Search for Dark Matter Produced in Association with a Higgs Boson Decaying to $b\bar{b}$ at $\sqrt{s} = 13$ TeV with the ATLAS Detector

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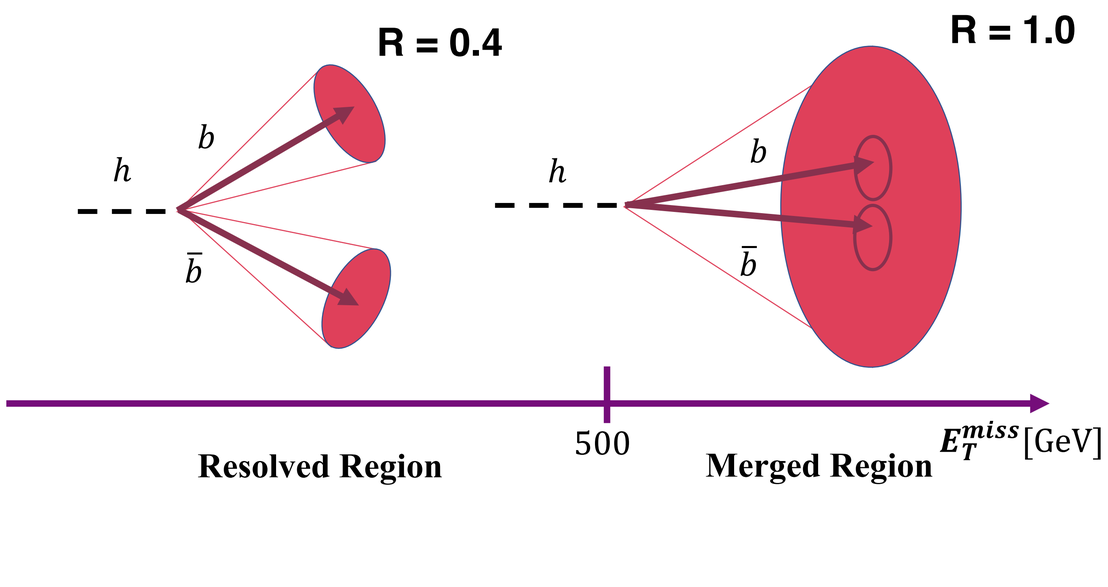
Introduction

Several extensions of the Standard Model predict associated production of Dark Matter particles with a Higgs boson. Such processes are searched for in final states with missing transverse momentum and a Higgs boson decaying to $b\bar{b}$. Because h radiation off the initial state is Yukawa-suppressed, the $h + E_T^{miss}$ process represents a direct probe of the interaction involving DM particles. Limits are placed on the cross-sec tion of associated production of Dark Matter particles and a Higgs boson for a simplified Dark Matter model. The visible cross-section of non-SM events without extra model assumptions are also provided.

