Search for Flavor Changing Neutral Currents in Top decays at CDF

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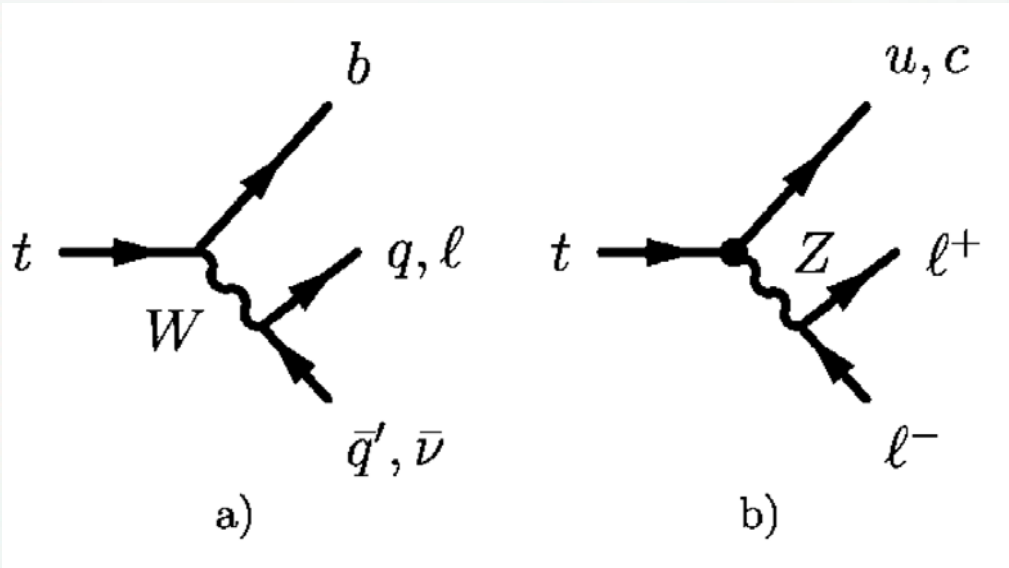
on behalf of the CDF Collaboration

