New Physics Searches with ATLAS

Alaettin Serhan Mete
UC Irvine
On Behalf of the ATLAS Collaboration

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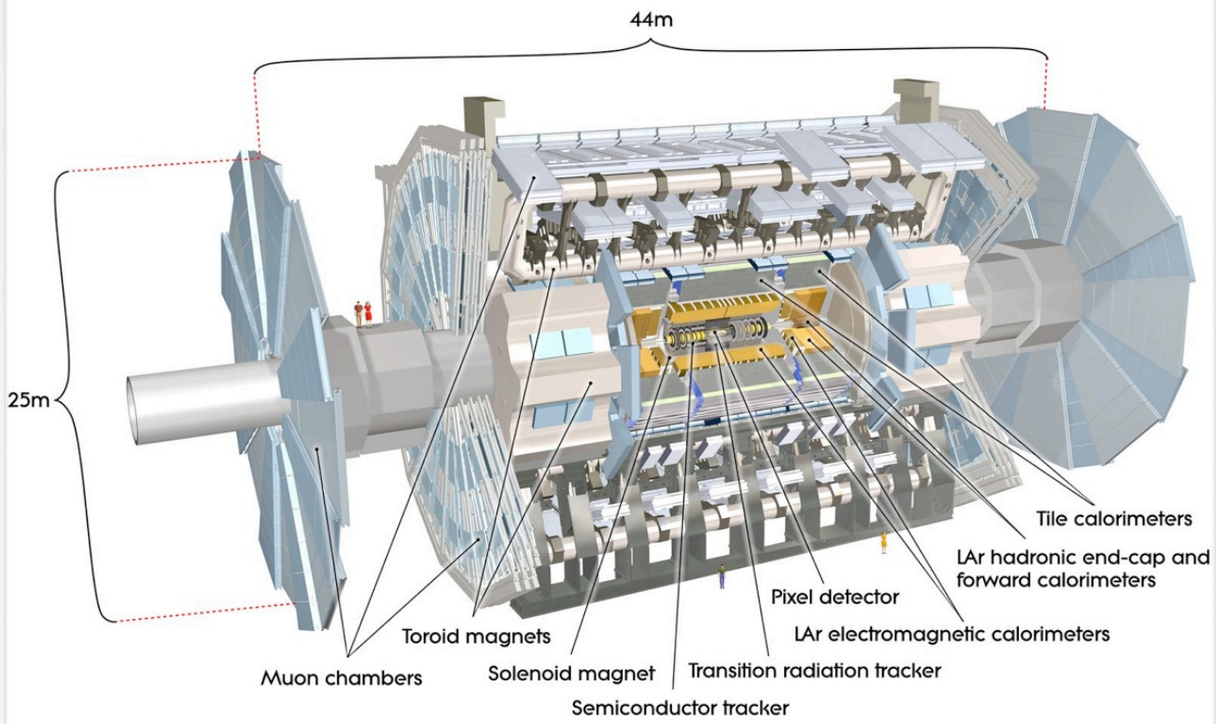
Introduction

- A glimpse of ATLAS searches for physics beyond the Standard Model
  - For the SUSY searches see Mitsou's talk

- Emphasis will be given on the recent results:
  - Heavy resonances with di-lepton / di-jet / di-boson signatures
  - Heavy neutrinos and W_R bosons in leptons + jets channels
  - $t\bar{t}$ / tb resonances in semi/di-leptonic final states
  - $b'\bar{b}'$ pair production with leptons + jet(s) final states

- For these and more ATLAS results : *https://twiki.cern.ch/twiki/bin/view/AtlasPublic*

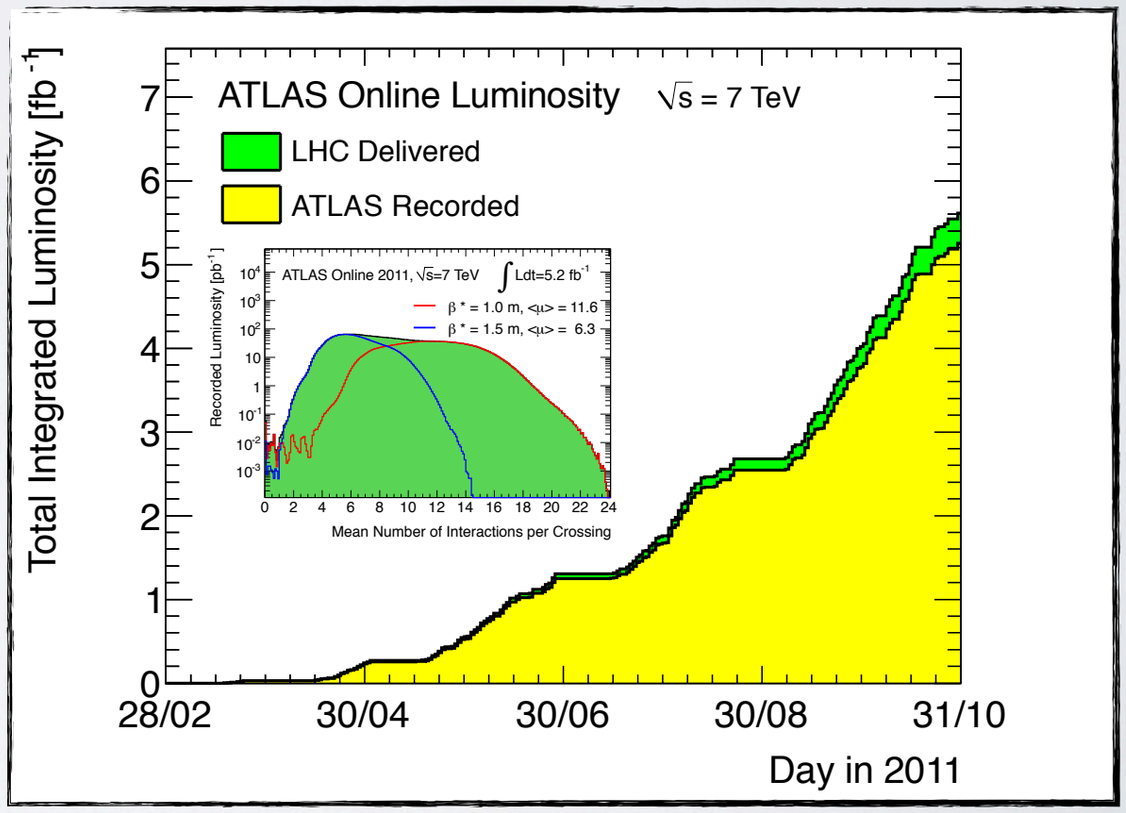
ATLAS & 2011 Data Taking



- Toroid (~ 0.5T barrel; ~1T end-cap)
- Solenoid (~ 2T)
- 7000 tons & 3000 km of cables...
- 88 Million channels...
- Largest particle detector in history!

