Measurement of the ttbar Cross Section Using Kinematics

Blessing– Aug. 07, 2003

RDE, Presenting for the OSU/Fermilab/Rutgers Group

Richard Hughes, Radu Marginean, Evelyn Thomson, Brian Winer
The Ohio State University

Robin Erbacher, Rob Roser
Fermilab

John Conway
Rutgers University

Questions from Preblessing

- $\Delta\phi$ cut related questions:
  - The ratio of electrons/muons is different for njet=1,2 vs 3,4. Is this caused by the $\Delta\phi$ cut?
    - NO. The ratio is slightly modified by the $\Delta\phi$ cut since this cut removes more electrons than muons (more background in the electrons).
  - The $\Delta\phi$ cut seems to remove more events than you would expect. Is this true?
    - NO. Using the efficiency of the $\Delta\phi$ cut for signal (W's) and background, and the predicted amount of background in each jet multiplicity bin, we can predict how many events should pass the $\Delta\phi$ cut. Things are as expected.

Njet	Obs Muons	Pred Muons	Obs Elec	Pred Elec
1	4474	4469.2	6105	6026.7
2	704	635.1	913	944.0
3	80	92.1	153	162.2
4	22	23.7	53	52.8

Questions from Preblessing

- The Jet Et scale systematic looks large. Split out effects.
  - To make sure we are doing this correctly, we have exchanged extensive emails with te jet corrections group (Anwar and Beate)
  - The dominant effects come from the Relative, Scale and Absolute corrections. True in both the 3 and the 4 jets samples.
  - These dominant effects all contribute about equally to the final results of approximately 30%.

Questions from Preblessing

- KS Test for goodness of fit looks flawed.
  - It was flawed. We fixed this by using pseudo-experiments (PEs), following the suggestion of Igor Volobouev. We compared the KS distance observed in our data fit to that expected from PEs using the fitted mix of signal plus background. See tables later in talk. Conclusions reached previously still hold: fits look poor in W+1 jet, but look good in W+2 and W+3 jet cases.

- Fit questions:
  - Let the QCD float: Done, answer hardly changes.
  - Remove ttbar from signal fits: Done: KS goodness of fit indicates poorer fit without ttbar in both 3 and 4 jet cases.

Questions from Preblessing

- Add a systematic for MET vs ISO
  - Done. Used method for W->enu cross section.

- Add a systematic for Q**2
  - Done. Used ALPGEN Mw**2 (instead of default Mw**2+Sum(Pt**2)).
    - A large effect in the W+>3 jet bvin (14% systematic), much smaller in the W+>=4 jet bin (0.31%). Expected fraction of ttbar is approximately twice as large in >=4 jet sample.

- Smear Jet Et's.
  - Did not do this for lack of time. Remember that the comparisons of Ht, Et(jet 1,2,3), Met, etc look good in the W+2,3 jet bins with the default MC, and we include a substantial systematic for th Jet Et scale already. However, we will investigate this in the near future.

Changes Since Preblessing

List of improvements

Changes affecting fit results:

- Full *final* good run list used (added 2 pb^{-1})
- Fix typo in curvature correction
- Include all the EWK backgrounds in the shape for fit

Cross Checks:

- Use modified KS test to compare data to MC
- Correct MET v. Iso for W-like events, obtain normalization systematic
- Divide jet correction systematic into components
- Estimate the uncertainty due to Q^2 scale
- Estimate the shape uncertainty due to PDFs

We have a document detailing answers to questions raised during preblessing. Answers are also included throughout updated **CDF6206**

Measurement Approach

Measure top cross section using kinematic and event shape variables to discriminate ttbar from background

- Initially: use a single variable to fit data to W+jets, QCD, and ttbar. H_T is our main discriminator but have examined others.
- Eventually: More sophisticated method using multivariate techniques and neural networks.

Determine the tt fraction, then extract the top cross section

Key Analysis Components

- Determine QCD contribution using MET v. isolation
- Validate QCD model, evaluate W+Jets backgrounds
- Fit signal region for W+≥3 Jet and W+≥4 Jet events
- Determine systematic errors using pseudo experiments
- Extract the top cross section

Data and MC Samples

Data: Standard lepton sample from Evelyn

- Backgrounds:
  - –W+Jets Monte Carlo: ALPGEN W+n parton
  - –QCD
    - Non-isolated (I>0.2) electrons/muons
    - Aside from isolation, cuts the same (MET, lepton ID, N jets)
- Top
  - –Pythia MC (175)
  - –Herwig MC (175): systematic
  - –Systematic studies use Pythia for ISR and top mass (170,180GeV/c^2) studies

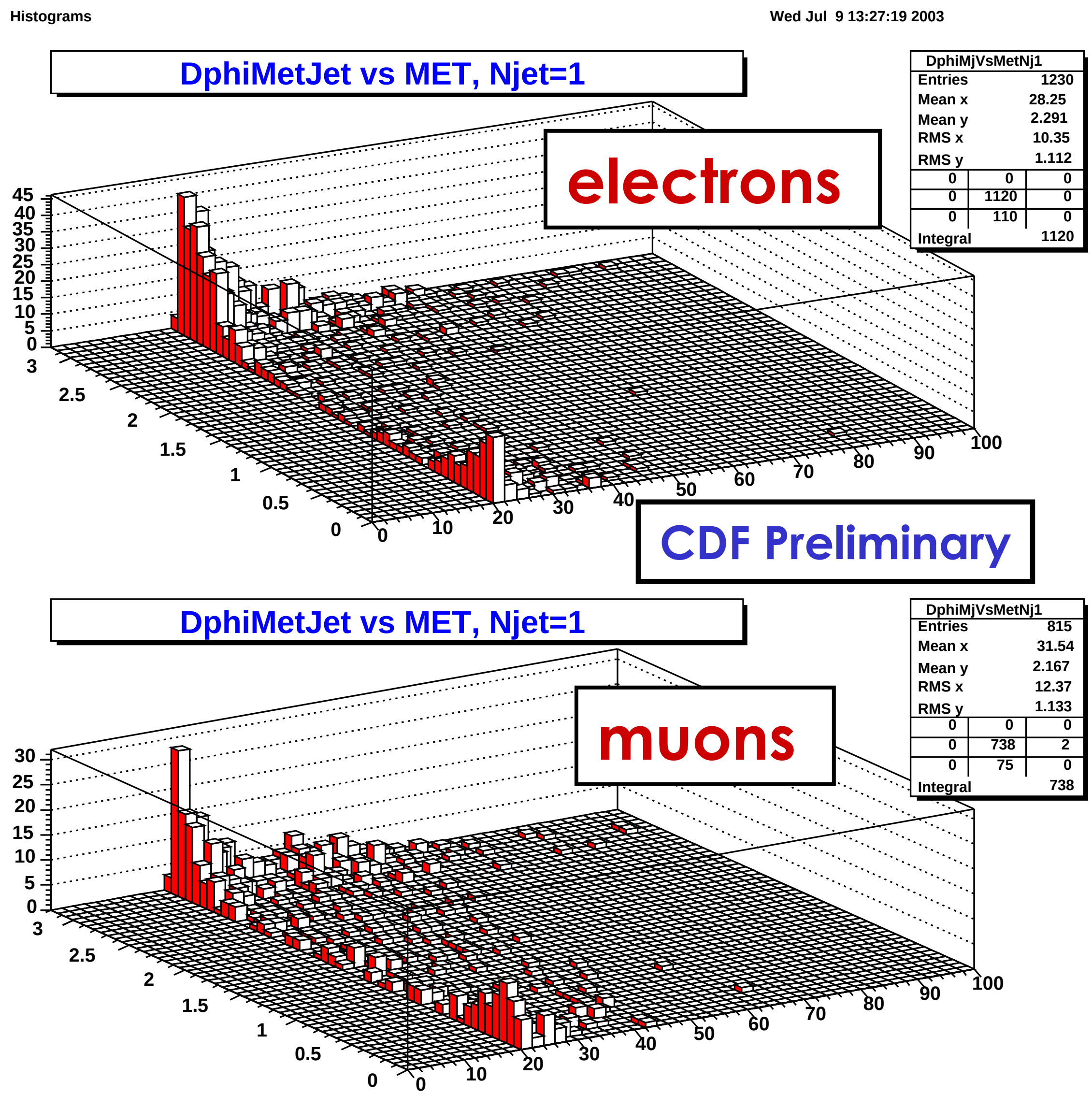
Event Selection

- Require good run and CEM, CMUP, CMX trigger path
- Lepton ID requirements: Standard (CDF Note 6574)
- Require "N" reconstructed jets with:
  - Corrected E_T > 15.0 GeV
  - $|$Detector $\eta|$ < 2.0
- Require event MET >20.0 GeV (after corrections)
- If 20.0 < MET < 30.0 GeV, also require:
  - 0.5 < $\Delta\phi$ (MET-Leading Jet) < 2.5
- Signal Samples: $\geq$3 Jets and $\geq$4 Jets
  - Will also investigate 3 (only) Jets sample

Δϕ v. MET for non-isolated leptons

Δϕ between MET and lead jet, 1 Jet Data

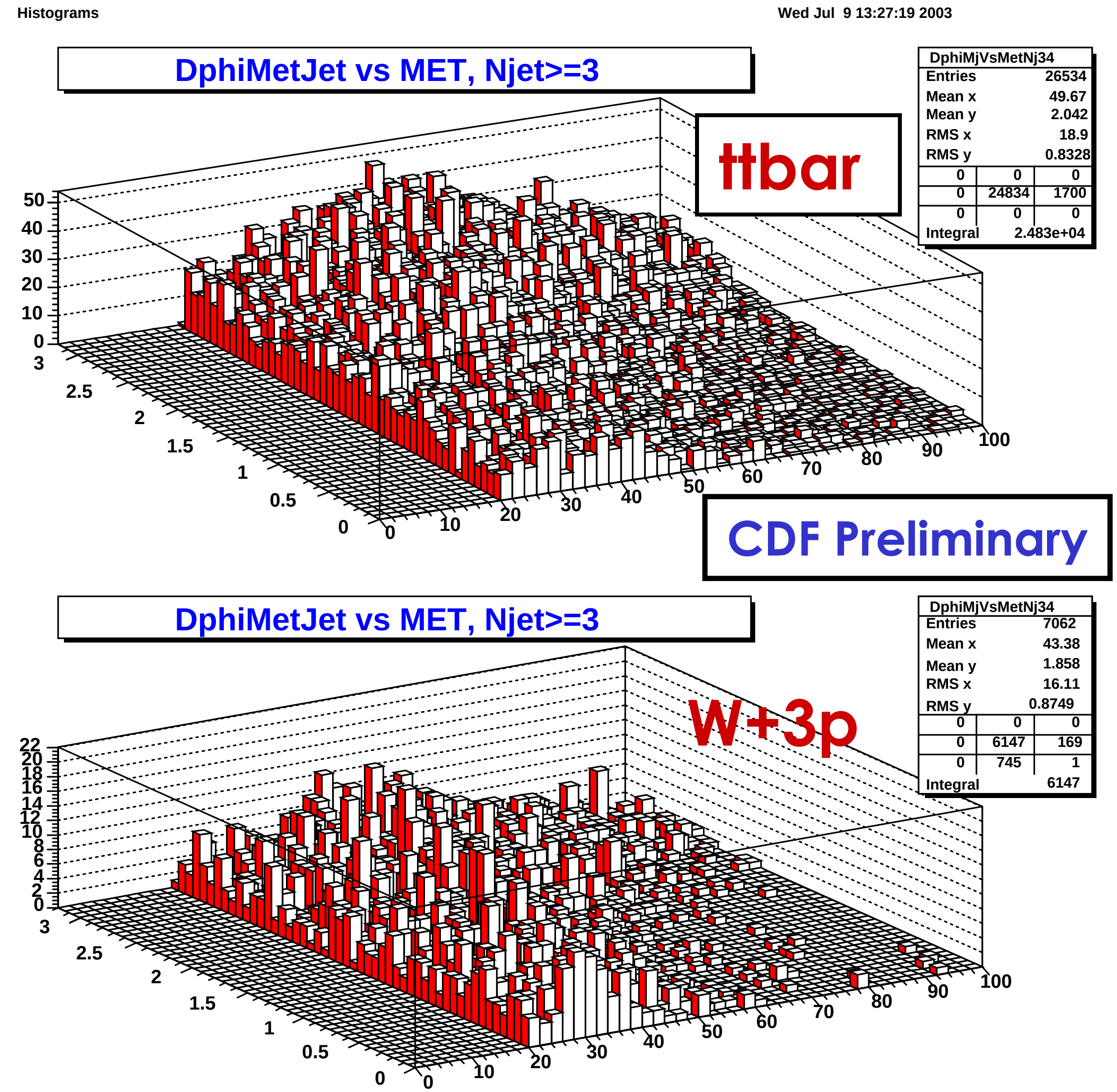
For Blessing



$\Delta\phi$ v. MET ttbar and W+jets MC

$\Delta\phi$ between MET and lead jet, $\geq$3 Jet events, W+3p and tt MC

For Blessing



Sensitivity to $\Delta\phi$ Cut

Use PE's to determine the utility of the $\Delta\phi$ cut as well as the sensitivity to it.

- This cut reduces our background by ~factor of 2
- Does it help statistical precision?
- Does it help systematic?
  - We have two models for background: non-isolated leptons and conversions
  - Sample from one, and fit using the other to set the systematic.

Sensitivity to and Utility of $\Delta\phi$ Cut

→ PE's indicate this is an efficient cut choice ←

Sample	Observed Data Events (no trigger req.)	Expected ttbar events (7pb xsec)	Expected Precision on Fit fraction (stat only)	Relative shift of ttbar fraction
W+≥3, no $\Delta\phi$ cut	391	71	28 ± 8 %	32%
W+≥3, with $\Delta\phi$ cut	346 (predicted)	67	28 ± 8 %	16%

For Blessing

Including the $\Delta\phi$ cut in event selection…

- **Has no impact on the expected statistical precision**
- **Reduces the systematic effect due to poor background modeling by ~factor of 2.**

Observed/Expected Event Yield

For Blessing

Jets	Data Electrons	Data Muons	Data Total	$t\bar{t}$ Fraction	$t\bar{t}$ Events
0	59655	44737	101663	0.2%	0.2
1	6105	4474	10359	4.0%	3.4
2	913	704	1600	18.5%	16.1
3	153	80	234	34.5%	29.7
4	39	18	57	32.0%	27.6
≥5	14	3	17	10.6%	9.1

Expected QCD Background Fraction

W+"n" jets	Electron bkgnd	Muon bkgnd	Total bkgnd
1	3.8 ± 0.2%	2.9± 0.2%	3.4 ± 0.3%
2	6.1 ± 0.5 %	2.0 ± 0.2%	4.3 ± 0.5%
≥3	7.7 ± 1.4 %	3.1 ± 0.9%	6.3 ± 1.7%

