DPF 2009
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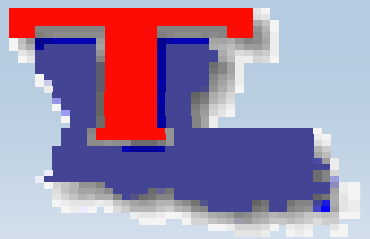
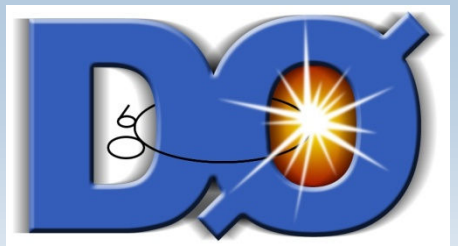
Wayne State University, Detroit, MI

Top Production Measurements with the D0 Detector

Mike Arov (Louisiana Tech University)
for D0 Collaboration



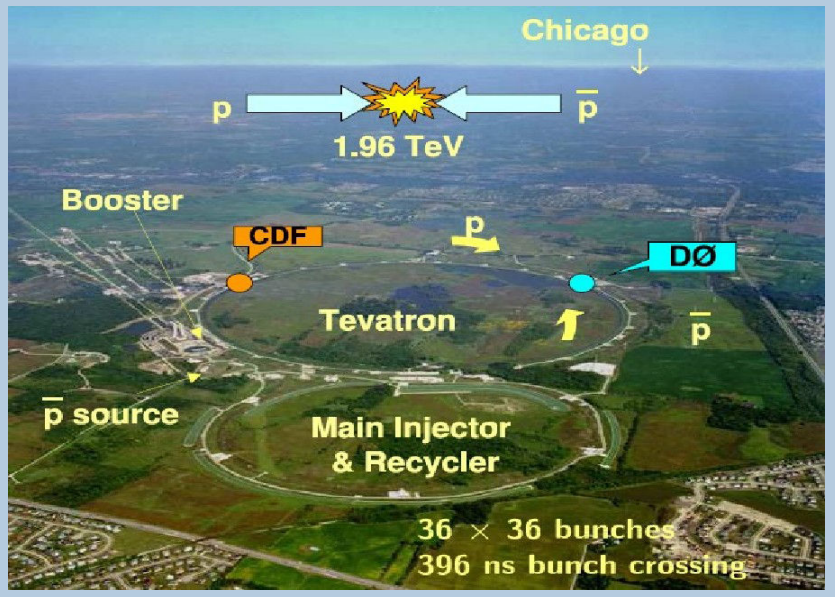


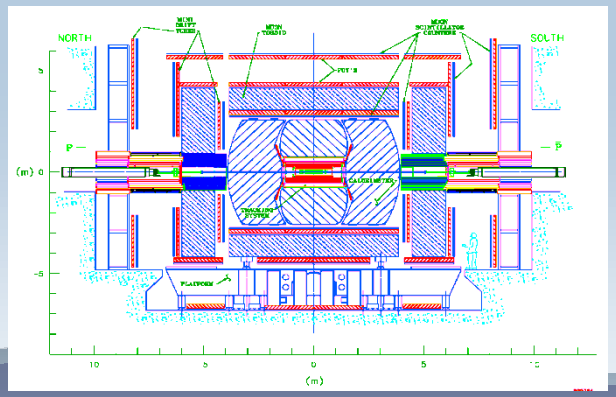
Outline

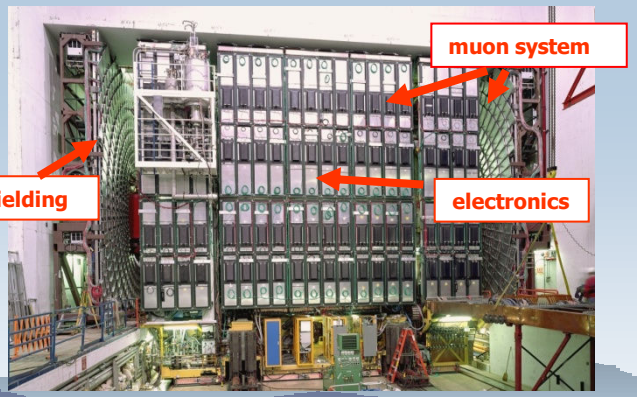
- D0 Detector
- Top Production Cross Section Combination
- Search for Charged Higgs boson
- Measurement of the Forward-Backward Charge Asymmetry in Top-Antitop Production
- Search for ttbar Resonances in the Lepton+Jets Final State

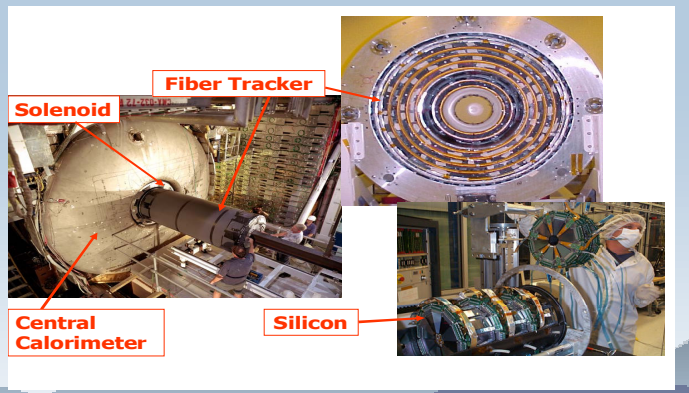
D0 Detector

- One of the two detectors on the Tevatron
- Run II at collision energy of 2 TeV since 2001
- 6.0 fb^{-1} collected

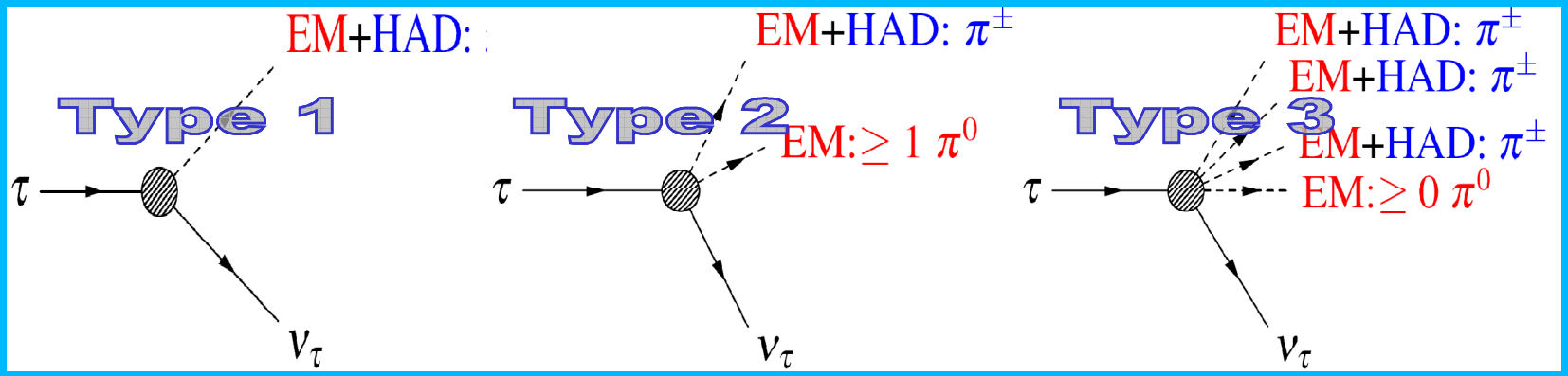








Top Production Cross Section with the D0 Detector



Lepton+tau channel

- **2 jets**
- **One τ candidate with high Neural Network output (3 τ types)**
- **Jets matched to a τ removed**
- **One b-tagged jet**

eτ :

