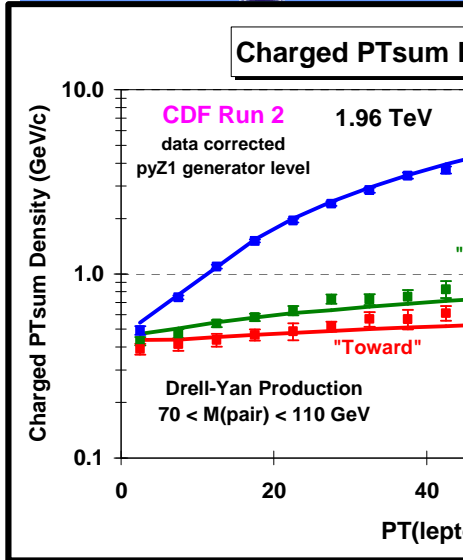
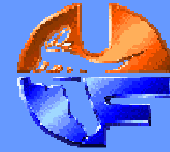
PYTHIA Tune Z1



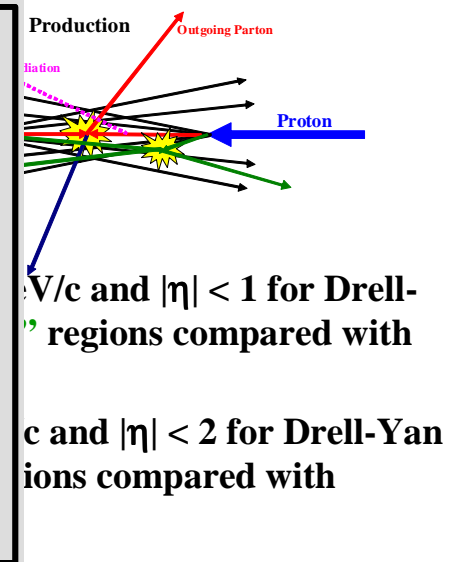
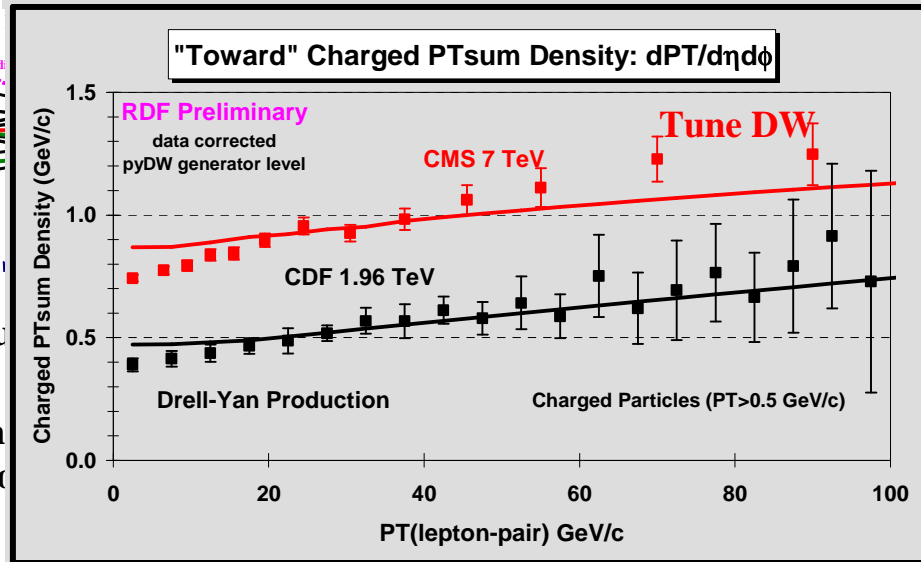
- ➔ **CDF data at 1.96 TeV** on the charged PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 1$ for Drell-Yan production as a function of $P_T(Z)$ for the "toward", "away", and "transverse" regions compared with **PYTHIA Tune Z1**.
- ➔ **CMS data at 7 TeV** on the charged PTsum density, $dPT/d\eta d\phi$, with $p_T > 0.5$ GeV/c and $|\eta| < 2$ for Drell-Yan production as a function of $P_T(Z)$ for the "toward", "away", and "transverse" regions compared with **PYTHIA Tune Z1**.



PYTHIA Tune Z1

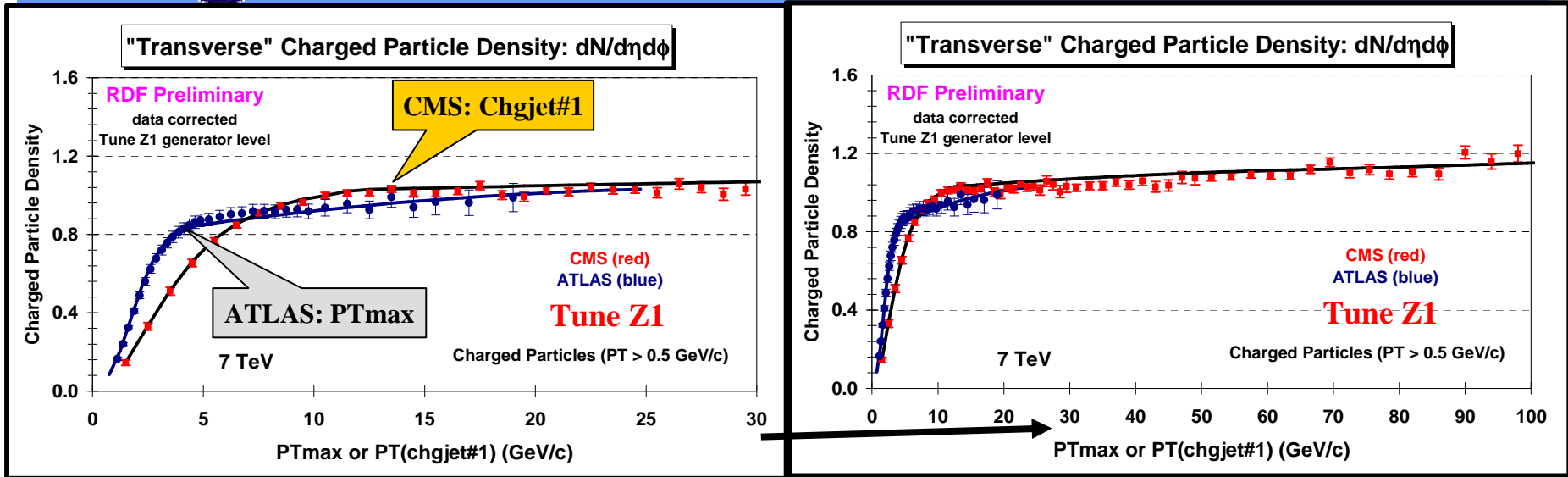
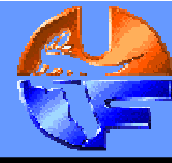


- ➔ CDF data at 1.96 TeV on Drell-Yan production as a function of P_T compared with PYTHIA Tune Z1.
- ➔ CMS data at 7 TeV on Drell-Yan production as a function of P_T compared with PYTHIA Tune Z1.





