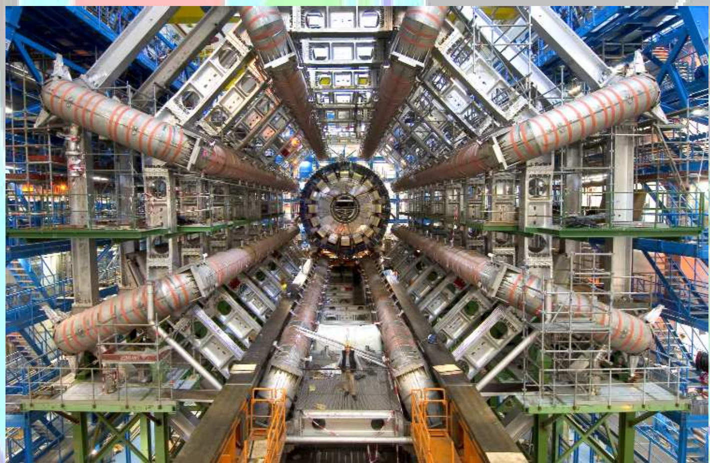
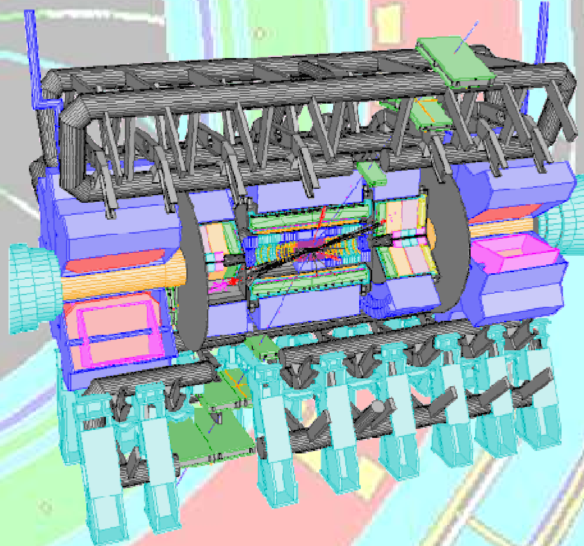
Top Physics with the ATLAS detector at LHC





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CNRS-Blaise Pascal Univ./ LPC Clermont-FD

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Université Blaise Pascal

Why the Top quark is so interesting ?

- Properties
  - Large mass M_t = 173.1±1.2 GeV [arXiv:0903.2503 (CDF+D0)]
  - Top-Higgs Yukava coupling : $\lambda_t = \sqrt{2}\, M_T / v \sim 1$
  - Interact heavily with the higgs sector

    => Suggest that the Top quark play a specific role in the electro weak symmetry breaking (EWSB).

    => All New Physics in connection with EWSB should couple preferentially to the Top quark : Top sector is an ideal laboratory to search for 'New Physics'

  - Short lifetime => The Top Quark decays before hadronisation

    => study the properties of a « bare » quark (Top Mass)

- Shopping list
  - Explore properties

    Production mechanisms (X-sec, search for resonances), top properties (mass, charge,decays…) top&W polarisations,…
  - Precise meass measurement => consistency test of the SM, and constraint for the Higgs boson
  - Search for new physics

    Top is a BKG for New Physics searches, need to be understood (X-sections)

  - In addition at LHC
    1. Top is a Reference point => Re- establishment of the top
    2. Tool for Detector commissionning :

       JES determination, b-tag and trigger efficiency measurement

Top and LHC : from rare to common

- **LHC**
  - Top factory
    - Measurement limited by systematics very soon
  - New generation of detectors
  - Start-up Phase
    - Progressive ramping of the LHC (E, L) to reach 14 TeV, 10^{33} $cm^{-2}s^{-1}$
      - O(100 pb-1) expected in 2009-2010 @ 7-10 TeV
    - Detector to be tuned and performance to be understood

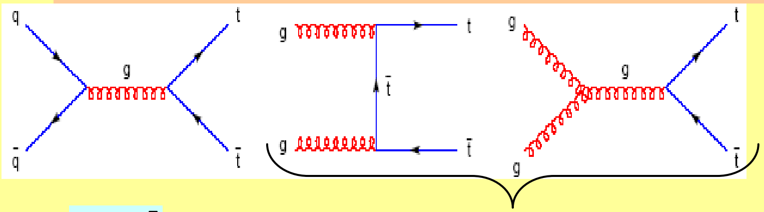
=> But great potential for Top properties

- **Projections from ATLAS @14TeV and 10 TeV shown here**

14 TeV	10 TeV
`expected Performance of the ATLAS Experiment Detector, Trigger and Physics' CERN-OPEN-2008-020 and ATL-PHYS-PUB-2009-081	ATLAS-PHYS-PUB-2009-086 ATLAS-PHYS-PUB-2009-087

Top Production at LHC/Tevatron

Pair production



$q\bar{q} \rightarrow t\bar{t}$ $gg \rightarrow t\bar{t}$

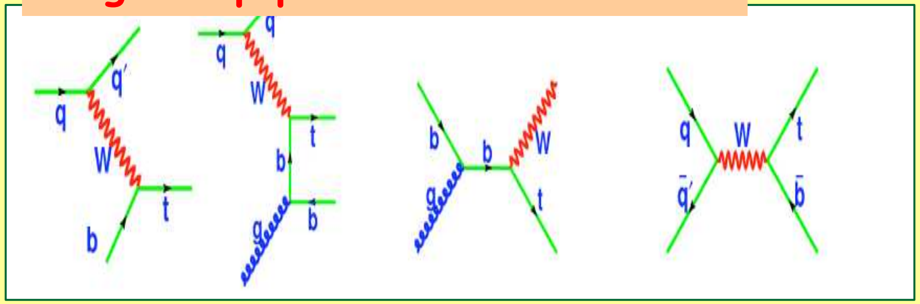
~10% ~90%

Opposite to Tevatron

6,7pb

833pb(±11%)

Single Top production

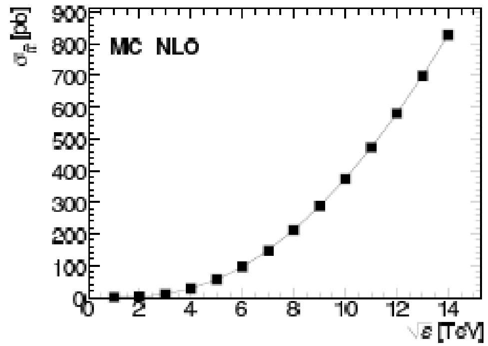


	t channel	Wt channel	s channel
Tev	1.47 pb	0.15 pb	0.75 pb
LHC	250 pb (±4%)	60 pb (±8%)	10 pb (±8%)

LHC, 14 TeV

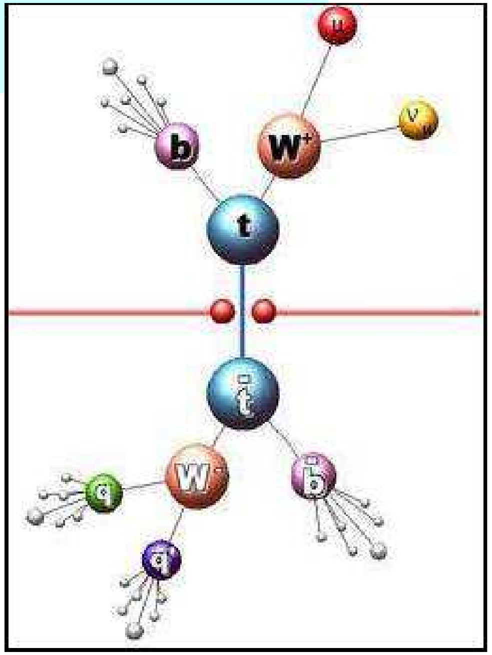
At 7 TeV, X-sections drop by a factor 5 vs 14 TeV