- **One isolated electron**

μτ:

- **One isolated muon**

Lepton+jets channel

- **3 jets**
- **One b-tagged jet**
- **Missing E_T**

e+jets:

- **One isolated electron**

μ+jets:

- **One isolated muon**

Top Production Cross Section Results

- All included channels have excellent agreement with theory
- Top signal here is normalized to 7.9 pb

Channel	$t\bar{t}$	$t\bar{t}$+background	observed
e+jets 3 jets 1tag	79.04 ± 0.32	180.73 ± 4.71	183
e+jets $\geq$ 4 jets 1tag	78.94 ± 0.31	100.95 ± 2.23	113
e+jets 3 jets 2tag	29.71 ± 0.15	40.40 ± 1.16	40
e+jets $\geq$ 4 jets 2tag	40.35 ± 0.18	43.59 ± 0.89	30
μ+jets 3 jets 1tag	57.03 ± 0.27	140.81 ± 3.78	133
μ+jets $\geq$ 4 jets 1tag	63.69 ± 0.27	82.11 ± 2.34	99
μ+jets 3 jets 2tag	23.05 ± 0.13	32.61 ± 1.19	31
μ+jets $\geq$ 4 jets 2tag	34.44 ± 0.16	36.99 ± 1.00	34
ee	11.22 ± 0.14	14.59 ± 0.4	17
$e\mu$ 1jet	8.58 ± 0.11	18.08 ± 0.66	21
$e\mu$ 2jets	35.19 ± 0.17	44.55 ± 0.69	39
$\mu\mu$	8.79 ± 0.10	15.15 ± 0.57	12
$e + \tau$	10.31 ± 0.18	14.66 ± 1.75	16
$\mu + \tau$	12.15 ± 0.17	22.31 ± 2.85	20

Top Production Cross Section Combination

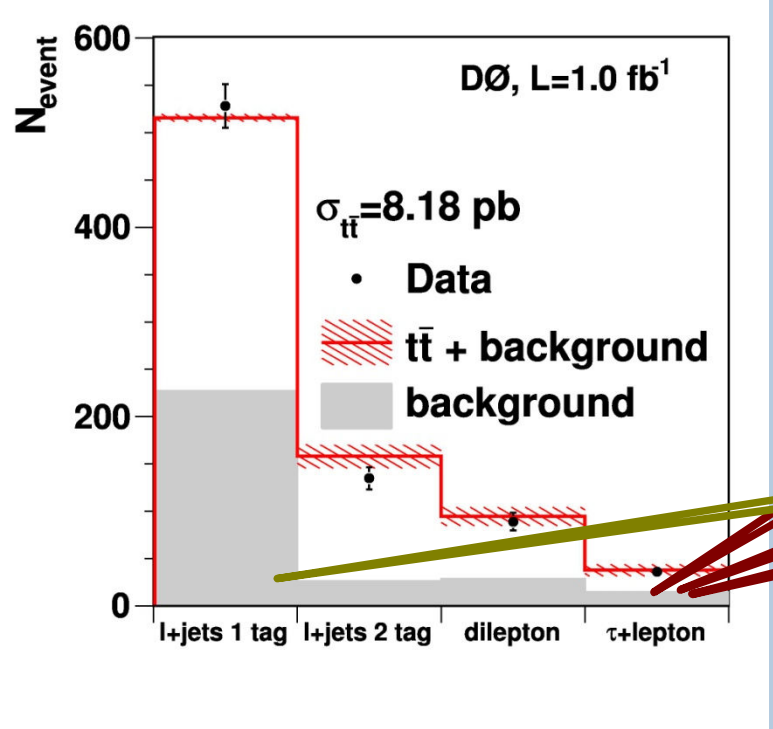


TABLE II: Summary of uncertainties on the combined $\sigma_{t\bar{t}}$.

Source	$\Delta\sigma_{t\bar{t}}$ (pb)
Statistical	+0.47 −0.46
Lepton identification	+0.13 −0.14
Tau identification	+0.02 −0.02
Jet identification	+0.11 −0.11
Jet energy scale	+0.34 −0.32
b jet identification	+0.17 −0.15
Signal modeling	+0.14 −0.14
Background estimation	+0.12 −0.12
Multijet background	+0.56 −0.48
Luminosity	+0.13 −0.14
Other	+0.78 −0.69
Total systematic uncertainty	