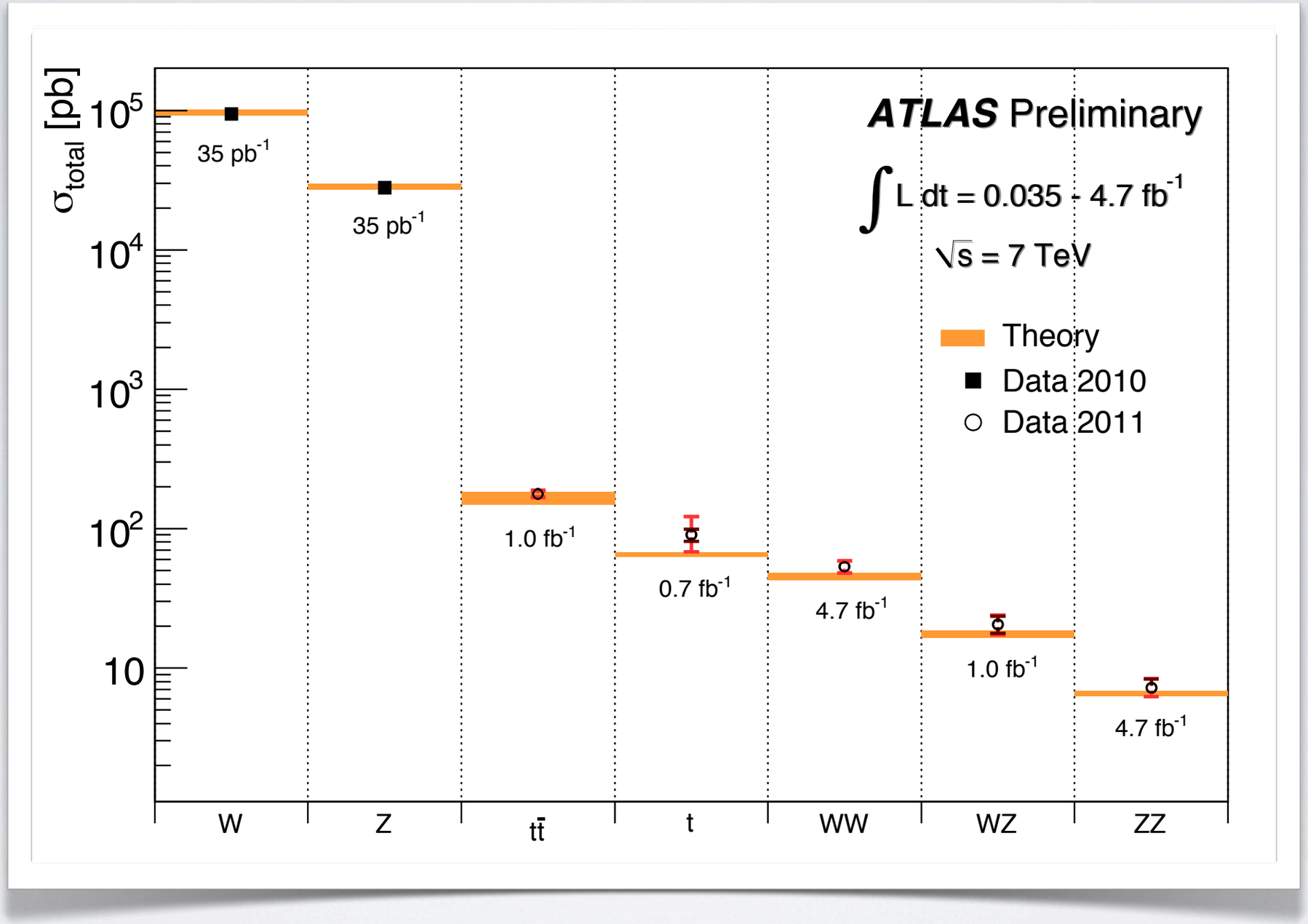
ATLAS 2011 p–p run												
Inner Tracking			Calorimeters				Muon Detectors				Magnets	
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.8	99.6	99.2	97.5	99.2	99.5	99.2	99.4	98.8	99.4	99.1	99.8	99.3

Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in pp collisions at √s=7 TeV between March 13th and October 30th (in %), after the summer 2011 reprocessing campaign



- **~ 99% of channels working**
- **Exceptional detector performance!**

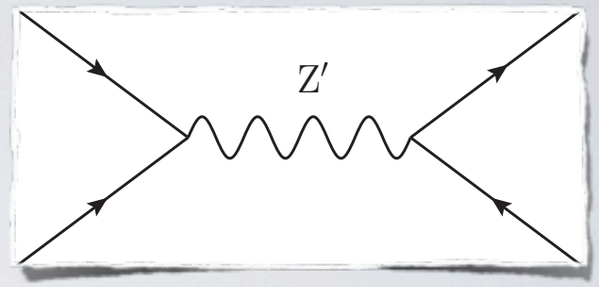
Standard Model at ATLAS



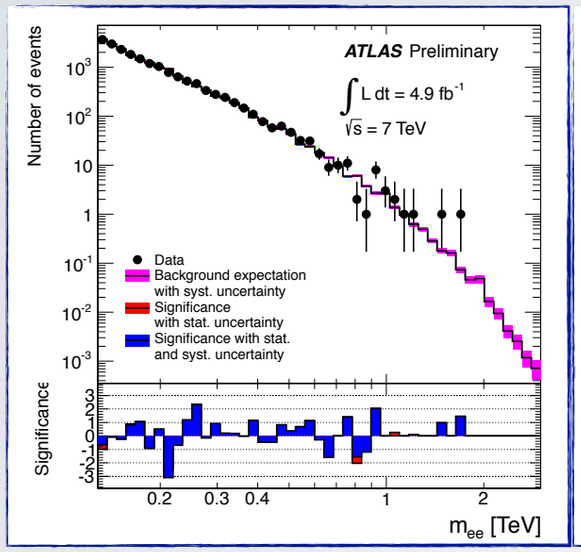
Foundation of all New Physics searches

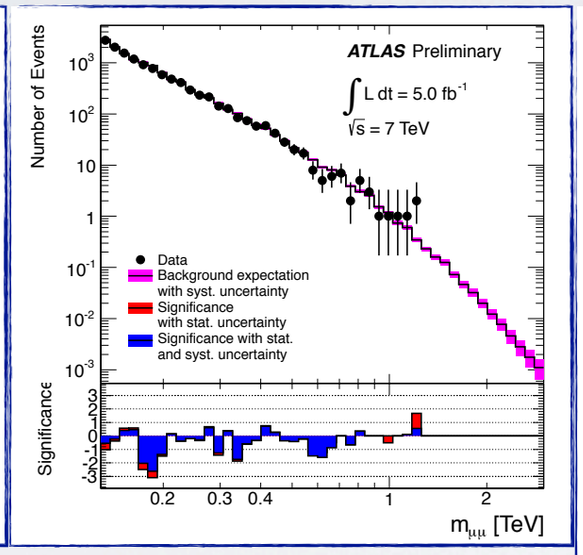
Search for Di-Lepton Resonances

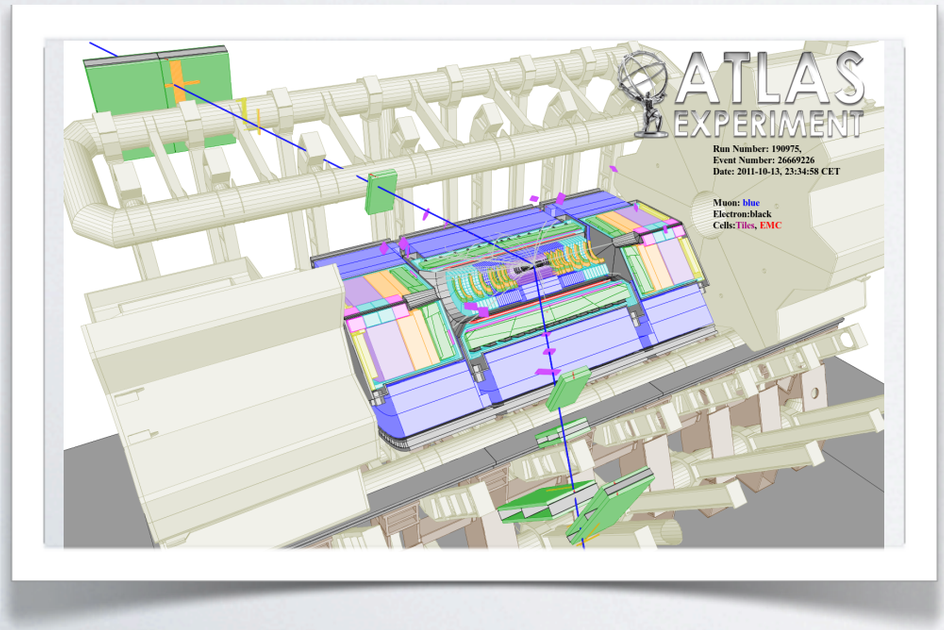
- Predicted by many extensions to the Standard Model
- Common to use Sequential SM Z′ as benchmark
- Multiple events w/ m_{ll} > 1 TeV !

