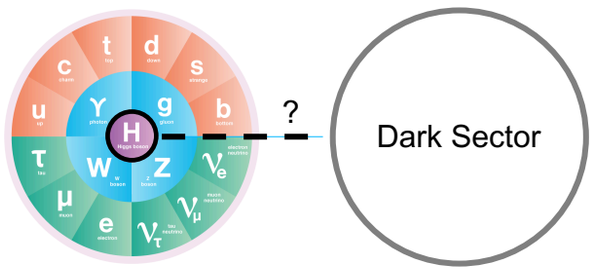
Searching for Invisible decays of the SM Higgs boson with the ATLAS detector at $\sqrt{s} = 13$ TeV

Interpreting the LHC Run 2 Data and Beyond – ICTP Trieste, 29 May 2019

Introduction

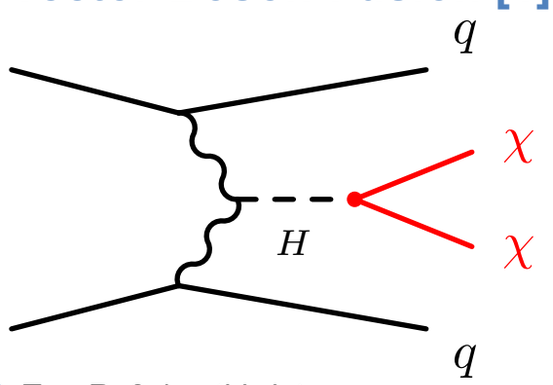
- Search for **invisible decays** of the Higgs boson
- SM $B_{H\to inv} \approx 10^{-3}$ via $H \to ZZ^* \to 4\nu$



- Interpretable in the framework of **Higgs-Portal** models as **decays to WIMP** candidates for particle Dark Matter

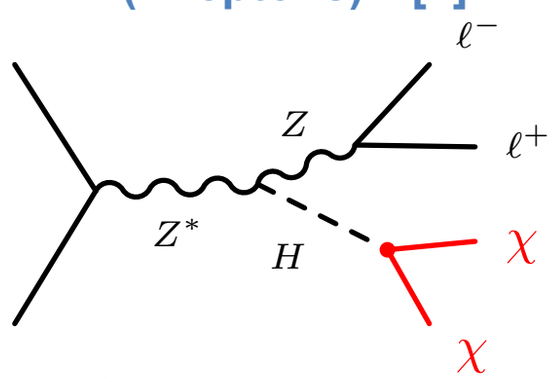
Dedicated searches for different signal topologies

Vector-Boson-Fusion [1]



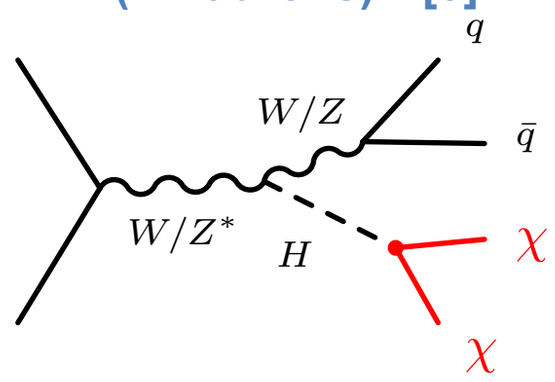
- Two R=0.4 anti-k_t jets
- $m_{jj} > 1$ TeV and $|\Delta\eta_{jj}| > 4.8$
- E_T^{miss} > 180 GeV and lepton veto
- Main backgrounds: $Z(\nu\nu)$+jets and $W(l\nu)$+jets
- CRs containing one or two charged leptons for normalization
- Limited by MC statistics, jet energy scale and V+jets modelling

Z(→leptons)H [2]