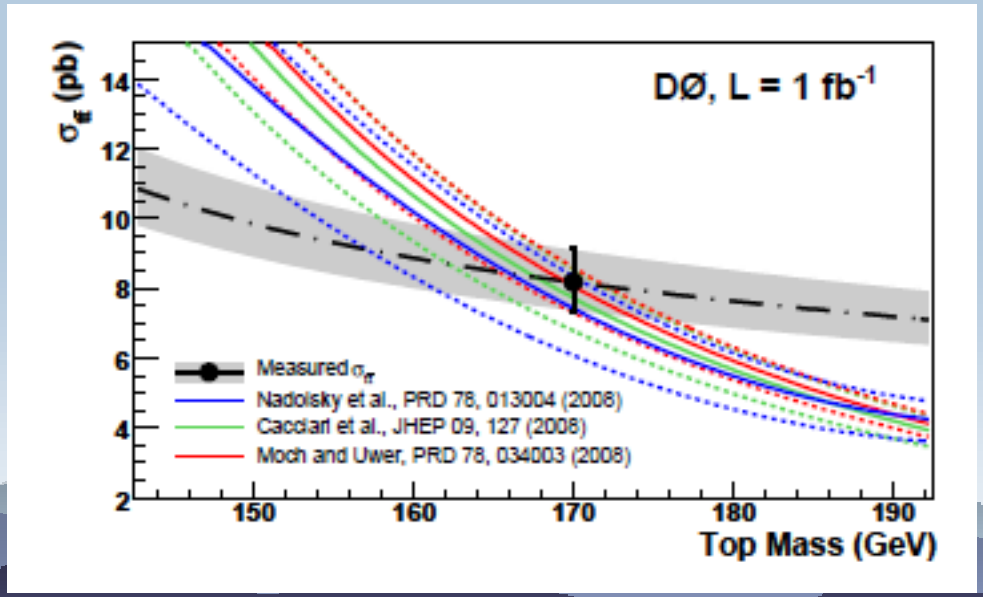
Dominant uncertainties

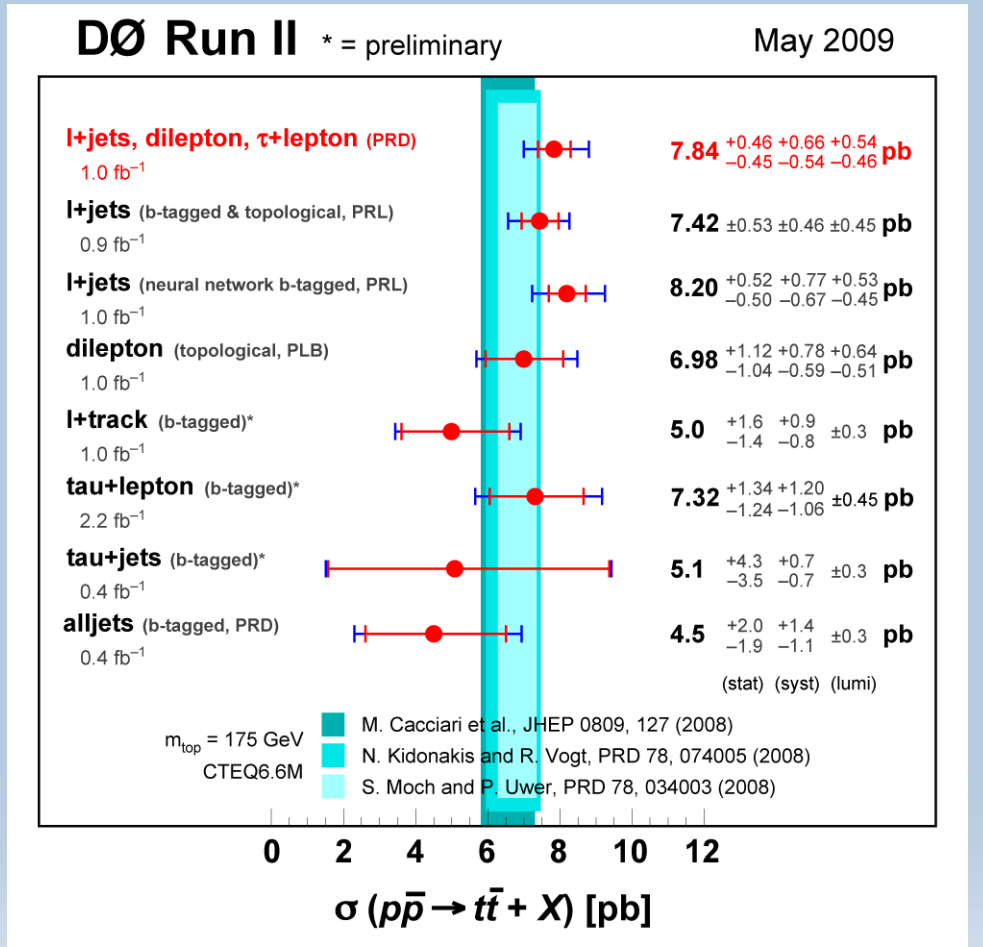
$$\sigma_{t\bar{t}} = 8.18^{+0.98}_{-0.87}\ \text{pb}$$

arXiv:/0903.5525 [hep-ex]

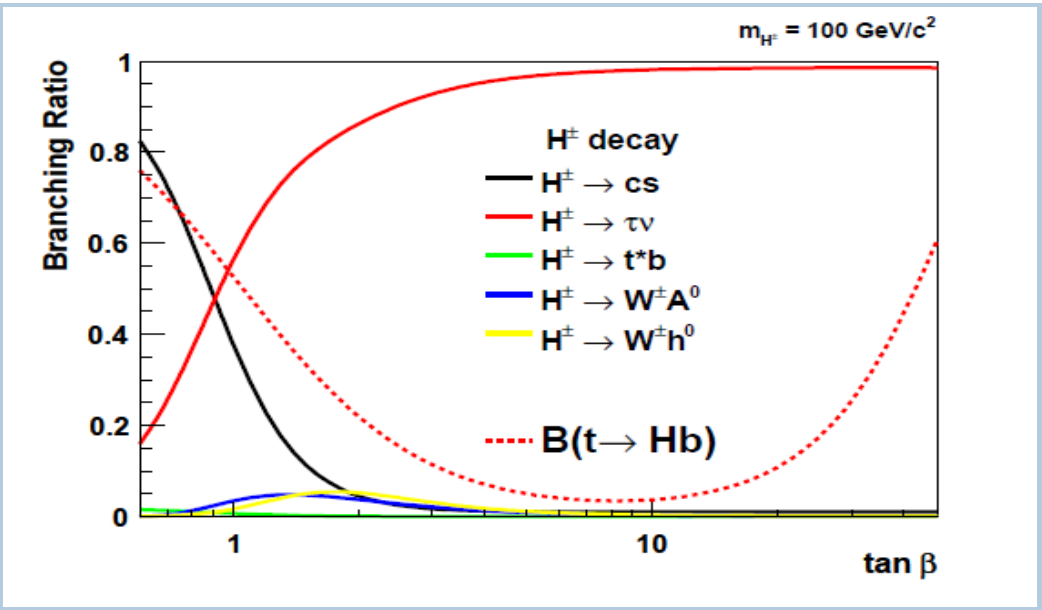
Top Production Cross Section Summary

- **The combined result has mass dependence in agreement with SM theory**
- **And is the most precise measurement of top pair cross section so far**





Search for Charged Higgs boson



If H+ is lighter than top we can have the following scenarios:

$t\bar{t} \rightarrow W^+ b W^- \bar{b}$

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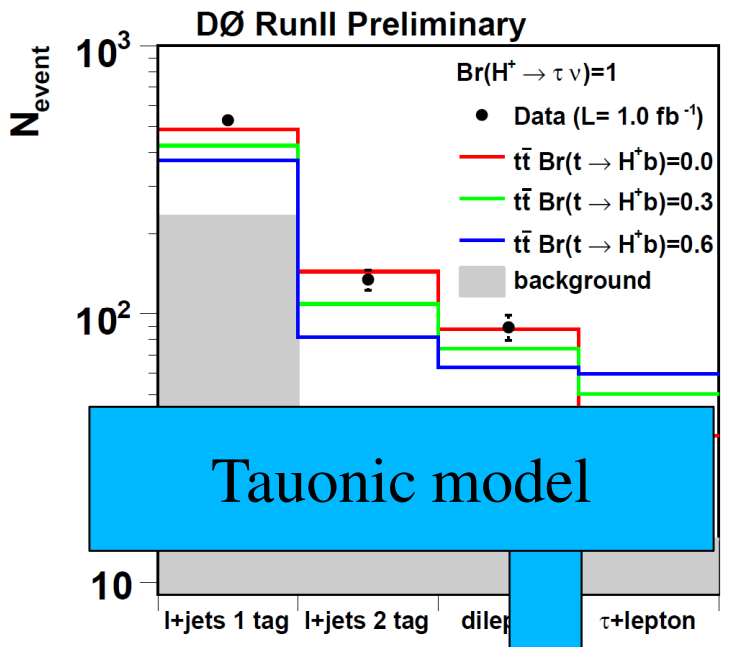
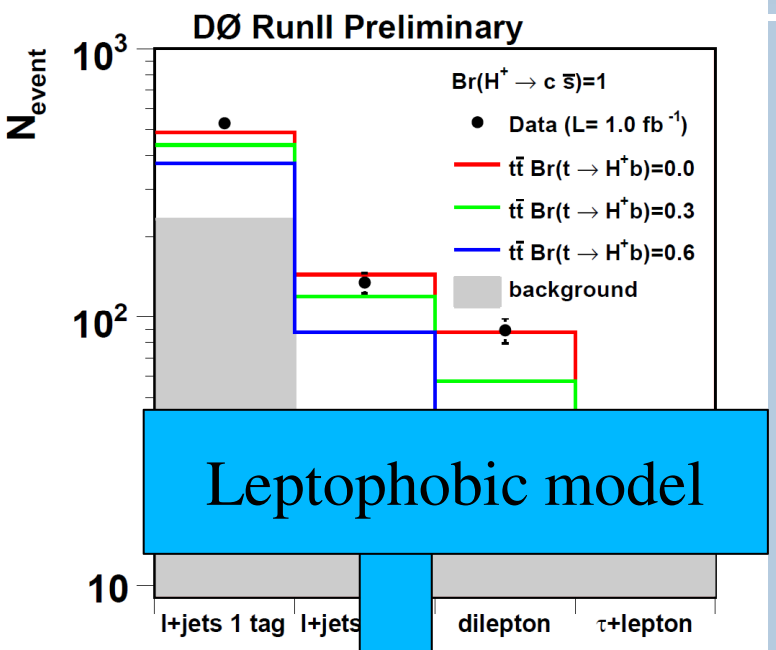
$$N_{t\bar{t}} = \left[(1-B)^2 \cdot \epsilon_{t\bar{t}\rightarrow W^+bW^-\bar{b}} + 2B(1-B) \cdot \epsilon_{t\bar{t}\rightarrow W^+bH^-\bar{b}} + B^2 \cdot \epsilon_{t\bar{t}\rightarrow H^+bH^-\bar{b}}\right] \sigma_{t\bar{t}} L \,, \quad (3)$$

