Search for high-mass dilepton resonances with the ATLAS experiment at $\sqrt{s}$ = 7 TeV

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Physics in Collision

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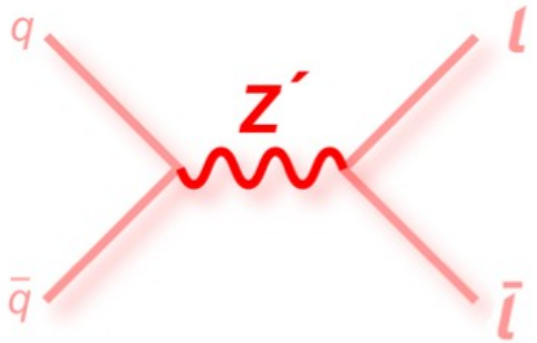
Introduction

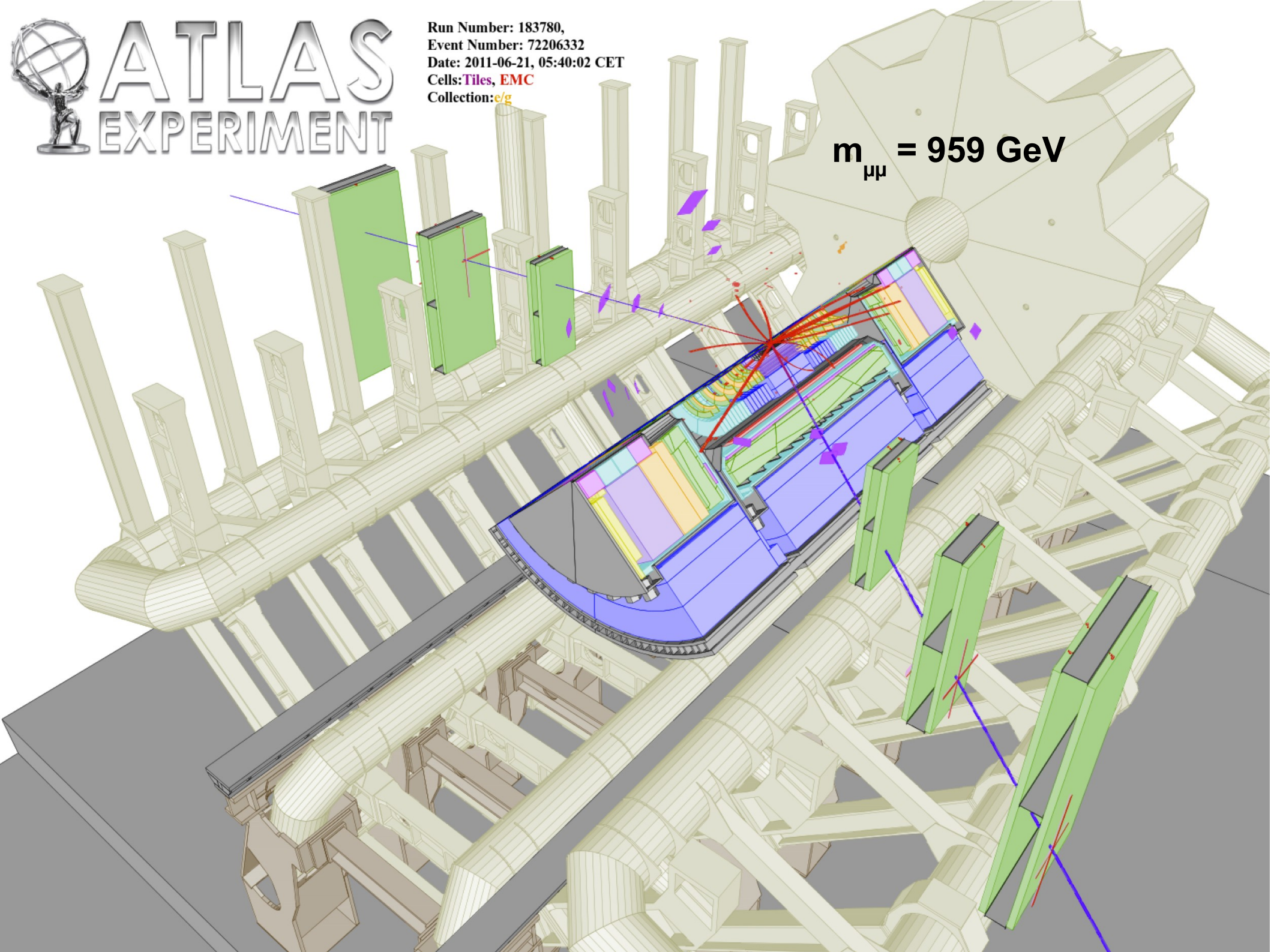
- New high-mass resonances decaying into lepton pairs are predicted by many hypotheses that go beyond the SM
- Benchmark models:
  - Spin 1: New gauge boson Z'
    - Z'_{SSM} with the same couplings as the Standard Model Z
    - Z' from $E_6 \rightarrow SU(5) \times U(1)_\psi \times U(1)_\chi$ where the U(1) can mix:

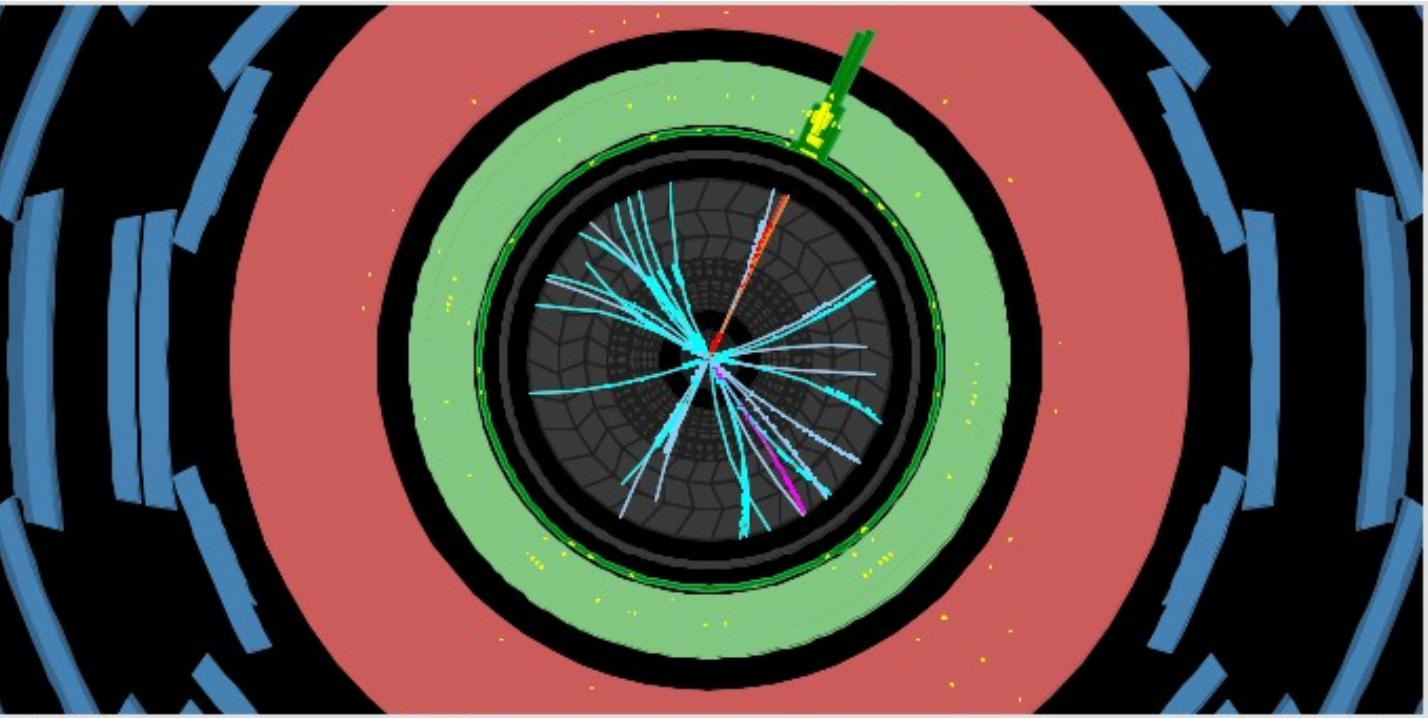
$$Z'(\theta_{E_6}) = Z'_\psi \cos(\theta_{E_6}) + Z'_\chi \sin(\theta_{E_6}), \ \textit{where} \ 0 \le \theta_{E_6} < \pi$$
$$= Z'_\psi,\ Z'_N,\ Z'_\eta,\ Z'_I,\ Z'_S,\ Z'_\chi,\ \textit{for specific}\ \theta_{E_6}$$

