LHC Days - Split, October 5th 2010

Top Physics at the Tevatron

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- Top physics in sqrt(s)=1.96 TeV proton-antiproton collisions: production and decay

- Top mass measurements highlights
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- Single top production cross section measurements
- Top quark properties:
  - Top quark width
  - Top charge asymmetry
  - W helicity in top decays
- Searches with top quarks:
  - $t \rightarrow Zq$ search
  - limits on t’ quark mass

- Conclusions and outlook

Un-contents – what I will NOT show

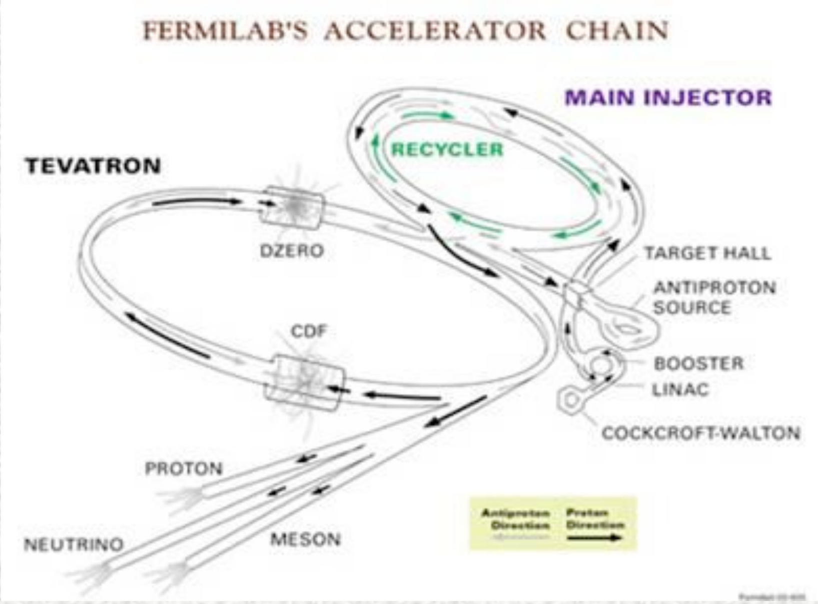
- The top physics measurements performed in Run II by CDF and D0 are O(100) – in 25' I can only show a very small, hopefully representative, selection of results
  - Personal choice, attempt to discuss hottest/most interesting topics (at least to me!)
    - No attempt to "balance" CDF/D0 material
  - What is left out:
    - top mass: three dozen results
    - top cross section: two dozen results
    - top lifetime with decay length, top BR $t \rightarrow Wb/Wq$, pair production mechanism, top spin correlations, top quark charge, top-antitop mass difference, $d\sigma/dM_{tt}$
    - searches in top samples: b', boosted top, $Z' \rightarrow tt$, $W' \rightarrow tb$, $t \rightarrow H^+b$
    - plus more
  - Please visit the public pages of the two experiments for a complete list and links to each measurement and paper
    - CDF: http://www-cdf.fnal.gov/physics/new/top/top.html
    - D0: http://www-d0.fnal.gov/Run2Physics/top_public_web_pages/top_public.html

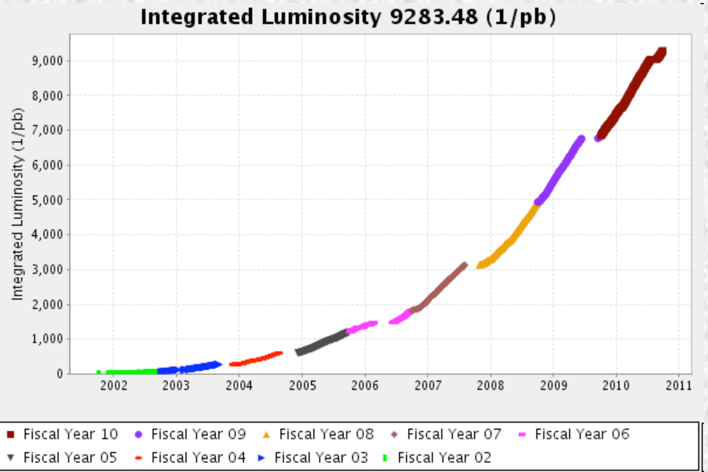
The experimental landscape

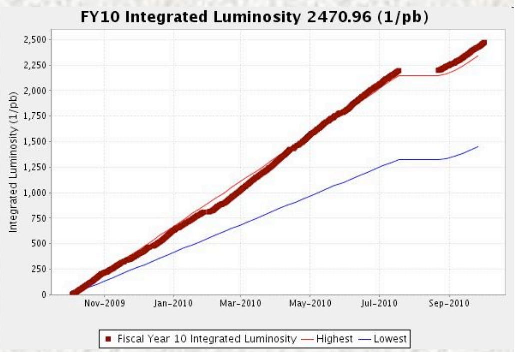
Tevatron performance

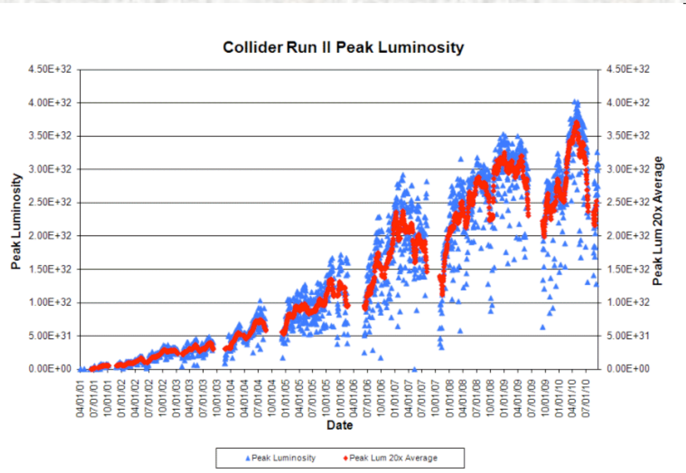
- The Tevatron continues to run at an excellent pace
  - Recorded so far over 9/fb
  - Record inst. luminosity: 4E32 cm^{-2} s^{-1}
  - Integrating O(55/pb/w), O(2/fb/y)
    - FY 2010 record: 2.47 /fb !!!

- No technical problem is apparent in sustaining this rate for a few more years
  - Recently suggested to keep running until 2013 (PAC recommendation)
    - this would impact the long-term plans of the lab

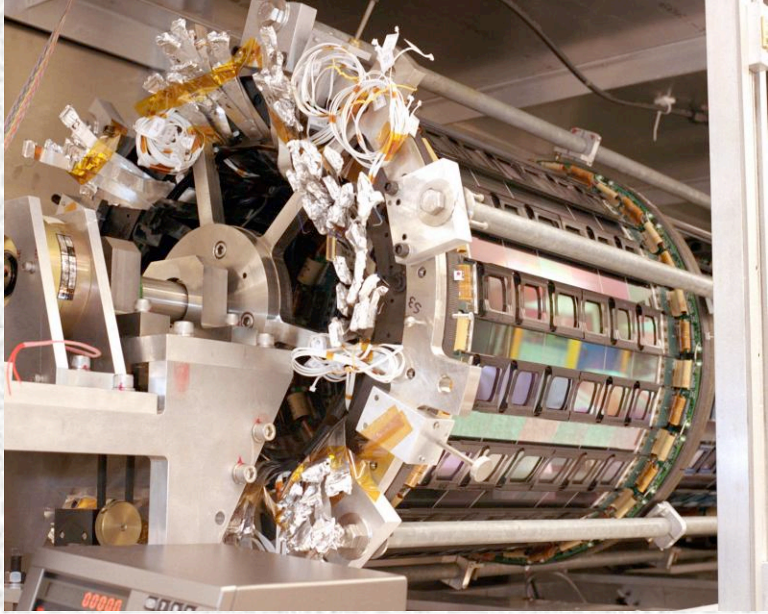








The CDF detector

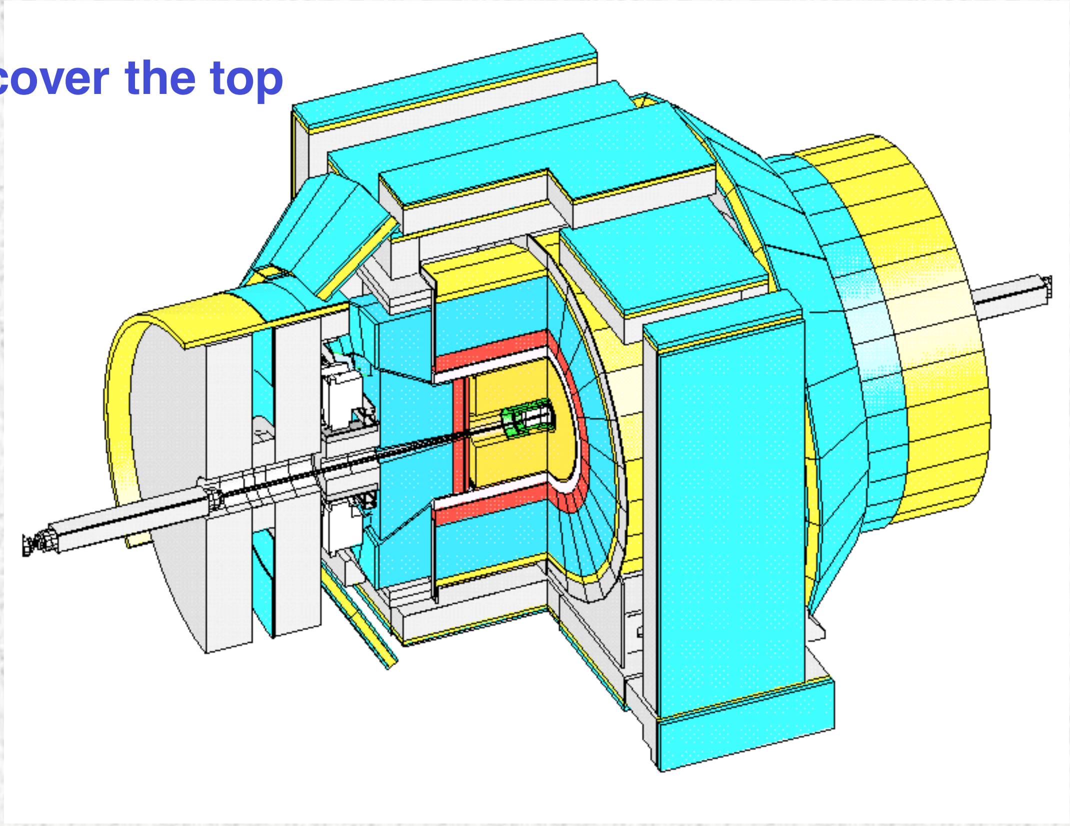


A magnetic (B=1.4T) all-purpose detector, composed of:

- L00+SVX+ISL: 7 silicon layers
- COT, central tracker to $|\eta|<1.1$
- EM calorimeters for electrons ($|\eta|<2$) and photons; HAD calorimeters
- An extended system of muon chambers covering $|\eta|<1.5$

Original structure designed to discover the top quark 25 years ago

It has achieved a LOT more!

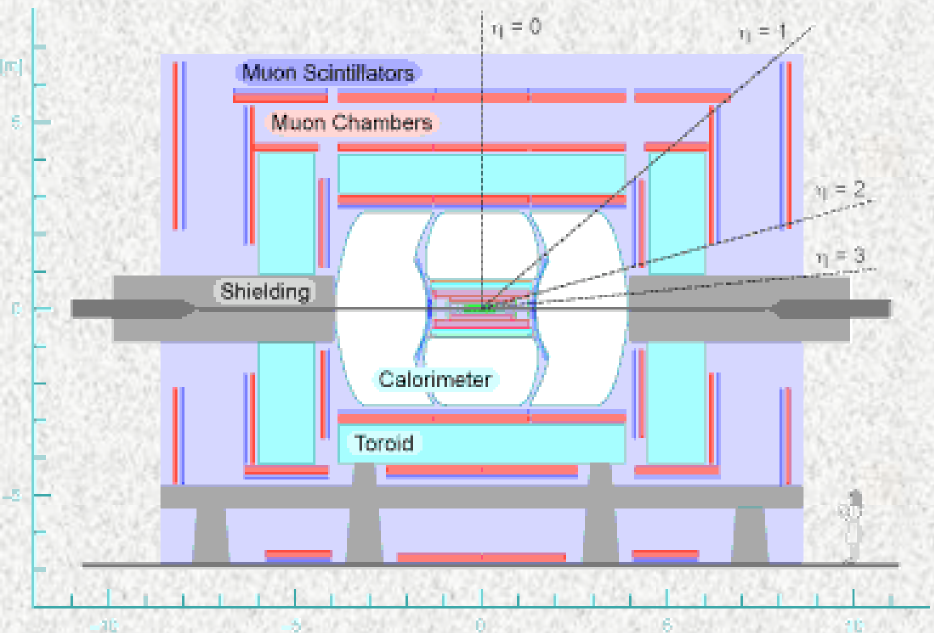


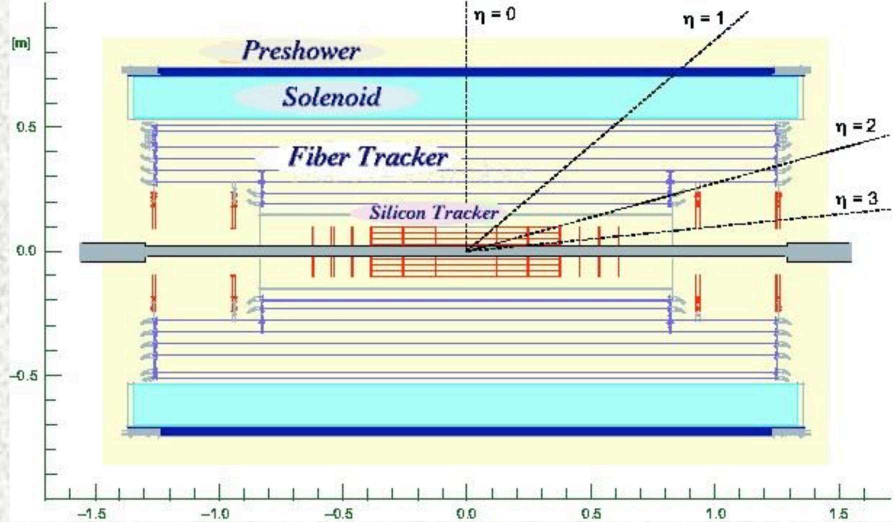
The D0 Detector

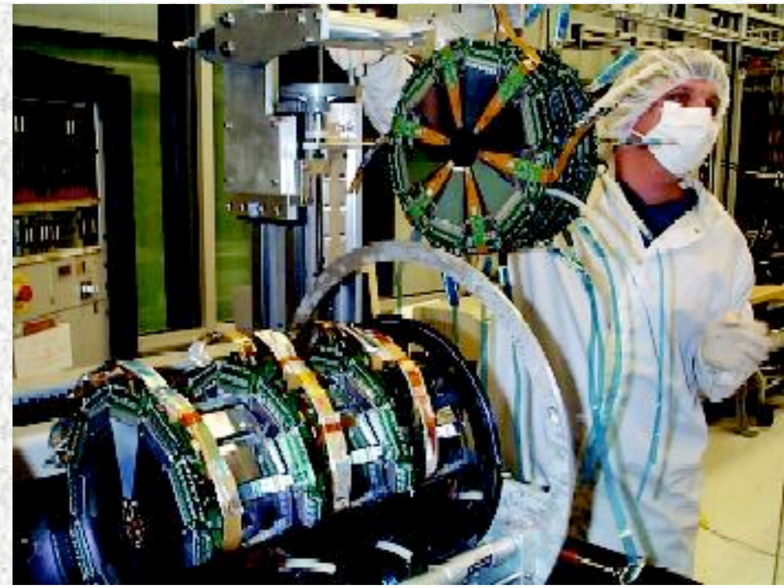
CDF's younger brother is also a complete and redundant system, endowed with

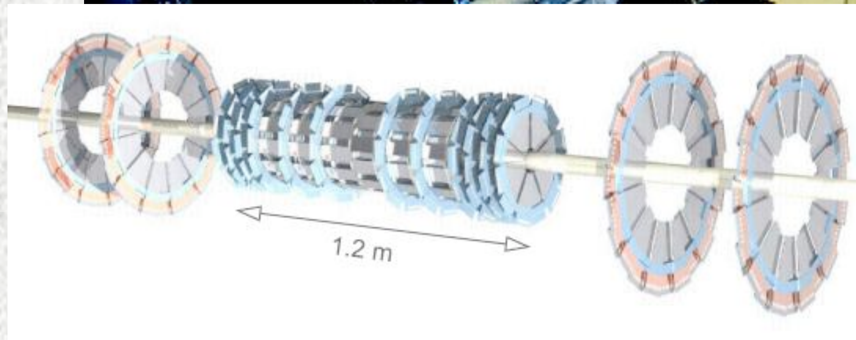
- silicon detector covering up to $|\eta|<3$ rapidity
- compact scintillating fiber tracker
- 2.0 Tesla axial B field
- hermetic U/liquid Ar calorimeter
- Extended muon coverage

