Measurement of Inclusive Jet cross section

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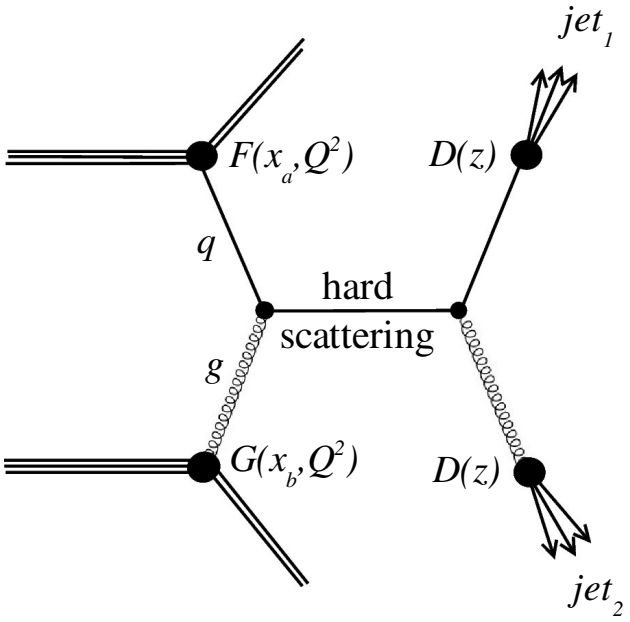
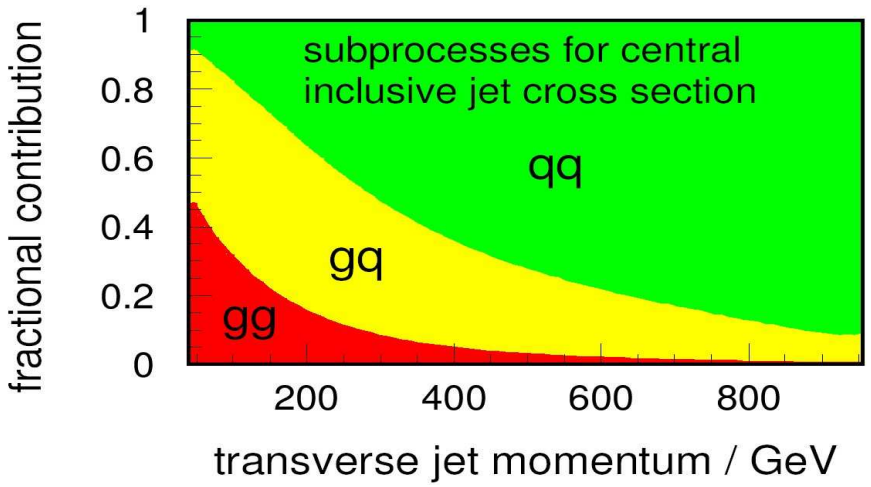
Outline

- Motivation – Jet Physics at Tevatron
- DØ Detector, DØ Calorimeter
- Jets and Cone Jet Algorithm
- Data sample
- Cross Section Measurement
- Conclusions

Motivation



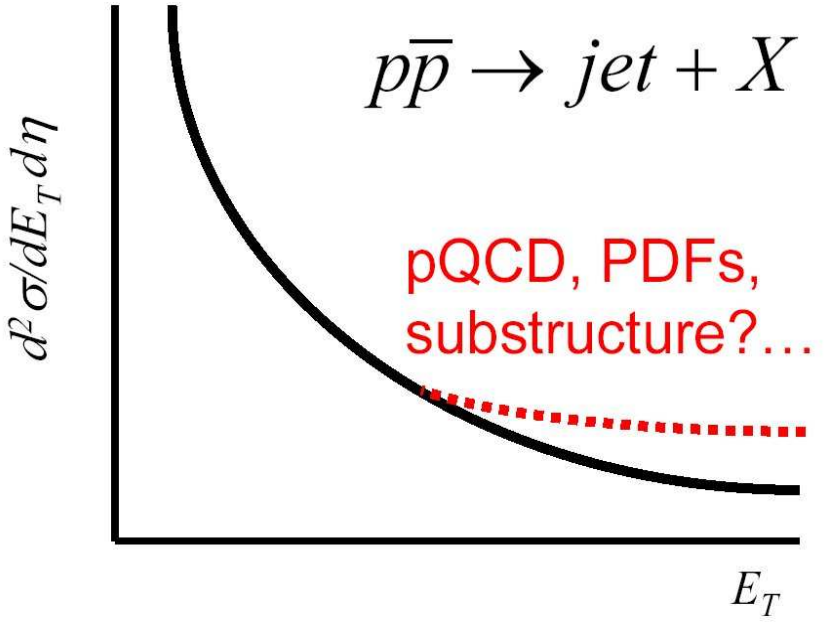
- inclusive jet and di-jet cross sections are directly sensitive to strong coupling constant α_S, PDFs and pQCD matrix elements



- gluon **P**arton **D**istribution **F**unction (**PDF**) for high $\underline{x}$ was extrapolated from low and medium $\underline{x}$ – the rapidity dependent Run I inclusive jet cross section measurement drives PDF at medium to high $\underline{x}$

