Search for a new Heavy Resonance in final states with dijets or di-bjets with the ATLAS Detector

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Introduction

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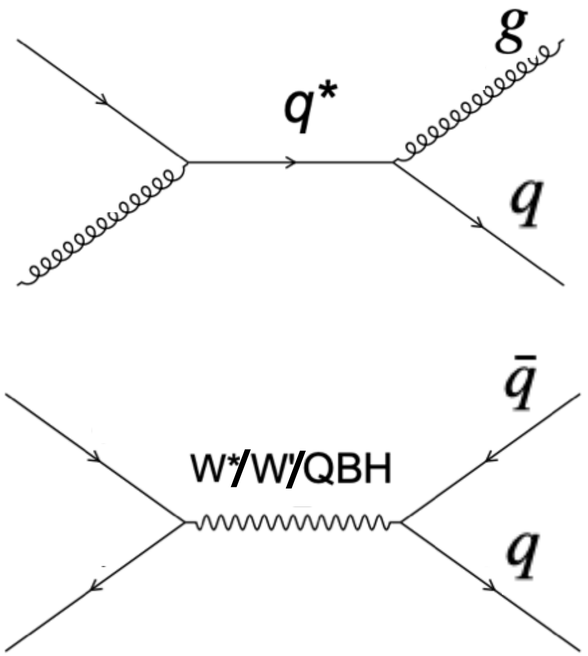
- Search for new physics

  - Created by quarks/gluons -> decay to quarks/gluons
  - Very large statistics
  - Many theory models predict decay to dijets
  - What if new physics couples preferentially to beauty quarks?
    —> Dedicated search in final states with b-jets.

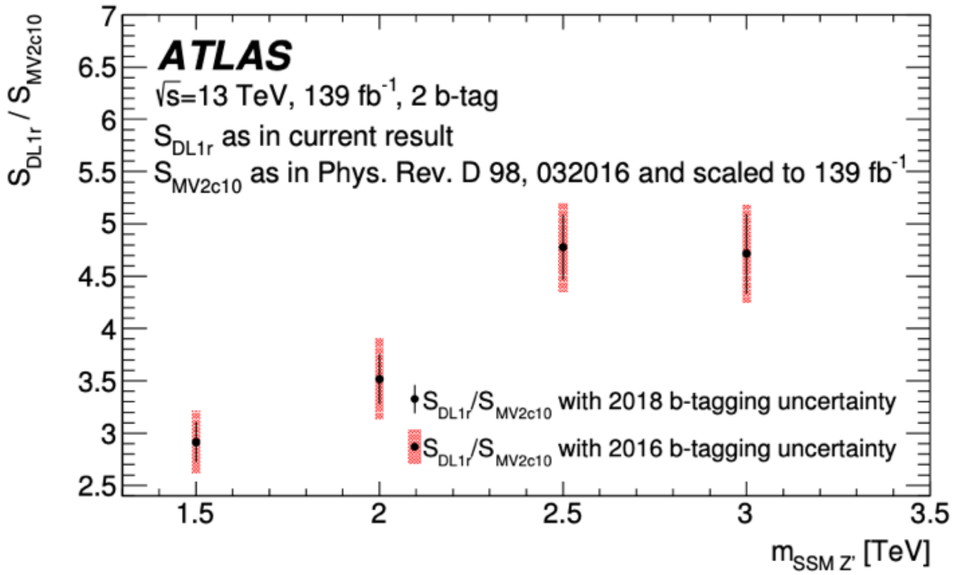
- Generic search with 139fb^{-1} of Full Run 2 data collected by ATLAS Detector

particles decay to dijets



Event Selection

- Events are selected using a trigger that requires at least one jet with p_T greater than 420 GeV.
- Specific cuts for m_{jj} and y* depending on different categories.
- DL1r tagger at fixed cut 77% WP sleeted to do b-tagging.
  - Using DL1r tagger for the first time at ATLAS
  - The inputs of the DL1r network includes discriminating variables construed by a recurrent neural network which exploits the correlations between tracks originating from same b-hadron
  - Improve the performance of jets with high p_T



