Top Quark Mass and Kinematics

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for the CDF and DØ Collaborations

- Top quarks at the Tevatron
- General techniques for measuring the top mass
- Mass in the ℓ+jets channel
- Mass in the dilepton channel
- Anomalous kinematics
- ttbar mass spectrum

Introduction

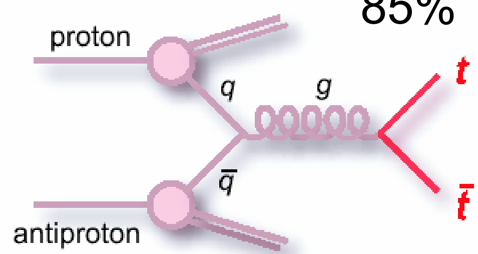
Top Quark Production and Decay

- In proton anti-proton collisions at Tevatron energies, top quarks are primarily produced in pairs via strong interactions

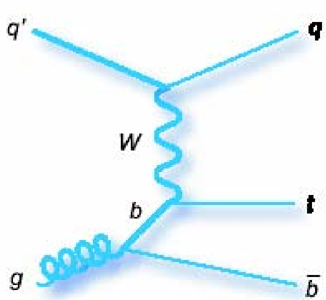
LO diagrams

15%

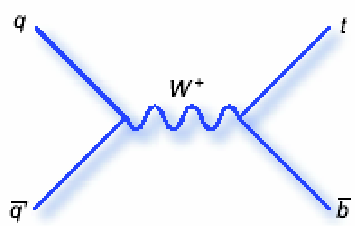
85%



- EW single top production: not yet observed

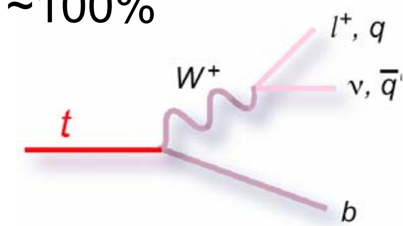


t-channel

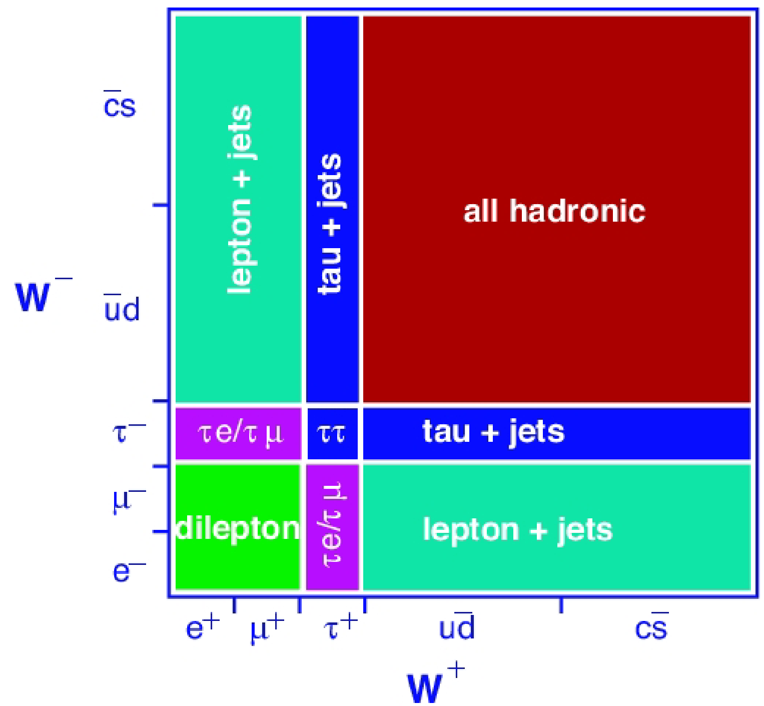


s-channel

- Br(t→Wb) ~100%



tt̄ decay modes

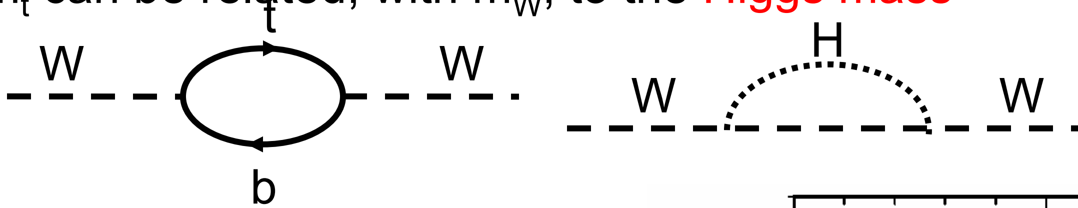


The Top Quark mass

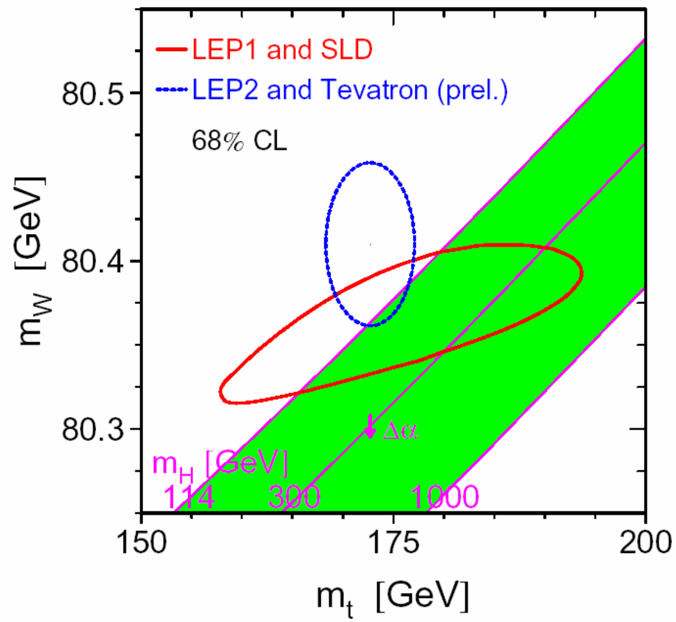
Fundamental parameter of the Standard Model

- Affects predictions of SM via radiative corrections
  $\Rightarrow m_t$ can be related, with m_W, to the Higgs mass

$$\delta m_W \propto m_t^2, \ln(m_H)$$

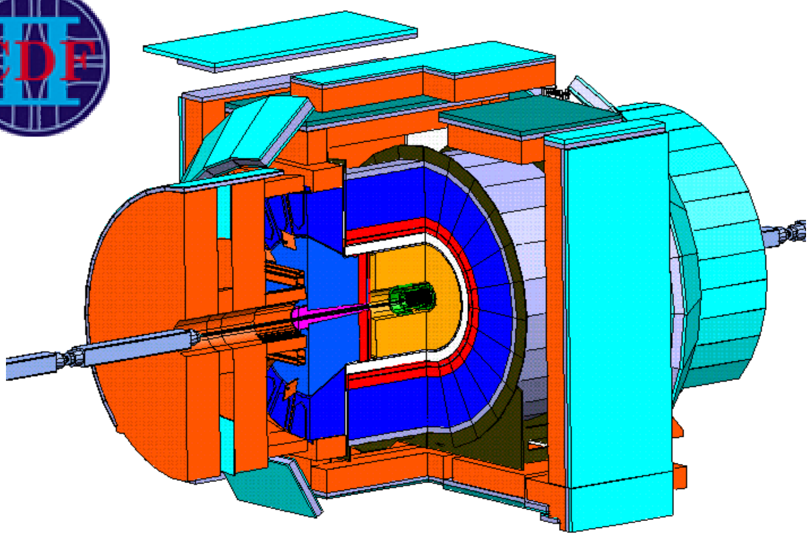


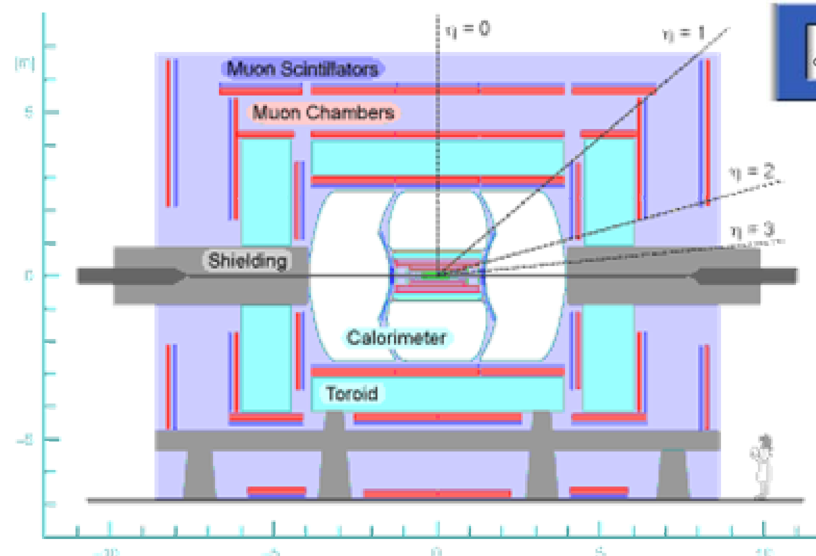
- m_t is roughly ½ the vacuum expectation value of the Higgs field
  $\Rightarrow$ probing the EWSB mechanism (new physics?)



Precision measurement $\Rightarrow$ 2 fb^{-1} projection: $\delta m_t \sim 1.5$ GeV ($\delta M_H/M_H = 30\%$)

CDF and DØ, the Tevatron detectors





- Precise tracking and vertexing: new silicon vertex detectors. Tracking chambers and TOF (CDF)/ fiber tracker (DØ).
  - Upgraded calorimeters, preshowers.
  - Upgraded Muon systems.
  - Upgraded DAQ/trigger systems.

Data taking efficiency: ≥85%

Run II results presented here: 160-750 pb^{-1}

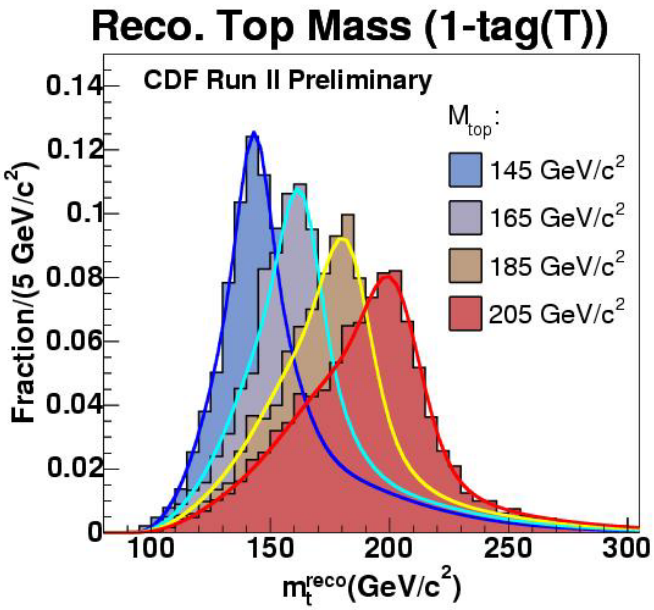
Top mass measurement ingredients

Precision measurement ⇒ maximize statistical significance with sophisticated mass extraction techniques + minimize systematic uncertainties (jet energy scale, signal/background modeling).

Main mass extraction techniques:

- Template methods: typically, one mass per event from kinematic fit, compare data to MC templates.