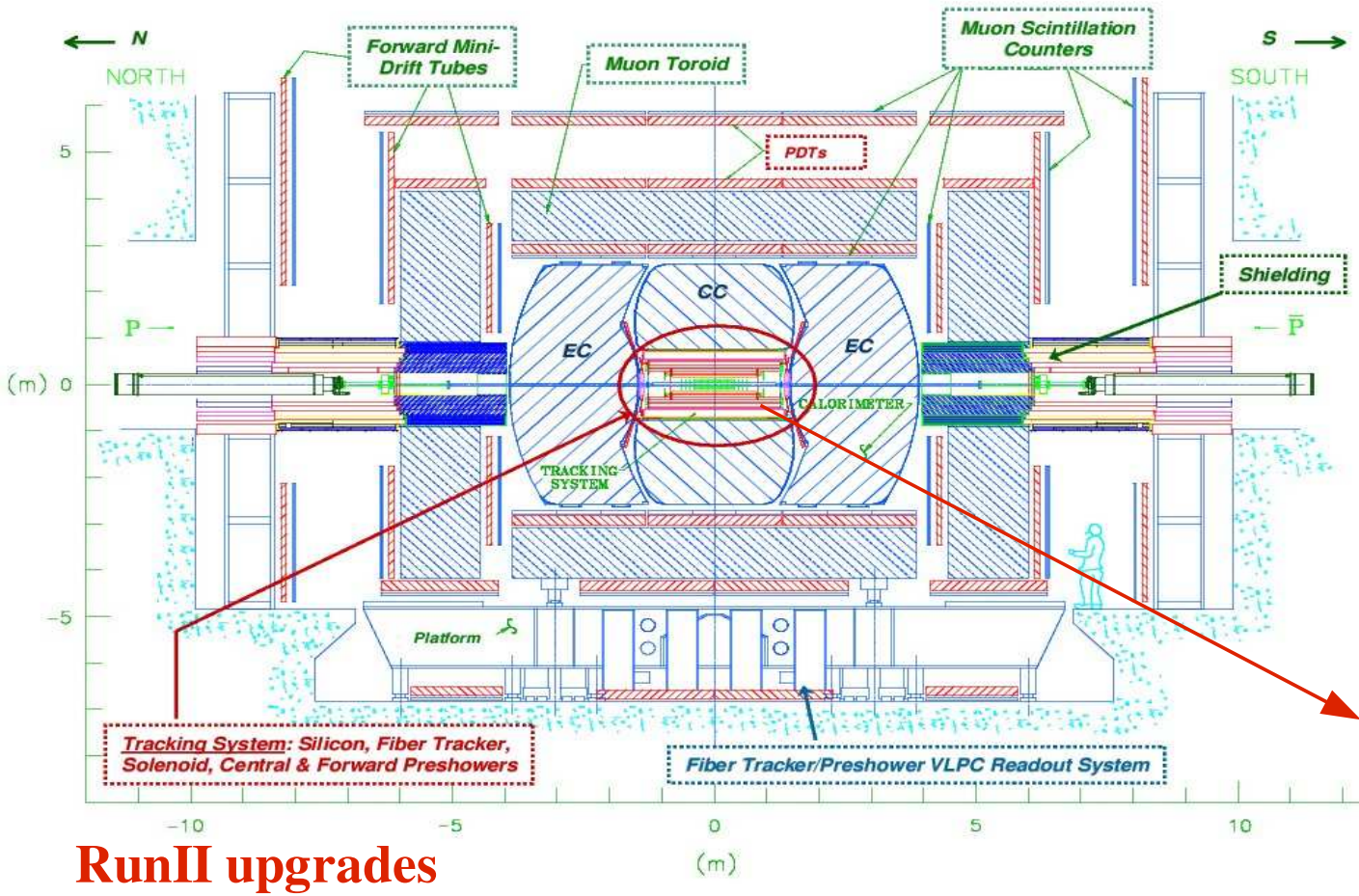
Motivation

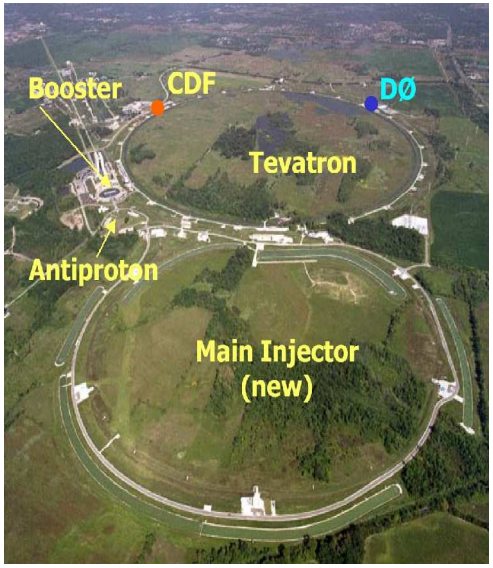
- Run II datasets have better discrimination of PDFs – for *gluons* at high x
- reliable test of accuracy of parton-level NLO calculation and pQCD matrix elements

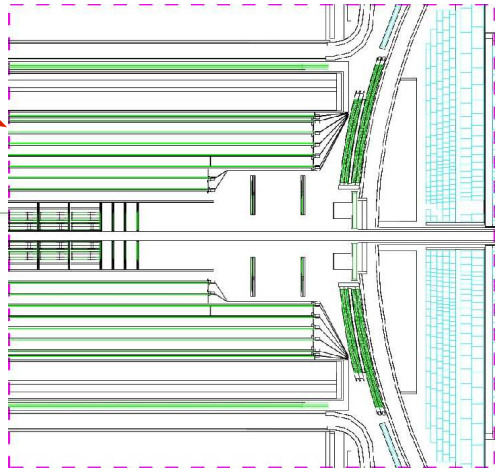


- place to search for new physics, traditionally
  - central region ⇨ the largest transverse energy ⇨ sensitive to PDFs and potential new physics
  - forward regions ⇨ still sensitive to PDFs but less "sensitive" to new physics

