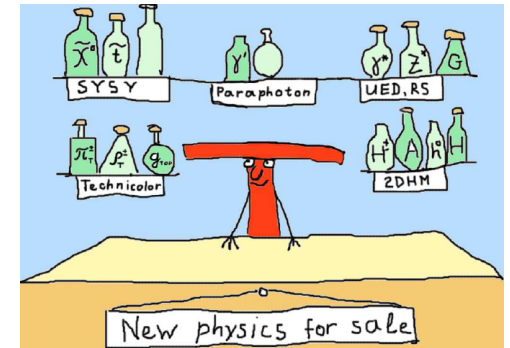


Поиск отклонений от предсказаний СМ в процессах одиночного рождения топ-кварка в эксперименте D0



Э. Боос, В. Буничев, Л. Дудко, М. Перфилов

Одиночное рождение топ-кварка в СМ

Одиночное рождение топ-кварка вне рамок СМ:

W' , Аномальные Wtb связи, FCNC, Заряженный скаляр

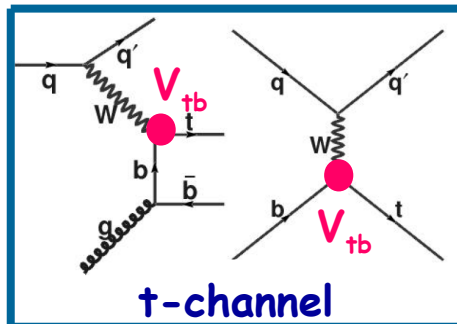
Топ кварк, одиночное рождение

- Фермион, спин $1/2$, изотопический партнер b-кварка, цветовой триплет, электрический заряд $+2/3$, Масса 170.9 ± 1.8 ГэВ
- Одиночное (электрослабое) рождение:

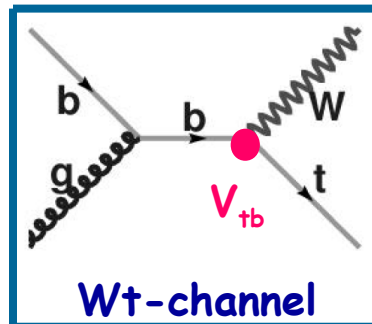
t-channel ($Q_W^2 < 0$)

s-channel ($Q_W^2 > 0$)

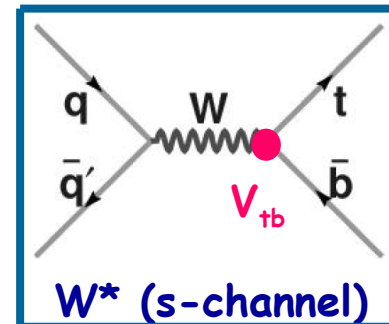
associated tW ($Q_W^2 = M_W^2$)



$\sigma \sim 250$ pb (LHC)
2 pb (Tevatron)



$\sigma \sim 70$ pb (LHC)
0.1 pb (Tevatron)



$\sigma \sim 10$ pb (LHC)
1 pb (Tevatron)

Главные особенности одиночного рождения топ-кварка

- Независимый электрослабый канал рождения топ-кварков
 $\sigma_{\text{TEVATRON}} = 2.9 \text{ pb}$; $\sigma_{\text{LHC}} = 320 \text{ pb}$;
- Прямое измерение параметра $|V_{tb}|$ ККМ матрицы
- Важный фон при поиске Хиггс-бозона
- Уникальные спиновые свойства
- Уникальные возможности для поиска «Новой физики»
 - Аномальные Wtb связи
 - Нейтральные токи (FCNC)
 - Дополнительные векторные и скалярные бозоны (W' , H^+ , π' , π_T , ρ_T)
- Отработка новых многомерных методов анализа

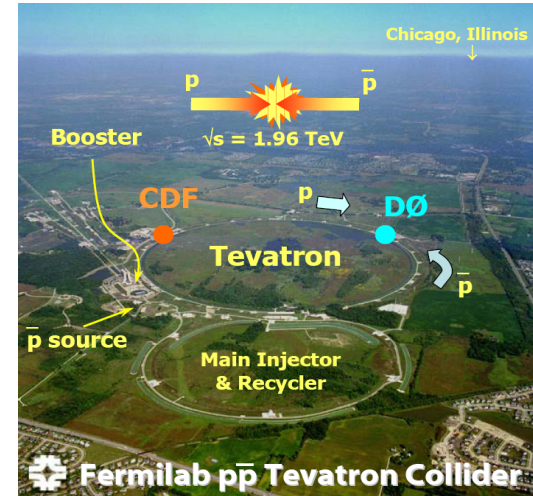
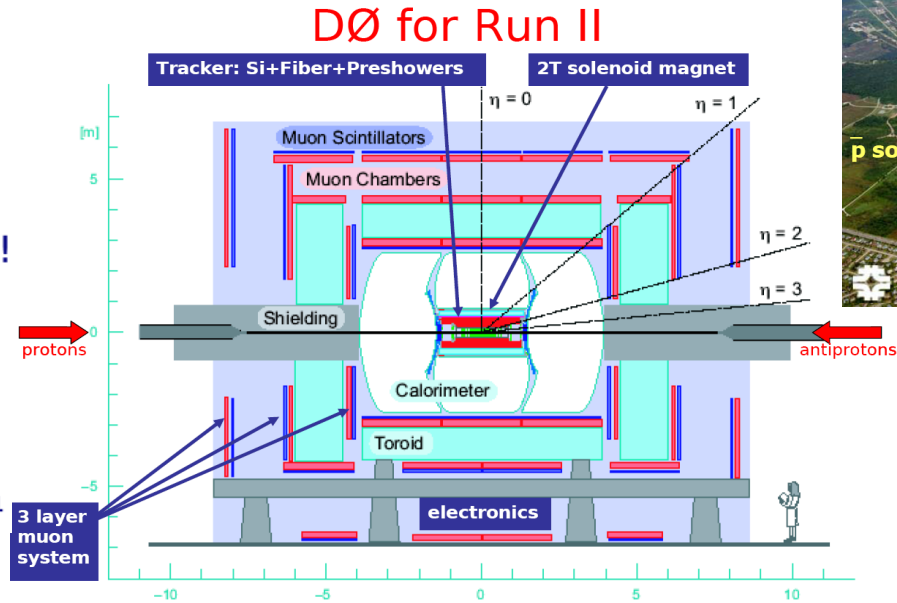
D0 детектор коллайдера Теватрон

The highest energy particle accelerator in the world!

Proton-antiproton collider

Run I 1992-1995
Top quark discovered!

Run II 2001-09(?)
 $\sqrt{s} = 1.96 \text{ TeV}$
 $\Delta t = 396 \text{ ns}$
 $> 1 \text{ fb}^{-1}$ delivered
Peak Lumi: $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$



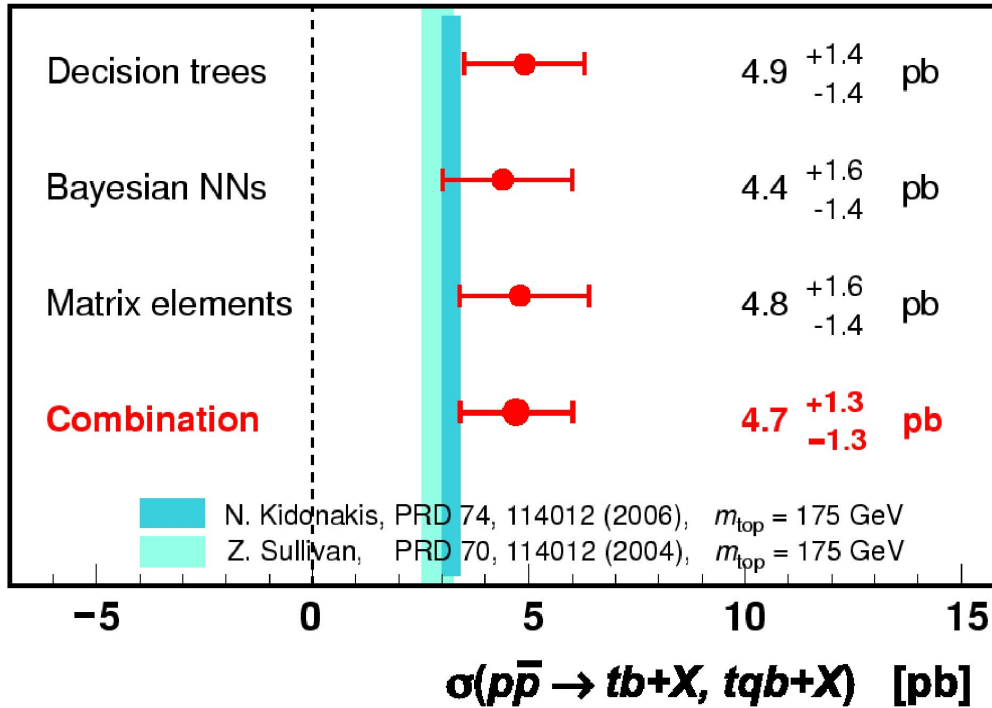
Коллаборация DZero: 600 человек, 90 институтов, 19 стран

Группа DZero Single Top: 48 человек

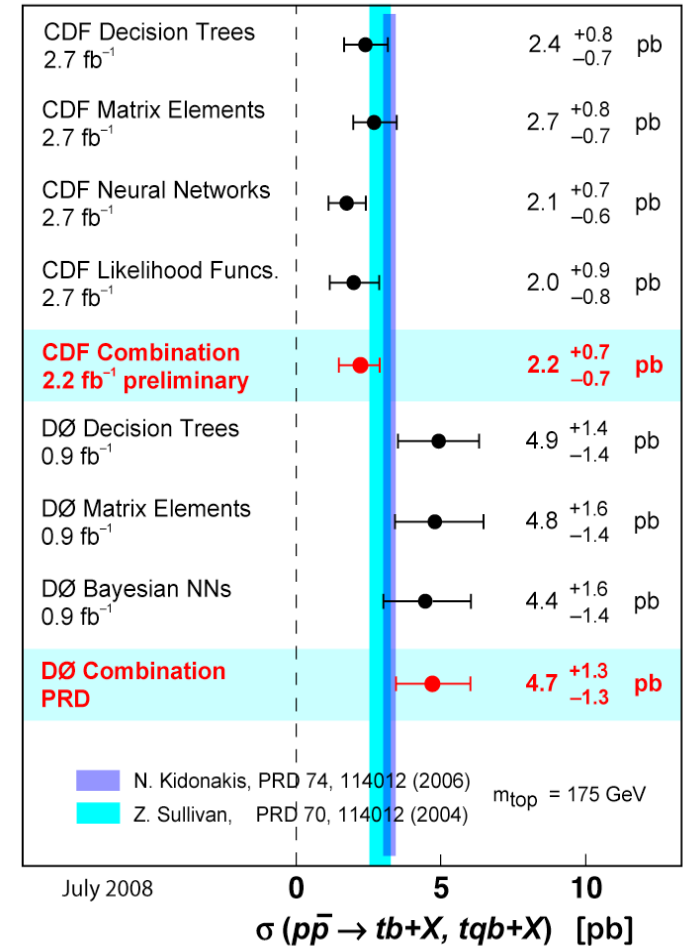
Первое наблюдение электрослабого рождения топ-кварков (DØ, 2006 год)

PRD 78, 012005 (2008)