100pb^{-1} @ 7TeV => ~16000 Top pairs produced



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

- MS: BR ($t \to Wb$) ~ 1

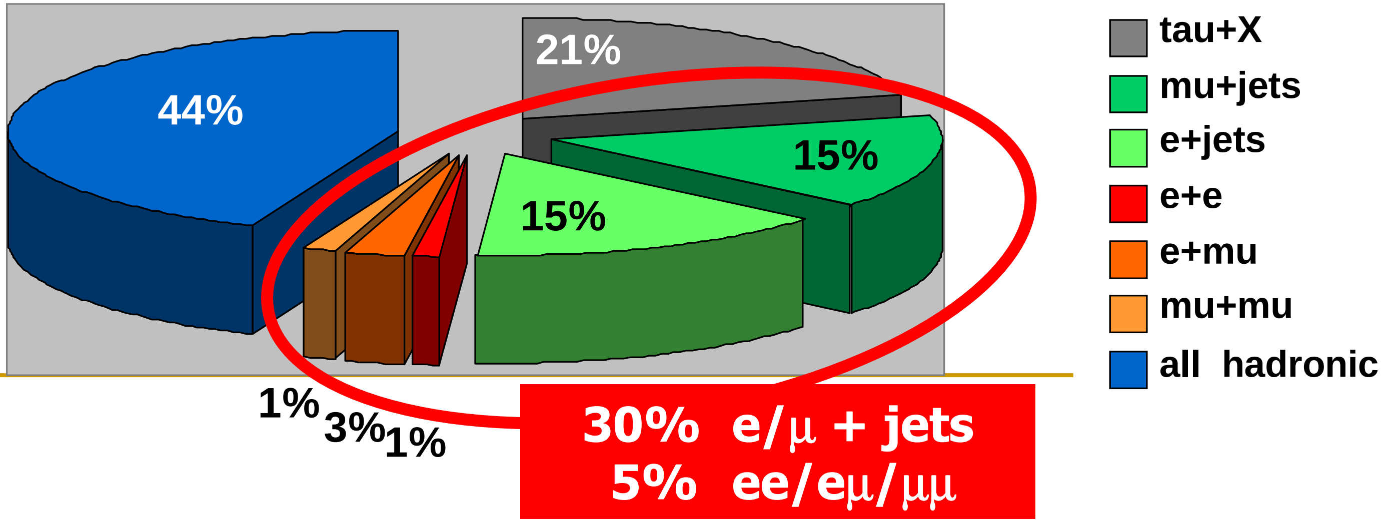


$t \to W^+ \, b$

$\bar{t} \to W^- \, \bar{b}$

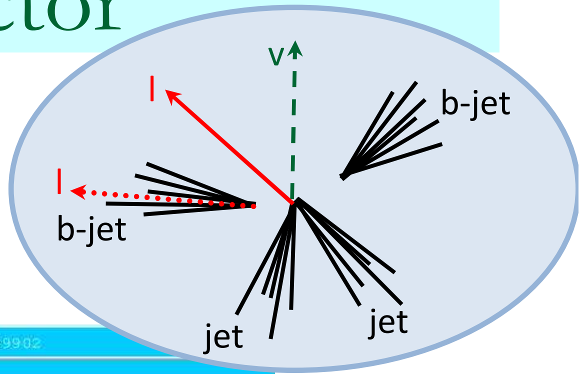
	Di lepton	semi-leptonic or Lepton+jets		full hadronic
W^+	$l^+\nu$	$q\bar{q}$	$l^+\nu$	$q\bar{q}$
b	b	b	b	b
W^-	$l^-\bar{\nu}$	$l^-\bar{\nu}$	$\bar{q}q$	$\bar{q}q$
$\bar{b}$	$\bar{b}$	$\bar{b}$	$\bar{b}$	$\bar{b}$

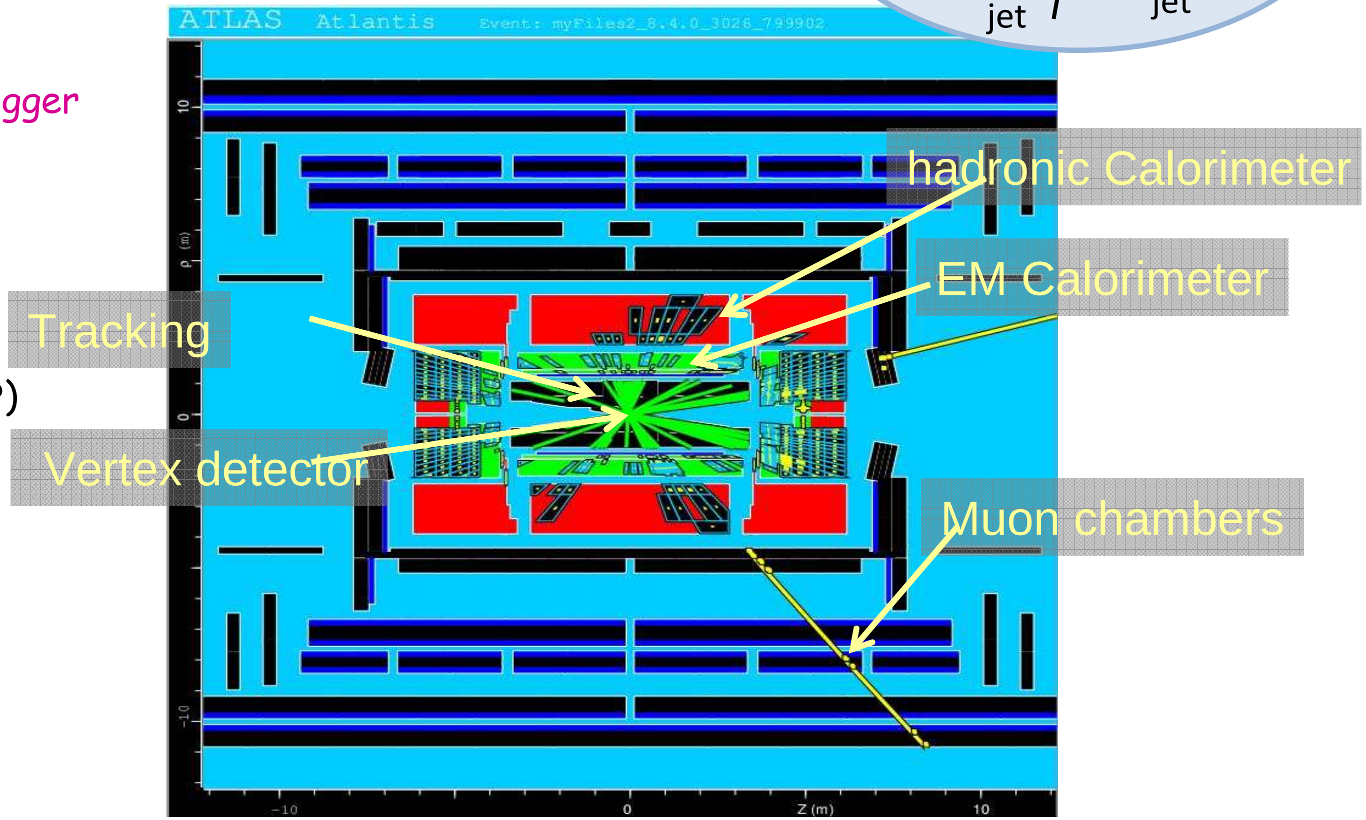
Decay Mode : Di lepton, semi-leptonic or Lepton+jets, full hadronic



Top Physics & the ATLAS detector

- Top quark detection and reconstruction involve many detector properties :
  - Lepton reconstruction and Identification +trigger
  - Jet reconstruction and calibration
  - Missing transverse Energy evaluation
  - b-tagging (lower eff at beginning?)



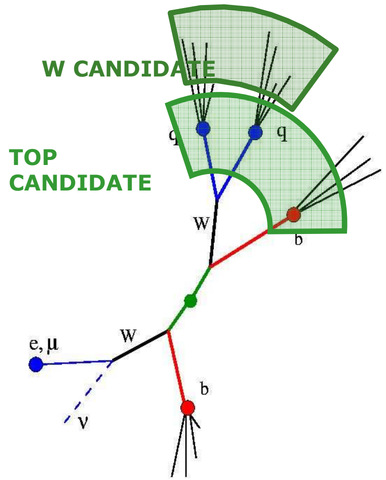


Complete detector capability at play

Top pair x-sec measurement with 200pb^{-1} @ 10 TeV

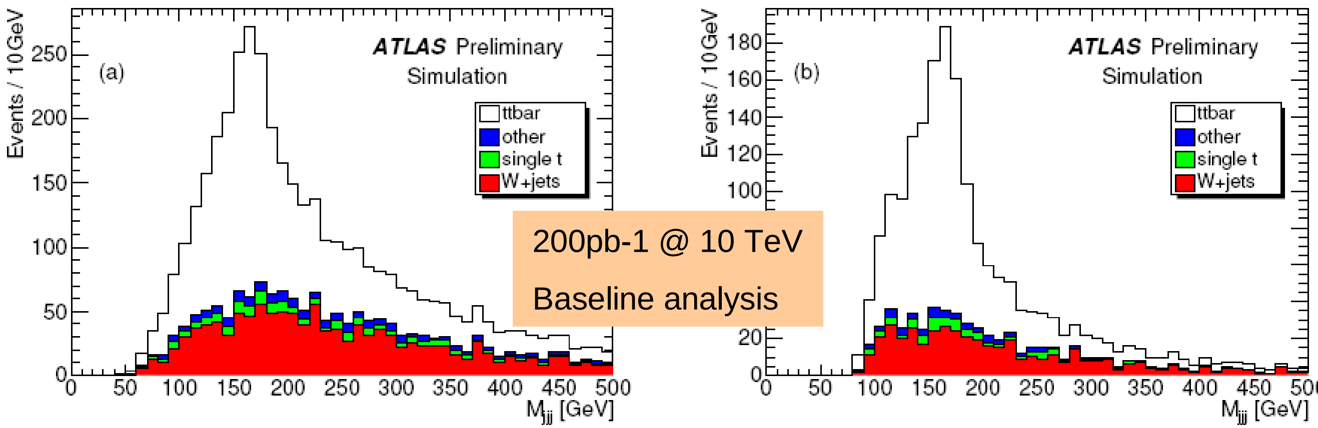
Lepton+jet evts

- Baseline analysis
  - lepton trigger pT >15 GeV
  - 1 lepton p_T >20 GeV
  - ≥4 jets p_T >20 GeV, ≥ 3 jets pT >40 GeV
  - E_T miss>20 GeV
  - No b tag
  - Had Top recons= 3 jets giving Highest Pt sum
  - (W constraint Mw+- 10 GeV) for 1 jj comb.
- Alternative method with no E_T miss cut



Default selection S/B~1.5, eff~24%, 2600 evts

With W constraint S/B~3.5 eff~ 12%, 1600 evts



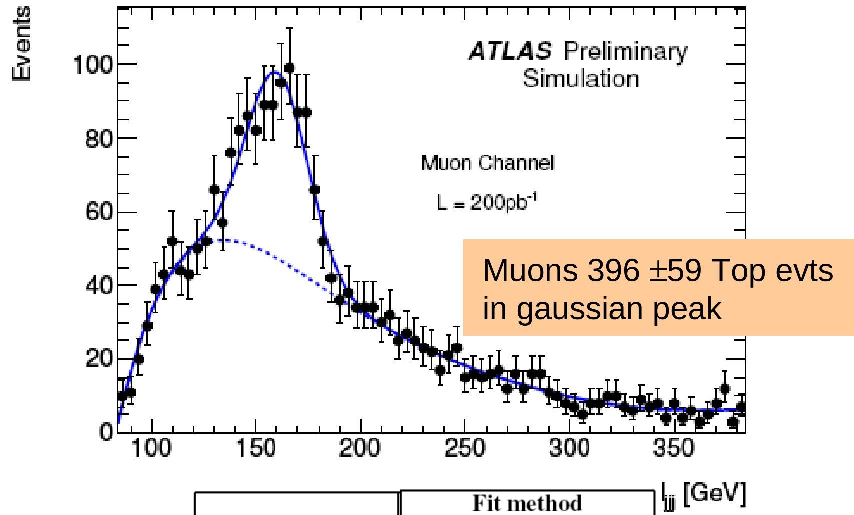
Top pair x-sec measurement with 200pb^{-1} @ 10 TeV