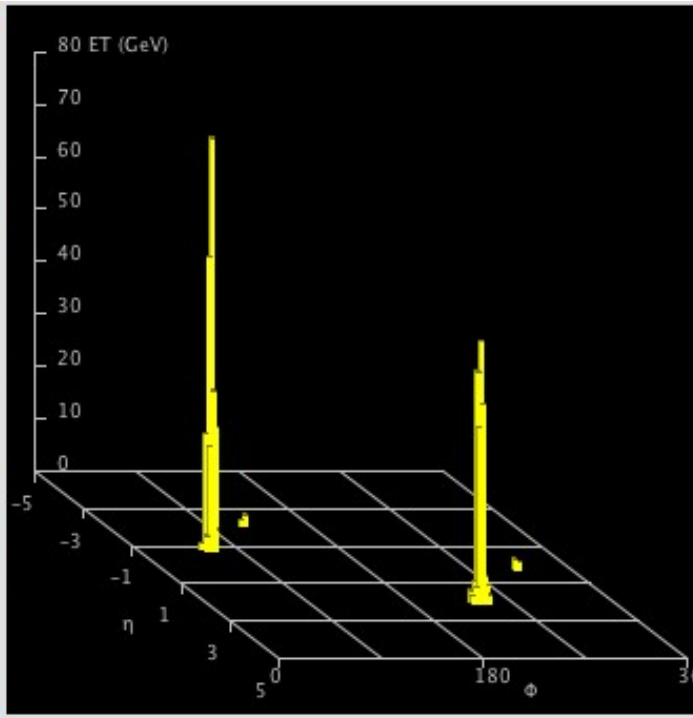
  - Spin 2: Randall-Sundrum Kaluza-Klein graviton (G*)
    - Narrow for couplings $k/m_{Pl} \le 0.1$

