Search for $t\bar{t}$ Resonances

NRW Pheno

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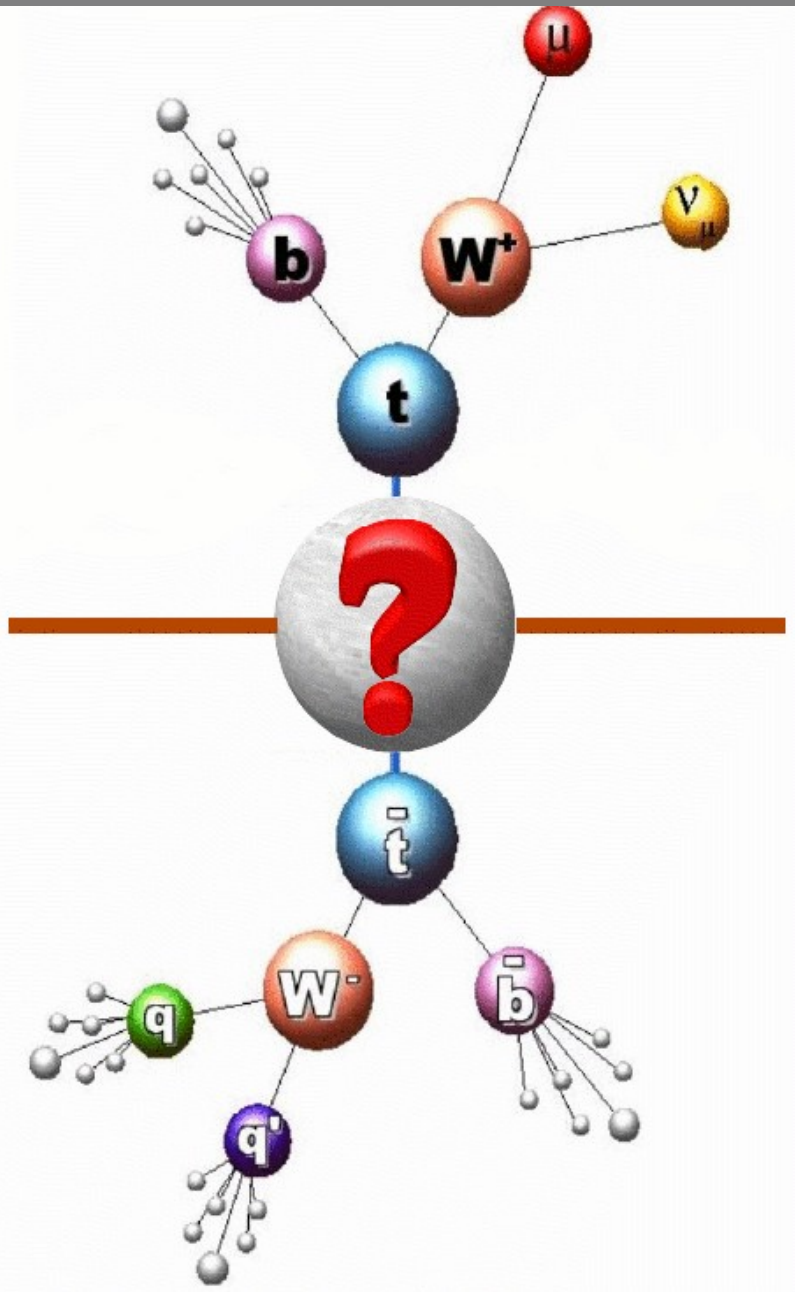
Maren Vaupel

Bergische Universität Wuppertal

Search for $t\bar{t}$ production via new Resonance

- No resonance production in $t\bar{t}$ system is expected in SM
- Some models predict $t\bar{t}$ bound states:
  - large top mass can be generated through dynamical $t\bar{t}$ condensate X
  - new strong gauge force coupling to 3rd generation
- e.g. topcolor-assisted technicolor
  - predicts leptophobic Z'
- search for resonance signal in invariant mass distribution of the $t\bar{t}$ decay products
- narrow: smaller than mass resolution of the detector

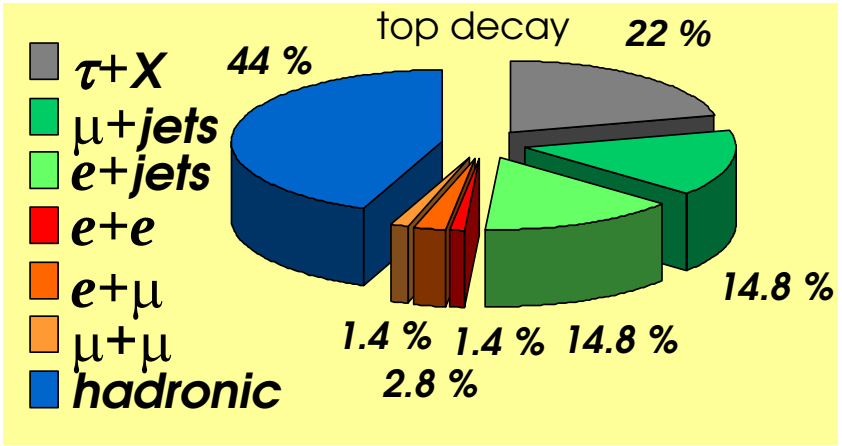


Resonance MC

- use Pythia to generate a resonance X
- process is: $Z' \rightarrow t\bar{t}$ (only)
- adjust vector and axial couplings to get $\Gamma_x = 0.012\ M_x$
- no interference gamma/Z/Z' considered
- ten different samples with resonance masses from 350-1000GeV and $\Gamma_x = 0.012\ M_x$

