Searches for $t\bar{t}$ Resonances at the Tevatron

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on behalf of the CDF and DØ Collaborations

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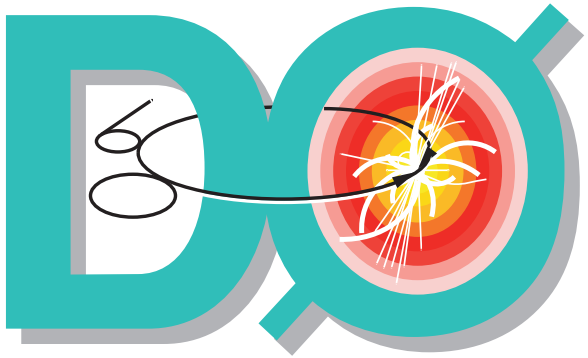
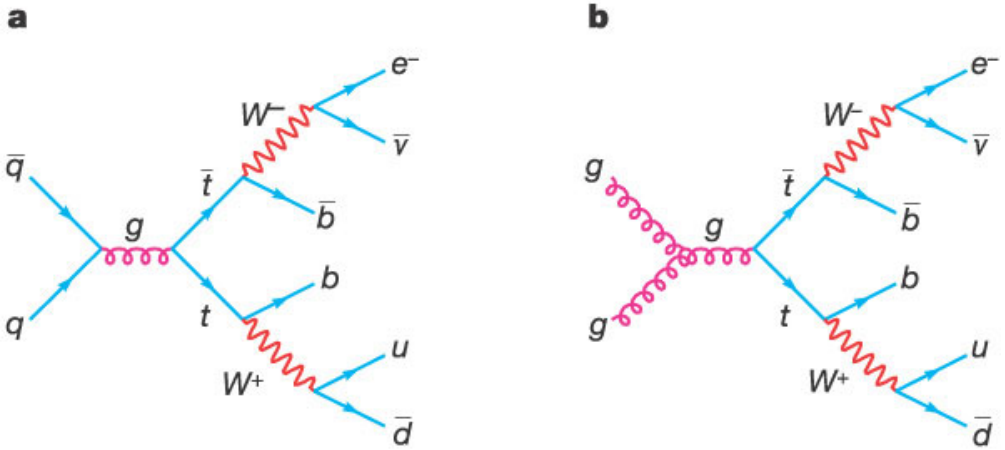
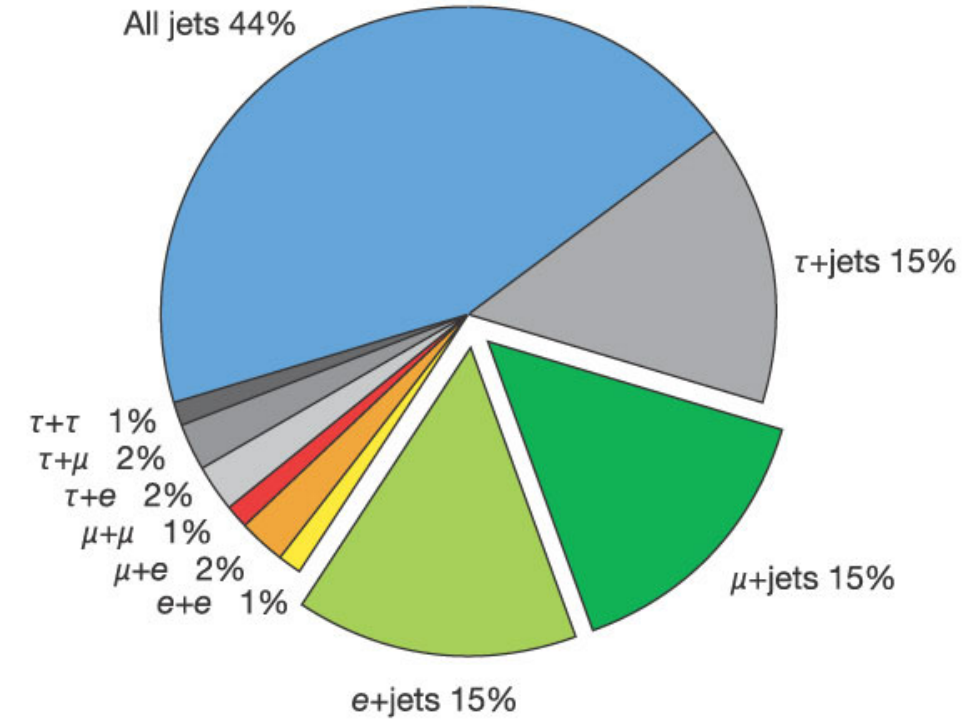


