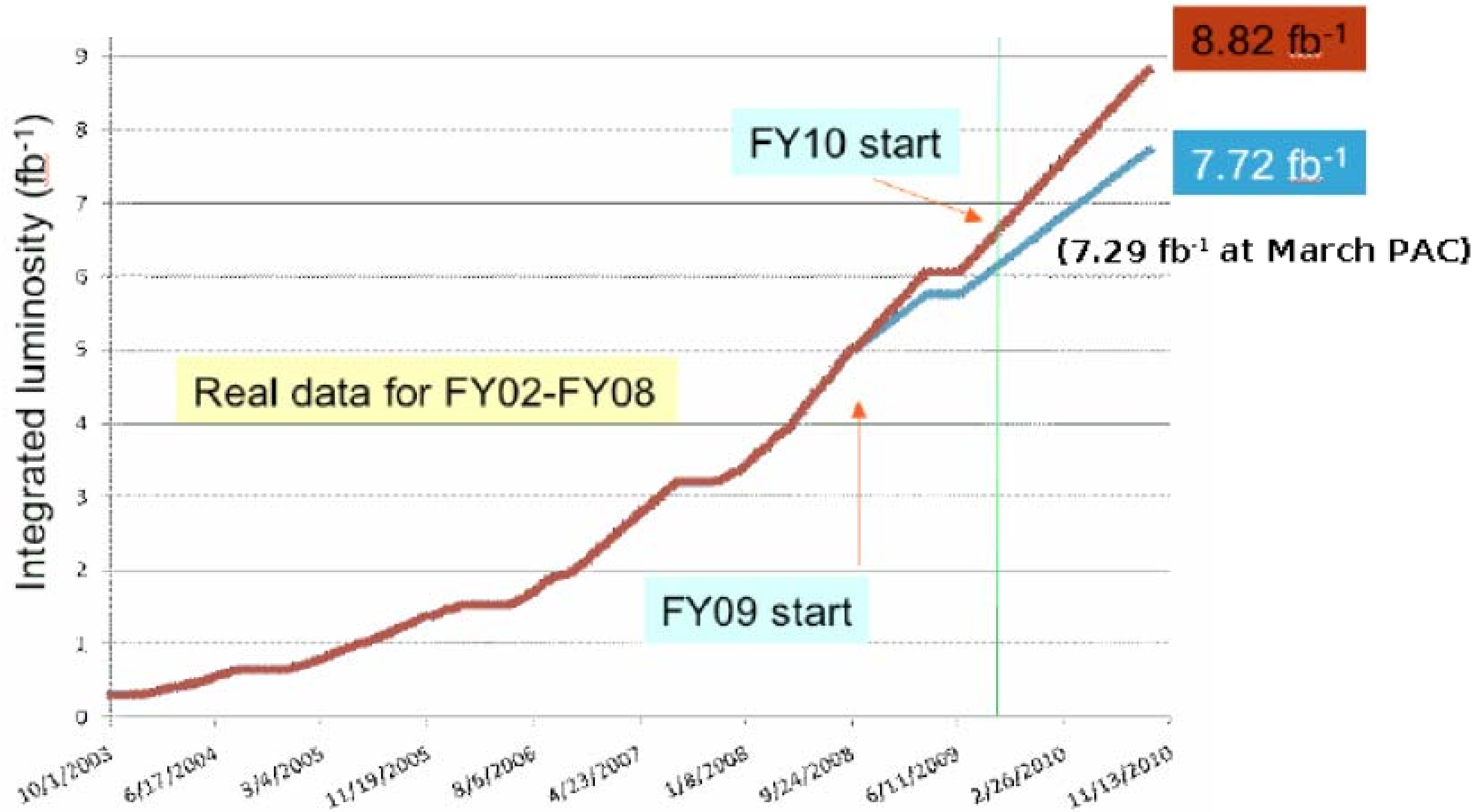
DZero experiment

Теватрон вышел на проектную светимость,
и в настоящее время за 1 месяц работы набирается
интегральная светимость больше чем во всём Run I.

К концу 2009 г. – 6-7 fb^{-1}, 2010 – 8-9 fb^{-1}, 2011 ?



Physics Goals

Precision tests of the Standard Model
- Weak bosons, top quark, QCD, B-physics

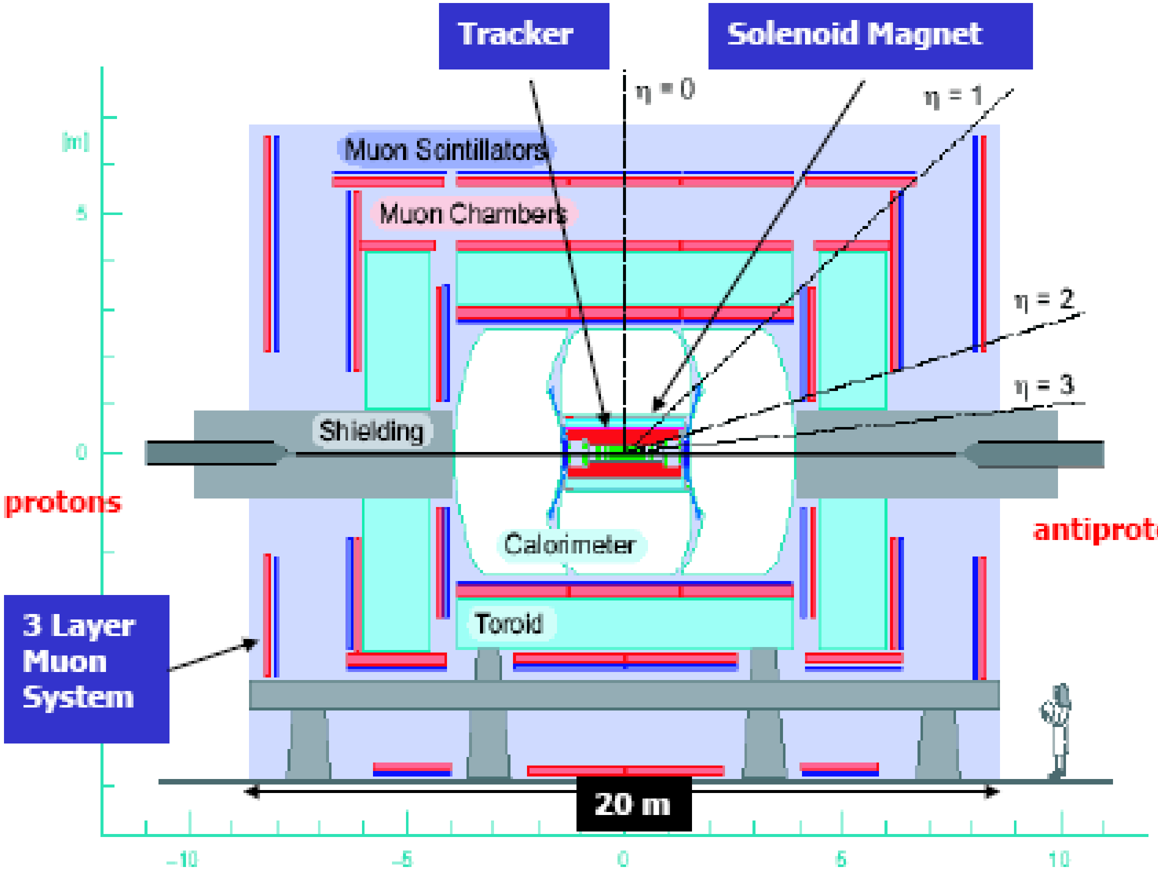
Search for particles and forces beyond those known
- Higgs, supersymmetry, extra dimensions….

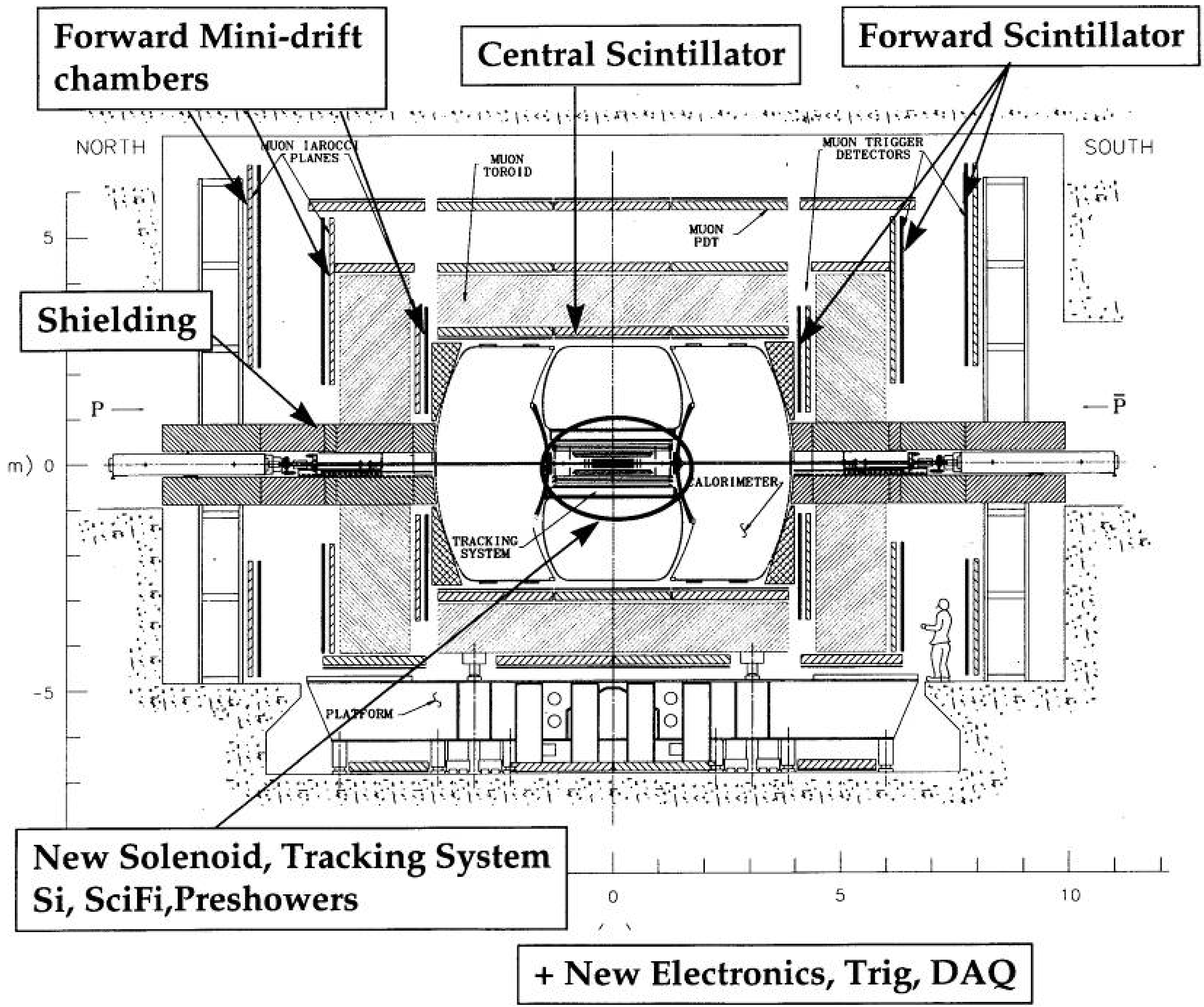
Driven by these goals, the detector emphasizes