DØ 0.9 fb⁻¹



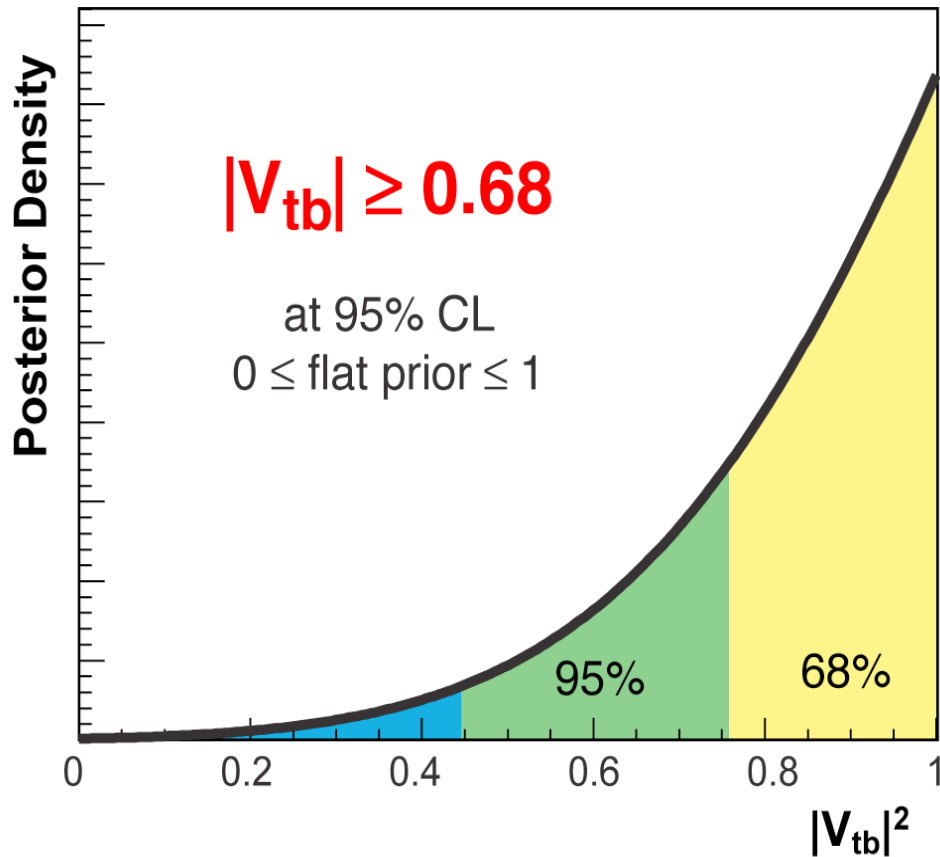
CDF and DØ tb+tqb Cross Section



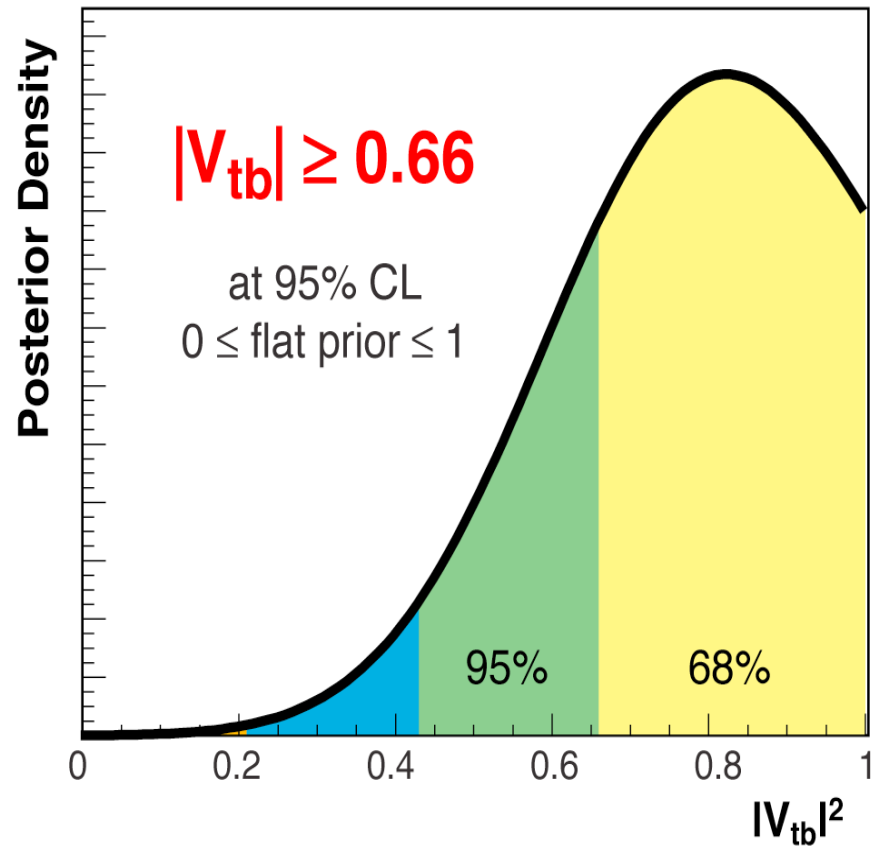
July 2008

Первые прямые измерения V_{tb}

$D\bar{D}$ PRL, PRD 0.9 fb^{-1}



CDF preliminary 2.2 fb^{-1}



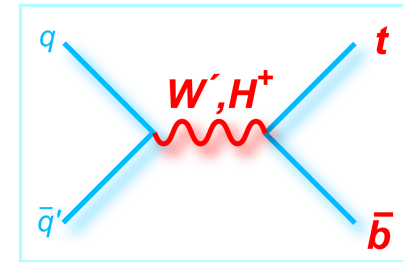
Одиночное рождение топ-кварка вне рамок Стандартной модели (СМ)

- Аномальные связи в структуре Wtb вершины

$$\Gamma_{Wtb}^\mu = -\frac{g}{\sqrt{2}} V_{tb} \left\{ \gamma^\mu [f_1^L P_L + f_1^R P_R] - \frac{i\sigma^{\mu\nu}}{M_W} (p_t - p_b)_\nu [f_2^L P_L + f_2^R P_R] \right\}$$

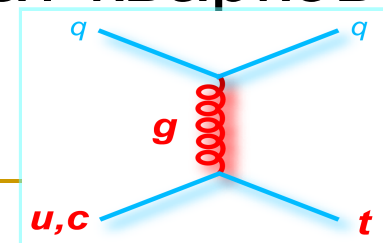
- Дополнительные векторные и скалярные бозоны (W' , H^+)

$$L = \frac{V_{q_i q_j}}{2\sqrt{2}} g_W \bar{q}_i \gamma_\mu [a_{q_i q_j}^R P_R + a_{q_i q_j}^L P_L] W' q_j + H.C.$$



- Нейтральные токи меняющие аромат кварков (FCNC)

$$\frac{\kappa_f}{\Lambda} g_s \bar{f} \sigma^{\mu\nu} \frac{\lambda^a}{2} t G_{\mu\nu}^a$$

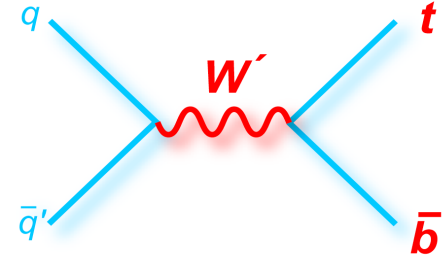


$$P_{L,R} = 1/2 \cdot (1 \mp \gamma_5) \quad \sigma^{\mu\nu} = i/2 [\gamma^\mu, \gamma^\nu]$$

Дополнительный векторный бозон W'

$$L = \frac{V_{q_i q_j}}{2\sqrt{2}} g_W \bar{q}_i \gamma_\mu [a_{q_i q_j}^R (1 + \gamma_5) + a_{q_i q_j}^L (1 - \gamma_5)] W' q_j + H.C.$$

$a_{q_i q_j}^R, a_{q_i q_j}^L$ - left and right couplings of W' to fermions



$$|M|^2 = SM + 2 \cdot a_{ud}^L \cdot a_{tb}^L \text{ (Interference of } W \text{ and } W') +$$

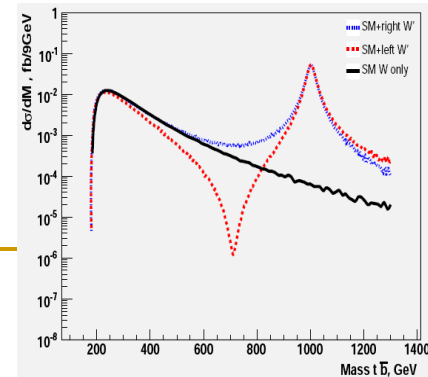
$$+ [(a_{ud}^L)^2 (a_{tb}^L)^2 + (a_{ud}^R)^2 (a_{tb}^R)^2] W' + [(a_{ud}^L)^2 (a_{tb}^R)^2 + (a_{ud}^R)^2 (a_{tb}^L)^2] W'$$

- to simulate general coupling dependence we need: [Phys. Lett. B 655:245-250, 2007 E.Boos, V.Bunichev, L.Dudko, M.Perfilov](#)

1) purely right-handed W' : $a_{ud}^R = a_{tb}^R = 1, a_{ud}^L = a_{tb}^L = 0$

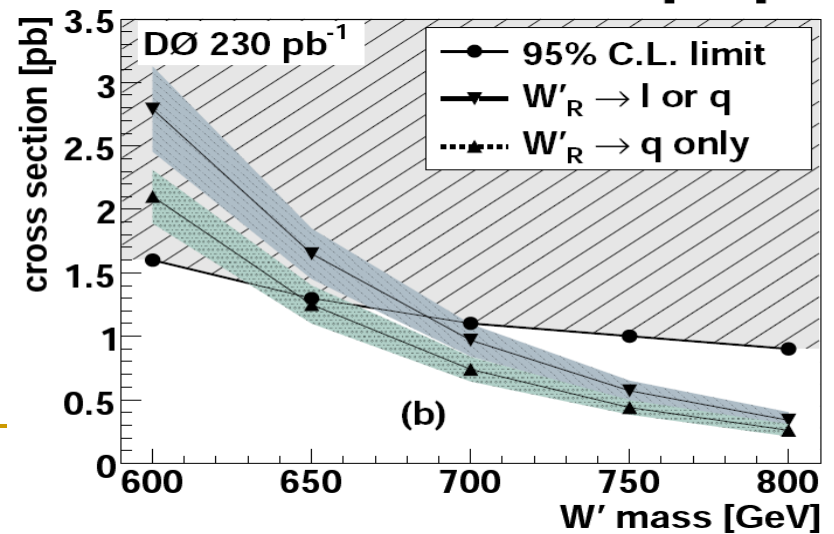
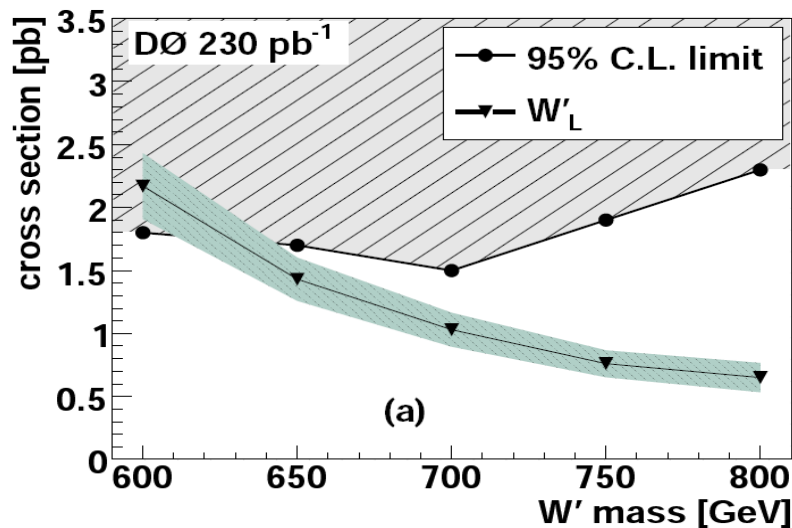
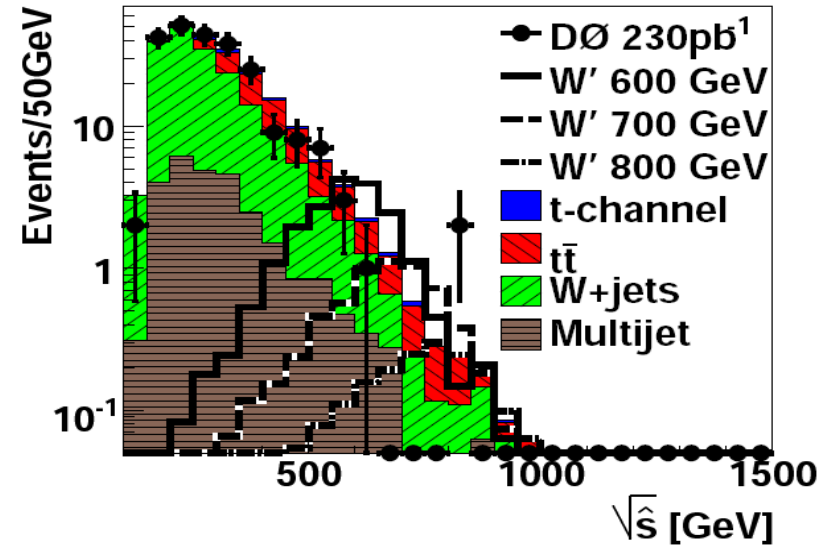
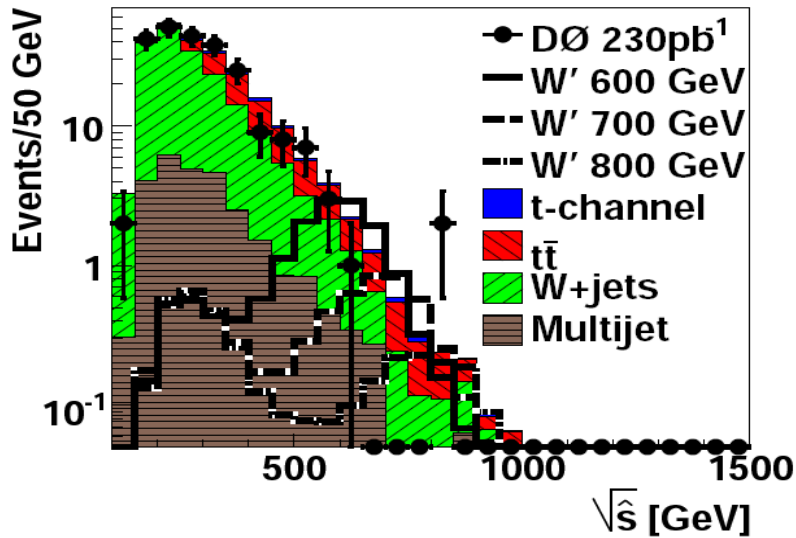
2) purely left-handed W' : $a_{ud}^L = a_{tb}^L = 1, a_{ud}^R = a_{tb}^R = 0$

3) L-R mixing: $a_{ud}^L = a_{tb}^R = a_{tb}^L = a_{ud}^R = 1$



$W' \rightarrow tb$ первые результаты D0 230pb^{-1}

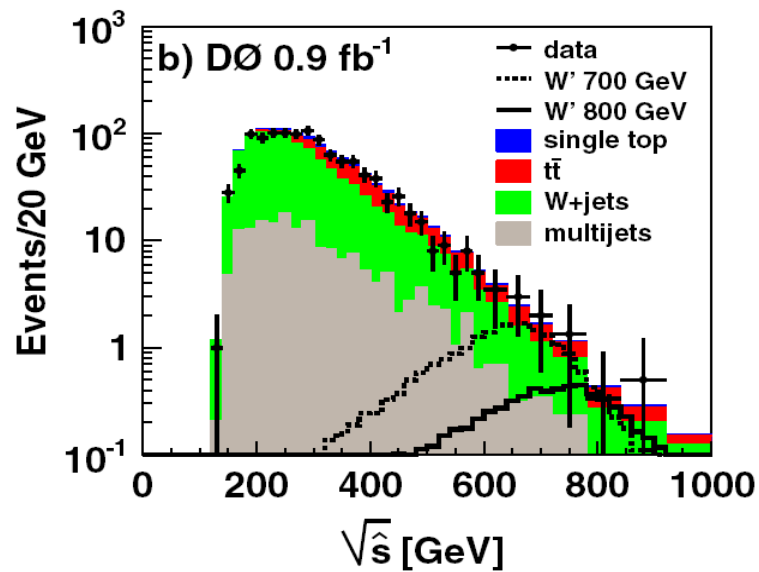
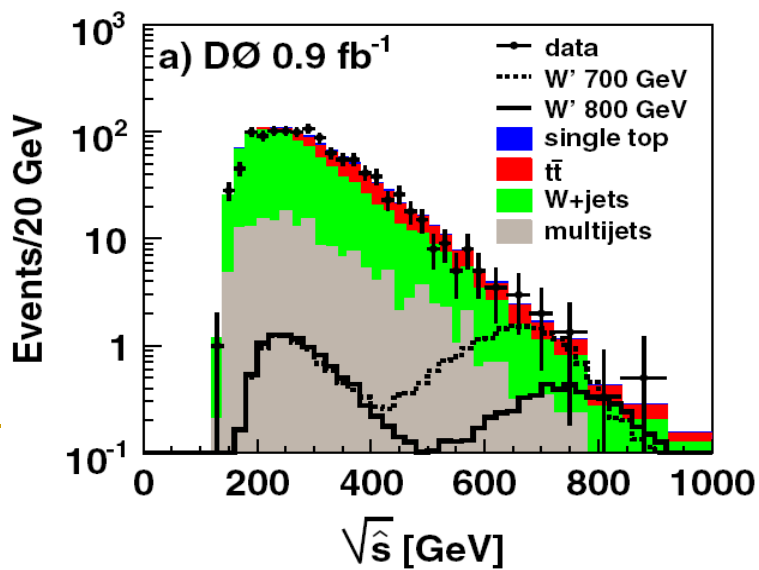
Phys. Lett. B, 641 (2006) 423-431



