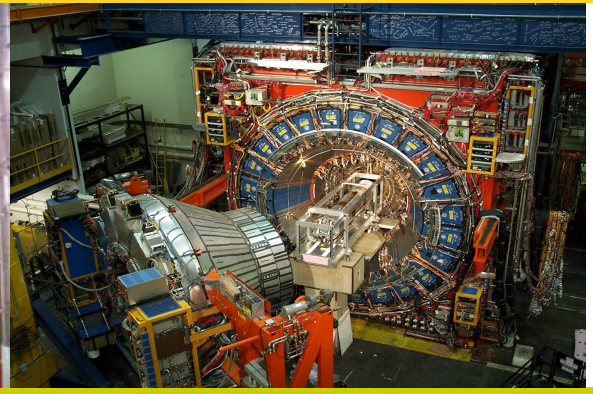
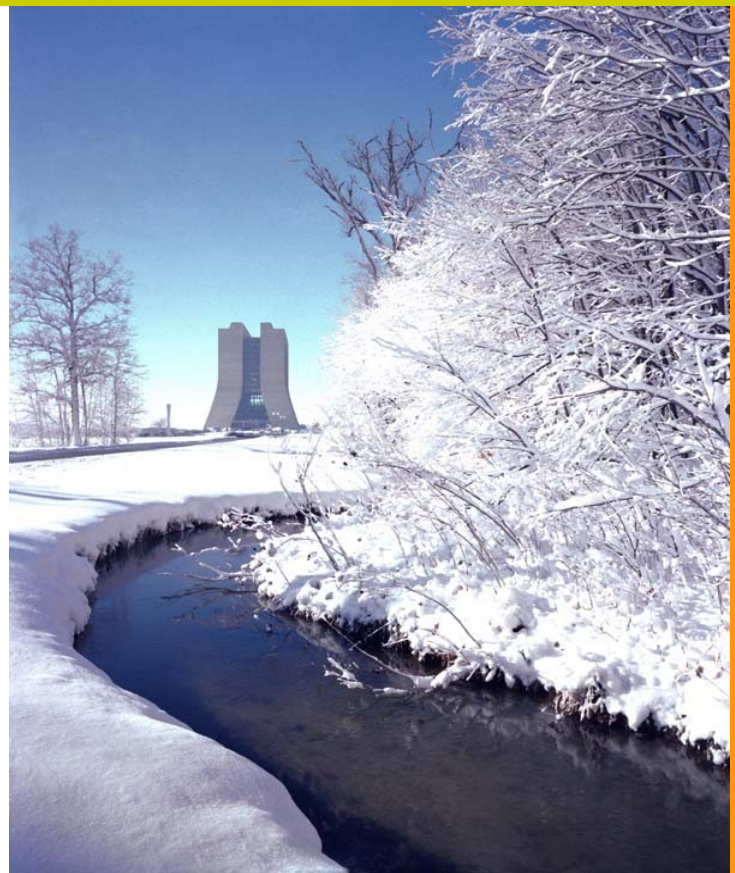



γ+jets production at $\sqrt{s}$ = 1.96 TeV

Carolina Deluca

IFAE-Barcelona

On behalf of the CDF and DØ Collaborations



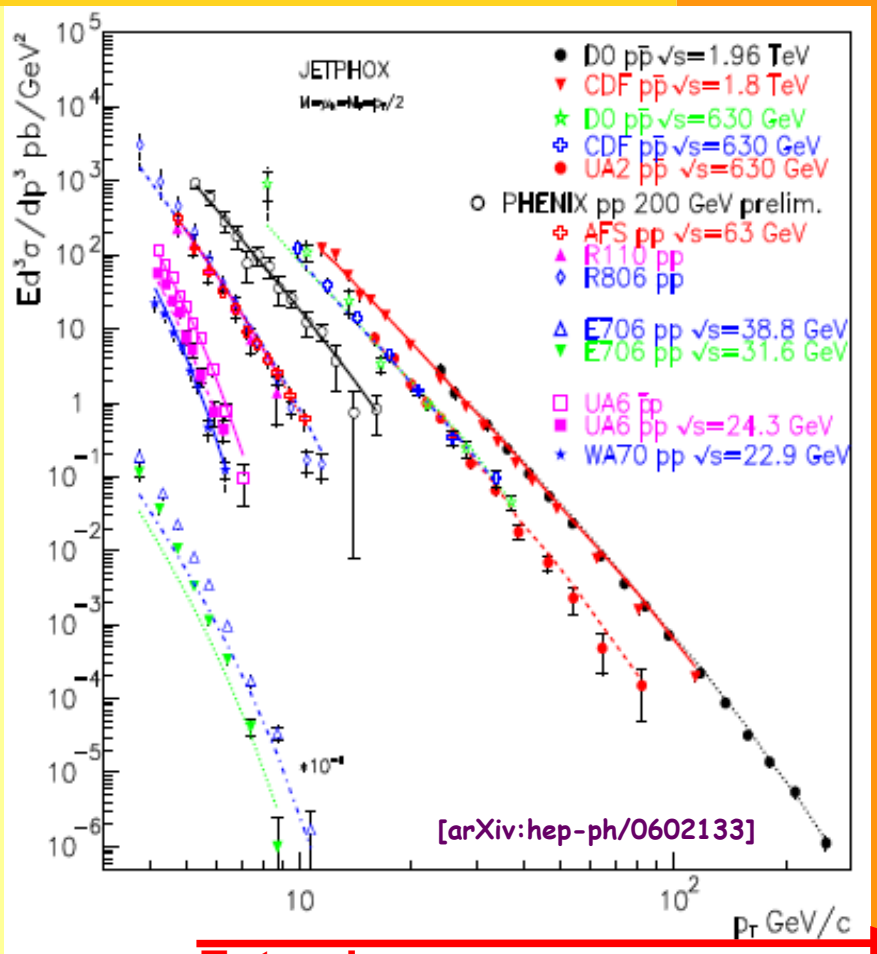
Moriond QCD, March 18th 2009

Introduction and Motivation

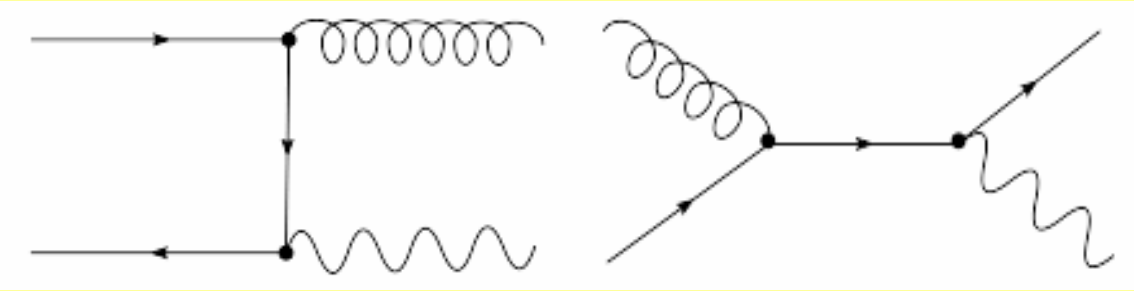
- **Test pQCD predictions over several orders of magnitude**
- The gluon-mediated production dominates up to 150 GeV → the high statistics Tevatron datasets can further constrain the **gluon PDF**

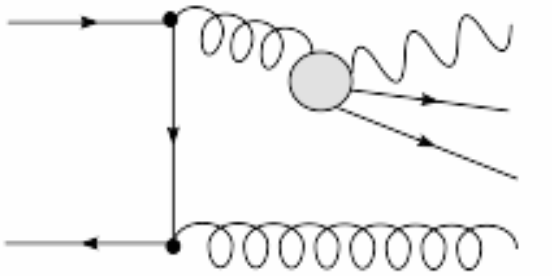
- **Advantages over pure QCD**
  - ✶ **Point-like coupling** of quarks and photons
  - ✶ **No need of algorithms** to define photons
  - ✶ **Better energy resolution** (EM calorimeters)

- Probe **photon techniques** over a wide energy range
- **Irreducible background** for important searches (f.ex. light Higgs)



