ICHEP 2020 Poster Session [ATLAS-CONF-2020-007]

Measurement of Higgs boson production at high momentum in the VH, H→bb channel with the ATLAS detector

Novel analysis using boosted Higgs boson reconstruction techniques

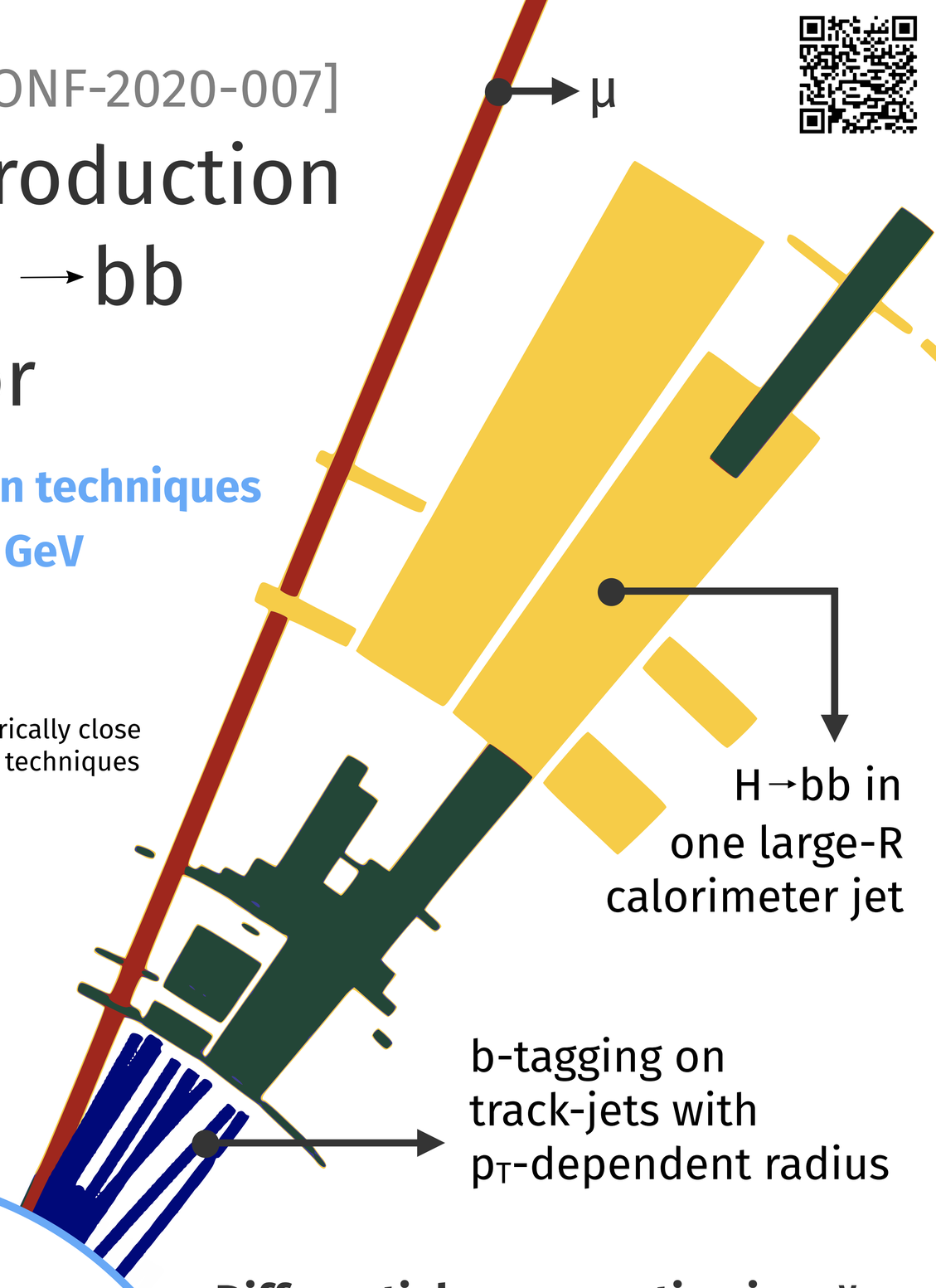
First direct measurement of VH production for p_T^V > 400 GeV