Electron and muon identification

Jets and **missing transverse energy**

Flavor tagging through **displaced vertices** and **leptons**




Forward Mini-drift chambers
Central Scintillator
Forward Scintillator
NORTH
SOUTH
MUON IAROCCI PLANES
MUON TOROID
MUON TRIGGER DETECTORS
MUON PDT
Shielding
P
P̄
CALORIMETER
TRACKING SYSTEM
PLATFORM
5
0
-5
10
New Solenoid, Tracking System
Si, SciFi,Preshowers
+ New Electronics, Trig, DAQ

Physics Program

- Limit on the B_s to $\mu\mu$ branching ratio
- CP violation studies in B_s system
  - Mass difference Δm_s
  - Lifetime Γ and lifetime difference $\Delta\Gamma$
  - CP-violating phase ϕ_s
- High precision measurement of W boson mass
- High precision measurement of the top quark mass
- Studies of the top quark production and properties
- Precision measurements of the top quark production cross sections
- Search for SM Higgs boson
- Search for non-SM Higgs boson(s)
- Search for SUSY in many modes
- Search for high mass resonances (Z′, extra dimensions, etc.)
- Highest energy QCD jets studies
- Di-boson production and studies of anomalous couplings

PNPI

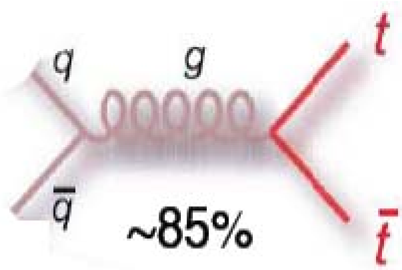
Readout electronics for 50 000 mini drift tubes
Software for the data acquisition by our electronics
Software for the electronics interface
Determination of the D0-Tevatron luminosity
Calibration of the D0 Calorimeter
Calibration of the D0 ICD
Repairing electronic blocks
Reprogramming of the electronics
Estimation of the D0 SM background for top quark and Higgs boson physics

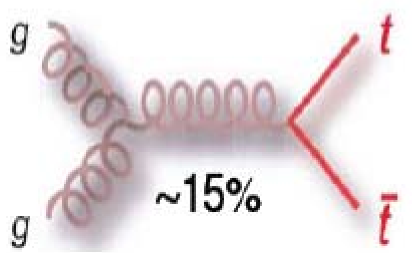
Publications

~ 20 in 2007
~ 40 in 2008
~ 40 in 2009
~ 140 in total during Run II
Our contribution - 1 paper

Top quark Pair Production & Decay

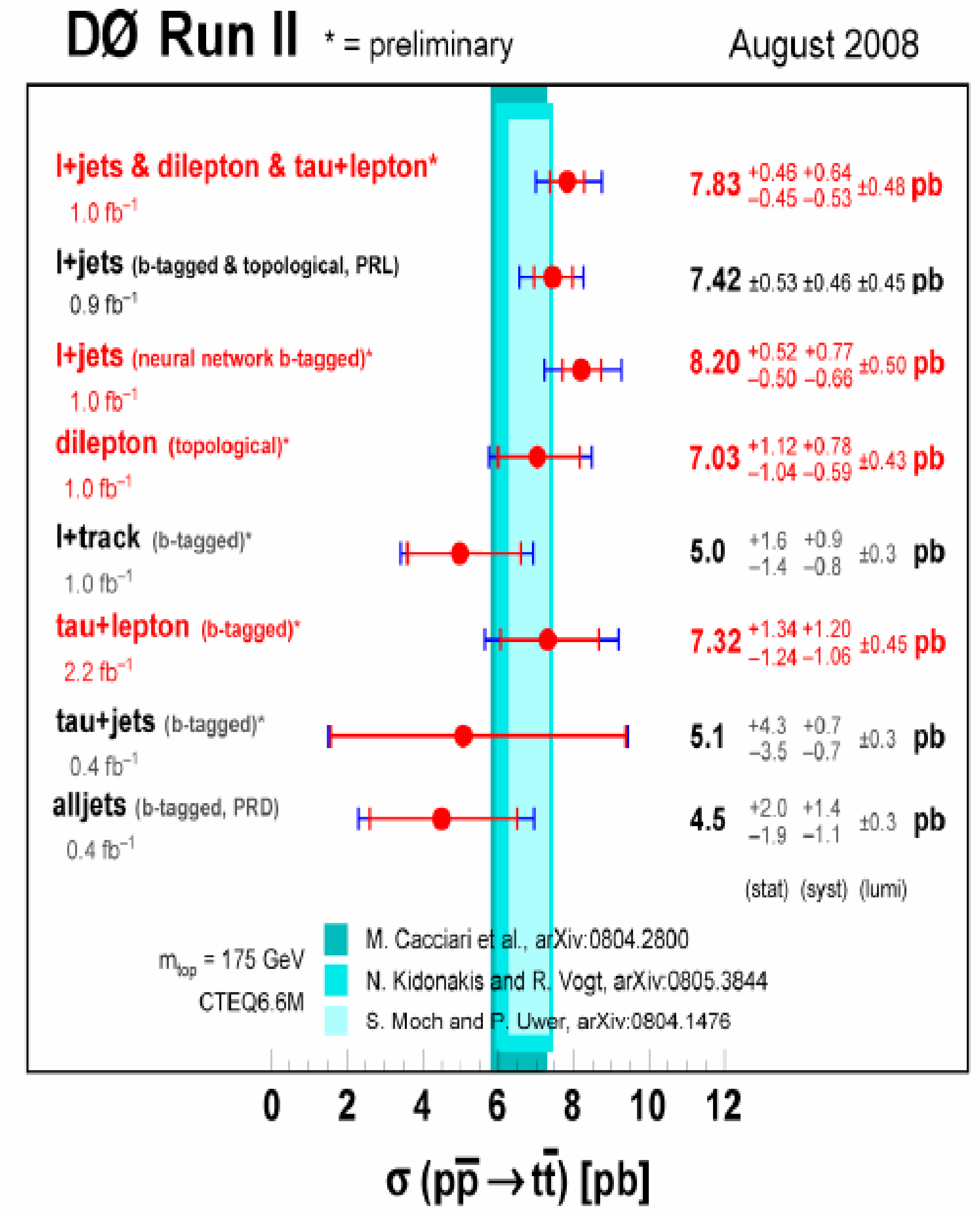
Top quarks are mainly produced in pairs, via the strong interaction