- Dynamical methods: event by event weights according to quality of agreement with Standard Model top and background differential cross-sections.



$$P(x;m_{top}) = \frac{1}{\sigma}\int d^n\sigma(y;m_{top})dq_1dq_2f(q_1)f(q_2)W(x\,|\,y)$$

differential cross-section (LO matrix element)

PDF's

Transfer function: mapping from parton level variables (y) to reconstructed level variables (x)

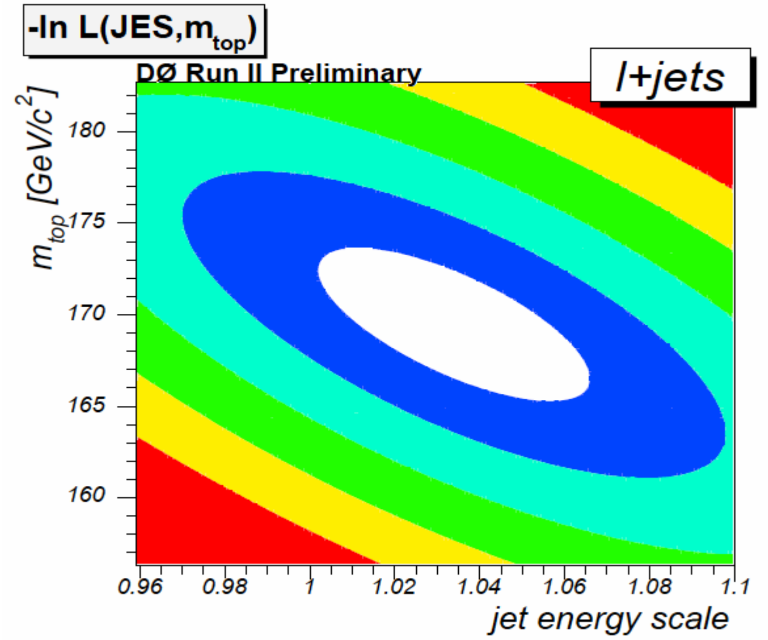
Top mass measurement ingredients

Handles on systematic uncertainties:

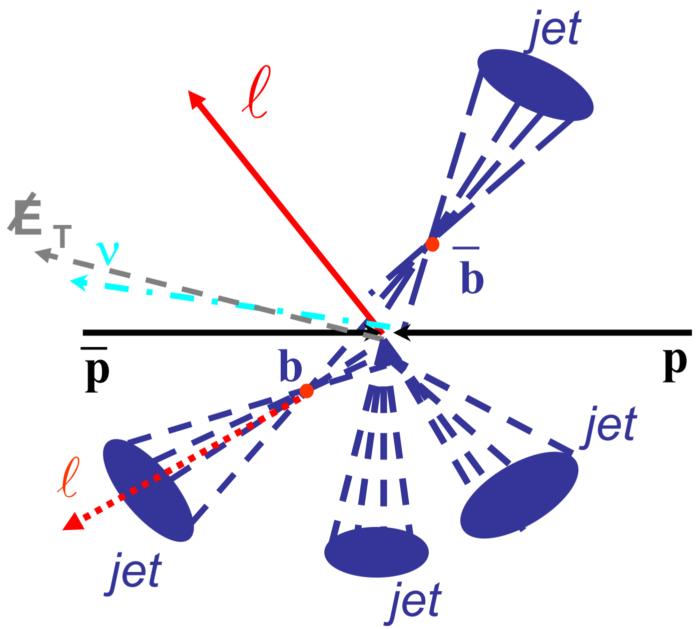
- JES systematic can be reduced with in-situ calibration of the hadronic W mass in top decays $\Rightarrow$ simultaneous determination of M_{top} and JES from reconstructed m_{top} and M_W templates.

- b-tagging can be used to reduce physics backgrounds as well combinatorial.

- Many systematical uncertainties are expected to decrease with larger data samples.



Mass in the ℓ+jets channel



t(→W±b) t(→W±b)

└→ e±,μ± └→ qq

CDF: Template Method, 680 pb^{-1}

Reconstructed m_{top} and m_{jj} from data are compared to templates of various true M_{top} and Δ_{JES} (jet energy calibration shift) using an unbinned likelihood fit

$\Rightarrow$ uses *in-situ* m_W constraint to calibrate the jet energy scale.

Event selection:

- 1 e or μ with $p_T > 20$ GeV
- $E_T^{miss} > 20$ GeV
- 4 exclusive samples with different jet pT selections: 0, 1 (L/T), 2 b-tags

360 candidates, 4 samples with different S/B and sensitivity to M_{top}:

- 0 b-tag : 4 jets $E_T > 21$GeV
- 1 b-tag (loose) : 3 jets $E_T > 15$GeV, 4th jet 8GeV < E_T < 15GeV (S:B = 1:1)
- 1 b-tag (tight) : 4 jets $E_T > 15$GeV (S:B = 4:1)
- 2 b-tags: 3 jets $E_T > 15$GeV, 4th jet $E_T > 8$GeV (S:B = 11:1)

Backgrounds:

	2-tag	1-tag(T)	1-tag(L)	0-tag
Non-w(QCD)	0.6 ± 0.2	5.0 ± 1.4	4.4 ± 1.4	
W+Heavy Flavor	2.4 ± 1.0	8.4 ± 3.0	14.6 ± 4.7	
W+light jets	0.9 ± 0.2	6.9 ± 1.4	8.9 ± 1.9	100%
WW/WZ	0.11 ± 0.03	1.0 ± 0.3	1.5 ± 0.4	
Single Top	0.02 ± 0.01	1.1 ± 0.3	1.3 ± 0.3	
Total Background	4.0 ± 1.3	22.2 ± 4.7	30.6 ± 6.7	
$t\bar{t}$ ($\sigma_{t\bar{t}} = 6.1$ pb)	42.8	82.2	33.6	
Total	46.8	104.4	64.2	

CDF: Template Method, 680 pb^{-1}

m_{top} reconstruction: from kinematic fit that yields the lowest χ^2 (with $\chi^2 < 9$)

$$\chi^2 = \sum_{i=\ell,4\text{jets}} \frac{(\hat{p}_T^i - p_T^i)^2}{\sigma_i^2} + \sum_{j=x,y} \frac{\left(\hat{p}_j^{UE} - p_j^{UE}\right)^2}{\sigma_j^2} + \frac{(m_{jj} - m_W)^2}{\Gamma_W^2} + \frac{(m_{\ell\nu} - m_W)^2}{\Gamma_W^2} + \frac{(m_{bjj} - m_t^{reco})^2}{\Gamma_t^2} + \frac{(m_{b\ell\nu} - m_t^{reco})^2}{\Gamma_t^2}$$

m_{jj} reconstruction: uses all combinations of untagged jets

Template fits: parametrization of m_{top} and m_{jj} for input values of M_{top} and Δ_{JES} (signal) + parametrization of m_{top}, m_{jj} background shapes $\Rightarrow$ probabilities

Unbinned Likelihood fit: extraction of M_{top}, Δ_{JES}, n_s, n_b (constructed from the probabilities determined with the Template fits)

CDF: Template Method, 680 pb^{-1}

Likelihood for each sample: $\mathcal{L}_{\text{sample}} = \mathcal{L}^{m_t^{\text{reco}}}_{\text{shape}} \times \mathcal{L}^{m_{jj}}_{\text{shape}} \times \mathcal{L}_{\text{nev}} \times \mathcal{L}_{\text{bg}}$

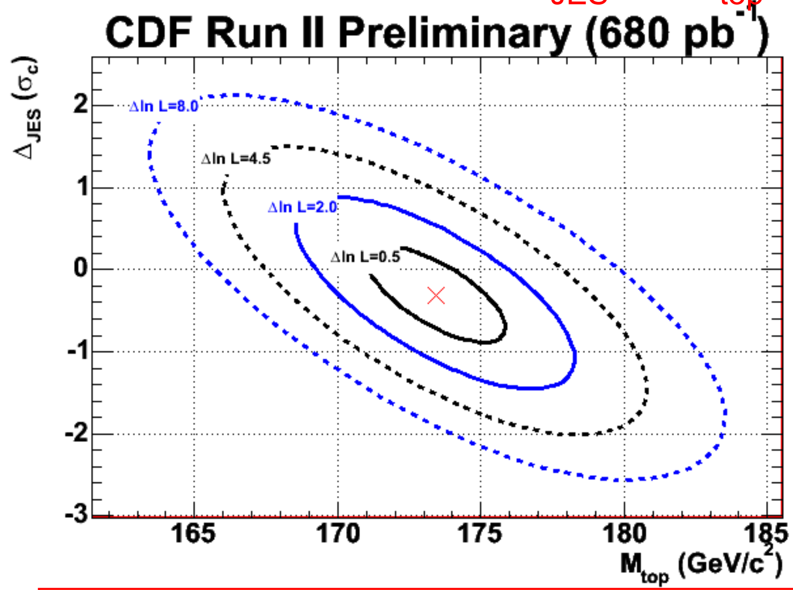
Combined Likelihood: $\mathcal{L}_{\text{total}}(m_t, JES) = \mathcal{L}_{\text{2-tag}} \times \mathcal{L}_{\text{1-tag(T)}} \times \mathcal{L}_{\text{1-tag(L)}} \times \mathcal{L}_{\text{0-tag}} \times \mathcal{L}_{\text{JES}}$

Gaussian constraint on Δ_{JES}

External JES calibration uncertainty: 3 GeV

M_{jj} in-situ calibration leads to a 40% improvement on the external σ_{JES}

Combined Likelihood Δ_{JES} vs M_{top}:



Systematic uncertainties:

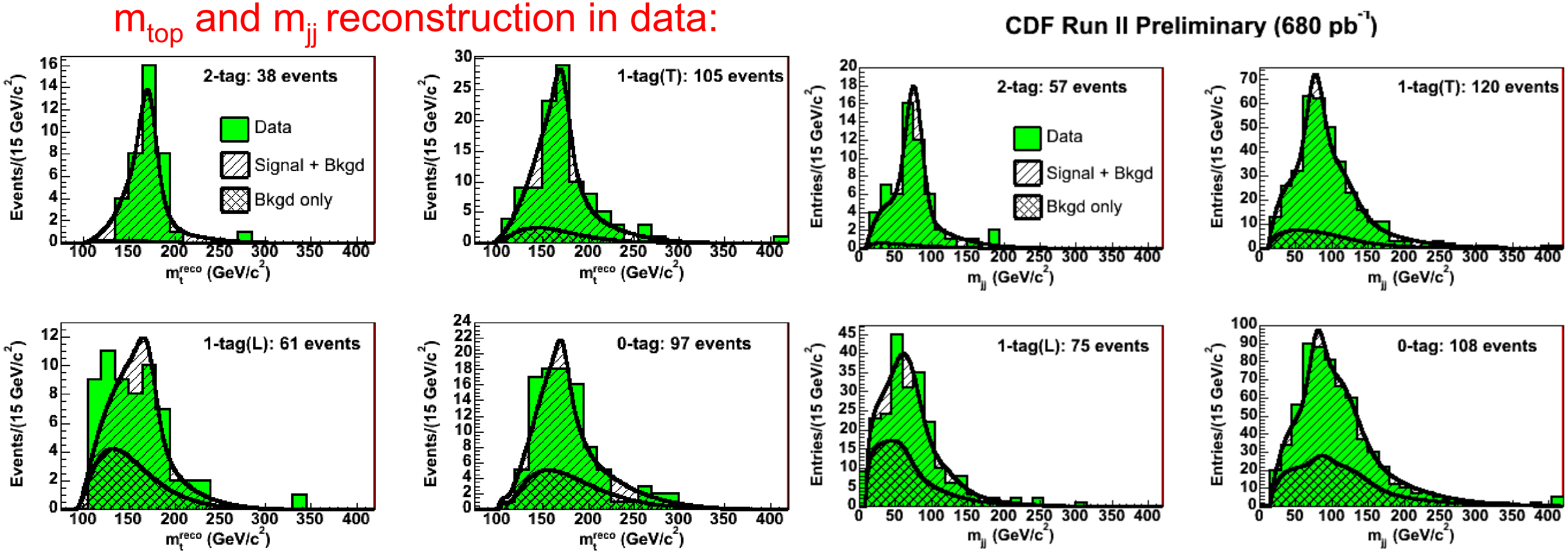
Systematic Source	ΔM_{top}
b-jet energy scale	0.6
Residual JES	0.7
Background JES	0.4
ISR	0.5
FSR	0.2
Parton Distribution Functions	0.3
Generators	0.2
Background Shape	0.5
b-tagging	0.1
Monte Carlo statistics	0.3
TOTAL	1.3

$$M_{top} = 173.4 \pm 2.5(\text{stat} + \Delta_{JES}) \pm 1.3 \text{GeV/c}^2$$
$$M_{top} = 173.4 \pm 2.8 \text{GeV/c}^2$$