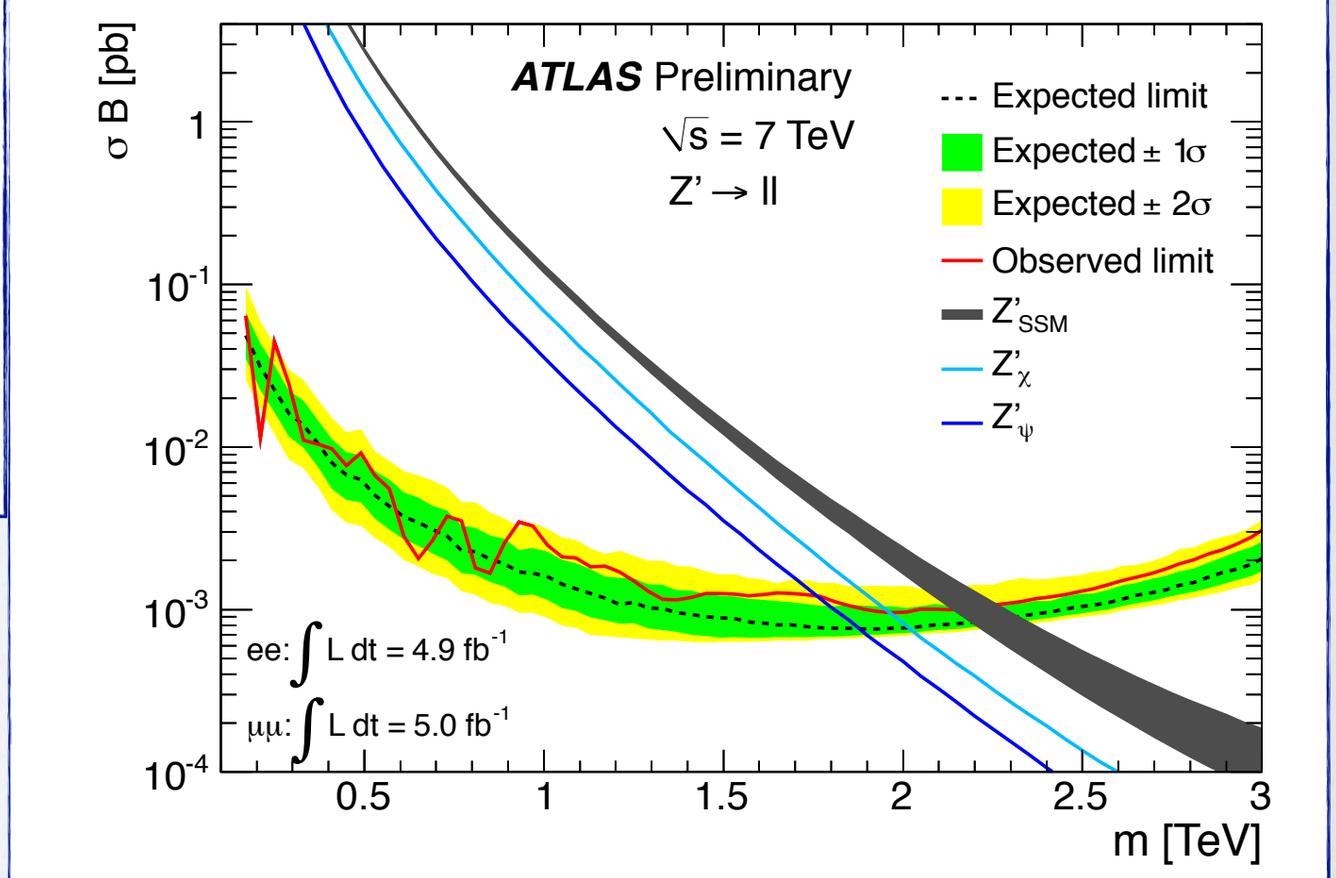


ATLAS-CONF-2012-007





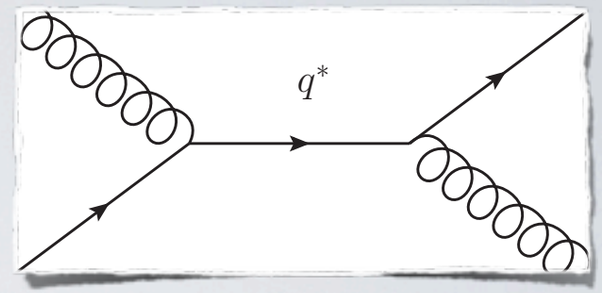




95 % CL limit @ m_{ll} > 2.21 TeV for SSM Z′

Search for Di-Jet Resonances

- Powerful to test the Standard Model and look beyond
- q*, axigluon, colour-octet scalar, string resonance…
- Search for excess above phenomenological fit to data



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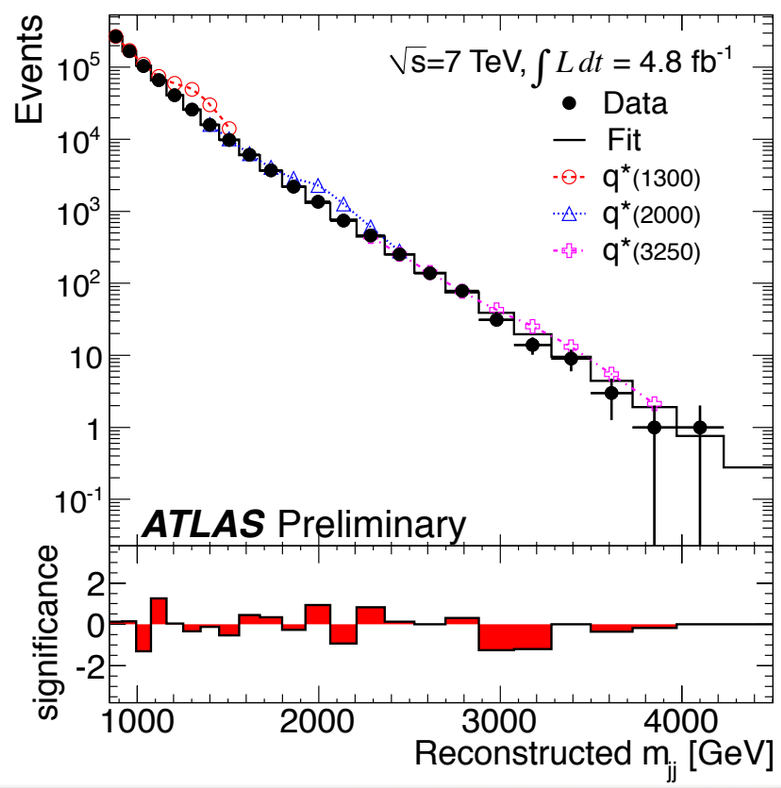
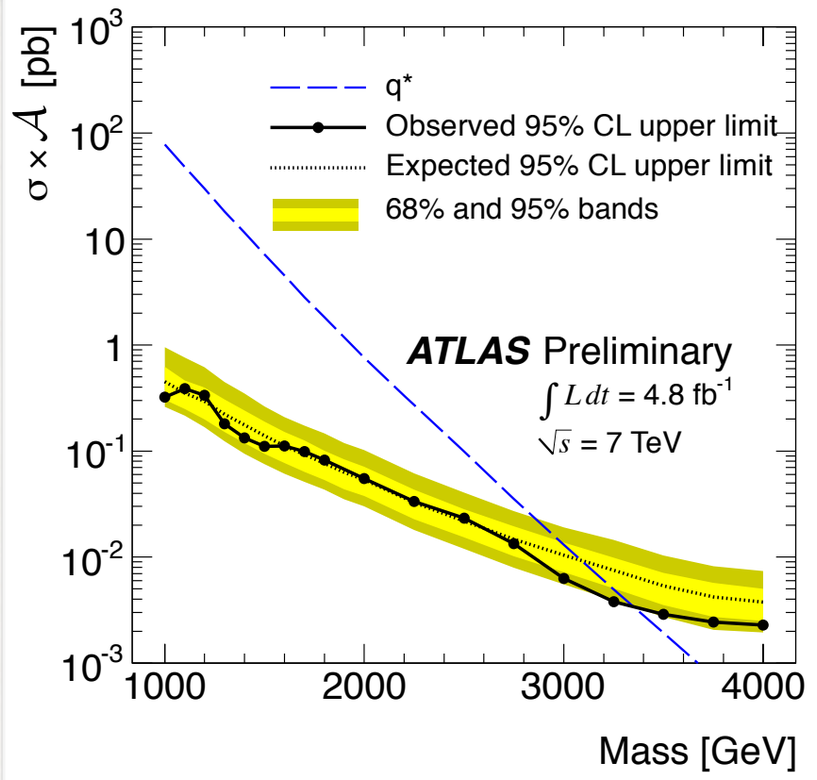
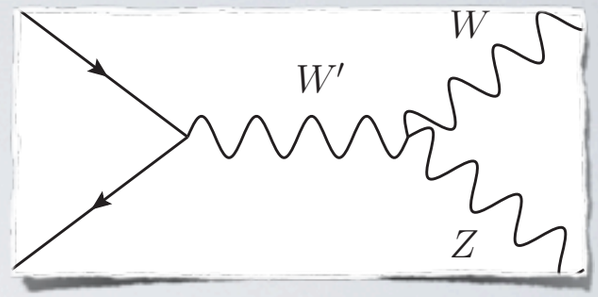