The DØ Detector



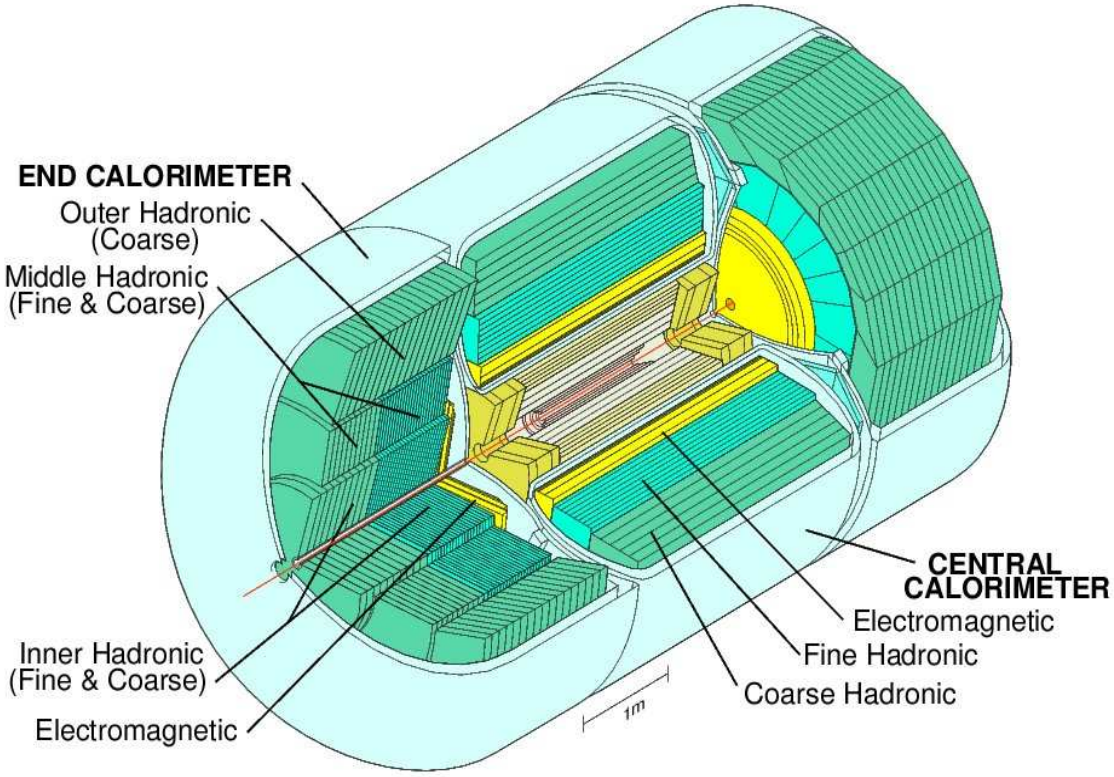




RunII upgrades

- shorter time between bunch crossing ⇨ *396 ns* ⇨ faster trigger and readout electronics
- more material in front of the calorimeter ⇨ magnet, tracker, new pre-shower detector