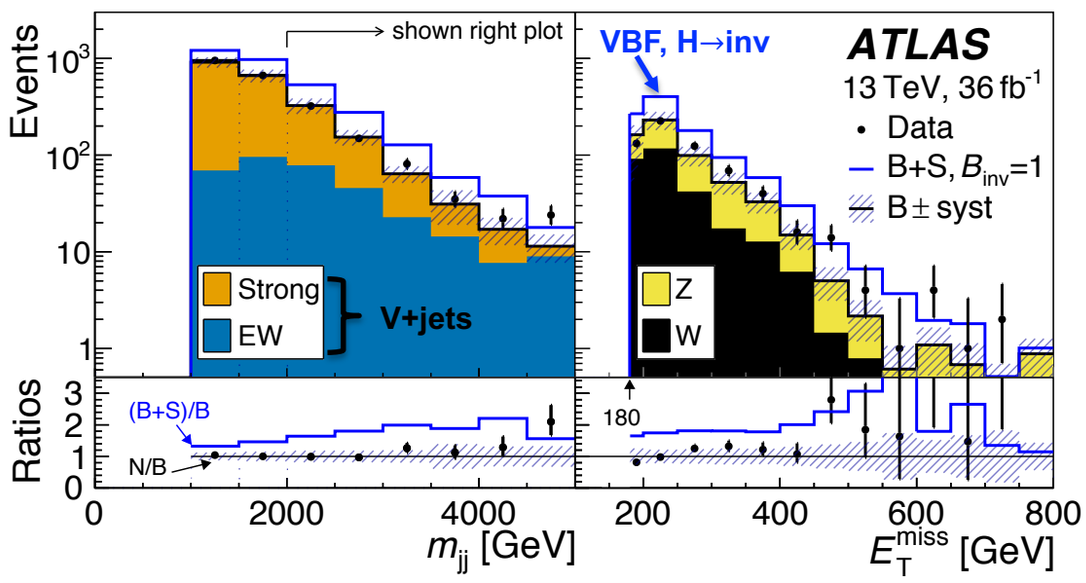


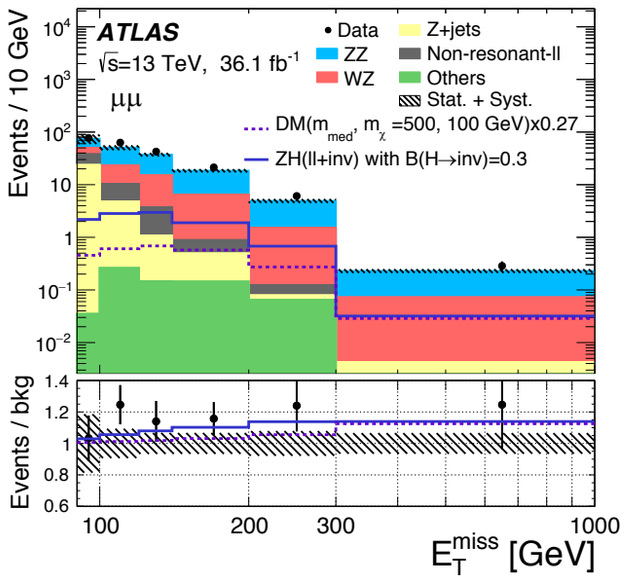
- Pair of electrons or muons consistent with m_Z
- E_T^{miss} > 90 GeV and b-jet veto
- $Z(\nu\nu)Z(ll)$ estimated from MC, normalized to theory prediction
- $W(l\nu)Z(ll)$ estimated from MC, normalized by scale factor from CR
- Z+jets from data via sideband fit method
- Limited by statistics and ZZ modelling

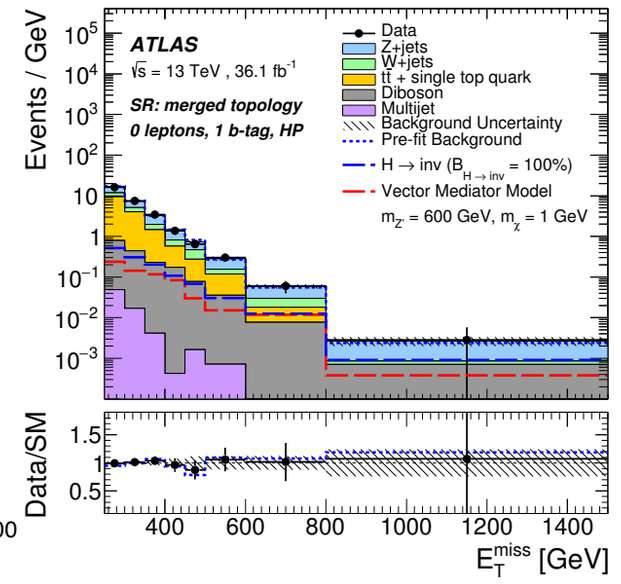
V(→hadrons)H [3]



- Resolved (≥ 2 R=0.4 jets) and merged (≥ 1 R=1.0 jets) regimes, using anti-k_t
- E_T^{miss} > 150 GeV resolved and > 250 GeV merged, lepton veto
- b-tagging categories
- Main backgrounds: V+jets and ttbar
- MC predictions constrained with CRs containing one or two charged leptons
- Limited by Jet/Lepton systematics and MC statistics

