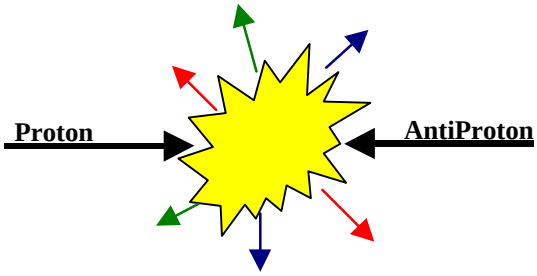
Min-Bias Physics: Fitting the Data

Rick Field and Dave Stuart

Talk by Rick Field Presented at the QCD Meeting January 14, 1999



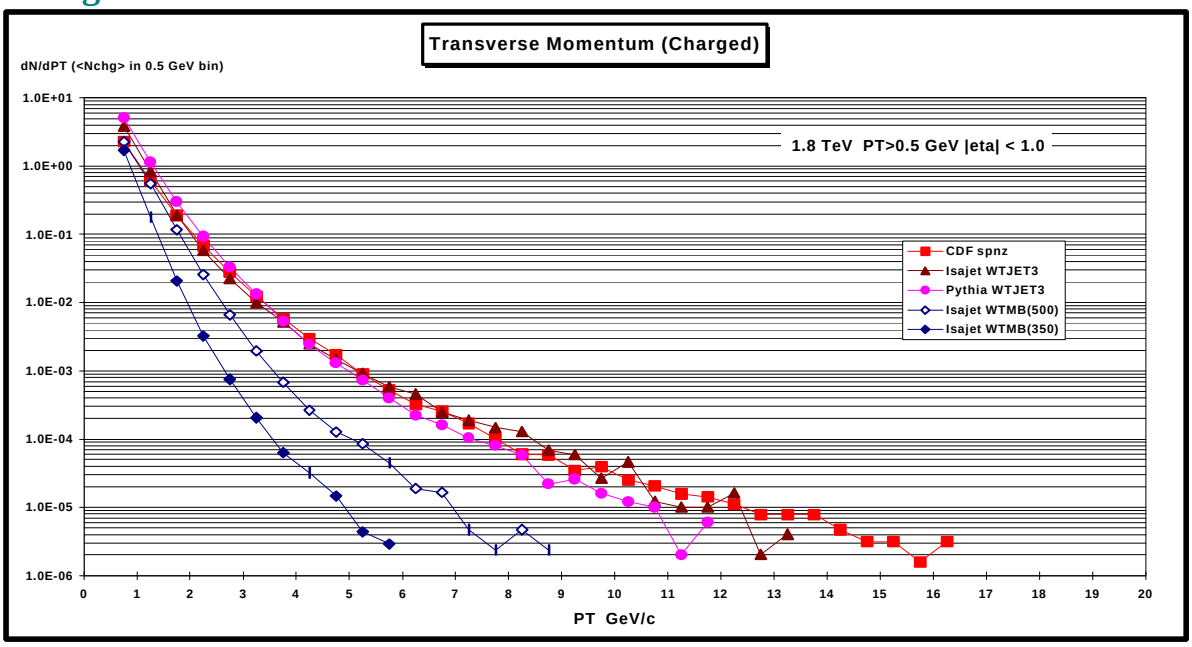
- **Study the CDF "Min-Bias" Data with the goal of providing a Monte-Carlo Generator that will fit the data. Would like the generator to describe all the features of the entire inelastic cross section (low PT and high PT)!**
- **Look at the data (plot many observables) and compare to Isajet and Pythia.**
- **Plot distributions: inclusive PT, PTmax, PTsum, Multiplicity, inclusive jet PT, PTjet#1, PTjet#2, PTjet#3.**
- **Look at correlations: N-flow and PT-flow relative to PTmax direction.**
- **Look at PTmax dependence (plot averages versus PTmax): <Nchg>, <PTsum>, <PT>, <Njet>, <NchgJet#1>, <PTjet#1>, <PTjet#2>, <PTjet#3>, <JetSize>, etc..**
- **Look at Multiplicity dependence (plot averages versus Nchg): <PTmax>, <PTsum>, <PT>, <Njet>, <NchgJet#1>, <PTjet#1>, <PTjet#2>, <PTjet#3>, <JetSize>, etc..**
- **Look at PTjet#1 dependence (plot averages versus PTjet#1): <PTmax>, <Njet>, <NchgJet#1>, <PTjet#2>, <PTjet#3>, <JetSize>, etc..**
- **Look at Jet Development: N-flow and PT-flow relative to Jet#1 direction versus PTjet#1.**
- **Many more transparencies than I can show in this talk! All 40 transparencies are on the WEB.**

N. Moggi

http://www.phys.ufl.edu/~rfield/cdf/QCD_Talk1.html

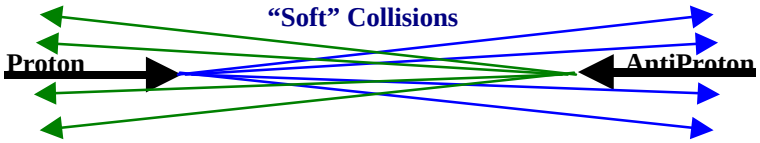
Min-Bias Data - Distributions

Charged Transverse Momentum Distribution:



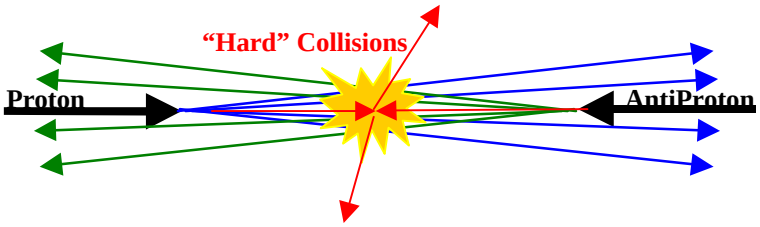
Distributions are (1/Nev)dNchg/dPT (integral = <Nchg>).

Isajet WTMB(350) is Isajet "Min-Bias": "Soft-Physics" no correlations (except resonances) with <PT> = 350 MeV/c (default).
Isajet WTMB(500) is Isajet "Min-Bias": "Soft-Physics" no correlations (except resonances) with <PT> = 500 MeV/c.



Isajet WTJET3 is Isajet 2-2 parton-parton "hard" scattering with k_T(hard) > 3 GeV/c.

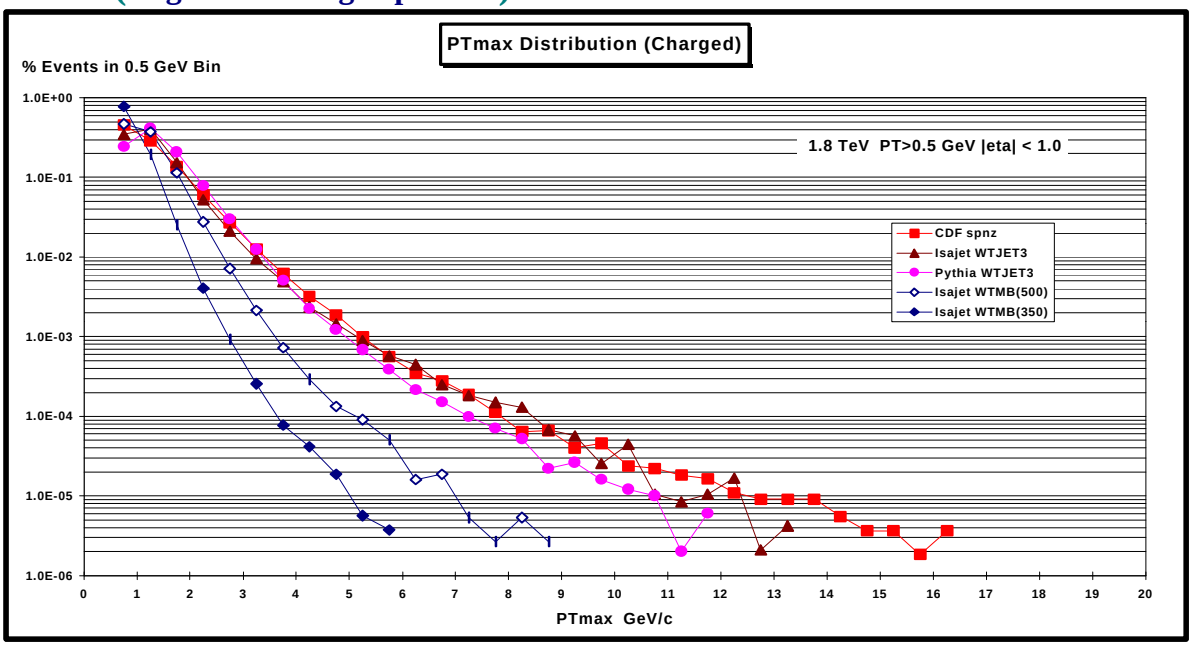
Pythia WTJET3 is Pythia 2-2 parton-parton "hard" scattering with k_T(hard) > 3 GeV/c.



All the Monte-Carlo events are required to satisfied the CDF Min-Bias Trigger and have been corrected for efficiency. Only look at the region PT > 0.5 GeV and |η| < 1, where efficiency corrections are small.

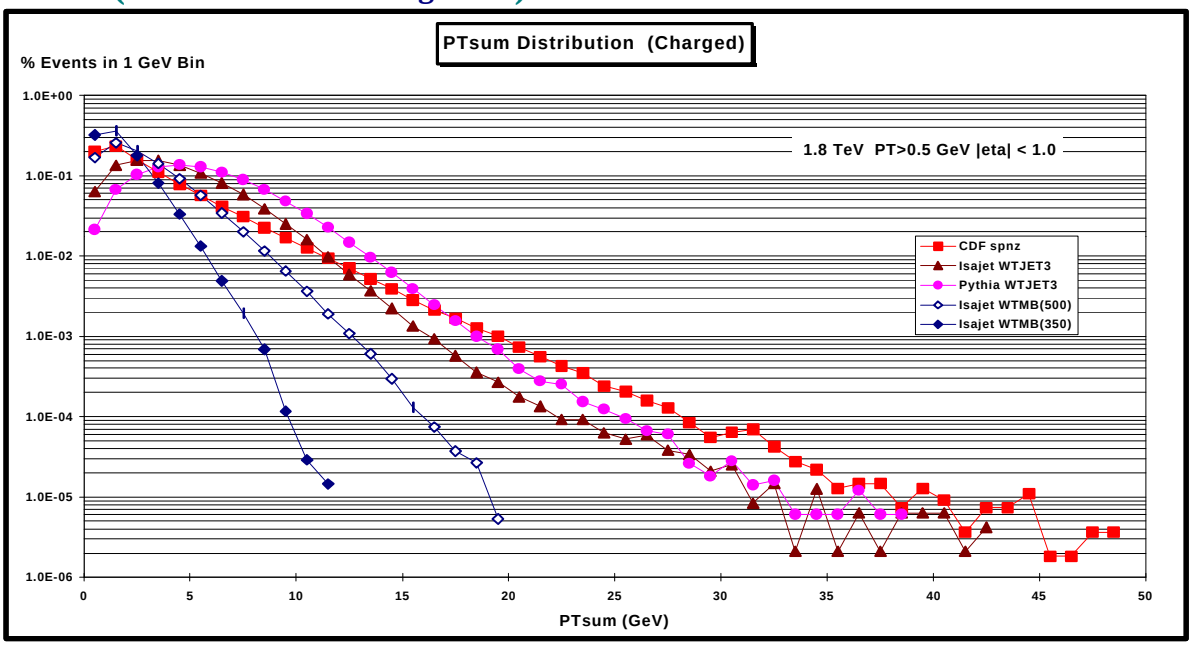
Min-Bias Data - Distributions

PTmax (largest PT charged particle) Distribution:



Distributions are normalized to 1.

PTsum (scalar sum of all charged PT) Distribution:

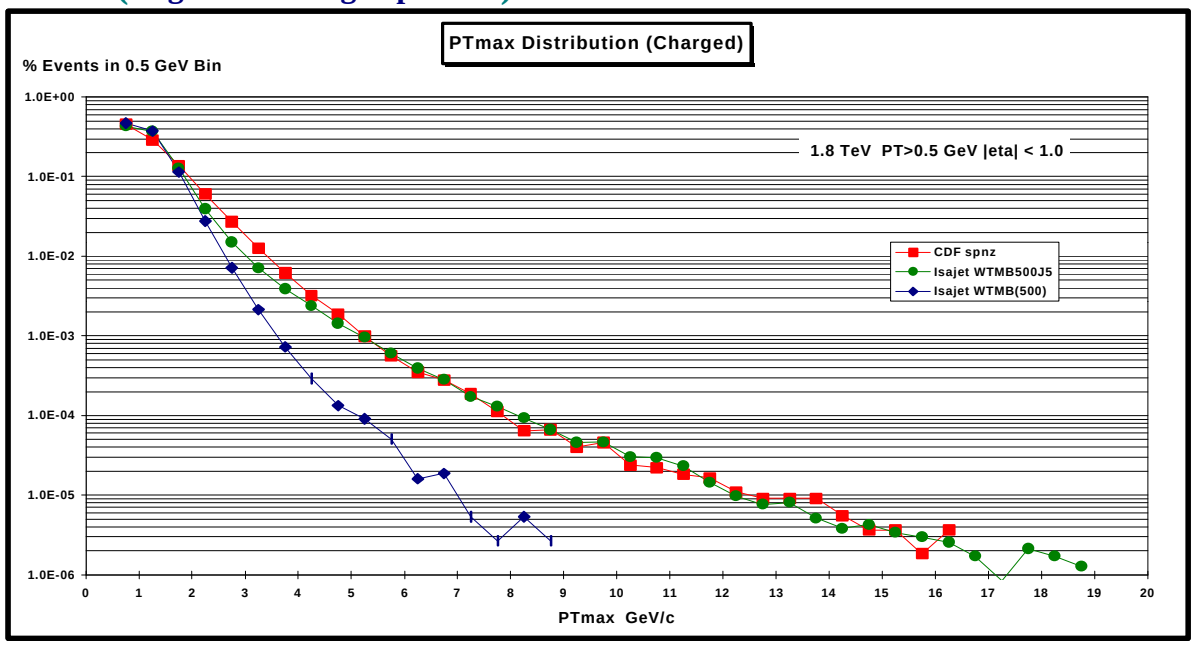


Distributions are normalized to 1.

Min-Bias Data - Distributions

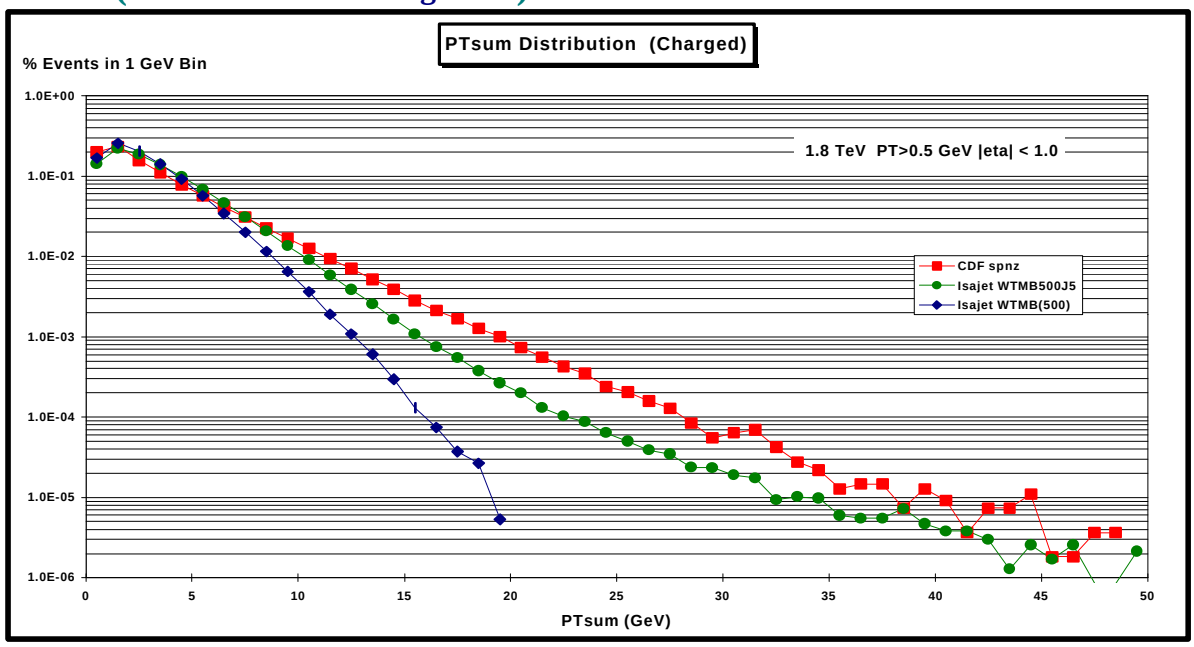
Isajet WTMB500J5 is sum of Isajet WTMB(500) is Isajet "Soft" scattering (<PT> = 500 MeV/c) plus Isajet 2-2 parton-parton "hard" scattering with (kT(hard) > 5 GeV/c).

PTmax (largest PT charged particle) Distribution:



Distributions are normalized to 1.

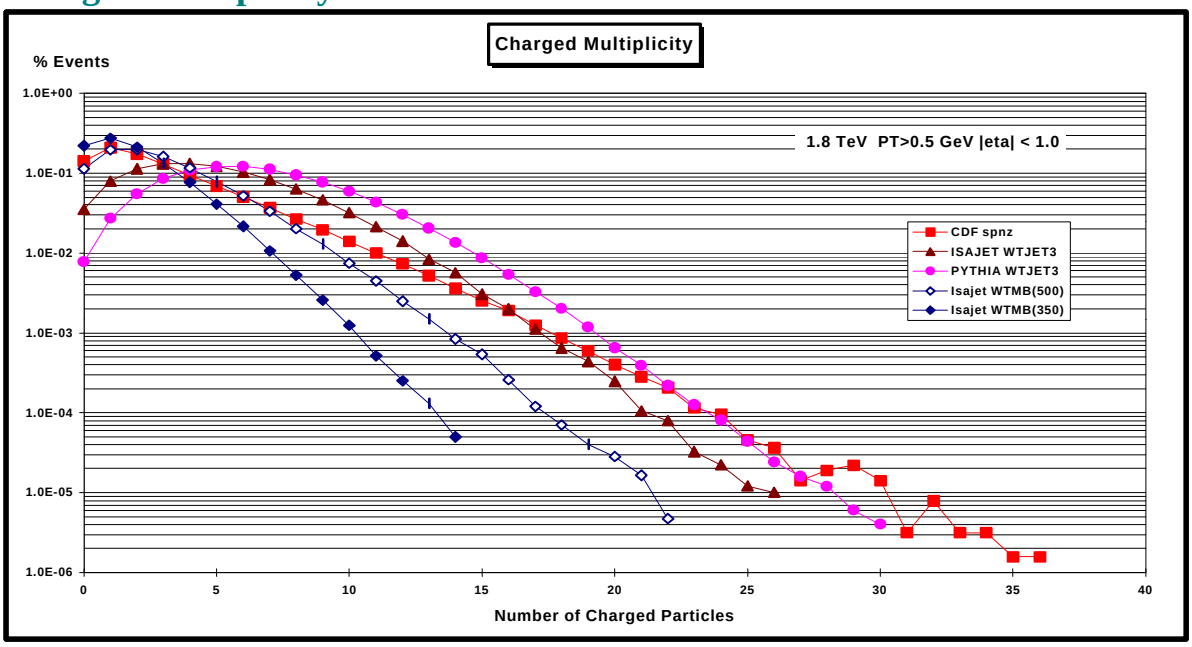
PTsum (scalar sum of all charged PT) Distribution:



Distributions are normalized to 1.

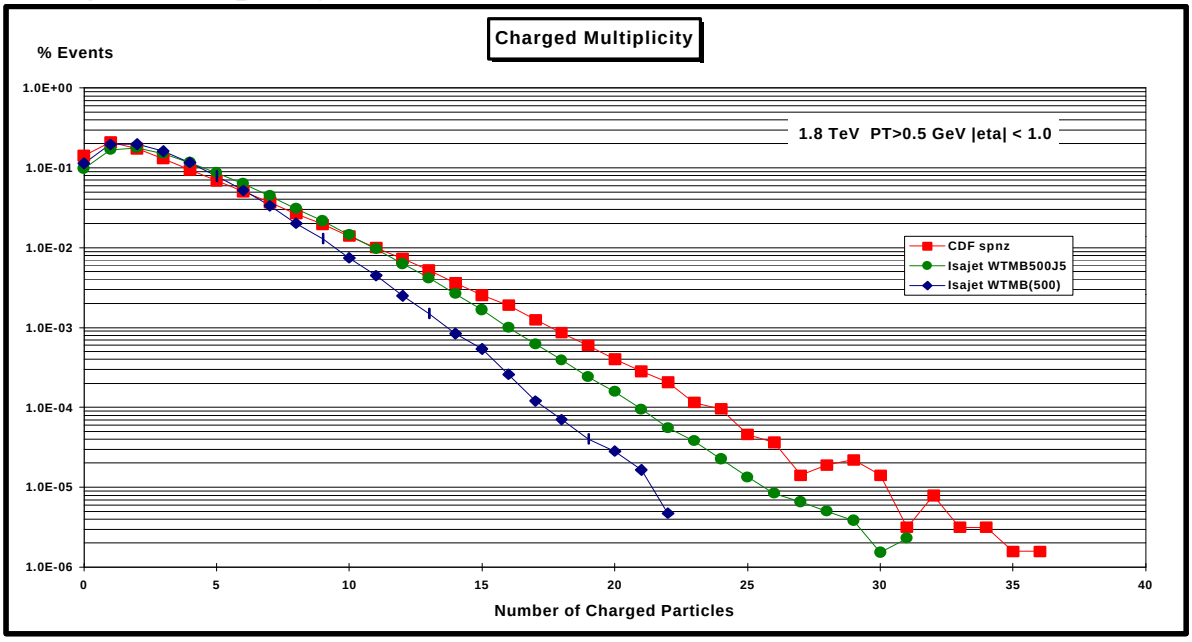
Min-Bias Data - Distributions

Charged Multiplicity Distribution:



Distributions are normalized to 1.

Charged Multiplicity Distribution:

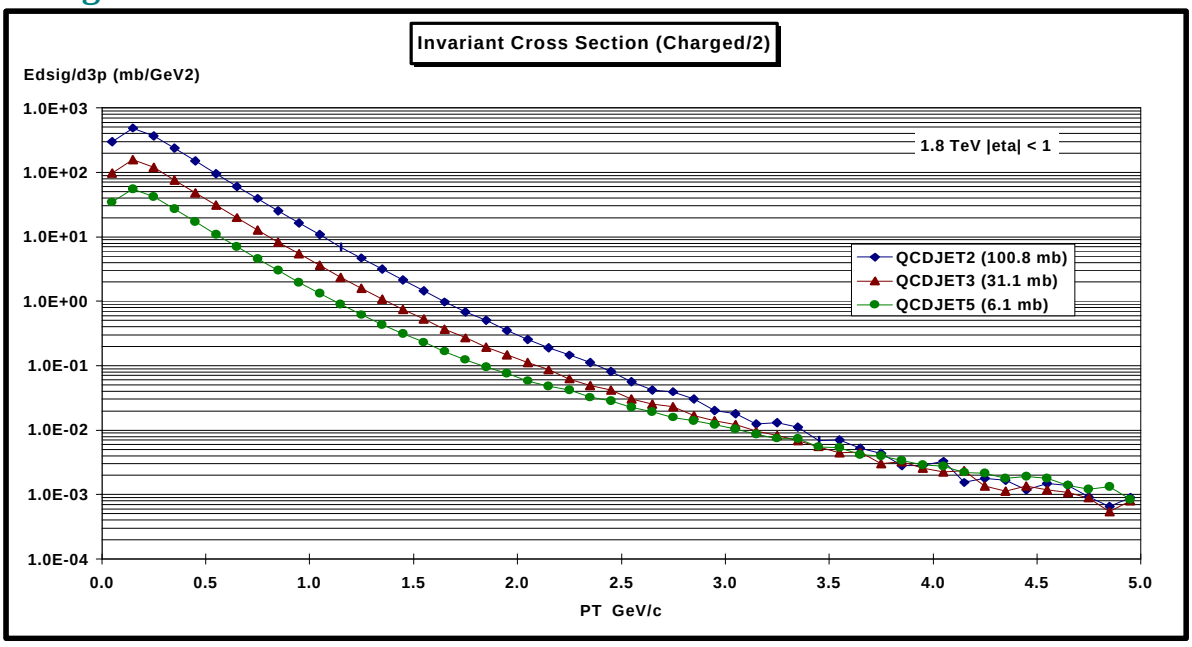


Distributions are normalized to 1.