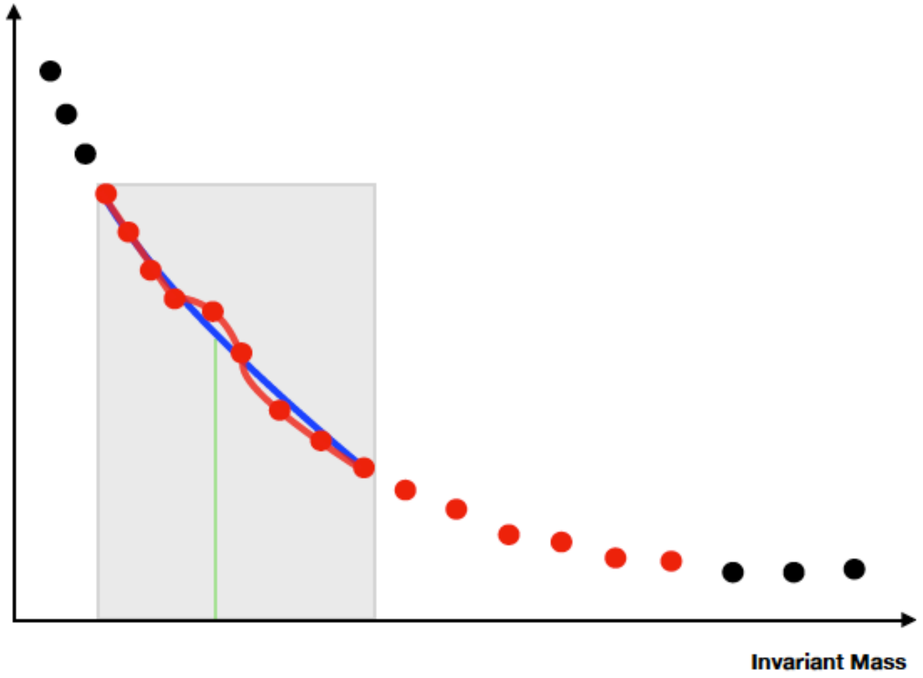
Category	Inclusive		1*b*	2*b*
Jet p_T	> 150 GeV			
Jet $\|\eta\|$	-		< 2.0	
$\|y^*\|$	< 0.6	< 1.2	< 0.8	
m_{jj}	> 1100 GeV	> 1717 GeV	> 1133 GeV	
b-tagging	no requirement		$\geqslant$ 1 *b*-tagged jet	2 *b*-tagged jets

Background Estimation

- The SM background of the m_{jj} spectrum is determined by a functional fit to data:

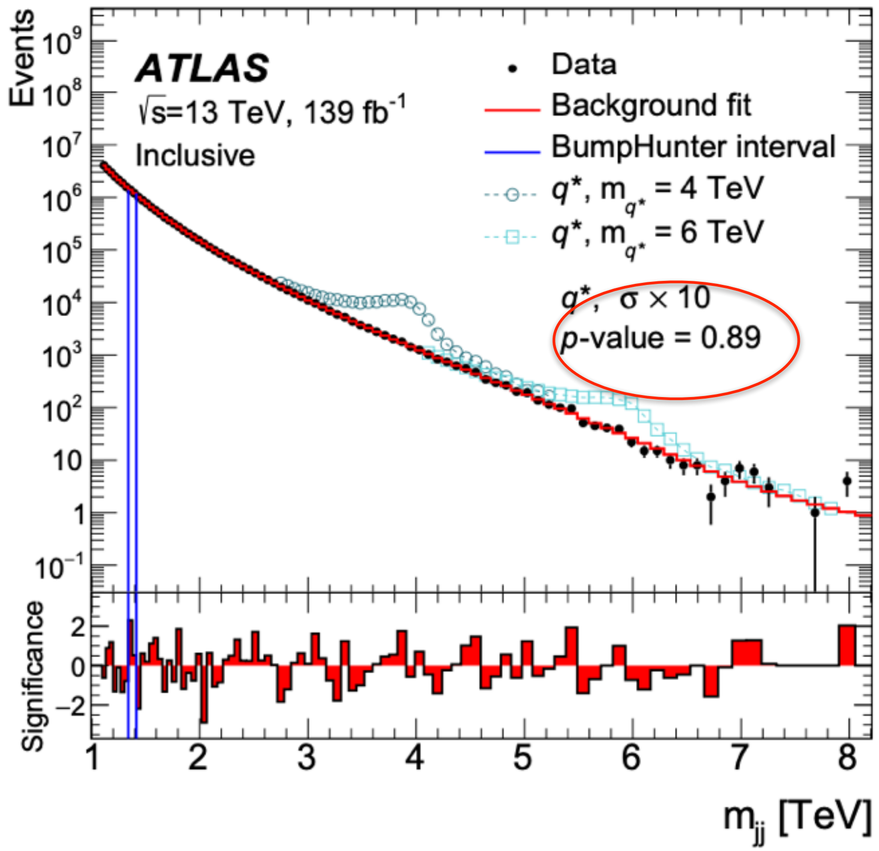
$$f(x) = p_1(1-x)^{p_2}x^{p_3+p_4\ln x} \quad \text{where } x = m_{jj}/\sqrt{s}$$