For Blessing

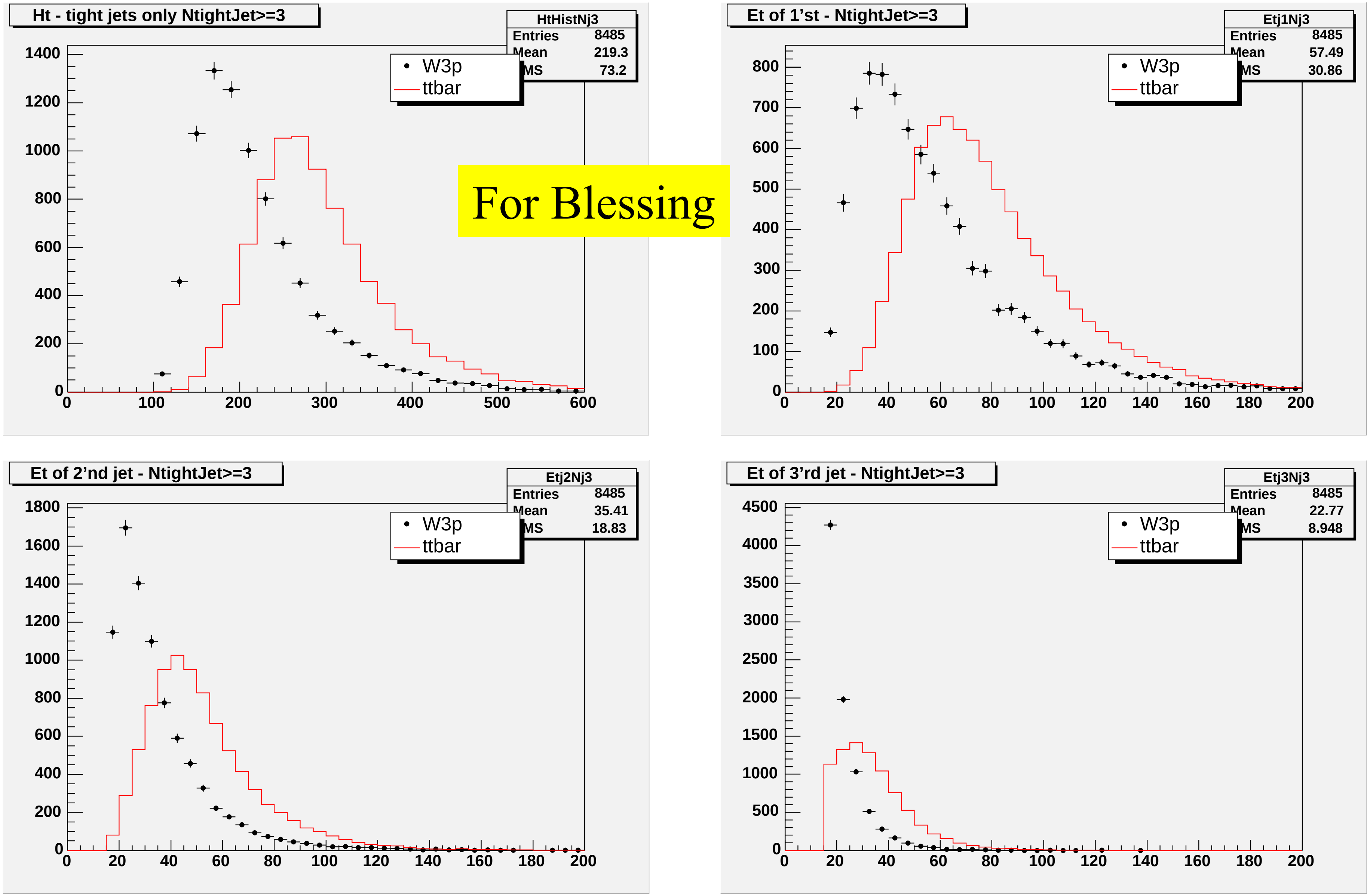
Determine QCD background normalization using MET vs Isolation

Discriminating Variables

- **Use a single input neural network to discriminate ttbar from W+jets.**
- **Table: % of correct classifications possible using each variable.**
- **E.g: For E_T of the 3rd leading jet, its possible to correctly classify 74.4% of a sample of W+jets and ttbar. For sphericity, only 60% can be correctly classified.**
- **Many variables were studied. Shown are just the best E_T based and shape-based variables.**

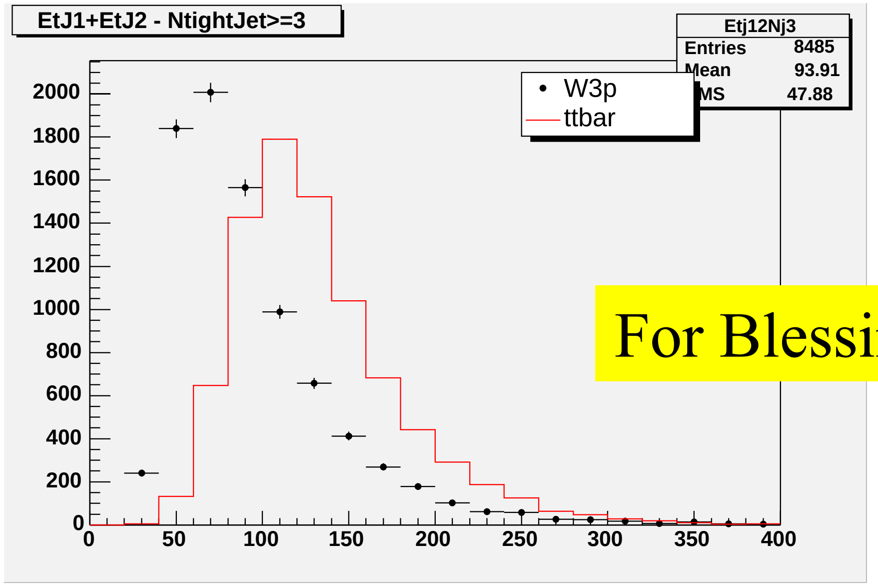
	HERWIG tt ALPGEN W+jets	PYTHIA tt ALPGEN W+jets
E_T(jet 3)	74.4 ± 0.5	73.7 ± 0.5
H_T	73.9 ± 0.5	72.5 ± 0.5
E_T(jet 2 + jet 3)	73.9 ± 0.5	73.4 ± 0.5
E_T(jet 2)	73.7 ± 0.5	71.8 ± 0.5
min(m_{jj})	72.3 ± 0.6	71.0 ± 0.6
E_T(jet 1 + jet 2)	71.0 ± 0.6	71.0 ± 0.6
event inv. mass	70.8 ± 0.6	70.1 ± 0.6
E_T(jet 4)	69.4 ± 0.6	69.5 ± 0.6
E_T(jet 1)	67.7 ± 0.6	67.1 ± 0.6
sum dijet mass	66.6 ± 0.6	64.9 ± 0.6
$\Sigma E_z/\Sigma E_T$	63.3 ± 0.6	64.0 ± 0.6
aplanarity	59.2 ± 0.6	60.2 ± 0.6
min jet sep.	60.3 ± 0.6	60.6 ± 0.6
sphericity	60.0 ± 0.6	59.6 ± 0.6
missing E_T	57.7 ± 0.6	55.7 ± 0.6

