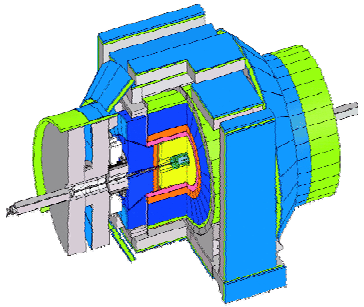


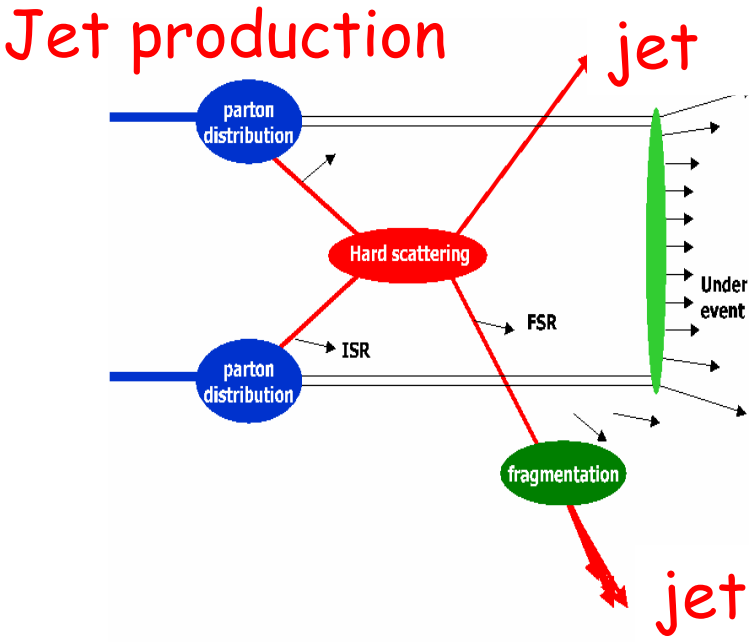
Inclusive Jet Cross Section

Olga Norniella

IFAE-Barcelona

CDF Collaboration meeting Feb 2-3, 2006

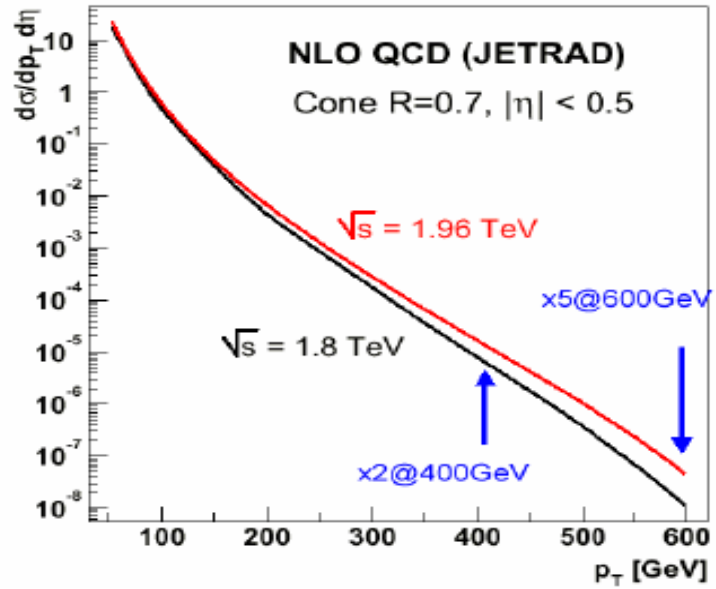
Jets @ Tevatron



→ Stringent test of p-QCD

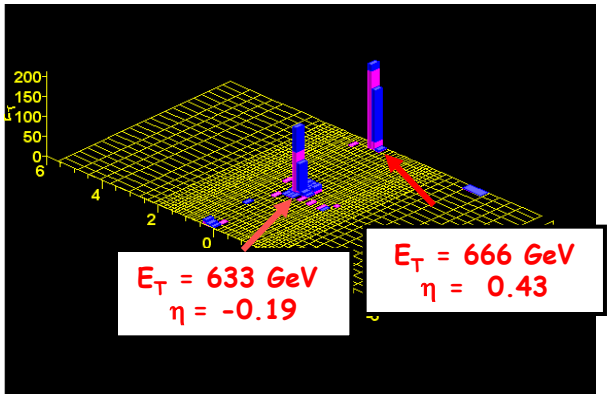
- Over 9 order of magnitude
- Sensitivity to distances ~ 10^{-19} m

