Search for Single Top Production

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Overview

- Standard Model Framework for Top
- Single Top Production
- Search in Run I Data
  - Technique
  - Results
- Prognostications for Run II

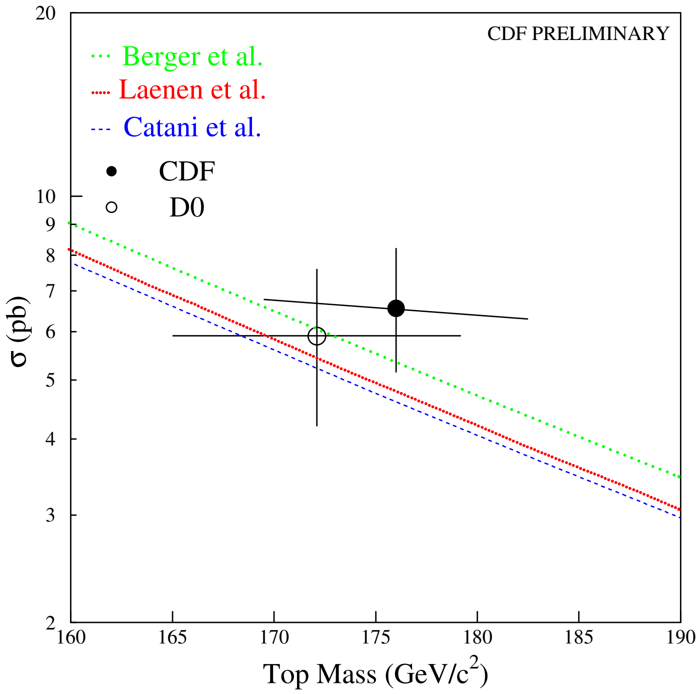
Work done primarily by Sarah Wolinski
and Pierre Savard

Top Quark Production

Top has been observed through the LO SM process

$$p\bar{p} \rightarrow t\bar{t}$$

$$\sigma_{t\bar{t}} = 6.5^{+1.7}_{-1.4} \text{ pb}$$



- Theory predictions range from 4.7 to 5.5 pb

However, this is not the only source of top quarks!

Single Top Production

Single top production is a much lower rate process

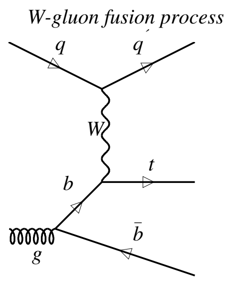
- Sensitive to Γ_t and V_{tb}

$$\frac{|V_{tb}|^2}{|V_{td}|^2 + |V_{ts}|^2 + |V_{tb}|^2} = 0.99 \pm 0.29$$

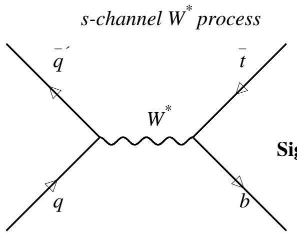
- Also could have contributions from non-SM sources

There are two primary SM production processes

1. t-channel $W - g$ fusion $\Rightarrow W^+bq$ final state
2. s-channel W^* process $\Rightarrow W^+b\bar{b}$ final state