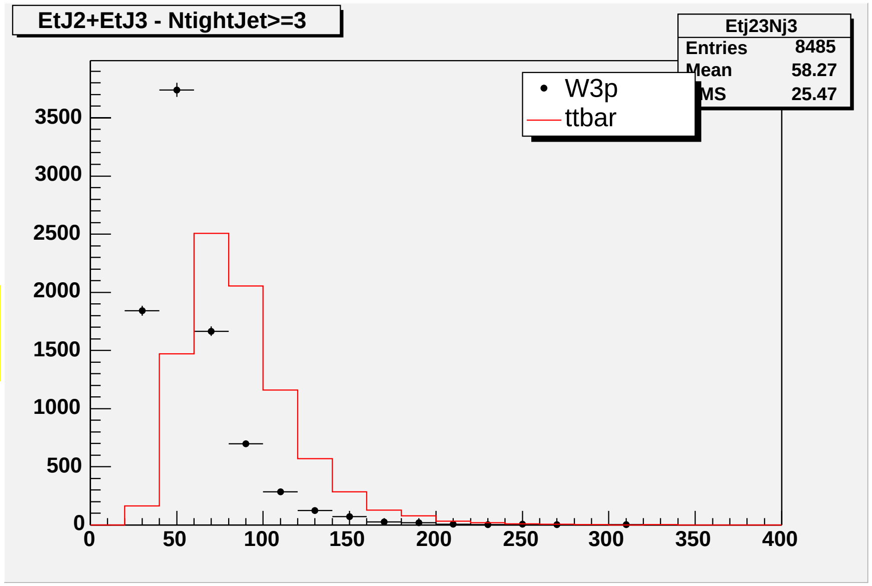
Kinematic Variables: ttbar v. W+3p MC



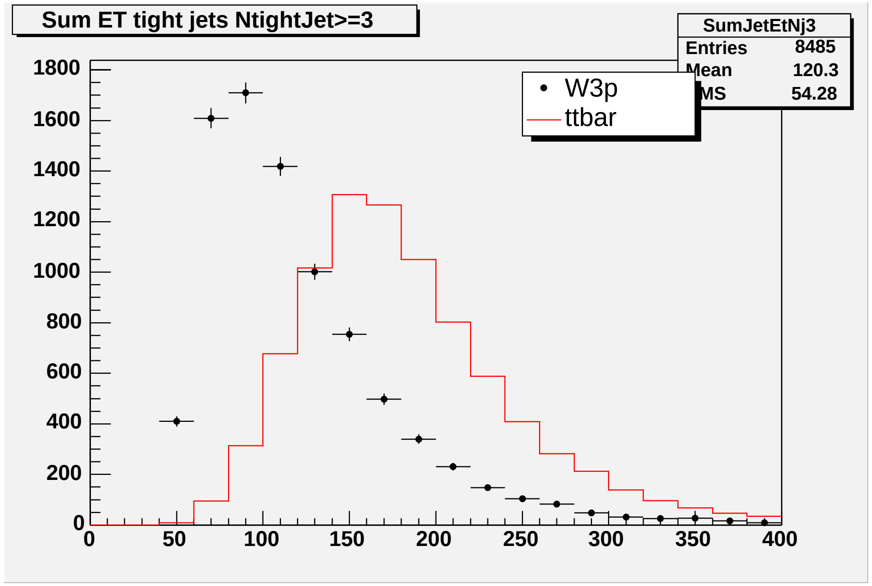
For Blessing

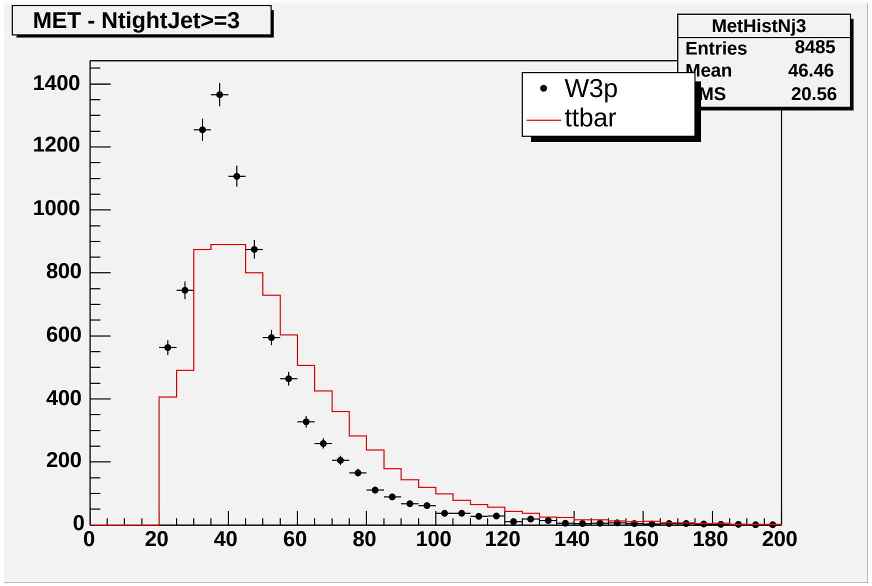
More Kinematics: ttbar v. W+3p MC



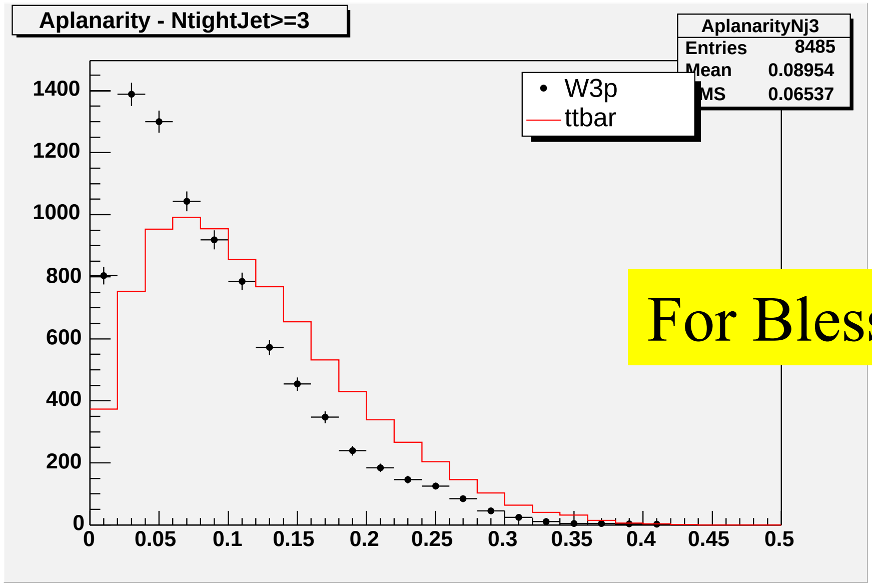


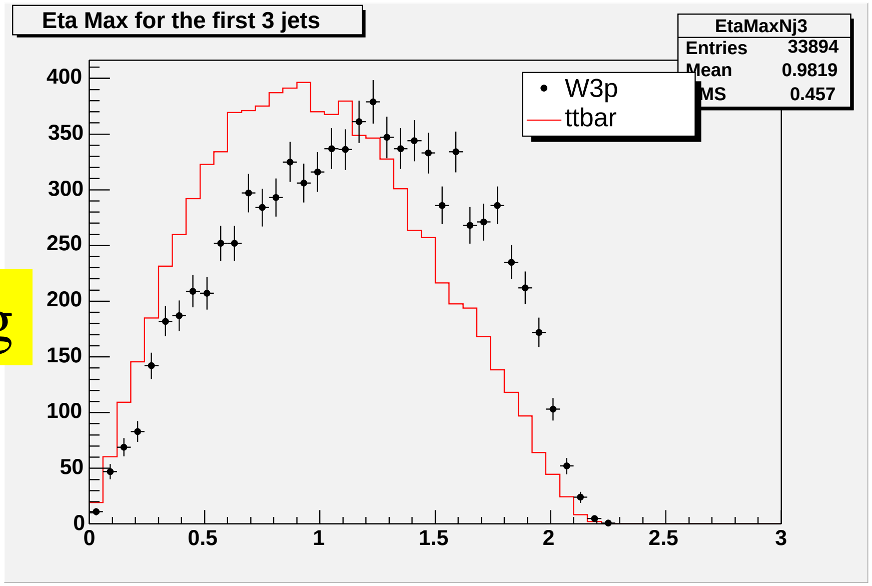
For Blessing



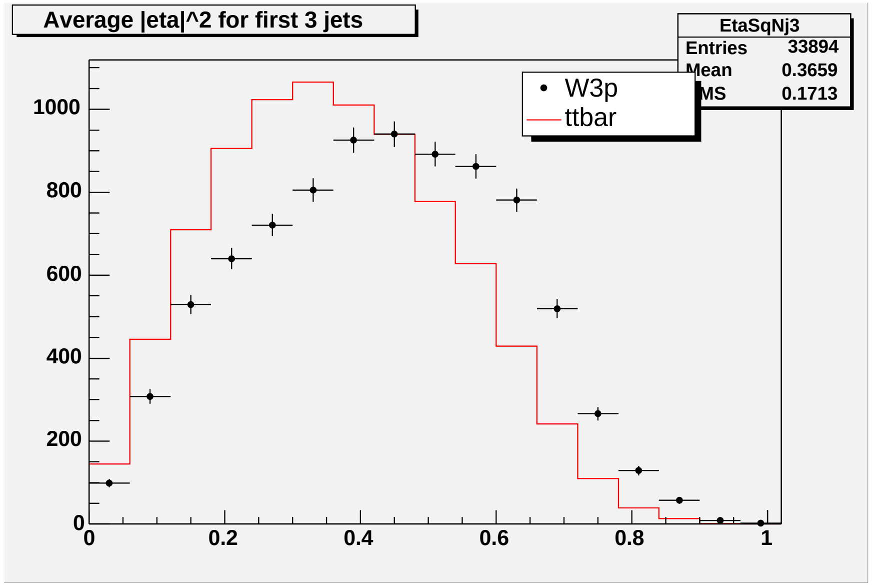


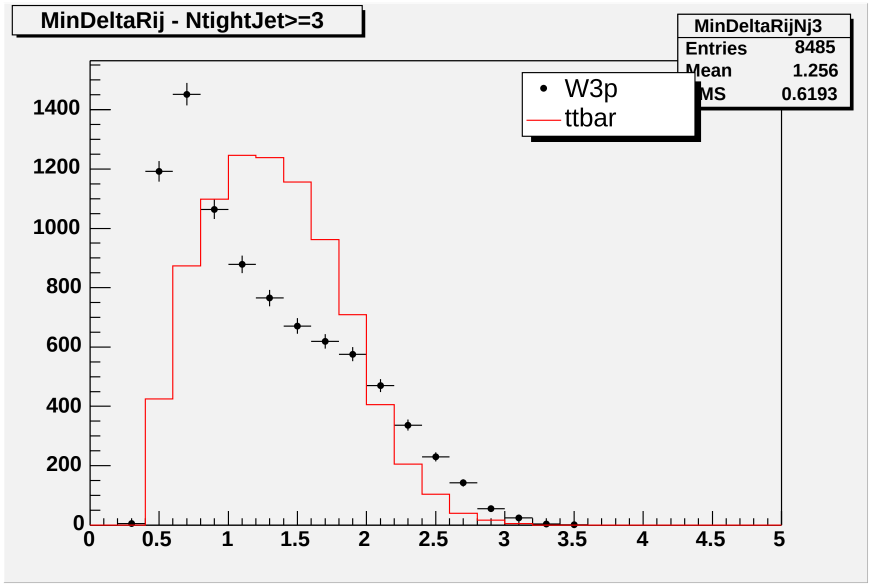
Event Shape Variables: ttbar v. W+3p MC





For Blessing

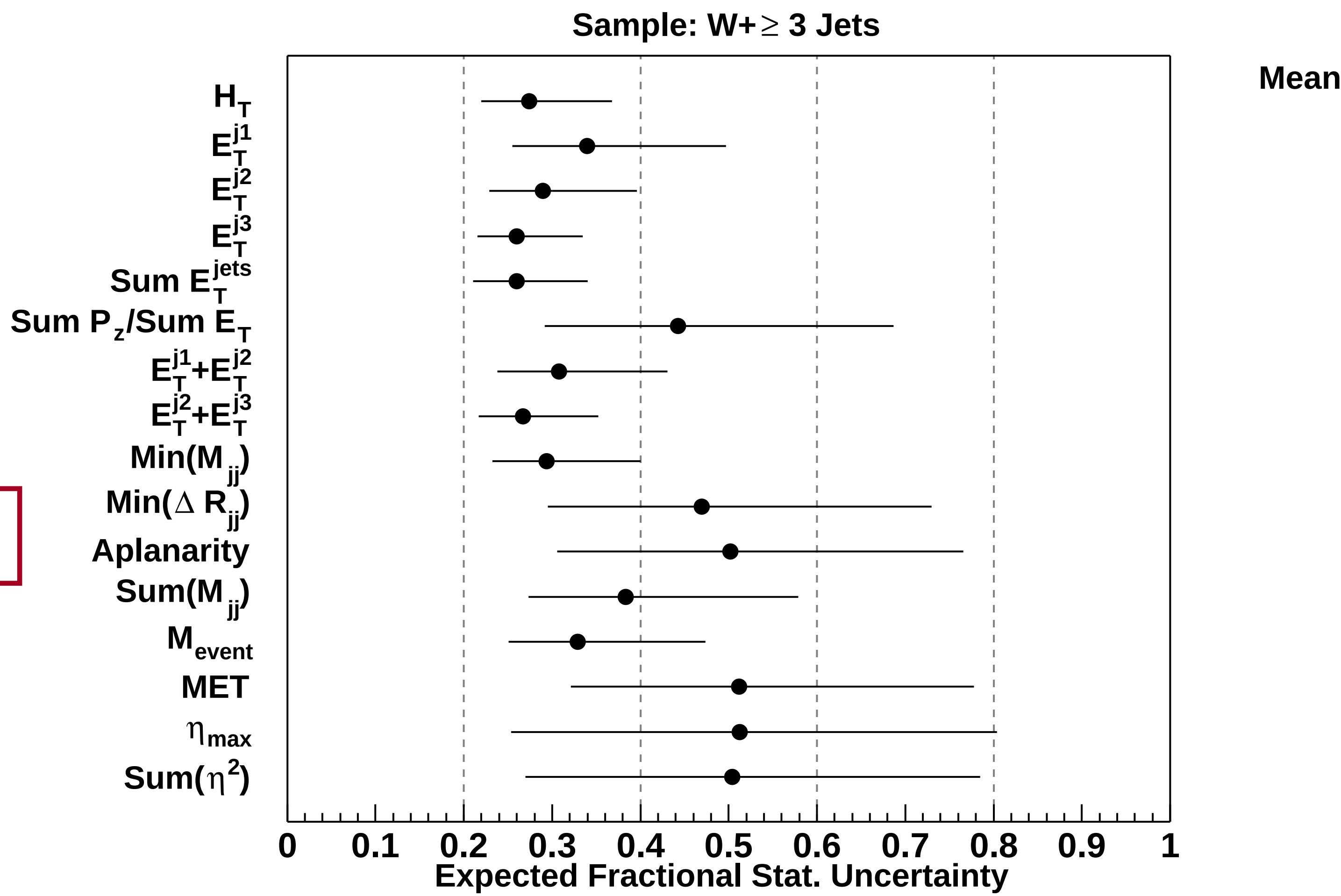




Sensitivity to Various Event Variables

For Blessing

3 or more jets

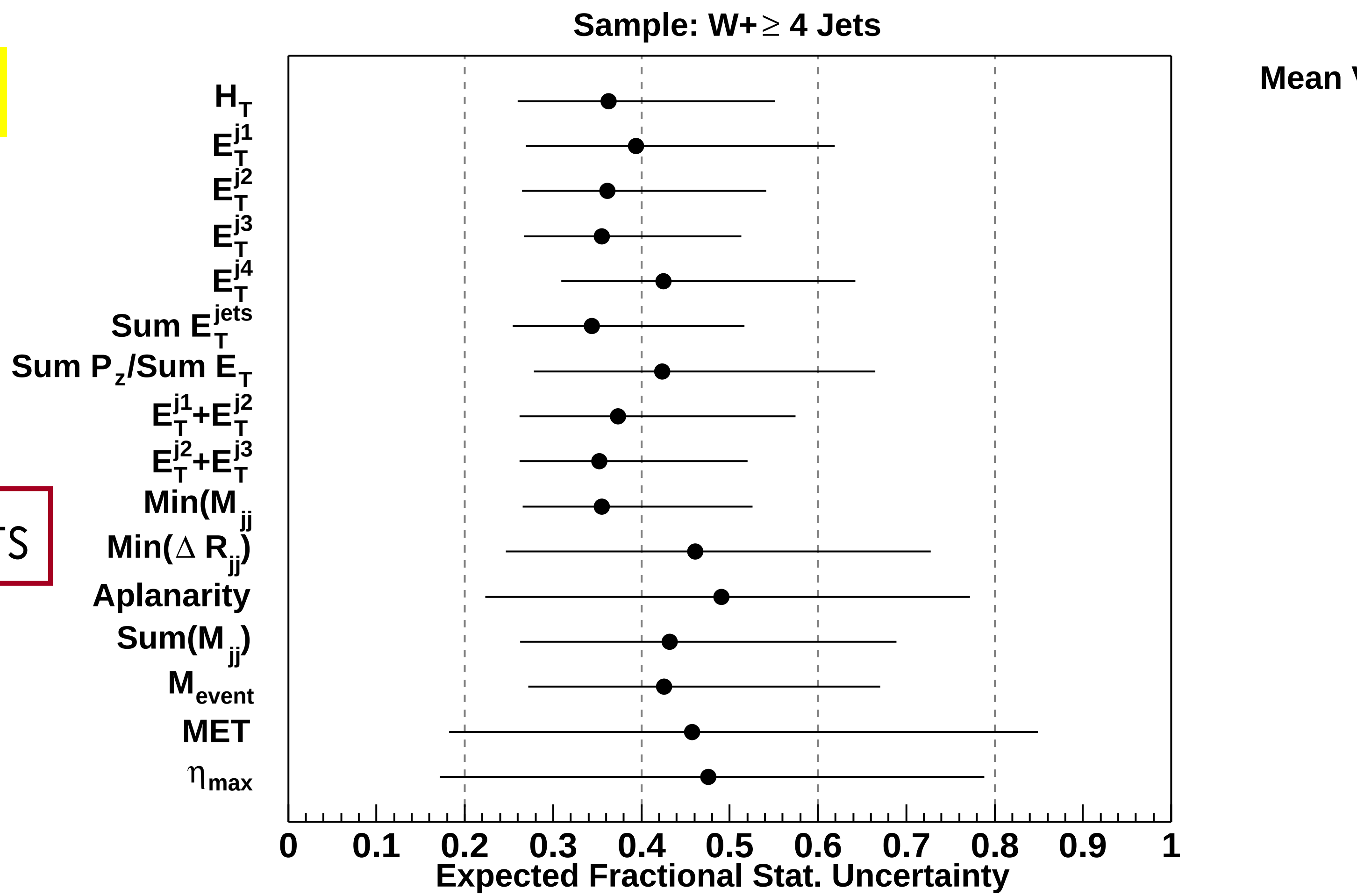


Points are the mean returned uncertainties from fitting the PE's. Error bars represent the 1 sigma range of possible returned uncertainty from the fit.

Sensitivity to Various Event Variables

For Blessing

4 or more jets



Points are the mean returned uncertainties from fitting the PE's. Error bars represent the 1 sigma range of possible returned uncertainty from the fit.

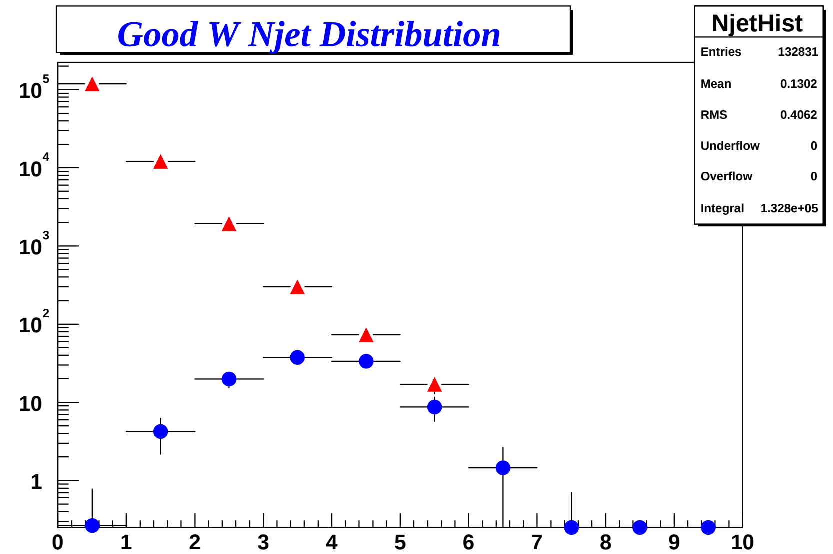
Validating the Background MC

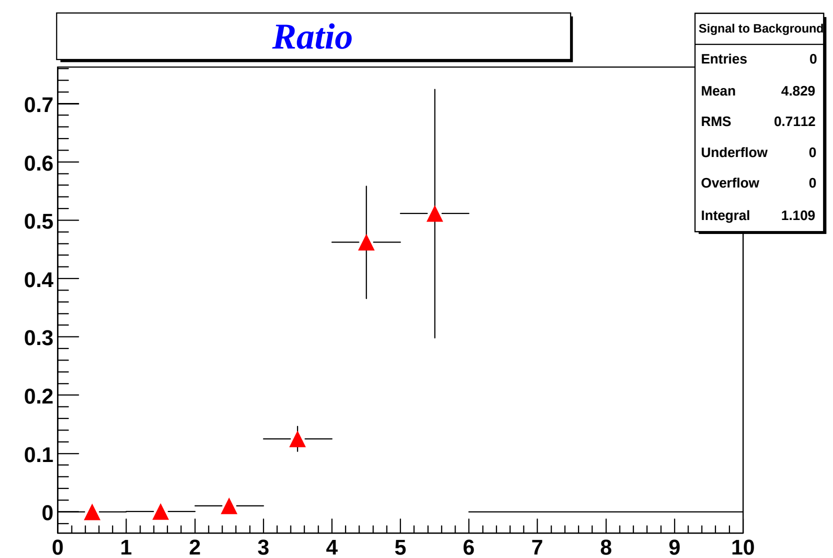
Main background:
W+Jets, modeled by ALPGEN W+n parton Monte Carlo.

→ Validate this MC in a top-depleted region: W+1,2 jet data.

Upper plot: observed W+jets data (red) along with a prediction for the amount of ttbar (blue), as a function of jet multiplicity.

Lower plot: The top/W ratio is about 1:1 in the 4 and 5 jet bins, but only about 12% in the W+3 jet bin.





For Blessing

Testing the Model

- **Use the W+1, 2, and 3 jet data samples to compare to the Monte Carlo.**
- **In the W+1 jet sample we fit using:**
  - **ALPGEN W+1 parton, plus non-isolated leptons**
- **In W+2 jet sample:**
  - **ALPGEN W+2 parton**
- **In the W+3 jet sample, we fit using:**
  - **ALPGEN W+3 parton, Herwig ttbar, plus non-isolated leptons**
- **In the W+$\geq$3 jets and W+$\geq$4 jets fits, the $\Delta\phi$ cut is imposed.**

Data/ MC Comparisons

For Blessing

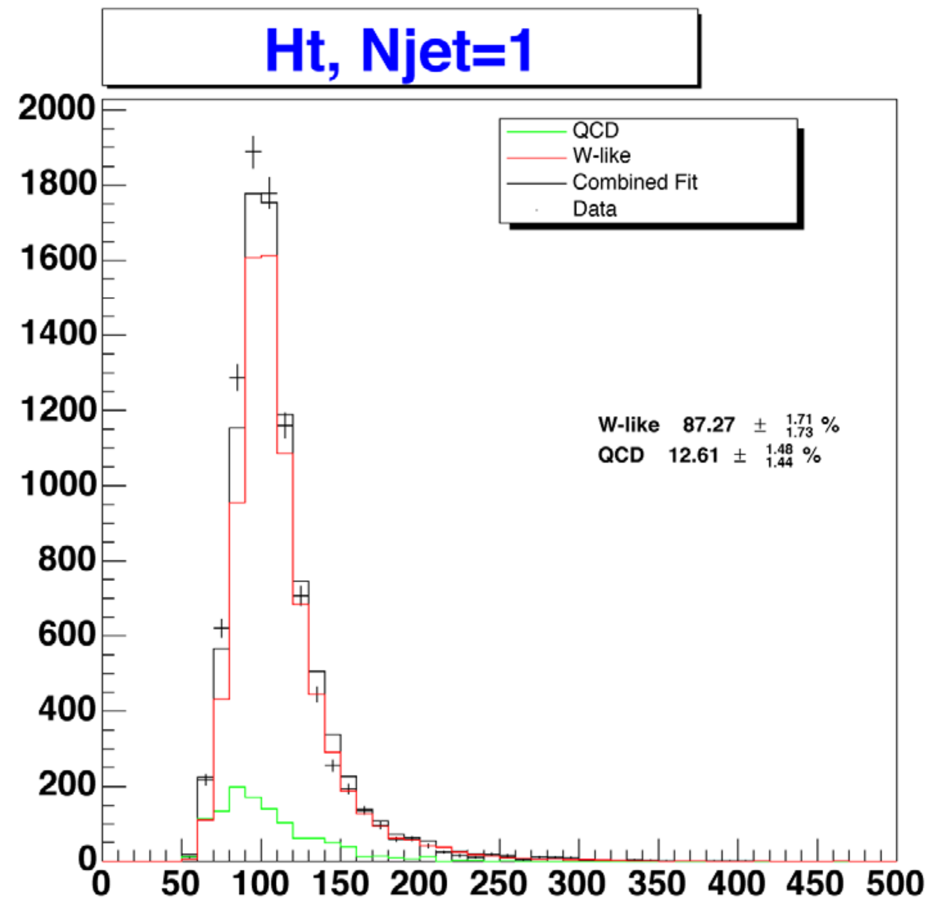
- **Problem: Examining the H_T distribution in the W+1 jet data: the fit undershoots H_T in the low end, and overshoots H_T at the high end.**

How to quantify the difference?

