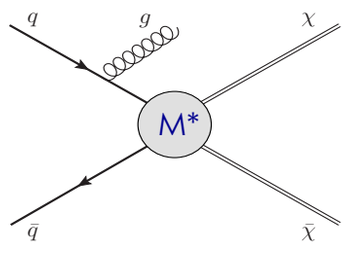
NEW PHYSICS SEARCH IN MONO-JET FINAL STATES WITH THE ATLAS EXPERIMENT AT THE LHC

The Mono-jet analysis is a search for events with a high transverse momentum jet and missing transverse energy (E_T^{miss}) in the final state. This topology constitutes a clean and distinctive signature in searches for new physics beyond the Standard Model (SM) at colliders.



The Mono-jet final state has more statistics with respect to other Mono-X (Mono-γ, Mono-Higgs etc.) final states @LHC ($\alpha_S >> \alpha_{EW}$). It is sensitive to New Physics predicted by many theories such as cold Dark Matter candidates, SUSY, extra spatial dimensions and invisible Higgs decays.

Run1 Analysis Strategy

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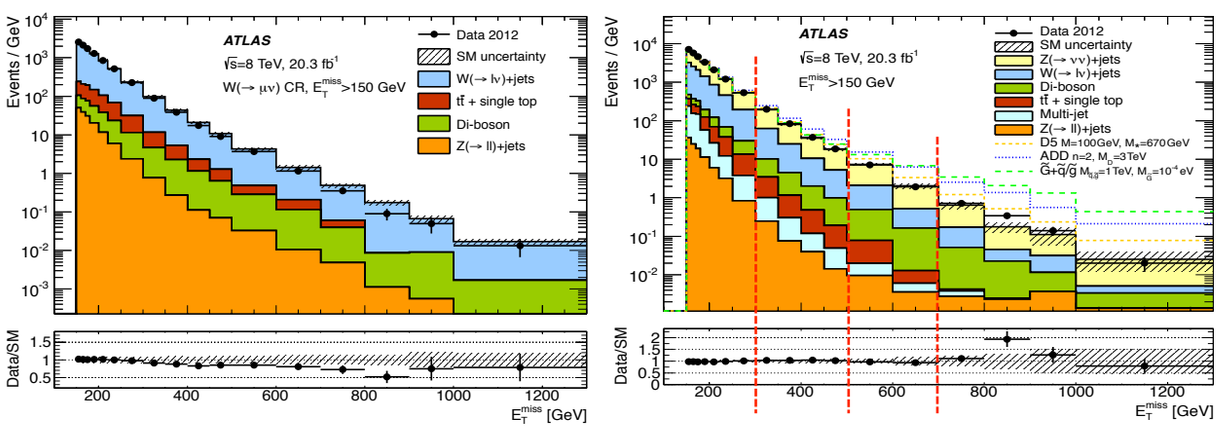
Selection criteria
Primary vertex
$E_{\mathrm{T}}^{miss} > 150, ..., 700$ GeV
Jet quality requirements
At least one jet with $p_{\mathrm{T}} > 30$ GeV and $\lvert\eta\rvert < 4.5$
Lepton and isolated track vetoes
The leading jet with $p_{\mathrm{T}} > 120$ GeV and $\lvert\eta\rvert < 2.0$
Leading jet $p_{\mathrm{T}}/E_{\mathrm{T}}^{miss} > 0.5$
$\Delta\phi(\mathrm{jet}, E_{\mathrm{T}}^{miss}) > 1.0$

Z(νν)+jets and **W(τν)+jets** dominant bkgs estimated by **W(μν)** and **W(eν) Control Regions** (CRs) respectively.

Other sources of bkg coming from V+jets are estimated by Z(ll), W(lν) CRs (defined as the SRs with the request of one or two isolated leptons), top and di-boson processes by MC simulations and the multi-jet bkgs are based on the data.

