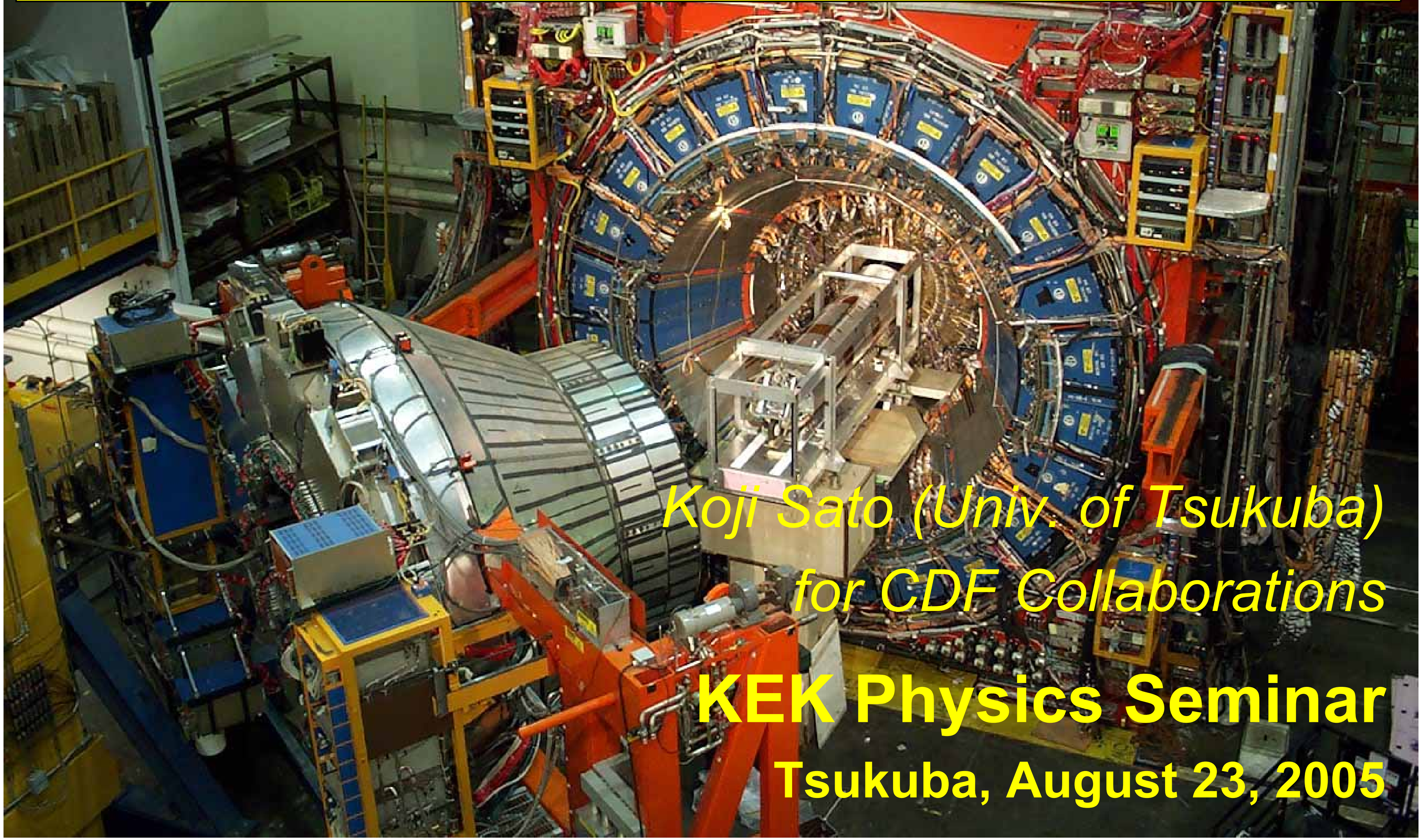
Top Quark Mass Measurement in CDF Run II



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for CDF Collaborations

KEK Physics Seminar

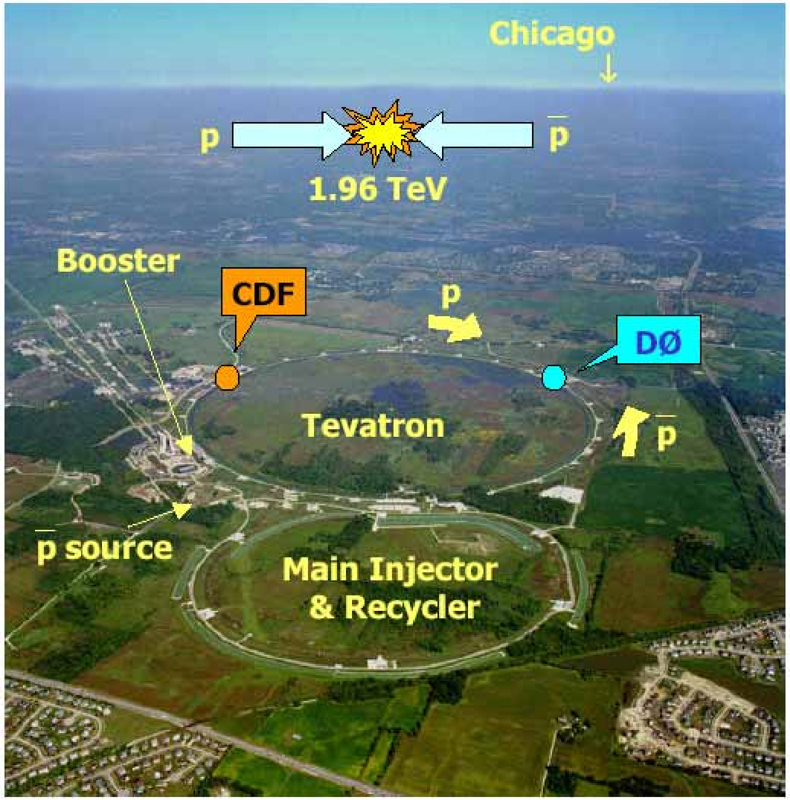
Tsukuba, August 23, 2005

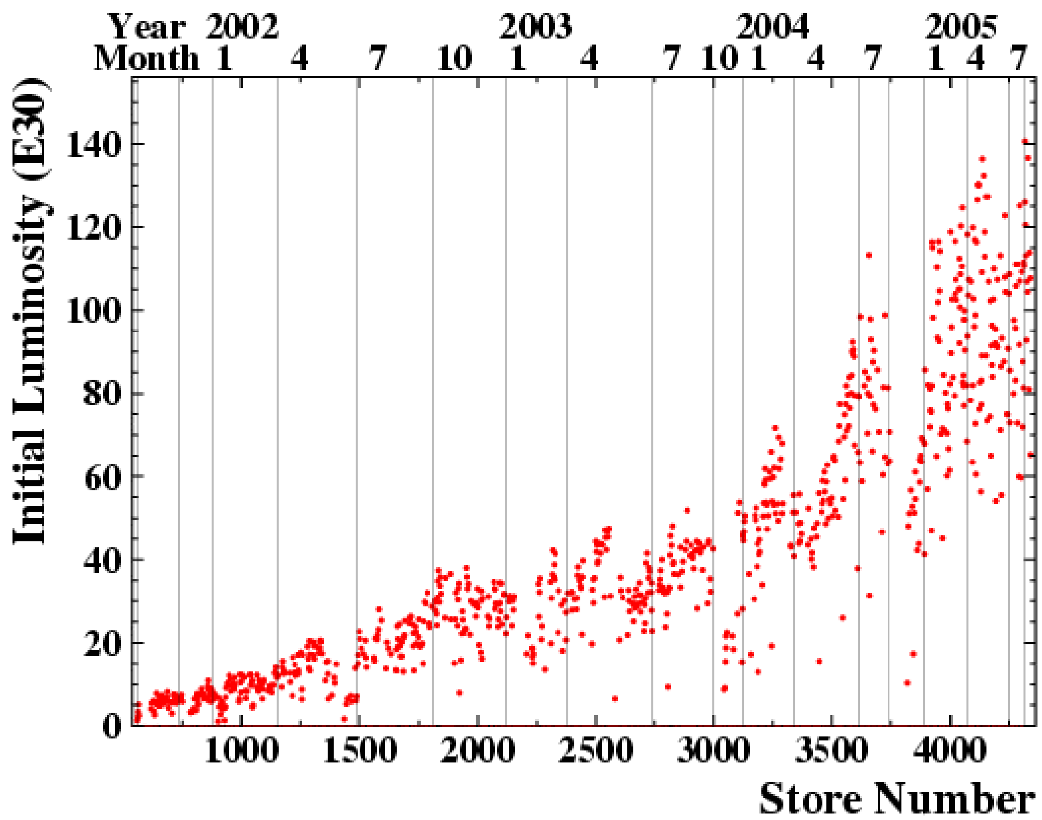
Contents

- Introduction
  - Experimental facility
  - Motivation for top mass measurement
  - Properties of signal process and related issues
- Current world’s best single measurement
  - Traditional template method in lepton+jets channel
  - Improved template method w/ in-situ JES calib.
- Other measurement methods
- Combined result of CDF/D0, Run I/Run II measurements
  - Updated Electroweak fit result
  - Updated Standard Model Higgs upper limit

Introduction

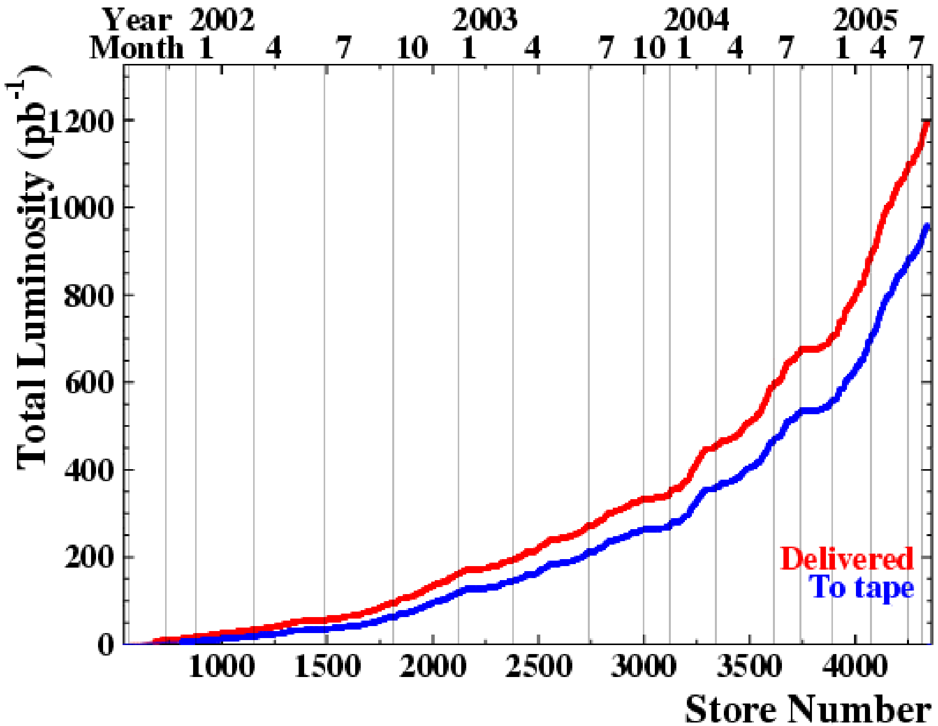
Tevatron Run II

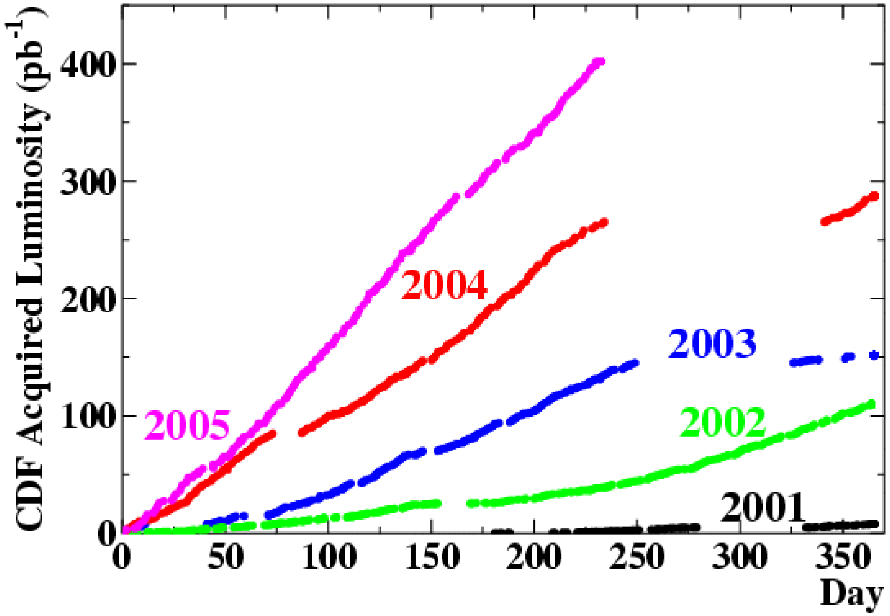




- $p-\overline{p}$ collisions at $\sqrt{s}$ = 1.96 TeV (1.8 TeV in Run I).
- Peak luminosity record : 1.4×10^{32} $cm^{-2}\cdot s^{-1}$.
- Direct study on top quark is only possible at Tevatron!

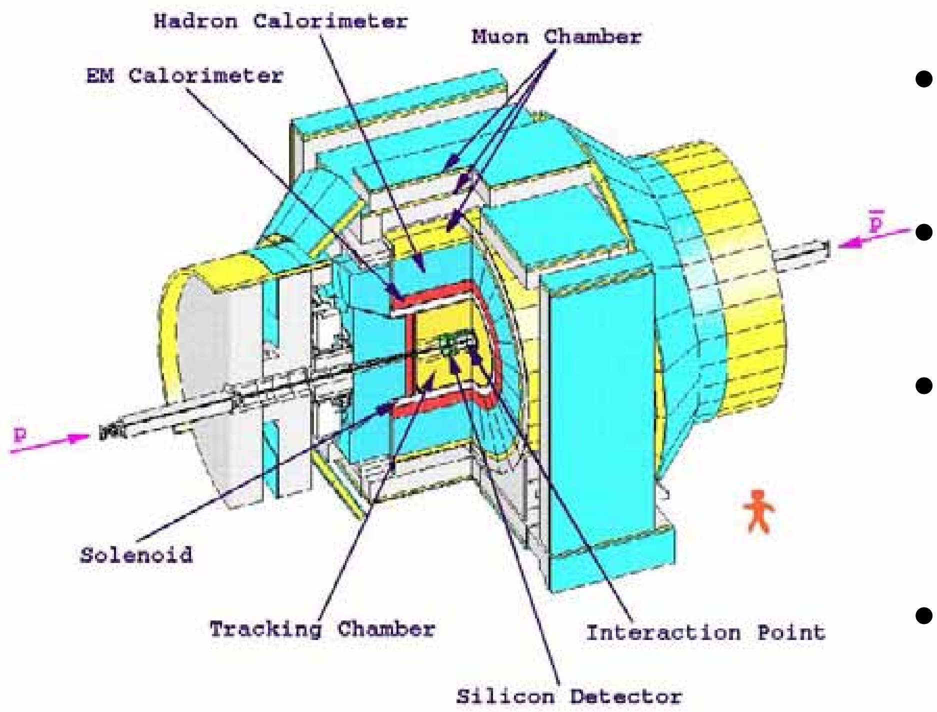
Tevatron Run II Luminosity Status





- Tevatron has already delivered ~1.2 fb^{-1} of collisions in Run II.
- CDF has acquired ~1 fb^{-1} of data.
- Annual integrated luminosity is doubled each year.
- Analyses in this presentation use 300 – 400 pb^{-1} of data.
- We will analyze dataset of size ~1fb^{-1} in Winter 2006!

Collider Detector at Fermilab

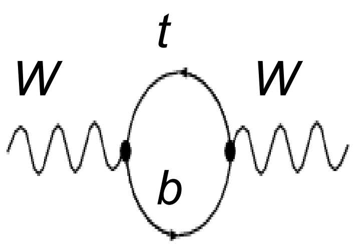


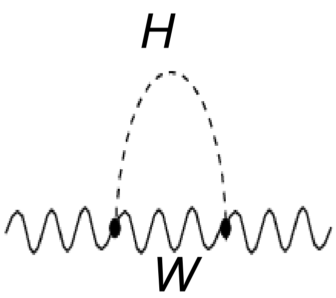
Multi-purpose detector

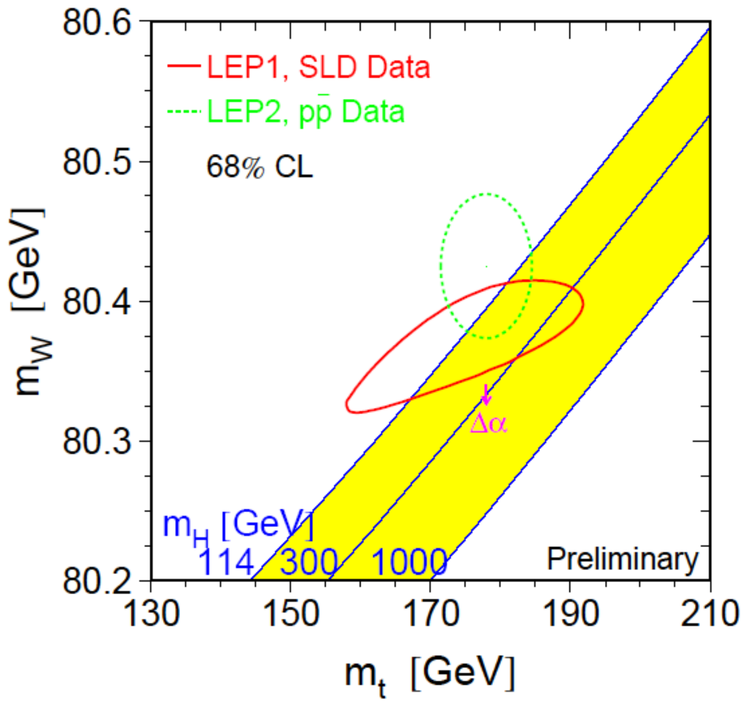
- Tracking in magnetic field.
  - Coverage $|\eta|<\sim 1$.
- Precision tracking with silicon.
  - 7 layers of silicon detectors.
- EM and Hadron Calorimeters.
  - $\sigma_E/E \sim 14\%/\sqrt{E}$ (EM).
  - $\sigma_E/E \sim 84\%/\sqrt{E}$ (HAD).
- Muon chambers.

