Measurement of Single Top Quark Production cross section with ATLAS

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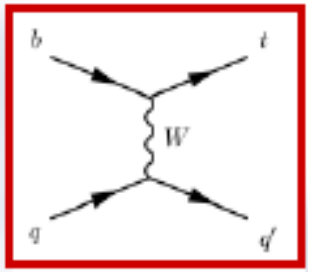
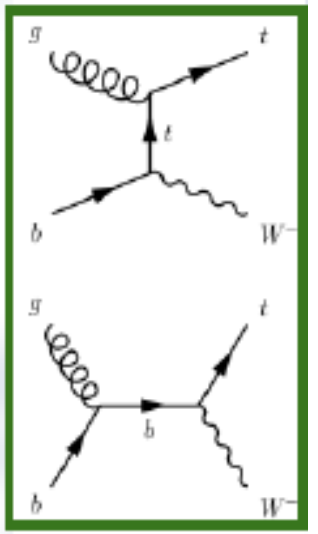
Introduction

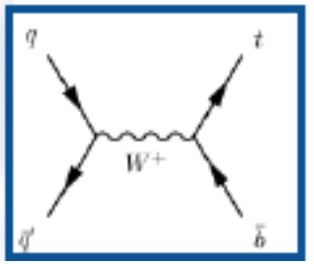
- t-channel ($\sigma = 65pb^{+29}_{-22}$)
  - Largest production rate
  - Backgrounds : top pairs, W/Z+jets, multijets,dibosons



- associated tW production
  - Lepton+jets: 1 lepton +3 jets (1b ,2 light) +
    - Backgrounds : top pairs, W/Z+jets, multijets,dibosons
  - Dilepton:2 leptons + 1 b-jet +
    - Background: top pairs, Z+jets, dibosons



- s-channel
  - Small production rate at LHC



Motivation

Single top quark production

- to study the nature of the weak interaction
- direct measurement of the Cabibbo-Kobayashi-Maskawa (CKM) matrix element
- Access to the b quark PDFs $\begin{bmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{bmatrix}$

without assumption of Unitarity and three families $\Rightarrow |V_{tb}|$

[Alwall, Frederix, Gerard, Giammanco, Herquet, Kalinin, Kou, Lemaitre, Maltoni '07]

Status of the theory

LO and NLO cross section for single top quark production at the Tevatron and LHC for $m_t = 175\,GeV$.

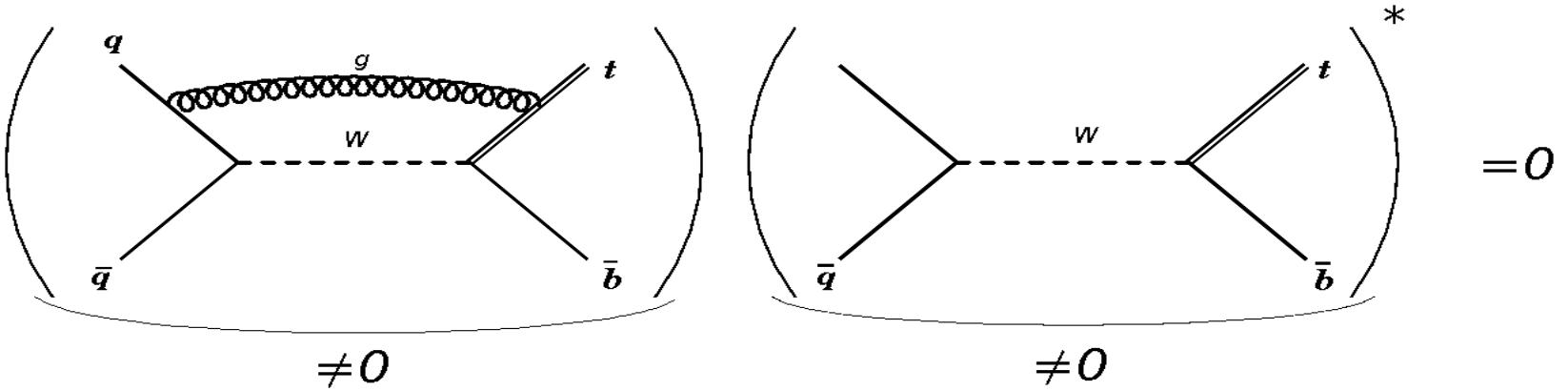
[B.W.Harris, E. Laenen, L.Phaf, Z. Sullivan, S. Weinzierl '02]