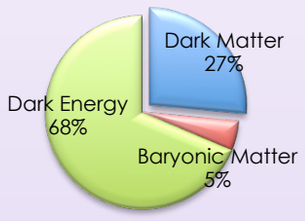


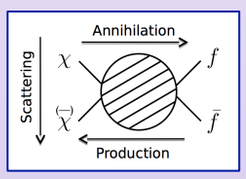
bkg uncertainties ~3÷6÷14%
(top, di-boson, V p_T modelling, JES/JER...)

SR (E_{T}^{miss} cut)	300 GeV	500 GeV	700 GeV
Observed events	18020	1028	126
SM expectation	18000 ± 500	1030 ± 60	97 ± 14

The Dark Matter paradigm

The existence of a Dark Matter (DM) particle is a well-established hypothesis that explains a range of astrophysical and cosmological measurements.
None of the known SM particles provides suitable candidates for DM, but several theories beyond the SM postulate the existence of new particles that are stable (or at least long-lived) and neutral, thus fulling two important requirements for being the DM in the universe.





The detection of DM candidates in a collider can give complementary results with respect to the direct (DAMA, LUX etc.) and indirect experiments (AMS, Ice-Cube etc.) and this kind of analysis is sensitive in the **low DM mass** region (currently the direct detection cannot reach the spectrum area below ~3GeV).

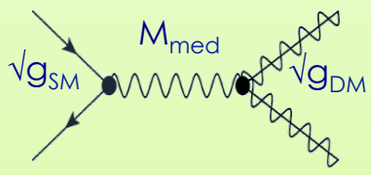
DM

Contact interaction in the Effective Field Theory (EFT) can be considered if
$M_{med}=M^*(g_{SM}g_{DM})^{1/2} >> \sqrt{\hat{s}} >> 2m_\chi$

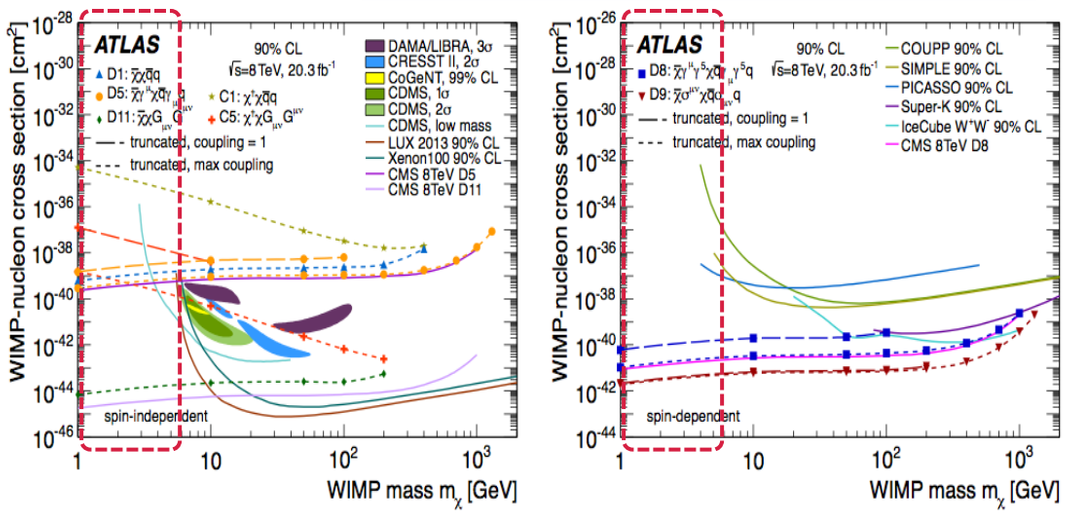
Several operators that describe the type of interaction are investigated considering the DM a Dirac fermion or scalar WIMP…