The tracker allows high performance b-jet tagging out to $|\eta|<2.0$



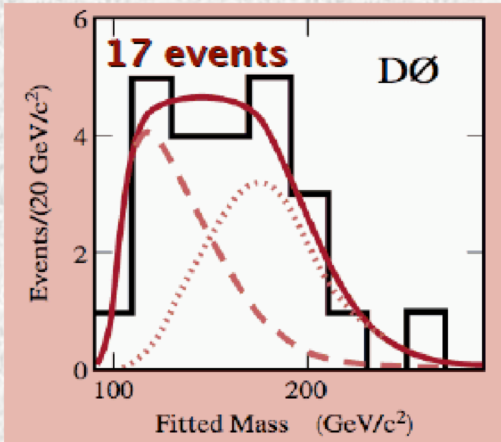


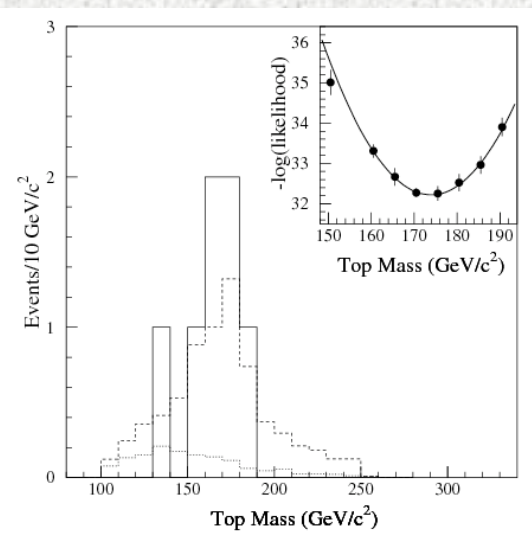


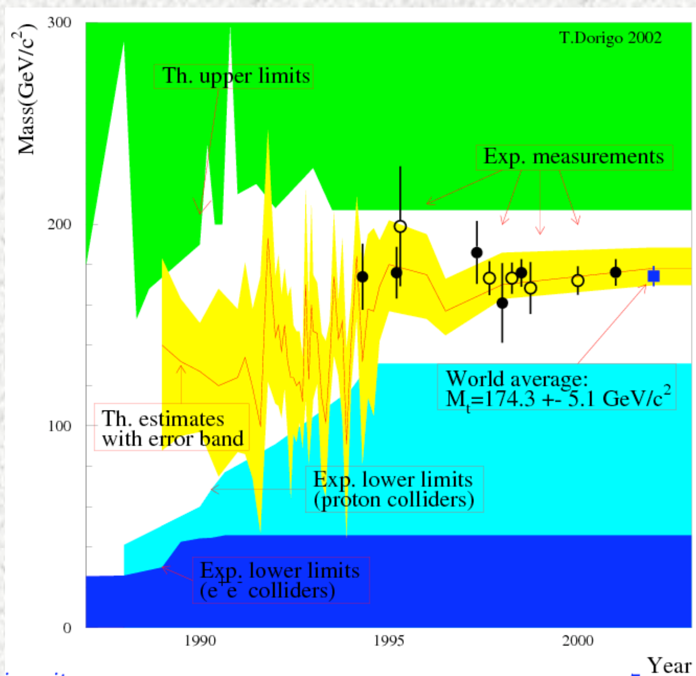


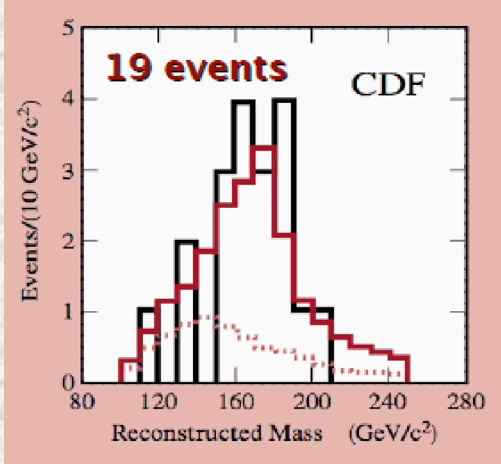
A Brief History of the Top Quark

1971 Three quark generations first hypothesized by Kobayashi and Maskawa
1977 Isospin partner needed for anomaly cancellations after b-quark discovery
1983 PETRA determines I^3_b with A_{fb} measurements
1984 UA1 “discovery” (M_t=40±10 GeV with 12 events, 3.5 expected), then retracted
1987 B mixing measurements imply a large top mass
1992 LEP determines I^3_b=-1/2
1988-93 increasing lower limits on top mass by CDF and D0
1994 First evidence by CDF, M_t=174±12 GeV !
1995 Observation of top pairs by CDF & D0
2008 Observation of single top by CDF and D0

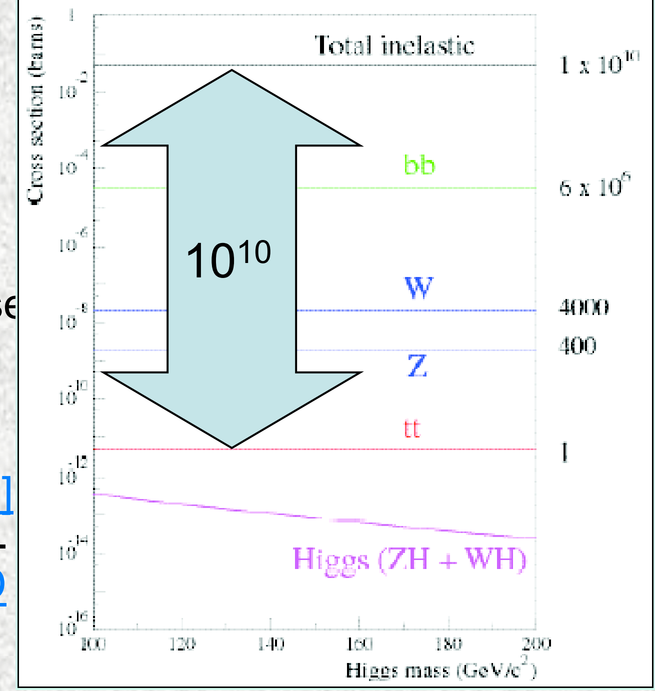








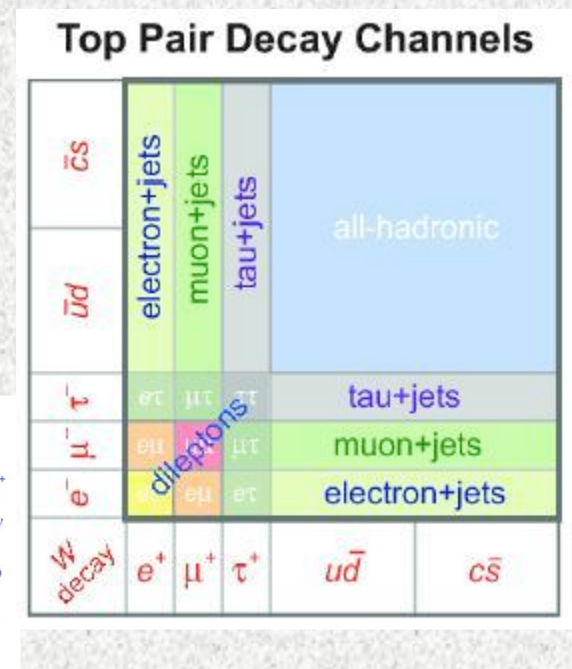
Top production & decay

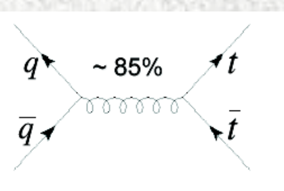


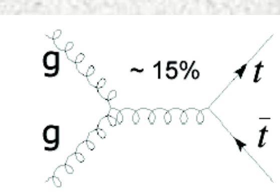
- At the Tevatron top pair production proceeds from qq annihilation and gluon-fusion processes, in percentages inverse to LHC collisions (85/15)
  - One in 10 billions (compare LHC 7 TeV two per billion)
- The cross section for 1.96 TeV ppbar collisions is
  $\sigma_{tt} = 7.46^{+0.48}_{-0.67}$pb [S.Moch, P.Uwer, PRD78 (2008) 034003]
- Single top production is due to s-channel (1.12±0.04 pb) and t-channel (2.34±0.12 pb) processes [N. Kidonakis, Phys. Rev. D **74**, 114012 (2006)]
  - Not irrelevant, but much harder to extract!

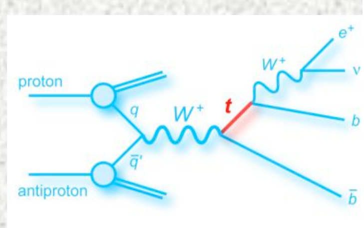
- Top quarks decay >99% of the time as t→ W^+b, then W+→qq' (2/3) or →lν (3x1/9)
- For top pairs, the final states divide according to the W decays
  - dilepton: $l^+l^-\nu\nu$bb → "dilepton plus 2 jets plus missing E_T"
  - single lepton: lνqq'bb → "lepton plus 4 jets plus missing E_T"
  - all-hadronic: qq'qq'bb → "multijet"

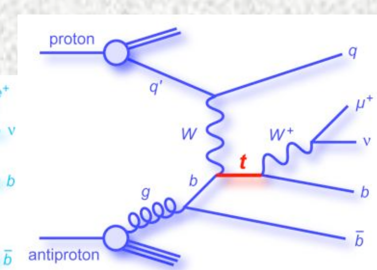
    NB: "leptons" mostly mean e,μ; recently also the "missing E_T plus jets" category was used with success by CDF
- For single top production, final states depend on the production process



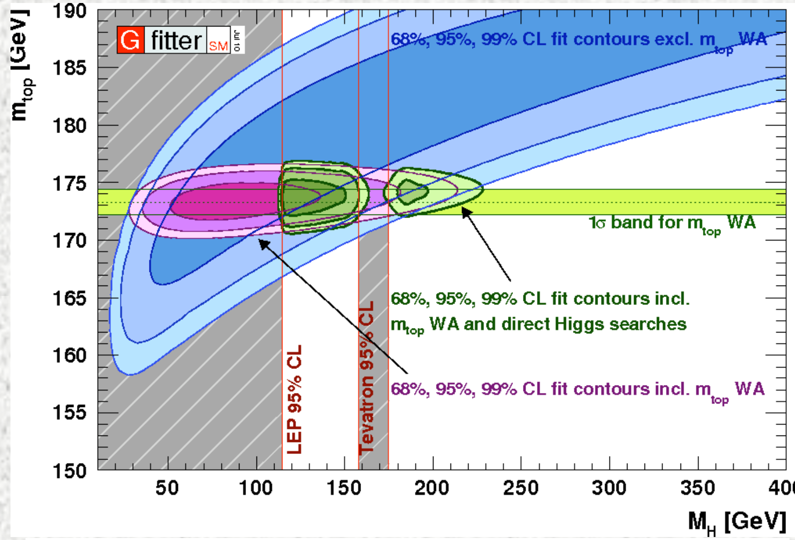








Top Mass, Again ?

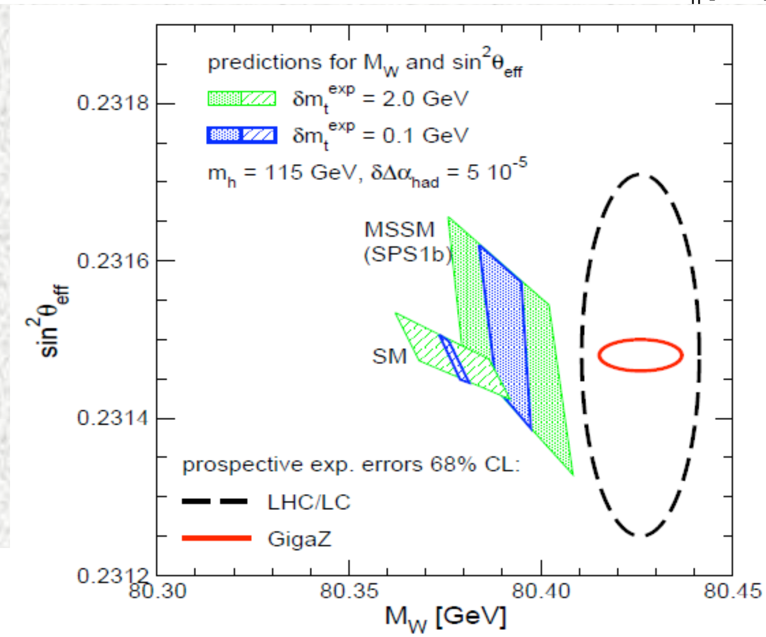


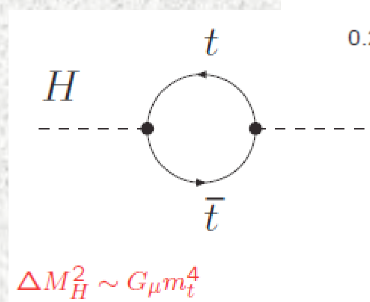
- Top is the quark whose mass is best known: O(0.67%, see below), and decreasing "by the conference". But a question arises: Do we really need to pursue a better precision ?
  If the SM is all there is, answer is: not for constraining the Higgs mass!

- However, precision on other parameters still significantly driven by δM_t

- In general, as far as EW parameters are concerned, both in the SM and in the MSSM a sub-GeV M_t knowledge makes a big difference!

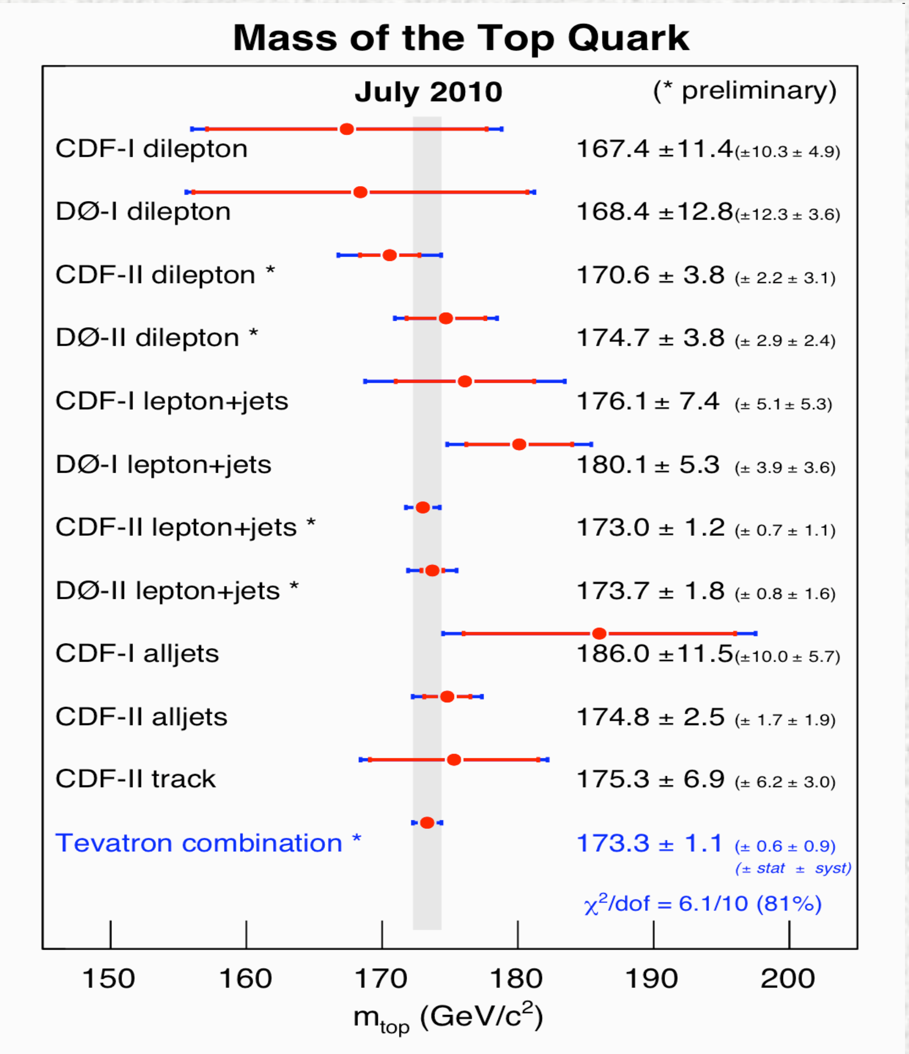
  In SUSY (and almost any other BSM model) M_H is free, and tightly connected to M_t via loops:
  δM_t=1 GeV ←→ δM_H=1 GeV
  [S.Heinemeyer et al., hep-ph/0306181]





Precision Higgs physics requires precision top physics!