Process	$\sqrt{S}$	$\sigma_{LO}(pb)$	$\sigma_{NLO}(pb)$
s-channel	1.8 TeV $p\bar{p}$	0.224	0.377
	2.0 TeV $p\bar{p}$	0.297	0.4597
	14 TeV pp	4.612	6.56
t-channel	1.8 TeV $p\bar{p}$	0.735	0.725
	2.0 TeV $p\bar{p}$	1.068	1.062
	14 TeV pp	152.7	155.9

- Why are NNLO corrections needed?

Why NNLO?

The corrections of some diagrams like



disappear at NLO due to colour.

➡ NNLO calculation

t-channel

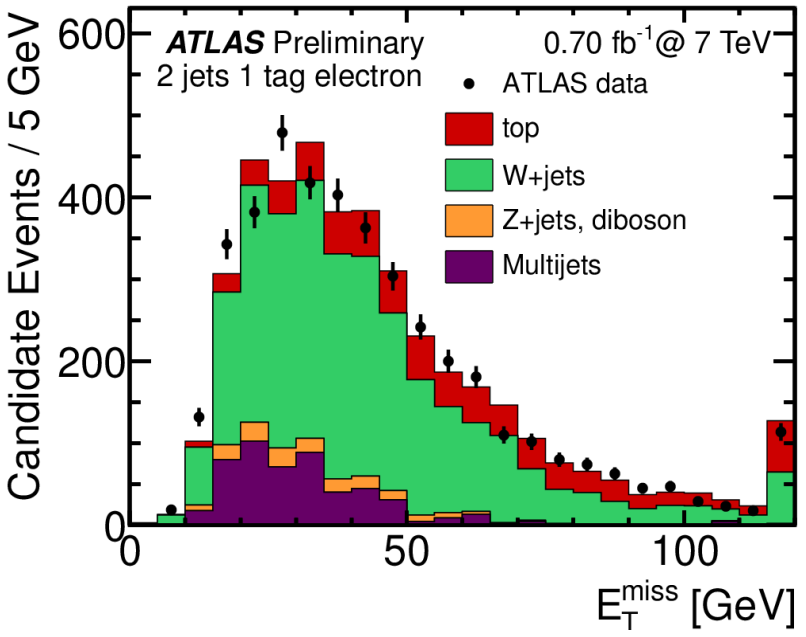
- Single top-quark cross section in 0.7 $fb^{-1}$of pp colisions of $\sqrt{s} = 7Tev$
- Simulated events for all three single-top processes produced with “ACERMAC”-program, $m_t = 172.5GeV$
- For (W/Z) prod. With jets is using the LO generator “ALPGEN”, and for “Diboson” using “HERWIG”
- s- and t-channel hadronization is performed by “PYTHIA”

Object definition and event selection

- Electron-candidates are reconstructed off line using ***cluster-based algorithm*** required:

$$\begin{cases} E_T > 25GeV \\ |\eta_{cl}| < 2.47 \end{cases}$$

- The sum of transverse energy within a cone of radius $\Delta R = \sqrt{\Delta\eta^2 + \Delta\Phi^2}$ must be less than 15% of the transverse energy of electron E_T



