Top Physics at the LHC

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OUTLINE

Introduction : from the TeVatron to the LHC

I. Top quark as a tool

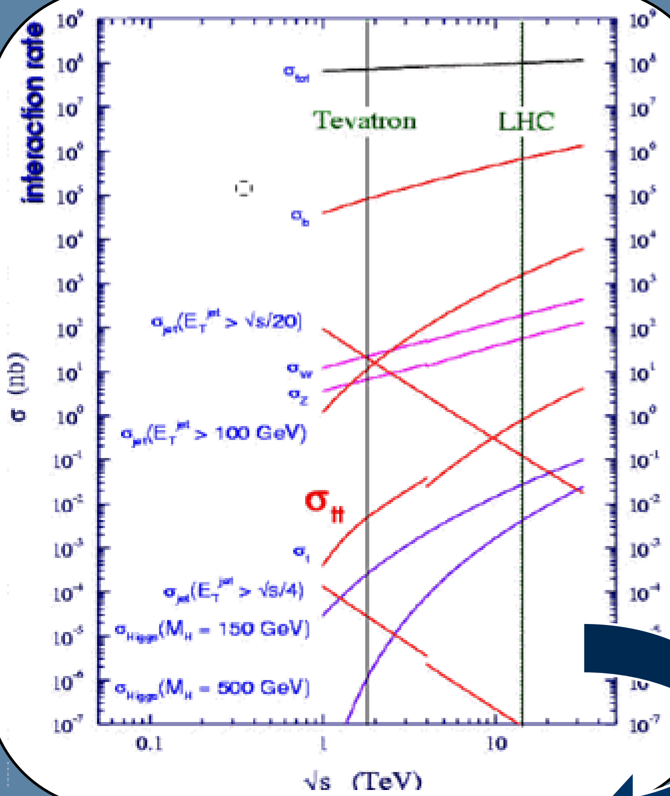
II. Top pair measurements

III. Single-top measurements

IV. Top quark properties

Conclusion

Top Physics Context at the TeVatron

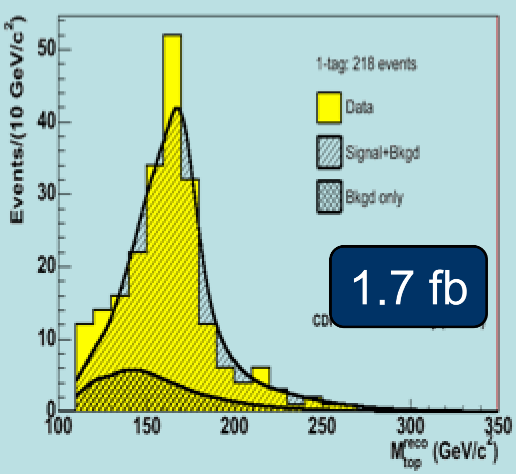


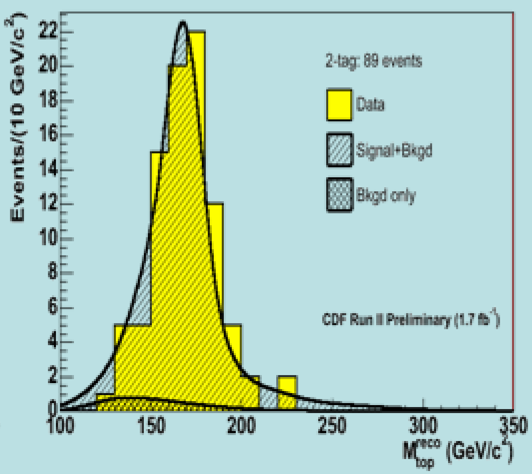
Top Quark Selection

~10 pairs a day (before selection)
~500 pairs selected so far
~few single-top
S/B lower than the LHC : W+jets

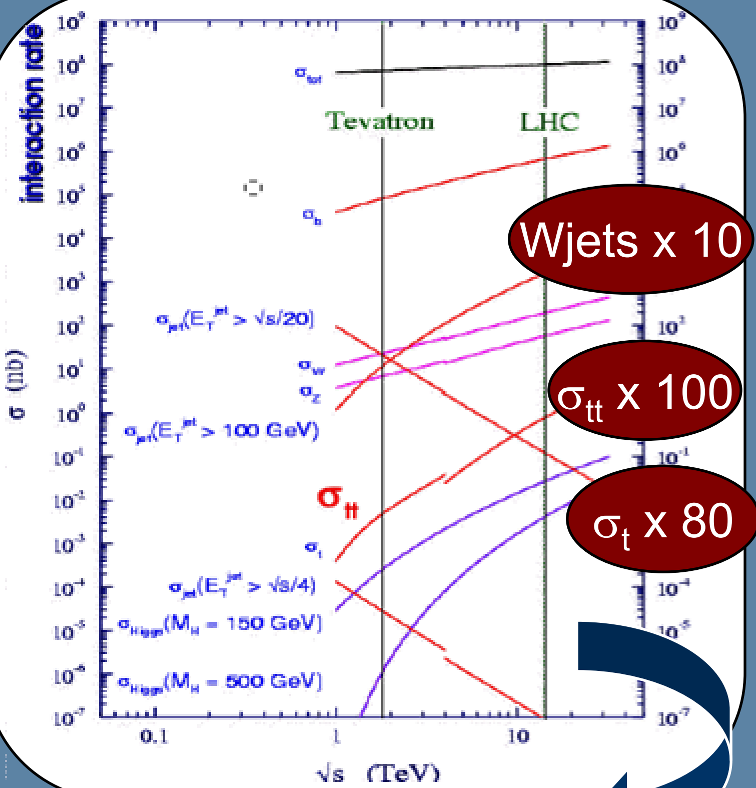
Top Quark @ TeVatron …

Besides the discovery…
Stringent tets of QCD and the EW sector
– Top mass is known at ~1% level
– QCD production mechanism at ~12%
– V-A couplings and W polarization at ~20%
– CKM matrix |Vtb| > 0.68 @ 95% CL
– Electroweak production evidence @ 3.4σ





…and at the LHC



Top Quark Selection

Nominal luminosity of $L=10^{33}$:

~1000 selected pairs a day

~a few 10 single-top a day

S/B more favorable than TeVatron

Top as a Tool

Commissioning with early data:

– in situ JES determination

– b-tagging performance calibration

– Missing ET

Top as a precision test of SM

Mass, cross-section, properties analyses

– Measurements in all channels

– Theoretically limited very early

Systematics limited analyses early

– Data driven analyses

– Use of MVA techniques mandatory

Experience from TeVatron crucial !

Top as a probe to new Physics

In production or decays :

– High mass resonance

– Anomalous couplings

– Top and charged Higgs

– Top and SUSY

Top quark as a tool at the LHC

1) Introduction

2) Top quark as a tool

Jet energy scale determination

- Rescaling
- Templates

b-tagging performance

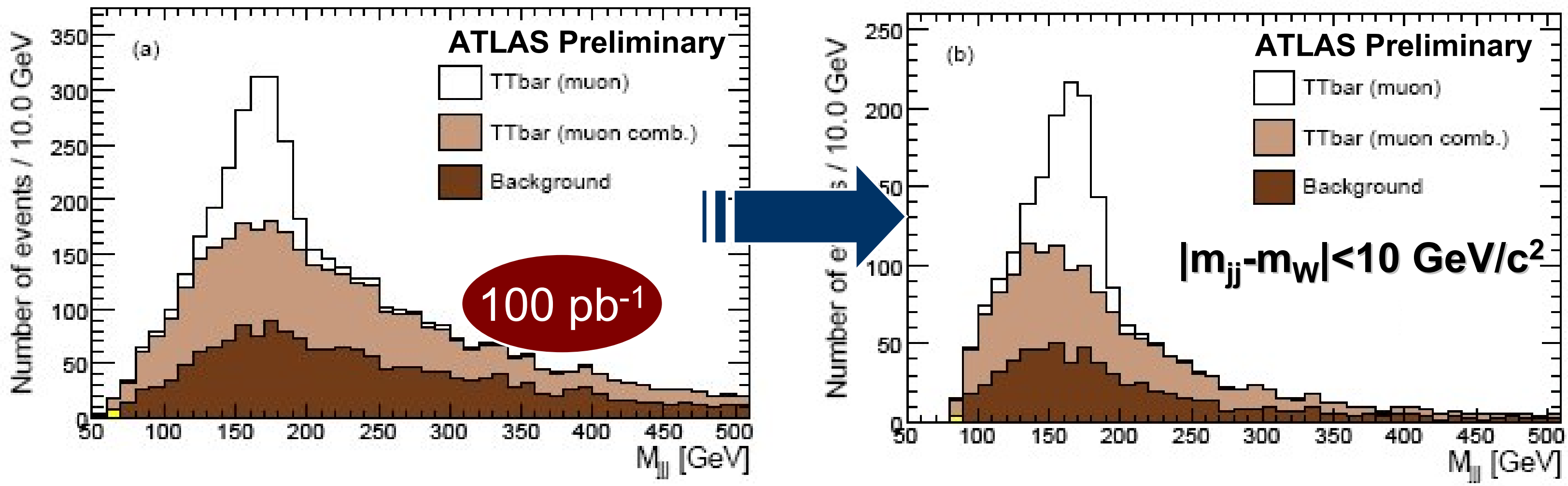
- Couting method
- Topological selection

3) Top quark pair measurement

4) Single-top measurement

5) Top Properties

2-3 weeks of ATLAS data…



Top pair events in 100 pb^{-1}

Standard Selection:

– Missing E_T, 1 lepton, ≥4 jets

– No b-tag !

Event yields

– Efficiency ~ 5.3 %

Expected performance

Background (comb.+ W+jets)

Resolution: $\sigma(m_t)$ ~ 15.4 ± 2.0 GeV

Use for commissioning :

→ light jet calibration

→ b-tagging algo calibration

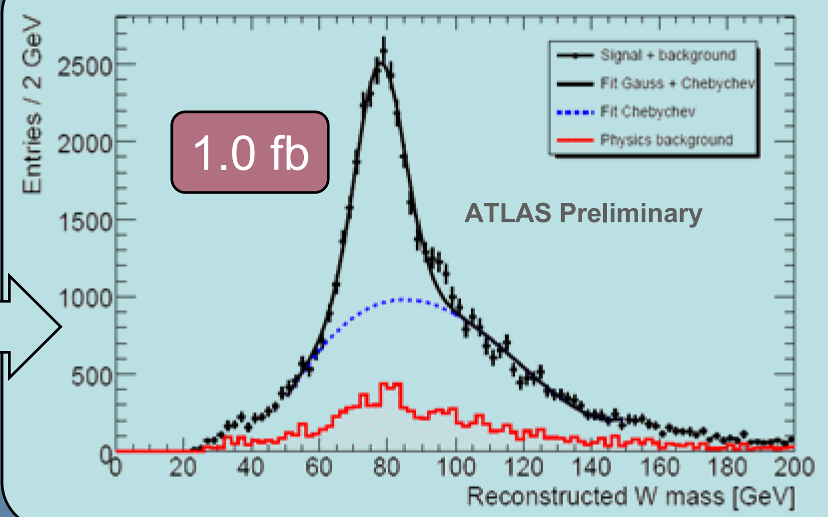
Top as a Tool : JES determination (1)

Select a leptonic top (to tag the event)

– L1+HLT trigger (μ,e) ~ 80%
– 1 high-p_T lepton > 20 GeV/c
– at least 3 high-p_T jets > 40 GeV/c
–1 high-p_T jets > 20 GeV/c
– 2 btagged jets

Reconstruct the hadronic side…

– Take jet pair in top mass window
– Determine light JES from W→ jj



(Iterative) Rescaling method

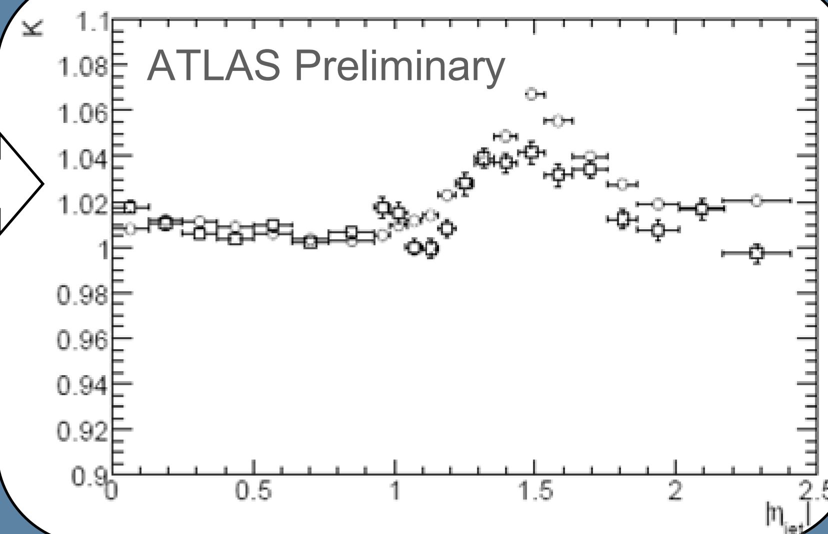
Determine Jet energy scale from W→ jj

– $M_W^{PDG}=\sqrt{K(\eta_1 E_1)K(\eta_2 E_2)}\, M_{jj}$

Statistical precision: ~1% (1 fb^{-1})

Systematics :

– correlations in (η,E) ~1%
– background (purity 80%) ~ 0.2 GeV
– jet p_T cut bias ~1-2%



Top as a Tool : JES determination (2)

Select a leptonic top (to tag the event)