CMS-ATLAS UE Data

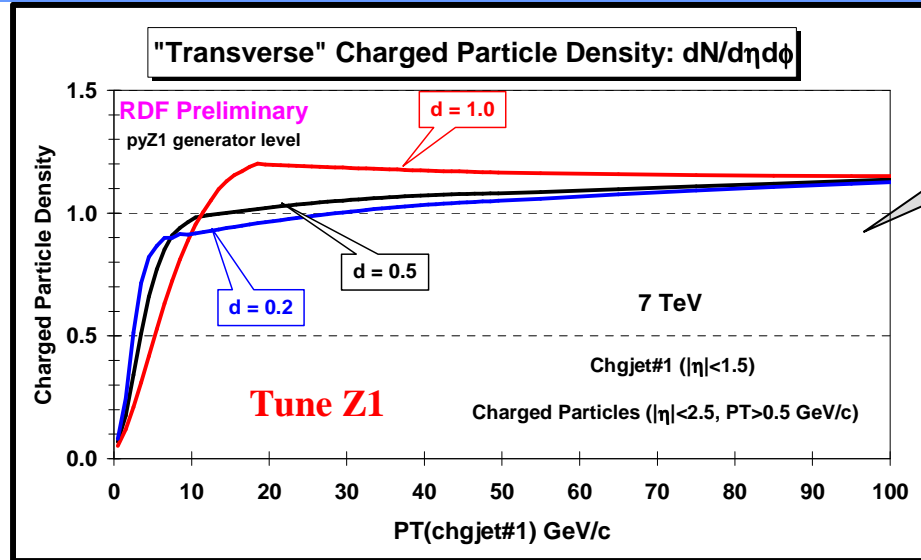


- ➔ **CMS preliminary data at 7 TeV** on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.0$ together with the **ATLAS published data at 7 TeV** on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

Amazing agreement!



Jet Radius Dependence



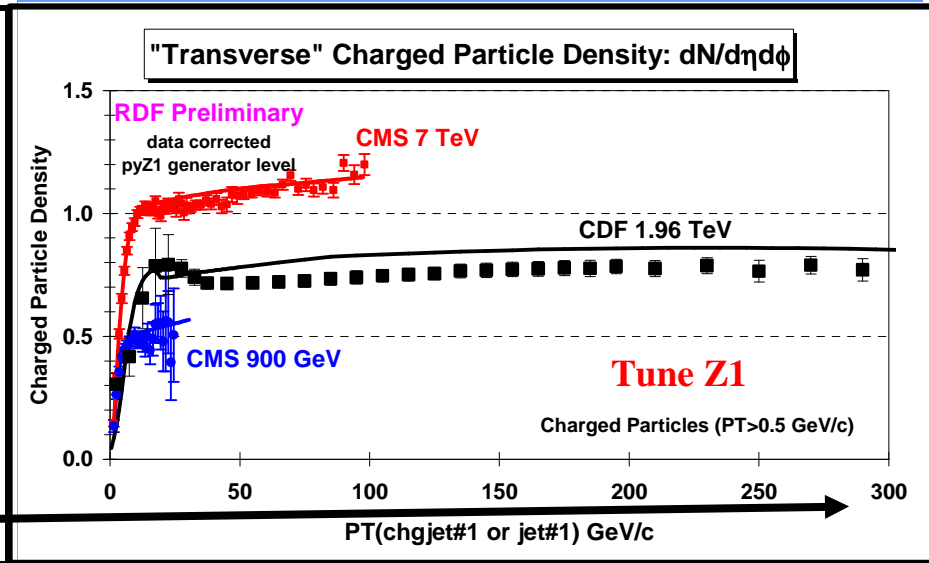
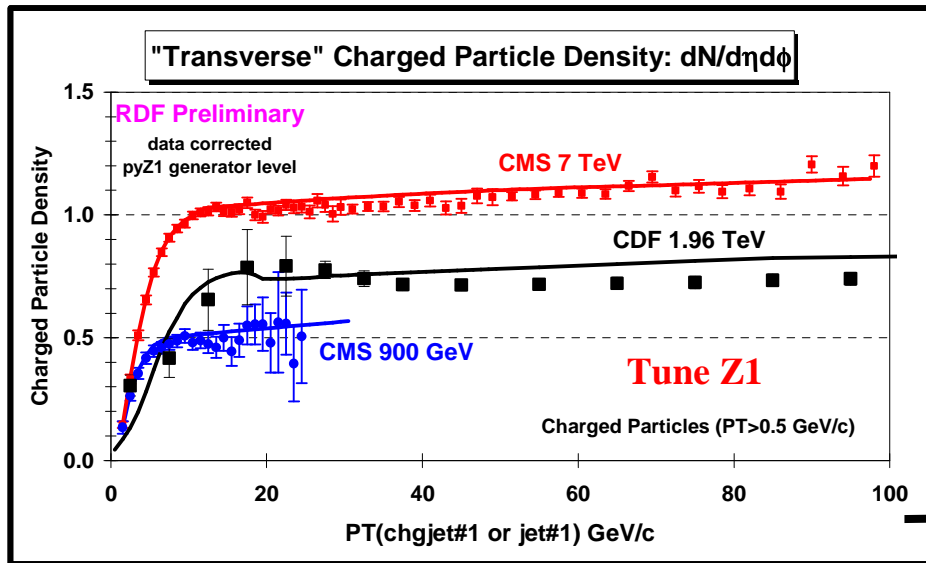
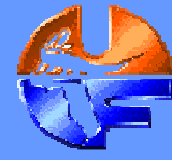
The UE activity is higher for large jet radius!

- The charged particle density in the “transverse” region as defined by the leading charged particle jet from PYTHIA **Tune Z1**. The charged particles are in the region $p_T > 0.5$ GeV/c and $|\eta| < 2.5$. Charged particle jets are constructed using the Anti-KT algorithm with $d = 0.2, 0.5,$ and 1.0 from charged particles in the region $p_T > 0.5$ GeV/c and $|\eta| < 2.5$, however, the leading charged particle jet is required to have $|\eta(\text{chgjet}\#1)| < 1.5$.

