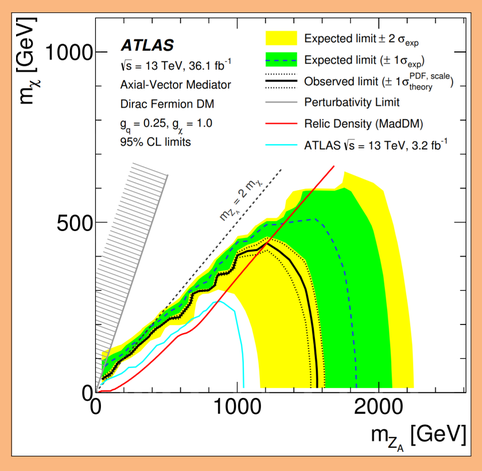
Searches for Dark Matter and Dark Energy produced in association with a jet using the ATLAS detector

Jack Lindon & Steven Worm - On Behalf of The ATLAS Collaboration

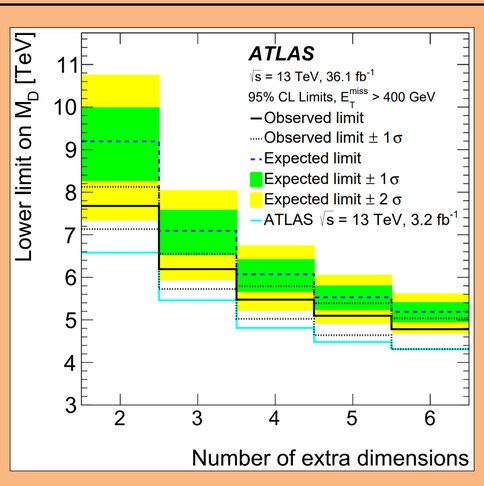
Interpretations

WIMPs[4]

The monojet search is sensitive to various WIMP candidates. Pair-production involving an axial-vector, vector or a pseudoscalar mediator in the s-channel, & a coloured scalar mediator are considered.



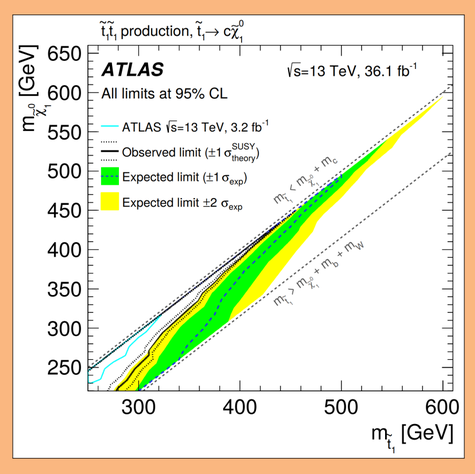
Large Extra Spatial Dimensions (LED)[4]



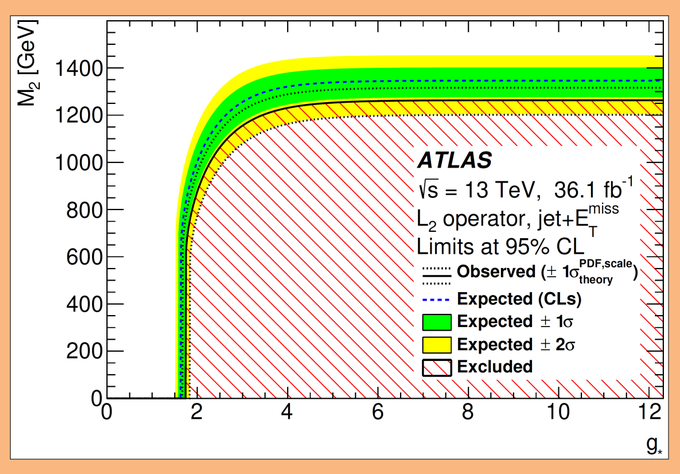
LED can explain the difference between the EW scale O(100) GeV and the Planck scale O(10^{19}) GeV. The ADD model of LED leads to a reduced Planck Scale M_D, predicted to be on the TeV scale, accessible at the LHC. It also results in massive graviton modes escaping into the LED resulting in E_T^{miss} leading to a monojet signature.

SUSY[4]

Pair production of stop and sbottom squarks has been considered. Exclusion limits are enhanced for the compressed scenario where the stop and neutralino masses are almost degenerate.

