Searches for New Phenomena in Dijet Events with the ATLAS Detector

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Motivation

Generic searches for new physics with strong interactions

- if new heavy resonances are directly produced in collisions, decays to jets are expected

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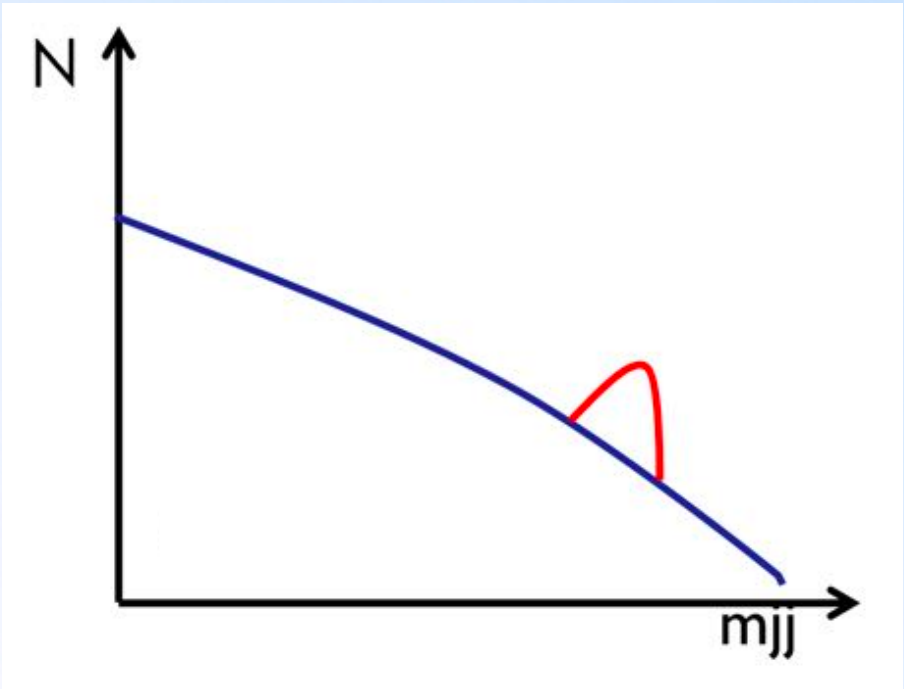
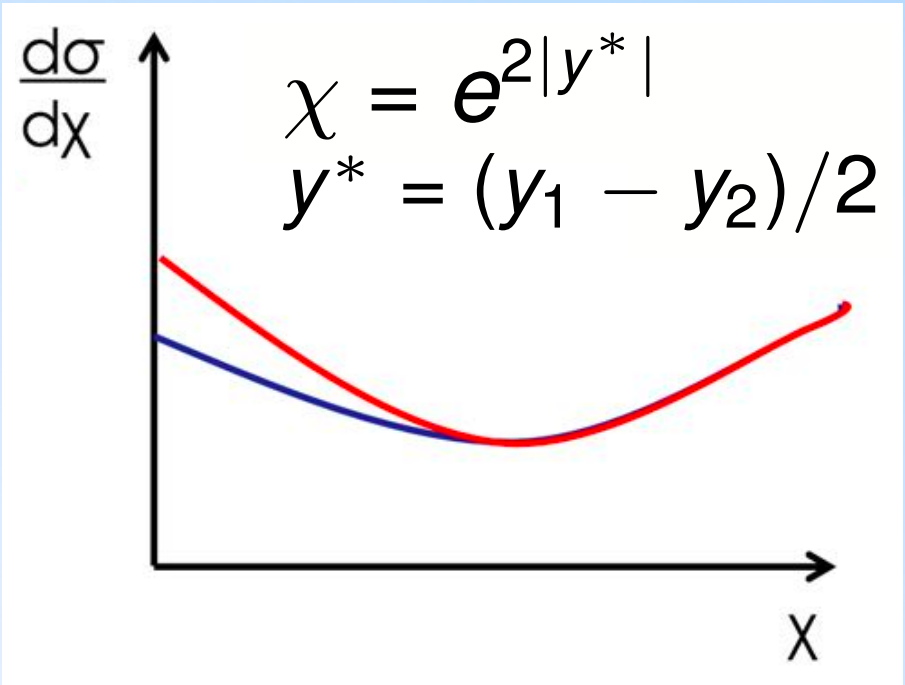
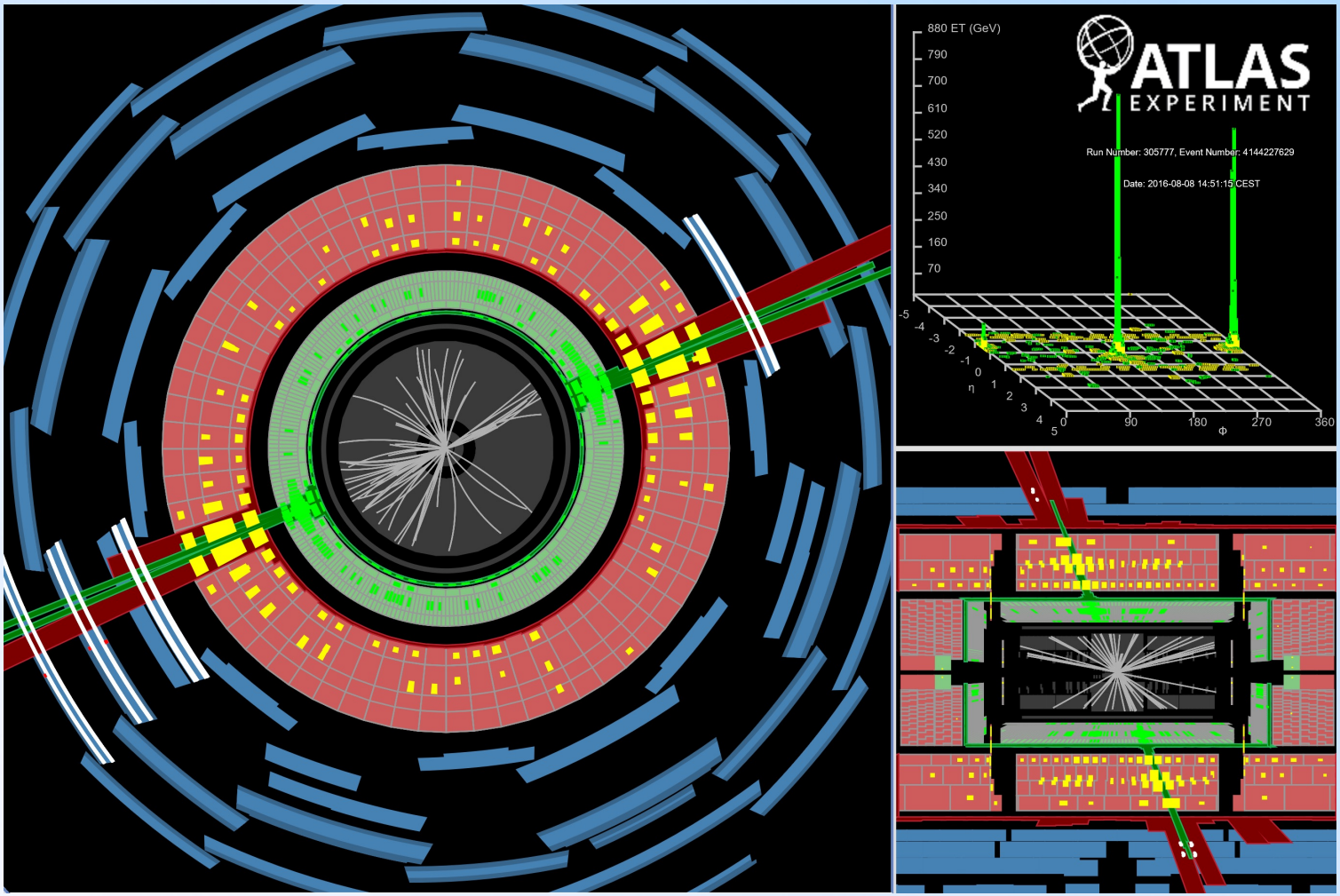
How?