- Counting Method (Baseline analysis)

$$\sigma = \frac{N_{\text{sig}}}{\mathscr{L} \times \varepsilon} = \frac{N_{\text{obs}} - N_{\text{bkg}}}{\mathscr{L} \times \varepsilon}$$

  - BKG estim from MC+data driven method
  - Signal Efficiency from MC
  - sensitive to BKG normalisation, #jets, JES, less to shape

- Likelihood fit (Baseline analysis)
  - gaussian+chebychev bkg
  - extract X-sec by scaling with efficiency



Cut & count

$e \quad \Delta\sigma/\sigma = 3(stat)^{+14}_{-15}(syst) \pm 22(lumi) \quad \%$

$\mu \quad \Delta\sigma/\sigma = 3(stat)^{+12}_{-15}(syst) \pm 22(lumi) \quad \%$

Fit

$e \quad \Delta\sigma/\sigma = 14(stat)^{+6}_{-15}(syst) \pm 20(lumi) \quad \%$

$\mu \quad \Delta\sigma/\sigma = 15(stat)^{+6}_{-15}(syst) \pm 20(lumi) \quad \%$

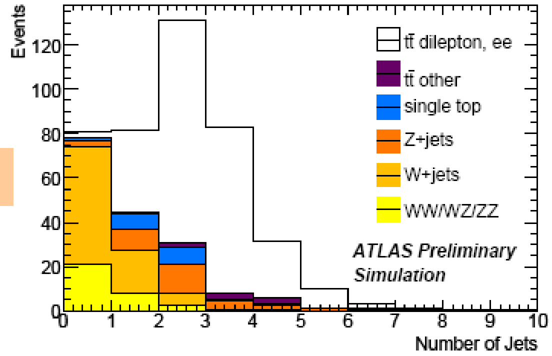
	Fit method	
Source	e-analysis	μ-analysis
	+M_W-cut (%)	+M_W-cut (%)
Stat.	± 14.1	± 15.2
Lepton ID eff.	± **1.0**	± **1.0**
Lepton trig. eff.	± **1.0**	± **1.0**
50% W+jets	± 3.3	± 5.6
20% W+jets	± **1.5**	± **2.6**
JES (10%,-10%)	-14.4	-15.4
JES (5%,-5%)	**-3.7**	**-3.9**
PDFs	± **1.9**	± **1.4**
ISR/FSR	**-12.9**	**-12.9**
Signal MC	± **4.5**	± **1.4**
Back. Uncertainty	-	-
Fitting Model	± **3.3**	± **4.7**
10% Lumi.	±10	±10
20% Lumi.	±**20**	± **20**
Tot. without Lumi.	**+6.4 -14.9**	**+6.0 - 14.8**

Top pair x-sec measurement with 200pb^{-1} @ 10 TeV

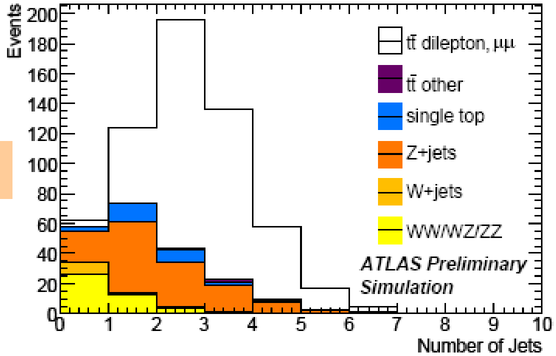
Di-Lepton evts

- Selection
  - lepton trigger pT >15 GeV
  - 2 opp charge leptons (**ee,eμ,μμ**) p_T >20-35 GeV
  - ≥ 2 jets p_T >20 GeV
  - E_T miss>20 GeV
  - No b tag
  - BKG rejection |M(Z)-m(ll)| >5 GeV
- Data driven evaluation of
  - DY evts
  - jets miss-identified as leptons in QCD & W+jets evts
- other BKG from MC
  - Di-boson, single Top Wt, Z-> ττ , Wbb

ee channel



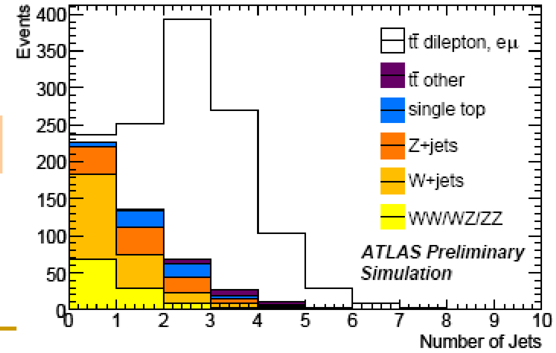
μμ channel



X-sec from counting method

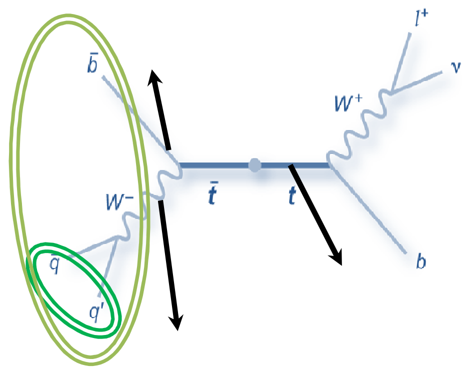
$$\Delta\sigma/\sigma = 3.1(stat)^{+9.6}_{-8.7}(syst)^{+26.2}_{-17.4}(lumi) \quad \%$$

eμ channel



Top mass measurement with 1 fb^{-1} @ 14 TeV

- tt→lνb+jjb
  - Golden plated channel
  - avoid contribution from BKG, rely on well measured objects
  - Top mass estimator built from the invariant mass of the hadronic top decay products
  - The precision on the mass depends mainly on the accuracy to determine the Jet energy scale for light jets (JES) and b jets (JES_b)



- Selection
  - at least 1 lepton pT>20 (25) GeV (trigger)
  - at least 4 jets pT>40 GeV to keep only well measured jets
  - Missing Et >20 GeV (for the escaping ν)
  - All particles emitted in |η|<2.5 to keep only well measured & Identified particles

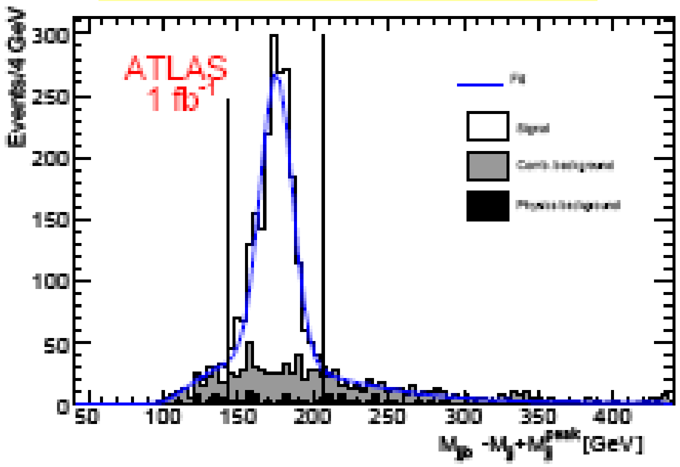
  - Select sub-samples with
    - 0, 1 or 2 identified b-jets among all selected jets
      - eff(b) =60% ; light jet rejection factor ~ 130

Top mass measurement with 1 fb^{-1} (2 b-tag)

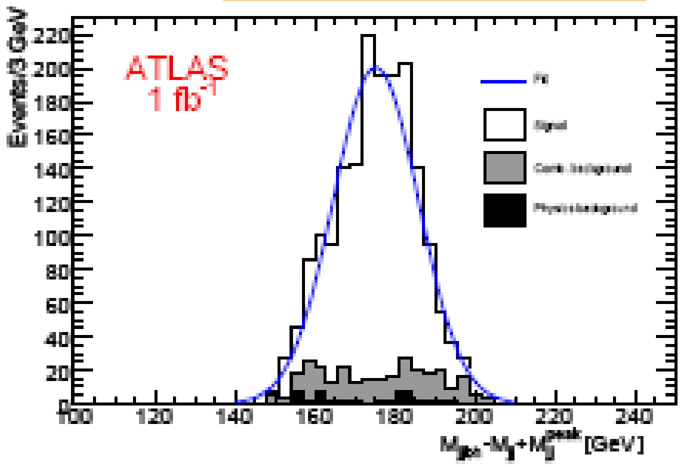
- σ Mjjb =10.6±0.4 GeV
- $\delta(Mtop)_{stat}$ < 0.4 GeV
- Systematics uncertainties
  - Dominant uncertainty after a few fb^{-1} of data
  - Main contribution to syst are JES & JES_b
  - $\delta(Mtop)_{syst}$ ~ 1 (3.5) GeV if b-JES accuracy is 1 (5)%

