Search for resonances in multi-body invariant masses in events with an isolated lepton using 139 fb^{-1} of $\sqrt{s} = 13$ TeV *pp* collisions collected by the ATLAS detector

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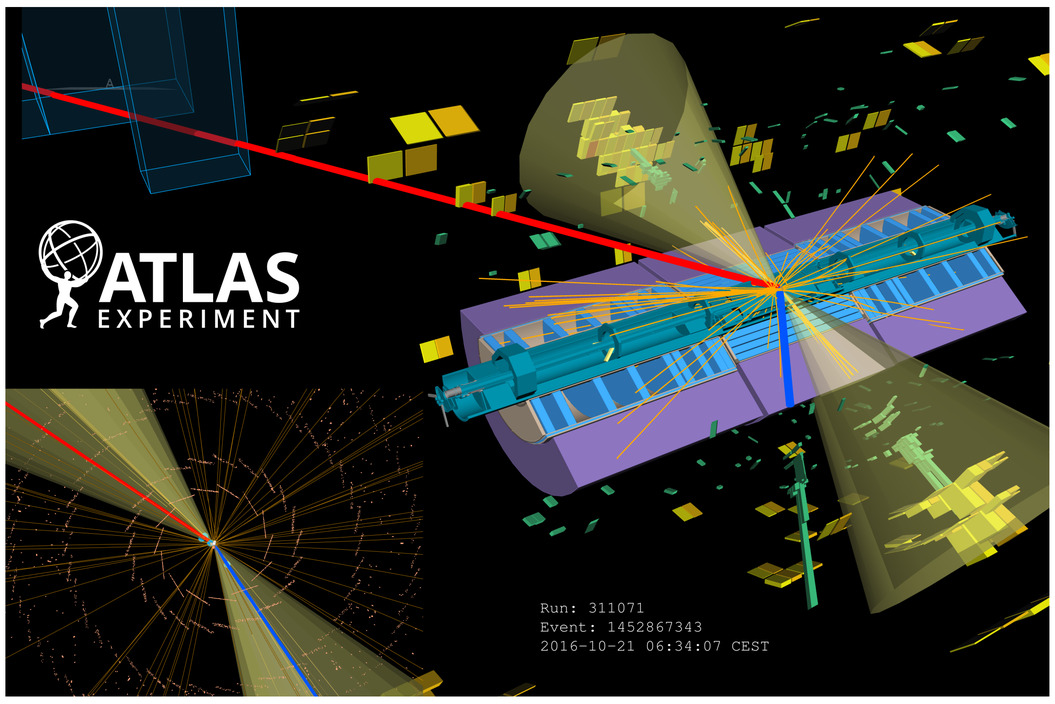
Introduction



- Searches for resonances in dijet invariant mass distributions provide a means to investigate a wide range of theories beyond the Standard Model (BSM).
- Including a lepton gives sensitivity to BSM particles with novel decay modes, and using lepton-based triggers allow us to probe lower invariant masses compared to jet triggers.
- Searched in four channels with two jets and 1 or 2 leptons ($m_{jjl}, m_{jbl}, m_{bbl}, m_{jjll}$), with leading lepton p_T > 60 GeV, and subleading lepton and jet p_T > 30 GeV [1]

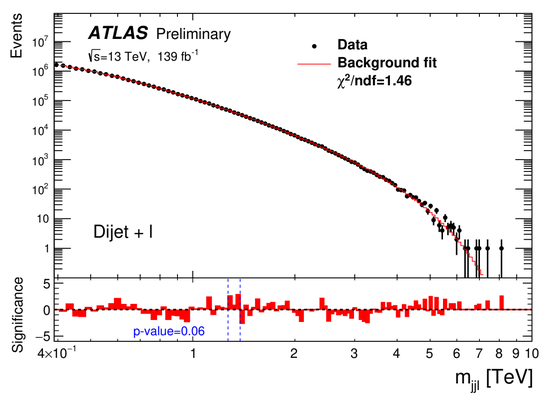
Background Estimation

- Background distribution is represented by a smoothly falling analytical function.

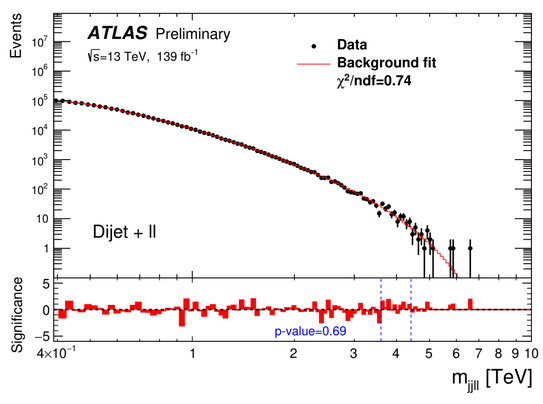
$$f(x) = p_1(1-x)^{p_2} x^{p_3 + p_4 \ln(x) + p_5 \ln^2(x)}$$

- Local p-value is found by looking for the largest excess of data over background in consecutive bins for a range of mass windows.
- Account for the look-elsewhere effect to obtain global p-value.