Analysis Strategy & Event Selection

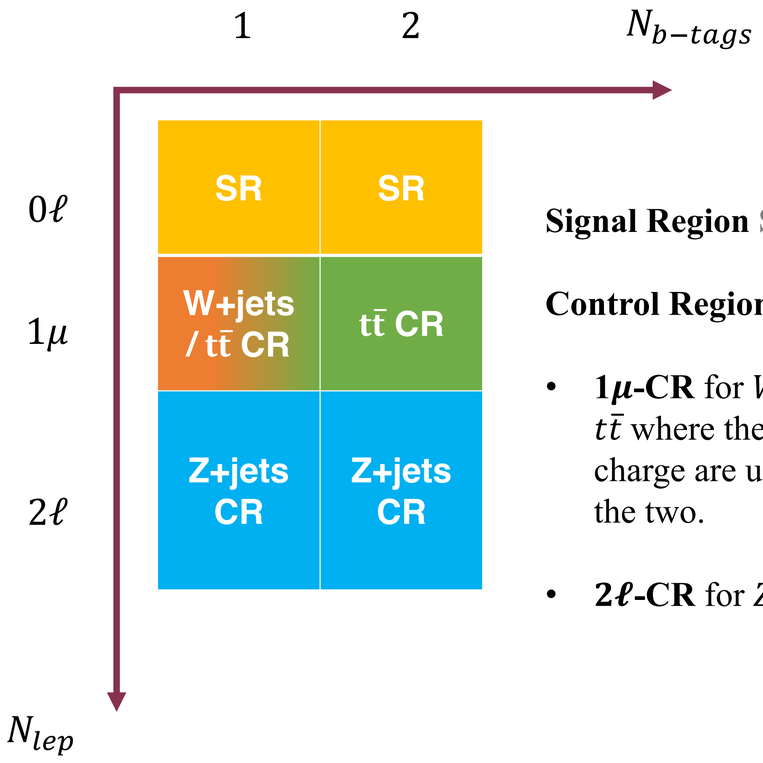
The signal region is formed to target different regions of phase space based on the topology of the $h \rightarrow b\bar{b}$ decay. This is done by selecting events with large missing transverse momentum. Jets are reconstructed with different radius parameters R, depending on E_T^{miss}.



Background Estimation

Dominant backgrounds: $Z \rightarrow \nu\nu + jets$, $W \rightarrow l\nu + jets$, and $t\bar{t}$
For the dominant backgrounds we use Monte Carlo templates and adjust their normalizations using control regions.
Smaller backgrounds: single-top, di-boson, SM Vh($h \rightarrow b\bar{b}$), multi-jets.

Combined fit of signal and control region are used to search for a resonant excess near m_h and estimate backgrounds.



