Exotic Searches in ATLAS

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Introduction

One of the primary aim of the LHC physics program is to search for experimental answers to many open questions in the Standard Model:

- EWSB mechanism, fundamental particle spectrum, real nature of space-time, unification of forces ...

The ability to reconstruct with accuracy physics signals with energies and momenta from few hundreds of MeV to multi-TeV, place ATLAS in a privileged position to fulfill such a goal

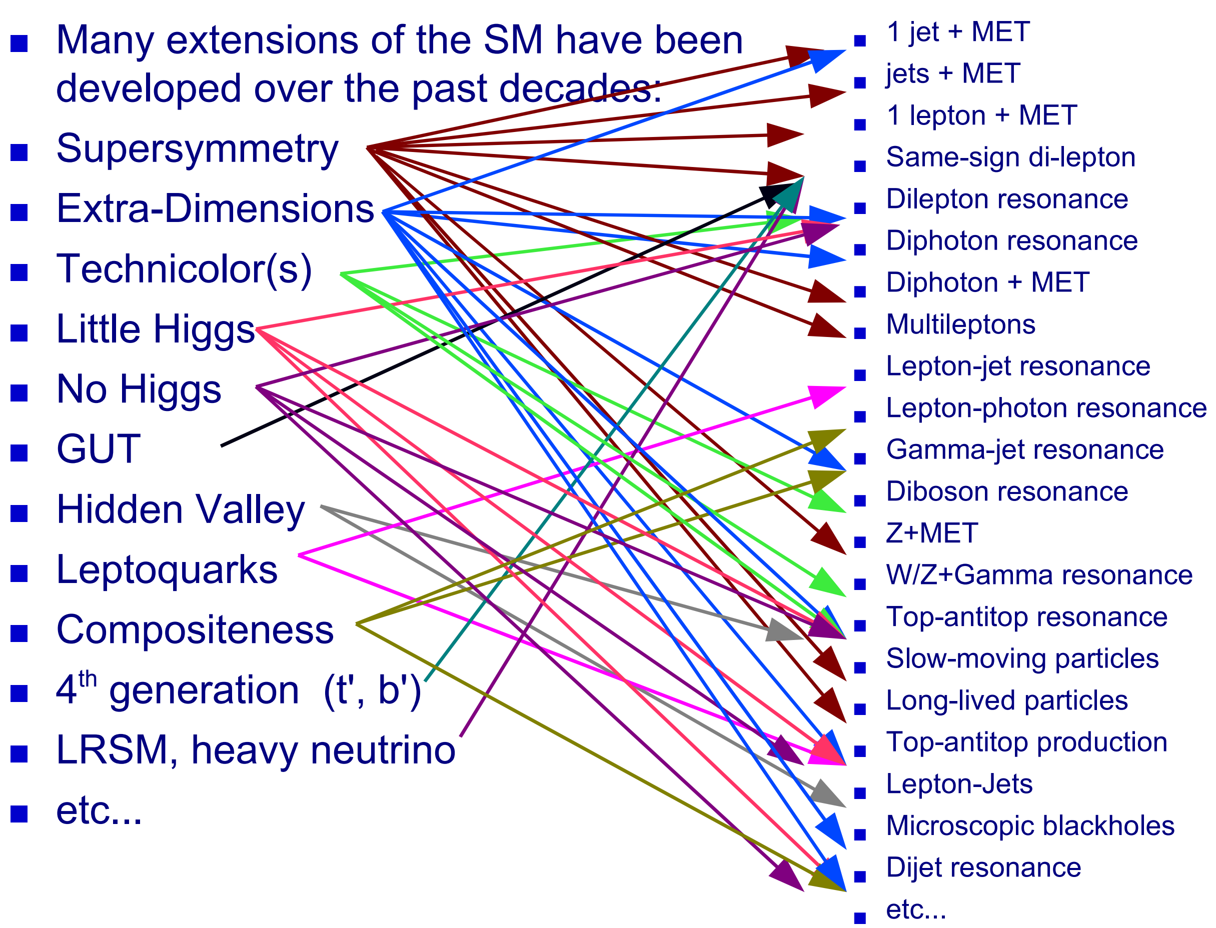
I'll review here the current status of the ATLAS experiment searches for signals from Exotic BSM physics, trying to focus on most recent ones ...

Note: no enough time to cover everything here. A full and daily updated list of all the ATLAS results, with details on each analysis is available here:

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

Topological or Topic-based?

- Same final state probing very different models or topics
- Experimentally a topological signature-based approach is more natural:
  - practical
  - less model dependent
  - allows to cover every possible signature



stolen from Henri Bachacou@LP2011

- A topic-based approach is more convenient in presenting the analysis results:
  - no jumps between different types of physics being addressed
  - easier to combine constraints on models from different signatures
  - in some cases same topology do not imply a simple re-interpretation: different optimizations/analysis strategies

in this talk I'll try to follow a topic-based approach ...

Outline

- The ATLAS experiment

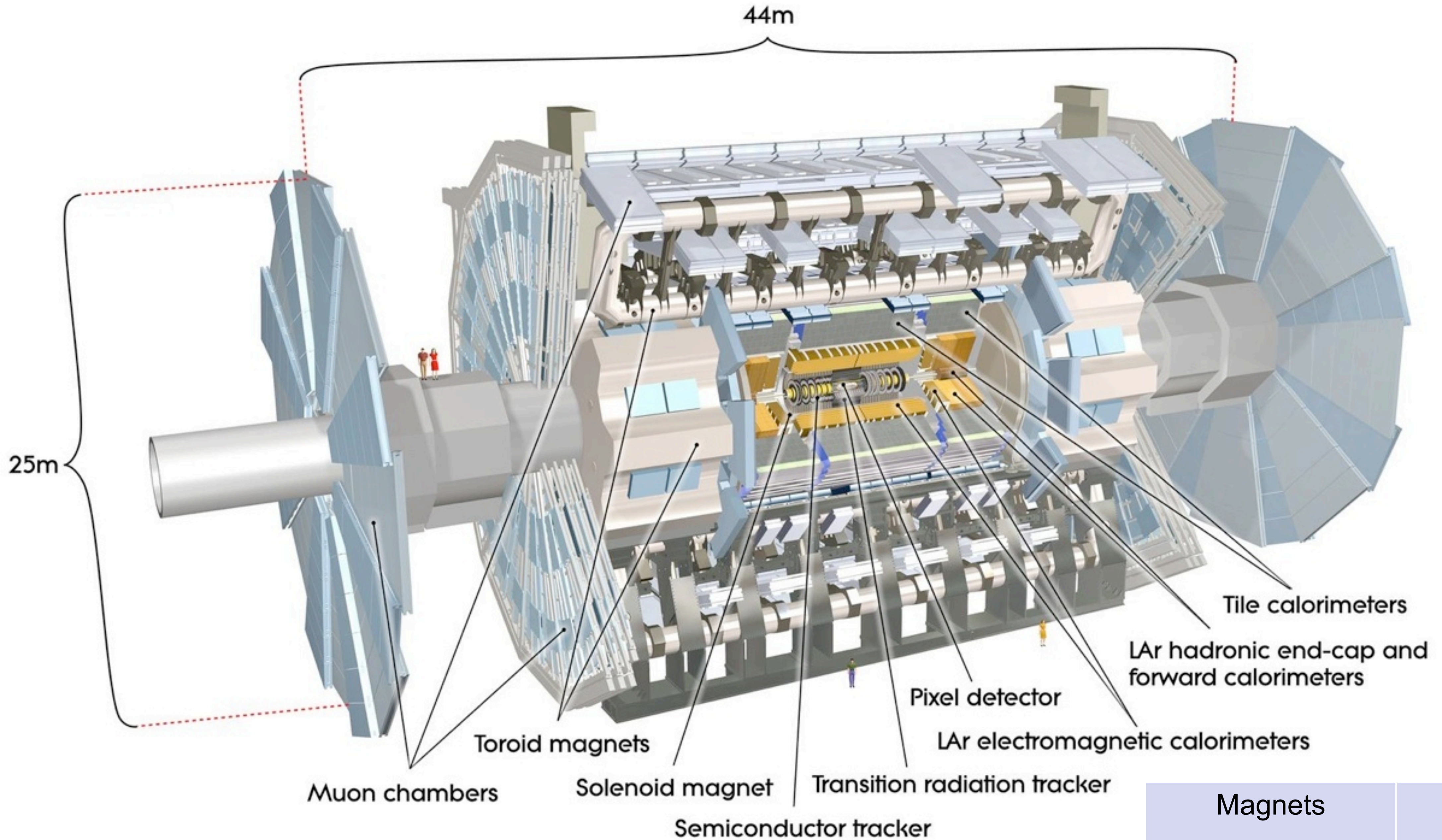
- status and performances

- EXOTIC searches with ATLAS

- Search for new gauge bosons, excited quarks, new color resonances ...
- Doubly charged Higgs
- Extra Dimensions
- Techni-hadrons
- 4th generation fermions
- Lepto-Quarks

- Summary and future perspectives

ATLAS@CERN

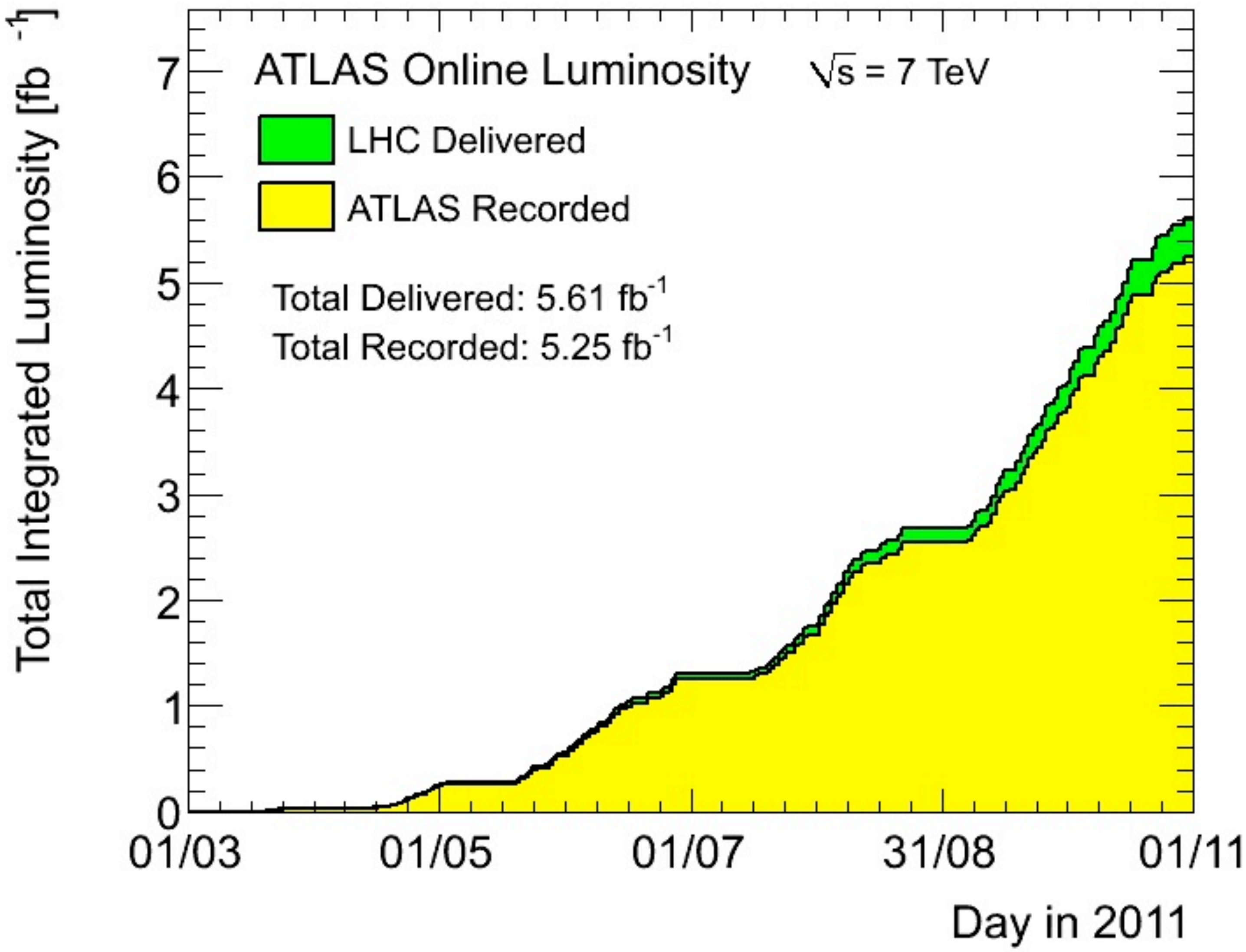


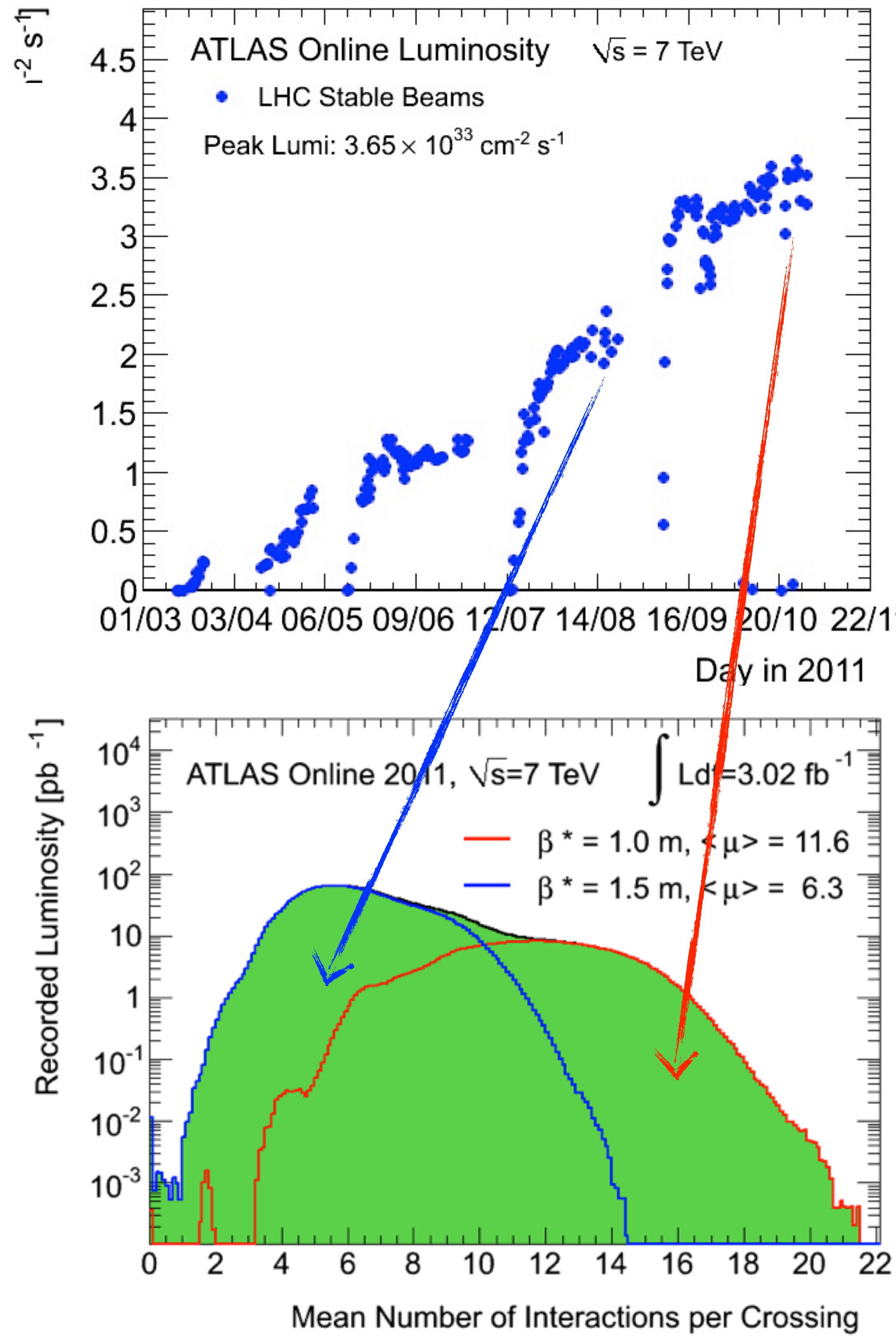
Magnets	2T solenoid 3 air-core toroids
Tracking	silicon + transition radiation tracker
EM Calorimetry	sampling LAr technology
Hadron Calorimetry	plastic scintillator (barrel) LAr technology (endcap)
Muon	independent system with trigger capabilities

- general purpose detector
- design optimized for severe LHC environment

Data sample

2011





2010 / 2011 (today) @ $\sqrt{s}$ = 7 TeV

L ~0.2 / ~3.6 10^{33} $cm^{-2}s^{-1}$

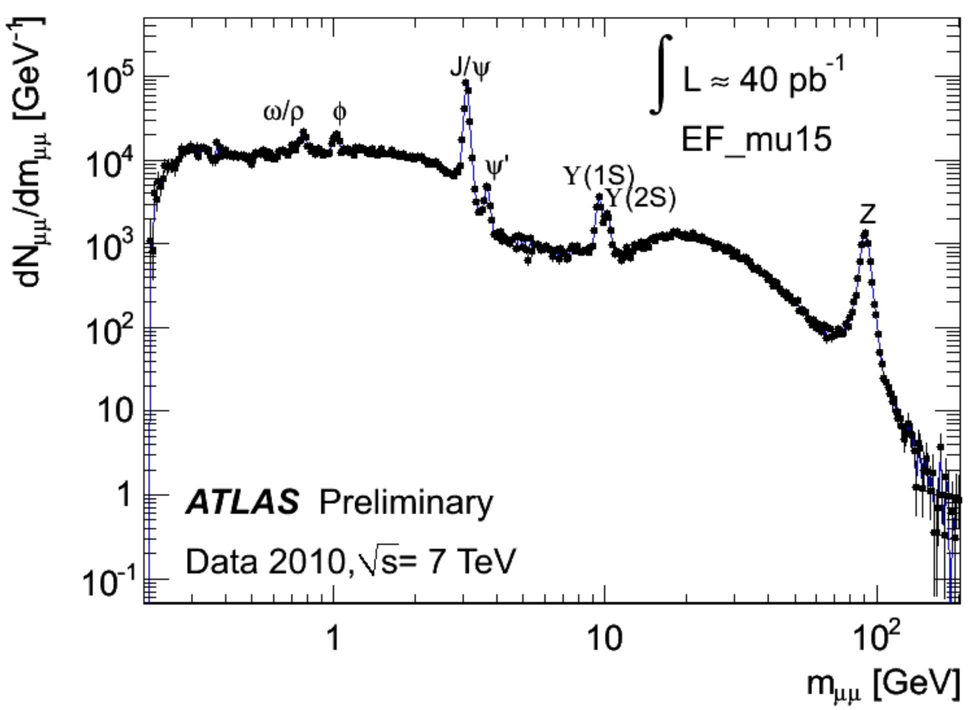
∫Ldt ~0.05 / ~5.3 fb^{-1}

results presented here are based on the first 1-2 fb^{-1} ...

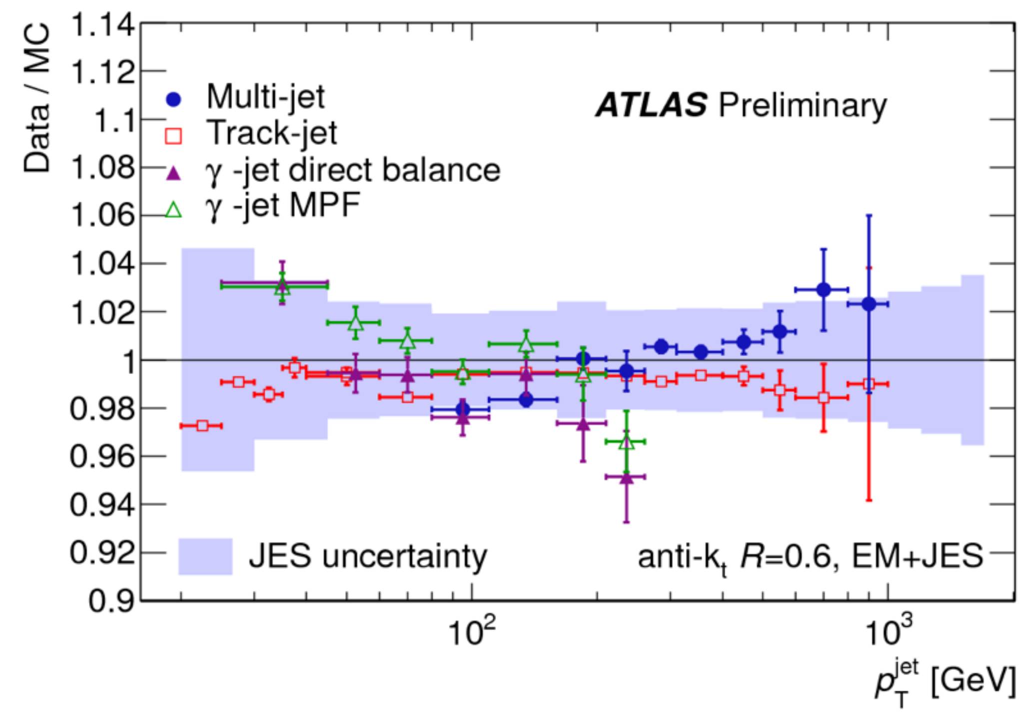
ATLAS Performances: physics objects

ATLAS performances close to or exceeding design specs in all compartments

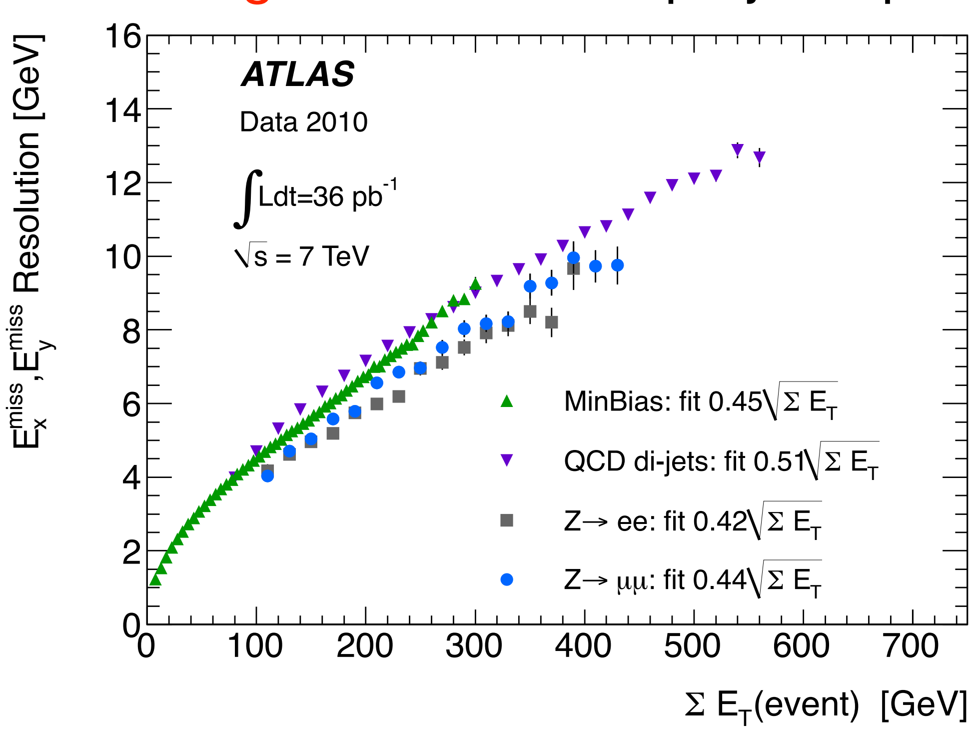
Electrons & Muons: already close to nominal performances



Jets: energy scale uncertainty 2-4% for $p_T > 20$ GeV

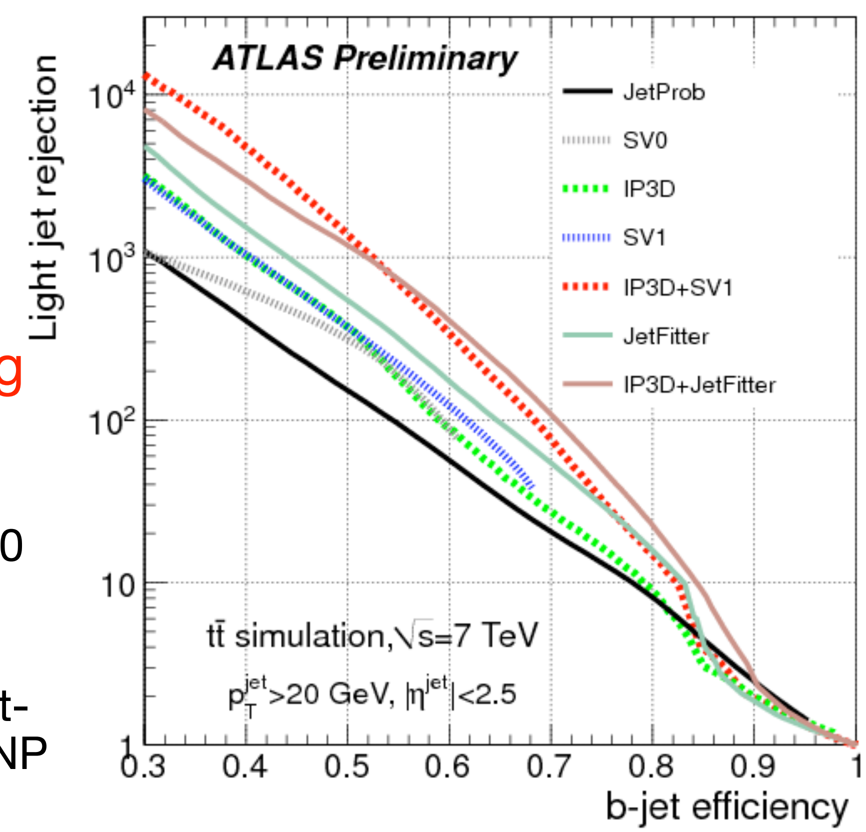


Missing E_T: better than project specs

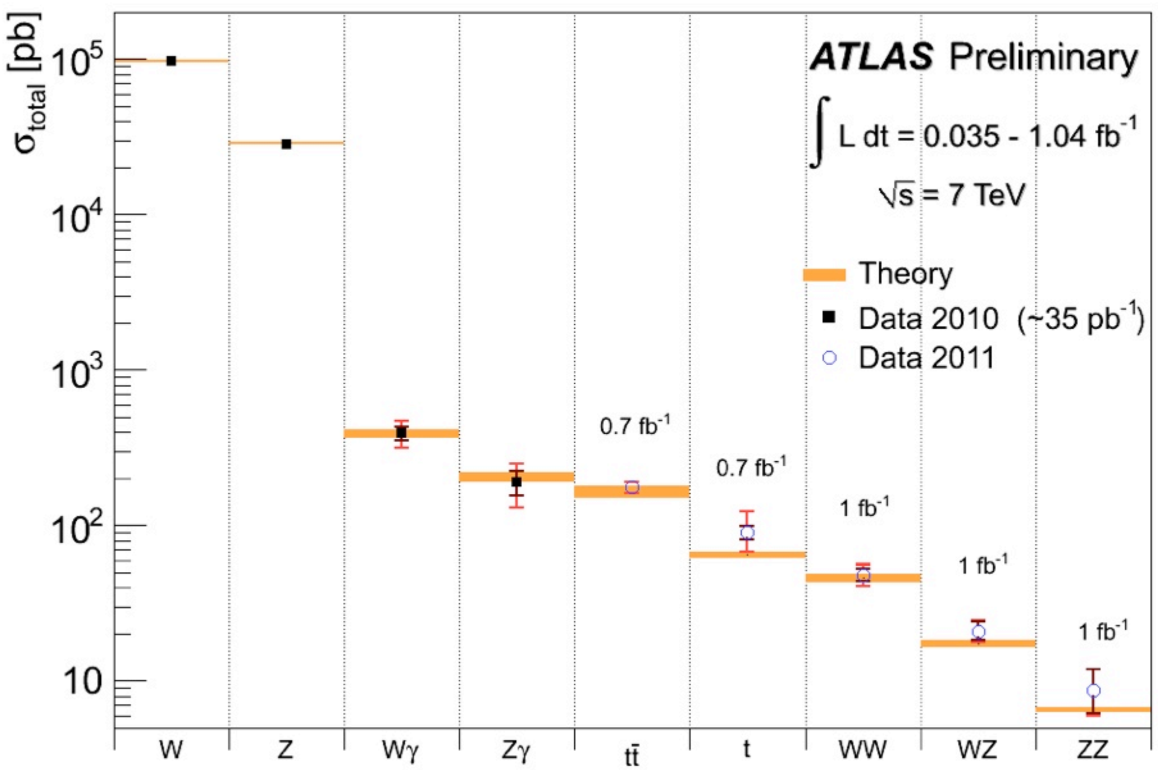


New advanced b-tagging algorithms:

- x 2÷5 mistag rate reduction at same tagging efficiency of 2010 taggers
- can be operated at ≥70% efficiency, with acceptable light-jets rejection → promising for NP



ATLAS Precision Measurements



ATLAS has already managed to measure most of the known SM processes

- very precise measurements with detailed understanding of the systematic uncertainties
- surprisingly good data/MC agreement

ideal conditions to search for new physics effects ...

