Searches for low-mass dark matter mediators decaying to jets with the ATLAS detector

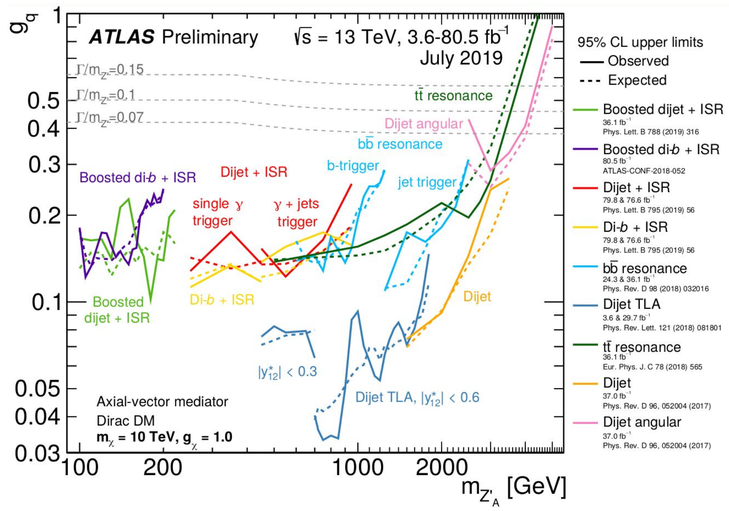
Low-mass mediator dijet searches [1]

Dark matter mediator models: ATLAS has a **wide, complementary search programme.**

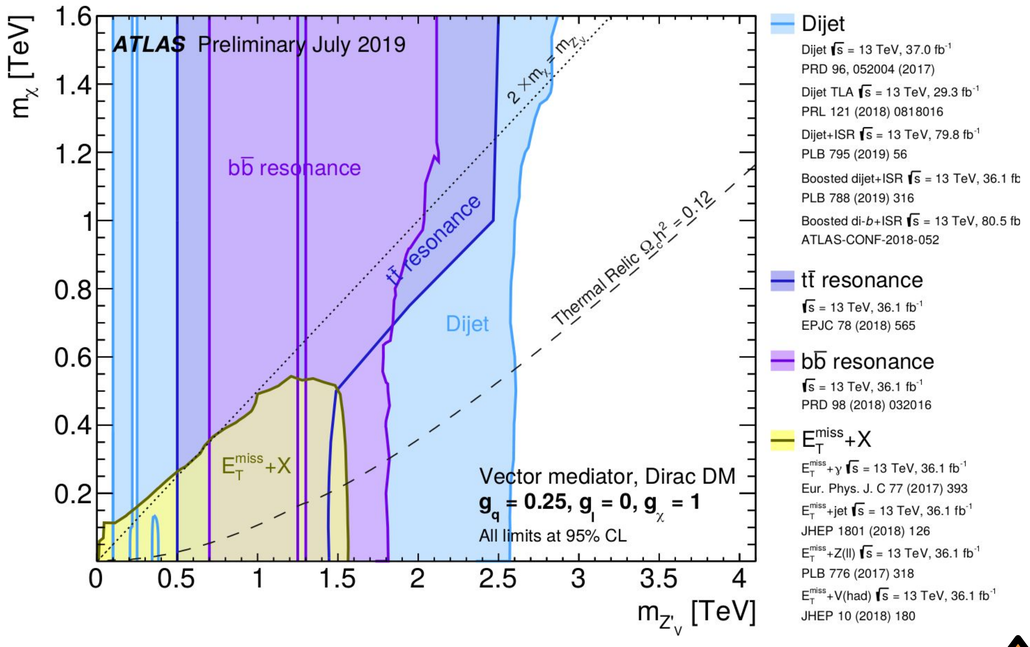
Issue at low mass: huge QCD multijet background. Unprescaled jet trigger p_T thresholds typically too high to probe hadronically decaying mediator masses $\lesssim$1 TeV.