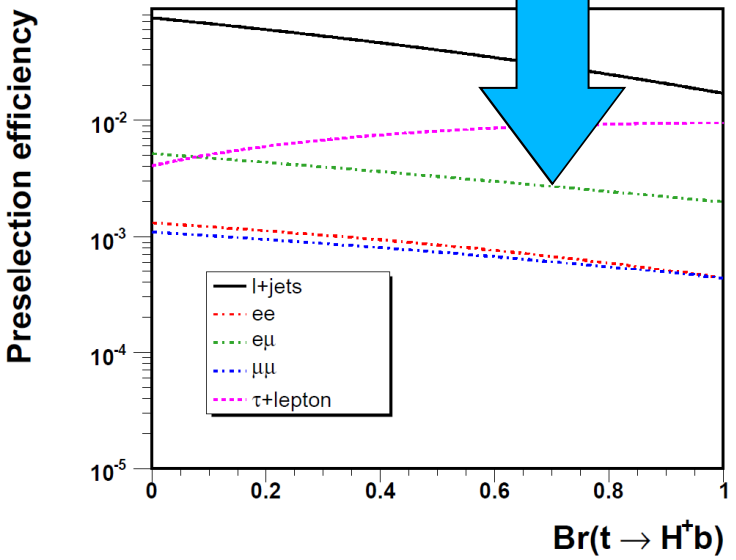
Search for Charged Higgs boson

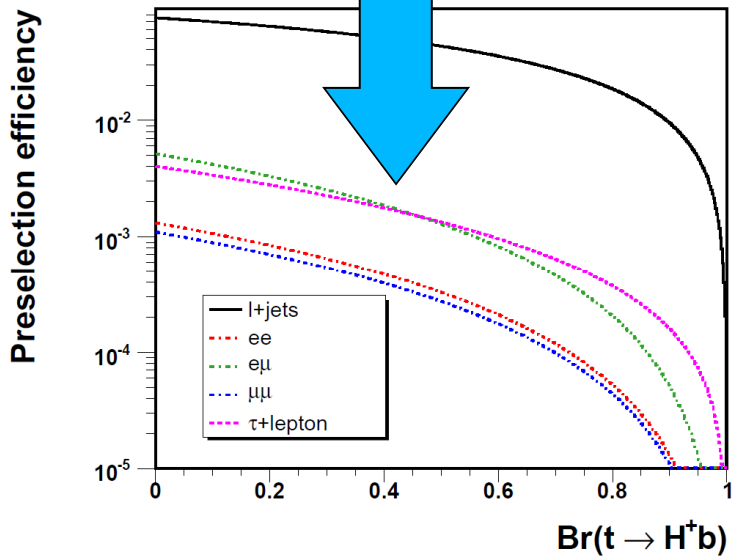




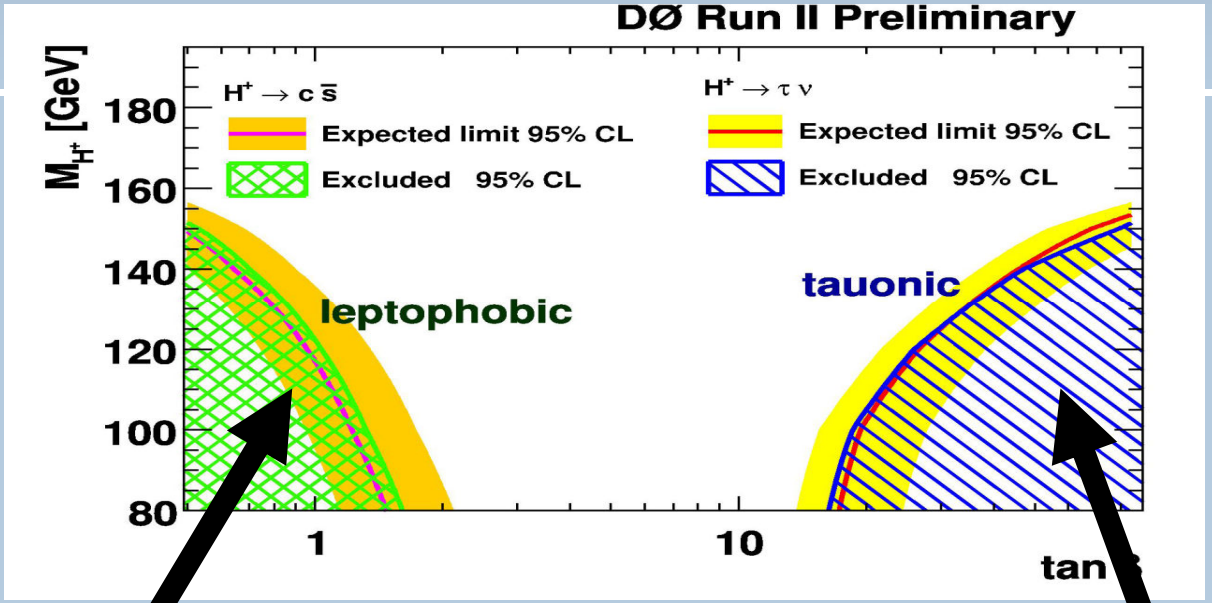
Tauonic model

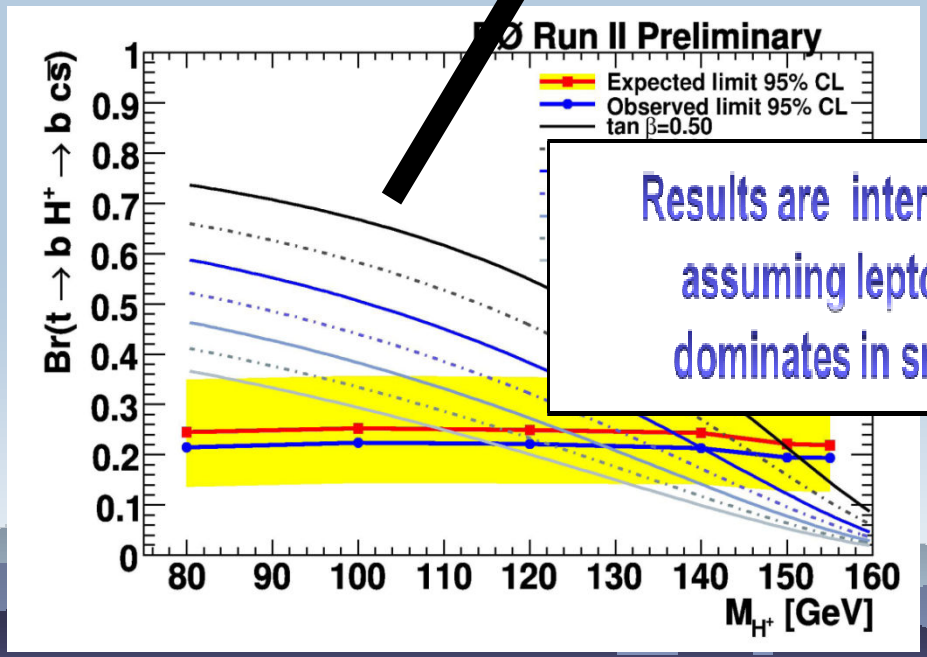
Leptophobic model

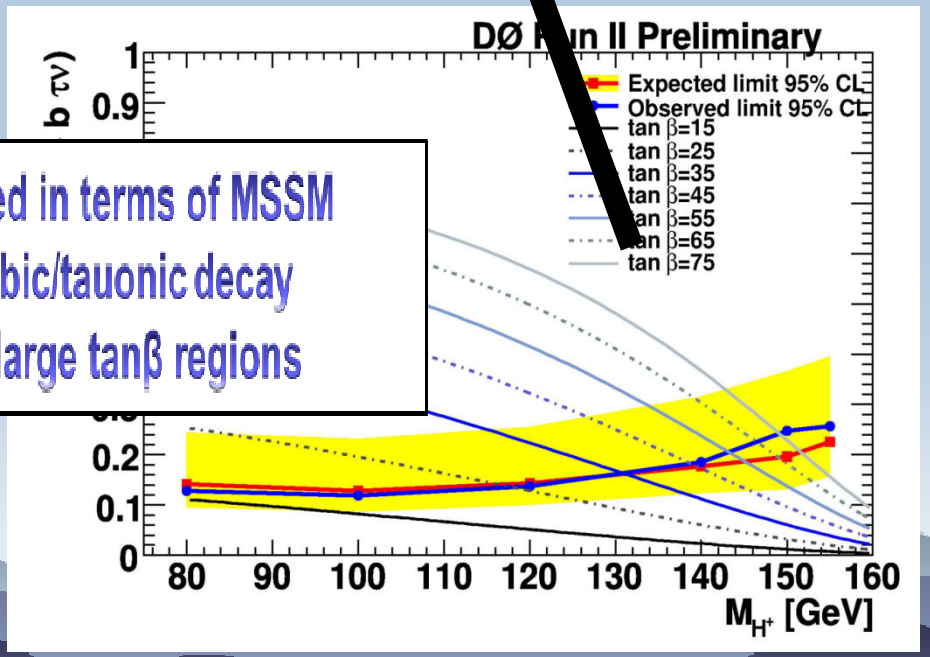




Search for Charged Higgs boson





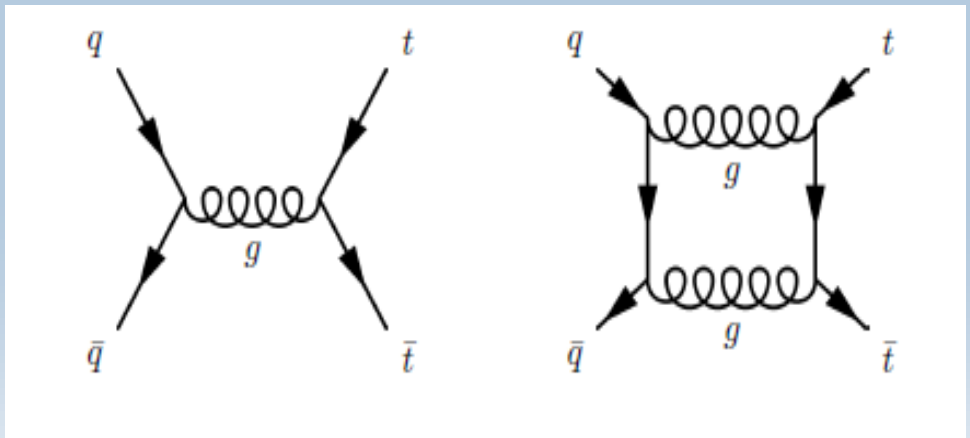


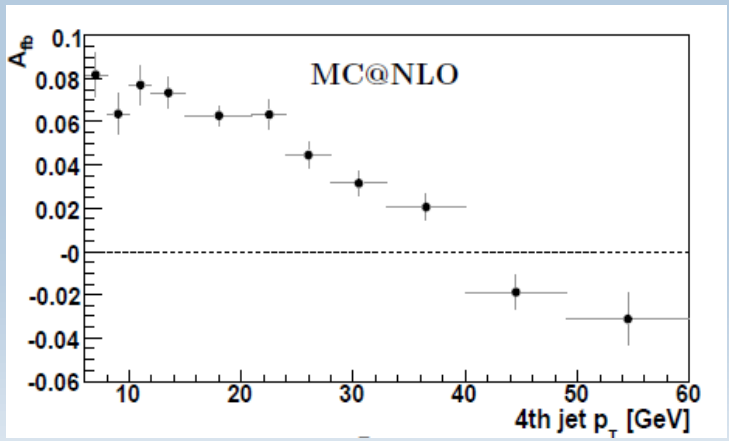
Results are interpreted in terms of MSSM assuming leptophobic/tauonic decay dominates in small/large tanβ regions

