High p_T Jets and Photons at DØ

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(on behalf of DØ Collaboration)

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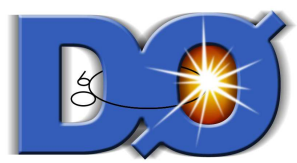
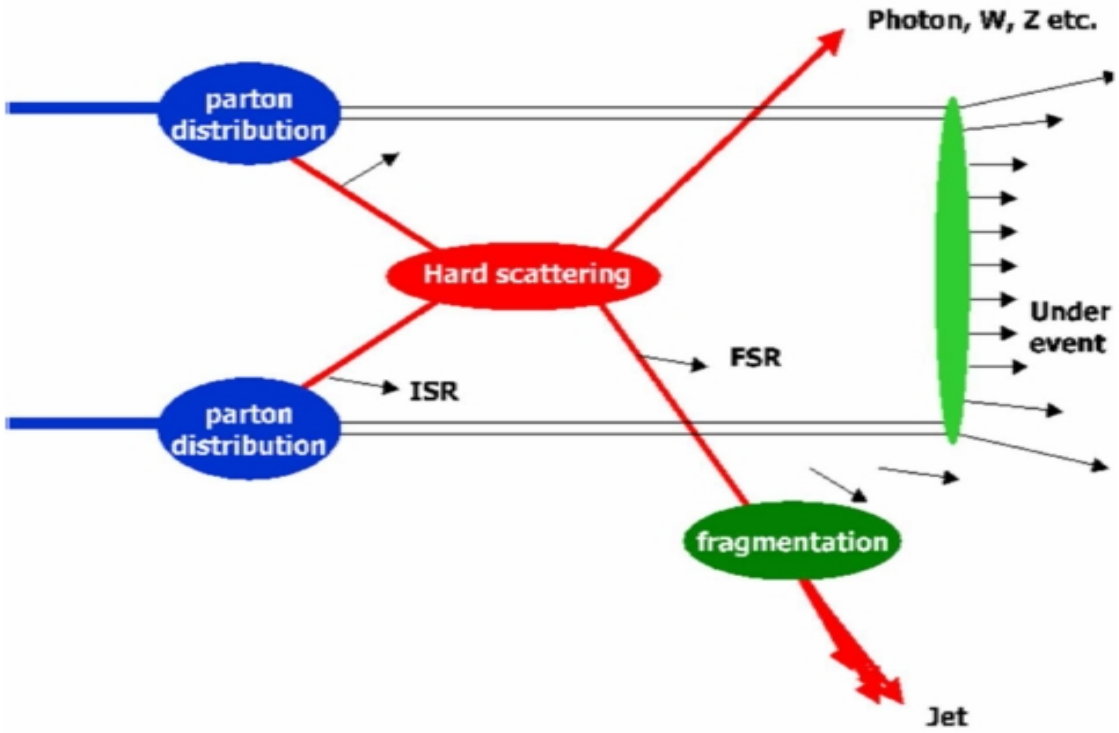