$m_t > m_W + m_b \Rightarrow$ dominant 2-body decay $t \rightarrow Wb$

$\Gamma_t^{SM} \approx 1.4$ GeV at $m_t = 175$ GeV



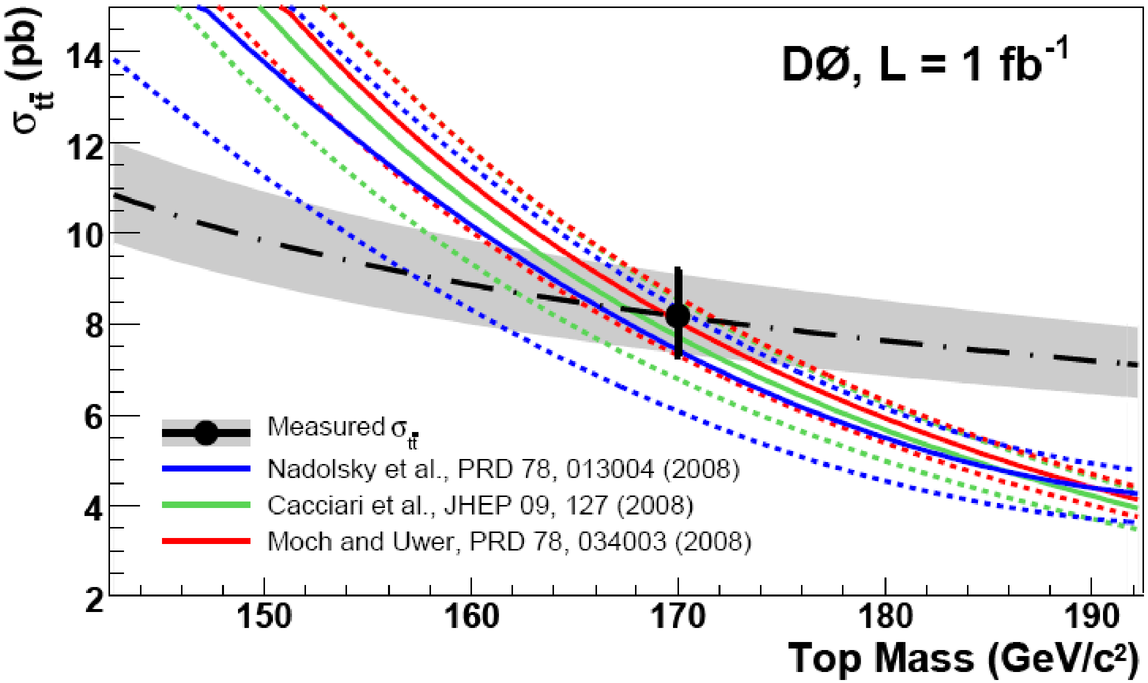
D0 2009

ℓ + jets, $\ell + \ell$, $\tau + \ell$ channels

σ = 8.18 + 0.98 – 0.87 pb

Top quark cross section production: σ = 6.8 +/- 0.6 pb

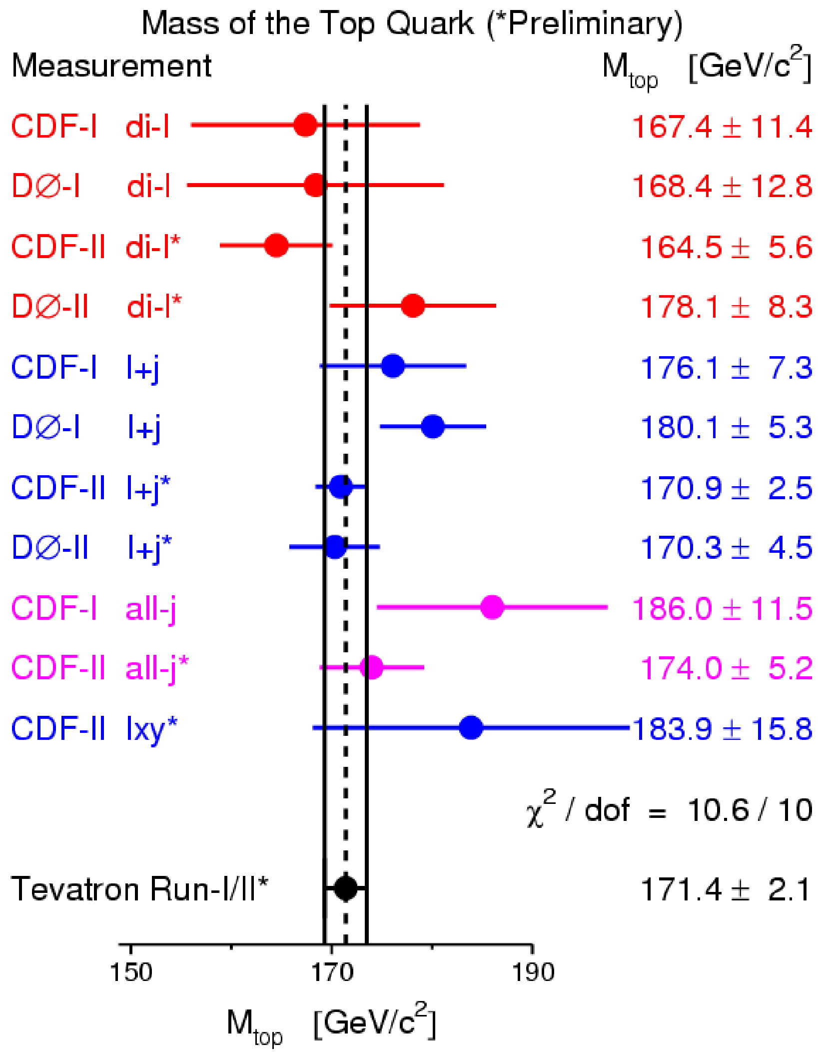
Assuming that production is governed by the SM, Top quark mass can be extracted comparing the measured cross section with theory



Theoretical prediction	m_t (GeV/c^2)
NLO [1]	$165.5^{+6.1}_{-5.9}$
NLO+NLL [2]	$167.5^{+5.8}_{-5.6}$
approximate NNLO [3]	$169.1^{+5.9}_{-5.2}$
approximate NNLO [4]	$168.2^{+5.9}_{-5.4}$

The top-quark mass from direct measurements is

171.2 ± 2.1 GeV/c²



$m_t \sim 170$ GeV vs $m_b \sim 5$ GeV

m_t ~ gold atom

It is the only bare quark.
It decays so quickly that the strong force does not confine it.

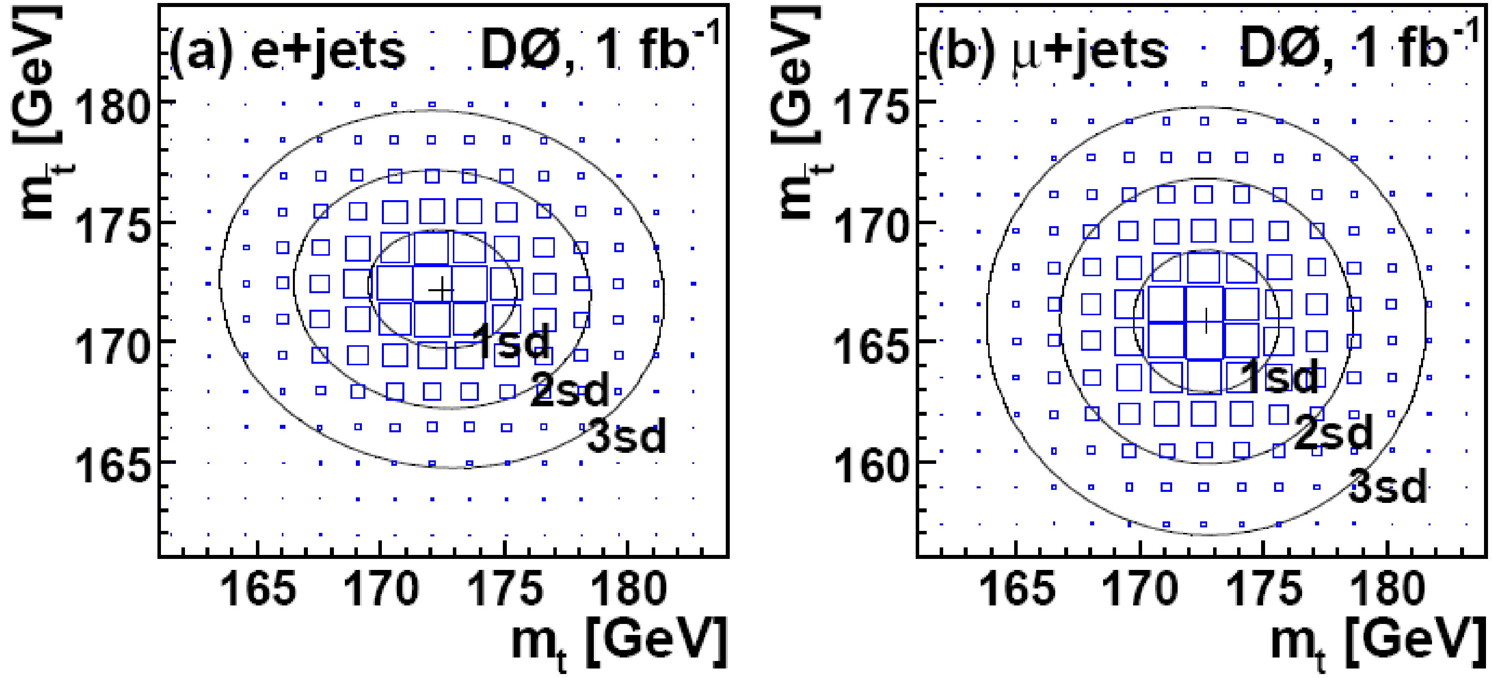
M_t & $M_W \rightarrow M_H$

M(top)=172.4±0.7±1.0 GeV

D0 2009

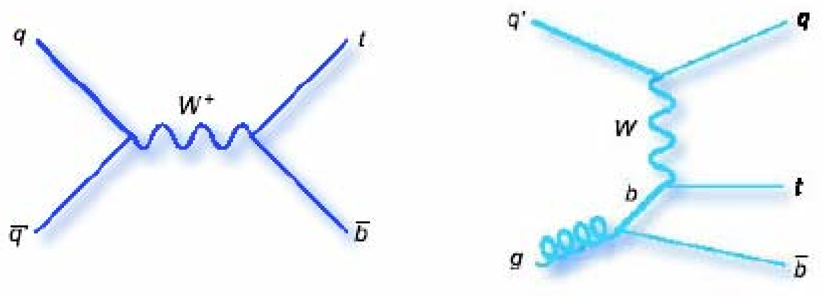
Direct measurement of the mass difference between top and antitop quarks

CPT: the mass of a particle = the mass of its antiparticle



$\Delta m = 3.8 \pm 3.7$ GeV/c^2

Single Top Production



***s*-channel**	***t*-channel**
$\sigma = 0.88 \pm 0.11$ pb	$\sigma = 1.98 \pm 0.25$ pb

Single top quark production for the first time was observed at D0 (in 2008)

D0 2009: $\sigma = \sigma_s + \sigma_t = 3.94 \pm 0.88$ pb Significance: 5σ

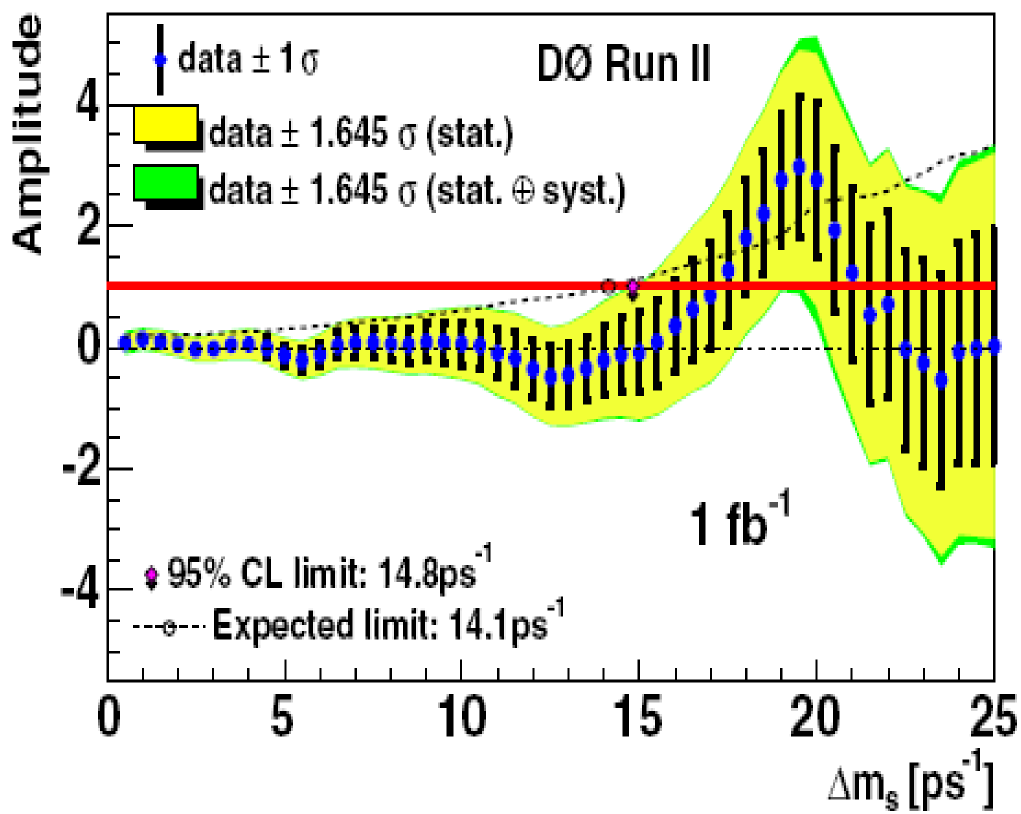
D0 new 2009 result: $\sigma_s = 1.05 \pm 0.81$ pb; $\sigma_t = 3.14 + 0.94 - 0.81$ pb

