Search for a new resonance decaying into ttbar

$$\boxed{p\bar{p} \longrightarrow X^o \longrightarrow t\bar{t}}$$

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for the CDF and D0 collaborations

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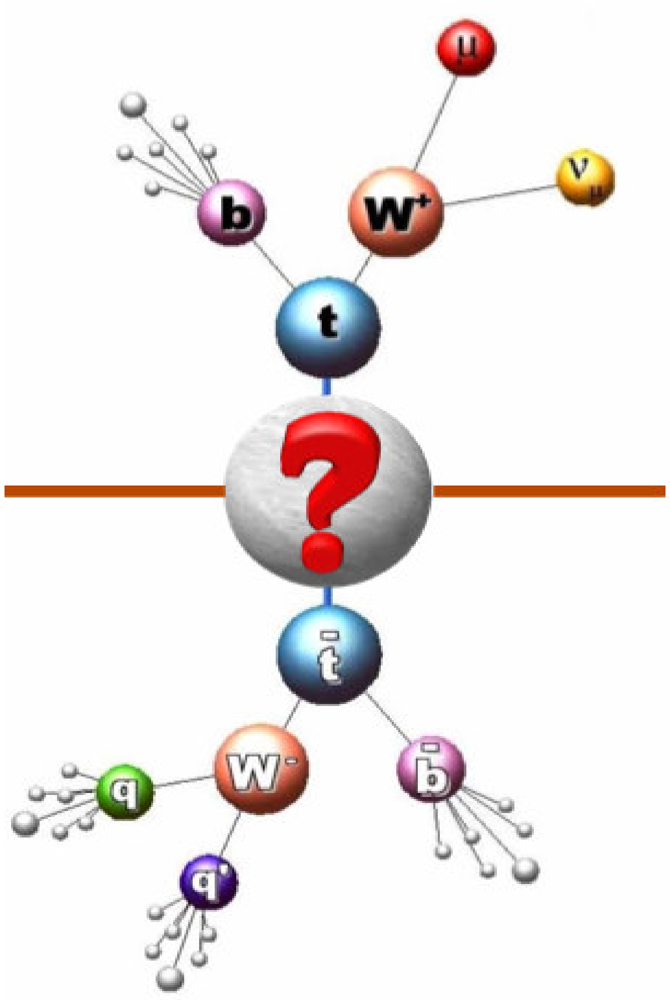
- Introduction
- Run I results
- Run II results
- Summary

Introduction

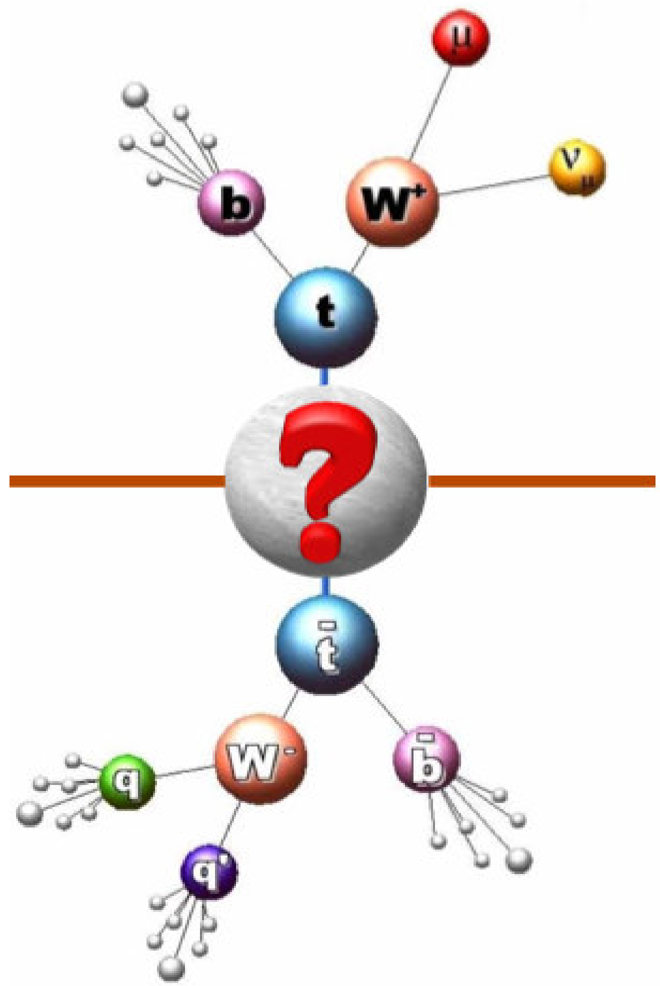
- No resonance production is expected in **SM**
- Why is Top so heavy ?
  - Indication of coupling to New Physics ?
  - Third generation 'special' ?
- Theoretical models predict it
  - Leptophobic topcolor assisted technicolor
    - Couples predominantly to third generation quarks

    Harris, Hill, Parke hep-ph/9911288
  - And many others…
- Top production is relatively unknown experimentally, needs investigation
- Experimental check :
  - Search for a bump in the reconstructed invariant mass spectrum