$W' \rightarrow tb$ результаты D0 2008, 0.9 fb^{-1}

Phys. Rev. Lett. 100, 211803 (2008)

Process	Events		$M_{W'}$ (GeV)	W'_L			W'_R					
	SM + W'_L search	W'_R search		Theory	Evts	Exp	Obs	Theory	Evts	Exp	Obs	
Single top	6.4 ± 1.4	10.2 ± 2.2						(I)	(II)			
$t\bar{t}$		59.1 ± 14.4	600	2.17	58	0.69	0.66	2.10	2.79	61	0.67	0.58
W + jets		91.0 ± 18.8	650	1.43	33	0.65	0.69	1.25	1.65	35	0.55	0.59
Multijets		29.7 ± 5.9	700	1.01	19	0.69	0.74	0.74	0.97	20	0.50	0.54
Total background	186.1 ± 40.4	190.0 ± 41.2	750	0.76	11	0.80	0.93	0.44	0.57	12	0.44	0.50
Data		182	800	0.62	6	1.04	1.23	0.26	0.34	7	0.42	0.47
			850	0.55	4	1.46	1.77	0.16	0.20	4	0.42	0.48
			900	0.51	3	2.35	2.79	0.09	0.12	2	0.40	0.44



$W' \rightarrow tb$ результаты D0 2008, 0.9 fb^{-1}

PRL **100**, 211803 (2008)

PHYSICAL REVIEW LETTERS

week ending
30 MAY 2008

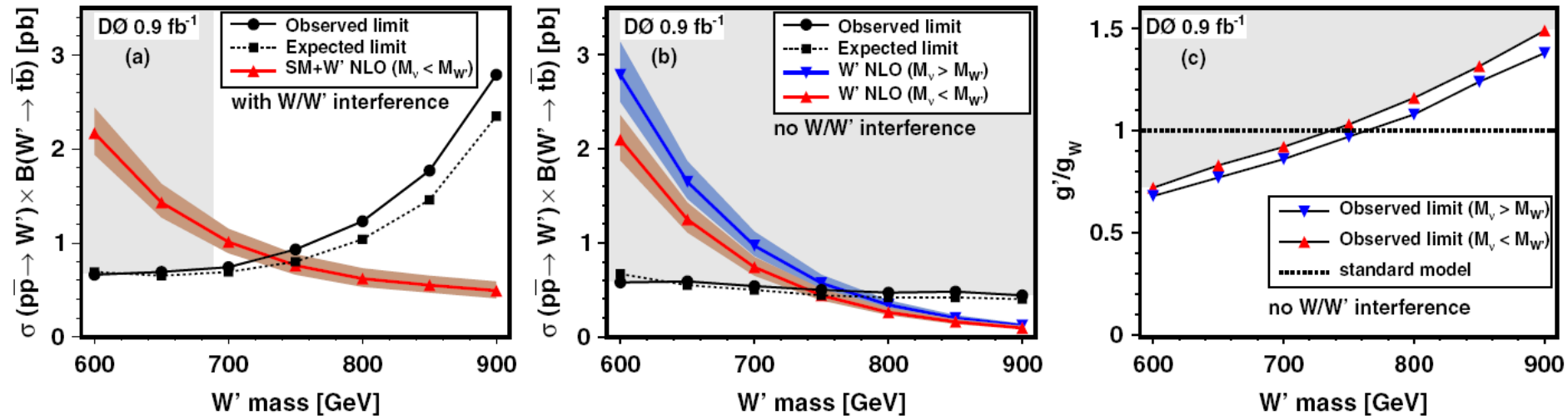
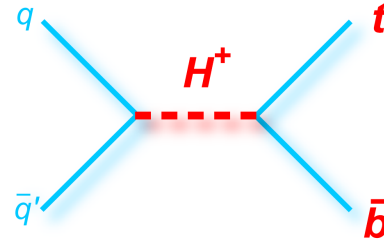


FIG. 2 (color online). NLO theory cross sections and 95% C.L. limits for $\sigma_{W'} \times B(W' \rightarrow tb)$ as a function of W' mass for (a) W'_L production and (b) W'_R production. Observed limits on the ratio of coupling constants g'/g_w are shown in (c). The shaded regions are excluded by this analysis.

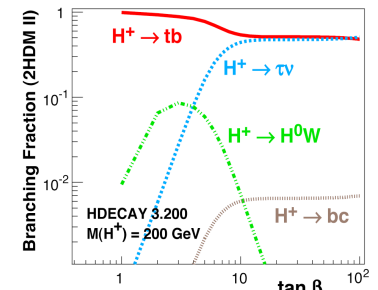
$$g' = g_w a_{ij}^R$$

Поиск заряженного скалярного бозона (H^+)

$$\mathcal{L} = H^+ \bar{q}_i \left[g_L^{ij} \left(\frac{1 - \gamma^5}{2} \right) + g_R^{ij} \left(\frac{1 + \gamma^5}{2} \right) \right] q_j$$



Charged Higgs Branching Fractions



2HDM Type I

$$g_L^{qq'} = -V_{qq'} g \frac{m_q}{\sqrt{2}M_W} \tan \beta$$

$$g_R^{qq'} = V_{qq'} g \frac{m_{q'}}{\sqrt{2}M_W} \tan \beta$$

2HDM Type II

$$g_L^{qq'} = V_{qq'} g \frac{m_q}{\sqrt{2}M_W} \cot \beta$$

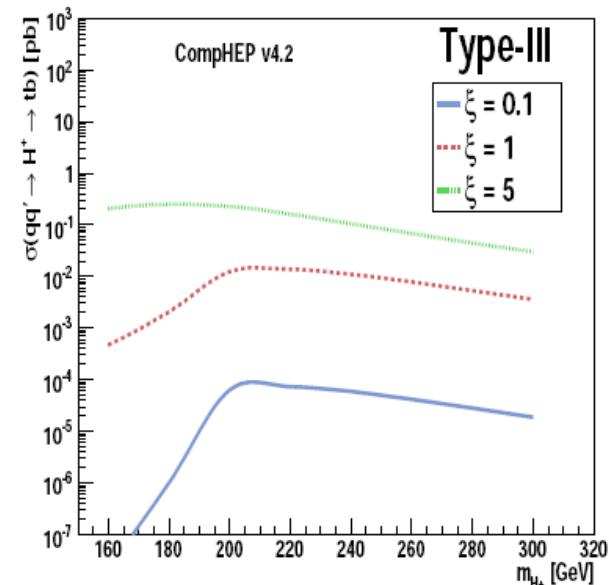
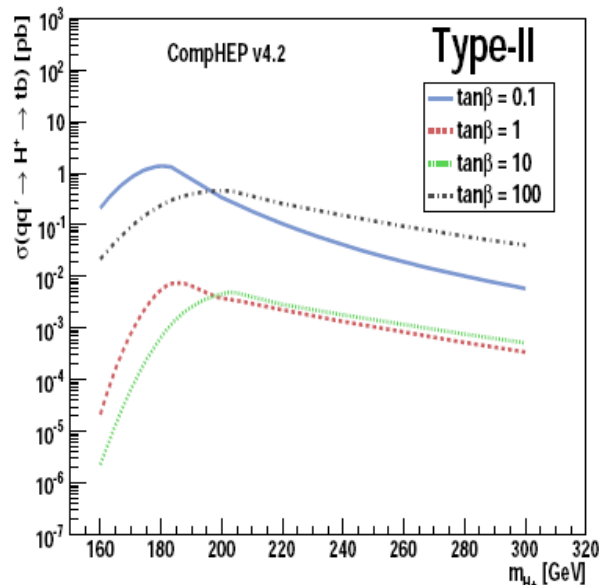
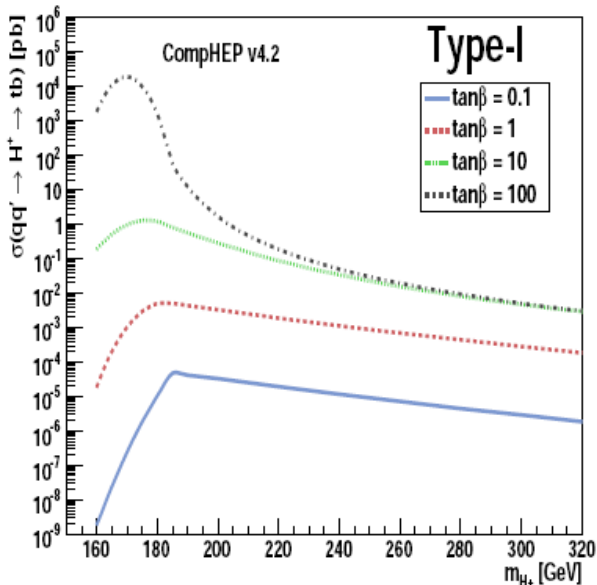
$$g_R^{qq'} = V_{qq'} g \frac{m_{q'}}{\sqrt{2}M_W} \tan \beta$$

2HDM Type III

$$g_L^{qq'} = (\hat{Y}_U^\dagger V_{CKM})_{qq'} = \begin{pmatrix} \hat{Y}_{uu}^* & Y_{cu}^* & Y_{tu}^* \\ \hat{Y}_{uc}^* & \hat{Y}_{cc}^* & \hat{Y}_{tc}^* \\ \hat{Y}_{ut}^* & \hat{Y}_{ct}^* & \hat{Y}_{tt}^* \end{pmatrix} \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}_{qq'}$$

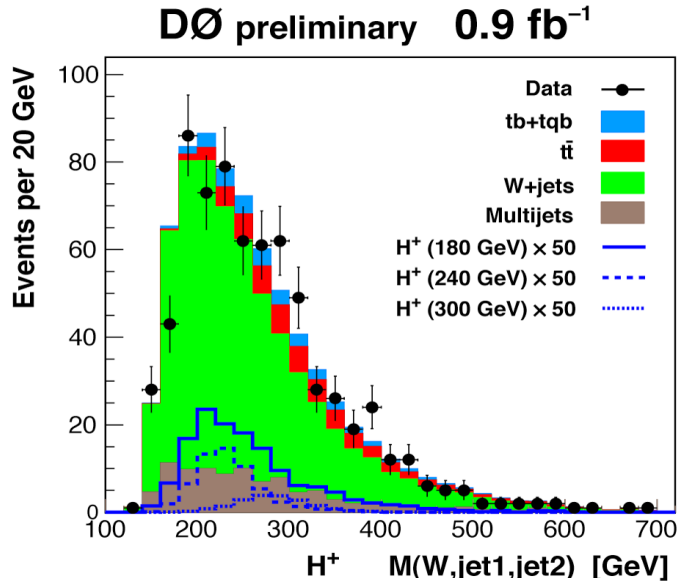
$$g_R^{qq'} = -(V_{CKM} \hat{Y}_D)_{qq'} = - \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} \hat{Y}_{dd} & \hat{Y}_{ds} & \hat{Y}_{db} \\ \hat{Y}_{sd} & \hat{Y}_{ss} & \hat{Y}_{sb} \\ \hat{Y}_{bd} & \hat{Y}_{bs} & \hat{Y}_{bb} \end{pmatrix}_{qq'}$$

$$\hat{Y}_{qq'} = \xi_{qq'} \sqrt{2m_q m_{q'}} / v$$

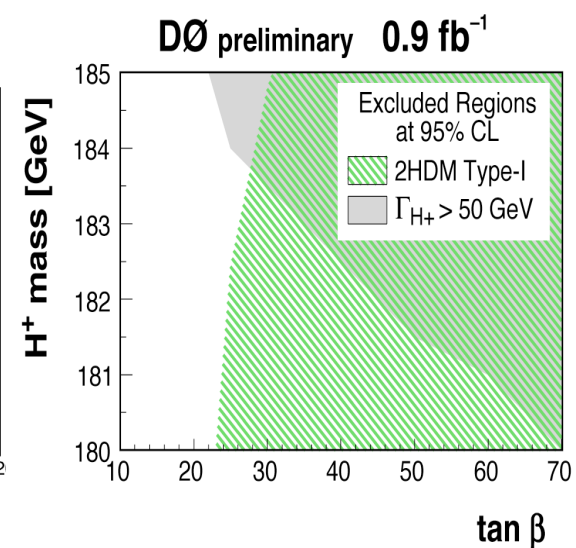
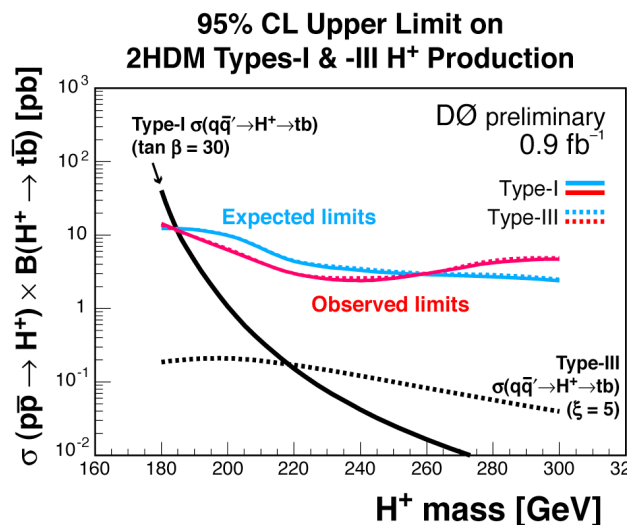
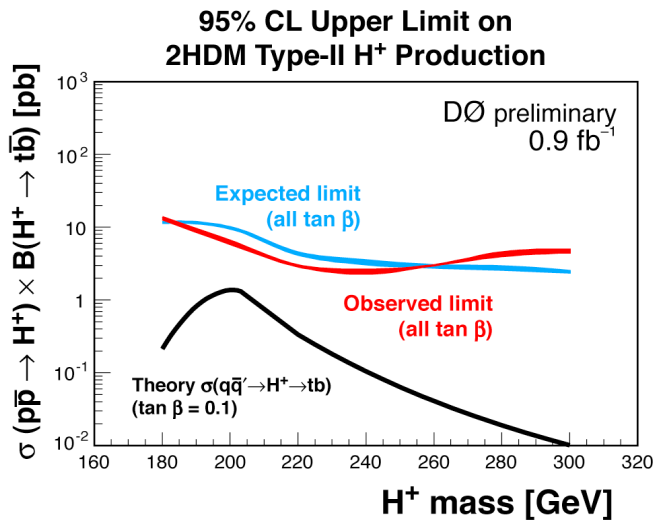


Ограничения на рождение заряженного скалярного бозона

Наблюдаемые (ожидаемые) ограничения на сечения
ArXiv:0807.0859 (subm. To PRL)