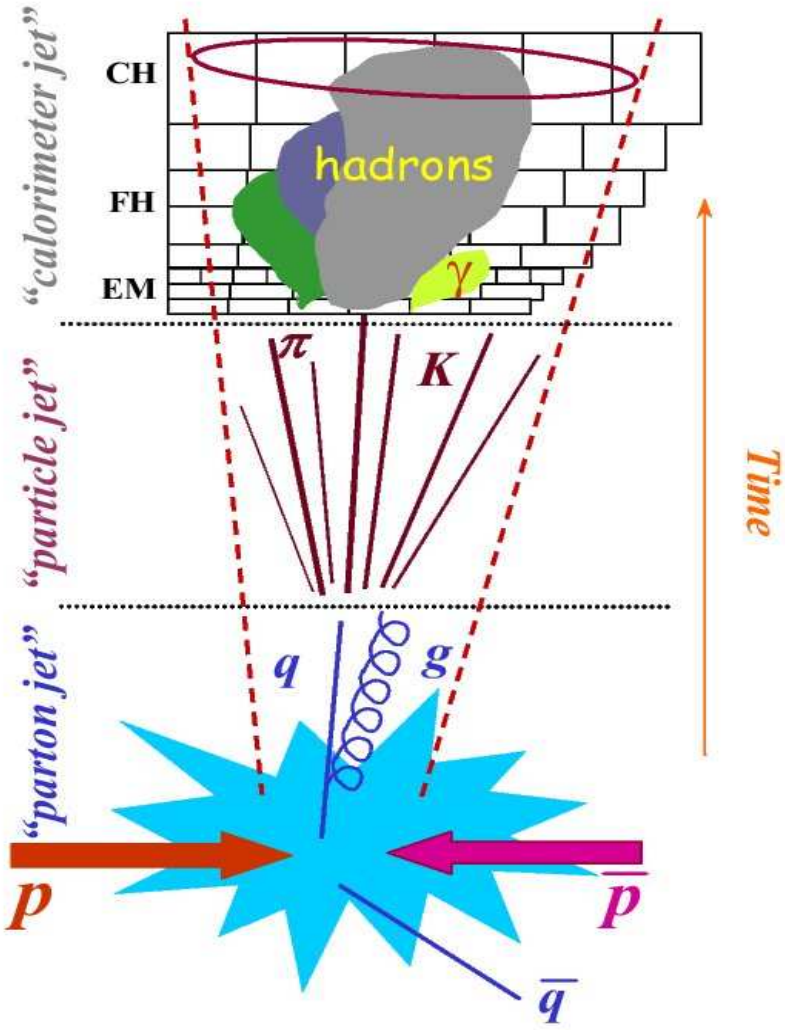
The DØ Calorimeter



- liquid Argon active medium
- Uranium absorber
- uniform and hermetic
- coverage up to $|\eta|<4.2$
- large part of the calorimeter with fine segmentation (up to: $|\eta|<3.2$): $\Delta\eta\times\Delta\varphi=0.1\times0.1$
- compensating: $e\sim\pi$

$$\eta_{det} = -\log\tan\left(\frac{\vartheta}{2}\right)$$

Jets



- **calorimeter jet**
  - calorimeter – main tool to measure jets
  - collection of hit cells within a region grouped in towers
  - calorimeter jets – energy deposited in calorimeter towers
- **particle jet**
  - after hadronization and fragmentation
  - influence of hadronization on high-p_T jets is small therefore particle jet (a spray of particles) and parton jet properties are similar
- **parton jet**
  - parton hard scattering
  - parton showers

Run II Cone Jet Algorithm

- all particles are used as **seeds** (experiment: calorimeter towers/MC: stable particles/pQCD: partons)
- combines 4-vectors within a cone of radius $R_{cone} = 0.7$ in rapidity (y_{jet}) and azimuthal angle (φ) around the cone axis into jets in "*E-scheme*" ⇨ jets are massive

$$y = \frac{1}{2}\log_{10}\left(\frac{E+p_z}{E-p_z}\right) \qquad \Delta R = \sqrt{\Delta^2 y + \Delta^2 \varphi} < R_{cone}$$

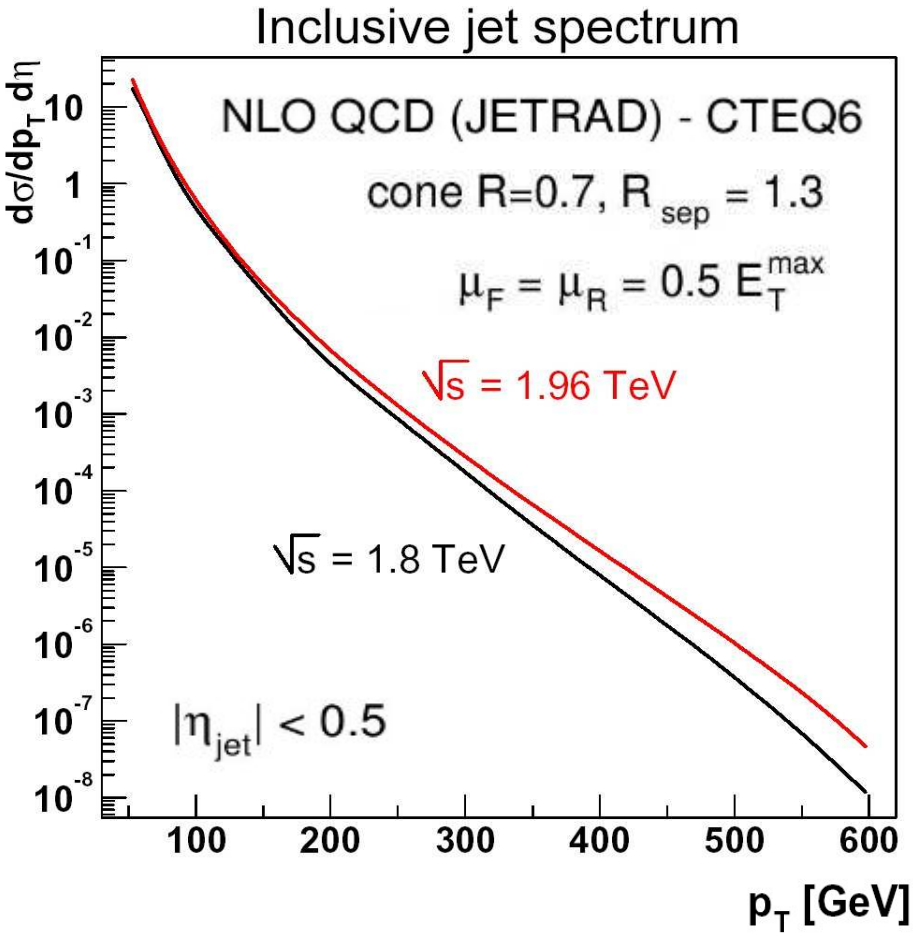
- calculates jet axis – iterates until the solution stabilized ⇨ cone axis=jet axis
- after clustering, uses midpoints between pairs of jets as **additional seeds**
- removes identical solutions, and merges jets with overlapping cones (if the overlap area contains more than 50% of the p_T from the lower p_T jet), otherwise particles are assigned to the nearest jet.