Motivation

Many BSM models predict deviations ~ (energy scale)^2

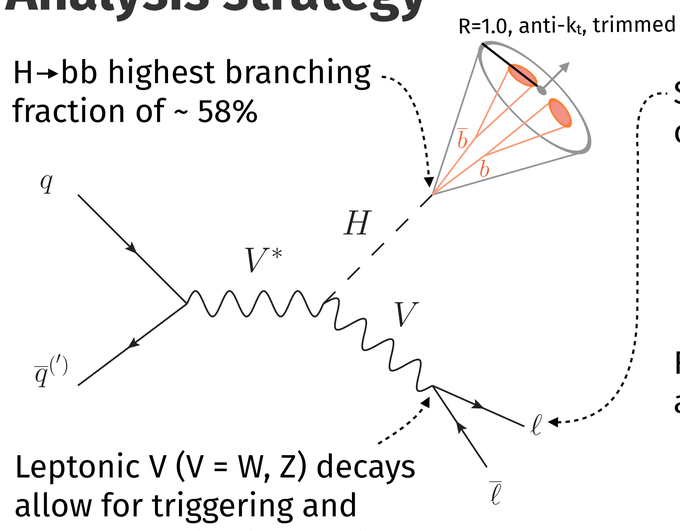
Relative contribution of qq→VH w.r.t. other production modes rises with p_T^{Higgs}

High p_T Higgs bosons
→ decay products geometrically close
→ boosted reconstruction techniques



Analysis strategy

H→bb highest branching fraction of ~ 58%



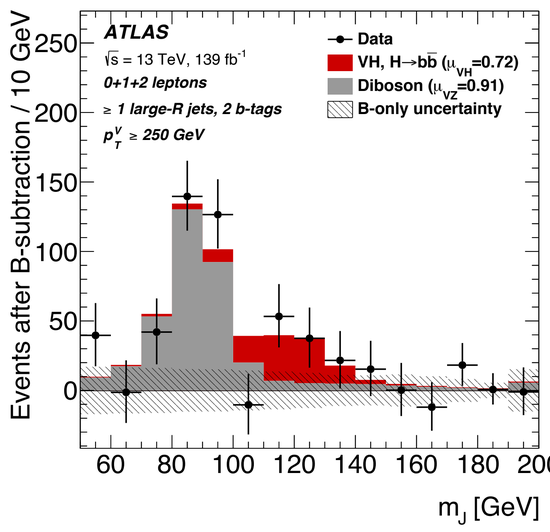
Leptonic V (V = W, Z) decays allow for triggering and to suppress backgrounds

Sub-channels according to number of charged leptons (e or μ)