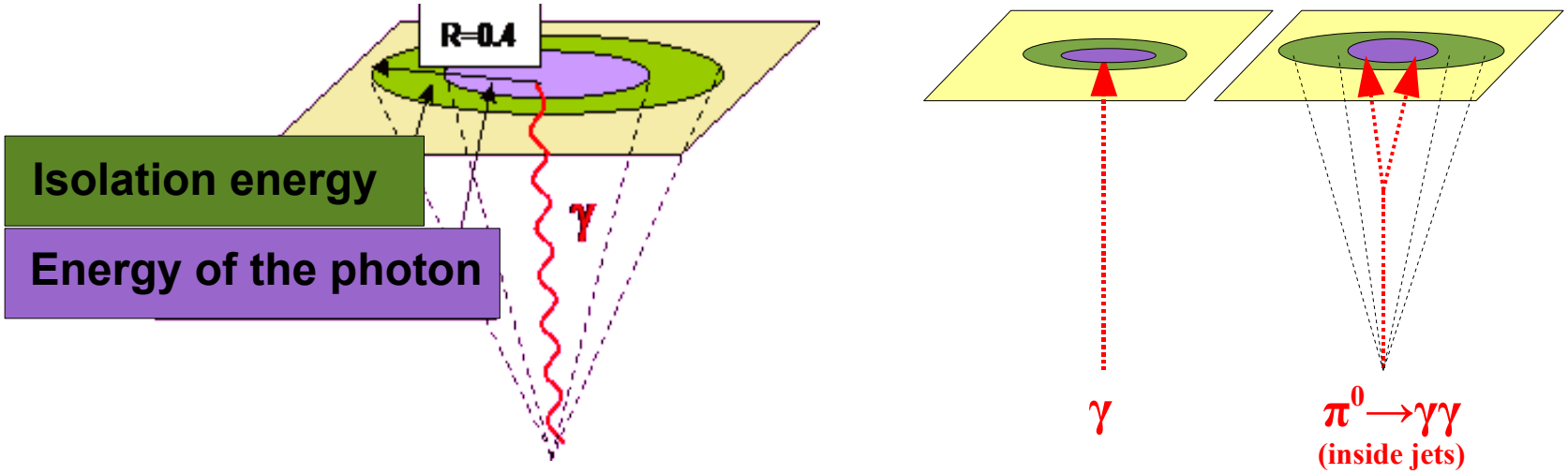
Extend p_T coverage





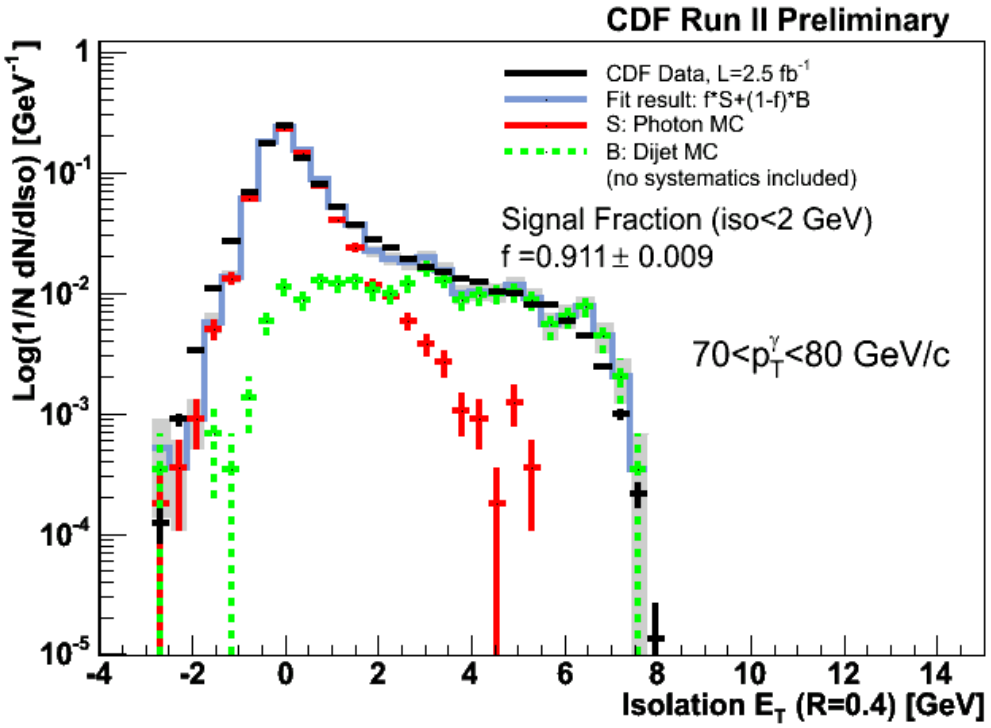
Photon detection

- Main background: **photons from light meson decays**
  - Suppressed by requiring **isolated photons**
  - **isolation E_T** = energy in a cone of radius ~0.4 around the photon



- **The isolation partially removes the contribution from meson decays (and also part of the fragmentation component in the signal)**

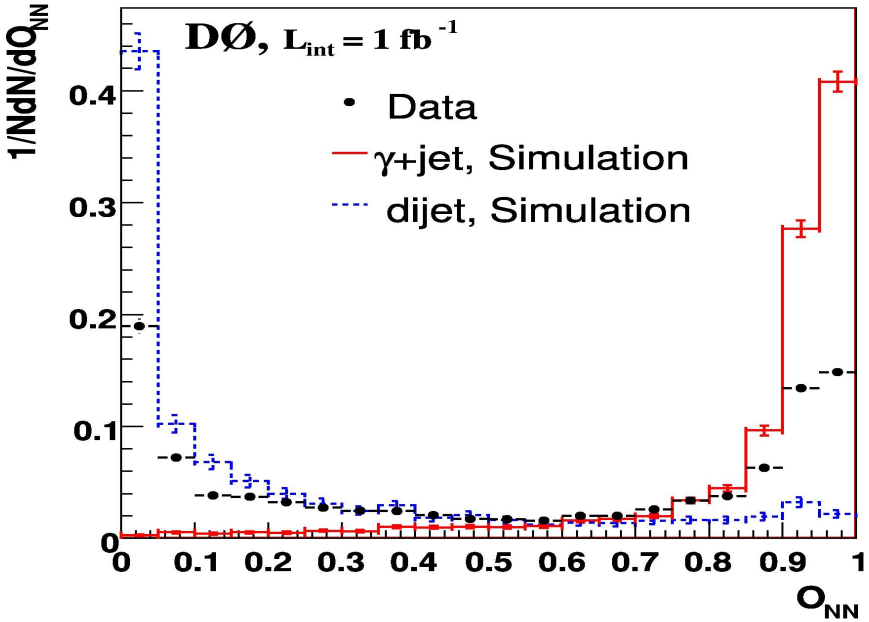
The isolated meson background



Photons from mesons surviving the isolation cuts are removed in a statistical manner

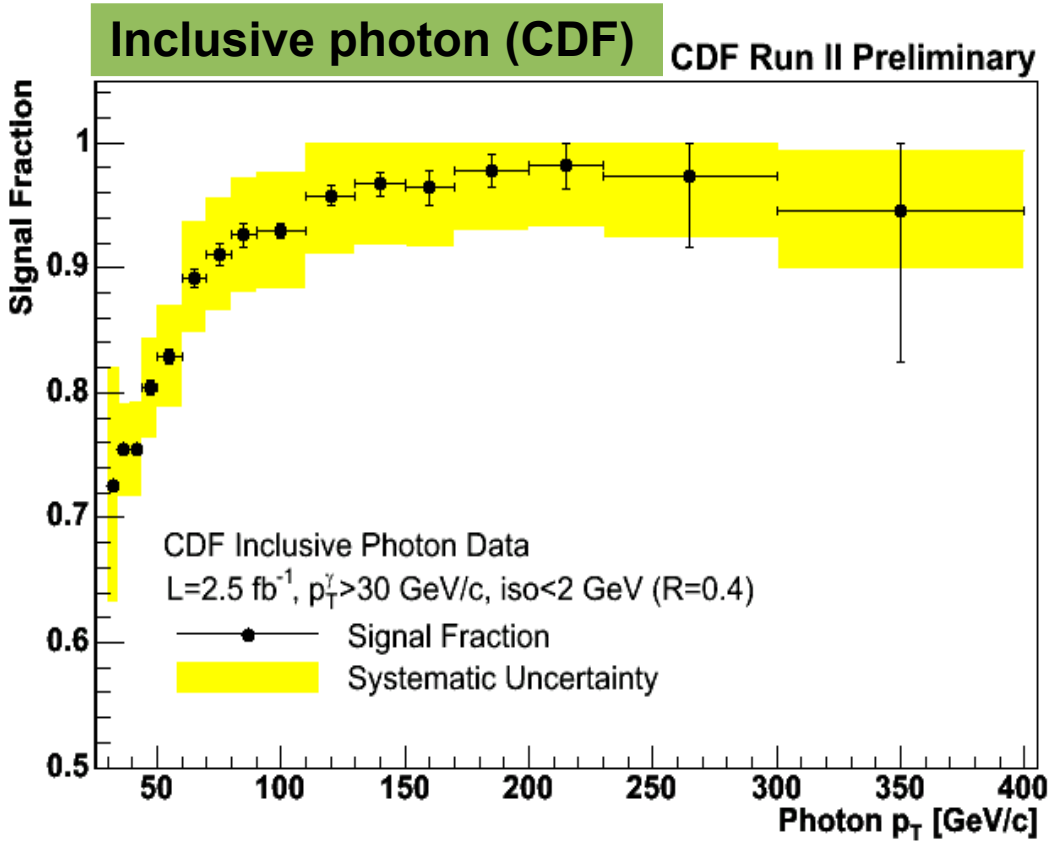
Different experiments use different techniques

- **Shower shape and conversion probabilities**
- **Fits to the isolation distribution**
- **Neural Network**

