Inclusive and heavy quark jet cross sections from CDF

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Outline

- Motivation
- The Tevatron and CDF
- Jet recostruction
- Inclusive jet cross section
- High p_t b-jet inclusive cross section
- $b\bar{b}$ jet cross section
- Summary

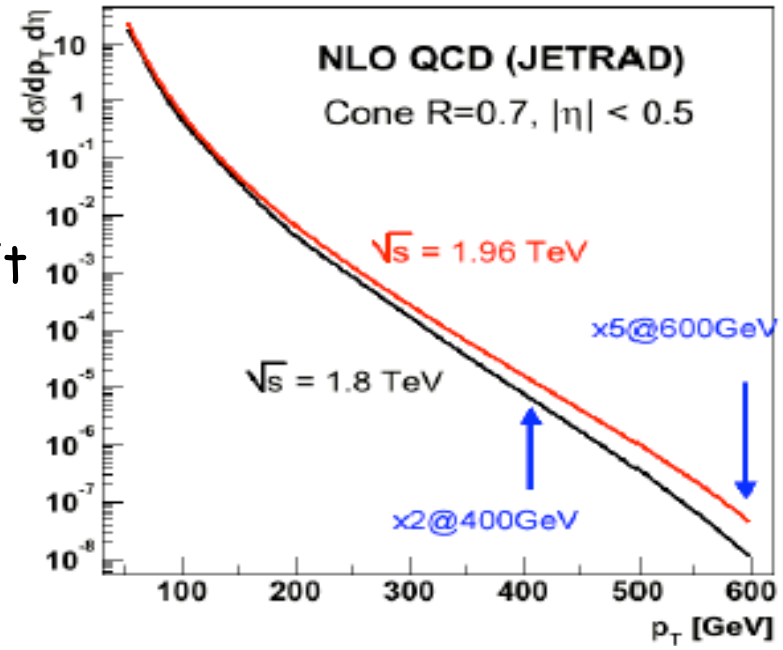
Motivation

- **Precise test to pQCD**
- Higher center of mass energy

  -> increase cross section @ high Et

  x2 @ 400GeV, x5 @ 600GeV

  -> Probe higher energies
- Recent theory advancements:
  - New PDF
  - New structure functions
  - Better understanding of underlying event
- **Test Kt performances at a hadron collider**
  - Comparison to cone-based algorithms

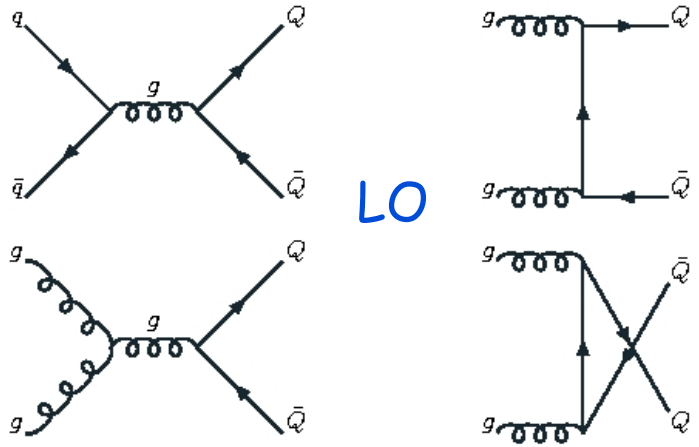


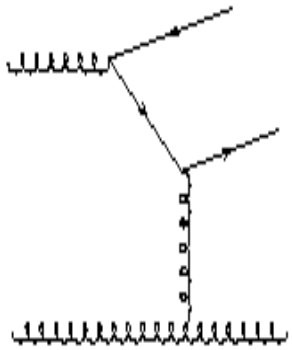
Motivation (II)