Object definition and event selection

- Muon candidates are reconstructed by combining track segments found in the inner detector and in the muon spectrometer, required:

$$\begin{cases} P_T > 25GeV \\ |\eta| < 2.5 \end{cases}$$

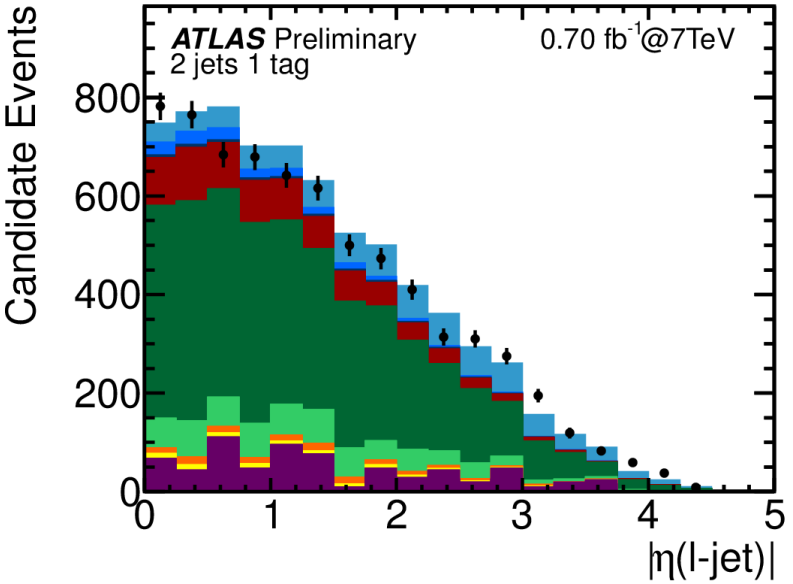
- Particle jets are reconstructed using anti-k_T
- Jets overlapping with selected e^- candidates within $\Delta R < 0.2$ are removed, only jets having $P_T > 25GeV$ and $|\eta| < 4.5$ are considered.

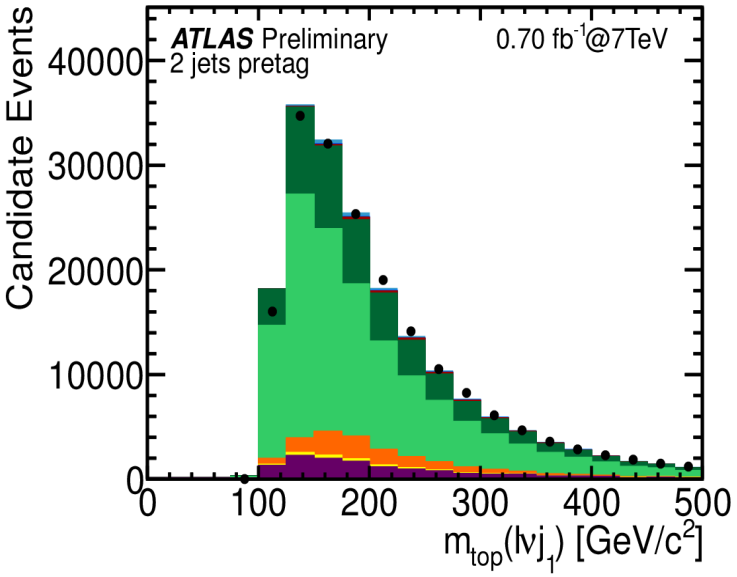
Backgrounds

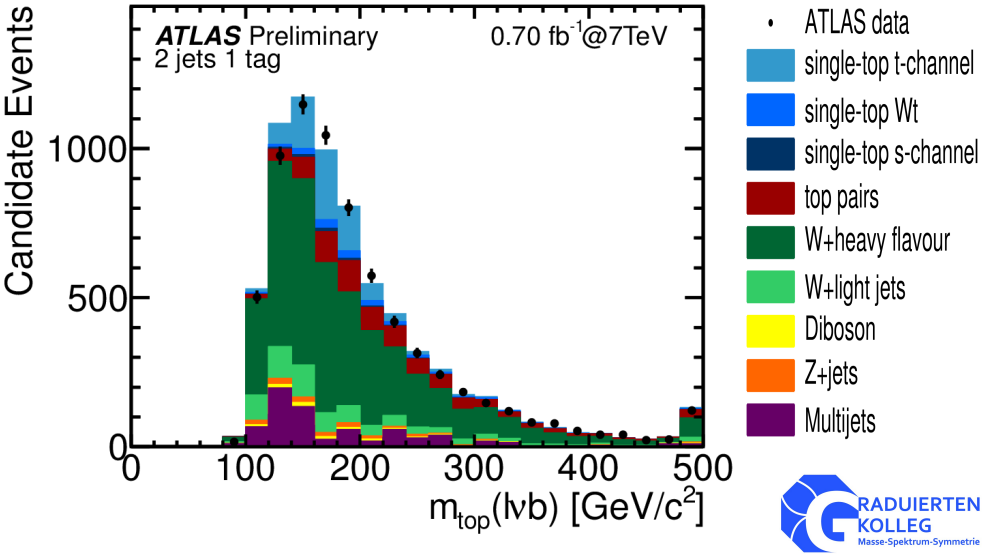
- *Multijets background* (jet-electron model) events where the electron requirement in the selection is replaced by a jet ($P_T > 25GeV$)
- W+Jets:shape from theory, normalization and flavor composition from data