Source of systematics	Top mass shift (GeV/c²)
Light JES	0.2 /%
b jet scale (1%)	0.7 /%
ISR/FSR	≤ 0.3
b quark fragmentation	≤ 0.1
background	negligible
method	0;1-0.2
TOTAL	0.8

standard Purification cuts



high Purification cuts



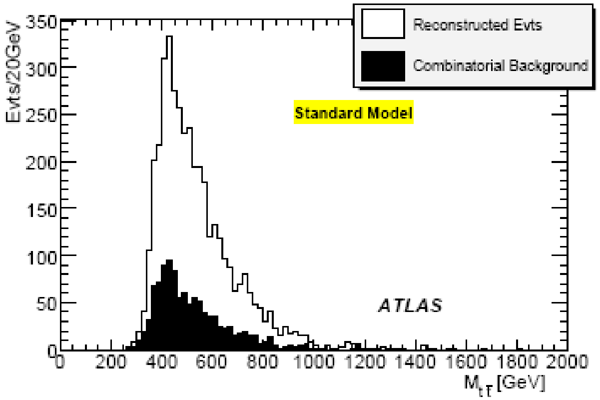
$1fb^{-1}$
@ 14 TeV

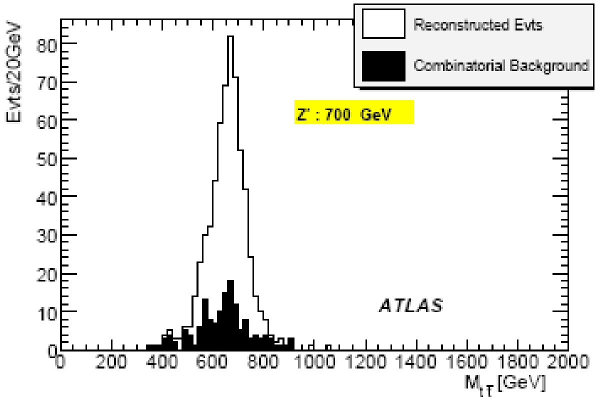
ATLAS will measure the Top mass with a precision of 1 (3.5) GeV if b-JES controlled at 1% (5%)

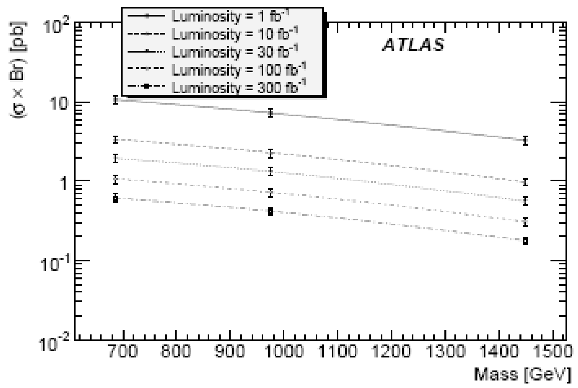
TTbar resonances

- Top sector is an ideal laboratory to search for 'New Physics'. Models provide candidates for tt resonances
  - Z' topcolor, kk excited states,…
- Could be revealed in the tt mas spectrum (distortion or resonance)
  - Model independant search for a generic resonance

- Study with standard ATLAS Top reconstruction
  - full reconstruction of tt→lνb+jjb with 2 b-tagged jets



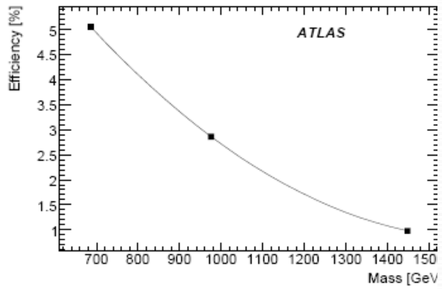


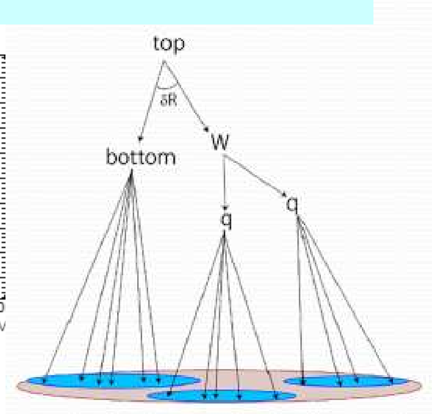


1fb^{-1} @14 TeV : ATLAS able to discover tt res 700 GeV if σ×BR>11pb

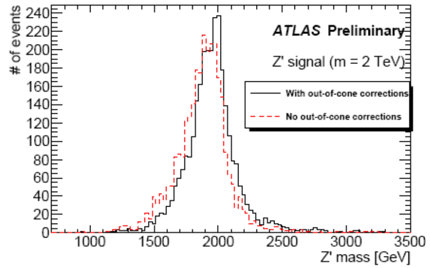
TTbar resonances

- ATLAS study dedicated to high masses
  - At increasing tt masses
    - SM 'BKG' decrease
    - Combinatorial BKG contribution decrease
    - But Reconstruction efficiency drops
      - Top decay particles mixed
        => monojet
        =>Lepton non isolated





  - Look at tt→lνb+jjb evts with
    - 2 monojets pt>300 geV
      - 1 bjet merged with a lepton from leptonic Top
      - 1 cluster of 3 jets merged from hadronic Top
        - Log likelihood variable (y_L) using jet mass and $k_\perp$ splitting scales to cut QCD multijet evts

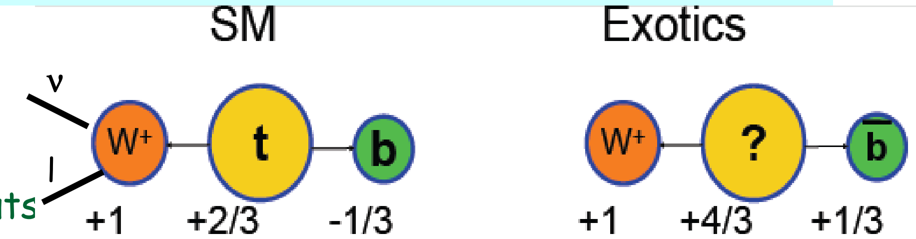


ATL-PHYS-PUB-2009-081

95% C.L. limits on σ x BR($t\bar{t}$) (fb)	$y_L > 0.6$	$y_L > 0.9$	$y_L > 1.2$
$m = 2$ TeV	550	650	1400
$m = 3$ TeV	160	180	450

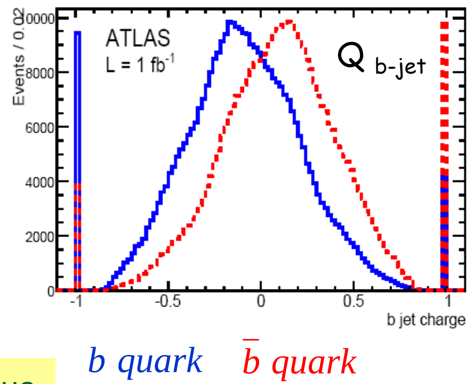
Table 3: Expected sensitivities in the $m = 2$ and 3 TeV mass windows for different hadronic top monojet likelihood cuts for 1 fb^{-1} of data. Results are given in terms of 95% C.L. limits on the signal production cross-section time branching ratio to $t\bar{t}$ in fb.

Top Quark Charge with 1 fb^{-1} @ 14 TeV

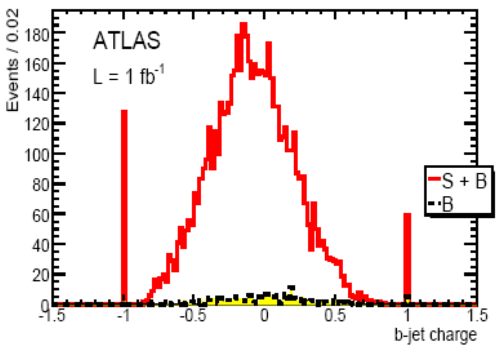


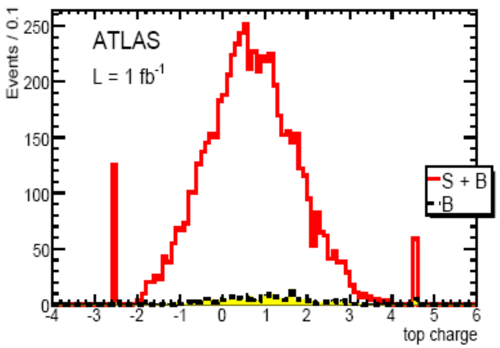
- 4/3 excluded at 87% (92%) CL by CDF (D0)
- tt→lνb+jjb; lνb+ lνb with 2 b-tagged jets
  - Lepton+ b-jet pairing (purity 86%) using Ml-b cuts
  - W->lν charge from lepton
  - b –quark charge from
    - b-quark charge from charge weighting technique
    - Lepton charge in semi-leptonic b-decay

$$Q_{\mathrm{bjet}} = \frac{\sum_i q_i |\vec{j}_i \cdot \vec{p}_i|^{\kappa}}{\sum_i |\vec{j}_i \cdot \vec{p}_i|^{\kappa}}$$



weighting technique





<b-jet charge> = $-0.094 \pm 0.004_{stat}$

<top quark charge> = xxx $\pm 0.06_{stat} + 0.08_{syst}$

$$Q_t = Q_l + Q_{b-jet} \times C_b$$

C_b b-jet charge calibration coefficient

ATLAS is likely to distinguish between SM and exotic charge hypotheses with a significance well above 5σ for 1fb^{-1} of data

Rare Top decays

- FCNC
  - Current exp. limits

	LEP	HERA	Tevatron
BR ($t \to qZ$)	7.8%	49%	3.7%
BR ($t \to q\gamma$)	2.4%	0.75%	3.2%
BR ($t \to qg$)	17.0%	13%	0.1-1%

