Latest top physics results at ATLAS

L. Mijović[1] on behalf of the ATLAS collaboration

[1] **D**eutsches **E**lektronen-**Sy**nchrotron

1st March 2012

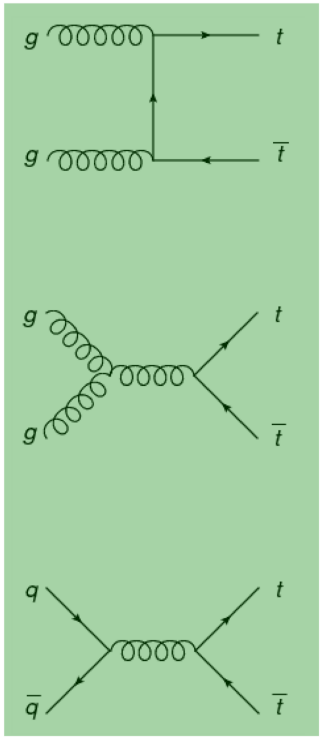
XXVI Rencontres de Physique de La Vallée d'Aoste

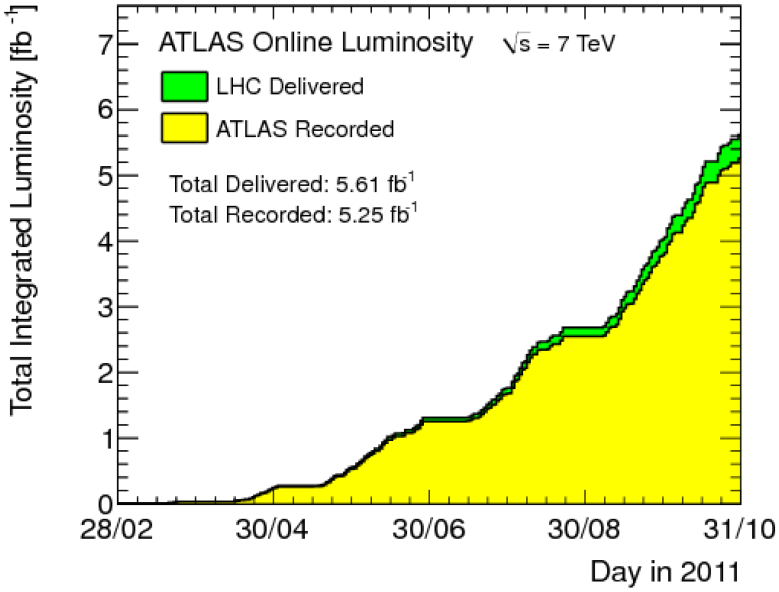
Detecting Top Quarks with the ATLAS detector in 2011

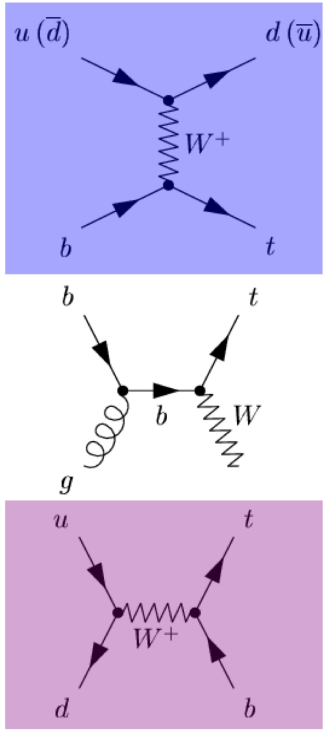
$$N_{\text{events}} = \mathcal{L}_{\text{int}} \sigma_{\text{process}}$$

$$N_{\text{analysis}} \ll N_{\text{events}}$$

Due to **final state BR**, (quality, selection) **cuts**, **smaller** $\mathcal{L}_{\text{int}}$ (not all data analysed yet)...







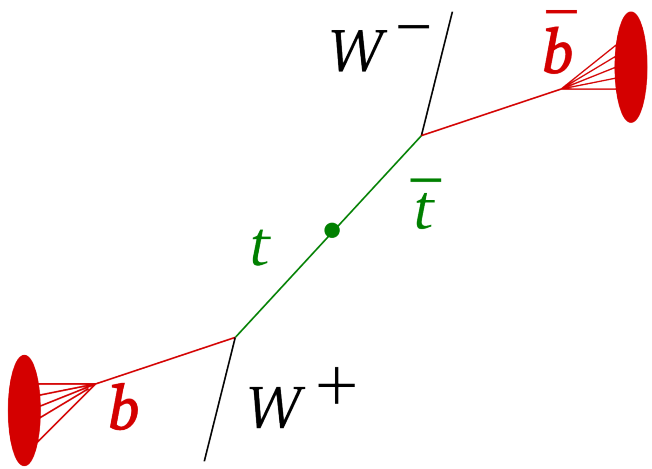
Process	σ [pb]	N_{events} (5 fb^{-1})	S/B
$t\bar{t}$ production	170	$1000 \cdot 10^3$	~ 10
single top t-chan.	65	$400 \cdot 10^3$	~ 1
single top Wt-chan.	16	$100 \cdot 10^3$	~ 0.1
single top s-chan.	4.6	$25 \cdot 10^3$	~ 0.05

$t\bar{t}$ decay channels and signatures

Top production process signature is determined by the production and decay channels.

- branching ratio for $t \to Wb \sim 1$
- observable final state depends on W^+ and W^- decays:

$$t\bar{t} \to W^+ b \; W^- \bar{b} \to$$



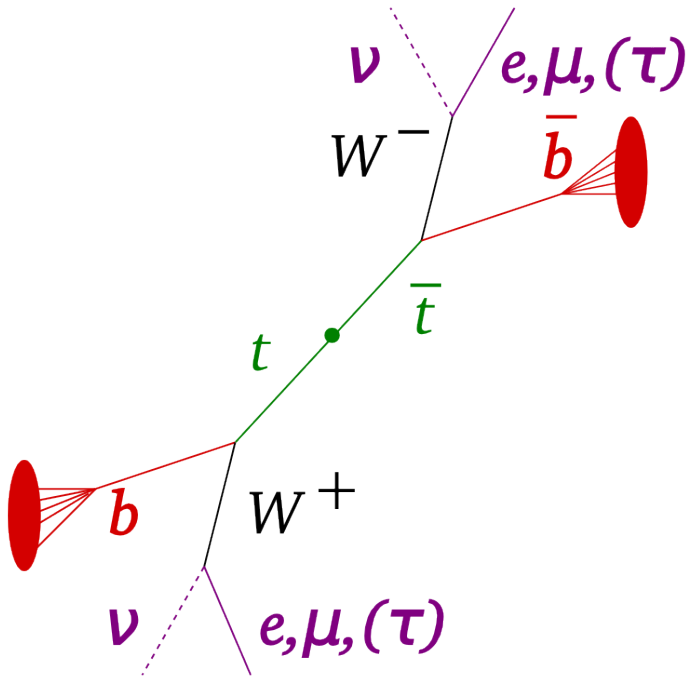
- $\mathrm{BR}(W \to l\nu) = 0.108$ for each of $l = e, l = \mu, l = \tau$
- $\mathrm{BR}(W \to q\bar{q}) = 1 - 3 \cdot 0.108 = 0.676$

$t\bar{t}$ decay channels and signatures

Top production process signature is determined by the production and decay channels.

- branching ratio for $t \to Wb \sim 1$
- observable final state depends on W^+ and W^- decays:

$t\bar{t} \to W^+ b\ W^- \bar{b} \to l\nu b\ l\nu \bar{b}$: **DILEPTONIC DECAY CHANNEL**



- $\mathrm{BR}(W \to l\nu) = 0.108$ for each of $l = e, l = \mu, l = \tau$
- $\mathrm{BR}(W \to q\bar{q}) = 1 - 3 \cdot 0.108 = 0.676$

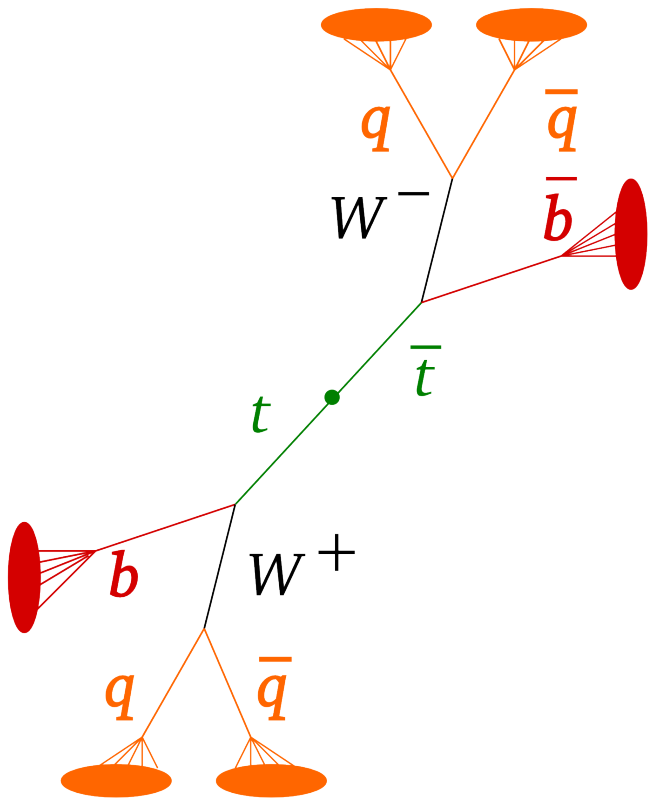
$\Rightarrow \mathrm{BR}(\mathrm{DILEPT.}) = (3 \cdot 0.108)^2 \sim 11\%$

$t\bar{t}$ decay channels and signatures

Top production process signature is determined by the production and decay channels.

