A Limit on the Branching Ratio of the Flavor-Changing Top Quark Decay $t \rightarrow Z^0c$

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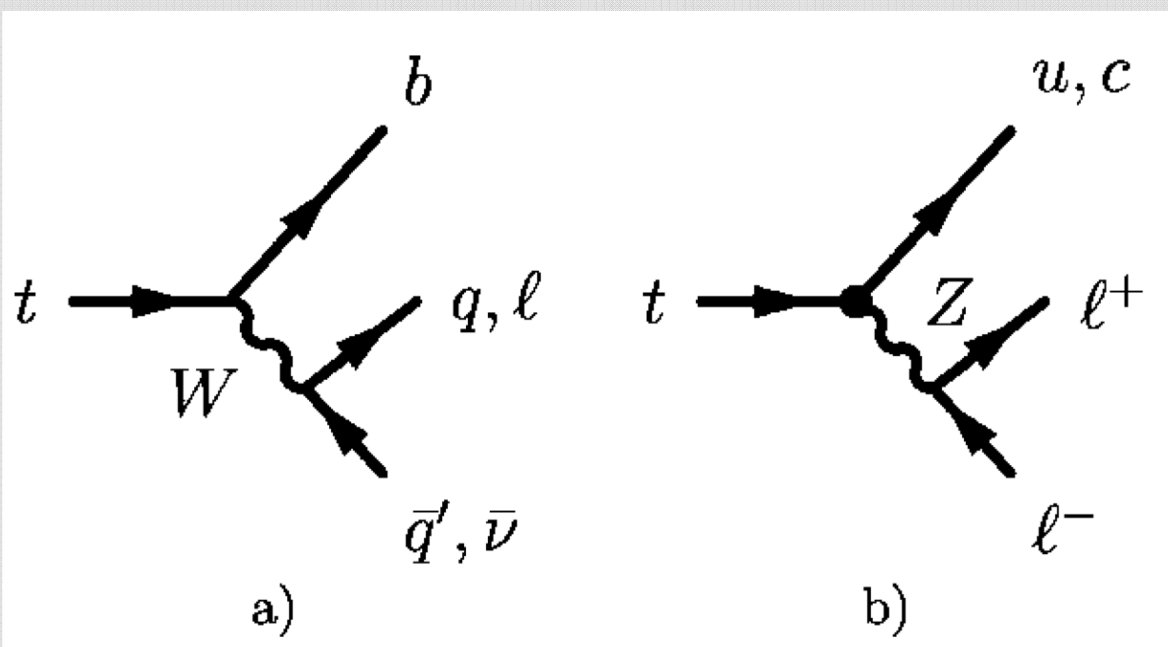
1. Introduction

- The Top quark is very heavy (~170GeV) and special.
- Most often it decays to 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 any FCNC decays of the top quark so any signal is an idication of new physics.