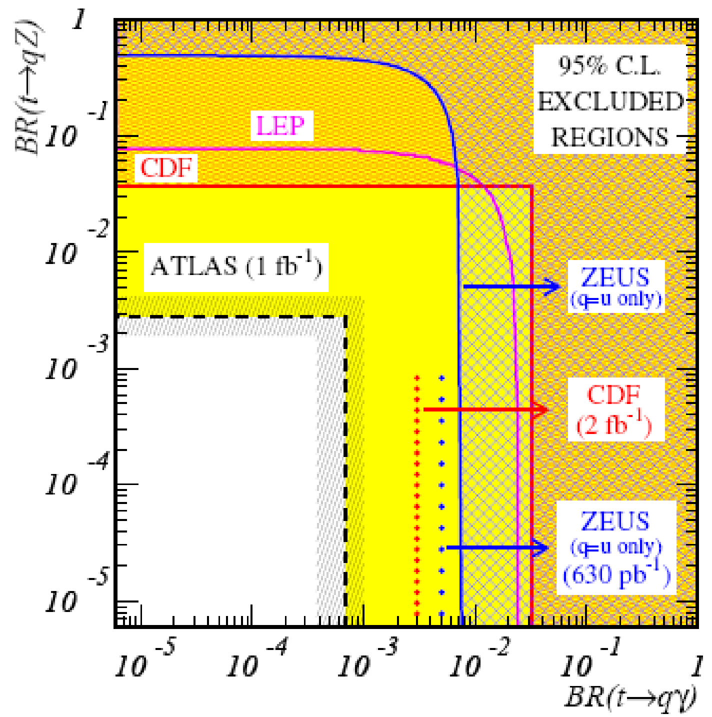
  - BR(t-> FCNC) in several models

	SM	QS	2HDM	FC 2HDM	MSSM	$\not R$ SUSY
$t \to q\gamma$	$\sim 10^{-14}$	$\sim 10^{-9}$	$\sim 10^{-6}$	$\sim 10^{-9}$	$\sim 10^{-6}$	$\sim 10^{-6}$
$t \to qZ$	$\sim 10^{-14}$	$\sim 10^{-4}$	$\sim 10^{-7}$	$\sim 10^{-10}$	$\sim 10^{-6}$	$\sim 10^{-5}$
$t \to qg$	$\sim 10^{-12}$	$\sim 10^{-7}$	$\sim 10^{-4}$	$\sim 10^{-5}$	$\sim 10^{-5}$	$\sim 10^{-4}$

[Acta Phys. Polon. B 35 (2004) 2695]

- Study Atlas reach for tt->(blv)(qX) , X=g,γ,Z-> l+l-
  - Full event reconstruction (no b-tag)

	-1σ	Expected	$+1\sigma$
$t\bar{t} \to bWq\gamma$:			
e	4.3×10^{-4}	1.1×10^{-3}	1.9×10^{-3}
μ	4.5×10^{-4}	8.3×10^{-4}	1.3×10^{-3}
ℓ	3.8×10^{-4}	6.8×10^{-4}	1.0×10^{-3}
$t\bar{t} \to bWqZ$:			
3e	5.5×10^{-3}	9.4×10^{-3}	1.4×10^{-2}
3μ	2.4×10^{-3}	4.2×10^{-3}	6.4×10^{-3}
3ℓ	1.9×10^{-3}	2.8×10^{-3}	4.2×10^{-3}
$t\bar{t} \to bWqg$:			
e	1.3×10^{-2}	2.1×10^{-2}	3.0×10^{-2}
μ	1.0×10^{-2}	1.7×10^{-2}	2.4×10^{-2}
ℓ	7.2×10^{-3}	1.2×10^{-2}	1.8×10^{-2}



conclusion

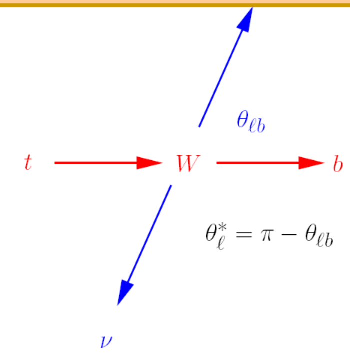
- LHC will be a Top factory offering a great potential for Top precision studies
  - Hope to see first Tops in Europe in 2010
- SM tests with Top (from ATLAS studies @14TeV)
  - Establish Top signal ~10pb-1
  - Top pair production X-section stat(5%)-syst(15-5%)-lumi(3%) ~100pb-1
  - Top mass measurement (5%-2%) ~100pb-1, 1fb-1
  - Top as a Tool light jet (2-1%) b tag eff 3% ~100pb-1, 1fb-1
  - Single Top production t channel@5σ ~1fb-1
  - Top properties top charge 5 σ, W pol 5-10%, FCNC BR 10^{-3}, ~ 1fb-1
- BSM
  - Search for New physics using Top ≥ 1fb-1
- But before any measurement
  - Detector understanding
  - Measurement of detector performance
    - Trigger, Calibrations, alignement, b tagging
  - Background studies
  - MC tuning on data

=>Top events serve as a tool for these studies

Polarisations in tt events

Test of the top quark production and decay mechanisms

- W boson or top spin information inferred from angular distribution of daugther particles in the parent rest frame



- W-boson polarization
  - W produced with different helicities

$$F_0^{SM} = 0.695 \quad F_L^{SM} = 0.304 \quad F_R^{SM} = 0.001, \quad (F_0 + F_L + F_R = 1)$$

$$\frac{1}{N}\frac{dN}{d\cos\theta^*_\ell} = \frac{3}{2}\left[F_0\left(\frac{\sin\theta^*_\ell}{\sqrt{2}}\right)^2 + F_L\left(\frac{1-\cos\theta^*_\ell}{2}\right)^2 + F_R\left(\frac{1+\cos\theta^*_\ell}{2}\right)^2\right]$$

  - BSM : different helicity fractions possible

  - Measurement of W helicities in tt→lvb+jjb channel:

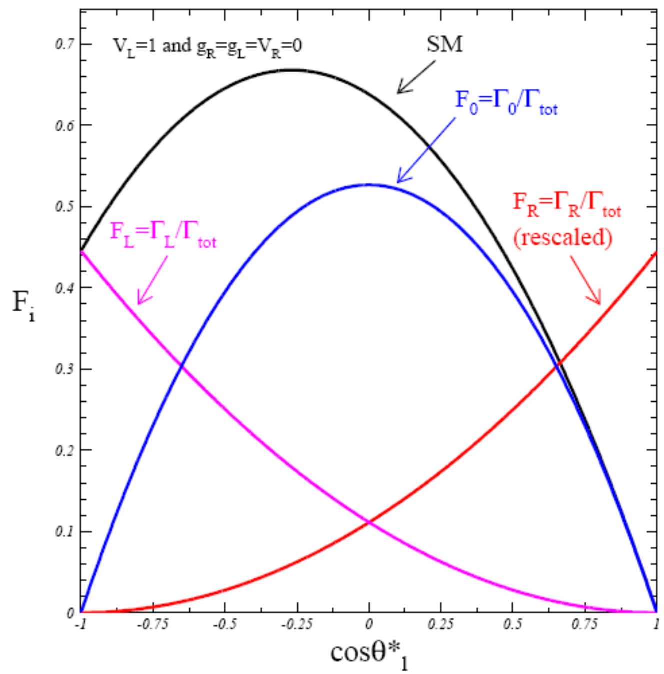
⇒ Determination of the Cosθ*$_l$ distribution

⇒ Correct distribution distorded mainly by event selection, quark fragmentation and particle radiation

⇒ Extraction of F_0 F_l F_R

F_L	F_0	F_R
xxx ±0.02 ±0.03	xxx ±0.04 ±0.02	xxx ±0.02 ±0.02

1 fb^{-1} : F0 FL FR measured with a precision of 0.04, 0.04 and 0.03 respectively

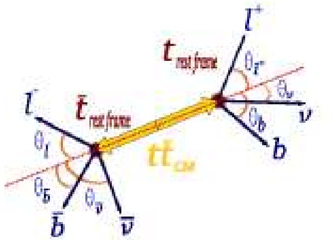


Polarisations in tt events

- Top spin correlations
  - Top quark decays before hadronisation => spin information conserved
    - SM : top unpolarised but top spins correlated.
    - production asymmetry
    - BSM : different correlation allowed

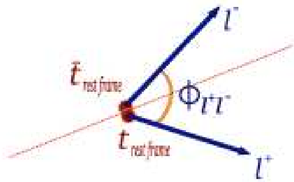
$$A = \frac{\sigma(t_\uparrow \bar{t}_\uparrow) + \sigma(t_\downarrow \bar{t}_\downarrow) - \sigma(t_\uparrow \bar{t}_\downarrow) - \sigma(t_\downarrow \bar{t}_\uparrow)}{\sigma(t_\uparrow \bar{t}_\uparrow) + \sigma(t_\downarrow \bar{t}_\downarrow) + \sigma(t_\uparrow \bar{t}_\downarrow) + \sigma(t_\downarrow \bar{t}_\uparrow)}$$

  - two angular distributions can be used to probe the top spins correlation



$$\frac{1}{N}\frac{d^2N}{d\cos\theta_1 d\cos\theta_2} = \frac{1}{4}(1 - A|\alpha_1\alpha_2|\cos\theta_1\cos\theta_2)$$

$$\alpha_i = \text{spin analysing power of i}$$



$$\frac{1}{N}\frac{dN}{d\cos\Phi} = \frac{1}{2}(1 - A_D|\alpha_1\alpha_2|\cos\Phi)$$

$$A^{SM} = 0.326^{+0.003}_{-0.002}(\mu)^{+0.013}_{-0.001}(PDF)$$

$$A^{SM} = 0.422 \quad (m_{t\bar{t}} < 550 \text{ GeV})$$

$$A^{SM}_D = -0.237^{+0.005}_{-0.007}(\mu)^{+0.000}_{-0.006}(PDF)$$

$$A^{SM}_D = -0.290 \quad (m_{t\bar{t}} < 550 \text{ GeV})$$

  - Measurement of the spins correlation in tt→lνb+jjb channel:
    - from θ1,θ2 (A) and Φ (A_D) angular distributions (corrected from phase space)
    - assuming α=0.51