- branching ratio for $t \to Wb \sim 1$
- observable final state depends on W^+ and W^- decays:

$t\bar{t} \to W^+ b\ W^- \bar{b} \to q\bar{q}b\ q\bar{q}\bar{b}$: **FULLY HADRONIC DECAY CHANNEL**



- $\mathrm{BR}(W \to l\nu) = 0.108$ for each of $l = e, l = \mu, l = \tau$
- $\mathrm{BR}(W \to q\bar{q}) = 1 - 3 \cdot 0.108 = 0.676$

$\Rightarrow \mathrm{BR}(\mathrm{DILEPT.}) = (3 \cdot 0.108)^2 \sim 11\%$

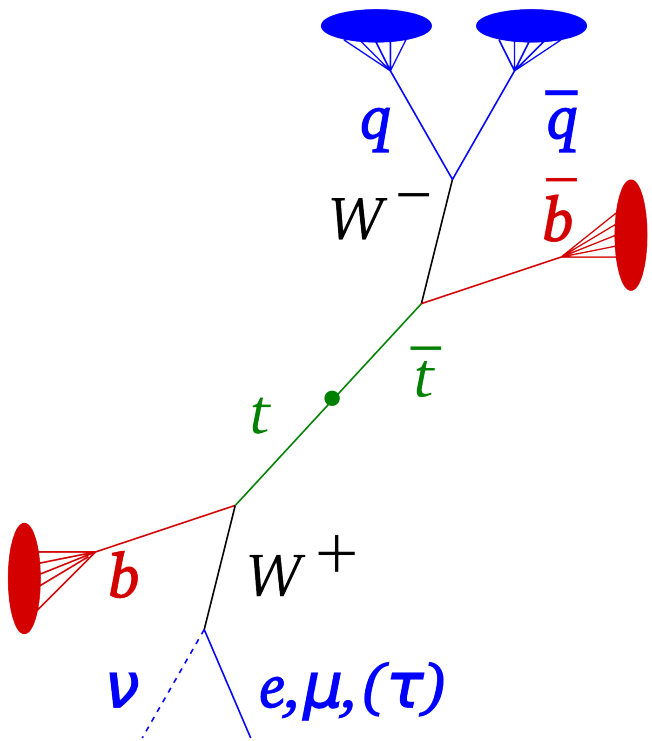
$\Rightarrow \mathrm{BR}(\mathrm{FULLY\ HAD.}) = 0.676^2 \sim 46\%$

$t\bar{t}$ decay channels and signatures

Top production process signature is determined by the production and decay channels.

- branching ratio for $t \to Wb \sim 1$
- observable final state depends on W^+ and W^- decays:

$t\bar{t} \to W^+ b\ W^- \bar{b} \to q\bar{q} b\ l\nu\bar{b}$: **SINGLE LEPTON DECAY CHANNEL**



- $\mathrm{BR}(W \to l\nu) = 0.108$ for each of $l = e, l = \mu, l = \tau$
- $\mathrm{BR}(W \to q\bar{q}) = 1 - 3 \cdot 0.108 = 0.676$

$\Rightarrow \mathrm{BR}(\mathrm{DILEPT.}) = (3 \cdot 0.108)^2 \sim 11\%$

$\Rightarrow \mathrm{BR}(\mathrm{FULLY\ HAD.}) = 0.676^2 \sim 46\%$

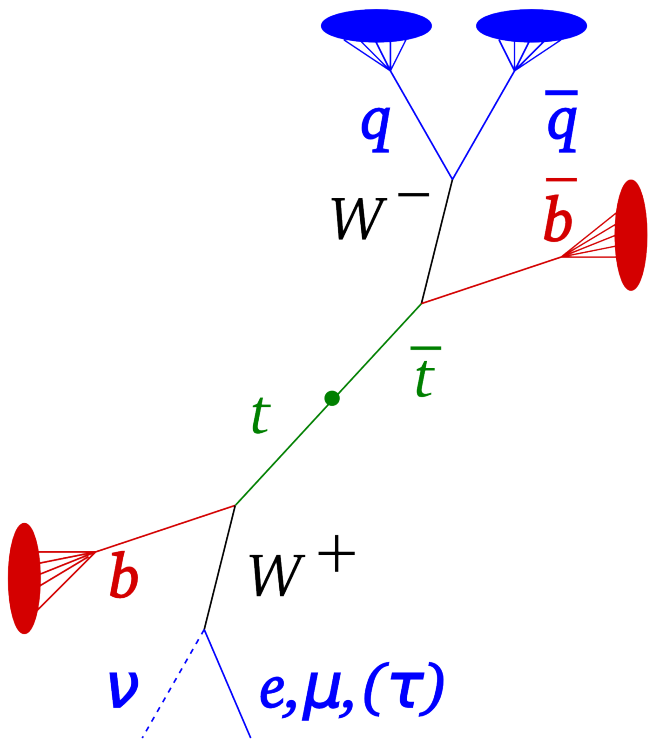
$\Rightarrow \mathrm{BR}(\mathrm{SINGLE\ LEPT.}) \sim 43\%$

$t\bar{t}$ decay channels and signatures

Top production process signature is determined by the production and decay channels.

- branching ratio for $t \to Wb \sim 1$
- observable final state depends on W^+ and W^- decays:

$t\bar{t} \to W^+ b\ W^- \bar{b} \to q\bar{q}b\ l\nu\bar{b}$: **SINGLE LEPTON DECAY CHANNEL**



Typically request l and (anti-kt R=0.4) jets:

- $\mathrm{p_T} > 25$ GeV
- $|\eta| < 2.5$

Outline

The following 2011 dataset analyses results will be presented:

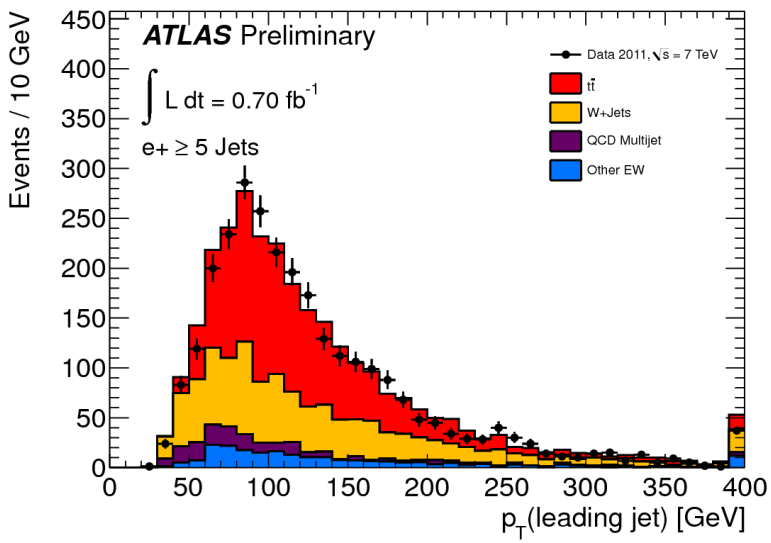
- **cross section measurement in $t\bar{t}$ events**
- **top quark mass measurement in $t\bar{t}$ events**
- **measurement of top quark properties in $t\bar{t}$ events**
- **new particle searches in top(like) production**
- **results in single top production processes**

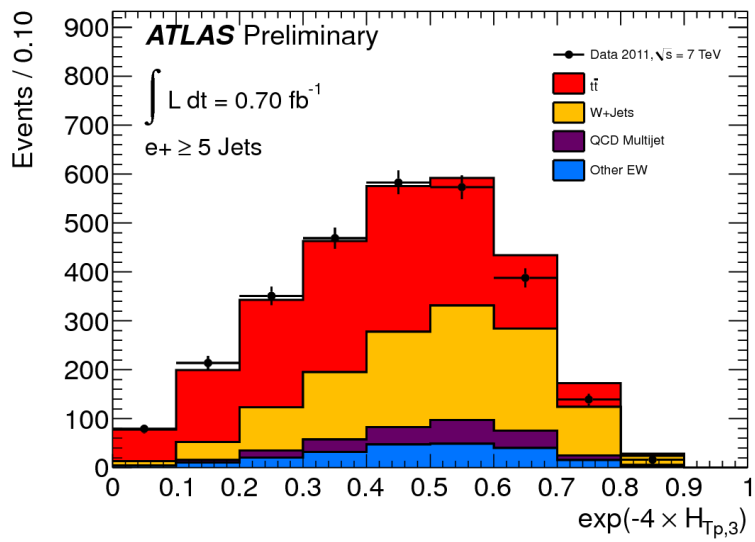
$t\bar{t}$ cross section measurement in single lepton channel

- $\boxed{\mathcal{L}_{\rm int} = 0.70 \ \ {\rm fb}^{-1}}$, ATLAS-CONF-2011-121

Analysis strategy:

- using e and μ final states
- construct likelihood discriminant using the kinematics difference between signal and background
- **Kinematic variables:** lepton η, leading jet $\mathrm{p_T}$, aplanarity, $H_{\mathrm{T,3p}} = \frac{\sum_{i=3}^{N_{\rm jets}} |p^2_{\mathrm{T},i}|}{\sum_{j=1}^{N_{\rm objects}} |p_{z,j}|}$
- create signal and background templates
- perform simultaneous fit of S and B to the data





Result (ATLAS single most precise):

$$\boxed{\sigma_{t\bar{t}} = 179.0 \pm 9.8(\mathrm{stat.} + \mathrm{syst.}) \pm 6.6(\mathrm{lumi.})\ \mathrm{pb}}$$

$t\bar{t}$ cross section measurement in fully hadronic decay channel

- $\boxed{\mathcal{L}_{\text{int}} = 1.02 \ \text{fb}^{-1}}$, ATLAS-CONF-2011-140

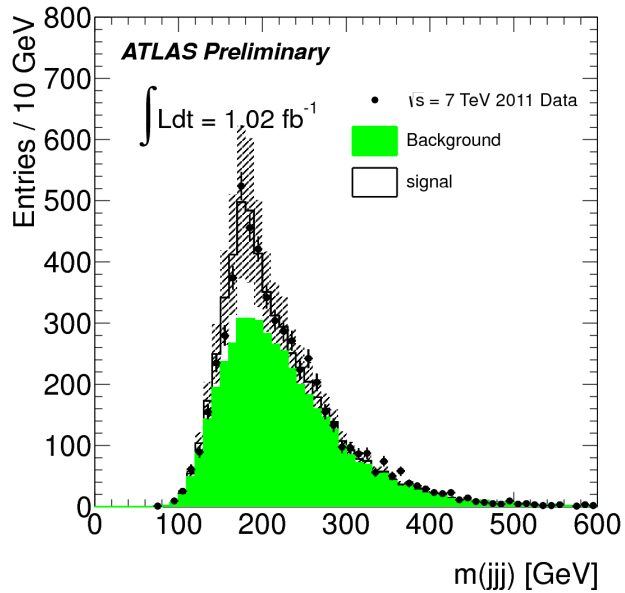
Analysis strategy:

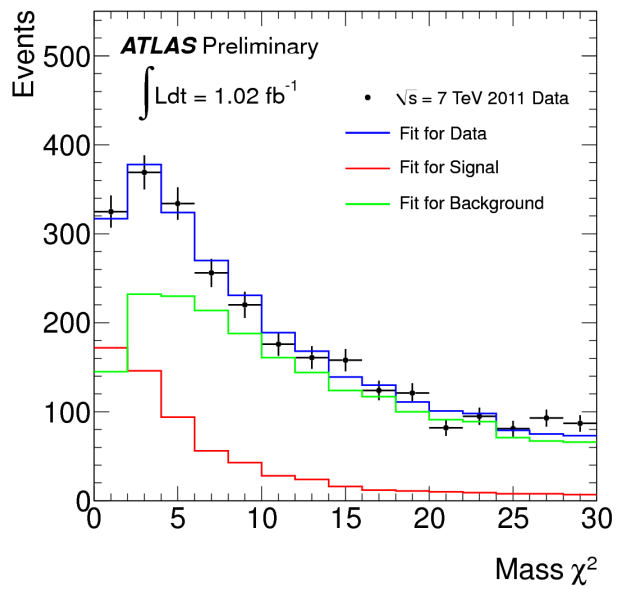
- six **high**-p_T jets: ≥ 5 with $p_T > 55$ GeV, 6th with $p_T > 30$ GeV (need multi-jet trigger)
- (2 b-jets) and no isolated leptons in the final state
- preselection signal efficiency $\sim 1\%$
- find jet assignment that minimizes the $t\bar{t}$ hypothesis χ^2:

$$\chi^2 = \frac{\left(m_{j_1,j_2} - m_W\right)^2}{\sigma_W^2} + \frac{\left(m_{j_1,j_2,b_1} - m_t\right)^2}{\sigma_t^2} + \frac{\left(m_{j_3,j_4} - m_W\right)^2}{\sigma_W^2} + \frac{\left(m_{j_3,j_4,b_2} - m_t\right)^2}{\sigma_t^2}$$

- create signal and background templates
- perform simultaneous fit of S and B to the data
- **Result:**

$$\boxed{\sigma_{t\bar{t}} = 167.0 \pm 18(\text{stat.}) \pm 78(\text{syst.}) \pm 6(\text{lumi.}) \ \text{pb}}$$



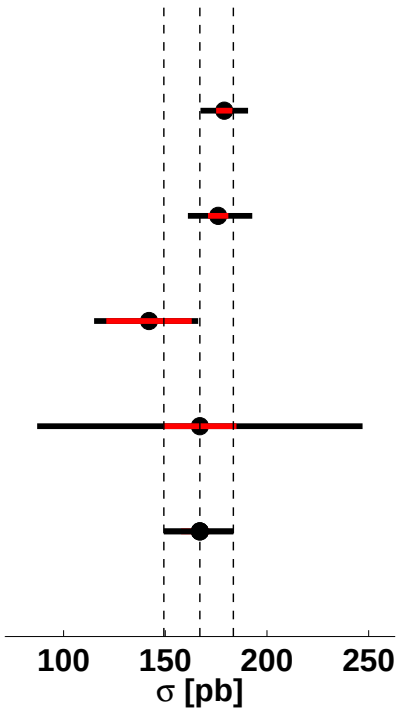


$t\bar{t}$ cross section measurement summary ($m_t = 172.5$ GeV)

Other cross section measurements with the 2011 dataset:

- $\mu + \tau$ **channel**, $\mathcal{L}_{\rm int}$ =1.08 fb^{-1}, ATLAS-CONF-2011-119
- **dilepton channel**, $\mathcal{L}_{\rm int}$ =0.70 fb^{-1}, arXiv:1202.4892, submitted to JHEP

Single lepton	**179 + 4 − 4 (stat.) +11 −11 (syst.)**
Dilepton	**176 + 5 − 5 (stat.) +16 −14 (syst.)**
muon + tau	**142 +21 −21 (stat.) +12 −17 (syst.)**
Fully hadronic	**167 +18 −18 (stat.) +78 −78 (syst.)**
Approx. NNLO	**167 + 5 − 9 (scale) +16 −15 (PDF+ alpha$_s$)**

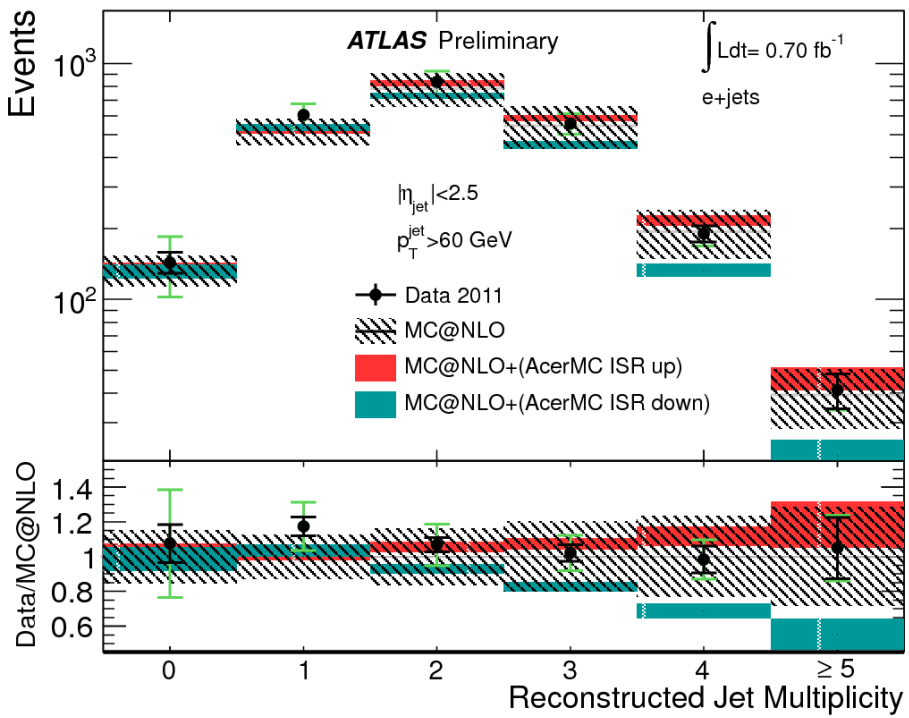


- **Measurements in good agreement with the theory prediction.**
- **Experimental uncertainty comparably small to the state of the art theo. calculations.**
- **For the most precise measurements uncertainty is syst. dominanted.**

$t\bar{t}$ + jet and $t\bar{t} + \gamma$ production

$t\bar{t}$ + jet

- $\mathcal{L}_{\text{int}} = 0.70 \ \text{fb}^{-1}$, ATLAS-CONF-2011-142
- **motivation: tuning & MC modelling checks**
- single lepton (e,μ) channel
- background substracted Njet distribution, aimed at generator tuning
- **similar to existing W/Z+jets results, but adding a jet p_T scan**

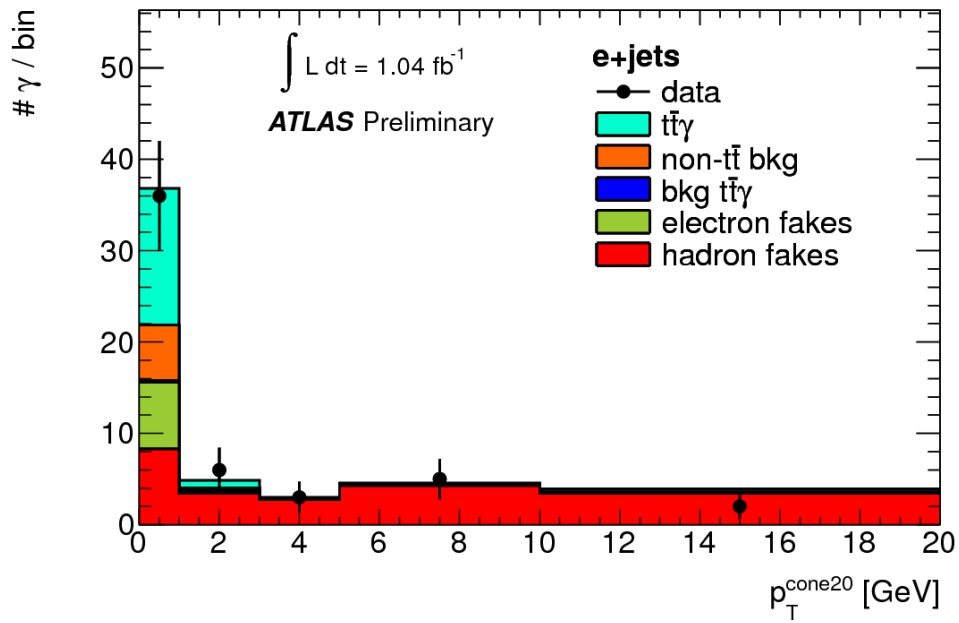


- aiming at unfolding + Rivet implementation

$t\bar{t}$ + jet and $t\bar{t} + \gamma$ production

$t\bar{t} + \gamma$

- $\mathcal{L}_{\text{int}} = 1.04 \ \text{fb}^{-1}$, ATLAS-CONF-2011-153
- motivation: probing top QED coupling
- measurement of $t\bar{t} + \gamma$ σ in single lepton events
- $\text{p}_{\text{T}}(\gamma) > 15 GeV$
- only handful of events (52, 72 in e, μ chan.) pass the event selection criteria



- **Estimated σ** for events with photon $\text{p}_{\text{T}} > 8$ GeV and $\geq 1e, \mu, \tau$ is **consistent with SM predictions (2.1 ± 0.4 pb):**

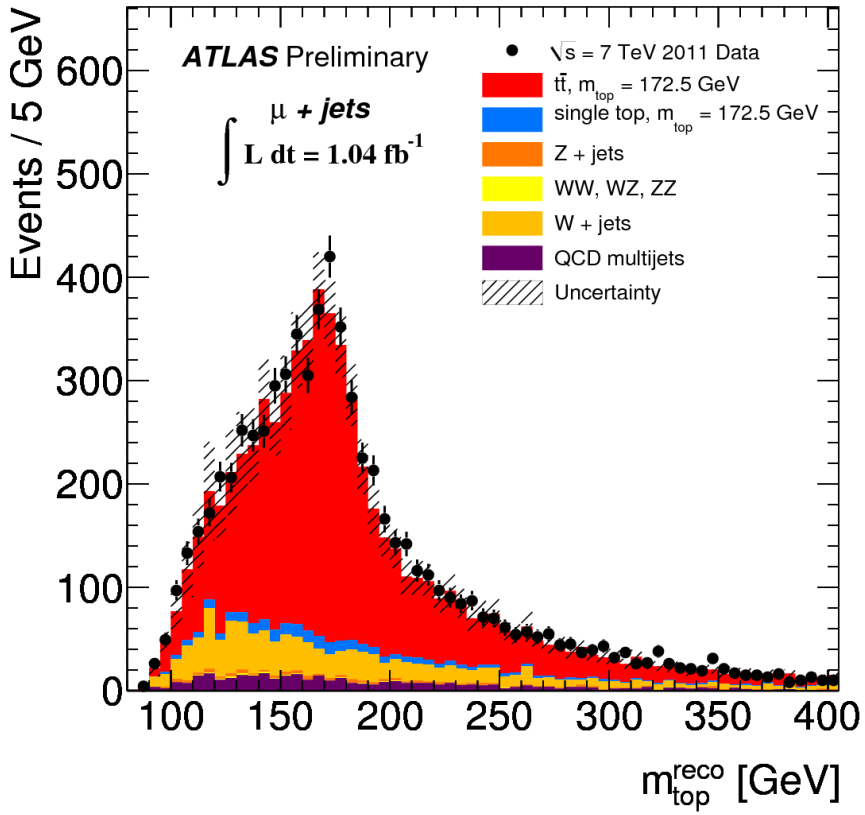
$$\sigma(t\bar{t} + \gamma) = 2.0 \pm 0.5 \ (\text{stat}). \pm 0.7 \ (\text{syst.}) \ \text{pb}$$

top quark mass measurement, NEW!