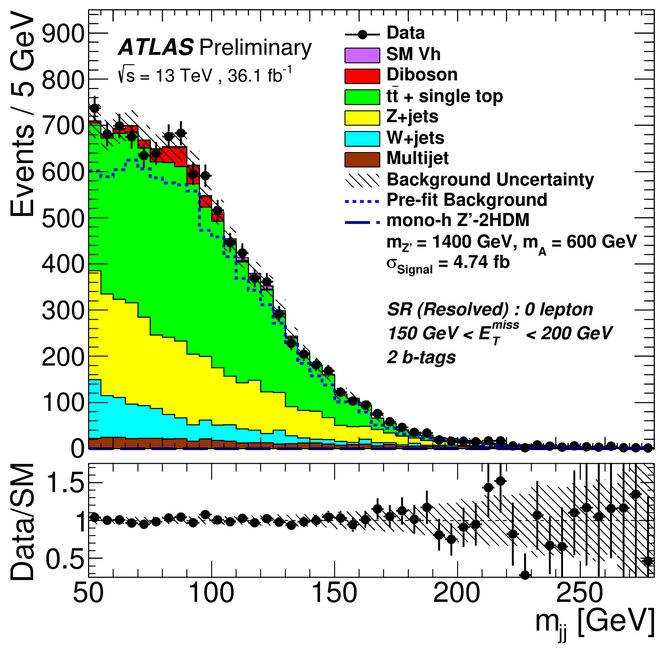
Signal Region SR

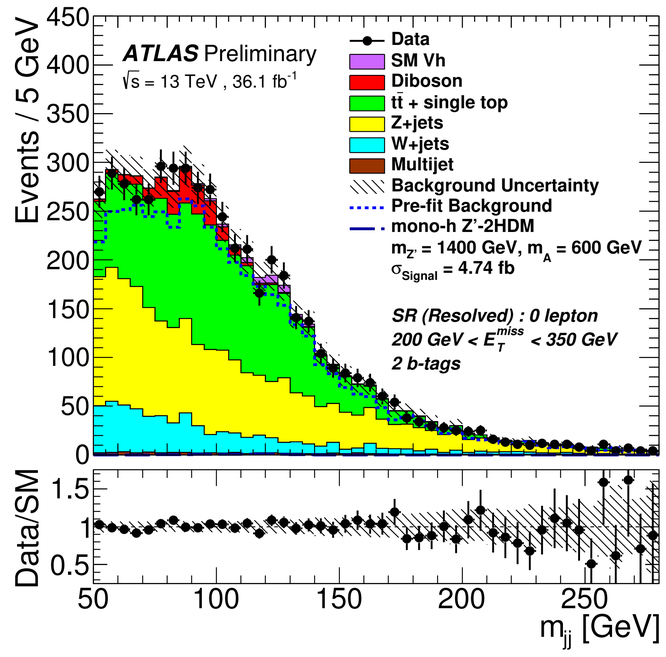
Control Region CR

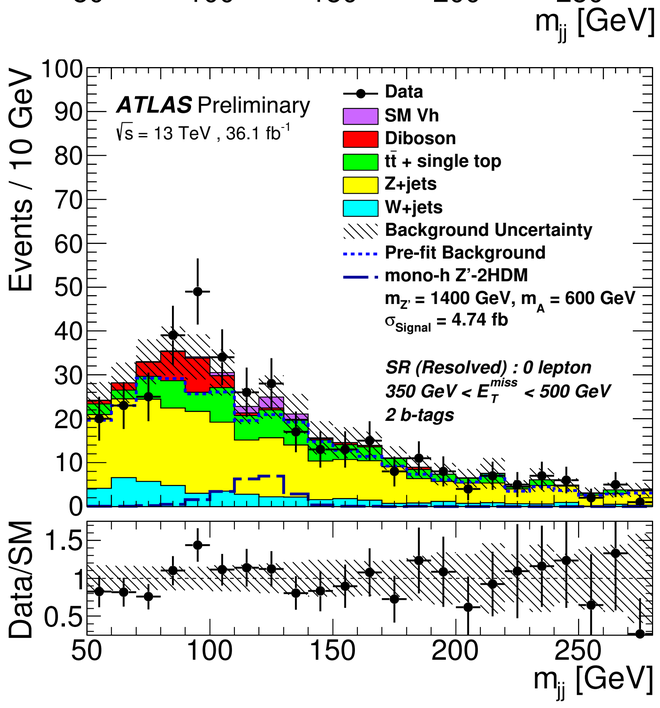
- **1μ-CR** for $W \rightarrow \mu\nu + jets$ and $t\bar{t}$ where the number of b-tag and muon charge are used for separating between the two.
- **2ℓ-CR** for $Z \rightarrow ll + jets$ background

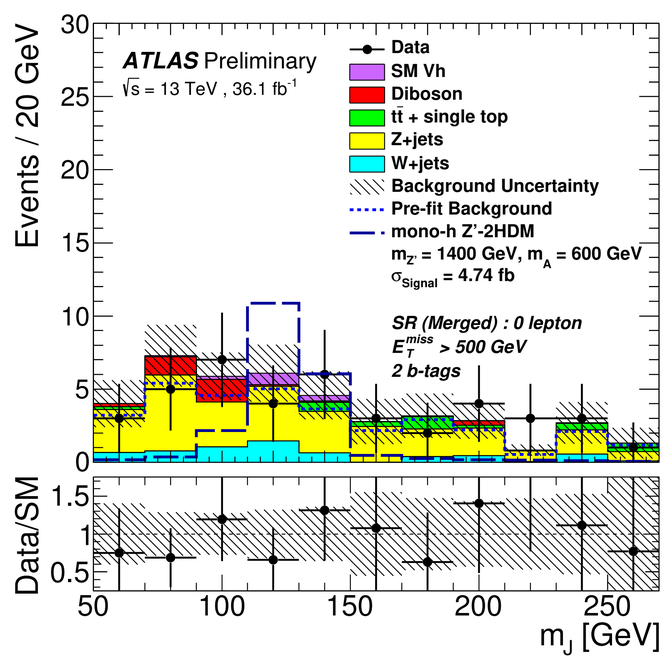
Results

Good agreement on the discriminating variables (m_{jj}/m_J) is observed between the data and the background simulation in all channels.