It seems that large jet radius “biases” the UE to be more active!

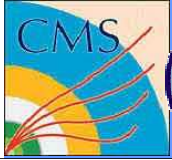


PYTHIA Tune Z1

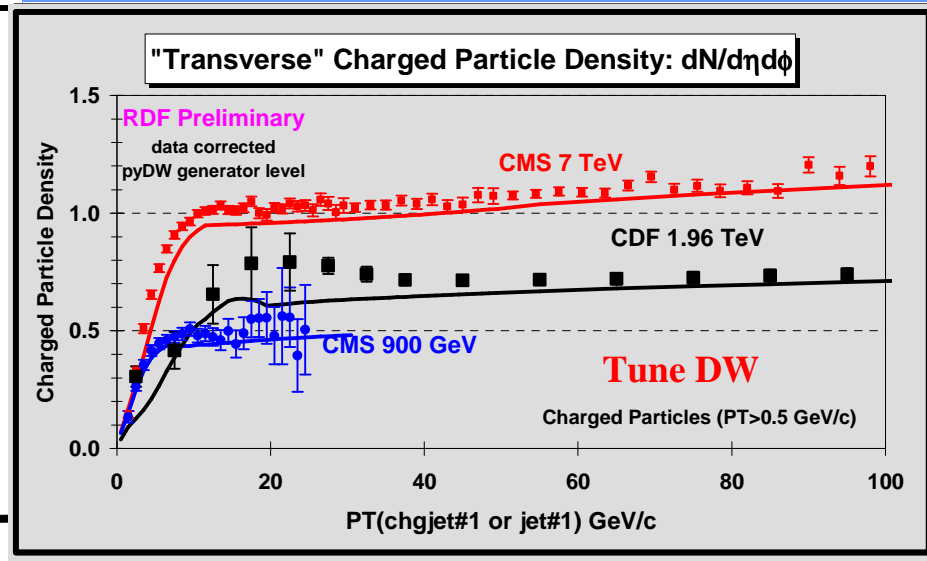
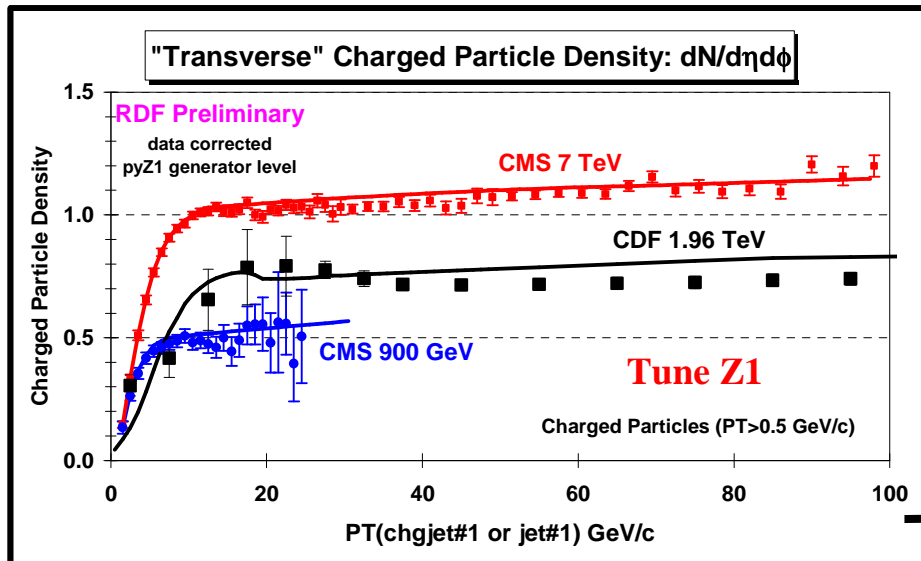
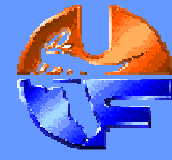


→ CMS data at 900 GeV on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

→ CDF data at 1.96 TeV on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading calorimeter jet (jet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 1.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.



PYTHIA Tune Z1

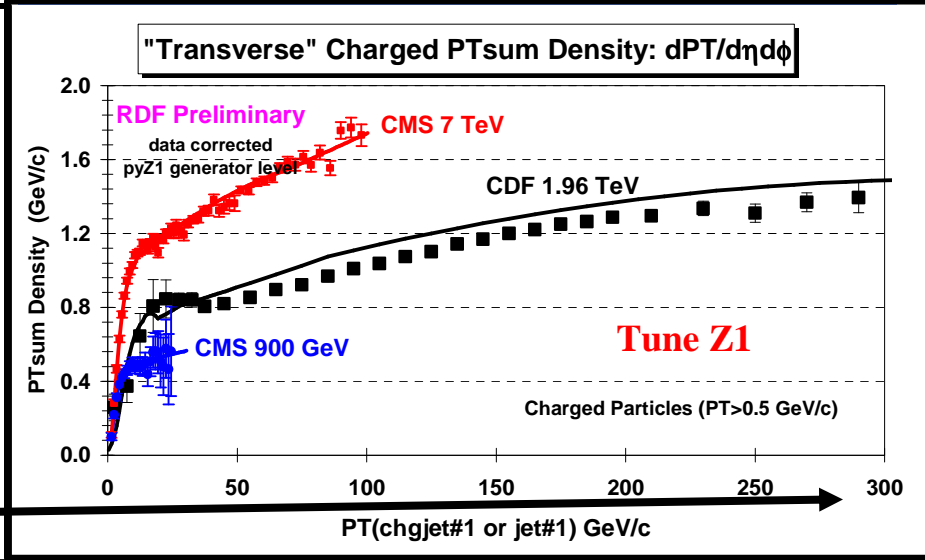
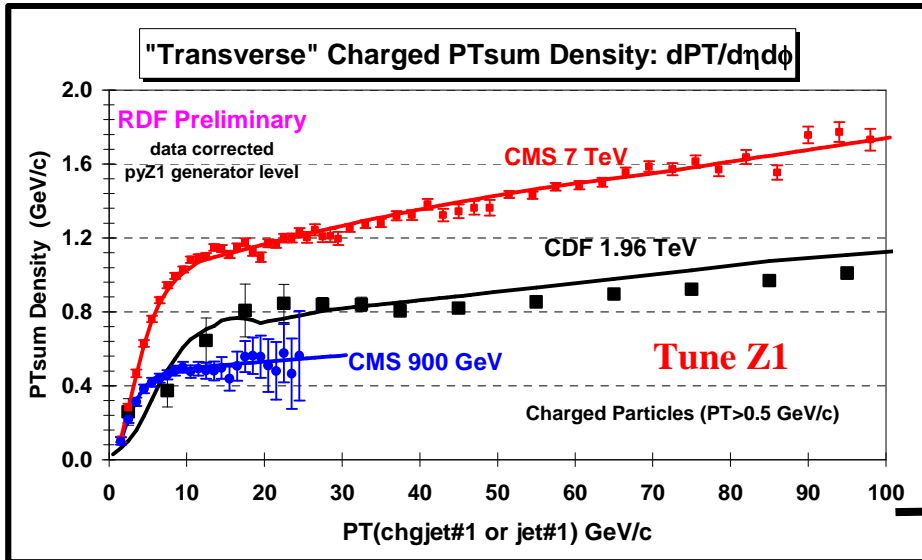
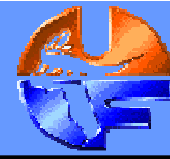


→ CMS data at 900 GeV on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

→ CDF data at 1.96 TeV on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading calorimeter jet (jet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 1.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.