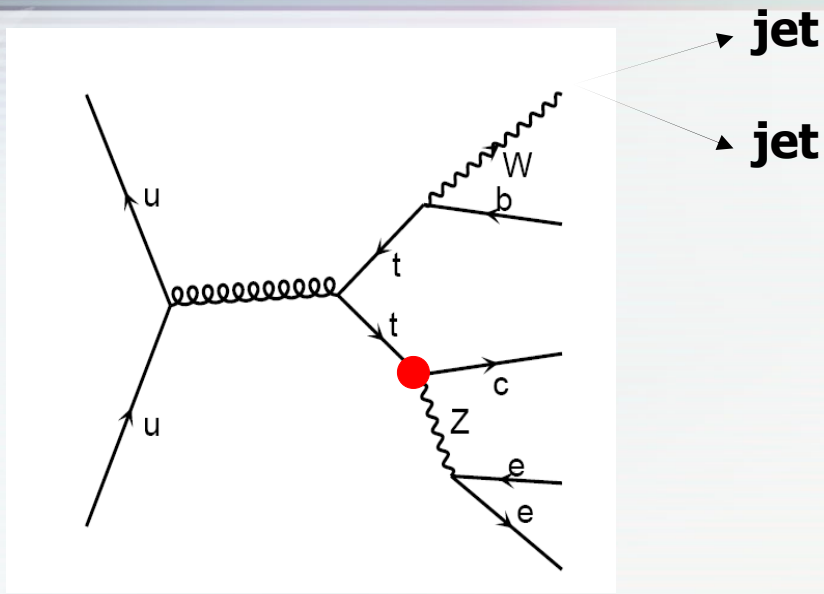
PHENO **April 29, 2008**

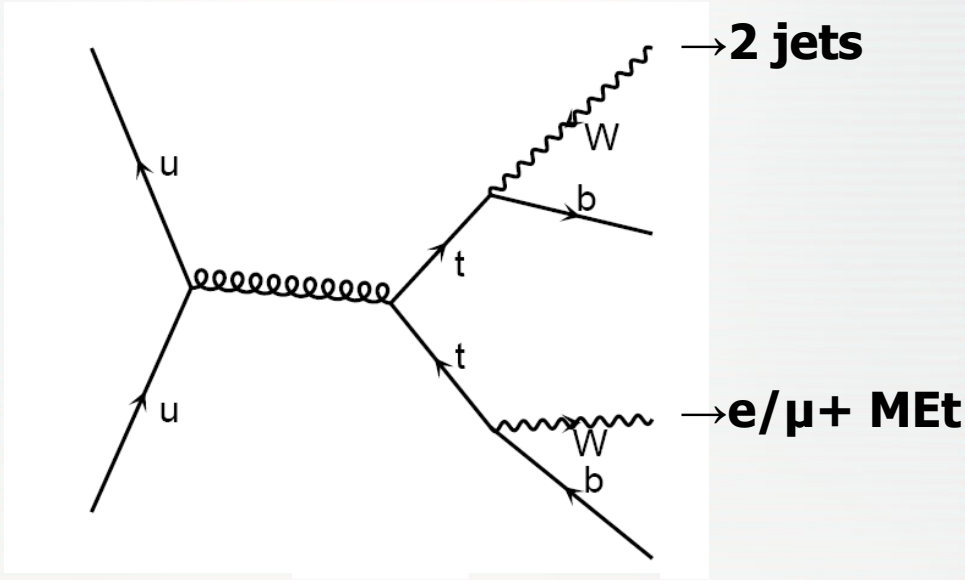
Introduction

- **The Top quark is very heavy (~170 GeV) and special.**
- **Most often it decays to a W boson and a b-quark: $t \rightarrow Wb$ (Fig a)**
- **We are interested in the decay of $t \rightarrow Z^0c$ (Fig b) which is a Flavour Changing Neutral Current (FCNC)**
- **The Standard Model does not allow FCNC decays so any excess is an indication of <u>new</u> physics.**



Analysis overview





2 leptons (forming Z^0) and 4 jets

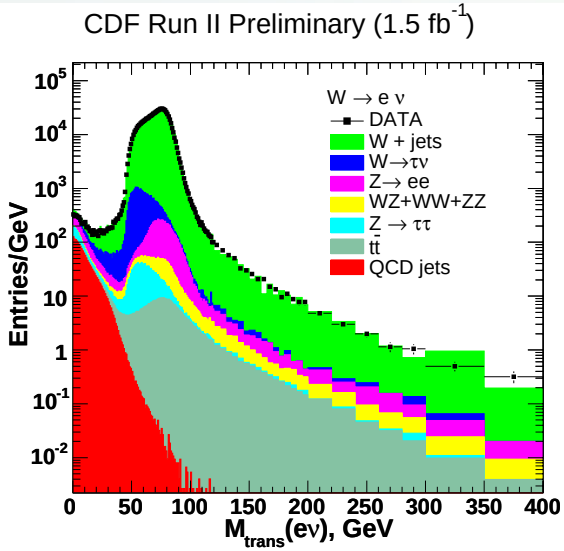
lepton+missing energy (MEt) and 4 jets

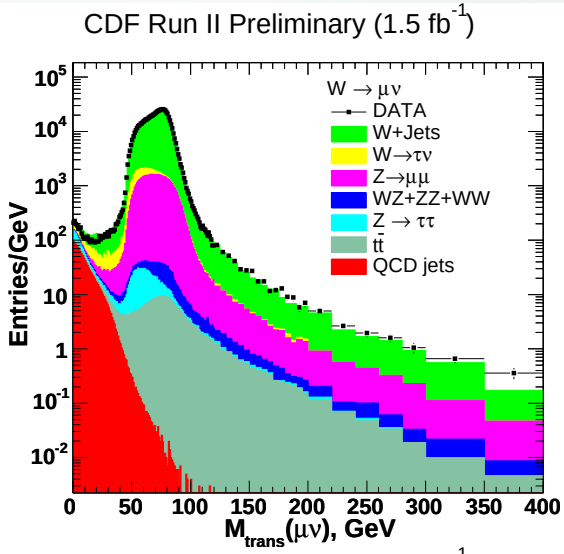
- The top-antitop pairs are produced in collisions of protons and anti-protons at Tevatron at $\sqrt{s}$ = 1.96 TeV.
- The W- and Z^0-bosons are identified via their leptonic decays.
- Decays of the b-quarks and c-quarks are detected by finding a proper displaced vertex (decay) within a jet.
- The analysis is based on the comparison of two decay processes: $t\bar{t} \rightarrow WbZ^0c\bar{b}$ and $t\bar{t} \rightarrow WbW\bar{b}$.
- The simultaneous study of the two decay processes allows cancellation of major systematic uncertainties.