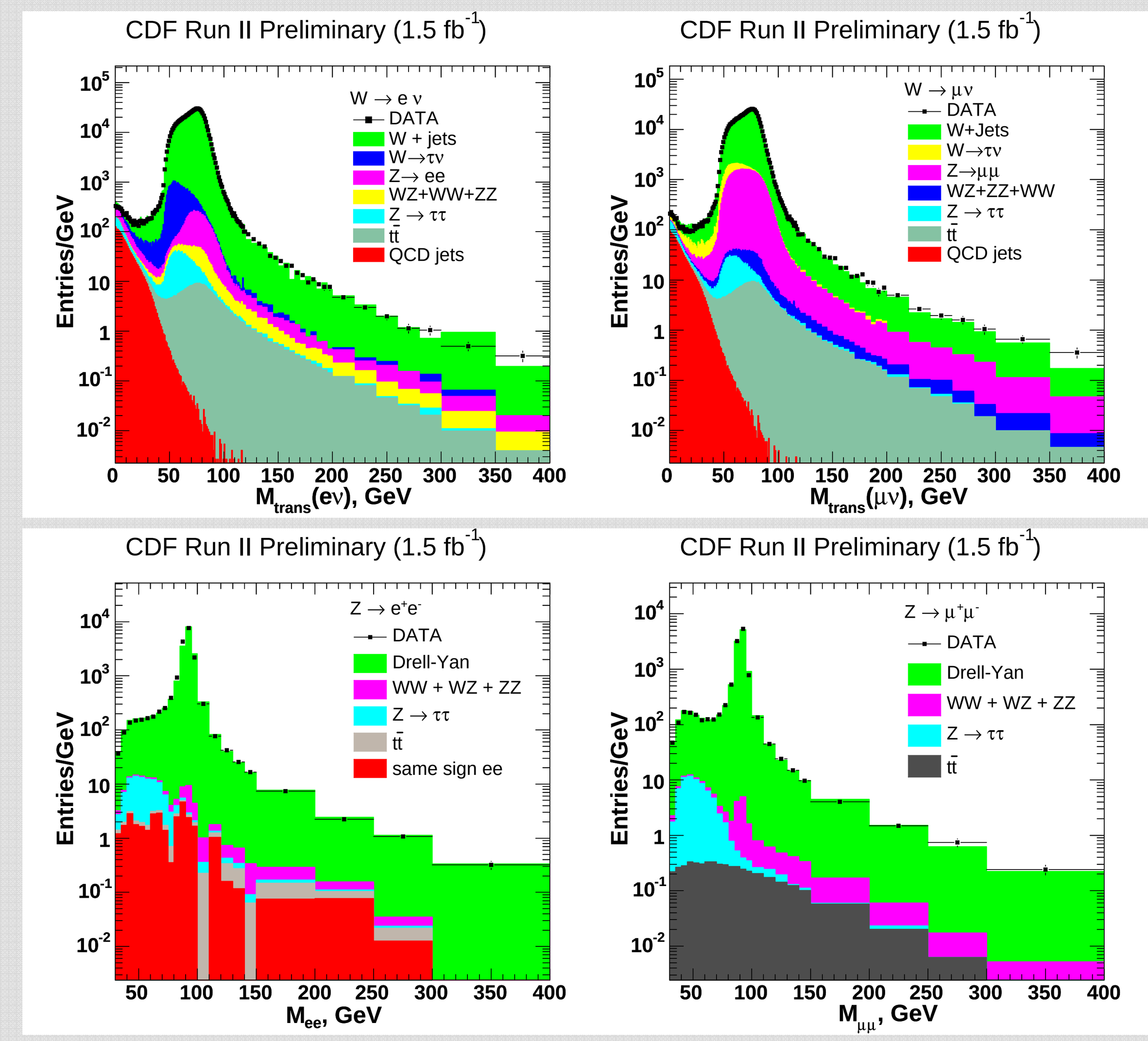


2. Analysis overview

- The top-antitop pairs are produced in collisions of protons and anti-protons at 1.86 TeV.
- Most often the top quark decay weakly to a W-boson and a b-quark.
- We test a hypothesis that a top-quarks can decay to a Z-boson and a c-quark.
- The W– and Z-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 essentially relies on the comparison of two decays processes: $tt \rightarrow WbZc$ and $tt \rightarrow WbWb$.
- The simultaneous study of the two decay processes allows cancellation of major systematic uncertainties.
- We validate Monte Carlo (MC) simulations with inclusive W's and Z's.