→ Tail sensitive to new physics and PDFs

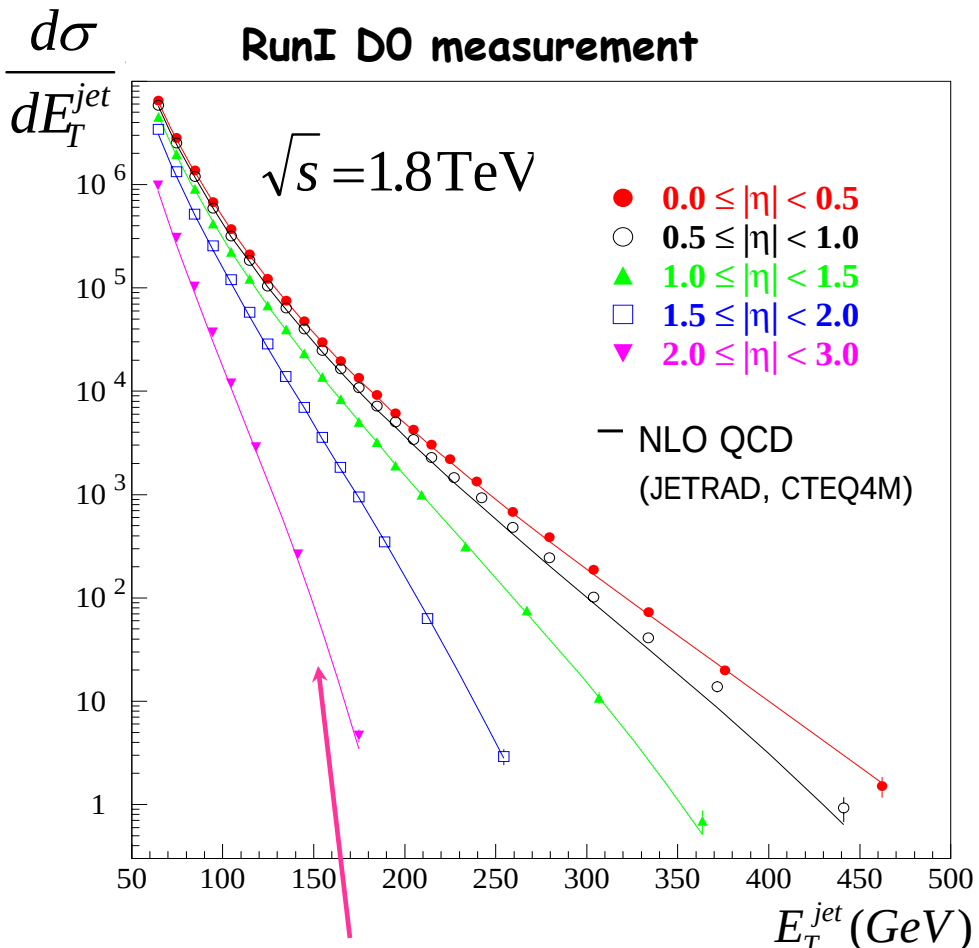


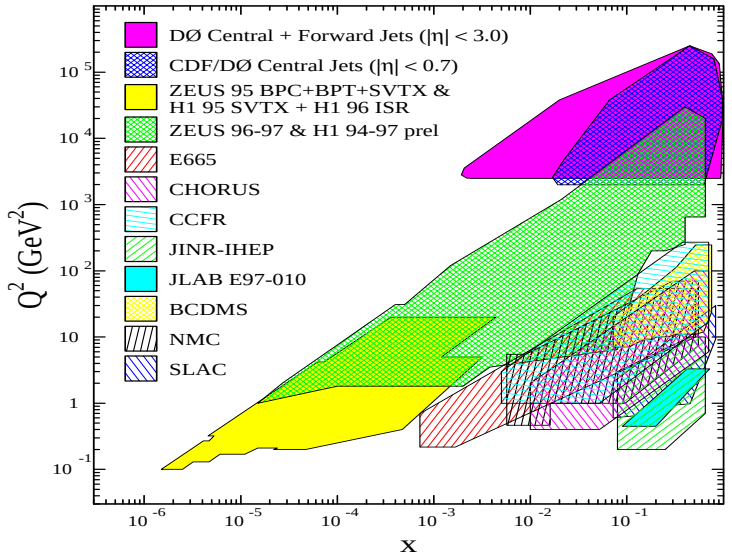
- Higher σ_{jet} with respect to RunI
- Increased p_T range for jet production

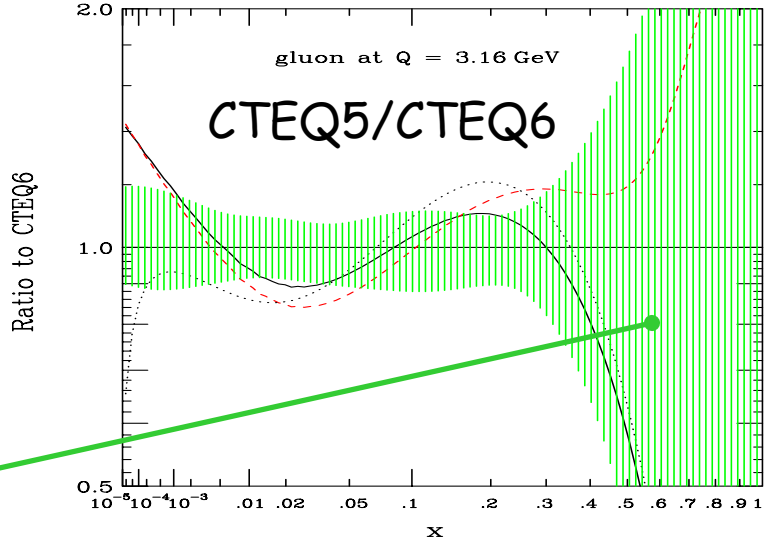
Highest dijet mass so far: Mass ≅1.3 TeV



Run I cross section vs η







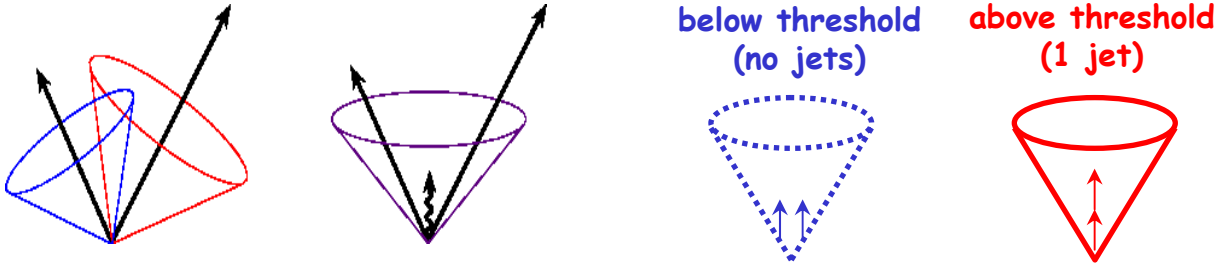
Measurements in the forward region allow to constrain the gluon distribution

Big uncertainty still remains for high-x gluons

Jet Measurement: Cone algorithms

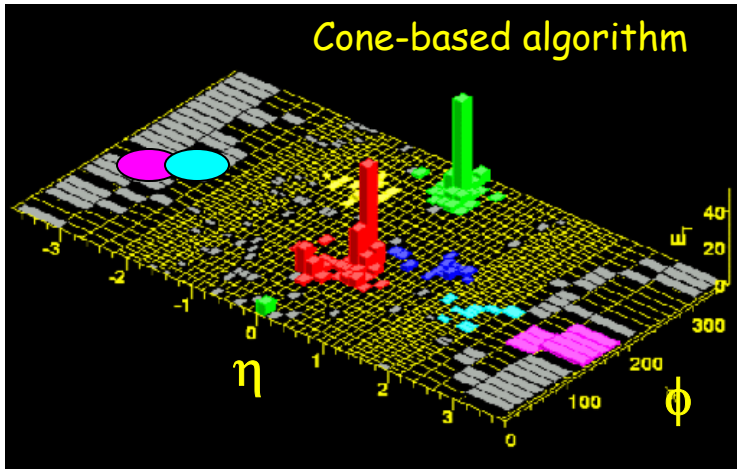
Precise jet search algorithm necessary to compare with theory