- L1+HLT trigger (μ,e) ~ 80%
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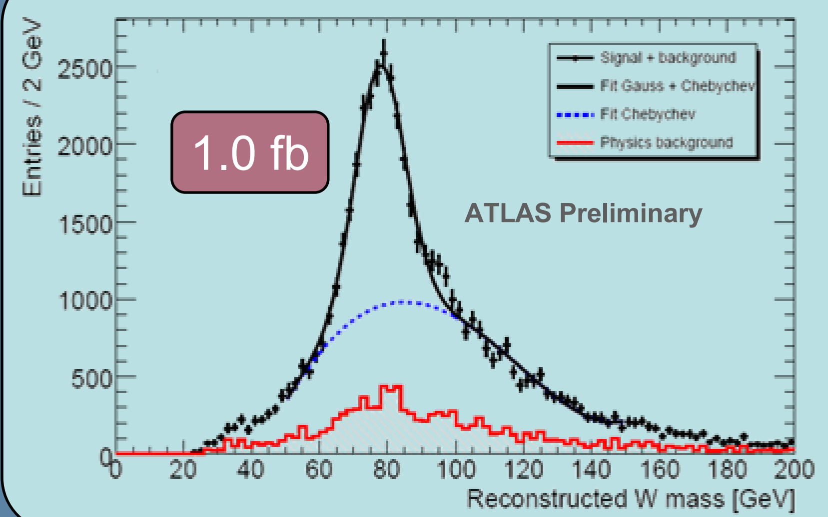


Template Method

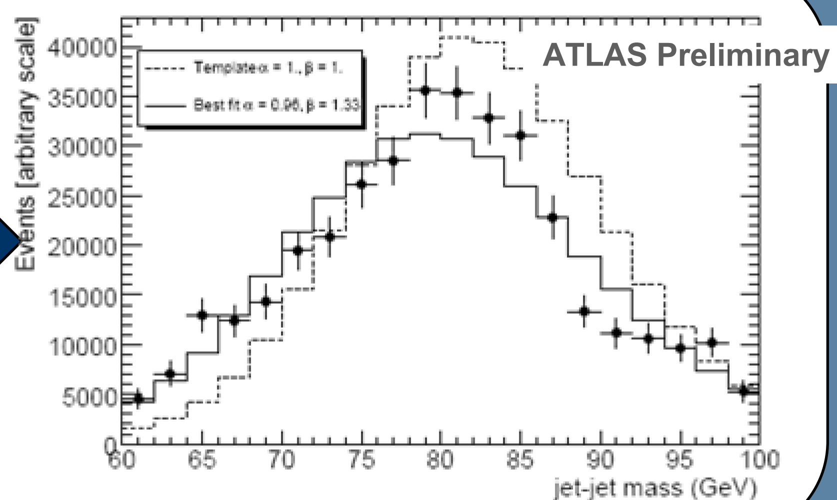
Template w/ various JES α & resolution β

→ Compute χ^2 in the (α,β) plane

Statistical precision: ~0.5% (1 fb^{-1})

Systematics :

- correlations, resolution degradation~0.3%
- combinatorial background ~ 0.3%
- Top mass ~0.5%



Top as a Tool : b-tagging in ATLAS

B-tagging in ATLAS

Several b-taggers in ATLAS

– IP2D, IP3D, Sec. Vertex

– JetProb, soft lepton …

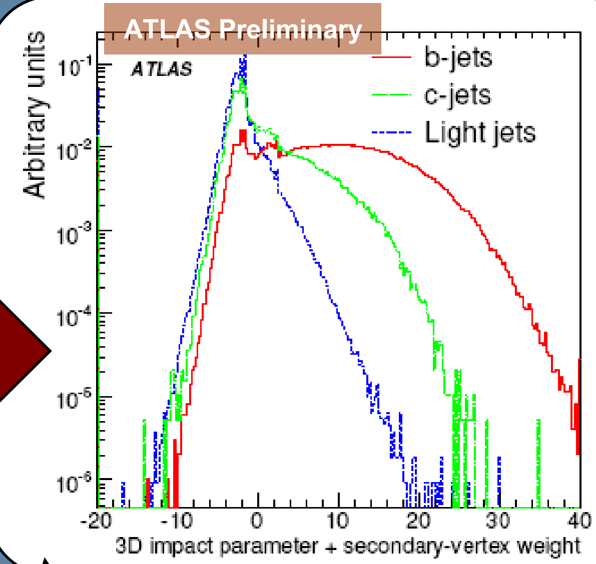
Combination of b-taggers :

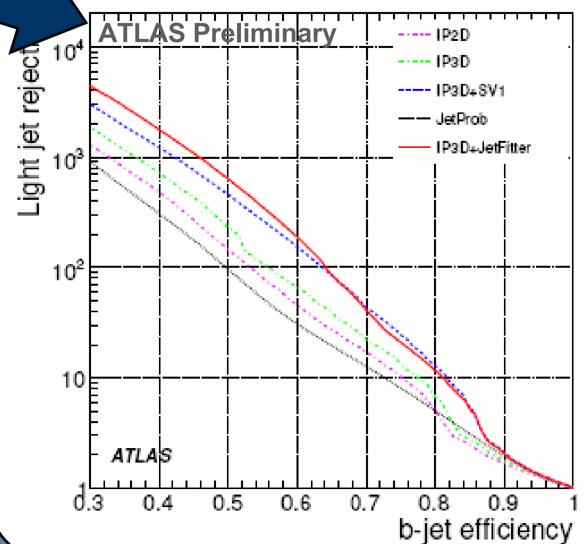
– btag weight w as SV1+ IP3D …

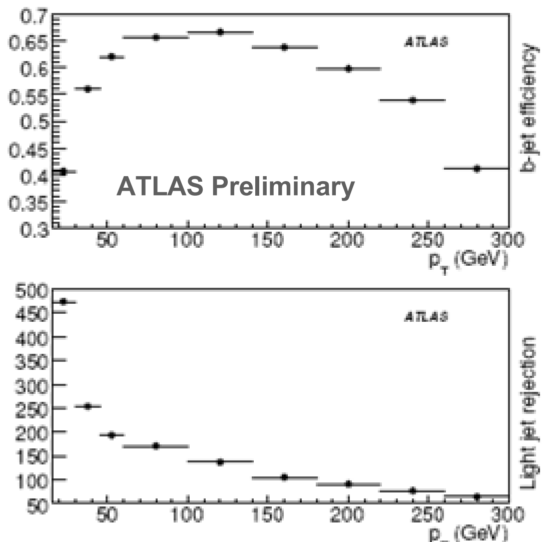
Question : how do we compute …

– efficiencies and rejection as f(w)

…by using DATA ?







b-tagging performance : Counting Method

Counting b-tagged jets in top pair events

Assume SM BR(t→bW)

Assume no correlation between btags

Sample « l+jets »

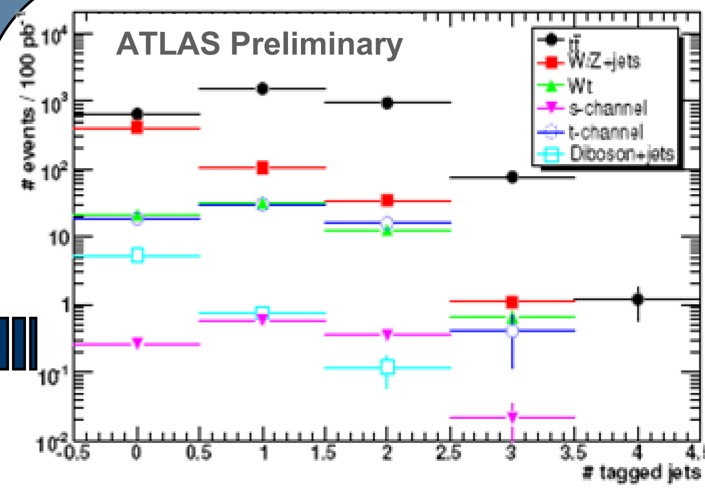
– Fix ε_{uds}

– Measure (σ_{tt}, ε_b, ε_c) with (N_{1b},N_{2b},N_{3b})

Sample « dilepton »

– Fix ε_{uds} and ε_c

– measure (σ_{tt}, ε_b) with (N_{1btag},N_{2btag})



Systematic in %	Counting lepton+jet	Counting dilepton
Light jets and τ	0.1	0.7
Charm jets	0.0	0.8
Jet energy scale	0.9	0.5
b-jet labelling	1.4	1.4
MC generators	0.1	2
ISR/FSR	2.7	2
W+jet background	1.2	0.3
Single top background	0.1	0.1
Top quark mass	0.3	0.5
Total systematic	3.4	3.5
Statistical (100 pb^{-1})	2.7	4.2
Statistical (200 pb^{-1})	1.9	3.0

B-tag efficiency measurement

Background subtraction → purity

– « l+jets » S/B ~15 (1 btag) to 27 (≥1 btag)

–« dilep » S/B > 80 (1 btag)

→ Efficiency vs *w*-cut

Systematics for ε_b

– ISR/FSR, b-jet labelling, JES

– background subtraction, mistag rates

b-tagging performance : Topological Selection

Topological Selection

Reconstruct fully tt events

Use the leptonic Top decay to estimate ε_b

– Reconstruct hadronic top

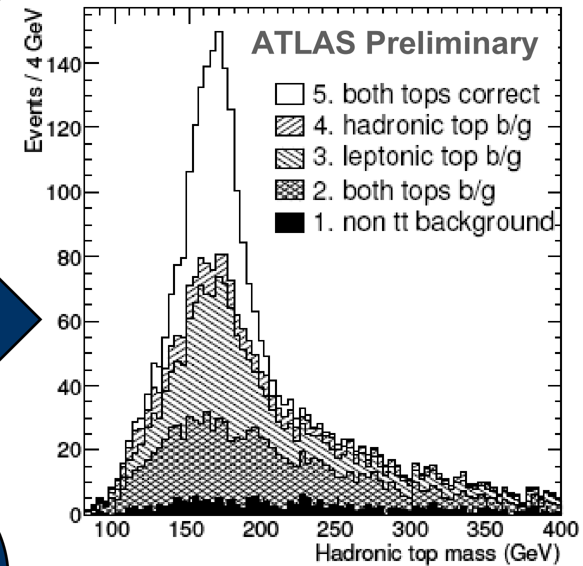
W → jj with j as untagged (*w*< cut)

t → jjj with mass constraint and *w*>cut

– Reconstruct leptonic top

W → lν with W-mass constraint

t → lνj in m_t-window, **no cut on *w***



B-tag efficiency measurement

Use jet in the « leptonic top » decay

– per jet p_T bins (20-40, 40-80,…)

Background subtraction from data :

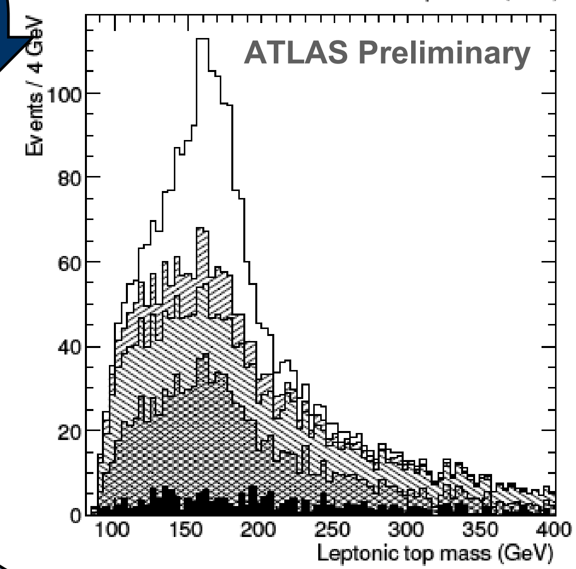
– Using sideband+fit in $m_{l\nu b}$ for bkgd shape

– Fit simultaneously signal+control sample (m_{jjj})

Determine ε_b as function of *w*

Systematics dominated from ~1 fb^{-1}

– Backgrounds, charm contamination,JES



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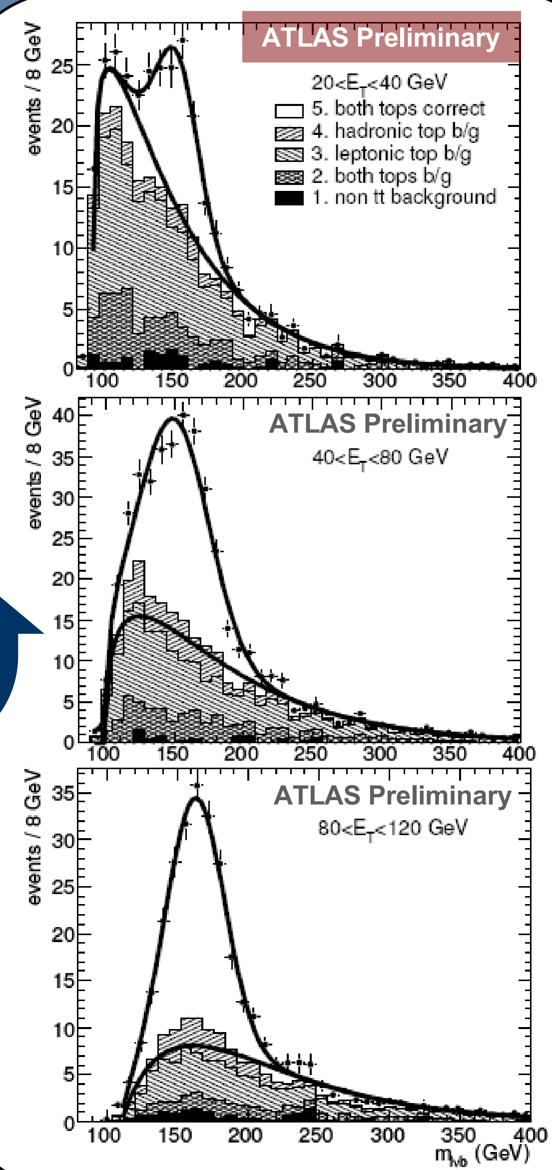