B_s^0 oscillations

$B_s^0 - (bs)$ $\tau(B_s) \approx 1.5$ ps

$B_s^0 \rightarrow \mu^+ D_s^- X$,
$D_s^- \rightarrow \varphi\pi^-$, $\varphi \rightarrow K^+ K^-$

$\Delta m_s \sim |V_{tb}V_{ts}|^2$, $\Delta m_d \sim |V_{tb}V_{td}|^2$

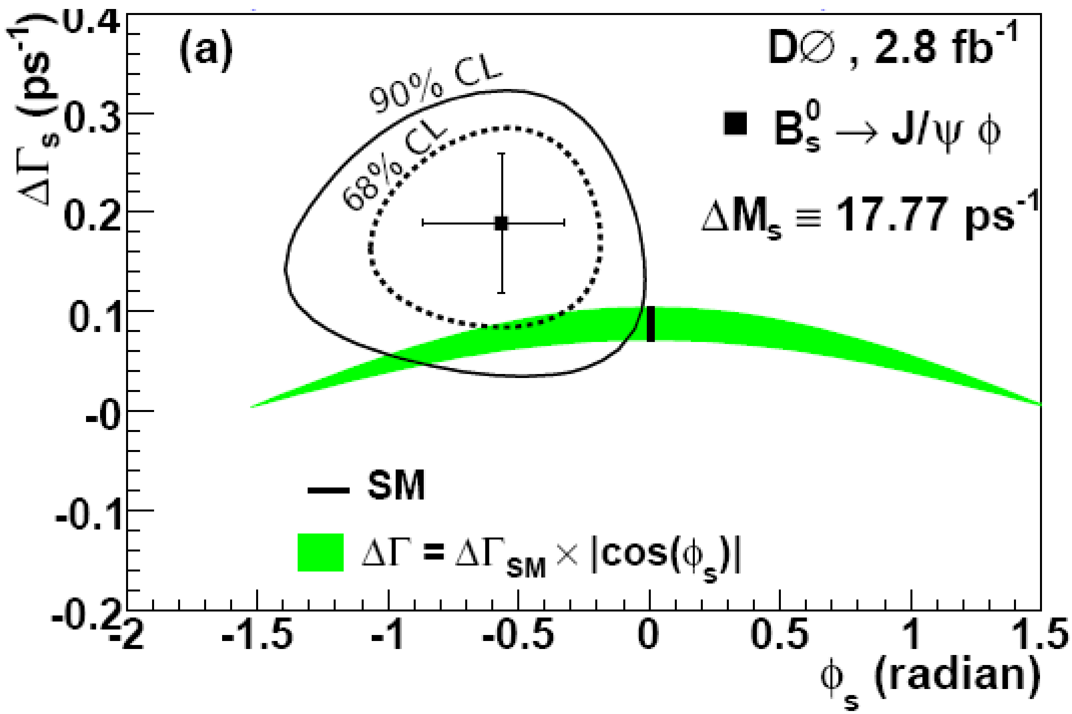


SM: $\Delta m_s = 21 +5 -4\ ps^{-1}$
D0: $17 \leq \Delta m_s \leq 21\ ps^{-1}$
CDF: $\Delta m_s = 17.3 +0.4 - 0.2\ ps^{-1}$

$|V_{td}|/|V_{ts}|=0.21 +/- 0.01$

This result rules out some versions of the SUSY theory which predict faster rates of oscillations

B_s^0 mixing parameters

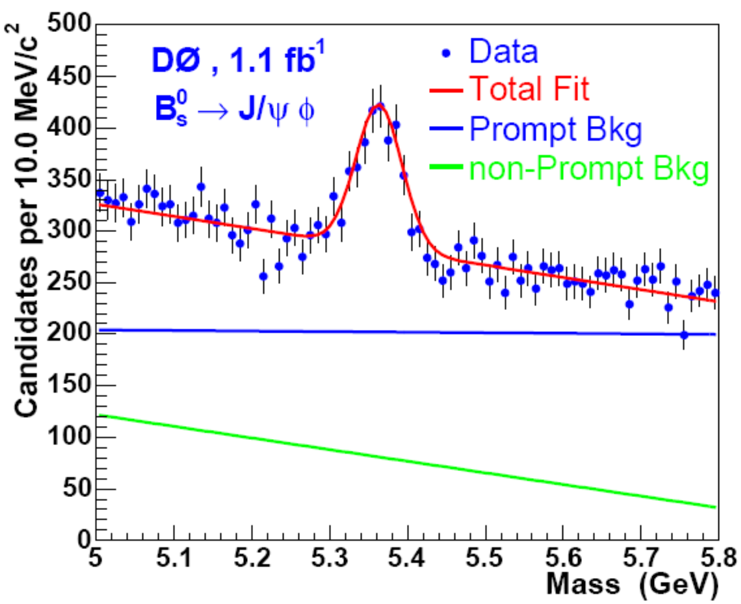


$B_s^0 \to J/\psi\ \varphi$

$J/\psi \to \mu^+\mu^-$

$\Phi \to K^+K^-$

Time-dependent angular distributions of μ^+, μ^-, K^+, K^-



SM → $\Phi_s = -0.04 \pm 0.01$

$\overline{\tau}(B_s^0) = 1.52 \pm 0.05$ (stat) ± 0.01 (syst) ps

$\Delta\Gamma_s = 0.19 \pm 0.07$ (stat) ${}^{+0.02}_{-0.01}$ (syst) ps^{-1}

CP violating phase:

$\phi_s = -0.57^{+0.24}_{-0.30}$ (stat) ${}^{+0.07}_{-0.02}$ (syst) rad

- Probability of SM 6.6% $\Rightarrow\ \sim 1.8\sigma$

First direct observation of the strange b baryon Ξ_b^-

The **STANDARD MODEL**

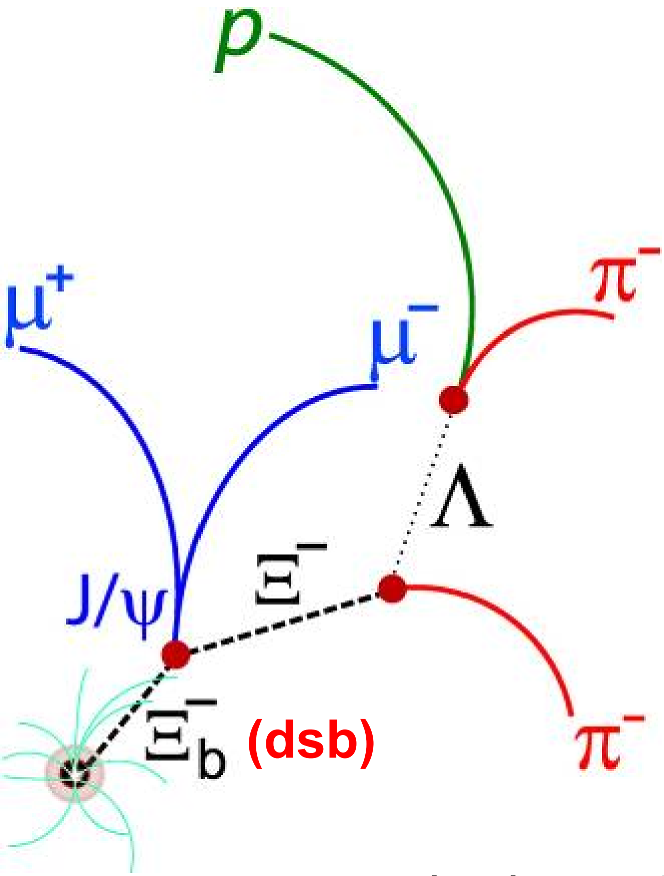
d u	M_d=6 MeV, M_u=3 MeV,
s c	M_s=100 MeV, M_c=1.2 GeV,
b t	M_b=4.4 GeV, M_t=173 GeV