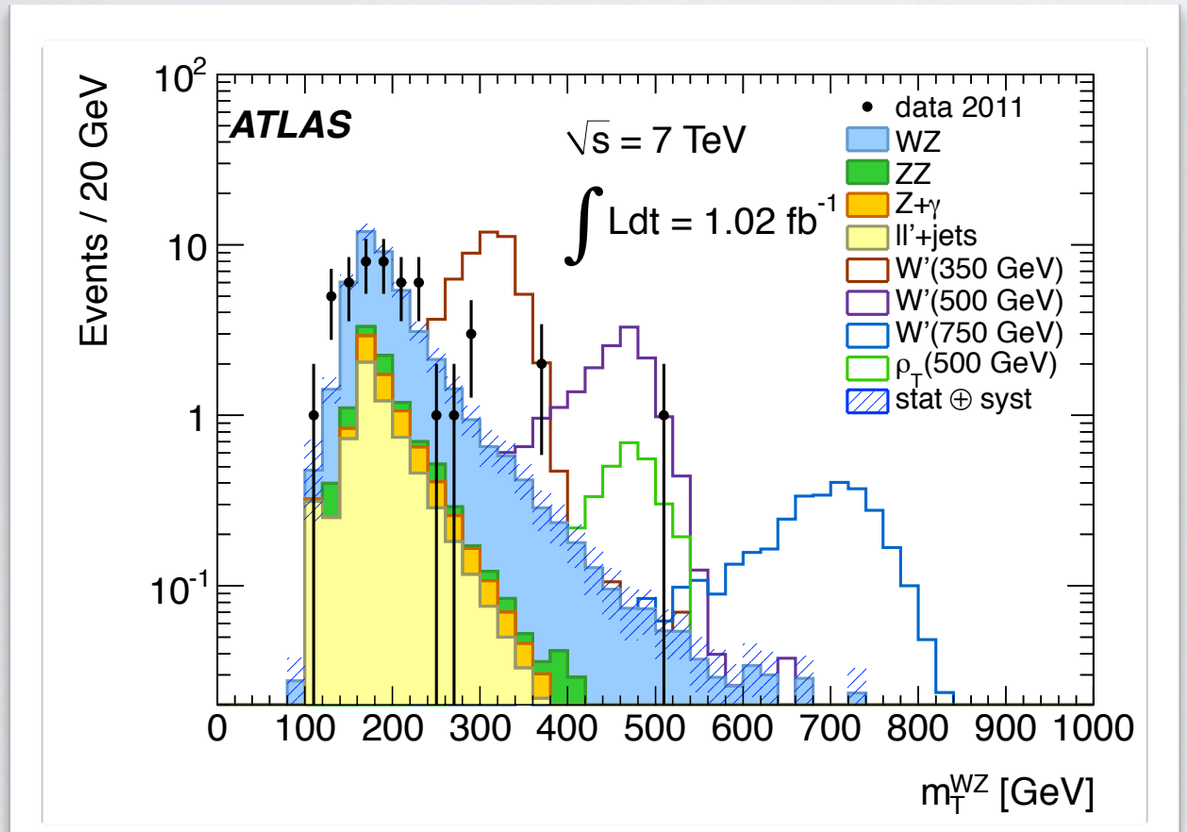


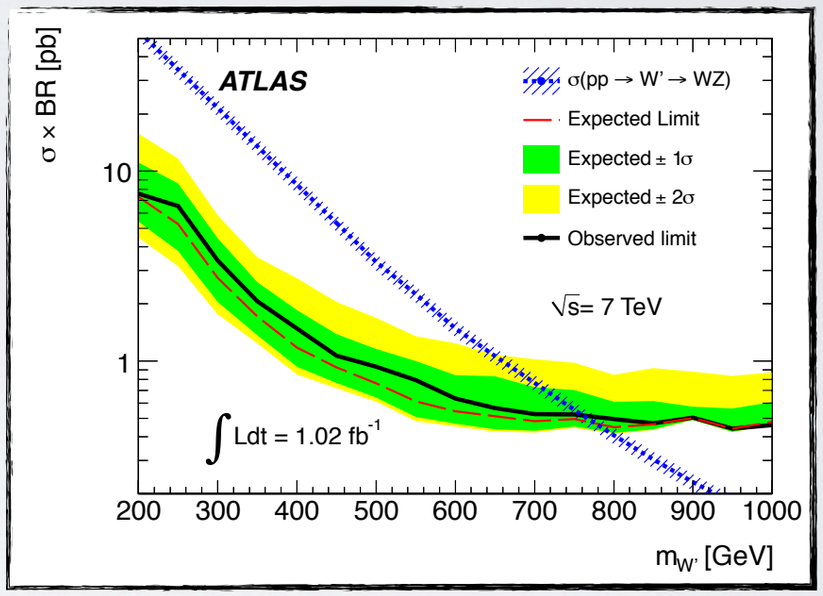
95 % CL limit @ m_{jj} > 3.35 TeV for q*

Search for WZ Resonances

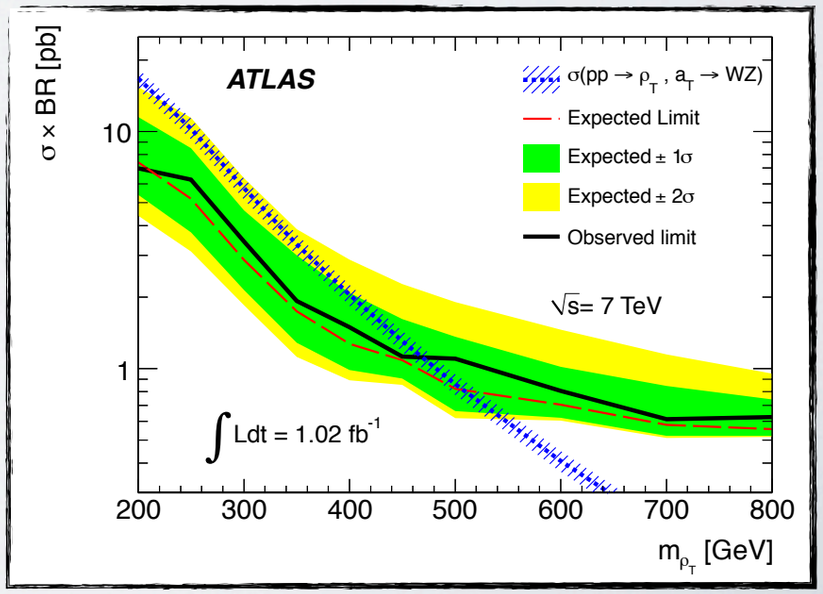
- Predicted by many extensions to the Standard Model
  - Leptophobic EGM W′, Low Scale Technicolor (LSTC)
- Decay chain considered: X → WZ → l E_T^{Miss} l′ l′
- No excess beyond the SM (main background WZ production) arXiv:1204.1648