=> two unbiased estimators of A and A_D are built C=-9 x cosθ1 x cosθ2 and D=-3 x cosΦ

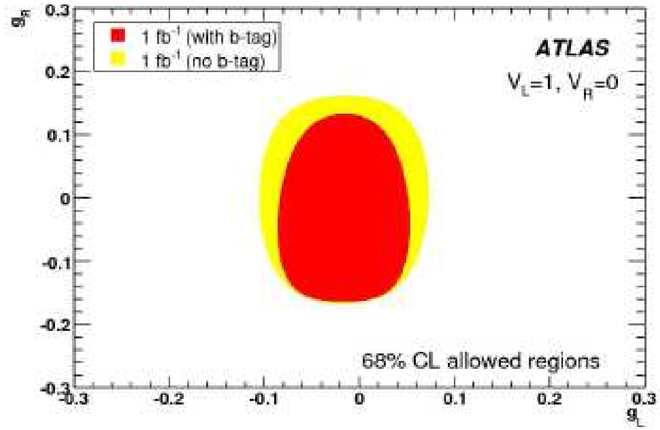
A	A_D
xxx ±0.17±0.18 ±0.25	xxx ±0.11 ±0.09

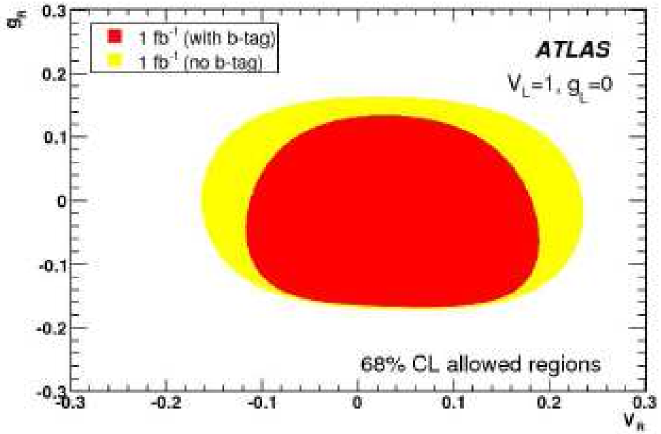
1 fb^{-1} : A and A_D measured with a precision of 50% and 34% respectively

anomalous couplings at the Wtb vertex

- The W-boson polarisation is sensitive to new anomalous couplings associated wtih the Wtb vertex
  - General Wtb vertex $\mathscr{L} = -\frac{g}{\sqrt{2}}\bar{b}\gamma^{\mu}\,(V_L P_L + V_R P_R)\,t\,W_{\mu}^{-} - \frac{g}{\sqrt{2}}\bar{b}\,\frac{i\sigma^{\mu\nu}q_{\nu}}{M_W}\,(g_L P_L + g_R P_R)\,t\,W_{\mu}^{-}$

$$\left.\begin{aligned} \rho_L &= F_L / F_0 \\ \rho_R &= F_R / F_0 \\ A_+ &= 3\beta[F_0 + (1+\beta)F_R] \\ A_- &= -3\beta[F_0 + (1+\beta)F_L] \end{aligned}\right\} \xrightarrow{\text{fit}} \left\{\begin{aligned} &V_R \\ &g_L \\ &g_R \end{aligned}\right.$$

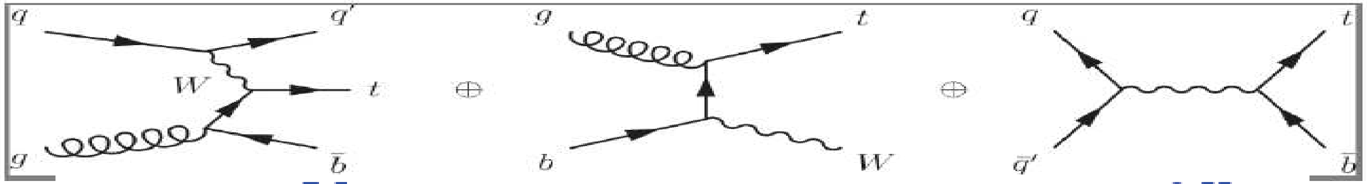




- SM : $V_L = V_{tb}$ and other term vanish
- ATLAS limits on anomalous couplings ($1fb^{-1}$) :
  - red : analysis with b-tagging
  - Yellow : analysis without b-tagging

Single Top production

- The single Top X-sections measurement
  - lead to direct measurement of Wtb
  - Constitute a probe for new physics (H^+, t channel -> FCNC, s channel -> W' bosons,..)



$\sigma_t = 155.9^{+7.5}_{-7.7}$ pb $\quad \sigma_t = 41.1 \pm 4.2$ pb $\quad \sigma_t = 7.23^{+0.55}_{-0.47}$ pb

$\sigma_{\bar{t}} = 90.7^{+4.3}_{-4.5}$ pb $\quad \sigma_{\bar{t}} = 41.1 \pm 4.2$ pb $\quad \sigma_{\bar{t}} = 4.03^{+0.14}_{-0.16}$ pb

- Atlas measurement
  - W+jets,Top pair channel brings large BKG => complex analyses
    - use of multivariate tools
  - Common preselection for all channels; dedicated MVA for each channel

$1fb^{-1}$: ATLAS results @ 14 TeV

t channel : $\Delta\sigma/\sigma$ =5.7(stat)±22(syst) %

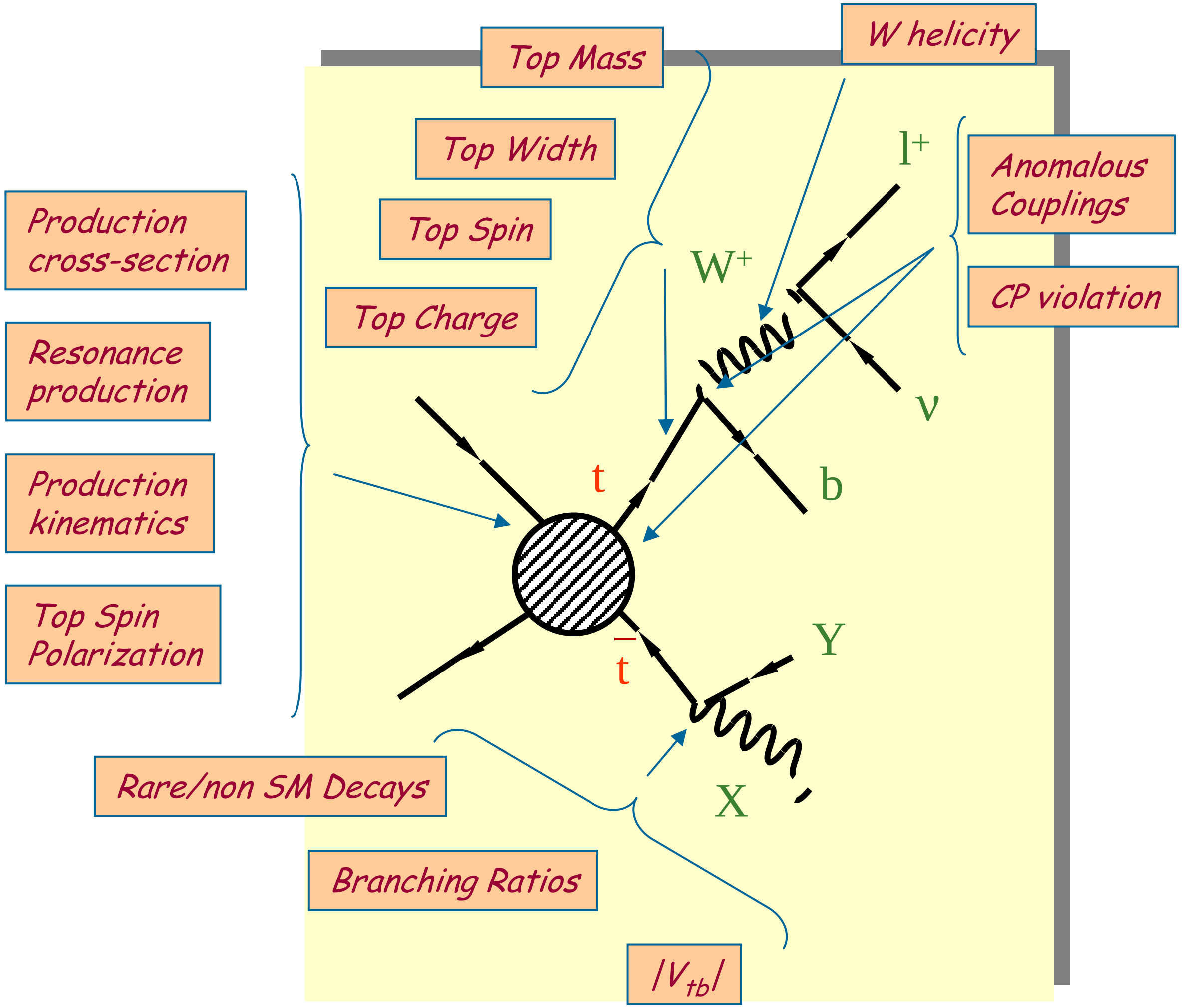
Wt channel : $\Delta\sigma/\sigma$ =20.6(stat)±48(syst) % **=> $\Delta |V_{tb}| / |Vtb|$ = 12%**

