Search for Flavor Changing Neutral Currents in Single Top Quark Production in ATLAS

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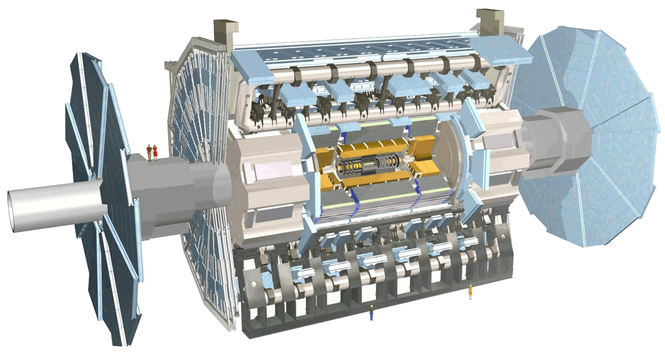
Introduction

The top quark is the heaviest elementary particle known M_t=173.3 ±1.1 GeV.

Top quark is an excellent object to test the Standard Model SM of particle physics.



This analysis used 35 pb^{-1} of data collected by ATLAS at 7 TeV in 2010.

In the SM, flavor changing neutral currents (FCNC) are forbidden at tree level.

At one-loop level their branching ratio goes down to 10^{-13} .

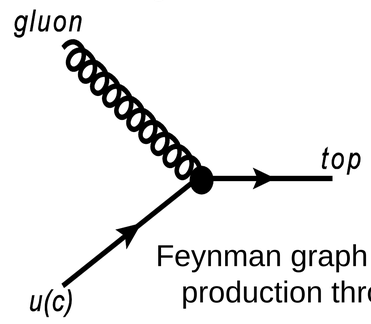
Motivation

Some extensions of the SM, like Supersymmetry (SUSY) and the 2-Higgs (2HDM) doublet model, predict the presence of FCNC contributions at tree level.

They significantly enhance the FCNC decay branching ratios compared to Standard Model predictions.

Process	SM	2HDM	SUSY
$u+g \rightarrow t$	$3.7 * 10^{-14}$	10^{-4}	$8 * 10^{-5}$
$c+g \rightarrow t$	$4.6 * 10^{-12}$	10^{-4}	$8 * 10^{-5}$

Branching ratio of FCNC in different models



Feynman graph for single-top production through FCNC

Event Selection

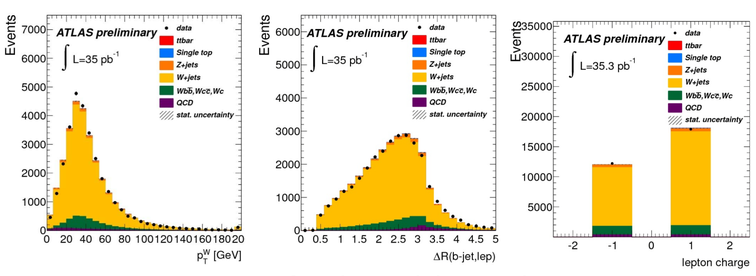
- ❑ Only one isolated lepton (μ,e)
- ❑ Missing transverse energy
- ❑ Transverse W boson mass cut
- ❑ Only one jet
- ❑ One b-quark jet

Channel	Electron	Muon
Signal(σ = 1pb)	1 ± 0	2 ± 0
Single top	13 ± 1	21 ± 2
ttbar	5 ± 1	7 ± 1
W+light jets	38 ± 8	71 ± 15
Wbb/Wcc +jets	9 ± 2	17 ± 4
Wc+jets	53 ± 11	117 ± 23
Z+jets	2 ± 0	12 ± 3
QCD(data driven)	14 ± 7	33 ± 17
Total background	132 ± 15	278 ± 33
Data	150	340

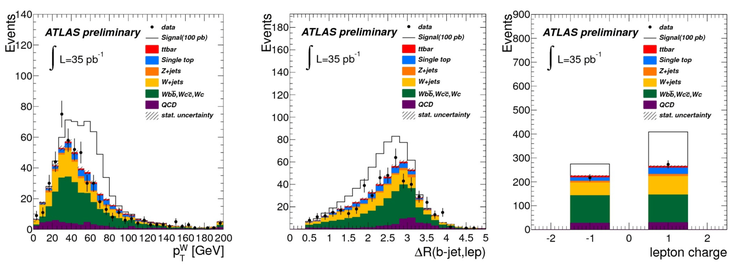
Expected number of events for each background process normalized to 35 pb^{-1}, the uncertainties include statistical and cross section uncertainties, data collected in 2010

Kinematics

Best variables used to extract the signal



Pre-tag: Before b-quark jet requirement

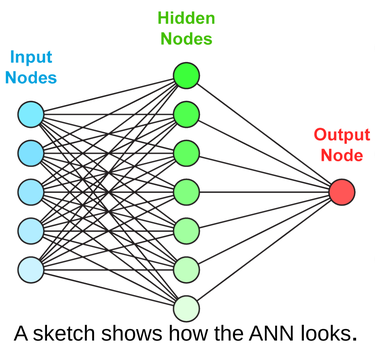


Tagged: After b-quark jet requirement

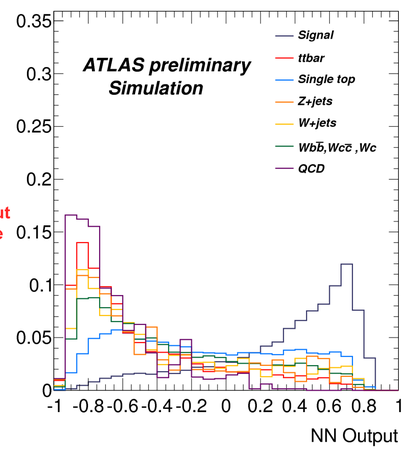
Neural Network

A Neural network(ANN) was used to separate the signal from the background:

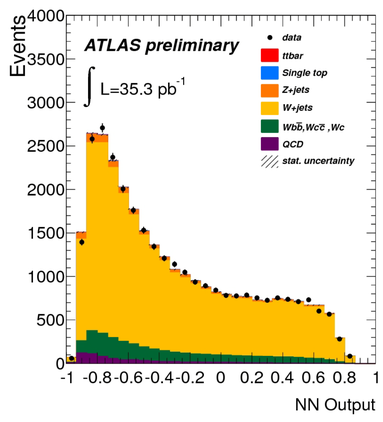
- 13 input variables
- 14 internal nodes
- 1 output node



A sketch shows how the ANN looks.