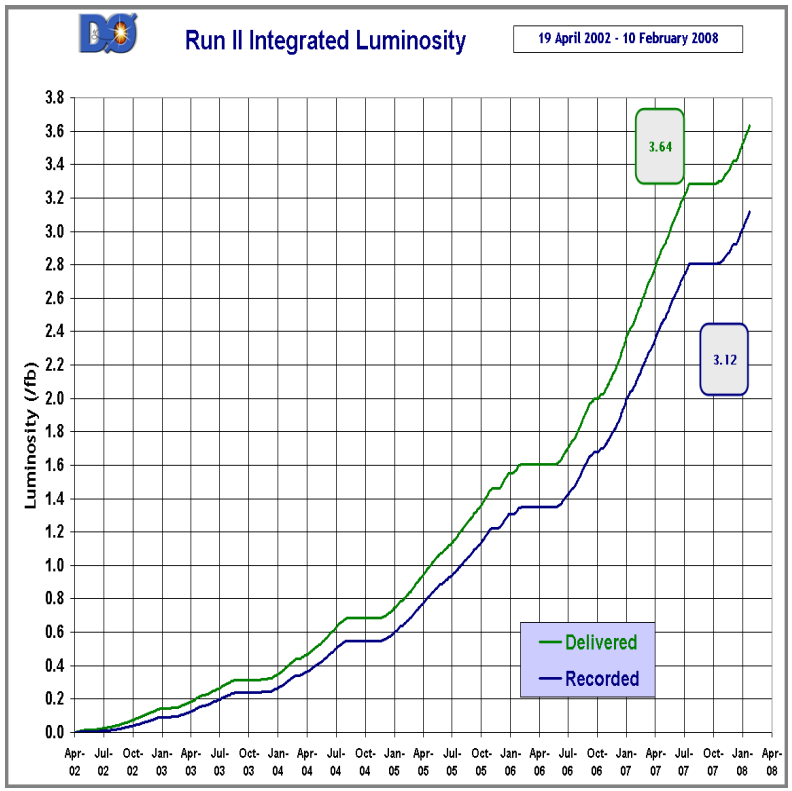
QCD & Proton Structure

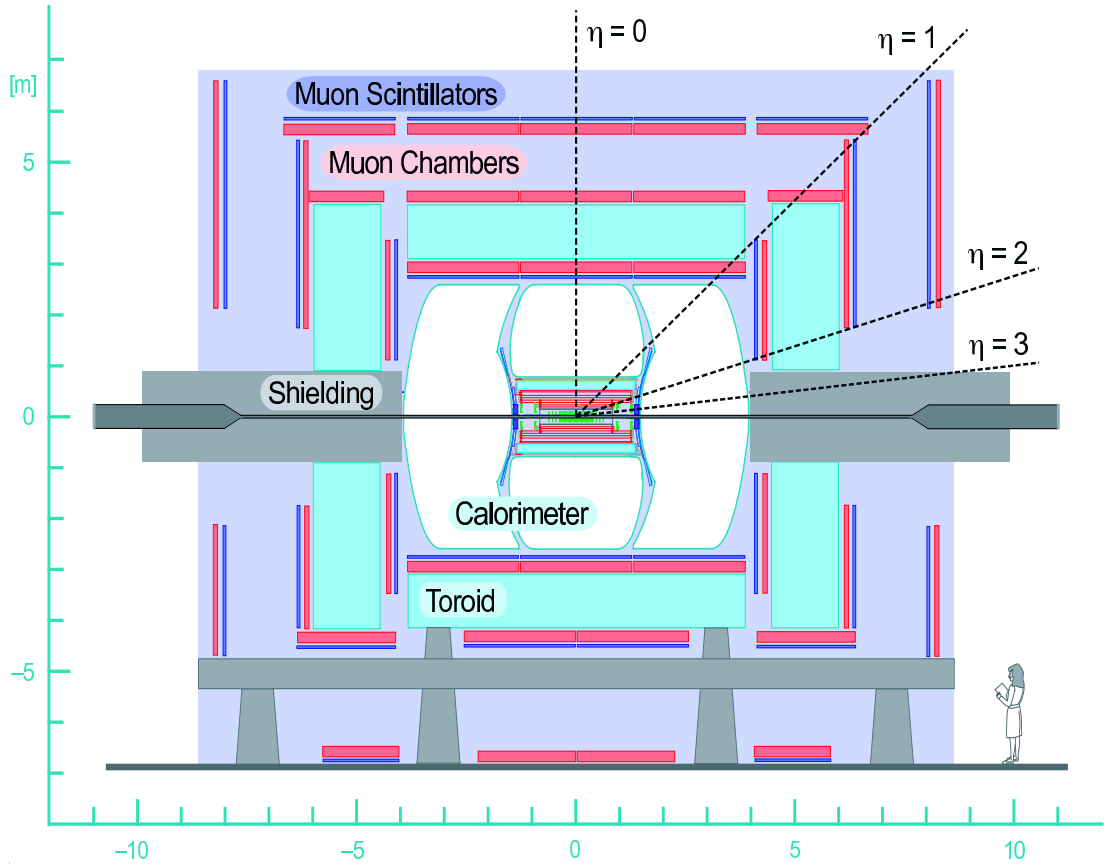
Measurements of various jet cross sections give us hints about the proton structure, in particular about



- Parton distribution functions
- QCD matrix elements, strong coupling constant α_S
- New physics

DØ Experiment



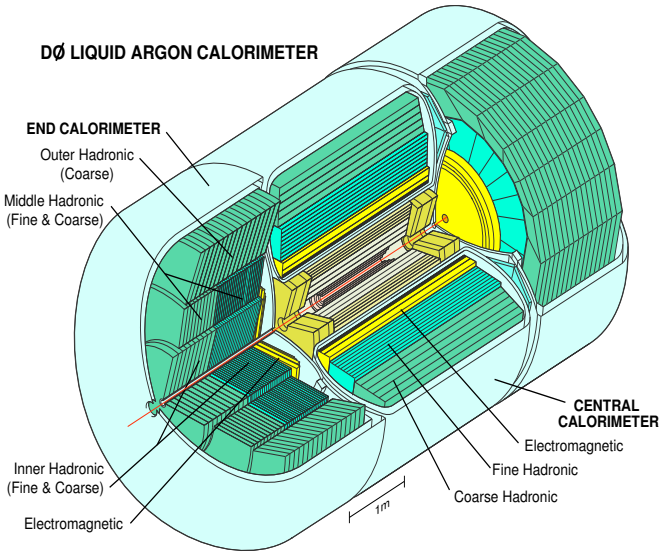


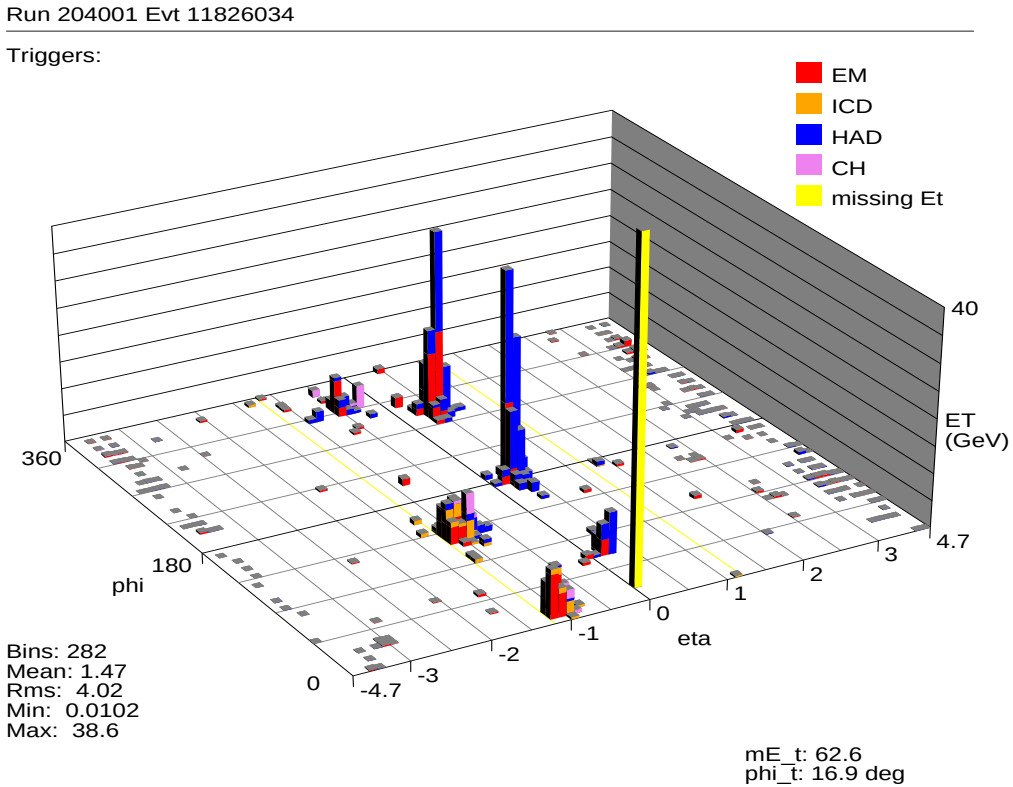
Tevatron $p\bar{p}$ accelerator:

- $\sqrt{s} = 1.96\text{TeV}$
- Integrated luminosity $> 3\text{fb}^{-1}$

Jets in the DØ Detector

Most of the events contain clusters of hadrons (**jets**)





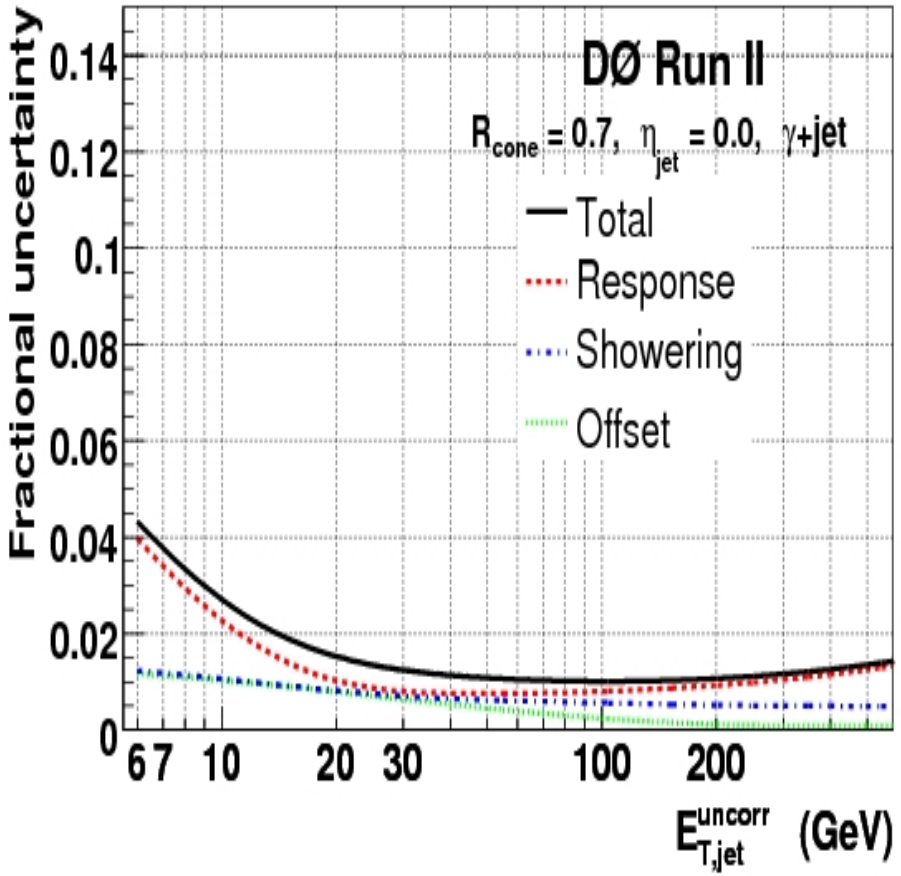
Need a tool which finds jets = **jet algorithm**