  - **Kolmogorov-Smirnov statistic is biased in ROOT**

- **Modify procedure:**

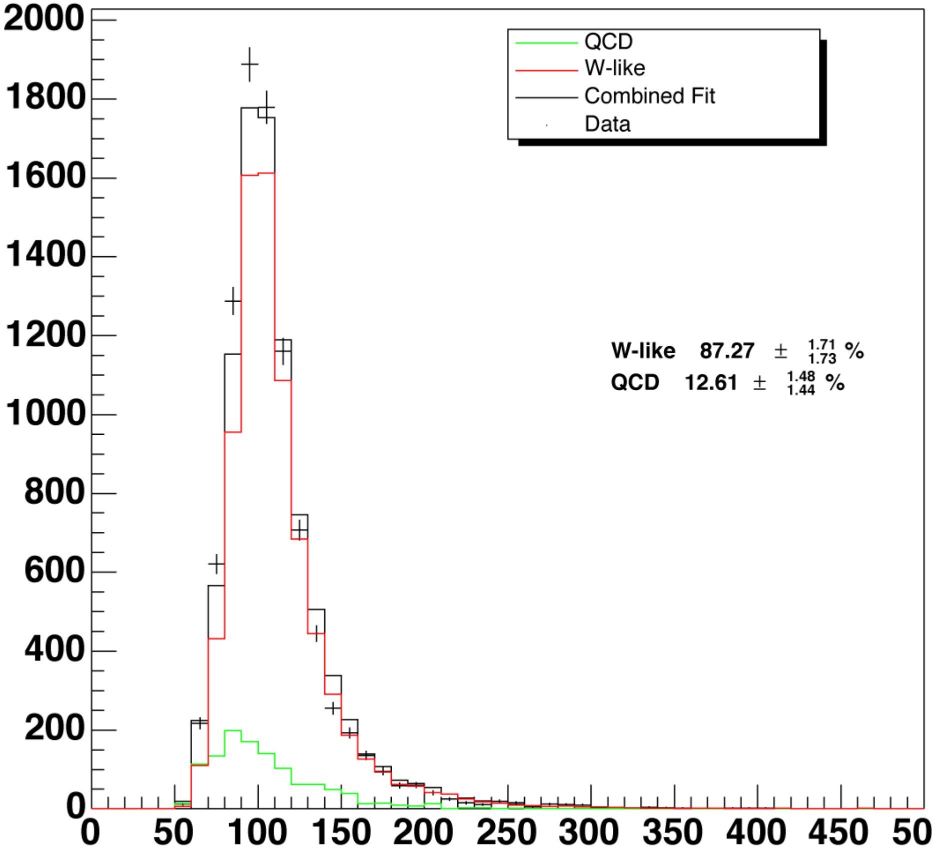
– **Flatten KS distribution using integral distribution.**



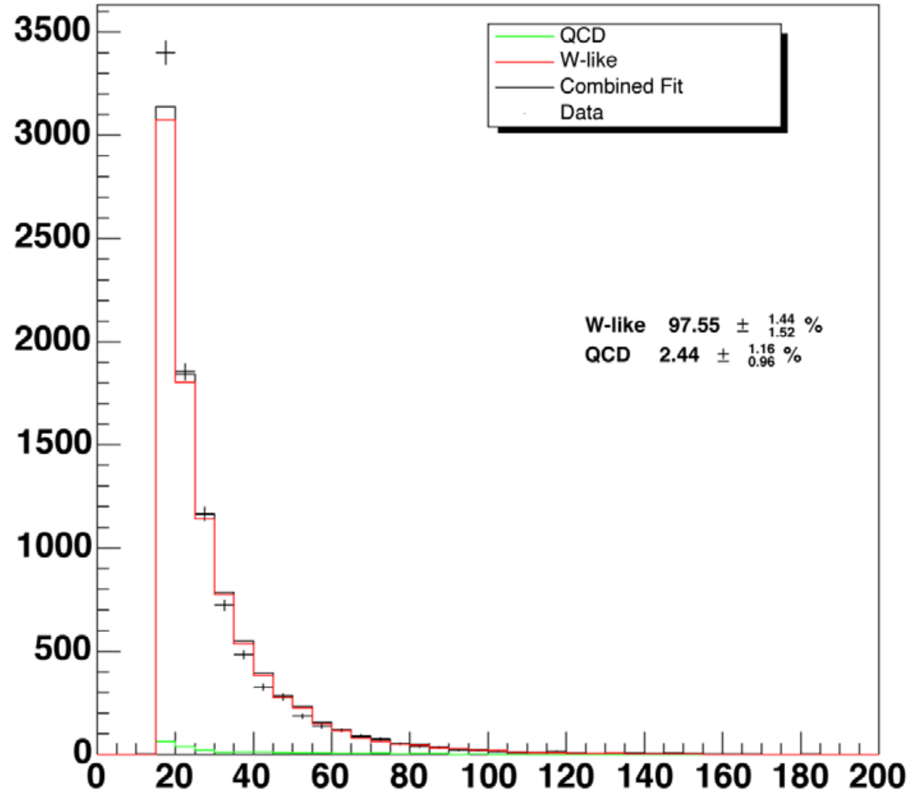
Distributions for 1 Jet Bin

For Blessing

Ht, Njet=1



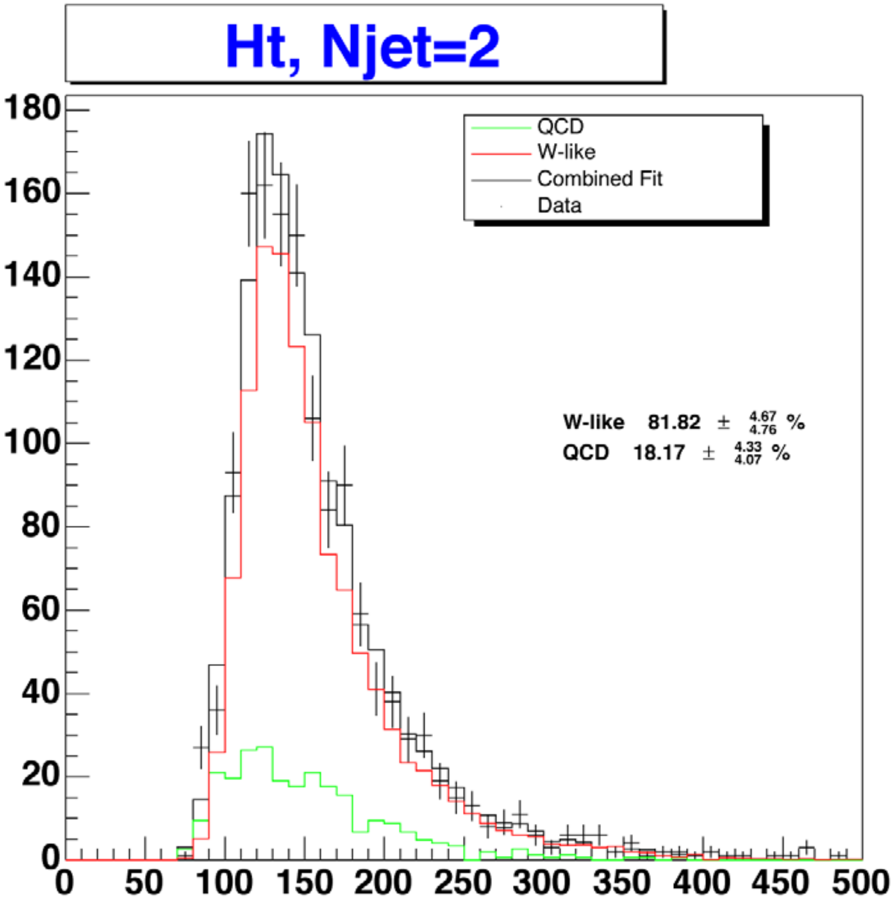
Et of leading jet, Njet=1

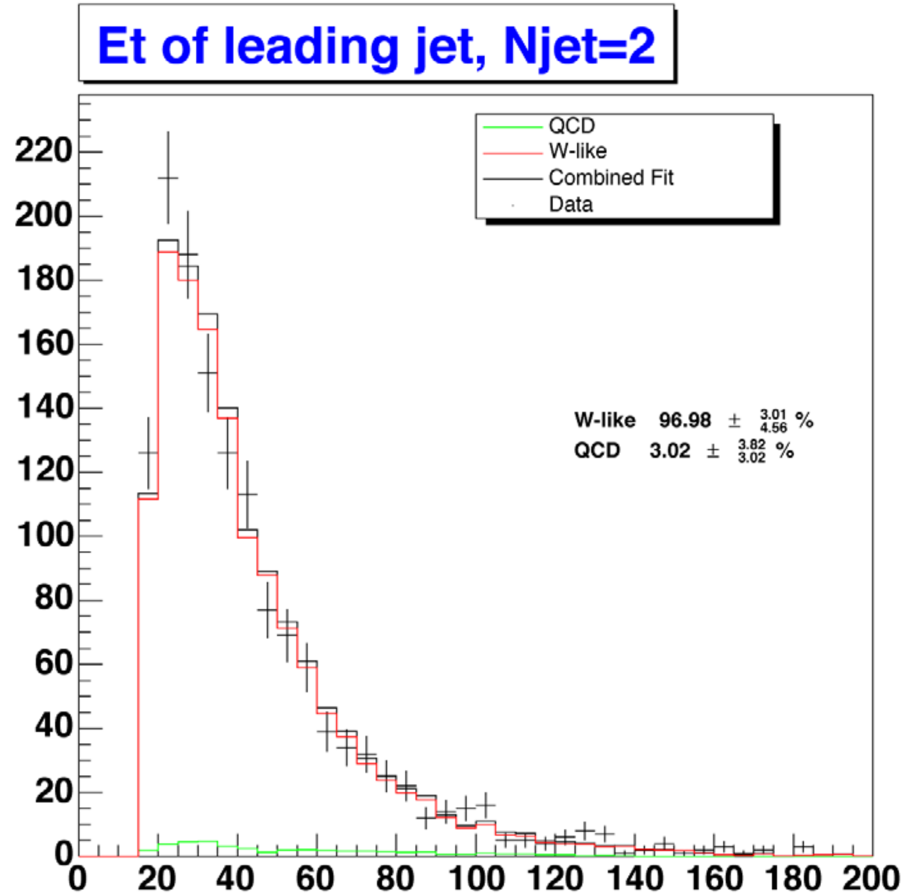


CDF Preliminary

Distributions for 2 Jet Bin

For Blessing

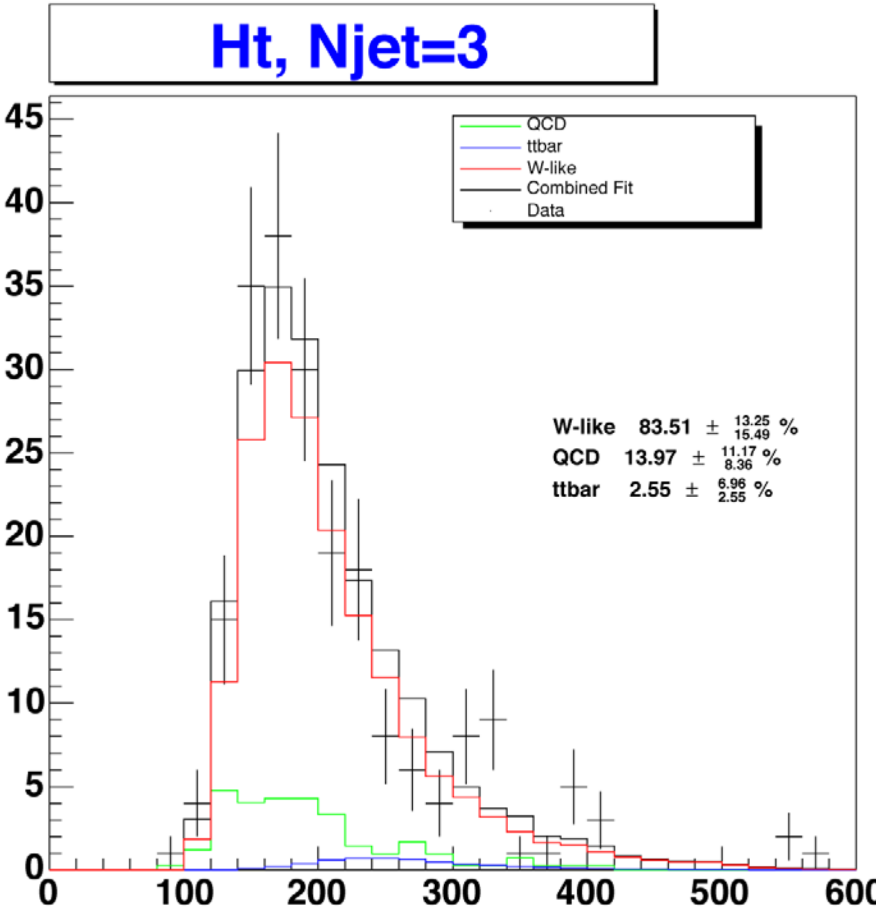


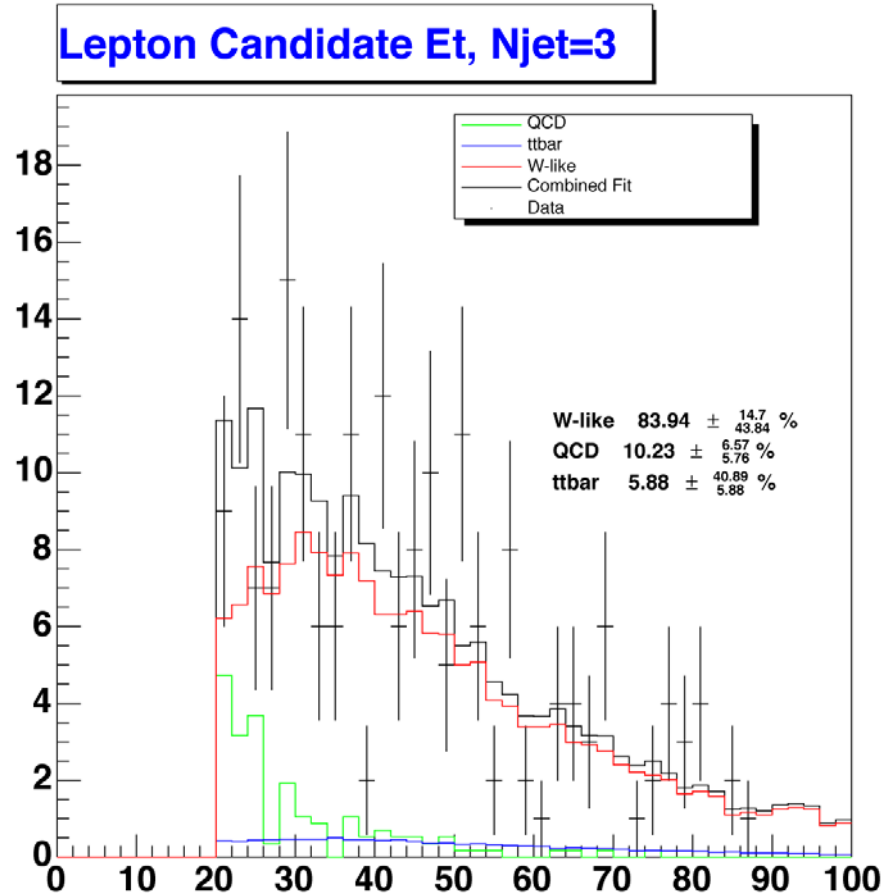


CDF Preliminary

Distributions for 3 Jet Bin

For Blessing





CDF Preliminary

Comparison Results: 1,2,3 Jet Bins

Variable	1 Jet Bin	2 Jet Bin	3 Jet Bin
Ht	0%	42.4%	47.6%
LeptonEt	0%	65.8%	71.4%
MET	0%	24.0%	86.3%
Et Jet 1	11.4%	14.1%	45.1%
Et Jet 2	N/A	90.0 %	98.9%
Et Jet 3	N/A	N/A	74.5%

Results of the modified KS test for a subset of the variables in the W+1, W+2, and W+3 jet bins are shown above. "QCD" Background in these fits is the non-isolated lepton sample.