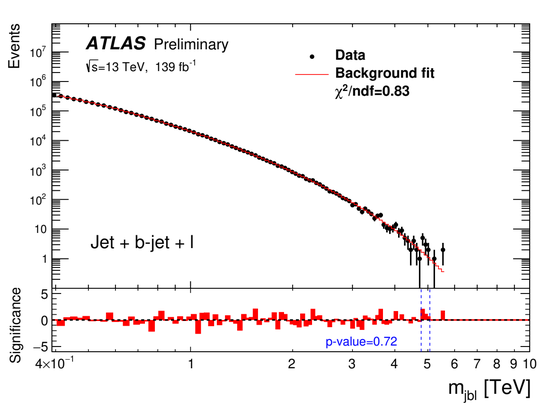
Fit Results



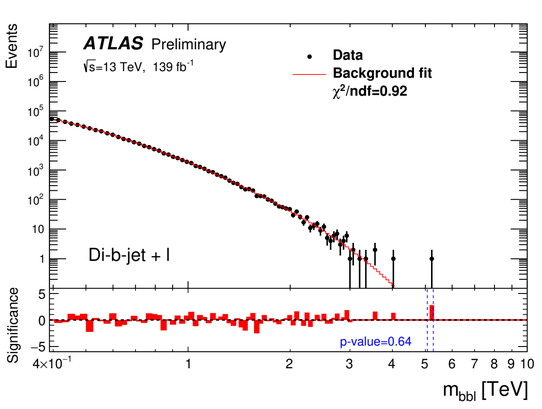
(a) 2 jets + 1 lepton



(b) 2 jets + 2 leptons



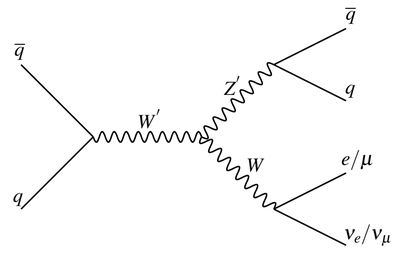
(c) 2 jets with 1 b-tagged jet + 1 lepton



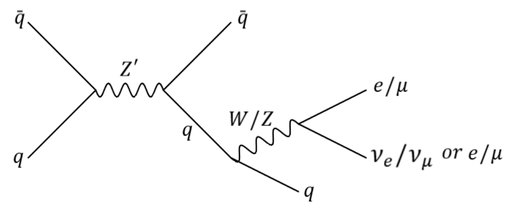
(d) 2 b-tagged jets + 1 lepton

- No statistically significant excess found in any channel.
- Largest excess found in m_{jjl} at 1.3 TeV with local significance of 3.5σ and global significance of 1.5σ.

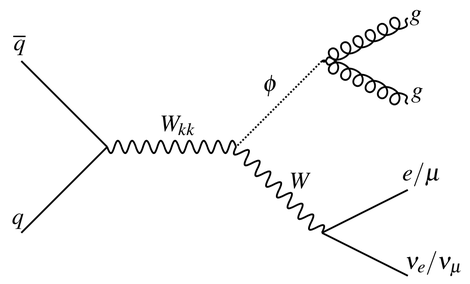
Signal Models



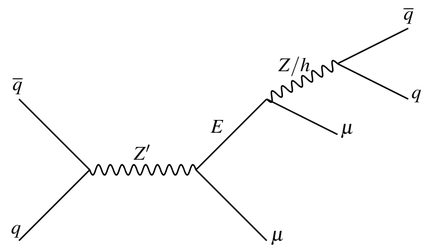
(a) Sequential Standard model



(b) Simplified Dark Matter model



(c) Radion model



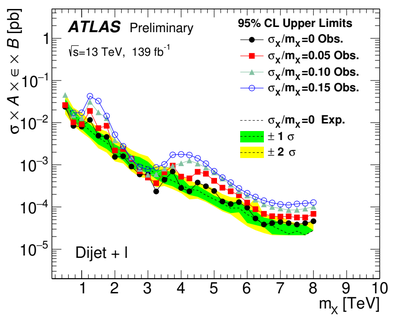
(d) Composite Lepton model

Limits were set on generic Gaussian shaped signals as well as four BSM models:

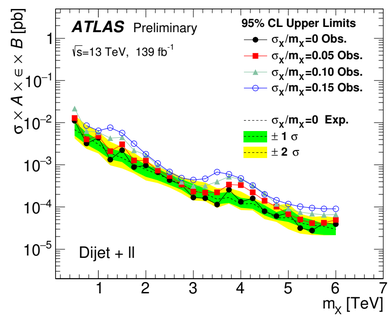
(a) Sequential Standard Model with new vector bosons W' and Z'.
(b) Benchmark simplified dark-matter model with an axial-vector mediator Z'.
(c) Kaluza-Klein gauge boson model with Radions decaying to two gluons.
(d) Composite resonance model with mediator Z' and composite lepton E.