PYTHIA Tune Z1

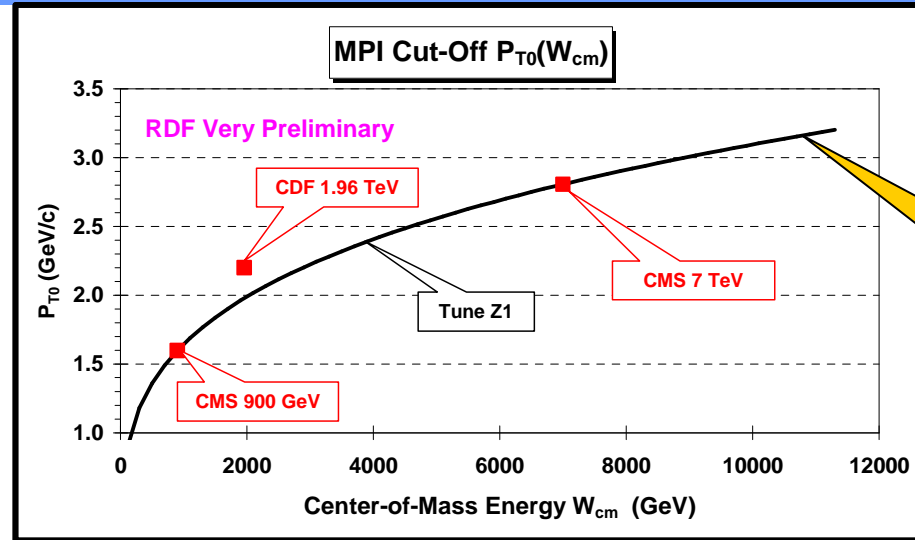


→ CMS data at 900 GeV and 7 TeV on the “transverse” charged PTsum density, $dPT/d\eta d\phi$, as defined by the leading charged particle jet (chgjet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 2.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

→ CDF data at 1.96 TeV on the “transverse” charged PTsum density, $dPT/d\eta d\phi$, as defined by the leading calorimeter jet (jet#1) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 1.0$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.