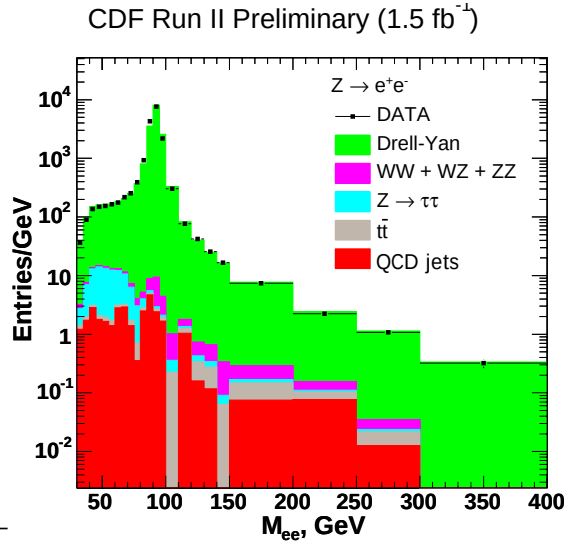
Precision check of MC simulations

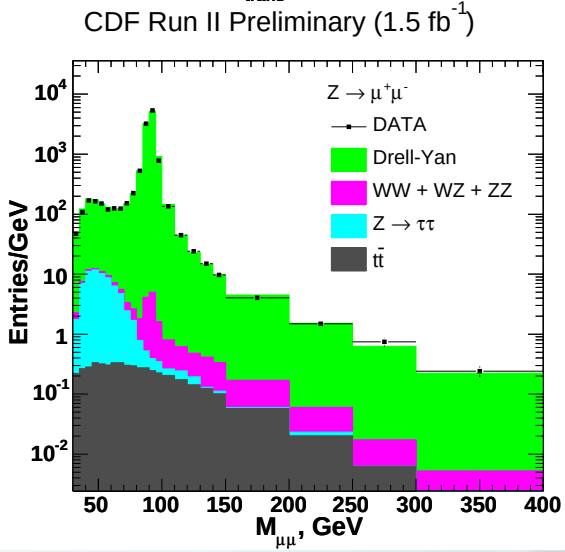
- We make a precision check of Monte Carlo (MC) simulations with inclusive W's and Z's.
- Leptonic decays of inclusively produced W- and Z^0-bosons
- Test of trigger and lepton identification
- Electrons and muons
- The R-ratio is within 2% of its NNLO value