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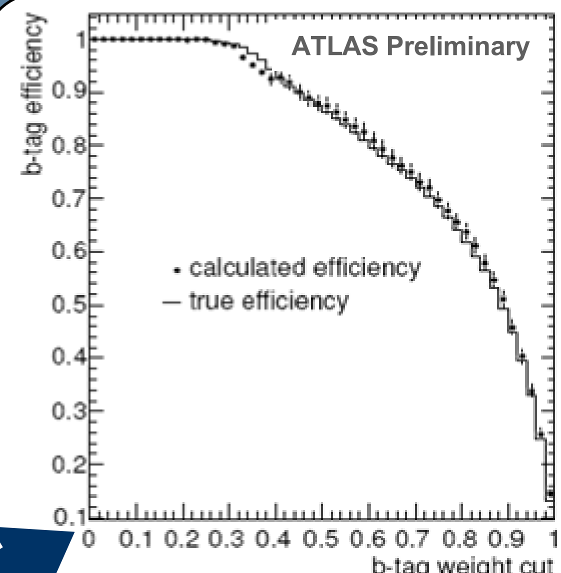

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– Fit simultaneously signal+control sample (m_{jjj})

Determine ε_b as function of *w*

Systematics dominated from ~1 fb^{-1}

– Backgrounds, charm contamination,JES

Systematic	Topological In %
Light jets and τ	0.5
Charm jets	0.7
Jet energy scale	0.5
b-jet labelling	-
MC generators	0.2
ISR/FSR	1
W+jet background	2.8
Single top background	1.2
Top quark mass	-
Total systematic	3.4
Statistical (100 pb^{-1})	-
Statistical (200 pb^{-1})	6.4

Top quark as a test to the SM

1) Introduction

2) Top quark as a tool

3) Top quark pair measurement

- Cross-section measurement
- Mass measurement
- Sensitivity to New Physics

4) Single-top measurement

5) Top Properties

Top Pair Production at the LHC

Top pair production

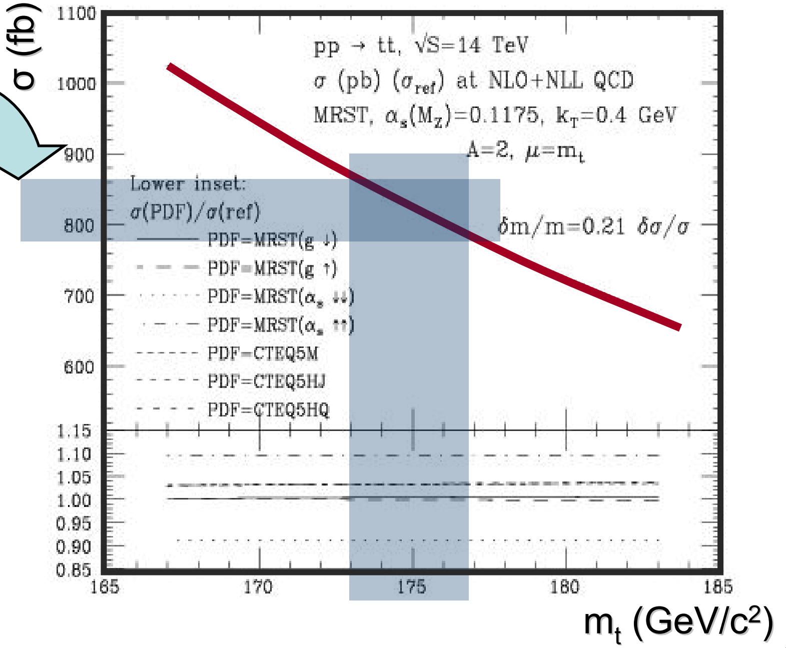
NLO calculations

$\sigma(tt) = 835$ pb $\pm 10\%_{pdf} \pm 6\%_{\mu\text{-scale}}$

– Production via gg (90%) and qq (10%)

– Dependence in Top Mass :

$\delta\sigma_{tt}/\sigma_{tt} \approx 5 \times \delta m_t/m_t$



Top quark decays

– In the SM: BR(t→Wb) ~1

– Final states labbelled from W decays

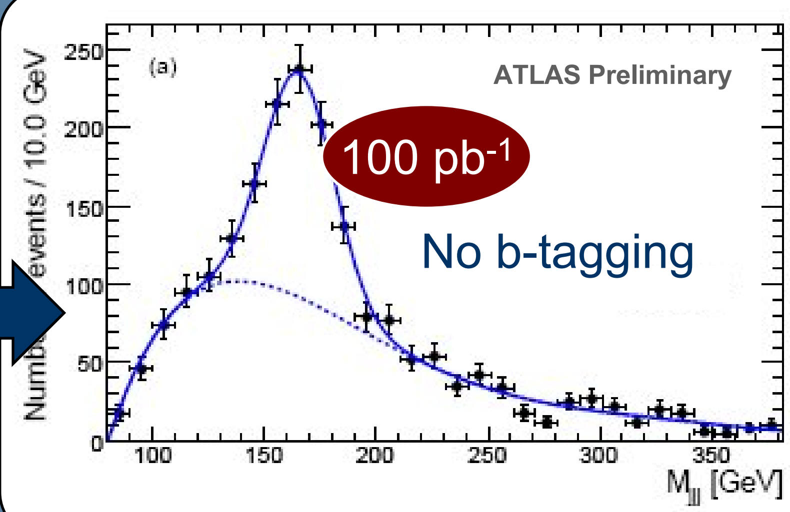
	BR	N_{evt} (1 fb^{-1})	
tt → (lν)b (jj)b	~30%	250,000	"lepton+jets"
tt→(lν)b(lν)b	~5%	40,000	"dilepton"
tt→(jj)b (jj)b	~44%	370,000	"full-hadronic"

Top cross-section in the lepton+jets channel

Event Selection
- L1+HLT lepton : ε ~ 80%
- at least 1 high p_T lepton
- at least four high p_T central jets
- large Missing ET

Simple W-mass constraint
- 1 comb. in W-mass window

b-tagging to purify
- (0,) 1 or 2 b-tagged jets



Cross-section extraction

No b-tagging option
- Counting and likelihood fit

Systematics @ 100 pb^{-1}
- JES, ISR/FSR modeling

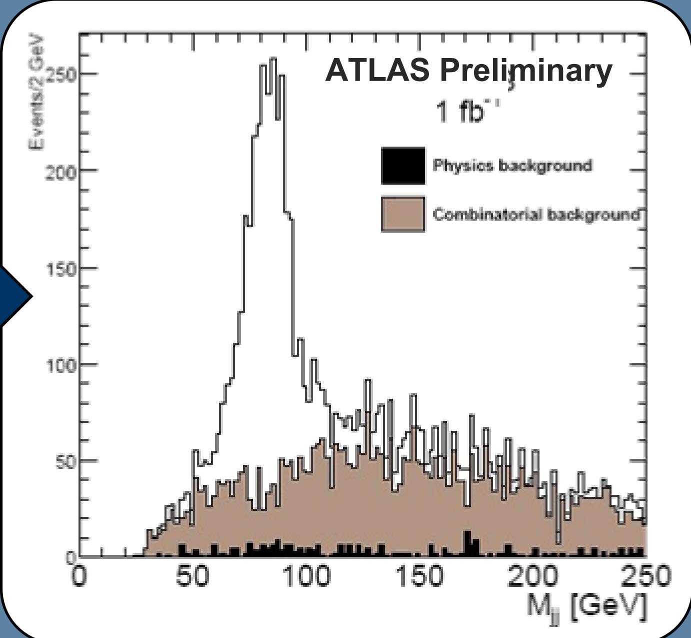
B-tagging to enhance purity
- $\delta\sigma/\sigma$ ~4.5%$_{stat}$±18%$_{syst}$ @ 100 pb^{-1}
- b-tagging, ISR/FSR, bckgd

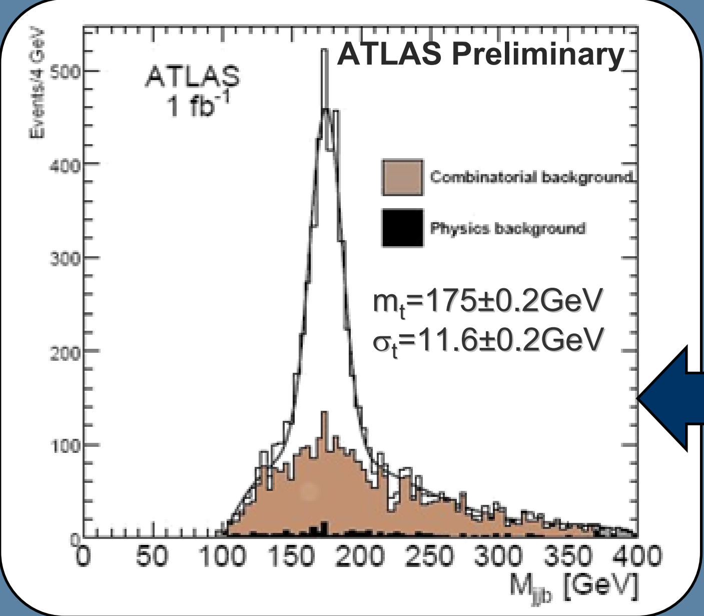
Source	Likelihood fit Electron (%)	Likelihood fit Muon (%)	Counting Default (%)
Statistical	10.5	8.0	2.7
Lepton ID efficiency	1.0	1.0	1.0
Lepton trigger efficiency	1.0	1.0	1.0
50% more W+jets	1.0	0.6	14.7
20% more W+jets	0.3	0.3	5.9
Jet Energy Scale (5%)	2.3	0.9	13.3
PDFs	2.5	2.2	2.3
ISR/FSR	8.9	8.9	10.6
Shape of fit function	14.0	10.4	-

Top Mass in the lepton+jet channel

W boson reconstruction & re-scaling
Light jet association W → jj
– Select jet-pair such: $|m_{jj} - m_W| \leq 3\,\sigma_W$
– Event-by-event rescaling
– Minimization of:

$$\chi^2 = \frac{\left(M_{jj}(\alpha_1,\alpha 2) - M_W\right)^2}{\Gamma_W^2} + \left(\frac{E_{j1}(1-\alpha_1)}{\sigma_{j1}}\right)^2 + \left(\frac{E_{j2}(1-\alpha_2)}{\sigma_{j2}}\right)^2$$





Top quark reconstruction
Association of hadronic W and b-jet :
Combination → highest p_T^{top}
or that maximizes $\Delta R(l,b)$
or minimizes $\Delta R(b, W \rightarrow jj)$
Purity : 70% w/ Efficiency : 1.2%

Top Mass in the lepton+jet channel (‘ed)

Top mass performance

Event yields : ~6,800 per 1 fb^{-1}

Mass resolution : $\sigma \approx$ 11.6 GeV

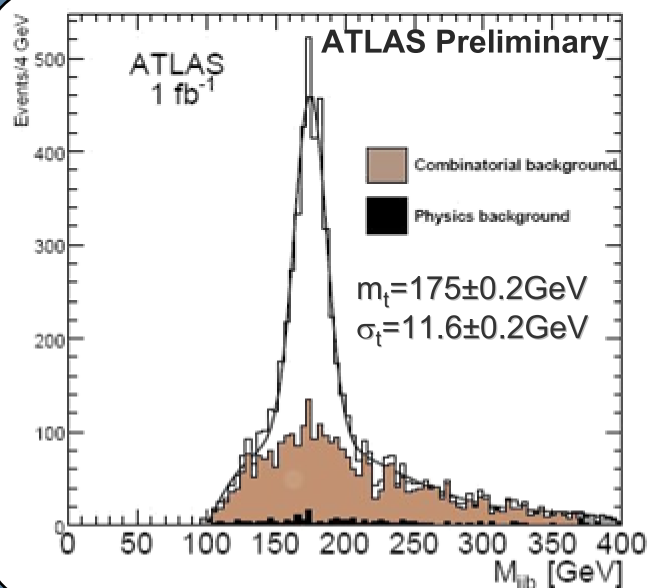
→stat. error ~0.05 GeV (10 fb^{-1})

Main systematics

– b and light JES

– FSR modeling

Main uncertainties	δm_t(GeV)	δm_t(GeV
light jet energy sc.(1%)	0.2	0.2
b-jet energy scale(1%)	0.7	0.7
Initial State Radiation	0.1	0.1
Final State Radiation	1.0	≤ 0.5
b-quark fragmentation	0.1	0.1
Combinatorial backgd	0.1	0.1
Total SYSTEMATIC	1.3	0.9
Total STATISTICAL	0.05	0.