s channel : $\Delta\sigma/\sigma$ =60(stat)±90(syst) %

BACKUP

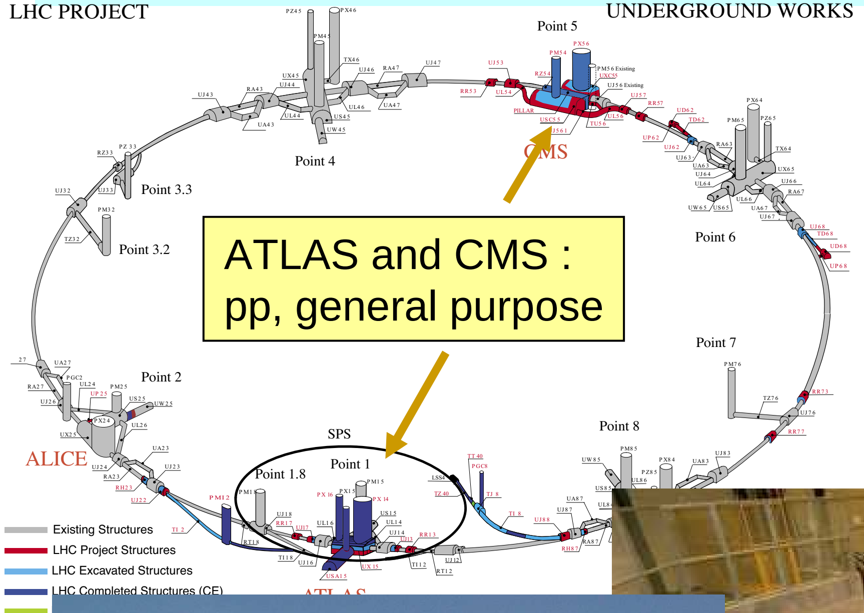
Top physics: broad physics content

- Productions mechanisms
  - Production X-sections
  - Vtb
  - Spin correlations
  - Ttbar production by new resonances
- Properties
  - Top mass
  - Charge
  - Decay properties
    - Electroweak (V-A) vertex: W helicity
    - Rare Top decays
- Search for New physics using heavy flavour

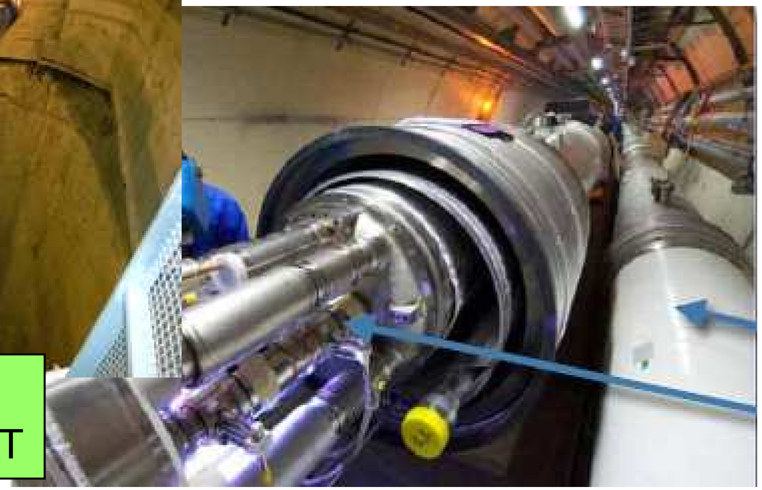


The Large Hadron Collider

- pp collision cm : 14 TeV (x7 Tevatron)
- 25 ns bunch spacing
- 1.1 10^{11} proton/bunch
- Design luminosity 10^{34} $cm^{-2}s^{-1}$
  100 fb^{-1} /year; ≈ 20 int./x-ing
- Initial/low lumi L≤10^{33} cm^{-2} s^{-1}
  10 fb^{-1} /year ; ≈ ≤2 int./x-ing
- 4 interaction regions

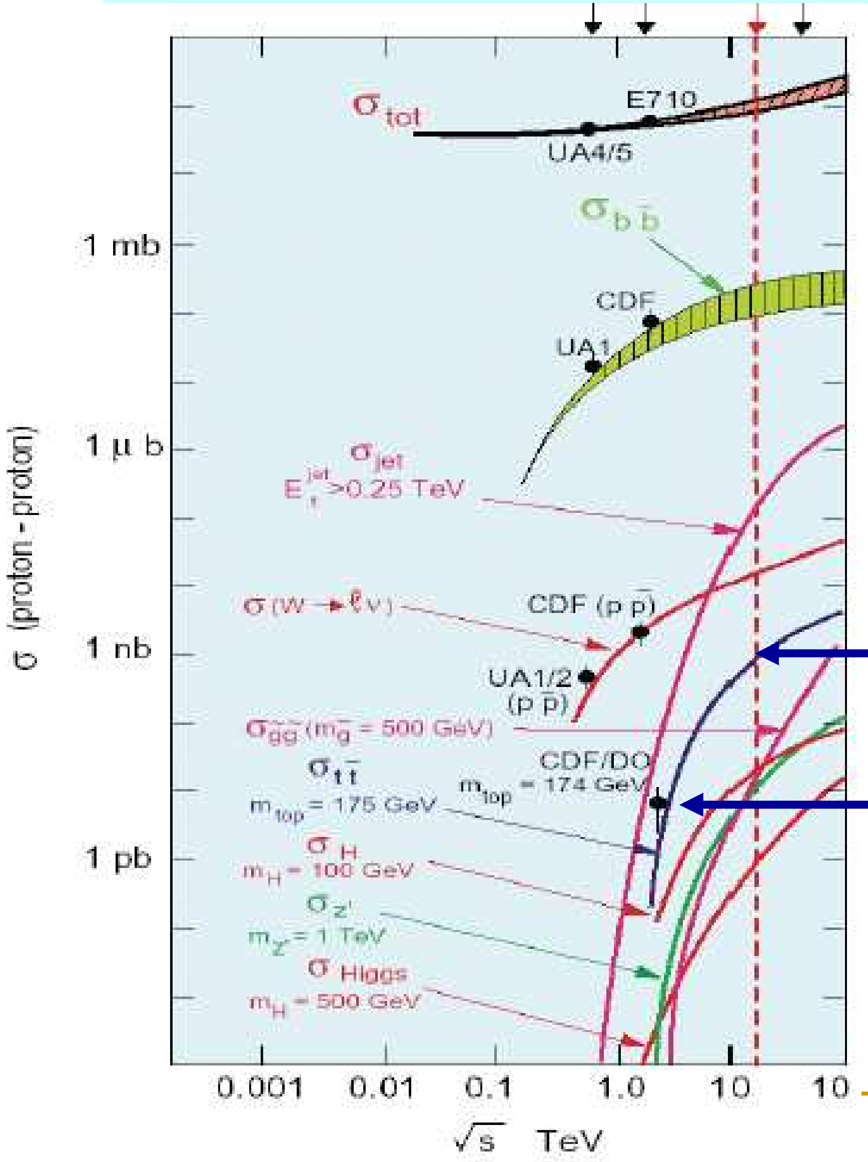


ATLAS and CMS :
pp, general purpose



27 km ring
1232 dipoles B=8.3 T

Top Production at LHC



At low Luminosity (10^{33}), 14 TeV
~ one top pair produced per second
LHC is a Top factory

But 10^{8} evts /s are produced

LHC σtt ~830 pb

X100

Tevatron σtt ~ 6,7 pb

LHC Low L 10^{33} $cm^{-2}s^{-1}$

Tevatron 10^{32}

X10

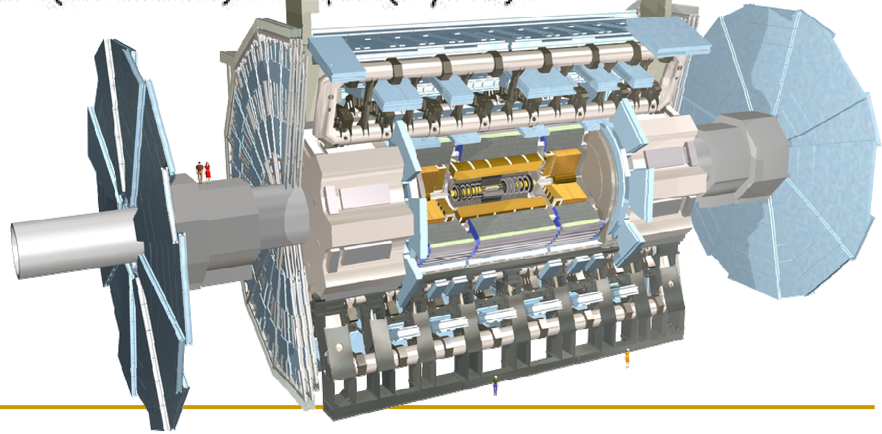
Prod Rate X1000

Which detector performance on day one ?

	Expected performance day 1	Physics samples to improve (examples)
ECAL uniformity e/γ scale	~ 1% (ATLAS), 4% (CMS) 1-2 % ?	Minimum-bias, $Z \to ee$ $Z \to ee$
HCAL uniformity Jet scale	2-3 % < 10%	Single pions, QCD jets $Z (\to ll) +1j$, $W \to jj$ in $t\bar{t}$ events
Tracking alignment	20-500 μm in Rϕ ?	Generic tracks, isolated μ , $Z \to \mu\mu$

Ultimate statistical precision achievable after few days of operation. Then face systematics ....

E.g. : tracker alignment : 100 μm (1 month) $\to$ 20μm (4 months) $\to$ 5 μm (1 year) ?