$$R = \frac{\sigma(W) * Br(W \to l\nu)}{\sigma(Z^0) * Br(Z^0 \to l^+l^-)}$$





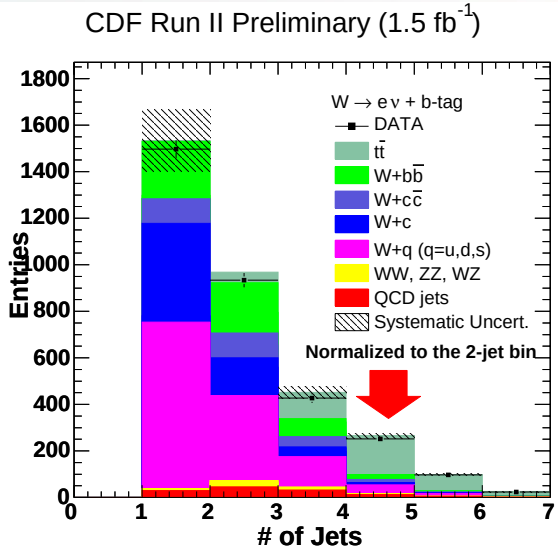


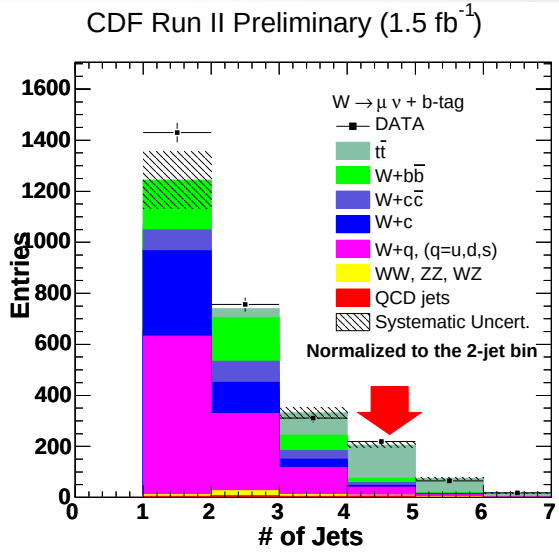


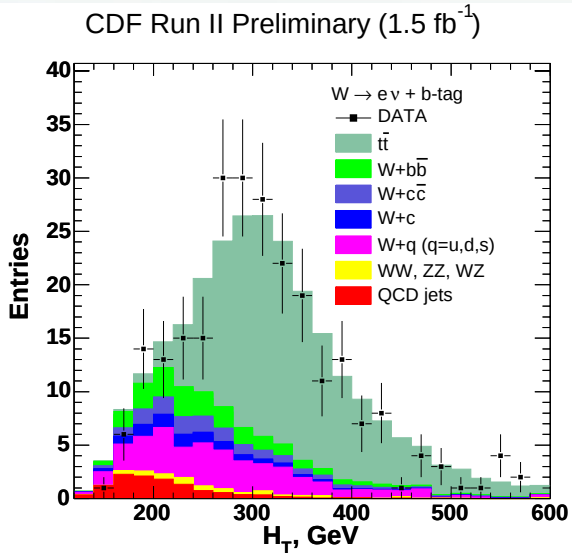
$t\bar{t} \rightarrow W + 4$ jets

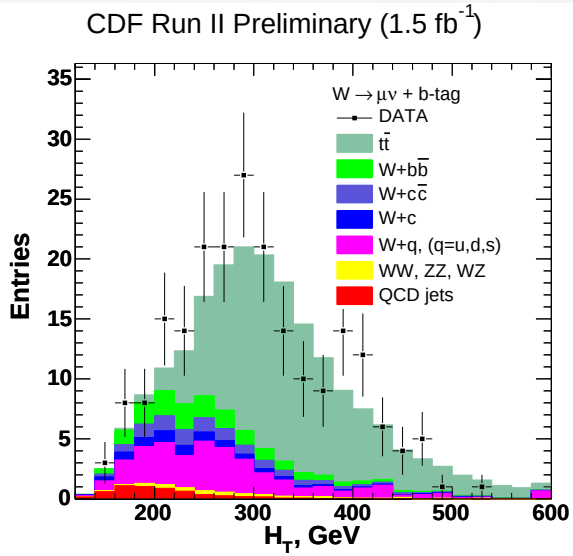
The processes contributing to the final state with a leptonic decay of a W-boson and 4 jets:

- $t\bar{t} \rightarrow WbWb$
- $t\bar{t} \rightarrow Z^0cWb$
- $t\bar{t} \rightarrow Z^0cZ^0c$









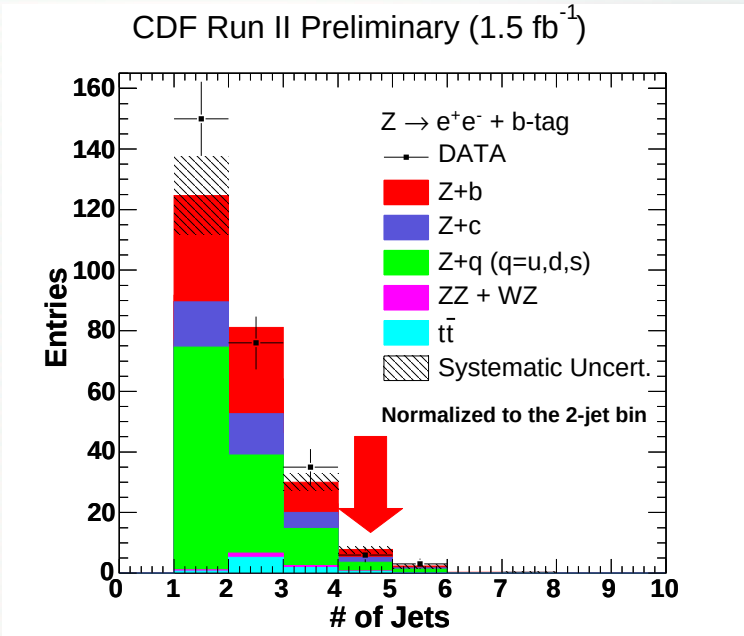
H_T is the total transverse energy in event.