- **Run I** ⇨ massless jets, no infrared safety, $[E_T, \eta]_{\text{Run I}}$
- **Run II** ⇨ infrared safe ⇨ possible predictions from pQCD, $[p_T, y]_{\text{Run II}}$

Data Sample

- NLO calculations – JETRAD
- PDFs parametrization – CTEQ6, $\alpha_s(M_Z) = 0.118$
- renormalization scale: $\mu_r = 0.5 p_T^{max}$
- factorization scale: $\mu_f = 0.5\, p_T^{max}$
- max. distance of particles within jet: $R_{cone}.R_{sep}$, $R_{sep} = 1.3$

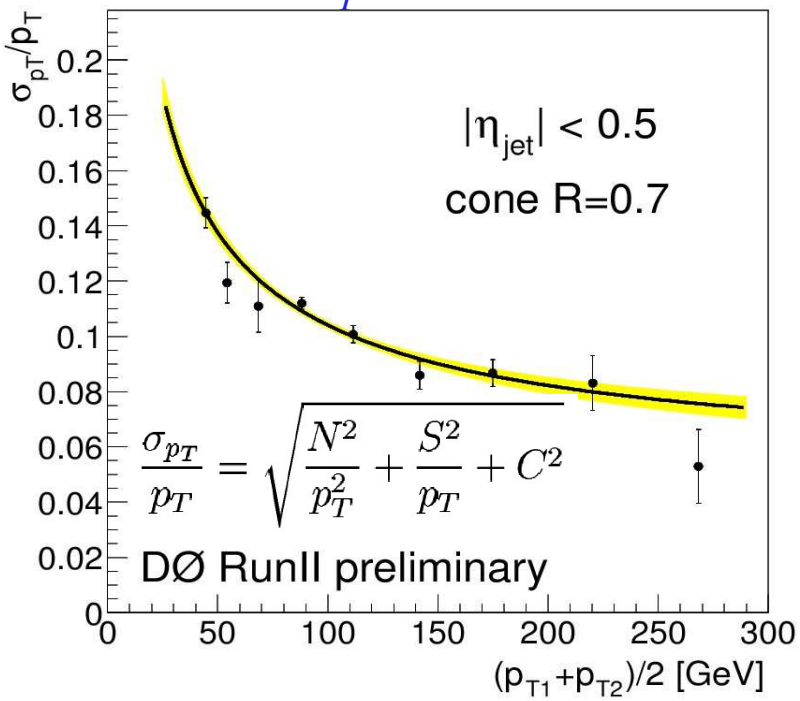
- analyzed data sample: ***143 pb^{-1}***
- Tevatron still keeps colliding and DØ still keeps collecting data!)
- selected events – inclusive jet triggers, based on energy deposited in the calo-rimeter towers – central & forward:
  - $|y_{jet}| < 0.5$, and $1.5 < |y_{jet}| < 2.4$