Min-Bias Data – Inelastic Cross Section

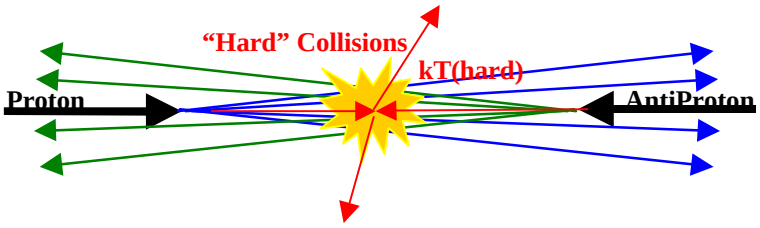
Would like to parameterize the entire inelastic cross section!

Charged Invariant Cross Section:



Remember that the perturbative total cross section diverges,

$$\int_{k_T} \frac{d\,s^{\,pert}}{dk_T} dk_T = \infty$$



Two Component Model:

σ(inelastic) =

σ("hard perturbative", $k_T > k_T$min) + σ("soft", everything else)

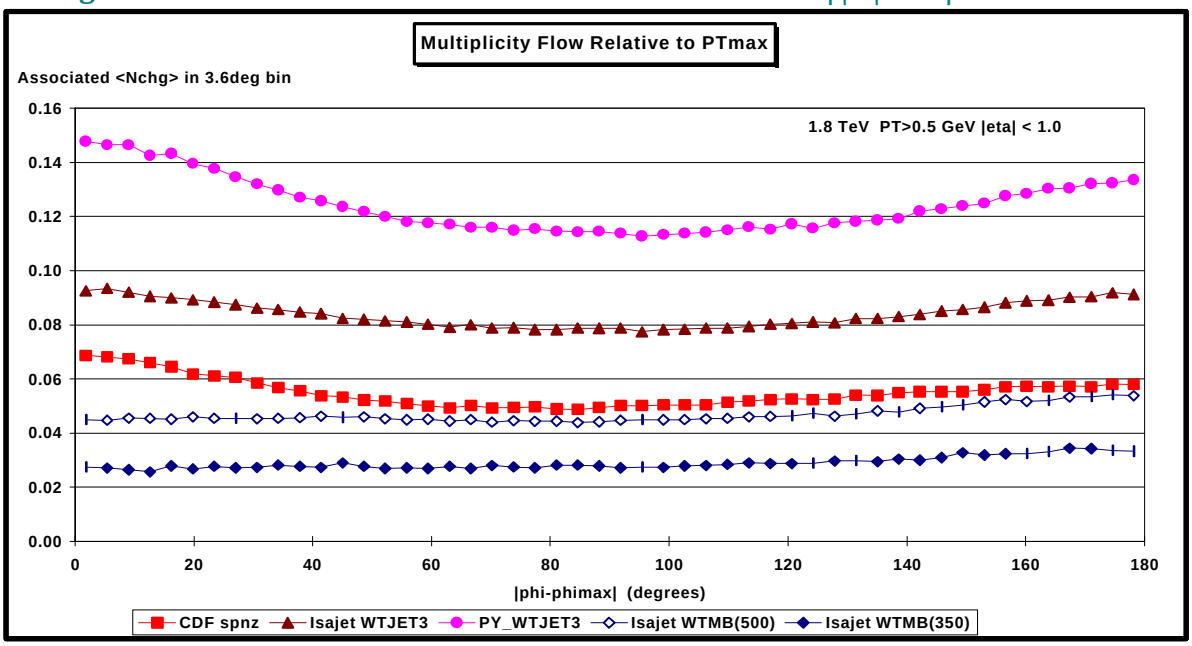
One Component Model:

σ(inelastic) =

σ("hard perturbative", all kT but cut-off the divergences)

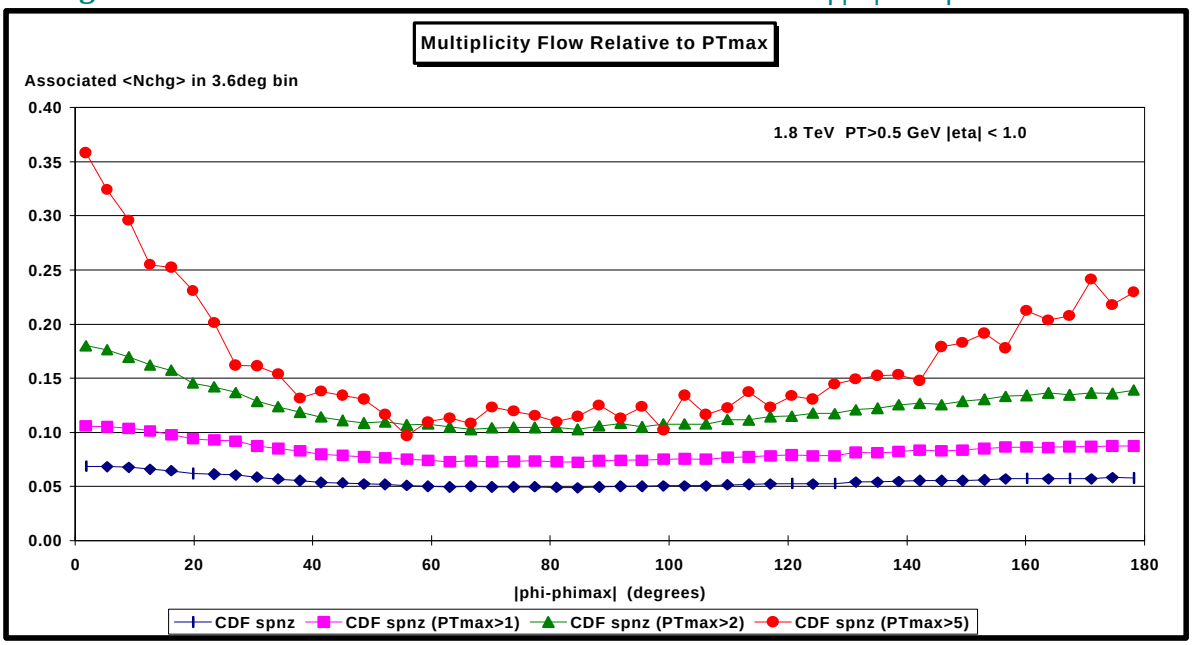
Min-Bias Data – N-Flow

<Nchg> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

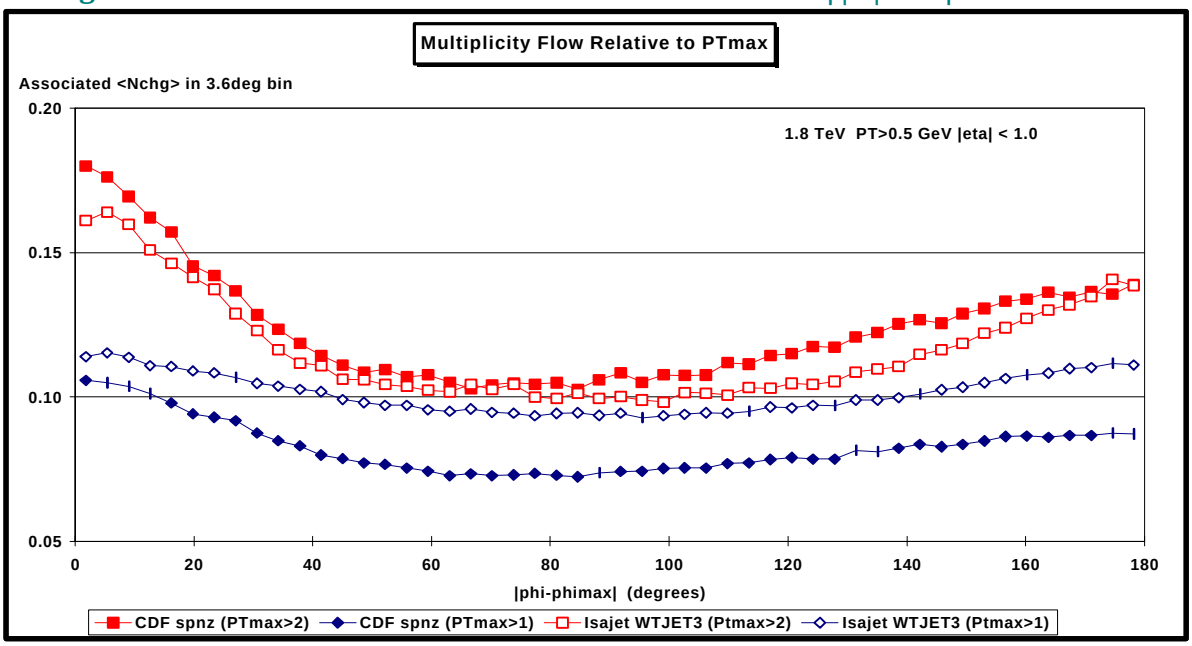
<Nchg> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

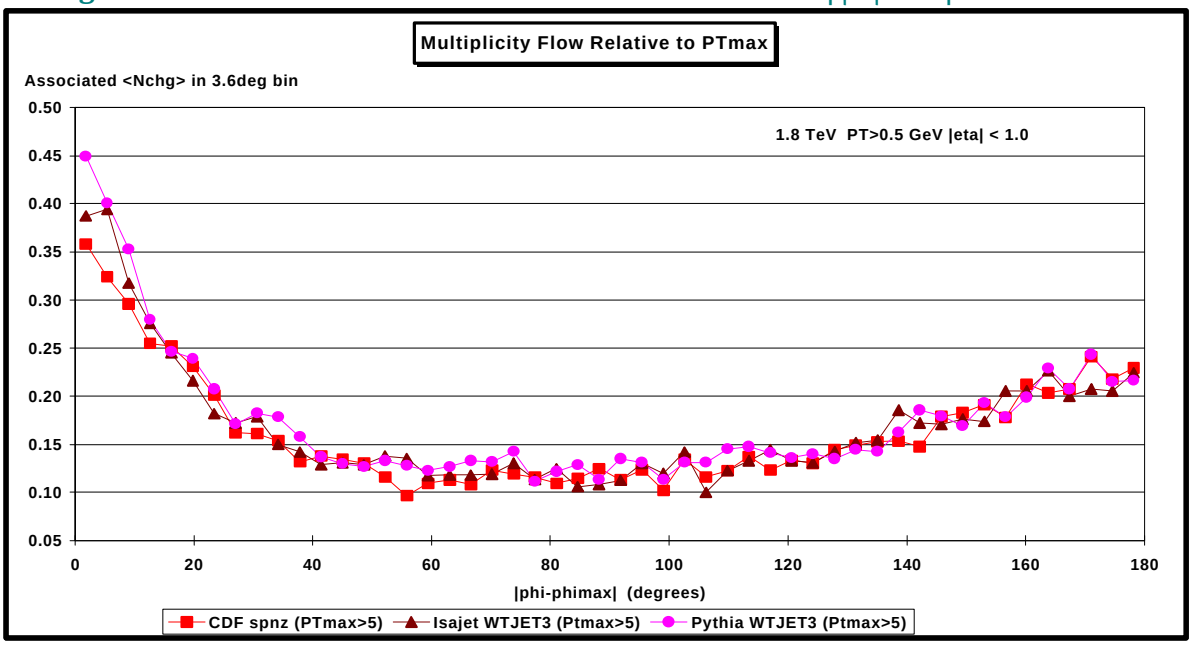
Min-Bias Data – N-Flow

<Nchg> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

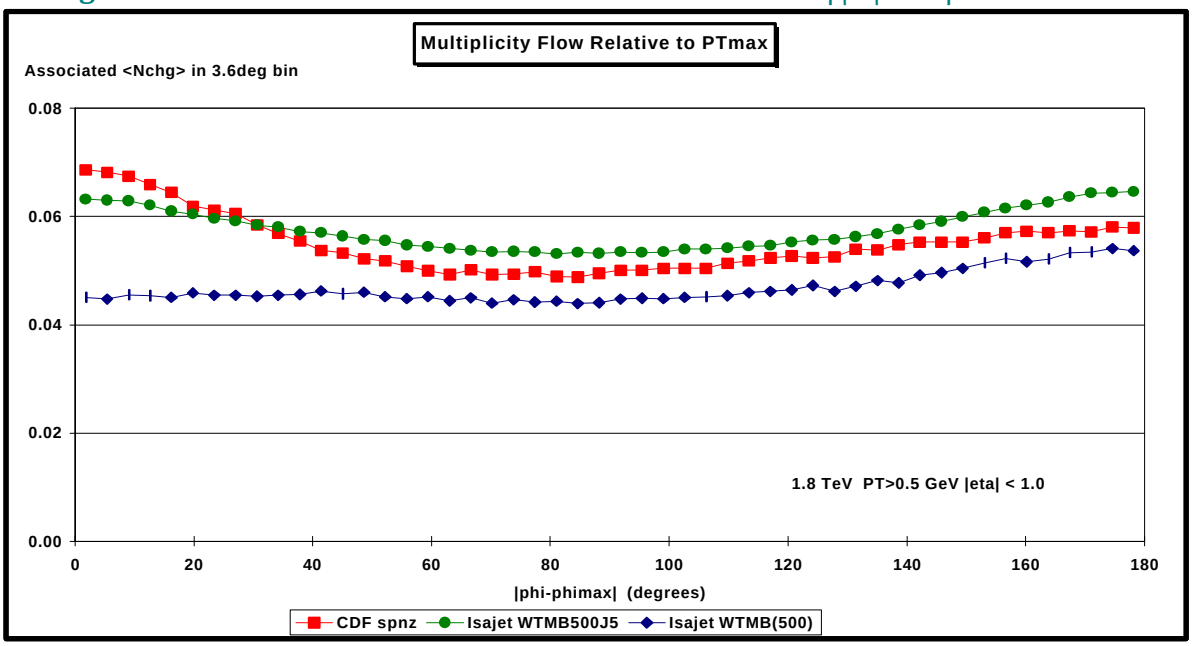
<Nchg> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

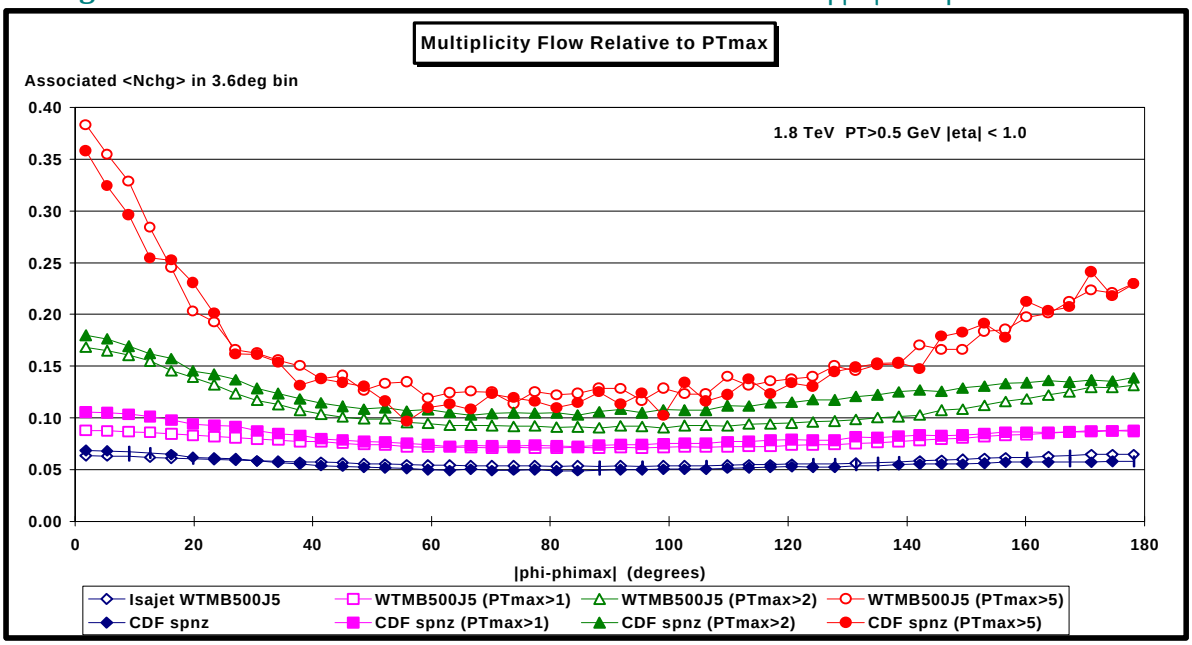
Min-Bias Data – N-Flow

<Nchg> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

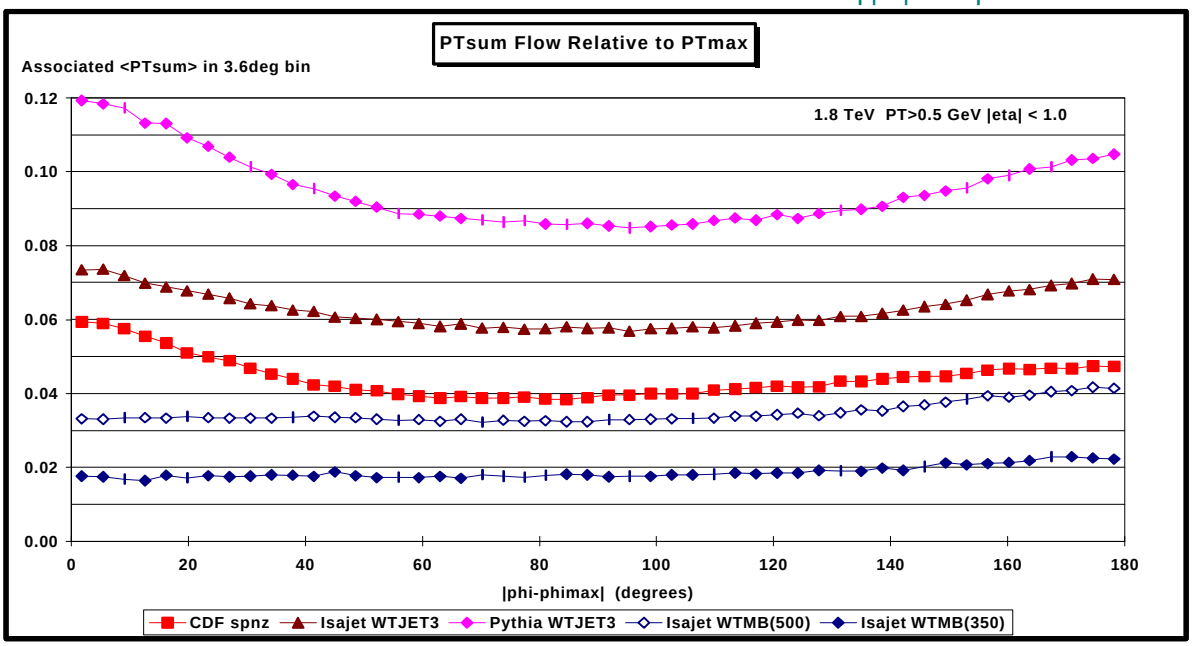
<Nchg> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

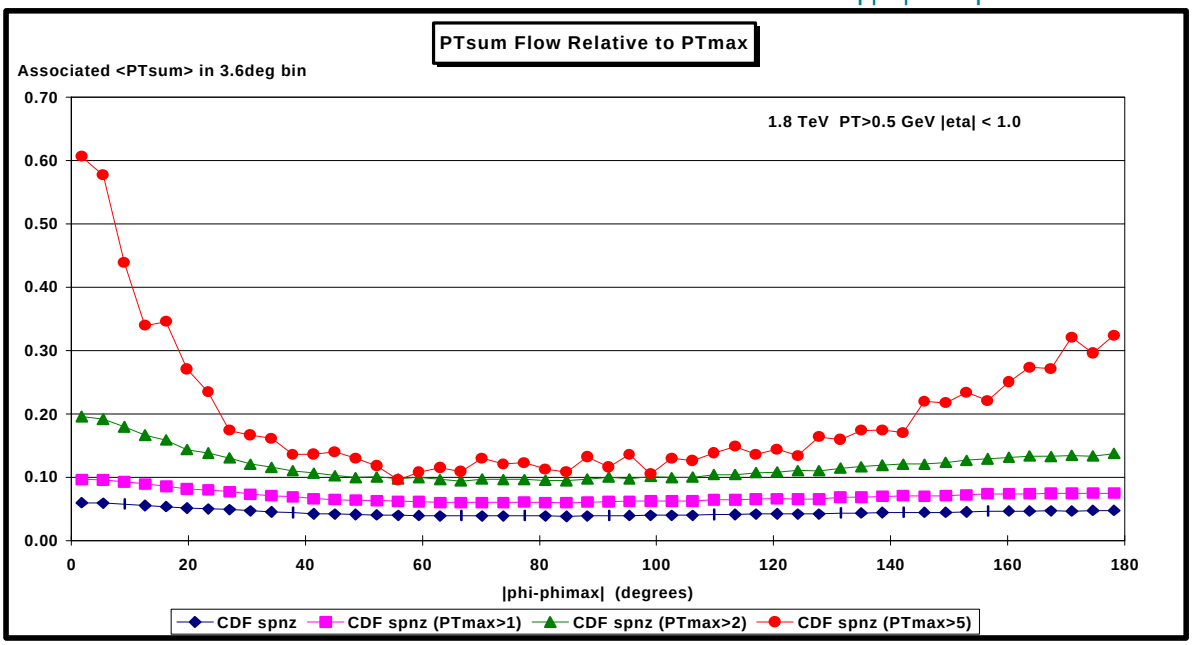
Min-Bias Data – PT-Flow

<PTsum> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

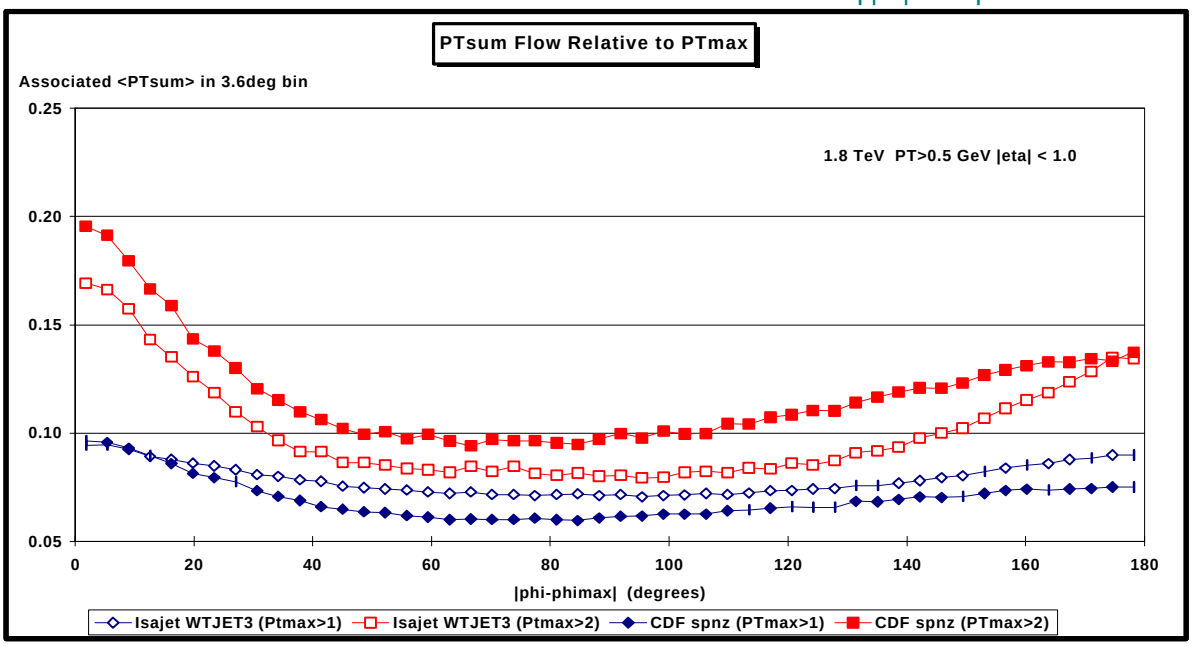
<PTsum> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