comparison with direct detection experiments

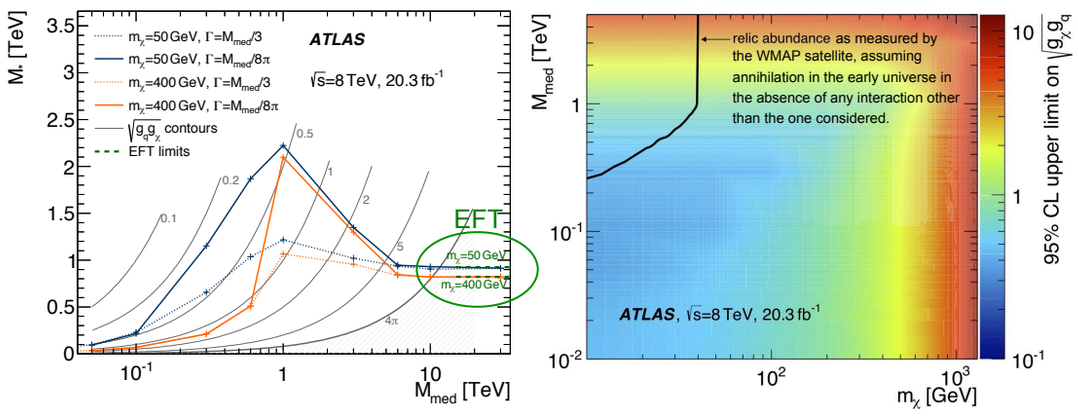
But @LHC we can do more!
In fact it is also possible to probe the couplings ($\sqrt{g_{SM}g_{DM}}$) studying the relation between M^* and M_{med} choosing a particular kind of mediator ***(Simplified Models)***



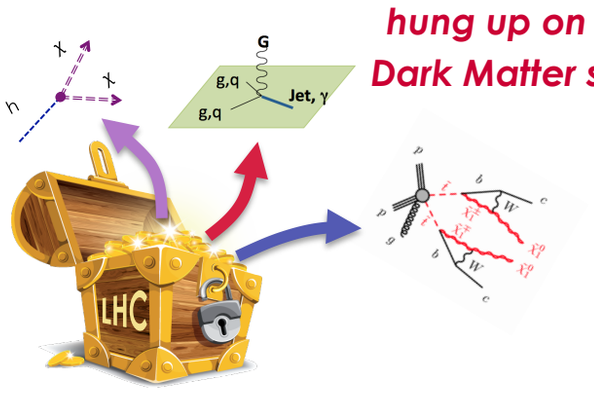
Limit on SI and SD χ-nucleon interaction xsec



Limits on DM particles which couple to SM quarks via a Z' boson



We don't want to get hung up on the Dark Matter side!



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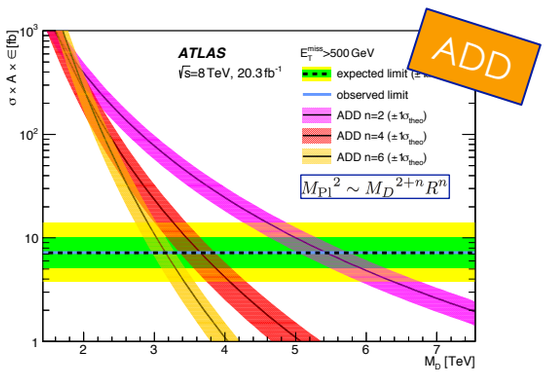
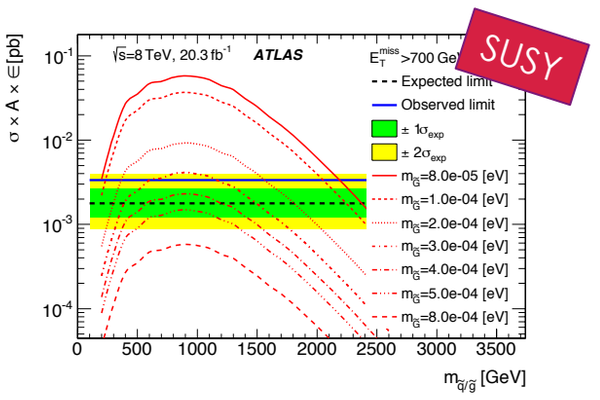