- $\sigma(b\bar{b}) \sim 50\ \mu b$ @ 1.96 TeV

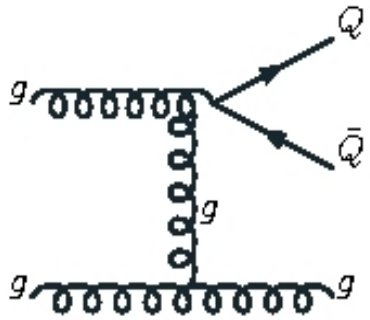
  -> **Espected event rate of few kHz**

- Study mechanisms of beauty production





Flavour excitation

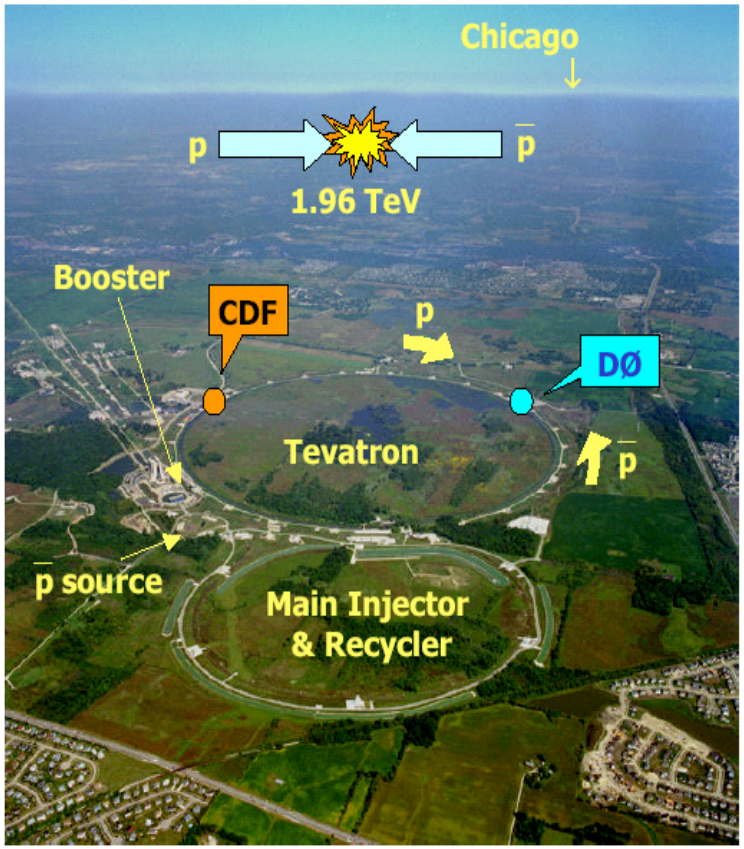


Gluon splitting

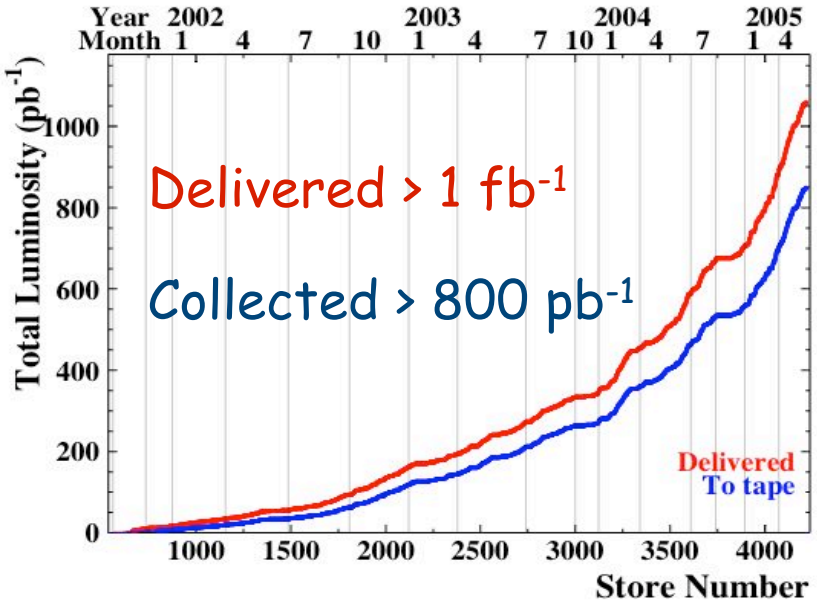
Recent theory advancements

- Full NLO calculations available in MC

The Tevatron

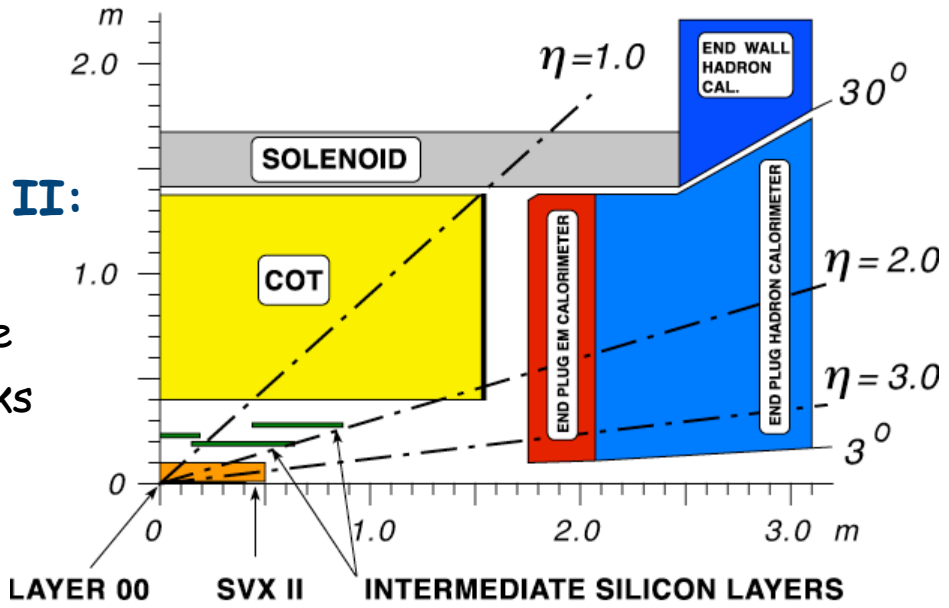


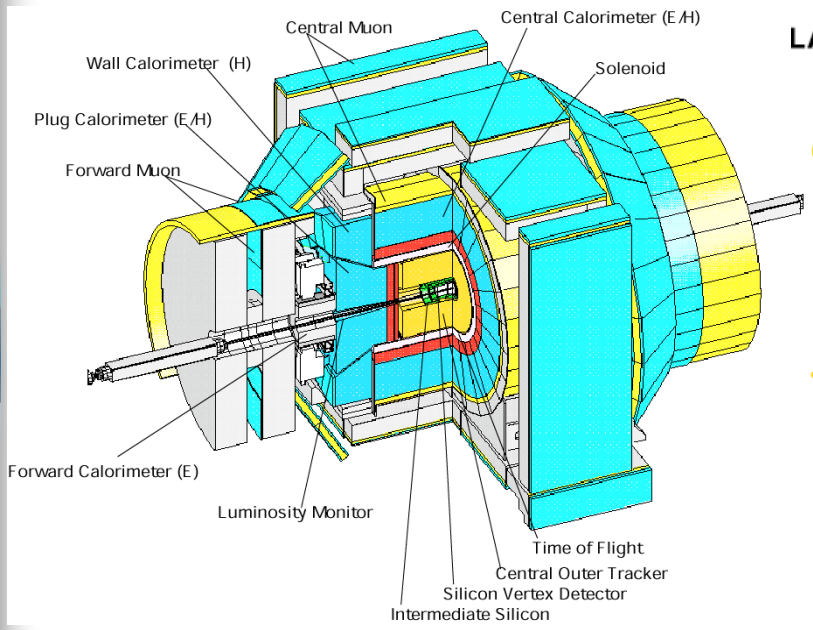
- $p\bar{p}$ collider @ $\sqrt{s} \approx 1.96$ TeV
- Peak lum $1.2\ 10^{32}\ cm^{-2}\ s^{-1}$
- $1\ fb^{-1}$ delivered to experiments
- Analyses ~ $60\text{-}400\ pb^{-1}$



CDF

- **CDF fully upgraded for Run II:**
  - Si & tracking
  - Extended calorimeters range
  - L2 trigger on displaced tracks
  - High rate trigger/DAQ





Calorimeter

- CEM lead + scint $13.4\%/\sqrt{E_t} \oplus 2\%$
- CHA steel + scint $75\%/\sqrt{E_t} \oplus 3\%$