- Conclusions: While the KS tests shown at preblessing to attempt to quantify agreement between data and MC were skewed, conclusions remain the same:

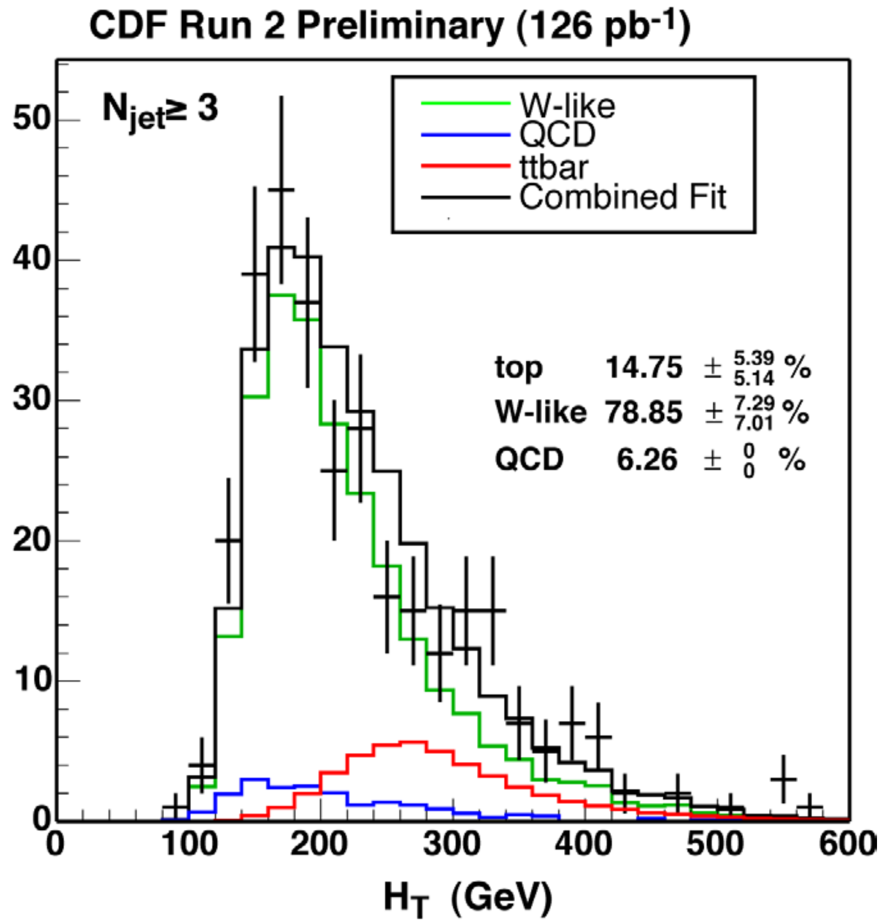
Although the fits look poor in the W+1 jet sample, in the W+2 and W+ 3 jet bins a mixture of W+np MC, ttbar MC, and non-isol leptons describe the data well.

Fitting the Signal Region

Now we fit in the W+≥3 and W+≥4 jet sample:

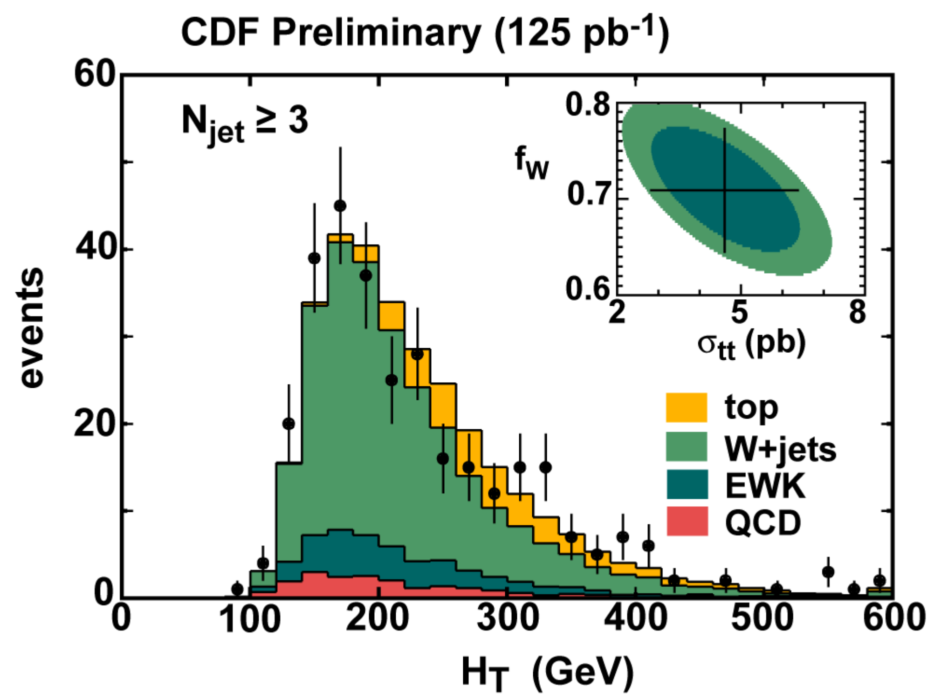
- **The fit uses**
  - Pythia ttbar 175 to model the top contribution (float)
  - ALPGEN W+3p MC to model W+jets for the W+≥3 jet sample (float)
  - ALPGEN W+4p MC to model W+jets for the W+≥4 jet sample (float)
  - non-isolated leptons as the QCD background
- **Fix QCD bkgnd to expectation from MET vs Iso (6.3%)**
- **Other backgrounds in fit: WW+1p, W→τν+2p, Z→ee/μμ/ττ+2p, WZ+0p, Wlνbb+1p, single top.**
  - These bkgnds add to ~11% and have similar shape to W+jets (at least for H_T).
  - We fix this shape within the W+3p shape
- **Our primary variable is H_T, but we investigate the fit fraction stability for the other kinematic variables.**

H_T Fit to Signal Region, ≥3 Jets



For Blessing

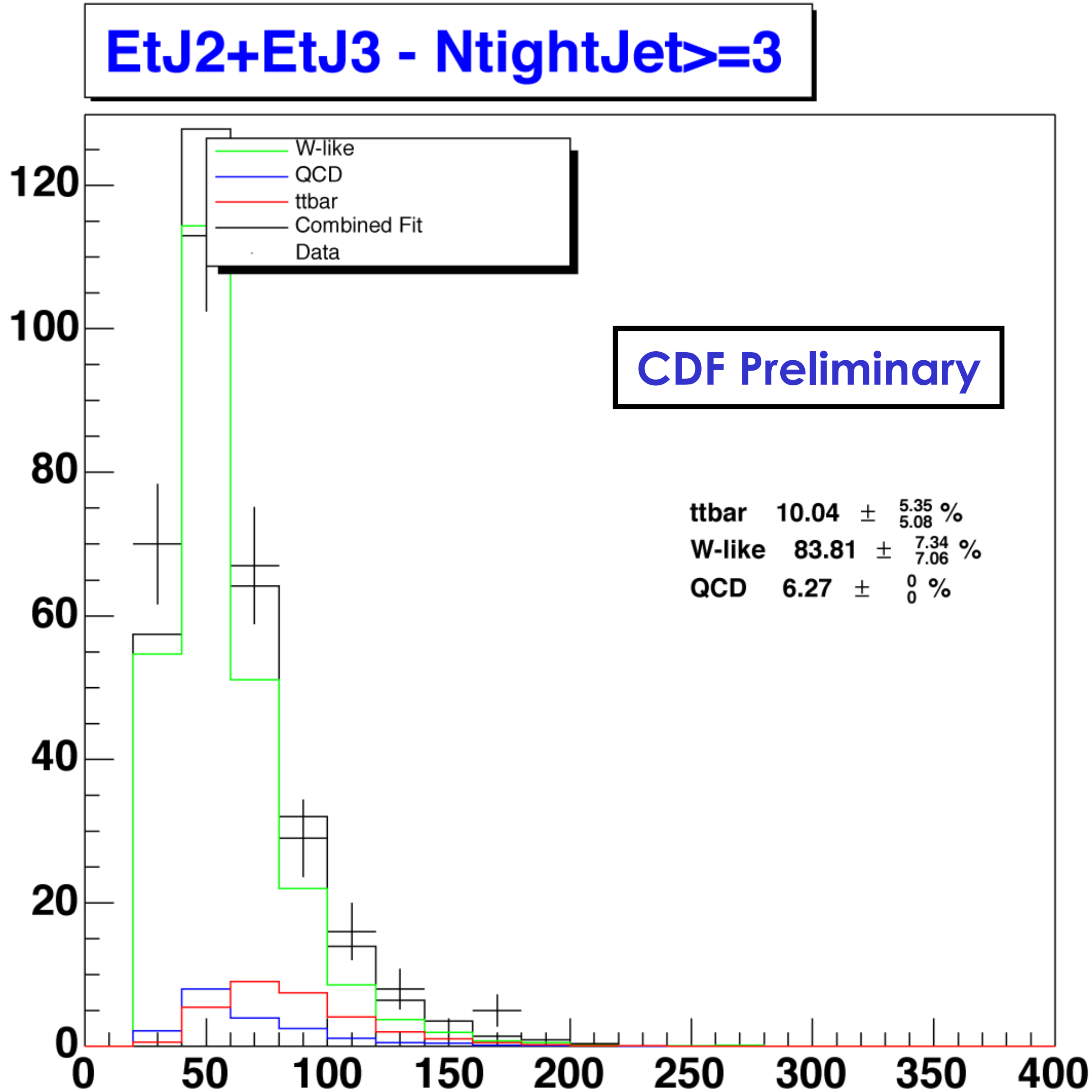
Plot showing stacked conrib-ution from each component



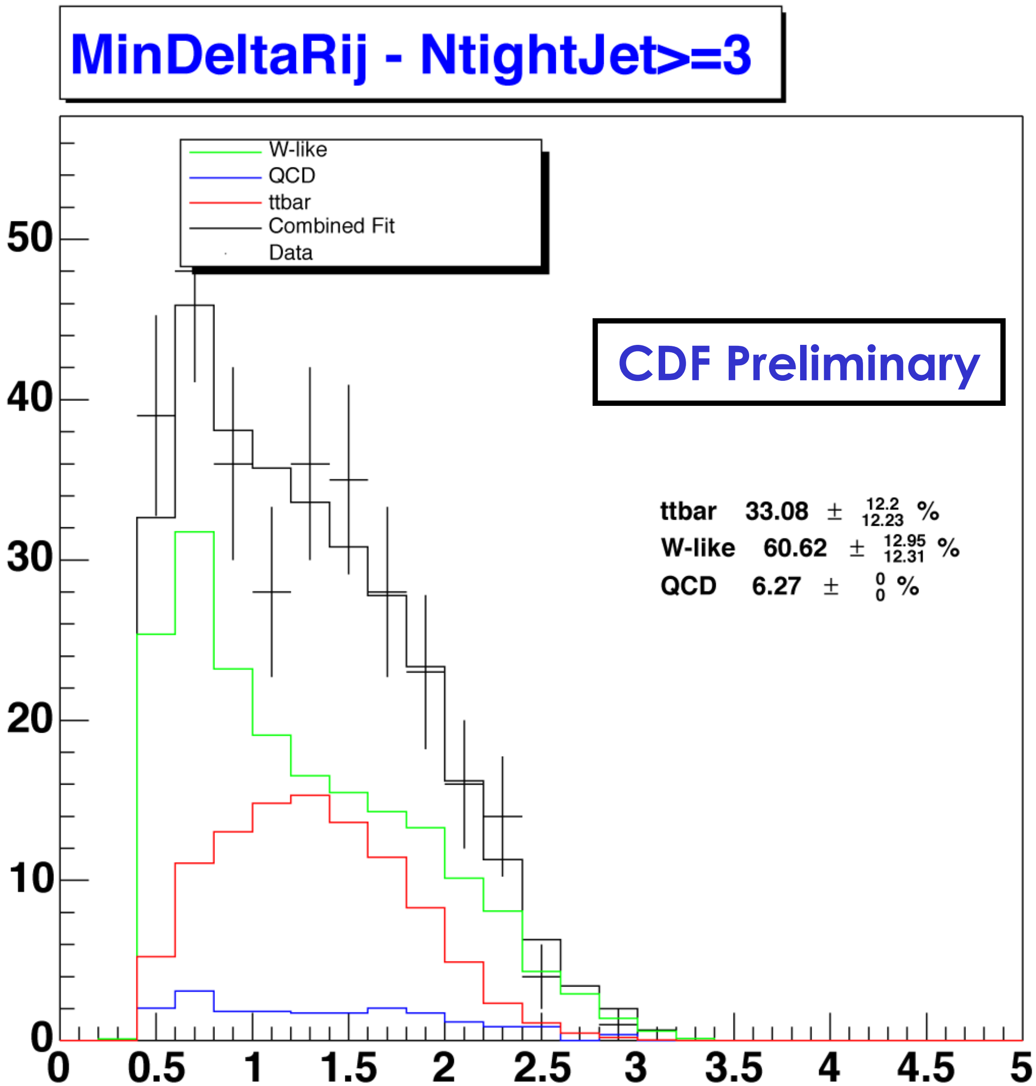
Plot showing shapes of contributing components