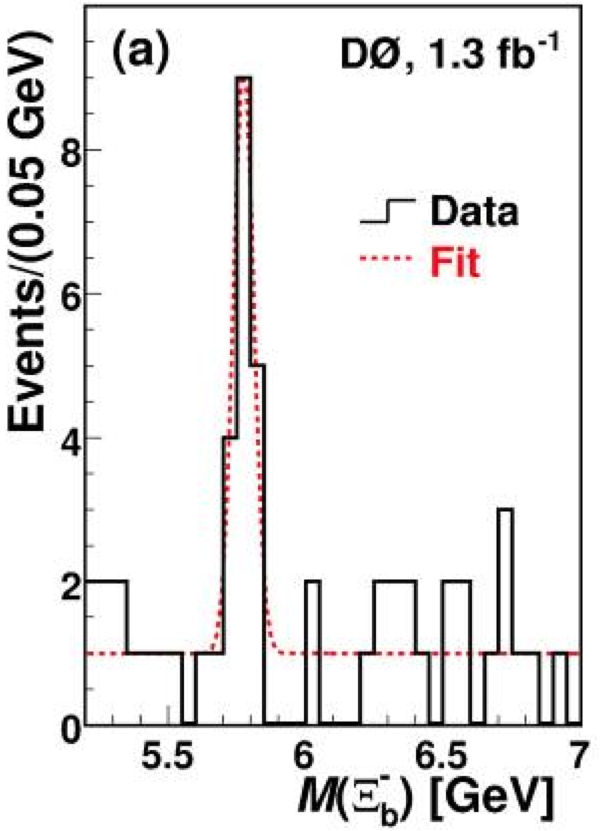
$\Xi_b^- \rightarrow J/\Psi + \Xi^-$

$J/\Psi \rightarrow \mu^+ \mu^-$

$\Xi^- \rightarrow \Lambda \pi^-$

$\Lambda \rightarrow p \pi^-$



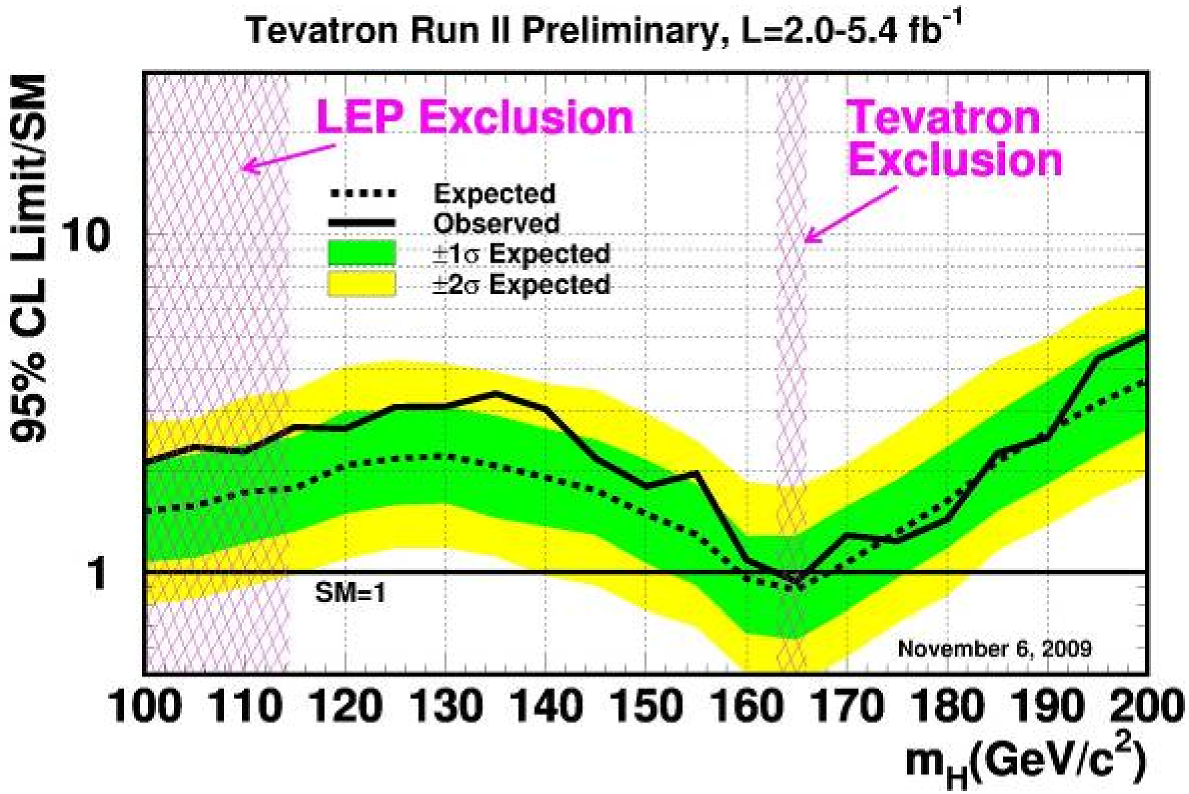


$M(\Xi_b^-)$=5.774 +/- 0.19 GeV

Higgs search at DZero

Previous studies – M_{Higgs} > 114 GeV   Indirect evidence – M_{Higgs} < 180 GeV

Combined D0 and CDF result (2009)



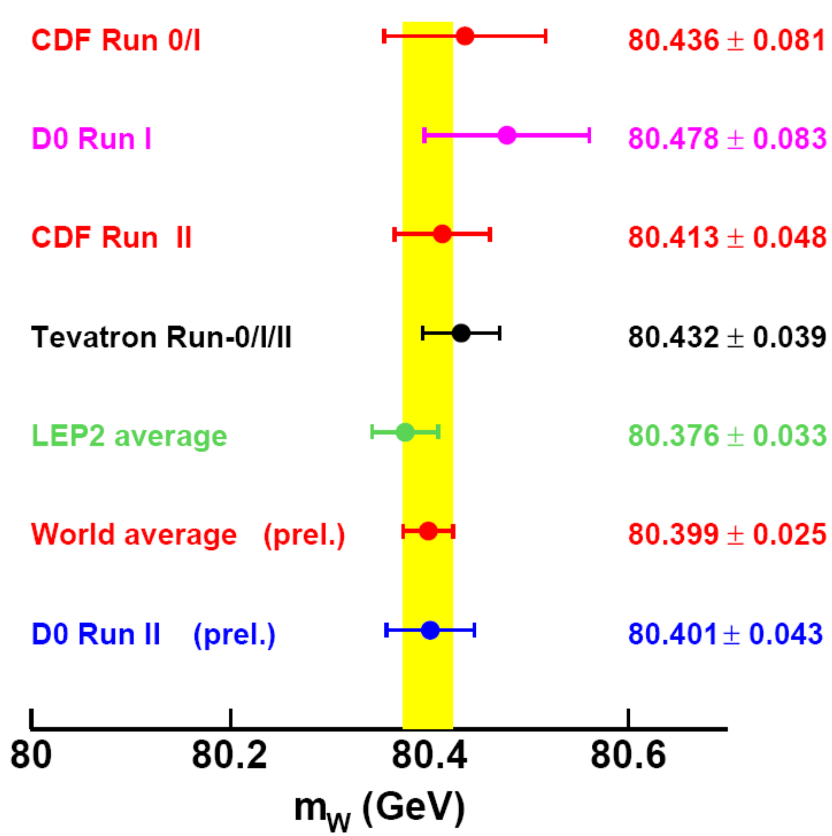
D0+CDF exclude a Higgs boson with a mass of ~163 - 166 GeV at the 95% confidential level.

W Boson Mass

Constraint on SM Higgs mass is now dominated by the W mass uncertainty:

Δm_t = 1.2 GeV ➔ ΔM_H = +9/-8 GeV

ΔM_W = 25 MeV ➔ ΔM_H = +17/-13 GeV



D0 2009

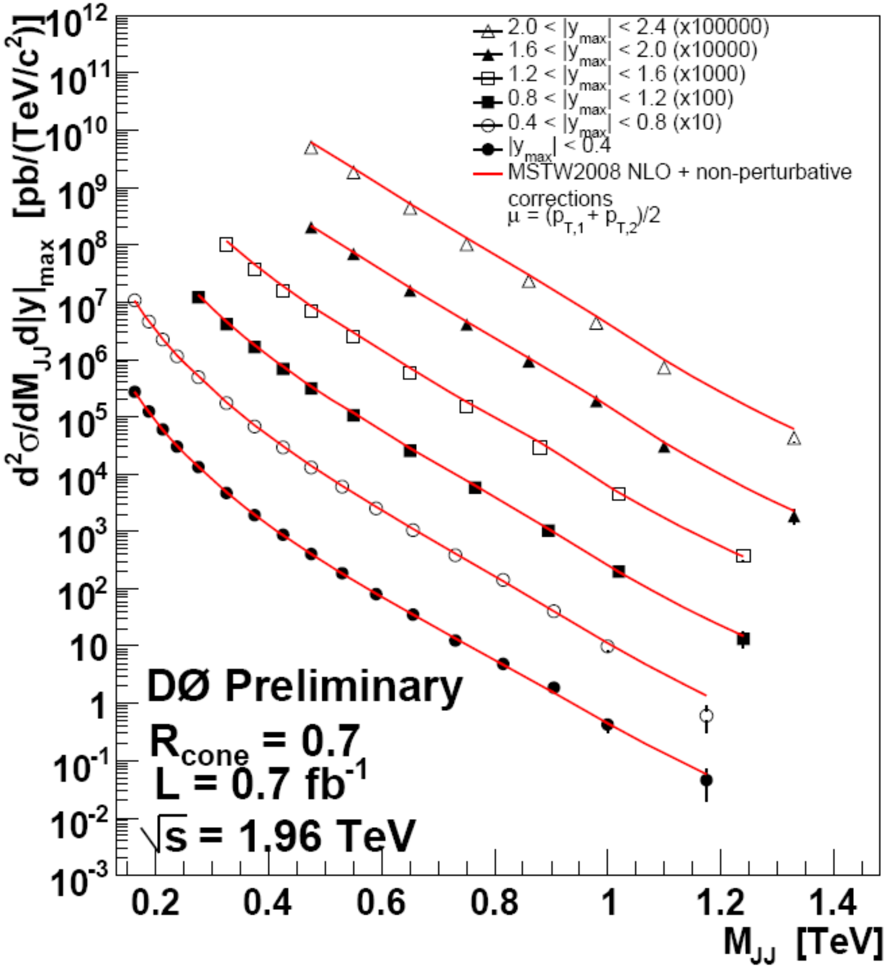
m_W = 80.401 ± 0.043 GeV/c^2

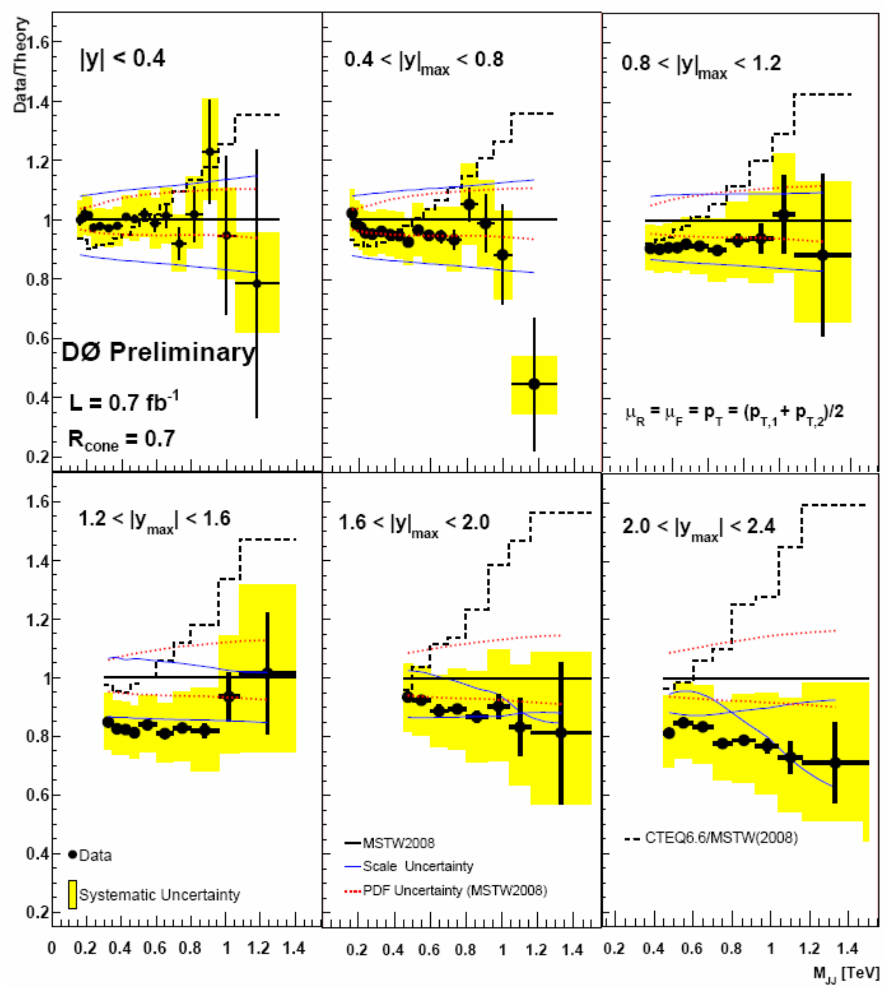
W boson mass width:

Γ_W = 2.028 ± 0.072 GeV/c^2

These are the most precise measurements from one experiment

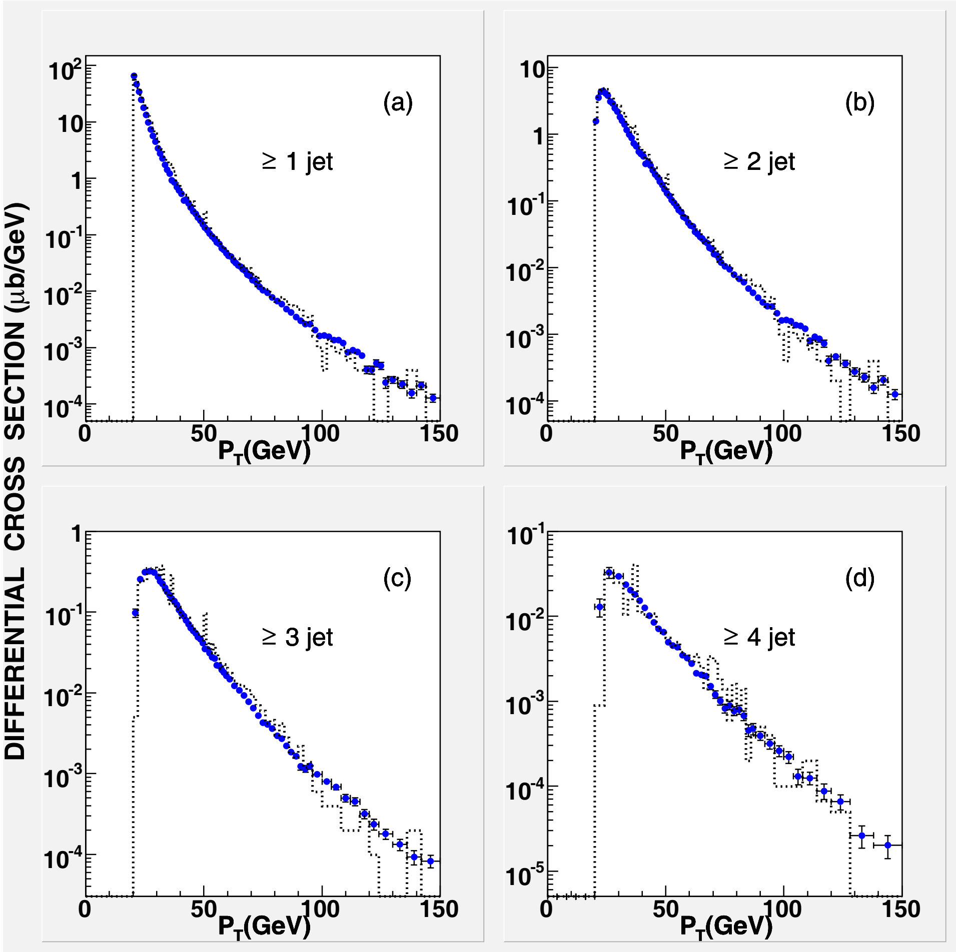
Dijet mass spectrum





Data over theory ratio

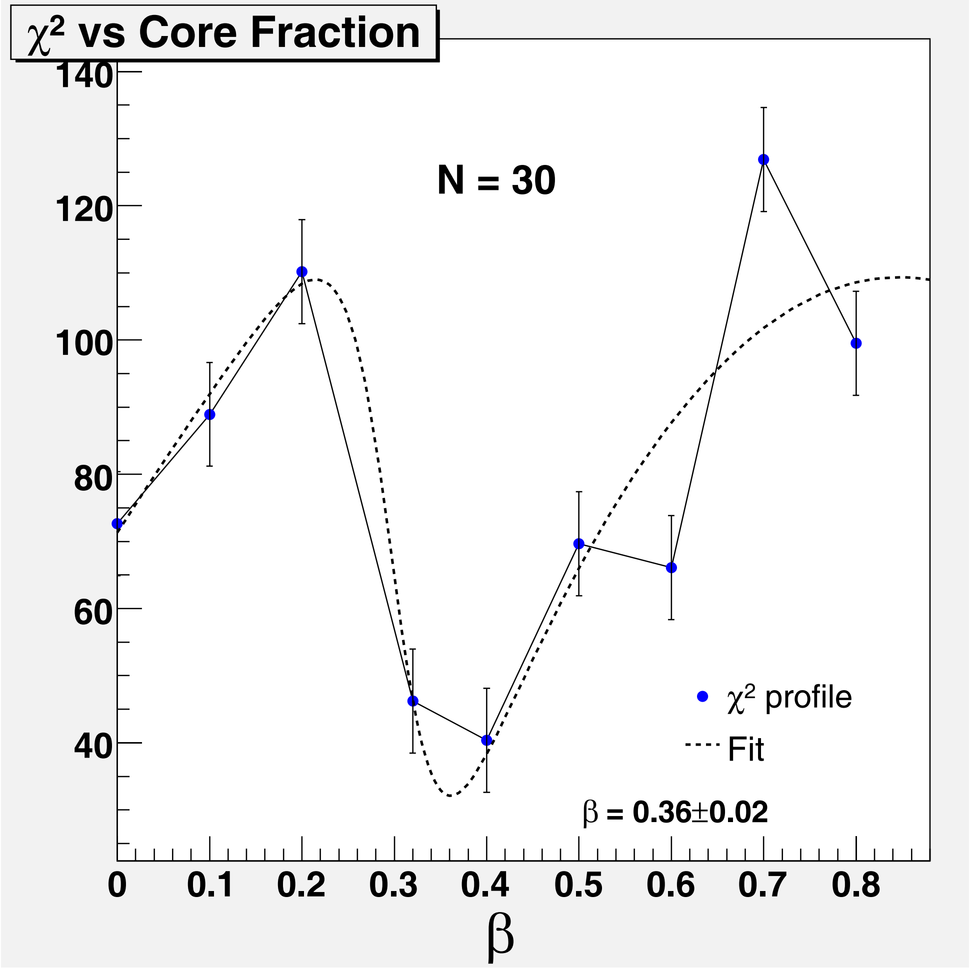
D0 2009



Г. Обрант

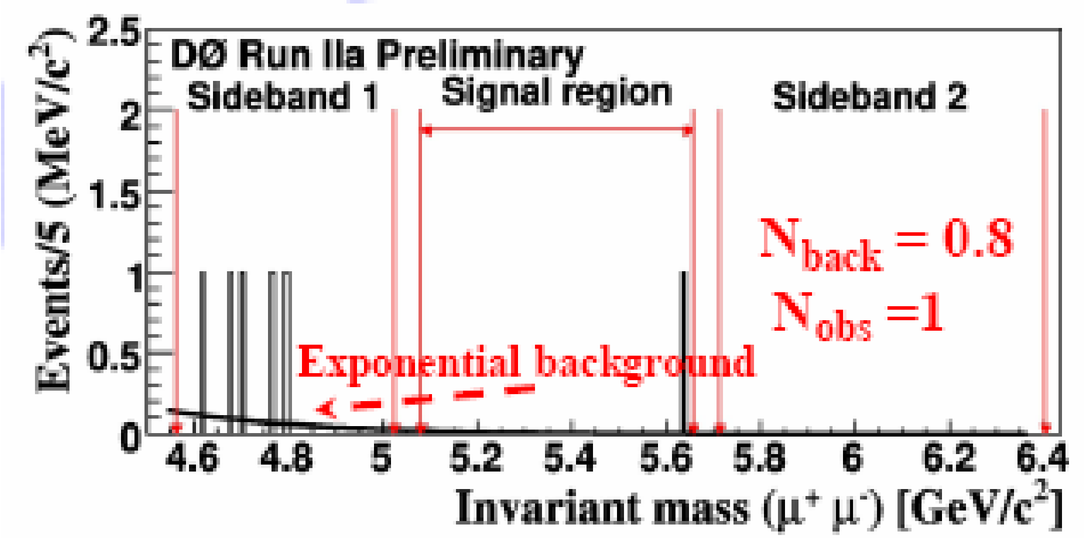
Данные свидетельствуют
о большом (~50%) вкладе
в сечение множественных
партонных взаимодействий

Распределения по поперечному импульсу лидирующей струи для одно- , дважды- , трижды- и четырежды инклюзивным событиям: (a), (b), (c) и (d), соответственно. Гистограммы показывают результаты моделирования PYTHIA.