Tracking

- $\sigma(d0) = 40\mu m$ (incl. $30\mu m$ beam)
- $\sigma(pt)/pt = 0.15\ \%\ pt$

Kt algorithm

Separate jets according to relative transverse momentum

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

$$d_i = (P_{T,i})^2$$

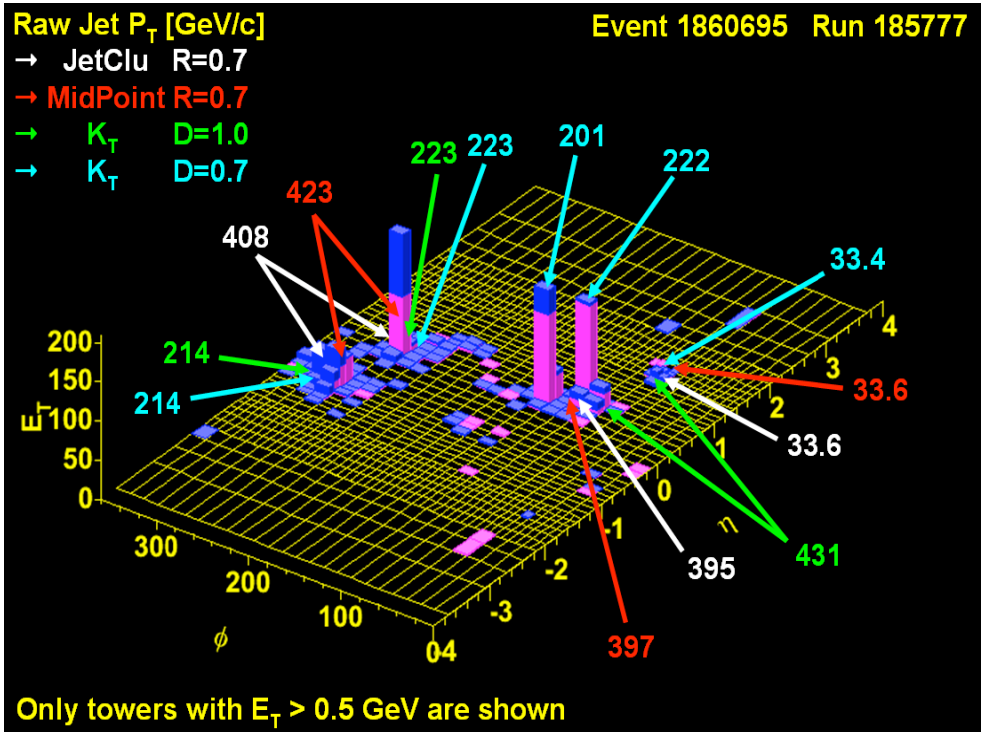
D ~ jet size

Infrared, collinear safe

- **Cone based (seeded) algorithms**
  - **JetClu** (RunI)

    Difficult to implement at hadron level, compare with theory
  - **MidPoint** (new RunII)

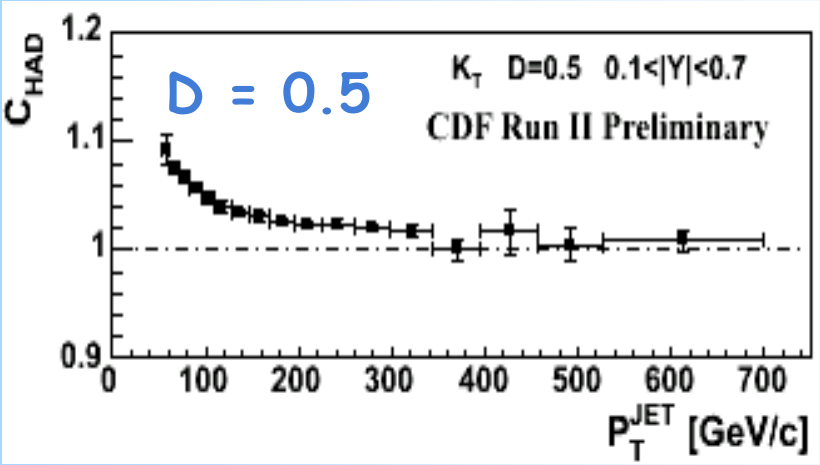
    Infrared safe and well defined
- **Merging pairs of particles**
  - **Kt** (recently used @ CDF)



Inclusive jet cross section

- Inclusive calorimetric trigger

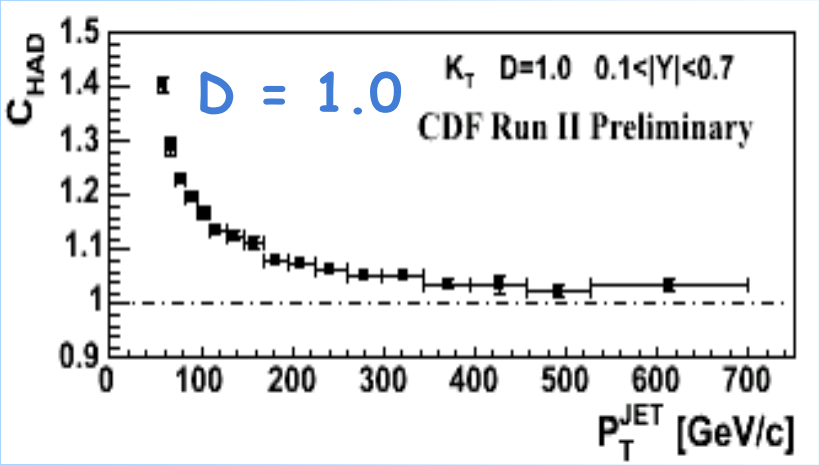
  L3 E_t> x (5,20,50,70,100)
- Kt jets D=0.5, 0.7, 1.0
- 0.1<|Y|<0.7, P_t>54GeV/c
- Jet energy scale correction and unfolding to hadron level



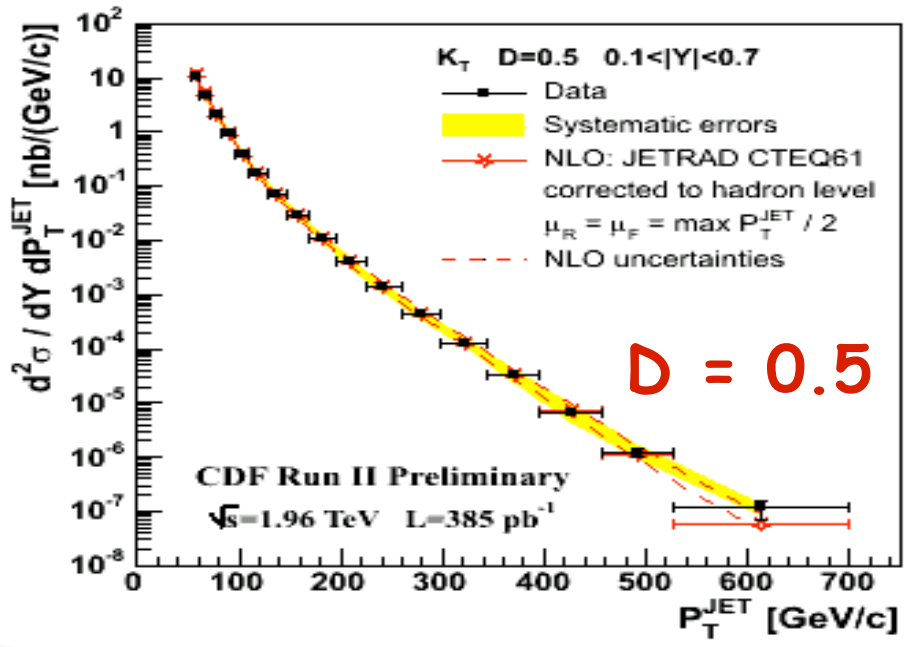
- NLO JETRAD prediction:
  - Parton-to-hadron correction to allow direct comparison data/MC

