Search for Dilepton Resonances in *pp* Collisions at $\sqrt{s}$=7 TeV with the ATLAS Detector

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Motivation

- Search for physics beyond the standard model
- Several theories extending the standard model assume existence of new heavy bosons
  - Sequential standard model (SSM) predicts gauge boson Z` with same coupling to fermions as the Z boson.

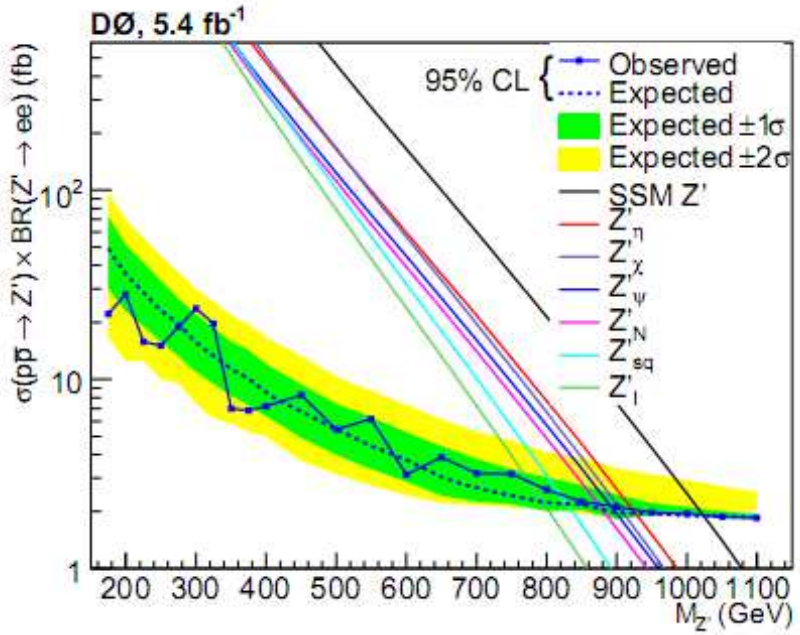
Motivation

- E_6 grand unified symmetry group predicts $Z`(\theta_{E_6})$, choice of $\theta_{E_6}$ leads to the specific $Z`$ states named $Z`_\psi$ $Z`_N$, $Z`_\eta$, $Z`_I$, $Z`_S$, $Z`_X$
- Randall-Sundrum (RS) model predicts spin-2 graviton G*

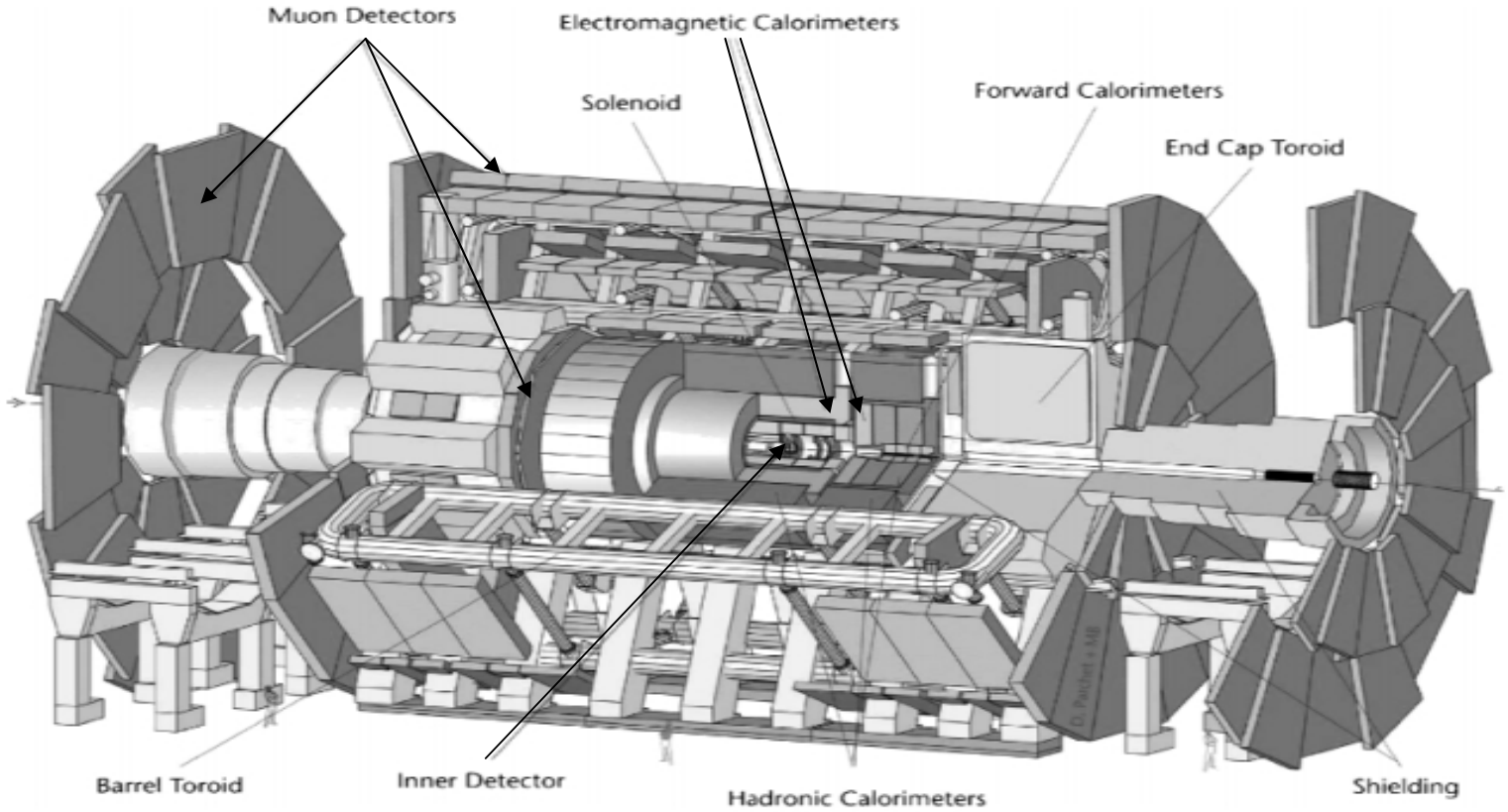
- All these bosons can decay into lepton pairs e^+e^- and $\mu^+\mu^-$