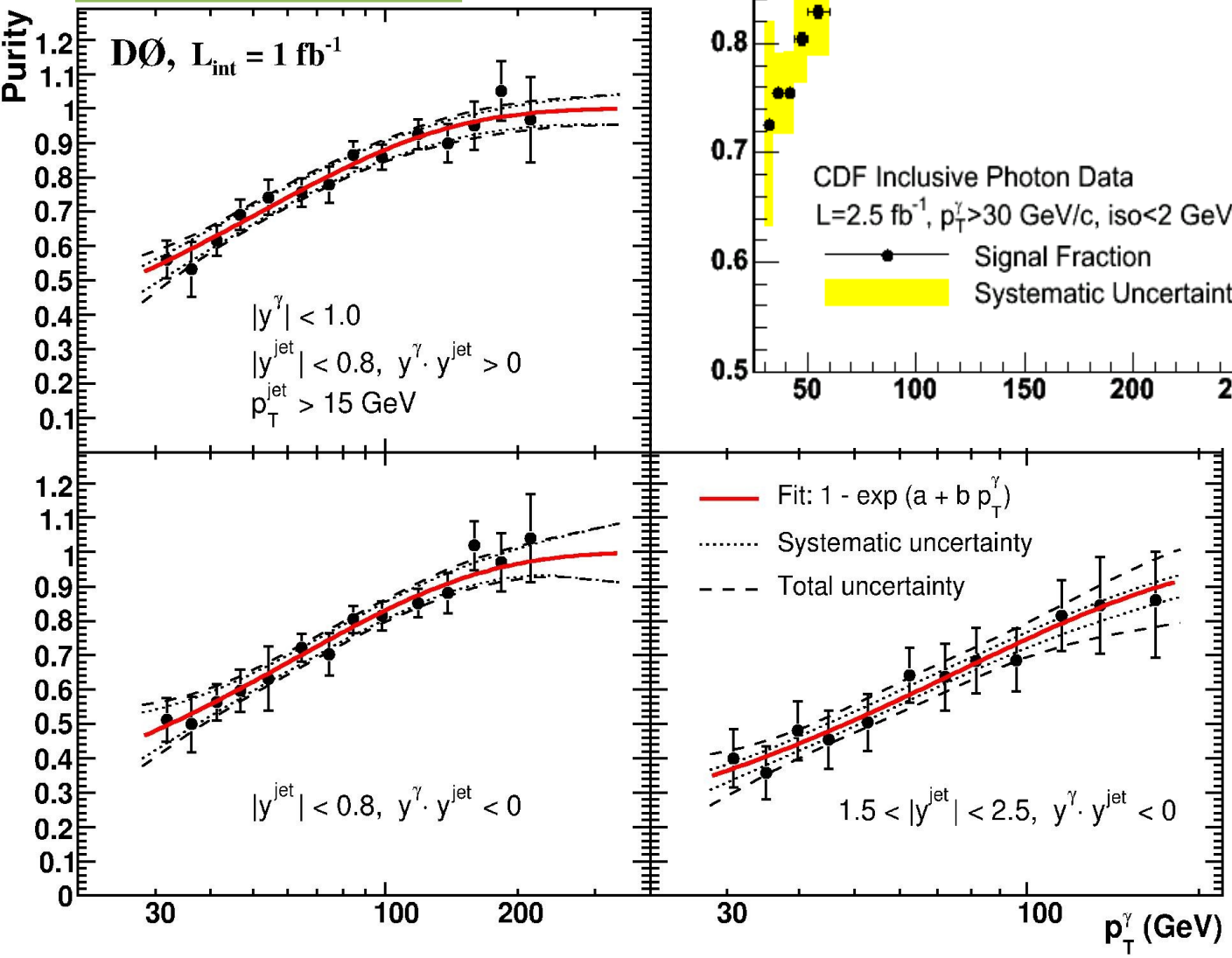


Photon purity

Inclusive photon (CDF)

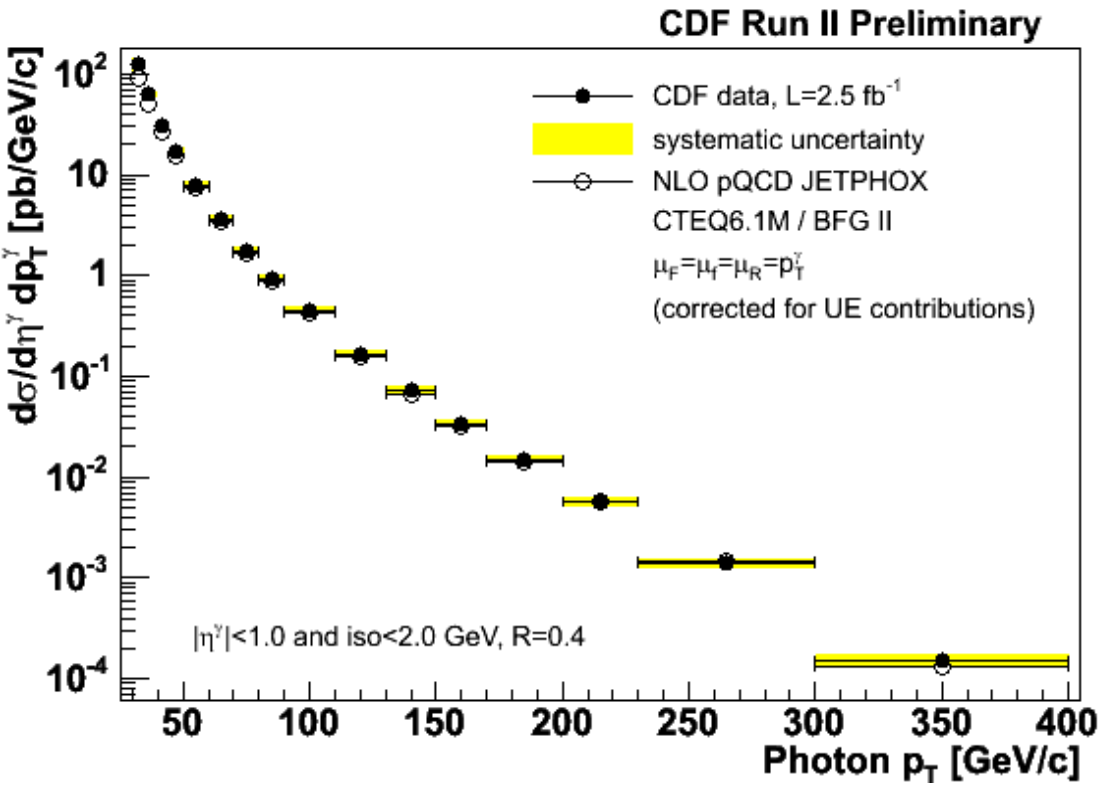


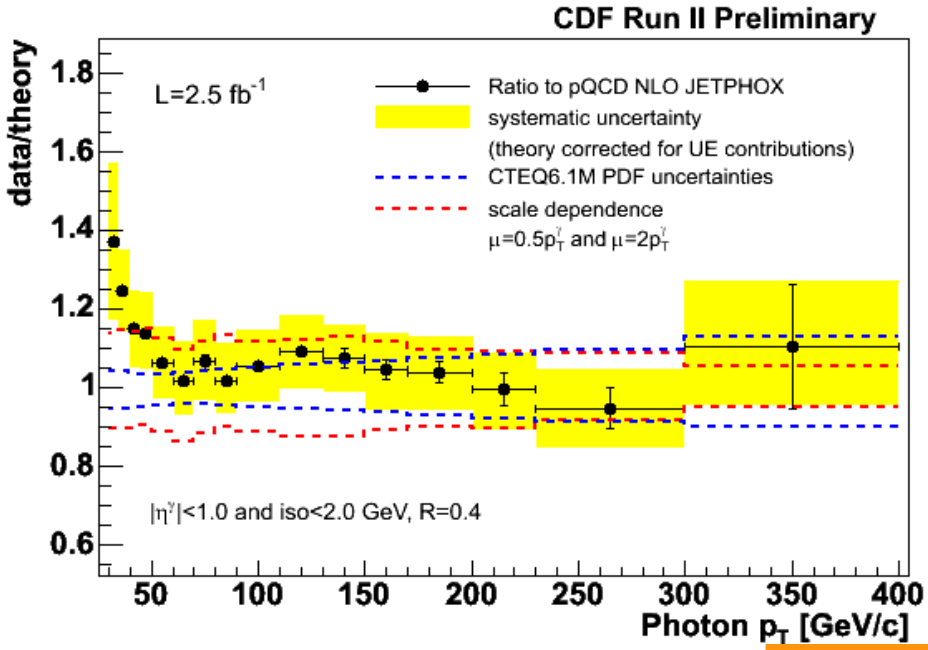
Photon + jet (DØ)

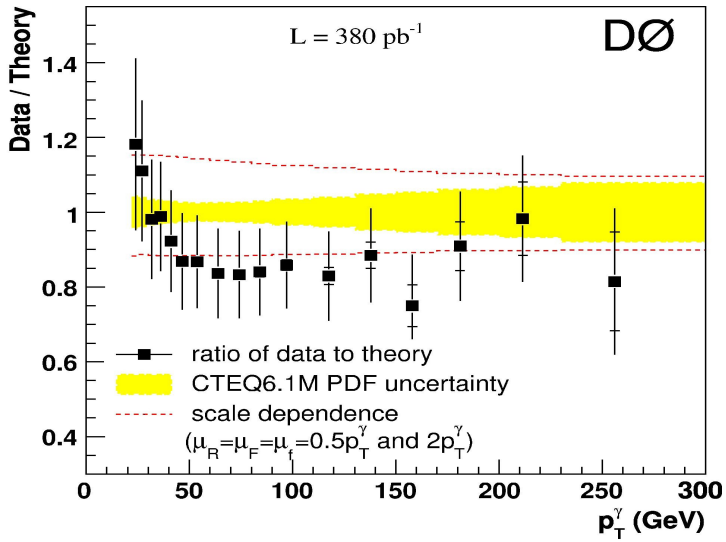


Inclusive photon

2.5fb^{-1}







- New measurement by CDF extends the p_T coverage up to 400 GeV/c
- Agreement between data and theory
- But different shape at low p_T
  - CDF and DØ measure same shape
  - Also measured by the Tevatron Run I