    (UE and hadronization)

Correction increases with D
-> higher contribution of UE



Inclusive jet cross section



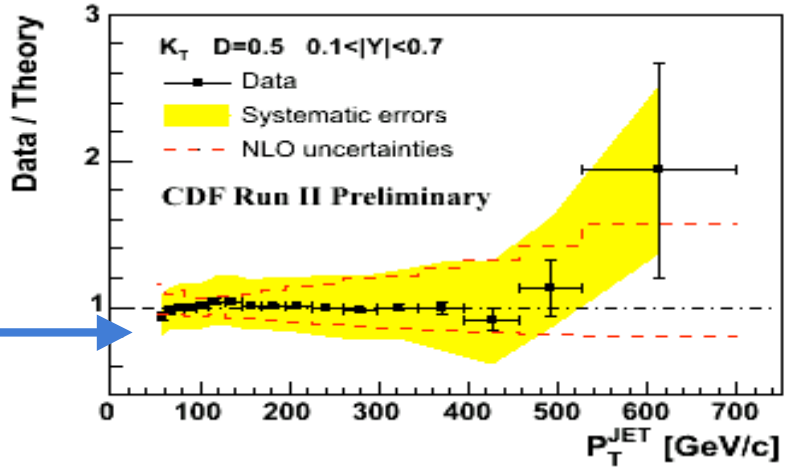
~ 385 pb^{-1}

Pt ~ 54 - 700 GeV

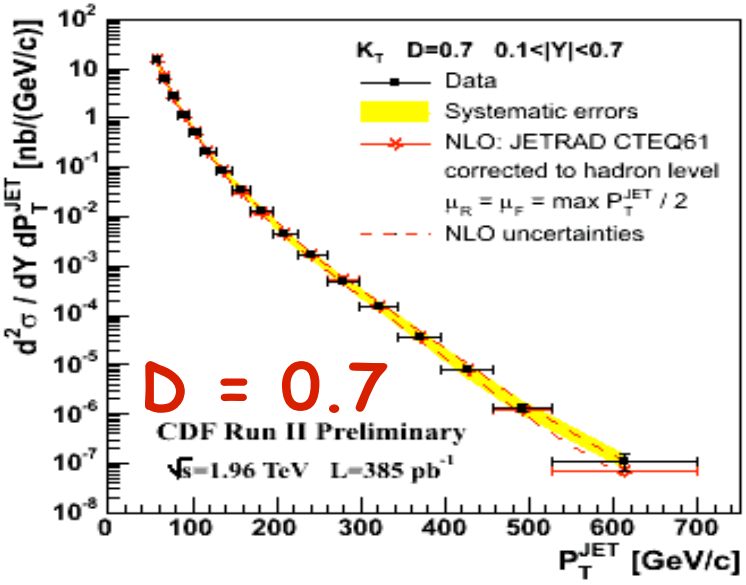
Main systematics:

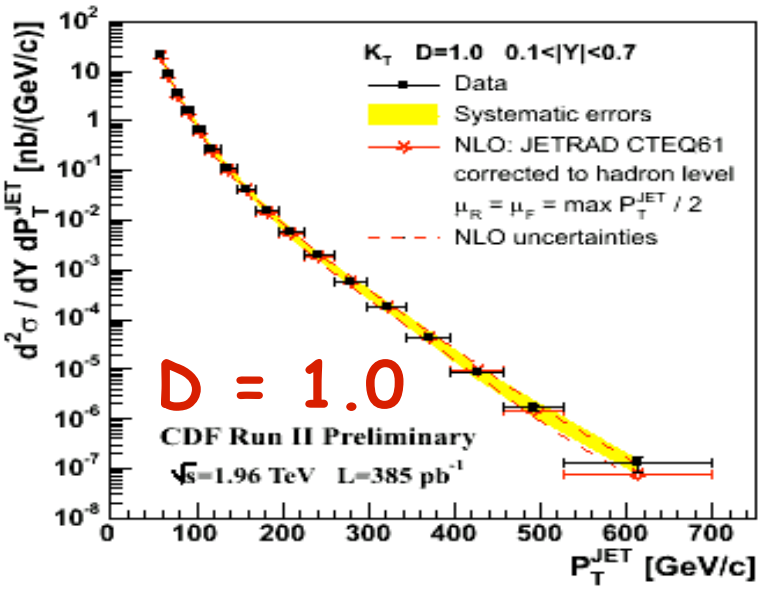
- Data: Energy scale 15-40%
- NLO: mainly from PDF

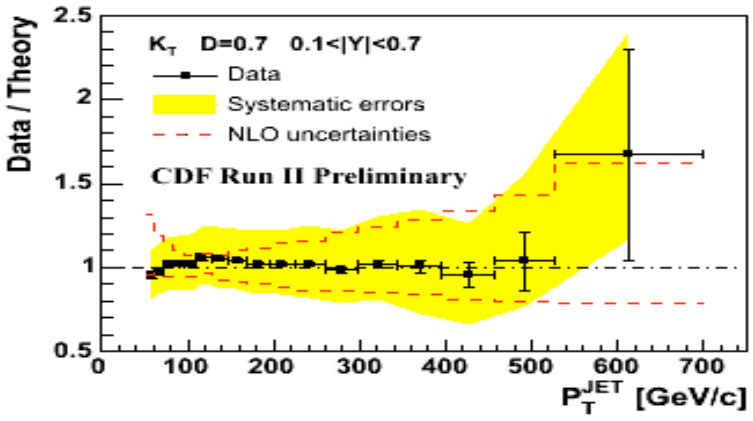
Measurement extended
over 8 orders of magnitude
Very good agreement with NLO

