W/Z+jets and Z p_T measurements at the Tevatron

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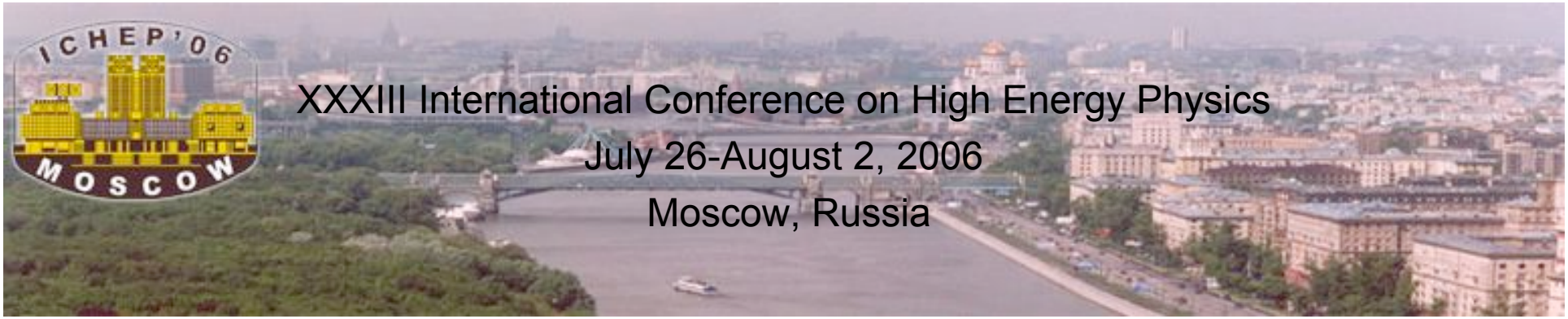
for the CDF and DØ collaborations



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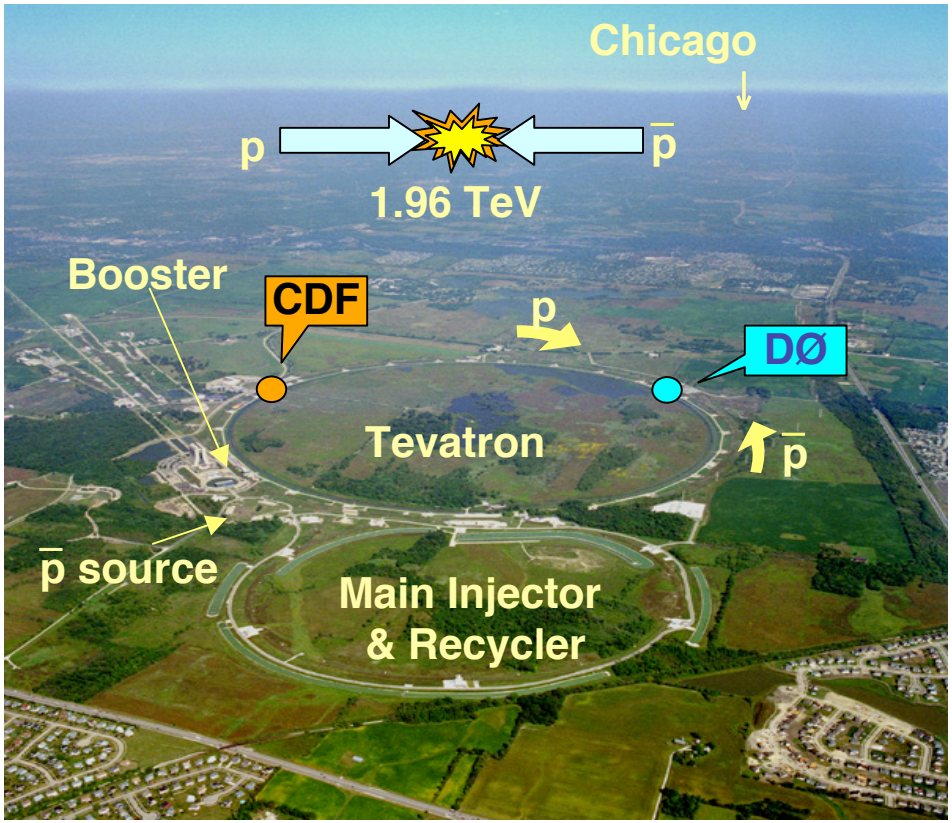
Outline

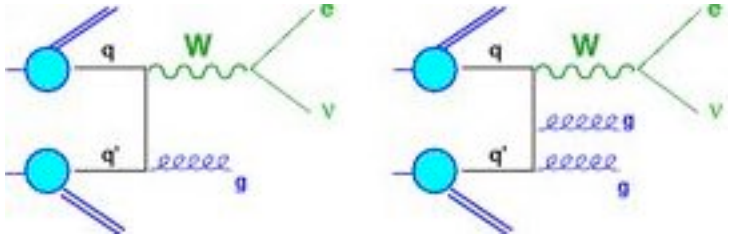
- Introduction
- DØ/CDF detectors
- W+jets production
- Z+jets production
- Z p_T measurement
- Summary



✓ p-pbar at √s=1.96 TeV
✓ peak L ~ 1.7x10^{32} cm^{-2}/s
✓ ~ 1.6 fb^{-1} delivered

W/Z+jets production

- W/Z+jets are signatures for
  - ➢ Top pair & single top
  - ➢ Higgs boson (WH, ZH)
  - ➢ SUSY

