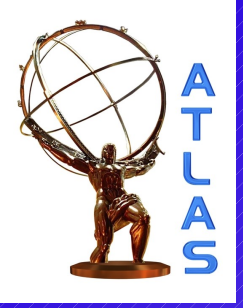

Exotic Searches in Top and Top-like Final States with the ATLAS Detector

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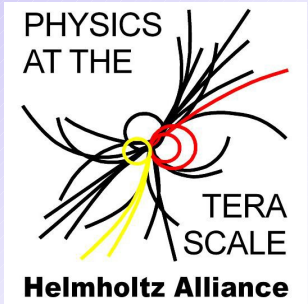
DESY
on behalf of the ATLAS Collaboration

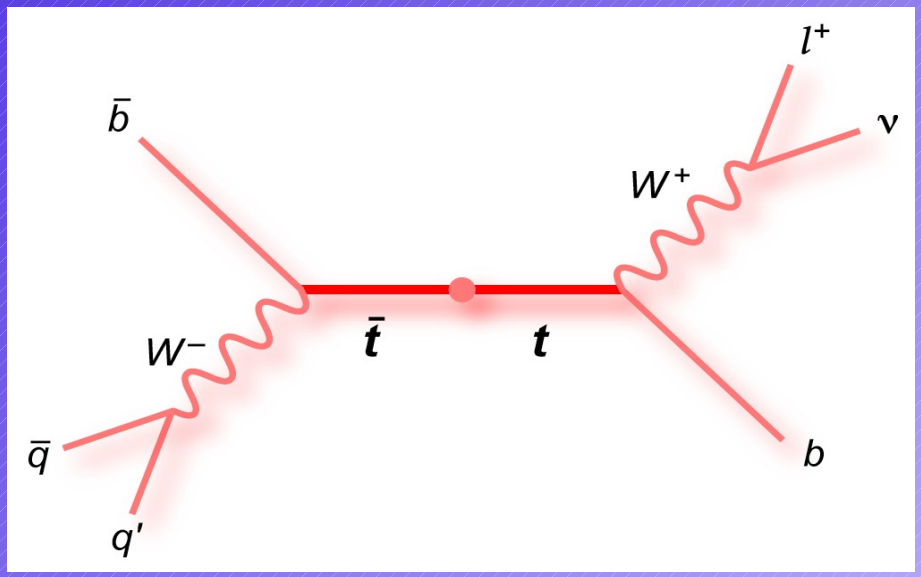
EPS-HEP 2011 Grenoble, 21.07.2011



Overview

Top is heaviest standard model particle:

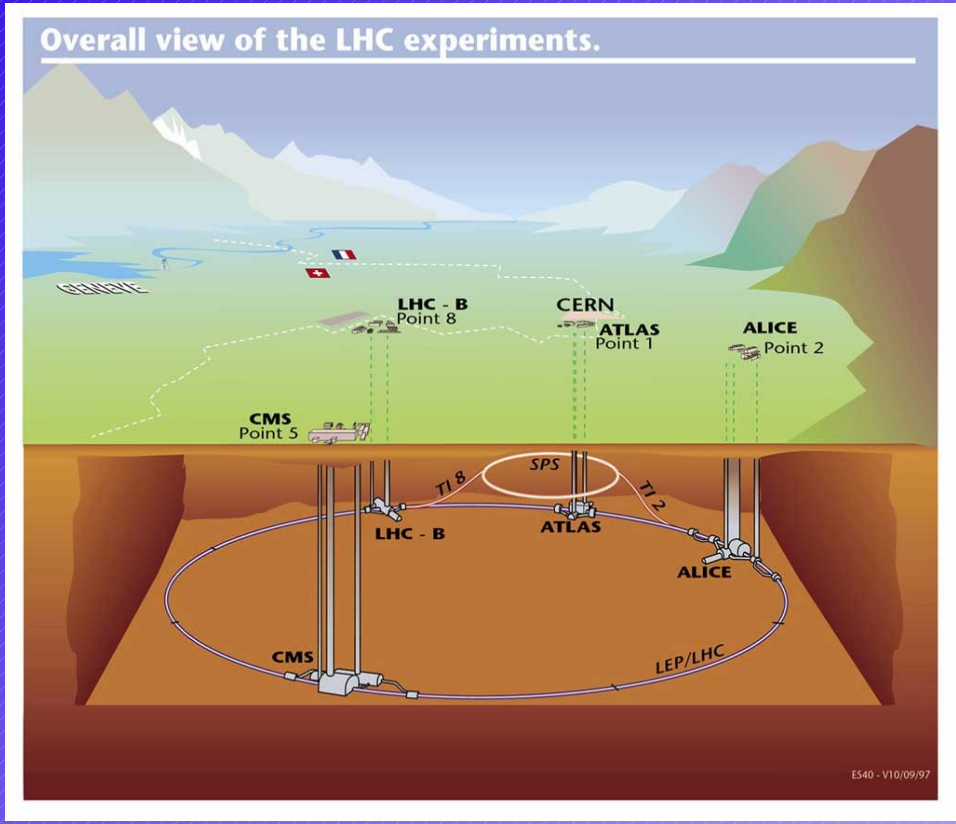
Exceptional status for new physics, especially if new physics couples to the mass

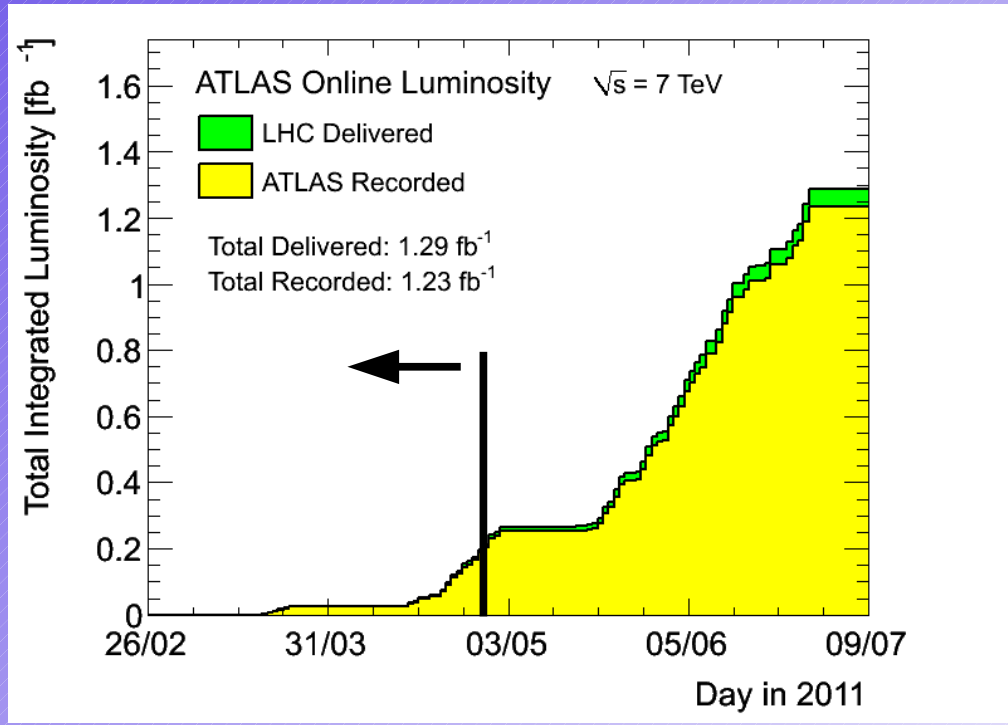


Search for new, exotic physics:

- Resonant Top-pair production: (ATLAS-CONF-2011-087, ATLAS-CONF-2011-073)
- Excess at high m_{tt} (black holes)(ATLAS-CONF-2011-070)
- Top-Pairs + Missing energy (ATLAS-CONF-2011-070)
- Heavy top like particles: 4th Generation quarks (ATLAS-CONF-2011-022)
- Production, decay and properties of Top (FCNC, Top-charge … not part of this talk)

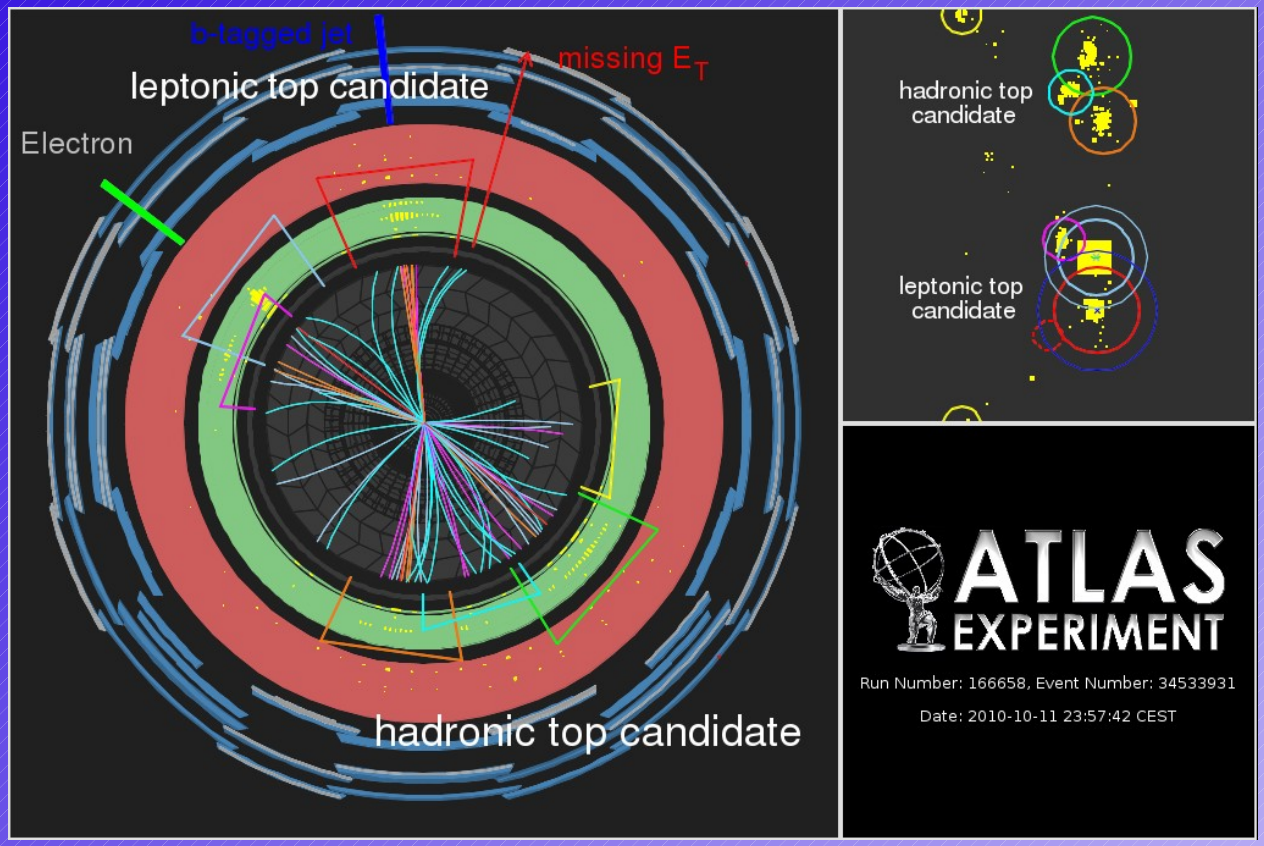
Data Set





- LHC: Excellent performance of the machine at 7 TeV, ~1.3 fb^{-1} of data delivered per experiment
- This talk contains results based on luminosity of 35-200 pb^{-1}

Resonance searches: Signal signature

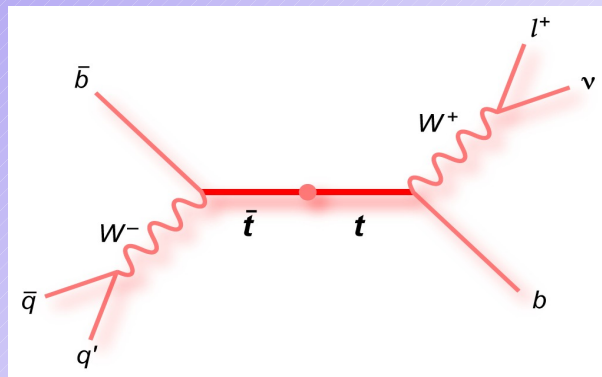


Resolved signature:

- 1 lepton (e or m)
- At least 4 jets
- At least 1 b-tagged jet
- Covered ~ 36% of all SM top pairs decays (Lepton essential for trigger and QCD reduction)

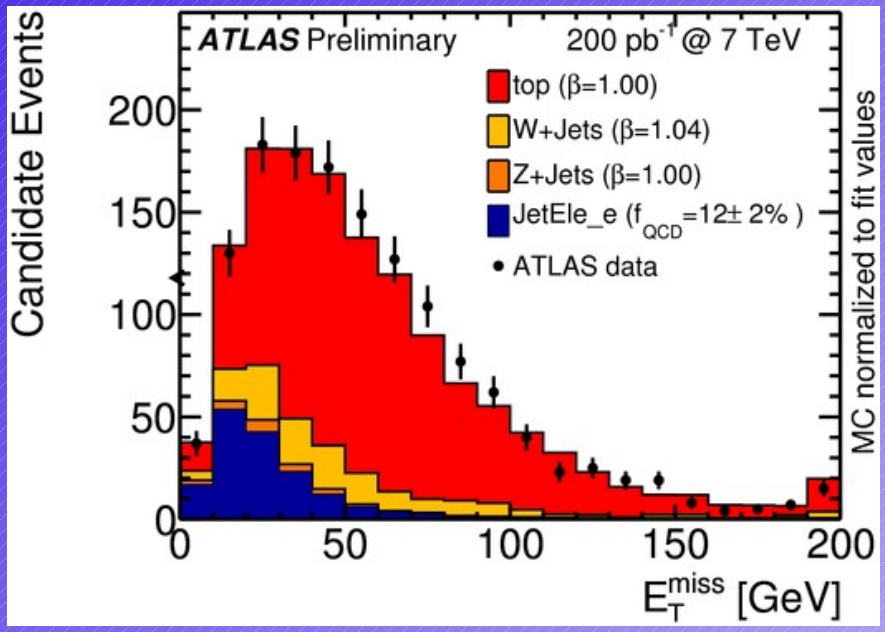
At high m_{tt} :