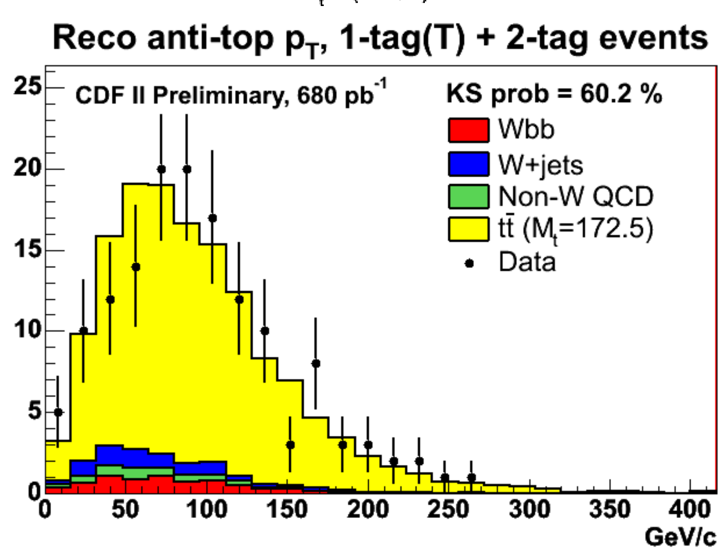
$\Rightarrow$ most precise single measurement

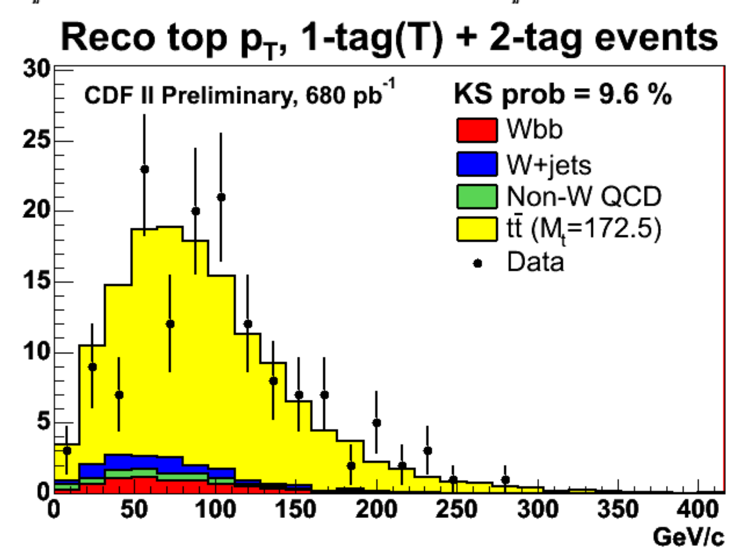
CDF: Template Method, 680 pb^{-1}

m_{top} and m_{jj} reconstruction in data:



Additional kinematics distributions:



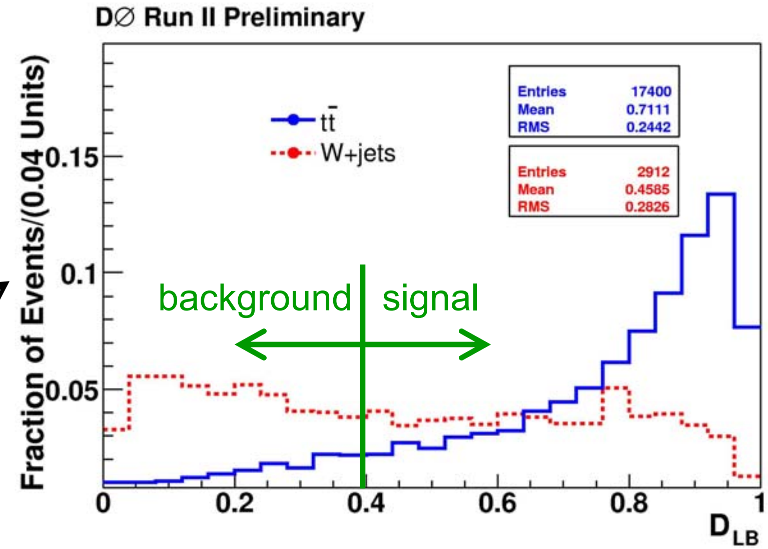


DØ: Template Method, 230 pb^{-1}

Event selection:

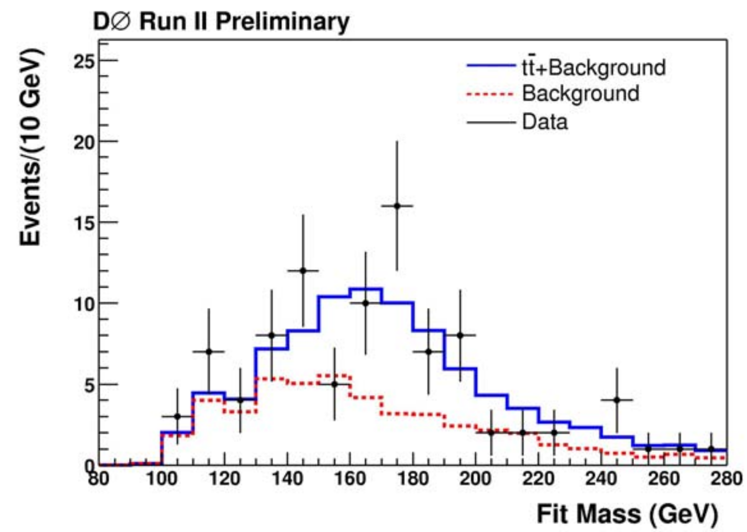
- 1 e or μ with p_T > 20 GeV
- E_T^{miss} > 20 GeV
- ≥ 4 jets, E_T > 20 GeV

- Topological selection: discriminant of input variables uncorrelated with m_{top}



- Lowest χ^2 solution for reconstructed m_{top}, data compared to MC templates with a likelihood fit.

reconstructed m_{top}:



- 94 candidates, S:B = 1:1

$$M_{top} = 169.9 \pm 5.8(\text{stat})^{+7.8}_{-7.1}(\text{sys})\,\text{GeV/c}^2$$

DØ: Template Method, 230 pb^{-1}

Event selection:

- 1 e or μ with p_T > 20 GeV
- E_T^{miss} > 20 GeV
- ≥ 4 jets, E_T > 15 GeV

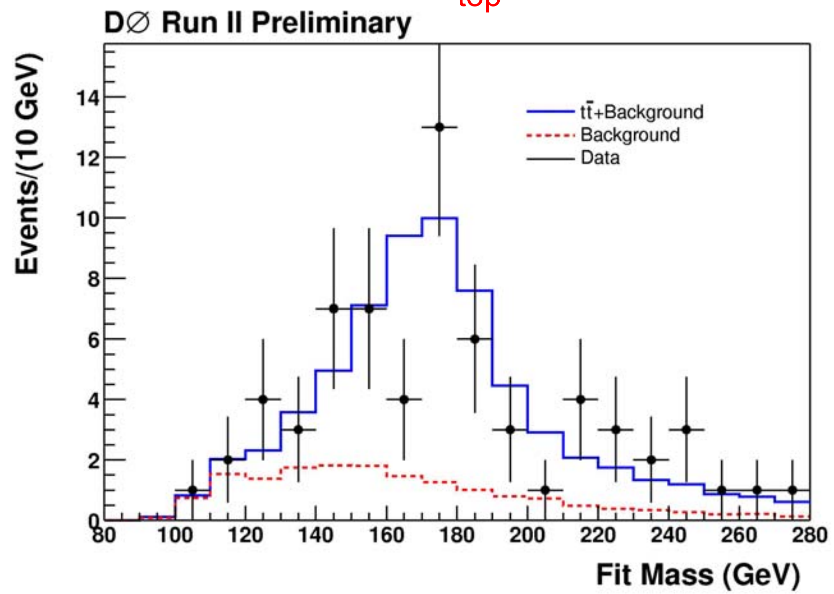
- ≥ 1 b-jet(s)

- Lowest χ^2 solution for reconstructed m_{top}. Data compared to MC templates with a likelihood fit.

- 69 candidates, S:B = 3:1

$$M_{top} = 170.6 \pm 4.2(\text{stat}) \pm 6.0(\text{sys})\text{GeV}/c^2$$

reconstructed m_{top}:



Systematic uncertainties:

	untagged	tagged
JES	+6.8/-6.5	+4.7/-5.3
Jet resolution	0.9	0.9
Gluon radiation	2.6	2.4
Signal Model	2.3	2.3
Backg. Model	0.7	0.8
b-tagging	--	0.7
Calibration	0.5	0.5
Trigger bias	0.5	0.5
MC statistics	0.5	0.5
Total	+7.8/-7.1 GeV	6 GeV

DØ: Ideogram Method, 160 pb^{-1}

Same kinematic fitting and discriminant as the Template analysis.
Event-by-event likelihood, each event gives a distribution of masses.

$$\mathcal{L}_{evt}(m_{top}, P_{sample}) = P_{evt} \int \sum e^{-\frac{1}{2}\chi_i^2} G(m_i, m', \sigma_i) BW(m', m_{top}) dm' + (1 - P_{evt}) \sum e^{-\frac{1}{2}\chi_i^2} BG(m_i)$$