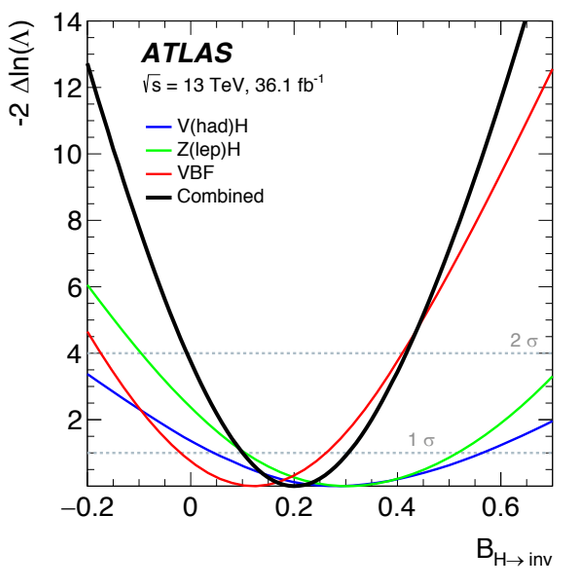


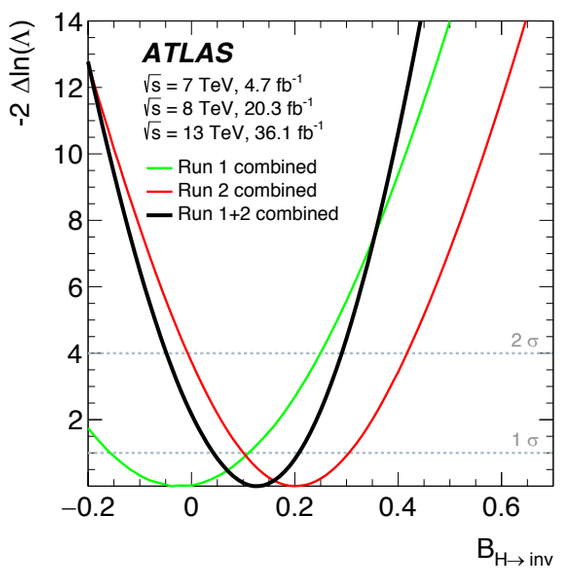




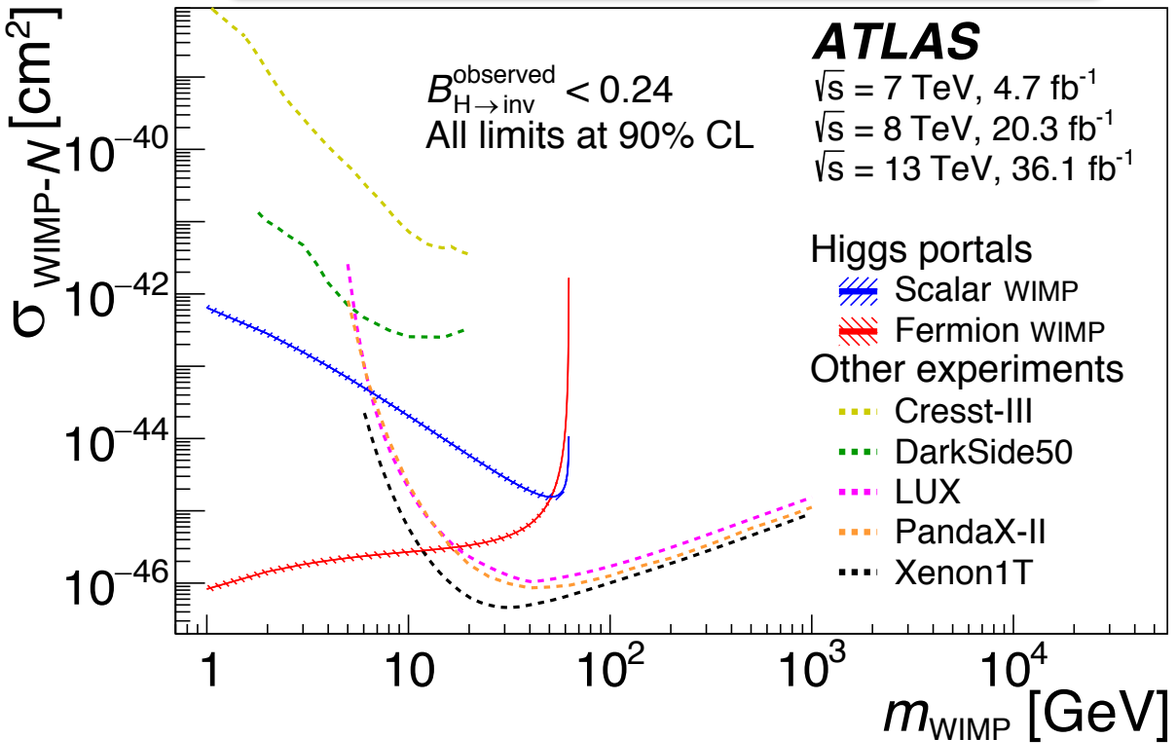
Statistical combination [5]: $B_{H\to inv} < 0.26\ (0.17^{+0.07}_{-0.05})$ observed (expected) at 95% CL