Precision measurements provide also a probe for BSM by themselves ...

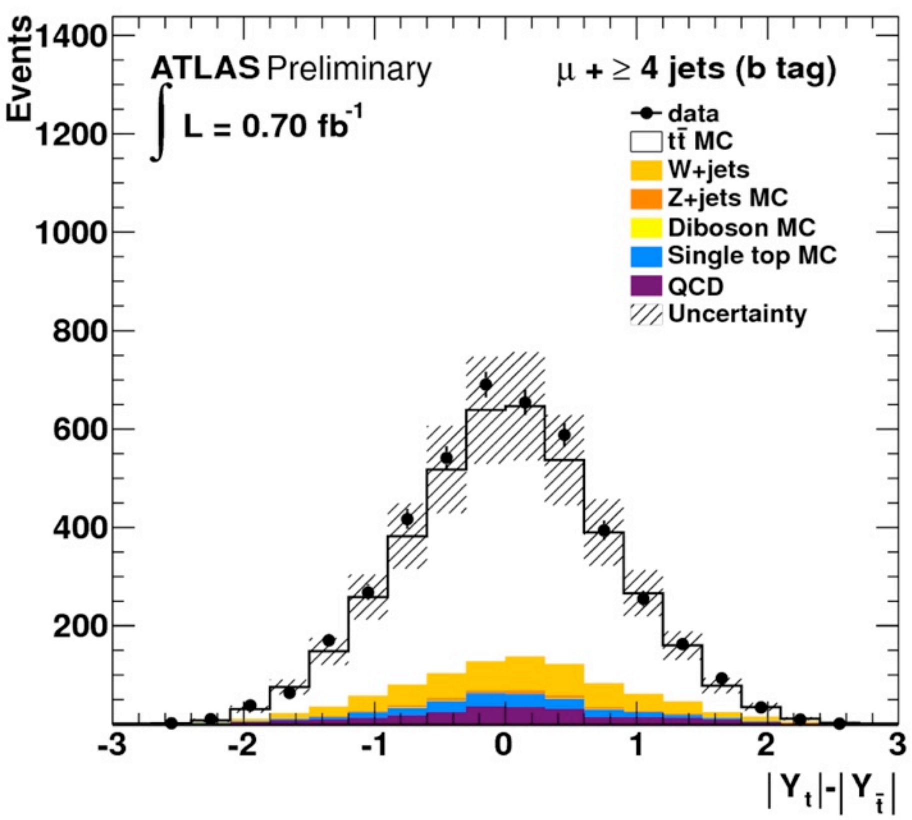
Example: Charge Asymmetry in tt production

$$A_C = \frac{N(\Delta|Y| > 0) - N(\Delta|Y| < 0)}{N(\Delta|Y| > 0) + N(\Delta|Y| < 0)}$$

- tt production in SM symmetric under charge conjugation
- asymmetry may arise in BSM processes, via vector/axial couplings or by interference with the SM

$$A_C = -0.024 \pm 0.016(stat) \pm 0.023(syst)$$

$$\text{SM(MC@NLO)}: A_C = 0.006$$



Δ|Y|

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also studied tt/single top production, tt spin correlations, W polarization in top decays, FCNC: in all cases good agreement with SM expectation found ...

New Gauge Bosons: ll and l+MET channels

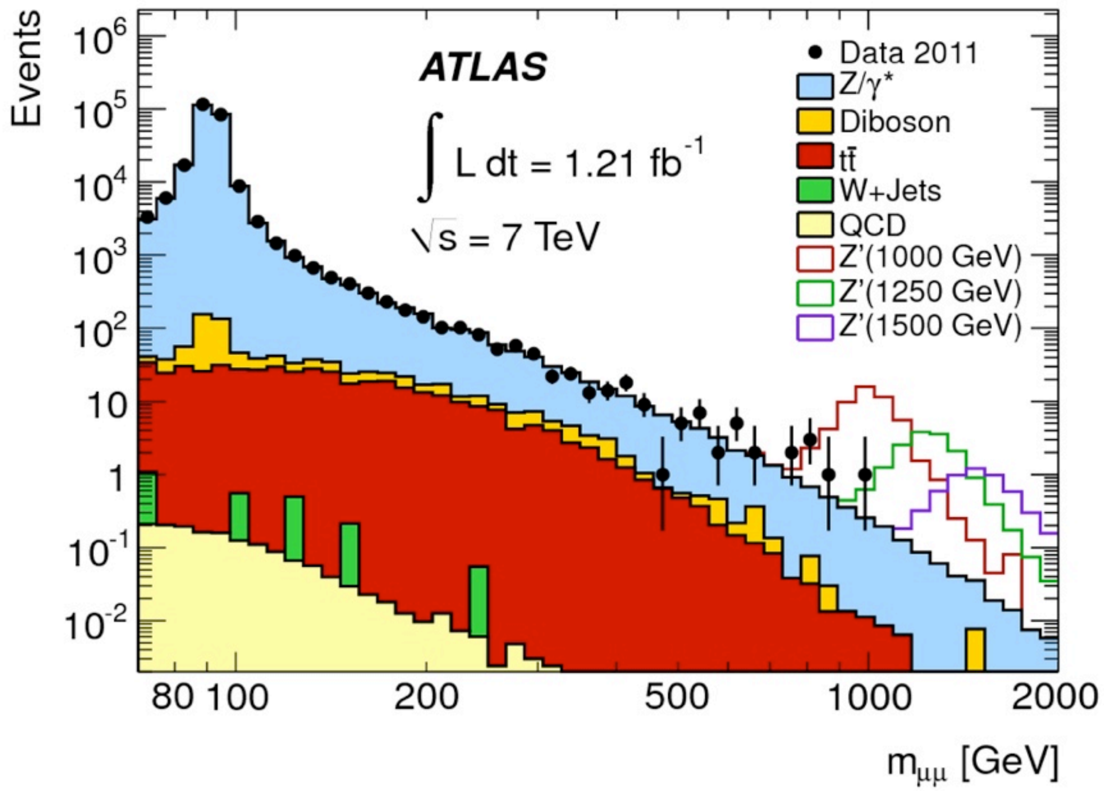
New Gauge Bosons present in the particle spectrum of many extensions of the Standard Model:

- Sequential SM: Z'/W' with same couplings as in SM
- GUT-inspired theories E6, SO(10): heavy gauge bosons
- Randall-Sundrum Kaluza-Klein gravitons, Little/Littlest Higgs heavy gauge bosons, narrow techni-hadrons

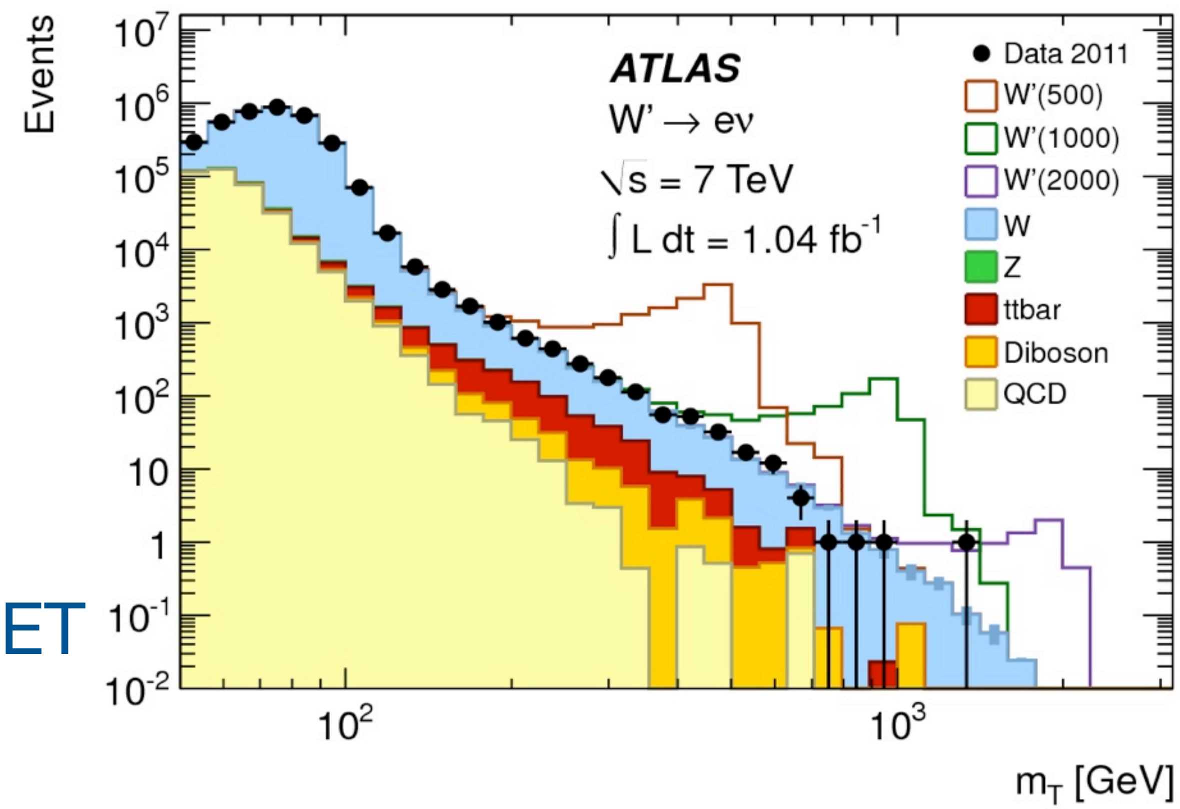
- No precise prediction for mass scale of such resonances
- di-lepton and lepton+MET spectrum: a very clean place to look
- Experimental signature: bumps or Jacobian peaks in the invariant mass distributions

arXiv:1108.1316 - arXiv:1108.1582

ll



l+MET



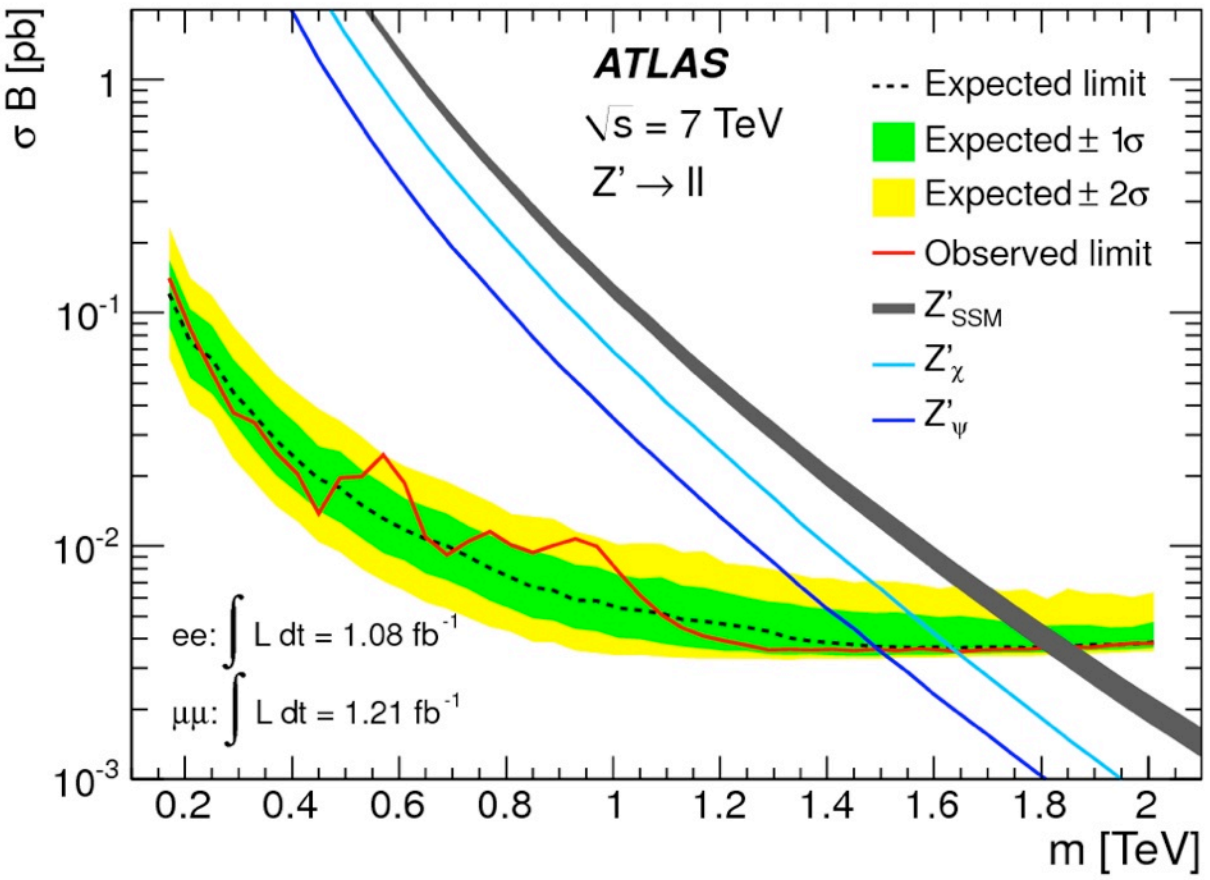
$$m_T = \sqrt{2p_T^l E_T^{miss}(1-\cos\phi_{l\nu})}$$

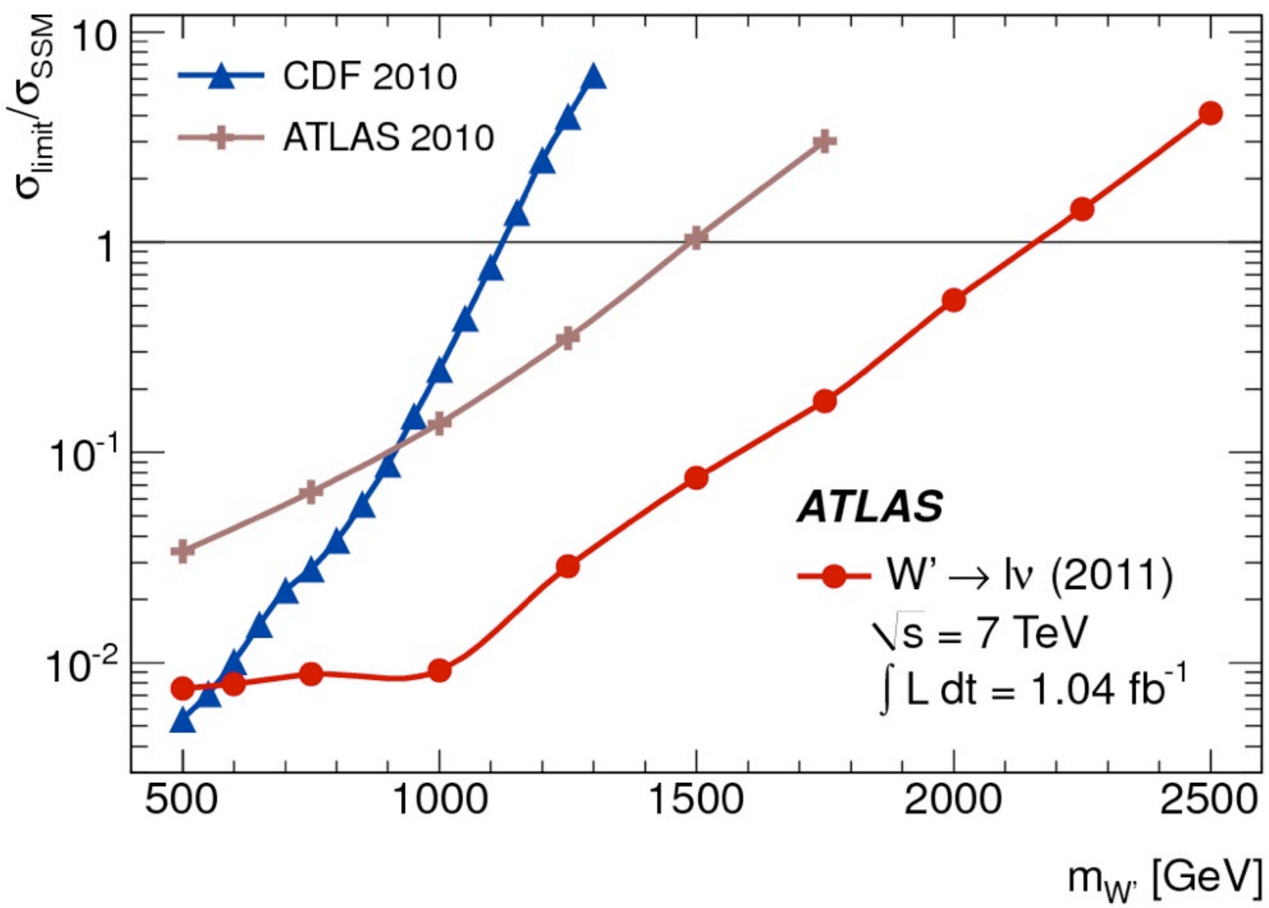
- Experimental challenges:
  - detector resolution and efficiency at very high momentum (with almost no control samples)
- Backgrounds:
  - tails of SM processes

no significative deviations observed from SM expectations ...

New Gauge Bosons: ll and l+MET channels

Mass Limits





arXiv:1108.1316 - arXiv:1108.1582

95% CL Limits	Excluded Mass
SSM Z′	1.83 TeV
E6 Z′χ	1.64
E6 Z′ψ	1.49

$M_{W'} > 2.15\ \mathrm{TeV}/c^2$@95% CL

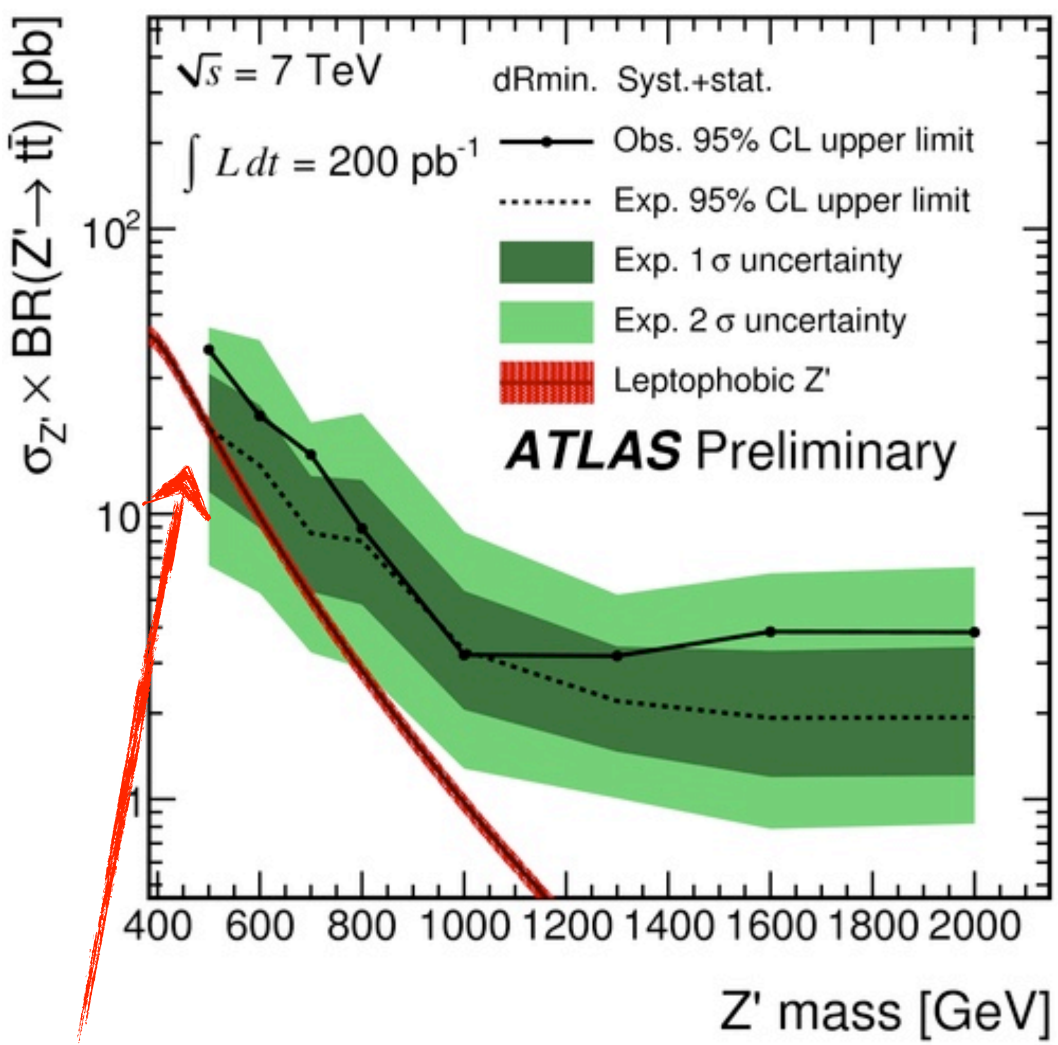
Z′as $t\bar{t}$ resonance

Search for narrow ttbar resonances in the leptons+jets sample

- Sensitive to effects from new strong dynamics: Technicolor, Topcolor, ...
- Benchmark models:
  - Leptophobic model IV Topcolor: extra Z' boson with O(TeV) mass with coupling only to quarks (width = 1.2% M(Z'))
  - Kaluza-Klein gluon resonance in Randal-Sundrum models

ATLAS-CONF-2011-087 - ATLAS-CONF-2011-123

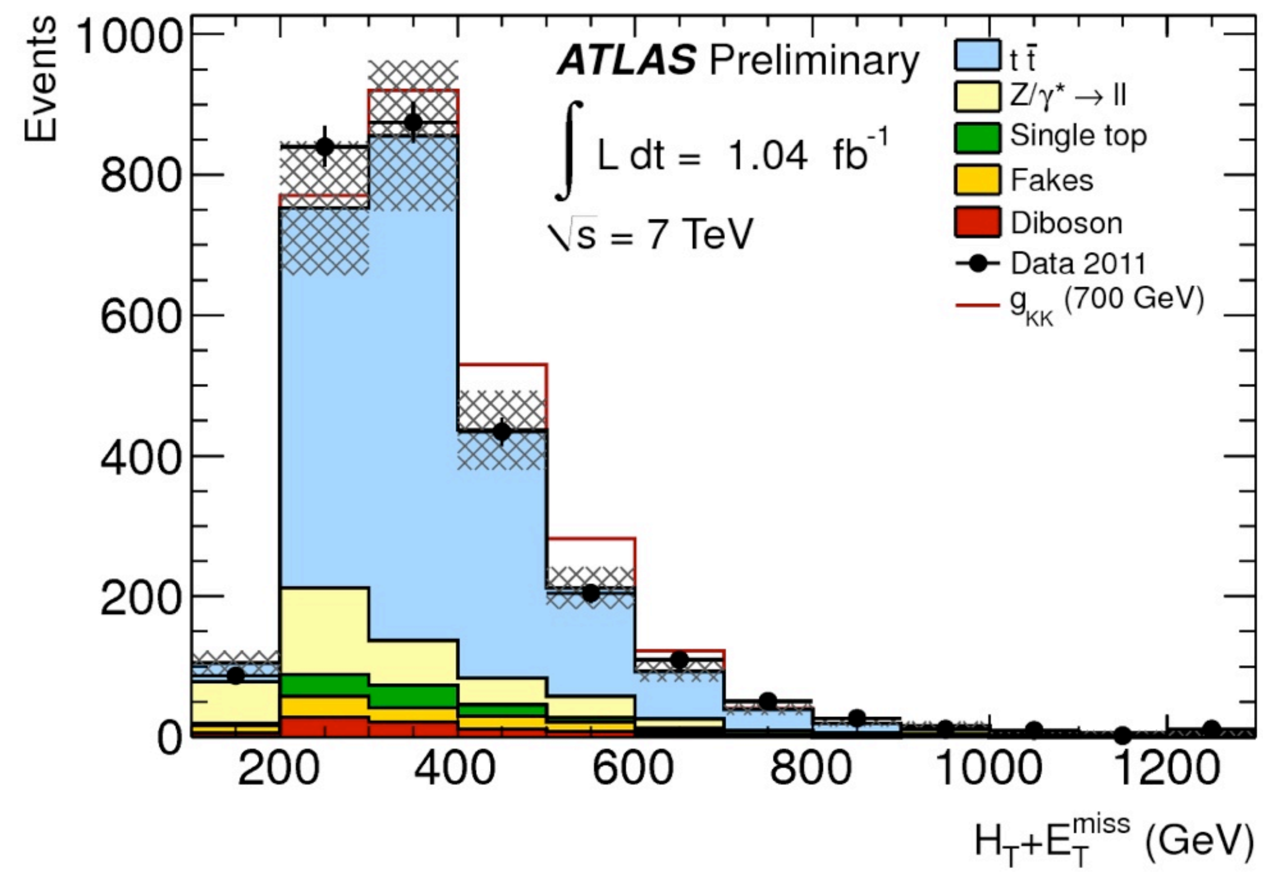
- search for Z'→tt in l+jets: 1 hadronic, 1 leptonic top
- use m_{tt} as discriminating observable



Expected exclusion: ~500 GeV

stat. fluctuation in low-mass region → no observed exclusion

- search in the dilepton channel: 2 leptonic top
- use H_T+MET as discriminating observable



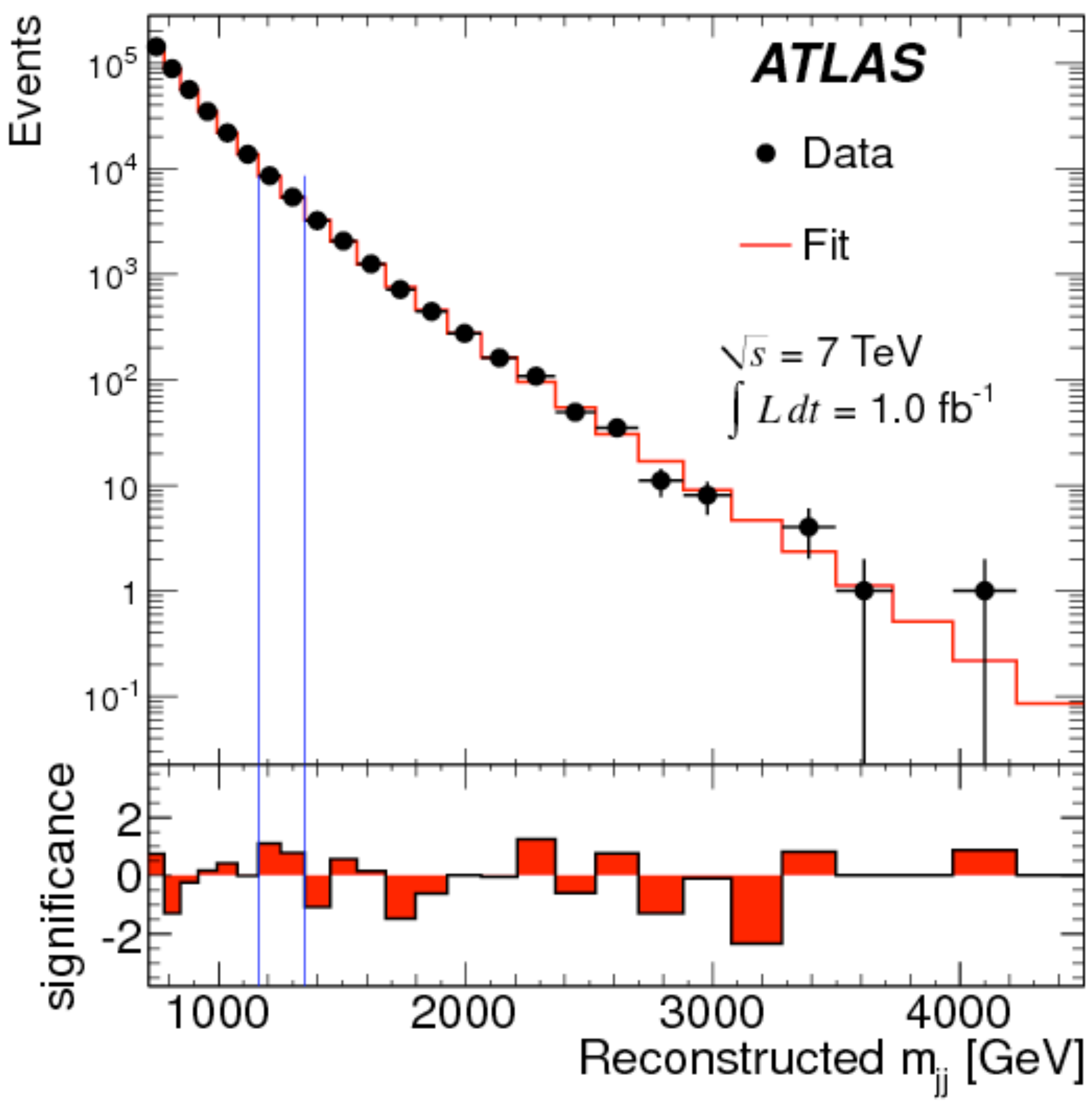
	Mass Limit (TeV)	
$g_{qqg_{KK}}/g_s$	Expected	Observed
-0.20	0.80	0.84
-0.25	0.88	0.88
-0.30	0.95	0.92
-0.35	1.02	0.96