- $\mathcal{L}_{\rm int} = 1.04\ {\rm fb}^{-1}$

Analysis strategy:

- single lepton $t\bar{t}$ events, e and μ channels
- main observables: jet pairs and jet triplets inv. mass (m_W and m_t estimators)
- 2-D template analysis: simultan. fit of m_t and global JSF [a]
- known m_W used to constrain JES effects for light jets



- **Result** (e and μ chan. combination):

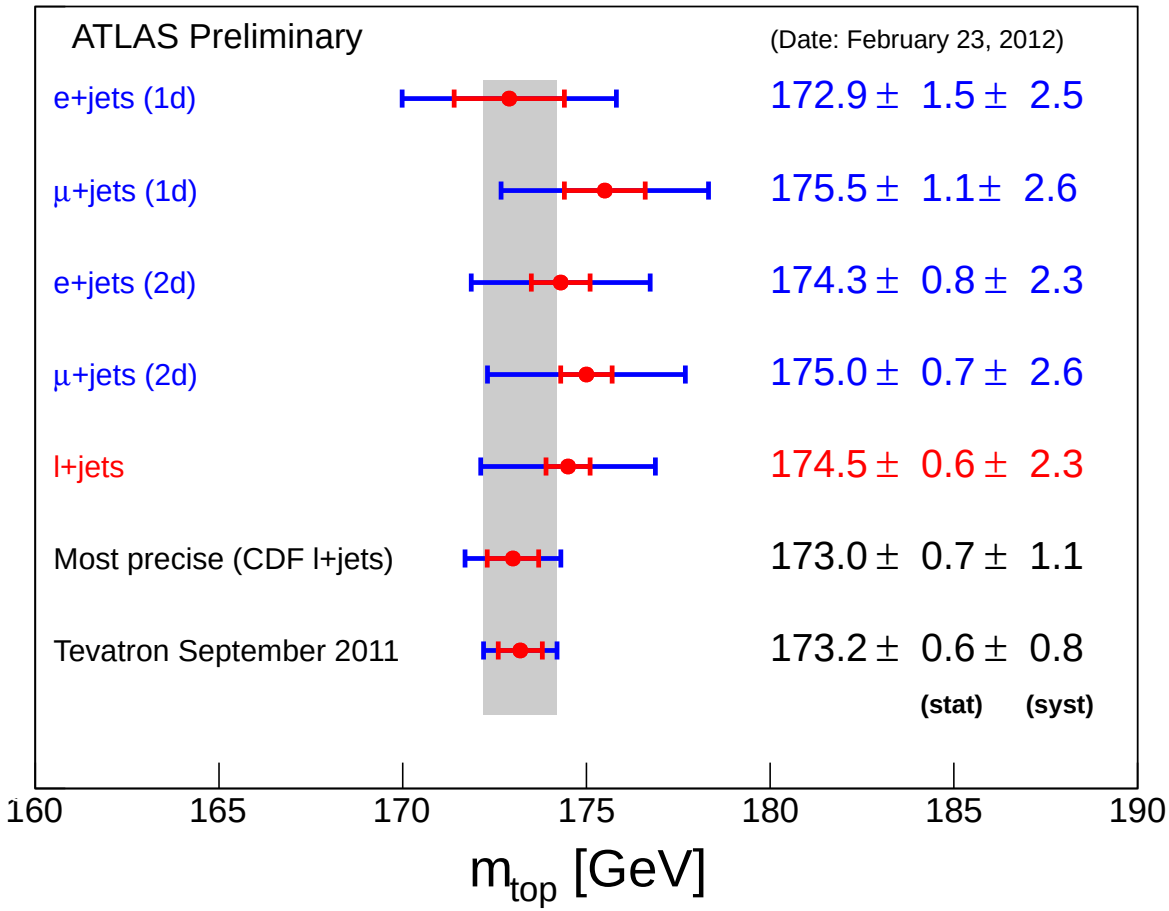
$$m_t = 174.5 \pm 0.6\ ({\rm stat}). \pm 2.3\ ({\rm syst.})\ {\rm GeV}$$

[a] Global ($p_{\rm T}$ and η independent) Jet Scale Factor

top quark mass measurement status

Current world average:

- $m_t = 173.18 \pm 0.56\ (\mathrm{stat}). \pm 0.76\ (\mathrm{syst.})\ \mathrm{GeV}$
- measurements by CDF and D0 with Run I and Run II data, $\mathcal{L}_{\mathrm{int}}$ 5.8 fb^{-1}.



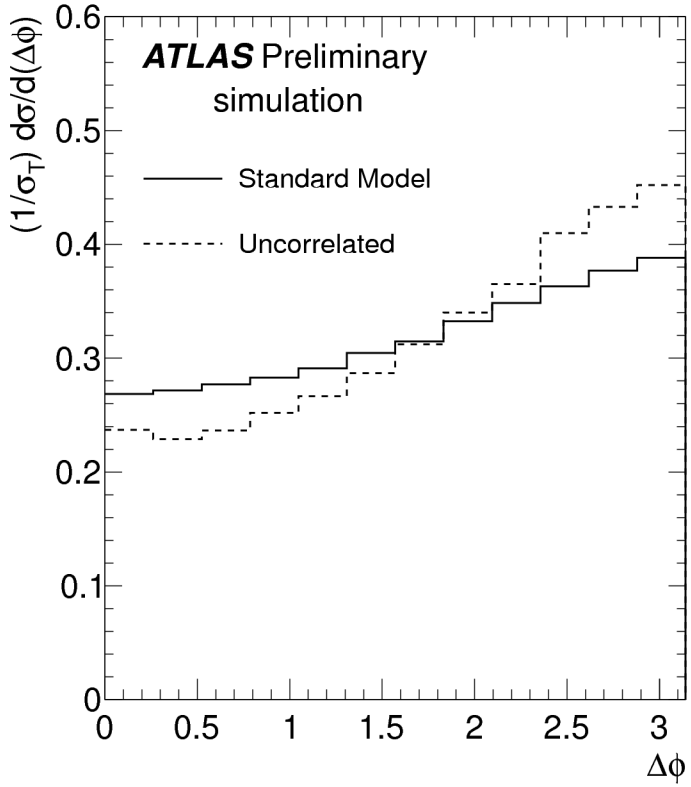
- reduction of the systematics uncertainty needed to reach Tevatron measurement uncertainty.
- Challenging, but there is a lot of space for improvement wrt. currently published measurement, incl. reducing JES, MC modelling uncertainties, reducing MC stats. effects by generating huge samples . . .

spin correlation in $t\bar{t}$ production

- $\mathcal{L}_{\rm int}$ =0.7 fb^{-1}, ATLAS-CONF-2011-117
- SM: τ(top decay) $<$ τ(hadronization)
  $\Rightarrow$ t and $\bar{t}$ spin corr. at decay products level
- **can be tested at LHC!**

Analysis strategy:

- **dileptonic $t\bar{t}$ events, ee, $\mu\mu$, $e\mu$ channels**
- **sensitive observable: $\Delta\phi$ between the leptons**
- **one of the estimated quantities: f^{SM} fraction of Standard Model-like events**
- extracted from binned likelyhood fit to the templates produced from samples with/wo spin correlations



- **Result(s) consistent with SM** (all channels combination):

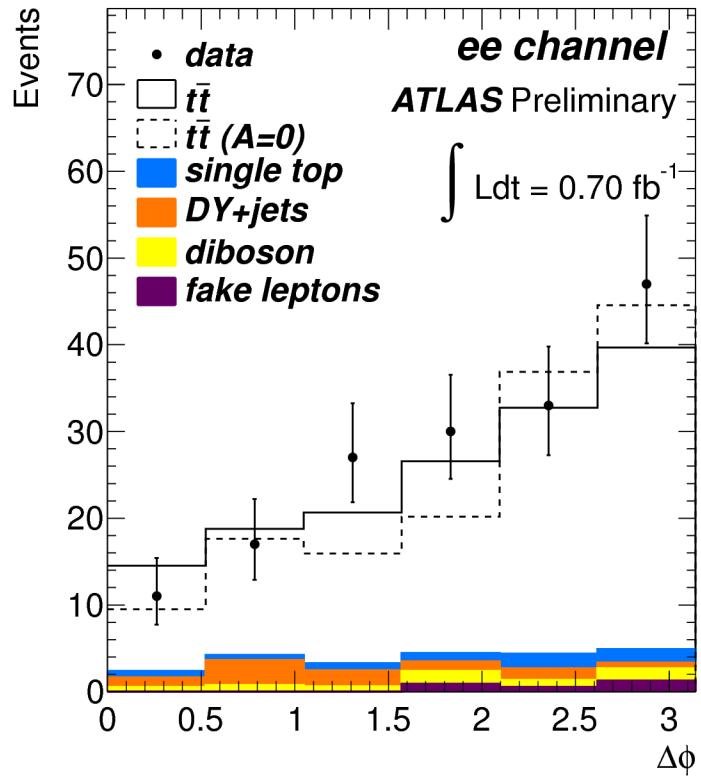
$$f^{SM} = 1.06 \pm 0.21\ (\text{stat}).^{+0.40}_{-0.27}\ (\text{syst.}), (\text{SM} : f^{SM} = 1.0)$$

spin correlation in $t\bar{t}$ production

- $\mathcal{L}_{\mathrm{int}} = 0.7\ \mathrm{fb}^{-1}$, ATLAS-CONF-2011-117
- SM: τ(top decay) $<$ τ(hadronization)
  $\Rightarrow$ t and $\bar{t}$ spin corr. at decay products level
- **can be tested at LHC!**

Analysis strategy:

- **dileptonic $t\bar{t}$ events, ee, $\mu\mu$, $e\mu$ channels**
- **sensitive observable: $\Delta\phi$ between the leptons**
- **one of the estimated quantities: f^{SM} fraction of Standard Model-like events**
- extracted from binned likelyhood fit to the templates produced from samples with/wo spin correlations



- **Result(s) consistent with SM** (all channels combination):

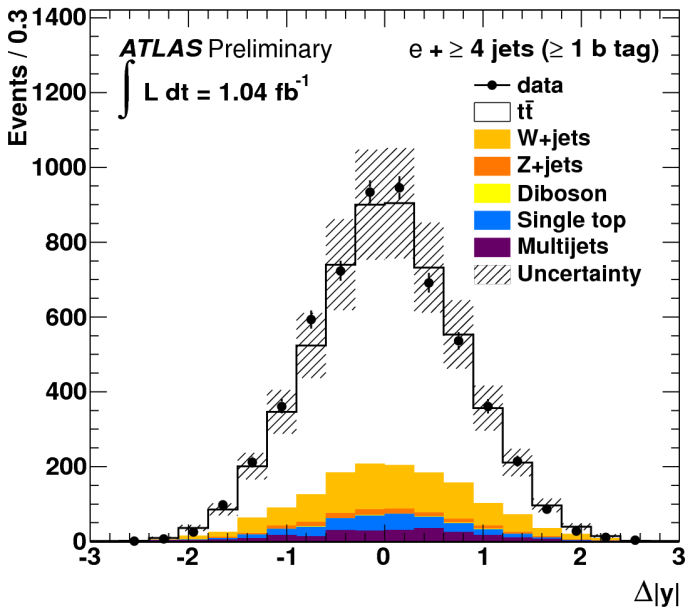
$$f^{SM} = 1.06 \pm 0.21\ (\mathrm{stat}).^{+0.40}_{-0.27}\ (\mathrm{syst.}), (\mathrm{SM} : f^{SM} = 1.0)$$

Charge asymmetry in $t\bar{t}$ production, NEW!