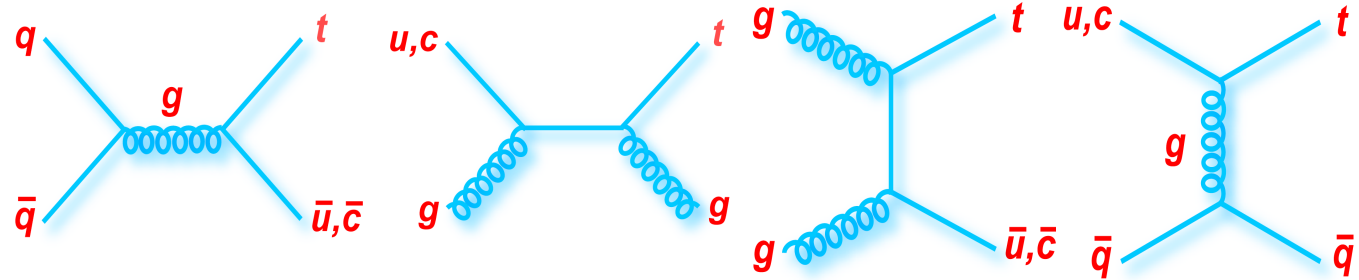


M_{H^+} (GeV)	$\tan\beta < 0.1$	$\tan\beta = 1$	$\tan\beta = 5$	$\tan\beta > 10$
180	12.9 (11.4)	14.3 (12.2)	13.7 (11.7)	13.7 (12.2)
200	[5.9 (9.6)]	6.3 (9.9)	6.5 (10.0)	6.5 (10.0)
220	[2.9 (4.2)]	3.0 (4.4)	3.0 (4.5)	3.0 (4.5)
240	[2.3 (3.1)]	2.4 (3.3)	2.6 (3.5)	2.6 (3.5)
260	[3.0 (2.8)]	3.0 (2.9)	3.0 (3.0)	3.0 (3.0)
280	[4.0 (2.6)]	4.2 (2.7)	4.5 (2.9)	4.5 (2.9)
300	[4.5 (2.4)]	4.7 (2.4)	4.9 (2.5)	4.9 (2.5)



Поиск нейтральных токов меняющих аромат кварков (FCNC)

$$\frac{\kappa_f}{\Lambda} g_s \bar{f} \sigma^{\mu\nu} \frac{\lambda^a}{2} t G_{\mu\nu}^a$$

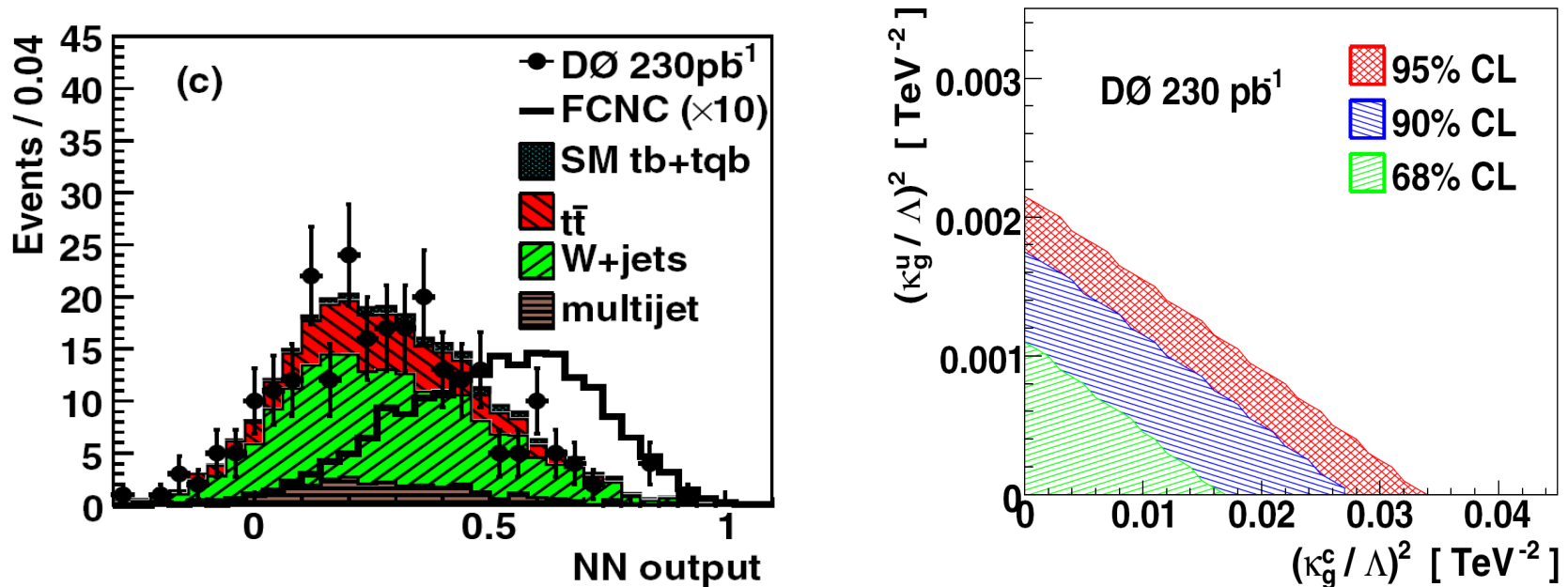


κ_g/Λ [TeV ⁻¹]	$\sigma(t)$ [pb]	
	<i>tcg</i> ($\kappa_g^u = 0$)	<i>tug</i> ($\kappa_g^c = 0$)
0.01	0.05	0.88
0.03	0.45	7.92
0.07	2.40	42.61
0.11	5.86	104.78

Source	Electron channel	Muon channel
<i>tcg</i>	0.6 ± 0.2	0.6 ± 0.2
<i>tug</i>	8.4 ± 2.1	9.8 ± 2.7
SM single top (<i>tb</i> + <i>tqb</i>)	6.4 ± 1.4	6.1 ± 1.4
<i>t\bar{t}</i>	31.8 ± 6.9	31.4 ± 7.0
<i>W</i> + jets	84.6 ± 10.2	76.8 ± 8.5
Multijets	13.7 ± 4.3	17.2 ± 1.5
Total SM background	136.5 ± 13.4	131.5 ± 12.7
Observed no. of events	134	118

Ограничения на tsg , tug FCNC связи

Phys. Rev. Lett. 99, 191802 (2007)



Observed (expected) limits [TeV⁻¹]

$$\kappa_g^c / \Lambda$$

$$\kappa_g^u / \Lambda$$

Electron channel

0.16 (0.19)

0.046 (0.052)

Muon channel

0.21 (0.21)

0.049 (0.050)

Combined

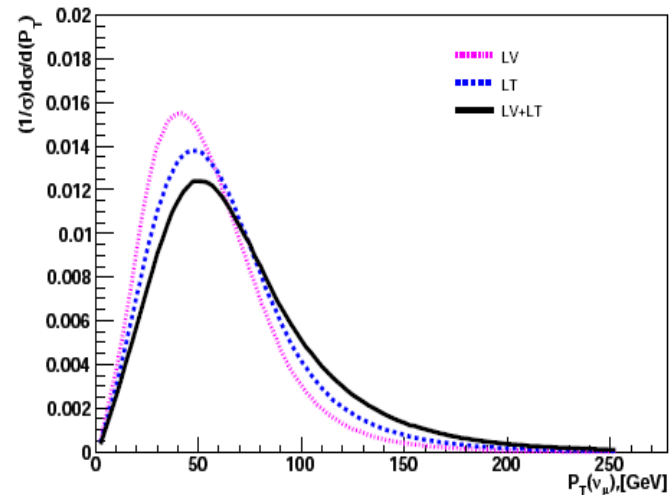
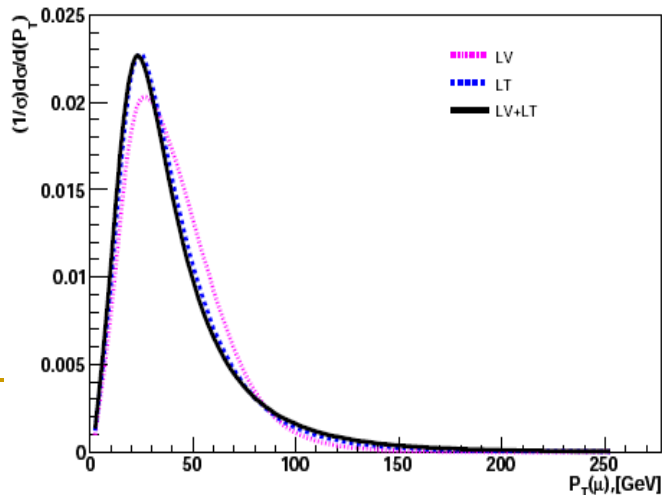
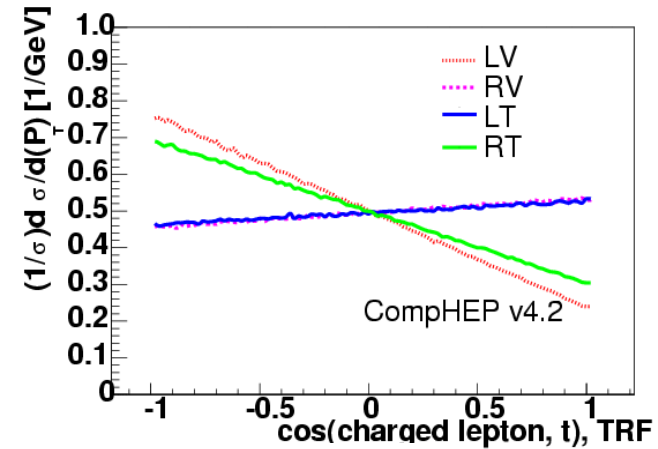
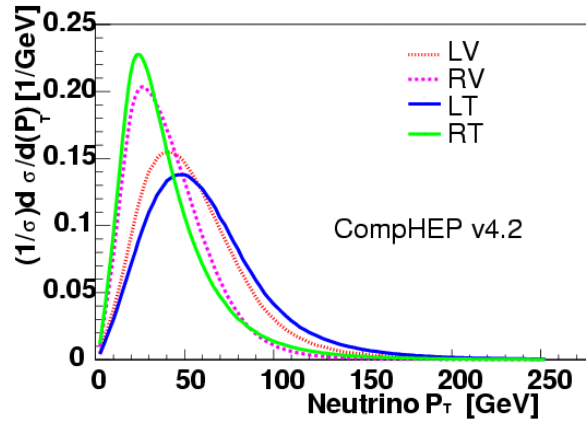
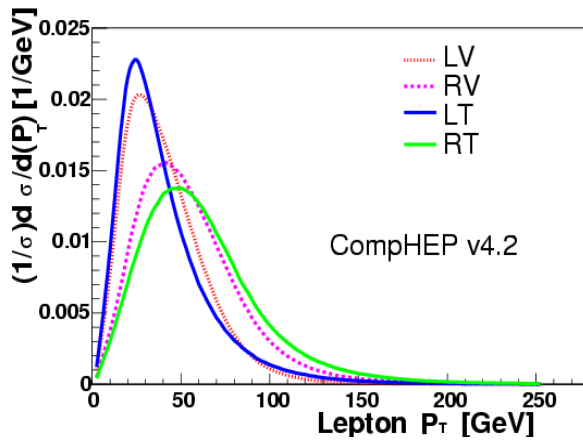
0.15(0.16)

0.037(0.041)

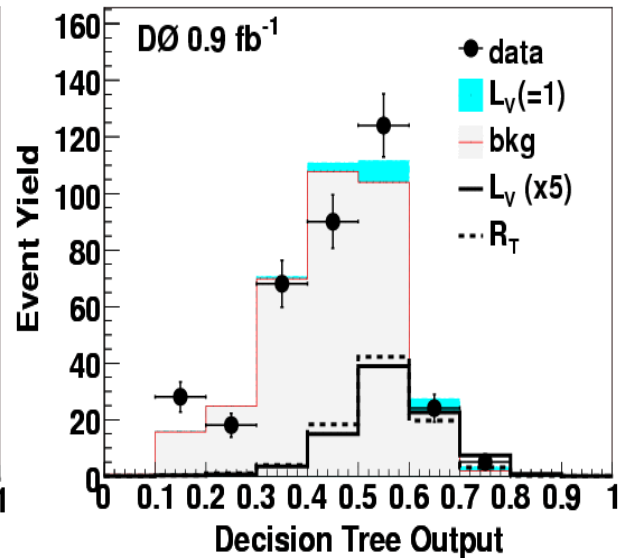
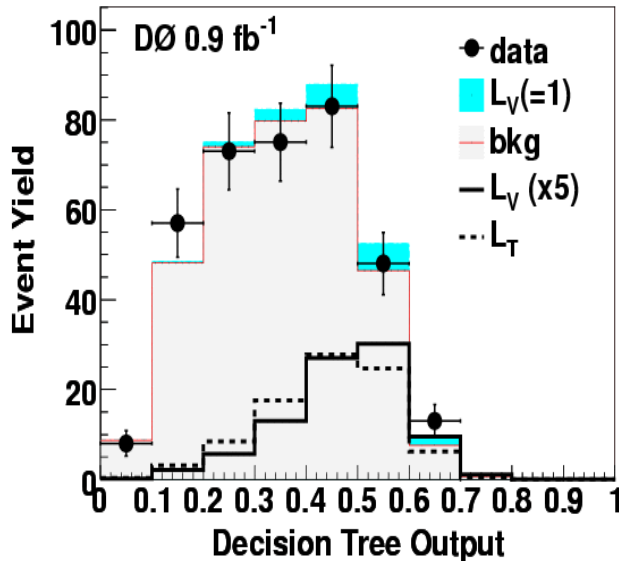
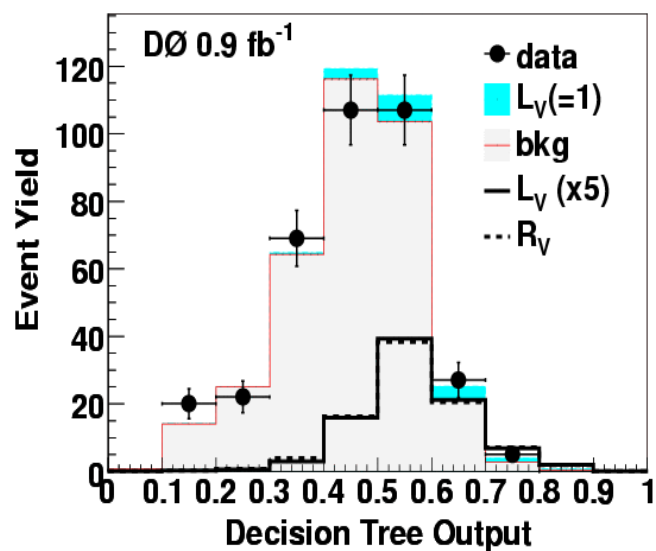
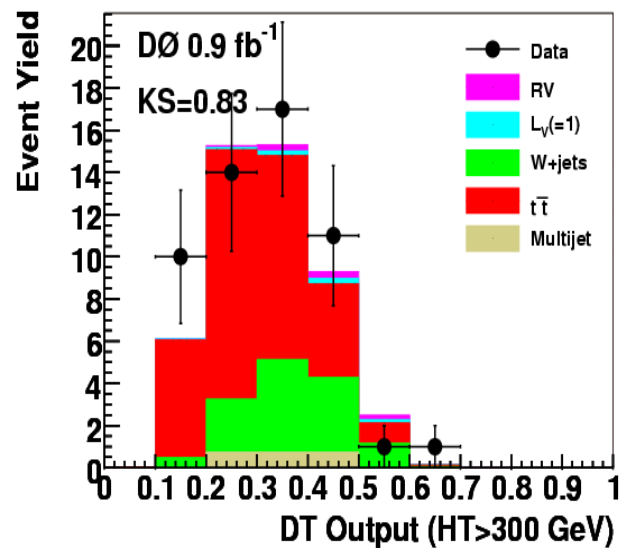
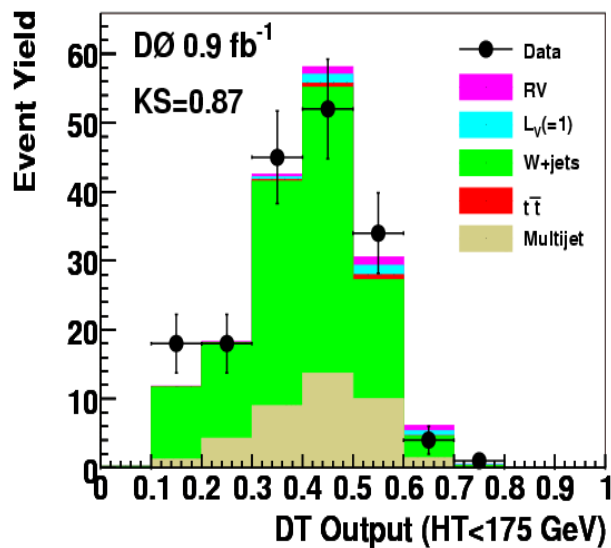
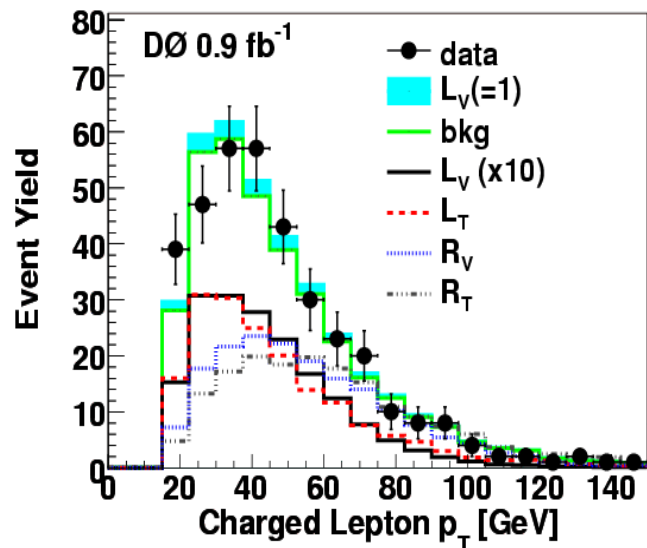
Поиск аномальных Wtb связей