Motivation

- Top is the heaviest fundamental particle
- While its mass is known with great precision, there are many questions yet to be answered
- How are $t\bar{t}$ pairs produced? Only by SM QCD?
- Is there New Physics? Are $t\bar{t}$ produced by massive resonances?
- Resonant $t\bar{t}$ production is a feature shared by many models of physics beyond the Standard Model
- ...these include (but aren't limited to): extended guage theories (*e.g.* $SO(10)$), Kaluza Klein states of the gluon or Z, axigluons, topcolor...
- At the Tevatron, we investigate these questions

$t\bar{t}$ Production and Decay

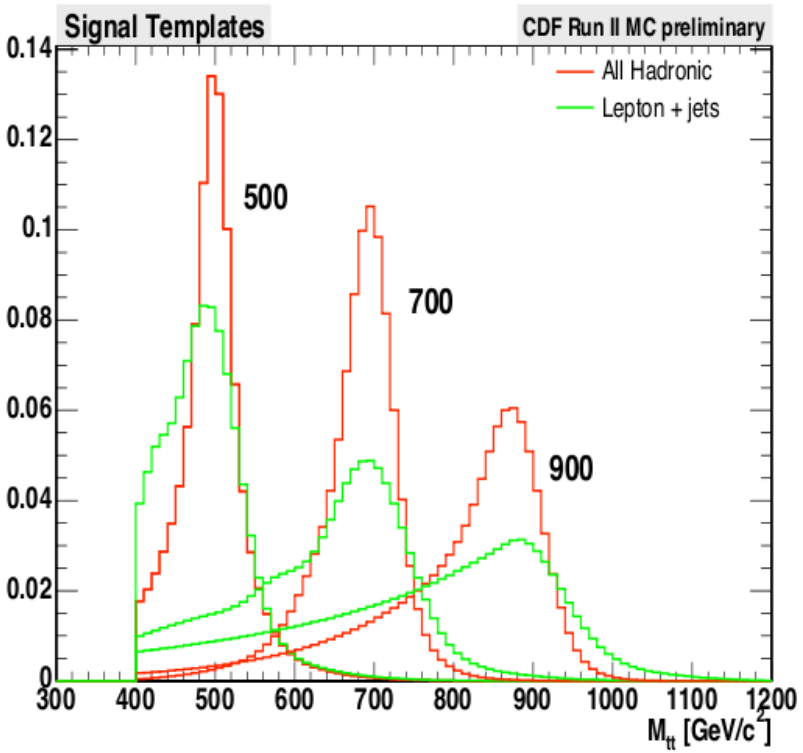




- SM QCD production of $t\bar{t}$ at Tevatron: 15% due to gluon–gluon fusion, 85% due to quark–quark annihilation
- Three $t\bar{t}$ decay channels: dilepton, all–hadronic, lepton+jets
- $t\bar{t}$ cross section has uncertainties on order of 0.5 pb...
- There is plenty of room for New Physics to hide in $t\bar{t}$ production!