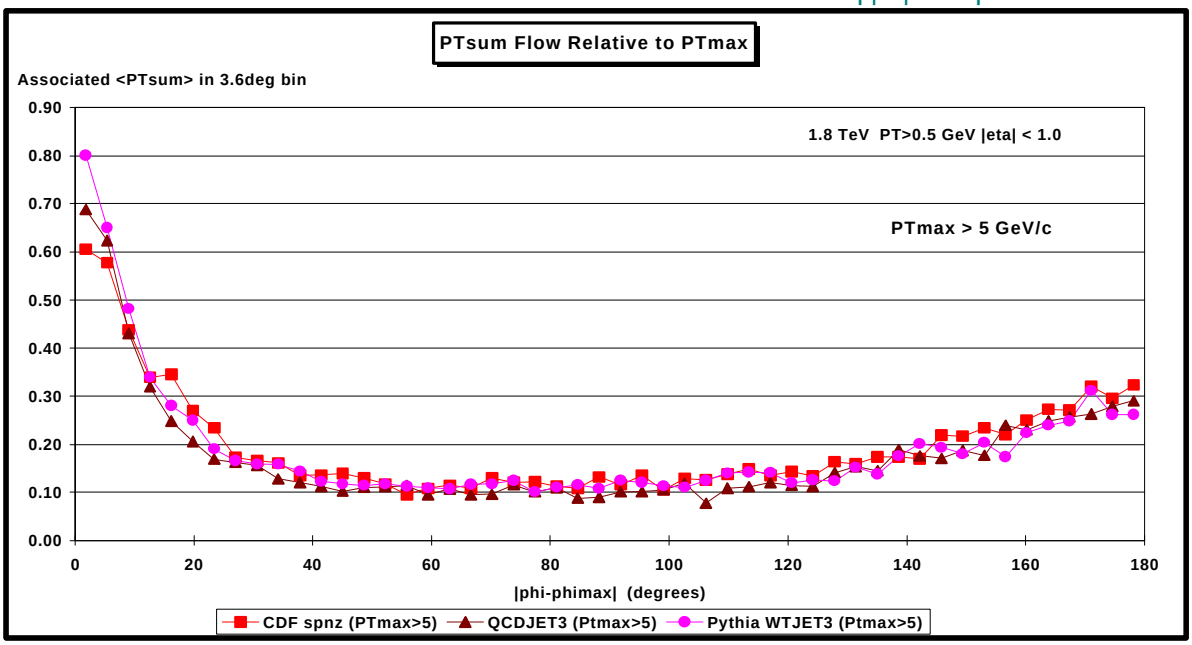
Min-Bias Data – PT-Flow

<PTsum> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

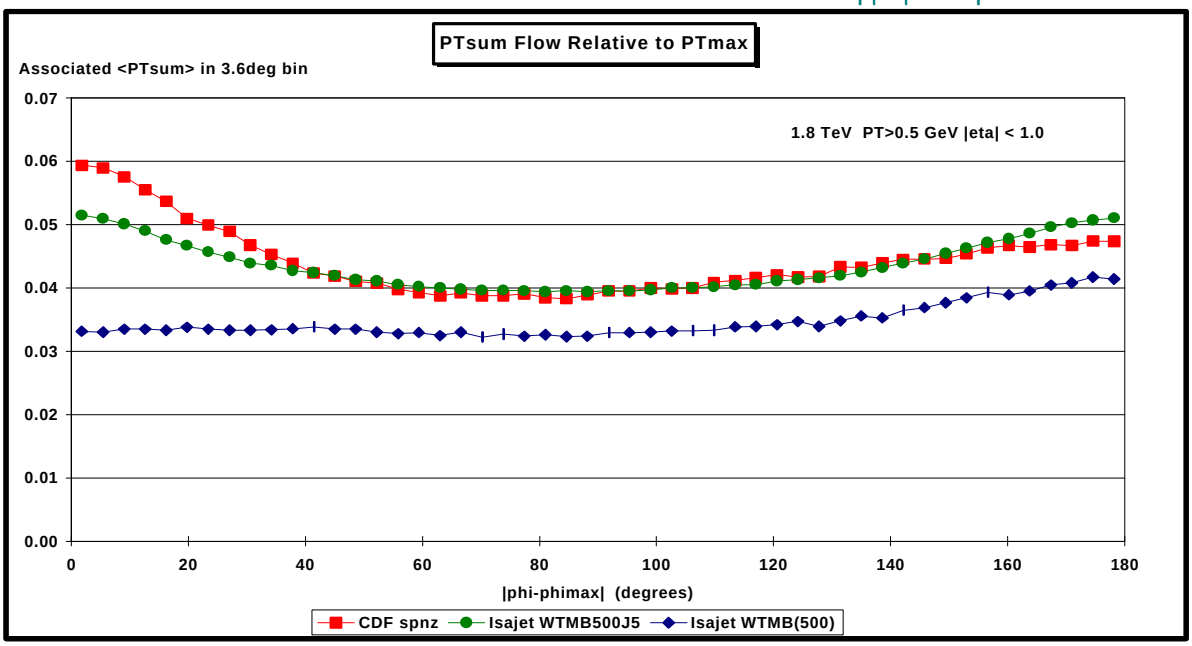
<PTsum> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

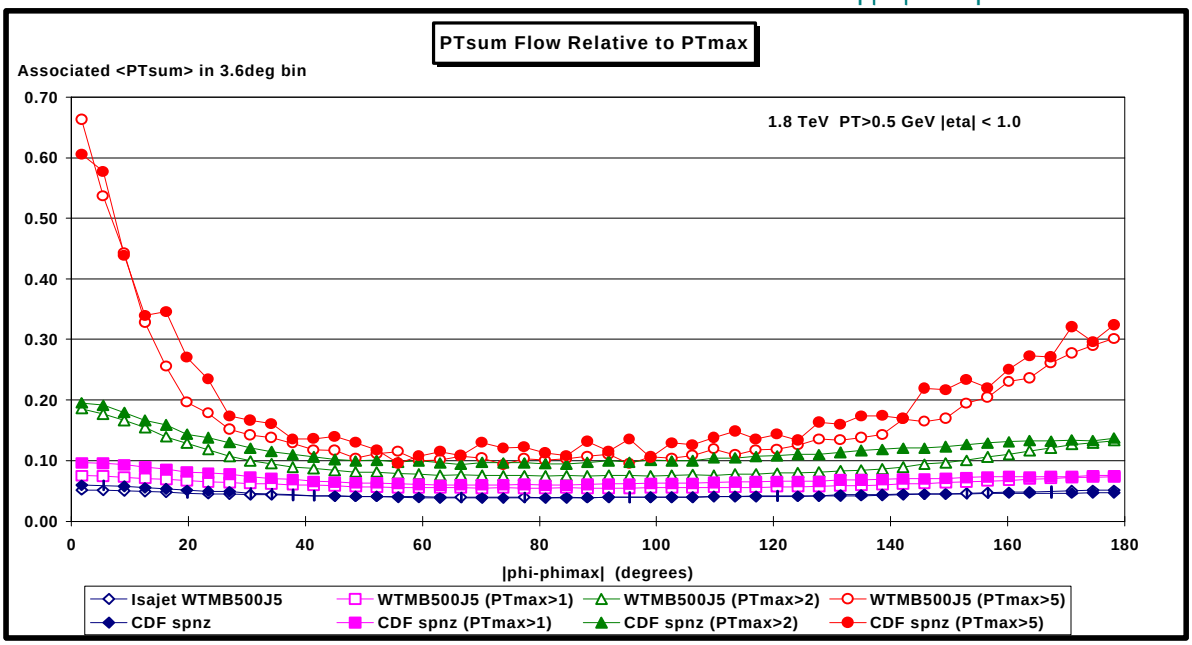
Min-Bias Data – PT-Flow

<PTsum> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

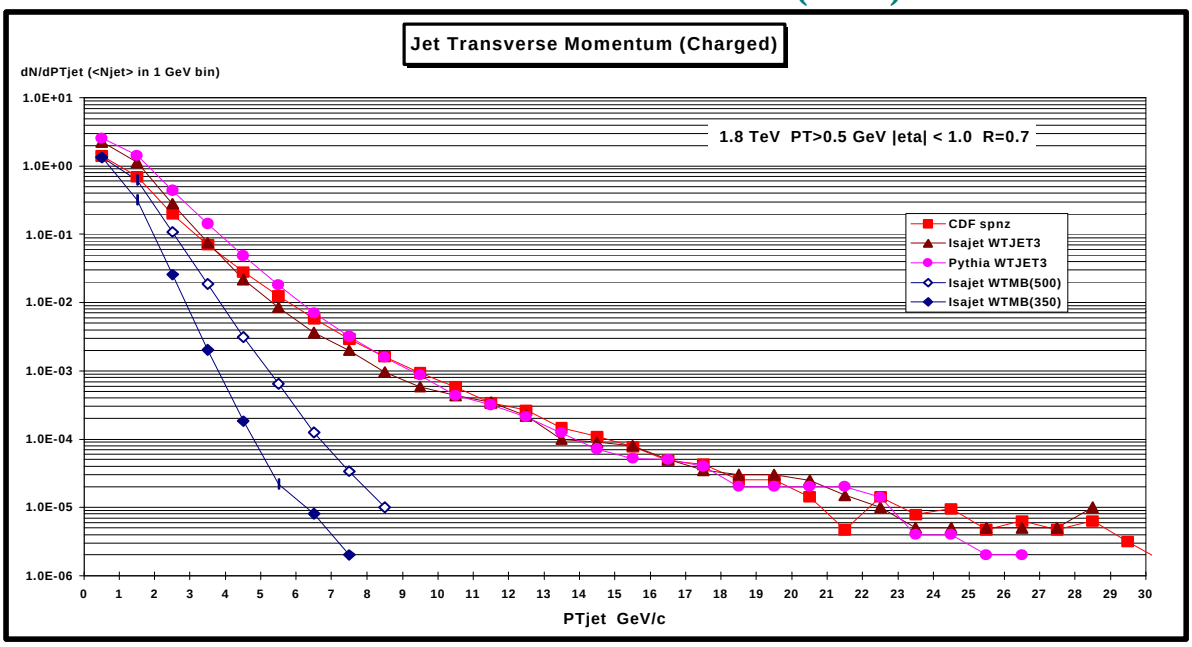
<PTsum> Produced in Association with PTmax versus |ϕ-ϕmax|:



Does not include PTmax (Nchg >=2).

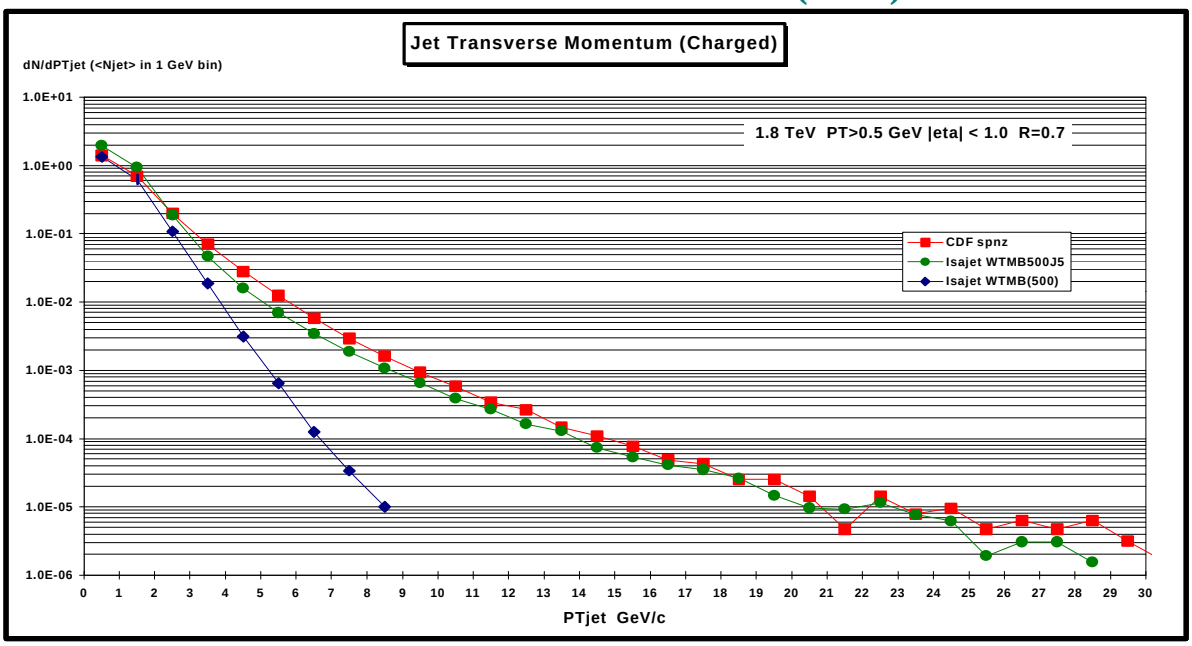
Min-Bias Data - Distributions

Inclusive Jet Transverse Momentum Distribution (R=0.7):



Distributions are (1/Nev)dNjet/dPT (integral = <Njet>).

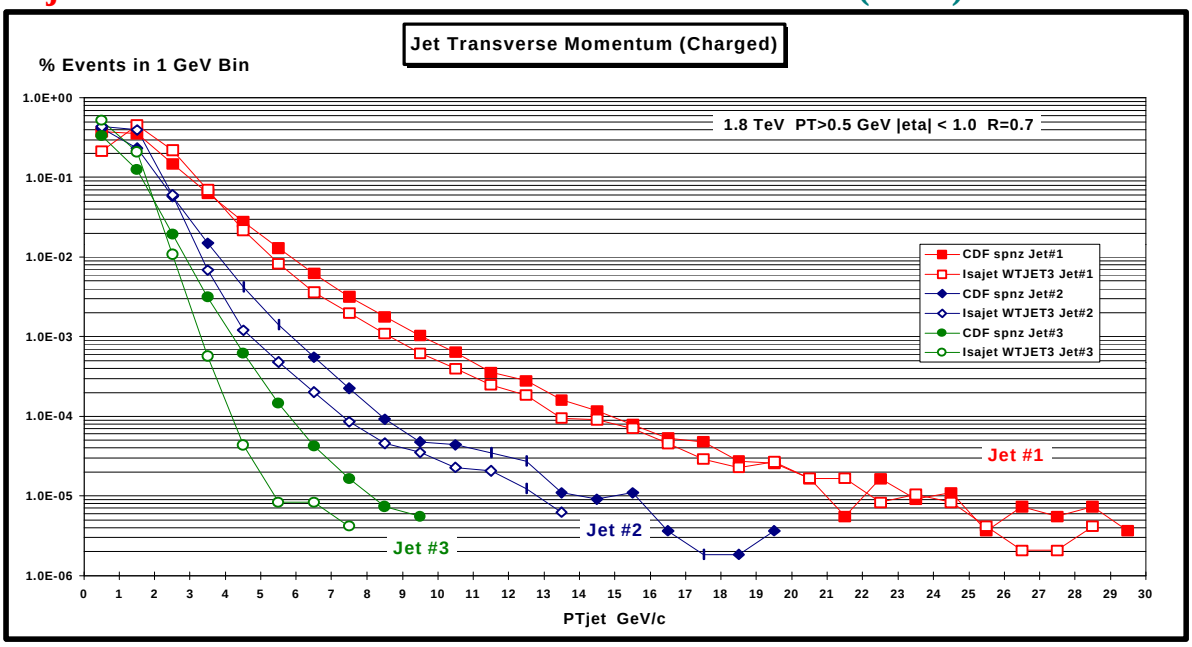
Inclusive Jet Transverse Momentum Distribution (R=0.7):



Distributions are (1/Nev)dNjet/dPT (integral = <Njet>).

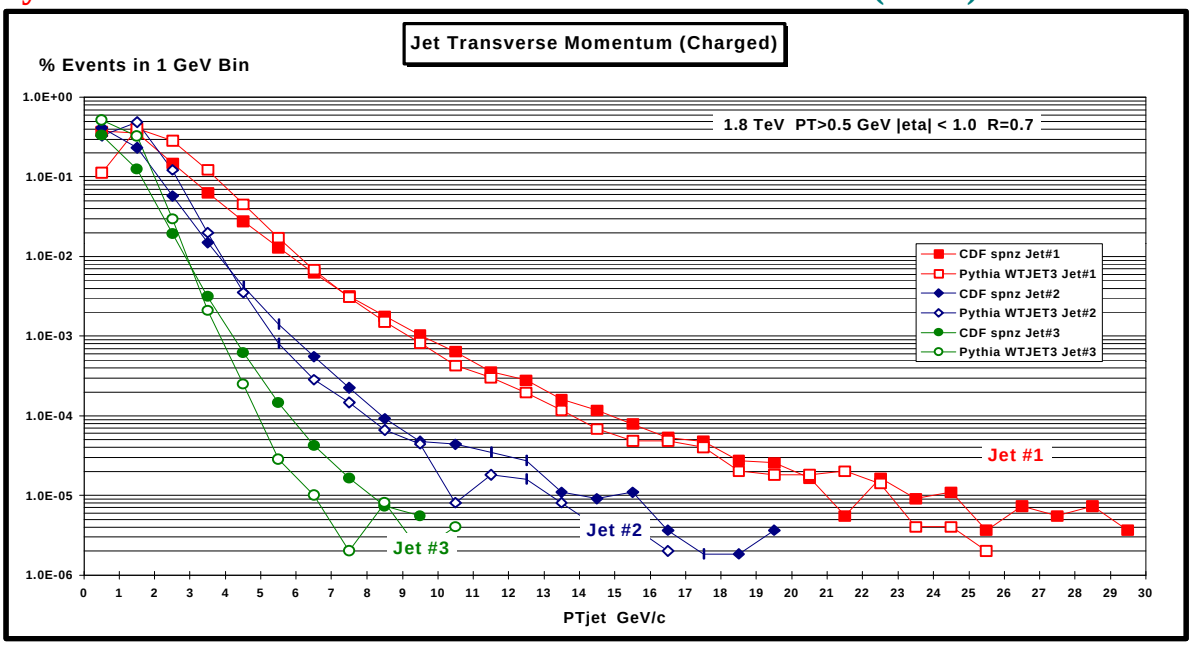
Min-Bias Data - Distributions

Isajet Multi-Jet Transverse Momentum Distributions (R=0.7):



Jet#1 distribution is normalized to 1.

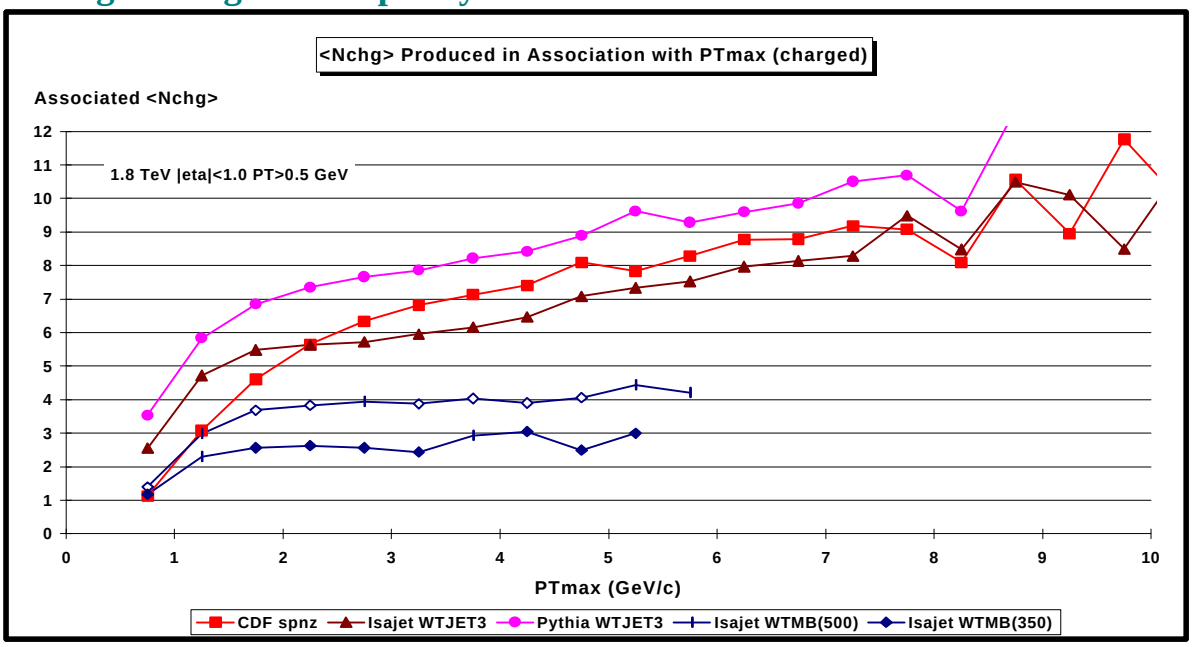
Pythia Multi-Jet Transverse Momentum Distributions (R=0.7):



Jet#1 distribution is normalized to 1.