E.g. **Trigger Level Analysis** uses smaller-sized trigger-level objects, storing more events triggered by the lower-threshold hardware trigger.

To reach even lower masses: trigger on **high-p_T associated objects,** using jet substructure techniques for highly boosted resonance decays:



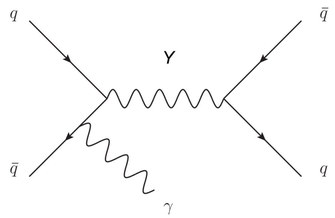
Dark matter vector mediator summary [1]

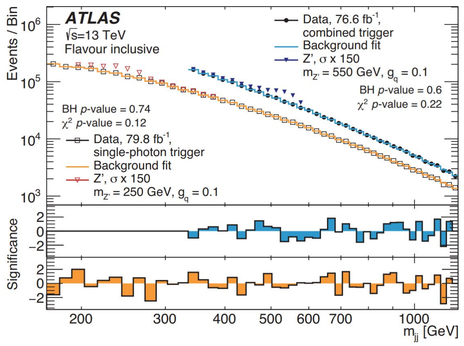


(resolved) dijet+ISR analysis [2]

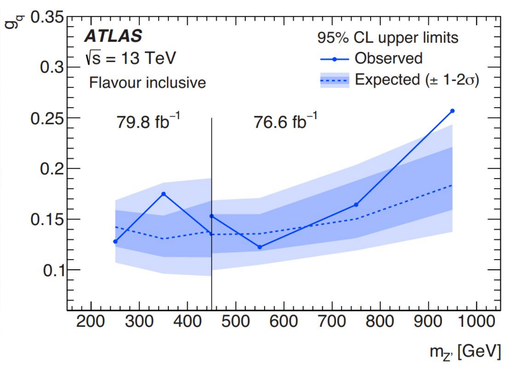
Requiring additional **high-p_T object** (e.g. γ) lowers the event rate: can access very low-p_T jets.

Also: *2b* final state—very sensitive even with universal quark couplings!

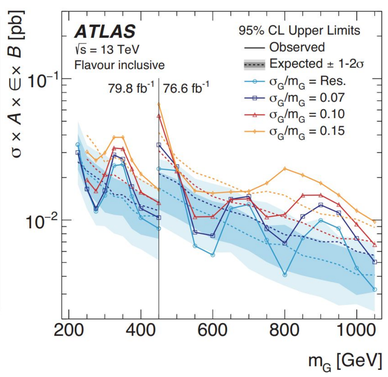




Data fitted with a functional form, and bumps hunted. **No signal found...**



…so we **set limits** on a benchmark *Z'* mediator model [3]...



...and generic Gaussians, useful for reinterpretation.

Analytical reinterpretation

Communicate complementarity of the ATLAS search programme, inform decisions about future searches: individual analysis **limits compiled in summary plots**.

But each analysis can assume **different scenarios**, models and parameter spaces. Thus, results need to be **reinterpreted** into a common model space.

Previous method [4,5] required generating signal samples with correct parameters; takes weeks. But reinterpretation can be done **purely analytically** [6] in seconds!

Analysis limits in (g_q, $M_{Z'}$), parameters P
Summary plot in (m_{DM}, $M_{Z'}$), parameters Q

Write **analysis-excluded cross-section**, equate to cross-section expressed in summary parameters:

$$\sigma_{analysis}(g_q, M_{Z'}, P) = \sigma_{summary}(m_{DM}, M_{Z'}, Q).$$

Cross-sections are known functions,

$$\sigma = \Gamma_{initial} \times \Gamma_{final} \times \Gamma^{-1}_{total},$$

so invert RHS to get excluded summary model parameters in terms of analysis quantities!

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References
[1] ATL-COM-PHYS-2019-940
[2] Phys. Lett. B 795 (2019) 56
[3] arXiv:1507.00966 [hep-ex]
[4] Phys. Rev. Lett. 121 (2018) 081801
[5] PRD 96 052004 (2017)
[6] Phys. Lett. B 769 (2017) 520