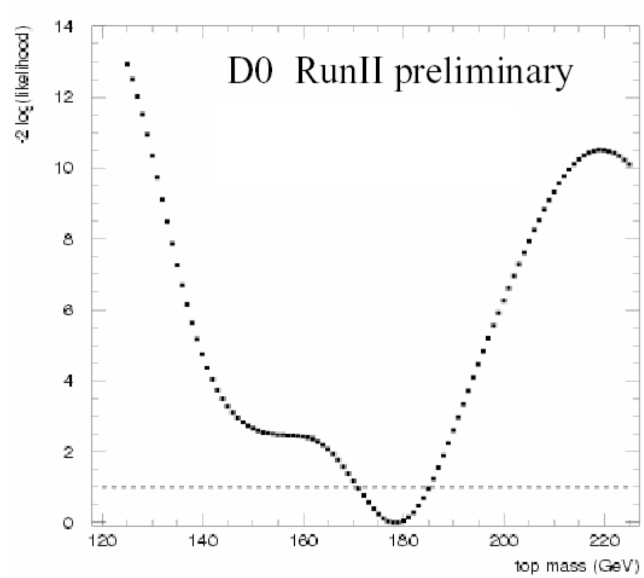
discriminant

combinatorics weight

Gaussian resolutions

Signal Breit-Wigner's

Background shape



$$M_{top} = 177.5 \pm 5.8(stat) \pm 7.1(sys) GeV/c^2$$

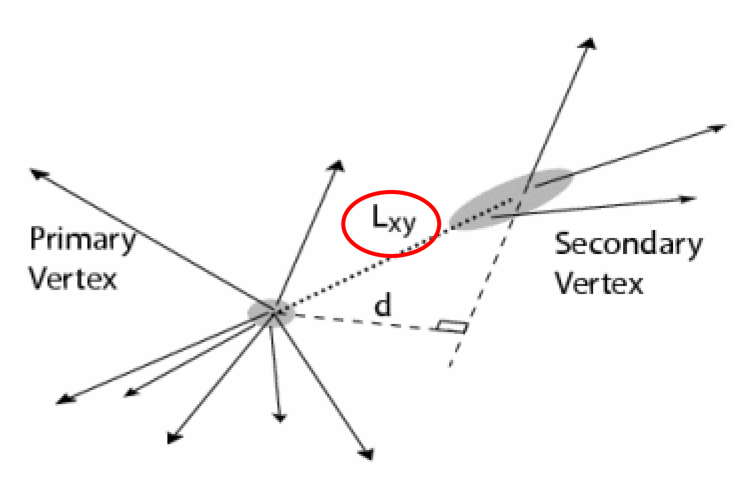
CDF: Decay Length Method, 695 pb^{-1}

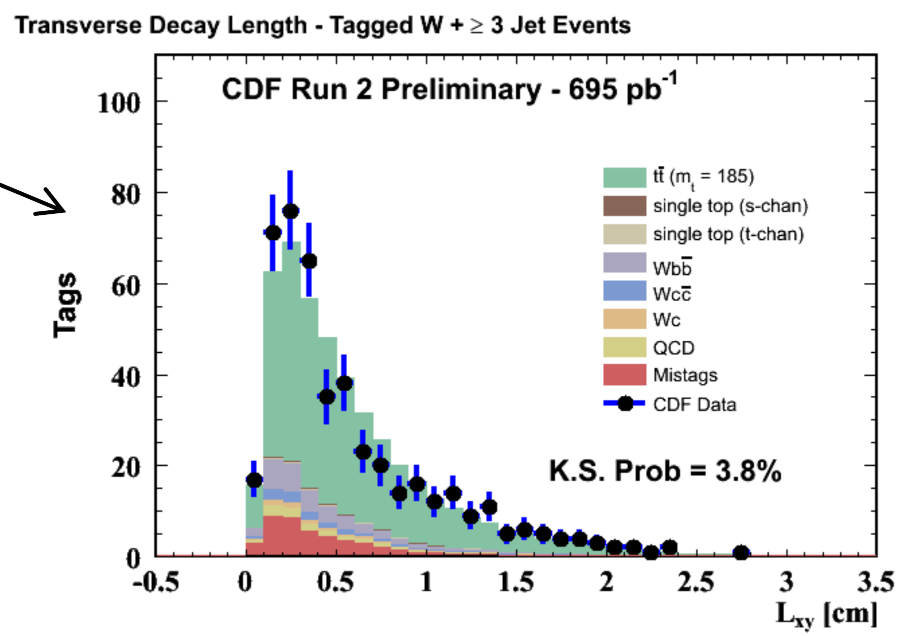
Uncorrelated to other measurements:
relies on tracking (no dependency on JES)

Boost of b-quarks is correlated to m_{top}:

$$\gamma_b = \frac{m_t^2 + m_b^2 - m_W^2}{2 m_t m_b} \approx 0.4 \frac{m_t}{m_b}$$

use b-lifetime, or $\langle L_{xy} \rangle$, to infer m_{top}





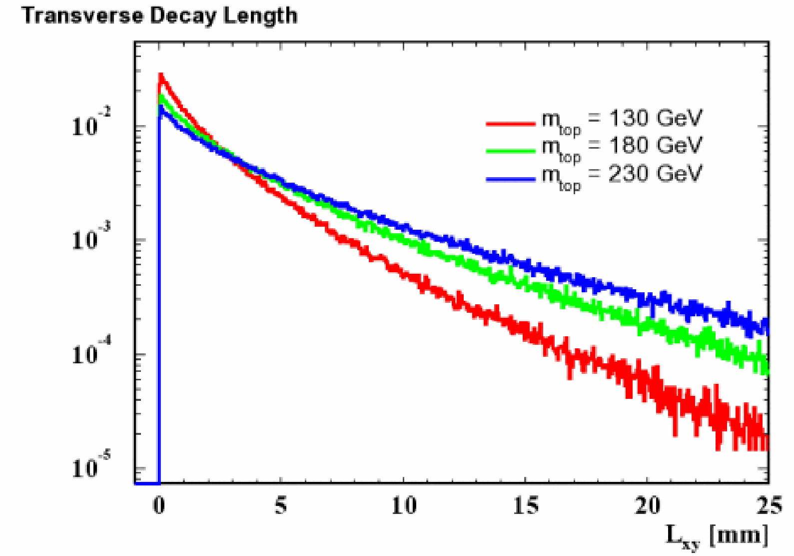
Event Selection

- 1 e or μ with p_T > 20 GeV
- E_T^{miss} > 20 GeV
- ≥ 3 jets, E_T > 15 GeV

- ≥ 1 b-tagged jet

CDF: Decay Length Method, 695 pb^{-1}

- Signal and background L_{xy} distributions used as PDF's for pseudo-experiments ensembles →

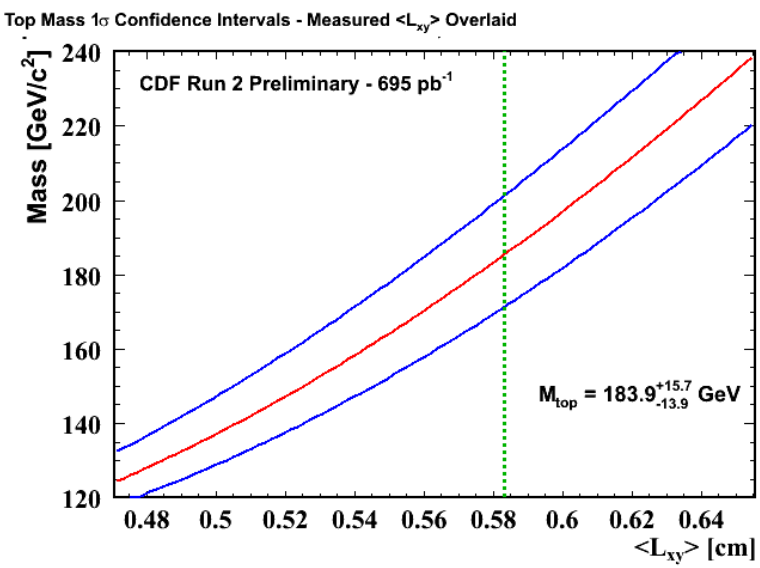


- 375 candidates, S:B = 2:1

Systematic uncertainties:

Source of Systematic Error	Uncertainty (GeV)
Generator/Fragmentation	0.7
ISR	1.0
FSR	0.9
PDF	0.5
Jet Energy Scale	0.3
Background Shape	2.3
Background Normalization	2.3
Multiple Interactions	0.2
Data/MC $\langle L_{xy} \rangle$ SF	4.2
Total	5.6

$$M_{top} = 183.9^{+15.7}_{-13.9}(\text{stat}) \pm 5.6(\text{sys})\,\text{GeV}/c^2$$



DØ: Matrix Element Method, 320 pb^{-1}

Pioneered by DØ with re-analysis of Run I data $\Rightarrow$ uses *in-situ* M_W constraint to calibrate the jet energy scale.

Makes maximal use of information in each event by calculating event-by-event probability to be signal or background, based on the respective matrix elements:

$$P_{evt}(x; m_{top}, JES) = f_{top} P_{sig}(x; m_{top}, JES) + (1 - f_{top}) P_{bkg}(x; JES)$$

- x: reconstructed lepton and jets kinematics
- JES from M_W constraint.
- Signal and background probabilities: from differential cross-sections

$$P(x; m_{top}) = \frac{1}{\sigma} \int d^n\sigma(y; m_{top})\, dq_1\, dq_2\, f(q_1)\, f(q_2)\, W(x, y)$$

- All events are combined in a likelihood

$$-\ln L(x_1, \ldots, x_n; m_{top}, JES) = -\sum_{i=1}^{n} \ln P_{evt}(x_i; m_{top}, JES)$$

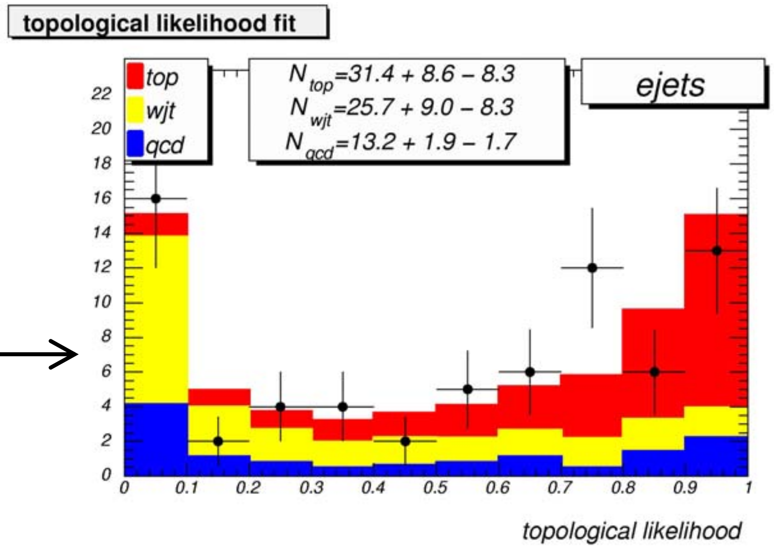
- Likelihood is maximized as a function of m_{top} and JES.