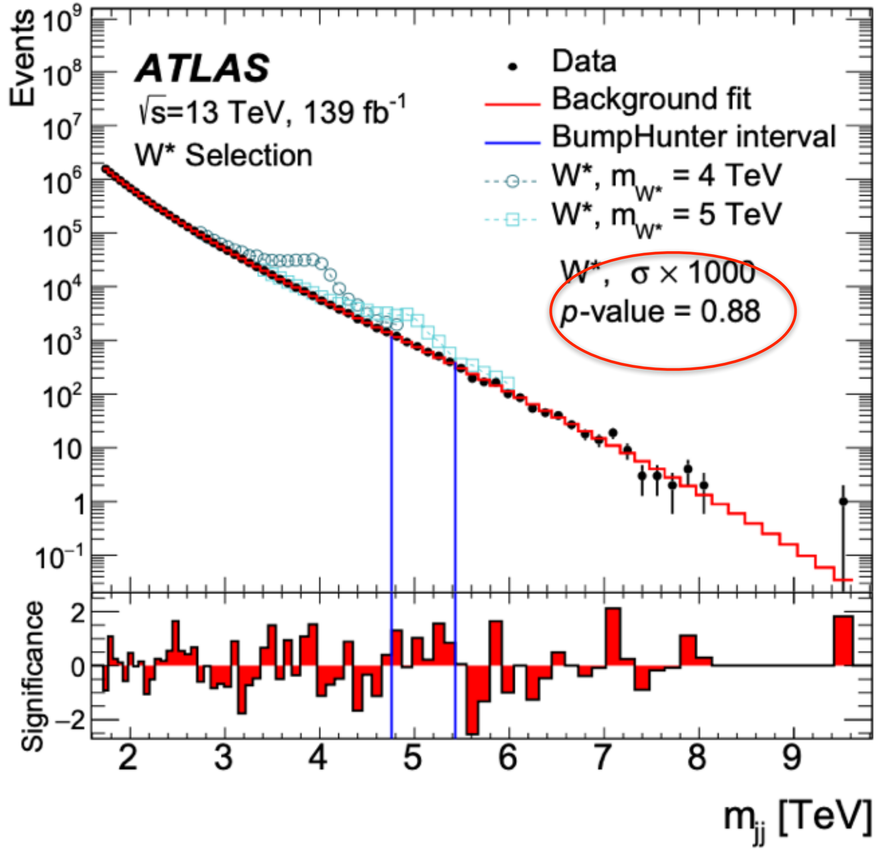
- Sliding Window Fit (SWiFt) instead of global fit
  - Sliding localized fit on smaller m_{jj} range
  - Background in each mass bin is predicted by fitting in a mass window around that bin
  - window size chosen to be the largest possible window satisfies fit requirements described below



- The quality of the fit to the data:
  - Global Chi-square p-value > 0.05
  - BumpHunter p-value > 0.01