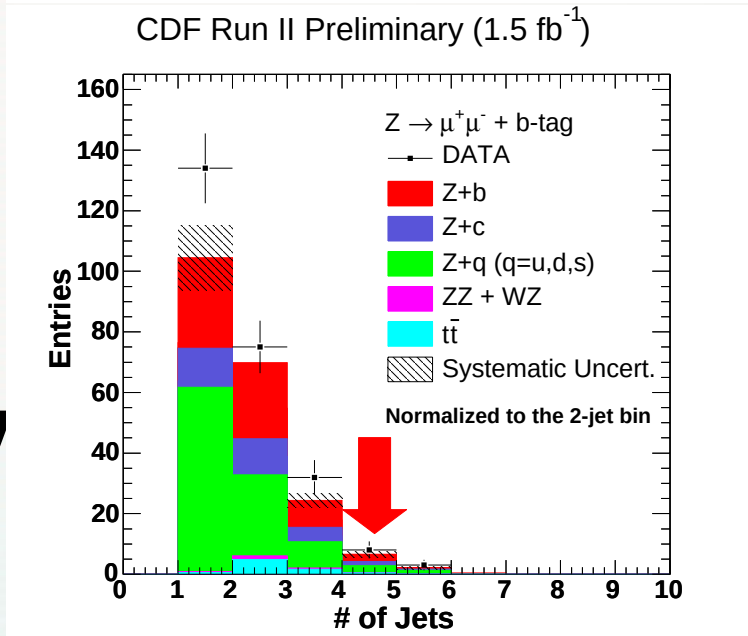
$t\bar{t} \rightarrow Z^0 + 4$ jets

The final state with four jets and a leptonic decay of a Z^0-boson is contributed from the following two processes:

- **$t\bar{t} \rightarrow Z^0cWb$**
- **$t\bar{t} \rightarrow Z^0cZ^0c$**

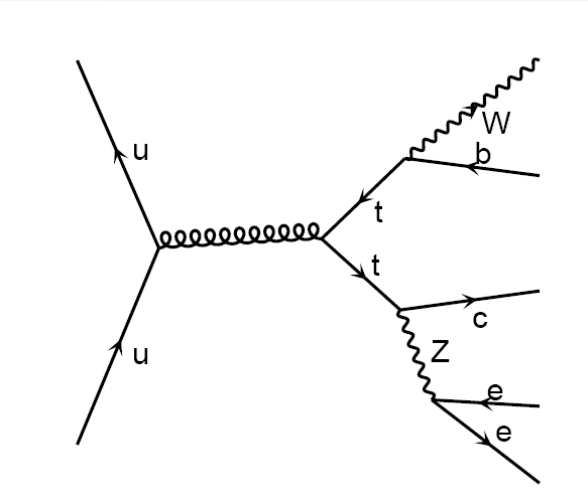
This is the decay mode where you'd most likely see the FCNC signal.



