COMBINATION OF SEARCHES FOR INVISIBLE HIGGS BOSON DECAYS WITH THE ATLAS DETECTOR
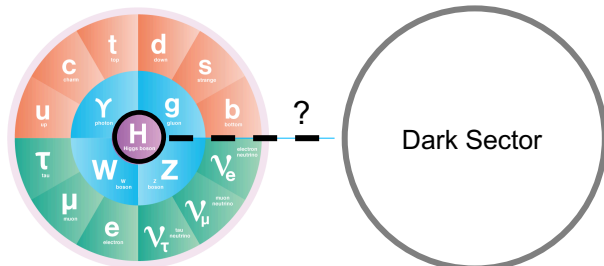
LHCC Poster Session – CERN, 27 February 2019

Input channels
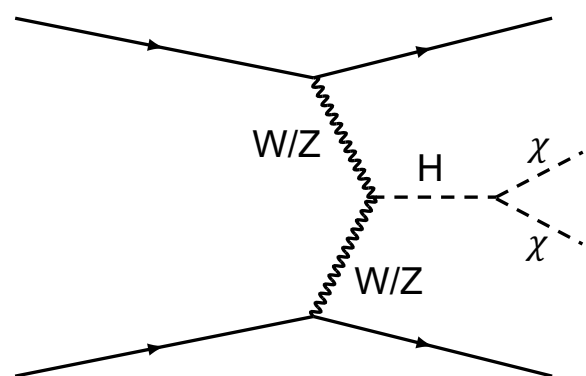
Vector-Boson-Fusion [1]

Z(→leptons)H [2]

V(→hadrons)H [3]

Introduction

- ❑ Searching for invisible decays of the Higgs boson
- ❑ Standard Model: BR ~10^{-3} via $H \to ZZ^* \to 4\nu$
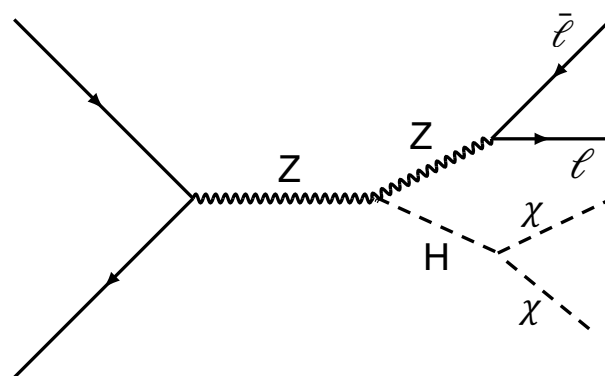- ❑ Higgs-Portal models connect Higgs boson to Dark Sector

Vector-Boson-Fusion

- ❑ Two R=0.4 anti-k_t jets, $|\Delta\eta_{jj}| > 4.8$
- ❑ $E_T^{miss} > 180$ GeV
- ❑ Main backgrounds: $Z(\nu\nu)$+jets and $W(l\nu)$+jets
- ❑ Background control regions for normalization
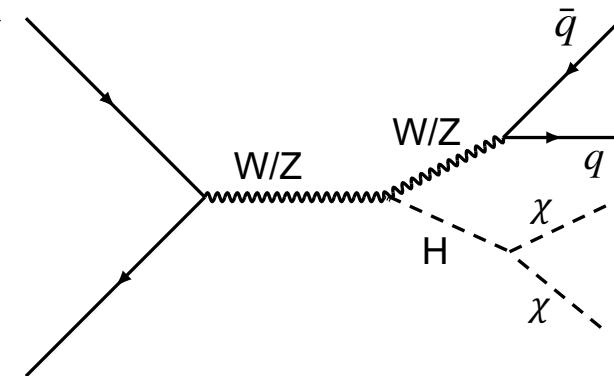- ❑ Main uncertainties: MC statistics, JES and V+jets modelling

Z(→leptons)H

- ❑ Pair of electrons or muons consistent with m_Z
- ❑ $E_T^{miss} > 90$ GeV and b-jet veto
- ❑ $Z(\nu\nu)Z(ll)$ estimated from MC, normalized to theoretical prediction
- ❑ $W(l\nu)Z(ll)$ estimated from MC, normalized by scale factor from control region
- ❑ Z+jets estimated via ABCD method on data

