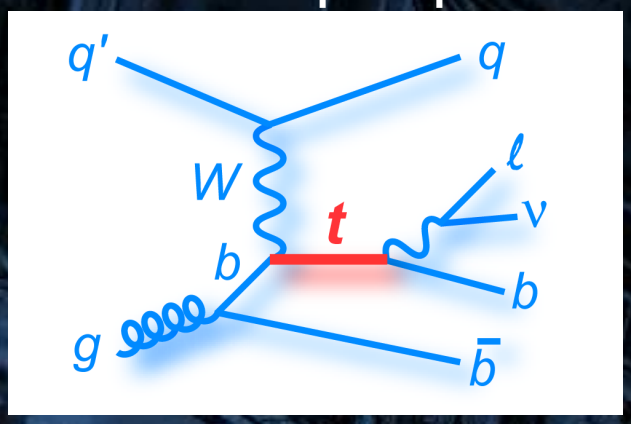
Single-Top Production at the ATLAS EXPERIMENT

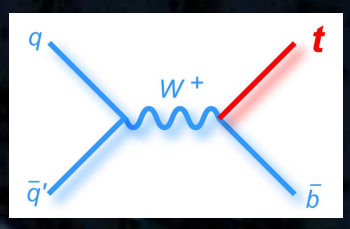
Oliver Maria Kind · on behalf of the ATLAS Collaboration

http://atlas.ch

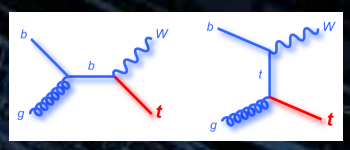
Electroweak t-quark production at the LHC



t-channel, $\sigma_t = 66$ pb

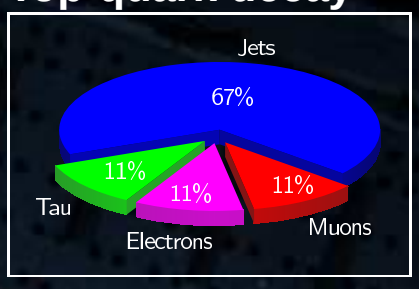


s-channel, $\sigma_s = 4$ pb



Wt prod., $\sigma_{Wt} = 15$ pb

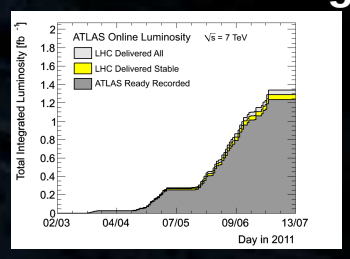
Top-quark decay



$\mathcal{BR}(t \to Wb) \approx 100\,\%$

The leptonic decay channels e/μ provide the best reconstruction performance.

ATLAS data taking

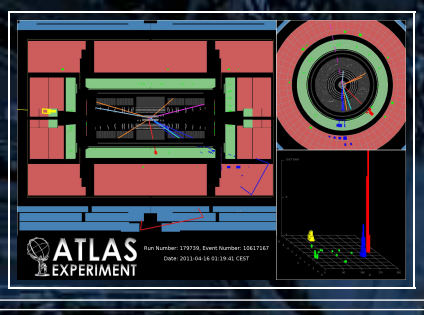


For the presented single-top analyses a total integrated luminosity of 0.70 fb^{-1} of pp collisions at $\sqrt{s} = 7$ TeV from the LHC was used.

Lepton + Jets t-Channel Analysis

Introduction

The electroweak production of top-quarks was observed by the CDF and DØ collaborations. Recently CMS [3] and ATLAS [1,2] reported first measurements of the single-top production cross-section at the LHC for the t-channel. These provide direct access to the Wtb coupling and allows to measure the CKM element V_{tb} directly. They are sensitive to models of new physics like anomalous couplings, 4th generation or FCNC.[4]



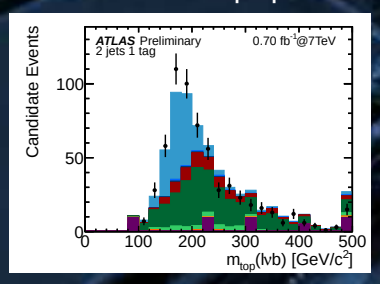
Event selection

Electron: $E_t > 25$ GeV, $|\eta_{cl}| < 2.47$, isolation criteria
Muon: $p_t > 25$ GeV, $|\eta| < 2.5$, isolation criteria
Jets: anti-k_t alg. (width=0.4), $p_t > 25$ GeV, $|\eta| < 4.5$, b-tag eff.=50 %
removal of jets overlapping with e within $\sqrt{\Delta\eta^2 + \Delta\varphi^2} < 0.2$
Other: $\not{E}_t > 25$ GeV, lepton trigger match, $M_t(W) > 60$ GeV$-\not{E}_t$

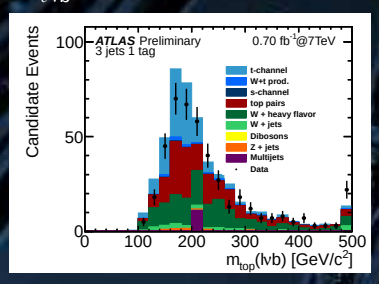
Cut-based analysis #jets = 2,3

In addition to the event pre-selection the following cuts are applied:

★ Reconstructed top-quark mass $150 < M_{\ell\nu b} < 190$ GeV



2-Jets



3-Jets

★ Total transverse energy $\sum E_t > 210$ GeV
★ Angle between b-tagged and untagged jet $\Delta\eta$(b-jet1, u-jet1) > 1.0
★ Pseudo-rapidity of the untagged jet $|\eta(1-\text{jet})| > 2.0$