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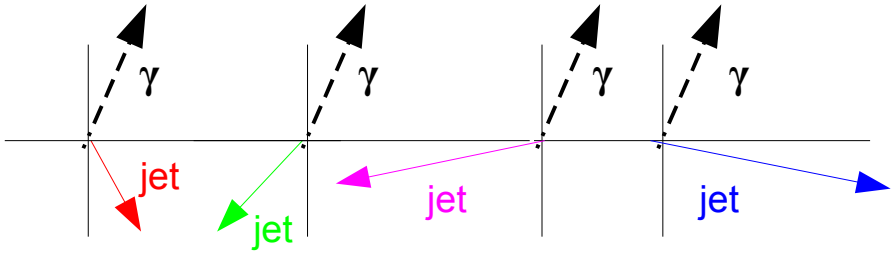
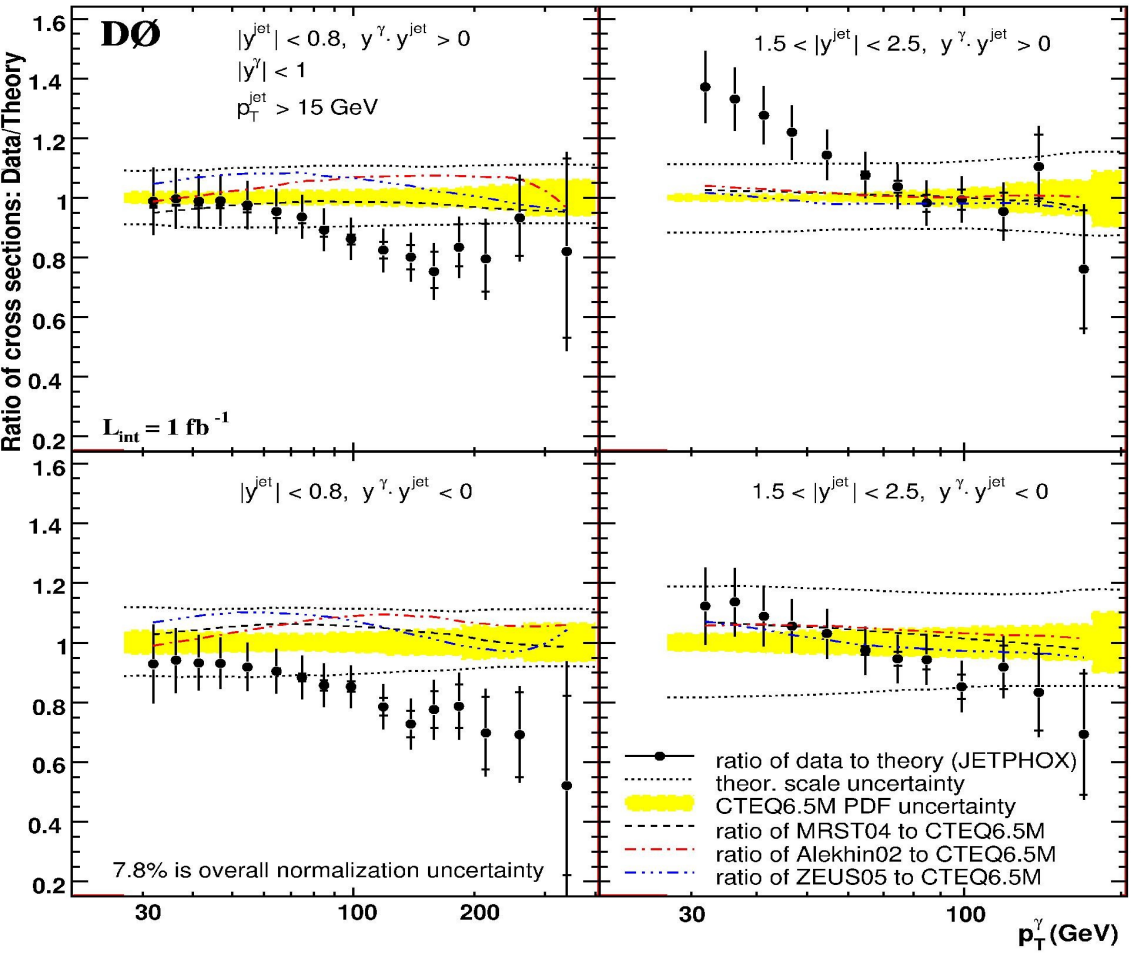
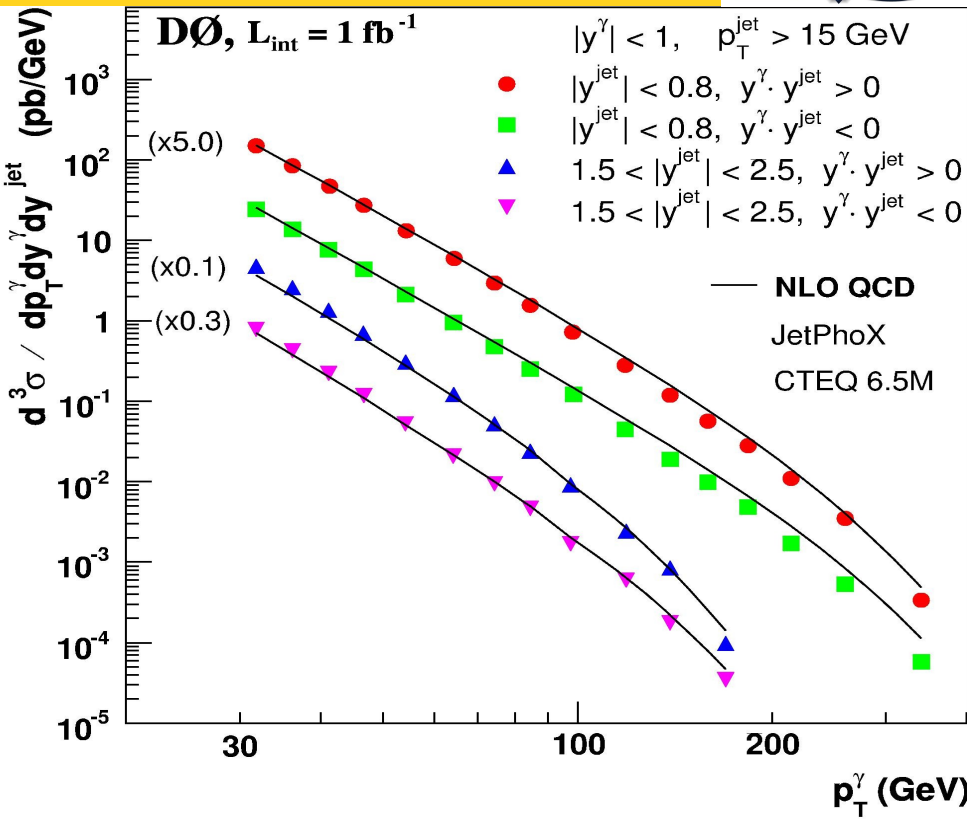
Photon+jet

1fb^{-1}

- Measure in **4 rapidity regions**
  - **Central jets:** $y^{\gamma}y^{jet}>0$ & $y^{\gamma}y^{jet}<0$
  - **FWD jets:** $y^{\gamma}y^{jet}>0$ & $y^{\gamma}y^{jet}<0$





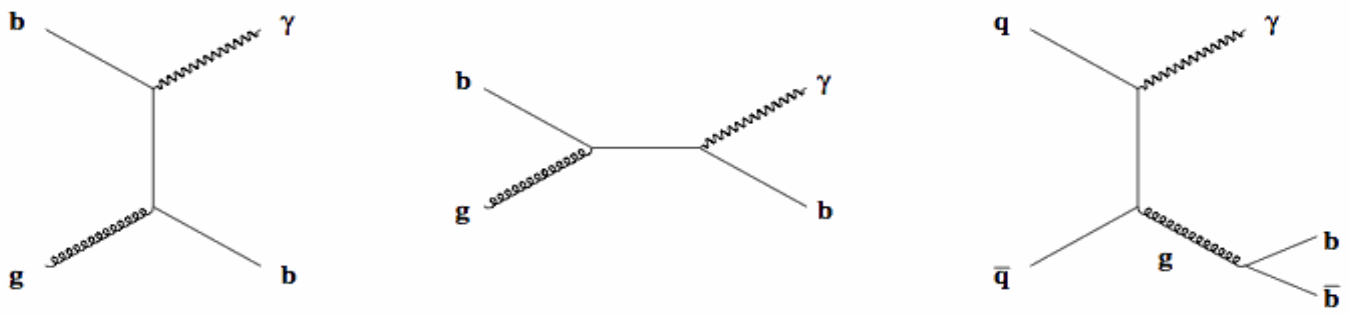


- **Theory does not describe the shape of the data in the whole measured range**
- **Similar shapes as those observed in the inclusive measurements**

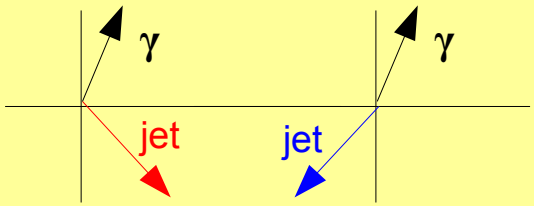
Photon+HF jet

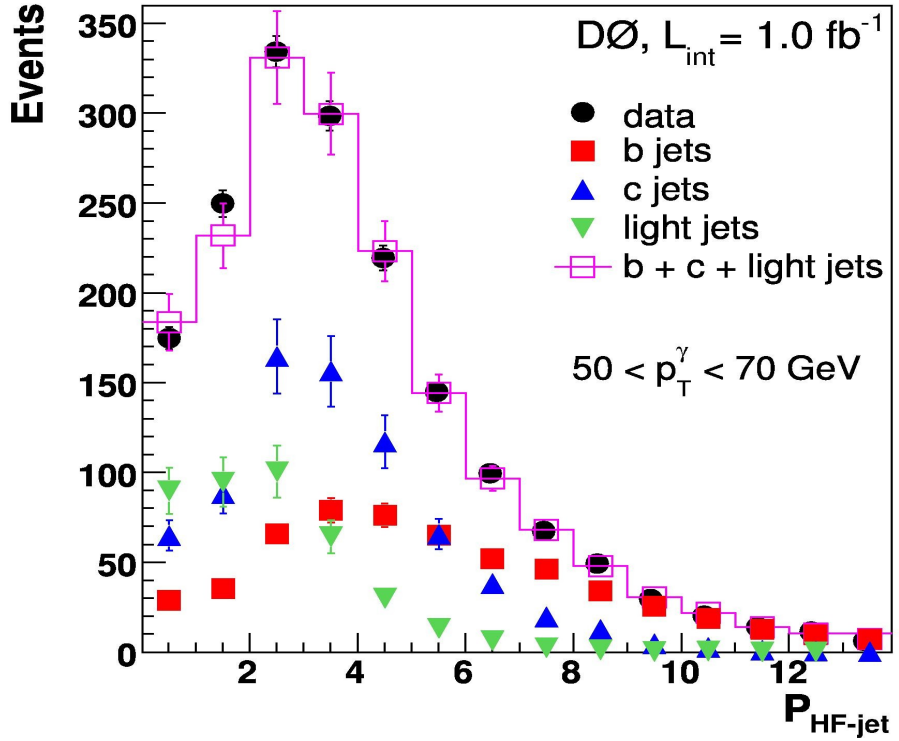
1fb^{-1}

- **Photon+HF jet** measurements can provide information about the **HF content of the proton**