Combined Top Mass Measurement

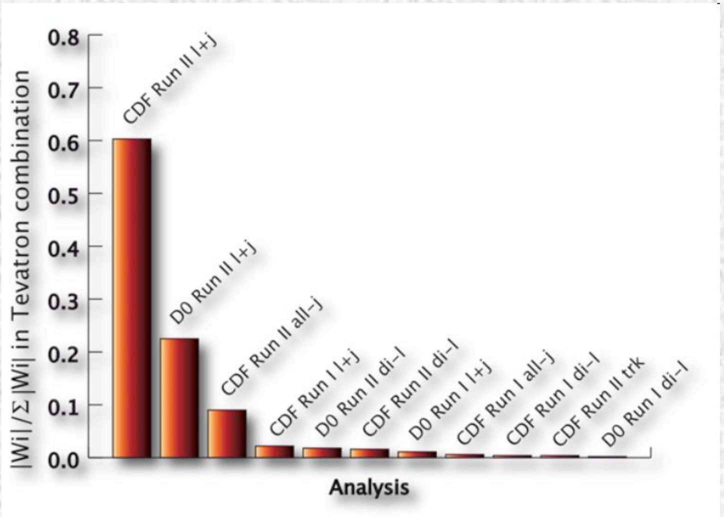


The most precise CDF and D0 Run II results using up to 5.6/fb have been combined with the Run I ones in July 2010, using BLUE

- Careful tracking of correlations
- Account for 6 different ways by which Jet Energy Scale uncertainty affects combined results
- Include lower-precision results which have no JES systematics

The CDF Run II lepton+jets result carries alone 60% of the weight

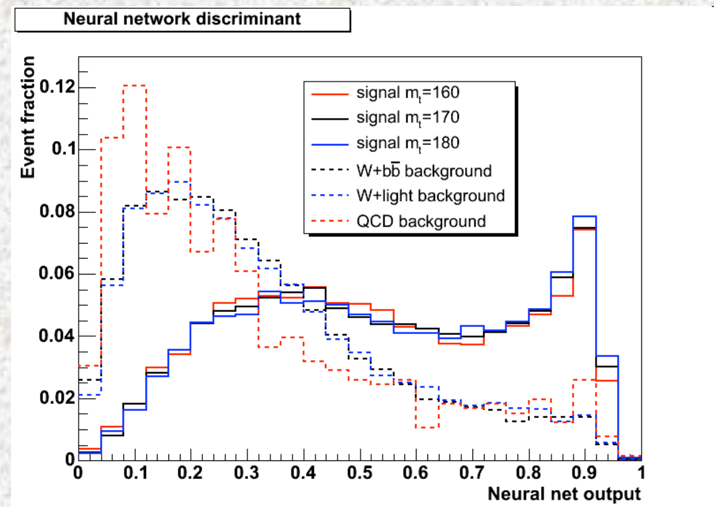
The combined result has a 0.61% uncertainty!

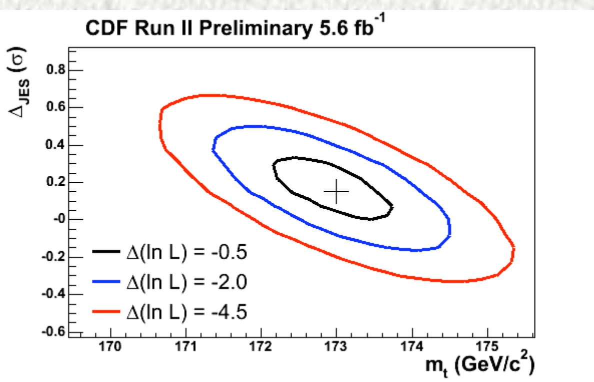


$M_t = 173.32 \pm 0.56(\text{stat}) \pm 0.89(\text{syst})$ GeV

A look at the single most precise result – CDF SL w/Matrix Element

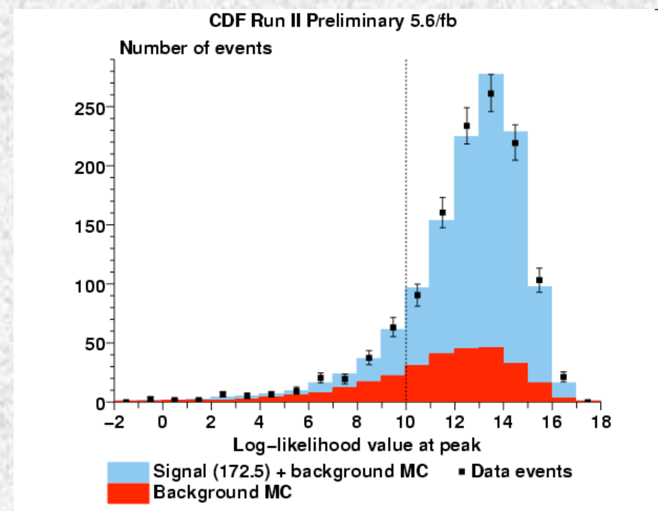
- CDF obtains its most precise single-analysis result in a 5.6/fb lepton plus jets sample by using a matrix-element technique
- Simple cuts on lepton, jets, and missing energy, plus secondary vertex b-tagging allow to obtain 1016 single b-tagged and 247 double b-tagged events, with S/N of 3:1 and 10:1
- A ME calculation integrates over parton→jet transfer functions and extracts the likelihood of each event, assumed to be due to ttbar production with parameters M_t and JES
- Each event is classified by a neural network employing kinematical quantities
- An "event signal fraction" is extracted from the NN, and the background likelihood is subtracted using its calculated fraction.
- Top mass extracted using likelihood profiling in JES



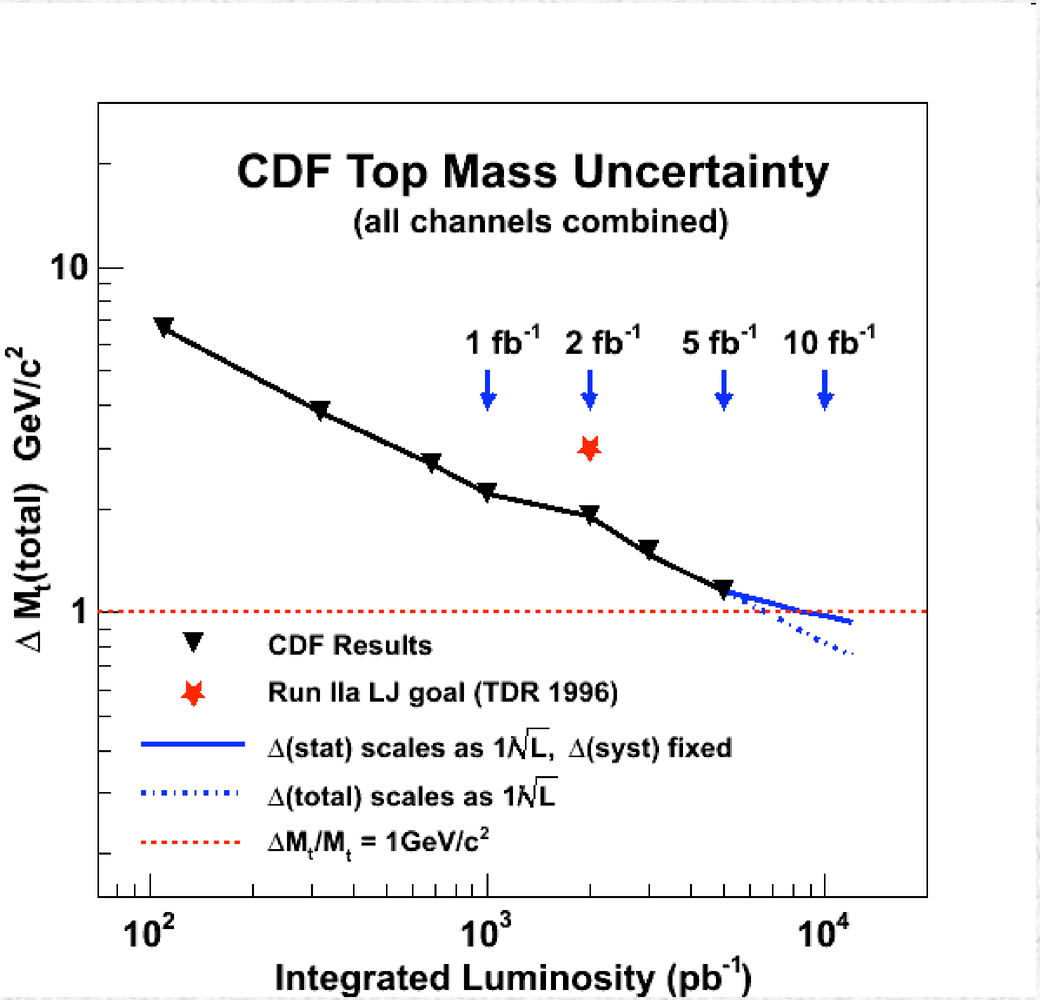


The result is

M_t = 173.0±0.7(stat) ±0.6(JES) ±0.9(oth. syst) = 173.0 ± 1.2 GeV

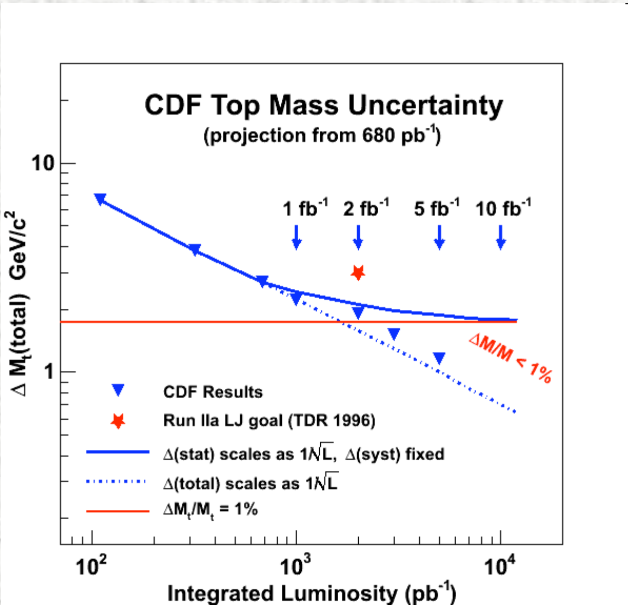


Future precision on the top mass

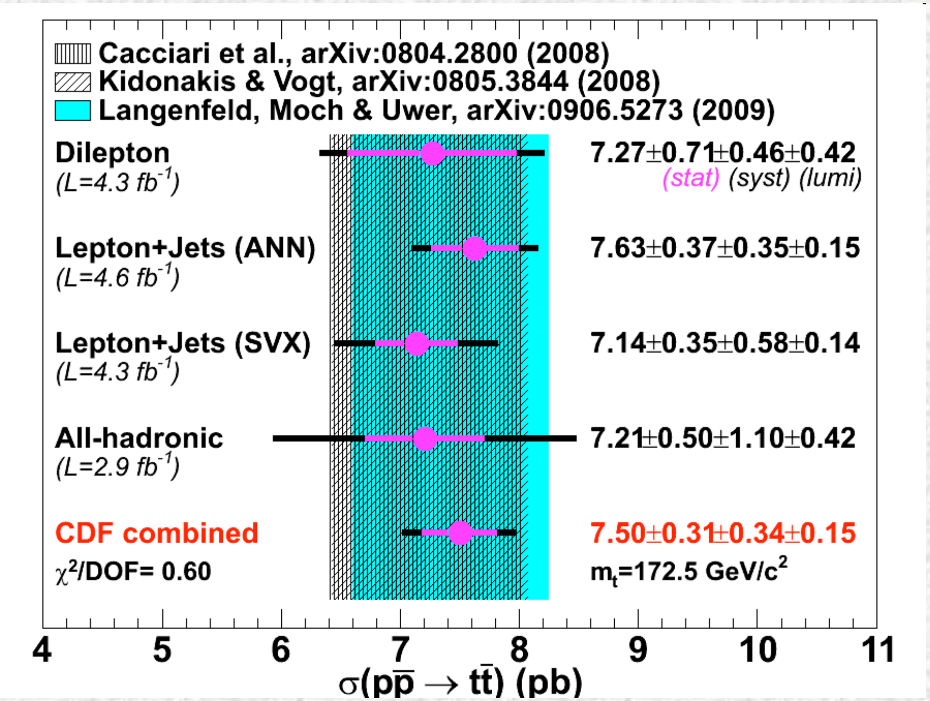


- CDF forecast the future precision of their top mass measurement assuming
  1) conservatively that no improvement in the systematics will be provided by the additional data (full curve), or alternatively
  2) that total systematics scale with $L^{1/2}$ (dashed curve)
- The conservativity of the full blue line can be checked below, by comparing the latest results with earlier extrapolations

CDF alone will reach well below 1 GeV precision
With D0 combination, likely get to 600 MeV precision
→a true legacy, hard to surpass until a LC is built



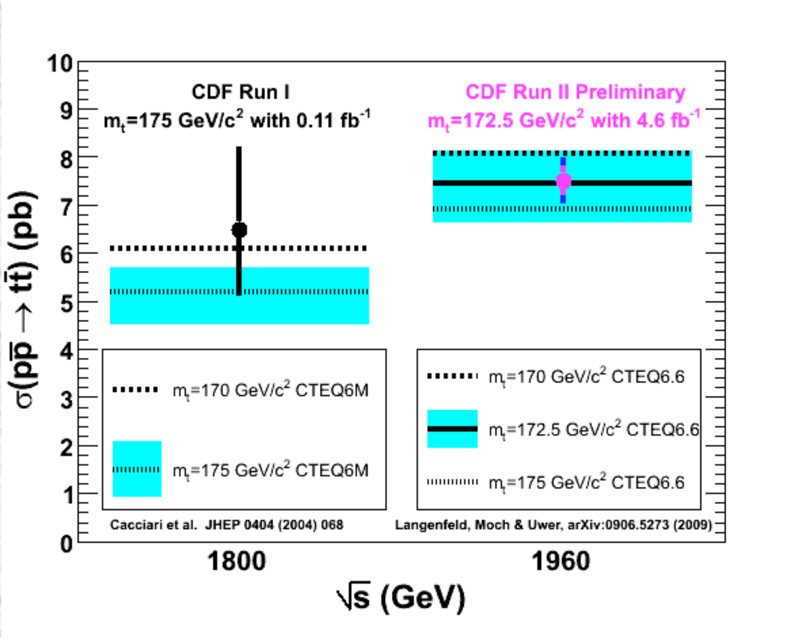
Top-Antitop Cross Section



The top pair cross section is by now a "less hot" measurement than it used to be

Still a very precise check of perturbative QCD NLO calculations; other typical motivations:
- high xs → new production mechanisms;
- low xs → new decay channels

Interest nowadays driven by top quarks being a background to other searches (e.g. SUSY, 4^{th} gen, Higgs, ...)



The top pair production cross section is now known to 6.4%, a precision exceeding that of theoretical estimates (NLO+s.g.NNLO)

Results in great agreement with QCD predictions ($7.46^{+0.66}_{-0.80}$ pb for M_t = 172.5 GeV using CTEQ6.6, Langenfeld et al., arXiv:0906.5273)

Cross Section – Most precise result

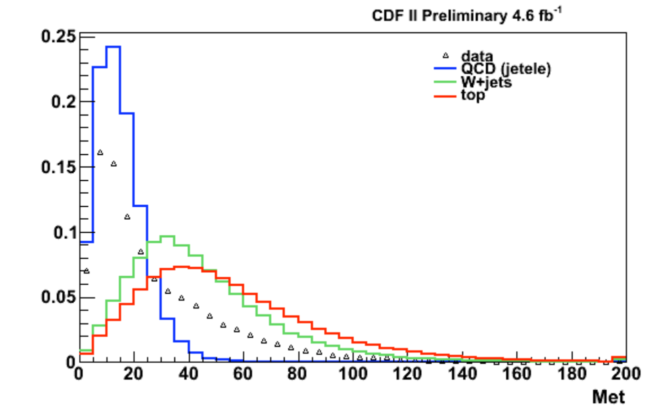
- The most precise result from the Tevatron comes from CDF when they normalize the cross section to the yield of Z bosons in the same dataset – this gets rid of most of the 5.6% luminosity uncertainty

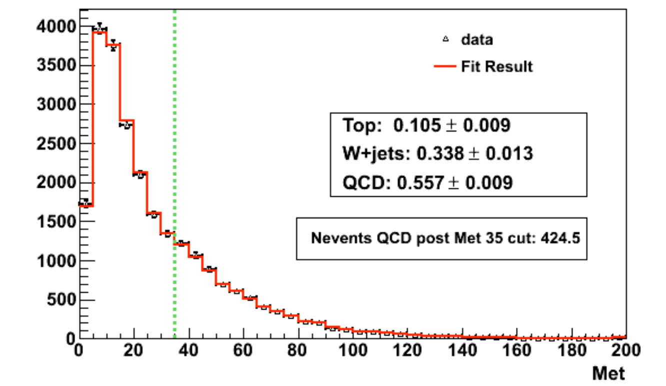
- Data selection is loose, no b-tagging!
- Kinematics used to disentangle signal:
  H_t, $M(jj)_{min}$, A, $\Sigma P_z/\Sigma P_t$, $|\eta|_{max}$, E_t^{345}, ΔR_{jj}^{min}

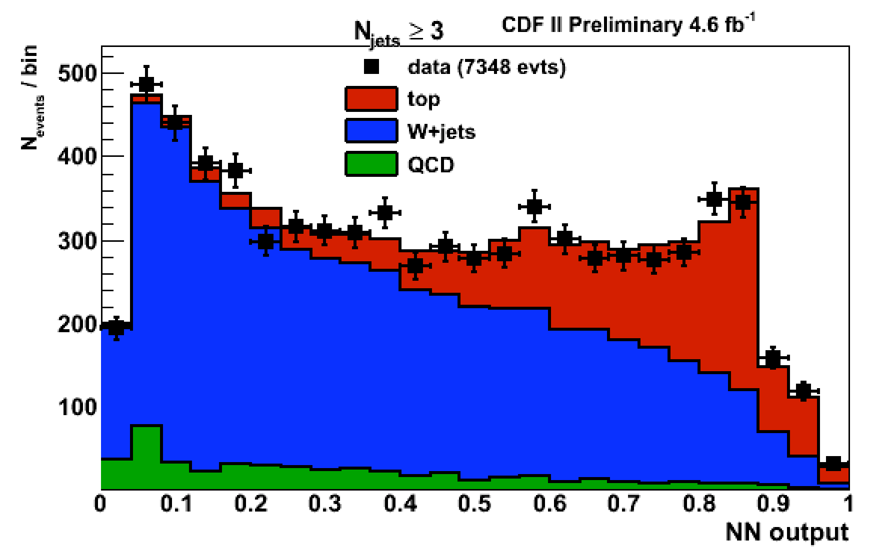
- QCD and W+jets backgrounds are derived by a fit to the missing E_t distribution (right)