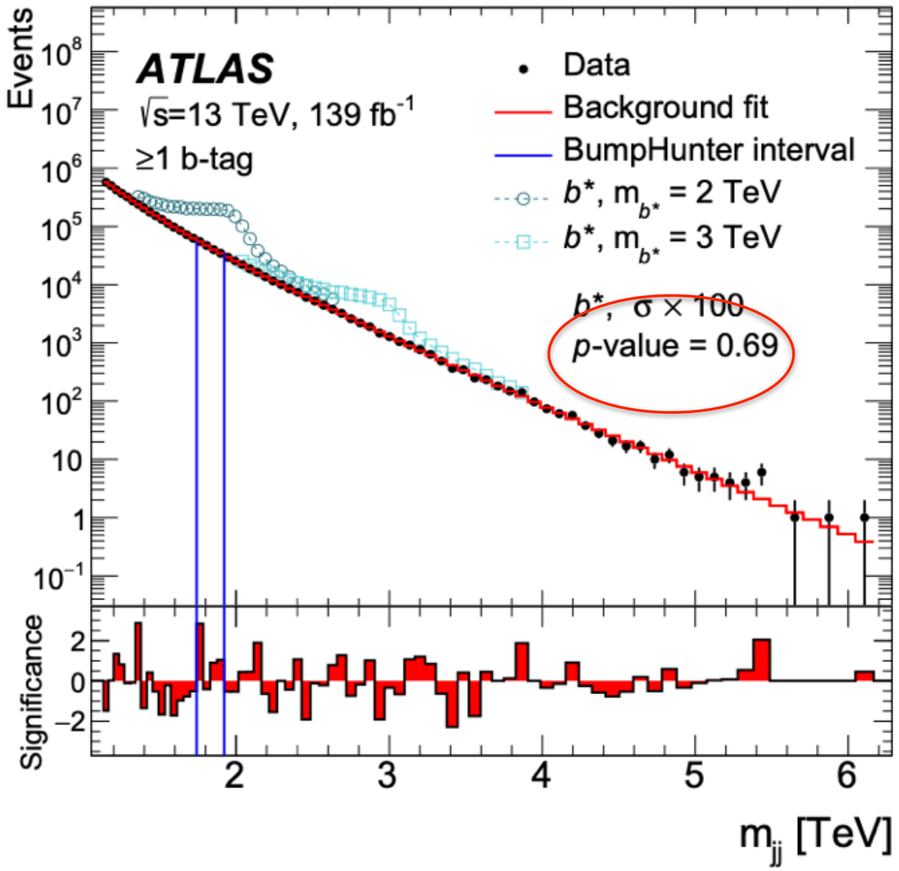
Search Results — Inclusive

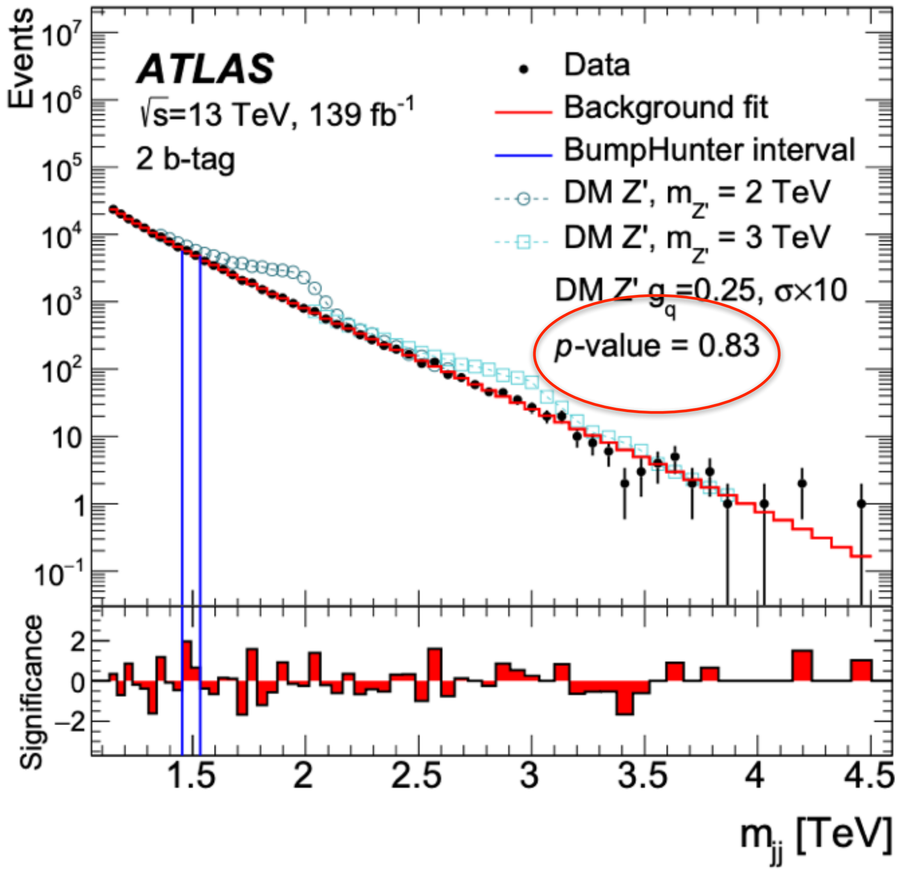




- Use Bump-Hunter to calculate the significance of any excess, from 2 bins to half spectrum
- Most significant interval defined by bins have smallest probability of arising from fluctuation
- BumpHunter p-value: probability of random fluctuations to create at least as much excess observed anywhere
- **No evidence of new resonances was observed**