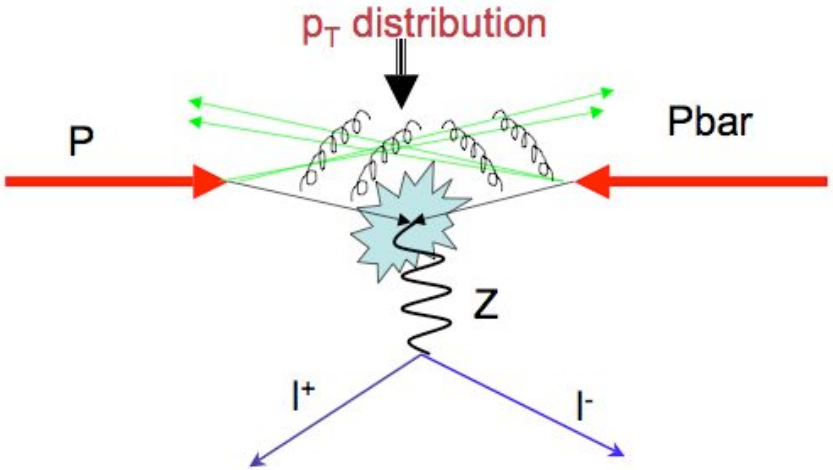


- ✓ But large QCD production is main backgrounds
- ✓ Knowing of cross section and kinematic properties are essential for reliable background estimates

and test of

- ➢ pQCD at high Q^2
- ➢ LO and NLO Matrix Element + Parton Showering: modeling MC is very crucial for LHC

Z p_T distribution

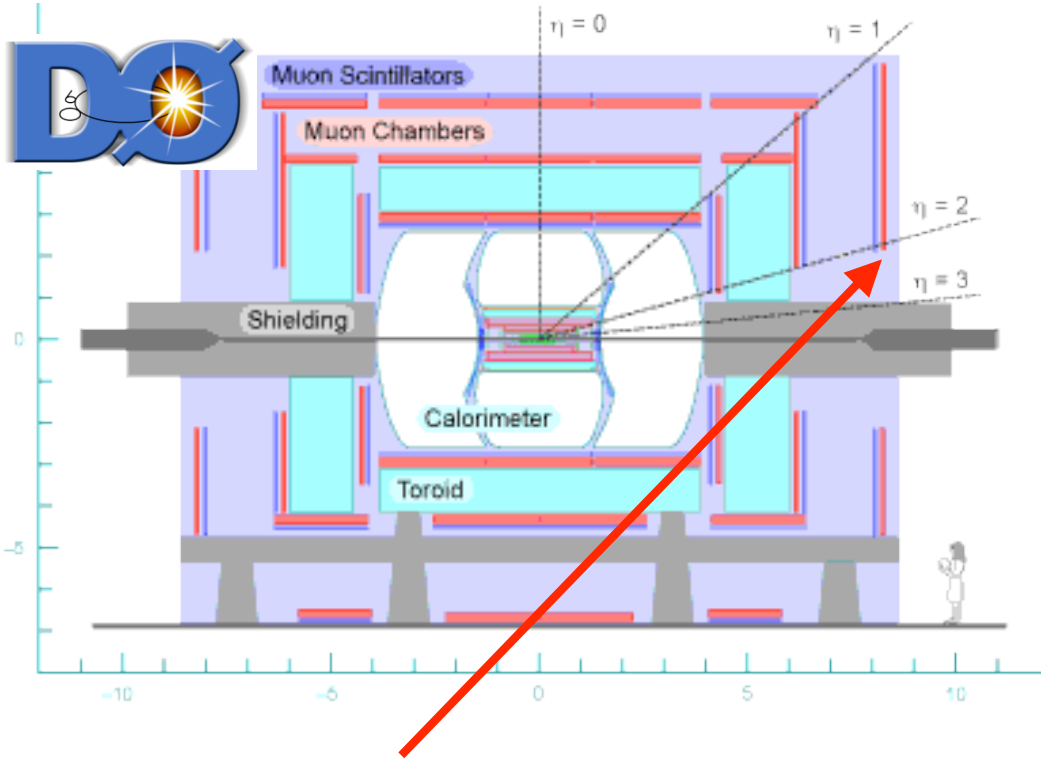


- Initial state QCD radiations:
  - Number of jet distributions : impact on many other channels (ex. W/Z/ttbar +(n)jets)
  - Understanding of boson (W,Z) p_T is important

At Tevatron, we use clean Z events for boson p_T

- ✓ High p_T region : pQCD test
- ✓ Low p_T region : non-pQCD (resummation) test
- ✓ Understanding of p_T distribution reduces the W mass uncertainty (CDF Goal ~ 40 MeV, 13 MeV from W p_T)
- ✓ Deviations at high p_T are sign of new physics

DØ and CDF detectors



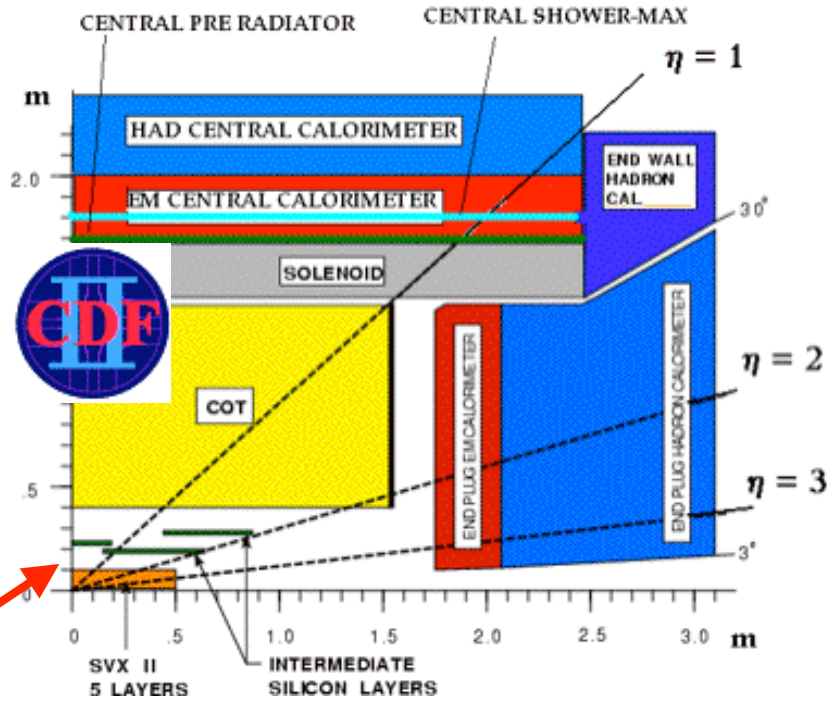
Excellent muon ID and acceptance

Multi-purpose detector:

Precision tracking with SI

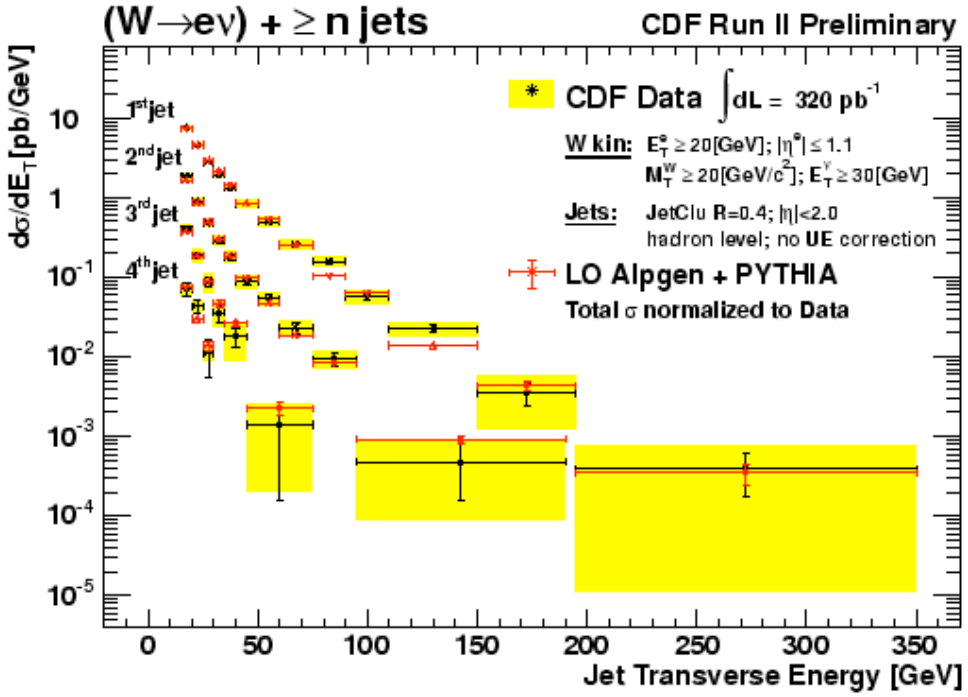
EM & Hadron Calorimeters

Muon Chambers



Excellent tracking

W+ jets production (CDF 320 pb^{-1})



W(→eν) + jet

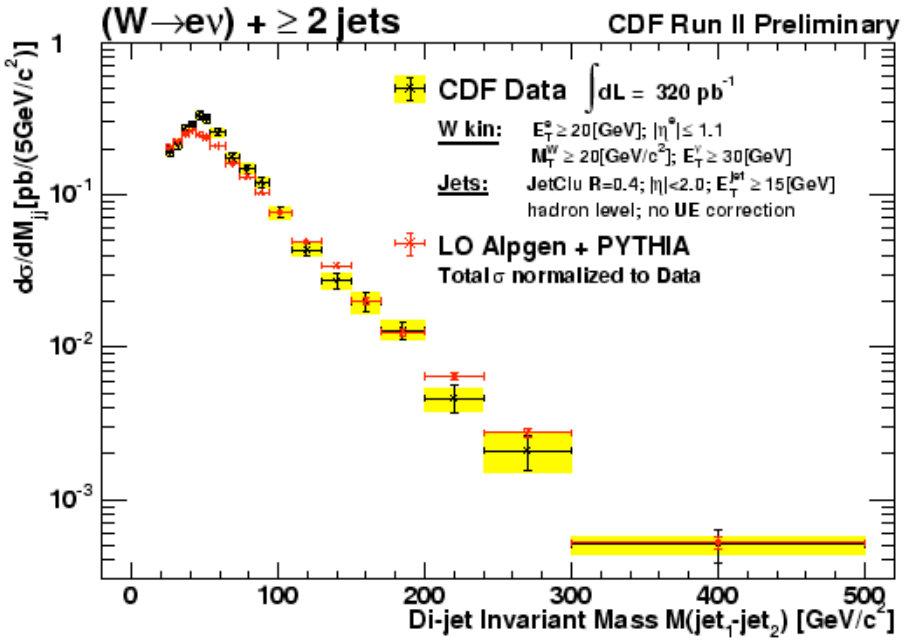
Restrict W cross section to the measurable phase space to minimize the model dependence

- E_T(e)>20 GeV
- M_T(W)> 20 GeV
- MET>30 GeV
- |η(e)|<1.1
- JETCLU 0.4,
- E_T(jet) >15 GeV
- |η(jet)| < 2.0