Event yields:

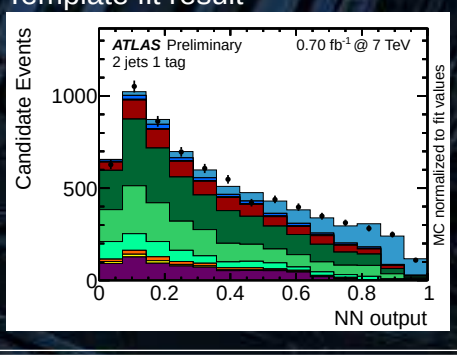
	Cut-based 2-jets		Cut-based 3-jets	
	Leptons+	Leptons-	Leptons+	Leptons-
t-channel	51.8±16.4	23.7±6.5	33.0±7.0	16.3±4.8
s-channel	0.9±0.2	0.6±0.2	0.3±0.1	0.3±0.1
Wt	1.1±0.5	0.6±0.7	1.5±0.6	1.5±1.2
tt	7.1±3.2	7.2±2.9	26.8±8.0	25.0±7.6
W+jets	3.7±1.7	2.6±1.2	2.1±1.5	2.1±1.4
Wc+jets	18.3±3.8	11.7±3.4	7.8±3.0	6.5±2.6
Wbb+jets	7.7±5.9	2.5±2.5	6.2±5.2	2.9±2.4
Wcc+jets	3.1±2.4	1.3±1.0	3.6±2.8	1.7±1.4
Diboson	0.1±0.1	0.1±0.1	0.2±0.2	0.1±0.1
Z+jets	0.2±0.4	0.1±0.2	1.0±1.0	1.5±1.3
QCD	<0.1	<0.1	<0.1	<0.1
TOTAL Exp	94.1±18.4	50.2±8.5	82.6±12.7	57.9±10.1
S/B	1.23	0.89	0.67	0.39
DATA	118	68	74	60

Neural network analysis #jets = 2

A three-layer feed-forward neural network with a complex preprocessing (NeuroBayes®) is used [5]. The net consists of 13 input nodes, 33 hidden nodes and a single output node. The singal yield is extracted by performing a ML fit to the discriminant output variable for DATA and Monte Carlo templates. The input variables are the same as for the cut-based analysis plus 9 additional ones.

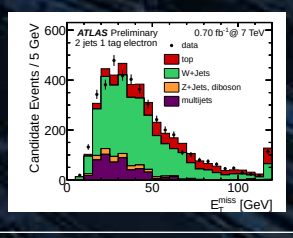
Source	yield after NN fit
t-channel	900 ± 60
s-channel	52 ± 5
Wt	165 ± 16
tt	770 ± 64
W+jets	545 ± 173
Wc+jets	1480 ± 400
Wbb/cc+jets	2130 ± 420
Diboson	79 ± 4
Z+jets	139 ± 78
Multijets	700 ± 250
TOTAL Exp	6950 ± 880
DATA	6953

Template fit result



Background estimate

★ Bkg. for tt, Z+jets, di-boson and single-top (Wt and s-channel) are normalised to theory.
★ The mutli-jet normalisation is obtained by a template fit of the $\not{E}_t$ distribution to DATA.
★ The W+jets overall normalisation and flavour composition are estimated from DATA.



Systematics

$\Delta\sigma/\sigma$ [%]		DATA statistics	MC statistics	Object modeling	Generators & PDF	Bkg. normalization	Luminosity	All systematics	Total
c.b.	▲	+13	+6	+23	+25	+10	+7	+41	+44
	▼	-13	-6	-14	-22	-10	-6	-27	-30
NN	▲	+10	+7	+36	+19	+3	+5	+44	+45
	▼	-10	-7	-25	-17	-3	-5	-34	-34

Results

$\sqrt{s} = 7$ TeV, $\int Ldt = 0.70$ fb^{-1}

★ Cut-based:
- 2-jet: $\sigma_t = 102^{+12}_{-11}(\text{stat})^{+38}_{-27}(\text{syst})$ pb $= 102^{+40}_{-30}$ pb
- 3-jet: $\sigma_t = 50^{+15}_{-14}(\text{stat})^{+30}_{-22}(\text{syst})$ pb $= 50^{+34}_{-27}$ pb
- **comb.**: $\sigma_t = \mathbf{90^{+9}_{-9}(stat)^{+31}_{-20}(syst)\,pb} = \mathbf{90^{+32}_{-22}\,pb}$
- expect.: $\sigma_t^{exp} = 65^{+28}_{-19}$ pb

★ Neural network:
- **2-jet**: $\sigma_t = \mathbf{105^{+7}_{-7}(stat)^{+36}_{-30}(syst)\,pb} = \mathbf{105^{+37}_{-31}\,pb}$
- expect.: $\sigma_t^{exp} = 65^{+29}_{-22}$ pb

References

[1] ATLAS Collab., ATL-CONF-2011-101, CERN 2011.
[2] ATLAS Collab., ATL-CONF-2011-088, CERN 2011.
[3] CMS Collab., S. Chatrchyan et al., arXiv:1106.3052[hep-ex].
[4] T.M.P. Tait and C.P. Yuan, Phys. Rev. D 63 (2000) 014018.
[5] M. Feindt, U. Kerel, Nucl. Instr. Meth. A559 (2006) 190–194.

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