DØ uses RunII Midpoint Cone Algorithm with $R_{\text{cone}} = 0.5$ or 0.7

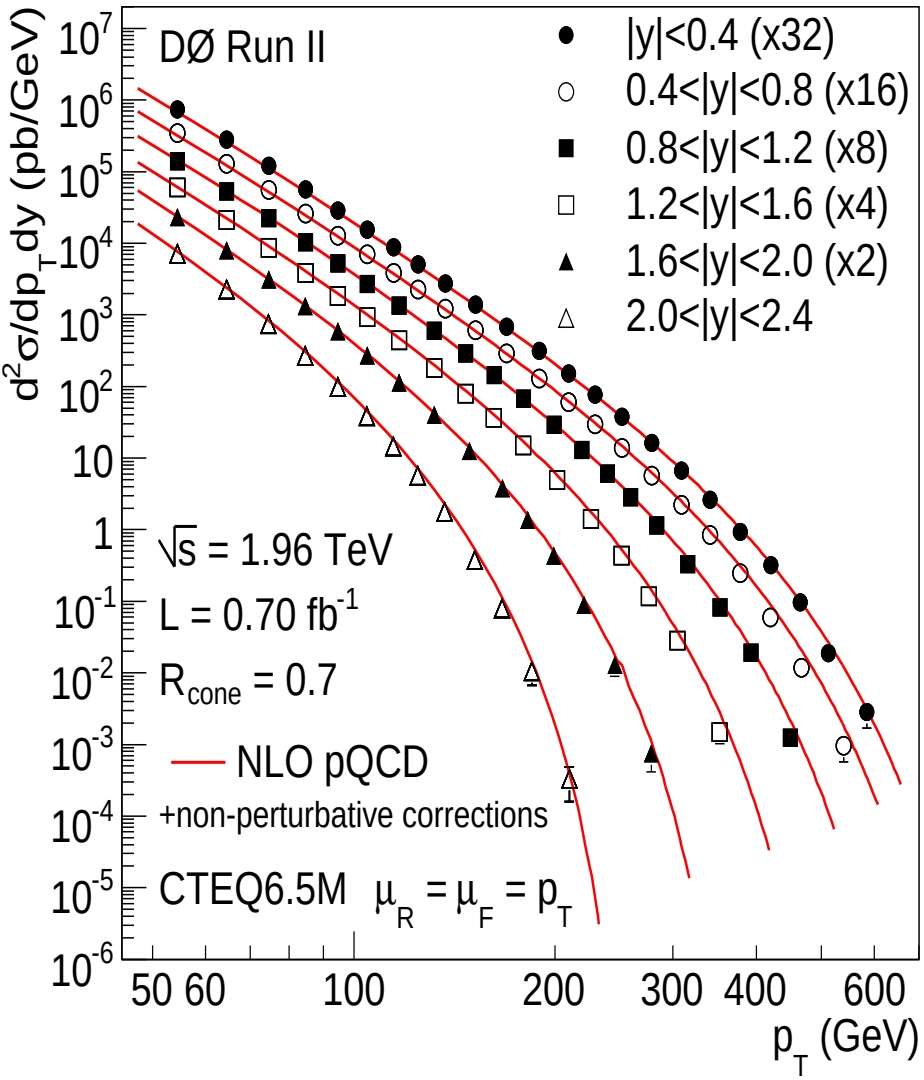
Jet Energy Calibration

$$E_{\text{jet}}^{\text{corrected}} = \frac{E_{\text{jet}}^{\text{calorimeter}} - O}{R \cdot S} \cdot k_{\text{bias}}$$

- Offset (O) coming from calorimeter noise, underlying event, multiple interactions and pile-up
- Response (R) of the calorimeter to jets
- Showering (S) is a fraction of energy deposited outside the jet cone
- Remaining biases (k_{bias})

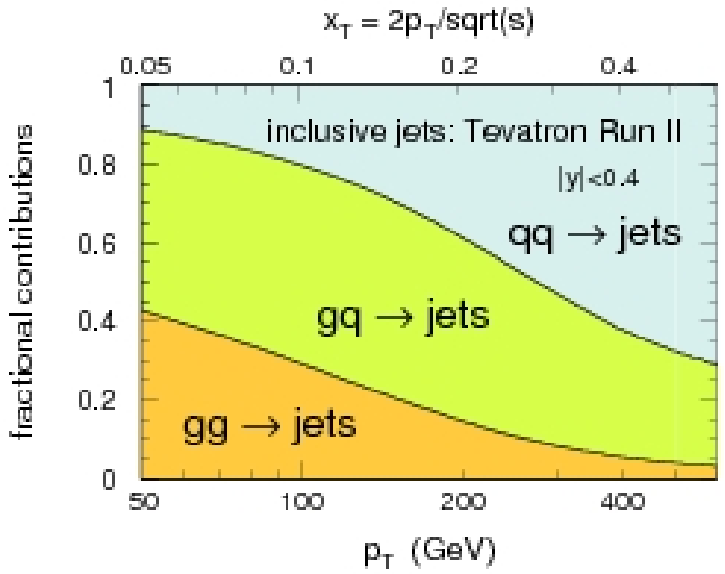


Inclusive Jet Cross Section $\frac{\mathrm{d}^2\sigma}{\mathrm{d}p_\mathrm{T}\mathrm{d}y}(p\bar{p} \rightarrow \text{jet} + X)$