→ Run I cone-based algorithm is not infrared/collinear safe to all orders in p-QCD



→ Run II ⇒ new cone-based algorithm: MidPoint

- Cone-based jet algorithms include an "experimental" prescription to resolve situations with overlapping cones
  - This is emulated in pQCD theoretical calculations by an arbitrary increase of the cone size : R → R' = R * 1.3
  - Still differences between D0/CDF algorithm implementation



- Theory suggests to separate jets according to their relative transverse momentum

Jet Measurement: K_T algorithm

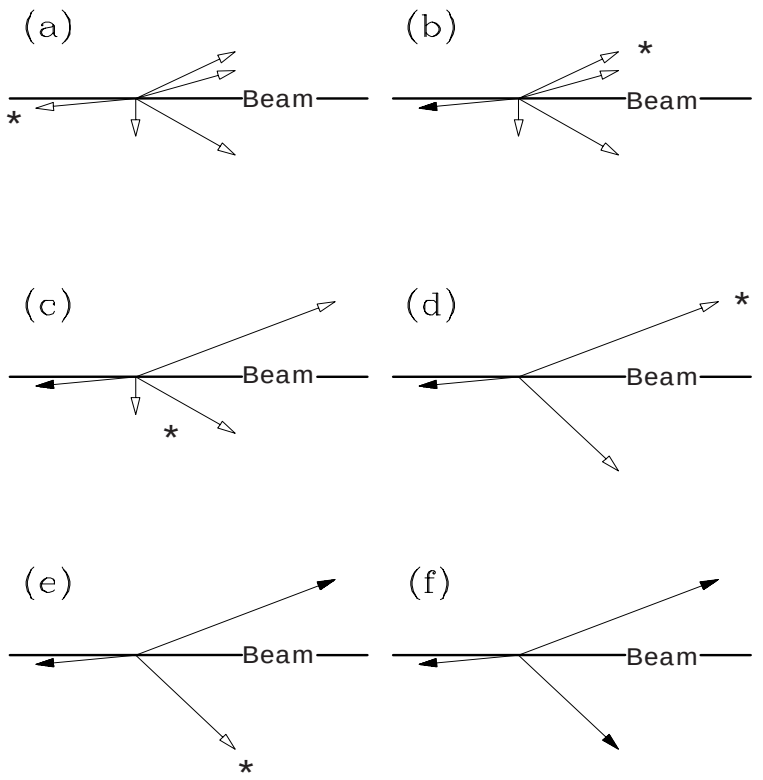
→ K_T Algorithm preferred by theory

- Separate jets according to their relative transverse momentum

1. Compute for each pair (i,j) and for each particle (i) the quantities:

$$d_{ij} = \min(P^2_{T,i}, P^2_{T,j})\frac{\Delta R^2}{D^2} \qquad d_i = (P_{T,i})^2$$

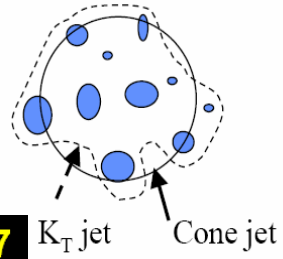
2. Starting from smallest $\{d_{ij}, d_i\}$:
3. If it is a d_i then it is called a jet and is removed from the list
4. If it is a d_{ij} the particles are combined in "proto-jets" (E scheme)
5. Iterate until all particles are in jets



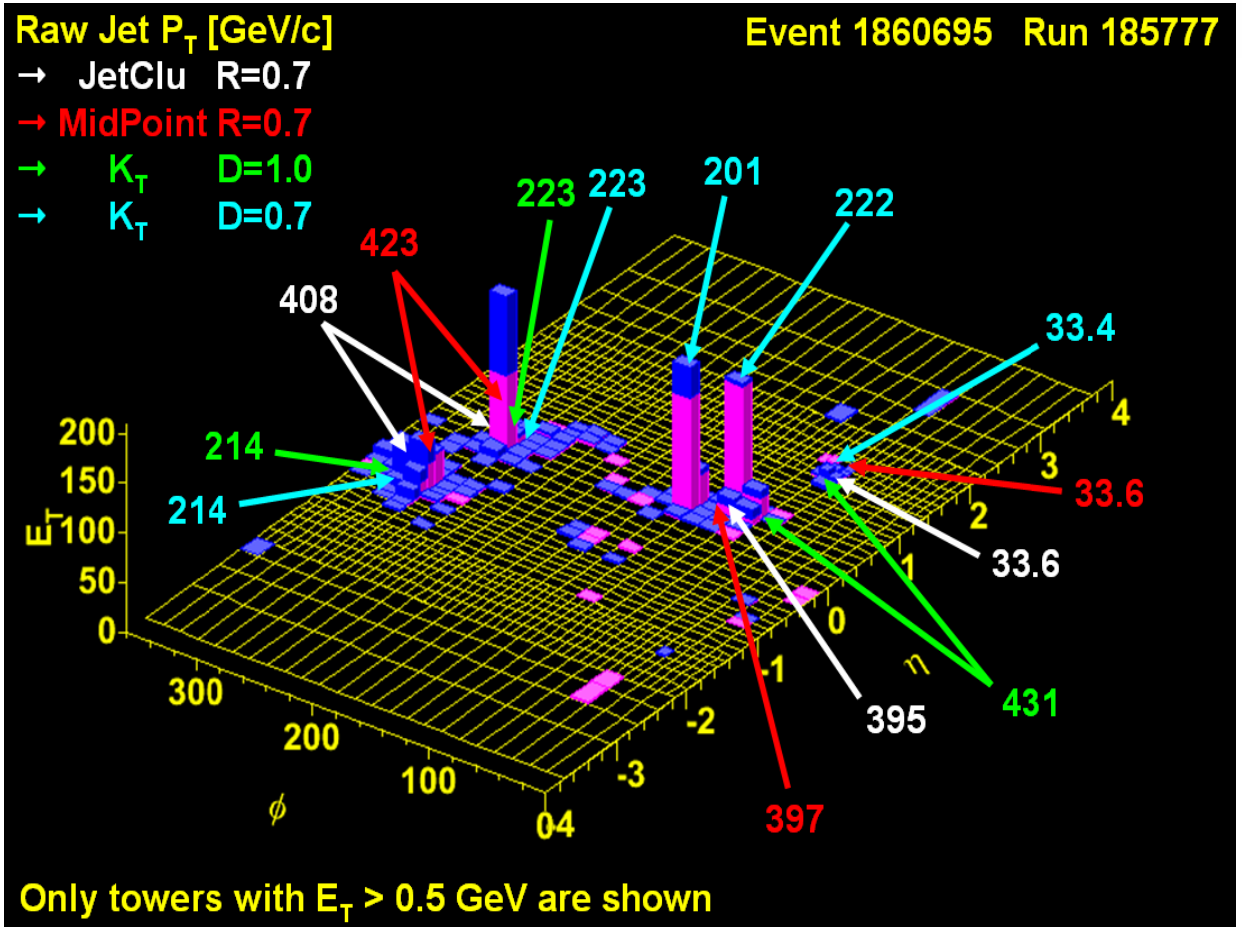
- Infrared/collinear safe to all order in p-QCD (relevant for NNLO)
- No merging/splitting parameter needed