Search Results - b-tagged



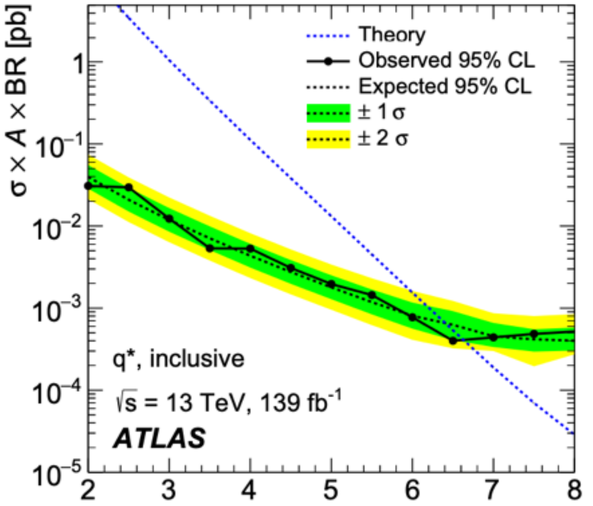


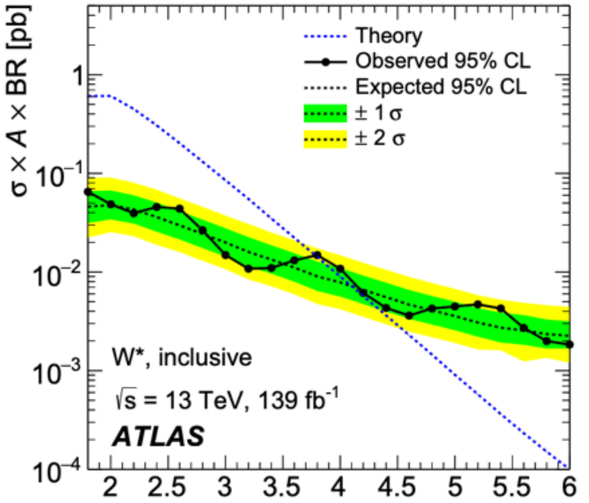
- **No significant deviations seen**

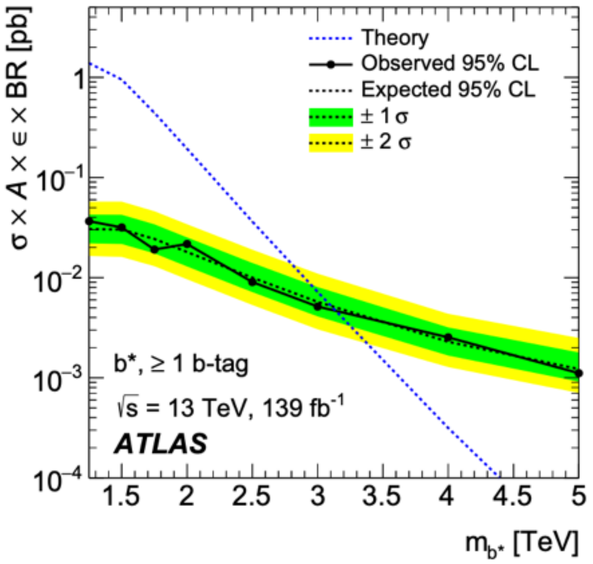
Model Dependent Limits

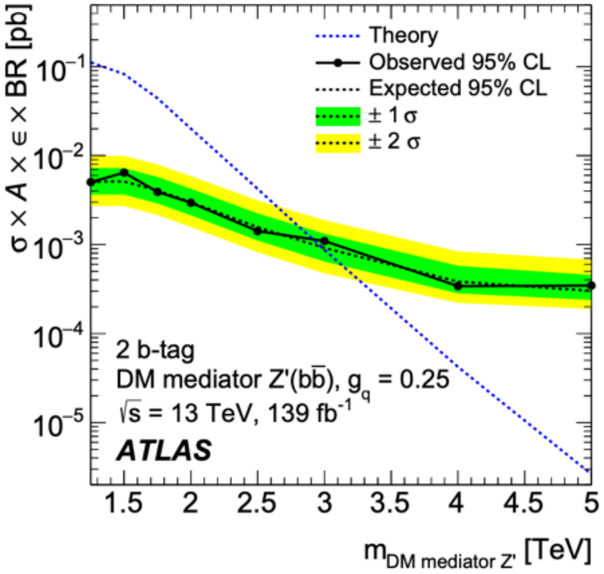
- Limits derived using frequentist method.
- Uncertainties incorporated by varying uncertainty sources according Gaussian probability distribution.
- Upper limits at 95% confidence level.

Category	Model	Lower limit on signal mass at 95% CL	
		Observed	Expected
Inclusive	q^*	6.7 TeV	6.4 TeV
	QBH	9.4 TeV	9.4 TeV
	W'	4.0 TeV	4.2 TeV
	W^*	3.9 TeV	4.1 TeV
	DM mediator Z', $g_q = 0.20$	3.8 TeV	3.8 TeV
	DM mediator Z', $g_q = 0.50$	4.6 TeV	4.9 TeV
$1b$	b^*	3.2 TeV	3.1 TeV
$2b$	DM mediator Z' $g_q = 0.20$	2.8 TeV	2.8 TeV
	DM mediator Z', $g_q = 0.25$	2.9 TeV	3.0 TeV
	SSM Z',	2.7 TeV	2.7 TeV
	graviton, $k/\overline{M}_{PL} = 0.2$	2.8 TeV	2.9 TeV