Signal is W+b+q



Signal is W+b+b̄

- Predicted cross sections are 1.7 ± 0.3 and 0.7 ± 0.1 pb

Search Technique

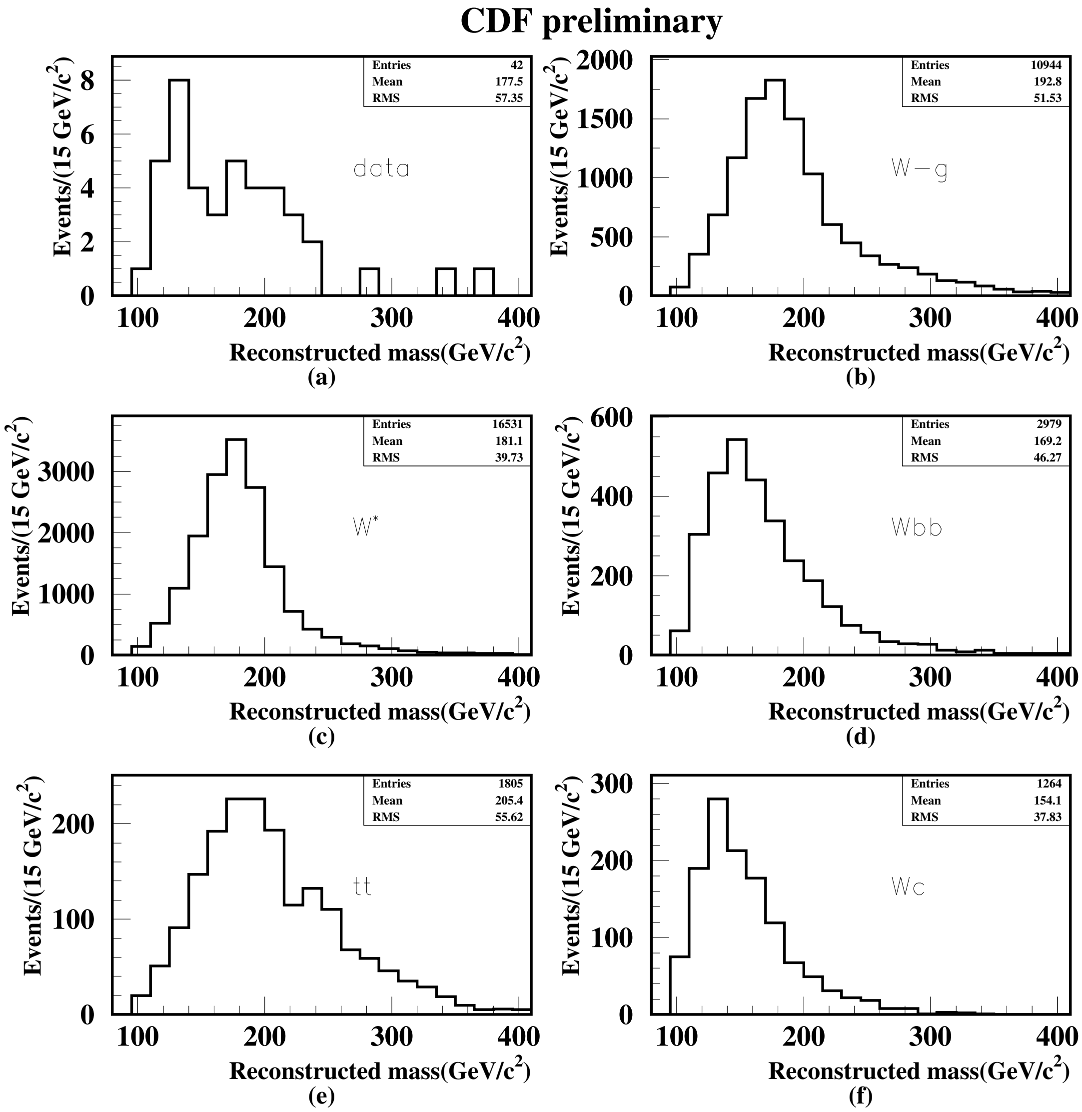
Kinematics of production processes different

- Use the same selection for both processes
  - 1, 2 or 3 jets with $E_T > 15$ Gev and $|\eta| < 2.0$
  - At least one b-tagged jet
  - Require $140 \leq M_{top} \leq 210$ GeV/c^2
- Fit H_T distribution with signal and background terms

$$H_T \equiv \sum_{\text{partons}} E_T$$

	W^*	W-gluon
σ_{theory} (pb)	0.73 ± 0.10	1.7 ± 0.3
Integrated luminosity (pb^{-1})	106 ± 4	106 ± 4
$W + n$ jet acceptance (%)	4.5 ± 0.7	6.7 ± 1.0
SVX b-tag efficiency (%)	37.5 ± 3.1	24.8 ± 2.0
Number of expected events	1.3 ± 0.3	3.0 ± 0.6