Successfully used at LEP and HERA but its is relatively new in hadron colliders
⇨ more difficult environment (Underlying Event, Multiple $p\bar{p}$ interactions)

MidPoint vs K_T algorithm



→ An example:



Differences in the number of jets, the jet E_T ...

Different Cross section measurement

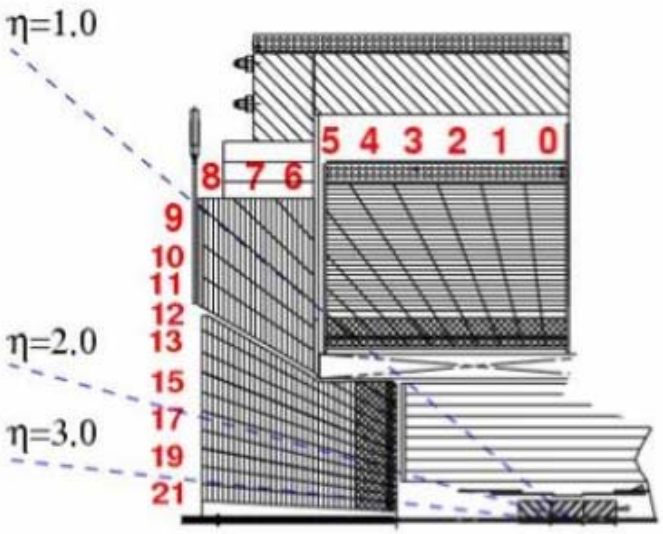
Event Selection

→ Measurements based on ~ 900 pb^{-1} of CDF Run II data

→ Event Selection

- Jets defined with K_T algorithm (D=0.7) or MidPoint algorithm
- Primary vertex position $|V_Z| < 60$ cm
- Missing E_T significance cut
- Jets in different Y regions

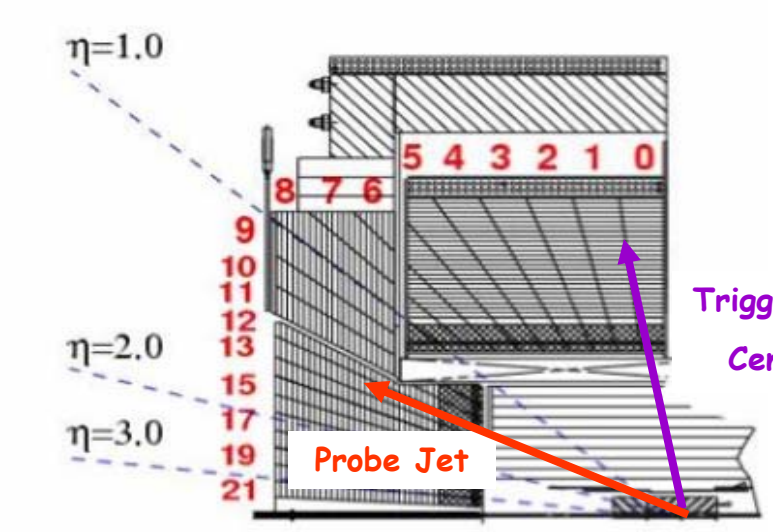
Region 1 : $|Y| < 0.1$ (90° crack)
Region 2 : $0.1 < |Y| < 0.7$ (Central Calorimeter)
Region 3 : $0.7 < |Y| < 1.1$ (Central Cal. + 30° crack)
Region 4 : $1.1 < |Y| < 1.6$ (30° crack + Plug Cal.)
Region 5 : $1.6 < |Y| < 2.1$ (Plug Cal.)



→ Pythia MC samples used to correct the measurements

MC studies: Dijet Balance

→ To study the jet response relative to central calorimeter region where the MC provides a proper description of the data

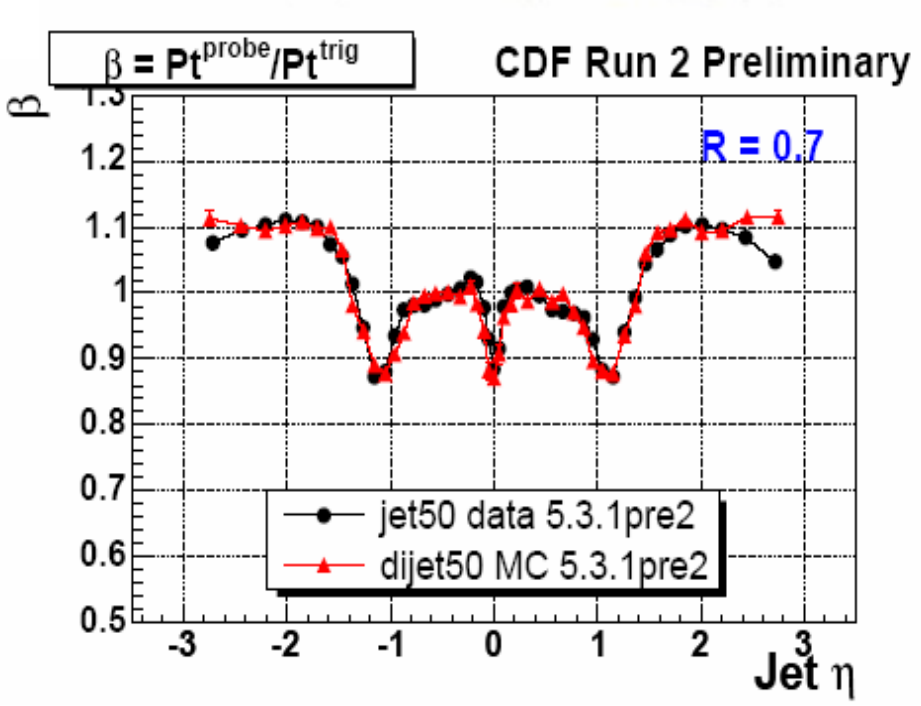


Central Region: Calorimeter + Tracking

⬇

Jet Calorimeter response well understood

(within ± 2-3% energy scale)