- Top pairs get more and more p_T (boosted tops)
- objects (leptons and jets) merge → monojets



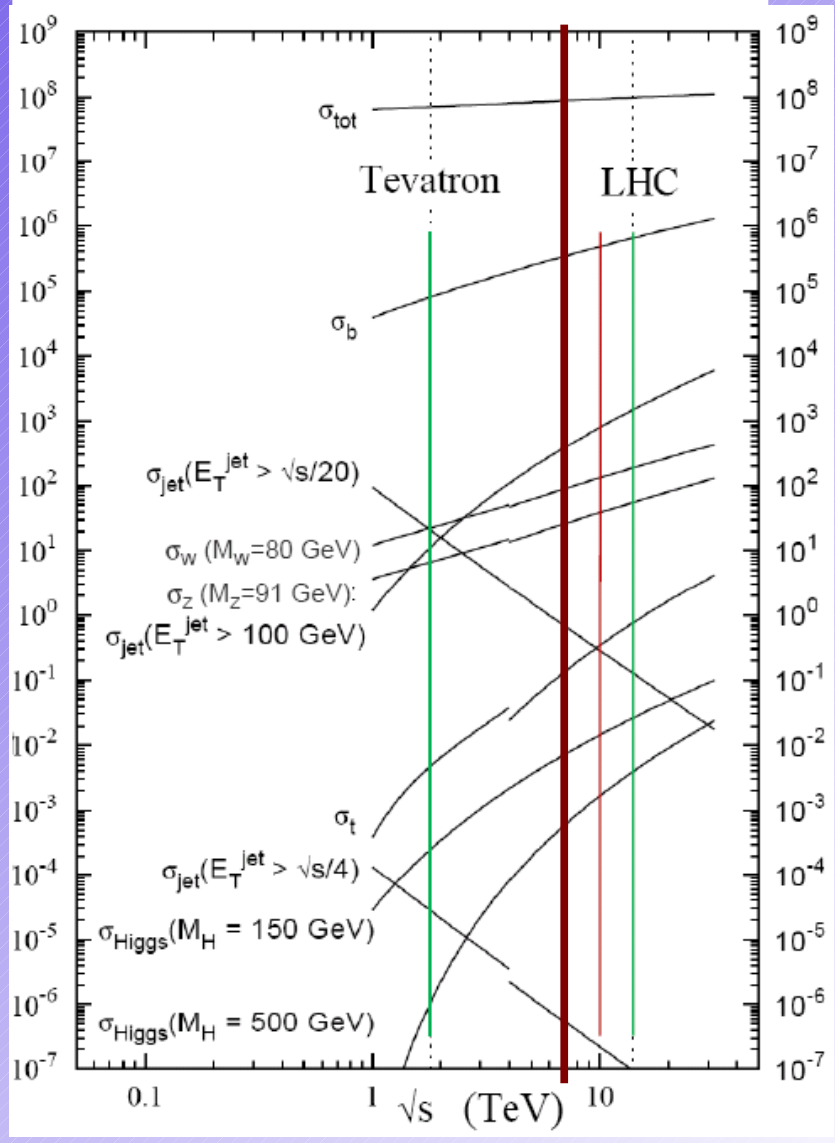
Backgrounds

Main backgrounds:
- Ttbar (basically irreducible)
- W+jets (rejection via b-tag)
- QCD Multijet (no real leptons)



QCD background cross section/rejection not well modeled by Monte Carlo:
→ need (semi-)data driven background estimate; fit of QCD template from data to E_t^{miss} distribution

Proton-Proton cross section in pb



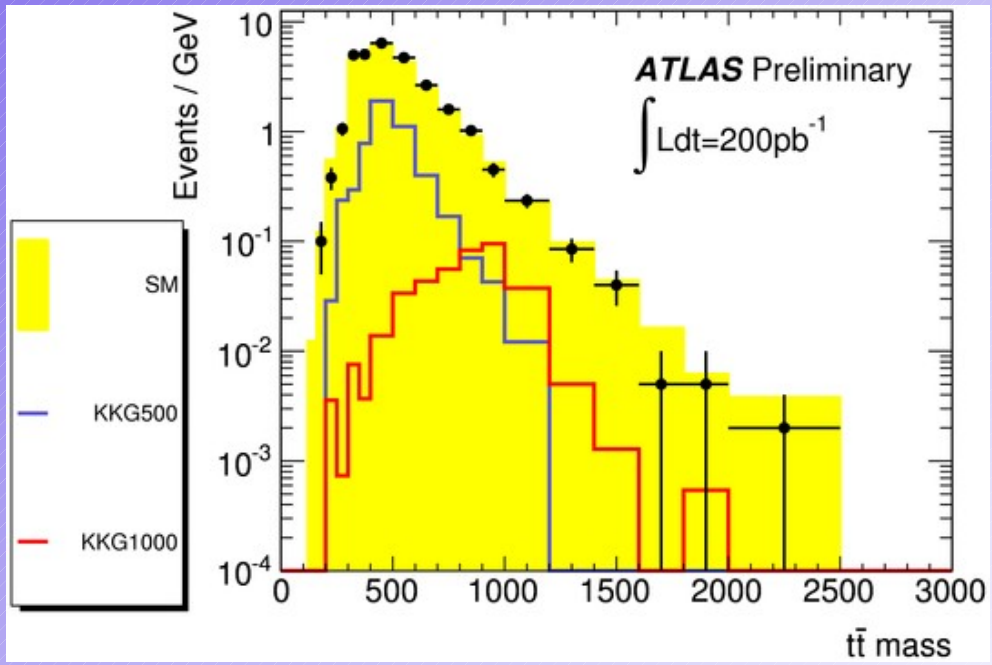
Mass reconstruction

Use simple and robust mass reconstruction schema:

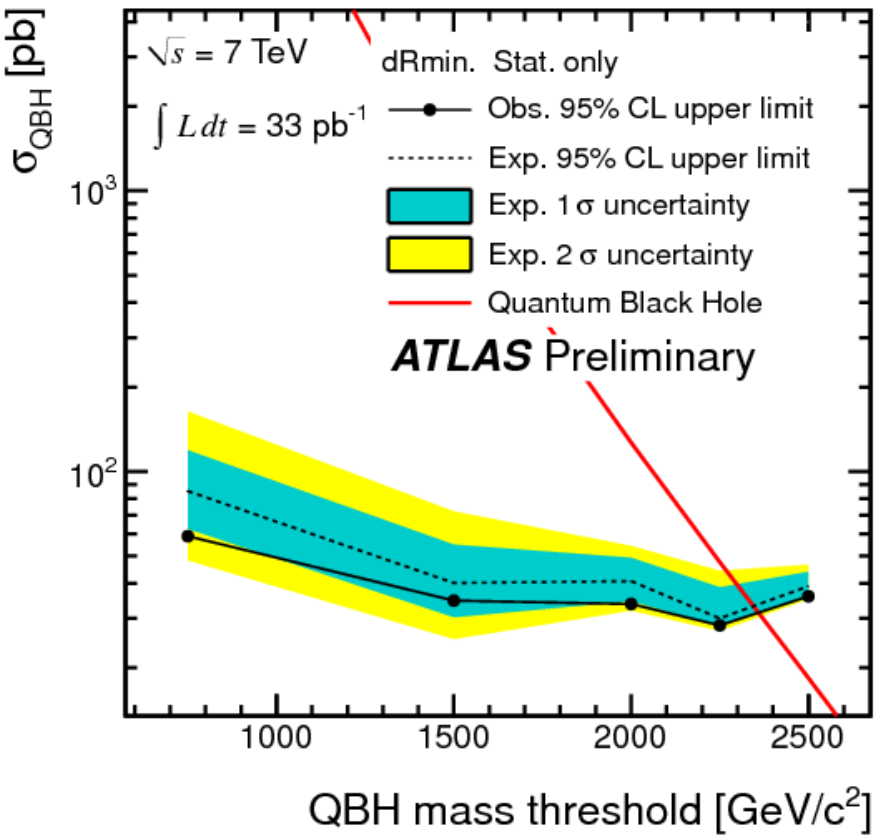
- Reconstruct full final state instead of two separate tops
- Using 4 leading jets for m_{tt} leads to a long tail in resolution (initial state radiation)

→ better: ΔR(min) method: exclude jets which are clearly separated from other jets/lepton (good ISR candidates)

	Electron channel	Muon channel
$t\bar{t}$	724	988
Single top	36	50
W+jets	93	172
Z+jets	6	8
Diboson	2	2
Total MC Background	861	1220
QCD Background	35	105
Total Expected	896	1325
Data observed	935	1396
Z', m = 500 GeV	15	21
g_{KK}, m = 700 GeV	68	93



Black hole limits



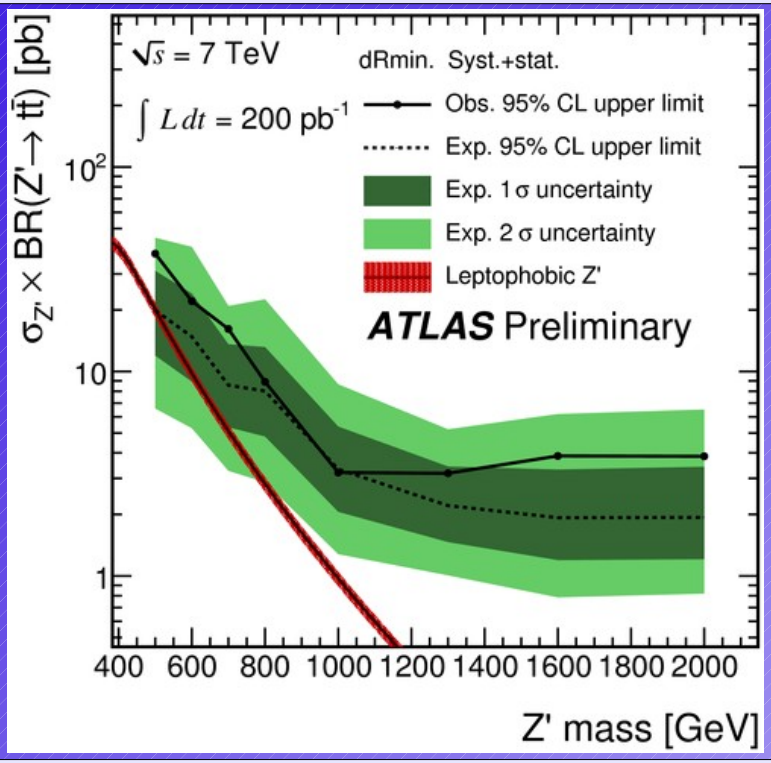
Black holes:

- First Limit from Atlas from ttbar high mass analysis
- Black holes decaying via strong gravitational scattering (JHEP 0805 (2008) 003, JHEP 0805 (2008) 003)
- 24-38% BR (750-2500 GeV black hole threshold mass) of t+X and low parton multiplicity
- → Looking for an excess of tops at high m_{tt}

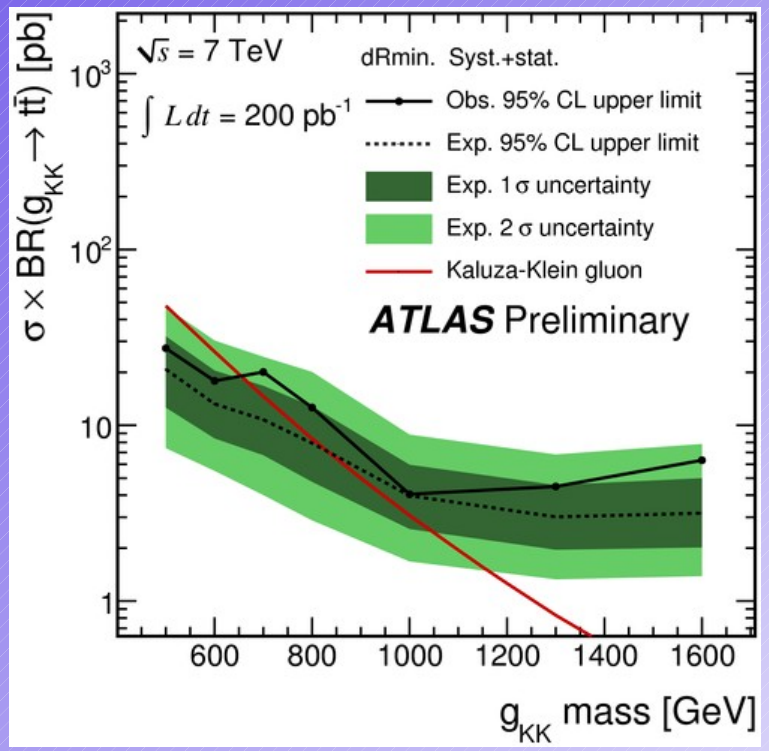
Exclude quantum black hole mass thresholds below 2.35 TeV

Limits for resonances

Narrow Z' produced weakly



Wider Kaluza-Klein-Gluons produced strongly



Leptophobic Top-Color:
- arXiv:hep-ph/9911288;
- No exclusion up to now (200 pb^{-1})
- Tevatron exclude m_{tt}~900 GeV with 3-5 fb^{-1} lumi