Top Quark Mass - Introduction

- Top is one of the least well studied elementary particles (evidence by CDF in 1994 / discovery by CDF/D0 in 1995).
- Top mass is a fundamental parameter of the Standard Model.
- Mass measurements of top and W constrain the Higgs mass.





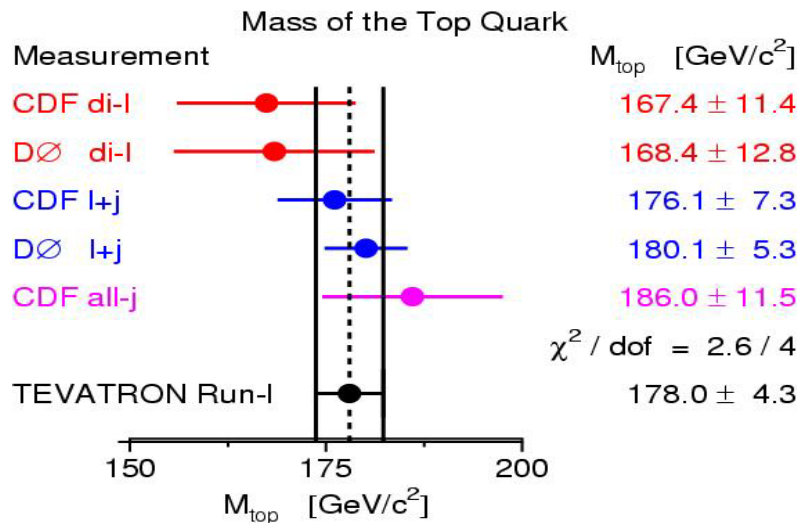


- m_{top} ~ EWSB scale.

→Special role of top?

Summary of Run I Results

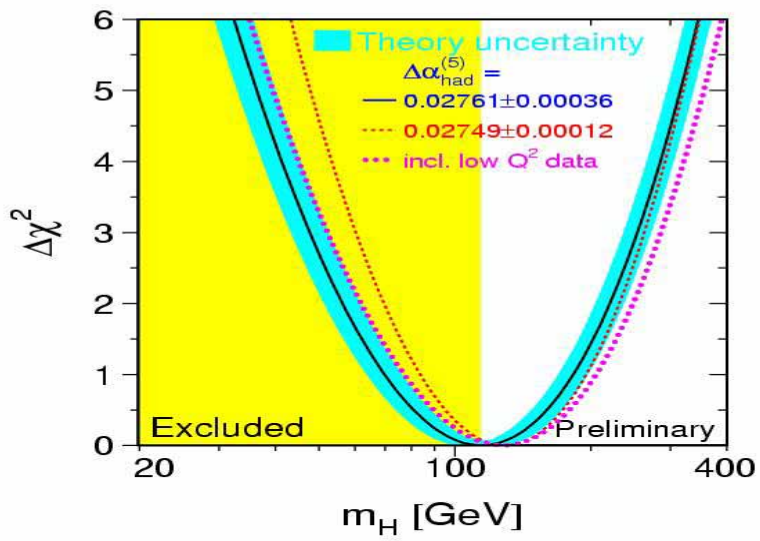
- Tevatron Run I average
  (~100 pb^{-1}/exp.) :
  $m_{top} = 178.0 \pm 2.7 \pm 3.0$ GeV/c^2
  ($= 178.0 \pm 4.3$ GeV/c^2)



→ $\boxed{m_{higgs} = 114\ {+69}/{-45}\ \text{GeV}/c^2 \quad m_{higgs} < 260\ \text{GeV}/c^2\ (95\%)}$

- CDF Run II goal :

$$\boxed{\int L\,dt = 4 - 8\ \text{fb}^{-1} \qquad \Delta m_{top} \sim 2\ \text{GeV}/c^2}$$

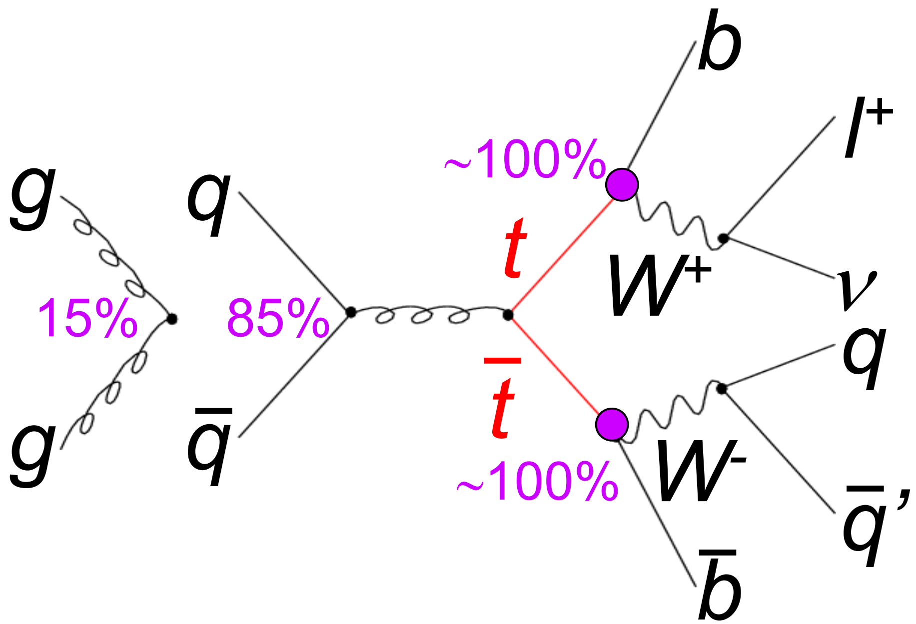


Top Quark Production and Decay

- We use pair creation events (σ~6pb^{-1}) to measure m_{top}.
- Top decays before hadronization.

  τ_{top}=0.4x10^{-24} s < 1/Λ_{QCD}~10^{-23} s.

  Br(t→Wb) ~ 100%.



Final states :

Mode	Br.(%)	
dilepton	5%	Clean but few signal. Two ν's in final state.
lepton+jets	30%	One ν in final state. Manageable bkgd.
all hadronic	44%	Large background.
τ + X	21%	τ-ID is challenging.

Event Selection

Lepton+jets

- 1 lepton (e/μ)
- $\not{E}_T$
- 4 jets (2 *b*-jets) (cone algorithm)
- Special cut on for 0tag event (CDF:hard cut on E_T^{4thjet})
- Secondary vertex *b*-tagging.

Dilepton

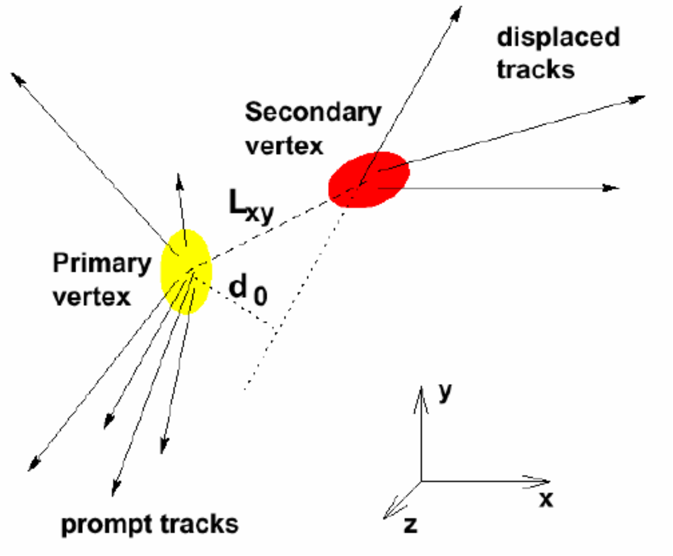
- 2lepton (e/μ)
- $\not{E}_T$
- 2 jets (2 *b*-jets)
- No *b*-tagging (good purity / low rate)

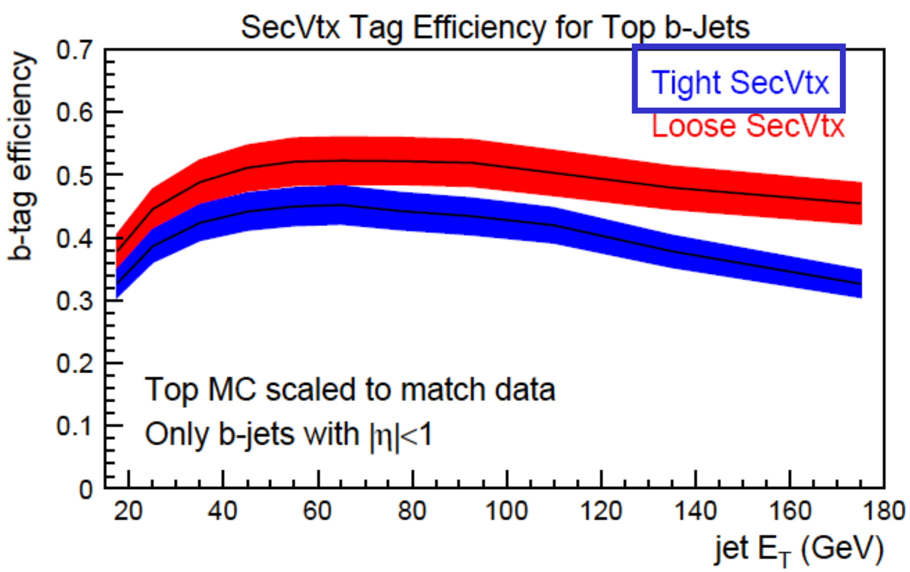
Typical CDF event rate and S/B

	L+jets			Dilepton
	0tag	1tag	2tag	
Nevt (320pb^{-1})	40	82	16	33
S/B	1/1	2/1	18/1	2/1

B-Tagging

- B-jet tagging by secondary vertex displacement from the primary vertex.
- B-tagging reduces wrong jet-parton assignment as well as background events.
- ~25 lepton+jets event w/ (≥1) b-tag / 100 pb^{-1}.
- Light flavor rejection factor ~300.

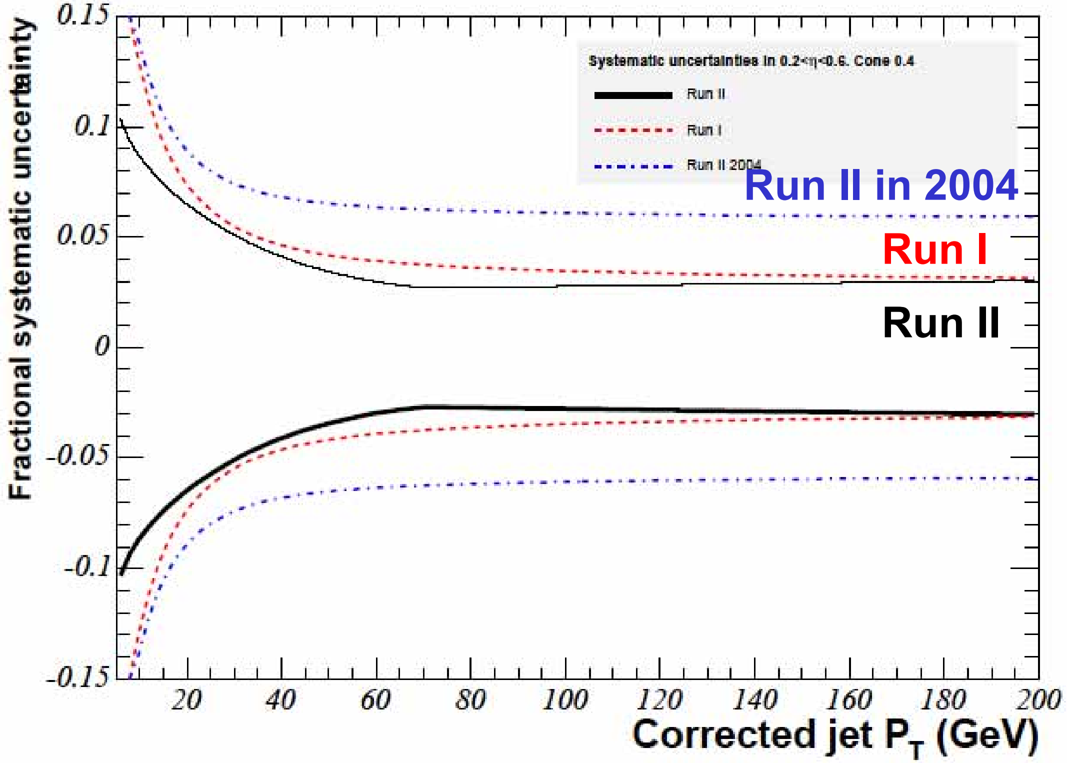




Jet Energy Scale

Jet energy scale uncertainty has been the dominant source of systematic uncertainty on top mass measurement.

- Uncertainty on Run I World Ave. on top mass ±4.3 GeV/c^2
  - ±2.6 GeV/c^2 from JES
  - ±2.7 GeV/c^2 from stat.
- A lot of effort has been made to improve JES systematics.
- Current Run II JES uncertainty is at the same level or better than Run I.



Measurement Methods

Template Method

- Reconstruct event-by-event M_{top}.
- Describe dependence of M_{top} distribution on true top mass m_{top} using MC — Templates.
- Likelihood fit looks for m_{top} that describes data M_{top} distribution best (template fit).
- Less assumptions / robust measurement.

Matrix Element Method

- Calculate likelihood (probability) for m_{top} in each event by Matrix Element calculation.
- Multiply the likelihood over the candidate events.
- m_{top} determination by the joint likelihood maximum.
- Better statistical precision expected w/ using more info.

All methods in all channels are well validated by a blind sample.

Template Method in Lepton+Jets Channel

Event Reconstruction

Minimize χ^2 to reconstruct event-by-event top mass (2-C fit).

Fluctuate particle momenta according to detector resolution.

M_{top} as free param.

$$\chi^2 = \boxed{\sum_{i=l,jets} \frac{(P_T^{i,fit} - P_T^{i,meas.})^2}{\sigma_i^2} + \sum_{j=x,y} \frac{(UE_j^{j,fit} - UE_j^{j,meas.})^2}{\sigma_j^2}}$$
$$+ \boxed{\frac{(M_{jj} - M_W)^2}{\Gamma_W^2} + \frac{(M_{l\nu} - M_W)^2}{\Gamma_W^2}} + \boxed{\frac{(M_{l\nu b} - M_{top})^2}{\Gamma_{top}^2} + \frac{(M_{jjb} - M_{top})^2}{\Gamma_{top}^2}}$$

Constrain masses of 2 W's.

t and $\bar{t}$ have the same mass.

- 2jets from W decay + 2*b*-jets. $\rightarrow$12 jet-parton assignments.

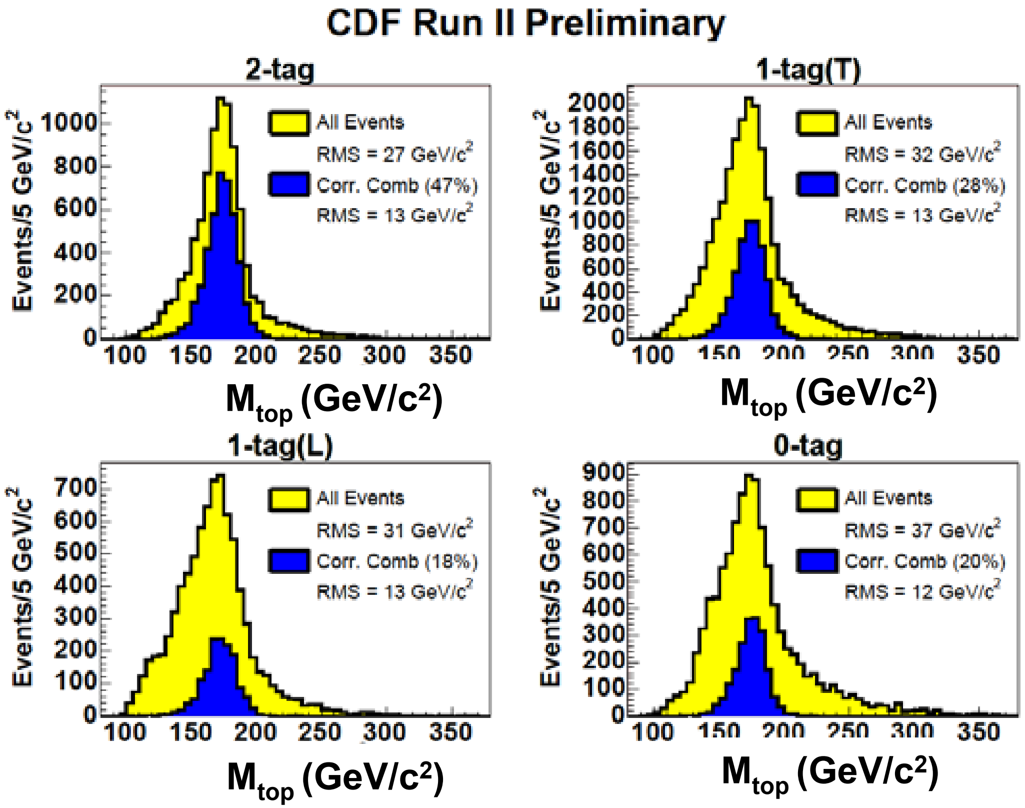
➔ We choose the assignment with smallest χ^2 as seemingly correct event reconstruction.

Sample Subdivision

Category	2-tag	1-tag(T)	1-tag(L)	0-tag
j1-j3 j4	$E_T>15$ $E_T>8$	$E_T>15$ $E_T>15$	$E_T>15$ $15>E_T>8$	$E_T>21$ $E_T>21$
S/B	18/1	4.2/1	1.2/1	0.9/1
# jet-parton assign.	2	6	6	12
Correct %	47	28	18	20

- 2jets from W decay + 2*b*-jets. →12 jet-parton assignments.
- *B*-tagging helps reject wrong assignments besides reduces background.