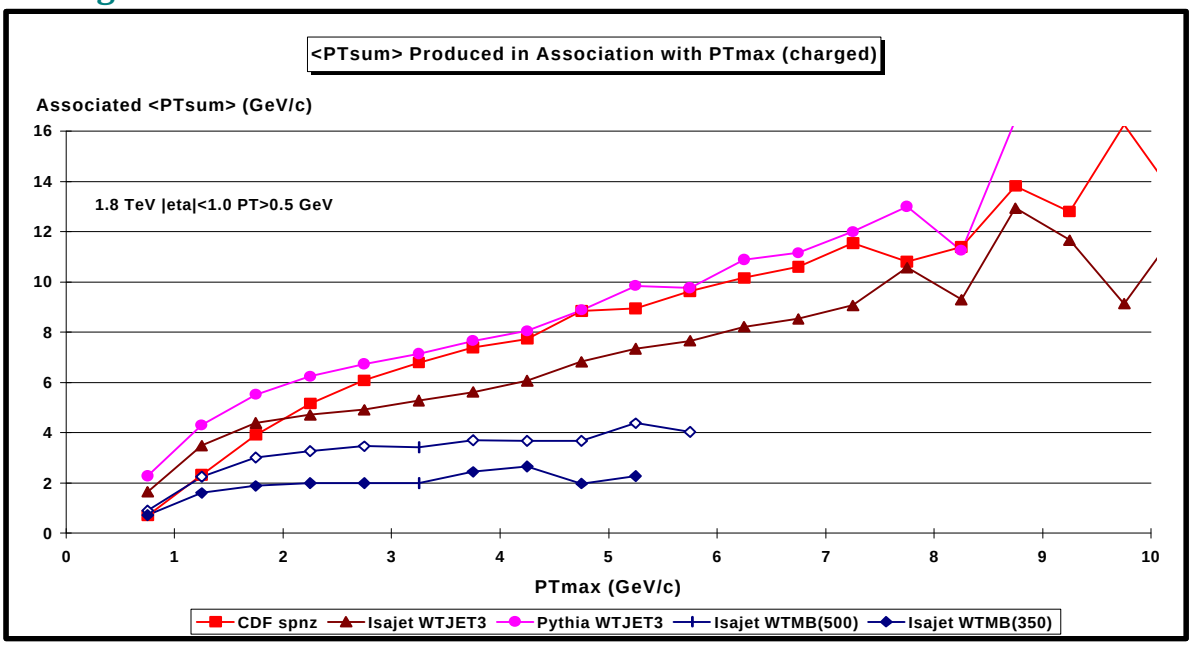
Min-Bias Data - Dependence on PTmax

Average Charged Multiplicity Produced in Association with PTmax:



Does not include PTmax, but includes zeros.

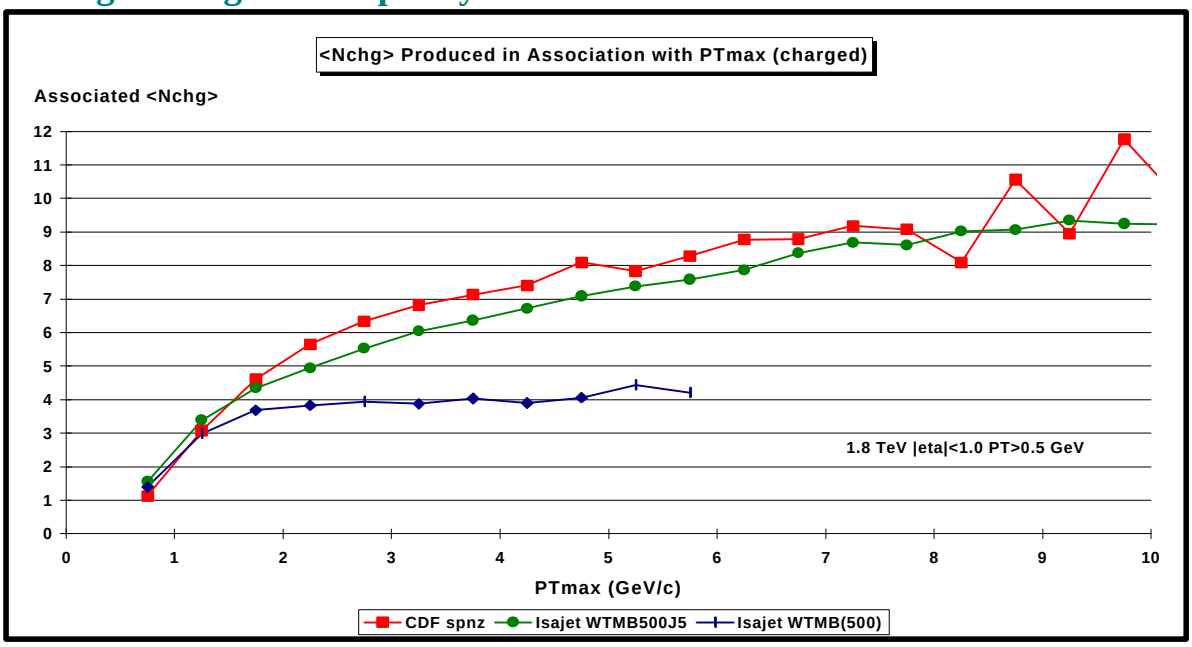
Average PTsum Produced in Association with PTmax:



Does not include PTmax, but includes zeros.

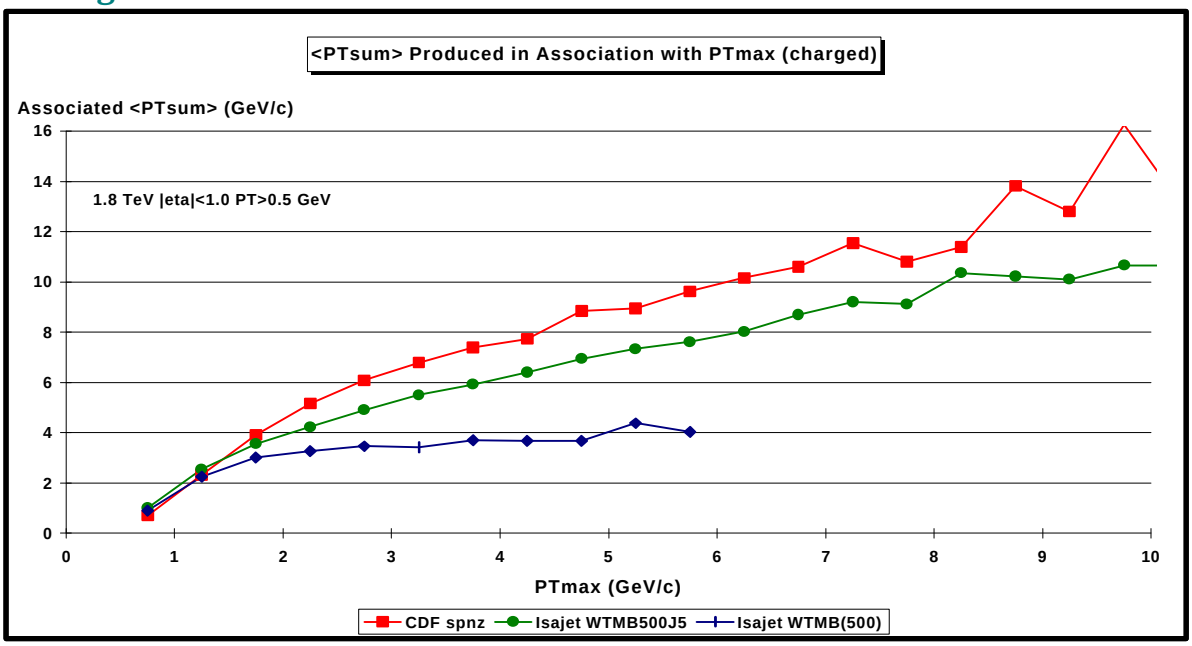
Min-Bias Data - Dependence on PTmax

Average Charged Multiplicity Produced in Association with PTmax:



Does not include PTmax, but includes zeros.

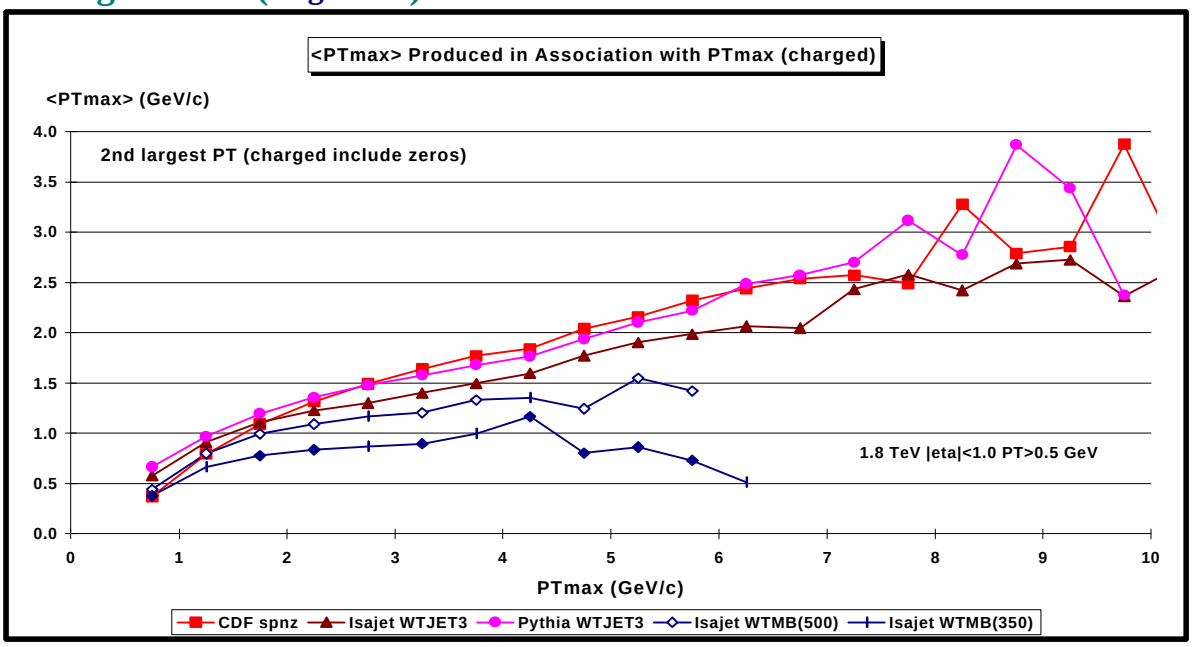
Average PTsum Produced in Association with PTmax:



Does not include PTmax, but includes zeros.

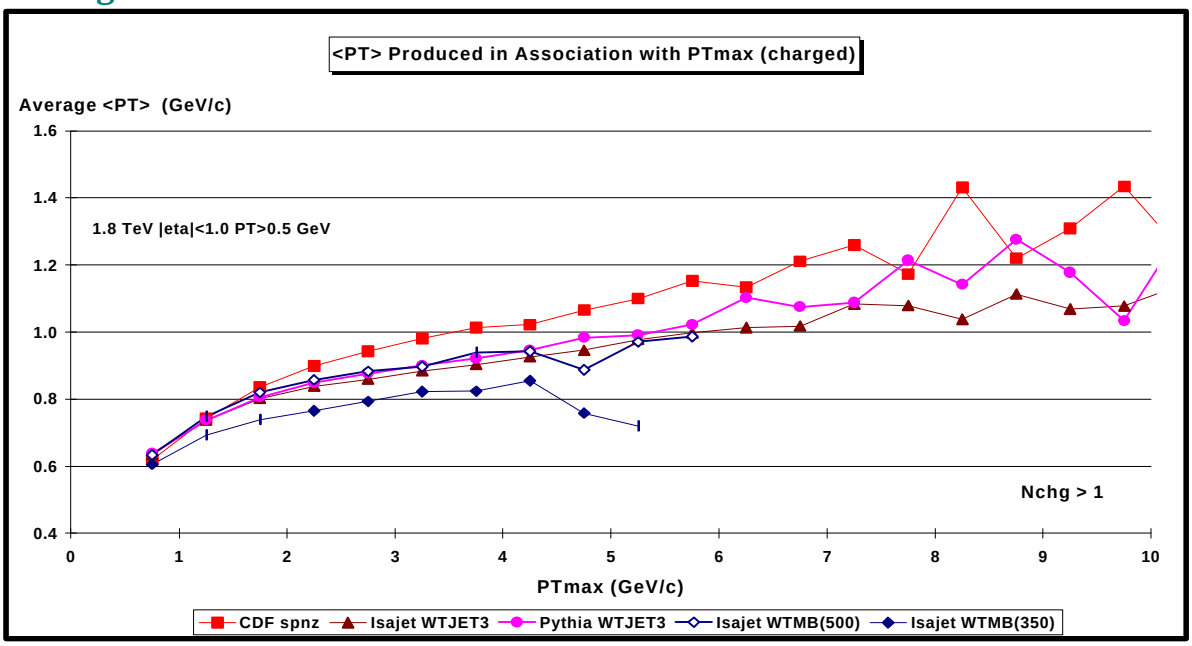
Min-Bias Data - Dependence on PTmax

Average PTmax (largest PT) Produced in Association with PTmax:



Does not include PTmax, but includes zeros.

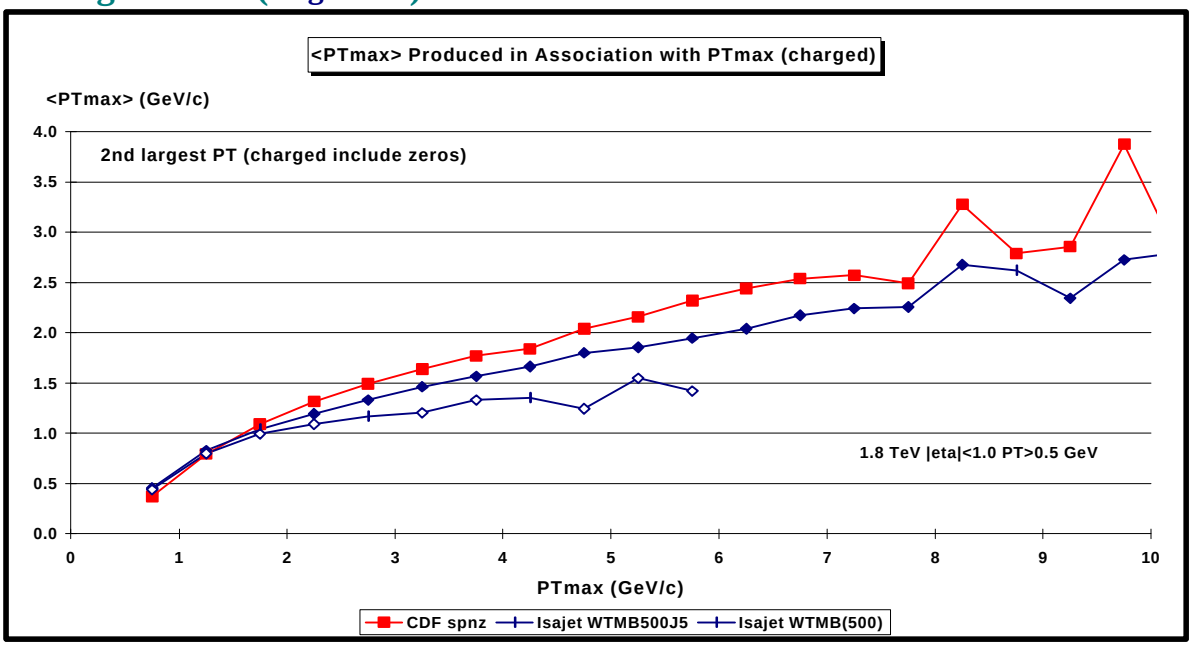
Average <PT> Produced in Association with PTmax:



Does not include PTmax and does not include zeros.

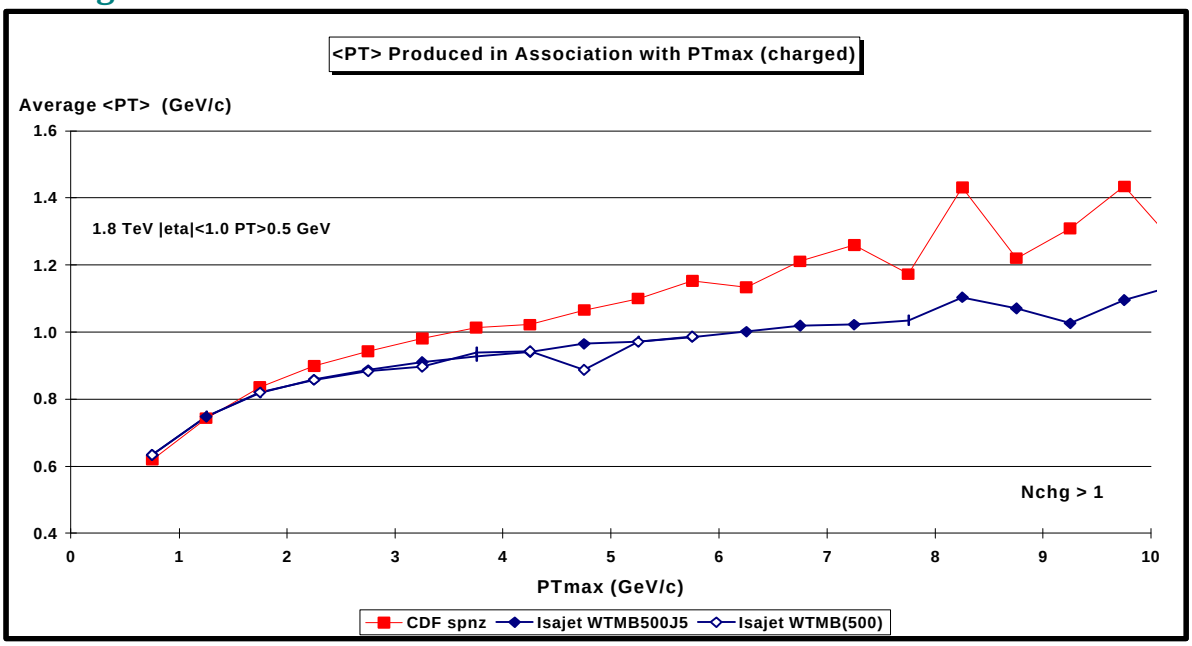
Min-Bias Data - Dependence on PTmax

Average PTmax (largest PT) Produced in Association with PTmax:



Does not include PTmax, but includes zeros.

Average <PT> Produced in Association with PTmax:



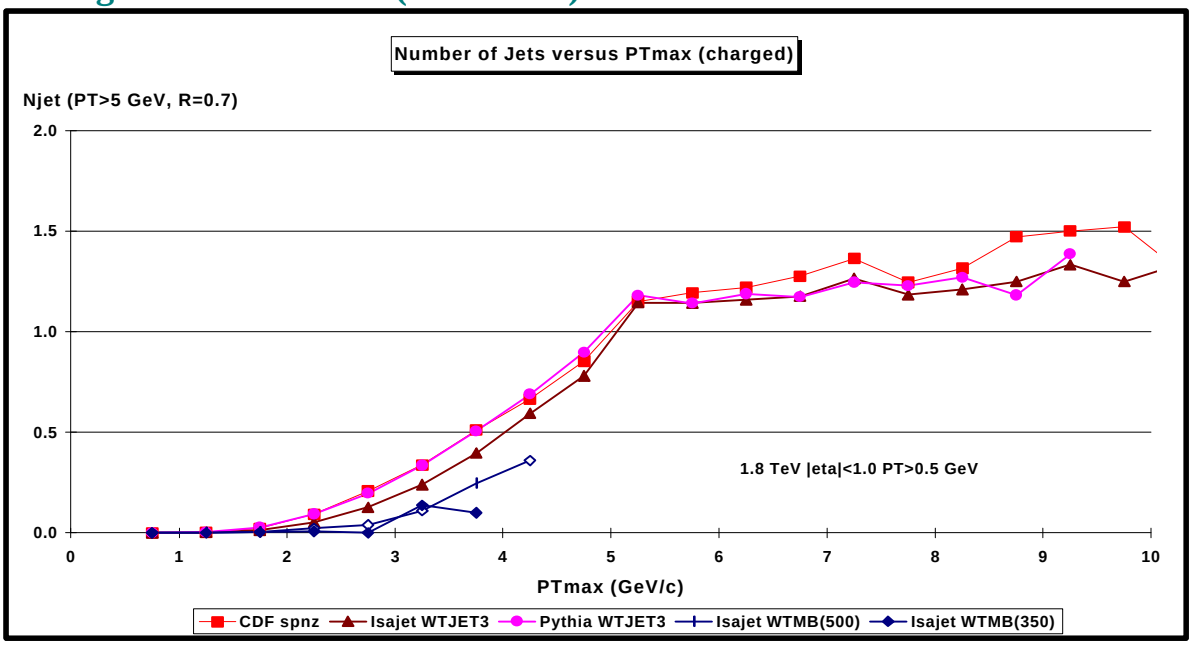
Does not include PTmax and does not include zeros.

Min-Bias Data - Dependence on PTmax

Average Number of Jets (PT > 0.5 GeV) versus PTmax:

Jets are constructed from the charged particles with R=0.7.

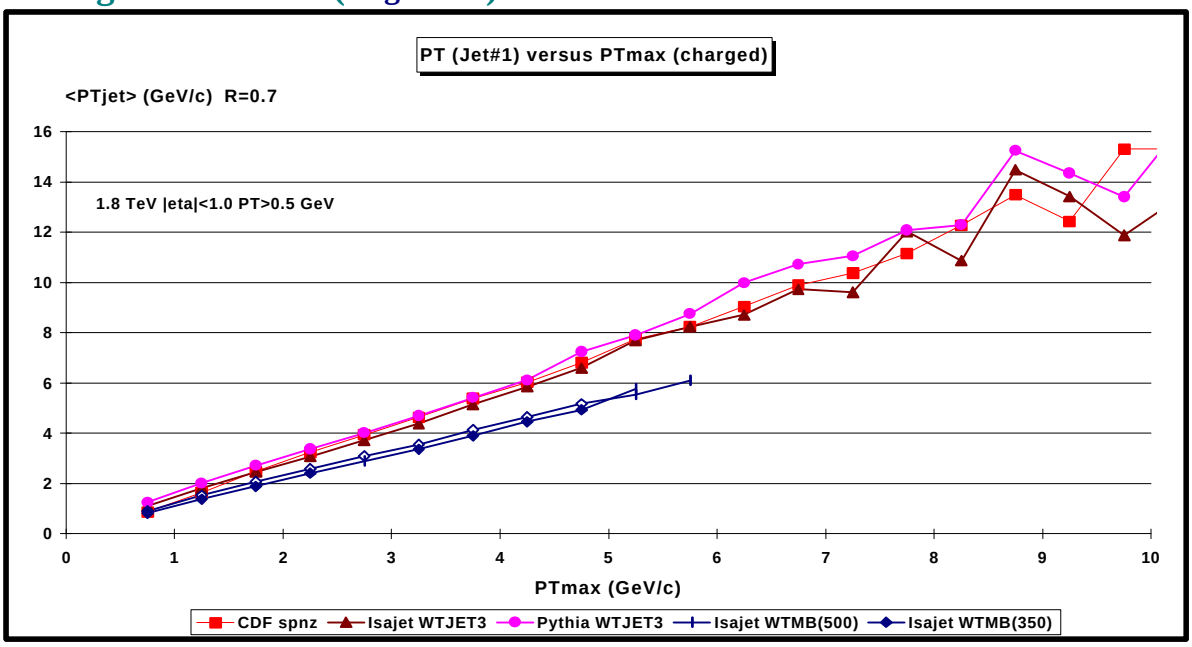
Average Number of Jets (PT > 5 GeV) versus PTmax:



Jets are constructed from the charged particles with R=0.7.