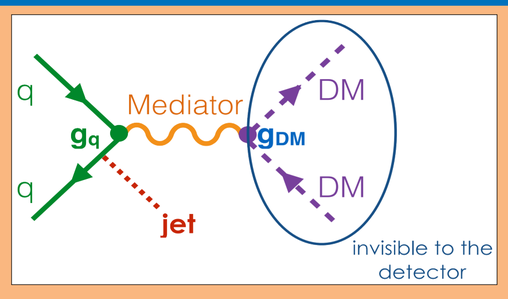


Scalar Dark Energy (DE)[1]



A horndeski model postulating a DE scalar field that couples to both SM matter fields and gravitational fields in such a way as to cause a small cosmological constant has been considered. The DE field results in an invisible scalar particle thats coupling is enhanced at high momentum transfers which are involved in the monojet signature.

Monojet Final State



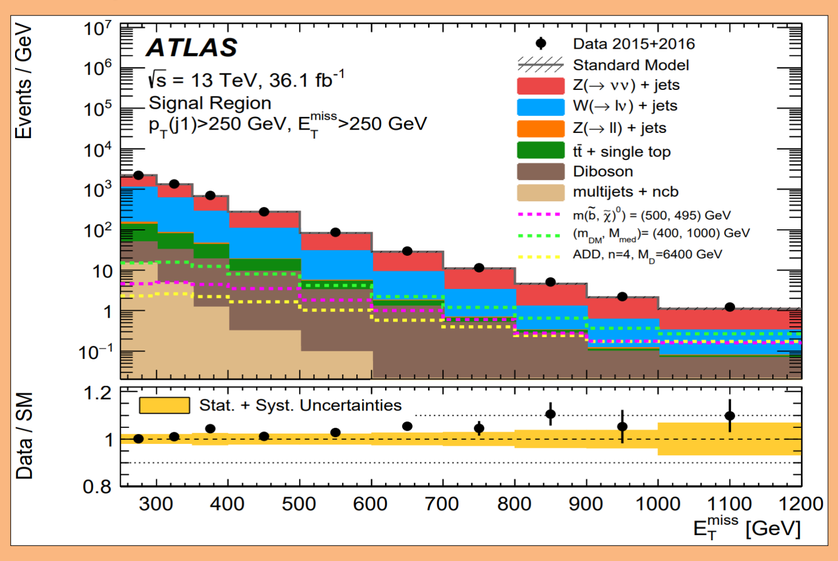
A final state with 1 energetic jet & high E_T^{miss} can probe phenomena where an invisible particle recoils off the jet. As this can arise from Initial State Radiation (ISR) which doesn't require a jet to interact directly with the invisible particles a large range of BSM is probed.

Event Selection

- $E_T^{miss} > 250$ GeV
- Leading jet $p_T > 250$ GeV
- Jet quality restrictions (pileup and non collision background rejection)
- $n_{jets} \leq 4$ with $p_T > 30$ GeV & $|\eta| < 2.8$
- $|\Delta\phi(jet, p_T^{miss})| > 0.4$ for any jet
- Electrons with $p_T > 20$ GeV vetoed
- Muons with $p_T > 10$ GeV vetoed
- Signal Regions (SR) defined based on E_T^{miss}