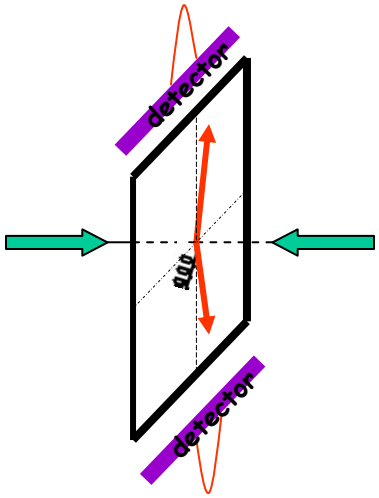
- Dijet events P_T > 10 Gev/c
- Definitions
  - -> $P_T^{Mean} = (P_T^{Trig} + P_T^{Prob})/2$
  - -> $\Delta P_T^F = (P_T^{Prob} - P_T^{Trig})/P_T^{Mean}$
  - -> $\beta = (2+ \langle \Delta P_T^F \rangle)/(2- \langle \Delta P_T^F \rangle)$

Event by event: $\beta = P_T^{Prob} / P_T^{Trig}$

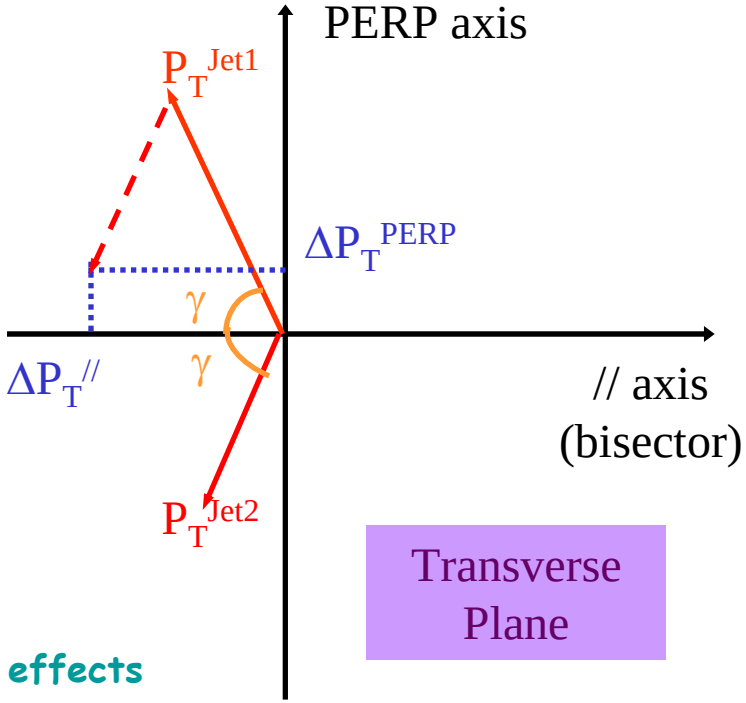
Corrections have been applied based on the dijet balance studies

MC Studies: Bisector Method

→ To study the jet energy resolution



The P_T unbalance between the jets is sensitive to physic (ISR) and detector effects