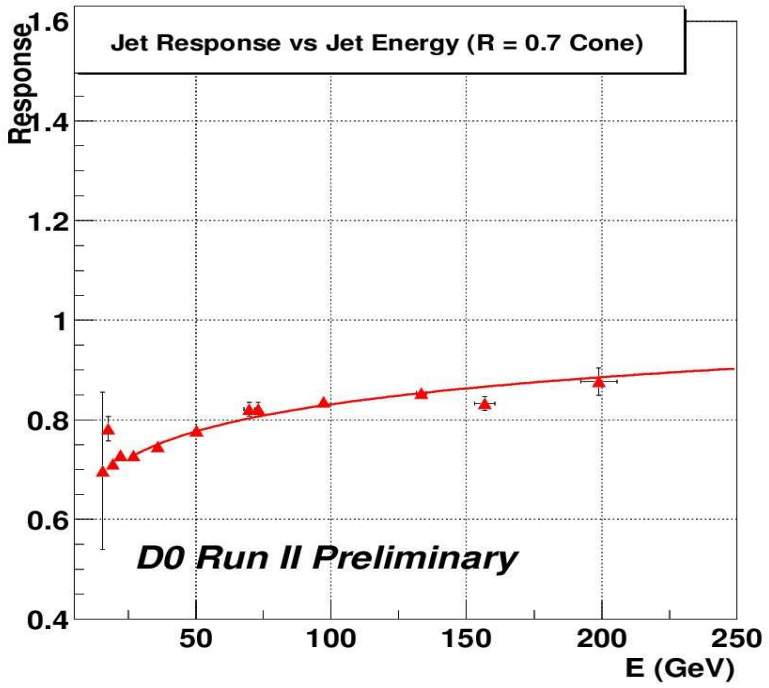


Uncertainties: jet energy scale

Jet Energy Scale

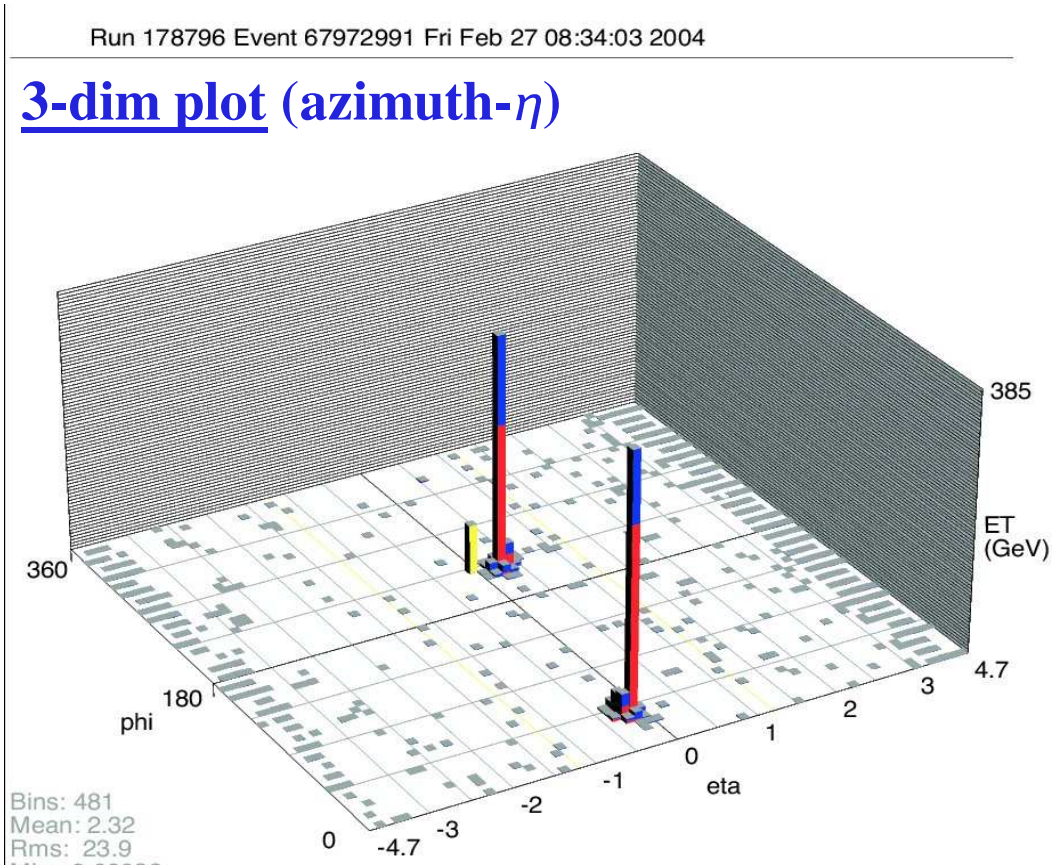
Jet p_T resolution

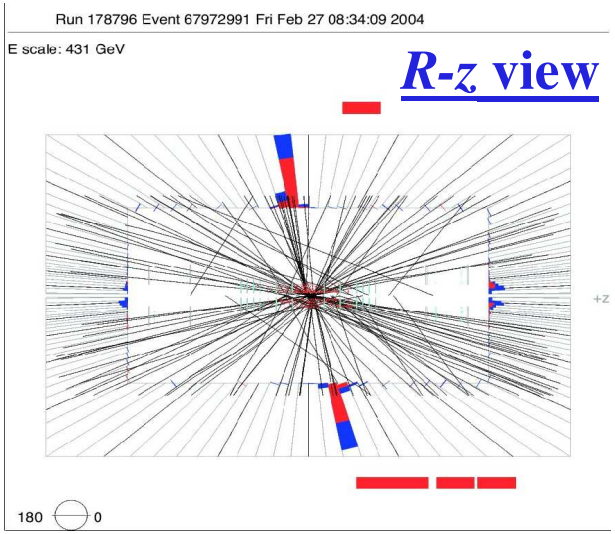


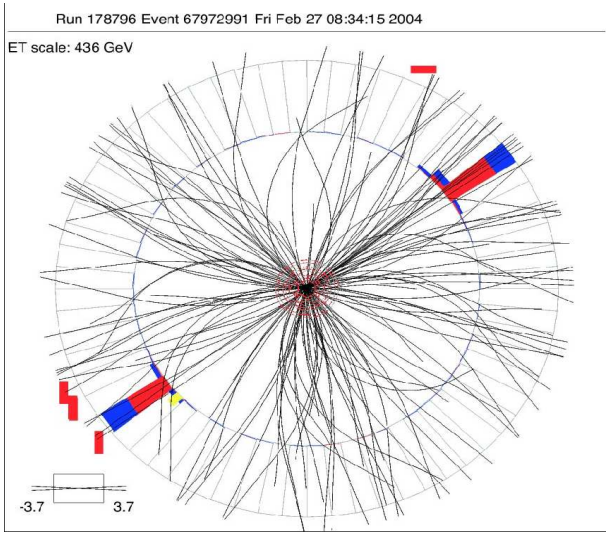


- corrections of jet energy, measured on the detector level, to the jet energy on the particle level
- showering – losses due to showers in the calorimeter outside the jet cone, calorimeter response to jets, energy not associated with hard interaction – noise, pile-up from previous crossing