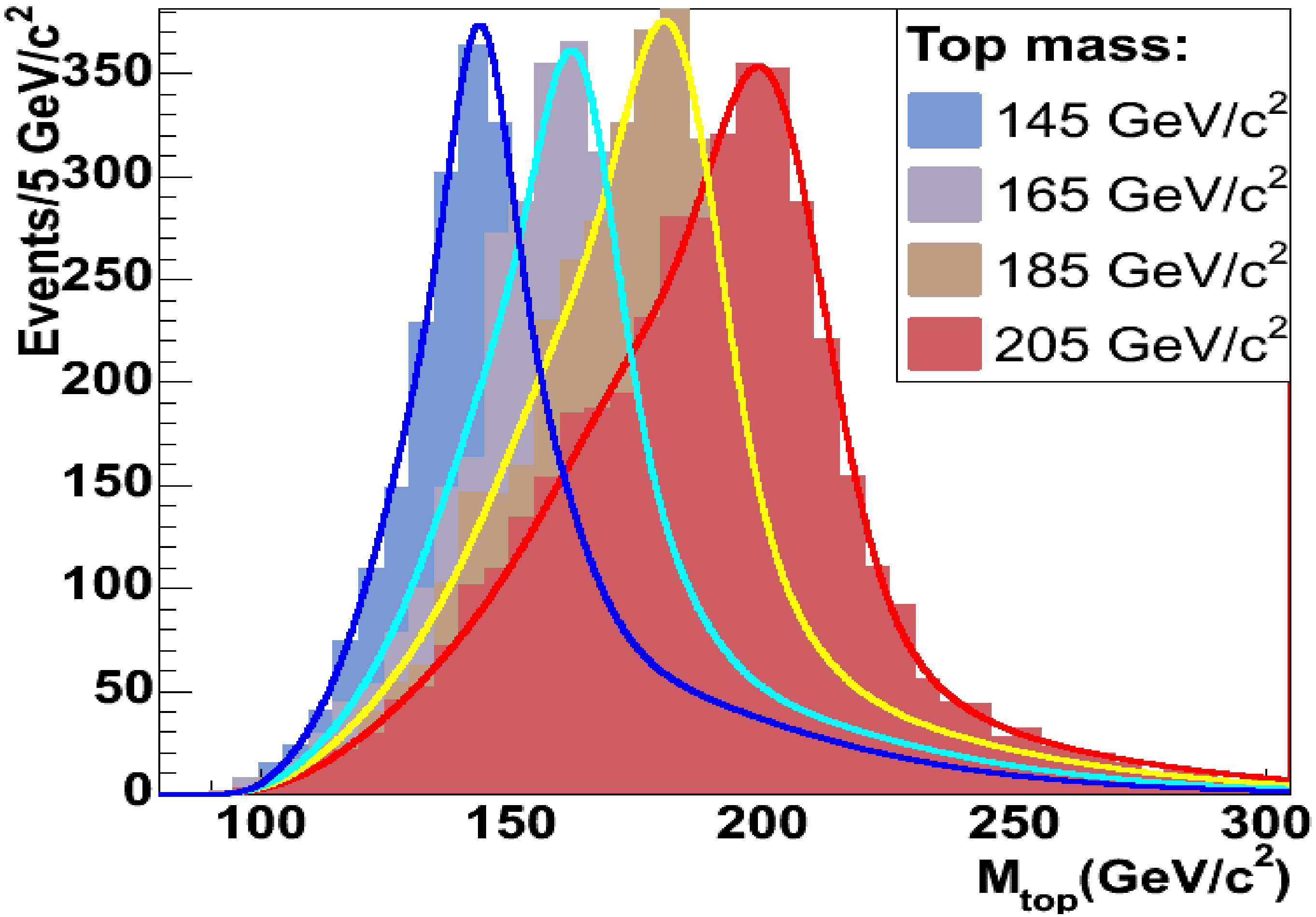
→ Sample subdivision by #b-tagged jets in event.



Top Mass Templates (Signal)

M_{top} distribution shape is parameterized as a function of true top mass using Monte Carlo samples.

Signal Template (1tagT)



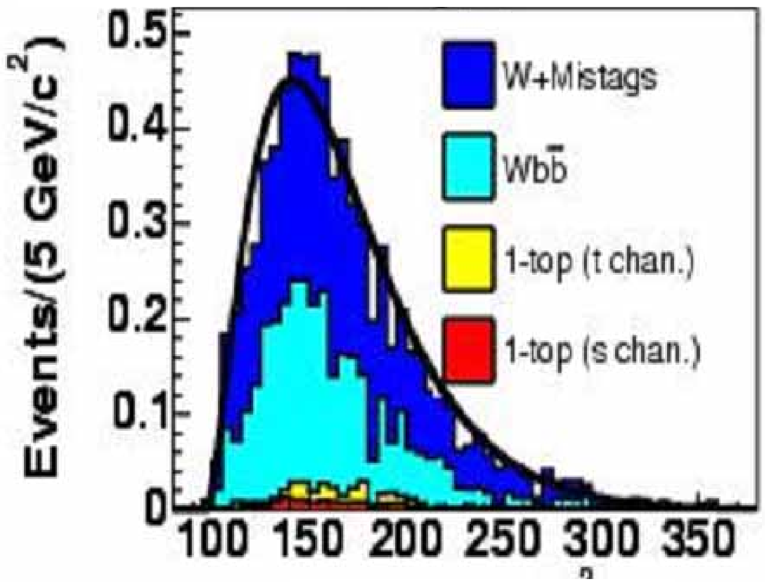
Top Mass Templates (Bkgd.)

Estimated # of Background $\mathcal{L} = 318\ pb^{-1}$

	2tag	1tagT	1tagL	0tag
W+jets	0.40±0.08	3.22±0.41	4.14±0.53	–
W+HF	1.12±0.43	3.91±1.23	6.82±1.85	–
WW/WZ	0.05±0.01	0.45±0.10	0.71±0.13	–
non-W	0.31±0.08	2.32±0.50	2.04±0.54	–
single top	0.008±0.002	0.49±0.09	0.60±0.11	–
Total Bkg.	**1.89±0.52**	**10.4±1.7**	**14.3±2.5**	–
#candidate	**16**	**57**	**25**	**40**

Background distribution is also fit into a function.

Background Template (1tagT)



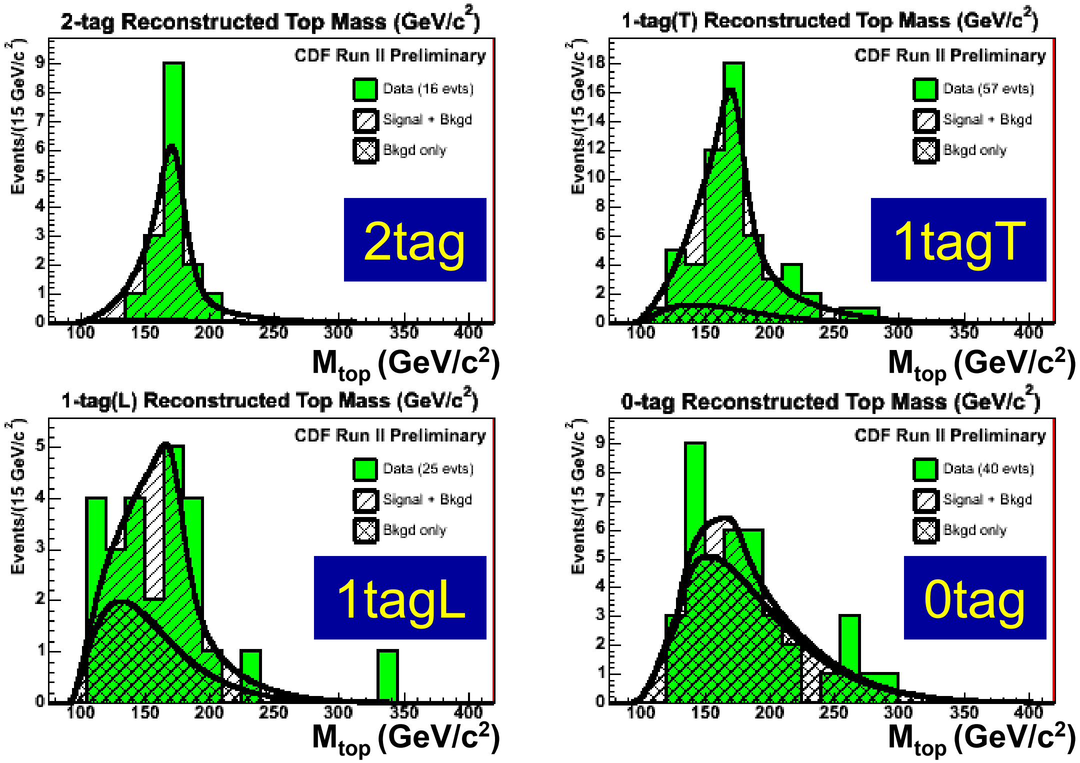
M_{top} (GeV/c^2)

Result of Traditional Fit

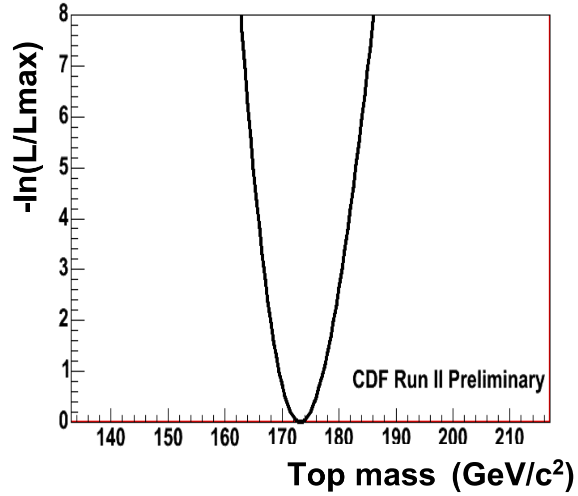
Likelihood fit looks for top mass that describes the data M_{top} distribution best (template fit).

The background fraction is constrained by estimation.

$\mathcal{L} = 318\ pb^{-1}$



Likelihood vs m_{top}



$$m_{top} = 173.2\ {+2.9/-2.8}\ (\text{stat}) \pm 3.4\ (\text{syst})\ \text{GeV}/c^2$$

Systematic Uncertainties

CDF Run II Preliminary (318 pb^{-1})

Systematic Source	**Uncertainty (GeV/c^2)**
Jet Energy Scale	3.1
B-jet modelling	0.6
Initial State Radiation	0.4
Final State Radiation	0.4
Parton Distribution Functions	0.4
Generators	0.3
Background Shape	1.0
MC statistics	0.4
B-tagging	0.2
Total	**3.4**

JES is dominant!

CDF Run II Preliminary (318 pb^{-1})

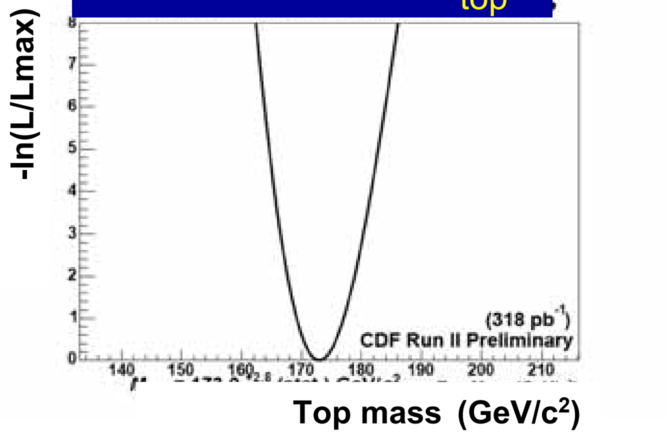
Jet Systematic Source	**Uncertainty (GeV/c^2)**
Relative to Central	0.6
Corrections to Hadrons (Absolute Scale)	2.2
Corrections to Partons (Out-of-Cone)	2.1
Total	**3.1**

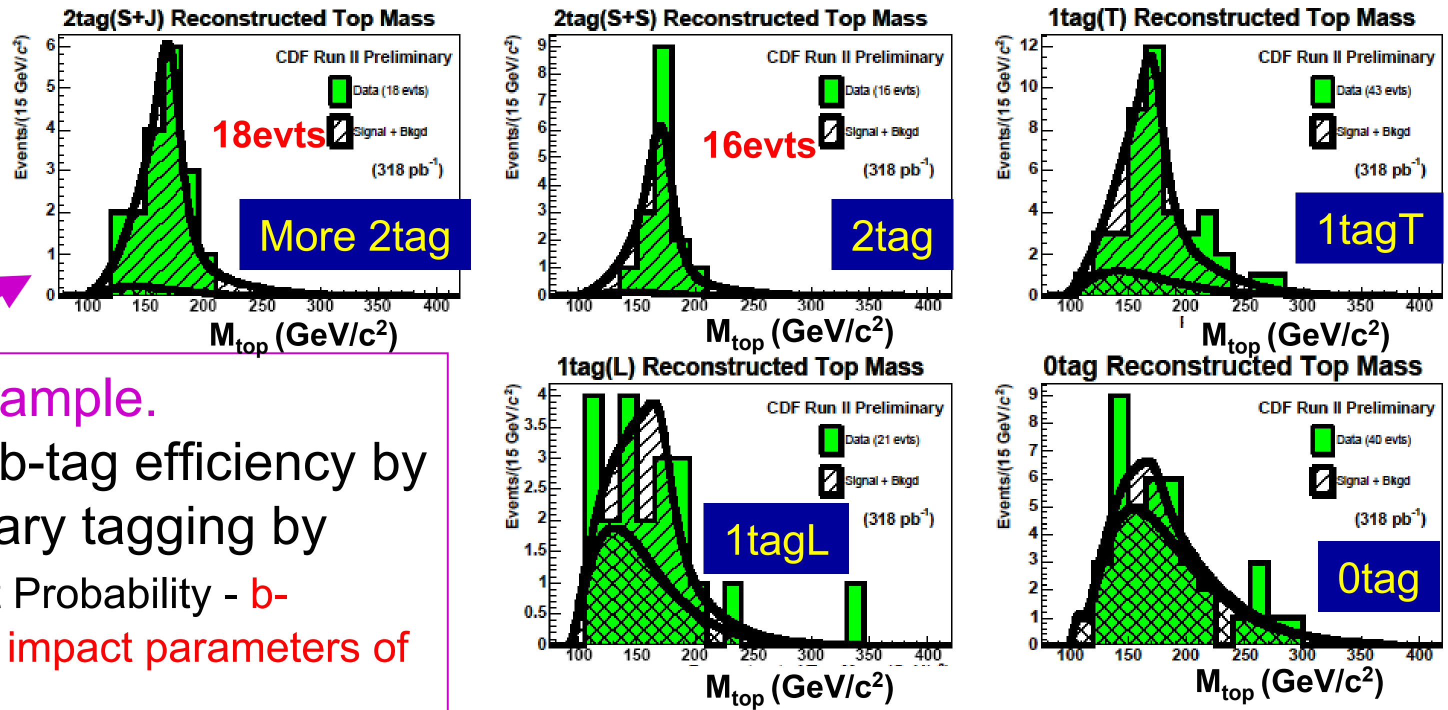
Alternative Fit Result

As a cross check, another fit with different sample subdivision was performed.

$\mathcal{L}$ = 318 pb^{-1}

Likelihood vs m_{top}





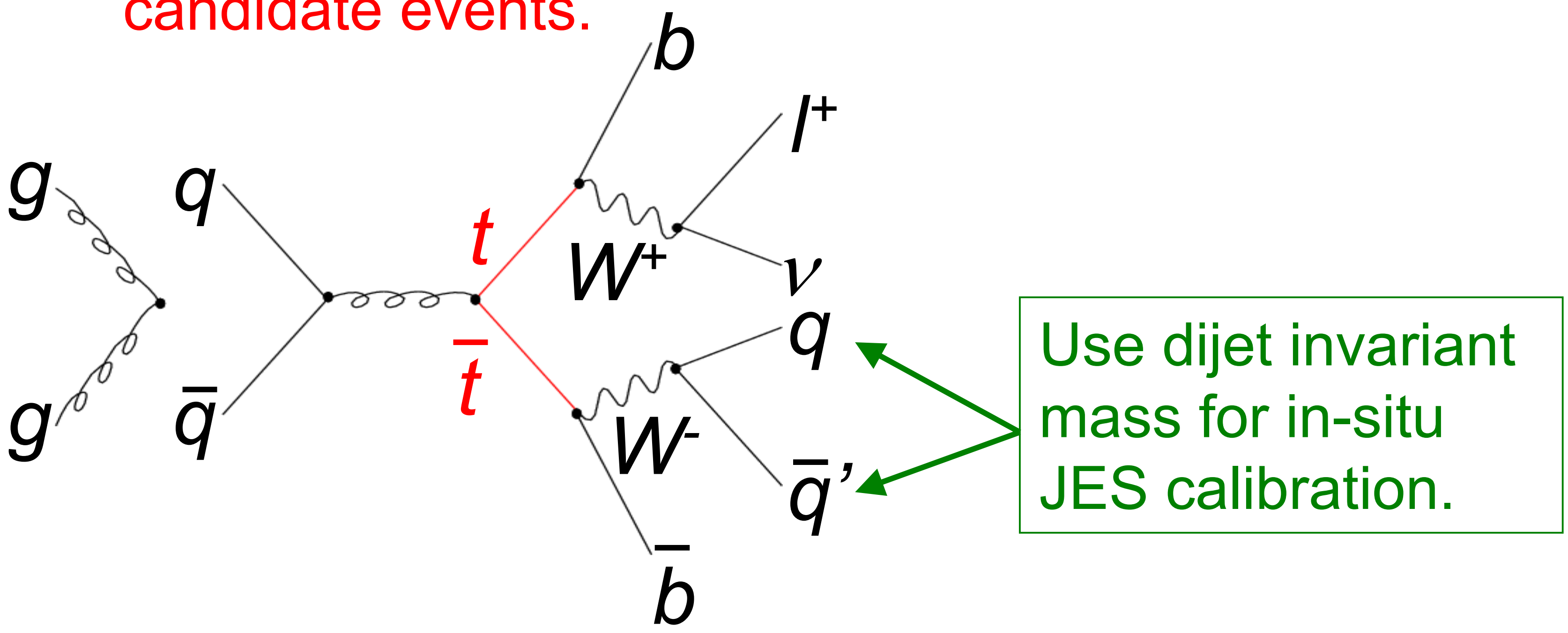
Additional 2tag sample.
Increase double b-tag efficiency by enabling secondary tagging by looser tagger (Jet Probability - b-tagging by looking at impact parameters of tracks in the jet).

m_{top} = 173.0 +2.9/-2.8 (stat) ± 3.3 (syst) GeV/c^2

Improved Fitting Method

- Syst. Uncertainty = ±3.4 GeV/c^2 is dominated by JES uncertainty (±3.1 GeV/c^2).
- Most JES uncertainties are shared between light flavor and b-jets. Only 0.6 GeV/c2 additional uncertainty on m_{top} due to b-jet specific systematics.