Search for resonant $t\bar{t}$ production in the all–hadronic channel @ CDF

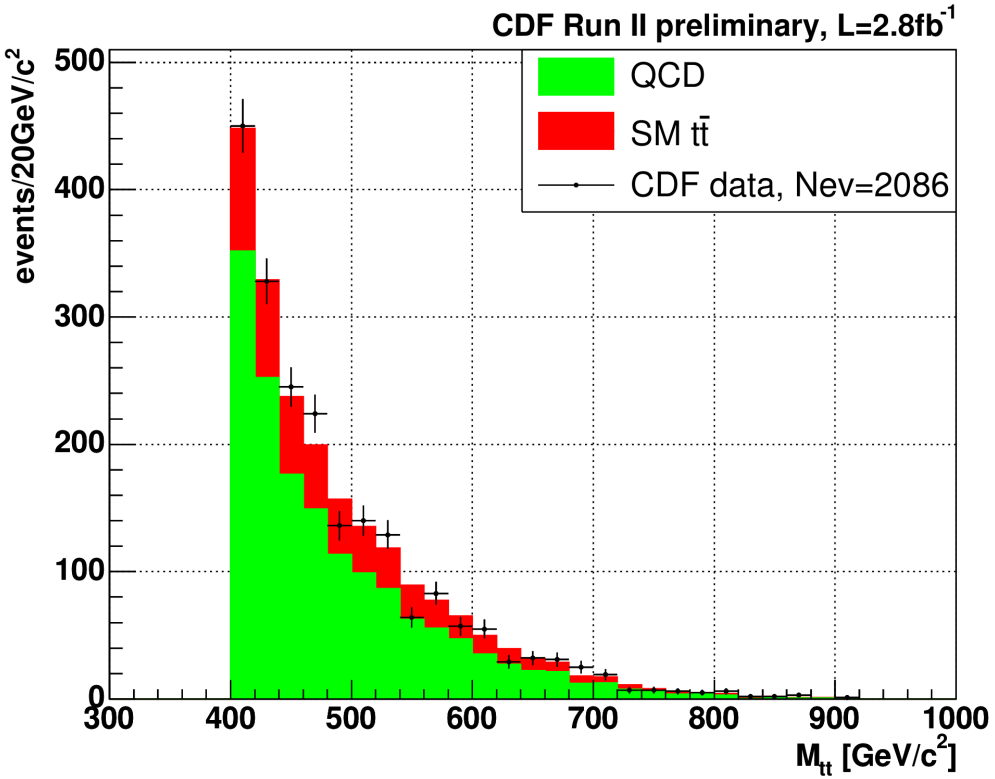
- Why all–hadronic? It's difficult with so much QCD multijet background to isolate $t\bar{t}$
- It does offer the highest branching ratio of $t\bar{t}$ decay channels
- (Resonance) mass resolution is much improved over lepton+jets
- It provides opportunity for a cross–check in an independent sample (useful in the case of discovery!)