Possible Improvements :

Use kinematic fit on the entire event

→ reconstruct hadronic / leptonic top

Use of Mass constraints (evt by evt):

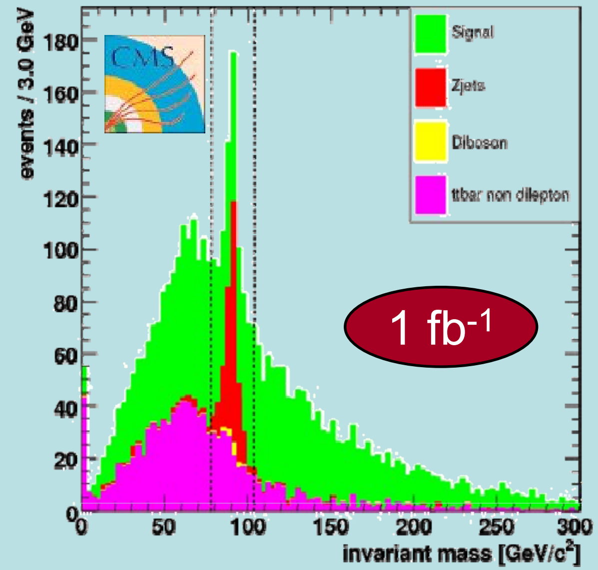
$m_{jj} = m_W$ & $m_{l\nu} = m_W$, $m_{jjb} = m_{l\nu b}$

→Use (χ^2,m_t^{fit}) to reduce contamination from badly reconstructed b-jets (FSR)

Top cross-section in the dilepton channel

Event Selection

- Triggering L1+HLT w/ ε ~ 80%
- Two high pT leptons
  - Isolated, opposite signs
  - Veto on Z-mass peak
- At least two high pT jets
- two b-tagged jets
- Missing Transverse Energy



Event kinematic reconstruction

Six constraints / 6 unknowns :

$m_{l\nu}=m_{W1}$ and $m_{l\nu}=m_{W2}$

$m_{l\nu b}=m_{t1}$ and $m_{l\nu b}=m_{t2}$

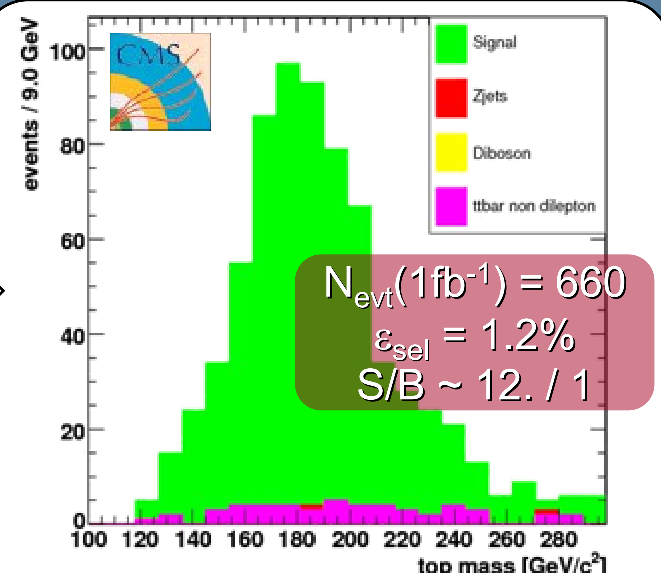
$m_{t1} = m_{t2}$ and $\Sigma\, p_T = 0$

Solve for several m_{top} hypothesis

→ Weight each solution

Top mass Determination

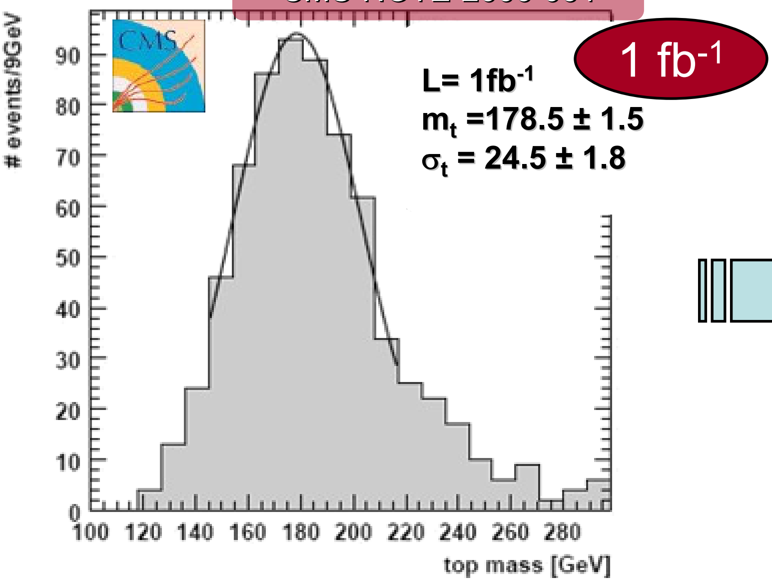
→Preferred solution's weight



Top cross section in the dilepton channel

Cross-sections Measurements
Di-lepton kinematic reconstruction

CMS-NOTE-2006-064



Systematics dominated
Modeling are dominant effects:
– PDF, gluon radiation, pile-up+UE,…
Experimental biases :
– b-tagging and JES

Uncertainties in 10 fb^{-1}	$\Delta\sigma/\sigma$
b-tag efficiency (5%)	3.8%
Jets energy scale (3%)	3.6%
Lepton reconstruction	1.6%
Missing E_T	1.1%
Pile up (30% On-Off)	3.6%
Underlying Event	4.1%
Gluon Radiation(Λ,Q^2)	2.5%
b-quark fragmentation	5.1%
Parton Density Function	5.2%
Luminosity	3%
Total SYSTEMATIC	**11%**
Total STATISTICS	**0.9%**

Top pair production as a probe to BSM physics

Top Mass measurement

Check consistency of SM Higgs

– Equal contributions to χ^2 :

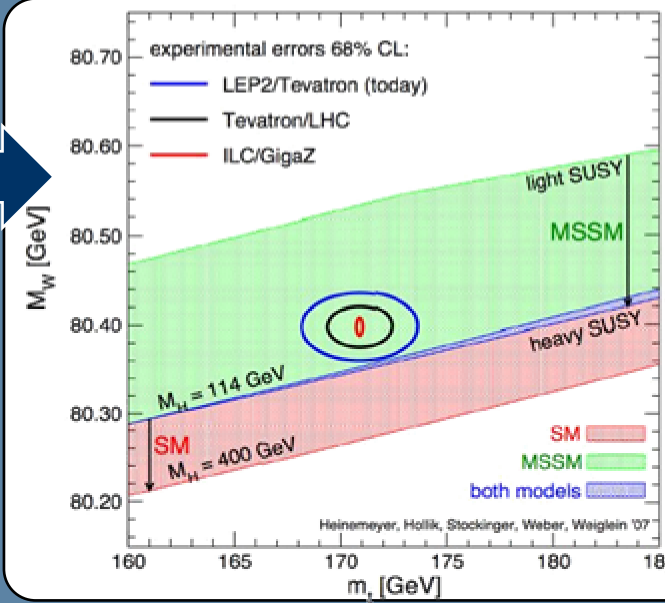
$$\Delta mW \approx 0.7\% \, \Delta mt$$

– Help identify the underlying framework

$$m_h^2 = m_Z^2 + \frac{3G_F m_t^4}{\pi^2\sqrt{2}} \ln \frac{M_t^2}{m_t^2}$$

s-top mass

➔ Precision on **both** (m_W, m_t) required !



Cross-sections measurement

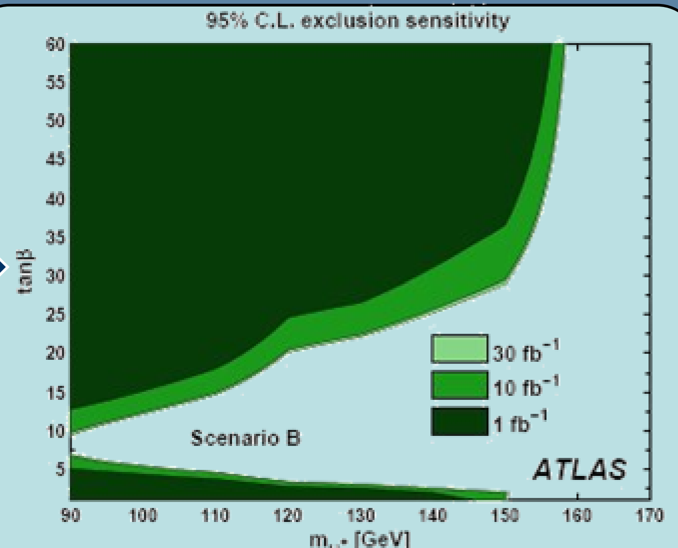
– Sensitive to BSM

– MSSM Charged Higgs

→Crucial to assess BRs

BR(e,μ) vs BR(τ)

BR(lepton) vs BR(jets)



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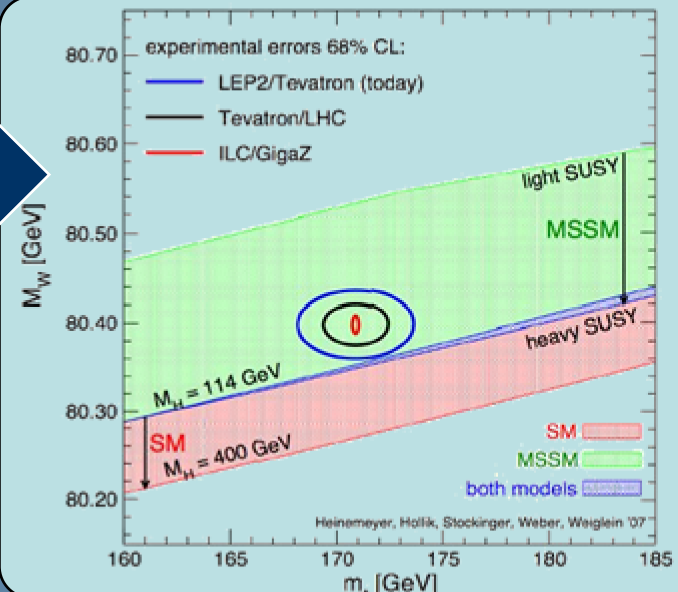

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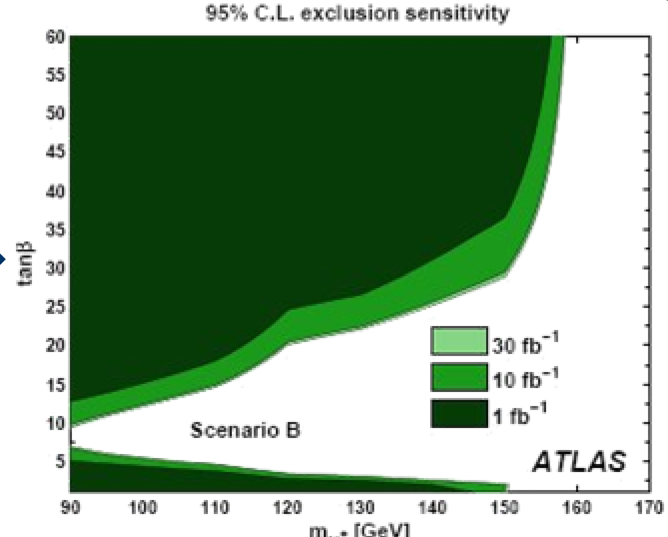

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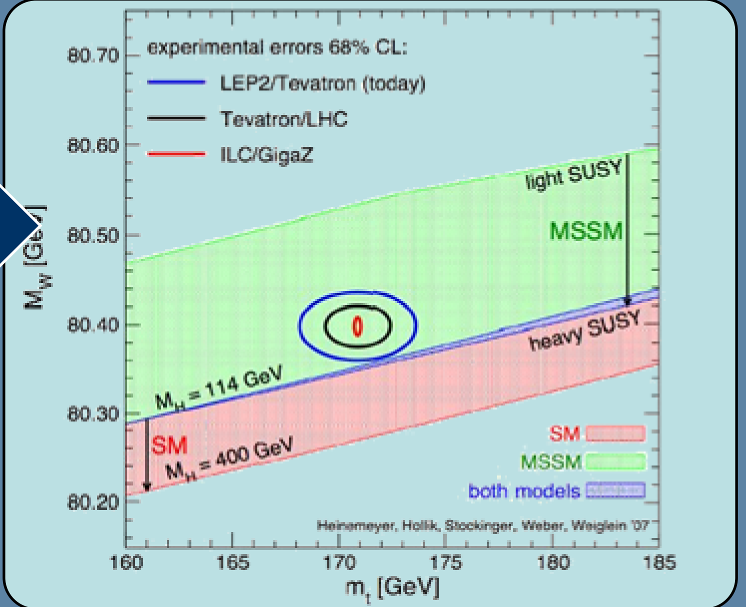

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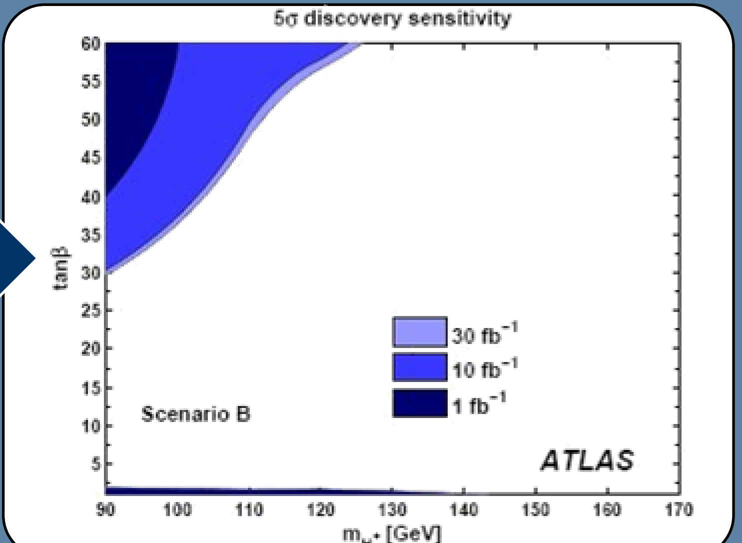