Measurement of the Forward-Backward Charge Asymmetry in Top-Antitop Production

$$A_{fb} = \frac{N_+ - N_-}{N_+ + N_-}$$

- N_+ is the number of events where top has larger rapidity then antitop, while N_- is the number of events where it is smaller
- In LO QCD it is 0, but in NLO it isn't due to interference between diagrams like these





Measurement of the Forward-Backward Charge Asymmetry in Top-Antitop Production

- The theoretical prediction is strongly shaped by acceptance and geometrical dilution due to incorrect charge reconstruction.

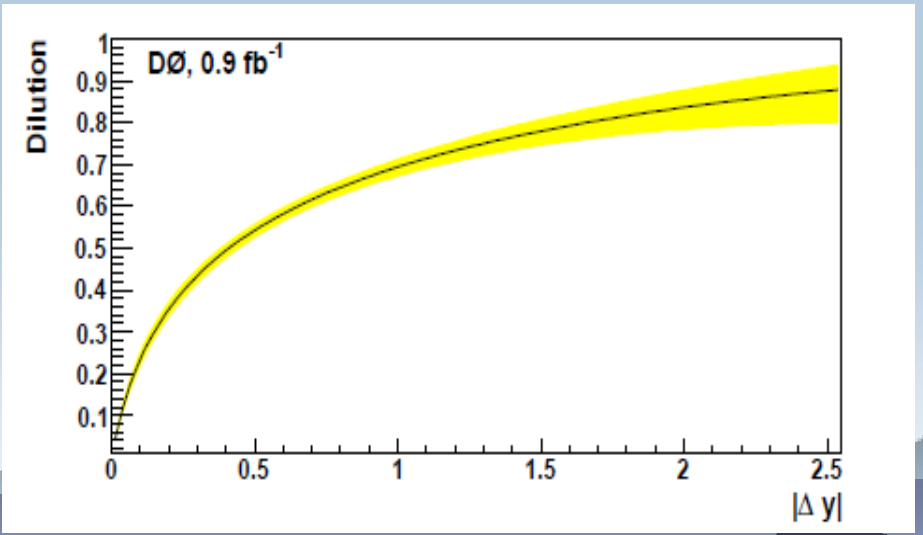
$$A_{\mathrm{fb}}^{\mathrm{pred}} = \int_0^{\infty} A_{\mathrm{fb}}(\Delta y)\, \mathcal{D}(\Delta y)\, [g(\Delta y) + g(-\Delta y)]\, d\Delta y.$$

$$A_{\mathrm{fb}}(|\Delta y|) = \frac{g(|\Delta y|) - g(-|\Delta y|)}{g(|\Delta y|) + g(-|\Delta y|)},$$

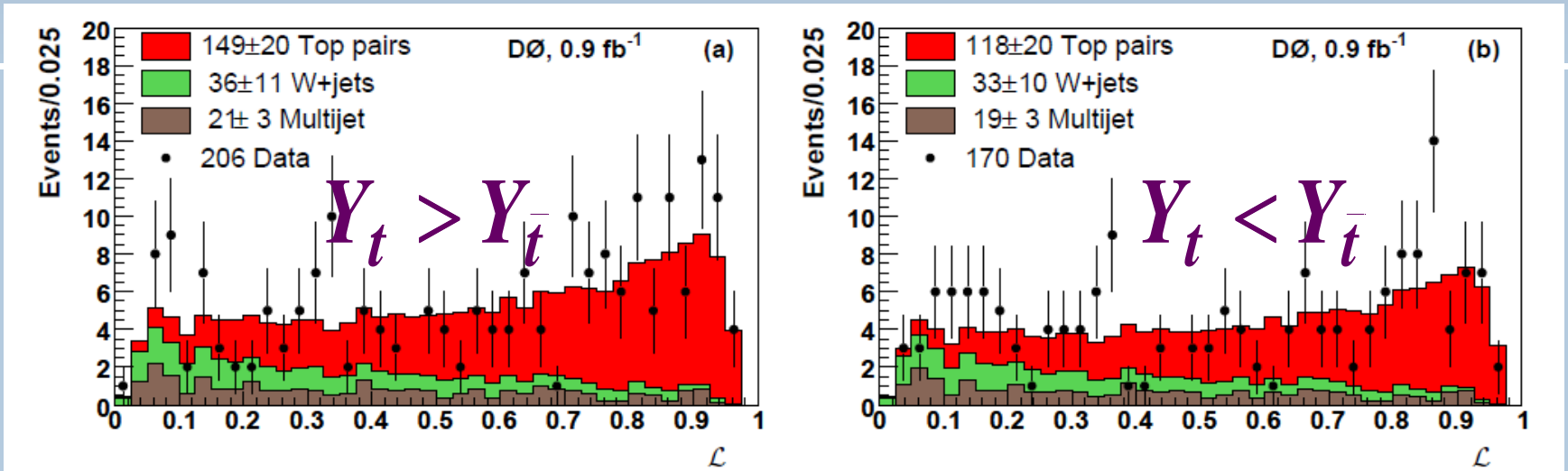
- The dilution was measured and fitted in MC

$$\mathcal{D}(|\Delta y|) = c_0 \ln\left(1 + c_1 |\Delta y| + c_2 |\Delta y|^2\right)$$