Highest-mass di-jet event

$m_{jj} = 8.12\,TeV$



High-mass di-jet search / Phys. Rev. D 96 (2017) 052004

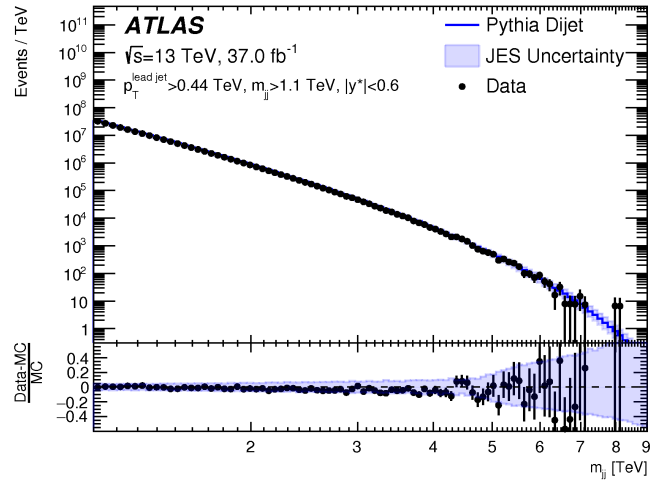
Resonance search

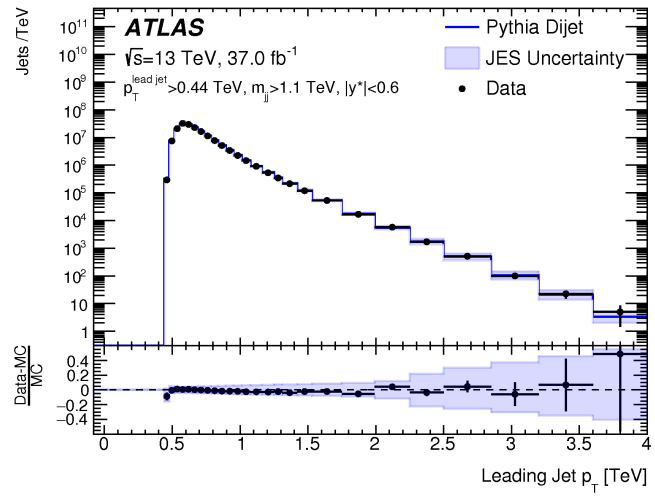
- low-end mass range dictated by jet trigger threshold
- y^* selection to reject some QCD background
- data-driven background estimate using empirical function and new sliding window approach
- BumpHunter to search for excesses

Angular search

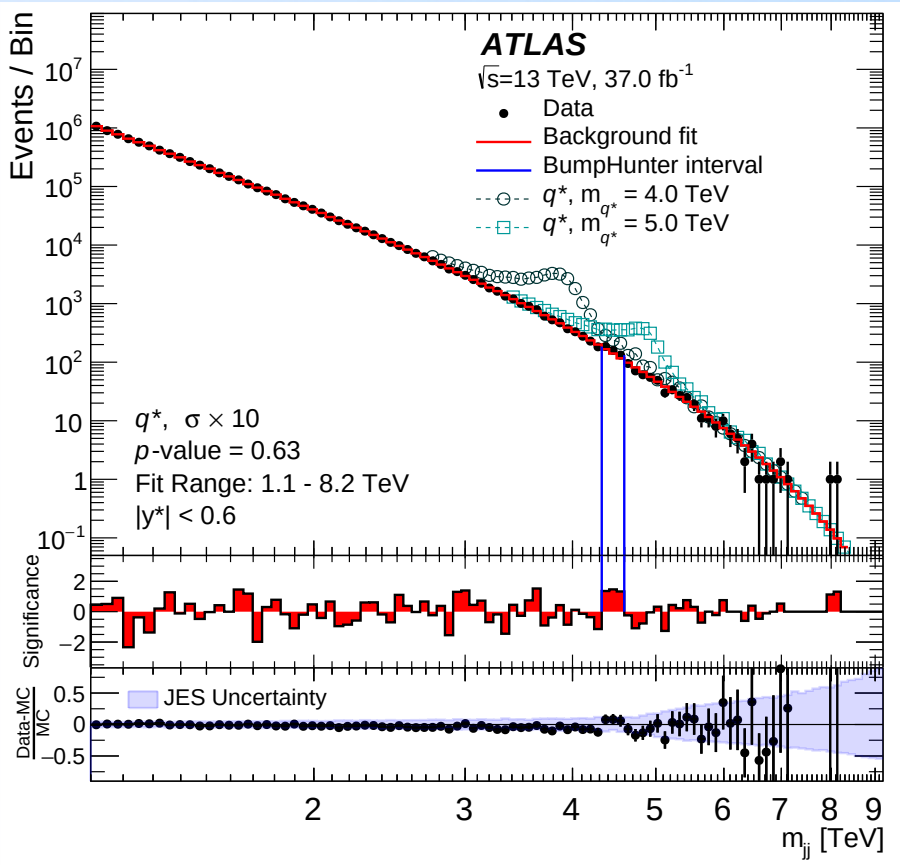
- similar analysis strategy but focus on angular distributions
- higher sensitivity to non-resonant new physics
- $dN/d\chi$ is approximately independent of $\chi = e^{2|y*|}$ unless new physics appears