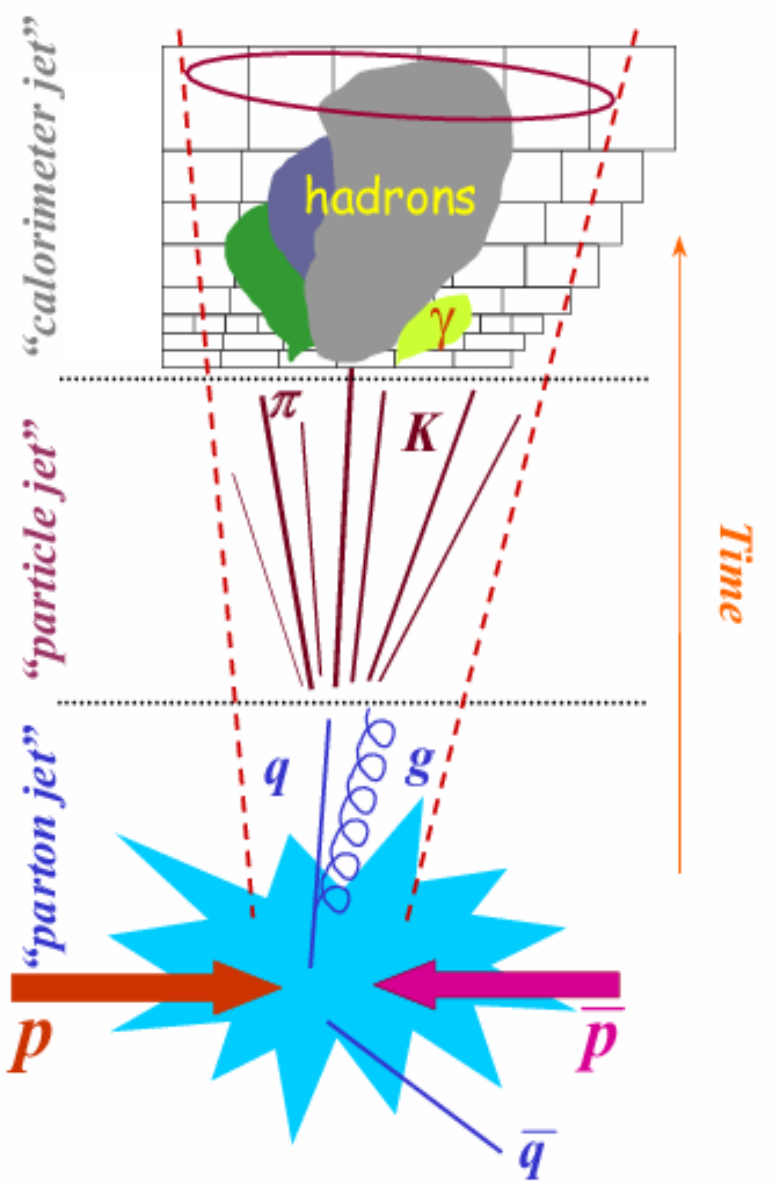


- Dijet events P_T > 10 Gev/c
- Definitions
  - -> $\gamma = |(\phi^{Jet1} - \phi^{Jet2})/2|$
  - -> $\Delta P_T^{//} = \pm (P_T^{Jet1} + P_T^{Jet2}) \cos(\gamma)$
  - -> $\Delta P_T^{PERP} = (P_T^{Jet1} - P_T^{Jet2}) \sin(\gamma)$
- Relevant variables
  - $\sigma_{//}$ = rms of $\Delta P_T^{//}$ distribution ⇨ **physics effects**

    σ_{PERP} = rms of ΔP_T^{PERP} distribution ⇨ **detector + physics effects**
  - $\sigma_D = \sqrt{(\sigma^2_{PERP} - \sigma^2_{//})}$

Corrections have been applied in the MC for the most forward regions

Corrections strategy



From calorimeter to hadron level

→ Multiple $p\bar{p}$ interaction correction

To remove contributions from multiple interactions per bunch crossing

- P_T contribution (ε) to the P_T^{Jet} for each additional primary vertex ⇨ ~1-2 GeV/c

$$P_T^{RAW}(\text{corrected}) = P_T^{RAW} - \varepsilon \times (\text{Num.vert} - 1)$$

→ First an average p_T correction (based on MC)

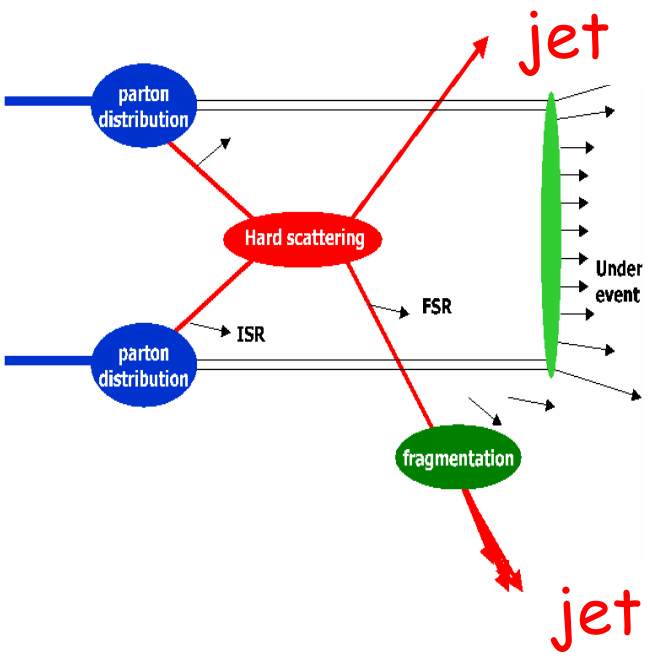
To correct in **average** the energy measured in the calorimeter to take into account non-compensation and dead material

→ Unfolding correction (based on MC)

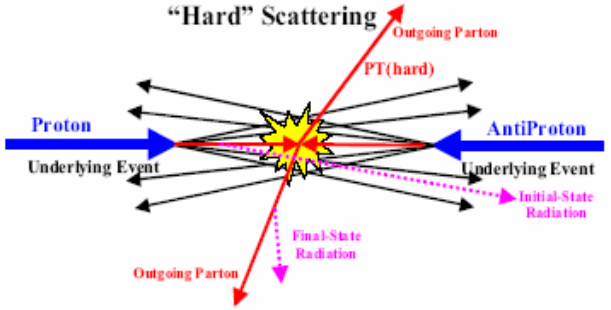
To take into account smearing/resolution effects

NLO corrections

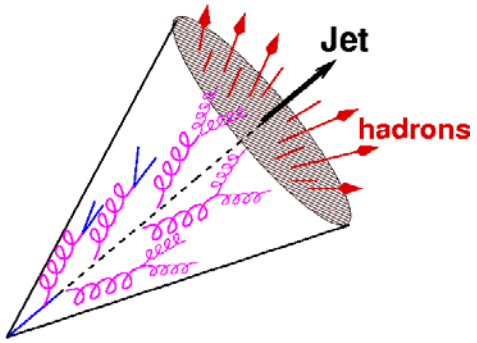
For comparison to NLO pQCD calculations corrections has to be applied for Underlying event and Hadronization effect (model dependent)