Excited quarks/Axigluons/new Colour Resonances

Check the di-jet invariant mass distribution against expectations from QCD

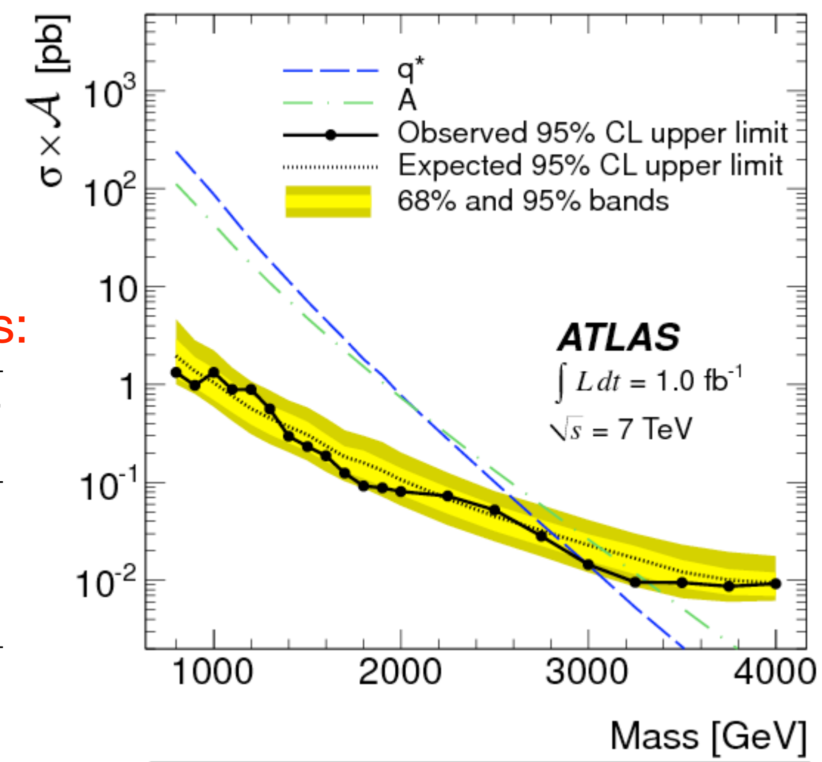
- resonances predicted in numerous models (excited quarks, strong gravity, contact interactions ...)
- probed jets with transverse momenta up to multi-TeV
- search for “bumps” in m_{jj}, describing QCD shape via a smooth functional form

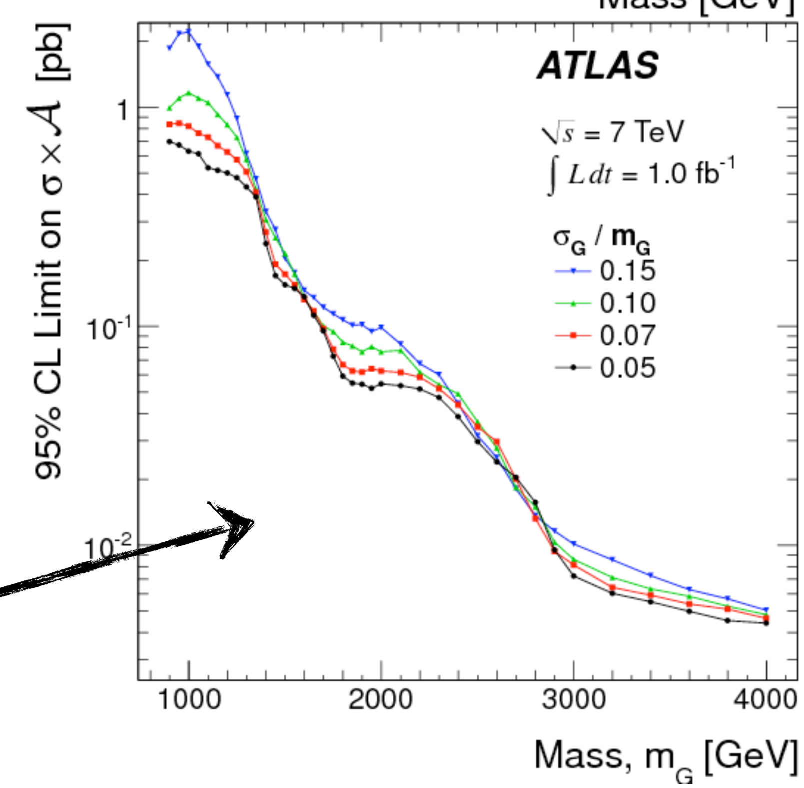
arXiv:1008.6311 - arXiv:1103.3864 (NJP 13(2011)053044)



Resonant new physics limits:

Model	95% CL Limit [TeV]
Excited quark	2.99
Axigluon	3.32
Colour Octet Scalar	2.99





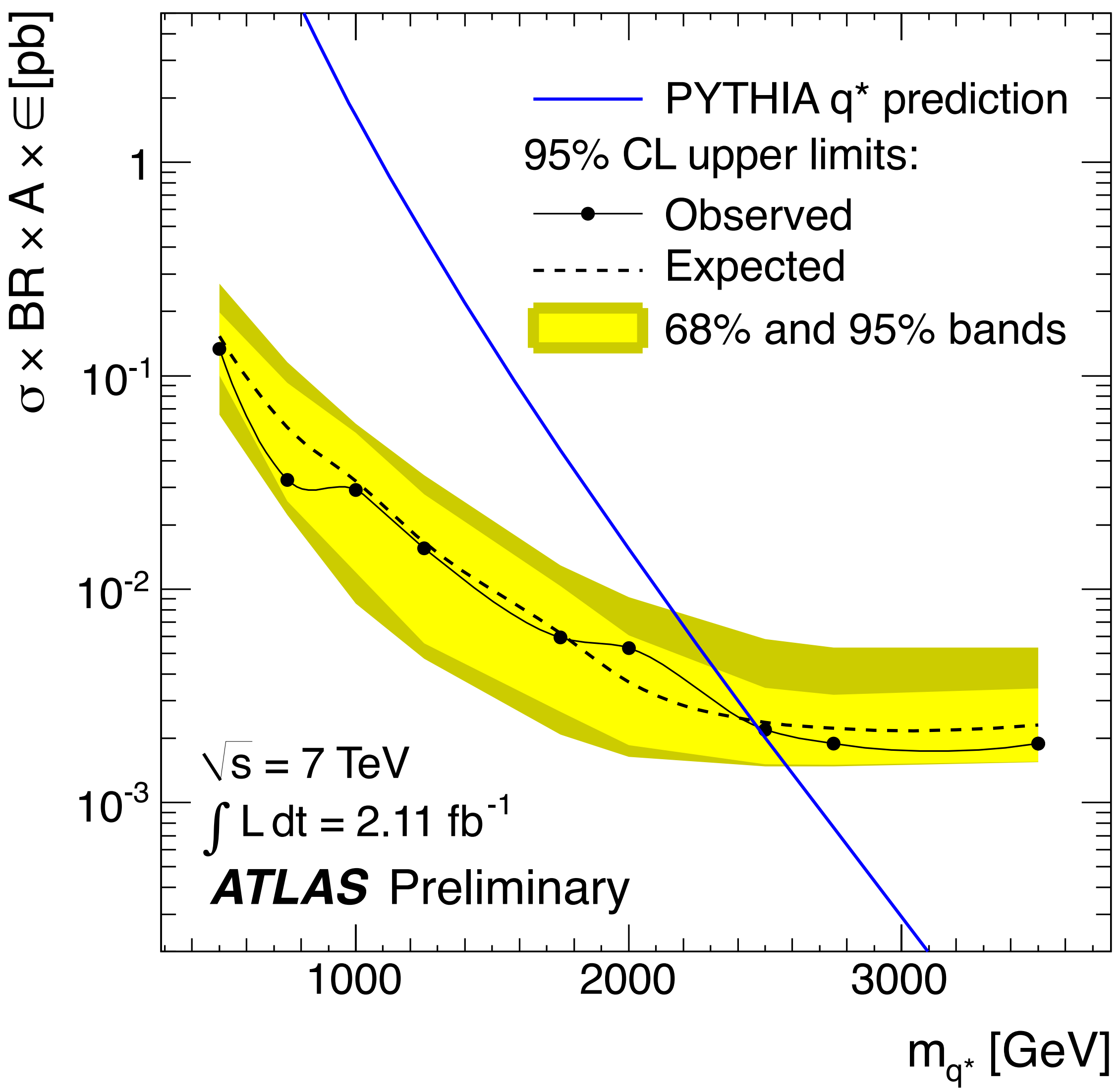
Also provides model-independent limits

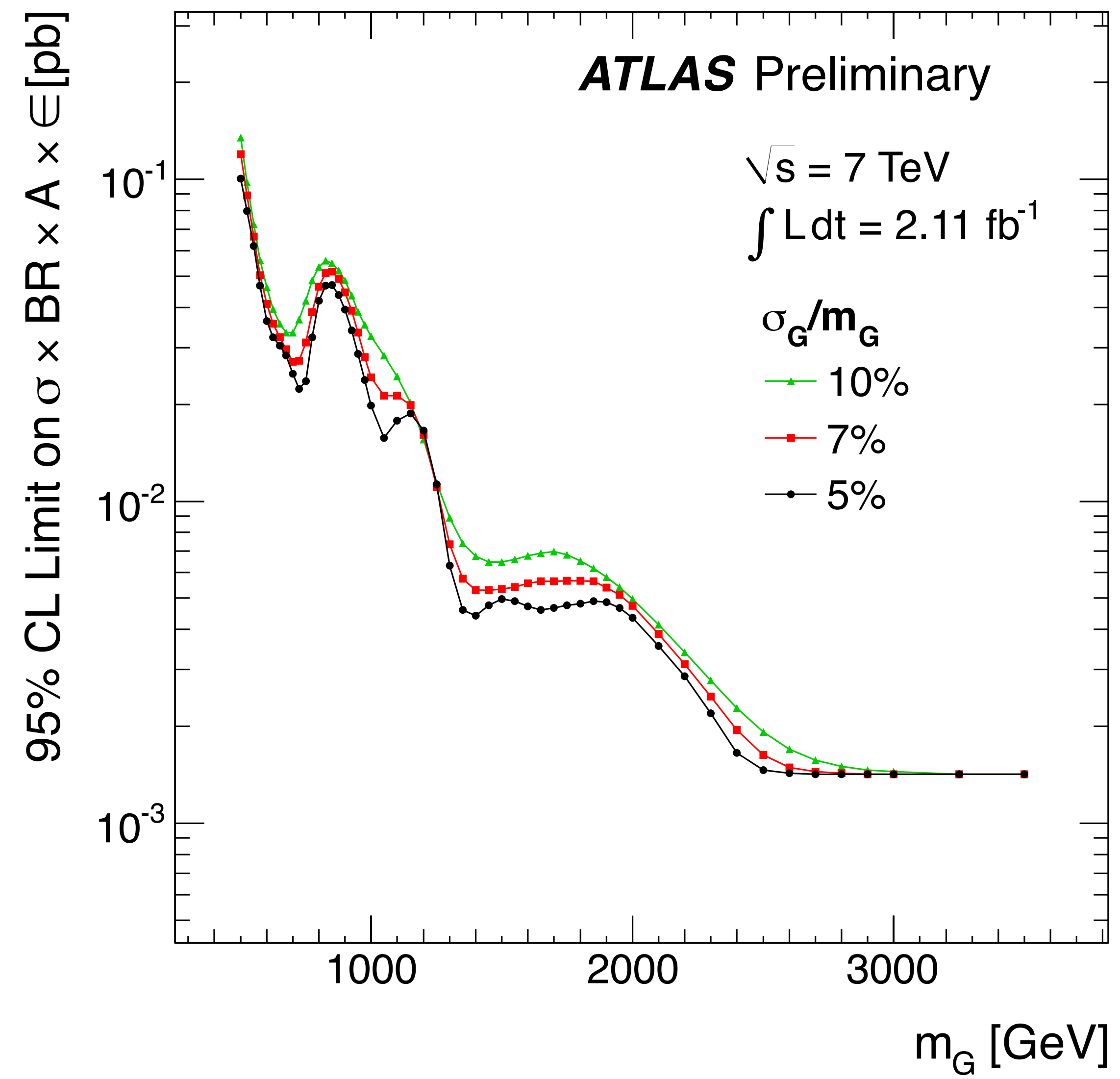
- assuming m_{jj} gaussian distributed
- mean $m_G \in [0.9,4]$ TeV/c^2, $\sigma_G/m_G \in [5\%,15\%]$

also search in the γ+Jet sample

Resonant production of X → γ+Jet

- Complementary with di-jet, di-γ searches
- Benchmark model: $q^* \to q\gamma$: BR~2%, much lower than $q^* \to qg$~85% but with lower background
- Similar strategy as di-jet: search for "bumps" in $m_{\gamma j}$, describing BG shape via a smooth functional form





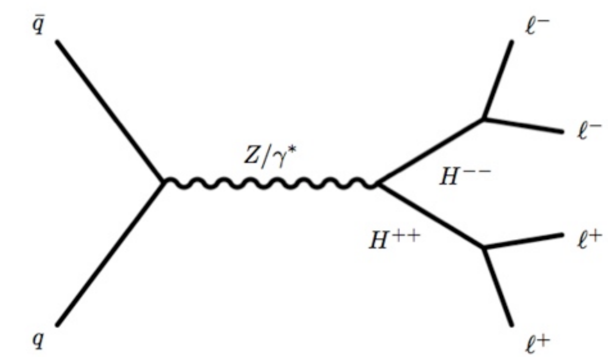
$M_{q^*} > 2.46$ TeV/c^2 @ 95% CL

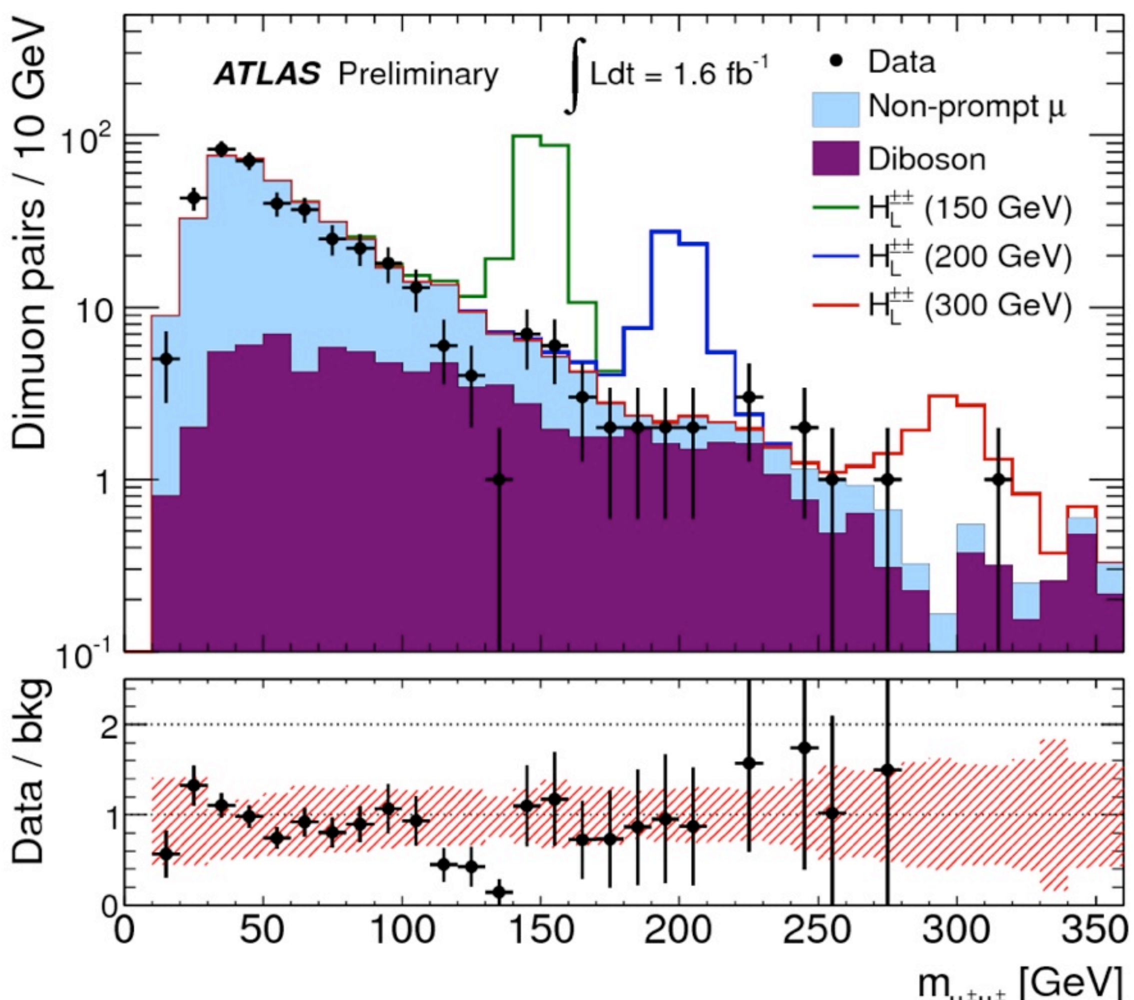
Just Released

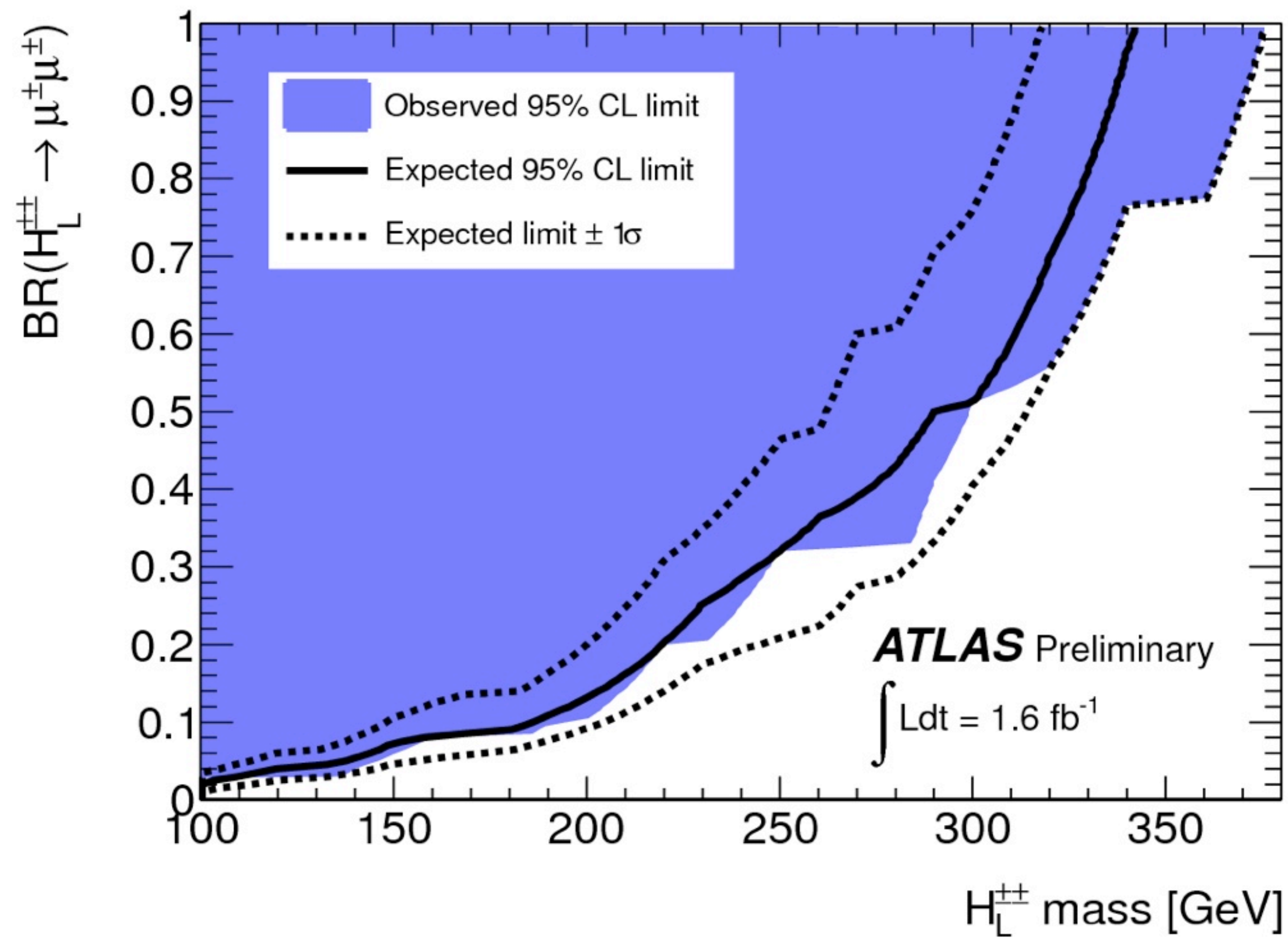
Doubly-charged Higgs: SS di-leptons

Doubly-charged Higgs particles present in many NP scenarios: L-R symmetric models, Little Higgs, Higgs triplets models ...

- dominant production: pair production
- search for signals in the same-sign di-muon invariant mass spectrum
- clean signature: SS leptons production in SM very rare, main background from non prompt b/c semi-leptonic leptonic decays and K/π decay in flight
- BG estimated via data-driven methods







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assuming 100% BR(μμ), and Drell-Yan production

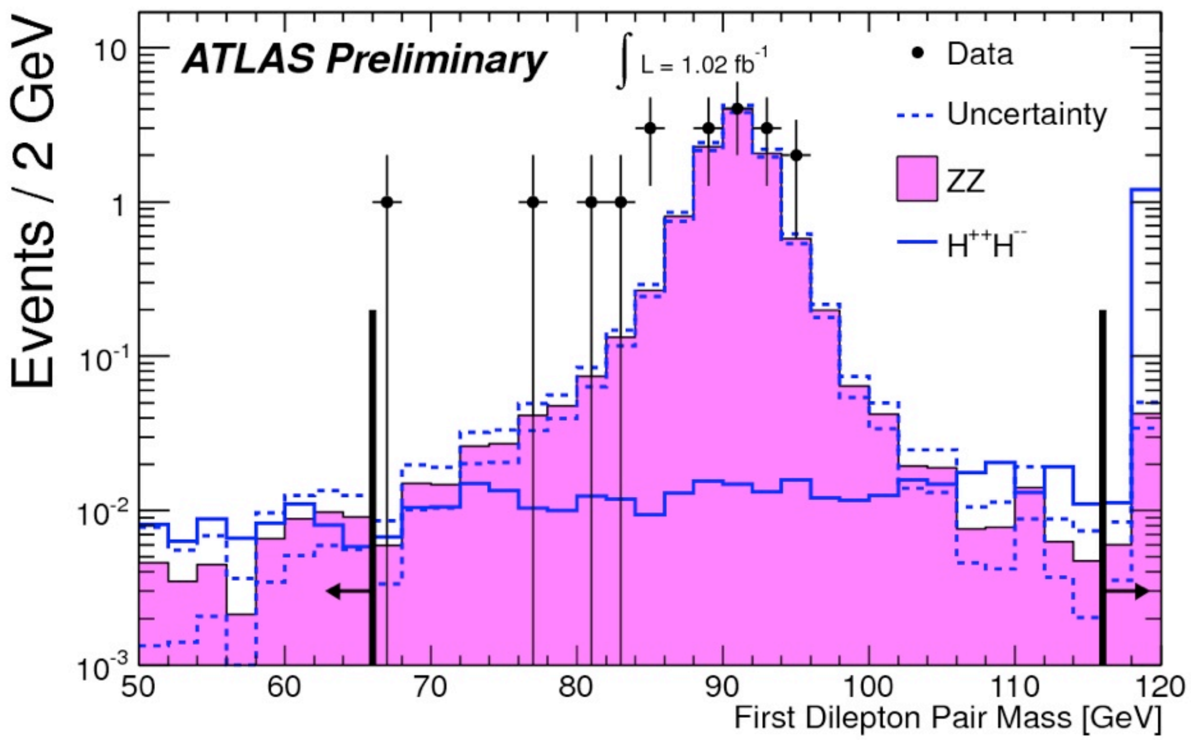
$M(H_L^{++}) > 375$ GeV@95% CL
$M(H_R^{++}) > 295$ GeV@95% CL

Doubly-charged Higgs: 4-leptons

ATLAS-CONF-2011-144

Search $H^{\mp\mp}$ directly in 4 leptons events that contains no identified $Z \rightarrow l^+l^-$ decays

- very low expected background outside the ZZ kinematic region

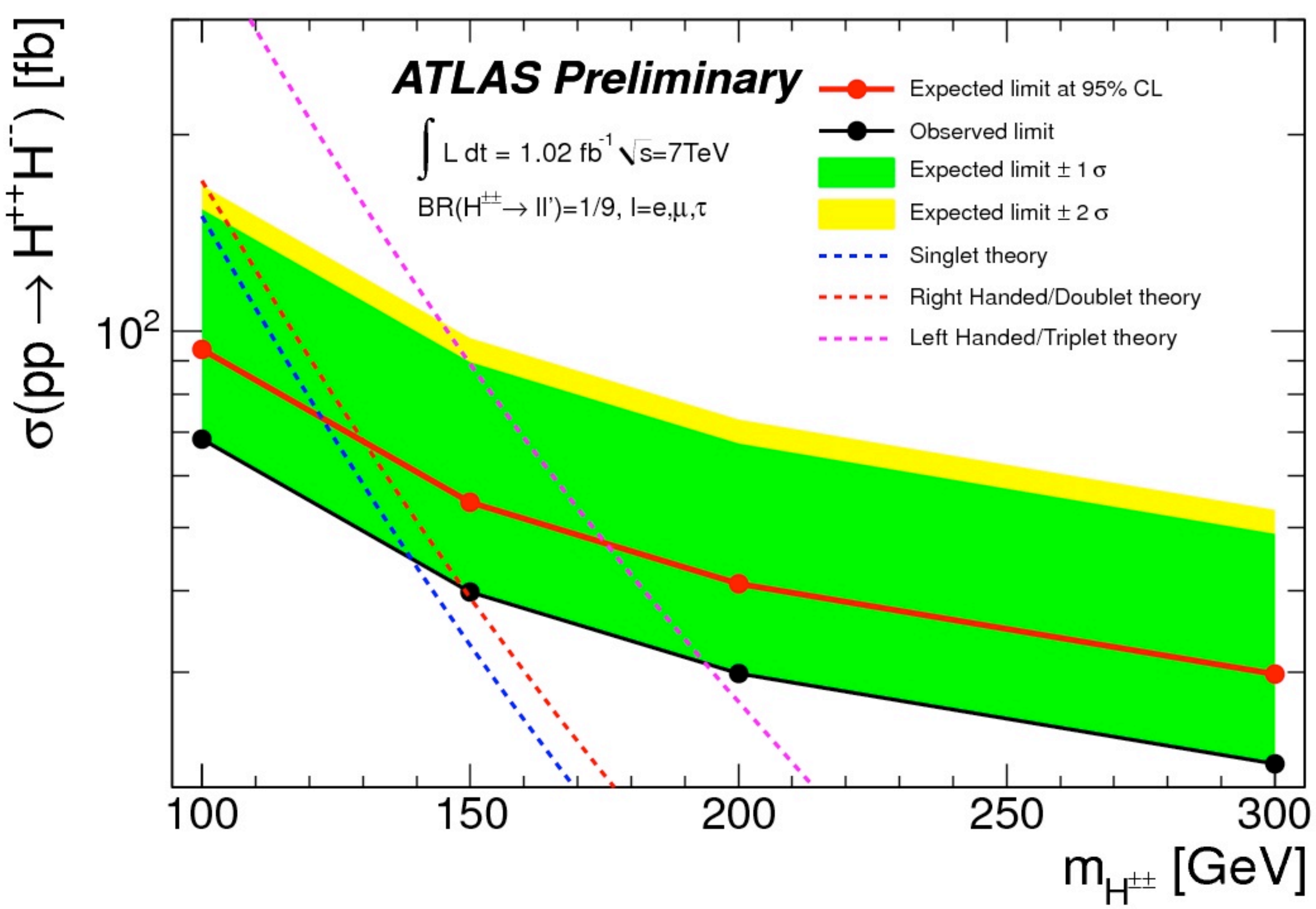


Fiducial Region:

- 4l (e/μ), p_T>15 GeV, |η|<2.5
- no opposite charge, same flavor pairs with $m_{ll} \in [66,116]$ GeV

N_{SM}(exp.): $0.7^{+1.3}_{-0.6}(\text{stat})\ ^{+0.9}_{-0.5}(\text{syst})$ events

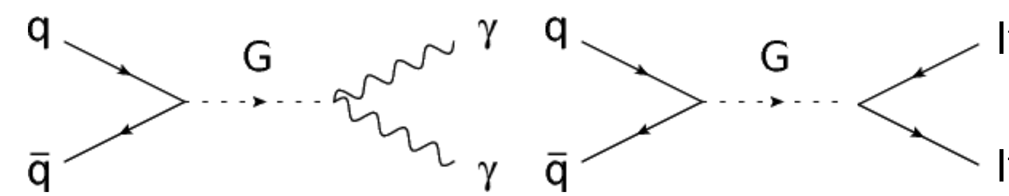
N(obs): 0 events



efficiency dominated by lepton reconstruction →
results can be applied in other NP processes within the same fiducial region