- $\boxed{\mathcal{L}_{\rm int} = 1.04\ {\rm fb}^{-1}}$
- The measurement is particularly interesting since the **Tevatron experiments report 2-3 σ excess in forward-backward asymmetry (A_{FB}) in $t\bar{t}$ events.**
- at LHC the physics effects responsible for Tevatron (A_{FB}) are manifest in charge asymmetry defined as:

$$A_C^{pp} = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)},$$

  where $\Delta|y| = |y_t| - |y_{\bar{t}}|$
- SM value [1] of $A_C^{pp} = 0.006 \pm 0.002$.

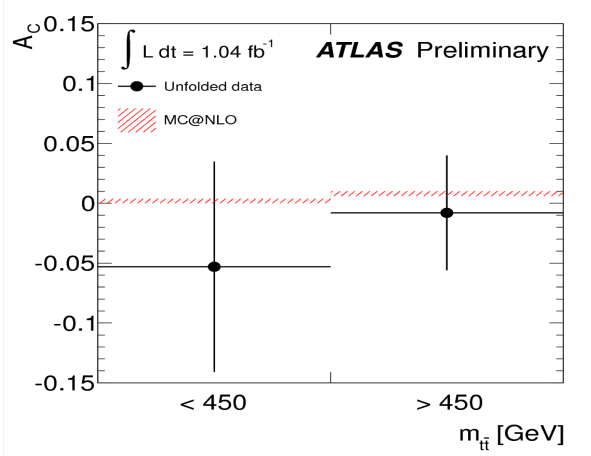


[1] for the analysis kinematics cuts, using MC@NLO

Charge asymmetry in $t\bar{t}$ production, NEW!

Analysis strategy:

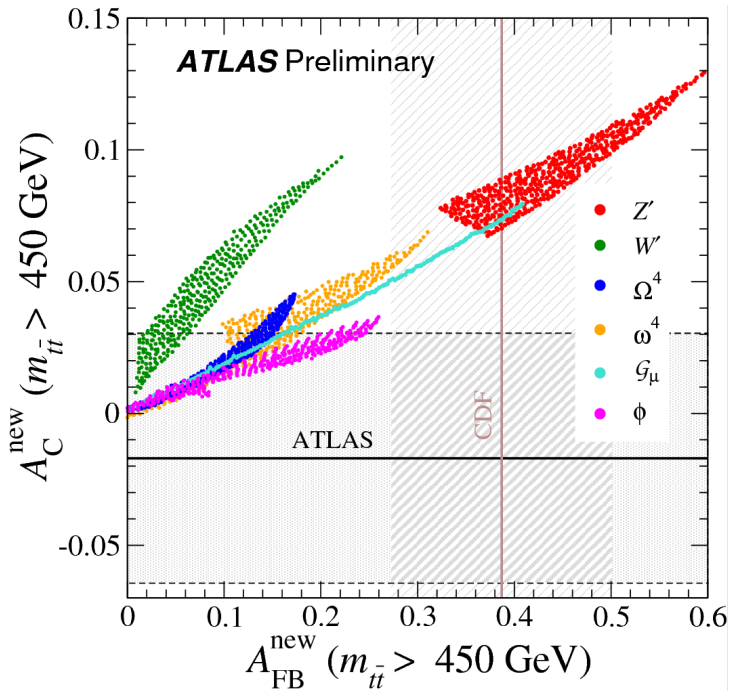
- single lepton (e,μ) channel
- full $t\bar{t}$ system reco.; charge of the $t(\bar{t})$ follows from the charge of the final state lepton
- two inv. mass bins: $m_{t\bar{t}} < 450$ GeV and $m_{t\bar{t}} > 450$ GeV
- unfolding for theory comparisons



Result:

$A_C = -0.018 \pm 0.028\ (\text{stat}). \pm 0.023\ (\text{syst}.)$ [a]

- **consistent with the SM value** of $A_C^{pp} = 0.006 \pm 0.002$
- **sensitivity can be improved; reducing syst. uncertainty, using different kinematics region**
- **limits on allowed A_C(LHC) and A_{FB}(Tevatron) regions** can constrain some models proposed to explain the Tevatron A_{FB}



[a] $A_C = -0.053, -0.008 \pm 0.070, 0.035\ (\text{stat}). \pm 0.054, 0.032\ (\text{syst}.),\ m_{t\bar{t}} < 450\ \text{GeV},\ m_{t\bar{t}} > 450\ \text{GeV}$

Further top properties in $t\bar{t}$ events results

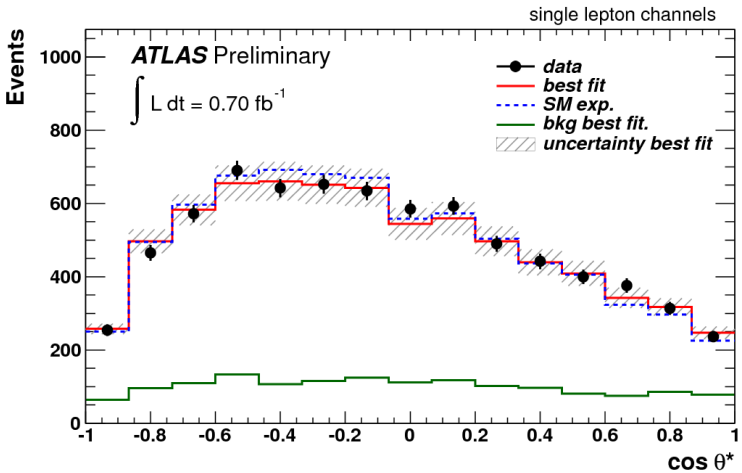
- $\mathcal{L}_{\rm int}$ =0.7 fb^{-1}

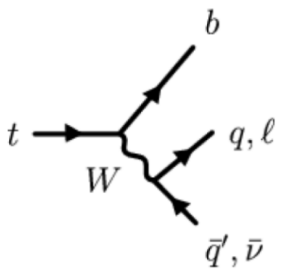
Measurement of W polarization in $t\bar{t}$ decays

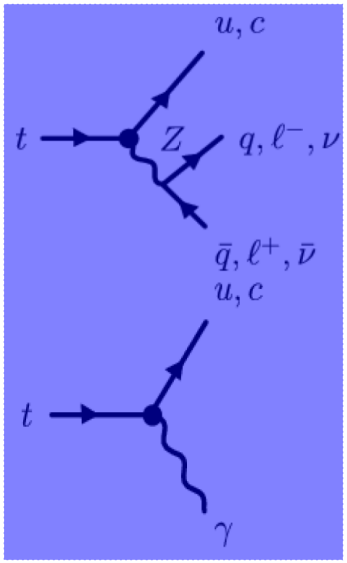
- ATLAS-CONF-2011-122
- θ^* = angle between the direction of charged lepton from W and the reversed direction of b from top, both boosted to W rest frame
- **no deviations from SM helicity fractions** ($F_0 = 0.678 \pm 0.005$, $F_L = 0.311 \pm 0.005$, $F_R = 0.0017 \pm 0.0001$) **observed**;

  $F_0 = 0.75 \pm 0.08$ (stat.+syst.),

  $F_L = 0.25 \pm 0.08$ (stat.+syst.),$F_R \sim 0$







Search for FCNC in $t\bar{t}$ decays

- ATLAS-CONF-2011-154
- no evidence for an FCNC signal was found

  $R(t \to qZ)$ <1.1(1.3)% obs.(exp.)

Measurement of the top quark charge

- ATLAS-CONF-2011-141

  exotic charge -4/3 t excluded at $> 5\sigma$

Search for pair-produced heavy quarks ($Q\overline{Q}$), NEW!

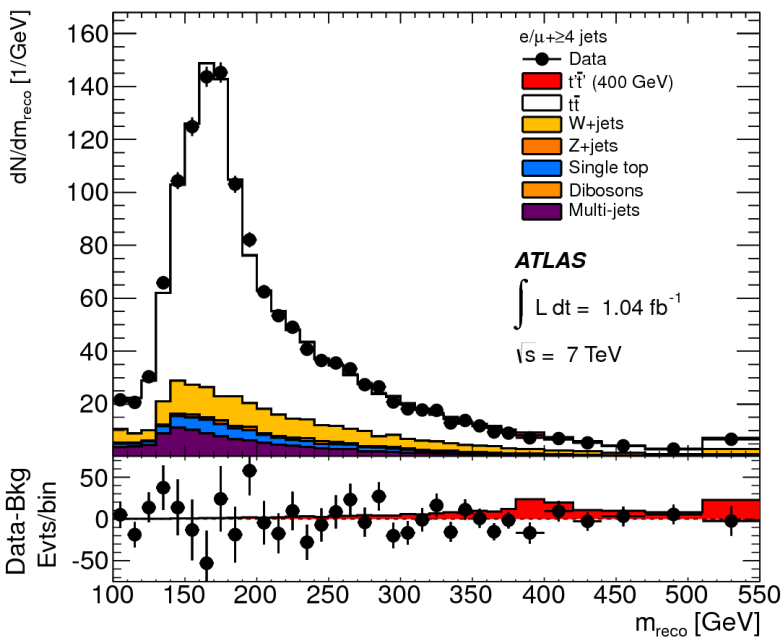
- $\mathcal{L}_{\rm int}$ =1.04 fb^{-1}, single lepton (e,μ) channel, **no excess over SM background ⇒ limits**
- **motivation:** direct test of 4th gen. quark existence