V(→hadrons)H

- ❑ Split into resolved and merged regime
- ❑ $E_T^{miss} > 150$ (resolved) and > 250 GeV (merged)
- ❑ Different b-tagging categories
- ❑ Main backgrounds are V+jets and ttbar
- ❑ MC predictions constrained with control regions containing one or two charged leptons
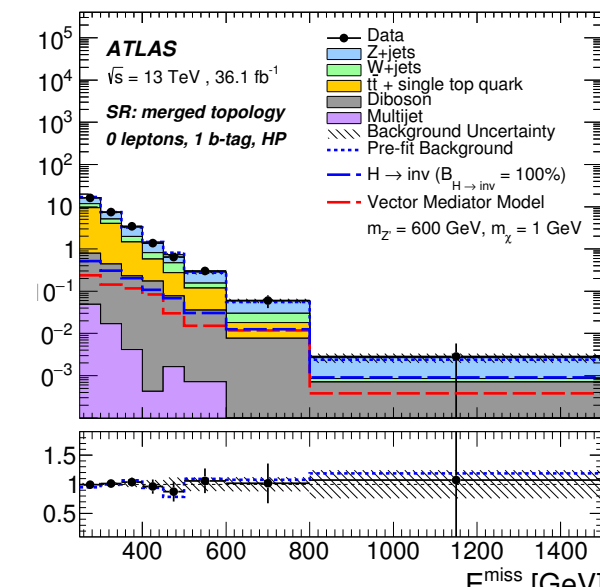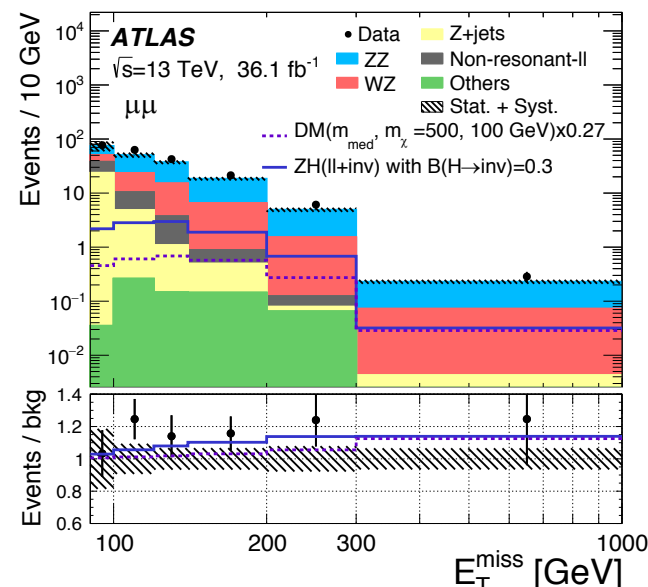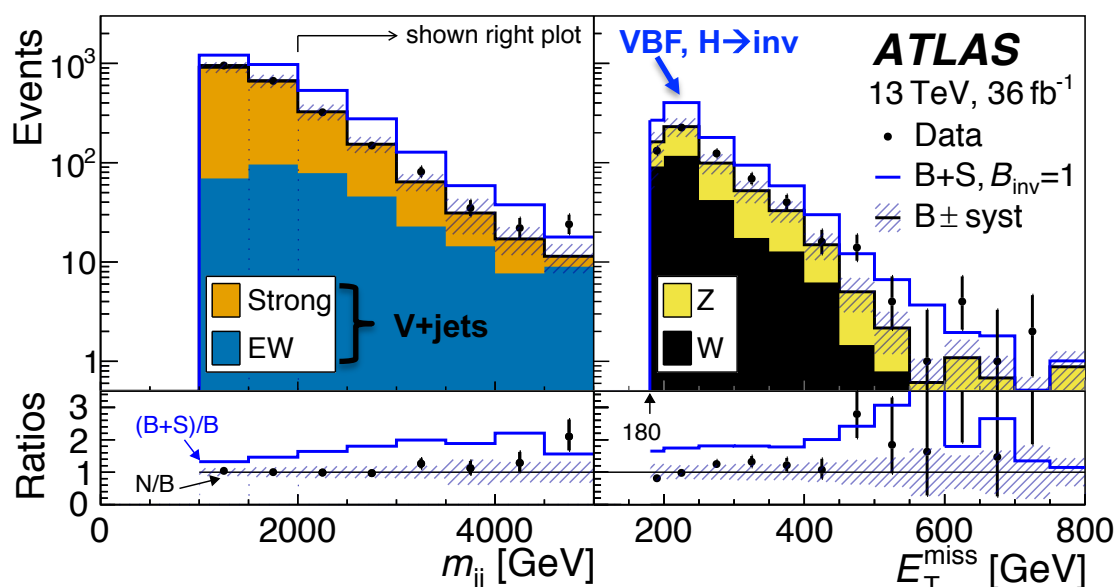
Methodology