$$\mathcal{L}_{tbW} = \frac{g}{\sqrt{2}} W_{\mu}^{-} \bar{b} \gamma^{\mu} (f_1^L P_L + f_1^R P_R) t - \frac{g}{\sqrt{2} M_W} \partial_{\nu} W_{\mu}^{-} \bar{b} \sigma^{\mu\nu} (f_2^L P_L + f_2^R P_R) t + h.c.$$

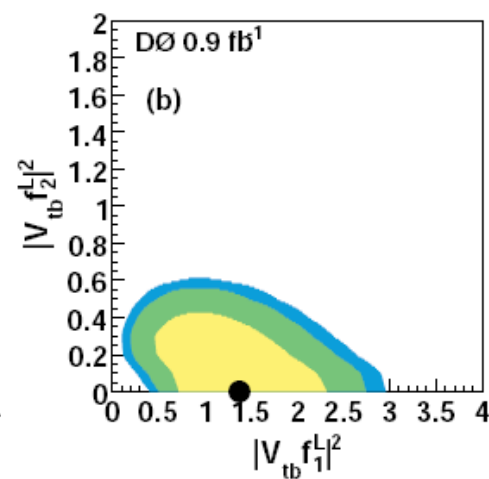
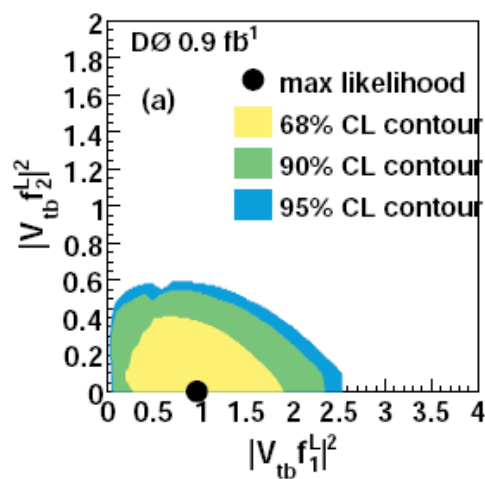
$$\sigma \propto A \cdot (F_{L1})^2 + B \cdot (F_{R1})^2 + C \cdot (F_{L1} \cdot F_{L2}) + D \cdot (F_{R1} \cdot F_{R2}) + E \cdot (F_{L2})^2 + G \cdot (F_{R2})^2$$



Поиск аномальных Wtb связей

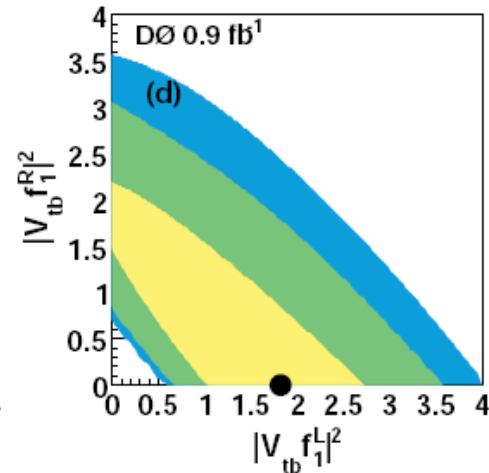
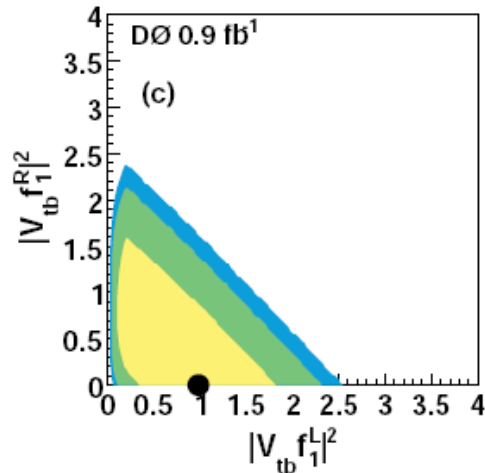


Ожидаемые
ограничения
 $L_V - L_T$



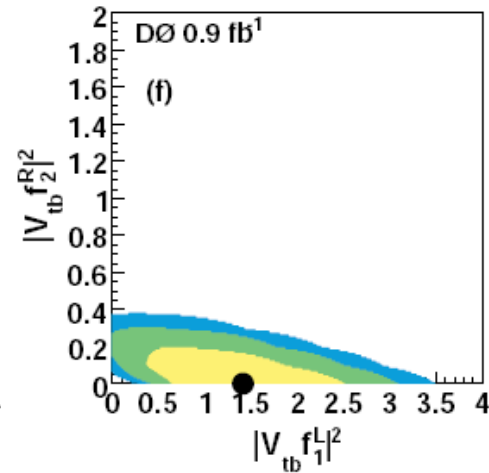
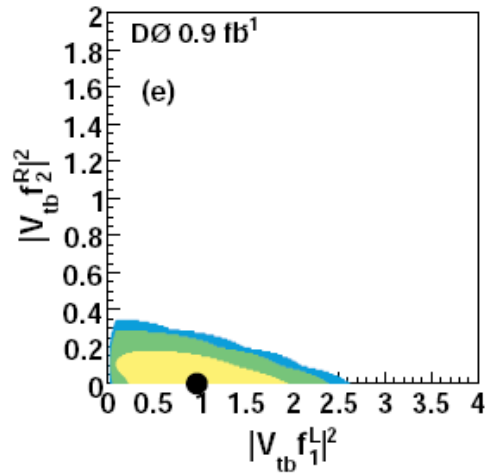
Измеренные
ограничения
 $L_V - L_T$

$L_V - R_V$



$L_V - R_V$

$L_V - R_T$



$L_V - R_T$

Первые прямые ограничения на аномальные Wtb связи, $D0\ 0.9\ \text{fb}^{-1}$

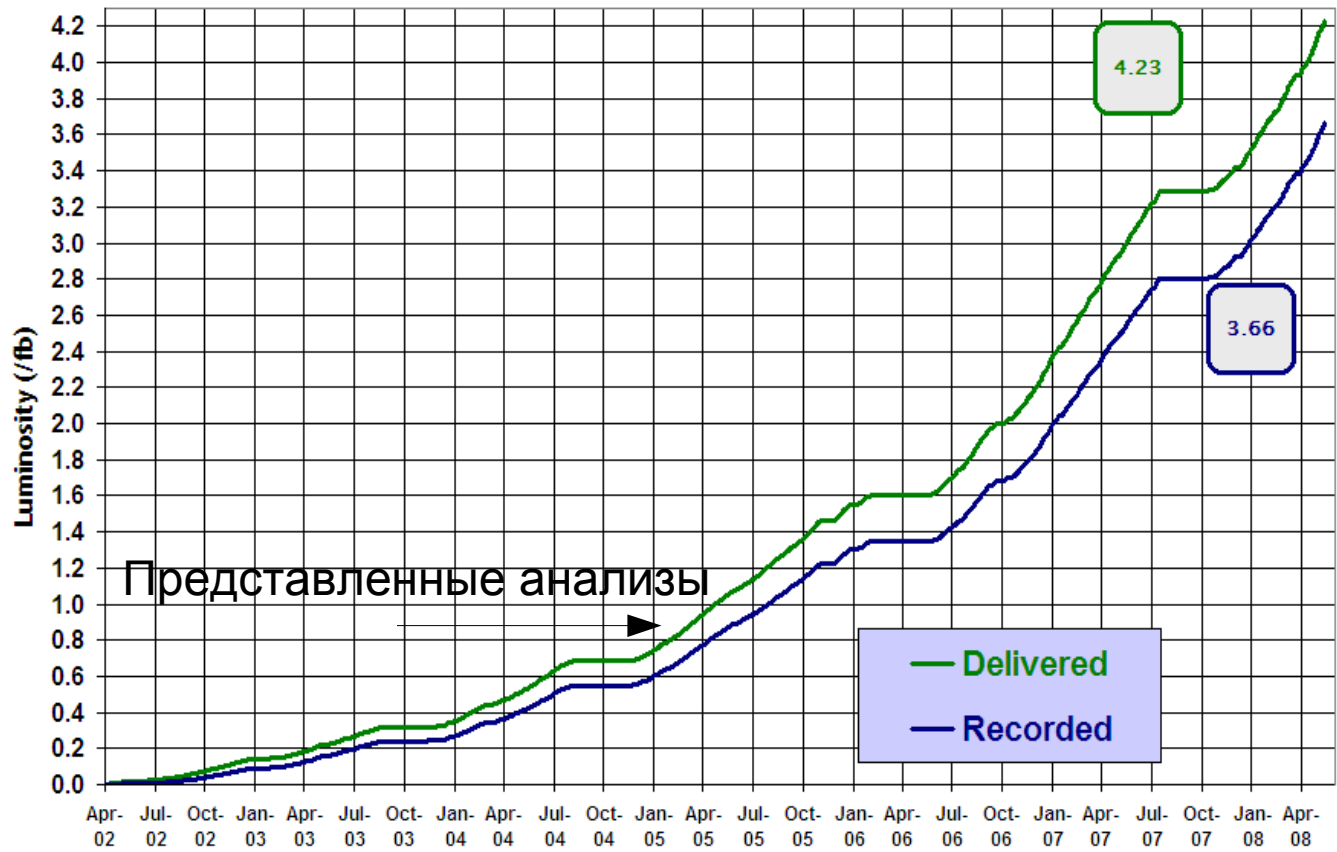
PRL 101, 221801 (2008)

Scenario	Cross Section	Coupling
(L_1, L_2)	$4.4^{+2.3}_{-2.5}\ \text{pb}$	$ V_{tb} f_1^L ^2 = 1.4^{+0.6}_{-0.5}$ $ V_{tb} f_2^L ^2 < 0.5$ at 95% C.L.
(L_1, R_1)	$5.2^{+2.6}_{-3.5}\ \text{pb}$	$ V_{tb} f_1^L ^2 = 1.8^{+1.0}_{-1.3}$ $ V_{tb} f_1^R ^2 < 2.5$ at 95% C.L.
(L_1, R_2)	$4.5^{+2.2}_{-2.2}\ \text{pb}$	$ V_{tb} f_1^L ^2 = 1.4^{+0.9}_{-0.8}$ $ V_{tb} f_2^R ^2 < 0.3$ at 95% C.L.



Run II Integrated Luminosity

19 April 2002 - 1 June 2008



- Expect ~6 fb⁻¹ by Apr 2009, and 8 fb⁻¹ by Oct 2010.