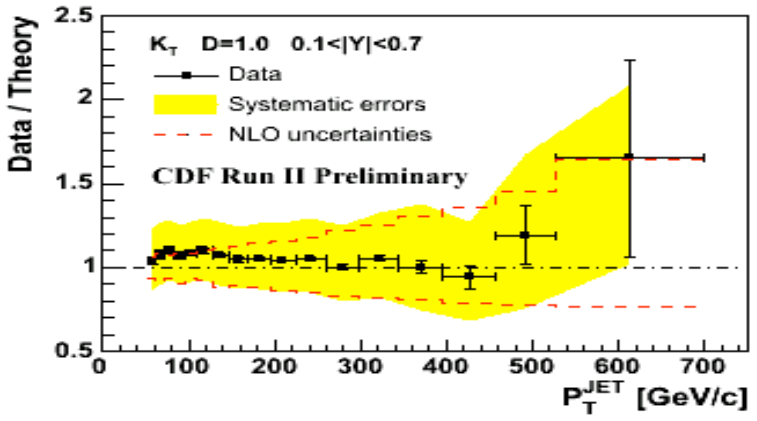


Inclusive jet cross section



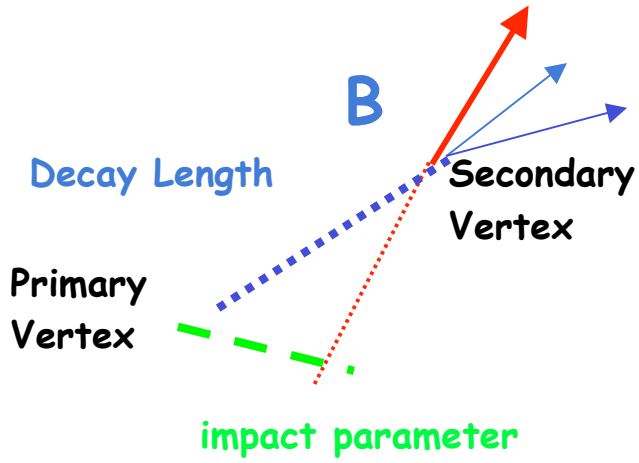


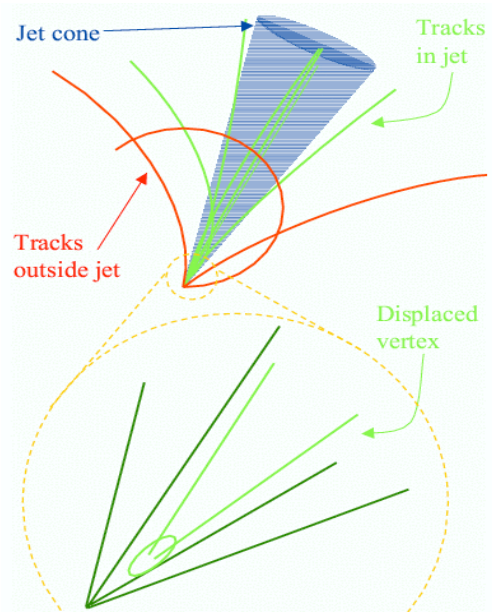


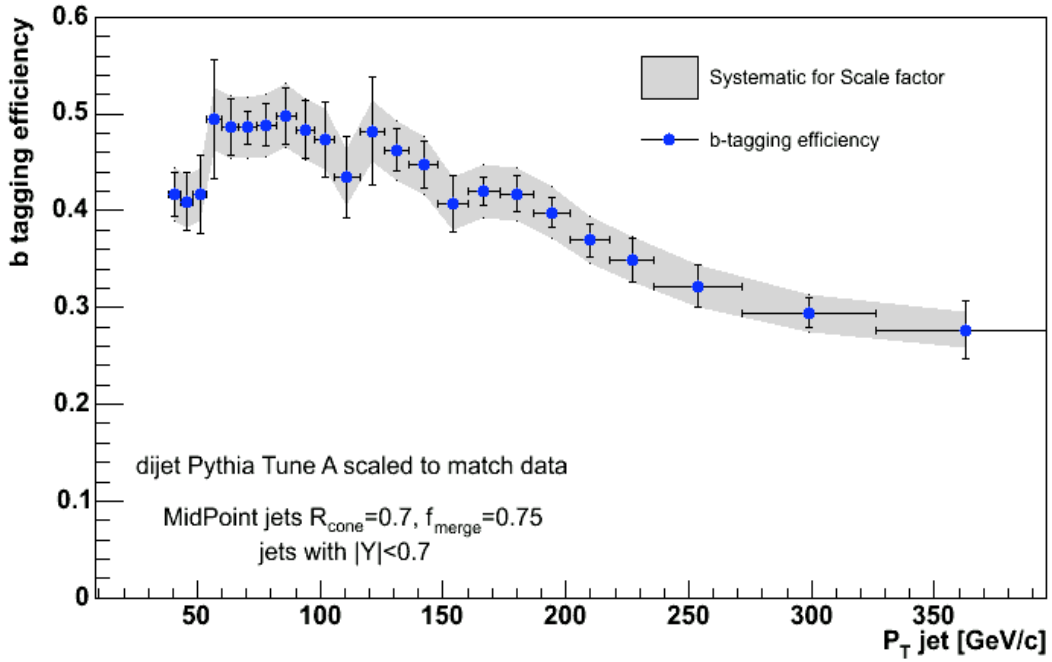


Tagging b jets

- Long B lifetime $c\tau \sim 450\ \mu m$
- Select **displaced** tracks inside the jet
- Reconstruct **secondary vertex**
- Reject fakes cutting on **decay length**