- **b and c jets are identified using the longer lifetime of B and D mesons**
- **γ+ b,c jets are measured in 2 regions**
  - $y^{\gamma}y^{jet}>0$ (central jets)
  - $y^{\gamma}y^{jet}<0$ (central jets)





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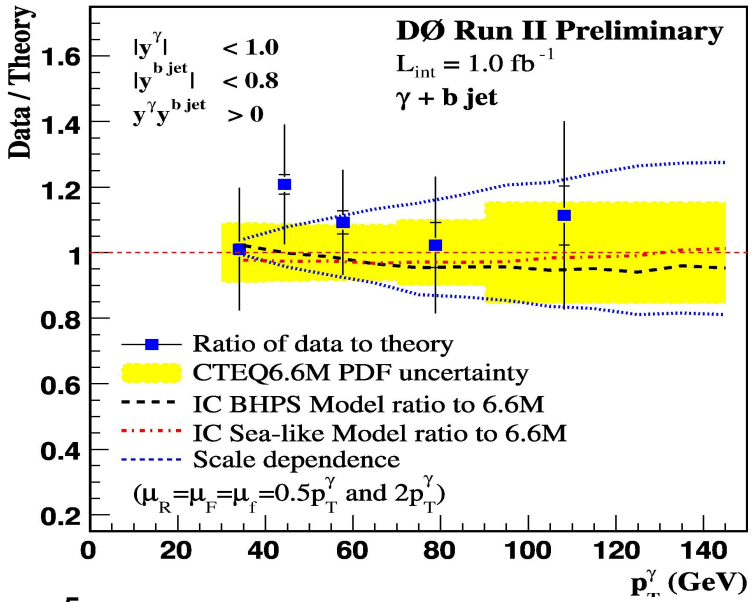
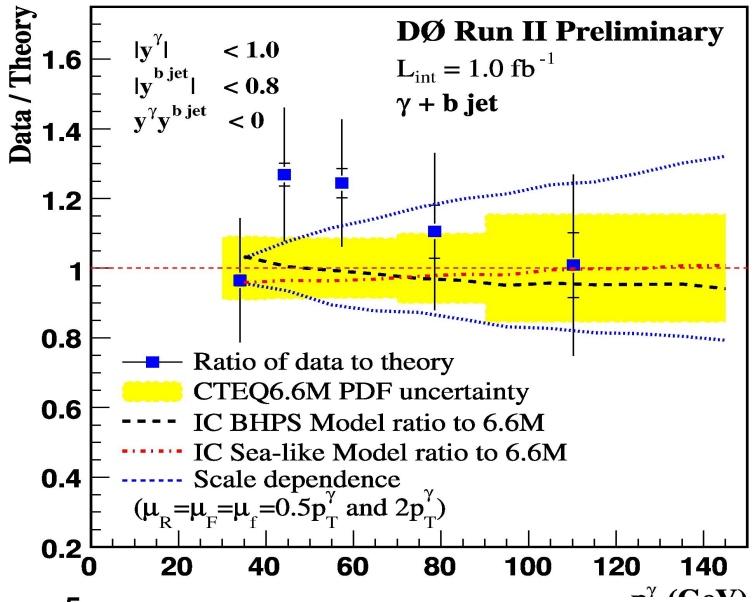
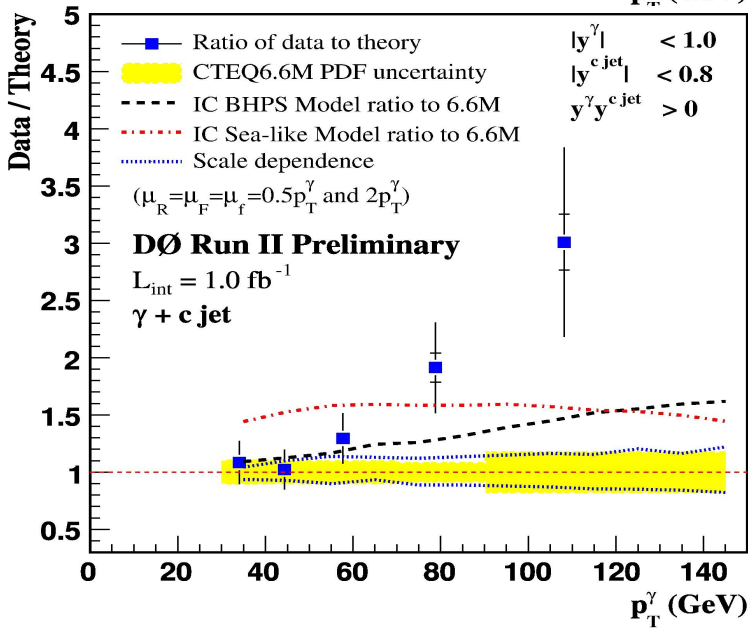
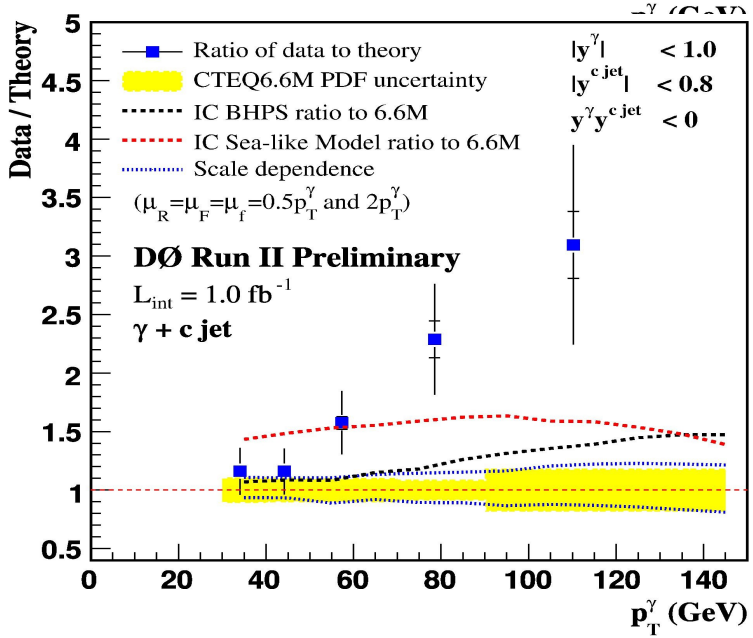
Photon+HF jet (II) 1fb^{-1}





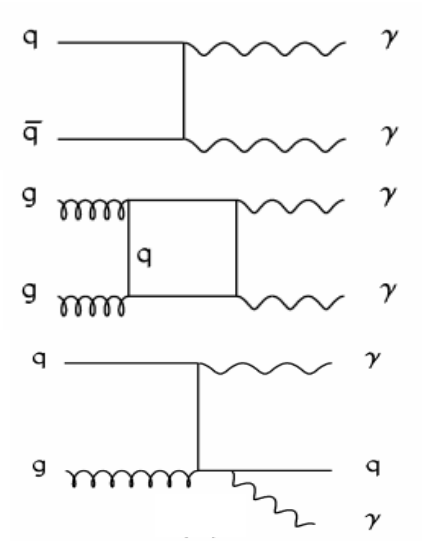




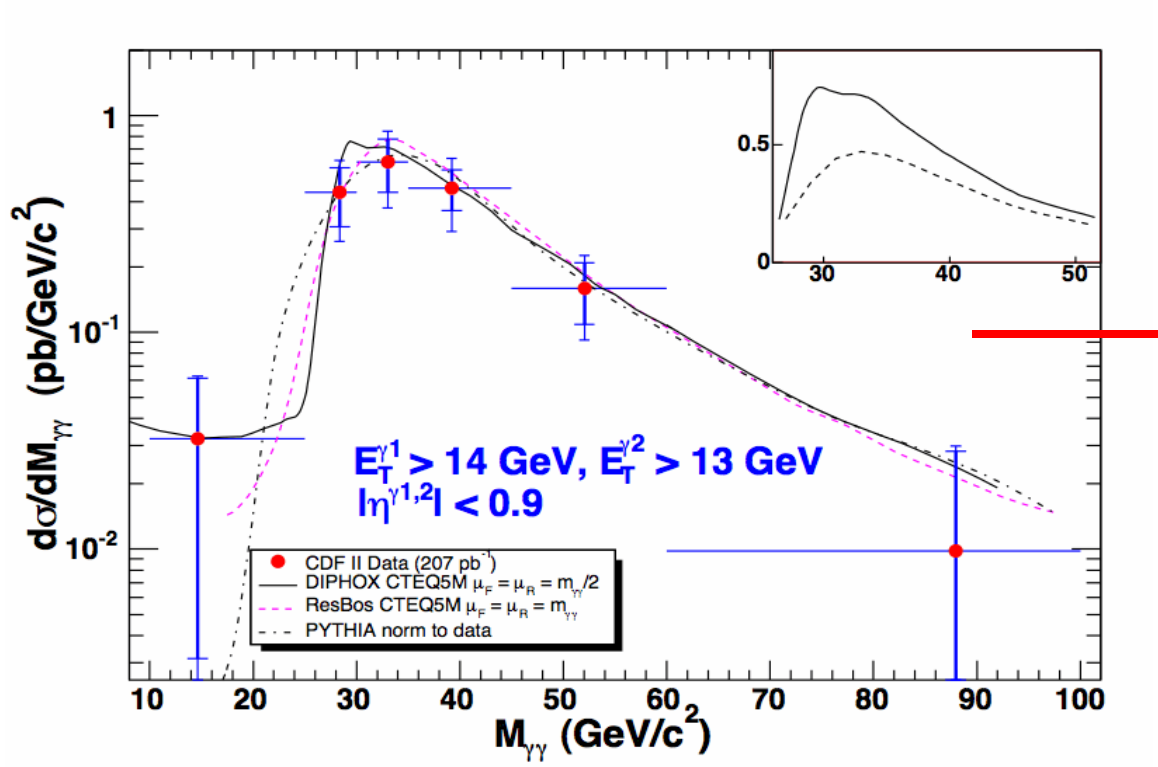
- **Agreement for γ+bjet cross sections, but not in γ+cjet for p_T^{γ}>70 GeV/c**
  - Underestimation of gluon splitting at high p_T?
  - Confirmation from CDF?

