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, DESY, Hamburg  
November 21, 2011  
Rick Field – Florida/CDF/CMS
Shows the charged particle density in the “transverse” region for charged particles ($p_T > 0.5$ 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 $d = 0.5$. 
CDF data at 1.96 TeV on the density of charged particles, dN/dηdϕ, with p_T > 0.5 GeV/c and |η| < 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).
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).
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).
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).
- **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.

---

**MPI@LHC, DESY, Hamburg**

Rick Field – Florida/CDF/CMS

Page 7

November 21, 2011
**Charged Particle Density**

CDF data at 1.96 TeV on the density of charged particles, dN/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 2 for Drell-Yan production as a function of P_T(Z) for the “toward”, “away”, and “transverse” regions compared with PYTHIA Tune DW.

**CDF**
- Proton-Antiproton Collisions at 1.96 GeV
- Lepton Cuts: p_T > 20 GeV |η| < 1.0
- Mass Cut: 70 < M(lepton-pair) < 110 GeV
- Charged Particles: p_T > 0.5 GeV/c |η| < 1.0

**CMS**
- Proton-Proton Collisions at 7 GeV
- Lepton Cuts: p_T > 20 GeV |η| < 2.4
- Mass Cut: 60 < M(lepton-pair) < 120 GeV
- Charged Particles: p_T > 0.5 GeV/c |η| < 2.0

**Notes**

- **CDF**
  - Data corrected pyOW generator level
  - Drell-Yan Production
  - 70 < M(pair) < 110 GeV

- **CMS**
  - Data corrected pyOW generator level
  - Drell-Yan Production
  - 60 < M(pair) < 120 GeV
Large increase in the UE in going from 1.96 TeV to 7 TeV as predicted by PYTHIA Tune DW!

CDF data at 1.96 TeV on the density of charged particles, dN/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 2 for Drell-Yan production as a function of P_T(Z) for the “toward”, “away”, and “transverse” regions compared with PYTHIA Tune DW.
CDF data at 1.96 TeV on the charged PTsum density, dPT/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 1 for Drell-Yan production as a function of PT(Z) for the “toward”, “away”, and “transverse” regions compared with PYTHIA Tune DW.
Large increase in the UE in going from 1.96 TeV to 7 TeV as predicted by PYTHIA Tune DW!

CDF data at 1.96 TeV on the charged PTsum density, dPT/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 1 for Drell-Yan production as a function of PT(Z) for the “toward”, “away”, and “transverse” regions compared with 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 \( p_T > 0.5 \text{ GeV/c} \) 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 \( p_T > 0.5 \text{ GeV/c} \) and \( |\eta| < 2.5 \). The data are corrected and compared with PYTHIA Tune DW at the generator level.
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 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 generator level.

CDF 1.96 TeV Leading Jet preliminary data corrected with PYTHIA Tune DW generator level.
CMS preliminary data at 900 GeV and 7 TeV on the “transverse” charged PTsum density, dPT/dηdφ, as defined by the leading charged particle jet (chgjet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 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/dηdφ, as defined by the leading charged particle (PTmax) for charged particles with p_T > 0.5 GeV/c and |η| < 2.5. The data are corrected and compared with PYTHIA Tune DW at the generator level.
CMS preliminary data at 900 GeV and 7 TeV on the “transverse” charged PTsum density, dPT/d\eta\phi, defined by the leading charged particle jet (pt>0.5 GeV/c and |\eta|<2.0).

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\phi, defined by the maximum PT (PTmax) for charged particles with pt>0.5 GeV/c and |\eta|<2.5.

The data are corrected and compared with PYTHIA Tune DW at the generator level.
Charged Particle Density: $dN/d\eta d\phi$

**CMS Preliminary**
- Data corrected pyDW generator level
- Drell-Yan Production $60 < M(\text{pair}) < 120$ GeV
- Average Charged Density
- Charged Particles ($|\eta|<2.0$, $PT>0.5$ GeV/c) excluding the lepton-pair

**"Toward" Charged Particle Density: $dN/d\eta d\phi$**
- Charged Particle Density
- Drell-Yan Production
- Charged Particles ($PT>0.5$ GeV/c)

**"Transverse" Charged Particle Density: $dN/d\eta d\phi$**
- Charged Particle Density
- Charged Particles ($PT>0.5$ GeV/c)