The highest p_T & di-jet mass



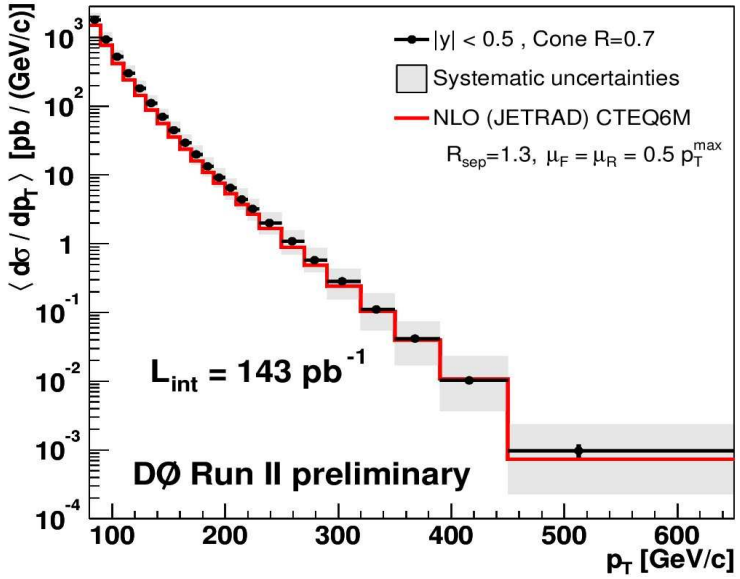


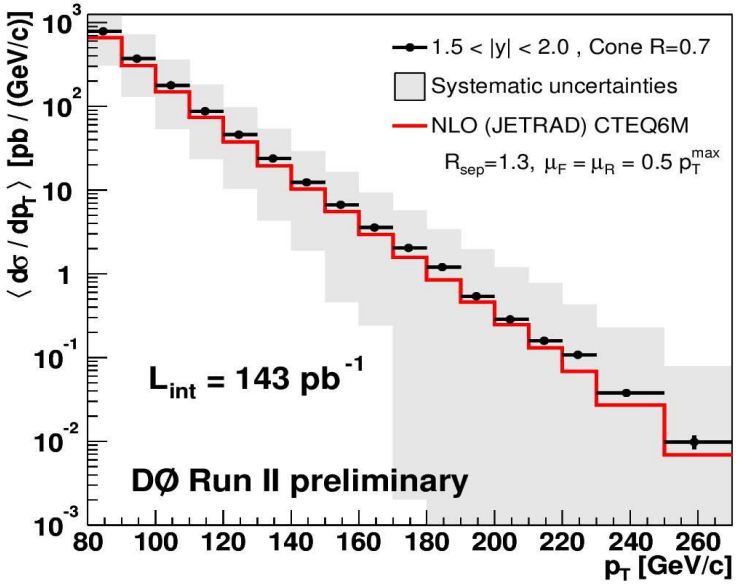


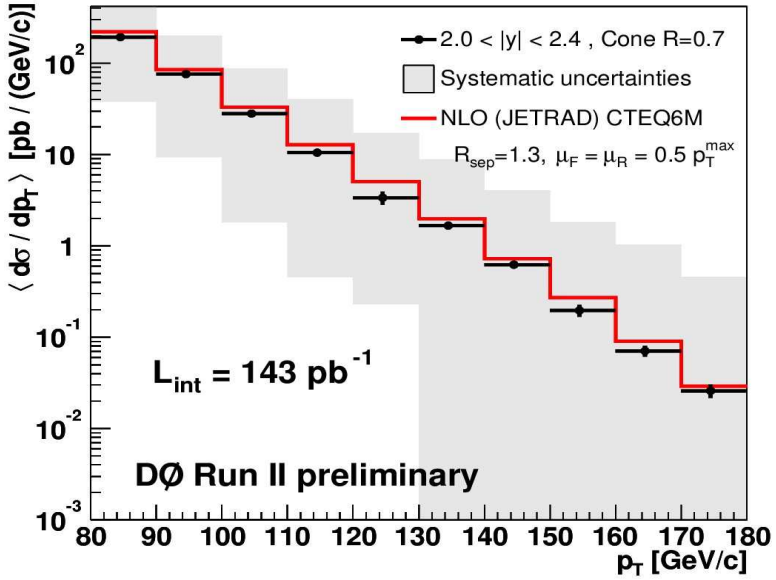
x-y view

	1st jet	2nd jet
p_T [GeV/c]	616	557
η	-0.19	0.25
φ [rad]	0.65	3.78

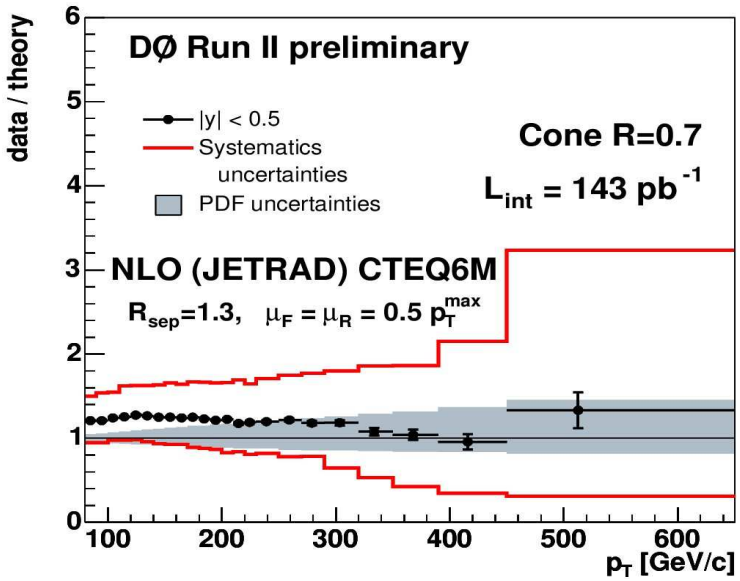
Inclusive Jet Cross Section: measurement