- Final result from fit of NN output

- Result systematics dominated – largest no longer luminosity but jet energy scale and top generation modeling (2.5-3%), 2% from Z theory, 1% from Q^2 scale in W+jets production
  → σ_{tt} = 7.82 ± 0.38 ± 0.37 ± 0.15 (Z th.) pb

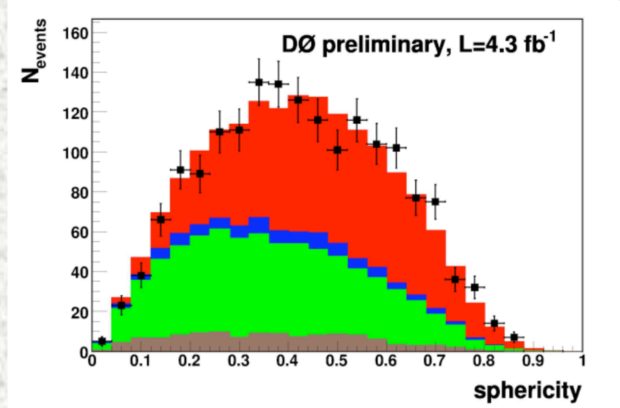


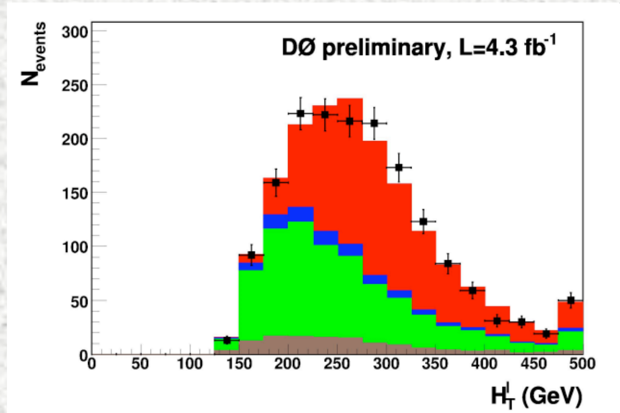


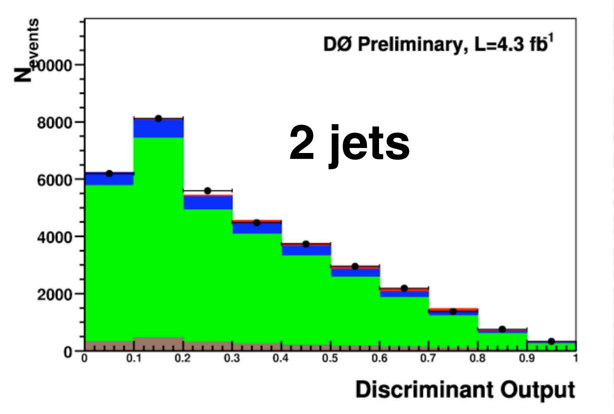


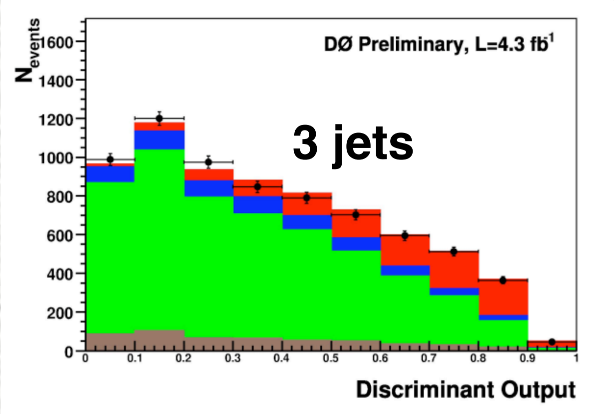
Cross Section – D0 single lepton

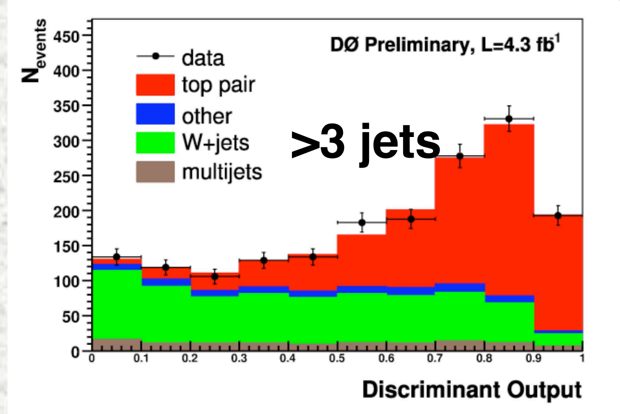
- The most precise D0 result for the top pair production cross section comes from the analysis of 4.3/fb of single-lepton candidates, using kinematics (no b-tagging)
- Events selected with standard cuts; backgrounds mainly from W+jets, QCD, diboson, single top
- Kinematics used in BDT (A,S,H_t,...) for six classes of events (e,μ, 2,3,>=4 jets) to discriminate tt from W+jets
- Normalization of W+jets derived from data, QCD from a matrix method, others from MC (ALPGEN, PYTHIA, COMPHEP)
- Likelihood fit extracts signal fraction from BDT outputs (Random Forests) in all classes
- Result: $\sigma_{tt} = 7.70^{+0.79}_{-0.70}$ pb (D0 note 6037)





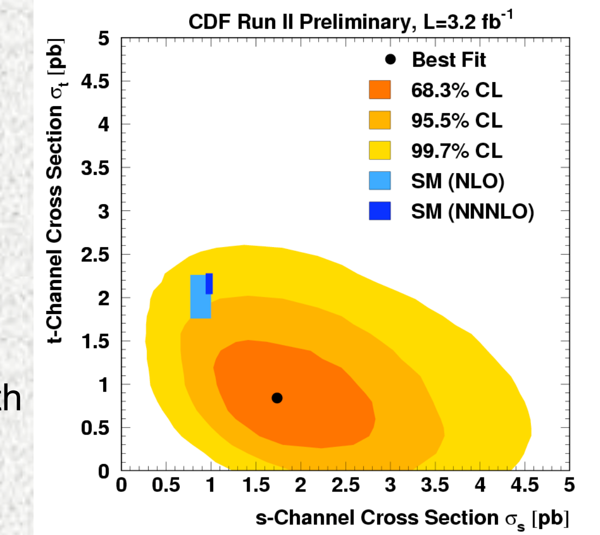


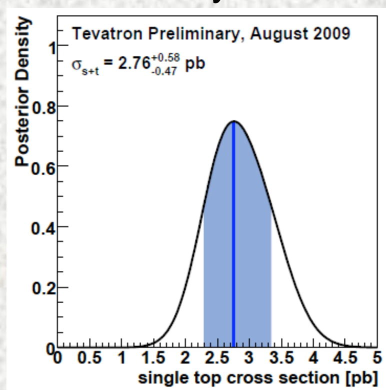


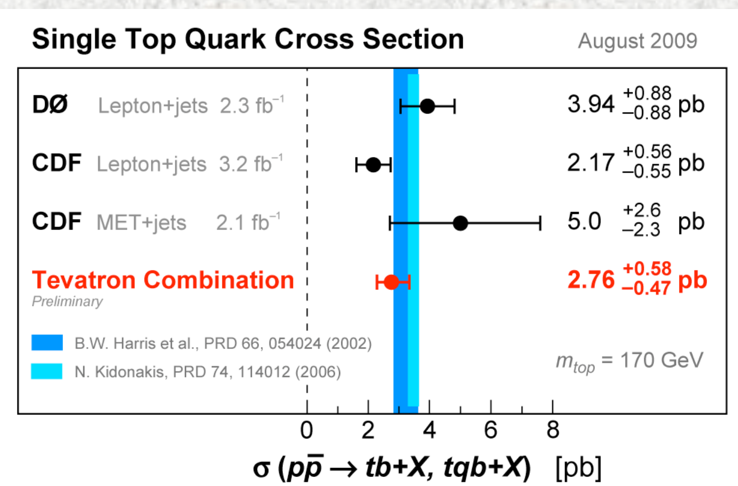


Single Top Cross Section

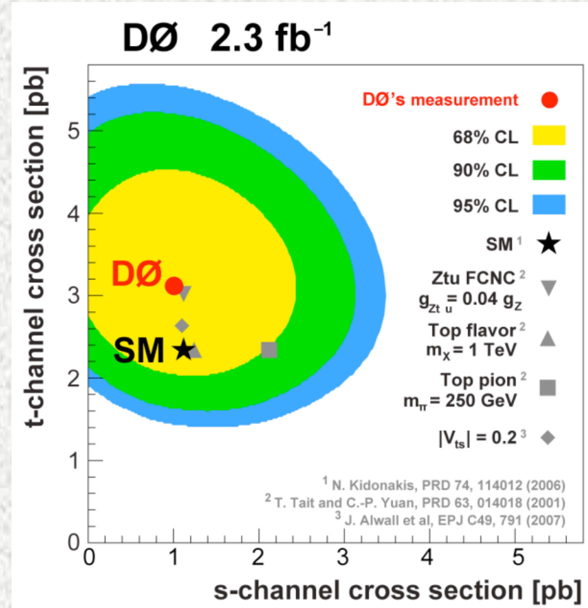
- Single top quark production has been observed by CDF and D0 in 2008
- Combined result from all analyses extracted with a Bayesian calculation
  - truncated Gaussians for nuisance pars, truncated $1/\sigma$ prior for signal cross section
- The resulting cross section is $\sigma_{s+t}=2.76^{+0.58}_{-0.47}$ pb, in good agreement with SM predictions
- From the same data, information on $|V_{tb}|$ has been extracted, assuming zero the off-diagonal CKM elements but no unitarity constraint:
  $|V_{tb}|= 0.88\pm0.07$ (>0.77 @95% CL) using the theoretical cross section of 3.46 pb from Harris et al. – see arXiv:0908.2171 [hep-ex]
- Independent s- and t-channel measurements also extracted by both experiments
  - good agreement in D0
  - 2-sigma discrepancy in CDF





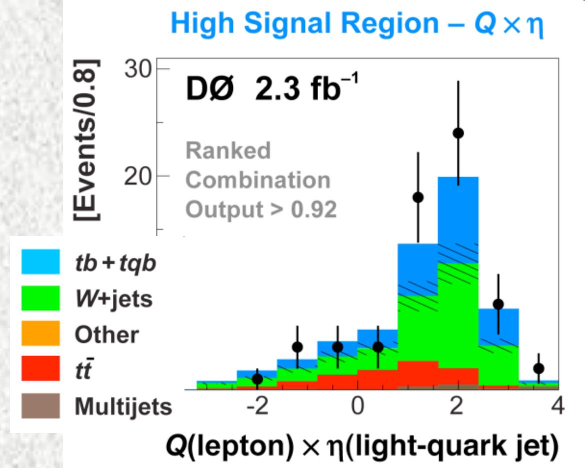


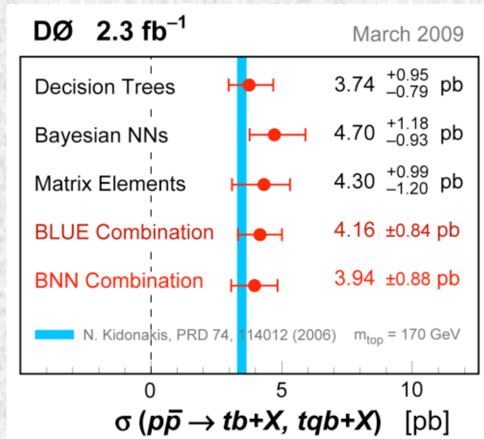
Single Top Cross Section	Signal Significance Expected	Signal Significance Observed	CKM Matrix Element V_{tb}
DØ (2.3 fb^{-1}) March 2009 PRL **103**, 092001 (2009) (m_{top} = 170 GeV)			
3.94 ± 0.88 pb	4.5 σ	5.0 σ	$\lvert V_{tb}f_1^L\rvert = 1.07 \pm 0.12$ $\lvert V_{tb}\rvert > 0.78$ at 95% CL
CDF (3.2, 2.1 fb^{-1}) March 2009 PRL **103**, 092002 (2009) (m_{top} = 175 GeV)			
$2.3^{+0.6}_{-0.5}$ pb	>5.9 σ	5.0 σ	$\lvert V_{tb}f_1^L\rvert = 0.91 \pm 0.13$ $\lvert V_{tb}\rvert > 0.71$ at 95% CL
DØ & CDF combined August 2009 FERMILAB-TM-2440-E (m_{top} = 170 GeV)			
$2.76^{+0.58}_{-0.47}$ pb			$\lvert V_{tb}f_1^L\rvert = 0.88 \pm 0.07$ $\lvert V_{tb}\rvert > 0.77$ at 95% CL

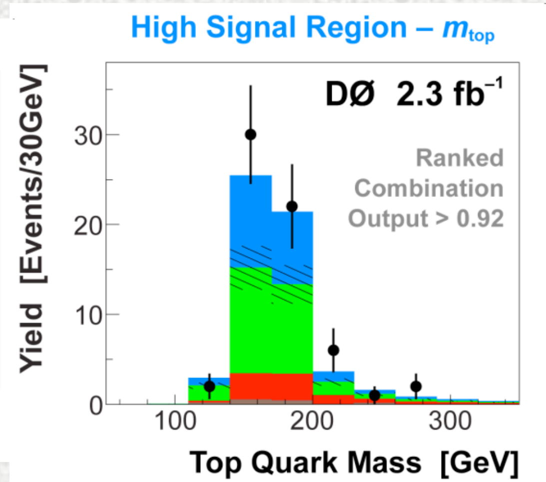


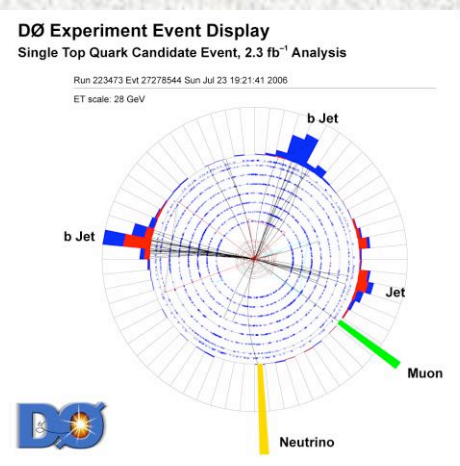
Single Top: D0 Measurement Details

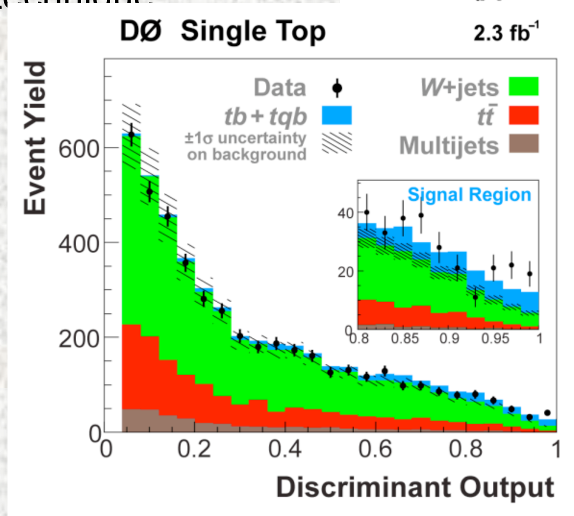
- D0 selects events with single-lepton topology and applies a NN b-tagging
- Signal fraction 1:20 before further analysis
- Three independent analyses are performed on 2.3/fb of data:
  - Boosted decision trees
  - Bayesian Neural Network
  - Matrix element technique
- t/s=2.1 xs ratio assumed from theory
- W+jets and MJ backgrounds are normalized using data; others with MC
- MC used: COMPHEP+PYTHIA (signal), ALPGEN+PYTHIA (tt, W/Z+jets), PYTHIA (diboson)
- The three cross section results are combined with both BLUE and a BNN technique

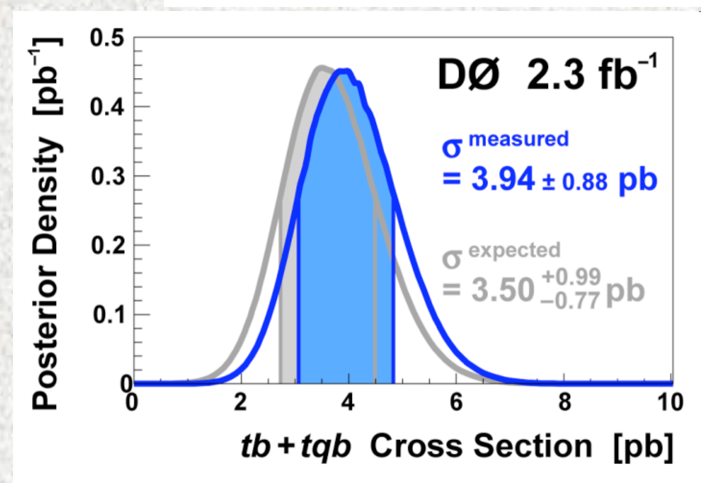












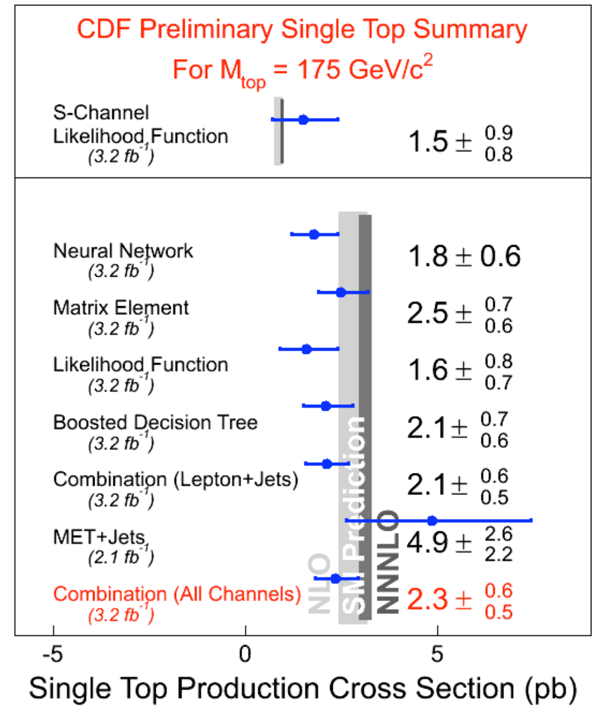
Single top: CDF measurement details

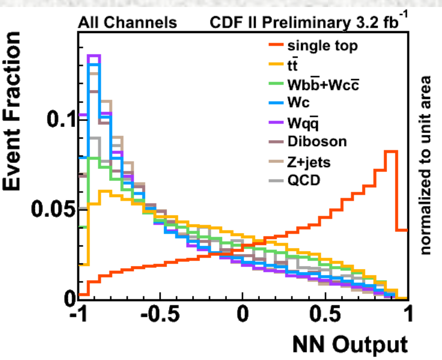
CDF combines five l+jets measurements in 3.2/fb together using a multivariate technique, and then includes the 2.1/fb missing E_t plus jets result which adds 30% signal acceptance

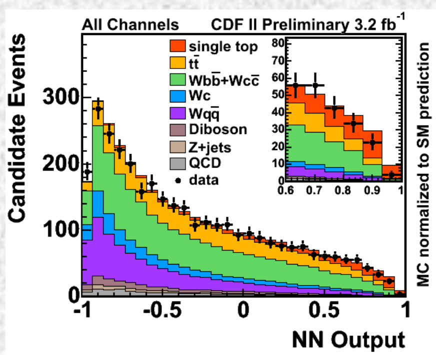
- Use s/t cross section ratio from theory,
- Assume $|V_{tb}|=1$

They obtain a combined result of $\sigma_{s+t} = 2.3^{+0.6}_{-0.5}$ pb for s- and t-channels together.