DØ: Matrix Element Method, 320 pb^{-1}

Event selection:

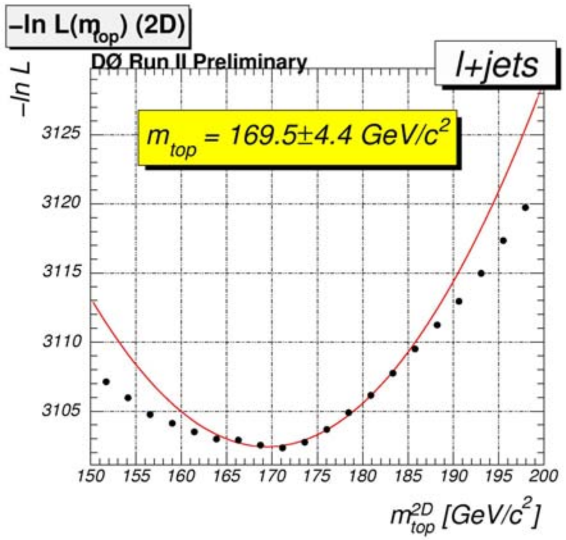
- 1 e or μ with $p_T > 20$ GeV
- $E_T^{miss} > 20$ GeV, $\Delta\phi$ (E_T^{miss},ℓ) cut
- = 4 jets, $E_T > 20$ GeV

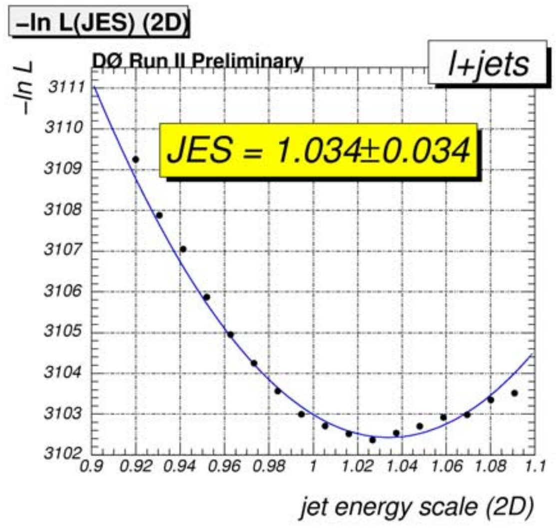
- Signal and background fractions cross-checked with a likelihood fit →
- 150 candidates, S:B = 1:2



Simultaneous fit of m_{top}, JES, and f_{top}:

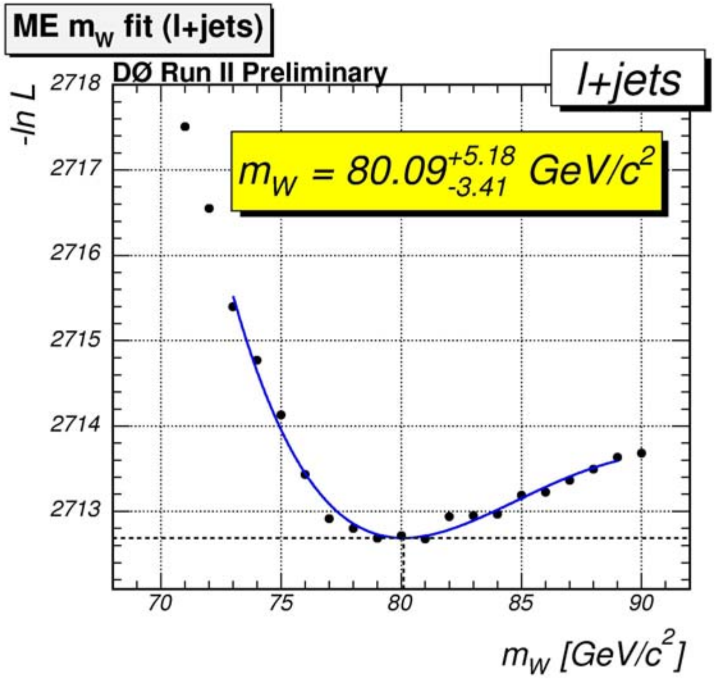
m_{top} and JES projections ⇒





DØ: Matrix Element Method, 320 pb^{-1}

Cross check on W mass:
(scaling jets by fitted JES)



Systematic uncertainties:

Uncertainty	ℓ+jets [GeV/c^2]
JES p_T dependence	± 0.7
b fragmentation	± 0.71
b response (h/e)	$+0.87 \; -0.75$
signal modeling	± 0.34
background modeling	± 0.32
signal fraction	$+0.50 \; -0.17$
QCD contamination	± 0.67
MC calibration	± 0.38
trigger	± 0.08
PDF uncertainty	± 0.07
TOTAL	$+1.7 \; -1.6$

$$M_{top} = 169.5 \pm 4.4(\text{stat}+\text{JES})^{+1.7}_{-1.6}(\text{sys})\,\text{GeV}/c^2$$

CDF: Matrix Element Method, 680 pb^{-1}

Event selection:

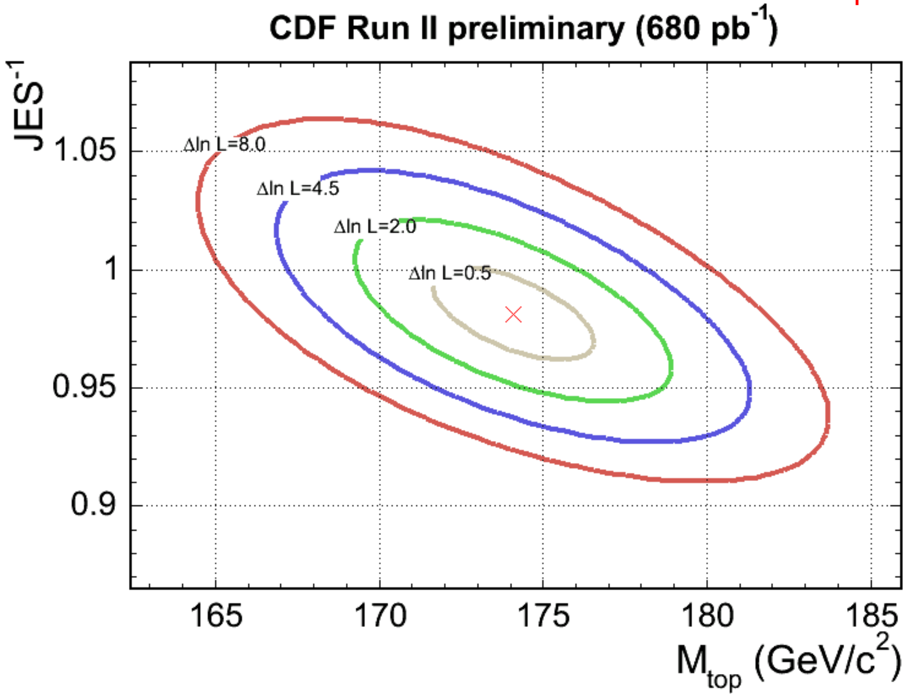
lepton	$E_T > 20$ GeV (e), $p_T > 20$ GeV/c (μ)
jets	$E_T > 15$ GeV, $\lvert\eta\rvert < 2.0$
missing E_T	missing $E_T > 20$ GeV
b-tag	≥ 1 jet coming from secondary vertex
QCD veto	$0.5 < \Delta\phi < 2.5$ (missing $E_T < 30$ GeV)

- 118 candidates, S:B = 2:1

Simultaneous fit of m_{top}, JES, and f_{top}

Systematic uncertainties (GeV/)	
JES residual	0.42
Initial state radiation	0.72
Final state radiation	0.76
Generator	0.19
Background composition and modeling	0.21
Parton distribution functions	0.12
b-JES	0.60
b-tagging	0.31
Monte Carlo statistics	0.04
Total	1.35

Combined Likelihood $1/$JES vs M_{top}:



$$M_{top} = 174.1 \pm 2.5(\text{stat}+\text{JES}) \pm 1.3(\text{sys})\,\text{GeV}/c^2$$

CDF: Dynamical Likelihood Method, 318 pb^{-1}

Event selection:

- 1 e or μ with $p_T > 20$ GeV
- $E_T^{miss} > 20$ GeV
- = 4 jets, $E_T > 15$ GeV

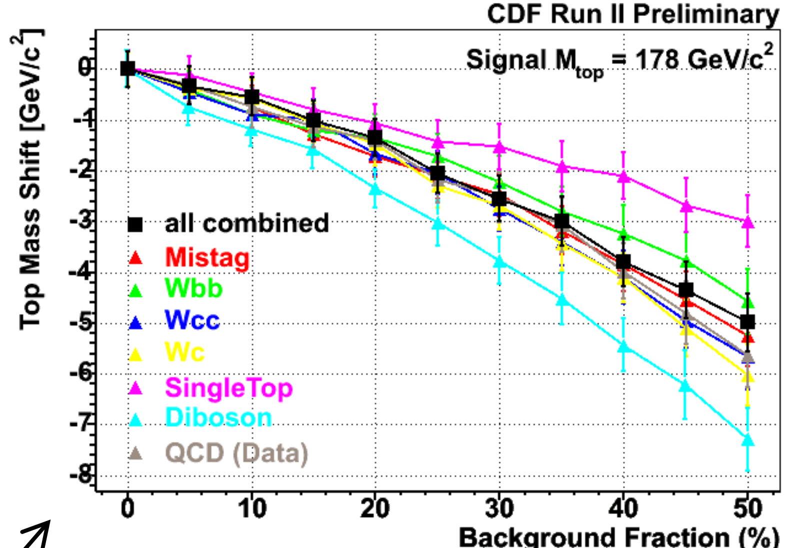
- ≥ 1 b-tag

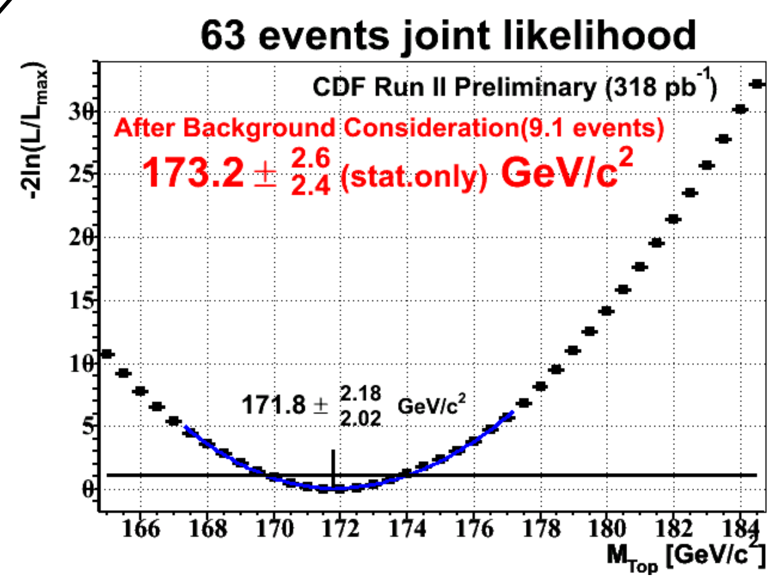
- 63 candidates, S:B = 6:1

Likelihood based on event-by event probability to be signal from ttbar LO Matrix Element.

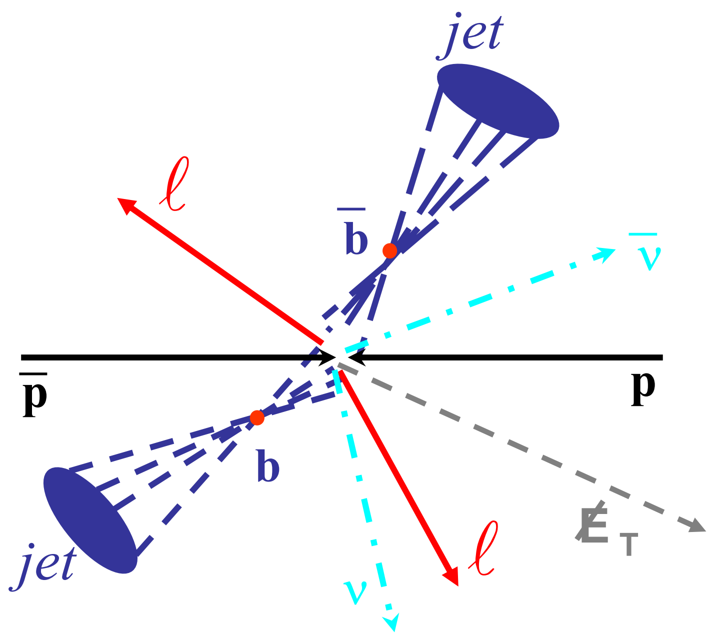
Shift on m_{top} estimated as a function of background fraction (14.5% in the data)

$$M_{top} = 173.2^{+2.6}_{-2.4}(\text{stat}) \pm 3.2(\text{sys})\,\text{GeV/c}^2$$





Mass in the ℓℓ+jets channel



$t(\rightarrow W^+ b)\ \bar{t}(\rightarrow W^- \bar{b})$

$\quad \hookrightarrow e^+, \mu^+ \qquad \hookrightarrow e^-, \mu^-$

DØ: Template Methods, Matrix Weighting 370 pb^{-1}

General: the dilepton channel is underconstrained. Template methods assume values for certain variables in order to extract a solution, and assign weights to the different solutions.