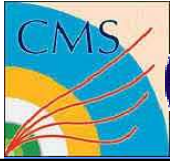
PYTHIA Tune Z1



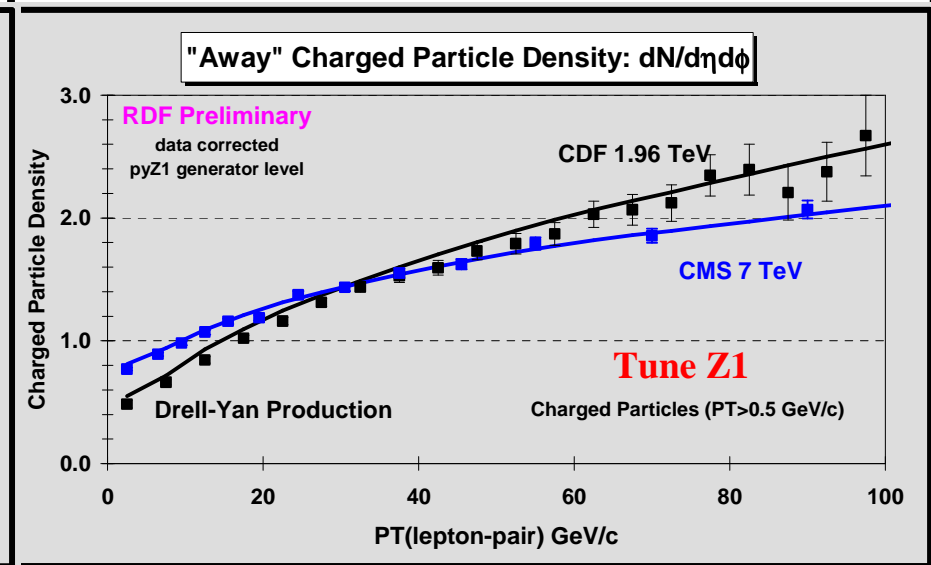
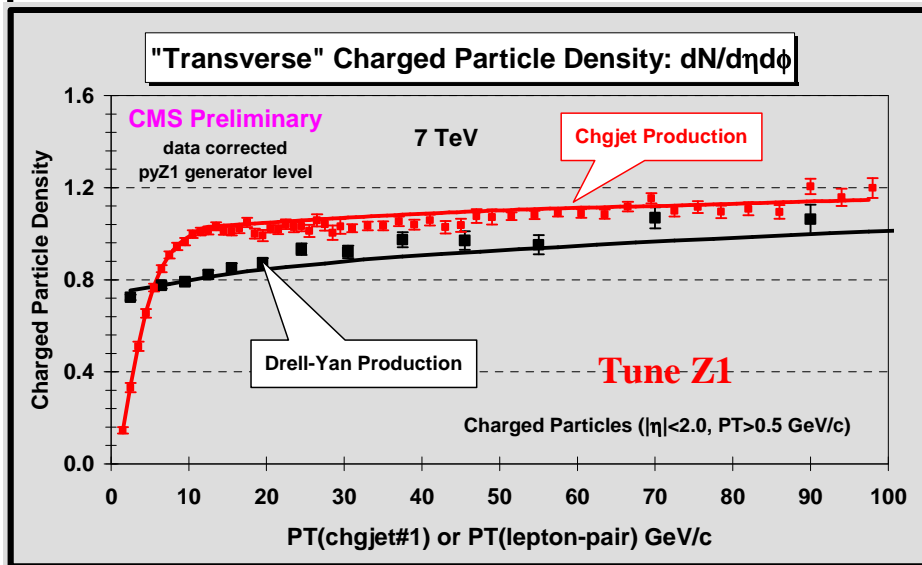
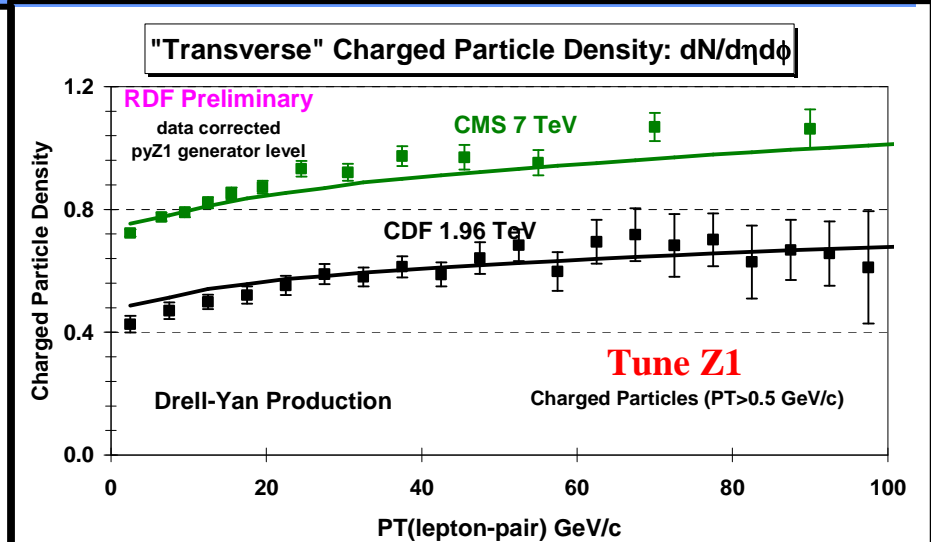
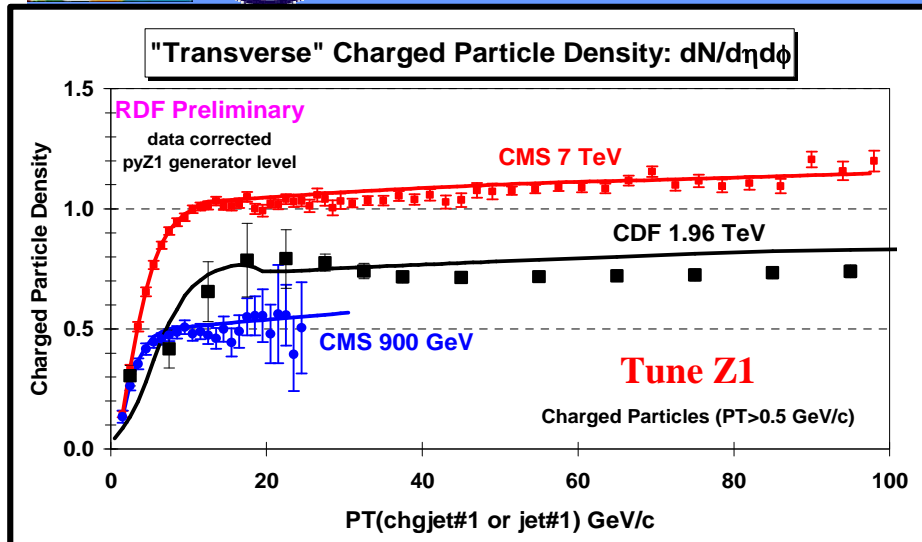
$$p_{T0}(W) = p_{T0}(W/W_0)^\epsilon$$

- ➔ **MPI Cut-Off versus the Center-of Mass Energy W_{cm} :** PYTHIA **Tune Z1** was determined by fitting p_{T0} independently at 900 GeV and 7 TeV and calculating $\epsilon = \text{PARP}(90)$. The best fit to p_{T0} at CDF is slightly higher than the Tune Z1 curve. This is very preliminary! Perhaps with a global fit to all three energies (*i.e.* “Professor” tune) one can get a simultaneous fit to all three??

$$p_{T0}(W) = p_{T0}(W/W_0)^\epsilon \quad \epsilon = \text{PARP}(90) \quad p_{T0} = \text{PARP}(82) \quad W = E_{cm}$$