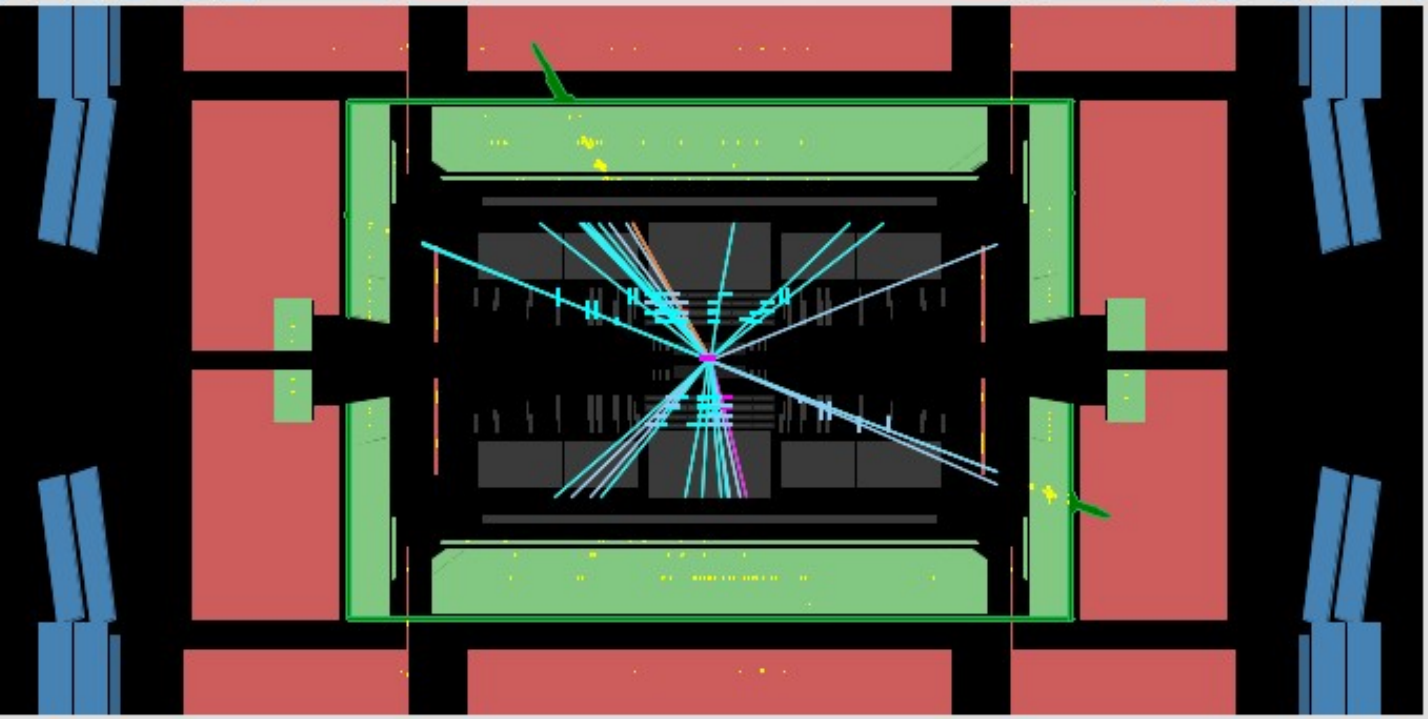


- We are looking for two opposite-sign muons or electrons, forming a narrow peak in the invariant mass spectrum.


ATLAS
EXPERIMENT
Run Number: 183780,
Event Number: 72206332
Date: 2011-06-21, 05:40:02 CET
Cells:Tiles, EMC
Collection:e/g
$m_{\mu\mu}$ = 959 GeV







ATLAS EXPERIMENT

Run Number: 183462, Event Number: 48979599

Date: 2011-06-14 02:48:15 PDT

m_{ee} = 993 GeV

Event Selection

Electron channel:

Two electrons satisfying

- E_T > 25 GeV
- |η| < 2.47, without 1.37 < |η| < 1.52
- Cuts on the transverse shower shape and leakage into the Hadronic Calorimeter
- Track quality, track match cuts
- Hit in first layer of pixel detector
- Object Quality (Calorimeter region)
- Leading electron isolation:

$$\Sigma E_T(\Delta R<0.2) < 7\,GeV$$

Muon channel:

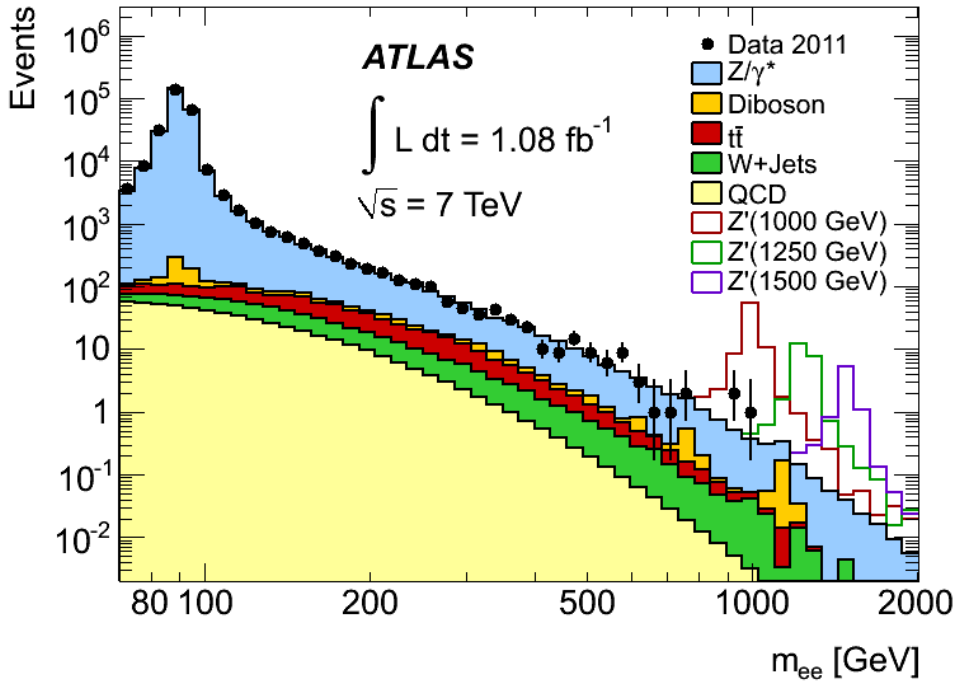
Two muons satisfying

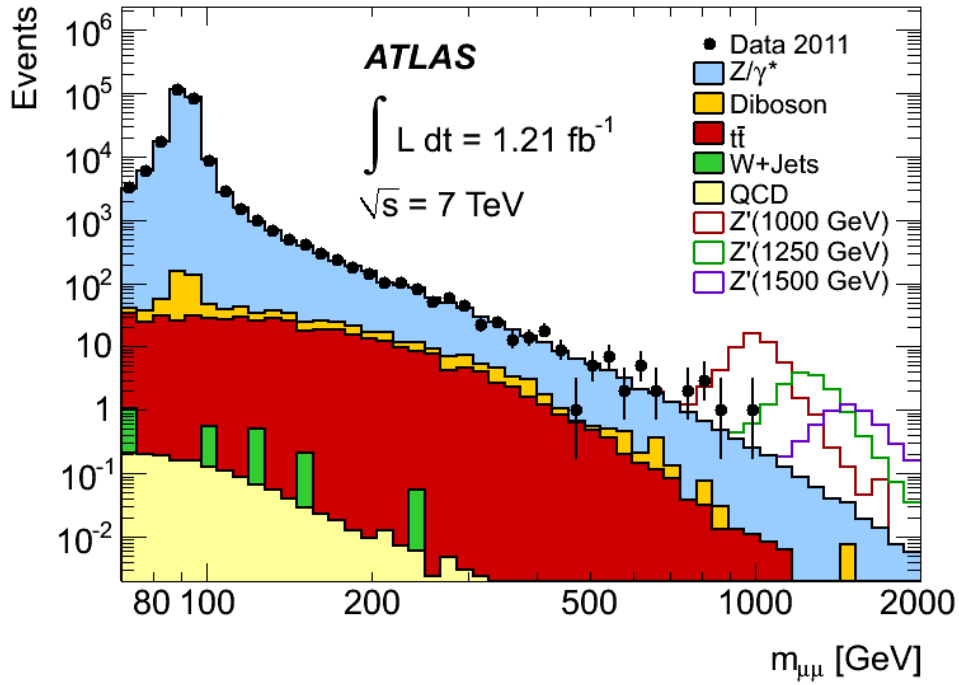
- p_T > 25 GeV
- Stringent hit requirements in both the Inner Detector and Muon Spectrometer; includes a three-layer requirement in the Muon Spectrometer
- Cosmic veto using the track impact parameters
- Muon track isolation:

$$\Sigma p_T^{trk}(\Delta R<0.3) < 0.05\,p_T$$

The signal acceptance for Z'_{SSM} at 1.5 TeV is 65% (ee), 40% (μμ)