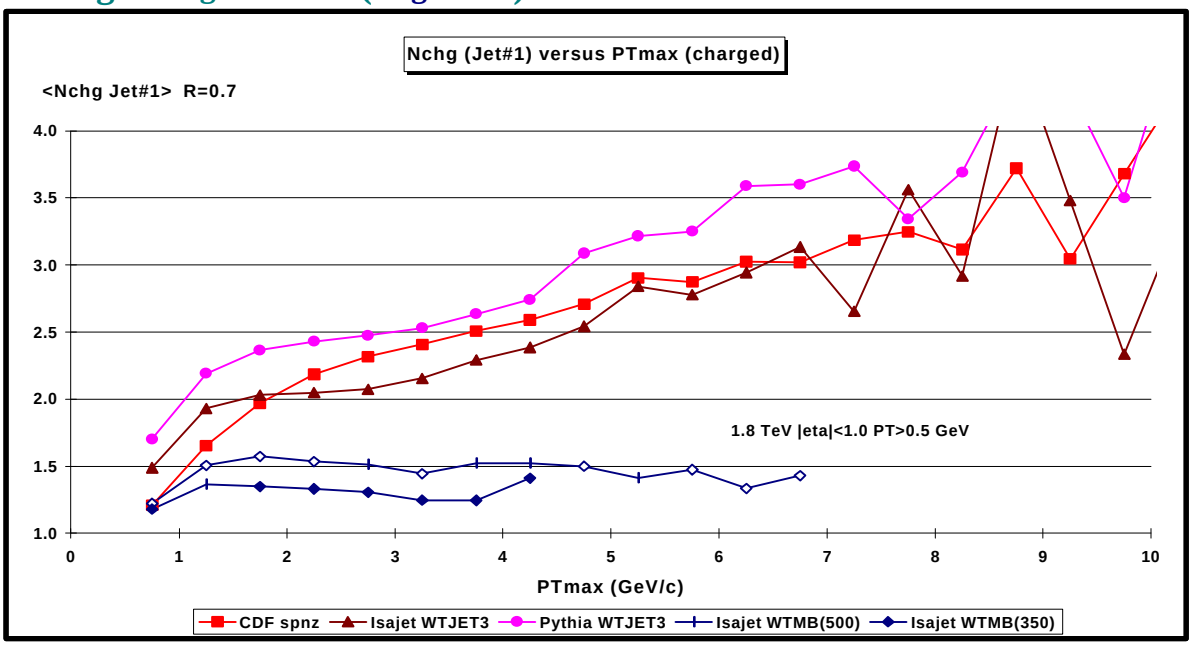
Min-Bias Data - Dependence on PTmax

Average PT of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

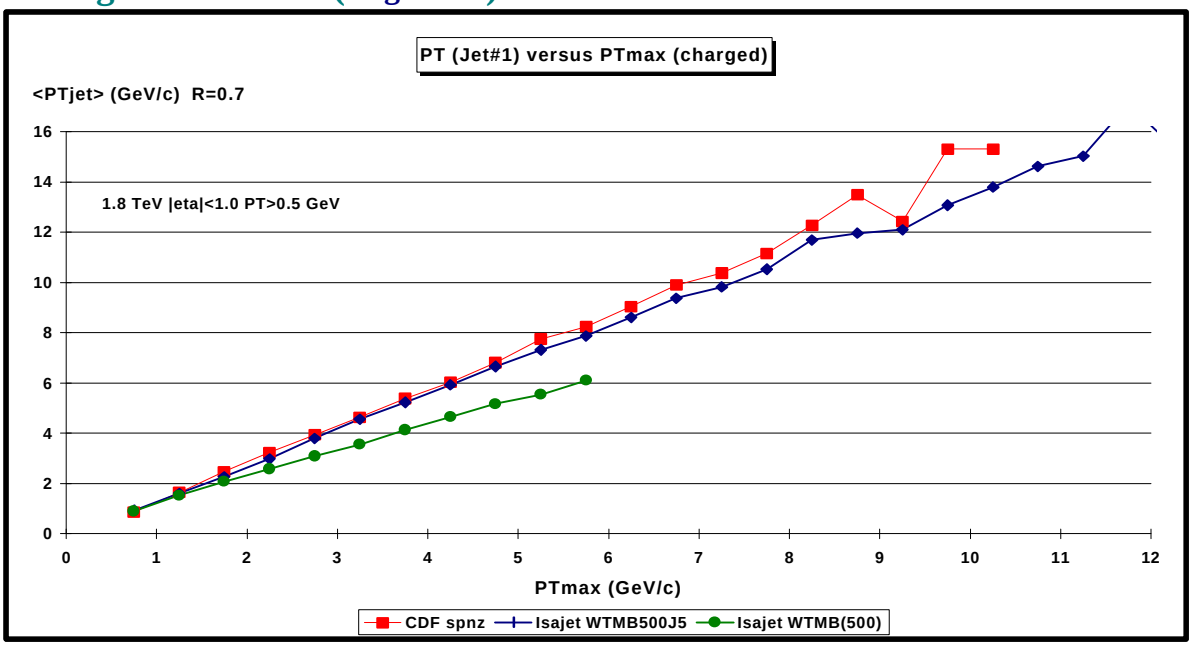
Average Nchg of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

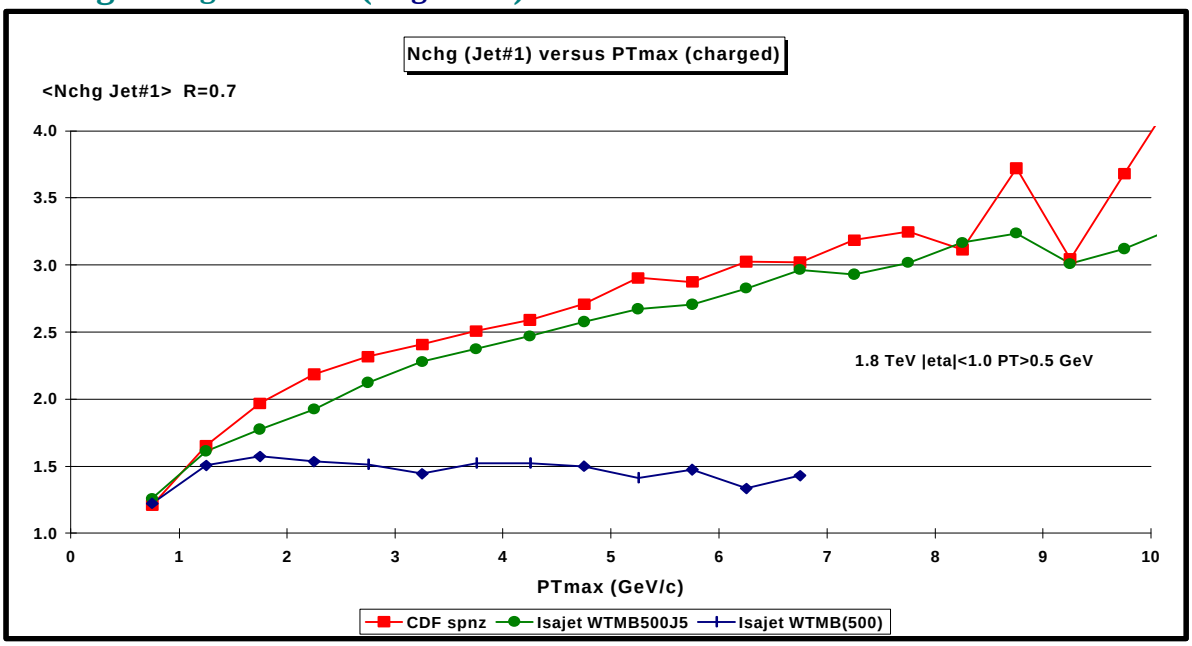
Min-Bias Data - Dependence on PTmax

Average PT of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

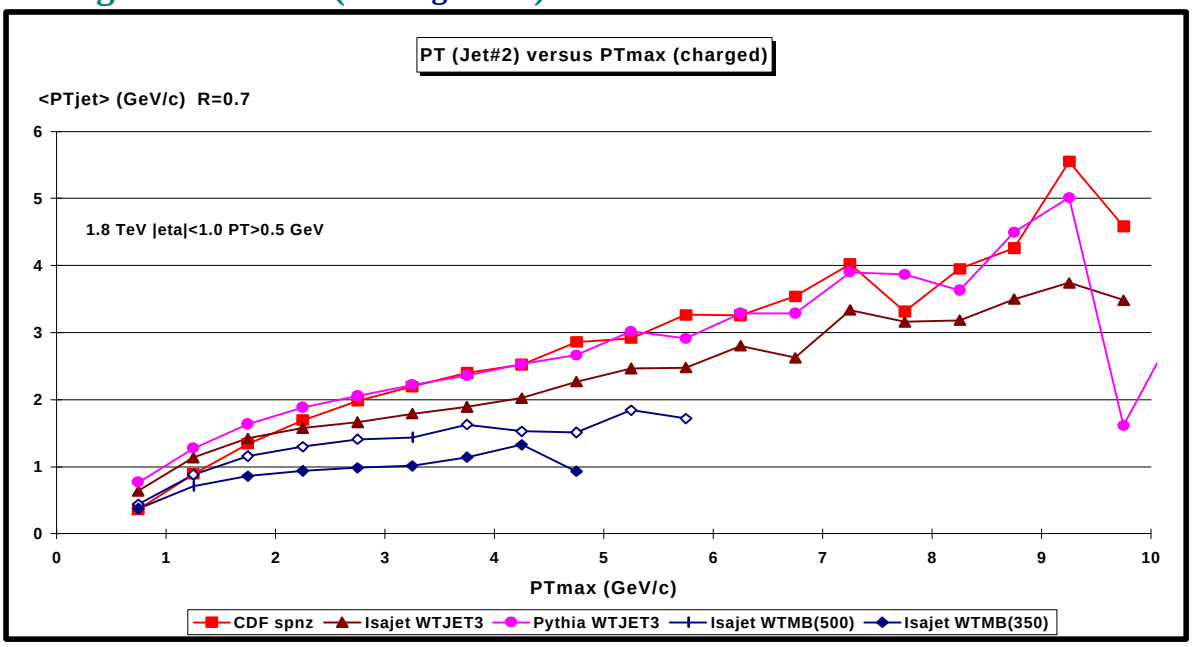
Average Nchg of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

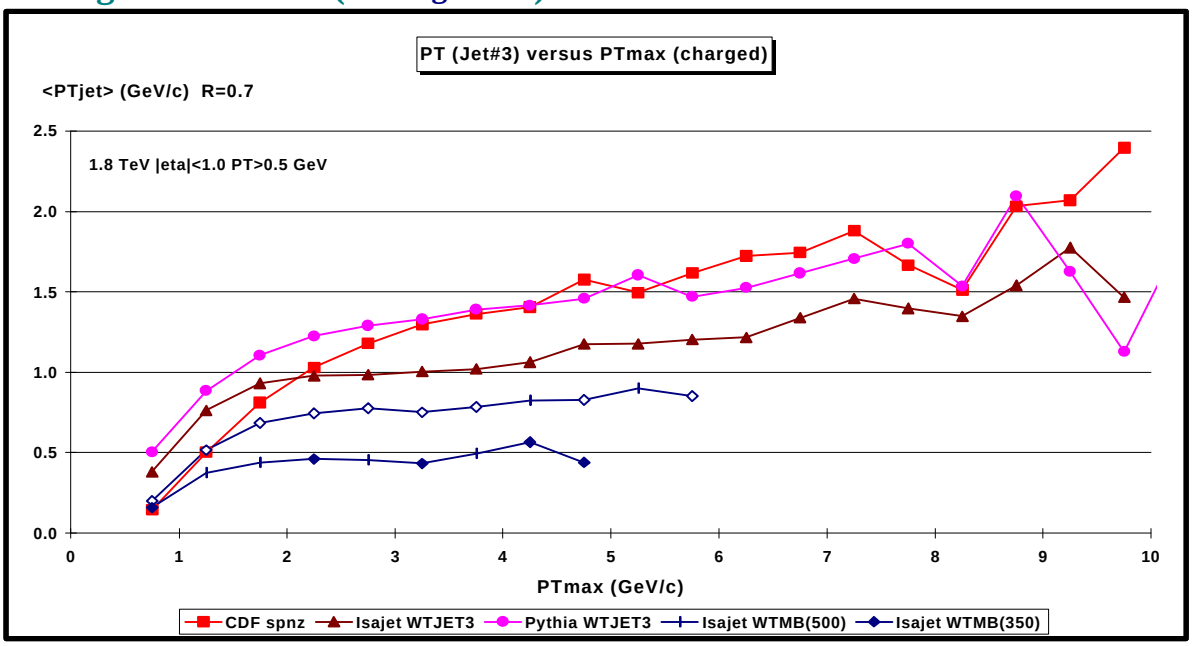
Min-Bias Data - Dependence on PTmax

Average PT of Jet#2 (2nd largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

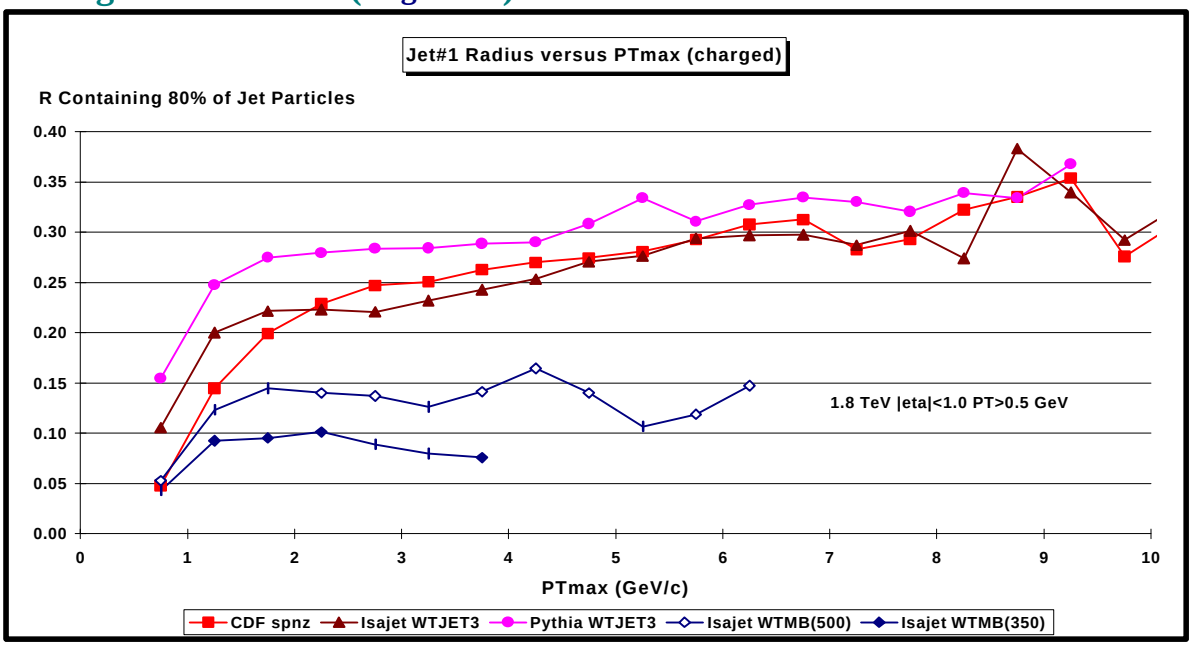
Average PT of Jet#3 (3nd largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

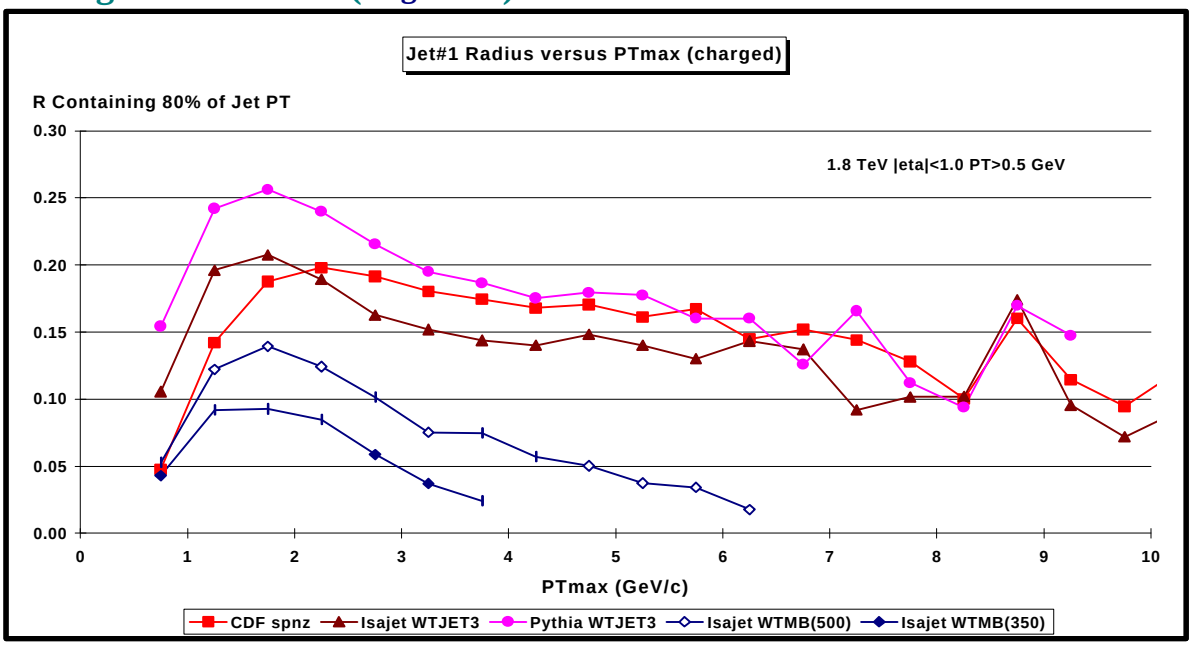
Min-Bias Data - Dependence on PTmax

Average Size of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

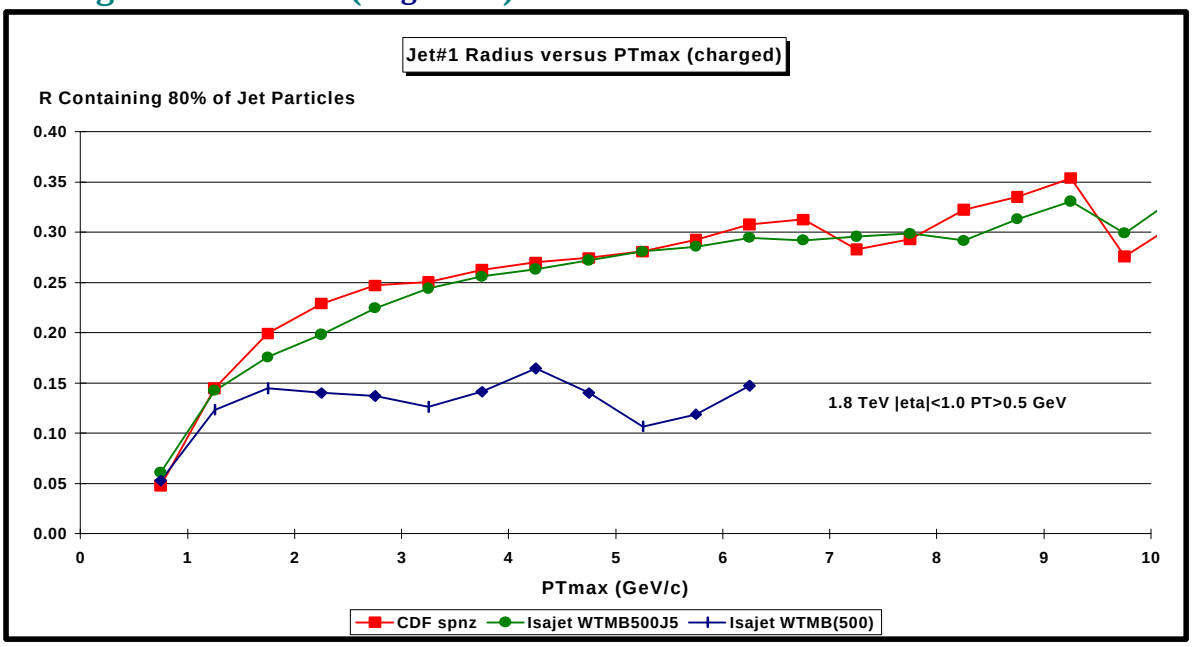
Average Size of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

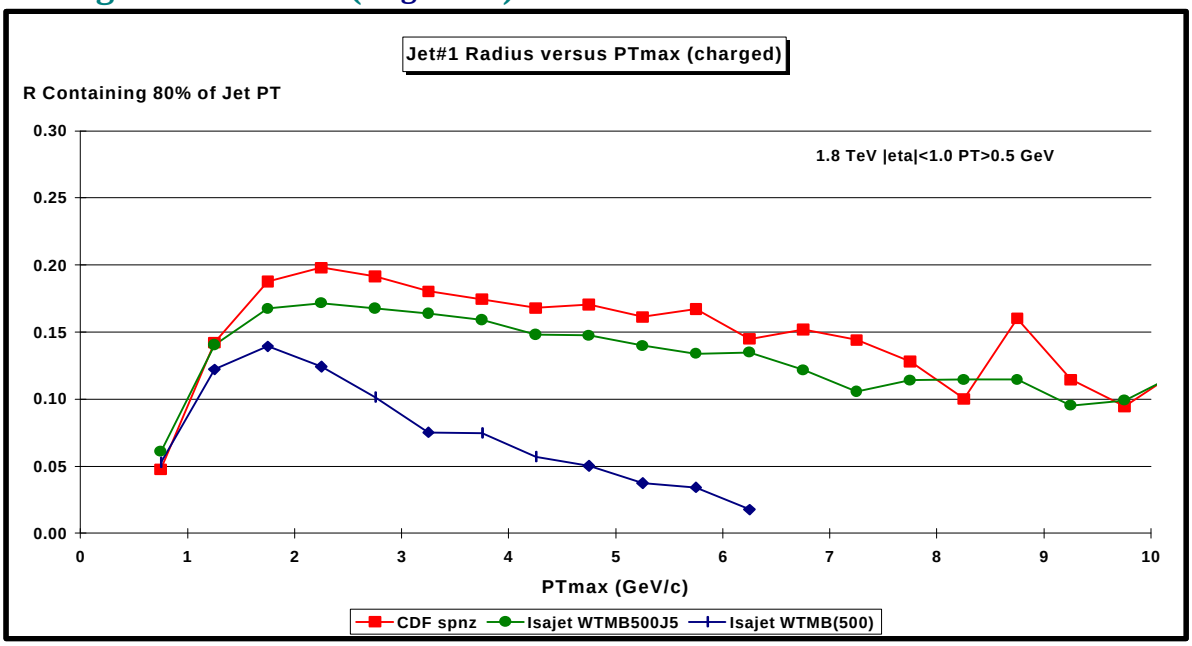
Min-Bias Data - Dependence on PTmax

Average Size of Jet#1 (largest PT) versus PTmax:



Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

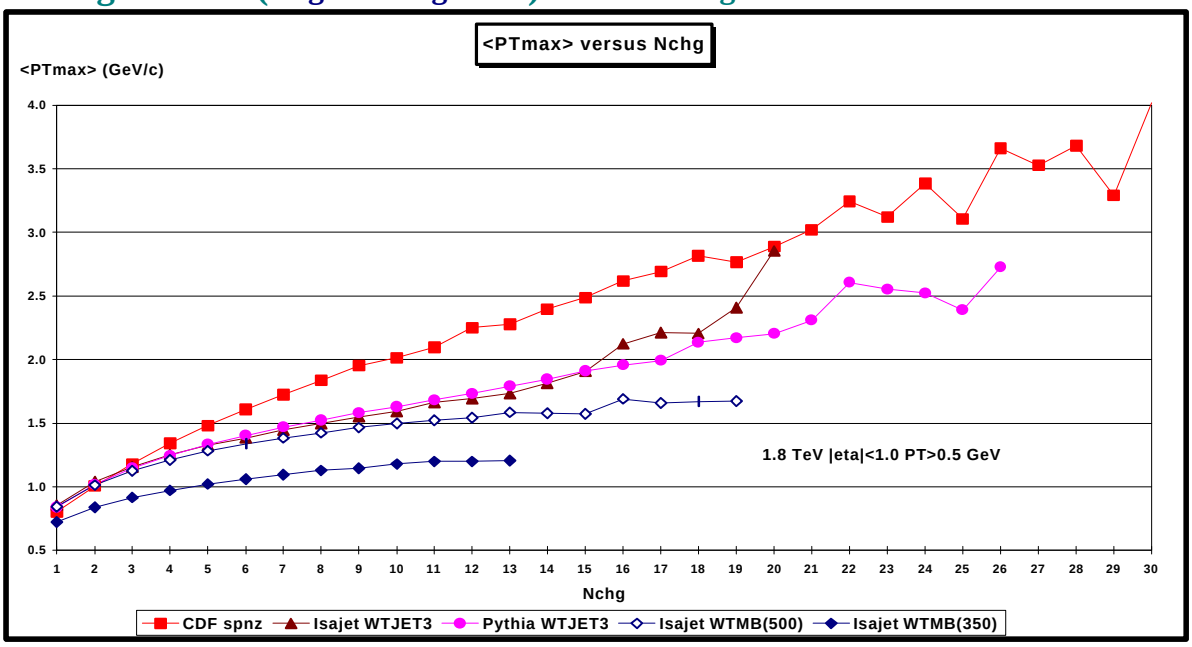
Average Size of Jet#1 (largest PT) versus PTmax:



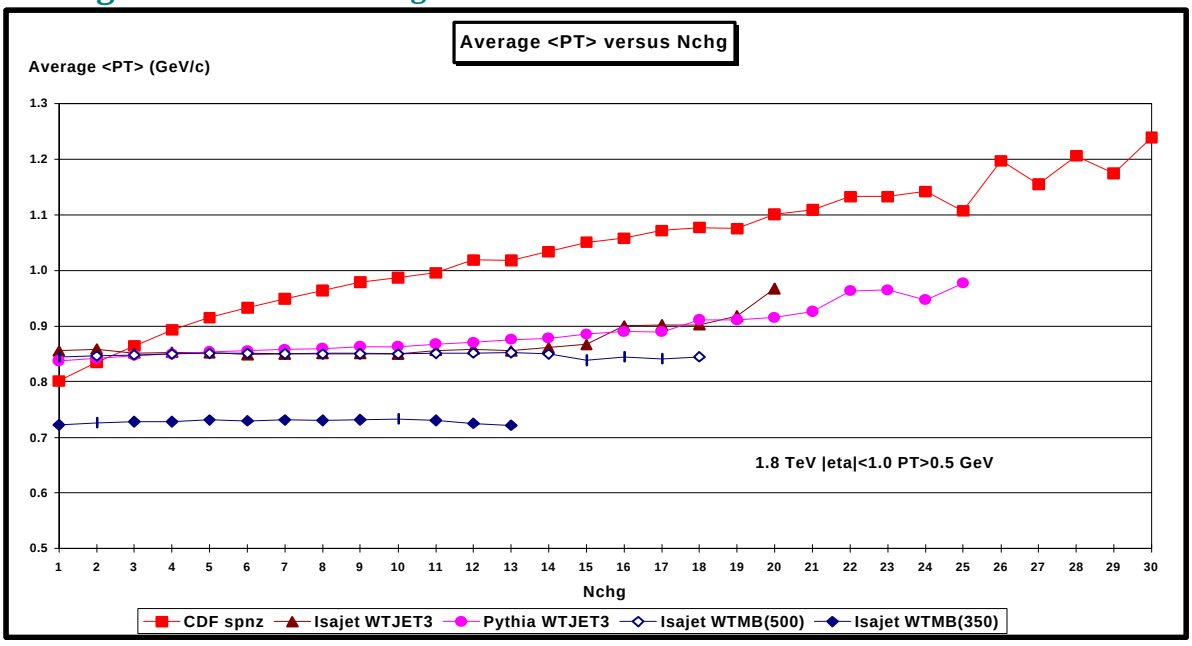
Jets are constructed from the charged particles with R=0.7 and PT(jet)>0.5 GeV.

Min-Bias Data - Dependence on Nchg

Average PTmax (largest charged PT) versus Nchg:

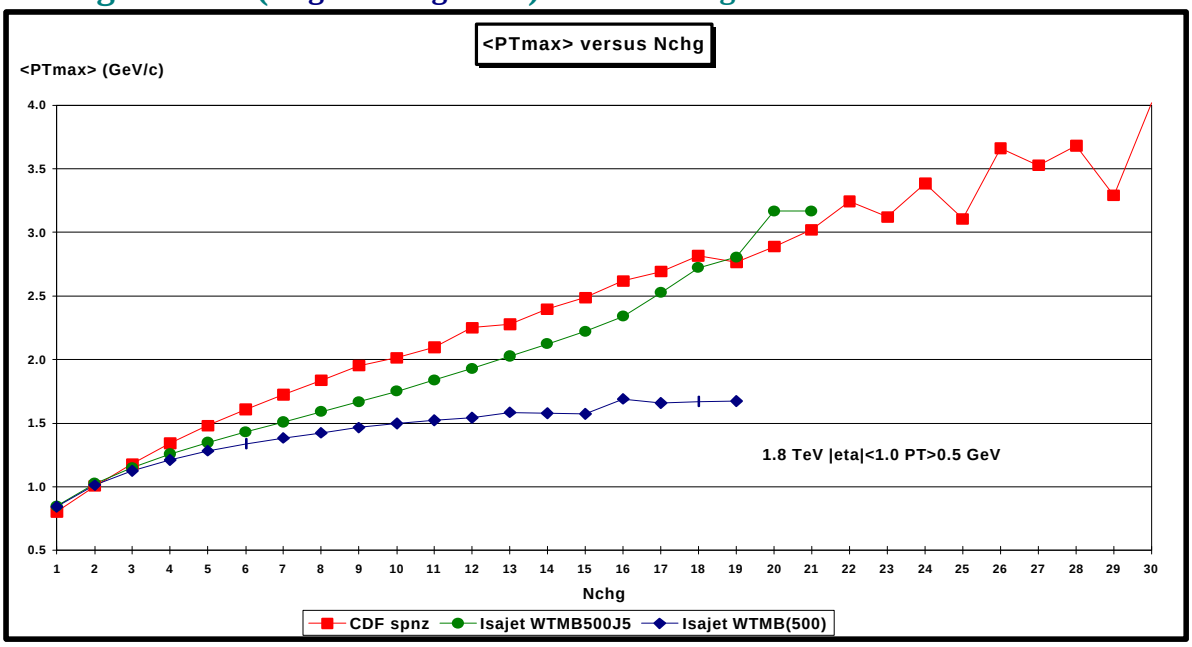


Average <PT> versus Nchg:

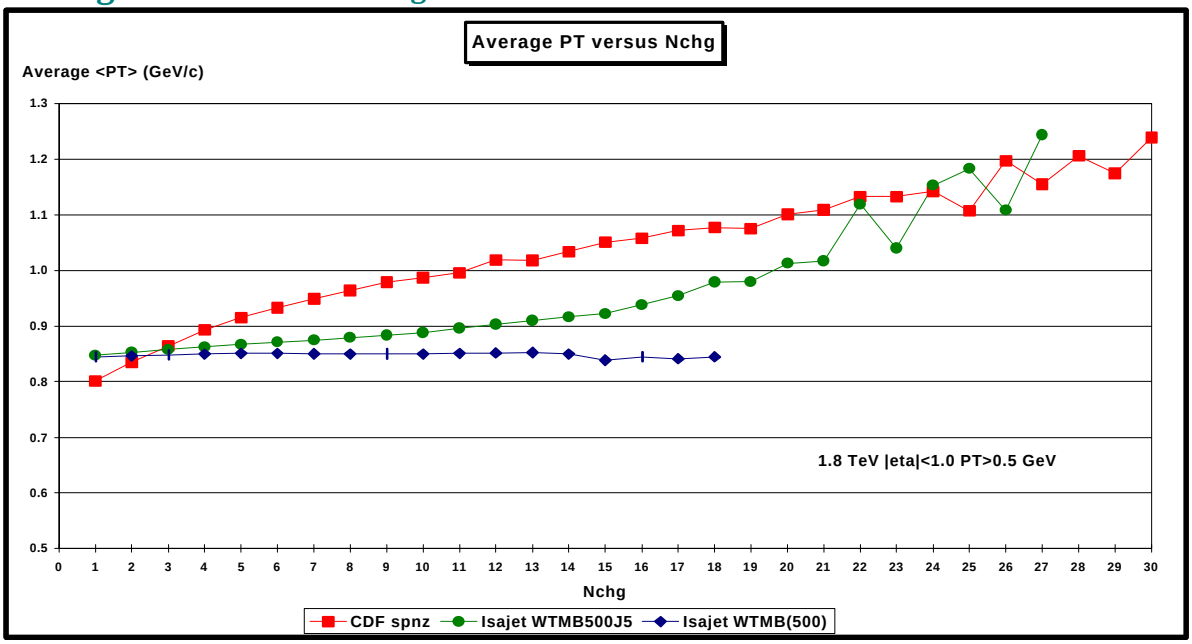


Min-Bias Data - Dependence on Nchg

Average PTmax (largest charged PT) versus Nchg:

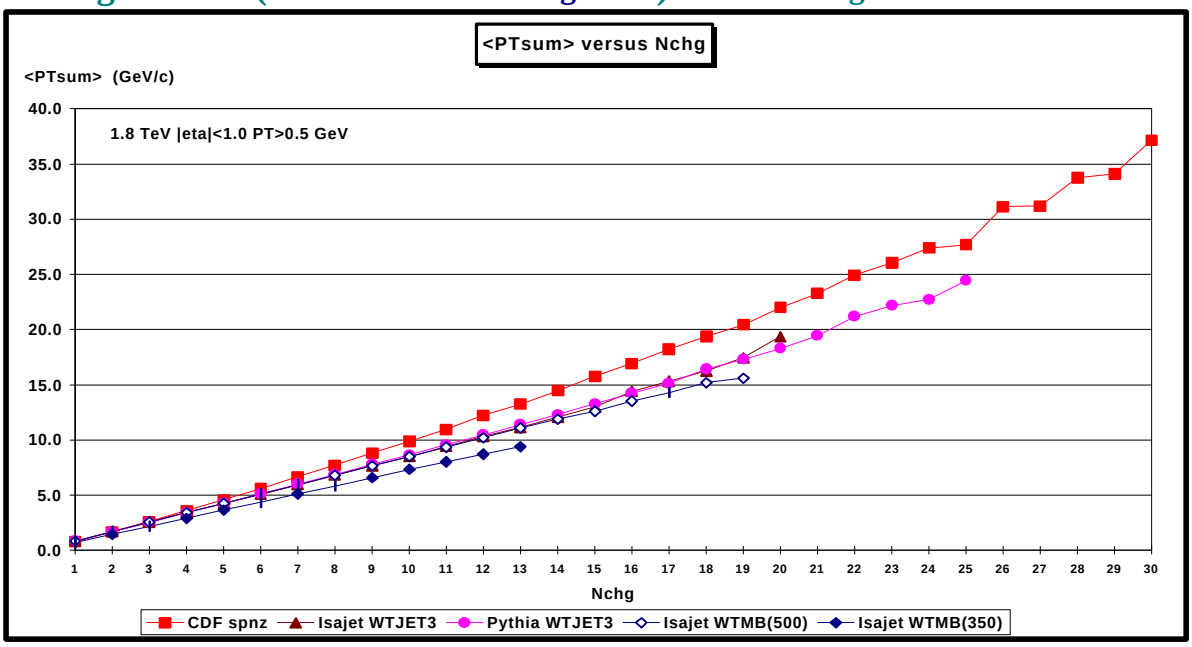


Average <PT> versus Nchg:

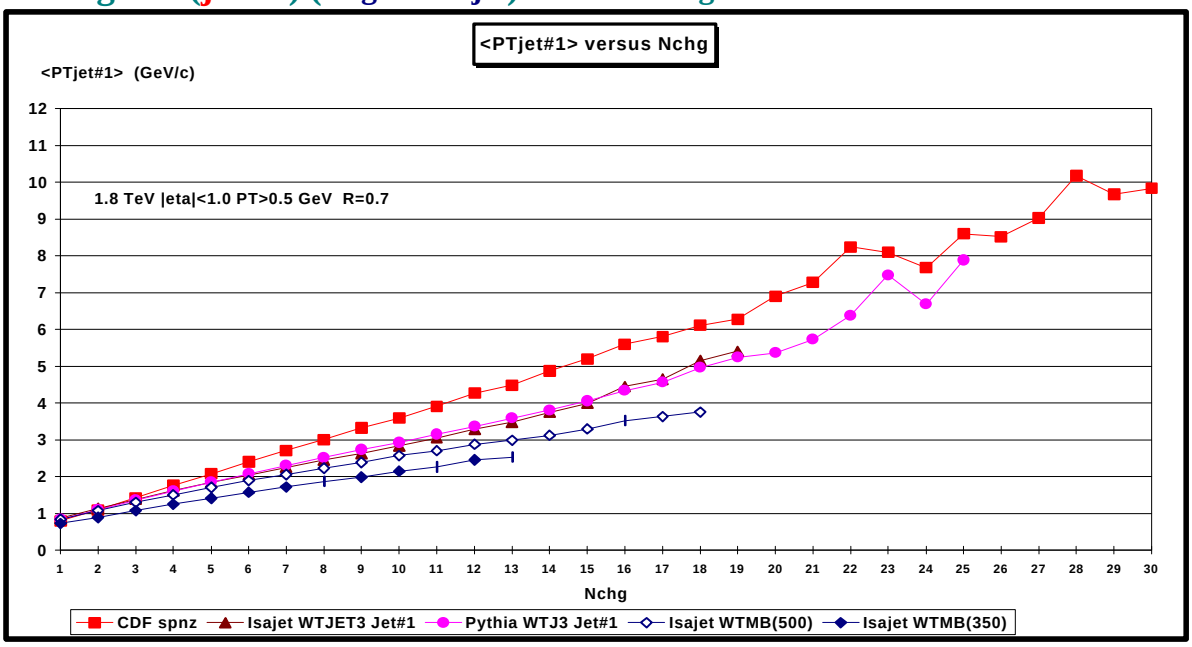


Min-Bias Data - Dependence on Nchg

Average PTsum (scalar sum of all charged PT) versus Nchg:

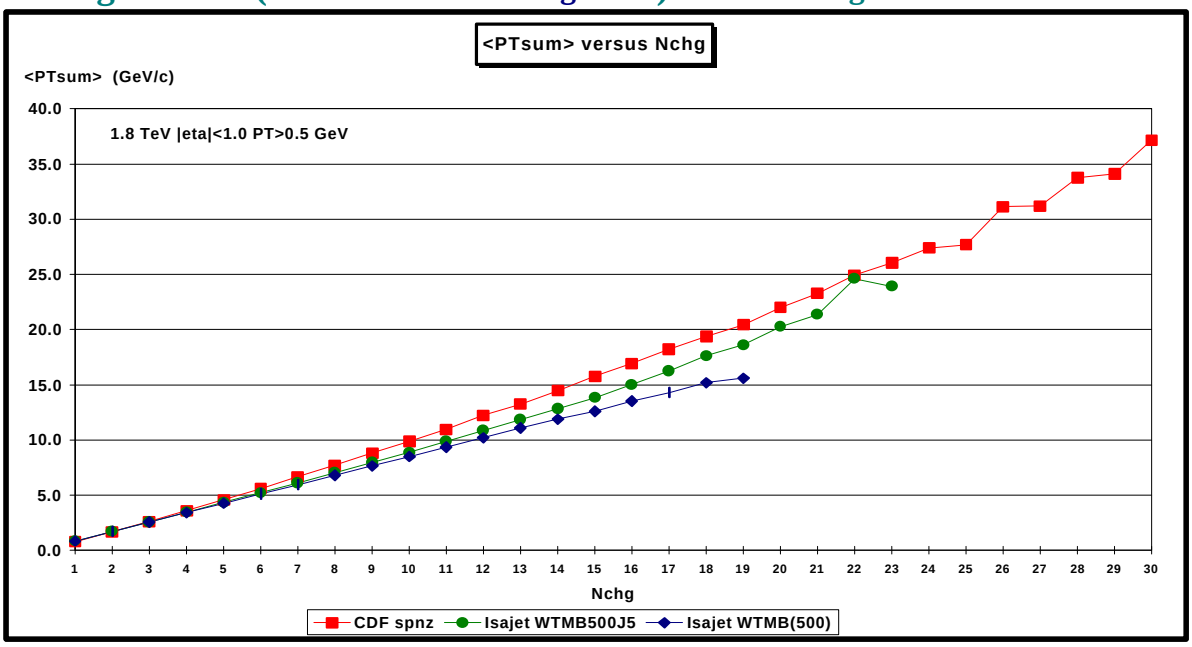


Average PT(jet #1) (largest PT jet) versus Nchg:

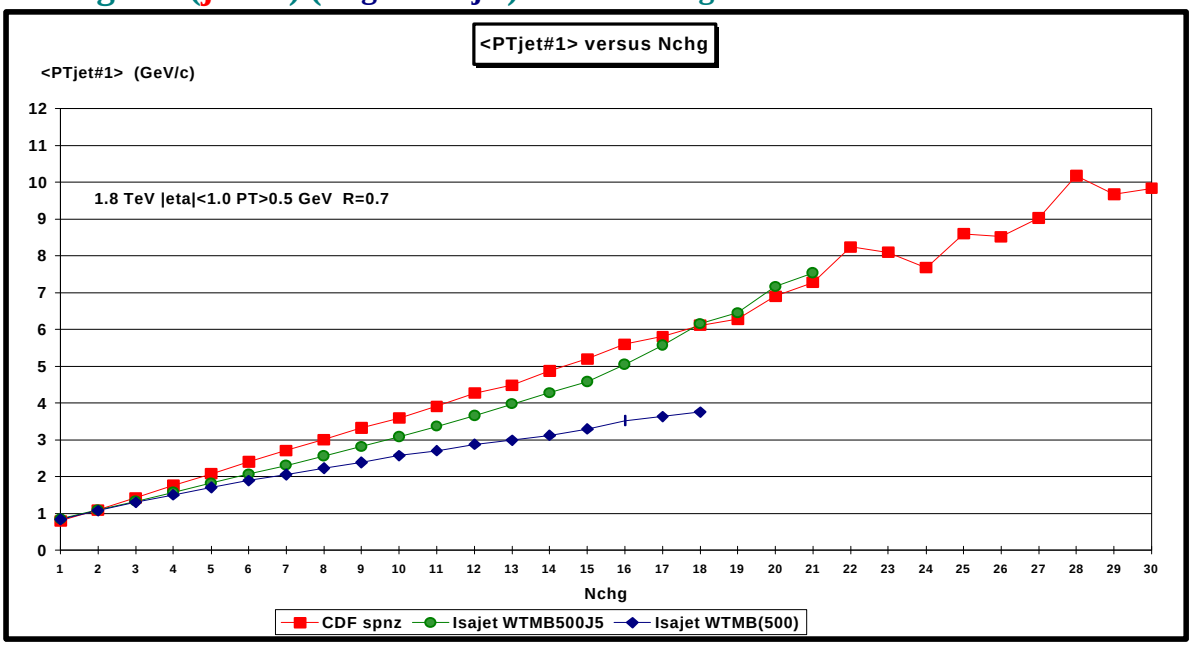


Min-Bias Data - Dependence on Nchg

Average PTsum (scalar sum of all charged PT) versus Nchg:

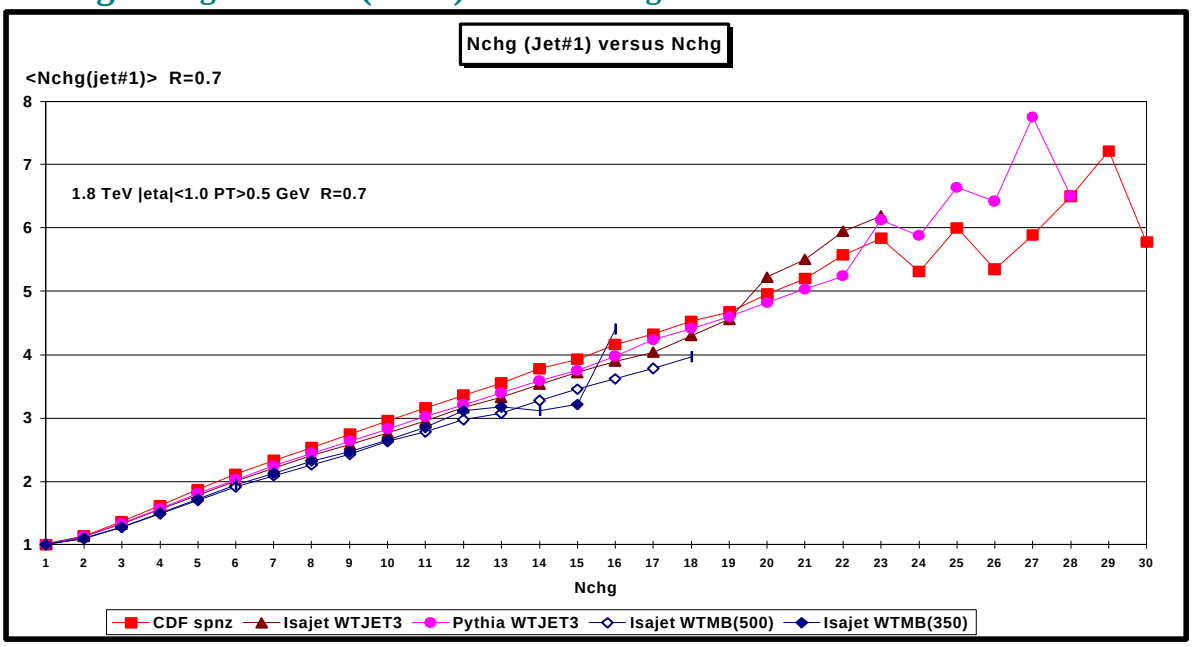


Average PT(jet #1) (largest PT jet) versus Nchg:

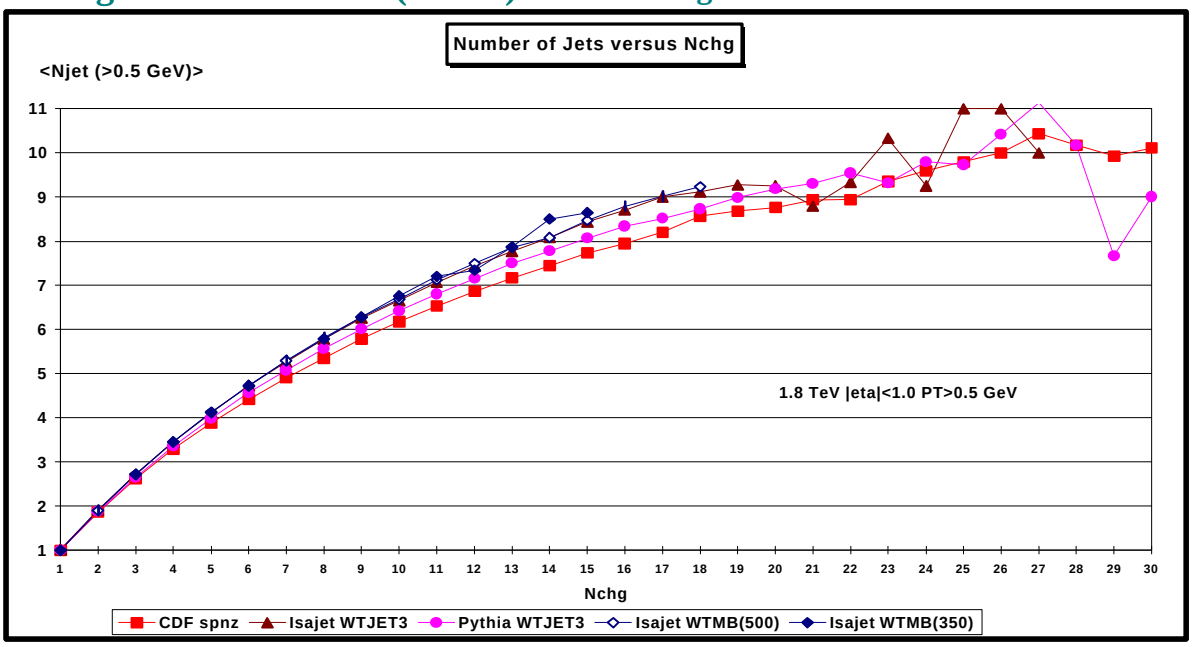


Min-Bias Data - Dependence on Nchg

Average Nchg of Jet#1 (R=0.7) versus Nchg:

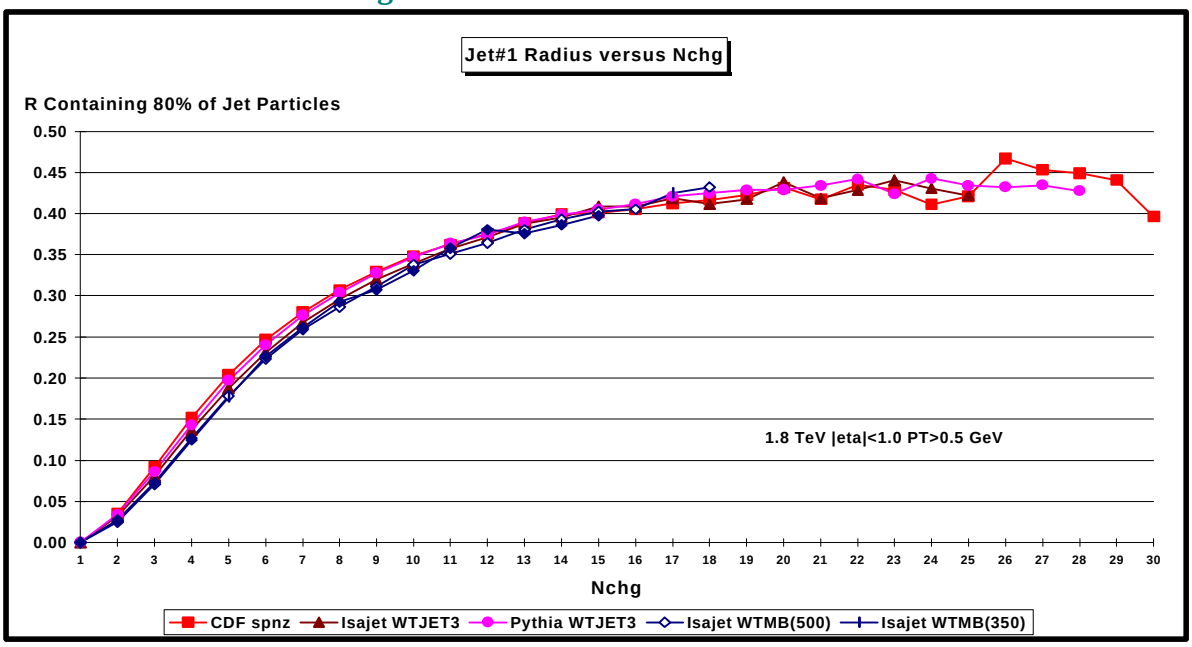


Average Number of Jets (R = 0.7) versus Nchg:

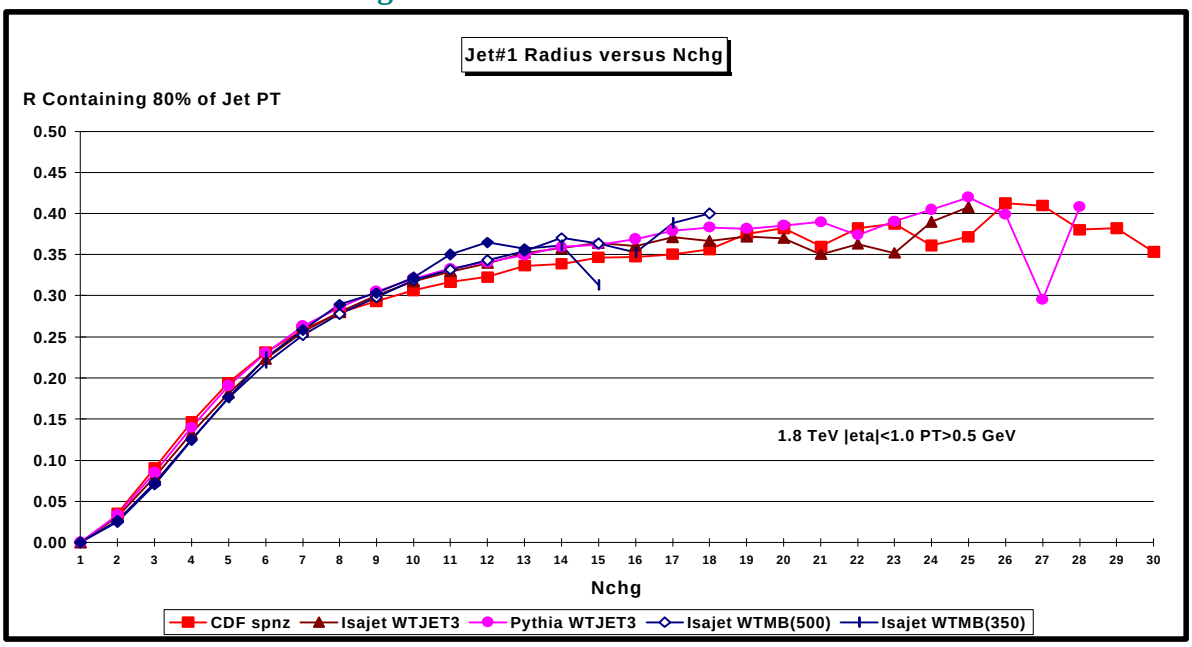


Min-Bias Data - Dependence on Nchg

Size of Jet#1 versus Nchg:

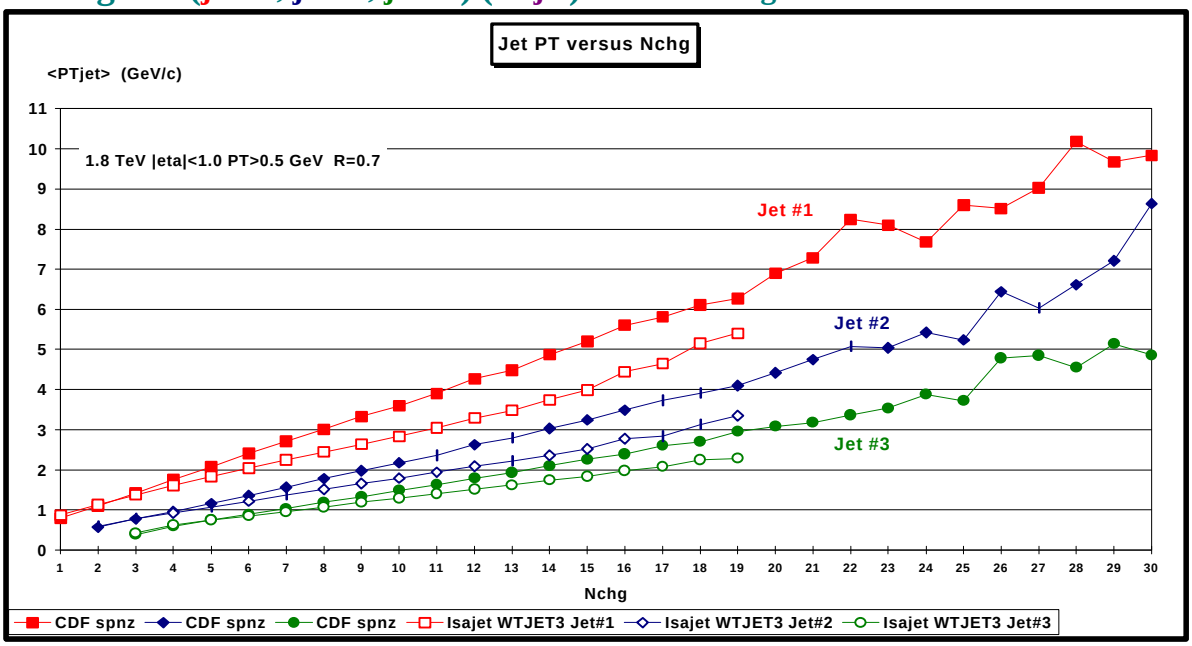


Size of Jet#1 versus Nchg:

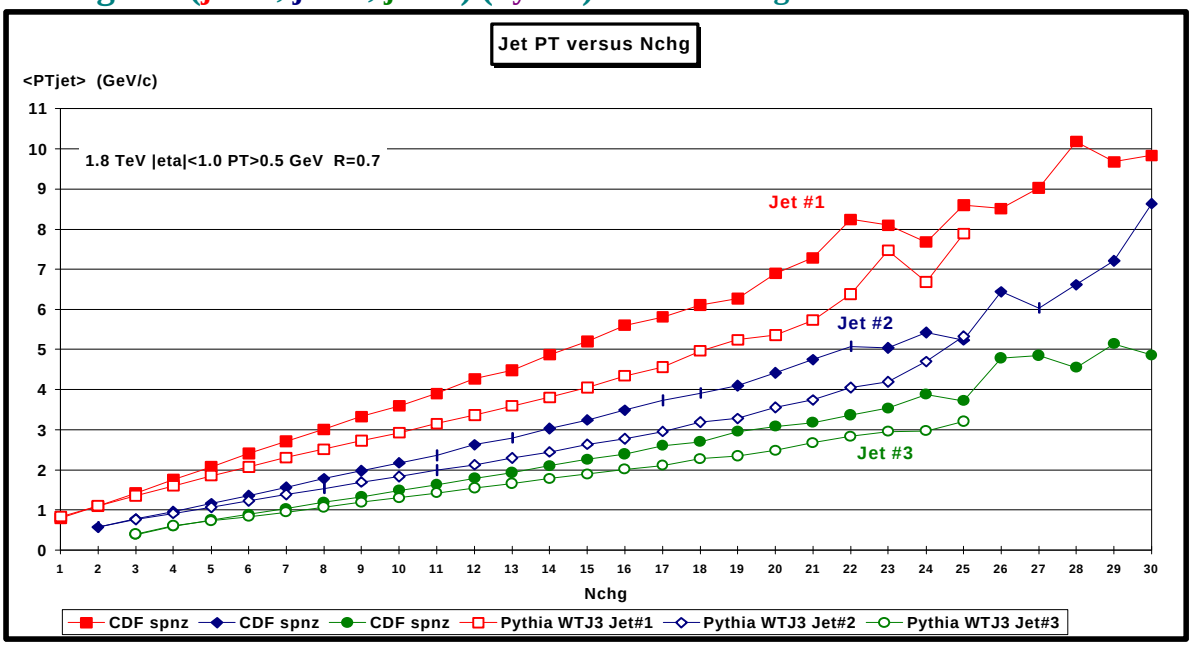


Min-Bias Data - Dependence on Nchg

Average PT(jet #1, jet #2, jet #3) (Isajet) versus Nchg:

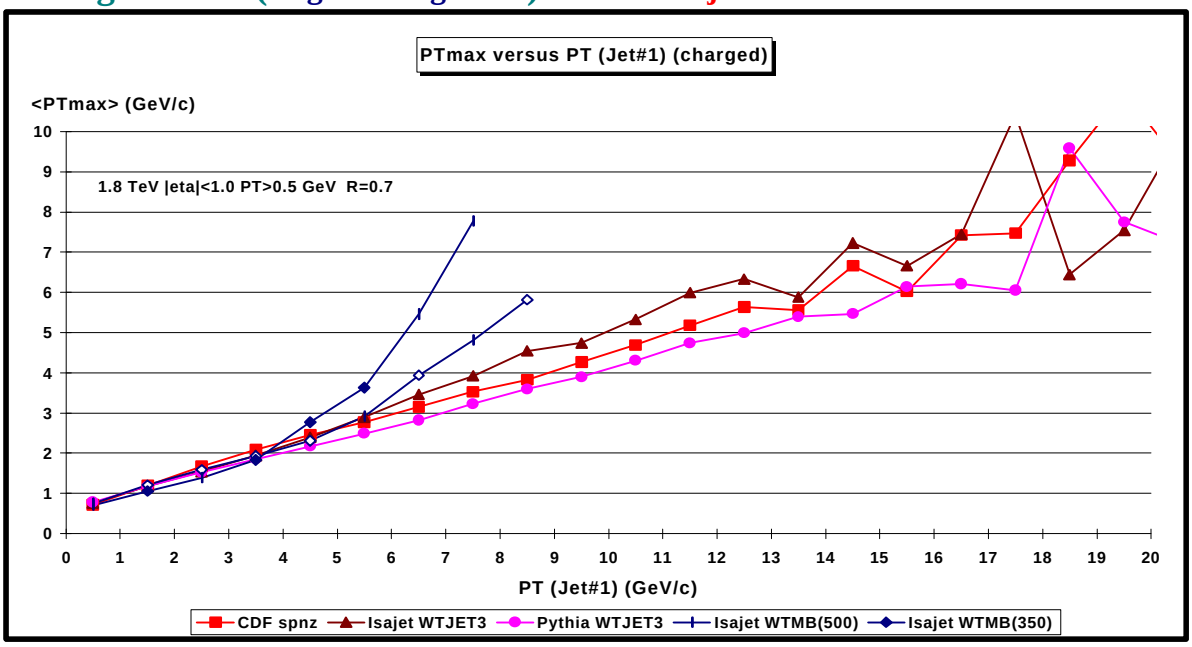


Average PT(jet #1, jet #2, jet #3) (Pythia) versus Nchg:

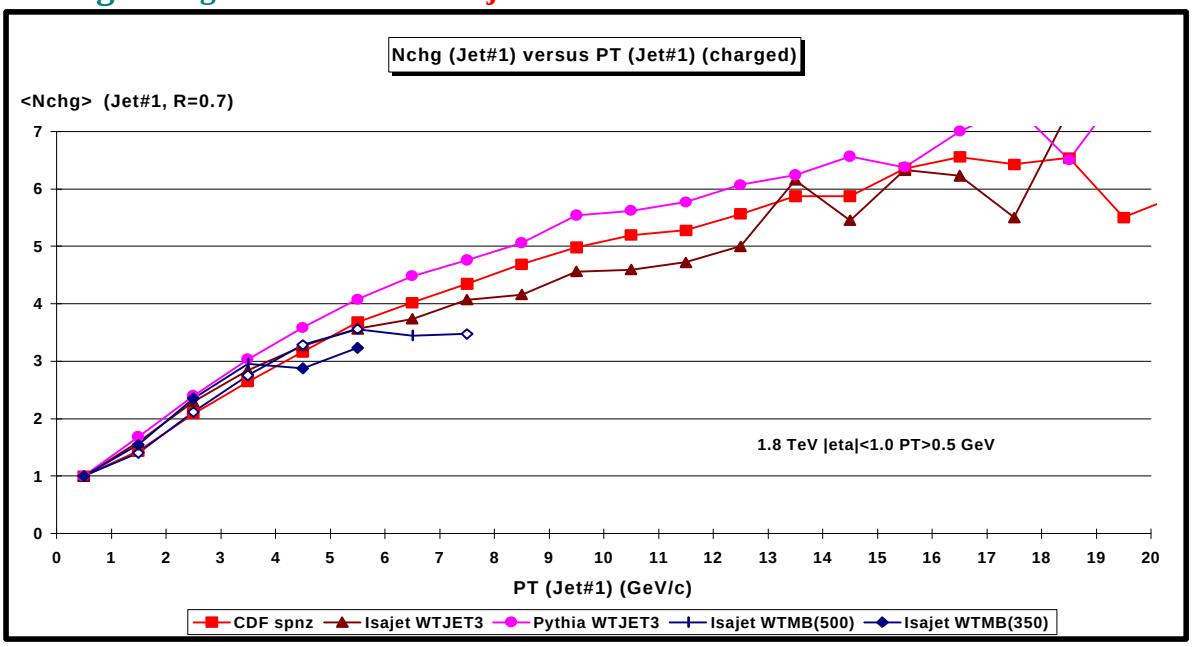


Min-Bias Data - Dependence on PTjet#1

Average PTmax (largest charged PT) versus PTjet#1:

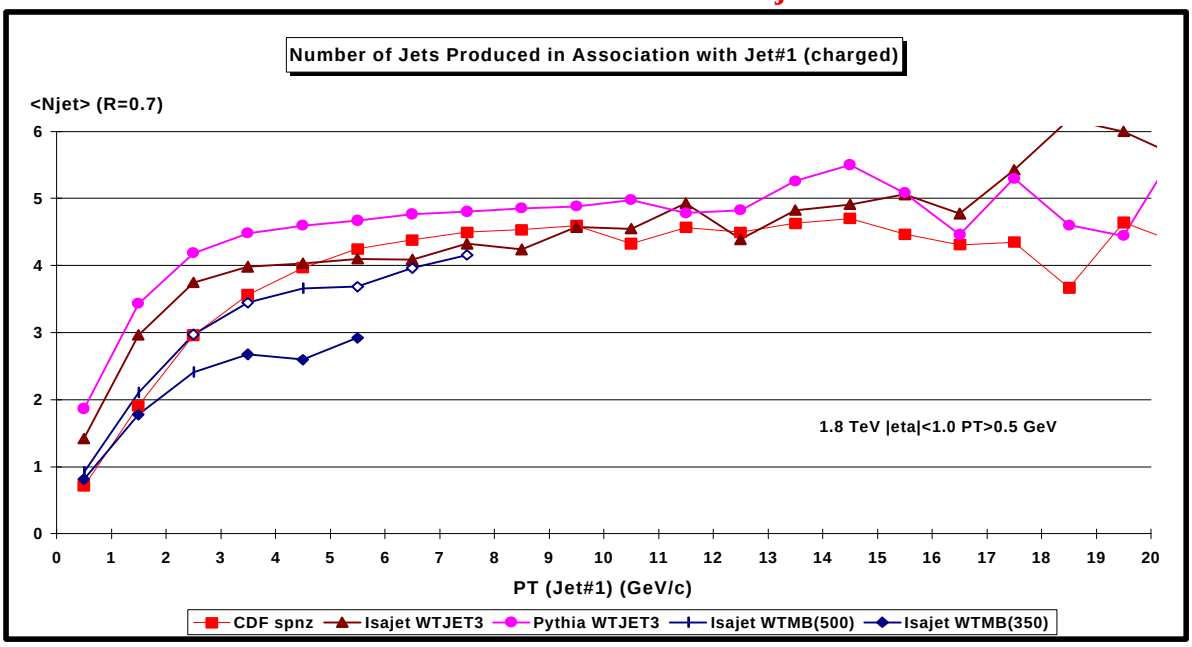


Average Nchg Jet #1 versus PTjet#1:



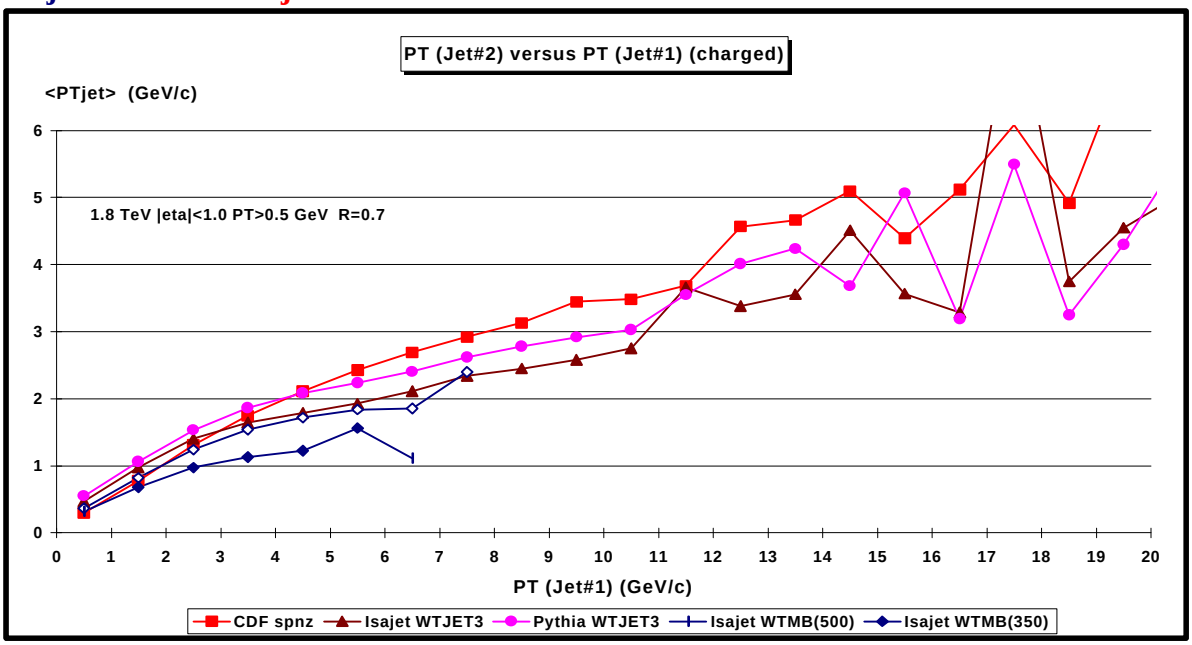
Min-Bias Data - Dependence on PTjet#1

Number of Jets Produced in Association with PTjet#1:



Does not include Jet#1, but includes zeros.