Search for Randal-Sundrum Gravitons

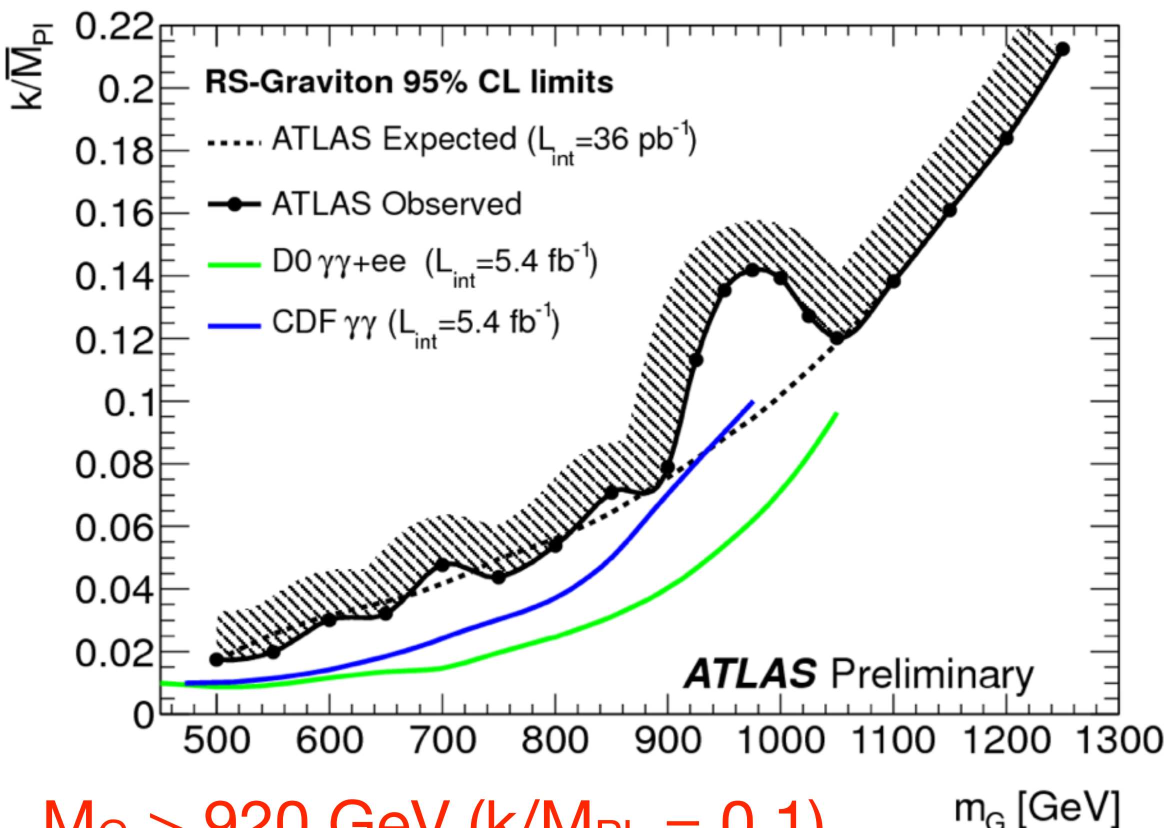
- Graviton excitations expected in the di-photon and di-lepton spectra in R-S warped extra dimension models



ATLAS-CONF-2011-044 - arXiv:1108.1582

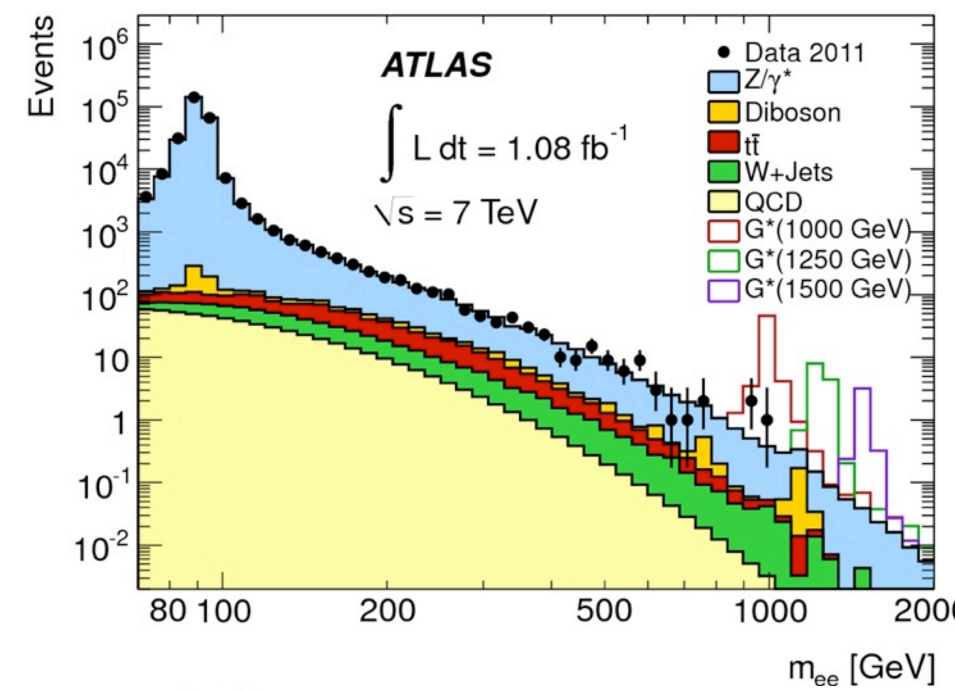
- Early γγ analysis with 2010 data:

Limits in the m_G - k/M_{PL} plane

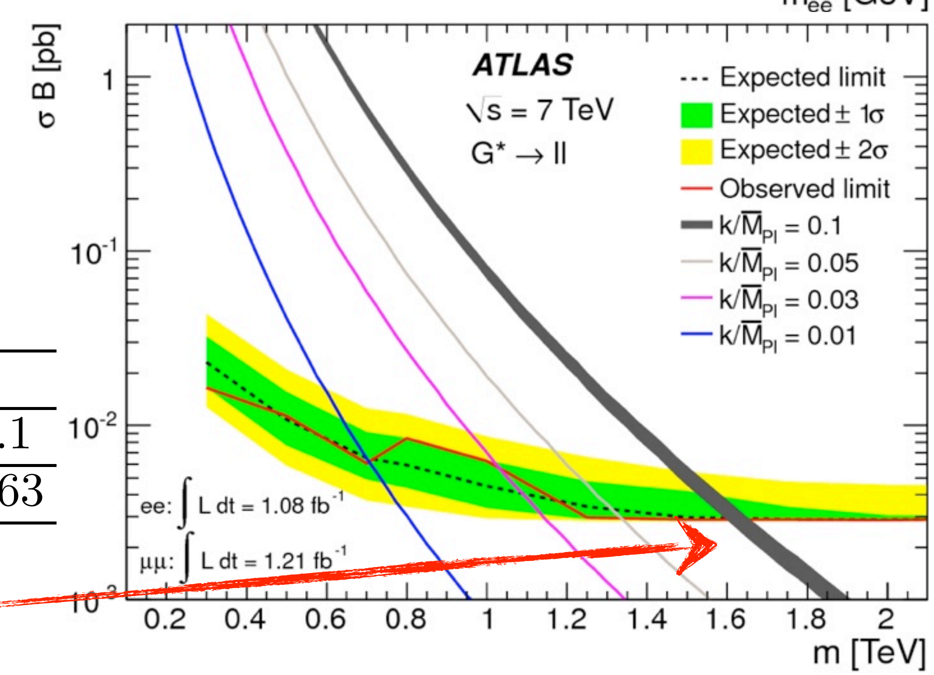


$M_G > 920$ GeV ($k/M_{PL} = 0.1$)

- Di-lepton analysis: same as for Z'→ll, only different interpretation



	RS Graviton			
Model/Coupling	0.01	0.03	0.05	0.1
Mass limit [TeV]	0.71	1.03	1.33	1.63

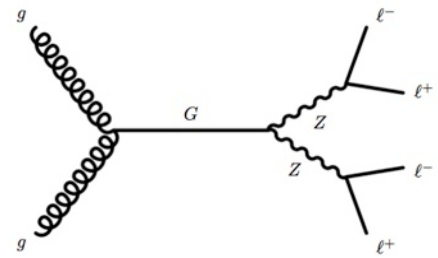


$M_G > 1.63$ TeV/c^2 @ 95% CL for $k/M_{Pl}=0.1$

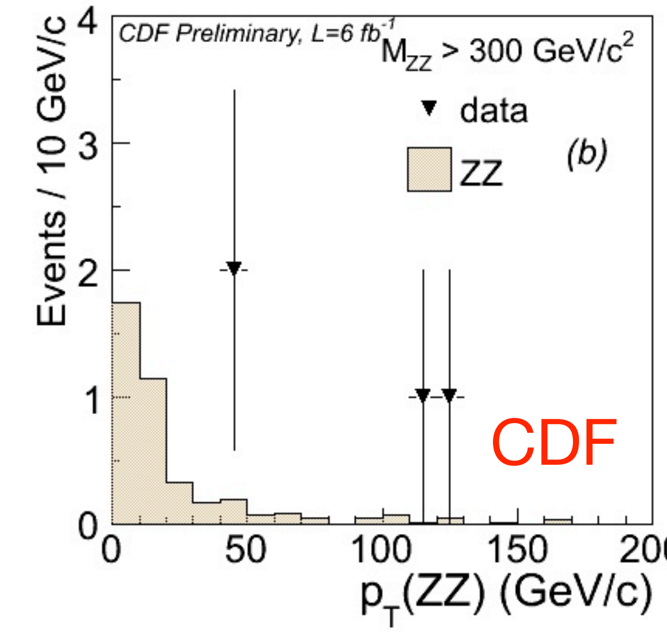
... and in ZZ → 4-leptons

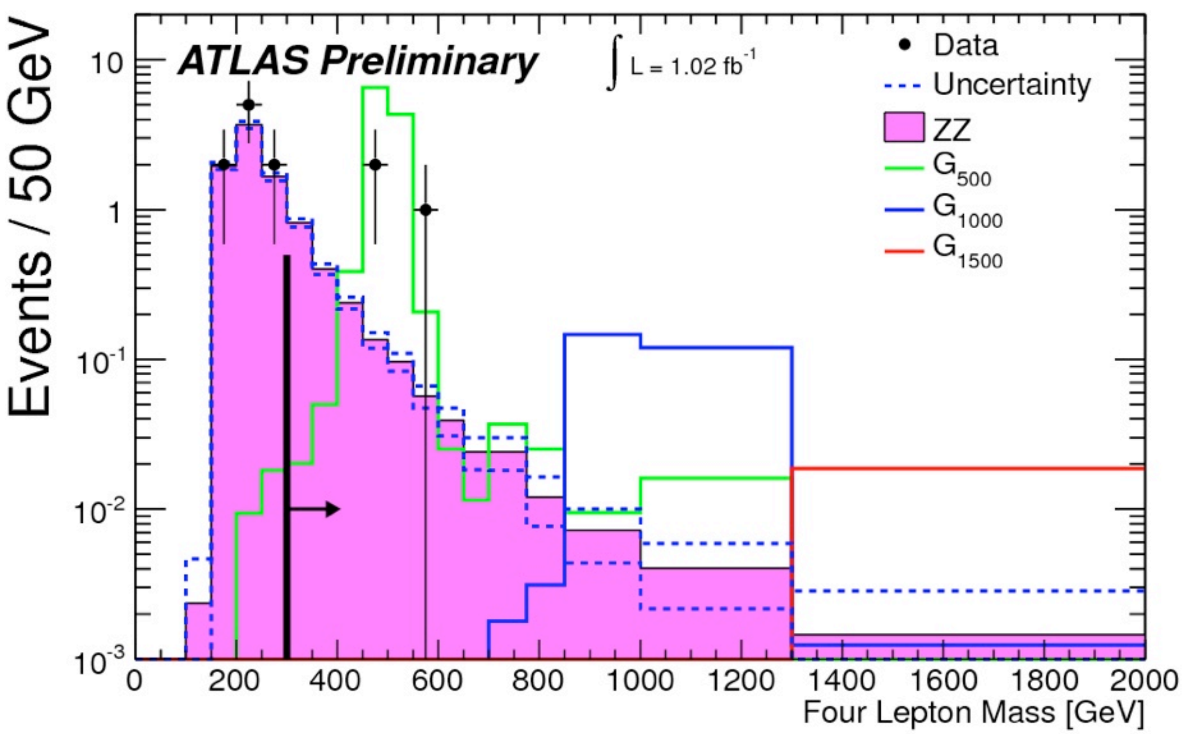
Analyze events with two identified Z→ll in the 4-leptons dataset

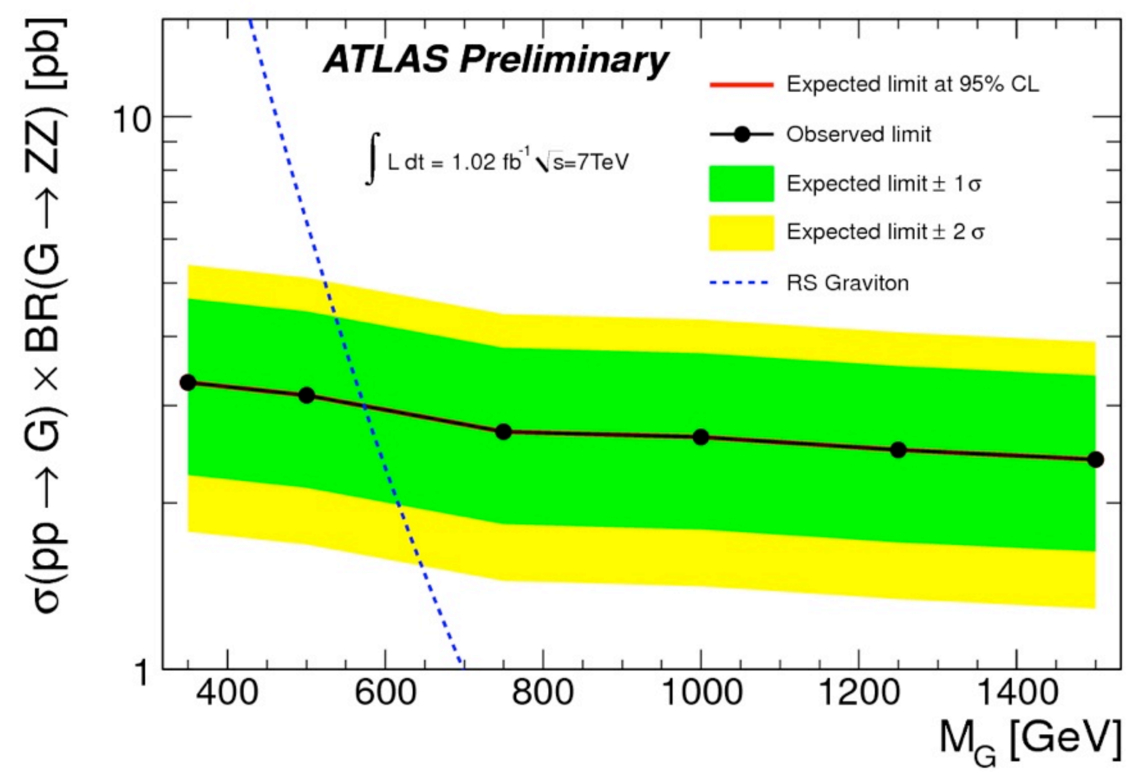
- search for RS Graviton decaying in two Z bosons



- also sensitive to other di-boson resonances as in GUT theories, TC models
- 4-events excess at m_{ZZ}~327 GeV seen by CDF recently, but no excess seen in lljj or ll+MET







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Process	Total
ZZ	$1.85 \pm 0.11 \pm 0.09$
Fakes	$0.02^{+1.03}_{-0.01}{}^{+0.75}_{-0.02}$
Total Bkg.	$1.87^{+1.04}_{-0.11}{}^{+0.75}_{-0.09}$
Data	3

Expected Signal k/M_{Pl}=0.1

G(350 GeV)	$71 \pm 3 \pm 4$
G(500 GeV)	$12 \pm 0.5 \pm 0.6$
G(750 GeV)	$1.5 \pm 0.08 \pm 0.07$
G(1000 GeV)	$(2.7 \pm 0.2 \pm 0.1) \times 10^{-1}$
G(1250 GeV)	$(6.6 \pm 0.4 \pm 0.3) \times 10^{-2}$
G(1500 GeV)	$(1.9 \pm 0.1 \pm 0.1) \times 10^{-2}$

M_G > 575 GeV (k/M_{PL} = 0.1)

Search for Large ED in monojets+MET

Large Extra Dimension (ADD)

- large flat ED
- bring the Plank scale down to the TeV scale
- only Gravitons propagate in the bulk → can escape detection, providing a missing energy signature

$$M_{Pl} \sim M_D^{2+n} R^n$$

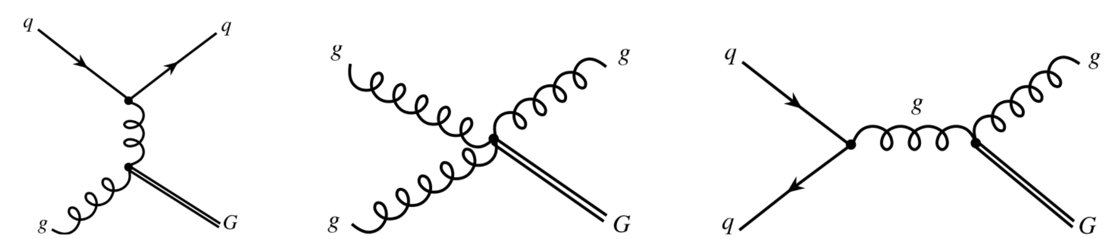
effective Plank scale

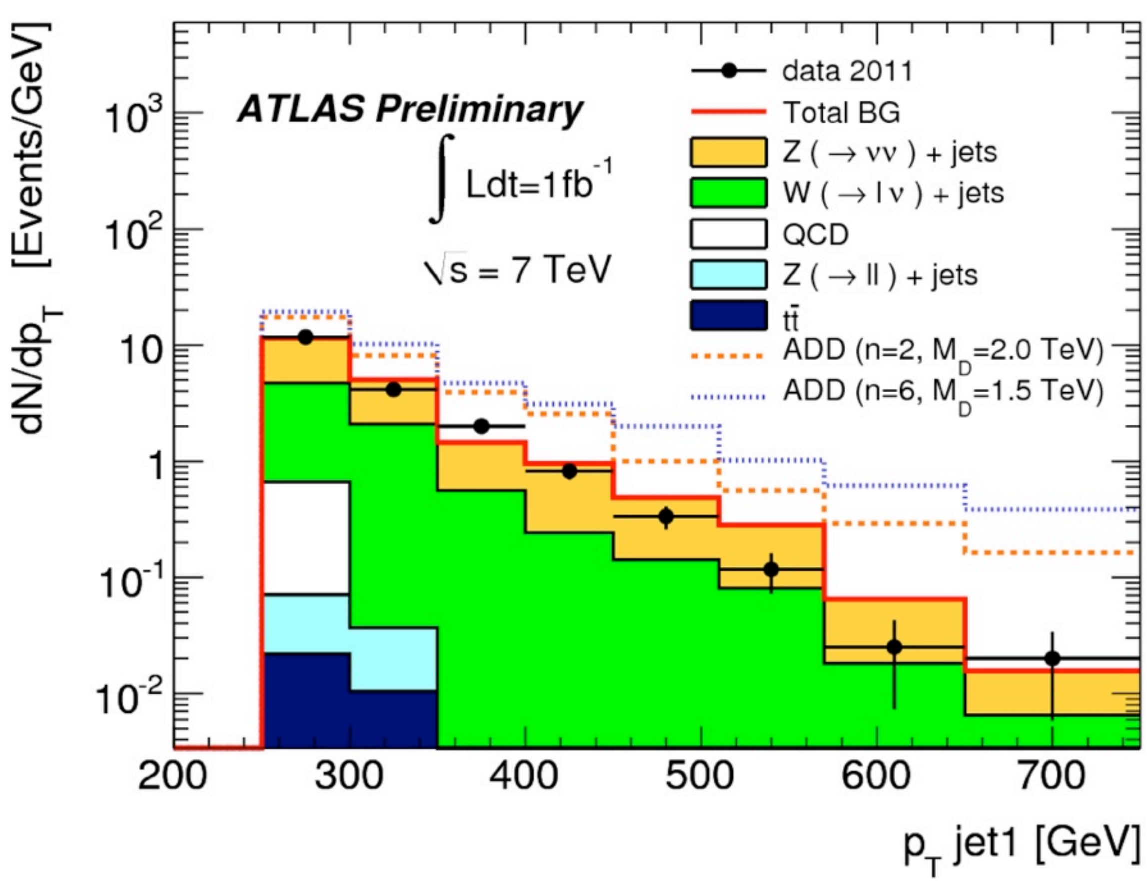
size of ED

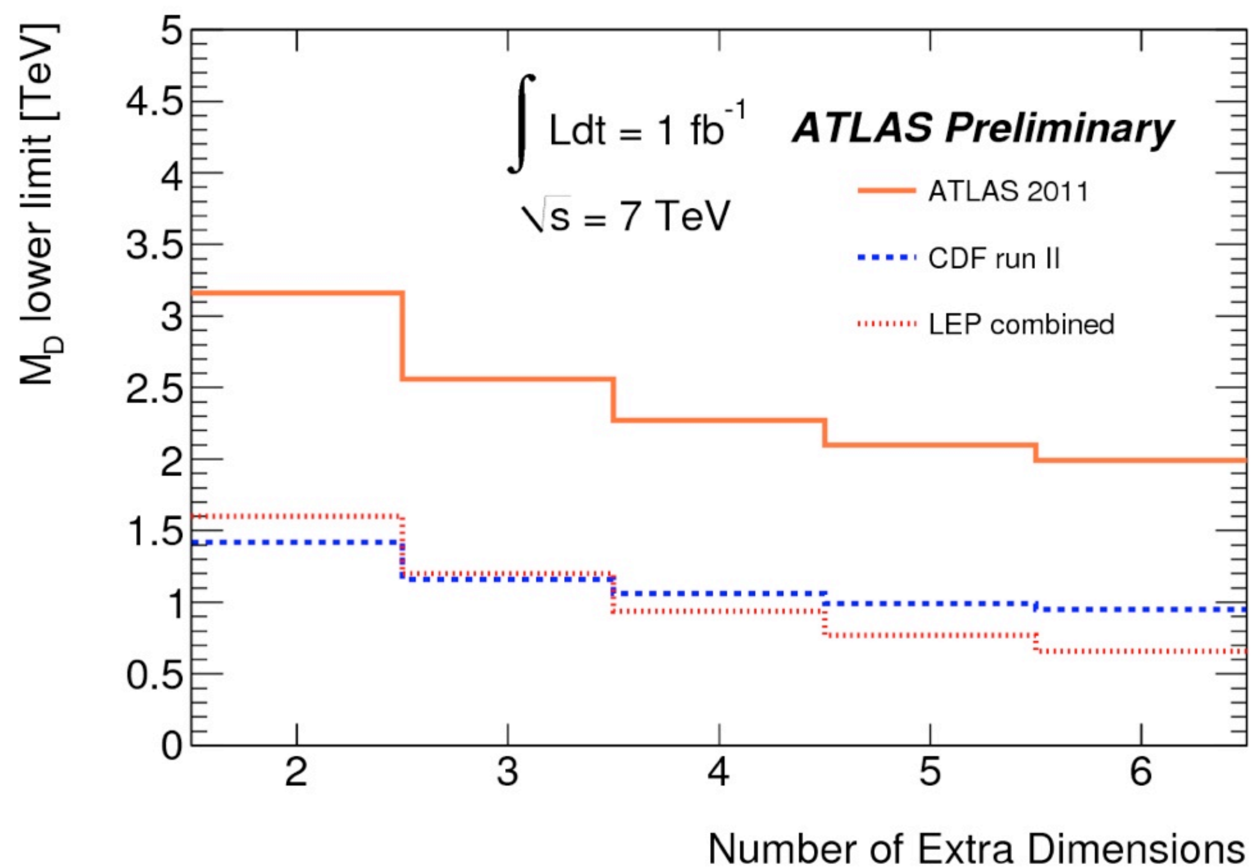
foundamental Plank scale

ATLAS-CONF-2011-096

- Look for a high-p_T jet, MET and no other activity
- Experimentally challenging:
  - Understanding $Z(\to \nu\nu)$+Jets SM production
  - Instrumental background





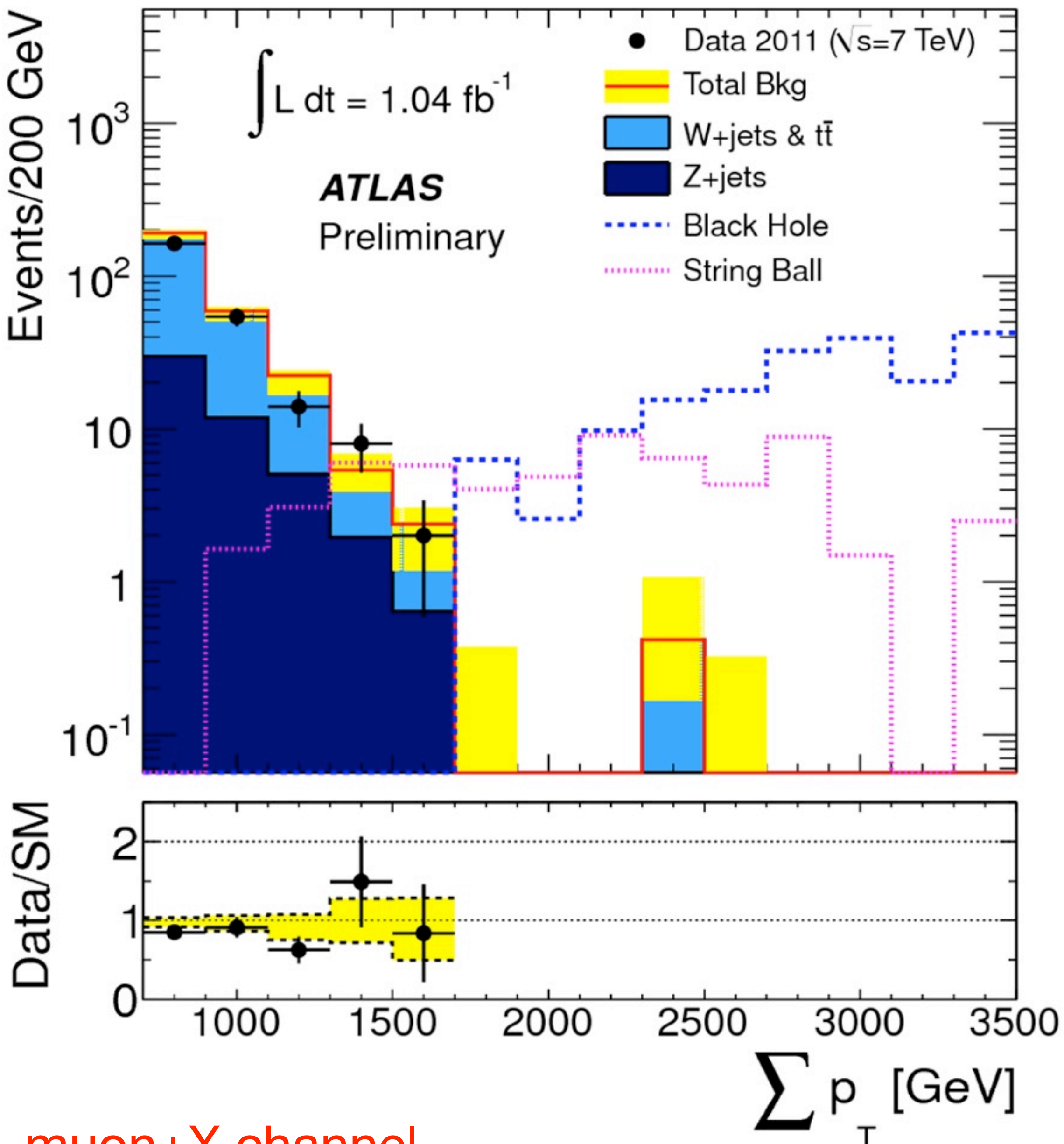


Interpreted in ADD Large ED model: M_D > 3.39÷2.12 TeV for n=2÷6

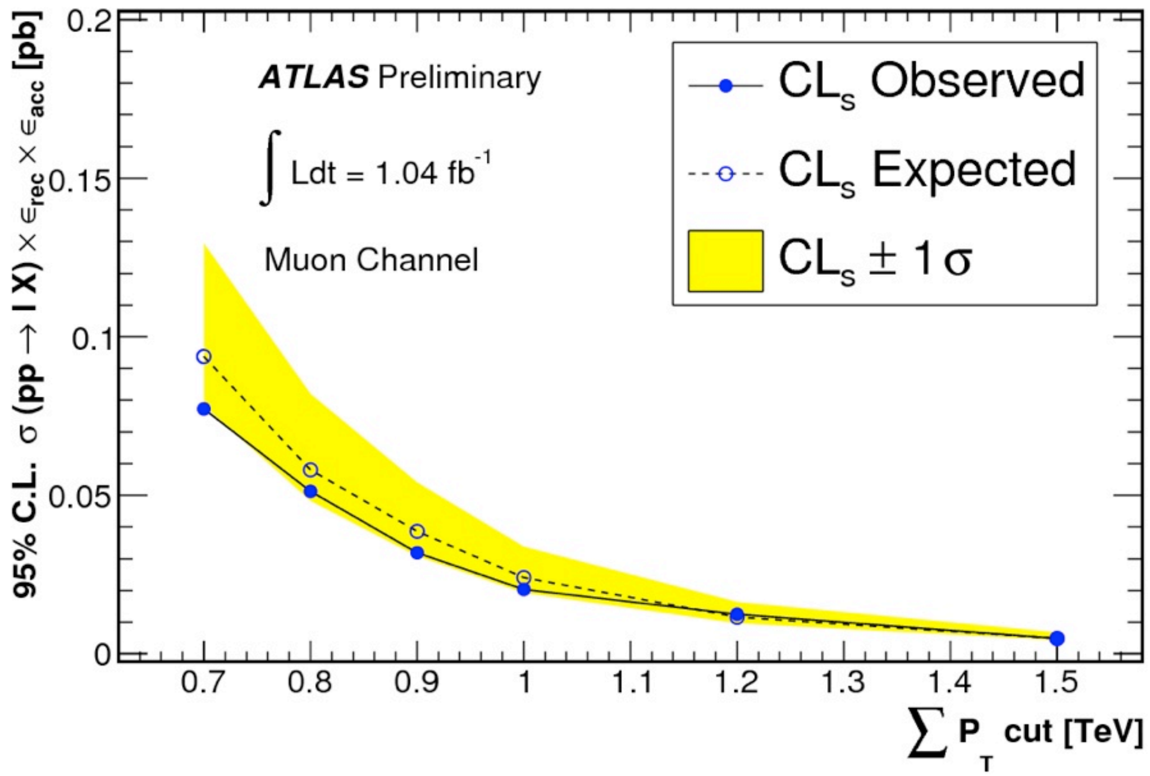
Search Black Holes/String Balls with leptons & jets