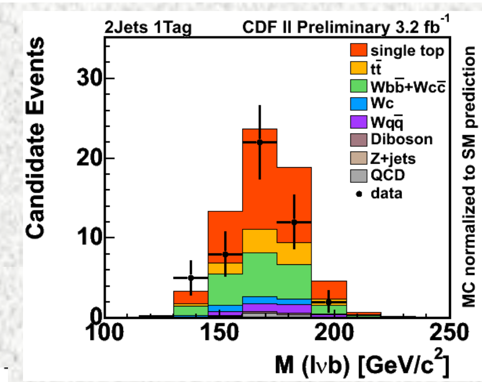
A separate analysis requires double b-tagging to extract the s-channel cross section $\sigma_s = 1.5^{+0.9}_{-0.8}$ pb

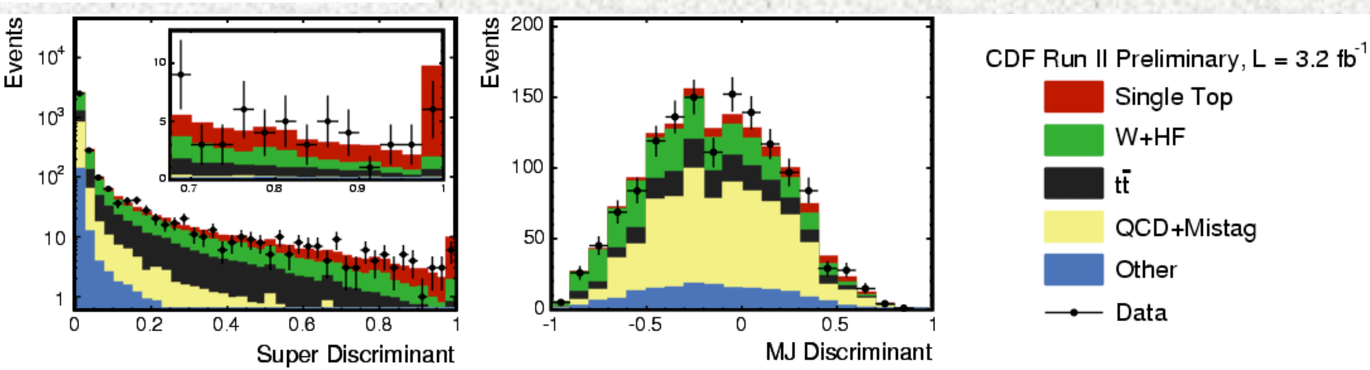






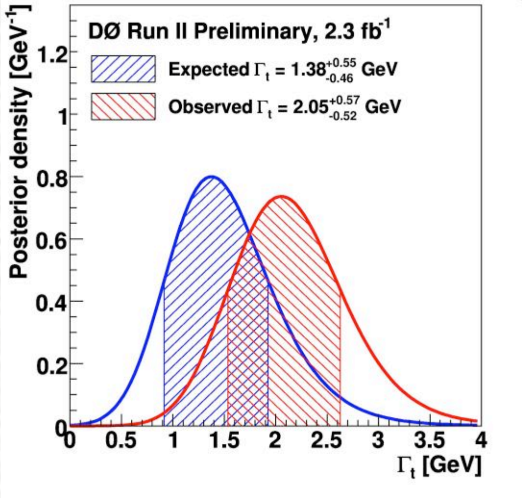
Events with high value of NN discriminant are used to verify kinematical prediction





Super-discriminant is used together with MEt+jets discriminant for combination

Top Quark Width



The total width Γ_t of the top quark is dominated by the t→Wb branching, and is predicted in the SM to be 1.26 GeV for a top mass of 170 GeV (other inputs: M_W=80.399 GeV, $\alpha_s(M_Z)$=0.118, G_F=1.16637*10^{-5} GeV^{-2})

D0 measures the top width indirectly: they extract a measurement of the partial width from their signal of t-channel single top production:

$$\Gamma(t \to Wb) = \sigma(t\text{-channel}) \frac{\Gamma(t \to Wb)_{\rm SM}}{\sigma(t\text{-channel})_{\rm SM}}$$

To extract the total top quark width they include a separate measurement of the branching fraction t→Wb obtained from top pair production cross section measurements with different number of b-tags:

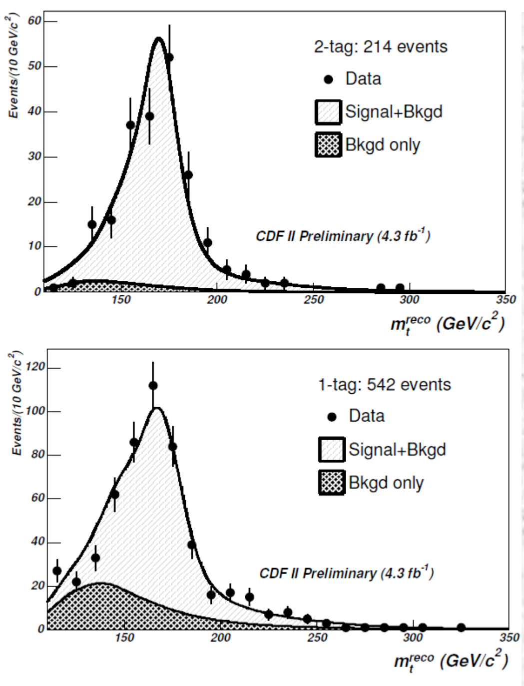
$$\mathcal{B}(t \to Wb) = 0.962^{+0.068}_{-0.066}(\text{stat})\ ^{+0.064}_{-0.052}(\text{syst})$$

This translates in a width of

$\Gamma_t = 2.05^{+0.57}_{-0.52}$ GeV

or a lifetime of

$\tau_t = 3.2^{+1.1}_{-0.7} * 10^{-25}$ s



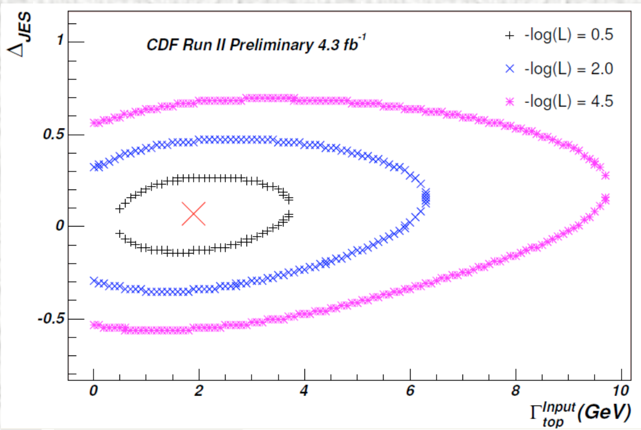
CDF performs a direct measurement of the width in well-reconstructed single-lepton top pairs

Single- and double-b-tagged events fit separately, constraining *in situ* the jet-energy scale

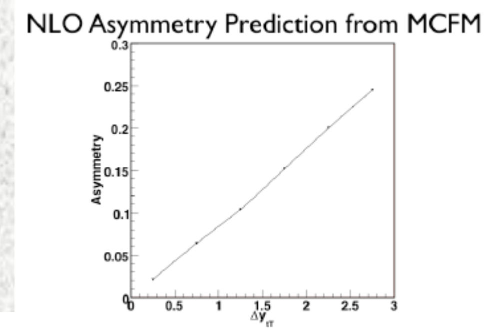
FC construction allows to get

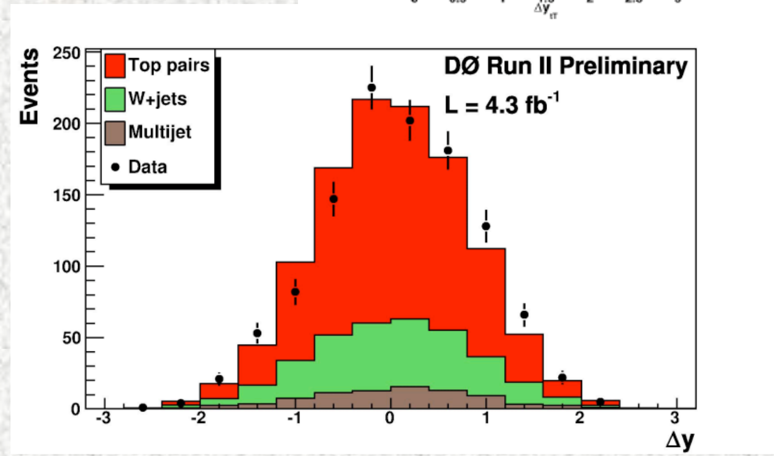
Γ_t<7.6 GeV (95%CL),

0.3<Γ_t<4.4 GeV (68%CL interval)



Forward-Backward Asymmetry in Top Pair Production



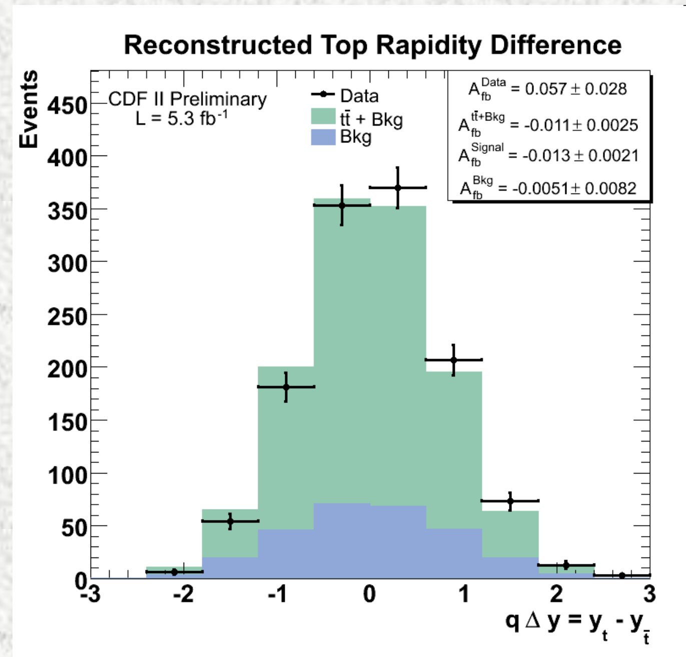


- A recent hot topic: do t^+ quarks get produced preferentially in the proton direction ?
- At LO in QCD the answer is no. At NLO few-percent-level asymmetries are predicted in the SM. Larger asymmetries may be due to Z'→tt decays; smaller ones also possible signatures of NP
- Asymmetry, defined in the tt frame as

$$A_{fb} = \frac{N^{\Delta y>0} - N^{\Delta y<0}}{N^{\Delta y>0} + N^{\Delta y<0}}$$

can be computed in single-lepton decays by determining top rapidities with kinematic fits
- Both D0 and CDF measure a non-zero asymmetry. No easy combination (CDF unsmears data, D0 smears MC&NLO theory).
- CDF: $A_{lab}=0.150\pm0.050\pm0.024$ (NLO QCD predicts $A_{lab}=0.038\pm0.006$)
- D0 (4.3/fb): simultaneously fit sample composition and A_{fb}; measure $A_{fb} = 8\pm4\pm1\%$ (MC@NLO predicts $A_{fb}=1\pm2\%$ for SM top pairs)

- It appears that this spot requires further watch!



W helicity in top decays

- SM predicts helicity of W bosons emitted in top decay: V-A dictates that f_0 is very nearly 70%, f_+=0%. These numbers can be precisely tested in well-reconstructed top pair decays, to check for a V+A component not predicted by the SM.

- Measurement can proceed by reconstructing top decay system, deriving distribution of x = cos(θ*) (angle between top and down-type fermion) which is

$$F(x) = 2(1-x^2)f_0+(1-x)^2 f_- +(1+c)^2 f_+$$

- D0 performs the measurement on dilepton and single lepton candidates from up to 2.9/fb of data.

$$f_0 = 0.490 \pm 0.106\ (\mathrm{stat.}) \pm 0.085\ (\mathrm{syst.})$$
$$f_+ = 0.110 \pm 0.059\ (\mathrm{stat.}) \pm 0.052\ (\mathrm{syst.})$$

- CDF reports several measurements; the most precise uses a matrix element technique in 2.7/fb:

$$f_0 = 0.88 \pm 0.11\ (\mathrm{stat}) \pm 0.06\ (\mathrm{syst})$$
$$f_+ = -0.15 \pm 0.07\ (\mathrm{stat}) \pm 0.06\ (\mathrm{syst})$$

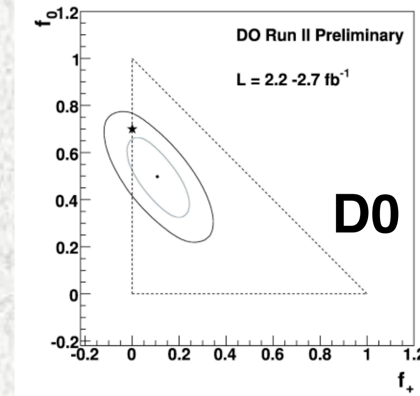
- Fixing f_+ = 0 CDF also obtains

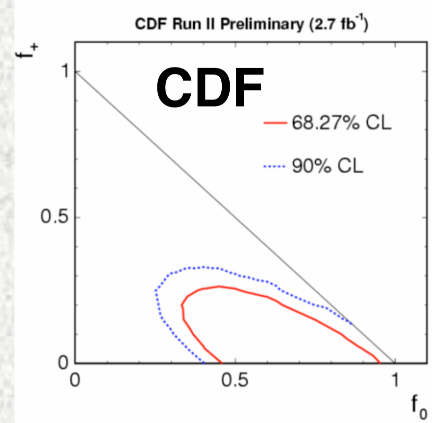
f_0 = 0.70 ± 0.06 (stat) ± 0.04 (syst)