Event Selection & Sample Composition

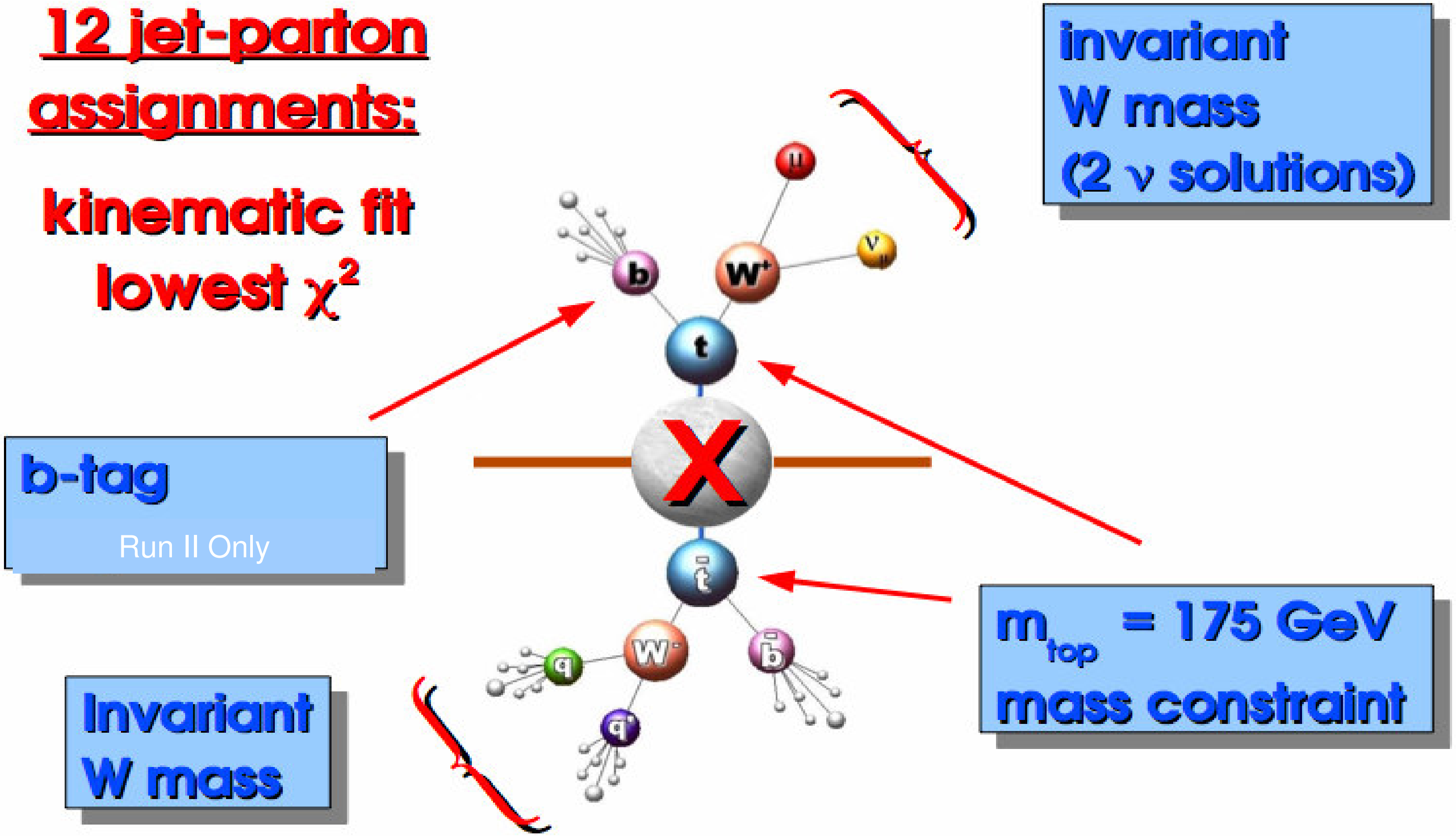
- Analysis is done in the "lepton + jets" channel
- Event Selection:
  - 1 high Pt lepton
  - High missing transverse energy (neutrino)
  - At least 4 high Et jets
- Sample composition :
  - SM ttbar, W + multijets
    - about 90% or more
  - QCD, Dibosons, Single Top
    - Minor backgrounds



ttbar invariant mass reconstruction : D0

Unknown quantities : 4 quark momenta and neutrino 3-momentum

Solution : find most likely values based on jet energy resolutions
And kinematical constraints like W, Top masses using a kinematic fit



ttbar invariant mass reconstruction : CDF

- Run I : similar to D0
- Run II :

Assume the top mass to be known , Mtop = 175 GeV

For each event, for each combination, build the posterior probability density:

$$\pi^{post}(p_b, p_{\bar{b}}, p_q, p_{\bar{q}}, \vec{p_\nu} | \vec{j_1}, \vec{j_2}, \vec{j_3}, \vec{j_4}, \vec{p_l})$$

$$\pi^{post}(\{p\}|\{j\}) \propto \pi^{prior}(\{p\}) \cdot T(\{j\}|\{p\})$$

The *prior* is the ttbar differential cross-section

Parton-to-jet transfer functions
Probability of measuring jet energy j knowing parton energy p

The posterior allows the derivation of the **event** Mtt probability density:

$$\rho^{post}(x|\{j\}) = \int \{dp\} \pi^{post}(\{p\}|\{j\}) \cdot \delta(x - M_{t\bar{t}}(\{p\}))$$

We 'project' the multidimensional posterior on one 'dimension' of our choice, Mtt in this case