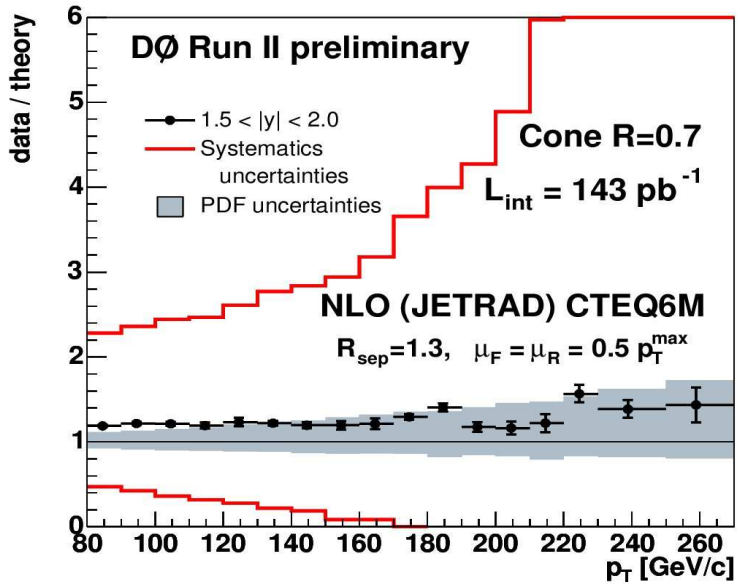


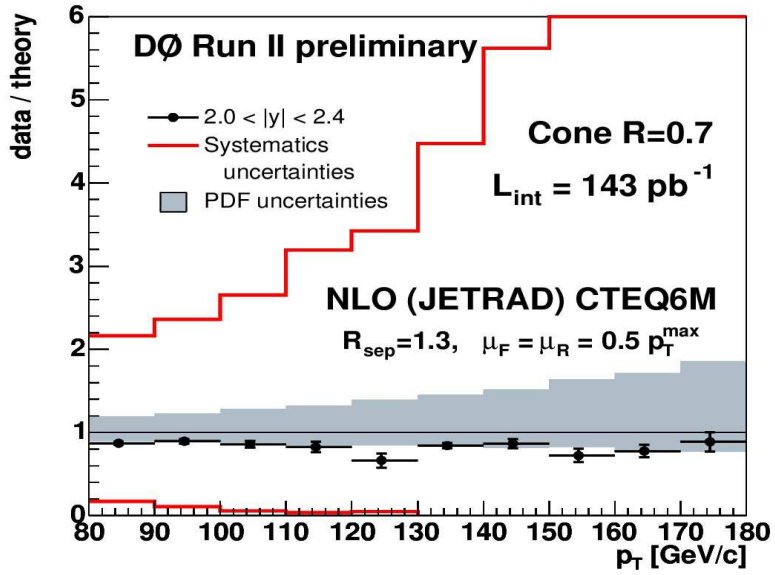




Inclusive Jet Cross Section: theory vs. data

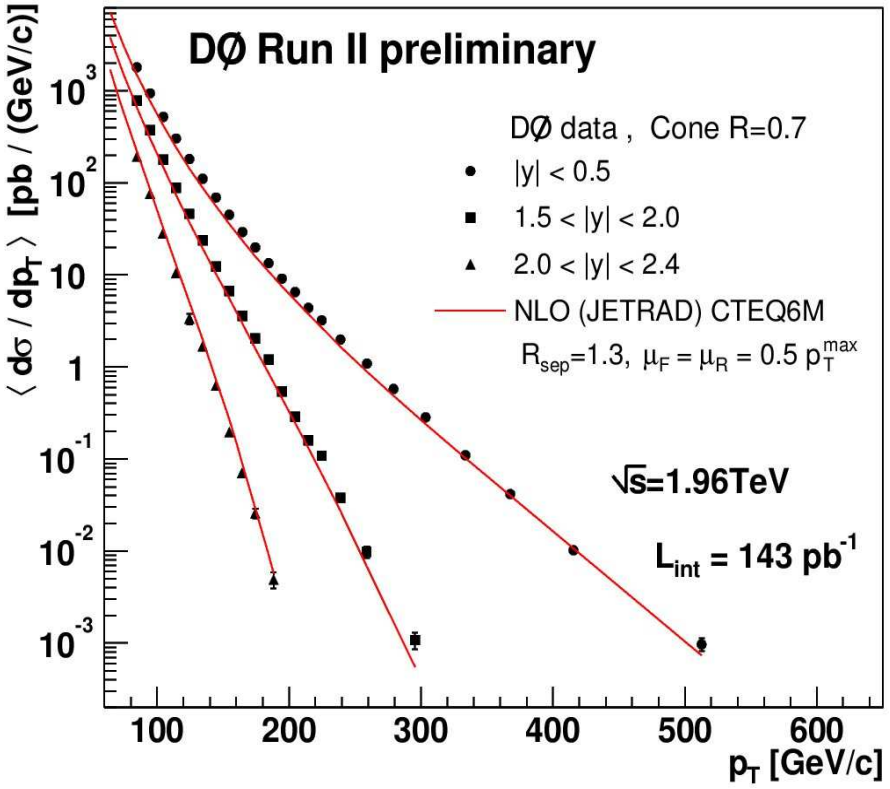






Conclusions

- We measured inclusive cross section in the central and forward calorimeter regions.
- Run II – higher p_T than Run I (p_T~350 GeV)
- All presented results are preliminary – more luminosity is being collected.



- Our measurement is well described by the next-to-leading order perturbative QCD throughout the whole kinematic region – theory is in good agreement with measured data, given the uncertainties.