  $\rightarrow$Likelihood fit with constraint on the dijet mass in candidate events.



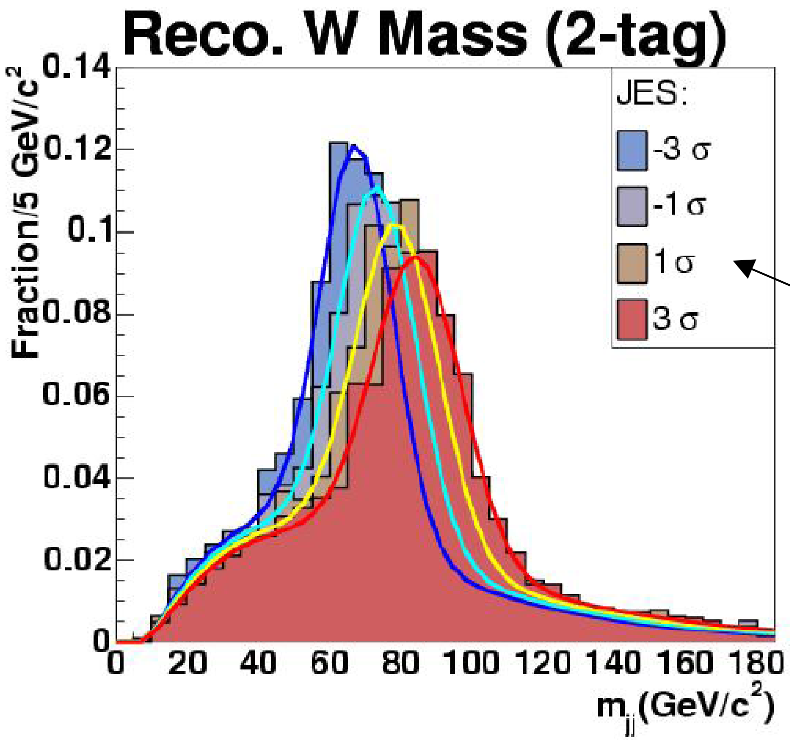
Template with JES

M_{top} and hadronic W invariant mass distributions are parametrized as functions of true top mass and Jet Energy Scale (JES) using Monte Carlo samples.

- m_{jj} varies significantly as a function of JES.

- Event-by-event M_{top} is also largely dependent on JES.
  - $\rightarrow M_{top}$ distribution is now parameterized as a function of true top mass m_{top} and JES.

Hadronic W mass Template



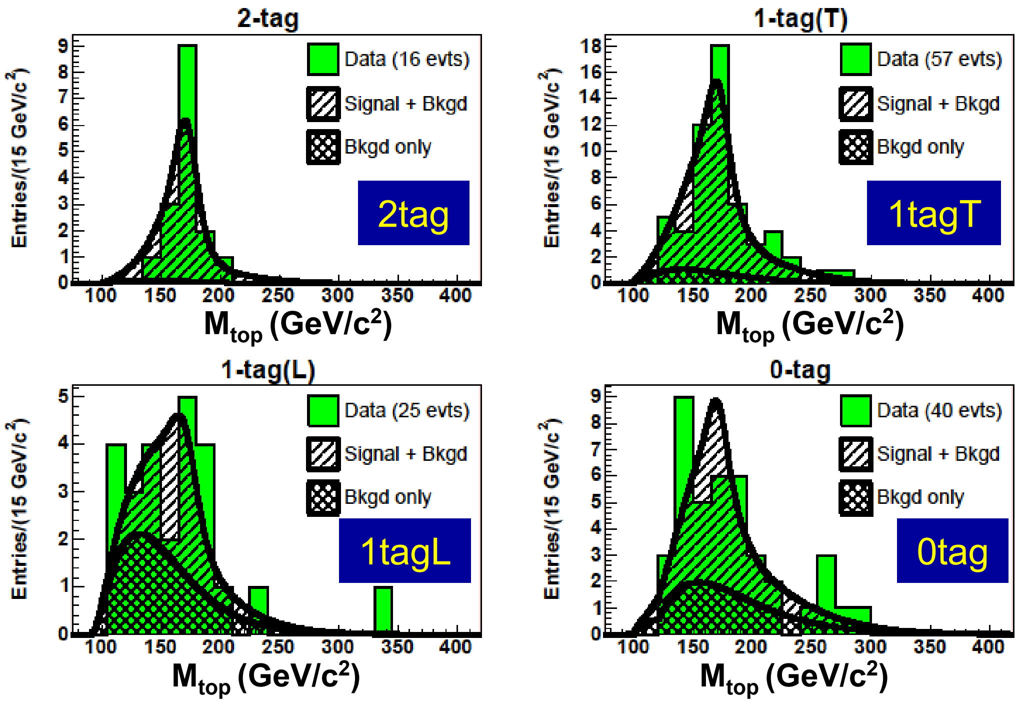
JES shifted by –3σ,-1σ,… of generic jet calibration

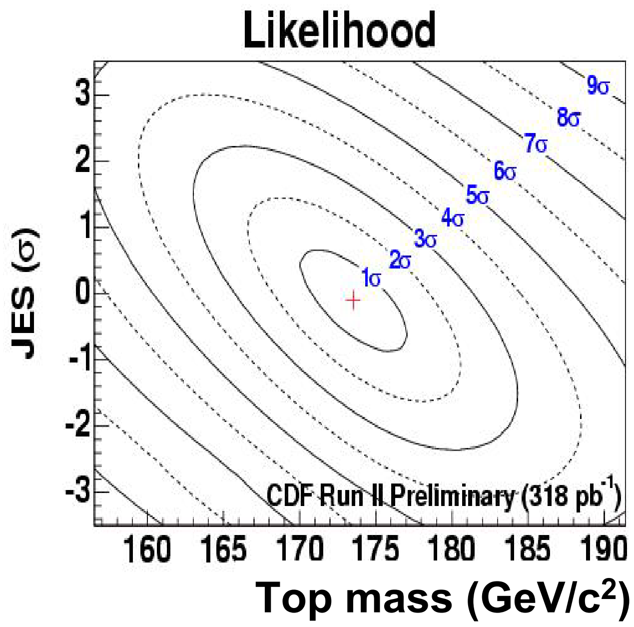
Top Mass Result of 2D Fit

Likelihood fit looks for top mass, JES and background fraction that describes the data M_{top} and m_{jj} distributions best.

M_{top} distributions : **CDF Run II Preliminary**

$\mathcal{L} = 318\ pb^{-1}$





$$m_{top} = 173.5\ {+3.7/-3.6}\ (\text{stat+JES}) \pm 1.7\ (\text{syst})\ \text{GeV}/c^2$$

$$m_{top} = 173.5\ {+2.7/-2.6}\ (\text{stat}) \pm 3.0\ (\text{syst})\ \text{GeV}/c^2$$

World's Best Single Measurement!!

Even better than Run I World Ave!

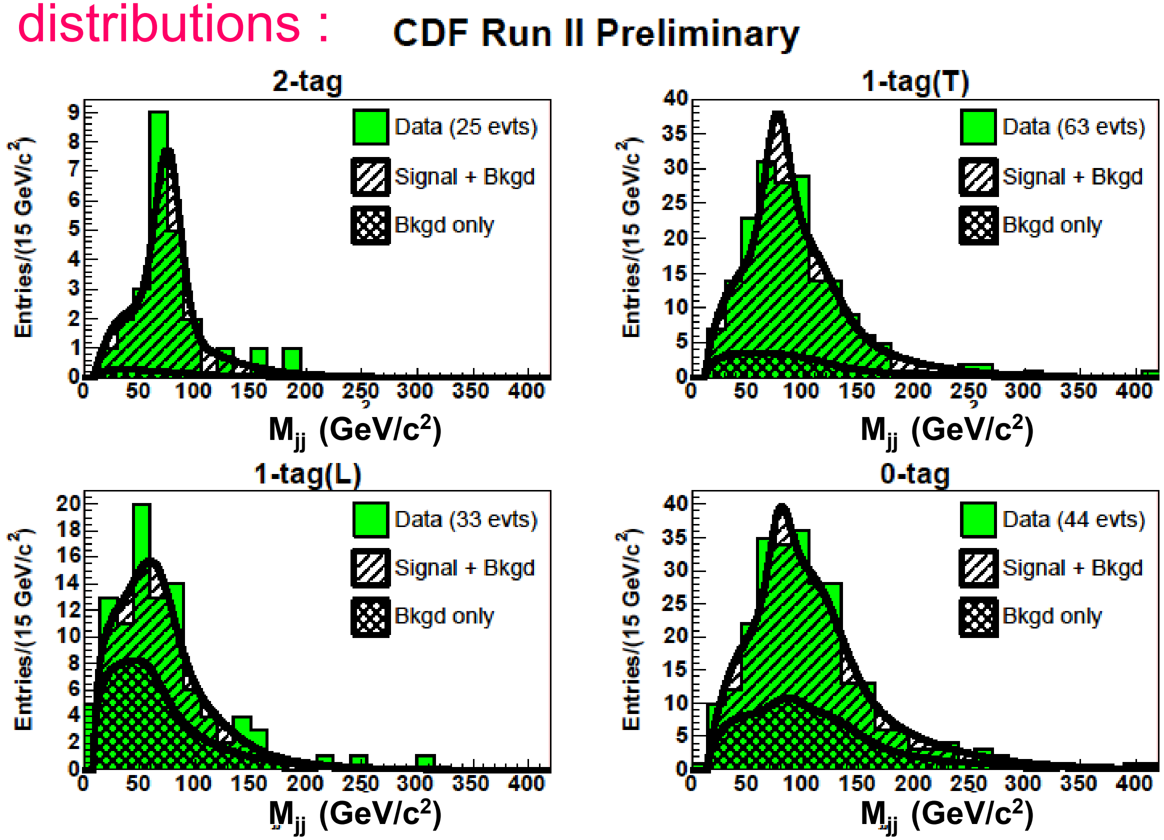
JES syst 2.5 compared to 3.1 wo/ in situ calibration

JES Result of 2D Fit

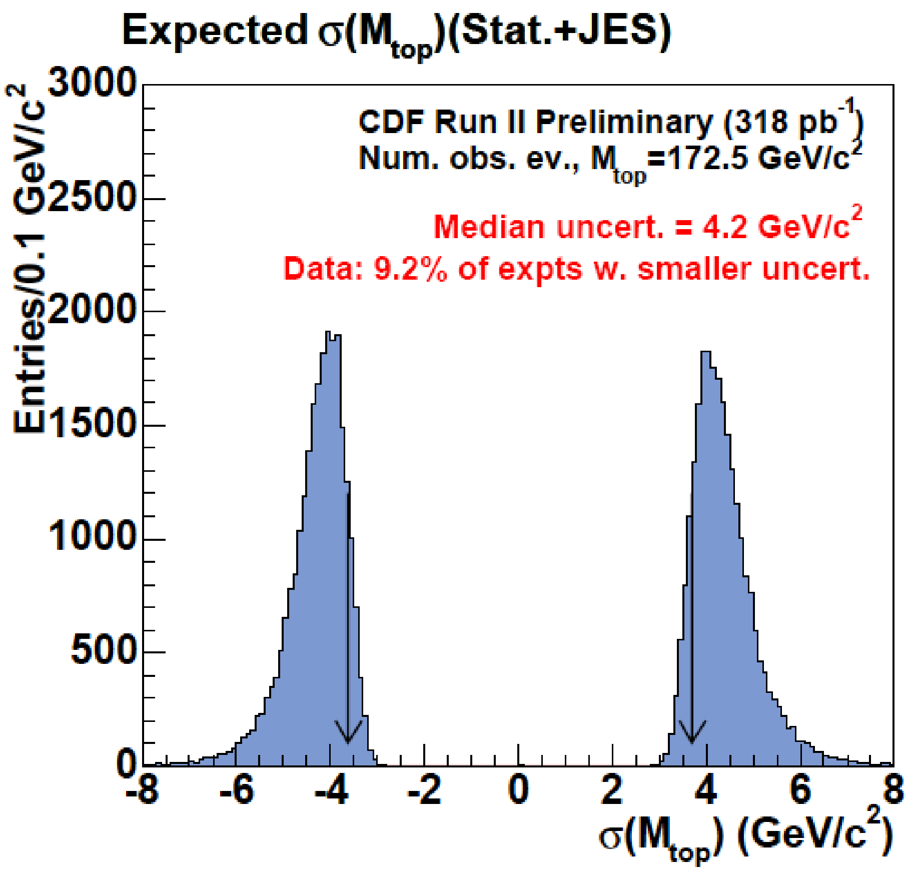
JES = -0.10 +0.78/-0.80 σ

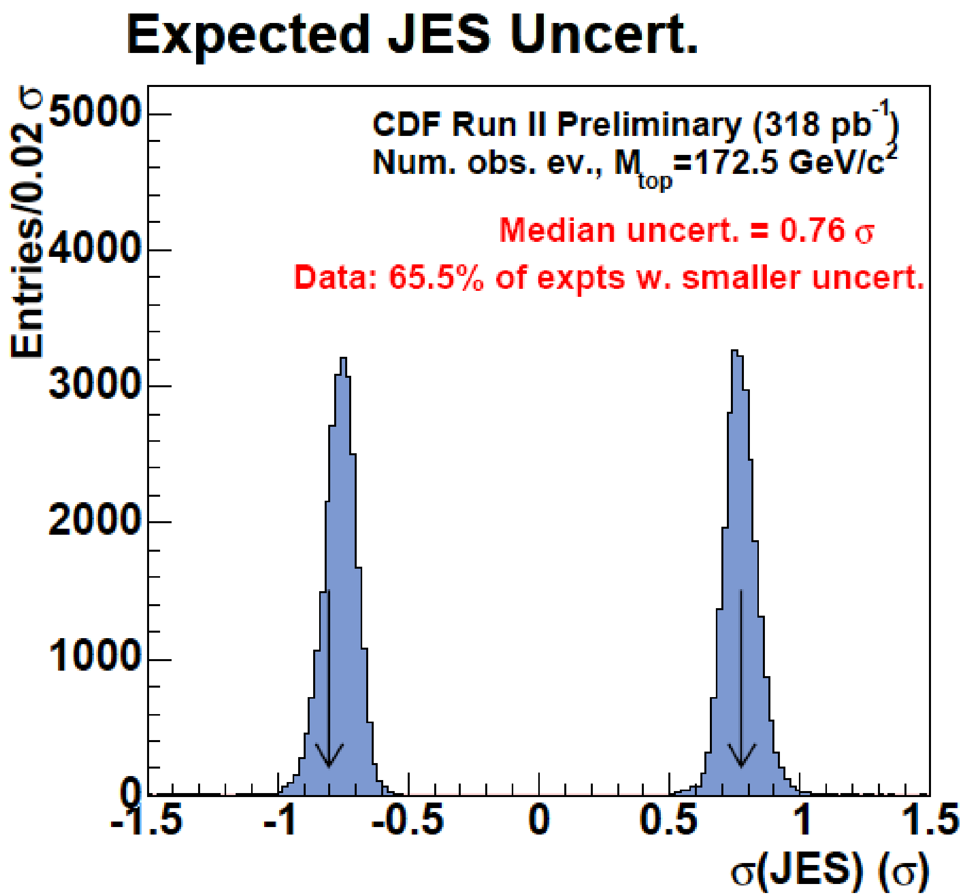
- Data-MC JES are proved to agree quite well.
- The fit improved JES uncertainty by 20%.

m_{jj} distributions :



Stat. Uncertainty

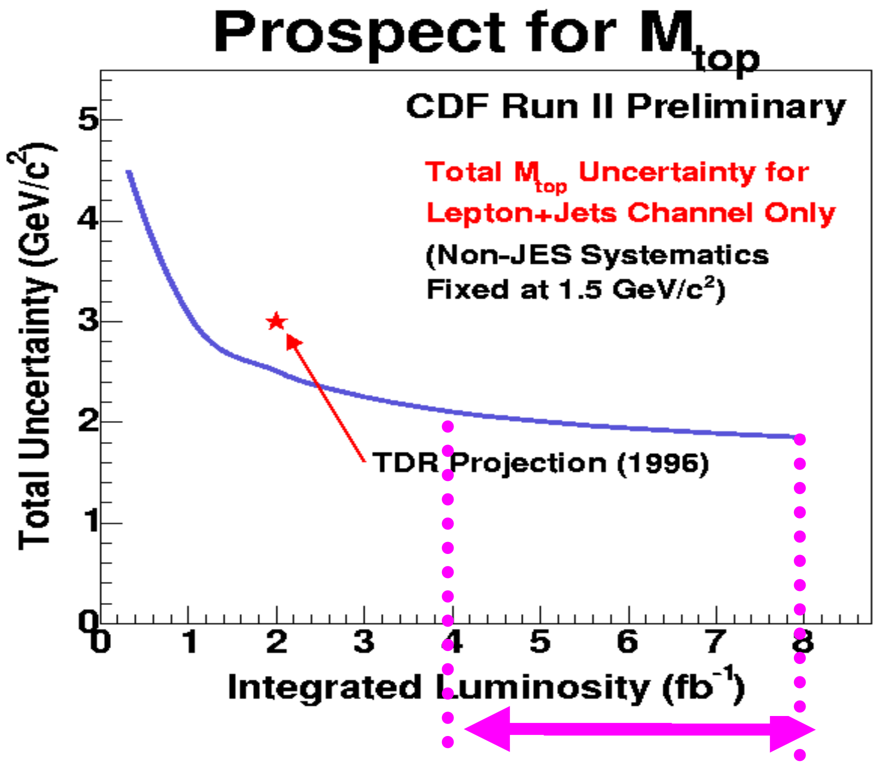




- Our stat. uncertainty is a bit on the lucky side as for the measurement of top mass, but reasonable.