Some examples of studies

- SM tests with Top
  - Establish Top signal ~10pb-1
  - Top pair production X-section stat(5%)-syst(15-5%)-lumi(3%) ~100pb-1
  - Top mass measurement (5%-2%) ~100pb-1, 1fb-1
  - Top as a Tool light jet (2-1%) b tag eff 3% ~100pb-1, 1fb-1
  - Single Top production t channel@5σ ~1fb-1
  - Top properties top charge 5 σ, W pol 5-10%, FCNC BR 10^{-3}, ~ 1fb-1
- BSM
  - Search for New physics using Top ≥ 1fb-1

From the updated TDR (CSC BOOK)

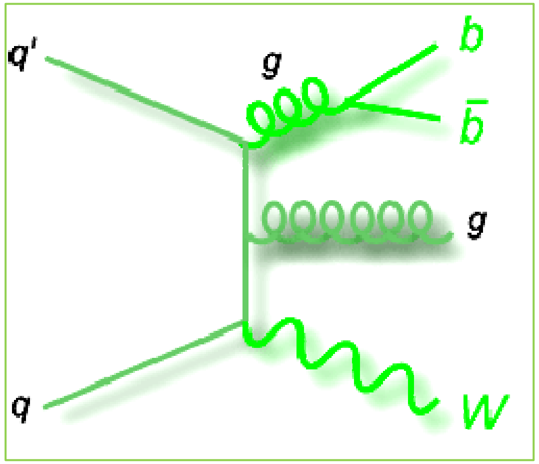
Expected Performance of the ATLAS Experiment : Detector, Trigger and Physics'

(arXiv:0901.0512 ; CERN-OPEN-2008-020)

Studies @10^{33} 14 TeV, 1fb^{-1} of data

tt→μνb+jjb selection

- Physical BKG
  - Main background: W+n jets
  - Others
    - QCD bb
    - Z+jets
    - WZ
    - tt→ jets, tt→τ+X, Single Top
      - partially counted as signal
        when only tt→ jjb is considered



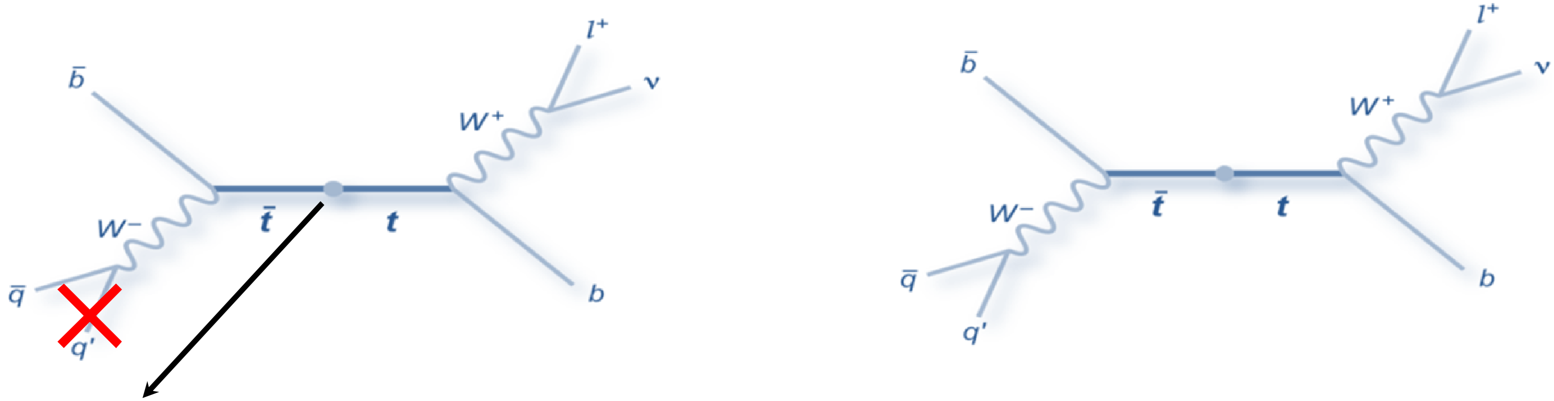
Eff= 14% (5%)

Purity=75% (91%)

F[illegible] 1 fb^{-1}	Number of events	1 isolated lepton $p_T > 20$ GeV and $\not{E}_T > 20$GeV	>= 4 jets $p_T > 40$ GeV	2 b-jets $p_T > 40$ GeV
Signal	313200	132380	43370	15780
W boson backgrounds	9.5×10^5	154100	9450	200
all-jets (top pairs)	466480	1020	560	160
di-lepton (top pairs)	52500	16470	2050	720
single top, t channel	81500	24400	1230	330
single top, W t channel	9590	8430	770	170
single top, s channel	720	640	11	5

HadronicTop reconstruction
2 b-jet case

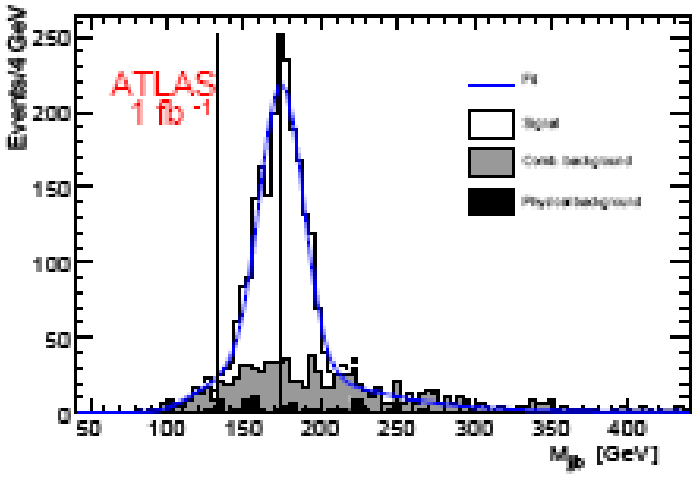
- Comb bKG is made of
  - Wrong association chosen
  - One of the jet has not been selected => the right combination cant be selected (main contribution to comb BKG) (Wrong W mainly)



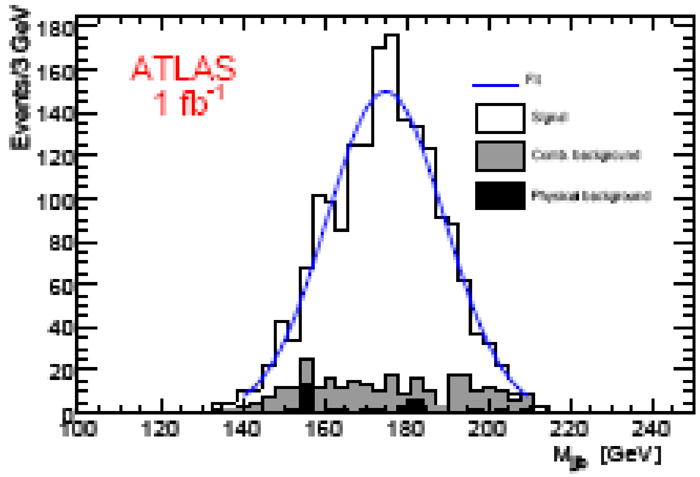
=> Purification cuts to remove the comb bkg

HadronicTop reconstruction
2 b-jet case

standard Purification cuts



high Purification cuts



Standard Purification cuts

(eff=75%, 85% of bkg rejection)

M_{top}= 174.6 ±0.5 GeV

σ=14.1±0.5 GeV

High Purification cuts

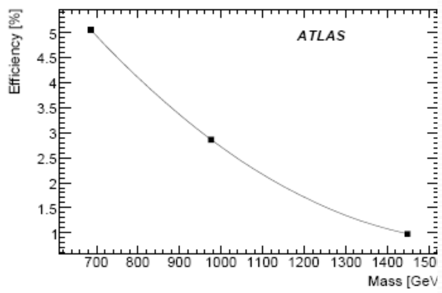
(eff=65%, 95% of bkg rejection)

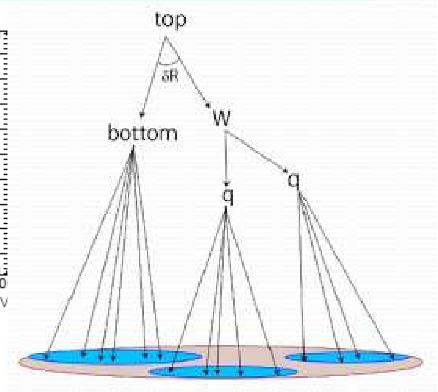
M_{top}= 175.0 ±0.4 GeV

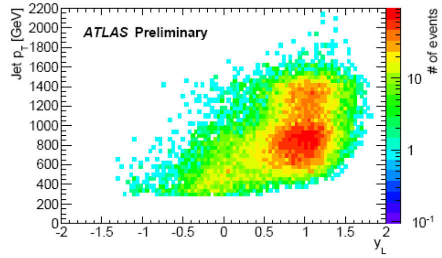
σ=14.3±0.3 GeV

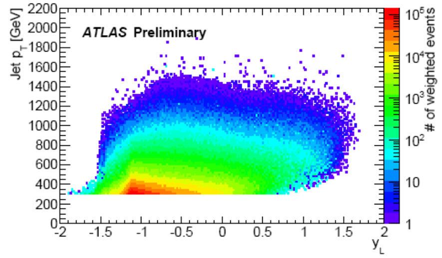
TTbar resonances

- ATLAS study dedicated to high masses
  - At increasing tt masses
    - SM 'BKG' decrease
    - Combinatorial BKG contribution decrease
    - But Reconstruction efficiency drops
      - Top decay particles mixed
        => monojet
        =>Lepton non isolated
  - Look at tt→lνb+jjb evts with
    - 1 non isolated lepton in a jet pT>200 GeV (b jet)
      - Fake lepton rejection
    - Missing Et associated to ν to reconstruct leptonic W
    - 1 monojet candidate pT>300GeV (bqq)
      - Log likelihood variable (y_L) using jet mass and $k_\perp$ splitting scales









ATL-PHYS-PUB-2009-081

95% C.L. limits on σ x BR($t\bar{t}$) (fb)	$y_L > 0.6$	$y_L > 0.9$	$y_L > 1.2$
m = 2 TeV	550	650	1400
m = 3 TeV	160	180	450

Table 3: Expected sensitivities in the $m = 2$ and 3 TeV mass windows for different hadronic top monojet likelihood cuts for 1 fb^{-1} of data. Results are given in terms of 95% C.L. limits on the signal production cross-section time branching ratio to $t\bar{t}$ in fb.