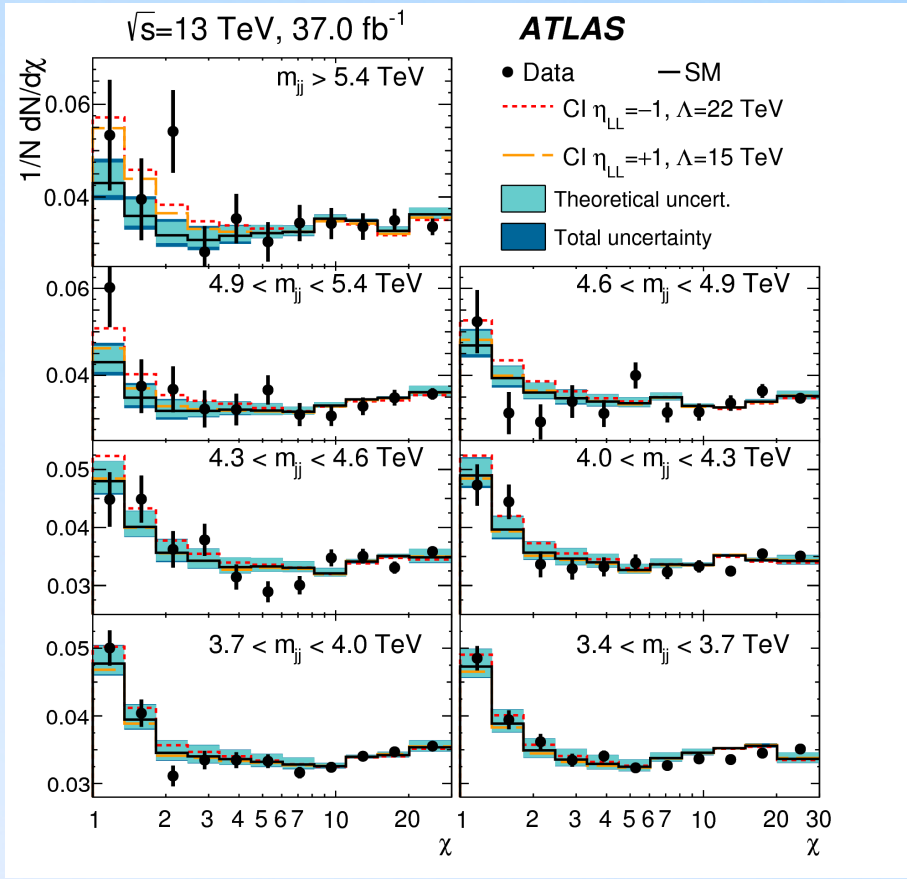
	$p_{\mathrm{T}}^{\mathrm{leading}}$	$p_{\mathrm{T}}^{\mathrm{subleading}}$	$\lvert y^* \rvert$	$\lvert y_{\mathrm{B}} \rvert$	m_{jj}
Resonance	> 0.44 TeV	> 0.06 TeV	< 0.6	-	> 1.1 TeV
W^*	> 0.44 TeV	> 0.06 TeV	< 1.2	-	> 1.7 TeV
Angular	> 0.44 TeV	> 0.06 TeV	< 1.7	< 1.1	> 2.5 TeV