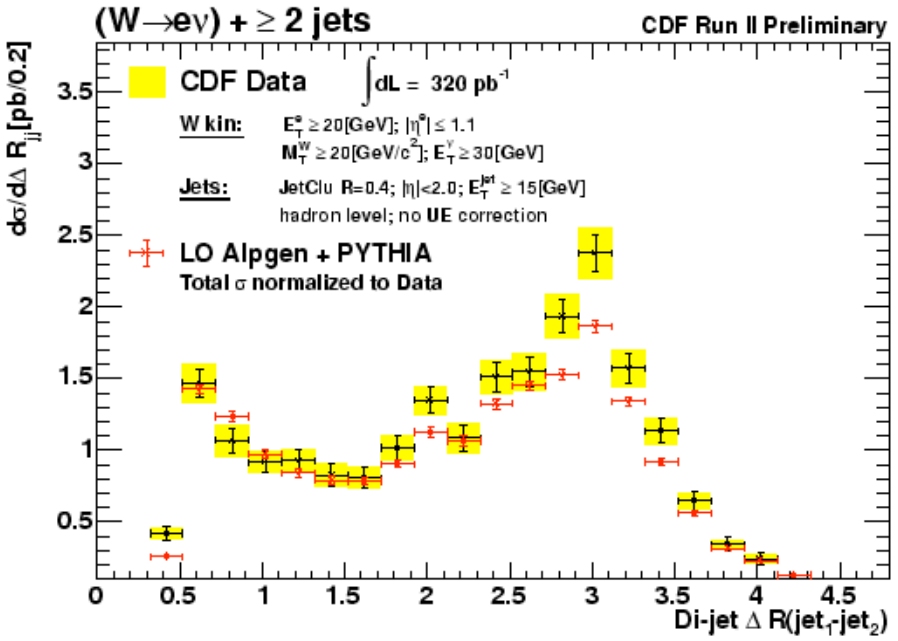
✓ Jets are corrected to the hadron level
✓ Comparison with LO Alpgen ME (v2) + Pythia PS
✓ Normalized for each jet multiplicity
✓ Agreement is good in shape

W+≥2jets (CDF 320 pb^{-1})

dσ/dM vs. M(jet, jet)

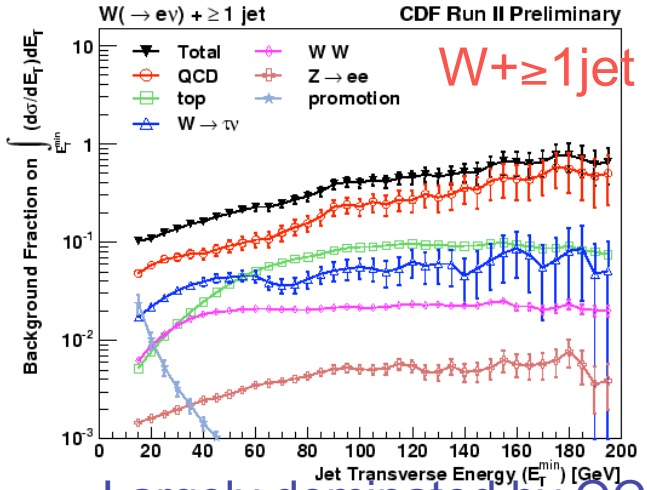


dσ/dΔR vs. ΔR(jet,jet)

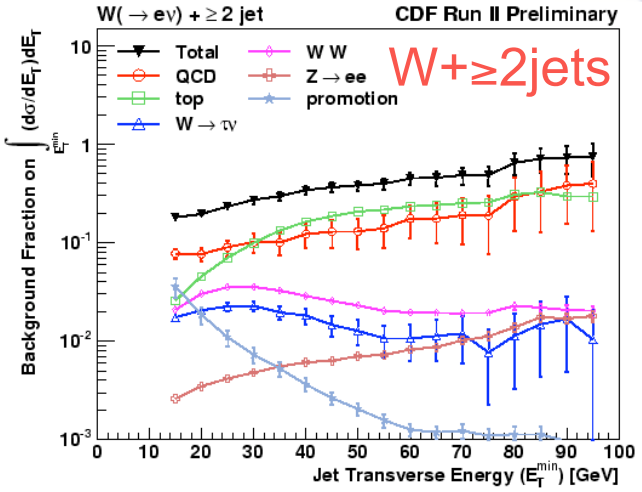


Comparison with LO Alpgen (v2) + Pythia in shape only
(MC have been normalized to the measured cross section)
Reasonable agreement between data and predictions

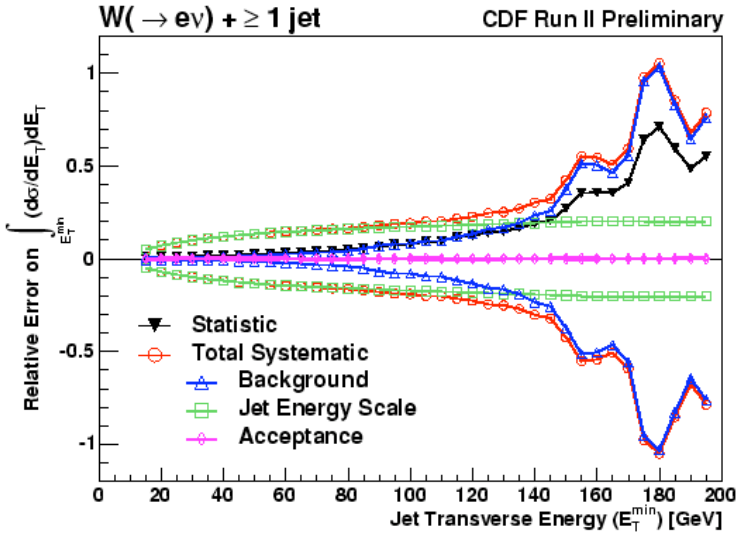
Backgrounds & Uncertainties



Largely dominated by QCD



top contribution is sizeable in high jet multiplicity and high jet E_T



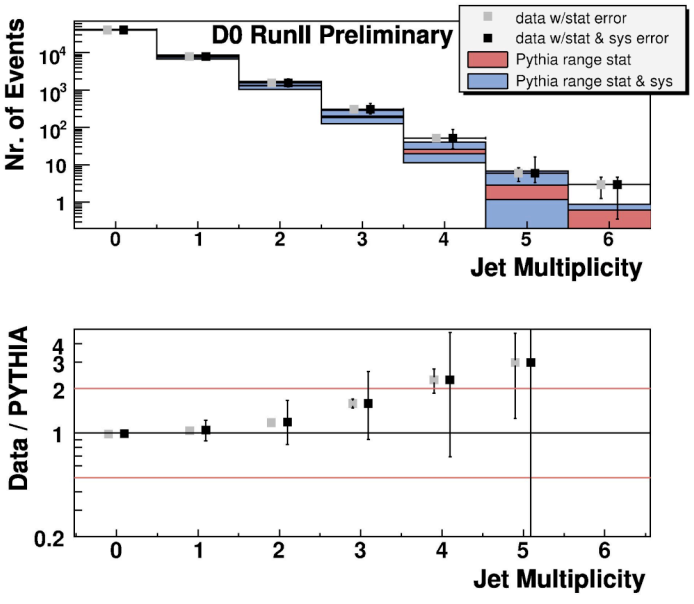
Still large statistic uncertainty at high E_T