Before the experiment

- Already different lower mass limits around 1 TeV from previous experiments at Tevatron and on ≈ 40 pb^{-1} of data recorded in 2010 at LHC
- try to look for them at higher energies / to put higher mass constrains



ATLAS


Muon Detectors
Electromagnetic Calorimeters
Solenoid
Forward Calorimeters
End Cap Toroid
Barrel Toroid
Inner Detector
Hadronic Calorimeters
Shielding

ATLAS

Consists of 4 detectors:

- Inner detector
- Electromagnetic calorimeter

  $\Delta E/E \approx 11{,}5\% / \sqrt{E} \pm 0{,}5\%$ (energy in GeV)
- Hadronic calorimeter
- Muon detector

  $\Delta p/p \approx$ 2-3% (10 GeV < p < 200 GeV)

  $\Delta p/p \approx 10\%$ ($p \approx$ 10 TeV)

  Track of electrons is recorded in inner detector and in electromagnetic calorimeters where they are absorbed. Muons are highly penetrating and they are absorbed in muon detector.

Selection criteria for e^+e^-

- Isolated electrons with transverse energy $E_T > 25$ GeV and $|\eta| < 2{,}47$ per lepton are required
- It is not necessary to have opposite charge to minimize the impact of possible charge misidentification
- A hit in the first active pixel layer is required to suppress background from photon conversions.

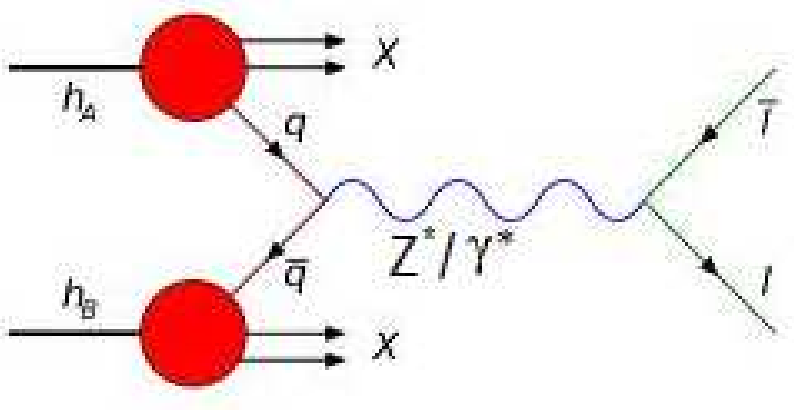
Selection criteria for $\mu^+ \mu^-$

- Two isolated muon candidates of opposite charge are required, each satisfying

  $p_T > 25$ GeV
- To suppress background from cosmic rays, the muon tracks are required to have a transverse impact parameter $|d_0| < 0.2$ mm