Results





$m_{e^+e^-}$ [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

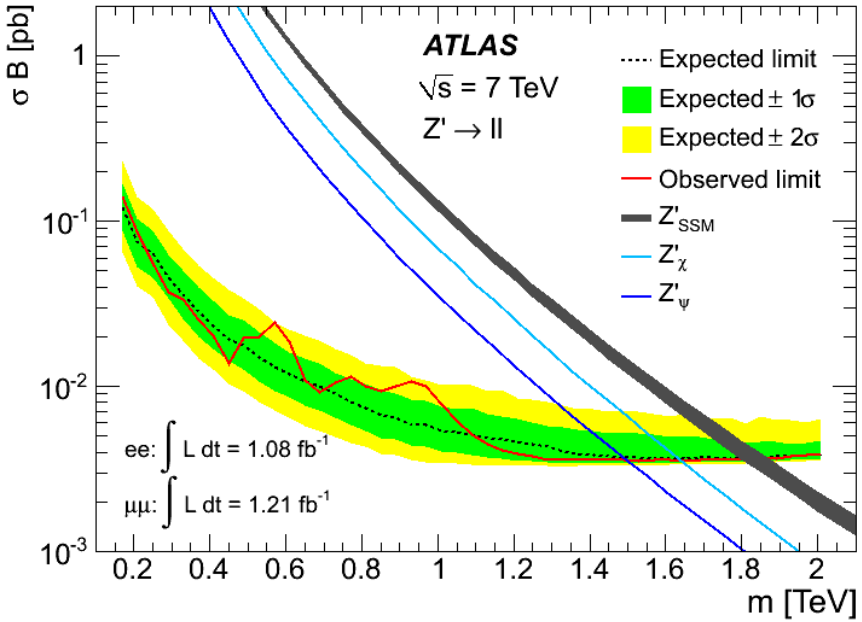
$m_{\mu^+\mu^-}$ [GeV]	70-110	110-200	200-400	400-800	800-3000
DY	236319 ± 320	5171 ± 150	483 ± 22	40.3 ± 2.5	2.0 ± 0.3
$t\bar{t}$	193 ± 21	193 ± 20	63 ± 6	4.2 ± 0.4	0.1 ± 0.0
Diboson	307 ± 16	69 ± 5	25 ± 2	1.7 ± 0.5	< 0.05
W+jets	1 ± 1	1 ± 1	< 0.5	< 0.05	< 0.05
QCD	1 ± 1	< 0.5	< 0.5	< 0.05	< 0.05
Total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

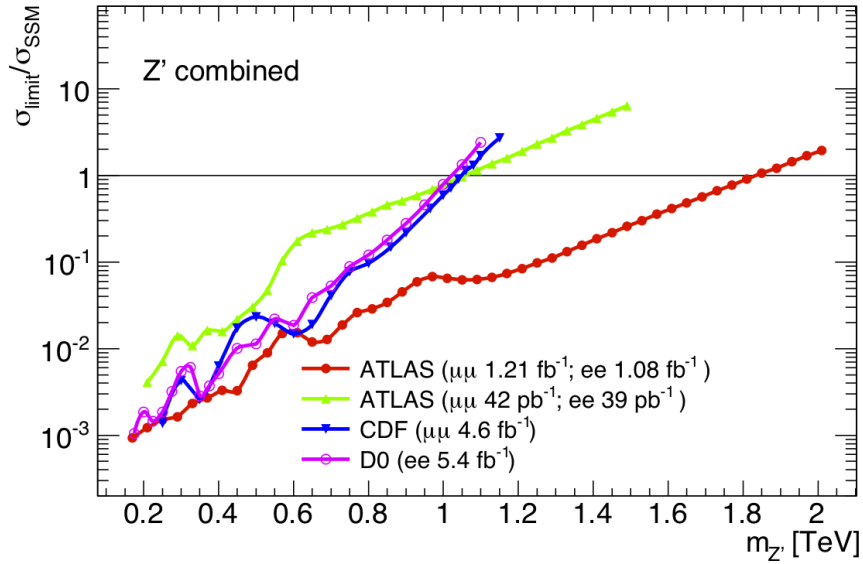
Resulting p-values: **54%** (ee) and **24%** (μμ)