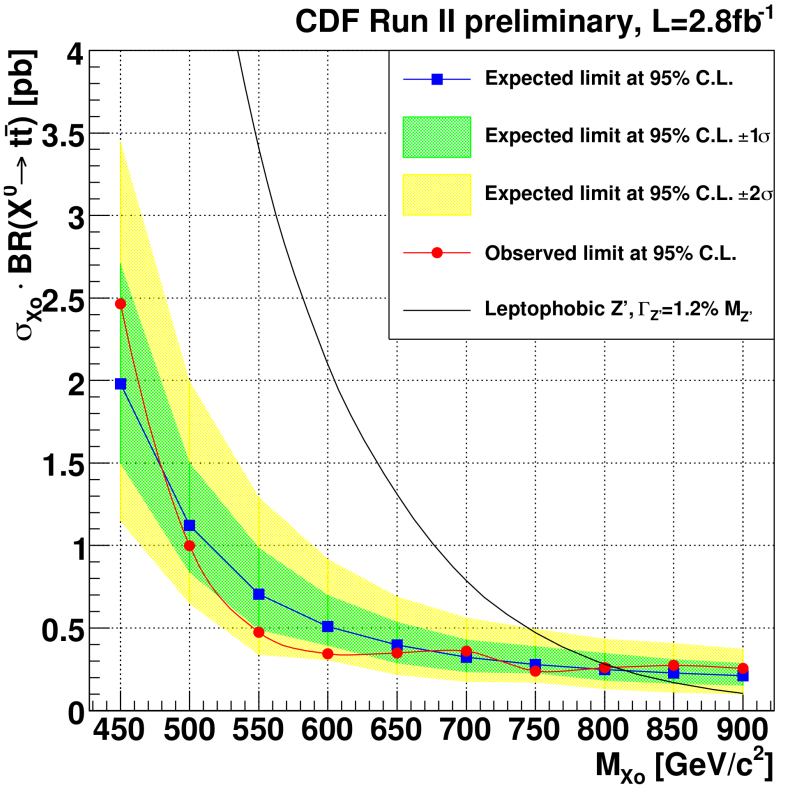


Search for resonant $t\bar{t}$ production in the all–hadronic channel @ CDF

- Events must pass multijet trigger (at least 4 jets with $E_T > 10$ GeV)
- At reconstruction level, we select events with 6 or 7 jets having $E_T > 25$ GeV, $|\eta| < 2$
- Require at least one b–tagged jet
- Final selection using a Neural Net trained to isolate $t\bar{t}$
- before NN selection signal–to–background ratio is 1:1000 after selection it's 1:4
- The multijet background is modeled using control regions from data: *i.e.* regions of NN discriminant value known to have very little $t\bar{t}$ content
- The $t\bar{t}$ invariant mass is estimated using a Matrix Element reconstruction

Search for resonant $t\bar{t}$ production in the all–hadronic channel @ CDF

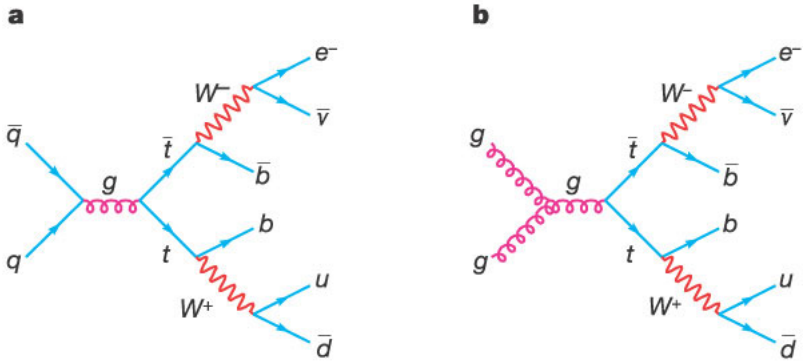


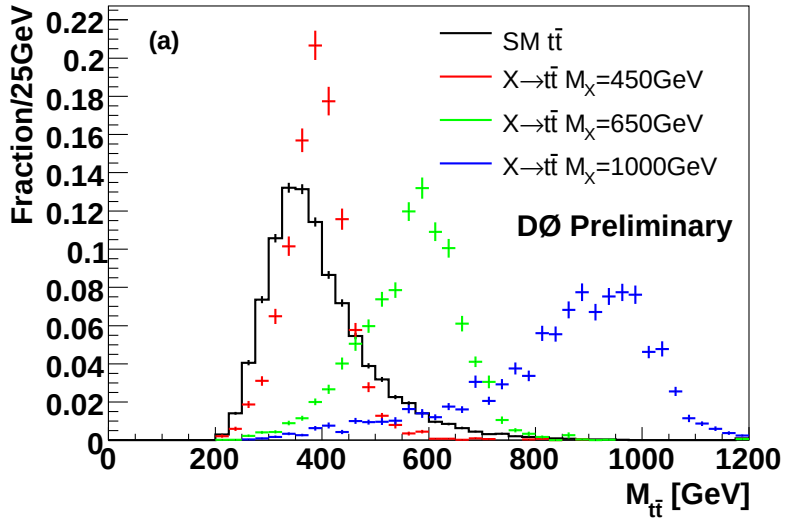


95% CL exclusion of top-color-assisted technicolor Z' with $m_{Z'} < 805$ GeV for $\Gamma_{Z'} = 0.012 M_{Z'}$