t-channel - Cut Based Selection

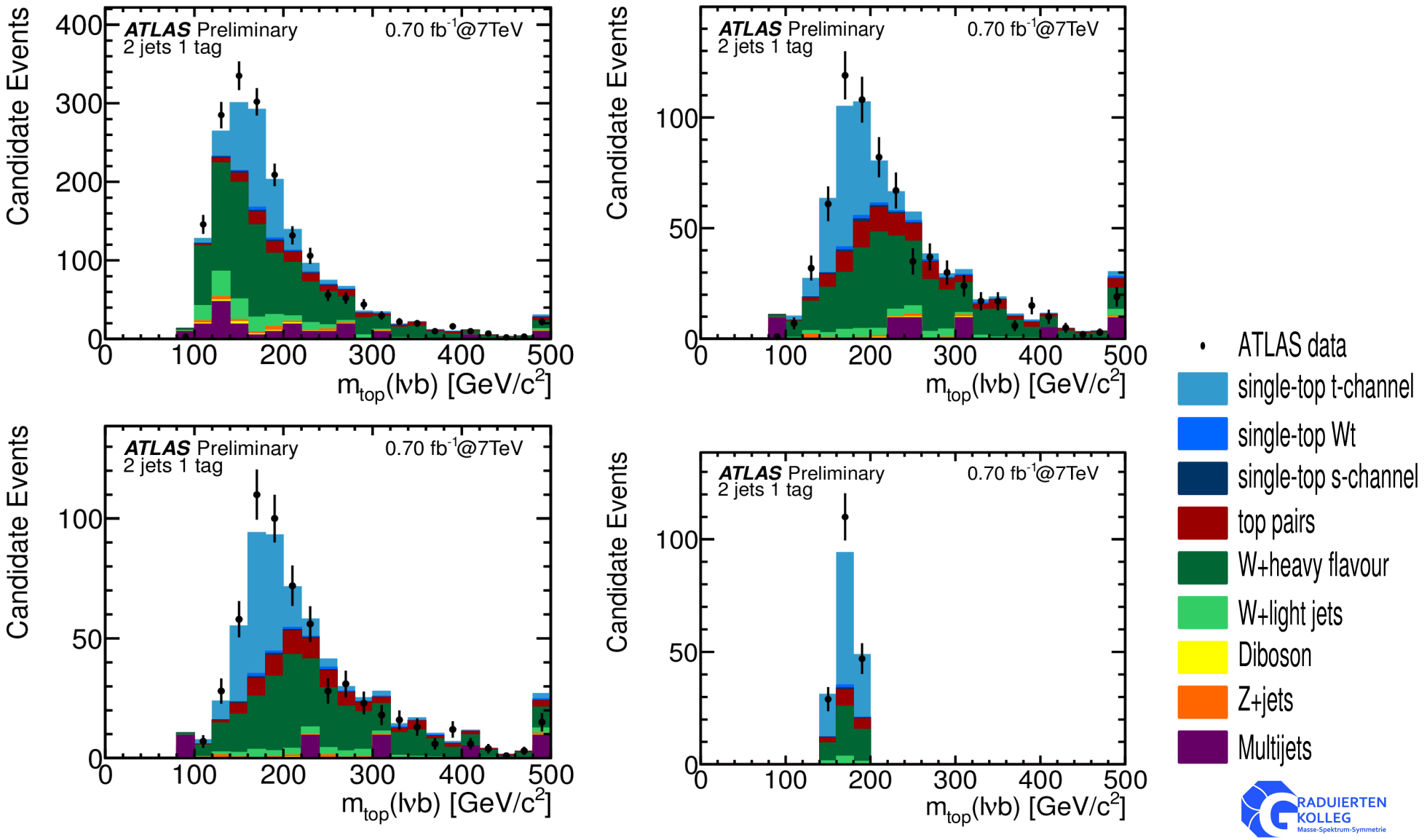
- $|\eta_{jetlight}| > 2.0$
- $H_T > 200GeV$
- $150GeV < m_{l\nu b} < 190GeV$
- $\Delta\eta_{bjetlight} > 1.0$