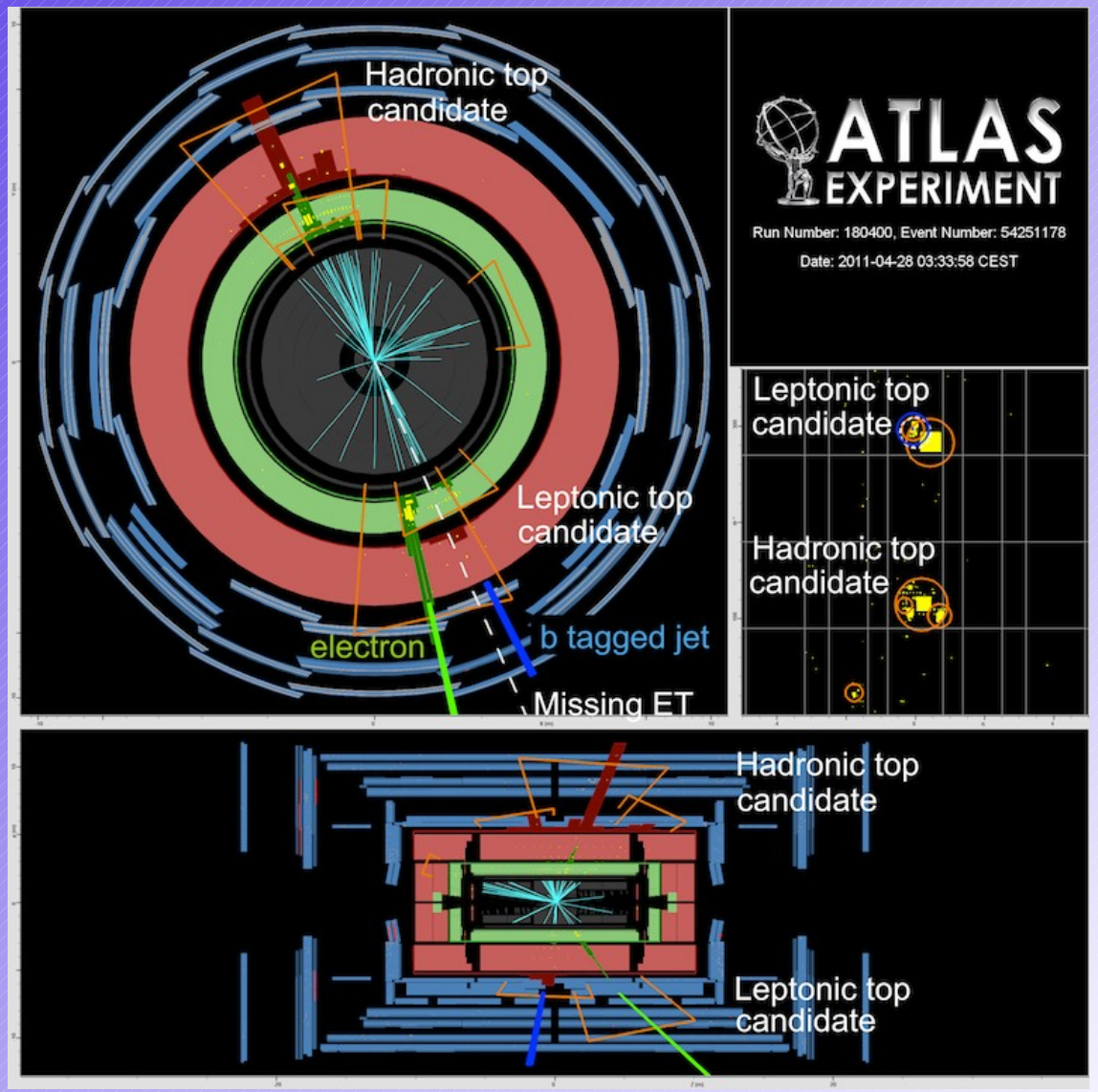
Randal-Sundrum Modell:
- arXiv:hep-ph/0701166; ATL-PHYS-PUB-2010-008;
- Exclude low masses (< 700 GeV)

Heavy Resonances: Boosted top pairs

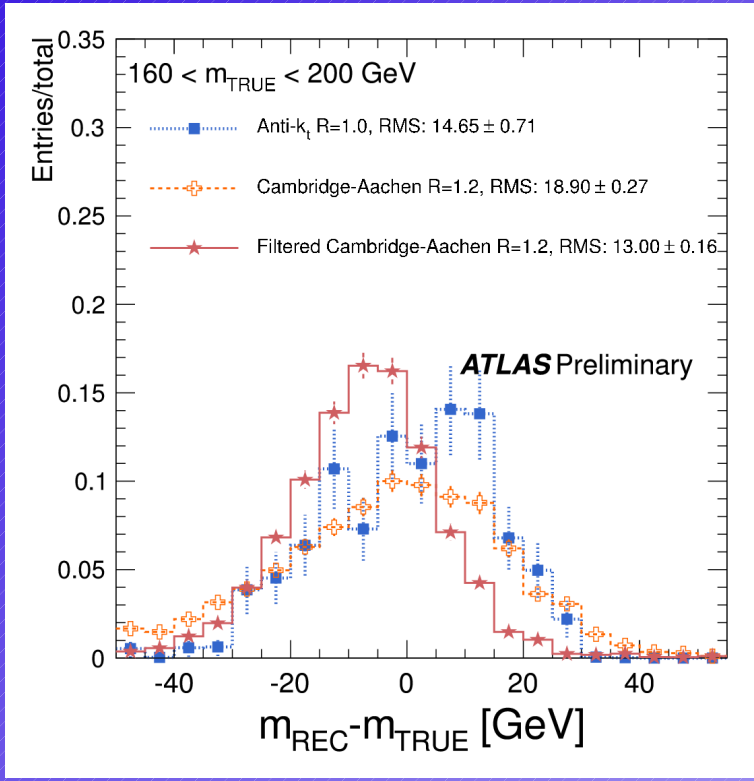
Candidate with m_{tt}~1.6 TeV:

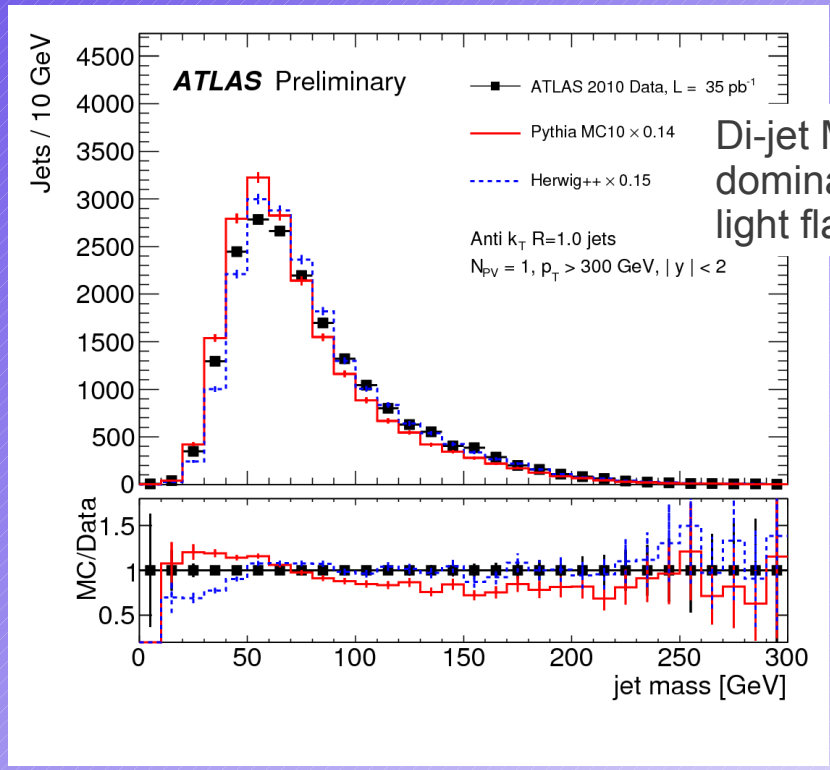
- Tops get heavily boosted
- Partons only just in separated jets
- Higher m_{tt} need other reconstruction strategy than standard top selection
→ fat jets including all partons

First step:
- Reconstruction of hadronic top as one fat object



Boosted top quarks: substructures





Di-jet MC, dominated by light flavors

In Simulation final states with $m_{jet} \sim m_{top}$ have a good jet-mass resolution

- Pile up is biggest problem:
  - influences anti-kt 1.0; needs calibration
  - Cambridge-Aachen seems less affected
- Jet mass in data described reasonably by Pythia and Herwig

Top-Pairs plus missing E_T

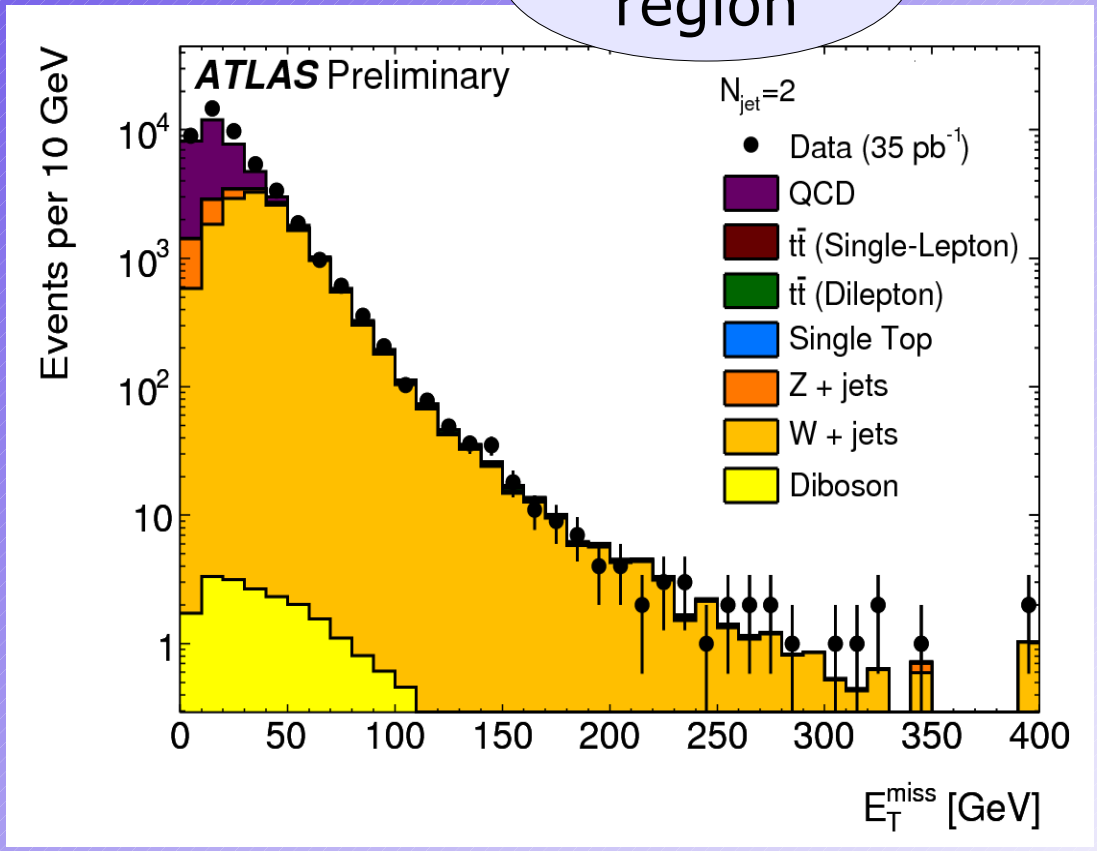
- Example: TT → ttA_0A_0

Top Quarks plus missing E_t^{miss}

- Sensitive to production of heavy particle decaying into Top quarks plus additional neutral particles
- Essential: Good knowledge of missing E_t
- Early studies have low statistics → validate background in lower njet bin (here n_{jet}=2).

→ good agreement between data and Monte Carlo

Control region



Top-Pairs plus missing E_T

Signal region

N-jet=4 low statistics

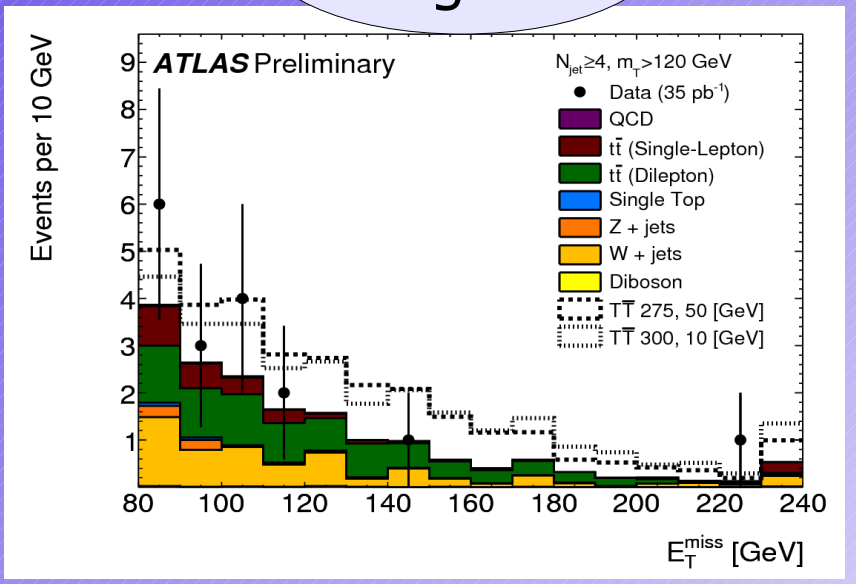
- Data-Monte Carlo comparison fair agreement