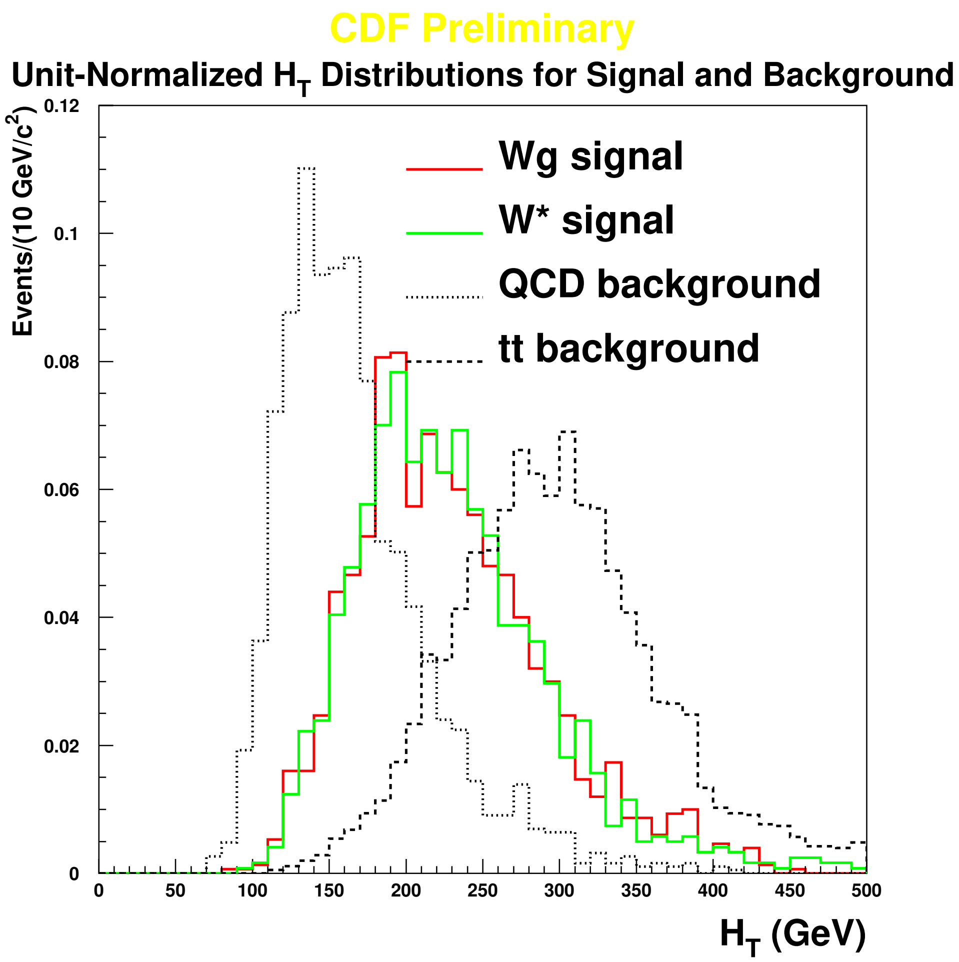
Top Mass Reconstruction



H_T Reconstruction

The variable H_T is an effective discriminator

- QCD Background
- $t\bar{t}$ background
- Single top signal



Results of Search

Observed 65 events in this sample

- Largest single background are mistags
  - $t\bar{t}$ itself is a problem now

Process	Event Yield
Mistags	25.9 ± 7.5
$Wb\bar{b} + Wc\bar{c}$	28.7 ± 7.5
Wc	17.2 ± 6.2
Non-W	12.1 ± 4.1
Miscellaneous	5.1 ± 0.9
After M_t cut	54 ± 11
$t\bar{t}$	8.4 ± 2.7
W-gluon	3.0 ± 0.6
W^*	1.3 ± 0.3
Total expected	67 ± 11
Observed	65

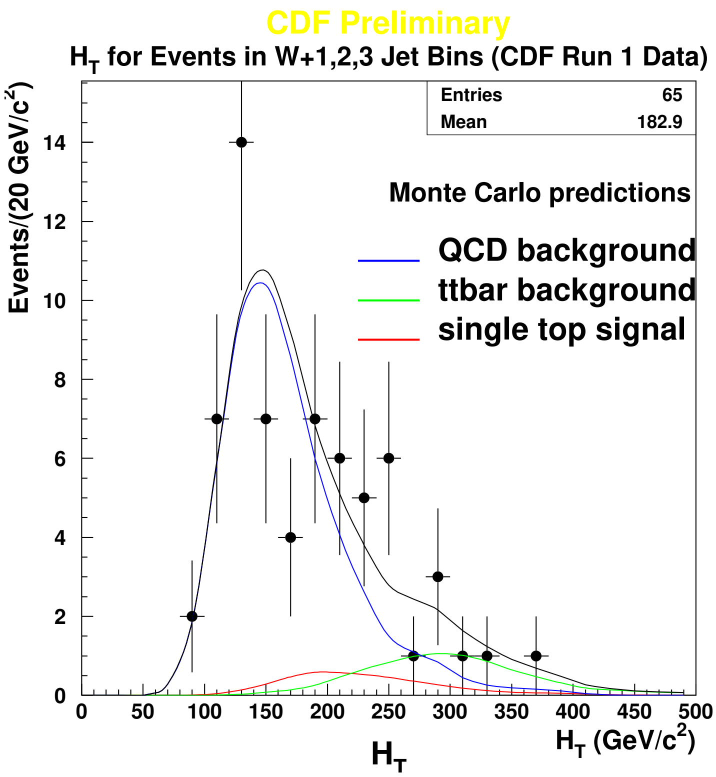
Not yet sensitive to SM single top rate

- Can set limits on total single top rate

Single Top Production Cross Section Limits

Use H_T distribution to fit signal and background shapes

- Set upper limit using a Bayesian technique
- Fit gives $\sigma_t < 13.5$ pb at 95% CL



Still well away from SM rate

- Can conclude that there is no huge anomaly
- It is a feasable measurement for Run II
  - Can get $S/N = 2.9$ on $W + 2,3$ jet sample

Run II Forecasts

Run II will start this summer at $\sqrt{s} = 2.0$ TeV

- CDF will begin with engineering run (no SVX II)
- Both detectors will be completed by end of 2000
- Physics running will commence in 2001

Will be worth the wait

- Begin with ~ 3 fb^{-1}/year per detector
- Finish up with ~ 5 fb^{-1}/year
- Literal "Top Factory" with
  - 300 dilepton events
  - 3000 tagged lepton+jet events
  - 1500 events in "mass sample"

Single top production

- Measure σ_t with 10% uncertainty
- Measure V_{tb} with 12% uncertainty

Summary

Debut of top using Run I data coming to close

- Have seen that it looks much like a SM fermion
- Clearly observed through QCD $t\bar{t}$ production
- Single top harder to extract
  - 95% CL upper limit of $\sigma_t < 13.5$ pb at 95% CL

All this sets the stage for Run II

- Run for 2-4 years, with goal of ~ 6 fb^{-1}

  $\Rightarrow$ Increase top quark sample $\times 50$

  - Should be able to measure single top production
    - $S/N \sim 2$
    - $\sigma_t \sim 10\%$