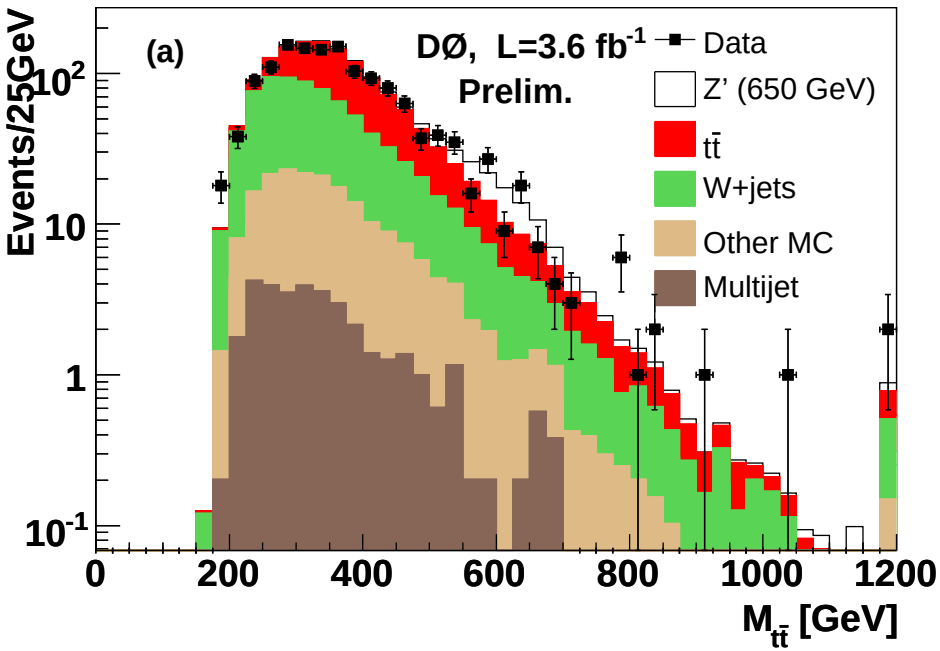
Search for resonant $t\bar{t}$ production in lepton+jets @ DØ

- One W decays to an electron or muon
- Backgrounds are reduced by requiring one jet be "tagged" according to DØ's Neural Network tagger
- Events are reconstructed by solving for the neutrino z–component of momentum
- This allows 3–jet events to be included
- $t\bar{t}$ invariant mass reconstructed simply by adding four–vectors of objects observed in event (*i.e.* jets, lepton, $\not\!\!E_T$)