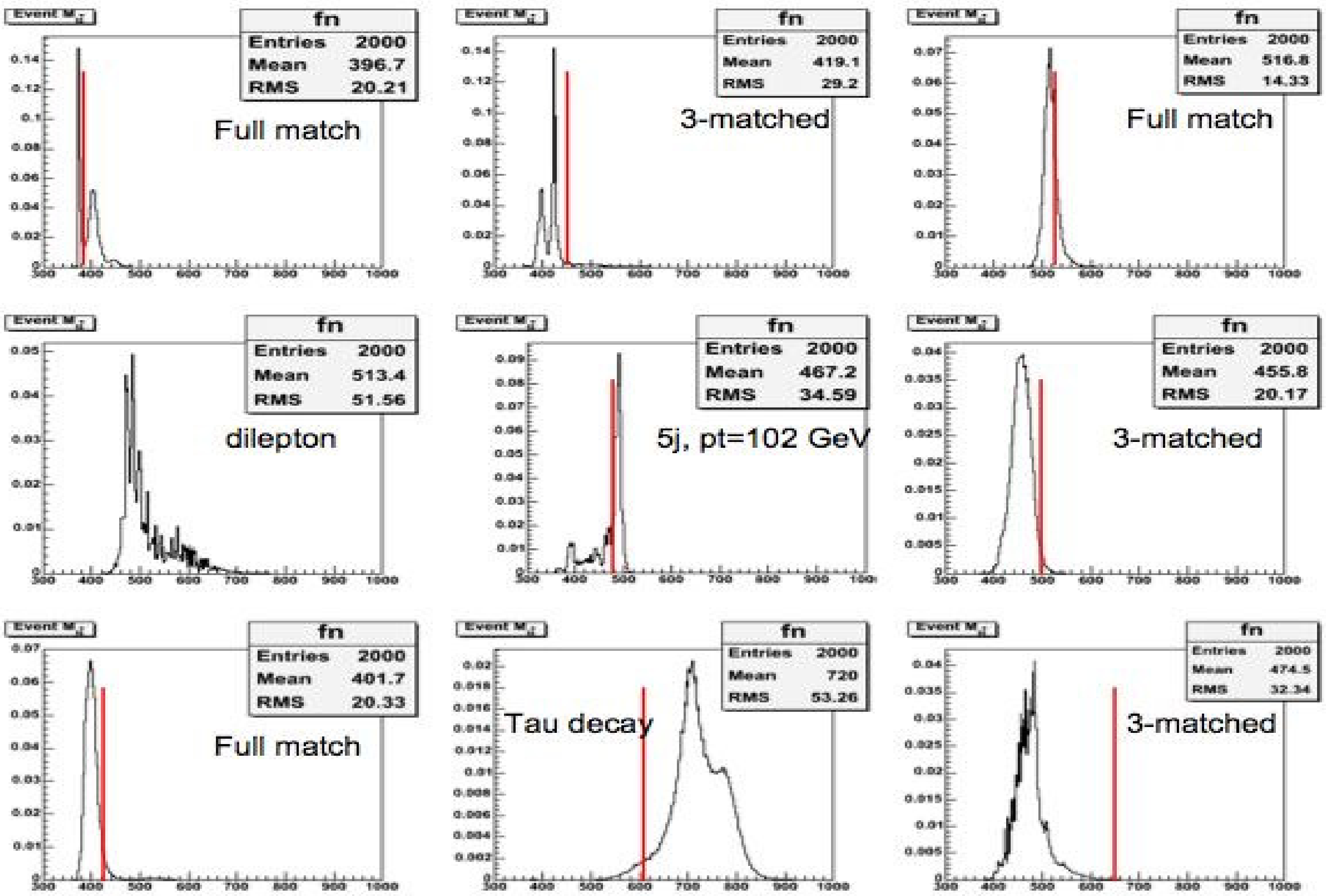
We average over all jet-parton assignments allowed by b-tagging information

The mean Mtt value defines the 'reconstructed' event Mtt.