The matrix Weighting method scans over top masses and assigns a weight to the solution, based on the Matrix Element predictions for the lepton p_T's:

$$W_o(m_{top}) = \sum_{solutions} \sum_{jets} f_{PDF}(x) f_{PDF}(\overline{x}) p(E_l^* \mid m_{top}) p(E_{\bar{l}}^* \mid m_{top})$$

- binned maximum likelihood fit to signal and background templates

Event selection:

eμ channel

- 1 e, $p_T(e)$>15 GeV
- 1 μ, $p_T(\mu)$>15 GeV
- H_T > 122 GeV
- ≥ 2 jets, E_T > 20 GeV

ee channel

- 2 e's, $p_T(e)$>15 GeV
- m_{ee}< 80(>100) GeV
- ≥ 2 jets, E_T > 20 GeV
- E_T^{miss}>40(35) GeV [m_{ee}<80(>100) GeV]
- sphericity > 0.15

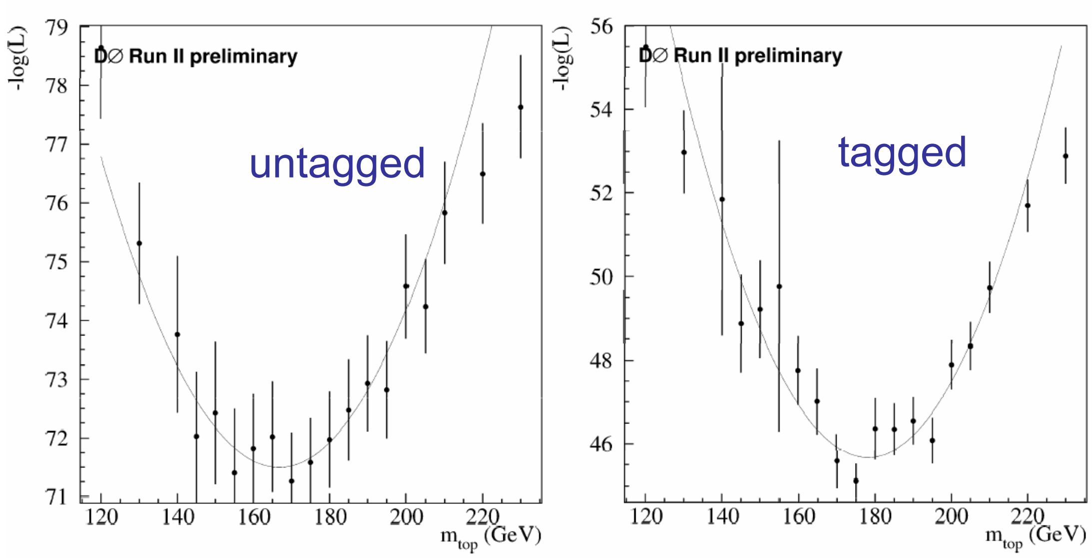
μμ channel

- 2 μ, $p_T(\mu)$>15 GeV
- contour cut on E_T^{miss} and $\Delta\phi(\mu_1, E_T^{miss})$
- ≥ 2 jets, E_T > 20 GeV
- Z fitter χ^2 test

DØ: Template Methods, Matrix Weighting 370 pb^{-1}

- Untagged analysis: 21 candidates, S:B = 4:1
- b-tagged (≥ 1 b-tag) analysis: 14 candidates, S:B = 48:1

Likelihood fits:



Systematic uncertainties:

	untagged	tagged
JES	3.5	3.5
PDF	0.9	0.9
Gluon radiation	0.8	0.8
background	0.7	0.2
calibration	0.6	0.6
template stat.	0.3	0.3
Total	3.8 GeV	3.8 GeV

$$M_{top} = 165.0 \pm 13.5(\text{stat}) \pm 3.8(\text{sys})\,\text{GeV}/c^2$$ untagged

$$M_{top} = 176.6 \pm 11.2(\text{stat}) \pm 3.8(\text{sys})\,\text{GeV}/c^2$$ tagged

DØ: Template Methods, Neutrino Weighting 370 pb^{-1}

The Neutrino Weighting method scans over top masses and the η's of the two neutrinos and assigns a weight (as a function of m_{top}) to the solution, based on the agreement of the calculated neutrino p_T's and the observed E_T^{miss}

$$w = \frac{1}{N_{iter}} \sum_{i=1}^{N_{iter}} exp\left(\frac{-(E_{x,i}^{calc} - E_{x}^{obs})^2}{2\sigma_{E_x}^2} \right) exp\left(\frac{-(E_{y,i}^{calc} - E_{y}^{obs})^2}{2\sigma_{E_y}^2} \right)$$

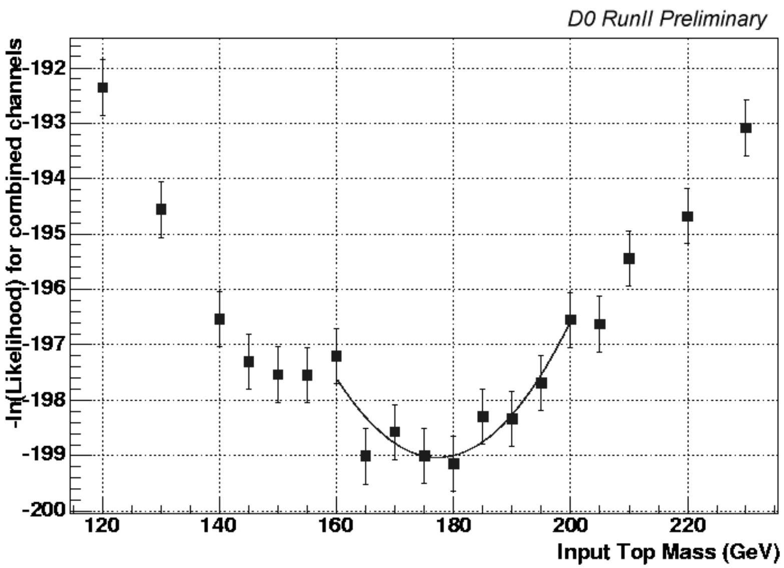
- maximum likelihood fit to signal and background templates

Event selection: similar to the matrix weighting measurement, only exception: simpler electron likelihood cut, E_T^{miss} > 25 GeV, and H_T(ℓ,jets) > 144 GeV in the ee channel.

- Untagged analysis: 21 candidates, S:B = 4:1

DØ: Template Methods, Neutrino Weighting 370 pb^{-1}

Likelihood fit:



Systematic uncertainties:

JES	5.3
Jet resolution	0.5
Muon resolution	0.4
PDF	0.7
Gluon radiation	2.0
background	1.3
template stat.	0.9
Total	6.0 GeV

$$M_{top} = 175.6 \pm 10.7(\text{stat}) \pm 6.0(\text{sys})\,\text{GeV}/c^2$$

CDF: Template Methods, Neutrino Weighting 358.6 pb^{-1}

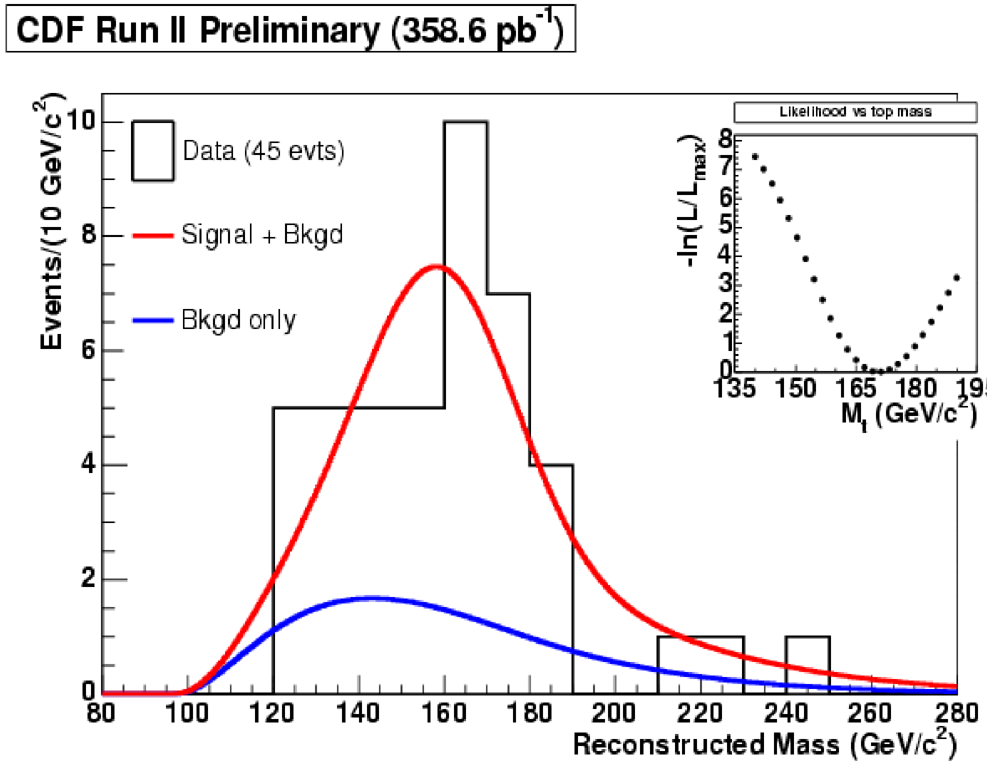
Event selection: ℓ+track

- 1 e(μ) with p_T >20 GeV
- E_T^{miss} > 20 GeV
- ≥ 2 jets, E_T > 15 GeV
- isolated track, p_T >20 GeV

- 46 candidates, S:B=2:1

Systematic uncertainties:

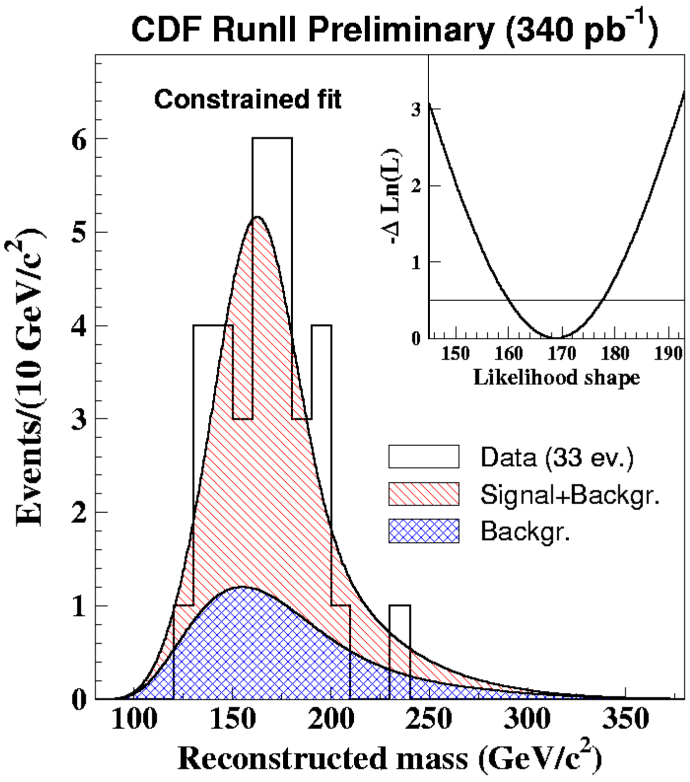
JES	3.4
b-jet energy	0.6
MC generator	0.5
PDF's	0.5
ISR	0.6
FSR	0.5
Signal templates	0.2
Backg. templates	1.3
Backg. shape	2.6
Total	4.6 GeV



$$M_{top} = 170.7^{+6.9}_{-6.5}\,(\text{stat}) \pm 4.6(\text{sys})\,\text{GeV/c}^2$$