Decay Topology in $t\bar{t}$

Top quarks decay predominantly (~100%) to a W-Boson and a b-quark

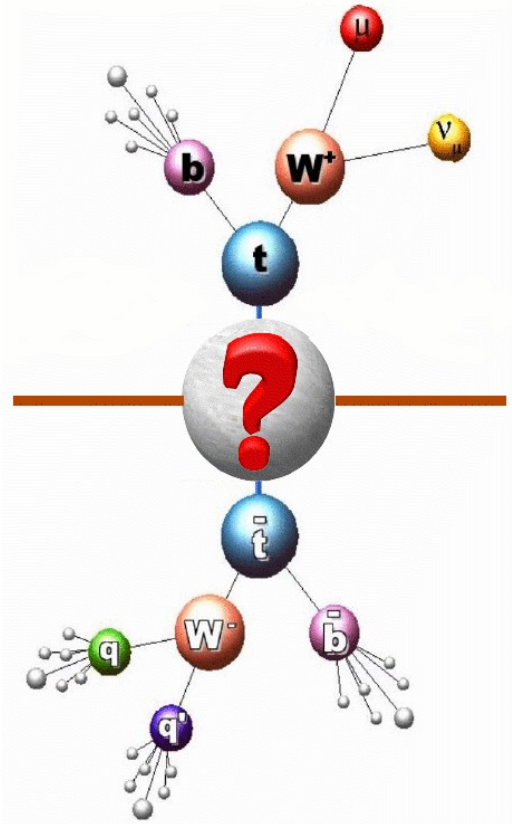


Top-Antitop Signatures:

`dilepton channel'
5% : 2 jets, 2 charged leptons, 2 ν

'lepton+jets channel'
30%: 4 jets, e or μ, 1 ν

'all-jets channel'
44%: 6 jets

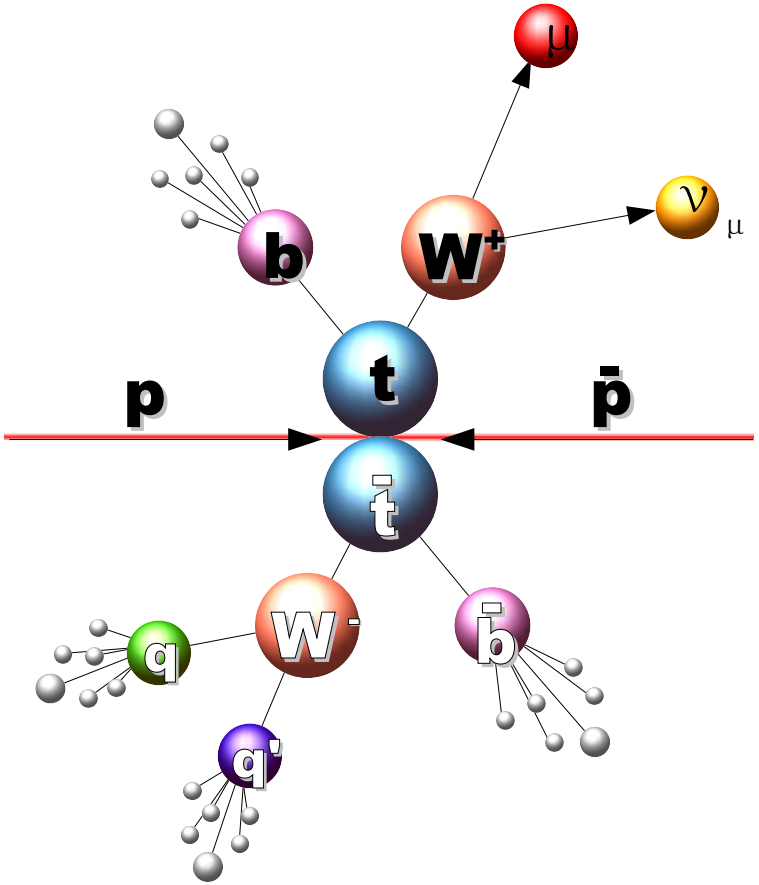


always 2 jets are b-jets

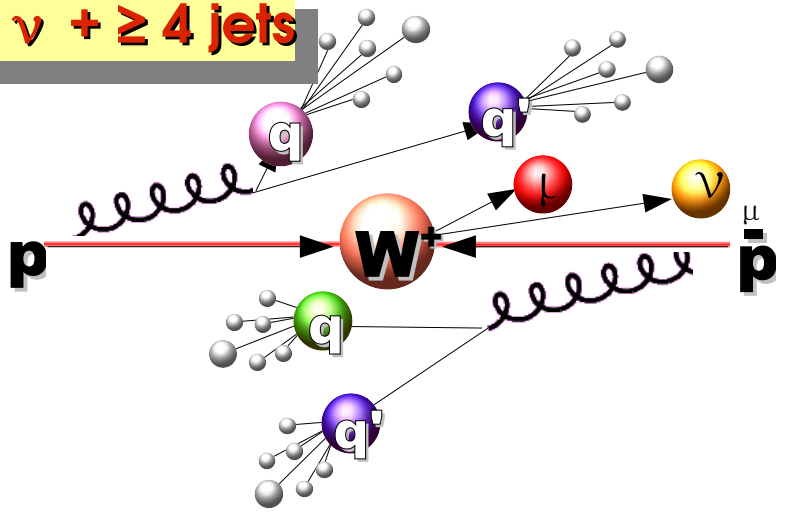
Background Topology

$t\bar{t}$ in SM (dominant background)

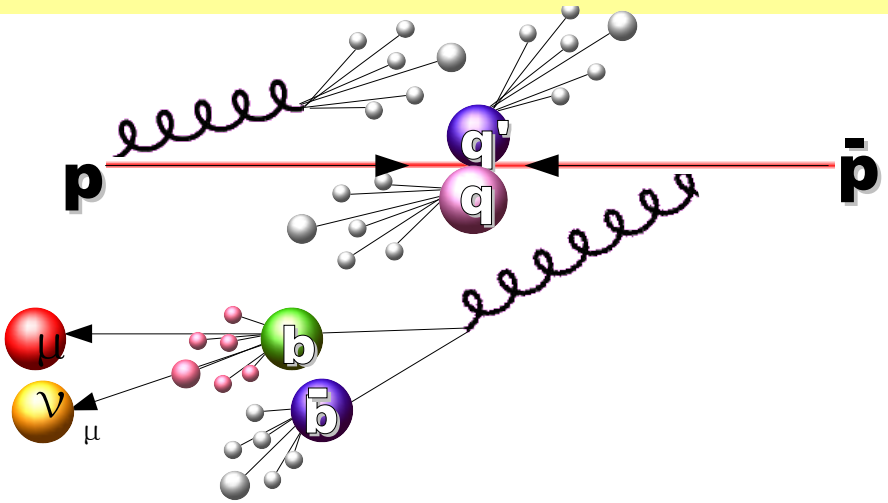
- 1 lepton with high p_T
- 1 ν (missing transverse energy = MET)
- ≥ 4 jets