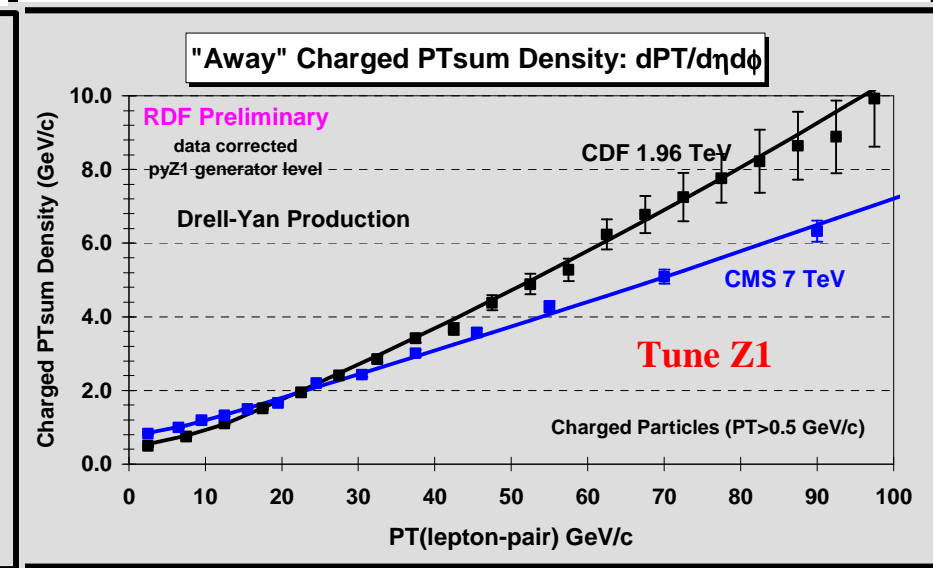
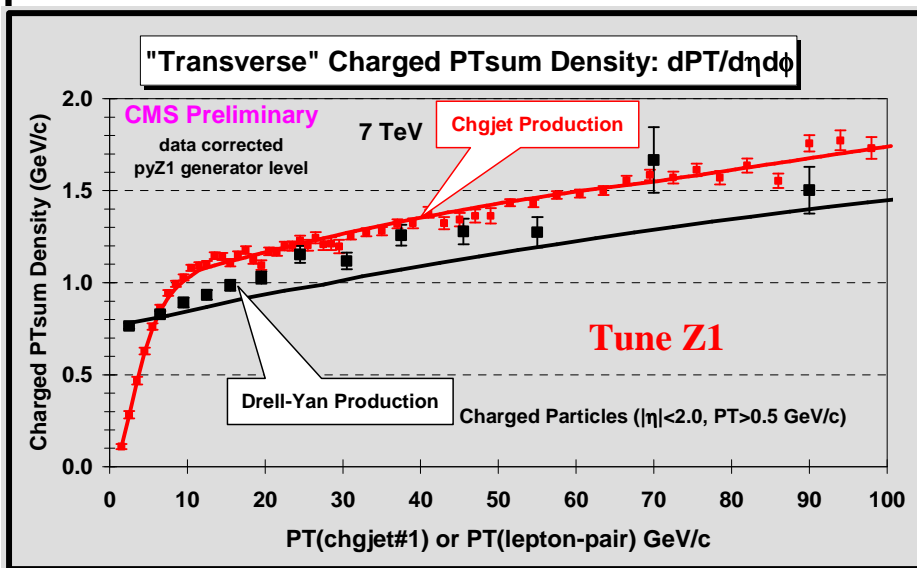
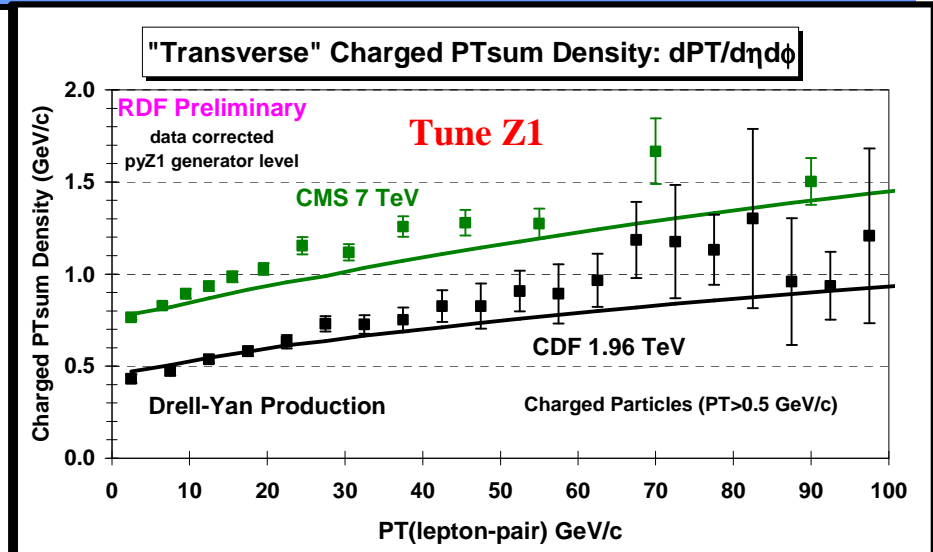
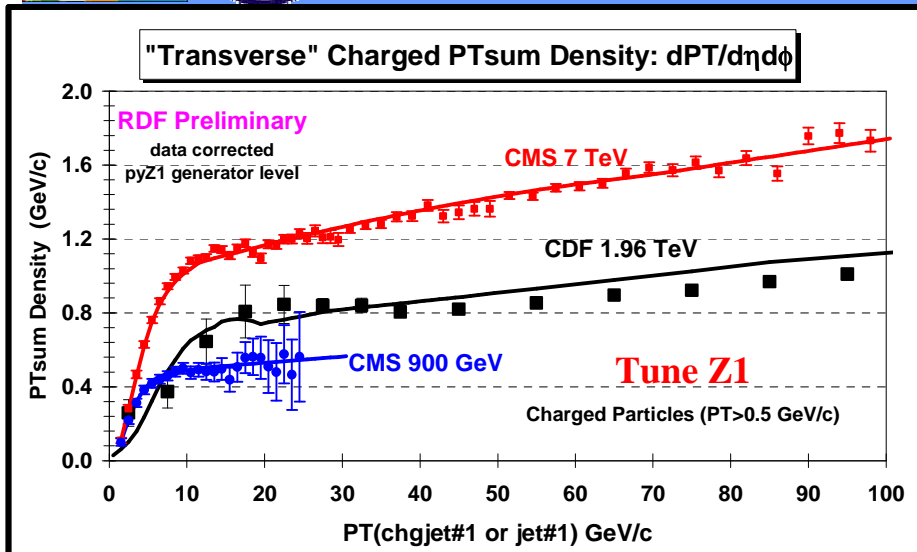


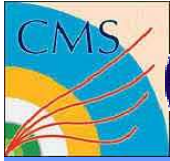
PYTHIA Tune Z1



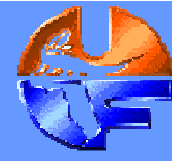


PYTHIA Tune Z1





How Universal are the Tunes?



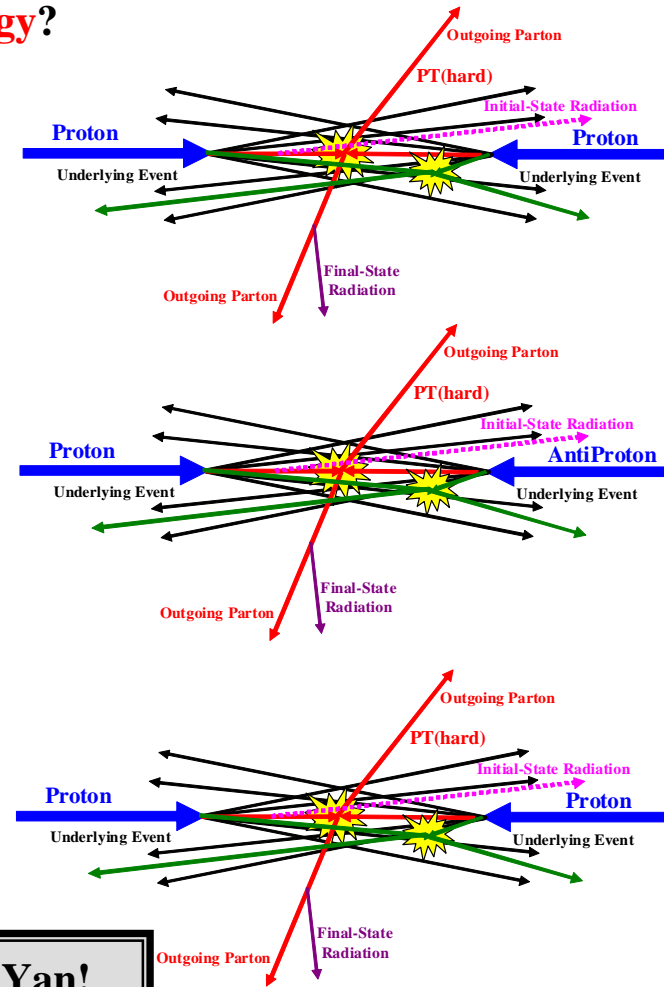
➔ Do we need a separate tune for **each center-of-mass energy**?
900 GeV, 1.96 TeV, 7 TeV, etc.