Systematic uncertainty:

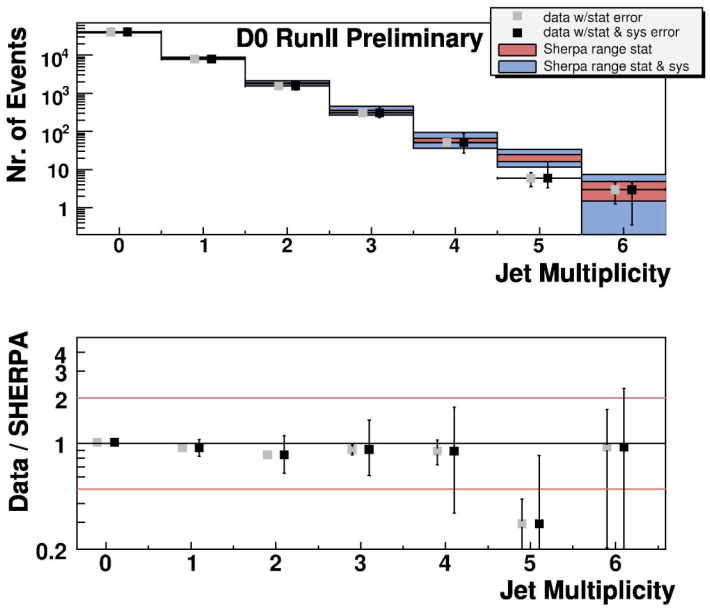
- ✓ Jet energy scale (~3%) is dominant at low E_T
- ✓ Uncertainty due to background subtraction will scale with luminosity

Z+jet production (DØ 950 pb^{-1})

Pythia 6.319 with CTEQ6L



SHERPA 1.0.6 with CTEQ6L

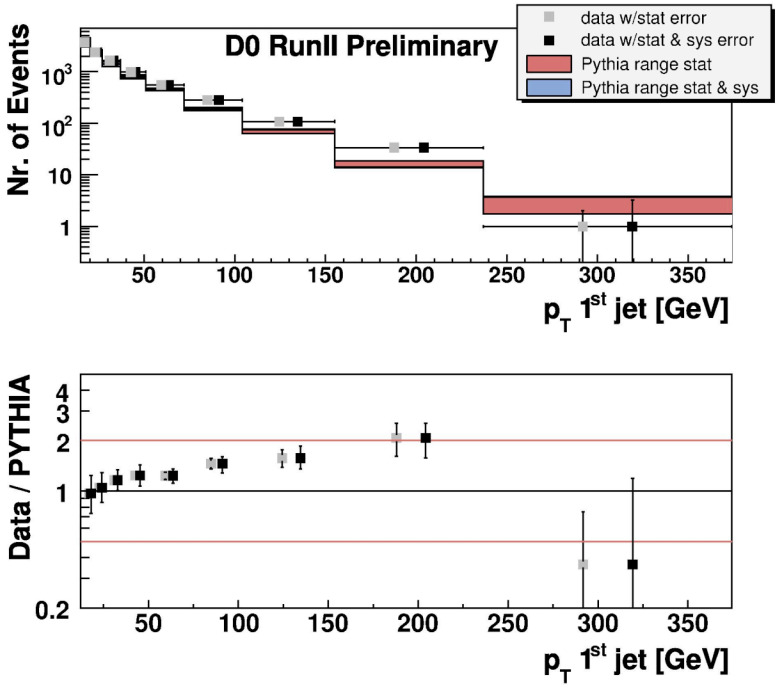


Z/γ^* ($\rightarrow$ee)+ jet
- Oppositely charged
- p_T(e)>25 GeV
- One e $|\eta|$ <1.1
- Another e $|\eta|$ <2.5
- 70<M(ee)<100 GeV
- Cone jets
- p_T(jet) > 15 GeV
- ΔR (jet,e)>0.5

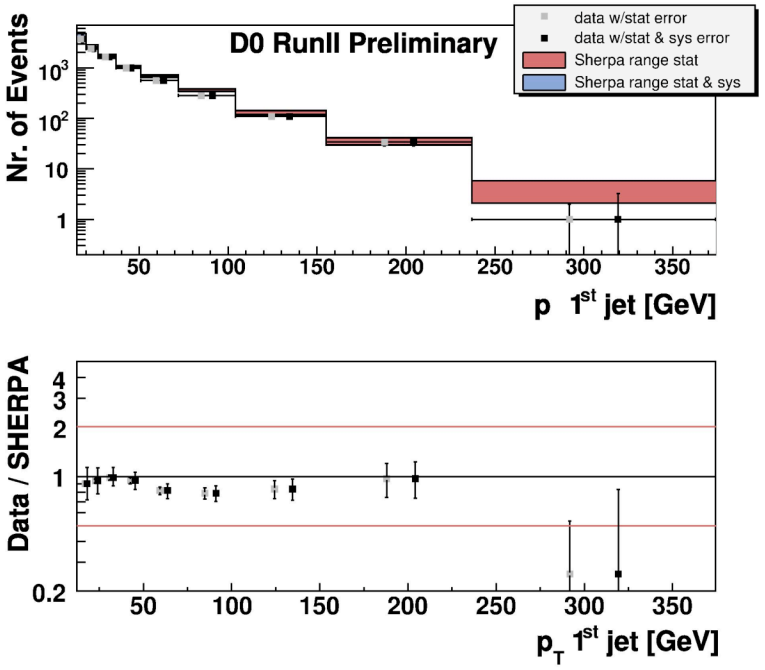
- ✓ MC samples are normalized to the total number of Z/γ^* in the data
- ✓ Pythia tends to produce too few multi-jet events
- ✓ SHERPA predictions are somewhat higher than in data
- ✓ Both predictions are in agreement with data within errors