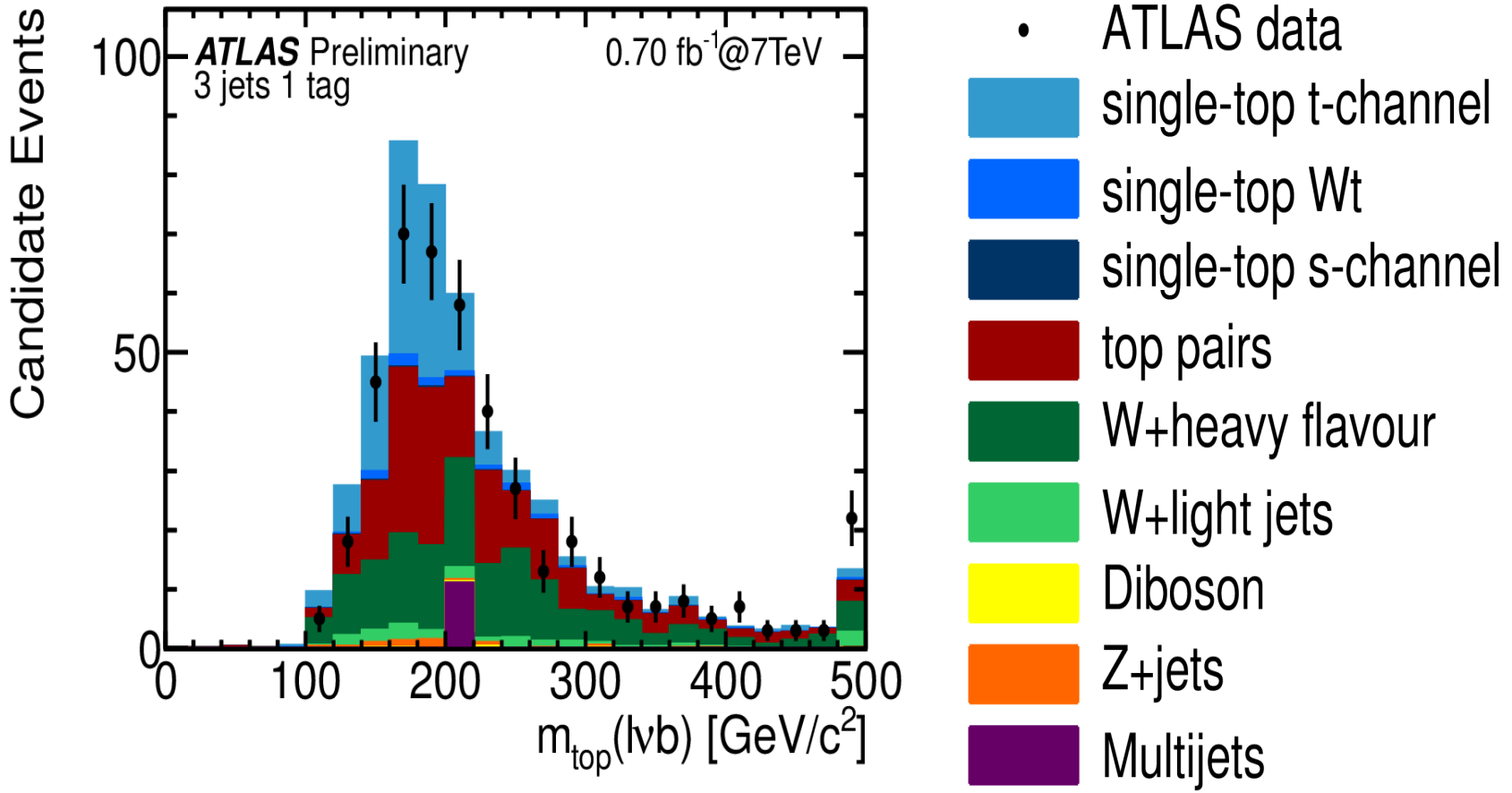




Distribution of the variable $M_{l\nu b}$ *in the 2-jet sample*