Заключение

- В ближайшее время можно ожидать открытия одиночного рождения топ-кварков на уровне достоверности в 5σ
- Увеличение статистики (в 4-6 раз) позволит существенно повысить точность измерения V_{tb} и ограничения на возможные отклонения от предсказаний СМ
- Данные LHC позволят исследовать электрослабое рождение топ-кварка на принципиально новом уровне статистической достоверности.
- Накопленный опыт исследования данных процессов напрямую используется в коллаборации CMS (LHC)

Дополнительная информация

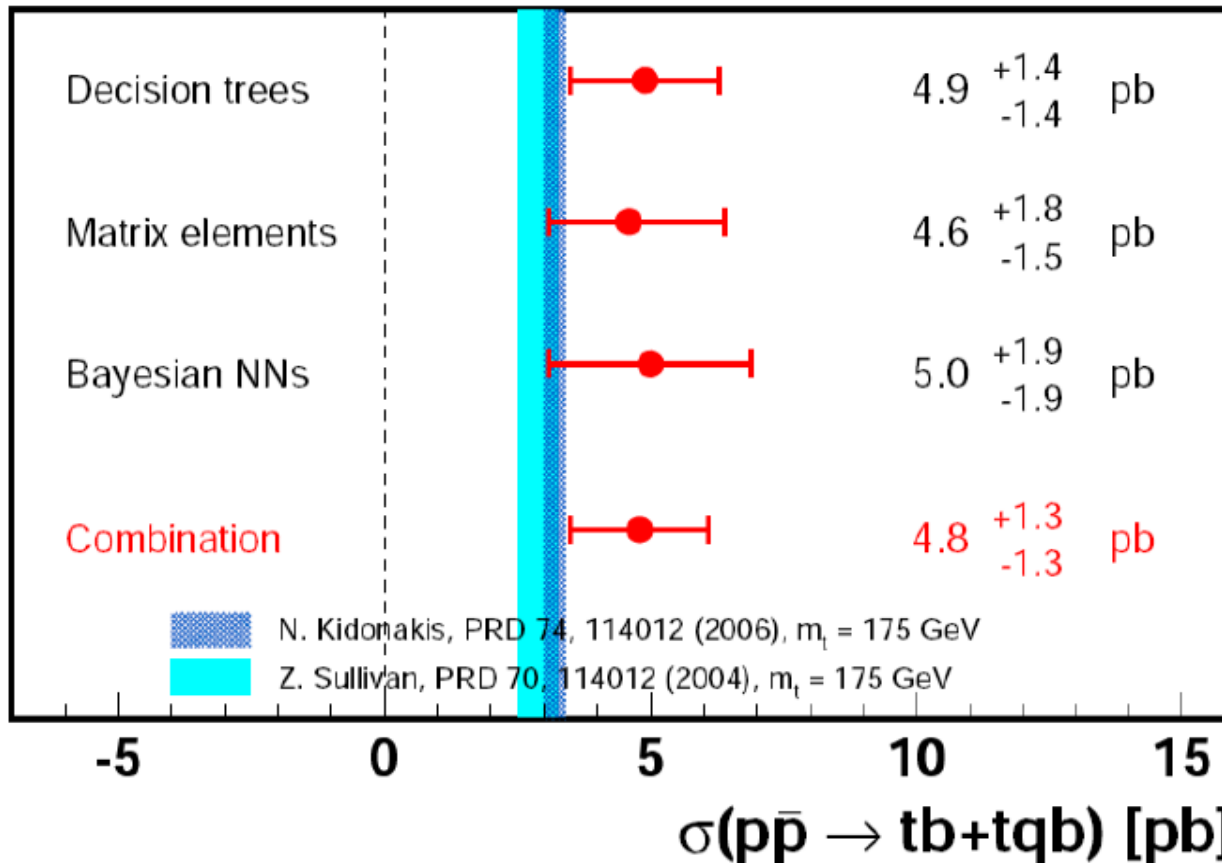
Комбинация результатов трех методов отбора событий

- ▶ Combine the three measurements with BLUE method
- ▶ Method requires to measure the correlations
- ▶ Used SM pseudo-datasets with systematics

$$\rho = \begin{pmatrix} & DT & ME & BNN & \\ DT & 1 & 0.57 & 0.51 & DT \\ ME & 0.57 & 1 & 0.45 & ME \\ BNN & 0.51 & 0.45 & 1 & BNN \end{pmatrix}$$

DØ Run II

0.9 fb⁻¹

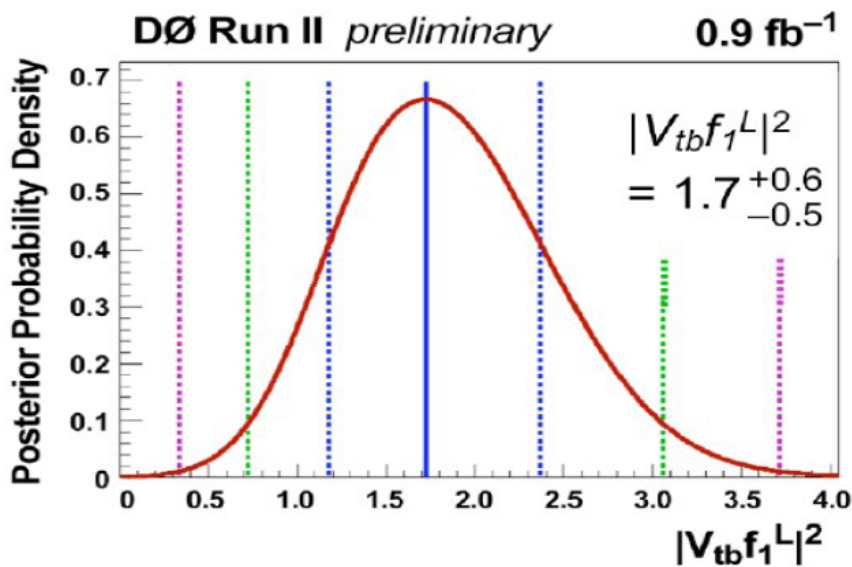


Комбинированный результат 4.8 ± 1.3 pb с достоверностью 3.5σ

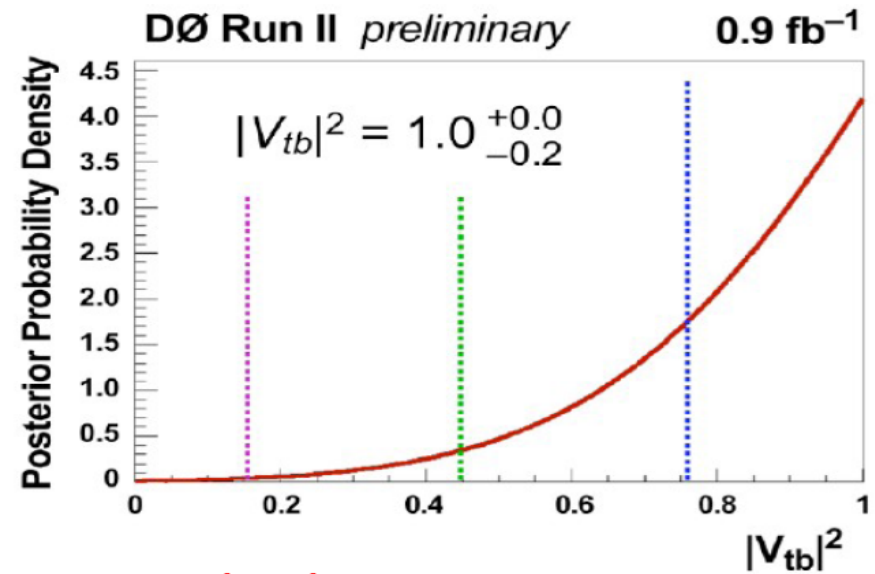
соответствует вероятности флуктуации фона до измеренного значения сечения 0.027%

Первое прямое измерение $|V_{tb}|$

- ▶ Calculate posterior in $|V_{tb}|^2$: $\sigma \propto |V_{tb}|^2$
- ▶ Assume:
 - SM top decay: $V_{td}^2 + V_{ts}^2 \ll V_{tb}^2$
 - Pure V-A and CP conserving interaction



$|V_{tb} f_1^L| = 1.3 \pm 0.2$



$|V_{tb}| > 0.68$ @ 95 C.L.
 assuming $f_1^L = 1$ (SM)

This measurement does not assume 3 generations or unitarity

Search for

Single top

Cosmic μ

$W + jets$

Wbb

$t\bar{t}$

Multijet fake



Basic production processes cross sections

	σ_{NLO} (pb)	$q\bar{q} \rightarrow t\bar{t}$	$gg \rightarrow t\bar{t}$
Tevatron ($\sqrt{s} = 1.8$ TeV $p\bar{p}$)	$4.87 \pm 10\%$	90%	10%
Tevatron ($\sqrt{s} = 2.0$ TeV $p\bar{p}$)	$6.70 \pm 10\%$	85%	15%
LHC ($\sqrt{s} = 14$ TeV pp)	$833 \pm 15\%$	10%	90%

	s channel	t channel	Wt
Tevatron ($\sqrt{s} = 2.0$ TeV $p\bar{p}$)	$0.90 \pm 5\%$	$2.0 \pm 5\%$	$0.1 \pm 10\%$
LHC ($\sqrt{s} = 14$ TeV pp)	$10.6 \pm 5\%$	$250 \pm 5\%$	$75 \pm 10\%$

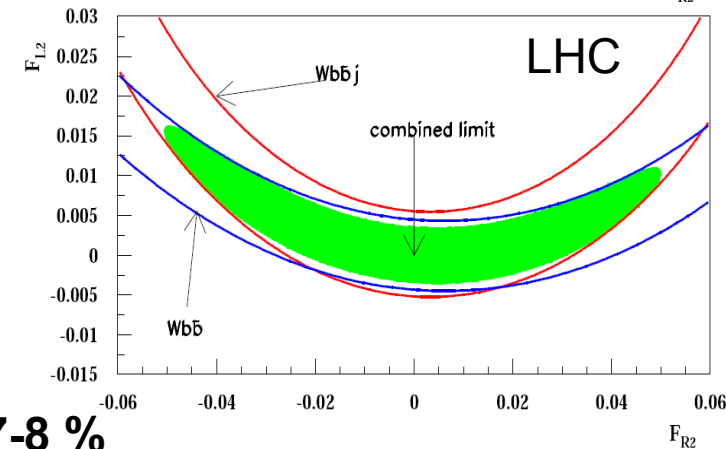
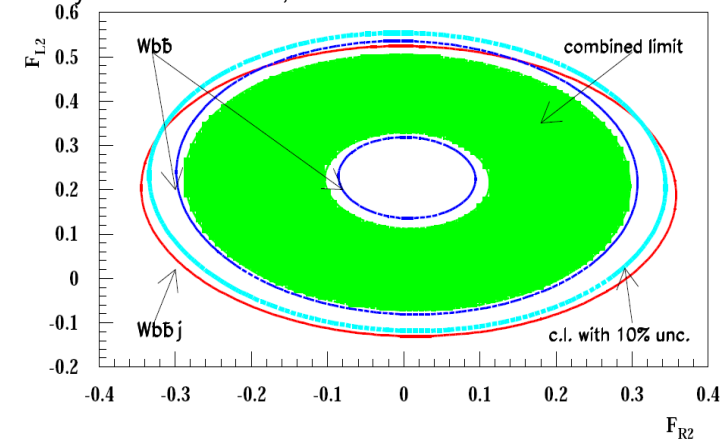
The single top rate is about 0.4 of the top pair rate

Продолжение исследований в CMS

- Моделирование СМ сигнала с новой моделью CMS детектора
- Моделирование возможных отклонений от СМ
- Подготовка методов оптимизации анализа и оценка ожидаемых результатов с учетом современной модели детектора и программ реконструкции

Eur.Phys.J.C11:473-484,1999

Tevatron



$$V_{tb} : 10\% \rightarrow 7-8 \%$$

$$f_2^L : -0.2 \div +0.5 \rightarrow -0.05 \div +0.1$$

$$f_2^R : -0.25 \div +0.25 \rightarrow -0.12 \div +0.12$$

$$k_g^u / \Lambda < 0.037 \text{ TeV}^{-1} \rightarrow 4.4 \cdot 10^{-3} \text{ TeV}^{-1}$$

$$M_W : 600 \text{ GeV} \rightarrow 2 \div 3 \text{ TeV}$$

$|V_{tb}|$ measurements

If CKM unitarity and 3 generations are assumed

$$|V_{tb}| = 0.9991_{-0.00004}^{+0.000034}$$

Without the 3-generation unitarity constrain $|V_{tb}|$ is left practically unconstrained

$$|V_{tb}| = 0.07 - 0.9993$$

From top quark loop contributions to $\Gamma(Z \rightarrow b\bar{b})$

$$|V_{tb}| = 0.77_{-0.24}^{+0.18}$$

From measurements of $R = \frac{|V_{tb}|^2}{|V_{tb}|^2 + |V_{ts}|^2 + |V_{td}|^2}$ by D0 and CDF analysing top pair production

$$R = 1.03_{-0.17}^{+0.19} \Rightarrow |V_{tb}| > 0.78$$

Measurements from the single top: Production*Decays $\Rightarrow |V_{tb}|^2 \frac{|V_{tb}|^2}{|V_{tb}|^2 + |V_{ts}|^2 + |V_{td}|^2 + (Exotics)}$

Assumptions (no 3-generation unitarity constrain):

* V-A interaction

* $|V_{tb}|^2 \gg |V_{ts}|^2 + |V_{td}|^2 + (Exotics)$

Anomalous Wtb Couplings

- Lagrangian

$$\mathcal{L} = \frac{g}{\sqrt{2}} V_{tb} \left[W_{\nu}^{-} \bar{b} \gamma_{\mu} P_{-} t - \frac{1}{2M_W} W_{\mu\nu}^{-} \bar{b} \sigma^{\mu\nu} (F_2^L P_{-} + F_2^R P_{+}) t \right] + h.c.$$

with $W_{\mu\nu}^{\pm} = D_{\mu} W_{\nu}^{\pm} - D_{\nu} W_{\mu}^{\pm}$, $D_{\mu} = \partial_{\mu} - ieA_{\mu}$,

$\sigma^{\mu\nu} = i/2[\gamma_{\mu}, \gamma_{\nu}]$ and $P_{\pm} = (1 \pm \gamma_5)/2$. The couplings F_2^L and F_2^R are proportional to the coefficients of the effective Lagrangian