SSM W′



Techni-rho

95 % CL limits @

$m_{W'}$ > 760 GeV

	Excluded ρ_T mass [GeV]	
	$m_{a_T} = 1.1 m_{\rho_T}$	$m_{a_T} \gg m_{\rho_T}$
$A \times \epsilon$ from W' sample	483 (553)	469 (507)
$A \times \epsilon$ from ρ_T sample	467 (506)	456 (482)

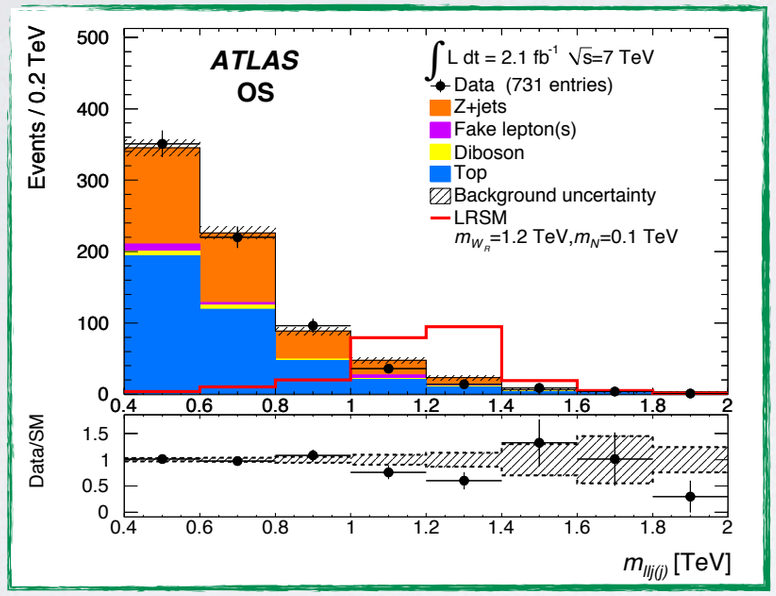
Search for Heavy Neutrinos and W_R

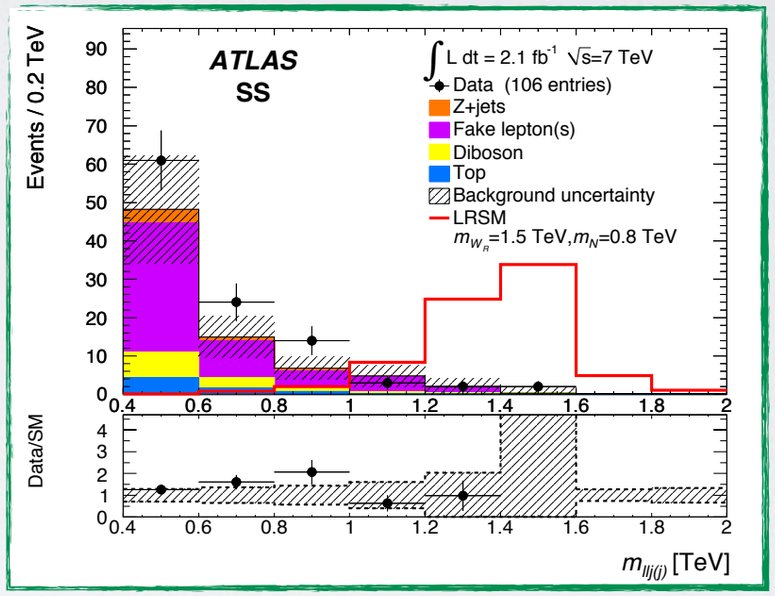
- Additional gauge bosons (W_R) predicted by Left-Right Symmetric Models
- Possible chain $W_R \rightarrow \ell_1 N \ell \rightarrow \ell_1 \ell_2 W_R^* \rightarrow \ell_1 \ell_2 jj$

arXiv:1203.5420

- Search for both Dirac and Majorana type heavy neutrinos (N)