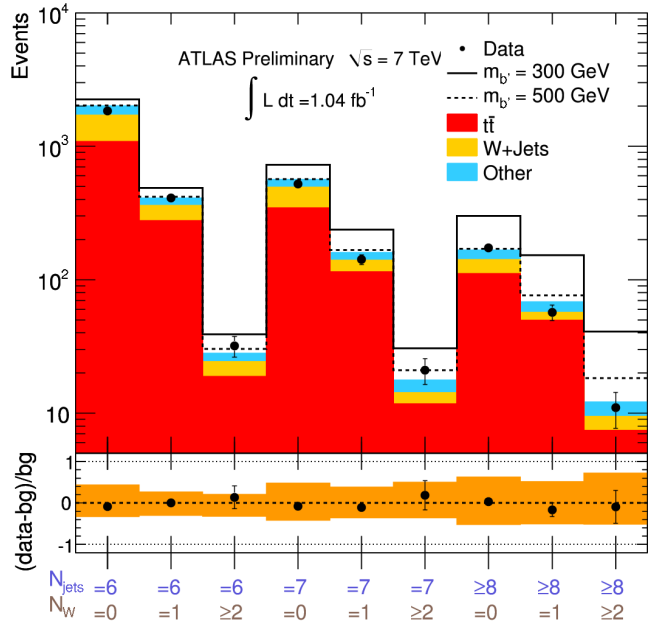
arXiv:1202.3076 (subm. to Phys. Rev. Lett.):
$Q\overline{Q} \to W^+bW^-\overline{b}$

- main observable: reconstructed (Q) mass

NEW!
$Q\overline{Q} \to W^+tW^-\overline{t}$:

- main observable: Njet as a function of N_W (jet-jet pairs with mass close to m_W)



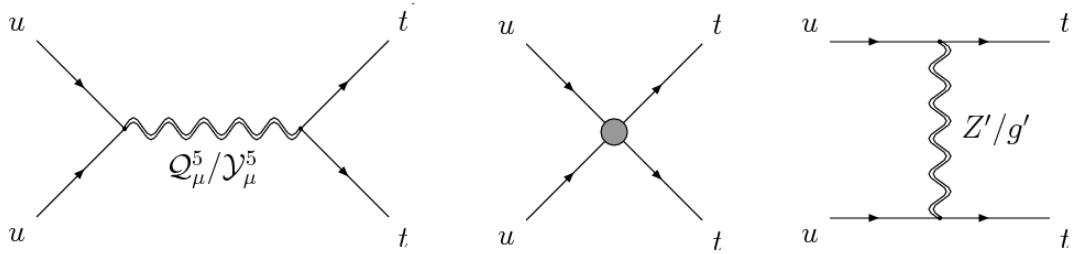


$m_Q > 404(394)$ GeV obs.(exp.), 95%CL

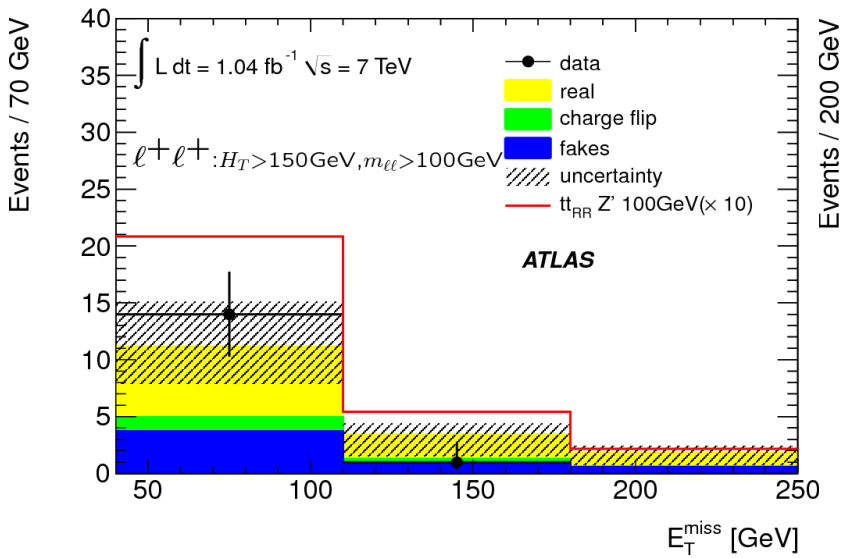
$m_Q > 480(440)$ GeV obs.(exp.), 95% CL

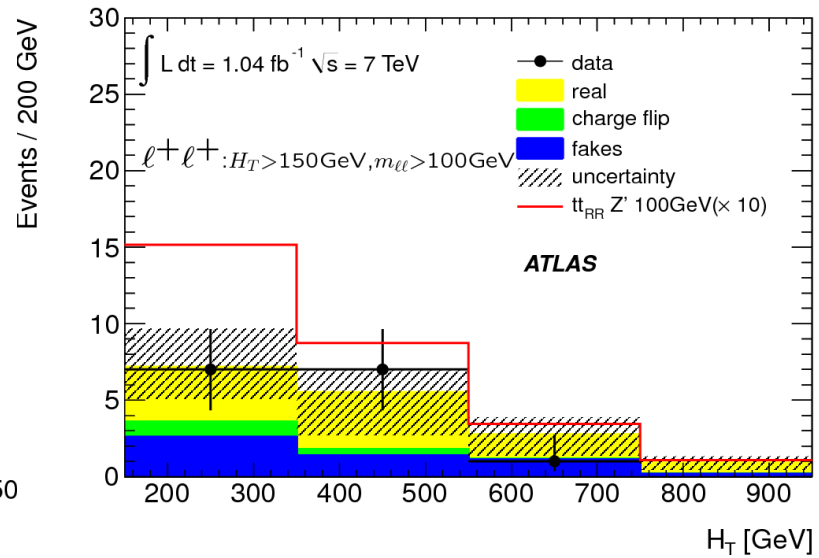
Search for same-sign top pair production

- $\mathcal{L}_{\rm int}$ =1.04 $\rm fb^{-1}$, arXiv:1202.5520, submitted to JHEP
- **motivation:** e.g. flavour changing Z' proposed to explain Tevatron A_{FB}
- **no excess over SM background** $\Rightarrow$ limits



- events with 2 same sign leptons (e,μ), separation from SM background: $E_{\rm T}^{\rm miss}$, H_T[2]





$\sigma_{Z'} < 1.4(1.5) - 2.0(2.1)$ pb obs.(exp.) for $m_{Z'}$=200 GeV- 100 GeV

[2] $H_T = \sum_i |p_T|, i \in \text{leptons, jets}$

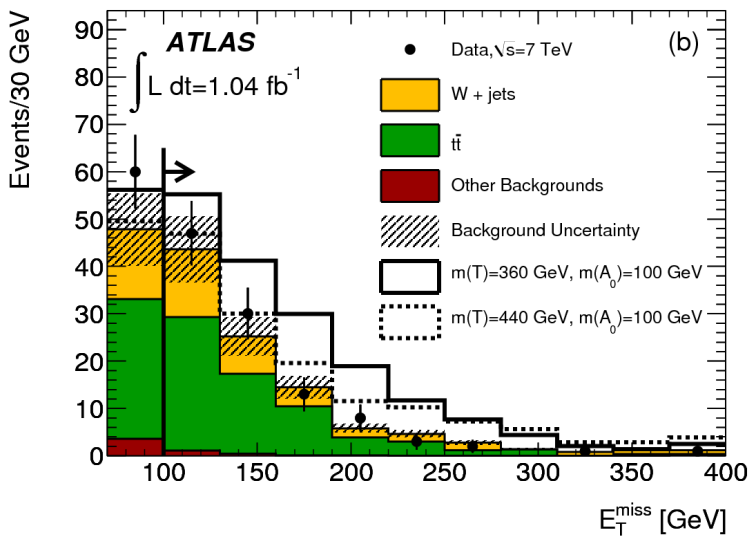
Searches for $t\bar{t} + E_{\mathrm{T}}^{\mathrm{miss}}$ and resonant $t\bar{t}$ production

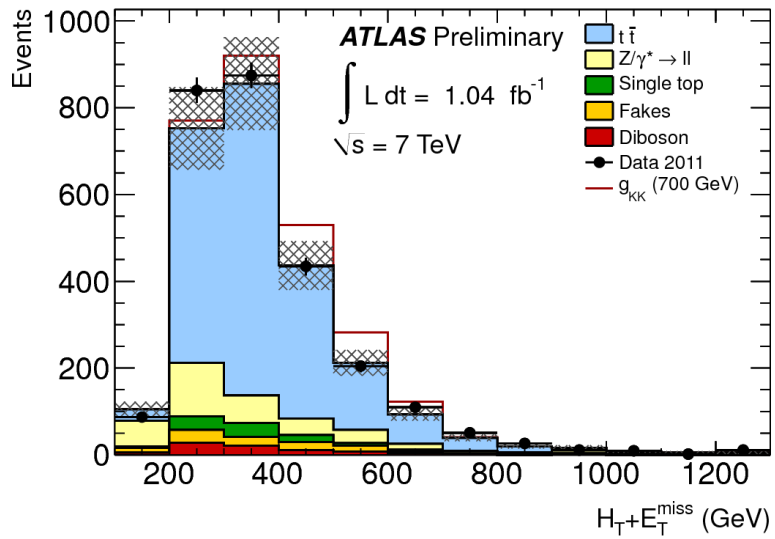
$t\bar{t} + E_{\mathrm{T}}^{\mathrm{miss}}$:

- $\boxed{\mathcal{L}_{\mathrm{int}} = 1.04\ \mathrm{fb}^{-1}}$,
  Phys. Rev. Lett. 108 (2012)
- **Final state:** $T\overline{T} \rightarrow t\bar{t}A_0A_0$,
  T = exotic top partner,
  A_0 = stable, neutral weakly interacting particle
- e.g. stop squark and neutralino/gluino
- main observable: $\not{E}_{\mathrm{T}}$

resonant $t\bar{t}$ production:

- $\boxed{\mathcal{L}_{\mathrm{int}} = 1.04\ \mathrm{fb}^{-1}}$,
  ATLAS-CONF-2011-123
- resonances $\rightarrow t\bar{t}$ predicted by many BSM models;
- KK-gluon in the Randall-Sundrum model taken for the bechmark
- main observable: $E_{\mathrm{T}}^{\mathrm{miss}} + \mathrm{H}_T$





$\boxed{m_T > 420\ \mathrm{GeV}, m_{A_0} > 140\ \mathrm{GeV}, 95\%\ \mathrm{CL}}$

$\boxed{m_{gKK} > 0.84(0.80)\ \ \mathrm{GeV}\ \text{obs.(exp.)}, 95\%\ \mathrm{CL}}$

Summary of new particle searches in top production events

No excess over SM expectations observed $\Rightarrow$ limits on new particle properties.