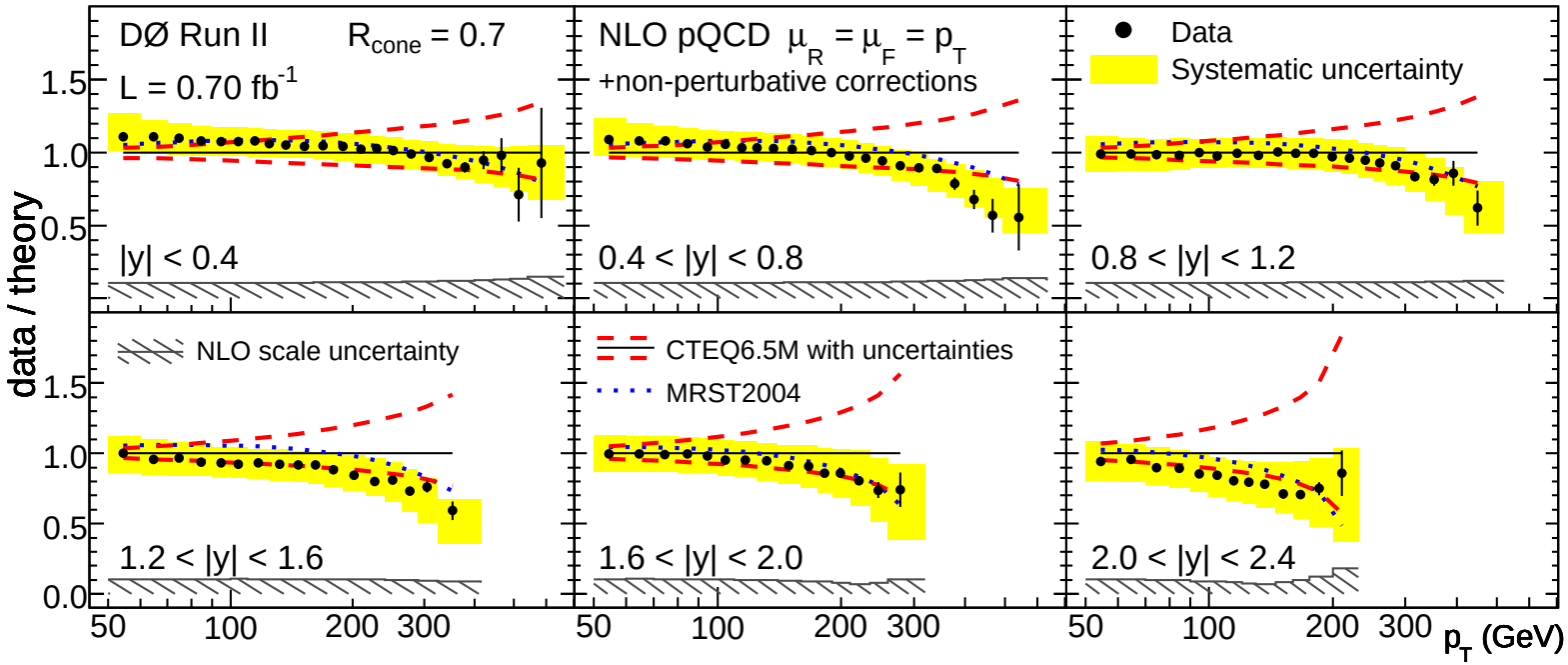


Highest energy available:

- constraint on high x gluon PDF
- shortest distance explored - search for new physics
- Larger cross section + larger dataset than in RunI