ET(2) + ET(3) Fit, ≥3 Jets

For Blessing



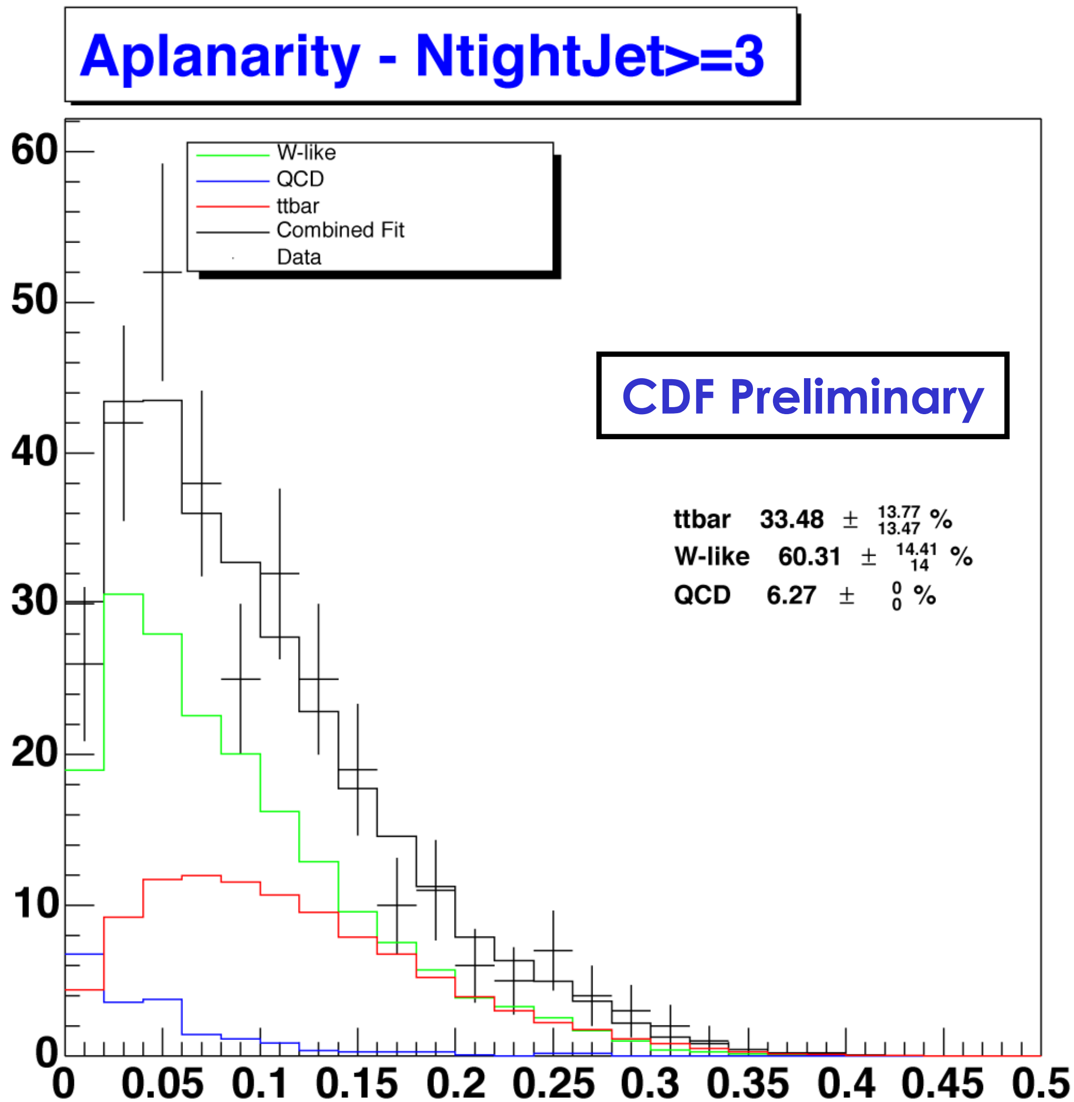
Min(DeltaR jj) Fit, ≥3 Jets



For Blessing

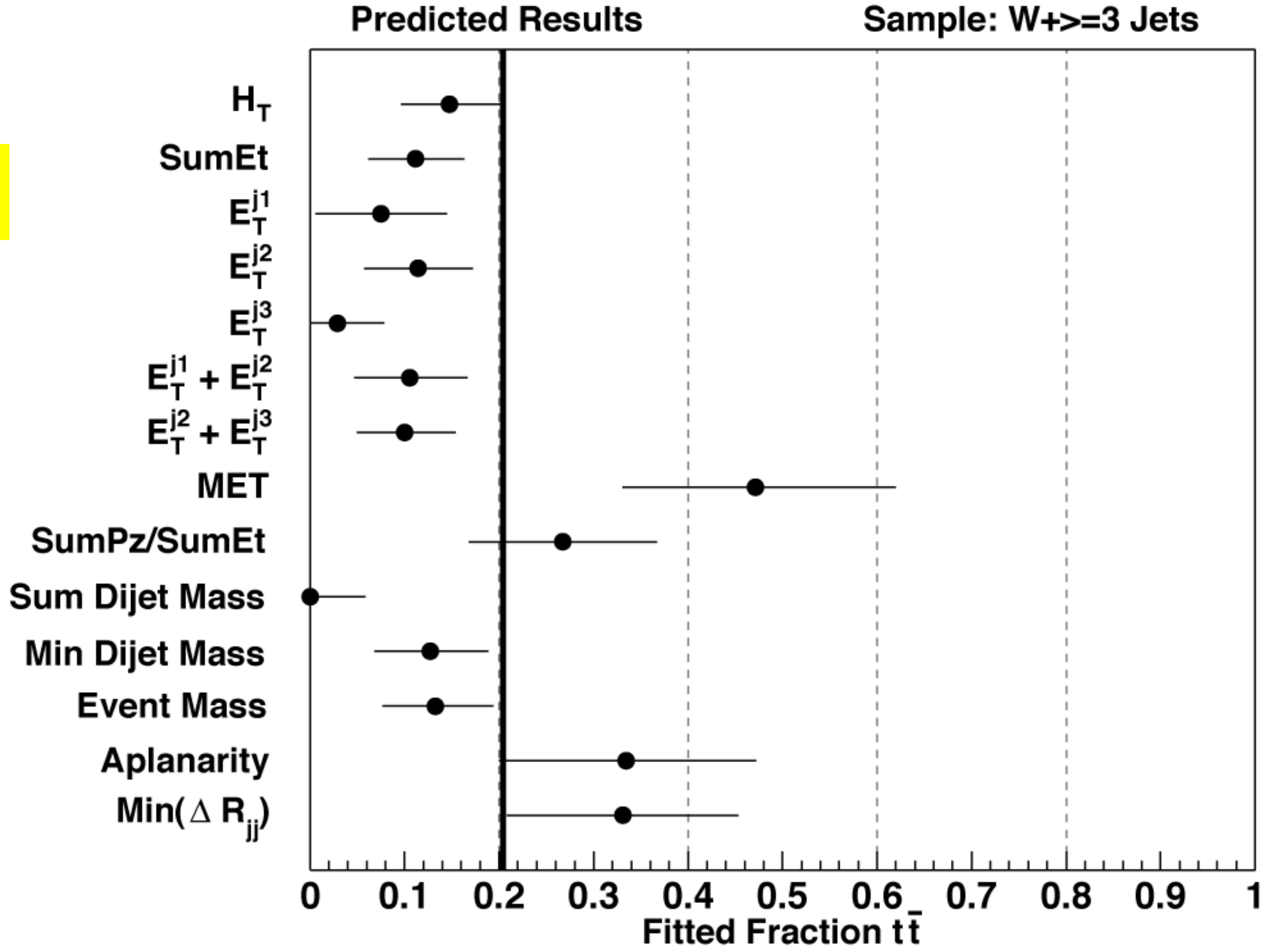
Aplanarity Fit, ≥3 Jets

For Blessing



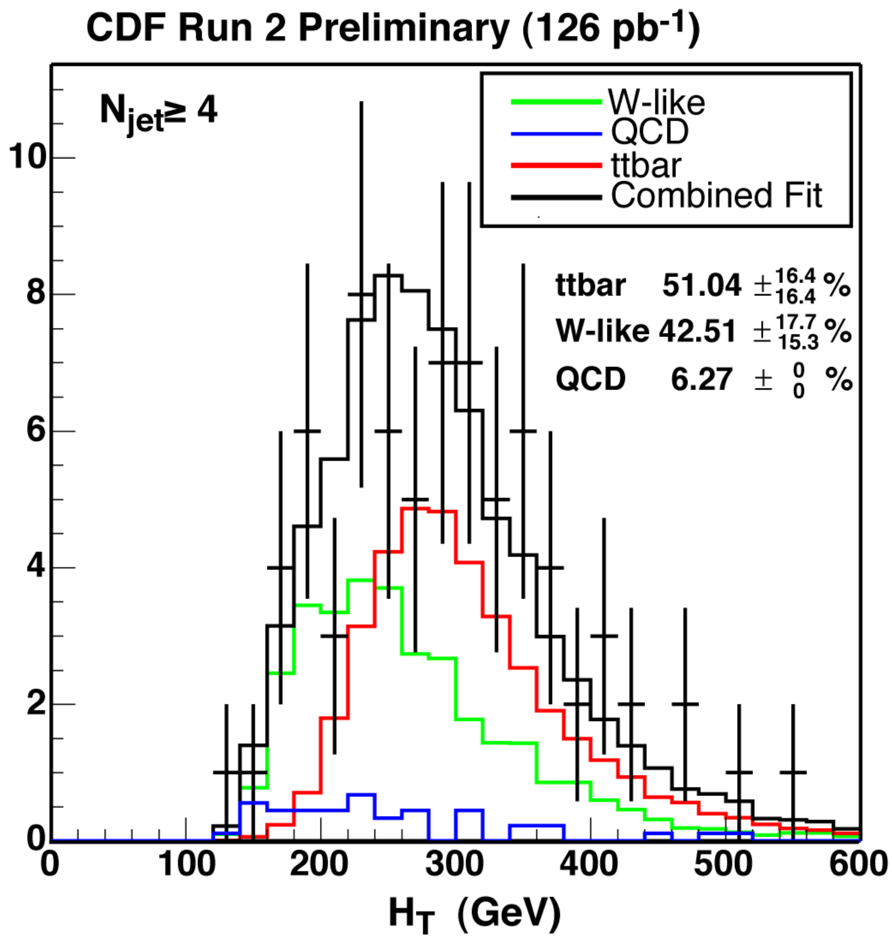
Fit Results for the W+≥3 Jets Sample

For Blessing



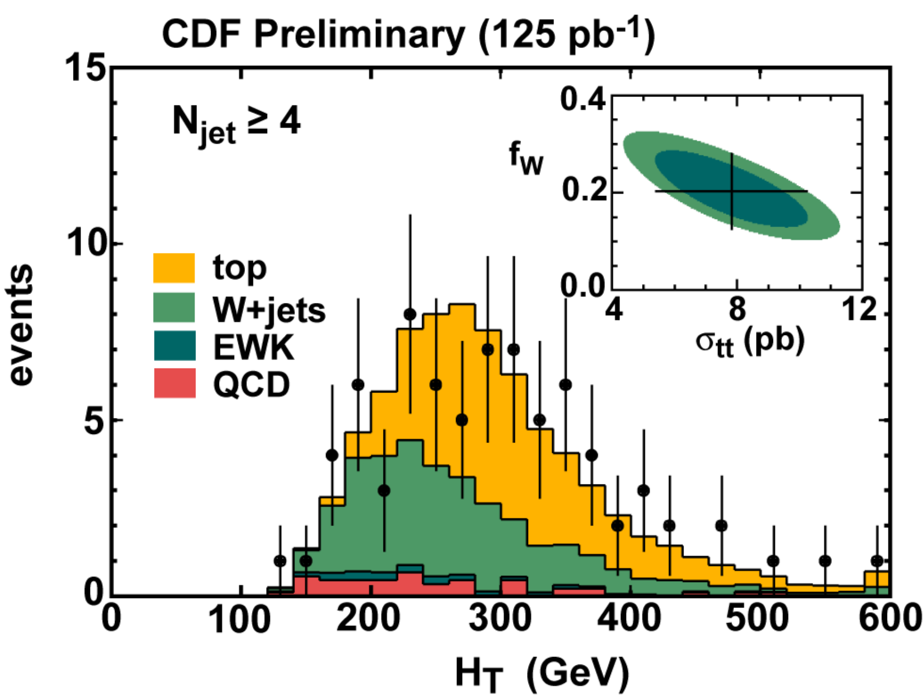
CDF Preliminary

H_T Fit to Signal Region, ≥4 Jets



For Blessing

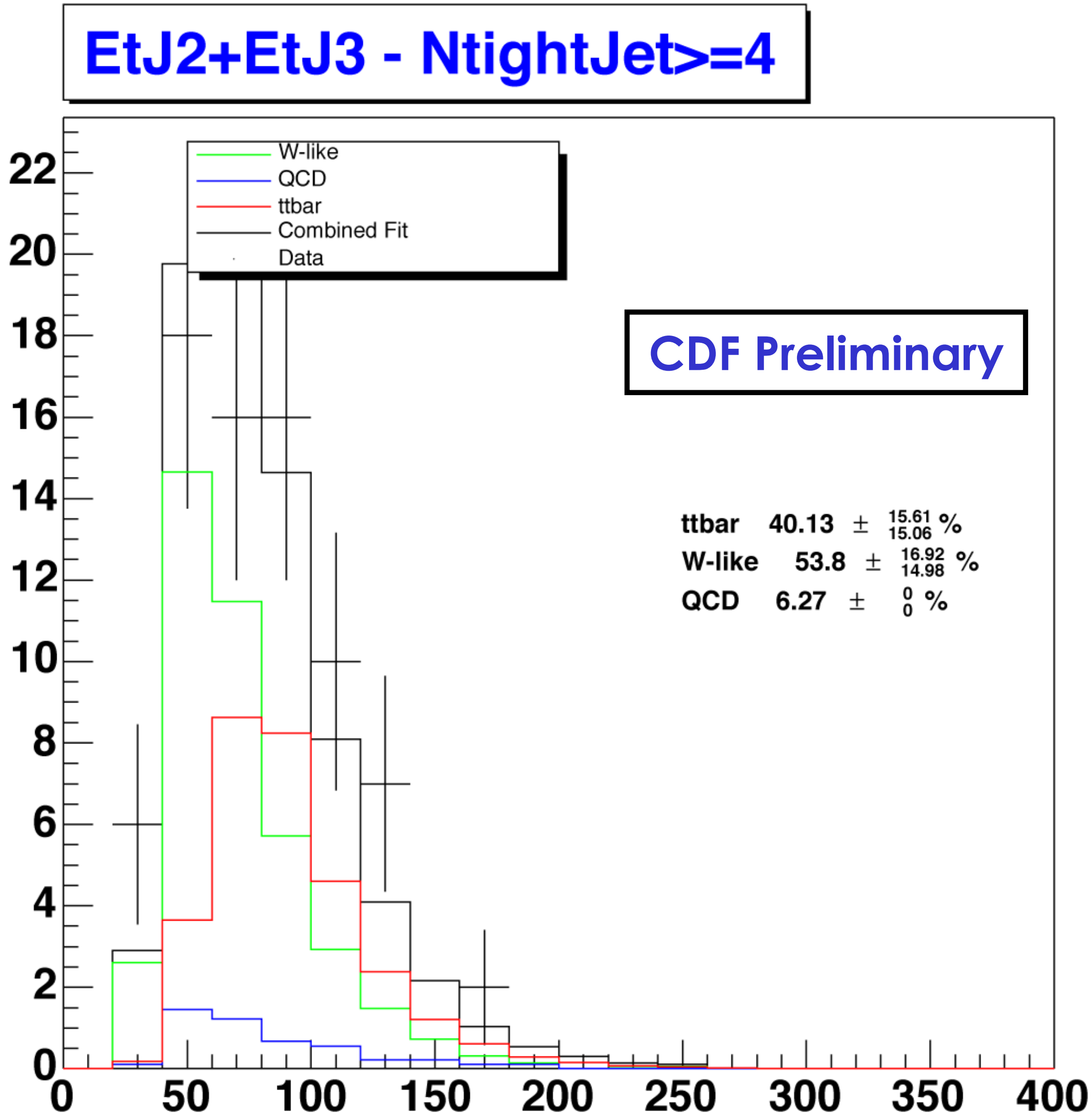
Plot showing contribution amt. from each component