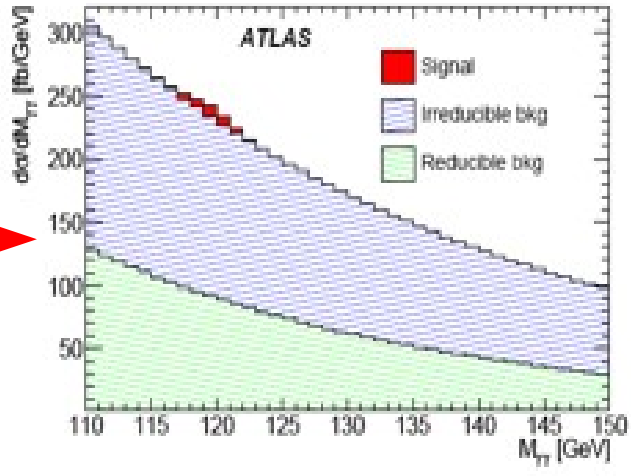
Diphoton

207 pb^{-1}



- **Direct probe of colliding partons p_T, and sensitive to soft gluon emission**
- **Irreducible background** to
  - SM Higgs searches (H→γγ)
  - BSM searches (SUSY with light gravitino, etc.)





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Conclusions

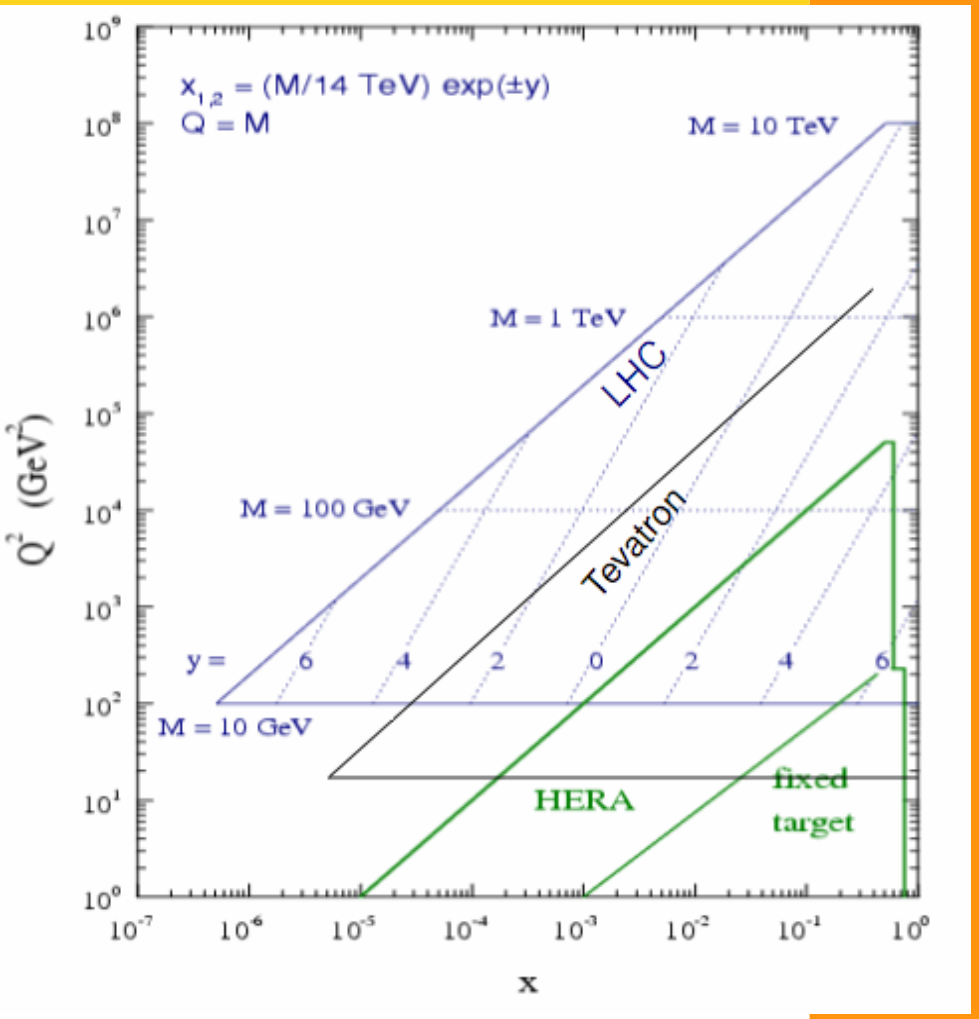
- **Latest Tevatron results with luminosities up to 2.5 fb^{-1}**
- High statistics, high precision:
  - Experimental uncertainties ~ Theory uncertainties

- **inclusive photon**
  - **CDF and DØ results agree with theory**
  - **But data and theory show different shape at low p_T**

- **photon+jet**
  - **Similar trend at low p_T**

- **photon+bjet**
  - **Agreement between data and theory**

- **photon+cjet**
  - **Data over theory at high p_T**
  - **Need additional understanding and other measurements**



Still more to come at the Tevatron and at the LHC!

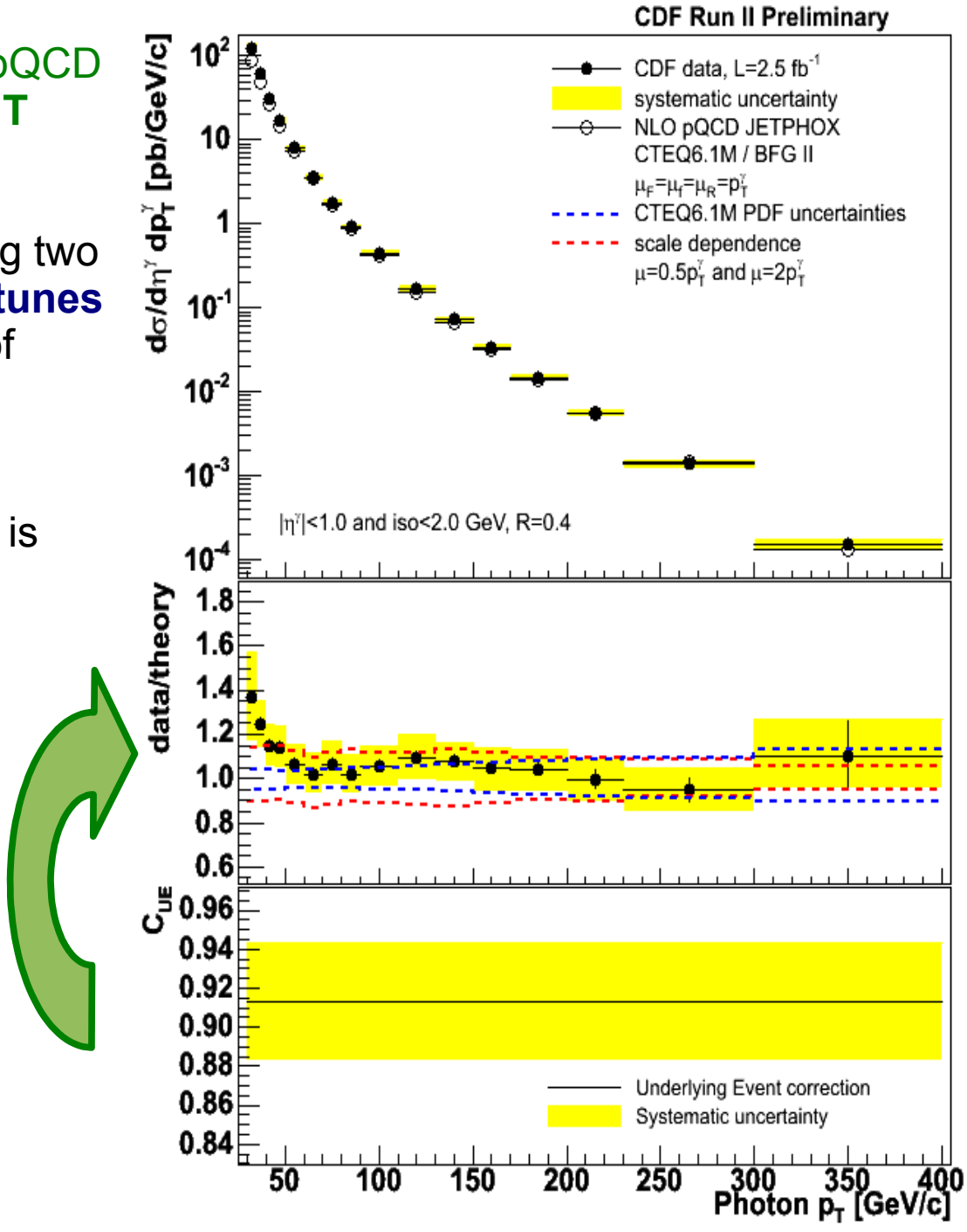
Inclusive photon – non pQCD corr

- Theory is corrected for the non-pQCD effect of the **UNDERLYING EVENT**

- This correction is estimated using two **PYTHIA samples with different tunes** of the underlying event (see talk of Deepak Kar this afternoon)

- The mean of the two predictions is taken as a correction

C_{UE} ~ 9% (constant with p_T^{γ})