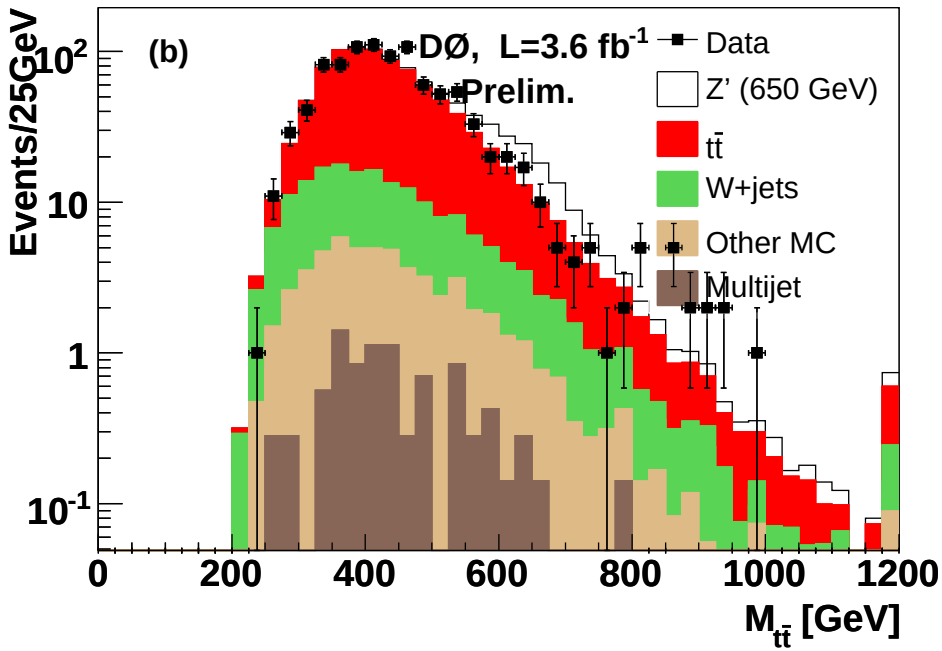




Search for resonant $t\bar{t}$ production in lepton+jets @ DØ

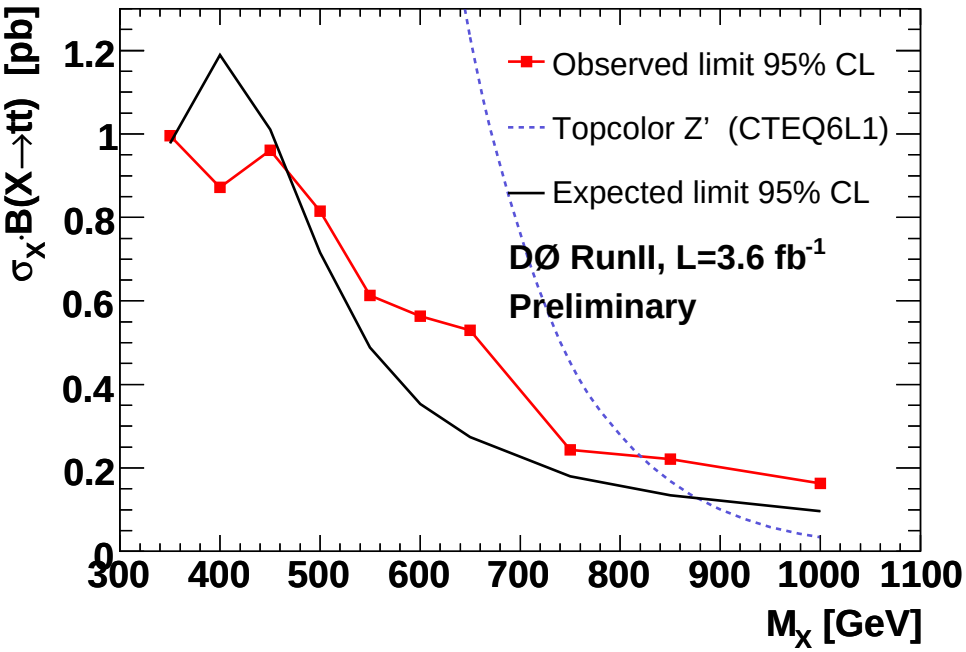


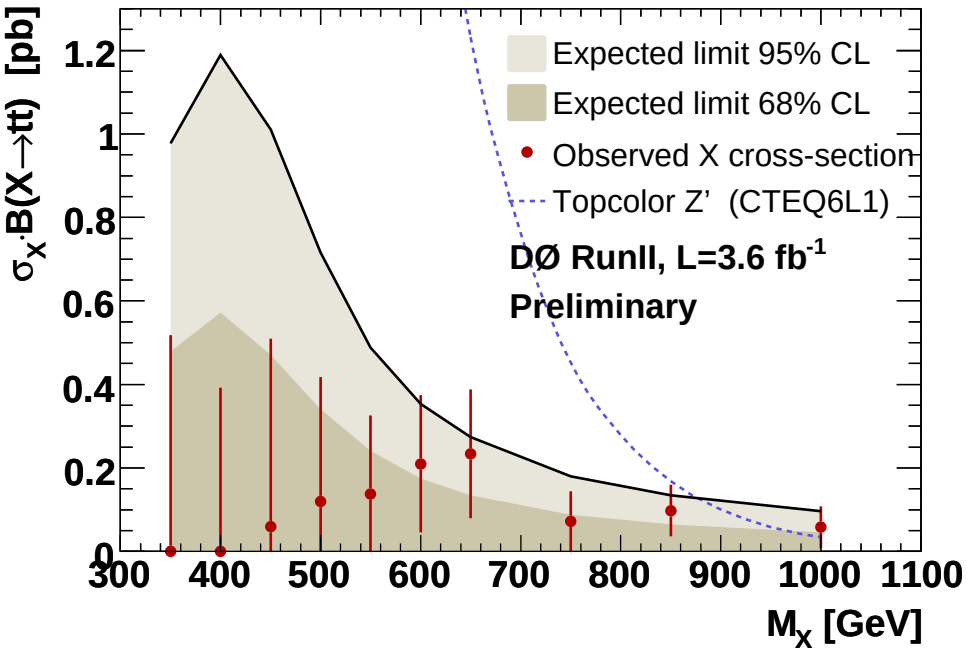
3 jets



$\geq$ 4 jets

Search for resonant $t\bar{t}$ production in lepton+jets @ DØ

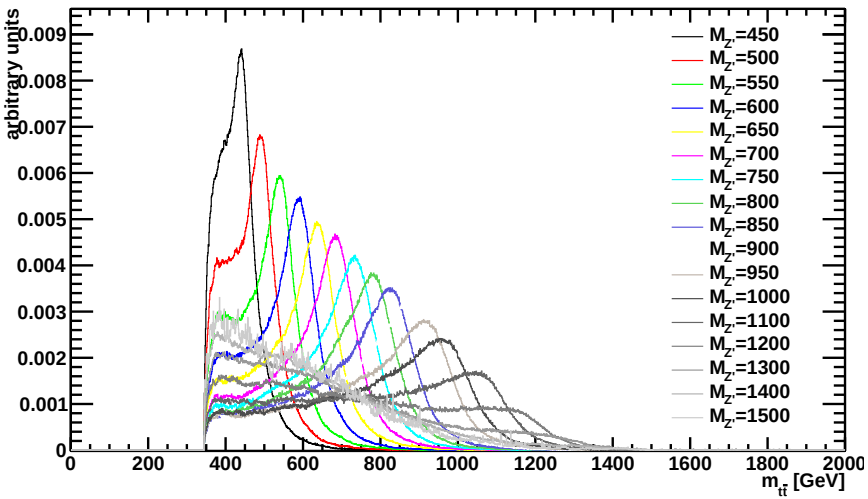


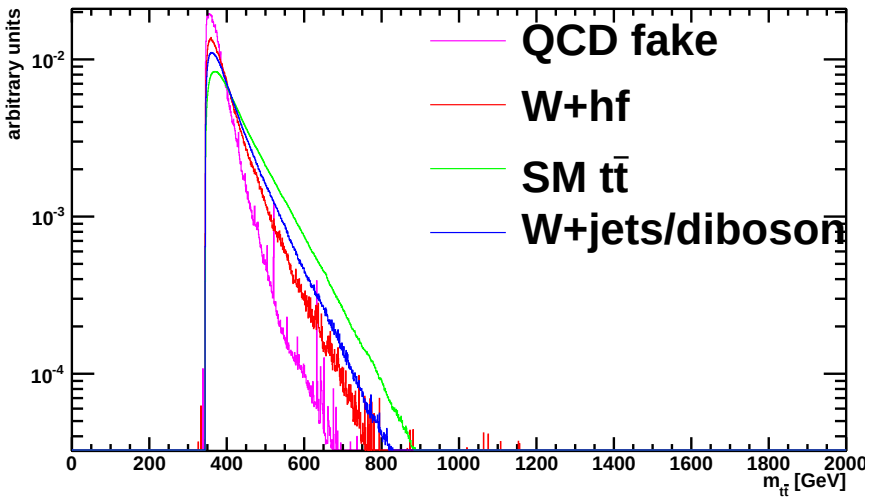


95% CL exclusion of top-color-assisted technicolor Z' with $m_{Z'} < 820$ GeV for $\Gamma_{Z'} = 0.012 M_{Z'}$

Search for resonant $t\bar{t}$ production in lepton+jets @ CDF

- Full Matrix Element reconstruction
- For each event, observe PDF of $m_{t\bar{t}}$, not a single value
- Require $\geq$ 4 jets, one or more b–tag
- SM $t\bar{t}$ modeled by Pythia, weighted by $t\bar{t}$ invariant mass spectrum from NLO generator MCFM using CTEQ6.6 PDFs