Opposite Sign Region





Same Sign Region

SS

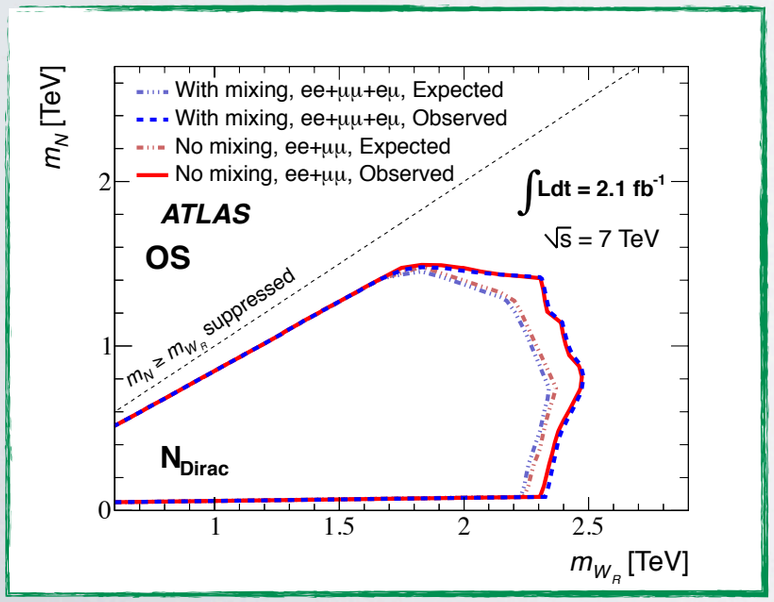
Powerful in case of Majorana N

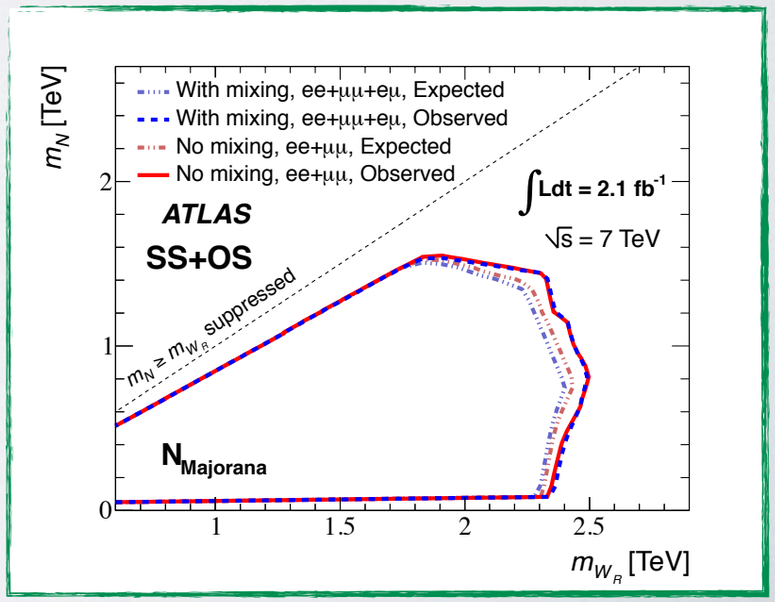
Major background is fakes

OS

Used to search for Dirac N

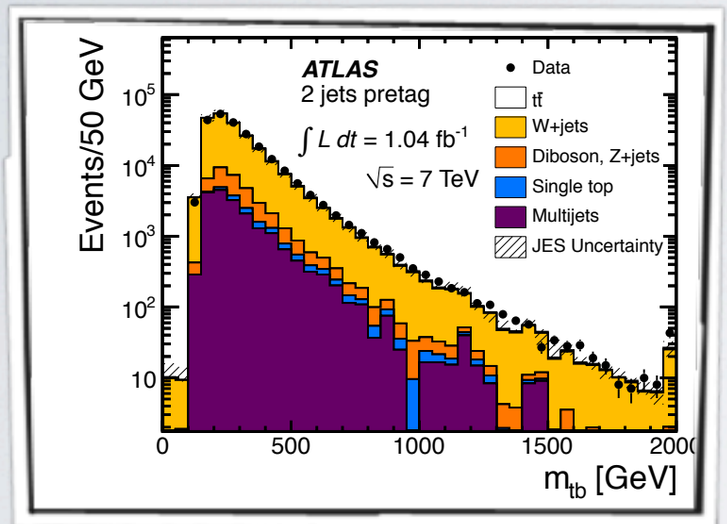
Main background is Z+jets



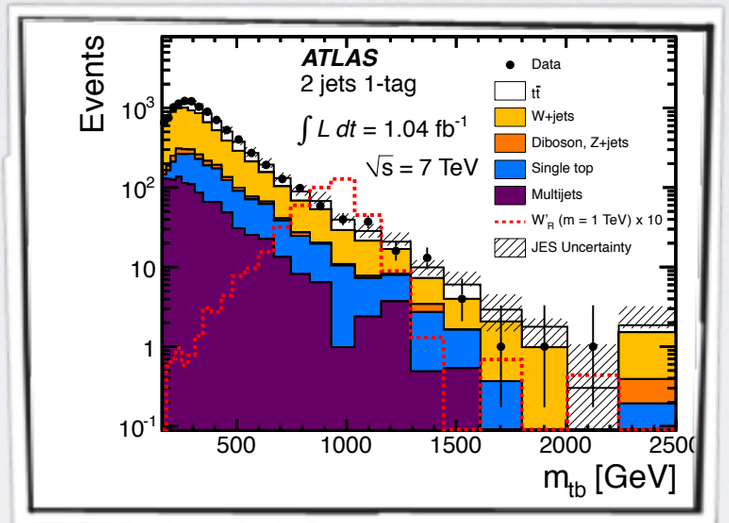


Search for tb Resonances

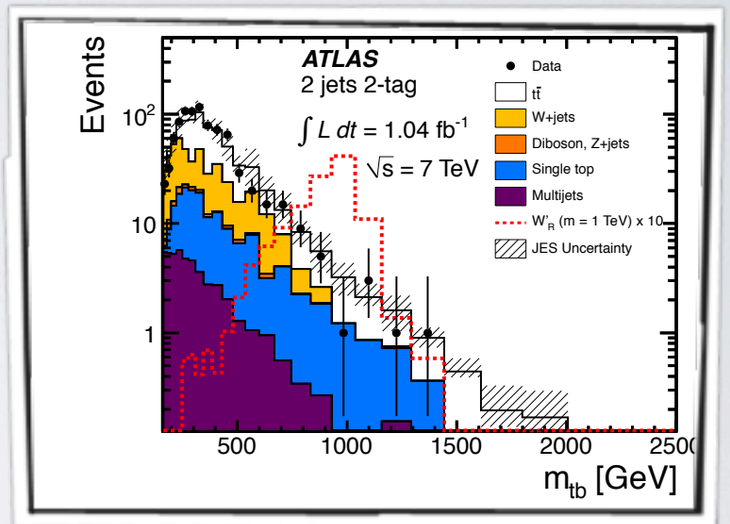
- Benchmark model right-handed W_R' w/ SM couplings
- Signature is 1 lepton (e/μ) w/ large E_T^{Miss} and 2 jets (1/2 b-tag) arXiv:1205.1016
- Can fully reconstruct invariant mass of tb system

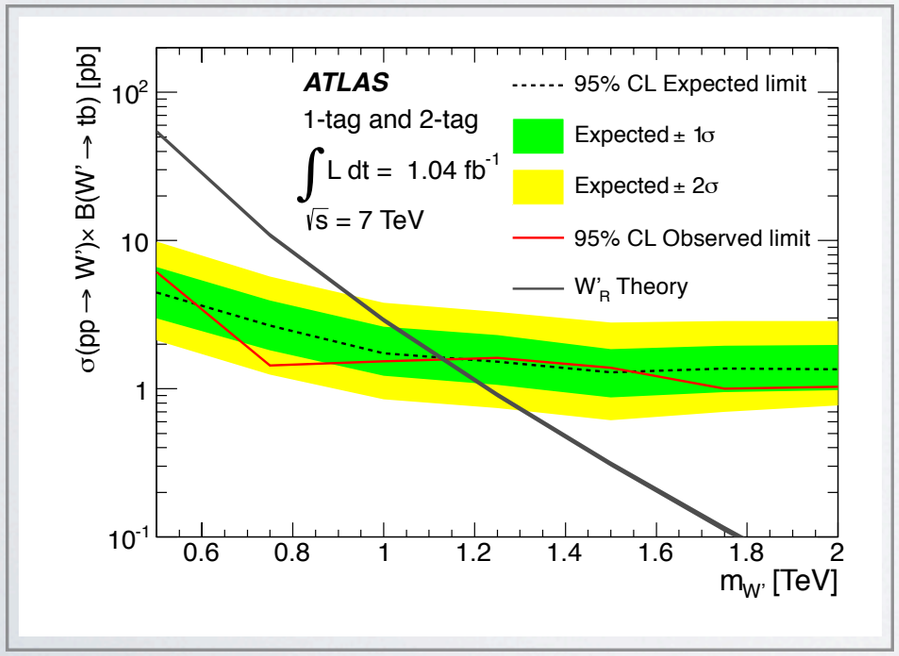


1-tag



2-tag



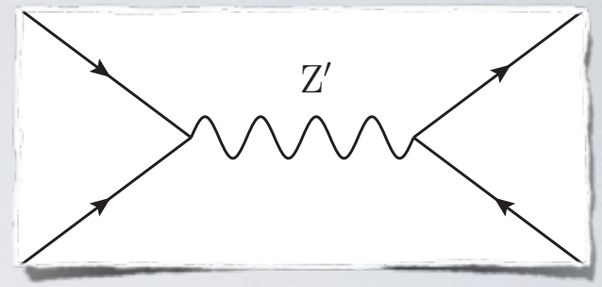


- No excess beyond the Standard Model
- Set limits on $\sigma(pp \rightarrow W') \times BR(W' \rightarrow tb)$

95 % CL limit @ $m_{W'}$ > 1.13 TeV

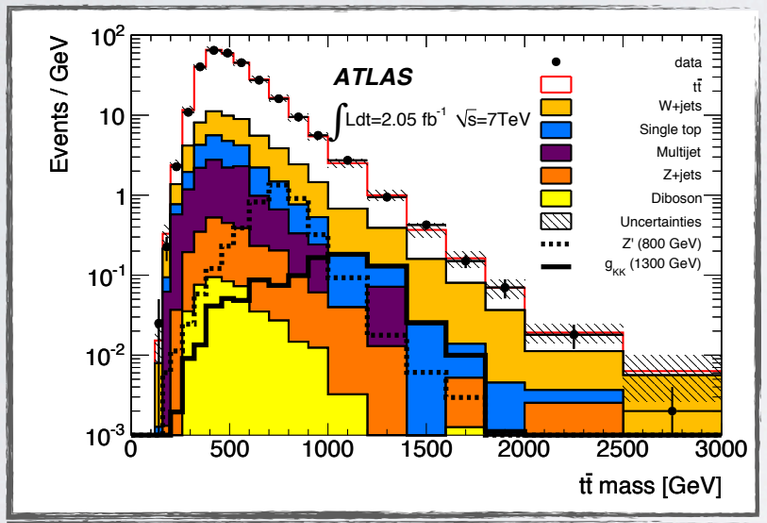
Search for $t\bar{t}$ Resonances

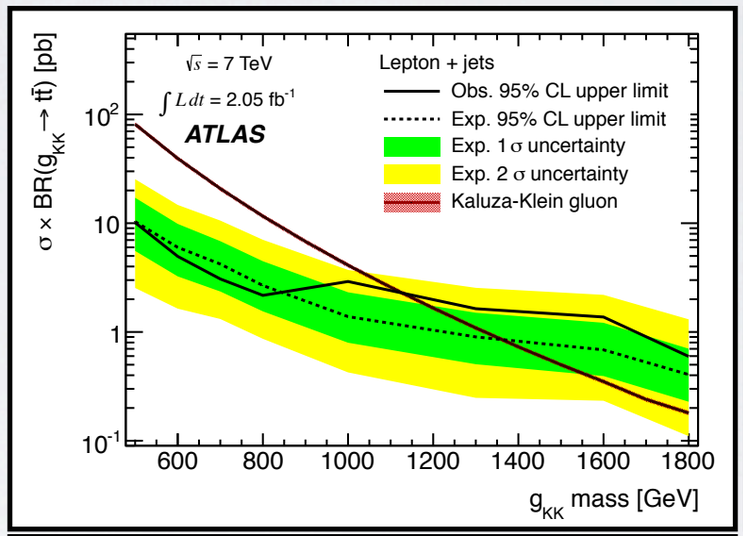
- Sufficiently heavy leptophobic Z′
- Kaluza-Klein gluon excitation in Randall-Sundrum Model
- Search is performed in final states with >=1 lepton (e/μ)
- Main background is irreducible SM top-pair production