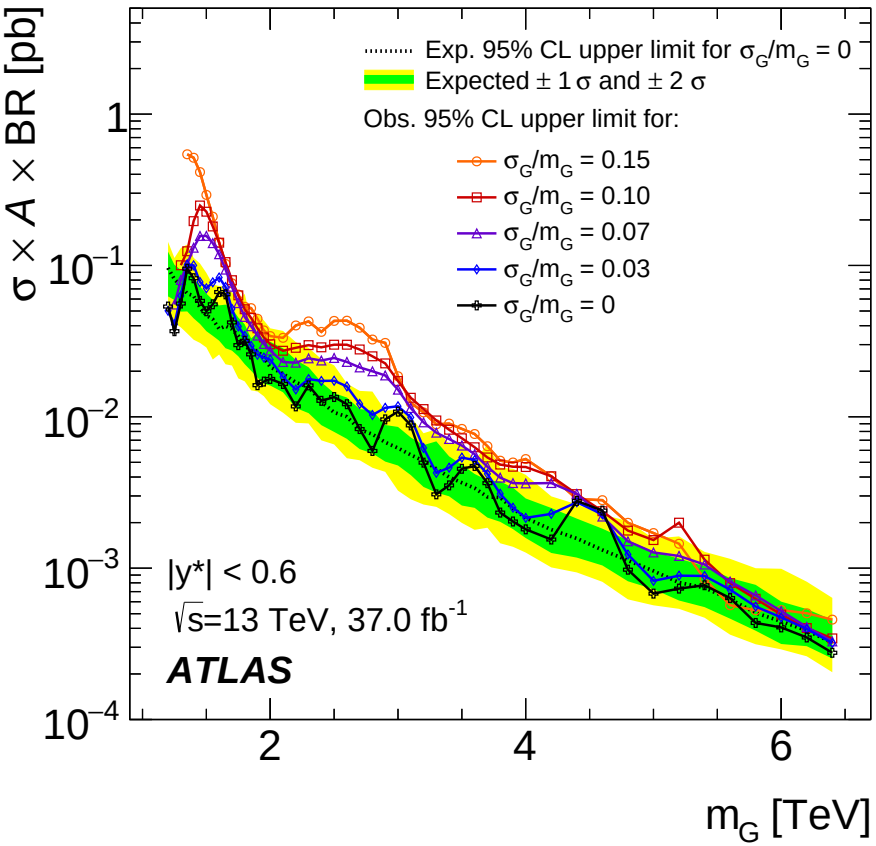


High-mass di-jet search / Phys. Rev. D 96 (2017) 052004





High-mass di-jet search / Phys. Rev. D 96 (2017) 052004



Model	95% CL exclusion limit	
	Observed	Expected
Quantum black hole	8.9 TeV	8.9 TeV
W'	3.6 TeV	3.7 TeV
W^*	3.4 TeV 3.77 TeV – 3.85 TeV	3.6 TeV
Excited quark	6.0 TeV	5.8 TeV
Z' ($g_q = 0.1$)	2.1 TeV	2.1 TeV
Z' ($g_q = 0.2$)	2.9 TeV	3.3 TeV
Contact interaction ($\eta_{\mathrm{LL}} = -1$)	21.8 TeV	28.3 TeV
Contact interaction ($\eta_{\mathrm{LL}} = +1$)	13.1 TeV 17.4 TeV – 29.5 TeV	15.0 TeV

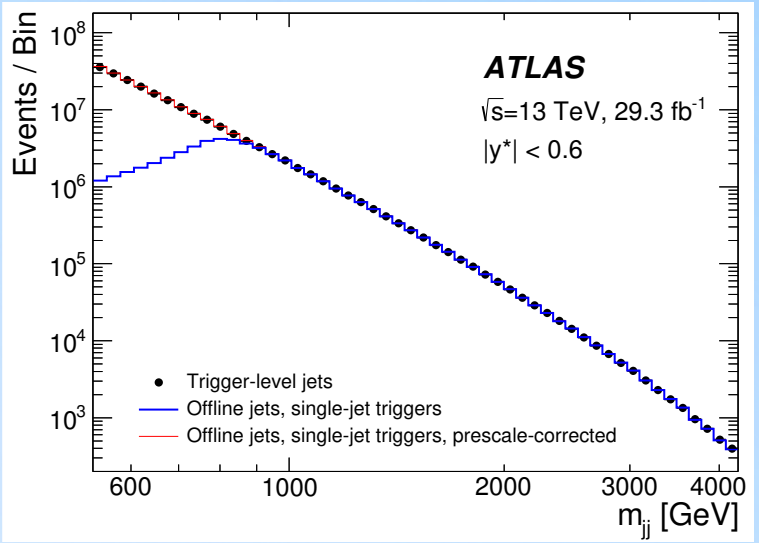
- 95% CL exclusion limits for a variety of models being presented
- analogous limits on an hypothetical signal with cross-section σ_G producing a Gaussian contribution to the particle-level m_{jj} distribution

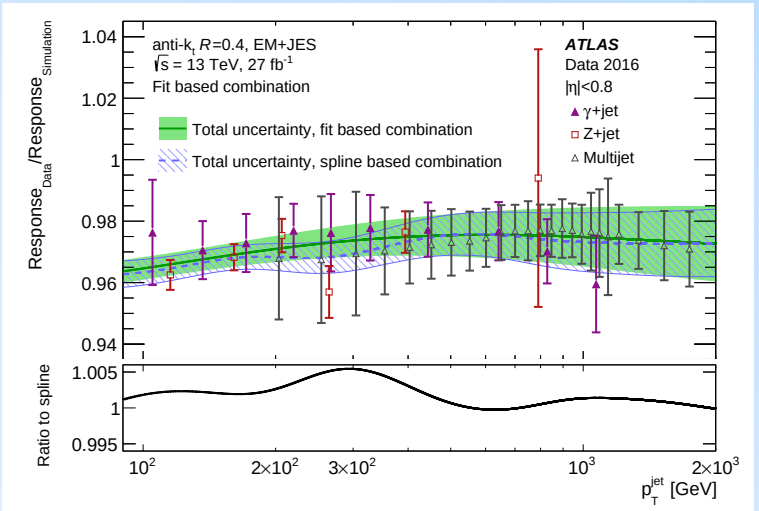
Di-jet search at trigger level / arXiv 1804.03496

Trigger-level resonance search

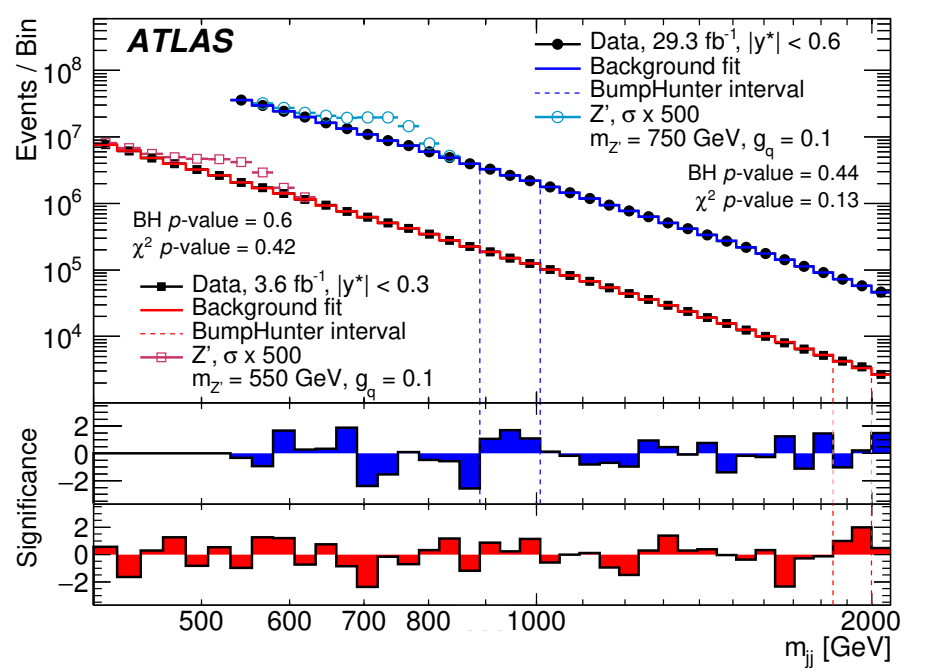
- only trigger-level jets for expanding the reach towards lower m_{jj} values
- dedicated stream with partial event building corresponding to $\sim 5\%$ of full event size
- dedicated jet calibration for online jets
- analysis then follows with usual data-driven background estimate and BumpHunter to search for excesses