Z+jet production (DØ 950 pb^{-1})

Pythia



SHERPA



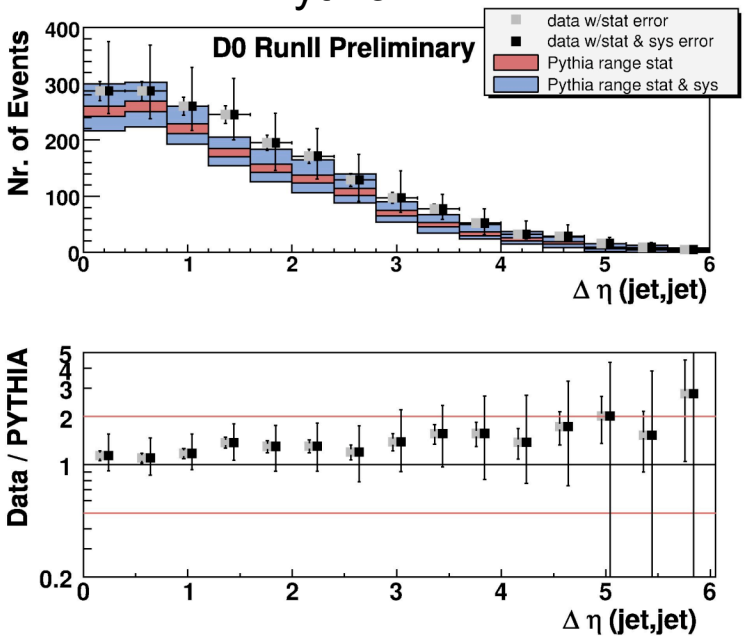
- ✓ MC samples are normalized to the total number of Z/γ* in the data
- ✓ Positive slope in the ratio for Pythia prediction (larger for 2nd and 3rd jets)
- ✓ SHERPA prediction is consistent with data within errors
- ✓ Also good matches between SHERPA and data for 2nd and 3rd hardest jets

Z+jet production (DØ 950 pb^{-1})

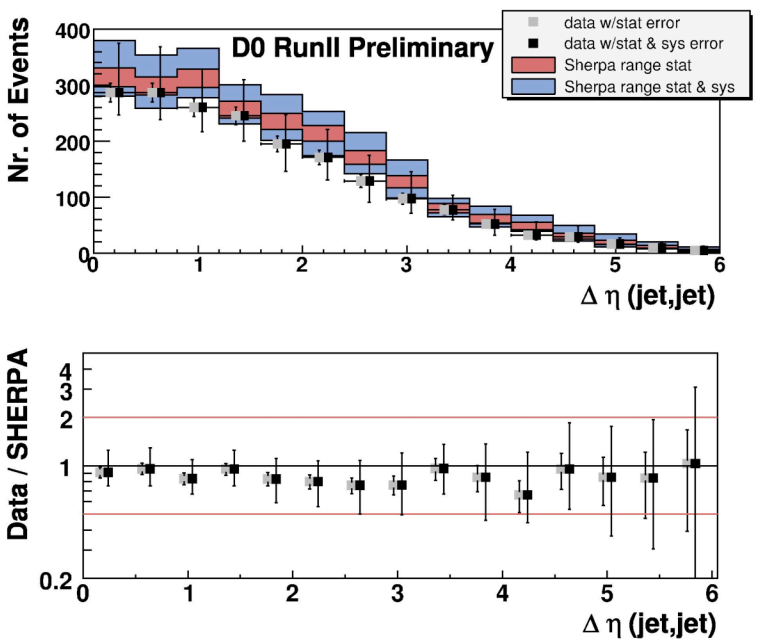
Angular correlations between pairs of hard final state jets

$\Delta\eta$(jet,jet)