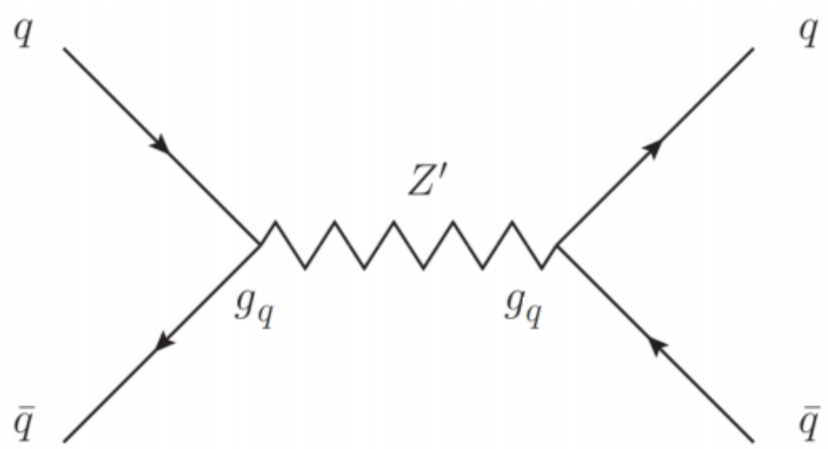


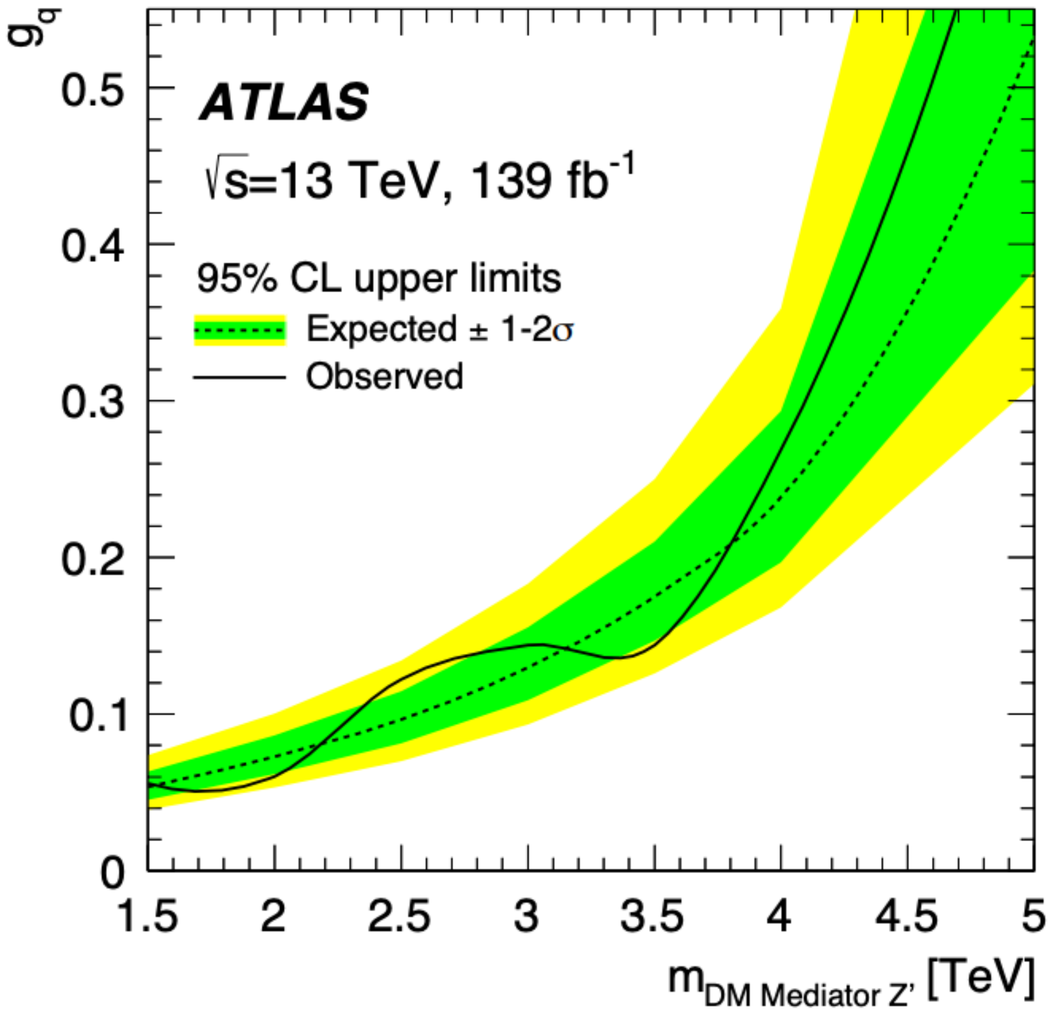






Model Dependent Limits - Inclusive

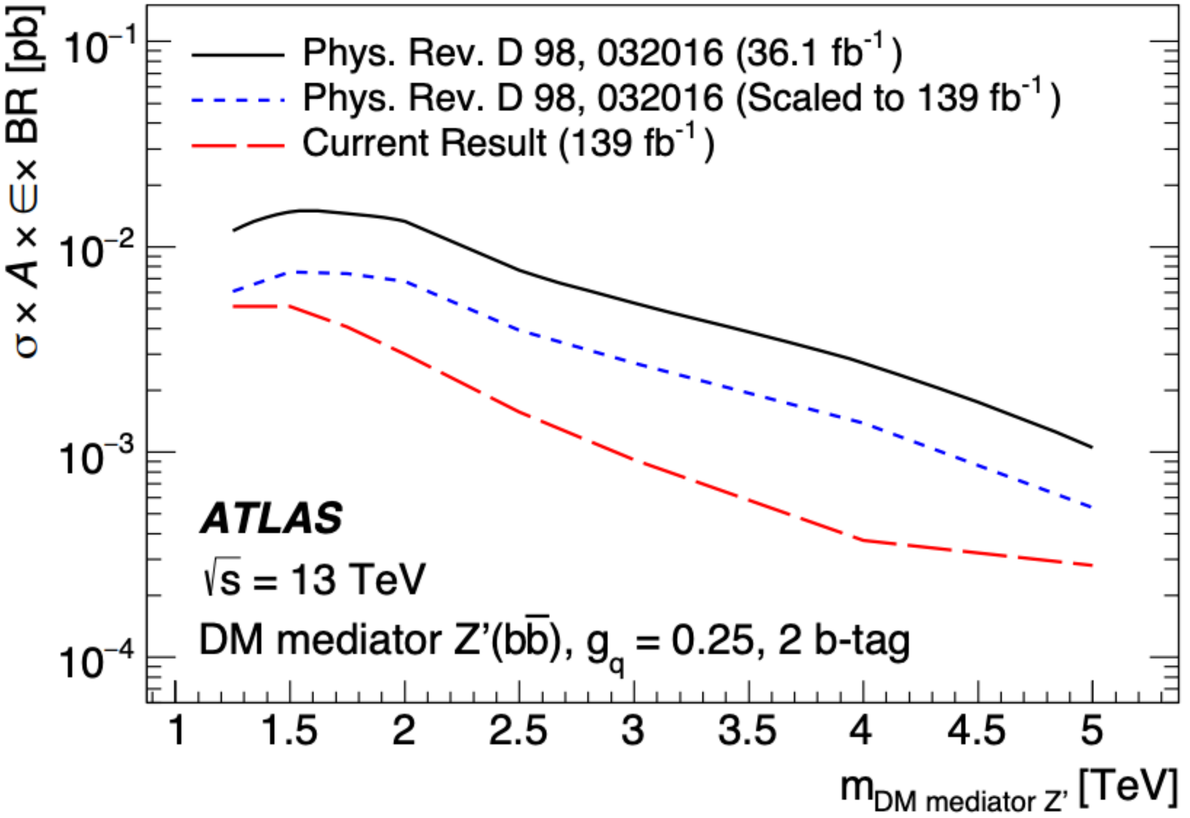




- 2D plots for limit of the Dark Matter Z' model for different couplings and resonance masses.

Model Dependent Limits - b-tagged