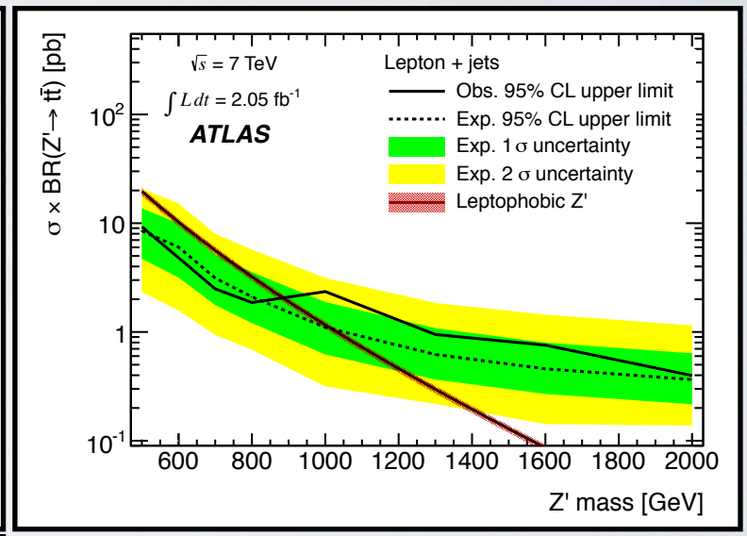


arXiv:1205.5371

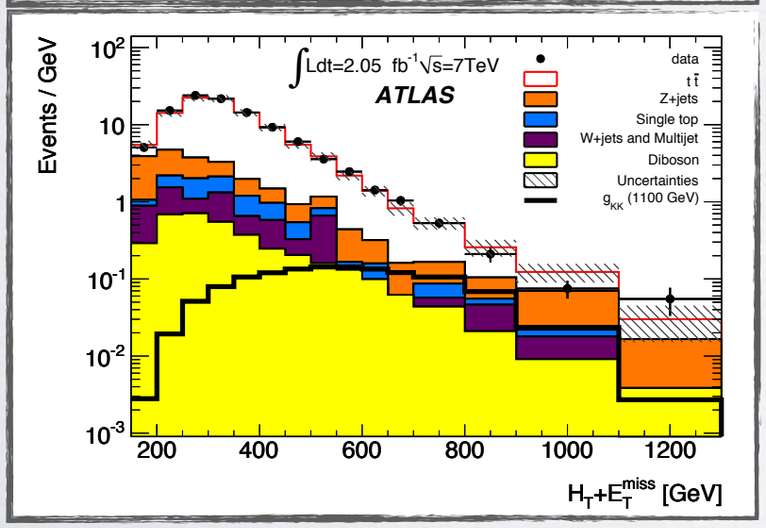
l+jets

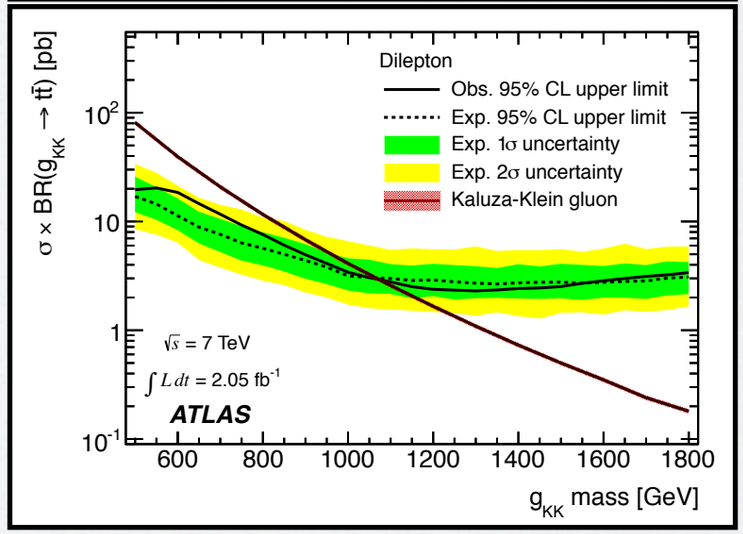






di-lepton



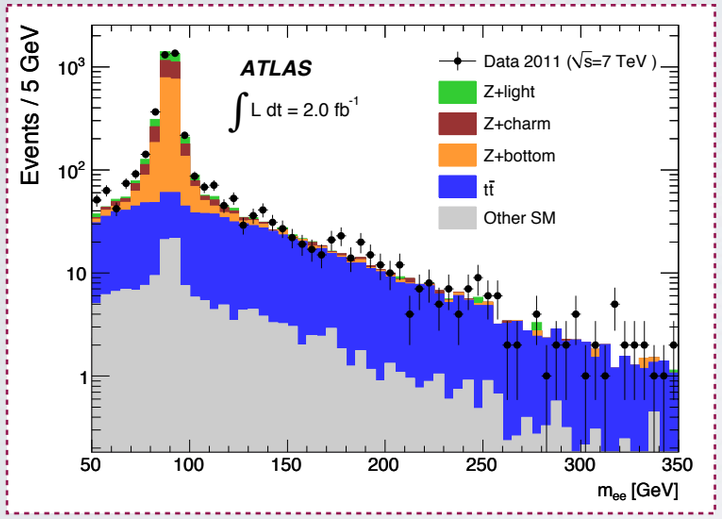


95 % CL limits @
$m_{Z'}$ > 880 GeV &
m_{gkk} > 1130 GeV

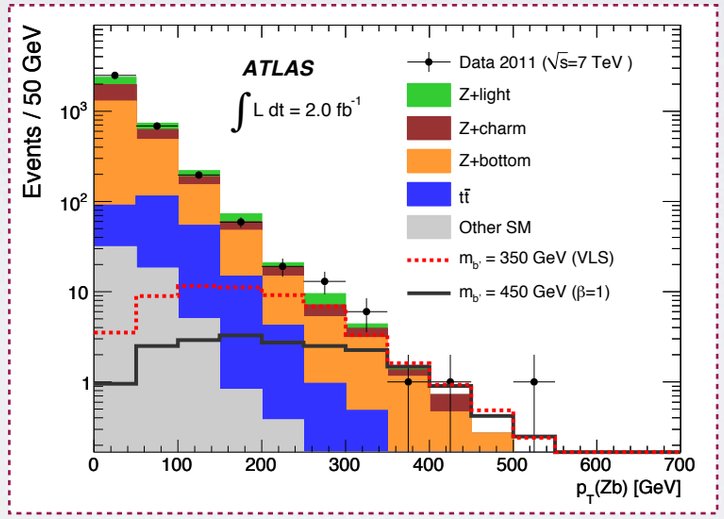
Search for $b'\bar{b}'$ Pair Production

- Search for extra quarks beyond the third generation
- Request at least 1 b′ to decay into a Z (ee) and a b-quark
- Main backgrounds are Z+jets and top pair-production