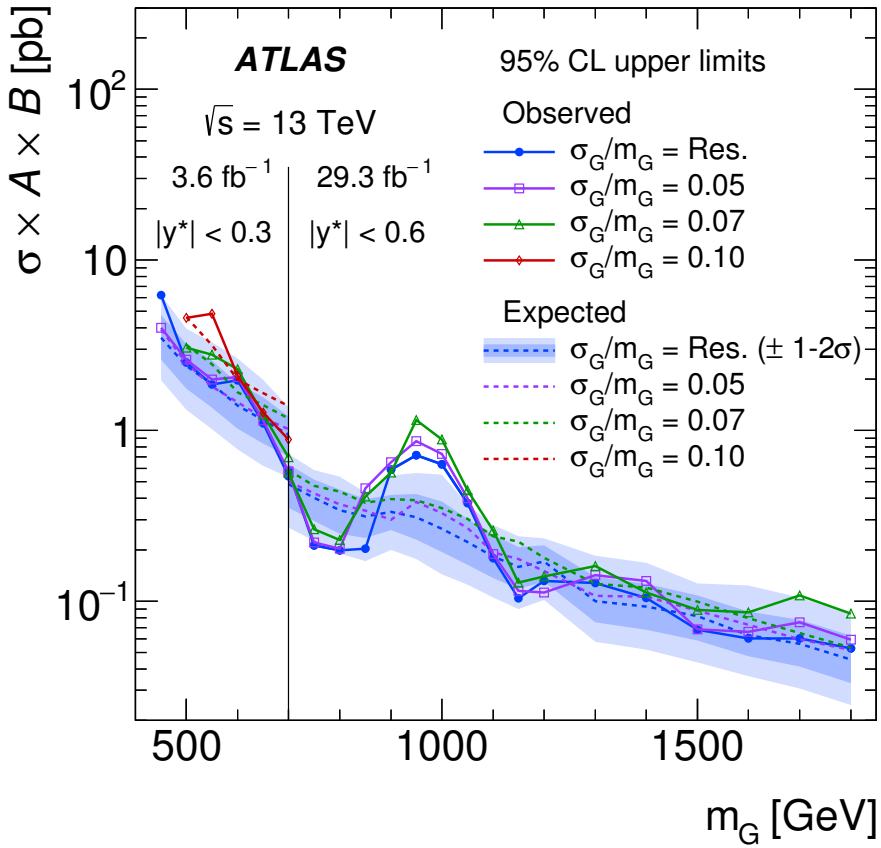
bandwidth = event rate x event size





Di-jet search at trigger level / arXiv 1804.03496



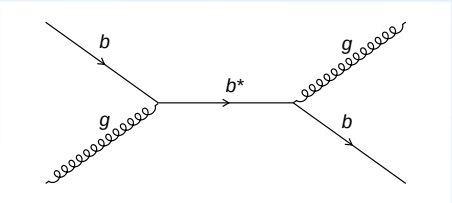


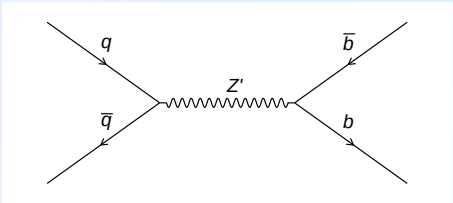
- 95% CL exclusion limits for Z' models and Gaussian processes
- probing new resonances with masses down to 450 GeV

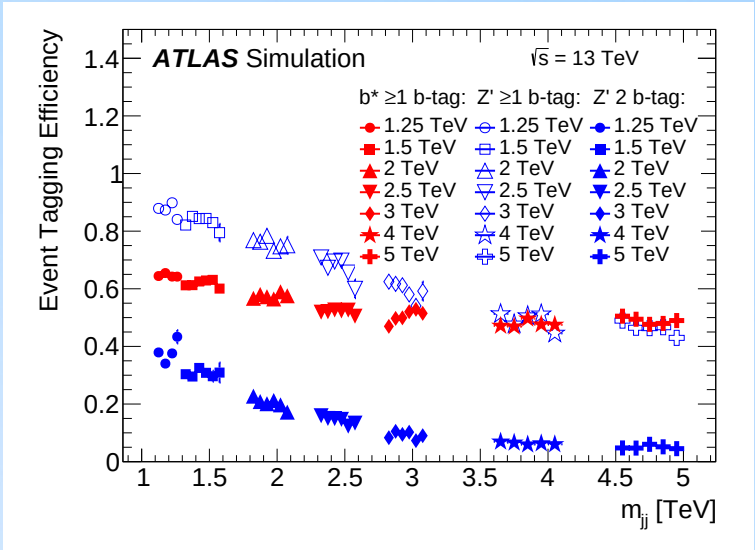
Di-jet search with b-tagging / arXiv 1805.09299