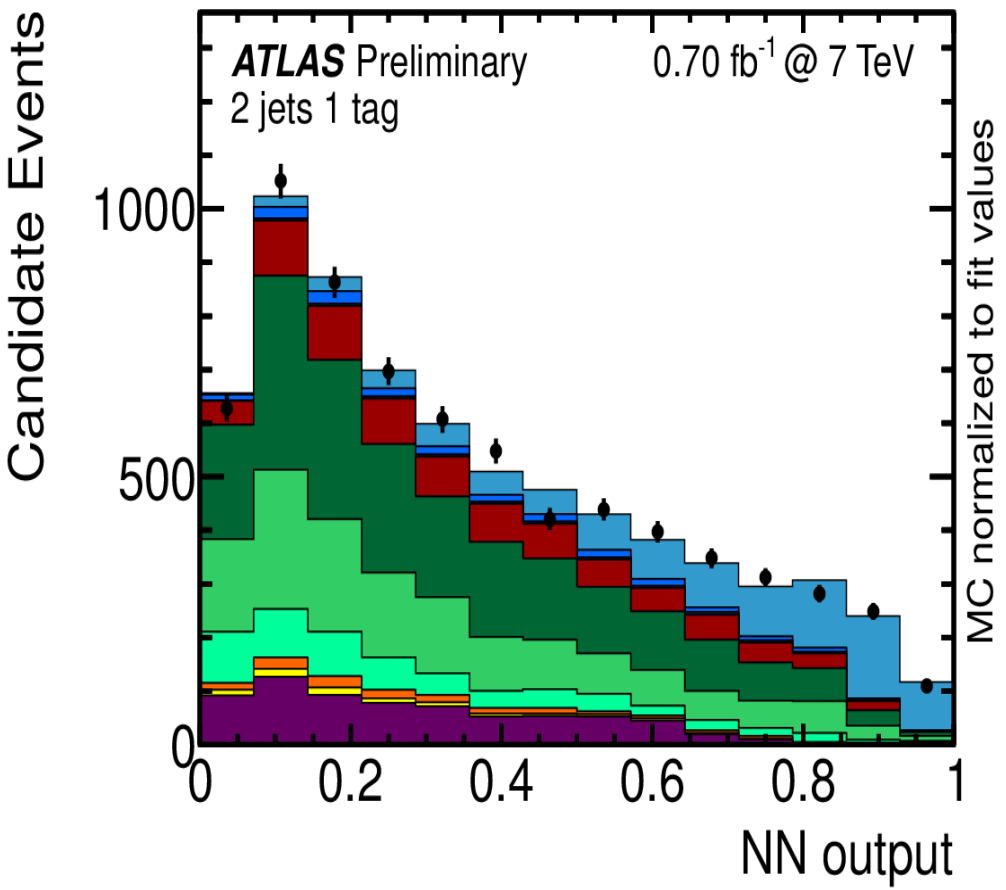
Distribution of the variable $M_{l\nu b}$ *in the 3-jet sample*