$$\mathcal{M}_{t\bar{t}} = < \rho^{post}(x|\{j\}) >$$

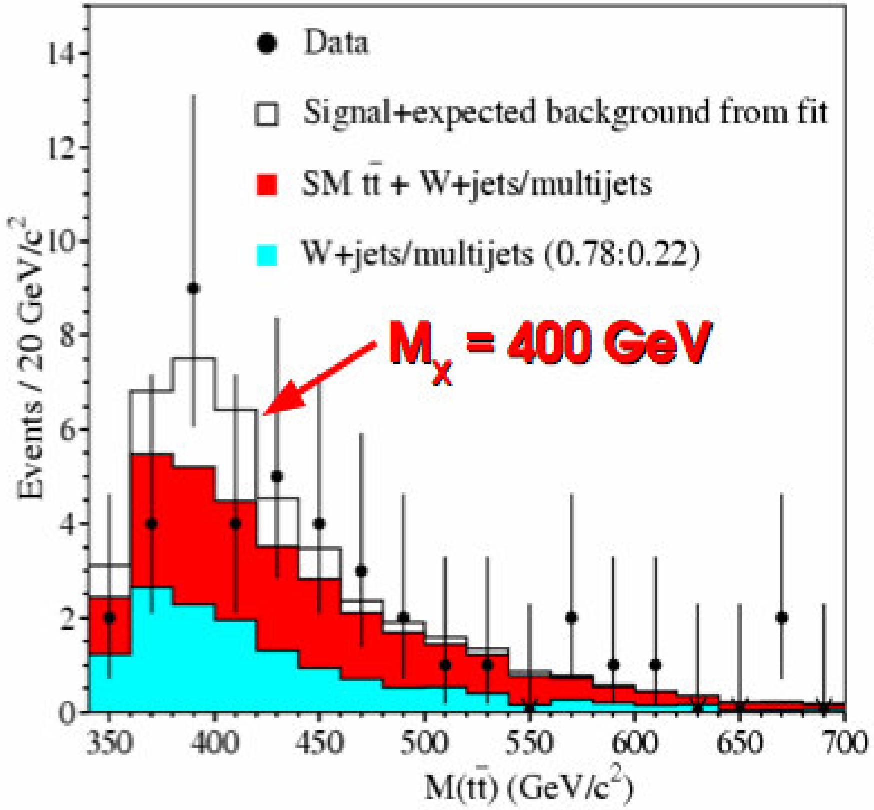
Example of event Mtt distributions

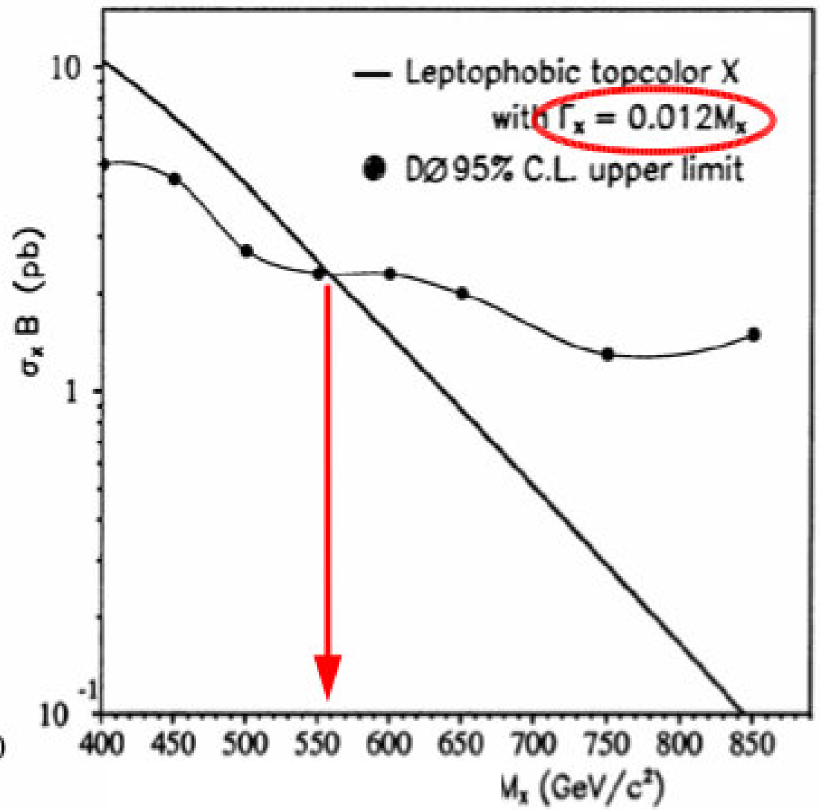
◎ Red : true value from Monte Carlo.



Run I Results : D0

Phys. Rev. Lett. 92, 221804 (2004)