Single top at the LHC

1) Introduction

2) Top quark as a tool

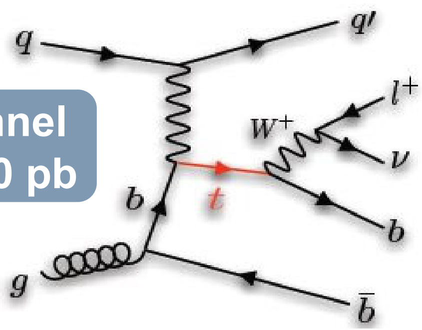
3) Top quark pair measurement

4) Single-top measurement
- strategy at the LHC
- selection of s-, t- and Wt- channels
- Sensitivity to new physics

5) Top Properties

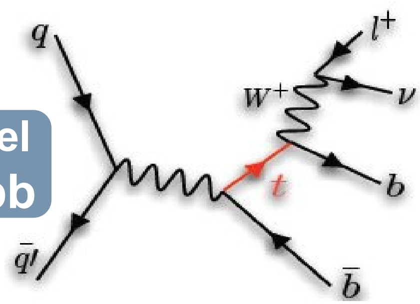
Single-top at the LHC : strategy

t-channel
$\sigma \sim 240$ pb



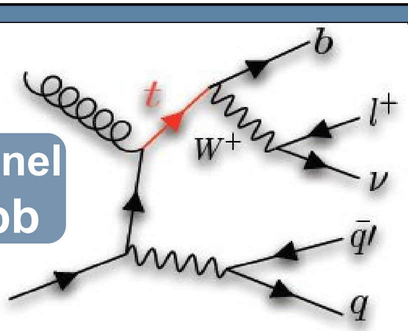
- 1 lepton+missing ET (W decay)
- 2-3 high pT jets
- 1 bjet

s-channel
$\sigma \sim 10$ pb



- 1 lepton+missing ET (W decay)
- 2-3 high pT jets
- 2 b-jets

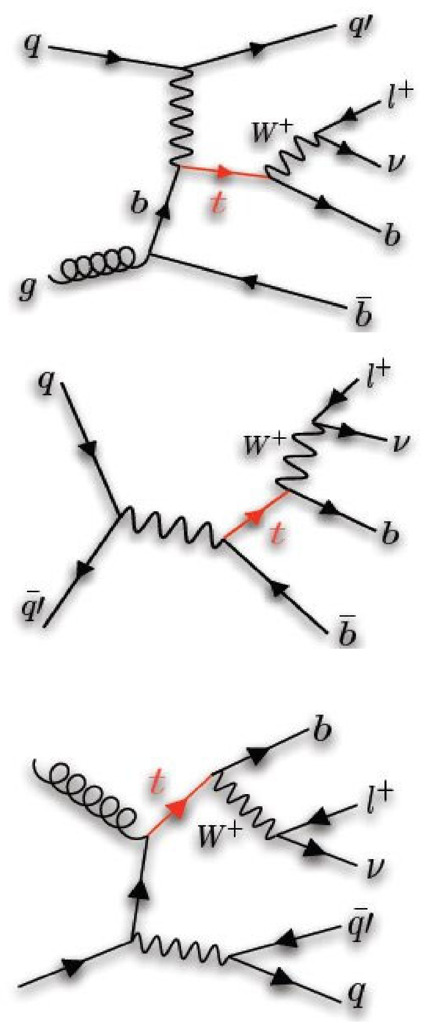
W+t channel
$\sigma \sim 60$ pb



- 1 lepton+missing ET (W decay)
- 2 high pT light jets (W decay)
- 1 b-jet

Contrary to the Tevatron, the main Background is now…top pairs !

Single-top in ATLAS : strategy



Common pre-selection

Inclusive lepton trigger ~80% efficiency

– at least one isolated high p_T lepton

– at least two jets

– at least one b-tagged jet

– missing ET

All single-top analyses are

– Background dominated w/ S/B ~few %

– Systematics on background dominate !

→ Use of data driven techniques mandatory

→ Necessity to enhance purity : use of MVA !

Thanks Dzero !!

Analyses Strategy

MVA vs CutBased selections

Cross-section extraction using σ = D-B/εL

Selection optimization:

– Cuts on MVA outputs that minimize systematics

– Use of toy MC to generate D,B as Poisson and D,B, ε for all sources of systematics

Single-top at the LHC : t-channel

Event Selection

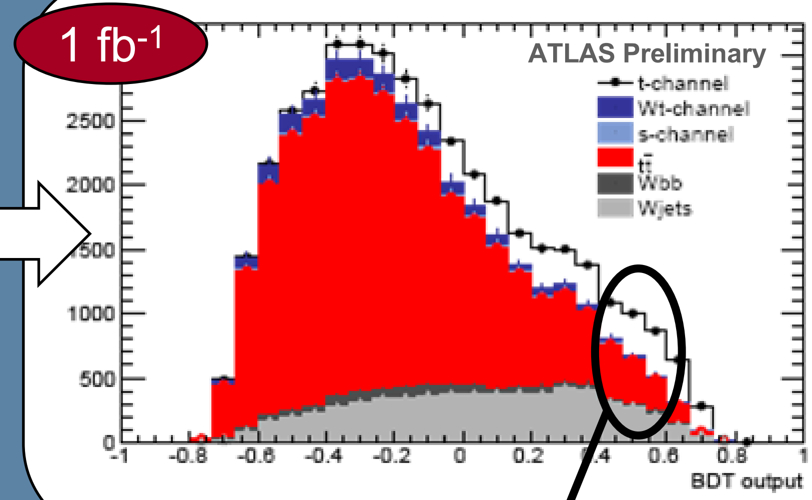
Exactly 2 high-p_T jets:

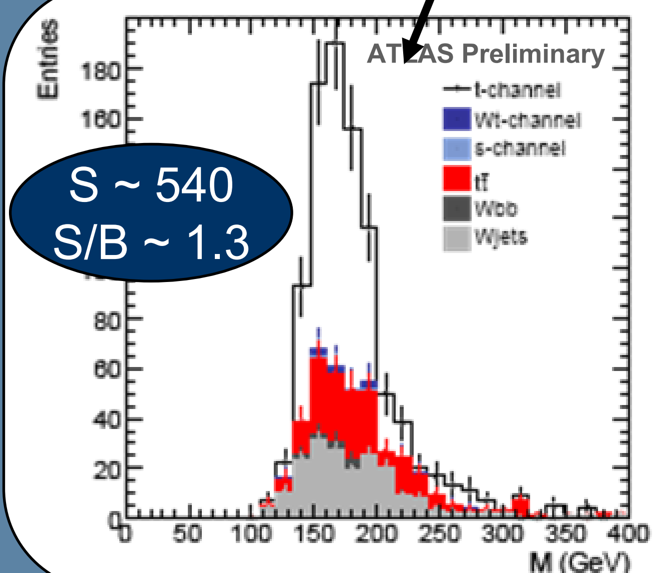
- 1 high pT central b-jet
- 1 forward light jet $|\eta|>2.5$

BDT analysis

- 6 variables not (too) sensitive to JES
- Optimization vs top pair

Signal : $\varepsilon \approx$ 1-2% N ~ 500 evts





Systematics @ 1 fb^{-1}	$\delta\sigma/\sigma$
Luminosity	8.8%
Jet energy scale	9.9%
B-tagging	6.6%
Backgrounds (MC)	8.2%
ISR/FSR + PDF …	9.9%
MC statistics	7.9%
Total SYSTEMATIC	**22.4%**
Total STATISTICAL	**5.7%**

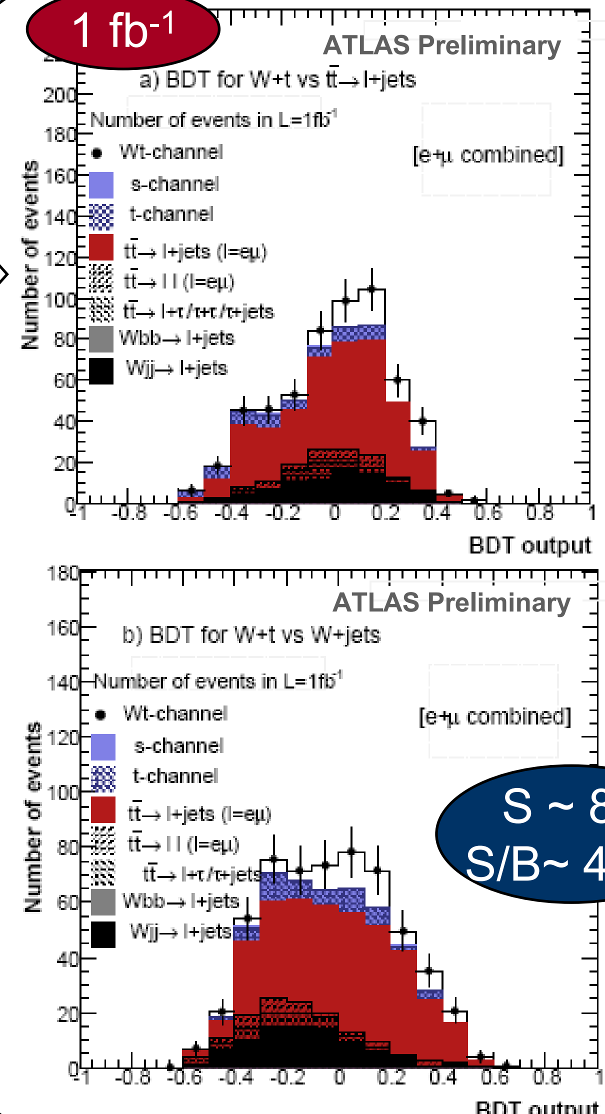
Single-top at the LHC : W+t channel

W+t channel selection

–2 high-p_T untagged-jets
 reconstruct W→ jj
– Veto of a 2nd b-tagged jet
Boosted Decision Trees:
– Set of 4 BDTs vs specific bkgds
– Set of BDTs for 2/3/4 jet final states

Systematics @ 10 fb^{-1}	$\delta\sigma/\sigma$
Luminosity	7.9%
B-tagging	6.6%
Jet energy scale	2.0%
Backgrounds (MC)	9.6%
ISR/FSR+ PDF +b frag	13.3%
Lepton ID, trigger	6%
Total SYSTEMATIC	**19.4%**
Total STATISTICAL	**6.6%**

1 fb^{-1}



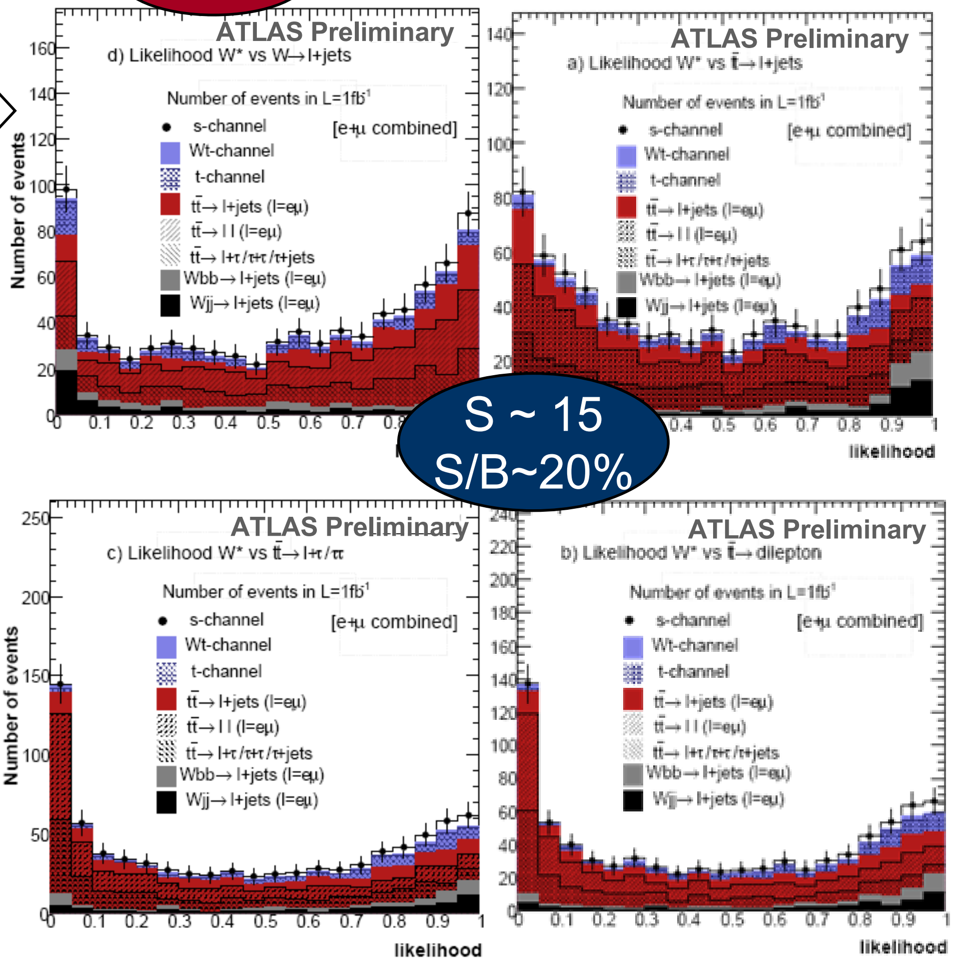
S ~ 80
S/B~ 40%

Single-top at the LHC : s-channel

s-channel selection
– 2 high-pT b-jets
– Veto of a 3rd jet
Likelihood functions:
– 5 likelihoods vs specific bkgds
– Choice of ~indpt variables