W → l ν + ≥ 4 jets



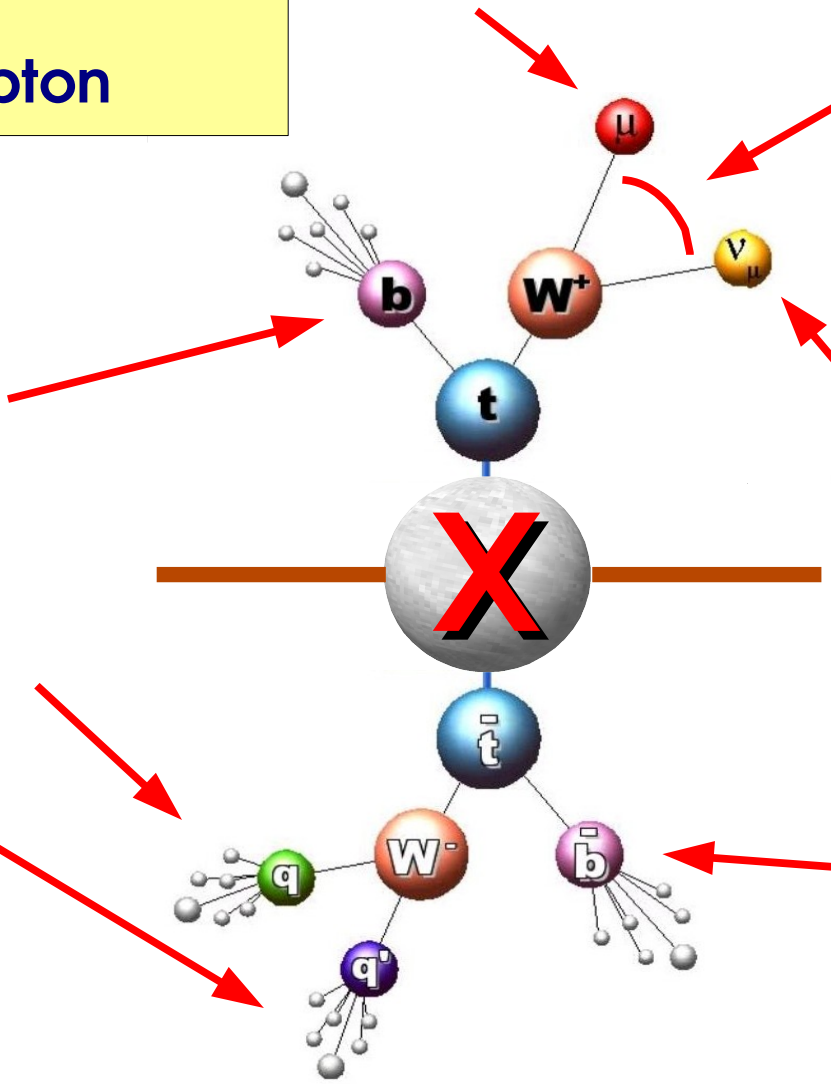
multijet background (QCD)
+ misreconstructed met
+ fake isolated μ or e