Inclusive Jets - Data to Theory Comparison

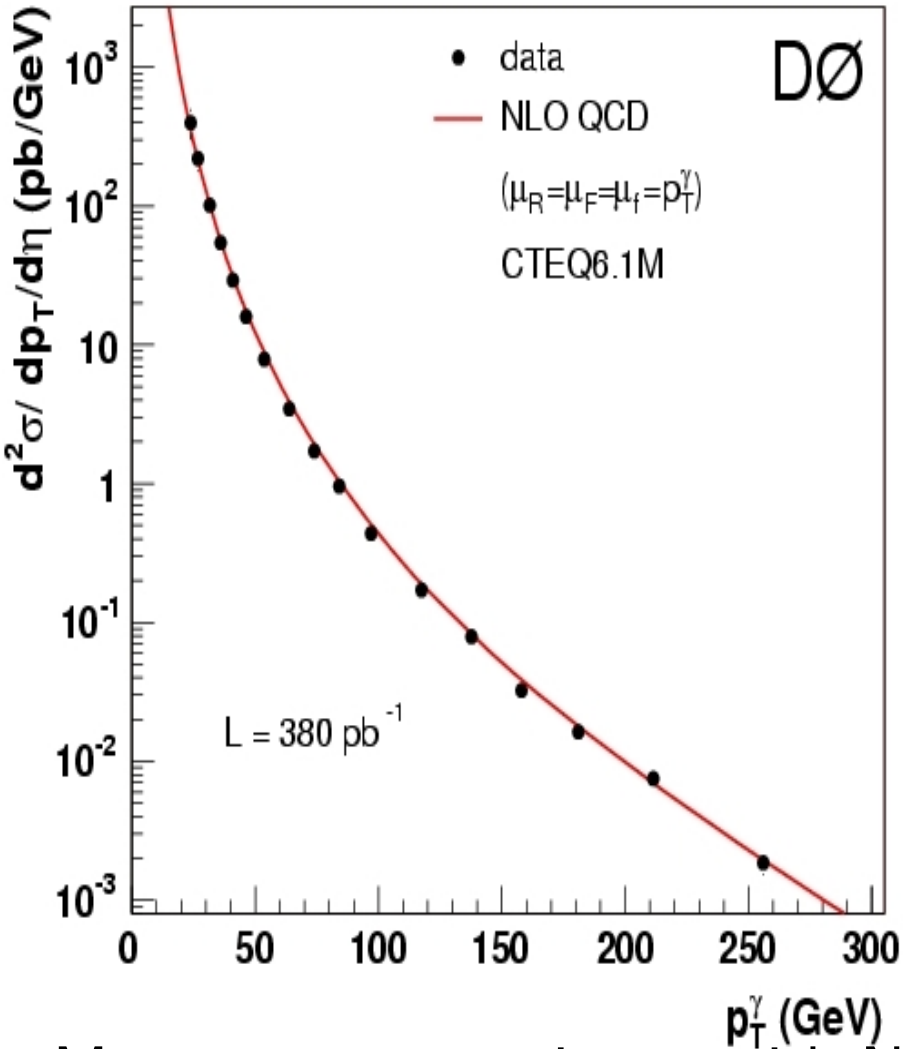


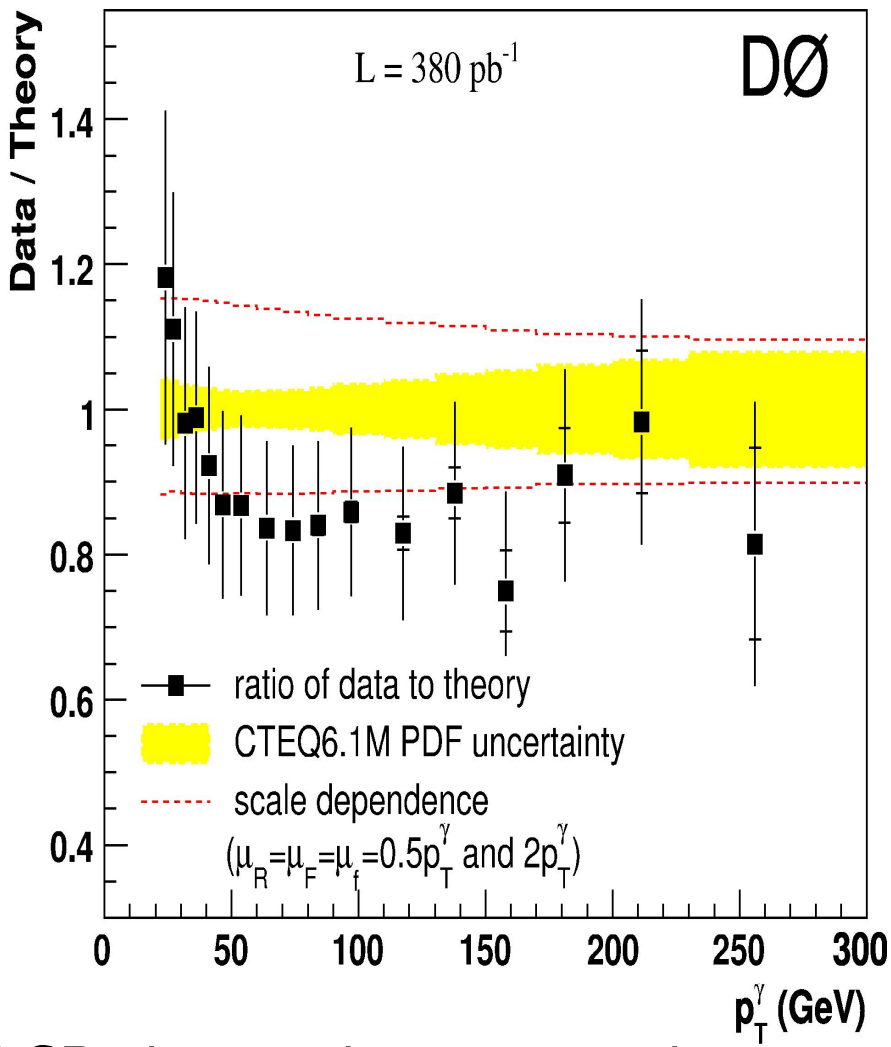
- Significant reduction of experimental errors - measurement can be used for further constraining the PDFs
- No excess observed at high p_T

Direct Photons Produced in Hard Scattering

- γ is directly produced in the hard scattering process + no hadronization $\longrightarrow$ direct probe of QCD
- Cross section for photons is lower by a few orders of magnitute than for jets
- Problem of photon purity - need to separate photons from particle decays

Isolated Photon Cross Section

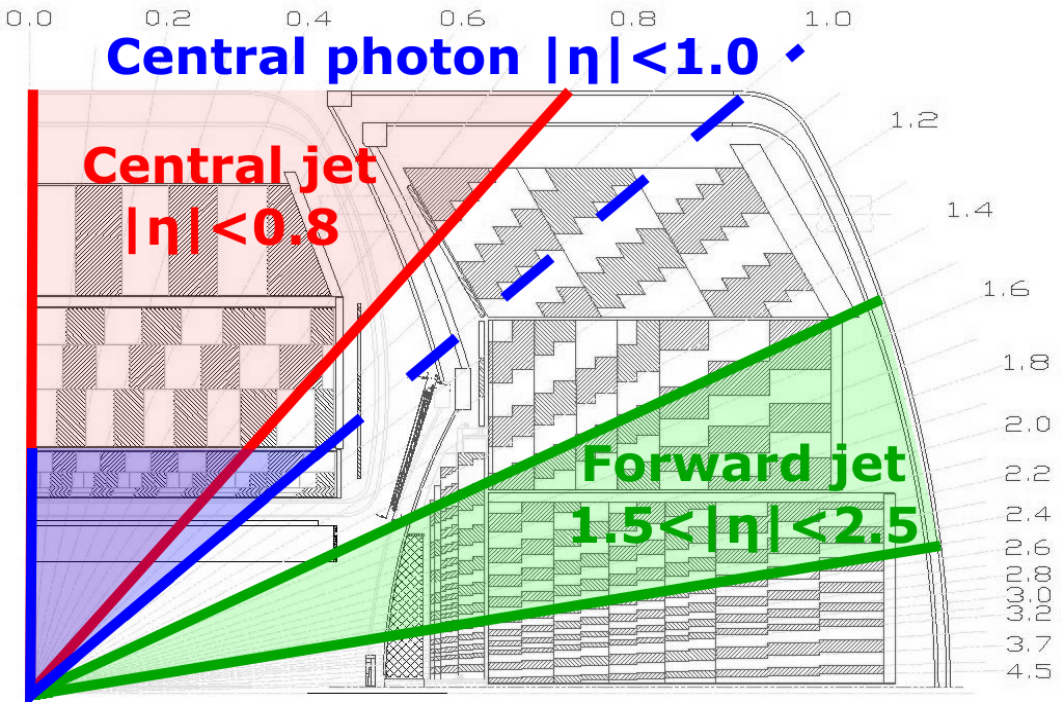




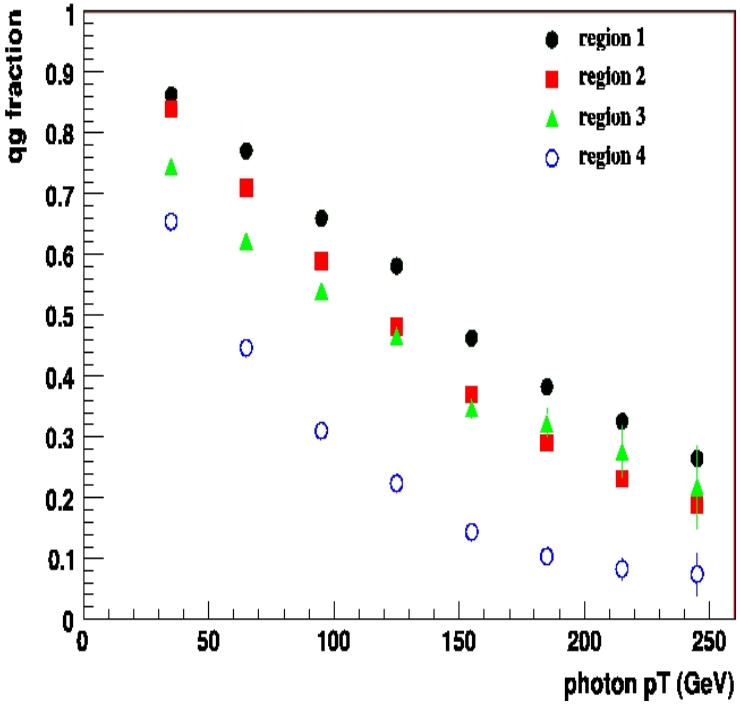
Measurement consistent with NLO QCD, but perhaps some shape is present