Systematics @ 10 fb^{-1}	**$\delta\sigma/\sigma$**
Luminosity	18%
B-tagging	25%
Jet energy scale	8%
Backgrounds (MC)	16%
ISR/FSR+ PDF +b frag	30%
Lepton ID, trigger	6%
Total SYSTEMATIC	**48%**
Total STATISTICAL	**20%**

1 fb^{-1}



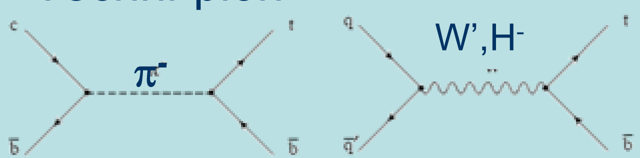
S ~ 15
S/B~20%

Single top at the LHC as a probe to New Physics

Interpretations Beyond SM

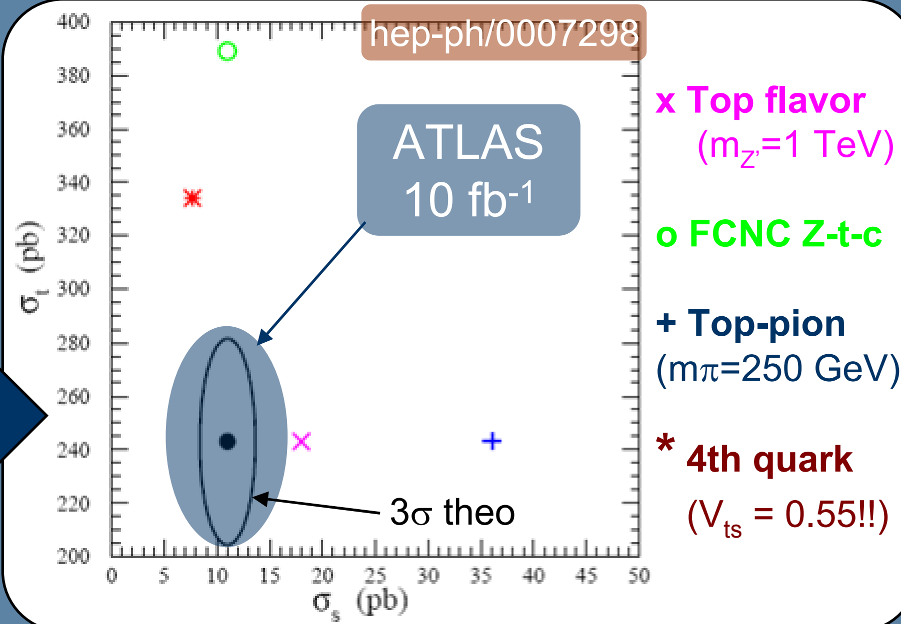
Single tops as probe to NP
- Cover a large spectrum
- in top production or decay
- in V_{tb} or new particles

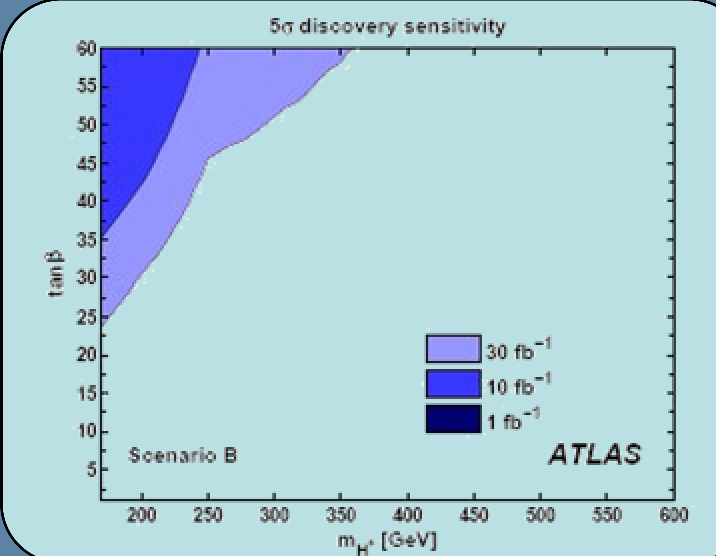
s-channel sensitive to:
- W' in GUT/ED
- $H^{\pm}$ in NMSM or MSSM
- Techni-pion



t-channel sensitive to:
- Anomalous couplings
- Anomalous polarization

W+t channel :
- $H^{\pm}$ search !
  pp → $H^{\pm}$t production





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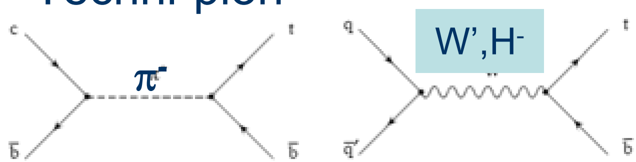

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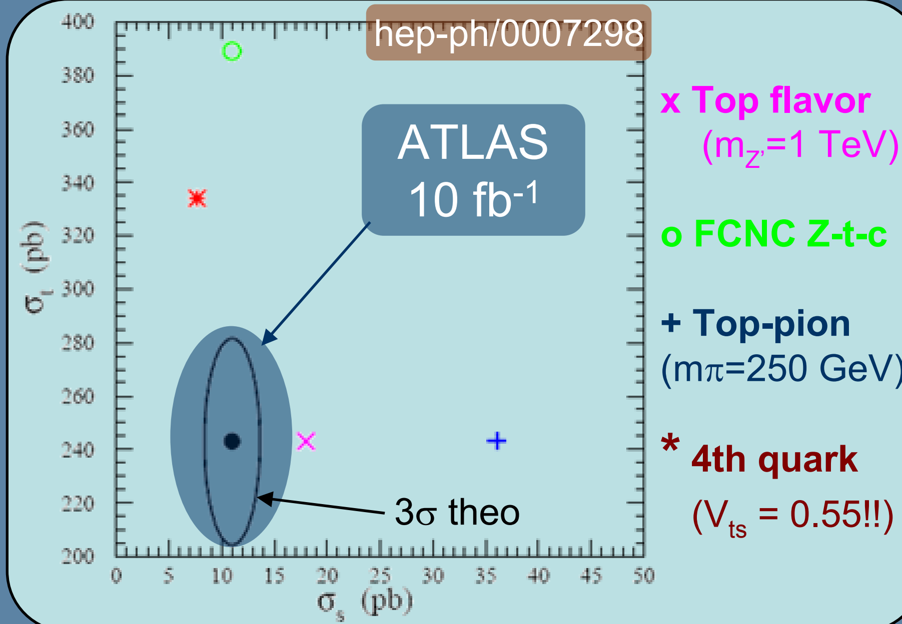
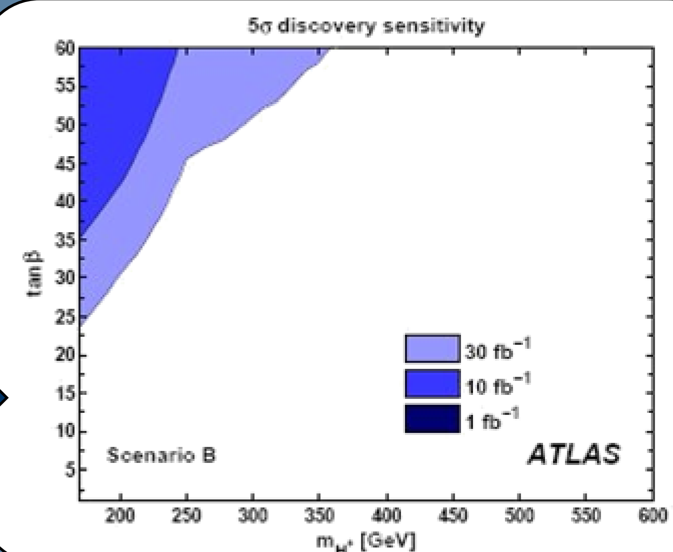
W+t channel :

– $H^{\pm}$ search !

pp → $H^{\pm}$t → blν τνb





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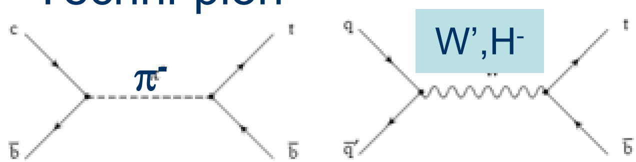

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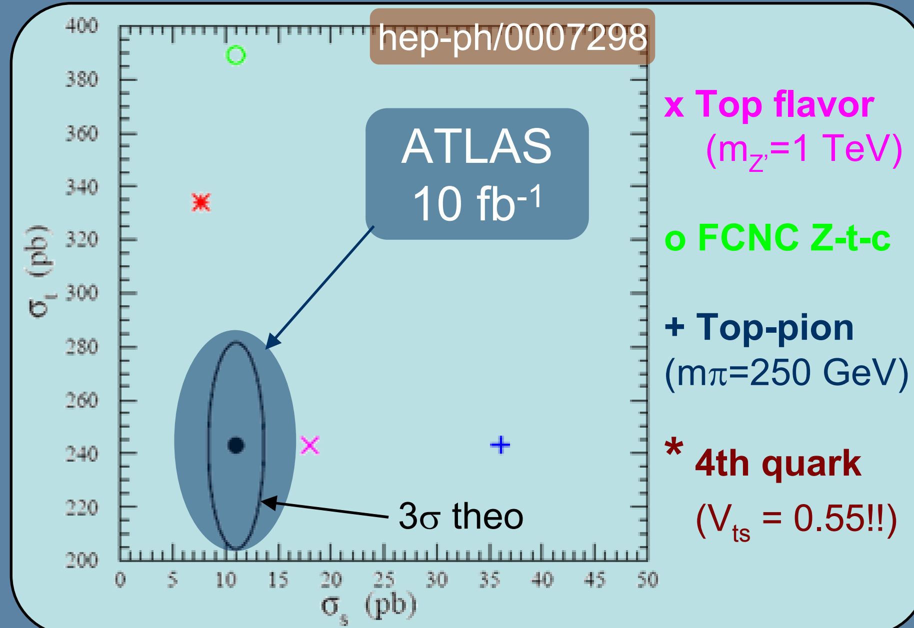
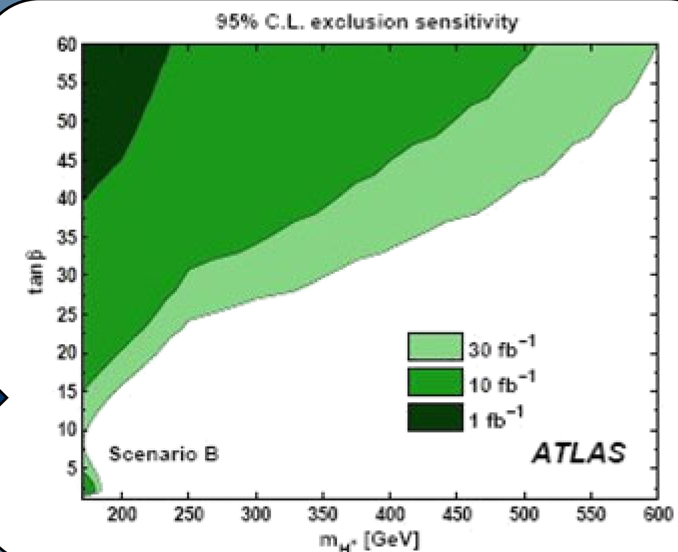
W+t channel :

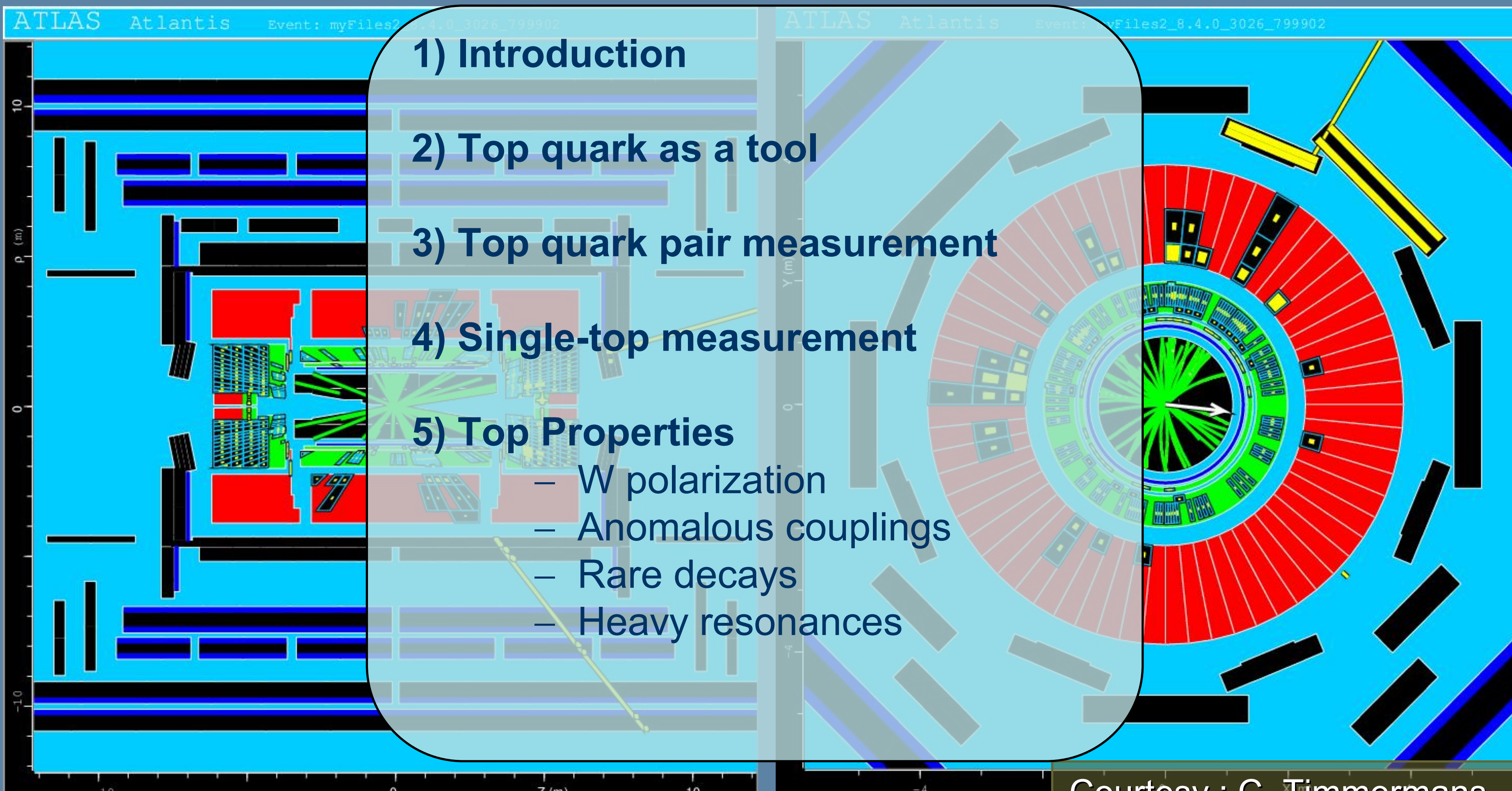
– $H^{\pm}$ search !