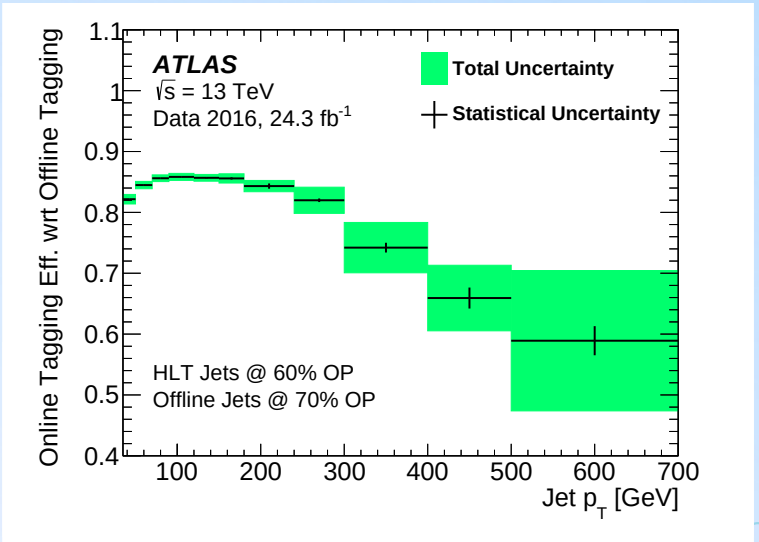
Analysis ingredients

- high-mass search ($m_{jj} > 1.2$ TeV) with different b-tagging multiplicity requirements
- low-mass search (570 GeV $< m_{jj} <$ 1.5 TeV) where b-tagging is also applied at the trigger level
- dedicated b-tagging calibration at trigger level
- per-event tagging efficiency is signal dependent due to gluon splitting in b^* events
- analysis then follows with usual data-driven background estimate and BumpHunter to search for excesses

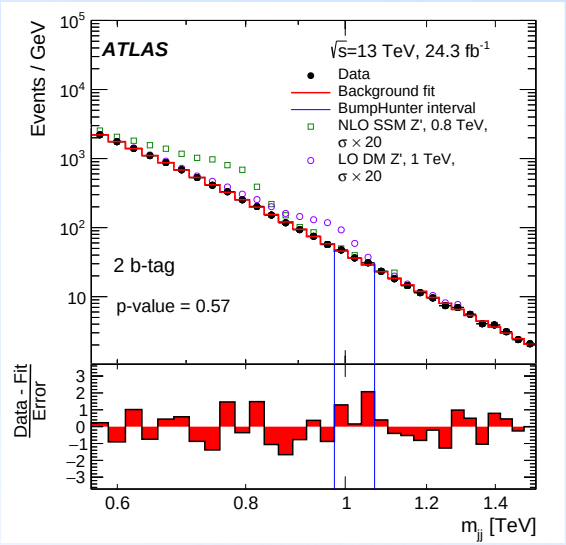


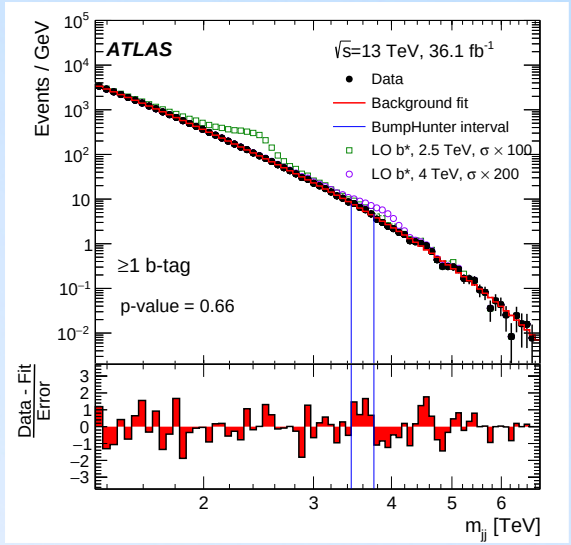


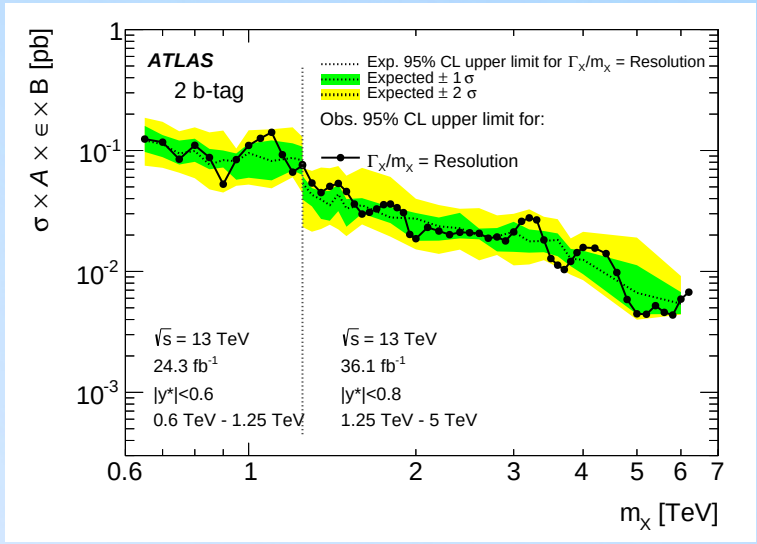




Di-jet search with b-tagging / arXiv 1805.09299





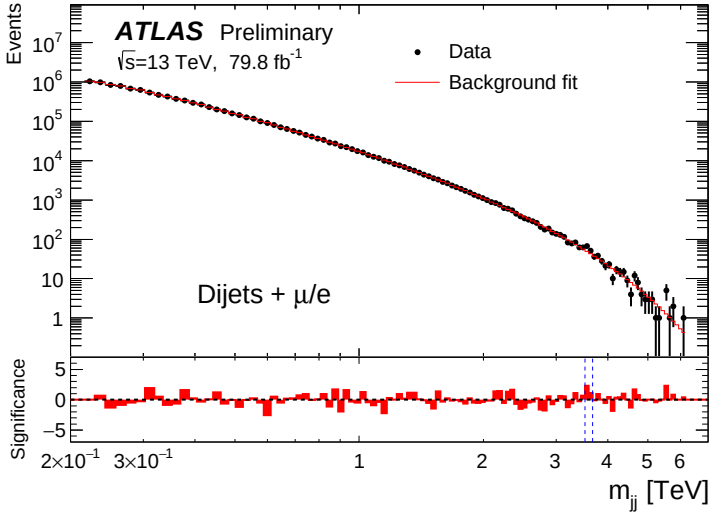


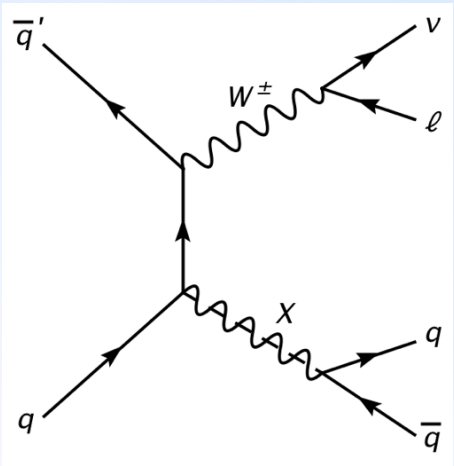
- 95% CL exclusion limits for b^*, Z' and Gaussian processes
- kinematic acceptance and b-tagging efficiency into account
- probing new resonances with preferred coupling to b-quarks with masses down to 570 GeV