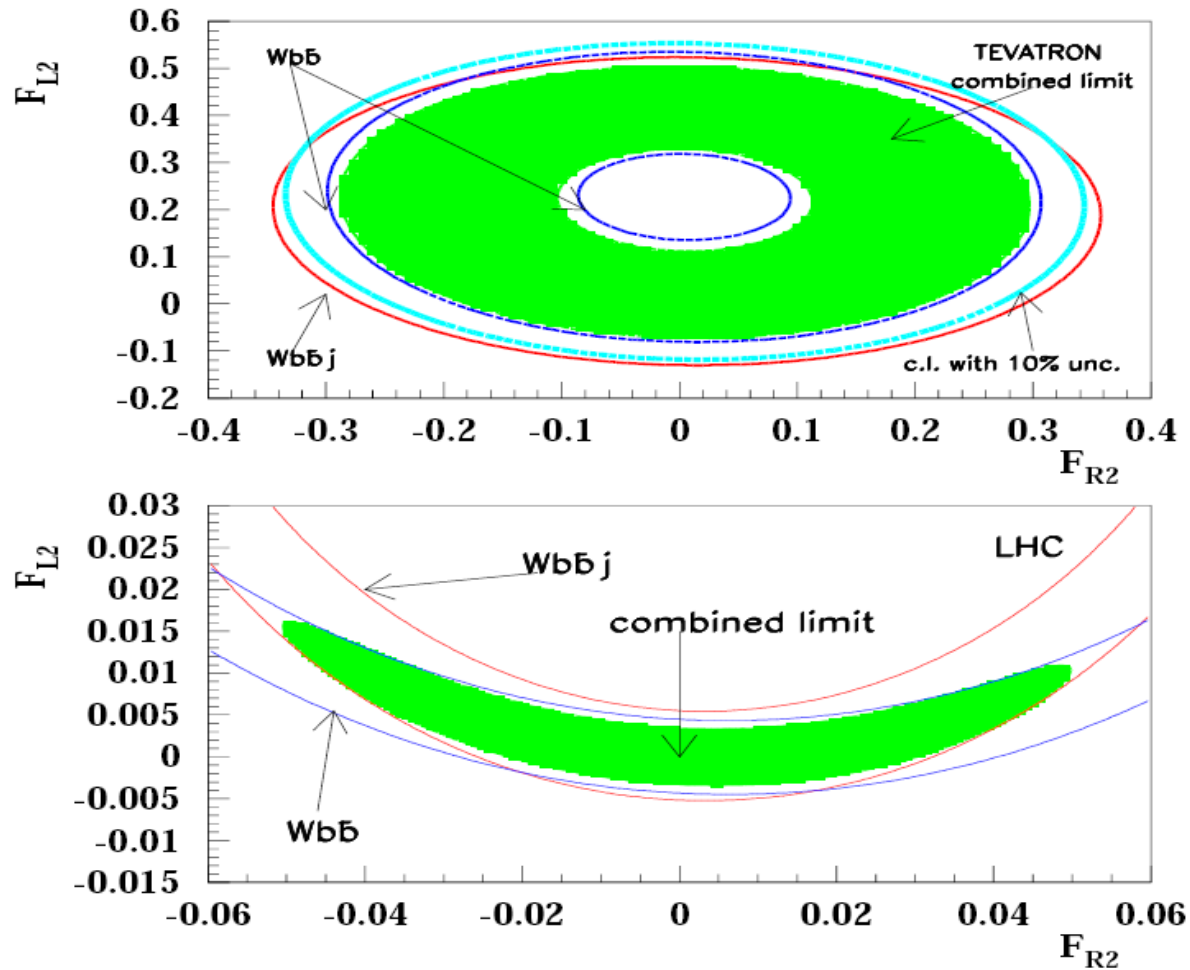
$$F_{L2} = \frac{2M_W}{\Lambda} \kappa_{tb}^W (-f_{tb}^W - ih_{tb}^W),$$

$$F_{R2} = \frac{2M_W}{\Lambda} \kappa_{tb}^W (-f_{tb}^W + ih_{tb}^W), \quad |F_{L2,R2}| < 0.6 \text{ from unitary bounds}$$

- $|V_{tb}|$ is very close to 1 in SM with 3 generations. ($|V_{tb}|$ is very weakly constrained in case of 4 generations, e.g.)
- A possible $V + A$ form factor is severely constrained by the CLEO $b \rightarrow s\gamma$ data to 3×10^{-3} level

Wtb anomalous couplings limit on TEVATRON and LHC:

(E.Boos,L.Dudko,T.Ohl,EPJ99)

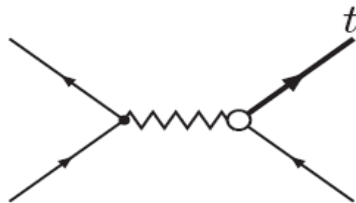


FCNC couplings

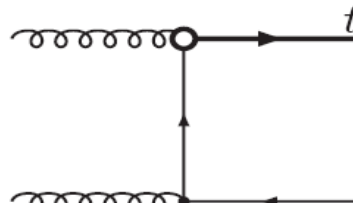
- Couplings: tqg , $tq\gamma$, tqZ , where $q = u, c$

$$\Delta\mathcal{L}^{eff} = \frac{1}{\Lambda} [\kappa_{tq}^{\gamma,Z} e\bar{t}\sigma_{\mu\nu}qF_{\gamma,Z}^{\mu\nu} + \kappa_{tq}^g g_s\bar{t}\sigma_{\mu\nu}\frac{\lambda^i}{2}qG^{i\mu\nu}] + h.c.$$

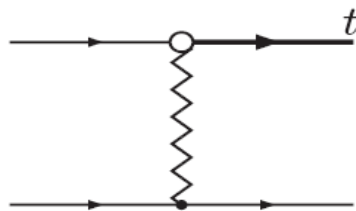
Information on FCNC couplings come from either top pair production with subsequent decays to rear modes $t \rightarrow qV$, where $V = \gamma, Z, g$ or from additional contributions to the single top production



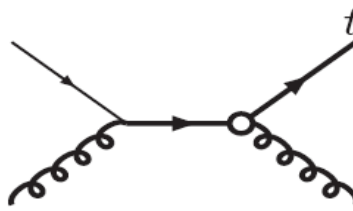
$q\bar{q} \rightarrow t\bar{c}$



$cg \rightarrow tg$

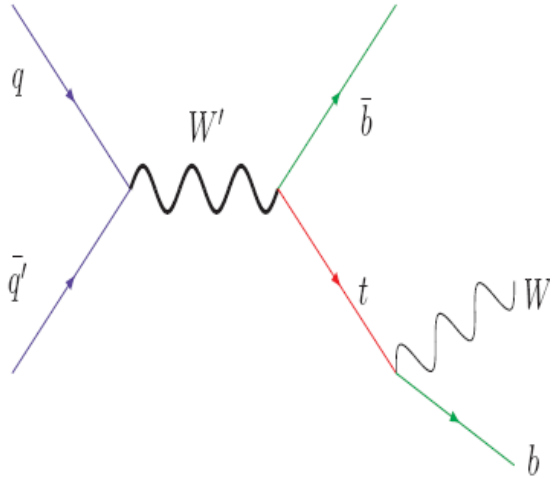


$c\bar{q} \rightarrow t\bar{q}$



$gg \rightarrow t\bar{c}$

Searches for W'



$$\mathcal{L} = \frac{V_{q_i q_j}}{2\sqrt{2}} g_w \bar{q}_i \gamma_\mu (a_{q_i q_j}^R (1 + \gamma^5) + a_{q_i q_j}^L (1 - \gamma^5)) W' q_j + \text{H.c.}, \quad (1)$$

The notations are taken such that for so-called SM-like W' $a_{q_i q_j}^L = 1$ and $a_{q_i q_j}^R = 0$.

Problems and requirements for a generator for the single top signal:

- Double counting and negative weights
- Matching of various NLO contributions at the generator level. One should have the correct NLO rate and correct shapes of the NLO distributions
- Matching to showering programs
- Correct spin correlations
- Finite top and W widths
- Separation Top and antiTop since the rates are different (for the LHC)
- Anomalous Wtb and FCNC couplings

t-channel

Splitting on p_t of the b-jet (b-jet not from top decay)

$2 \rightarrow 2$ with ISR at "small" p_t region

(CompHEP + ISR from PYTHIA)

$2 \rightarrow 3$ at "large" p_t region

(CompHEP)

(for both cases with spin correlated $1 \rightarrow 3$ top subsequent decay)

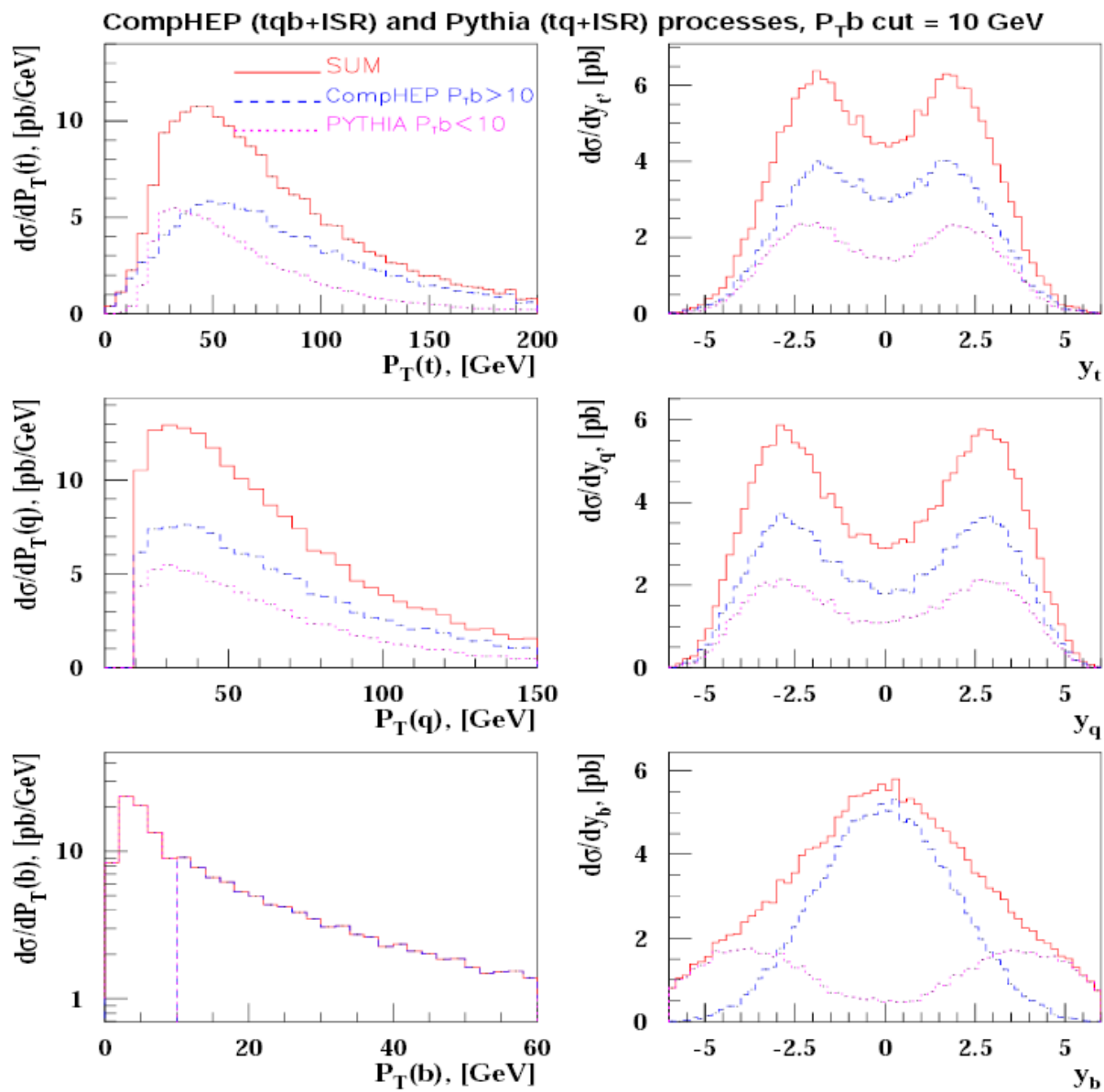
The separation parameter $(P_0)_t^b$ of "small" and "large" p_t regions is turned such that:

1. The total rate is normalized to the NLO rate

$$\sigma_{2 \rightarrow 2} |_{P_t^b < (P_0)_t^b} + \sigma_{(2 \rightarrow 3)} |_{P_t^b > (P_0)_t^b} \\ = \sigma_{\text{NLO}}$$

2. The distributions are smooth

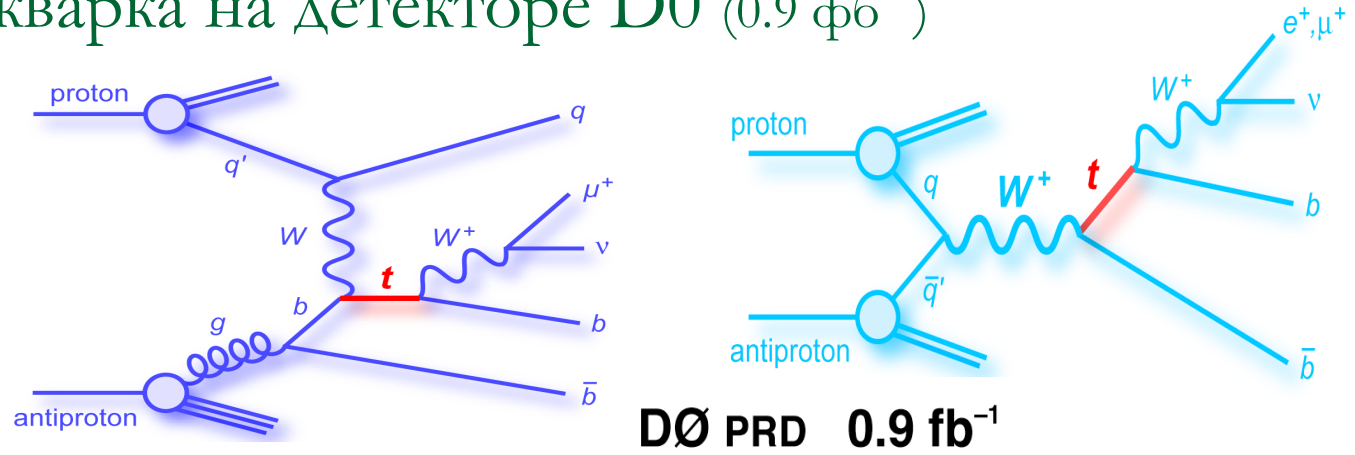
Matching CompHEP&PYTHIA($2 \rightarrow 2$) and CompHEP ($2 \rightarrow 3$) distributions ($P_T^q > 10$ GeV)



including deays $2 \rightarrow 4$ and $2 \rightarrow 5$ (LHC)

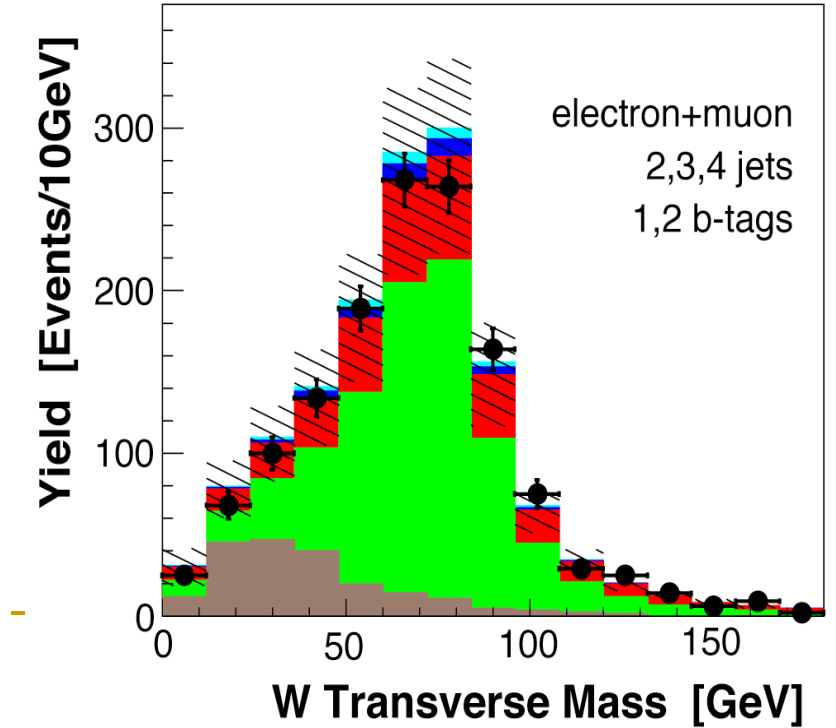
Первое экспериментальное наблюдение одиночного рождения топ-кварка на детекторе D0 (0.9 fb^{-1})