$pp \rightarrow H^{\pm}t \rightarrow bl\nu\ \tau\nu b$





Top pair measurement at the LHC



1) Introduction

2) Top quark as a tool

3) Top quark pair measurement

4) Single-top measurement

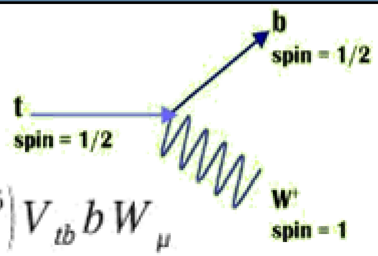
5) Top Properties
- W polarization
- Anomalous couplings
- Rare decays
- Heavy resonances

Courtesy : C. Timmermans

W polarization in top pair events

V-A current

In the SM:



$$\frac{-i\,g}{2\sqrt{2}}\bar{t}\,\gamma^{\mu}\left(1-\gamma^{5}\right)V_{tb}\,b\,W_{\mu}$$

W helicity : longitudinal or left

Polarization measurement

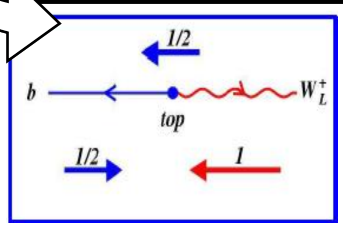
Use the lepton from W as a "spin analyzer"

– Angle ψ between l^+ (W rest frame) and the W^+ directions (top rest frame)

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

→ Access to F_0, F_L, F_R

"Left handed" F_L

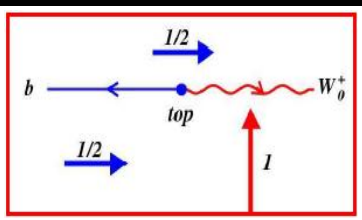


Standard Model:

$F_L=2m_W^2/(m_t^2+2m_W^2)$

$= 0.297$

"Longitudinal" F_0

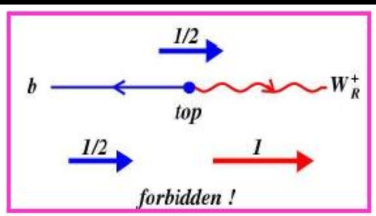


Standard Model:

$F_0=m_t^2/(m_t^2+2m_W^2)$

$= 0.703$

"Right handed" F_R



Standard Model:

$F_R= 0.00$

(forbidden)

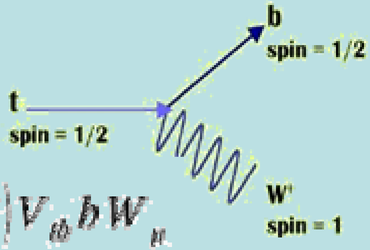
(m_b=0 approx.)

W polarization in top pair events

V-A current

In the SM:

$$\frac{-ig}{2\sqrt{2}}\bar{t}\gamma^{\mu}(1-\gamma^{5})V_{tb}\,b\,W_{\mu}$$



W helicity : longitudinal or left

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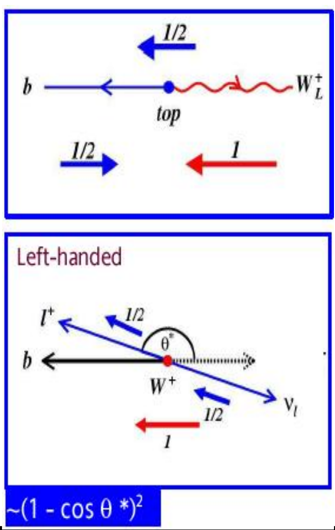
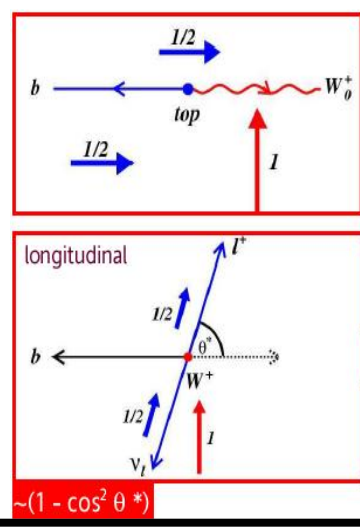
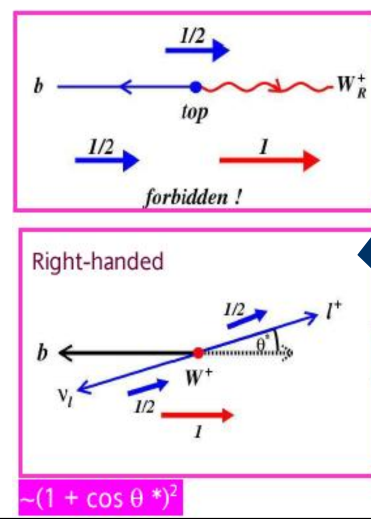


“Longitudinal” F_0



“Right handed” F_R



Polarization in top pair events

Event Selection

– At least 1 lepton
– At least 4 high p_T jets
– 2 b-tagged jets
– high missing E_T
→Purification w/ W reco

Polarization measurement

Use the lepton from W as a “spin analyzer”

– Angle ψ between l^+ (W rest frame) and the W^+ directions (top rest frame)

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

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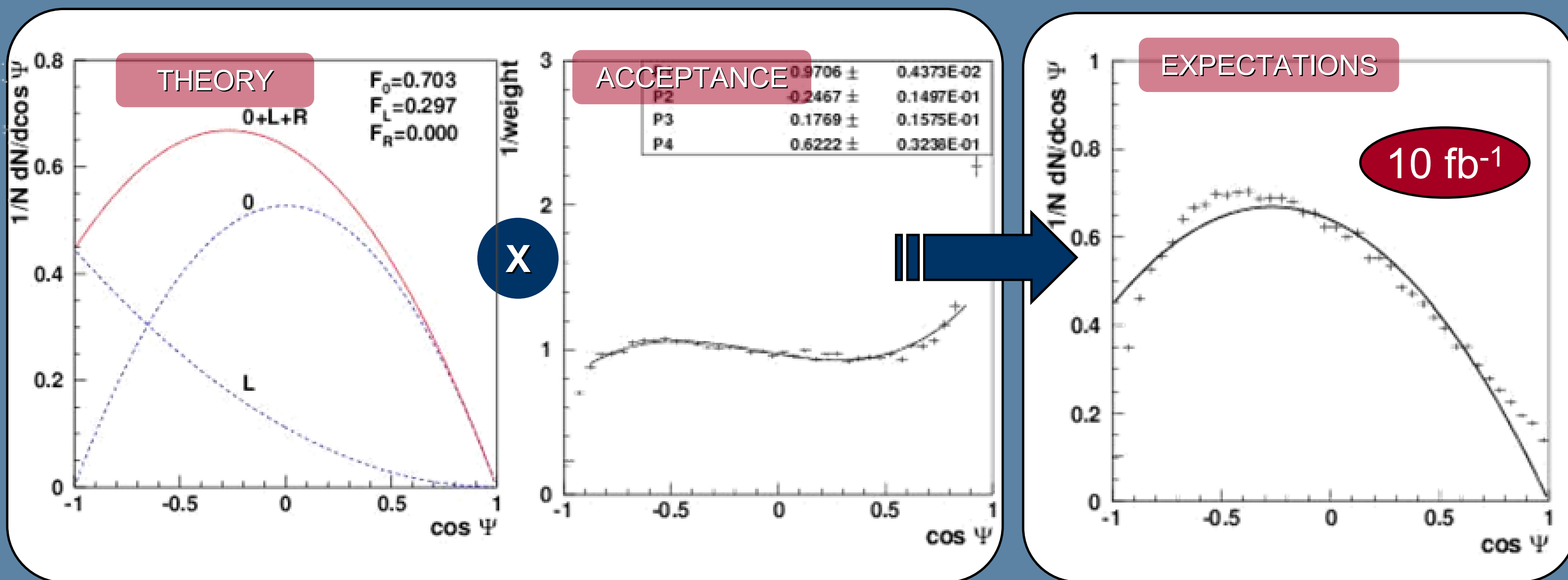

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→ Access to F_0, F_L, F_R

Expected Performance

– Luminosity of 10 fb^{-1}
– Total uncertainties ~3-8%

Systematics dominated analyses

– b-jet energy scale, b-tagging efficiency
– Input top mass, FSR modeling
– Pile-up+underlying event

Comparison with TeVatron limits

– Luminosity of 1 ~fb^{-1}
–Total uncertainties ~22% (F_0), limits on F_R

Source of uncertainty	Semileptonic channel		
	F_L	F_0	F_R
Generation			
Q-scale	0.000	0.001	0.001
Structure function	0.003	0.003	0.004
ISR	0.001	0.002	0.001
FSR	0.009	0.007	0.002
b-fragmentation	0.001	0.002	0.001
Hadronization scheme	0.010	0.016	0.006
Reconstruction			
b-tagging (5%)	0.006	0.006	0.000
b-jet miscalibration (3%)	0.011	0.005	0.005
Input top mass (2 GeV)	0.015	0.011	0.004
Others			
S/B scale (10%)	0.000	0.000	0.000
Pile-up (2.3 events)	0.005	0.002	0.006
TOTAL	0.024	0.023	0.012

Top quark anomalous couplings

Anomalous couplings in Wtb

Wtb sensitive to new physics

$$\mathscr{L} = -\frac{g}{\sqrt{2}}\bar{b}\gamma^{\mu}(V_L P_L + V_R P_R)\,t\,W_{\mu}^{-} - \frac{g}{\sqrt{2}}\bar{b}\frac{i\sigma^{\mu\nu}q_{\nu}}{M_W}(g_L P_L + g_R P_R)\,t\,W_{\mu}^{-} + \mathrm{h.}$$

Define observables:

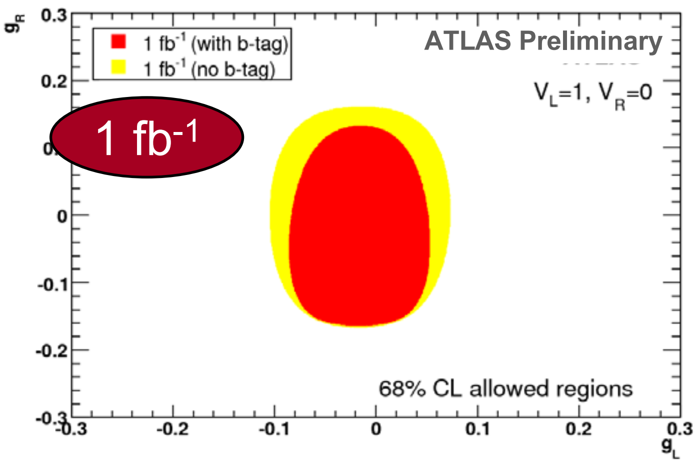
– $\rho_{R,L} = F_{R,L}/F_0$ (ρ_L=0.423 in SM)

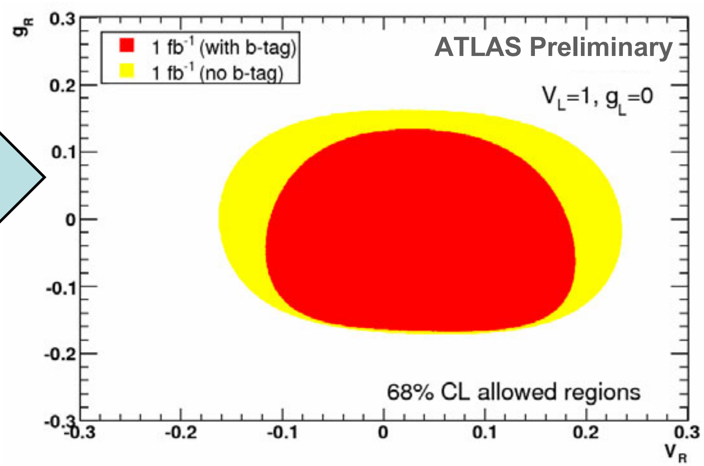
– Define $A_{FB} = ¾\,(F_R - F_L)$ (-0.222 in SM)