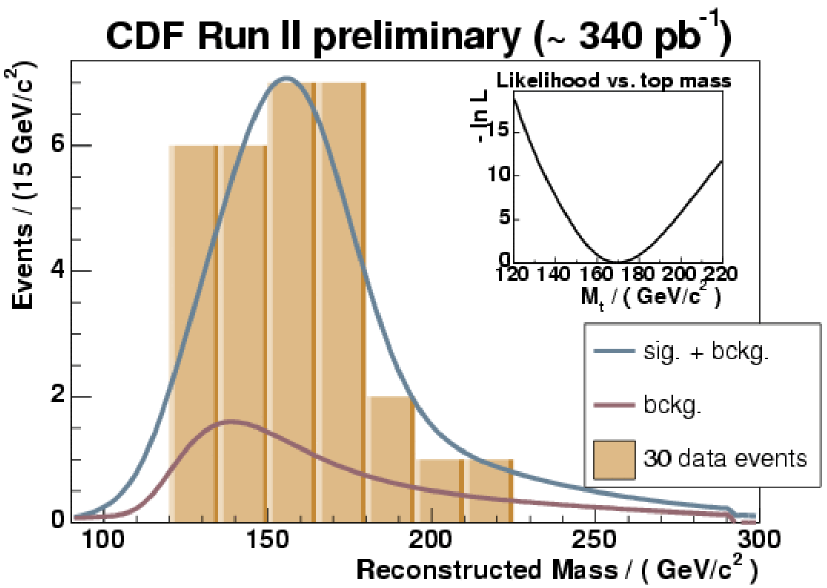
CDF: Template Methods, ϕ and P_z Weighting 340 pb^{-1}

Weight on the neutrinos ϕ's



$$M_{top} = 169.7^{+8.9}_{-9.0}(stat) \pm 4.0(sys) GeV/c^2$$

Integrate over the value of ttbar P_z



$$M_{top} = 169.5^{+7.7}_{-7.2}(stat) \pm 4.0(sys) GeV/c^2$$

CDF: Matrix Element Method 750 pb^{-1}

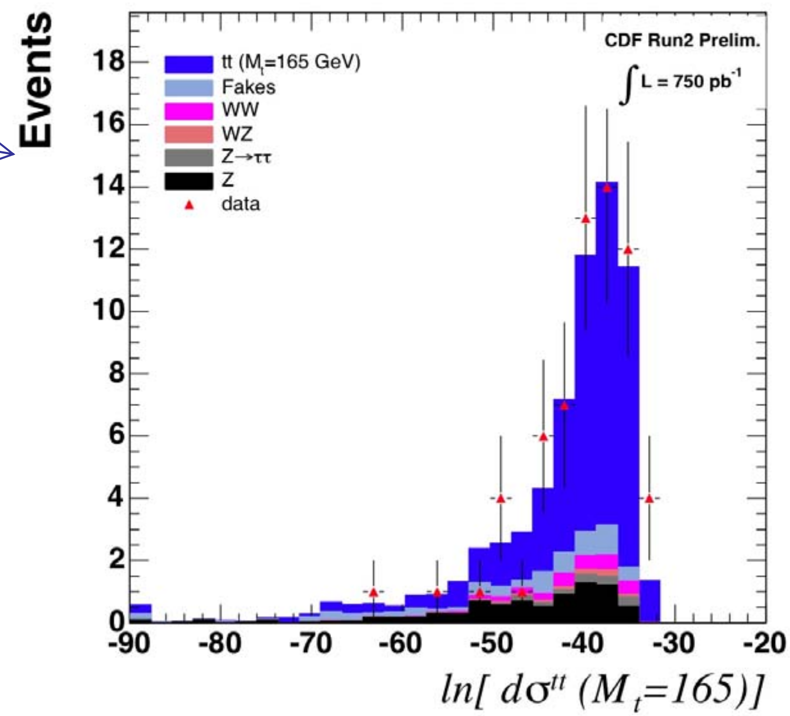
Uses a per-event probability for the mass as a weighted sum of the differential cross-section for LO top quark pair production and of the differential cross section for background processes:

signal/backg fractions

$$P(\boldsymbol{x}\,|\,M_t) = P_s(\boldsymbol{x}\,|\,M_t)\,p_s + P_{bg1}(\boldsymbol{x})\,p_{bg1} + P_{bg2}(\boldsymbol{x})\,p_{bg2} + \ldots$$

$$P_s(\boldsymbol{x}\,|\,M_t) = \frac{1}{\sigma(M_t)}\frac{d\sigma(M_t)}{d\boldsymbol{x}}$$

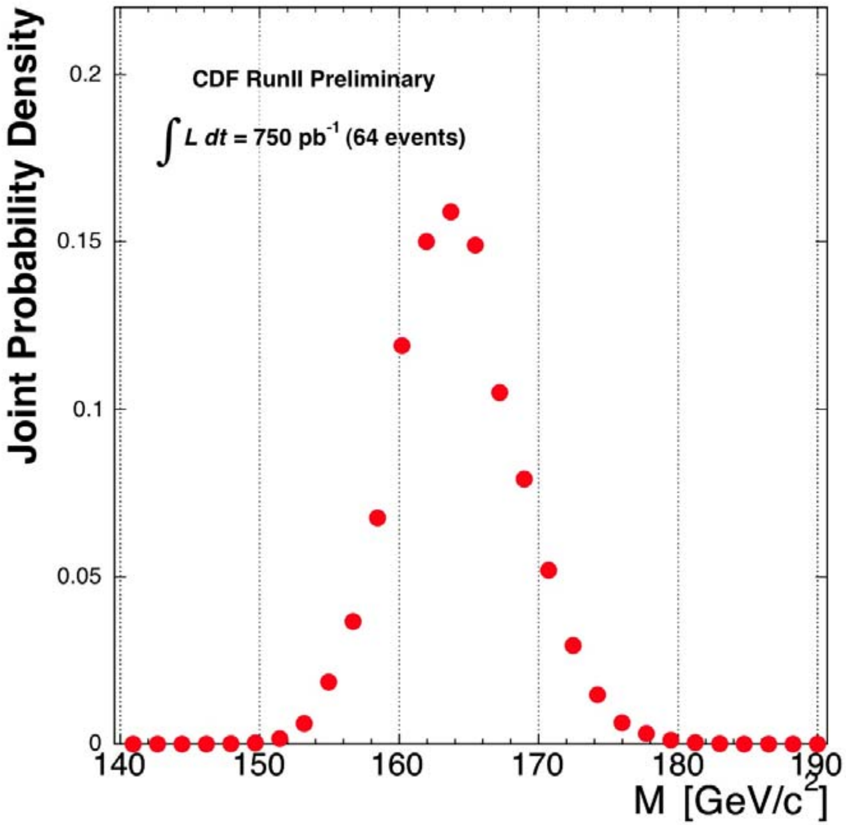
- **Posterior probability density:** product of a flat prior and the joint likelihood, (mean,σ) ⇒ (M_{top}, ΔM_{top}).
- **Event Selection:**
  - 2 e(μ) with p_T >20 GeV
  - E_T^{miss} > 25 GeV
  - $\Delta\phi(E_T^{miss}, \ell$ or j)>20°
  - ≥ 2 jets, E_T > 15 GeV



CDF: Matrix Element Method 750 pb^{-1}

- 64 candidates, S:B=2:1

Joint probability density



Systematic errors:

Source	ΔM_t (GeV/c^2)
Jet Energy Scale	2.6
Generator	0.5
Response uncertainty	0.3
Sample composition uncertainty	0.7
Background statistics	0.8
Background modeling	0.8
ISR modeling	0.5
FSR modeling	0.5
PDFs	0.6
Total	3.1

$$M_{top} = 164.5 \pm 4.5(stat) \pm 3.1(sys) GeV/c^2$$

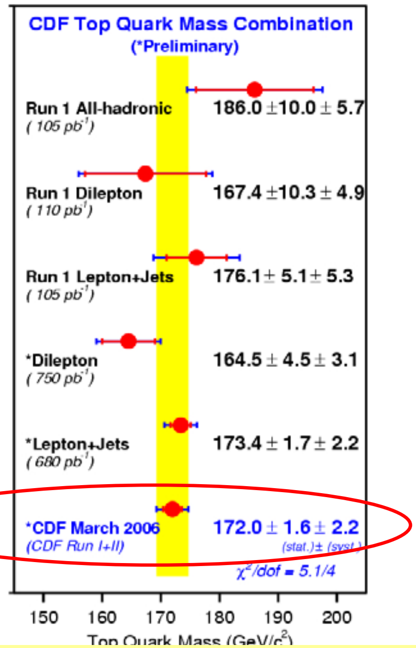
⇒ most precise dilepton measurement

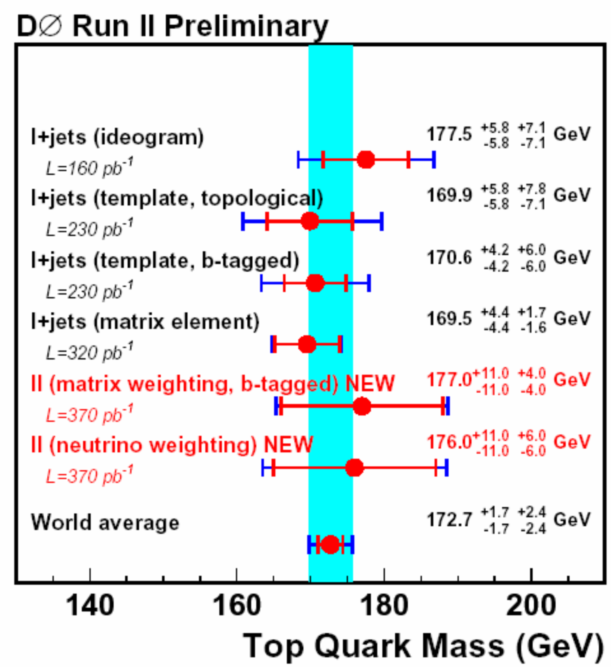
Dynamical Likelihood Method (340 pb^{-1}):

$$M_{top} = 166.6^{+7.3}_{-6.7}(stat) \pm 3.2(sys) GeV/c^2$$

Mass summary & combination

Top quark mass: Summary





CDF average $M_{top} = 172.0 \pm 2.7$ GeV

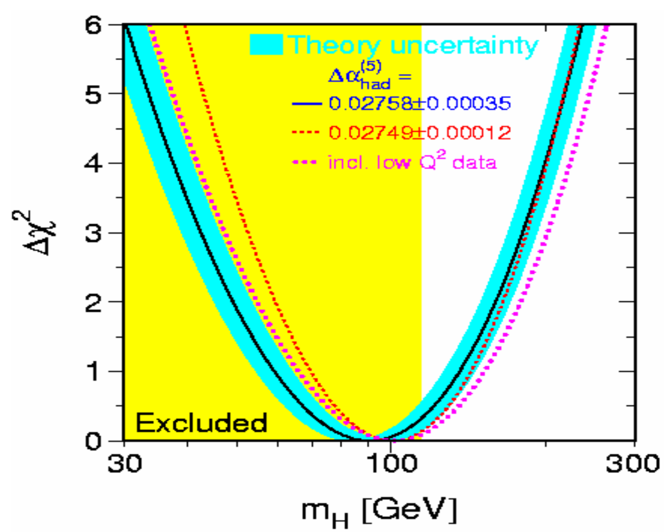
- New Run II measurements achieving better uncertainties than Run I world average.
- EPS 2005 Run I+ Run II world average:

$$M_{top} = 172.7 \pm 2.9\,\text{GeV};\ \chi^2/\text{dof} = 6.5/7$$

Impact on SM Higgs boson:

$$M_H = 91^{+45}_{-32}\,\text{GeV};\ M_H < 186\,\text{GeV} @ 95\%\text{CL}$$

⇒uncertainty now dominated by ΔM_W



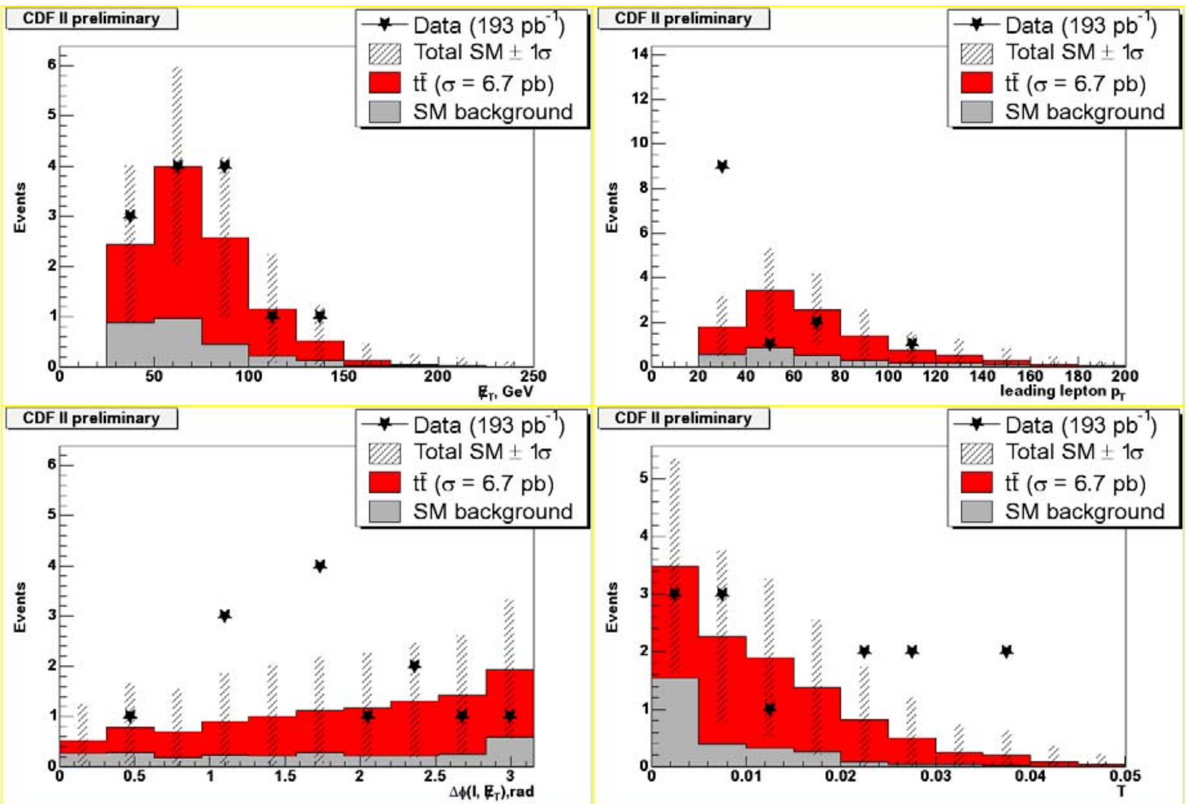
Search for new physics

Anomalous ttbar kinematics

Estimate consistency of observed kinematics of the ttbar system with SM

(in Run I, several CDF events at high E_T^{miss} and $p_{T\ell}$)

- four chosen variables: E_T^{miss}, $p_{T\ell}$, $\Delta\phi(\ell, E_T^{miss})$, dilepton “topology” (T)



$$T_w = \int \exp\left\{-\frac{(\vec{\not{E}}_T^{\,predicted} - \vec{\not{E}}_T^{\,measured})^2}{2\sigma^2_{\not{E}_T}}\right\} d\vec{\not{E}}_T^{\,predicted}$$

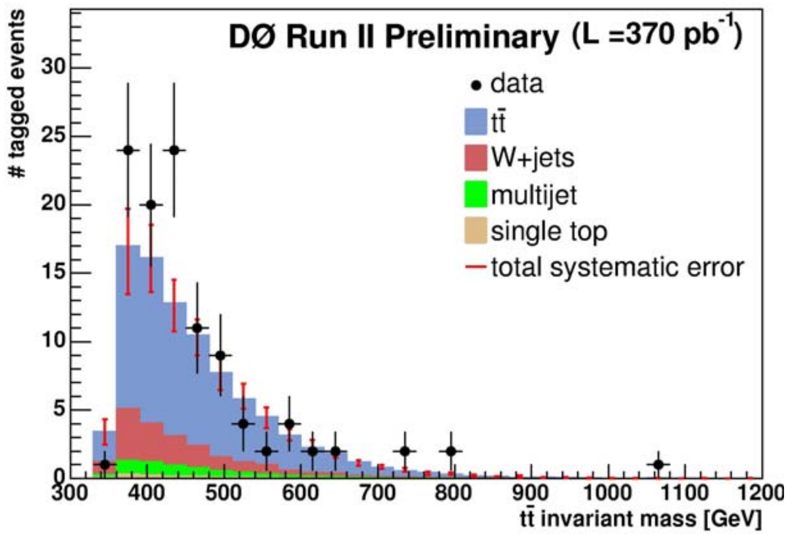
CDF, 193 pb^{-1} consistent with the SM with a probability of 1-4.5%

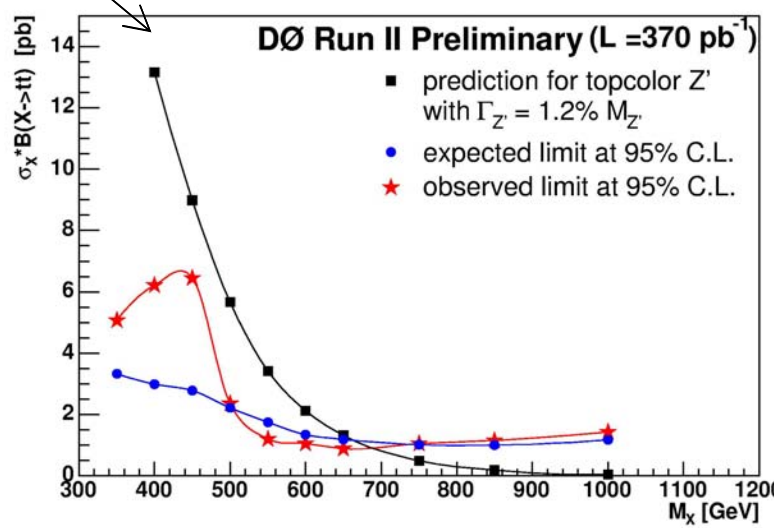
Model independent search for new physics

DØ: ttbar mass spectrum

Search for new particles in Top production, leading to a resonance in the ttbar mass spectrum

- ℓ+≥4 jets candidate events (≥1 b-tag), $370 pb^{-1}$
- ttbar invariant mass reconstructed with ttbar production hypothesis (kinematic fitting)
- Model independent limits on σxBr(X→ttbar)



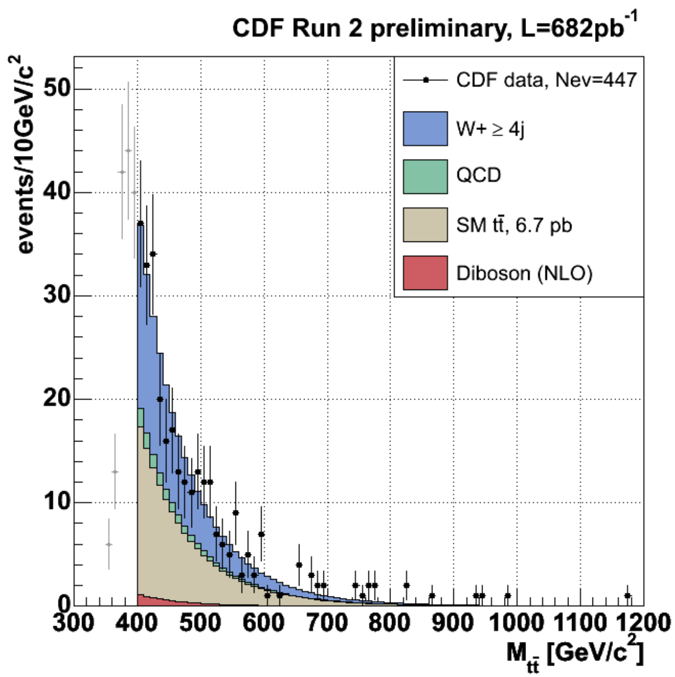


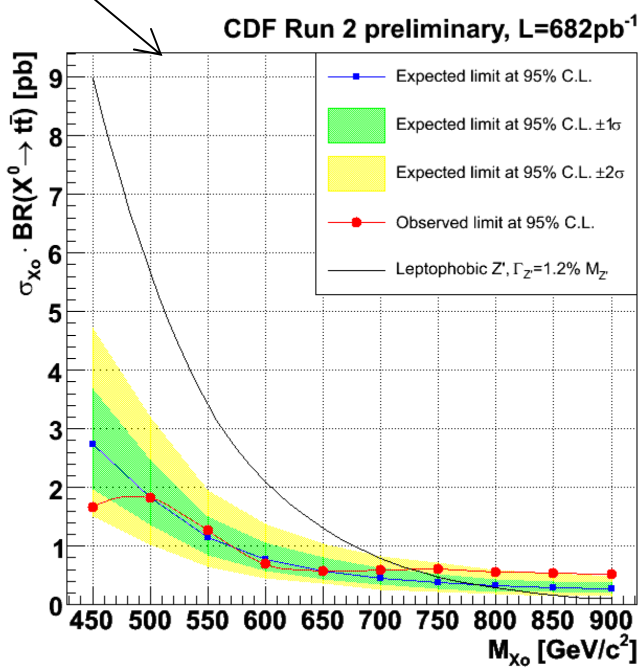
Limit on a narrow leptophobic Z' (total width $\Gamma_{Z'}=1.2\%M_{Z'}$):

$M_{Z'}>680$ GeV at 95% CL

CDF: ttbar mass spectrum

- ℓ+≥4 jets candidate events, 682pb^{-1}
- ttbar invariant mass reconstructed with ttbar production hypothesis (likelihood incorporating LO matrix element for ttbar)
- Model independent limits on σxBr(X→ttbar)





Limit on a narrow leptophobic Z' ($\Gamma_{Z'}$=1.2%$M_{Z'}$):

$M_{Z'}$>725 GeV at 95% CL

Summary and conclusions

Results on Top mass and kinematics presented for datasets up to 750 pb^{-1}, with single mass measurements already exceeding past world average values.

The excellent performance of the Tevatron and the CDF and DØ experiments are the key to precision measurements in top physics and to the search for new physics coupled to the top quark.

It's good to look behind us, but the real excitement is in what lies ahead!