**"Away" Charged Particle Density: $dN/d\eta d\phi$**
- Charged Particle Density
- Charged Particles ($PT>0.5$ GeV/c)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tune Z1 (R. Field CMS)</th>
<th>Tune AMBT1 (ATLAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parton Distribution Function</td>
<td>CTEQ5L</td>
<td>LO*</td>
</tr>
<tr>
<td>PARP(82) – MPI Cut-off</td>
<td>1.932</td>
<td>2.292</td>
</tr>
<tr>
<td>PARP(89) – Reference energy, E0</td>
<td>1800.0</td>
<td>1800.0</td>
</tr>
<tr>
<td>PARP(90) – MPI Energy Extrapolation</td>
<td>0.275</td>
<td>0.25</td>
</tr>
<tr>
<td>PARP(77) – CR Suppression</td>
<td>1.016</td>
<td>1.016</td>
</tr>
<tr>
<td>PARP(78) – CR Strength</td>
<td>0.538</td>
<td>0.538</td>
</tr>
<tr>
<td>PARP(80) – Probability colored parton from BBR</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>PARP(83) – Matter fraction in core</td>
<td>0.356</td>
<td>0.356</td>
</tr>
<tr>
<td>PARP(84) – Core of matter overlap</td>
<td>0.651</td>
<td>0.651</td>
</tr>
<tr>
<td>PARP(62) – ISR Cut-off</td>
<td>1.025</td>
<td>1.025</td>
</tr>
<tr>
<td>PARP(93) – primordial kT-max</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>MSTP(81) – MPI, ISR, FSR, BBR model</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>MSTP(82) – Double gaussian matter distribution</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>MSTP(91) – Gaussian primordial kT</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>MSTP(95) – strategy for color reconnection</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Parameters not shown are the PYTHIA 6.4 defaults!
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 \( p_T > 0.5 \text{ GeV/c} \) 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 \( p_T > 0.5 \text{ GeV/c} \) and \( |\eta| < 2.0 \). The data are corrected and compared with PYTHIA Tune Z1 at the generator level.

Very nice agreement!
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 (PTmax) 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
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.
CDF data at 1.96 TeV on the density of charged particles, dN/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 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

**Charged Particle Density dN/dηφ**

- **CDF Run 2**: Drell-Yan Production (70 < M(pair) < 110 GeV) corrected pyZ1 generator level.
- **CMS 7 TeV**: Charged Particles (PT>0.5 GeV/c) excluding the lepton-pair.
- **Drell-Yan Production**: Charged Particles (|η|<1.0, PT>0.5 GeV/c).
- **CDF 1.96 TeV**: Charged Particles (|η|<2.0, PT>0.5 GeV/c).

**Toward** Charged Particle Density: dN/dηφ

- **CDF 1.96 TeV**: Charged Particles (|η|<2.0, PT>0.5 GeV/c).
- **CMS 7 TeV**: Charged Particles (|η|<2.0, PT>0.5 GeV/c).

**Transverse** Charged Particle Density: dN/dηφ

- **CMS 7 TeV**: Charged Particles (|η|<1.0, PT>0.5 GeV/c).
- **CDF 1.96 TeV**: Charged Particles (|η|<1.0, PT>0.5 GeV/c).

**Away** Charged Particle Density: dN/dηφ

- **CDF 1.96 TeV**: Charged Particles (|η|<1.0, PT>0.5 GeV/c).
- **CMS 7 TeV**: Charged Particles (|η|<1.0, PT>0.5 GeV/c).

**Z-Boson Direction**

- **"Toward"**
- **"Away"**
- **"Transverse"**
- **High PT Z-Boson**

- **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 PT(Z) for the "toward", "away", and "transverse" regions compared with PYTHIA Tune Z1.
CDF data at 1.96 TeV on the charged PTsum density, dPT/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 2 for Drell-Yan production as a function of P_T(Z) for the “toward”, “away”, and “transverse” regions compared with PYTHIA Tune Z1.
CDF data at 1.96 TeV on the charged PTsum density, dPT/dηdφ, with p_T > 0.5 GeV/c and |η| < 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/dηdφ, with p_T > 0.5 GeV/c and |η| < 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 at 1.96 TeV
- CDF data at 1.96 TeV on Drell-Yan production as a function of PYTHIA Tune Z1.