t-channel - Neural Network

Most important variables

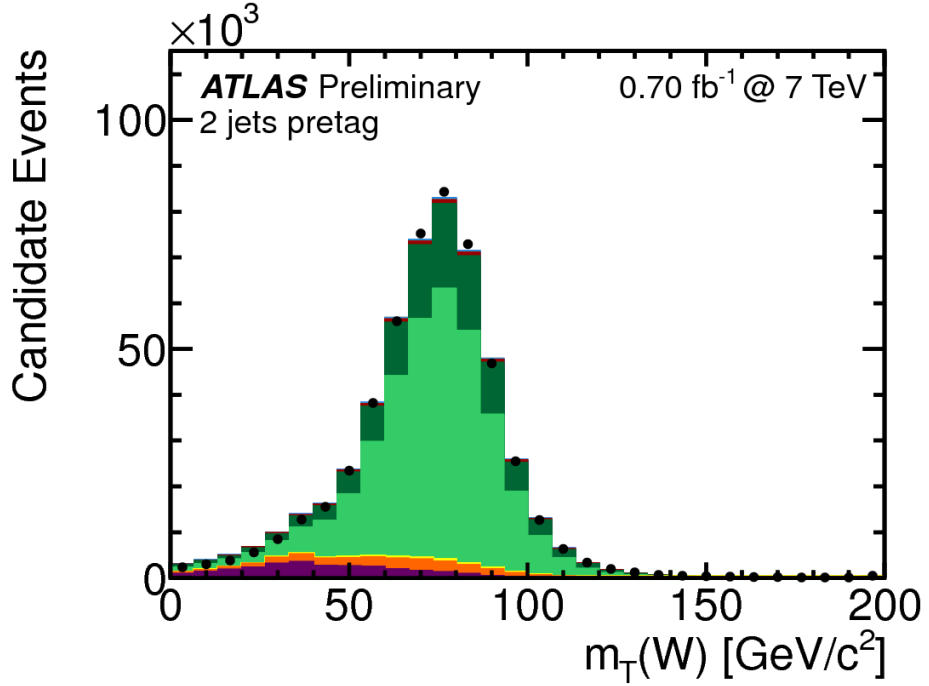
- $M_{l\nu b}$
- $|\eta_{ligtjet}|$
- E_T *untagged jet*

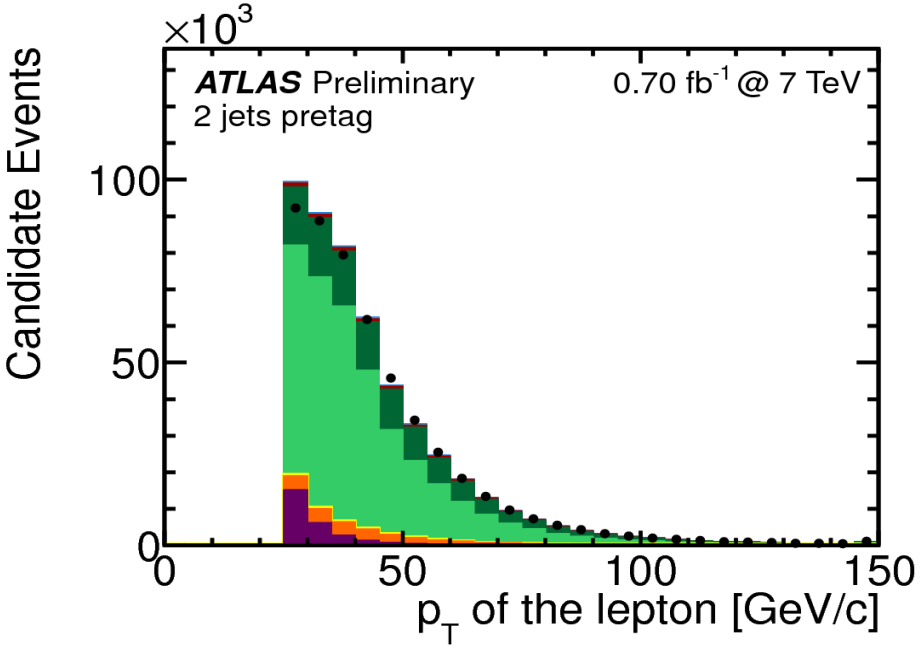


s-channel - Selection & Backgrounds

Event Selection

- Single isolated lepton
- $E_T > 25GeV$
- 2 jets with $P_T > 25GeV$
- 1 or 2 tagged jets