Microscopic black-holes decaying through Hawking radiation predicted in low-scale gravity models

- also String Balls in the context of weakly-coupled string theory
- General assumption: at LHC if produced then will decay isotropically and democratically in all particle species...
  - high multiplicity final states → look for many leptons and jets at high mass/p_T



muon+X channel



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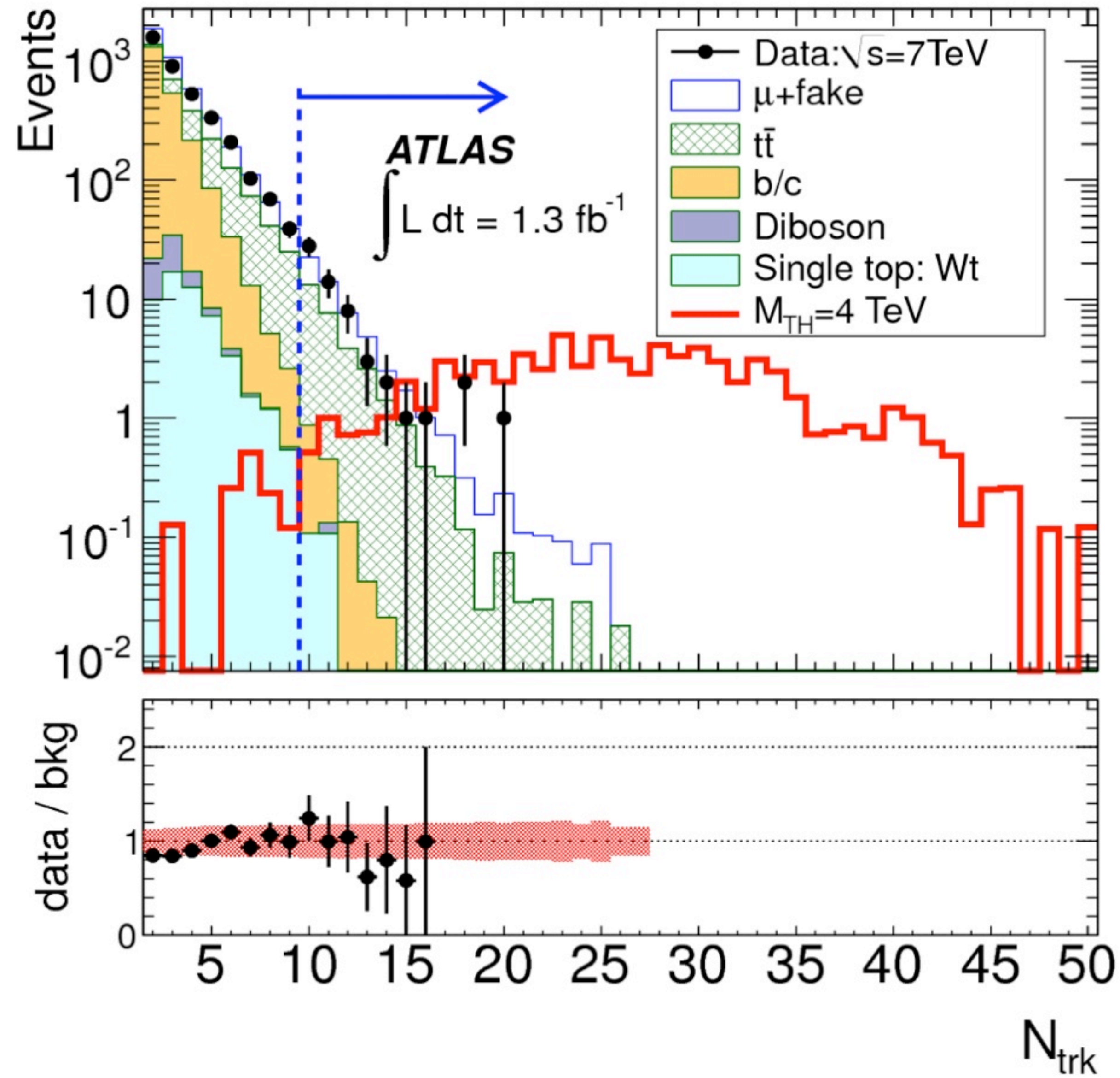
Upper limits on σ×A for multiple benchmark sets: rotating/ non rotating BH/SB, w/ varying M_D and M_{TH}, produced with Blackmax and Charybdis

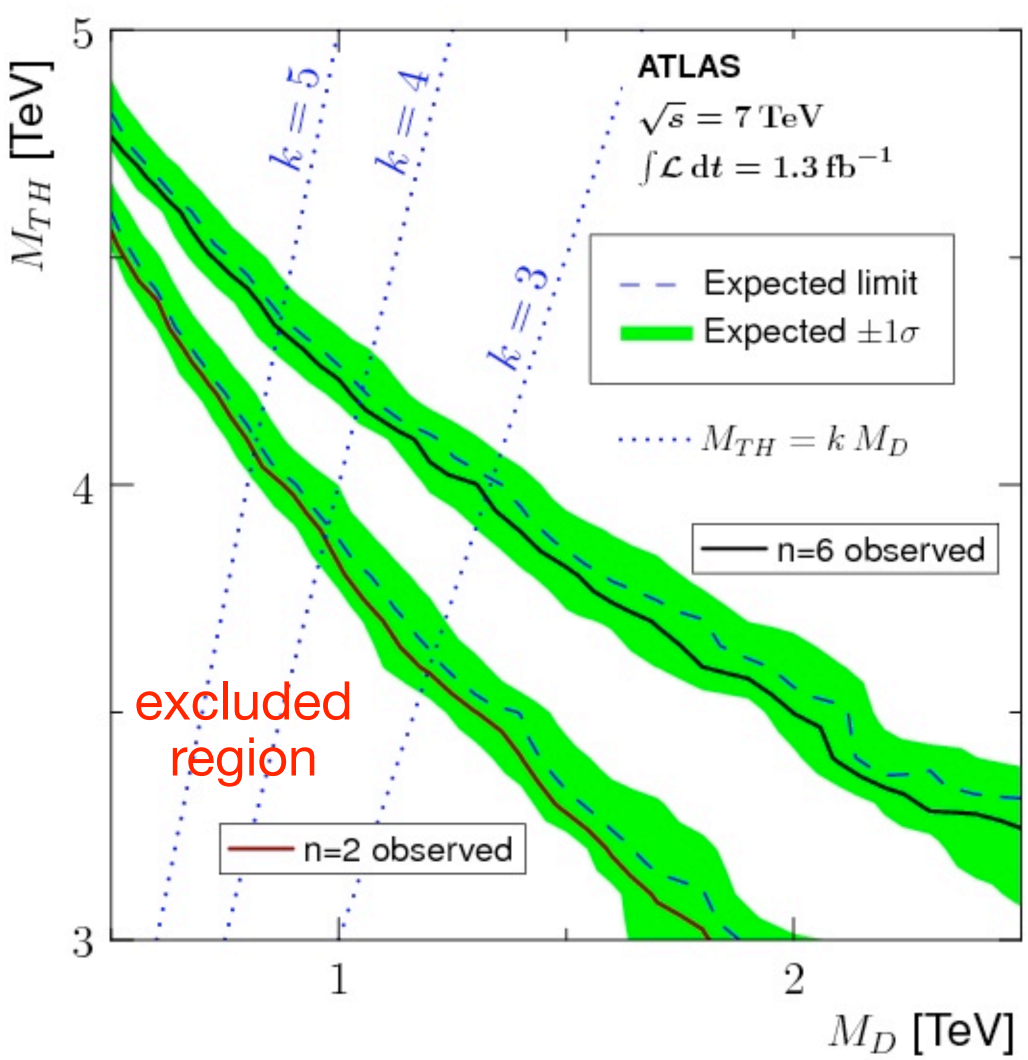
... and in same-sign di-muon pairs

Background to BH search can be further reduced searching in like-sign di-muon decays

Strategy:

- high p_T track multiplicity discriminates signal and background effectively
- counting experiment in a pre-defined signal region
  - muon+fake background from data (W+jets, QCD)
  - other backgrounds (tt, bb) from MC





Model independent limit:
σ·B·A < 0.018 pb @95% CL

Set limits in two dimensions of M_D and the mass of the black hole M_{TH} for different number (n) of extra dimensions in the ADD low gravity scale model

arXiv:1111.0080

Search for signals from Technicolor

ATLAS-CONF-2011-125

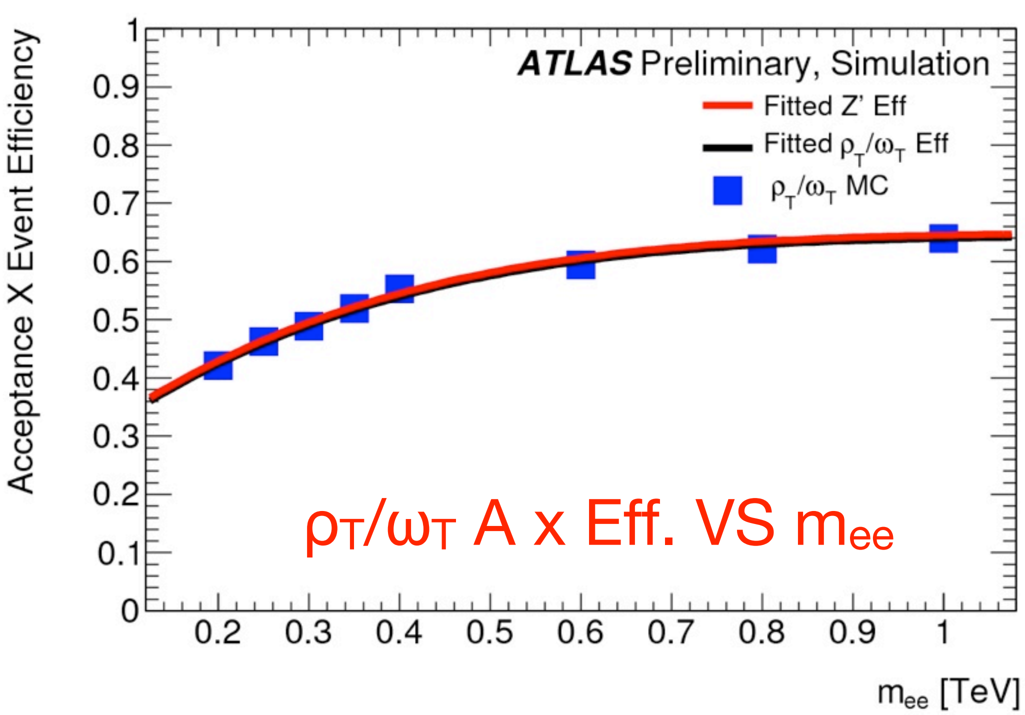
TC: new strong dynamics to provide alternate mechanism of EWSB

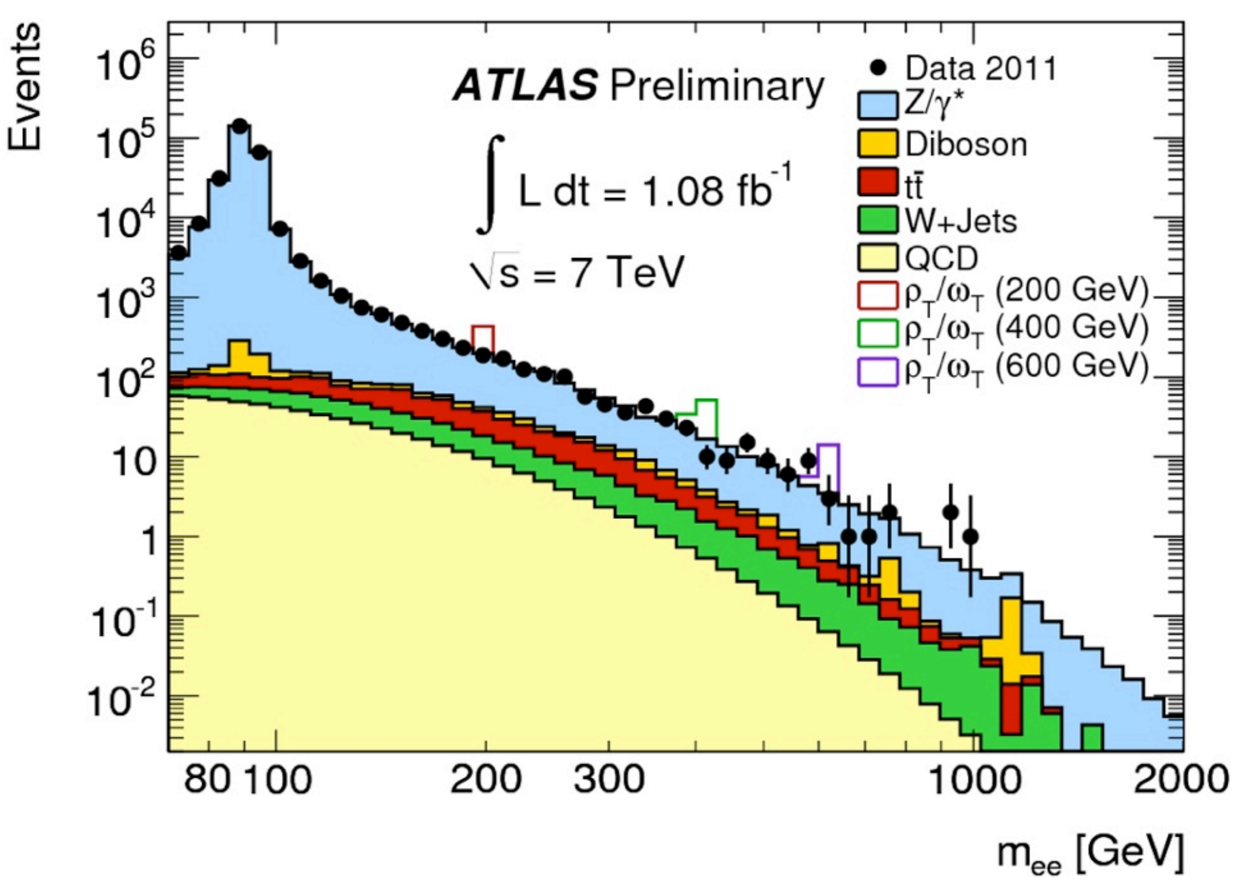
- no fundamental Higgs boson
- new strong gauge interactions (like $SU(N_{TC})$)
- new fermions sensitive to TC (techni-quarks)

- In ATLAS searches in the context of the Low-Scale TC model
  - QCD-like particle spectrum with scale $O(\Lambda_{TC})$~100 GeV: π_T, ρ_T, ω_T ~mass degenerate, a_T at higher mass
  - with Walking TC: $V \rightarrow n\pi_T$ forbidden ⇒ narrow resonances

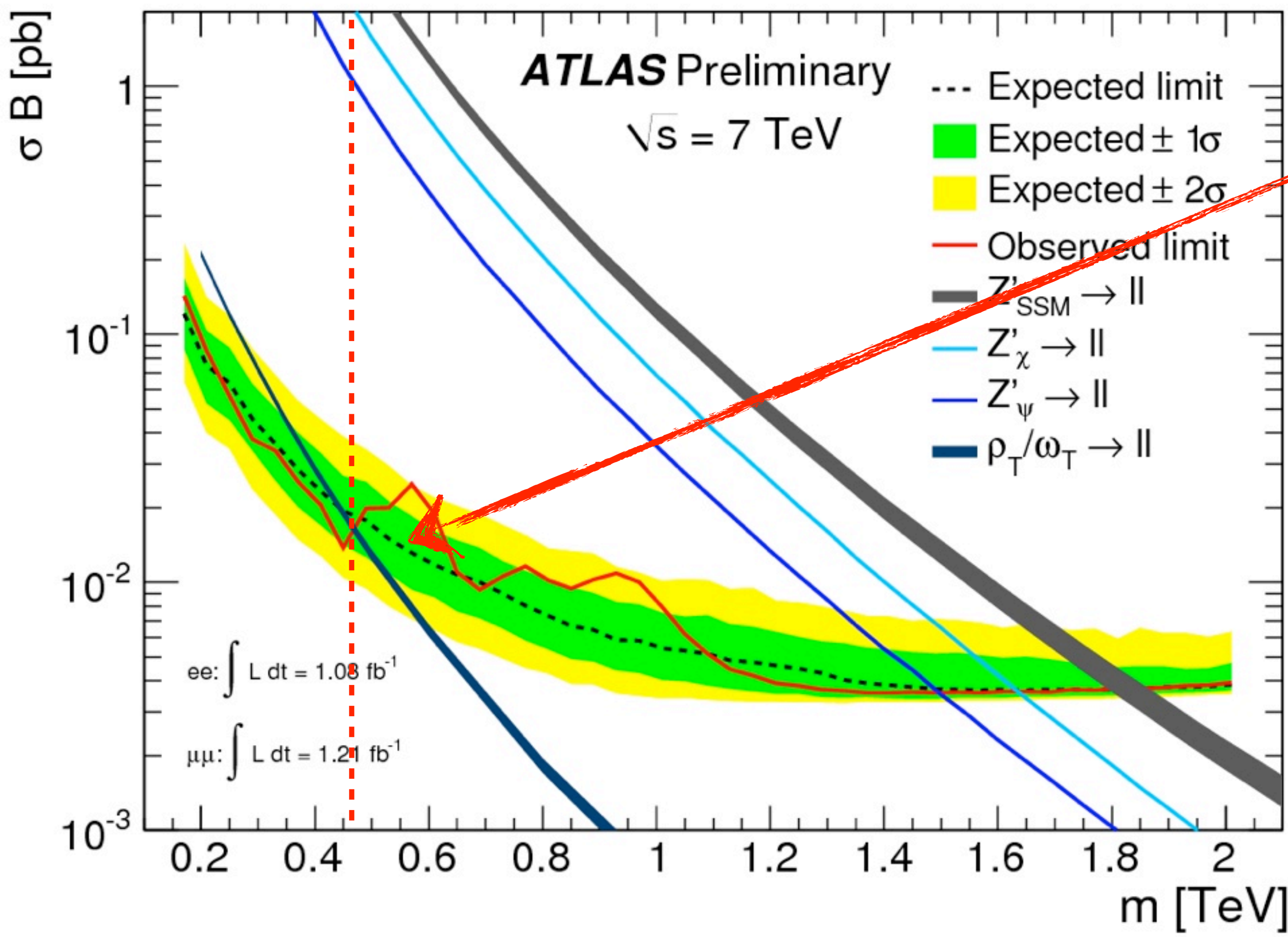
- Main decay modes:
  - ρ_T, $\omega_T \rightarrow$ ll, Z/Wγ, WZ, Z/W π_T ($\pi_T \rightarrow jj$)

- Since techni-mesons are narrow, spin 1, resonances, the same analysis methodology used for the Z' searches in di-leptons can be used w/o modifications





Search for tchni-mesons in dileptons

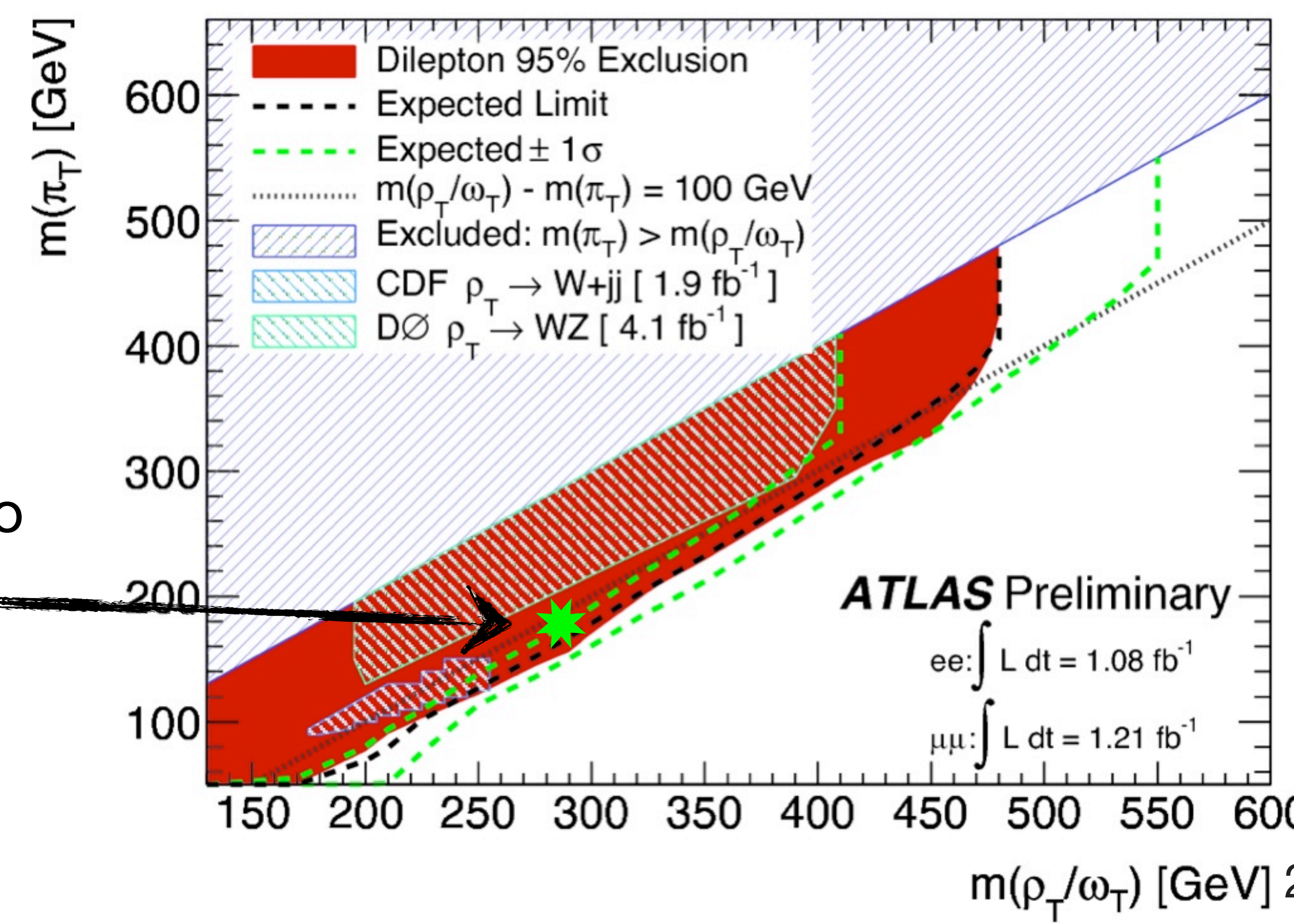


Limit on $M(\rho_T)$: > 470 GeV @ 95% CL

assume: $M(\pi_T) = M(\rho_T)$ - 100 GeV

Exclusion in the $M(\rho_T)$ VS $M(\pi_T)$ plane

- significant improvement over Tevatron
- LSTC interpretation of CDF Wjj excess fall into the excluded region



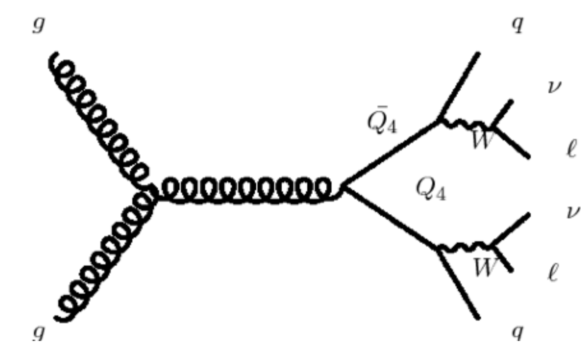
ATLAS-CONF-2011-125

4th generation quarks

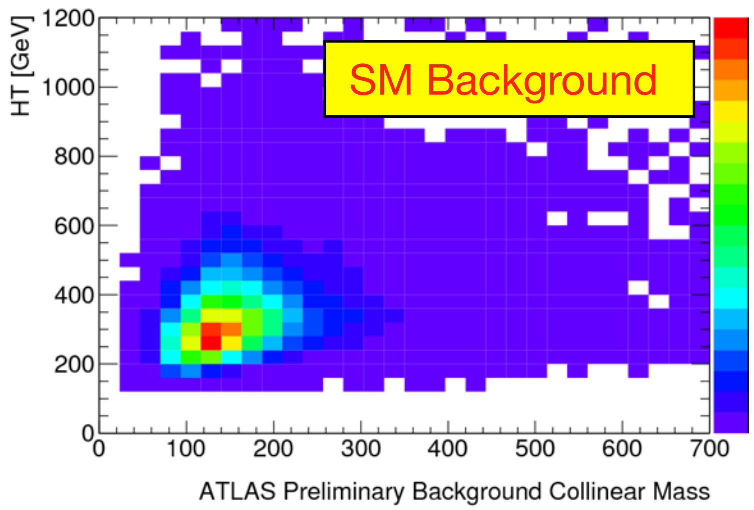
Simple and natural extension of the Standard Model

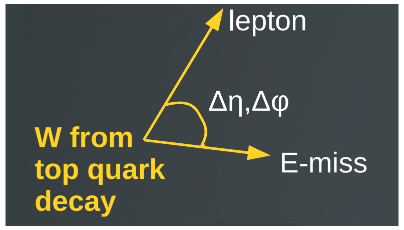
- provides a source of CP Violation in B_s decays, accommodate a heavy Higgs boson
- a benchmark model for more general new scenarios with heavy fermions (Little Higgs, strong EWSB: Composite Higgs, TC etc...)
- Multiple searches performed in ATLAS, exclusive and inclusive ...