0-lepton: Z→νν
1-lepton: W→ℓν
2-lepton: Z→ℓℓ

Fit the large-R jet mass m_J in 10 signal and 4 control regions

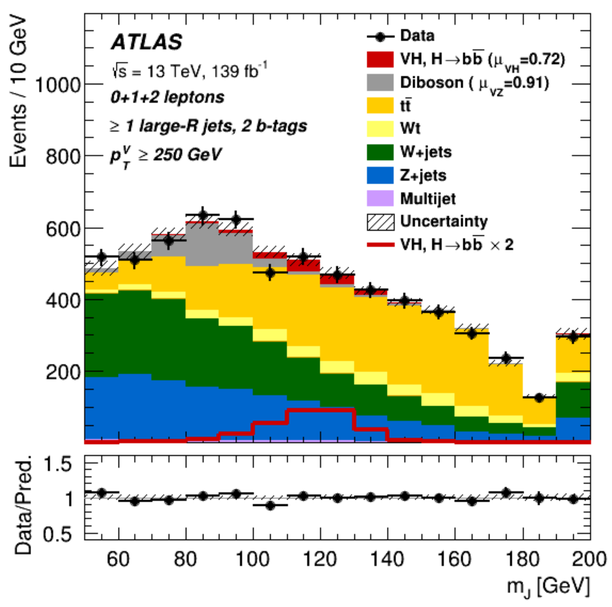
Results



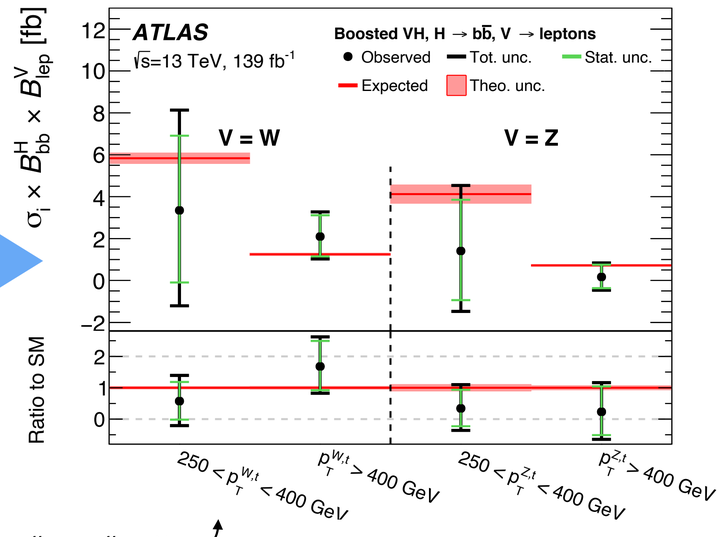
Simultaneously extract **VH(bb)** and **VZ(bb)** signal:

$\mu_{VZ}^{bb} = 0.91 \pm 0.15(\text{stat.})^{+0.25}_{-0.17}(\text{syst.})$ with $Z_{\text{obs}} = 5.2\sigma$

$\mu_{VH}^{bb} = 0.72^{+0.29}_{-0.28}(\text{stat.})^{+0.26}_{-0.22}(\text{syst.})$ with $Z_{\text{obs}} = 2.1\sigma$