Underlying event



Hadronization

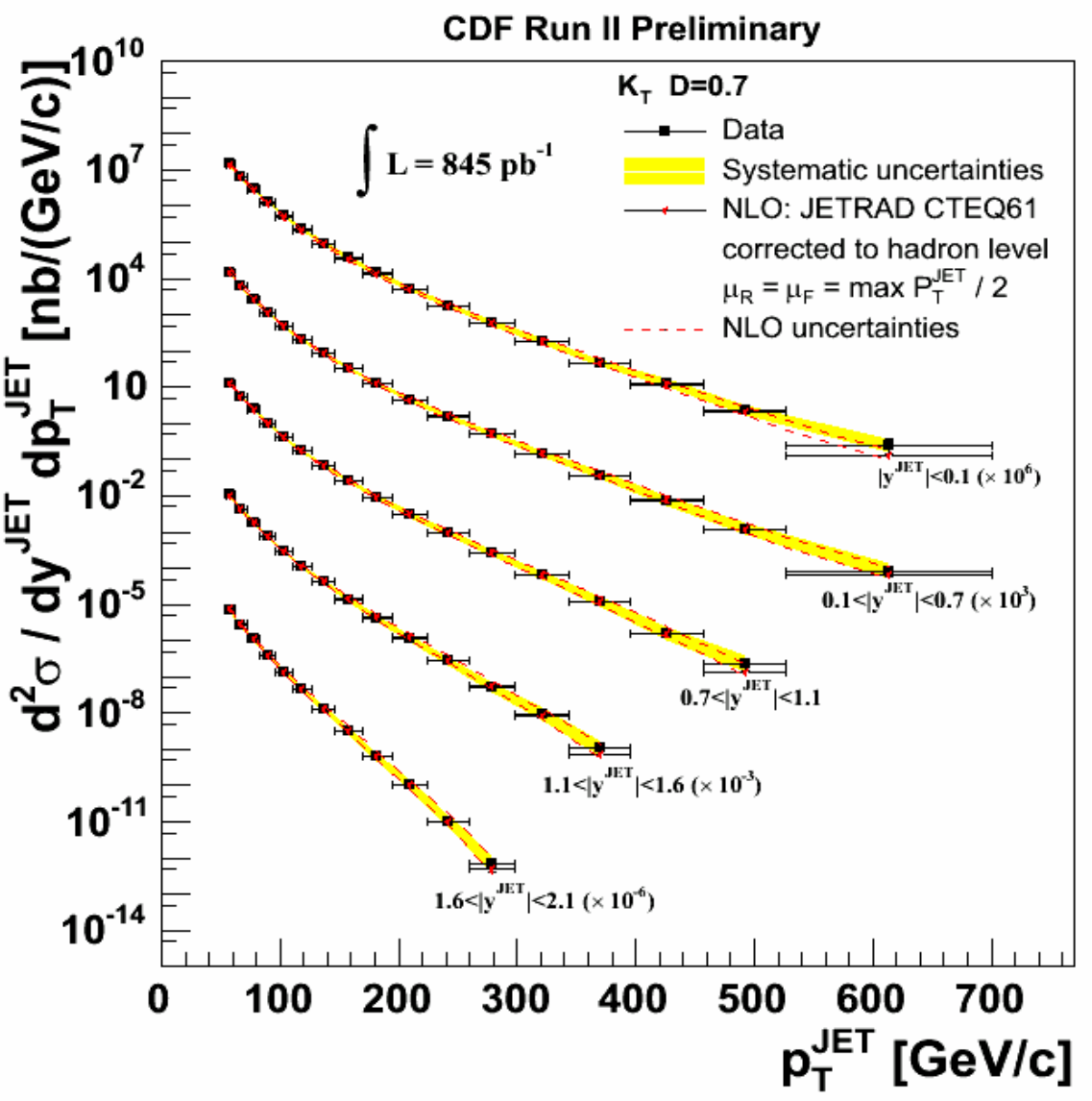


$$C_{HAD}(P_T^{Jet}, Y^{Jet}) = \frac{\sigma\ (\text{Hadron Level Pythia Tune A with MPI})}{\sigma\ (\text{Parton Level Pythia Tune A no MPI})}\ (P_T^{Jet}, Y^{Jet})$$

Jets cross sections with K_T

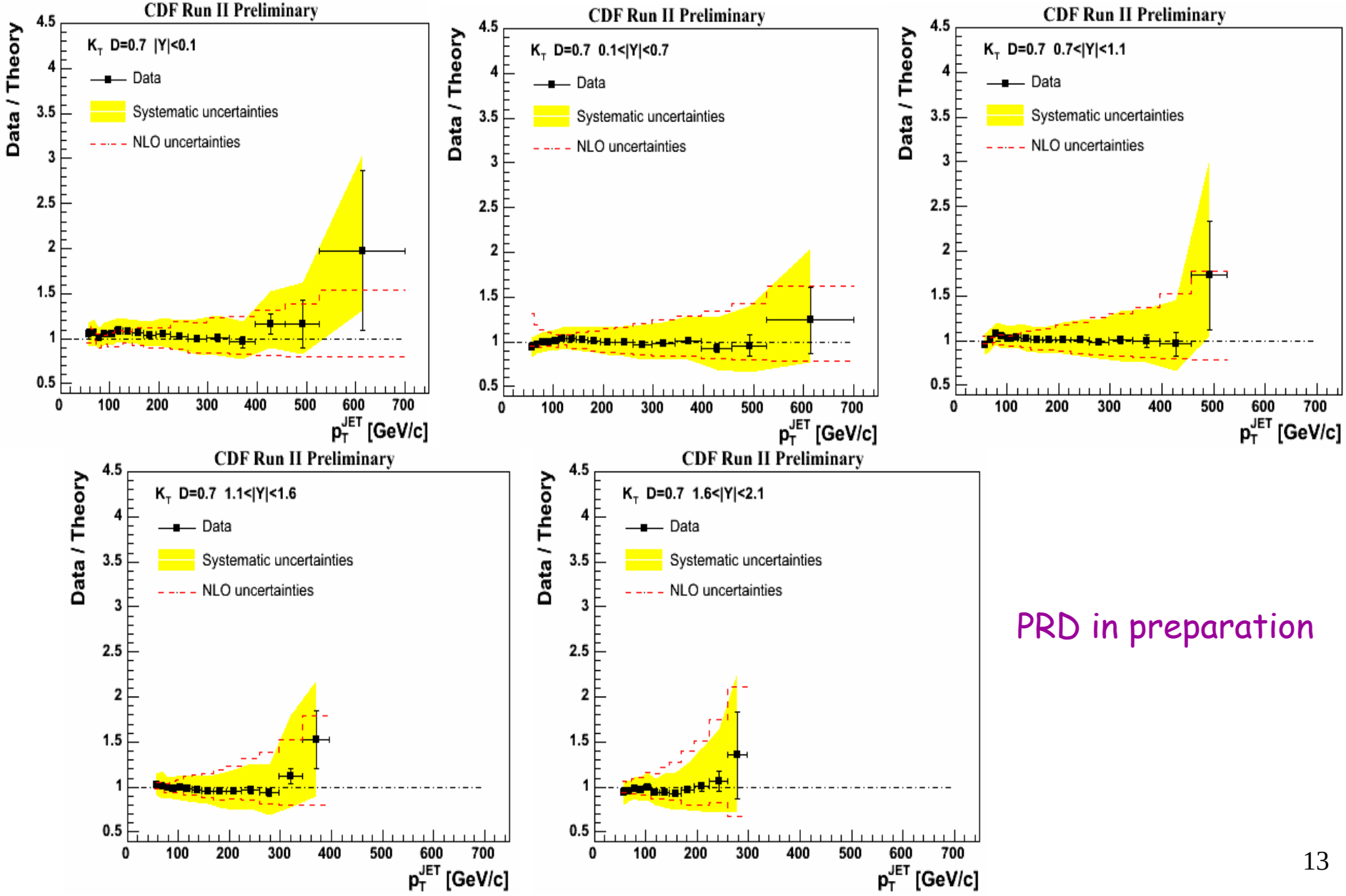
Regis Lefevre
Mario Martinez
Olga Norniella