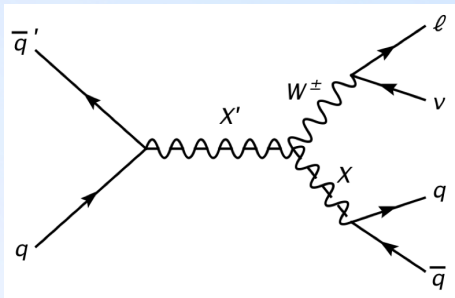
Di-jet search with isolated lepton / ATLAS-CONF-2018-015

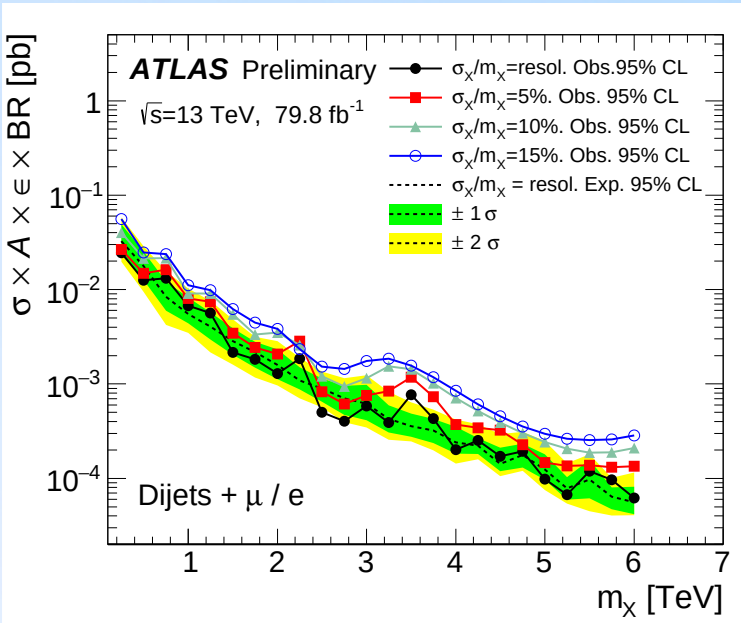
Analysis ingredients

- new experimental signature following the 'inclusive is not conclusive' paradigm
- at least one isolated electron or muon is asked, then m_{jj} distribution is studies with standard techniques
- resonances in the mass range between 0.25 TeV and 6 TeV are looked for