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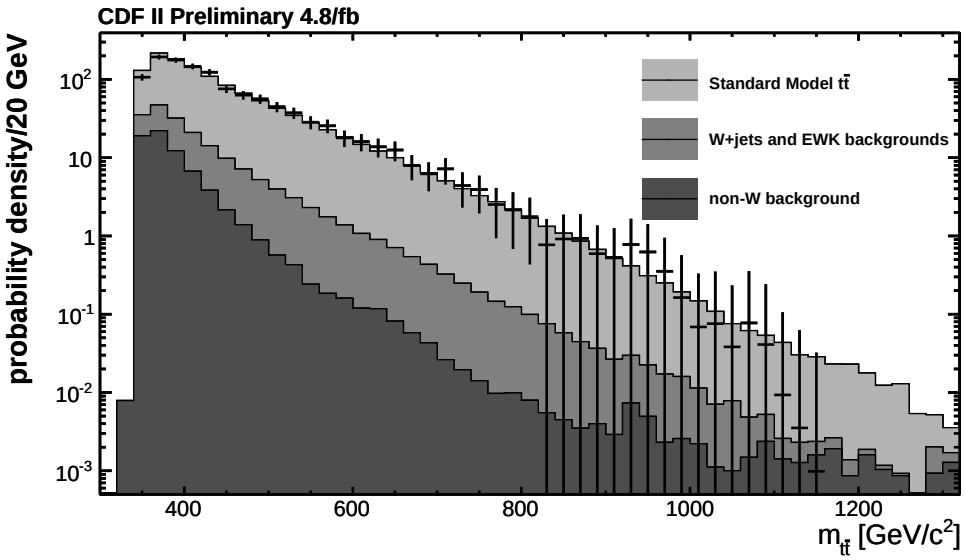

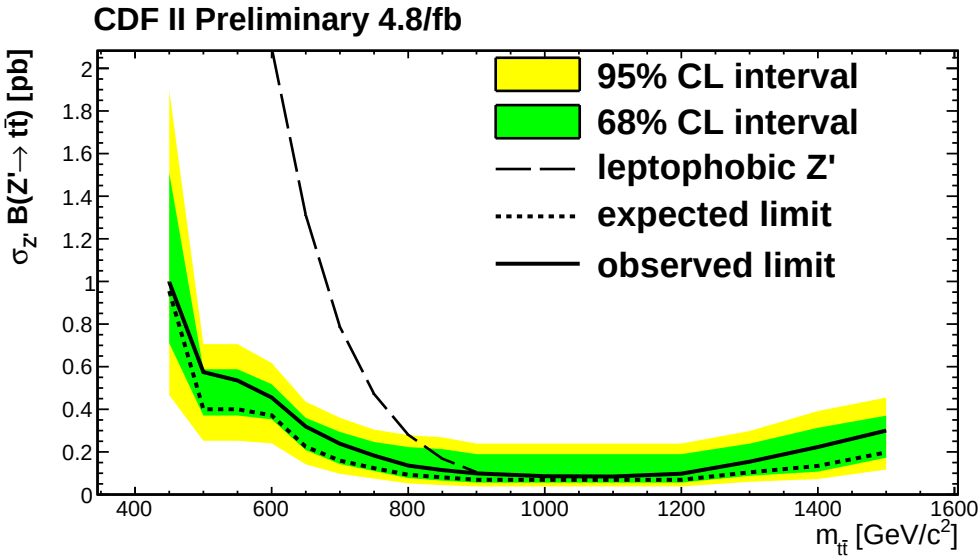

95% CL exclusion of top-color-assisted technicolor Z' with $m_{Z'} < 900$ GeV for $\Gamma_{Z'} = 0.012 M_{Z'}$

Conclusions

- No evidence for resonant production of $t\bar{t}$ at the Tevatron
- Limits on $Z' \rightarrow t\bar{t}$ cross section set at the level of a few percent of SM QCD $t\bar{t}$ cross-section
- CDF all–hadronic (2.8 fb^{-1}): $m_{Z'} < 805$ GeV
- DØ lepton+jets (3.6 fb^{-1}): $m_{Z'} < 820$ GeV
- CDF lepton+jets (4.8 fb^{-1}): $m_{Z'} < 900$ GeV
- Approaching exclusion of resonant $t\bar{t}$ at mass of 1TeV!
- The Tevatron is probing New Physics at cross sections of $\simeq 0.1$ pb over a large range of Z' masses!

Thank You