- ❑ **Statistical combination** of Run 2 analyses and the Run 1 combination [4]
- ❑ Performing **combination of likelihoods**
- ❑ Common systematics are **correlated** across channels
- ❑ **Profile likelihood ratio** used as test statistic
- ❑ Limits on the BR at 95% confidence level set with the **CLs technique** based on the asymptotic approximation
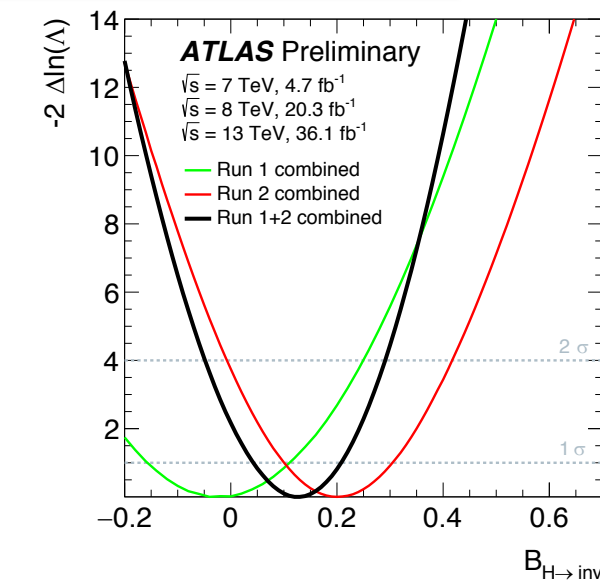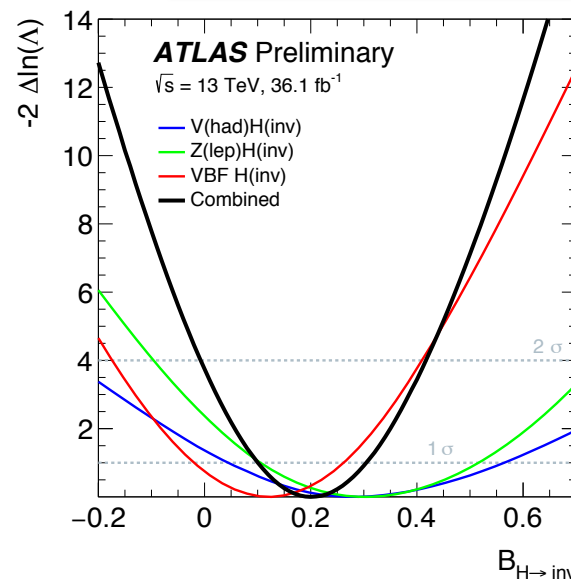
Correlation model

- ❑ **Correlated systematics** include:

  ➤ **Run 2:**
  - ○ Luminosity
  - ○ Muon + electron systematics
  - ○ Jets
  - ○ PDF uncertainty on signal
  - ○ QCD scale uncertainty on signal (VH and ZH)
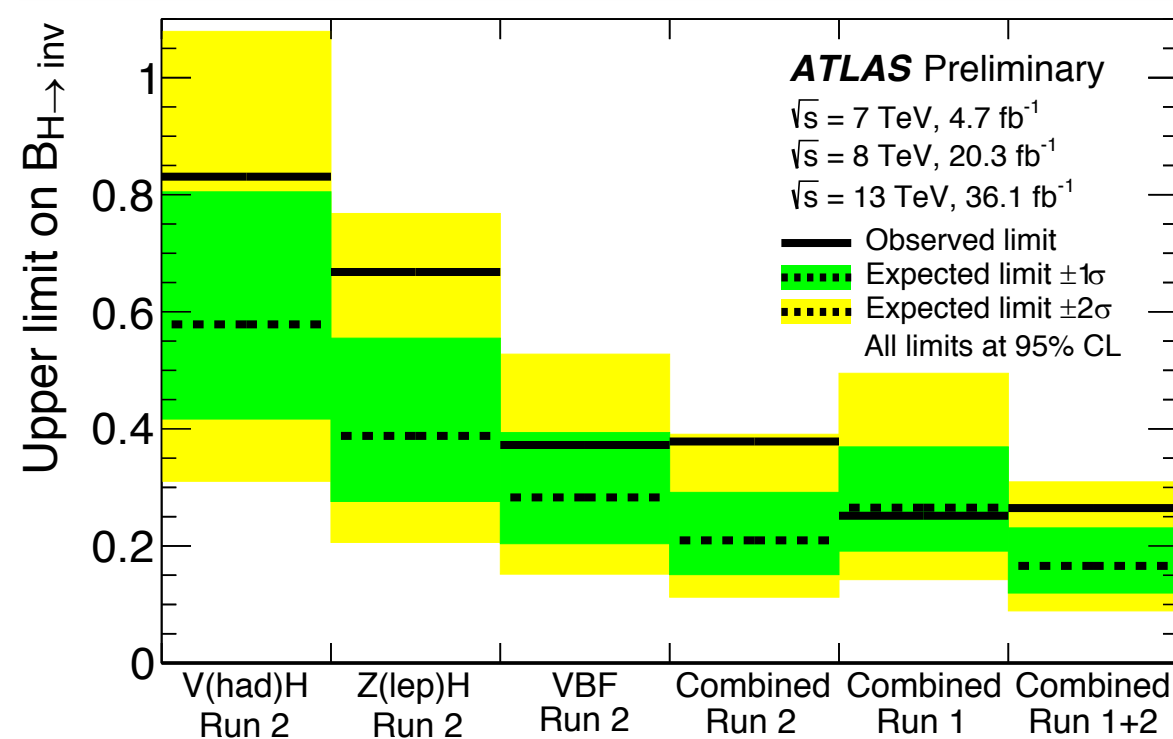
  ➤ **Run 1+2:**
  - ○ Parton shower modelling uncertainty for VH
  - ○ Missing higher order corrections for ZH
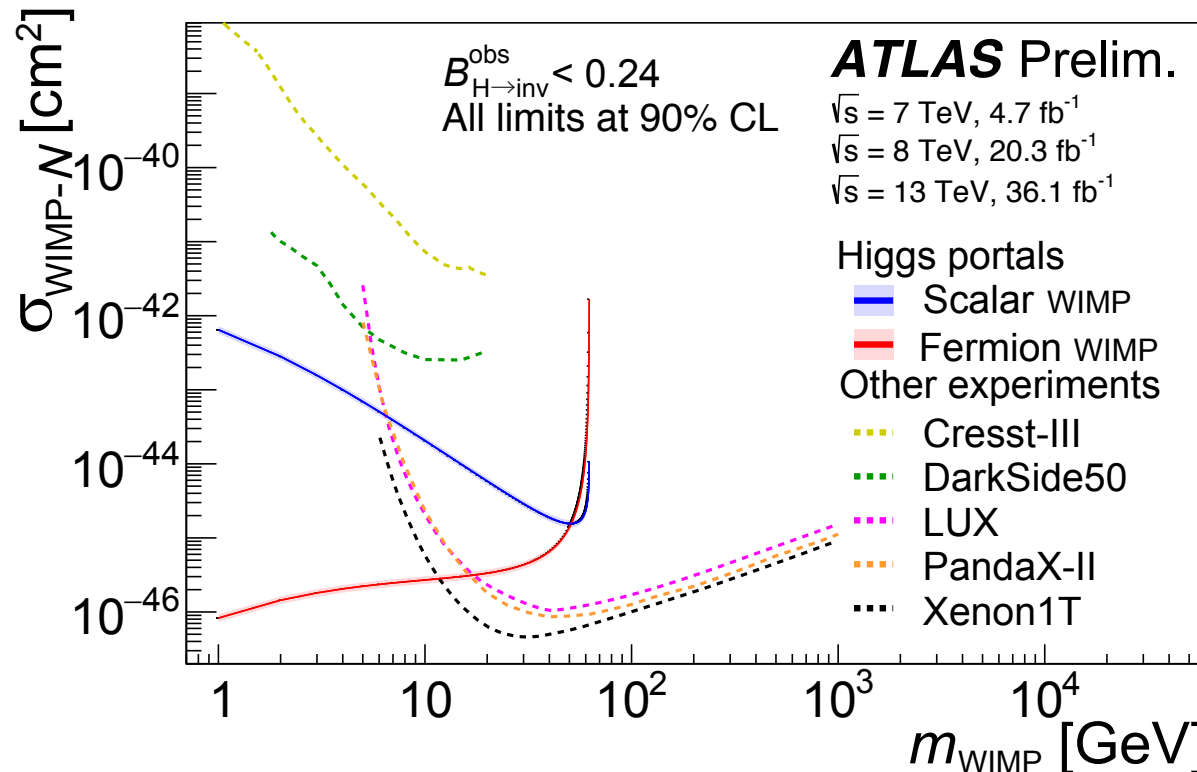 - ○ Uncertainty on the jet multiplicity for VBF

Likelihood Scans

$BR(H \to inv) < 0.26\ (0.17^{+0.07}_{-0.05})$ observed (expected) at 95% CL [5]

Comparison to Direct Detection

[1] arXiv: 1809.06682
[2] Phys. Lett. B 776 (2018) 318, arXiv: 1708.09624
[3] JHEP 10 (2018) 180, arXiv: 1807.11471
[4] JHEP 11 (2015) 206, arXiv: 1509.00672
[5] ATLAS-CONF-2018-054

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