Process	Channel	Reference	$\mathcal{L}_{\rm int}$ [fb^{-1}]	obs.(exp.) 95% CL limits	note
pair-produced heavy quarks					
$Q\overline{Q} \to W^+qW^-\overline{q}$, (q=u,d,c,s,b)	dilept.	arXiv:1202.3389	1.04	$m_Q > 350(335)$ GeV	1)
$Q\overline{Q} \to W^+bW^-\overline{b}$	single lept.	arXiv:1202.3076	1.04	$m_Q > 404(394)$ GeV	1)
$Q\overline{Q} \to W^+tW^-\overline{t}$	single lept.	**NEW!**	1.04	$m_Q > 480(440)$ GeV	
$Q\overline{Q} \to W^+tW^-\overline{t}$	dilept.	**NEW!**	1.04	$m_Q > 450$ GeV	2)
same-sign $t\bar{t}$ production					
$uu \to tt$	$\mu\mu$	arXiv:1201.1091	1.6	$\sigma'_Z = 3.7 - 2.2$ pb for $m_{Z'} = 0.1 - gg1$ TeV	3)
tt	ll, $l = e, \mu$	arXiv:1202.5520	1.04	$\sigma'_Z = 2.0 - 1.4$ pb for $m_{Z'} = 0.1 - 0.2$ TeV	4)
search for $t\bar{t} + E_{\rm T}^{\rm miss}$					
$T\overline{T} \to t\bar{t}A_0A_0$	single lept.	Phys. Rev. Lett. 108 (2012)	1.04	$m_T > 420$ GeV, $m_{A_0} > 140$ GeV	5)
search for resonances					
$t\bar{t}$	dilepton	ATLAS-CONF-2011-123	1.04	$m_{gKK} > 0.84(0.80)$ GeV	6)

1) limit applies to heavy up- and down- type quark pair production as well as exotic quark pair production with the specified decay pattern
2) the same analysis also sets limits on same-sign top production
3) limits are also set to generic new physics processes with same-sign $\mu\mu$ final states as well as $H^{\pm}H^{\pm}$ production
4) same-sign top production limits are set at 1.7 pb for each $t\bar{t}$ chirality combination and translated into limits on the coefficients of corresponding effective operators. Apart from the light Z' limits, the limits are also placed on generic classes of models with the new particles mediating the same-sign $t\bar{t}$ production. Limits on neutral color singlets pose world best exclusion limits of contributions to the forward-backward asymmetry in $t\bar{t}$ production at Tevatron.
5) excl. limits derived as a function of T and A_0 masses
6) limits derived for various strong coupling parameter values

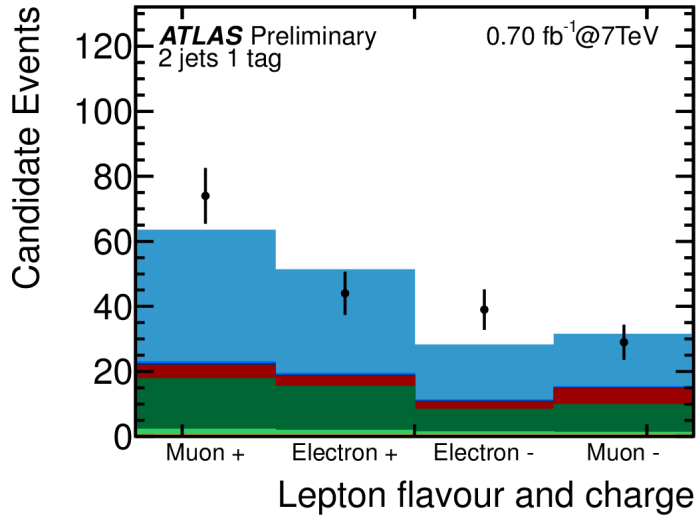
single top cross section measurement

- $\mathcal{L}_{\text{int}} = 0.70 \ \text{fb}^{-1}$
- update measurements for all three decay channels (s-,t-,Wt).

t-channel:

- ATLAS-CONF-2011-101
- **cut** and neural network analysis results
- single lepton (e,μ) final states
- variables with good S-B separation power: 3-jet top mass, leading untagged jet η

$$\sigma_t = 90 \pm 9(\text{stat.}) + 31 - 20(\text{syst.}) \ \text{pb}$$



Wt-channel:

- ATLAS-CONF-2011-104
- cut based analysis, final state: both $W \to l\nu$

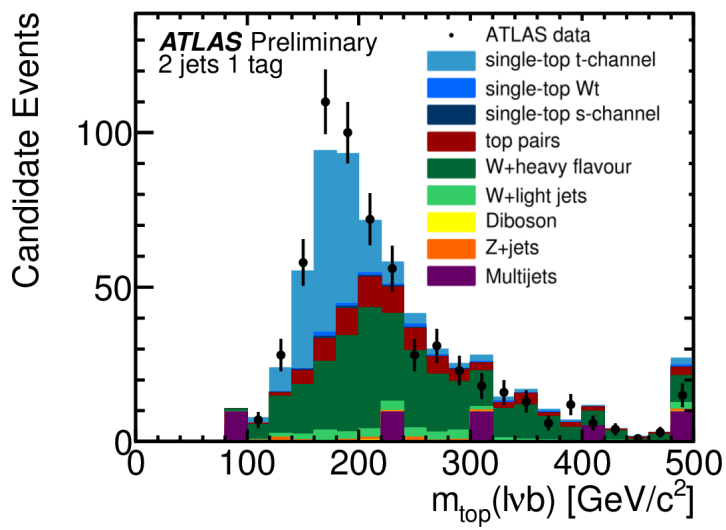
$$\sigma_t < 39.1(40.6) \ \text{pb obs.(exp.)}, 95\%\text{CL}$$

$$\sigma_t = 14 + 5.3 - 5.1(\text{stat.}) + 9.7 - 9.4(\text{syst.}) \ \text{pb}$$

s-channel:

- ATLAS-CONF-2011-118
- cut based analysis, single lepton (e,μ) final states

$$\sigma_t < 26.5(20.5) \ \text{pb obs.(exp.)}, 95\%\text{CL}$$

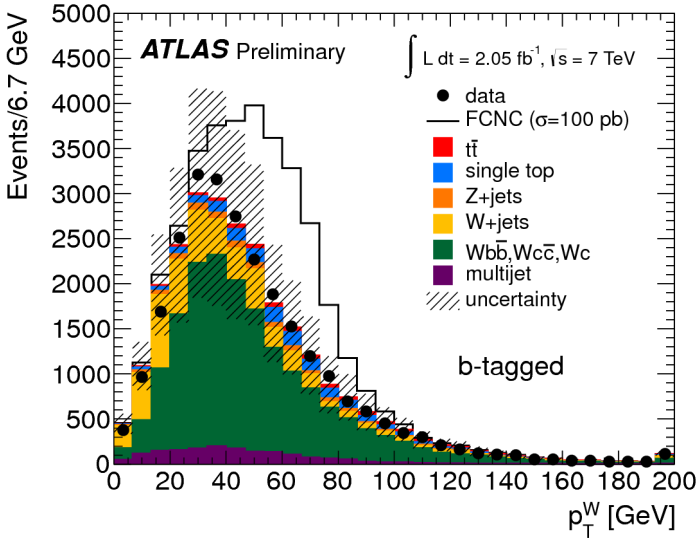


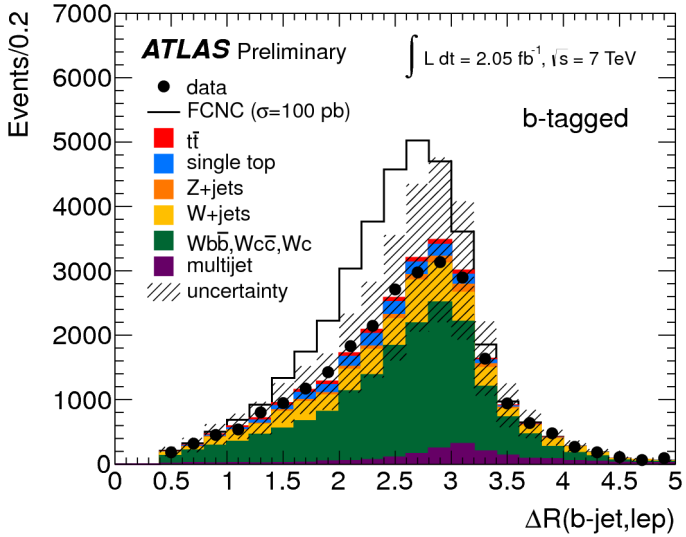
search for FCNC single top production, NEW!

- $\mathcal{L}_{\mathrm{int}} = 2.05\ \mathrm{fb}^{-1}$

Analysis strategy:

- use leptonic decays
- classify events as signal- or background-like using a neural network
- most significant variables: W boson $\mathrm{p_T}$, ΔR(b-jet,lepton) and lepton charge.





Results (no excess over SM observed $\Rightarrow$ limits):

$\sigma(qg \to t) \cdot B(t \to Wb) < 3.9$ pb (95% CL),

$B(t \to ug) < 5.7 \cdot 10^{-5}$, $B(t \to cg) < 2.7 \cdot 10^{-4}$ **(world best)**

Summary & Outlook

Summary

in 2011 ATLAS has collected a relatively large number of top quark production (candidate) events:

- $t\bar{t}$ **production:**
  - **cross section:** uncertainty dominanted by syst., precision comparable to state of the art theory calculations
  - **mass:** uncertainty dominanted by syst., considerable effort needs to be invested if one is to reach precision close to Tevatron
  - **properties:** many measurements (spin, charge . . .), so far all consistent with SM predictions
  - **searches:** so far consistent with SM predictions, enabled us to set limits on new physics models
- **single top production:**
  - **cross section:** estimated/limited in all three (t,Wt,s channels)
  - world best limits on FCNC $\mathcal{B}(t \to u(c)g)$

(2011 dataset analysis) Outlook

- use the full $\mathcal{L}_{\mathrm{int}} \sim 5\ \mathrm{fb}^{-1}$ (results coming for Moriond-)
- use improved simulation, larger MC samples tuned to the recent LHC data
- use recent systematics improvements
- use data-driven modeling systematics and pursue further improvement of the modeling systematics prescriptions