Results $|y^{Jet}| < 2.1$



Good agreement with NLO

Results with K_T: Data/NLO

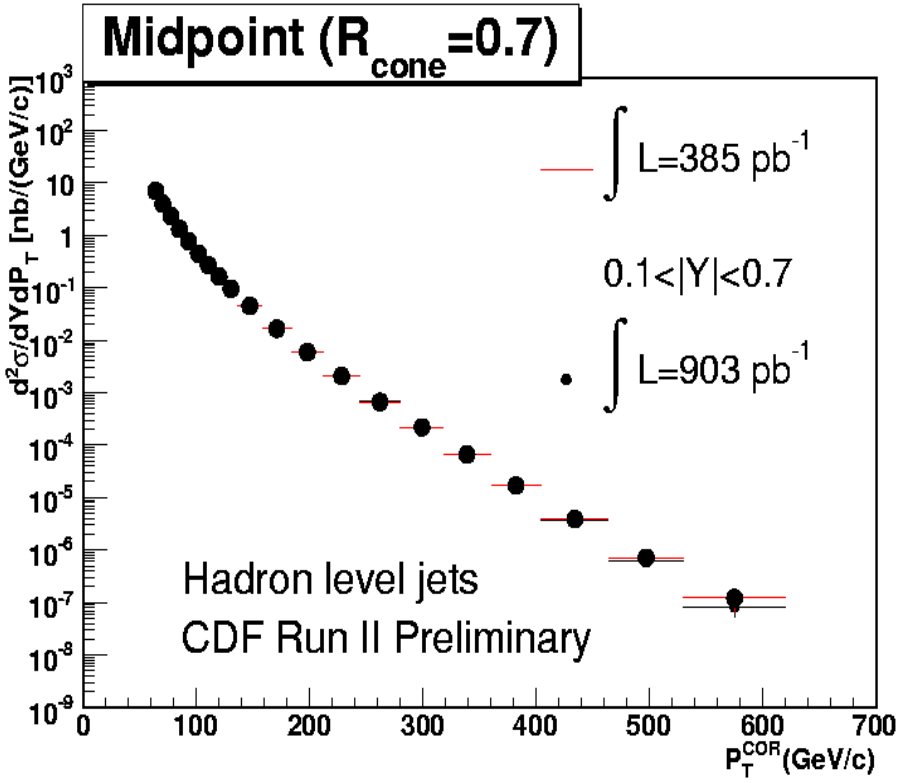


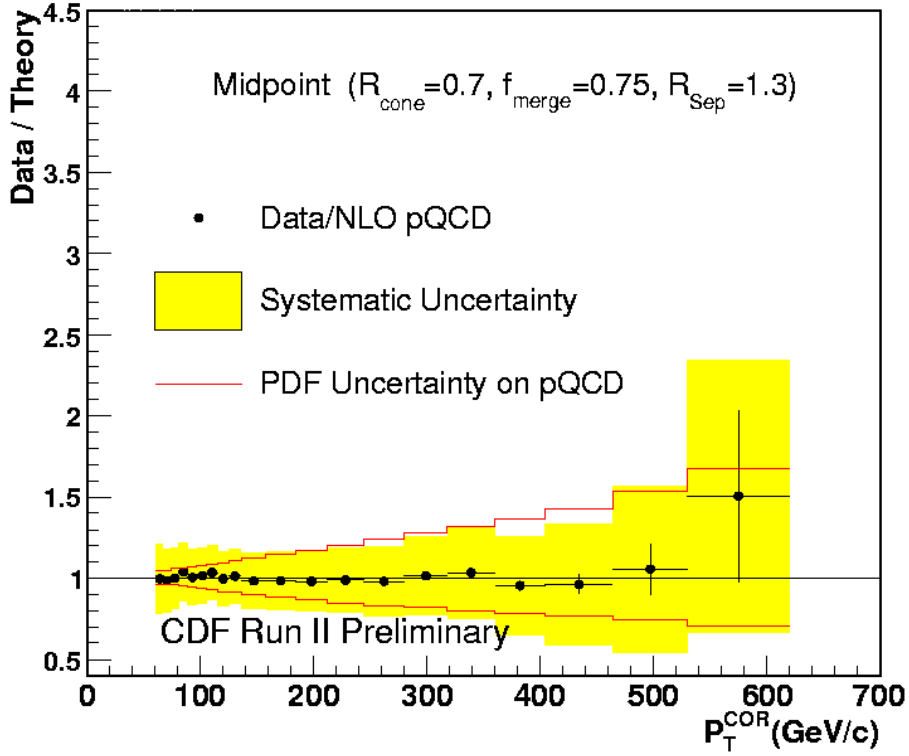
PRD in preparation

Jets cross sections with MidPoint

Craig Group
Ken Hatakeyama
Frank Chlebana
…

Results $0.1 < |Y^{Jet}| < 0.7$





…also good agreement with NLO

Summary & Plans

→ Inclusive jet cross section measured using ~900 pb^{-1} of CDF Run II data in five rapidity regions:

$|Y^{Jet}| < 0.1$; $0.1 < |Y^{Jet}| < 0.7$; $0.7 < |Y^{Jet}| < 1.1$; $1.1 < |Y^{Jet}| < 1.6$; $1.6 < |Y^{Jet}| < 2.1$

- Using the K_T algorithm and MidPoint algorithms

  → PRLs submitted in December with 385 pb^{-1} for central jets

- Fully corrected to the hadron level
- Good agreement with theory (corrected for UE / Hadronization)

→ Results are going for blessing for winter conferences

- MidPoint: Central jets (Forward regions results in spring)
- K_T algorithm: Five Rapidity regions

  → PRD is already in preparation

  → running over the new 150 pb^{-1} up to Nov 9th