Future Projection

- Total uncertainty of
  $\Delta m_{top} \sim 2$ GeV/c^2
  in the end of CDF Run II.
- Conservative projection assuming only stat. and JES will improve.
  $\rightarrow$ We will do better!
  (I will discuss later).



Aimed for luminosity of Tevatron Run II.

Other Methods

CDF L+jets Dynamical Likelihood Method (1)

Calculate likelihood as a function of m_{top} according to Matrix Element for each event.

Sum over jet-parton combination.

Probability for $P_T(t\bar{t})$

$$L(m_{top}) = \sum \int \frac{2\pi^4}{Flux} PDF_{a/p}(z_a) \cdot PDF_{\bar{b}/\bar{p}}(z_b) \cdot \boxed{f(P_T)}$$

$$\times \left| \boxed{\mathcal{M}_{t\bar{t}}(a,b \rightarrow \mathbf{x}; m_{top})} \right|^2 \cdot \boxed{w(\mathbf{x},\mathbf{y})}\, d\mathbf{x}$$

Matrix Element for signal

Transfer func. (**parton $E_T \rightarrow$ jet E_T**)

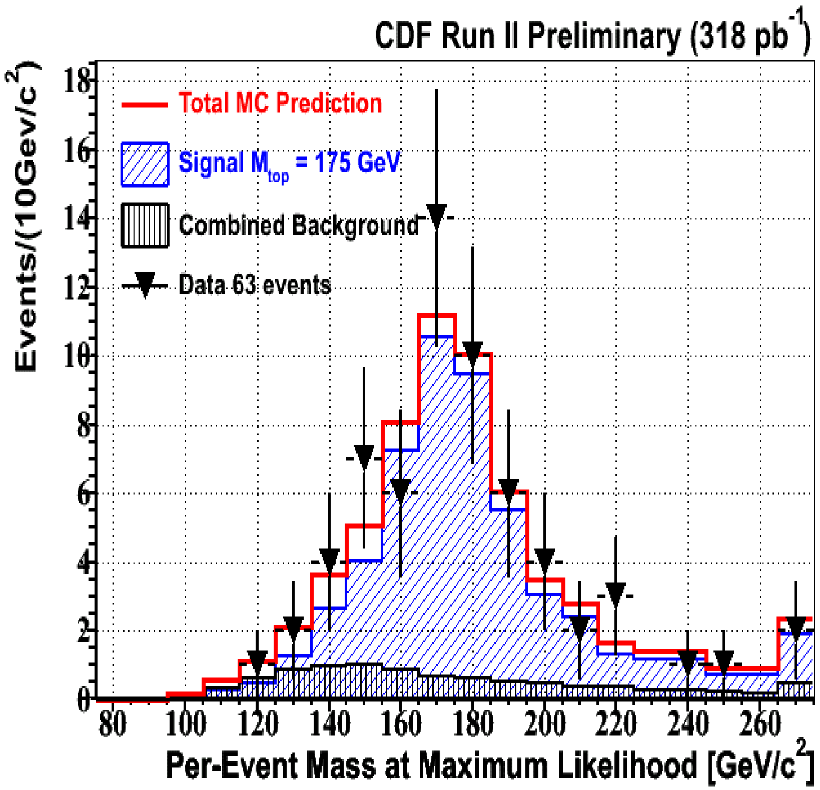
x(Parton), ***y***(Observable)

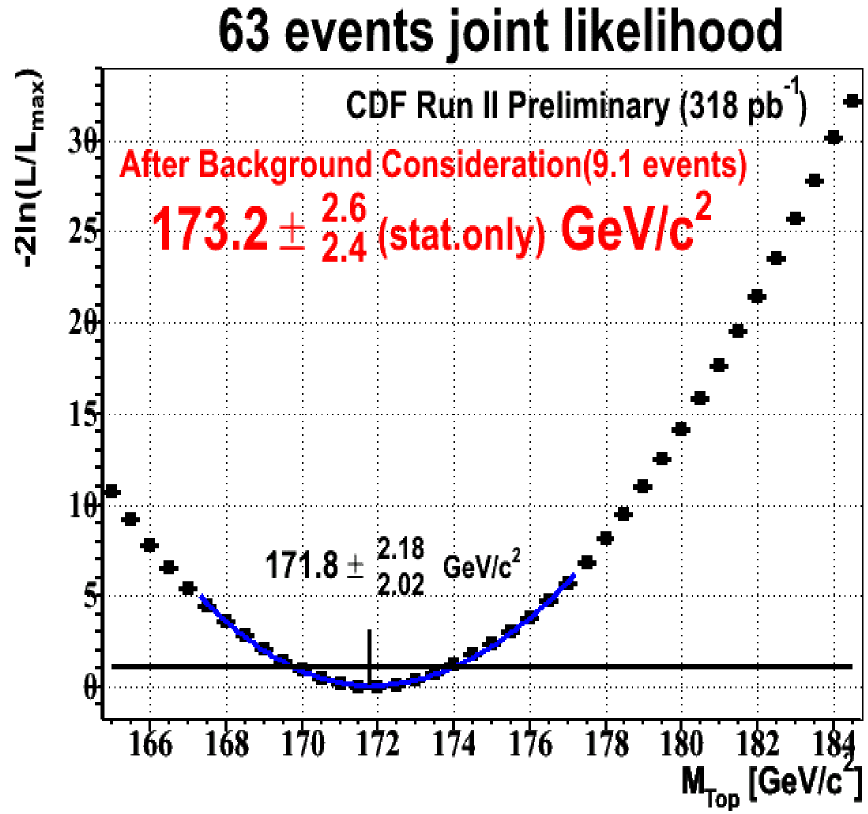
CDF L+jets Dynamical Likelihood Method (2)

$\mathcal{L}$ = 318 pb^{-1}

- 63 candidates with exact 4 jets (≥1 jet *b*-tagged).
- Signal fraction ~ 85.5%.

to reduce impact of gluon radiation events





M_{top} = 173.8 +2.6/-2.4(stat) ± 3.2(syst) GeV/c^2

CDF Dilepton Neutrino Weighting Method (template method)

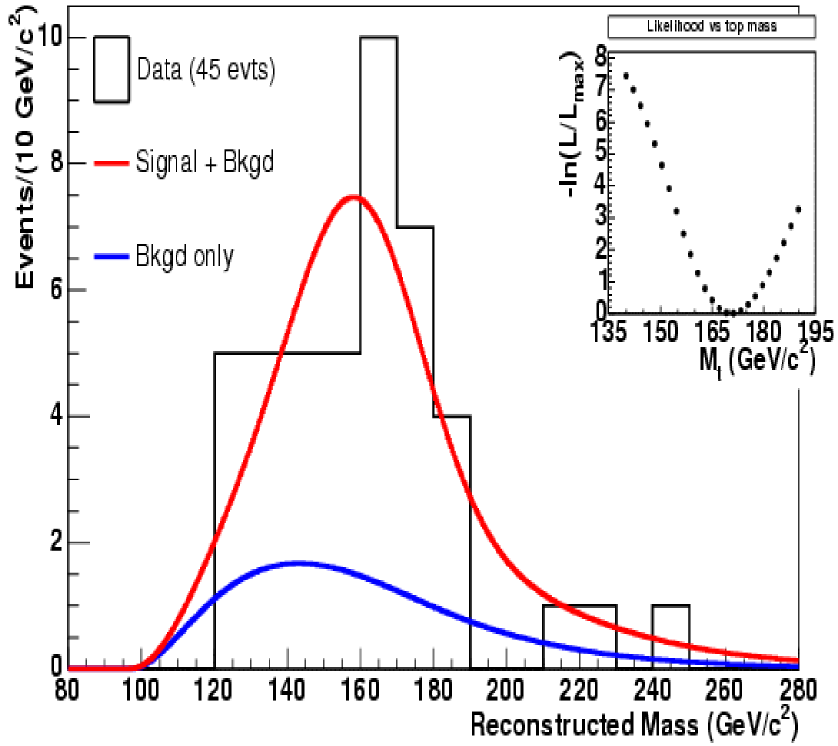
Dilepton$\rightarrow 2\nu$'s
$\rightarrow$under-constrained system
$\rightarrow$need kinematic assumption

CDF assumes
$(\eta_{\nu 1}, \eta_{\nu 2}), (\phi_{\nu 1}, \phi_{\nu 2}), P_z(t\bar{t})$

- Assume pseudo-rapidity of 2 ν's and M_{top}.
- Solve the 4-vector of ν's due to (E,p) conservation.
- Calculate the probability of measuring observed $\not{E}_T$.
- Scan over assumed variables.
  $\rightarrow$ probability of M_{top}.
- Pick the most probable value of M_{top} for the event.
  $\rightarrow$ Template fit.

CDF Run II Preliminary (358.6 pb^{-1})

$\mathcal{L}$ = 359 pb^{-1}

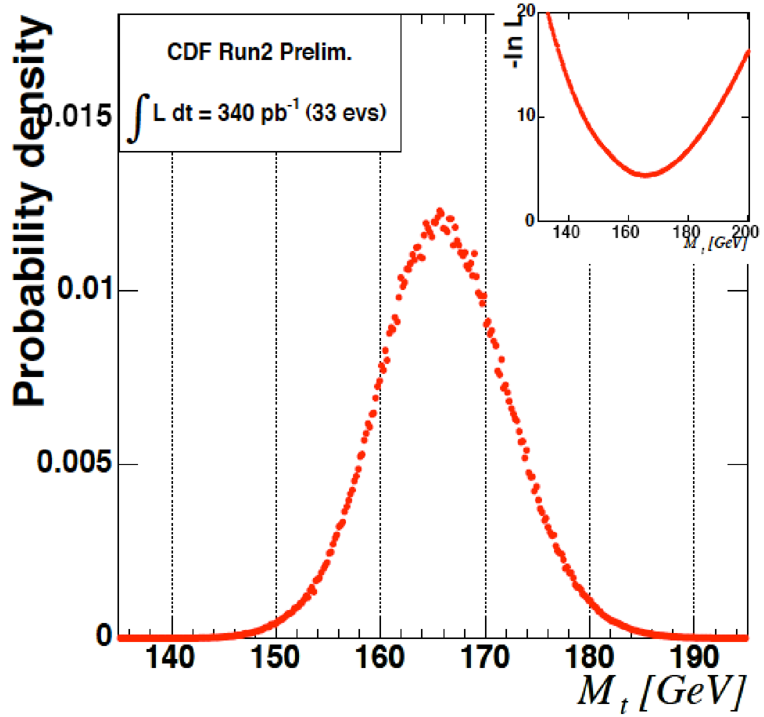


m_{top} = 170.6 +7.1/-6.6 (stat) ± 4.4 (syst) GeV/c^2

CDF Dilepton
Matrix Element Method

$\mathcal{L} = 340\ pb^{-1}$

- Calculate per-event differential cross section due to LO Matrix Element.
- Background ME is also considered to reduce the impact of background contamination.
- Calculates probability vs m_{top} for each event.



$M_{top} = 165.3 \pm 6.3\ (stat) \pm 3.6\ (syst)\ GeV/c^2$

CDF L+jets L_{XY} Method

Boost of *b* in top rest frame : $\gamma_b \sim 0.4\ m_{top}/m_b$

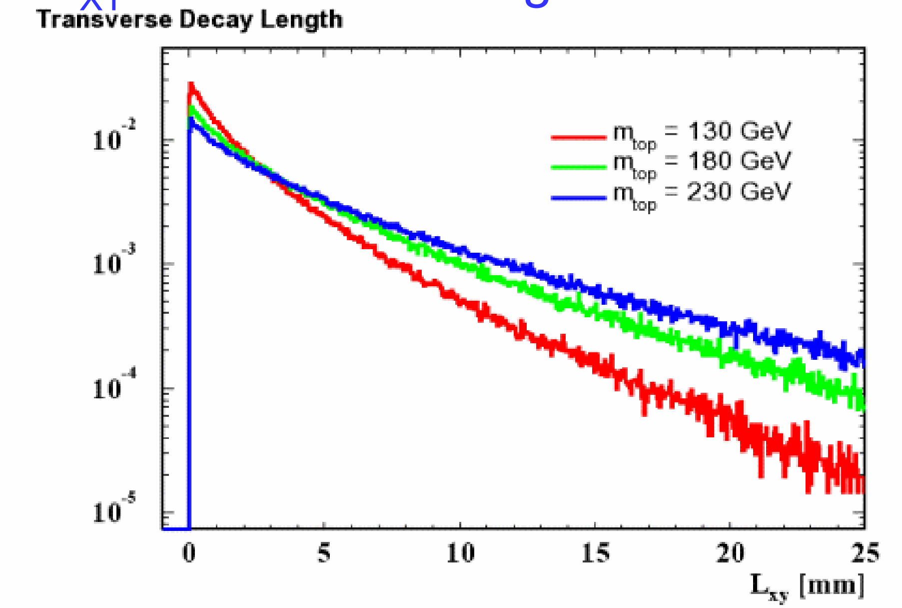
Transverse decay length L_{XY} of B depends on m_{top}

Use 216 secondary vertex b-tagged jets found in 178 events w/ ≥3 jets.