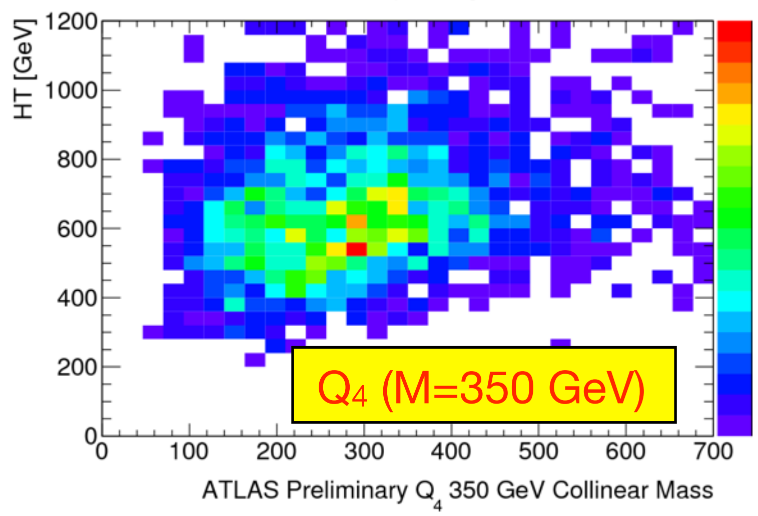
- Final states with leptons and jets produced by 4th generation chiral quarks
  - signature: 2l + 2jets + MET
  - dominant background: ttbar decays, controlled using M_{coll} VS H_T
    - H_T = scalar sum of E_T from leptons, jets and MET
    - M_{coll} = Q_4 reconstructed mass in collinear approximation for neutrinos

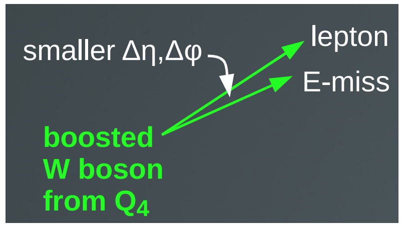


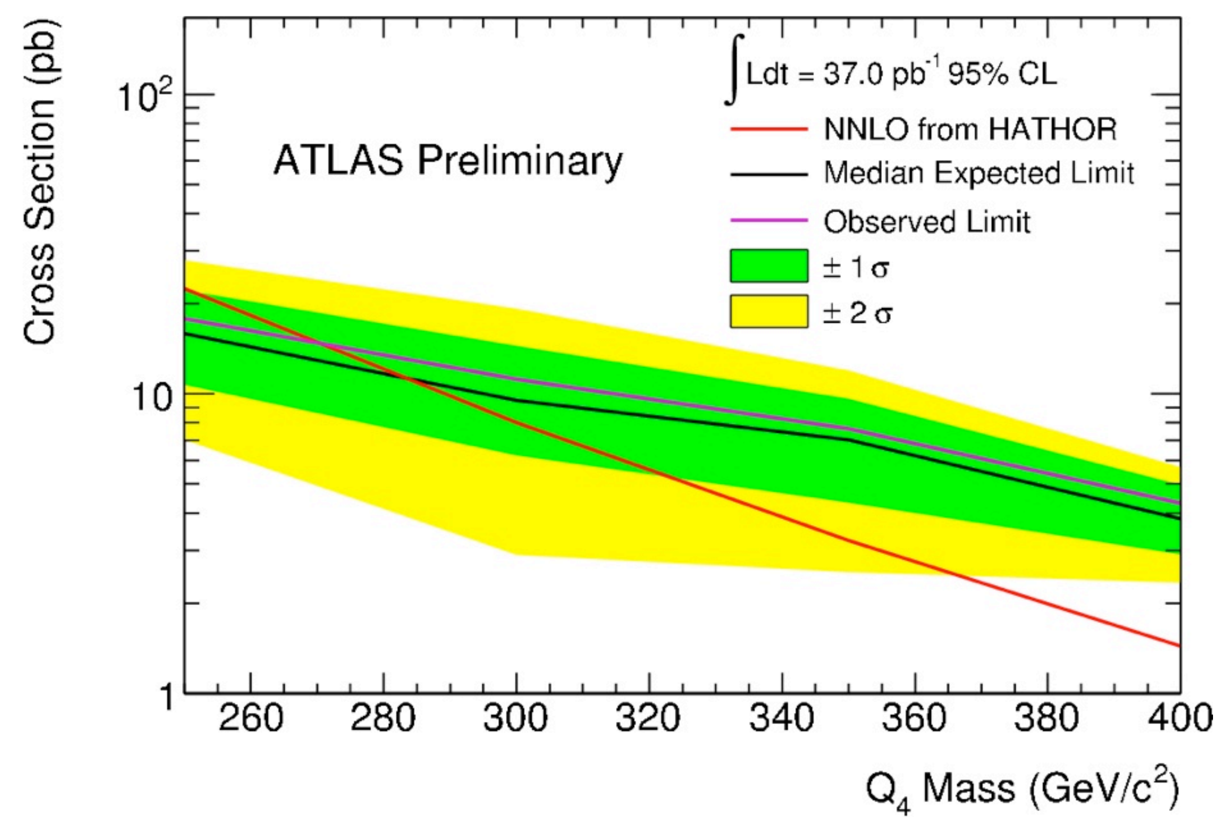
ATLAS-CONF-2011-022











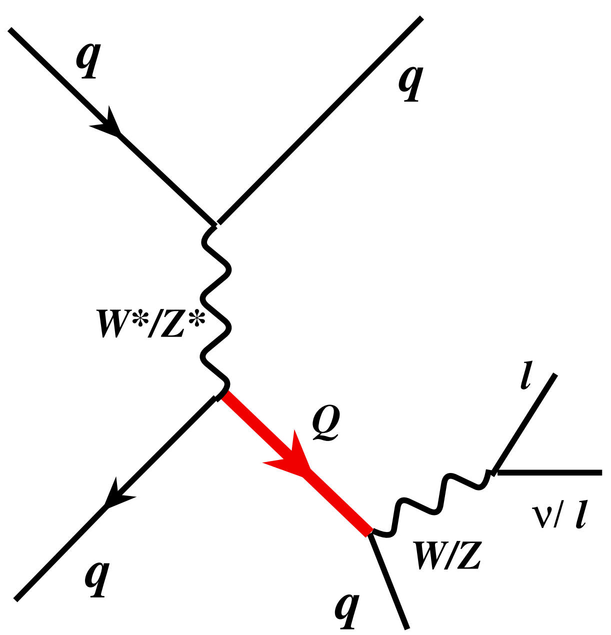
Limit 95% CL Obs (Exp)
M_{Q4} > 270 (284) GeV

Search for heavy vector-like quarks coupling to light quark

Just Released

Single production of vector-like heavy quarks (GUT, ED, ...) decaying to a jet and a vector boson

- signature: a high-p_T W or Z + 2jets
- signals peak in the invariant mass of W/Z and one jet



Limits 95% CL
M_Q > 900 GeV (W channel)
M_Q > 760 GeV (Z channel)

assuming VLQ-light quark coupling $\kappa_{qQ} = v/m_Q$

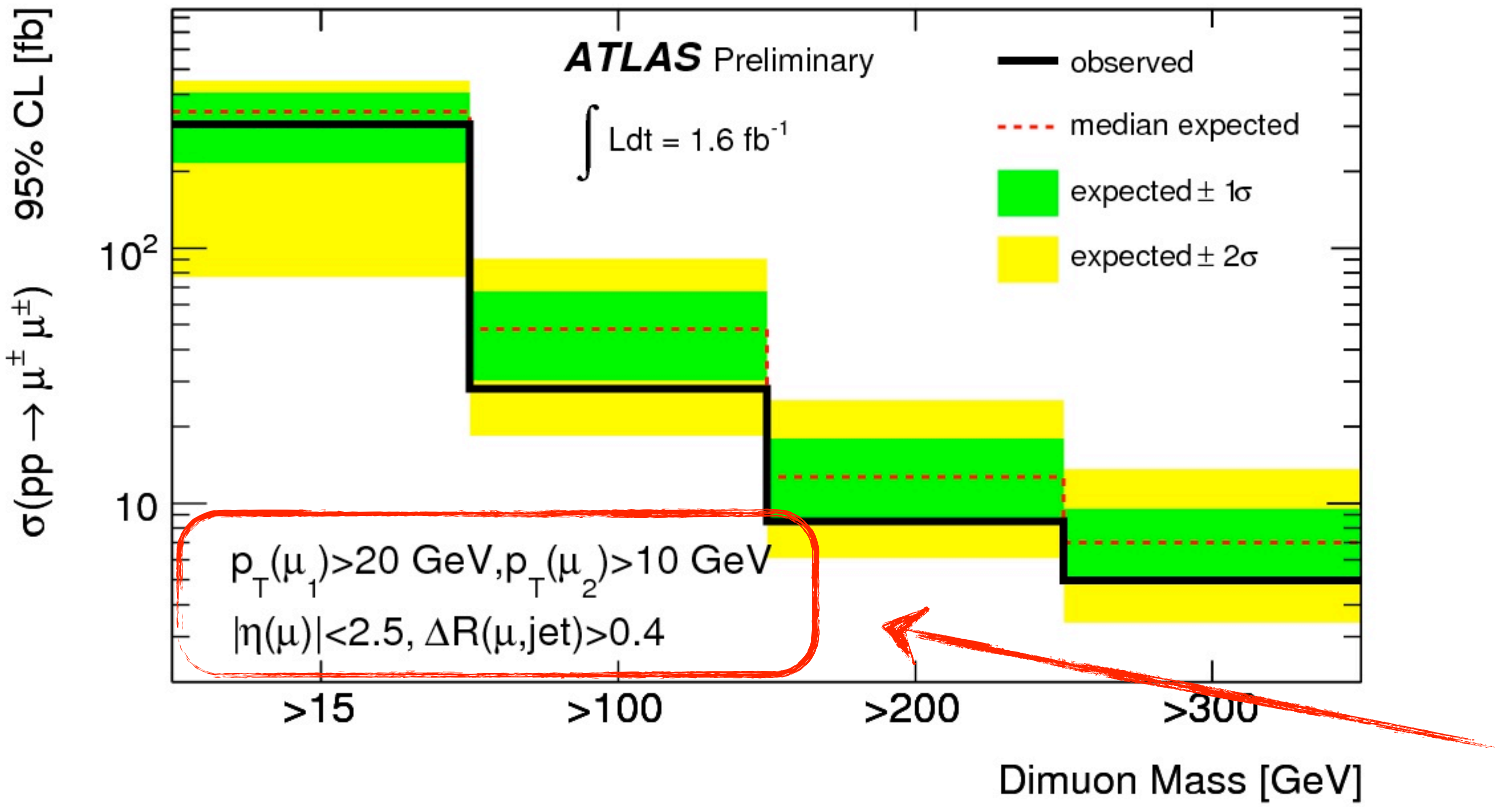
Inclusive Model-independent search

ATLAS-CONF-2011-126, ATLAS-CONF-2011-139

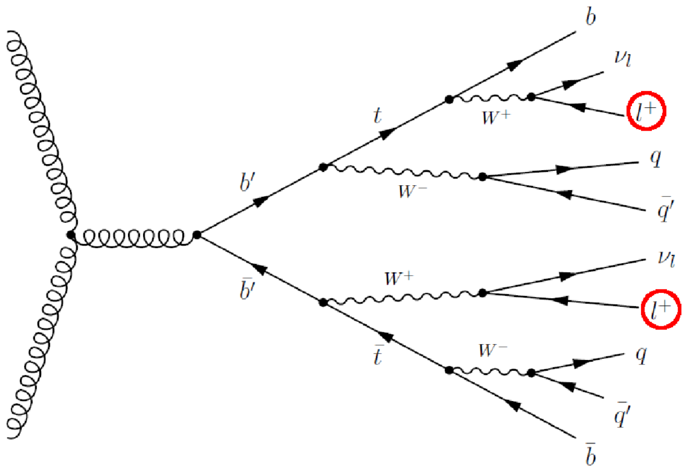
Search for inclusive non SM production of two prompt, isolated muons with the same electric charge:

- sensitivity to a variety of NP models: 4th generation quarks/doubly-charged Higgs/heavy Majorana neutrinos/ SUSY/UED ...
- very inclusive analysis: no requirements on the activity of the event, broad range for muon kinematics
- upper limits on contributions from NP expressed as fiducial cross-sections limits

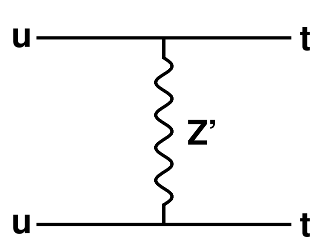
Lower limit on fiducial x-section VS $M_{\mu\mu}$



acceptance relative to
d4d4→Wt Wt→bWW bWW→ll + X



Same analysis set also best limits on anomalous production of top pairs with the same electrical charge via a flavor-changing Z′ boson:

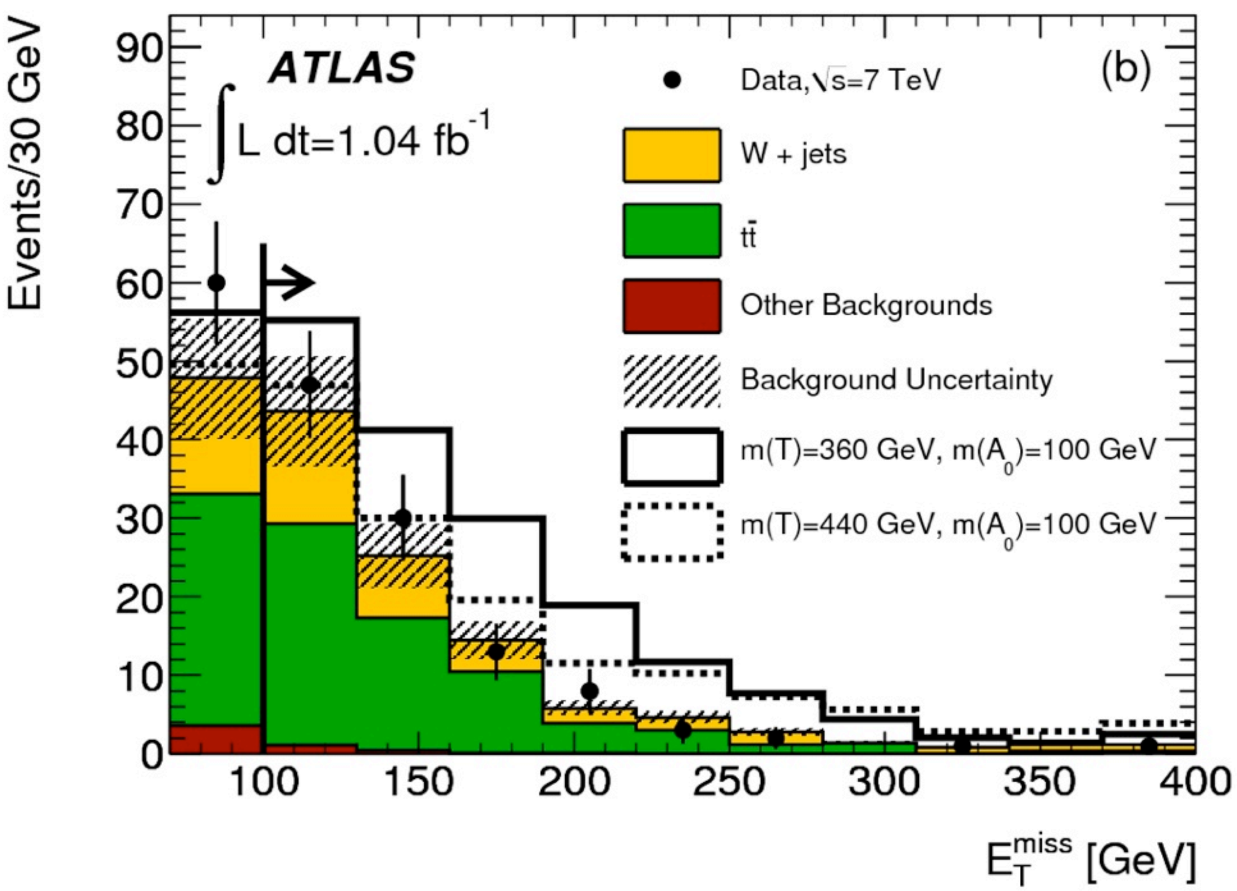


Mass range [GeV]	$\sigma_{95}(tt)$ (pb)							
	$m(Z')$ = 100 GeV		$m(Z')$ = 150 GeV		$m(Z')$ = 200 GeV		$m(Z') \gg$ 1 TeV	
	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.
$m(\mu^+\mu^+) > 200$ GeV	4.1	4.1	3.3	3.3	3.0	3.0	2.9	2.9

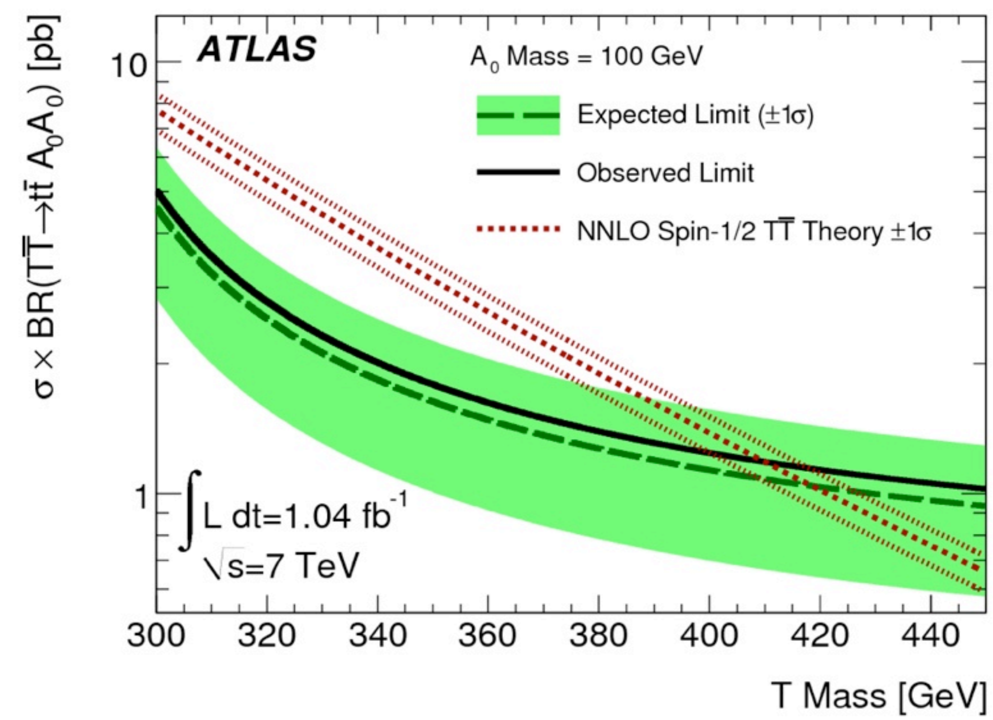
T→t+A0

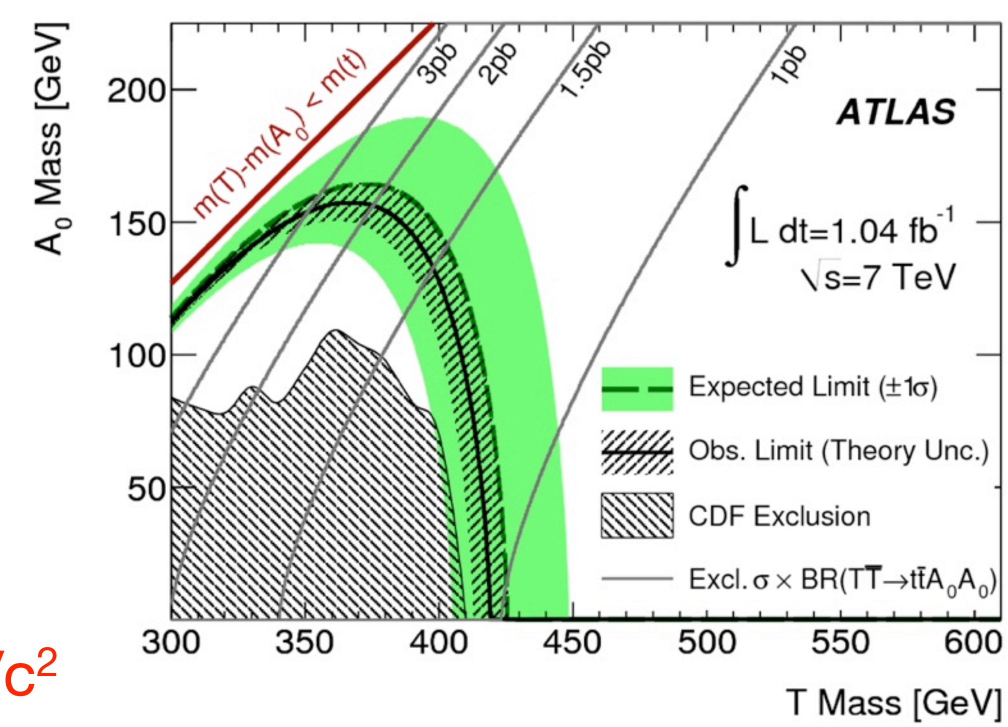
Search for a pair-produced exotic top partner T, which always decays to a top quark and a stable, neutral weakly-interacting scalar particle A0

- T has quark-like quantum numbers, produced as tt through qq annihilation and gluon fusion.
- Signature: same as ttbar, but with large missing transverse energy from the undetected A0's.



Source	Number of events
Dilepton $t\bar{t}$	62 ± 15
Single-lepton $t\bar{t}/W$+jets	33.1 ± 3.8
Multi-jet	1.2 ± 1.2
Single top	3.5 ± 0.8
Z+jets	0.9 ± 0.3
Dibosons	0.9 ± 0.2
Total	101 ± 16
Data	105





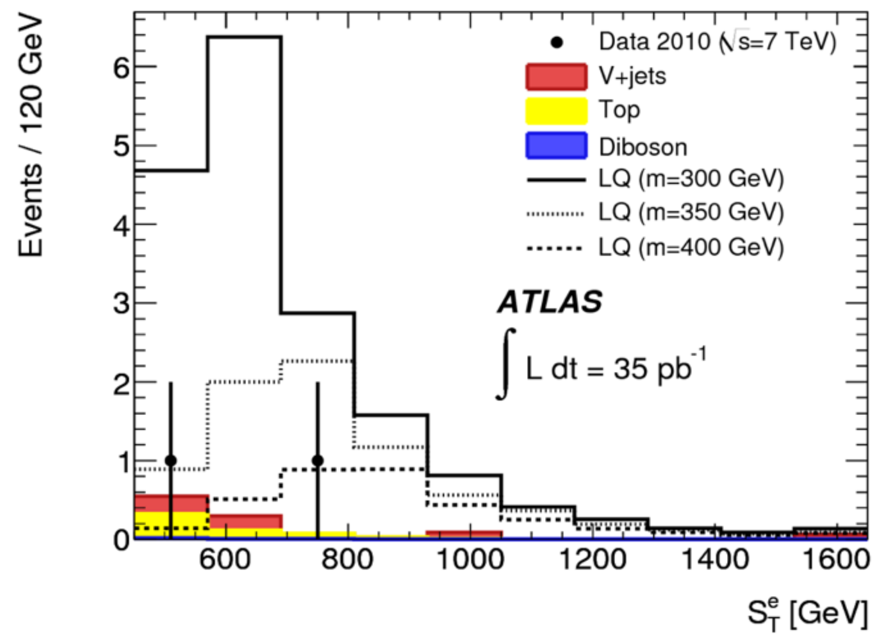
arXiv:1109.4725

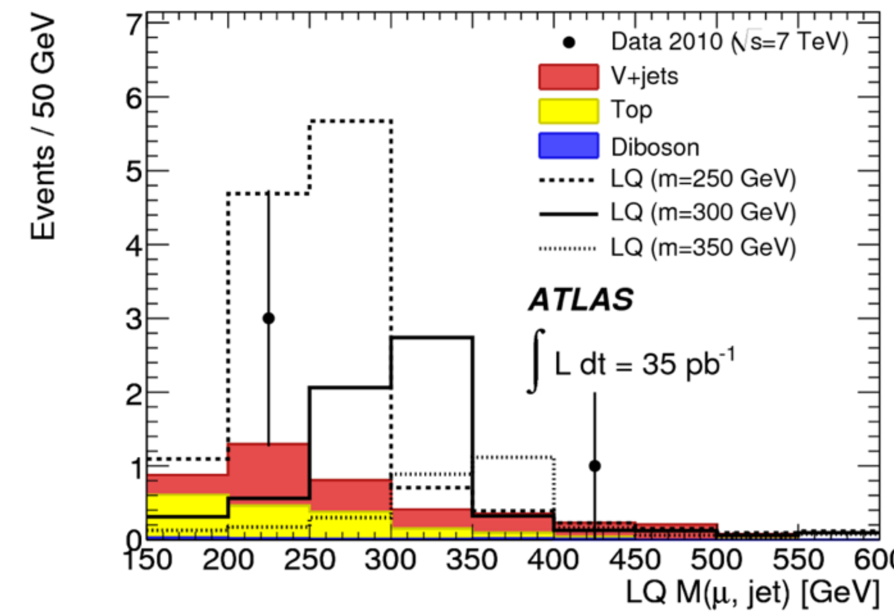
MT excluded up to 420 GeV/c² and A0 up to 140 GeV/c²

LeptoQuarks (LQ)

LQ are new particles that arise in various extensions of SM (GUT, ETC, compositeness ...) and couple to both lepton and quarks and carry color

- Produced in pair at LHC→ search for final states with jjll or jjlν
- Low background expected due to the high mass of the LQ





- Experimental discriminants:
  - LQ Transverse mass
  - event transverse energy

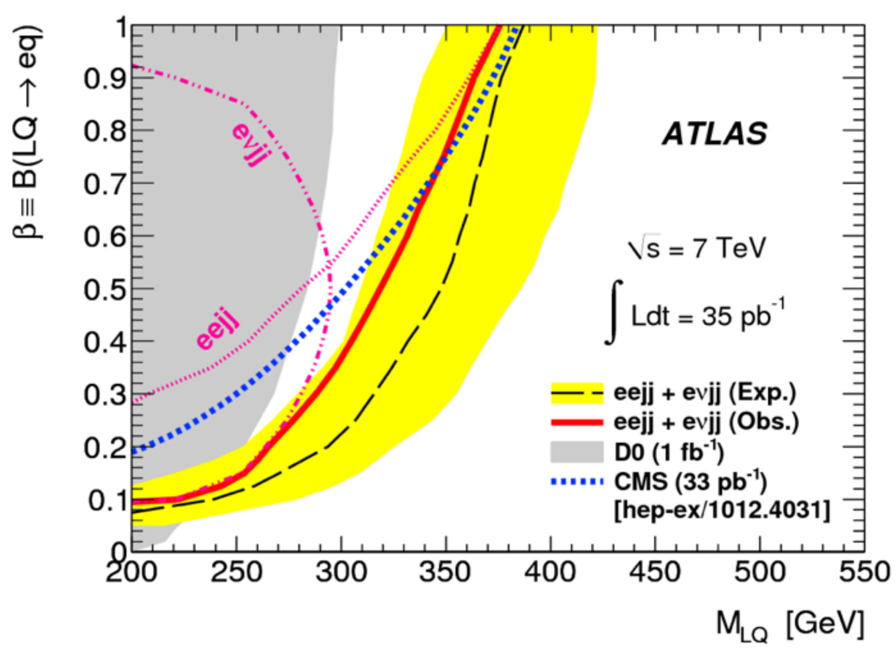
$$m^T_{LQ} = \sqrt{2p^j_T E^{miss}_T (1 - \cos\phi_j)}$$

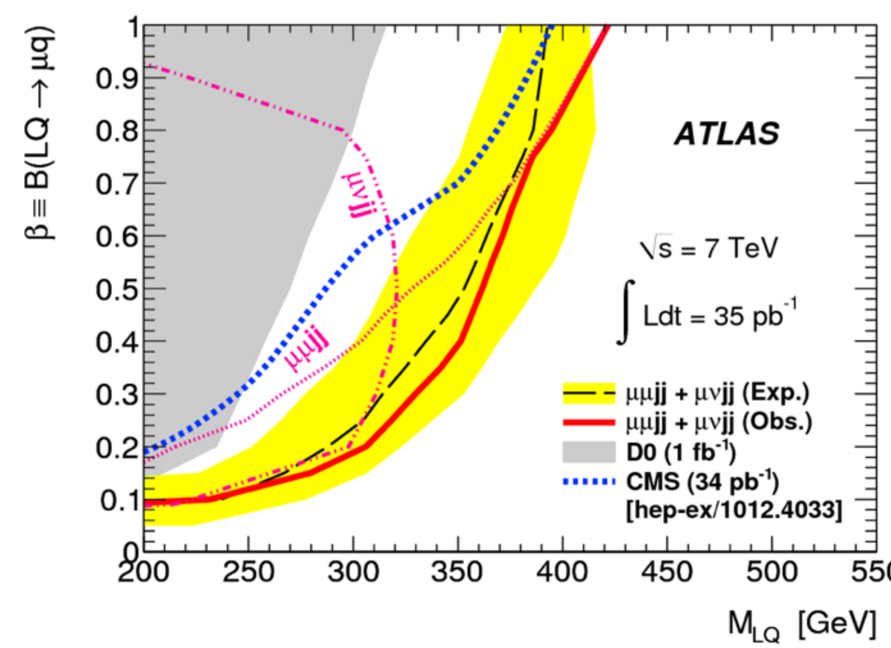
$$S_T = p^{l_1}_T + p^{l_2}_T + p^{j_1}_T + p^{j_2}_T$$

Limit 95% CL for β=1

1st gen. M > 376 GeV

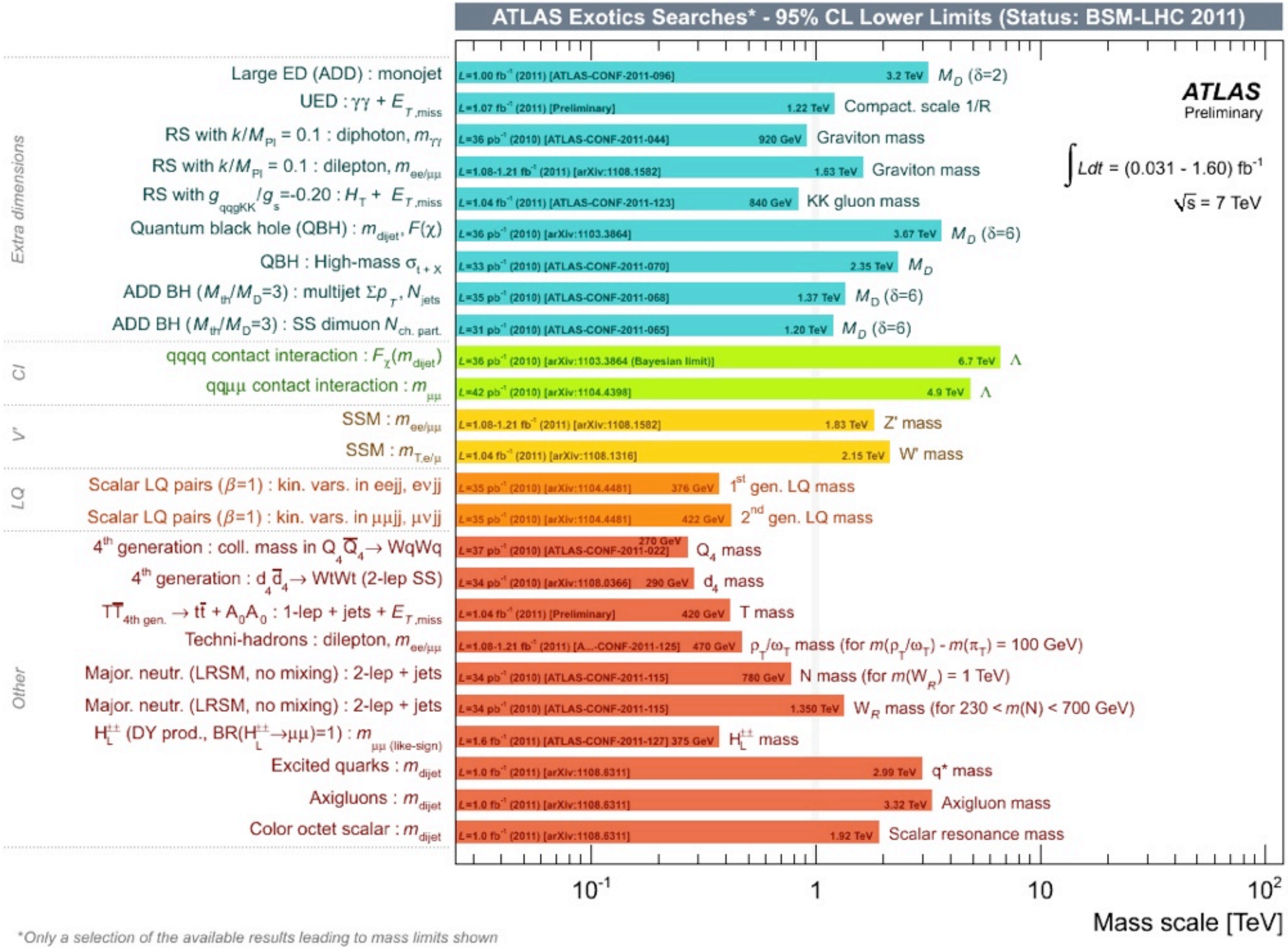
2nd gen. M > 422 GeV





arXiv:1104.4481 - Phys. Rev. D83 112006 (2011)