Limit Setting

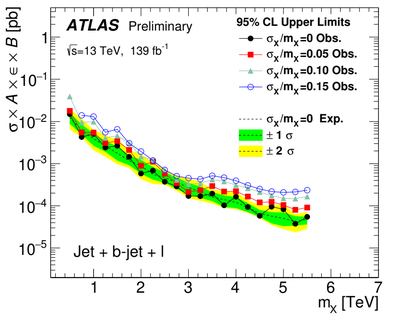
Gaussian Limits



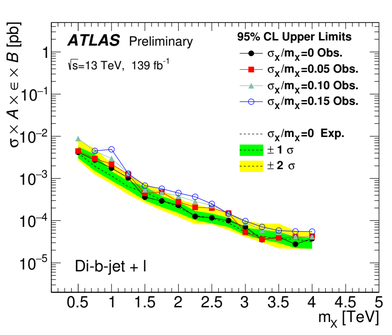
(a) 2 jets + 1 lepton



(b) 2 jets + 2 leptons

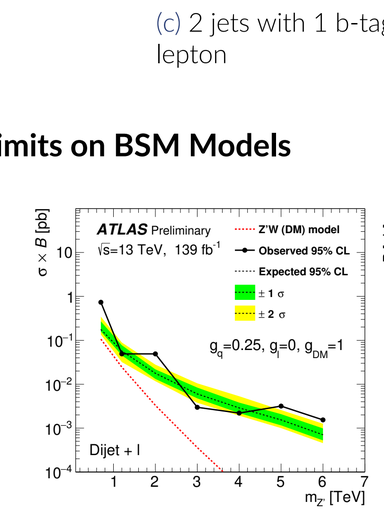


(c) 2 jets with 1 b-tagged jet + 1 lepton

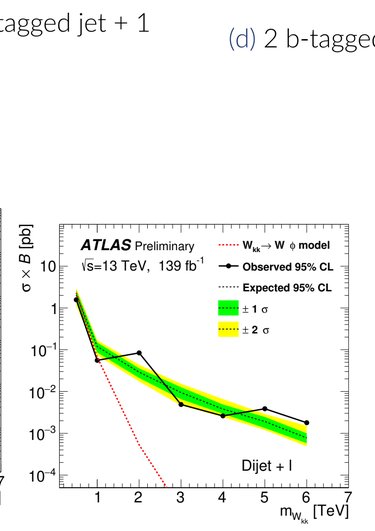


(d) 2 b-tagged jets + 1 lepton

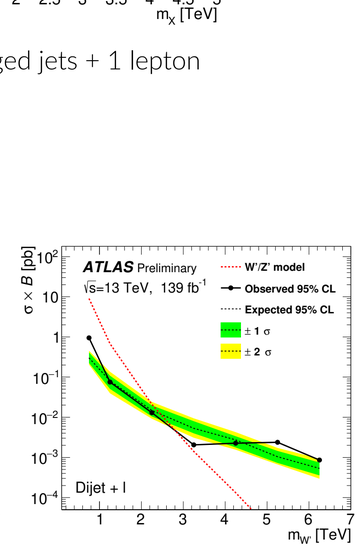
Limits on BSM Models



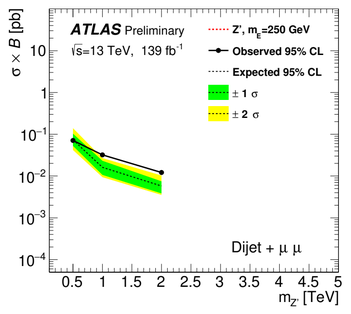
(a) Simplified Dark Matter Model



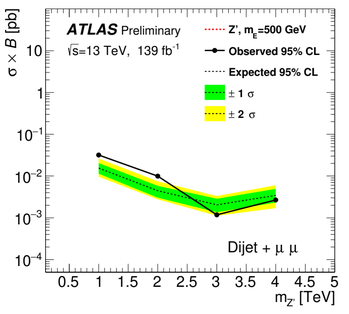
(b) Radion Model



(c) Sequential Standard Model



(d) Composite Lepton Model with $m_E = 250$GeV



(e) Composite Lepton Model with $m_E = 500$GeV

References

[1] The ATLAS Collaboration. Search for new phenomena in multi-body invariant masses in events with at least one isolated lepton using √s = 13 TeV proton–proton collision data collected by the ATLAS detector. Geneva, Jun 2022.