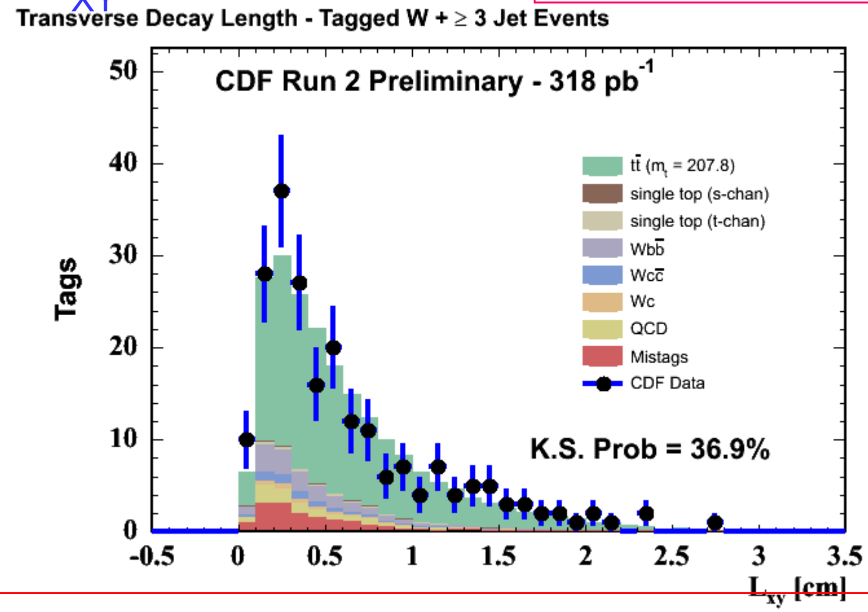
to increase efficiency

$\mathcal{L}$ = 318 pb^{-1}

L_{XY} distribution for signal



L_{XY} distribution

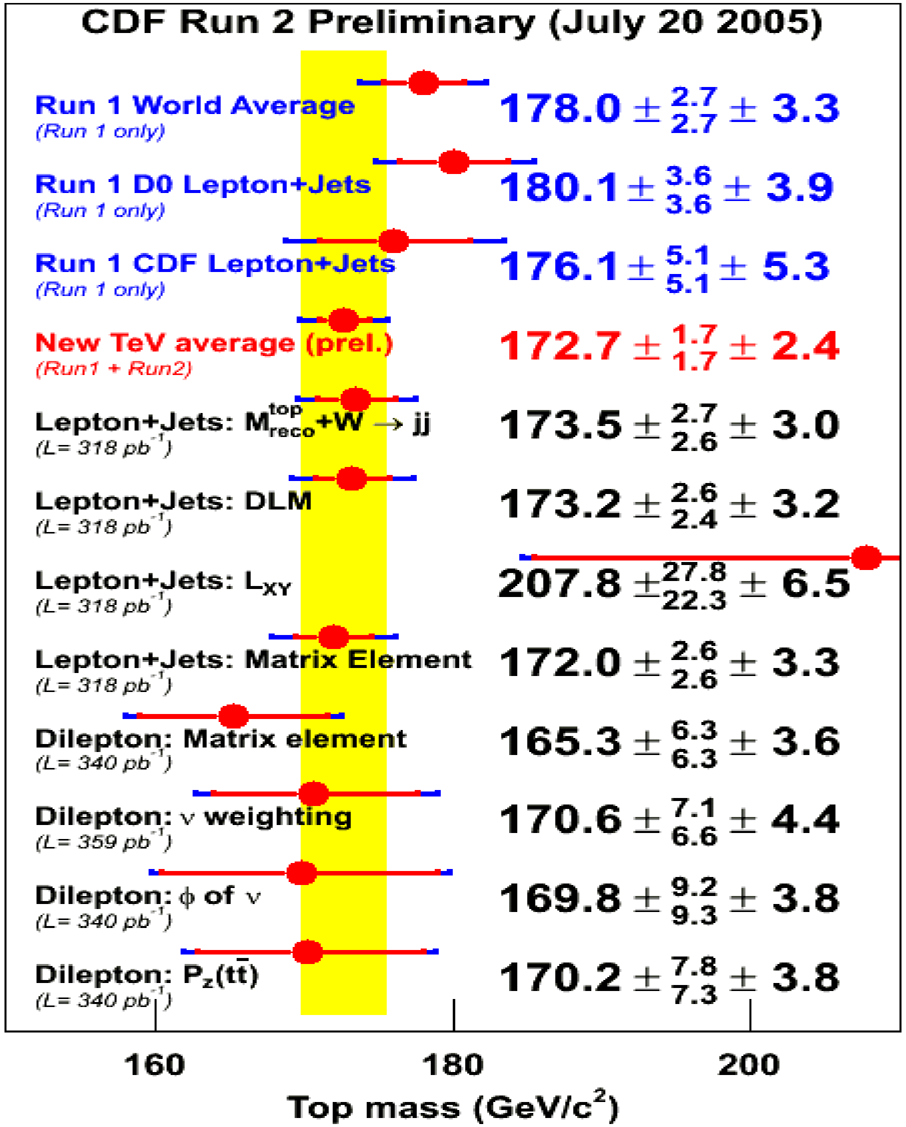


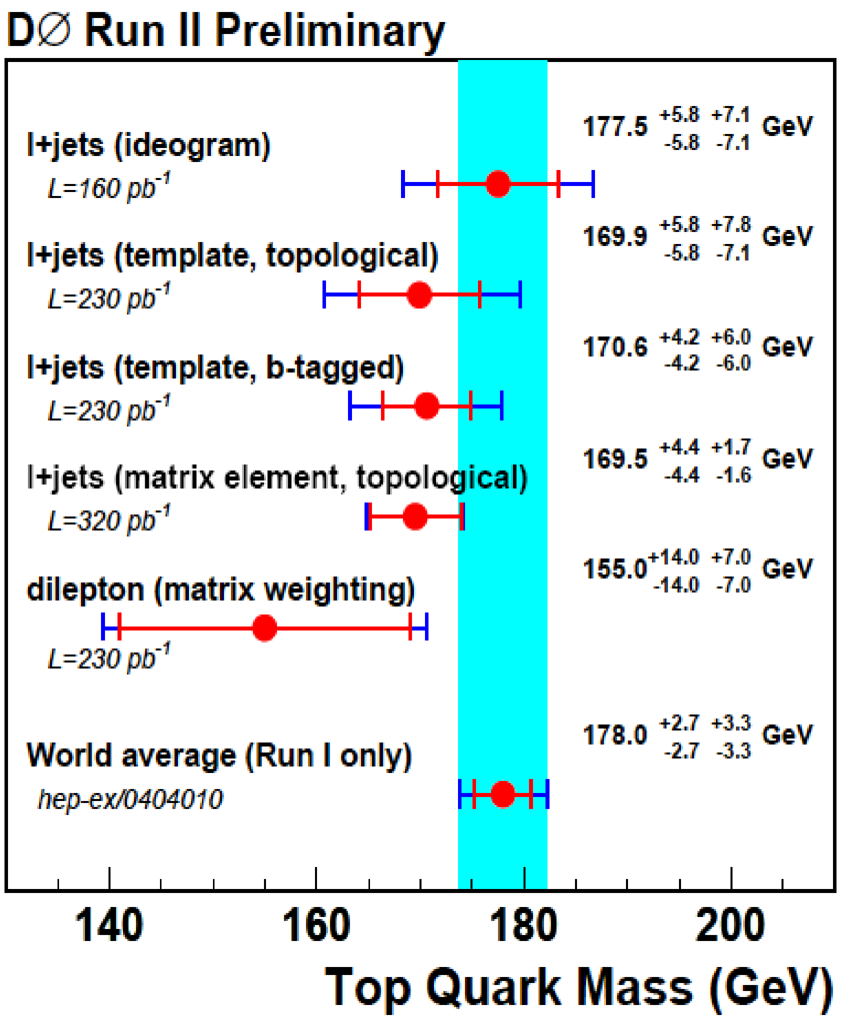
M_{top} = 207.8 +27.8/-22.3 (stat) ± 6.5 (syst) GeV/c^2

Syst. highly uncorrelated from other measurements.

- Data/MC $\langle L_{XY} \rangle$ scale factor : ±5.1 GeV/c^2
- JES : ±0.3 GeV/c^2

Summary of Measurements

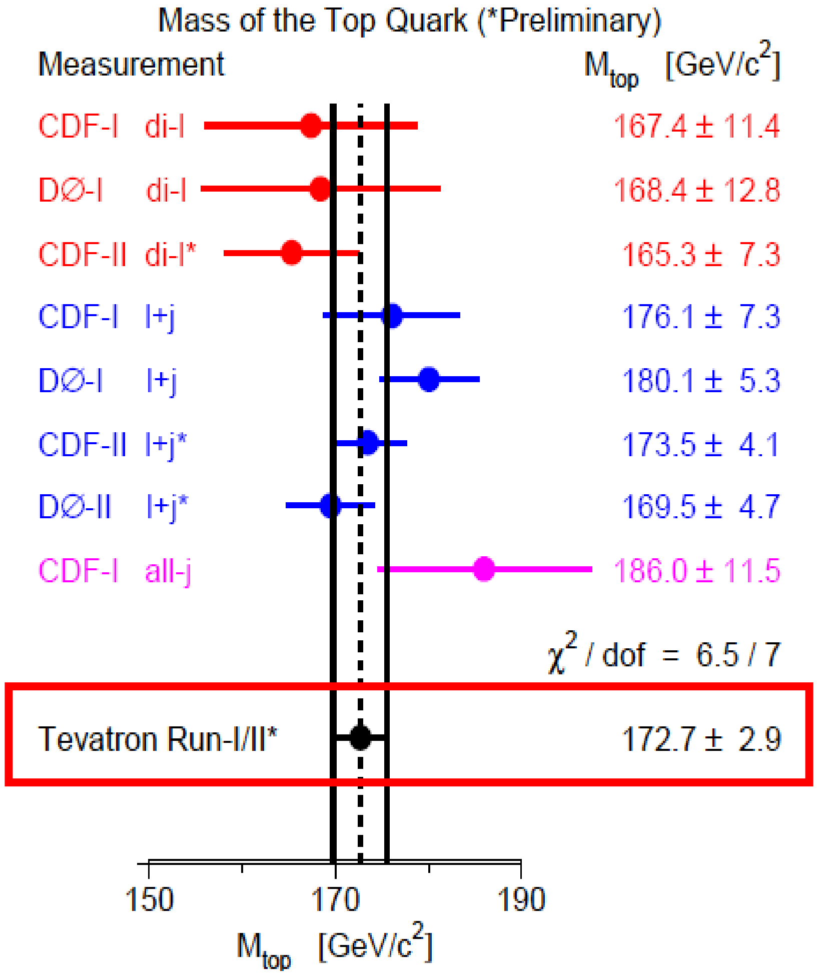




Combination of Measurements

Combination of Measurements

Only best analysis from each decay mode, each experiment.



Correlation :

- uncorrelated
  - stat.
  - fit method
  - in situ JES
- 100% w/i exp (same period)
  - JES due to calorimeter
- 100% w/i channel
  - bkgd. model
- 100% w/i all
  - JES due to fragmentation,
  - signal model
  - MC generator

Future Improvement

Combined Result:

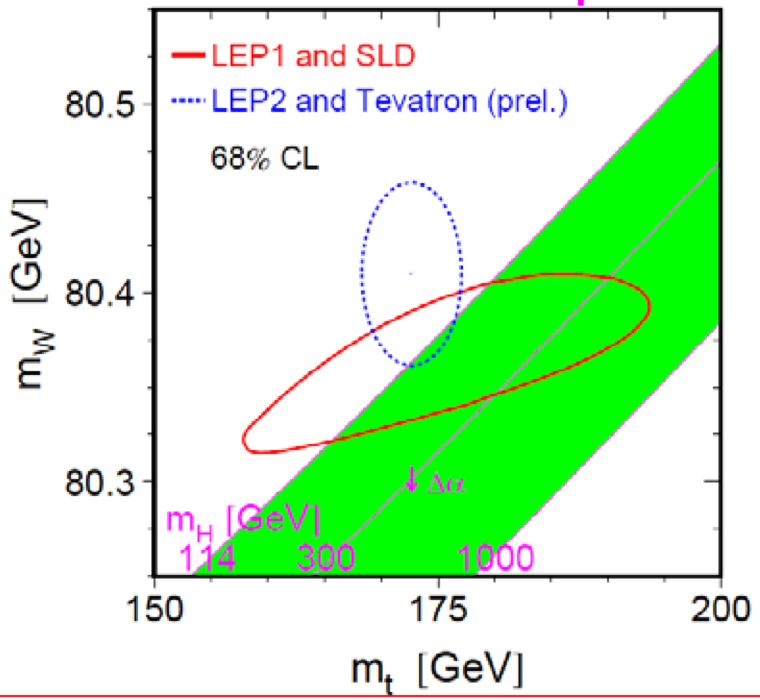
	GeV/c^2
Result	172.7
Stat.	1.7
JES	2.0
Sig. Model	0.9
Bkgd. Model	0.9
Multi-Interaction	0.3
Fit Method	0.3
MC Generator	0.2
Total Syst.	2.4
Total Error	2.9

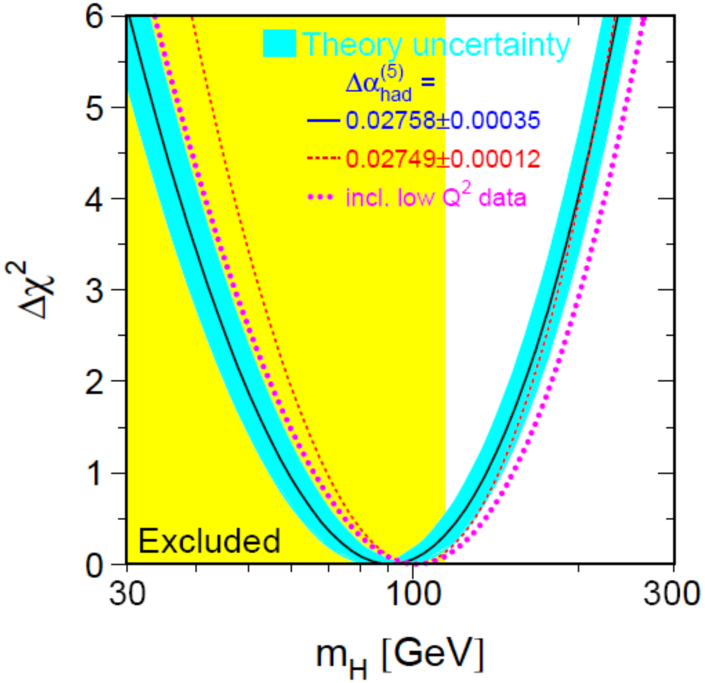
- Syst. already dominates the uncertainty!
- Basic improvement by $\sim 1/\sqrt{\mathcal{L}}$
  - $\mathcal{L} \sim 1\,\mathrm{fb}^{-1}$ in next Winter.
  - In-situ JES calibration is a powerful tool. It can be introduced to other L+jets analyses.
- Sig./Bkgd. Modeling (ISR/FSR/Q^2 dependence etc.) can be improved by using our own data.
- D0 Run II Dilepton measurement is coming soon.
- Measurements in All Hadronic mode (CDF/D0) are under development.

New ElectroWeak Fit

w/ Preliminary CDF + D0, Run I + Run II Combined :

m_{top}=172.7 ±2.9 GeV/c^2





m_{higgs}=91 +45/-32 GeV/c^2

m_{higgs}<186 GeV/c^2 (95% CL)

w/ Tevatron Run I average : 178.0 ± 2.7 ±3.3 GeV/c^2 :

m_{higgs}=114 +69/-45 GeV/c^2, m_{higgs}<260 GeV/c^2 (95% CL)

Summary

- CDF L+Jets Template Method is the best single measurement :

$$m_{top}=173.5\ {+4.1}/{-4.0}\ \mathrm{GeV}/c^2$$

and will achieve $\Delta m_{top}\sim 2\ \mathrm{GeV}/c^2$ in Run II.

- Preliminary combination of CDF and D0 (RunI + Run II):

$$m_{top}=172.7 \pm 2.9\ \mathrm{GeV}/c^2 .$$

(Run I average : $178.0 \pm 4.3\ \mathrm{GeV}/c^2$)

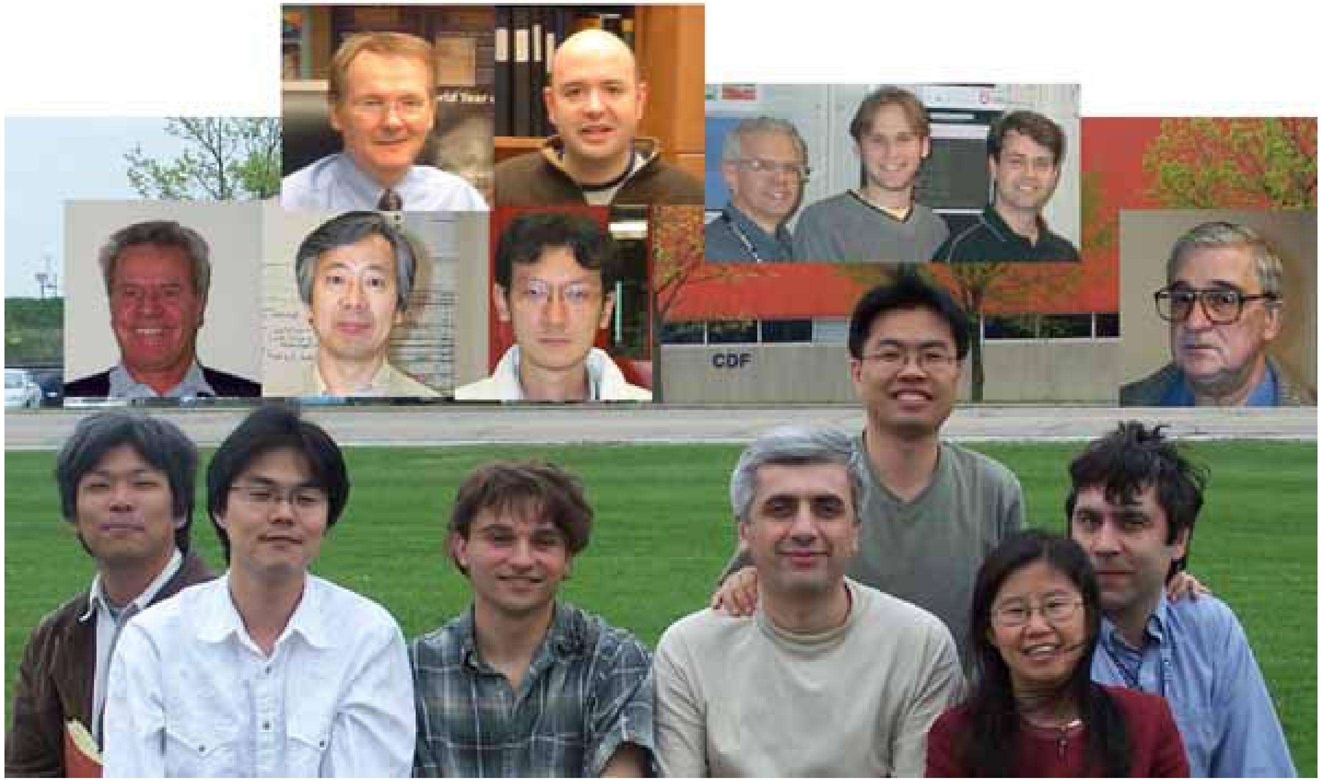
→ $m_{higgs}=91\ {+45}/{-32}\ \mathrm{GeV}/c^2$, $m_{higgs}<186\ \mathrm{GeV}/c^2$ (95% CL).

- Next Winter with $\sim 1\mathrm{fb}^{-1}$.

  - Improvement of dominant uncertainties by $\sim 1/\sqrt{L}$.
  - D0 Run II Dilepton and All Hadronic channel from CDF/D0 Run II will be included in combined measurement.

Backup

CDF L+jets Template Group



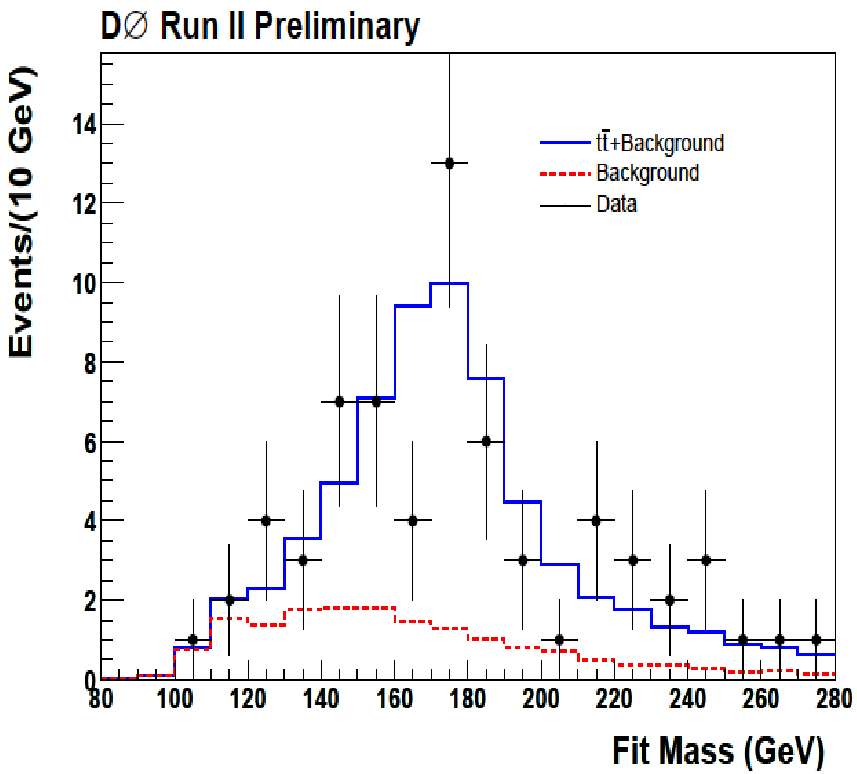
Intstitutes :
Tronto 3
UC Berkeley 2
Chicago 4
JINR 2
Fermilab 1
Pisa 1
Tsukuba 4
Rockefeller 1

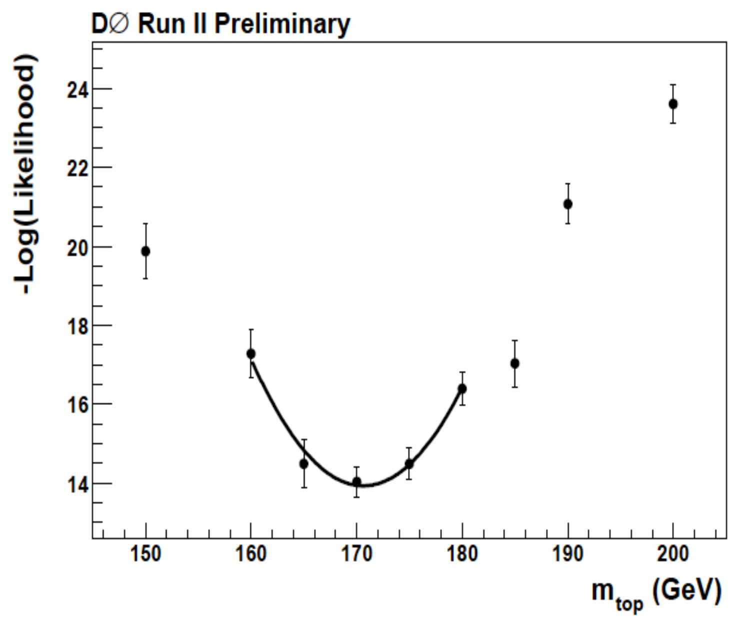
- Template Method measurement was reported by
  - Fermilab Today "CDF Tops the Top World Average" (April 21, 2005)
  - KEK News "質量起源の解明をめざして" (May 19, 2005)

D0 L+jets Template Method

- Event-by-event M_{top} by χ^2 fit.
- Use 69 candidate events with ≥1 *b*-tagged jet.