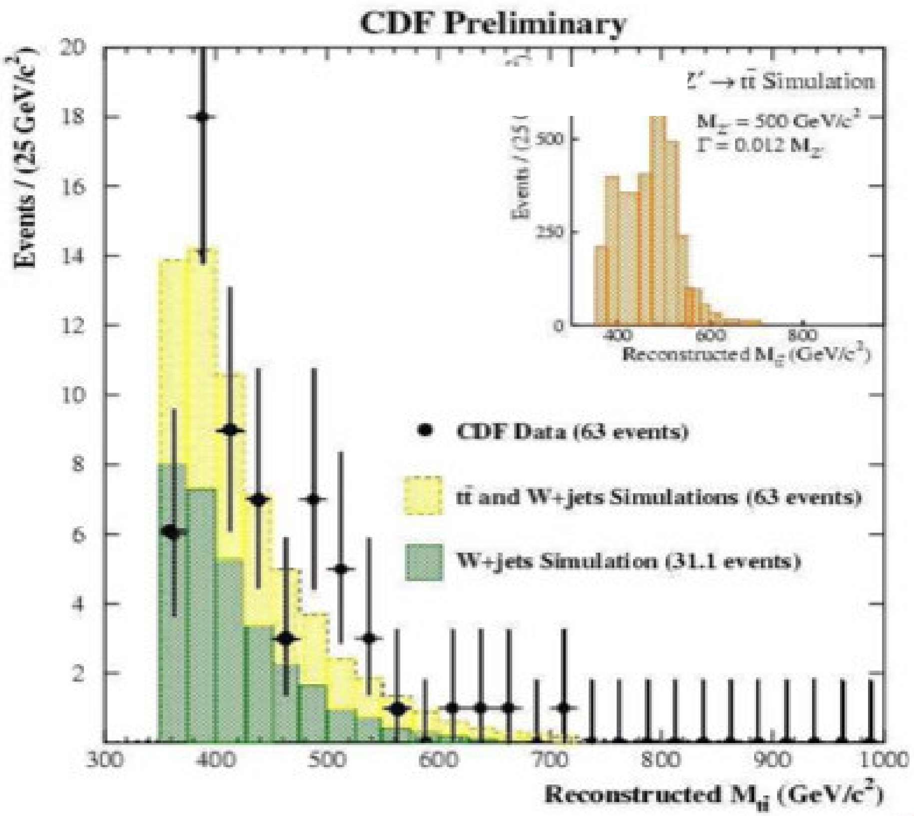
L = 130 pb^{-1}

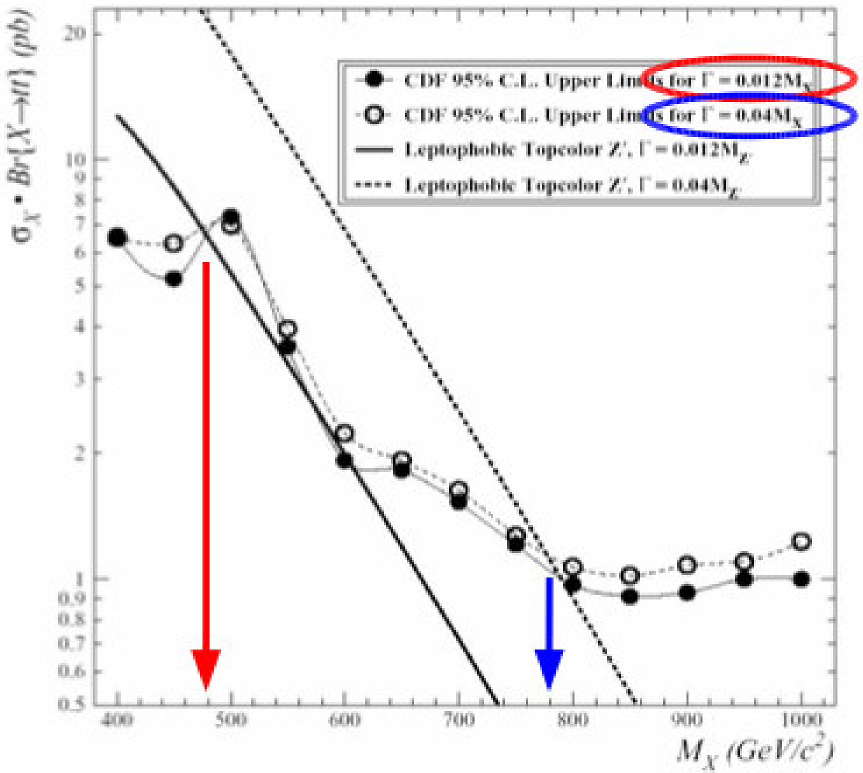
N = 41 events

$M_X > 540$ GeV , $\Gamma_X = 0.012M_X$

Run I Results : CDF

Phys. Rev. Lett. 85, 2062 (2000)