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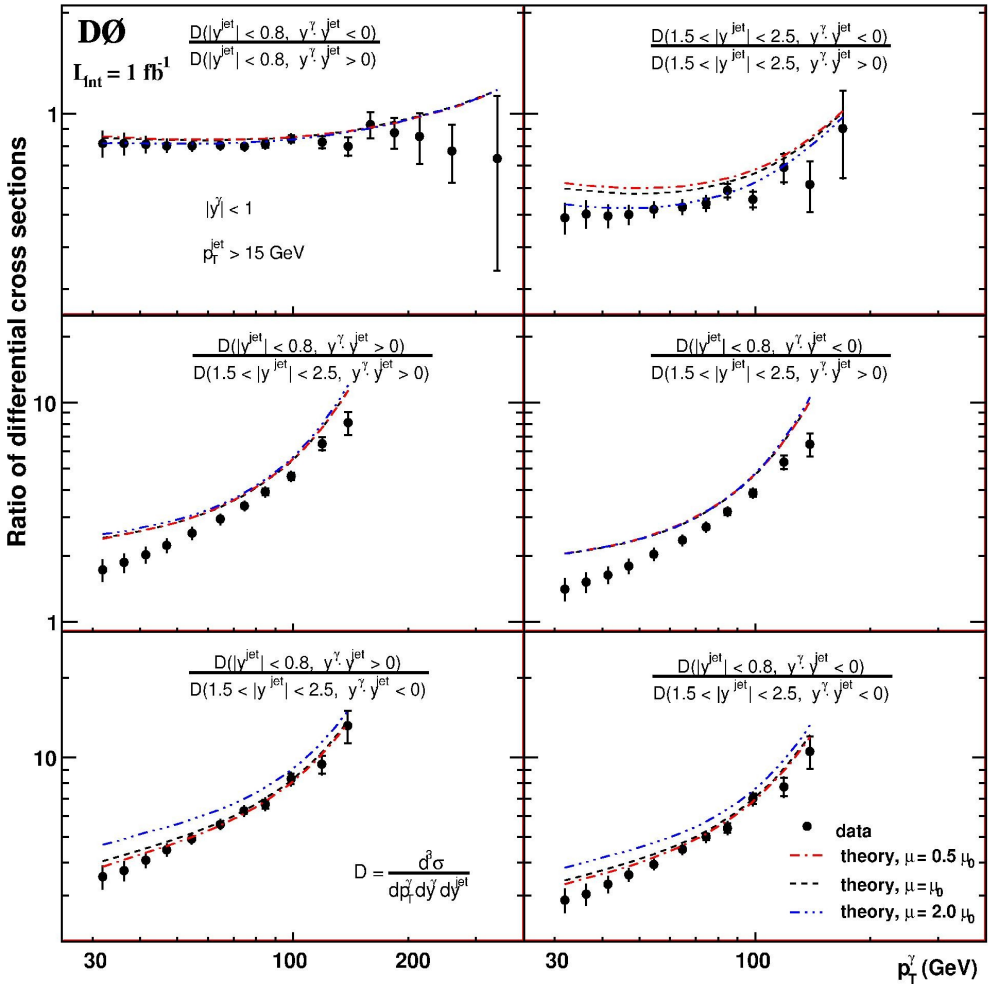
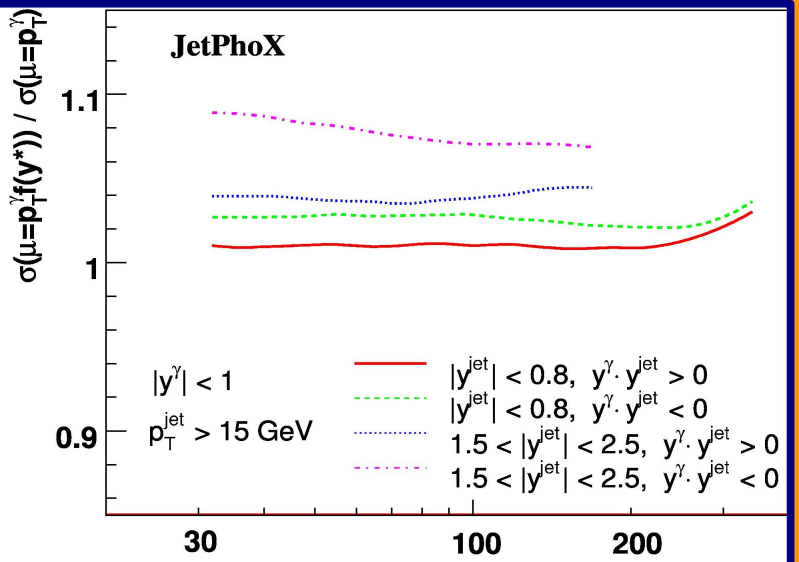
Photon+jet (II)

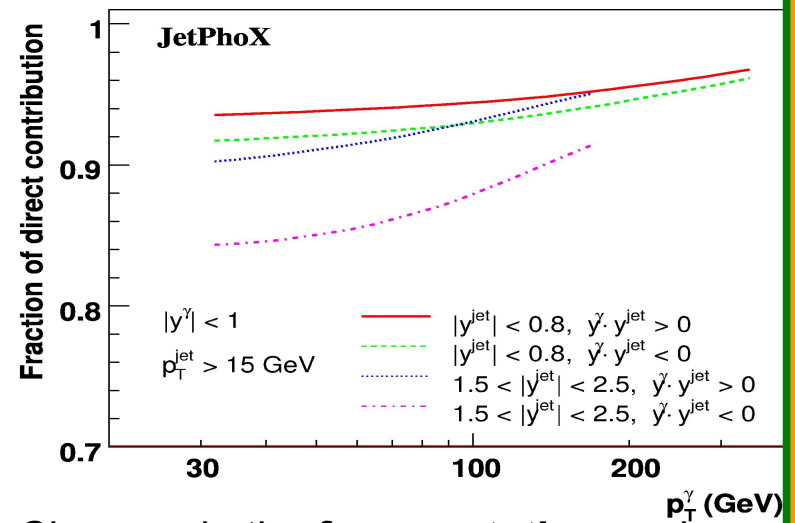
1fb^{-1}

- Ratios between measurements in the different regions show a **better qualitative agreement** (and also reduce sys unc)





- Different **scale** choice does not cover differences in shape



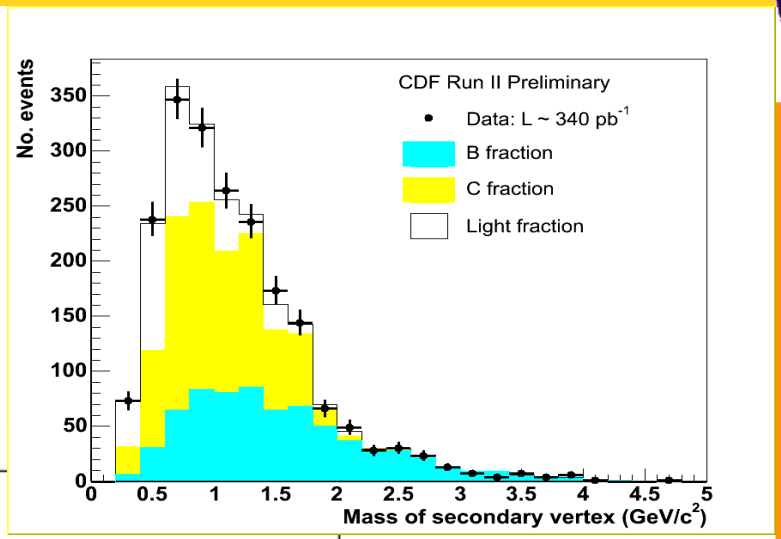
- Changes in the **fragmentation** scale or in the description of the fragmentation component change the cross section by 3% at most