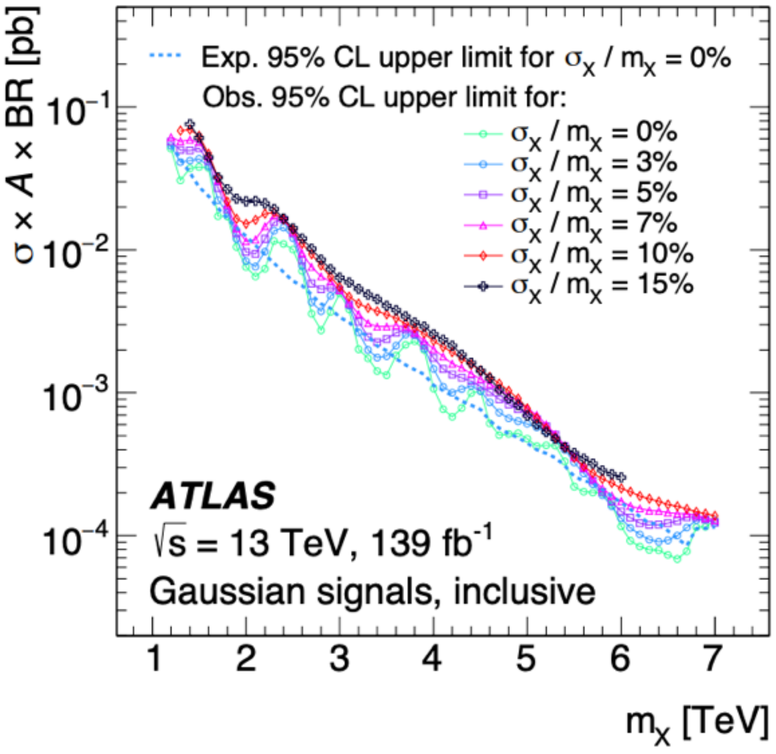
- Improvement compared to previous publication:
  - Benefits from substantial improvement in the b-jet tagging algorithm and associated systematic uncertainties.
  - The improvement is a factor within 1.2 and 3.5, maximum improvement at 4 TeV.