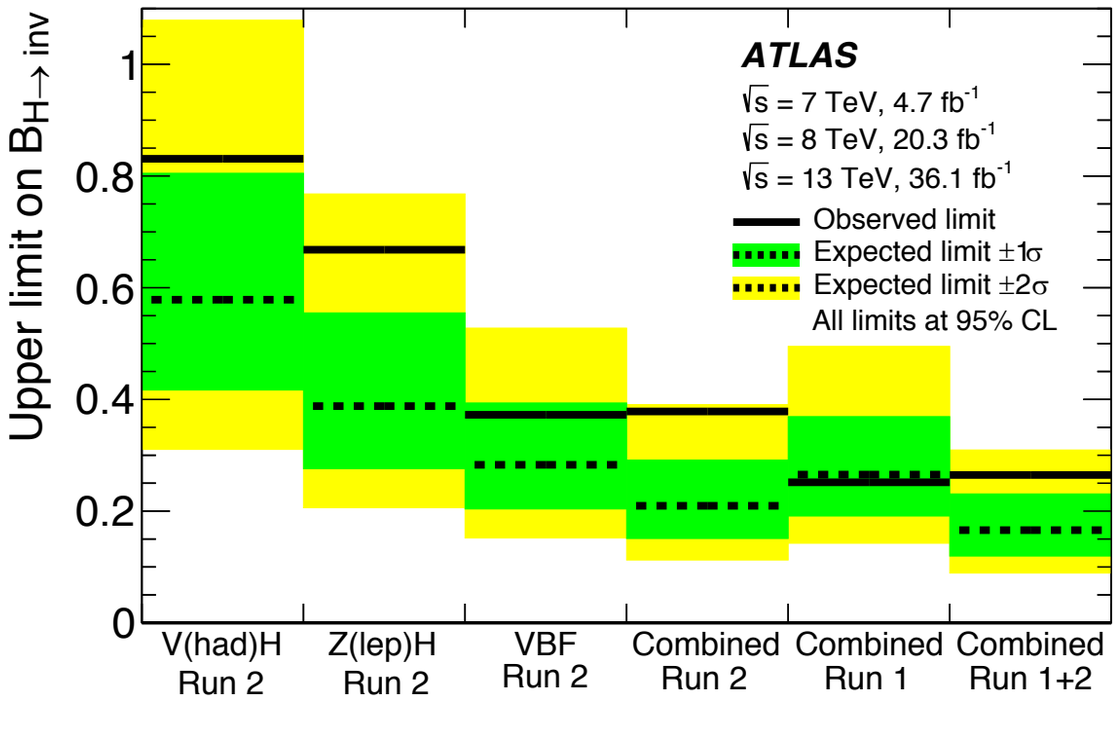
- **Statistical combination** of the Run 2 analyses with 36 fb^{-1}, and further with the Run 1 combination [4]
- Performed by constructing the **product of input analyses likelihoods**
- Common **systematics are correlated** across analyses
- **Compatibility**
  - with SM: ρ_{SM} = 0.1
  - Between individual Runs: 1.5σ
- Limit setting via **CL_S** technique
- **Limiting systematic** uncertainties:
  - reconstruction and calibration of leptons and jets
  - available MC statistics
  - Background modelling, mainly of V+jets
- Result will **improve with more data**, analyses using full Run 2 dataset started!





Comparison to Direct Detection





[1] Phys. Lett. B (2019) , 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] arXiv:1904.05105, accepted by PRL

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