Background

- Sources:
  - Mostly Drell-Yan
  - $t\bar{t}$
  - Diboson
  - W + jets
  - QCD

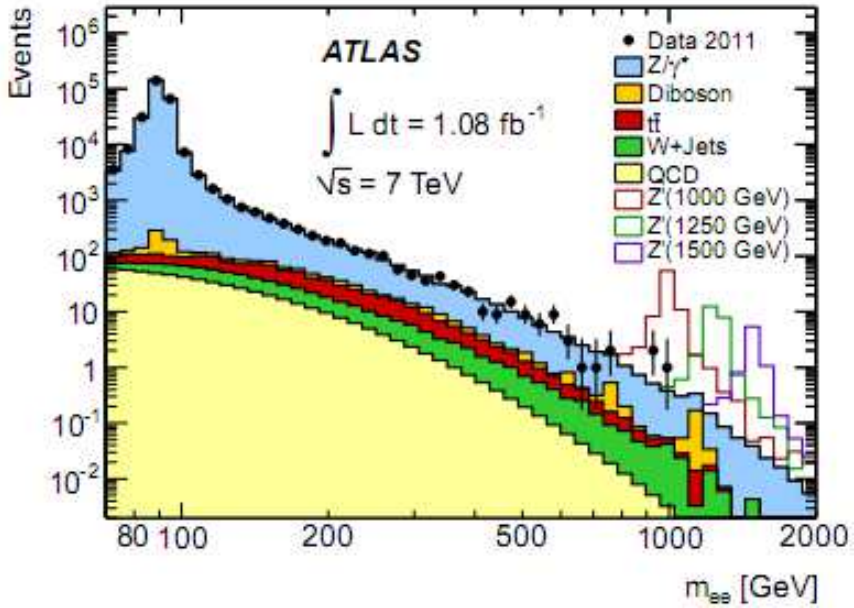


Experimental results/background

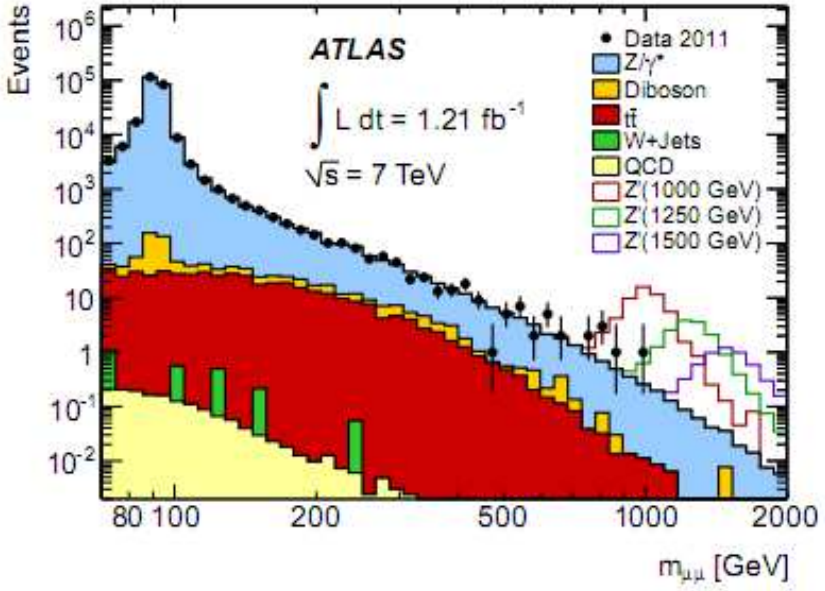
$m_{e^+e^-}$ [GeV]	70-110	110-200	200-400	400-800	800-3000
DY	258482 ± 410	5449 ± 180	613 ± 26	53.8 ± 3.1	2.8 ± 0.1
$t\bar{t}$	218 ± 36	253 ± 10	82 ± 3	5.4 ± 0.3	0.1 ± 0.0
Diboson	368 ± 19	85 ± 5	29 ± 2	3.1 ± 0.5	0.3 ± 0.1
W+jets	150 ± 100	150 ± 26	43 ± 10	4.6 ± 1.8	0.2 ± 0.4
QCD	332 ± 59	191 ± 75	36 ± 29	1.8 ± 1.4	< 0.05
Total	259550 ± 510	6128 ± 200	803 ± 40	68.8 ± 3.9	3.4 ± 0.4
Data	259550	6117	808	65	3

$m_{\mu^+\mu^-}$ [GeV]	70-110	110-200	200-400	400-800	800-3000
DY	236319 ± 320	5171 ± 150	483 ± 22	40.3 ± 2.5	2.0 ± 0.3
$t\bar{t}$	193 ± 21	193 ± 20	63 ± 6	4.2 ± 0.4	0.1 ± 0.0
Diboson	307 ± 16	69 ± 5	25 ± 2	1.7 ± 0.5	< 0.05
W+jets	1 ± 1	1 ± 1	< 0.5	< 0.05	< 0.05
QCD	1 ± 1	< 0.5	< 0.5	< 0.05	< 0.05
Total	236821 ± 487	5434 ± 150	571 ± 23	46.1 ± 2.6	2.1 ± 0.3
Data	236821	5406	557	51	5