Plot showing shapes of contributing components

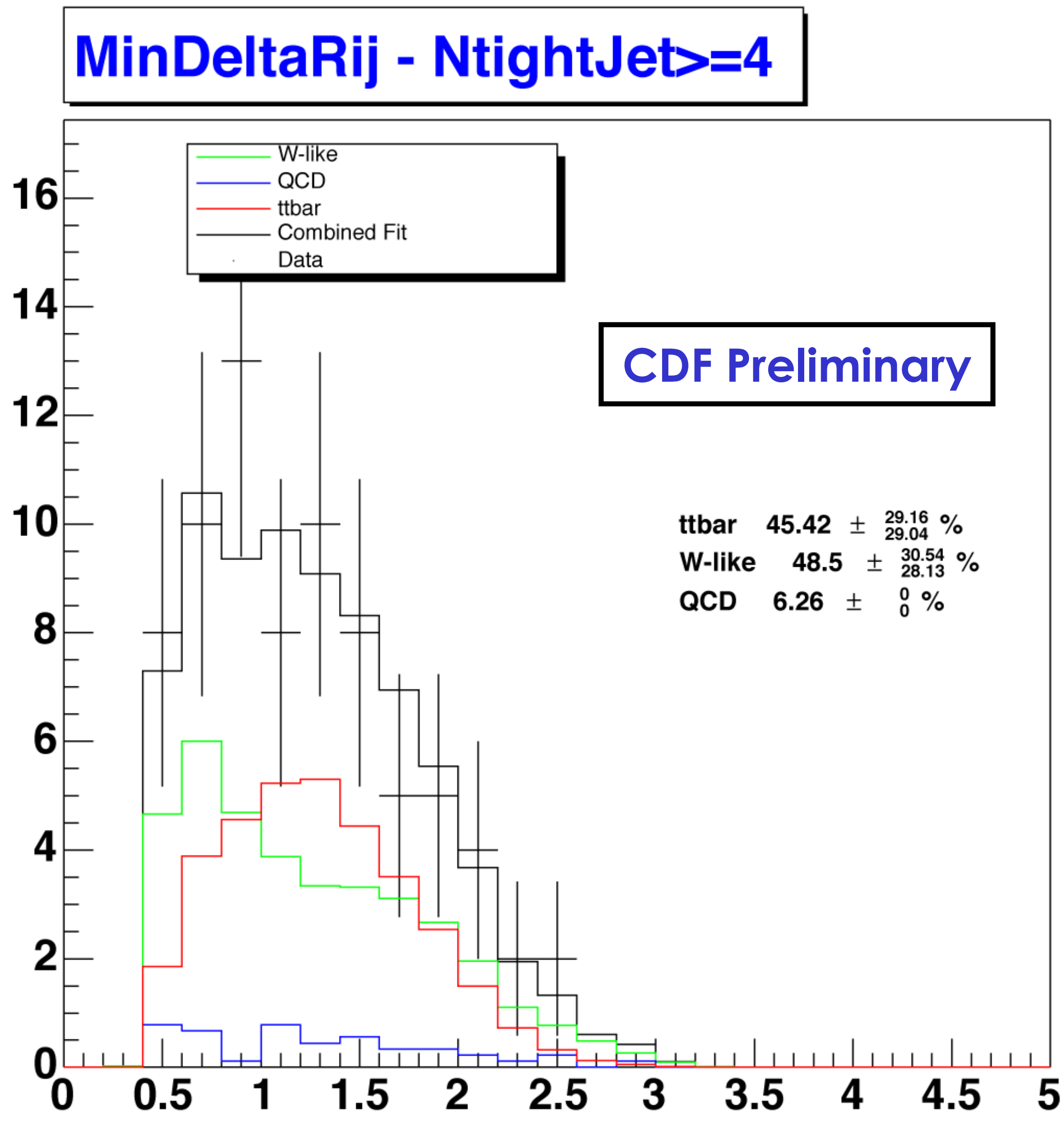
ET(2) + ET(3) Fit, ≥4 Jets

For Blessing



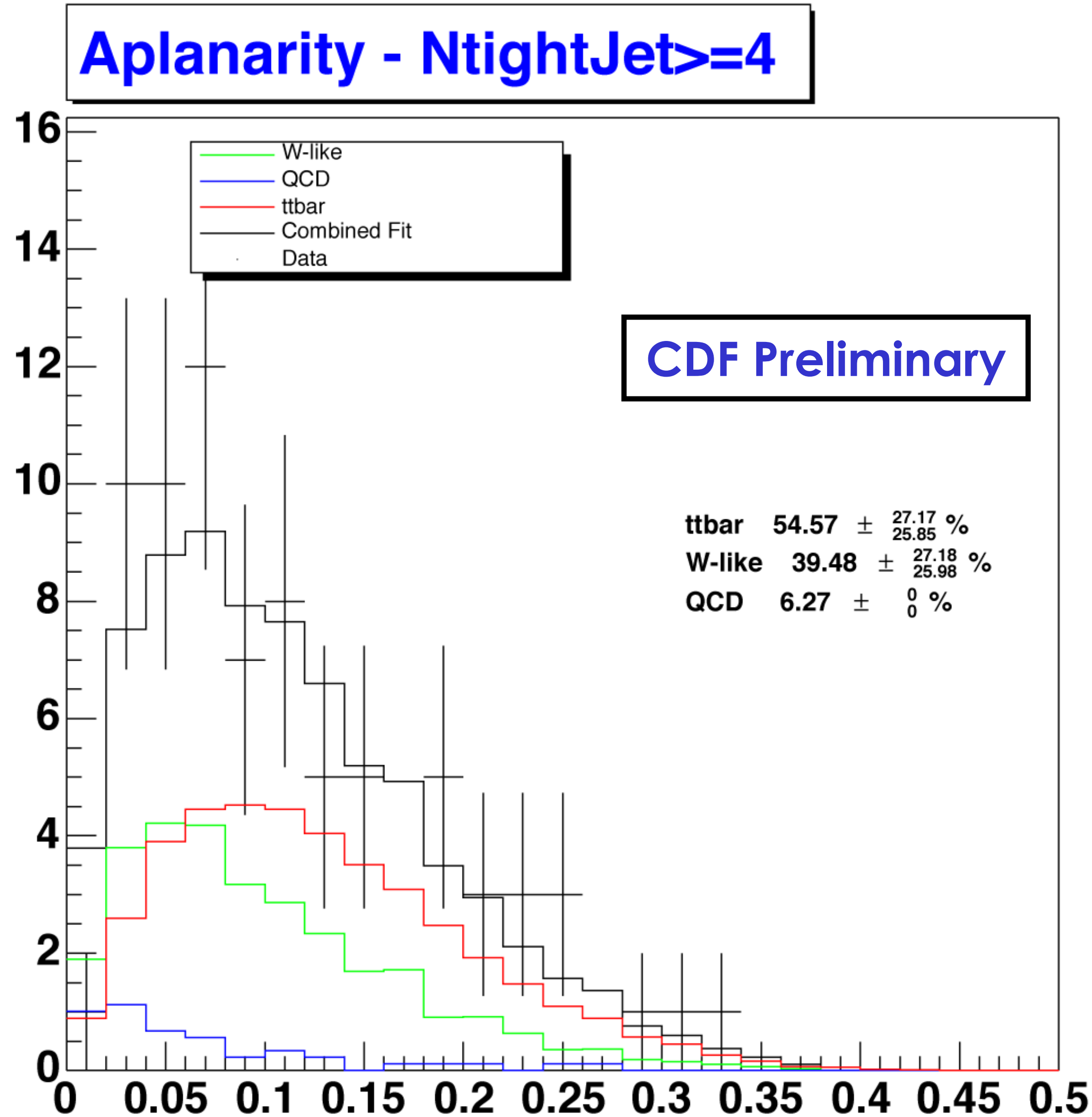
Min(DeltaR jj) Fit, ≥4 Jets

For Blessing



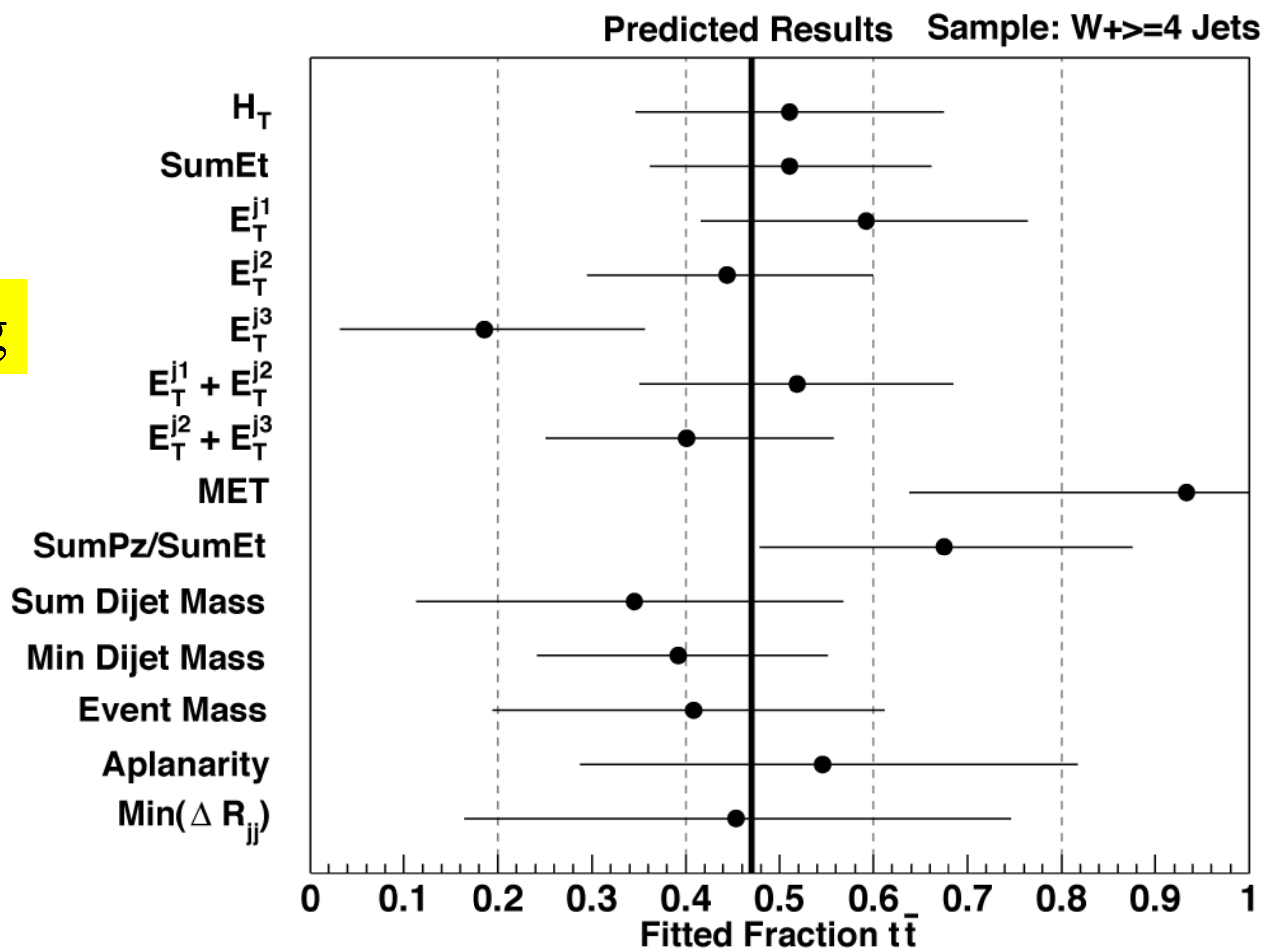
Aplanarity Fit, ≥4 Jets

For Blessing



Fit Results for the W+≥4 Jets Sample

For Blessing



CDF Preliminary

Summary of Fit Fraction Results

Our final result for the cross section is the ttbar fraction taken from the H_T fits.

- **fraction of ttbar in W+≥3 Jets**
  - **Fraction = 0.148 ± 0.053**
- **fraction of ttbar in W+≥4 Jets**
  - **Fraction = 0.510 ± 0.164**

CDF Preliminary

Determination of the Cross Section

$$\sigma(t\bar{t}) = \frac{F \cdot N_{data}^{obs}}{\left[\varepsilon_{cmx}^{t\bar{t}} \cdot L_{cmx} + \varepsilon_{cmu}^{t\bar{t}} \cdot L_{cmu} + \varepsilon_{cem}^{t\bar{t}} \cdot L_{cem}\right] \cdot \varepsilon_{common} \cdot \varepsilon_{d\phi} \cdot \varepsilon_{jet}}$$

$$L_{cmx} = 109.44 \pm 6.44 \quad pb^{-1}$$

$$L_{cem} = L_{cmu} = 125.82 \pm 7.41 \quad pb^{-1}$$

$$\varepsilon_{d\phi} = 0.947 \pm 0.001$$

$$\varepsilon_{jet}(n \geq 3) = 1.0$$

$$\varepsilon_{jet}(n \geq 4) = 0.554 \pm 0.002$$

$$\varepsilon_{cmx}^{t\bar{t}} = 0.0091 \pm 0.004$$

$$\varepsilon_{cmu}^{t\bar{t}} = 0.0244 \pm 0.0008$$

$$\varepsilon_{cem}^{t\bar{t}} = 0.0466 \pm 0.0009$$

$$\varepsilon_{common} = 0.951 \pm 0.062$$

For Blessing

CDF Preliminary

Sample	Data Observed	Fraction	Cross Section
W+≥3 Jets	308	0.148 ± 0.053	5.1 ± 1.8 pb
W+≥4 Jets	75	0.510 ± 0.164	7.7 ± 2.4 pb

Studies of Systematic Effects

Systematics are studied to determine impact on:

- Fit result due to shape difference in H_T
- Acceptance

- **Systematics examined:**
  - Jet Energy scale: method prescribed by Jet Corrections Group
  - Generator for ttbar: Determine using Pythia vs Herwig
  - Top Mass: Determine using Pythia (170-180 GeV/c^2)
  - Q^2 for Background Model: AlpGen $Q^2 = M_W^2$ v. $Q^2 = M_W^2 + \Sigma P_T^2$(Jets)
  - Lepton ID: From CDF6574
  - PDF's: From CDF6574 and from shape study
  - Background model: conversions vs non-isolated leptons
  - ISR: on/off using Pythia ttbar
- **Method: use PE's**

Jet Energy Scale Systematics

Data	Shape Error %	Acceptance Error %	Total Error %
relative	0.090	0.009	0.099
cal stability	0.046	0.004	0.049
energy scale	0.129	0.012	0.141
MC	**Shape Error %**	**Acceptance Error %**	**Total Error %**
Relative	0.105	0.016	0.121
energy scale	0.033	0.017	0.181
mult. Int.	0.00	0.00	0.00
absolute	0.022	0.015	0.120
OOC	0.005	0.020	0.046
splash out	0.010	0.024	0.073
Total	± 26.4%	± 4.5%	± 30.2%

Table for NJets $\geq$ 3

Result for NJets $\geq$ 4:
± 31.5%

QCD Background Model Systematic

<u>Normalization:</u> Use MET v. Iso. technique to estimate quantity of QCD fakes in our sample. Determine error: vary MET and isolation cuts independently. See a ~10% shift (see table in note). Re-fit using PE's and get a negligible shift in the fraction.

Normalization error obtained but doubling and halving our QCD →

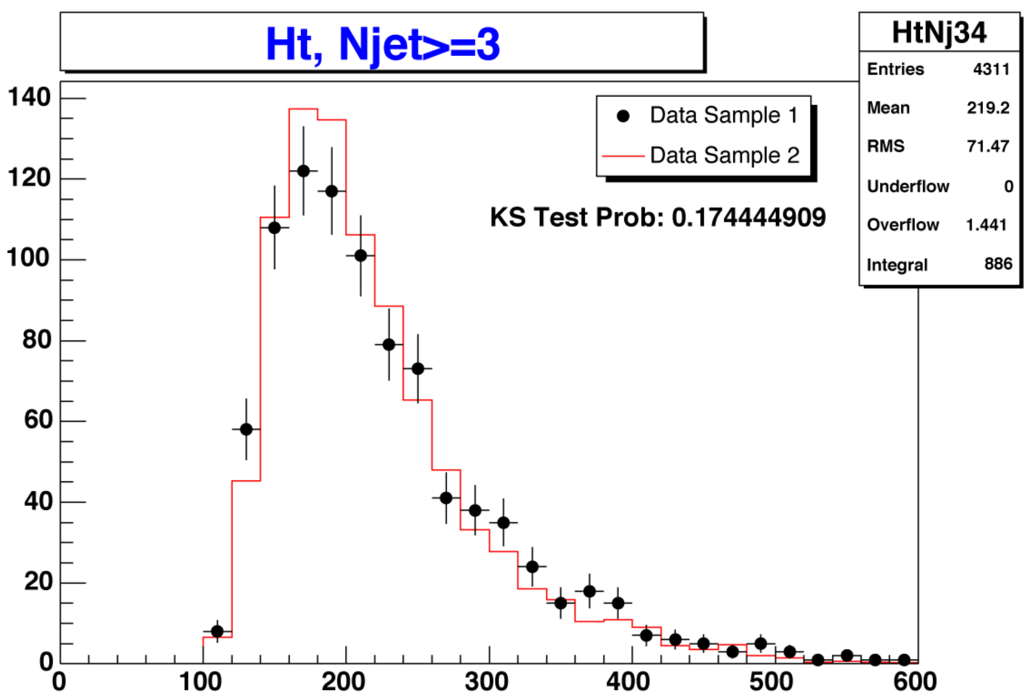
H_T	double	half	Error
NJets $\geq$ 3	2.0%	1.4%	1.7%
NJets $\geq$ 4	5.3%	1.4%	3.3%

<u>Shape:</u> Use conversion electron sample for alternate Ht shape. Generate PE's and re-fit data twice: with non-isolated lepton sample and with conversions. Take mean of difference of fits. Result: 16%

Systematic for Q^2 Scale

Almost all of the MC samples of X+n parton (jet) in the top group are AlpGen with a fairly hard Q^2 scale: $Q^2 = M_W^2 + \Sigma P_T^2(\text{Jets})$

We obtained a sample of AlpGen W+3p MC at $Q^2 = M_W^2$, and ran it through simulation/production



Performed PE's with shifted shapes much like with the jet corrections, took difference of fits ÷2

fit	Error
NJets $\geq$ 3	14%
NJets $\geq$ 4	0.6%

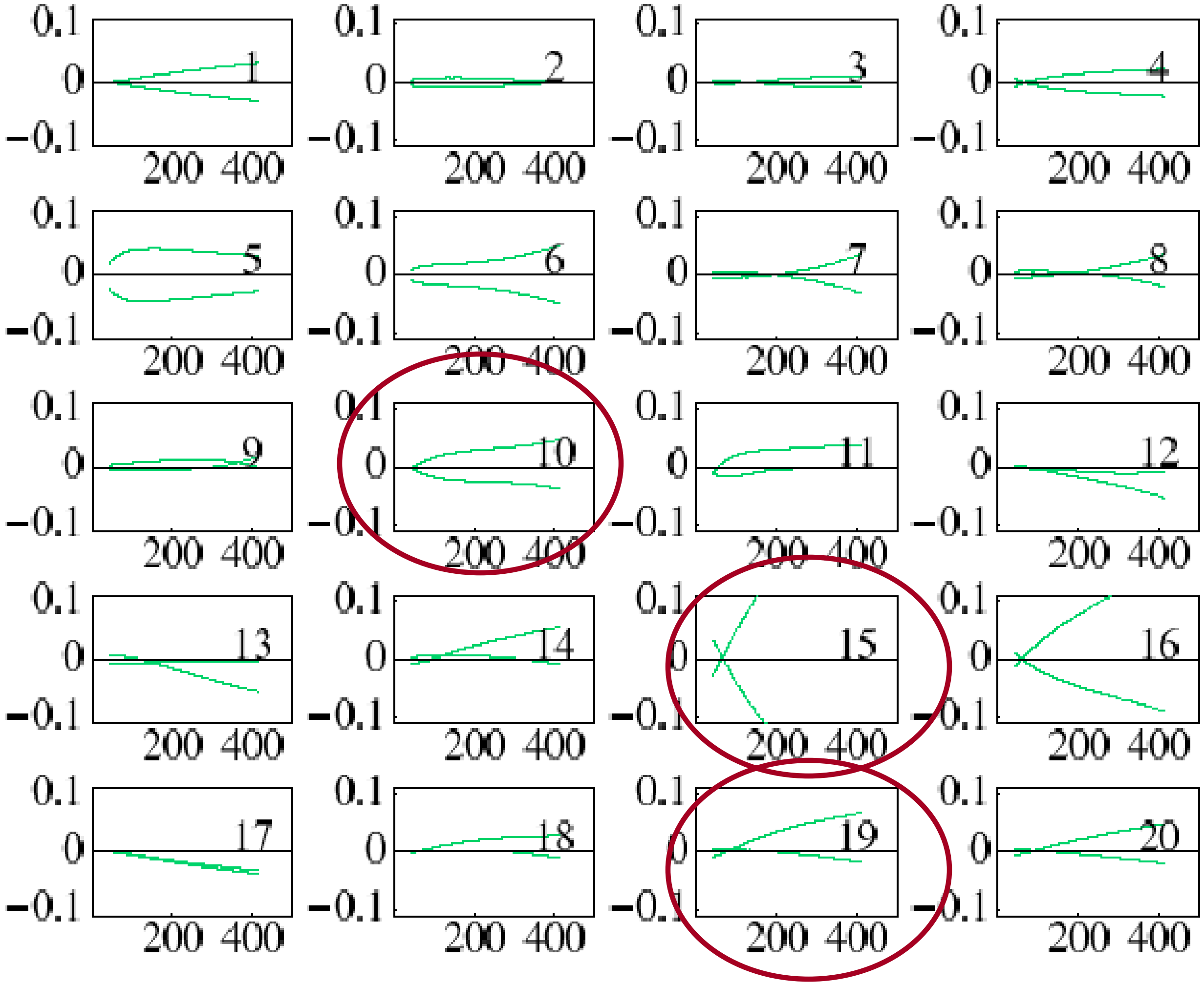
PDF Shape Systematic

CTEQ6 with NLO + HERWIG / PYTHIA with LO
Eigenvector #15: gluon distribution functions dominate

Consider largest contributing Eigenvectors:
10, 15, 19

Create shifted Templates, refit Using PE's.