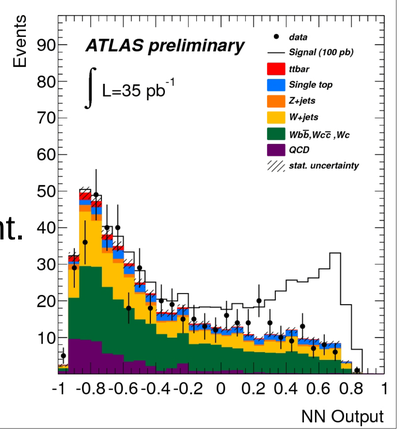


ANN validation



ANN output before b-tagging requirement.

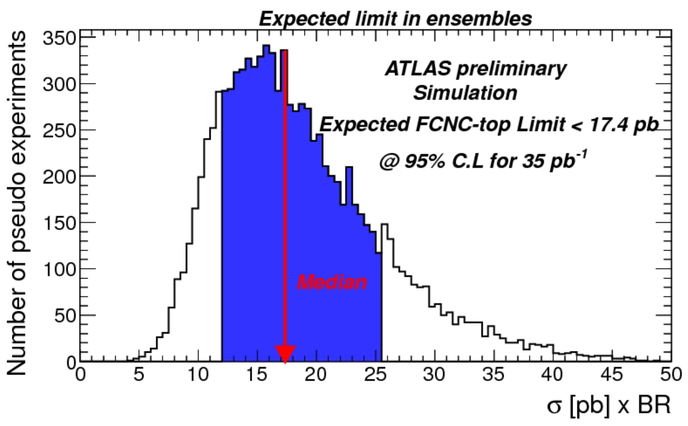
ANN output after b-tagging requirement.



Statistical methods

Bayesian statistics was used to calculate an upper limit at 95% confidence level.

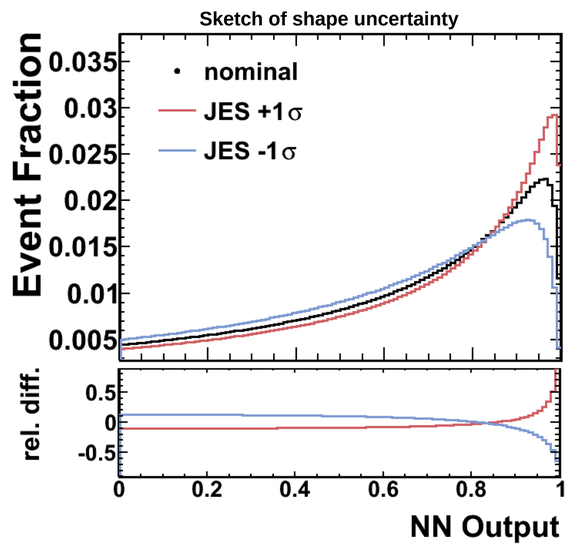
A binned likelihood method is used to fit the observed data events, assuming Poisson probability



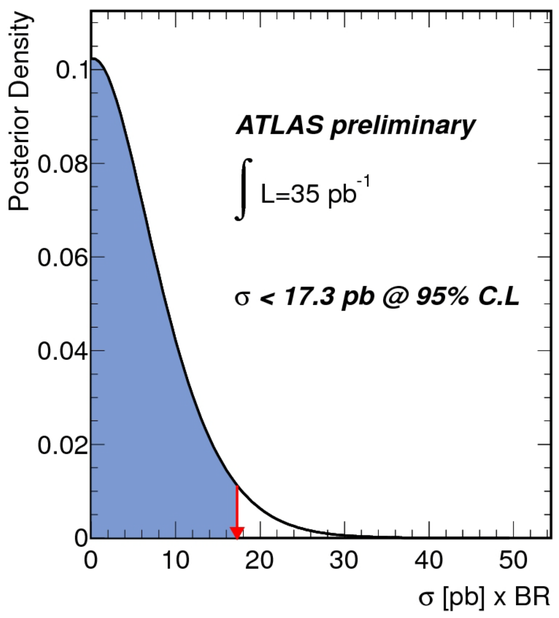
The expected 95% CL upper limit is estimated using 10000 pseudo-experiments and defined by the median of the resulting distribution of the upper limit of each pseudo-experiment.

Systematic Uncertainties

- Rate uncertainties:
  - ➢ QCD normalization 50%
  - ➢ Cross section uncertainties (10-25)%
  - ➢ Heavy flavor fraction 50%
  - ➢ Luminosity 3.4%
- Shape uncertainties:
  - ➢ Jet energy scale
  - ➢ b-tagging efficiency
  - ➢ PDF, ISR/FS, pile-up



Results



The signal posterior density function

	Expected limit -1 σ	Median	+1 σ	Observed
Only normalization uncertainties	9.6	13.7	19.7	15.6
With all uncertainties	12.0	17.4	25.6	17.3