Event Selection

e (μ) isolated, $p_T > 20$ GeV,
$|\eta| < 1.1$ (2.0),
no other high p_T lepton

minimum $\Delta\varphi$

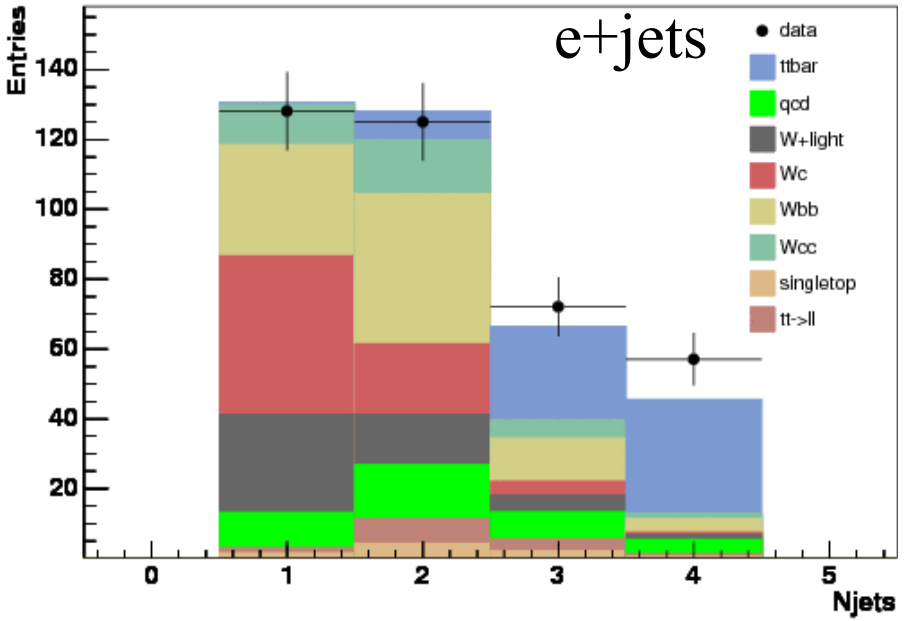


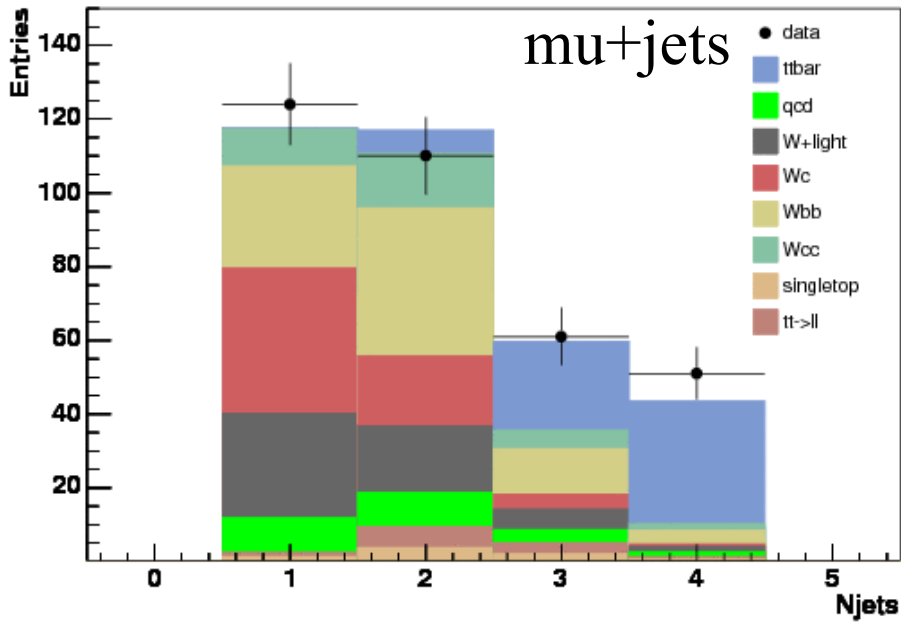
missing $E_T > 20$ GeV

at least 4 jets,
$p_T > 15$ GeV,
$|\eta| < 2.5$

at least 1 jet
b-tagged
(secondary
vertex)

Prediction of the sample composition





SM: use $t\bar{t}$ cross section

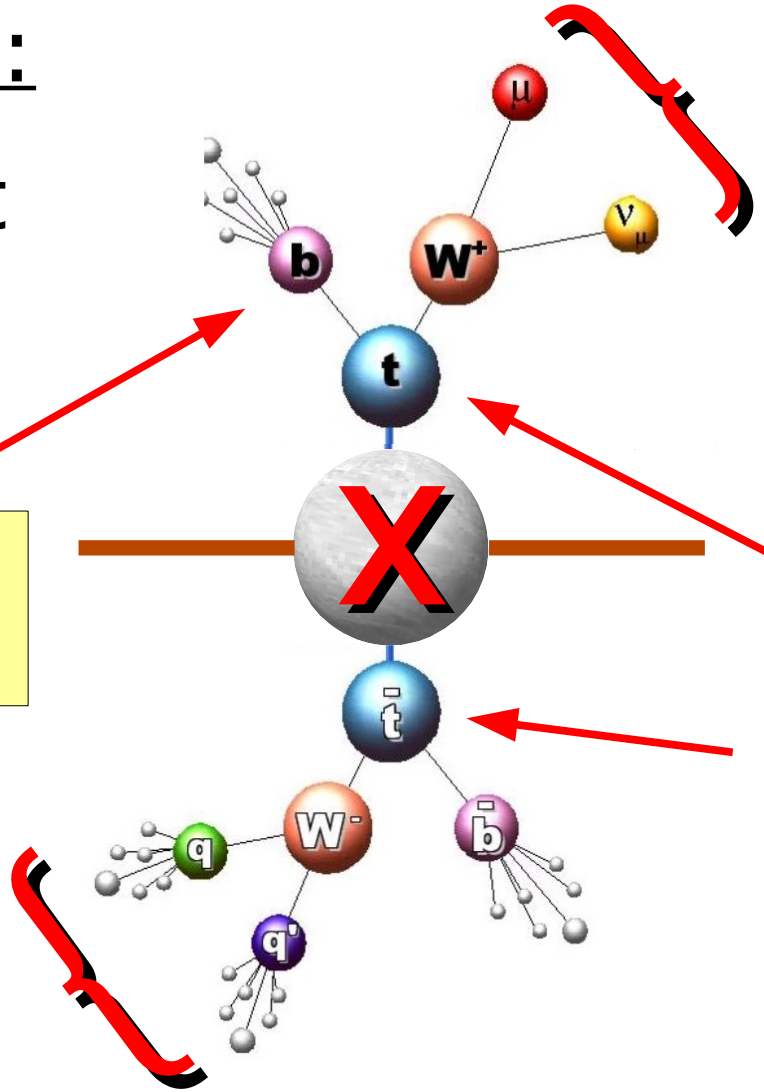
6.77 ± 0.42 pb (NNLO)

	e+jets	mu+jets
W+jets	7.6 ± 0.2	7.7 ± 0.2
QCD	4.0 ± 1.4	1.2 ± 1.1
tt->ll	0.74 ± 0.02	0.66 ± 0.03
singletop	0.72 ± 0.03	0.66 ± 0.02
tt->l+jets	32.6 ± 0.3	33.3 ± 0.3
total	45.6 ± 1.5	43.6 ± 1.1
observed	57	51

Reconstruction of $t\bar{t}$ Invariant Mass

12 jet-parton assignments:

kinematic fit lowest χ^2



invariant W mass (2 ν solutions)

b-tag

(not used for this result)