- Signature**
- isolated lepton
 - \cancel{E}_T
 - 2-4 jets
 - at least 1 b-jet

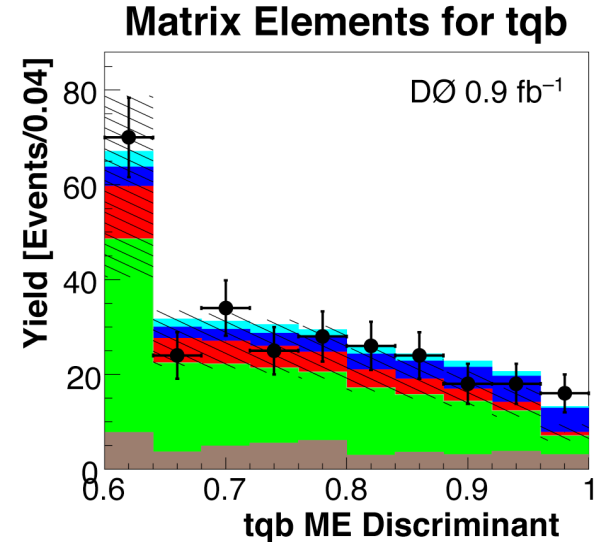
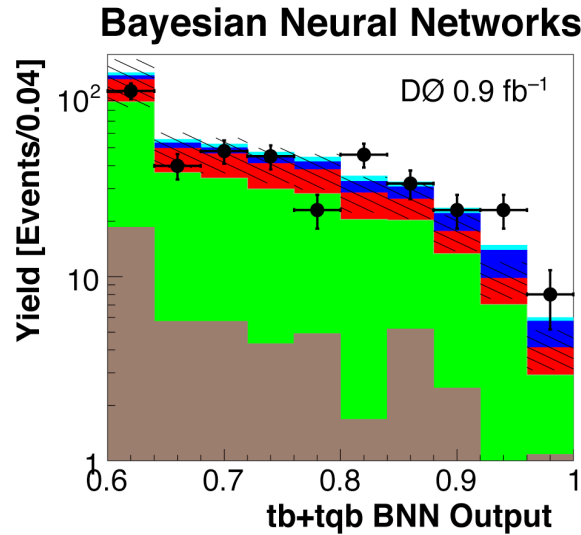
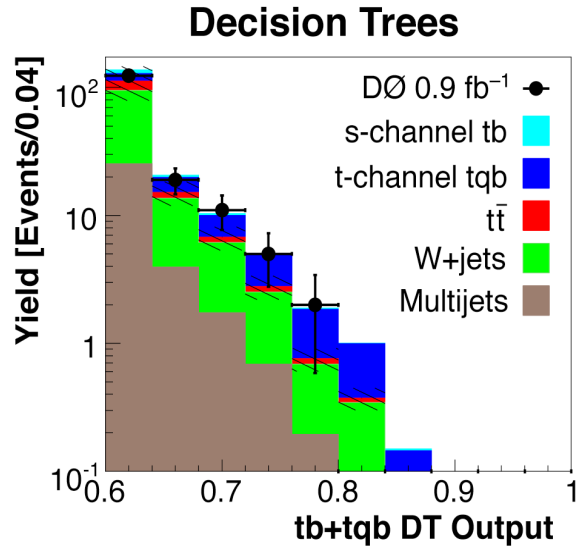


D0 PRD 0.9 fb^{-1}

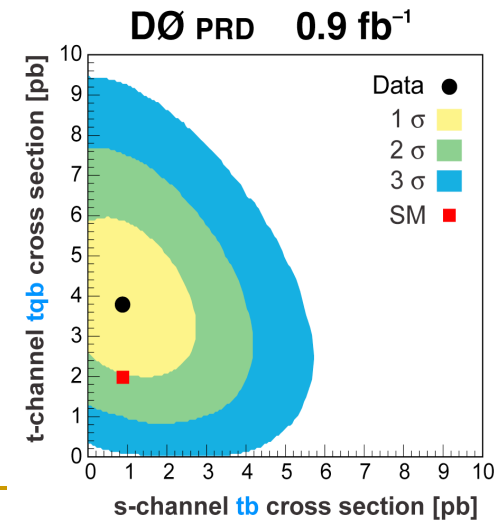
D0 PRD	0.9 fb^{-1}	
1,2 b-tags	2-jets	3-jets
■ s-channel tb	16	8
■ t-channel tqb	20	12
■ W+light-jets	119	43
■ W+charm	151	85
■ W+bottom	261	120
■ $t\bar{t} \rightarrow \text{dileptons}$	39	32
■ $t\bar{t} \rightarrow \text{lepton+jets}$	20	103
■ Multijets	95	77
Total prediction	721	480
● Data	697	455



Результат многомерных методов анализа



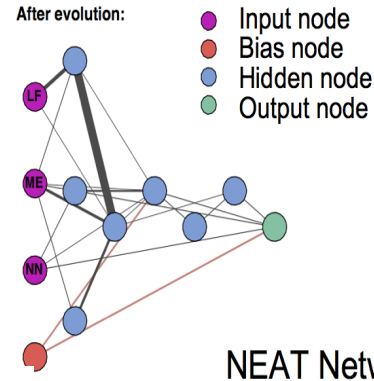
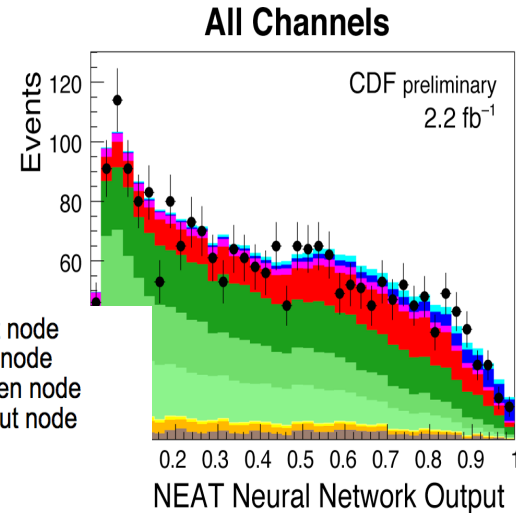
<i>tb+tb</i> Results	DØ PRD 0.9 fb ⁻¹		
	DT	BNN	ME
Expected significance	2.1 σ	2.2 σ	1.9 σ
Observed significance	3.4 σ	3.1 σ	3.2 σ
Cross section	4.9 ^{+1.4} _{-1.4} pb	4.4 ^{+1.6} _{-1.4} pb	4.8 ^{+1.6} _{-1.4} pb



$$DØ \quad \sigma(p\bar{p} \rightarrow tb + X, tqb + X) = 4.7 \pm 1.3 \text{ pb}$$

Сравнение измерений CDF и D0

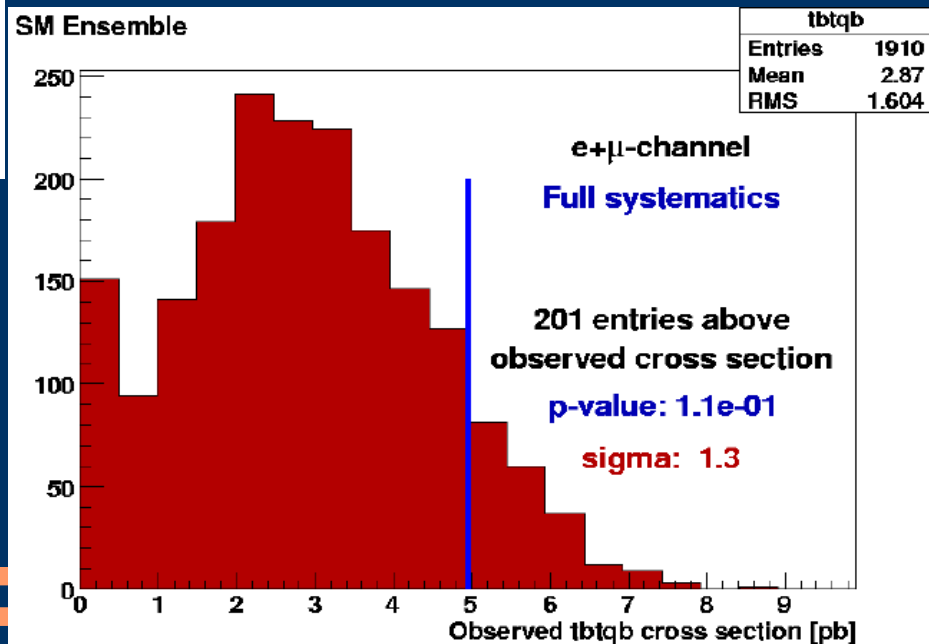
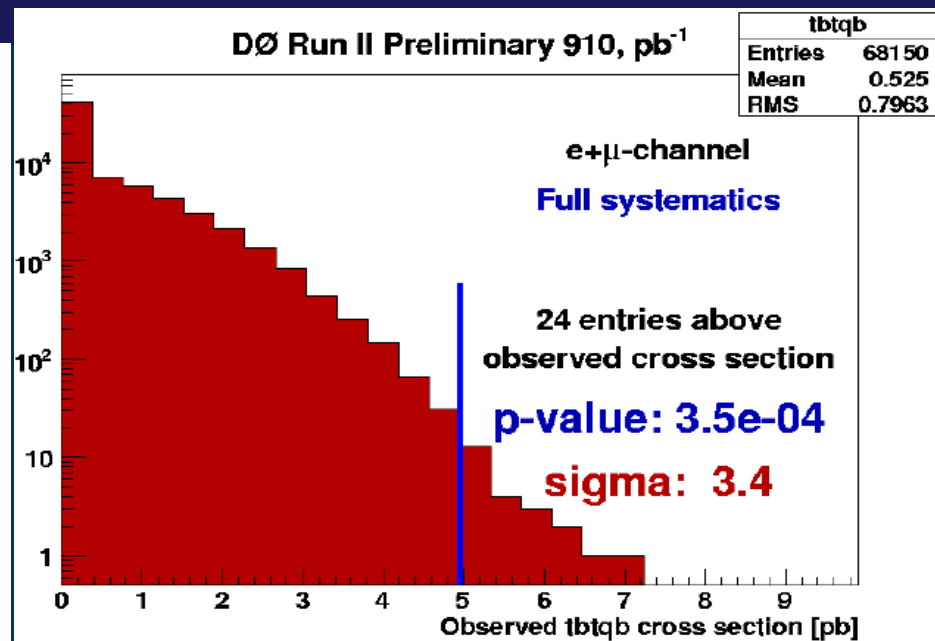
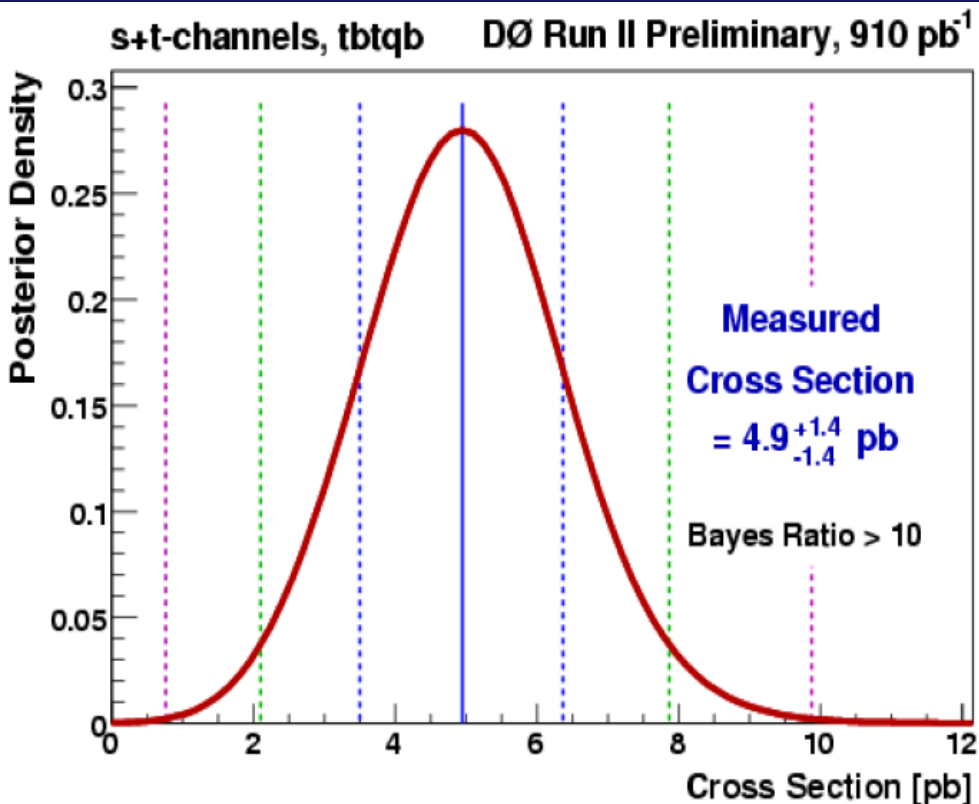
<i>tb+tb</i> Results	CDF preliminary 2.2 fb ⁻¹		
	LF	NN	ME
Expected significance	3.4 σ	4.4 σ	4.5 σ
Observed significance	2.0 σ	3.2 σ	3.4 σ
Cross section	1.8 ^{+0.9} _{-0.8} pb	2.0 ^{+0.9} _{-0.8} pb	2.2 ^{+0.8} _{-0.7} pb



<i>tb+tb</i> Combined Results		
	DØ PRD 0.9 fb ⁻¹	CDF prelim. 2.2 fb ⁻¹
Expected significance	2.3 σ	5.1 σ
Observed significance	3.6 σ	3.7 σ
Cross section	4.7 ± 1.3 pb	2.2 ± 0.7 pb

Signal Acceptances		
	CDF	DØ
<i>s</i> -channel <i>tb</i>	2.8%	3.2%
<i>t</i> -channel <i>tb</i>	1.8%	2.1%

Decision Trees - Observed



Fermilab Result of the Week, 19.06.08

<http://www.fnal.gov/pub/today/resultoftheweek/>

June 19, 2008

Upstaging the W boson