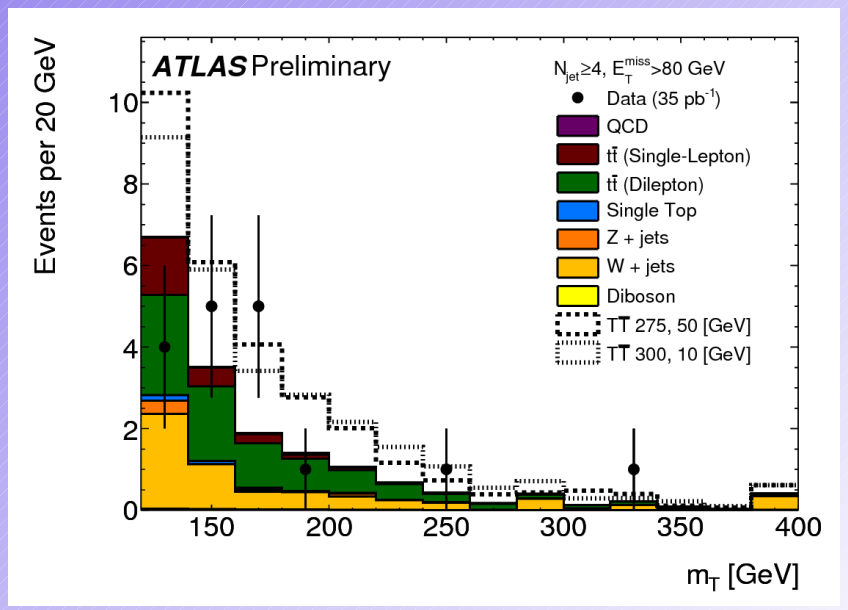
Transversal Mass distribution

- No signal of heavy particle seen

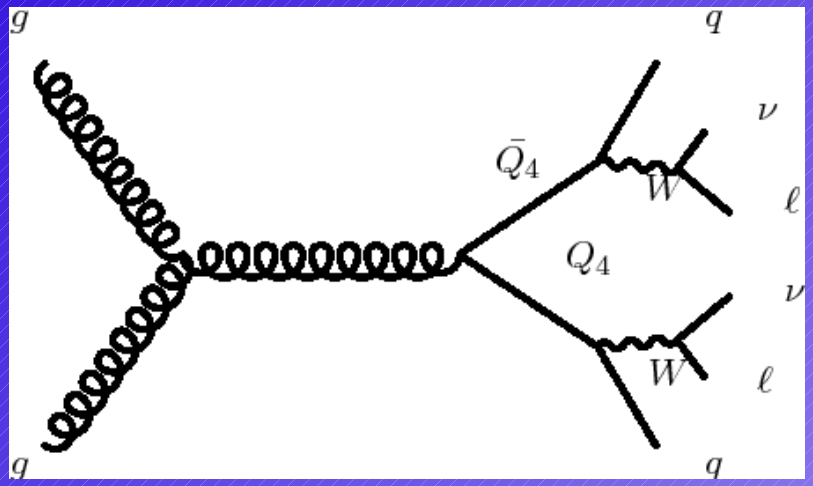
→ Exclusion with 35 pb^{-1} (cut and count, simple model of quark like objects decaying to top plus heavy neutral particle arXiv:0909.3555):

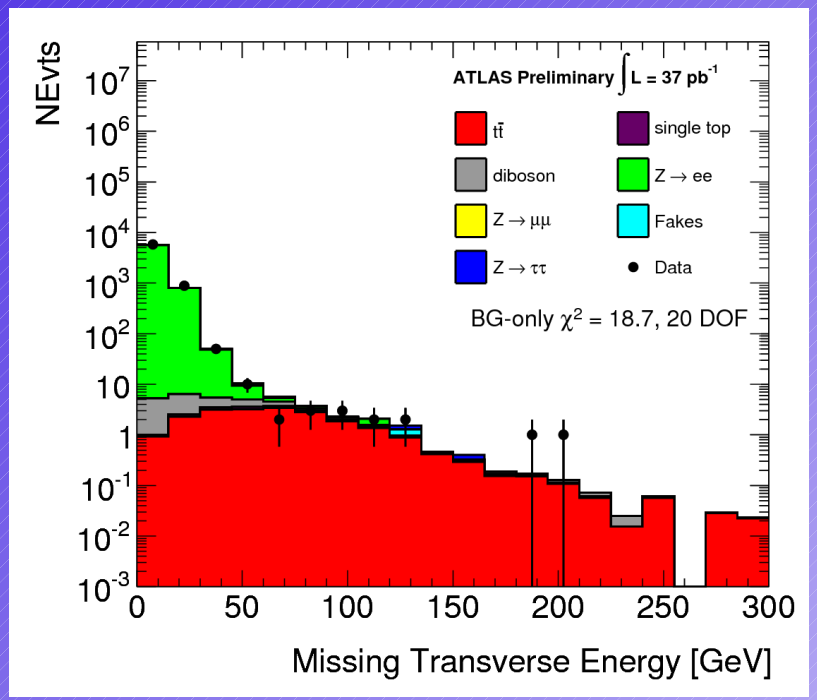
- 275 GeV T decaying into top and 50 GeV A_0
- 300 GeV T decaying into top and 10 GeV A_0





4th generation quarks





Natural extension of Standard Model

- Add CP violation for baryon asymmetry
- Higgs naturalness problem

Top like: Q_4 decaying into Wq
(arXiv:0907.3155,$\sigma(m \simeq (300\ \text{GeV}) \sim 5\text{pb}^{-1}$)

- Does not test Q_4 charge: sensitive to 4/3 …. -1/3 charged 4. generation quarks

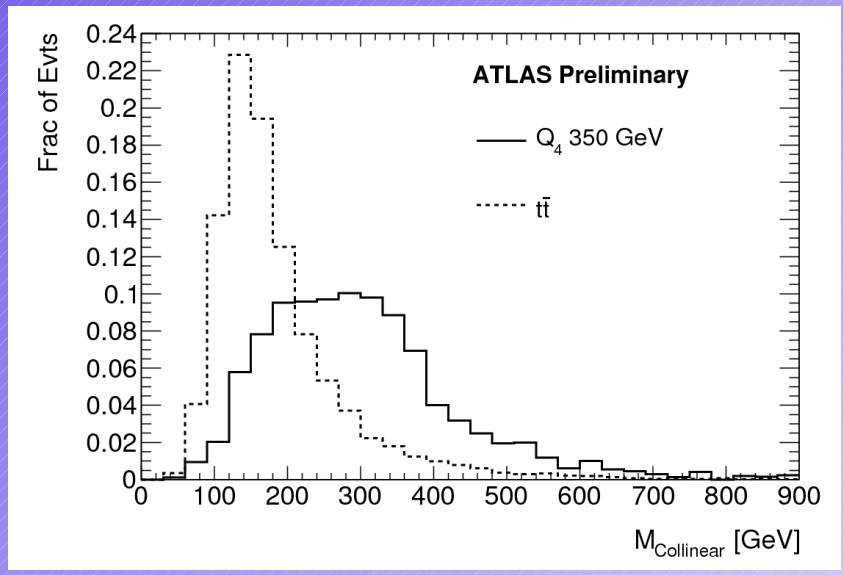
Final state has heavy top pair signature:

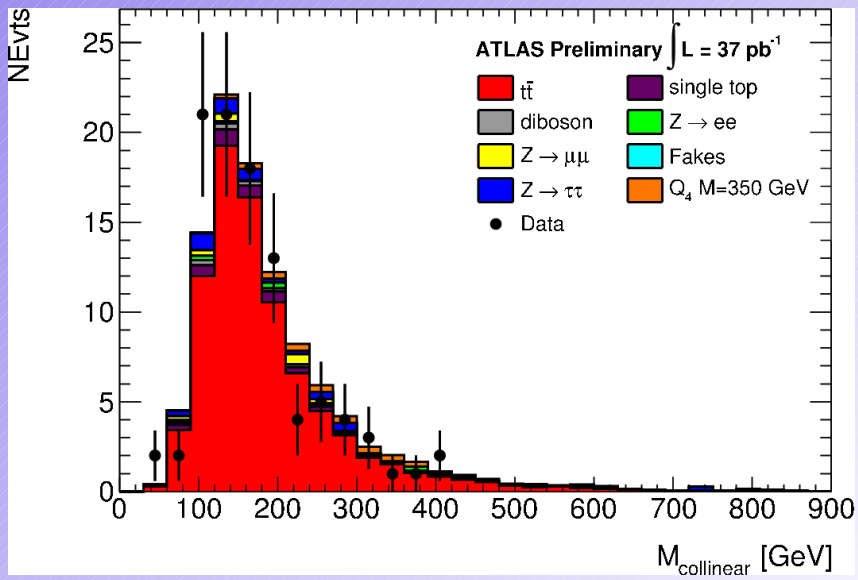
- 2 leptons
- 2 jets
- Missing E_T (→ plot for ee)
- higher boost of the decay products

4th generation quarks: mass

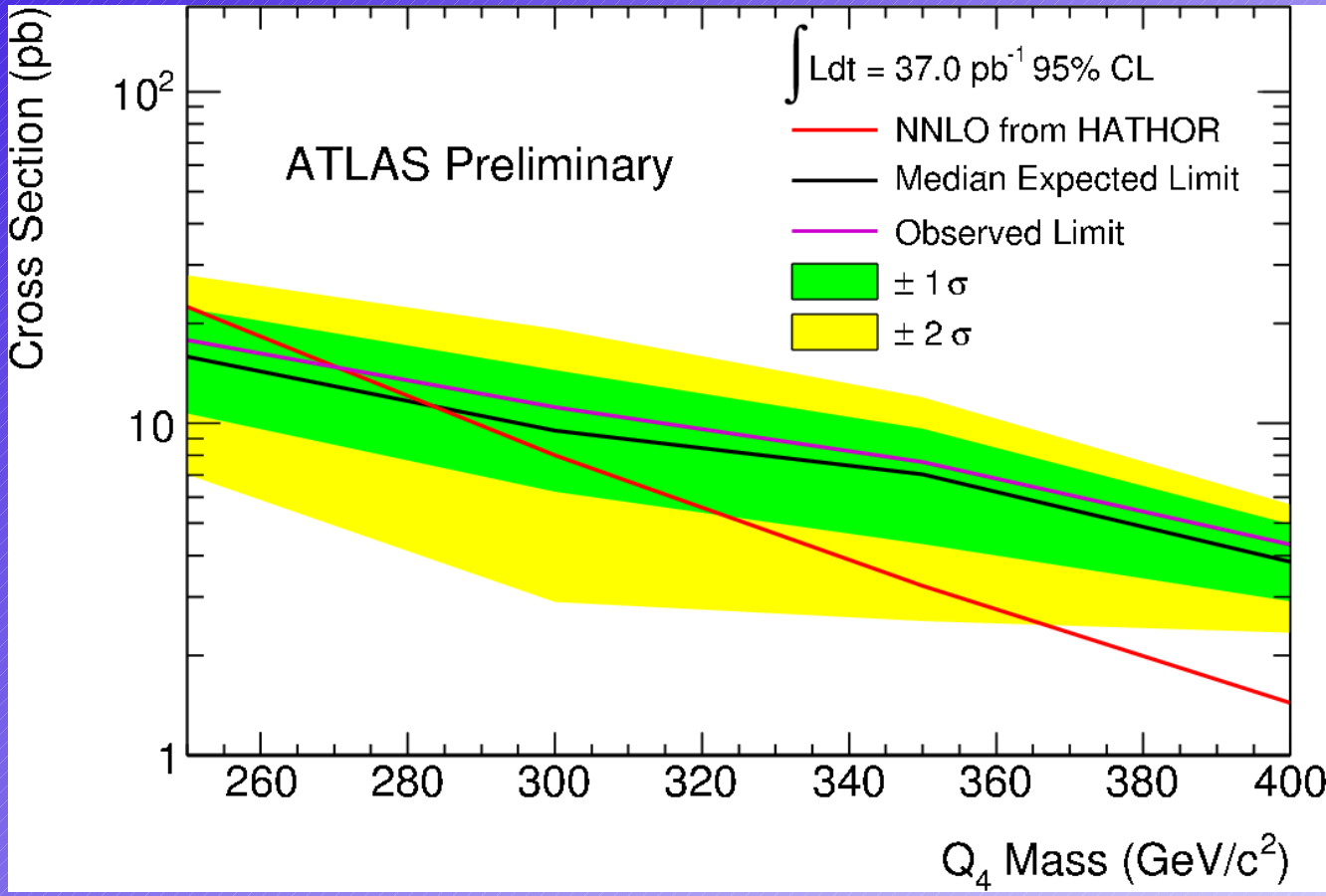
Collinear mass (neutrino has same flight direction like lepton) shifted vs top-pair final state:

→ looking for a very broad excess in the mass distribution
Data agreement for 37 pb^{-1} quite reasonable





4th generation quarks: Limits



Limit on production cross section of Q_4 for 37 pb^{-1}:

→ Translates to lower mass limit: M_{Q4}>270 GeV

(Best Tevatron limits (CDF, 4.6 fb^{-1}: m_{Q4}>335 GeV))

Summary

- LHC ideal for studying exotic physics in top final states
  - X-section much bigger than at Tevatron
  - Already collected more than 1 fb^{-1} of luminosity per experiment
- Many exotics top-like final states already studied:
  - Resonances decaying into top-pairs:
    - Digging into allowed phase space
    - Tevatron sensitivity soon in reach
    - Exclude low mass black holes
  - Top-pairs plus missing E_T:
    - first exclusions at ATLAS
  - Shown first ATLAS limits on 4. Generation quarks
- More data already taken → analyses are being updated
- New upcoming analysis boosted tops are upcoming with the higher sensitivity range