m_{top} = 175 GeV mass constraint

Invariant W mass

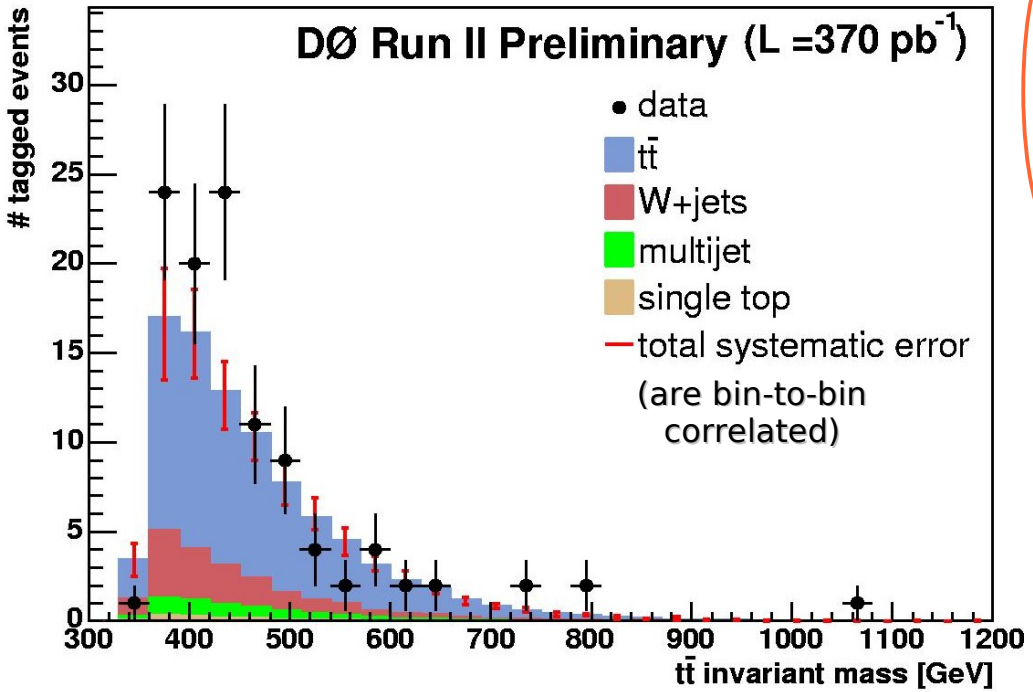
Results for e, μ combined

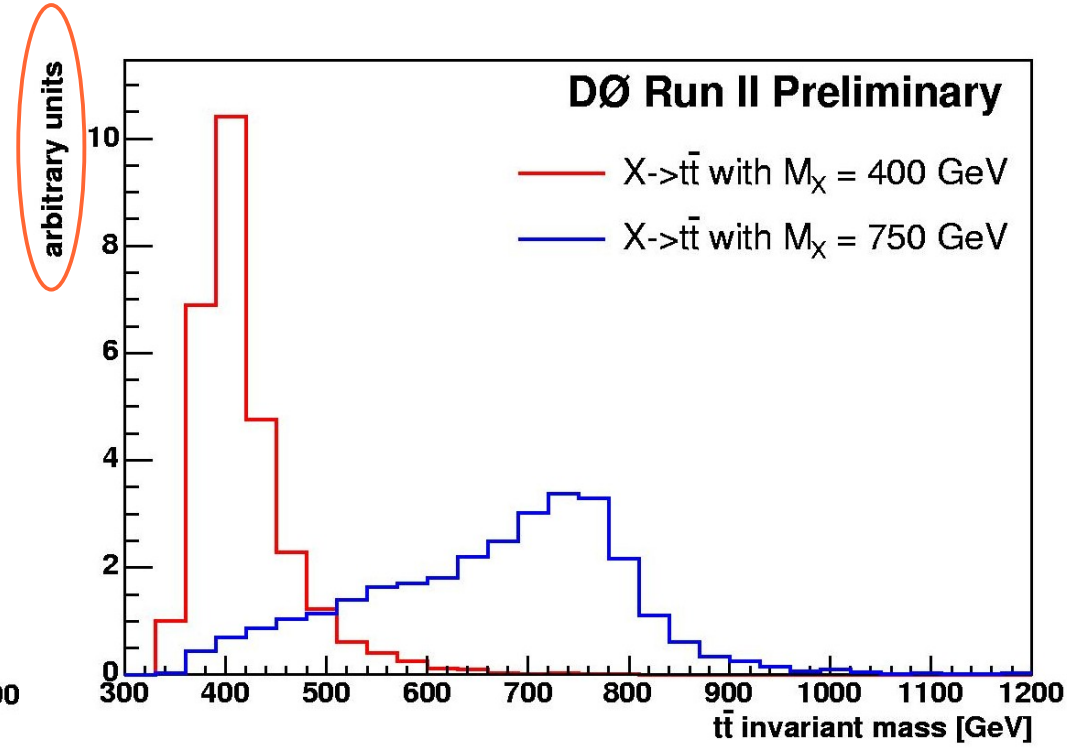
Data and SM:

SM: use $t\bar{t}$ cross section

6.77 ± 0.42 pb (NNLO)

Signal:





⇒ e, μ + jets combined: 108 events, $89.2^{+11.7}_{-13.2}$ expected

Systematic Uncertainties

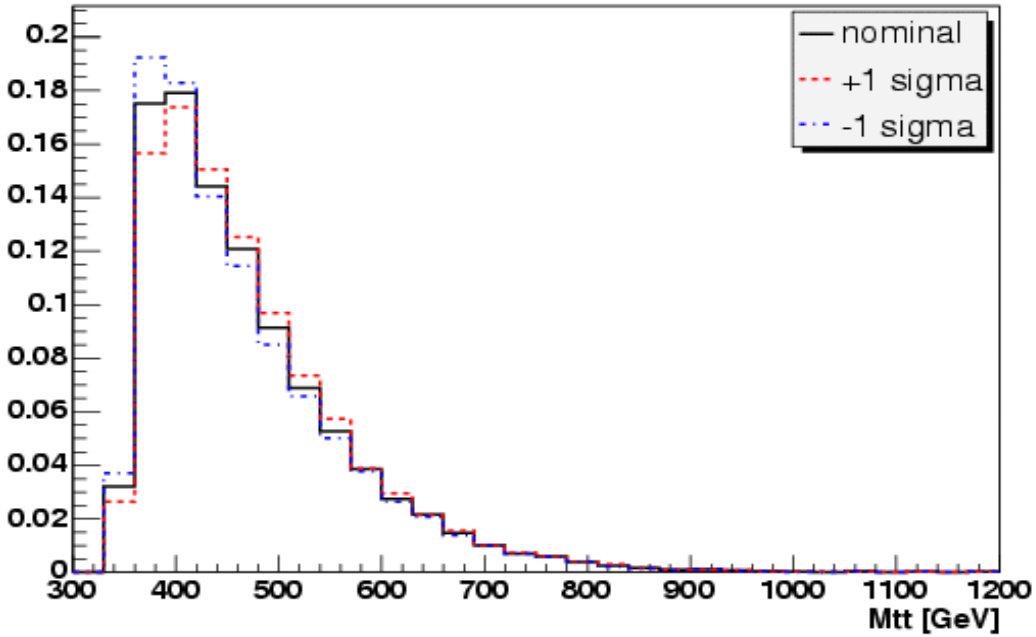
relative systematic change on overall normalization of SM background:

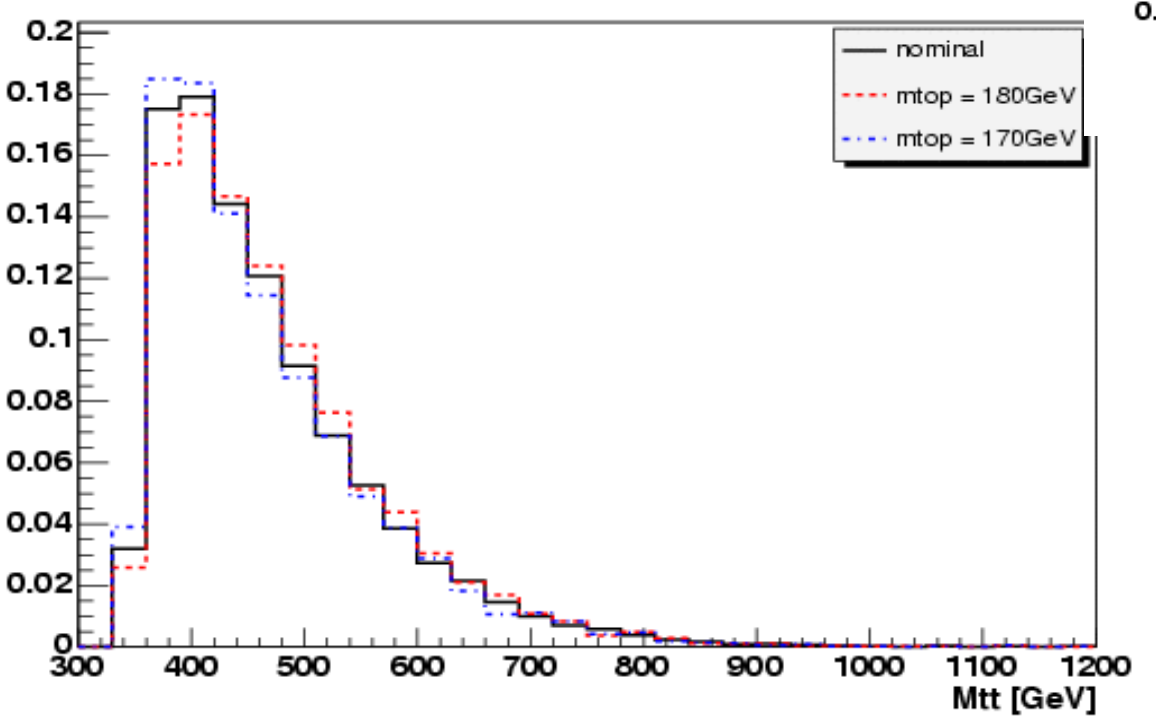
source	rel. syst. uncertainty (%)	
	σ^+	σ^-
Top quark mass (includes effect on $\sigma_{t\bar{t}}$)	+8.7	−7.6
Signal subtraction from W+jets background estimate	+0.0	−6.6
Jet reconstruction	+5.6	−6.9
Luminosity	+4.6	−4.6
Theoretical uncertainty on $\sigma_{t\bar{t}}$	+4.2	−4.2
W+jets flavor composition	+2.9	−3.0
Jet energy calibration	+2.7	−3.2
b-tagging rate	+2.6	−2.6
MC-to-data correction factors	+2.5	−2.5
Theoretical uncertainty on $\sigma_{singletop}$	+0.2	−0.2
Total	+13.2	−14.8

uncertainties which change shape of invariant mass distribution are also taken into account

Shape changing systematics

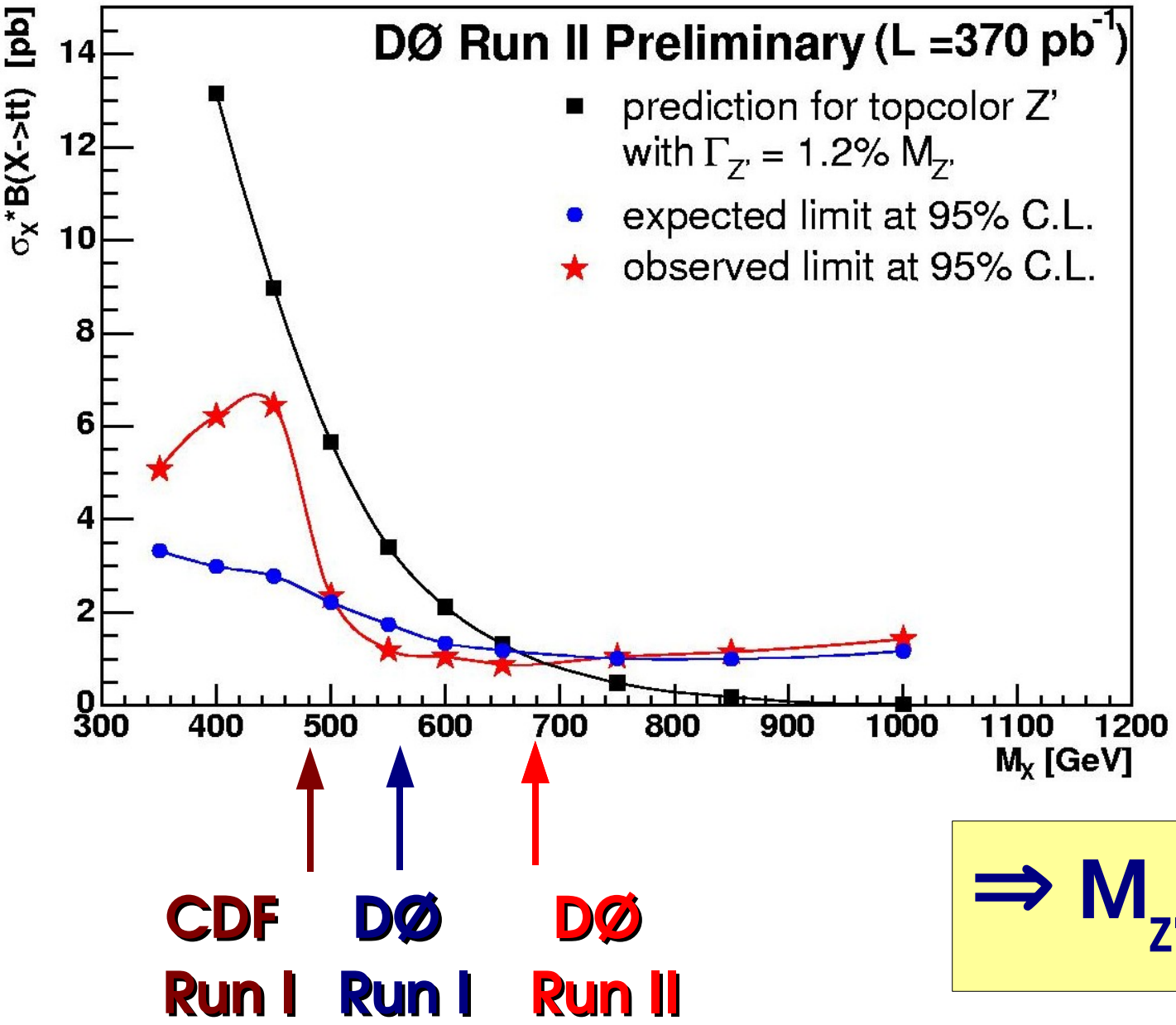
comparison of nominal and +-1sigma JES variation for the dominant $t\bar{t}$ background