→ Constraints on g_L, g_R, V_R

Systematic uncertainties

Source	ρ_L	ρ_R	A_{FB}
Jet energy scale	0.04	0.001	0.010
Luminosity	0.01	0.000	0.006
Top quark mass	0.03	0.003	0.013
Background	0.01	0.000	0.003
ISR+FSR	0.05	0.006	0.024
MC generator	0.01	0.008	0.009
Pile-up	0.15	0.006	0.012
Total	0.16	0.012	0.033





Rare top decays and FCNC

Rare top decays and FCNC

Tree level suppressed in SM

→effects at 1-loop only

Exotic models foresee FCNC

– SUSY, Quark Singlet,…

Process	SM	QS	2HDM	MSSM	$\not R$ SUSY
$t \to uZ$	8×10^{-17}	1.1×10^{-4}	–	2×10^{-6}	3×10^{-5}
$t \to u\gamma$	3.7×10^{-16}	7.5×10^{-9}	–	2×10^{-6}	1×10^{-6}
$t \to ug$	3.7×10^{-14}	1.5×10^{-7}	–	8×10^{-5}	2×10^{-4}
$t \to cZ$	1×10^{-14}	1.1×10^{-4}	$\sim 10^{-7}$	2×10^{-6}	3×10^{-5}
$t \to c\gamma$	4.6×10^{-14}	7.5×10^{-9}	$\sim 10^{-6}$	2×10^{-6}	1×10^{-6}
$t \to cg$	4.6×10^{-12}	1.5×10^{-7}	$\sim 10^{-4}$	8×10^{-5}	2×10^{-4}

Event Selection in top pairs

Assume one of the tops decays in SM

– tt → blν qX where X=γ,Z→ll,g

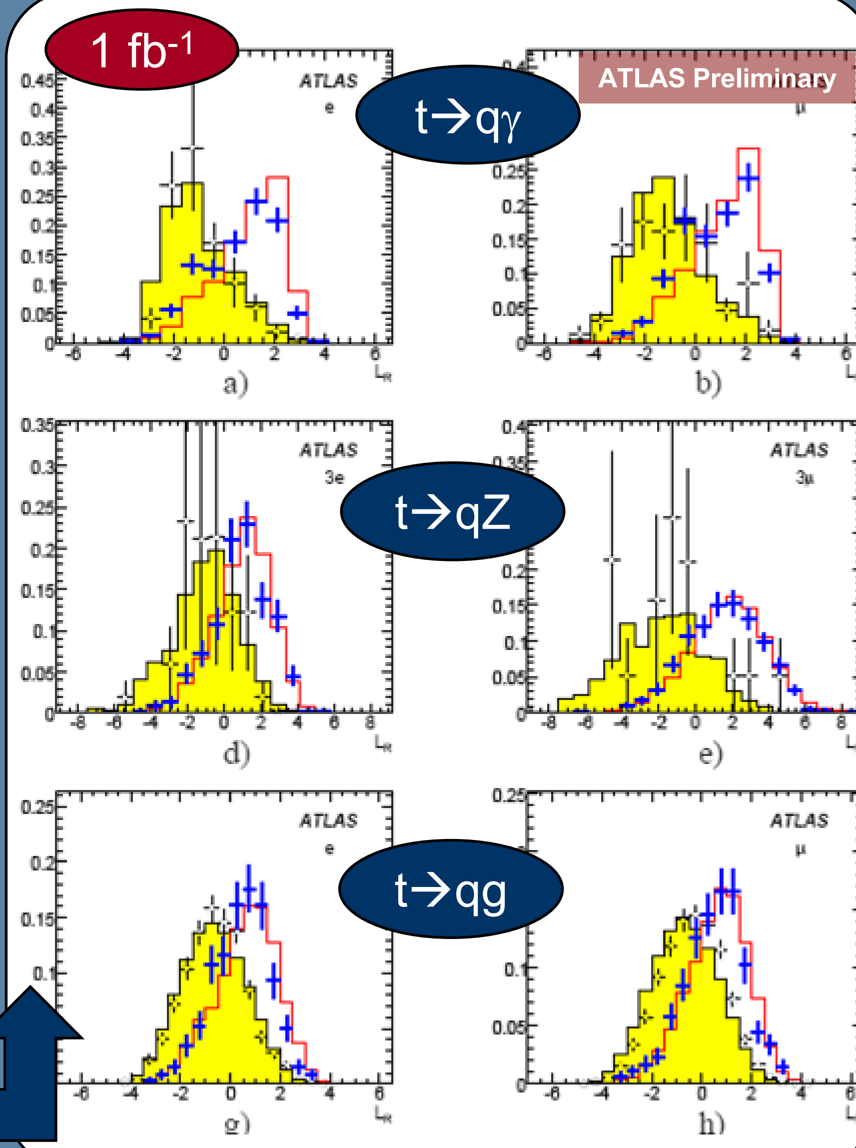
Procedure:

– Common preselection

– Specific selections (γ, 3l, …)

– Apply mass constraint χ^2 to reco $t^{fcnc}t^{SM}$

– Form specific Likelihood functions



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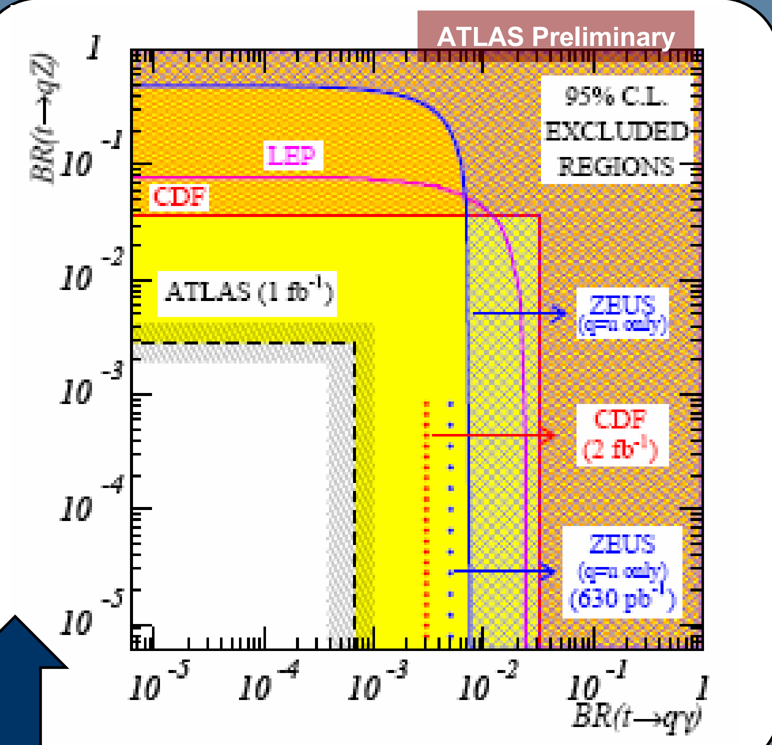


Top pair resonance searches

Event Selection

Selection of « l+jets » events

Combinatorial background only matters

Reconstruct fully tt events

– leptonic and hadronic tops

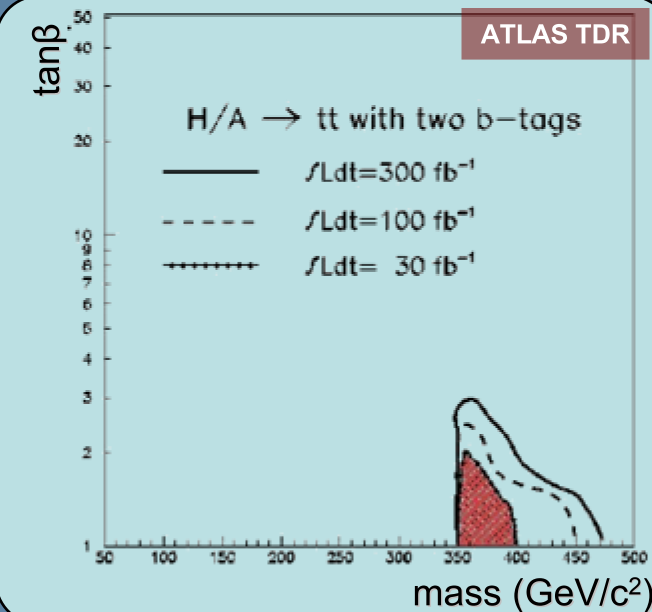
– tt system

Reconstruction efficiency :

– 5 to 1% for $M_{Z'}$ in [700,1500] GeV

– 40 to 100 GeV resolution

– Purity of Z' sample ~80%



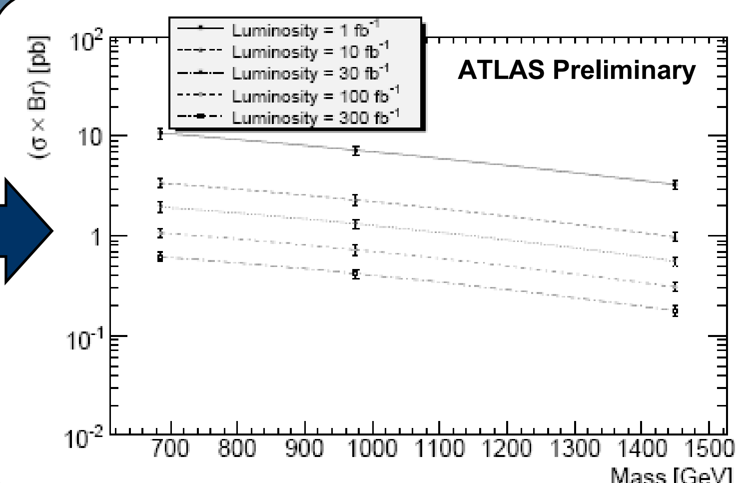
Z' searches

Sensitivity to generic resonances

– 5σ discovery potential vs lumi

Systematics + stat. Limited:

Reconstruction efficiency	8.3 %
Background contribution	3.1 %
tt mass resolution	2 to 11 %
Luminosity	2.5 %
Jet energy scale	-



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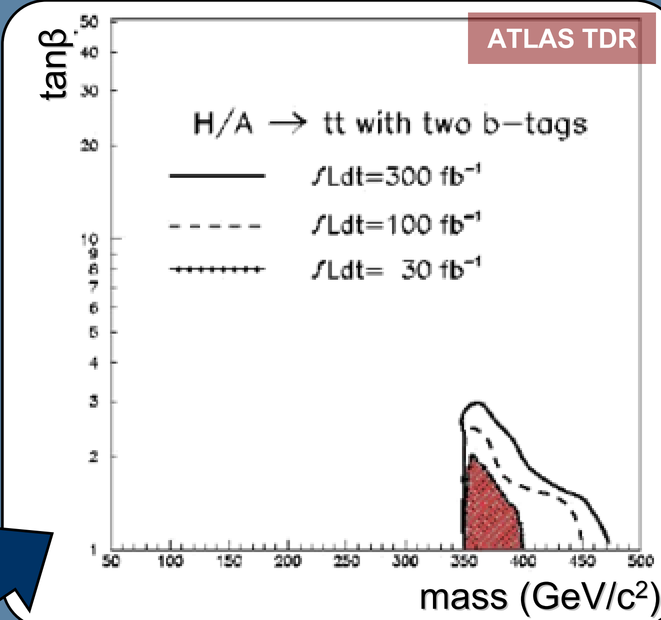


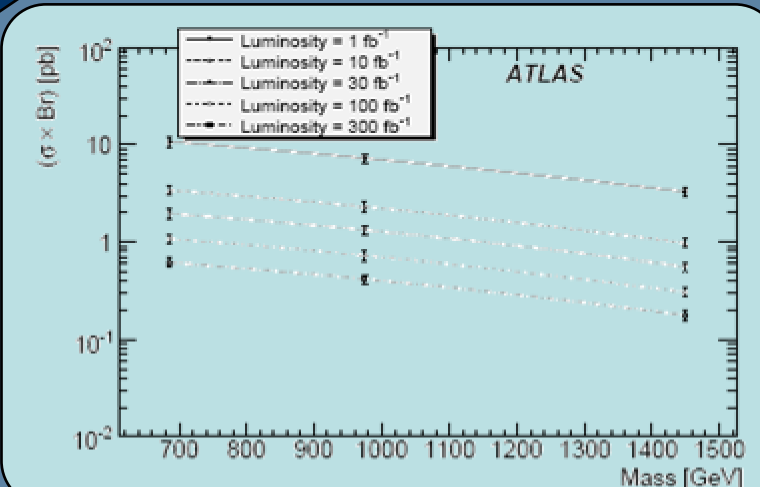
Performance on H/A→tt

Sensitivity to generic resonances

– 5σ discovery potential vs lumi

Sensitivity to MSSM Higgs

– 5σ discovery potential in (m,tanβ)



Conclusion

Looking forward to seing exciting times…

Expect more than 300k recorded events a year

– Use top pair for commissionning analyses

– New area of precision measurements

systematics limited

matching (at least) theoretical prediction

– Sensitivity to several sources of new physics

Top mass measurements

– TeVatron results will be difficult to match

– Error of ~1 GeV is achievable

➔ Consistency check of the SM or MSSM

Top cross-section measurements

– Should match early theoretical uncertainties

– Should provide a test of QCD at ~5% level

– Sensitivity to heavy resonance, MSSM H±…

Single top measurements

– Difficult because of tt production

– Precision measts on t- and Wt-

→Sensitivity to anomalous couplings, Higgs and FCNC

Top properties

Precision at ~1-2% level

Top spin correlation asymmetry to ~4%

→ sensitivity to anomalous couplings