$\mathcal{L}$ = 229 pb^{-1}





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

CDF L+jets Matrix Element Method (1)

Similar to D0 L+jets ME, but does not include JES in probability definition.

$$P_{t\bar{t}}(x; m_t) = \frac{1}{\sigma_{tot}} \int d\sigma_{t\bar{t}}(y; m_t) dq_1 dq_2 f(q_1) f(q_2) W(x, y)$$

x ≡ measured quantities, y ≡ parton level

$d\sigma = \vert\mathcal{M}\vert^2 d\Phi$	LO qqbar matrix element from Mahlon & Parke
$f(q_1) f(q_2)$	Structure functions, (q_i ≡ momentum fraction)
$W(x, y)$	Transfer functions (Map measured quantities into parton level quantities).

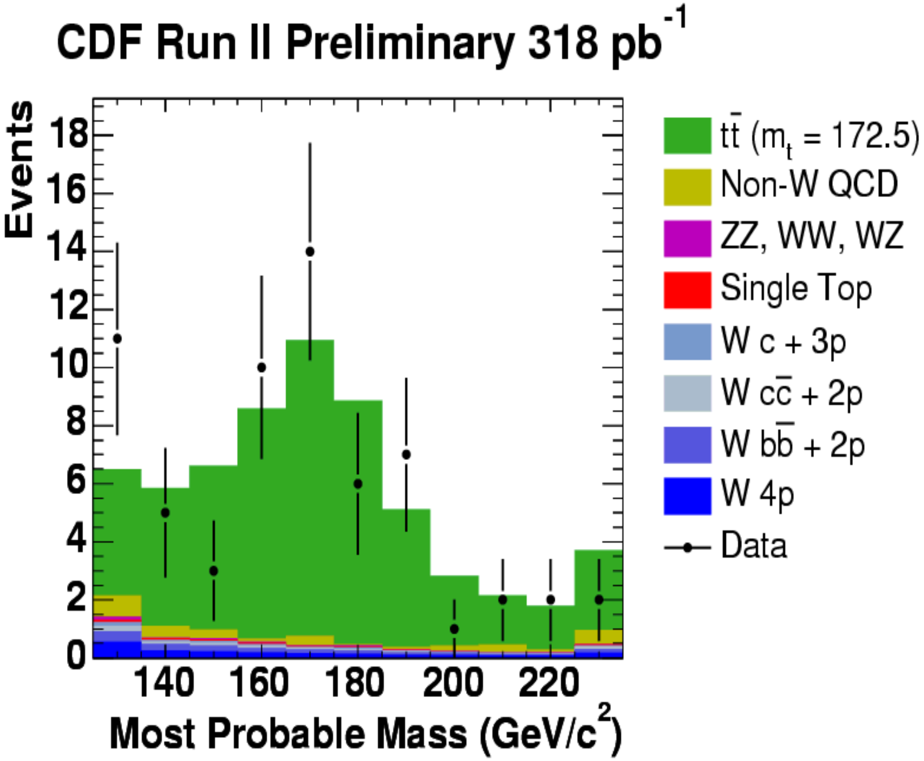
$$L(m_t) = \prod_{i=1}^{N} c_1 \frac{P_{t\bar{t}}(x_i; m_t)}{\langle Acc(x) \rangle_{t\bar{t}}(m_t)} + (1 - c_1) \frac{P_{Back}(x_i)}{\langle Acc(x) \rangle_{Back}}$$

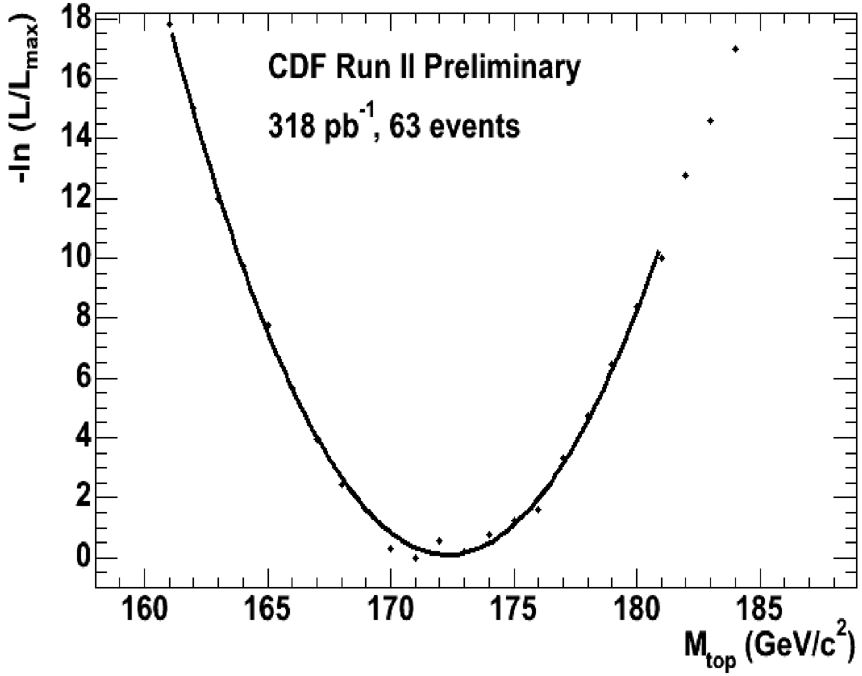
CDF L+jets Matrix Element Method (2)

$\mathcal{L}$ = 318 pb^{-1}

63 candidates with exact 4 jets (≥1 jet *b*-tagged).

to reduce impact of gluon radiation events





$$m_{top} = 172.0 \pm 2.6\ (\text{stat}) \pm 3.3\ (\text{syst})\ \ \text{GeV}/c^2$$

D0 L+jets Matrix Element Method (1)

- Calculate probability density for m_{top}.
- Matrix Element for background included.
- In situ calibration of JES.

Probability density for m_{top}

Hadronic W mass in ME

In situ JES calib.

Signal probability for m_{top} calculated w/ Matrix Element

$$P_{evt}(m_{top}, JES) = f_{top} \cdot \boxed{P_{sig}(\mathbf{y}; m_{top}, \boxed{JES})}$$
$$+ (1 - f_{top}) \cdot \boxed{P_{bkgd}(\mathbf{y}; JES)}$$

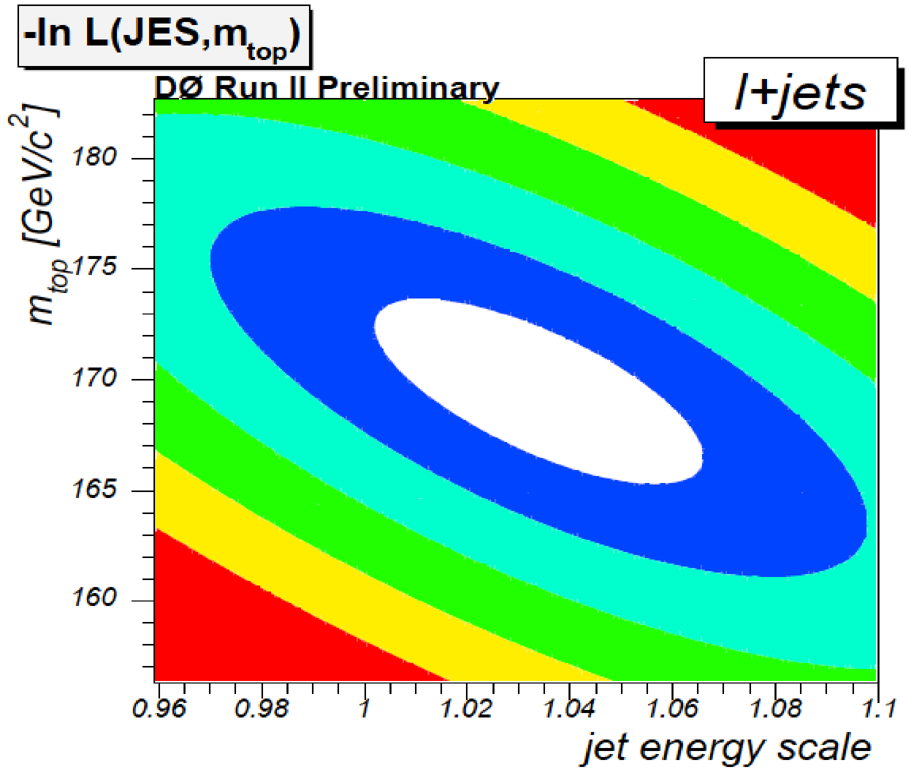
Signal fraction in measurement sample

Background probability Calculated w/ ME

D0 L+jets Matrix Element Method (2)

- 150 candidates w/ exactly 4 jets (w/o b-tagging).
- Signal fraction ~ 36.4%.

$\mathcal{L}$ = 320 pb^{-1}



M_{top} = 169.5 ±4.4(stat+JES) +1.7/-1.6(syst) GeV/c^2

Very competitive result for a pre-tag measurement!!

Dilepton Template Methods

With 2 ν's, dilepton decay of tt is an under-constraint system even supposing pole mass of W.

- D0 matrix weighting
- CDF ν weighting
- CDF ϕ of ν
- CDF $P_z(tt)$

How do we measure top mass?

Make an assumption.

- (x_1,x_2), $(\eta_{\nu 1}, \eta_{\nu 2})$, $(\phi_{\nu 1}, \phi_{\nu 2})$, $P_z(tt)$, etc., ….

↓

Calculate probability for M_{top}.

Scan the assumed variable due to Monte Carlo distributions.

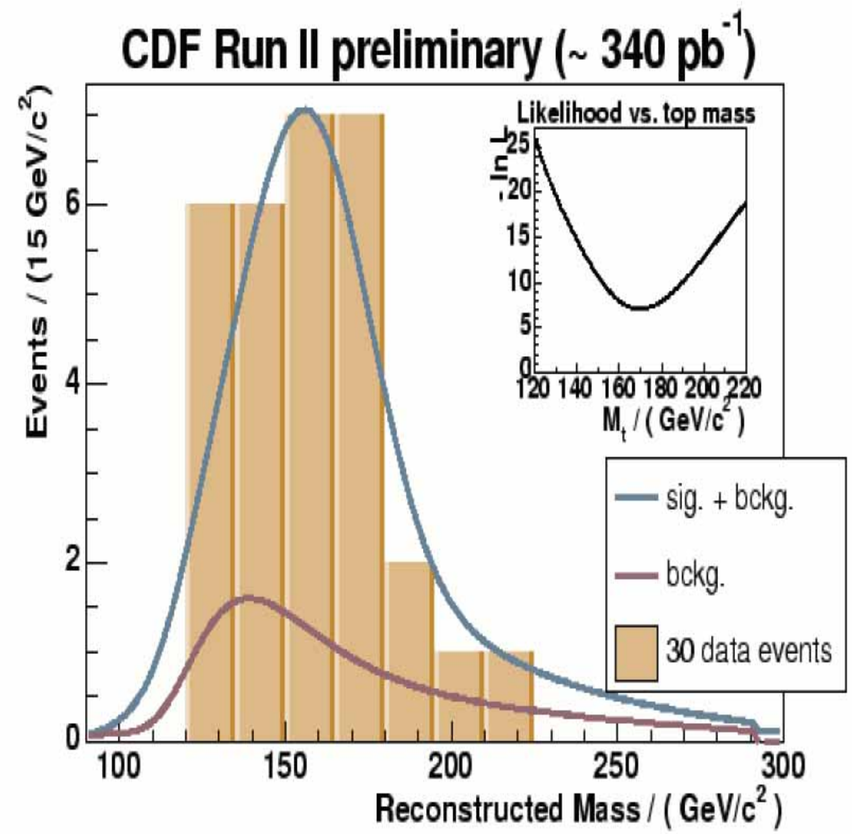
Calculate the most probable M_{top} for each event.

↓

Template fit.

CDF Dilepton $P_z(t\bar{t})$ Method

- By assuming P_z of $t\bar{t}$ system, momenta of the 6 final particles can be calculated from the observables.
- Calculate the invariant mass of top.
- Scan over assumed variables.
  $\rightarrow$ probability of M_{top}.
- Pick the most probable value of M_{top} for the event.
  $\rightarrow$ Template fit.



$\mathcal{L}$ = 340 pb^{-1}

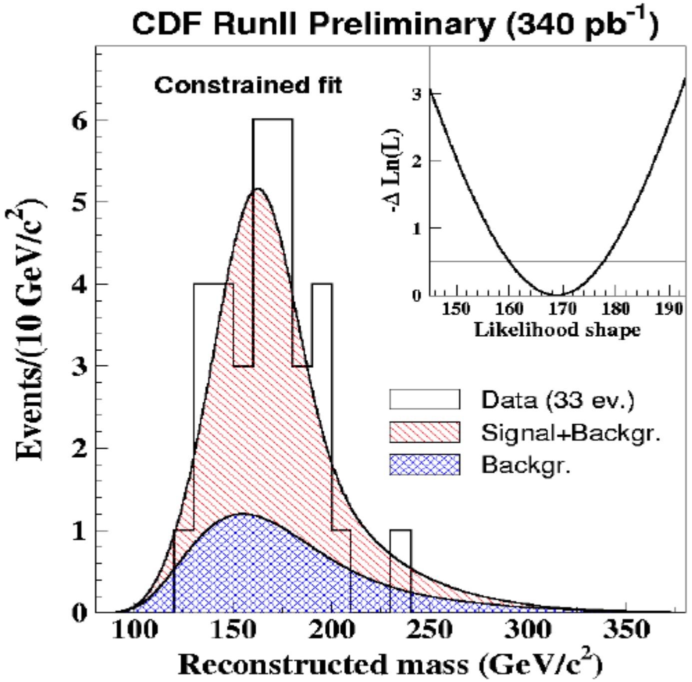
$$m_{top} = 170.2\ {+7.8/-7.2}\ (\text{stat}) \pm 3.8\ (\text{syst})\ \text{GeV}/c^2$$

CDF Dilepton ϕ of ν Method

$$\chi^2 = \sum_{i=l,jets} \frac{(P_T^{i,fit} - P_T^{i,meas.})^2}{\sigma_i^2} + \sum_{j=x,y} \frac{(UE_j^{j,fit} - UE_j^{j,meas.})^2}{\sigma_j^2}$$
$$+ \frac{(M_{l_1\nu_1} - M_W)^2}{\Gamma_W} + \frac{(M_{l_2\nu_2} - M_W)^2}{\Gamma_W} + \frac{(M_{l_1\nu_1 b_1} - M_{top})^2}{\Gamma_{top}} + \frac{(M_{l_2\nu_2 b_2} - M_{top})^2}{\Gamma_{top}}$$

- Assume $(\phi_{\nu 1},\phi_{\nu 2})$.
- Calculate M_{top} by χ^2 fit.
- Scan over assumed variables.
  $\rightarrow$ probability of M_{top}.
- Pick the most probable value of M_{top} for the event.

$\rightarrow$ Template fit.



$\mathcal{L}$ = 340 pb^{-1}

m_{top} = 169.8 +9.2/-9.3 (stat) $\pm$ 3.8 (syst) GeV/c^2

D0 Dilepton Matrix Weighting Method (template method)

Dilepton$\to 2\nu$'s $\to$under-constrained system $\to$need kinematic assumption
CDF assumes $(\eta_{\nu 1}, \eta_{\nu 2}), (\phi_{\nu 1}, \phi_{\nu 2}), P_z(t\bar{t})$

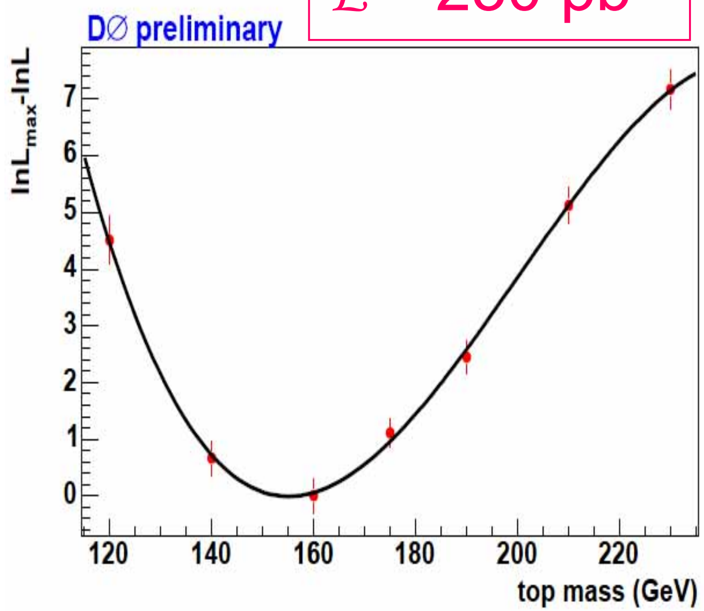
- Assume (x_1, x_2).
- Calculate weight for each event.

$$W(M_{top}) = \sum_{solution} PDF_{a/p}(x_1) \cdot PDF_{b/\bar{p}}(x_2) \times \boxed{p(E_l^* \mid M_{top})} \cdot p(E_l^* \mid M_{top})$$

Probability to observe E_l^* in top decay

- Scan (x_1, x_2).
- Pick M_{top} at maximum weight.
- Template fit (w/ 13 candidates).