comparison of nominal 175GeV, 170GeV and 180GeV top mass for the dominant $t\bar{t}$ background

Limits for e, μ combined



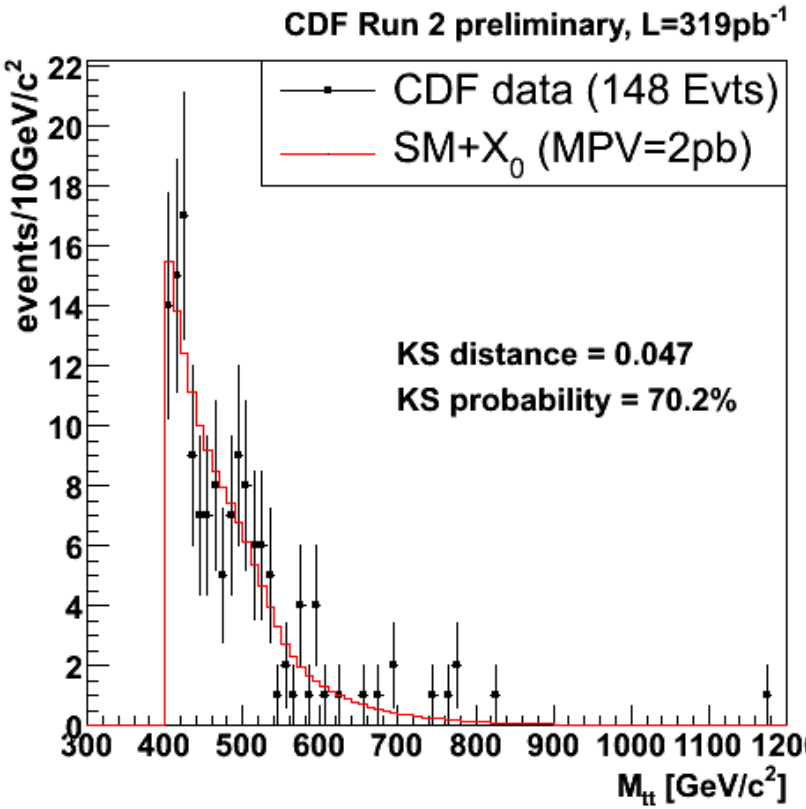
$\Gamma_X = 0.012\ M_X$

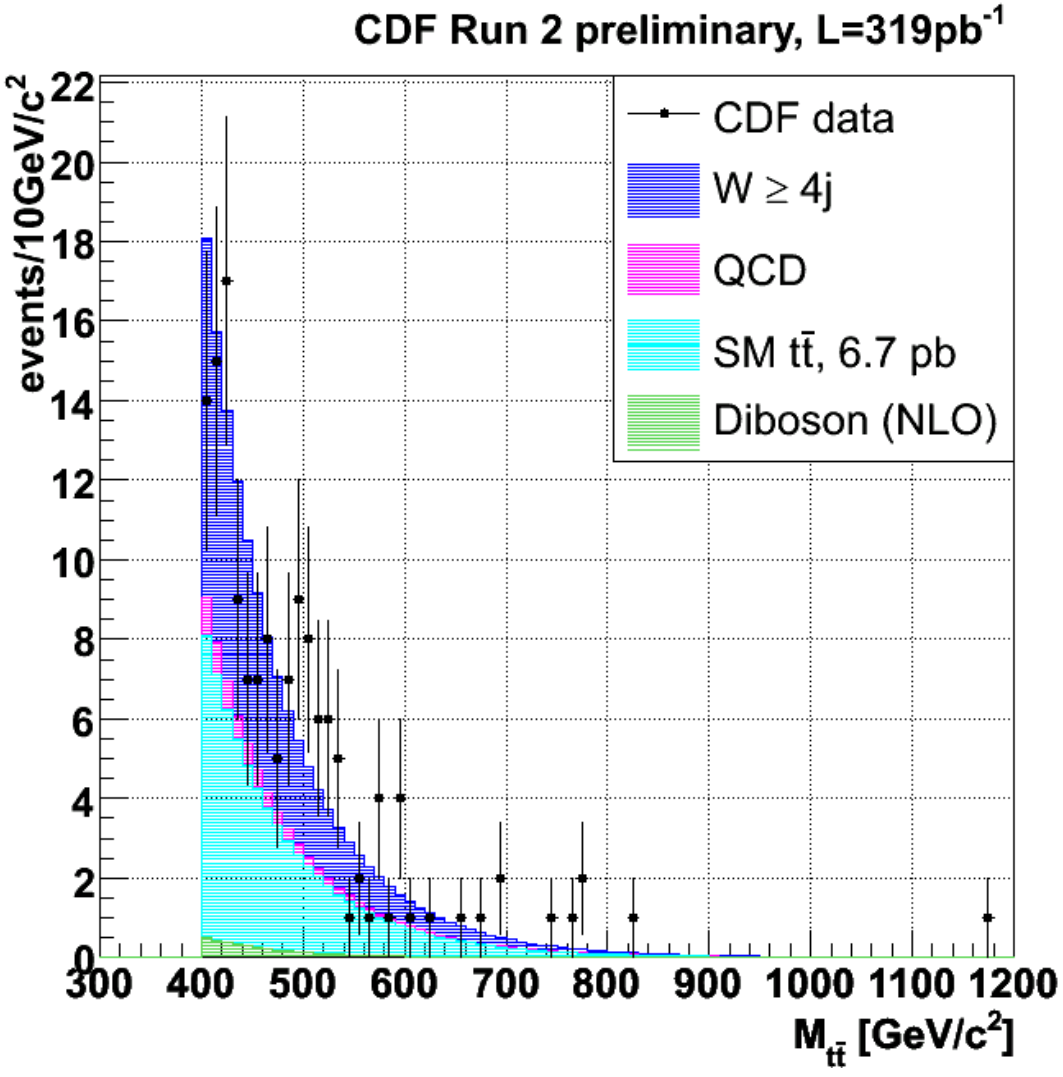
Bayesian approach to calculate 95% C.L. upper limits