- Dilution can be used to compare any theoretical model to measured result



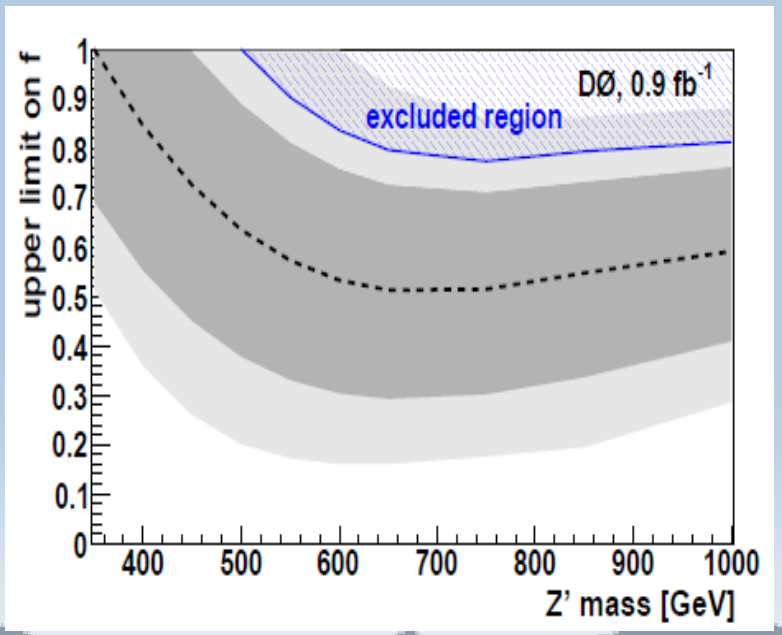
Asymmetry Fit and Results



N_{jet}	$A_{\text{fb}}^{\text{pred}}$ (in %)
$\geqslant 4$	$0.8 \pm 0.2(\text{stat.}) \pm 1.0(\text{accept.}) \pm 0.0(\text{dilution})$
4	$2.3 \pm 0.2(\text{stat.}) \pm 1.0(\text{accept.}) \pm 0.1(\text{dilution})$
$\geqslant 5$	$-4.9 \pm 0.4(\text{stat.}) \pm 1.0(\text{accept.}) \pm 0.2(\text{dilution})$

$$A_{fb} = \left(12 \pm 8(fit) \pm 1(syst)\right)\%$$

	$\geqslant 4$ Jets	4 Jets	$\geqslant 5$ Jets
No. Events	376	308	68
$t\bar{t} + X$	266^{+23}_{-22}	214 ± 20	54^{+10}_{-12}
W+jets	70 ± 21	61^{+19}_{-18}	7^{+11}_{-5}
Multijets	40 ± 4	$32.7^{+3.5}_{-3.3}$	$7.1^{+1.6}_{-1.5}$
A_{fb}	$(12 \pm 8)\%$	$(19 \pm 9)\%$	$(-16^{+15}_{-17})\%$

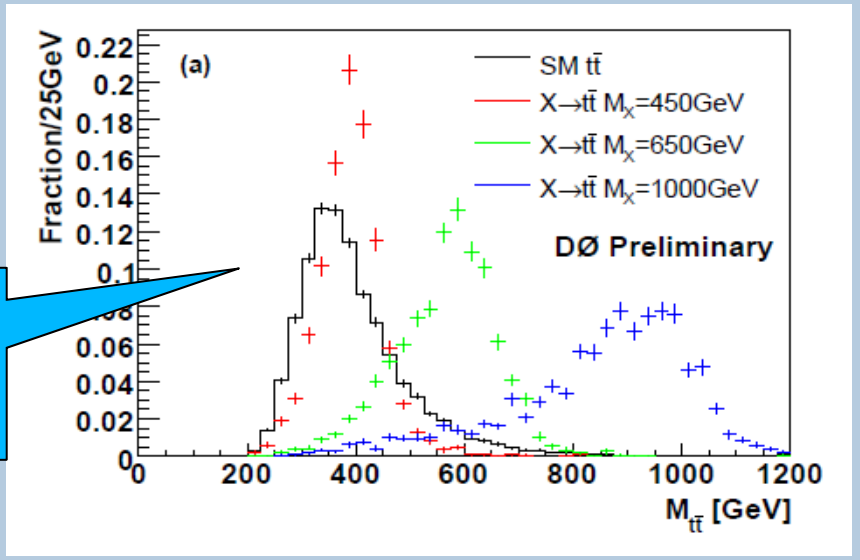


Phys. Rev. Lett. 100 , 142002 (2008)

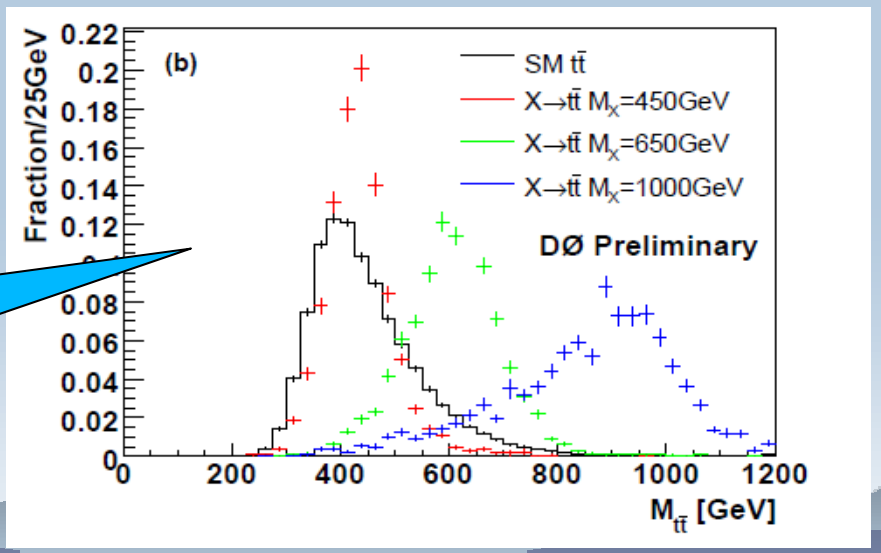
Search for ttbar Resonances in the Lepton+Jets Final State

- Z' appears in many theories included topcolor-assisted technicolor
- Narrow resonance can be discovered by looking at the invariant mass of top pairs
- At the plots we can observe how the peak changes from SM