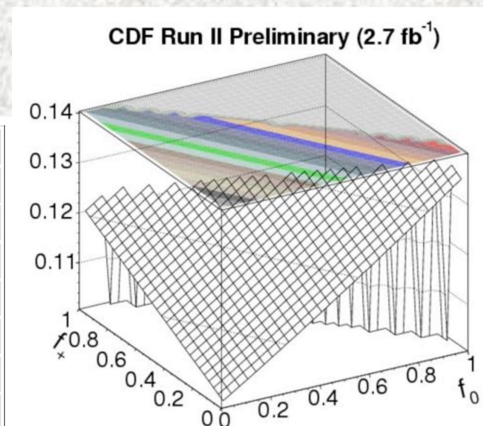
or fixing f_0 = 0.7 extracts

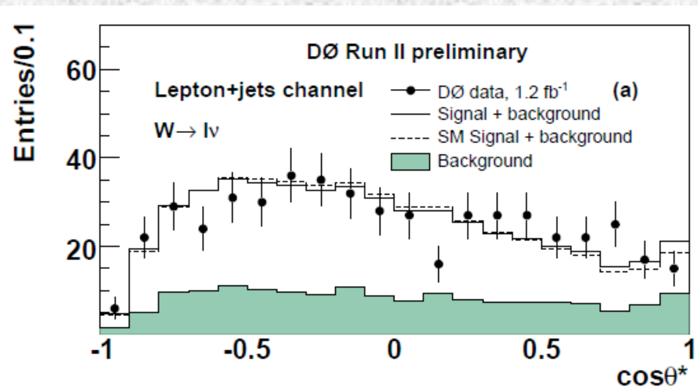
f_+ = -0.01 ± 0.02(stat) ± 0.05 (syst)

in excellent agreement with SM predictions







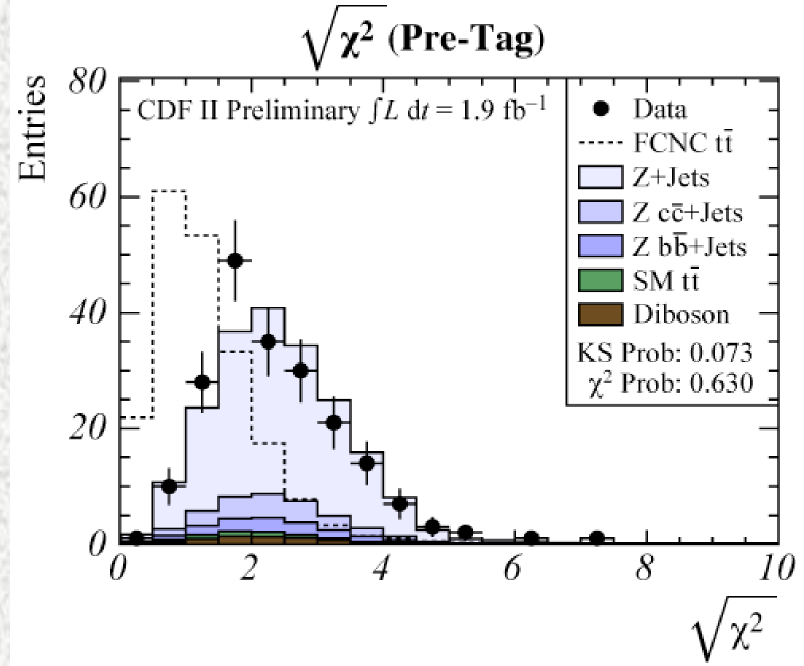


Process	Central	Forward	met+Jets
	e, μ	e	μ
ttbar (6.7 pb)	478 ± 66	58 ± 8	134 ± 19
W+hf	71 ± 22	13 ± 9	19 ± 6
W+lf	23 ± 6	5 ± 7	6 ± 2
EWK	17 ± 10	3 ± 1	5 ± 3
QCD	28 ± 22	46 ± 37	1 ± 1
Total expected	616 ± 74	125 ± 40	165 ± 20
Observed	650	136	178

Rare top decays

- FCNC top decays are exceptionally rare in the SM: t→Zc(u), t→gc(u) both have $B<10^{-10}$. Clearly this is a field where LHC will take over very soon

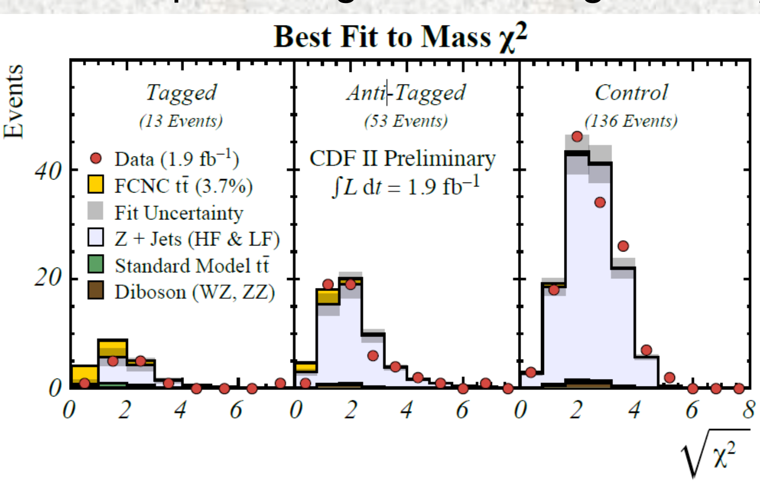
- Before the latest CDF analysis the best limit on t→Zu was 13.7% at 95%CL, by L3 who did not observe any e^+e^-→tq events. CDF now has B(Zc)<3.7% @95%CL (exp. lim. 5.0%), with the analysis of 1.9/fb of data.



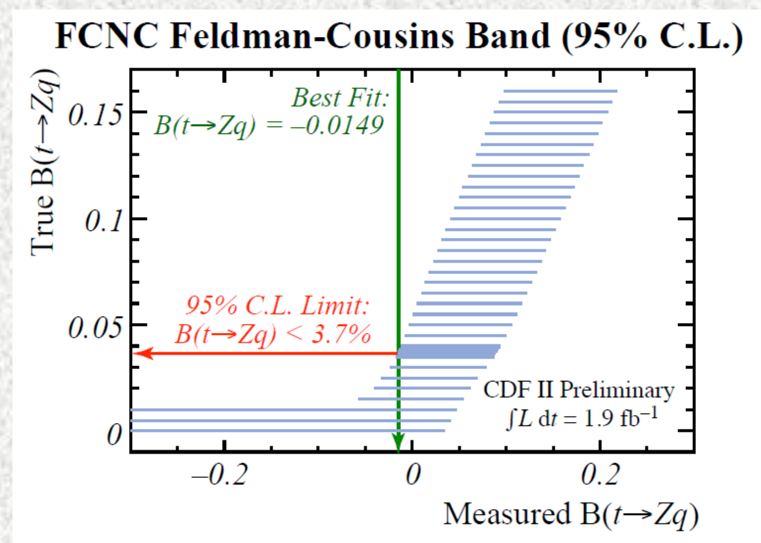
- Limit is extracted by studying a top mass chisquare variable constructed on Z+4 jets events:

$$\chi^2 = \left(\frac{m_{W,\text{rec}} - m_{W,\text{PDG}}}{\sigma_W}\right)^2 + \left(\frac{m_{t\to Wb,\text{rec}} - m_t}{\sigma_{t\to Wb}}\right)^2 + \left(\frac{m_{t\to Zq,\text{rec}} - m_t}{\sigma_{t\to Zq}}\right)^2$$

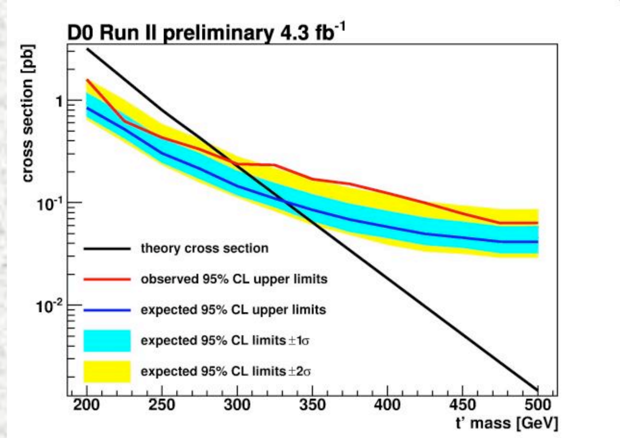
- Signal hypothesis is tt→Zq Wb , with the W decaying hadronically. The leptonic Z boson decay cleans the sample enough that the higher W→jj BR is exploitable.



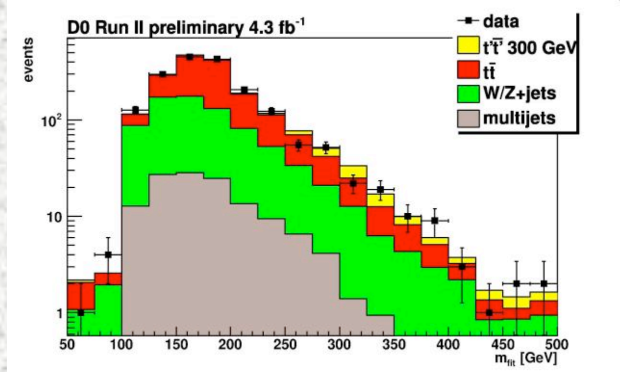
Template morphing used to reduce JES systematic on discretized χ^2 templates

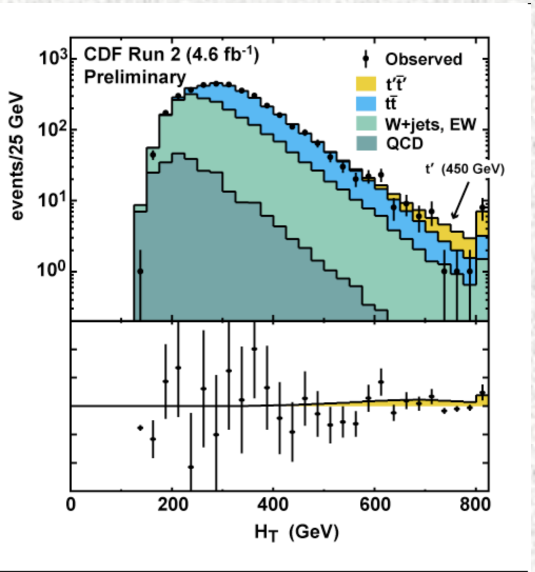


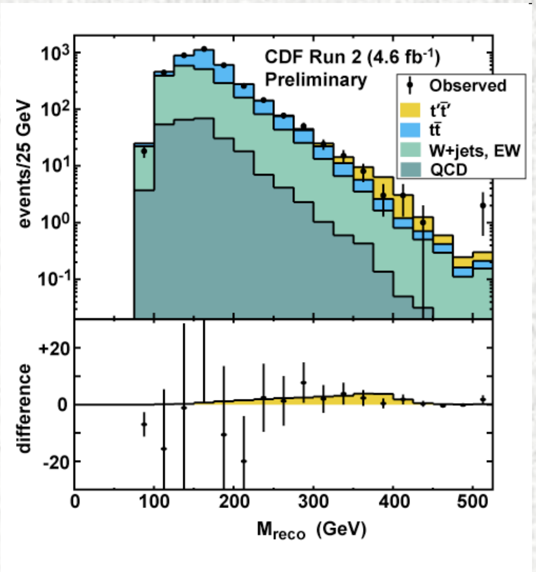
A Reasonable Deviation: a 4^{th} generation t'

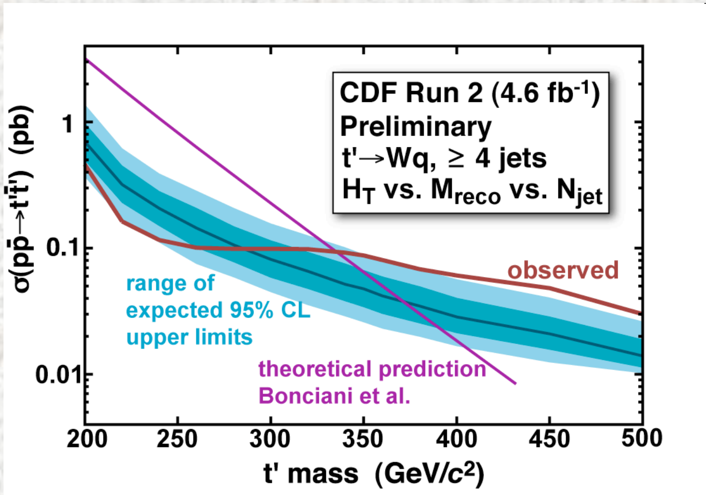


- Arguably, this is still top physics – the search is for a heavier brother of top quarks, with same production and decay mechanism
- Both CDF (in 4.6/fb) and D0 (in 4.3/fb) search for pair-production of a t' quark, decaying 100% of the times into W^+b final state
- A simultaneous fit to reconstructed t' mass and H_t of W+ 4 jet events is used to extract a limit on the yield
- Both experiments set limits (D0: $M_{t'}$>296 GeV; CDF: $M_{t'}$>335 GeV)
- Both limits are significantly weaker than expected, but distributions do not scream of a t'.









Conclusions and Outlook

- The Fermilab top physics program is a success beyond expectations
  - the top mass uncertainty is consistently below forecasts
    - Providing <1% normalization point for jet energy scale to next generation of experiments
    - single top production duly observed
  - peculiarity of top quarks exploited by several highly interesting measurements and searches
    - top width measured, other characteristics also studied in detail
    - constraining rare decays at the percent level
    - need to keep watching A_{fb}
    - fourth-generation t' ruled out below 335 GeV
  - Further theoretical input needed in some areas
    - perturbative calculations of top cross sections beyond NLO

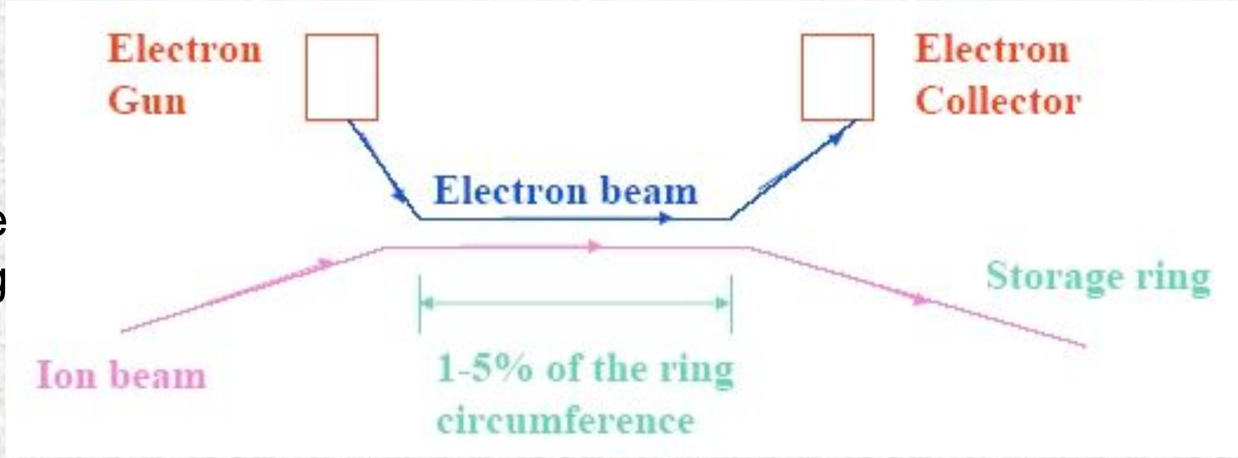
- and it is not over yet
  - further x2 decrease in M_{top} uncertainty possible
    - still large amount of extractable information on SM and BSM

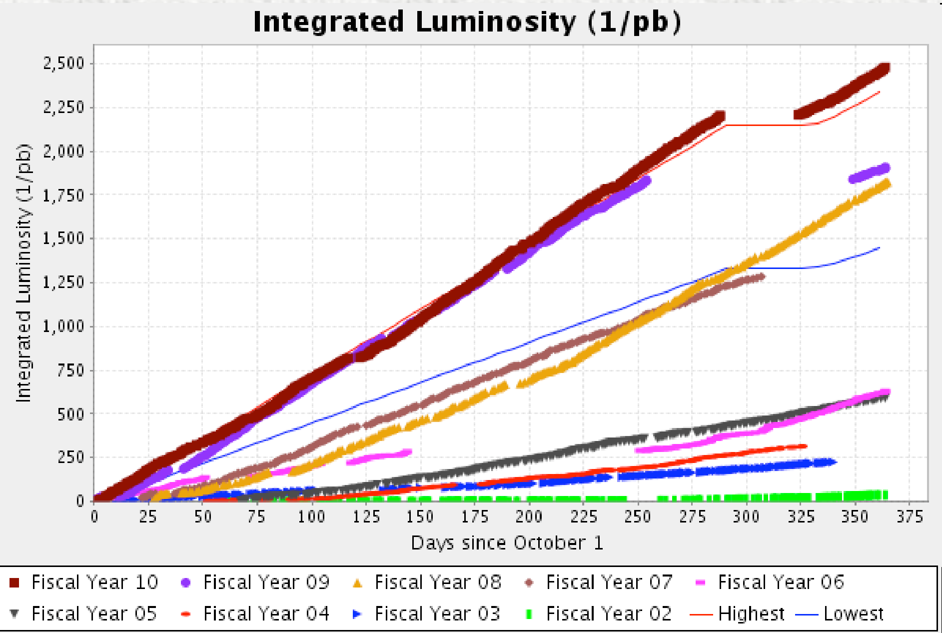
- The LHC already produces twice more top quarks per second than the Tevatron, but...
  - the precise measurement of the top mass will remain firmly a Fermilab business for at least a few years
  - A_{fb} deviations not as easy to measure in pp collisions
    - but any new physics hidden there would be likely to show up directly

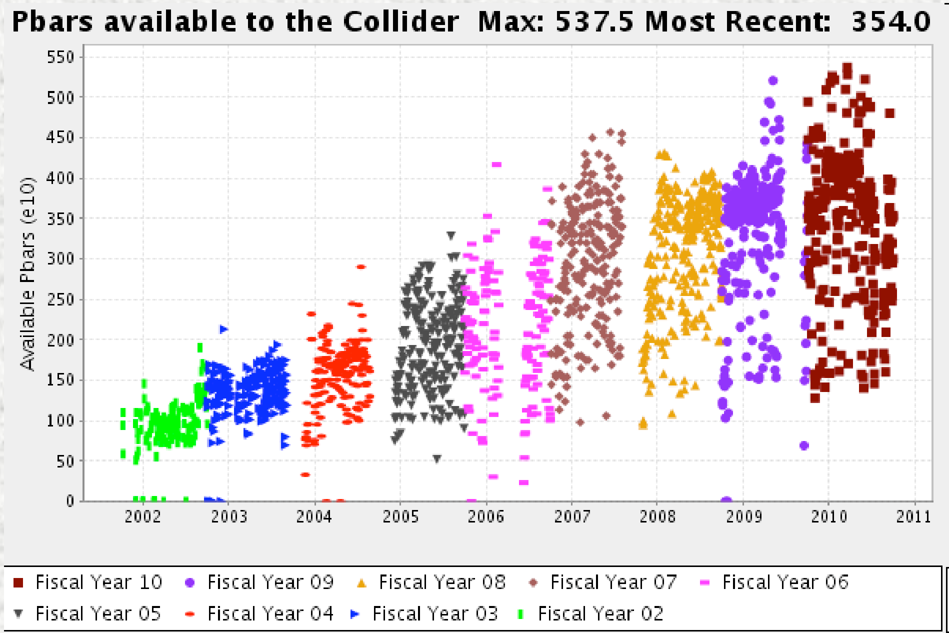
Backup Slides

BKP - Upgrades at Tevatron

The single most important factor in the luminosity increase during Run II is electron cooling
→ a big success!