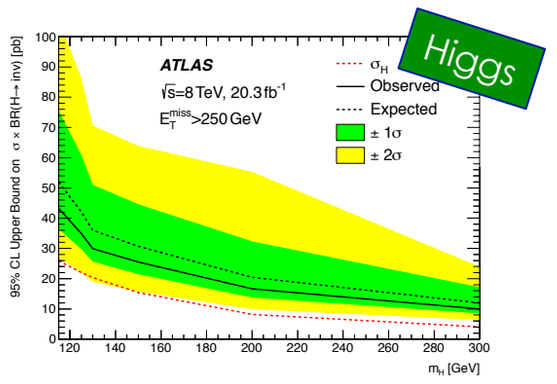
Jet + graviton modes escaping detection.
We can investigate the scenarios with several number of extra dimensions;

SUSY



SUSY with LSP Gravitino
$pp \rightarrow \tilde{G}\tilde{g}(\tilde{q})+X \rightarrow \tilde{G}\tilde{G}g(q)+X$

Higgs



Invisible Higgs decays are also investigated (sizable BR still allowed).

First look at √s = 13 TeV data

Similar Run1 event selection strategy adapted to the new collision energy but more commitment in the Simplified Model interpretations is planned!
(arXiv:1507.00966)

First public results with 'relaxed' definitions that show our control of the non-collision background (by removing the jet cleaning) and our readiness to use the new data..

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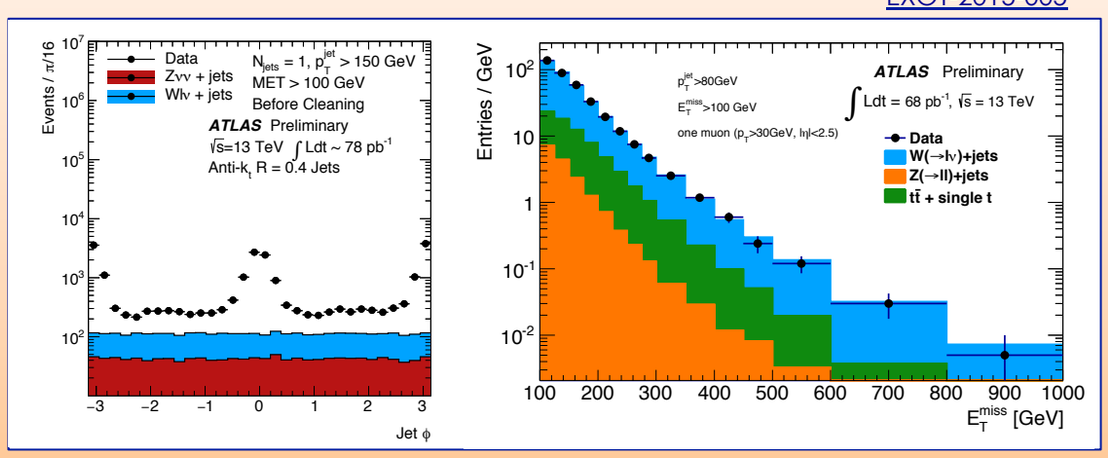

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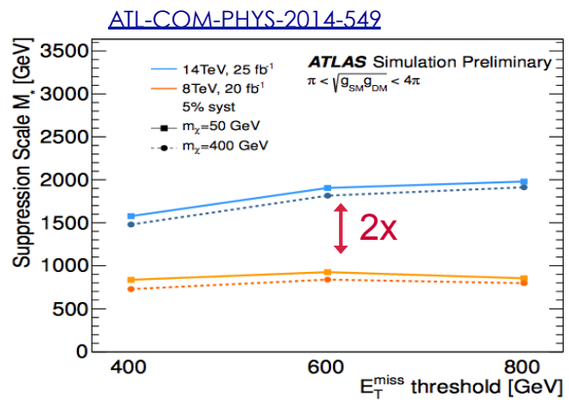

Promising prospects at the new energy! The best is yet to come…

Giuliano Gustavino for the Atlas collaboration – Sapienza Università di Roma – INFN Roma1