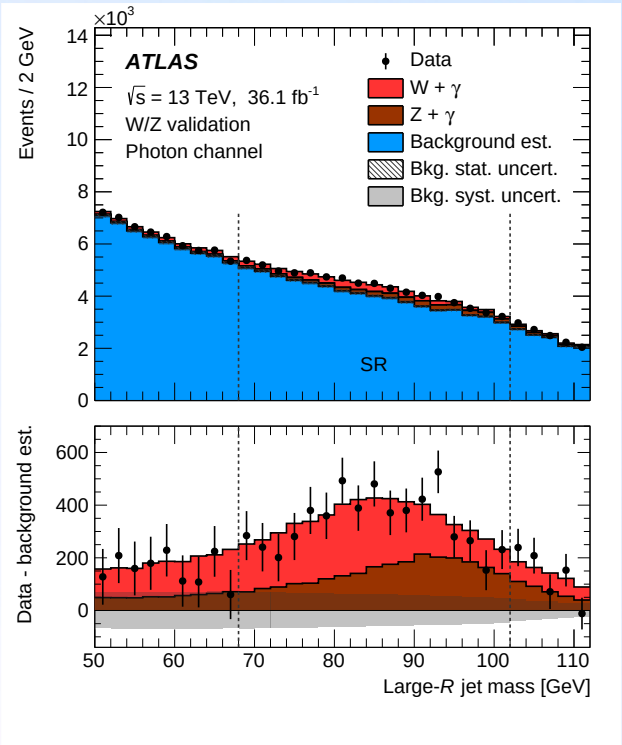


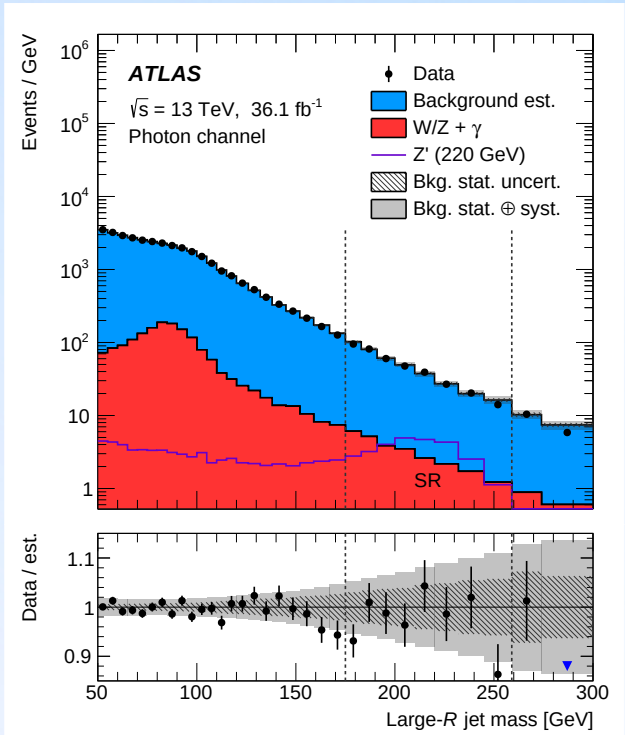


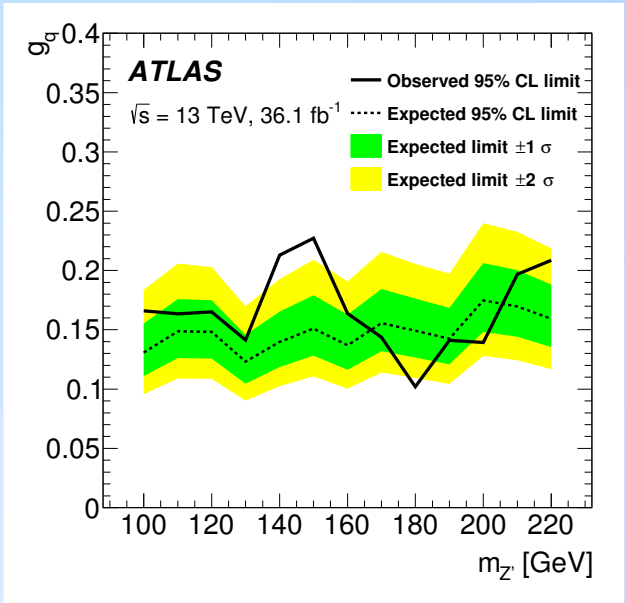


Di-jet search with high-p_T γ or jet / arXiv 1801.08769

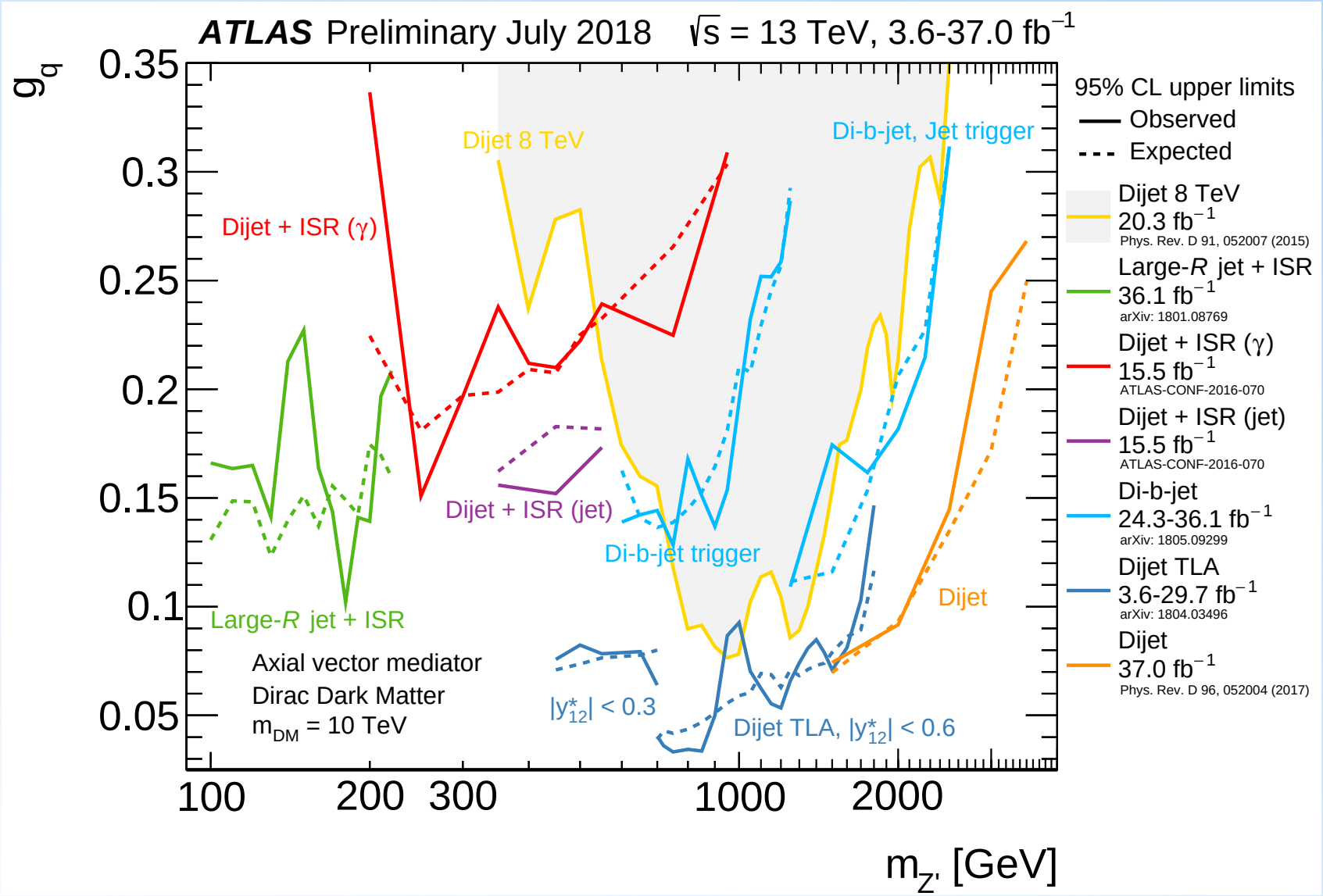
- looking for light resonances boosted via recoil from high-p_T ISR photon or jet
- large-R radius jet with substructure techniques to suppress the background
- data-driven background estimate validated using the SM W and Z bosons







Summary of various di-jet searches interpreted in DM context



Conclusions

Wide experimental program of new resonance searches at ATLAS

- many approaches being pursued giving results in different regions of the phase-space

New physics is still hiding

- more statistics being collected
- new signatures being examined to enhance the physics reach

No more energy steps in the near future

- focus is on improving analysis techniques and background estimate strategies
- improved substructure techniques, improved b-tagging at high-p_T, etc

Challenge to keep in mind

- underlying assumption that mass spectra are smooth
- non-smoothness is being introduced by reduced statistical errors and e.g. JES, b-tagging

THANK YOU FOR YOUR ATTENTION !

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