Pythia

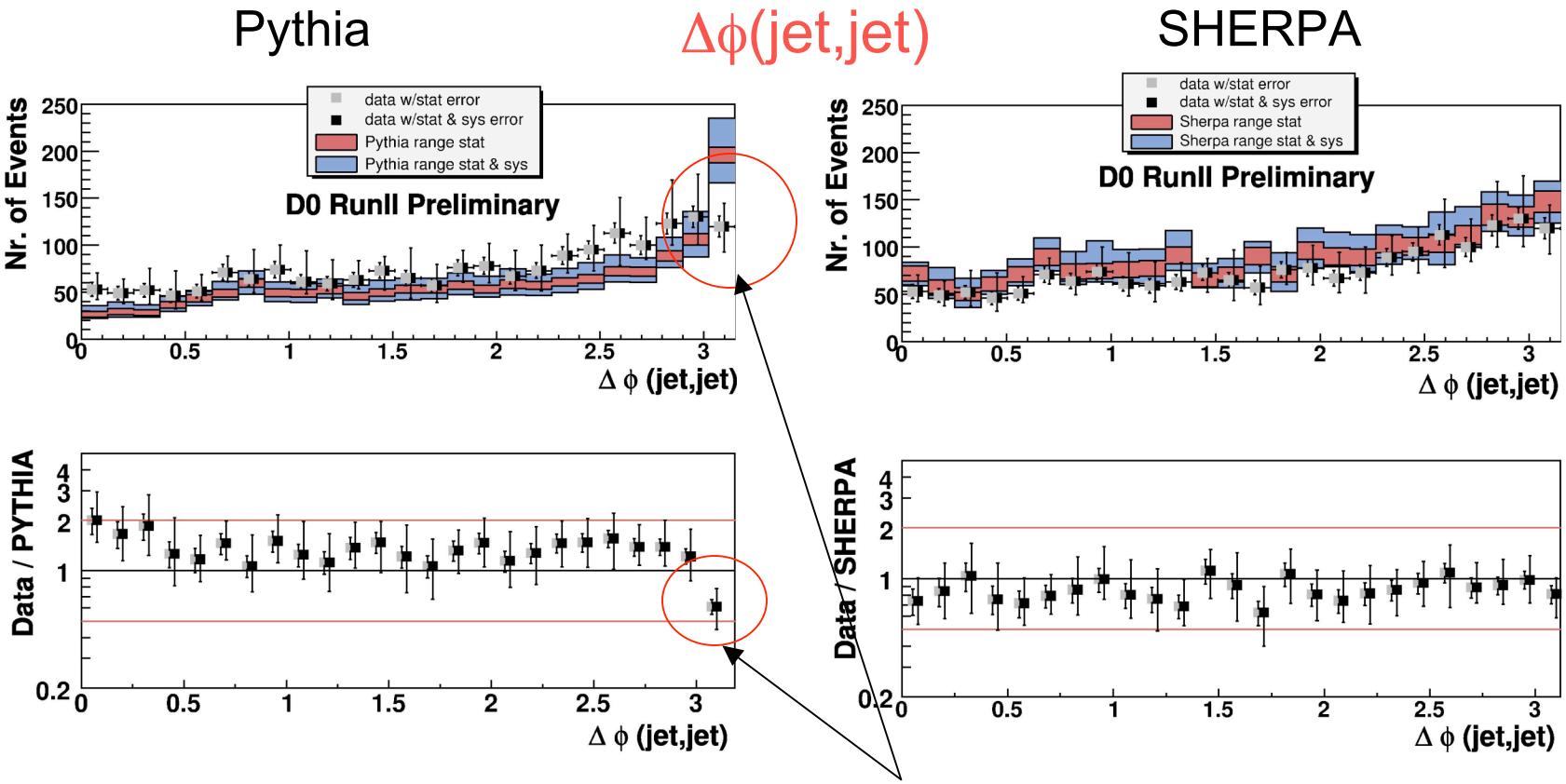


SHERPA



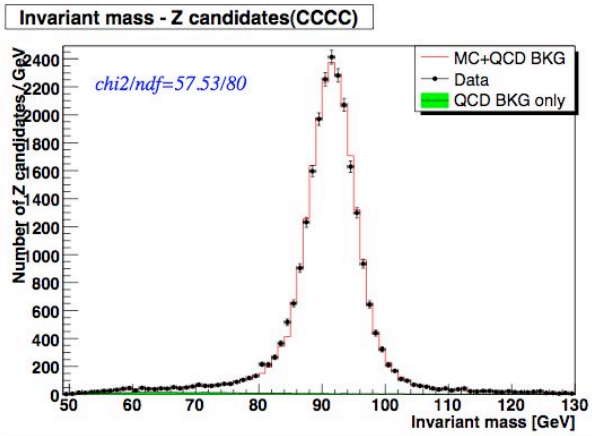
✓ Both predictions describe the $\Delta\eta$ observed in data within errors

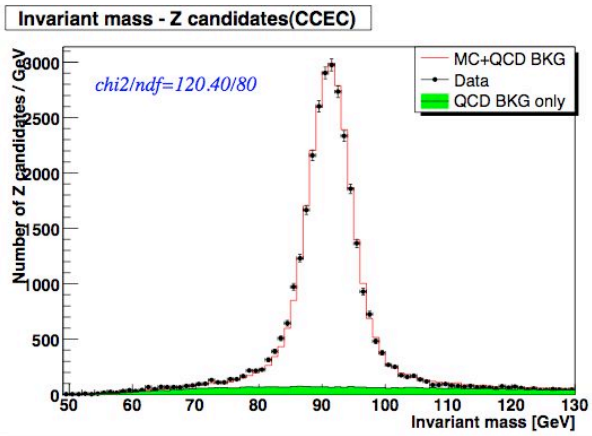
Z+jet production (DØ 950 pb^{-1})

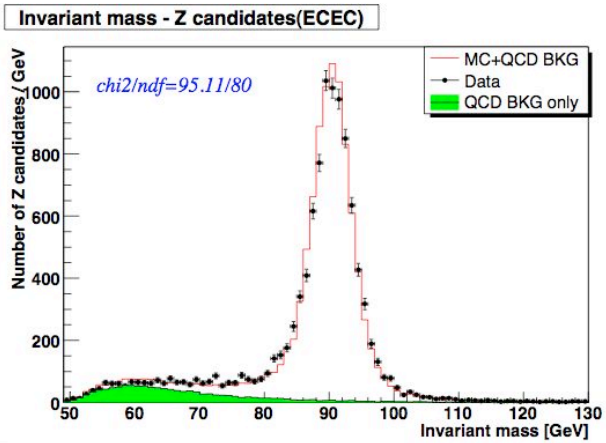


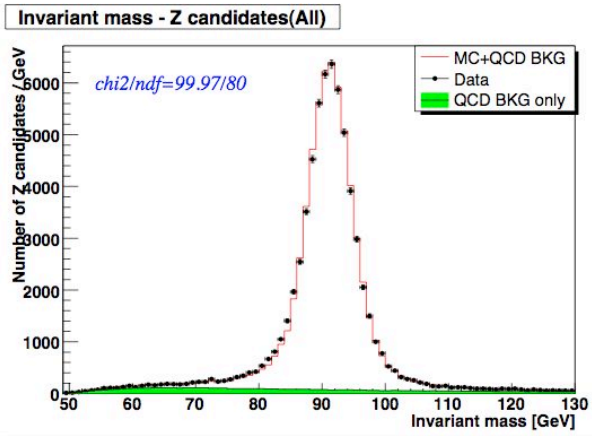
- ✓ Pythia predicts data well except at $\Delta\Phi=\pi$
- ✓ SHERPA gives a very good description of data
- ✓ A previous DØ study shows a good agreement between SHERPA and data in QCD di-jet events