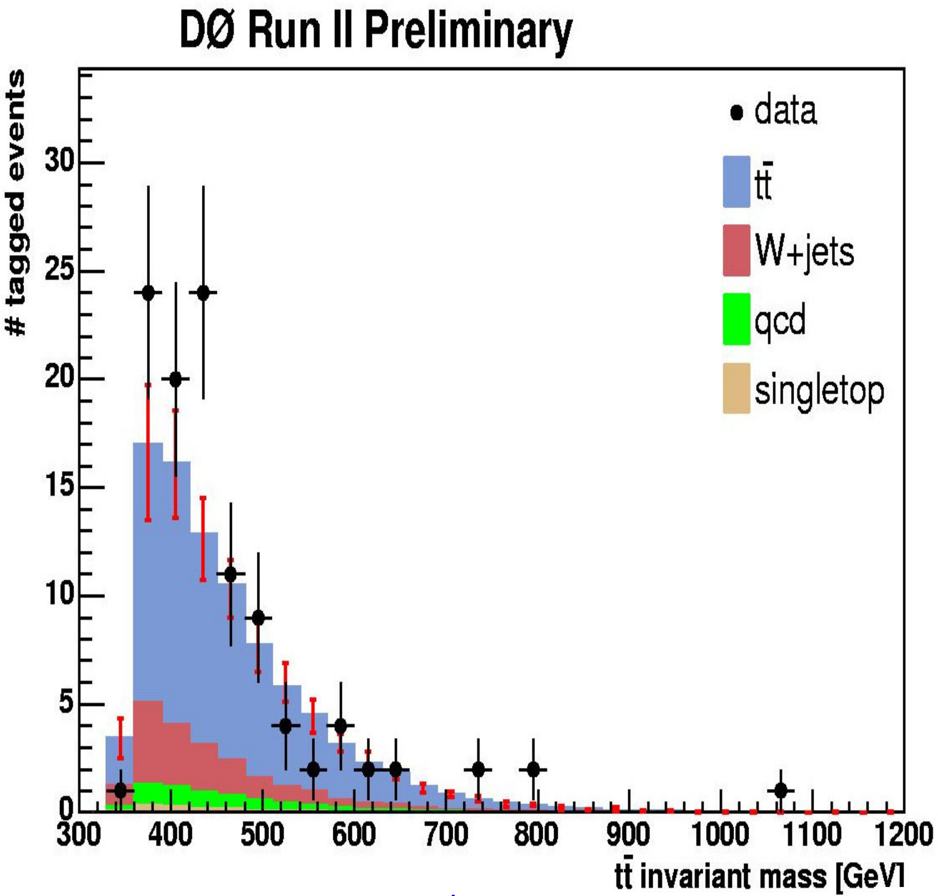
$M_x > 480$ GeV $\Gamma_x = 0.012M_x$

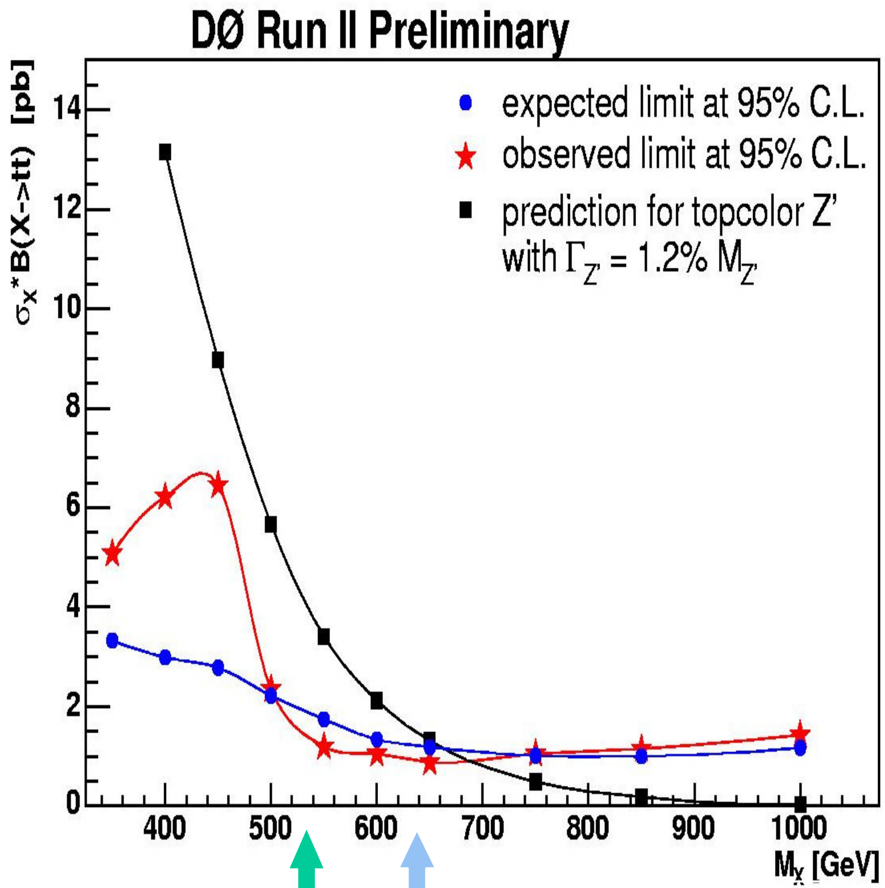
$M_x > 780$ GeV $\Gamma x = 0.04Mx$

$L = 109\ pb^{-1}$

$N = 63$ events

New Run II Results : D0





D0 Run I
$M_X > 560$GeV

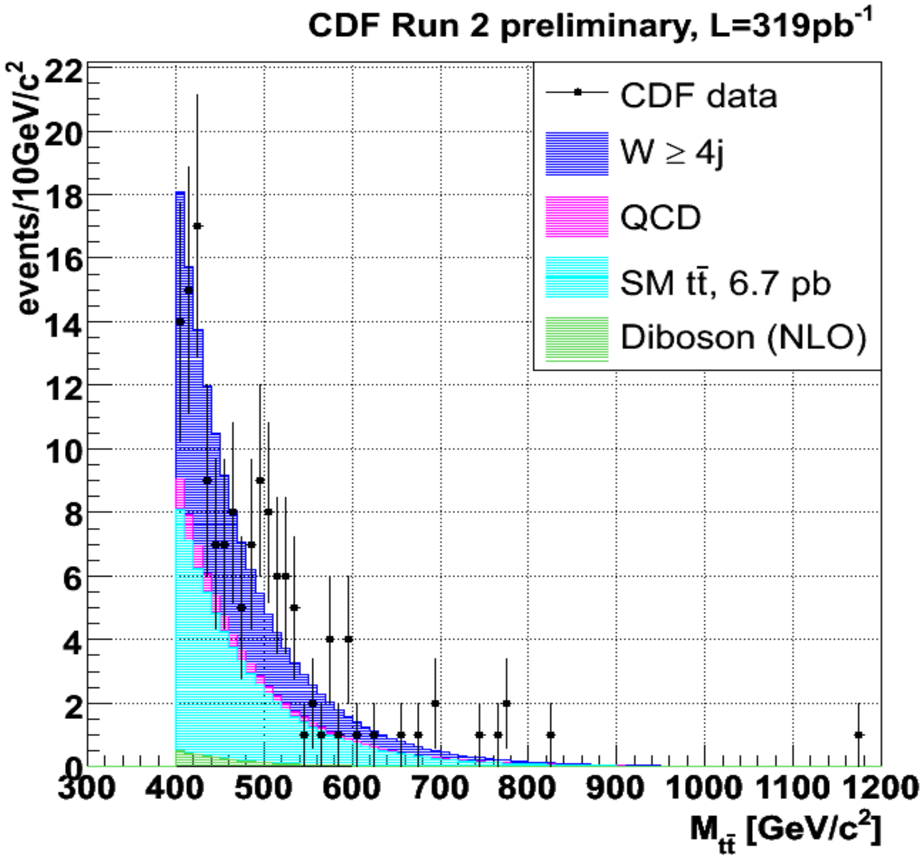
D0 Run II
$M_X > 680$GeV

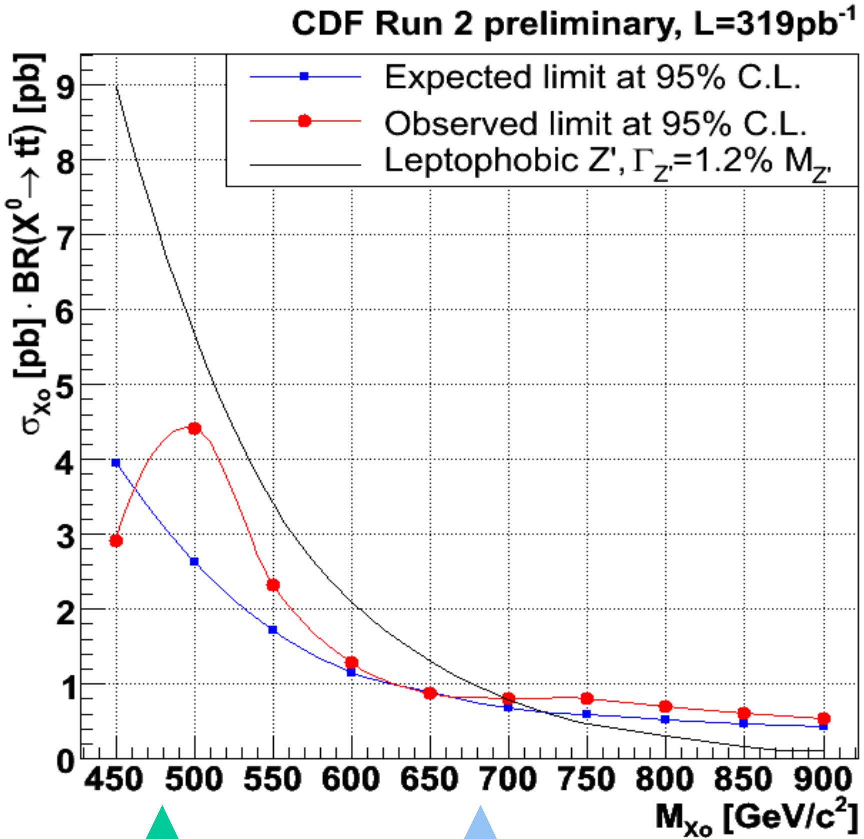
L = 370 pb^{-1}

N = 108 events

Requires 1 or more b-tagged jets

New Run II Results : CDF