Grand Summary



+ many new/updated analyses on track to be approved for HCP!
check the daily updated list in: https://twiki.cern.ch/twiki/bin/view/AtlasPublic

Outlook and future perspectives

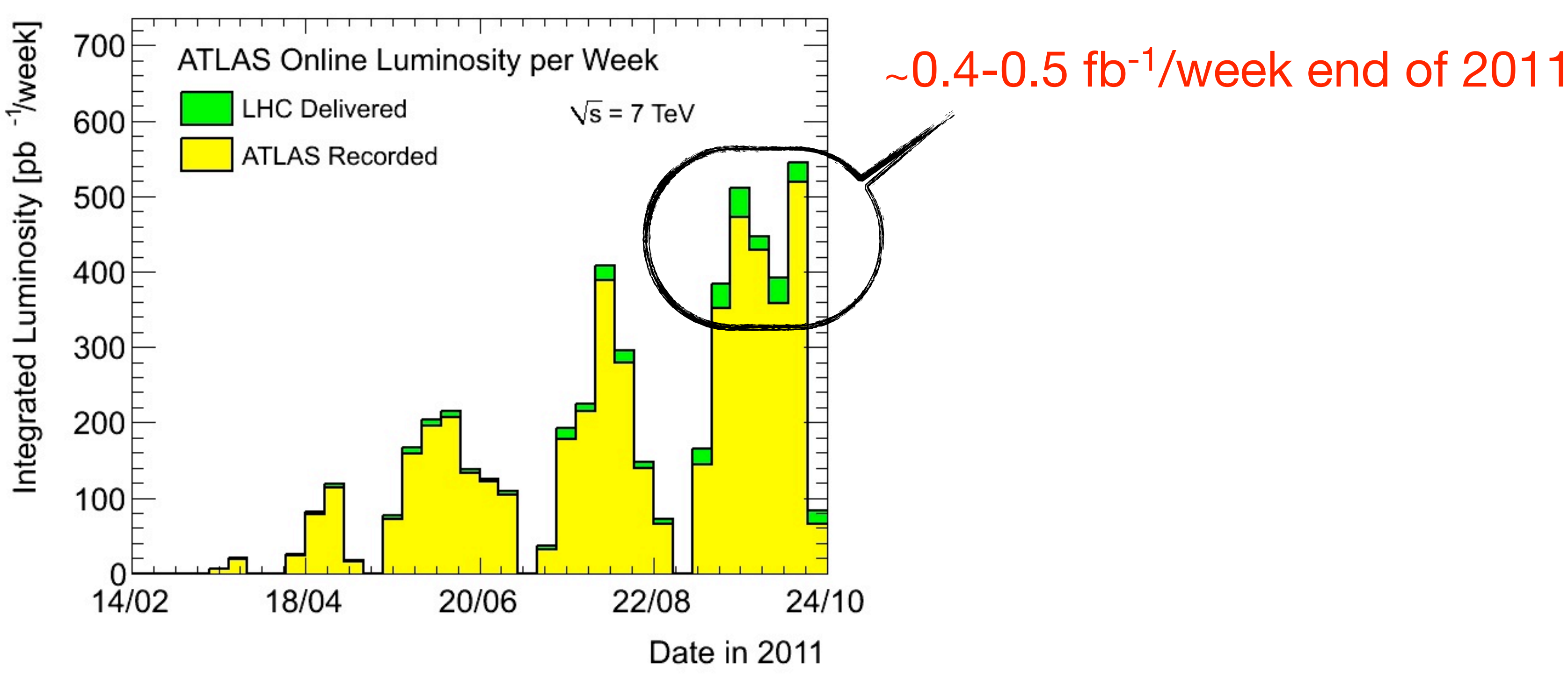
With less than 2 fb^{-1} of integrated luminosity ATLAS has been able to produce world class quality results, extending the parameter space explored at previous facilities with just 1 year of data taking ...

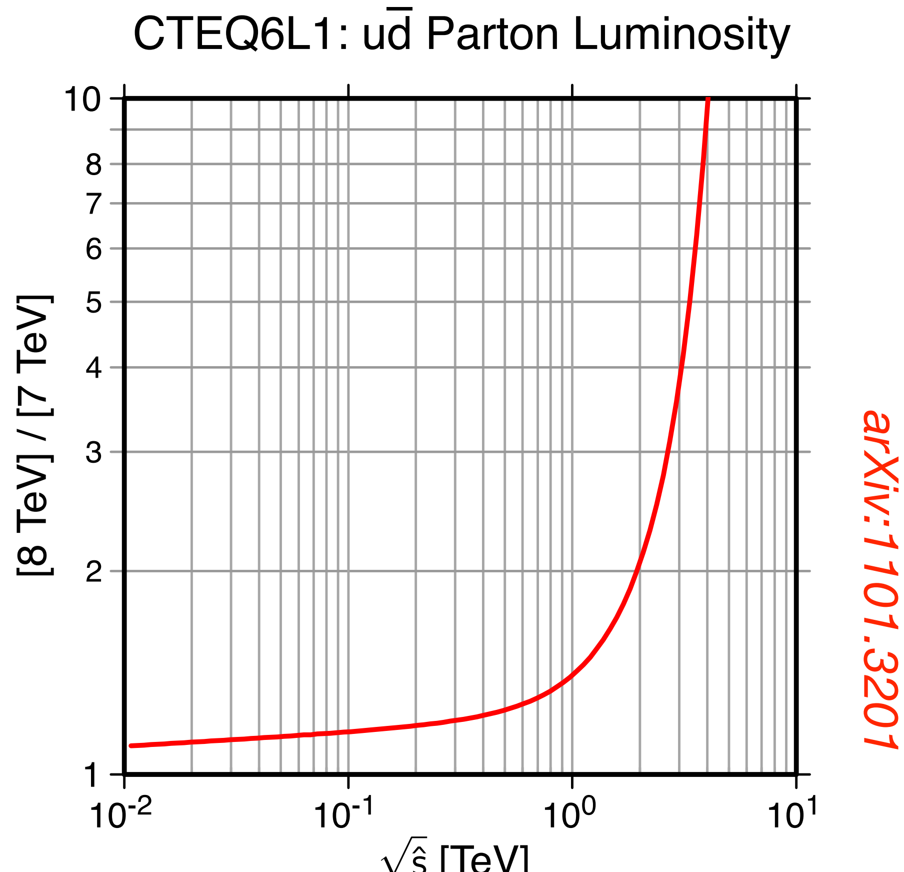
- heavy resonances excluded past 2 TeV
- 4th generation/techni-hadrons excluded up to ~0.4 TeV
- gravitions up to ~1.6 TeV
- excited quarks/axigluons excluded past 3 TeV

... but so far only exclusion limits, no hint of new physics yet

Additional 3 fb^{-1} already under analysis, O(10) expected in 2012 → access to the multi-TeV scale

- higher center-of-mass energy perhaps a better option than a x10 data at 7 TeV





... the discovering journey has just begun!

BKUP SLIDES

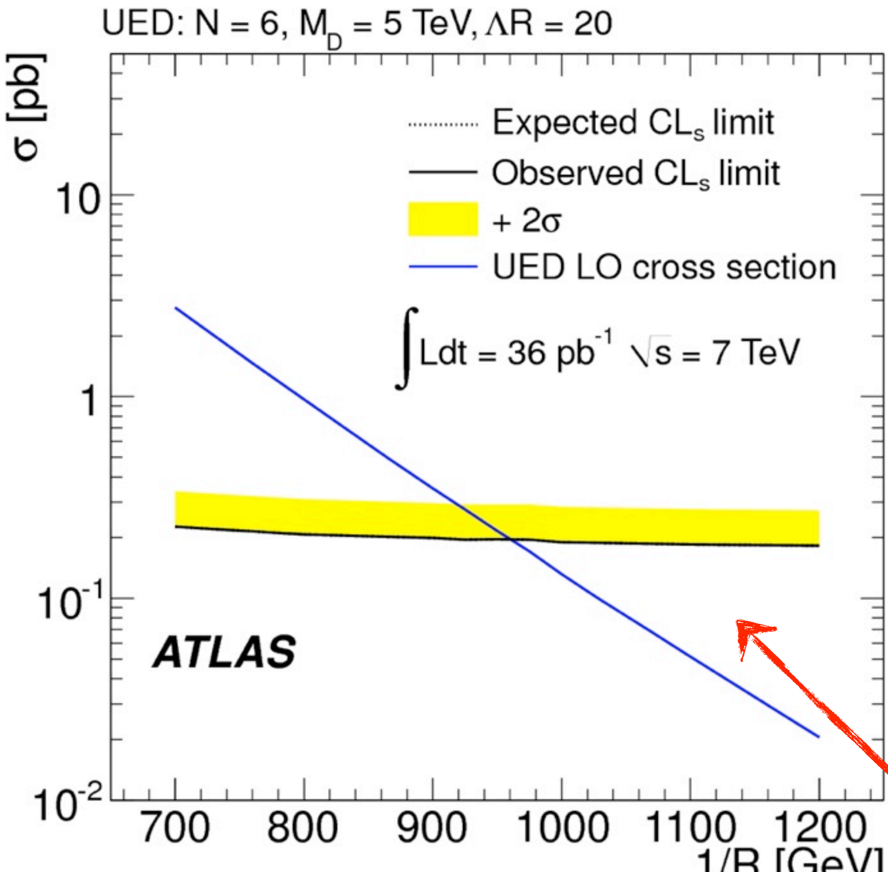
Search for UED in γγ+MET

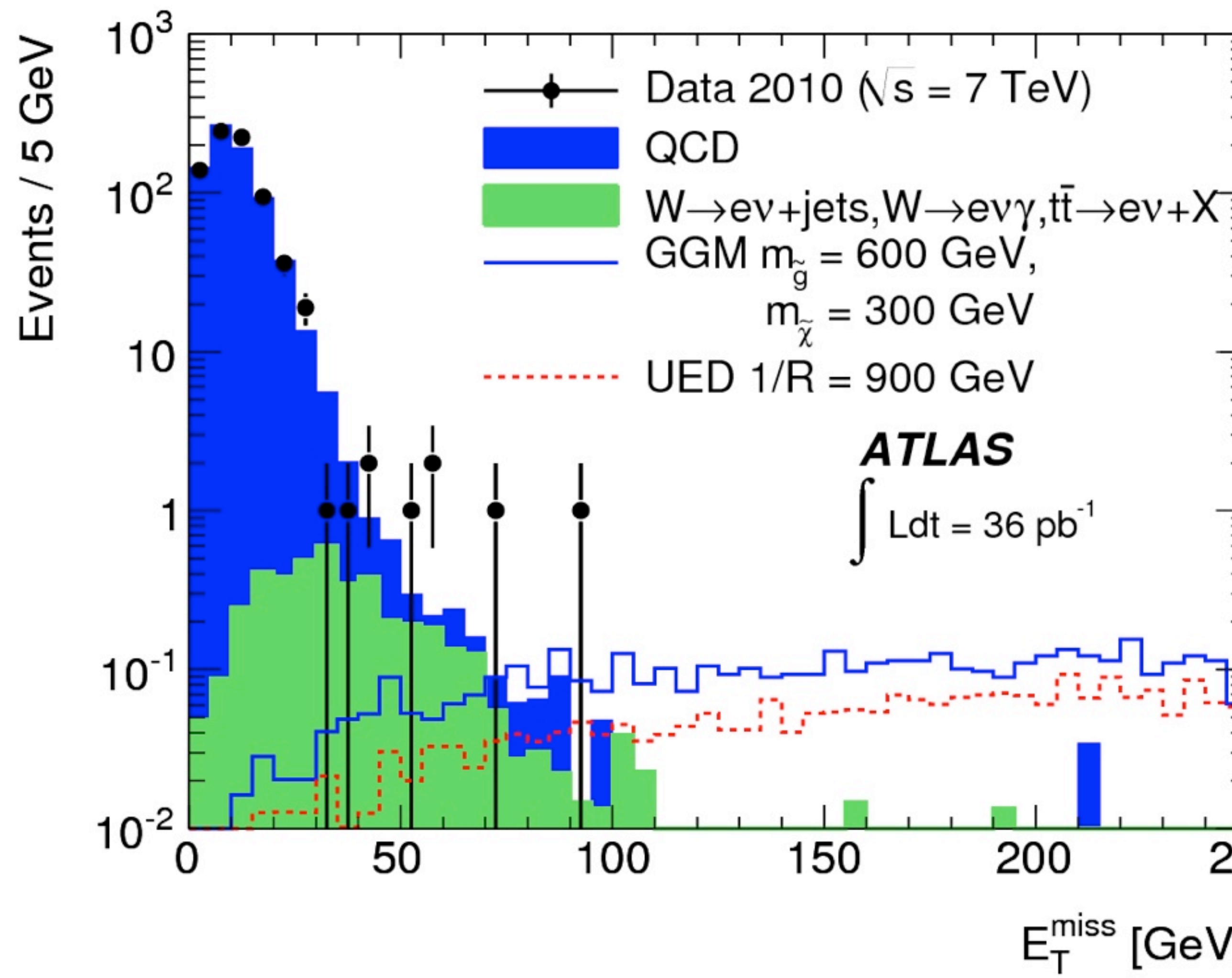
In UED models (but also GMSB) sizable yields of γγ+MET events compared to SM

- in UED the lightest KK particle γ* can decay gravitationally to γ+G
- the graviton G is one of a tower of eV-spaced graviton states, leading to a distribution of graviton mass between 0 and 1/R (compactification radius)
- Two decay chains per event → γγ+MET, with MET due to the escaping graviton in the ED

Analysis strategy:

- two photons (E_T>30 GeV) + large MET (>125 GeV)
- looks for excess on the MET spectrum
- main backgrounds estimated using control samples
  - QCD: γγ, γ+j, jj
  - W+jets, tt





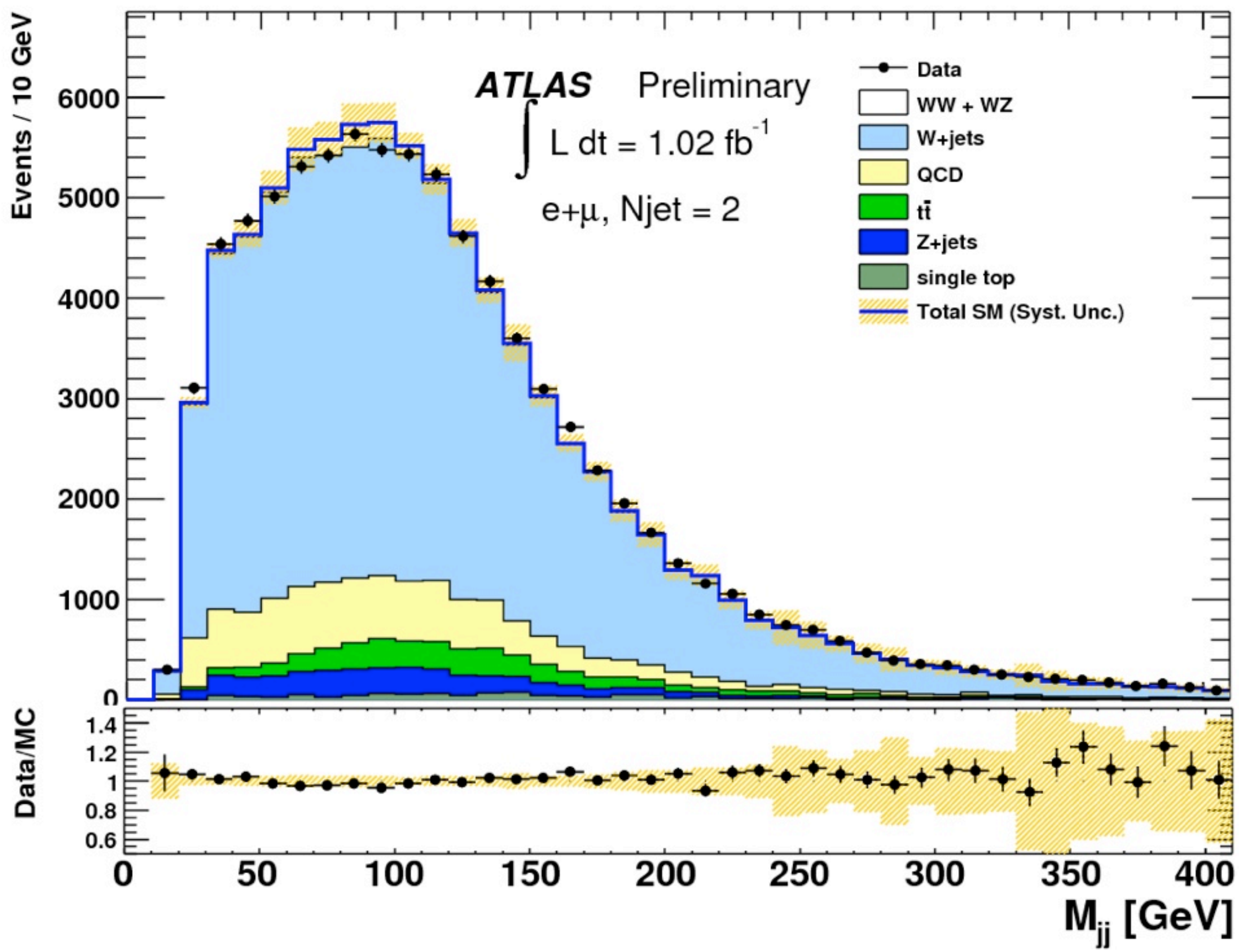
E_T^{miss} range [GeV]	Data events	Predicted background events Total	QCD	$W/t\bar{t}(\rightarrow e\nu)+\text{jets}/\gamma$	Expected UED
0 - 20	698	-	-	-	0.02 ± 0.01
20 - 75	63	61.4 ± 2.3	58.3 ± 2.2	2.99 ± 0.12	0.25 ± 0.02
75 - 125	1	0.38 ± 0.08	0.17 ± 0.08	0.19 ± 0.03	0.43 ± 0.02
> 125	0	0.10 ± 0.04	0.034 ± 0.034	0.057 ± 0.015	5.35 ± 0.11

exclude 1/R < 961 GeV @95% CL

arXiv:1107.0561

Search techni-mesons in W+jets

- Repeat CDF study of W+2jets production
  - sensitive to $\rho_T \rightarrow W+\pi_T(\rightarrow jj)$
  - keep selection as close as possible to CDF
  - harder than at Tevatron: worst S/B (signal x4, W+jets BG x20)



Selection:

$E_T > 25$ GeV (e), $p_T > 20$ GeV (μ)

MET > 25 GeV, $m_T > 40$ GeV

p_T(jet) > 25 GeV, $|\eta|<2.8$

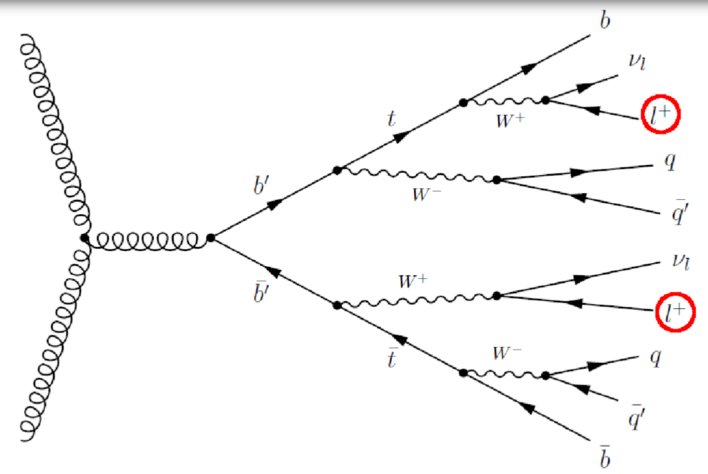
$p_T^{jj} > 4$ GeV, $|\Delta\eta^{jj}|>2,5$

ATLAS-CONF-2011-097

no significative discrepancy seen between data and simulation

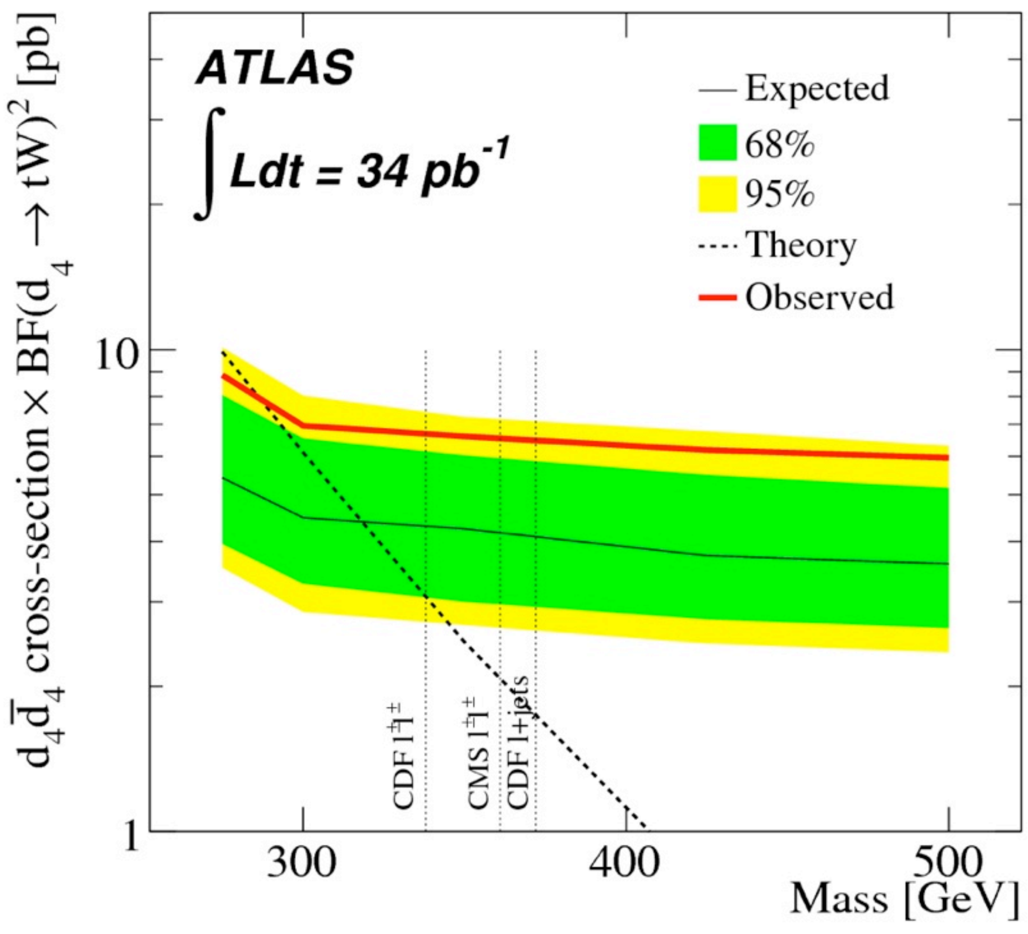
p-value in “CDF region” [120,160] GeV = 0.3 (0.5σ)

d4→Wt and Heavy Neutrinos in same-sign di-leptons

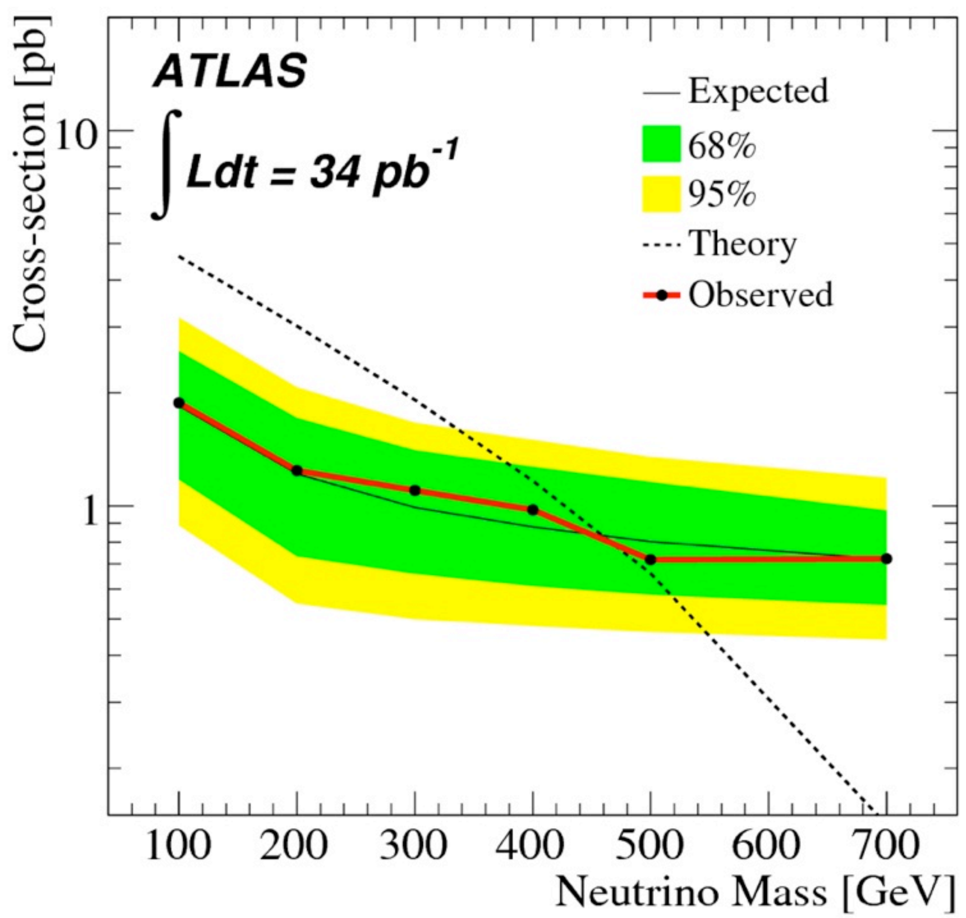


Search for 4th generation d-quark decaying to Wt

- d4d4→Wt Wt→bWW bWW → ll + 6j + MET
- analysis sensitive to many NP models: SUSY/UED/Majorana neutrinos/... done in the context of a generic same-sign di-lepton search
- strong BG reduction by requiring same-sign leptons and high MET



M_{d4} > 290 GeV/c^2 @95% CL



arXiv:1108.0366

Same analysis set limits on heavy neutrinos as 4th generation particles:

- N_2N_2→N_1Z N_1Z→ll + 2j + MET
- model: 4-fermions effective vector operator

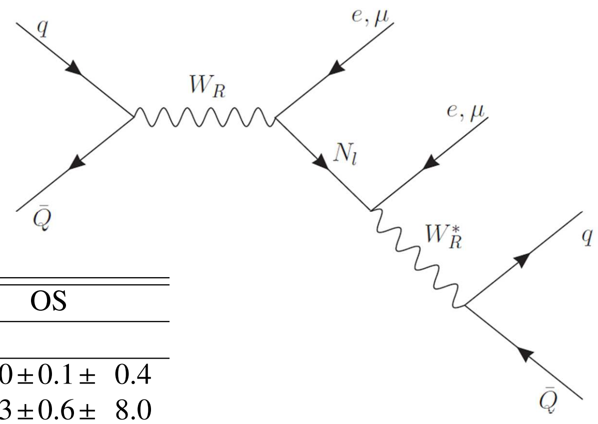
M_{N1} > 460 GeV/c^2 @95% CL
assuming NP scale Λ=1 TeV