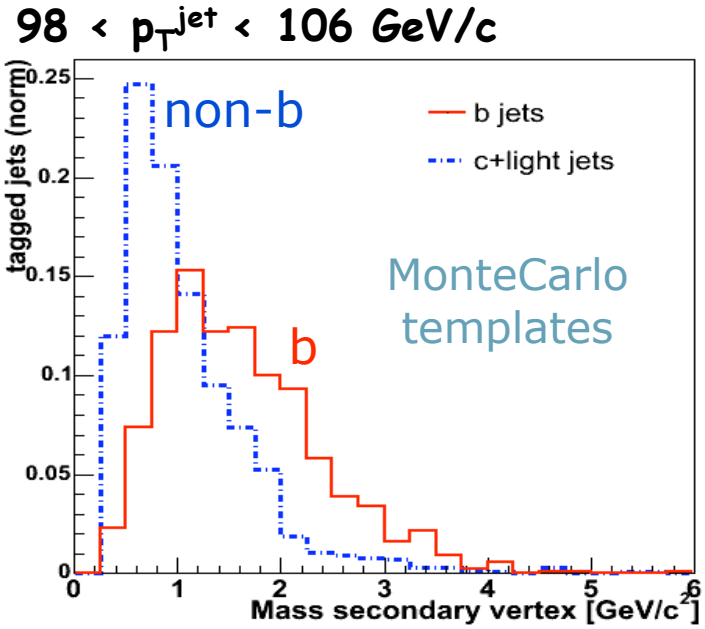


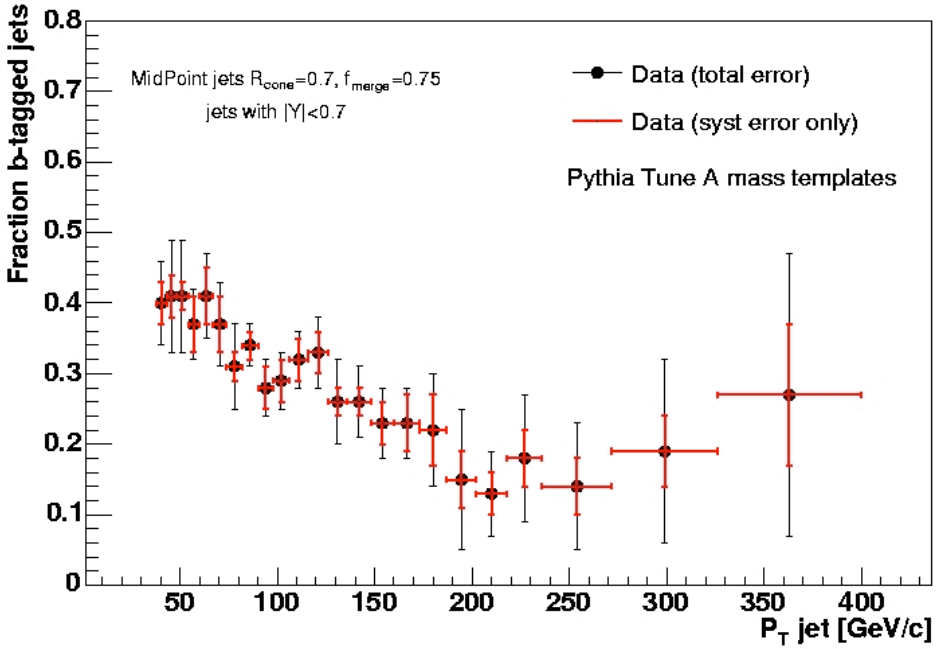
b-jet fraction

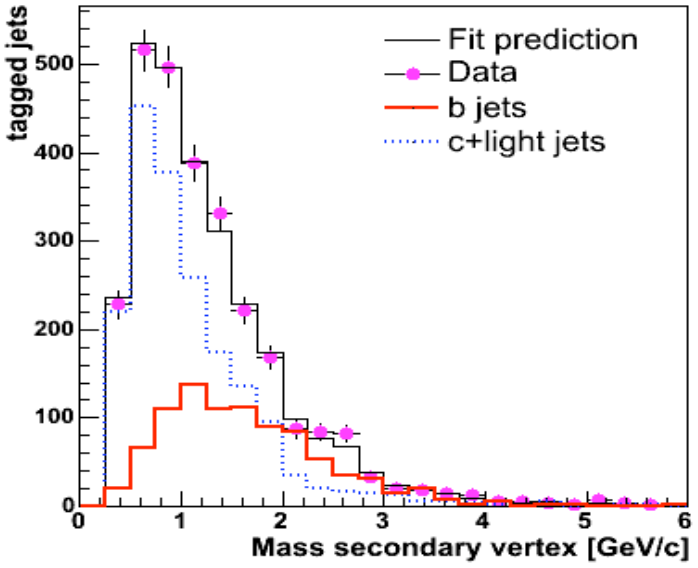
Which is the real b content (purity)?

Extract a fraction from data

- Use shape **secondary vertex mass**
  - Different P_t bins to cover wide spectrum
  - Fit data to MC templates



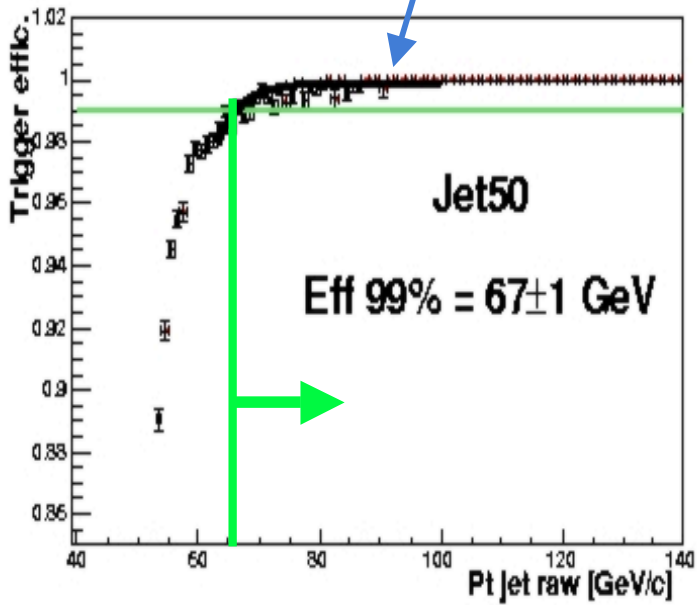




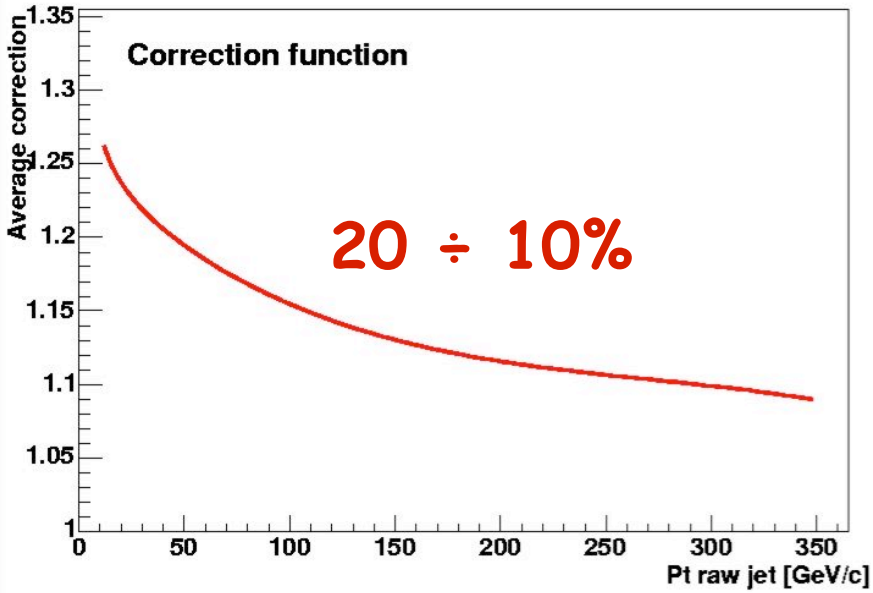
High p_t b jet cross section

- **MidPoint** R_{cone} 0.7, |Y| < 0.7
- Pt ranges defined to have
  99% efficiency (97% Jet05)

Inclusive calorimetric triggers
- L3 Et > x (5,20,50,70,100)