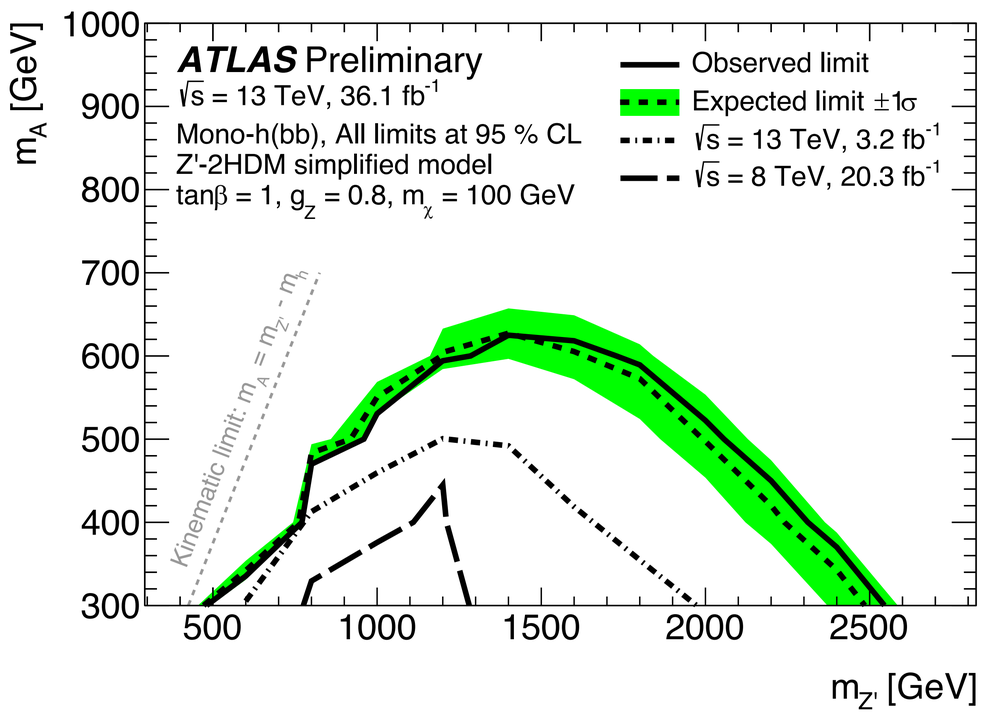








The final results are interpreted in the context of a Z'-2HDM signal model. The combined fit of the model to the data is based on the mass of Higgs Boson candidate through a binned likelihood function.



Upper limits are also set on the visible production cross-section $\sigma_{vis,h+MET}$ of $h + MET$ events per E_T^{miss} bin at the detector level without extra model assumptions. Here, $\sigma_{vis,h+MET} \equiv \sigma_{,h+MET} \times BR(h \rightarrow b\bar{b}) \times \mathcal{A} \times \varepsilon$, where $\mathcal{A}$ represents the kinematic acceptance and ε accounts for the experimental efficiency.

Range in E_T^{miss}/GeV	$\sigma^{obs}_{vis,h+MET}$ [fb]	$\sigma^{exp}_{vis,h+MET}$ [fb]	$\mathcal{A} \times \varepsilon$ %
[150, 200)	19.1	$18.3^{+7.2}_{-5.1}$	15
[200, 350)	13.1	$10.5^{+4.1}_{-2.9}$	35
[350, 500)	2.4	$1.7^{+0.7}_{-0.5}$	40
[500, ∞)	1.7	$1.8^{+0.7}_{-0.5}$	55

[1] A. Berlin, T. Lin and L.-T. Wang, Mono-Higgs detection of dark matter at the LHC, JHEP 06 (2014) 078, arXiv: 1402.7074 [hep-ph].
[2] 2016 mono-Hbb Run 2 Paper, arXiv: 1609.04572 [hep-ex].
[3] 2017 mono-Hbb Run 2 CONF Note, ATLAS-CONF-2017-028, 2016, https://cds.cern.ch/record/2259066.