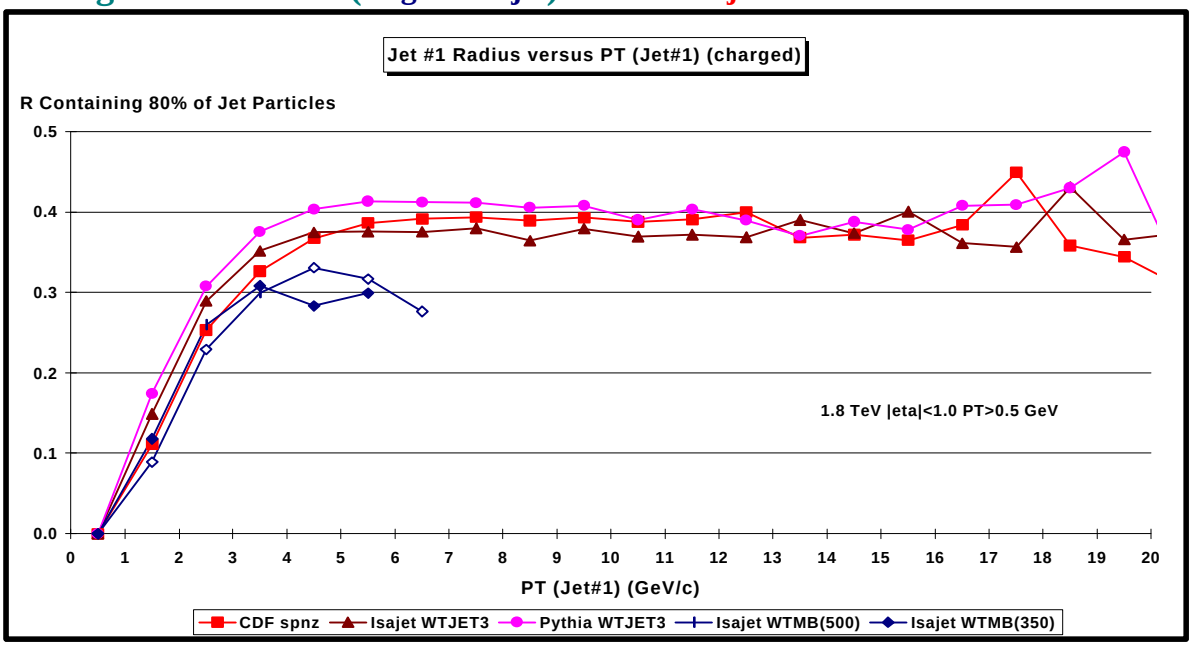
PTjet#2 versus PTjet#1:



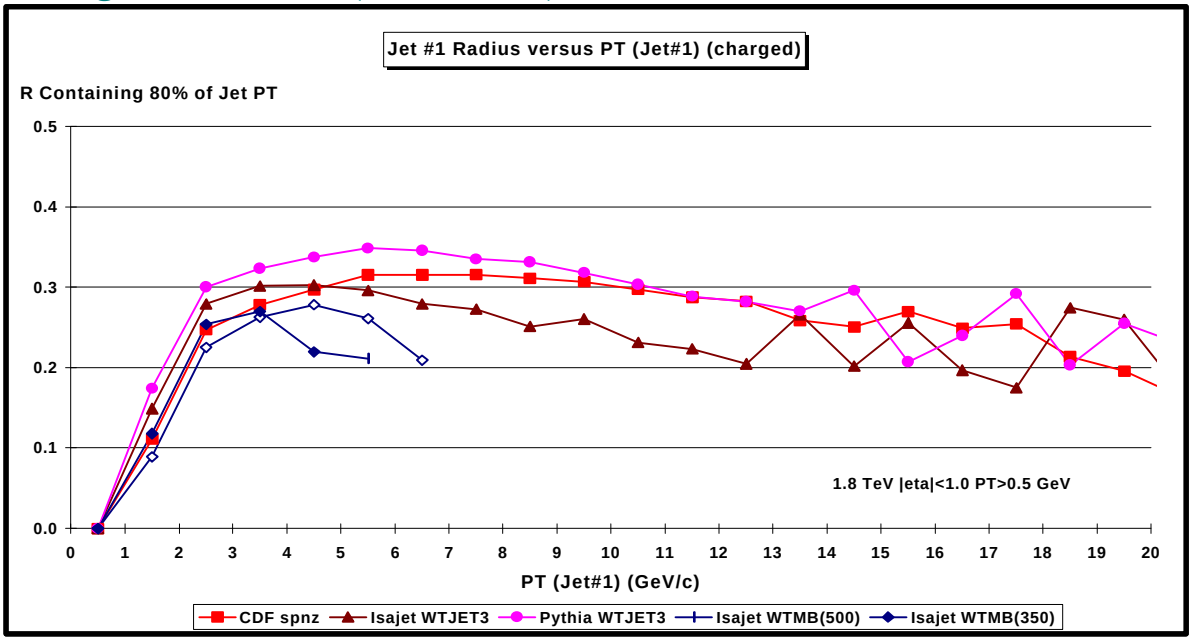
Includes zeros.

Min-Bias Data - Dependence on PTjet#1

Average Size of Jet#1 (largest PT jet) versus PTjet#1:

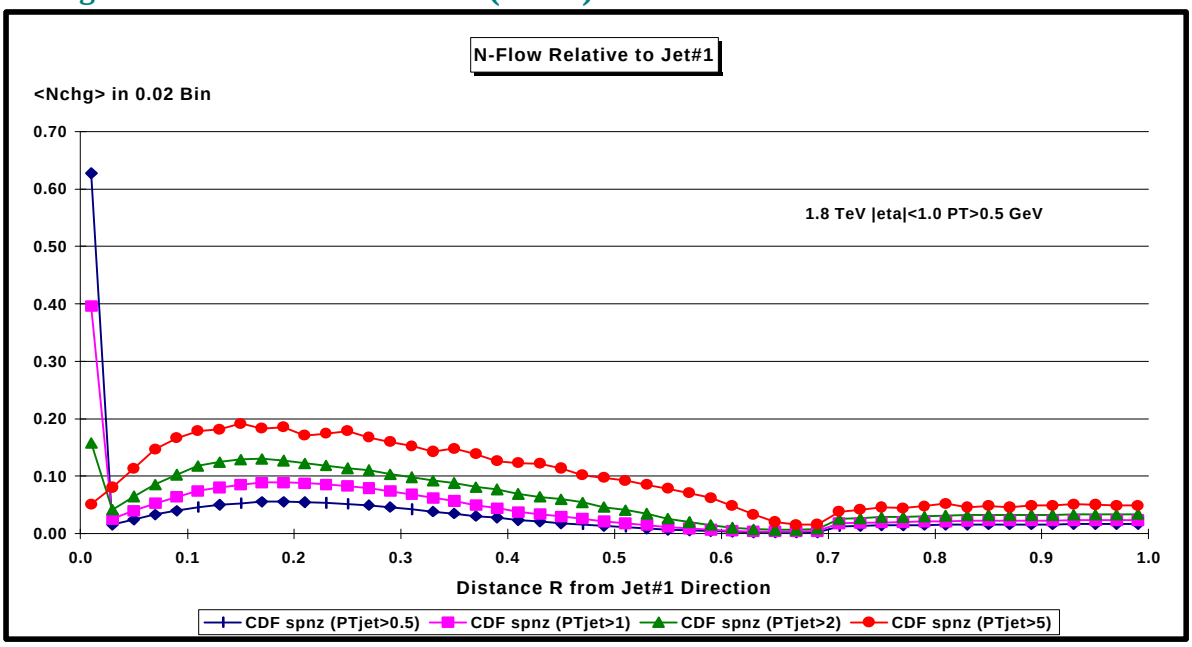


Average Size of Jet#1 (largest PT jet) versus PTjet#1:



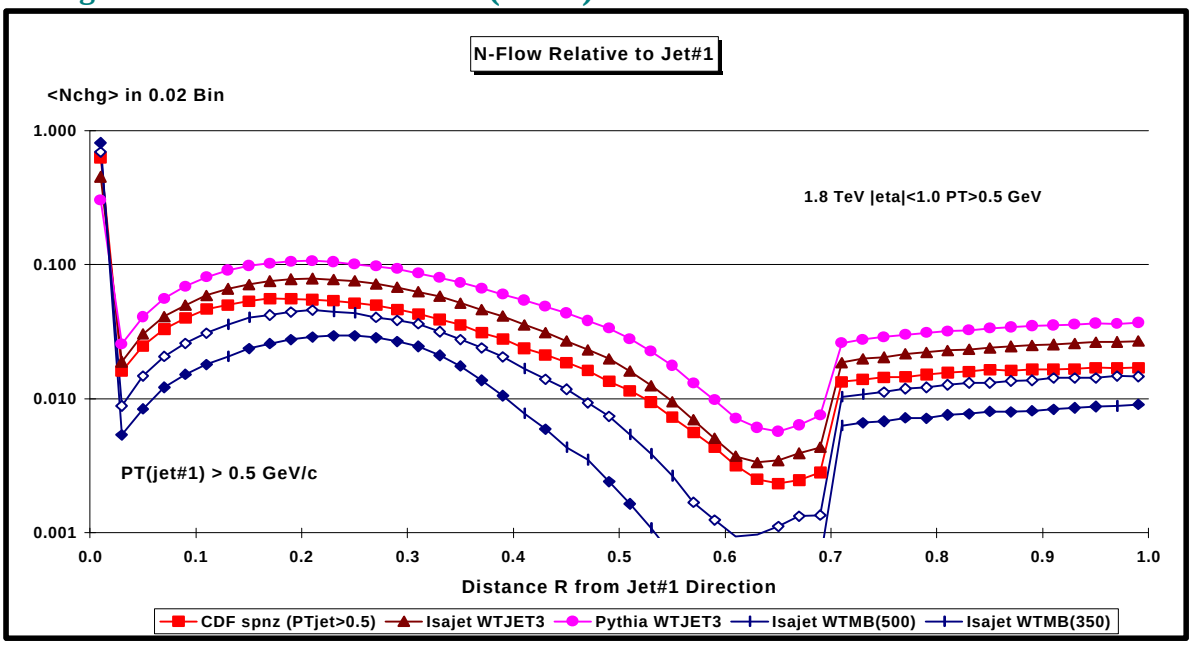
Min-Bias Data – N-Flow

<Nchg> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

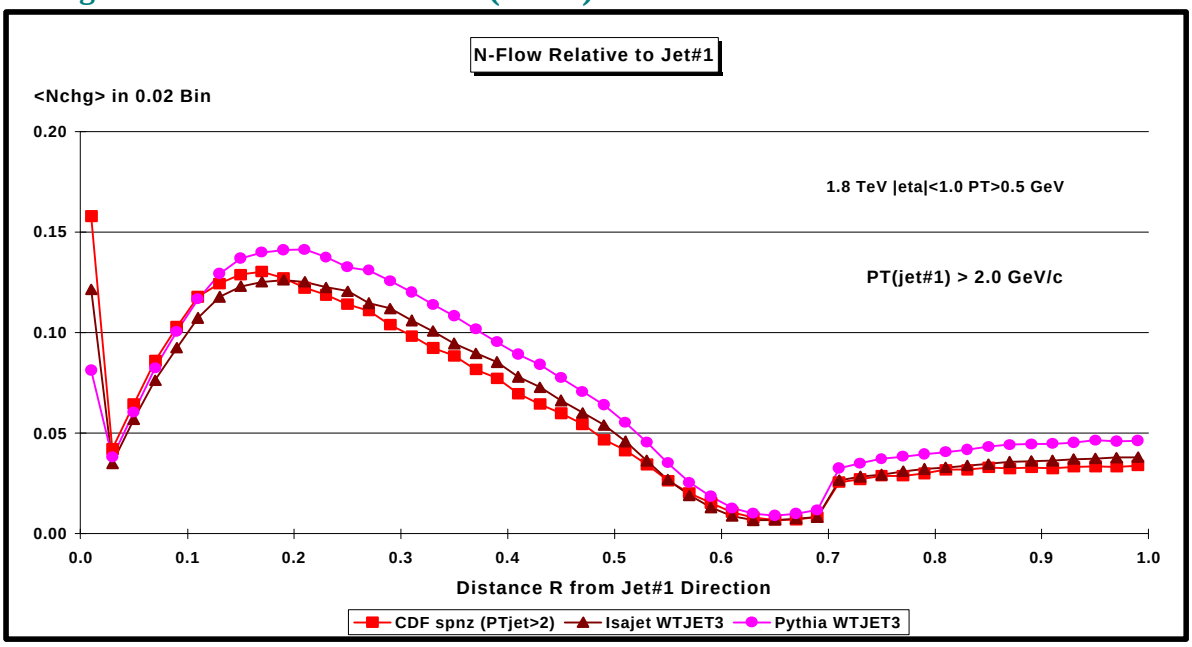
<Nchg> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

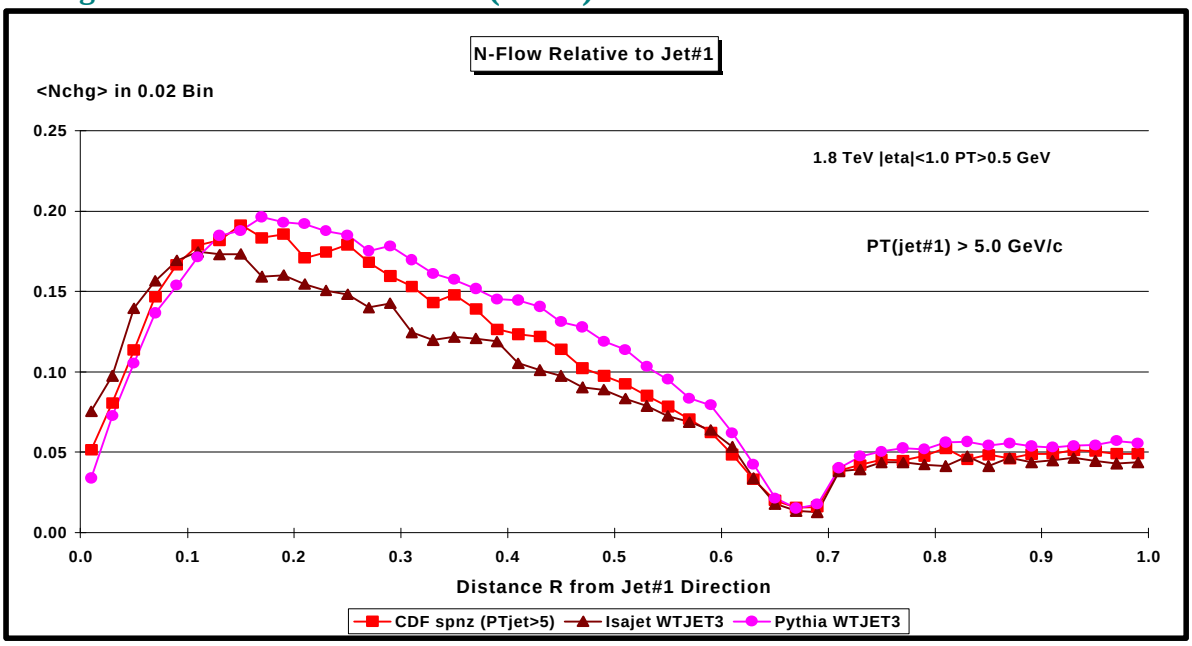
Min-Bias Data – N-Flow

<Nchg> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

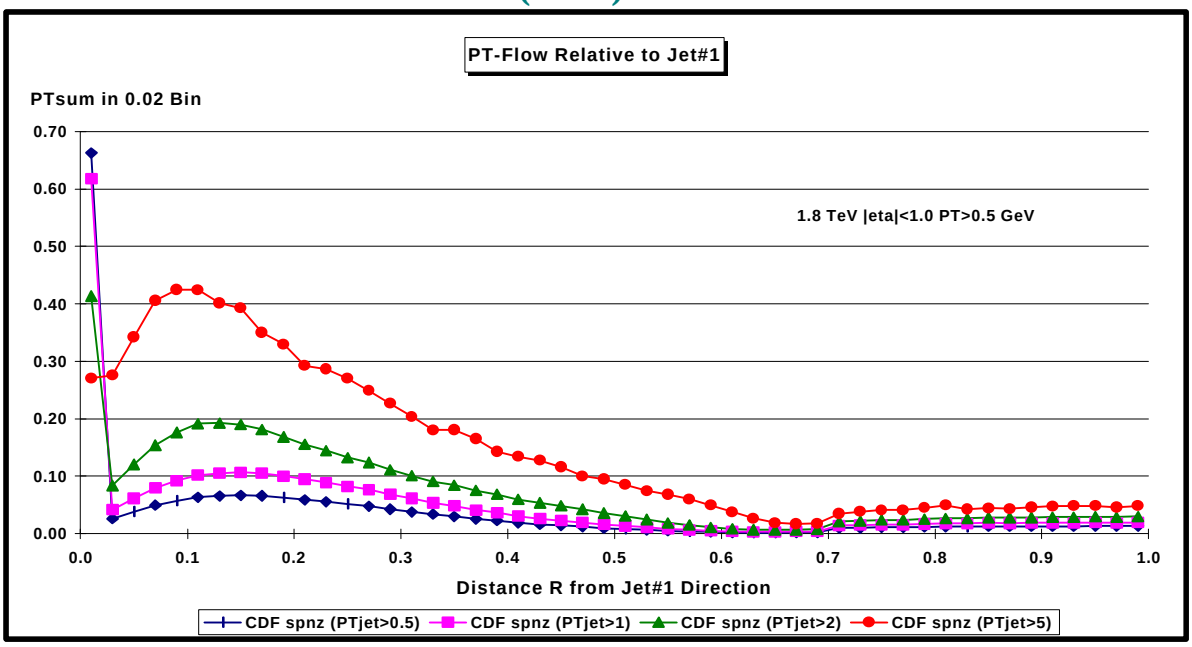
<Nchg> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

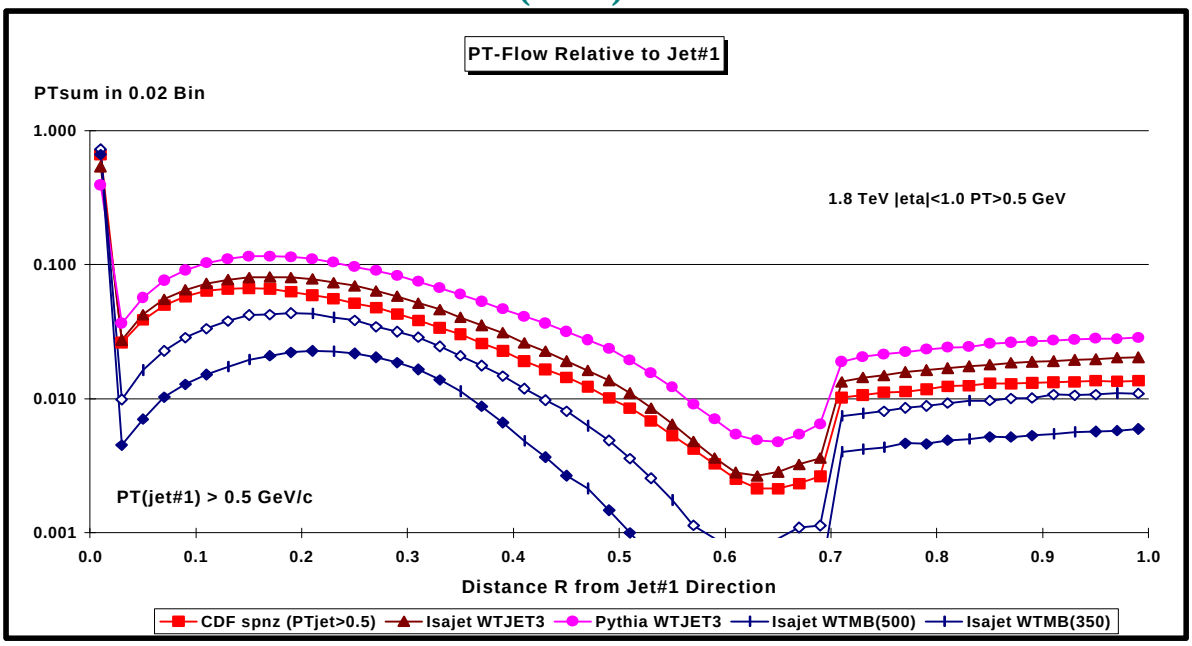
Min-Bias Data – PT-Flow

<PTsum> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

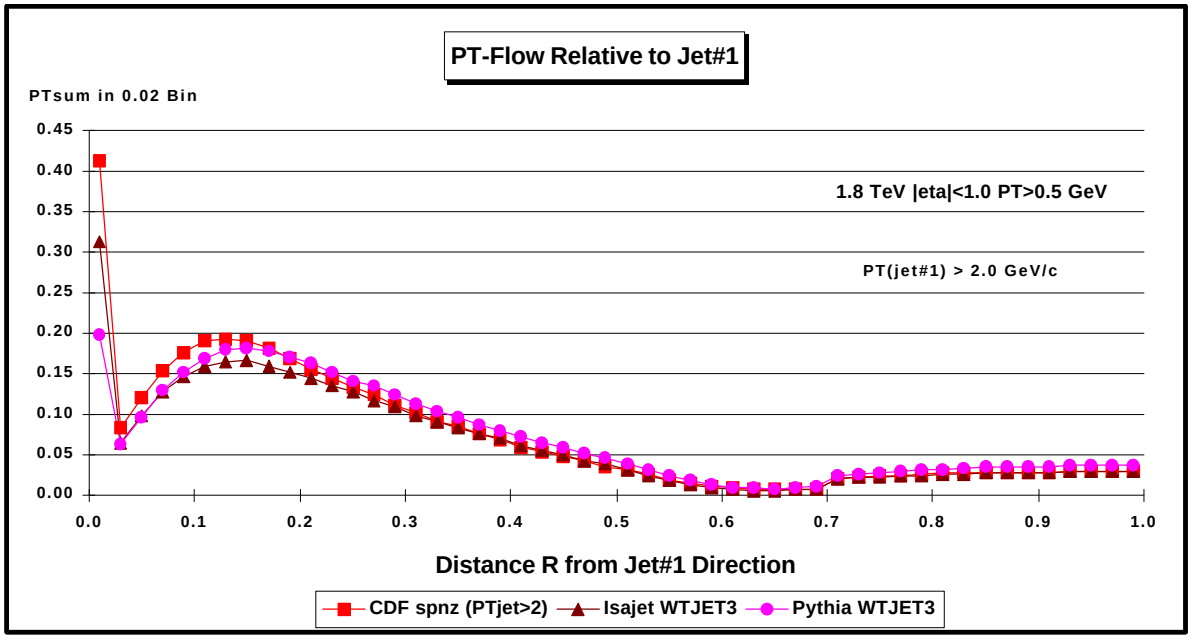
<PTsum> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

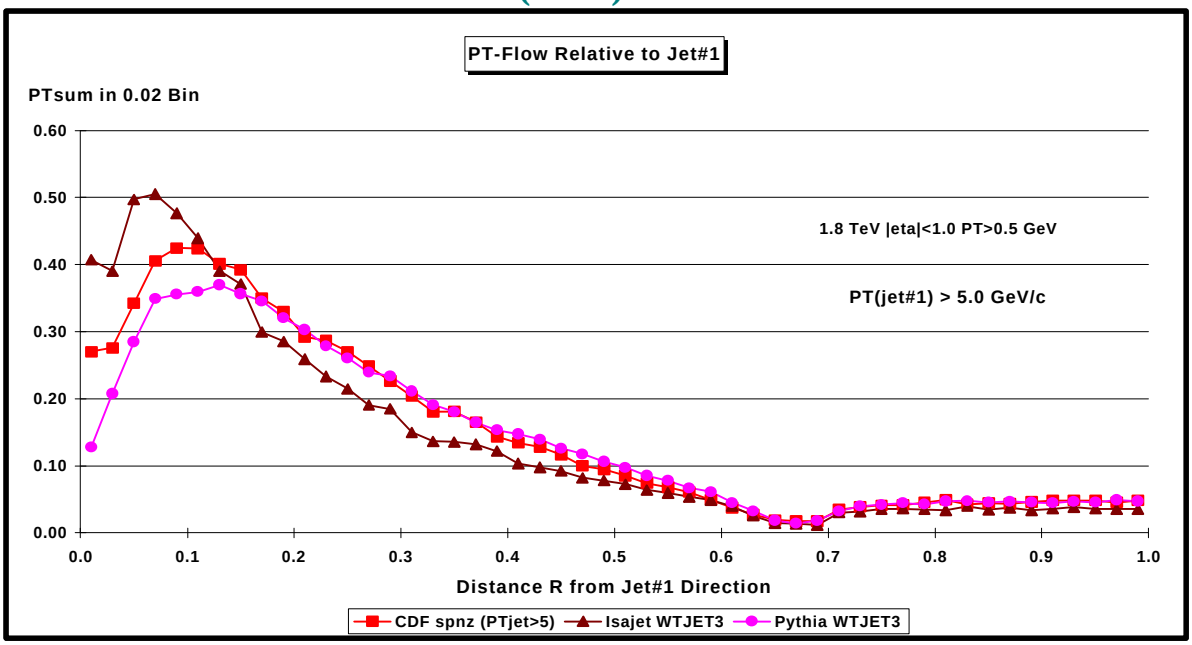
Min-Bias Data – PT-Flow

<PTsum> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.

<PTsum> Flow Relative to Jet#1 (R=0.7) Direction:



Includes all charged particles.