Invariant mass distribution

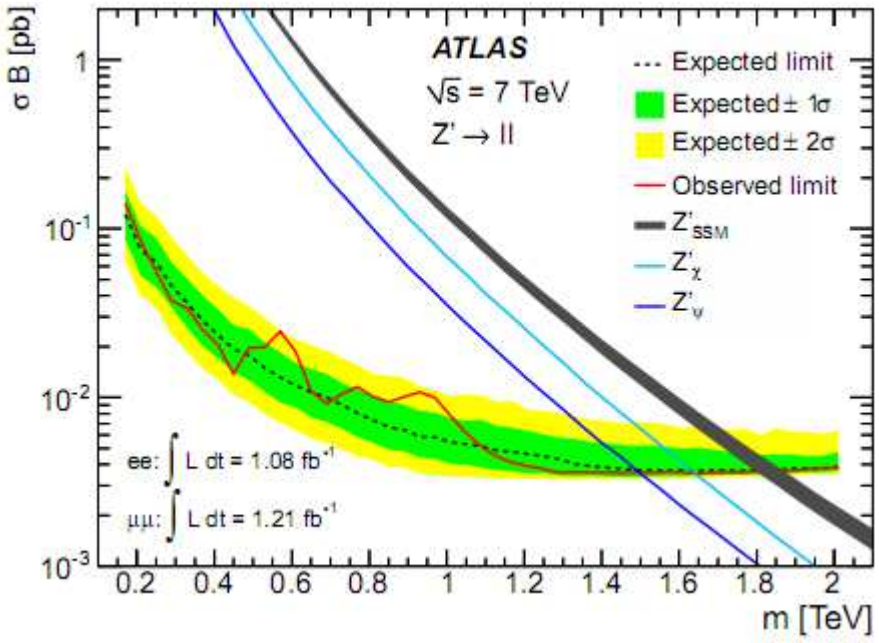


Electrons

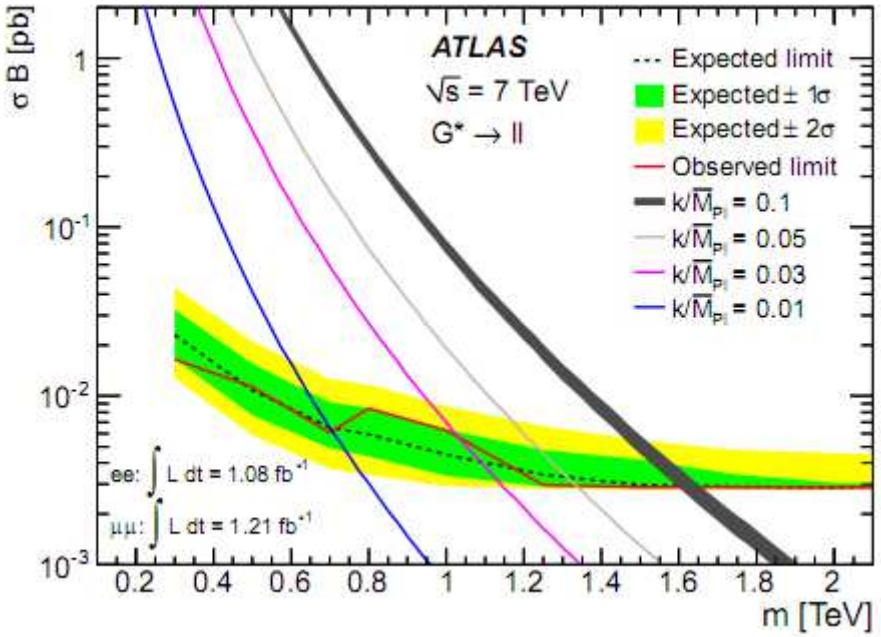


Muons

Limit of Z` and Graviton mass



Z` boson



Graviton

Uncertainties and statistics

- Data are consistent with SM predictions at *p* value 54% for e^+e^- and 24% for $\mu^+\mu^-$
- Dominant uncertainties are theoretical, estimated 10% due to PDF and α_S variations
- Upper limits are set at the 95% C.L. on the cross section times branching fraction, meaning that there is no hint for resonance in these energies

Resulting mass limits for different models

- 1,83 TeV for sequential standard model Z` boson
- 1,49-1,64 TeV for various E_6-motivated Z` bosons
- 0,71-1,63 TeV for a Randall-Sundrum graviton with various couplings