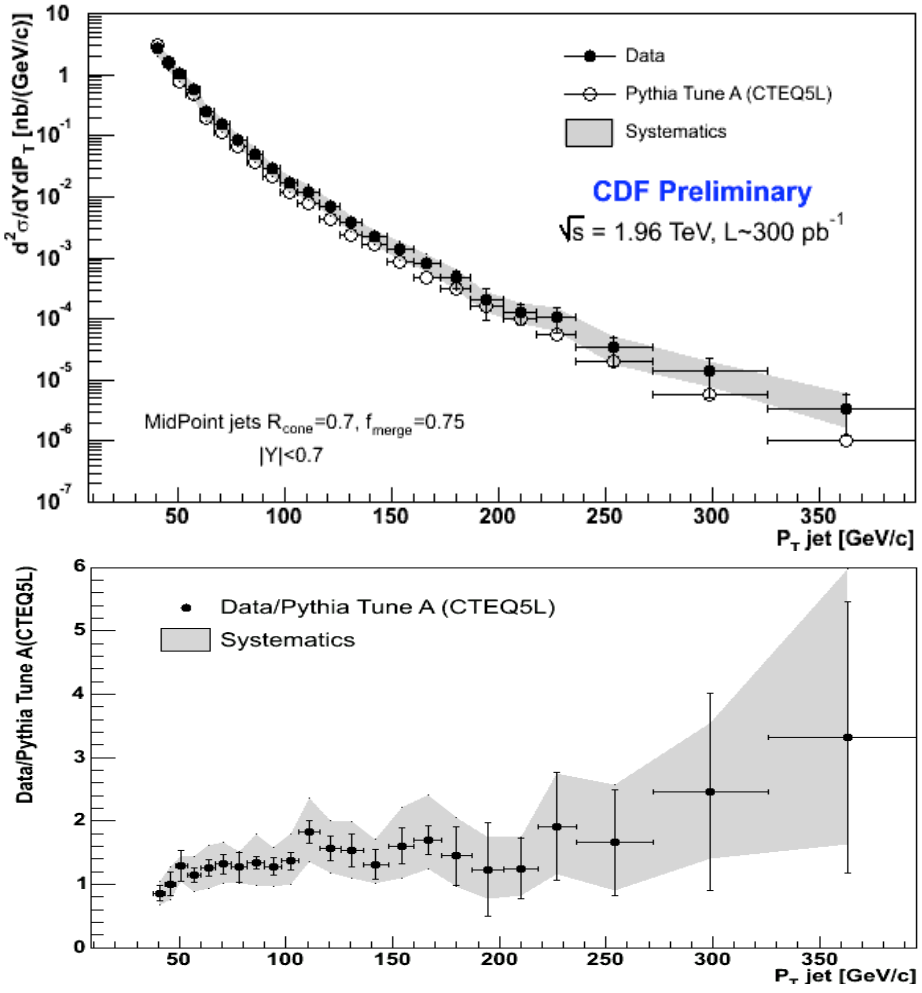
- Jets corrected for det effects



~ 300 pb^{-1}

Pt ~ 38 - 400 GeV

High p_t b-jet cross section



- Main sources of systematics:
  - Absolute energy scale
  - B-tagging

Systematic Error	low P_T	high P_T
Luminosity	6%	6%
Absolute Energy Scale	15-20%	40%
Jet energy resolution	6%	6%
B-tagging efficiency	10%	15%
B-tagged jets fraction	10-15%	40%
Unfolding	8%	8%

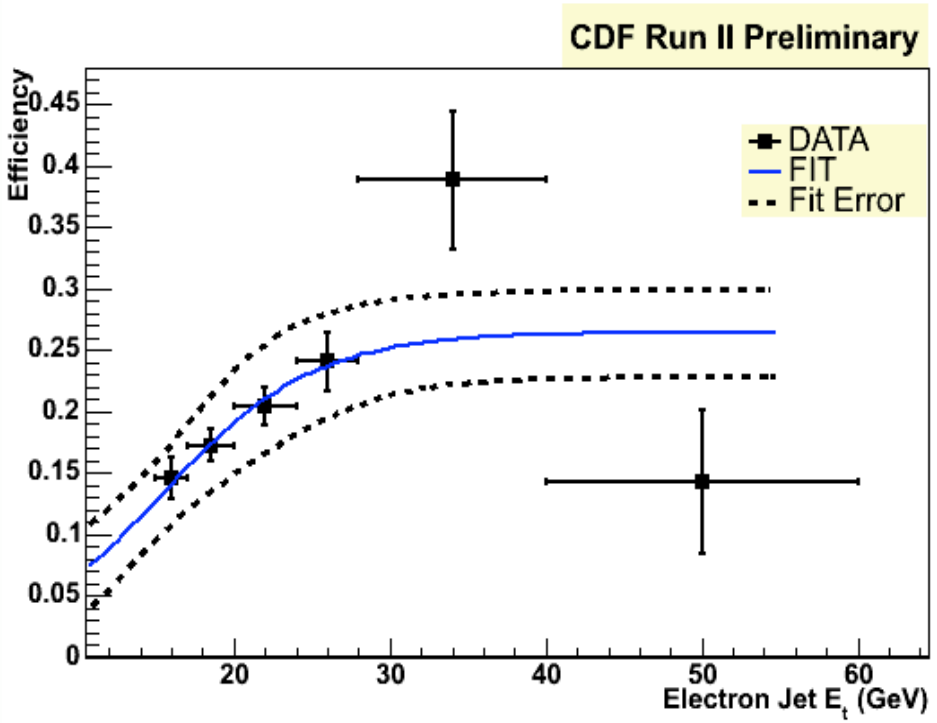
Data/Pythia tune A ~ 1.4

As expected from preliminary NLO/LO comparison

$b\bar{b}$ cross section

Preliminary!

- JetClu cone 0.7
- Two central jets $|\eta|< 1.2$, asymmetric Et cut
- Energy scale corrected for detector effects



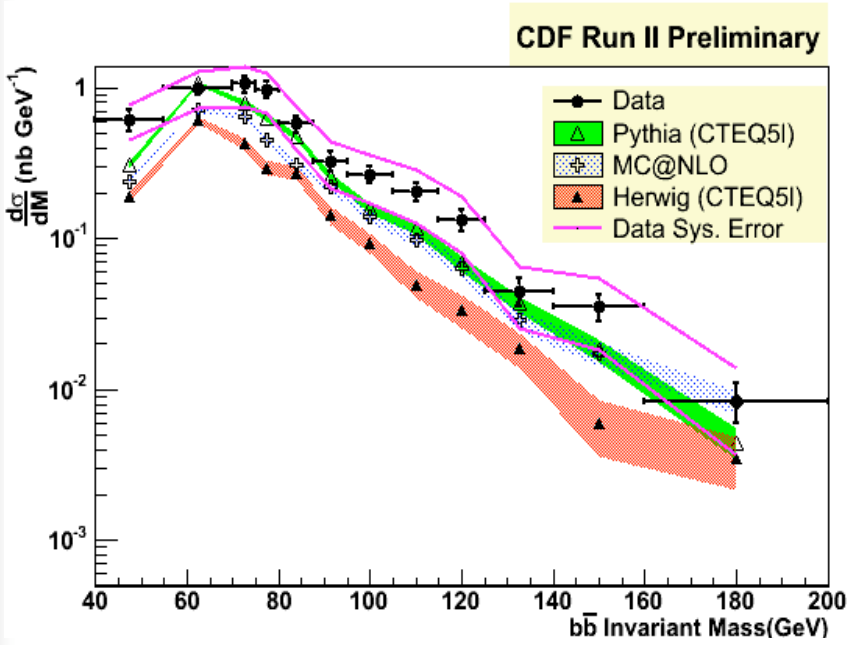
- b tagging efficiency from data
  - Use an electron sample to increase bjets content
- b fraction
  - Fit to secondary vertex mass templates