$\Rightarrow M_{Z'} > 680$ GeV

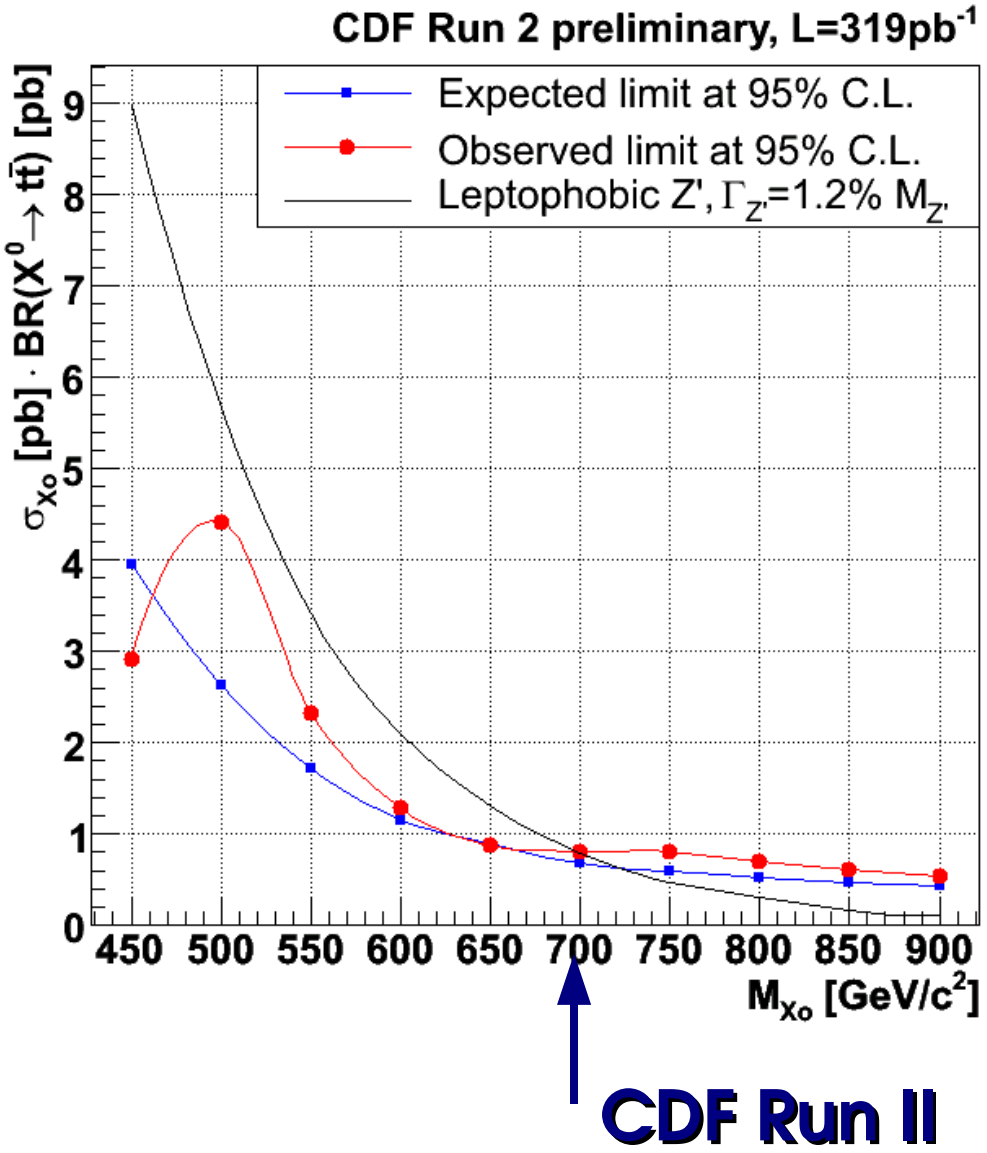
Invariant Mass from CDF

- use matrix element method to extract M_{tt}
- peak around 500 GeV
  - 2 σ effect





New Limits from CDF



Bayesian approach to calculate 95% C.L. upper limits

$\Rightarrow M_{Z'} > 700$ GeV

Conclusions

- Search for $t\bar{t}$ production via intermediate resonance
- No evidence for a resonance
  - only small excess around 400 GeV (D0) and 500 GeV (CDF)
- Cross section limits
- Leptophobic Z':
  - $M_{Z'} > 680$ GeV, $\Gamma_X = 0.012\, M_X$ D0
  - $M_{Z'} > 700$ GeV, $\Gamma_X = 0.012\, M_X$ CDF
- Looking forward to include more data into the analysis