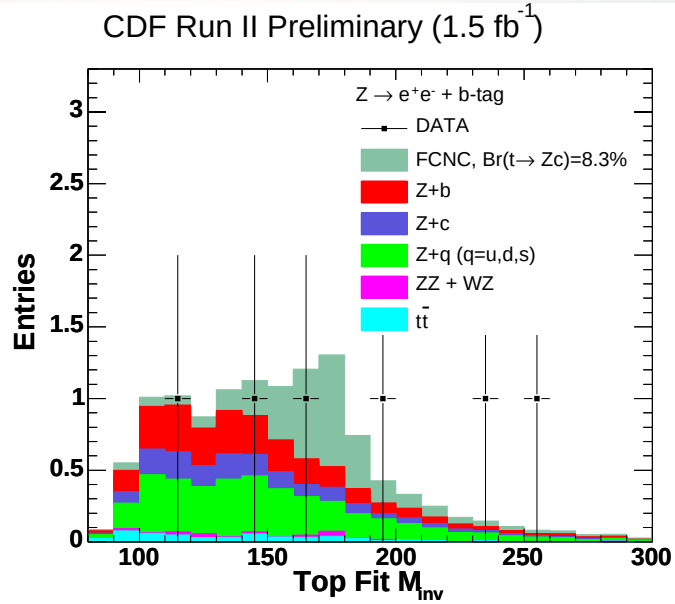


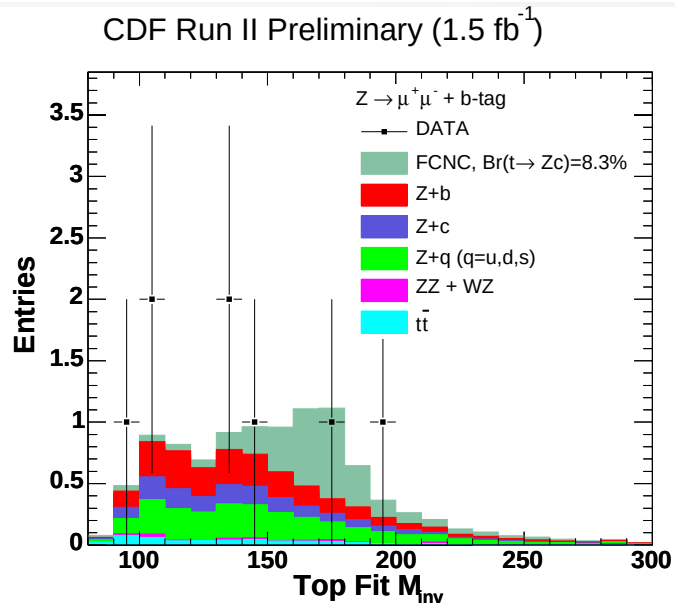
Reconstruction of the top quark's mass

In events with a Z^0-boson and four jets we can reconstruct the invariant masses of the top-quarks.



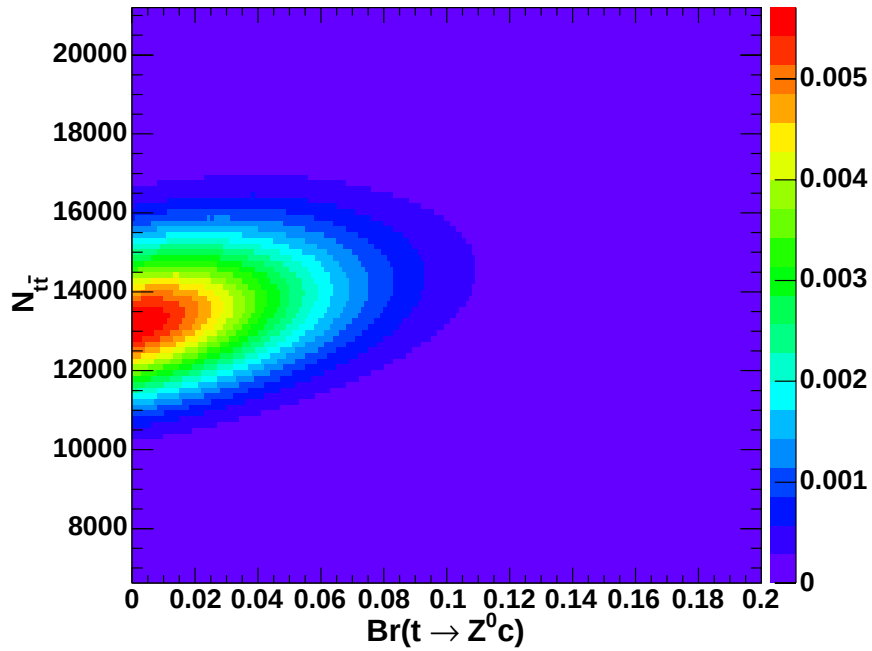
The mass distribution provides additional separation between the FCNC signal and the Standard Model backgrounds.





Statistical Interpretation of data

- 2D likelihood $P\{DATA|\ \sigma(t\bar{t}),Br(t\rightarrow Z^0c)\}$ is constructed using Poisson statistics
- Bayesian approach with two priors for σ(tt):
  - Theory-independent ("Flat")
  - With theoretical cross-section ("Gaussian")
- To present the result in a model-independent way we parameterize the limit as a function of the fraction of longitudinally-polarized Z^0-bosons in the decay of $t\rightarrow Z^0c$.



$P\{DATA|\ \sigma(t\bar{t}),Br(t\rightarrow Z^0c)\}$

Results / Conclusions

- **The Flavor-Changing Neutral Currents in the top decays $t \rightarrow Z^0 c$ are not seen, alas.**
- **We set limits on Br($t \rightarrow Z^0 c$) at 95% C.L.**
- **The observed limits agree with the expected ones.**

Fraction of Longitudinal Z-bosons	0.00	0.25	0.50	0.75	1.0
Gaussian prior	9.0%	8.8%	8.6%	8.5%	8.3%
Flat prior	10.2%	10.0%	9.7%	9.5%	9.2%