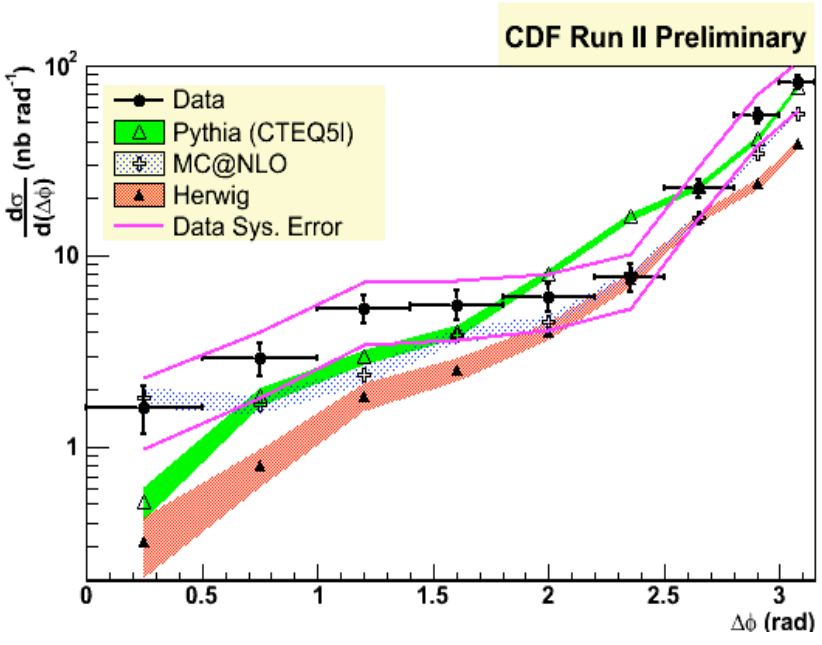
$b\bar{b}$ cross section

- Main **systematics**:
  - Jet energy scale (~20%)
  - b tag efficiency (~8%)
- UE description lowers Herwig prediction

Total cross section

Data	34.5 ± 1.8 ± 10.5nb
Pythia(CTEQ5l)	38.71 ± 0.62nb
Herwig(CTEQ5l)	21.53 ± 0.66nb
MC@NLO+Herwig	28.49 ± 0.58nb

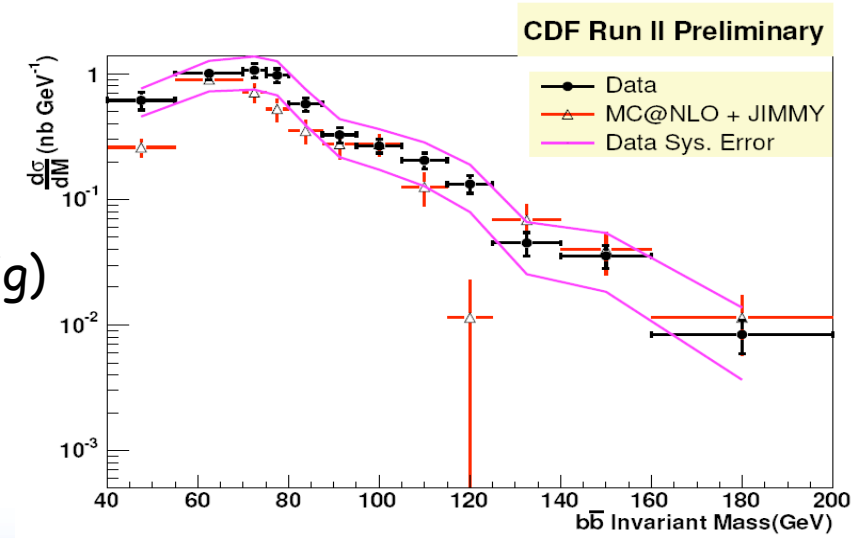




$b\bar{b}$ cross section

- Use MC@NLO + JIMMY
  - Generator for multiparton interactions (links to Herwig)

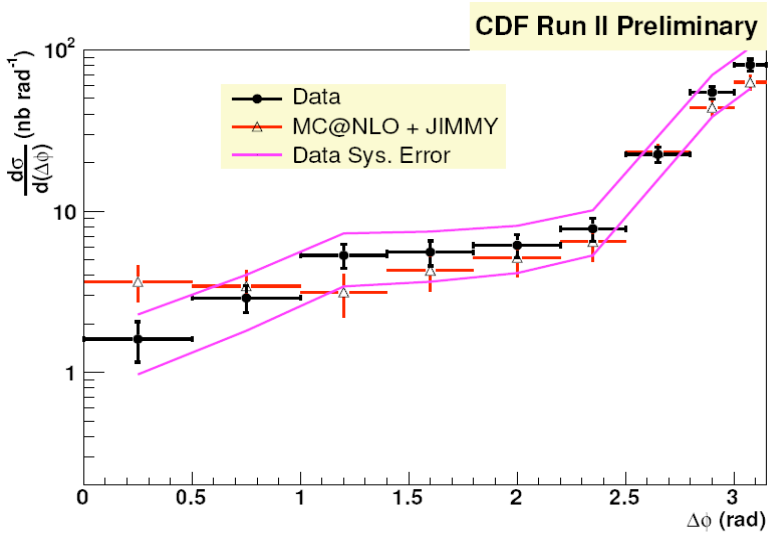
    --> Better description of **underlying event**



Result is preliminary:

σ = 36 ± 2 nb

Better agreement with data and Pythia



- Need to find a better tuning
- Increase statistics of both data and MC

Summary

- New RunII measurements reported:
  - **Inclusive jet cross section, Kt algorithm**: good agreement with NLO Monte Carlo, work is in progress to extend measurement in the forward region

    (coming up next MidPoint measurement)
  - New **inclusive b jet cross section** considerably increases range in p_t (**RunI D0 measurement < 100 GeV**): expected LO ratio (**Data/Pythia ~1.4**) and NLO comparison in preparation
  - **bb jet cross section** and angular correlations: extend analysis to more data but already a reasonable agreement with LO and NLO Monte Carlo