Heavy Neutrinos and W_R in 2l+2jets

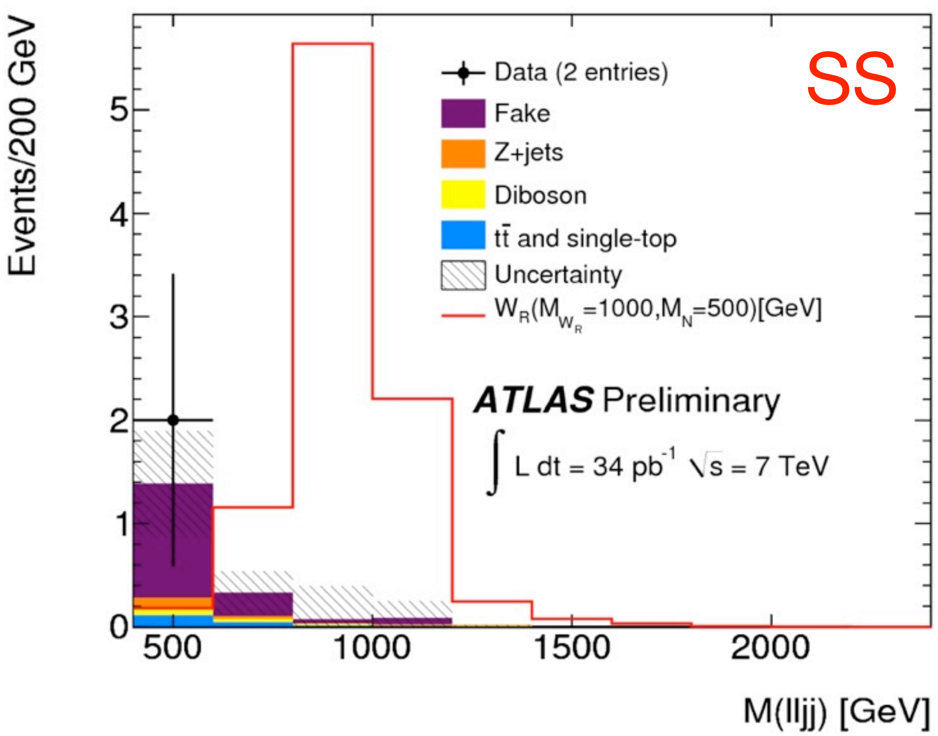
ATLAS-CONF-2011-115

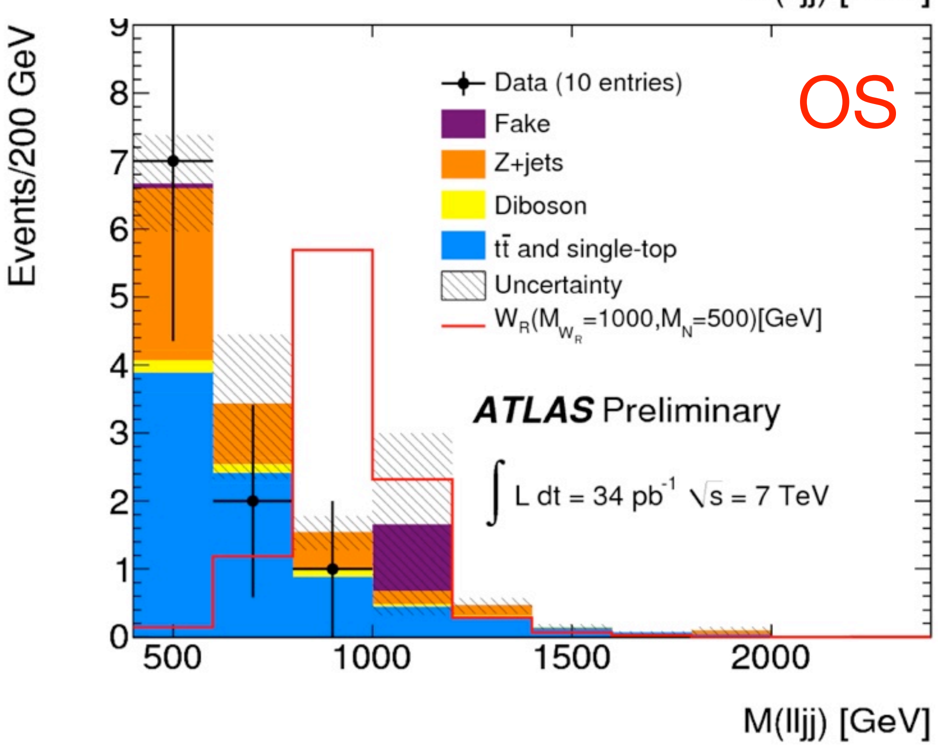
Benchmark: heavy neutrinos in L-R symmetric extension of Standard Model

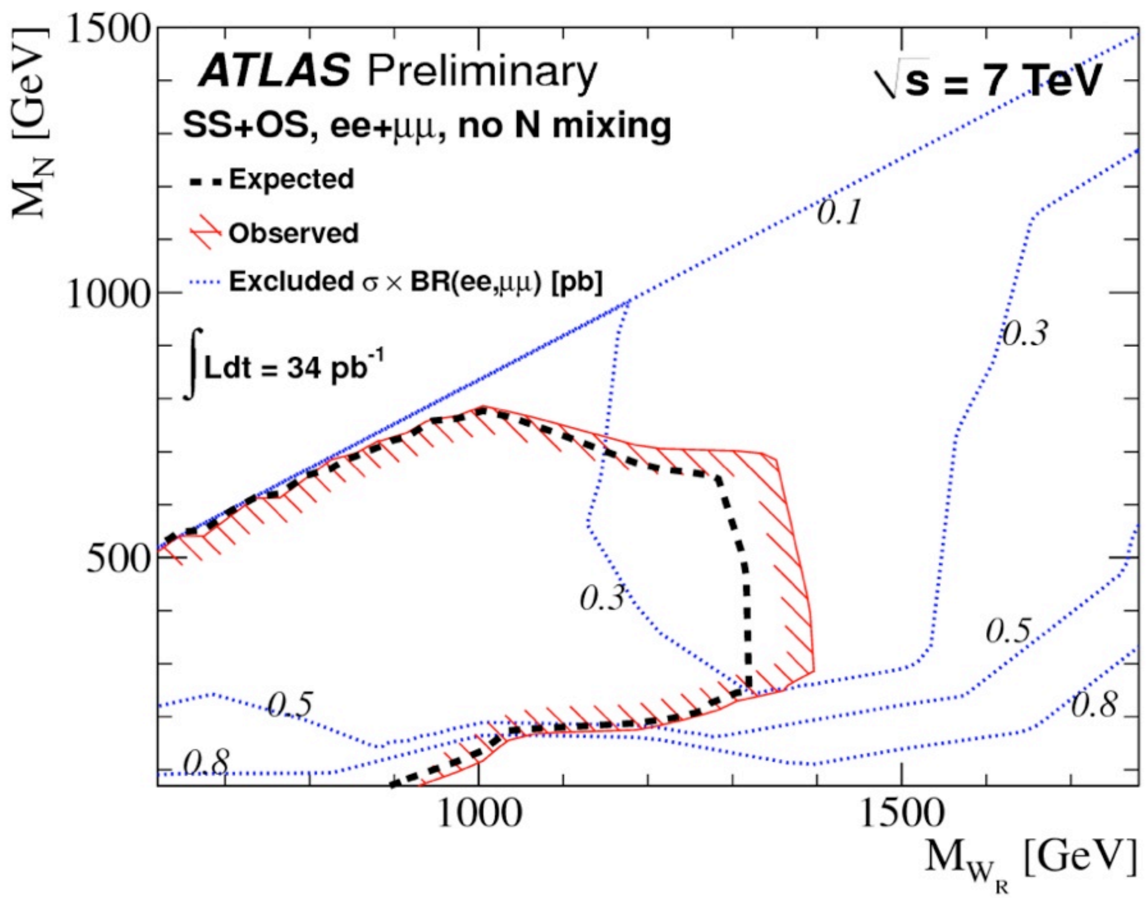
- $W_R \to N_1 l \to ll' W_R^* \to ll'jj$: search for resonances in the 2l+2j system
- both same sign (Majorana type neutrinos) and opposite sign (Majorana and non Majorana) lepton pairs considered



Physics Processes	SS	OS
	Preselection	
Diboson	0.18 ± 0.01 ± 0.01	4.0 ± 0.1 ± 0.4
$t\bar{t}$ + single top	0.39 ± 0.01 ± 0.06	56.3 ± 0.6 ± 8.0
$Z \to ll$	0.81 ± 0.06 ± 0.15	106.6 ± 3.2 ± 14.0
Fake lepton(s)	5.81 ± 1.27 ± 2.06	6.9 ± 2.3 ± 2.7
Total background	7.2 ± 1.3 ± 2.1	173.8 ± 3.9 ± 16.7
Observed in data	5	177
	Final selection	
Total background	1.9 ± 0.4 ± 0.5	13.3 ± 1.2 ± 2.1
Observed in data	2	10







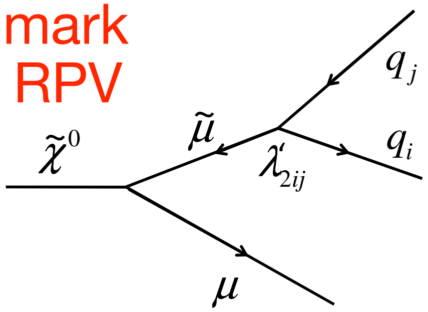
Significant extension of previous limits from LEP/Tevatron

Searches for LLP: displaced vertices

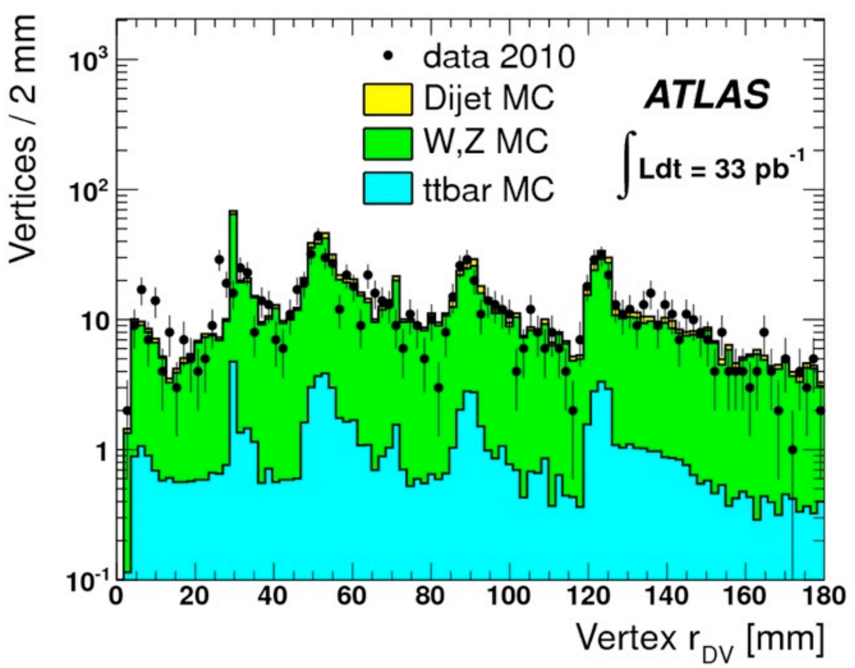
Inclusive search for vertices outside the beam-pipe, in association with a high p_T muon

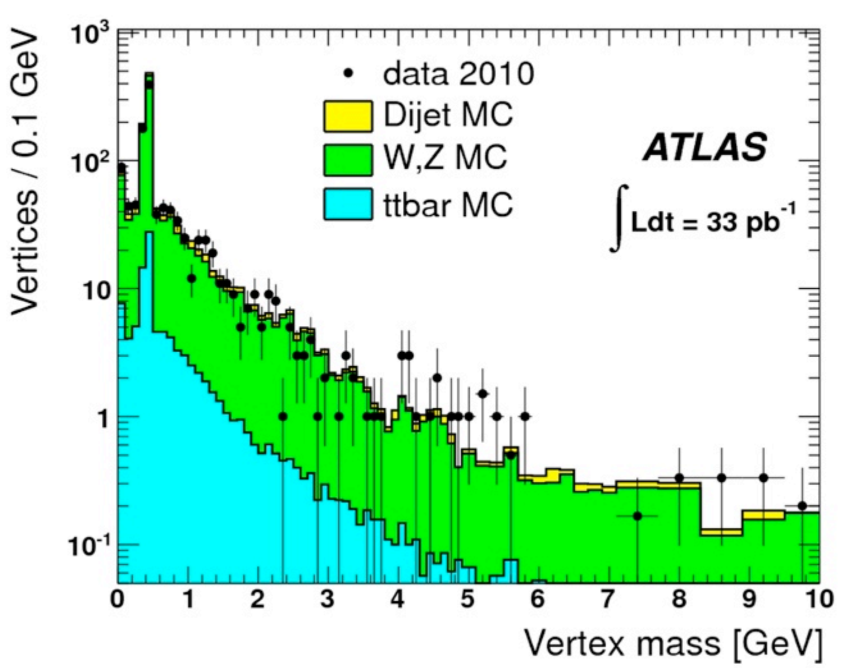
Crucial: good understanding of tracking, detector passive material

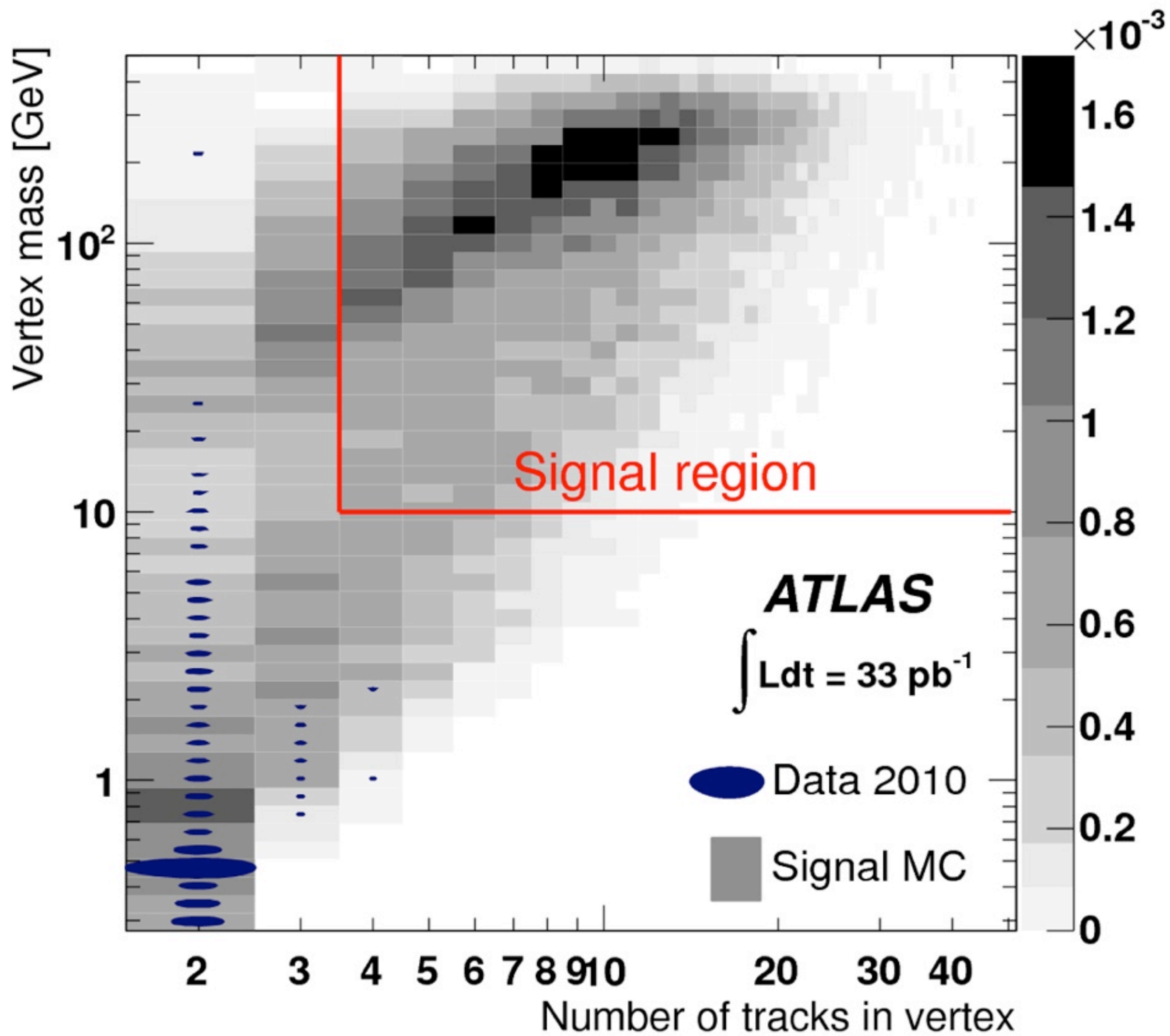
Benchmark SUSY RPV



Background:
- vertices from BG from hadronic interactions with detector material
- typically low-mass, but coinciding tracks at large angle can result in high mass vertex
- veto vertex position with material map from 2010 data







arXiv:1109.2242

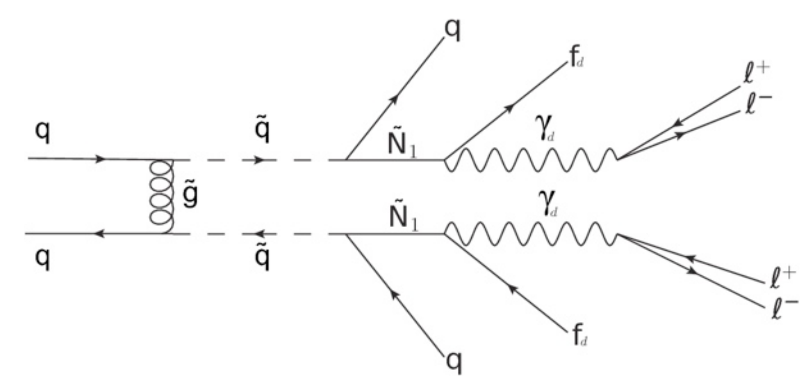
Control region:
- M_{vertex}<10 GeV, allows 2-track vertices, no material veto
- excellent agreement in shape and yield

Hidden Valley: prompt lepton-jets

Search for new light (m~GeV scale) Hidden Valley bosons (dark photons γ_d) decaying to muons

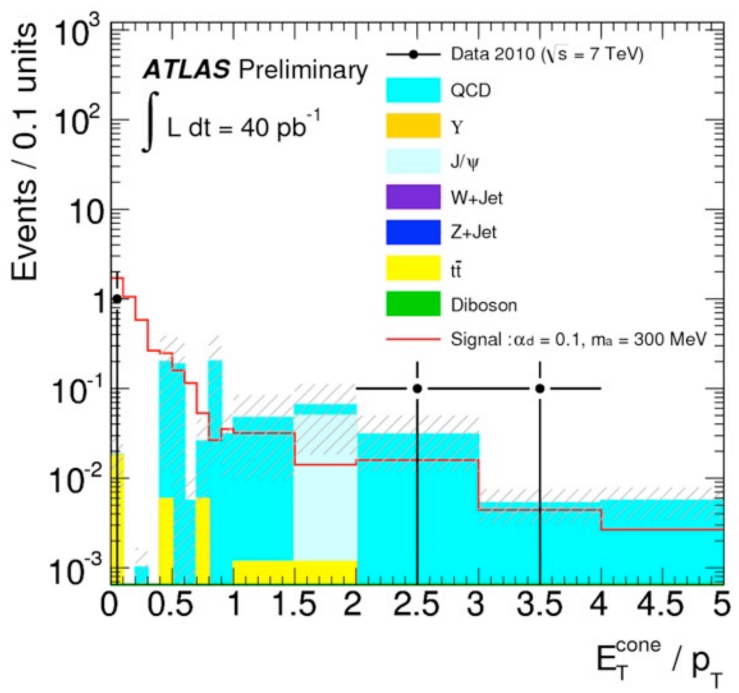
- predicted in many Hidden Valley models, with SUSY (used as benchmark) and w/o SUSY
- Proposed to explain anomalies in astrophysical observations related to abundance of cosmic electron/positrons and dark matter searches

- highly boosted final state muons → collimated jets of leptons (lepton-jets)
- dark photons γ_d may have long lifetimes or decay promptly, first pilot analysis focused on prompt objects

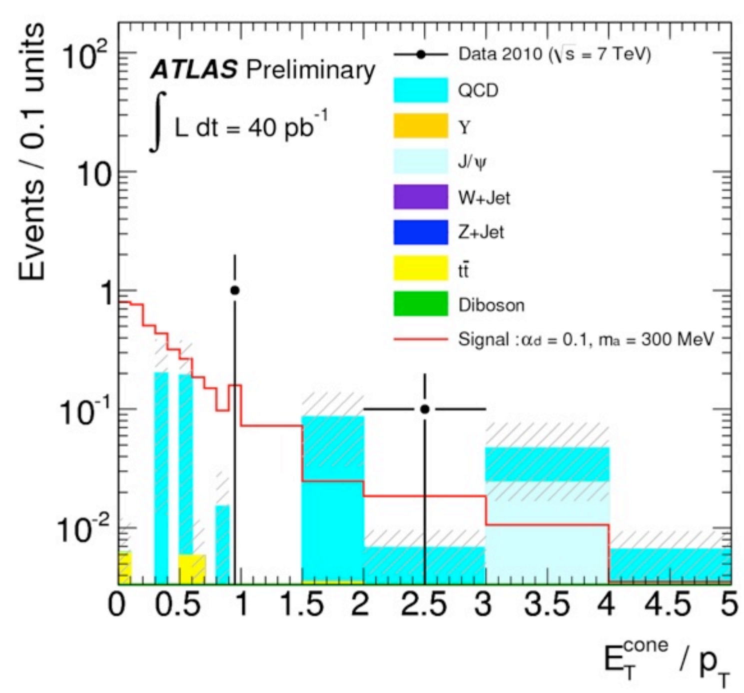


ATLAS-CONF-2011-076

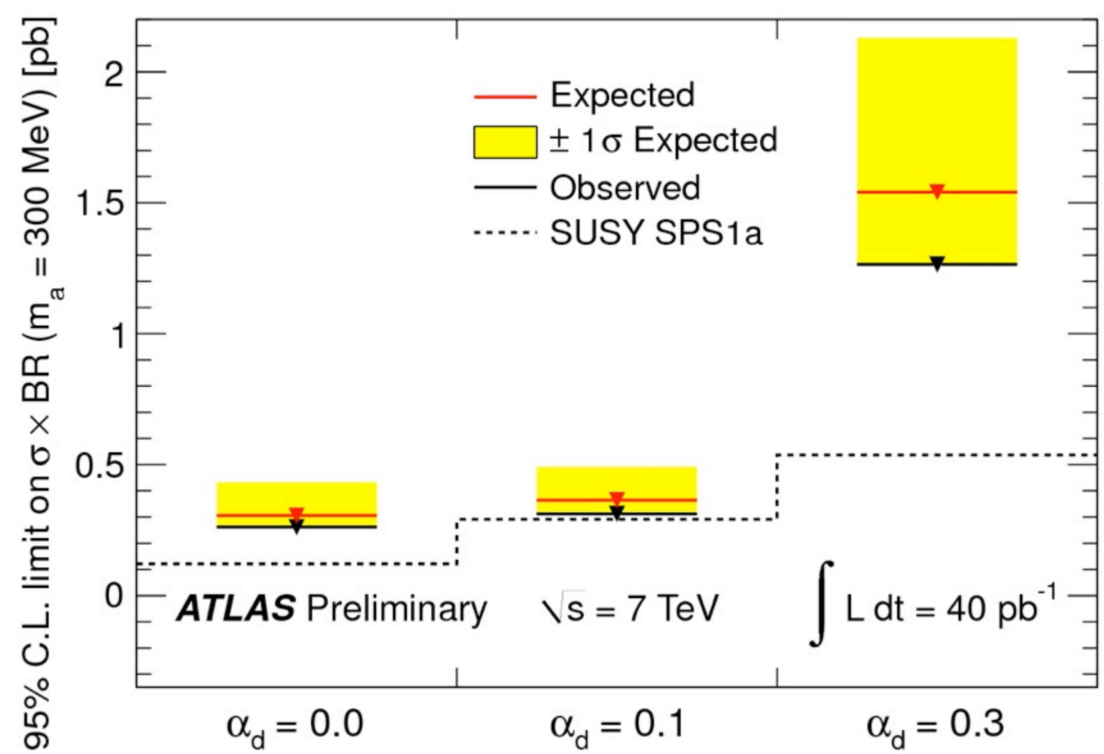
Leading p_T Lepton-Jet



2nd leading p_T LJ



LJ scaled isolation
$\sum E_T/p_T$



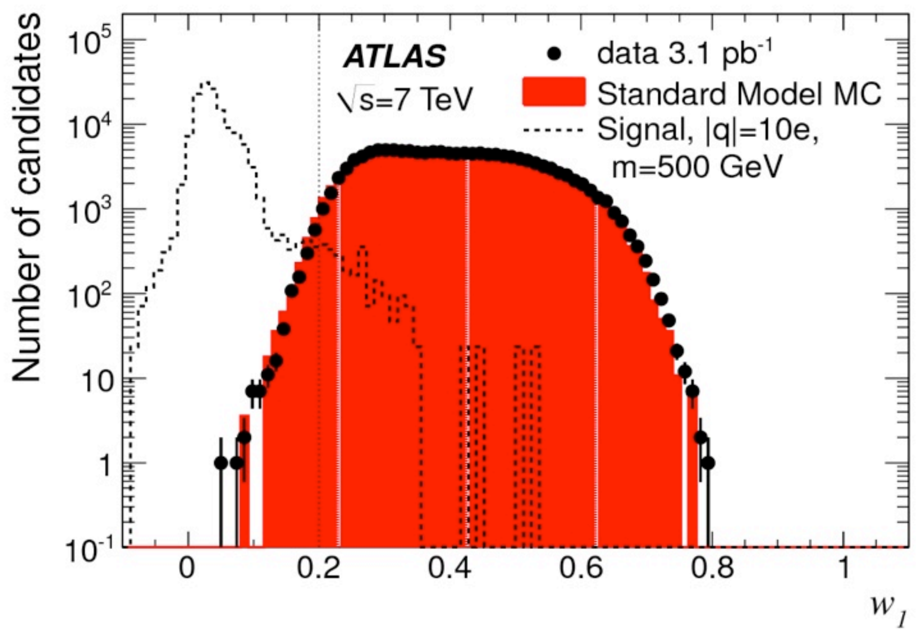
With 40 pb^{-1} sensitivity at the level of expected signal x-section

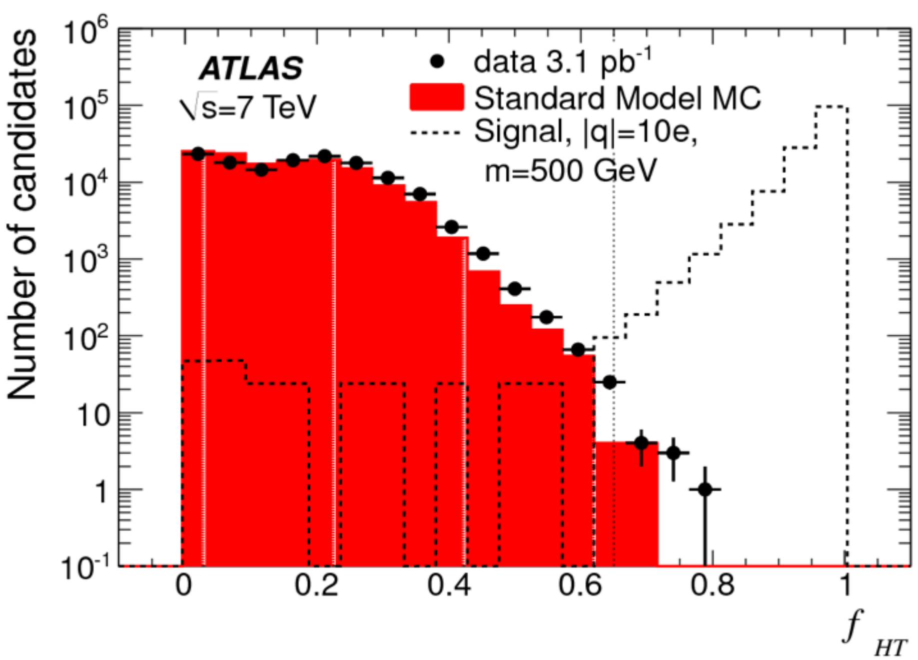
... full statistic analysis ready soon together results for displaced LJ ...

Highly Ionizing Particles

Predicted by Q-balls, stable μ-BH, monopoles, dyons, ...

- Large mass → slowly moving through the detector volume
- |q| >> electron charge → high specific ionization
- Generic signature: very high ionization track and narrow EM cluster → very low Background
  - First and so far only search at LHC energies (2010 data, 3.1 pb^{-1}): sensitive to |q| in the range 6e-17e
  - Second generation analyses in progress: larger statistic, sensitive to larger intervals of HIP charge and to magnetic monopoles





w_1 = lateral extent of EM energy deposition in second layer

f_{HT} = fraction of track TRT hits that pass high threshold

m [GeV]	$\lvert q\rvert = 6e$	$\lvert q\rvert = 10e$	$\lvert q\rvert = 17e$
200	1.4	1.2	2.1
500	1.2	1.2	1.6
1000	2.2	1.2	1.5

Pair production cross section (pb) upper limits 95% CL, in fiducial ranges (η, E_{kin})

m [GeV]	$\lvert q\rvert = 6e$	$\lvert q\rvert = 10e$	$\lvert q\rvert = 17e$
200	11.5	5.9	9.1
500	7.2	4.3	5.3
1000	9.3	3.4	4.3

Pair production cross section (pb) upper limits 95% CL, assuming Drell-Yan kinematics

arXiv:1102.0459 - Phys.Lett. B698:353-370,2011