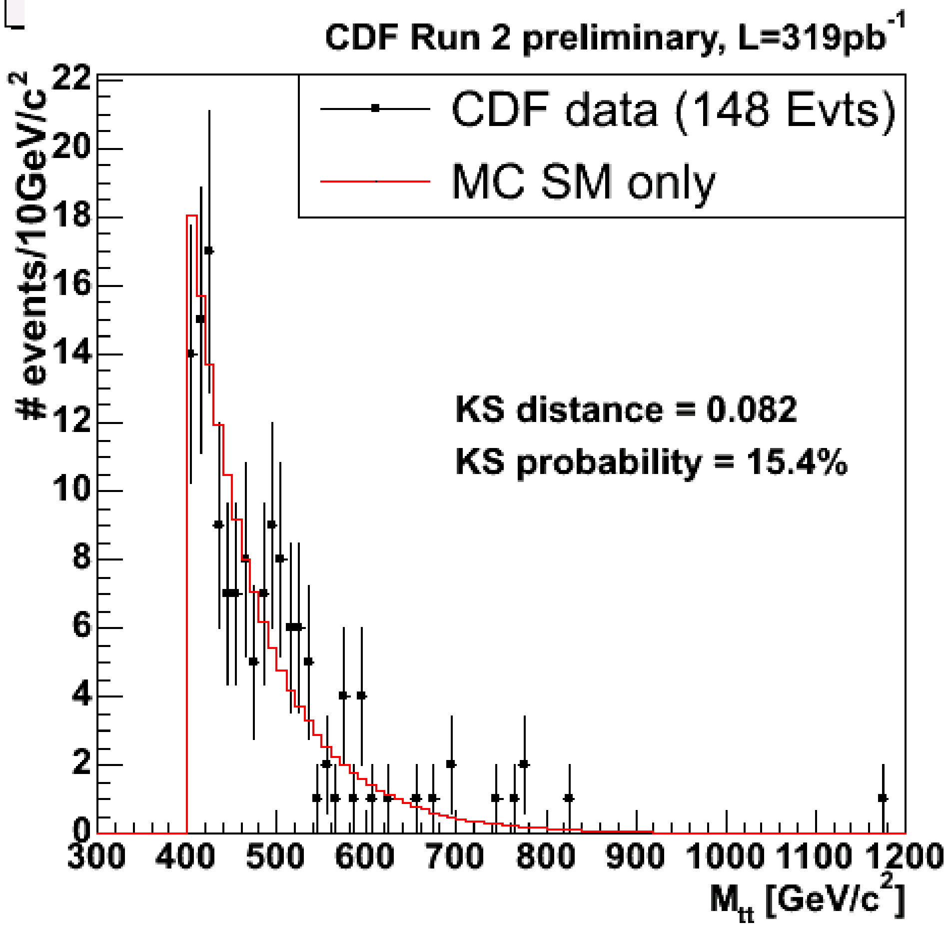


CDF Run I
M_X > 480GeV

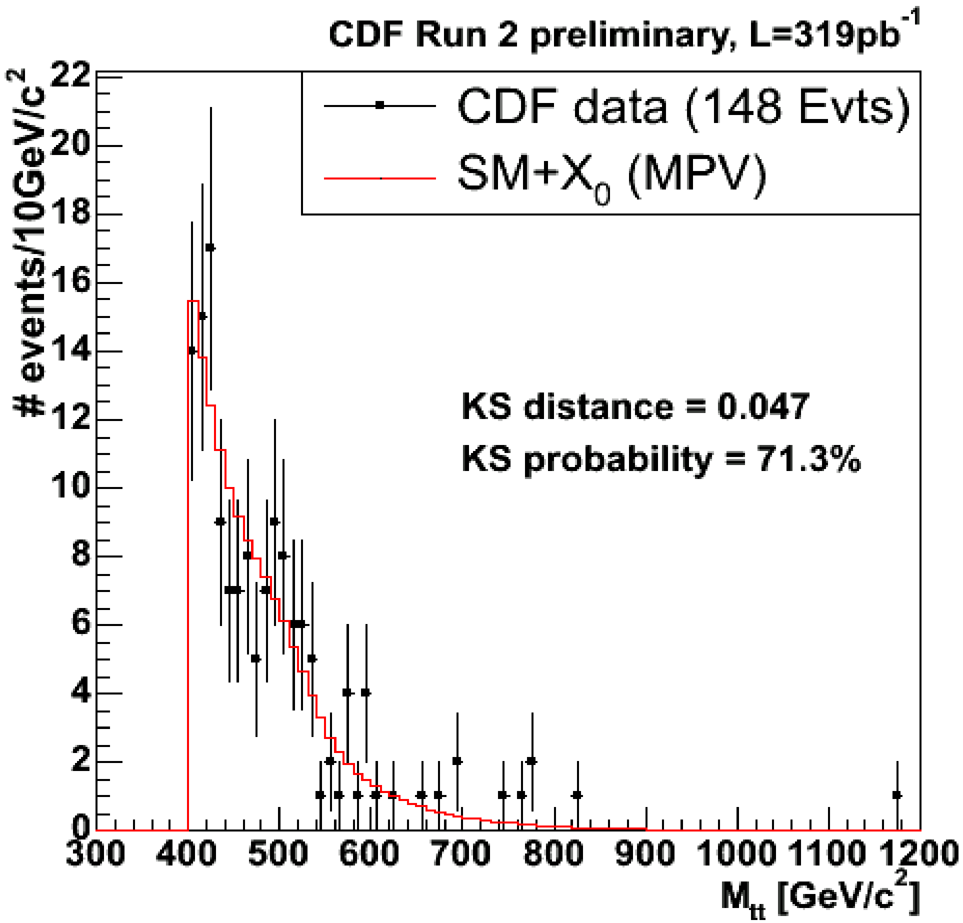
CDF Run II
M_X > 700GeV

L = 319 pb^{-1}
N = 148 events

New Run II Results : CDF



KS test, SM only



KS test, SM + X(500GeV) at most probable x-sec 2pb

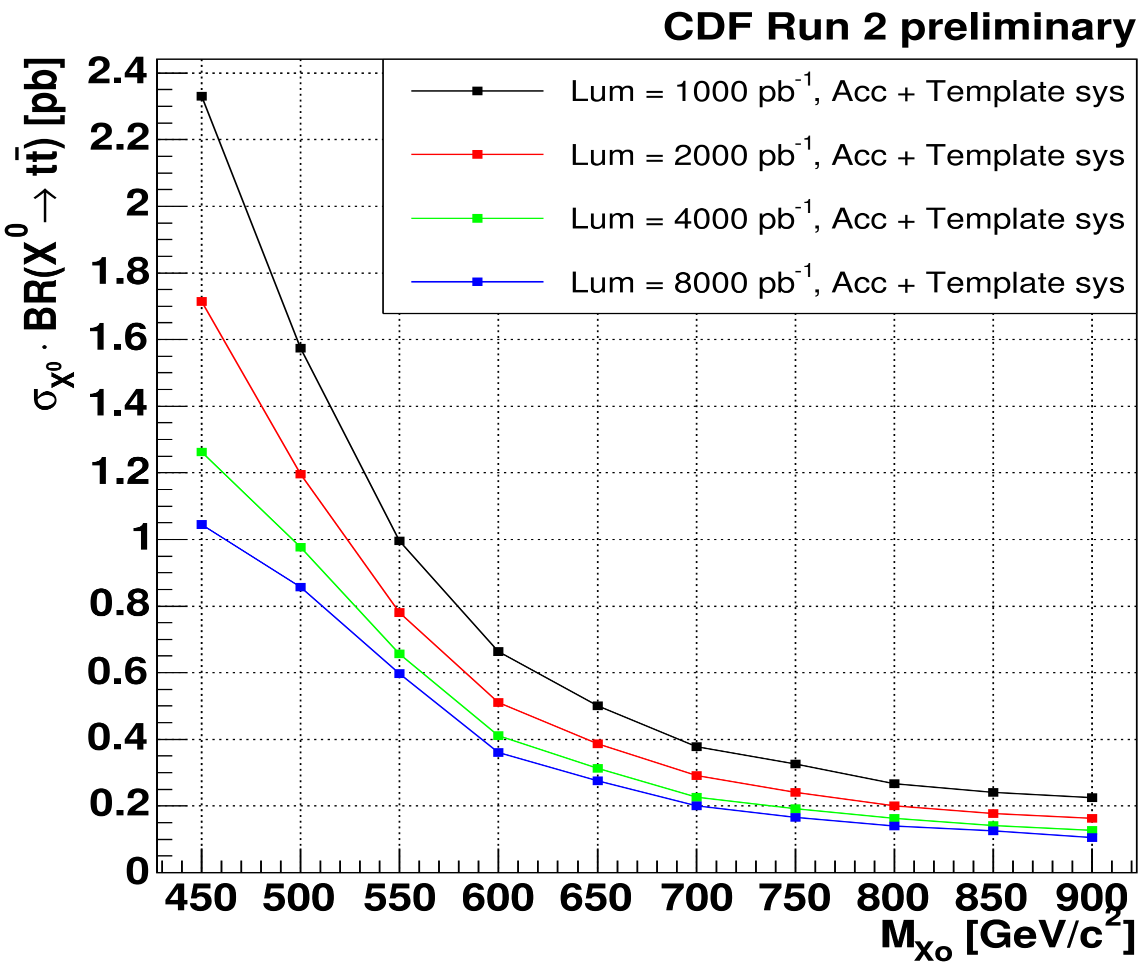
Summary

	Run I	Run II
D0	Method : Kinematical fit B-tags : any Limit : 560 GeV	Method : Kinematical fit B-tags : 1 or more Limit : 680 GeV
CDF	Method : Kinematical fit B-tags : any Limit : 480 GeV	Method : Matrix Element B-tags : any Limit : 700 GeV

- No evidence for a new resonance found
- Cross section limits were improved compared to Run I
- Leptophobic Z′ model :
  - New limit $M_{Z'} > 700$ GeV for $\Gamma_{Z'} = 0.012 M_{Z'}$

- More data will be added soon !

Expected sensitivity for the future



Run II in progress, we will be able to test for smaller New Physics contamination soon !