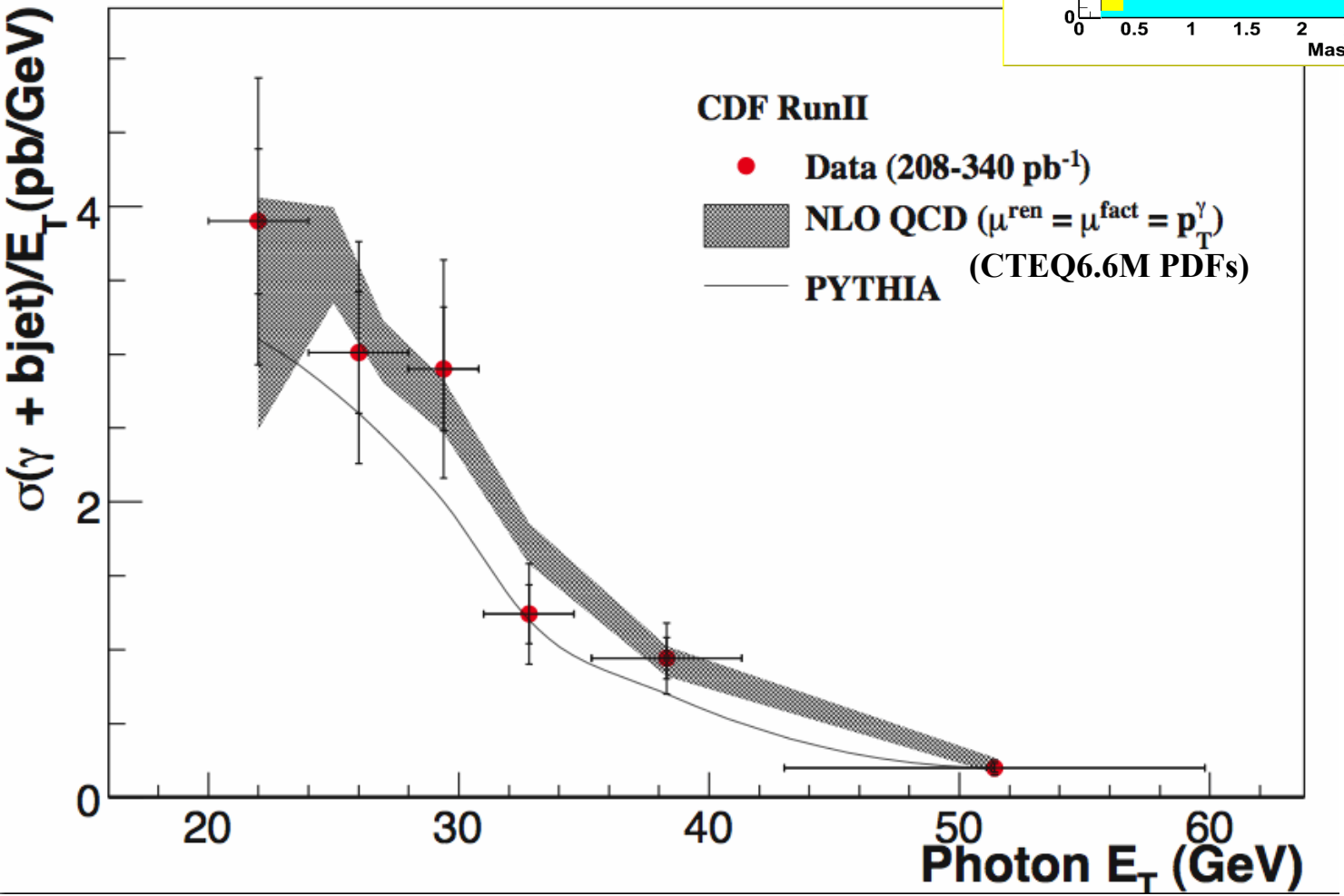
Photon+bjet

340pb^{-1}

Combination of two CDF old results with 208 and 340 pb^{-1}

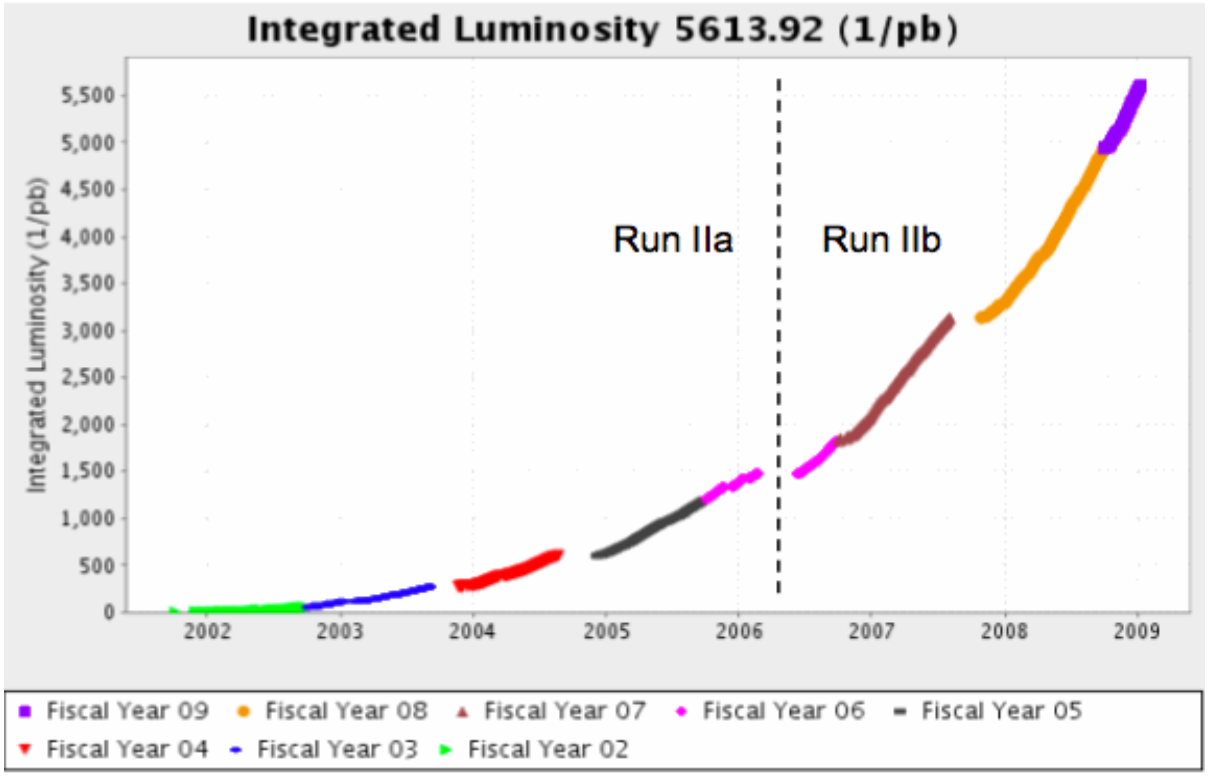
Theory and data agree within uncertainties





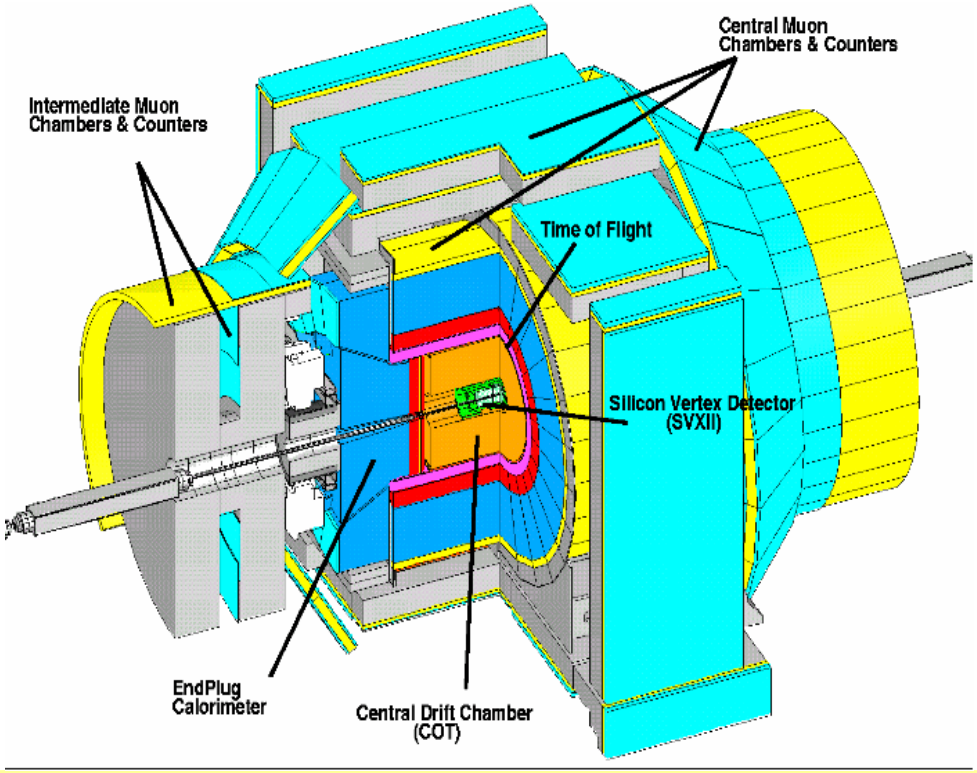
The Tevatron Collider

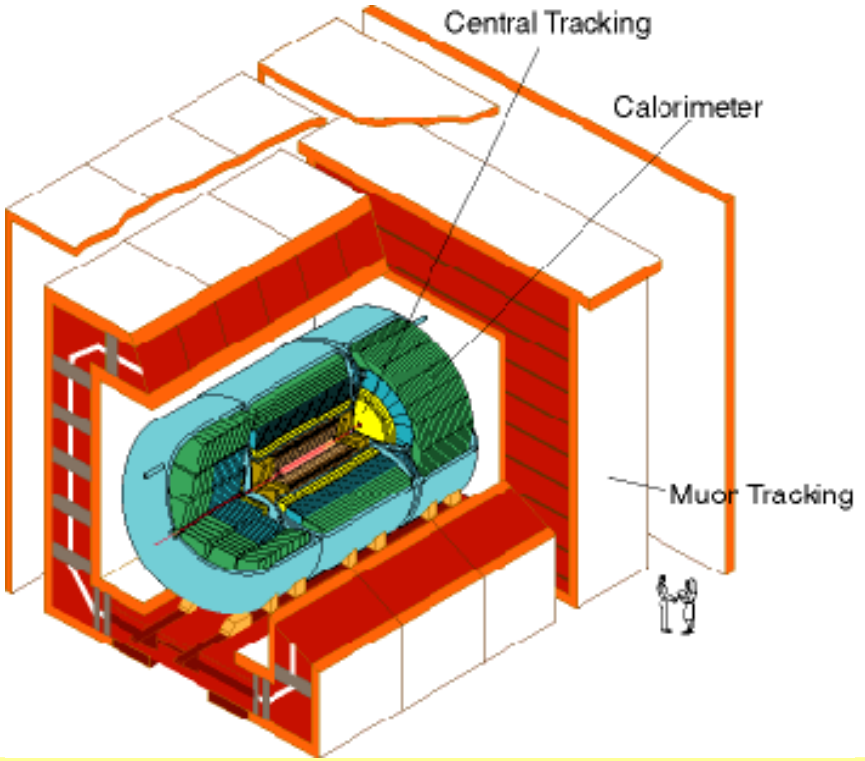
- The Tevatron is a **p-pbar collider at $\sqrt{s}$=1.96 TeV** located Fermilab (Illinois, USA)
- In Run II (2001) it has **already delivered more than 3.5fb^{-1}** of data
- Current previsions **expect a total dataset of more than 8fb^{-1}**



The CDF and DØ detectors are located at two of its collision points

The CDF and DØ detectors





- **CDF and DØ are general purpose particle detectors**
  - Vertex detector (Silicon pixel)
  - Tracking system (wire chambers)
  - Solenoidal magnetic field
  - EM Calorimetry
  - HAD Calorimetry
  - Muon detectors

- **Photons are reconstructed as clusters of towers in the EM calorimeter (1 to 3 towers at CDF, 2x2 towers at DØ)**