Z p_T measurement (DØ 960 pb^{-1})









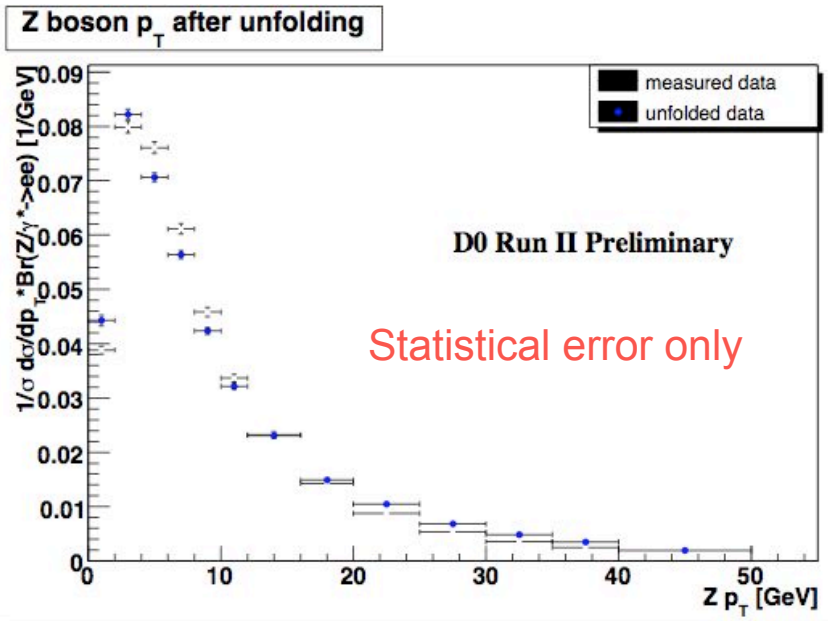
Z/γ^* ($\rightarrow$ee)
- $E_T(e)>25$ GeV
- $|\eta_{det}(e)| <1.1$ (CC) or $1.5<|\eta_{det}(e)| <3.2$ (EC)
- $70<M(ee)<100$ GeV/C^2

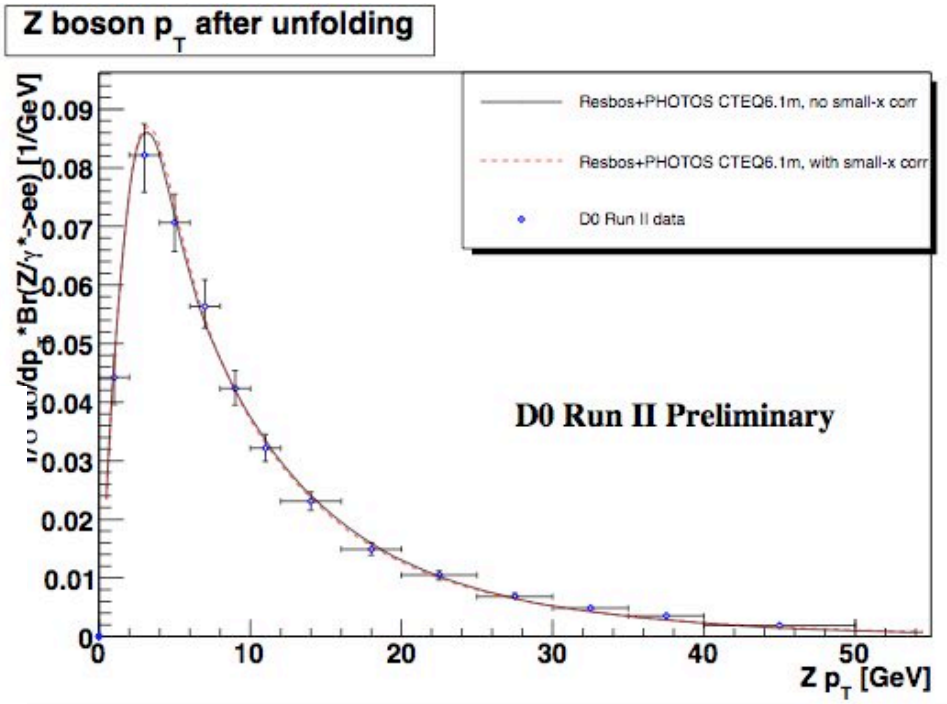
63901 selected events
~5000 forward Z events

- ✓ Invariant mass, M(ee), distribution (signal+background)
- ✓ ResBos (resummation) + PHOTOS (QED radiation) MC
- ✓ Good agreement between data and predictions

Z p_T measurement (DØ 960 pb^{-1})

Measured Z p_T is smeared due to detector resolution effects: unfold the effects to compare with theory directly





- ✓ ResBos+PHOTOS (CTEQ6.1m) describes the data well (χ^2/ndf=16.8/13)
- ✓ Z p_T for y(Z)>2 will be available soon

Summary

- CDF has a measurement of W+jets production
  - Data with 320 pb^{-1}
  - Agreement with LO Alpgen(v2)+Pythia is good
- DØ has measured the Z+jets production
  - Data with 950 pb^{-1}
  - SHERPA prediction is consistent with data within errors
- DØ has a new measurement of Z p_T distribution
  - Data with 960 pb^{-1}
  - ResBos+PHOTOS MC describes the data well
  - Z p_T for y(Z)>2 is expected to be available soon
- Stay tuned as the Tevatron continues to produce improved results on boson+jet(s) and boson p_T distribution