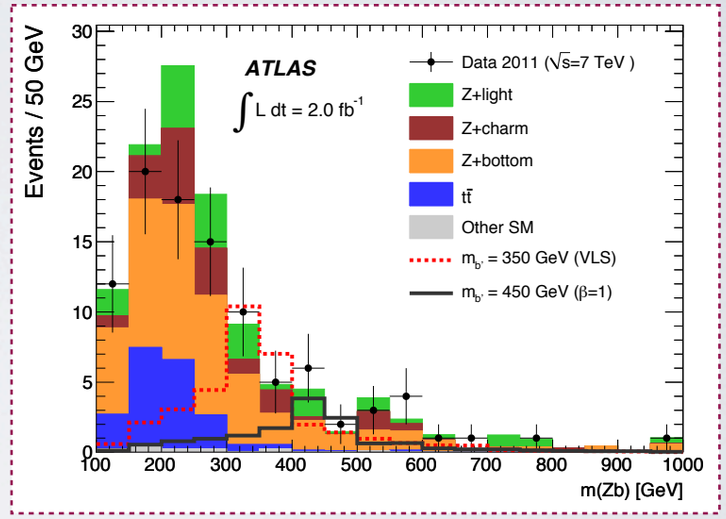
arXiv:1204.1265



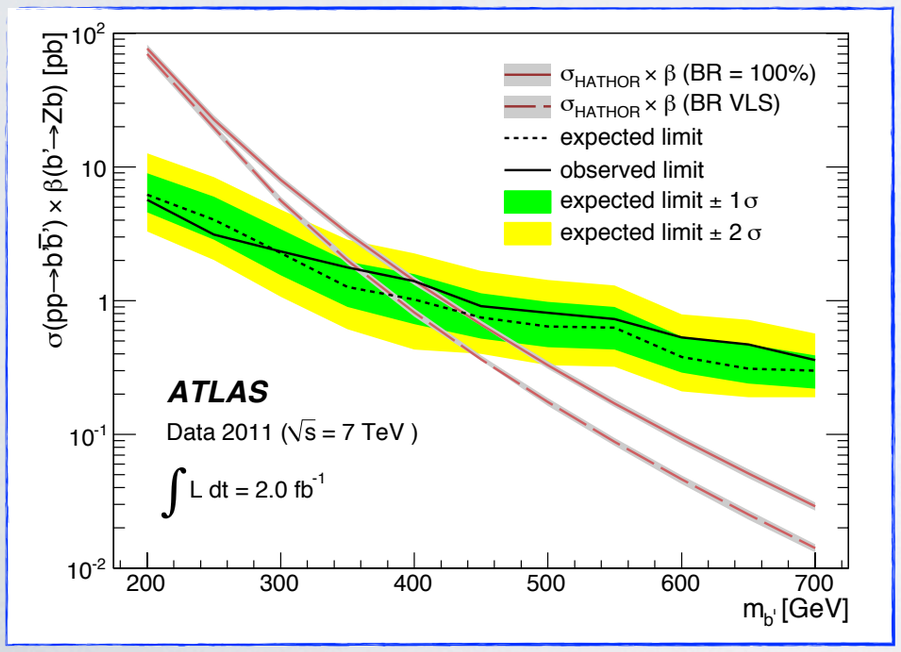
Events w/ Z+=>1 b-jet



Select events w/ $p_T(Zb) > 150$ GeV



Search for excess in m(Zb)



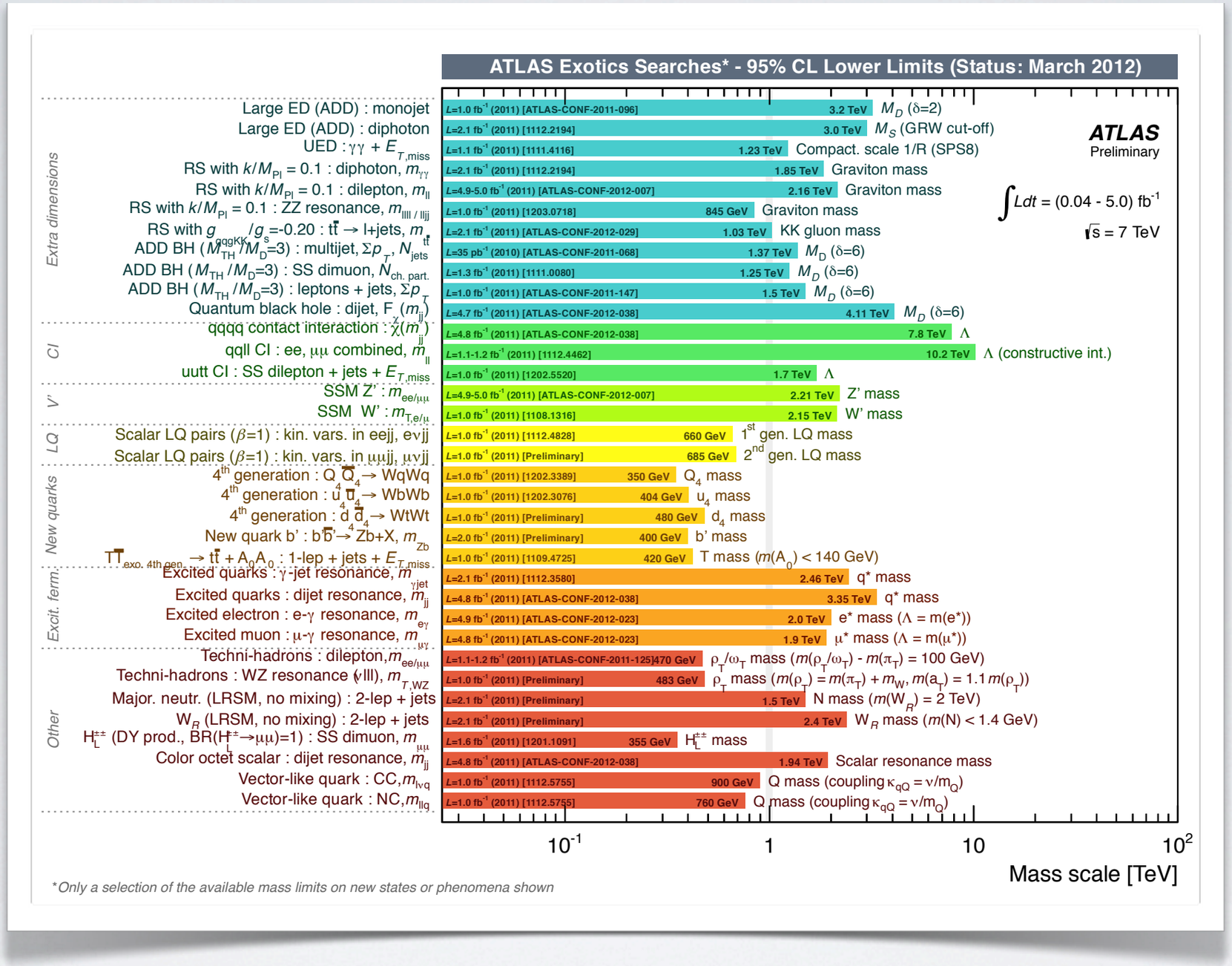
- Set two limits:
  1. BR(b′→ Zb) = 1
  2. BR(b′→ Zb) as a function of m(b′) : Vector-Like Singlet (VLS) mixing

95 % CL limits:

1. $m_{b'} > 400$ GeV

2. $m_{b'} > 358$ GeV

Search for BSM Physics at ATLAS



- A complete list of all BSM results can be found @ https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ExoticsPublicResults

Summary and Conclusions

- 2011 has been a very successful year both for LHC and ATLAS
- Detector is very well understood and performing remarkably well
- No evidence for New Physics, just yet...
  - Many interesting events such as TeV di-lepton and top-quark pairs...
- Many analysis are already underway with the new 2012 data (> 4 fb^{-1})
  - New challenges - pileup, TeV leptons...

Thank you for your attention...