Профиль χ^2 как функция доли кора β в плотности партонов.
Видим, что χ^2 имеет минимум при $\beta = 0.36$.

$B_s \to 2\mu$



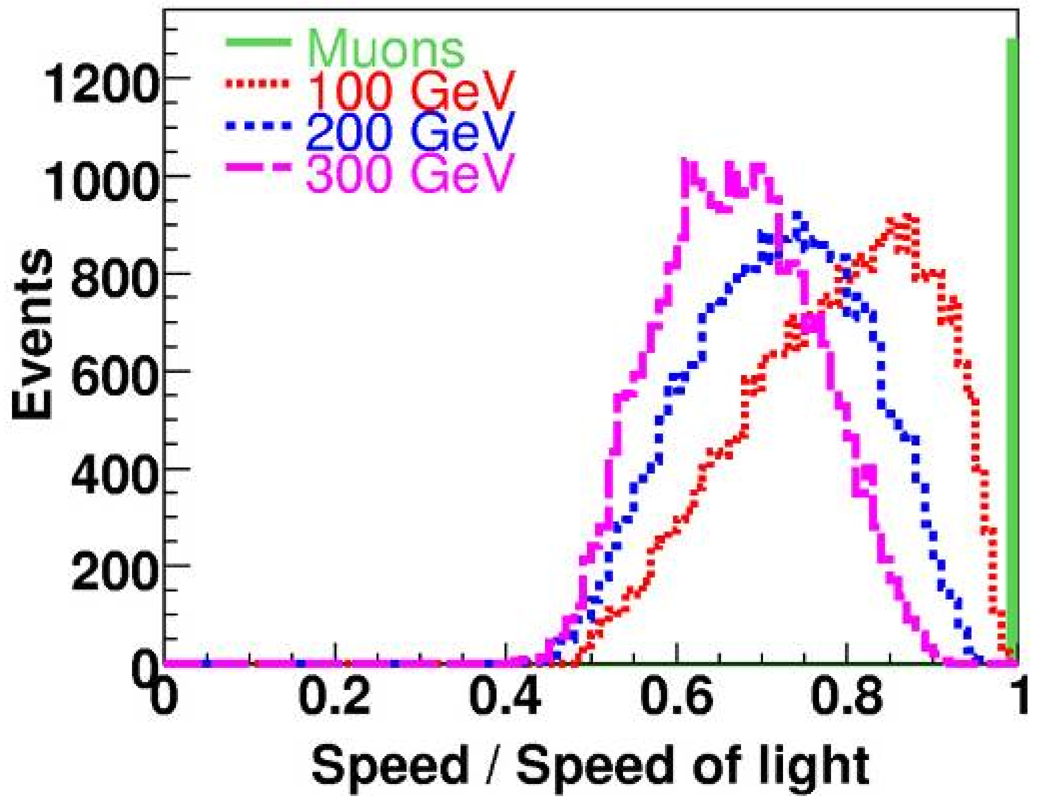
Димюонный спектр в области инвариантной массы $\mathbf{B_s \to 2\mu}$

$Br(B_s \to 2\mu) = 5.1 \to 0.9 \cdot 10^{-7}$ 95% CL $\to 10^{-8}$?

(SM - $3 \cdot 10^{-9}$)

Search for charged massive "stable" particles

(tau sleptons, gaugino-like charginos, higgsino-like charginos, candidates for dark matter)



Mass (GeV)	Signal Acceptance ($x10^{-3}$)	Exp. Signal Events	Predicted Background	Obs. Events
		(a) stau		
60	$64 \pm 1 \pm 5$	4.7	$30.9 \pm 2.2 \pm 1.9$	38
80	$38 \pm 1 \pm 5$	1.1	$2.6 \pm 0.6 \pm 0.4$	1
100	$56 \pm 1 \pm 4$	0.7	$1.6 \pm 0.5 \pm 0.3$	1
150	$123 \pm 2 \pm 13$	0.3	$1.7 \pm 0.5 \pm 0.2$	1
200	$139 \pm 2 \pm 11$	0.1	$1.7 \pm 0.5 \pm 0.5$	1
250	$133 \pm 2 \pm 13$	0.01	$1.7 \pm 0.5 \pm 0.3$	1
300	$117 \pm 2 \pm 13$	0.004	$1.9 \pm 0.5 \pm 0.2$	2
		(b) gaugino-like charginos		
60	$32 \pm 1 \pm 3$	445	$23.6 \pm 1.9 \pm 1.4$	24
80	$24 \pm 1 \pm 3$	85	$1.9 \pm 0.5 \pm 0.3$	1
100	$46 \pm 1 \pm 4$	65	$1.6 \pm 0.5 \pm 0.3$	1
150	$85 \pm 1 \pm 9$	20	$1.2 \pm 0.4 \pm 0.1$	1
200	$89 \pm 1 \pm 7$	5	$1.9 \pm 0.5 \pm 0.0$	1
250	$74 \pm 1 \pm 7$	1	$1.7 \pm 0.5 \pm 0.3$	1
300	$59 \pm 1 \pm 7$	0.2	$1.7 \pm 0.5 \pm 0.1$	2
		(c) higgsino-like charginos		
60	$29 \pm 1 \pm 2$	94	$17.9 \pm 1.7 \pm 1.1$	21
80	$24 \pm 1 \pm 3$	23	$1.6 \pm 0.5 \pm 0.3$	1
100	$49 \pm 1 \pm 4$	20	$1.6 \pm 0.5 \pm 0.3$	1
150	$89 \pm 1 \pm 9$	7	$1.4 \pm 0.5 \pm 0.1$	1
200	$96 \pm 1 \pm 8$	2	$1.9 \pm 0.5 \pm 0.0$	1
250	$81 \pm 1 \pm 8$	0.5	$1.7 \pm 0.5 \pm 0.3$	1
300	$64 \pm 1 \pm 7$	0.1	$1.7 \pm 0.5 \pm 0.1$	1

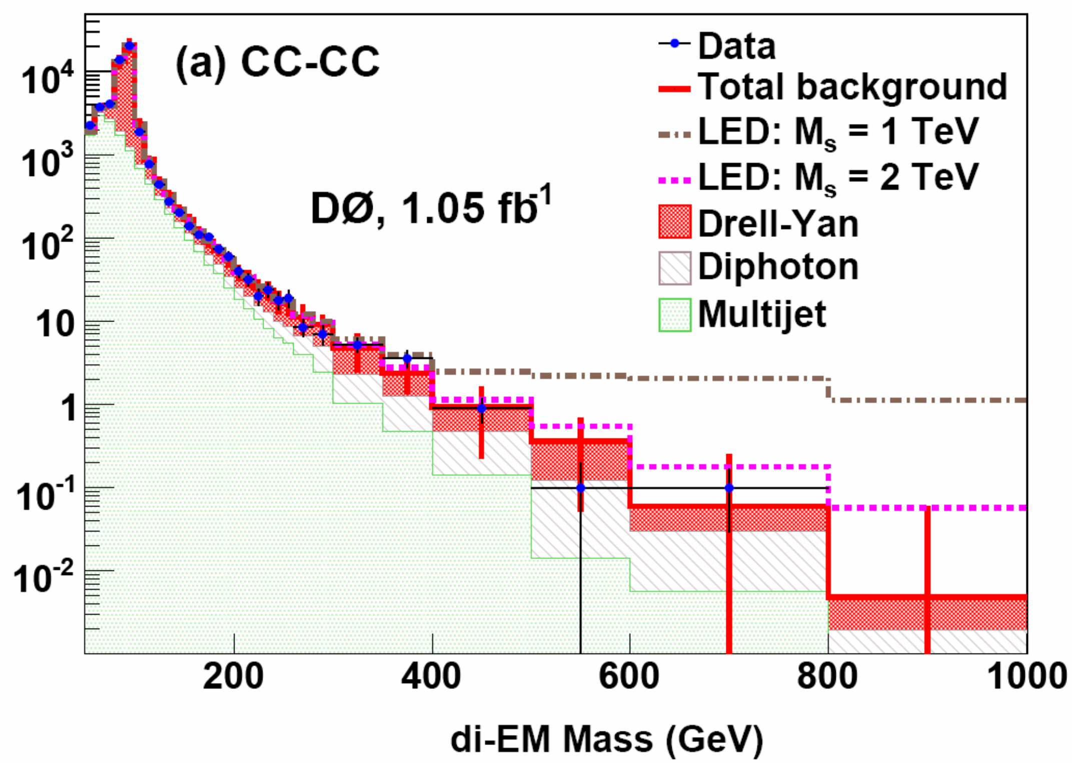
No evidence for such particles. $\sigma < 0.3 – 0.04$ pb for stau masses 60 – 300 GeV

Search for large extra dimensions in the dielectron and diphoton channels

$pp \rightarrow e + e + X$ $pp \rightarrow \gamma + \gamma + X$ $G_{KK} \rightarrow e + e$ $G_{KK} \rightarrow \gamma + \gamma$

G_{KK} – Kaluza Klein graviton

LED amplitudes will result in enhancement of the cross sections for production of ee and **γγ** pairs above the SM values, especially at high energies.