3 jets

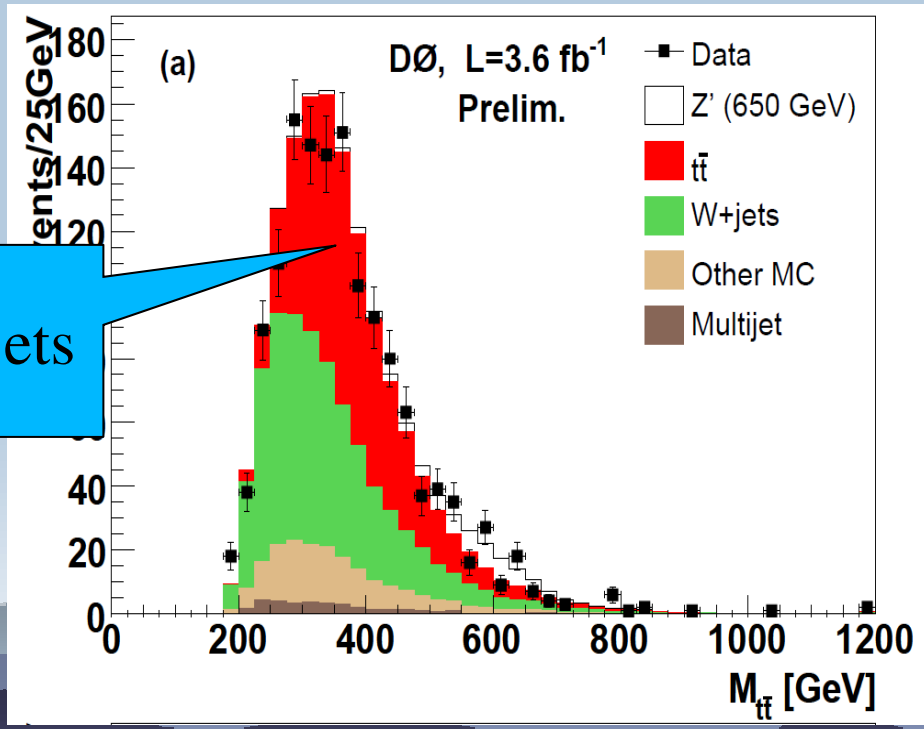


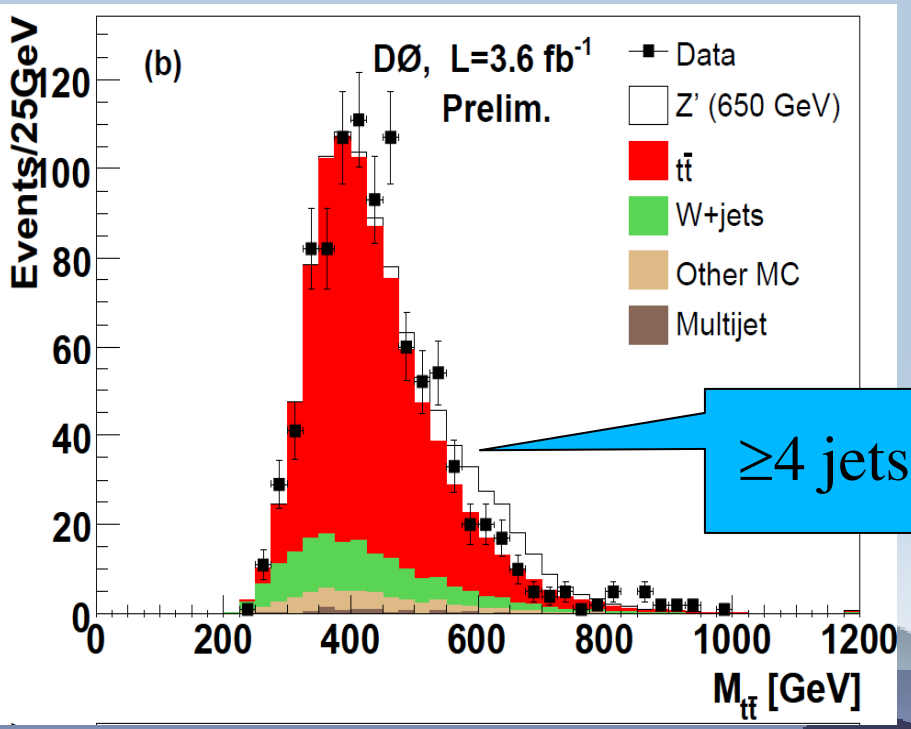
≥4 jets



Search for ttbar Resonances in the Lepton+Jets Final State

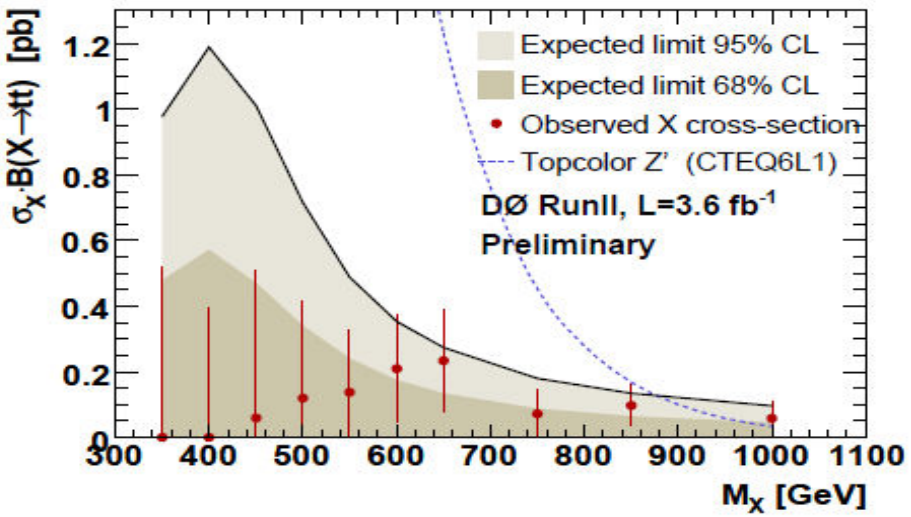
- Invariant mass was plotted for l+jets candidate events
- Good agreement was observed and no resonant production signal

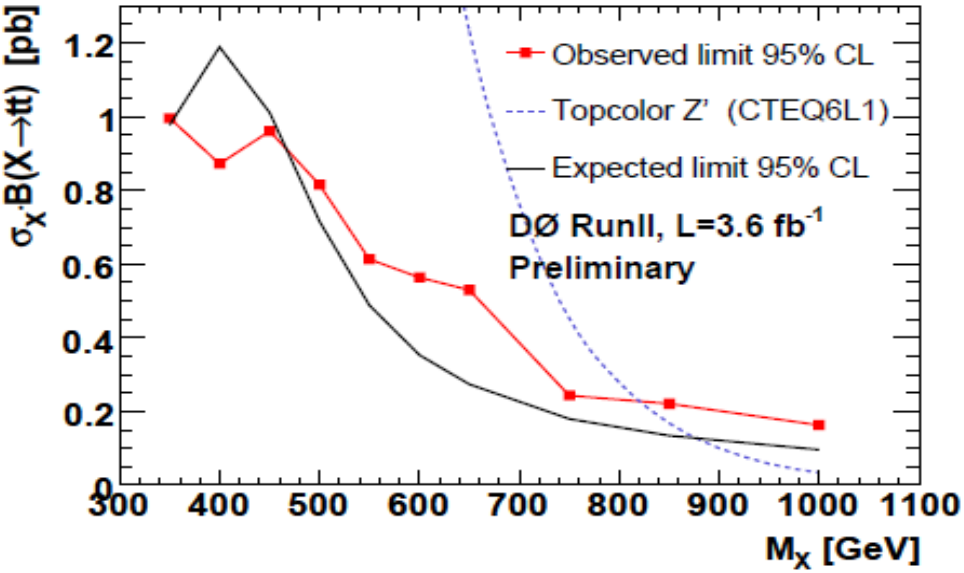




Search for ttbar Resonances in the Lepton+Jets Final State

- Using M_{tt} distributions the limit is set





Less then 2σ at 650 GeV

For topcolor-assisted technicolor
$M_{Z'} > 820$ GeV

Summary

- Top physics at D0 is diverse research field covering both SM and beyond SM physics.
- In this talk I presented our last combined and most precise measurements of top pair cross section. And I also showed H^+ search, first top pair asymmetry measurement and search for resonant top pair production.
- More exciting measurements and searches are to come as the full collected 6 pb^{-1} data set is analyzed.