CMS at 7 TeV
- CMS data at 7 TeV on Drell-Yan production as a function of PYTHIA Tune Z1.

Z-Boson Direction

- "Toward" Charged PTsum Density: dPT/d\(\eta\)\(\phi\)
  - Quit
  - Away
  - Transverse

Charged PTsum Density: dPT/d\(\eta\)\(\phi\)

- Charged Particles (|\(\eta|<1.0, PT>0.5 \text{ GeV/c}) excluding the lepton-pair

Drell-Yan Production

- CDF 1.96 TeV
- CMS 7 TeV

RDF Preliminary
- Data corrected pyZ1 generator level

Initial-State Radiation

Proton

Outgoing Parton

Production

High PT Z-Boson
CMS preliminary data at 7 TeV on the “transverse” charged particle density, dN/dηdφ, as defined by the leading charged particle jet (chgjet\#1) for charged particles with p_T > 0.5 GeV/c and |η| < 2.0 together with the ATLAS published data at 7 TeV on the “transverse” charged particle density, dN/dηdφ, as defined by the leading charged particle (PTmax) for charged particles with p_T > 0.5 GeV/c and |η| < 2.5 The data are corrected and compared with PYTHIA Tune Z1 at the generator level.

Amazing agreement!
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!
CMS data at 900 GeV on the “transverse” charged particle density, dN/dηdφ, as defined by the leading charged particle jet (chgjet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 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/dηdφ, as defined by the leading calorimeter jet (jet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 1.0. The data are corrected and compared with PYTHIA Tune Z1 at the generator level.
CMS data at 900 GeV on the “transverse” charged particle density, dN/dηdφ, as defined by the leading charged particle jet (chgjet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 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/dηdφ, as defined by the leading calorimeter jet (jet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 1.0. The data are corrected and compared with PYTHIA Tune Z1 at the generator level.
CMS data at 900 GeV and 7 TeV on the “transverse” charged PTsum density, dPT/dηdφ, as defined by the leading charged particle jet (chgjet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 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/dηdφ, as defined by the leading calorimeter jet (jet#1) for charged particles with p_T > 0.5 GeV/c and |η| < 1.0. The data are corrected and compared with PYTHIA Tune Z1 at the generator level.
MPI Cut-Off versus the Center-of Mass Energy \(W_{\text{cm}}\): PYTHIA Tune Z1 was determined by fitting \(p_{T0}\) independently at 900 GeV and 7 TeV and calculating \(\varepsilon = \text{PARP}(90)\). 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??

\[
p_{T0}(W) = p_{T0}(W/W_0)^\varepsilon \quad \varepsilon = \text{PARP}(90) \quad p_{T0} = \text{PARP}(82) \quad W = E_{\text{cm}}
\]
PYTHIA Tune Z1

"Transverse" Charged Particle Density: $dN/d\eta d\phi$

Charged Particle Density vs. $PT_{\text{chgjet#1 or jet#1}}$ (GeV/c)

- CMS 7 TeV
- CDF 1.96 TeV
- CMS 900 GeV
- Tune Z1

"Away" Charged Particle Density: $dN/d\eta d\phi$

Charged Particle Density vs. $PT_{\text{lepton-pair}}$ (GeV/c)

- CMS Preliminary
- 7 TeV
- Chgjet Production
- Tune Z1

RDF Preliminary data corrected pyZ1 generator level

Charged Particles ($|\eta|<2.0$, $PT>0.5$ GeV/c)

Drell-Yan Production

CDF 1.96 TeV

CMS 7 TeV

Tune Z1
PYTHIA Tune Z1

"Transverse" Charged PTsum Density: $dPT/d\eta d\phi$

![Graph](image)

"Away" Charged PTsum Density: $dPT/d\eta d\phi$

![Graph](image)
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!
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
ATLAS preliminary data at 900 GeV and 7 TeV on the “transverse” charged particle density, dN/dηdφ, as defined by the leading charged particle (PTmax) for charged particles with p_T > 0.5 GeV/c and |η| < 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 (PTmax) 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.

- Predictions for CDF 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 $|\eta| < 0.8$ from PYTHIA Tune Z1 at the generator 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!
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.