3. Precision check of MC simulations

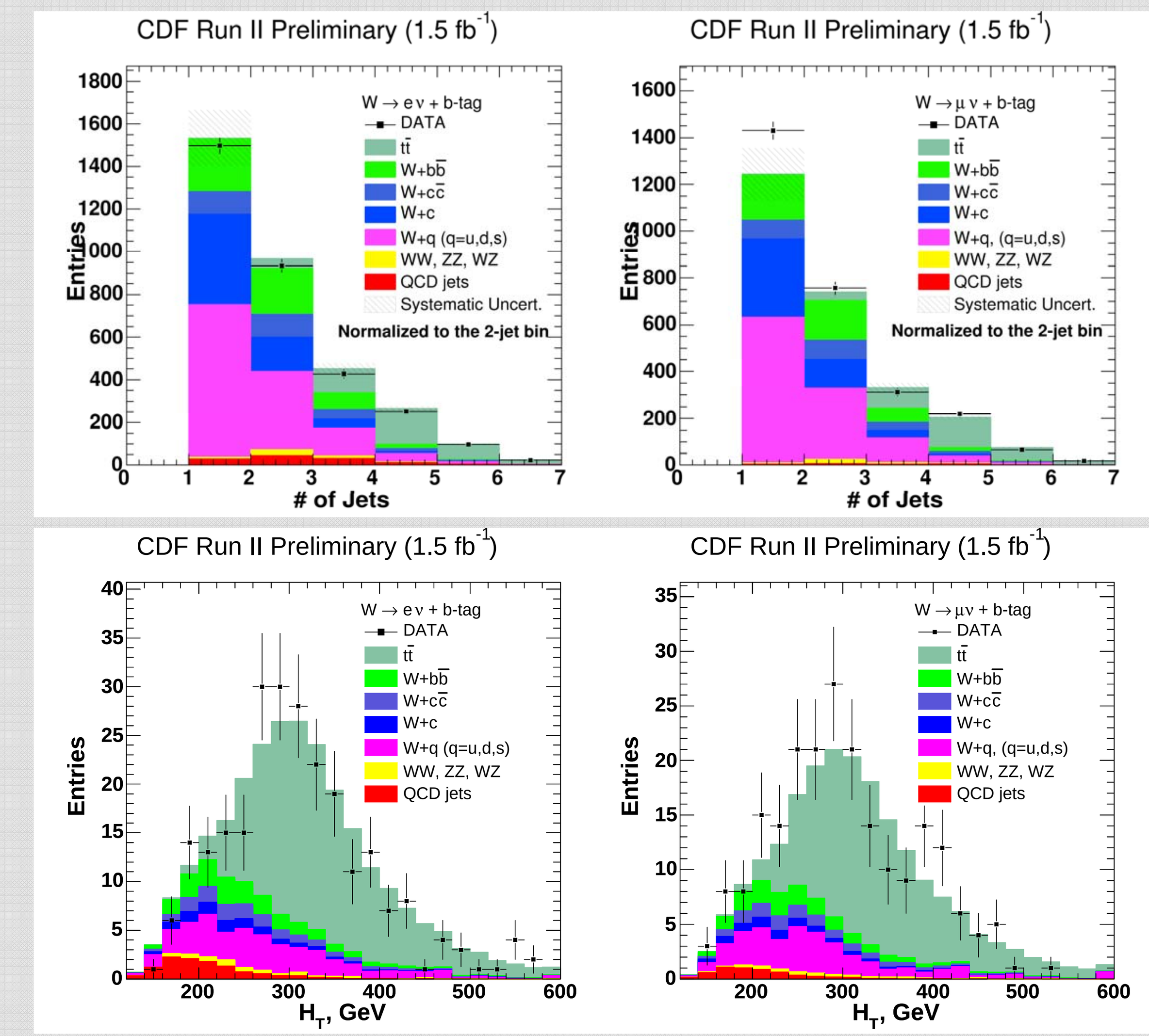
Inclusive processes: $pp \rightarrow W + X$ and $pp \rightarrow Z + X$, where W's and Z's decay leptonically:



4. tt → W + 4 jets

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

1. $tt \rightarrow WbWb$
2. $tt \rightarrow Z^0cWb$
3. $tt \rightarrow Z^0cZ^0c$

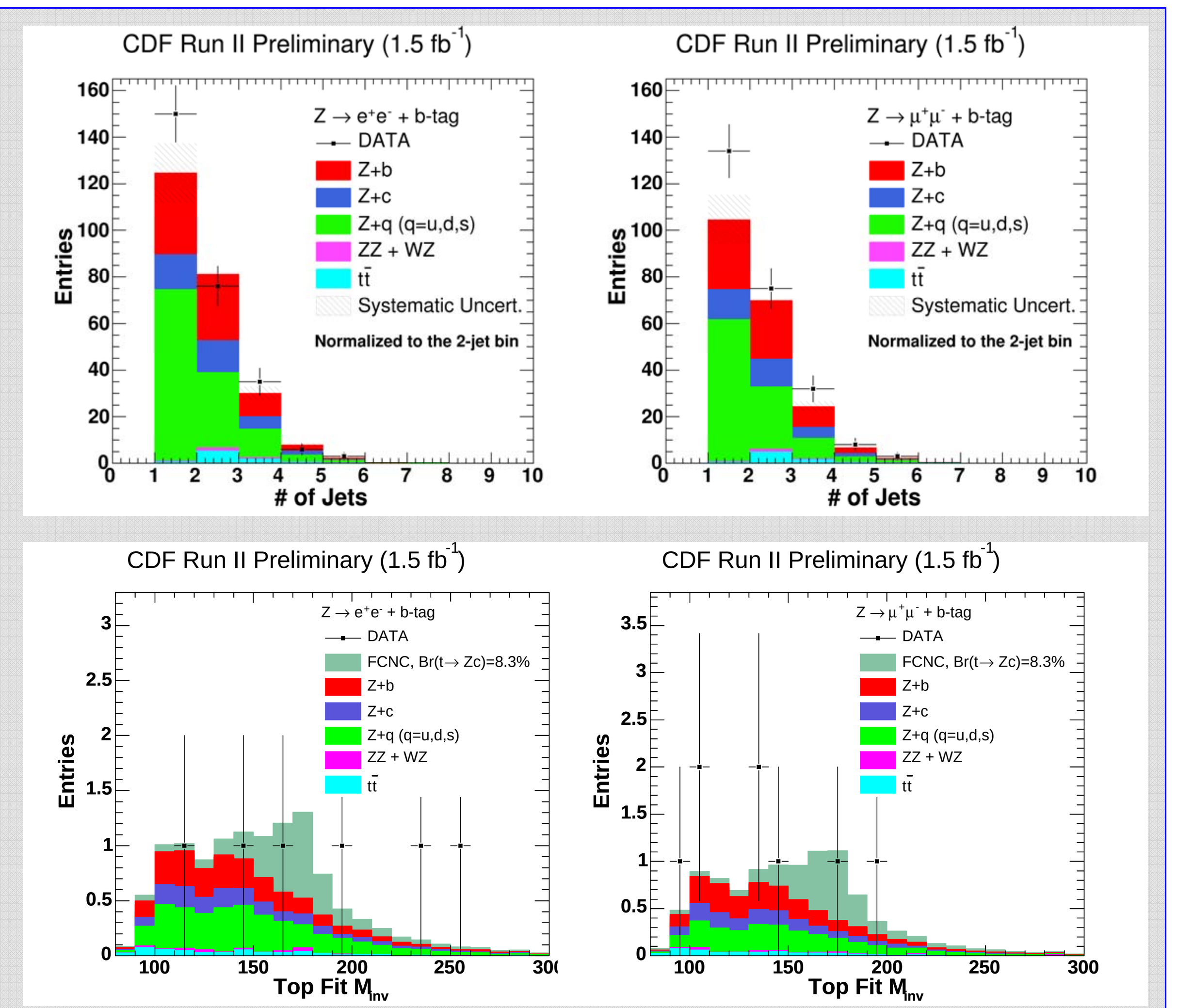


5. tt → Z^0 + 4 jets

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

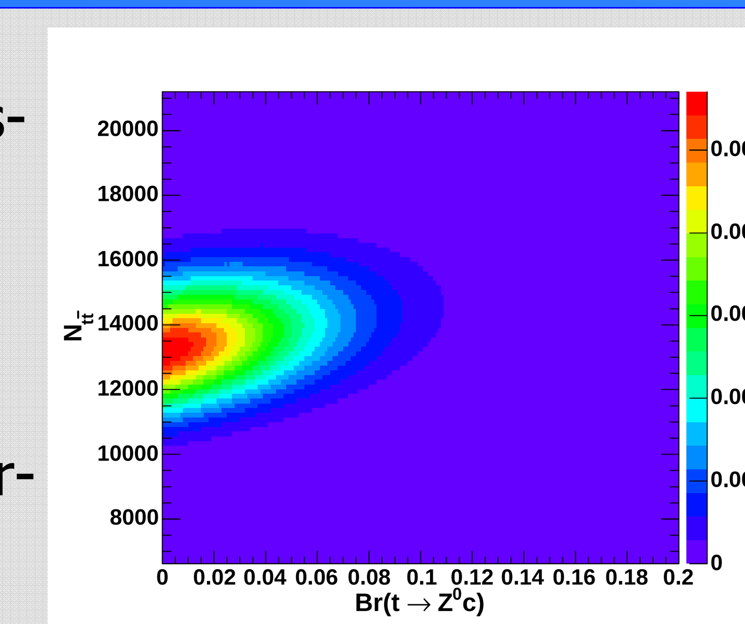
1. $tt \rightarrow Z^0cWb$
2. $tt \rightarrow Z^0cZ^0c$

The invariant mass of the top-quark can be fully reconstructed in these two cases. This provides an additional separation between the signal and the backgrounds.



6. Statistical Interpretation and Results

- 2D likelihood P{ observed | σ(tt), Br(t→Z^{0}c)} is constructed using Poisson statistics
- Bayesian approach with two priors for σ(tt):
  1. Theory-independent ("Flat")
  2. With theoretical cross-section ("Gaussian")
- To present the result in a model-independent way we parameterize the limit as a function of a fraction longitudinally-polarized Z-bosons in the decay of t→Z^{0}c.
- The observed limits are at 95% C.L. and agree with the expected.



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%