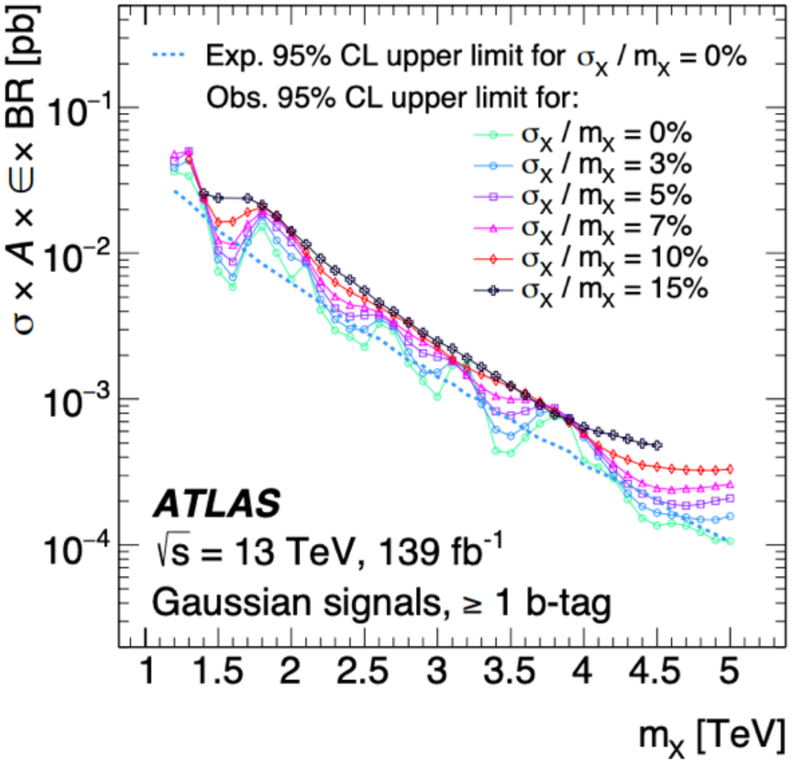


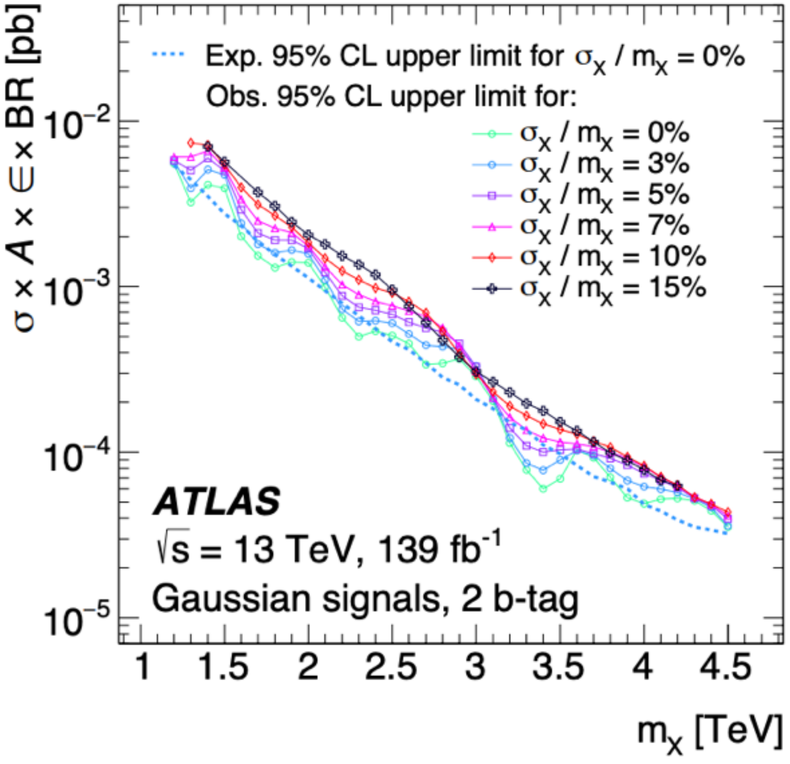
Model Independent Limits

- Signals are Gaussian shaped with different width.

  - 0-width means width << mass resolution







Conclusion

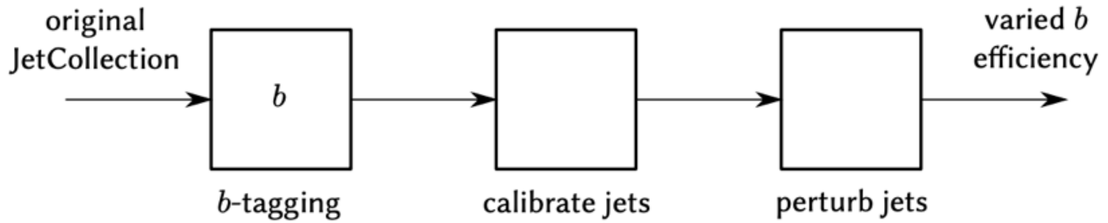
- Searched for the new resonance in final states with two jets/b-jets using Full Run 2 dataset.
- No evidence of new physics was observed.
- The analysis with b-tagging benefits from the awesome DL1r tagger!

Thank you!

Backup

b-tagging Systematics

previous



1. apply b-tagging to AOD-level jets
   ⇝ mainly (exlusively?) for historical reasons?
2. fully calibrate jets and apply systematic variations
   ⇝ `R4_CategoryReduction_SimpleJER` (Summer 2018) used at the moment
3. compute (varied) b-jet efficiency and compare to *nominal* case

At present:

⇝ try to investigate explicit p_T-dependence of `DL1r`