Triple Differential Photon+Jets Cross Section $\frac{d^3\sigma}{dp_T^\gamma d\eta^\gamma d\eta^{jet}}$

Extended the photon measurement to include also additional jets -



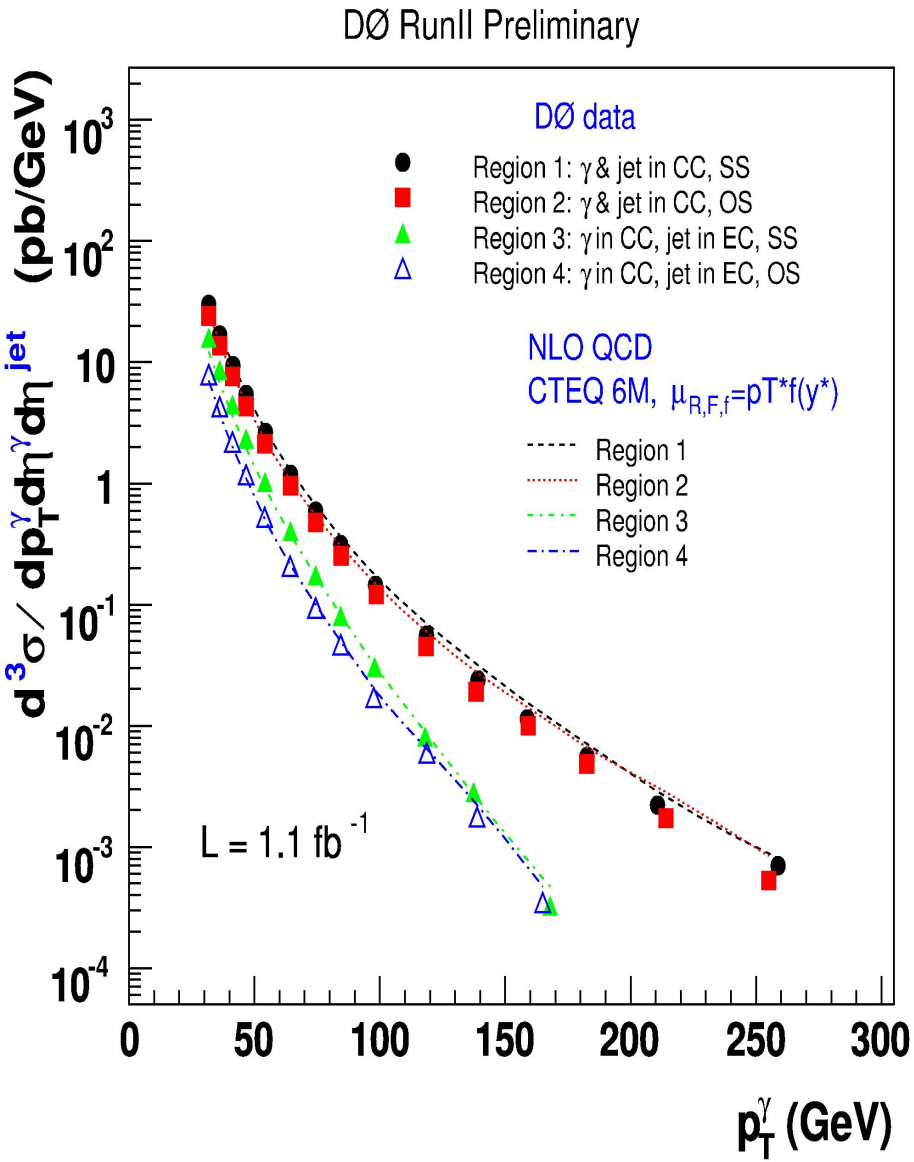
Quark-gluon fraction:

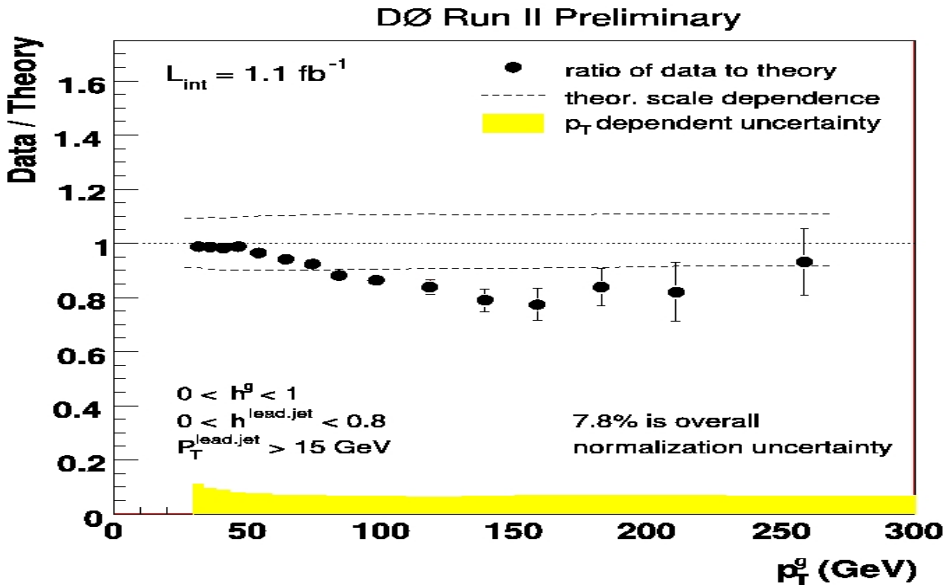


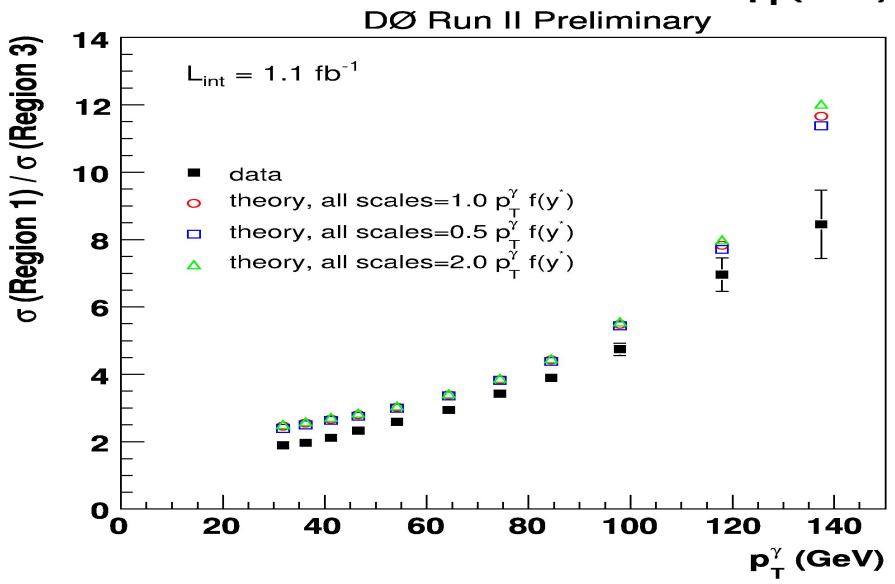
Region 1 - central (CC) jet and SS γ **Region 3** - forward (EC) jet and SS γ

Region 2 - central (CC) jet and OS γ **Region 4** - forward (EC) jet and OS γ

Photon+Jets Cross Section



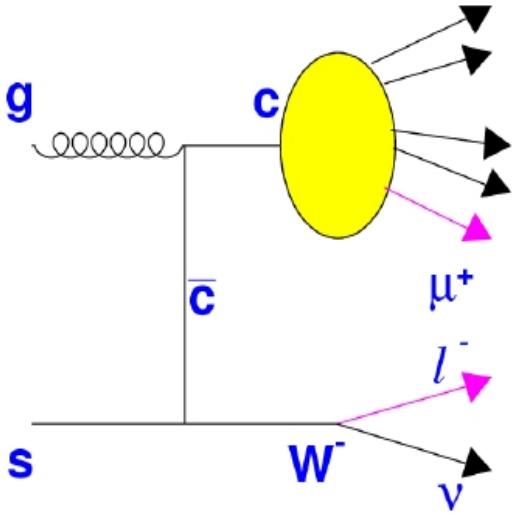


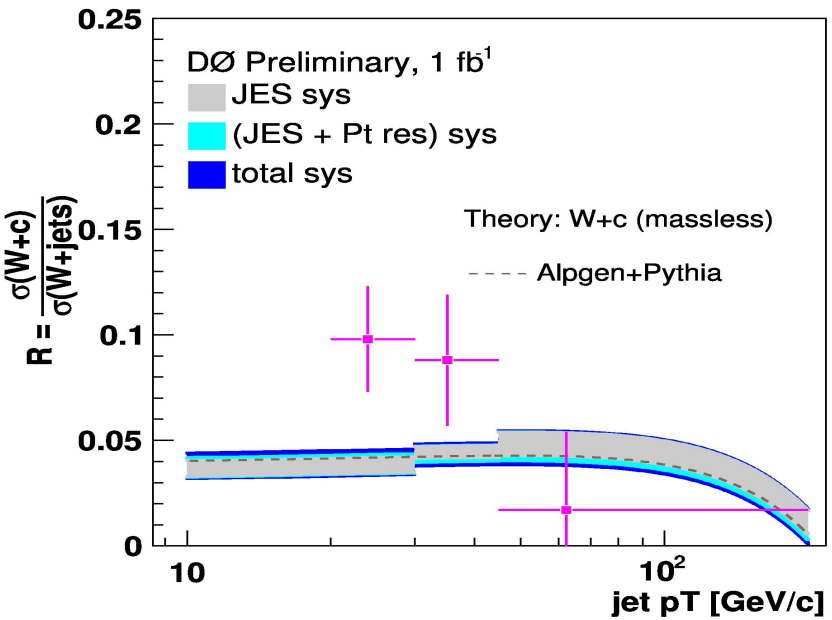


Other PDFs - Strange Quark Distribution

Measurement of $W + c$-jet to W+jet(s) ratio

- Dominant contribution from $sg \rightarrow W^- c$ or $\bar{s}g \rightarrow W^+ \bar{c}$ ($dg \rightarrow W^- c$, $\bar{d}g \rightarrow W^+ \bar{c}$ are suppressed because of $|V_{cd}|^2$)
- A first test of QCD evolution for s quark PDF
- Important background to top, stop or Higgs physics
- Measured differentially in jet p_T





Proton Structure and QCD

Conclusions:

- Inclusive jet cross section measurement with the new energy calibration has largely reduced the experimental errors and can be used for further constraints of PDFs
- Photon+jet cross sections described only fairly by the current theory
- $W + c$ allows tests of evolution of s quark PDF important for Higgs searches at the LHC
- More measurements still to come