PYTHIA **Tune DW** describes the Drell-Yan UE data at both 1.97 TeV and 7 TeV. It describes the “Leading Jet” UE data at 1.96 TeV, but **does not fit perfectly the PTmax and “Leading Chgjet” UE data at 900 GeV and 7 TeV.**

PYTHIA **Tune Z1** describes the Drell-Yan UE data at both 1.97 TeV and 7 TeV. It describes the PTmax and “Leading Chgjet” UE data at 900 GeV and 7 TeV, but **does not fit perfectly the “Leading Jet” UE data at 1.96 TeV.**

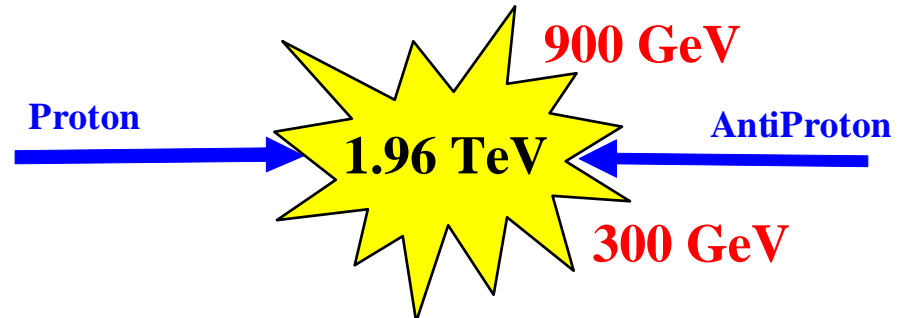
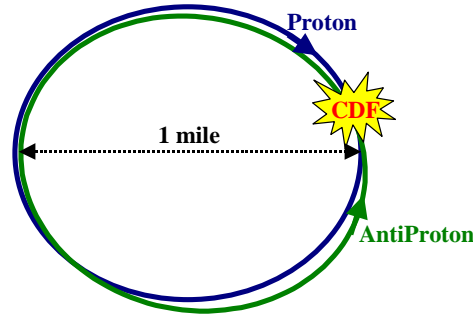
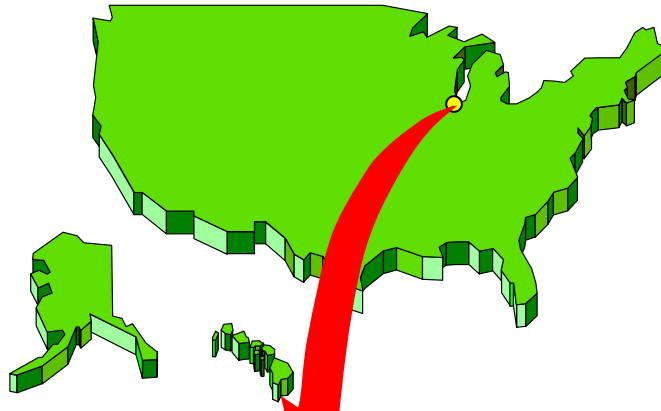
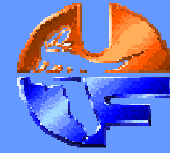
➔ Do we need a separate tune for **each hard QCD subprocess**? Jet Production, Drell-Yan Production, etc.

The same tune can describe both Jet Production and Drell-Yan!





Tevatron Energy Scan



➔ In September 2011 CDF has collected more than 10M “min-bias” events at several center-of-mass energies!

300 GeV 12M MB Events

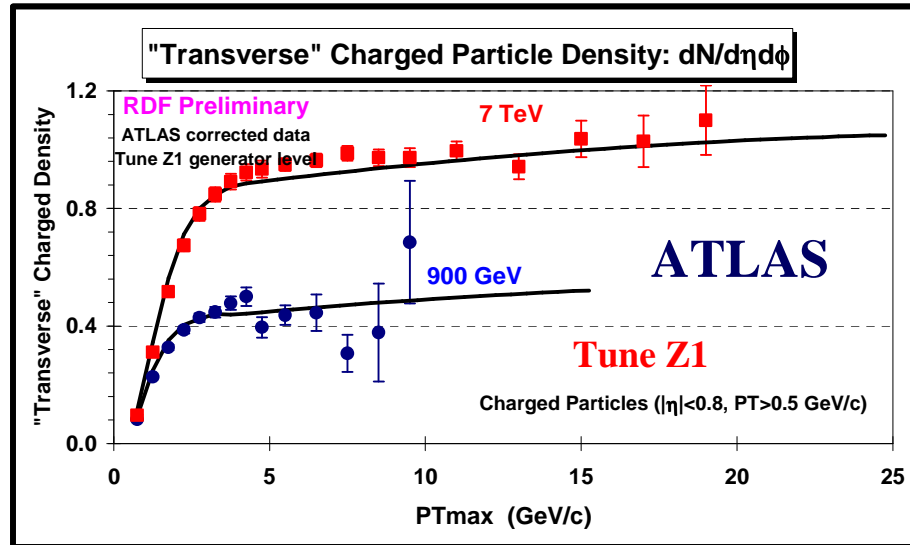
900 GeV 17M MB Events



LPCC “Common Plots”