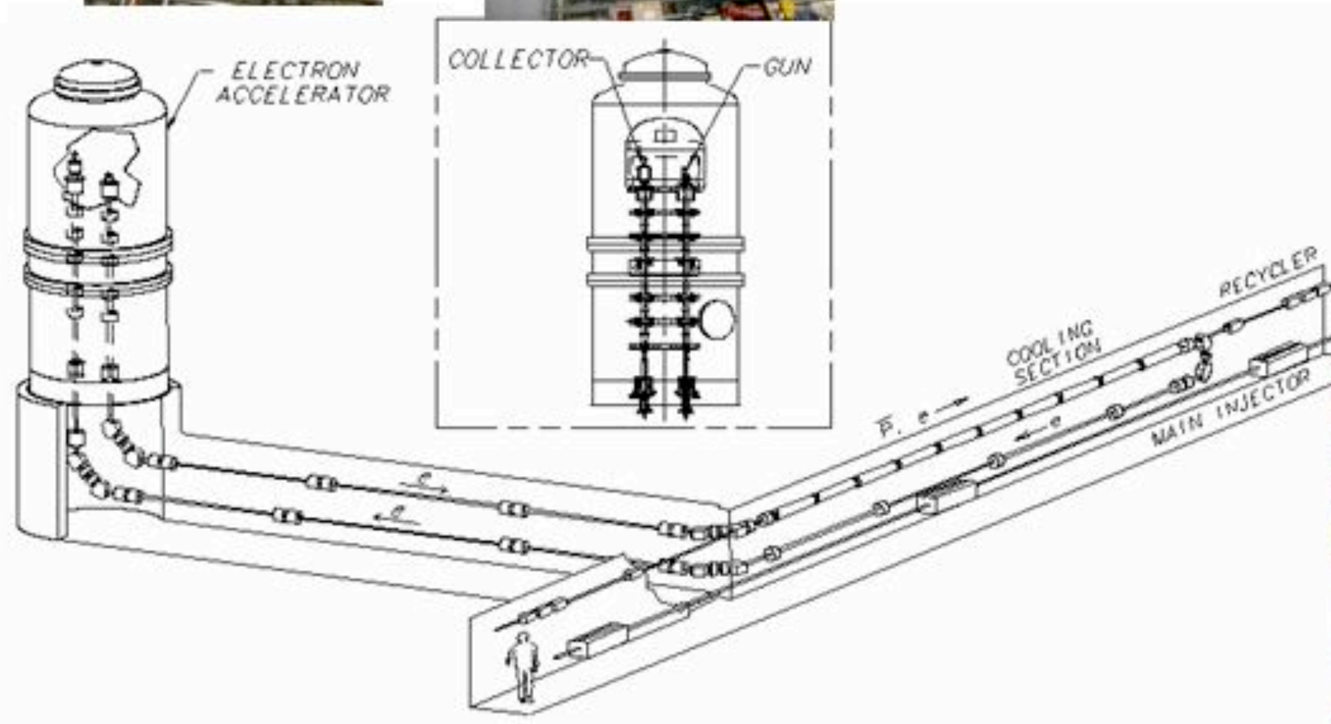






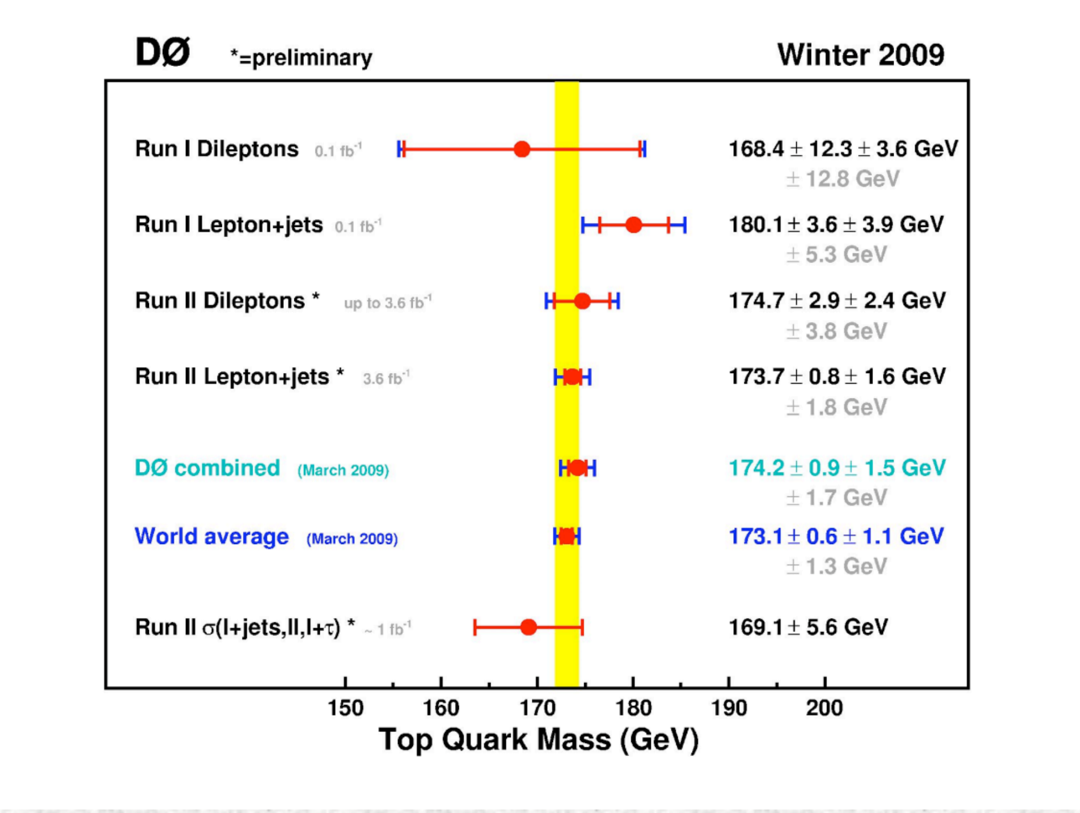
Electron cooling

- Electron beam: 4.34 MeV - 0.5 Amps DC - 200μrad angular spread
- Max beam current 730 mA Circulated in cooling section
- In U-Bend mode currents of 1500 mA has been obtained.

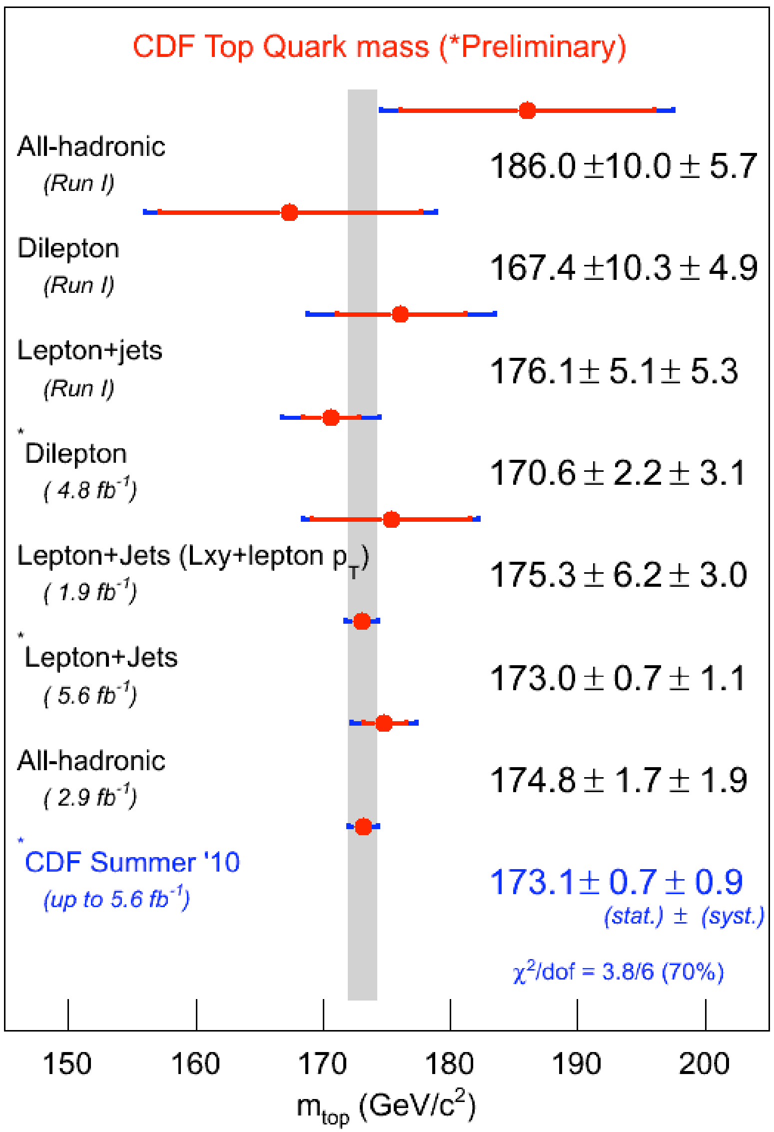


D0 Top Mass Combination

- The latest D0 combination of top mass measurements has been performed in March 2009
- Only selected results up to 3.6/fb have been included in this average
- D0 alone reaches a 1% uncertainty: M_t=174.2+-0.9+-1.5 GeV
- A more recent result not yet combined is the updated dilepton measurement with 5.3/fb (superset of former meas.), yielding M_t=173.3+-2.4+-2.1 GeV



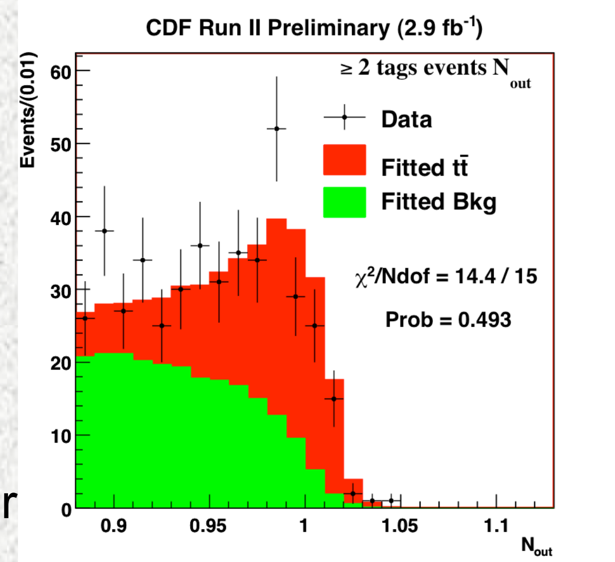
The CDF Top Mass Combination



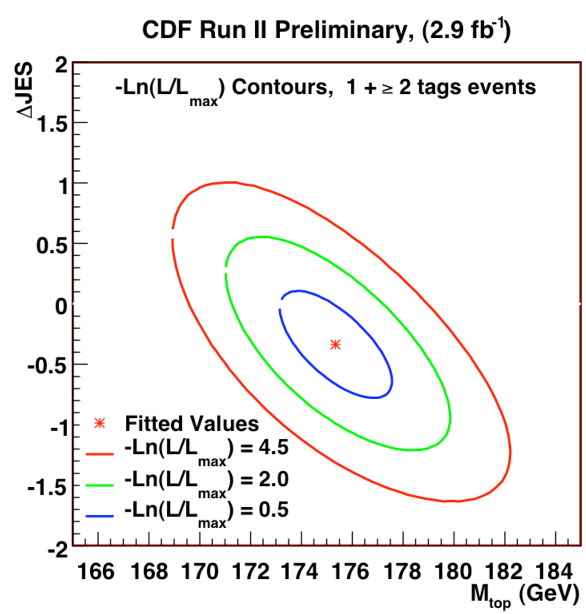
- Taking correlated uncertainties properly into account the resulting preliminary CDF average mass of the top quark is
- Mtop = 173.13 ± 0.67 (stat) ± 0.95 (syst) GeV/c2
- which corresponds to a total uncertainty of 1.16 GeV/c2, or equivalently to a 0.67% precision.
- Notably, the all-hadronic result is now the second most precise measurement – something few would have believed ten years ago

The CDF All-Hadronic Top Mass Measurement

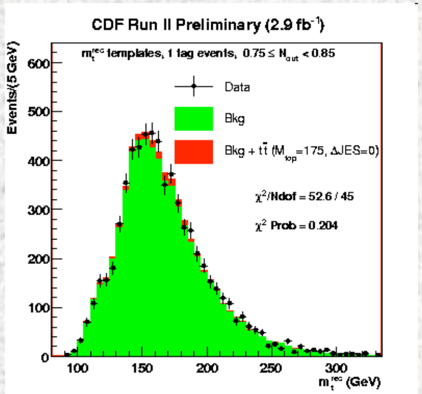
A result based on a 2.9/fb luminosity has been obtained in the all-hadronic channel by combining a neural network data selection, a kinematic fitter, and a likelihood with mass and jet energy scale as parameters.

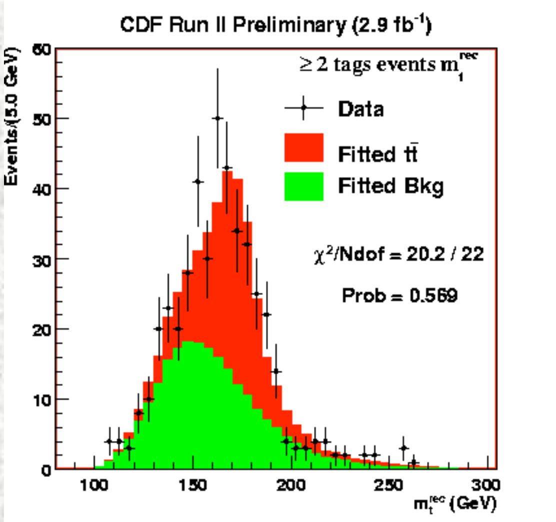


$$\chi^2 = \frac{\left(m_{jj}^{(1)} - M_W\right)^2}{\Gamma_W^2} + \frac{\left(m_{jj}^{(2)} - M_W\right)^2}{\Gamma_W^2} + \frac{\left(m_{jjb}^{(1)} - m_t^{rec}\right)^2}{\Gamma_t^2} + \frac{\left(m_{jjb}^{(2)} - m_t^{rec}\right)^2}{\Gamma_t^2} + \sum_{i=1}^{6} \frac{\left(p_{T,i}^{fit} - p_{T,i}^{meas}\right)^2}{\sigma_i^2}$$