Systematic Error:
Njets $\geq$ 3: **3.3%**
Njets $\geq$ 4: **4.3%**



Systematic Effects W+$\geq$3 Jets

Effect	Shape	Acceptance	Total
Energy Scale	28%	5.1%	30%
Generator	0.60%	---	0.6%
Top Mass	8.0%	5.0%	13%
Q^2 Choice	14%	---	14%
PDF	3.3%	5.3% (from lepton ID)	8.6%
ISR (Pythia)	0.56%	0.78%	1.3%
Luminosity			5.9%
Background model	16%	1.7% (normalization)	16%
Total			40.6%

For Blessing

Systematic Effects W+$\geq$4 Jets

Effect	Shape	Acceptance	Total
Energy Scale	20.4%	13.0%	32%
Generator	0.60%	---	0.6%
Top Mass	8.0%	5.0%	13%
Q^2 Scale	0.31%	---	0.3%
PDF	4.3%	5.3% (from lepton ID)	9.6%
ISR	0.56%	0.78%	1.3%
Luminosity			5.9%
Background model	16%	3.3% (normalization)	16%
Total			39.5%

For Blessing

Summary

We've measured the top cross section in the lepton + jets channel using H_T .

Requiring 3 or more jets: σ (ttbar) = 5.1 ± 1.8 (stat) ± 2.1 (sys)

Requiring 4 or more jets: σ (ttbar) = 7.1 ± 2.4 (stat) ± 3.0 (sys)

Backup Slides

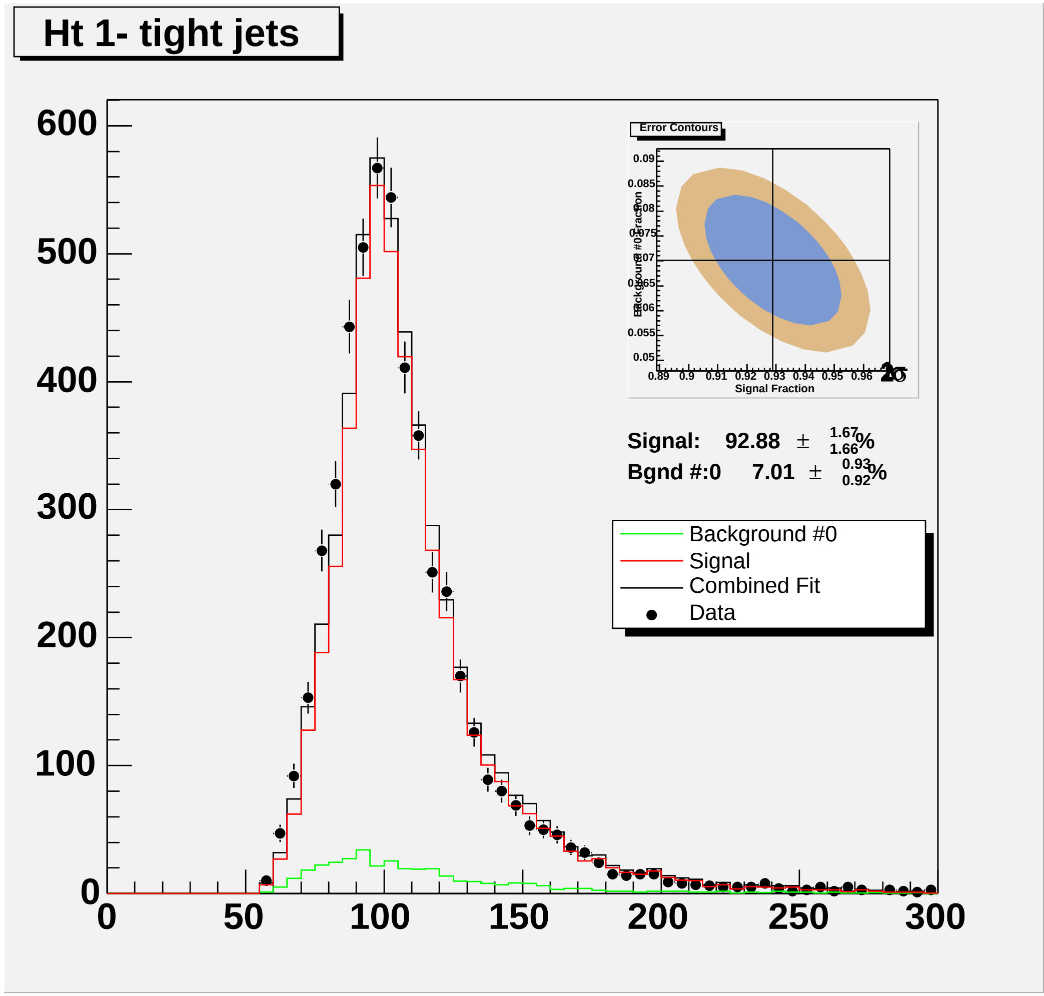
Data/ MC Comparisons

- Problem: Examining the H_T distribution in the W+1 jet data: the fit undershoots H_T in the low end, and overshoots H_T at the high end.

How to quantify the difference?

  - Kolmogorov-Smirnov statistic *flawed (biased?) in ROOT*

For Blessing



- Modify procedure:
- Fit MC+QCD to data
- Obtain Kolmogorov distance ‘D’
- Generate PE events according to fitted MC
- Refit random events
- Obtain Kolmogorov distance ‘d’ between random sample and fit
- Probability of data fit = fraction of time D < d

Acceptance

$$\sigma(t\bar{t}) = \frac{F \cdot N_{data}^{obs}}{\left[\varepsilon_{cmx}^{t\bar{t}} \cdot L_{cmx} + \varepsilon_{cmu}^{t\bar{t}} \cdot L_{cmu} + \varepsilon_{cem}^{t\bar{t}} \cdot L_{cem}\right] \cdot \varepsilon_{common} \cdot \varepsilon_{d\phi} \cdot \varepsilon_{jet}}$$

F : Fraction from kinematic fit

N_{data}^{obs} : Number of events observed in W+ ≥ 3 or ≥ 4 jets

$$L_{cmx} = 109.44 \pm 6.44 \ \ pb^{-1}$$
$$L_{cem} = L_{cmu} = 125.82 \pm 7.41 \ \ pb^{-1}$$

$$\varepsilon_{cmx}^{t\bar{t}} = 0.0091 \pm 0.004$$
$$\varepsilon_{cmu}^{t\bar{t}} = 0.0244 \pm 0.0008$$
$$\varepsilon_{cem}^{t\bar{t}} = 0.0466 \pm 0.0009$$
$$\varepsilon_{common} = 0.951 \pm 0.062$$

$$\varepsilon_{d\phi} = 0.947 \pm 0.001$$

$$\varepsilon_{jet}(n \geq 3) = 1.0$$
$$\varepsilon_{jet}(n \geq 4) = 0.554 \pm 0.002$$

Expected QCD Background Fraction

Update this!

For Blessing

No Δϕ cut imposed

W+"n" jets	Electron bkgnd	Muon bkgnd	Total bkgnd
1	9.6 ± 0.3%	5.1 ± 0.2%	7.6 ± 0.4%
2	12.6 ± 0.8%	4.0 ± 0.4%	8.7 ± 0.9%
≥ 3	15.0 ± 1.9%	5.6 ± 1.2%	11.7± 2.2%

Use MET vs Isolation to determine the background normalization and effect of the Δϕ **cut**

Δϕ cut imposed

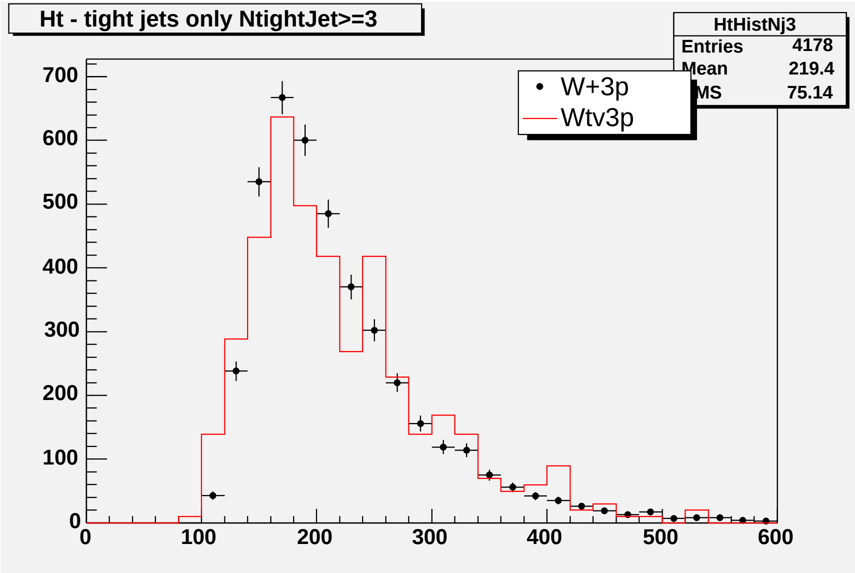
W+"n" jets	Electron bkgnd	Muon bkgnd	Total bkgnd
1	3.8 ± 0.2%	2.9± 0.2%	3.4 ± 0.3%
2	6.1 ± 0.5 %	2.0 ± 0.2%	4.3 ± 0.5%
≥3	8.9 ± 1.5 %	3.4 ± 0.9%	7.0 ± 1.7%

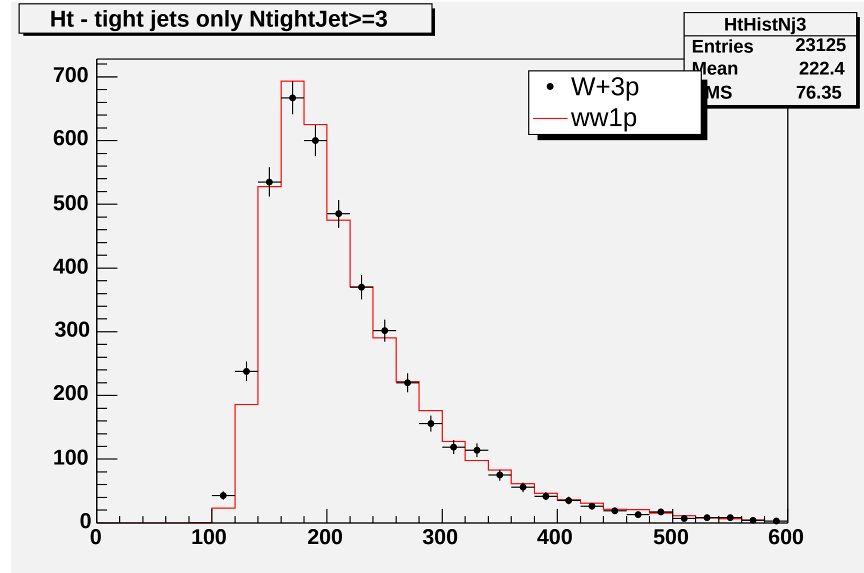
For Blessing

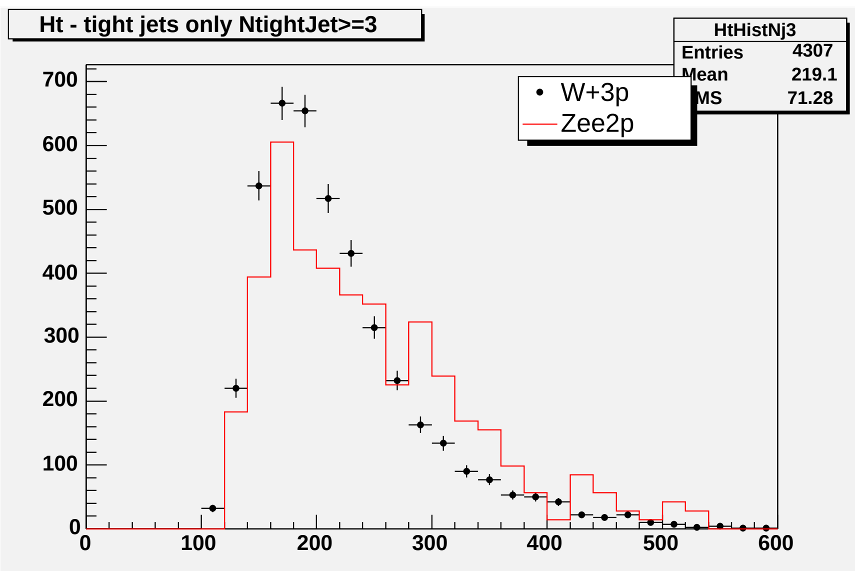
Determination of Sensitivities

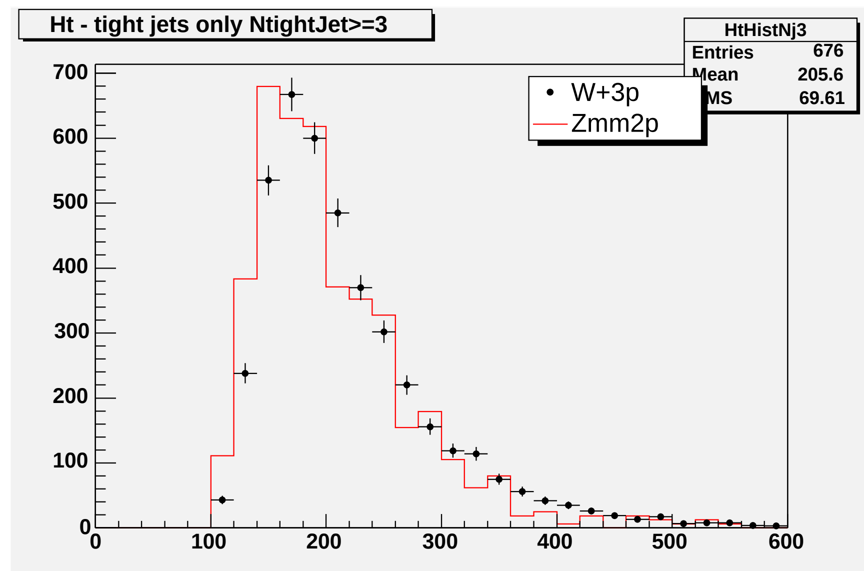
- Use pseudo-experiments (PE's) to determine expected precision on cross section:
  - Number of ttbar using acceptance, luminosity, theory σ (7pb)
  - Number of QCD from MET vs ISO
  - Number of W's: # observed events minus (expected ttbar + QCD)
  - Each of the above numbers correspond to mean of Poisson
  - Use Ht as the discriminating variable; sample from ttbar and AlpGen MC's, and conversion data sample.

H_T Shape Comparison, W+3p v. Smaller Backgrounds









QCD Background Findings(old)

Njets (muons)	MET v. Isol
1	0.111 ± 0.004
2	0.077 ± 0.005
3+4	0.070 ± 0.012
Njets (electrons)	**MET v. Isol**
1	0.186 ± 0.004
2	0.159 ± 0.006
3+4	0.196 ± 0.017

QCD higher for electrons as expected. Numbers still under study… muon 3-4 jet strange. Also studying shapes from low MET and high "isolation" region.

Bias in KS Probability Due to Fitting

Note: 50% of PE's have KS probability>80%

Bias in KS