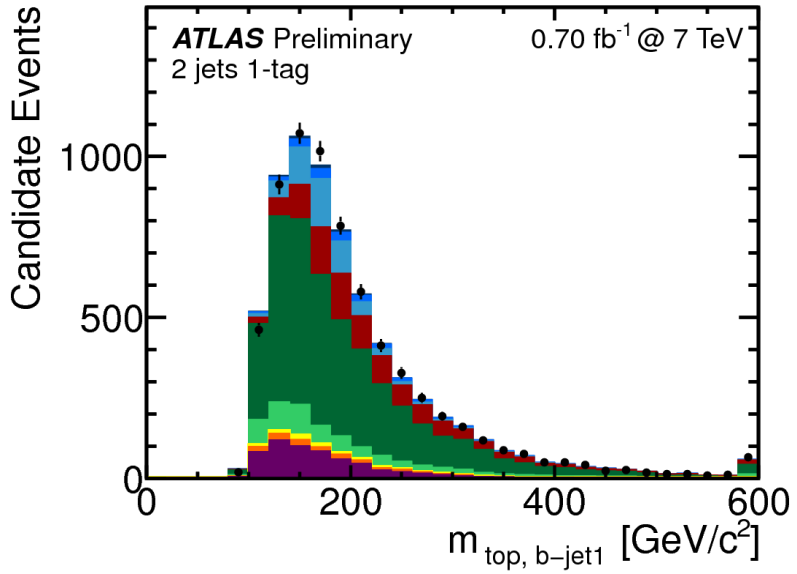


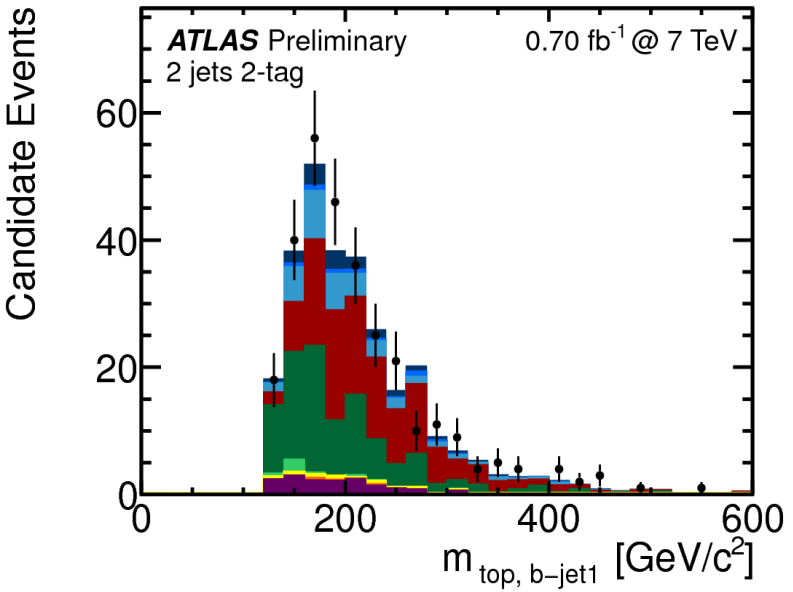


Backgrounds

- Multijet: jet-electron
- W+jets: shape from MC,normalization to data
- Others: tt, Z+jets, diboson

s-channel - Cut Optimization





Selection	Signal	Background	$S/\sqrt{B}$
Preselection Only	104	153802	0.26
Number of tagged jets=2	18	415	0.88
$30 < m_{top,jet2} < 247$ GeV/c^2	17	349	0.91
$p_T(jet1, jet2) < 189$ GeV/c	17	346	0.91
$m_T(W) < 111$ GeV/c	17	318	0.95
$0.43 < \Delta R(b - jet1, lepton) < 3.6$	17	308	0.97
$123 < m_{top,jet1} < 788$ GeV/c^2	17	302	0.98
$0.74 < \Delta R(b - jet1, b - jet2) < 4.68$	16	269	0.98