The NN is tested extensively in the kinematics of signal-poor control samples





Mtop = 174.8 ± 1.7(stat) ± 1.6(JES) +1.2 -1.0(syst.) GeV/c2

Details on on top cross section measurement with NN and Z normalization

Selection details:
W+3 jets, Et>20 GeV (highest Et>35 GeV); missing Et>35 GeV

Table of systematics uncertainties

CDF II Preliminary

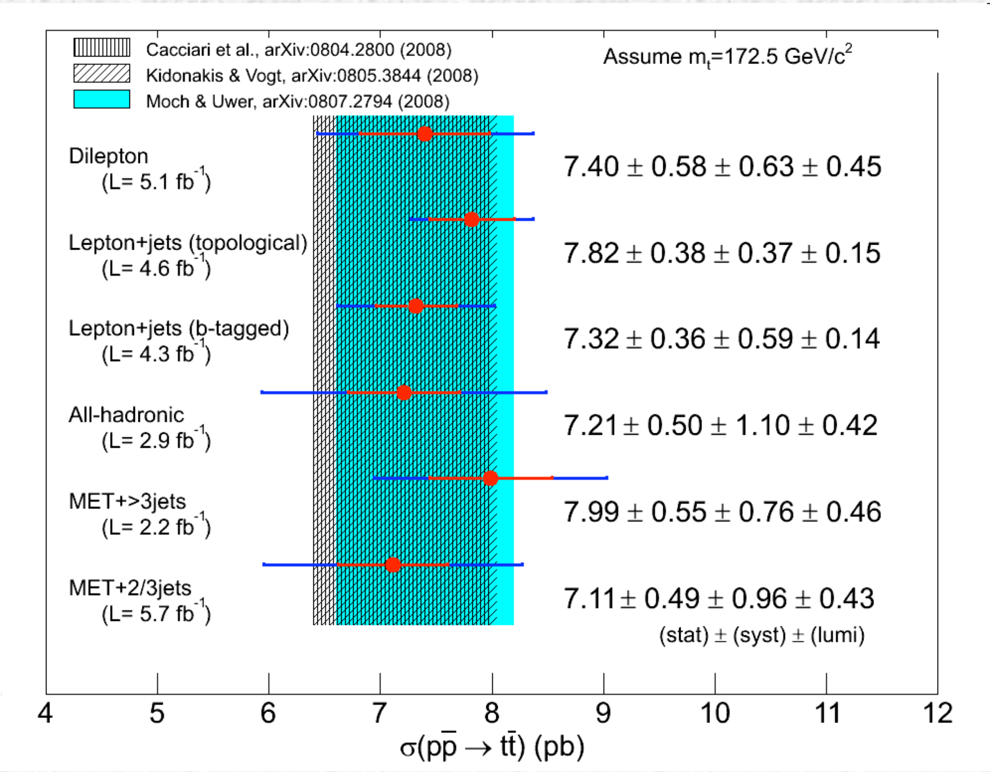
Effect	Top Cross section neg shift	pos shift	symmetrised
Statistical top	-4.82	+4.88	4.85
Statistical Z	-0.32	+0.32	0.32
Jet E_T Scale	-2.90	+2.93	2.91
W+jets Q^2 Scale	-1.33	+1.33	1.33
Z+jets Q^2 Scale	-0.27	+0.27	0.27
$t\bar{t}$ IFSR	-0.42	+0.42	0.42
QCD shape	-0.48	+0.48	0.48
QCD fraction	-0.81	+0.81	0.81
$t\bar{t}$ generator	-2.50	+2.50	2.50
$t\bar{t}$ gen. branching ratio	-0.21	+0.95	0.58
$t\bar{t}$ PDF	-0.79	+1.10	0.94
$t\bar{t}$ Colour Reconnection	-0.16	+0.16	0.16
Other EWK	-1.00	+1.00	1.00
MC statistics	-0.14	+0.14	0.14
CEM ID SF	-0.48	+0.46	0.47
CMUP ID SF	-0.03	+0.03	0.03
CEM trigger efficiency	-0.25	+0.25	0.25
CMUP trigger efficiency	-0.39	+0.39	0.39
Z_{vtx} SF	-0.00	+0.00	0.00
nJet (NLO)	-0.02	+0.02	0.02
CEM energy Scale	-0.08	+0.08	0.08
CMUP energy Scale	-0.02	+0.02	0.02
Z Background	-0.04	+0.04	0.04
Track ID	-0.61	+0.60	0.60
Luminosity	-0.39	+0.00	0.19
Total systematic	-4.51	+4.67	4.57
Total uncertainty ratio	-6.60	+6.75	6.66
Z theory	-1.99	+1.99	1.99
Total uncertainty	**-6.89**	**+7.04**	**6.95**

Recent top cross section results

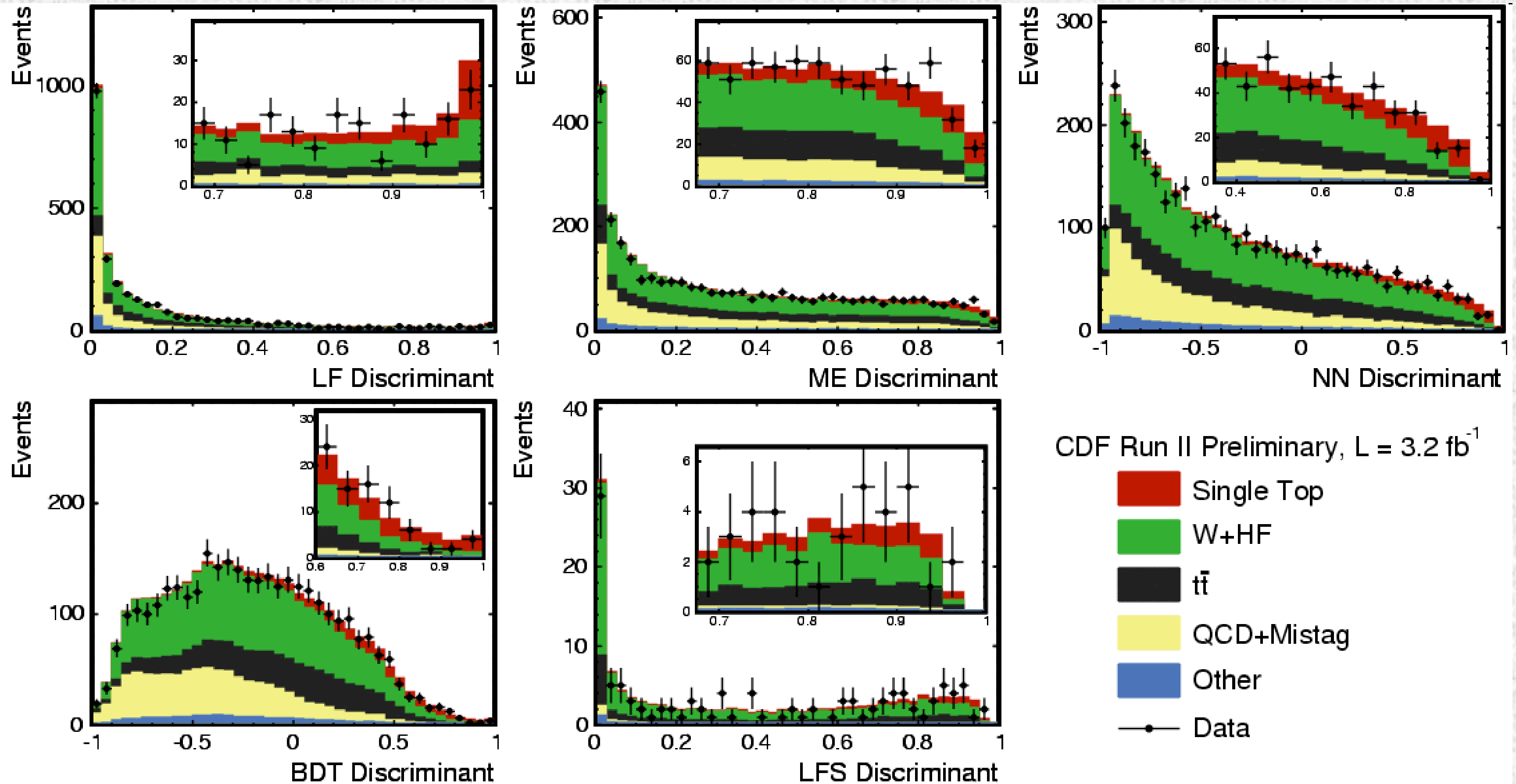
- Apart from those presented above, CDF produced new results from two other searches: a dilepton search (L=5.1/fb) and a Missing Et plus 2,3 jets (L=5.7/fb)

- DZERO also produced new results

→ quali ?

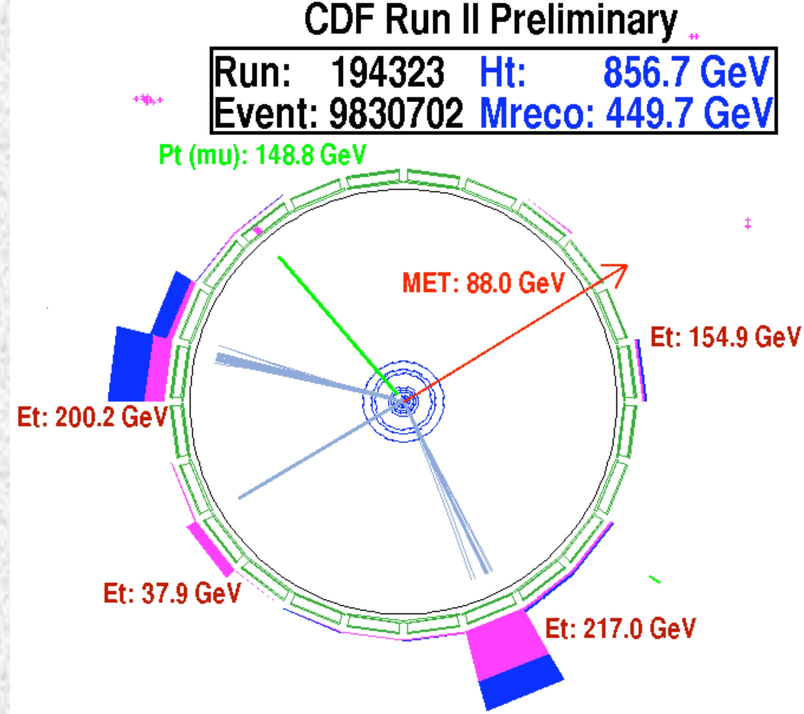


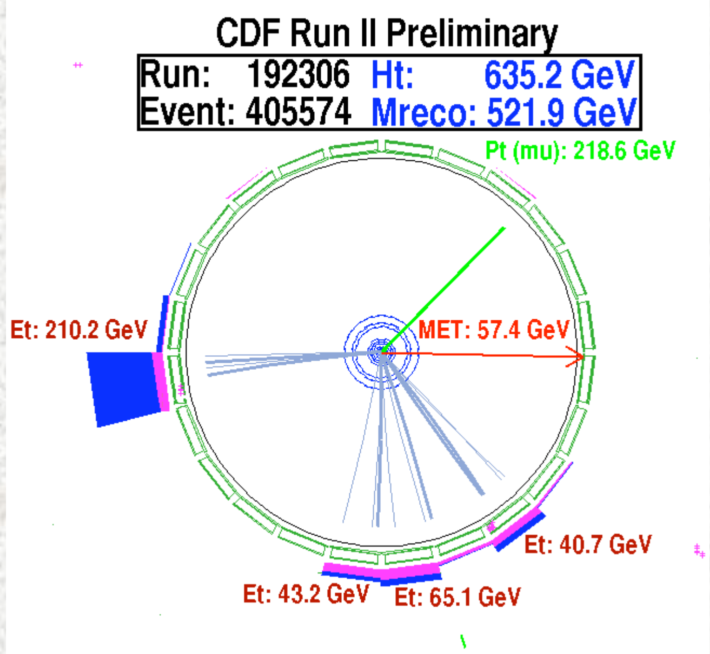
CDF inputs to single top super-discriminant



Some t' candidates

Selected high-mass events from CDF in t' search are spectacular

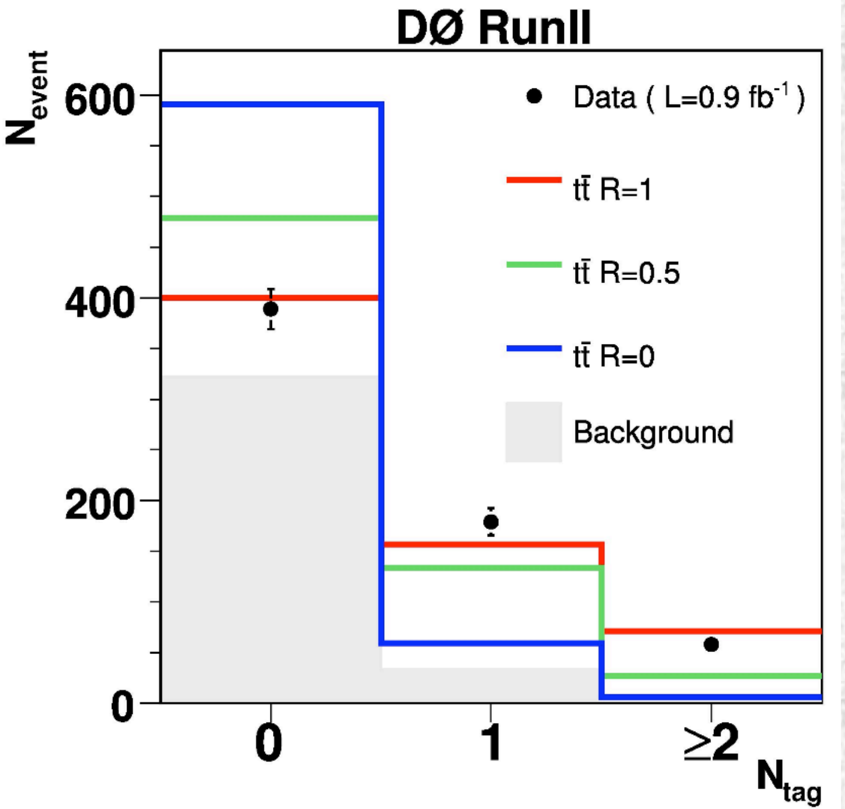




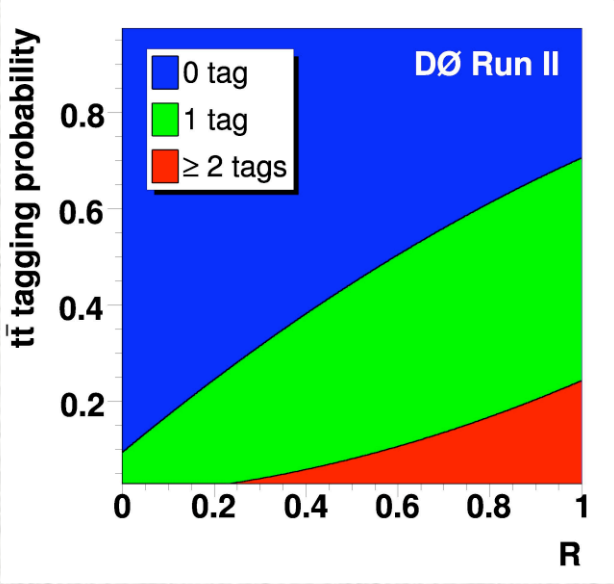
Top BR, D0

- D0 measures B(Wb)/B(Wq) in single lepton top events by looking at the number of b-tagged jets
- Find R=0.960+0.093-0.084
- This measurement is used in indirect Γ_t estimate

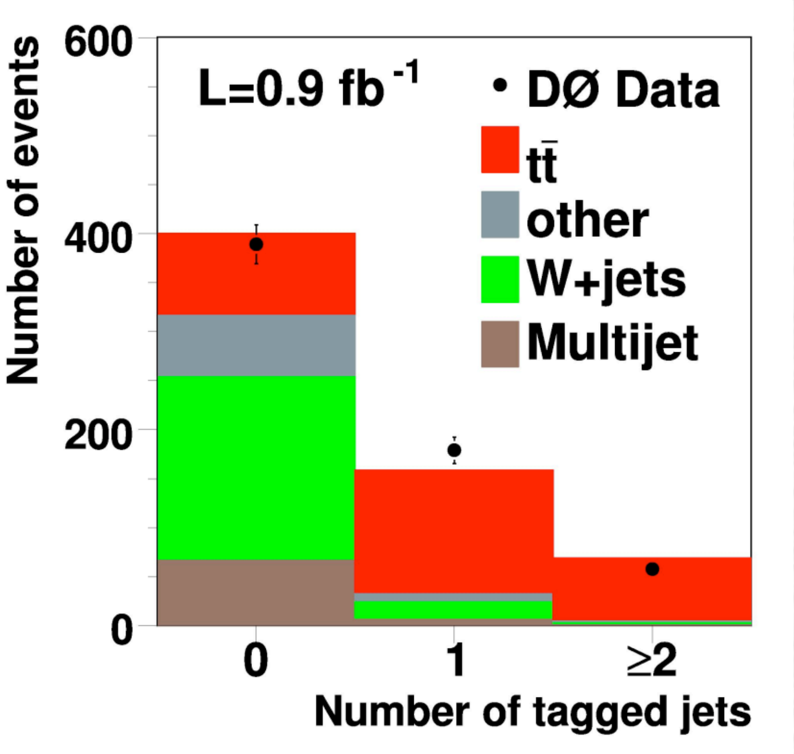
- PRL 100/192003 (2008)

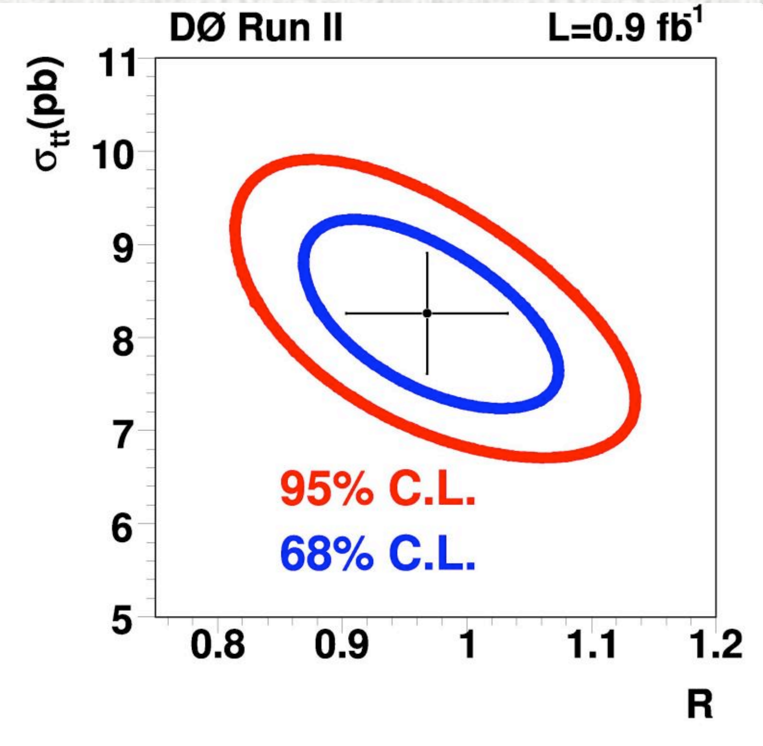


Vtb measurement, D0



- Use a NN b-tagger to separate tt production in the SL channel into 12 classes (3,>=4 jets, 0,1,2 tags, e, μ)
- Fit separately σ_{tt} and R=B(t→Wb)/B(t→Wq)
- Extract $R=0.97^{+0.07}_{-0.08}$, $|V_{tb}|=$





CDF results for W helicity