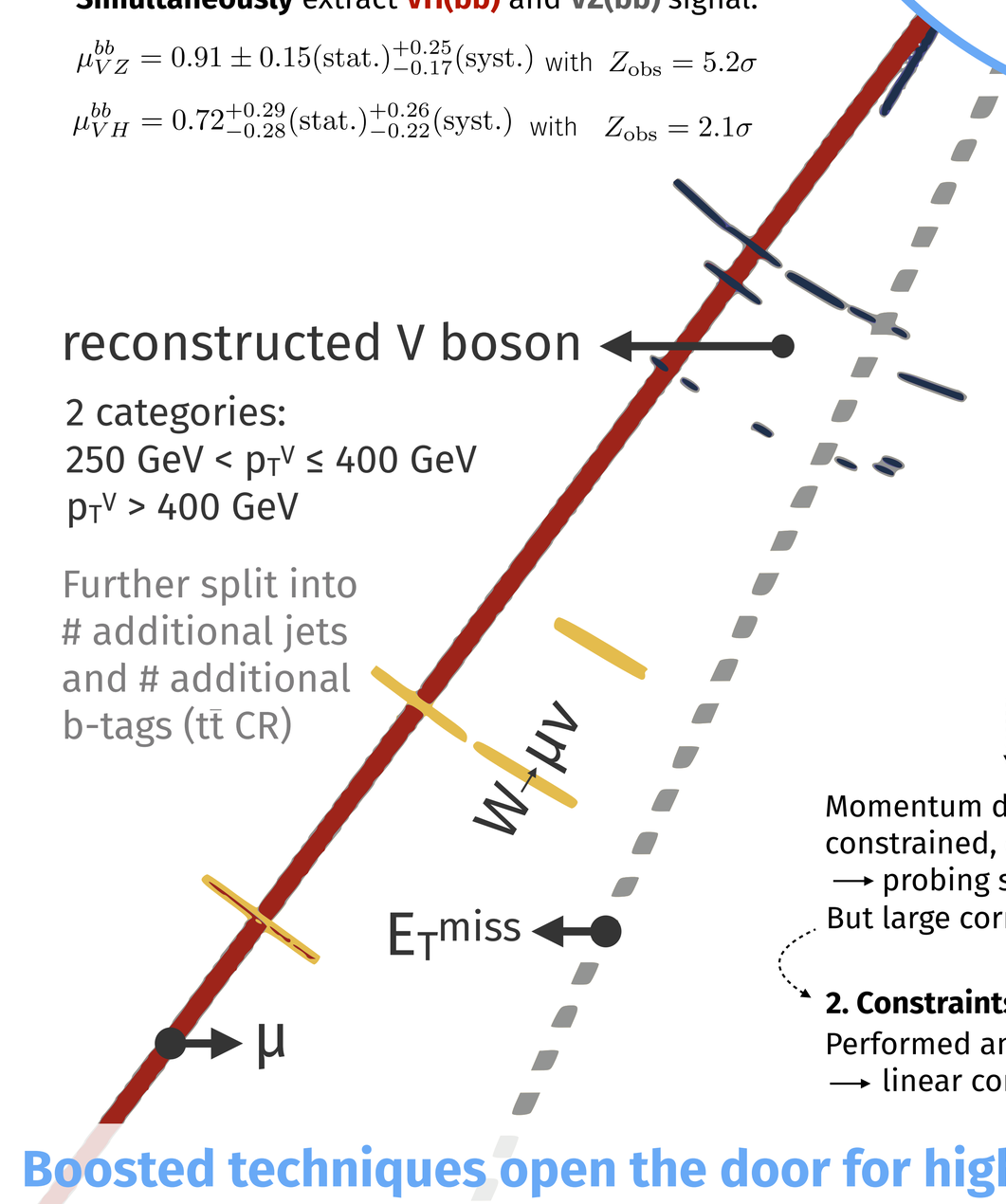


large-R jet mass



"true" p_T^V

Differential cross-section in p_T^V



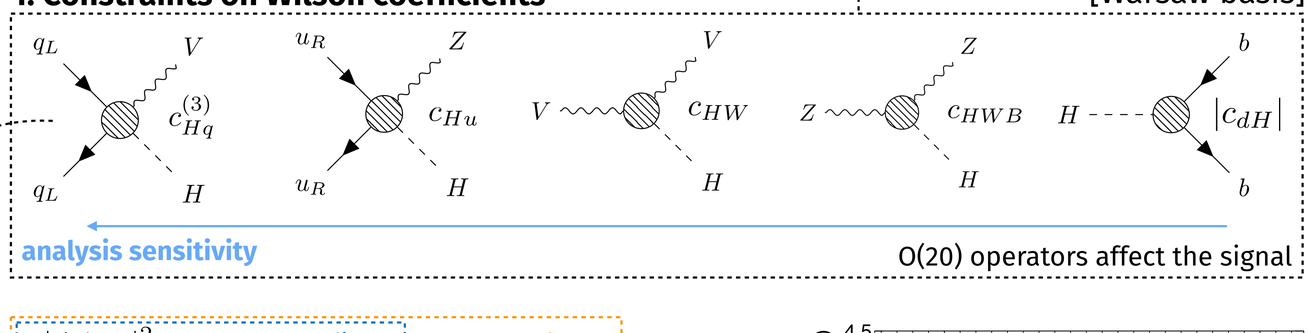
Effective Field Theory Interpretation

Wilson coefficients = free parameters

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \frac{1}{\Lambda}\mathcal{L}_5 + \frac{1}{\Lambda^2}\sum_i c_i \mathcal{O}_i^{(\text{dim}=6)} + \frac{1}{\Lambda^3}\mathcal{L}_7 + \frac{1}{\Lambda^4}\mathcal{L}_8 + \dots$$

Suppression scale of new physics

1. Constraints on Wilson coefficients [Warsaw basis]



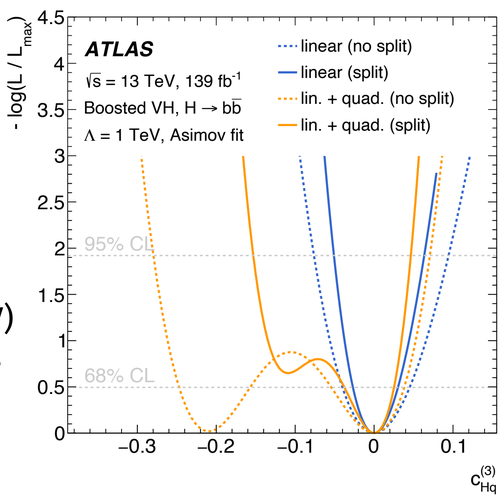
analysis sensitivity

O(20) operators affect the signal

$$\sigma \sim \underbrace{|\mathcal{M}_{\text{SM}}|^2}_{\text{linear}} + \underbrace{2\frac{c}{\Lambda^2}\text{Re}(\mathcal{M}_{\text{SM}} \times \mathcal{M}_{\text{BSM}})}_{\text{linear + quadratic}} + \underbrace{\frac{c^2}{\Lambda^4}|\mathcal{M}_{\text{BSM}}|^2}_{\text{linear + quadratic}}$$

Momentum dependent operators highly constrained, e.g. $c_{Hq}^{(3)}$ < 0.06 @ 95% CL
→ probing scales up to Λ ~ 4 TeV
But large correlations between coefficients

Differential measurement (split at 400 GeV) improves limits by factor 2



2. Constraints on Eigen-directions

Performed an Eigenvector-decomposition
→ linear combinations of coefficients that are orthogonal on data

Boosted techniques open the door for high energies and set tight constraints on p_T-dependent effects

Brian Moser (Nikhef) for the ATLAS collaboration
brian.moser@cern.ch