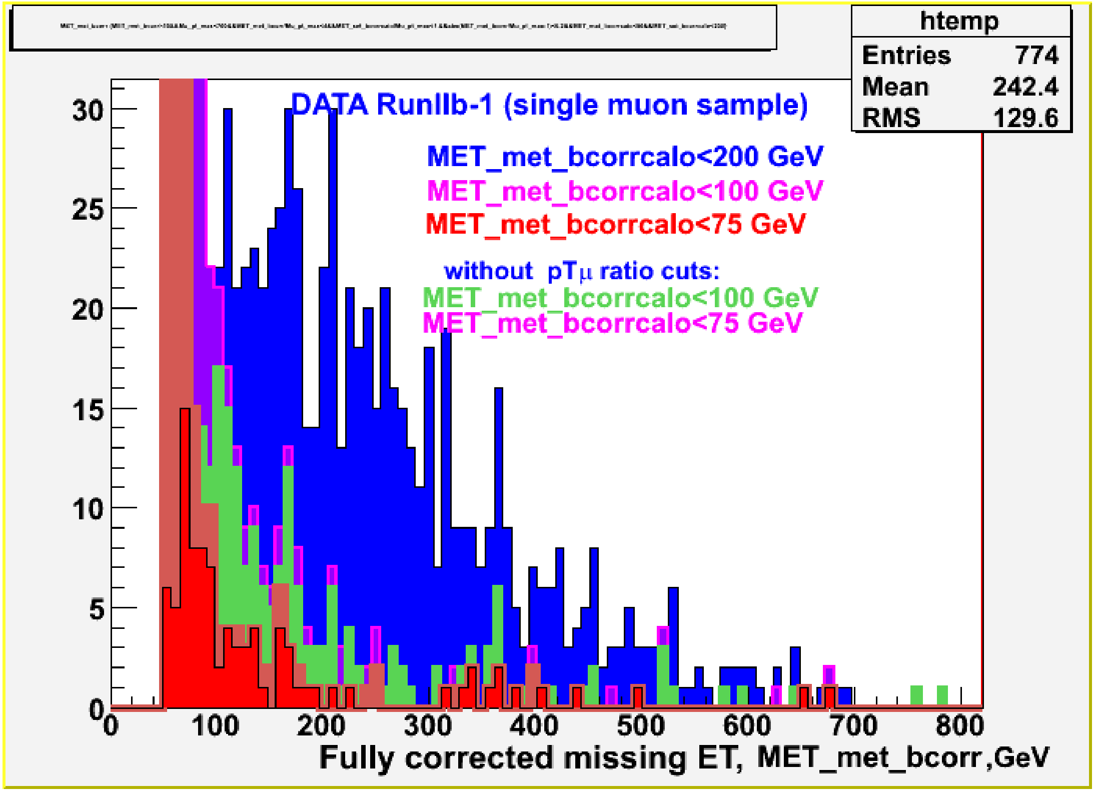


Lower 95% CL limits are set on the effective Plank scale between 2.1 and 1.3 TeV for 2 to 7 extra dimensions

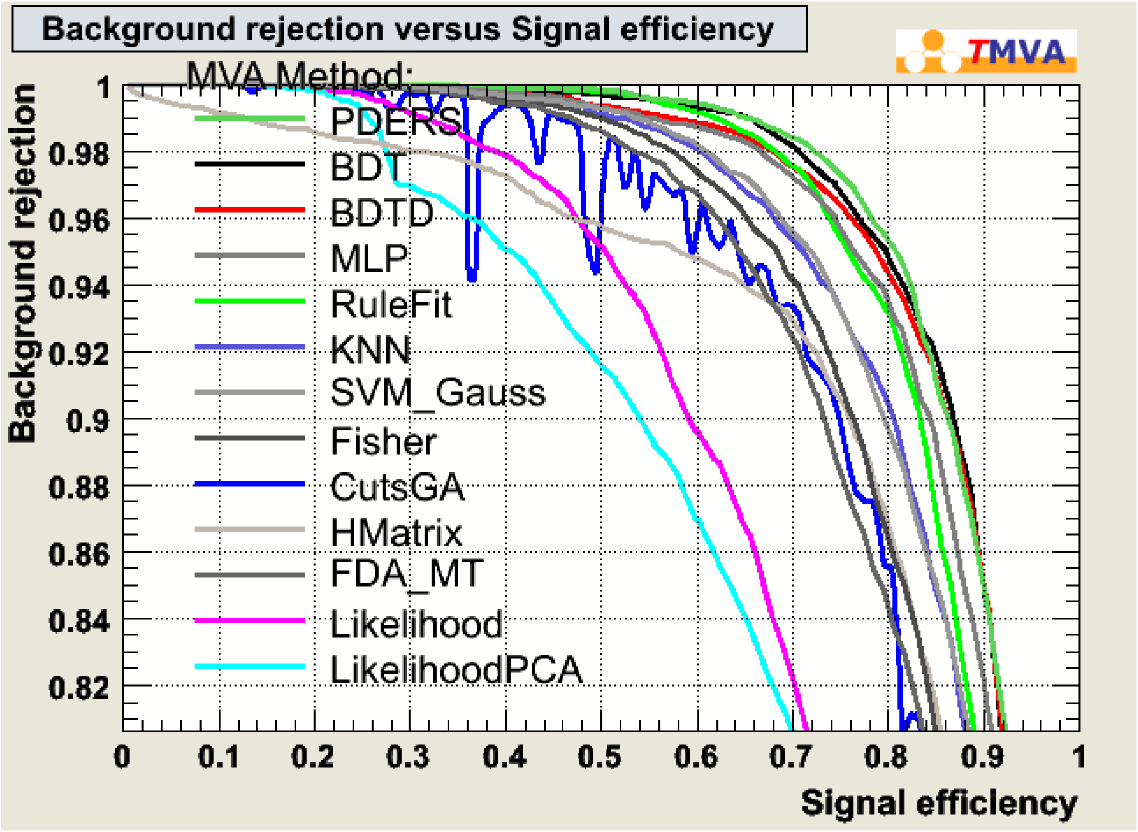
Поиск квантовой гравитации (Ю. Щеглов)

pp → W(Z) + G_{KK} W → μ + ν G_{KK} – Kaluza-Klein graviton

Отбор: малая суммарная энергия в калориметре, большой поперечный импульс μ – мезона, большая недостающая поперечная энергия.
pp → W(Z) + G_{KK} modernized generator has been included to Pythia 8.3



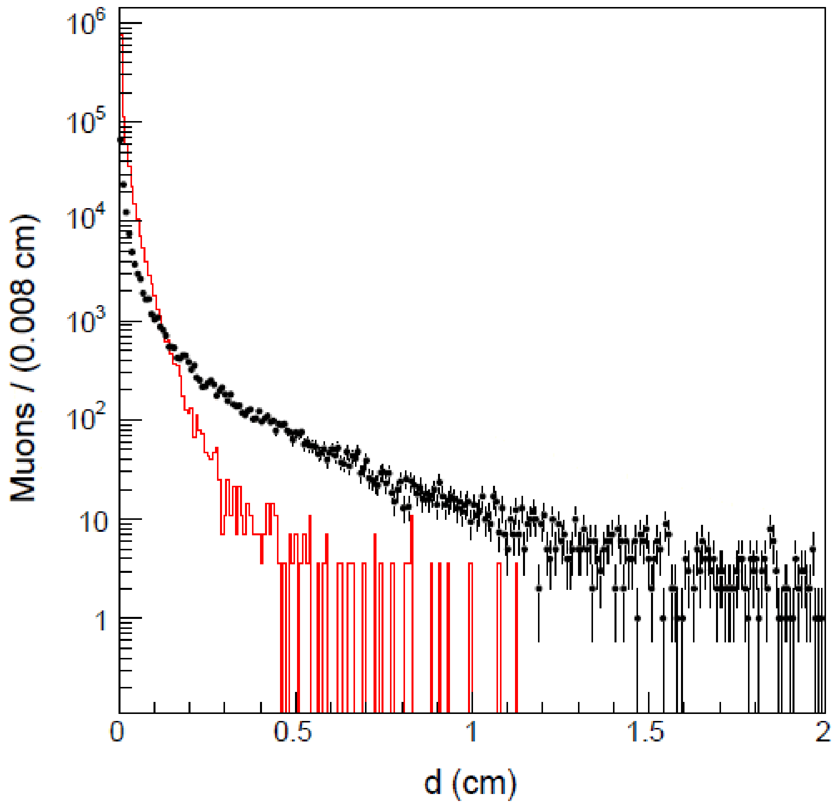
Экспериментальное распределение по недостающей поперечной энергии (MET) в канале μ+MET после предварительного отбора.



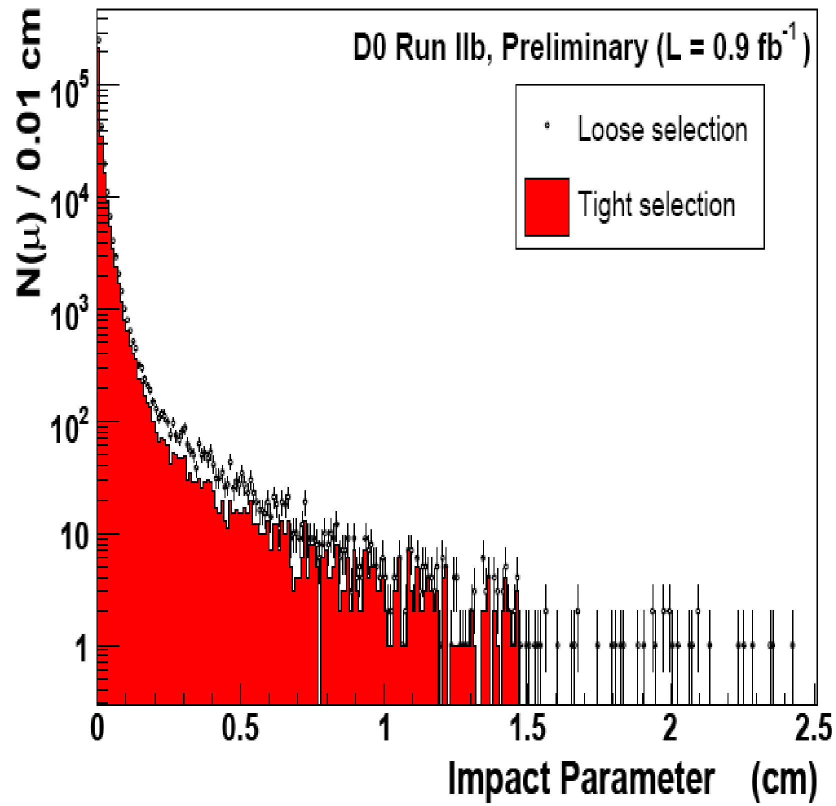
Экспериментально полученная зависимость эффективности подавления фона для процесса $W(\mu\nu)+G_{kk}$ от эффективности регистрации сигнальных событий.

CDF

D0



Production of ghost muons



D0: The fractional excess of muons produced outside of the beam pipe is (0.40 +/- 0.26 +/- 0.53)%, significantly smaller than the ~12% observed at CDF

- Завершение набора данных в Run II : 2010 г. (2011г. ?)

- Завершение анализа данных по исследованию распределений многоструйных событий

- Завершение анализа данных по поиску LED (?)

- Завершение анализа данных по двухструйным событиям, используемых для изучения корреляций по быстроте с целью поиска асимптотических КХД-эффектов (эффектов БФКЛ) (?)