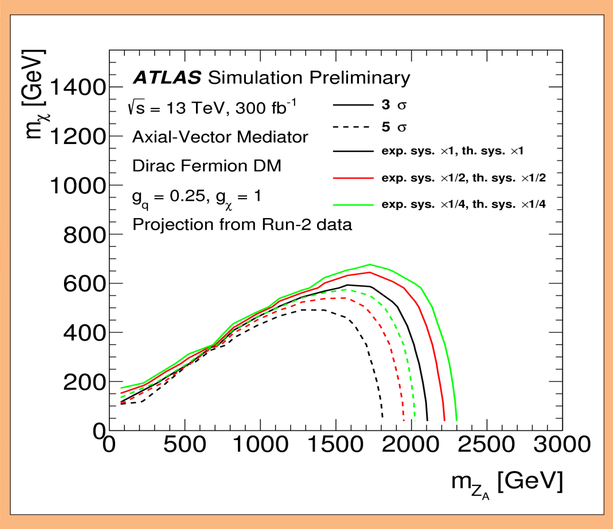
Results

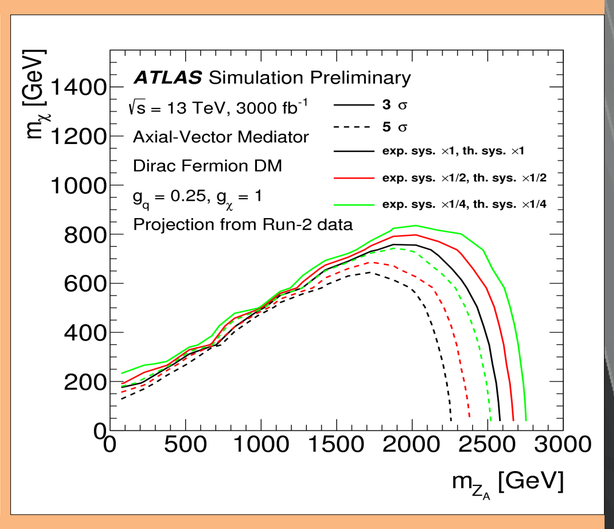
Backgrounds measured with various Control Regions (CR) & modelled within the SR. Monte Carlo is normalized with data in the CR, by a global fit including systematics. A 2.4% background uncertainty on total events in the SR is reached.



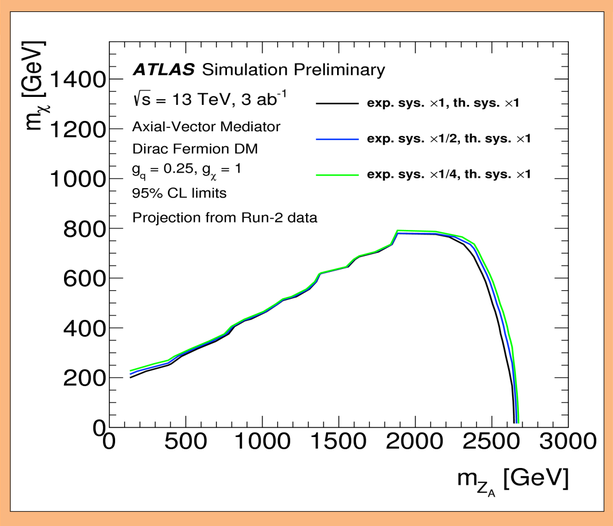
Projections

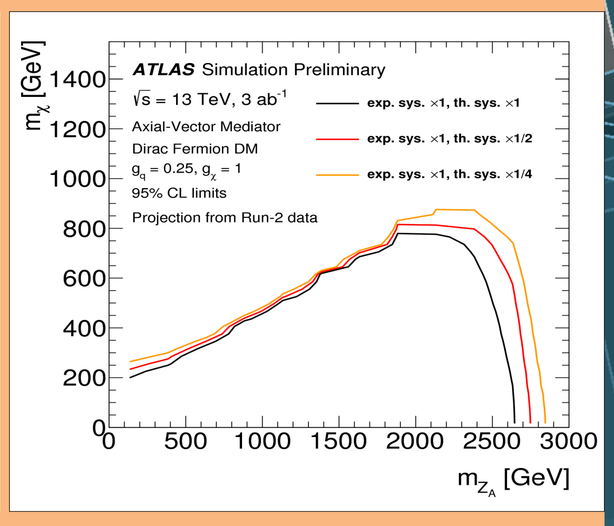
[3] The LHC will be upgraded in the mid 2020s to the High Luminosity LHC (HL-LHC), colliding high energy protons at an unprecedented rate. ATLAS is expected to collect 3000fb^{-1} of data by 2036, greatly enhancing the monojet discovery potential.





Systematic improvements also enhance discovery potential, especially theoretical systematics.





Improvements to discovery potential are gained by optimizing the monojet search, & by the expected increase in $\sqrt{S}$ from $13 \rightarrow 14$ TeV as the WIMP σ considered increases by 25-40%.

References - The ATLAS Collaboration.

[1] "*Search for scalar dark energy in $t\bar{t} + E_T^{miss}$ and mono-jet final states with the ATLAS detector*" ATL-PHYS-PUB-2018-008

[2] "*Constraints on mediator-based dark matter & dark energy using $\sqrt{s} = 13$ TeV pp data at ATLAS*" JHEP (2019): 142.

[3] "*Extrapolation of E_T^{miss}+jet search results to an integrated luminosity of 300 and 3000 fb^{-1}*" ATL-PHYS-PUB-2018-043

[4] "*Search for dark matter & other new phenomena in events with energetic jet & large E_T^{miss} at ATLAS*" JHEP (2018): 126.

jack.lindon@cern.ch