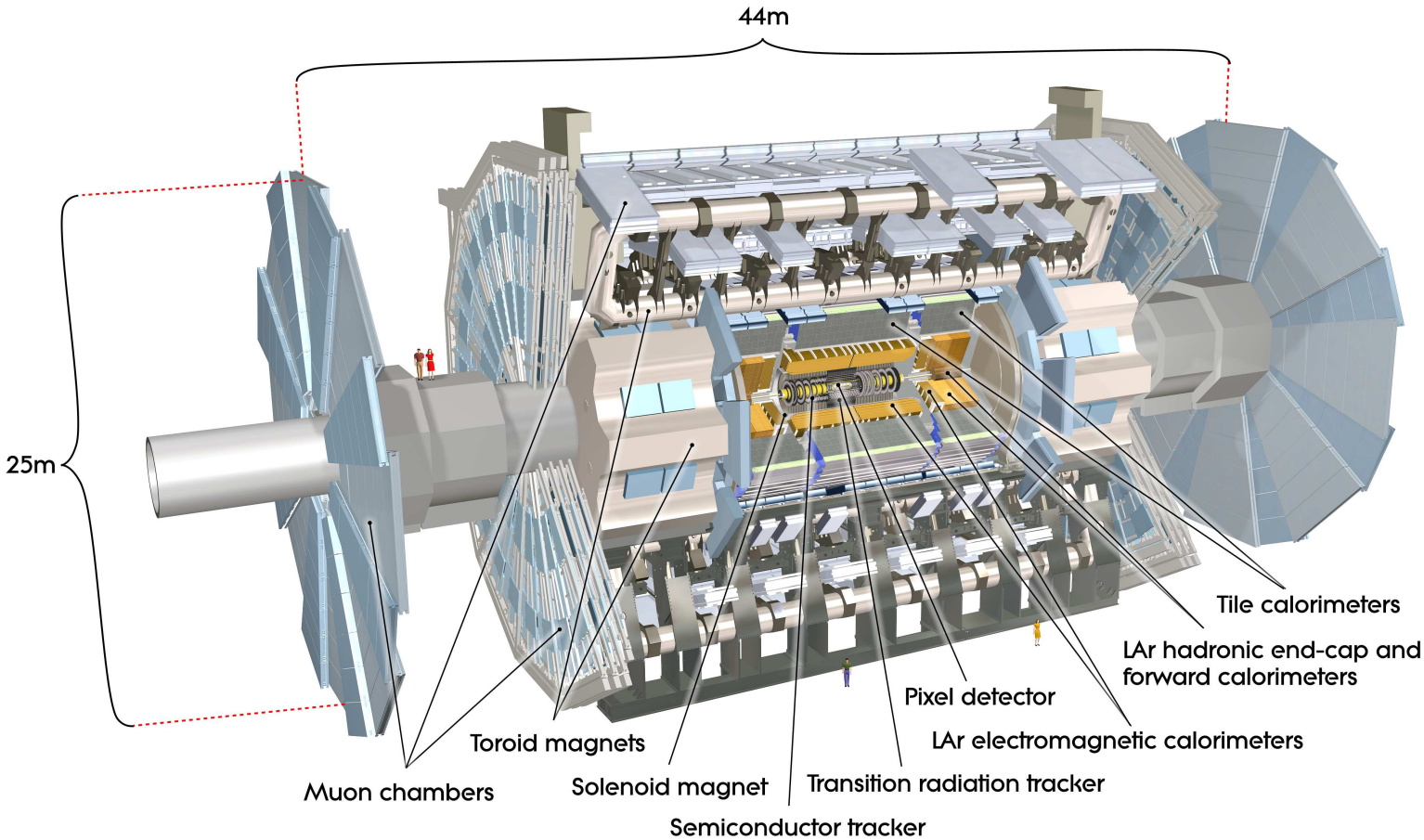
Public results page:

`https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TopPublicResults`

Additional Slides

The ATLAS Collaboration and Detector

- **A T**oroidal **L**HC **A**pparatu**S** is a particle physics experiment at the Large Hadron Collider at CERN.
- **Collaboration**: 38 countries, $\sim$ 3000 physicists, $>$ 170 universities and laboratories.
- The dimensions of the ATLAS detector (figure below) are 25 m in height and 44 m in length. The overall weight is 7000 tonnes.

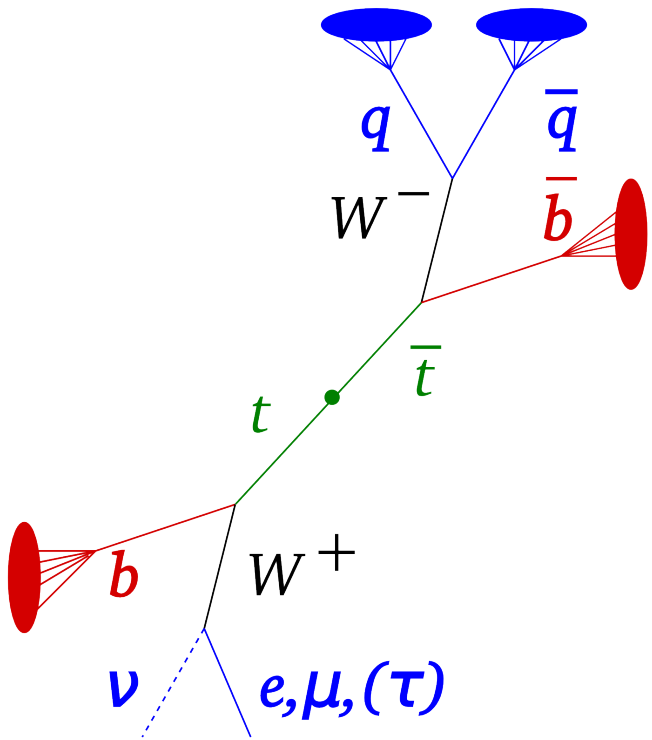


$t\bar{t}$ decay channels and signatures

Top production process signature is determined by the production and decay channels.

- branching ratio for $t \to Wb \sim 1$
- observable final state depends on W^+ and W^- decays:

$t\bar{t} \to W^+ b\ W^- \bar{b} \to q\bar{q} b\ l\nu\bar{b}$: **SINGLE LEPTON DECAY CHANNEL**

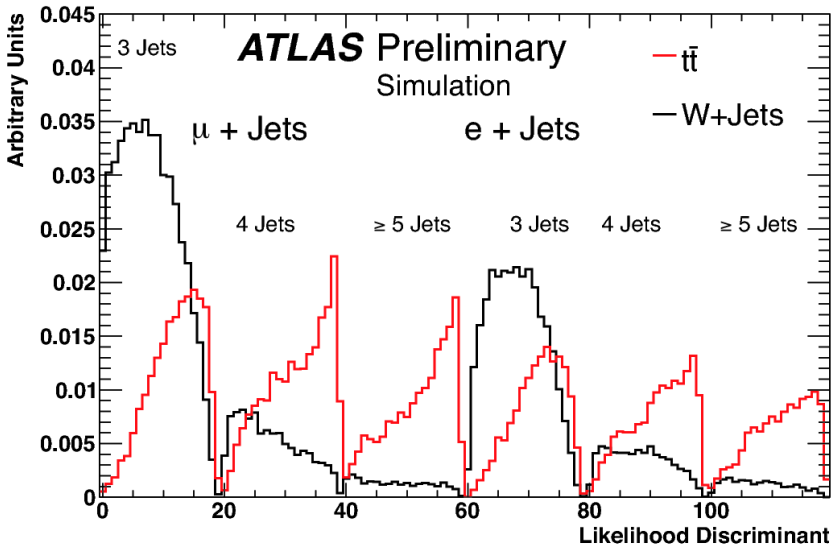


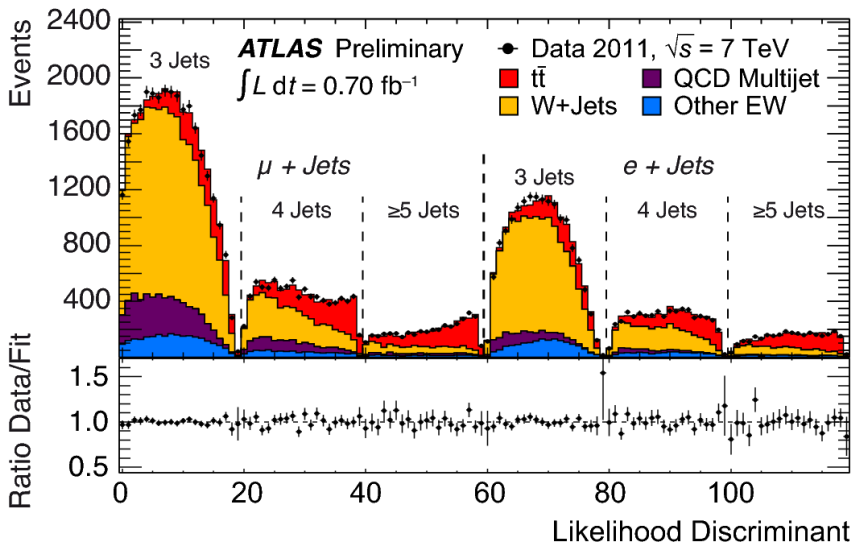
Typical selection criteria:

- **event cleaning:** GRL conditions, PV with $\geq$ 5 tracks, bad jets and cosmics veto
- **electron:** $Et > 25\ \mathrm{GeV}$, $|\eta| < 2.5$, calo isolation, track matching
- **muon:** $\mathrm{p_T} > 20\ \mathrm{GeV}$, $|\eta| < 2.5$, calo and track isolation, segments in tracker & muon detector
- $E_{\mathrm{T}}^{\mathrm{miss}}$: vector sum of calo energy deposits, corrected for identified objects
- **jet:** $\mathrm{p_T} > 20\ \mathrm{GeV}$, $|\eta| < 2.5$, topo clusters, Anti-kT (R=0.4), calibration checked w/data
- **b-jet:** displaced tracks or secondary lepton, algs: SV0: reconstruct sec.vertex, JetProb: track/jet compatibility with primary vertex, IP3D+SV1 and JetFitter: advanced taggers

$t\bar{t}$ cross section measurement in single lepton channel

- $\boxed{\mathcal{L}_{\text{int}} = 0.70 \ \text{fb}^{-1}}$, ATLAS-CONF-2011-121
- **Likelihood distribution and fit to the data:**





- Likelihood distribution in μ (3, 4, $\geq$ 5 jets) and e (3, 4, $\geq$ 5 jets) channels
- $t\bar{t}$ and W+jets (main background) well separated

Charge asymmetry in $t\bar{t}$ production, NEW!

Limits on allowed A_C(LHC) and A_{FB}(Tevatron) regions:

- Z': flavour-changing boson with right-handed couplings, exchanged in the t-chan. in $u\bar{u} \to t\bar{t}$
- W': boson with right-handed couplings contributing to $d\bar{d} \to t\bar{t}$
- $\Omega_4(\omega_4)$, charge=4/3 scalar colour-sextet(triplet) contributing to u-chan. $u\bar{u} \to t\bar{t}$
- G_μ: heavy axigluon exchanged in s-chan.
- Φ: scalar doublet with the same quantum numbers as the SM Higgs

Figure details:

- coloured areas = mass and coupling scans (consistent with exp. data)
- solid(dashed) lines = experimental measurement(uncertainty)
- SM value is substracted from A_C,A_{FB} values