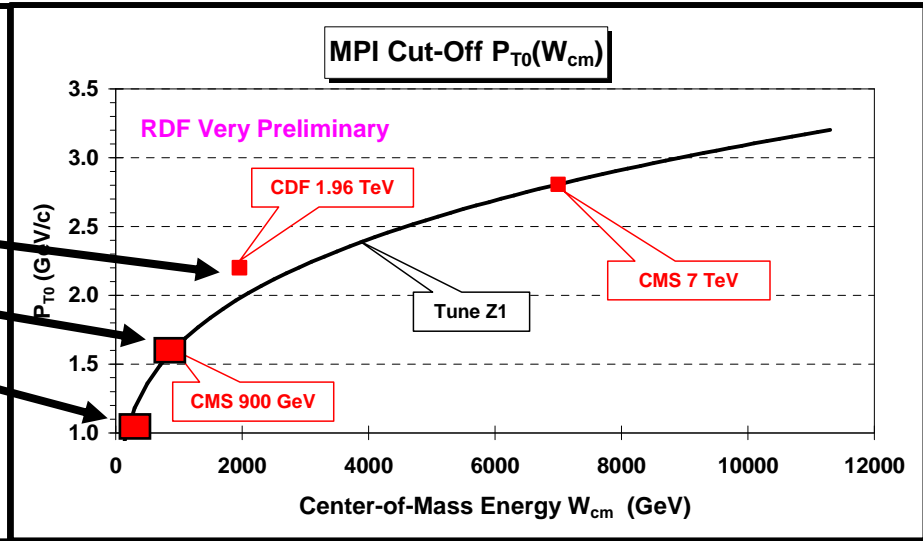
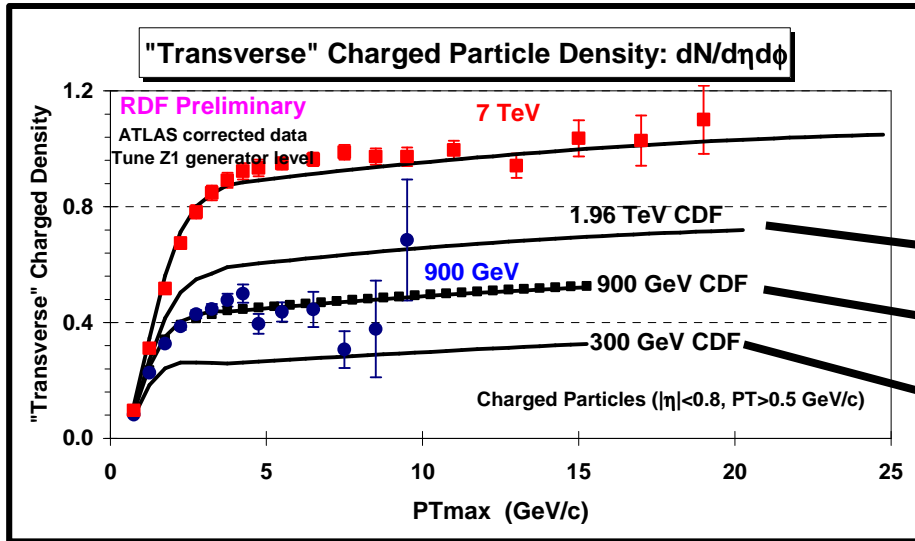
LPCC MB&UE Working Group
LHC Physics Centre at CERN



- ➔ **ATLAS preliminary data at 900 GeV and 7 TeV** on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5$ GeV/c and $|\eta| < 0.8$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.



New CDF Energies

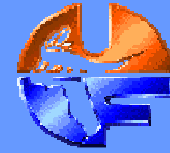


➔ **ATLAS preliminary data at 900 GeV and 7 TeV** on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5 \text{ GeV}/c$ and $|\eta| < 0.8$. The data are corrected and compared with **PYTHIA Tune Z1** at the generator level.

➔ **Predictions for CDF** on the “transverse” charged particle density, $dN/d\eta d\phi$, as defined by the leading charged particle (PT_{max}) for charged particles with $p_T > 0.5 \text{ GeV}/c$ and $|\eta| < 0.8$ from **PYTHIA Tune Z1** at the generator level.



Rick's Plan UE



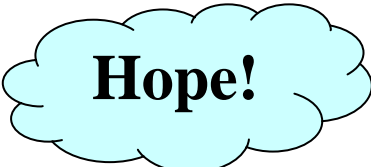
Standard CDF Track Selection:

COT tracks (do not need silicon)

One and only one primary vertex

$|z| \leq 60 \text{ cm}$, $|d_0| < 0.5 \text{ cm}$, $|z - Z_{\text{vtx}}| < 2 \text{ cm}$

$p_T > 0.5 \text{ GeV}/c$, $|\eta| < 1.0 \ \& \ 0.8$

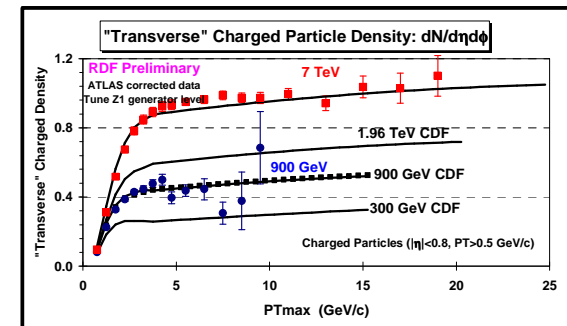
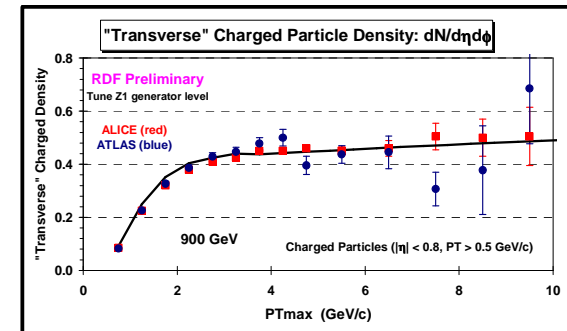
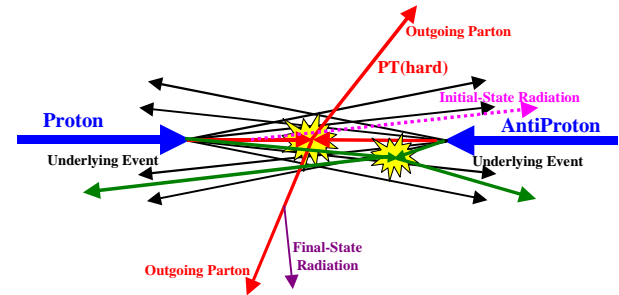


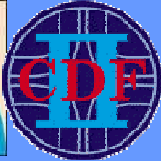
Correct the data to the particle level!

➔ Produce the CDF PTmax UE “common plots” at 900 GeV to compare with ALICE-ATLAS-CMS.

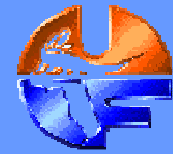
➔ Study the energy dependence of the UE using PTmax at CDF (300 GeV, 900 GeV, **1.96 TeV**).

**Never did PTmax
UE at 1.96 TeV!**





Margaret Morlan



Margaret Field in “The Man From Planet X” (1951)



Rick & Maggie (Malibu June 2011)

- ➔ **My mother was born on May 10, 1922, in Houston Texas. She died on Sunday November 6, 2011 in Malibu, California at age 89. She had a wonderful life and my wife Jimmie and I will miss her very much.**