Therefore the data are consistent with the Standard Model

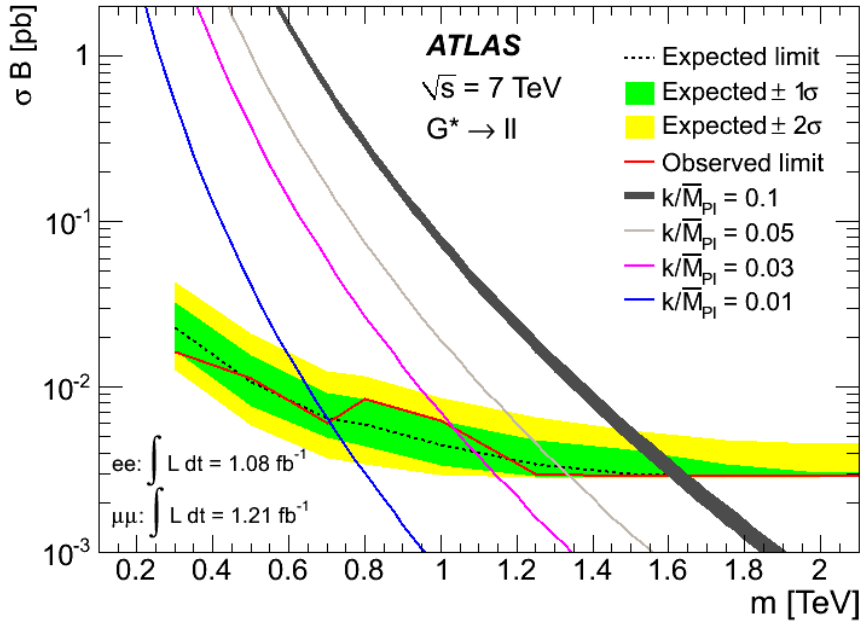
Limits

$Z' \rightarrow ll$





$G^* \rightarrow ll$



	Observed limit mass [TeV]	Expected limit mass [TeV]
$Z'_{SSM} \rightarrow e^+e^-$	1.70	1.70
$Z'_{SSM} \rightarrow \mu^+\mu^-$	1.61	1.61
$Z'_{SSM} \rightarrow \ell^+\ell^-$	1.83	1.83
$G^* \rightarrow e^+e^-$	1.51	1.50
$G^* \rightarrow \mu^+\mu^-$	1.45	1.44
$G^* \rightarrow \ell^+\ell^-$	1.63	1.63

	E_6 Z' Models						RS Graviton			
Model/Coupling	Z'_ψ	Z'_N	Z'_η	Z'_I	Z'_S	Z'_χ	0.01	0.03	0.05	0.1
Mass limit [TeV]	1.49	1.52	1.54	1.56	1.60	1.64	0.71	1.03	1.33	1.63

Summary and Next Steps

- A search for Z' and G* resonances has been performed at ATLAS
  - Over 1 fb^{-1} analyzed, and more to come
  - No significant excess beyond Standard Model expectations so far
  - Cross-section limits are set, converted into mass limits, e.g.

    $M_{Z'SSM} > 1.83$ TeV

- Next objectives:
  - Increase the signal acceptance
  - Set limits on a wider range of theoretical models

- See my poster for more details!