$\mathcal{L}$ = 230 pb^{-1}



m_{top} = 155 +14/-13 (stat) ± 7 (syst) GeV/c^2

New Preliminary World Average

Combination of the best analysis from each decay mode, each experiment.

Correlation :

Split into 2 to isolate “in situ” JES systematics from other JES

		Run-I published					Run-II preliminary			
		CDF			DØ		CDF			DØ
		all-j	l+j	di-l	l+j	di-l	$(l+j)_i$	$(l+j)_e$	di-l	l+j
CDF-I	all-j	1.00								
CDF-I	l+j	0.32	1.00							
CDF-I	di-l	0.19	0.29	1.00						
DØ-I	l+j	0.14	0.26	0.15	1.00					
DØ-I	di-l	0.07	0.11	0.08	0.16	1.00				
CDF-II	$(l+j)_i$	0.04	0.12	0.06	0.10	0.03	1.00			
CDF-II	$(l+j)_e$	0.35	0.54	0.29	0.29	0.11	0.45	1.00		
CDF-II	di-l	0.19	0.28	0.18	0.17	0.10	0.06	0.30	1.00	
DØ-II	l+j	0.02	0.07	0.03	0.07	0.02	0.07	0.08	0.03	1.00

$$\boxed{m_{top}=172.7 \pm 1.7\ (\text{stat}) \pm 2.4\ (\text{syst})\ \text{GeV}/c^2}$$

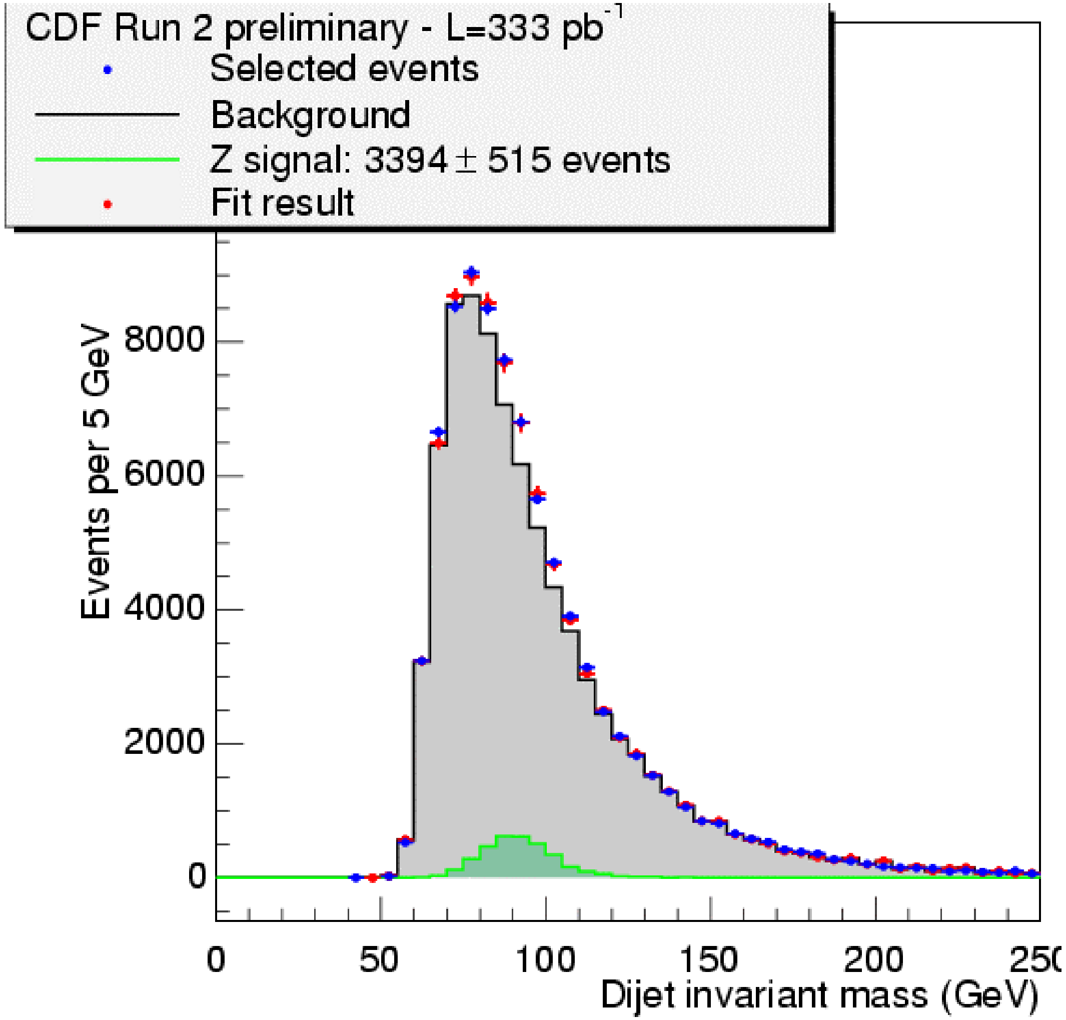
$Zb\bar{b}$

Trigger :

- 2 SVT track + 2 10GeV clusters.

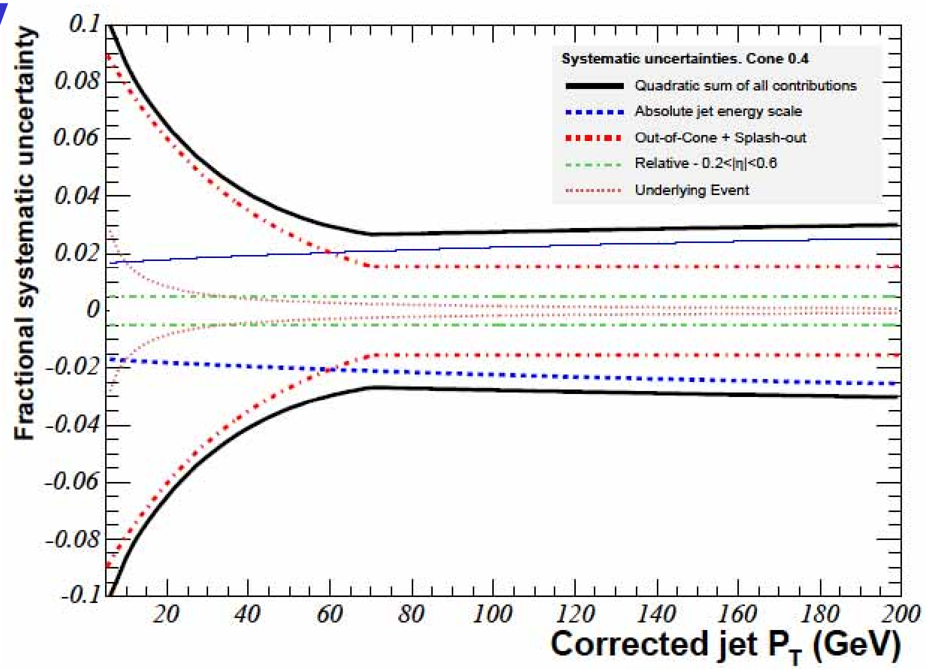
Offline Cuts :

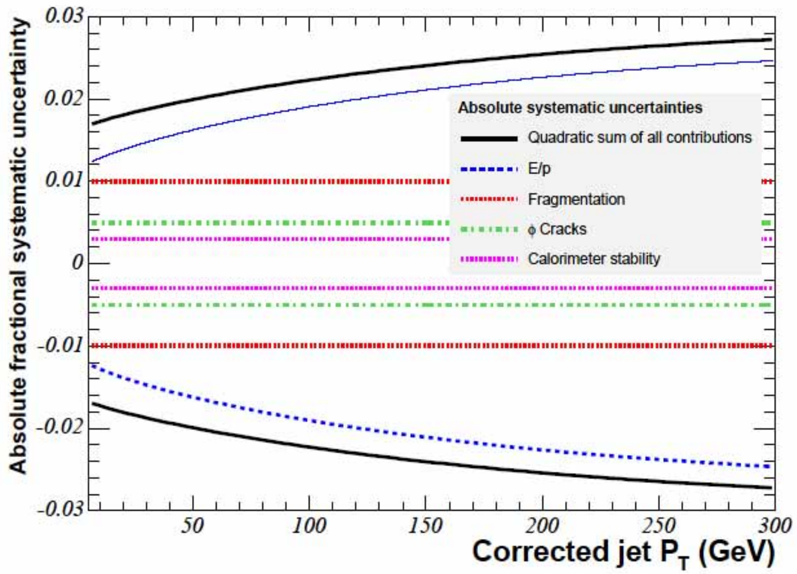
- N==2 jets w/ E_T>20GeV, $|\eta|$<1.5 (JetClu cone 0.7).
- Both jets are required to have secondary vertex tag.
- $\Delta\phi(j1,j2)>3.0$.
- $E_T^{3rd\text{-}jet}$<10GeV.



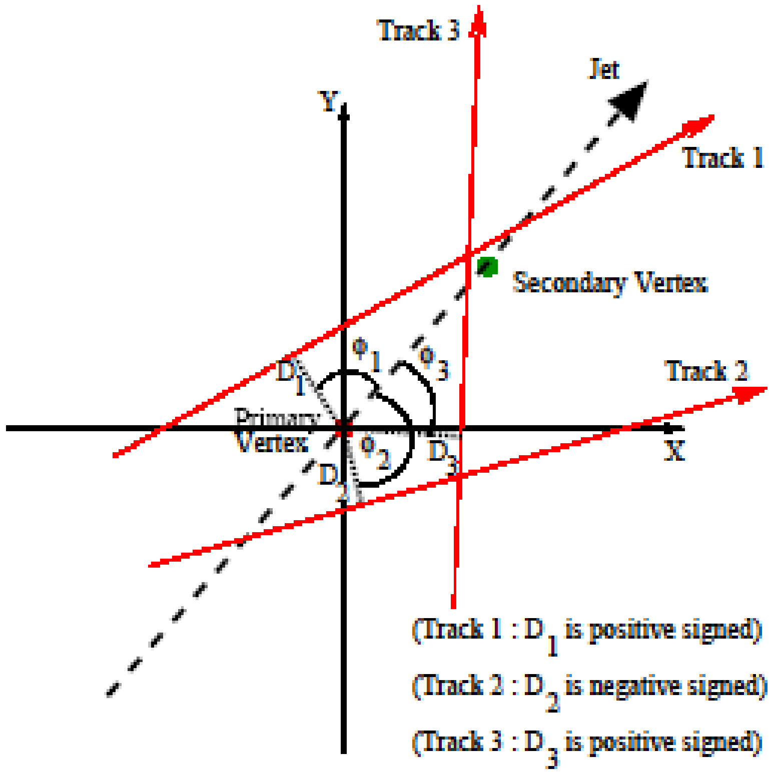
JES Uncertainty

- Largest uncertainty is from out of cone in E_T<60GeV and absolute scale in E_T>60GeV. Absolute scale uncertainty is dominated by the simulation tuning due to limited stat. of single track events.
- Current uncertainty on absolute scale ranges from 1.8% at 20 GeV to 2.9% at 300 GeV.
- The out of cone uncertainty ranges from 6% at 20GeV to 0.8% at 140GeV.





Jet Probability Algorithm (1)



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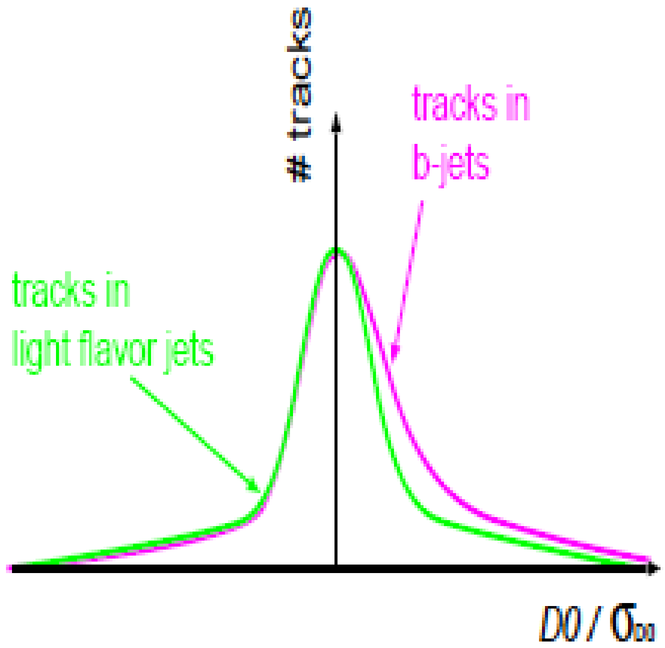
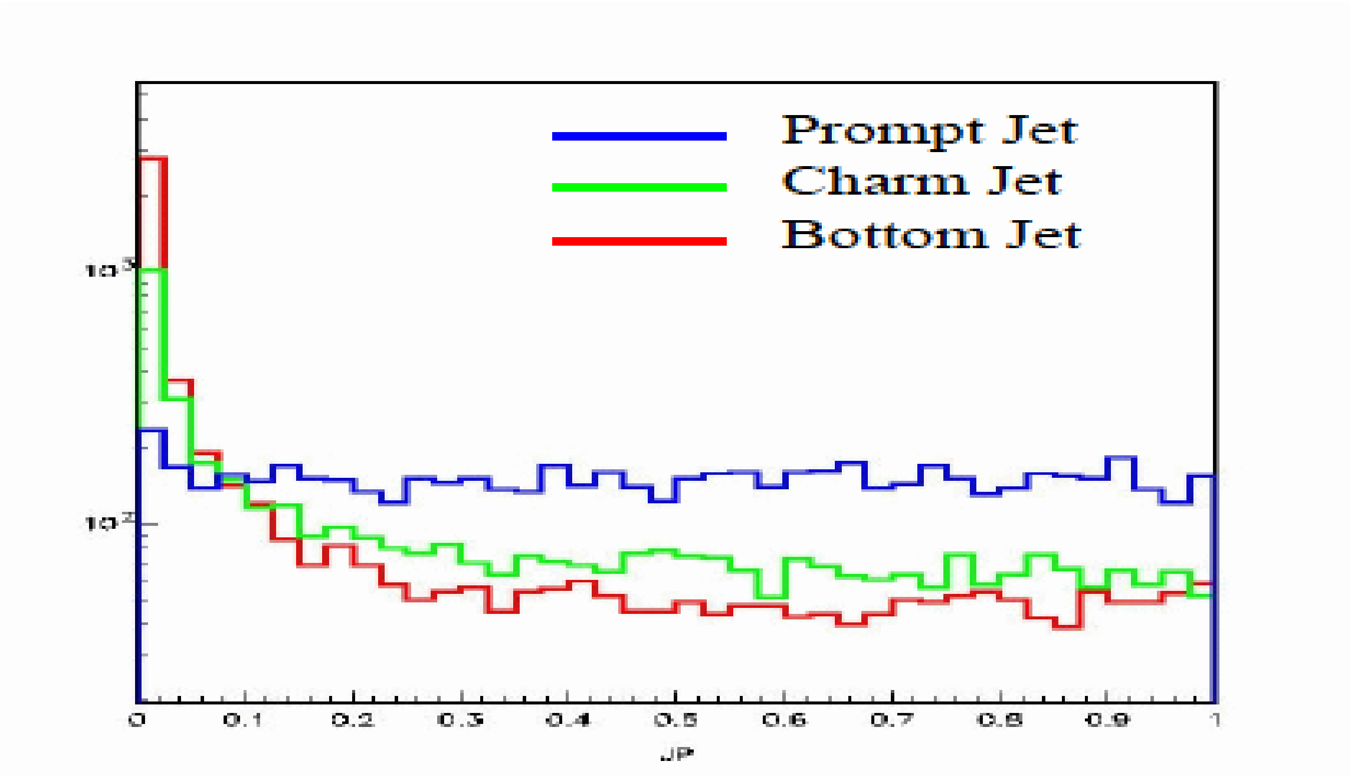


Assign sign (±) to the impact parameter $D0$ of each track based on its direction.

Jet Probability Algorithm (2)

Combine $D0$ significance of all the tracks in the jet and calculate "the probability of the jet originating in the primary vertex" (Jet Probability).



(Jet Probability in $t\bar{t}$ MC Events)

We can cut at arbitrary Jet Probability value for the b-tagging.
This enables us to loosen the b-tagging condition easily.

Abstract

高エネルギー加速器研究機構 KEK
HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

Physics Seminar

DATE: 2005-08-23 16:00 - 17:00

PLACE: Room 345 in the 4th building, 3rd floor

TITLE: Physics Seminar: Top Quark Mass Measurement in CDF Run II

CONTACT: 4342

SPEAKER: Koji Sato (University of Tsukuba)

URL: http://seminar.kek.jp/physics/

ABSTRACT: Top quark was discovered in pbar p collisions of TEVATRON Run I in 1995. It still remains one of the least well-studied elementary particles discovered so far. The measurement of the mass of the top quark is especially valuable as an input to precision electroweak analyses where the validity of the Standard Model can be checked extensively. Due to its uniquely heavy mass, the top quark is expected to strongly couple with the Higgs boson, and the measurement of the top quark mass along with the W boson mass constrains the mass of the Higgs boson. TEVATRON and its detectors have been upgraded in the last decade in order to offer a better potencial for physics studies, and started the Run II in 2001. The top quark mass 173.5 +4.1/-4.0 GeV/c2 measured by CDF Collaboration using 320 pb^{-1} of lepton+jets dataset of Run II in Spring 2005 already surpasses the previous world average. At the same time, CDF Collaboration is trying several new measurement techniques to better exploit the potential of TEVATRON Run II. The seminar will focus on our best measurement, as well as summarize the status of the new measurement schemes.

[index]